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1301-N and 1325-N Liquid Waste Disposal Facilities Limited Field Investigation Report

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EXECUTIVE SUMMARY

This report summarizes results of the 1301-N and 1325-N Liquid Waste Disposal Facilities limited field investigation (LFI) and qualitative risk assessment (QRA). Efforts have focused on providing information to support decisions regarding both immediate and long-term remedial actions for the protection of human health and the environment. Site investigation data, site conceptual model refinement, and evaluation of potential threats to human health and groundwater resources have been presented in this report.

The 1301-N and 1325-N facilities are former liquid waste disposal sites in the 100-NR-1 Operable Unit (OU) at Hanford's 100-N Area. These facilities received radioactive effluent discharges along with some hazardous wastes. The facilities are classified as Treatment, Storage and Disposal Facilities under the *Resource Conservation and Recovery Act of 1976* (RCRA). Hazards are being addressed by an integrated cleanup strategy under the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1990) signed by the Washington State Department of Ecology, U.S. Environmental Protection Agency, and the U.S. Department of Energy (Tri Parties).

The purposes of this LFI project as established by the Tri Parties were to supplement previous field investigations, verify historical information, and provide the necessary information to the Tri Parties so they can address the following two objectives:

1. Determine if immediate action on soil at 1301-N and/or 1325-N is required to protect groundwater.

2. Determine if, for the long-term, soil remediation is required to protect groundwater from a future potential impact, and, if so, when remediation should be performed.

The LFI field activities included borehole drilling, sampling, and geophysical logging to investigate the contaminant and moisture distribution in soil beneath the 1301-N and 1325-N facilities. Previous studies provided considerable information on near-surface contamination and subsurface conditions at some distance from the facilities. Three new boreholes (199-N-107A, 199-N-108A, and 199-N-109A) were drilled at the facilities. Borehole 199-N-107A was drilled within the 1301-N crib, while boreholes 199-N-108A and 199-N-109A were drilled immediately adjacent to the 1301-N trench and 1325-N crib, respectively. Soil removed from the boreholes was surveyed in the field for radioactivity. Vadose zone soils were sampled and submitted for physical, chemical, and radiological laboratory analysis. Downhole geophysical techniques were used to measure gamma-ray emitting contaminants, soil density, and moisture distribution. In addition to the new boreholes, four existing wells were also geophysically logged. They included 199-N-35, 199-N-45, 199-N-67 and Research Well No. 1.

Field investigations showed soil contaminant concentrations were highest near the base of the facilities, and decreased dramatically with depth. Principal radionuclides were the same at

1301-N and 1325-N. They included cobalt-60, cesium-137, strontium-90, and plutonium-239/240. Of these, strontium-90 was detected throughout the vadose zone. Although information was gathered pertaining to four inorganic metals, only chromium was consistently found at concentrations of potential concern. Vadose zone moisture profiles at each facility showed soil pore spaces were well below saturation.

The LFI data have provided updated information on soil contaminant distribution. Results have confirmed the prior conceptualization of contaminant distribution. Data from new boreholes has been combined with existing data for use in the QRA.

The QRA has supplemented an earlier 100-NR-1 OU QRA by focusing on project-specific objectives. Risk to human receptors from potential direct soil exposure was confirmed, and impact to groundwater assessed.

Potential direct exposure risk to humans is high due to radionuclide inventory in the surface sediments and shallow subsurface soils at each facility. Two human exposure scenarios were considered in the QRA: a rural-residential scenario and a recreational scenario.

The concentrations of cobalt-60, cesium-137, and strontium-90 in the vadose zone will decay to undetectable levels prior to reaching groundwater. However, plutonium-239/240 is predicted to reach groundwater after several hundred thousand years. Additionally, chromium may migrate from the soil to the groundwater, but uncertainty exists regarding its properties and travel time.

Based on the results presented in this report and previous studies, primarily the 100-NR-1 LFI and QRA, the 1301-N and 1325-N facilities should remain on the interim remedial measure pathway.

CONTENTS

1.0 INTRODUCTION 1-1
1.1 PURPOSES AND OBJECTIVES 1-2
1.2 SCOPE 1-2
1.3 REPORT ORGANIZATION 1-2
1.4 RFI/CMS PROCESS FOR 1301-N AND 1325-N 1-3
1.4.1 1301-N/1325-N RFI/CMS Process to Date 1-3
1.4.2 Future 1301-N/1325-N RFI/CMS Process 1-5
1.5 BACKGROUND 1-5
1.5.1 N Reactor Operations and Effluent 1-5
1.5.2 1301-N and 1325-N Operation and Design 1-6
1.6 SECTION SUMMARY 1-8

2.0 INVESTIGATIVE APPROACH 2-1
2.1 FIELD WORK 2-1
2.1.1 Borehole Drilling 2-1
2.1.2 Geophysical Borehole Logging 2-2
2.1.3 Sample Collection 2-3
2.2 SAMPLE ANALYSIS 2-4
2.2.1 Physical Properties Testing 2-4
2.2.2 Radionuclide/Metals Analysis 2-4
2.3 DATA VALIDATION 2-4
2.4 INVESTIGATION SUMMARY 2-5

3.0 INVESTIGATION RESULTS 3-1
3.1 GENERAL HYDROGEOLOGY OF 1301-N AND 1325-N 3-1
3.2 1301-N RESULTS 3-3
3.2.1 Geology 3-3
3.2.2 Soil Samples 3-4
3.2.3 Geophysical Logging 3-7
3.2.4 Field Screening 3-8
3.2.5 Surface Radiation Measurements 3-8
3.3 1325-N RESULTS 3-9
3.3.1 Geology 3-9
3.3.2 Soil Samples 3-9
3.3.3 Geophysical Logging 3-11
3.3.4 Field Screening 3-11
3.3.5 Surface Radiation Measurements 3-12
3.4 RESULTS OF OTHER INVESTIGATIONS 3-12
3.5 SUMMARY OF RESULTS 3-13

4.0 CONTAMINATION DISTRIBUTION, TRANSPORT, AND FATE IN THE VADOSE ZONE 4-1
4.1 CONTAMINANTS OF CONCERN AND DATA INVENTORY 4-1
4.1.1 Contaminant Characteristics 4-2
4.1.2 Contaminant Distribution in the Vadose Zone 4-3
4.2 SOURCE-TERM CHARACTERISTICS 4-7
4.2.1 Water Source Term 4-7
4.2.2 Contaminant Source Term 4-8
4.3 HYDROGEOLOGIC CHARACTERISTICS 4-8
4.3.1 Geology 4-8
4.3.2 Hydrostratigraphy 4-9
4.3.3 Hydrology 4-9
4.3.4 Volumetric Moisture Content Moisture Retention in the Vadose Zone 4-10
4.4 WATER MOVEMENT FROM LWDFS AND EFFECTS ON CONTAMINANT DISTRIBUTION 4-11
4.4.1 Lateral Movement of Water 4-11
4.4.2 Drainage after Operations 4-11
4.4.3 Recharge 4-12
4.4.4 Strontium-90 Concentration and Resaturation of the Lower Vadose Zone 4-13
4.5 Summary and Conclusions 4-14

5.0 QUALITATIVE RISK ASSESSMENT 5-1
5.1 INTRODUCTION 5-1
5.1.1 Purpose and Approach 5-1
5.1.2 Previous Risk Assessments 5-3
5.2 OVERVIEW OF THE QRA APPROACH 5-3
5.2.1 Risk to Humans 5-4
5.2.2 Impact to Groundwater 5-4
5.3 DATA EVALUATION 5-5
5.4 EXPOSURE ASSESSMENT 5-6
5.4.1 Contaminant Sources 5-7
5.4.2 Receptors and Exposure Routes 5-8
5.5 RISK AND IMPACT EVALUATION 5-9
5.5.1 Evaluation of the Risk to Humans from Potential Exposure to Contaminants in Surface Sediments and Shallow Subsurface Soils (Zone A) 5-9
5.5.2 Evaluation of the Magnitude of a Driving Force and the Impact to Groundwater (Zones A, B, & C) 5-11
5.6 WATER TABLE FLUCTUATION IMPACTS ON CONTAMINANT MIGRATION 5-16
5.7 SUMMARY OF THE QRA 5-16

6.0 CONCLUSIONS 6-1
6.1 SUMMARY OF RESULTS 6-1
6.2 OTHER CONSIDERATIONS 6-2
6.3 CONCLUSION 6-2

7.0 REFERENCES 7-1

APPENDICES

A 1301-N AND 1325-N ANALYTICAL DATA ..... A-i
B GEOLOGIC DATA FOR 1301-N AND 1325-N ..... B-i
C TRAVEL TIME METHODOLOGY AND RESULTS ..... C-i
D RESRAD CALCULATIONS ..... D-i

FIGURES

1-1. Hanford Site and 100-N Area 1-9
1-2. Location of 1301-N and 1325-N and Adjacent Wells and Boreholes 1-10
1-3. 100-N Area Consolidated Corrective Action 1-11
1-4. September 1995 Aerial View of N-Area Structures 1-12
2-1. New Boreholes and Existing Wells Used in This LFI Report 2-7
2-2. Depths of Samples at Boreholes 2-8
3-1. 1301-N Cross Sections with Depths and Elevations 3-14
3-2. 1325-N Cross Sections with Depths and Elevations 3-15
3-3. Locations of Stratigraphic Cross Sections 3-16
3-4. Stratigraphic Cross-Section A-A' 3-17
3-5. Stratigraphic Cross-Section B-B' 3-18
3-6. Stratigraphic Cross-Section C-C' 3-19
3-7. Stratigraphic Cross-Section D-D' 3-20
3-8. Summary Log for Borehole 199-N-107A 3-21
3-9. Summary Log for Borehole 199-N-108A 3-23
3-10. Radionuclide Contamination with Depth, Borehole 199-N-107A 3-25
3-11. Radionuclide Contamination with Depth, Borehole 199-N-108A 3-26
3-12. Cobalt-60 and Cesium-137 for Wells 199-N-67 and RW#1 3-27
3-13. Borehole 199-N-107A Porosity and Moisture Log 3-28
3-14. Borehole 199-N-108A Porosity and Moisture Log 3-29
3-15. 1301-N Trench Surface Measurements 3-30
3-16. Summary Log for Borehole 199-N-109A 3-31
3-17. Radionuclide Contamination with Depth, Borehole 199-N-109A 3-33
3-18. Cobalt-60 in 199-N-35 and 199-N-45 3-34
3-19. Borehole 199-N-109A Porosity and Moisture Log 3-35
3-20. 1325-N Surface Radiation Measurements 3-36

4-1. LFI Site Conceptual Model 4-16
4-2. Mass Balance Calculation for Cobalt-60 4-17
4-3. Mass Balance Calculation for Cesium-137 4-18
4-4. Mass Balance Calculation for Plutonium-239/240 4-19
4-5. Mass Balance Calculation for Strontium-90 4-20
4-6. Average Daily Discharge Rate by Year to 1301-N and 1325-N 4-21
4-7. December 1994 Water Table (a) and Maximum Height of Operational-Era Water Table (b). 4-22
4-8. Maximum Change in Height of Water Table between Operations and Post-Operations (a) and Perspective View of Maximum Water Table and Post-Operations Water Table (shown in cutaway view) (b) 4-23
4-9. Moisture Characteristic Curves for a Clean Sand and a Clean Gravel 4-24
4-10. Comparison of Hanford and Ringold Moisture Characteristic Curves to those of a Clean Sand and a Clean Gravel 4-25
4-11. Comparison between Water Levels and Strontium-90 Concentrations in Well 199-N-67 4-26
5-1. Conceptual Site Model with Zones A, B, and C 5-18
5-2. Cross-Sections A to A' and B to B' 5-19
5-3. Cross-Section A to A' with Cobalt-60 Concentrations by Depth 5-20
5-4. Cross-Section A to A' with Cesium-137 Concentrations by Depth 5-21
5-5. Cross-Section A to A' with Strontium-90 Concentrations by Depth 5-22
5-6. Cross-Section A to A' with Plutonium-239/240 Concentrations by Depth 5-23
5-7. Cross-Section A to A' with Cadmium Concentrations by Depth 5-24
5-8. Cross-Section A to A' with Chromium Concentrations by Depth 5-25
5-9. Cross-Section A to A' with Lead Concentrations by Depth 5-26
5-10. Cross-Section A to A' with Nickel Concentrations by Depth 5-27
5-11. Cross-Section B to B' with Cobalt-60 Concentrations by Depth 5-28
5-12. Cross-Section B to B' with Cesium-137 Concentrations by Depth 5-29
5-13. Cross-Section B to B' with Strontium-90 Concentrations by Depth 5-30
5-14. Cross-Section B to B' with Plutonium-239/240 Concentrations by Depth 5-31
5-15. Cross-Section B to B' with Cadmium Concentrations by Depth 5-32
5-16. Cross-Section B to B' with Chromium Concentrations by Depth 5-33
5-17. Cross-Section B to B' with Lead Concentrations by Depth 5-34
5-18. Cross-Section B to B' with Nickel Concentrations by Depth 5-35
5-19. Travel Times for Water and Cobalt-60 from the Bottom of 1301-N Crib to Groundwater (199-N-107A) 5-36
5-20. Travel Times for Water and Cesium-137 from the Bottom of 1301-N Crib to Groundwater (199-N-107A) 5-37
5-21. Travel Times for Water and Strontium-90 from the Bottom of 1301-N Crib to Groundwater (199-N-107A) 5-38
5-22. Travel Times for Water and Plutonium-239/240 from the Bottom of 1301-N Crib to Groundwater (199-N-107A) 5-39
5-23. Travel Times for Water and Cobalt-60 from the Bottom of 1301-N Trench to Groundwater (199-N-108A) 5-40

5-24. Travel Times for Water and Cesium-137 from the Bottom of 1301-N Trench to Groundwater (199-N-108A) 5-41
5-25. Travel Times for Water and Strontium-90 from the Bottom of 1301-N Trench to Groundwater (199-N-108A) 5-42
5-26. Travel Times for Water and Plutonium-239/240 from the Bottom of 1301-N Trench to Groundwater (199-N-108A) 5-43
5-27. Travel Times for Water and Cobalt-60 from the Bottom of 1325-N Crib to Groundwater (199-N-109A) 5-44
5-28. Travel Times for Water and Cesium-137 from the Bottom of 1325-N Crib to Groundwater (199-N-109A) 5-45
5-29. Travel Times for Water and Strontium-90 from the Bottom of 1325-N Crib to Groundwater (199-N-109A) 5-46
5-30. Travel Times for Water and Plutonium-239/240 from the Bottom of 1325-N Crib to Groundwater (199-N-109A) 5-47

TABLES

1-1. Summary of Data Quality Objectives and Criteria for 1301-N and 1325-N 1-13
2-1. Analytical Parameters and Methods 2-9
3-1. Conversion of Feet to Meters 3-37
3-2. 199-N-107A Analytical Data from the Quanterra Laboratory 3-38
3-3. 199-N-108A Analytical Data from the Quanterra Laboratory 3-39
3-4. 199-N-107A Analytical Screening Data from the 222-S Laboratory 3-40
3-5. 199-N-108A Analytical Screening Data from the 222-S Laboratory 3-41
3-6. 199-N-108A Physical Properties Data 3-42
3-7. 199-N-109A Analytical Data from the Quanterra Laboratory 3-43
3-8. 199-N-109A Analytical Screening Data from the 222-S Laboratory 3-44
3-9. 199-N-109A Physical Properties Data 3-45
4-1. Form and Speciation of Radionuclides 4-27
4-2. Radionuclide Bulk Distribution Coefficients 4-28
4-3. Comparison between Laboratory Measured Moisture Content and Estimated Moisture Content from Characteristic Curves 4-29
5-1. Sediment Data from the 1325-N Crib (CS-01 to CS-12) and the 1301-N Trench (TS-01 to TS-09). Original and Decayed Concentrations with Summary Statistics for Decayed Concentrations 5-48
5-2. Original and Decayed Concentrations of the Risk-Driver Radionuclides from the LFI Boreholes 5-50
5-3. Original and Decayed Concentrations of the Risk-Driver Radionuclides from the Pump-and-Treat Wells and the Near-River Borehole 5-52
5-4. Mean and 95% UCL Concentrations (pCi/g) of the Risk-Driver Radionuclides in Surface Sediments from the 1301-N Trench and the 1325-N Crib (Decayed to April 1, 1996) 5-55

5-5. Maximum Concentrations (pCi/g) of the Risk-Driver Radionuclides in Soil by Depth from the LFI Boreholes -- 107A, 108A, and 109A (Decayed to April 1, 1996) 5-56
5-6. Single Radionuclide Soil Concentrations in the Year 2010 Corresponding to a 15 mrem/yr Dose Rate for the Rural-Residential and Recreational Scenarios 5-58
5-7. Comparison of the 95% UCL Concentrations (pCi/g) of the Risk-Driver Radionuclides in Surface Sediments from the 1301-N Trench and the 1325-N Crib with Single Radionuclide Soil Concentrations (pCi/g) in the Year 2010 Corresponding to a 15 mrem/yr Dose Rate 5-59
5-8. Comparison of the Maximum Concentrations (pCi/g) of the Risk-Driver Radionuclides in Shallow Subsurface Soils (Zone A) from the LFI Boreholes with Single Radionuclide Soil Concentrations (pCi/g) in the Year 2010 Corresponding to a 15 mrem/yr Dose Rate 5-60
5-9. Comparison of the Maximum Concentrations (mg/kg) of Metals in Soil from the LFI Boreholes with Hanford Background Values (mg/kg), Practical Quantitation Limits (mg/kg), and MTCA Cleanup Levels (mg/kg) 5-61
5-10. Distribution Coefficients, Retardation Factors, and Half-Lives for the Risk-Driver Radionuclides 5-62
5-11. Travel Times to the 1995 Water Table with a Recharge Rate of 2 cm/yr 5-63
5-12. Comparison of Times of Decay to the Detection Limit (1 pCi/g) with Travel Times to the Water Table for Maximum Concentrations of the Risk-Driver Radionuclides 5-64
5-13. Input Parameters Used in the Summer's Model to Evaluate Chromium Impact to Groundwater 5-65
5-14. Estimated Concentrations (ug/L) of Chromium in Groundwater Using Different Mixing Zone Widths and Distribution Coefficients 5-66

ABBREVIATIONS AND ACRONYMS

ALARA	as low as reasonably achievable
bgs	below ground surface
CMS	corrective measures study
DOE	U.S. Department of Energy
DOW	description of work
DQO	data quality objective
EAL	Environmental Analytical Laboratory
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ERA	expedited response action
HPPS	*Hanford Past Practice Strategy*
HSRAM	Hanford Site Risk Assessment Methodology
ICR	incremental cancer risk
IRM	interim remedial measure
LFI	limited field investigation
LWDF	Liquid Waste Disposal Facility
MCL	maximum concentration level
MSL	mean sea level
MTCA	*Model Toxics Control Act*
OU	operable unit
PAM	portable alpha monitor
PNNL	Pacific Northwest National Laboratory
QAPP	Quality Assurance Project Plan
QRA	qualitative risk assessment
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	Radiological Control Technician
RESRAD	RESidual RADioactivity
RL	U.S. Department of Energy, Richland Operations Office
RLS	radionuclide logging system
RW	research well
SwRI	Southwest Research Institute
TPA	Tri-Party Agreement
TSD	Treatment, Storage, and Disposal
UCL	upper confidence limit
WHC	Westinghouse Hanford Company

PREFACE

This report summarizes the results of the 1301-N and 1325-N Liquid Waste Disposal Facility limited field investigation (LFI) and qualitative risk assessment (QRA) to meet the Tri-Party Agreement (TPA) Milestone M-15-12A. This LFI report differs from previous 100-Area LFIs for the following reasons:

- It contains the risk assessment that has previously been written as a separate document.
- It does not determine if an interim remedial measure (IRM), expedited response action (ERA), or LFI are warranted since 1301-N and 1325-N are already on the IRM pathway.
- It has a different purpose and objectives.

The purposes of this LFI project as established by the Tri Parties were to supplement previous field investigations, verify historical information, and provide the necessary information to the Tri Parties so they can address the following two objectives:

1. Determine if immediate action on soil at 1301-N and/or 1325-N is required to protect groundwater.
2. Determine if, for the long-term, soil remediation is required to protect groundwater from a future potential impact, and, if so, when remediation should be performed.

1.0 INTRODUCTION

This report summarizes the results of the 1301-N and 1325-N Liquid Waste Disposal Facility (LWDF) limited field investigation (LFI) and qualitative risk assessment (QRA) to meet the TPA Milestone M-15-12A. The 1301-N and 1325-N facilities (Figures 1-1 and 1-2) that are the targets of this LFI, are classified as Treatment, Storage, and Disposal (TSD) Facilities under the *Resource Conservation and Recovery Act of 1976* (RCRA). These facilities made use of the vadose zone to remove radioactive and hazardous materials from effluent that was discharged to them from the N Reactor. They were assigned by the Washington State Department of Ecology (Ecology), the U.S. Environmental Protection Agency (EPA), and the U.S. Department of Energy (DOE), Richland Operations Office (RL), known as the Tri Parties, as high-priority sites for potential remediation because of the contamination that is present in the vadose zone and groundwater.

This LFI report differs from previous 100-Area LFIs for the following reasons:

- It contains the risk assessment that has previously been written as a separate document.
- It supplements previous work that has placed 1301-N and 1325-N on an interim remedial measure action pathway.
- It has a different purpose and objectives.

The QRA is included in this report because it contains the vital information necessary to address the objectives of this LFI project. A discussion of the site conceptual model has been added to LFI to provide the link between the results of the field investigation and the assessment of risk.

Tri Parties designated the 1301-N and 1325-N facilities as high-priority sites because of contamination present in soil and groundwater. This designation, coupled with negotiations by the Tri Parties, placed these facilities on the IRM pathway. In addition, the 1992 LFI for the 100-NR-1 Operable Unit (OU) recommended that these facilities remain on the IRM pathway. Consequently, the focus of this project is not to reiterate that 1301-N and 1325-N should remain on the IRM pathway. Rather, this project focuses on presenting data that will support decisions specific to 1301-N and 1325-N that will be negotiated among the Tri Parties.

1.1 PURPOSES AND OBJECTIVES

The purposes of this LFI project as established by the Tri Parties were to supplement previous field investigations, verify historical information, and provide the necessary information to the Tri Parties so they can address the following two objectives:

1. Determine if immediate action on soil at 1301-N and/or 1325-N is required to protect groundwater.

2. Determine if, for the long-term, soil remediation is required to protect groundwater from a future potential impact, and, if so, when remediation should be performed.

The purposes and objectives concerning this investigation were established in data quality objective workshops (BHI, 1996). Additional information about the process for this LFI appears in Section 1.4.1.3.

1.2 SCOPE

The site investigation activities for this LFI were conducted from November 1995 through January 1996 in accordance with the *Description of Work for Vadose Zone Characterization of the 1301-N and 1325-N Liquid Waste Disposal Facility* (DOE-RL, 1995a). This investigation focused on collecting and evaluating data on contaminant distribution in soil and hydrogeologic information specific to 1301-N and 1325-N. The scope of this project consisted of the following:

- Planning activities
- Performing field work
- Analyzing samples
- Evaluating and interpreting data
- Writing this LFI report.

This report does not address contamination that is already present in the groundwater. The groundwater contamination is the scope of projects for the 100-NR-2 OU and the N-Springs ERA. This report focuses only on the contamination that is present in the vadose zone at 1301-N and 1325-N and on the impact, as found during the field investigation and corresponding risk assessment, that this contamination may pose to groundwater.

1.3 REPORT ORGANIZATION

This report discusses the processes used to meet the objectives of the LFI project and to provide the results of the risk evaluation. The seven sections included in this report have been structured to provide the information necessary to understand the contaminant distribution and hydrogeologic conditions at the 1301-N and 1325-N facilities. Site investigation data,

conceptual model refinement, and evaluation of potential threats to human health and the environment have been discussed so that the Tri Parties will have the information and data necessary to address their issues and concerns about these facilities.

The seven sections of the report follow:

- Section 1.0, Introduction
- Section 2.0, Investigative Approach
- Section 3.0, Investigative Results
- Section 4.0, Site Conceptual Model
- Section 5.0, Qualitative Risk Assessment
- Section 6.0, Conclusions
- Section 7.0, References

The following appendices have been included to provide detailed scientific data that supports the results and conclusions of this LFI:

- A 1301-N and 1325-N Analytical Data
- B Geologic Data for 1301-N and 1325-N
- C Travel Time Methodology and Results
- D RESRAD Calculations

1.4 RFI/CMS PROCESS FOR 1301-N AND 1325-N

This section summarizes the RCRA facility investigation/corrective measures study (RFI/CMS) activities related to 1301-N and 1325-N. These activities were undertaken pursuant to the Tri-Party Agreement (TPA) (Ecology et al., 1990) Milestone M-15-12A, identified in the September 29, 1994, Milestone Change Request M-15-94-04. To implement the TPA, the Tri Parties developed the *Hanford Past Practice Strategy* (HPPS) (DOE-RL, 1993).

The HPPS is used to enhance the efficiency of ongoing RFI/CMS activities through the use of IRMs including 1301-N and 1325-N activities and ERAs. This strategy was used by the Tri Parties to establish 1301-N and 1325-N as high-priority waste sites on the IRM pathway. The following subsections describe the implementation of the HPPS at 1301-N and 1325-N by discussing the activities that have been undertaken while 1301-N and 1325-N have been on the IRM pathway.

1.4.1 1301-N/1325-N RFI/CMS Process to Date

The corrective action strategy for 1301-N and 1325-N is presented in Figure 1-3. The strategies for 100-NR-1, 100-NR-2, and the N-Springs ERA are also presented to show their interrelationships to 1301-N and 1325-N.

The 100-N Area was divided into two OUs: 100-NR-1 and 100-NR-2. The 100-NR-1 OU is located within the boundaries of the 100-N Area and contains physical structures, waste sites, and the Hanford Generating Plant. The 1301-N and 1325-N facilities are within the 100-NR-1 OU. The second OU, 100-NR-2, is referred to as the groundwater OU and includes 100-N Area groundwater, surface water, sediment, and aquatic biota.

1.4.1.1 100-NR-1 Work Plan (1990). Pursuant to the HPPS, the 100-NR-1 RFI/CMS Work Plan (DOE/RL-90-22) was first issued in 1990 as Draft A and established the objectives, procedures, tasks, and schedule for conducting the RFI/CMS for the 100-NR-1 OU. The current version of the work plan, Revision 0, was issued in March 1996 (DOE-RL, 1996a).

1.4.1.2 100-NR-1 LFI and QRA (1992). In 1992, an LFI was conducted for waste sites in the 100-NR-1 OU including the 1301-N and 1325-N facilities. The results were presented in two separate reports: the 100-NR-1 LFI (DOE-RL, 1995b) and 100-NR-1 QRA (BHI, 1995). The scope of the 100-NR-1 LFI included the results from soil samples collected for chemical analyses from three wells (199-N-75, 199-N-76 and 199-N-80) located more than 100 m (328 ft) away from 1301-N toward the Columbia River. Also, these wells were drilled to support the 100-NR-2 LFI.

The QRA used two sets of data to evaluate risks to human health and the environment:

1. historical sediment data collected from the top 15 cm (6 in.) of sediment at the bottom of 1301-N and 1325-N

2. limited field investigation data from 1992.

The 1992 100-NR-1 LFI summarized the results from the QRA and concluded that 1301-N and 1325-N should remain on the IRM pathway because of the indication of high risk from soil contamination and past impacts to groundwater. Because characterization information on the vadose zone at 1301-N and 1325-N was not available in 1992, the QRA did not evaluate the risk posed to groundwater by contaminants associated with the facilities. Consequently, there were no conclusions regarding protection of groundwater from soil contamination.

1.4.1.3 Present 1301-N/1325-N RFI/CMS (1996). After the 100-NR-1 LFI and QRA were concluded, the 1301-N and 1325-N LFI and QRA were conducted to meet TPA Milestone M-15-12A. This LFI provides vadose zone information to assess potential threats to groundwater resources from key contaminants. It supplements the 100-NR-1 LFI and QRA, verifies historical information, addresses the two objectives noted in Section 1.1, and meets TPA Milestone M-15-12A. The results are presented in this report.

During the planning phases for this LFI, a data quality objective (DQO) workshop for 1301-N and 1325-N was conducted. The workshop meetings were used to establish an approach to field activities so that sufficient information could be collected for the Tri Parties to address the two

objectives of this LFI. The DQO process identified the contaminants of potential concern for this investigation– a key subset of those anticipated at the facilities.

Application of the DQO process resulted in a cost-effective sampling-and-analysis plan designed to keep radiation exposures as low as reasonably achievable (ALARA) while effectively addressing the issues and concerns of the Tri Parties. The DQOs and sampling-and-analysis plan were subsequently agreed to by the Tri Parties and then incorporated into the 1301-N and 1325-N Description of Work (DOW) (DOE-RL, 1995a). The DQOs and associated criteria used in the workshop are presented in Table 1-1. Also listed in the table are documents where these objectives and criteria have been or will be addressed. Details of the DQO process have been reported in *Data Quality Objectives Workshop Results for 1301-N and 1325-N Characterization* (BHI, 1996).

1.4.2 Future 1301-N/1325-N RFI/CMS Process

The 1301-N and 1325-N facilities are on the IRM pathway and are moving toward corrective action and closure. The data from this LFI report will be used to support the evaluation of corrective measures in the 1301-N and 1325-N CMS to be submitted to Ecology March 31, 1997, in support of the TPA Milestone (M-15-12A). The CMS will include additional information about facility contaminant sources that may have contributed contaminants not evaluated as a part of this LFI. Future activities at 1301-N and 1325-N also consist of a permit modification and then implementation of corrective actions (Figure 1-3).

1.5 BACKGROUND

1301-N and 1325-N are RCRA TSD facilities located within the 100-N Area at Hanford (Figure 1-1 and 1-2). Their purpose was to dispose of effluent from N-Reactor operations. This section gives a description of the effluent discharged from N- Reactor operations, describes the history of 1301-N and 1325-N, and discusses their operation and design.

1.5.1 N Reactor Operations and Effluent

The N Reactor was different from all other reactors in the 100 Area because it was designed to be a dual-purpose reactor capable of producing special nuclear material as well as steam for electricity. While the N Reactor was operating, the following effluent streams were discharged from the N Reactor to 1301-N and 1325-N:

- reactor primary coolant water
- spent fuel storage basin cooling water
- reactor periphery systems cooling water
- reactor primary coolant loop decontamination and rinse solution, and
- miscellaneous drainage from reactor support facilities.

The effluent contaminants were primarily cobalt-60 (Co-60), cesium-137 (Cs-137), strontium-90 (Sr-90), and plutonium-239/240 (Pu-239/240). In addition, the effluent contained hazardous wastes. The estimated annual and cumulative releases of radionuclides and total amount of hazardous waste discharges to 1301-N and 1325-N are tabulated in Appendix A, Tables A7-1 and A7-2.

1.5.2 1301-N and 1325-N Operation and Design

1301-N and 1325-N made use of the vadose zone to remove radioactive and hazardous materials from the reactor operations' effluent. As discharged effluent percolated through the soil column, radioactive materials and hazardous constituents were retained in the soil through filtration, absorption, adsorption, and ion exchange. Eventually the soil's capacity to remove contaminants from the effluent was exceeded; thus some contaminants traveled to the groundwater and on to the Columbia River. Of primary concern is Sr-90 that is currently in the groundwater above the maximum concentration level (MCL) allowed by the *National Primary Drinking Water Regulations* (40 CFR 141) of 8 pCi/L. In addition, some constituents such as tritium were not retained in the soil but traveled with the effluent.

1301-N and 1325-N were renamed 116-N-1 and 116-N-3, respectively, to be consistent with facility and waste-site designations used in databases by the Hanford Environmental Restoration Program. However, the original, more recognized names, 1301-N and 1325-N, have been used in this report.

Characteristics of 1301-N and 1325-N are described below. The facilities' dimensions were taken from the most current available as-built drawings. Figure 1-4 shows a September 1995 aerial view of the area. Figures in Chapter 3 provide readers with additional elevation information and views of characteristic cross sections. A more detailed description of 1301-N and 1325-N, including associated piping, design and layout, is being prepared for the *1301-N and 1325-N Corrective Measures Study* to be issued in March 1997.

1.5.2.1 1301-N Facility. 1301-N operated from 1964 to September 1985 and had an average flow rate of 6,800 Lpm (1,800 gpm). The facility is located approximately 240 m (800 ft) from the Columbia River (Figure 1-2). The crib area is approximately 88 m (290 ft) long by 38 m (125 ft) wide and from 1.5 to 5.8 m (averaging about 10 ft) deep as measured from the top of the perimeter embankment. The bottom of the crib was filled with a 0.9 m (3 ft) layer of large boulders. In early 1981, an additional 0.6 m (2 ft) layer of cobbles was added to the top of the large boulders. A sloped soil and gravel embankment forms the walls of the crib. An underground 91 cm (36 in.) diameter main effluent line from the 105-N lift station discharged into the crib through a 16 m by 3.7 m (52 ft by 12 ft) concrete weir box. The weir box is commonly referred to as the "horse trough." Also discharging into the crib were an underground 30 cm (12 in.) diameter effluent drain line from the N Reactor basin floor drains, and a 15 cm (6 in.) diameter effluent drain line from the 109-N floor drains.

The 1301-N zigzag trench was constructed in 1965 and is 490 m (1,600 ft) by 3 m (10 ft) wide at the bottom and 3.7 m (12 ft) deep with sloped side walls. Water flowed downward from the crib to the trench. Unlike the crib, boulders and cobbles were not placed in the trench. In 1982, precast concrete panels 15 m (50 ft) wide were installed to cover the entire trench to minimize wildlife intrusion and airborne contamination. The sides of the concrete cover were backfilled and grouted. However, the gaps between each concrete panel that extends across the trench width were not grouted together, so small gaps exist between adjoining panels. Discharges to 1301-N ceased in September 1985.

1.5.2.2 1325-N Facility. The second RCRA TSD, called 1325-N, was constructed and put into operation in 1983 as a replacement to 1301-N, which had reached its disposal capacity. The decreased effectiveness of on-site soil retention of radionuclides was indicated by riverbank spring monitoring that detected radionuclide concentrations in the springwater. Between 1983 and September 1985, both 1301-N and 1325-N were in service. Piping allowed identical waste disposal at either unit. 1325-N first received N-Reactor effluent in 1983 and operated from then until 1991 when discharges ceased. It received an average flow of 1,700 Lpm (450 gpm) during its operational years and was disabled in 1993. The 1325-N is located approximately 300 m (1,000 ft) east and 61 m (200 ft) north of 1301-N (away from the Columbia River). (See Figure 1-2.)

Effluent was delivered to the 1325-N crib-header box through a 366 m (1,200 ft) long by 91 cm (36 in.) diameter pipeline. Precast concrete panels covering the below grade pipeline can be seen in Figure 1-4. A reinforced concrete header box-and- trough system distributed the effluent in the 1325-N crib. The 1325-N crib is 76 m (250 ft) by 73 m (240 ft) and has a concrete cover 3 m (10 ft) below the surrounding grade. The cover is made of precast concrete panels that are sealed with grout. Some panels have small hatches (0.61m x 0.61m) to allow inspection (or sampling) beneath the cover. The crib's soil percolation surface is 2 m (6 ft) below the cover. During an inspection of the facility in 1995, standing water was observed in the concrete distribution troughs. Some areas of soil beneath the cover were moist, but there no standing water was observed on the infiltration surface (soil).

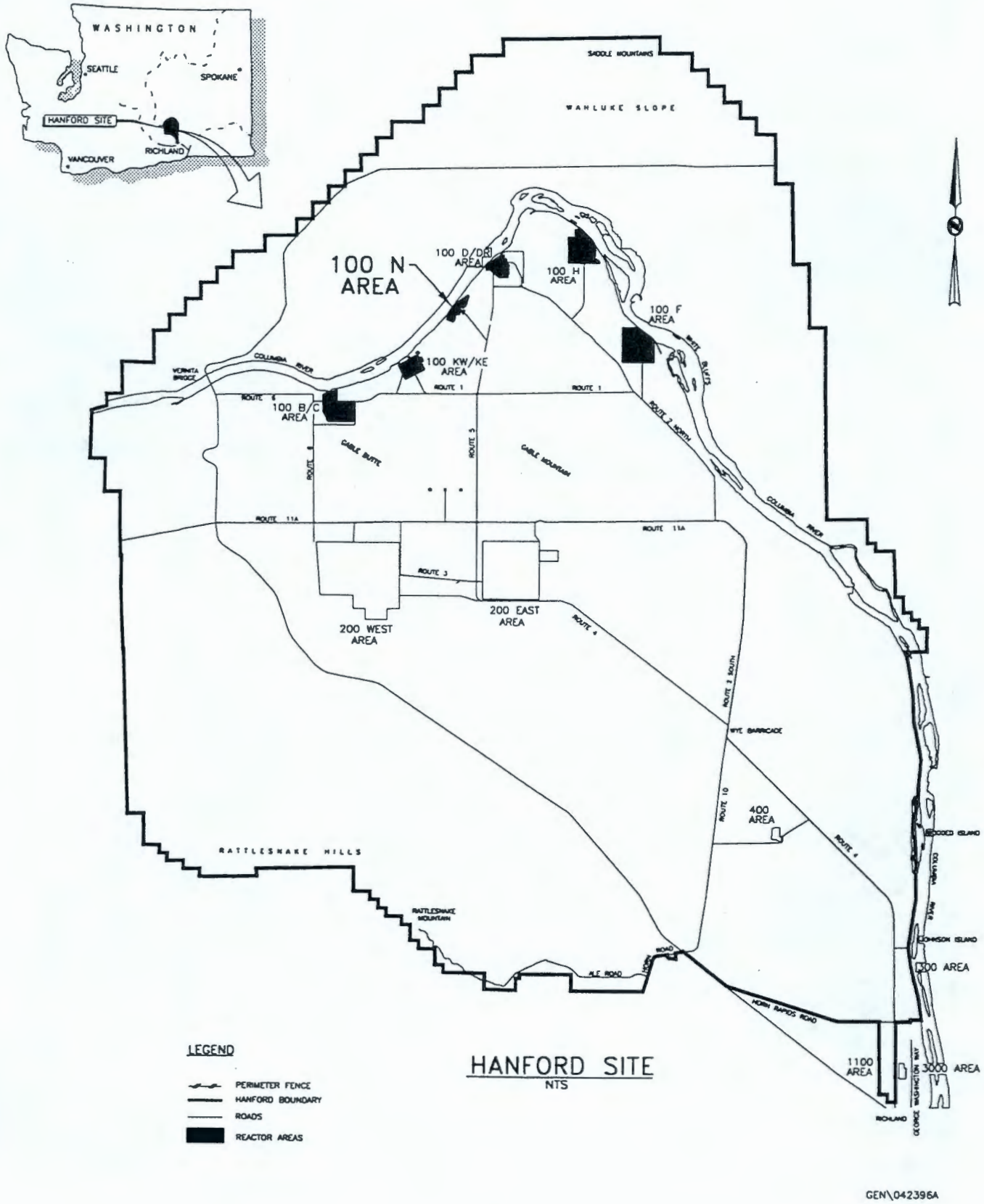
The 1325-N straight extension trench was put in full service in September 1985. It is 914 m (3,000 ft) by 16.8 m (55 ft) and is 2.7 m (9 ft) deep from the bottom of the concrete panels to the percolation surface. Only the first 226 m (740 ft) of the 1325-N trench was used; a dam located below the concrete panels blocked the remainder of the trench from receiving water. This trench is also covered with precast concrete panels placed close together but left unsealed. The panels have lifting lugs. Two centracore concrete panels measuring 0.6 m (2 ft) by 20.3 cm (8 in) were placed, unsealed, along the side of the trench. The sides of the trench were backfilled, thus creating a minimum barrier distance of 0.9 m (3 ft) for burrowing animals. The trench is divided into four equal sections by three dams that are composed of structural fill and concrete. A layer of riprap was added on the downstream side of each dam to prevent scouring. The top 0.6 m (2 ft) of the trench bottom was screened to remove fines and reduce plugging. The trench ties into the crib at two points (from the crib's northern and eastern corners) with the effluent from the points combining in a common weir box. The tie-in is composed of rubber gasket-joined,

precast, reinforced concrete box sections. From the weir box, the trench extends about 914 m (3,000 ft) in a north-northeasterly direction. Discharges to 1325-N ceased in 1993.

1.6 SECTION SUMMARY

Section 1.0 has introduced the purpose, objectives, and scope of this document. It has also described the historical background of the 1301-N and 1325-N facilities and discussed the RFI/CMS activities related to them. Section 2.0 will explain the investigative approach used to accomplish the objectives set forth in Section 1.0 of this LFI.

Figure 1-1. Hanford Site and 100-N Area



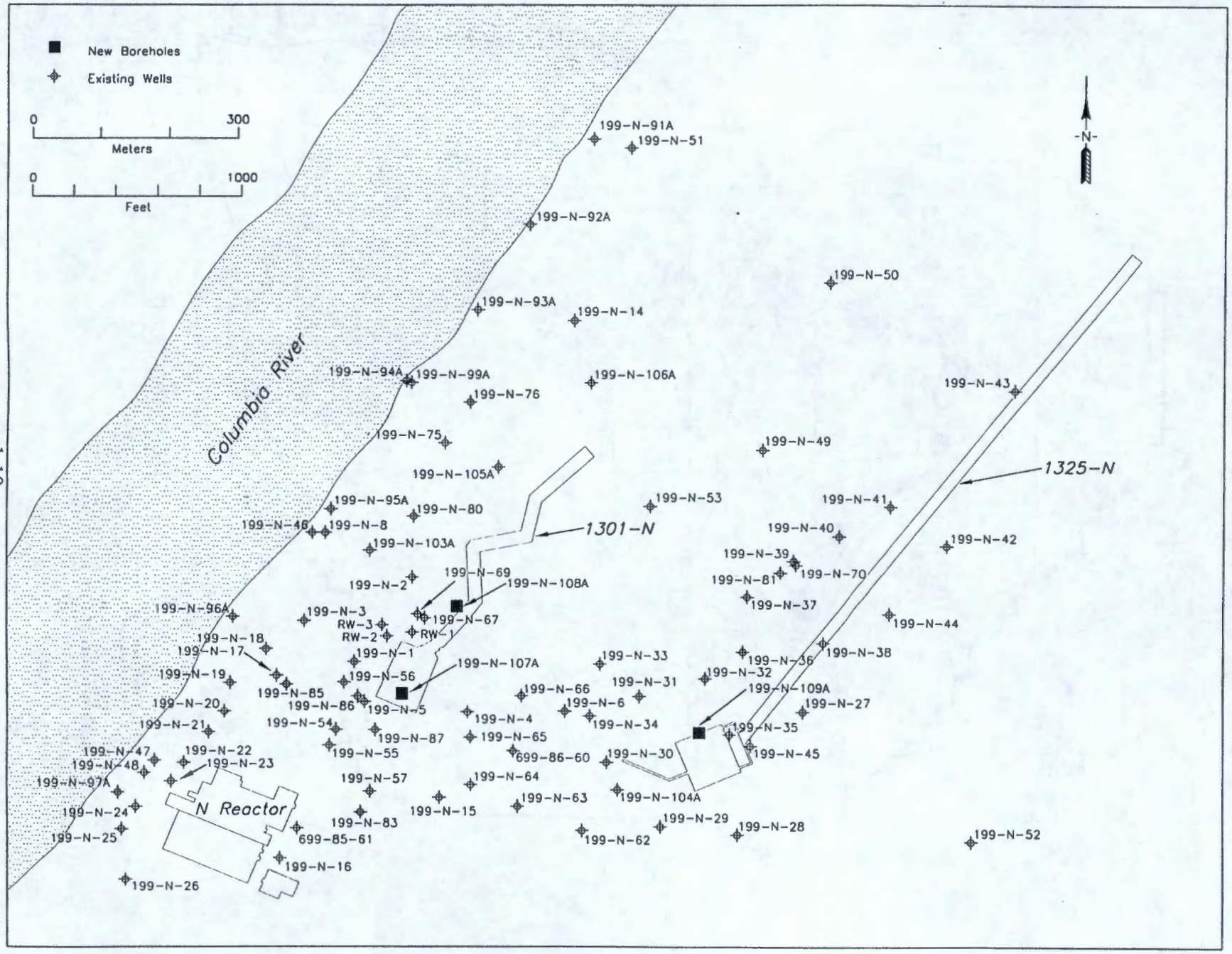


Figure 1-2. Location of 1301-N and 1325-N and Adjacent Wells and Boreholes

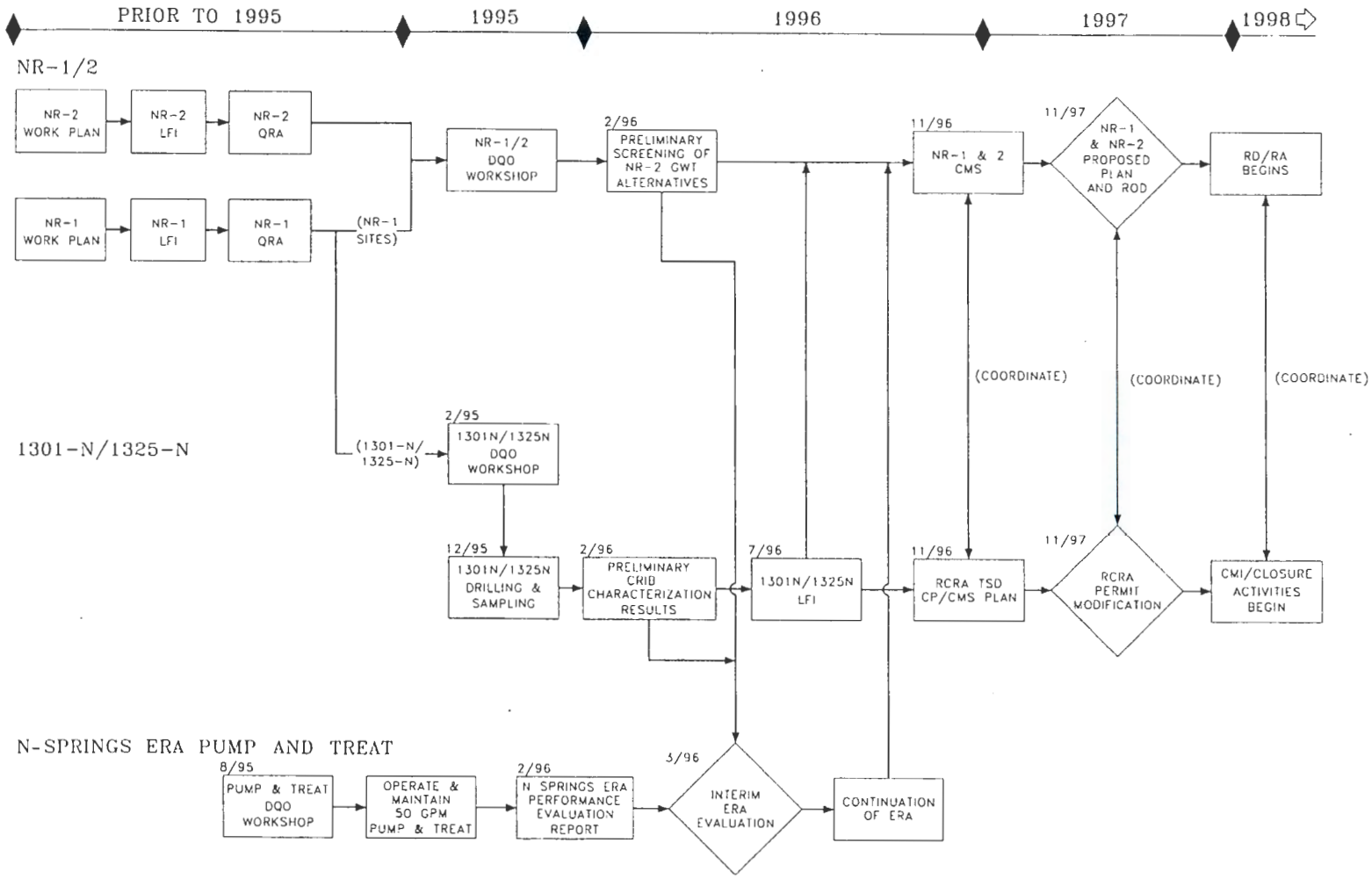


Figure 1-3. 100-N Area Consolidated Corrective Action

Figure 1-4. September 1995 Aerial View of N-Area Structures

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Table 1-1. Summary of Data Quality Objectives and Criteria for 1301-N and 1325-N[a]

Data Quality Objective and Criteria	Document Where Addressed
Provide sufficient information to assess impact to groundwater	This report
Provide sufficient information to prepare a qualitative risk assessment	This report
Provide sufficient information to evaluate the existence of a driving force	This report
Provide sufficient information to refine conceptual model	This report
Provide sufficient information to evaluate remedial alternatives	CMS[b]
Provide sufficient information to estimate total inventory	CMS
Provide sufficient information to assess lateral distribution	CMS
Provide sufficient information to evaluate dangerous waste	CMS
Provide sufficient information to evaluate transuranic waste	CMS
Keep radiation exposures As Low As Reasonable Achievable	DOW[c]
Be Cost Effective	DOW

[a]These objectives and criteria were taken directly from the DQO report (BHI, 1996)
[b]Corrective Measure Study for the 1301-N and 1325-N will be submitted to the regulators in March 1997
[c]Description for Work for 1301-N and 1325-N (DOE-RL, 1995a)

2.0 INVESTIGATIVE APPROACH

This section describes the field operations and laboratory analyses performed for the 1301-N and 1325-N Liquid Waste Disposal Facilities' LFI. Sampling and analysis requirements were documented in the DQO report and agreed upon by Ecology, EPA, and RL (BHI, 1996). Contaminants of concern were not inclusive of all contaminants from the facilities but were identified in the DQO workshop. The DOW, *Description of Work for Vadose Zone Characterization of the 1301-N and 1325-N Liquid Waste Disposal Facilities* (DOE-RL, 1995a), was used for guiding the field work and allowed for minor deviations because of changing field conditions. The investigation activities are summarized in subsections of this chapter and include the following:

- Cable-tool drilling of three LFI boreholes from November 6, 1995 to January 11, 1996 (199-N-107A, 199-N-108A, 199-N-109A)
- Geophysical logging to measure gamma-ray emissions at four existing wells (199-N-35, 199-N-45, 199-N-67, and Research Well No. 1 [RW#1])
- Geophysical logging to determine soil moisture content at three existing wells (199-N-35, 199-N-45, and 199-N-67)
- Geophysical logging (spectral gamma and soil moisture content) in the three LFI boreholes
- Soil sample collection from three LFI boreholes
- Sample analysis for radionuclides, metals, and physical properties performed on soil collected from the three LFI boreholes
- Data validation of primary laboratory results.

2.1 FIELD WORK

2.1.1 Borehole Drilling

The field investigation included the drilling of three vadose zone boreholes (199-N-107A, 199-N-108A, and 199-N-109A), referred to in this report as "LFI boreholes." Each borehole was drilled to groundwater using the cable-tool drilling method. No drilling fluids were added during the drilling process. The boreholes were drilled by Water Development Hanford Company, and the drilling was observed by an Environmental Restoration Contractor well-site geologist who also prepared borehole logs. Radiological control technicians (RCTs) performed radiation monitoring. Borehole 199-N-107A was drilled within the 1301-N crib; boreholes 199-N-108A

and 199-N-109A were drilled immediately adjacent to the 1301-N trench and 1325-N crib, respectively. Drilling began on November 6, 1995, and was completed on January 11, 1996. The locations of the LFI boreholes are shown in Figure 2-1.

Carbon steel well casings were left in place as a temporary measure and will remain in place until a final decision is made concerning whether to conduct further testing. Concrete pads and a locking cap were installed around the temporary well casings after all boreholes were completed. Borehole elevations were surveyed to North American Vertical Datum of 1988 in meters and were later converted into National Geodetic Vertical Datum of 1929 in feet for consistency with other 100-N survey data. Horizontal position was reported in meters referenced to Washington Coordinate System of 1983 South Zone (WCS835/1991).

2.1.2 Geophysical Borehole Logging

Four existing wells, 199-N-35, 199-N-45, 199-N-67, and RW#1, were geophysically logged. These four wells are referred to as "existing wells" in this report. Neutron moisture and gamma log data for the existing wells has been provided in Appendix B. The wells were logged to determine the extent of contamination spread away from 1301-N and 1325-N. The locations of the wells are shown in Figure 2-1.

Neutron-neutron moisture and gamma-gamma density geophysical logs were acquired from the LFI boreholes by Schlumberger Well Services. Both types of Schlumberger geophysical logs have been adapted for the unsaturated Hanford borehole environment. Geophysical logging DQOs for the neutron-neutron moisture and gamma-gamma density logging methods were established in Ellis et al., (1995).

The neutron-neutron moisture logging DQOs were considered sufficient to meet the moisture content data needs of the LFI and were subsequently adopted into the DOW (DOE-RL, 1995a). To meet DQO requirements for geophysical logging, single strings of steel casings were logged. To ensure that the entire LFI borehole was logged through only one string of casing, each borehole was logged on two separate occasions: prior to telescoping of the 20-cm (8-in.) casing within the 25-cm (10-in.) surface casing, and after the well reached total depth. A primary logging pass and a full repeat pass were conducted for each service on each logging run. All geophysical logging was performed in accordance with procedures approved by BHI and in accordance with the DOW (DOE-RL, 1995a).

Westinghouse Hanford Company (WHC) collected neutron moisture logs from existing wells 199-N-35, 199-N-45, and 199-N-67. All WHC neutron moisture logging was performed in accordance with approved logging procedures.

High-resolution spectral gamma-ray logs (referred to as radionuclide logging system [RLS]) were collected from all the LFI boreholes and the four existing monitoring wells. The logs were used to provide contaminant distribution data for gamma-emitting radionuclides. WHC ran spectral gamma sondes in each LFI borehole before telescoping of casing during drilling and

after total depth was reached for each borehole. Existing wells 199-N-35, 199-N-45, and 199-N-67 were logged in July 1995, several months before the LFI boreholes were drilled, to aid in refining sample collection locations. Well RW#1 was logged in November 1995. All high-resolution spectral gamma geophysical logging was performed in accordance with EII 11.1, "Geophysical Logging" (WHC, 1988).

2.1.3 Sample Collection

The three LFI boreholes were sampled following the guidance presented in the DOW and EIP 4.0, "Soil and Sediment Sampling" (BHI-EE-01, *Environmental Investigations Procedures*). A cable-tool drive barrel was used to advance the borehole and remove soil. An RCT screened the removed soil for alpha and beta-gamma radioactivity using hand-held instruments. The measured radioactivity was compared to the site (shielded) background to assist in selecting sample collection intervals for laboratory analysis. Material removed from the borehole was identified and described by the site geologist and summarized on a borehole log per EIP 7.0, "Geologic Logging" (BHI-EE-01).

Radiological field screening performed by the RCTs, in conjunction with the predicted waste site sample target depths, assisted the geologist in selecting sample collection intervals. Target depths identified in the DQO were sampled using a 13-cm (5-in.) outside-diameter stainless steel split-spoon sampler to obtain undisturbed soil samples. An on-site shielded glovebox was used to extract representative portions of soil from the split-spoon liners. Before the samples were shipped to a primary laboratory, a subsample was radiologically screened by the WHC 222-S Laboratory. The results of the screening were used to verify that samples were within the radiological acceptance criteria of the primary laboratory and for preparing sample shipments in accordance with U.S. Department of Transportation regulations. These samples were analyzed for radionuclides, metals, and physical properties. A total of fourteen split-spoon samples was collected: six from 199-N-107A and four each from 199-N-108A and 199-N-109A. Split-spoon sample depths for each borehole are presented in Figure 2-2.

Soil cuttings were also collected as grab samples from the cable-tool drive barrel. These grab samples were used to provide radiological contaminant information between the split-spoon sample collection intervals and assisted in the selection of the split-spoon sample intervals. The RCT radiologically screened every drive barrel of cuttings as drilling progressed. If results from a drive barrel exceeded three times the previous interval's radiological field-screening results, a grab sample was collected. Grab sample locations were based upon those measurements, with a minimum of one sample collected every 3.0 m (10 ft). At the end of each day, the grab samples were transported to the WHC 222-S Laboratory for radiological screening. Certain grab samples identified by the site geologist were also tested for moisture content and particle size distribution. The locations of grab sample collection points are shown in Figure 2-2.

Approximately every 3.0 m (10 ft), and at significant lithology changes, soil was collected from either the drive barrel or the split-spoon sampler and archived in two-liter plastic jars. The archived samples were collected to provide soil in the event additional testing is needed. The

samples are stored at the 1301-N site until RL and Ecology concur that they may be disposed of. A chain of custody is stored with the archived samples.

2.2 SAMPLE ANALYSIS

2.2.1 Physical Properties Testing

Physical properties testing was performed on all split-spoon samples from boreholes 199-N-108A and 199-N-109A. The testing included particle size distribution, bulk density/porosity, saturated hydraulic conductivity, moisture content, and moisture retention. Physical properties testing was not required for samples from borehole 199-N-107A because of potential radiological exposure problems associated with the large volume of soil required for analysis and the expected high radiological activity. Grab samples were analyzed for moisture content and particle size distribution only. Except moisture retention, physical properties tests for borehole 199-N-108A were performed by the WHC Geotechnical Laboratory. Physical properties' tests for borehole 199-N-109A, including moisture retention for borehole 199-N-108A samples, were performed by Southwest Research Institute (SwRI) of San Antonio, Texas, due to the closing of the WHC Geotechnical Laboratory prior to completion of this project. Nineteen samples were analyzed for moisture content; eight split-spoon liners were analyzed for particle size distribution, bulk density, saturated hydraulic conductivity, and moisture retention; and ten samples were analyzed for particle size distribution. Results of the physical properties testing are discussed in Section 3.0.

2.2.2 Radionuclide/Metals Analysis

For chemical/radionuclide analyses, analytical techniques were selected based primarily on their ability to detect potential contaminants at low levels required to support the QRA. Radionuclide and metals analyses of split-spoon samples were performed by the Quanterra Environmental Services, Inc. (QES) laboratory in Richland, Washington. The laboratory used SW-846 methods (EPA, 1990) for metals' analysis and laboratory-specific methods, approved under the RL contract, for radionuclide analysis. Radionuclide screening of grab and split-spoon samples was performed by the WHC 222-S Laboratory under a project-specific statement of work. Sample analytical methods and parameters are presented in Table 2-1. Radionuclide and metals analytical results are presented in Section 3.0.

2.3 DATA VALIDATION

Data validation was performed by an independent subcontractor to verify that the project DQOs were met and to ensure the defensibility of the data. The validation responsibilities are defined in associated statements of work. All validation was performed per quality assurance/quality control (QA/QC) specifications outlined in the "Quality Assurance Project Plan" (QAPP), Appendix F of the DOW, and in compliance with *Data Validation Procedures for Chemical*

Analyses (WHC, 1993a) and *Data Validation Procedures for Radiochemical Analyses* (WHC, 1993b). Per the QAPP, 10 percent of all off-site analytical laboratory data packages were to be validated. However, current validation protocols require any data package containing field QC samples to be validated. Consequently, all three data packages, one per LFI borehole, from QES were validated. The DOW did not require analytical data from the WHC 222-S Laboratory, WHC Geotechnical Laboratory, or SwRI to be validated. The following reports present the data validation for each of the data packages from the primary laboratory:

- "Inorganic Data Validation Report for Data Package WO823-QES 1301-N/1325-N LWDF," Vadose Zone Characterization Project
- "Radiochemistry Data Validation Report for Data Package WO823-QES 1301-N/1325-N LWDF," Vadose Zone Characterization Project
- "Inorganic Data Validation Report for Data Package WO847-QES 1301-N/1325-N LWDF," Vadose Zone Characterization Project
- "Radiochemistry Data Validation Report for Data Package WO847-QES 1301-N/1325-N LWDF," Vadose Zone Characterization Project
- "Inorganic Data Validation Report for Data Package WO867-QES 1301-N/1325-N LWDF," Vadose Zone Characterization Project
- "Radiochemistry Data Validation Report for Data Package WO867-QES 1301-N/1325-N LWDF," Vadose Zone Characterization Project.

Analytical results were compiled into tabular summaries that were reviewed for use in preparing the QRA. Electronic files in Contract Laboratory Program format, validation reports, and laboratory result forms were used as sources of data. The data from validation reports and laboratory forms were manually entered into the tabular summaries, 100 percent verified, and corrected if needed. This was done to verify that validation results were incorporated into the analytical database and that the data qualifiers were listed. Data that are termed "usable" (detected compounds or estimated values, qualified with a "J") can be used in the risk assessment. Data that are not considered usable were rejected (qualified with an "R") by the data validator.

2.4 INVESTIGATION SUMMARY

The LFI field activities resulted in the collection of an extensive environmental data set for 1301-N and 1325-N. Radiological contaminant distribution was measured using geophysical logging techniques, hand-held field detectors, and laboratory analysis. Discrete samples were collected for laboratory analysis of metals concentrations. Physical properties, including moisture, were determined by using geophysical logging and collecting discrete samples for laboratory analysis. These data are presented in Section 3.0 of this report.

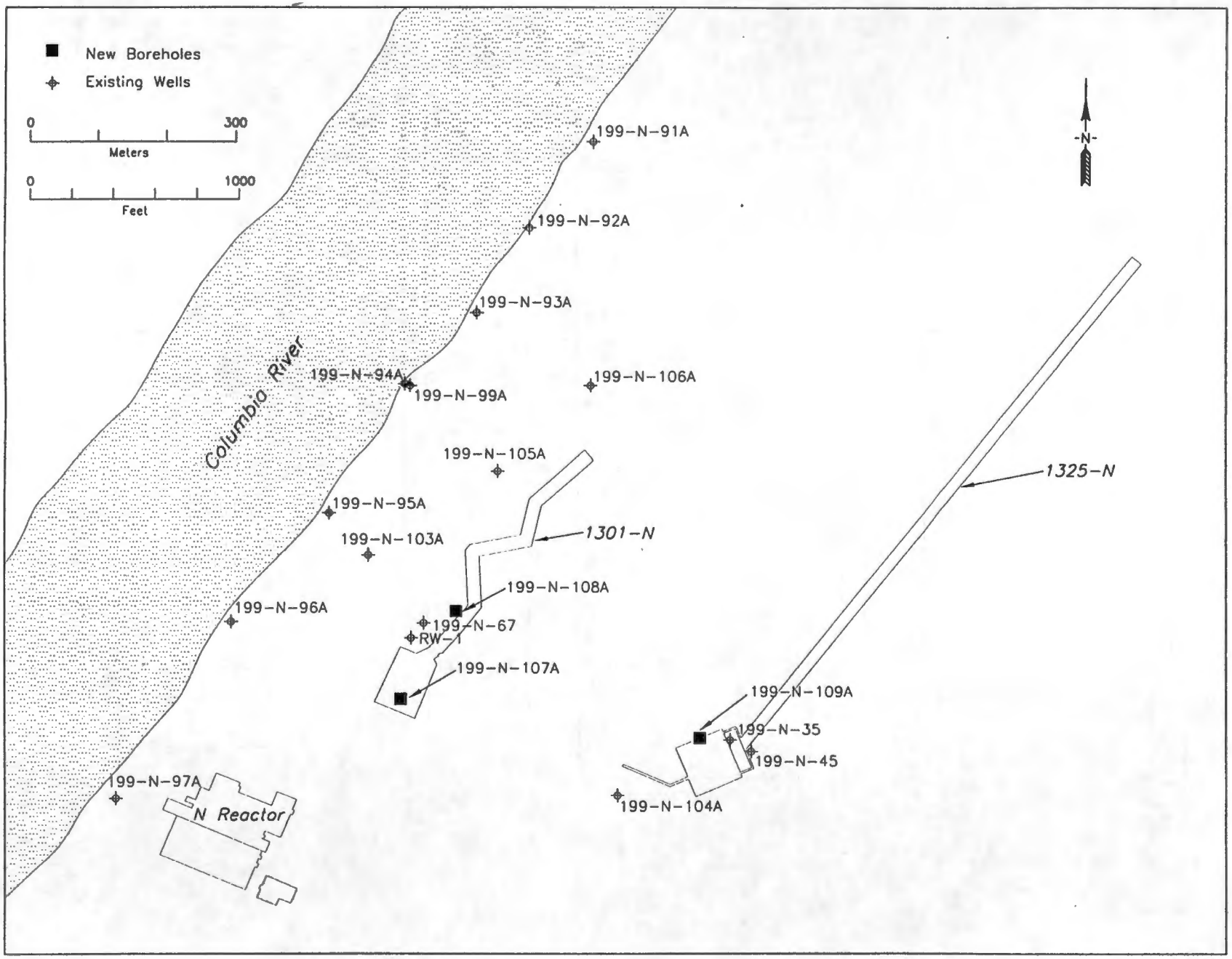

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Figure 2-1. New Boreholes and Existing Wells Used in This LFI Report

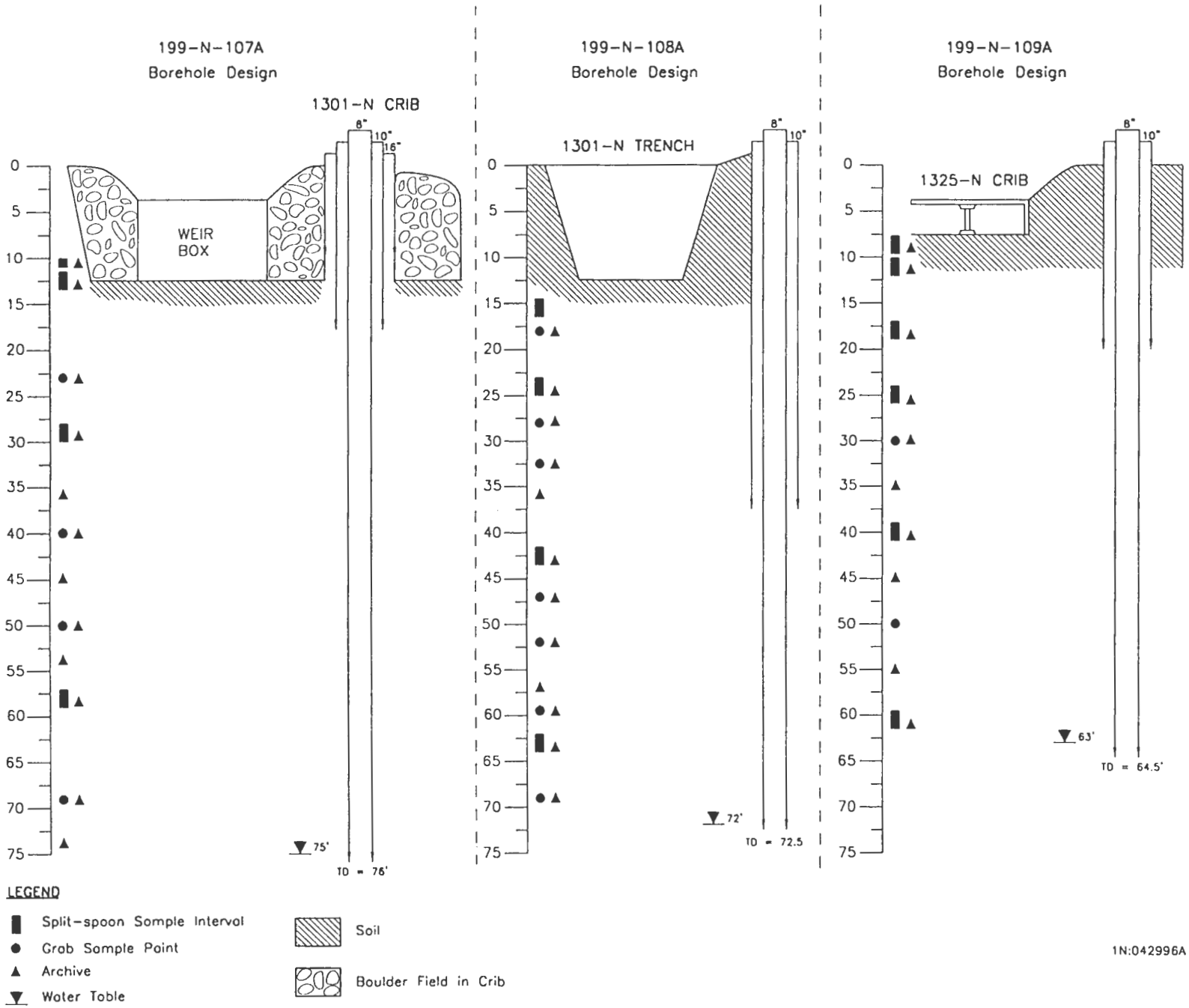


Figure 2-2. Depths of Samples at Boreholes

Table 2-1. Analytical Parameters and Methods (Page 1 of 2)

Analytical Category	Analytical Parameters	Analytical Method	Detection Limit
Analytical Data[a] Metals	Cadmium Chromium Nickel	SW-846, method 6010, ICP metals	1.0 ppm
	Lead	SW-846, method 7421 , AA metals	1.0 ppm
Analytical Data[a] Radionuclides	Strontium-90	Gas proportional/RICHRC-5006	1.0 pCi/g
	Plutonium-238 Plutonium-239/240	Alpha spectroscopy/RICHRC-5010	0.6 pCi/g
	Uranium-234 Uranium-235 Uranium-238	Alpha spectroscopy/RCHRC-5030	0.6 pCi/g
	Gross alpha	Gas proportional/ITAS-RD-3222	7.0 pCi/g
	Gross beta	Gas proportional/ITAS-RD-3222	8.0 pCi/g
	Cerium-134 Cesium-134 Cesium-137 Cobalt-60 Europium-154 Europium-155 Manganese-54 Potassium-40 Radium-226 Ruthenium-106 Thorium-228 Thorium-232	Gamma spectroscopy/ RICHRC-5017	0.75 pCi/g 0.25 pCi/g 0.25 pCi/g 0.05 pCi/g 0.75 pCi/g 0.75 pCi/g 0.25 pCi/g 10.0 pci/g 4.5 pCi;/g 1.5 pCi/g 0.6 pCi/g 0.6 pCi/g
Radiological Screening[b]	Strontium-90	Beta counting	1.0 pCi/g
	Gross alpha[d]	Gas proportional	7.0 pC/g
	Gross beta	Gas proportional	8.0 pCi/g
	Gamma emitters[g]	Gamma spectrometry	0.5 pCi/g
Physical Properties[c]	Moisture Content	ASTM D2216 (GEL-14)	n/a
	Moisture Retention	ASTM D2325, ASTM D3152 (GEL-18)	n/a
	Bulk Density / Porosity	ASTM D2937, ASTM D4564 (GEL-14)	n/a
	Permeability (Saturated Hydraulic Conductivity)	ASTM D2434 (GEL-09)	n/a
	Particle Size Distribution	ASTM D422 (GEL-07)	n/a

Table 2-1. Analytical Parameters and Methods (Page 2 of 2)

Analytical Category	Analytical Parameters	Analytical Method	Detection Limit
Geophysical Logging Radionuclides	Cerium-134 Cesium-134 Cesium-137 Cobalt-60 Europium-154 Europium-155 Manganese-54 Potassium-40 Radium-226 Ruthenium-106 Thorium-228 Thorium-232	Gamma spectrometry using RLS[e]	5.0 pCi/g 1.0 pCi/g 1.0 pCi/g 1.0 pCi/g 1.0 pCi/g 10 pCi/g 1.0 pCi/g 2.0 pCi/g 5.0 pCi/g 5.0 pCi/g 5.0 pCi/g 1.0 pCi/g
Geophysical Logging Physical Properties	Moisture Content	Neutron Moisture[f]	n/a

[a]Samples collected using split-spoon sampler and analyzed by Quanterra Environmental Services, Richland, Washington.
[b]Grab samples collected from drive barrel and split spoon and analyzed by the Westinghouse Hanford Company (WHC) 222-S Laboratory.
[c]All parameters were ran on split-spoon samples; moisture content and particle size only for grab samples.
[d]If gross alpha activity exceeded 20 pCi/g, Pu-238, Pu-239 analyzed.
[e]RLS using a high-purity germanium detector.
[f]Performed using an accelerated porosity sonde.

AA - Atomic absorption
ASTM - American Society for Testing and Materials
GEL - WHC Geotechnical Engineering Laboratory
ICP - Inductively coupled plasma
RLS - Radionuclide Logging System

3.0 INVESTIGATION RESULTS

The results of the data-gathering activities conducted during this LFI are presented in this section. The general hydrogeology at 1301-N and 1325-N is presented, followed by the specific geology of each borehole. Next, the laboratory results of the soil samples and the field screening are presented for 1301-N boreholes (199-N-107A and 199-N-108A) and then for the 1325-N borehole (199-N-109A). Additional characterization information has recently been collected from 1301-N as part of another project and is summarized at the end of this section. Appendix A and B contain all the data discussed in this chapter as well as other pertinent historical data.

Cross sections of 1301-N and 1325-N are provided in Figures 3-1 and 3-2 to supplement the discussion of results and aid in comparing data. Figures 3-1 and 3-2 present the depths and corresponding elevations for each LFI borehole. Figure 3-1 shows a cross section of the 1301-N crib and 199-N-107A and a cross section for the 1301-N trench and 199-N-108A. The cross section of both the crib and trench is shown to illustrate the differences in depths and elevations because of the lower elevation of the trench. Figure 3-2 presents the same information relating to 1325-N. As an example, a soil sample collected from borehole 199-N-107A at a depth of 9 m (30 ft) is at the same elevation (131 m [430 ft] above mean sea level [MSL]) as a sample collected from borehole 199-N-108A at a depth of 7.9 m (26 ft).

A meter-to-feet conversion table (Table 3-1) has been provided for Sections 3.2 and 3.3. The intent is to present a clear discussion of contaminant distribution without creating lengthy conversions within the sentence structure.

3.1 GENERAL HYDROGEOLOGY OF 1301-N AND 1325-N

This section presents the general hydrogeology in the vicinity 1301-N and 1325-N. Complete details of the geology of each LFI borehole are presented in following subsections. The source of the following discussion of the hydrogeology of the 100-N Area is Hartman and Lindsey (1993).

Stratigraphic divisions underlying the 100-N Area include the Hanford formation, the Ringold Formation, and Elephant Mountain Member of the Saddle Mountains Basalt. The Hanford formation overlies the Ringold Formation and consists of two gravel-dominated facies: an upper cobble-boulder unit and a lower pebble-cobble unit. The Ringold Formation overlies the Elephant Mountain Member and consists of seven units. Thickness ranges for the Hanford formation and the Ringold Formation are 5.8 to 24.5 m (19 to 77 ft) and 137.2 to 150.6 m (450 to 494 ft), respectively. General stratigraphic relationships of the geologic units are illustrated in the geologic cross sections shown in Figures 3-3 through 3-7.

Wells and boreholes drilled in the area were used to construct the cross sections (Figures 3-4 through 3-7). Wells 199-N-103A, 199-N-104A, 199-N-105A, and 199-N-106A were drilled for

the N Springs Pump-and-Treat Project. Detailed lithologic descriptions of 199-N-103A, 199-N-104A, and 199-N-105A are found in Glaman and Walker (1995). Details of Well 199-N-106A are published in Walker (1996). Geologic field logs of 199-N-107A, 199-N-108A, and 199-N-109A are included in Appendix B.

Groundwater in the unconfined aquifer flows primarily in a west-northwesterly direction most of the year and discharges to the Columbia River. Fluctuations in river stage, because of dam operations and seasonal variations, can impact the flow direction, hydraulic gradients, and groundwater levels within the unconfined aquifer. The significant stratigraphic divisions at and above the water table at 1301-N and 1325-N are the Ringold Formation and the Hanford formation. The unconfined aquifer is contained in the gravel-dominated Unit E lithofacies of the Ringold Formation. A detailed description of this unit and the Hanford formation is found in Hartman and Lindsey (1993).

Extensive grading, excavation, and backfilling of the surficial Hanford formation have occurred within and around 1301-N and 1325-N. Consequently, it is difficult to distinguish undisturbed Hanford formation from anthropogenically disturbed Hanford formation because of similar bulk composition. The zone of disturbed material is up to 6 m (20 ft) thick and consists of unconsolidated basaltic cobble- to boulder-sized clasts with sand infilling. Clasts often exhibit white calcium carbonate coatings. Crushed gravel was used to create clean roadways to the drill sites and to existing wells 199-N-67 and 199-N-69 within the 1301-N and 1325-N fenced areas prior to drilling. The roadfill is up to 0.9 m (3 ft) thick and consists of angular basaltic pebbles with sand.

The upper portion of the Hanford formation is composed of unconsolidated basaltic cobble and boulder-sized clasts. Cobbles as large as 15 cm (6 in.) were encountered during drilling, although boulders as large as 0.9 m (3 ft) can be seen around 1301-N and 1325-N. Below the cobble-boulder unit, clast size decreases to pebbles and cobbles with local dominant sand. The gravel and sand are predominantly basaltic in composition. Sometimes, significant sand layers are intercepted during drilling. A sand layer consisting of very coarse to fine sand 4.9 m (16 ft) thick was encountered in well 199-N-103A. A 1.5-m (5-ft) sand layer was encountered during the drilling of well 199-N-104A. A 3-m (10-ft) sand layer was encountered in borehole 199-N-107A. A 1.9-m (6-ft) sand layer was encountered in borehole 199-N-108A. Minor sand lenses were encountered in borehole 199-N-109A. In the vadose zone, sand layers may have promoted the localized lateral spread of contamination from 1301-N and 1325-N during operation of the facilities. The sand zones are discontinuous and cannot, with certainty, be traced between wells.

The underlying Ringold Formation is composed of fluvial pebble- to cobble-sized gravels with a silty sandy matrix. The sediments range from well cemented, with carbonates and/or iron oxides, to uncemented. Cementation is discontinuous but laterally extensive. Basalt content of the gravels is typically less than 50 percent by volume. Some thin discontinuous sand lenses are found in the areas of 1301-N and 1325-N. The contact between the Hanford formation and the Ringold Formation is sometimes difficult to determine because a transition zone of reworked

Ringold Formation is often present. The contact is a potential perching layer in the vadose zone because of the cemented nature of the Ringold Unit E. However, no perched water was observed during drilling.

3.2 1301-N RESULTS

Two existing wells (199-N-67 and RW#1) were geophysically logged and two boreholes (199-N-107A and 199-N-108A) were drilled and geophysically logged to characterize 1301-N. Well 199-N-67 is located about 41.1 m (135 ft) downgradient from the 1301-N Trench, and RW#1 is located about 30.5 m (100 ft) downgradient from the 1301-N crib (see Figure 2-1). Borehole 199-N-107A was drilled close to the weir box through the 1301-N Crib, and borehole 199-N-108A was drilled about 6.4 m (21 ft) away from the concrete panels of the trench on the Columbia River side. The following discussions relate to these wells and boreholes.

3.2.1 Geology

The stratigraphic units encountered during drilling are the Hanford formation and the gravel-dominated Unit E of the Ringold Formation. The Hanford/Ringold contact was encountered at 12.8 m (42 ft) below ground surface (bgs) in borehole 199-N-107A and 11.9 m (39 ft) bgs in borehole 199-N-108A (Figures 3-8 and 3-9). The water table was encountered at 22.9 m (75 ft) on December 8, 1995, and at 21.9 m (72 ft) on November 16, 1995, in boreholes 199-N-107A and 199-N-108A, respectively. Detailed borehole logs for each borehole are presented in Appendix B.

The initial 2.7 m (9 ft) of borehole 199-N-107A is primarily basaltic sandy gravel fill material from the upper Hanford formation. Below the fill material is undisturbed Hanford formation. The Hanford formation encountered in this borehole consists primarily of basalt gravel in a matrix of sand and silt with one gravelly sand interval at 8.5 to 11.6 m (28 to 38 ft). The basalt content of the gravels is greater than 70 percent, and some clasts exhibit carbonate coatings. The contact between the Hanford formation and the Ringold gravels is gradational in this area and was difficult to recognize during drilling; however, differences in geophysical logging responses indicate that the contact is at approximately 12.8 m (42 ft).

Unit E of the Ringold Formation consists primarily of gravel in a matrix of sand and silt with variable siliceous and calcareous cementation. The gravel clasts are mostly subrounded to rounded basalt, quartzite, and granite. The basalt content of the gravel ranges from 30 to 50 percent. Some cemented sand and silt on the clasts was noted. One gravelly, very coarse-to-coarse sand interval was encountered from 14.6 to 15.8 m (48 to 52 ft).

The Hanford formation encountered in borehole 199-N-108A consists primarily of basalt gravel in a matrix of sand and silt with a thin sand lens from 4.3 to 4.4 m (14 to 14.5 ft) and a very fine- to fine-grained sand from 6.4 to 8.2 m (21 to 27 ft). The basalt content of the gravels is greater than 80 percent, and some clasts exhibit carbonate coatings. The contact between the Hanford

formation and the Ringold gravels is apparently gradational and was difficult to recognize during drilling; however, differences in geophysical logging responses indicate that the contact is at approximately 11.9 m (39 ft). No perched water was observed during drilling.

Unit E of the Ringold Formation consists primarily of gravel in a matrix of sand and silt with variable siliceous and calcareous cementation. The gravel clasts are mostly subrounded to rounded basalt, quartzite, and granite. The basalt content of the gravel ranges from 30 to 50 percent. Some cemented sand and silt on the clasts was noted. Two sand layers were noted: a very fine- to fine-grained sand from 15.2 to 18 m (50 to 59 ft) and a medium to very coarse sand from 20.3 to 20.9 m (66.5 to 68.5 ft).

3.2.2 Soil Samples

The following discussion focuses on contaminant distribution below the base of the 1301-N crib and trench. All sample collection depth intervals are discussed relative to the excavated base of the facility. The corresponding depth below the ground surface is given in parentheses. Refer to Figures 3-1 and 3-2 to aid in the discussion and Table 3-1 for the metric conversion.

Soil samples were collected at discrete depths from boreholes 199-N-107A and 199-N-108A. Borehole summary logs for 199-N-107A and 199-N-108A are presented in Figures 3-8 and 3-9, respectively. The figures show the elevation and depth of sample collection intervals, well construction, sample collection methods, sample identification numbers, analytical laboratory, lithology, sieve analyses, and moisture content in weight percent. Samples from 199-N-108A were submitted for chemical, radiological, and physical property analyses. Samples from 199-N-107A were analyzed only for chemical and radiological constituents. Physical properties' analyses were not planned to be performed on material from 199-N-107A because of shipping and handling concerns regarding the potentially high radiation levels in the soil.

3.2.2.1 Metal Analysis. Soil samples from boreholes 199-N-107A and 199-N-108A were analyzed for cadmium, chromium, lead, and nickel to evaluate the vertical and lateral distribution of these metals beneath 1301-N. These data are presented in Tables 3-2 (199-N-107A) and 3-3 (199-N-108A).

The highest concentrations of metals are at the base of the 1301-N crib in borehole 199-N-107A. Specifically, chromium (up to 57.7 mg/kg) and lead (up to 21.9 mg/kg) have been detected at depths to 3 ft below the crib base (13 ft bgs) at concentrations above background (18.5 and 10.2 mg/kg, respectively). Below this depth, chromium and lead are detectable at background concentrations. Nickel was detected in the soil at background concentrations. Cadmium was also detected in the soil at concentrations up to 0.73 mg/kg. A cadmium concentration representative of Hanford background was not available.

Nickel and lead are at background concentrations in borehole 199-N-108A. Chromium has been detected throughout the soil column in concentrations up to 27.3 mg/kg. Cadmium was not detected.

3.2.2.2 Radionuclide Analysis. Radionuclide analysis on 199-N-107A and 199-N-108A indicates that the majority of contamination occurs as Co-60, Cs-137, Sr-90, and Pu-239/240. These data are summarized in Tables 3-2 through 3-5.

Table 3-2 presents the results of the primary laboratory (Quanterra) analyses for samples collected with a split spoon from within the 1301-N crib (199-N-107A). Table 3-2 presents the results of the primary laboratory data for samples collected with a split spoon at the site adjacent to the 1301-N trench (199-N-108A). Tables 3-4 and 3-5 present the radiological screening data for both split-spoon samples and drive-barrel grab samples that were analyzed at the 222-S Laboratory. The results of a grab sample (B0GGC3), from soil scraped off a boulder excavated from the crib base during installation of the well starter casing and prior to drilling, are included. The associated radiological values from the boulder sample are very high and may not be representative of the overall soil matrix. Figures 3-10 and 3-11 illustrate the vertical distribution of Cs-137, Co-60, and Sr-90 for boreholes 199-N-107A and 199-N-108A. Analytical results from the primary laboratory, radiological screening, and the RLS are provided for each contaminant to demonstrate the comparability of these data sets. No RLS data are available for Sr-90 because the RLS cannot measure concentrations of beta emitters such as Sr-90. For Figures 3-10 and 3-11, a log scale was used to facilitate presentation of all three contaminants on the same page.

The following radionuclides were detected in soil samples collected from boreholes 199-N-107A and 199-N-108A: americium (Am)-214, Cs-134, Cs-137, Co-58, Co-60, europium (Eu)-154, Eu-155, manganese (Mn)-54, Pu-238, Pu-239/240, K-40, radium (Ra)-226, Ra-228, Sr-90, thorium (Th)-228, Th-232, uranium (U)-234, and U-238. Concentrations of cerium (Ce)-144, Eu-152, iron (Fe)-59, ruthenium (Ru)-106, and U-235 have not been detected by gamma ray spectrometry.

The majority of the contamination within 1301-N occurs from Co-60, Cs-137, Sr-90, and Pu-239/240. The highest concentrations of Co-60 (up to 139,000 pCi/g) occur at the crib base to a few feet (~3 ft) below the crib base (13 ft bgs). The interval from the base of the crib to a few feet below is referred to as the "concentrated layer." The concentrated layer also contains chromium and lead at concentrations above background. Cobalt-60 concentrations decrease significantly, from 132,000 to 23.9 pCi/g within a depth range of 10 ft (from 3 to 13 ft below the crib base [13 to 23 ft bgs]). Concentrations below the concentrated layer decrease from 23.9 pCi/g to <1 pCi/g. Figure 3-10 illustrates the Co-60 distribution.

The highest concentrations of Cs-137 (up to 102,000 pCi/g) are also at the crib and are present deeper (~10 ft more to a depth of 13 ft below the crib base [23 ft bgs]) in the crib than Co-60. Below 13 ft (23 ft bgs), concentrations decrease from 6.1 pCi/g to less than detectable near the water table.

Strontium-90 has been detected throughout the soil column from the crib base to the water table in concentrations ranging from 92,999 pCi/g on the crib boulder sample to 50 pCi/g at the water table. Concentrations decrease significantly with depth, with levels in the thousands of pCi/g in

the zone from the crib base to 20 ft (30 ft bgs), and then decreasing to the hundreds and tens of pCi/g from 20 ft (30 ft bgs) to the water table.

Plutonium-239/240 occurs in concentrations up to 12,700 pCi/g in the crib to a depth of a few feet generally coincident with the Co-60. The Pu-239/240 concentrations are below the level that is considered transuranic waste (100,000 pCi/g). Concentrations of Pu-239/240 have not been detected at depth.

Soil samples were collected from borehole 199-N-108A to evaluate the lateral spreading of contamination away from 1301-N and to determine the concentrations primarily of Sr-90 below the old operational water table mound (old groundwater mound) at a location close to 1301-N.

The high concentrations (~100,000 pCi/g range) of Co-60, Cs-137, and Sr-90 detected at the base of the 1301-N crib are not present in borehole 199-N-108A (Figure 3-11). This indicates that these contaminants are located primarily within the concentrated layer at the base of the crib and trench. The distribution of Co-60, Cs-137, and Sr-90 in the side borehole is similar to that of 199-N-107A below the concentrated layer. The highest concentrations of Co-60 (up to 3,300 pCi/g), Cs-137 (up to 15,700 pCi/g), Sr-90 (up to 1,740 pCi/g), and Pu-239/240 (up to 73.7 pCi/g) detected in the borehole are associated with the sand layers between 3.5 ft above the trench base to 7 ft below the trench base (14 and 27 ft bgs).

Other COPCs were detected at elevated concentrations (>1,000 pCi/g) in the concentrated layer, including Am-241, Eu-154, and Eu-155. In addition, Pu-238 and K-40 are present in the concentrated layer (<1,000 pCi/g). Ru-106 and U-235 were not detected in either well.

The gross alpha concentrations (up to 38,200 pCi/g) detected in the concentrated layer are indicative of the alpha emitters, primarily Pu-239/240 and Am-241, that are present in high concentrations (>1,000 pCi/g). Gross alpha concentrations decrease to less than 3 pCi/g near the water table. The gross beta concentrations (up to 305,000 pCi/g) detected are indicative of the beta emitter Sr-90 (>10,000 pCi/g) that is present. Near the water table gross beta concentrations are <130 pCi/g.

3.2.2.3 Physical Property Analysis. Vadose zone physical property data from borehole 199-N-108A are summarized in Table 3-6. Physical property samples were not collected at borehole 199-N-107A. Gravimetric moisture content ranges from 2.60 to 8.86 percent. Particle density values have been estimated by the WHC Geotechnical Laboratory based on previous on-site work to range from 2.70 to 2.72 g/cm^3. Dry bulk density ranges from 1.76 to 2.08 g/cm^3. The gravimetric moisture data can be used to calculate volumetric moisture content if the dry bulk density of the soil is known. The volumetric moisture content is determined by multiplying the dry bulk density by the gravimetric moisture content. Porosity ranges from 24 to 35 percent. Saturated vertical hydraulic conductivity ranges from 3.0E-5 to 8.2E-4 cm/sec. Moisture retention curves and particle size distribution curves are presented in Appendix B. Generalized particle size distributions are illustrated graphically in Figure 3-9.

3.2.3 Geophysical Logging

The RLS results for Co-60 and Cs-137 in boreholes 199-N-107A and 199-N-108A are presented in Figures 3-10 and 3-11 and are compared to the laboratory analyses of soil samples removed from the boreholes. The complete set of RLS logs is presented in Appendix B. The radionuclide concentrations of Co-60 and Cs-137 measured by RLS compare well to laboratory results for soil. The RLS data provide a more detailed record of the contaminant distribution with depth and supplement the laboratory results. Because the high radionuclide concentrations exceeded the range of the detector, neither Cs-137 nor Co-60 concentrations are available at 199-N-107A in the concentrated layer to about 14 ft bgs. The concentrations of the naturally occurring radionuclides potassium, uranium, and thorium are typical for Hanford sediments.

The RLS results for Co-60 and Cs-137 in wells 199-N-67 and RW#1 are presented in Figure 3-12. Cobalt-60 concentrations in 199-N-67 range from 1 to 10 pCi/g. Cesium-137 concentrations range from 1 to 320 pCi/g. The results from Well 199-N-67 may be less than those actually present in the soils because the readings were not compensated for bentonite that is present around the well. Soils at borehole 199-N-108A do not exhibit noticeable increases of Co-60 or Cs-137 below the old groundwater mound. The maximum Co-60 and Cs-137 concentrations in RW#1 are 1,300 pCi/g at 7 m (23 ft) bgs and 18,000 pCi/g at 6.7 m (22 ft) bgs, respectively. The bottom of RW#1 is at 8.2 m (27 ft bgs) and does not penetrate the old groundwater mound or the present water table.

Moisture and porosity profiles of the soil column at boreholes 199-N-107A and 199-N-108A were measured by Schlumberger Well Services (Figures 3-13 and 3-14). The moisture data were measured with a neutron-neutron logging tool; the porosity data were measured with a gamma-gamma density logging tool. The profiles are also presented in Appendix B. Both data types were collected continuously throughout the boreholes; however, the neutron-neutron system was not run in the upper 2.4 to 3 m (8 to 10 ft) for reasons of worker safety.

Figures 3-13 and 3-14 present moisture and porosity profiles for boreholes 199-N-107A and 199-N-108A, respectively. Overall, the sediments at 1301-N range from dry to moist. The profiles provide a continuous log of the percentages of formation occupied by mineral matrix (i.e., sediment clasts and cement), air-filled porosity, and moisture-filled porosity. The neutron-neutron logging tool can not differentiate between hydrogen in water molecules and in other minerals (e.g. hydrous minerals such as clays). Because there are very few hydrous minerals present, the measurements represent the moisture content of the soil. Cementatious materials do not affect the moisture measurements. The volume of air-filled porosity is measured with a gamma-gamma density log allowing for moisture volume corrections. The sum of air-filled porosity and moisture is the total formation porosity. If the total formation porosity and moisture curves were to touch when plotted, the formation at that depth would be saturated. When the pores of the formation are completely filled with water, the formation is considered saturated. The volumetric soil moisture content ranges from 8.4 to 15.2 percent in 199-N-107A and from 6.2 to 18.5 percent in 199-N-108A. The average moisture values are 12.3 and 10.0 percent in 199-N-107A and 199-N-108A, respectively. In a study by Engelman and others

(1995), many gravimetric moisture data from the unsaturated Hanford formation were converted to volume percent. The majority of the moisture readings are between two and 20 volume percent. There are no saturated zones in either borehole.

Zones where a large volume of air-filled porosity occurs are indicative of low-moisture porous sands. The zones where the logged air-filled porosity is in error, because of high activities of gamma-emitting contamination, are indicated in Figures 3-13 and 3-14. The moisture log is unaffected by the contaminated zones.

The moisture content log run by WHC for Well 199-N-67 was not evaluated because the neutron tool was measuring the moisture content of the bentonite around the well casing rather than soil conditions. RW#1 was not included in the DOW for moisture content logging because it was not known whether the well was still in place. Once it was determined that the casing was in place, it was also determined that the WHC neutron tool was no longer acceptable. Therefore, the well was logged by RLS only. WHC moisture data does not meet DQOs and should only be used qualitatively.

3.2.4 Field Screening

A radiological control technician (RCT) performed field screening for radioactivity using a portable scintillation counter to measure levels of beta-gamma activity. Alpha activity was measured using a portable alpha monitor (PAM). The measured radioactivity was compared to the site (shielded) background to assess radiological contamination levels present in the soil. To decrease the site background radioactivity at the 199-N-108A drill site, drums filled with water were placed between the drill site and the trench. Small shielded enclosures were made at the drill site and in the sampling van to further reduce the background radiation level so that samples could be surveyed.

The highest radiological readings were measured on crib gravels removed from borehole 199-N-107A at 3.4 m (11 ft), with up to 150 mR/hr, on contact through the drive barrel. Split-spoon samplers in borehole 199-N-107A had contact radiation exposure levels measuring 31 mR/hr on a sample at 3.4 m (11 ft) decreasing to 5 mR/hr at 4 m (13 ft) and 1 mR/hr at 7 m (23 ft). As radiological activity decreased with depth, the measurements of radiological exposures in mR/hr changed to the measurement of radiological contamination in terms of disintegrations per minute. In general, changes in field readings correlated with changing lithology (i.e., zones with higher silt content would have higher field readings). Only one sample from 1301-N had field detectable alpha activity (up to 2,200 dpm) on contact with soil in the split spoon, measured at about 3.5 m (11.5 ft) in 199-N-107A.

3.2.5 Surface Radiation Measurements

During the planning phases of the LFI, radiation measurements in mrem/hr were collected 1 m (3 ft) above the concrete panels (about 5.2 m [17 ft] above the ground surface) on the 1301-N trench. These measurements were taken to support radiation dose estimations for the LFI

workers and to assist in locating borehole 199-N-108A at a location of potential high contamination. The results of this survey are shown in Figure 3-15. The survey indicated that the majority of gamma energy radionuclides (essentially Co-60 and Cs-137) in the near surface are located at the portion of the trench closest to the crib. The dose rate was about 300 mrem/hr.

3.3 1325-N RESULTS

Two wells were geophysically logged by RLS (199-N-35 and 199-N-45), and one borehole was drilled (199-N-109A) and geophysically logged to characterize 1325-N. Wells 199-N-35 199-N-45 are located 3 m (10 ft) and 25.9 m (85 ft) from the 1325-N crib, respectively. Borehole 199-N-109A was drilled about 3 m (10 ft) away from the edge of the 1325-N crib concrete panel toward 1301-N and the Columbia River. The following discussions relate to these wells and borehole.

3.3.1 Geology

The stratigraphic units encountered during drilling were the Hanford formation and the Ringold Formation. In borehole 199-N-109A, the Hanford/Ringold contact was encountered at 13.4 m (44 ft) bgs and the water table was encountered at 19.2 m (63 ft) on December 28, 1995, (Figure 3-16). A detailed geologic log is presented in Appendix B.

The Hanford formation encountered in 199-N-109A consists primarily of basalt gravel in a matrix of sand and silt. No distinguishable sand layers were encountered. The basalt content of the gravels is greater than 75 percent, and some clasts exhibit carbonate coatings. The contact between the Hanford formation and the Ringold gravels was recognized during drilling by a slower drill rate and distinct lithologic change at about 13.4 m (44 ft). An increase in K-40 was noted at 13.4 m (44 ft) in the geophysical log, which is indicative of the Unit E of the Ringold Formation.

Unit E of the Ringold Formation consists primarily of gravel in a matrix of sand and silt with variable siliceous and calcareous cementation. The gravel clasts are mostly subrounded-to-rounded basalt, quartzite, and granite. The basaltic content of the gravel is about 30 percent. No distinct sand layers were encountered at this location. No perched water was observed during drilling.

3.3.2 Soil Samples

Soil samples from borehole 199-N-109A were collected at discrete depths and submitted for radiological, chemical, and physical property analyses. The borehole summary log for 199-N-109A is presented in Figure 3-16. The summary log shows the elevation and depth of sample collection intervals, well construction, sample collection methods, sample identification numbers, analytical laboratory, lithology, sieve analyses, and moisture content in weight percent.

3.3.2.1 Metal Analysis. Soil samples were analyzed for cadmium, chromium, lead, and nickel to determine the distribution of these metals adjacent to 1325-N. These data are presented in Table 3-7. Concentrations of these metals are at background except cadmium, which does not have a reported background concentration.

3.3.2.2 Radionuclide Analysis. Radionuclide analysis on 199-N-109A soil indicates that the contamination at 1325-N occurs from Co-60, Cs-137, and Sr-90 and is comparable to the distribution profile adjacent to 1301-N (199-N-108A). The data are presented in Table 3-7 (Quanterra) and Table 3-8 (222-S Laboratory). For comparative purposes and to support the discussion of radionuclide distribution, Figure 3-17 presents the laboratory data and the RLS results for borehole 199-N-109A.

The following radionuclides have been detected adjacent to the 1325-N crib: actinium (Ac)-228, Am-241, bismuth (Bi)-214, Cs-137, Co-60, Eu-152, Eu-154, Eu-155, lead (Pb)-214, Mn-54, K-40, Pu-238, Pu-239/240, Ra-224, Ra-226, Ra-228, Sr-90, Th-228, Th-32, U-234, U-235, and U-238. Cesium-144, Cs-134, Co-58, Fe-59, and Ru-106 were not detected by gamma ray spectrometry.

The highest concentrations of Co-60 (up to 379 pCi/g), Cs-137 (573 pCi/g), and Sr-90 (1,340 pCi/g) are near the depth of the 1325-N Crib base. Concentrations decrease with depth to the low pCi/g levels. Plutonium-239/240 has been detected in the low pCi/g (up to 24.1 pCi/g) range.

The gross alpha concentrations (up to 39.8 pCi/g) detected are indicative of the alpha emitters, primarily Pu-239/240 and Am-241, that are present at low concentrations (<25 pCi/g). The gross beta concentrations (up to 3,170 pCi/g) detected are indicative of the beta emitter Sr-90 that is present (>1,000 pCi/g). Just above the water table, the gross alpha concentration is less than detectable, and the gross beta concentration is <43 pCi/g.

Other radionuclides (Eu-154, Eu-155, Mn-54, K-40, Ra-226, U-234) that were detected were found essentially at low concentrations (<15 pCi/g) near the crib base. Ru-106 was not detected. U-235 was detected at less than 1 pCi/g.

3.3.2.3 Physical Property Analysis. Physical property analyses are summarized in Table 3-9. Gravimetric moisture content ranges from 2.54 to 5.76 percent. Particle density values range from 2.864 to 2.981 g/cm^3. Dry bulk density ranges from 1.921 to 2.175 g/cm^3. Wet bulk density ranges from 1.986 to 2.239 g/cm^3. The gravimetric moisture data can be used to calculate volumetric moisture content if the dry bulk density of the soil is known. The volumetric moisture content is determined by multiplying the dry bulk density by the gravimetric moisture content. Porosity ranges from 24.4 to 34.4 percent. Saturated vertical hydraulic conductivity (permeability) ranges from 5.3E-2 to 6.2E-2 cm/sec. Moisture retention curves and particle size distribution curves are presented in Appendix B. Generalized particle size distributions are presented in Figure 3-16.

3.3.3 Geophysical Logging

The RLS results for Co-60 and Cs-137 for borehole 199-N-109A are presented in Figure 3-17 and are compared to the laboratory analyses on soil removed from the borehole. A complete set of the RLS geophysical logs is presented in Appendix B.

The concentrations of Co-60 detected by RLS are similar to those detected by laboratory analyses on soil collected during drilling. The maximum concentration of Co-60 detected was 175 pCi/g at the base of the crib. Cesium-137 was detected at the base of the crib in concentrations up to 420 pCi/g and has not been detected at depths between 2.5 ft below the trench base (12 ft bgs) to the water table.

The RLS results for Co-60 in soil at wells 199-N-35 and 199-N-45 are presented in Figure 3-18. Cobalt-60 concentrations range from 1 to 10 pCi/g with a noticeable increase in concentrations below the old groundwater mound. This increase below the mound was not detected in 199-N-109A. Cesium-137 in soil has not been detected in these wells. Moisture profiles of wells 199-N-35 and 199-N-45, measured by WHC, are presented and discussed in Appendix B. The profiles are qualitative because they do not meet DQOs; however, they provided preliminary data on moisture distribution and were used to support the proposition that 1325-N is analogous to 1301-N.

Moisture and porosity profiles of the soil column at 199-N-109A were measured by Schlumberger Well Services (Figure 3-19). A discussion of profile format is presented in Section 3.2.3, and the profiles are presented in Appendix B. Both logs were collected continuously throughout the borehole; however, the neutron-neutron system was not run in the upper 2.6 m (8.5 ft). Figure 3-19 presents moisture and porosity profiles for 199-N-109A. Overall, the sediments range from dry to moist. The volumetric soil moisture ranges from 8.2 to 17.9 percent with an average value of 11.7 percent. There are no saturated zones in this borehole.

Zones where a large volume of air-filled porosity occurs are indicative of low-moisture porous sands. The zone where the logged air-filled porosity is in error, because of high activities of gamma-emitting contamination, is indicated in Figure 3-19. The moisture log is unaffected by the contaminated zones.

3.3.4 Field Screening

An RCT performed field screening for radioactivity using a portable scintillation counter to measure levels of beta-gamma activity. Alpha activity was measured using a PAM. The measured radioactivity was compared to the site (shielded) background to assess radiological contamination levels present in the soil. To decrease the site background radioactivity at the 199-N-109A drill site, a metal shield was placed on the concrete crib panels next to the drilling area. Small shielded enclosures were made at the drill site and in the sampling van to further reduce the background radiation level so that samples could be surveyed.

Contamination was first detected just above the crib base 2.4 ft (8 ft bgs) at 30,000 dpm beta-gamma. The highest activity detected was approximately 45,000 dpm beta-gamma on the first split-spoon sample collected from the crib base. Radiological activity progressively decreased with depth to less than 2,000 dpm below 25.5 ft (35 ft bgs) and became difficult to determine above the background for the borehole site. Using field instruments, no detectable radiological activity was found in samples collected from 35.5 ft (45 ft bgs) and below. No alpha activity was detected on any of the borehole soils.

3.3.5 Surface Radiation Measurements

During the planning phases of the LFI, radiation measurements in mrem/hr were collected 1 m (3 ft) above the concrete panels (about 4 m [13 ft] above the ground surface) on the 1325-N crib. The results of this survey are shown in Figure 3-20. In general, the dose rate was about 50 mrem/hr at the 1325-N crib, with maximum readings up to about 125 mrem/hr.

3.4 RESULTS OF OTHER INVESTIGATIONS

Soil characterization information was collected during drilling for the N Springs ERA and were evaluated for this LFI because Sr-90 was detected in soil near the water table. In 1995, three extraction wells (199-N-103A, 199-N-105A, and 199-N-106A) and one injection well (199-N-104A) were drilled to support the N-Springs Pump-and Treat Project (Walker, 1996; Glaman and Walker, 1995). The purpose of the pump-and-treat system is to remove Sr-90 from extracted groundwater. During well drilling eighty soil samples were collected for one or all of the following by a split-spoon sampler or from the drive barrel:

- total activity to characterize the soil and waste for shipping (222-S Laboratory)
- total activity, gamma spectrometry, and Sr-90 to characterize soil (Environmental Analytical Laboratory [EAL])
- physical properties to verify screen size and filter pack decisions (WHC Geotechnical Laboratory)
- strontium-90 sorbtion to characterize soil (Pacific Northwest National Laboratory [PNNL])
- total strontium desorbtion to estimate the remobility of the contamination (PNNL)
- metals, total paraffin hydrocarbon-diesel, gross alpha, gross, beta, Sr-90, tritium, Co-60, and Cs-137 to determine the method used to dispose of drill cuttings (Quanterra).

The laboratories that performed the analyses are indicated in parentheses. The results of these analyses are presented in Appendix A, Table A8-1.

Because the three extraction wells were drilled at locations where Sr-90 is present in groundwater, they were expected to have detectable levels of Sr-90 in soil. The analytical results can be used for comparison to the LFI borehole results for informative purposes only. Soil samples were not collected in the exact manner as those collected during this LFI, so caution should be used when making decisions based on a comparison. For example, the PNNL results for Sr-90 are not directly comparative because different analyses and size fractions were performed for different purposes resulting in different concentrations from EAL results. The PNNL samples analyzed were oven-dried, at <2-mm aliquots of selected sediments to determine the sorbtion and desorbtive properties of Sr-90 on finer soils present in the soil column.

Strontium-90 was detected in the old groundwater mound at concentrations about 700 pCi/g. The conceptual model (Section 4.0) and QRA (Section 5.0) use this previously acquired data for evaluation purposes.

3.5 SUMMARY OF RESULTS

The results of the LFI are summarized as follows:

- The vadose zone consists of Hanford formation sands and gravels overlying gravel-dominated Unit E of the Ringold Formation.
- The current average depth to groundwater below the facilities ranges from about 22.9 m (65 ft) to 19.8 m (75 ft).
- The highest concentrations of metals are located at 1301-N in the "concentrated" layer from the base of the crib to a few feet below it.
- The majority of radionuclide contamination occurs as Co-60, Cs-137, Sr-90, and Pu-239/240 and is located primarily in the concentrated layer.
- Concentrations of Co-60, Cs-137, Sr-90, and Pu-239/240 decrease significantly with depth.
- Strontium-90 has migrated deeper than the other radionuclides, but concentrations also decrease with depth.
- Four wells drilled near 1301-N and 1325-N for another project had Sr-90 in soil near the water table.
- No saturated zones were encountered above the water table during the LFI drilling.

The following section presents the conceptual model for 1301-N and 1325-N and provides the framework for the QRA.

Figure 3-1. 1301-N Cross Sections with Depths and Elevations

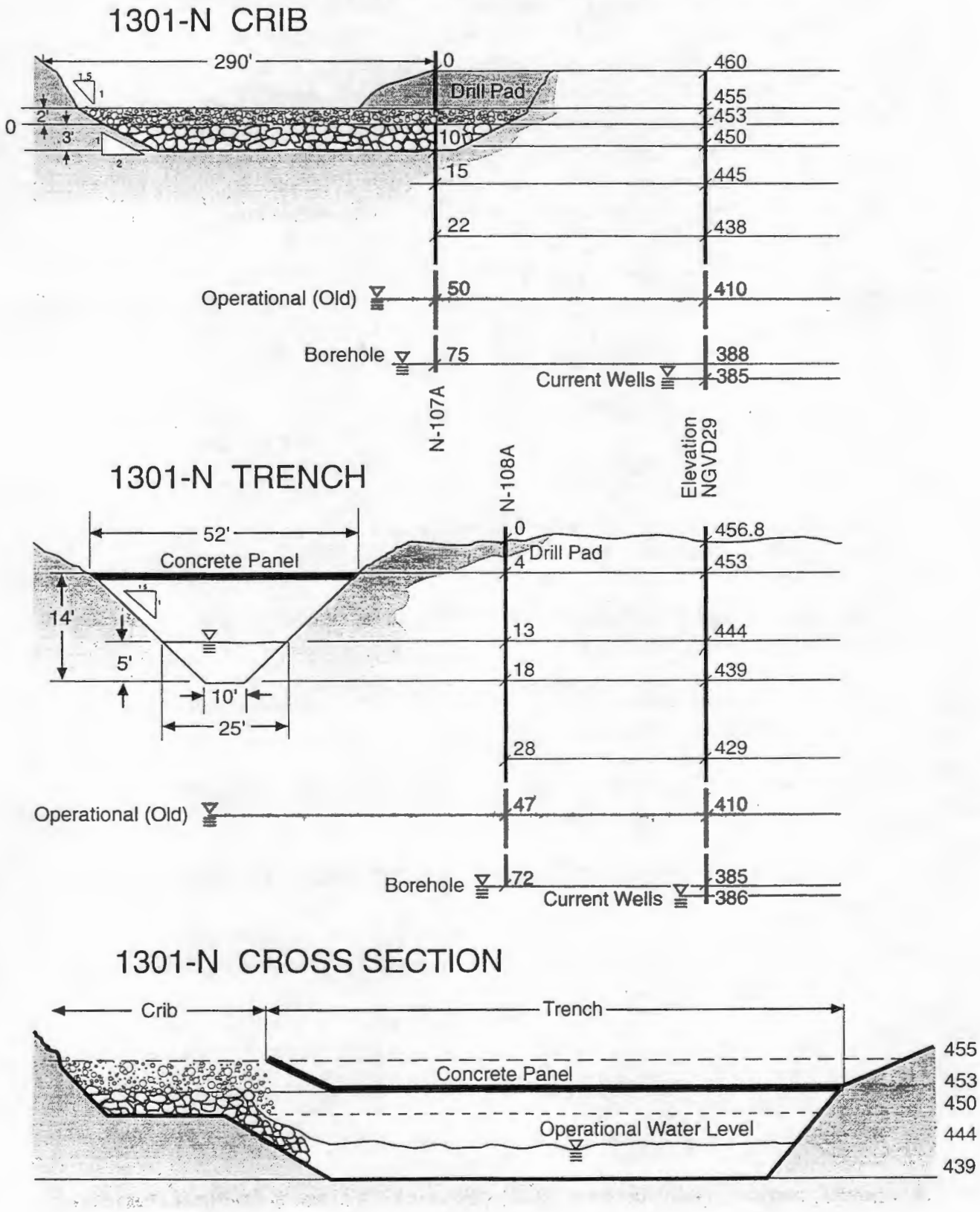


Figure 3-2. 1325-N Cross Sections with Depths and Elevations

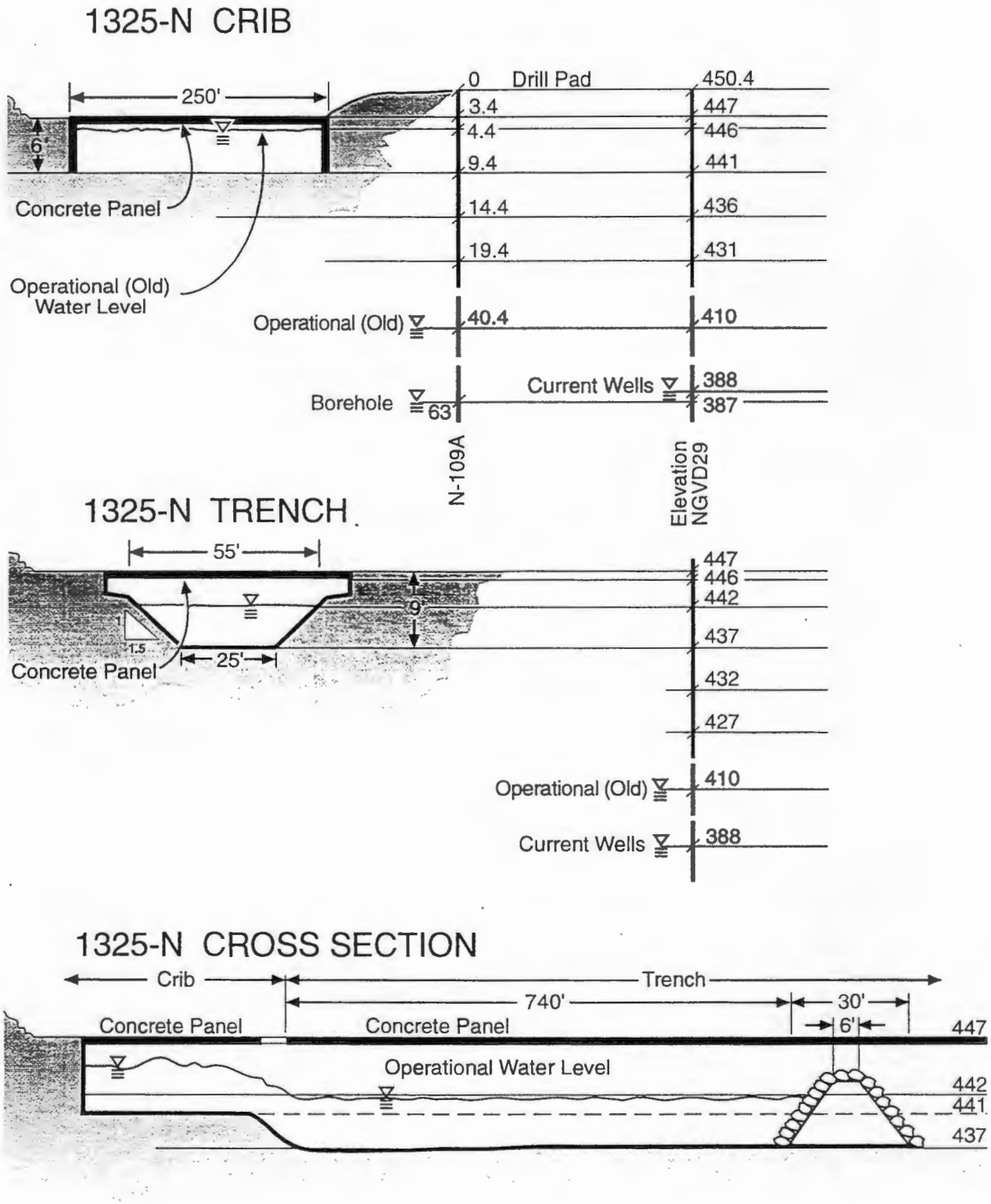
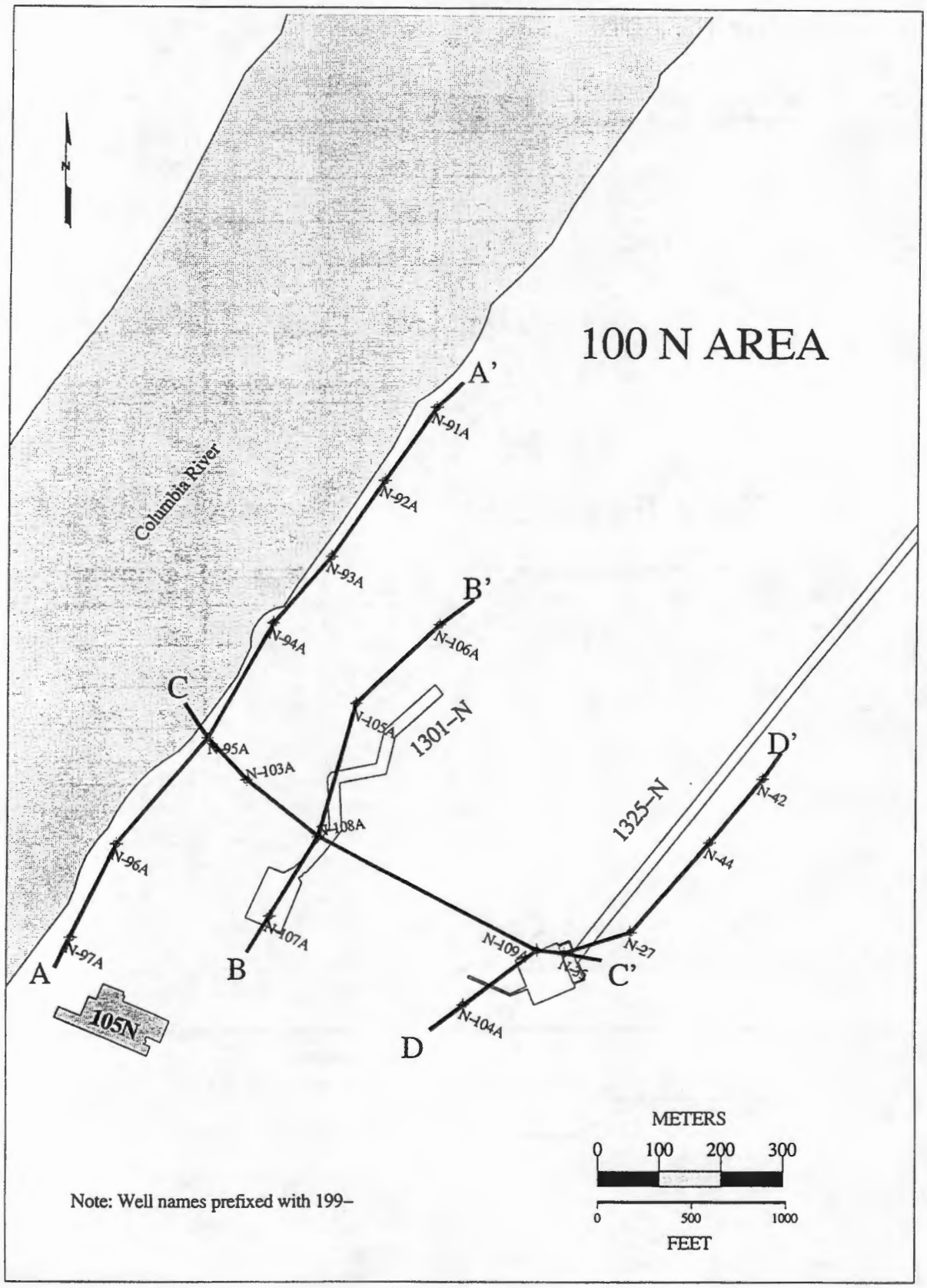
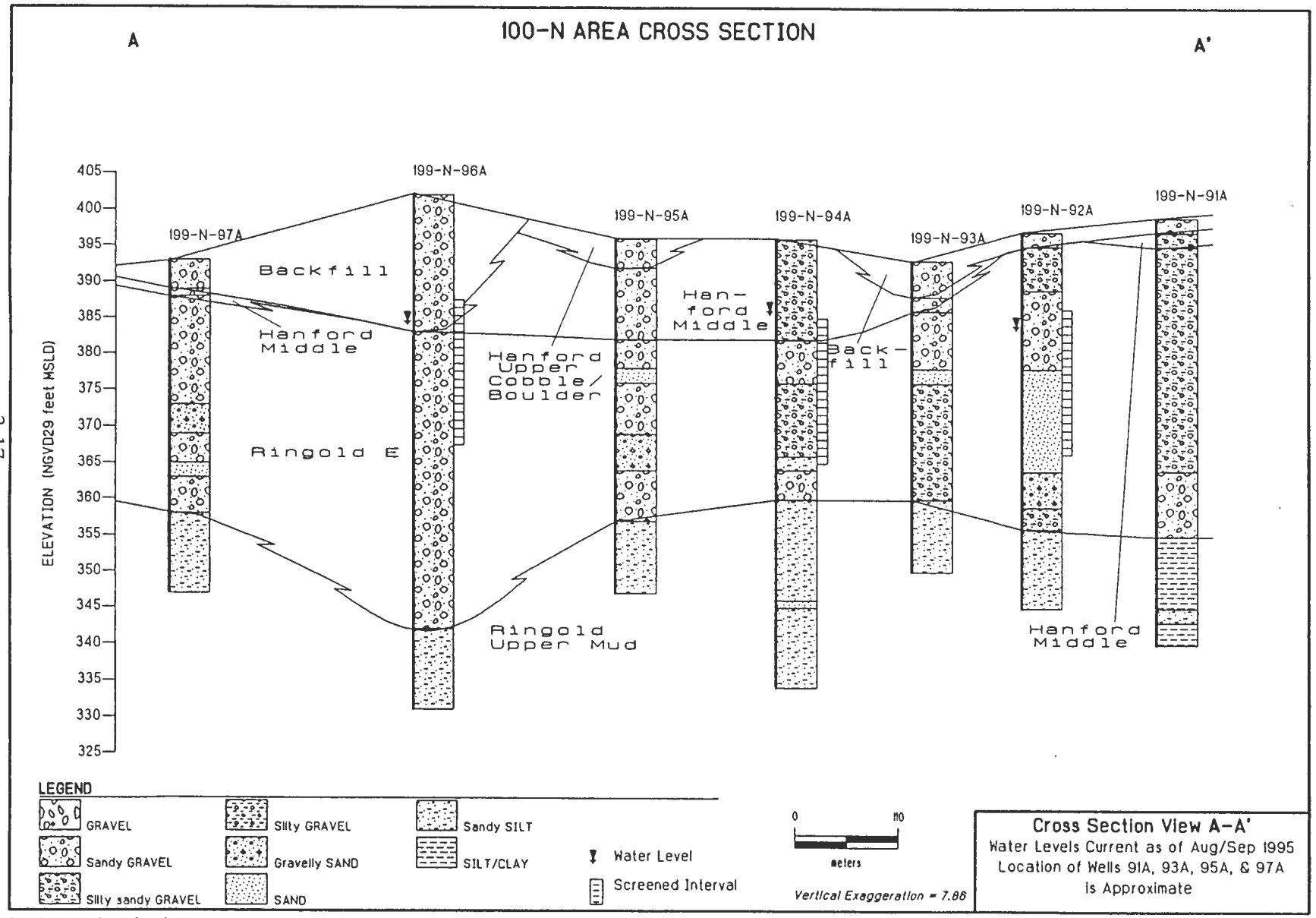


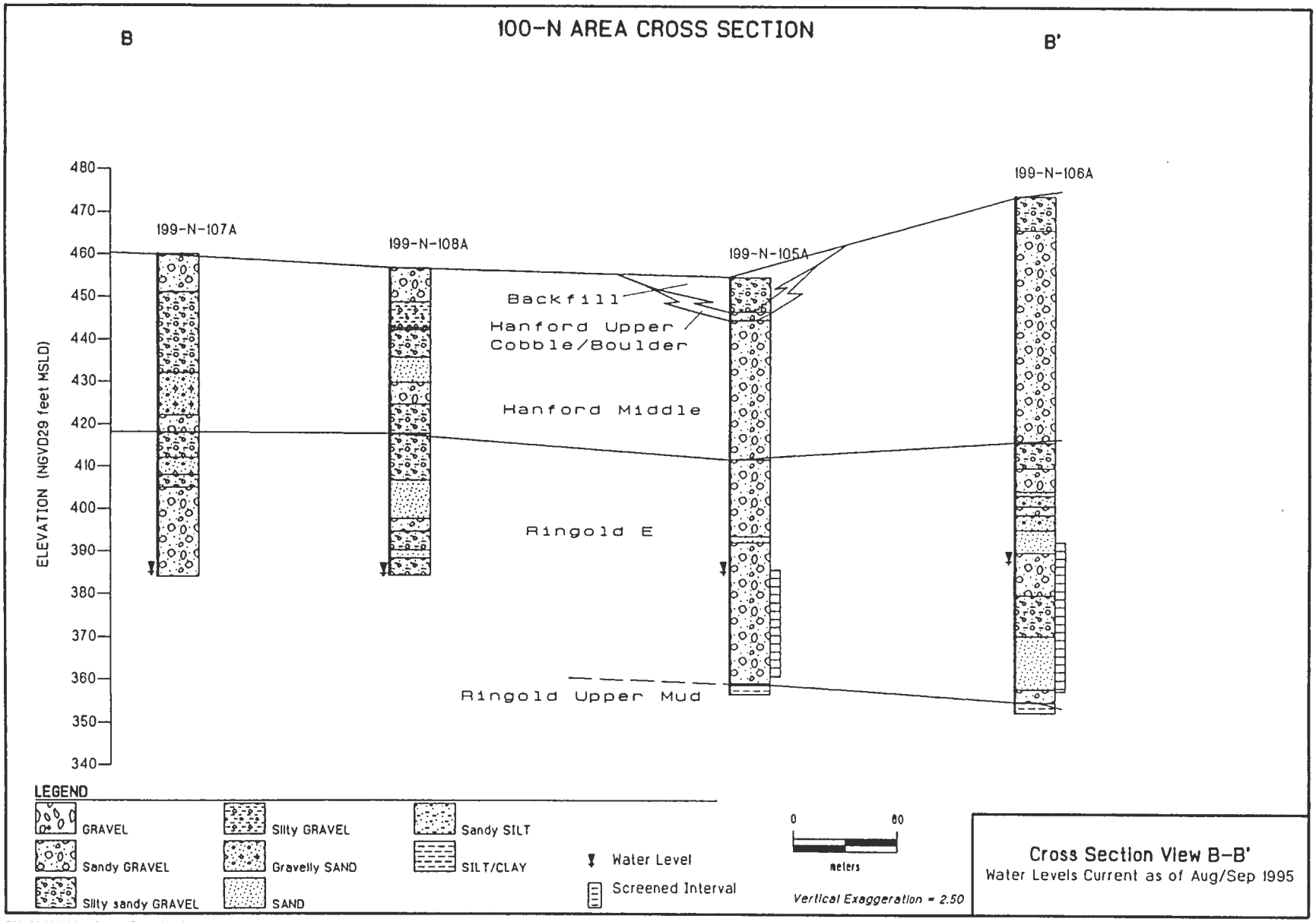
Figure 3-3. Locations of Stratigraphic Cross Sections





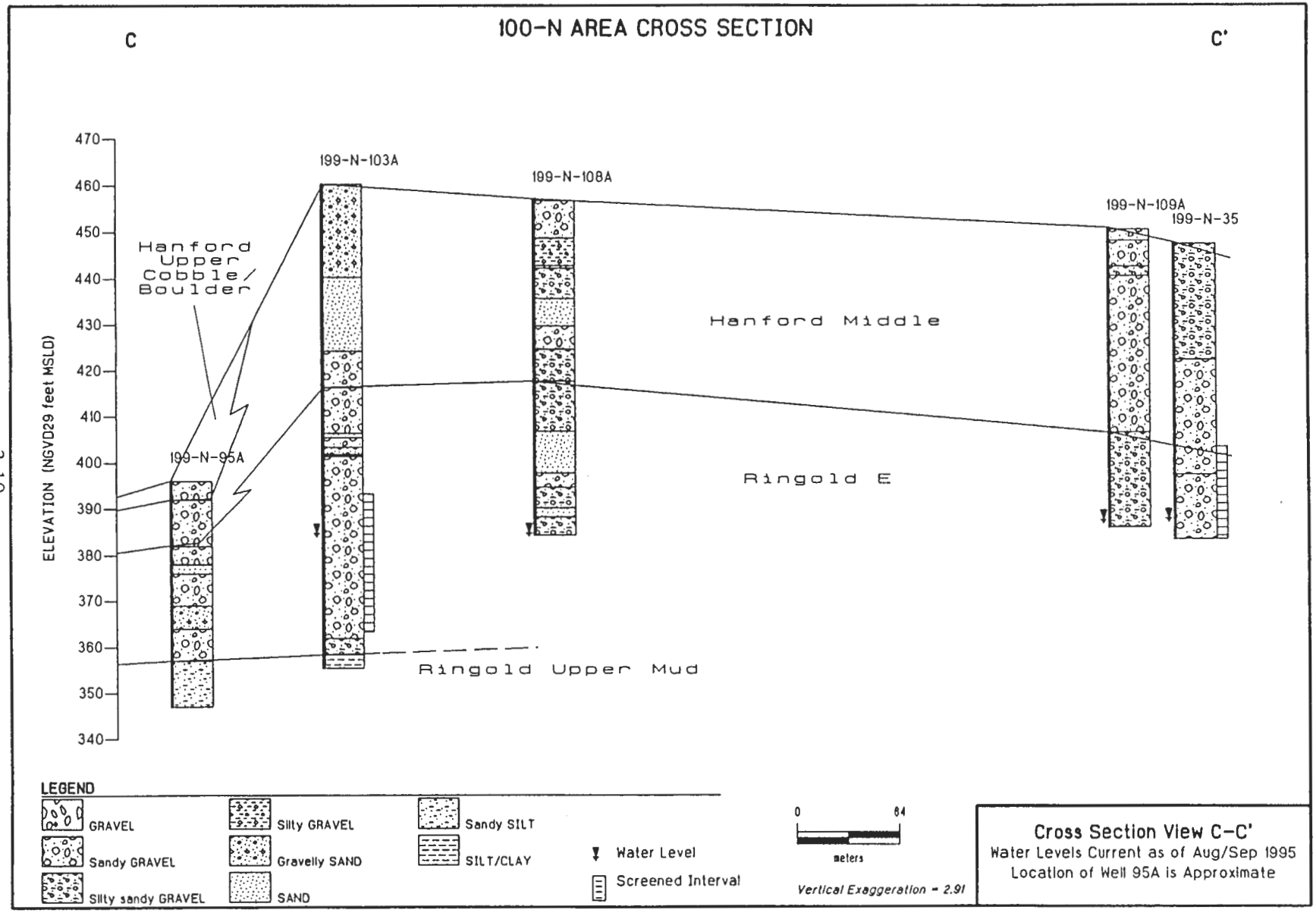
CH2M Hill Hanford, Inc./gkj

Figure 3-4. Stratigraphic Cross-Section A-A'



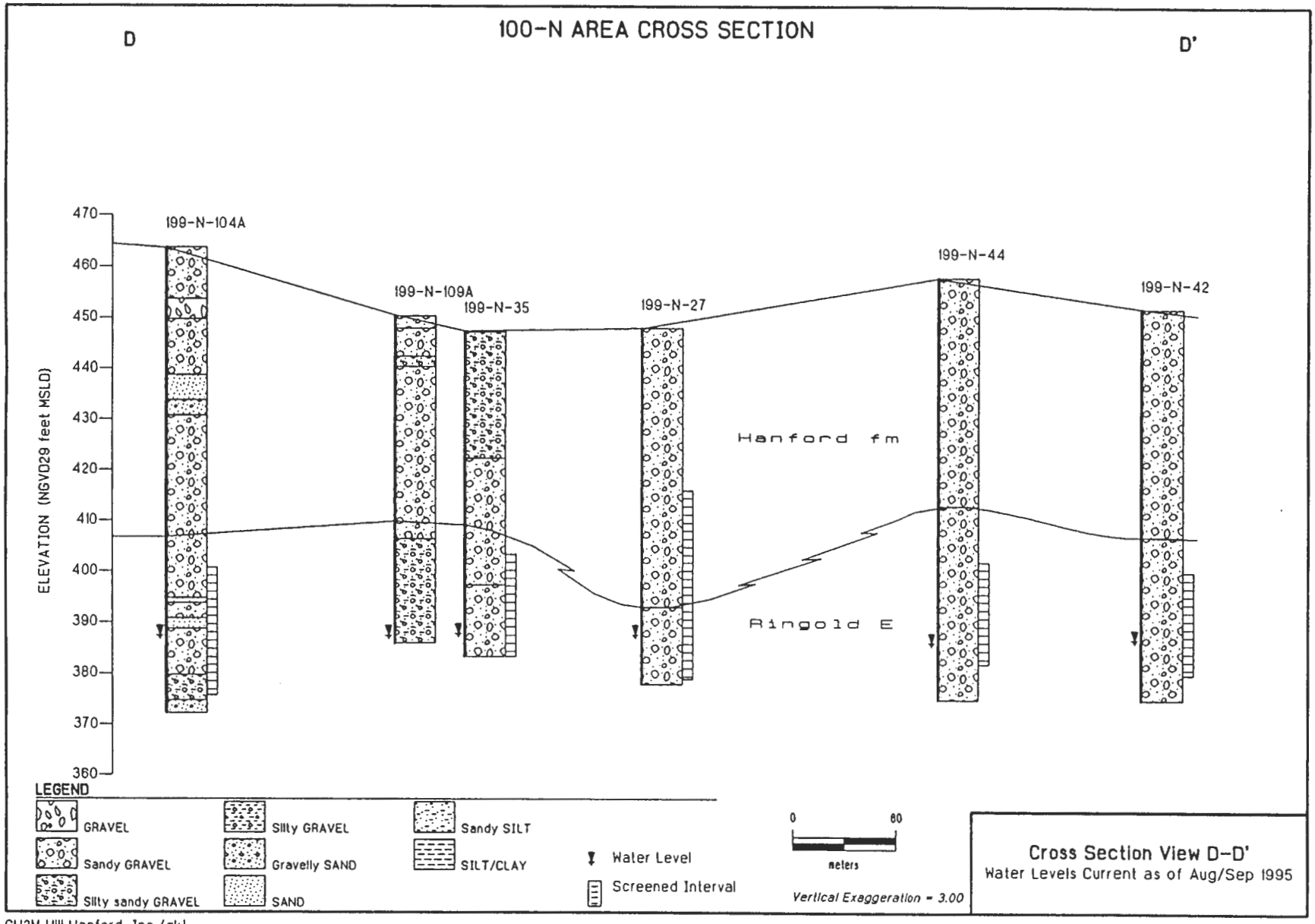
CH2M Hill Hanford, Inc./gkj

Figure 3-5. Stratigraphic Cross-Section B-B'



CH2M Hill Hanford, Inc./gkj

Figure 3-6. Stratigraphic Cross-Section C-C'



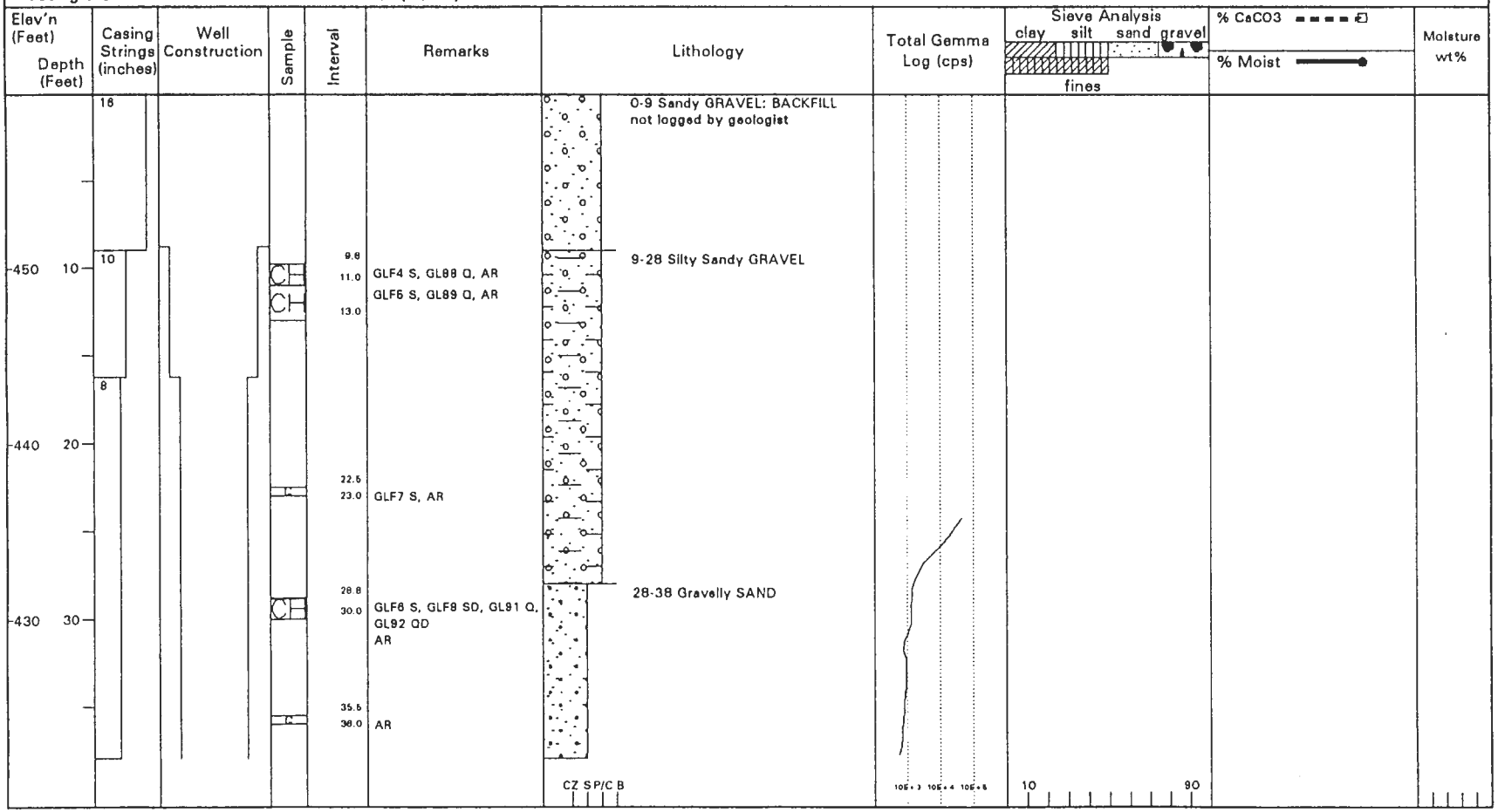
CH2M Hill Hanford, Inc./gkj

Figure 3-7. Stratigraphic Cross-Section D-D'

Figure 3-8. Summary Log for Borehole 199-N-107A (Page 1 of 2)

Project: 1301-N/1325-N LWDF Drilling		Well No: 199-N-107A	Page 1 of 2
Date Started: 11-28-95	Date Completed: 12-8-95	Total Depth: 76.00	Static Water Level: 75.00
Logged By: D. C. Weekes	Checked By: G. G. Kelty	Surface Elevation: 460.05	Casing Elevation: 463.92
Drilling Co: Water Development Hanford Co.	Driller: M. Wrasplr/G. Howell	Northing: 149685.11	Easting: 571462.35
Drilling Method: Cable tool		Drilling Equipment: Bucyrus Erie 22W	
Screen: NA			
Filter Pack: NA			
Permanent Casing:		Temporary Casing: 16" 0-9', 10" 0-16.2', 8" 0-75.2'	

Comments: Characterization borehole through 1301-N Crib (see DOE/RL-94-104) elevation is in FEET NGVD29 (calculated from NAVD88 in meters), Northing and Easting are in METERS referenced to WCS83(1991)S



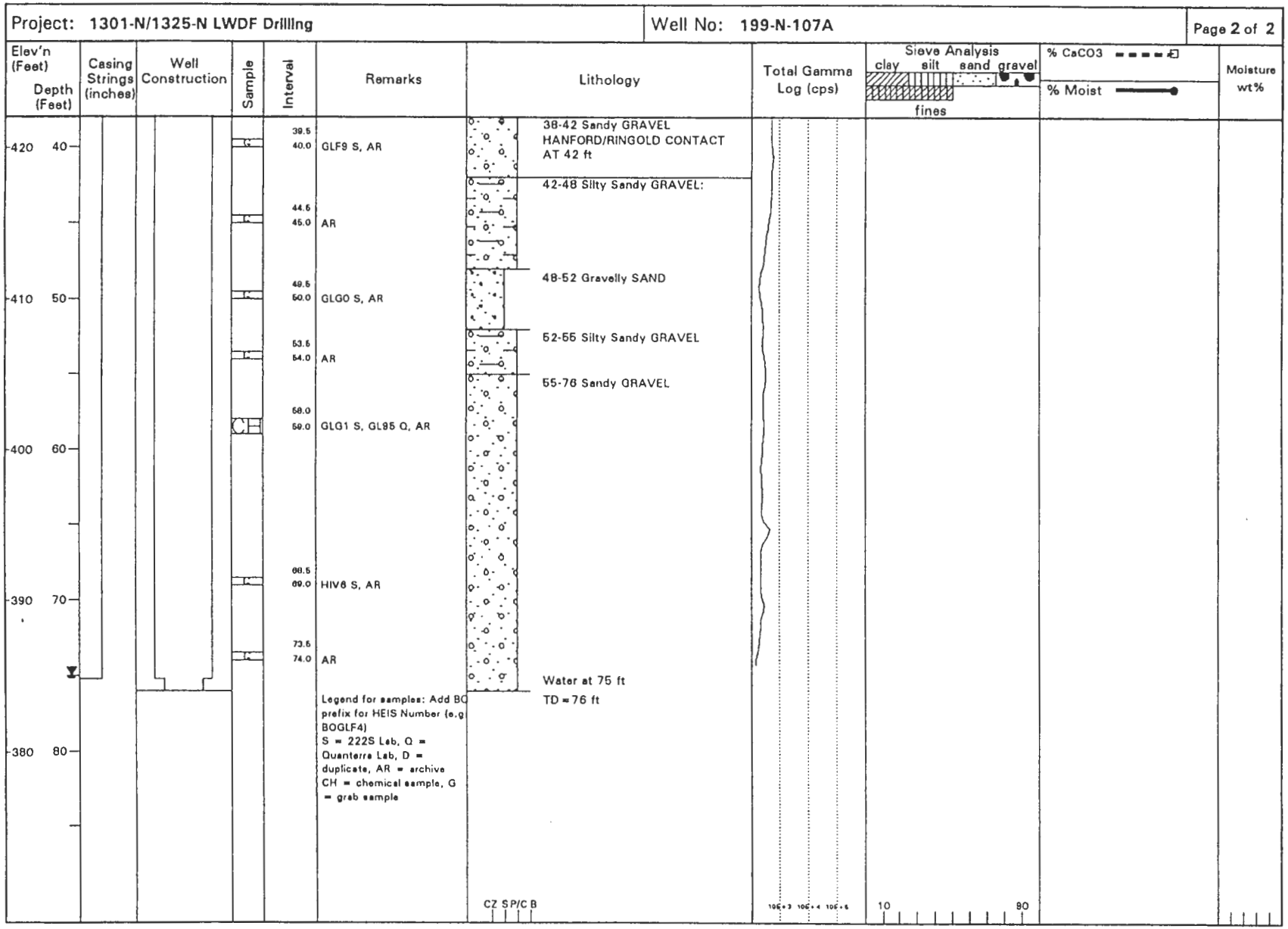


Figure 3-8. Summary Log for Borehole 199-N-107A (Page 2 of 2)

Figure 3-9. Summary Log for Borehole 199-N-108A (Page 1 of 2)

Project: 1301-N/1325-N LWDF Drilling		Well No: 199-N-108A	Page 1 of 2
Date Started: 11-6-95	Date Completed: 11-16-95	Total Depth: 75.00	Static Water Level: 72.00
Logged By: D. C. Weekes	Checked By: G. G. Kelty	Surface Elevation: 456.76	Casing Elevation: 460.29
Drilling Co: Water Development Hanford Co.	Driller: G. Howell/M. Wrasplr	Northing: 149812.50	Easting: 571541.51
Drilling Method: Cable tool		Drilling Equipment: Bucyrus-Erie 22W	
Screen: NA			
Filter Pack: NA			
Permanent Casing:		Temporary Casing: 10" 0-36.4', 8" 0-70.8'	

Comments: Characterization borehole next to 1301-N Trench (see DOE/RL-94-104) elevation is in FEET NGVD29 (calculated from NAVD88 in meters), Northing and Easting in METERS referenced to WCS83(1991)S

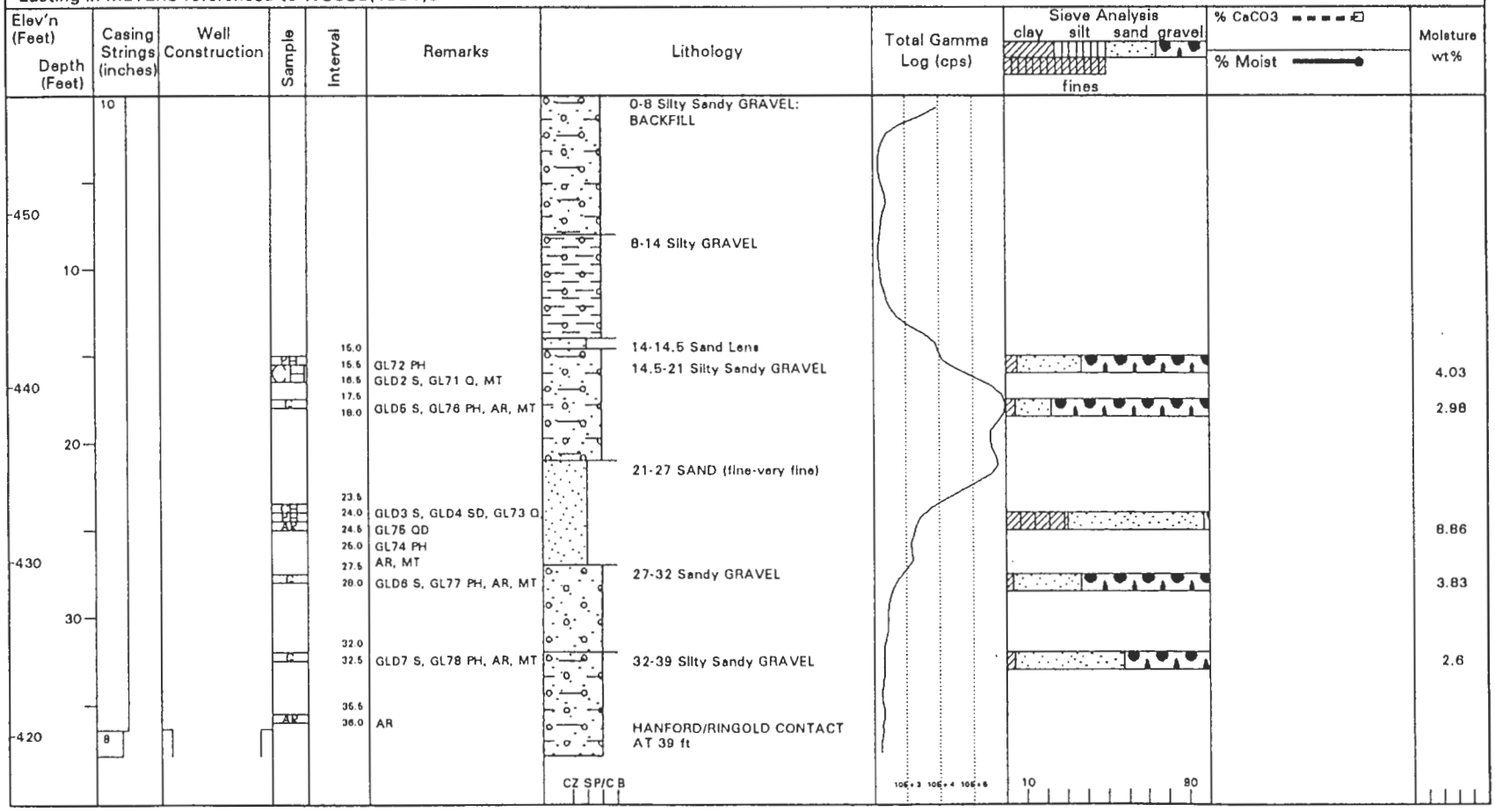


Figure 3-9. Summary Log for Borehole 199-N-108A (Page 2 of 2)

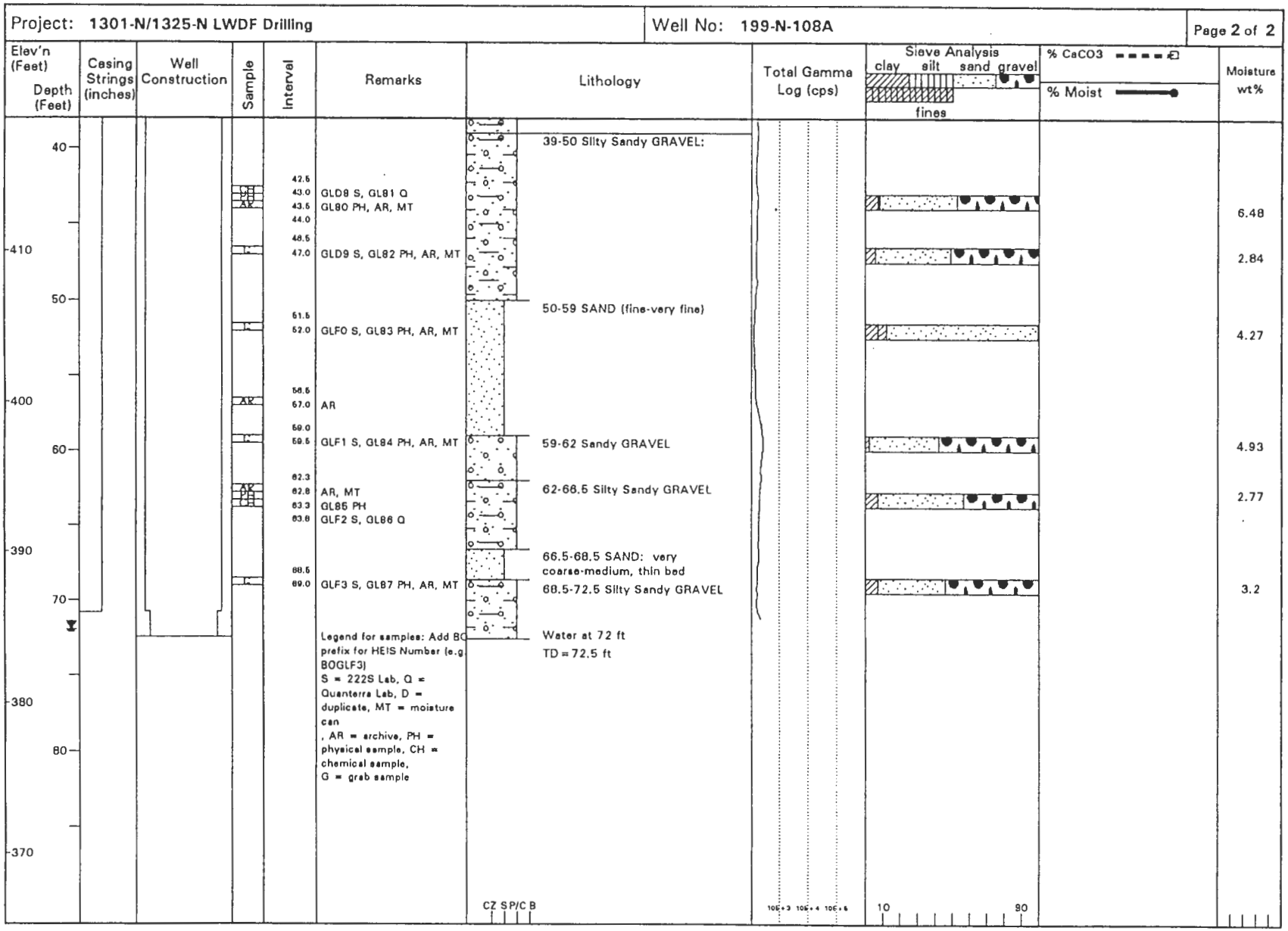
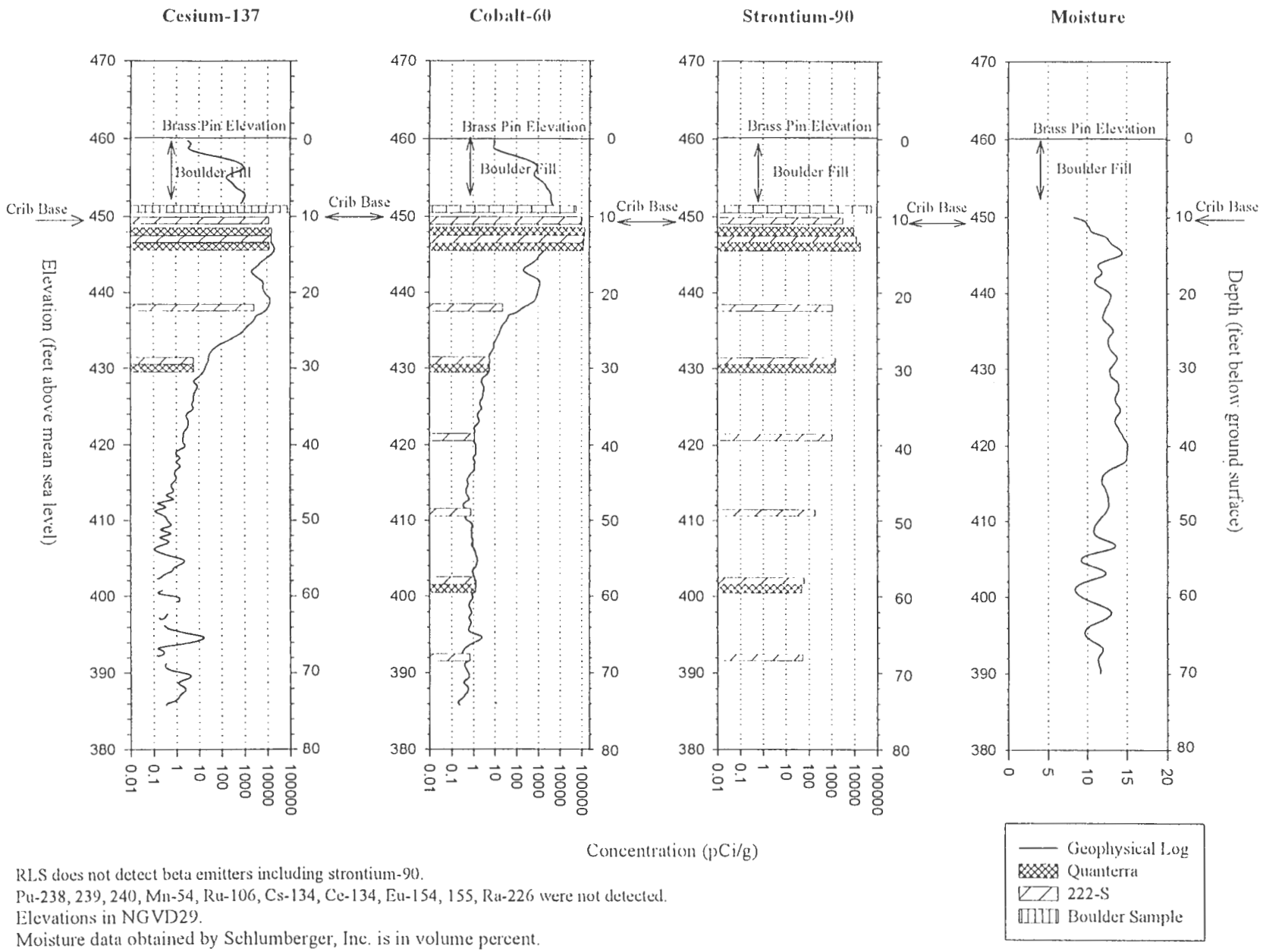
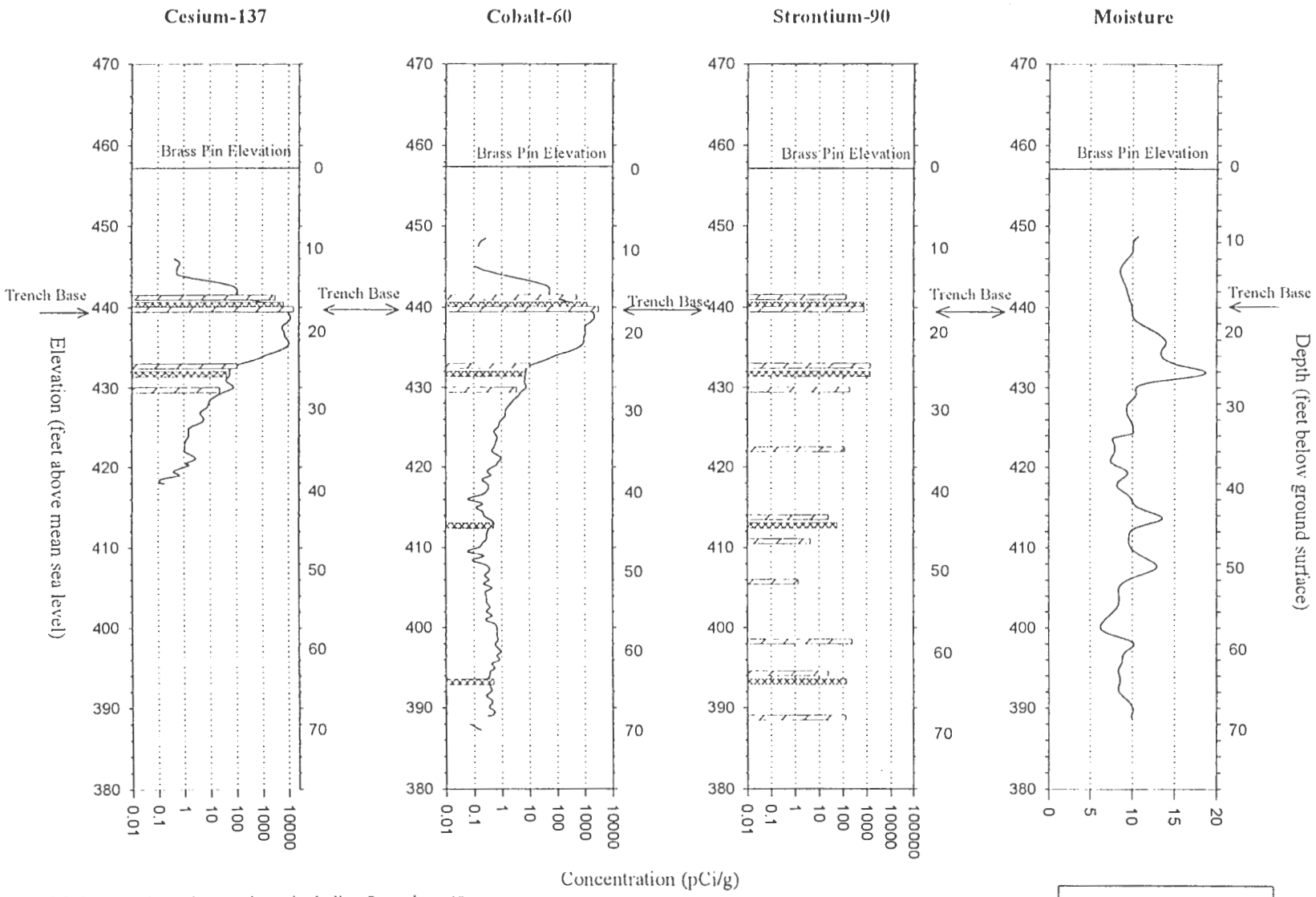


Figure 3-10. Radionuclide Contamination with Depth, Borehole 199-N-107A



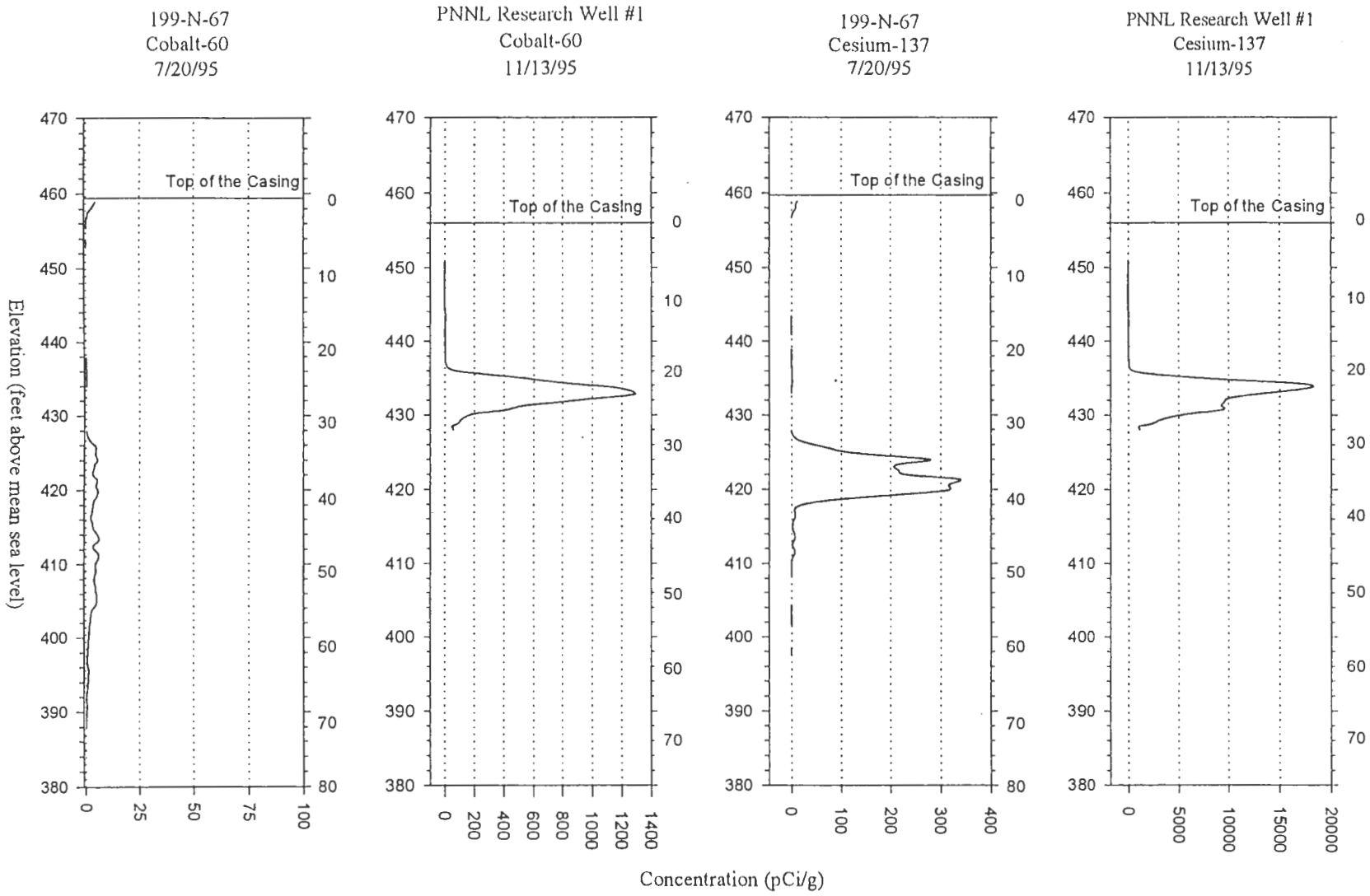
RLS does not detect beta emitters including strontium-90.
Pu-238, 239, 240, Mn-54, Ru-106, Cs-134, Ce-134, Eu-154, 155, Ra-226 were not detected.
Elevations in NGVD29.
Moisture data obtained by Schlumberger, Inc. is in volume percent.

Figure 3-11. Radionuclide Contamination with Depth, Borehole 199-N-108A



RLS does not detect beta emitters including Strontium-90.
Cesium-137 not detected on RLS log below 418 feet elevation.
Pu-238, 239, 240, Mn-54, Ru-106, Cs-134, Ce-134, Eu-154, 155, Ra-226 were not detected.
Elevations in NGVD29.
Moisture data obtained by Schlumberger, Inc. is in volume percent.

Figure 3-12. Cobalt-60 and Cesium-137 for Wells 199-N-67 and RW#1



Since activities in Research Well #1 are significantly higher than in 199-N-67 they are plotted at different scales.
Elevation in NGVD29.

Figure 3-13. Borehole 199-N-107A Porosity and Moisture Log

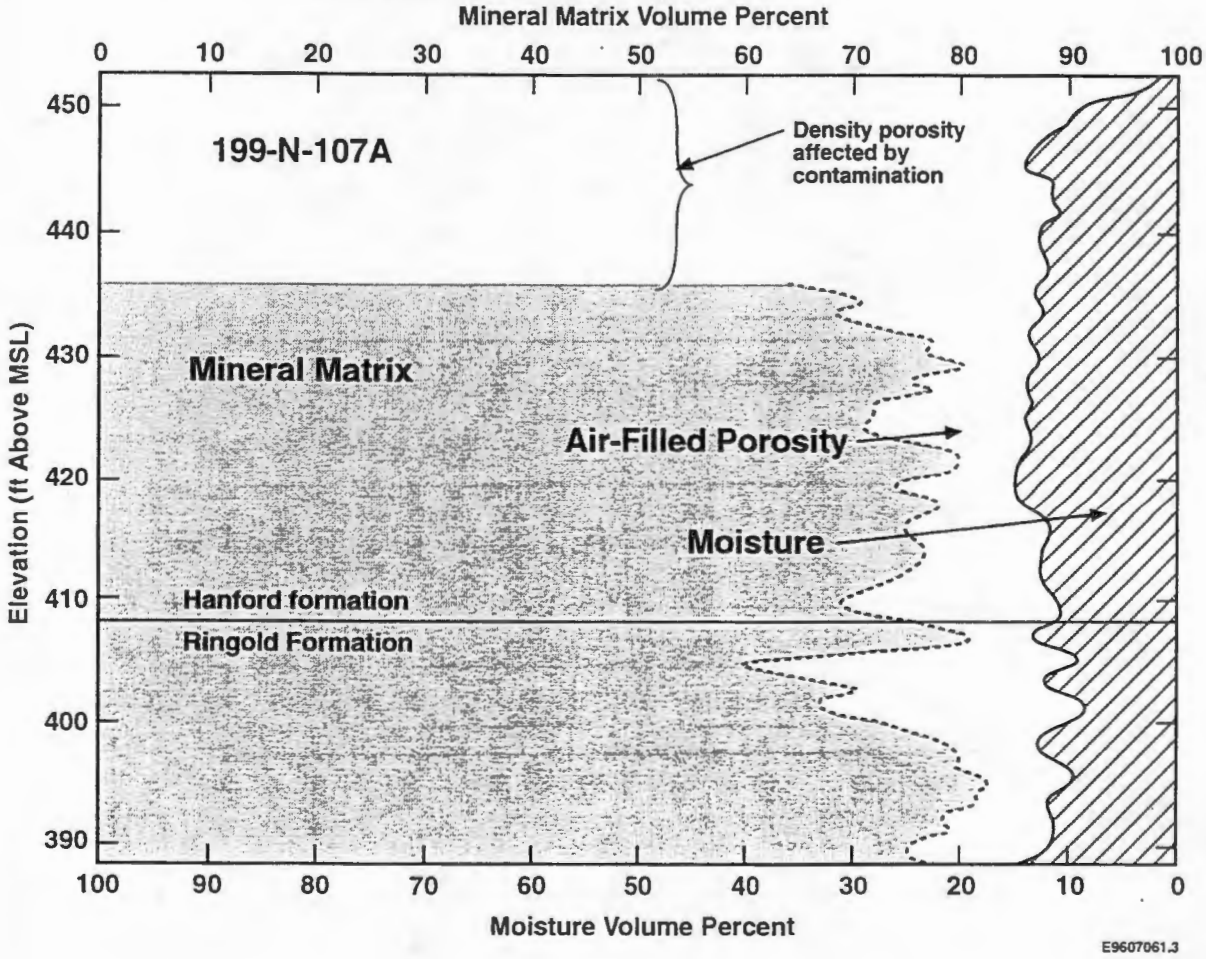
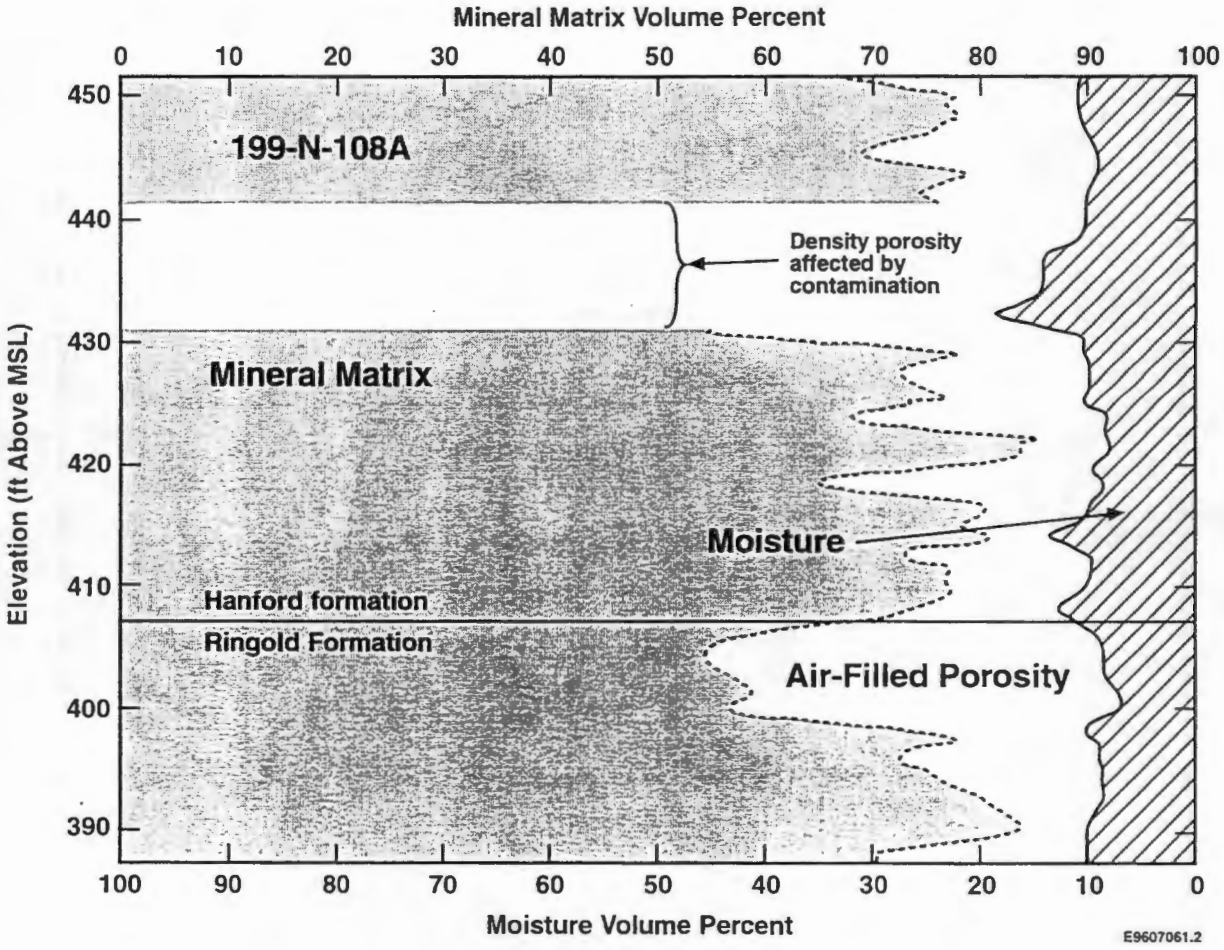


Figure 3-14. Borehole 199-N-108A Porosity and Moisture Log



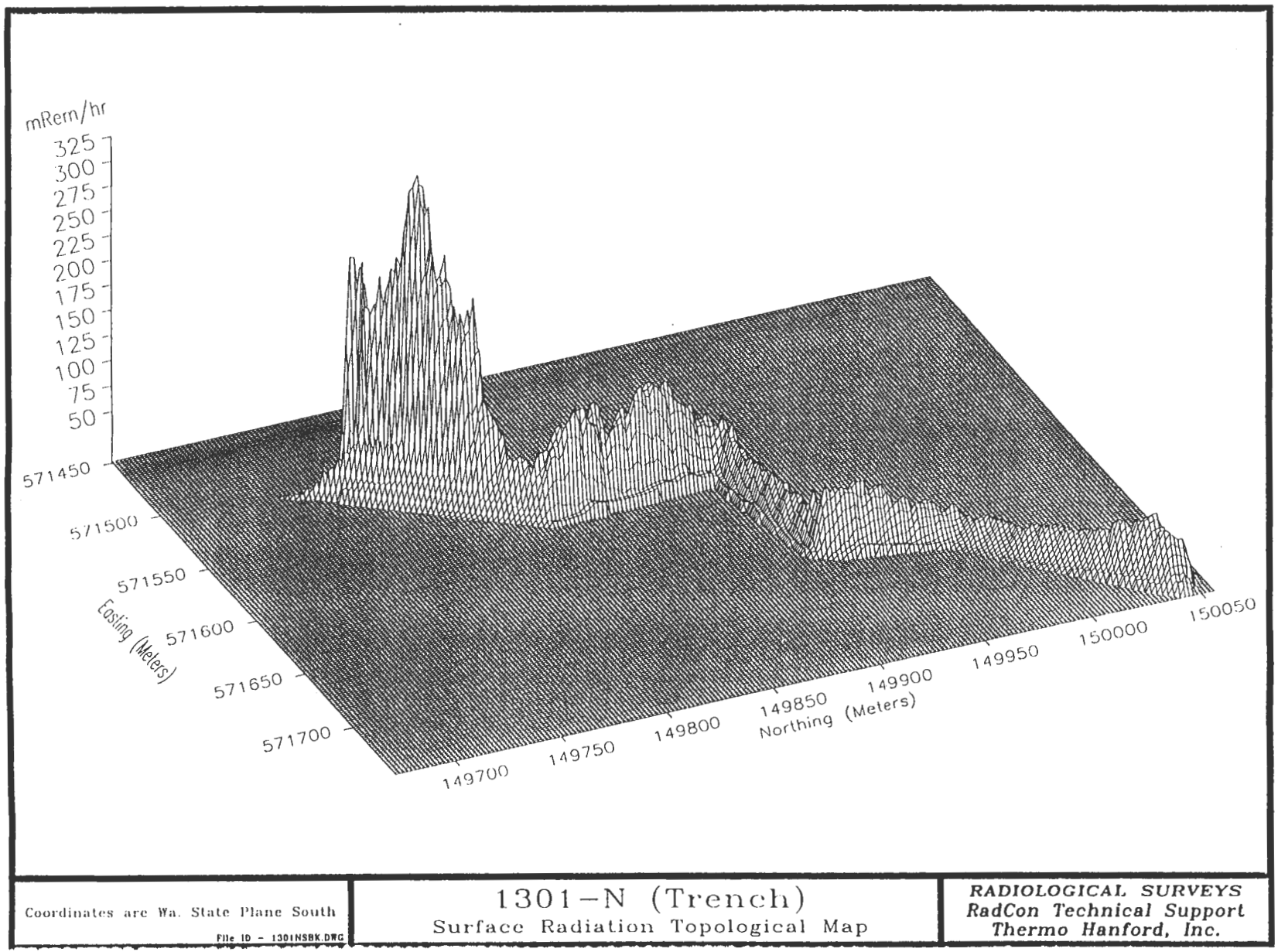


Figure 3-15. 1301-N Trench Surface Measurements

Figure 3-16. Summary Log for Borehole 199-N-109A (Page 1 of 2)

Project: 1301-N/1325-N LWDF Drilling		Well No: 199-N-109A	Page 1 of 2
Date Started: 12-19-95	Date Completed: 12-28-95	Total Depth: 64.64	Static Water Level: 63.00
Logged By: D. C. Weekes	Checked By: G. G. Kelty	Surface Elevation: 450.45	Casing Elevation: 454.85
Drilling Co: Water Development Hanford Co.	Driller: M. Wraspir/G. Howell	Northing: 149630.62	Easting: 571898.17
Drilling Method: Cable tool		Drilling Equipment: Bucyrus-Erie 22W	
Screen: NA			
Filter Pack: NA			
Permanent Casing:		Temporary Casing: 10" 0-21', 8" 0-64.64'	

Comments: Characterization borehole next to 1325-N Crib (see DOE/RL-94-104) elevation is in FEET NGVD29 (calculated from NAVD88 in meters), Northing and Easting in METERS referenced to WCS83(1991)S, 8" casing was driven below the hole depth

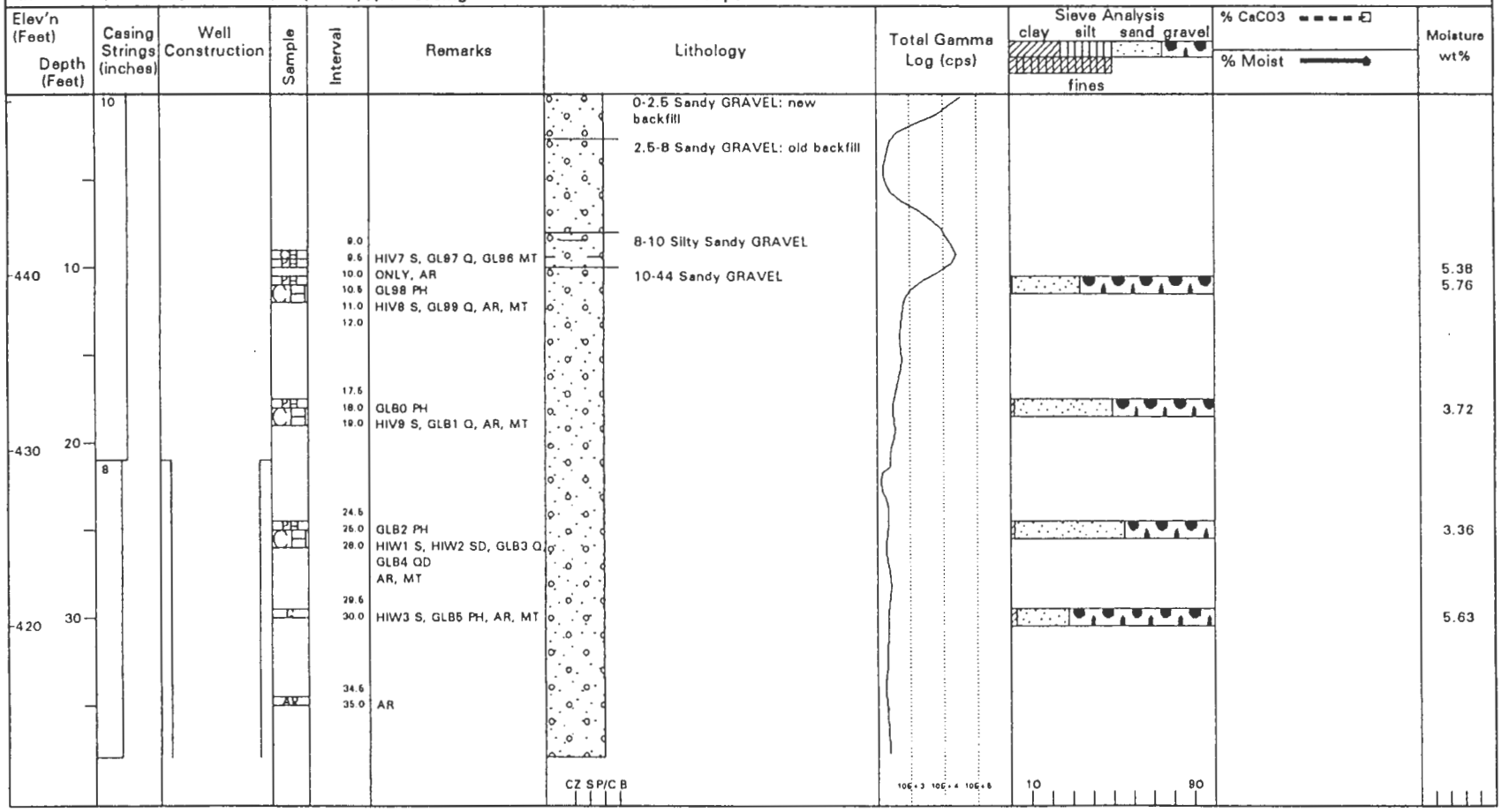


Figure 3-16. Summary Log for Borehole 199-N-109A (Page 2 of 2)

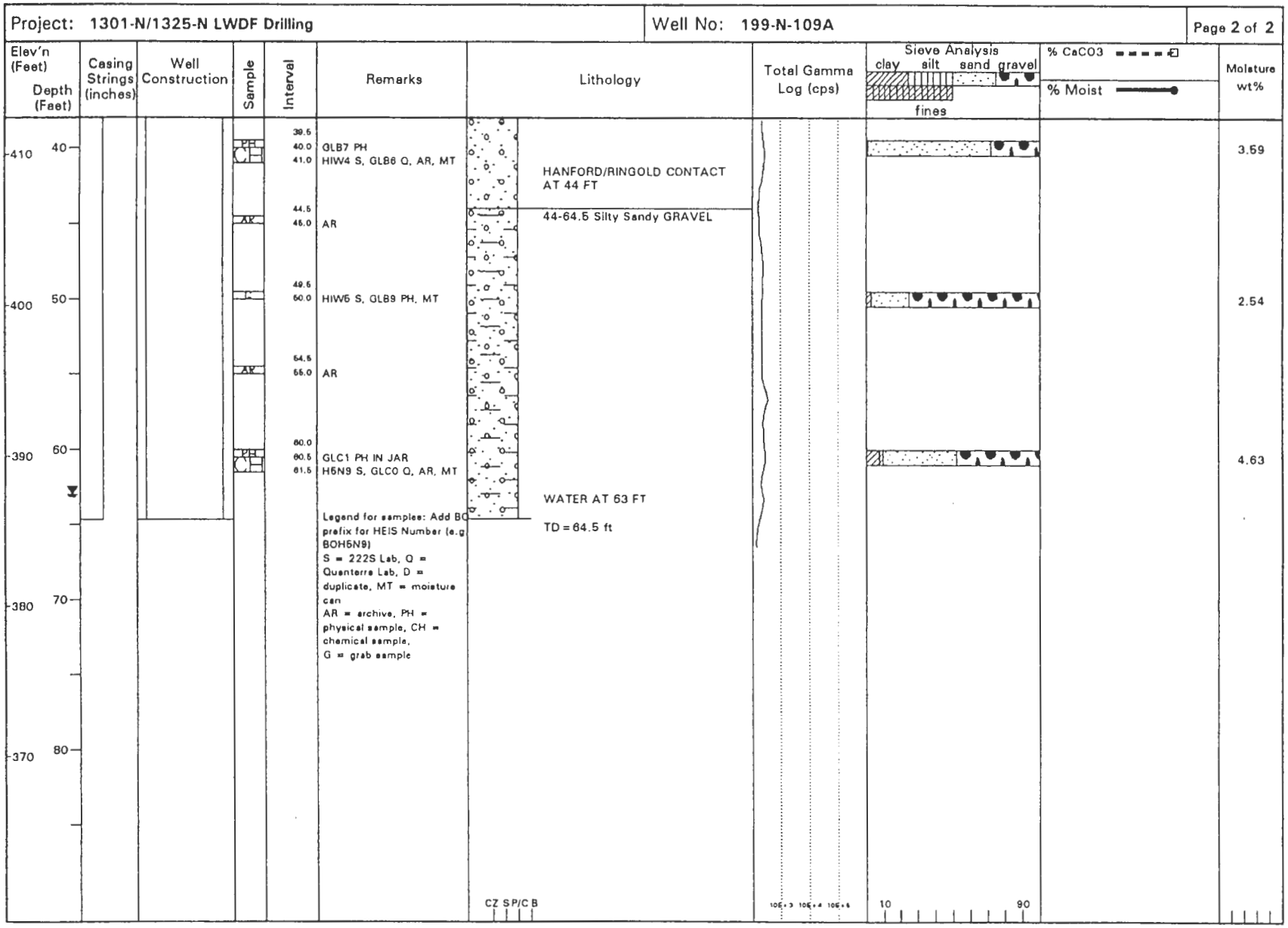
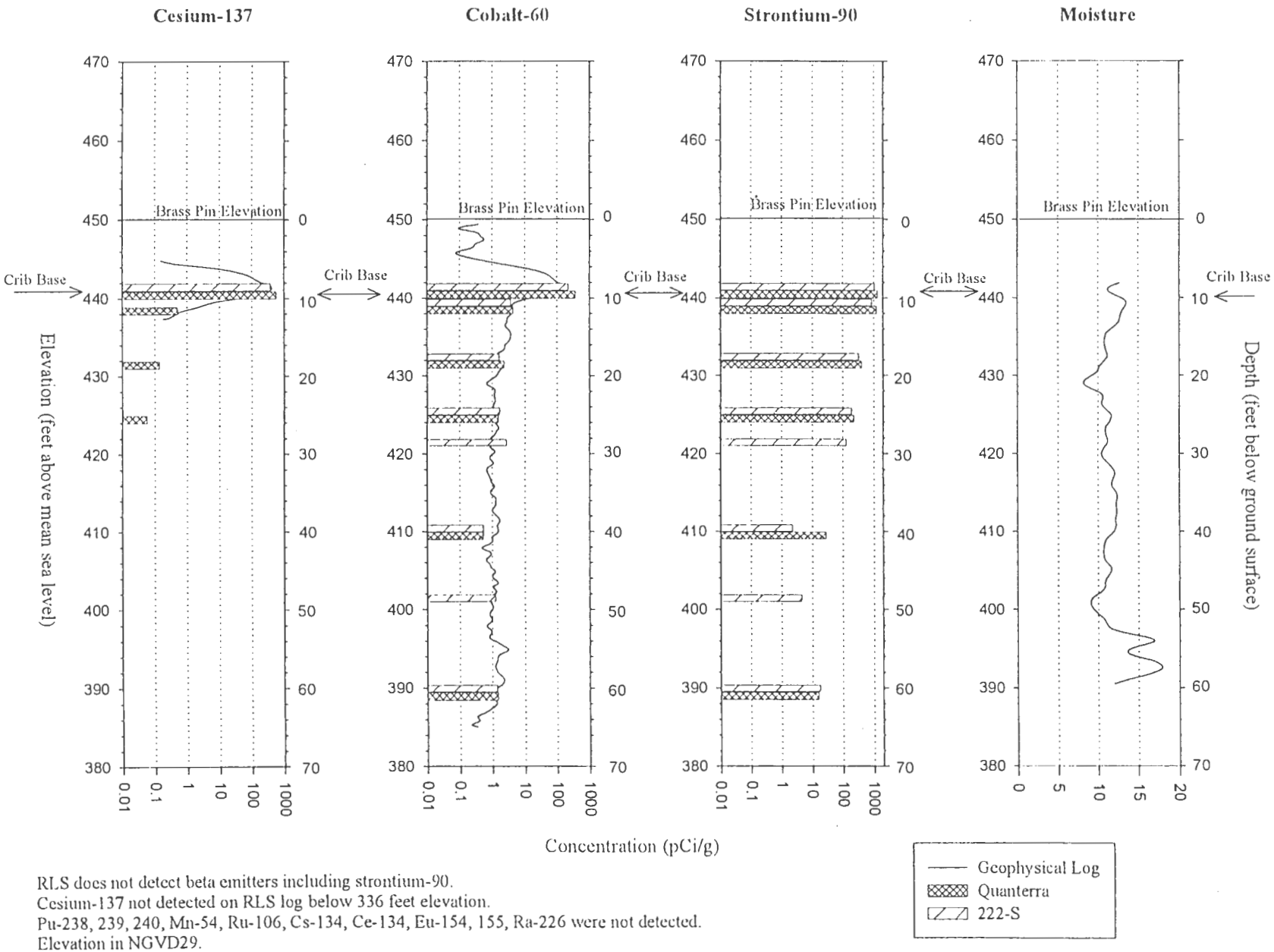
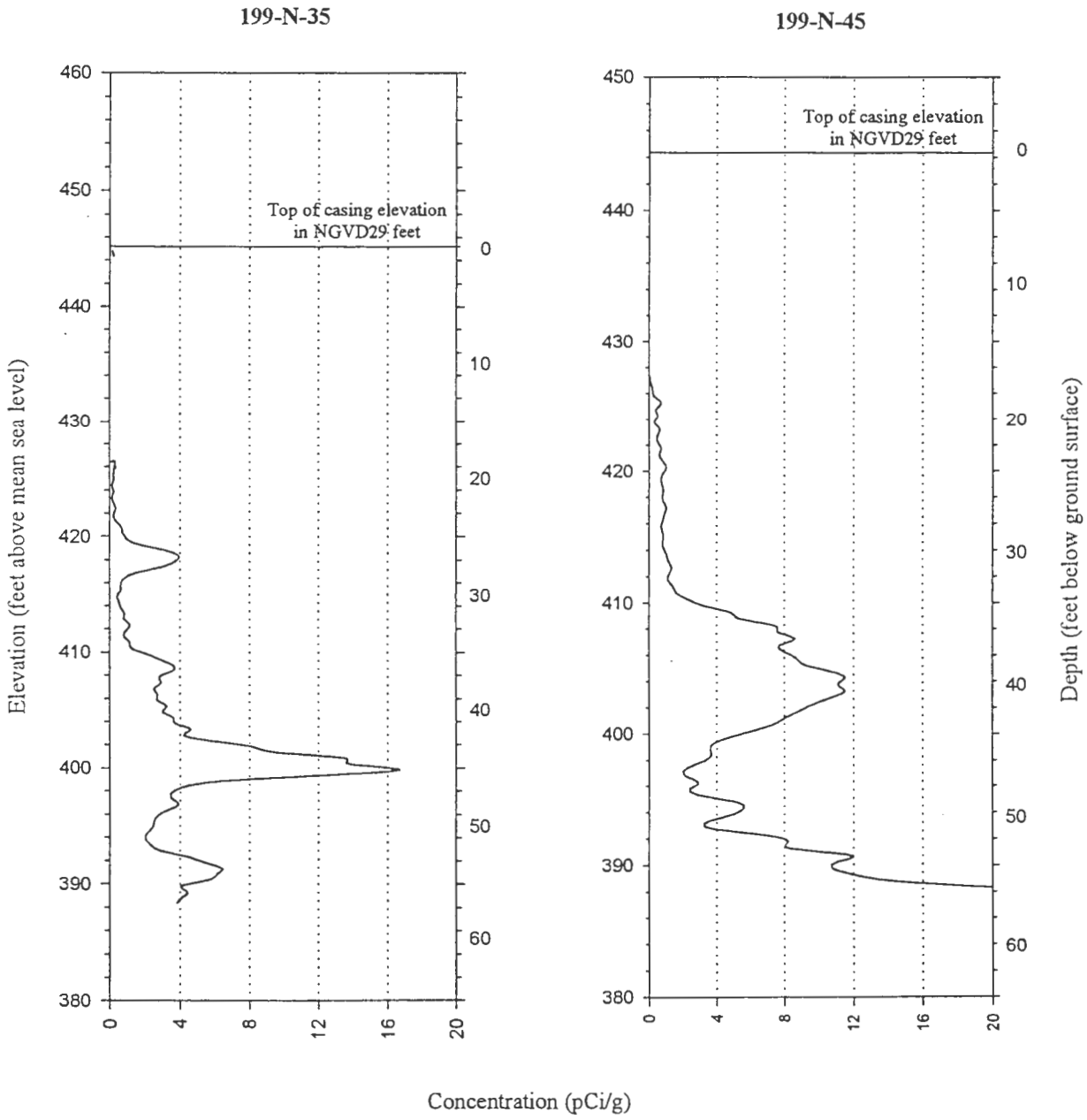


Figure 3-17. Radionuclide Contamination with Depth, Borehole 199-N-109A



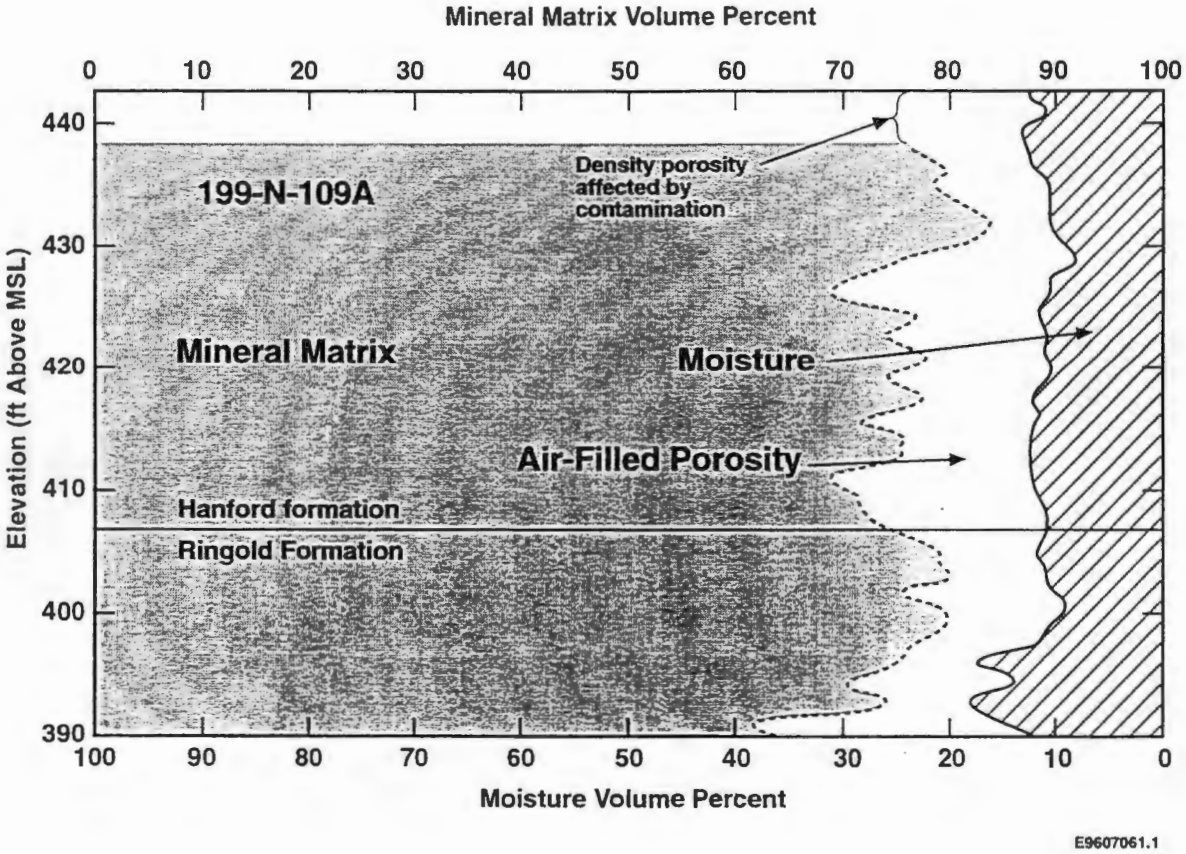
RLS does not detect beta emitters including strontium-90.
Cesium-137 not detected on RLS log below 336 feet elevation.
Pu-238, 239, 240, Mn-54, Ru-106, Cs-134, Ce-134, Eu-154, 155, Ra-226 were not detected.
Elevation in NGVD29.
Moisture data obtained by Schlumberger, Inc. is in volume percent.

Figure 3-18. Cobalt-60 in 199-N-35 and 199-N-45



Cesium-137 was not detected..
Elevation in NGVD29.

Figure 3-19. Borehole 199-N-109A Porosity and Moisture Log



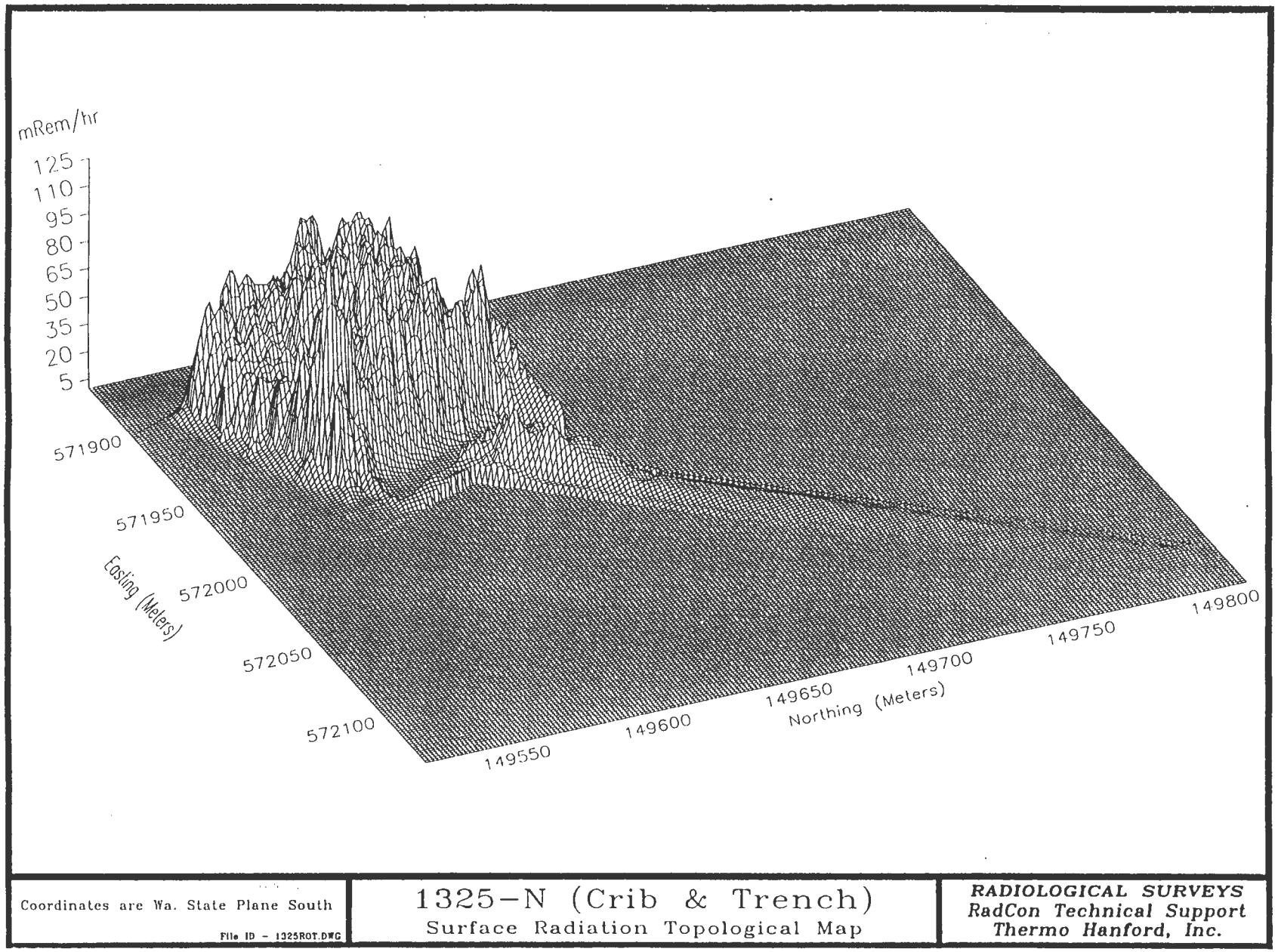


Figure 3-20. 1325-N Surface Radiation Measurements

Table 3-1. Conversion of Feet to Meters

Feet	1	2	3	4	5	6	7	8	9	10
Meters	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.1
Feet	11	12	13	14	15	16	17	18	19	20
Meters	3.4	3.7	4.0	4.3	4.6	4.9	5.2	5.5	5.8	6.1
Feet	21	22	23	24	25	26	27	28	29	30
Meters	6.4	6.7	7.0	7.3	7.6	7.9	8.2	8.5	8.8	9.1
Feet	31	32	33	34	35	36	37	38	39	40
Meters	9.5	9.8	10.1	10.4	10.7	11.0	11.3	11.6	11.9	12.2
Feet	41	42	43	44	45	46	47	48	49	50
Meters	12.5	12.8	13.1	13.4	13.7	14.0	14.3	14.6	14.9	15.2
Feet	51	52	53	54	55	56	57	58	59	60
Meters	15.5	15.9	16.2	16.5	16.8	17.1	17.4	17.7	18.0	18.3
Feet	61	62	63	64	65	66	67	68	69	70
Meters	18.6	18.9	19.2	19.5	19.8	20.1	20.4	20.7	21.0	21.3
Feet	71	72	73	74	75	76	77	78	79	80
Meters	21.6	22.0	22.3	22.6	22.9	23.2	23.5	23.8	24.1	24.4

Table 3-2. 199-N-107A Analytical Data from the Quanterra Laboratory

Sample ID:	B0GL88	B0GL89	B0GL91	B0GL92 (Dup)	B0GL95	B0GL94(EB)	
Elevation (feet above mean sea level):	451-449	449-447	432-430	432-430	403-401	--	
Depth (feet below ground surface):	9-11	11-13	28-30	28-30	57-59	--	
Depth from crib base (feet):	(-1)-1	1-3	18-20	18-20	47-49	--	Background
Sample collected:	11/29/95	11/30/95	12/5/95	12/5/95	12/8/95	12/8/95	Values
Radionuclides (pCi/g)							
Americium-241	1,110	1,050	NR	NR	NR	NR	**
Cerium-144	-130 U	62.9 U	-0.57 U	0.0968 U	-0.0378 U	-0.103 U	**
Cesium-134	31.1 U	4.84 U	-0.01 U	-0.0459 U	-0.0177 U	-0.00734 U	**
Cesium-137DA	15,800	12,500	2.46	6.01	0.0144 U	0.0116 U	0.919
Cobalt-58	-120 U	-100 U	0.0383 U	-0.00793 U	0.0116	-0.0553 U	**
Cobalt-60	139,000	120,000	4.96	5.57	1.29	-0.00425 U	**
Europium-152	2.85 U	71.7 U	0.0936 U	-0.207 U	0.0341 U	0.0453 U	**
Europium-154	990	807	0.155 U	0.147 U	0.0133 U	-0.0017 U	**
Europium-155	207	141	0.0209 U	0.133 U	0.0133 U	0.0359 U	**
Gross Alpha	1,980	2,530	7.43	6.43 U	6.61	3.62 U	**
Gross Beta	128,000	131,000	4,480	5,120	293	2.88	**
Iron-59	-40 U	142 U	-0.284 U	-0.0398 U	0.0729 U	-0.0956 U	**
Manganese-54	56.8 U	19.3 U	0.0983 U	0.047 U	0.0357 U	-0.0116 U	**
Plutonium-238	226	465	-0.00126 U	0.00823 U	0.00339 U	-0.000822 U	**
Plutonium239/40	1,590	3,340	0.023 U	0.0708	-0.00156 U	0.00472 U	0.021
Potassium-40	879	55.4	9.33	9.93	15.7	0.488	16.64
Radium-224DA	NR	NR	NR	0.552 U	0.435	0.0857	**
Radium-226	NR	NR	NR	NR	NR	NR	**
Radium-226DA	104 U	25 U	0.346 J	0.369 J	0.365 J	0.189 J	0.815
Radium-228	NR	NR	NR	NR	NR	NR	**
Radium-228DA	NR	NR	NR	NR	0.562	NR	**
Ruthenium-106DA	103 U	-425 U	0.403 U	-0.203 U	-0.146 U	-0.0924 U	**
Strontium-90	9,560	19,700	1,530	1,310	50	0.0771 U	0.167
Thorium-228DA	35.5 U	144 U	0.47	0.402	0.462	0.179	**
Thorium-232DA	62.2 U	-156 U	1.08	0.388 U	0.624	NR	1.315
Uranium-234	10.5 U	5.12 U	0.414	0.479	0.302	0.0347	**
Uranium-235	0.677 U	-0.672 U	0.0227 U	0.00386 U	0.0193 U	0.00388 U	**
Uranium-238	-0.226 U	9.99 U	0.363	0.441	0.364	0.0127 U	**
Inorganics (mg/Kg)							
Cadmium	0.46 B	0.73	0.37 B	0.47 B	0.19	0.08 U	**
Chromium	45.7 J	57.7 J	8 J	12.7 J	12.4 J	0.23 BJ	18.5
Lead	6.3 J	21.9 J	1.3 J	1.2 J	1.5 J	0.1 U	10.2
Nickel	16.7 J	15.7 J	5 J	7.5 J	13.8 J	0.4 UJ	19.1

U = The concentration is undetected at the specified detection limit.
J = The concentration have been qualified as estimated.
NR = Not requested
EB = Equipment Blank
-- = No depth associated with equipment blank.
BJ = The concentration reported is less than the contract required detection limit (CRDL) but greater than the instrument detected limit (IDL).
Due to minor quality control deficiency identified during data validation the associated data have been qualified as estimated.
DA (Daughters) = Actual gamma lines are measured from a daughter isotope with assumed equilibrium with the reported parent.
Negative radionuclide results = Radioactive results are measured as decay counts (e.g. counts per/minute).
An average background count subtraction is applied, which may be more than the specific sample count, therefore a negative result is possible.
Background values for Inorganics are from Hanford Site Background, Part 1, DOE/RL-92-24, Rev. 3 and are the 90th percentile from the log normal distribution.
Background values for Radionulcides are from Hanford Site Background, Part 2, DOE/RL-96-12, Draft A and are the 90th percentile from the log normal distribution.

B = Concentration is less than the contract required detection limit (CRDL) but greater than the instrument detected limit (IDL).
UJ = Concentration may not accurately reflect the sample detection limit and the associated data have been qualified as estimated.
Dup = Duplicate sample collected at the site.
** = Not reported.

Table 3-3. 199-N-108A Analytical Data from the Quanterra Laboratory

Sample ID:	B0GL71	B0GL73	B0GL75 (Dup)	B0GL81	B0GL86	B0GL79(EB)	
Elevation (feet above mean sea level):	442.5-440.5	434-432	434-432	415-413	395-393.5	--	
Depth (feet below ground surface):	14.5-16.5	23-25	23-25	42-44	62-63.5	--	
Depth from trench base (feet):	(-3.5)-(-1.5)	5-7	5-7	24-26	44-45.5	--	Background
Sample collected:	11/9/95	11/10/95	11/10/95	11/15/95	11/16/95	11/15/95	Values
Radionuclides (pCi/g)							
Americium-241	6.55	NR	NR	NR	NR	NR	**
Cerium-144	-0.638 U	0.163 U	0.259 U	-0.0552 U	-0.0879 U	0.0565 U	**
Cesium-134	5.28	-0.0578 U	-0.0252 U	0.0237 U	-0.037 U	-0.0188 U	**
Cesium-137DA	6,770	44.3	65.8	0.00704 U	-0.0205 U	0.0135 U	0.919
Cobalt-58	-0.559 U	-0.00341 U	-0.0123 U	0.0425 U	0.0158 U	-0.0118 U	**
Cobalt-60	1,200	7.1	9.2	0.547	0.535	-0.0278 U	**
Europium-152	0.833 U	0.00937 U	0.0632 U	-0.0682 U	-0.00833 U	-0.0386 U	**
Europium-154	8.17	0.178 U	0.232	0.0979 U	-0.0225 U	0.00875 U	**
Europium-155	2.36	0.013 U	0.112 U	-0.00806 U	0.109 U	-0.0316 U	**
Gross Alpha	30.1	7.69	7.6	9.33	2.9 U	2.99 U	**
Gross Beta	5,750	3,790	2,740	132	328	2.14 U	**
Iron-59	0.221 U	-0.127 U	0.0766 U	-0.219 U	0.0356 U	-0.0121 U	**
Manganese-54	0.936	0.0565 U	0.0493 U	-0.0179 U	-0.00807 U	0.00963 U	**
Plutonium-238	1.17 U	0.105 U	0.0862 U	-0.00376 U	0 U	-0.00608 U	**
Plutonium239/40	12.6	0.0211 U	0.301 U	-0.00376 U	-0.00416 U	-0.00187 U	0.021
Potassium-40	13.7 J	18.1 J	15.8 J	10.9 J	18.6	5.68 J	16.64
Radium-224DA	NR	0.772	0.903	0.462	0.415	0.115	**
Radium-226	NR	NR	NR	NR	NR	NR	**
Radium-226DA	1.54 U	0.599 J	0.808 J	0.5 J	0.524 J	0.258 J	0.815
Radium-228	NR	NR	NR	NR	NR	NR	**
Radium-228DA	NR	NR	0.59	0.814	NR	NR	**
Ruthenium-106DA	0.378 U	-0.271 U	-0.159 U	0.0126 U	-0.13 U	-0.145 U	**
Strontium-90	768	1430	1,740	57.9	144	0.274	0.167
Thorium-228DA	0.744 U	0.883	1.08	0.748	0.635	0.185 J	**
Thorium-232DA	-1.13 U	NR	1.12	0.596	0.822	0.27	1.315
Uranium-234	0.111 U	0.407 U	1 U	0.534	0.398	0.0433	**
Uranium-235	-0.111 U	0.0762 U	0.104 U	0.0324 U	0.0268 U	-0.00146 U	**
Uranium-238	1.74	0.343 U	0.842	0.487	0.48	0.0892	**
Inorganics (mg/Kg)							
Cadmium	0.35 U	0.36 U	0.36 U	0.35 U	0.09 U	0.08 U	**
Chromium	22.2 J	18.5 J	20.4 J	27.3 J	13 J	0.12 BJ	18.5
Lead	0.57 J	0.69 J	0.76 J	0.21 BJ	0.63 J	0.1 UR	10.2
Nickel	13.1 J	9.3 J	9.8 J	14.5 J	12.5 J	0.4 U	19.1

U = The concentration is undetected at the specified detection limit.
J = The concentration have been qualified as estimated.
NR = Not requested
EB = Equipment Blank
B = Concentration is less than the contract required detection limit (CRDL) but greater than the instrument detected limit (IDL).
Dup = Duplicate sample collected at the site.
** = Not reported.
-- = No depth associated with equipment blank.
BJ = The concentration reported is less than the contract required detection limit (CRDL) but greater than the instrument detected limit (IDL).
Due to minor quality control deficiency identified during data validation the associated data have been qualified as estimated.
DA (Daughters) = Actual gamma lines are measured from a daughter isotope with assumed equilibrium with the reported parent.
Negative radionuclide results = Radioactive results are measured as decay counts (e.g. counts per/minute).
An average background count subtraction is applied, which may be more than the specific sample count, therefore a negative result is possible.
Background values for Inorganics are from Hanford Site Background, Part 1, DOE/RL-92-24, Rev. 3 and are the 90th percentile from the log normal distribution.
Background values for Radionulcides are from Hanford Site Background, Part 2, DOE/RL-96-12, Draft A and are the 90th percentile from the log normal distribution.

Table 3-4. 199-N-107A Analytical Screening Data from the 222-S Laboratory

Sample ID:	B0GGC3*	B0GLF4	B0GLF5	B0GLF7	B0GLF6	B0GLF8 (Dup)	B0GLF9	B0GLG0	B0GLG1	B0H1V6	
Elevation (feet above mean sea level):	N/A	451-449	449-447	437	432-430	432-430	420	410	403-401	391	
Depth (feet below ground surface):	N/A	9-11	11-13	23	28-30	28-30	40	50	57-59	69	
Depth from crib base (feet):	N/A	(-1)-1	1-3	13	18-20	18-20	30	40	47-49	59	Background
Sample Collected:	8/25/95	11/29/95	11/30/95	12/5/95	12/5/95	12/5/95	12/6/95	12/6/95	12/8/95	12/8/95	Values
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Americium-241	**17,300**	**856**	**1,130**	NR	NR	NR	NR	NR	NR	NR	**
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Cerium-144	NR	456 U	402 U	11.2 U	6.5 U	NR	2.51 U	1.17 U	2.44 U	2.45 U	**
Cesium-134	NR	97.9 U	87.8 U	**2.61**	0.282 U	0.225 U	0.097 U	0.076 U	0.144 U	0.161 U	**
Cesium-137	**102,000**	**12,100**	**15,100**	**2,790**	**5.81**	**5.69**	0.143 U	NR	0.41 U	0.421 U	0.919
Cobalt-60	**56,300**	**107,000**	**132,000**	**23.9**	**5.82**	**5.25**	**1.2**	**0.786**	**1.15**	**0.709**	**
Europium-154	**11,800**	**1,030**	**1,370**	0.978 U	0.557 U	0.567 U	0.286 U	0.294 U	0.524 U	0.49 U	**
Europium-155	**4,120**	**355**	**304**	5.55 U	2.01 U	1.85 U	0.716 U	0.332 U	0.703 U	0.697 U	**
Gross Alpha	**13,900**	**941**	**38,200**	2.52 U	2.18 U	3.39 U	1.44 U	0.968 U	1.96 U	**2.77**	**
Gross Beta	**305,000**	**63,700**	**60,600**	**4,310**	**2,810**	**2,490**	**1,680**	**145**	**124**	**123**	**
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Manganese-54	NR	140 U	127 U	0.568 U	0.265 U	0.258 U	0.097 U	0.105 U	0.241 U	18.3 U	**
Plutonium-238	NR	NR	222 U	NR	NR	NR	NR	NR	NR	NR	**
Plutonium-239	**12,700**	--	**689**	--	--	--	--	--	--	--	0.021
Potassium-40	NR	422 U	457 U	**0.11**	7.02 U	NR	**11.6**	**2.05**	**16.9**	17	16.64
Radium-224	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Radium-226	NR	1,410 U	1,260 U	45 U	6.77 U	9.28 U	3.36 U	2.07 U	4.94 U	4.53 U	0.815
Ruthenium-106	NR	1,930 U	1,740 U	29 U	4.81 U	4.69 U	1.85 U	1.76 U	3.52 U	3.36 U	**
Strontium-90	**92,299**	**3,250**	**12,600**	**1,170**	**1,550**	**1,350**	**1,080**	**188**	**63.1**	**54.6**	0.167
Thorium-228	NR	5,270 U	4,650 U	**152**	54.2 U	**50.4**	19.9 U	8.84 U	20.6 U	18.2 U	**

*Sample was collected from soil on a boulder removed from the base of the crib.
U = The concentration is undetected at the specified detection limit.
NR = Not requested
N/A = Not applicable
Dup = Duplicate (second) sample collected at borehole.
-- = Analysis was not performed because the total alpha activity was less than 20 pCi/g.
** = Not reported.
Background values are from Hanford Site Background, Part 2, DOE/RL-96-12, Draft A and are the 90th percentile from the log normal distribution.

Table 3-5. 199-N-108A Analytical Screening Data from the 222-S Laboratory

Sample ID:	B0GLD2	B0GLD5	B0GLD3	B0GLD4 (Dup)	B0GLD6	B0GLD7	B0GLD8	B0GLD9	B0GLF0	B0GLF1	B0GLF2	B0GLF3	
Elevation (feet above mean sea level):	443-441	439	434-432	434-432	429	424.5	415-413	410	405	397.5	395-393.5	388	
Depth (feet below ground surface):	14.5-16.5	18	23-25	23-25	28	32.5	42-44	47	52	59.5	62-63.5	69	
Depth from trench base (feet):	(-3.5)-(-1.5)	0	5-7	5-7	10	14.5	24-26	29	34	41.5	44-45.5	51	Background Values
Sample Collected:	11/9/95	11/9/95	11/10/95	11/10/95	11/10/95	11/10/95	11/15/95	11/15/95	11/15/95	11/15/95	11/16/95	11/16/95	
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Americium-241	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Cerium-144	66.7 U	107 U	22 U	15.5 U	12 U	6.89 U	7.42 U	9.32 U	10.1 U	11.1 U	8.47 U	7.54 U	**
Cesium-134	5.54 U	**17.1**	1.5 U	1.32 U	0.962 U	0.622 U	0.536 U	0.808 U	0.688 U	0.855 U	0.827 U	0.463 U	**
Cesium-137	**3,200**	**15,700**	**108**	**84.9**	**24.1**	1.34 U	1.73 U	2.27 U	1.7 U	2.52 U	2.06 U	1.86 U	0.919
Cobalt-60	**522**	**3,300**	**10.4**	**14.2**	**3.53**	0.999 U	0.832 U	0.976 U	1.37 U	1.77 U	0.983 U	0.604 U	**
Europium-154	9.05 U	18.3 U	3.99 U	3.64 U	2.2 U	1.61 U	2.24 U	3.11 U	3.76 U	3.74 U	1.92 U	2.41 U	**
Europium-155	16.1 U	24.1 U	6.09 U	4.21 U	3.18 U	1.66 U	1.98 U	2.12 U	2.68 U	2.62 U	2.21 U	1.8 U	**
Gross Alpha	**1.4**	**51.1**	1.33 U	1.45 U	1.31 U	1.38 U	1.02 U	1.86 U	2.46 U	1.53 U	**1.65**	1.47 U	**
Gross Beta	**2,280**	**17,600**	**2,690**	**2,770**	**435**	**228**	**80.9**	**34.8**	**20**	**537**	**272**	**74**	**
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Manganese-54	5.05 U	9.49 U	1.35 U	0.978 U	0.943 U	0.591 U	0.589 U	0.969 U	0.988 U	0.876 U	0.719 U	0.765 U	**
Plutonium-238	NR	**11.2**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Plutonium-239	--	**73.7**	--	--	--	--	--	--	--	--	--	--	0.021
Potassium-40	43.1 U	43.3 U	48.4 U	13 U	35.4 U	15.7 U	27.1 U	35.2 U	12.6 U	25.1 U	16.6 U	30 U	16.64
Radium-224	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Radium-226	121 U	200 U	36.1 U	27.1 U	20.8 U	11.7 U	12.9 U	16.2 U	21.8 U	20.3 U	14.7 U	14.1 U	0.815
Ruthenium-106	109 U	184 U	31.4 U	16.1 U	20 U	10.6 U	12.6 U	14.4 U	18.9 U	17.6 U	15.8 U	13.6 U	**
Strontium-90	**139**	**785**	**1,410**	**1,380**	**195**	**119**	**24.6**	**4.33**	**1.38**	**239**	**24.7**	**129**	0.167
Thorium-228	427 U	651 U	165 U	115 U	81 U	51.7 U	48.9 U	63.5 U	75.4 U	74.6 U	61.7 U	50.4 U	**

U = The concentration is undetected at the specified detection limit.
NR = Not requested
Dup = Duplicate (second) sample collected at borehole.
-- = Analysis was not performed because the total alpha activity was less than 20 pCi/g.
** = Not reported.
Background values are from Hanford Site Background, Part 2, DOE/RL-96-12, Draft A and are the 90th percentile from the log normal distribution.

Table 3-6. 199-N-108A Physical Properties Data

Sample Interval (ft bgs)	Sample Elevation (ft aMSL)	Sample Number	Moisture Content (Wt%)	Particle Size Distribution	Dry Bulk Density (g/cm³)	Particle Density (g/cm³)	Porosity	Moisture Retention	Saturated Hydraulic Conductivity (cm/sec)
15 - 15.5	441.76 - 441.26	BOGL72	4.03	Gravel 69.1% Sand 25.5% Fines 5.4%	2.08	2.72 (estimated)	0.24	see graph in Appendix B	3.2×10^{-4}
18	438.76	BOGL76	2.98	Gravel 83.7% Sand 11.6% Fines 4.7%	NA	NA	NA	NA	NA
24 - 24.5	432.76 - 432.26	BOGL74	8.86	Gravel 3.5% Sand 66.1% Fines 30.4%	1.76	2.70 (estimated)	0.35	see graph in Appendix B	3.0×10^{-5}
28	428.76	BOGL77	3.83	Gravel 66.6% Sand 30.1% Fines 3.3%	NA	NA	NA	NA	NA
32	424.76	BOGL78	2.60	Gravel 54.3% Sand 41.3% Fines 4.4%	NA	NA	NA	NA	NA
43 - 43.5	413.76 - 413.26	BOGL80	6.48	Gravel 60.9% Sand 31.1% Fines 8.0%	2.00	2.72 (estimated)	0.26	see graph in Appendix B	8.2×10^{-4}
47	409.76	BOGL82	2.84	Gravel 62.9% Sand 31.3% Fines 5.8%	NA	NA	NA	NA	NA
52	404.76	BOGL83	4.27	Gravel 0.5% Sand 87.9% Fines 11.6%	NA	NA	NA	NA	NA
59.5	397.26	BOGL84	4.93	Gravel 60.0% Sand 37.7% Fines 2.3%	NA	NA	NA	NA	NA
62.8 - 63.3	393.96 - 393.46	BOGL85	2.77	Gravel 50.8% Sand 42.2% Fines 7.0%	1.96	2.72 (estimated)	0.28	see graph in Appendix B	7.4×10^{-4}
69	387.76	BOGL87	3.20	Gravel 66.2% Sand 26.8% Fines 7.0%	NA	NA	NA	NA	NA

Note: See Appendix B for detailed results

Gravel = particles greater than 2 mm
Sand = particles between 2 and 0.075 mm
Fines = particles below 0.075 mm
NA = not analyzed
Estimated = particle density determination was not requested; laboratory estimated value based on previous onsite work.

Table 3-7. 199-N-109A Analytical Data from the Quanterra Laboratory

Sample ID:	B0GL97	B0GL99	B0GLB1	B0GLB3	B0GLB4 (Dup)	B0GLB6	B0GLC0	B0GLB8 (EB)	
Elevation (feet above mean sea level):	443-441	4415-439	434-432	427-425	427-425	412-410	391.5-389.5	--	
Depth (feet below ground surface):	8-10	10-12	17-19	24-26	24-26	39-41	59.5-61.5	--	
Depth from crib base (feet):	(-1.5)-0.5	1-3	8-10	15-17	15-17	30-32	49.5-52	--	Background
Sample collected:	12/19/95	12/20/95	12/20/95	12/22/95	12/22/95	12/27/95	12/28/95	12/27/95	Values
Radionuclides (pCi/g)									
Americium-241	14.2	NR	NR	NR	NR	NR	NR	NR	**
Cerium-144	2.36 U	-0.079 U	-0.176 U	-0.0485 U	-0.131 U	-0.0915 U	-0.173 U	-0.0309 U	**
Cesium-134	0.633 U	-0.0107 U	-0.00192 U	-0.0138 U	-0.0137 U	0.0031 U	-0.0296 U	-0.0113 U	**
Cesium-137DA	573	0.522	0.143	0.0587	0.0337 U	0.00348 U	-0.0148 U	-0.00721 U	0.919
Cobalt-58	0.268 U	-0.03 U	-0.0036 U	0.00897 U	0.00889 U	-0.0391 U	0.00725 U	-0.013 U	**
Cobalt-60	379	4.51	2.37	1.57	1.43	0.546	1.48	-0.00818 U	**
Europium-152	-0.315 U	-0.116 U	-0.0339 U	2.05	0.703	0.216	0.00186 U	0.0472 U	**
Europium-154	2.86	0.00621 U	0.106 U	0.164 U	0.129 U	0.0456 U	0.0676 U	-0.00481 U	**
Europium-155	2.02	0.0156 U	0.0136 U	0.0912 U	-0.0231 U	0.0212 U	-0.0203 U	-0.00461 U	**
Gross Alpha	39.8	6.69	5.7	5.52	6.8	5.79	4.53 U	-0.906 U	**
Gross Beta	3,170	2,450	808	530	491	64	60.5	1.53 U	**
Iron-59	0.236 U	-0.135 U	-0.0845 U	-0.131 U	-0.127 U	0.0867 U	-0.0488 U	0.0232 U	**
Manganese-54	2.74	-0.000466 U	-0.0106 U	0.00315 U	0.0234 U	0.00878 U	0.0152 U	0.0205 U	**
Plutonium-238	3.81	0 U	0.0751 U	0 U	0.0142 U	-0.00257 U	0.00589 U	-0.00105 U	**
Plutonium239/40	24.1	0.385 U	0.15	0.0246 U	-0.00228 U	0 U	0.0103 U	-0.00105 U	0.021
Potassium-40	12.5 J	9.01 J	9.62 J	8.03 J	7.93 J	8.62 J	12.4 J	4.19 J	16.64
Radium-224DA	NR	0.353	0.422	0.473	0.477	0.535	0.627	0.125	**
Radium-226	NR	NR	NR	NR	NR	NR	NR	NR	**
Radium-226DA	1.58	0.322 J	0.368 J	0.415 J	0.304 J	0.358 J	0.34 J	0.116 U	0.815
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	**
Radium-228DA	NR	NR	0.481	NR	NR	NR	0.434	NR	**
Ruthenium-106DA	2.44 U	0.178 U	0.205 U	0.153 U	-0.162 U	0.245 U	0.0541 U	-0.00963 U	**
Strontium-90	1,340	1,230	401	226	200	27.7	16	-0.013 U	0.167
Thorium-228DA	0.535 U	0.409	0.42	0.406	0.498	0.574	0.567	0.304	**
Thorium-232DA	-0.167 U	NR	0.622	0.504	0.156	0.682	0.616	0.134 U	1.315
Uranium-234	1.36	0.451 U	0.727	0.642	0.354	0.348	0.454	0.0509	**
Uranium-235	-0.21 UJ	0.0846 UJ	0.0333 UJ	-0.00422 UJ	0.00763 UJ	0.0169 UJ	0.0291 J	0.00324 UJ	**
Uranium-238	0.776 U	0.564 U	0.44	0.435	0.531	0.5	0.418	0.0278	**
Inorganics (mg/Kg)									
Cadmium	0.36 U	0.36 U	0.35 U	0.35 U	0.35 U	0.09 U	0.36 U	0.08 U	**
Chromium	8.9 J	6.2 J	3.2 J	5 J	3.6 J	1.7 J	12.2 J	0.24 BJ	18.5
Lead	2.7	1.9	1.7	1.6	1.7	1.2	3.2	0.1 U	10.2
Nickel	8.5 J	7.4 J	4.6 J	5.5 J	4.5 J	3.4 J	11.9 J	0.4 U	19.1

U = The concentration is undetected at the specified detection limit.
J = The concentration have been qualified as estimated.
NR = Not requested
EB = Equipment Blank
-- = No depth associated with equipment blank.
B = Concentration is less than the contract required detection limit (CRDL) but greater than the instrument detected limit (IDL).
UJ = Concentration may not accurately reflect the sample detection limit and the associated data have been qualified as estimated.
Dup = Duplicate sample collected at the site.
** = Not reported.
BJ = The concentration reported is less than the contract required detection limit (CRDL) but greater than the instrument detected limit (IDL).
Due to minor quality control deficiency identified during data validation the associated data have been qualified as estimated.
DA (Daughters) = Actual gamma lines are measured from a daughter isotope with assumed equilibrium with the reported parent.
Negative radionuclide results = Radioactive results are measured as decay counts (e.g. counts per/minute).
An average background count subtraction is applied, which may be more than the specific sample count, therefore a negative result is possible.
Background values for Inorganics are from Hanford Site Background, Part 1, DOE/RL-92-24, Rev. 3 and are the 90th percentile from the log normal distribution.
Background values for Radionulcides are from Hanford Site Background, Part 2, DOE/RL-96-12, Draft A and are the 90th percentile from the log normal distribution.

Table 3-8. 199-N-109A Analytical Screening Data from the 222-S Laboratory

Sample ID:	B0H1V7	B0H1V8	B0H1V9	B0H1W1	B0H1W2 (Dup)	B0H1W3	B0H1W4	B0H1W5	B0H5N9	
Elevation (feet above mean sea level)	443-441	441-439	434-432	427-425	427-425	421	412-410	401	391.5-389.5	
Depth (feet below ground surface)	8-10	10-12	17-19	24-26	24-26	30	39-41	50	59.5-61.5	
Depth from crib base (feet)	(-1.5)-0.5	1-3	8-10	15-17	15-17	21	30-32	41	49.5-52	Background Values
Sample Collected:	12/19/95	12/20/95	12/20/95	12/22/95	12/22/95	12/22/95	12/27/95	12/27/95	12/28/95	
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Actinium-228	NR	**0.866**	NR	NR	NR	NR	**0.794**	**0.85**	**0.866**	**
Americium-241	**6.51**	NR	NR	NR	NR	NR	NR	NR	NR	**
Bismuth-214	NR	**0.65**	**0.59**	NR	NR	NR	**0.709**	**0.929**	**0.846**	**
Cerium-144	5.29 U	2.29 U	1.57 U	5.79 U	3.33 U	3.02 U	0.936 U	1.03 U	1.05 U	**
Cesium-134	0.478 U	0.105 U	0.0917 U	0.402 U	0.185 U	0.241 U	0.0763 U	0.0843 U	0.0904 U	**
Cesium-137	**371**	0.211 U	0.14 U	0.498 U	0.415 U	0.512 U	0.14 U	0.151 U	0.144 U	0.919
Cobalt-60	**225**	**3.83**	**1.65**	**1.73**	**1.95**	**2.78**	**0.542**	**1.25**	**1.42**	**
Europium-154	1.05 U	0.332 U	0.287 U	1.2 U	0.654 U	0.681 U	0.264 U	0.34 U	0.311 U	**
Europium-155	1.37 U	0.677 U	0.448 U	1.05 U	1.05 U	0.826 U	0.264 U	0.293 U	0.288 U	**
Gross Alpha	**5.26**	**0.969**	1.15 U	**0.981**	1.42 U	**0.912**	1.45 U	**1.15**	0.997 U	**
Gross Beta	**2,440**	**1,610**	**579**	**346**	**319**	**228**	**30.5**	**11.3**	**42.3**	**
Lead-214	NR	**1.09**	**0.788**	NR	NR	NR	**0.787**	**1.62**	**1.16**	**
Manganese-54	**1.11**	0.13 U	0.109 U	0.417 U	0.209 U	0.246 U	0.089 U	0.1 U	0.11 U	**
Plutonium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	**
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.021
Potassium-40	**10.1**	**9.18**	**6.56**	17.9 U	**7.19**	6.38 U	**9.86**	13 U	**13.8**	16.64
Radium-224	NR	NR	NR	NR	**20.5**	NR	NR	NR	NR	**
Radium-226	9.32 U	3.28 U	2.29 U	10 U	4.83 U	5.23 U	1.77 U	2.01 U	1.98 U	0.815
Ruthenium-106	9.29 U	2.07 U	1.67 U	7.23 U	4.08 U	3.99 U	1.42 U	1.6 U	1.76 U	**
Strontium-90	**1,080**	**866**	**331**	**193**	**147**	**127**	**2.34**	**4.61**	**18.1**	0.167
Thorium-228	36.5 U	18.2 U	12 U	27.6 U	28.3 U	22.9 U	7.23 U	7.82 U	8.16 U	**

U = The concentration is undetected at the specified detection limit.
NR = Not requested
Dup = Duplicate (second) sample collected at borehole.
-- = Analysis was not performed because the total alpha activity was less than 20 pCi/g.
** = Not reported.
Background values are from Hanford Site Background, Part 2, DOE/RL-96-12, Draft A and are the 90th percentile from the log normal distribution.

Table 3-9. 199-N-109A Physical Properties Data

Sample Interval (ft bgs)	Sample Elevation (ft aMSL)	Sample Number	Moisture Content (Wt%)	Particle Size Distribution	Dry Bulk Density (g/cm^3)	Particle Density (g/cm^3)	Porosity	Moisture Retention	Saturated Hydraulic Conductivity (cm/sec)
10	440.45	BOGL96	5.38	NA	NA	NA	NA	NA	NA
10.5 - 11	439.95 - 439.45	BOGL98	5.76 (3.969% from liner)	Gravel 76.1% Sand 23.2% Fines 0.7%	2.201 (wet) 2.117 (dry)	2.981	0.290	see graph in Appendix B	5.9×10^{-2}
17.5 - 18	432.95 - 432.45	BOGLB0	3.72 (3.208% from liner)	Gravel 64.5% Sand 33.5% Fines 2.0%	2.135 (wet) 2.069 (dry)	2.864	0.278	see graph in Appendix B	5.8×10^{-2}
24.5 - 25	425.95 - 425.45	BOGLB2	3.36 (2.97% from liner)	Gravel 72.0% Sand 26.3% Fines 1.7%	2.239 (wet) 2.175 (dry)	2.875	0.244	see graph in Appendix B	6.2×10^{-2}
30	420.45	BOGLB5	5.63	Gravel 77.7% Sand 19.5% Fines 2.8%	NA	NA	NA	NA	NA
39.5 - 40	410.95 - 410.45	BOGLB7	3.59 (3.391% from liner)	Gravel 72.1% Sand 27.0% Fines 0.9%	1.986 (wet) 1.921 (dry)	2.927	0.344	see graph in Appendix B	5.3×10^{-2}
50	400.45	BOGLB9	2.54	Gravel 79.2% Sand 17.9% Fines 2.9%	NA	NA	NA	NA	NA
60	390.45	BOGLC1	4.63	Gravel 58.0% Sand 32.6% Fines 9.4%	NA	NA	NA	NA	NA

Note: See Appendix B for detailed results.

Gravel = particles greater than 2 mm
Sand = particles between 2 and 0.075 mm
Fines = particles below 0.075 mm
NA = not analyzed

4.0 CONTAMINATION DISTRIBUTION, TRANSPORT, AND FATE IN THE VADOSE ZONE

This section addresses the distribution, transport, and fate of contaminants of concern identified in the DQO report (BHI, 1996) for the 1301-N and 1325-N facilities. The overall objectives of this section are to provide a comprehensive description of the contamination resulting from 1301-N and 1325-N and to provide an explanation of the vadose zone contaminant transport mechanisms. These results provide the technical and physical framework on which the RA and analytical contaminant transport analyses are to be based. The conceptualization presented in the DQO report (BHI, 1996) has not been changed as a result of this LFI. However, the discussion and presentation of the site conceptual model presented in the DQO report have been revised to support the objectives of this section. The zones established in the DQO were not used here because they were established to identify data gaps and guide the effort to collect new data. The discussion presented here is based on the interpretation of the previously collected and compiled data and the new data collected for this LFI.

Specifically, the objectives of the section are to

- Identify the data and describe the contaminant characteristics relevant to the current distribution, transport, and fate of the contaminants of concern.
- Describe the source term characteristics.
- Describe the hydrogeologic characteristics of the vadose zone.
- Discuss contaminant mobility in the vadose zone related to lateral movement, drainage, recharge, and river stage effects.

Figure 4-1 depicts the site conceptual model from BHI (1996) upon which this discussion is based.

4.1 CONTAMINANTS OF CONCERN AND DATA INVENTORY

Cobalt-60, Cs-137, Sr-90, Pu-239/240, and Cr have been identified as contaminants that are consistently present at elevated concentrations at the base of and/or in the deeper vadose zone below the 1301-N and/or 1325-N facilities. Four sources of data are available to define the contaminant distribution at 1301-N and 1325-N:

1. Historical sediment samples from the 1301-N trench (TS-01 to TS-09) (Table A2-1) and the 1325-N crib (CS-01 to CS-12) (Table A3-1).

2. Soil sample and RLS data collected from the LFI boreholes 199-N-107A, 199-N-108A, and 199-N-109A (Section 3.0).

3. Soil sample data collected from the N-Springs pump-and-treat Wells 199-N-103A, 199-N-104A, 199-N-105A, and 199-N-106A (Table A8-1), and PNL research Wells 1, 2, and 3 (Table A8-1).

4. RLS data collected from the Wells 199-N-35, 199-N-45, 199-N-67, and PNL Research Well 1 (Appendix B-4).

Radionuclide concentrations have been decayed to April 1996 for comparative purposes to support the following discussions and the RA. The concentrations of chromium can be found in Tables 3-2, 3-3, and 3-7. The contaminants were detected at 1301-N and 1325-N in the following concentration ranges:

- Co-60 - 0.54 pCi/g up to 139,000 pCi/g
- Cs-137 - 0.06 pCi/g up to 102,000 pCi/g
- Sr-90 - 2.34 pCi/g up to 92,299 pCi/g
- Pu-239/240 - 0.15 pCi/g up to 12,700 pCi/g
- Chromium - 0.12 mg/Kg up to 57.7 mg/Kg.

The physical and chemical characteristics of these contaminants that affect their distribution are discussed below.

4.1.1 Contaminant Characteristics

A major factor controlling the subsurface distribution and mobility of radionuclides is the physical state and speciation of the contaminants. The radionuclide speciation data are presented in Table 4-1. Overall, cationic and particulate forms of the radionuclide contaminants are expected to have low mobility in the subsurface because they exhibit large distribution coefficients (K_d) and react and adsorb quite readily to soil. Cobalt-60 was discharged in both particulate and cationic form; Cesium-137 was discharged primarily in cationic form. Information regarding the physical state of the Pu-239/240 in the effluent is not available, but Pu-239/240 is known to precipitate in solutions with pH > 2. Although the form of Sr-90 in the discharge is also unknown, it is assumed to be cationic because of its observed behavior. The distribution coefficient of Sr-90 present in 100-N Area soils has been thoroughly investigated (see Ames and Serne, 1991; Serne and LeGore, 1996) and Sr-90 has been shown to be retarded in the subsurface. Table 4-2 shows the reported range of K_d values for the radionuclides of concern under conditions applicable to 1301-N and 1325-N.

Sodium dichromate was discharged to 1301-N from 1968 until the early 1970s (BHI, 1996); therefore, the chromium was originally discharged to the soil as hexavalent chromium. Hexavalent chromium is highly soluble and does not generally adsorb to the soil to any significant degree. Hexavalent chromium tends to reduce to trivalent chromium in the presence

of organic matter and iron while trivalent chromium can be oxidized to hexavalent chromium in the presence of manganese (Bartlett and James, 1979; Bartlett and Kimball, 1976; and Bartlett and James, 1988). The soil at 1301-N is high in iron, based on the high iron levels found in samples sent to Quanterra. The speciation of the chromium in the vadose zone is currently unknown, but is believed to be trivalent (see Section 4.2.2). Trivalent chromium migration through soil is retarded in the soil, whereas hexavalent chromium is not. The K_ds for trivalent chromium are >200 mg/L and for hexavalent chromium range from 0 to 5 mg/L depending on soil conditions. At the Hanford Site, the K_d for hexavalent chromium is assumed to be effectively zero.

4.1.2 Contaminant Distribution in the Vadose Zone

Cobalt-60. The highest concentration of Co-60 occurs near the base of the facilities or directly below them in the shallow subsurface identified as the concentrated layer in Section 3. Sampling and radionuclide logging system (RLS) results collected from the three boreholes drilled for this LFI all display this pattern of contamination. Below the concentrated layer, the concentration decreases sharply with depth and asymptotically approaches 1 pCi/g beginning at a depth of ~35 ft below the base of the crib and ~15 below the base of the trench* at 1301-N, and ~5 ft below the base of the crib[1] at 1325-N. Contamination levels within the 1301-N trench and 1325-N facility are probably higher than those measured in the boreholes, and the concentrated layer probably extends farther down than previously detected in the boreholes, but the pattern of contamination is essentially the same. Results from other analogous sites, such as the 116-K-2 process effluent trench, also indicate that Co-60 accumulates and remains near the base of discharge facilities (BHI, 1996).

Within the 1301-N crib, the concentration decreases from over 100,000 pCi/g to between 10 and 100 pCi/g (~4 orders of magnitude) in the interval between 10 to 20 ft below the base. Adjacent to the 1301-N trench, the concentration decreases from over 1000 pCi/g to ~10 pCi/g (~2 orders of magnitude) in the interval from the base of the trench to 10 ft below it. The concentration of Co-60 in sediment samples collected in the 1301-N trench in 1985 ranged between 260,000 and 1,600,000 pCi/g, which represents about an order of magnitude decrease from the data collected in the years 1980 to 1984. Reasons for the decrease are uncertain and may include changes in operations, changes in sampling collection technique, and changes in concentration measurement technique. However, if the 1985 concentration values are accurate and representative of conditions in the trench at that time, then the concentrations decayed to April 1996 would be on the order of 250,000 pCi/g, which is consistent with the value measured in the LFI 1301-N crib borehole.

Concentrations of Co-60 directly beneath 1325-N in the concentrated layer are believed to be similar to the levels beneath the 1301-N trench, but less by about half an order of magnitude than

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*Note that the LFI borehole was not drilled within the facility, but the sampling results are assumed to represent the contamination profile beneath the facility.

those detected at the 1301-N crib. The 1325-N crib received significantly less effluent than 1301-N, and the average Co-60 concentration of the 1985 1301-N trench sediment samples was more than twice the average Co-60 concentration of the 1985-1987 1325-N crib sediment samples (1,000,000 versus 370,000 pCi/g). Further evidence supporting this assertion comes from the surface radiation survey above the concrete panels of both facilities conducted prior to the field investigation for this LFI. The dose rates measured 4.0 m (13 ft) above the 1325-N crib soil surface (~50 mrem/hr) were much less than those measured 5.2 m (17 ft) above the 1301-N trench soil surface near the crib (~300 mrem/hr), but close to the dose rate measured along the remainder of the trench (~100 mrem/hr, see Figures 3-15 and 3-20). Knowing that the contaminants at 1301-N and 1325-N are distributed in the vadose zone in a similar profile (see Section 3.0), the lower dose rates at 1325-N indicate that the concentrations of Co-60 (and other gamma-energy radionuclides such as Cs-137) are less there than at 1301-N. Consequently, it is assumed that, if a borehole were drilled through the 1325-N crib, the concentrated layer would be present, and the concentrations would be less by about a half an order of magnitude than those found at the 1301-N crib.

Minimal lateral spreading of Co-60 has occurred in the upper vadose zone around the 1301-N and 1325-N facilities. Evidence of this comes from soil samples from the boreholes located closest (within ~50 m) to the facilities (Well 199-N-67 and PNL Research Wells 1, 2, and 3 at 1301-N, and Wells 199-N-35 and 199-N-45 at 1325-N), and the pump-and-treat extraction and injection wells installed as part of the N-Springs ERA (refer to Figure 2-1). PNL Research Wells 1, 2, and 3 were sampled in August 1982 when sediment concentrations in the upper end of the 1301-N trench exceeded 20,000,000 pCi/g. Sampling occurred in the N Springs ERA pump-and-treat wells when they were installed in 1995. RLS was performed in Wells 199-N-67, 199-N-35, 199-N-45, and RW 1 in 1995.

The maximum sample concentrations in RW 1 occurred 45 to 55 ft bgs and ranged between 9 and 10.5 pCi/g. The maximum sample concentrations in the other two research wells occurred ~55 to 80 ft bgs and ranged between ~0.6 to and ~1.5 pCi/g. RLS measurements made during 1995 in Wells RW 1 and 199-N-67 indicate that Co-60 has migrated sparsely laterally. RLS readings in RW 1 peaked at ~1300 pCi/g at a depth of ~23 ft bgs, but readings outside the depth interval 20 to 25.5 ft bgs were below 10 pCi/g. At 199-N-67, about 6 pCi/g were observed from ~30 to ~55 ft bgs. Well 199-N-103A is the closest of the N Springs ERA pump-and-treat wells to 1301-N crib. Co-60 sampling there began at a depth of 29 ft bgs, but Co-60 was not detected until sampling reached 59 ft bgs. Co-60 was detected in 5 out of 13 samples and was detected at a concentration >1 pCi/g only in the sample taken at a depth of 70-72 ft bgs. Co-60 was only detected in 3 of 21 samples taken at Well 199-N-105A (maximum concentration 1.52 pCi/g at a depth 51-53 ft bgs) and 4 of 14 samples taken at Well 199-N-106A (maximum concentration 0.453 pCi/g at a depth 96-98 ft bgs). Based on the information available, Co-60 contamination in the vadose zone around the 1301-N facility does not appear widespread laterally. Certainly there was no immediate lateral movement in the direction of the PNL research wells, otherwise the concentrations encountered there in 1982 would have been much higher. There may be some locations where changes in lithology or general vadose zone heterogeneities have caused some

minor spreading (discussed in section 4.3), but almost all of the contamination remains within the footprint of the 1301-N facility.

RLS results from Wells 199-N-35 and 199-N-45 indicate that virtually no lateral spreading has occurred around the 1325-N facility. The maximum activity encountered at both wells was less than 20 pCi/g, with the peak occurring ~50 ft bgs at 199-N-35 and ~65 ft bgs at 199-N-45. The log of 199-N-45 shows a second peak of about 10 pCi/g occurring between ~45 and ~55 ft bgs. Sampling during installation of Well 199-N-104A detected Co-60 almost continually from a depth of ~65 ft bgs to ~90 ft bgs, but at concentrations less than 0.2 pCi/g. Contamination around 1325-N has not spread laterally to any significant degree, but some minor lateral migration has probably occurred because of interfingering sand lenses or general vadose zone heterogeneities (see Section 4.3).

Cesium-137. At 1301-N and 1325-N, the distribution of Cs-137 contamination is almost identical to Co-60 in the three LFI boreholes, except that the Cs-137 concentration was three orders of magnitude higher than the Co-60 concentration in the sample taken about 3.0 m (10 ft) beneath the 1301-N crib. The shape of the RLS plots is practically the same for Co-60 and Cs-137 in the three LFI boreholes. The concentration of Cs-137 detected in the concentrated layer in 1301-N crib was ~100,000 pCi/g, decreasing to ~6 pCi/g at 13 ft bgs, and approaching 1 pCi/g asymptotically beginning at a depth of ~40 ft below the base of the crib. The same inferences made about the Co-60 contamination levels from the surface dose surveys also apply to Cs-137 (Co-60 and Cs-137 are both gamma emitters). Concentration levels in 1325-N crib are expected to be close to those found in the 1301-N trench, and about half an order of magnitude less than those found in the 1301-N crib.

Besides the single sample from Well 199-N-107A, the only other differences in the Co-60 and Cs-137 data are that the RLS results at PNL Research Well 1 showed a peak concentration of about 18,000 pCi/g at a depth of ~20 ft bgs, Cs-137 was not detected during the RLS performed at 199-N-35 and 199-N-45, and Cs-137 was detected much less frequently than Co-60 during the 1982 sampling of PNNL Research Wells 1, 2, and 3, and during the installation of N Springs ERA pump-and-treat Wells 199-N-103A, 199-N-104A, 199-N-105A, and 199-N-106A. Considering that Co-60 and Cs-137 were discharged together in the effluent and their transport characteristics in soil are very similar, the contaminant distribution of these two radionuclides in the vadose zone is expected to be similar.

Strontium-90. Strontium-90 is present throughout the vadose zone beneath the 1301-N and 1325-N. The highest concentration levels are located within the concentrated layer. Contamination in this layer ranges between 10,000 and 100,000 pCi/g, which is consistent with the trench sediment samples collected at the 1301-N trench and the 1325-N crib. No inferences can be made from the surface radiation measurements because Sr-90 is a beta emitter, not a gamma emitter. The concentration decreases approximately 1 to 2 orders of magnitude from 10 to 30 ft bgs. The concentration remains fairly uniform below ~30 ft bgs, although it does appear to taper off with increasing depth (approximately one order of magnitude over 30 ft). In wells and boreholes located around the facilities and toward the Columbia River, Sr-90 is present in the

deeper vadose zone, especially within the volume occupied by the old groundwater mound. The concentrations in soil generally decrease with distance away from the facilities toward the Columbia River. In addition, Sr-90 is present in elevated concentrations in the groundwater.

Plutonium-239/240. The soil samples collected during this LFI supplement the results from the sediment samples collected during facility operations and confirm that plutonium is concentrated at the base of the facilities. Except for one of the duplicate sample taken at 18-20 ft below the 1301-N crib (0.07 pCi/g) and the sample taken 8-10 ft below the 1325-N crib (0.15 pCi/g), Pu-239/240 was not detected in the LFI boreholes below a depth of 3 ft below the base of the either facility. The highest Pu-239/240 detected during this LFI was at the base of the 1301-N crib. In the concentrated layer of 1301-N crib, the Pu-239/240 concentration measured between 689 and 12,700 pCi/g. During facility operations, Pu-239/240 concentration averaged ~20,000 pCi/g in nine 1301-N Trench samples collected in 1985, and ~33,000 pCi/g in eleven samples collected from 1325-N crib in 1987. Both the historical sediment sampling events and the LFI results confirm that the Pu-239/240 is present in a thin layer at 1301-N and 1325-N.

The results of this LFI confirm that minimal lateral spreading has occurred. Plutonium was detected in the low pCi/g range in shallow soil adjacent to the 1325-N crib, in contrast to the high concentrations (nCi/g ranges) detected at the base of the 1325-N crib during its operation. Pu-239/240 was not detected during installation of the N-Springs ERA pump-and-treat wells, except for a single sample taken at a depth of 96-98 ft bgs from Well 199-N-106A (0.122 pCi/g). No data were available from the PNL Research wells.

Chromium. Chromium is present in the concentrated layer and throughout the vadose zone. The sample data from Well 199-N-107A show that most of the retained chromium in the 1301-N crib is contained within the concentrated layer where the concentrations range between 45 and 60 mg/kg. Below that, the concentration remains fairly uniform at ~12 mg/kg. Data from the two LFI wells drilled adjacent to the facilities show chromium more evenly distributed through depth. The concentration next to the 1301-N trench ranges between 13 and 27 mg/kg, and the concentration next to the 1325-N crib ranges between 3 and 12 mg/kg.

Contaminant Mass Balance Estimates. Before the LFI boreholes were drilled, estimates of radionuclide inventory in the subsurface were made using the reported inventory discharged to 1301-N, the near surface sediment sampling, the facility dimensions, and the assumed bulk density of the soils underneath the facility. These calculations were performed for the DQO report (BHI, 1996). The mass balance calculations indicate that the entire documented inventory of Co-60, Cs-137, and Pu-239/240 should be accounted for in the upper 0.76 m (2.5 ft) for 1301-N, while for Sr-90 the mass balance calculations indicate relatively high concentrations (>10,000 pCi/g) are likely to be distributed in the first 4 m (13 ft) directly underneath the facility. How these calculations were made and the assumptions that went into them are given in Figures 4-2 through 4-5. The mass balance calculations in the DQO report (BHI, 1996) used a bulk density of 1.6 g/cm^3. The physical property data collected during the LFI indicates the soils underlying these facilities have a bulk density of approximately 2 g/cm^3. This would decrease the depth of contamination predicted by the DQO report by approximately 20 percent.

There is excellent agreement between what was predicted by the mass balance calculations for 199-N-107A and what was actually observed in the LFI borehole. The mass balance calculations predicted that most of the Co-60, Cs-137, and Pu-239/240 contamination should be contained within ~0.06-0.07 m (~0.20-0.25 ft) of the crib base. For Co-60 and Pu-239/240, relatively high concentrations (> 100,000 pCi/g for Co-60, and > 1,000 pCi/g for Pu-239/240) were measured in the first 0-1 m (0 - 3 ft) below 1301-N. The concentration then decreased by approximately three orders of magnitude at the next sample location 4 m (13 ft) below 1301-N crib base. For Cs-137, the change in concentration at 199-N-107A was only about one order of magnitude for the same sample interval. Comparing the Co-60 and Cs-137 RLS plots and sampling from other depths in 199-N-107A indicates that the Cs-137 concentrated layer probably does not extend this deep into the ground. Furthermore, contaminant data collected from the other LFI wells indicate that the concentrated layer of Cs-137 does not extend all the way to the depth of 4 m (13 ft) below the crib surface.

The mass balance calculations predicted that most of the Sr-90 contamination should be contained within ~4 m (13ft) of the crib base. Sr-90 was detected throughout the vadose zone and at fairly uniform concentrations below the concentrated layer. While Sr-90 is retarded in the soil, it is not retarded as much as the other radionuclides. The difference between the model results and the data findings merely indicates that while the concentrated layer sorbed large quantities of the Sr-90 during disposal, a quantity of Sr-90 also migrated downward all the way through the vadose zone and into the aquifer. This fact has been verified and is the subject of an on-going ERA.

4.2 SOURCE-TERM CHARACTERISTICS

The operational history and characteristics of the effluent discharged to the 1301-N and 1325-N facilities are important controlling factors on the nature and distribution of contaminants associated with these facilities. As described in Section 1.1 of this report, 1301-N and 1325-N are the primary sources of contaminants found in the vicinity of these facilities. Contamination originating from other nearby facilities and unplanned releases is thought to have no impact on the contamination observed at 1301-N and 1325-N.

4.2.1 Water Source Term

A significant volume of water was discharged continuously to 1301-N and 1325-N throughout most of their operational histories. Figure 4-6 illustrates the average discharge volume for each year of operation for both facilities. An average operational areal recharge rate for the LWDFs can be calculated from approximate discharge volume (~1.0E+7 L/d for 1301-N and ~2.5E+6 L/d for 1325-N) and the surface area of the LWDF's (~5000 m^2 for 1301-N and ~5800 m^2 for 1325-N). 1301-N had an operational recharge rate of ~73,000 cm/y, while 1325-N operational recharge rate was ~16,000 cm/y. For 1301-N, the annual areal recharge rate could come down depending upon what assumptions are made for water level in the 1301-N Trench, which would increase the surface area receiving effluent for this facility. If the level of the water

in the trench were kept at 1.5 m (5 ft) above the bottom, the surface area of the 1301-N LWDF would increase to ~7,100 m^2 and the resulting areal recharge would be 51,400 cm/y.

4.2.2 Contaminant Source Term

As identified previously in Section 1.0, waste-effluent discharged to 1301-N and 1325-N contained radionuclides and hazardous constituents. Contaminants known to have been discharged to the facilities are identified in Appendix A, Tables A7-1 and A7-2. Most of the contaminants associated with the waste effluent were disposed to both facilities although a much smaller inventory of contaminants is associated with 1325-N. The 1325-N facility received less inventory because it operated for a shorter period of time; thus, it received a smaller volume of effluent.

The N-Reactor operations records and operations staff indicated that sodium dichromate was used as a corrosion inhibitor in the Horizontal Control Rod and Shield Wall cooling systems. Coolant was discharged to the 1301-N from startup of N-Reactor to the early 1970s. The cooling systems were changed over to a recirculation system in the early 1970s at which time the use of sodium dichromate ceased. There has been no documented discharge of chromium solutions to 1325-N.

Although the waste effluent contained high concentrations of radionuclides and hazardous constituents, the water was primarily cooling and decontamination-flush water. This water had low ionic strength, neutral to basic pH, low organic content, and a low percentage of dissolved solids (Ames and Serne, 1991; WHC, 1989, WHC, 1990, and WHC, 1993). The physical state (form) and speciation of Co-60, Cs-137, Sr-90 and Pu-239/240 are presented in Table 4-1.

4.3 HYDROGEOLOGIC CHARACTERISTICS

4.3.1 Geology

Geologic characteristics of the subsurface in the vicinity of the 1301-N and 1325-N facilities are detailed in Section 3.0 of this report. For the purpose of the conceptual model, only the Hanford formation and Unit E and Upper Mud Unit of the Ringold Formation are discussed because the contaminants are distributed in the first two geologic units. The Lower Mud Unit forms the base of the unconfined aquifer. Overall geologic and stratigraphic relationships at both facilities are generally similar as illustrated in Figure 3-6. The geologic contact between the Hanford formation and the Ringold Unit E is found at an elevation of ~125.1 m (~417 ft) AMSL in the vicinity of the 1301-N and ~122 m (~408 ft) AMSL near 1325-N. The base of the unconfined aquifer is at an elevation of ~107 m (350 ft).

Textural variations in the geology are also noted in Section 3.0 of this report (Figures 3-8, 3-9 and 3-16). At the 199-N-107A and 199-N-108A LFI boreholes, significant lithologic variations are noted in the geologic logs. In the vicinity of 1301-N these variations include the presence of sand and gravelly sand units interbedded with gravel dominated units in both the Hanford

formation and Unit E of the Ringold Formation. Near 1325-N, the textural variability appears to be less than that observed in the vicinity of 1301-N. Higher moisture was present in the sand layers found at boreholes N-107A and N-108A.

4.3.2 Hydrostratigraphy

The hydrostratigraphic units of relevance to 1301-N and 1325-N include the vadose zone and the unconfined aquifer. The evidence from sampling LFI and nearby boreholes, as well as crib sediment sampling establishes that most of the contaminant mass is contained in the concentrated layer at the bottom of the LWDFs, and to less extent in the underlying vadose zone. Only a small fraction of the total contaminant inventory appears to have migrated from the vadose zone to the unconfined aquifer (BHI, 1996). The vadose zone is comprised of both the Hanford formation and the Ringold Unit E, while the unconfined aquifer is contained entirely within the Ringold Unit E throughout most of the 100-N Area. At 1301-N, the thickness of the vadose zone averages ~22.9 m (~75 ft). The thickness of the vadose zone at 1325-N averages ~19.8 m (~65 ft). Vadose-zone thickness can change as a result of surface elevation variations and groundwater table fluctuations. The underlying aquitard is the Ringold Upper Mud Unit.

4.3.3 Hydrology

The unconfined aquifer at 100-N Area both prior to- and post- operations is relatively flat with a average gradient of 0.001 m/m (ft/ft) toward the northwest where it is bounded by the Columbia River (Figure 4-7a). The water table in this area is dominated by Columbia River water level stages. The use of the Priest Rapids Dam as a peaking power facility causes the Columbia River's water level to fluctuate as much as 2.6 m (8.5 ft) in a single day. The daily water level changes stress the unconfined aquifer by transmitting a pressure wave inland through the groundwater. This pressure wave is easily observable on a daily basis by wells close to the Columbia River (e.g. less than 152 m (500 ft) from the river). The pressure wave is also observable at distances ranging to hundreds of meters inland over longer time periods (i.e. weekly, monthly, and seasonal).

However, once operations were started at 100-N, the large volumes of water discharged caused the water table to rise underneath these facilities. The water table rose approximately 9.1 m (30 ft) creating a large groundwater mound with a much steeper groundwater gradient (0.02 to 0.05 m/m (ft/ft)) toward the Columbia River. During operations this mound became the dominant feature of the unconfined aquifer. Figure 4-7b shows the maximum height to which the water table rose during operations. Following the termination of effluent disposal to 1301-N and 1325-N, the water table subsided to near-static conditions (Figure 4-7a). Figure 4-8a shows the change in the height of the water table caused by facility operations. Figure 4-8b is a perspective view showing both the operational and post-operational water tables. The pre- and post-operational water table is shown in the cut-away.

An issue was raised in the DQO process (BHI, 1996) involving the potential for perched water in the vadose zone. However, no evidence of perched water has been found in any of the charac-

terization studies conducted in the 100-N Area subsequent to the termination of effluent disposal to 1325-N. In addition, no perched water was observed while drilling any of the LFI boreholes. Although perched water cannot be entirely ruled out, it is unlikely that perched water will be found in the vadose zone given the nature of the Hanford formation at 100-N. This unit is primarily gravels (particle size fraction 50 % > 2mm) with interbedded sand lenses (particle size fraction 50 percent between 2 mm and 0.075 mm). Neither sand nor the gravel could form an aquitard causing perched water.

4.3.4 Volumetric Moisture Content Moisture Retention in the Vadose Zone

The volumetric moisture content of the coarse-grained geologic units varied from 5 to 13 volume percent for laboratory measured moisture content and from 9 to 10 volume percent as determined from the geophysical method. To convert from the gravimetric moisture content in tables 3-6 and 3-9 to volumetric moisture content multiply the gravimetric moisture value in the table by the soil bulk density. The geophysical and the laboratory measurements used different techniques for measuring water content. Therefore, it is not surprising that there are differences in the moisture content results between the two measurements. It is not believed that these differences are significant given the nature of these soils. Variation between the laboratory and the geophysical measurement are most likely due to sampling volume, size fraction, and sample handling between the borehole and moisture tin.

Finer-grained materials, such as sands and silts, retain more moisture due to capillary pressure and tension effects than do coarser-grained sediments. Nearly all the finer-grained geologic units encountered during LFI borehole drilling exhibited volumetric moisture contents significantly greater than the coarse-grained geologic units. The volumetric moisture content for the fine-grained units ranged from 15 to 20 for the geophysical measurements and 9 to 16 for the laboratory measurements. The peaks on the moisture profile given in Figure 4-1 are caused by finer-grained units which have a higher volumetric moisture content than coarse grained units under the same recharge conditions.

Moisture retention data were collected from samples in boreholes 199-N-108A and 199-N-109A. The moisture retention data had to be corrected for gravel content (Bouwer and Rice, 1983) because the standard ASTM method for measuring moisture retention is performed on the particle size fraction less than 2 mm (See Appendix C for a complete description of this process). The effect of the gravel correction is to reduce the effective saturated volumetric moisture content from that measured in the laboratory. The moisture retention data is used to predict volumetric moisture content under a specified recharge rate.

4.4 WATER MOVEMENT FROM LWDFS AND EFFECTS ON CONTAMINANT DISTRIBUTION

4.4.1 Lateral Movement of Water

During operations, water movement underneath the LWDFs through the vadose zone was primarily downward with some lateral spreading caused by water encountering different lithologic types (i.e. sand lenses). The actual amount of lateral spreading cannot be determined from the LFI boreholes. However, evidence of lateral spreading exists in the LFI borehole (N-108A) and nearby (less than 45 m (150 ft) from the LWDFs) boreholes (N-67 and PNNL Research Well #1).

These boreholes contained discrete zones which had higher levels of contamination than the sediments above and below the zone. These discrete zones were located above the operational water table. In well 199-N-108A, the discrete zone can be correlated to a sand lens occurring at approximately 25 ft below ground surface and just below the bottom of the 1301-N Trench. The other two wells were drilled earlier (1988 for N-67 and 1982 for PNNL Research Well #1) and no detailed geologic logs for these two wells exist. Therefore, a correlation between a contaminated zone within these boreholes to the lithology cannot be made. However, in all three boreholes, the contamination is greatly reduced directly below these zones. This suggests the lateral movement of water and contaminants in the vadose zone is caused by interfingering of coarse and fine grain sediments. For wells further away from the LWDFs (i.e. N-103A, N-104A, N-105A, and N-106A), no contamination is found above the operational water table, thus indicating no widespread lateral movement of water throughout the vadose zone.

4.4.2 Drainage after Operations

The results from the LFI boreholes indicate that drainage of the soil at 1301-N and 1325-N has already occurred, and the observed moisture content is a function of natural recharge and sediment's particle size. Moisture measurements can either be taken over time and compared to previous measurements to determine if soil drainage is ongoing. Or alternatively, a comparison can be made between the moisture content in the LFI boreholes to wells close to the LWDFs. To date, there have been no moisture measurements made over time or in nearby wells.

Other indicators that the vadose zone beneath the facilities has drained to natural conditions are the combined porosity and volumetric moisture logs presented in Figures 3-13, 3-14, and 3-19. The information provided in these figures indicates that there are no significant high-moisture zones at or near saturation beneath either facility. High-moisture zones at or near saturation in coarse-grained sediments would be indicative of incomplete drainage.

Additionally, one can qualitatively estimate whether drainage is complete based on the shape of the moisture characteristic curves for soils of this type. Clean gravel (WHC, 1995 grout) and clean sand moisture characteristic curves (van Genuchten, et al., 1991) are given in Figure 4-9. The left hand plot shows the matric potential (suction head) plotted against moisture content. For gravels, the moisture characteristic curve is relatively flat. This implies that as the matric

potential goes down, the gravels rapidly lose moisture. The sand curve is not nearly as flat as the gravel curve, which means the sand will retain higher moisture than the gravel at the same matric potential.

The right hand plot of Figure 4-9 is the unsaturated hydraulic conductivity plotted against volumetric moisture content for the same materials. Under the unit gradient assumption (Appendix C), the unsaturated hydraulic conductivity is equal to the annual recharge rate. The moisture distribution in the LFI boreholes falls within the range predicted by the moisture characteristic curves for the expected recharge. The expected volumetric water content for a soil for a mixed sand/gravel soil (such as Hanford and Ringold gravels) should be between 2 and 12 volume percent (shaded area on this plot) for a recharge rates between 0.2 cm/y and 10 cm/y.

4.4.3 Recharge

Recharge refers to the flux of water from the vadose zone to the unconfined aquifer. The availability of water to the subsurface is the primary factor controlling the generally downward migration of contaminants. The only present-day source of water to the subsurface in the vicinity of 1301-N and 1325-N is the infiltration of precipitation [~15 cm/y (6 in/y)]. Several studies have been conducted across the Hanford Site to determine the range of natural recharge (precipitation minus the effects of evapotranspiration) to the aquifer. In the 100 Areas, natural recharge values range from 0.2 cm/yr (0.08 in./yr) up to 10 cm/yr (4 in./yr). For the 100-N Area, the natural recharge is estimated to be 2 cm/yr (0.8 in./yr) (PNL, 1995). Currently, no sources of artificial recharge are available to either facility.

However, the concrete covers over the 1301-N Trench and the 1325-N Crib could increase natural recharge by collecting and funneling the water off of the covers. For the 1325-N Crib the water would be funnelled off to the side away from the concentrated layer at the bottom of the crib because the joints between the panels are grouted. The joints between the panels over the 1301-N Trench are not grouted and some water would percolate through the joints.

Figure 4-10 is a comparison between the moisture characteristic curves for the LFI boreholes and a clean sand and a clean gravel. All moisture characteristic curves for the LFI boreholes plot between the clean sand and clean gravel except for sample BOGL74 which is a silty sand. From the recharge rates, an estimate of the volumetric moisture content can be made that is used in estimating travel times through the vadose zone to the water table (Section 5 and Appendix C). The three recharge rates used to estimate travel times to the water table have been added to this figure. The estimated volumetric moisture content from the moisture characteristic curves are in agreement with the measured laboratory water content (Table 4-3). The largest deviation between observed moisture content and predicted moisture content occurs for sample BOGL74 which is the fine-grained sediment. The moisture characteristic curve for this sample over predicts the moisture content versus observed moisture by approximately 10 volume percent for 2 cm/yr recharge. For the other samples, the moisture characteristic curve over predicts moisture on some samples and underpredicts on other samples to the observed laboratory measured moisture content for the same samples. Given the heterogeneity of these soils, it is not surprising

that there are differences between the predicted moisture content, the laboratory measured moisture content, and the moisture content as determined through geophysical methods.

Comparison of the operational recharge at 1301-N and 1325-N to natural recharge indicates the minimal significance of the present source of water as a driving force for contaminant migration. The operational recharge rate was approximately 51,400 cm of water each year at 1301-N. Today, using a natural recharge rate of 2 cm/yr (0.8 in./yr), it would take more than 25,000 years to duplicate one year of the driving force at 1301-N. This comparison illustrates that natural recharge is much less likely to affect contaminant migration than is the operational recharge rate. Consequently, the distribution of contaminants present today are a result of the large volumes of water discharged during operation. The magnitude of the natural recharge rate as a driving force of contaminants is evaluated and discussed further in Section 5.0, "Qualitative Risk Assessment."

4.4.4 Strontium-90 Concentration and Resaturation of the Lower Vadose Zone

Water movement from the operating LWDFs through the vadose zone was primarily downward until it reached the pre-operational water table. As water continued to be discharge to the 1301-N, the water table rose underneath the LWDF forming a groundwater mound (Figure 4-7b and 4-8). For water moving through the vadose zone, the principal hydraulic gradient is vertical due to force of gravity. Upon reaching the unconfined aquifer, the pressure head becomes equal to the elevation head. Once the pressure head is equal to the elevation head, the principle hydraulic gradient becomes horizontal and water moves radially outward from where it is entering the unconfined aquifer. The implication follows: contaminants with a bulk distribution coefficient (Kd) of 0, such as tritium and hexavalent chromium, would move with the water and contaminate the pre-operational water table both laterally by advection and vertically by dispersion.

However, contaminants (Sr-90) with a low to moderate K_d ($0 < K_d < 50$) would move at a slower rate than the water. The measured K_d for Sr-90 in the 100-N sediments is 15 ml/g. The effect of K_d for Sr-90 is to reduce the average linear velocity for the center of mass by approximately hundredfold over groundwater. This suggests that Sr-90 arrived at the water table when the mound caused by the effluent disposal to the LWDF was most likely well developed. Upon reaching the mound, the Sr-90 would spread laterally along the top of the mounded water table, rather than vertically, because the principle hydraulic gradient at the water table is lateral. This is also what has been observed in almost all soil sampling for Sr-90 at 100-N Area (DOE, 1996). The highest concentrations of Sr-90 are found close to the top of the operational water table and taper off by the time the existing water table is reached. As the Sr-90 in the groundwater moves through the sediments, it is adsorbed onto the sediments because the concentration on the sediments is less than the water passing through it. At chemical equilibrium, the ratio of Sr-90 on the sediments to Sr-90 found in the groundwater is 15 to 1. This means the sediments above the post-operational and below the operational water table became contaminated with Sr-90. Once operations and drainage ceased, the only driving force moving Sr-90 in the upper portions of the operational groundwater mound toward the present day water table is natural recharge. The rate at which Sr-90 moves under natural recharge is slow enough that the Sr-90 contami-

nation occurring in this zone will decay away before reaching groundwater (Section 5). Contaminants with a high K_d (>50) (Cs-137, Co-60, and Pu-239/240) would tend to stay at the base of the LWDF or in the first few feet underneath the LWDF.

Although it is believed that Sr-90 adsorbed onto the sediments between the operational and post-operational water tables will decay away before reaching the water table, there is another mechanism which could increase the quantity of Sr-90 in the unconfined aquifer. The lower portion of this zone could become resaturated due to high water levels on the Columbia River which causes the water table to rise. For instance, at Well 199-N-67, the water level had dropped to approximately 117.5 m (385.5 ft) above MSL by late 1984. However, due to extremely high runoff in the Cascade Mountains, and the subsequent increase in the Columbia river stage in early 1996, the water level in this well had increased to 118.87 m (390 ft) above MSL. The high river stage brought groundwater with a lower concentrations of Sr-90 into sediments with a higher concentration of Sr-90. This caused Sr-90 to desorb from the sediments and go into solution, causing the Sr-90 concentrations in the groundwater to rise. Concentrations of Sr-90 in groundwater were observed to increase in several monitoring wells and more than double in Well 199-N-67. Sr-90 did not remobilize and enter the aquifer, rather the water table rose into sediments with higher concentrations of adsorbed Sr-90. When the water table declines, the observed concentrations of Sr-90 in the monitoring wells would decrease based on past observations at the monitoring wells. Figure 4-11 has been prepared to show the correlation between water levels and Sr-90 concentrations in Well 199-N-67.

4.5 SUMMARY AND CONCLUSIONS

Significant volumes of water were continuously discharged to the 1301-N and 1325-N during their operation. Based on the data provided in this report, most of the contaminants disposed to the facilities are contained within the vadose zone. The vadose zone at the two facilities is about 21m (70 ft) thick and consists of the Hanford formation and Ringold Gravel Unit E. The vadose zone moisture content appears to have drained to pre-operational levels; the only known source of recharge occurring today is precipitation. Lenses of higher moisture content and contamination do exist at lithology changes but are not considered indicative of widespread contamination. The contamination profile for 1301-N and 1325-N presented here is used to discuss the contamination problems associated with the facilities. The magnitude of these problems is discussed in Section 5.0, "Qualitative Risk Assessment."

The effluent had low ionic strength, neutral to basic pH, low organic content, and low dissolved solid content. Co-60, Cs-137, and Pu-239/240 were adsorbed almost entirely in the concentrated layer directly beneath the facilities and remain there. Some migration from the concentrated layer may have occurred because of spot heterogeneities in the vadose zone, but no evidence of widespread vertical or horizontal contamination of these contaminants exists. The highest concentrations of Sr-90 were measured in the concentrated layer, but Sr-90 also migrated deeper throughout the vadose zone and reached the water table. The hydraulic mound caused by disposal operations redirected the discharge laterally thus resulting in the lateral spreading of

Sr-90. Cr is present in the concentrated layer at 1301-N, but the concentration at the other depths sampled in the boreholes was either below or just above background level. Chromium remaining in the vadose zone is not believed to be hexavalent (i.e.,. soluble and mobile) because the quantity of water disposed of at the facilities should have been ample to transport the hexavalent chromium through the vadose zone.

As a result of river stage fluctuations, vadose sediments with adsorbed Sr-90 may become resaturated, thus resulting in increased Sr-90 concentrations observed in groundwater. When these sediments become unsaturated, the observed groundwater concentrations will decrease.

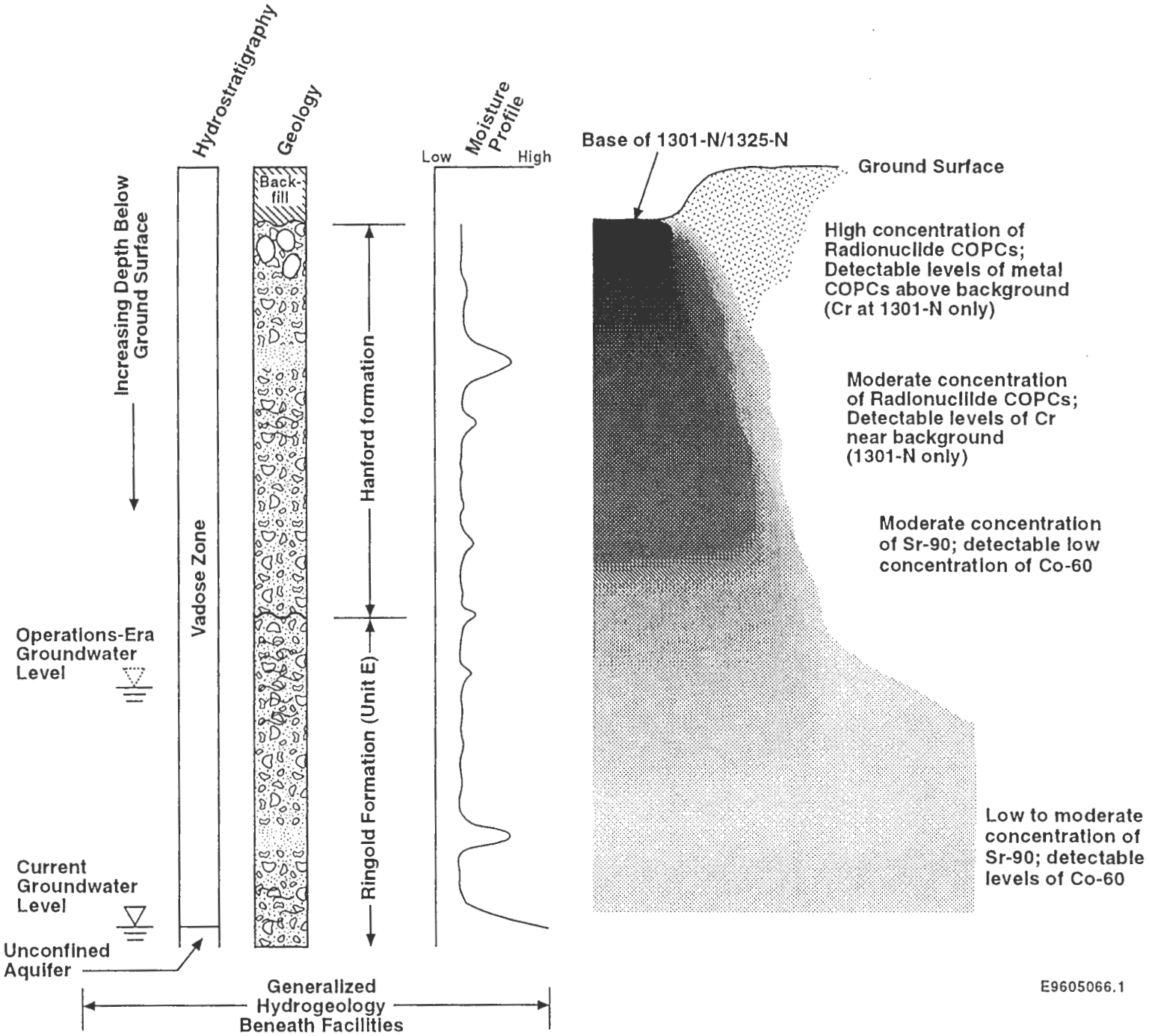
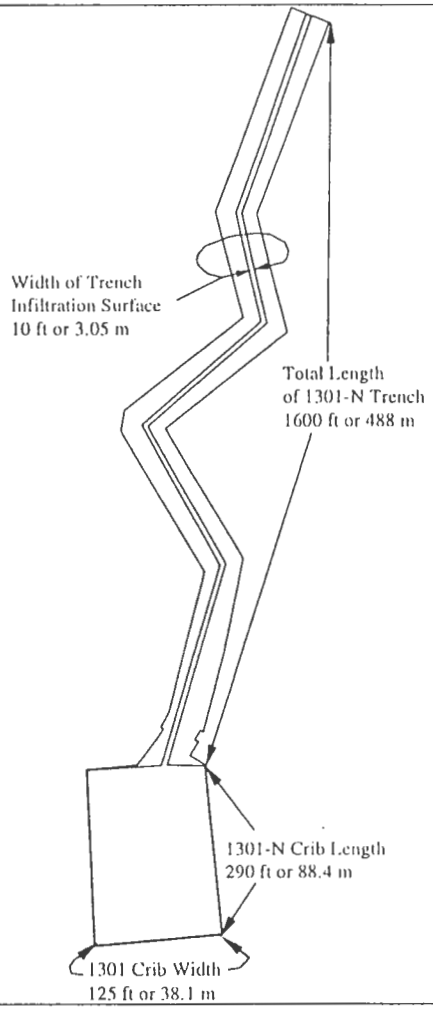


Figure 4-1. LFI Site Conceptual Model

Figure 4-2. Mass Balance Calculation for Cobalt-60



1. Calculate area of trench and crib

   a.) Crib area

   88.4 m X 38.1 m = 3,368.04 m^2

   b.) Tench area

   3.05 m X 487.7 m = 1,487.42 m^2

   c.) Total area

   3,368.04 m^2 + 1,487 m^2 = 4,855.46 m^2

2. Assume a unit volume (depth = 1 m)

   Volume of soil = 4,855.46 m^2 X 1 m = 4,855.46 m^3
   Convert m^3 to cm^3
   4,855.46 m^3 X 1,000,000 cm^3 = 4.86E+09 cm^3

3. Calculate the mass of soil in a unit volume (bulk density = 1.6 gm/cm^3)

   4.86E+09 cm^3 X 1.6 gm/cm^3 = 7.78E+09 gm of soil

4. Use the 10-year (1975-1984 [UNI-3533]) average concentration for Cobalt-60 in sediment samples from 1301-N Trench to calculate the number of curies in the bottom of the LWDF.

Ten year average concentration for Cobalt-60 = 10,000,000 pCi/gm or 1.0E-05 Ci/gm

7.78E+09 gm X 1E-05 Ci/gm = 7.78E+04 Ci

5. If the 10-year average concentration is maintained for each unit volume, It would require this many unit volumes to account for Cobalt-60 5,100 Ci by 1985 [UNI-3533]) disposed to the 1301-N LWDF:

   5,100 Ci / 77,800 Ci = ~0.07 unit volumes

6. Because a unit volume is equal to 1 m depth, most of the Cobalt-60 should be accounted for in the first 0.07 m (0.25 ft) of soil directly underneath the LWDF.

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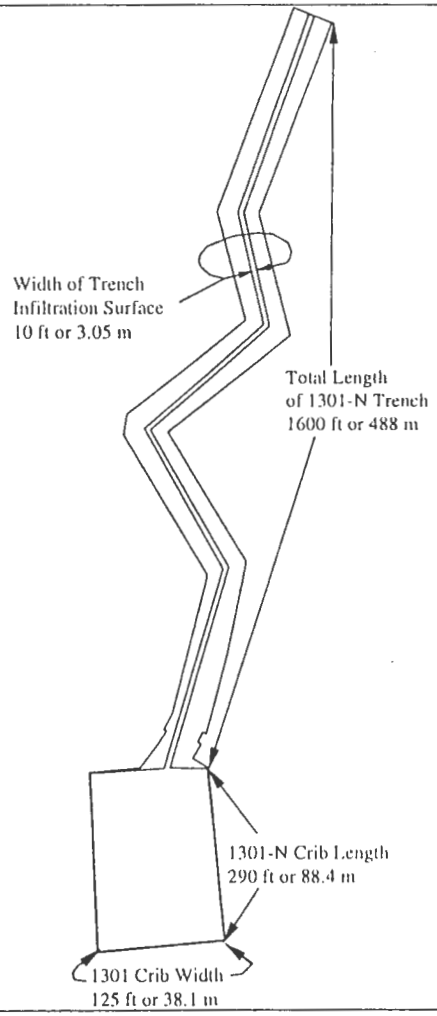
Figure 4-3. Mass Balance Calculation for Cesium-137



1. Calculate area of trench and crib

   a.) Crib area

   88.4 m X 38.1 m = 3,368.04 m^2

   b.) Tench area

   3.05 m X 487.7 m = 1,487.42 m^2

   c.) Total area

   3,368.04 m^2 + 1,487 m^2 = 4,855.46 m^2

2. Assume a unit volume (depth = 1 m)

   Volume of soil = 4,855.46 m^2 X 1 m = 4,855.46 m^3
   Convert m^3 to cm^3
   4,855.46 m^3 X 1,000,000 cm^3 = 4.86E+09 cm^3

3. Calculate the mass of soil in a unit volume (bulk density = 1.6 gm/cm^3)

   4.86E+09 cm^3 X 1.6 gm/cm^3 = 7.78E+09 gm of soil

4. Use the 10-year (1975-1984 [UNI-3533]) average concentration for Cesium-137 in sediment samples from 1301-N Trench to calculate the number of curies in the bottom of the LWDF.

Ten year average concentration for Cesium-137 = 560,000 pCi/gm or 5.6E-07 Ci/gm

7.78E+09 gm X 5.6E-7 Ci/gm = 4360 Ci

5. If the 10-year average concentration is maintained for each unit volume, It would require this many unit volumes to account for Cesium-137 (3,000 Ci by 1985 [UNI-3533]) disposed to the 1301-N LWDF:

   3,000 Ci / 4360 Ci = ~0.7 unit volumes

6. Because a unit volume is equal to 1 m depth, most of the Cesium-137 should be accounted for in the first 0.7 m (2.5 ft) of soil directly underneath the LWDF.

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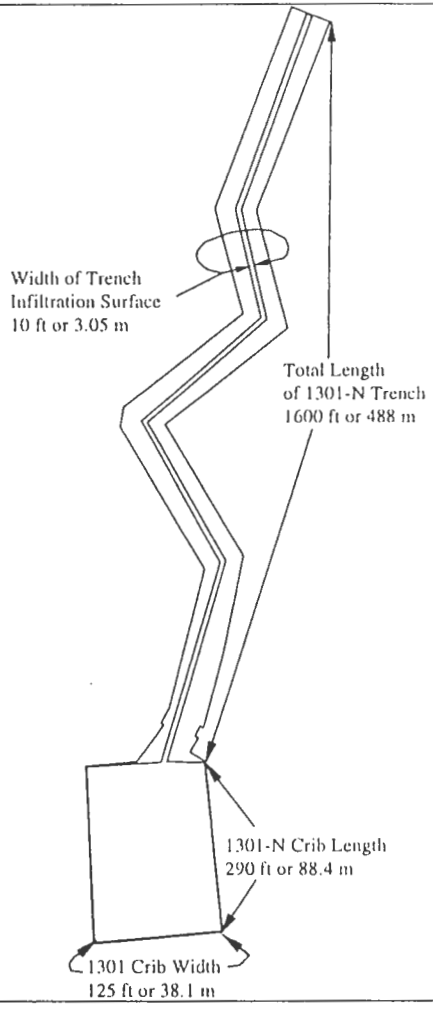
Figure 4-4. Mass Balance Calculation for Plutonium-239/240



1. Calculate area of trench and crib

   a.) Crib area

   88.4 m X 38.1 m = 3,368.04 m^2

   b.) Tench area

   3.05 m X 487.7 m = 1,487.42 m^2

   c.) Total area

   3,368.04 m^2 + 1,487 m^2 = 4,855.46 m^2

2. Assume a unit volume (depth = 1 m)

   Volume of soil = 4,855.46 m^2 X 1 m = 4,855.46 m^3
   Convert m^3 to cm^3
   4,855.46 m^3 X 1,000,000 cm^3 = 4.86E+09 cm^3

3. Calculate the mass of soil in a unit volume (bulk density = 1.6 gm/cm^3)

   4.86E+09 cm^3 X 1.6 gm/cm^3 = 7.78E+09 gm of soil

4. Use the 10-year (1975-1984 [UNI-3533]) average concentration for Plutonium-239/240 in sediment samples from 1301-N Trench to calculate the number of curies in the bottom of the LWDF.

Ten year average concentration for Plutonium-239/240 = 53,000 ρCi/gm or 5.6E-07 Ci/gm

7.78E+09 gm X 5.3E-8 Ci/gm = 412 Ci

5. If the 10-year average concentration is maintained for each unit volume, It would require this many unit volumes to account for Plutonium-239/240 (22 Ci by 1985 [UNI-3533]) disposed to the 1301-N LWDF:

   22 Ci / 412 Ci = ~0.06 unit volumes

6. Because a unit volume is equal to 1 m depth, most of the Plutonium-239/240 should be accounted for in the first 0.06 m (0.2 ft) of soil directly underneath the LWDF.

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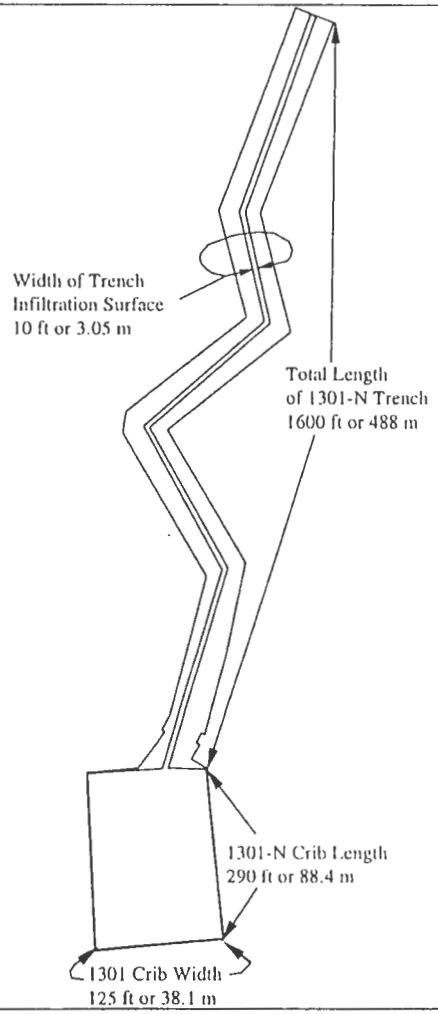
Figure 4-5. Mass Balance Calculation for Strontium-90



1. Calculate area of trench and crib

   a.) Crib area

   88.4 m X 38.1 m = 3,368.04 m^2

   b.) Tench area

   3.05 m X 487.7 m = 1,487.42 m^2

   c.) Total area

   3,368.04 m^2 + 1,487 m^2 = 4,855.46 m^2

2. Assume a unit volume (depth = 1 m)

   Volume of soil = 4,855.46 m^2 X 1 m = 4,855.46 m^3
   Convert m^3 to cm^3
   4,855.46 m^3 X 1,000,000 cm^3 = 4.86E+09 cm^3

3. Calculate the mass of soil in a unit volume (bulk density = 1.6 gm/cm^3)

   4.86E+09 cm^3 X 1.6 gm/cm^3 = 7.78E+09 gm of soil

4. Use the 10-year (1975-1984 [UNI-3533]) average concentration for Strontium-90 in sediment samples from 1301-N Trench to calculate the number of curies in the bottom of the LWDF.

Ten year average concentration for Strontium-90 = 69,000 pCi/gm or 6.9E-08 Ci/gm

7.78E+09 gm X 6.9E-8 Ci/gm = 537 Ci

5. If the 10-year average concentration is maintained for each unit volume, It would require this many unit volumes to account for Strontium-90 (2,100 Ci by 1985 [UNI-3533]) disposed to the 1301-N LWDF:

   2,100 Ci / 537 Ci = ~3.91 unit volumes

6. Because a unit volume is equal to 1 m depth, most of the Strontium-90 should be accounted for in the first 4 m (13 ft) of soil directly underneath the LWDF.

8/14/95 /cggl/mike/crib

Figure 4-6. Average Daily Discharge Rate by Year to 1301-N and 1325-N

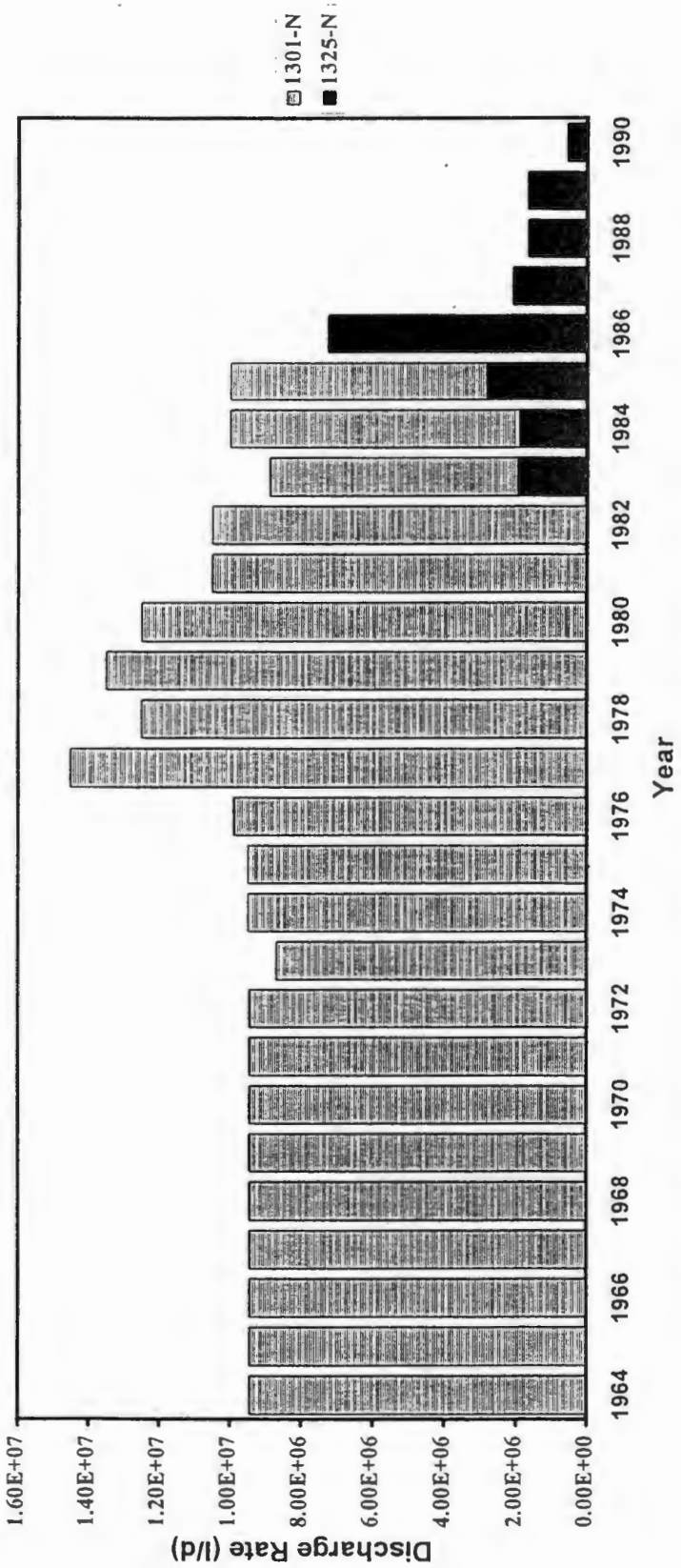


Figure 4-7. December 1994 Water Table (a) and Maximum Height of Operational-Era Water Table (b).

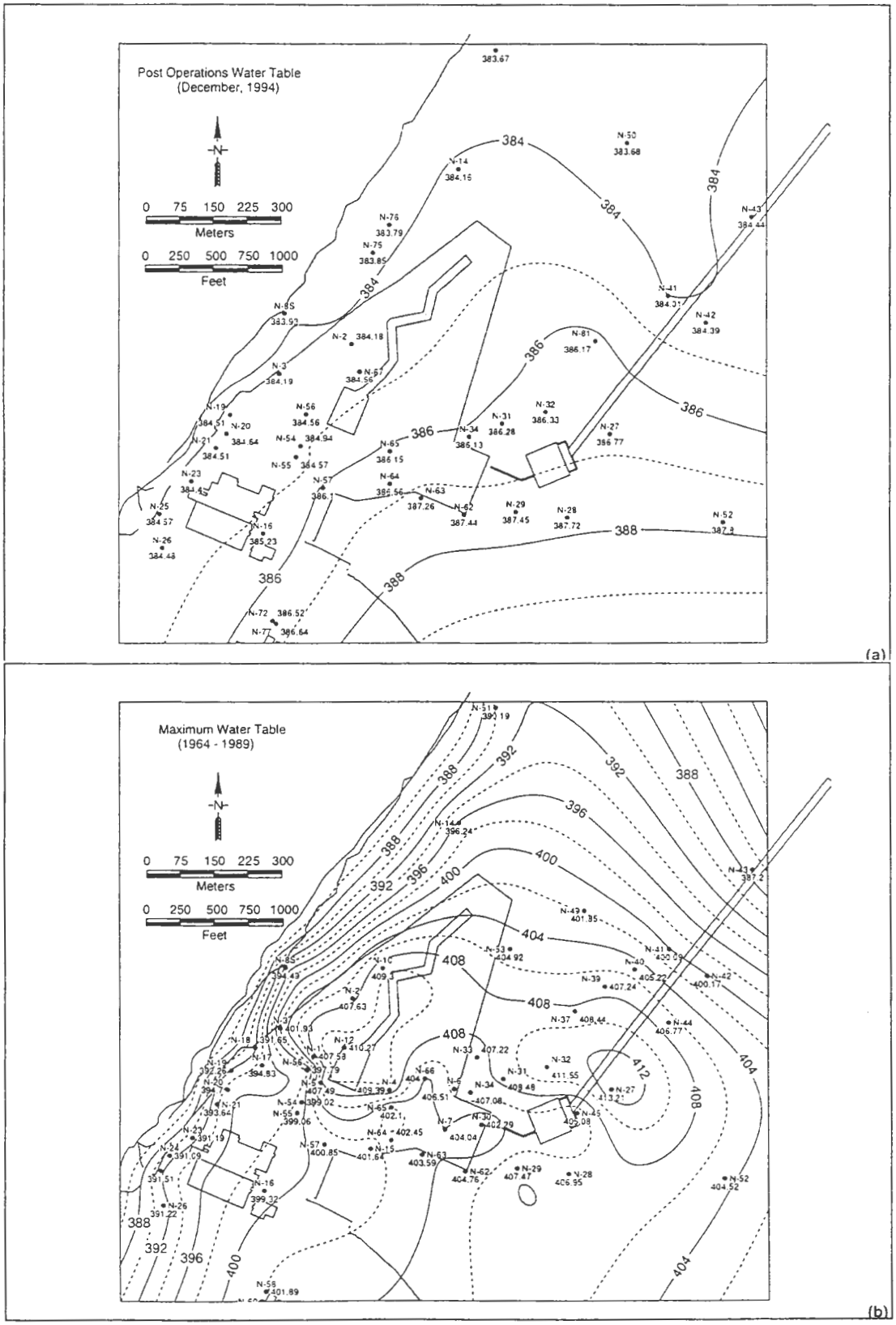
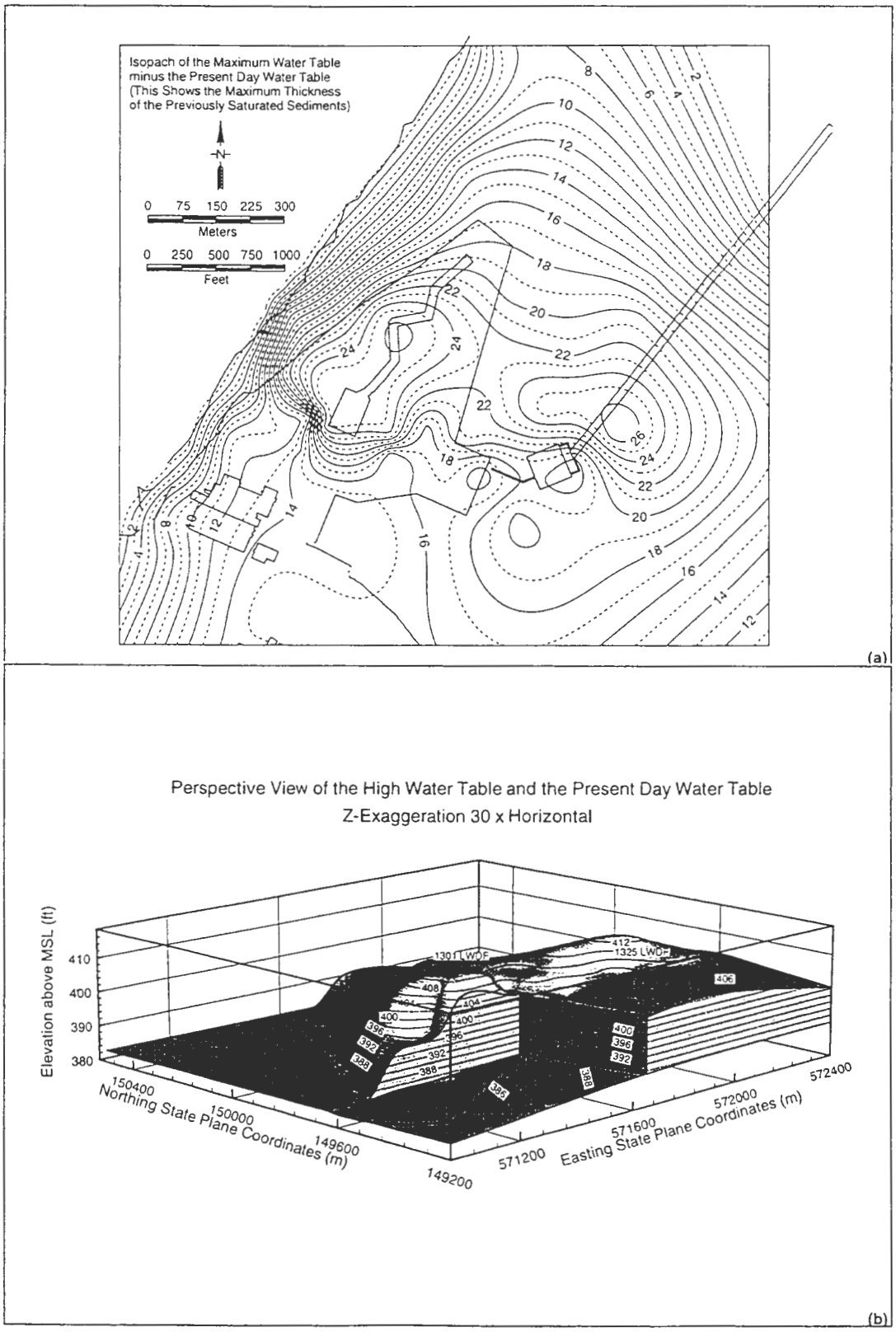


Figure 4-8. Maximum Change in Height of Water Table between Operations and Post-Operations (a) and Perspective View of Maximum Water Table and Post-Operations Water Table (shown in cutaway view) (b)



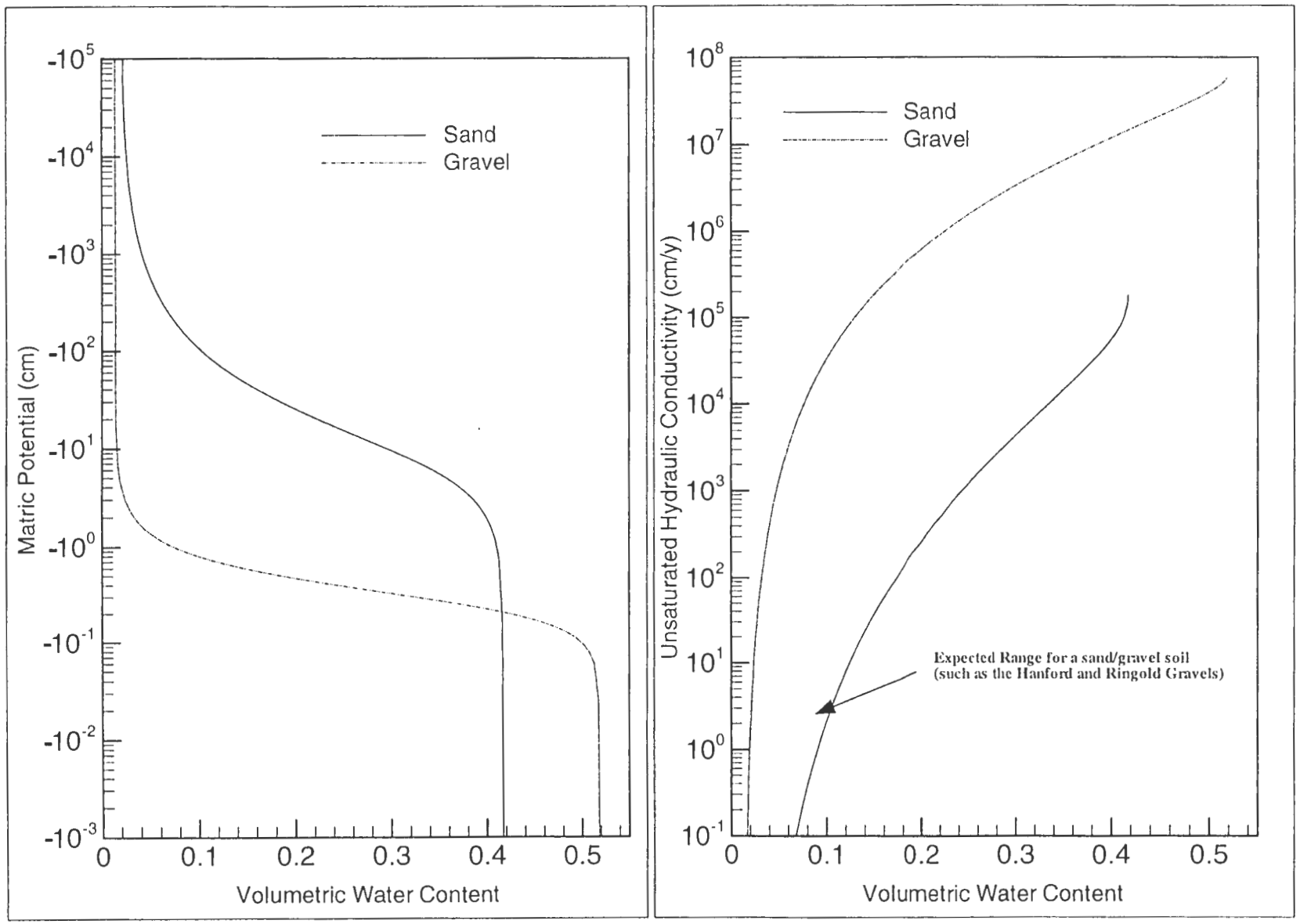
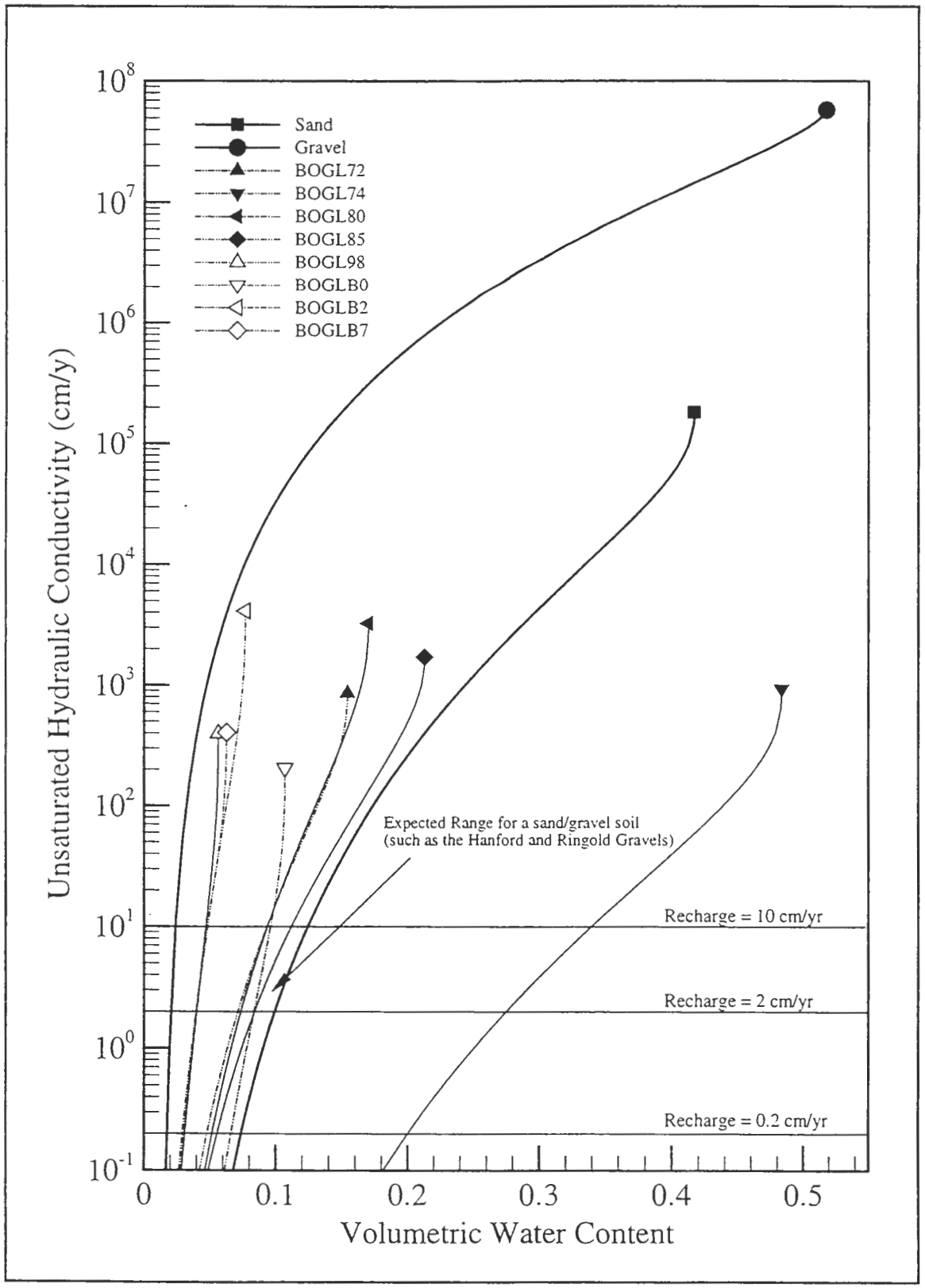


Figure 4-9. Moisture Characteristic Curves for a Clean Sand and a Clean Gravel

Figure 4-10. Comparison of Hanford and Ringold Moisture Characteristic Curves to those of a Clean Sand and a Clean Gravel



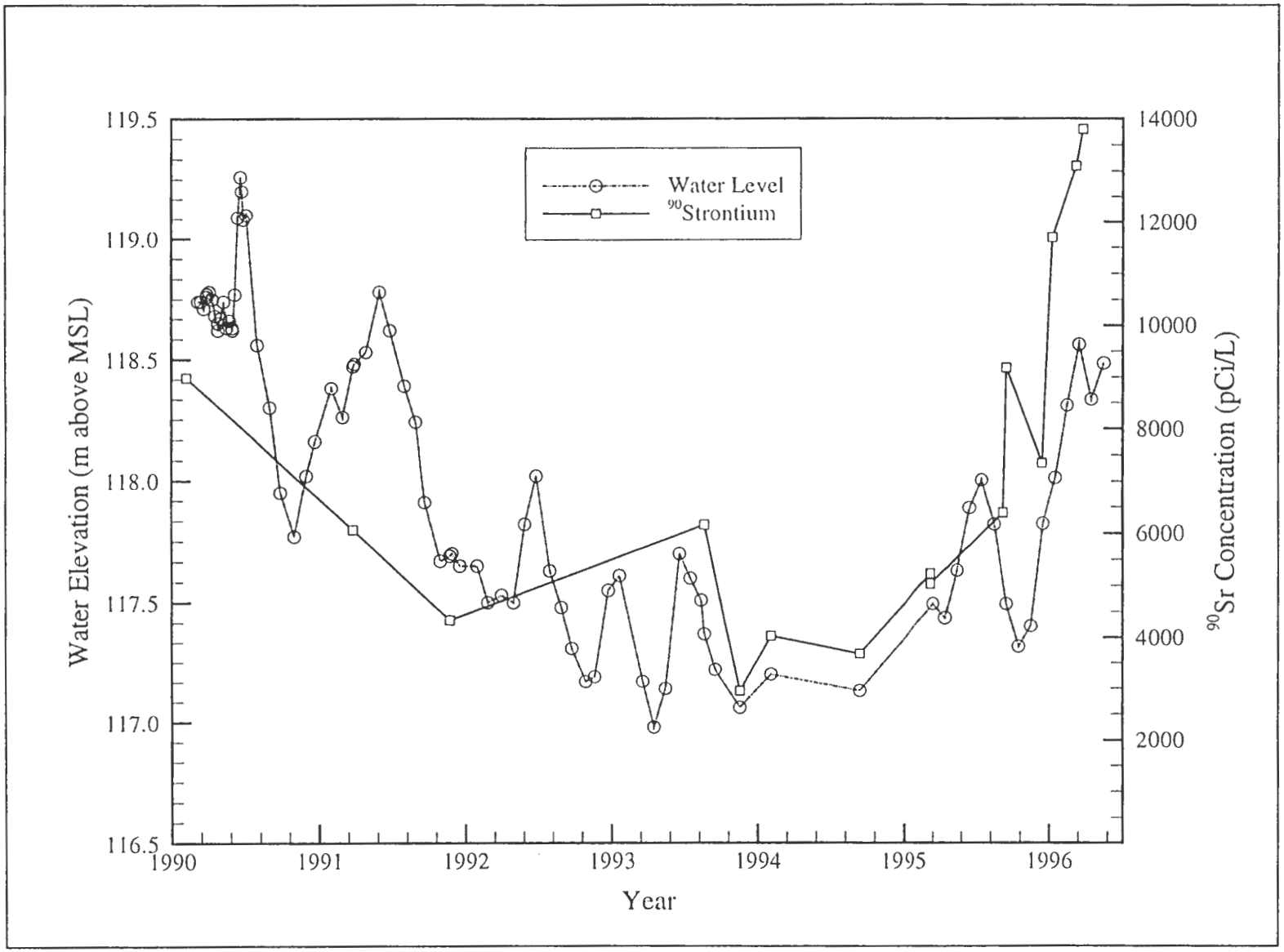


Figure 4-11. Comparison between Water Levels and Strontium-90 Concentrations in Well 199-N-67

Table 4-1. Form and Speciation of Radionuclides

Radionuclide	Particulate	Cationic	Anionic
Cobalt-60	40 to 98 %	2 to 60 %	< 1 %
Cesium-137	1 to 5 %	85 to 100 %	< 1.4 %
Strontium-90	N/A	N/A	N/A
Plutonium-239/240	Precipitate at pH>2	N/A	N/A

reference: BHI, 1996

Table 4-2. Radionuclide Bulk Distribution Coefficients

Radionuclide	Kd
Cobalt-60	10 to 3,000
Cesium-137	50 to 3,000
Strontium-90	15[a] to 200
Plutonium-239/240	100 to 2,000

Ames and Serne, 1991; Serne and LeGore, 1996
LFI results indicate that Kd is as low as 15. A Kd of 20 was reported in the references.

Table 4-3. Comparison between Laboratory Measured Moisture Content and Estimated Moisture Content from Moisture Characteristic Curves.

Sample	Well	Elevation above MSL (ft)	Laboratory Measured Moisture Content	Predicted Moisture Content (10 cm/yr)	Predicted Moisture Content (2 cm/yr)
BOGL72	N-108A	441.5	0.08	0.09	0.07
BOGL74	N-108A	432.5	0.16	0.34	0.27
BOGL80	N-108A	413.5	0.13	0.09	0.08
BOGL85	N-108A	393.75	0.05	0.11	0.08
BOGL98	N-109A	439.75	0.12	0.05	0.04
BOGLB0	N-109A	432.75	0.07	0.1	0.08
BOGLB2	N-109A	425.75	0.07	0.05	0.04
BOGLB7	N-109A	410.75	0.05	0.05	0.04

5.0 QUALITATIVE RISK ASSESSMENT

A qualitative assessment of potential risks associated with 1301-N and 1325-N is presented in this section. This QRA uses the data presented in Section 3.0 to evaluate the following:

- the risk to human receptors from potential exposure to contaminants in the surface sediments and shallow subsurface soils
- the impact to groundwater posed by the potential migration of contaminants through the vadose zone to the water table.

The approach used to conduct these two evaluations is different from that applied in the *Qualitative Risk Assessment for the 100-NR-1 Source Operable Unit* (BHI, 1995), the previous QRA that addressed the risk associated with 1301-N and 1325-N. The approach and a description of how it differs are discussed in Sections 5.1 and 5.2. Section 5.3 presents the data set used in this QRA, while Section 5.4 discusses the exposure assessment. The evaluations of risk to humans and impact to groundwater are found in Section 5.5. A discussion of water table fluctuation and its impact on contaminant migration to groundwater comprises Section 5.6. A summary of this QRA is presented in Section 5.7.

5.1 INTRODUCTION

As described in the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL, 1995d), a QRA is intended to help characterize site risk and provide information to determine the proper remedial pathway in the Hanford past practice remedial investigation/feasibility study process, also known in RCRA terminology as the RFI/CMS process. A QRA generally is used to help determine the need for IRMs or an ERA, to select an appropriate IRM or ERA, and to support the development of risk-based cleanup levels for an IRM. Additionally, a QRA is intended to focus remediation on the principal risk drivers in the waste site(s). Because the QRA for the 100-NR-1 (BHI, 1995) addressed these items for 1301-N and 1325-N, this QRA focuses on the risk-based DQOs and associated objectives and decisions as defined in the *Data Quality Objectives Workshop Results for 1301-N and 1325-N Characterization* (BHI, 1996) and discussed previously in Section 1.0.

5.1.1 Purpose and Approach

The purpose and approach for this QRA are different from those used for other 100-Area QRAs:

- The Tri Parties, through the DQO process, established specific objectives and decisions beyond those associated with a traditional QRA to be addressed by this QRA. Whereas the 100-NR-1 QRA provided a basis to continue on an IRM pathway, this QRA focuses on the objectives and decisions established by the Tri Parties.

- While risks posed by potential exposure to contaminants associated with 1301-N and 1325-N were assessed in the 100-NR-1 QRA, it did not specifically evaluate the impact to groundwater posed by the potential for contaminants to migrate from soil to the water table.

- New, site-specific parameters, based on data collected during the LFI, have been used to evaluate the impact associated with the potential for contaminants to migrate from soil to groundwater.

The DQO workshop document for 1301-N and 1325-N and the *Description of Work for Vadose Zone Characterization of the 1301-N and 1325-N Liquid Waste Disposal Facilities* (DOE-RL, 1995a) state that the LFI and associated QRA are required to address two key objectives: (1) to determine if immediate action on soil at 1301-N and/or 1325-N is required to protect groundwater, and (2) to determine if, for the long-term, soil remediation is required to protect groundwater from a future potential impact, and, if so, when remediation should be performed. To address these two objectives, the following tasks were accomplished in this QRA (as defined by the DQO process in Section 1.0):

- A qualitative assessment of risk including an evaluation of the risk to humans from direct exposure to contaminants in sediments and shallow subsurface soils was prepared.

- The magnitude of a driving force and its contribution to the migration of contaminants from the soil to the groundwater was determined.

- The impact to groundwater posed by the potential for contaminants to migrate from the soil to the water table was evaluated.

The QRA presented in this document was conducted in accordance with the HSRAM, and it focuses on a limited set of human exposure scenarios. Rural-residential and recreational exposure scenarios for human receptors have been evaluated in this QRA to provide bounding estimates of risk. The rural-residential scenario is consistent with the "unrestricted use" terminology used in the *Interim Remedial Action Record of Decision for the 100-BC-1, 100-DR-1, and 100-HR-1 Operable Units* (interim remedial action ROD) (EPA, 1995), and it is identical to the scenario incorporated in the *Remedial Design Report/Remedial Action Work Plan for the 100 Area* (RDR/RAWP) (DOE-RL, 1996c). Both the rural-residential and recreational scenarios are consistent with those being incorporated in the *100-NR-1/NR-2 Corrective Measures Study* (to be completed in November 1996). Potential risks to ecological receptors have not been specifically addressed in this QRA. Radionuclide concentrations of concern associated with human-health exposure scenarios are lower than those concentrations associated with ecological receptor exposure (DOE-RL, 1995d). Therefore, ecological receptors are protected at radionuclide concentrations deemed protective of human health (EPA,1993).

The potential impact to groundwater was evaluated by estimating travel times for water through the vadose zone to the water table using a unit gradient approach. (See Appendix C for a complete description of this methodology.) Once the travel times for water were calculated, a retardation factor was applied to calculate the travel times for contaminants through the vadose zone to the water table. The retardation factor is based on a contaminant's distribution coefficient (K_d), the bulk density of the soils, and the volumetric water content of the soils. Travel times for radioactive contaminants were compared to decay times to determine if contaminants will reach groundwater at detectable concentrations.

5.1.2 Previous Risk Assessments

The 100-NR-1 QRA was conducted to support selection, design, and implementation of an IRM. Based on the results of the 100-NR-1 QRA, it was concluded that 1301-N and 1325-N pose a high risk to human health with total estimated lifetime incremental cancer risks (ICR) greater than 1E-02. Thus, the 100-NR-1 LFI recommended that 1301-N and 1325-N remain on the IRM pathway. Principal risk drivers were cobalt-60 and cesium-137 (via the external exposure route) and plutonium-239/240 (via the ingestion and inhalation exposure routes). The 100-NR-1 QRA did not evaluate the impact to groundwater posed by contaminants in the vadose zone.

5.2 OVERVIEW OF THE QRA APPROACH

Two evaluations are presented in this QRA to address the DQOs developed for the 1301-N and 1325-N characterization: (1) an evaluation of the risk to human receptors from potential exposure to contaminants in accessible surface sediments and shallow subsurface soils, and (2) an evaluation of the impact to groundwater that may result from contaminants migrating to the water table through the vadose zone underlying 1301-N and 1325-N.

To facilitate these two evaluations, the site conceptual model discussed in Section 4.0 was partitioned into three distinct zones. Figure 5-1 incorporates the boundaries for Zones A, B, and C with the site conceptual model (Figure 4-1). These three zones were assigned based on the potential for human exposure, the distribution of contaminants in the soil column, and hydrogeologic features. They are defined as follows:

- Zone A: The surface sediments and shallow subsurface soils including the concentrated layer associated with 1301-N and 1325-N

- Zone B: The middle depths of the vadose zone above the boundary of the old groundwater mound associated with the former operations-era water table

- Zone C: The deep vadose zone above the saturated zone (the current water table) including the old groundwater mound associated with the former operations-era water table.

5.2.1 Risk to Humans

To evaluate the risk to human receptors from potential exposure to individual radionuclide contaminants in accessible surface sediments and shallow subsurface soils associated with 1301-N and 1325-N in Zone A, concentrations in Zone A were compared to calculated concentrations of individual radionuclides that correspond to a dose of 15 mrem/year above natural background. The 15 mrem/year value is the allowable dose limit to be achieved by remediation of radioactive-contaminated soils as presented in the *NRC Radiological Criteria Decommissioning: Proposed Rule* (59 FR 43200). The 15 mrem/year proposed standard corresponds to a lifetime ICR of 3E-04, which falls within the range of other radiation protection standards promulgated by the EPA. In addition, 15 mrem/year is the radiological cleanup standard used in the interim remedial action ROD for the 100-BC-1, 100-DR-1, and 100-HR-1 source OUs.

To evaluate the risk to human receptors from potential exposure to nonradioactive contaminants in accessible shallow subsurface soils associated with 1301-N and 1325-N in Zone A, maximum concentrations measured throughout the vadose zone were compared to cleanup standards in soil. The cleanup standards are specified under the *State of Washington Model Toxics Control Act* (MTCA), Method B, (WAC 173-340).

5.2.2 Impact to Groundwater

Two pathways exist for the migration of contaminants in soil at 1301-N and 1325-N to groundwater and, ultimately, to the Columbia River. The first contaminant migration pathway is the result of precipitation (natural recharge water) traveling through the soil column to groundwater. The second contaminant migration pathway is the result of resaturation of the deep vadose zone and temporary remobilization of contaminants from an elevated water table associated with high river levels. This QRA presents a quantitative evaluation of contaminant migration through soil and a brief discussion of potential contaminant remobilization as a result of an elevated water table. This second pathway is believed to have functioned during high Columbia River water levels (January through May of 1996). Its significance is discussed in Section 5.6.

To evaluate the impact to groundwater posed by the potential migration of contaminants through the soil column (Zones A, B, and C) to the water table, an assessment of the time for natural recharge water (i.e., natural infiltration) to travel to the groundwater was combined with contaminant-specific soil retardation factors and radionuclide decay to estimate the magnitude of contaminant migration and potential concentrations reaching the water table. For contaminants reaching the water table, the Summer's Model (EPA, 1989), a simple steady-state dilution model, was used to convert concentrations in soils (pCi/g or mg/kg) at the water table to estimated contaminant concentrations in groundwater (pCi/L or μg/L). The impact from the estimated contaminant concentrations in groundwater was characterized by comparing the predicted concentrations with MCLs and health-based standards as specified by MTCA.

5.3 DATA EVALUATION

Cobalt-60, cesium-137, strontium-90, plutonium-239/240, cadmium, chromium, lead, and nickel were identified during the DQO process as major contaminants of concern for the 1301-N and 1325-N LFI; thus, they are the focus of this QRA. The LFI analytical results confirm the relative importance of the radionuclide contaminants and indicate that chromium is the only metal detected consistently at levels of concern. As shown in Tables 3-2 through 3-5, 3-7, and 3-8, the four radionuclides identified in the DQO process are present at consistently higher concentrations compared with other radionuclides detected in soil, and they are considered the principal risk drivers in this QRA. These radionuclides are considered risk drivers because remedial action alternatives that address risks associated with these radionuclides also will address residual risks associated with the other radionuclides present in the soil.

The following four sources of data for this QRA have been used to describe contaminant distributions in the site conceptual model discussed in Section 4.0:

- the historical sediment samples from the 1301-N trench (TS-01 to TS-09) and the 1325-N crib (CS-01 to CS-12)
- the samples collected from the 1301-N and 1325-N LFI boreholes (199-N-107A, 199-N-108A, and 199-N-109A)
- the samples collected from the pump-and-treat wells (199-N-103A, 199-N-104A 199-N-105A, and 199-N-106A)
- the samples collected from a near-river borehole (199-N-95A).

Tables 5-1 through 5-3 present the radionuclide concentrations decayed to April 1, 1996. Figure 5-2 shows the cross-sections A to A' and B to B' through the area around 1301-N and 1325-N. Figures 5-3 through 5-18 depict borehole and well locations, contaminant concentrations by depth, and boundaries of Zones A, B, and C. The zone boundary locations vary among boreholes and wells as a result of differences in elevation, contaminant concentrations, and hydrogeologic features. Figures 5-3 through 5-10 identify the boundaries of Zones A, B, and C for each borehole or well in cross-section A to A' and maximum contaminant concentrations by depth for: Co-60, Cs-137, Sr-90, Pu-239/240, cadmium, chromium, lead, and nickel. Figures 5-11 through 5-18 identify the boundaries of Zones A, B, and C for each borehole or well in cross-section B to B' and maximum contaminant concentrations by depth. Data and associated figures for cadmium, lead, and nickel are presented for completeness.

Some data obtained from the saturated zone, below ~117m to 118m (~385 to 388 ft) above MSL, are presented in Tables 5-2 and 5-3 as well as in Figures 5-3 through 5-18. These data are presented for information only and were not used in this QRA because only vadose zone data was evaluated.

The historical sediment data and the data from the three LFI boreholes were used to evaluate the risk to humans from potential exposure to radionuclide contaminants in Zone A soils. The risk to humans from potential exposure to nonradioactive contaminants was evaluated using maximum concentrations measured in soil from the LFI boreholes. The historical sediment data, data from the LFI boreholes, the four pump-and-treat wells, and the near-river borehole were used to evaluate impact to groundwater resulting from potential contaminant migration. The pump-and-treat wells and the near-river borehole were included in this evaluation because they provide current data on Sr-90 concentrations in the vicinity of 1301-N and 1325-N.

Maximum contaminant concentrations measured in the soil, except the sediment data, are used in this QRA to evaluate the potential risk to human health and the potential impact to groundwater. Ninety-five percent upper confidence limit (UCL) values of the sediment data were used because the large size of the available data set supports the calculation of summary statistics. The HSRAM recommends using the mean and 95 percent UCL to calculate exposure concentrations in a risk assessment.

The mean and 95 percent UCL values (summary statistics were developed using concentrations decayed to April 1, 1996) for the historical sediment data from the 1325-N crib and the 1301-N trench were calculated using data from Table 5-1. These values are presented in Table 5-4. Maximum concentrations by depth for the principal risk-driver radionuclides from each LFI borehole were extracted from Table 5-2 and are presented in Table 5-5.

5.4 EXPOSURE ASSESSMENT

The objective of an exposure assessment is to estimate the type and magnitude of potential exposures to contaminants at a site. The exposure assessment methodology incorporated in this QRA is presented in Section 3.2 and Appendix A of the HSRAM. This assessment includes the following elements: potential receptors, exposure pathways, routes of exposure, and points of contact. These elements were integrated to develop exposure scenarios to assess risk to humans from exposure to contaminants in the surface sediments and shallow subsurface soils in Zone A at 1301-N and 1325-N.

The concern, when assessing impact to groundwater from exposure to contaminants, is the potential migration of contaminants through the vadose zone to groundwater and, ultimately, to the Columbia River. Potential impacts to groundwater are addressed by evaluating the potential migration of contaminants in soil to groundwater and by comparing estimated concentrations in groundwater with drinking-water MCLs (Section 5.5.2.2).

The site conceptual model for 1301-N and 1325-N, presented in Section 4.0 and Figures 4-1 and 5-1, identifies soil contaminant sources and ranges of contaminant concentrations. Figures 5-3 through 5-18 expand the scale of the site conceptual model and provide specific contaminant concentrations by depth. Conceptual exposure models that illustrate how receptors

could come in contact with the contaminants associated with 1301-N and 1325-N are also discussed in this section.

5.4.1 Contaminant Sources

Contaminant sources in Zone A are surface sediments in 1301-N and 1325-N and shallow subsurface soils under these structures. The vertical extent of Zone A is slightly different for each LFI borehole because of differences in elevation and contaminant concentrations. The sediment layer is ~15.2 cm (~6 in.) thick and is assumed to be present across the surface of the 1301-N crib, the 1301-N trench, the 1325-N crib, and the upper section of the 1325-N trench. Zone A represents the greatest potential for human exposure, contains the highest concentrations of radionuclides, and, therefore, presents the highest risk. Measured radionuclide concentrations in the sediment layer are in the uCi/g to pCi/g range; radionuclide concentrations in the underlying subsurface soil are in the pCi/g to nCi/g range. Metal concentrations in Zone A range from

- nondetect up to 0.73 mg/kg for cadmium
- 3.2 mg/kg up to 57.7 mg/kg for chromium
- 0.57 mg/kg up to 21.9 mg/kg for lead
- 4.6 mg/kg up to 16.7 mg/kg for nickel.

Contaminants in Zone B are present in the vadose soils to the upper boundary of the old groundwater mound (the elevation of the operations-era water table at ~125 m [~410 ft] above MSL). The boundaries of Zone B vary between the boreholes and wells because of differences in elevation and contaminant concentrations. Soils in this zone (usually deeper than 7.6 m [25 ft] bgs) are unlikely to be disturbed by human activity (i.e., through excavation). Contaminants in this zone, both radionuclides and metals, could theoretically migrate to groundwater via natural surface recharge. The extent of migration would be estimated by the rate of recharge to groundwater and the tendency for contaminants to be adsorbed to soil. Measured radionuclide concentrations in this zone are in the pCi/g range. Metal concentrations in Zone B range from

- nondetect up to 0.47 mg/kg for cadmium
- 1.7 mg/kg up to 27.3 mg/kg for chromium
- 0.21 mg/kg up to 1.7 mg/kg for lead
- 3.4 mg/kg up to 14.5 mg/kg for nickel.

Contaminants in Zone C are present from the upper boundary of the old groundwater mound (the elevation of the operations-era water table at ~125 m [~410 ft] above MSL) to the current water table ~117 to 118 m [~385 to 388 ft] above MSL). Soils in this zone are unlikely to be disturbed by excavation. As with Zone B, contaminants in Zone C could theoretically migrate to groundwater via natural surface recharge. The extent of migration would be estimated by the rate of recharge to groundwater and the tendency for contaminants to be adsorbed to soil. In addition, contaminants in the deepest section of Zone C, a few feet above the water table, could

migrate to groundwater via the resaturation pathway introduced in Section 5.2.2. Measured radionuclide concentrations in this zone are in the pCi/g range. Metal concentrations in Zone C range from

- nondetect up to 0.19 mg/kg for cadmium
- 12.2 mg/kg up to 13 mg/kg for chromium
- 0.63 mg/kg up to 3.2 mg/kg for lead
- 11.9 mg/kg up to 13.8 mg/kg for nickel.

5.4.2 Receptors and Exposure Routes

Under current (1996) conditions, human access to 1301-N and 1325-N is prohibited by institutional controls such as fences and locks that prohibit entrance. The groundwater underlying the sites is not used for consumption or irrigation.

Future land use at 1301-N and 1325-N has not yet been determined. Therefore, two future populations that may inhabit or use the sites have been assumed for purposes of evaluating potential human health risks associated with contaminants in the surface sediments and shallow subsurface soils at 1301-N and 1325-N: a rural-residential population and a recreational population. The rural-residential and recreational scenarios are differentiated by the input assumptions and parameters including the amount of time spent at the site and the applicable routes of exposure.

Rural-Residential Use: The rural-residential exposure scenario used in this QRA is a slight modification of the residential or frequent-use scenario described in the HSRAM, and it is consistent with the assumptions developed for the RDR/RAWP, the 100-NR-1/NR-2 CMS, and EPA's radionuclide soil cleanup standard. Under this scenario, groundwater underlying 1301-N and 1325-N will not be used as a potable water supply or for irrigation purposes for at least 200 years. Occupancy of the land surface, for exposure purposes, is assumed to be continuous for 365 days per year for a period of 30 years. For post remediation, it is assumed that human receptors could come into direct contact with contaminants in soil to a depth of 4.6 m (15 ft) because basements or other subsurface structures could be constructed within the site (excavation to 3.7 m [12 ft] with a 0.9 m [3 ft] buffer of clean soil). These activities could potentially allow human contact with contaminated subsurface soil if the soil has not been removed. It is reasonable to assume that, beyond the 4.6-m (15-ft) depth, soils would remain undisturbed by human activities, and that direct contact with contaminants deeper than 4.6 m (15 ft) would not occur.

The direct human exposure routes to soil contaminants within the top 4.6 m (15 ft) of soil evaluated in this QRA under the rural-residential scenario are ingestion of contaminated soil, inhalation of suspended dust, and external exposure to radiation. Indirect exposure routes are consumption of vegetables, meat, and milk produced at the site.

Recreational Use: The recreational exposure scenario used in this QRA is based on the recreational scenario described in the HSRAM, and it is consistent with the assumptions being developed for the 100-NR-1/NR-2 CMS. Under this scenario, groundwater underlying 1301-N and 1325-N will not be used as a potable water supply or for irrigation purposes for at least 200 years. For exposure purposes, it is assumed that an individual will use the area for recreational purposes (e.g., hiking, camping, swimming, boating) for only 7 days per year for a period of 30 years; humans will not inhabit the area. In addition, it is assumed that human receptors could come into direct contact with contaminants in soil to a depth of 1.8 m (6 ft). This assumption is based on the following:

- Shallow excavations of a meter or so may occur during recreational activities.
- Animals may live in burrows as deep as 1.8 m (6 ft), and these animals could bring soil from a depth of 1.8 m (6 ft) to the surface.

Recreational scenarios developed previously have assumed potential human exposure to contaminants in soil to a depth of 3.1 m (10 ft) based upon the possibility that plant roots may extend to that depth. The 3.1 m (10 ft) depth is considered conservative and the 1.8 m (6 ft) depth is considered adequate for mitigation of risk associated with potential human exposure.

The direct human exposure routes to soil contaminants within the top 1.8 m (6 ft) of soil evaluated in this QRA under the recreational scenario are ingestion of contaminated soil, inhalation of suspended dust, and external exposure to radiation.

5.5 RISK AND IMPACT EVALUATION

This section presents the risk and impact evaluations required to address the two objectives of this report (Section 1.0). These evaluations are intended to provide sufficient information to help the Tri Parties make defensible decisions concerning the risk to humans and the impact to groundwater posed by contaminants in the soils underlying 1301-N and 1325-N.

5.5.1 Evaluation of the Risk to Humans from Potential Exposure to Contaminants in Surface Sediments and Shallow Subsurface Soils (Zone A)

Using a dose assessment model, radionuclide concentrations (pCi/g) in soil must be converted to a dose rate (mrem/year) to evaluate risk from exposure to radionuclide contaminated soils. This same model is used to determine radionuclide concentrations in soil that correspond to a dose rate of 15 mrem/year above natural background. The use of a model requires an exposure scenario that specifies a hypothetical receptor (e.g., a resident or recreational-user of a site), pathways of exposure from radionuclides in soil to the receptor, and assumptions and parameters for estimating exposures and doses to the receptor from radionuclides in soil. The "RESidual RADioactivity" (RESRAD) model was selected for this evaluation. The model was developed by Argonne National Laboratory (ANL, 1993) for implementing DOE guidelines for residual

radioactive material in soil. The RESRAD model has been evaluated and approved by the EPA for use in performing dose assessments to support the EPA's proposed radionuclide soil cleanup standard of 15 mrem/year above natural background. The RESRAD input parameters used for calculating dose for the rural-residential and recreational scenarios are identified in the RESRAD outputs in Appendix D.

Radionuclide concentrations that correspond to 15 mrem/year above natural background in the year 2010 for both rural-residential and recreational exposure scenarios are presented in Table 5-6. The year 2010 is the proposed start date for remediation of 1301-N and 1325-N (Liedle, 1995). These values represent general action levels for evaluating the potential human health risks associated with radionuclide concentrations in soil based on the RESRAD input parameters presented in Appendix D. The values are not intended to represent concentrations to be achieved by corrective action at a particular site. These values are based on currently accepted rural-residential and recreational scenarios. However, even if scenario assumptions and associated 15-mrem/yr concentrations change, the outcome of this human exposure risk evaluation will not change because radionuclide concentrations in the surface sediments and shallow subsurface soils are extremely high.

Radionuclide concentrations detected in surface sediments and shallow subsurface soils (Zone A) exceed the single radionuclide soil concentrations corresponding to 15 mrem/yr above natural background in many instances (Tables 5-7 and 5-8). Based on this comparison, it is possible to state that doses a hypothetical individual would be exposed to under the assumptions outlined for the rural-residential or recreational scenarios would exceed 15 mrem/yr above natural background by several orders of magnitude. Specific doses resulting from exposure, under either a rural-residential or recreational scenario, to the high radionuclide concentrations in Zone A were not determined because the RESRAD model was developed for use with residual radionuclide concentrations. The dose conversion factors and transfer coefficients incorporated in the RESRAD model are appropriate for evaluating residual radionuclide concentrations in soil. They are not applicable for evaluating the very high concentrations in soil present at 1301-N and 1325-N. Potential doses to humans from exposure to such high radionuclide concentrations would likely significantly exceed 15 mrem/yr. Thus, the risk to humans is greater than the 3E-04 ICR associated with 15 mrem/yr and probably exceeds the range of acceptable risk specified under CERCLA and MTCA.

Metals detected in the vadose zone are not considered a risk to humans via direct exposure because maximum measured values are at Hanford background values or less than MTCA health-based action levels in soil. Table 5-9 compares maximum concentrations of metals measured in soil from the LFI boreholes with Hanford background values and MTCA values.

5.5.2 Evaluation of the Magnitude of a Driving Force and the Impact to Groundwater (Zones A, B, & C)

The DQO workshop identified as an immediate concern the possibility that high concentrations of contaminants in soil, particularly radionuclides, underlying 1301-N and 1325-N were likely to migrate downward through the soil column to groundwater and ultimately to the Columbia River. Data collected from recent sampling events within the 100-N Area have provided site-specific information on concentrations of radionuclides in soils within the vadose zone, soil lithology, hydraulic conductivity, bulk density, volumetric moisture content, porosity, and contaminant distribution coefficients. These data have been used to evaluate whether or not contamination in the vadose zone will migrate downward and impact the groundwater. This section presents an evaluation of the magnitude of a driving force (water from natural surface recharge) for migration of contaminants from soil to groundwater and the impact to groundwater posed by the potential migration of contaminants.

Soil sampling within the 100-N Area in the vicinity of 1301-N and 1325-N generally has revealed nondetect, low, or decreasing concentrations of radionuclides through Zones B and C. In some cases, however, radionuclide concentrations increase in Zone C (Figures 5-3 through 5-6 and 5-11 through 5-14). For example, in pump-and-treat Well 199-N-105A, the concentration of Sr-90 increases from 3.02 to 692 pCi/g at the top of the old groundwater mound (Figure 5-13). The Sr-90 concentration then decreases to 111 pCi/g at the 1995 water table ~117 to 118 m (~385 to 388 ft) above MSL (Figure 5-13). While the mechanisms resulting in this contaminant distribution in soil are uncertain, these instances of increased radionuclide concentrations correspond to the elevation of the old groundwater mound.

The remainder of Section 5.5.2 addresses whether or not the principal risk-driver radionuclides, Co-60, Cs-137, Sr-90, and Pu-239/240, and the metal contaminants cadmium, chromium, lead, and nickel will migrate from the vadose zone to the water table.

5.5.2.1 Magnitude of a Driving Force. Water and contaminant movement through the vadose zone to the water table is controlled by the following factors: depth to the water table; amount of natural and artificial recharge; thickness, lateral distribution, and dip of the underlying soils; moisture content of the soils; saturated and unsaturated hydraulic conductivities; porosity and density of the soils; and distribution coefficients for the contaminants of concern.

The following six-step process, presented fully in Appendix C, is used to estimate the time for water to travel from a specified depth to the 1995 water table:

1. Determine the moisture retention characteristics in 1301-N and 1325-N soils

2. Determine the unsaturated hydraulic conductivity as a function of volumetric moisture content of the vadose zone

3. Define the analytical solution to predict relative hydraulic conductivity at a specified volumetric moisture content

4. Develop moisture characteristic curves of unsaturated hydraulic conductivity versus volumetric moisture content

5. Develop equations to estimate the length of time for water to travel through a depth of soil at 1301-N and 1325-N

6. Calculate the length of time for Co-60, Cs-137, Sr-90, and Pu-239/240 to travel through a depth of soil at 1301-N and 1325-N.

Estimated travel-times to the water table were calculated for the soil types observed in boreholes 199-N-107A, 199-N-108A, and 199-N-109A using three different recharge rates: 0.2 cm/yr (0.08 in./yr), 2.0 cm/yr (0.8 in./yr), and 10 cm/yr (3.9 in./yr). The 0.2 cm/yr (0.08 in./yr) rate was used in the *100 Area Source Operable Unit Focused Feasibility Study* (DOE-RL, 1995e), the 2.0 cm/yr (0.8 in./yr) rate was determined in *Estimation of Natural Groundwater Recharge for the Performance Assessment of a Low-Level Waste Disposal Facility at the Hanford Site* (Rockhold et al., 1995). The 10 cm/yr (3.9 in./yr) rate has been applied for comparative purposes. Based on the above Rockhold reference, the 2.0 cm/yr (0.8 in./yr) recharge rate is considered the most appropriate for the 100-N Area. Table C-2 in Appendix C contains the volumetric moisture content values corrected for gravel content for these recharge rates along with porosity and particle density values for soils from 199-N-107A, 199-N-108A, and 199-N-109A.

Travel-times for water (i.e., the driving force) moving from the bottom of both 1301-N and 1325-N to the water table ~117 to 118 m [~385 to 388 ft] above MSL) for each recharge rate are plotted as a function of elevation (left Y-axis) or depth (right Y-axis) on the left hand graph in Figures 5-19 through 5-30. The discontinuities in the "water only" plots are a result of differences in soil types with depth. (See Appendix C for the discussion of soil types.) To arrive at a travel time at a particular elevation, draw a line perpendicular to the Y-axis until it intersects the recharge rate of interest and then read off the travel time from that point to the water table from the X-axis. For example, using Figure 5-19, for water present at a depth of 9.1 m (30 ft) or 131 m (430 ft) above MSL, and a recharge rate of 2 cm/yr (0.8 in./yr), it would take 90 years for water to travel through 12.8 m (42 ft) of soil to the groundwater (~117 to 118 m [~385 to 388 ft] above MSL).

5.5.2.2 Impact to Groundwater from Radionuclide Migration. After the magnitude of the driving force was identified, the impact of this force on contaminants in the soil was estimated. This impact was quantified by determining the time required for contaminants to travel through the soil column. This was accomplished by modifying the retardation equation for unsaturated flow to estimate the relative velocity of each contaminant to the groundwater as described in Appendix C. The distribution coefficients, retardation factors, and half lives used in this evaluation of impact to groundwater are presented in Table 5-10.

Estimated travel-times for Co-60, Cs-137, Sr-90 and Pu-239/240 migrating from the bottom of 1301-N and 1325-N to the water table for the 100-N recharge rate (2 cm/yr [0.8 in./yr]) are plotted as a function of elevation (left Y-axis) or depth (right Y-axis) on the right hand graph in Figures 5-19 through 5-30.

The same process used to estimate the travel-time of water through a vertical section of soil was also used to estimate the travel-time for contaminants. For example, using Figure 5-21, it takes 20,000 years for Sr-90, present at a depth of 9.1 m (30 ft), to travel to groundwater. For comparative purposes, the 0.2-cm/yr (0.08-in./yr) and 10-cm/yr (3.9-in./yr) recharge rates and the "water only" travel-time plots have been provided.

The impact that these contaminants could have on groundwater is illustrated by Figures 5-19 through 5-30. Approximate travel times to the 1995 water table from major points of concern have been extracted from these figures and are presented in Table 5-11. Major points of concern are the bottom of 1301-N and 1325-N, the top of the old groundwater mound ~125 m (~410 ft) above MSL, and at the high water table associated with high Columbia River flows that occurred in early 1996 at ~119.8 m (~393 ft) above MSL .

The results of the travel-time calculations (Appendix C) suggest that radionuclide travel-times through the vadose zone to the existing water table are on the order of 1,000 years to greater than 100,000 years. Radionuclides will undergo radioactive decay as they migrate through the vadose zone. Consequently, the potential for a radioactive contaminant to reach groundwater depends upon the depth in soil at which the contaminant is located, the concentration present, and the half-life of the radionuclide. If a sufficient number of half-lives elapse during travel through the vadose zone, it is possible for high concentrations to be present in soil without posing an impact to groundwater via migration. As an example, the evaluation of the potential impact to groundwater posed by Sr-90 in soil from 199-N-107A is presented below (for this example, reference Figure 5-21):

- Select the soil sample from 199-N-107A with the maximum decayed concentration of Sr-90 from Table 5-5 -- (19,543 pCi/g at a depth of 3.4 to 4.0 m [11 to 13 ft] or an elevation of 134 to 136 m [449 to 447 ft] above MSL).

- Calculate the time of decay from 19,543 pCi/g to the laboratory detection limit (1 pCi/g)
  -- (416 years) for the selected maximum concentration of Sr-90.

- Use Figure 5-21 to estimate the travel time from 136.55 m (448 ft) above MSL (the elevation at which the sample containing the maximum measured Sr-90 concentration was collected) to the 1995 water table with recharge rate of 2 cm/yr (0.8 in./yr) -- (28,351 years).

- Compare the time of decay to the detection limit with the travel-time to the 1995 water table -- (416 years versus 28,351 years).

- Determine the maximum concentration of Sr-90 measured in 199-N-107A decays to nondetectable levels before it can travel to groundwater.

- Conclude that the maximum concentration of Sr-90 measured in 199-N-107A does not pose an impact to groundwater.

This evaluation is presented in Table 5-12. Similar evaluations for the risk-driver radionuclides were performed using the maximum 95 percent UCL decayed concentrations from the surface sediments data (Table 5-4) and maximum decayed concentrations detected in Zones A, B, and C from the LFI boreholes (Table 5-5).

Based on these evaluations, concentrations of Co-60, Cs-137, and Sr-90 in the surface sediments, the shallow subsurface soils, and the deeper soils (Zones A, B, and C) do not pose an impact to groundwater via the migration pathway because they decay before they reach groundwater. However, concentrations of the long-lived radionuclides Pu-239 and Pu-240 may reach the water table in hundreds of thousands of years. Given the magnitude of time involved, the impact posed to groundwater by plutonium migrating to the water table is not an immediate concern.

5.5.2.3 Impact to Groundwater from Metals Migration. Concentrations of cadmium, lead, and nickel do not pose an impact to groundwater because measured values were not consistently above detection limits or Hanford soil background values. However, chromium was measured above the detection level and above background in soils underlying 1301-N.

The Summer's Model was used to perform an evaluation of the potential impact to groundwater posed by chromium migrating through the soil column to the water table. For purposes of the Summer's Model evaluation, the site area was defined as the total area of the 1301-N crib and trench which equals 4856 m^2 (BHI, 1996). The mixing zone width (i.e., the site width perpendicular to the direction of groundwater flow as measured from the southwest corner of the crib to a point due south of the southeast corner of the trench) was defined as 315 m. For bounding purposes, a mixing zone width of 105 m was also used, and several K_ds were evaluated. Table 5-13 contains both the site-specific and general input parameters used in the Summer's Model for this evaluation. The results of this evaluation are presented in Table 5-14.

Using a mixing zone width of 315 m, a K_d of zero, and assuming the maximum measured concentration of chromium, 57.7 mg/kg is all hexavalent; the estimated concentration of chromium in groundwater is 2,783 ug/L. If a mixing zone width of 105 m is used, the estimated concentration of chromium in groundwater is 8,290 ug/L. However, the representative maximum concentration of chromium (measured as total chromium) currently detected in the groundwater underlying 1301-N and 1325-N is 240 ug/L. The MCL for hexavalent chromium is 80 ug/L.

Although the Summer's Model estimates chromium concentrations in groundwater exceeding the MCL as a result of potential contaminant migration through the soil column, uncertainty is associated with the evaluation. Several factors contribute to this uncertainty including the

applicable mixing zone width, the valence of the chromium in soils beneath 1301-N, and the K_d values applicable to chromium species in Hanford soils.

In the case of 1301-N, the applicable mixing zone width is a subjective decision due to the shape and orientation of the facility. Thus, the bounding cases of 315 m and 105 m were carried through the evaluation.

Chromium in soil at 1301-N and 1325-N was characterized as total chromium, but the form, trivalent, or hexavalent, was not determined. Thus, it is not known if the chromium detected is all trivalent or all hexavalent, or some combination. This creates uncertainty about the potential mobility of chromium in soil. Chromium was originally discharged to 1301-N as hexavalent chromium. While 1301-N was in use, the travel-time of water through the vadose to the water table was relatively short, and hexavalent chromium would have traveled with the water (given a K_d of zero as discussed in Section 4.0). After sodium dichromate releases to 1301-N ceased in the early 1970s, millions of liters of water continued to be discharged to the facility every year for approximately 15 years. Given the copious amount of water discharged to the soil, any residual hexavalent chromium remaining in the soil should have moved with the water through the soil column to the groundwater. Once all discharges to 1301-N ceased, the rate of hexavalent chromium migration would have decreased considerably, and chromium was then subject to chemical transformation based on soil characteristics (as discussed in Section 4.0). If the chromium remaining in the soil after discharges ceased did not transform to the trivalent state, it should have migrated to the water table in approximately 10 years (Figure 5-19). The fact that chromium concentrations are still detected in the soil above background after 20-plus years indicates that the majority of the chromium is likely present in the trivalent state.

Compounding the uncertainty associated with the valence of the chromium is the lack of substantiated data concerning the K_d values applicable to chromium in Hanford soils. If one assumes the migration of chromium is slightly retarded in soil (i.e., K_d equals 2), then the estimated concentration in groundwater, using mixing zone widths of 315 m and 105 m, decreases substantially to 69.4 ug/L and 207 ug/L respectively.

Chromium migration to the water table may or may not pose a potential impact to groundwater; however, uncertainty exists due to information gaps in the behavior of chromium in Hanford soils. The actual K_d value for chromium in Hanford soils has not been measured and the valence and resulting behavior of the chromium detected in the soils below 1301-N is uncertain. It is possible that the chromium present is not all hexavalent chromium with a K_d of zero. Therefore, it is possible that chromium detected in soils below 1301-N does not represent an increased impact to groundwater over existing conditions.

5.6 WATER TABLE FLUCTUATION IMPACTS ON CONTAMINANT MIGRATION (ZONE C)

The migration of contaminants to groundwater as a result of a fluctuating water table is addressed briefly in this section.

Radionuclides have been detected through the vadose zone to the water table at ~117 to 118 m (~385 to 388 ft) above MSL near 1301-N and 1325-N and downgradient toward the Columbia River. At the old groundwater mound, Sr-90 increases in concentration and then at most wells, decreases in concentration with depth. Resaturation of deep vadose zone soils may occur whenever the water table rises. This periodic resaturation of contaminated soils may result in a temporary increase of contaminant concentrations in groundwater.

This possible increase in concentration between the 1995 water table and the old groundwater mound has the following implication: if the water table rises, resaturation of soils that contain elevated levels of radionuclides may occur. This resaturation may increase the levels of contamination in the groundwater over those observed in the past.

In early 1996, the Columbia River levels were unusually high. As a result, the water table underlying 1301-N and 1325-N rose ~1.5 to 2.4 m (~5 to 8 ft) and resaturated soils containing elevated concentrations of Sr-90. The concentration of Sr-90 in groundwater increased from an average of 1094 pCi/L before this rise in the water table to an average of 1942 pCi/L after the rise. These results will be published in the *1996 100-NR-2 Annual Report* to be published in the spring of 1997.

The resaturation phenomenon and the corresponding increase in Sr-90 concentration in groundwater is not considered a concern for this QRA because it is an infrequent and temporary impact that is currently being addressed by the N-Springs pump-and-treat system and the 100-NR-2 CMS.

5.7 SUMMARY OF THE QRA

The evaluations conducted in this QRA are summarized below:

- Potential exposure to radionuclide contaminants in the surface sediments and shallow subsurface soils (Zone A) associated with both 1301-N and 1325-N poses a high risk to humans as discussed in Section 5.5.1.

- Potential exposure to metals in the vadose zone associated with both 1301-N and 1325-N poses no significant risk to humans as discussed in Section 5.5.1.

- Cobalt-60, cesium-137, and strontium-90 concentrations present in the surface sediments, shallow subsurface soils, and deep vadose zone (Zones A, B, and C) beneath both

1301-N and 1325-N, as well as concentrations in vadose zone soils beneath the extraction wells and the near-river well, do not pose an impact to groundwater via the recharge migration pathway because of radioactive decay during the time of migration. Plutonium-239/240 reaches the groundwater, but the impact is not of immediate concern given the magnitude of the time involved.

- Chromium in the vadose zone soils (Zones B and C) beneath 1301-N may impact groundwater because the estimated concentration reaching groundwater under a worst-case scenario is above the MCL.

- Radionuclide contaminants in the deep vadose zone soils of the capillary fringe between the "normal" water table level and the "high" water table level (a difference in elevation of ~1.5 to 2.4 m [~5 to 8 ft]) associated with high Columbia River levels may flush to the groundwater via the resaturation migration pathway as discussed in Section 5.6.

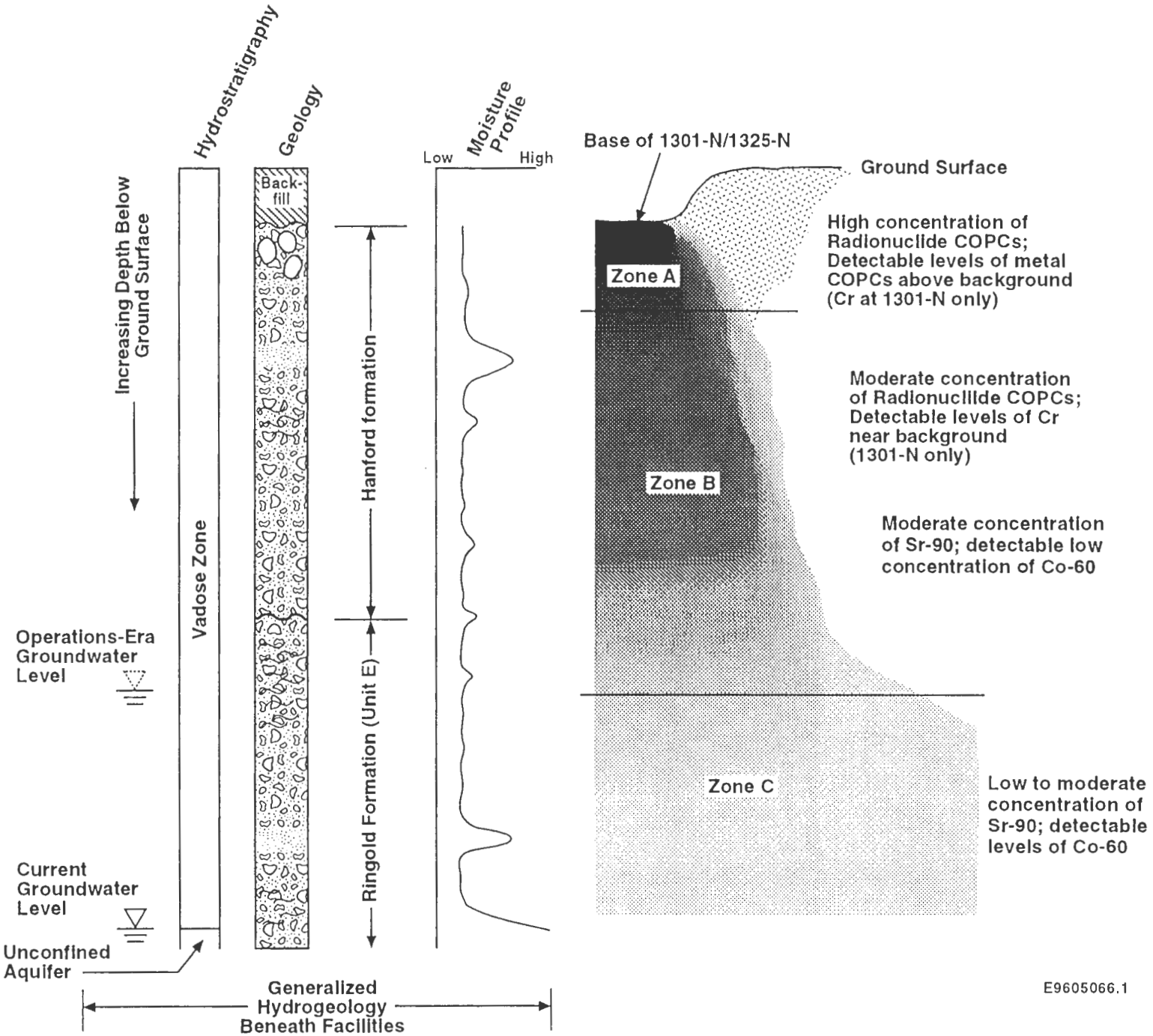
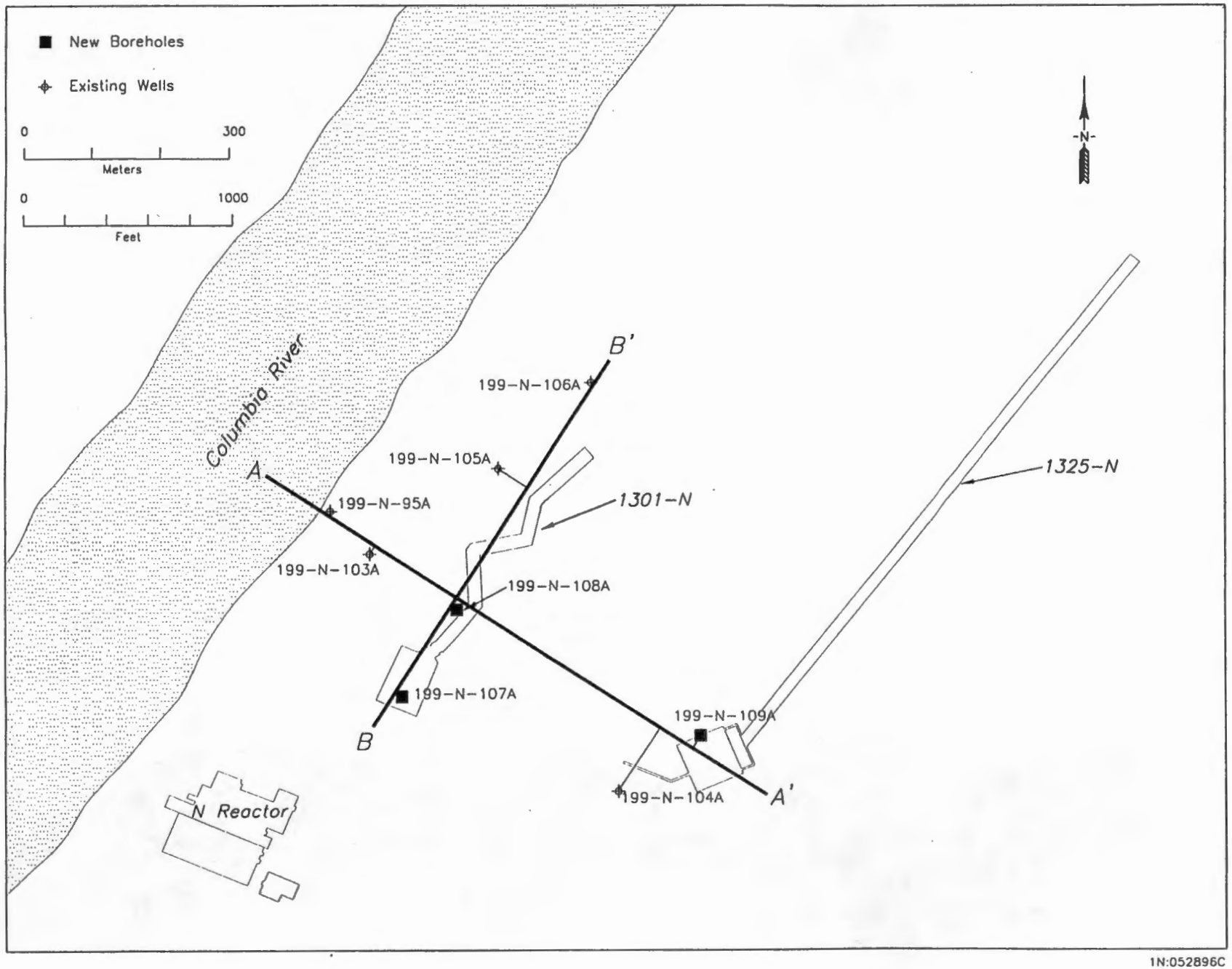


Figure 5-1. Conceptual Site Model with Zones A, B, and C



1N:052896C

Figure 5-2. Cross-Sections A to A' and B to B'

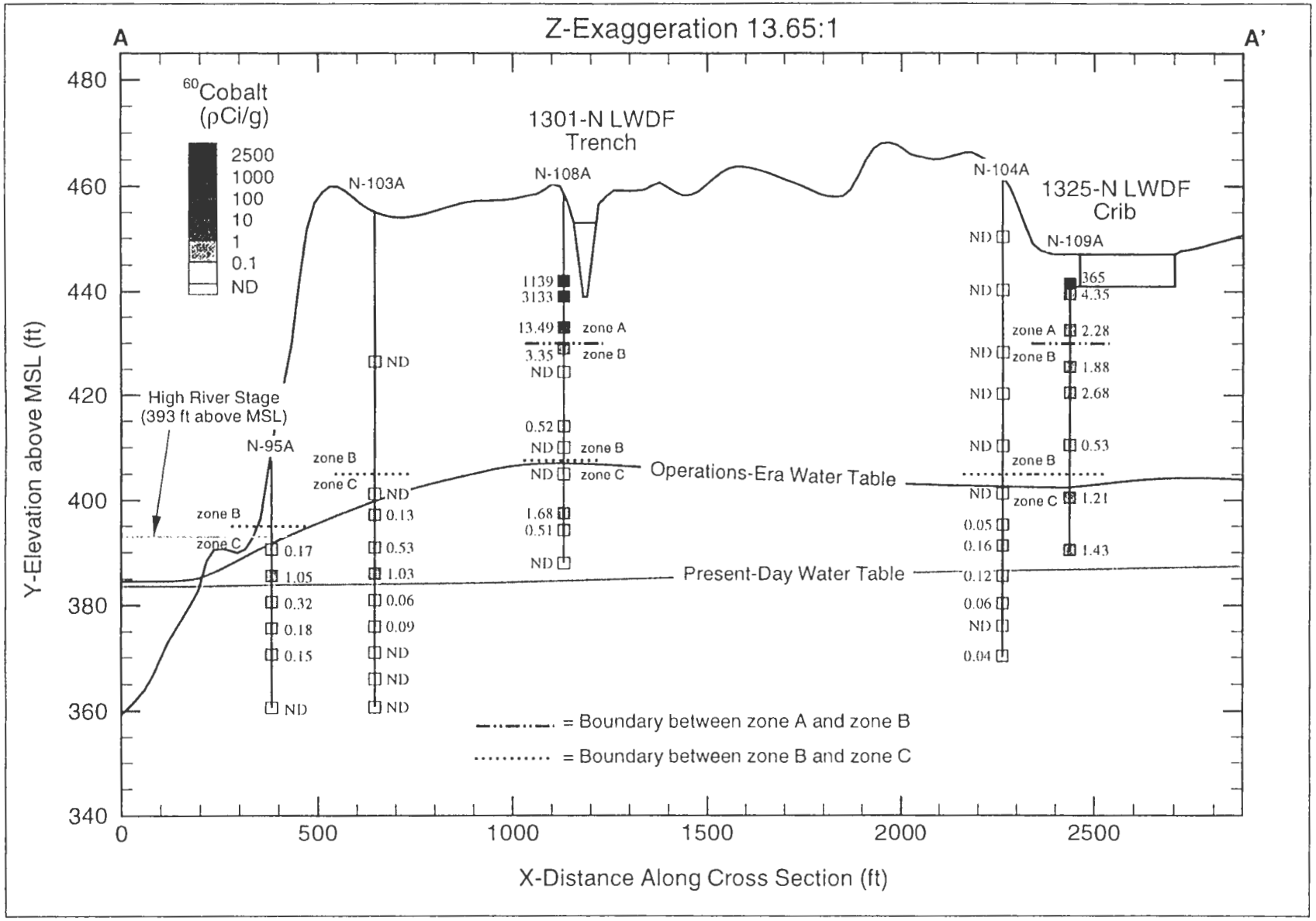


Figure 5-3. Cross-Section A to A' with Cobalt-60 Concentrations by Depth

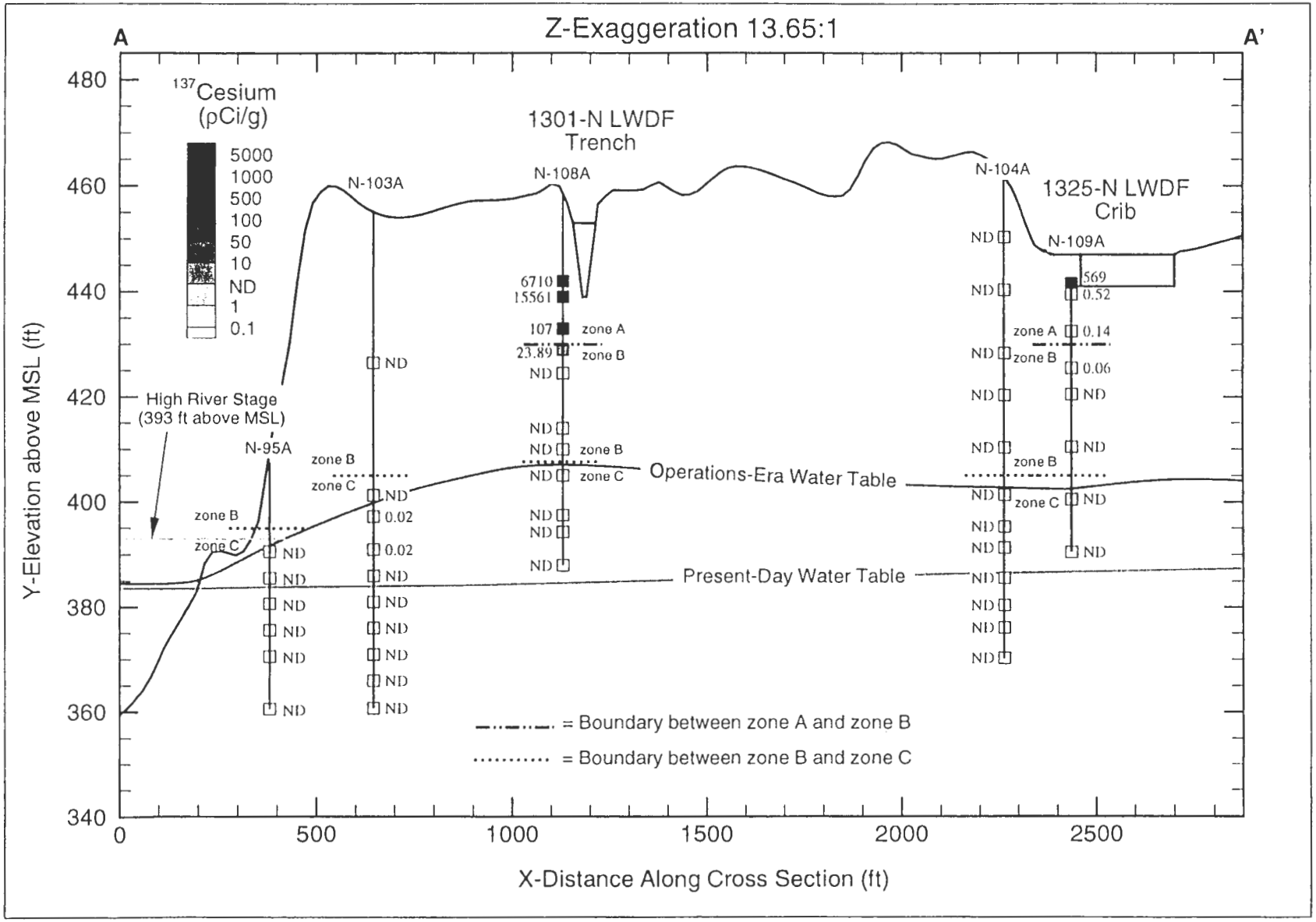


Figure 5-4. Cross-Section A to A' with Cesium-137 Concentrations by Depth

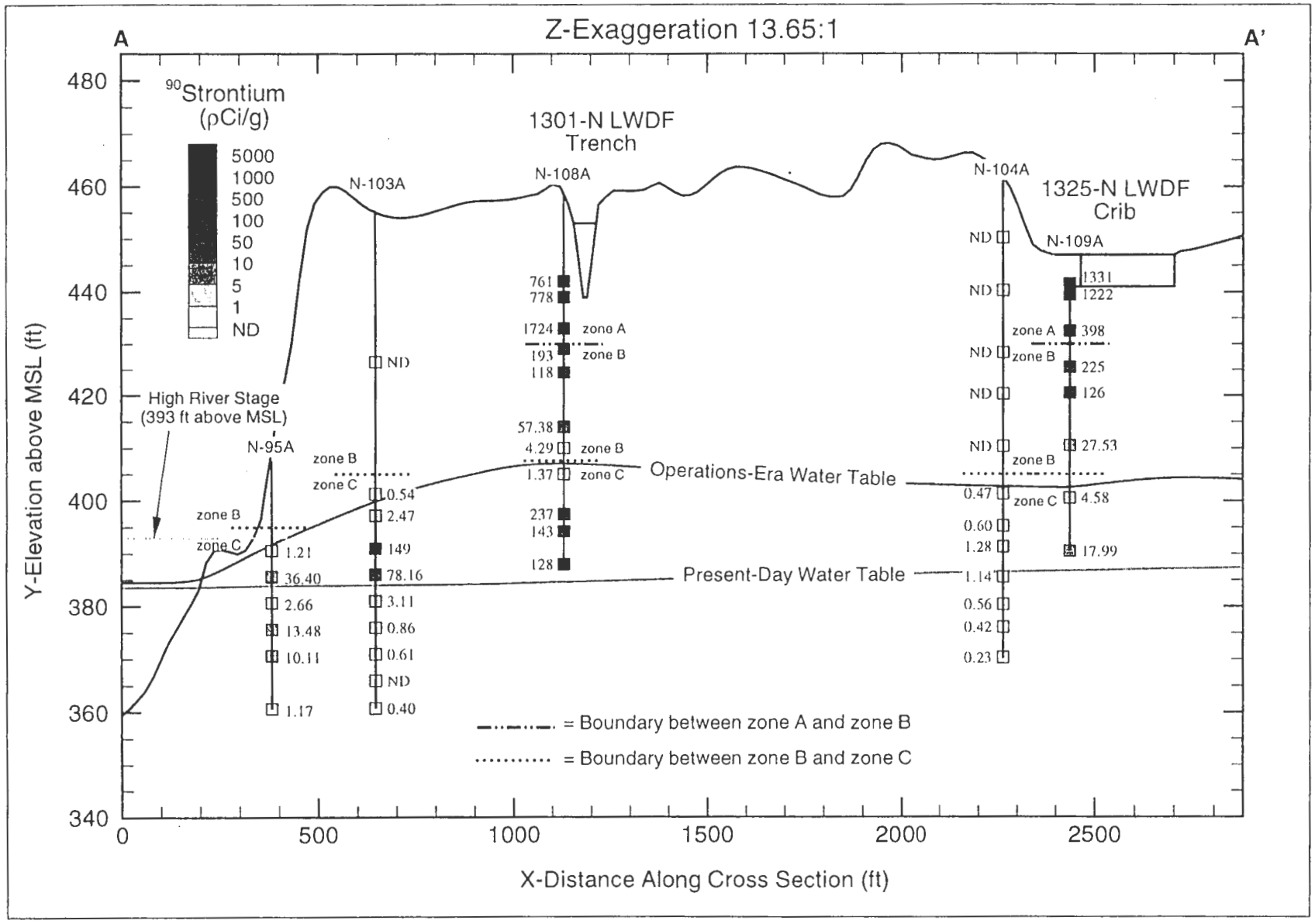


Figure 5-5. Cross-Section A to A' with Strontium-90 Concentrations by Depth

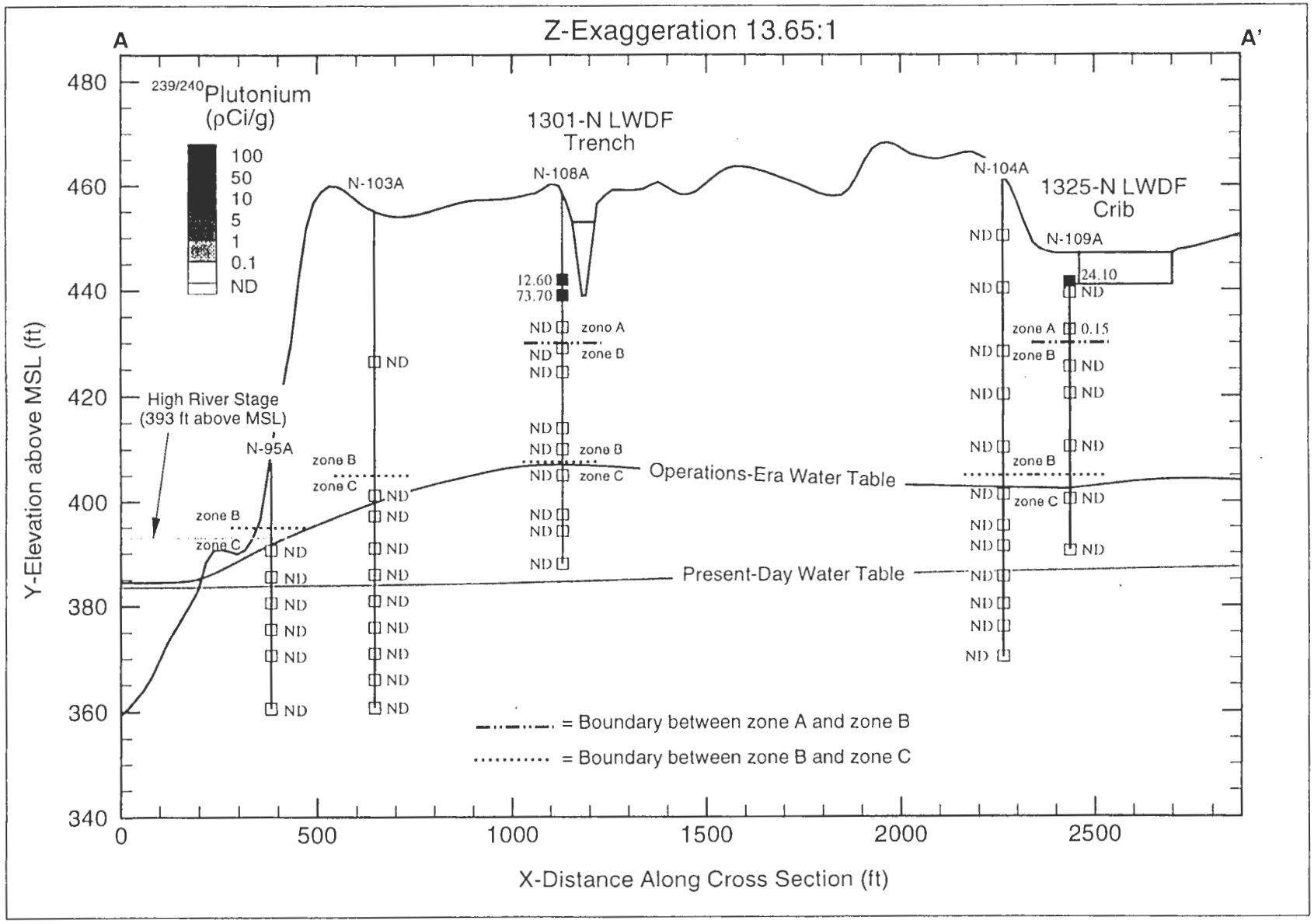


Figure 5-6. Cross-Section A to A' with Plutonium-239/240 Concentrations by Depth

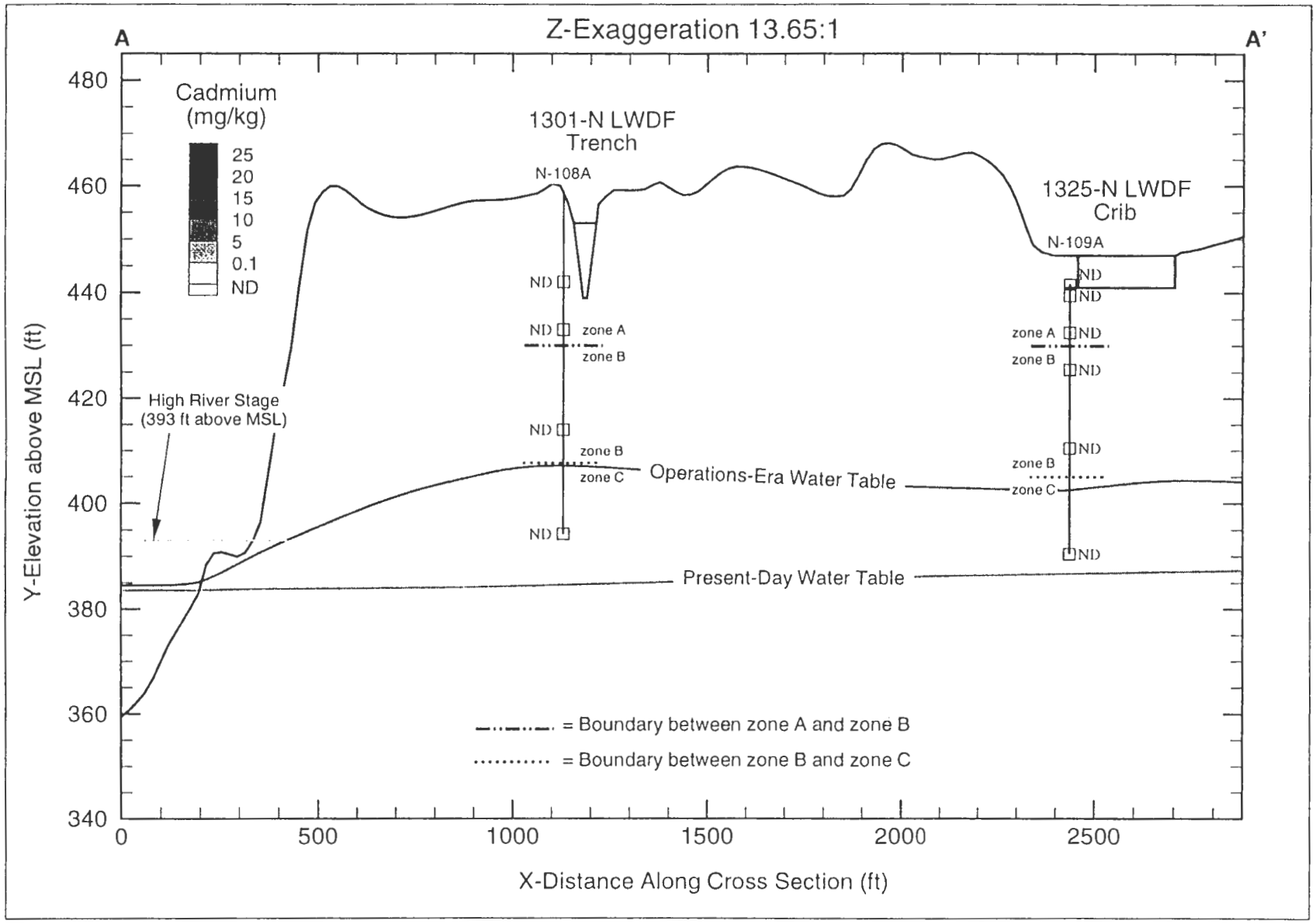


Figure 5-7. Cross-Section A to A' with Cadmium Concentrations by Depth

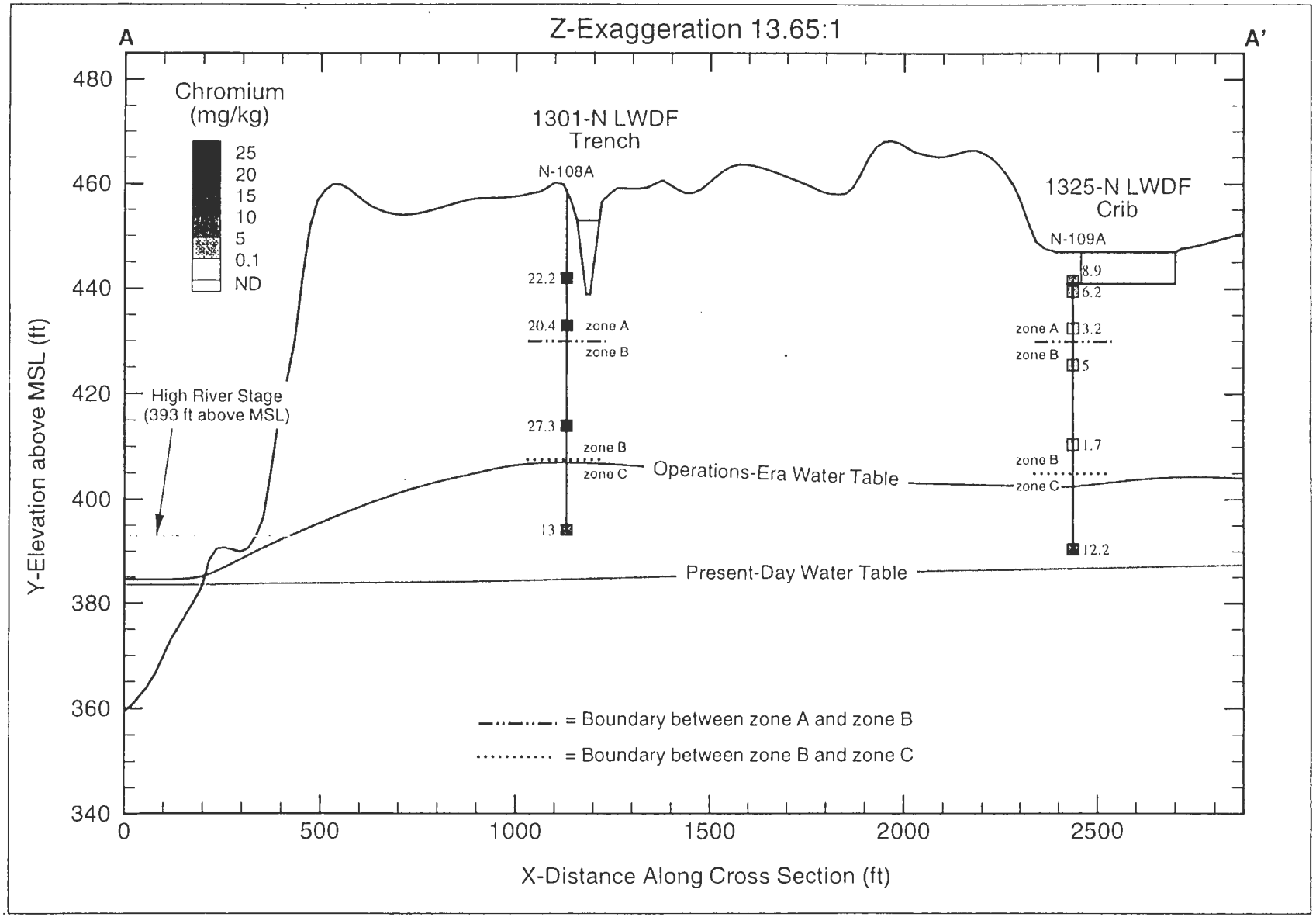


Figure 5-8. Cross-Section A to A' with Chromium Concentrations by Depth

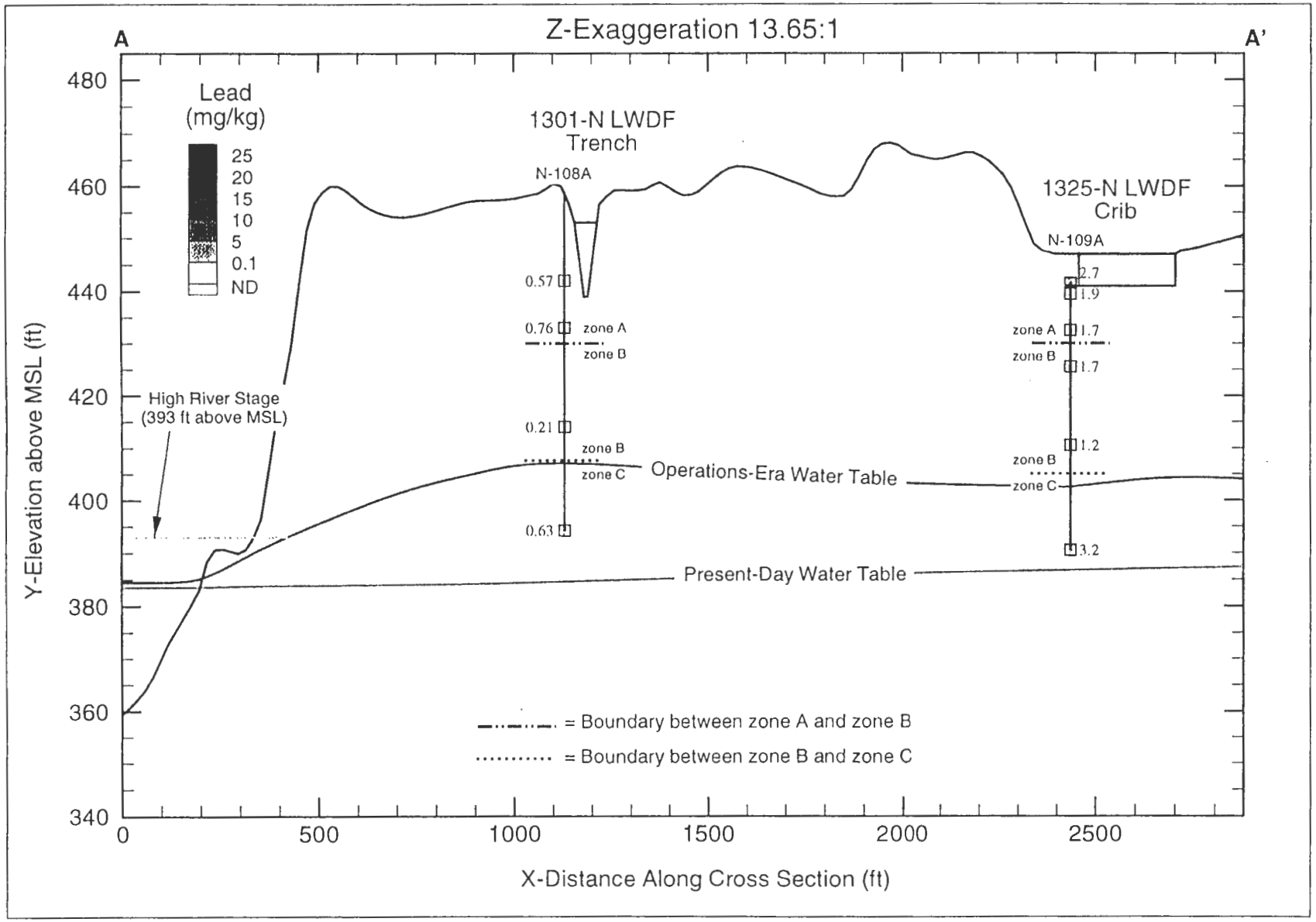


Figure 5-9. Cross-Section A to A' with Lead Concentrations by Depth

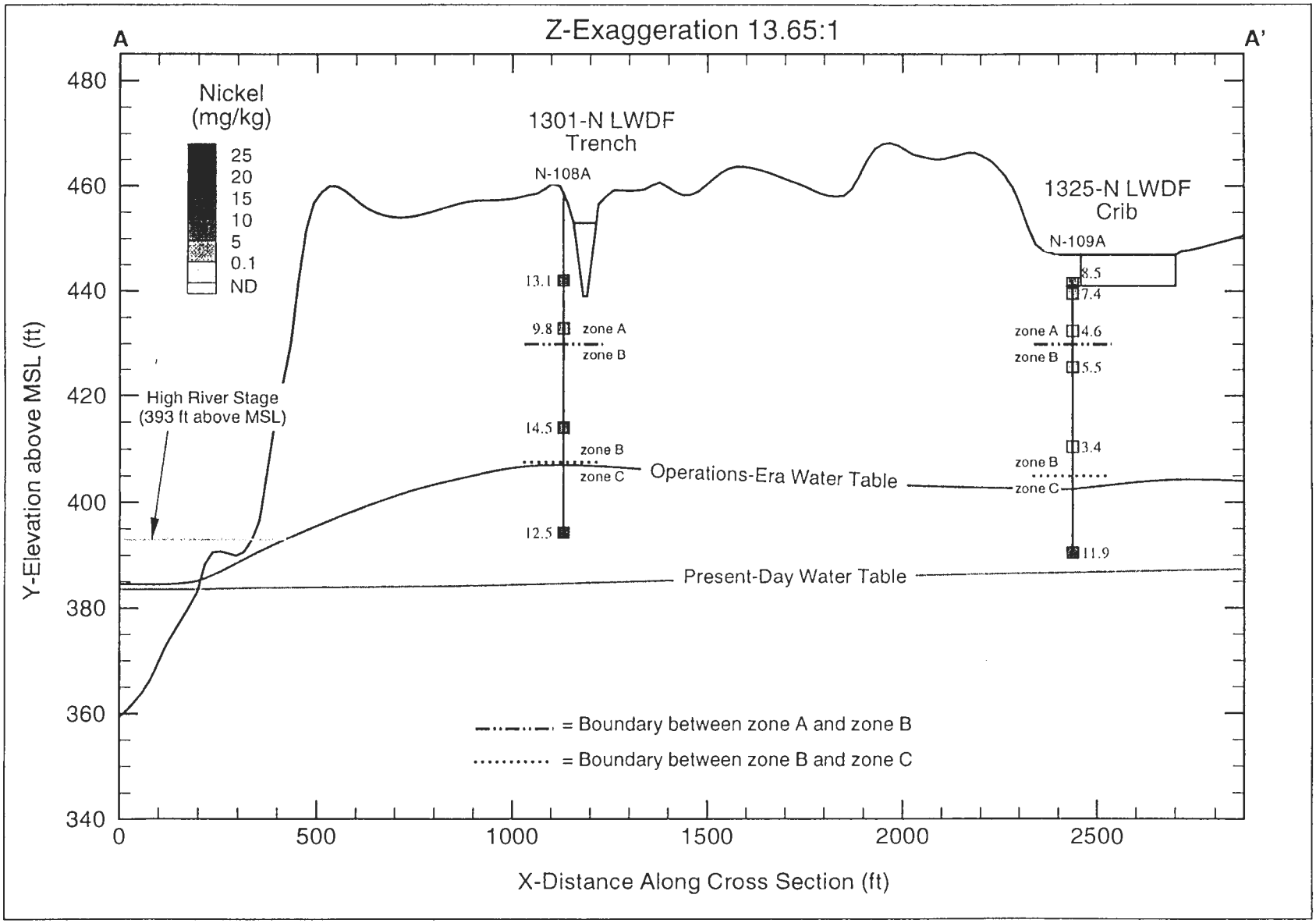


Figure 5-10. Cross-Section A to A' with Nickel Concentrations by Depth

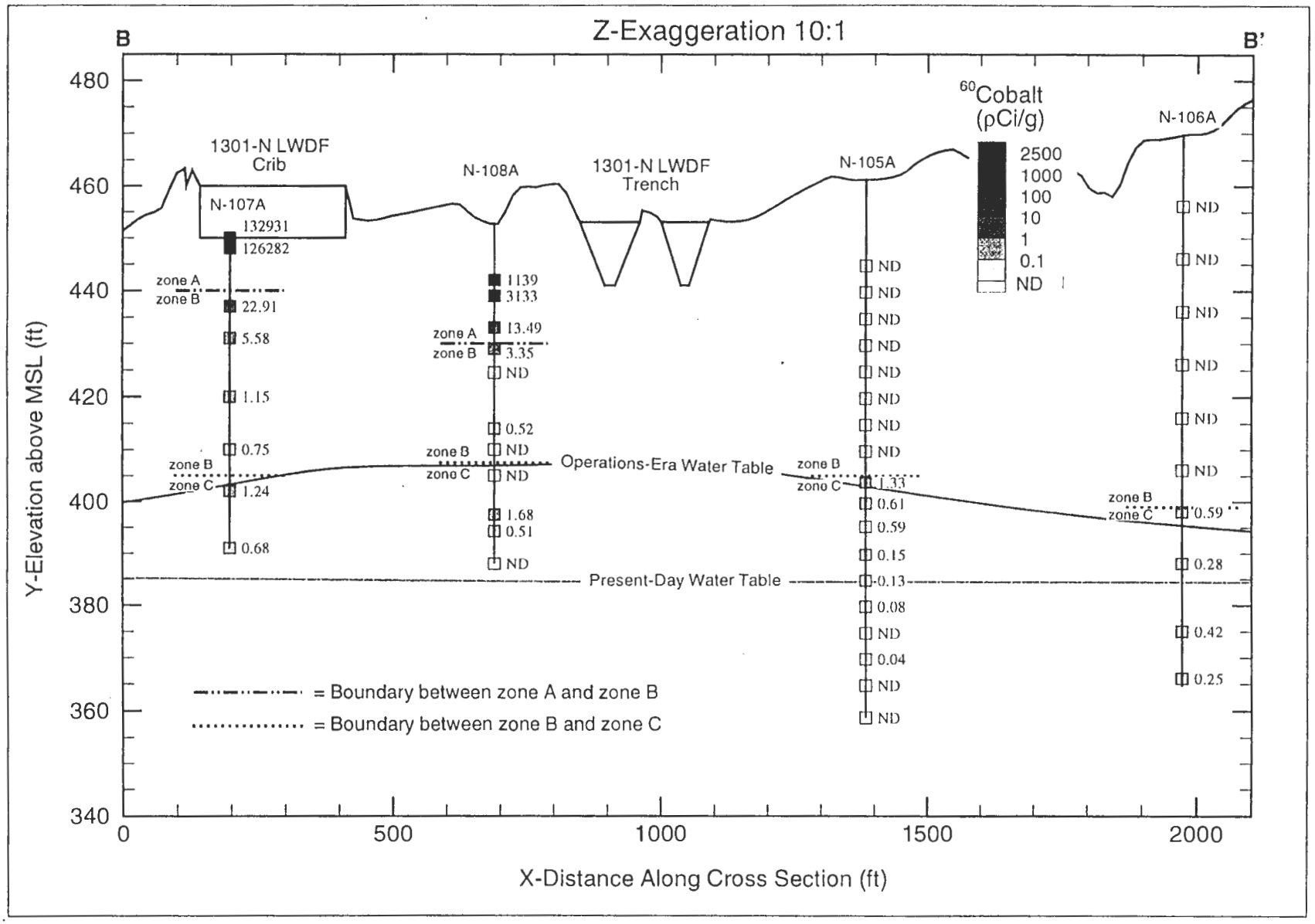


Figure 5-11. Cross-Section B to B' with Cobalt-60 Concentrations by Depth

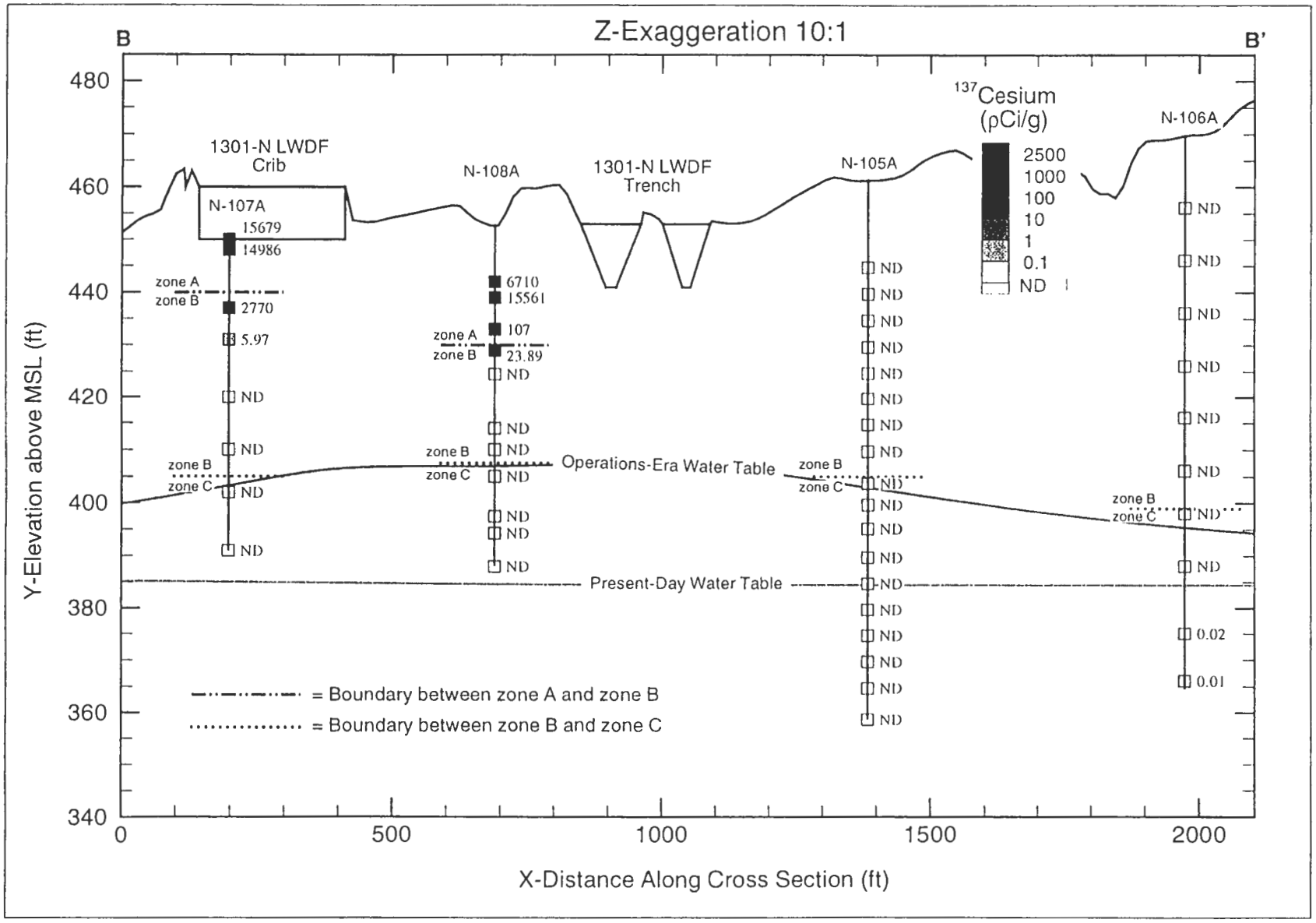


Figure 5-12. Cross-Section B to B' with Cesium-137 Concentrations by Depth

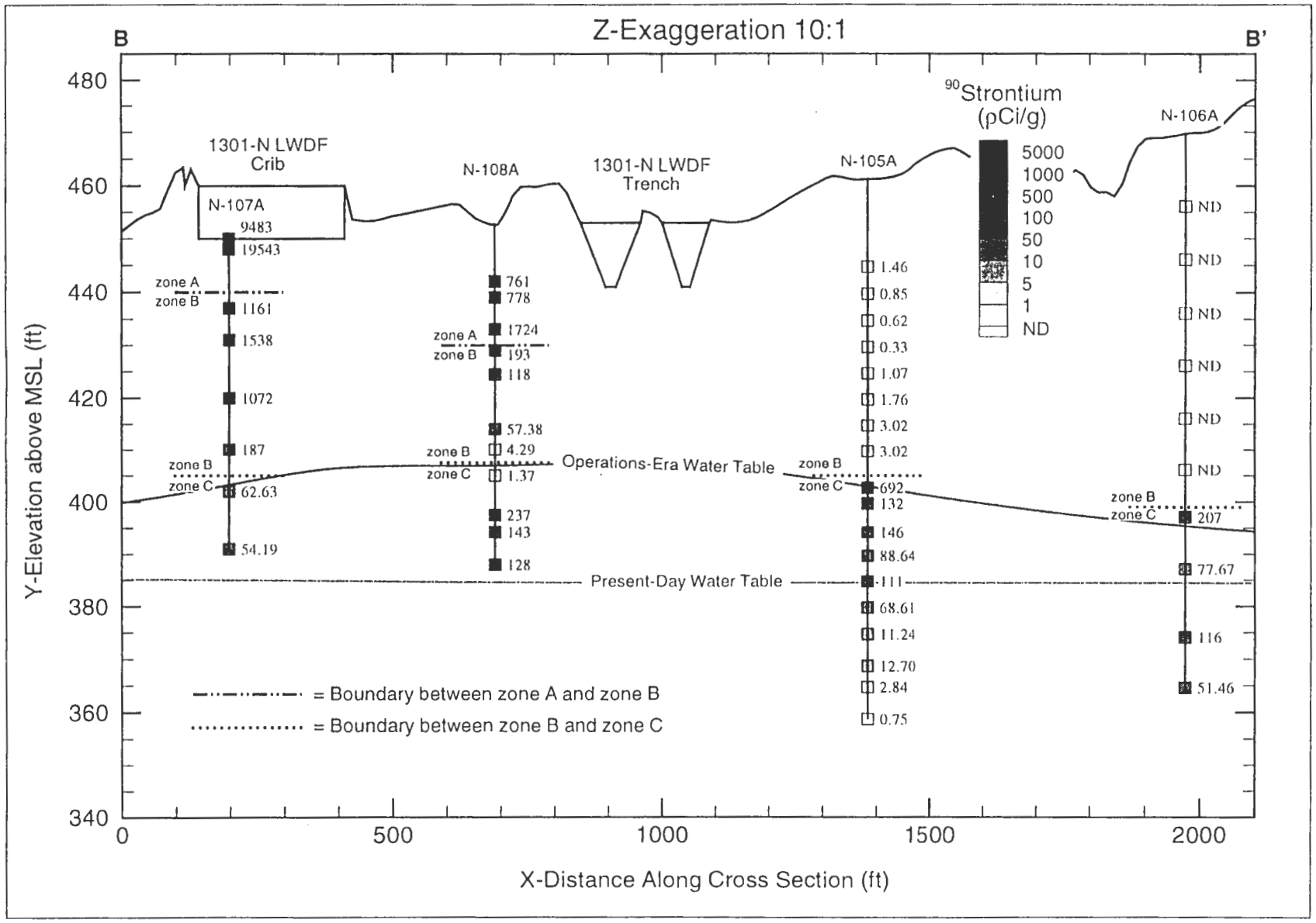


Figure 5-13. Cross-Section B to B' with Strontium-90 Concentrations by Depth

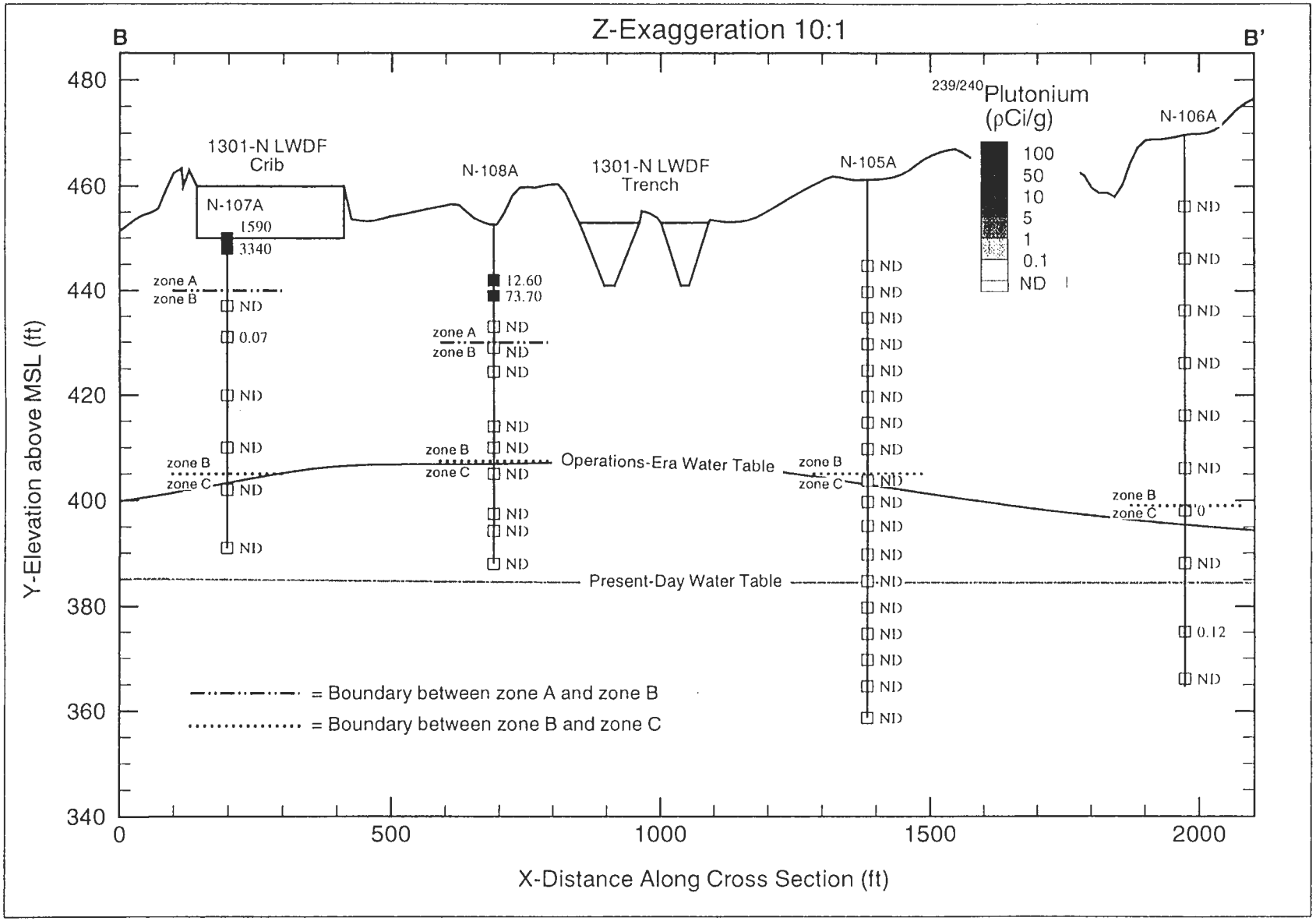


Figure 5-14. Cross-Section B to B' with Plutonium-239/240 Concentrations by Depth

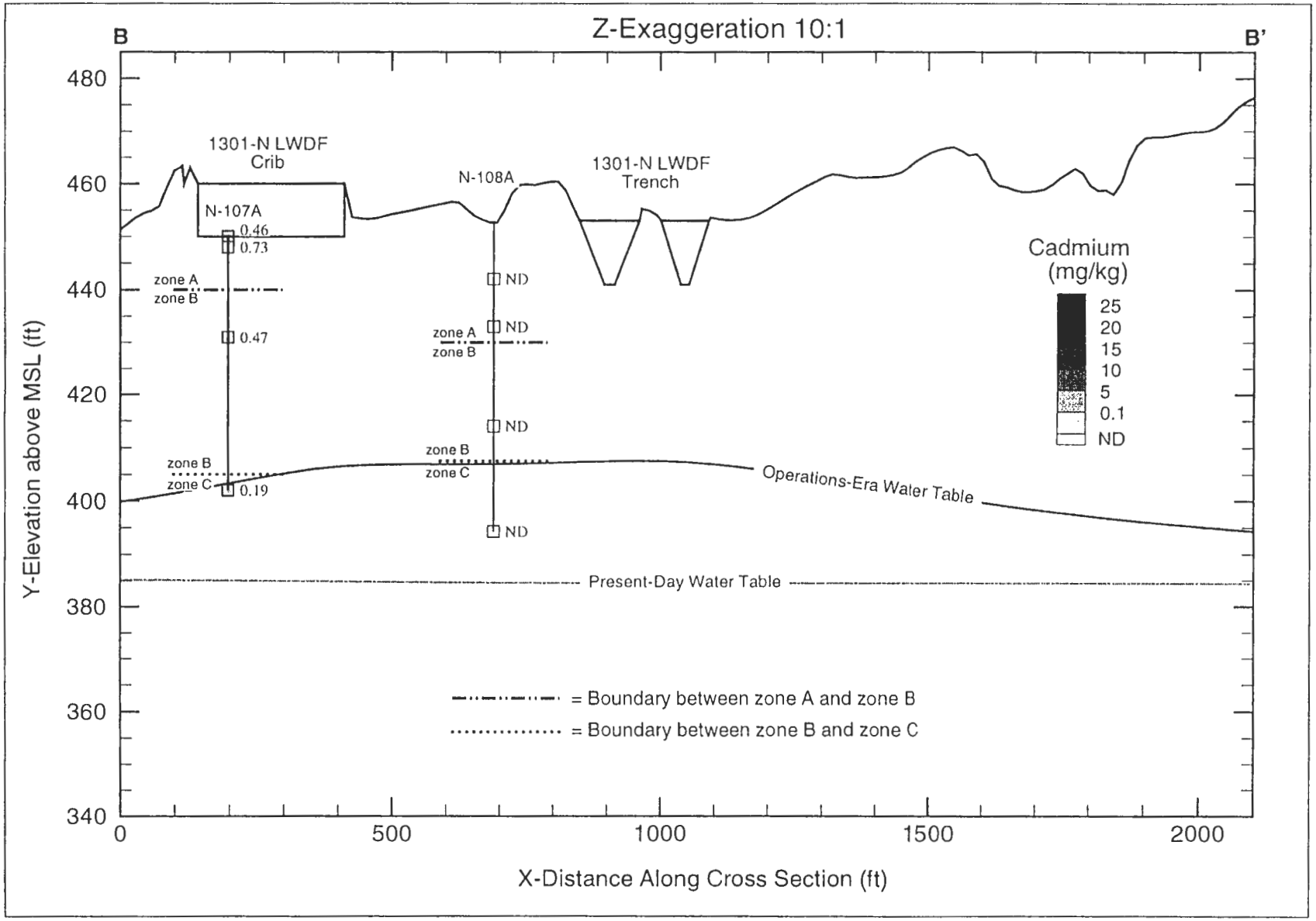


Figure 5-15. Cross-Section B to B' with Cadmium Concentrations by Depth

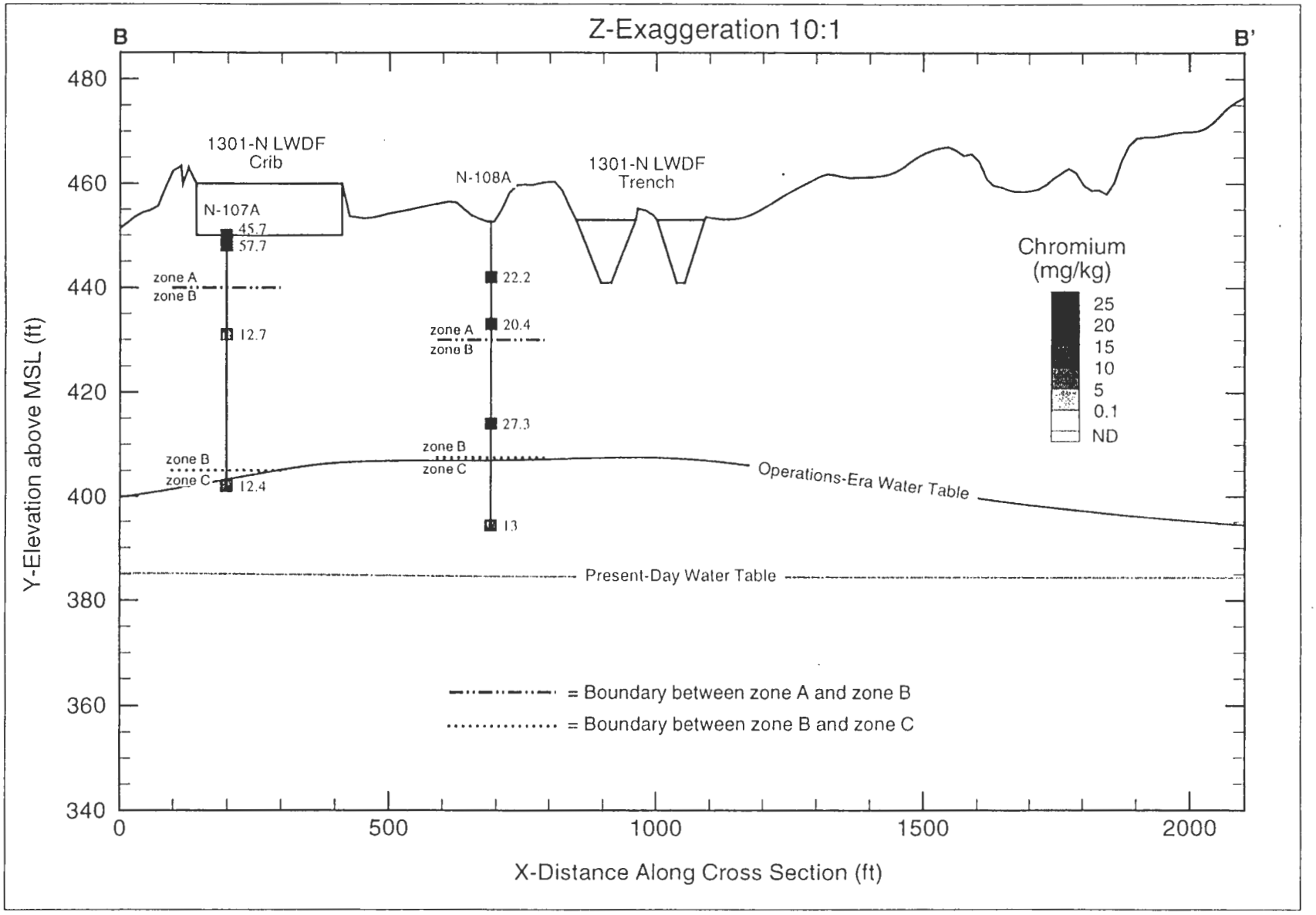


Figure 5-16. Cross-Section B to B' with Chromium Concentrations by Depth

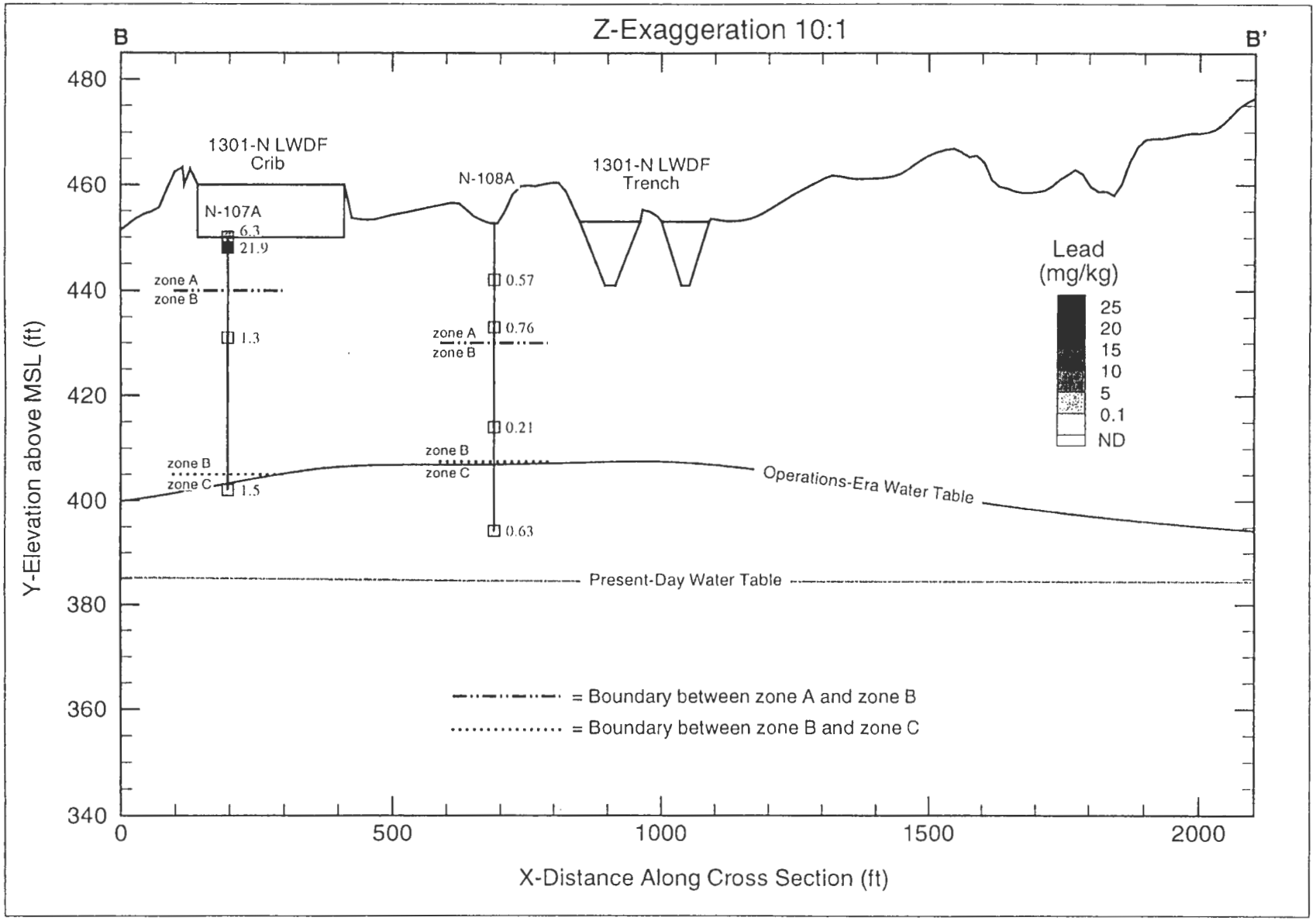


Figure 5-17. Cross-Section B to B' with Lead Concentrations by Depth

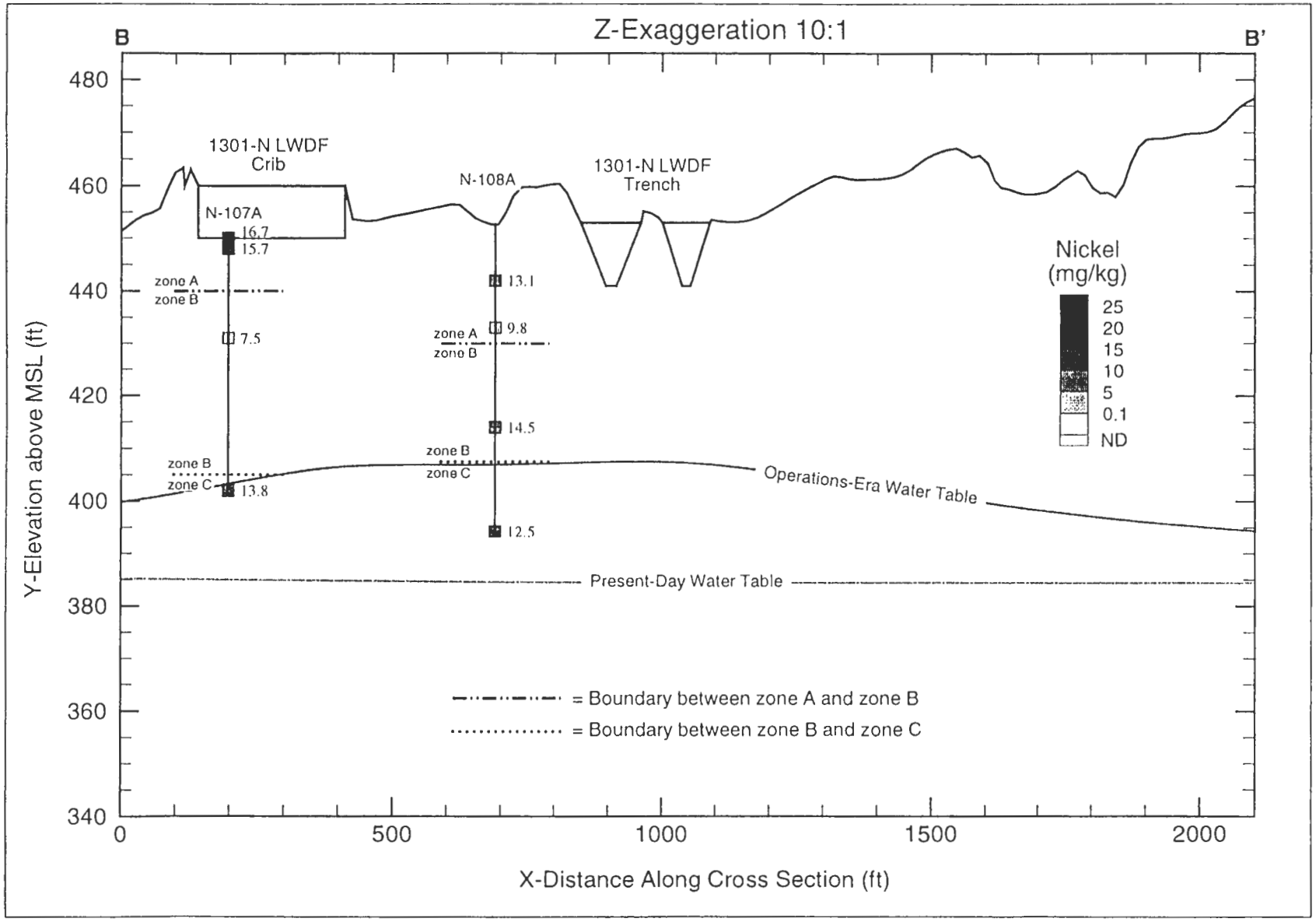


Figure 5-18. Cross-Section B to B' with Nickel Concentrations by Depth

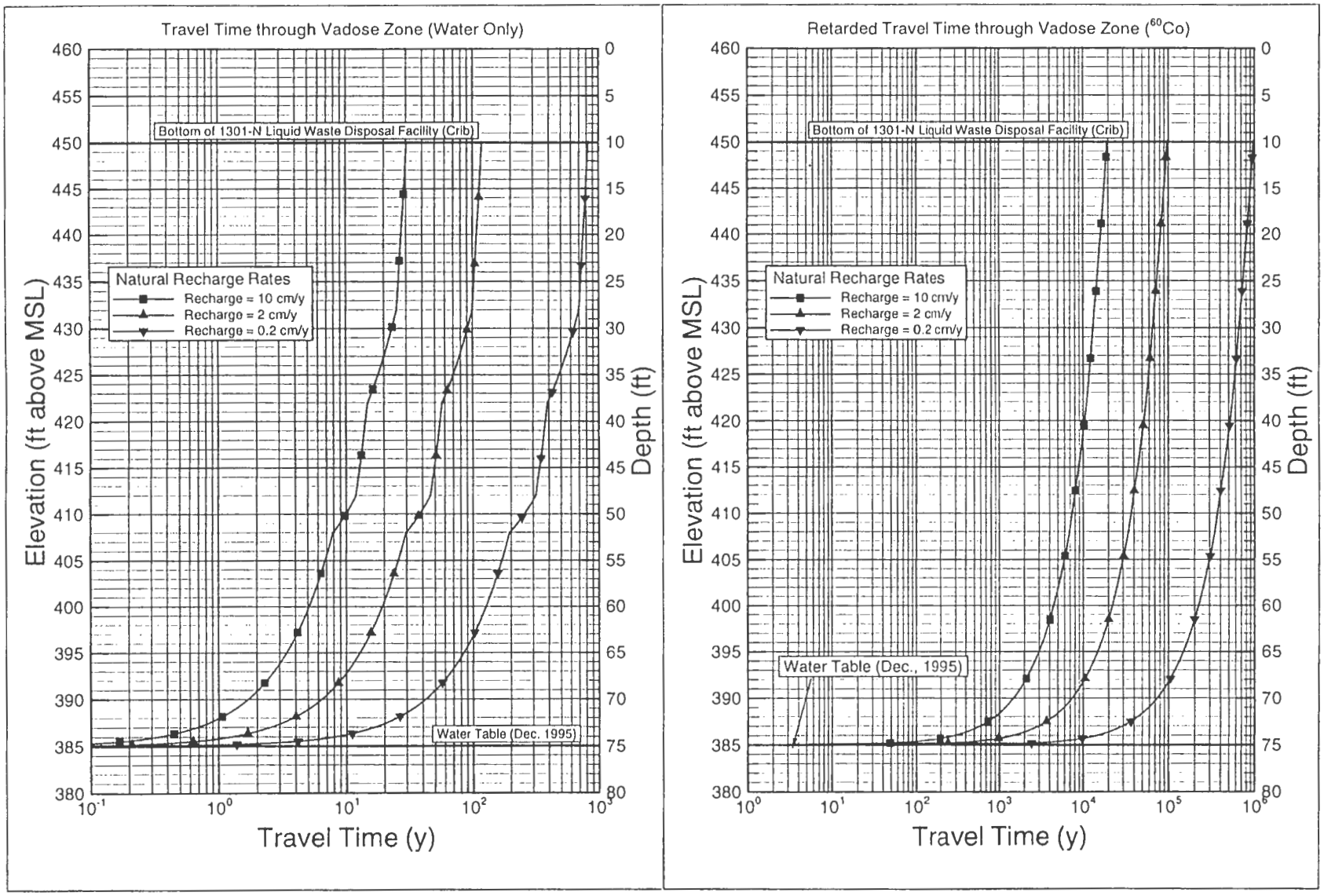


Figure 5-19. Travel Times for Water and Cobalt-60 from the Bottom of 1301-N Crib to Groundwater (199-N-107A)

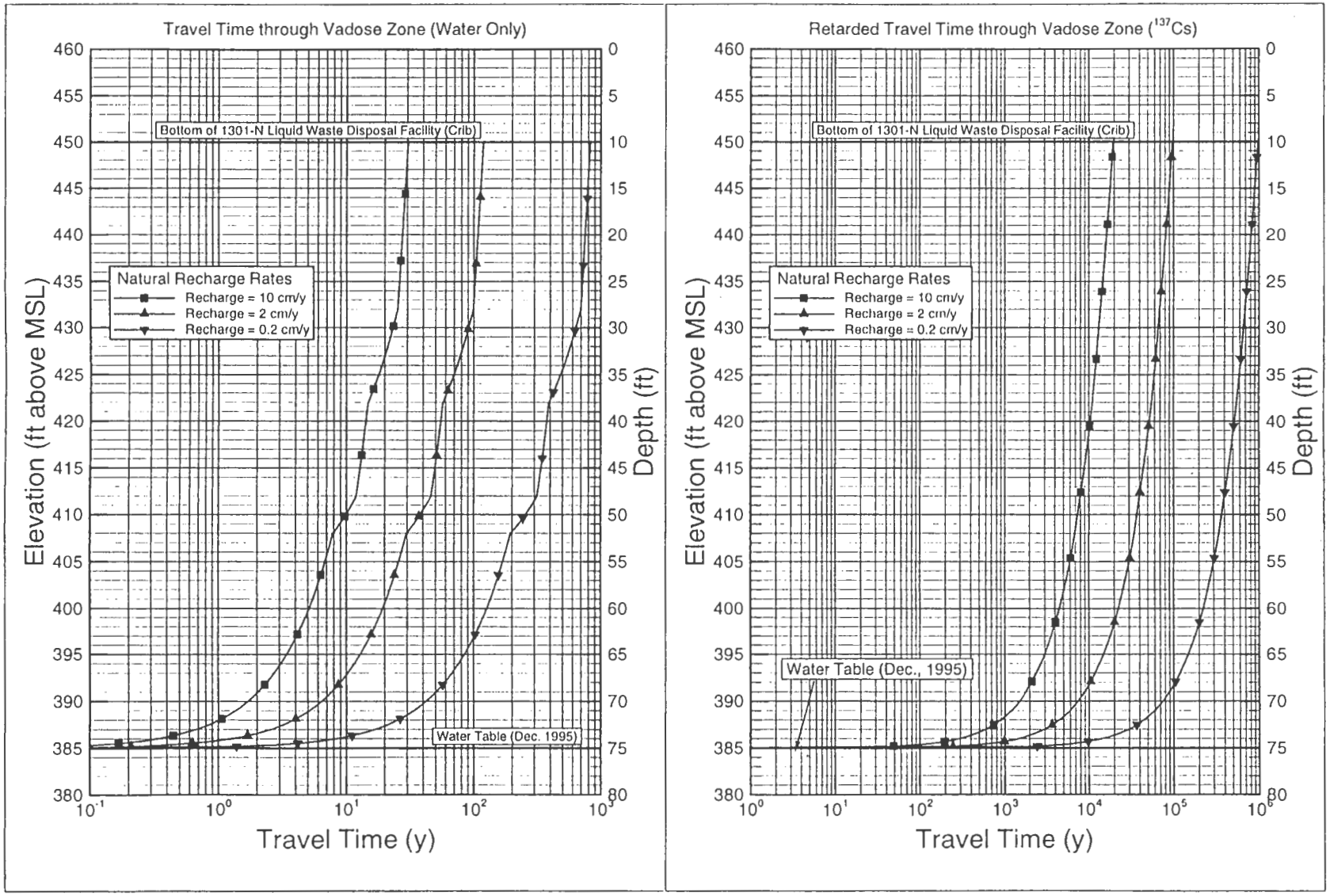


Figure 5-20. Travel Times for Water and Cesium-137 from the Bottom of 1301-N Crib to Groundwater (199-N-107A)

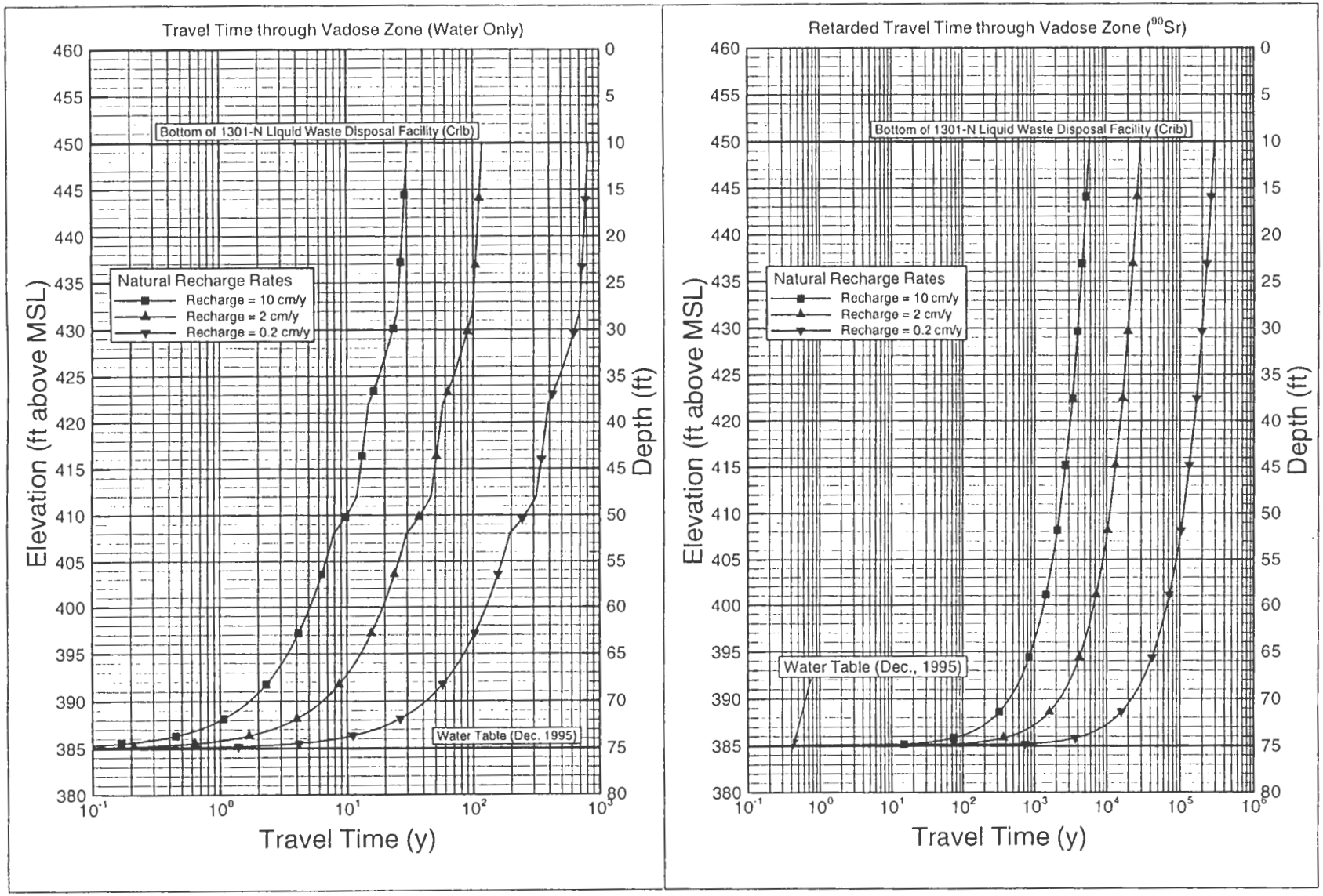


Figure 5-21. Travel Times for Water and Strontium-90 from the Bottom of 1301-N Crib to Groundwater (199-N-107A)

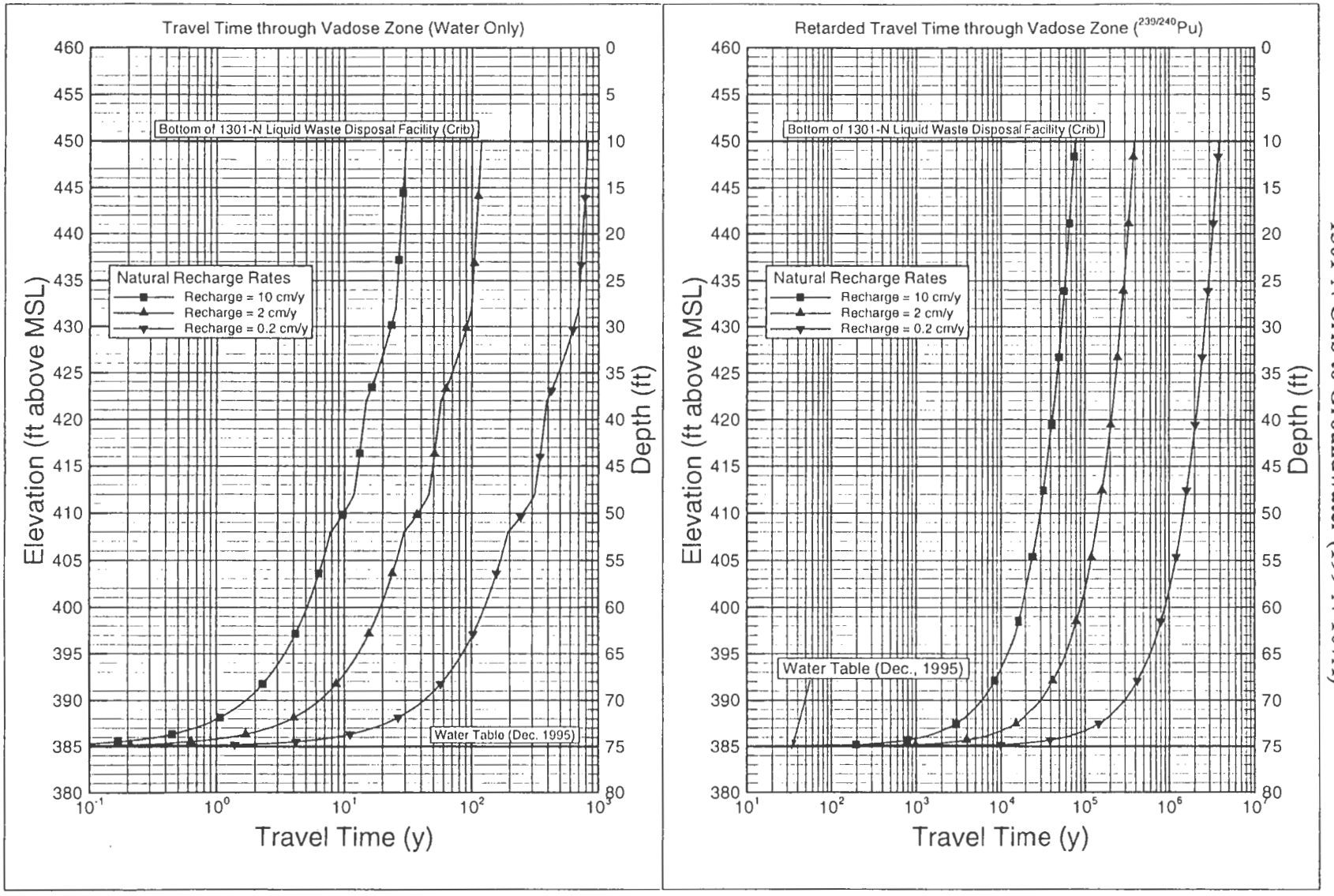


Figure 5-22. Travel Times for Water and Plutonium-239/240 from the Bottom of 1301-N Crib to Groundwater (199-N-107A)

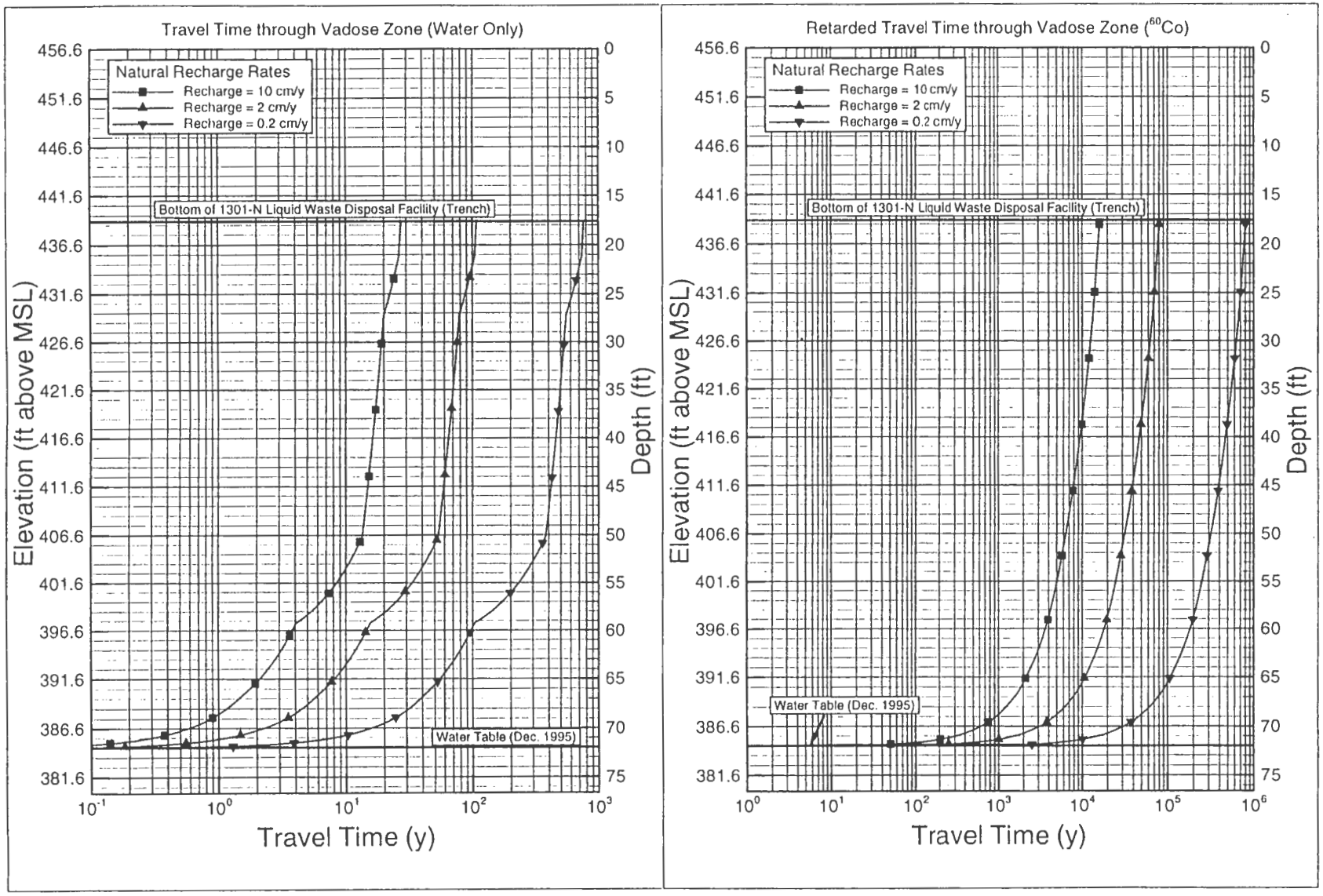


Figure 5-23. Travel Times for Water and Cobalt-60 from the Bottom of 1301-N Trench to Groundwater (199-N-108A)

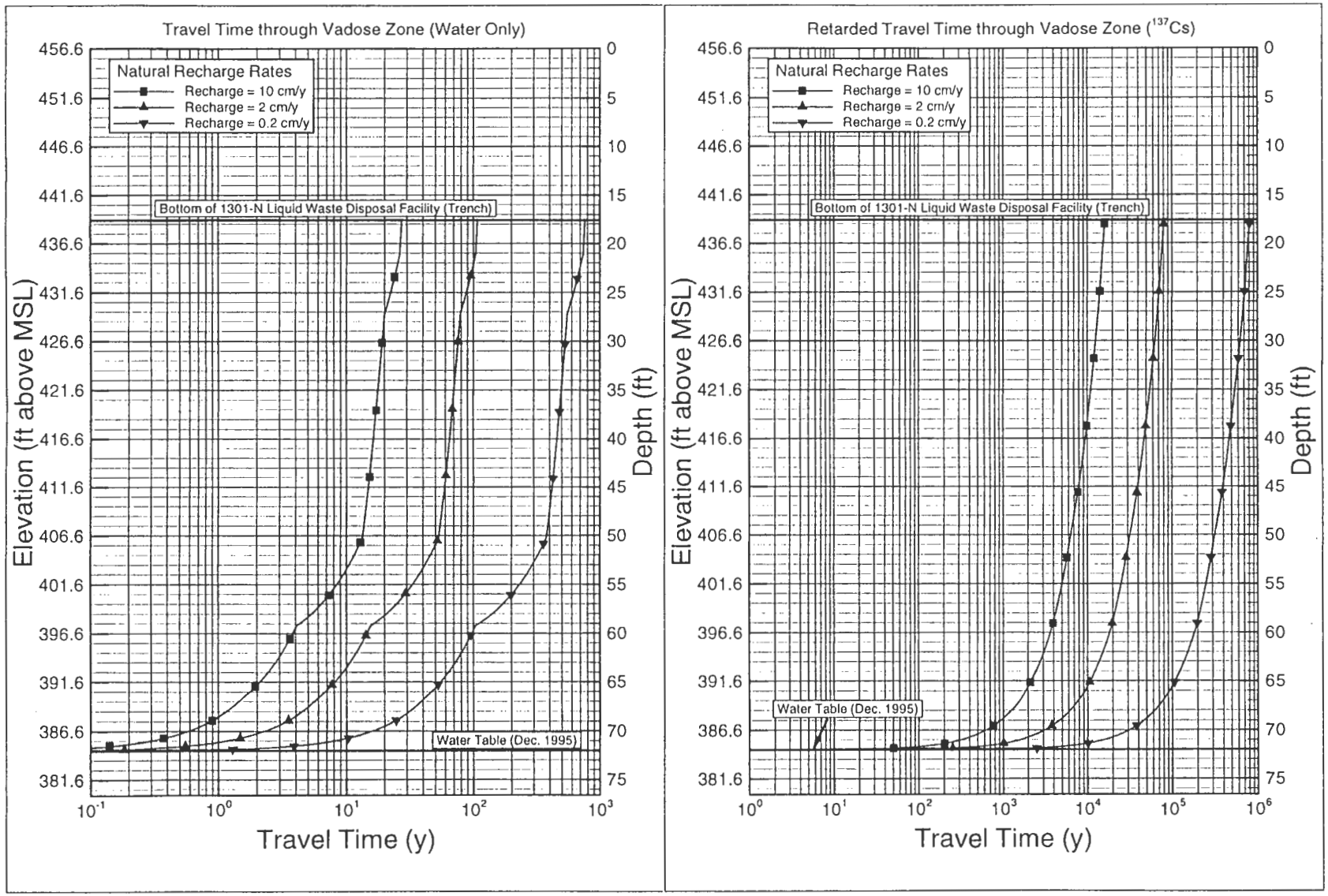


Figure 5-24. Travel Times for Water and Cesium-137 from the Bottom of 1301-N Trench to Groundwater (199-N-108A)

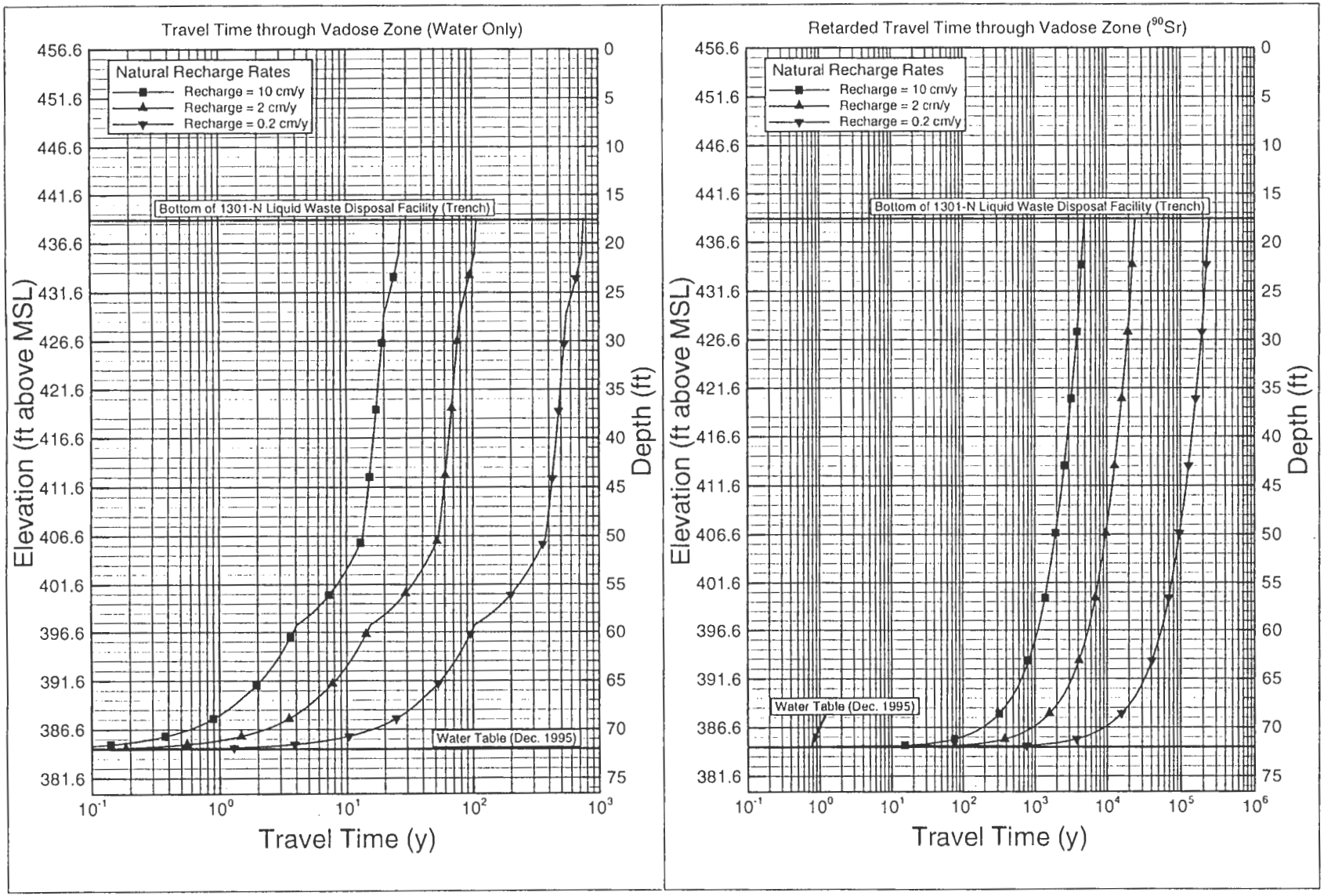


Figure 5-25. Travel Times for Water and Strontium-90 from the Bottom of 1301-N Trench to Groundwater (199-N-108A)

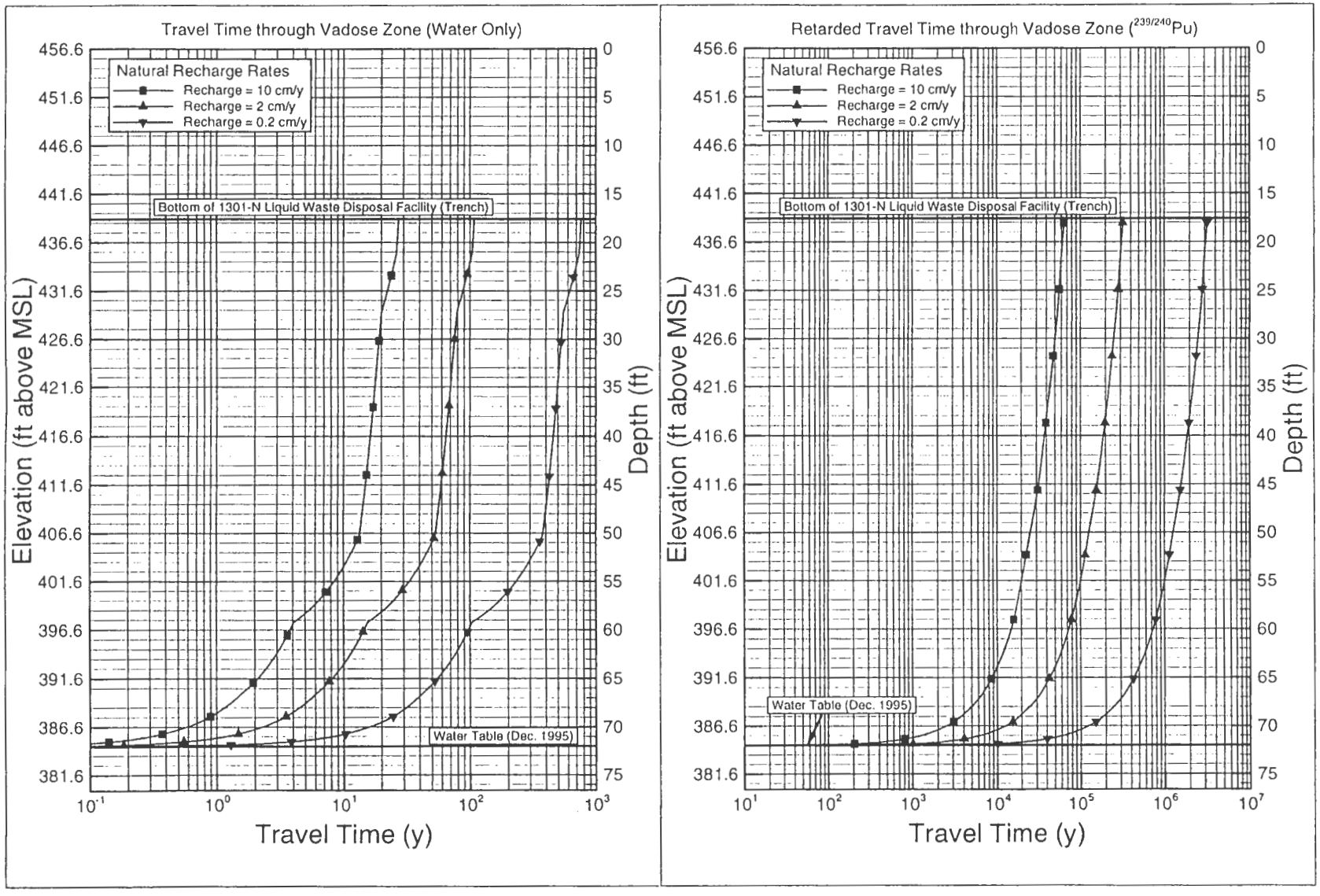


Figure 5-26. Travel Times for Water and Plutonium-239/240 from the Bottom of 1301-N Trench to Groundwater (199-N-108A)

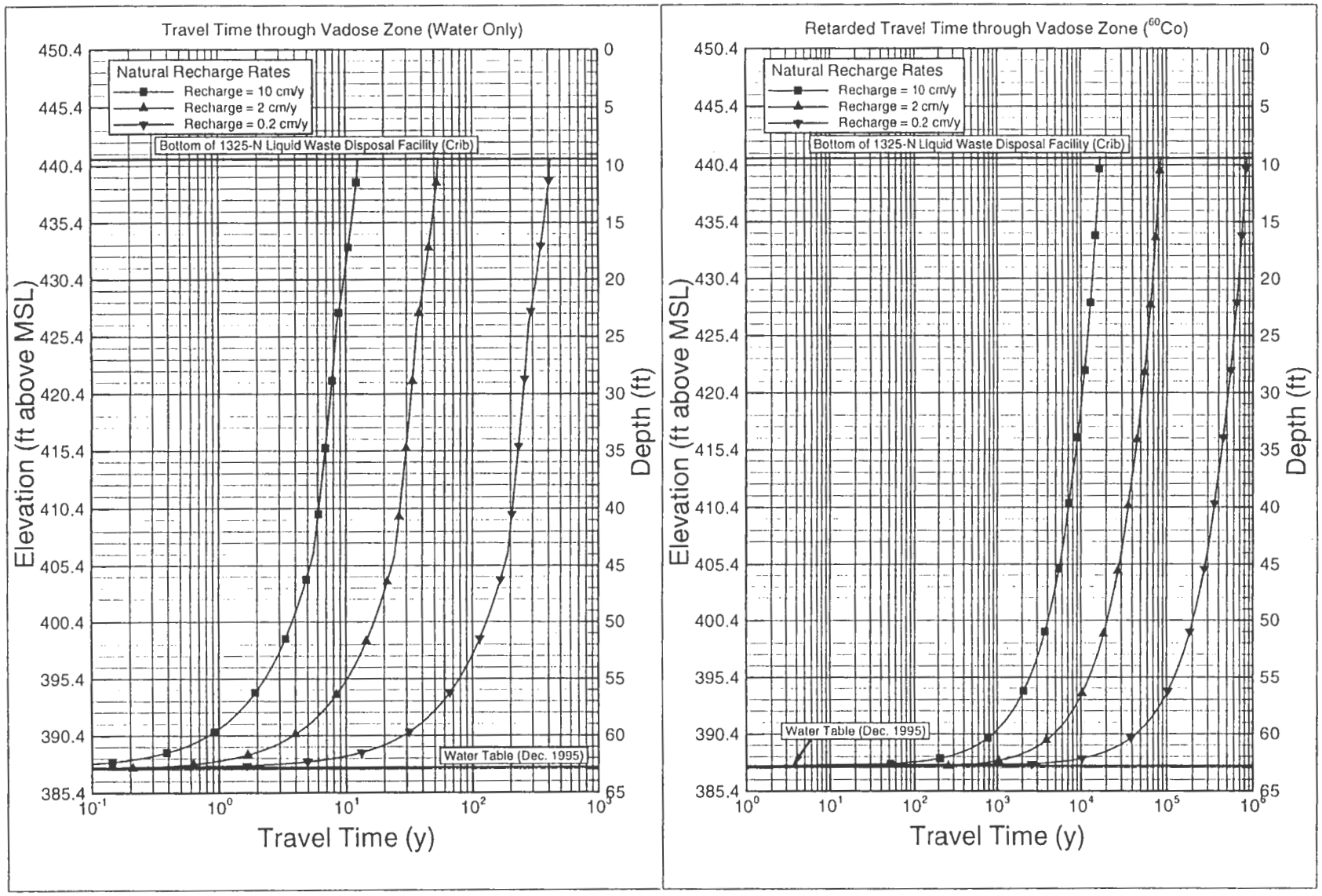


Figure 5-27. Travel Times for Water and Cobalt-60 from the Bottom of 1325-N Crib to Groundwater (199-N-109A)

9613494.0767

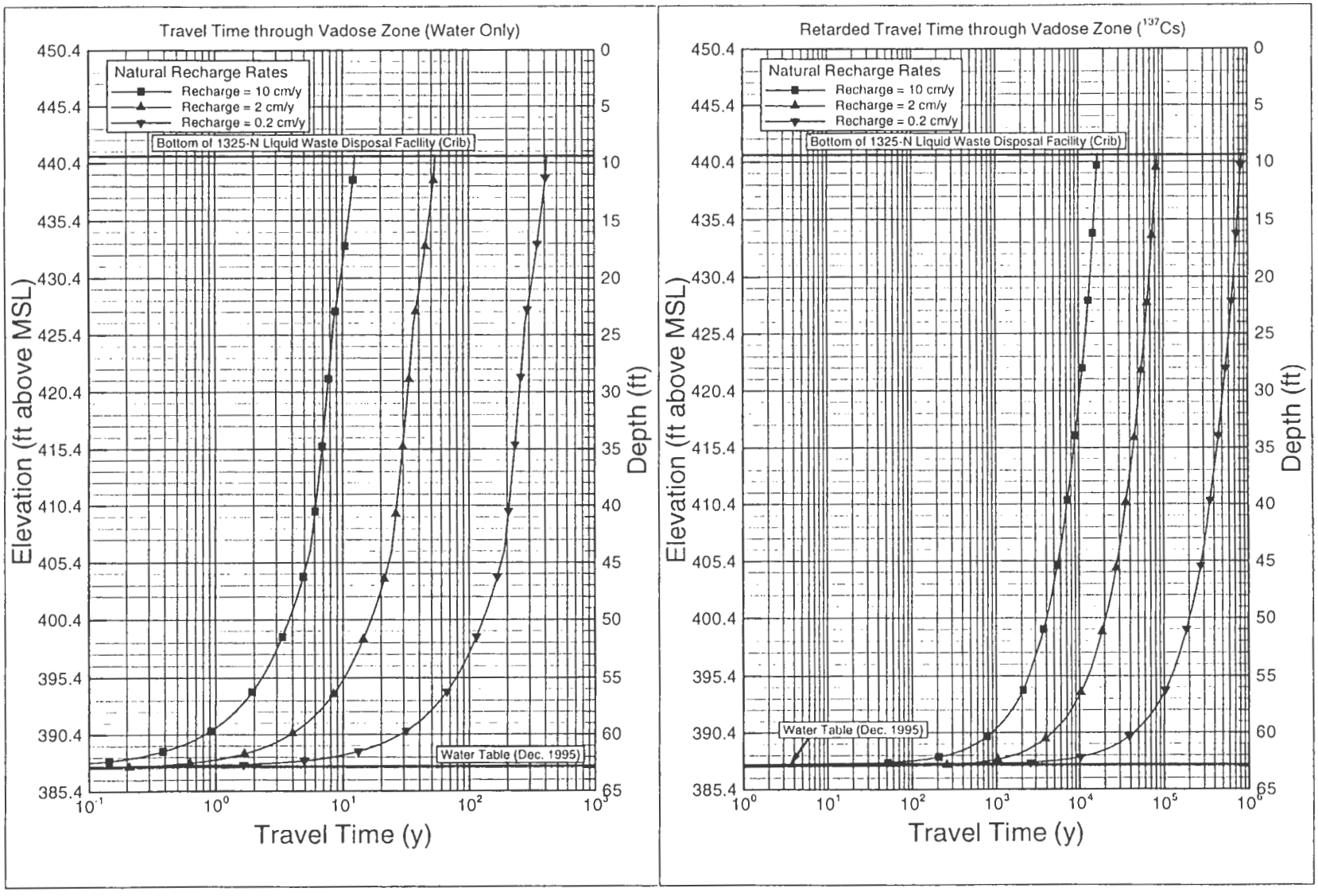


Figure 5-28. Travel Times for Water and Cesium-137 from the Bottom of 1325-N Crib to Groundwater (199-N-109A)

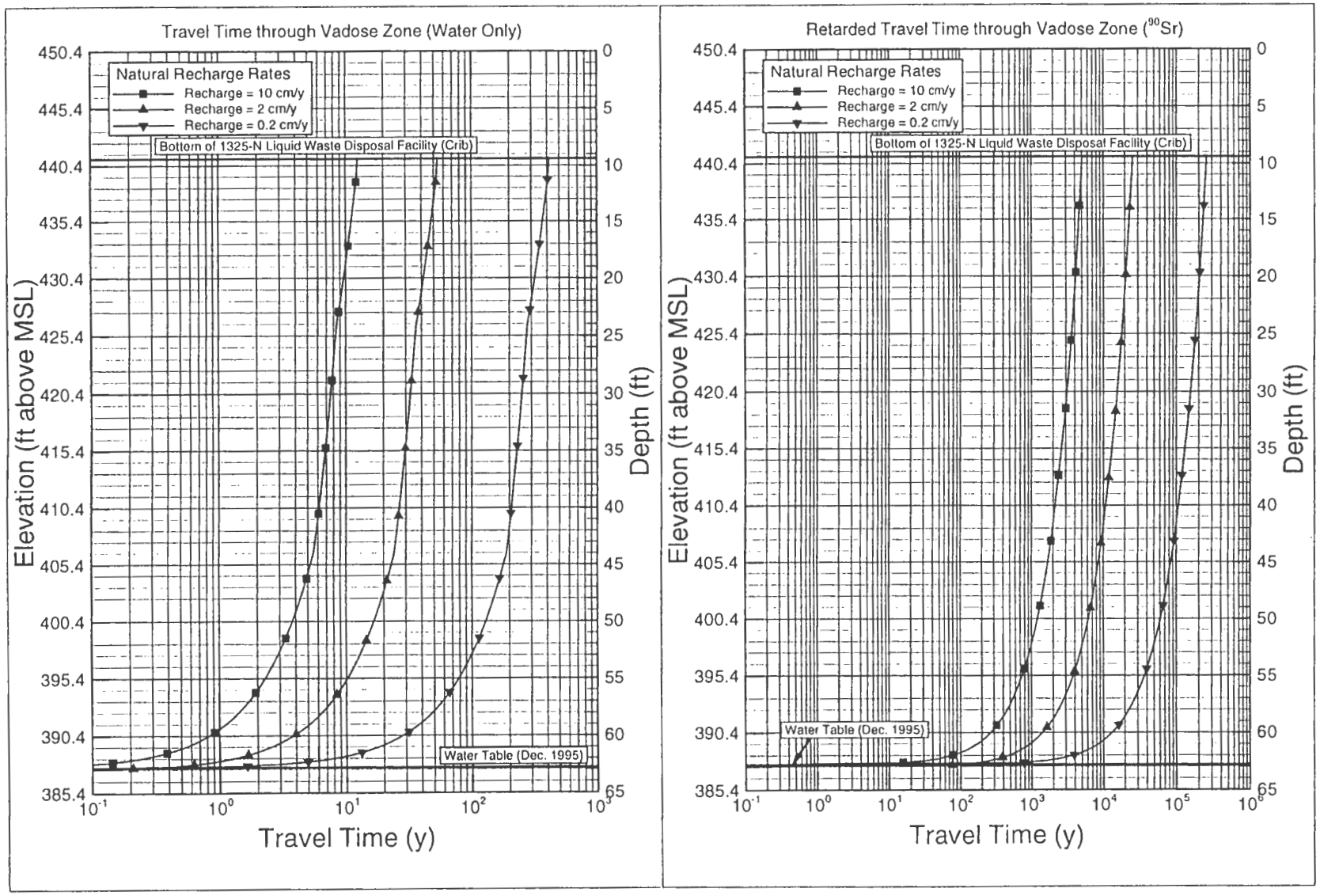


Figure 5-29. Travel Times for Water and Strontium-90 from the Bottom of 1325-N Crib to Groundwater (199-N-109A)

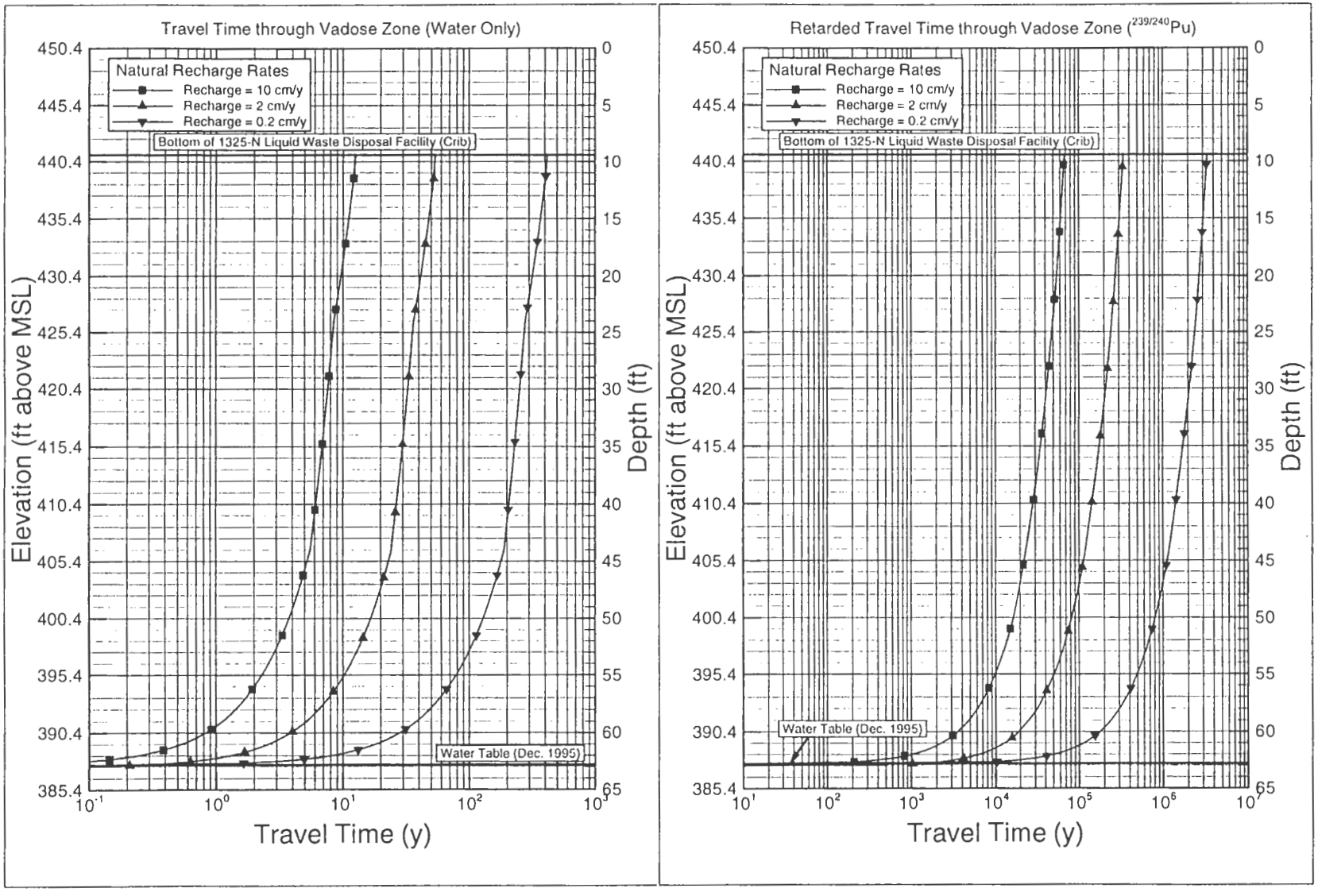


Figure 5-30. Travel Times for Water and Plutonium-239/240 from the Bottom of 1325-N Crib to Groundwater (199-N-109A)

Table 5-1. Sediment Data from the 1325-N Crib (CS-01 to CS-12) and the 1301-N Trench (TS-01 to TS-09). Original and Decayed Concentrations with Summary Statistics for Decayed Concentrations (Page 1 of 2)

Location	Collection Date	Original Data (pCi/g)				Decayed to April 1, 1996 (pCi/g)			
		Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240	Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240
CS-01	8/1/85	1,300,000	41,000	88,000	12,000	319,703	32,227	68,255	12,000
	6/24/86	9,100,000	180,000	9,100		2,517,539	144,373	7,210	
	7/8/87	820,000	32,000	14,000	5,200	260,022	26,275	11,370	5,200
CS-02	8/1/85	660,000	49,000	26,000	5,000	162,311	38,515	20,166	5,000
	6/24/86	520,000	62,000	3,900		143,859	49,729	3,090	
	7/8/87	1,400,000	ND	40,000	49,000	443,941	ND	32,487	49,000
CS-03	8/1/85	1,100,000	49,000	89,000	13,000	270,518	38,515	69,031	13,000
	6/24/86	2,300,000	88,000	5,000		636,301	70,583	3,962	
	7/8/87	630,000	18,000	5,900	1,600	199,773	14,779	4,792	1,600
CS-04	8/1/85	600,000	35,000	27,000	4,300	147,555	27,511	20,942	4,300
	6/24/86	2,500,000	85,000	5,000		691,632	68,176	3,962	
	7/8/87	630,000	29,000	4,300	9,900	199,773	23,811	3,492	9,900
CS-05	8/1/85	180,000	13,000	15,000	2,800	44,267	10,218	11,634	2,800
	6/24/86	620,000	92,000	3,400		171,525	73,791	2,694	
	7/8/87	680,000	30,000	10,000	8,500	215,628	24,632	8,122	8,500
CS-07	8/1/85	1,600,000	11,000	200,000	30,000	393,481	8,646	155,126	30,000
	6/24/86		ND				ND		
	7/8/87	1,300,000	48,000	630,000	98,000	412,231	39,412	511,670	98,000
CS-08	8/1/85	1,700,000	29,000	100,000	56,000	418,073	22,795	77,563	56,000
	6/24/86	1,700,000	66,000			470,309	52,937		
	7/8/87	1100000	15000	270000	120,000	348,811	12,316	219,287	120,000
CS-09	8/1/85	140,000	5,000	17,000	12,000	34,430	3,930	13,186	12,000
	6/24/86	2,800,000	80,000	9,200		774,627	64,166	7,290	
	7/8/87	820,000	17,000	10,000	8,300	260,022	13,958	8,122	8,300
CS-10	8/1/85	520,000	56,000	13,000	2,300	127,881	44,018	10,083	2,300
	7/8/87	140,000	21,000	14,000	1,400	44,394	17,243	11,370	1,400
CS-11	8/1/85	800,000	48,000	12,000	6,900	196,740	37,729	9,308	6,900
	7/8/87	840000	13000	29000	20,000	266,364	10,674	23,553	20,000
CS-12	8/1/85	580,000	71,000	5,800	34,000	142,637	55,808	4,499	34,000
	7/8/87	1,200,000	13,000	35,000	39,000	380,521	10,674	28,426	39,000

	Cobalt-60	Cesium-137	Strontium-90	Plutonium 239/240
CS-01-CS-012				
mean	368,789	37,052	48,239	24,509
StDev	453,087	29,396	103,387	31,724
Count	29	28	28	22
95% CL	5,276	348	1,225	424
UCL	374,064	37,400	49,464	24,933

Table 5-1. Sediment Data from the 1325-N Crib (CS-01 to CS-12) and the 1301-N Trench (TS-01 to TS-09). Original and Decayed Concentrations with Summary Statistics for Decayed Concentrations (Page 2 of 2)

Location	CollectionDate	Original Data (pCi/g)				Decayed to April 1, 1996 (pCi/g)			
		Cobalt-60	Cesium-137	Strontium-90	Plutonium 239/240	Cobalt-60	Cesium-137	Strontium-90	Plutonium 239/240
TS-01	1/1/80	13,000,000	270,000	NA	NA	1,534,333	187,103		
	1/1/81	6,600,000	190,000	170,000	26,000	888,688	134,677	118,227	26,000
	1/1/82	21,000,000	940,000	110,000	28,000	3,224,764	681,495	78,343	28,000
	1/1/83	22,000,000	83,000,000	46,000	12,000	3,852,782	61,547,238	33,551	12,000
	8/1/84	53,000,000	3,100,000	NA	NA	11,428,950	2,382,345		
	8/1/85	1,300,000	29,000	93,000	26,000	319,703	22,795	72,133	26,000
TS-02	1/1/80	8,800,000	210,000	NA	NA	1,038,625	145,524		
	1/1/81	6,300,000	190,000	770,000	9,200	848,293	134,677	535,501	9,200
	1/1/82	27,000,000	490,000	250,000	63,000	4,146,125	355,247	178,052	63,000
	1/1/83	16,000,000	550,000	46,000	13,000	2,802,023	407,843	33,551	13,000
	8/1/84	22,000,000	960,000	NA	NA	4,744,092	737,758		
	8/1/85	1,100,000	26,000	77,000	16,000	270,518	20,437	59,723	16,000
TS-03	1/1/80	8,400,000	120,000	NA	NA	991,415	83,157		
	1/1/81	19,000,000	530,000	110,000	25,000	2,558,345	375,677	76,500	25,000
	1/1/82	34,000,000	940,000	320,000	170,000	5,221,047	681,495	227,907	170,000
	1/1/83	25,000,000	580,000	29,000	10,000	4,378,161	430,089	21,152	10,000
	8/1/84	32,000,000	820,000	NA	NA	6,900,498	630,169		
	8/1/85	1,600,000	37,000	210,000	27,000	393,481	29,083	162,882	27,000
TS-04	1/1/80	5,100,000	220,000	NA	NA	601,930	152,454		
	1/1/81	6,000,000	330,000	36,000	12,000	807,899	233,912	25,036	12,000
	1/1/82	6,400,000	530,000	150,000	2,800,000	982,785	384,247	106,831	2,800,000
	1/1/83	8,000,000	380,000	26,000	7,500	1,401,012	281,783	18,964	7,500
	8/1/84	16,000,000	750,000	NA	NA	3,450,249	576,374		
	8/1/85	1,200,000	28,000	110,000	23,000	295,111	22,009	85,319	23,000
TS-05	1/1/80	3,100,000	260,000	NA	NA	365,879	180,173		
	1/1/81	4,400,000	490,000	21,000	5,500	592,459	347,324	14,605	5,500
	1/1/82	6,600,000	540,000	110,000	660,000	1,013,497	391,497	78,343	660,000
	1/1/83	5,200,000	720,000	13,000	3,000	910,658	533,904	9,482	3,000
	8/1/84	8,300,000	1,300,000	NA	NA	1,789,817	999,048		
	8/1/85	950,000	55,000	190,000	21,000	233,629	43,232	147,369	21,000
TS-06	1/1/80	5,600,000	210,000	NA	NA	660,943	145,524		
	1/1/81	17,000,000	570,000	96,000	25,000	2,289,046	404,030	66,764	25,000
	1/1/82	15,000,000	500,000	230,000	44,000	2,303,403	362,497	163,808	44,000
	1/1/83	16,000,000	950,000	46,000	9,800	2,802,023	704,456	33,551	9,800
	8/1/84	23,000,000	750,000	NA	NA	4,959,733	576,374		
	8/1/85	1,100,000	68,000	120,000	24,000	270,518	53,450	93,075	24,000
TS-07	1/1/80	1,700,000	240,000	NA	NA	200,643	166,313		
	1/1/81	8,900,000	530,000	110,000	30,000	1,198,383	375,677	76,500	30,000
	1/1/82	14,000,000	1,000,000	83,000	17,000	2,149,843	724,994	59,113	17,000
	1/1/83	6,000,000	800,000	27,000	6,200	1,050,759	593,226	19,693	6,200
	8/1/84	16,000,000	980,000	NA	NA	3,450,249	753,128		
	8/1/85	1,300,000	56,000	120,000	14,000	319,703	44,018	93,075	14,000
TS-08	1/1/80	7,600,000	630,000	NA	NA	896,994	436,573		
	1/1/81	5,400,000	440,000	25,000	6,600	727,109	311,883	17,386	6,600
	1/1/82	4,500,000	460,000	70,000	16,000	691,021	333,497	49,855	16,000
	1/1/83	4,000,000	400,000	13,000	4,600	700,506	296,613	9,482	4,600
	8/1/84	16,000,000	730,000	NA	NA	3,450,249	561,004		
	8/1/85	260,000	22,000	70,000	11,000	63,941	17,293	54,294	11,000
TS-09	1/1/80	4,300,000	350,000	NA	NA	507,510	242,540		
	1/1/81	8,300,000	780,000	45,000	20,000	1,117,593	552,883	31,296	20,000
	1/1/82	4,300,000	560,000	150,000	13,000	660,309	405,997	106,831	13,000
	1/1/83	4,000,000	390,000	8,700	4,300	700,506	289,198	6,345	4,300
	8/1/84	15,000,000	1,300,000	NA	NA	3,234,608	999,048		
	8/1/85	640,000	25,000	110,000	20,000	157,392	19,651	85,319	20,000

NA - Not analyzed.

	Cobalt-60	Cesium-137	Strontium-90	Plutonium 239/240
TS-01-TS-09				
mean	1,899,069	1,527,826	84,718	117,297
StDev	2,069,032	8,330,082	93,937	472,824
Count	54	54	36	36
95% CL	17,656	71,083	982	4,942
UCL	1,916,725	1,598,909	85,700	122,239
TS-01-TS-03				
mean	3,085,658	3,832,600	133,127	35,433
StDev	2,858,156	14,413,901	141,966	44,768
Count	18	18	12	12
95% CL	42,244	213,038	2,570	810
UCL	3,127,902	4,045,638	135,697	36,244
TS-04-TS-09				
mean	1,305,775	375,439	60,514	158,229
StDev	1,195,200	258,062	44,215	577,928
Count	36	36	24	24
95% CL	12,491	2,697	566	7,397
UCL	1,318,266	378,137	61,080	165,627

Table 5-2. Original and Decayed Concentrations of the Risk-Driver Radionuclides from the LFI Boreholes (Page 1 of 2)

Location	Zone	Lab	Depth (feet below ground surface)	Elevation (feet above mean sea level)	Collection Date	Concentration (pCi/g)							
						Original Data				Decayed to April 1, 1996			
						Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240	Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240
199-N-107A	A	222-S*	NA	NA	8/25/95	56300	102000	92299	12700	52013	100623	90984	12700
		222-S	9 - 11	451 - 449	11/29/95	107000	12100	3250	NR	102328	12008	3224	
		Quanterra	9 - 11	451 - 449	11/29/95	139000	15800	9560	1590	132931	15679	9483	1590
		222-S	11 - 13	449 - 447	11/30/95	132000	15100	12600	689	126282	14986	12499	689
		Quanterra	11 - 13	449 - 447	11/30/95	120000	12500	19700	3340	114802	12405	19543	3340
	B	222-S	23	437	12/5/95	23.90	2790	1170	NR	22.91	2770	1161	
		222-S	28 - 30	432 - 430	12/5/95	5.82	5.81	1550	NR	5.58	5.77	1538	
		Quanterra	28 - 30	432 - 430	12/5/95	4.96	2.46	1530	ND	4.75	2.44	1518	
		222-S (Dup)	28 - 30	432 - 430	12/5/95	5.25	5.69	1350	NR	5.03	5.65	1340	
		Quanterra (Dup)	28 - 30	432 - 430	12/5/95	5.57	6.01	1310	0.07	5.34	5.97	1300	0.07
		222-S	40	420	12/6/95	1.20	ND	1080	NR	1.15		1072	
		222-S	50	410	12/6/95	0.79	NR	188	NR	0.75		187	
	C	222-S	57 - 59	403 - 401	12/8/95	1.15	ND	63.10	NR	1.10		62.63	
		Quanterra	57 - 59	403 - 401	12/8/95	1.29	ND	50.00	ND	1.24		49.63	
		222-S	69	391	12/8/95	0.71	ND	54.60	NR	0.68		54.19	
199-N-108A	A	222-S	14.5 - 16.5	442.5 - 440.5	11/9/95	522	3200	139	NR	496	3172	138	
		Quanterra	14.5 - 16.5	442.5 - 441	11/9/95	1200	6770	768	12.60	1139	6710	761	12.60
		222-S	18	439	11/9/95	3300	15700	785	73.70	3133	15561	778	73.70
		222-S	23 - 25	434 - 432	11/10/95	10.40	108	1410	NR	9.88	107	1397	
		Quanterra	23 - 25	434 - 432	11/10/95	7.10	44.30	1430	ND	6.74	43.91	1417	
		222-S (Dup)	23 - 25	434 - 432	11/10/95	14.20	84.90	1380	NR	13.49	84.15	1367	
		Quanterra (Dup)	23 - 25	434 - 432	11/10/95	9.20	65.80	1740	ND	8.74	65.22	1724	
	B	222-S	28	429	11/10/95	3.53	24.10	195	NR	3.35	23.89	193	
		222-S	32.5	424.5	11/10/95	ND	ND	119	NR			118	
		222-S	42 - 44	415 - 413	11/15/95	ND	ND	24.60	NR			24.38	
		Quanterra	42 - 44	415 - 413	11/15/95	0.55	ND	57.90	ND	0.52		57.38	
		222-S	47	410	11/15/95	ND	ND	4.33	NR			4.29	
	C	222-S	52	405	11/15/95	ND	ND	1.38	NR			1.37	
		222-S	59.5	397.5	11/15/95	1.77	ND	239	NR	1.68		237	
		222-S	62 - 63.5	395 - 394	11/16/95	ND	ND	24.70	NR			24.48	
		Quanterra	62 - 63.5	395 - 394	11/16/95	0.54	ND	144	ND	0.51		143	
		222-S	69	388	11/16/95	ND	ND	129	NR			128	

Table 5-2. Original and Decayed Concentrations of the Risk-Driver Radionuclides from the LFI Boreholes (Page 2 of 2)

Location	Zone	Lab	Depth (feet below ground surface)	Elevation (feet above mean sea level)	Collection Date	Concentration (pCi/g) Original Data Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240	Decayed to April 1, 1996 Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240
199-N-109A	A	222-S	8 - 10	443 - 441	12/19/95	225	371	1080	NR	217	369	1073	
		Quanterra	8 - 10	443 - 441	12/19/95	379	573	1340	24.10	365	569	1331	24.10
		222-S	10 - 12	441 - 439	12/20/95	3.83	ND	866	NR	3.69		860	
		Quanterra	10 - 12	441 - 439	12/20/95	4.51	0.52	1230	ND	4.35	0.52	1222	
		222-S	17 - 19	434 - 432	12/20/95	1.65	ND	331	NR	1.59		329	
		Quanterra	17 - 19	434 - 432	12/20/95	2.37	0.14	401	0.15	2.28	0.14	398	0.15
	B	222-S	24 - 26	427 - 425	12/22/95	1.73	ND	193	NR	1.67		192	
		Quanterra	24 - 26	427 - 425	12/22/95	1.57	0.06	226	ND	1.51	0.06	225	
		222-S (Dup)	24 - 26	427 - 425	12/22/95	1.95	ND	147	NR	1.88		146	
		Quanterra (Dup)	24 - 26	427 - 425	12/22/95	1.43	ND	200	ND	1.38		199	
		222-S	30	421	12/22/95	2.78	ND	127	NR	2.68		126	
		222-S	39 - 41	412 - 410	12/27/95	0.54	ND	2.34	NR	0.52		2.33	
		Quanterra	39 - 41	412 - 410	12/27/95	0.55	ND	27.70	ND	0.53		27.53	
	C	222-S	50	401	12/27/95	1.25	ND	4.61	NR	1.21		4.58	
		222-S	59.5 - 61.5	391.5 - 389.5	12/28/95	1.42	ND	18.10	NR	1.37		17.99	
		Quanterra	59.5 - 61.5	391.5 - 389.5	12/28/95	1.48	ND	16.00	ND	1.43		15.90	

NR = Not requested
ND = Not detected
Dup = Duplicate
EAL = Environmental Analytical Laboratory
PNNL = Pacific Northwest National Laboratory
*Sample was collected from soil on a boulder removed from the base of the crib.
Zones A, B, and C are used in the risk assessment.

Table 5-3. Original and Decayed Concentrations of the Risk-Driver Radionuclides from the Pump-and-Treat Wells and the Near-River Borehole (Page 1 of 3)

Location	Zone	Lab	Depth (feet below ground surface)	Elevation (feet above mean sea level)	Collection Date	Concentration (pCi/g)							
						Original Data				Decayed to April 1, 1996			
						Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240	Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240
199-N-95A	C	Quanterra	5	390.6	9/1/94	0.21	ND	1.26	ND	0.17		1.21	
		Quanterra	10	385.6	9/1/94	1.29	ND	37.80	ND	1.05		36.40	
	N/A	Quanterra	15	380.6	9/1/94	0.39	ND	2.76	ND	0.32		2.66	
		Quanterra	20	375.6	9/1/94	0.22	ND	14.00	ND	0.18		13.48	
		Quanterra	25	370.6	9/1/94	0.19	ND	10.50	ND	0.15		10.11	
		Quanterra	35	360.6	9/1/94	ND	ND	1.22	ND			1.17	
199-N-103A	B	Quanterra	29 - 32	428 - 425	1/30/95	ND	ND	ND	NR				
	C	EAL	55 - 57	402 - 400	2/1/95	ND	ND	NR	ND				
		PNNL	55 - 56.5	402 - 400.5	2/1/95	ND	ND	0.56	ND			0.54	
		Quanterra	59 - 60.5	398 - 396.5	2/2/95	0.15	0.02	2.26	NR	0.13	0.02	2.20	
		EAL	60 - 61.5	397 - 395.5	2/2/95	ND	ND	NR	ND				
		PNNL	60 - 61.5	397 - 395.5	2/2/95	NR	NR	2.54	NR			2.47	
		Quanterra	65 - 67	392 - 390	2/6/95	0.62	0.02	153	NR	0.53	0.02	149	
		EAL	65 - 67	392 - 390	2/3/95	ND	ND	NR	ND				
		PNNL	65 - 65.5	392 - 391.5	2/3/95	NR	NR	120	NR			117	
		PNNL (Dup)	65 - 65.5	392 - 391.5	2/3/95	NR	NR	119	NR			116	
		EAL	70 - 72	387 - 385	2/7/95	1.20	ND	NR	ND	1.03			
		PNNL	70 - 71.5	387 - 385.5	2/7/95	NR	NR	80.32	NR			78.16	
	N/A	EAL	75 - 77	382 - 380	2/8/95	0.07	ND	NR	NR	0.06			
		PNNL	75 - 76.5	382 - 380.5	2/8/95	NR	NR	3.19	ND			3.11	
		Quanterra	77 - 78	380 - 379	2/9/95	0.07	ND	0.98	NR	0.06		0.95	
		EAL	80 - 82	377 - 375	2/9/95	0.11	ND	NR	ND	0.09			
		PNNL	81 - 82	376 - 375	2/9/95	NR	NR	0.88	NR			0.86	
		EAL	85 - 87	372 - 370	2/22/95	ND	ND	NR	ND				
		PNNL	85 - 87	372 - 370	2/22/95	NR	NR	0.62	NR			0.61	
		EAL	90 - 92	367 - 365	2/23/95	ND	ND	NR	ND				
		EAL	95 - 97	362 - 360	3/2/95	ND	ND	NR	ND				
		PNNL	95.5 - 97	361.5 - 360	3/2/95	ND	ND	0.41	ND			0.40	
199-N-104A	B	EAL	10	450.3	2/16/95	ND	ND	NR	ND				
		EAL	20	440.3	2/17/95	ND	ND	NR	ND				
		EAL	30	430.3	2/21/95	ND	ND	NR	ND				
		Quanterra	31 - 33	429.3 - 427.3	2/21/95	ND	ND	ND	NR				
		EAL	40	420.3	2/23/95	ND	ND	NR	ND				
		EAL	50	410.3	2/24/95	ND	ND	NR	ND				

Table 5-3. Original and Decayed Concentrations of the Risk-Driver Radionuclides from the Pump-and-Treat Wells and the Near-River Borehole (Page 2 of 3)

Location	Zone	Lab	Depth (feet below ground surface)	Elevation (feet above mean sea level)	Collection Date	Concentration (pCi/g) Original Data				Concentration (pCi/g) Decayed to April 1, 1996			
						Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240	Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240
199-N-104A	C	PNNL	58.5 - 59.5	401.8 - 400.8	2/24/95	NR	NR	0.49	NR			0.47	
		EAL	60	400	2/27/95	ND	ND	NR	ND				
		EAL	65	395	2/27/95	0.06	ND	NR	ND	0.05			
		PNNL	64 - 65	396 - 395	2/27/95	NR	NR	0.61	NR			0.60	
		EAL	68 - 70	392 - 390	2/28/95	0.18	ND	NR	ND	0.16			
		PNNL	69 - 70	391 - 390	2/28/95	NR	NR	1.32	NR			1.28	
	N/A	Quanterra	73.5 - 76	386.8 - 384	2/28/95	0.14	ND	1.17	NR	0.12		1.14	
		Quanterra (Dup)	73.5 - 76	386.8 - 384	2/28/95	0.14	ND	ND	NR	0.12			
		Quanterra (Dup)	73.5 - 76	386.8 - 384	2/28/95	0.12	ND	0.97	NR	0.11		0.95	
		EAL	75	385	2/28/95	0.13	ND	NR	ND	0.11			
		PNNL	74 - 75	386 - 385	2/28/95	NR	NR	1.01	NR			0.98	
		PNNL	79.5 - 80.5	380.8 - 379.8	3/3/95	NR	NR	0.58	NR			0.56	
		PNNL (Dup)	79.5 - 80.5	380.8 - 379.8	3/3/95	NR	NR	0.53	NR			0.52	
		EAL	80	380	3/3/95	0.07	ND	NR	ND	0.06			
		PNNL	84 - 84.5	376 - 375.8	3/8/95	NR	NR	0.44	NR			0.42	
		EAL	85	375	3/8/95	ND	ND	NR	ND				
		Quanterra	89 - 91	371 - 369	3/8/95	0.05	ND	ND	NR	0.04			
		PNNL	89.5 - 90.5	370.8 - 369.8	3/10/95	NR	NR	0.23	NR			0.23	
		EAL	90	370	3/10/95	ND	ND	NR	ND				
199-N-105A	B	EAL	10	445	3/16/95	ND	ND	1.50	ND			1.46	
		EAL	15	440	3/16/95	ND	ND	0.87	ND			0.85	
		EAL	20	435	3/17/95	ND	ND	0.64	ND			0.62	
		EAL	25	430	3/20/95	ND	ND	0.34	ND			0.33	
		EAL	30	425	3/21/95	ND	ND	1.10	ND			1.07	
		Quanterra	34 - 36	421 - 419	3/21/95	ND	ND	ND	NR				
		EAL	35	420	3/21/95	ND	ND	1.80	ND			1.76	
		EAL	40	415	3/22/95	ND	ND	3.10	ND			3.02	
		PNNL	40	415	3/22/95	NR	NR	0.42	NR			0.41	
		EAL	45	410	3/22/95	ND	ND	3.10	ND			3.02	
		PNNL	45	410	3/22/95	NR	NR	0.39	NR			0.38	
	C	EAL	50	405	3/22/95	0.12	ND	14.00	ND	0.10		13.66	
		PNNL	51 - 52	404 - 403	3/24/95	NR	NR	431	NR			421	
		PNNL (Dup)	51 - 52	404 - 403	3/24/95	NR	NR	503	NR			491	
		Quanterra	51 - 53	404 - 402	3/24/95	1.52	ND	709	NR	1.33		692	
		EAL	55	400	3/27/95	0.70	ND	60.00	ND	0.61		58.57	
		PNNL	54.5 - 55.5	400.2 - 399.2	3/27/95	NR	NR	136	NR			132	

Table 5-3. Original and Decayed Concentrations of the Risk-Driver Radionuclides from the Pump-and-Treat Wells and the Near-River Borehole (Page 3 of 3)

Location	Zone	Lab	Depth (feet below ground surface)	Elevation (feet above mean sea level)	Collection Date	Concentration (pCi/g) Original Data				Concentration (pCi/g) Decayed to April 1, 1996			
						Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240	Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240
199-N-105A	C	PNNL	59.5 - 61.5	395.2 - 393.2	3/28/95	NR	NR	149	NR			146	
		EAL	60	395	3/28/95	0.67	ND	43.00	ND	0.59		41.97	
		EAL	65	390	3/30/95	0.17	ND	50.00	ND	0.15		48.81	
		PNNL	66 - 67	389 - 388	3/30/95	NR	NR	90.79	NR			88.64	
	N/A	EAL	70	385	3/31/95	0.15	ND	24.0	ND	0.13		23.43	
		Quanterra	70 - 72	385 - 383	3/31/95	0.15	ND	114	NR	0.13		111	
		PNNL	71 - 72	384 - 383	3/31/95	NR	NR	101	NR			98.89	
		PNNL (Dup)	71 - 72	384 - 383	3/31/95	NR	NR	112	NR			109	
		EAL	75	380	4/6/95	0.10	ND	5.70	ND	0.08		5.57	
		PNNL	74 - 75	381 - 380	4/6/95	NR	NR	70.24	NR			68.61	
		EAL	80	375	4/12/95	ND	ND	ND	ND				
		PNNL	80 - 81	375 - 374	4/12/95	NR	NR	11.50	NR			11.24	
		EAL	85	370	4/13/95	ND	ND	ND	ND				
		Quanterra	85 - 87	370 - 368	4/13/95	0.05	ND	13.00	NR	0.04		12.70	
		PNNL	85.5 - 86.5	369.2 - 368.2	4/13/95	NR	NR	1.66	NR			1.62	
		EAL	90	365	4/17/95	ND	ND	ND	ND				
		PNNL	90.5 - 91.5	364.2 - 363.2	4/17/95	NR	NR	2.91	NR			2.84	
		PNNL	96 - 97	359 - 358	4/18/95	NR	NR	0.76	NR			0.75	
199-N-106A	B	EAL	15	456	8/10/95	ND	ND	NR	ND				
		EAL	25	446	8/11/95	ND	ND	NR	ND				
		EAL	35	436	8/14/95	ND	ND	NR	ND				
		EAL	45	426	8/16/95	ND	ND	NR	ND				
		EAL	55	416	8/16/95	ND	ND	NR	ND				
		EAL	65	406	8/17/95	ND	ND	NR	ND				
	C	Quanterra	73 - 75	398 - 396	8/22/95	0.64	ND	210	ND	0.59		207	
		EAL	75	396	8/22/95	ND	ND	NR	ND				
		Quanterra	83 - 85	388 - 386	8/23/95	0.30	ND	78.80	ND	0.28		77.67	
		EAL	85	386	8/23/95	ND	ND	NR	ND				
	N/A	Quanterra	96 - 98	375 - 373	8/25/95	0.45	0.02	118	0.12	0.42	0.02	116	0.12
		EAL	103	368	8/26/95	ND	ND	NR	ND				
		Quanterra	105 - 108	366 - 363	8/26/95	0.27	0.01	52.20	ND	0.25	0.01	51.46	
		EAL	115	356	8/28/95	ND	ND	NR	ND				

NR = Not requested
ND = Not detected
Dup = Duplicate
EAL = Environmental Analytical Laboratory

PNNL = Pacific Northwest National Laboratory
Zones A, B, and C are used in the risk assessment.
N/A = Not applicable. Soil samples collected below the current water table were not used in QRA, but are shown for completeness.

Table 5-4. Mean and 95% UCL Concentrations (pCi/g) of the Risk-Driver Radionuclides in Surface Sediments from the 1301-N Trench and the 1325-N Crib (Decayed to April 1, 1996)

Sampling Point		Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240
1301-N Trench					
TS-01 - TS-03 upper end of trench	mean 95% UCL	3,085,658 3,127,902	3,832,600 4,045,638	133,127 135,697	35,433 36,244
TS-04 - TS-09 lower end of trench	mean 95% UCL	1,305,775 1,318,266	375,439 378,137	60,514 61,080	158,229 165,627
TS-01 - TS-09 entire trench length	mean 95% UCL	1,899,069 1,916,725	1,527,826 1,598,909	84,718 85,700	117,297 122,239
1325-N Crib					
CS-01 - CS-12	mean 95% UCL	368,789 374,064	37,052 37,400	48,239 49,464	24,509 24,933

Table 5-5. Maximum Concentrations (pCi/g) of the Risk-Driver Radionuclides in Soil by Depth from the LFI Boreholes -- 107A, 108A, and 109A (Decayed to April 1, 1996) (Page 1 of 2)

Zone	Depth (ft bgs)	Elevation (ft above MSL)	Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240
199-N-107A						
A	9 - 11	451 - 449	132,931	15,679	9,483	1,590
A	11 - 13	449 - 447	126,282	14,986	19,543	3,340
B	23	437	22.91	2,770	1,161	ND
B	28 - 30	432 - 430	5.58	5.97	1,538	0.07
B	40	420	1.15	ND	1,072	ND
B	50	410	0.75	ND	187	ND
C	57 - 59	403 - 401	1.24	ND	62.63	ND
C	69	391	0.68	ND	54.19	ND
199-N-108A						
A	14.5 - 16.5	442.5 - 440.5	1,139	6,710	761	12.60
A	18	439	3,133	15,561	778	73.70
A	23 - 25	434 - 432	13.49	107	1,724	ND
B	28	429	3.35	23.89	193	ND
B	32.5	424.5	ND	ND	118	ND
B	42 - 44	415 - 413	0.52	ND	57.38	ND
B	47	410	ND	ND	4.29	ND
C	52	405	ND	ND	1.37	ND
C	59.5	397.5	1.68	ND	237	ND
C	62 - 63.5	395 - 393.5	0.51	ND	143	ND
C	69	388	ND	ND	128	ND
199-N-109A						
A	8 - 10	442.5 - 440.5	365	569	1,331	24.10
A	10 - 12	440.5 - 438.5	4.35	0.52	1,222	ND
A	17 - 19	433.5 - 431.5	2.28	0.14	398	0.15

Table 5-5. Maximum Concentrations (pCi/g) of the Risk-Driver Radionuclides in Soil by Depth from the LFI Boreholes -- 107A, 108A, and 109A (Decayed to April 1, 1996) (Page 2 of 2)

Zone	Depth (ft bgs)	Elevation (ft above MSL)	Cobalt-60	Cesium-137	Strontium-90	Plutonium-239/240
B	24 - 26	426.5 - 424.5	1.88	0.06	225	ND
B	30	420.5	2.68	ND	126	ND
B	39 - 41	411.5 - 409.5	0.53	ND	27.53	ND
C	50	400.5	1.21	ND	4.58	ND
C	59.5 - 61.5	391.5 - 389.5	1.43	ND	17.99	ND

bgs = below ground surface
MSL = Mean Sea Level
ND = Not Detected

Table 5-6. Single Radionuclide Soil Concentrations in the Year 2010 Corresponding to a 15 mrem/yr Dose Rate for the Rural-Residential and Recreational Scenarios

Radionuclide	Soil Concentrations Corresponding to a 15 mrem/yr Dose Rate (pCi/g)	
	Rural-Residential Scenario	Recreational Scenario
Cobalt-60	10	323
Cesium-137	9	338
Strontium-90	4	35,640
Plutonium-239/240	21	990

Table 5-7. Comparison of the 95% UCL Concentrations (pCi/g) of the Risk-Driver Radionuclides in Surface Sediments from the 1301-N Trench and the 1325-N Crib with Single Radionuclide Soil Concentrations (pCi/g) in the Year 2010 Corresponding to a 15 mrem/yr Dose Rate

Radionuclide	Soil Concentrations (pCi/g) Corresponding to a 15 mrem/yr Dose Rate		95% UCL Concentrations (pCi/g) in Surface Sediments	
	Rural-Residential Scenario	Recreational Scenario	1301-N trench	1325-N crib
Cobalt-60	10	323	1,916,725	374,064
Cesium-137	9	338	1,598,909	37,400
Strontium-90	4	35,640	85,700	49,464
Plutonium-239/240	21	990	122,239	24,933

Table 5-8. Comparison of the Maximum Concentrations (pCi/g) of the Risk-Driver Radionuclides in Shallow Subsurface Soils (Zone A) from the LFI Boreholes with Single Radionuclide Soil Concentrations (pCi/g) in the Year 2010 Corresponding to a 15 mrem/yr Dose Rate

Radionuclide	Soil Concentrations (pCi/g) Corresponding to a 15 mrem/yr Dose Rate		Maximum Concentrations (pCi/g) in Shallow Subsurface Soils (Zone A) from the LFI Boreholes		
	Rural-Residential Scenario	Recreational Scenario	107A	108A	109A
Cobalt-60	10	323	132,931	3,133	365
Cesium-137	9	338	15,679	15,561	569
Strontium-90	4	35,640	19,543	1,724	1,331
Plutonium-239/240	21	990	3,340	73.70	24.10

Table 5-9. Comparison of the Maximum Concentrations (mg/kg) of Metals in Soil from the LFI Boreholes with Hanford Background Values (mg/kg), Practical Quantitation Limits (mg/kg), and MTCA Cleanup Levels (mg/kg)

Metal	Maximum Concentration (mg/kg)	Hanford Background Value (mg/kg)[a]	Practical Quantitation Limit (mg/kg)[b]	MTCA B Cleanup Level (mg/kg)[c]
Cadmium	0.73	NA[d]	0.5	80
Chromium (VI)	57.7	18.5[e]	1	400
Lead	21.9	10.2	0.3	250[f]
Nickel	16.7	19.1	4	1600

[a]Background concentrations are 90% percentile values of the lognormal distribution of the Hanford Site-Wide soil data, as required by MTCA. Source: *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, DOE/RL-92-94. Rev. 3, 1995.

[b]Source: Contract-Required Quantitation Limits/Contract-Required Detection Limits (CRQL/CRDL) specified in 100 Area Quality Assurance Project Plans (QAPPs).

[c]*Model Toxics Control Act Cleanup Levels and Risk Calculations* (CLARC II) Update, February 1996. Publication #94-145, Washington State Department of Ecology.

[d]NA - not applicable, contaminant not statistically evaluated in soil background because most values are below the detection limit of 0.66 mg/kg. Maximum background value is 11 mg/kg.

[e]Measured as total chromium in the Hanford Site background study.

[f]MTCA Method B value not available for lead. MTCA Method A value of 250 mg/kg is used as the cleanup level for lead.

Table 5-10. Distribution Coefficients, Retardation Factors, and Half-Lives for the Risk-Driver Radionuclides

Radionuclide	Distribution Coefficient	Retardation Factor		Half-Life (years)
		Saturated Soil with 30% Porosity	Unsaturated Soil with 10% Volumetric Water Content	
Cobalt-60	50	333.3	1,000	5.3
Cesium-137	50	333.3	1,000	30.2
Strontium-90	15	100	300	29.1
Plutonium-239/240	200	1,333	4,000	24,131 - Pu-239 6,569 - Pu-240

Table 5-11. Travel Times to the 1995 Water Table with a Recharge Rate of 2 cm/yr

	Travel Times (years) to the 1995 Water Table (385-388 ft)								
	1996 High Water Table (393 ft)			Old Groundwater mound (410 ft)			Bottom of 1301-N		Bottom of 1325-N (ft)
	N-107A	N-108A	N-109A	N-107A	N-108A	N-109A	N-107A	N-108A	N-109A
Water	10	10	7	38	57	26	118	108	54
Cobalt-60	12000	13000	8500	37000	37000	34900	97400	81000	84900
Cesium-137	12000	13000	8500	37000	37000	34900	97400	81000	84900
Strontium-90	3600	3900	2600	11100	11000	10500	29300	24400	25500
Plutonium-239/240	48000	51500	34000	149000	148000	140000	389000	323500	339500

Table 5-12. Comparison of Times of Decay to the Detection Limit (1 pCi/g) with Travel Times to the Water Table for Maximum Concentrations of the Risk-Driver Radionuclides

Location	Zone	Depth (ft bgs)	Elevation (ft above MSL)	Radionuclide	Decayed Concentration (pCi/g)	Time of Decay to Detection Limit (years)	Travel Time to the 1995 Water Table (years)
1301-N trench	Sediment	18	439	Cobalt-60	3,127,902	114	81,000
1301-N trench	Sediment	18	439	Cesium-137	4,045,638	663	81,000
1301-N trench	Sediment	18	439	Strontium-90	135,697	498	24,400
1301-N trench	Sediment	18	439	Plutonium-239	165,627	418,462	323,500
				Plutonium-240	165,627	113,915	323,500
199-N-107A	A	9 - 11	451 - 449	Cobalt-60	132,931	90	97,357
199-N-107A	A	9 - 11	451 - 449	Cesium-137	15,679	421	97,357
199-N-107A	A	11 - 13	449 - 447	Strontium-90	19,543	416	28,351
199-N-107A	A	11 - 13	449 - 447	Plutonium-239	3,340	282,529	376,574
				Plutonium-240	3,340	76,911	376,574
199-N-107A	B	23	437	Cobalt-60	22.91	24	15,361
199-N-107A	B	23	437	Cesium-137	2,770	345	15,361
199-N-107A	B	23	437	Strontium-90	1,161	297	23,107
199-N-107A	B	40	420	Strontium-90	1,072	294	15,670
199-N-107A	B	28 - 30	432 - 430	Plutonium-239	ND	NA	NA
				Plutonium-240	ND	NA	NA
199-N-108A	C	59.5	397.5	Cobalt-60	1.68	4	14,683
NA	C	NA	NA	Cesium-137	ND	NA	NA
199-N-108A	C	59.5	397.5	Strontium-90	237	230	5,916
199-N-108A	C	69	388	Strontium-90	128	204	1,594
NA	C	NA	NA	Plutonium-239	ND	NA	NA
				Plutonium-240	ND	NA	NA

Table 5-13. Input Parameters Used in the Summer's Model to Evaluate Chromium Impact to Groundwater

Maximum Measured Concentration of Chromium (mg/kg)	57.7
Allowable Concentration in Groundwater (MCL) (ug/L)	50
Recharge Rate (m/yr)	0.02
Darcy Velocity (m/yr)	27.8
Mixing Zone Thickness (m)	4.6
Volumetric Moisture Content	0.1
Dry Soil Density (g/mL)	2.0
Horizontal Area of Contamination (m^2)	4856
Width of the Mixing Zone (m)	315 and 105
Distribution Coefficients (mL/g)	0, 1, 2, and 6

Table 5-14. Estimated Concentrations (ug/L) of Chromium in Groundwater Using Different Mixing Zone Widths and Distribution Coefficients

Mixing Zone Width (m)	Distribution Coefficient (mL/g)	Estimated Concentration (ug/L)
315	0	2,780
	1	139
	2	69.4
	6	23.1
105	0	8,290
	1	414
	2	207
	6	69.1

6.0 CONCLUSIONS

The purpose of this LFI was to provide supplementary and confirmatory information regarding the nature, distribution, and potential transport of several priority radionuclide and metal contaminants associated with disposal of contaminated effluent to 1301-N and 1325-N. The data evaluation in this LFI report is focused primarily on providing the necessary information to the Tri Parties so they can address the following two objectives:

1. Determine if immediate action on soil at 1301-N and/or 1325-N is required to protect groundwater.

2. Determine if, for the long-term, soil remediation is required to protect groundwater from a future potential risk, and, if so, when remediation should be performed.

6.1 SUMMARY OF RESULTS

Performing the LFI at 1301-N and 1325-N and evaluating the data have added to the knowledge of the facilities' subsurface conditions. The following points, made in this LFI report, should be considered when addressing the objectives:

- The contaminant distribution of key radionuclides predicted in previously developed conceptual models was confirmed.

- The following radionuclides were detected at levels of concern: Co-60, Cs-137, Sr-90, and Pu-239/240.

- The following metals were detected above background: chromium and lead.

- The driving force of contaminant migration is natural recharge.

- The soil contamination in the concentrated layer and in shallow subsurface soil poses a high risk to human health from potential direct exposure.

- The concentrations of Co-60, Cs-137, and Sr-90 in the soil column will decay to less than detectable levels before they reach groundwater; therefore, they do not pose an impact to groundwater.

- The concentrations of Pu-239/240 will not decay to undetectable levels before they reach groundwater because of their long half-lives.

- The concentrations of chromium detected in the concentrated layer at 1301-N may have a future impact on the groundwater because the estimated concentration in a worst-case scenario is above the MCL.

- The infrequent increase in the groundwater table, because of high Columbia River levels, that results in resaturation of soil may cause temporary increases in concentrations of Sr-90 in groundwater.

6.2 OTHER CONSIDERATIONS

When addressing the objectives, the following considerations on access control and other project activities should also be taken:

Under current conditions, access to 1301-N and 1325-N is prohibited by institutional controls. Both facilities are completely fenced and locked, and access is administratively controlled. A 1.5 m (5 ft) thick layer of large boulders and smaller rocks at the 1301-N crib and concrete panels at the 1301-N trench, the 1325-N crib, and the 1325-N trench minimize wildlife intrusion.

Additionally, the infrequent groundwater table fluctuations which may result in a temporary increase of Sr-90 concentrations will be addressed in the 100-NR-1/2 CMS to be submitted to Ecology in September 1996 in support of TPA Milestone M-15-12C. Furthermore, the pump-and-treat facility at 100 N is extracting groundwater to remove Sr-90, thereby mitigating the short-term Sr-90 concerns.

6.3 CONCLUSION

The information collected for this LFI confirms the conclusion from the 1992 100-NR-1 LFI that 1301-N and 1325-N should remain on the IRM pathway. The results and conclusions of this LFI will be used to prepare the closure plan and CMS for 1301-N and 1325-N to be submitted to Ecology in March 1997 in support of TPA Milestone M-15-12B. Then, based on the requirements in the closure plan, the RCRA permits for 1301-N and 1325-N will be modified. After permit modification, corrective measures identified in the closure plan and permit modification will be implemented.

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APPENDIX A

1301-N and 1325-N ANALYTICAL DATA

This appendix presents the following analytical data for 1301-N and 1325-N. This appendix does not include any decay adjusted data.

- 1301-N Sediment Data
- 1325-N Sediment Data
- 1301-N Dose Rate Survey
- 1325-N Dose Rate Survey
- Water Samples From Within 1301-N and 1325-N
- Inventory Data
- 100N Soil Borings
- 100N Surface Soil Samples
- Special Gamma Logs for 100N Wells

CONTENTS

A-1. SAMPLE LOCATIONS A1-1
A1-1. Sediment Sampling Locations for 1301-N and 1325-N A1-3
A1-2. Boreholes and Wells near 1301-N and 1325-N A1-4
A1-3. Grid Network of Radiation Survey Locations A1-5
A1-4. Surface Soil Sampling Locations at 100-N A1-6

A-2. 1301-N SEDIMENT DATA A2-1
A2-1. Radionuclides Concentrations Detected in 1301-N Trench Sediment from 1980 to 1985 from Locations TS-01 to TS-09 ..... A2-3
A2-2. Ranges in Percentage of Radionuclides Associated with Different Fractions of Soil Phases from 1301-N A2-5
A2-3. Turbidity Measurements, 1301-N A2-6

A-3. 1325-N SEDIMENT DATA A3-1
A3-1. Radionuclide Concentrations Detected in 1325-N Crib Sediments from 1985 to 1987 from Locations CS-01 to CS-12 ..... A3-3
A3-2. Semivolatile Organics Results for 1325-N - Sediment A3-4
A3-3. Inorganic Compounds Detected in 1325-N Crib Sediments in 1989 ..... A3-6
A3-4. Results from Anions Analysis by Ion Chromatography for 1325-N A3-7
A3-5. Results from Cold Vapor Mercury Analyses A3-8
A3-6. Bulk Chemical and Radiological Analysis (Gamma-Emitters Only) of Settled Solids from 1325-N Crib A3-9
A3-7. Turbidity Measurements, 1325-N A3-10

A-4. 1301-N DOSE RATE SURVEY A4-1
A4-1. 1301-N Radiation Measurements A4-3
A4-2. Surface Radiation Readings at 1301-N A4-6

A-5. 1325-N DOSE RATE SURVEY A5-1
A5-1. 1325-N Radiation Measurements A5-3

A-6. WATER SAMPLES FROM WITHIN 1301-N AND 1325-N A6-1
A6-1. Concentration of Selected Cations, Anions, and Radionuclides in the 1301-N Horse Trough A6-3
A6-2. Dangerous Waste Analysis on 1301-N and 1325-N Water Influent (August 1989) A6-4
A6-3. Chemical Composition of 1301-N Trench, Including Manways for 1983 .. A6-5

A6-4. Hydrophillic Organics in Waters from the Low-Level Waste Disposal Site (ppb x 100) A6-6

CONTENTS (Continued)

A6-5. Analytical Charge-Form Specification for 1301-N Trench Radionuclides A6-7

A-7. INVENTORY DATA A7-1
A7-1. Annual and Cumulative Release to 1301-N and 1325-N LWDFs (Curies) . . A7-3
A7-2. Estimated Amounts of Hazardous Waste Discharged to 1301-N and 1325-N A7-4
A7-3. Water Flow Rates from 1301-N and 1325-N Liquid Waste Disposal Facilities A7-5

A-8. 100N SOIL BORINGS A8-1
A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N A8-3
A8-2. Volatile Organic Compounds Detected in Soil Borings Near 1301-N and 1325-N in 1992 . . . . . A8-26
A8-3. Semivolatile Organics Compounds Detected in Soil Near 1301-N/1325-N in 1992 . . . . . A8-27
A8-4. Inorganics Compounds Detected in Soil Near 1301-N and 1325-N in 1992 . . . . . A8-29
A8-5. Metals Analysis on Soil Borings A8-31

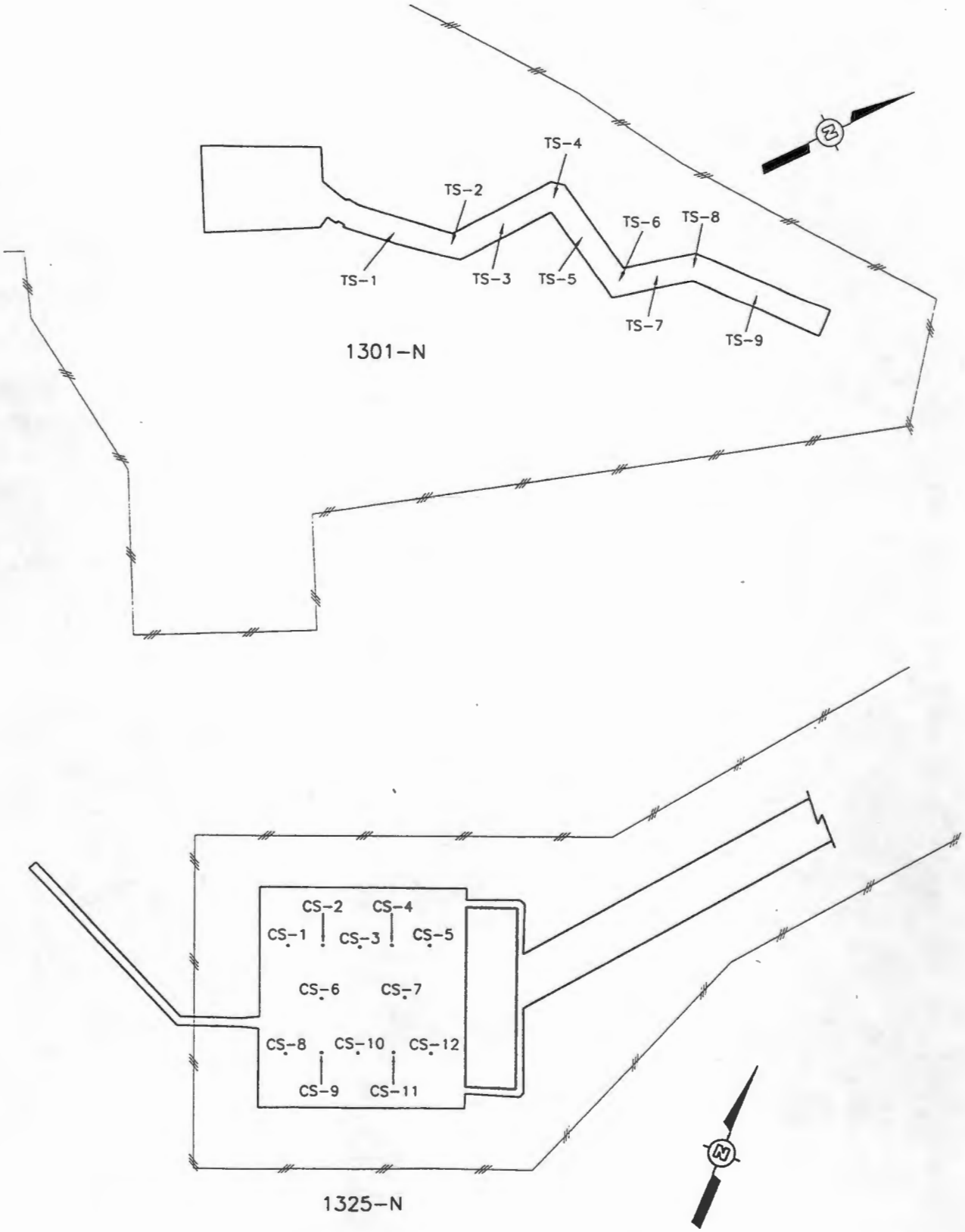
A-9. 100N SURFACE SOIL SAMPLES A9-1
A9-1. Concentrations of Radionuclides Detected in Surface Soils A9-3

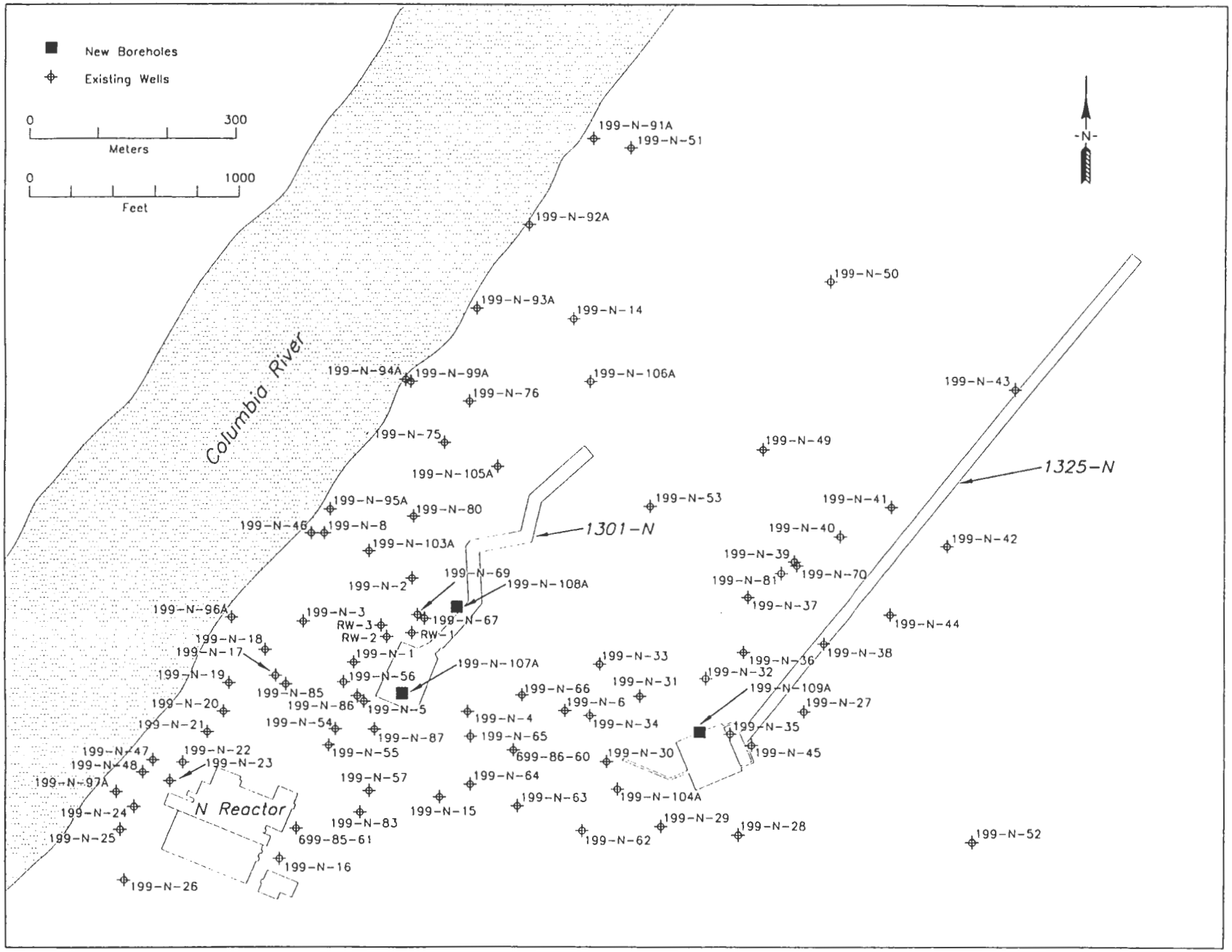
A-10. SPECTRAL GAMMA LOGS FOR 100N WELLS A10-1
A10-1. Spectral Gamma Logging and Field Screening Results for Wells Near 1301-N/1325-N A10-3

APPENDIX A1-1

SAMPLE LOCATIONS

Figure A1-1. Sediment Sampling Locations for 1301-N and 1325-N

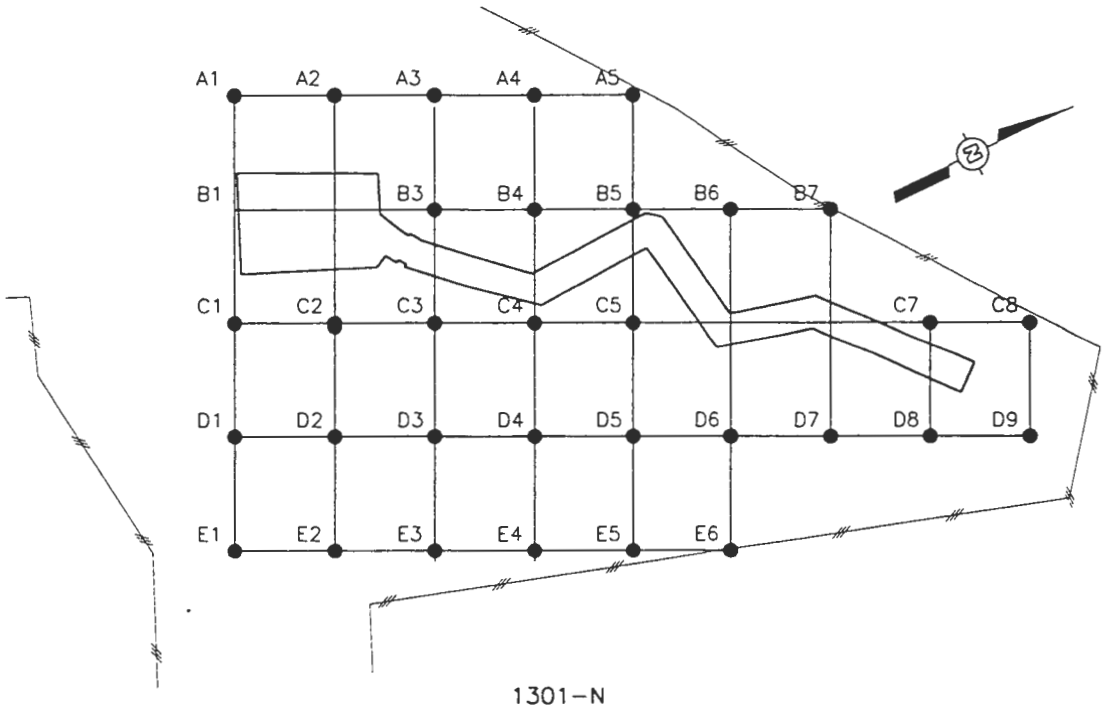


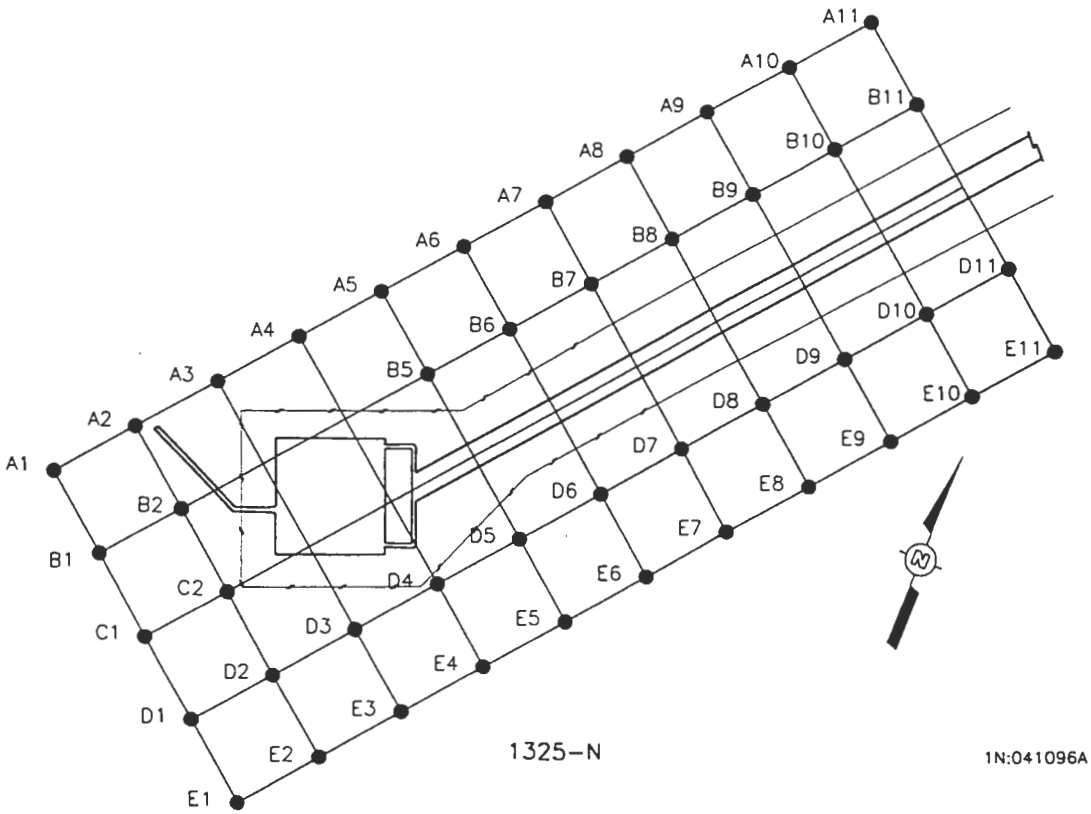


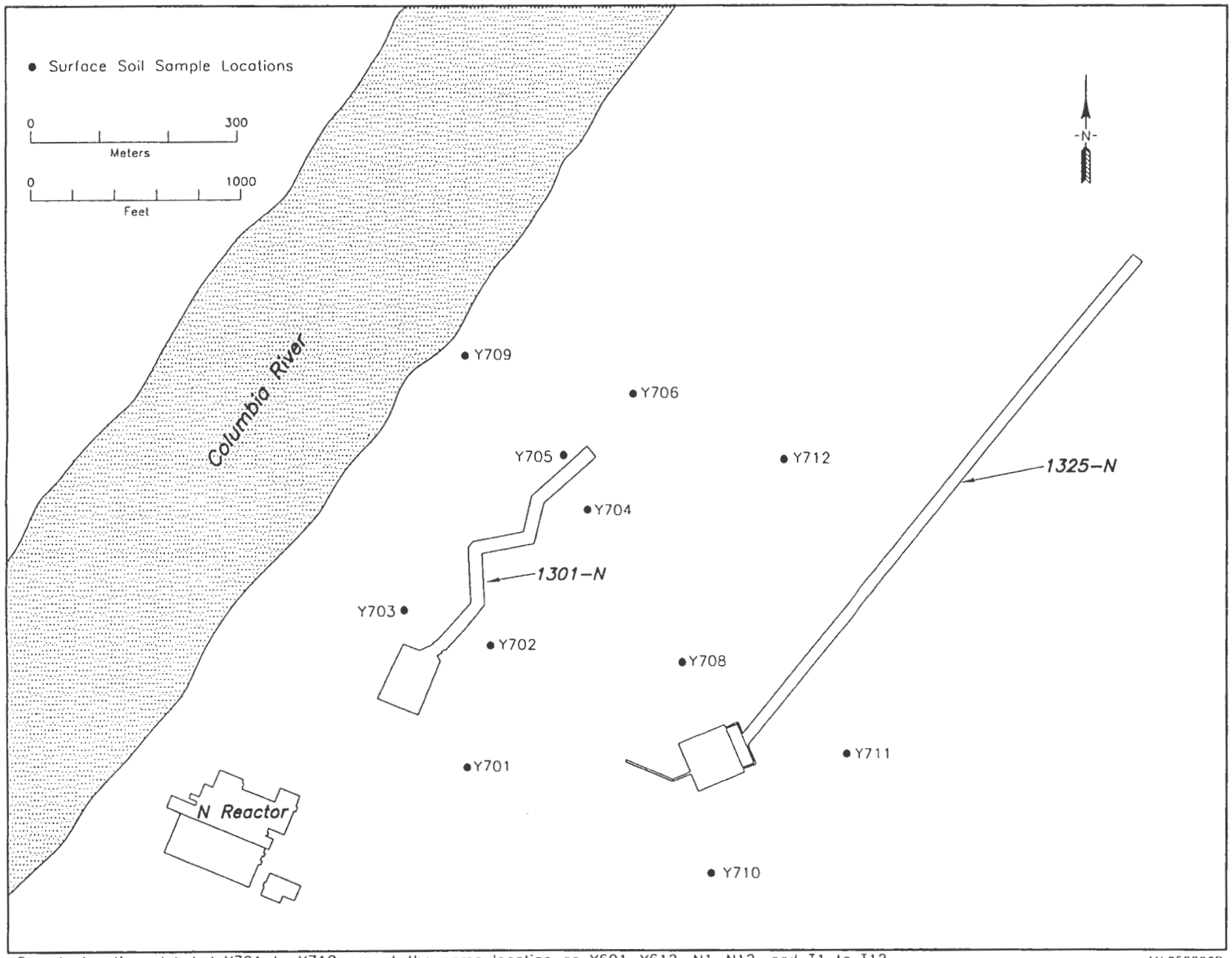
1N:052896A

Figure A1-2. Boreholes and Wells near 1301-N and 1325-N

Figure A1-3. Grid Network of Radiation Survey Locations







Sample locations labeled Y701 to Y712 are at the same location as Y601-Y612, N1-N12, and T1 to T12.

1N:052896B

Figure A1-4. Surface Soil Sampling Locations at 100-N

APPENDIX A-2

1301-N SEDIMENT DATA

Table A2-1. Radionuclides Concentrations Detected in 1301-N Trench Sediment from 1980 to 1985 from Locations TS-01 to TS-09 (Page 1 of 2)

Location:	TS-01	TS-02	TS-03	TS-04	TS-05	TS-06	TS-07	TS-08	TS-09
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Collection Date:	1980								
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	11,000,000	4,100,000	1,100,000	800,000	510,000	860,000	410,000	ND	330,000
Cesium-134	NA	NA	NA	NA	41,000	NA	NA	NA	NA
Cesium-137	270,000	210,000	120,000	220,000	260,000	210,000	240,000	630,000	350,000
Cobalt-58	250,000		NA	NA	NA	NA	NA	NA	NA
Cobalt-60	13,000,000	8,800,000	8,400,000	5,100,000	3,100,000	5,600,000	1,700,000	7,600,000	4,300,000
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	330,000	NA	NA	NA	NA	NA	NA	NA
Manganese-54	4,400,000	2,800,000	1,400,000	1,000,000	610,000	1,100,000	350,000	430,000	700,000
Niobium-95	3,600,000	1,500,000	220,000	260,000	140,000	270,000	92,000	ND	120,000
Plutonium-238	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-103	NA	110,000	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	2,700,000	870,000	NA	NA	NA	NA	NA	NA	NA
Strontium-90	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zirconium-95	1,980,000	790,000	NA	NA	NA	NA	NA	NA	NA
Collection Date:	1981								
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	2,700,000	1,100,000	NR	1,200,000	440,000	770,000	840,000	790,000	110,000
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	190,000	190,000	530,000	330,000	490,000	570,000	530,000	440,000	780,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	6,600,000	6,300,000	19,000,000	6,000,000	4,400,000	17,000,000	8,900,000	5,400,000	8,300,000
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	1,300,000	1,100,000	1,700,000	980,000	390,000	1,300,000	900,000	750,000	990,000
Niobium-95	140,000	90,000	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	5,500	1,500	6,200	1,800	780	4,900	6,300	1,200	4,000
Plutonium-239/240	26,000	9,200	25,000	12,000	5,500	25,000	30,000	6,600	20,000
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	750,000	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	170,000	770,000	110,000	36,000	21,000	96,000	110,000	25,000	45,000
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collection Date:	1982								
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	NA	2,100,000	NA	NA	NA	NA	NA	NA	1,300,000
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	940,000	490,000	940,000	530,000	540,000	500,000	1,000,000	460,000	560,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	21,000,000	27,000,000	34,000,000	6,400,000	6,600,000	15,000,000	14,000,000	4,500,000	4,300,000
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	710,000	1,900,000	860,000	460,000	460,000	470,000	490,000	270,000	ND
Niobium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	5,500	14,000	29,000	510,000	120,000	9,300	3,800	9,500	1,100
Plutonium-239/240	28,000	63,000	170,000	2,800,000	660,000	44,000	17,000	16,000	13,000
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	110,000	250,000	320,000	150,000	110,000	230,000	83,000	70,000	150,000
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A2-1. Radionuclides Concentrations Detected in 1301-N Trench Sediment from 1980 to 1985 from Locations TS-01 to TS-09 (Page 2 of 2)

Location:	TS-01	TS-02	TS-03	TS-04	TS-05	TS-06	TS-07	TS-08	TS-09
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Collection Date:	1983								
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	NA	NA	NA	380,000	NA	NA	NA	NA	NA
Cesium-134	ND	ND	ND	ND	28,000	ND	37,000	28,000	NA
Cesium-137	83,000,000	550,000	580,000	380,000	720,000	950,000	800,000	400,000	390,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	22,000,000	16,000,000	25,000,000	8,000,000	5,200,000	16,000,000	6,000,000	4,000,000	4,000,000
Europium-154	130,000	ND	ND	54,000	80,000	170,000	ND	ND	ND
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	610,000	410,000	620,000	940,000	130,000	300,000	140,000	170,000	220,000
Niobium-95	NA	NA	NA	120,000	NA	NA	NA	NA	NA
Plutonium-238	2,400	3,000	1,800	1,500	560	2,000	1,100	830	920
Plutonium-239/240	12,000	13,000	10,000	7,500	3,000	9,800	6,200	4,600	4,300
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	46,000	46,000	29,000	26,000	13,000	46,000	27,000	13,000	8,700
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collection Date:	1984								
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	NA	NA	NA	NA	NA	NA	870,000	NA	NA
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	3,100,000	960,000	820,000	750,000	1,300,000	750,000	980,000	730,000	1,300,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	53,000,000	22,000,000	32,000,000	16,000,000	8,300,000	23,000,000	16,000,000	16,000,000	15,000,000
Europium-154	NA	NA	NA	NA	150,000	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	790,000 U	470,000	520,000	1,300,000	190,000 U	350,000	3,200,000	750,000	1,100,000
Niobium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collection Date:	1985								
Gross alpha	35,000	28,000	52,000	38,000	34,000	42,000	19,000	18,000	28,000
Gross beta	1,900,000	19,000,000	13,000,000	6,500,000	5,000,000	10,000,000	6,000,000	2,800,000	2,300,000
Cerium-144	87,000 U	67,000 U	84,000 U	85,000 U	69,000 U	79,000 U	50,000	11,000 U	63,000 U
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	29,000	26,000	37,000	28,000	55,000	68,000	56,000	22,000	25,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	1,300,000	1,100,000	1,600,000	1,200,000	950,000	1,100,000	1,300,000	260,000	640,000
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	54,000	17,000	23,000 U	100,000	56,000	18,000 U	150,000	28,000	40,000
Niobium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	4,600	2,900	5,100	4,000	3,900	4,200	2,300	1,800	3,400
Plutonium-239/240	26,000	16,000	27,000	23,000	21,000	24,000	14,000	11,000	20,000
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	93,000	77,000	210,000	110,000	190,000	120,000	120,000	70,000	110,000
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA

U = Concentration was undetected at specified detection level.
NA = Not analyzed
ND = Not detected; no detection limit given
NR = Not reported
Trench sediment samples collected by attaching a jar to a pole and using this device as a scoop. The top six inches of trench sediments were sampled through standing water.

References:
UNI-1581 = Radiological Surveillance Report for the 100-N Area-FY 1980
UNI-1849 = UNC Environmental Surveillance Report for 100 Areas-FY 1981
UNI-2226 = UNC Environmental Surveillance Report for 100 Areas-FY 1982
UNI-2640 = UNC Environmental Surveillance Report for 100 Areas-FY 1983
UNI-3069 = UNC Environmental Surveillance Report for 100 Areas-FY 1984
UNI-3760 = UNC Environmental Surveillance Report for 100 Areas-FY 1985

Table A2-2. Ranges in Percentage of Radionuclides Associated with Different Fractions of Soil Phases from 1301-N

Form	Cerium-144	Cesium-134	Cesium-137	Ruthenium-106	Manganese-54	Cobalt-60	Europium-155	Niobium-95	Antimony-125
Readily Ion Exchangeable	0.1-1	10-20	10-20	~1	~1	~1	~1	<1	<10
Soluble Organics	1-5	5-8	3-7	15-30	<1	<1	<10	10-20	10-20
Hydrous Oxide	60-80	10-20	10-20	15-30	30-80	20-70	70-90	40-70	40-70
Peroxide Soluble	1-10	10-20	10-20	40	1-5	<1	<10	30-50	25-75
Strong Acid Soluble	10-30	40-70	40-70	30-60	20-70	30-80	~30	10-30	40-70
Refractory	<1-1	3-4	3-4	<1-1	7-20	3-15	8-30	10-30	40-60

Reference: Influence of the Physicochemical Forms of Radionuclides During Migration in Groundwaters Annual Progress Report for 1981, p. 31

Table A2-3. Turbidity Measurements, 1301-N

Sample No.	1301-N (Horse Trough) 10/5/84		
	Time (a.m.)	Unfiltered (NTU)	Filtered (NTU)
1	10:01	0.39	
2	10:01	0.49	
3	10:02	0.39	0.15
4	10:05	0.40	
5	10:05	0.36	
6	10:10	0.37	
7	10:10	0.40	
8	10:15	0.42	0.15
9	10:15	0.54	
10	10:20	0.41	
11	10:20	0.47	
12	10:25	0.40	
13	10:25	0.40	0.15
14	10:30	0.42	
15	10:30	0.46	
16	10:35	0.32	
17	10:35	0.36	
18	10:40	0.33	
19	10:40	0.32	
20	10:45	0.36	
21	10:45	0.35	
22	10:50	0.38	
23	10:50	0.37	0.15
24	10:55	0.37	
25	10:55	0.36	
26	11:00	0.37	
27	11:00	0.42	
28	9:35	0.50	0.15
29	9:35	0.49	
30	9:40	0.50	
31	9:40	0.66	
32	9:45	0.63	
33	9:45	0.67	
34	9:50	0.49	
35	9:50	0.66	
36	9:55	0.51	
37	9:55	0.59	
38	10:00	0.59	
39	10:00	0.59	
40	10:05	0.62	
41	10:05	0.64	0.15
42	10:10	0.54	
43	10:10	0.50	
44	10:15	0.52	
45	10:15	0.65	
46	10:20	0.67	
47	10:20	0.63	
48	10:25	0.70	0.15
49	10:25	0.63	
50	10:30	0.74	
51	10:30	0.71	
52	10:35	0.60	
53	10:35	0.61	0.15

Water collected from 1301-N weir box.
NTU = nephelometric turbidity unit
Reference: UNI-2999 = Engineering Study Liquid Effluent Disposal Facility, Project H-672. Jan. 15, 1985, p. I-36, 37 & 38

APPENDIX A-3

1325-N SEDIMENT DATA

Table A3-1. Radionuclide Concentrations Detected in 1325-N Crib Sediments from 1985 to 1987 from Locations CS-01 to CS-12

Location:	CS-01	CS-02	CS-03	CS-04	CS-05	CS-06	CS-07	CS-08	CS-09	CS-10	CS-11	CS-12
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Collection Date:	1985											
Gross alpha	18,000	7,000	18,000	6,000	4,700	NR	44,000	26,000	18,000	12,000	9,700	6,100
Gross beta	2,300,000	3,100,000	1,600,000	830,000	400,000	NR	15,000,000	2,400,000	2,200,000	1,100,000	1,500,000	620,000
Cerium-144	120,000	64,000	94,000	41,000	5,800	NR	100,000 U	100,000	15,000	67,000	76,000	40,000
Cesium-137	41,000	49,000	49,000	35,000	13,000	NR	11,000	29,000	5,000	56,000	48,000	71,000
Cobalt-60	1,300,000	660,000	1,100,000	600,000	180,000	NR	1,600,000	1,700,000	140,000	520,000	800,000	580,000
Manganese-54	270,000	190,000	280,000	160,000	52,000	NR	260,000	360,000	32,000	150,000	240,000	170,000
Plutonium-238	2,000	740	2,000	660	460	NR	5,000	8,600	1,800	350	1,100	530
Plutonium-239/240	12,000	5,000	13,000	4,300	2,800	NR	30,000	56,000	12,000	2,300	6,900	34,000
Strontium-90	88,000	26,000	89,000	27,000	15,000	NR	200,000	100,000	17,000	13,000	12,000	5,800
Collection Date:	1986											
Gross alpha	NR	NR	NA	NA	NA	NR	NR	NA	NA	NR	NR	NR
Gross beta	NR	NR	NA	NA	NA	NR	NR	NA	NA	NR	NR	NR
Cerium-144	770,000	34,000	86,000	130,000	55,000	NR	NR	120,000	130,000	NR	NR	NR
Cesium-137	180,000	62,000	88,000	85,000	92,000	NR	NR	66,000	80,000	NR	NR	NR
Cobalt-60	9,100,000	520,000	2,300,000	2,500,000	620,000	NR	NR	1,700,000	2,800,000	NR	NR	NR
Manganese-54	1,600,000	140,000	380,000	480,000	170,000	NR	NR	310,000	510,000	NR	NR	NR
Plutonium-238	NA	NA	NA	NA	NA	NR	NR	NA	NA	NR	NR	NR
Plutonium-239/240	NA	NA	NA	NA	NA	NR	NR	NA	NA	NR	NR	NR
Strontium-90	9,100	3,900	5,000	5,000	3,400	NR	NR	NR	9,200	NR	NR	NR
Collection Date:	1987											
Gross alpha	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NA	NA
Cerium-144	60,000 U	91,000 U	35,000 U	53,000 U	58,000 U	NR	98,000 U	81,000 U	46,000 U	16,000 U	73,000 U	83,000 U
Cesium-137	32,000	17,000 U	18,000	29,000	30,000	NR	48,000	15,000	17,000	21,000	13,000	13,000
Cobalt-60	820,000	1,400,000	630,000	630,000	680,000	NR	1,300,000	1,100,000	820,000	140,000	840,000	1,200,000
Manganese-54	130,000	200,000	97,000	96,000	100,000	NR	270,000	120,000	120,000	31,000	130,000	140,000
Plutonium-238	1,100	6,700	250	1,400	1,300	NR	17,000	21,000	1,300	2,300	3,100	6,000
Plutonium-239/240	5,200	49,000	1,600	9,900	8,500	NR	98,000	120,000	8,300	1,400	20,000	39,000
Strontium-90	14,000	40,000	5,900	4,300	10,000	NR	630,000	270,000	10,000	14,000	29,000	35,000

U = Concentration was undetected at specified detection level
NR = Not reported
NA = Not analyzed

References: UNI-3760 = UNC Environmental Surveillance Report for the 100 Areas - FY 1985
UNI-4065 = UNC Environmental Surveillance Report for the100 Areas - FY 1986
WHC-EP-0161 = Westinghouse Hanford Co. Environmental Surveillance Annual Report-100 Areas-FY 1987

Samples of surface sediment were collected from the bottom of the 1325-N Crib. Approximately 10 grams of sediment per sample were collected through the sample port located in the cover of the facility. The samples were collected during operations through standing water.

Table A3-2. Semivolatile Organics Results for 1325-N - Sediment (Page 1 of 2)

Sample ID:	A	B	C	D	E	F
	89-0073	89-0074	89-0075	89-0076	89-0077-R	89-0078
Units:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Phenol	0.33 U	0.33 U	0.33 U	0.33 U	**0.48**	0.33 U
bis(2-Chloroethyl) Ether	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
2-Chlorophenol	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
1,3-Dichlorobenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
1,4-Dichlorobenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Benzyl alchohl	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
1,2-Dichlorbenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
2-Methylphenol	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
bis(2-chloroisopropyl) ether	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
4-Methylphenol	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
N-Nitroso-Di-n-propylamine	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Hexachloroethane	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Nitrobenzene	0.33 U	0.33 U	0.33 U	0.33 U	**0.034 J**	0.33 U
Isophorone	0.33 U	0.33 U	0.33 U	0.33 U	**0.091 J**	0.33 U
2-Nitrophenol	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
2,4-Dimethylphenol	0.33 U	0.33 U	0.33 U	0.33 U	**0.058 J**	0.33 U
Benzoic acid	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U
bis(2-Chloroethoxy)methane	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
2,4-Dichlorophenol	0.33 U	0.33 U	0.33 U	0.33 U	**0.078 J**	0.33 U
1,2,4-Trichlorobenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Naphthalene	0.33 U	0.33 U	0.33 U	0.33 U	**0.042 J**	0.33 U
4-Chloroaniline	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Hexachlorobutadiene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
4-Chloro-3-methylphenol	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
2-Methylnaphthalene	0.33 U	0.33 U	0.33 U	0.33 U	**0.022 J**	0.33 U
Hexachlorocyclopentadiene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
2,4,6-Trichlorophenol	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
2,4,5-Trichlorophenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U
2-Chloronaphthalene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
2-Nitroaniline	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U
Dimethylphthalate	0.33 U	0.33 U	0.33 U	0.33 U	0.51	0.33 U
Acenaphthylene	0.33 U	0.33 U	0.33 U	0.33 U	**0.014 J**	0.33 U
2,6-Dinitrotoluene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
3-Nitroaniline	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U
Acenaphthene	0.33 U	0.33 U	0.33 U	0.33 U	**0.04 J**	0.33 U
2,4-Dinitrophenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U
4-Nitrophenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U
Dibenzofuran	0.33 U	0.33 U	0.33 U	0.33 U	**0.03 J**	0.33 U
2,4-Dinitrotoluene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Diethylphthalate	0.33 U	0.33 U	0.33 U	0.33 U	**0.092 J**	0.33 U
4-Chlorophenyl-phenylether	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Fluorene	0.33 U	0.33 U	0.33 U	0.33 U	**0.035 J**	0.33 U
4-Nitroaniline	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U
4,6-Dinitro-2-methylphenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U
N-Nitrosodiphenylamine (1)	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
4-Bromophenyl-phenylether	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Hexachlorobenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Pentachlorophenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.6 U
Phenanthrene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Anthracene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Di-n-butylphthalate	**0.028 J**	0.33 U	0.33 U	**0.012 J**	**2.8 J**	**0.022 J**
Fluoranthene	0.33 U	0.33 U	0.33 U	**0.015 J**	**0.23 J**	0.33 U
Pyrene	0.33 U	0.33 U	0.33 U	**0.018 J**	**0.43 J**	0.33 U
Butylbenzylphthalte	**0.024 J**	**0.022 J**	**0.026 J**	**0.028 J**	0.32 U	**0.023 J**
3,3'-Dichlorobenzidine	0.66 U	0.67 U	0.65 U	0.66 U	0.65 U	0.66 U
Benzo(a)anthracene	0.33 U	0.33 U	0.33 U	**0.015 J**	**0.34**	0.33 U
Chrysene	0.33 U	0.33 U	0.33 U	**0.015 J**	**0.37**	0.33 U
bis(2-Ethylhexyl)phthalate	**0.4 B**	**0.44 B**	**0.25 JB**	**0.45 B**	**3.8 B**	**0.83 B**
Di-n-octylphthalte	**0.33 B**	**0.013 JB**	**0.018 JB**	**0.022 JB**	**5.2 BE**	**0.1 JB**
Benzo(b) fluoranthene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Benzo(k) fluoranthene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Benzo(a) pyrene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Indeno(1,2,3-cd) pyrene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Dibenz (a,h) anthracene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U
Benzo (g,h,i) perylene	0.33 U	0.33 U	0.33 U	0.33 U	0.32 U	0.33 U

Table A3-2. Semivolatile Organics Results for 1325-N - Sediment (Page 2 of 2)

Sample ID:	G 89-0079	H 89-0080	I 89-0081	J 89-0082	K 89-0083	Method Blank
Units:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Phenol	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
bis(2-Chloroethyl) Ether	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2-Chlorophenol	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
1,3-Dichlorobenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
1,4-Dichlorobenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Benzyl alchohl	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
1,2-Dichlorbenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2-Methylphenol	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
bis(2-chloroisopropyl) ether	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	**0.022 JB**
4-Methylphenol	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
N-Nitroso-Di-n-propylamine	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Hexachloroethane	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Nitrobenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Isophorone	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2-Nitrophenol	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2,4-Dimethylphenol	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Benzoic acid	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.7 U
bis(2-Chloroethoxy)methane	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2,4-Dichlorophenol	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
1,2,4-Trichlorobenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Naphthalene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
4-Chloroaniline	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Hexachlorobutadiene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
4-Chloro-3-methylphenol	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2-Methylnaphthalene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Hexachlorocyclopentadiene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2,4,6-Trichlorophenol	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2,4,5-Trichlorophenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.7 U
2-Chloronaphthalene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2-Nitroaniline	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.7 U
Dimethylphthalate	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Acenaphthylene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2,6-Dinitrotoluene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
3-Nitroaniline	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.7 U
Acenaphthene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2,4-Dinitrophenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.7 U
4-Nitrophenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.7 U
Dibenzofuran	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
2,4-Dinitrotoluene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Diethylphthalate	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
4-Chlorophenyl-phenylether	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Fluorene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
4-Nitroaniline	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.7 U
4,6-Dinitro-2-methylphenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.7 U
N-Nitrosodiphenylamine (1)	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
4-Bromophenyl-phenylether	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Hexachlorobenzene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Pentachlorophenol	1.7 U	1.7 U	1.6 U	1.6 U	1.6 U	1.7 U
Phenanthrene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Anthracene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Di-n-butylphthalate	**0.017 J**	**0.022 J**	**0.027 J**	**0.11 J**	**0.14 J**	0.33 U
Fluoranthene	0.33 U	**0.009 J**	0.33 U	0.33 U	**0.013 J**	0.33 U
Pyrene	0.33 U	**0.014 J**	0.33 U	**0.011 J**	**0.022 J**	0.33 U
Butylbenzylphthalte	**0.04 J**	**0.046 J**	**0.028 J**	0.33 U	0.33 U	0.33 U
3,3'-Dichlorobenzidine	0.66 U	0.66 U	0.66 U	0.66 U	0.66 U	0.67 U
Benzo(a)anthracene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Chrysene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
bis(2-Ethylhexyl)phthalate	**0.72 B**	**0.84 B**	**0.6 B**	**0.34 B**	**0.54 B**	**0.45 B**
Di-n-octylphthalte	**0.026 JB**	**0.019 JB**	**0.063 JB**	**0.025 JB**	**0.022 JB**	**0.054 JB**
Benzo(b) fluoranthene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Benzo(k) fluoranthene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Benzo(a) pyrene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Indeno(1,2,3-cd) pyrene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Dibenz (a,h) anthracene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U
Benzo (g,h,i) perylene	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U	0.33 U

U = Concentration was undetected at specified detection levels
J = Estimated result
JB = Analyte found in associated blank at estimated quantity
BE = Out of calibration range
B = Blank contamination

Analysis method is unknown.
Sample locations unknown
Sampled received 4-13-89.
Reference: Analytical Report for 1325-N Crib Samples, May 22, 1989, Table 4

Table A3-3. Inorganic Compounds Detected in 1325-N Crib Sediments in 1989

Sample ID:	1	A	B	C	D	E	F	G	H	I	J	J (Dup)	K
Units:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Aluminum	ND	3,500	3,100	5,650	5,150	4,400	5,100	5,150	4,100	4,200	4,700	4,450	5,550
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Barium	220	83	65	126	95	220	116	110	109	99	100	100	109
Beryllium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	22,000	6,950	3,950	22,000	5,350	10,300	6,100	6,300	5,250	5,150	5,050	5,250	8,000
Chromium	450	ND	ND	ND	ND	450	ND	ND	30 J	ND	ND	ND	20 J
Cobalt	15	ND	ND	ND	ND	ND	ND	ND	ND	ND	15 J	10 J	ND
Copper	230	80 J	20 J	40 J	40 J	230	30 J	40 J	40 J	30 J	40 J	30 J	10 J
Iron	135,000	28,700	21,900	26,700	31,800	135,000	36,000	37,300	30,000	29,000	31,800	32,300	29,800
Lead	500	ND	ND	ND	ND	500 J	ND	ND	ND	ND	ND	ND	ND
Magnesium	8,950	4,650	3,800	8,950	5,400	3,200	5,450	5,850	4,000	4,600	4,450	4,750	6,601
Manganese	920	370	230	505	370	920	370	370	280	530	330	350	480
Mercury	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	200	ND	20 J	50 J	30 J	200 J	30 J	30 J	50 J	30 J	30 J	30 J	50 J
Phosphorus	2,400	1,700 J	800 J	2,100 J	1,200 J	2,400 J	1,200 J	1,000 J	1,000 J	1,000 J	1,100 J	1,000 J	1,000 J
Potassium	500	280 J	280 J	500 J	450 J	250 J	400 J	450 J	350 J	400 J	500 J	450 J	400 J
Silver	ND	450	470	430	330	380	500	500	320	300	500	330	300
Sodium	430	270 J	270 J	430 J	350 J	300 J	360 J	370 J	320 J	330 J	310 J	350 J	350 J
Strontium	45	25	15	42	25	45	24	23	21	19	19	21	25
Thallium	3,350	1,650	1,900	2,200	2,700	620	3,350	2,850	1,750	2,680	2,600	2,100	2,150
Vanadium	100	40	50	70	80	20 J	100	100	60	80	80	70	60
Zinc	1,650	60	90	240	150	1,650	230	250	200	130	190	170	290
Zirconium	40	10 J	20 J	40 J	30 J	20 J	10 J	20 J	40 J	40 J	30 J	30 J	30 J

Dup = Duplicate
Samples analyzed by EPA Method ICP Metals.
ND = Not detected, no detection limit given
J = Estimated value
Location of samples not given. A sample ID for 1 was not given in the report, so it was assigned for this report.
Reference: WHC-SD-EN-DP-056, Rev. 0-A

Table A3-4. Results from Anions Analysis by Ion Chromatography for 1325-N

Sample ID:	A	B	C	D	E	F	G	H	I	J	J (Dup)	K	Field Blank
Units:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Ammonium	50 U	50 U	50 U	50 U	50 U	NA	50 U	50 U	50 U	50 U	50 U	50 U	50 U
Chlorine	**52**	**52**	**53**	**52**	**55**	NA	**50**	**52**	**51**	**53**	**57**	**53**	**52**
Fluorine	1 U	1 U	1 U	1 U	1 U	NA	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Glycol	30 U	30 U	30 U	30 U	30 U	NA	30 U	30 U	30 U	30 U	30 U	30 U	30 U
Nitrate	**14**	**5**	**22**	**6**	5 U	NA	5 U	5 U	5 U	**7**	14	5 U	5 U
Nitrite	5 U	5 U	5 U	5 U	5 U	NA	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Phosphate	**24**	20 U	**36**	20 U	20 U	NA	20 U	**34**	20 U	**26**	**27**	**30**	20 U
Sulfate	5 U	**75**	5 U	**72**	**99**	NA	**71**	5 U	5 U	5 U	**30**	**39**	5 U

U = Concentration was undetected at specified detection levels

NA = Not analyzed

Dup = Duplicate

Samples collected 3-20-89

Sample location not given.

Reference: Battelle Analytical Report for the 1325-N Crib Samples, May 22, 1989, Table 3

Table A3-5. Results from Cold Vapor Mercury Analyses

1325-N	Mercury 3/20/89 mg/Kg
A	0.30 U
B	**0.30**
C	0.30 U
D	0.30 U
E	**1.3**
F	**0.50**
G	0.30 U
H	**0.32**
I	**0.44**
J	**0.88**
J (Dup)	**0.58**
K	**1.0**

U = Concentration was undetected at specified detection levels

Dup = Duplicate

Sample location was not given

Samples collected 3/20/89 and analyzed by EPA SW-846/7471

Reference: Battelle Analytical Report for the 1325-N Crib

Table A3-6. Bulk Chemical and Radiological Analysis (Gamma-Emitters Only) of Settled Solids from 1325-N Crib

Constituents	wt%	mg/Kg	pCi/g
Inorganics			
Aluminum	2.4	---	
Calcium	4.4	---	
Chromium	---	653	
Copper	---	643	
Iron	26.1	---	
Lead	---	571	
Manganese	---	9,920	
Molybdenum	---	47	
Nickel	---	1,251	
Radionuclides			
Cerium-144			135,000,000
Cesium-137			500,000
Cobalt-60			160,000,000
Manganese-54			435,000,000
Nickel-59			2,900,000
Phosphorus	2.2	---	
Potassium	0.4	---	
Silicon	8.4	---	
Uranium	---	858	
Zinc	---	2,600	
Zinc-65			37,000,000
Zirconium	---	843	
Zirconium-95			4,100,000

Samples collected in 1984.

Bulk mineralogical analysis was performed by x-ray powder diffraction.

Bulk elemental analysis was performed using dispersive x-ray fluorescence.

Reference: UNI-2999 Rev. 0 = Engineering Study Liquid Effluent Disposal Facility, Project H-672, Page I-13

Table A3-7. Turbidity Measurements, 1325-N

Sample No.	1325-N Crib (a) 11/20/84		
	Time (a.m.)	Location	Turbidity
1	9:30	Southeast Manway	0.73
2	9:30	Southeast Manway	0.71
3	9:35	Southeast Manway	0.55
4	9:35	Southeast Manway	0.6
5	9:40	Southeast Manway	0.53
6	9:40	Southeast Manway	0.63
7	9:45	Southeast Manway	0.58
8	9:45	Southeast Manway	0.54
9	9:50	Southeast Manway	0.53
10	9:50	Southeast Manway	0.52
11	9:55	Southeast Manway	0.74
12	9:55	Southeast Manway	0.73
13	10:00	Middle, South Manway	0.55
14	10:00	Middle, South Manway	0.52
15	10:05	Middle, South Manway	0.46
16	10:05	Middle, South Manway	0.44
17	10:10	Middle, South Manway	0.45
18	10:10	Middle, South Manway	0.5
19	10:15	Middle, South Manway	0.48
20	10:15	Middle, South Manway	0.46
21	10:20	Middle, South Manway	0.44
22	10:20	Middle, South Manway	0.5
23	10:25	Middle, South Manway	0.44
24	10:25	Middle, South Manway	0.46
25	10:30	Southwest Manway	0.48
26	10:30	Southwest Manway	0.54
27	10:35	Southwest Manway	0.53
28	10:35	Southwest Manway	0.56
29	10:40	Southwest Manway	0.57
30	10:40	Southwest Manway	0.62
31	10:45	Southwest Manway	0.55
32	10:45	Southwest Manway	0.58
33	10:50	Southwest Manway	0.54
34	10:50	Southwest Manway	0.55
35	10:55	Southwest Manway	0.54
36	10:55	Southwest Manway	0.55

(a) Estimated crib influent rate = <300 gal/min per, L. P. Diediker, 11/19/84.

Reference: UNI-2999 Rev. 0 = Engineering Study Liquid Effluent Disposal Facility, Project H-672, Jan. 15, 1985, p.I-36, 37 and 38

APPENDIX A-4

1301-N DOSE RATE SURVEY

Table A4-1. 1301-N Radiation Measurements (Page 1 of 3)

	1980				1981		1982		1983		1984	
	Ground Level		One Meter Above Concrete Panel		Ground Level*		Ground Level		Ground Level		Ground Level	
Grid Point	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr
A1	200	90	388	100	710	320	380	900	795	900	875	600
A2	225	100	345	110	600	270	205	550	315	600	355	400
A3	176	70	234	80	450	203	200	260	200	350	145	230
A4	117	70	212	70	340	153	90	150	90	200	95	150
A5	102	60	192	60	230	104	105	120	150	145	80	110
B1	5,960	OS*	25,400	OS*	9,900	4,455	11,000	OS*	NR	NR	NR	NR
B3	330	220	842	260	1,500	675	305	700	370	775	570	650
B4	200	100	391	170	360	162	120	240	175	400	155	400
B5	393	200	3,270	OS*	1,400	630	120	270	160	325	175	300
B6	200	120	323	120	270	122	95	150	115	170	140	175
B7	NR	NR	NR	NR	150	68	100	110	70	110	120	120
C1	244	160	512	400	2,200	990	740	750	735	1,180	390	400
C2	402	250	310	250	370	167	410	550	330	600	335	350
C3	536	250	573	400	480	216	280	400	280	500	270	400
C4	416	290	487	300	420	189	170	280	165	400	190	350
C5	301	260	394	280	340	153	140	200	140	210	135	230
C7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
C8	204	130	346	130	280	126	140	200	110	210	140	200
C9	119	60	202	50	190	86	90	80	100	80	130	90
D1	NR	NR	NR	NR	300	135	250	230	305	450	110	160
D2	NR	NR	NR	NR	240	108	170	160	170	225	125	140
D3	NR	NR	NR	NR	200	90	130	160	165	215	165	120
D4	209	100	153	120	180	81	90	130	110	160	100	140
D5	130	120	207	130	360	162	160	120	85	140	100	120
D6	181	120	300	140	200	90	150	130	140	140	230	150
D7	182	120	272	140	270	122	100	120	75	135	105	140
D8	466	100	367	100	290	131	110	100	90	115	140	130
D9	166	160	480	240	330	149	90	100	85	110	145	120
E1	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E2	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E3	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
E6	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A4-1. 1301-N Radiation Measurements (Page 2 of 3)

	1985		1986		1987		1988		1989		1990	
	Ground Level		Ground Level		Ground Level		Ground Level		Ground Level		Ground Level	
Grid Point	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr
A1	1,000	NR	2,100	NR	2,100	NR	1,200	NR	1,200	NR	900	NR
A2	700	NR	3,700	NR	3,700	NR	2,000	NR	2,000	NR	2,000	NR
A3	400	NR	5,000	NR	5,000	NR	3,200	NR	3,200	NR	3,300	NR
A4	260	NR	4,500	NR	4,500	NR	2,800	NR	2,800	NR	2,800	NR
A5	210	NR	3,800	NR	3,800	NR	2,400	NR	2,400	NR	2,500	NR
B1	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
B3	1,200	NR	>5,000	NR	>5,000	NR	>5,000	NR	>5,000	NR	>5,000	NR
B4	700	NR	>5,000	NR	>5,000	NR	4,400	NR	4,400	NR	>5,000	NR
B5	600	NR	>5,000	NR	>5,000	NR	4,400	NR	4,400	NR	>5,000	NR
B6	200	NR	>5,000	NR	>5,000	NR	3,200	NR	3,200	NR	3,600	NR
B7	NR	NR	>5,000	NR	>5,000	NR	2,000	NR	2,000	NR	2,000	NR
C1	700	NR	>5,000	NR	>5,000	NR	1,200	NR	1,200	NR	1,800	NR
C2	500	NR	>5,000	NR	>5,000	NR	3,200	NR	3,200	NR	1,800	NR
C3	600	NR	>5,000	NR	>5,000	NR	4,800	NR	4,800	NR	>5,000	NR
C4	700	NR	>5,000	NR	>5,000	NR	4,400	NR	4,400	NR	>5,000	NR
C5	440	NR	>5,000	NR	>5,000	NR	4,000	NR	4,000	NR	4,800	NR
C7	500	NR	>5,000	NR	>5,000	NR	4,700	NR	4,700	NR	NR	NR
C8	150	NR	>5,000	NR	>5,000	NR	1,200	NR	1,200	NR	3,400	NR
C9	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	1,100	NR
D1	320	NR	1,000	NR	1,000	NR	NR	NR	NR	NR	NR	NR
D2	340	NR	2,100	NR	2,100	NR	NR	NR	NR	NR	NR	NR
D3	280	NR	3,200	NR	3,200	NR	2,400	NR	2,400	NR	2,400	NR
D4	260	NR	4,200	NR	4,200	NR	2,800	NR	2,800	NR	2,600	NR
D5	250	NR	3,800	NR	3,800	NR	2,000	NR	2,000	NR	2,400	NR
D6	240	NR	4,000	NR	4,000	NR	2,400	NR	2,400	NR	2,500	NR
D7	260	NR	3,700	NR	3,700	NR	2,400	NR	2,400	NR	2,200	NR
D8	240	NR	3,200	NR	3,200	NR	2,000	NR	2,000	NR	2,000	NR
D9	210	NR	2,900	NR	2,900	NR	1,600	NR	1,600	NR	1,700	NR
E1	200	NR	750	NR	750	NR	NR	NR	NR	NR	NR	NR
E2	230	NR	1,000	NR	1,000	NR	NR	NR	NR	NR	NR	NR
E3	250	NR	1,600	NR	1,600	NR	1,400	NR	1,400	NR	1,100	NR
E4	220	NR	1,700	NR	1,700	NR	1,600	NR	1,600	NR	1,200	NR
E5	180	NR	1,800	NR	1,800	NR	1,200	NR	1,200	NR	1,200	NR
E6	160	NR	1,700	NR	1,700	NR	1,400	NR	1,400	NR	1,200	NR

Table A4-1. 1301-N Radiation Measurements (Page 3 of 3)

	1991		1992		1993	
	Ground Level		Ground Level		Ground Level	
Grid Point	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr
A1	900	NR	800	NR	600	NR
A2	1,500	NR	1,600	NR	1,200	NR
A3	2,800	NR	2,600	NR	1,700	NR
A4	2,600	NR	2,200	NR	1,500	NR
A5	2,100	NR	2,000	NR	1,400	NR
B1	NR	NR	NR	NR	NR	NR
B3	>3,000	NR	>3,000	NR	>3,000	NR
B4	>3,000	NR	>3,000	NR	>3,000	NR
B5	>3,000	NR	>3,000	NR	>3,000	NR
B6	>3,000	NR	2,900	NR	2,100	NR
B7	1,700	NR	1,600	NR	1,200	NR
C1	900	NR	800	NR	700	NR
C2	2,800	NR	2,500	NR	1,700	NR
C3	>3,000	NR	>3,000	NR	>3,000	NR
C4	>3,000	NR	>3,000	NR	>3,000	NR
C5	>3,000	NR	>3,000	NR	2,700	NR
C7	NR	NR	>3,000	NR	1,900	NR
C8	>3,000	NR	2,700	NR	750	NR
C9	1,100	NR	1,000	NR	NR	NR
D1	NR	NR	NR	NR	NR	NR
D2	NR	NR	NR	NR	NR	NR
D3	2,100	NR	2,000	NR	1,500	NR
D4	2,300	NR	2,100	NR	1,200	NR
D5	2,000	NR	2,000	NR	1,500	NR
D6	2,300	NR	2,100	NR	1,500	NR
D7	1,900	NR	1,800	NR	1,400	NR
D8	1,800	NR	1,700	NR	1,200	NR
D9	1,400	NR	1,500	NR	1,100	NR
E1	NR	NR	NR	NR	NR	NR
E2	NR	NR	NR	NR	NR	NR
E3	1,000	NR	1,000	NR	800	NR
E4	1,100	NR	1,200	NR	750	NR
E5	1,000	NR	1,000	NR	700	NR
E6	1,000	NR	1,000	NR	700	NR

NR = Not reported, probably not measured.
OS* = Off Scale (high radiation area).
* Based on 1980 data, every 100 counts per minute detected on the integrating instrument is roughly equal to a dose rate of 45 µR/hr.
A radiation survey was taken at 200 ft intersecting points. A direct reading count rate instrument was used to measure activity and a UR meter was used to measure dose rate. Counts were made for two minutes and averaged.

References:

UNI-1581 = Radiological Surveillance Report For The 100-N Area Environment - FY 1980, p. 14
UNI-1849 =Radiological Surveillance Report For The 100-N Area Environment - FY 1981, p. 21
UNI-2226 = Radiological Surveillance Report For The 100-N Area Environment - FY 1982, p. 22
UNI-2460 = Radiological Surveillance Report For The 100-N Area Environment - FY 1983, p. 22
UNI-3069 = Radiological Surveillance Report For The 100-N Area Environment - FY 1984, p. 24
UNI-3760 = Radiological Surveillance Report For The 100-N Area Environment - FY 1985, p. 37
UNI-4065 = Radiological Surveillance Report For The 100-N Area Environment - FY 1986, p. 33
WHC-EP-0161 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1987, p. H 4
WHC-EP-0258 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1988, p. 7-4
WHC-EP-0258-1 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1989, p. H 4
WHC-EP-0258-2 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1991, p. 7-4
WHC-EP-0573 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1991, p. F-23
WHC-EP-0573-1 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1992, p. F 19
WHC-EP-0573-2 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1993, p. H 13

Table A4-2. Surface Radiation Readings at 1301-N

	1301-N Crib				1301-N Trench								
	A	B	C	D									
	At Rope mR/hr	Horsetrough mR/hr	Crib Middle mR/hr	Begin of Trenc mR/hr	TS-01 mR/hr	TS-02 mR/hr	TS-03 mR/hr	TS-04 mR/hr	TS-05 mR/hr	TS-06 mR/hr	TS-07 mR/hr	TS-08 mR/hr	TS-09 mR/hr
9-26-85	2.7		80	200-400	1,400								
9/30/85 (a)	2.1		75	600	1,500								
10-10-85	1.6		70	500	1,700	500	240	200	150	170	150	100	200
10-17-85	2.0		60	160-200	1,200	200	380	200	130	160	80 (b)	70 (b)	220
10-24-85	1.4		80	500	1,300	400	350	300	200	200	150	100	250
10-31-85	1.8		75	400	1,200	750	450	320	260	230	100	100	240
11-06-85	2.0		50	400	1,500								
11-18-85	2.0	SE Corner 60	30-50	400	1,500								
		NE Corner 100											
		NW Corner 50											
		SW Corner 130											
11-21-85	1.5		50	500	1,500								
12-05-85	1.5		50	500	1,500								
12-12-85	1.5		50	700	1,500								

(a) The 9-30-85 sample collection date was changed from the reference, which listed the date as 10-30-85.

(b) Readings taken near trench.

Soil sediment samples were collected by attaching a 50 mL jar to pole and using this as a scoop.

Samples collected after 1301-N no longer received effluent.

Readings were taken at the crib and trench centerline unless designated otherwise.

Reference: UNI-3809 Rev. 0 = Engineering Report - Stabilization of 1301-N Liquid Waste Disposal Facility, Feb. 5, 1986, Page 9

APPENDIX A-5

1325-N DOSE RATE SURVEY

Table A5-1. 1325-N Radiation Measurements (Page 1 of 2)

	1984		1985		1986		1987		1988		1989	
	Ground Level		Ground Level		Ground Level		Ground Level		Ground Level		Ground Level	
Grid Point	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr
A1	NR	NR	1,500	NR	310	NR	310	NR	450	NR	450	NR
A2	NR	NR	2,600	NR	350	NR	350	NR	NR	NR	NR	NR
A3	NR	NR	2,100	NR	390	NR	390	NR	1,600	NR	1,600	NR
A4	NR	NR	800	NR	410	NR	410	NR	NR	NR	NR	NR
A5	NR	NR	NR	NR	360	NR	360	NR	NR	NR	NR	NR
A6	NR	NR	NR	NR	180	NR	180	NR	700	NR	700	NR
A7	NR	NR	NR	NR	200	NR	200	NR	400	NR	400	NR
A8	NR	NR	NR	NR	140	NR	140	NR	180	NR	180	NR
A9	NR	NR	NR	NR	100	NR	100	NR	150	NR	150	NR
A10	NR	NR	NR	NR	75	NR	75	NR	100	NR	100	NR
A11	NR	NR	NR	NR	45	NR	45	NR	48	NR	48	NR
A12	NR	NR	NR	NR	31	NR	31	NR	32	NR	32	NR
B1	NR	NR	2,400	NR	200	NR	200	NR	750	NR	750	NR
B2	NR	NR	NR	NR	330	NR	330	NR	1,400	NR	1,400	NR
B3	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
B4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
B5	NR	NR	1,200	NR	580	NR	580	NR	2,100	NR	2,100	NR
B6	NR	NR	250	NR	340	NR	340	NR	1,000	NR	1,000	NR
B7	NR	NR	130	NR	200	NR	200	NR	520	NR	520	NR
B8	NR	NR	34	NR	100	NR	100	NR	210	NR	210	NR
B9	NR	NR	21	NR	70	NR	70	NR	150	NR	150	NR
B10	NR	NR	16	NR	51	NR	51	NR	72	NR	72	NR
B11	NR	NR	11	NR	31	NR	31	NR	40	NR	40	NR
B12	NR	NR	14	NR	22	NR	22	NR	28	NR	28	NR
B13	NR	NR	12	NR	NR	NR	NR	NR	NR	NR	NR	NR
B14	NR	NR	11	NR	NR	NR	NR	NR	NR	NR	NR	NR
B15	NR	NR	11	NR	NR	NR	NR	NR	NR	NR	NR	NR
C1	NR	NR	2,200	NR	150	NR	150	NR	750	NR	750	NR
C2	NR	NR	NR	NR	290	NR	290	NR	2,000	NR	2,000	NR
D1	NR	NR	1,100	NR	100	NR	100	NR	600	NR	600	NR
D2	NR	NR	NR	NR	180	NR	180	NR	1,100	NR	1,100	NR
D3	NR	NR	NR	NR	320	NR	320	NR	2,000	NR	2,000	NR
D4	NR	NR	1,600	NR	500	NR	500	NR	2,000	NR	2,000	NR
D5	NR	NR	1,700	NR	500	NR	500	NR	1,500	NR	1,500	NR
D6	NR	NR	650	NR	250	NR	250	NR	850	NR	850	NR
D7	NR	NR	150	NR	160	NR	160	NR	450	NR	450	NR
D8	NR	NR	NR	NR	78	NR	78	NR	180	NR	180	NR
D9	NR	NR	40	NR	49	NR	49	NR	120	NR	120	NR
D10	NR	NR	20	NR	31	NR	31	NR	60	NR	60	NR
D11	NR	NR	16	NR	20	NR	20	NR	32	NR	32	NR
D12	NR	NR	NR	NR	17	NR	17	NR	16	NR	16	NR
D13	NR	NR	14	NR	NR	NR	NR	NR	NR	NR	NR	NR
D14	NR	NR	11	NR	NR	NR	NR	NR	NR	NR	NR	NR
D15	NR	NR	12	NR	NR	NR	NR	NR	NR	NR	NR	NR
E1	NR	NR	NR	NR	75	NR	75	NR	390	NR	390	NR
E2	NR	NR	NR	NR	110	NR	110	NR	750	NR	750	NR
E3	NR	NR	1,700	NR	160	NR	160	NR	900	NR	900	NR
E4	NR	NR	1,400	NR	210	NR	210	NR	900	NR	900	NR
E5	NR	NR	950	NR	190	NR	190	NR	600	NR	600	NR
E6	NR	NR	NR	NR	120	NR	120	NR	440	NR	440	NR
E7	NR	NR	NR	NR	80	NR	80	NR	200	NR	200	NR
E8	NR	NR	NR	NR	52	NR	52	NR	120	NR	120	NR
E9	NR	NR	NR	NR	35	NR	35	NR	80	NR	80	NR
E10	NR	NR	NR	NR	23	NR	23	NR	40	NR	40	NR
E11	NR	NR	NR	NR	18	NR	18	NR	28	NR	28	NR
E12	NR	NR	NR	NR	18	NR	18	NR	20	NR	20	NR
W1	70	15	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
W2	100	25	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
W3	100	45	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
W4	70	60	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
W5	75	35	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
X1	70	15	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
X2	45	35	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
X3	4,600	400	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
X5	120	50	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Y1	100	20	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Y2	140	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Y3	9,000	100	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Y4	2,800	450	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Y5	80	50	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Z1	65	15	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Z2	90	25	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Z3	55	25	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Z4	100	30	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Z5	120	25	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A5-1. 1325-N Radiation Measurements (Page 2 of 2)

	1990		1991		1992		1993	
	Ground Level		Ground Level		Ground Level		Ground Level	
Grid Point	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr	CPM	µR/hr
A1	600	NR	1,000	NR	1,000	NR	700	NR
A2	NR	NR	NR	NR	1,700	NR	900	NR
A3	3,200	NR	>3,000	NR	>3,000	NR	2,300	NR
A4	2,500	NR	NR	NR	>3,000	NR	>3,000	NR
A5	1,600	NR	NR	NR	1,900	NR	1,100	NR
A6	700	NR	1,000	NR	1,000	NR	600	NR
A7	500	NR	300	NR	500	NR	190	NR
A8	260	NR	100	NR	250	NR	150	NR
A9	140	NR	130	NR	140	NR	80	NR
A10	70	NR	70	NR	90	NR	65	NR
A11	50	NR	50	NR	50	NR	30	NR
A12	30	NR	30	NR	30	NR	20	NR
B1	1,100	NR	1,400	NR	1,200	NR	900	NR
B2	3,200	NR	>3,000	NR	>3,000	NR	2,300	NR
B3	NR	NR	NR	NR	NR	NR	NR	NR
B4	NR	NR	NR	NR	NR	NR	NR	NR
B5	3,200	NR	>3,000	NR	>3,000	NR	2,100	NR
B6	1,100	NR	1,500	NR	1,400	NR	800	NR
B7	600	NR	500	NR	600	NR	350	NR
B8	280	NR	400	NR	280	NR	200	NR
B9	160	NR	150	NR	140	NR	90	NR
B10	80	NR	80	NR	80	NR	50	NR
B11	50	NR	40	NR	40	NR	30	NR
B12	30	NR	28	NR	26	NR	15	NR
B13	NR	NR	NR	NR	NR	NR	NR	NR
B14	NR	NR	NR	NR	NR	NR	NR	NR
B15	NR	NR	NR	NR	NR	NR	NR	NR
C1	1,200	NR	1,400	NR	1,400	NR	1,000	NR
C2	3,400	NR	>3,000	NR	>3,000	NR	2,700	NR
D1	850	NR	1,100	NR	1,000	NR	700	NR
D2	1,300	NR	2,300	NR	2,000	NR	1,400	NR
D3	3,800	NR	>3,000	NR	>3,000	NR	2,700	NR
D4	3,800	NR	>3,000	NR	>3,000	NR	>3,000	NR
,D5	2,100	NR	2,900	NR	2,300	NR	1,600	NR
D6	1,000	NR	1,200	NR	1,200	NR	500	NR
D7	600	NR	700	NR	600	NR	350	NR
D8	270	NR	150	NR	260	NR	160	NR
D9	150	NR	140	NR	140	NR	35	NR
D10	80	NR	70	NR	80	NR	25	NR
D11	43	NR	40	NR	40	NR	18	NR
D12	29	NR	30	NR	30	NR	15	NR
D13	NR	NR	NR	NR	NR	NR	NR	NR
D14	NR	NR	NR	NR	NR	NR	NR	NR
D15	NR	NR	NR	NR	NR	NR	NR	NR
E1	500	NR	600	NR	600	NR	400	NR
E2	800	NR	1,100	NR	1,000	NR	700	NR
E3	1,300	NR	1,700	NR	1,500	NR	1,100	NR
E4	1,400	NR	1,700	NR	1,600	NR	1,200	NR
E5	1,000	NR	1,200	NR	1,100	NR	750	NR
E6	600	NR	700	NR	700	NR	400	NR
E7	280	NR	500	NR	290	NR	200	NR
E8	180	NR	200	NR	180	NR	100	NR
E9	120	NR	110	NR	120	NR	70	NR
E10	50	NR	50	NR	60	NR	40	NR
E11	35	NR	30	NR	40	NR	30	NR
E12	25	NR	30	NR	24	NR	20	NR
W1	NR	NR	NR	NR	NR	NR	NR	NR
W2	NR	NR	NR	NR	NR	NR	NR	NR
W3	NR	NR	NR	NR	NR	NR	NR	NR
W4	NR	NR	NR	NR	NR	NR	NR	NR
W5	NR	NR	NR	NR	NR	NR	NR	NR
X1	NR	NR	NR	NR	NR	NR	NR	NR
X2	NR	NR	NR	NR	NR	NR	NR	NR
X3	NR	NR	NR	NR	NR	NR	NR	NR
X5	NR	NR	NR	NR	NR	NR	NR	NR
Y1	NR	NR	NR	NR	NR	NR	NR	NR
Y2	NR	NR	NR	NR	NR	NR	NR	NR
Y3	NR	NR	NR	NR	NR	NR	NR	NR
Y4	NR	NR	NR	NR	NR	NR	NR	NR
Y5	NR	NR	NR	NR	NR	NR	NR	NR
Z1	NR	NR	NR	NR	NR	NR	NR	NR
Z2	NR	NR	NR	NR	NR	NR	NR	NR
Z3	NR	NR	NR	NR	NR	NR	NR	NR
Z4	NR	NR	NR	NR	NR	NR	NR	NR
Z5	NR	NR	NR	NR	NR	NR	NR	NR

NR = Not reported, possibly not measured

* Based on 1980 data, every 100 counts per minute detected on the integrating instrument is roughly equal to a dose rate of 45 µR/hr. A radiation survey was taken at 200 ft intersecting points. A direct reading count rate instrument was used to measure activity and a UR meter was used to measure dose rate. Counts were made for two minutes and averaged.

References:

UNI-3069 = Radiological Surveillance Report For The 100-N Area Environment - FY 1984, p 24
UNI-3760 = Radiological Surveillance Report For The 100-N Area Environment - FY 1985, p. 37
UNI-4065 = Radiological Surveillance Report For The 100-N Area Environment - FY 1986, p. 33
WHC-EP-0161 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1987, p. H-4
WHC-EP-0258 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1988, p. 7-4
WHC-EP-0258-1 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1989, p. H-4
WHC-EP-0258-2 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1991, p. 7-4
WHC-EP-0573 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1991, p F-23
WHC-EP-0573-1 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1992, p. F-19
WHC-EP-0573-2 = Westinghouse Hanford Company Environmental Surveillance Report - 100 Areas - FY 1993, p H-13

APPENDIX A-6

WATER SAMPLES FROM WITHIN 1301-N AND 1325-N

Table A6-1. Concentration of Selected Cations, Anions, and Radionuclides in the 1301-N Horse Trough

	Concentration mg/L	Unfiltered pCi/L	Filtered pCi/L
Cations			
Barium	0.02		
Calcium	12.3		
Lithium	0.018		
Magnesium	3.14		
Manganese	0.006		
Molybdenum	0.01		
Silicon	2.2		
Sodium	1.77		
Strontium	0.06		
Anions			
Chlorine	2		
Nitrate	<1		
Nitrite	14		
Phosphate	0.9		
Sulfate	11		
Radionuclides			
Cesium-137		1,300	1,100
Cobalt-58		300	ND
Cobalt-60		2,070	220
Manganese-54		2,100	320
Molybdenum-99		550	ND
Niobium-95		375	ND
Zinc-95		305	ND

Sample collected in 1984.

ND = Not detected

Horse Trough water samples collected from the flow-proportional system attached to the trough.

Samples taken from flow-proportional system attached to the 1301-N horse trough.

Cation concentrations were determined using a spectrometer with an inductively coupled plasma source.

Anion concentrations determined by an ion chromatograph.

Gamma spectroscopy analysis was performed 15 mL filtered and unfiltered solutions to determine the contribution of suspended solids to radionuclide content.

Reference: UNI-2999 Rev. 0 = Engineering Study Liquid Effluent Disposal Facility, Project H-672, p. I-16

Table A6-2. Dangerous Waste Analysis on 1301-N and 1325-N Water Influent (August 1989)

Parameter	Average Concentration		
	Units	1301-N	1325-N
pH	pH units	**6.70**	**6.7**
Conductivity	µmhos/cm	**164**	**164**
Mercury	mg/L	0.001 U	0.001 U
Ethylene glycol	mg/L	10 U	10 U
Enhanced thiourea	mg/L	0.2 U	0.2 U
TOC	mg/L	**0.00197**	**0.00197**
Cyanide	mg/L	0.01 U	0.01 U
Barium	mg/L	**0.028**	**0.028**
Cadmium	mg/L	0.002 U	0.002 U
Chromium	mg/L	0.01 U	0.01 U
Lead	mg/L	0.03 U	0.03 U
Silver	mg/L	0.01 U	0.01 U
Sodium	mg/L	**1.810**	**1.810**
Nickel	mg/L	0.01 U	0.01 U
Copper	mg/L	0.01 U	0.01 U
Vanadium	mg/L	0.005 U	0.005 U
Antimony	mg/L	0.1 U	0.1 U
Aluminum	mg/L	0.15 U	0.15 U
Manganese	mg/L	0.005 U	0.005 U
Potassium	mg/L	**0.620**	**0.620**
Iron	mg/L	**0.069**	**0.069**
Beryllium	mg/L	0.005 U	0.005 U
Osmium	mg/L	0.3 U	0.3 U
Strontium	mg/L	0.3 U	0.3 U
Zinc	mg/L	0.005 U	0.005 U
Calcium	mg/L	**14.140**	**14.140**
Nitrate	mg/L	0.5 U	0.5 U
Sulphate	mg/L	**11.973**	**11.973**
Fluoride	mg/L	0.5 U	0.5 U
Chloride	mg/L	**1.530**	**1.530**
Phosphate	mg/L	1 U	1 U
Phosphorus Pesticides	mg/L	0.005 U	0.005 U
Chlorinated Pesticides	mg/L	0.001 U	0.001 U
Enhanced ABN List			
Citrus Red	mg/L	1 U	1 U
Arsenic	mg/L	0.005 U	0.005 U
Ammonium Ion	mg/L	0.05 U	0.05 U
Coliform	mg/L	**0.016**	**0.016**
Selenium	mg/L	0.005 U	0.005 U
Thallium	mg/L	0.01 U	0.01 U

Samples collected August 1985.
U = Not detected at specified detection limits
References:
Closure/Post Closure Plan 1301-N LWDF, Unpublished
Closure/Post Closure Plan 1325-N LWDF, Unpublished

Table A6-3. Chemical Composition of 1301-N Trench, Including Manways for 1983

Constituent	Units		1st Manway	Last Manway	1st Manway	Last Manway	2nd Manway	Last Manway	2nd Manway	Last Manway	2nd Manway	Last Manway
		1/26/83	2/15/83		3/30/83		5/5/83		6/16/83		9/9/83	
Temperature	°C	21	17	15	22	23	21	19	19.5	20.5	23	NS
pH	pH	7.3	9.2	9.25	8.58	8.7	9.1	8.7	7.3	7.2	7.8	NS
Eh (mv)	mv	405 *	155 *	150 *	245 *	265 *	155 *	315 *	195 *	180 *	190	NS
Dissolved O_2	mg/L	6.9	6.58	5.91	5.59	4.71	4.64	4.56	6.68	7.06	6.00	NS
Alkalinity - As $CaCO_3$	mg/L	38	63.3	63.0	41.6	41.0	46.0	48.4	36.5	39.7	44.0	NS
DOC	mg/L	1 U	0.4	0.7	NA	NA	NA	NA	NA	NA	0.70	NS
Calcium	mg/L	16.3	15.5	16	13.9	12.9	13.8	16.9	14.7	14.8	16.8	NS
Magnesium	mg/L	4	3.9	4.0	3.2	3.3	3.2	3.8	3.3	3.4	3.9	NS
Sodium	mg/L	1.68	1.63	1.72	1.7	1.5	1.8	2.2	1.9	1.9	2.1	NS
Potassium	mg/L	0.4	0.4	0.4	0.8	0.7	0.9	1.1	0.8	0.8	0.64	NS
Strontium	mg/L	0.081	0.082	0.083	0.072	0.067	0.078	0.096	0.079	0.078	0.093	NS
SO_4^{-2}	mg/L	14.3	10.0	6.7	12.7	11.3	14.3	12.6	15.2	15.0	17	NS
S^{-} (Polarographic)	mg/L	0.003 U	0.00001 U	0.00001 U	0.205	0.163	0.163	0.197	0.051	0.078	0.039	NS
SO_4^{-2} (Total by ICP)	mg/L	5.6	6.2	6.4	12.9	11.7	13.5	17.7	15.3	15.3	18.9	NS
NO_3	mg/L	9.2	1.3	1.3	2.1	3.0	3.2	4.1	0.73	1.2	2.9	NS
NO_2	mg/L	2.5	3.4	1.7	1.9	2.6	9.3	6.6	0.60	0.80	1.1	NS
F^{-}	mg/L	0.15 U	0.08 U	0.08 U	0.1 U	0.01 U	0.1 U	0.1 U	0.1 U	0.1 U	0.25 U	NS
PO_4^{-3}	mg/L	3.8	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.80	1.1		NS
P (Total by ICP)	mg/L	1.48	0.1 U	0.1 U	0.1 U	0.1 U	0.1	0.1 U	0.6	0.7	0.1 U	NS
Cl^{-}	mg/L	0.9	0.59	0.40	1.0	0.95	0.77	1.0	1.0	1.6	0.97	NS
Silicon	mg/L	1.8	1.74	1.80	2.3	2.1	2.1	2.5	2.4	2.4	1.8	NS
Aluminum	mg/L	0.05 U	0.03 U	0.1	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	NS
Arsenic	mg/L	0.03 U	0.02 U	0.02 U	0.03	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	NS
Boron	mg/L	0.01	0.02	0.02	0.022	0.025	0.01 U	0.025	0.01 U	0.01 U	0.02	NS
Barium	mg/L	34	30	31	36	35	26	19	29	29	29	NS
Cobalt	mg/L	10 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NS
Chromium	mg/L	0.01 U	0.01 U	0.01 U	NA	NA	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	NS
Fe (Total by ICP)	mg/L	0.11	0.03	0.03	0.02	0.06	0.041	0.016	0.016	0.02	0.035	NS
Fe^{-2+} (Colorimetric)	mg/L	0.0061	0.002 U	0.002 U	0.002 U	0.006	0.006 U	0.002 U	0.0059	0.0076 U	0.0163	NS
Fe^{-3+} (Colorimetric)	mg/L	0.0849	0.019	0.018	0.018	0.059	0.032	0.012	0.076	0.095	0.0206	NS
Fe^{-2+}/Fe^{-3+}	mg/L	0.067	NA	NA	NA	NA	NA	NA	NA	NA	NA	NS
Lithium	mg/L	0.005 U	0.005 U	0.005 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	NS
Manganese	mg/L	0.01 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	NS
Molybdenum	mg/L	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	NS
Nickel	mg/L	0.02 U	0.02 U	0.02	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	NS
Selenium	mg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	NS
Thallium	mg/L	0.01 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	NS
Vanadium	mg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	NS
Zinc	mg/L	0.024	0.037	0.011	0.01	0.01	0.005 U	0.005 U	0.01	0.01	0.01	NS

* = Water pumped through stainless steel sampling device - probable contamination with iron

U = Undetected at specified detection limits

NS = Not sampled

NA = Not analyzed

Reference: NUREG/CR-3712 = Radionuclide Migration in Groundwater, PNL5040, Annual Report for FY 1983, p. 90, 91, 92

Table A6-4. Hydrophillic Organics in Waters from the Low-Level Waste Disposal Site (ppb x 100)

Hydrophilic Organcis (a)	Manways (b)		
	No. 1 (2/15/83)	No. 2 (5/5/83)	No.10 (6/16/83)
Dicarboxylic acids			
Oxalic acid	272	93	16
Malonic acid	185	59	42
Succinic acid	245	90	97
Methyl succinic acid	37	ND	41
Pentanedioic acid	136	29	53
Hexanedioic acid	417	89	80
Heptanedioic acid	64	16	29
Octanedioic acid	58	65	86
Nonanedioic acid	231	153	112
Decanedioic acid	122	23	32
Undecanedioic acid	106	20	24
Dodecanedioic acid	101	12	13
Tridecanedioic acid	87	26	ND
Monocarboxylic acids			
Heptanoic acid	6	8	11
Octanoic acid	102	ND	ND
Nonanoic acid	202	29	24
Decanoic acid	79	29	36
Undecanoic acid	18	ND	17
Dodecanoic acid	125	100	101
Tetradecanoic acid	341	150	135
Pentadecanoic acid	125	64	52
Hexadecanoic acid	1525	554	465
Heptadecanoic acid	43	30	24
Octadecanoic acid	1000	172	218
Octadecenoic acid	166	ND	ND
Nonadecanoic acid	41	ND	14
Heneicosenoic acid	ND	ND	ND
Oxygenated acids			
2-Hydroxy propanoic acid	14	35	ND
2,2-Dimethoxy ethanoic aci	109	38	230
2,2-Dimethoxy propanoic a	92	147	24
4-Oxo-pentanoic acid	55	56	17
Aromatic acids			
Benzoic acid	131	31	17
Phthalic acid	318	4	193

ND = Not detected
(a) Methylated, BF /methanol
(b) Sampled 2/15/83 through 6/20/83
Reference: NUREG/CR-3712 = Radionuclide Migration in Groundwater, Annual Report for FY 1983, p. 29

Table A6-5. Analytical Charge-Form Speciation for 1301-N Trench Radionuclides (Page 1 of 5)

Radionuclide	1301-N Trench Water - Manway #1 (1/26/83 @ 1400)					1301-N Trench Water - Manway #1 (2/15/83 @ 1145)				
	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic
Antimony-124	1,355	60.9	0.8	34.7	3.6	10,000	93	0.7	5.7	0.8
Antimony-125	344	< 54	ND	98	2	< 280	NA	NA	NA	NA
Barium-140	38,990	14.2	85.8	< 0.1	< 0.1	14,450	NA	98.6 *	1.3	< 0.08
Cerium-141	NA	NA	NA	NA	NA	11,100	87.8	12.5	< 0.5	< 0.02
Cerium-144	7,010	~ 100	< 4	< 1	< 0.06	11,000	85.9	14.2	< 2	< 0.05
Cesium-137	16,100	0.1	99.9	< 0.1	< 0.1	23,000	4.9	96.1	< 0.1	< 0.01
Cobalt-58	3,670	23	76.3	0.5	< 0.02	46,800	97.9	2	< 0.07	< 0.02
Cobalt-60	49,330	58.5	41.3	0.1	0.03	473,000	98.1	1.7	0.2	0.07
Europium-154	670	~ 100	< 3	< 40	< 0.1	590 *		71 *	< 29 *	< 3
Iodine-131	31,980	2.7	2.9	94	0.5	9,380	NA	4.9 *	88.6 *	0.2 *
Iodine-133	459,200	4.1	< 0.05	95.5	0.4	13,470 *	NA	< 0.9 *	99.4 *	0.7 *
Iron-59	57,030	96.7	2.3	1	0.02	496,700	98.9	0.7	0.3	< 0.005
Lanthanum-140	113,880	63.6	36.3	0.1	< 0.1	12,680 *	NA	96.3	3.7	< 0.01
Manganese-54	109,900	11.8	87.6	0.6	0.002	271,800	86.5	12.6	0.8	< 0.007
Molybdenum-99	121,200	1.2	1.1	97.7	< 0.01	28,950 *	NA	< 1 *	100 *	< 0.01
Niobium-95	21,580	58.2	33.7	7.9	0.06	102,500	88.2	3.9	7.8	0.1
Ruthenium-103	4,140	74	12.2	12.6	1.2	13,830	88.9	5.6	5.2	< 0.3
Ruthenium-106	1,440	> 65	< 14	< 23	< 0.4	3,490	> 85	< 12	< 7	0.5
Technetium-99m	17,930	< 0.2	0.8	99.2	< 0.01	3,150 *	NA	< 0.4 *	100 *	< 0.03 *
Zinc-66	NA	NA	NA	NA	NA	7,220	99.7	0.3	< 1	< 0.04
Zirconium-96	11,230	90.6	3	6	0.4	35,700	90	4.3	5.4	0.2

Radionuclide	1301-N Trench Water - Manway #1 (3/30/83)					1301-N Trench Water - Manway #1 (6/16/83)				
	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic
Antimony-124	8,970	96.9	< 0.4	3.1	< 0.02	256	82.4	< 6	17.6	<
Antimony-125	223	52	< 14	> 33	0.2	182	12.1	< 33	87.9	<
Barium-140	43,900	NA	99.9	< 0.02	0.02	7,730	9	91	< 0.6	<
Cerium-141	11,950	86.8	12.6	< 0.1	0.5	7,780	77	14.6	7.9	
Cerium-144	11,260	90.4	9.2	< 0.7	0.4	10,400	78	13.7	7.8	
Cesium-137	62,070	7.7	92.3	< 0.01	< 0.005	27,500	10.2	89.8	0.007	<
Cobalt-58	60,210	94.9	5.1	0.02	0.01	354	99.1	< 8	0.9	<
Cobalt-60	567,100	97.2	2.6	0.1	0.02	32,700	41	58.6	0.49	
Europium-154	245	NA	> 99	< 20	3.3	292	18.4	73.4	9.8	
Iodine-131	8,560	1.2	3.1	95.6	0.09	1,010	4.7	28.9	66.3	
Iodine-133	NA	NA	NA	NA	NA	NA	NA	NA	NA	<
Iron-59	519,500	99.1	0.6	0.3	0.01	11,700	93.9	3.2	2.8	
Lanthanum-140	39,900	NA	98	1.7	0.3	20,800,000	6.3	93.7	< 0.1	
Manganese-54	244,300	54.9	44.8	0.2	0.004	86,200	5.8	94.1	0.078	<
Molybdenum-99	13,400	NA	3.5	96.4	0.1	NA	NA	NA	NA	NA
Niobium-95	70,940	73.2	22.7	3.9	0.09	35,200	51.2	35.5	13.1	
Ruthenium-103	18,200	82.9	8.3	7.8	0.9	7,430	85.1	13.4	20	
Ruthenium-106	3,850	73.2	24.8	< 2	2	2,890	59.9	18.5	20.2	
Technetium-99m	2,030	NA	< 0.6	100	< 0.06	NA	NA	NA	NA	NA
Zinc-66	10,020	98.7	1.3	< 0.2	0.003	475	56.2	43.7	0.11	
Zirconium-96	35,960	92.6	1.9	5.4	0.04	13,500	77.3	6.4	16.1	

Table A6-5. Analytical Charge-Form Speciation for 1301-N Trench Radionuclides (Page 2 of 5)

	Manway #2 (5/5/83)					Manway #2 (9/9/83)				
Radionuclide	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic
Antimony-124	1,730	52.1	1.8	47.7	0.16	525	80.4	< 6	19.4	0.1
Antimony-125	493	< 15	< 20	~ 100	0.006	172	< 14	< 48	~ 100	1
Barium-140	24,600	26.5	73.3	0.17	0.05	25,700	5.5	94.6	< 0.07	< 0.008
Cerium-141	6,260	96.2	3.7	< 0.1	0.06	4,050	79.6	19.4	< 0.1	0.9
Cerium-144	11,380	97.8	2.2	< 0.2	0.07	7,920	84.9	14.2	< 0.2	0.9
Cesium-137	57,500	7.3	92.7	< 0.009	< 0.004	59,950	9.9	90.1	< 0.005	< 0.0005
Cobalt-58	4,410	33.4	66.2	0.24	0.05	2,830	24.2	75.7	< 0.1	0.1
Cobalt-60	115,400	86.4	13.1	0.45	0.05	29,100	63.1	36.4	0.33	0.16
Europium-154	< 500	NA	NA	NA	NA	< 270	NA	NA	NA	NA
Iodine-131	5,620	9.9	5.6	84.4	0.08	4,910	2.8	1.2	95.9	0.07
Iodine-133	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron-59	37,900	99.3	0.3	0.33	0.006	62,900	91.1	5.9	2.7	0.23
Lanthanum-140	815,000	18.8	81	0.19	0.002	111,900	11	88.5	0.22	0.26
Manganese-54	133,100	34.4	65.2	0.33	0.01	122,200	6.9	93.1	0.05	0.008
Molybdenum-99	5,680	43.1	< 35	36.8	< 1	1,110	< 20	< 40	~ 100	< 3
Niobium-95	35,300	94.4	2.7	2.9	0.02	15,670	44	49.2	6.5	0.2
Ruthenium-103	8,960	68.2	15.5	14.9	1.4	3,010	60.8	16	20.1	3.1
Ruthenium-106	3,490	86.3	21.4	11.2	1.1	2,050	57.9	19.9	19.9	2.3
Technetium-99m	453	< 18	< 19	99.6	0.3	117	< 7	< 17	~ 100	< 2
Zinc-66	1,150	99.3	0.47	< 0.01	0.26	539	61.6	38.4	< 0.9	< 0.09
Zirconium-96	15,700	92.2	1.8	5.9	0.04	7,110	80.3	10.2	9.3	0.19

	1301-N Trench - Last Manway (2/15/83 @ 1520)					1301-N Trench - Last Manway (3/30/83)				
Radionuclide	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic
Antimony-124	1,760	54.7	2.8	37.6	4.8	585*	NA	5.2	94.6	0.09
Antimony-125	910	68.7	< 8	26.4	4.8	380*	NA	< 23	99.1	0.9
Barium-140	31,560	1	98.6	0.04	< 0.03	55,690	1	98.7	0.2	< 0.01
Cerium-141	5,450	57.3	42.7	0.5	0.6	2,010	43.8	54.2	< 1	2
Cerium-144	NR	NR	NR	NR	NR	1,250	< 20	97.4	< 7	2.4
Cesium-137	26,640	5.8	94.1	< 0.05	< 0.008	70,890	0.2	99.8	< 0.01	< 0.003
Cobalt-58	7,060	48.2	51.7	< 0.2	< 0.05	4,737	< 6	99.6	0.4	0.08
Cobalt-60	3,390	96.7	3.2	< 0.8	< 0.008	43,230	84.2	13	2.5	0.3
Europium-154	1,990	94.4	0.9	5.1	< 0.5	732	98.1	< 20	< 8	1.8
Iodine-131	7,930	0.8	3.7	95.4	< 0.08	11,110	0.8	0.5	98.6	0.07
Iodine-133	6,660	0.5	< 2	99	0.5	NA	NR	NR	NR	NR
Iron-59	250,600	96.6	1.7	1.6	< 0.03	72,250	97.1	0.76	2.1	0.05
Lanthanum-140	54,590	11.2	87.5	1.3	< 0.08	71,570	0.3	98.6	0.9	0.1
Manganese-54	137,500	41.1	58.3	0.6	< 0.007	125,860	10.1	89.4	0.4	0.05
Molybdenum-99	18,900	6.5	0.8	92.7	< 0.03	17,230	18.6	0.4	81	0.03
Niobium-95	24,560	25	60.6	14.2	0.2	6,650	< 3	3.3	94.3	2.3
Ruthenium-103	7,660	65.3	21.5	12.4	0.7	3,010	32.6	14.4	49	3.9
Ruthenium-106	630	100	ND	ND	ND	NA	NA	NA	NA	NA
Technetium-99m	1,970	18	< 0.6	81.9	< 0.04	3,310	11.7	0.4	87.8	< 0.01
Zinc-66	214,200	92	7.1	0.73	< 0.09	NA	NA	NA	NA	NA
Zirconium-96	7,780	39.8	21.2	35.7	3.2	2,290	< 20	4.5	94.7	0.7

Table A6-5. Analytical Charge-Form Speciation for 1301-N Trench Radionuclides (Page 3 of 5)

	Last Manway (5/5/83)					Last Manway (6/16/83)				
Radionuclide	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic
Antimony-124	993	18.6	< 4	79.8	1.6	169	80.4	< 25	19.5	< 0.2
Antimony-125	718	3.3	< 16	95.5	1.1	168	NA	NA	~ 100	NA
Barium-140	17,030	29.3	69.9	0.8	< 0.05	8,210	3.5	96.4	0.07	0.01
Cerium-141	7,061	95.1	2.9	1.8	0.14	5,380	74.1	16.7	8.1	1.2
Cerium-144	10,980	96.7	0.81	0.39	0.14	7,540	77	13.8	8	1.2
Cesium-137	91,900	5.6	94.4	< 0.002	< 0.002	35,100	14.3	85.7	NA	NA
Cobalt-58	2,350	26.5	73.2	0.25	0.03	246	75.3	22.5	2.3	0.08
Cobalt-60	60,630	54.3	44.4	1.2	0.07	32,300	24.3	75.2	0.46	0.02
Europium-154	197	< 50	64	< 36	< 5	< 360	NA	NA	NA	NA
Iodine-131	3,990	13	6.4	80.5	0.07	740	NA	NA	~ 100	NA
Iodine-133	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron-59	16,280	96.8	1.1	2.1	0.04	7,480	91.8	3.3	4.7	0.21
Lanthanum-140	339,700	NA	99.8	0.2	< 0.02	943,000	10.4	87.7	0.22	1.7
Manganese-54	153,100	16.8	82.8	0.44	0.02	98,600	2.8	97.1	0.07	0.002
Molybdenum-99	1,760	NA	43.4	55.5	0.8	NA	NA	NA	NA	NA
Niobium-95	45,900	94.2	3.2	2.6	0.05	24,200	37.3	48	14.5	0.23
Ruthenium-103	8,850	67	13.9	17.8	1.3	4,340	48.6	16.3	32.4	2.7
Ruthenium-106	5,210	65.3	22.3	11.4	1	1,620	56.3	4.8	35.9	3
Technetium-99m	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zinc-66	371	95.7	< 23	2.9	1.3	364	45.5	52.5	2.1	0.01
Zirconium-96	14,640	88.8	4.3	6.9	0.01	8,550	71.5	6.2	21.9	0.32

	RW - Well #1 (1/27/83 @ 1430)					RW - Well #1 (2/15/83 @ 1430)				
Radionuclide	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic
Antimony-124	233	< 0.2	0.5	91	9	203	< 0.3	2.1	96.1	1.9
Antimony-125	102	0.2	1	83.2	15.5	188	< 0.2	0.5	94.7	5.2
Barium-140	40	1.5	< 0.1	98.5	< 0.1	< 7	NA	NA	NA	NA
Cerium-141	NR	NR	NR	NR	NR	< 3	NA	NA	NA	NA
Cerium-144	< 60	NA	NA	NA	NA	NR	NR	NR	NR	NR
Cesium-137	< 1	NA	NA	NA	NA	1.8	27	49	10	15
Cobalt-58	12.2	< 0.2	8.2	90.2	1.1	< 2	NA	NA	NA	NA
Cobalt-60	210	0.4	64.8	33.7	1.1	160	7.8	32.5	57.9	1.4
Europium-154	< 50	NA	NA	NA	NA	5.7	53	ND	48	< 14
Iodine-131	11,120	0.4	4.9	94.7	< 0.1	1,320	0.8	4.5	94.6	0.08
Iodine-133	21,740	0.5	< 0.3	99.2	0.2	129	0.4	12.4	83.7	3.3
Iron-59	21.6	0.3	16	82.2	< 1	19.5	80	17.4	< 9	< 6
Lanthanum-140	< 6	NA	NA	NA	NA	3.9	< 15	61	< 40	38
Manganese-54	90.6	0.08	0.4	99.4	0.1	7.88	37.6	60.7	1.8	< 5
Molybdenum-99	13,590	0.2	0.7	99	< 0.01	1,570	0.5	5.4	94.1	< 0.2
Niobium-95	118	0.08	1.9	97.5	0.3	7.4	9.1	22.2	53	4.1
Ruthenium-103	300	0.3	11.7	86.7	1.2	316	1.1	21.5	74.7	2.6
Ruthenium-106	324	< 0.2	10.9	87.6	1.3	114	1.5	21	71.9	6.3
Technetium-99m	2,400	0.2	< 0.8	99	< 0.01	127	0.3	5	94.5	< 0.2
Zinc-66	NR	NR	NR	NR	NR	2.7	< 11	58.5	40	< 19
Zirconium-96	19.9	0.09	8	90.4	< 0.5	1.4	24.3	ND	37.9	< 39

Table A6-5. Analytical Charge-Form Speciation for 1301-N Trench Radionuclides (Page 4 of 5)

	RW - Well #1 (5/6/83)					RW - Well #1 (3/31/83)				
Radionuclide	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic
Antimony-124	72.8	0.2	< 0.4	98.1	1.7	129	1	< 0.9	84.3	14.7
Antimony-125	170	0.2	< 0.8	97.4	1.7	180	0.1	< 0.6	82.2	18.1
Barium-140	< 4	NA	NA	NA	NA	7.1	11	89	< 70	< 5
Cerium-141	< 0.6	NA	NA	NA	NA	< 20	NA	NA	NA	NA
Cerium-144	< 2	NA	NA	NA	NA	< 2	NA	NA	NA	NA
Cesium-137	3.9	21.6	78.2	< 5	< 7	1	16	84	< 50	< 5
Cobalt-58	1.8	51.5	34.5	13.8	< 2	6.6	86.7	13	< 22	< 1
Cobalt-60	292	5.6	60.7	32.7	0.96	381	19.6	29.1	50.1	1.1
Europium-154	< 2	NA	NA	NA	NA	< 10	NA	NA	NA	NA
Iodine-131	1,440	3.2	5.1	91.5	0.1	6,865	0.6	2.4	97	0.04
Iodine-133	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron-59	9.4	91.2	< 5	8.8	< 1	98.4	81.7	2.2	16	< 0.003
Lanthanum-140	426	< 9	~ 100	< 2	NA	46	3.7	96.3	< 4	< 1
Manganese-54	19.9	21	77.8	1.6	< 0.2	94.1	22.7	63.9	13.8	< 0.1
Molybdenum-99	.770	0.3	< 25	99.7	< 16	3,300	0.2	1.8	98	< 0.06
Niobium-95	3.5	48	34	18	< 0.03	77	11.6	63.2	23.9	< 0.08
Ruthenium-103	310	2.3	34.8	59.7	3.2	1,400	0.2	4	95.3	0.4
Ruthenium-106	200	3.1	35.4	58.1	3.4	395	0.8	9.9	88.6	0.7
Technetium-99m	166	0.2	< 5	99.8	< 2	1,150	0.05	0.9	99.1	< 0.007
Zinc-66	1.1	30	70	< 47	< 9	1.2	~ 100	NA	NA	NA
Zirconium-96	1.4	55	< 1	45	< 4	21.5	22.6	36.7	40.4	< 0.9

	RW - Well #1 (9/9/83)					RW - Well #3 (2/17//83 @ 1030)				
Radionuclide	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic
Antimony-124	210	< 0.04	0.16	85.9	13.9	< 0.5	NA	NA	NA	NA
Antimony-125	233	0.1	0.68	84.6	14.7	21.9	< 1	< 5	76	24
Barium-140	< 4	NA	NA	NA	NA	< 3	NA	NA	NA	NA
Cerium-141	< 4	NA	NA	NA	NA	< 0.6	NA	NA	NA	NA
Cerium-144	< 9	NA	NA	NA	NA		NA	NA	NA	NA
Cesium-137	< 1	NA	NA	NA	NA	< 1	NA	NA	NA	NA
Cobalt-58	0.27	< 11	~ 100	NA	< 11	1.8	< 2	57	40	< 11
Cobalt-60	89.6	4.5	58.8	34.9	1.9	125	3	50	43	3.1
Europium-154	< 2	NA	NA	NA	NA	< 2	NA	NA	NA	NA
Iodine-131	25	< 10	< 10	~ 100	NA	7.2	< 1	4	94	< 2
Iodine-133	NR	NR	NR	NR	NR	< 2	NA	NA	NA	NA
Iron-59	0.6	45	55	NA	< 17	3.5	~ 100	ND	ND	ND
Lanthanum-140	350	< 0.1	~ 100	< 0.5	< 0.6	< 2	NA	NA	NA	NA
Manganese-54	2.4	3.6	48.2	48.2	< 2	1.6	~ 100	ND	ND	ND
Molybdenum-99	2,810	0.06	< 2	99.9	< 0.07	< 7	NA	NA	NA	NA
Niobium-95	4.3	4.9	25.7	69.3	0.9	< 1	NA	NA	NA	NA
Ruthenium-103	271	1.1	10.7	74.8	1.2	13.6	0.9	15	82	3
Ruthenium-106	190	1.7	16.9	79.9	1.6	66.2	1.8	21.6	76.6	< 3
Technetium-99m	320	< 0.02	< 2	~ 100	< 0.04	< 0.5	NA	NA	NA	NA
Zinc-66	< 1	NA	NA	NA	NA	3.6	ND	100	ND	ND
Zirconium-96	3.5	3.4	< 28	96.6	< 2	1	33	ND	68	ND

Table A6-5. Analytical Charge-Form Speciation for 1301-N Trench Radionuclides (Page 5 of 5)

	Well #3 (1/26/83 @ 1300)				
Radionuclide	Total pCi/L	% Particulate	% Cationic	% Anionic	% Nonionic
Antimony-124	< 1	NA	NA	NA	NA
Antimony-125	22.5	0.4	1.7	96	1.8
Barium-140	< 1	NA	NA	NA	NA
Cerium-141	NA	NA	NA	NA	NA
Cerium-144	< 1	NA	NA	NA	NA
Cesium-137	< 1	NA	NA	NA	NA
Cobalt-58	0.74	1	29.7	58	12.3
Cobalt-60	165	0.5	63.8	34.2	1.3
Europium-154	< 5	NA	NA	NA	NA
Iodine-131	5	< 1	< 2	> 97	< 1
Iodine-133	< 1	NA	NA	NA	NA
Iron-59	< 1	NA	NA	NA	NA
Lanthanum-140	< 1	NA	NA	NA	NA
Manganese-54	< 1	NA	NA	NA	NA
Molybdenum-99	< 5	NA	NA	NA	NA
Niobium-95	< 1	NA	NA	NA	NA
Ruthenium-103	14.5	< 0.1	8.4	91.1	1.4
Ruthenium-106	82.6	0.9	9.6	88.3	1.3
Technetium-99	< 0.2	NA	NA	NA	NA
Zinc-66	NA	NA	NA	NA	NA
Zirconium-96	< 1	NA	NA	NA	NA

* = Water pumped through stainless steel sampling device - probable contamination with iron.
NA = Not analyzed
NR = Not reported, probably not measured
ND = Not detected

References:
NUREG/CR-3712 = Radionuclide Migration in Ground Water, Annual Report, FY83, p. 90-93
NUREG/CR-3712 = Radionuclide Migration in Ground Water, Annual Report, FY82, p. 90-93

APPENDIX A-7

INVENTORY DATA

Table A7-1. Annual and Cumulative Release to 1301-N and 1325-N LWDFs (Curies)

Year	Document Number for the Used for Reporting the Releases	Annual Release (Ci) Co-60	Annual Release (Ci) Sr-90	Annual Release (Ci) Ru-106	Annual Release (Ci) Cs-134	Annual Release (Ci) Cs-137	Annual Release (Ci) Pu-239/240	Cumulative Inventory (Ci) Co-60	Cumulative Inventory (Ci) Sr-90	Cumulative Inventory (Ci) Ru-106	Cumulative Inventory (Ci) Cs-134	Cumulative Inventory (Ci) Cs-137	Cumulative Inventory (Ci) Pu-239/240
1964	*UNI-3533 (page 12 table2)*	NR	NR	NR	NR	NR	NR						
1965	*UNI-3533 (page 12 table2)*	NR	NR	NR	NR	NR	NR						
1966	*UNI-3533 (page 12 table2)*	NR	NR	NR	NR	NR	NR	*500**	*580**	*130**	*40**	*180**	*2.3**
1967	UNI-3533 (page 12 table2)	200	270	NR	NR	88	NR	620	830	140	44	260	3.1
1968	UNI-3533 (page 12 table2)	82	270	NR	NR	41	NR	620	1100	140	48	290	3.9
1969	UNI-3533 (page 12 table2)	84	7.4	NR	NR	2.8	NR	630	1100	140	51	290	4.7
1970	UNI-3533 (page 12 table2)	230	7.3	29	16	51	NR	760	1000	100	53	330	5.5
1971	UNI-3533 (page 12 table2)	330	17	110	18	92	NR	980	1000	130	54	420	6.2
1972	UNI-3533 (page 12 table2)	220	21	63	4.1	18	NR	1100	1000	110	42	420	7.0
1973	UNI-158 (page 5)	320	16	190	23	46	NR	1200	1100	190	49	460	7.8
1974	UNI-349 (page 5)	320	63	82	39	170	NR	1400	1100	150	68	620	8.6
1975	UNI-544 (page 5)	370	93	110	50	240	0.37	1600	1100	160	91	840	8.9
1976	UNI-732 (page3)	640	110	130	110	320	0.55	2000	1200	170	120	1100	9.5
1977	UNI-999 (page 3)	870	120	230	83	380	0.67	2500	1300	250	160	1500	10
1978	UNI-1261 (page 7)	940	120	330	68	340	1.3	3100	1400	360	170	1800	11
1979	UNI-1474 (page 9)	770	130	310	56	290	1.1	3400	1500	410	170	2000	12
1980	UNI-1701 (page 9)	1200	160	320	55	360	1.4	4100	1600	440	170	2300	14
1981	UNI-2003 (page 11)	370	84	100	21	240	0.56	4000	1700	300	140	2500	14
1982	UNI-2358 (page 10)	500	140	120	30	270	2.2	4000	1800	240	120	2700	16
1983	UNI-2795 (page 9)	770	110	65	14	200	2	4200	1800	170	100	2900	18
1984	UNI-3284 (page 11)	1500	310	130	18	210	3.9	5100	2100	180	87	3000	22
1985	UNI-3880 (page 11)	590	240	80	5.7	88	3.4	5024	2288	149	67	3019	25
1986	UNI-4370 (page 11)	390	36	49	7.4	210	0.24	4771	2269	111	54	3158	26
1987	WHC-EP-0165 (table 3-1)	200	15	15	2	46	0.31	4370	2231	67	40	3132	26
1988	WHC-EP-0165-1 (table 3-1)	11	15	2.8	0.32	8	0.044	3842	2193	36	29	3068	26
1989	WHC-EP-0165-2 (table 3-1)	33	28	0	0.52	23	0.023	3399	2169	18	21	3021	26
1990	WHC-EP-0527 (tables 3-5)	7.8	14	0	0.12	7.1	0.0097	2988	2132	9	15	2960	26
1991	WHC-EP-0527-1 (table 3-5)	0.005	0.85	0	0.00064	0.13	0.00028	2619	2083	5	11	2893	26
1992								2297	2034	2	8	2827	26
1993								2014	1986	1	6	2763	26
1994								1765	1939	1	4	2700	26
1995								1548	1893	0	3	2639	26
	Radionuclides' Half-Life in Years							5.3	29.1	1.0	2.1	30.2	24111

1964-1966 Cumulative inventory values are extrapolated values.

Cumulative inventory values from 1964 through 1984 are from document UNI-3533

Cumulative inventory values from 1985 to 1995 are calculated in this spread sheet using the cumulative inventory formula in UNI-3533 listed below along with the Radionuclides' Half-Life

**Cumulative Inventory = (Annual Release(Curies to LWDF) * (1 - exp((-0.693 * 1 year)/Half-Life)) / (0.693/Half-Life)) + (Preceeding Year's Cumulative Inventory * exp((-0.693 * 1 Year)/Half-Life))

Table A7-2. Estimated Amounts of Hazardous Waste Discharged to 1301-N and 1325-N

Dangerous Waste	Total Pounds per Year 1301-N	Total Pounds per Year 1325-N
Acetone (F003)	6,200	6,200
Corrosive (D002)	20,600	20,600
Cadmium (D006)	100	100
Lead (D008)	150	150
Mercury (D009)	6,200	6,200
Hydrazine (U133)	100	100
Carcinogens (WC02)	4,000	4,000
Toxins (WT02)	15,000	15,000
Sodium dichromate (D007)	10,000	None

References:
CCN -16993 = RCRA Part A Permit for 1301-N, Rev. 5, 1995
CCN -16993 = RCRA Part A Permit for 1325-N, Rev. 5, 1995

Table A7-3. Water Flow Rates from 1301-N and 1325-N Liquid Waste Disposal Facilities

Year	Water Flow to 1301-N (liters/day)	Water Flow to 1325-N (liters/day)
1964 [a]	9,462,500	0
1965 [a]	9,462,500	0
1966 [a]	9,462,500	0
1967 [a]	9,462,500	0
1968 [a]	9,462,500	0
1969 [a]	9,462,500	0
1970 [a]	9,462,500	0
1971 [a]	9,462,500	0
1972 [a]	9,462,500	0
1973	8,702,000	0
1974	9,500,000	0
1975	9,500,000	0
1976	9,900,000	0
1977	14,500,500	0
1978	12,500,000	0
1979	13,500,000	0
1980	12,500,000	0
1981	10,500,000	0
1982	10,500,000	0
1983	6,942,000	1,960,000
1984	8,100,000	1,900,000
1985	7,200,000	2,800,000
1986	0	7,250,000
1987	0	2,100,000
1988	0	1,660,000
1989	0	1,660,000
1990	0	548,000
Average	**9,954,864**	**2,484,750**

Source: Adapted from Connelly et. at. 1991 and WHC 1991.
Values for 1989 from Rokkan 1990, and values for 1990 from Manley and Diediker 1992.

[a] No reliable data for average flow rates and average concentrations of effluents.
Rough estimates based on discharge volumes from 1973 to 1976 were used. Data for 1973 and 1990 are from yearly effluent release reports.

Reference: DOE-RL-93-23 = N Springs Expedited Response Action Proposal, Rev. 0, Jan. 1994, p. 2T-2

APPENDIX A-8

100N SOIL BORINGS

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 1 of 23)

Reference Document.:	WHC/H	WHC/H	WHC/H	WHC/H	WHC/H	WHC/H	WHC/H	WHC/H	WHC/H	WHC-SD	WHC/H
Location:	199-N-75	199-N-75	199-N-75	199-N-75	199-N-75	199-N-76	199-N-76	199-N-76	199-N-76	199-N-76	199-N-76
Sample ID:	B06837	B06838	B06839	B06843	B06845	B06835	B06836	B06840	B06841	B06842	B06844
Method:											
Sample Collected:	4/14/92	4/14/92	4/14/92	4/23/92	4/24/92	4/13/92	4/13/92	4/16/92	4/16/92	4/22/92	4/23/92
Depth (feet below ground surface):	2-3	5-6	9	56-58	68-70	2-3	5-6	24-25	24-25	55-57	64.5-66.5
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	3.1 U	1.9 U	8.5 U	-0.12 U	0.87 U	**3.5 J**	1.8 U	-0.94 U	5.3 U	5.9 U	0.65 U
Gross beta	**12 J**	**8.7 J**	**37**	**430**	**250**	**18**	**8.6**	**14 J**	**36**	**650**	**23**
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium-241	0.003 U	0.016 U	0.006 U	0.006 U	0.002 U	-0.004 U	0.029 U	-0.007 U	-0.004 U	0.011 U	-0.005 U
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon-14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	0.12 U	0.11 U	0.13 U	0.052 U	0.075 U	0.12 U	0.095 U	0.16 U	0.12 U	0.077 U	0.043 U
Cesium-137	0.095 U	0.096 U	0.095 U	0.046 U	0.034 U	0.1 U	0.064 U	0.099 U	0.1 U	0.057 U	0.033 U
Chromium-51	5.9 U	6.6 U	6.5 U	3.8 U	3.5 U	7 U	4.5 U	6 U	6.1 U	6 U	2.4 U
Cobalt-60	0.088 U	0.072 U	0.12 U	**0.52**	**0.28**	0.13 U	0.1 U	0.13 U	0.13 U	**1.2**	**0.18**
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	0.18 U	0.15 U	NR	NR	NR	NR	0.23 U	0.078 U
Europium-154	NR	NR	NR	0.1 U	0.097 U	NR	NR	NR	NR	0.15 U	0.057 U
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron-59	NR	NR	NR	0.52 U	0.43 U	NR	NR	NR	NR	0.68 U	0.46 U
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	0.007 U	0.003 U	0.002 U	-0.007 U	0.002 U	0.004 U	-0.003 U	-0.002 U	0.004 U	0.003 U	-0.002 U
Potassium-40	**10.0**	**1.1**	**9.4**	**13.0**	**12.0**	**9.4**	**9.3**	**8.8**	**7.6**	**13.0**	**12.0**
Radium-226	0.18 U	**0.35**	**0.49**	**0.35**	**0.35**	**0.27**	**0.26**	**0.35**	**0.43**	**0.43**	**0.4**
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	0.46 U	0.39 U	NR	NR	NR	NR	0.65 U	0.35 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	0.1 U	-1.6 U	-1.1 U	**190.0**	**120.0**	0.17 U	0.038 U	0.045 U	0.13 U	**320**	2.0
Technetium-99	**0.44 J**	0.74 U	0.19 U	-0.055 U	0.52 U	1	0.1 U	**0.43 J**	0.24 U	0.13 U	0.11 U
Thorium-228	**0.55**	**0.7**	**0.67**	**0.47**	**0.59**	**0.62**	**0.41**	**0.52**	**0.59**	**0.59**	**0.5**
Thorium-232	**0.42**	**0.52**	**0.72**	**0.39**	**0.62**	**0.69**	**0.43**	0.52 U	0.53 U	**0.41**	**0.46**
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-233/234	NR	NR	NR	**0.62**	**0.69**	NR	NR	NR	NR	**1.2**	0.4 U
Uranium-235	0.046 U	0.03 U	0.024 U	-0.026 U	0.11 U	0.08 U	0.021 U	0.1 U	0.047 U	-0.12 U	0.25 U
Uranium-238	**0.53**	**0.5**	**0.73**	**0.47**	0.18 U	**0.53**	**0.46**	**0.53**	**0.52**	**0.49**	**0.54**
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	0.29 U	0.24 U	0.3 U	0.15 U	0.13 U	0.33 U	0.21 U	0.27 U	0.3 U	0.22 U	0.13 U

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 2 of 23)

Reference Document.:	HEIS	HEIS	HEIS	HEIS	HEIS	HEIS	HEIS	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135
Location:	199-N-80	199-N-80	199-N-80	199-N-80	199-N-80	199-N-80	199-N-80	199-N-90A	199-N-90A	199-N-90A	199-N-90A	199-N-90A
Sample ID:	B06M60	B06M37	B06M62 (Dup)	B072P4	B072P5	B072P7	B072P9					
Method:												
Sample Collected:	7/1/92	7/1/92	7/1/92	7/1/92	7/1/92	7/1/92	7/1/92	1994	1994	1994	1994	1994
Depth (feet below ground surface):	45-47	50-52	50-52	57-59	68-70	75-77	95.7-99	0	5	10	15	100
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	8.8 R	3 R	6.9 R	0.75 R	4.2 R	4.9 R	0.34 R	**654**	**53**	**51**	**51**	**102**
Gross beta	**19**	**62**	NR	**130**	**200**	**93**	**20**	ND	ND	ND	ND	ND
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium-241	0.003 U	0.007 U	-0.012 U	0.007 U	0.009 U	0.006 U	0 U	ND	ND	ND	ND	ND
Antimony-125	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Carbon-14	3.9 U	3.1 U	4.2 U	-2.7 U	-6.3 U	0.28 U	1.6 U	ND	ND	ND	ND	ND
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	0.056 U	0.13 U	0.11 U	0.12 U	0.052 U	0.048 U	0.04 U	ND	ND	ND	ND	ND
Cesium-137	0.053 U	0.094 U	0.1 U	0.12 U	0.044 U	0.037 U	0.037 U	**0.9**	ND	ND	ND	ND
Chromium-51	1.2 U	1.7 U	1.4 U	2.1 U	1.1 U	0.75 U	0.72 U	ND	ND	ND	ND	ND
Cobalt-60	0.064 U	0.2 U	0.17 U	0.41 U	**0.23**	**0.13**	0.045 U	**19.8**	ND	ND	ND	ND
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	0.1 U	0.2 U	0.19 U	0.24 U	0.15 U	0.093 U	0.083 U	ND	ND	ND	ND	ND
Europium-154	0.068 U	0.13 U	0.12 U	0.17 U	0.098 U	0.068 U	0.055 U	ND	ND	ND	ND	ND
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron-59	0.33 U	0.36 U	0.42 U	0.61 U	0.21 U	0.22 U	0.2 U	ND	ND	ND	ND	ND
Lead-214	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Manganese-54	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Plutonium - 238	0.002 U	-0.012 U	0.015 U	-0.009 U	0.004 R	0.004 U	-0.003 U	ND	ND	ND	ND	ND
Plutonium-239/240	0 U	0.004 U	0.002 U	-0.003 U	0.008 R	0.002 U	-0.003 U	ND	ND	ND	ND	ND
Potassium-40	**13.0**	**8.6**	**9.0**	**12.0**	**13.0**	**14.0**	**12.0**	**2.00**	**6.30**	**8.00**	**7.90**	ND
Radium-226	**0.51**	**0.49**	NR	**0.27**	**0.34**	**0.43**	**0.4**	ND	ND	ND	ND	ND
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	0.5 U	0.88 U	0.87 U	0.89 U	0.4 U	0.35 U	0.31 U	ND	ND	ND	ND	ND
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Strontium-90	0.3 UJ	**28.0 J**	**25.0 J**	**52.0**	**81.0**	**43.0**	**1.6**	ND	ND	ND	ND	ND
Technetium-99	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Thorium-228	**1.1**	**0.64**	**0.47**	**0.49**	**0.63**	**0.75**	**0.81**	ND	ND	ND	ND	ND
Thorium-232	**0.67**	0.57 U	0.77 U	0.58 U	0.59 U	**0.8**	**0.62**	**0**	**1.3**	**0.7**	**0.3**	ND
Tin-125	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Tritium	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Uranium-233/234	0.38 R	0.32 R	0.18 R	**33**	**0.36**	**0.37**	**0.33**	ND	ND	ND	ND	ND
Uranium-235	0 R	0 R	-0.036 R	0.017 U	0 R	0.025 R	0.032 R	**0**	**1.2**	**0.7**	**1**	ND
Uranium-238	0.48 R	0.027 R	0.21 R	0.38 R	**0.35**	**0.35**	**0.27**	ND	ND	ND	ND	ND
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	0.18 U	0.35 U	0.29 U	0.31 U	0.11 U	0.12 U	0.1 U	ND	ND	ND	ND	ND

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 3 of 23)

Reference Document.:	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135
Location:	199-N-90A	199-N-90A	199-N-90A	199-N-90A	199-N-91A	199-N-91A	199-N-91A	199-N-91A	199-N-92A	199-N-92A	199-N-92A	199-N-93A
Sample ID:												
Method:												
Sample Collected:	1994	1994	1994	1994	1994	1994	1994	1994	1994	1994	1994	1994
Depth (feet below ground surface):	105	110	115	120	10	15	20	45	15	20	45	5
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	**120**	**109**	**88**	**125**	ND	ND	ND	ND	ND	ND	ND	ND
Gross beta	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium-241	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony-125	ND	ND	ND	ND	ND	ND	ND	ND	**0.77**	ND	ND	**0.36**
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cesium-137	ND	ND	ND	ND	ND	ND	ND	ND	**0.09**	ND	ND	ND
Chromium-51	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt-60	ND	ND	ND	ND	**0.12**	**0.26**	**0.15**	ND	**0.37**	**0.13**	ND	**0.39**
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Europium-154	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron-59	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead-214	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese-54	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Plutonium - 238	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Plutonium-239/240	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium-40	ND	ND	ND	ND	**23.8**	**22.9**	**21.5**	**28.8**	**32.8**	**28.6**	**12.2**	**23.2**
Radium-226	ND	ND	ND	ND	**0.74**	**0.73**	**0.93**	**1.5**	**1.06**	**0.63**	**0.66**	**0.83**
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	ND	ND	ND	ND	ND	**1.81**	ND	ND	ND	ND	**4.04**	ND
Ruthenium-103	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Strontium-90	ND	ND	ND	ND	**1.16**	**0.81**	**0.61**	**0.84**	**0.62**	**1.01**	**0.81**	**2.17**
Technetium-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thorium-228	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thorium-232	ND	ND	ND	ND	**0.84**	**0.77**	**1.02**	**2.02**	**1.34**	**0.74**	**1.71**	**0.92**
Tin-125	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tritium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.29**
Uranium-233/234	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium-235	ND	ND	ND	ND	ND	ND	ND	**2.84**	**2.63**	ND	ND	ND
Uranium-238	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 4 of 23)

Reference Document.:	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135
Location:	199-N-93A	199-N-93A	199-N-93A	199-N-94A	199-N-94A	199-N-94A	199-N-94A	199-N-94A	199-N-94A	199-N-95A	199-N-95A	199-N-95A
Sample ID:												
Method:												
Sample Collected:	1994	1994	1994	10/1/94	10/1/94	10/1/94	10/1/94	10/1/94	10/1/94	9/1/94	9/1/94	9/1/94
Depth (feet below ground surface):	10	15	45	5	10	15	25	30	45	5	10	15
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Gross beta	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium-241	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony-125	1.54	0.48	1.14	0.31	0.20	0.54	ND	ND	1.04	ND	ND	0.40
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	ND	ND	ND	ND	ND	ND	3.95	ND	ND	ND	ND	ND
Carbon-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cesium-137	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium-51	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt-60	1.2	0.43	ND	0.996	0.497	0.30	0.38	0.21	ND	0.206	1.29	0.39
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Europium-154	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron-59	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead-214	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese-54	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Plutonium - 238	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Plutonium-239/240	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium-40	22.1	26.4	32.1	20.36	25.3	23.0	24.6	23.2	28.2	21.8	22.6	19.7
Radium-226	1.56	0.84	1.63	0.758	0.856	0.857	1.02	0.894	1.644	0.673	0.647	0.789
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	1.81	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ruthenium-103	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Strontium-90	22.00	6.90	0.91	36.2	51.0	15.7	9.9	5.1	2.04	1.26	37.8	2.76
Technetium-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thorium-228	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thorium-232	2.06	1.02	2.52	0.809	1.07	0.998	1.139	1.06	2.29	0.76	0.73	1.23
Tin-125	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tritium	4.77	8.58	3.86	0.324	1.71	3.6	7.34	6.58	0.446	0.196	0.052	2.88
Uranium-233/234	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium-235	2.9	ND	5.76	ND	ND	ND	ND	ND	0.275	ND	ND	ND
Uranium-238	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 5 of 23)

Reference Document.:	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135	BHI-00135
Location:	199-N-95A	199-N-95A	199-N-95A	199-N-96A	199-N-96A	199-N-96A	199-N-96A	199-N-96A	199-N-97A	199-N-97A	199-N-97A	199-N-97A	199-N-97A
Sample ID:													
Method:													
Sample Collected:	9/1/94	9/1/94	9/1/94	1994	1994	1994	1994	1994	1994	1994	1994	1994	1994
Depth (feet below ground surface):	20	25	35	10	15	20	25	45	10	15	20	30	35
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Gross beta	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Americium-241	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Antimony-125	0.39	ND	0.62	ND	0.19	ND	ND	ND	ND	ND	ND	ND	ND
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Cadmium-109	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbon-14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Cesium-134	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cesium-137	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium-51	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt-60	0.22	0.19	ND	ND	ND	0.05	0.43	0.16	0.10	ND	0.08	ND	0.09
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Europium-152	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Europium-154	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Iron-59	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Lead-214	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese-54	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Plutonium - 238	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Plutonium-239/240	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium-40	18.5	19.5	19.0 D	22.7	19.5	26.8	21.2	23.1	19.0	22.3	24.1	ND	38.3
Radium-226	0.632	0.617	0.778	0.71	0.90	1.0	0.84	0.97	0.62	0.81	0.94	NR	1.82
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Ruthenium-106	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ruthenium-103	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Strontium-90	14.0	10.5	1.22	0.58	0.60	0.82	1.14	0.70	ND	0.84	0.86	ND	1.02
Technetium-99	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thorium-228	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thorium-232	0.72	0.75	1.16	0.7	0.84	1.03	1.05	1.33	0.65	1.08	1.25	NR	2.52
Tin-125	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Tritium	2.3	0.952	11.8	0.05	0.03	0.19	0.14	0.8	ND	ND	ND	ND	ND
Uranium-233/234	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium-235	ND	ND	ND	ND	2.22	ND	3.69	ND	ND	ND	ND	1.9	5.55
Uranium-238	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND	ND	ND	ND
Zinc-65	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 6 of 23)

Reference Document.:	Quanterra	PNNL	EAL	Quanterra	PNNL	EAL	Quanterra	EAL	PNNL	PNNL	EAL	PNNL
Location:	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A
Sample ID:	B0DRK7	103A/55-57	103A/55-57	B0DRK8	103A/60.5-62	103A/60.5-62	B0DRK9	103A/65-67	103A/65-67	103A/65-67	103A/70-72	103A/70-72
Method:	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST (Dup)	ST	ST
Sample Collected:	1/30/95	2/1/95	2/1/95	2/2/95	2/2/95	2/2/95	2/6/95	2/3/95	2/3/95	2/3/95	2/7/95	2/7/95
Depth (feet below ground surface):	29-32	55-56.5	55-57	59-60.5	60-61.5	60-61.5	65-67	65-67	65-65.5	65-65.5	70-72	70-71.5
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	**10.24**	NR	NR	**5.79**	NR	NR	**15.4**	NR	NR	NR	NR	NR
Gross beta	**26.3**	NR	NR	**25.4**	NR	NR	**337**	NR	NR	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ameriolum 241	NR	NR	2.8 U	NR	NR	2.8 U	NR	3.3 U	NR	NR	3.1 U	NR
Antimony-125	NR	NR	1.9 U	NR	NR	1.9 U	NR	2.1 U	NR	NR	2.1 U	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	4.2 U	NR	NR	3.7 U	NR	4.7 U	NR	NR	4.5 U	NR
Cesium 134	NR	NR	0.95 U	NR	NR	0.93 U	NR	1.2 U	NR	NR	1 U	NR
Cesium 137	0.00079 U	NR	0.86 U	**0.0159**	NR	0.91 U	**0.0201**	0.82 U	NR	NR	0.95 U	NR
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.00186 U	NR	0.95 U	**0.149**	NR	1.1 U	**0.617**	1.2 U	NR	NR	**1.2**	NR
Cobalt-58	0.00031 U	NR	NR	0.00821 U	NR	NR	0.0104 U	NR	NR	NR	NR	NR
Europium 152	0.00459 U	NR	7.3 U	0.00334 U	NR	4.5 U	-0.0254 U	6 U	NR	NR	6.5 U	NR
Europium 154	0.0141 U	NR	3.2 U	-0.005 U	NR	3.5 U	0.0293 U	3.8 U	NR	NR	3.9 U	NR
Europium-155	**0.0468**	NR	2.3 U	0.0166 U	NR	2.2 U	0.0466 U	2.7 U	NR	NR	2.5 U	NR
Iron 59	0.00291 U	NR	NR	0.00459 U	NR	NR	-0.035 U	NR	NR	NR	NR	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	NR	NR	110,000 U	NR	NR	110,000 U	NR	130,000 U	NR	NR	120,000 U	NR
Potassium 40	**15.4**	NR	10 U	**15.4**	NR	**17**	**16.2**	12 U	NR	NR	10 U	NR
Radium 226	**0.452**	NR	NR	**0.368**	NR	NR	**0.469**	NR	NR	NR	0 U	NR
Radium-224DA	**0.595**	NR	NR	**0.451**	NR	NR	**0.592**	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	**0.701**	NR	NR	**0.461**	NR	NR	**0.665**	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	NR	NR	**7.4**	NR	NR	6.6 U	NR	7 U	NR	NR	6.9 U	NR
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	0.0399 U	**0.56**	NR	**2.26**	**2.54**	NR	**153**	NR	**120.48**	**119**	NR	**80.322**
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	NR	NR	3.3 U	NR	NR	2.1 U	NR	2.8 U	NR	NR	2.1 U	NR
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	281 U	NR	NR	**127,000**	NR	NR	**84,800**	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	4.5 U	NR	NR	4.2 U	NR	5 U	NR	NR	4.5 U	NR
Uranium 238	**0.518**	NR	130 U	NR	NR	110 U	NR	120 U	NR	NR	120 U	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 7 of 23)

Reference Document.:	PNNL	EAL	Quanterra	EAL	PNNL	PNNL	EAL	EAL	EAL	PNNL	EAL	EAL
Location:	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-103A	199-N-104A	199-N-104A
Sample ID:	103A/75-77	103A/75-77	B0DRL0	103A/80-82	103A/80-82	103A/85-87	103A/85-87	103A/90-92	103A/95-97	103A/95-97	104A-10	104A-20
Method:	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	Gb	Gb
Sample Collected:	2/8/95	2/8/95	2/9/95	2/9/95	2/9/95	2/22/95	2/22/95	2/23/95	3/2/95	3/2/95	2/16/95	2/17/95
Depth (feet below ground surface):	75-76.5	75-77	77-78	80-82	81-82	85-87	85-87	90-92	95-97	95.5-97	10	20
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	NR	2.81 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	**23.6**	NR	NR	NR	NR	NR	NR	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	0.27 U	NR	0.44 U	NR	NR	0.48 U	0.41 U	0.5 U	NR	0.43 U	0.49 U
Antimony-125	NR	0.1 U	NR	0.15 U	NR	NR	0.32 U	0.16 U	0.18 U	NR	0.16 U	0.2 U
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	0.29 U	NR	0.46 U	NR	NR	0.51 U	0.41 U	0.5 U	NR	0.52 U	0.44 U
Cesium 134	NR	0.041 U	NR	0.074 U	NR	NR	0.084 U	0.077 U	0.099 U	NR	0.068 U	0.061 U
Cesium 137	NR	0.043 U	0.00435 U	0.068 U	NR	NR	0.048 U	0.059 U	0.067 U	NR	0.05 U	0.065 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	NR	0.07 U	**0.0678**	**0.11**	NR	NR	0.094 U	0.069 U	0.081 U	NR	0.1 U	0.093 U
Cobalt-58	NR	NR	0.00469 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 152	NR	0.19 U	-0.0112 U	0.36 U	NR	NR	0.47 U	0.28 U	0.25 U	NR	0.42 U	0.44 U
Europium 154	NR	0.16 U	-0.0283 U	0.19 U	NR	NR	0.26 U	0.27 U	0.22 U	NR	0.25 U	0.31 U
Europium-155	NR	0.17 U	0.0288 U	0.29 U	NR	NR	0.33 U	0.26 U	0.3 U	NR	0.28 U	0.28 U
Iron 59	NR	NR	-0.006 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	NR	7,100 U	NR	12,000 U	NR	NR	13,000 U	12,000 U	14,000 U	NR	13,000 U	12,000 U
Potassium 40	NR	**15**	**9.5**	**14**	NR	NR	**13**	**12**	**12**	NR	**11**	**10**
Radium 226	NR	NR	**0.301**	NR	NR	NR	NR	NR	NR	NR	0 U	NR
Radium-224DA	NR	NR	**0.394**	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	**0.424**	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	NR	0.36 U	NR	0.59 U	NR	NR	0.54 U	0.53 U	0.73 U	NR	0.62 U	0.7 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**3.194**	NR	**0.976**	NR	**0.88**	**0.621**	NR	NR	NR	**0.41**	NR	NR
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	NR	**0.52**	NR	**0.57**	NR	NR	**0.64**	**0.44**	**0.55**	NR	**0.55**	**0.38**
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	**59,400**	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	0.3 U	NR	0.45 U	NR	NR	0.56 U	0.36 U	0.55 U	NR	0.56 U	0.52 U
Uranium 238	NR	5.2 U	NR	9.3 U	NR	NR	NR	9 U	8.6 U	NR	7.2 U	8.0 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 8 of 23)

Reference Document.:	EAL	Quanterra	EAL	EAL	PNNL	EAL	EAL	PNNL	EAL	PNNL	Quanterra	Quanterra
Location:	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A
Sample ID:	104A-30	B0DRL1	104A-40	104A-50	104A-58-60	104A-60	104A-65	104A/63-65	104A-70	104A/68-70	B0DRL2	B0DRL3
Method:	Gb	ST	Gb	Gb	ST	Gb	Gb	ST	ST	ST	ST	ST (Dup)
Sample Collected:	2/21/95	2/22/95	2/23/95	2/24/95	2/24/95	2/27/95	2/27/95	2/27/95	2/28/95	2/28/95	3/1/95	3/1/95
Depth (feet below ground surface):	30	31-33	40	50	58.5-59.5	60	65	64-65	70	69-70	73.5-76	73.5-76
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	**6.25**	NR	NR	NR	NR	NR	NR	NR	NR	**6.44**	4.7 U
Gross beta	NR	**14.3**	NR	NR	NR	NR	NR	NR	NR	NR	**30.9**	**21.4**
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	0.42 U	NR	0.39 U	0.32 U	NR	0.44 U	0.33 U	NR	0.5 U	NR	NR	NR
Antimony-125	0.14 U	NR	0.14 U	0.11 U	NR	0.14 U	0.13 U	NR	0.2 U	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	0.37 U	NR	0.46 U	0.37 U	NR	0.41 U	0.4 U	NR	0.54 U	NR	NR	NR
Cesium 134	0.068 U	NR	0.07 U	0.056 U	NR	0.072 U	0.058 U	NR	0.093 U	NR	NR	NR
Cesium 137	0.06 U	-0.00118 U	0.063 U	0.05 U	NR	0.068 U	0.057 U	NR	0.085 U	NR	0.00734 U	-0.009 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.061 U	0.00567 U	0.083 U	0.069 U	NR	0.096 U	**0.062**	NR	**0.18**	NR	**0.138**	**0.137**
Cobalt-58	NR	-0.00186 U	NR	NR	NR	NR	NR	NR	NR	NR	0.00389 U	-0.015 U
Europium 152	0.4 U	0.0111 U	0.5 U	0.29 U	NR	0.36 U	0.3 U	NR	0.59 U	NR	-0.00717 U	-0.028 U
Europium 154	0.24 U	-0.0166 U	0.24 U	0.16 U	NR	0.17 U	0.21 U	NR	0.29 U	NR	0.0127 U	-0.005 U
Europium-155	0.24 U	0.00548 U	0.26 U	0.23 U	NR	0.27 U	0.25 U	NR	0.36 U	NR	0.0338 U	0.025 U
Iron 59	NR	-0.00665 U	NR	NR	NR	NR	NR	NR	NR	NR	-0.0217 U	0.037 U
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	11,000 U	NR	11,000 U	9,700 U	NR	12,000 U	11,000 U	NR	15,000 U	NR	NR	NR
Potassium 40	**8.7**	**7.1**	**9.3**	**8.2**	NR	**15**	**12**	NR	**19**	NR	**19.5**	**0.604**
Radium 226	NR	**0.276**	NR	0 U	NR	NR	0 U	NR	0 U	NR	**0.32**	-0.08 U
Radium-224DA	NR	**0.349**	NR	NR	NR	NR	NR	NR	NR	NR	**0.542**	**0.415**
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	**0.376**	NR	NR	NR	NR	NR	NR	NR	NR	**0.627**	**0.62**
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	0.57 U	NR	0.54 U	0.45 U	NR	0.65 U	0.53 U	NR	0.74 U	NR	NR	NR
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	NR	0.105 U	NR	NR	**0.485**	NR	NR	**0.613**	NR	**1.318**	**1.17**	0.25 U
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	**0.47**	NR	**0.51**	**0.37**	NR	**0.46**	**0.36**	NR	**0.67**	NR	NR	NR
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	73.9 U	NR	NR	NR	NR	NR	NR	NR	NR	**20,200**	0.336 U
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	0.39 U	NR	0.43 U	0.39 U	NR	0.44 U	0.43 U	NR	0.55 U	NR	NR	NR
Uranium 238	7.7 U	NR	7.8 U	5.4 U	NR	8.4 U	5.5 U	NR	NR	NR	**0.87**	0.05 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 9 of 23)

Reference Document.:	Quanterra	EAL	PNNL	PNNL	PNNL	EAL	PNNL	EAL	Quanterra	PNNL	EAL	EAL
Location:	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-104A	199-N-105A
Sample ID:	B0DRL4	104A-75	104A/73-75	104A/79-81	104A/79-81	104A-80	104A/84-84.5	104A-85	B0DRL5	104A/89-90	104A-90	105A-10
Method:	ST (Dup)	ST	ST	ST	ST (Dup)	ST	ST	ST	ST	ST	ST	Gb
Sample Collected:	3/1/95	2/28/95	2/28/95	3/3/95	3/3/95	3/3/95	3/8/95	3/8/95	3/10/95	3/10/95	3/10/95	3/16/95
Depth (feet below ground surface):	73.5-76	75	74-75	79.5-80.5	79.5-80.5	80	84-84.5	85	89-91	89.5-90.5	90	10
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	**7.78**	NR	NR	NR	NR	NR	NR	NR	**7.79**	NR	NR	NR
Gross beta	**33.6**	NR	NR	NR	NR	NR	NR	NR	**21.7**	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	0.48 U	NR	NR	NR	0.41 U	NR	0.38 U	NR	NR	0.37 U	0.39 U
Antimony-125	NR	0.17 U	NR	NR	NR	0.13 U	NR	0.15 U	NR	NR	0.13 U	0.16 U
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	0.5 U	NR	NR	NR	0.41 U	NR	0.38 U	NR	NR	0.41 U	0.46 U
Cesium 134	NR	0.078 U	NR	NR	NR	0.06 U	NR	0.058 U	NR	NR	0.062 U	0.059 U
Cesium 137	0.00667 U	0.085 U	NR	NR	NR	0.048 U	NR	0.051 U	-0.00344 U	NR	0.056 U	0.067 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	**0.124**	**0.13**	NR	NR	NR	0.069	NR	0.075 U	**0.0498**	NR	0.072 U	0.082 U
Cobalt-58	0.00159 U	NR	NR	NR	NR	NR	NR	NR	0.00582 U	NR	NR	NR
Europium 152	0.01 U	0.33 U	NR	NR	NR	0.27 U	NR	0.34 U	0.0128 U	NR	0.3 U	0.25 U
Europium 154	0.0268 U	0.3 U	NR	NR	NR	0.26 U	NR	0.27 U	0.0366 U	NR	0.19 U	0.24 U
Europium-155	0.0307 U	0.3 U	NR	NR	NR	0.26 U	NR	0.26 U	0.0247 U	NR	0.26 U	0.31 U
Iron 59	0.00157 U	NR	NR	NR	NR	NR	NR	NR	0.00265 U	NR	NR	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	NR	13,000 U	NR	NR	NR	10,000 U	NR	10,000 U	NR	NR	9,300 U	13000 U
Potassium 40	**18**	**17**	NR	NR	NR	**14**	NR	**10**	**14.7**	NR	**13**	**11**
Radium 226	**0.317**	NR	NR	NR	NR	NR	NR	NR	**0.349**	NR	NR	0 U
Radium-224DA	**0.542**	NR	NR	NR	NR	NR	NR	NR	**0.554**	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	**0.496**	NR	NR	NR	NR	NR	NR	NR	**0.582**	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	NR	0.56 U	NR	NR	NR	0.57 U	NR	0.47 U	NR	NR	0.43 U	0.6 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**0.97**	NR	**1.005**	**0.577**	**0.531**	NR	**0.435**	NR	0.00059 U	**0.231**	NR	**1.5**
Teohnetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	NR	**0.4**	NR	NR	NR	**0.5**	NR	**0.45**	NR	NR	**0.42**	**0.56**
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	**20,000**	NR	NR	NR	NR	NR	NR	NR	**14,300**	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	0.51 U	NR	NR	NR	0.42 U	NR	0.41 U	NR	NR	0.42 U	0.46 U
Uranium 238	NR	7.9 U	NR	NR	NR	6.7 U	NR	6.7 U	NR	NR	6.2 U	9.1 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 10 of 23)

Reference Document.:	EAL	EAL	EAL	EAL	Quanterra	EAL	PNNL	EAL	PNNL	EAL	EAL	PNNL
Location:	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A
Sample ID:	105A-15	105A-20	105A-25	105A-30	B0DRL6	105A-35	105A-40	105A-40	105A-45	105A-45	105A-50	105A/51-53
Method:	Gb	Gb	Gb	Gb	ST	Gb	Gb	Gb	Gb	Gb	Gb	ST
Sample Collected:	3/16/95	3/17/95	3/20/95	3/21/95	3/21/95	3/21/95	3/22/95	3/22/95	3/22/95	3/22/95	3/22/95	3/24/95
Depth (feet below ground surface):	15	20	25	30	34-36	35	40	40	45	45	50	51-52
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	NR	NR	NR	7.7	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	16.1	NR	NR	NR	NR	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	0.33 U	0.42 U	0.41 U	0.29 U	NR	0.34 U	NR	0.35 U	NR	0.4 U	0.74 U	NR
Antimony-125	0.15 U	0.13 U	0.12 U	0.095 U	NR	0.14 U	NR	0.12 U	NR	0.18 U	0.18 U	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	0.41 U	0.44 U	0.46 U	0.36 U	NR	0.39 U	NR	0.39 U	NR	0.46 U	0.77 U	NR
Cesium 134	0.053 U	0.06 U	0.068 U	0.06 U	NR	0.044 U	NR	0.049 U	NR	0.043 U	0.068 U	NR
Cesium 137	0.046 U	0.051 U	0.065 U	0.039 U	0.00295 U	0.041 U	NR	0.043 U	NR	0.059 U	0.062 U	NR
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.075 U	0.081 U	0.074 U	0.057 U	0.00269 U	0.08 U	NR	0.076 U	NR	0.093 U	0.12 U	NR
Cobalt-58	NR	NR	NR	NR	0.00265 U	NR	NR	NR	NR	NR	NR	NR
Europium 152	0.28 U	0.35 U	0.23	0.29 U	-0.0025 U	0.35 U	NR	0.3 U	NR	0.38 U	0.26 U	NR
Europium 154	0.18 U	0.22 U	0.26 U	0.19 U	0.0104 U	0.27 U	NR	0.19 U	NR	0.28 U	0.16 U	NR
Europium-155	0.24 U	0.25 U	0.28 U	0.21 U	0.0169 U	0.25 U	NR	0.24 U	NR	0.26 U	0.51 U	NR
Iron 59	NR	NR	NR	NR	0.00215 U	NR	NR	NR	NR	NR	NR	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	10,000 U	11,000 U	11,000 U	10,000 U	NR	10,000 U	NR	8,700 U	NR	11,000 U	17,000 U	NR
Potassium 40	11.0	10.0	11.0	7.1	9.22	8.5	NR	8.7	NR	13	10	NR
Radium 226	NR	NR	NR	0 U	0.353	NR	NR	NR	NR	NR	NR	NR
Radium-224DA	NR	NR	NR	NR	0.495	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	0.497	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	0.48 U	0.55 U	0.44 U	0.48 U	NR	0.5 U	NR	0.43 U	NR	0.61 U	0.62 U	NR
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	0.87	0.64	0.34	1.1	0.0724 U	1.8	0.419	3.1	0.392	3.1	14	431
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	0.44	0.53	0.55	0.38	NR	0.42	NR	0.29	NR	0.4	0.29	NR
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	148 U	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	0.42 U	0.42 U	0.46 U	0.37 U	NR	0.41 U	NR	0.39 U	NR	0.48 U	0.78 U	NR
Uranium 238	5.2 U	5.2 U	6.5 U	6.7 U	0.498	5 U	NR	6 U	NR	7.8 U	7.6 U	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 11 of 23)

Reference Document.:	PNNL	Quanterra	PNNL	EAL	PNNL	EAL	EAL	PNNL	Quanterra	EAL	PNNL	PNNL
Location:	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A
Sample ID:	105A/51-53	B0DRL7	105A/54-56	105A-55	105A/59.5-61.5	105A-60	105A-65	105A/65-67	B0DRL8	105A-70	105A/70-72	105A/70-72
Method:	ST (Dup)	ST	ST	Gb	ST	ST	Gb	ST	ST	ST	ST	ST (Dup)
Sample Collected:	3/24/95	3/24/95	3/27/95	3/27/95	3/28/95	3/28/95	3/30/95	3/30/95	4/4/95	3/31/95	3/31/95	3/31/95
Depth (feet below ground surface):	51-52	51-53	54.5-55.5	55	59.5-61.5	60	65	66-67	70-72	70	71-72	71-72
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	**4.17**	NR	NR	NR	NR	NR	NR	**9.49**	NR	NR	NR
Gross beta	NR	**1680**	NR	NR	NR	NR	NR	NR	**262**	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	NR	NR	1.2 U	NR	1.1 U	0.89 U	NR	NR	0.71 U	NR	NR
Antimony-125	NR	NR	NR	0.27 U	NR	0.27 U	0.19 U	NR	NR	0.15 U	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	1.2 U	NR	1.1 U	0.85 U	NR	NR	0.72 U	NR	NR
Cesium 134	NR	NR	NR	0.074 U	NR	0.12 U	0.068 U	NR	NR	0.072 U	NR	NR
Cesium 137	NR	-0.0144 U	NR	0.085 U	NR	0.11 U	0.078 U	NR	-0.00233 U	0.06 U	NR	NR
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	NR	**1.52**	NR	0.7 U	NR	0.67 U	0.17 U	NR	**0.148**	0.15 U	NR	NR
Cobalt-58	NR	0.00386 U	NR	NR	NR	NR	NR	NR	-0.013 U	NR	NR	NR
Europium 152	NR	-0.0293 U	NR	0.6 U	NR	0.59 U	0.41 U	NR	-0.0017 U	0.25 U	NR	NR
Europium 154	NR	0.0274 U	NR	0.24 U	NR	0.43 U	0.23 U	NR	0.0235 U	0.25 U	NR	NR
Europium-155	NR	-0.0362 U	NR	0.84 U	NR	0.76 U	0.62 U	NR	0.0156 U	0.49 U	NR	NR
Iron 59	NR	0.0321 U	NR	NR	NR	NR	NR	NR	-0.0465 U	NR	NR	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	NR	NR	NR	28,000 U	NR	25,000 U	21,000 U	NR	NR	17,000 U	NR	NR
Potassium 40	NR	**11.2**	NR	**12.0**	NR	**18.0**	**13.0**	NR	**15.4**	**11.0**	NR	NR
Radium 226	NR	**0.266**	NR	NR	NR	NR	NR	NR	**0.359**	NR	NR	NR
Radium-224DA	NR	**0.413**	NR	NR	NR	NR	NR	NR	**0.579**	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	**0.474**	NR	NR	NR	NR	NR	NR	**0.536**	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	NR	NR	NR	0.71 U	NR	0.8 U	0.69 U	NR	NR	0.52 U	NR	NR
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**503**	**709**	**136**	**60**	**149**	**43**	**50**	**91**	**114**	**24**	**101**	**112**
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	NR	NR	NR	**0.41**	NR	**0.43**	**0.41**	NR	NR	**0.43**	NR	NR
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	**16,200**	NR	NR	NR	NR	NR	NR	**68,700**	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	NR	1.2 U	NR	1.1 U	0.87 U	NR	NR	**0.71**	NR	NR
Uranium 238	NR	NR	NR	12 U	NR	11 U	8.3 U	NR	NR	6.7 U	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 12 of 23)

Reference Document.:	PNNL	EAL	PNNL	EAL	EAL	PNNL	Quanterra	PNNL	EAL	PNNL	EAL	EAL
Location:	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-105A	199-N-106A	199-N-106A
Sample ID:	105A74-75.5	105A-75	105A/80-81.5	105A-80	105A-85	105A/85-87	B0DRL9	105A/90-92	105A-90	105A/95-97	106A-15	106A-25
Method:	ST	ST	ST	ST	ST	ST	ST	ST	ST	ST	Gb	Gb
Sample Collected:	4/6/95	4/6/95	4/12/95	4/12/95	4/13/95	4/13/95	4/13/95	4/17/95	4/17/95	4/18/95	8/10/95	8/11/95
Depth (feet below ground surface):	74-75	75	80-81	80	85	85.5-86.5	85-87	90.5-91.5	90	96-97	15	25
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	NR	NR	NR	NR	NR	**6.78**	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	**46.3**	NR	NR	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	0.55 U	NR	0.42 U	0.39 U	NR	NR	NR	0.4 U	NR	0.36 U	0.39 U
Antimony-125	NR	0.13 U	NR	0.15 U	0.12 U	NR	NR	NR	0.12 U	NR	0.18 U	0.16 U
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	0.57 U	NR	0.46 U	0.41 U	NR	NR	NR	0.4 U	NR	0.5 U	0.46 U
Cesium 134	NR	0.054 U	NR	0.073 U	0.058 U	NR	NR	NR	0.074 U	NR	0.071 U	0.067 U
Cesium 137	NR	0.048 U	NR	0.055 U	0.055 U	NR	0.00396 U	NR	0.067 U	NR	0.078 U	0.055 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	NR	0.095 U	NR	0.092 U	0.067 U	NR	**0.0483**	NR	0.09 U	NR	0.1 U	0.086 U
Cobalt-58	NR	NR	NR	NR	NR	NR	-0.00432 U	NR	NR	NR	NR	NR
Europium 152	NR	0.37 U	NR	0.27 U	0.27 U	NR	-0.0143 U	NR	0.26 U	NR	0.5 U	0.42 U
Europium 154	NR	0.23 U	NR	0.25 U	0.21 U	NR	-0.00742 U	NR	0.23 U	NR	0.23 U	0.22 U
Europium-155	NR	0.39 U	NR	0.28 U	0.26 U	NR	0.0157 U	NR	0.25 U	NR	0.3 U	0.25 U
Iron 59	NR	NR	NR	NR	NR	NR	0.00434 U	NR	NR	NR	NR	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	NR	13,000 U	NR	13,000 U	9,700 U	NR	NR	NR	10,000 U	NR	12,000 U	13,000 U
Potassium 40	NR	**9.1**	NR	**11**	**10**	NR	**0.488**	NR	**10**	NR	**11**	**10**
Radium 226	NR	NR	NR	NR	NR	NR	**0.35**	NR	NR	NR	NR	0 U
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	0.471	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	NR	0.41 U	NR	0.59 U	0.52 U	NR	NR	NR	0.53 U	NR	0.43 U	0.62 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**70**	**5.7**	**11.5**	2.6 U	**1.9**	**1.7**	**13**	**2.9**	2.3 U	**0.8**	NR	NR
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	NR	**0.39**	NR	**0.54**	**0.46**	NR	NR	NR	**0.5**	NR	**0.58**	**0.45**
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	**17,300**	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	0.58 U	NR	0.48 U	0.47 U	NR	NR	NR	0.44 U	NR	0.52 U	0.49 U
Uranium 238	NR	6.1 U	NR	7.1 U	6.5 U	NR	NR	NR	5.2 U	NR	8.5 U	7.9 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 13 of 23)

Reference Document.:	EAL	EAL	EAL	EAL	Quanterra	EAL	Quanterra	EAL	Quanterra	EAL	Quanterra	EAL
Location:	199-N-106A	199-N-106A	199-N-106A	199-N-106A	199-N-106A	199-N-106A	199-N-106A	199-N-106A	199-N-106A	199-N-106A	199-N-106A	199-N-106A
Sample ID:	106A-35	106A-45	106A-55	106A-65	B0GGB6	106A-75	B0GGB7	106A-85	B0GGB8	106A-103	B0GGC1	106A-115
Method:	Gb	Gb	Gb	Gb	ST	ST	ST	ST	ST	Gb	ST	Gb
Sample Collected:	8/14/95	8/16/95	8/16/95	8/17/95	8/22/95	8/22/95	8/23/95	8/23/95	8/25/95	8/26/95	8/26/95	8/28/95
Depth (feet below ground surface):	35	45	55	65	73-75	75	83-85	85	96-98	103	105-108	115
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	NR	NR	NR	**5.43**	NR	**9.06**	NR	**9.68**	NR	**7.51**	NR
Gross beta	NR	NR	NR	NR	**649**	NR	**464**	NR	**372**	NR	**510**	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	0.41 U	0.41 U	0.41 U	0.45 U	NR	1.2 U	NR	0.48 U	NR	0.8 U	NR	0.35 U
Antimony-125	0.14 U	0.14 U	0.16 U	0.18 U	NR	0.3 U	NR	0.12 U	NR	0.21 U	NR	0.13 U
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	0.46 U	0.4 U	0.48 U	0.56 U	NR	1.1 U	NR	0.49 U	NR	0.85 U	NR	0.31 U
Cesium 134	0.077 U	0.076 U	0.076 U	0.09 U	NR	0.12 U	NR	0.047 U	NR	0.061 U	NR	0.1 U
Cesium 137	0.062 U	0.064 U	0.073 U	0.063 U	-0.0039 U	0.088 U	-0.0163 U	0.043 U	**0.0199**	0.093 U	**0.0113**	0.095 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.079 U	0.057 U	0.13 U	0.16 U	**0.641**	0.46 U	**0.302**	0.23 U	**0.453**	0.15 U	**0.272**	0.22 U
Cobalt-58	NR	NR	NR	NR	**0.0055**	NR	-0.0173 U	NR	**0.015**	NR	-0.0105 U	NR
Europium 152	0.27 U	0.33 U	0.39 U	0.34 U	-0.0094 U	0.58 U	-0.00276 U	0.19 U	-0.00907 U	0.54 U	**0.00184**	0.06 U
Europium 154	0.22 U	0.20 U	0.24 U	0.25 U	**0.0107**	0.34 U	**0.00629**	0.16 U	**0.0098**	0.28 U	**0.0202**	0.10 U
Europium-155	0.27 U	0.27 U	0.29 U	0.31 U	**0.0105**	0.78 U	**0.00858**	0.33 U	-0.00503 U	0.54 U	**0.0152**	0.34 U
Iron 59	NR	NR	NR	NR	**0.0008**	NR	**0.00597**	NR	-0.0135 U	NR	**0.0243**	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium - 238	NR	NR	NR	NR	-0.0489 U	NR	0 U	NR	-0.0136 U	NR	-0.0112 U	NR
Plutonium 239/240	11,000 U	13,000 U	13,000 U	13,000 U	0 U	28,000 U	-0.0422 U	12,000 U	**0.122**	20,000 U	-0.0111 U	0.31 U
Potassium 40	**9.2**	**9.2**	**11**	**15**	**14.5**	**9.2**	**15.6**	**6.5**	**15.4**	**14**	**18.4**	**1.3**
Radium 226	NR	NR	NR	NR	**0.362**	NR	**0.289**	NR	**0.529**	NR	**0.31**	NR
Radium-224DA	NR	NR	NR	NR	**0.463**	NR	**0.382**	NR	**0.809**	NR	**0.543**	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	**0.577**	NR	**0.45**	NR	**0.863**	NR	**0.558**	NR
Ruthenium 106	0.55 U	0.61 U	0.49 U	0.61 U	NR	0.88 U	NR	0.4 U	NR	0.73 U	NR	0.1 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	NR	NR	NR	NR	**210**	NR	**78.8**	NR	**118**	NR	**52.2**	NR
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	**0.491**	NR	**0.369**	NR	**0.8**	NR	**0.57**	NR
Thorium 232	**0.48**	**0.38**	**0.49**	**0.48**	NR	**0.59**	NR	**0.31**	NR	**0.64**	NR	**0.58**
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	0.47 U	0.45 U	0.46 U	0.5 U	NR	0.12 U	NR	0.5 U	NR	0.87 U	NR	0.31 U
Uranium 238	8.6 U	5.9 U	6.6 U	8.2 U	NR	15 U	NR	4.6 U	NR	8.1 U	NR	0.096 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 14 of 23)

Reference Document.:	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	Quanterra
Location:	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A
Sample ID:	B0GGC3*	B0GLF4	B0GLF5	B0GLF7	B0GLF6	B0GLF8 (Dup)	B0GLF9	B0GLG0	B0GLG1	B0H1V6	B0GL88
Method:											
Sample Collected:	8/25/95	11/29/95	11/30/95	12/5/95	12/5/95	12/5/95	12/6/95	12/6/95	12/8/95	12/8/95	9.0-11.0
Depth (feet below ground surface):	N/A	9-11	11-13	23	28-30	28-30	40	50	57-59	69	11/29/95
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	**13,900**	**941**	**38,200**	2.52 U	2.18 U	3.39 U	1.44 U	0.968 U	1.96 U	**2.77**	**1,980**
Gross beta	**305,000**	**63,700**	**60,600**	**4,310**	**2,810**	**2,490**	**1,680**	**145**	**124**	**123**	**128,000**
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	**17,300**	**856**	**1,130**	NR	NR	NR	NR	NR	NR	NR	**1,110**
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	456 U	402 U	11.2 U	6.5 U	NR	2.51 U	1.17 U	2.44 U	2.45 U	-130 U
Cesium 134	NR	97.9 U	87.8 U	**2.61**	0.282 U	0.225 U	0.097 U	0.076 U	0.144 U	0.161 U	31.1 U
Cesium 137	**102,000**	**12,100**	**15,100**	**2,790**	**5.81**	**5.69**	0.143 U	NR	0.41 U	0.421 U	**15,800**
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	**56,300**	**107,000**	**132,000**	**23.9**	**5.82**	**5.25**	**1.2**	**0.786**	**1.15**	**0.709**	**139,000**
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-120 U
Europium 152	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.85 U
Europium 154	**11,800**	**1,030**	**1,370**	0.978 U	0.557 U	0.567 U	0.286 U	0.294 U	0.524 U	0.49 U	**990**
Europium-155	**4120**	**355**	**304**	5.55 U	2.01 U	1.85 U	0.716 U	0.332 U	0.703 U	0.697 U	**207**
Iron 59	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	139,000
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	140 U	127 U	0.568 U	0.265 U	0.258 U	0.097 U	0.105 U	0.241 U	18.3 U	56.8 U
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	**226**
Plutonium 239/240	**12,700**	NR	**689**	NR	NR	NR	NR	NR	NR	NR	**1,590**
Potassium 40	NR	422 U	457 U	**0.11**	7.02 U	NR	**11.6**	**2.05**	**16.9**	**17**	**879**
Radium 226	NR	1,410 U	1,260 U	45 U	6.77 U	9.28 U	3.36 U	2.07 U	4.94 U	4.53 U	NR
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	104 U
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	NR	1,930 U	1,740 U	29 U	4.81 U	4.69 U	1.85 U	1.76 U	3.52 U	3.36 U	103 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**92,299**	**3,250**	**12,600**	**1,170**	**1,550**	**1,350**	**1,080**	**188**	**63.1**	**54.6**	**9,560**
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	5,270 U	4,650 U	**152**	54.2 U	**50.4**	19.9 U	8.84 U	20.6 U	18.2 U	35.5 U
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	62.2 U
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.677 U
Uranium 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-0.226 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	10.5 U
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 15 of 23)

Reference Document.:	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	222-S	222-S	222-S	222-S	222-S	222-S
Location:	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A
Sample ID:	B0GL89	B0GL91	B0GL92 (Dup)	B0GL94 (EB)	B0GL95	B0GLD2	B0GLD5	B0GLD3	B0GLD4 (Dup)	B0GLD6	B0GLD7
Method:											
Sample Collected:	11.0-13.0	28.0-30.0	28.0-30.0	N/A	57.0-59.0	11/9/95	11/9/95	11/10/95	11/10/95	11/10/95	11/10/95
Depth (feet below ground surface):	11/30/95	12/5/95	12/5/95	12/8/95	12/8/95	14.5-16.5	18	23-25	23-25	28	32.5
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	**2,530**	**7.43**	6.43 U	3.62 U	**6.61**	**1.4**	**51.1**	1.33 U	1.45 U	1.31 U	1.38 U
Gross beta	**131,000**	**4,480**	**5,120**	**2.88**	**293**	**2,280**	**17,600**	**2,690**	**2,770**	**435**	**228**
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	**1,050**	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	62.9 U	-0.57 U	0.0968 U	-0.103 U	-0.0378 U	66.7 U	107 U	22 U	15.5 U	12 U	6.89 U
Cesium 134	4.84 U	-0.01 U	-0.0459 U	-0.00734 U	-0.0177 U	5.54 U	**17.1**	1.5 U	1.32 U	0.962 U	0.622 U
Cesium 137	**12,500**	**2.46**	**6.01**	0.0116 U	0.0144 U	**3,200**	**15,700**	**108**	**84.9**	**24.1**	1.34 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	**120,000**	**4.96**	**5.57**	-0.00425 U	**1.29**	**522**	**3,300**	**10.4**	**14.2**	**3.53**	0.999 U
Cobalt-58	-100 U	0.0383 U	-0.00793 U	-0.0553 U	**0.0116**	NR	NR	NR	NR	NR	NR
Europium 152	71.7 U	0.0936 U	-0.207 U	0.0453 U	0.0341 U	NR	NR	NR	NR	NR	NR
Europium 154	**807**	0.155 U	0.147 U	-0.0017 U	0.0133 U	9.05 U	18.3 U	3.99 U	3.64 U	2.2 U	1.61 U
Europium-155	**141**	0.0209 U	0.133 U	0.0359 U	0.0133 U	16.1 U	24.1 U	6.09 U	4.21 U	3.18 U	1.66 U
Iron 59	120,000	4.96	**5.57**	-0.00425 U	**1.29**	NR	NR	NR	NR	NR	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	19.3 U	0.0983 U	0.047 U	-0.0116 U	0.0357 U	5.05 U	9.49 U	1.35 U	0.978 U	0.943 U	0.591 U
Plutonium - 238	**465**	-0.00126 U	0.00823 U	-0.000822 U	0.00339 U	NR	**11.2**	NR	NR	NR	NR
Plutonium 239/240	**3,340**	0.023 U	**0.0708**	0.00472 U	-0.00156 U	NR	**73.7**	NR	NR	NR	NR
Potassium 40	**55.4**	**9.33**	**9.93**	**0.488**	**15.7**	43.1 U	43.3 U	48.4 U	13 U	35.4 U	15.7 U
Radium 226	NR	NR	NR	NR	NR	121 U	200 U	36.1 U	27.1 U	20.8 U	11.7 U
Radium-224DA	NR	NR	0.552 U	**0.0857**	**0.435**	NR	NR	NR	NR	NR	NR
Radium-226DA	25 U	**0.346 J**	**0.369 J**	**0.189 J**	**0.365 J**	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	**0.562**	NR	NR	NR	NR	NR	NR
Ruthenium 106	-425 U	0.403 U	-0.203 U	-0.0924 U	-0.146 U	109 U	184 U	31.4 U	16.1 U	20 U	10.6 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**19,700**	**1,530**	**1,310**	0.0771 U	**50**	**139**	**785**	**1,410**	**1,380**	**195**	**119**
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	144 U	**0.47**	**0.402**	**0.179**	**0.462**	427 U	651 U	165 U	115 U	81 U	51.7 U
Thorium 232	-156 U	**1.08**	0.388 U	NR	**0.624**	NR	NR	NR	NR	NR	NR
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	-0.672 U	0.0227 U	0.00386 U	0.00388 U	0.0193 U	NR	NR	NR	NR	NR	NR
Uranium 238	9.99 U	**0.363**	**0.441**	0.0127 U	**0.364**	NR	NR	NR	NR	NR	NR
Uranium-234	5.12 U	**0.414**	**0.479**	**0.0347**	**0.302**	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 16 of 23)

Reference Document.:	222-S	222-S	222-S	222-S	222-S	222-S	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra
Location:	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A
Sample ID:	B0GLD8	B0GLD9	B0GLF0	B0GLF1	B0GLF2	B0GLF3	B0GL71	B0GL73	B0GL75 (Dup)	B0GL81	B0GL86
Method:											
Sample Collected:	11/15/95	11/15/95	11/15/95	11/15/95	11/16/95	11/16/95	14.5-16.5	23-25	23-25	42-44	62-63.5
Depth (feet below ground surface):	42-44	47	52	59.5	62-63.5	69	11/9/95	11/10/95	11/10/95	11/15/95	11/16/95
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	1.02 U	1.86 U	2.46 U	1.53 U	**1.65**	1.47 U	**30.1**	**7.69**	**7.6**	**9.33**	2.9 U
Gross beta	**80.9**	**34.8**	**20**	**537**	**272**	**74**	**5,750**	**3,790**	**2,740**	**132**	**328**
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	NR	NR	NR	NR	NR	**6.55**	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	7.42 U	9.32 U	10.1 U	11.1 U	8.47 U	-0.0378 U	-0.638 U	0.163 U	0.259 U	-0.0552 U	-0.0879 U
Cesium 134	0.536 U	0.808 U	0.688 U	0.855 U	0.827 U	0.463 U	**5.28**	-0.0578 U	-0.0252 U	0.0237 U	-0.037 U
Cesium 137	1.73 U	2.27 U	1.7 U	2.52 U	2.06 U	1.86 U	**6,770**	**44.3**	**65.8**	0.00704 U	-0.0205 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.832 U	0.976 U	1.37 U	1.77 U	0.983 U	0.604 U	**1,200**	**7.1**	**9.2**	**0.547**	**0.535**
Cobalt-58	NR	NR	NR	NR	NR	NR	-0.559 U	-0.00341 U	-0.0123 U	0.0425 U	0.0158 U
Europium 152	NR	NR	NR	NR	NR	NR	0.833 U	0.00937 U	0.0632 U	-0.0682 U	-0.00833 U
Europium 154	2.24 U	3.11 U	3.76 U	3.74 U	1.92 U	2.41 U	**8.17**	0.178 U	**0.232**	0.0979 U	-0.0225 U
Europium-155	1.98 U	2.12 U	2.68 U	2.62 U	2.21 U	1.8 U	**2.36**	0.013 U	0.112 U	-0.00806 U	0.109 U
Iron 59	NR	NR	NR	NR	NR	NR	0.221 U	-0.127 U	0.0766 U	-0.219 U	0.0356 U
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	0.589 U	0.969 U	0.988 U	0.876 U	0.719 U	0.765 U	**0.936**	0.0565 U	0.0493 U	-0.0179 U	-0.00807 U
Plutonium - 238	NR	NR	NR	NR	NR	NR	1.17 U	0.105 U	0.0862 U	-0.00376 U	0 U
Plutonium 239/240	NR	NR	NR	NR	NR	NR	**12.6**	0.0211 U	0.301 U	-0.00376 U	-0.00416 U
Potassium 40	27.1 U	35.2 U	12.6 U	25.1 U	16.6 U	30 U	13.7 J	**18.1 J**	**15.8 J**	**10.9 J**	**18.6**
Radium 226	12.9 U	16.2 U	21.8 U	20.3 U	14.7 U	14.1 U	1.54 U	**0.599 J**	**0.808 J**	**0.5 J**	**0.524 J**
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	**0.772**	**0.903**	**0.462**	**0.415**
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	**0.59**	**0.814**	NR
Ruthenium 106	12.6 U	14.4 U	18.9 U	17.6 U	15.8 U	13.6 U	0.378 U	-0.271 U	-0.159 U	0.0126 U	-0.13 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**24.6**	**4.33**	**1.38**	**239**	**24.7**	**129**	**768**	**1430**	**1,740**	**57.9**	**144**
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	48.9 U	63.5 U	75.4 U	74.6 U	61.7 U	50.4 U	0.744 U	**0.883**	**1.08**	**0.748**	**0.635**
Thorium 232	NR	NR	NR	NR	NR	NR	-1.13 U	NR	**1.12**	**0.596**	**0.822**
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	NR	NR	NR	NR	-0.111 U	0.0762 U	0.104 U	0.0324 U	0.0268 U
Uranium 238	NR	NR	NR	NR	NR	NR	**1.74**	0.343 U	**0.842**	**0.487**	**0.48**
Uranium-234	NR	NR	NR	NR	NR	NR	0.111 U	0.407 U	1 U	**0.534**	**0.398**
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 17 of 23)

Reference Document.:	Quanterra	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S
Location:	199-N-108A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A
Sample ID:	B0GL79(EB)	B0H1V7	B0H1V8	B0H1V9	B0H1W1	B0H1W2 (Dup)	B0H1W3	B0H1W4	B0H1W5	B0H5N9
Method:										
Sample Collected:		12/19/95	12/20/95	12/20/95	12/22/95	12/22/95	12/22/95	12/27/95	12/27/95	12/28/95
Depth (feet below ground surface):	11/15/95	8-10	10-12	17-19	24-26	24-26	30	39-41	50	59-61.5
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	2.99 U	**5.26**	**0.969**	1.15 U	**0.981**	1.42 U	**0.912**	1.45 U	**1.15**	0.997 U
Gross beta	2.14 U	**2,440**	**1,610**	**579**	**346**	**319**	**228**	**30.5**	**11.3**	**42.3**
Actinium-228	NR	NR	**0.866**	NR	NR	NR	NR	**0.794**	**0.85**	**0.866**
Americium 241	NR	**6.51**	NR	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	**0.65**	**0.59**	NR	NR	NR	**0.709**	**0.929**	**0.846**
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	0.0565 U	5.29 U	2.29 U	1.57 U	5.79 U	3.33 U	3.02 U	0.936 U	1.03 U	1.05 U
Cesium 134	-0.0188 U	0.478 U	0.105 U	0.0917 U	0.402 U	0.185 U	0.241 U	0.0763 U	0.0843 U	0.0904 U
Cesium 137	0.0135 U	**371**	0.211 U	0.14 U	0.498 U	0.415 U	0.512 U	0.14 U	0.151 U	0.144 U
Chromium 51	-0.0278 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	-0.0278 U	**225**	**3.83**	**1.65**	**1.73**	**1.95**	**2.78**	**0.542**	**1.25**	**1.42**
Cobalt-58	-0.0118 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 152	-0.0386 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 154	0.00875 U	1.05 U	0.332 U	0.287 U	1.2 U	0.654 U	0.681 U	0.264 U	0.34 U	0.311 U
Europium-155	-0.0316 U	1.37 U	0.677 U	0.448 U	1.05 U	1.05 U	0.826 U	0.264 U	0.293 U	0.288 U
Iron 59	-0.0121 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lead-214	NR	NR	**1.09**	**0.788**	NR	NR	NR	**0.787**	**1.62**	**1.16**
Manganese-54	0.00963 U	**1.11**	0.13 U	0.109 U	0.417 U	0.209 U	0.246 U	0.089 U	0.1 U	0.11 U
Plutonium - 238	-0.00608 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	-0.00187 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Potassium 40	5.68 J	**10.1**	**9.18**	**6.56**	17.9 U	7.19	6.38 U	**9.86**	13 U	**13.8**
Radium 226	**0.258 J**	9.32 U	3.28 U	2.29 U	10 U	4.83 U	5.23 U	1.77 U	2.01 U	1.98 U
Radium-224DA	**0.115**	NR	NR	NR	NR	**20.5**	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	**0.0433**	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	-0.0188 U	9.29 U	2.07 U	1.67 U	7.23 U	4.08 U	3.99 U	1.42 U	1.6 U	1.76 U
Ruthenium-103	-0.145 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**0.274**	**1,080**	**866**	**331**	**193**	**147**	**127**	**2.34**	**4.61**	**18.1**
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	**0.27**	36.5 U	18.2 U	12 U	27.6 U	28.3 U	22.9 U	7.23 U	7.82 U	8.16 U
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tin-125	0.0565 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	-0.00146 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 238	**0.0892**	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 18 of 23)

Reference Document.:	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra
Location:	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A
Sample ID:	B0GL97	B0GL99	B0GLB1	B0GLB3	B0GLB4 (Dup)	B0GLB6	B0GLC0	B0GLB8 (EB)
Method:								
Sample Collected: Depth (feet below ground surface):	8-10	10-12	17-19	24-26	24-26	39-41	59.5-61.5	
	12/19/95	12/20/95	12/20/95	12/22/95	12/22/95	12/27/95	12/28/95	12/27/95
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	39.8	6.69	5.7	5.52	6.8	5.79	4.53	-0.906
Gross beta	3170	2450	808	530	491	64	60.5	1.53
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	14.2	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	2.36	-0.079	-0.176	-0.0485	-0.131	-0.0915	-0.173	-0.0309
Cesium 134	0.633	-0.0107	-0.00192	-0.0138	-0.0137	0.0031	-0.0296	-0.0113
Cesium 137	573	0.522	0.143	0.0587	0.0337	0.00348	-0.0148	-0.00721
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	379	4.51	2.37	1.57	1.43	0.546	1.48	-0.00818
Cobalt-58	0.268	-0.03	-0.0036	0.00897	0.00889	-0.0391	0.00725	-0.013
Europium 152	NR	NR	NR	NR	NR	NR	NR	NR
Europium 154	2.86	0.00621	0.106	0.164	0.129	0.0456	0.0676	-0.00481
Europium-155	2.02	0.0156	0.0136	0.0912	-0.0231	0.0212	-0.0203	-0.00461
Iron 59	0.236	-0.135	-0.0845	-0.131	-0.127	0.0867	-0.0488	0.0232
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	2.74	-0.000466	-0.0106	0.00315	0.0234	0.00878	0.0152	0.0205
Plutonium - 238	3.81	0	0.0751	0	0.0142	-0.00257	0.00589	-0.00105
Plutonium 239/240	24.1	0.385	0.15	0.0246	-0.00228	0	0.0103	-0.00105
Potassium 40	12.5	9.01	9.62	8.03	7.93	8.62	12.4	4.19
Radium 226	NR	NR	NR	NR	NR	NR	NR	NR
Radium-224DA	NR	0.353	0.422	0.473	0.477	0.535	0.627	0.125
Radium-226DA	1.58	0.322	0.368	0.415	0.304	0.358	0.34	0.116
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	0.481	NR	NR	NR	0.434	NR
Ruthenium 106	2.44	0.178	0.205	0.153	-0.162	0.245	0.0541	-0.00963
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	1340	1230	401	226	200	27.7	16	-0.013
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	0.535	0.409	0.42	0.406	0.498	0.574	0.567	0.304
Thorium 232	-0.167	NR	0.622	0.504	0.156	0.682	0.616	0.134
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	-0.21	0.0846	0.0333	-0.00422	0.00763	0.0169	0.0291	0.00324
Uranium 238	0.776	0.564	0.44	0.435	0.531	0.5	0.418	0.0278
Uranium-234	1.36	0.451	0.727	0.642	0.354	0.348	0.454	0.0509
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 19 of 23)

Reference Document.:													
Location:	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1	RW #1
Sample ID:													
Method:													
Sample Collected:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82
Depth (feet below ground surface):	5	10	15	20	25	30	35	40	45	50	55	60	65
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium 134	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium 137	0.664	0.746	0.671	0.735	0.548	0.631	0.258	0.772	1.15	0.488	3.96	0.641	0.211
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.598	0.745	0.779	0.836	0.906	2.17	0.23	2.17	9.9	9	10.5	6.56	4.38
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 152	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron 59	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lead-214	0.408	0.428	0.424	0.385	0.4	0.375	0.441	0.668	0.376	0.347	0.362	0.389	0.454
Manganese-54	0.063	0.043	0.053	0.05	0.024	0.203	0.019	0.206	0.521	0.0383	0.658	0.143	0.043
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Potassium 40	9.3	10.3	10.3	7.6	8.21	4.74	10.08	8.16	8.52	8.41	9.57	10.70	13.30
Radium 226	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	0.04 U	0.04 U	0.05 U	0.04 U	0.064 U	0.063 U	0.04 U	0.05 U	1.6	1.39	1.47	1.2	1.3
Ruthenium-103	0.019	0.012	0.026	0.011 U	0.016	0.014 U	0.013 U	0.017 U	0.253	0.163	0.185	0.162	0.191
Strontium 90	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tin-125	0.115	0.145	0.131	0.194	0.189	0.102	0.013 U	0.057	2.99	2.91	3.13	2.25	1.76
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 20 of 23)

Reference Document.:												
Location:	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2
Sample ID:												
Method:												
Sample Collected:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82
Depth (feet below ground surface):	5	10	15	20	25	30	35	40	45	50	55	60
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium 134	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium 137	0.014	0.018	0.008	0.015	0.012	0.007 U	0.015	0.01	0.004 U	0.004 U	0.02 U	0.006 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.065	0.065	0.067	0.014	0.018	0.017	0.005	0.004 U	0.025	0.227	0.957	1.22
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 152	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron 59	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lead-214	0.432	0.448	0.319	0.519	0.303	0.359	0.324	0.331	0.356	0.322	0.349	0.363
Manganese-54	0.008	0.013 U	0.013	0.006 U	0.004 U	0.007 U	0.006 U	0.003 U	0.004 U	0.004 U	0.02 U	0.007 U
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Potassium 40	9.75	8.95	7.26	11.41	7.26	6.38	6.60	7.63	8.28	8.13	NR	10.30
Radium 226	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	0.04 U	0.04 U	0.06	0.05 U	0.03 U	0.06 U	0.03 U	0.03 U	0.03 U	0.04 U	0.23 U	0.157
Ruthenium-103	0.008 U	0.008	0.006 U	0.01 U	0.007 U	0.01 U	0.008 U	0.006 U	0.007 U	0.008 U	0.04 U	0.024
Strontium 90	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tin-125	0.013 U	0.013	0.01 U	0.041	0.014 U	0.019 U	0.01 U	0.01 U	0.01 U	0.062 U	0.623	0.707
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 21 of 23)

Reference Document.:												
Location:	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2	RW #2	RW #3	RW #3	RW #3	RW #3
Sample ID:												
Method:												
Sample Collected:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82
Depth (feet below ground surface):	65	70	75	80	85	90	95	100	5	10	15	20
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium 134	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium 137	0.01 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.043 U	0.023	0.017 U	0.025	0.009
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.905	0.623	1.48	0.654	0.16	0.185	0.17	0.211	0.054	0.019	0.019	0.006
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 152	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron 59	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lead-214	0.331	0.339	0.416	0.384	0.278	0.395	0.371	0.408	0.366	0.381	0.314	0.344
Manganese-54	0.01 U	0.02 U	0.03 U	0.03 U	0.02 U	0.03 U	0.02 U	0.006 U	0.006	0.004 U	0.006 U	0.003 U
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Potassium 40	9.47	9.99	11.60	10.60	8.83	9.07	9.47	10.80	7.10	7.19	5.91	2.39
Radium 226	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	0.255	0.19 U	0.6	0.2 U	0.2 U	0.2 U	0.2 U	0.078	0.03 U	0.03 U	0.05 U	0.03 U
Ruthenium-103	0.03 U	0.116	0.05 U	0.04 U	0.04 U	0.03 U	0.06 U	0.008 U	0.004 U	0.005 U	0.009 U	0.007 U
Strontium 90	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tin-125	0.647	0.64	0.938	0.519	0.273	0.255 U	0.192 U	0.142	0.01 U	0.01 U	0.028	0.01 U
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

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Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 22 of 23)

Reference Document.:												
Location:	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3	RW #3
Sample ID:												
Method:												
Sample Collected:	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82	8/1/82
Depth (feet below ground surface):	25	30	35	40	50	55	60	65	70	75	80	85
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium 134	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium 137	0.003 U	0.009	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.004 U	0.005 U	0.004 U	0.004 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.009	0.009	0.008	0.009	0.009	0.20	0.392	0.678	1.55	1.51	0.366	0.22
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 152	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Iron 59	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lead-214	0.326	0.337	0.348	0.338	0.385	0.376	0.323	0.354	0.353	0.352	0.381	0.363
Manganese-54	0.003 U	0.003 U	0.004	0.005 U	0.005 U	0.004 U	0.007 U	0.008 U	0.009 U	0.006 U	0.004 U	0.004 U
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Potassium 40	5.48	4.83	1.95	5.91	1.24	5.92	2.04	0.72	4.36	3.55	4.48	1.91
Radium 226	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	0.03 U	0.03 U	0.03 U	0.03 U	0.03 U	0.04 U	0.04 U	0.04 U	0.278	0.367	0.097 U	0.04 U
Ruthenium-103	0.005 U	0.005 U	0.006 U	0.006 U	0.008 U	0.006 U	0.008 U	0.009 U	0.037	0.034	0.025 U	0.024
Strontium 90	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tin-125	0.01 U	0.009 U	0.01 U	0.01 U	0.01 U	0.033 U	0.112	0.372	0.88	1.12	0.39	0.268
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 23 of 23)

Reference Document.:				
Location:	RW #3	RW #3	RW #3	RW #3
Sample ID:				
Method:				
Sample Collected:	8/1/82	8/1/82	8/1/82	8/1/82
Depth (feet below ground surface):	90	95	100	105
Units:	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR
Actinium-228	NR	NR	NR	NR
Americium 241	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR
Cadium-109	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR
Cesium 134	NR	NR	NR	NR
Cesium 137	0.005 U	0.004 U	0.004 U	0.004 U
Chromium 51	NR	NR	NR	NR
Cobalt 60	**0.165**	**0.141**	**0.093**	**0.159**
Cobalt-58	NR	NR	NR	NR
Europium 152	NR	NR	NR	NR
Europium 154	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR
Iron 59	NR	NR	NR	NR
Lead-214	**0.362**	**0.384**	**0.368**	**0.932**
Manganese-54	0.005 U	0.005 U	0.004 U	0.005 U
Plutonium - 238	NR	NR	NR	NR
Plutonium 239/240	NR	NR	NR	NR
Potassium 40	**8.42**	**6.76**	**6.54**	**5.95**
Radium 226	NR	NR	NR	NR
Radium-224DA	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR
Ruthenium 106	0.05 U	0.04 U	0.03 U	0.05 U
Ruthenium-103	0.011 U	0.011 U	0.009 U	0.006 U
Strontium 90	NR	NR	NR	NR
Technetium 99	NR	NR	NR	NR
Thorium 228	NR	NR	NR	NR
Thorium 232	NR	NR	NR	NR
Tin-125	**0.119**	**0.094**	**0.031**	**0.037**
Tritium	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR
Uranium 235	NR	NR	NR	NR
Uranium 238	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR

U = Concentration undetected at specified detection levels
J = Estimated value
NR = Not reported
Dup = Duplicate
EB = Equipment Blank
Gb = Grab Sample
ST = Split Tube
Negative radionuleide results - Radioactive results are measured as decay counts (e.g. counts per/minute) An average background count subtraction is applied, which may be more than the specific sample count, therefore a negative result is possible.
DA (daughters) = Actual gamma lines are measured from a daughter isotope with assumed equilibrium with the reported parent.
EAL = Environmental Analytical Laboratory
PNNL = Pacific Northwest National Laboratory
References:
TMA NORCAL = Summary Data Section, Reporting Group 7032, 8/6/92 p. 11-19
DOE/RL-93-80 = Limited Field Investigation Report for the 100-NR-1 Operable Unit
100-NR-1 = Summary of Maximum Concentrations for Radionuclides, p.1, 2 and 3.
WHC-SD-EN-DP-056, Rev. 0-A = Sediment Chemistry For Wells N-75, N-76, N-77, p. B19.
BHI-00446 Rev. 0 = Well Drilling Summary Report for Well 199-N-106A
BHI-00135, Rev.1 = N-Springs Barrier Wall Drilling Program Data Package
BHI-00420, Rev. 0 = N Spings Pump and Treat Well Drilling Summary Report

Table A8-2. Volatile Organic Compounds Detected in Soil Borings Near 1301-N and 1325-N in 1992

Concentration (mg/Kg)

Location	Sample ID	Depth (feet below ground surface)	Methylene Chloride	Acetone	Carbon Disulfide	Chloroform	Toluene	2-Butanone
199-N-75 (April 1992)		2-3	4 J	17	ND	ND	2 J	ND
		5-6	4 J	8 J	1 J	ND	ND	ND
		9	4	22	ND		ND	ND
		56-58	28	51 J	2 J		ND	ND
		56-58*	11 B	49 B	ND	3 BJ	ND	ND
		68-70	5 J	20 J	ND	ND	ND	ND
199-N-76 (April 1992)		2-3	3 J	12 J	ND	ND	ND	ND
		5-6	8 J	ND	ND	ND	ND	ND
		24-25	3 J	31 J	ND	ND	ND	ND
		24-25	4 J	40 J	ND	ND	ND	ND
		55-57	55	120 J	ND	ND	ND	ND
		55-57*	10 BJ	55 B	ND	3 BJ	ND	ND
199-N-80 (July 1992)	B06M60	44-46	6 J	23 J	ND	ND	4 J	ND
	B06M37	50-52	3 J	13 B	ND	ND	ND	ND
	B06M62	50-52	ND	9 J	ND	ND	ND	ND
	B072P4	61-63	ND	16	ND	ND	ND	ND
	B072P5	70-72	ND	ND	ND	ND	3 J	ND
	B072P7	75-77	ND	ND	ND	ND	7 J	ND
	B072P9	96-99	5 J	ND	ND	ND	6 J	8 J

B = The analyte is found in the associated blank as well as the sample.
J = The associated numerical value is an estimated quantity.
BJ = Value less than the required Detection Limit, but greater than or equal to the IDL. The data has been qualified as an estimate.
ND = Table indicates not detected at specified detection level. However, the reference indicates the sample was less than the concentration indicated.
* = Lab rerun.
Reference: DOE/RL-93-80, Rev. 0 = HEIS Data Base

Table A8-3. Semivolatile Organics Compounds Detected in Soil Near 1301-N/1325-N in 1992 (Page 1 of 2)

Location:	Soil from Well199-N-75						Soil from Well 199-N-76			
Sample ID:	B06837	B06838	B06839	B06843	B06843	B06845	B06835	B06836	B06841	B06841
Collection Date:	April 1992	April 1992	April 1992	April 1992	April 1992	April 1992	April, 1992	April, 1992	April, 1992	April, 1992
epth (feet below ground surface)	2-3	5-6	9	56-58	56-58 *	68-70	2-3	5-6	24-25	24-25
Units:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-chloroisopropyl) ether	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	ND	ND	ND	ND	ND	0.061 J	ND	ND	0.53 J	ND
Butylbenzylphthalte	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	0.051 J	0.042 J	ND	0.76 J	ND	0.11 J	0.063 J	0.056 J	0.056 J	ND
Di-n-octylphthalte	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dimethylphthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine (1)	ND	ND	0.11 J	ND	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table A8-3. Semivolatile Organics Compounds Detected in Soil Near 1301-N/1325-N in 1992 (Page 2 of 2)

Location:	Soil from Well 199-N-76			Soil from Well 199-N-80		
Sample ID:	B06842	B06842	B06844	B06M60	B06M61	B06M37
Collection Date:	April, 1992	April, 1992	April, 1992	July, 1992	July, 1992	July, 1992
Depth (feet below ground surface)	55-57	55-57*	64.5-66.5	44-46	44-46	50-52
Units:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
2,4-Dichlorophenol	ND	ND	ND	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND	ND	ND	ND
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND
4-Methyl-2-Pentanone	ND	ND	0.007 J	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND	ND
bis(2-chloroisopropyl) ether	ND	ND	ND	ND	ND	ND
bis(2-Ethylhexyl)phthalate	ND	ND	0.063 J	ND	0.26 J	ND
Butylbenzylphthalte	ND	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND	ND
Di-n-butylphthalate	0.1 J	ND	0.099 J	0.044 J	ND	0.039
Di-n-octylphthalte	ND	ND	ND	ND	ND	ND
Dibenzofuran	ND	ND	ND	ND	ND	ND
Diethylphthalate	ND	ND	ND	ND	ND	ND
Dimethylphthalate	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND
Isophorone	ND	ND	ND	ND	ND	ND
N-Nitrosodiphenylamine (1)	ND	ND	ND	ND	ND	ND
Naphthalene	ND	ND	ND	ND	ND	ND
Nitrobenzene	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND

ND = Not detected
J =Estimated value
B = The analyte is found in the associated blank as well as the sample.
Reference: Hanford Environmental Information System (HEIS)

Table A8-4. Inorganics Compounds Detected in Soil Near 1301-N and 1325-N in 1992 (Page 1 of 2)

Location:	Soil from Well 199-N-75					Soil from Well 199-N-76					
Sample ID:	B06837	B06838	B06839	B06843	B06845	B06835	B06836	B06840	B06841	B06842	B06844
Collection Date:	4/17/92	4/17/92	4/17/92	4/29/92	4/30/92	4/17/92	4/17/92	4/22/92	4/22/92	4/22/92	4/30/92
Depth (feet below ground surface)	2-3	5-6	9	56-58	68-70	2-3	5-6	24-25	24-25	55-57	64.5-66.5
Analyte: Units:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Aluminum	6,720	6,470	5,720	6,300	4,480	6,440	5,750	7,020	7,670	5,740	3,920
Arsenic	2.6	2.3	2.3	1.6 B	0.78 B	2.6	2.2	3.6	3.0	1.8 B	0.92 B
Barium	59	62.3	60.6	63.9	62	51.7	51	61.4	69.7	74.6	52.8
Beryllium	0.24 B	0.24 B	0.24 B	ND	ND	0.21 B	0.2 B	0.27 B	0.26 B	ND	ND
Cadmium	0.43 B	0.61 B	0.49 B	ND	ND	0.48 B	0.52 B	ND	ND	0.57 B	0.9 B
Calcium	6,780	6,380	7,370	2,590	2,240	7,040	5,980	5,670	5,790	2,530	4,480
Chromium	8.5	8.7	7.6	14.7	7.8	8.2	8.3	10	11.3	11.4	8.9
Cobalt	9.8 B	9.3 B	9.4 B	5.7 B	5.2 B	9.8 B	9.2 B	11 B	11.4	5.8 B	5.3 B
Copper	15.4	14.5	15.8	13.5	9.0	18.7	18.4	25.9	20	15.7	9.7
Iron	17,400	17,100	18,100	11,000	9,820	18,100	18,500	21,400	21,400	10,800	9,230
Lead	5.1	4.2	4.2	2.7	2.3	4.5	3.4	7.6	6.9	3.4	2.9
Magnesium	4,460	4,390	4,400	4,350	2,230	4,460	4,220	5,460	5,410	3,610	2,100
Manganese	320	296	317	227	182	269	262	328	345	345	206
Mercury	ND	ND	ND	ND	ND	ND	0.11	ND	ND	ND	ND
Nickel	11	9.6	9.2	14.4	8.4	10.4	10.2	12	13	14.8	8.6
Phosphorus	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	1,350	1,240	1,210	919 B	689 B	1040	855 B	1,220	1,350	831 B	639 B
Silver	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sodium	204 B	171 B	164 B	203 B	246 B	190 B	172 B	282 B	314	178 B	198 B
Strontium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	0.43 B	ND	ND	0.43 B	ND	ND	ND	ND	ND
Vanadium	35.5	36.8	33.9	23.1	23.6	34.1	36	43	45.4	22.3	22.9
Zinc	41.1	42.8	40.2	29	20.9	41.8	40.4	45	46.9	33.8	39.6
Zirconium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table A8-4. Inorganics Compounds Detected in Soil Near 1301-N and 1325-N in 1992 (Page 2 of 2)

Location:	Soil from Well 199-N-80								
Sample ID:	B06M58	B06M60	B06M61	B06M37	B06M62	B072P4	B072P5	B072P7	B072P9
Collection Date:	Jul-92	Jul-92	Jul-92	Jul-92	Jul-92	Jul-92	Jul-92	Jul-92	Jul-92
Depth (feet below ground surface)	3.5-5	45-47	45-47	50-52	50-52	57-59	68-70	75-77	95.7-99
Analyte: Units:	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
Aluminum	ND	3130 J	ND	ND	ND	ND	ND	ND	3690 J
Arsenic	ND	ND	ND	ND	1.7 B	ND	ND	ND	ND
Barium	ND	ND	ND	ND	ND	ND	ND	29.2 B	ND
Beryllium	ND	0.37 B	ND	ND	ND	ND	ND	ND	ND
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Calcium	ND	ND	4800 J	ND	ND	ND	ND	ND	ND
Chromium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cobalt	ND	10.7 B	ND	7.3 B	7.2 B	4.8 B	4.4 B	ND	4.6 B
Copper	ND	ND	ND	ND	ND	ND	ND	ND	
Iron	ND	ND	6470 J	ND	ND	ND	ND	ND	9890 J
Lead	ND	ND		ND	ND	ND	ND	ND	ND
Magnesium	ND	ND	2040 J	ND	ND	ND	ND	ND	135 J
Manganese	ND	ND	135 J	ND	ND	ND	ND	ND	0.05 B
Mercury	ND	ND	ND	ND	ND	ND	ND	ND	ND
Nickel	ND	ND	ND	ND	ND	ND	ND	4.9 B	ND
Phosphorus	ND	ND	ND	ND	ND	ND	ND	ND	ND
Potassium	ND	ND	ND	655 B	590 B	535 B	976 B	645 B	433 B
Silver	ND	1.2 B	ND	ND	ND	ND	ND	ND	1.1 B
Sodium	ND	227 B	ND	154 B	179 B	104 B	233 B	112 B	149 B
Strontium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	ND	ND	ND	ND	ND	ND	ND	ND	ND
Vanadium	42.4 J	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	39.7 J	ND	21.6 J	ND	ND	ND	ND	ND	ND
Zirconium	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND =Not detected
J = Estimated value
B = The analyte is found in the associated blank as well as the sample.
References:
HEIS = Hanford Environmental Information System
WHC-SD-EN-DP-056, Rev. 0-A

Table A8-5. Metals Analysis on Soil Borings

	Sample 2-1 mg/Kg	Sample 2-2 mg/Kg	Sample 3-1 mg/Kg	Sample 3-2 mg/Kg
Aluminum	**2,027**	**1,314**	**2,494**	**848**
Boron	**13.6**	12 U	13 U	10.4 U
Chromium	**5.4**	3.6 U	6.4 U	8.5 U
Cobalt	11.5 U	3.8 U	6.9 U	7.8 U
Copper	**9.4**	**6.1**	**9.8**	**5.2**
Iron	**7,536**	**3,463**	**9,902**	**2,026**
Manganese	**153**	**100**	**182**	**65.7**
Molybdenum	**9.2**	12.0 U	11 U	11.4 U
Nickel	13.5 U	9.1 U	6.4 U	10.2 U
Silicon	**2,482**	**1,412**	**3,283**	**857**
Vanadium	21.2 U	11.6 U	12 U	11.2 U
Zinc	**82.5**	**114**	**89.3**	**98.3**

Samples collected from RW #1, #2, or #3 in FY 82.
Concentrations are the average of two results.
U = Concentration undetected at specified detection level
-- = No result reported
Reference: NUREG/CR-3712 = Radionuclide Migration in Groundwater, Annual Report for FY 1983., p. 48.

APPENDIX A-9

100N SURFACE SOIL SAMPLES

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 1 of 19)

Reference Document:	UNI-2640	UNI-2640	UNI-2640	UNI-2640	UNI-2640	UNI-2640	UNI-2640	UNI-2640	UNI-2640	UNI-2640
Location:	N-01	N-02	N-03	N-04	N-05	N-06	N-07	N-08	N-01	N-02
Collection Date:	1982	1982	1982	1982	1982	1982	1982	1982	1983	1983
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	ND	ND
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	NR	NR	NR	NR	NR	NR	NR	NR	**0.36**	**7.5**
Cobalt-60	NR	NR	NR	NR	NR	NR	NR	NR	**1.7**	**2.0**
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR	**0.12**	**0.70**
Plutonium-238	**0.0055**	**0.0046**	**0.0045**	**0.0052**	**0.0023**	**0.002**	**0.0072**	**0.0081**	NR	NR
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR	-0.059	-0.502
Plutonium-239/240	**0.011**	**0.037**	**0.0096**	**0.014**	**0.019**	**0.0049**	**0.002**	**0.0082**	NR	NR
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.069**	**0.49**	**0.34**	**0.23**	**0.22**	**0.074**	**0.044**	**0.18**	NR	NR
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR	-0.030	-0.276
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 2 of 19)

Reference Document:	UNI-2640	UNI-2640	UNI-2640	UNI-2640	UNI-2640	UNI-2640	UNI-3069	UNI-3069	UNI-3069	UNI-3069
Location:	N-03	N-04	N-05	N-06	N-07	N-08	N-01	N-02	N-03	N-04
Collection Date:	1983	1983	1983	1983	1983	1983	1984	1984	1984	1984
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	ND	NR	ND	ND	ND	ND	ND	ND	ND	ND
Europium-154	NR	NR	NR	NR	NR	NR	ND	**0.35**	ND	**0.35**
Europium-155	ND	ND	ND	ND	ND	ND	NR	NR	NR	ND
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	**3.9**	**3.6**	**3.4**	**0.26**	**0.29**	**0.78**	**0.63**	ND	ND	**2.5**
Cobalt-60	**11**	**5.3**	**7.1**	**0.40**	**0.58**	**7.1**	**2.4**	**5.5**	**1.8**	**3.8**
Manganese-54	**0.75**	**0.23**	**0.27**	ND	ND	**0.21**	ND	**0.27**	**0.15**	**0.19**
Plutonium-238	NR	NR	NR	NR	NR	NR	**0.00084**	**0.014**	**0.0014**	**0.0011**
Plutonium-239	-0.378	-0.241	-0.221	-0.077	-0.045	-0.192	NR	NR	NR	NR
Plutonium-239/240	NR	NR	NR	NR	NR	NR	**0.0064**	**0.067**	**0.0056**	**0.0049**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	NR	NR	NR	NR	NR	NR	**0.19**		**0.21**	**0.15**
Strontium-91	-0.212	**-0.133**	-0.121	-0.142	-0.024	-0.106	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 3 of 19)

Reference Document:	UNI-3069	UNI-3069	UNI-3069	UNI-3069	UNI-3069	UNI-3069	UNI-3069	UNI-3069	UNI-3760	UNI-3760
Location:	N-05	N-06	N-07	N-08	N-09	N-10	N-11	N-12	N-01	N-02
Collection Date:	1984	1984	1984	1984	1984	1984	1984	1984	1985	1985
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
Europium-154	ND	ND	ND	ND	ND	ND	ND	ND	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	0.14	0.55	0.19	1.3	0.43	0.41	0.43	1.0	0.56	2.5
Cobalt-60	0.59	0.35	0.52	2.1	1	0.62	0.76	0.79	4.2	17
Manganese-54	0.12	ND	ND	ND	ND	ND	ND	ND	0.13 U	4.2
Plutonium-238	0.000081	0.00054	0.00017	0.00037	0.0061	0.00084	0.00068	0.001	NR	NR
Plutonium-239		NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	0.00071	0.0053	0.0014	0.017	0.038	0.0064	0.0056	0.025	0.013	0.021
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	0.05	0.55	0.04	0.21	0.21	0.06	0.53	0.38	0.15	0.28
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zirconium-95	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 4 of 19)

Reference Document:	UNI-3760	UNI-3760	UNI-3760	UNI-3760	UNI-3760	UNI-3760	UNI-3760	UNI-3760	UNI-3760	UNI-3760
Location:	N-03	N-04	N-05	N-06	N-07	N-08	N-09	N-10	N-11	N-12
Collection Date:	1985	1985	1985	1985	1985	1985	1985	1985	1985	1985
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	14	1.6	0.64	0.21	1	0.058	0.22	0.52	NA	1.1
Cobalt-60	38	1.9	1.2	0.35	1.5	0.64	0.50	0.78	NA	3.6
Manganese-54	1.4	0.13	0.14	0.076 U	0.12	0.1	0.050	0.084 U	NA	0.19
Plutonium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239	0.11	NR	0.0051	NR	NR	0.0017	NR	0.0081	0.017	0.018
Plutonium-239/240	0.11	0.0096	NR	0.0041	0.035	0.0017	0.0042	0.0081	0.017	0.018
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	2.6	0.15	0.094	0.12	0.23	0.064	0.0780	0.099	0.13	0.18
Strontium-91	2.6	NR	NR	NR	NR	NR	NR	0.099	0.13	0.18
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 5 of 19)

Reference Document:	UNI-4065	UNI-4065	UNI-4065	UNI-4065	UNI-4065	UNI-4065	UNI-4065	UNI-4065	UNI-4065	UNI-4065
Location:	N-01	N-02	N-03	N-04	N-05	N-06	N-07[b]	N-08[b]	N-09[b]	N-10[b]
Collection Date:	1986	1986	1986	1986	1986	1986	1986	1986	1986	1986
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	**1.1**	**0.63**	**10**	**0.43**	**0.22**	**0.12**	**1.4**	**0.58**	**0.32**	**0.26**
Cobalt-60	**3.7**	**2.4**	**15**	**0.85**	**0.28**	**0.23**	**0.4**	**0.63**	**0.27**	**0.37**
Manganese-54	**0.16**	**0.2**	**0.34**	**0.050**	**0.062**	0.072 U	0.089 U	0.087 U	0.076 U	0.072 U
Plutonium-238	**0.0045**	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239	NR	NR	NR	NR	**0.0017**	NR	NR	NR	NR	**0.0051**
Plutonium-239/240	**0.02**	**0.012**	**0.046**	**0.0041**	NR	**0.0013**	**0.024**	**0.0083**	**0.0053**	**0.0051**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.13**	**0.14**	**0.67**	**0.12**	**0.028**	**0.021**	**0.15**	**0.089**	**0.0680**	**0.083**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR	NR	**0.083**
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 6 of 19)

Reference Document:	UNI-4065	UNI-4065	UNI-4065	WHC-EP	WHC-EP	WHC-EP	WHC-EP	WHC-EP-0161	WHC-EP-0161
Location:	N-11	N-12	N-12	N-02	N-03	N-04	N-05	N-06	N-07
Collection Date:	1986	1986	1986	1987	1987	1987	1987	1987	1987
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	**0.74**	0.075 U	**0.084**	**2.3**	**2.2**	**1.3**	**0.54**	**0.31**	0.93 U
Cobalt-60	**0.85**	**0.12**	**0.34**	**7.9**	**11**	**1.0**	**0.52**	**0.52**	**0.44**
Manganese-54	**0.27**	0.07 U	0.1 U	**0.22**	**0.87**	0.099 U	0.10 U	0.086 U	0.089 U
Plutonium-238	NR	NR	**0.00011**	**0.0045**	**0.0075**	**0.0037**	**0.0060**	**0.0021**	**0.0012**
Plutonium-239	**0.013**	**0.00054**	NR	NR	NR	NR	**0.0036**	NR	NR
Plutonium-239/240	**0.013**	**0.00054**	**0.0005**	**0.031**	**0.045**	**0.0078**	NR	**0.0053**	**0.016**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.14**	**0.03**	**0.03**	**0.53**	**0.59**	**0.16**	**0.069**	**0.12**	**0.19**
Strontium-91	**0.14**	**0.03**	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 7 of 19)

Reference Document:	WHC-EP-0161	WHC-EP-0161	WHC-EP-0161	WHC-EP-0258	WHC-EP-0258	WHC-EP-0258	WHC-EP-0258	WHC-EP-0258
Location:	N-09	N-10	N-11	N-01	N-02	N-03	N-04	N-05
Collection Date:	1987	1987	1987	1988	1988	1988	1988	1988
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	**0.11**	**0.3**	**0.62**	**0.2**	**8**	**0.75**	**0.61**	**0.4**
Cobalt-60	**0.21**	**0.54**	**0.4**	**1.9**	**0.25**	**11**	**0.62**	**0.39**
Manganese-54	0.075 U	0.1 U	0.094 U	0.078 U	0.21 U	**0.32**	**0.033**	0.066 U
Plutonium-238	**0.00035**	**0.00048**	**0.0021**	**0.00054**	**0.0063**	**0.0037**	**0.00081**	**0.00038**
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	**0.0011**	**0.007**	**0.01**	**0.0047**	**0.038**	**0.033**	**0.0093**	**0.0017**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.0530**	**0.11**	**0.15**	**0.046**	**0.75**	**0.71**	**0.14**	**0.092**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 8 of 19)

Reference Document:	WHC-EP-0258	WHC-EP-0258	WHC-EP-0258	WHC-EP-0258	WHC-EP-0258	WHC-EP-0258	WHC-EP-0258	WHC-EP-0258-1
Location:	N-06	N-07	N-08	N-09	N-10	N-11	N-12	N-01
Collection Date:	1988	1988	1988	1988	1988	1988	1988	1989
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	**0.33**	**0.7**	**0.4**	**0.35**	**0.25**	**0.6**	**0.13**	**0.34**
Cobalt-60	**0.34**	**0.17**	**0.35**	**0.3**	**0.48**	**0.57**	**0.15**	**2.7**
Manganese-54	0.065 U	0.06 U	0.076 U	0.061 U	0.066 U	0.074 U	0.066 U	0.051 U
Plutonium-238	**0.000027**	**0.00072**	**0.00026**	**0.00031**	**0.00055**	**0.0012**	**0.000095**	**0.000032**
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	**0.006**	**0.018**	**0.013**	**0.008**	**0.0058**	**0.015**	**0.00052**	**0.0088**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.2**	**0.25**	**0.16**	**0.15**	**0.091**	**0.22**	**0.023**	**0.054**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 9 of 19)

Reference Document:	WHC-EP-0258-1	WHC-EP-0258-1	WHC-EP-0258-1	WHC-EP-0258-1	WHC-EP-0258-1	WHC-EP-0258-1	WHC-EP-0258-1	WHC-EP-0258-1
Location:	N-02	N-03	N-04	N-05	N-06	N-07	N-08	N-09
Collection Date:	1989	1989	1989	1989	1989	1989	1989	1989
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	**0.85**	**0.56**	**0.53**	**0.21**	**0.088**	**0.3**	**0.2**	**0.059**
Cobalt-60	**2.3**	**5.9**	**0.31**	**0.33**	**0.15**	**0.089**	**0.23**	**0.044**
Manganese-54	0.065 U	**0.13**	0.038 U	**0.043**	0.041 U	0.033 U	0.049 U	0.036 U
Plutonium-238	**0.0028**	**0.028**	**0.00071**	**0.00023**	**0.00034**	**0.00051**	**0.0057**	**0.00053**
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	**0.0016**	**0.17**	**0.016**	**0.0033**	**0.0064**	**0.027**	**0.043**	**0.007**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.25**	**0.22**	**0.17**	**0.038**	**0.13**	**0.19**	**0.34**	**0.66**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 10 of 19)

Reference Document:	WHC-EP-0258-1	WHC-EP-0258-	WHC-EP-0258-1	WHC-EP-0258-2	WHC-EP-0258-2	WHC-EP-0258-2	WHC-EP-0258-2	WHC-EP-0258-2
Location:	N-10	N-11	N-12	N-01	N-02	N-03	N-04	N-05
Collection Date:	1989	1989	1989	1990	1990	1990	1990	1990
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-137	0.063 U	**0.17**	**0.039**	**0.27**	**3.8**	**4**	**0.27**	**0.29**
Cobalt-60	0.066 U	**0.25**	**0.14**	**1.7**	**4.8**	**16**	**0.79**	**0.38**
Manganese-54	0.046 U	0.042 U	0.046 U	NR	NR	NR	NR	NR
Plutonium-238	**0.00033**	**0.00013**	0.000032 U	**0.0011**	**0.0044**	**0.016**	**0.00083**	**0.00042**
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	**0.0062**	**0.0025**	**0.00073**	**0.0075**	**0.046**	**0.11**	**0.0074**	**0.0031**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.082**	**0.042**	**0.013**	**0.076**	**0.067**	**1.30**	**0.11**	**0.056**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 11 of 19)

Reference Document:	WHC-EP-0258-2	WHC-EP-0258-2	WHC-EP-0258-2	WHC-EP-0258-2	WHC-EP-0258-2	WHC-EP-0258-2	WHC-EP-0258-2	WHC-EP-0573
Location:	N-06	N-07	N-08	N-09	N-10	N-11	N-12	N-01
Collection Date:	1990	1990	1990	1990	1990	1990	1990	1991
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	-0.049 U
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	0.36 U
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	-0.15 U
Europium-155	NR	NR	NR	NR	NR	NR	NR	**0.19**
Cerium-144	NR	NR	NR	NR	NR	NR	NR	0.35 U
Cesium-134	NR	NR	NR	NR	NR	NR	NR	-0.37 U
Cesium-137	**0.37**	**0.99**	**1.0**	**0.11**	**0.31**	**0.29**	0.03 U	**0.38**
Cobalt-60	**0.46**	**0.15**	**0.72**	**0.072**	**0.29**	**0.36**	**0.081**	0.0066 U
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-238	**0.00024**	**0.00072**	**0.0017**	0.00004 U	**0.0009**	**0.001**	0.000095 U	**0.00037**
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	**0.0084**	**0.023**	**0.022**	**0.0012**	**0.0061**	**0.0083**	**0.0009**	**0.008**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	**18**
Strontium-90	**0.11**	**0.22**	**0.23**	**0.045**	**0.098**	**0.11**	**0.016**	**0.16**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	0.026 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	-0.25 U
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	0.13 U

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 12 of 19)

Reference Document:	WHC-EP-0573	WHC-EP-0573	WHC-EP-0573	WHC-EP-0573	WHC-EP-0573	WHC-EP-00573	WHC-EP-0573	WHC-EP-0573
Location:	N-02	N-03	N-04	N-05	N-06	N-07	N-08	N-09
Collection Date:	1991	1991	1991	1991	1991	1991	1991	1991
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	0.027 U	0.2 U	-0.055 U	0.12 U	-0.038 U	-0.022 U	0.084 U	0.012 U
Beryllium-7	0.52 U	0.96 U	-0.78 U	0.44 U	0.91 U	-0.74 U	0.55 U	-0.24 U
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	0.031 U	**0.44**	0.073 U	0.015 U	-0.15 U	0.074 U	0.083 U	0.014 U
Europium-155	0.094 U	NR	-0.053 U	-0.088 U	0.049 U	0.062 U	0.1 U	-0.027 U
Cerium-144	0.26 U	-0.47 U	-0.49 U	-0.42 U	0.19 U	-0.26 U	0.022 U	0.17 U
Cesium-134	-0.36 U	**0.14**	-0.32 U	-0.34 U	-0.068 U	-0.15 U	-0.29 U	-0.23 U
Cesium-137	**2.6**	**2.1**	**0.97**	**0.55**	**0.24**	**0.31**	**13**	**0.29**
Cobalt-60	**12**	**50**	**0.58**	**0.49**	0.031 U	**13**	**0.75**	**0.47**
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-238	**0.0088**	**0.028**	**0.00089**	**0.0004**	**0.00026**	**0.00096**	**0.0013**	**0.00024**
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	**0.074**	**0.17**	**0.0061**	**0.0078**	**0.0039**	**0.0069**	**0.023**	**0.0044**
Potassium-40	**19**	**15**	**17**	**18**	**16**	**15**	**19**	**16**
Strontium-90	**0.36**	**0.46**	**0.22**	**0.17**	**0.099**	**0.039**	**0.21**	**0.17**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	**1.3**	-0.37 U	-0.2 U	-0.44 U	0.014 U	-0.15 U	0.091 U	0.082 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	-0.11 U	0.087 U	-0.58 U	-29 U	-0.22 U	-0.24 U	-0.31 U	-0.4 U
Ziconium-95	-0.25 U	0.92 U	0.04 U	-0.044 U	-0.16 U	0.03 U	**0.35**	0.059 U

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 13 of 19)

Reference Document:	WHC-EP-0573-1	WHC-EP-0573-1	WHC-EP-0573-1	WHC-EP-0573-1	WHC-EP-0573-1	WHC-EP-0573-1	WHC-EP-00573-	WHC-EP-0573-1
Location:	N-01	N-02	N-03	N-04	N-05	N-06	N-07	N-08
Collection Date:	1992	1992	1992	1992	1992	1992	1992	1992
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	**0.0688**	0.0451 U	0.0266 U	0.0111 U	0.00407 U	0.0122 U	0.00214 U	**0.0125**
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	0.0276 U	0.0443 U	**2.79**	**0.0671**	0.0285 U	**0.0608**	0.0319 U	0.0409 U
Europium-155	0.0255 U	0.0575 U	**0.754**	0.0323 U	**0.067**	**0.0478**	0.0348 U	**0.0814**
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	0.00234 U	0.0105 U	0.00357 U	**0.186**	**0.0769**	0.00547 U	0.000967 U	**0.0268**
Cesium-137	**0.176**	**2.15**	**1.61**	**0.883**	**0.425**	**0.0245**	**0.646**	**0.0874**
Cobalt-60	**0.705**	**13.8**	**17.9**	**0.879**	**0.42**	0.00293 U	**0.081**	0.00903 U
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-238	**0.000455**	**0.00487**	**0.0106**	**0.00095**	0.000571	0.0000366 U	**0.000302**	0.000118 U
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	**0.00433**	**0.0369**	**0.062**	**0.00936**	**0.00418**	0.000292 U	**0.0121**	**0.00105**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.0368**	**0.314**	**0.5**	**0.166**	**0.0743**	**0.00594**	**0.142**	**0.0208**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	0.0539 U	**0.445**	0.0456 U	0.0775 U	0.0168 U	0.0596 U	0.00359 U	0.0101 U
Uranium-234	**0.699**	**0.724**	**0.598**	**0.753**	**0.66**	**0.665**	**0.586**	**0.68**
Uranium-235	**0.018**	**0.0206**	**0.0248**	**0.028**	**0.03**	**0.0281**	**0.0297**	**0.0258**
Uranium-238	**0.723**	**0.74**	**0.619**	**0.712**	**0.722**	**0.661**	**0.614**	**0.672**
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 14 of 19)

Reference Document:	WHC-EP-0573-1	WHC-EP-0573-1	WHC-EP-0573-1	WHC-EP-0573-1	WHC-EP-0573-2	WHC-EP-0573-2	WHC-EP-0573-2	WHC-EP-0573-2
Location:	N-09	N-10	N-11	N-12	N-01	N-02	N-03	N-04
Collection Date:	1992	1992	1992	1992	1993	1993	1993	1993
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	0.00823 U	0.0169 U	0.00655 U	0.0171 U	-0.19 U	-0.052 U	-0.048 U	-0.031 U
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	0.00951 U	0.0284 U	0.0022 U	0.0233 U	**0.1**	**0.2**	0.12 U	0.0083 U
Europium-155	**0.0492**	**0.0719**	0.0187 U	**0.0471**	**0.19**	-0.016 U	-0.023 U	0.048 U
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	0.00282 U	0.0061 U	0.00482 U	**0.0176**	-0.031 U	0.011 U	**0.021**	-0.0028 U
Cesium-137	**0.419**	**0.166**	**0.275**	**0.866**	**27**	**1.3**	**1.8**	**0.98**
Cobalt-60	**0.117**	**0.244**	**0.0728**	**0.0715**	**25**	**2.1**	**21**	**0.6**
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-238	**0.0013**	**0.000419**	**0.000469**	**0.000917**	NR	NR	NR	NR
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	**0.0111**	**0.00454**	**0.00649**	**0.0178**	**0.23**	**0.025**	**0.073**	**0.013**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.119**	**0.0516**	**0.142**	**0.18**	**3.5**	**0.34**	**0.32**	**0.17**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	0.00943 U	0.0766 U	0.00897 U	0.0694 U	0.14 U	-0.081 U	-0.33 U	0.15 U
Uranium-234	**0.73**	**0.633**	**0.67**	**0.665**	**0.089**	**0.14**	**0.1**	**0.079**
Uranium-235	**0.0246**	**0.0173**	**0.0219**	**0.0278**	**0.0027**	**0.0066**	**0.002**	**0.0027**
Uranium-238	**0.665**	**0.0655**	**0.67**	**0.67**	**0.1**	**0.15**	**0.1**	**0.093**
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 15 of 19)

Reference Document:	WHC-EP-0573-2	WHC-EP-0573-2	WHC-EP-00573-	WHC-EP-0573-2	WHC-EP-0573-2	WHC-EP-0573-2	WHC-EP-0573-2	WHC-EP-0573-1
Location:	N-05	N-06	N-07	N-08	N-09	N-10	N-11	N-12
Collection Date:	1993	1993	1993	1993	1993	1993	1993	1993
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	-0.00028 U	0.0034 U	-0.035 U	0.047 U	0.02 U	-0.0036 U	-0.055 U	-0.036 U
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	-0.052 U	-0.031 U	0 U	-0.0043 U	**0.09**	-0.012 U	0.027 U	0.0073 U
Europium-155	0.014 U	0.089 U	0.072 U	0.021 U	0.14 U	**0.078**	0.078 U	0.039 U
Cerium-144	NR	NR	NR	NR	NR	NR	NR	NR
Cesium-134	-0.057 U	-0.046 U	-0.0017 U	-0.0007 U	0.0066 U	0.011 U	-0.028 U	0.00095 U
Cesium-137	**0.098**	**0.37**	**0.16**	**0.096**	**0.14**	**0.08**	**0.22**	**0.027**
Cobalt-60	0.023 U	**0.059**	-0.014 U	-0.012 U	**0.049**	0.02 U	**0.045**	-0.011 U
Manganese-54	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-238	N/R	NR	NR	NR	NR	NR	NR	NR
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	**0.0011**	**0.0064**	**0.0042**	**0.0036**	**0.0017**	**0.001**	**0.0065**	**0.00027**
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	**0.027**	**0.11**	**0.13**	**0.13**	**0.25**	**0.055**	**0.15**	**0.014**
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	-0.0051 U	0.063 U	0.13 U	-0.17 U	-0.12 U	0.17 U	0.13 U	0.098 U
Uranium-234	**0.13**	**0.077**	**0.11**	**0.13**	**0.1**	**0.14**	**0.15**	**0.11**
Uranium-235	**0.0068**	**0.0064**	**0.0059**	**0.0058**	**0.0042**	**0.0044**	**0.0075**	0.0018 U
Uranium-238	**0.15**	**0.081**	**0.12**	**0.12**	**0.097**	**0.16**	**0.16**	**0.12**
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 16 of 19)

Reference Document:	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581
Location:	T-01	T-02	T-03	T-04	T-05	T-06	T-07	T-08	T-09
Collection Date:	1980	1980	1980	1980	1980	1980	1980	1980	1980
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	**0.09**	ND	**0.16**	ND	**0.12**	ND	ND	ND	ND
Cerium-144	ND	**1.73**	**0.56**	**0.48**	ND	ND	ND	ND	ND
Cesium-134	ND[a]	**0.29**	**0.24**	**0.25**	**0.37**	ND	ND	ND	ND
Cesium-137	**0.43**	**4.76**	**4.43**	**4.66**	**6.03**	**0.21**	**0.74**	**0.21**	**0.84**
Cobalt-60	**2.62**	**33.10**	**8.31**	**9.93**	**11.4**	**1**	**1.7**	**0.3**	**0.39**
Manganese-54	**0.26**	**5.17**	**2.07**	**1.83**	**2.99**	**0.1**	**0.37**	ND	ND
Plutonium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ziconium-95	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 17 of 19)

Reference Document:	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581	UNI-1581
Location:	T-01	T-02	T-03	T-04	T-05	T-06	T-07	T-08	T-09
Collection Date:	1980	1980	1980	1980	1980	1980	1980	1980	1980
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR
Beryllium-7	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-154	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium-155	**0.09**	ND	**0.16**	ND	**0.12**	ND	ND	ND	ND
Cerium-144	ND	**1.73**	**0.56**	**0.48**	ND	ND	ND	ND	ND
Cesium-134	ND[a]	**0.29**	**0.24**	**0.25**	**0.37**	ND	ND	ND	ND
Cesium-137	**0.43**	**4.76**	**4.43**	**4.66**	**6.03**	**0.21**	**0.74**	**0.21**	**0.84**
Cobalt-60	**2.62**	**33.10**	**8.31**	**9.93**	**11.4**	**1**	**1.7**	**0.3**	**0.39**
Manganese-54	**0.26**	**5.17**	**2.07**	**1.83**	**2.99**	**0.1**	**0.37**	ND	ND
Plutonium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	NR	NR	NR	NR	NR	NR	NR	NR	NR
Potassium-40	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-90	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium-91	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-235	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-238	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc-65	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zirconium-95	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 18 of 19)

Reference Document:	WHC-EP-0573-3	WHC-EP-0573-3	WHC-EP-0573-3	WHC-EP-0573-3	WHC-EP-0573-3	WHC-EP-0573-3	WHC-EP-0573-3
Location:	Y601	Y602	Y603	Y604	Y605	Y606	Y607
Collection Date:	1994	1994	1994	1994	1994	1994	1994
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	0.003	0.034	0.037	0.0044	0.024	-0.011	0.021
Beryllium-7	NR	NR	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR	NR	NR
Europium-154	-0.012	0.028	0.015	-0.046	0.0035	-0.031	0.0061
Europium-155	0.051	0.048	0.051	0.049	0.051	0.049	0.031
Cerium-144	-0.076	0.045	-0.054	0.0094	-0.075	-0.036	0.012
Cesium-134	-0.0034	0.0083	-0.031	-0.12	-0.033	-0.037	-0.011
Cesium-137	0.051	2.3	4	0.8	0.24	0.25	0.47
Cobalt-60	0.87	4	13	0.34	0.32	0.095	0.049
Manganese-54	NR	NR	NR	NR	NR	NR	NR
Plutonium-238	0.0012	0.0091	0.014	0.018	0.004	0.00042	0.00034
Plutonium-239	NR	NR	NR	NR	NR	NR	NR
Plutonium-239/240	0.0052	0.0046	0.078	0.0096	0.0017	0.0039	0.016
Potassium-40	12	15	13	14	0.15	16	14
Strontium-90	0.024	0.54	0.9	0.15	0.044	0.072	0.14
Strontium-91	NR	NR	NR	NR	NR	NR	NR
Ruthenium-106	0.075	-0.13	0.084	0.00031	-0.017	-0.074	0.023
Uranium-234	0.14	0.093	0.09	0.08	0.057	0.069	0.064
Uranium-235	0.0041	0.0059	0.0076	0.0034	0.003	0.0023	0.0026
Uranium-238	0.13	0.089	0.091	0.079	0.061	0.071	0.063
Zinc-65	-0.012	-0.064	-0.12	-0.24	-0.17	-0.19	-0.072
Ziconium-95	-0.098	-0.0019	0.061	0.064	0.022	0.046	-0.045

Table A9-1. Concentrations of Radionuclides Detected in Surface Soils (Page 19 of 19)

Reference Document:	WHC-EP-0573-3	WHC-EP-0573-3	WHC-EP-0573-3	WHC-EP-0573-3	WHC-EP-0573-3
Location:	Y608	Y609	Y610	Y611	Y612
Collection Date:	1994	1994	1994	1994	1994
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Antimony-125	-0.018	0.015	0.023	0.013	-0.0065
Beryllium-7	NR	NR	NR	NR	NR
Gross alpha	NR	NR	NR	NR	NR
Gross beta	NR	NR	NR	NR	NR
Europium-152	NR	NR	NR	NR	NR
Europium-154	-0.027	0.0077	-0.038	0.032	-0.024
Europium-155	0.049	0.061	0.064	0.083	0.016
Cerium-144	0.088	0.054	0.033	0.086	-0.047
Cesium-134	0.0037	-0.053	0.0019	0.0094	0.0049
Cesium-137	0.11	0.087	0.44	0.78	0.11
Cobalt-60	0.28	0.015	0.16	0.36	0.074
Manganese-54	NR	NR	NR	NR	NR
Plutonium-238	0.00031	0.00018	0.0011	0.001	-0.000016
Plutonium-239	NR	NR	NR	NR	NR
Plutonium-239/240	0.0019	0.0012	0.007	0.021	0.00051
Potassium-40	11	15	16	15	11
Strontium-90	0.0064	0.045	0.1	0.23	0.019
Strontium-91	NR	NR	NR	NR	NR
Ruthenium-106	0.022	-0.034	0.072	-0.018	-0.084
Uranium-234	0.092	0.058	0.071	0.068	0.048
Uranium-235	0.006	0.0015	0.0033	0.0022	0.0019
Uranium-238	0.1	0.06	0.073	0.073	0.059
Zinc-65	-0.018	-0.21	-0.01	-0.07	-0.089
Ziconium-95	-0.1	0.035	-0.15	-0.092	-0.029

ND[a] = Not detected, no detection limit given. NR= Not reported. U = Not detected at specified detection limit.
ND = Not detected [b]Sample sites relocted in FY 1986

References:
UNI-1581 = Radiological Surveillance Report for the100-N Area - FY 1980, p. 10.
UNI-2640 = UNC Environmental Surveillance Report for the 100 Areas - FY 1983
UNI-3069 = UNC Environmental Surveillance Report for the 100 Areas - FY 1984
UNI-3760 = UNC Environmental Surveillance Report for the 100 Areas - FY 1985, p. 16, 30.
UNI-4065 = UNC Environmental Surveillance Report for the 100 Area - FY 1986, p.29.
WHC-EP-0161 = Westinghouse Hanford Company Environmental Suveillance Annual Report - 100 Area = FT 1987, p. E-3.
WHC-EP-0258 = Westinghouse Hanford Company Environmental Suveillance Annual Report - 100 Area = FT 1988.
WHC-EP-0258-1 = Westinghouse Hanford Company Environmental Suveillance Annual Report - 100 Area = FT 1989.
WHC-EP-0258-2 = Westinghouse Hanford Company Environmental Suveillance Annual Report - 100 Area = FT 1990
WHC-EP-0573(1)(2)(3) = Westinghouse Hanford Company Environmental Suveillance Annual Report - 100 Area = FT 1991, 1992, 1993, 1994

APPENDIX A-10

SPECTRAL GAMMA LOGS FOR 100N WELLS

Table A10-1. Spectral Gamma Logging and Field Screening Results for Wells Near 1301-N/1325-N (Page 1 of 6)

Depth (feet below ground surface)	RW #1 1982									RW #2 1982						RW #3 1982						N-27 1984		N-28 1984		N-25 1980
	Manganese-54	Cobalt-60	Cesium-137	Potassium-40	Cobalt-60	Ruthenium-103	Cesium-137	Iodine-131	Antimony-125	Potassium-40	Cobalt-60	Ruthenium-103	Cesium-137	Iodine-131	Antimony-125	Potassium-40	Cobalt-60	Ruthenium-103	Cesium-137	Iodine-131	Antimony-125	Gross	Cobalt-60	Gross	Cobalt-60	Gross
0																						310	1.1	978	0.3	
5	0.78	3.54	6.64	11.7	0.45		0.08	0.07	0.13													57		55		80
10	0.87	12.2	12.3	12.3	0.09		0.12			10.3	0.05											55		52		80
15	1.07	1.71	11	11.4	3.68		2.46			10.1	0.03					11						51		54		80
20	49.8	169	323	12.8	1.53		1.4		0.26	9.89	0.05					11.2	0.02	0.07		0.05		62		67		80
25	182	273	1836	10	0.61		1.02	0.04		9.44	0.01					10.7	0.01					69		67		80
30				11.1	0.15					10.1	0.03				0.19	11.6						65		65		80
35				12	0.11					11.1	0.02											124	1.1	67		80
40				13.6	11				0.07	11.5	0.03					12.1					0.15	126	0.8	64		80
45				12.4	10.5			0.69	1.97	11.1	0.03	0.04				13.2						173	2.5	64		80
50				11.8	7.7			0.72	1	11.5	0.71				0.27	12.5	0.38	0.03				1138	58.8	83		80
55				11.5	7.28	0.27		7.61	1.56	14.2	0.93	0.19		1.26	1.1	13.2	0.68		0.05			366	15.4	101		325
60																13.6	1.44	0.08		0.96	0.99	262	6.1	95	0.2	325
65																15	2.34			1.24	1.39	268	7.3	182	3.7	325
70																12.1	1.64			2.94	1.35			161	2.4	200
75																								102	0.9	200
80																								116	1.5	160
85																										150
90																										130
95																										
100																										
105																										
110																										
115																										
120																										

Table A10-1. Spectral Gamma Logging and Field Screening Results for Wells Near 1301-N/1325-N (Page 2 of 6)

Depth (feet below ground surface)	N-29 1984					N-30 1984	N-31 1984	N-32 1984	N-33 1984	N-34 1984	N-35 1984	N-36 1984	N-39 1984					N-40 1984	N-41 1984	N-42 1984	N-44 1984					N-45 1984
	Gross	Cobalt-60	Potassium-40	Uranium	Thorium	Gross	Gross	Gross	Gross	Gross	Gross	Gross	Gross	Cobalt-60	Potassium-40	Uranium	Thorium	Gross	Gross	Gross	Gross	Cobalt-60	Potassium-40	Uranium	Thorium	Gross
0	1025		6.2	0.9									171		10	0.7	0.6				180		8.8	0.8	0.9	
5	54		3.1	0.7	0.3	50	50	45	25	50	90	60	105		17.6	1.1	1.4	60	55	65	103		15.6	0.8	1.1	75
10	57		8.2	0.6	1	50	50	40	25	50	75	50	84		11.3	0.6	1	60	50	60	76		13.3	0.9	0.9	50
15	50		2.7	0.6	0.6	50	50	40	25	50	75	60	71		12.2	0.8	0.9	60	55	60	75		11.2	0.7	1	50
20	46		5.1	0.4	0.7	50	50	50	25	50	75	50	72		11.7	0.7	0.3	60	55	50	69		7.5	0.6	0.7	50
25	69		9.8	0.6	0.6	50	60	55	25	50	100	50	81		11.4	0.4	1.5	60	60	60	70		9.5	0.7	0.7	50
30	64		11.1	0.8	0.7	50	60	50	25	50	250	55	82		17	0.6	0.6	30	60	65	68		9.6	0.5	0.7	50
35	67	0.1	9.4	0.7	0.8	50	60	50	25	50	175	55	78		9.4	0.9	0.7	65	60	70	70		9.8		0.6	60
40	69		9.1	0.8	1.1	50	60	50	25	50	500	70	100		11.5	0.7	0.4	75	65	75	94		14.3	0.4	0.5	75
45	79		11.8	1.4	0.4	60	60	55	50	60	4000	60	81		11.5	0.3	0.4	75	65	75	92		12.1	0.4	0.7	90
50	92	0.1	8.3	0.5	0.5	75	75	70	50	60	2500	55	113	0.2	14.4	1.1	0.9	65	70	70	109		18.2	1.1	1.4	150
55	109	0.1	11	0.5	0.7	90	75	90	60	60	2100	45	108	0.1	15.9	1.2	0.7	65	65	75	113	1.3	13.5	0.5	0.4	125
60	151	0.9	9.1	0.6	0.6	100	75	100	60	75	2500	55	132	0.3	18	1.2	0.9	70	60	80	127	0.8	16.8	0.6	0.7	110
65	430	9	13.8	0.9	0.5	100	75	65	75	80	2500	70						55	55	65	181	4	19.3	0.8	0.7	800
70	175	1.3	12.9	0.8	0.5	140	100	60	75	100		55						55	50	55						800
75	129	1	16	0.9	0.7	150	125	55		125		50						55	50	50						
80	147	1.6	12.3	1.1	0.5	200	100	60		100		60							50							
85																										
90																										
95																										
100																										
105																										
110																										
115																										
120																										

Table A10-1. Spectral Gamma Logging and Field Screening Results for Wells Near 1301-N/1325-N (Page 3 of 6)

Depth (feet below ground surface)	N-67 1988	N-69 1988	N-70 1984					N-75 1984						N-76 1984					N-80 1984		N-90 1984					
	Gross	Gross	Gross	Cobalt-60	Potassium-40	Uranium	Thorium	Gross	Cesium-137	Cobalt-60	Potassium-40	Uranium	Thorium	Gross	Cobalt-60	Potassium-40	Uranium	Thorium	Gross	Cobalt-60	Gross	Cesium-137	Cobalt-60	Potassium-40	Uranium	Thorium
0			173		17.5	0.7	1.1	177			5.1			119		8.7	0.3	0.6	187		654	0.9	19.8	2	0	0
5	40	50	84		7.9	0.7	0.5	42			7.6	1.1		57		6.1	0.7		47		53			6.3	1.2	1.3
10	40	50	59		4.5	1.2	0.5	47			5.3	0.4	0.4	178		10.6	2.2	2.8	46		51			8	0.7	0.7
15		50	66		5.2	0.7	0.4	46			5.5	0.2	0.2	178		7.1	2.6	3	43		51			7.9	1	0.3
20	125	50	177		4.8	2.9	2.5	62			10.5	0.5	0.6	183		8.9	2.4	4.3	67							
25		50	150		9.4	1.6	2.3	65			8	0.4	1.1	167		7.8	2.5	2	67							
30	40	50	158		9	1.5	2.3	62			10.7	0.5	0.6	171		10.1	2.8	2.8	69							
35		55	156		9.3	2.3	1.7	61			10.2	0.6	0.9	174	0.1	10.8	2.8	2.4	74							
40	1000	60	195		8.3	2.2	3.2	69			11.4	0.8	0.6	168		13.2	2.7	3.1	76							
45		75	187		11.1	2.9	2.8	71			12.1	0.8	0.7	169		11.9	1.9	1.7	81							
50	800	110	178		9.9	1.9	4.5	72			11.1	0.4	0.9	182		13.6	2.5	3	91	0.2						
55		250	143		11.6	1.5	2.9	88		0.2	11.6	0.7	0.6	162	0.5	21.1	1.1	0.7	105	0.4						
60	200	225	121	0.3	16.6	1	1.3	126		0.2	13.4	0.9	0.7	128	0.2	18.4	1	0.7	97	0.3						
65		200	100		19.9	0.7	1.3	124		0.3	11.1		0.9	96		18.5		0.5	125	0.6						
70	125	180	87	0.1	8.8	0.4	1.5	61		0.2	8.2		0.5	93	0.1	16.2	0.4	1.1	94							
75	125	75	112	0.1	7.4	1.5	2.3	62			6.5	1		90		17	0.2	0.3	84							
80		75	113		12.1	2.3	2	58			9.6	0.8	1						73							
85		75	80	0.3	14.6	1.4		53		0.4	12.1	0.5	0.5						75							
90		75	94	1.3	12.7	0.7	0.8												79							
95		95	78	0.1	16.1	0.3	0.7												79							
100																			102		102					
105																			120		120					
110																			109		109					
115																			88		88					
120																			125		125					

Table A10-1. Spectral Gamma Logging and Field Screening Results for Wells Near 1301-N/1325-N (Page 4 of 6)

Depth (feet below ground surface)	199-N-91A 1994							199-N-92A 1994									199-N-93A 1994								
	Potassium-40	Cobalt-60	Ruthenium-106	Radium-226	Thorium-232	Uranium-235	Strontium-90	Potassium-40	Cobalt-60	Ruthenium-106	Antimony-125	Cesium-137	Radium-226	Thorium-232	Uranium-235	Strontium-90	Potassium-40	Cobalt-60	Antimony-125	Cesium-137	Radium-226	Thorium-232	Uranium-235	Tritium	Strontium-90
0																									
5																	23.24	0.39	0.36		0.83	0.92		0.29	2.17
10	23.84	0.12		0.74	0.84		1.16										22.11	1.20	1.54		1.56	2.06	2.90	4.77	22.00
15	22.85	0.26	1.81	0.73	0.77		0.81	32.82	0.37		0.77	0.09	1.06	1.34	2.63	0.62	26.37	0.43	0.48		0.84	1.02		8.56	6.90
20	21.45	0.15		0.93	1.02		0.61	28.63	0.13				0.63	0.74		1.01									
25																									
30																									
35																	32.10		1.14		1.63	2.52	5.76	3.86	0.91
40																									
45	28.79			1.50	2.02	2.84	0.84	12.17		4.04			0.66	1.71		0.81									
50																									
55																									
60																									
65																									
70																									
75																									
80																									
85																									
90																									
95																									
100																									
105																									
110																									
115																									
120																									

Table A10-1. Spectral Gamma Logging and Field Screening Results for Wells Near 1301-N/1325-N (Page 5 of 6)

Depth (feet below ground surface)	199-N-94A 1994									199-N-95A 1994							199-N-96A 1994							
	Potassium-40	Cobalt-60	Cadium-109	Antimony-125	Radium-226	Thorium-232	Uranium-235	Tritium	Strontium-90	Potassium-40	Cobalt-60	Antimony-125	Radium-226	Thorium-232	Tritium	Strontium-90	Potassium-40	Cobalt-60	Antimony-125	Radium-226	Thorium-232	Uranium-235	Tritium	Strontium-90
0																								
5	20.36	1.00		0.31	0.76	0.81		0.32	36.20	21.76	0.21		0.67	0.76	0.20	1.26								
10	25.34	0.50		0.20	0.86	1.07		1.71	51.00	22.57	1.29		0.65	0.73	0.05	37.80	22.65			0.71	0.70		0.05	0.56
15	23.03	0.30		0.54	0.86	1.00		3.60	15.70	19.69	0.39	0.40	0.79	1.23	2.88	2.76	19.47		0.19	0.90	0.84	2.22	0.03	0.60
20										18.45	0.22	0.39	0.63	0.72	2.30	14.00	26.83	0.05		1.00	1.03		0.19	0.82
25	24.57	0.38	3.95		1.02	1.14		7.34	9.86	19.49	0.19		0.62	0.75	0.95	10.50	21.19	0.43		0.84	1.05	3.69	0.14	1.14
30	23.23	0.21			0.89	1.06		6.58	5.10															
35										19.01		0.62	0.78	1.16	11.80	1.22								
40																								
45	28.22			1.04	1.64	2.29	0.28	0.45	2.04								23.14	0.16		0.97	1.33		0.80	0.70
50																								
55																								
60																								
65																								
70																								
75																								
80																								
85																								
90																								
95																								
100																								
105																								
110																								
115																								
120																								

Table A10-1. Spectral Gamma Logging and Field Screening Results for Wells Near 1301-N/1325-N (Page 6 of 6)

	199-N-97A 1994																													
Depth (feet below ground surface)	Potassium-40	Cobalt-60	Ruthenium-106	Antimony-125	Cesium-137	Radium-226	Thorium-232	Uranium-235	Strontium-90
0									
5									
10	19.01	0.10				0.62	0.65		
15	22.31		1.72	0.46		0.81	1.08		0.84
20	24.07	0.08		0.64		0.94	1.25		0.86
25									
30								1.90	
35	38.27	0.09			0.05	1.82	2.52	5.55	1.02
40									
45									
50									
55									
60									
65									
70									
75									
80									
85									
90									
95									
100									
105									
110									
115									
120									

Gross count rate in counts per second. All other concentrations are in pCi/g.
A blank is used to denote no isotope identified by spectroscopic system (i.e., below detection theshold if present).

APPENDIX B

GEOLOGICAL DATA FOR 1301-N AND 1325-N

CONTENTS

B-1. BOREHOLE LOGS B1-1
B1-1. 199-N-107A Borehole Log B1-3
B1-2. 199-N-108A Borehole Log B1-13
B1-3. 199-N-109A Borehole Log B1-23

B-2. PARTICLE SIZE DISTRIBUTION B2-1
B2-1. Particle Size Distributions for 199-N-108A Soil Samples B2-3
B2-2. Particle Size Distribution for 199-N-109A Soil Samples B2-4

B-3. MOISTURE RETENTION B3-1
B3-1. 199-N-108A Moisture Retention B3-3
B3-2. 199-N-109A Moisture Retention B3-7

B-4. GEOPHYSICAL LOGS B4-1
B4-1. 199-N-107A Geophysical Data Package B4-3
B4-2. 199-N-108A Geophysical Data Package B4-8
B4-3. 199-N-109A Geophysical Data Package B4-13
B4-4. 199-N-35 Geophysical Data Package B4-18
B4-5. 199-N-45 Geophysical Data Package B4-26
B4-6. 199-N-67 Geophysical Data Package B4-33
B4-7. RW No. 1 Geophysical Data Package B4-41
B4-8. Schlumberger Moisture and Density Porosity Log Plots of Well 199-N-107A B4-46
B4-9. Schlumberger Moisture and Density Porosity Log Plots of Well 199-N-108A B4-47
B4-10. Schlumberger Moisture and Density Porosity Log Plots of Well 199-N-109A B4-48

APPENDIX B-1

BOREHOLE LOGS

Figure B1-1. 199-N-107A Borehole Log (Page 1 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A)

Sheet 1 of 10

Location 1301N Crib

Project 1301/1325 N Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/16/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
1	Backhoe			Backfill – not logged by geologist	
2					
3					
4					
5					
6					
7					

Figure B1-1. 199-N-107A Borehole Log (Page 2 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A)

Sheet 2 of 10

Location 1301N Crib

Project 1301/1325 N Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/16/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
	Backhoe				16" carbon steel casing set ~9 ft in August 1996. No record of lithology (mostly backfill of Sandy GRAVE)
9					Started drilling 11/29/95
"D"	Empty	SS 9'-11' 60% recovery		Silty Sandy GRAVEL: 60% gravel, 25% sand, 15% silt, dark brown, moist, poorly sorted, gravels are SR-R (except for broken cobbles during drilling), 90% basalt, 10% qtz and other, maximum part size is 4", Archive sample is not representative because fines were partially removed for chem samples. Some $CaCO_3$ coatings on gravel.	Maximum reading on soil is 16 mR/hr window open and 15 mR/hr window closed. No alpha. 1025hrs Archive sample collected in 2ℓ plastic jar (10'). Bottom of casing at 8.8'. 10" threaded carbon steel casing installed to 9ft 11/29/95 End of shift 11/29/95
"C"	2225 sample BOGLF4 (AR) quantern sample BOGLB8				
10					
"B"					
"A"					
11					
"D"	2225 sample BOGLF5 quantern sample BOGLB9 AR	SS 11'-13' 100% recovery		As Above: siltier, 20% silt, 20% sand, black, moist	SS 11-13ft 0937hrs 11/30/95 Maximum reading at 11.5' 31 mR/hr window open, 25 mR/hr window closed, 120 to 220 cpm α.
"C"				11.8 down 30/95	
12				Sandier starting @ 12 ft to 12.5'	
"B"				Silty Sandy GRAVEL: 40% gravel, 40% sand, 20% silt, dark brown, moist, poorly sorted, grav is 95-100% basalt, SR-R, max part 5.	ARCHIVE is from left over "C" + "D" liners (11-12ft) (started at 13' on jar).
"A"					
13				Starting at 12.5' Silty Sandy GRAVEL: 60% gravel, 25% sand, 15% silt, dark brown to black, poorly sorted	13' 5mR/hr WC+WO. No α; SS 13-15ft 1045hrs 11/30/95. ~13.5' 7mR/hr WC+WO.
"D"	No samples retained	SS 13'-15' 100% recovery		As Above: Silty Sandy GRAVEL	
"C"					14' 5mR/hr WC+WO
14					
"B"					14.5 5mR/hr WC+WO
"A"					
15					15' 5mR/hr WC+WO
	No samples retained	SS 15'-17' 100% recovery		As Above: Silty Sandy GRAVEL	SS 15-17ft 1444hrs 11/30/95
					15.5' 1mR/hr WC+WO

Figure B1-1. 199-N-107A Borehole Log (Page 3 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A)

Sheet 3 of 10

Location 1301N Crib

Project 1301/1325N Characterization

Prepared By DCWeekes 1/16/96 (Sign/Print Name) Date

Reviewed By L.D. Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
				As Above: Silty Sandy GRAVEL	16' 1mR/hr WC+WO
					Bottom of 10" casing @ 16.2' @ 11/30/95
					16.5' 0.6mR/hr WC+WO
17					End of shift 11/30/95 (17')
	Drive barrel 7"				Downsized casing to 8" dia threaded carbon steel on 12/5/95. Started drilling same day.
18					
19					3mR/hr BK Window open and 1mR/hr win closed @ 19ft large rocks ~ 19.5'
20					
					1mR/hr BK @ 20.5 ft
21					
22					
					1306 hrs 12/5/95 (23')
	MT, AK, CF 23'	Grab sample		Silty Sandy GRAVEL: 70% G, 20% S, 10% silt, dark brown-gray, poorly sorted, SR to R, 90-100% basalt, max part size 4", moist	BOGL90 Moisture tin, BOGLFT 2225 Lab sample 1mR/hr BK on soil.
23	DB 7"				

Figure B1-1. 199-N-107A Borehole Log (Page 4 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A)

Sheet 4 of 10

Location 1301N Crib

Project 1301/1325N Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/16/96

Reviewed By D Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample: Type and No.	Sample: Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
24					
	8¾" 7" Drive Barrel				
					<0.5 mR/hr BY @ 24.5 ft
25					
26					40,000 dpm BY @ 26 ft
27					
				Slight Δ in lithology ~28' to	SS 28-30' 1400 hrs 12/5/95
28				Gravelly SAND: 25%G, 70%	40,000 dpm BY @ 28 ft
"D"		25 28'-30' 60% rec.		S, 5% silt; most of the sand is	BOGL91 } quaternary
				c+vc, basalt-rich, SA-SR; Gravel	BOGL92 }
"C"				is 90% basalt, 10% other, SR-R;	BOGL93 Moisture can
29	CH, AR, MT			dark brown gray, damp (less	BOGLF6 } 2225
				moisture than above), max part	BOGLF8 } sample
"B"				size ~3", moderately sorted	
"A"					
30					
	7" Drive Barrel		Rock		
					Rock between 30' + 31.5'
31					
					End of shift 12/5/95 31.5'

Figure B1-1. 199-N-107A Borehole Log (Page 5 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A)

Sheet 5 of 10

Location 1301N Crib

Project 1301/1325N Characterization

Prepared By DCWeekes (Sign/Print Name) Date 1/16/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
32					
33	7" Drive Barrel				40,000 dpm BY @ 33 ft.
34	7" Drive Barrel				40,000 dpm BY @ 34 ft.
35	7" Drive Barrel				
	AR only			As Above: Gravelly SAND.	60,000 dpm BY. Archive Sample labeled 34-36'. 0904 hrs 12/6/95 (36')
36	7" Drive Barrel				
37	7" Drive Barrel				30,000 dpm BY @ 37 ft.
38	7" Drive Barrel			Δ in lithology @ ~38 ft.	Approximate change at ~38 ft. Harder to push @ 38.5 ft
39	7" Drive Barrel			Sandy GRAVEL: 60% G, 35% S, 5% Silt; Gravel is SR to R, ~70% bas, 30% qtz, granite and other, Sand is mostly C, SA-SR; dark gray brown, moist, poorly sorted, max part size ~4" (broken).	30,000 dpm BY @ 39 ft. Looks like reworked Ringold gravel.
	AR CH Grab				40,000 dpm BY. Archive. BOGLF9 2223 Sample.

A-6000-382 (01/95)

Figure B1-1. 199-N-107A Borehole Log (Page 6 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A

Sheet 6 of 10

Location 1301N Crib

Project 1301/1325N Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/16/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample: Type and No.	Sample: Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
40					
	7" Drive Barrel				
41					
42				Geophysical evidence for Hanford/Ringold contact @ 42 ft is decreased moisture, increased K^{40}, decreased Ur, and decreased thorium). Use 42 ft for change in lithology.	20,000 dpm $\beta\gamma$ @ 42 ft
43					30,000 dpm $\beta\gamma$ @ 43 ft
				Δ in lithology ~ 44 ft.	Hanford/Ringold contact
44				Silty Sandy GRAVEL: 60% G, 25% S, 15% silt, dark greenish gray, moist, poorly sorted; Gravels are SR-R, some broken, ~50% basalt, 50% quartzite, granite and others; Sand is SA-SR, vc-c mostly; some clasts have cementation	Ringold "E" Archive marked as 44-45'. 30,000 dpm $\beta\gamma$ in glovebox! NOX. Sample @ 1259 hrs 12/6/95
	AR only				
45					
	7" Drive Barrel				
46					20,000 dpm $\beta\gamma$ @ 46 ft.
47					
				Δ in lithology ~ 48 ft.	20,000 dpm $\beta\gamma$ @ 48 ft

Figure B1-1. 199-N-107A Borehole Log (Page 7 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A)

Sheet 7 of 10

Location 1301 N Crib

Project 1301/1325N Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/16/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample: Type and No.	Sample: Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
48	7" Drive Barrel			Δ in lithology ~48 ft	
49				Gravelly SAND: 20% G, 75% c-vc sand, 5% silt, dark brown gray, moist; Gravel is mostly vf-f pebbles, ~50% bas, 50% other, R; sand is A-SA; max part size ~3".	20,000 dpm βγ @ 49 ft 1351 hrs 12/6/95 (50 ft 3,000 dpm βγ. Archive taken. BOGL 60 2225 Lab.
50	AR CH GRAB				
51	7" Drive Barrel				
52				Δ in lithology ~52 ft	<d dpm βγ @ 52 ft
53				Silty Sandy GRAVEL: 50% G, 35% S, 15% silt, brown, slightly damp; Gravel is SR-R, some broken, 50% bas, 50% other; Sand is A-SA; max part size ~4". Cemented sand. Trace mica	<d dpm βγ @ 53.5 ft 1430 hrs 12/6/95 3,500 dpm βγ in glovebox Collected 12/8/95 @ 0906 hrs
54	AR only				
55	7" Drive Barrel			Δ in lithology ~55 ft Sandy GRAVEL: See next page.	End of shift 12/6/95 55' Discrepancy between 12/6/95 + 12/8/95. Driller indicated depth was 55 on 12/6/95, however, started with archive, collected at 54 ft on 12/8/95. Using 12/8/95 depth. <0.5 mR/hr βγ @ 57 ft

Figure B1-1. 199-N-107A Borehole Log (Page 8 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A)

Sheet 8 of 10

Location 1301N Crib

Project 1301/1325-N Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/16/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
56	7" Drive Barrel				
57		SS 57-59' 100% rcvy.		Sandy GRAVEL: 30% G, 65% S, 5% silt, brown, slightly damp, poorly sorting; GRAVEL is 30% basalt, 70% other (granite, quartzite ect), mostly SR-F; Sand is mostly VC-C, SA-A; Max part size 5", mostly lo dse mat Sandier between 57.5-58.	2,500 dpm β/γ SS 57-59' 0938 hrs 12/8/95
"D"					
"C"					
58	CH AR				CH4AR from "A" & "B" liners. AR labelled 55-59'. BOGLG1 2225 Cts BOGL95 Quanterra
"B"					
"A"					
59	7" Drive Barrel				
60					2,000 dpm β/γ @ 60 ft.
					2,000 dpm β/γ @ 60.5 ft
61					
62					2,000 dpm β/γ @ 62 ft.
					2,000 dpm β/γ @ 62.5 ft.
63				Sandy Gravel As above except more gravel. 60% G, 35% S, 5% silt slightly damp, some cementation rocks, max part size ~6" (broken)	Sample from 64' not archived. 2,000 dpm β/γ @ 64 ft.

Figure B1-1. 199-N-107A Borehole Log (Page 9 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A)

Sheet 9 of 10

Location 1301N Crib

Project 1301/1325N Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/16/96

Reviewed By LD Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
64					
	7" Drive barrel				<1,000 dpm BY @ 64.5'
65					<1,000 dpm BY @ 65'
66					<1,000 dpm BY @ 66
67					1,000 dpm BY @ 67'
68				Sandy GRAVEL: 65% G, 30% S, 5% silt; lt. brown, slightly dry; G ~30% bas, 70% other SR-R; Sand is c-f, v poorly sorted, max part size ~4", cementation con.	2500 dpm BY. Archive at 69' 1412 hrs 12/18/95
	CH AR GRAB				BOB HIVG 2225 lbs.
69					
	7" Drive Barrel				
70					2,500 dpm BY @ 70 ft.
71					<1,000 dpm BY @ 71 ft.

Figure B1-1. 199-N-107A Borehole Log (Page 10 of 10)

BOREHOLE LOG

Boring or Well No. B2536 (199-N-107A)

Sheet 10 of 10

Location 1301N Crib

Project 1301/1325 N Characterization

Prepared By DC Ukekes (Sign/Print Name) Date 1/16/96

Reviewed By L.D. Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
72					
	7" Drive Barrel				
73					<1,000 dpm BY @ 73 ft.
	AR only			Sandy GRAVEL: As Above, mica common, v moist. very little silt.	<d BY. Archive taken at 74'.
74					
	7" Drive Barrel				
75				▽	Water hit @ 75'.
76					End of shift 12/6/95 TD @ 76 ft. 8" nom. threaded cs to 75.2'

Figure B1-2. 199-N-108A Borehole Log (Page 1 of 10)

BOREHOLE LOG

Boring or Well No. 22537 (199-N-108A)

Sheet 1 of 10

Location 1301N Trench

Project 1301/325N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 11/7/95

Reviewed By LD Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
	9" Drive Barrel			BACKFILL – Silty Sandy GRAVEL, 50% gravel, 40% sand, 10% silt, dark brown-gray, moist, poorly sorted, A-SA, 80% basalt, 20% other (qtz, granite), 6" maximum particle size, no HCl test made	Installing 9¾" ID x 10¾" OD threaded carbon steel casing (11/6/95).
1					
2					End of shift 11/6/95 (2 ft)
	8¾" Drive Barrel				
3					
4					
					<d BY @ 4.5 ft
5				Large cobble at 5 ft	
6				As above except A-R, dry, large cobbles	
7					<d BY @ 7 ft
				As Above contact @ 8 ft	<d BY @ 8 ft

A-6000-382 (01/93)

Figure B1-2. 199-N-108A Borehole Log (Page 2 of 10)

BOREHOLE LOG

Boring or Well No. B2537 (199-N-108A)

Sheet 2 of 10

Location 1301N Trench

Project 1301/1325N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 11/8/95

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
	8¾" Drive Barrel			Silty Sandy GRAVEL: 50% Gravel, 20% sand, 30% silt, brown, dry, poorly sorted, A to R, Gravel is 90-100% basalt, maximum clast size is 4" although larger clasts probable.	Casing @ 8 ft <d BX @ 9 ft
9					
					Casing @ 9.5 ft
10				As Above	<d BX @ 10 ft
11					
				As Above	
					Casing @ 11.3 ft <d BX @ 11.6 ft
12					
13					
					Casing @ 13.3 ft
				As Above	<d BX @ 13.5 ft
14					Change in lithology ~14 ft?
				SAND Lens 14-14.5' (?)	
					Casing @ 14 ft.
				Silty Sandy GRAVEL: 60% gravel, 20% sand, 20% silt, brown, moist (slight), poorly sorted, mostly R shows some broken due to drilling 90-100% basalt clasts, max size ~5", $CaCO_3$ coatings on some clasts, some brown FeOx coating also.	10,000 dpm β γ @ 14.5 ft End of shift 11/7/95
15	Mois-Con BOGL72 Phy. Prop BOGL72 Chem sample BOGL71	4" ss 100% recov. 12.0', 14.5', 16.5'			Samples @ 0918 hrs Moisture tin from bottom two liners. A rock showed 1.3 mR/hr wind closed & 4.5 mR/hr wind open @ 16.5'.

A-6000-362 (01/93)

Figure B1-2. 199-N-108A Borehole Log (Page 3 of 10)

BOREHOLE LOG

Boring or Well No. B2537 (199-N-108A)

Sheet 3 of 10

Location 1301 N Trench

Project 1301/1325 N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 11/10/95

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
	"A" Chem Sample				2225 Lab samp — BOGLD2
					Bottom of ss 10,000 dpm βγ
	8 3/4" Drive barrel				
17					50,000 dpm βγ, < 20 dpm α
					250,000 dpm DCW 11/10/95
				As Above: Increased gravel content	~~2.5 mR/hr~~ βγ
	Grab AR, CH, pH			to ~70%, Sand 10%, Silt 20%. 15 DCW 11/10/95 15 DCW 11/11/95	Archive, phy grab, +
18					chem grab taken 11/9/95
					PH-B'OGL76 (Part. Size Analysis)
					2225 Lab samp — BOGLD5
					Sampler was getting
					300,000 dpm α on soil in
19					glove box and 3mR/hr @ 18'.
					19.5' 30,000 dpm βγ, < 20 dpm α
20					20' 45,000 dpm βγ, < 20 dpm α
21				Geophysical logs suggest Δ in lithology to sand at ~21 ft instead of at 22 ft.	21.5' 150,000 dpm βγ, < 20 dpm α
22				Δ in lithology ~22 ft.	
					23' 50,000 dpm βγ
23					End of shift 11/9/95 23 ft.
"D"		4" ss 100% Recovery 23'-25'		SAND: 100% sand, very fine ~~med~~ DCW 11/10/95 dark brown, moist, well sorted,	2225 Lab Sample - BOGLD3
				random pebble occasionally	"C" liner used for
"C"	CH(a...n) BOGL73			possible silt content, moderately	chem/rad samples.
				consolidated, massive	Quanterra BOGL73

A-6000-382 (01/93)

Figure B1-2. 199-N-108A Borehole Log (Page 4 of 10)

BOREHOLE LOG

Boring or Well No. B2537 (199-N-108A)

Sheet 4 of 10

Location 1301N Trench

Project 1301/1325N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 11/15/95

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
24	Phy prop "B" BOGLT16	DOW 11/10/95		Rad levels decrease with depth in split spoon using 6M; 23' 80,000 dpm β/γ (shield) 23.5-24' 40,000 dpm β/γ 24.5' 30,000 dpm β/γ; 25' 15,000 dpm β/γ.	Liner for phy props 24'-24.5' ("B") liner for phys. props. Highest reading 80,000 dpm β/γ to 25'.
	"A" Archive (jar)	DOW 11/10/95			Archive @25 in jar Moisture tin @25' ("A" liner) (BOGLT4)
25					
	8¾" Drive Barrel				
26					40,000 dpm β/γ, <20 dpm α @ 26 ft.
					30,000 dpm β/γ, <20 dpm α @ 26.5 ft.
27				Geophysical logs suggest Δ in lithology at 27 ft.	
					2225 Lab sample - BOGL06 Phy Prop (PSA) in jar
	Grab PH BOGLT7			Δ in lithology ~27.5 ft Sandy GRAVEL: 75% Gravel, 20% sand, 5% silt, Gravel is rounded basalt, v poorly sorted, max particle size ~4" (broken), dark brown, moist	Archive and moisture 7,000 dpm β/γ @ 28 ft.
28					
29	8¾" Drive Barrel				5,000 dpm β/γ @ 29.5 ft
30					6,000 dpm β/γ @ 30.5 ft
31					5,000 dpm β/γ @ 31 ft
				Contact @ 32 ft (minor)	

A-6000-382 (01/93)

Figure B1-2. 199-N-108A Borehole Log (Page 5 of 10)

BOREHOLE LOG

Boring or Well No. B2537 (199-N-108A)

Sheet 5 of 10

Location 1301N Trench

Project 1301/1325N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 11/15/95

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
32	Grab AR, PH LH BOGL78			Silty Sandy GRAVEL: 40% gravel, 55% sand, 2-35% silt, gravel is SR-R with broken clasts up to 4", 95-100% basalt grav, slightly damp, v poorly sorted, unconsol.	GRAB @ 32.5 ft. 5,000 dpm BY @ 32.5 ft 2225 Lab sample - BOGL07
33	8¾" Drive Barrel				3,000 dpm BY @ 33.5 ft
34					2,000 dpm BY @ 34.5 ft
35					
36	AR B2537-36			As Above	<50 cpm BY @ 36 ft End of shift 11/10/95
37	8¾" Drive Barrel				Casing is 9¾" ID x 10¾" OD. Drove casing to 36.4' and drilled to 37.5' 11/13/95, logged casing with spectral gamma and other. End of shift 11/13/95 37.5' Drilling started again on 11/15/95. Installed 8" nominal threaded carbon steel casing
38	7" Drive Barrel				
39				Hanford/Ringold contact @ ~39 ft based on geophysical logs (Ringold has higher K content, higher thorium, large decrease in porosity and increase in moisture.	1,500 dpm BY @ 39 ft

A-6000-382 (01/93)

Figure B1-2. 199-N-108A Borehole Log (Page 6 of 10)

BOREHOLE LOG

Boring or Well No. B2537 (199-N-108A)

Sheet 6 of 10

Location 1301N Trench

Project 1301/1325N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 11/16/95

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
41	7" Drive Barrel				Hanford/Ringold contact not distinguishable during drilling. 1,500 dpm BY @ 40.5 ft
					<det dpm BY @ 41.5 ft
42				Silty	1,000 dpm BY @ 42 ft
	"D"	90% recovery (42'-44') SS stainless steel liners		Sandy GRAVEL: 50% gravel, 25% sand 15% silt, brown, v. poorly sorted, moist: gravel is R (when unbroken), 40% basalt, 60% qtz, granite and others, max particle size is ~3 in, partly cemented Ringold "E"	All material < background (which is 400 cpm BY) in the 2225 Lab sample - BOGLD9
	"C" BOGLB1 CH Quanterra				
43	BOGLB0 PH WHC Geo Lab "B"				
	"A" BOGLB0 moisture AR				
44	7" Drive Barrel				
45					
46					<1,000 dpm BY @ 46.5 ft
47	AR, CH, PH BOGLB2			As above except drier, max part. size is 4.5".	moisture content sample taken 2225 Lab sample - BOGLD9 Quanterra sample not taken.
	7" Drive Barrel				<det BY @ 47 ft
					<1,000 dpm BY @ 48 ft

A-6000-382 (01/93)

Figure B1-2. 199-N-108A Borehole Log (Page 7 of 10)

BOREHOLE LOG

Boring or Well No. B2537 (199-N-108A)

Sheet 7 of 10

Location 1301N Trench

Project 1301/1325N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 11/16/95

Reviewed By LD Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample: Type and No.	Sample: Blows or Recovery	Graphic Log	Sample Description: Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level
48					Using "8" casing.
49	7" Drive Barrel			Large cobble @ ~49 ft	
50				Contact @ 50 ft based on geophysical logs.	<1,000 dpm BK @ 50 ft
51					<1,000 dpm BK @ 51 ft
	AR, PH, CH, mois. B06L33			SAND: vf-f, 100% sand, tr small pebble, brown, slightly moist, well sorted, max pebble ~1 in.	<1,000 dpm BK 11/14/95 BOGLF0 2225 lab sample - ~~B06L33~~ 11/17/95
52	7" Drive Barrel				
53					
54					
55					<1,000 dpm BK @ 55 ft

A-6000-382 (01/93)

Figure B1-2. 199-N-108A Borehole Log (Page 8 of 10)

BOREHOLE LOG

Boring or Well No. B2537 (199-N-108A)

Sheet 8 of 10

Location 1301N Trench

Project 1301/1325N Crib Characterization

Prepared By DC Weekes / DC Weekes (Sign/Print Name) Date 11/16/95

Reviewed By LD Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
56	7" Drive Barrel				
	AR no WEIGHT			SAND: AS ABOVE	
57					2,000 dpm BK@ 57 ft
58	7" Drive Barrel				8,000 dpm BK@ 58 ft
59				Contact@ 59 ft based on geophysical logs.	(10,000 dpm BK@ 59.5 ft)
	PH, AR BOGL84			Sandy GRAVEL: 40% Gravel, 60% Sand, moist, dark brown, poorly sorted, SR-R, 40% bas, 60% qtz, granite, + other, max part size ~3 in	1,000 cpm BK, moist taken Sample depth 59.5' 2225 Lab sample – BOGLF1
60	7" Drive Barrel				End of shift @ 60.5 11/1/95
61					
				Slight Δ in lithology @ 62 ft.	
62		Rcvd 1.5' (83%)		Silty Sandy GRAVEL: 70% gravel, 15% sand, 15% silt, brown, dry, poorly sorted, SR-R, 40% bas, 60% qtz, granite, + other, max part size ~3", white powder common (maybe $CaCO_3$).	7,000 dpm BK @ 62 ft BOGL85 2225 Lab sample – BOGLF2 "A" liner used for Quanterra "B" liner used for Phy Props "C" liner used for moisture tin and archive samples. up to 5,000 dpm BK in glovebox.
"C"	Moist. + AR				
63 "B"	PH BOGL85	SS 62'–63.8'			
"A"	CH BOGL86				
63.8					

A-6000-382 (01/93)

Figure B1-2. 199-N-108A Borehole Log (Page 9 of 10)

BOREHOLE LOG

Boring or Well No. B2537 (199-N-108A)

Sheet 9-8 of 10 (PCW 11/16/95)

Location 1301 N Trench

Project 1301/1325 N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 11/17/95

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
64	7" Drive Barrel				
65					2,000 dpm β/γ @ 65 ft
66					2,000 dpm β/γ @ 66 ft
				Contact @ ~66.5 ft (?)	
67				SAND ~67'; unknown thickness, probably small lens, vc-m, moist	
68					2,000 dpm β/γ @ 68 ft
				Possible contact @ 68.5 ft (?) Silty Sandy GRAVEL: 60% Gravel, 25% sand, 15% silt, brown, slightly moist, poorly sorted, SR-R, 40% las, 60% qtz, granite, other, max part size ~5in. some white coating on gravels	
	AR, PH BOGL07				CH taken for 2225 Lab BOGLF3
69					<1,000 dpm β/γ; 2225 Lab sample – BOGLF3
70	7" Drive Barrel			dry	<1,000 dpm β/γ @ 70 ft
71					<1,000 dpm β/γ @ 71 ft
					Water table @ 72 ft 11/16/95

A-6000-282 (01/93)

Figure B1-2. 199-N-108A Borehole Log (Page 10 of 10)

BOREHOLE LOG

Boring or Well No. B2537 (199-N-108A)

Sheet 10 of 10

Location 1301N Trench

Project 1301/1325 N Crib Characterization

Prepared By DC Weekes / DC Weekes (Sign/Print Name) Date 11/17/95

Reviewed By LD Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description: Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level
72	7" Drive Barrel				
					Total depth 72.5 ft
					11/16/95
					Bottom of 8" casing
73					at 70.8 ft.
					End of shift 11/16/95
74					
75					
76					
77					
78					
79					

A-6000-382 (01/93)

Figure B1-3. 199-N-109A Borehole Log (Page 1 of 9)

BOREHOLE LOG

Boring or Well No. B2539 (199-N-109A)

Sheet 1 of 9

Location 1325N Crib

Project 1301/1325N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/22/96

Reviewed By C.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
	8¾" Drive Barrel			Sandy GRAVEL (SG) Backfill Basaltic gravel in sandy matrix (New backfill)	Started with 10" threaded carbon steel casing (12/19/95)
1					
2					<0.5 Kdpm @ 2 ft (BY)
				Old backfill starts at ~2.5 ft. No significant change seen. Cobbles and pebbles predominate.	
3					<1 Kdpm @ 3 ft (BY)
4				Large cobble @ 4 ft.	
					<1 Kdpm @ 4.5 ft (BY)
5					
					<1 Kdpm @ 5.5 ft (BY)
6					
					<1 Kdpm @ 6.5 ft (BY)
7					
				Possible change to insitu material.	30 Kdpm @ 8 ft (BY)

A-6000-382 (01/93)

Figure B1-3. 199-N-109A Borehole Log (Page 2 of 9)

BOREHOLE LOG

Boring or Well No. B2539 (199-N-109A)

Sheet 2 of 9

Location 1325N Crib

Project 1301/1325N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/22/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
8	"D"	SS 8-10' 75% recv.		Silty Sandy GRAVEL (msG): 40% G, 45% S, 15% M, dark brown, moist, poorly sorted; G is 75% bas, 25% other, SR-R max part size 3.5 in; S is mostly c-m; no HCl tried, some white coatings on gravel	Driven 12/19/95 1424 hrs. No phy props taken because of poor liner quality (other than moisture) Max rad 45,000 dpm BK (B liner)
9	"C" B0GL97 2223 B0HIV7 Quanterra "A" AR B0GL96 moist.			other readings: 20,000 dpm BK @ 10 ft (bottom)	B0GL97 2223 Lab B0HIV7 Quanterra AR is from "A" & "B" Liners Moisture can from "A" liner (labeled 10').
10	"D" "C" B0GL98 PH	SS 10'-12' 80% recv.		Sandy GRAVEL (sG): 50% G, 45% S, 5% M, dark brown-gray, moist, mod sorted; G is ~60% bas, 20% other, SR-R, mostly ~~0.5~~ 10-30 mm, max size 2 in (50 mm); S is mostly c, "salt and pepper", SA to SR; no HCl tried, some white coatings on gravel which is "rotter" than regular sand.	End of shift 12/19/95 10 ft. 10-12' driven 12/20/95 0827 hrs. "C" liner 10.5-11 to be sent for analysis. MT taken from A+B liners. CH taken from A+B liners AR taken from A+B after all others done. Highest reading 30 Kdpm BK @ 11-12 ft.
11	"B" AR "A"	CH B0GL99 2225 Lab B0HIV8 Quan			
12	8¾" Drive Barrel				
13					30 Kdpm @ 13' (BK)
14					30 Kdpm BK @ 14.5'
15					30 Kdpm BK @ 16'.

A-6000-382 (01/93)

Figure B1-3. 199-N-109A Borehole Log (Page 3 of 9)

BOREHOLE LOG

Boring or Well No. B2539 (199-N-109A)

Sheet 3 of 9

Location 1325N Crib

Project 1301/1325N Crib Characterization

Prepared By DCWeekes (Sign/Print Name) Date 1/22/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
16					
	8 3/4" Drive Bar.				
17					20K dpm β/γ @ 17'.
	"D"	SS 17-19' 100% recov.		Sandy GRAVEL (≤ G): As previous SS at 10-12 ft except more small pebbles, moist.	BOGLBI QUAN "A+B"
	"C"	BOGLBO PH			BOGHIV9 2225 "A+B"
					BOGLBO "C" PH
18		AR			MT @ 19' "A+B"
	"B"	BOGLBI QUAN BOGHIV9 2225			AR from "A+B"
					Background is 10,000 dpm β/γ.
	"A"				Max rad 18-18.5 ft is 5,000 dpm β/γ above background
19					
	8 3/4" Drive Barrel				
20					
21					9.5K dpm β/γ @ 21 ft.
	7" Drive Barrel			Bottom of 10" casing @ 21 ft @ 12/20/95.	End of shift 12/20/95 21'. Started drilling 12/22/95 Using 8" carbon steel casing (threaded).
22					
23					
					4K dpm β/γ @ 23.5 ft.
					2.5K dpm β/γ @ 24 ft.

A-6000-382 (01/93)

Figure B1-3. 199-N-109A Borehole Log (Page 4 of 9)

BOREHOLE LOG

Boring or Well No. B2539 (199-N-109A)

Sheet 4 of 9

Location 1325N Crib

Project 1301/1325N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/22/96

Reviewed By LD Walker / L.D Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
24	not used	SS 24'-26' 100% recv.		Sandy GRAVEL (SG): increased	SS driven 12/22/95 0930 hrs.
	"D"			gravel; 60%G, 35%S, 5%M,	
				dark gray, moist, mod sorted;	
	PH BOGLB2 "C"			G is 90% bas, 10% other, SR-R,	PH taken as "C" liner.
25				max part 3" (broken), mostly fine	MT taken from "A" + "B".
	CH from "A+B" "B"			pebs; S is mostly coarse, SA to SR,	BOGLB3 Quan } from "A" + "B"
				no HCl tried, no white coatings.	BOGLB4 Quan dup
					BOHIW1 2225 Lab
	AR from "A+B" MT "A"				BOHIW2 2225 Lab dup
					AR taken from "A" + "B"
26	7" Drive Barrel				
27					2.5 kdpm BY @ 27 ft.
28					
29					4 kdpm BY @ 29 ft.
	GRAB PH BOGLB5 AR			Sandy GRAVEL (SG): larger gravel,	Grab 12/22/95 1018 hrs.
				similar to above except larger pebs	BOGLB5 PH jar; MT
30				and small cobbles, max size 4" in, moist,	AR, ~~BOGLB6~~ 2225 Lab
				dark gray, poorly sorted, minor white	600 cpm BY on soil.
				coatings on gravel	(RCTs get 4 kdpm thru pbs.)
					BOHIW3
31	7" Drive Barrel				
					2500 dpm BY @ 32'.
					End of shift 12/22/95 32'

A-6000-382 (11/87)

Figure B1-3. 199-N-109A Borehole Log (Page 5 of 9)

BOREHOLE LOG

Boring or Well No. B2539 (199-N-109A)

Sheet 5 of 9

Location 1325 N Crib

Project 1301/1325 N Crib Characterization

Prepared By DC Weekes / DC Weekes (Sign/Print Name) Date 1/22/96

Reviewed By D Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
32	7" Drive Barrel				
33					2500 dpm β/γ @ 33 ft.
34				Sandy GRAVEL (SG): 40% G, 60% S, no mud; dark gray, moist; G is 80% bas, 20% other, SR-R, max part size 4"; S is mostly VC-M, SA-SR; poorly sorted	200 cpm β/γ in glove box. 0924 12/27/95 35-foot sample.
	AR NO HEAD #				
35	7" Drive Barrel				
36					3500 dpm β/γ @ 36.5 ft.
37					4000 dpm β/γ @ 37.5 ft.
38					
39		SS 39-41' 100% rcvy			SS 39-41' 1013 hrs 12/27/95
"D"				Sandy GRAVEL (SG): 70% G, 30% S, no mud, dark gray, moist, med sorted; G is 80% bas, 10% qtz, 10% other, SR-R, max part size	
"C"	pH BOGLB7				"C" liner for phy props.

Figure B1-3. 199-N-109A Borehole Log (Page 6 of 9)

BOREHOLE LOG

Boring or Well No. B2539 (199-N-109A)

Sheet 6 of 9

Location 1325 N Crib

Project 1301/1325 N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/22/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description: Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level
40	"B" "A" MIXED for Chem, MT, & AR			3 in; S is VC-m, SA-SR, 80% bas, 20% other; "clean" material - no coatings, loose, mostly pea gravel.	~~BOHIW4 QUAN~~ ~~BOGLF9~~ 225 BOHIW4 BOGLB6 Quan MT, AR RCT cleanout at 41' 2500 dpm
41					
42	7" Drive Barrel				
43					4000 dpm BK @ 43 ft.
44				Silty Sandy GRAVEL (msG): 60% G, 25% S, 15% M, brown, moist (drier than previous), poorly sorted; G is 30% bas, 70% granite, qtz + other, SR-R, max part size 3½"; S is vc-f; tr mica, tr clay(?) Ringold "E" Gravel	Started to be harder ~44' Δ in lithology to Ringold "E" Gravel
45	AR No HELS #				AR @ 1308 hrs 12/27/95 No elevated BK.
46	7" Drive Barrel				1500 dpm BK @ 46 ft.
47					1500 dpm BK @ 47 ft.
					1500 dpm BK @ 48 ft.

A-6000-387 (01/93)

Figure B1-3. 199-N-109A Borehole Log (Page 7 of 9)

BOREHOLE LOG

Boring or Well No. B2539 (199-N-109A)

Sheet 7 of 9

Location 1325N Crib

Project 1301/1325 N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/22/96

Reviewed By LD Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
48	7" Drive Barrel				
49					1000 dpm BY @ 49 ft.
	GRAB PH B06LB9			Silty Sandy GRAVEL (mSG): as above except larger cobbles, slightly drier, max size ~ 4 in (broken).	Taken: Phy grab B06LB9, MT, CH (2225), no AR 1407 hrs 12/27/95 <D BY.
50					2225 BOHIWS BOHIWS 2225
51	7" Drive Barrel				1000 dpm BY @ 51 ft.
52					1000 dpm BY @ 52 ft.
53				Very moist @ 53'	2500 dpm BY @ 53 ft.
54					1500 dpm BY @ 54 ft.
	AR No HEPA #			Silty Sandy GRAVEL (mSG): as above, max size ~ 4½ in (broken)	1517 hrs 12/27/95 <D BY.
55	7" Drive Barrel				End of shift 12/27/95 (55).

A-6000-382 (11/93)

Figure B1-3. 199-N-109A Borehole Log (Page 8 of 9)

BOREHOLE LOG

Boring or Well No. B2539 (199-N-109A)

Sheet 8 of 9

Location 1325 N Crib

Project 1301/1325 N Crib Characterization

Prepared By DC Weekes (Sign/Print Name) Date 1/22/96

Reviewed By L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
56					
	7" Drive Barrel				
57					2000 dpm B/G @ 57 ft.
58					1000 dpm B/G @ 58 ft.
59					
					0920 hrs 12/28/95
	"D"	SS 59.5'–61.5' 75% Rcvy.		Silty Sandy GRAVEL (mod G): 60% G, 25% S, 15% M, dark brown, v. moist; poorly sorted; G is 30% bas, 70% qtz, granite, and other, SR–R except where broken, max size ~ 5 in; S is m-vf, SA-SR,	Not enough material for a physical SS liner. BOGLCO QUAN ROH5N9 2225 Lab. BOGLC1 Phy prop jar + MT AR taken 61.5' Phy Prop jar taken @ 60' ("C")
60	"C"	PH, Vm, 1 BOGLC1			
	"B"	2 Lt mix 2 Dk mix BOGLC0 MT BOGLC1, AR			
61	"A"				
62	7" Drive Barrel				1000 dpm B/G @ 62 ft.
63				Water table @ 63'	2000 dpm B/G @ 63 ft.

A-6000-287 (01/97)

Figure B1-3. 199-N-109A Borehole Log (Page 9 of 9)

BOREHOLE LOG

Boring or Well No. B2539 (199-N-109A)

Sheet 9 of 9

Location 1325N Crib

Project 1301/1325N Crib Characterization

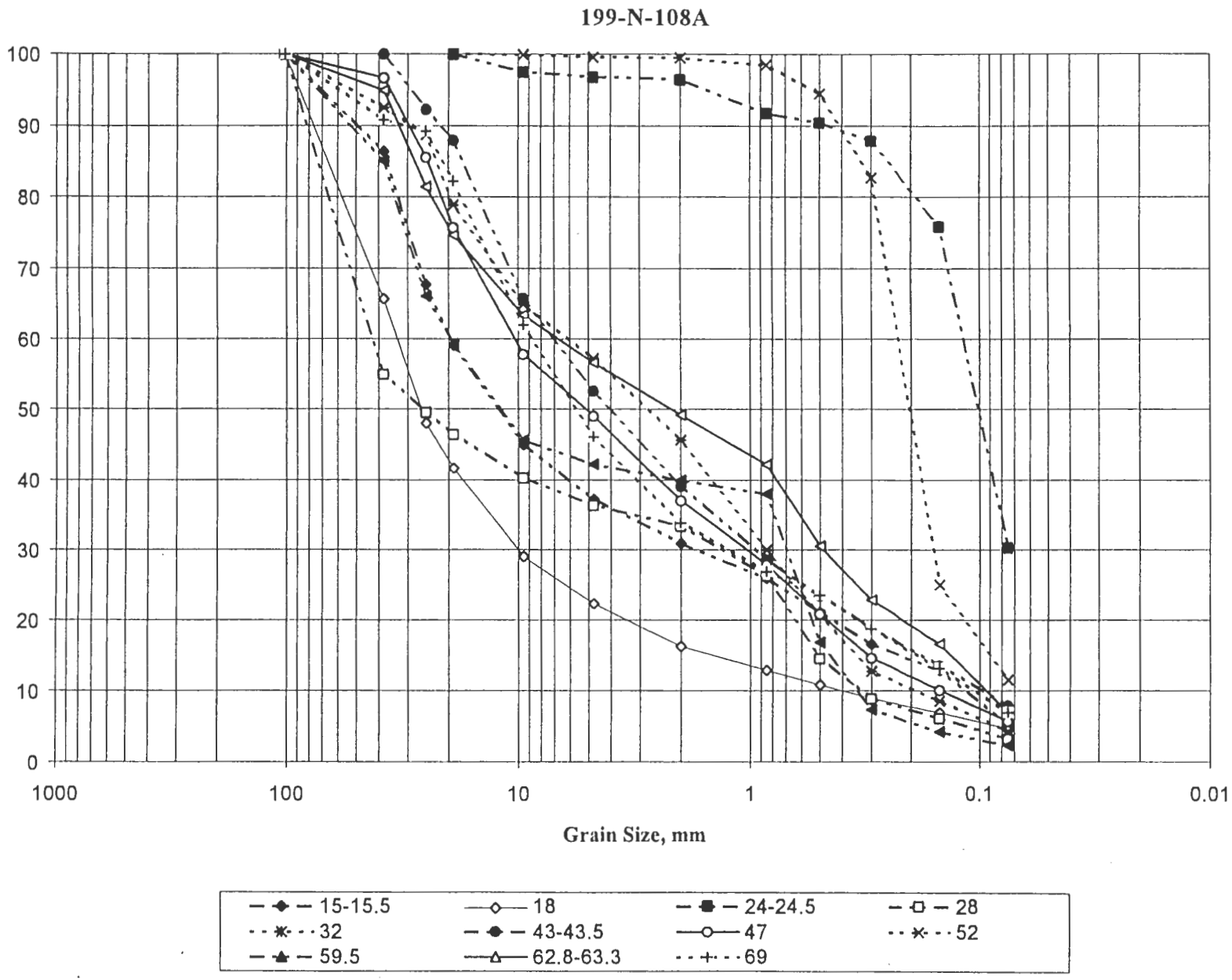
Prepared By DC Weekes (Sign/Print Name) Date 1/22/96

Reviewed By RD Walker / L.D. Walker (Sign/Print Name) Date 1-31-96

Depth (ft)	Sample Type and No.	Sample Blows or Recovery	Graphic Log	Sample Description (Group Name, Group Symbol, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Rate, Casing Size & Type, Bit Size, Water Level)
64	7" Drive Barrel				
					End of Shift 12/29/95
					TD @ 64.5 ft
					8" Casing @ 64.64 ft
65					<1000 dpm Bkg @ 64.5 ft.

APPENDIX B-2

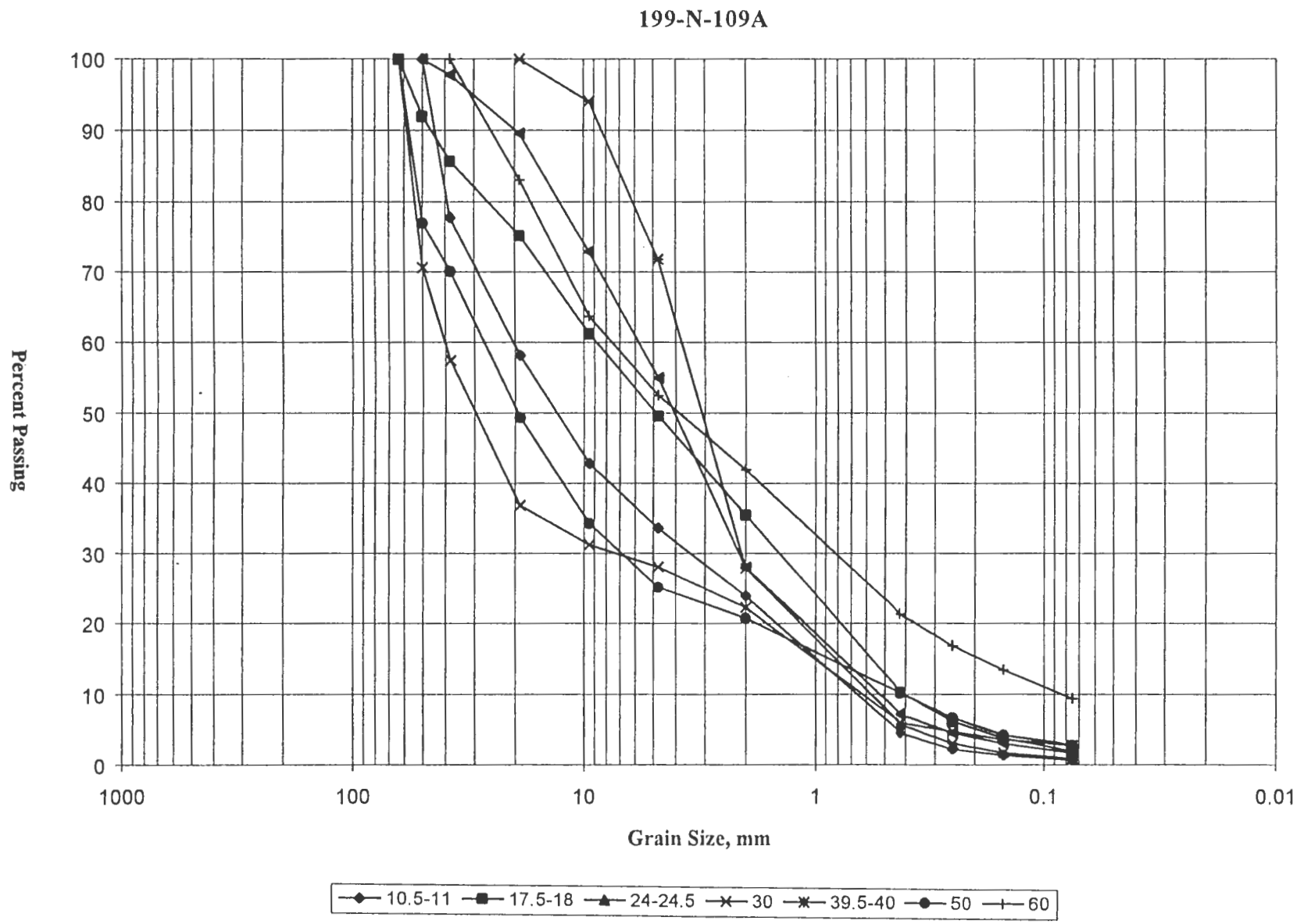
PARTICLE SIZE DISTRIBUTION



Sample depths in feet below ground surface.

Figure B2-1. Particle Size Distributions for 199-N-108A Soil Samples

Figure B2-2. Particle Size Distribution for 199-N-109A Soil Samples



Sample depths in feet below ground surface.

APPENDIX B-3

MOISTURE RETENTION

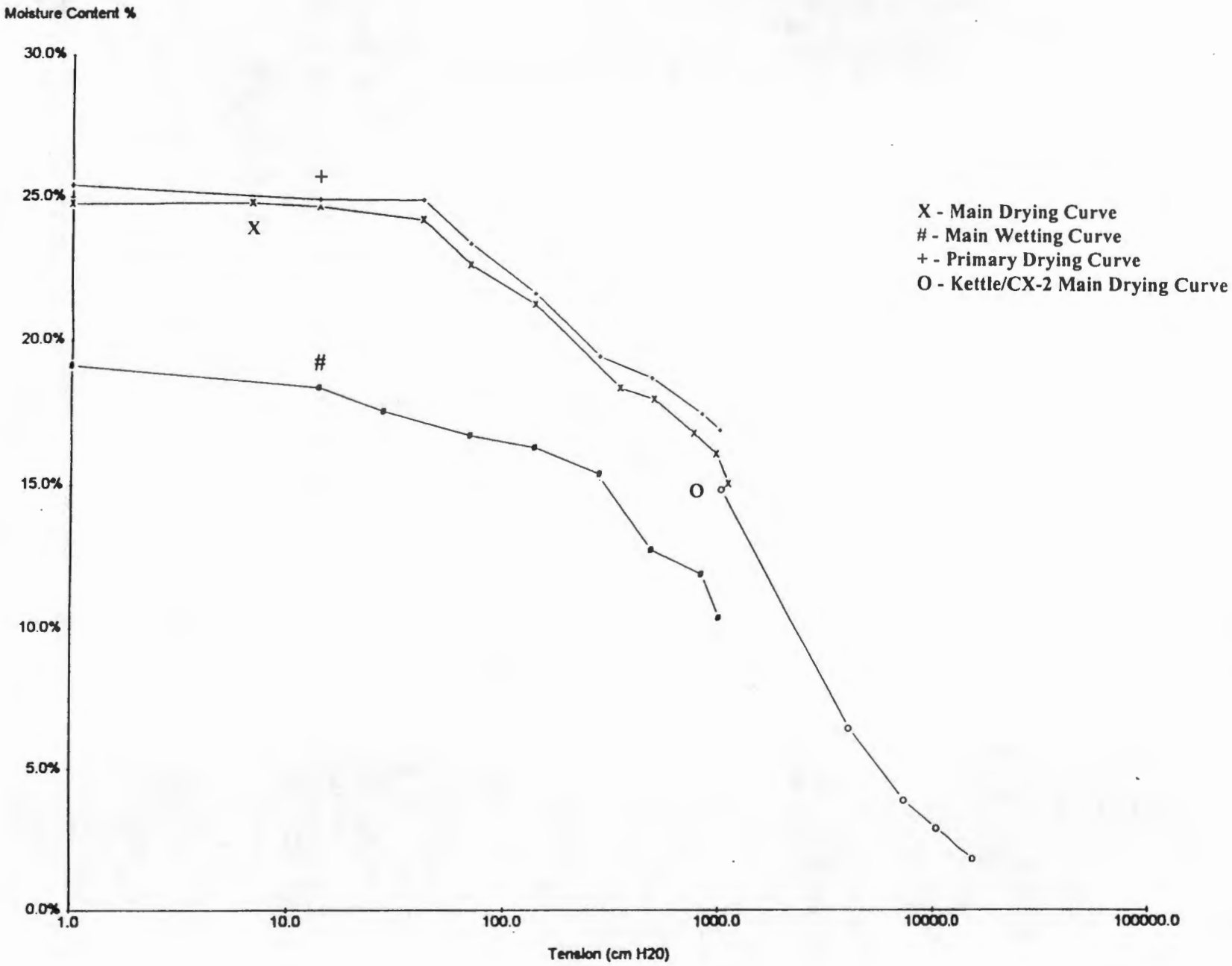


Figure B3-1. 199-N-108A Moisture Retention (Page 1 of 4)

Figure B3-1. 199-N-108A Moisture Retention (Page 2 of 4)

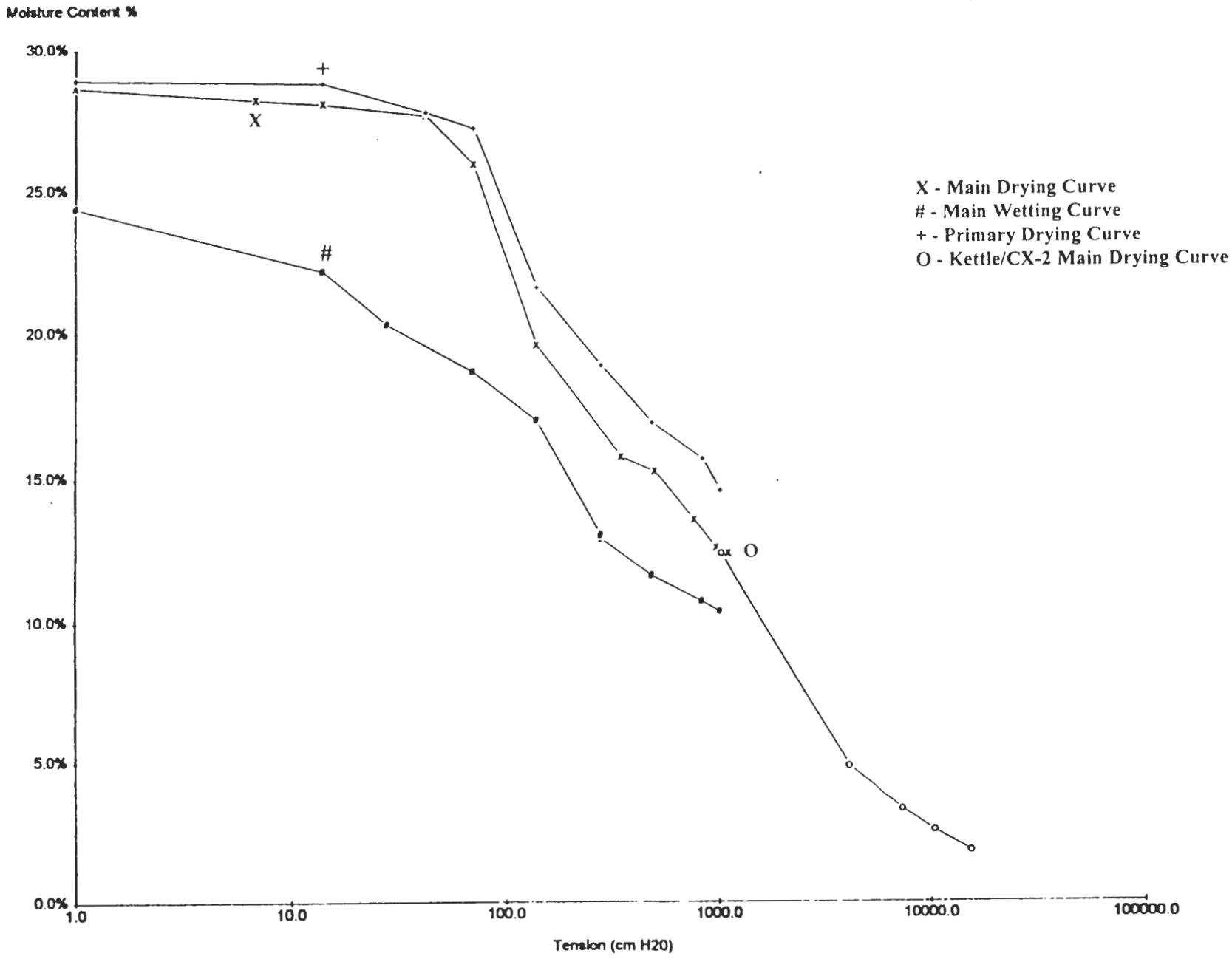


Figure B3-1. 199-N-108A Moisture Retention (Page 3 of 4)

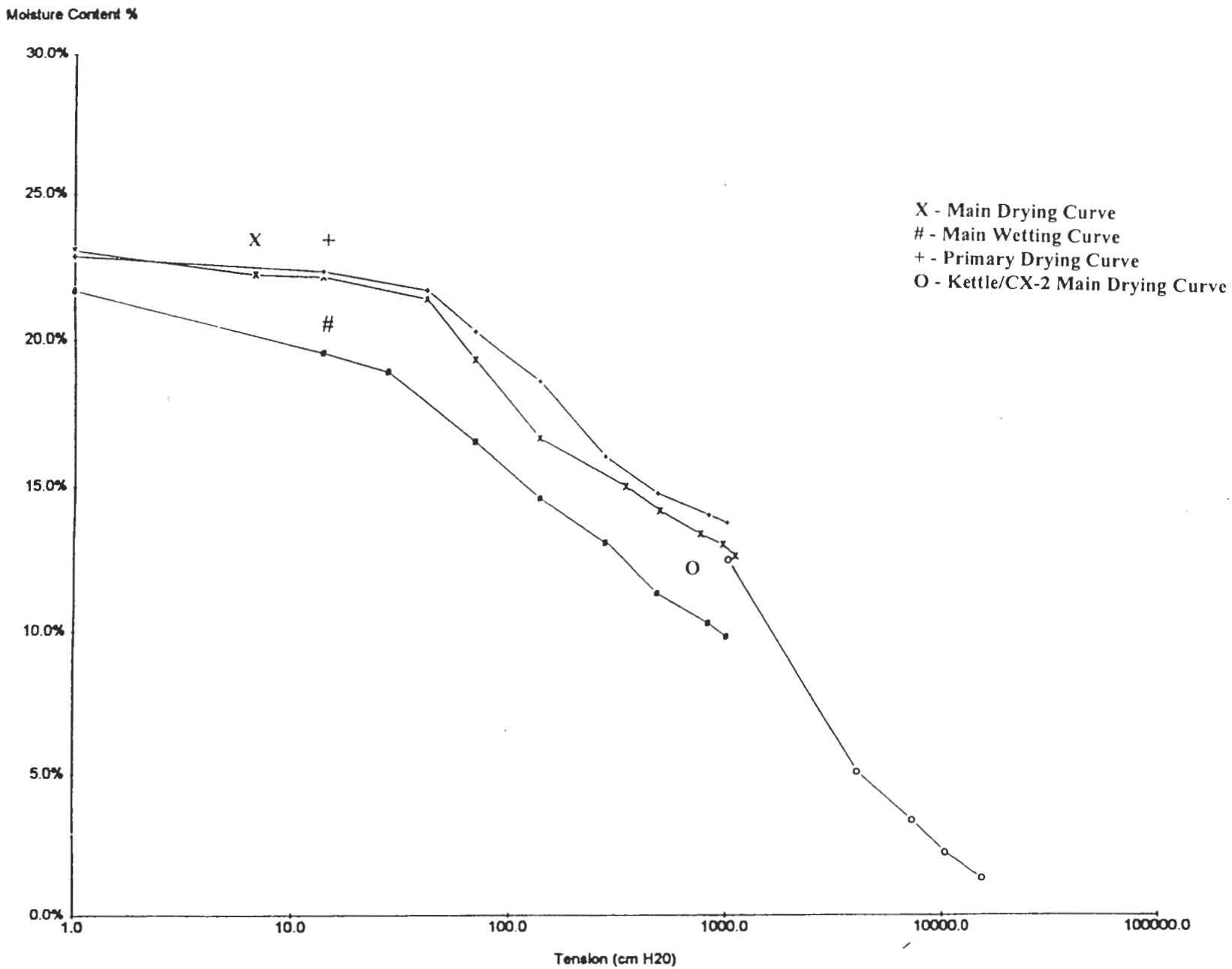


Figure B3-1. 199-N-108A Moisture Retention (Page 4 of 4)

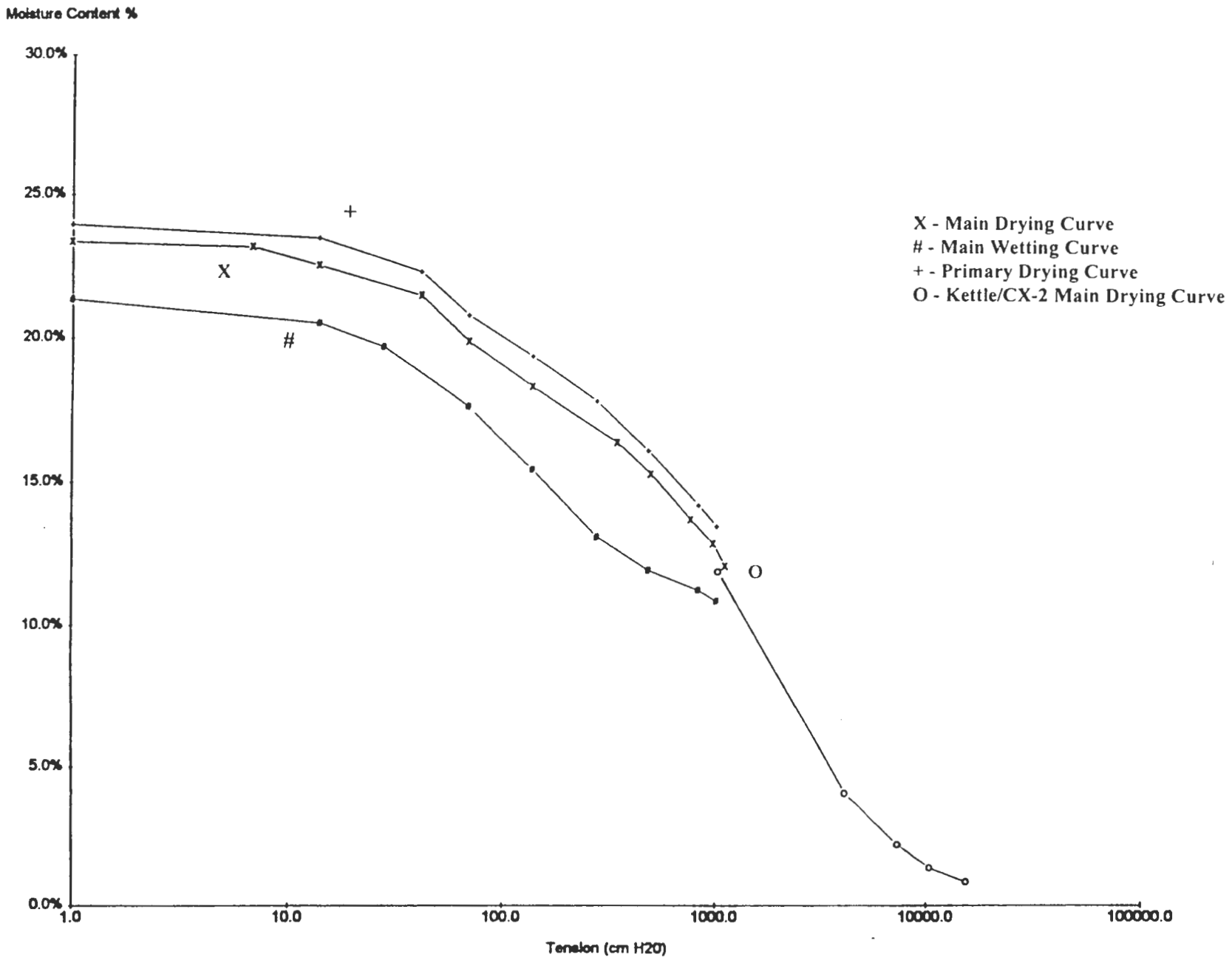


Figure B3-2. 199-N-109A Moisture Retention (Page 1 of 4)

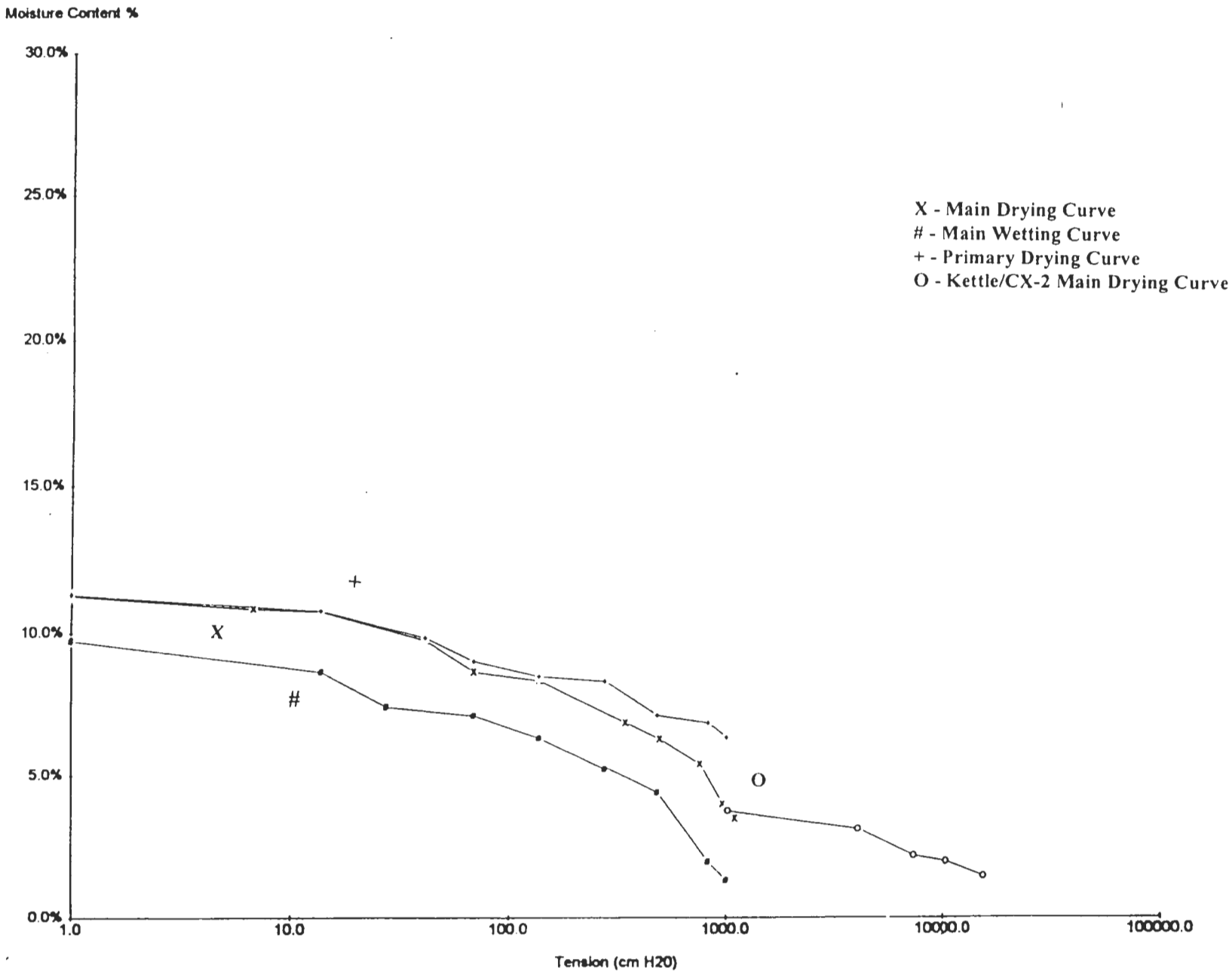


Figure B3-2. 199-N-109A Moisture Retention (Page 2 of 4)

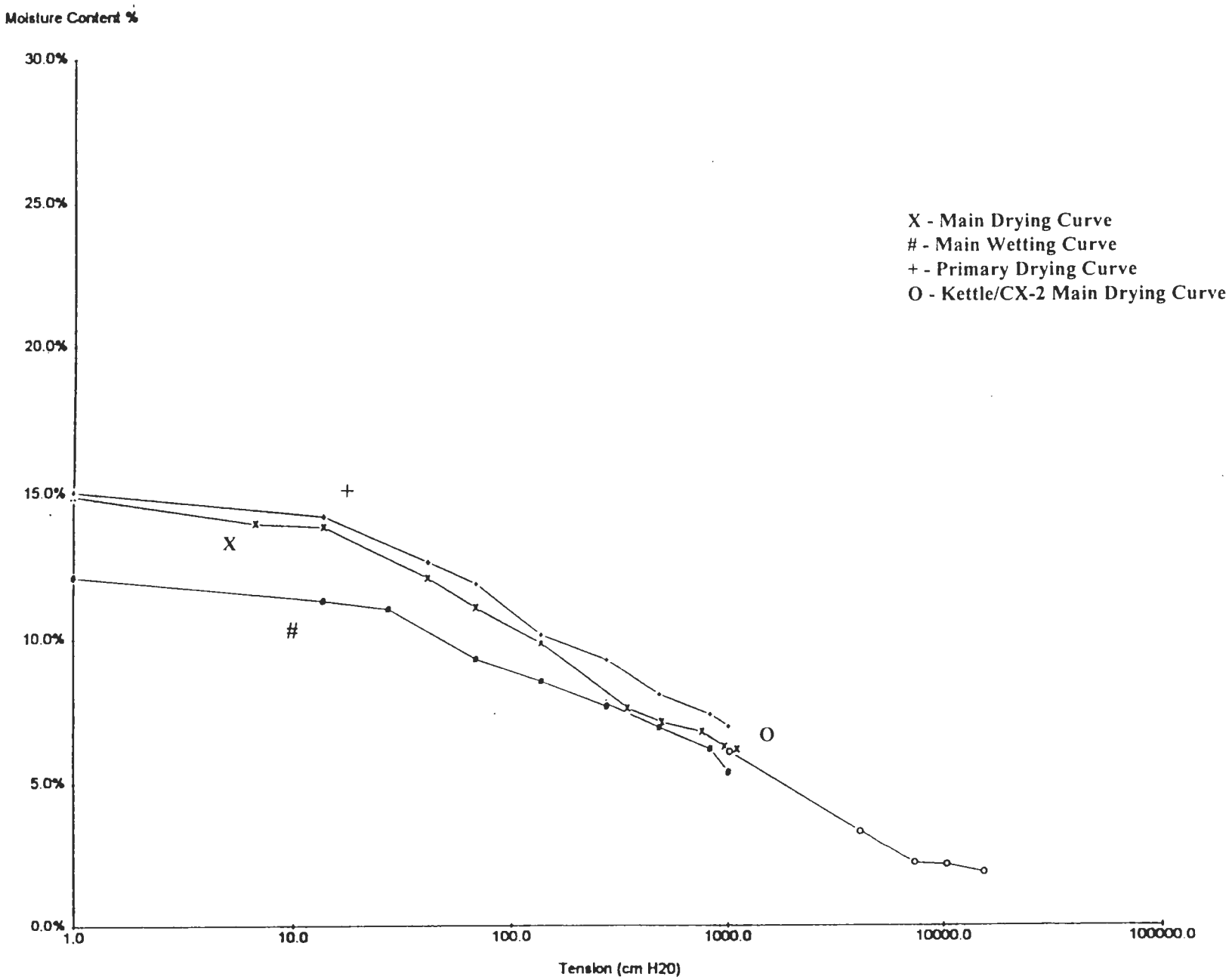


Figure B3-2. 199-N-109A Moisture Retention (Page 3 of 4)

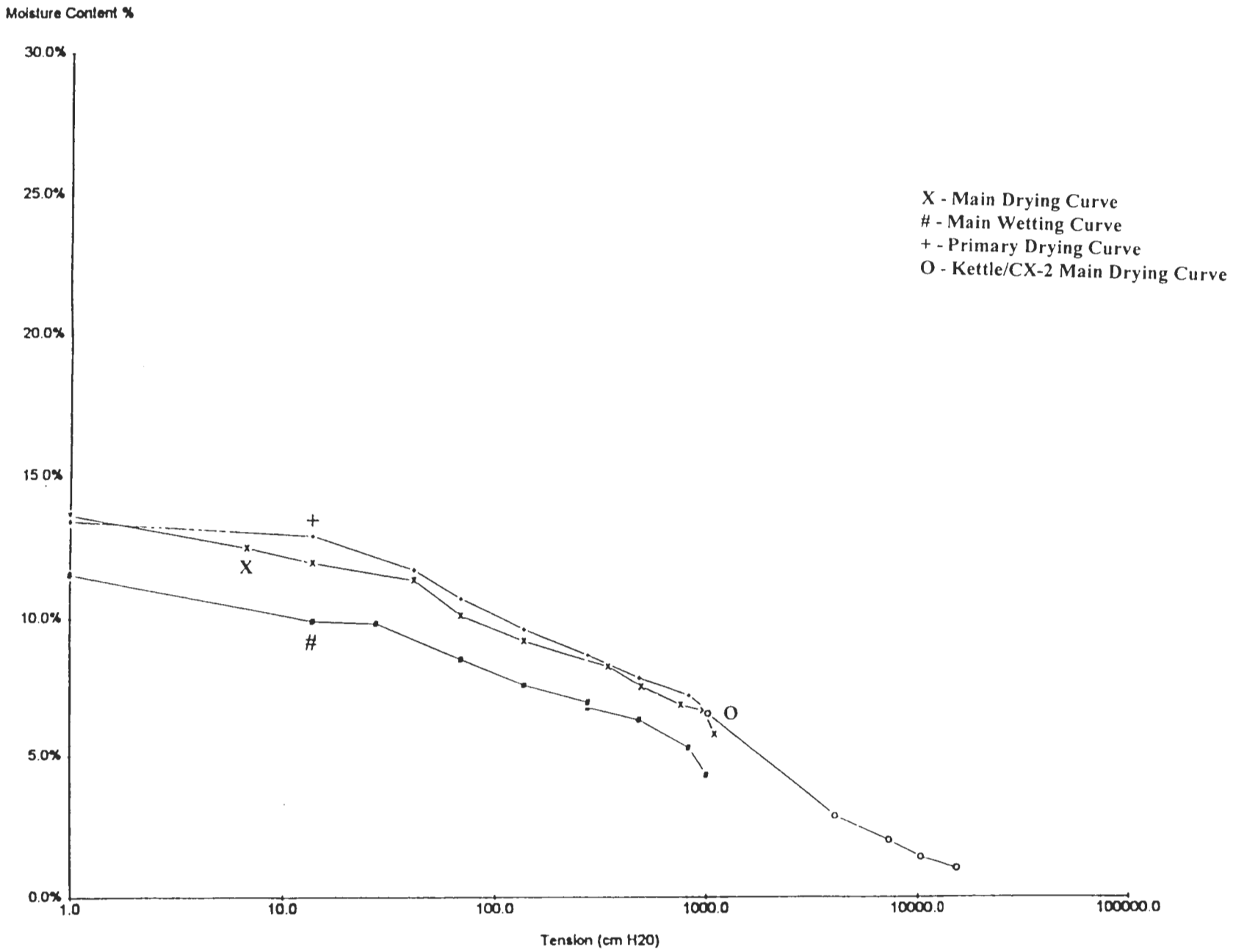
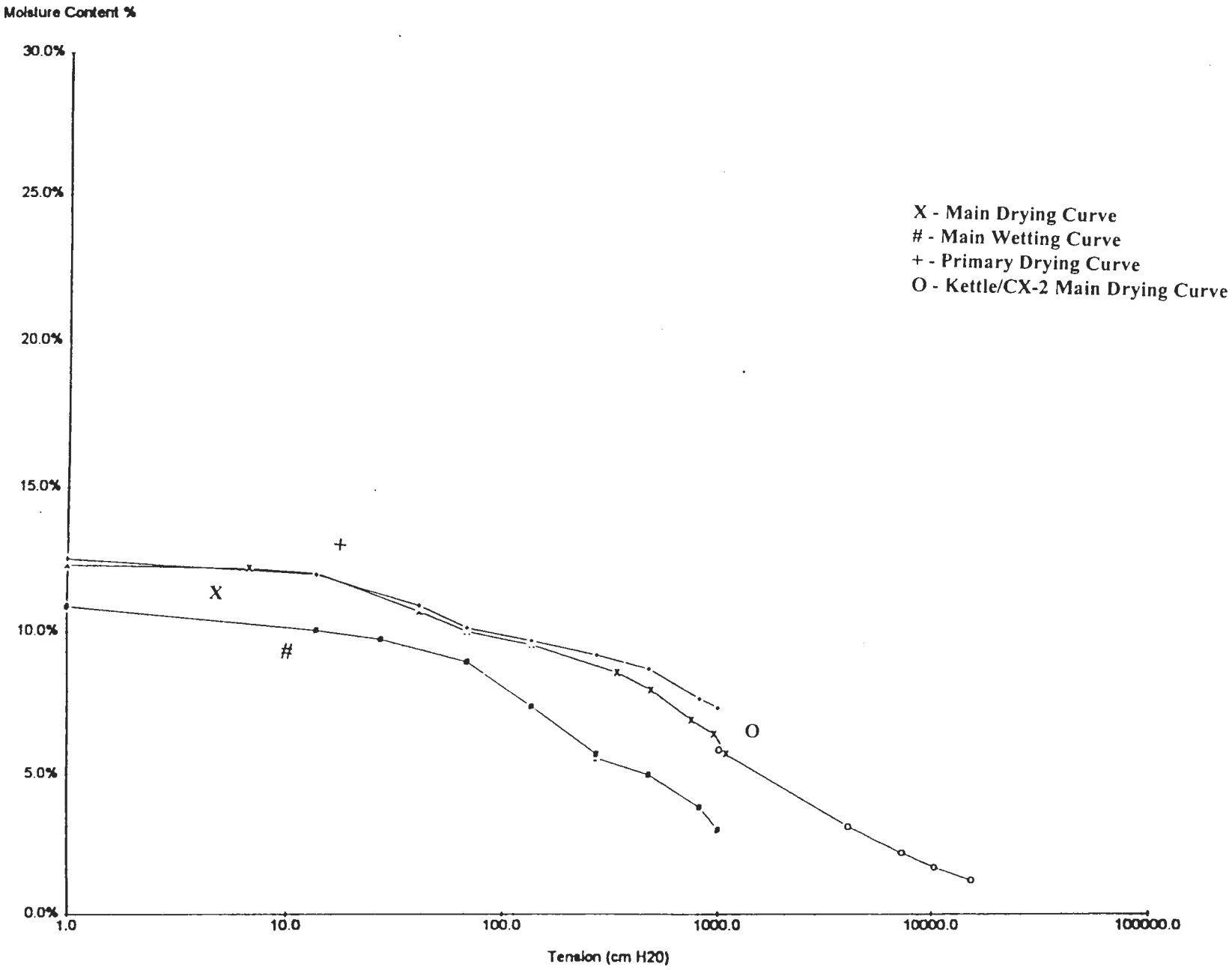


Figure B3-2. 199-N-109A Moisture Retention (Page 4 of 4)



APPENDIX B-4

GEOPHYSICAL LOGS

Figure B4-1. 199-N-107A Geophysical Data Package (Page 1 of 5)

RADIONUCLIDE LOGGING SYSTEM
Log Analysis Summary Report

Borehole: B2536 (199-N-107A)
Log Types: HPGe Spectral Gamma-Ray
Neutron Moisture

Report Date: Jan 17, 1996
Final Log Date: Dec 21, 1995

General Notes:
The borehole was surveyed after the 10-inch and 8-inch casings was advanced to their maximum depth, on December 1 and December 21, 1995. The survey depths are measured from top of casing. The borehole was surveyed with two HPGe detector sizes to assure accurate measurement of radionuclide concentrations at low and high activity levels. The low activity detector, RLSG3.0, contains a 35% germanium crystal that has detection range of 0.2 pCi/g to 500 pCi/g before electronics dead-time exceeds 40%. The high activity detector, RLSG5.0, contains a 10% germanium crystal inside a tungsten shield that reduces the observed gamma-ray activity by 1100%. The high activity probe also contains a cadmium-zinc-tellurium (CZT) detector for excessive count-rate intervals. The CZT detector was used to record the activity from 8' to 11' where both germanium detectors were saturated.

The computed radionuclide concentration could not be computed from 8' to 11' when the detector counting system was saturated. The computed radionuclide concentrations for all other log runs (RLSG3.0, RLSG5.0, single and double casings) and repeats are displayed on the data plot.

The concentrations of the naturally occurring radionuclides potassium, uranium, and thorium are typical for Hanford sediments. The high gamma-ray activity from 2' to 25' masked the natural gamma-ray activity, preventing reliable detection of the natural radionuclide concentrations.

Neutron Moisture
The neutron moisture survey is displayed with the spectral gamma survey. Moisture variations show good correlation with the contaminant distribution profile. Interpretation notes have been added to the log data plot. Note at 64' that the moisture and contaminant change is not consistent with the log responses above this depth.

Man-made Radionuclides
Cesium (Cs-137) was identified from the surface to the maximum survey depth of 74'. The decay activity exceeded 200 pCi/g from 1.5' to 25.5', and exceeded 5000 pCi/g from 7' to 22'. The maximum activity encountered was 22,000 pCi/g at 14.5'. The cesium activity between 8' and 11' is unknown.

Cobalt (Co-60) was identified from the surface to the maximum survey depth of 74'. The decay activity exceeded 200 pCi/g from 1.5' to 20.5', and exceeded 5000 pCi/g from 7.5' to 11'. The maximum activity encountered was 9000 pCi/g at the base of the detector saturation zone at 11', indicating that cobalt likely exceeds 9000 pCi/g between 8' and 11'.

Figure B4-1. 199-N-107A Geophysical Data Package (Page 2 of 5)

Westinghouse Hanford Company
Radionuclide Logging System Log Header

Project	1301-N LWDF	Log Types:	HPGe Spectral Gamma-Ray
Borehole	WID# = B2536 (199-N-107A)		Neutron Moisture

Borehole Environment Information

Borehole liquid depth 73 (ft) from Ground Level

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
16	0.5	0	9
10	0.5	-0.6	17
8	0.5	-1.0	77

RLS Passive Spectral Gamma Survey Information

Logging Engineer(s) J. E. Meisner J. R. Kunk E. R. Selle
Log depth reference at zero (0.0) depth is Top of Casing

Log Date	Archive Disk Detector ID	Log mode	speed	Depth interval (ft) Top	Base	Incr
Dec 1, 1995	B2536\B071	FIXED	0.7 fpm	0	16	0.5
	RLSG3.0 (35%)	"	"	0	5	0.5
Dec 1, 1995	B2536\B072	FIXED	0.7 fpm	0	16.5	0.5
	RLSG5.0 (10%)	"	"	11	16.5	0.5
Dec 21, 1995	B2536\B079	FIXED	0.7 fpm	15	74.5	0.5
	RLSG3.0 (35%)	"	"	63	74.5	0.5
Dec 21, 1995	B2536\B080	FIXED	0.7 fpm	8	30	0.5
	RLSG5.0 (10%)	"	"	20	30	0.5
Dec 21, 1995	B2536\MS35	MSA	30 sec	6	70	0.5
	RLSM1.1 moist	"	"	53	57	0.5
		"	"	63	68	.25

FIXED: Fixed Velocity of Cable Speed MSA: Move-Stop-Acquire fpm: feet per minute

Calibration and Analysis Information

RLS Calibration Date: Mar 22, 1995 (HPGe-35%), Nov 20, 1995 (HPGe-10%)
Calibration Report: WHC-SD-EN-TI-292, WHC-SD-EN-TI-306

Analyst Name(s): R. K. Price
Analysis Date: Jan 17, 1996

Analysis Notes: HPGe detectors saturated (8-11') for both probes
Radionuclides Identified: Cs-137 22,000 pCi/g @14.5' Co-60 9000 @11.5'

Figure B4-1. 199-N-107A Geophysical Data Package (Page 3 of 5)

RLS Spectral Gamma & Moisture Borehole Survey

Project: 1301-N LWDF
Borehole: B2536 (199-N-107A)

Last Log Date: Dec 21, 1995
Analysis Date: Jan 17, 1996
Westinghouse Hanford Company

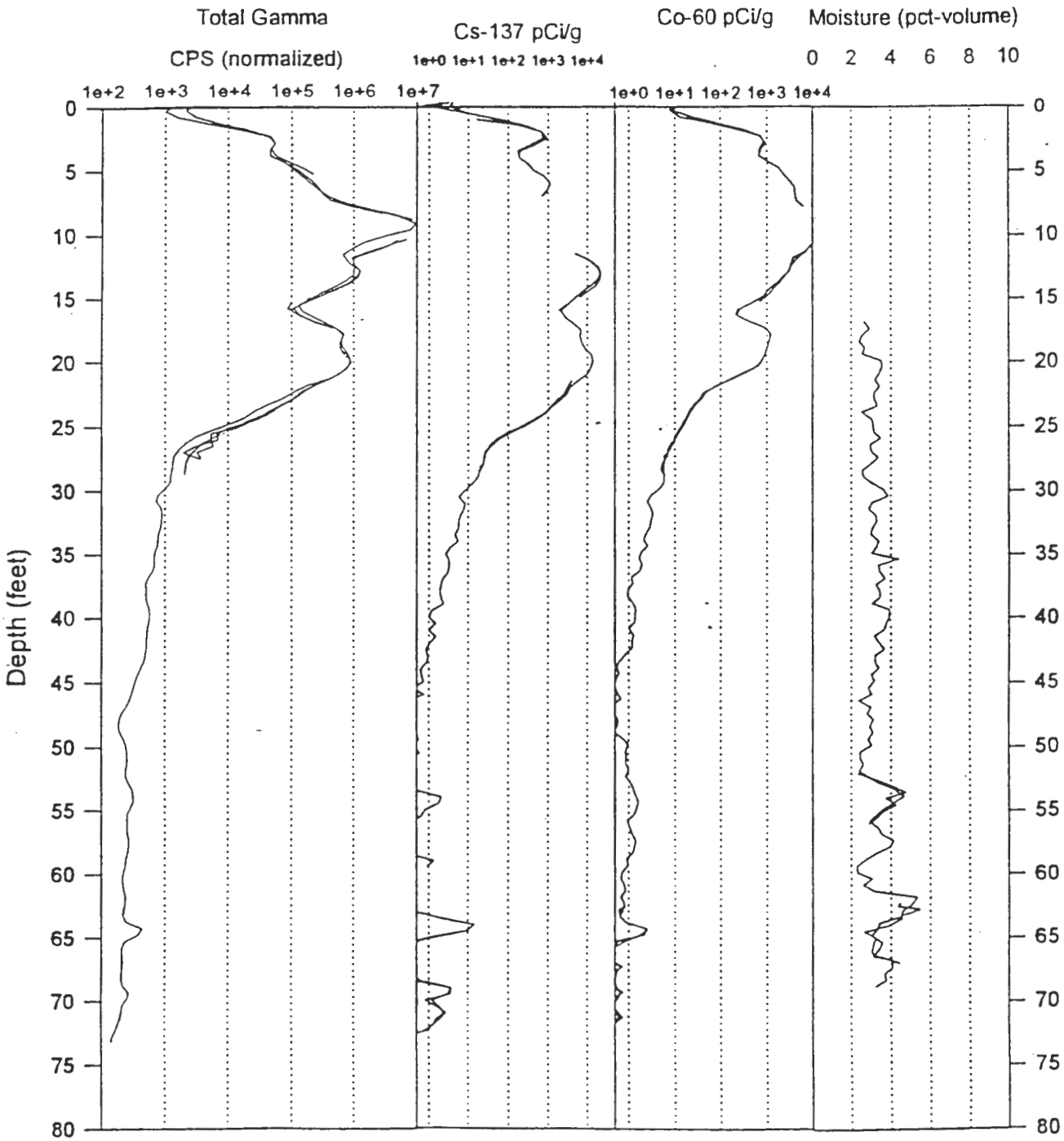


Figure B4-1. 199-N-107A Geophysical Data Package (Page 4 of 5)

RLS Spectral Gamma & Moisture Borehole Survey

Project: 1301-N LWDF
Borehole: B2536 (199-N-107A)

Last Log Date: Dec 21, 1995
Analysis Date: Jan 17, 1996
Westinghouse Hanford Company

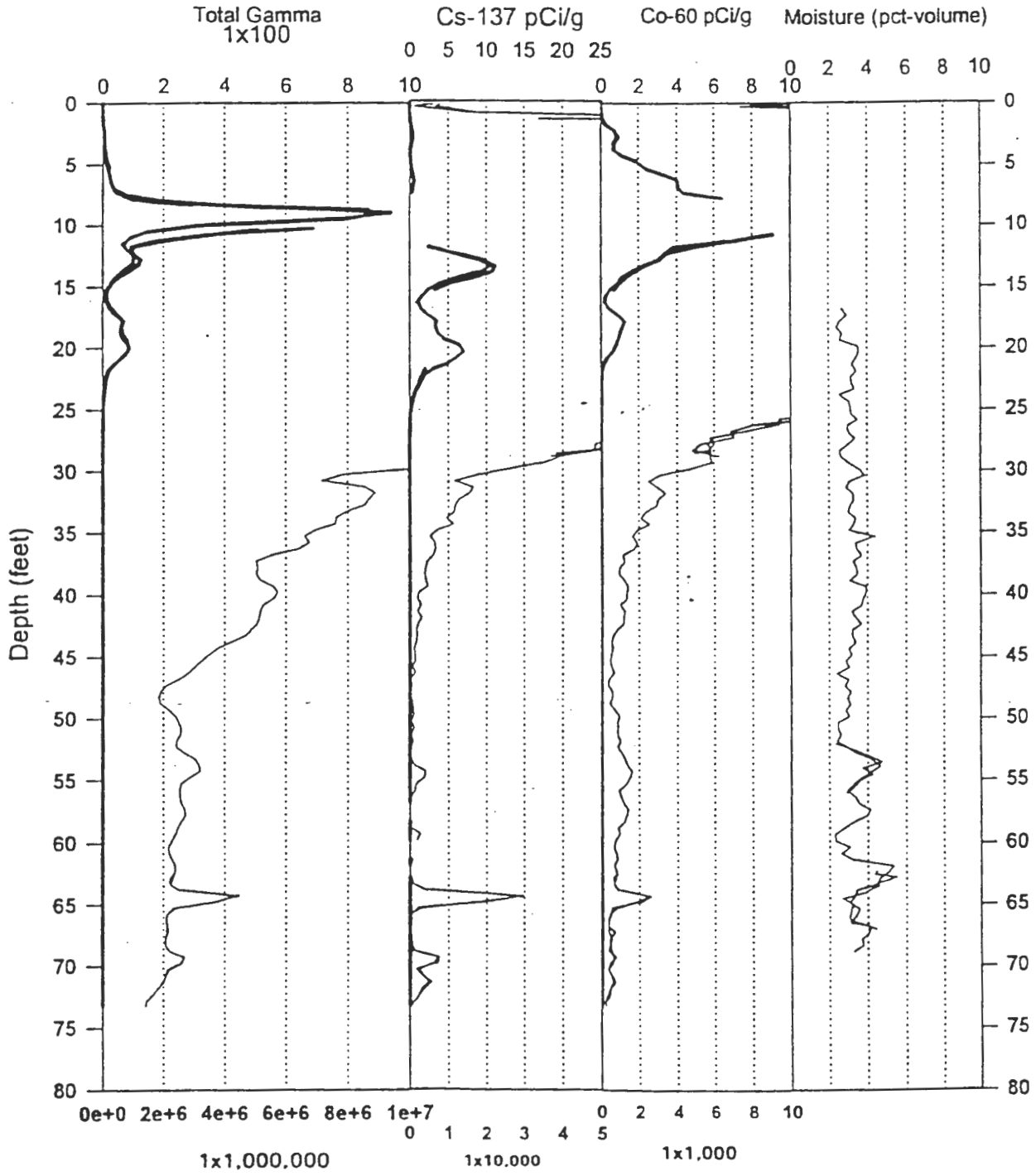


Figure B4-1. 199-N-107A Geophysical Data Package (Page 5 of 5)

RLS Spectral KUT Processed Data

Project: 1301-N LWDF
Borehole: B2536 (199-N-107A)

Last Log Date: Dec 21, 1995
Analysis Date: Jan 17, 1996
Westinghouse Hanford Company

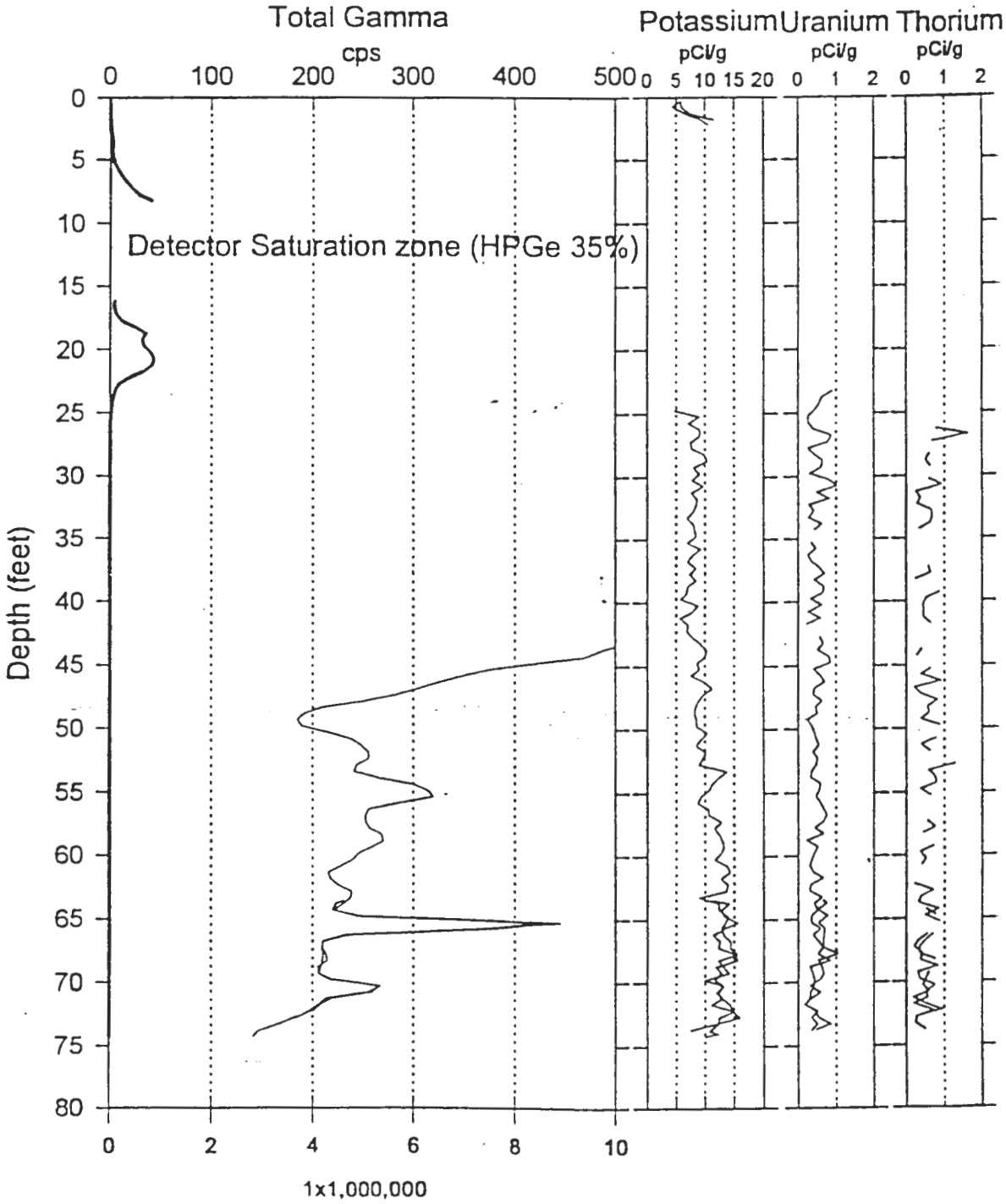


Figure B4-2. 199-N-108A Geophysical Data Package (Page 1 of 5)

RADIONUCLIDE LOGGING SYSTEM
Log Analysis Summary Report

Borehole: B2537(199-N-108A) **Report Date:** Dec 5, 1995
Log Types: HPGe Spectral Gamma Ray **Final Log Date:** Dec 1, 1995

General Notes:
The borehole was surveyed after each casing was advanced to its maximum depth, on November 13 and December 1, 1995. The survey depths are measured from top of casing. The borehole was surveyed with two HPGe detector sizes to assure accurate measurement of radionuclide concentrations at low and high activity levels. The low activity detector, RLSG3.0, contains a 35% germanium crystal that has detection range of 0.2 pCi/g to 500 pCi/g before electronics dead-time exceeds 40%. The high activity detector, RLSG5.0, contains a 10% germanium crystal inside a tungsten shield that reduces the observed gamma-ray activity by 1100%.

High gamma-ray activity, exceeded 40% dead-time, from 16' to 23' for one of the four survey runs though the interval. The computed radionuclide concentration for this portion of the survey is not displayed. The computed radionuclide concentrations for all other log runs (RLSG3.0, RLSG5.0, single and double casings) and repeats are displayed on the data plot.

Interpretation notes have been added to the data plot. Note at 21' the distribution ratio between cesium and cobalt change, with an increase of cesium between 21' and 23'.

The "Total Gamma" curve from the RLSG3.0 detector is displayed on the data plot. The two "thin-line" curves from 25' to 36' show the gamma-ray attenuation encountered through the second (8") casing for the over-lapped interval.

The concentrations of the naturally occurring radionuclides potassium, uranium, and thorium are typical for Hanford sediments.

Due to restricted field coverage in Radiation Control Areas, no neutron moisture survey was acquired by WHC in this borehole.

Man-made Radionuclides
Cesium (Cs-137) was identified near the surface, from 1' to 39'. The decay activity exceeded 200 pCi/g from 15' to 23.5', and exceeded 5000 pCi/g from 17' to 22'. The maximum activity encountered was 12,000 pCi/g at 18'.

Cobalt (Co-60) was identified from near the surface, from 1' to the maximum survey depth of 72'. The decay activity exceeded 200 pCi/g from 16' to 22.5'. The maximum activity encountered was 2230 pCi/g at 18'.

Figure B4-2. 199-N-108A Geophysical Data Package (Page 2 of 5)

Westinghouse Hanford Company
Radionuclide Logging System Log Header

Project	1301-N LWDF	Log Types:	HPGe Spectral Gamma-Ray
Borehole	WID# - B2537 (199-N-108A)		Neutron Moisture

Borehole Environment Information

Borehole liquid depth 72.3 (ft) from zero (0.0) depth reference of log

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
10	0.5	-0.6	36.5
8	0.5	-0.4	72

RLS Passive Spectral Gamma Survey Information

Logging Engineer(s) J. E. Meisner J. R. Kunk J. P. Kiesler
Log depth reference at zero (0.0) depth is Top of Casing

Log Date	Archive Disk Detector ID	Log mode	speed	Depth interval (ft) Top	Base	Incr
Nov 13, 1995	B2537\B070	FIXED	0.7 fpm	0	36.8	0.5
		"	"	31.8	36.8	0.5
	RLSG3.0 (35%)	"	"	25.0	32.0	0.5
Nov 13, 1995	B2537\B071	FIXED	0.7 fpm	12	32	0.5
		"	"	27	30	0.5
	RLSG5.0 (10%)	"	"	29	32	0.5
Dec 1, 1995	B2537\B073	FIXED	0.7 fpm	20	70.0	0.5
	RLSG3.0 (35%)	"	"	62	72.4	0.5
Dec 1, 1995	B2537\B077	FIXED	0.5 fpm	10	30	0.5
	RLSG5.0 (10%)	"	0.7 fpm	10	30	0.5

FIXED: Fixed Velocity of Cable Speed fpm: feet per minute

Calibration and Analysis Information

RLS Calibration Date: Mar 22, 1995 (HPGe-35%), Nov 20, 1995 (HPGe-10%)
Calibration Report: WHC-SD-EN-TI-292

Analyst Name(s): R. K. Price
Analysis Date: Dec 5, 1995

Analysis Notes: HPGe(35%) detector saturated thru zone in single casing
Radionuclides Identified: Cs-137, Co-60 (max 12,000 & 2230 pCi/g @ 18')

Figure B4-2. 199-N-108A Geophysical Data Package (Page 3 of 5)

RLS Spectral Gamma & Moisture Borehole Survey

Project: 1301-N LWDF
Borehole : B2537 (199-N-108A)

Last Log Date: Dec 3, 1995
Analysis Date: Dec 5, 1995
Westinghouse Hanford Company

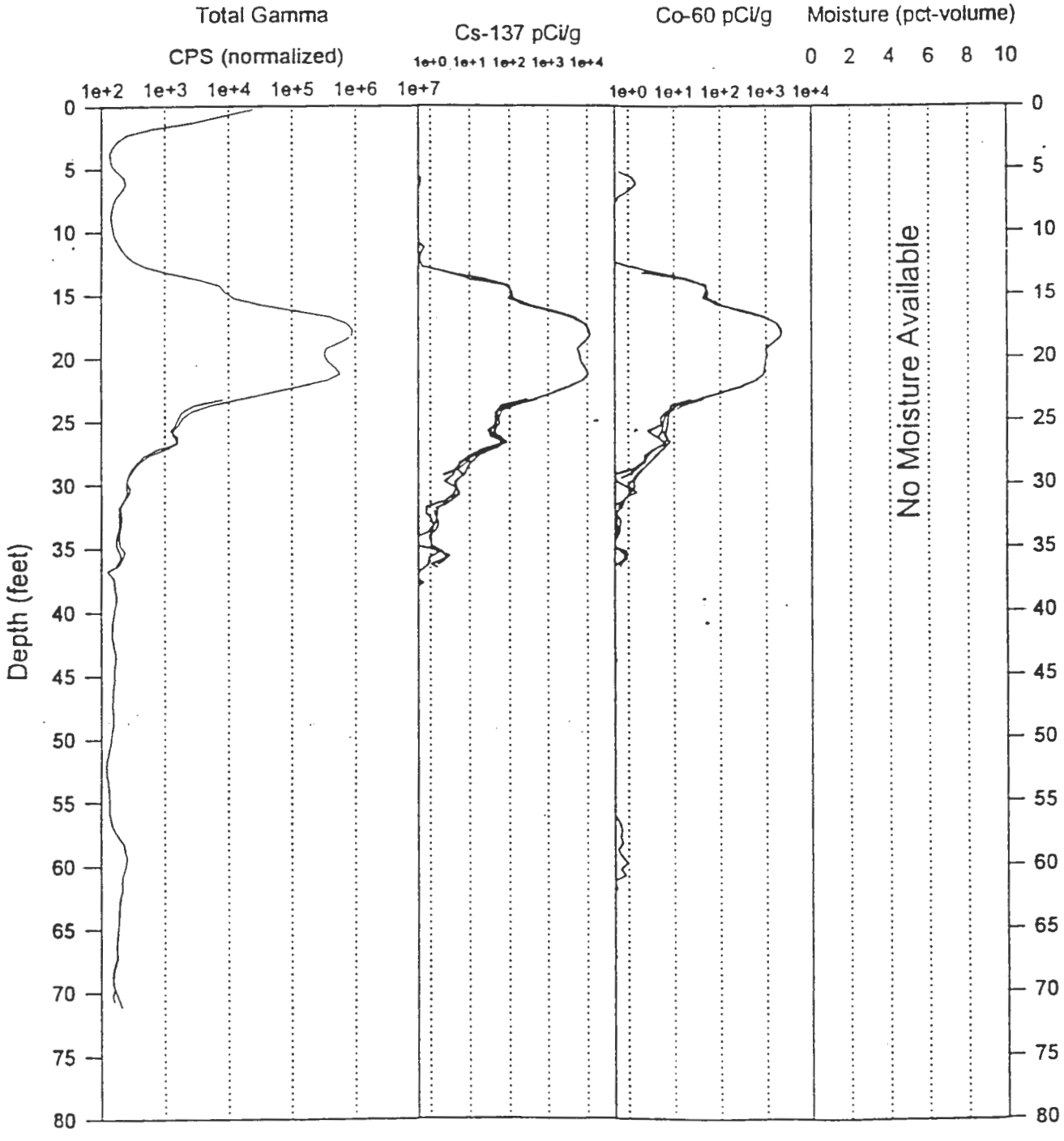


Figure B4-2. 199-N-108A Geophysical Data Package (Page 4 of 5)

RLS Spectral Gamma & Moisture Borehole Survey

Project: 1301-N LWDF
Borehole: B2537 (199-N-108A)

Last Log Date: Dec 3, 1995
Analysis Date: Dec 5, 1995
Westinghouse Hanford Company

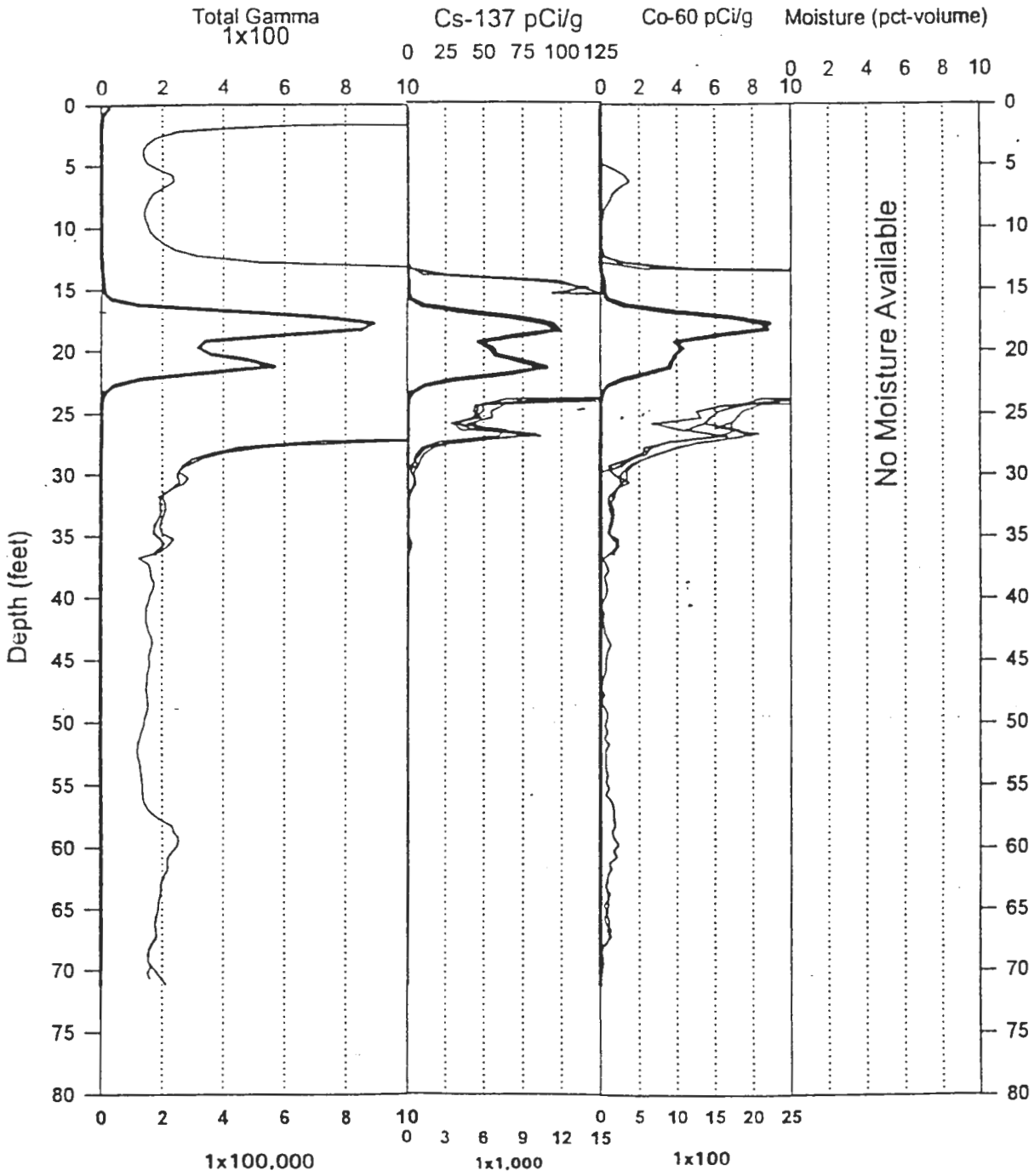


Figure B4-2. 199-N-108A Geophysical Data Package (Page 5 of 5)

RLS Spectral KUT Processed Data

Project: 1301-N LWDF
Borehole: B2537 (199-N-108A)

Last Log Date: Dec 3, 1995
Analysis Date: Dec 5, 1995
Westinghouse Hanford Company

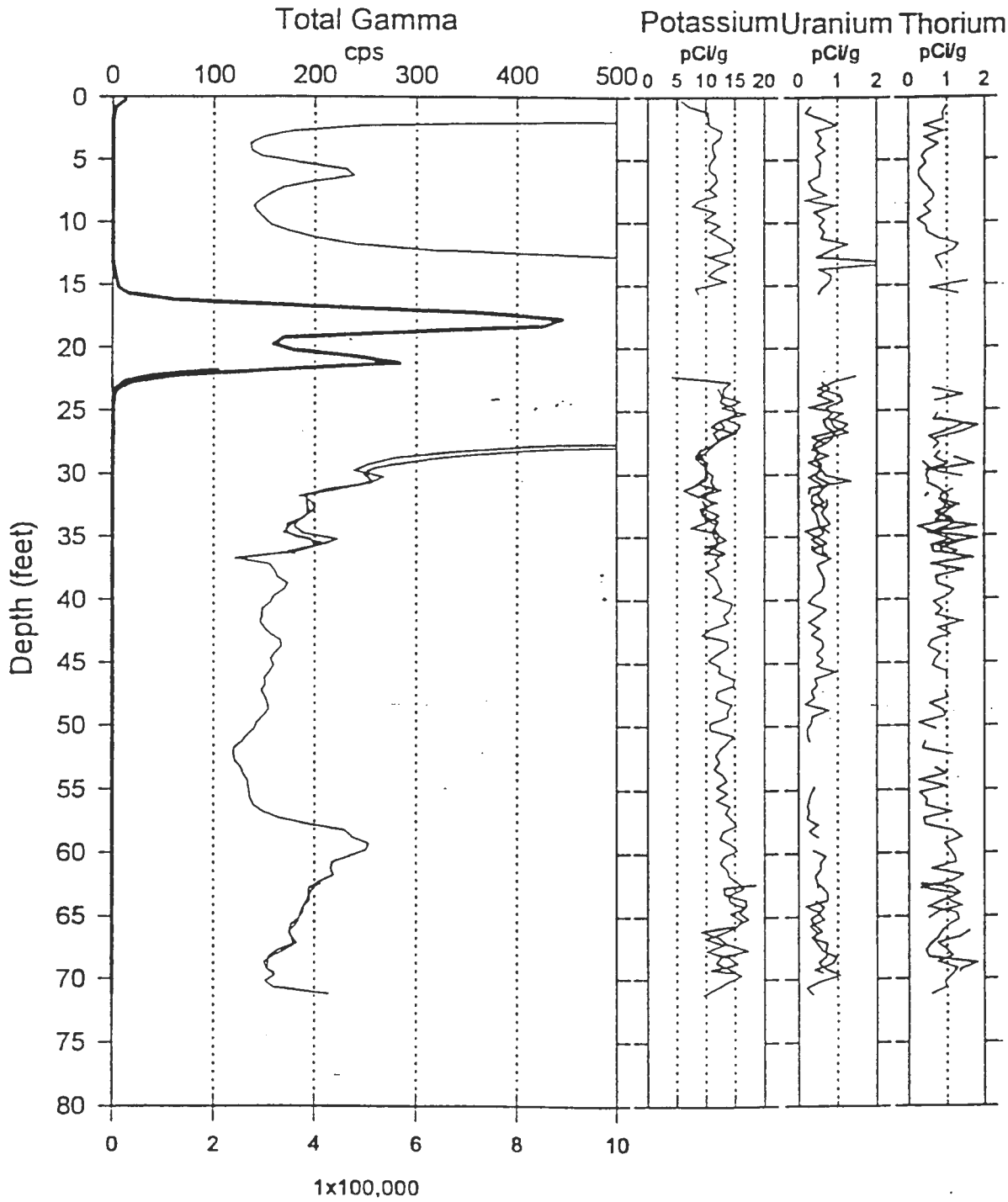


Figure B4-3. 199-N-109A Geophysical Data Package (Page 1 of 5)

RADIONUCLIDE LOGGING SYSTEM
Log Analysis Summary Report

Borehole: B2539 (199-N-109A) **Report Date:** Jan 22, 1996
Log Types: HPGe Spectral Gamma Ray **Final Log Date:** Jan 2, 1996
Neutron Moisture

General Notes:
The borehole was surveyed after each casing was advanced to its maximum depth, on December 20 and January 2, 1996. The survey depths are measured from top of casing.

The computed radionuclide concentrations for both log runs and repeats are displayed on the data plot. The depth reference of the data plots is the gound level.

The concentrations of the naturally occurring radionuclides potassium, uranium, and thorium are typical for Hanford sediments. The interface between the Hanford formation and Ringold formation is established at 44' and is identified by an increase in potassium content.

Neutron Moisture
The neutron moisture survey is displayed with the spectral gamma survey. Moisture variations show good correlation with the contaminant distribution profile. Interpretation notes have been added to the log data plot. Note at 58' that the moisture repeat at 0.25' increment identified fine stratification in the sediments.

Man-made Radionuclides
Cesium (Cs-137) was identified from 5' to 14'. The decay activity exceeded 200 pCi/g from 7.5' to 9'. The maximum activity encountered was 420 pCi/g at 8.5'.

Cobalt (Co-60) was identified from the surface to the maximum survey depth of 65'. The maximum activity encountered was 175 pCi/g at 8'.

Figure B4-3. 199-N-109A Geophysical Data Package (Page 2 of 5)

Westinghouse Hanford Company
Radionuclide Logging System Log Header

Project	1325-N LWDF	Log Types:	HPGe Spectral Gamma-Ray
Borehole	WID# - B2539 (199-N-109A)		Neutron Moisture

Borehole Environment Information

Borehole liquid depth 63 (ft) from ground level

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
10	0.5	-0.91	21.9
8	0.5	-2.0	64.6

RLS Passive Spectral Gamma Survey Information

Logging Engineer(s) J. E. Meisner - E. R. Selle
Log plot depth reference at zero (0.0) depth is Ground Level

Log Date	Archive Disk Detector ID	Log mode	speed	Depth interval (ft) Top	Base	Incr
Dec 20, 1995	B2539\B078	FIXED	0.7 fpm	0	21	0.5
	RLSG3.0 (35%)	"	"	0	21	0.5
Jan 2, 1996	B2539\B081	FIXED	0.7 fpm	0	66	0.5
	RLSG3.0 (35%)	"	"	55	66	0.5
Jan 2, 1996	B2539\MS36	MSA	30 sec	6	64	0.5
	RLSM1.1 moist	"	"	55	64	.25

FIXED: Fixed Velocity of Cable Speed MSA: Move-Stop-Acquire fpm: feet per minute

Calibration and Analysis Information

RLS Calibration Date: Mar 22, 1995 (HPGe-35%), Aug 31, 1995 (Moisture)
Calibration Report: WHC-SD-EN-TI-292, WHC-SD-EN-TI-306

Analyst Name(s): R. K. Price
Analysis Date: Jan 22, 1996

Analysis Notes: Geology change at 54' retained migrating contaminants
Radionuclides Identified: Cs-137, Co-60 (max 420 & 175 pCi/g @ 10')

Figure B4-3. 199-N-109A Geophysical Data Package (Page 3 of 5)

RLS Spectral Gamma & Moisture Borehole Survey

Project: 1325-N LWDF
Borehole: B2539 (199-N-109A)

Last Log Date: Jan 2, 1996
Analysis Date: Jan 22, 1996
Westinghouse Hanford Company

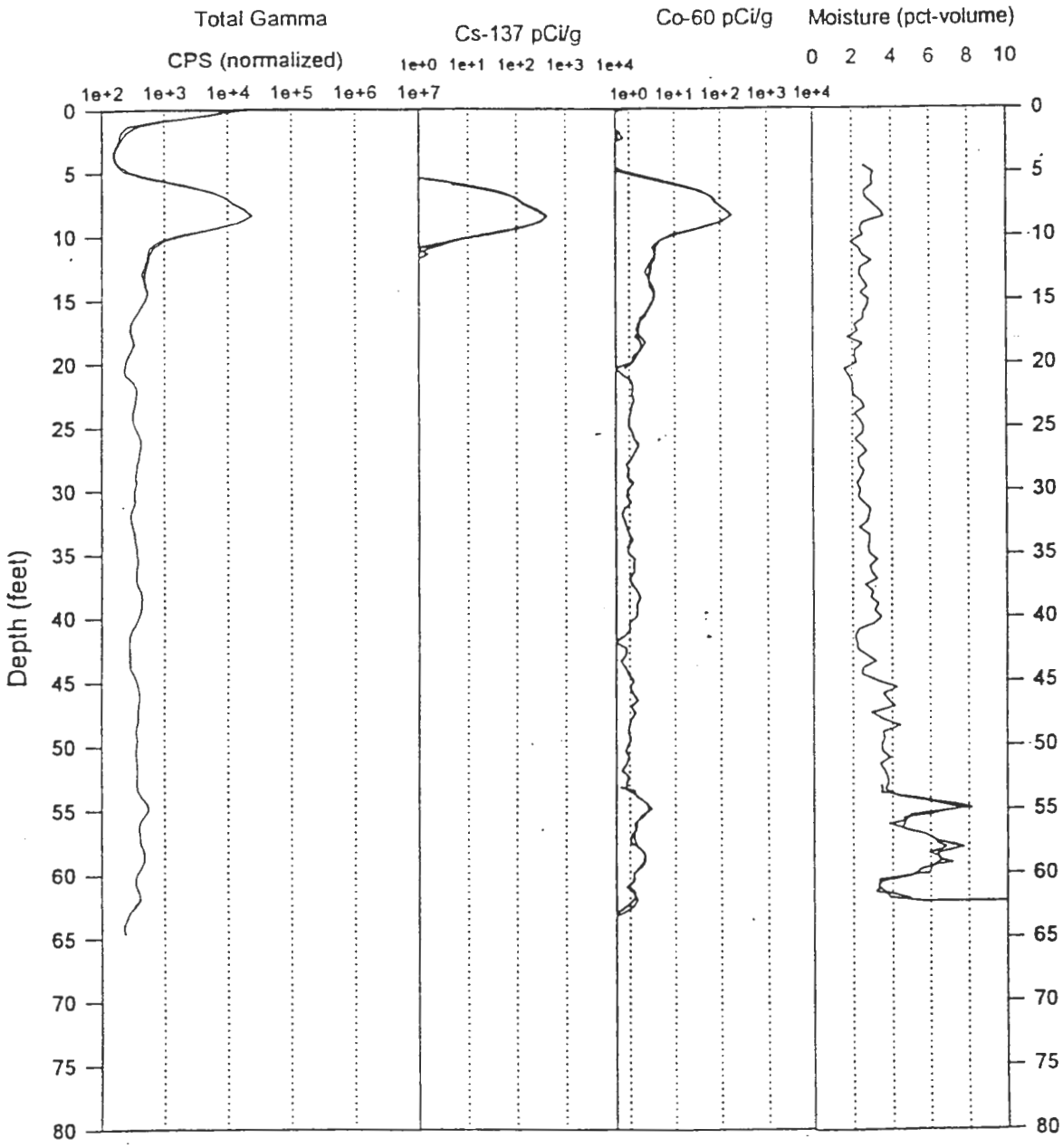


Figure B4-3. 199-N-109A Geophysical Data Package (Page 4 of 5)

RLS Spectral Gamma & Moisture Borehole Survey

Project: 1325-N LWDF
Borehole: B2539 (199-N-109A)

Last Log Date: Jan 2, 1996
Analysis Date: Jan 22, 1996
Westinghouse Hanford Company

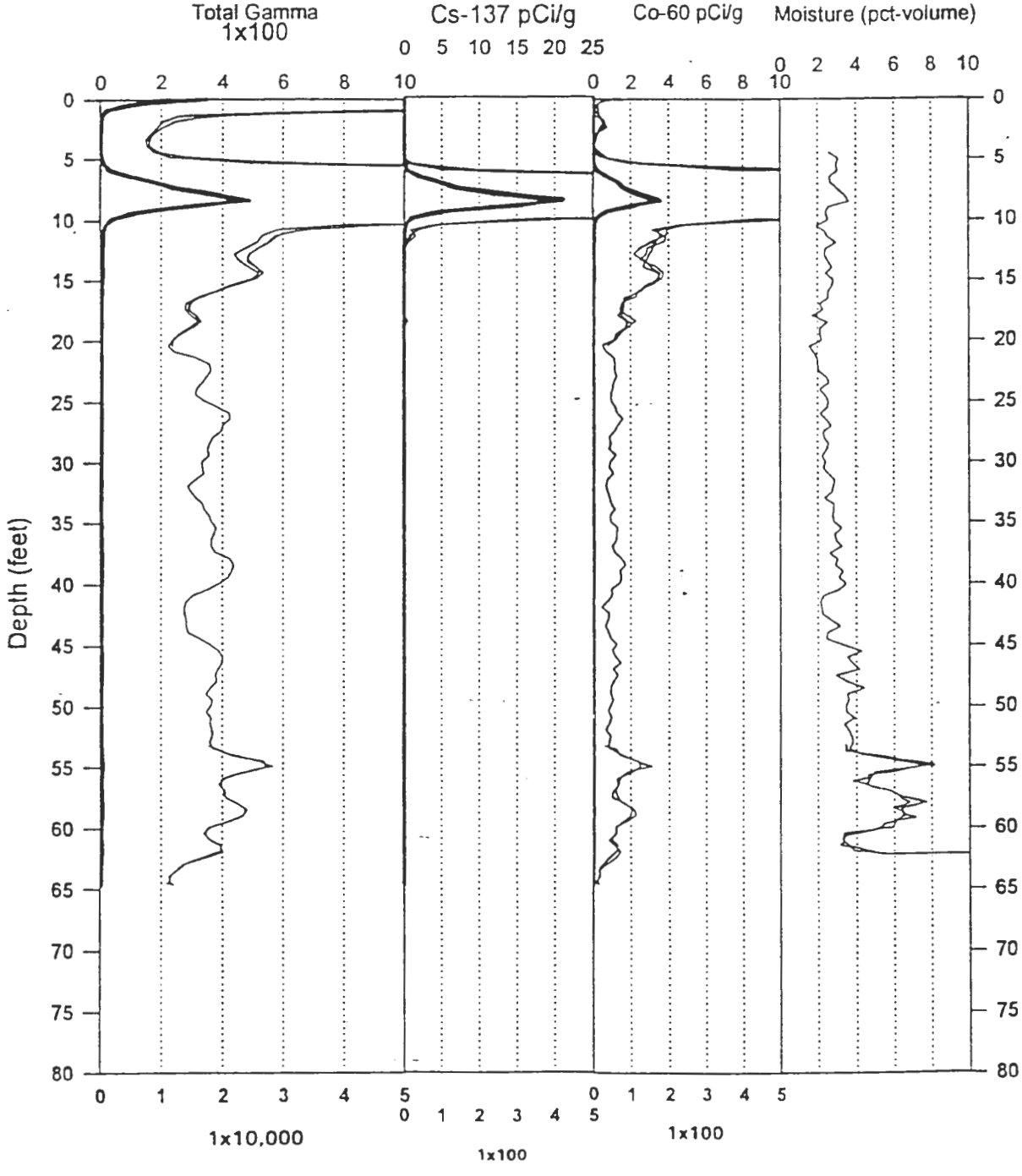


Figure B4-3. 199-N-109A Geophysical Data Package (Page 5 of 5)

RLS Spectral KUT Processed Data

Project: 1325-N LWDF
Borehole: B2539 (199-N-109A)

Last Log Date: Jan 2, 1996
Analysis Date: Jan 22, 1996
Westinghouse Hanford Company

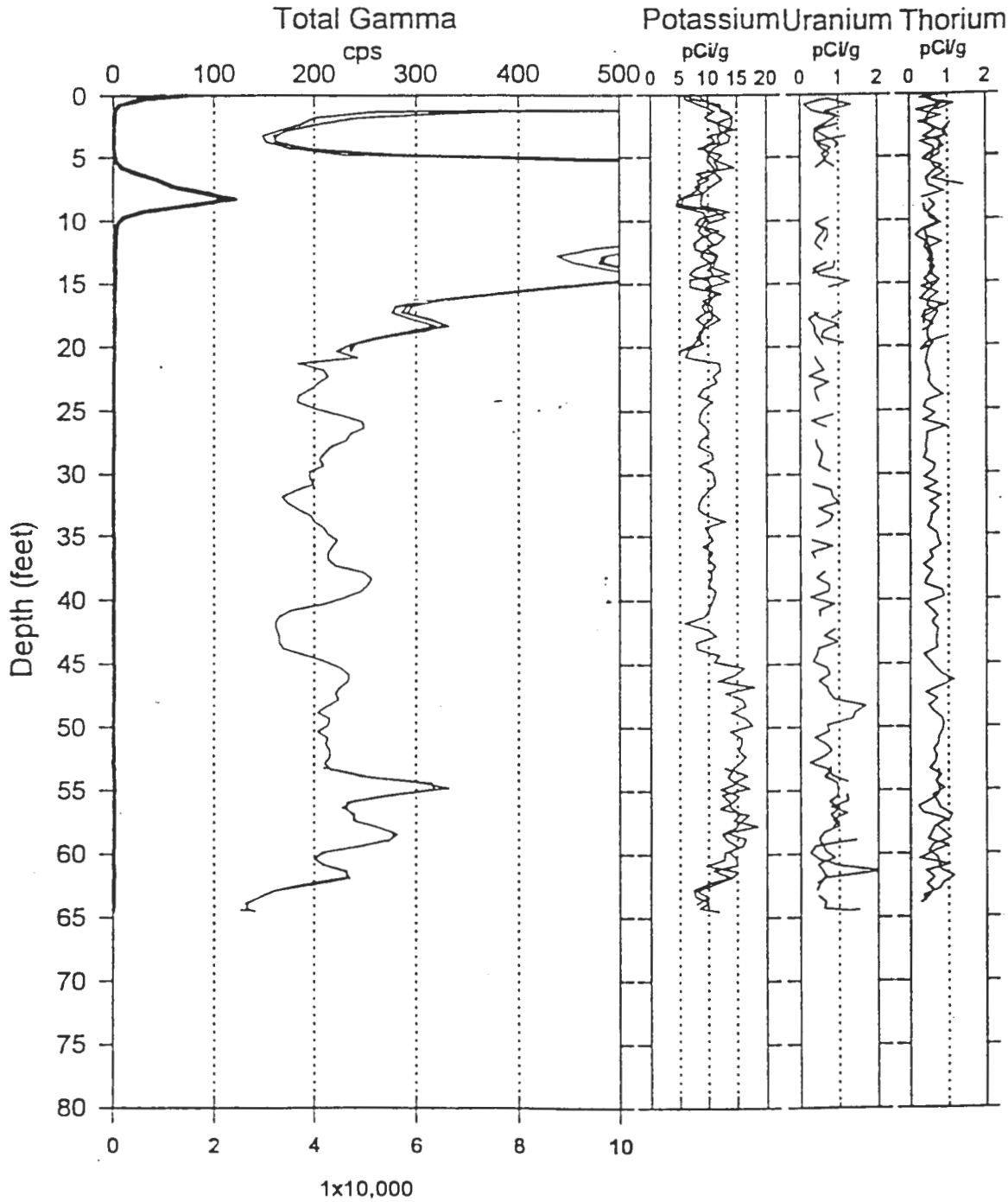


Figure B4-4. 199-N-35 Geophysical Data Package (Page 1 of 8)

RLS Borehole Survey Report

Borehole: 199-N-35 Report Date: June 23, 1995

Casing	Depth: 0'- 64'	Size: 6"	Thickness: 0.25"
Water	n/a		
Survey	Depth: 0'- 47'	Date: Jun 15, 1995	
	Depth: 40'- 62'	Date: Jun 21, 1995	
	Depth ref: Top-of-casing	Casing stick-up: 1'	

General Notes:
Activities on June 15, 1995 included: (1) Determine well/water depth from an acoustic depth instrument (43 ft). (2) Swab well for internal contamination prior to logging. The maximum swab depth of 43.3 ft corresponds to a telescoping screen (unknown configuration) from 44' to 64'. (3) The well was surveyed to 47' without reaching bottom, logging was aborted for fear of sticking the tool in the screen. Remote access to the well dictated that survey data from 5 ft to 0 ft be acquired using manual methods.

Activities on June 21, 1995 included: (1) Run "E-Tape" to determine water depth (62.25 ft). (2) Run dummy probe to check for restrictions in the hole. (3) Complete Spectral-Gamma survey to 62 ft. (4) Run neutron moisture survey to 62 ft.

All Spectral-Gamma survey data are included on the plots. A separate plot that combines the Total-Gamma and moisture survey is included. The survey depths are measured from top of casing.

The highest total gamma activity encountered (162,000 cps) occurred at the surface (0 ft). The measurement taken at the surface contained very high count rate with no gamma-ray peaks identifiable in the spectra, which is characteristic of back-scatter gamma-rays, probably from the crib its self.

The concentrations of the naturally occurring radionuclides potassium, uranium, and thorium (KUT) are typical for Hanford sediments.

The potassium and thorium activity decreases from 32' to the maximum survey depth, indicating a probable change in geology.

Man-made Radionuclides
Cobalt (Co-60) was identified from the surface to 6' and from 23' to the maximum survey depth of 62'. The maximum activity encountered was less than 20 pCi/g.

Antimony (SB-125) was detected from 30' to the maximum survey depth of 62'. When detected the concentration is approximately half the concentration of cobalt. The maximum activity encountered was less than 10 pCi/g.

Cesium (Cs-137) and Europium (Eu-152) are commonly encountered in the 100 Areas, but were not identified in the survey spectra. The plot tracks are shown for presentation uniformity.

Figure B4-4. 199-N-35 Geophysical Data Package (Page 2 of 8)

Westinghouse Hanford Company
RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 1325-N LWDF

Borehole	199-N-035		Drill Date Apr 1984
Coordinates	7485 N	4390 W ft	(N-Area System)
Elevation	449.38 ft		Top of Casing

Borehole Environment Information

Borehole liquid depth na (ft) from zero (0.0) depth reference of log

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
6	0.25	0	64

RLS Passive Spectral Gamma Survey Information

Logging Engineer(s) R. K. Price J. E. Meisner. J. P. Kiesler
Log depth reference at zero (0.0) depth is Top of Casing

Log Date	Archive file names	Log mode	speed	Depth interval (ft) Top	Base	Incr
Jun 15, 1995	H1N035\B061	FIXED	0.7 fpm	5	42	0.5
		FIXED	0.7 fpm	47	40	0.5
		MSA	45 sec	4	0	1.0
Jun 21, 95	H1N035\B062	FIXED	0.7 fpm	40	62	0.5
		FIXED	0.7 fpm	48	53	0.5
		MSA	300 sec	station	49.5	0
		MSA	200 sec	station	42.5	0

FIXED: Fixed Velocity or Cable Speed MSA: Move-Stop-Acquire fpm: feet per minute

Calibration and Analysis Information

RLS Calibration Date: Mar 22, 1995
Calibration Report: WHC-SD-EN-TI-292

Analyst Name(s): R. K. Price
Analysis Date: Jun 23, 1995

Analysis Notes: Maximum gross activity (162,000 cps) at surface
Radionuclides Identified: Co-60, Sb-125

Figure B4-4. 199-N-35 Geophysical Data Package (Page 3 of 8)

RLS Spectral Gamma-Ray Borehole Survey

Project: 1325-N LWDF
Borehole : 199-N-35

Log Date : Jun 21, 1995
Analysis Date: Jun 23, 1995

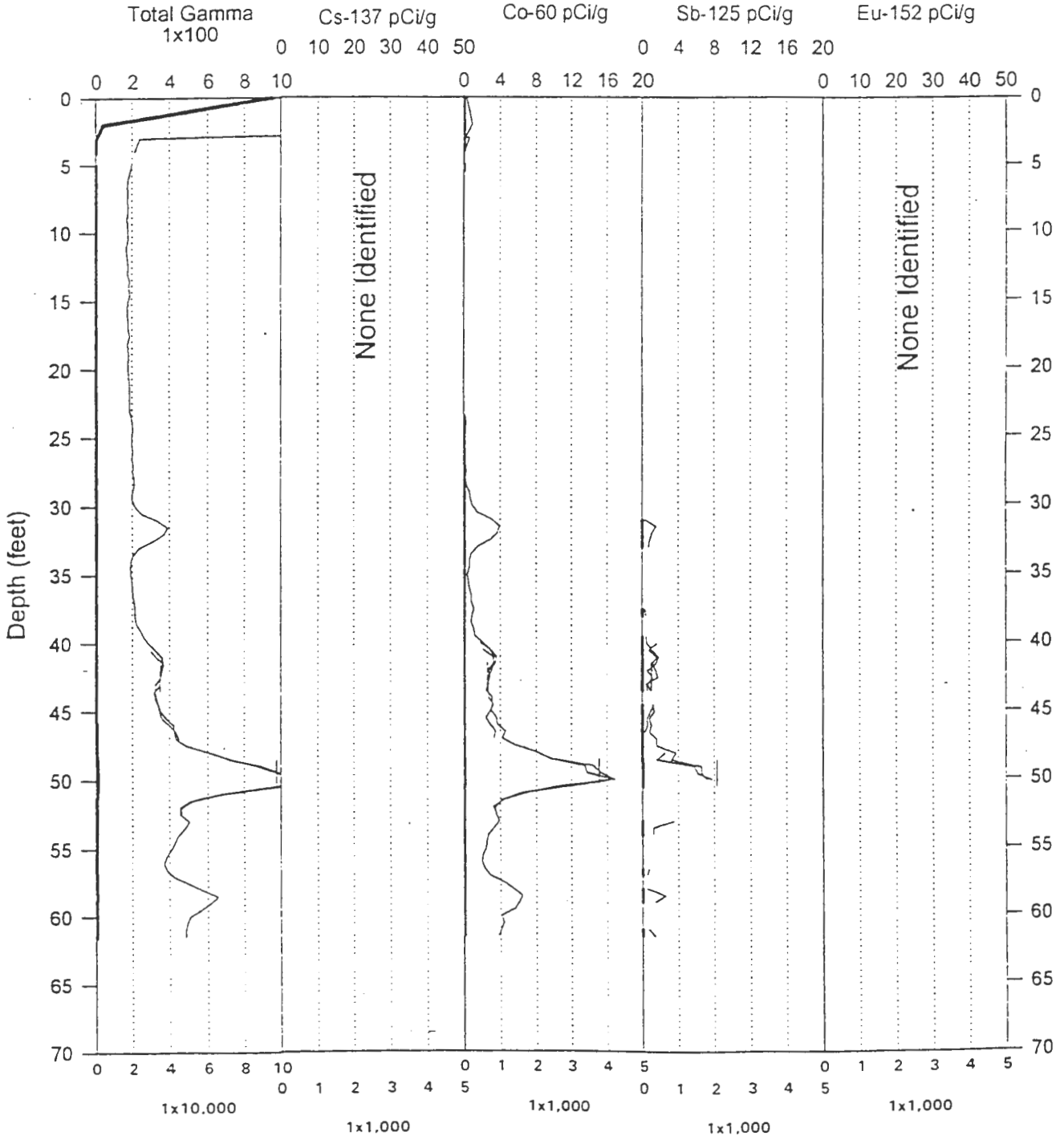


Figure B4-4. 199-N-35 Geophysical Data Package (Page 4 of 8)

RLS Spectral KUT Processed Data

Project: 1325-N LWDF
Borehole: 199-N-35

Log Date : Jun 15, 1995
Westinghouse Hanford Co.

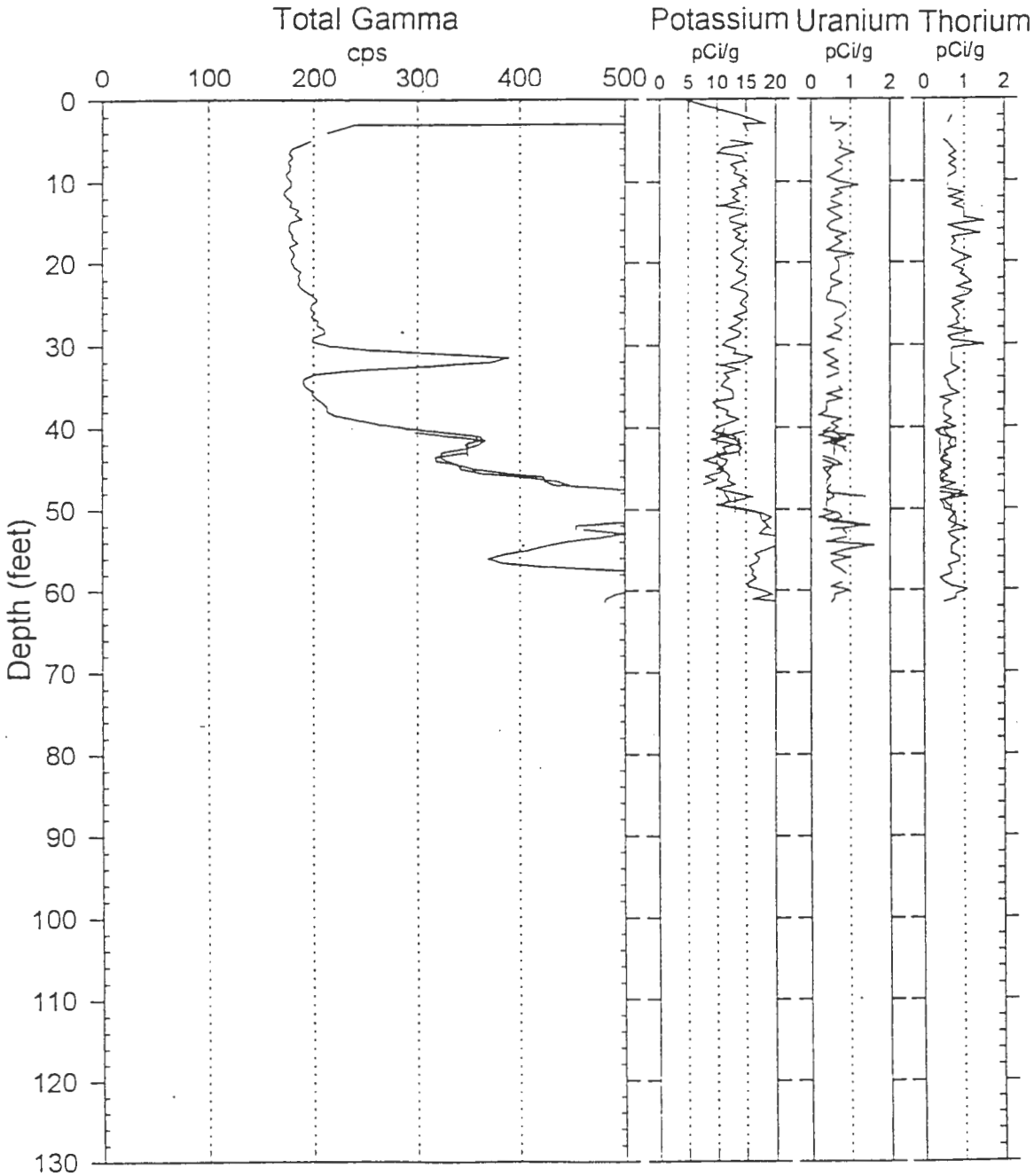


Figure B4-4. 199-N-35 Geophysical Data Package (Page 5 of 8)

Formation Moisture Borehole Survey Report

Borehole:	199-N-35		
Survey	Depth: 4.5'- 61'		Date: Jun 21. 1995
Casing	Depth: 0'- 64'	Size: 6" -	Thickness: 0.25"
Water	Depth: 62.25'		
Depth ref	Top-of-casing	Casing stick-up: 1.0'	

General Notes:
Prior to logging the water level was measured with an E-tape and a dummy probe was run to check for restrictions that might hang up the logging probes below the telescoping screen at 44 feet. The probe centralizer was not used for fear of hanging up the probe in the screen. The well was surveyed from 4.5' to 61' at move-stop-acquire mode for 30 seconds every 0.5'. The second log survey from 28' to 35' at 0.2' sample intervals was acquired. All survey data are included on the plot. The survey depths are measured from top of casing.

The grout installed while the starter casing was removed extends to 30'. as indicated by the decrease in moisture content at 30 ft.

The "Void Space" response indicates void spaces that are present behind the casing. The response is plotted in counts-per-second of the back-scattered gamma-rays from a source implanted in the probe. The response is plotted on a reverse scale to high-light problem zones. The "void space" count rate decreases (indicating a possible problem with the formation moisture measurement) when voids space is present behind the casing. This log shows that the count rate increases when the casing size decreases. as seen below 45 feet where the telescoping screen was inserted.

Formation Moisture
The water bound in the grout (unknown constituents) of approximately 18% by volume from 8' to 30' is consistent with other wells logged at Hanford.

The increase in formation moisture to 10% at 32 ft corresponds to the first major occurrence of cobalt-60 encountered in the spectral gamma log. This is possibly an interval of finer grained sediments that retained contaminants.

A second increase in formation moisture greater than 5% from 39.5 ft to 43.5 ft also retained cobalt-60 from the effluent discharge.

The decrease in apparent moisture content from 43.5 ft to 50 ft corresponds with an increase in the void space indicator signal and may <u>not</u> represent a decrease in formation moisture. Geologic inference of formation properties without further evidence is not appropriate.

The third interval of elevated formation moisture content (50 to 53 ft) is different than the previous two zones. if the moisture from 43 ft to 50 ft is validated. The spectral gamma survey shows that the cobalt-60 occurs above this interval and not concurrently. It is probable that the sediments from 50 ft to 53 ft retarded the downward movement of effluent liquids and caused them to spread horizontally above it. thus leaving significantly more cobalt-60 in the sediments than other zones.

Figure B4-4. 199-N-35 Geophysical Data Package (Page 6 of 8)

Westinghouse Hanford Company
Formation (Neutron) Moisture Borehole Survey Log Header

Project: 1325-N LWDF

Borehole	199-N-035		
Coordinates	7485 N	4390 W ft	(N-Area System)
Elevation	449.38 ft		Top of Casing

Borehole Environment Information

Borehole liquid depth 62.25 (ft) from zero (0.0) depth reference of log

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
6	0.25	0	64

Formation (Neutron) Moisture Survey Information

Logging Engineer(s) R. K. Price J. E. Meisner M. A. Wendling
Log depth reference at zero (0.0) depth is Top of Casing

Log Date	Archive file names	Log mode	speed	Depth interval (ft) Top	Base	Incr
Jun 21, 1995	H1N035\MS25	MSA	30 sec	4.5	61	0.5
		MSA	30 sec	28	35	0.2

FIXED: Fixed Velocity of Cable Speed MSA: Move-Stop-Acquire fpm: feet per minute

Calibration and Analysis Information

Calibration Date: Mar 16, 1995
Calibration Models: Hanford Moisture (Lampson-Pasco)

Analyst Name(s): R. K. Price
Analysis Date: Jun 23, 1995

Analysis Notes: Grouted well to 30 ft, masked formation reading

Figure B4-4. 199-N-35 Geophysical Data Package (Page 7 of 8)

Formation (Neutron) Moisture Borehole Survey

Borehole : 199-N-35
Location: LWDF 1325-N Crib

Log Date : June 21, 1995
Westinghouse Hanford Co.

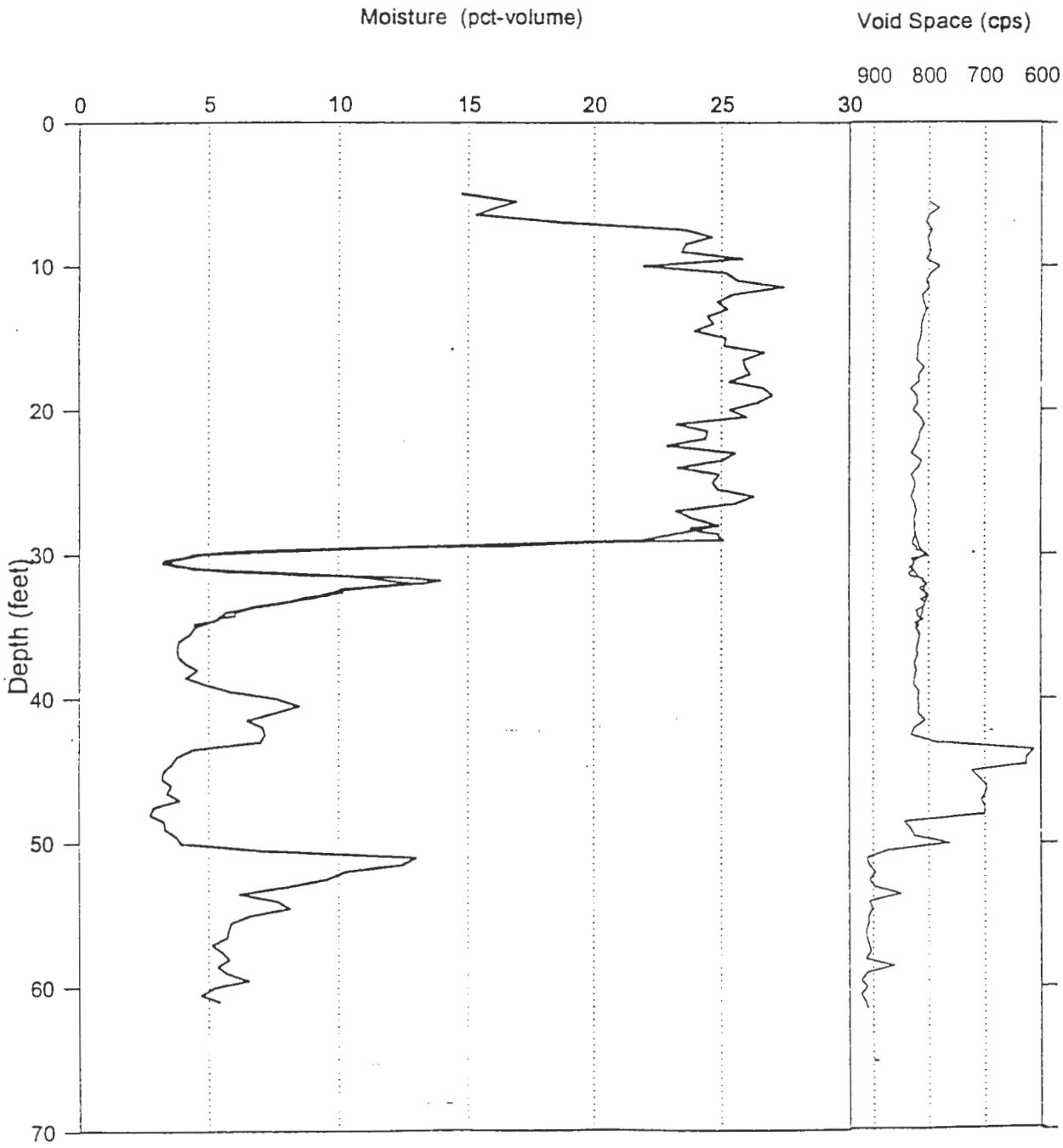


Figure B4-4. 199-N-35 Geophysical Data Package (Page 8 of 8)

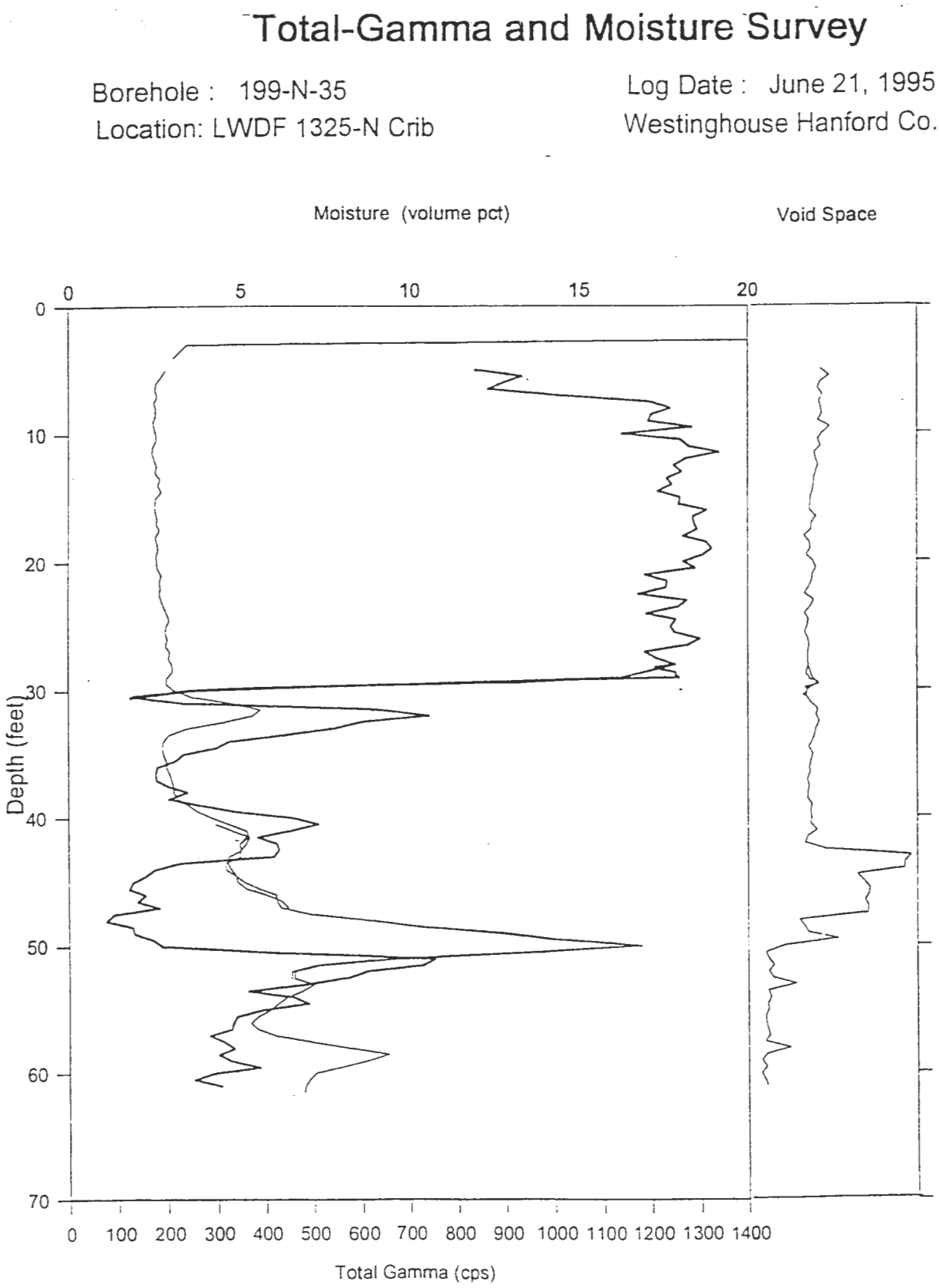


Figure B4-5. 199-N-45 Geophysical Data Package (Page 1 of 7)

RLS Borehole Survey Report

Borehole: 199-N-45 Report Date: Aug 1, 1995

Casing	Depth: 0'- 73'	Size: 8"	Thickness: 0.33"
Water	n/a		
Survey	Depth: 0'- 64'		Date: Jul 18, 1995
	Depth: 64'- 64.5'		Date: Jul 18, 1995
	Depth: 64'- 54'		Date: Jul 18, 1995
	Depth ref: Top-of-casing		Casing stick-up: 25"

General Notes:
Activities on July 18, 1995 included: (1) Determine well/water depth from an acoustic depth instrument (65ft). (2) Swab well for internal contamination prior to logging. The maximum swab depth of 51-54 ft corresponds to a telescoping screen (unknown configuration) from 51' to 71', (as per as built). (3) The well was surveyed to 64' without reaching bottom.

Activities on July 18, 1995 included: (1) Run "E-Tape" to determine water depth (65 ft). (2) Run dummy probe to check for restrictions in the hole. (3) Complete Spectral-Gamma survey to 64 ft. (4) Run neutron moisture survey to 64 ft.

All Spectral-Gamma survey data are included on the plots. Separate plots for the Total-Gamma including KUT and moisture survey are included. The survey depths are measured from top of casing.

The highest total gamma activity encountered (64,000 cps) occurred at the surface (0 ft). The measurement taken at the surface contained very high count rate with no gamma-ray peaks identifiable in the spectra, which is characteristic of back-scatter gamma-rays, probably from the crib its self.

The concentrations of the naturally occurring radionuclides potassium, uranium, and thorium (KUT) are typical for Hanford sediments.

The potassium activity increases from 42' to the maximum survey depth, indicating a probable change in geology.

Man-made Radionuclides
Cobalt (Co-60) was identified from the surface to 6' and from 24' to the maximum survey depth of 64'. The maximum activity encountered was less than 20 pCi/g.

Antimony (Sb-125) was detected from 45' to survey depth of 54'. When detected the concentration is not well correlated to the concentration of cobalt. The maximum activity encountered was less than 5 pCi/g.

Cesium (Cs-137) and Europium (Eu-152) are commonly encountered in the 100 Areas, but were not identified in the survey spectra. The plot tracks are shown for presentation uniformity.

Figure B4-5. 199-N-45 Geophysical Data Package (Page 2 of 7)

Westinghouse Hanford Company
RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 1325-N LWDF

Borehole	199-N-045	Drill Date	Apr 1984
Coordinates	7474 N 4273 W ft	(N-Area System)	
Elevation	452.31 ft	Top of Casing	

Borehole Environment Information

Borehole liquid depth na (ft) from zero (0.0) depth reference of log

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
6	0.25	?(51)	71
8	0.33	0	51-53(?)
(info from moisture log.			

RLS Passive Spectral Gamma Survey Information

Logging Engineer(s) J. E. Meisner J. Kunk

Log depth reference at zero (0.0) depth is Top of Casing

Log Date	Archive file names	Log mode	speed	Depth interval (ft) Top	Base	Incr
Jul 14, 1995	H1N045\B068	FIXED	0.7 fpm	0	64	0.5
		FIXED	0.7 fpm	64	64.5	0.5
		FIXED	0.7 fpm	64	56	0.5

FIXED: Fixed velocity at table speed MSA: Move-Stop-Acquire fpm: feet per minute

Calibration and Analysis Information

RLS Calibration Date: Mar 22, 1995

Calibration Report: WHC-SD-EN-TI-292, Rev.0

Analyst Name(s): R. R. Randall

Analysis Date: Aug 1, 1995

Analysis Notes: Maximum gross activity (64,000 cps) at surface

Radionuclides Identified: Co-60, Sb-125

Figure B4-5. 199-N-45 Geophysical Data Package (Page 3 of 7)

RLS Spectral Gamma-Ray Borehole Survey

Project: 1325-N LWDF
Borehole : 199-N-45

Log Date : July 14, 1995
Analysis Date: Aug 1, 1995

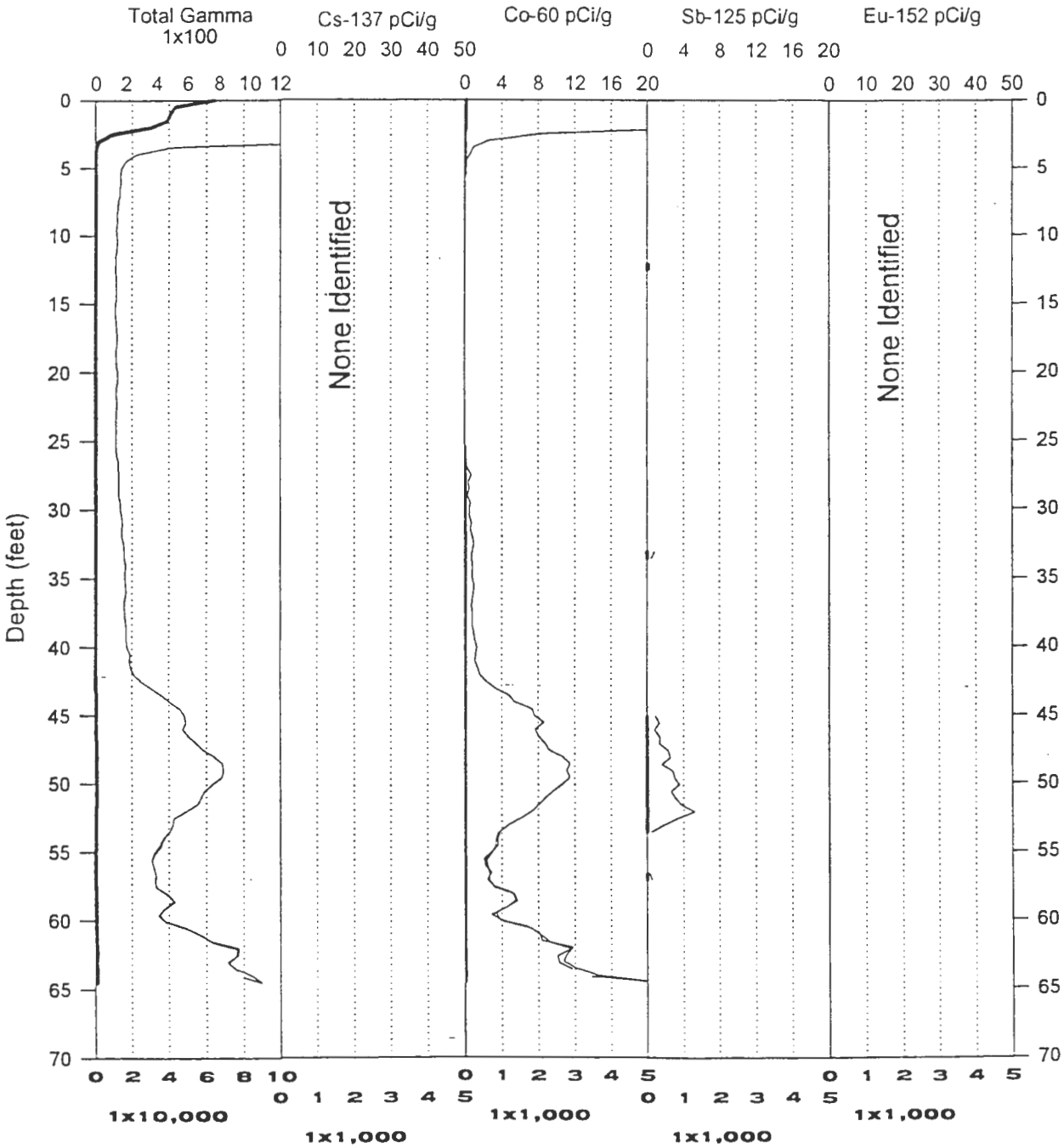


Figure B4-5. 199-N-45 Geophysical Data Package (Page 4 of 7)

RLS Spectral KUT Processed Data

Project: 1325-N LWDF
Borehole: 199-N-45

Log Date : July 14, 1995
Westinghouse Hanford Co.

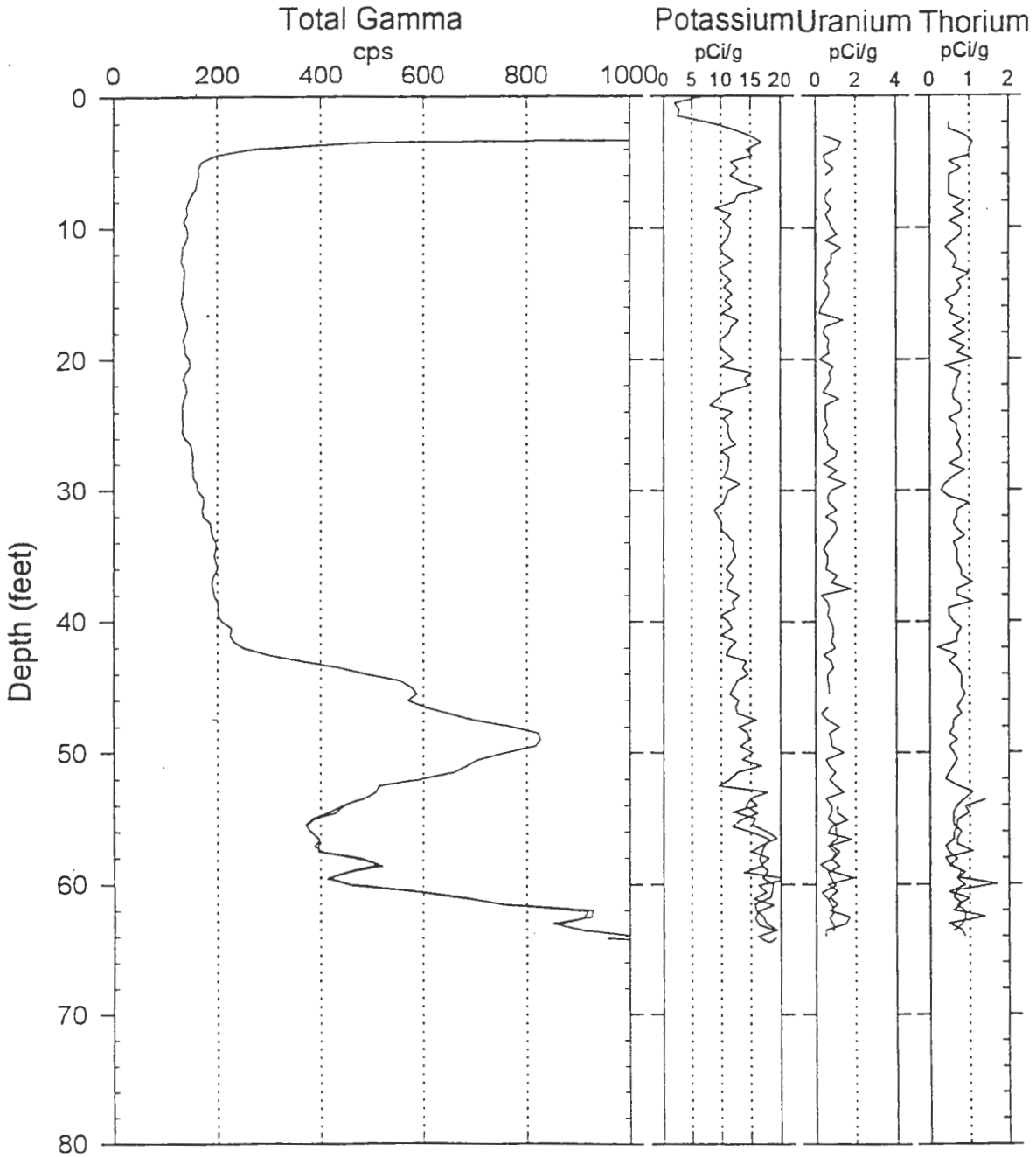


Figure B4-5. 199-N-45 Geophysical Data Package (Page 5 of 7)

Formation Moisture Borehole Survey Report

Borehole: 199-N-45
Survey Depth: 2.0'- 64' Date: Jul 18, 1995

Casing Depth: 0'- 64' Size: 8" Thickness: 0.25"
Water Depth: 65'
Depth ref Top-of-casing Casing stick-up: 25"

General Notes:
Prior to logging the water level was measured with an E-tape and a dummy probe was run to check for restrictions that might hang up the logging probes below the telescoping screen at 51 feet. The probe centralizer was not used for fear of hanging up the probe in the screen. The well was surveyed from 2' to 64' at move-stop-acquire mode for 30 seconds every 0.5'. The second log survey from 64' to 54' at 0.5' sample intervals was acquired. All survey data are included on the plot. The survey depths are measured from top of casing.

The "Void Space" response indicates void spaces that are present behind the casing. The response is plotted in counts-per-second of the back-scattered gamma-rays from a source implanted in the probe. The response is plotted on a reverse scale to high-light problem zones. The "void space" count rate decreases (indicating a possible problem with the formation moisture measurement) when voids space is present behind the casing. This log shows that the count rate increases when the casing size decreases, as seen below 54 feet where the telescoping screen was inserted. Moisture is not plotted in intervals of void indications.

Formation Moisture
The increase in formation moisture to 8% at 45 ft corresponds to the first major occurrence of cobalt-60 encountered in the spectral gamma log. This is possibly an interval of finer grained sediments that retained contaminants. Just at this point in the well, the void indicator informs that the use of the moisture response is not valid.

The void count rate from 57' to 64' is indicative of a 6" casing. The start of this 6" casing or screen is somewhere between 51' and 54', and the as built calls out a 51' depth start. Since there is some ambiguity about the screen diameter, the moisture calibration was applied for an 8" casing throughout the well survey.

Figure B4-5. 199-N-45 Geophysical Data Package (Page 6 of 7)

Westinghouse Hanford Company
Formation (Neutron) Moisture Borehole Survey Log Header

Project: 1325-N LWDF

Borehole	199-N-045		Drill Date Apr 1984
Coordinates	7474 N	4273 W ft	(N-Area System)
Elevation	452.31 ft		Top of Casing

Borehole Environment Information

Borehole liquid depth na (ft) from zero (0.0) depth reference of log

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
6	0.25	?(51)	71
8	0.33	0	51-53(?)
(info from moisture log)			

RLS Passive Spectral Gamma Survey Information

Logging Engineer(s) J. E. Meisner J. Kunk

Log depth reference at zero (0.0) depth is Top of Casing

Log Date	Archive file names	Log mode	speed	Depth interval (ft) Top	Base	Incr
Jul 18, 1995	H1N045\MS30	MSA	30 sec	2.0	64	0.5
		MSA	30 sec	64	54	0.5
		MSA	30 sec	11.5	13	0.5

FIXED: Fixed Velocity or Cable Speed MSA: Move-Stop-Acquire fpm: feet per minute

Calibration and Analysis Information

RLS Calibration Date: Mar 16, 1995
Calibration Report: Hanford Moisture (Lampson-Pasco)

Analyst Name(s): R. R. Randall
Analysis Date: Aug 1, 1995

Analysis Notes: Two intervals show void and moisture not plotted

Figure B4-5. 199-N-45 Geophysical Data Package (Page 7 of 7)

Formation (Neutron) Moisture Borehole Survey

Borehole : 199-N-45 Log Date : July 18, 1995

Location: LWDF 1325-N Crib Westinghouse Hanford Co.

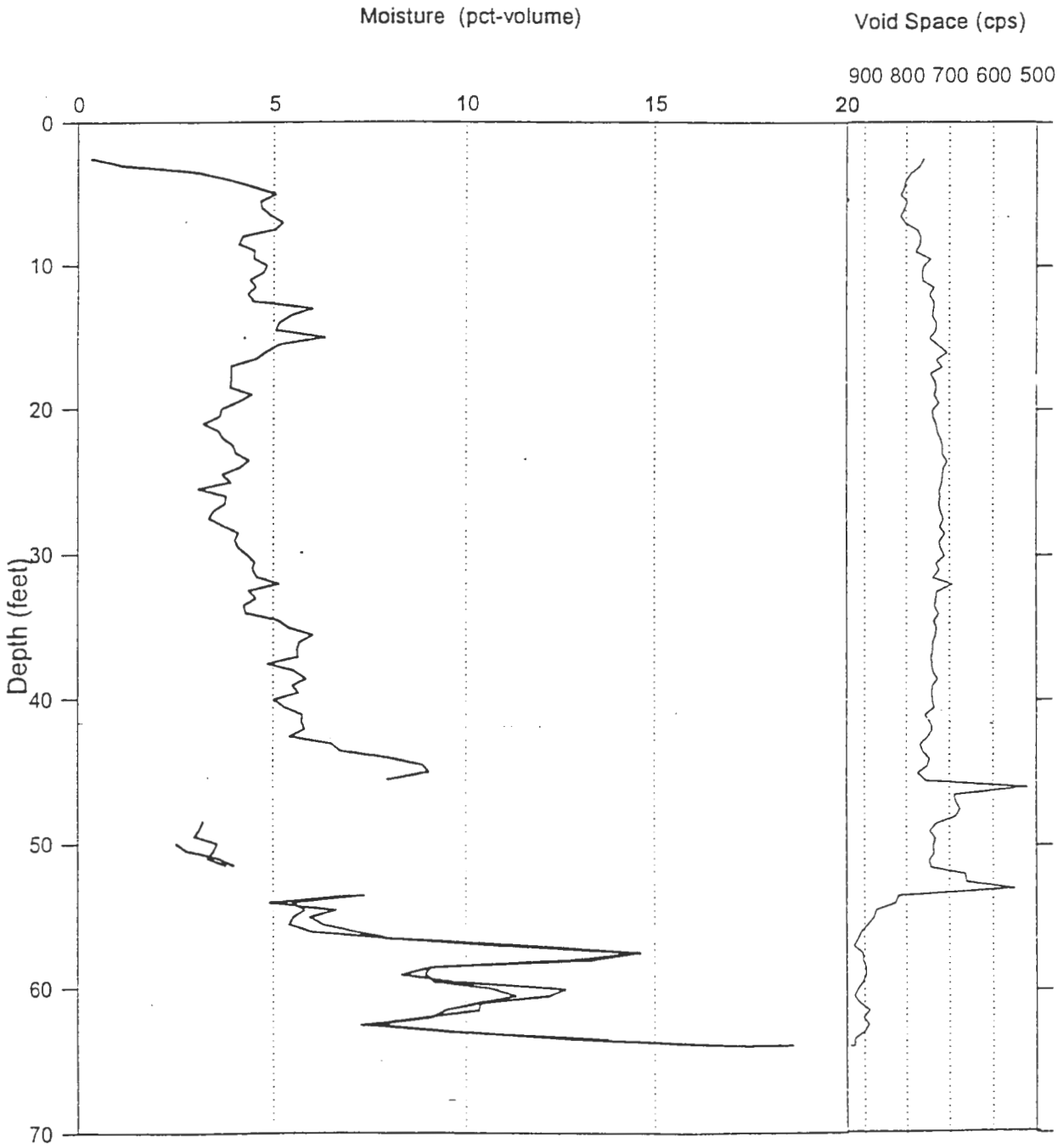


Figure B4-6. 199-N-67 Geophysical Data Package (Page 1 of 7)

RLS Borehole Survey Report

Borehole: 199-N-~~45~~ 67 Report Date: Aug 1, 1995

Casing	Depth: 0'- 76'	Size: 6"	Thickness: 0.25"
Water	71.9		
Survey	Depth: 4.6'- 67.5'	Date: Jul 20 1995	
	Depth: 64.7'- 67.5'	Date: Jul 20, 1995	
	Depth: 65.0'- 71.0'	Date: Jul 20, 1995	
	Depth ref: Top-of-casing	Casing stick-up: 25"	

General Notes:
Activities on July 20, 1995 included: (1) Determine well/water depth from an acoustic depth instrument (65ft). (2) Swab well for internal contamination prior to logging. The maximum swab depth of 71.9 ft corresponds to a tope of water.

Activities on July 20, 1995 included: (1) Run "E-Tape" to determine water depth (71.9 ft). (2) Run dummy probe to check for restrictions in the hole. (3) Complete Spectral-Gamma survey to 71 ft. (4) Run neutron moisture survey to 71 ft.

All Spectral-Gamma survey data are included on the plots. Separate plots for the naturally occurring KUT and the moisture survey are included. The survey depths are measured from top of casing.

The highest total gamma activity encountered (40,000 cps) occurred at the surface (0 ft). The measurement taken at the surface contained very high count rate with no gamma-ray peaks identifiable in the spectra, which is characteristic of back-scatter gamma-rays, probably from the crib its self.

The concentrations of the naturally occurring radionuclides potassium, uranium, and thorium (KUT) are close to typical for Hanford sediments. There are KUT responses that reflect the completions profile. This is confirmed by the moisture log response. There is bentonite from 23' to 59', with a gap at 45' that is also reflected in the KUT signature. This conclusion could not be derived upon the basis of the spectral gamma ray data only.

Man-made Radionuclides
Cesium (Cs-137) ~~Cobalt (Co-60)~~ was identified from the surface to 5' and from 31' to the depth of 70'. The maximum activity encountered was about 320 pCi/g.

Cobalt (Co-60) ~~Cesium (Cs-137)~~ was detected from surface to 5' and from 31' to survey depth of 70'. When detected the concentration is not well correlated to the concentration of cobalt. The maximum activity encountered was less than 10 pCi/g.

Figure B4-6. 199-N-67 Geophysical Data Package (Page 2 of 7)

Westinghouse Hanford Company
RLS Spectral Gamma-Ray Borehole Survey Log Header

Project: 1301-N LWDF

Borehole	199-N-067	Drill Date	Feb 1988
Coordinates	7438 N 5970 W ft		(N-Area System)
Elevation	458.46 ft		Top of Casing

Borehole Environment Information

Borehole liquid depth 71.9 (ft) from zero (0.0) depth reference of log

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
6	0.25	0	60.5
6 screen	0.25	60.5	76

RLS Passive Spectral Gamma Survey Information

Logging Engineer(s) J. E. Meisner J. Kiesler
Log depth reference at zero (0.0) depth is Top of Casing

Log Date	Archive file names	Log mode	speed	Depth interval (ft) Top	Base	Incr
Jul 20, 1995	H1N045\B068	MSA	30 sec	4.6	67.5	0.5
		MSA	30 sec	64.7	67.5	0.5
		MSA	30 sec	65	71	0.5

FIXED: Fixed velocity of cable speed MSA: Move-Stop-Acquire fpm: feet per minute

Calibration and Analysis Information

RLS Calibration Date: Mar 22, 1995
Calibration Report: WHC-SD-EN-TI-292, Rev.0

Analyst Name(s): R. R. Randall
Analysis Date: Aug 1, 1995

Analysis Notes: Maximum gross activity (40,000 cps) at surface
Radionuclides Identified: Co-60, Cs-137

Figure B4-6. 199-N-67 Geophysical Data Package (Page 3 of 7)

RLS Spectral Gamma-Ray Borehole Survey

Project: 1301-N LWDF
Borehole : 199-N-67

Log Date : July 20, 1995
Analysis Date: Aug 1, 1995

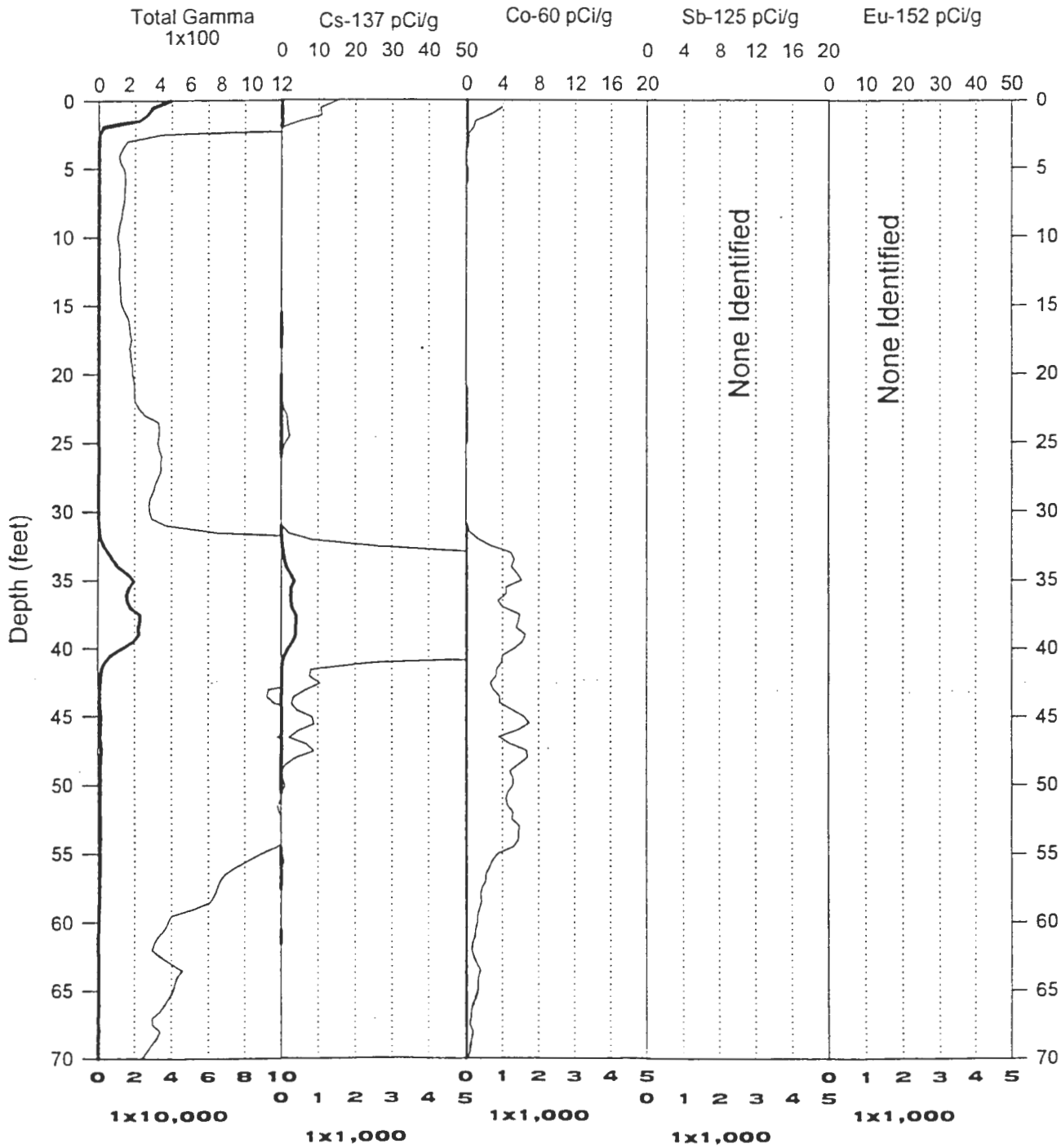


Figure B4-6. 199-N-67 Geophysical Data Package (Page 4 of 7)

RLS Spectral KUT Processed Data

Project: 1301-N LWDF
Borehole: 199-N-67

Log Date : July 20, 1995
Westinghouse Hanford Co.

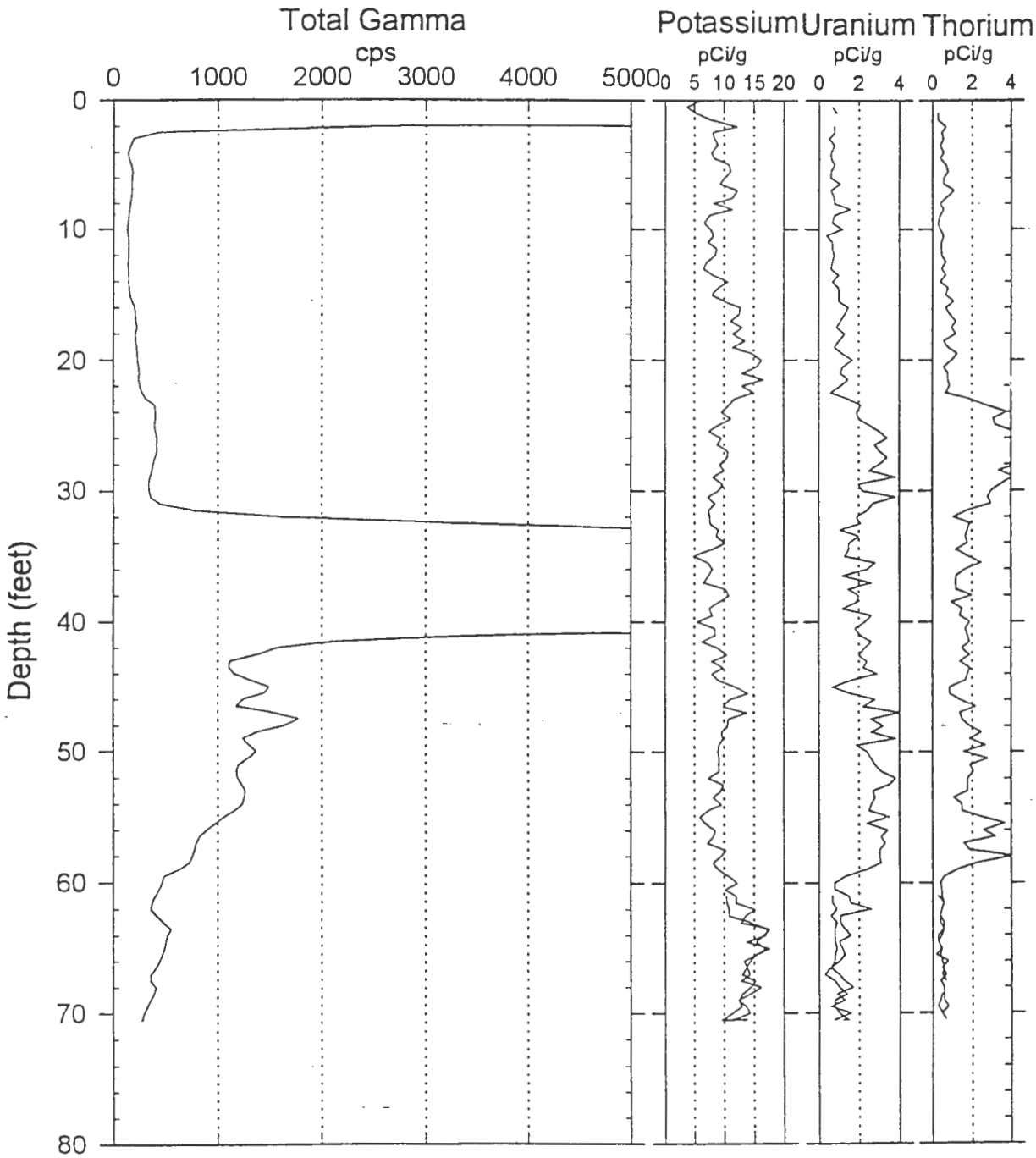


Figure B4-6. 199-N-67 Geophysical Data Package (Page 5 of 7)

Formation Moisture Borehole Survey Report

Borehole:	199-N-67		
Survey	Depth: 4.6'- 71'		Date: Jul 20, 1995
Casing	Depth: 0'- 76'	Size: 6"	Thickness: 0.25"
Water	Depth: 71.9'		
Depth ref	Top-of-casing	Casing stick-up: 25"	

General Notes:
Prior to logging the water level was measured with an E-tape and a dummy probe was run to check for restrictions that might hang up the logging probes below the start of screen at 60.5 feet. The probe centralizer was not used for fear of hanging up the probe in the screen. The well was surveyed from 4.6' to 71' at move-stop-acquire mode for 30 seconds every 0.5'. Two repeat passes were performed over the reference sections. All survey data are included on the plot. The survey depths are measured from top of casing.

The "Void Space" response indicates void spaces that are present behind the casing. The response is plotted in counts-per-second of the back-scattered gamma-rays from a source implanted in the probe. The response is plotted on a reverse scale to high-light problem zones. The "void space" count rate decreases (indicating a possible problem with the formation moisture measurement) when voids space is present behind the casing. This log shows very uniform character.

Formation Moisture
The only section of the well that has a formation moisture response is the interval from 60' to 71'. The upper section of the well is completed with bentonite seal. The instrument response is then the degree of filling the hole to outside of casing. Note the lack of seal at the 45 foot level in the well.

Figure B4-6. 199-N-67 Geophysical Data Package (Page 6 of 7)

Westinghouse Hanford Company
Formation (Neutron) Moisture Borehole Survey Log Header

Project: 1301-N LWDF

Borehole	199-N-067	Drill Date	Feb 1988
Coordinates	7438 N 5970 W ft	(N-Area System)	
Elevation	458.46 ft	Top of Casing	

Borehole Environment Information

Borehole liquid depth 71.9 (ft) from zero (0.0) depth reference of log

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
6	0.25	0	60.5
8	0.33	60.5	76

RLS Passive Spectral Gamma Survey Information

Logging Engineer(s) J. E. Meisner J. Kiesler

Log depth reference at zero (0.0) depth is Top of Casing

Log Date	Archive file names	Log mode	speed	Depth interval (ft) Top	Base	Incr
Jul 20, 1995	H1N045\MS32	MSA	30 sec	4.6	67.5	0.5
		MSA	30 sec	64.7	67.5	0.5
		MSA	30 sec	65.0	71.0	0.5

FIXED: Fixed Velocity or Cable Speed MSA: Move-Stop-Acquire fpm: feet per minute

Calibration and Analysis Information

RLS Calibration Date: Mar 16, 1995
Calibration Report: Hanford Moisture (Lampson-Pasco)

Analyst Name(s): R. R. Randall
Analysis Date: Aug 1, 1995

Analysis Notes: Bentonite seal displayed, upper 22' not fully sealed

Figure B4-6. 199-N-67 Geophysical Data Package (Page 7 of 7)

Formation (Neutron) Moisture Borehole Survey

Borehole : 199-N-67
Location: LWDF 1301-N Crib

Log Date : July 20, 1995
Westinghouse Hanford Co.

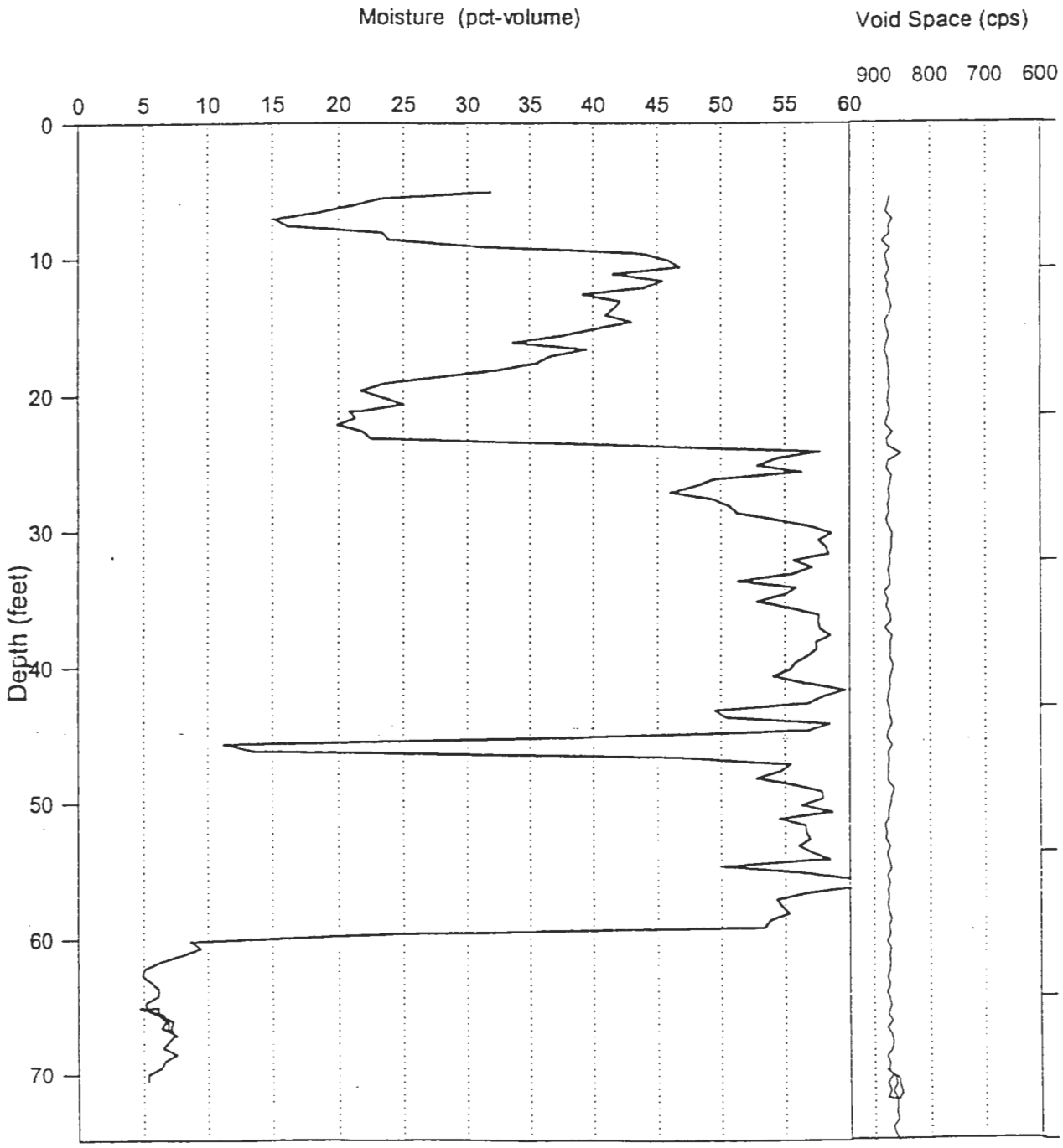


Figure B4-7. RW No. 1 Geophysical Data Package (Page 1 of 6)

RADIONUCLIDE LOGGING SYSTEM
Log Analysis Summary Report

Borehole: PNL Research Well 1 (RW#1) **Report Date:** Jan 23, 1996
Log Types: HPGe Spectral Gamma Ray **Final Log Date:** Nov 13, 1995

General Notes:
The existing borehole does not have a Hanford well number or Well ID number (WID) and was identified by Bechtel Hanford Inc as "Research Well 1" drilled by PNL. The survey depths are measured from top of casing. The borehole was surveyed with two HPGe detector sizes to assure accurate measurement of radionuclide concentrations at low and high activity levels. The low activity detector, RLSG3.0, contains a 35% germanium crystal that has detection range of 0.2 pCi/g to 500 pCi/g before electronics dead-time exceeds 40%. The high activity detector, RLSG5.0, contains a 10% germanium crystal inside a tungsten shield that reduces the observed gamma-ray activity by 1100%.

The computed radionuclide concentrations for both log runs (RLSG3.0, RLSG5.0) and repeats are displayed on the data plot.

Interpretation notes have been added to the log data plot. Note that the maximum radionuclide concentrations for cesium-137 and cobalt-60 occur at different depths. The distribution profiles for all three boreholes in the 1301-N facility (B2536, B2537, and Research Well 1) indicate that the contaminants (cesium & cobalt) migrated at different rates.

Man-made Radionuclides
Cesium (Cs-137) was identified from the first survey reading at 5' to the maximum survey depth of 27'. The decay activity exceeded 200 pCi/g from 17.5' to the maximum survey depth, and exceeded 5000 pCi/g from 18' to 23.5'. The maximum activity encountered was 18,000 pCi/g at 19.5'.

Cobalt (Co-60) was identified from the first survey reading at 5' to the maximum survey depth of 27'. The decay activity exceeded 200 pCi/g from 20' to 25.5'. The maximum activity encountered was 1300 pCi/g at 20.5'.

Figure B4-7. RW No. 1 Geophysical Data Package (Page 2 of 6)

Westinghouse Hanford Company
Radionuclide Logging System Log Header

Project	1301-N LWDF	Log Type:	HPGe Spectral Gamma-Ray
Borehole	PNL Research Well 1 (RW#1)		

Borehole Environment Information

Borehole liquid depth none (ft) from zero (0.0) depth reference of log

Casing size (in.)	Casing thickness (in.)	Top depth (ft)	Base depth (ft)
8	0.375	-2.25	27.9

RLS Passive Spectral Gamma Survey Information

Logging Engineer(s) J. E. Meisner J. R. Kunk
Log depth reference at zero (0.0) depth is Top of Casing

Log Date	Archive Disk Detector ID	Log mode	speed	Depth interval (ft) Top	Base	Incr
Nov 13, 1995	RESWEL\B072	FIXED	0.7 fpm	5	26.5	0.5
	RLSG3.0 (35%)	"	"	15	21	0.5
Nov 13, 1995	RESWEL\B073	FIXED	0.7 fpm	19	27	0.5
	RLSG5.0 (10%)	"	"	22	27	0.5

FIXED: Fixed Velocity of Cable Speed fpm: feet per minute

Calibration and Analysis Information

RLS Calibration Date: Mar 22, 1995 (HPGe-35%), Nov 20, 1995 (HPGe-10%)
Calibration Report: WHC-SD-EN-TI-292

Analyst Name(s): R. K. Price
Analysis Date: Jan 23, 1996

Analysis Notes: HPGe(10%) detector required to measure highest activity
Radionuclides Identified: Cs-137, Co-60 max 18,000 & 1300 pCi/g @ 19.5'

Figure B4-7. RW No. 1 Geophysical Data Package (Page 3 of 6)

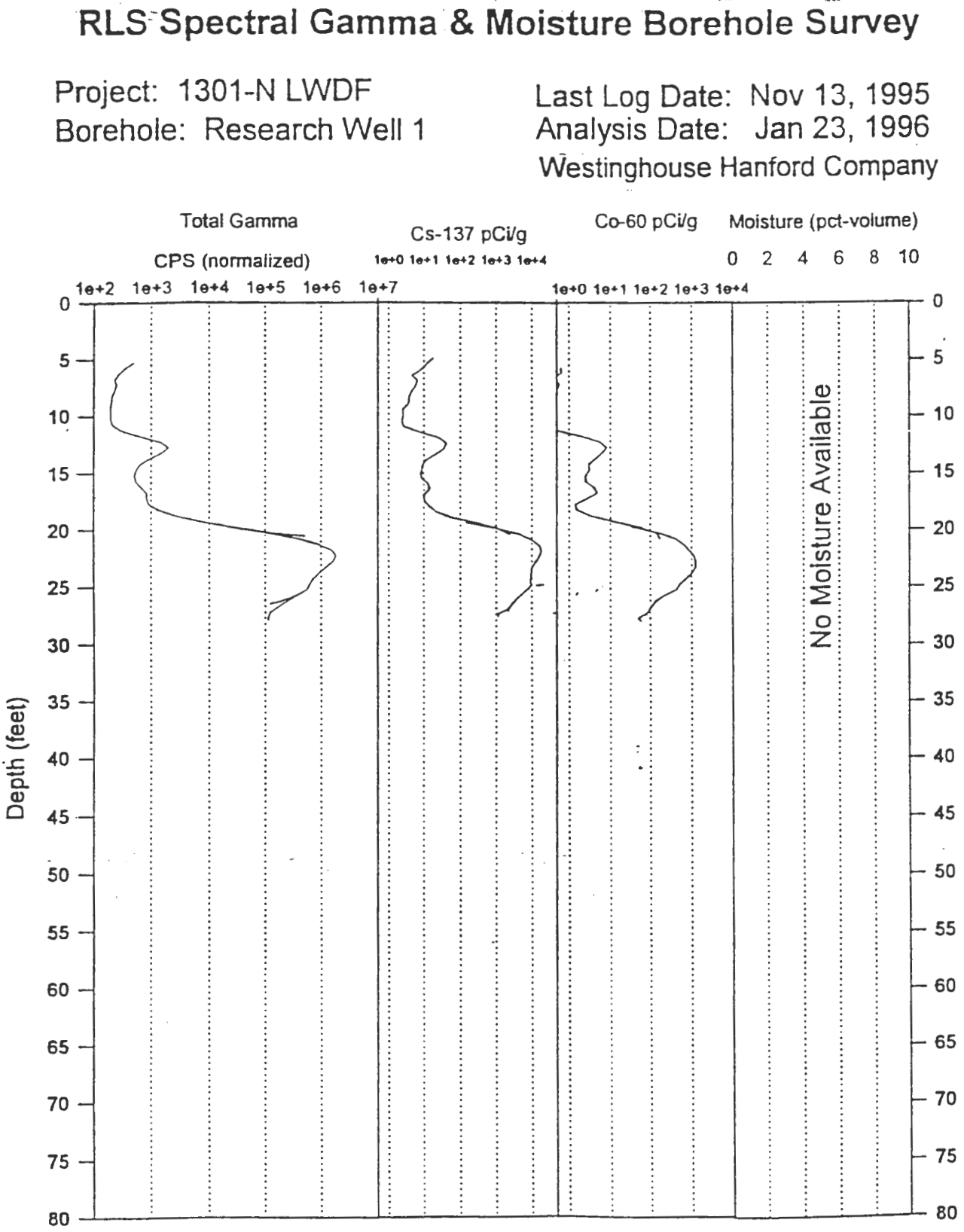


Figure B4-7. RW No. 1 Geophysical Data Package (Page 4 of 6)

RLS Spectral Gamma & Moisture Borehole Survey

Project: 1301-N LWDF
Borehole: Research Well 1

Last Log Date: Nov 13, 1995
Analysis Date: Jan 23, 1996
Westinghouse Hanford Company

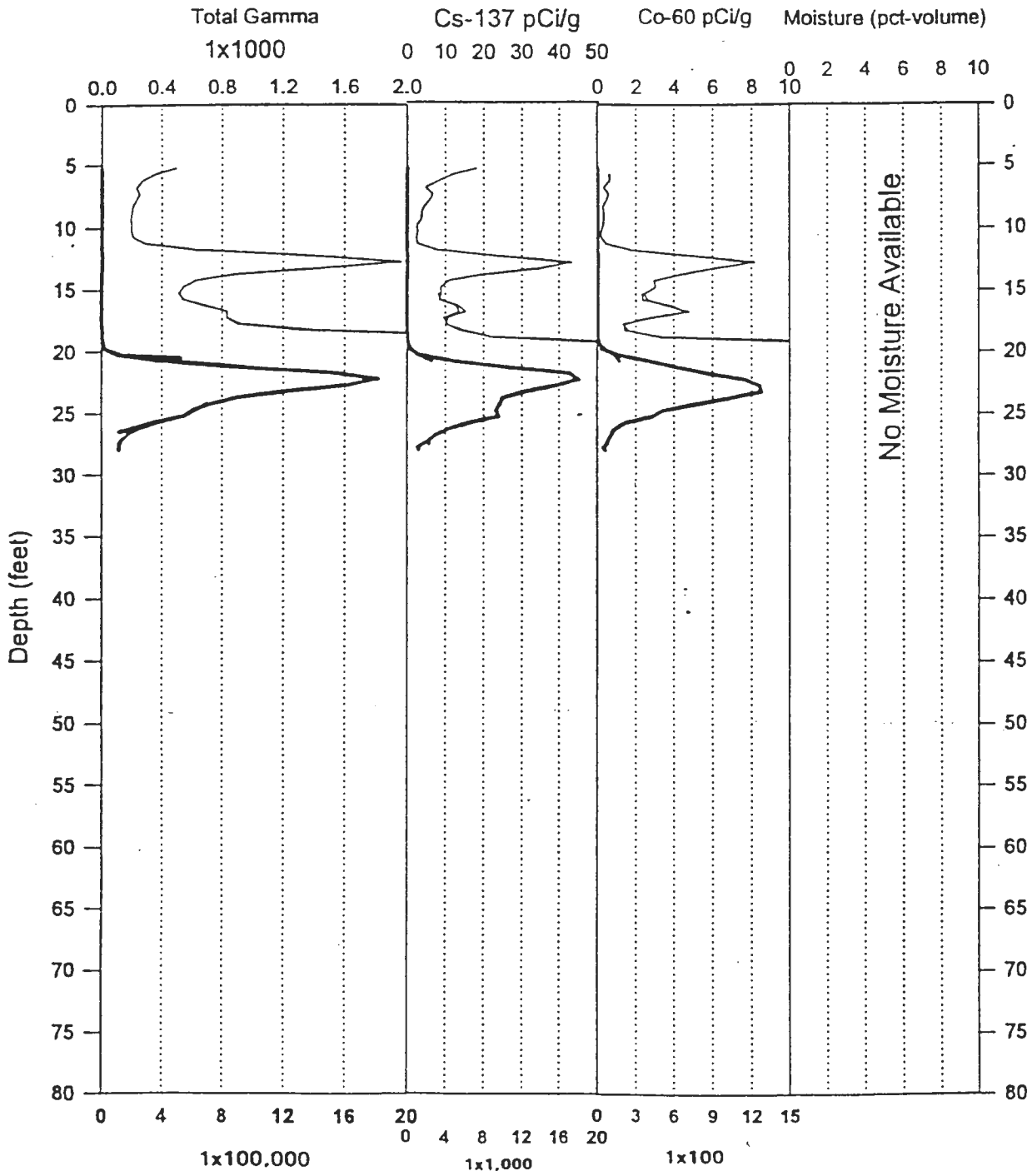


Figure B4-7. RW No. 1 Geophysical Data Package (Page 5 of 6)

RLS Spectral KUT Processed Data

Project: 1301-N LWDF
Borehole: Research Well 1

Last Log Date: Nov 13, 1995
Analysis Date: Jan 23, 1996
Westinghouse Hanford Company

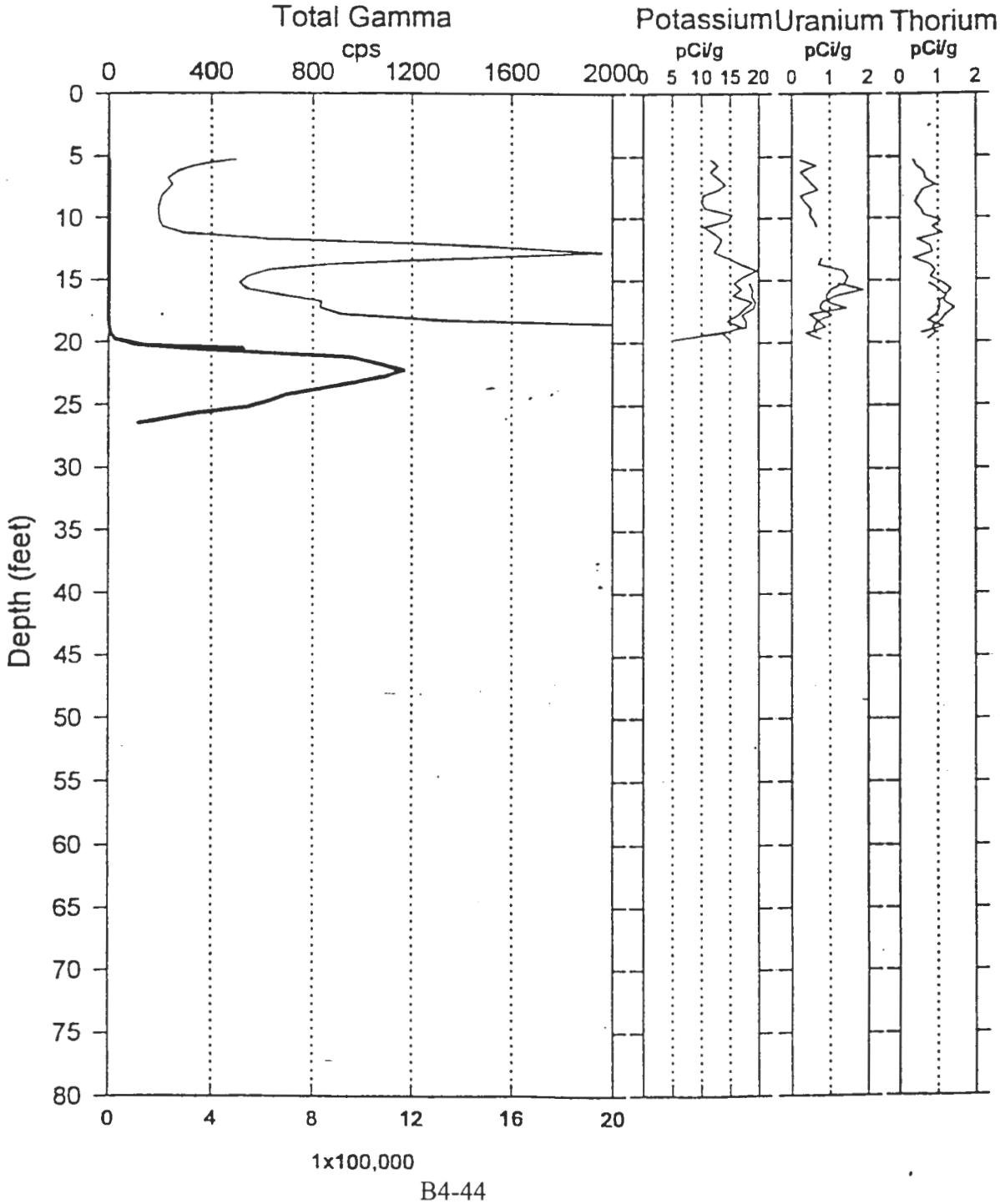


Figure B4-7. RW No. 1 Geophysical Data Package (Page 6 of 6)

Neutron Moisture (% volume fraction) for Wells 199-N-35, 199-N-45, 199-N-67

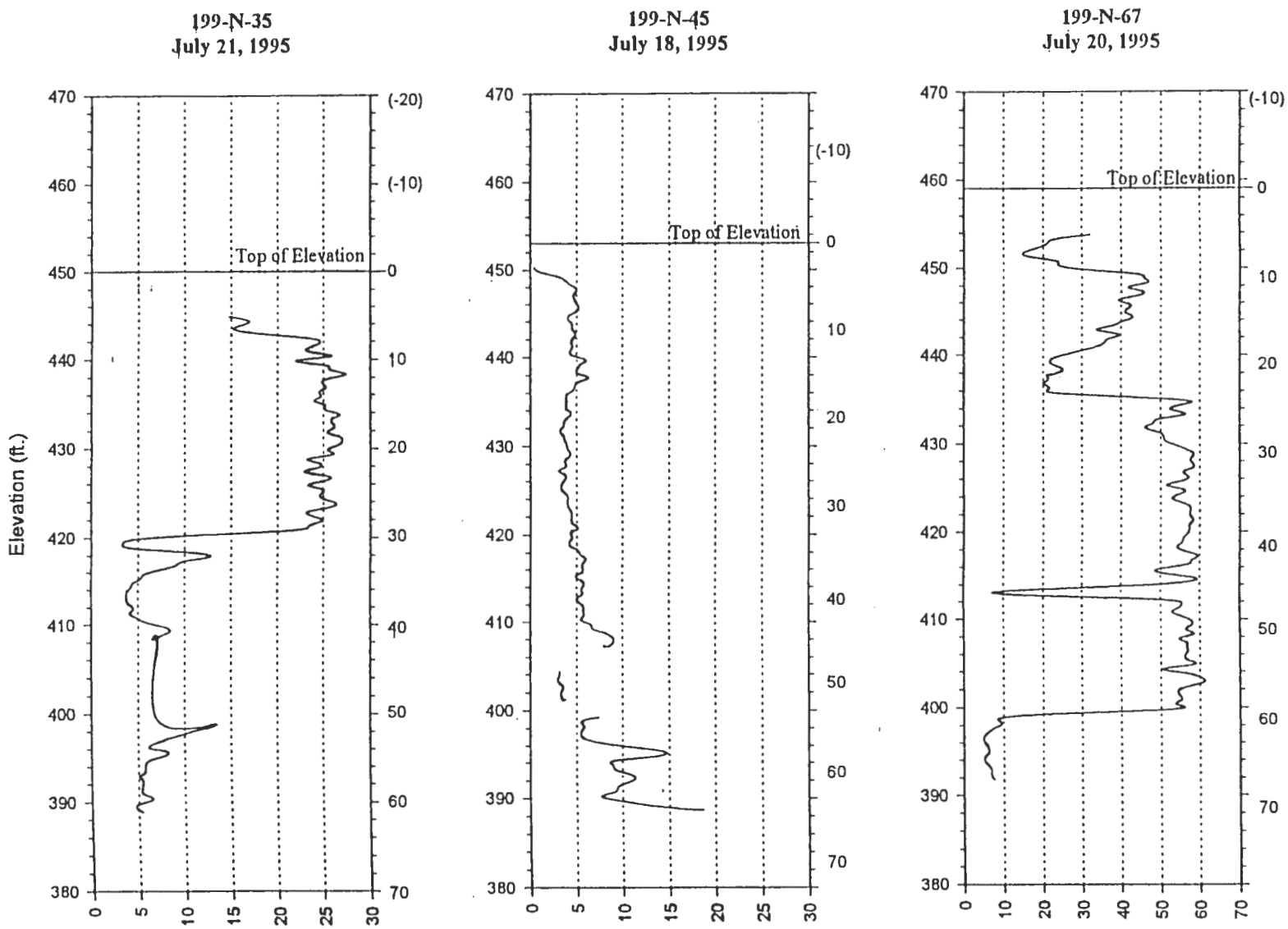


Figure B4-8. Schlumberger Moisture and Density Porosity Log Plots of Well 199-N-107A

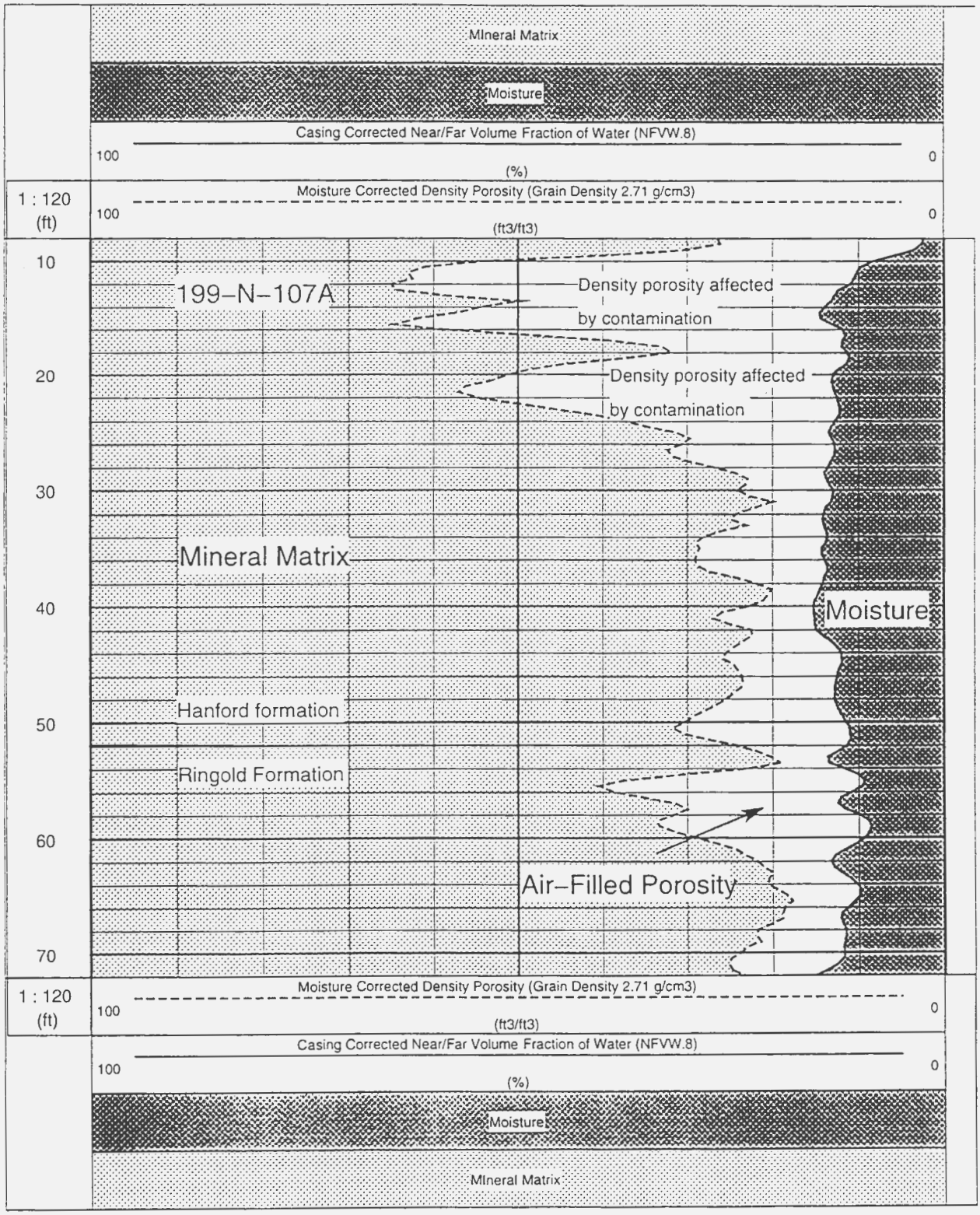


Figure B4-9. Schlumberger Moisture and Density Porosity Log Plots of Well 199-N-108A

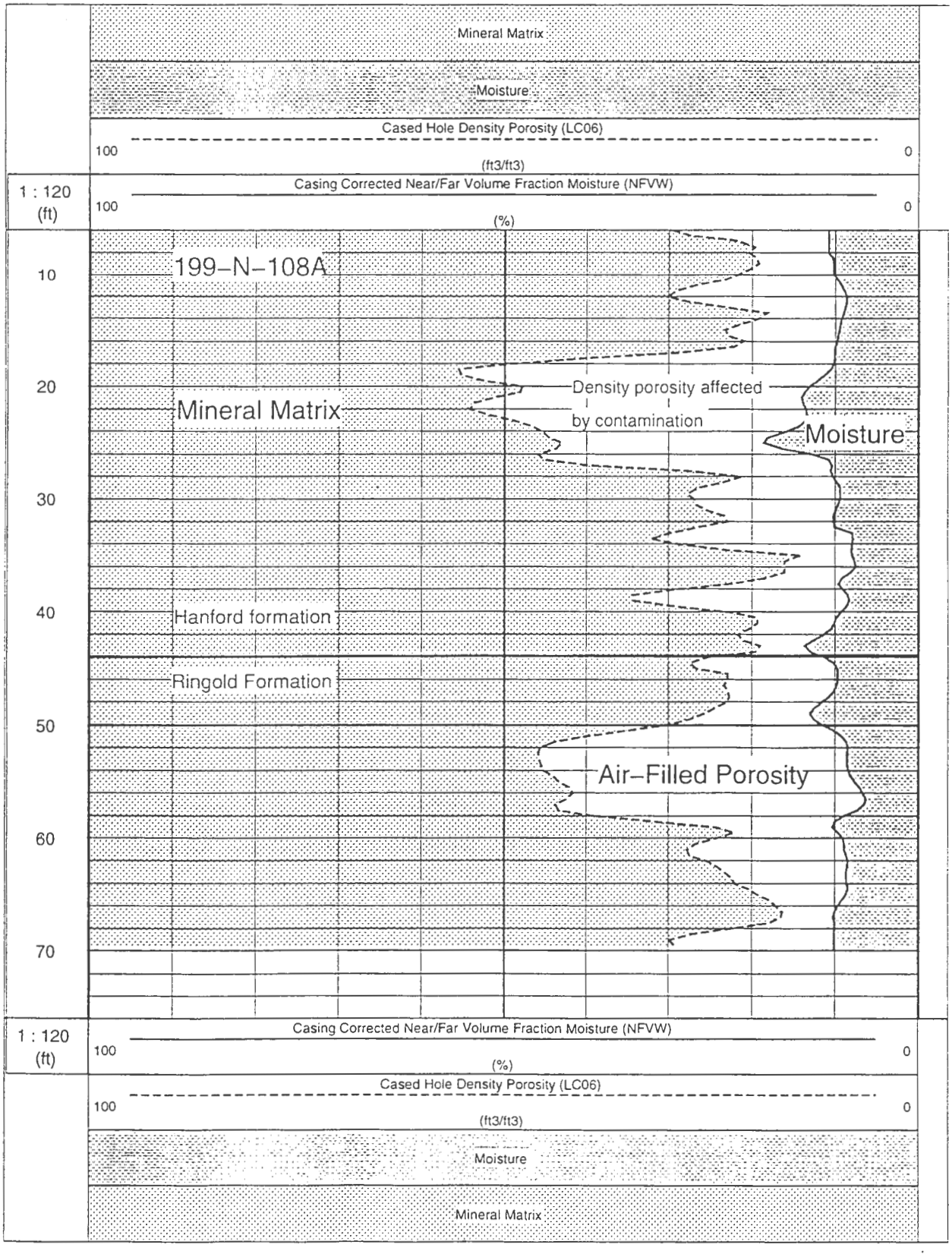
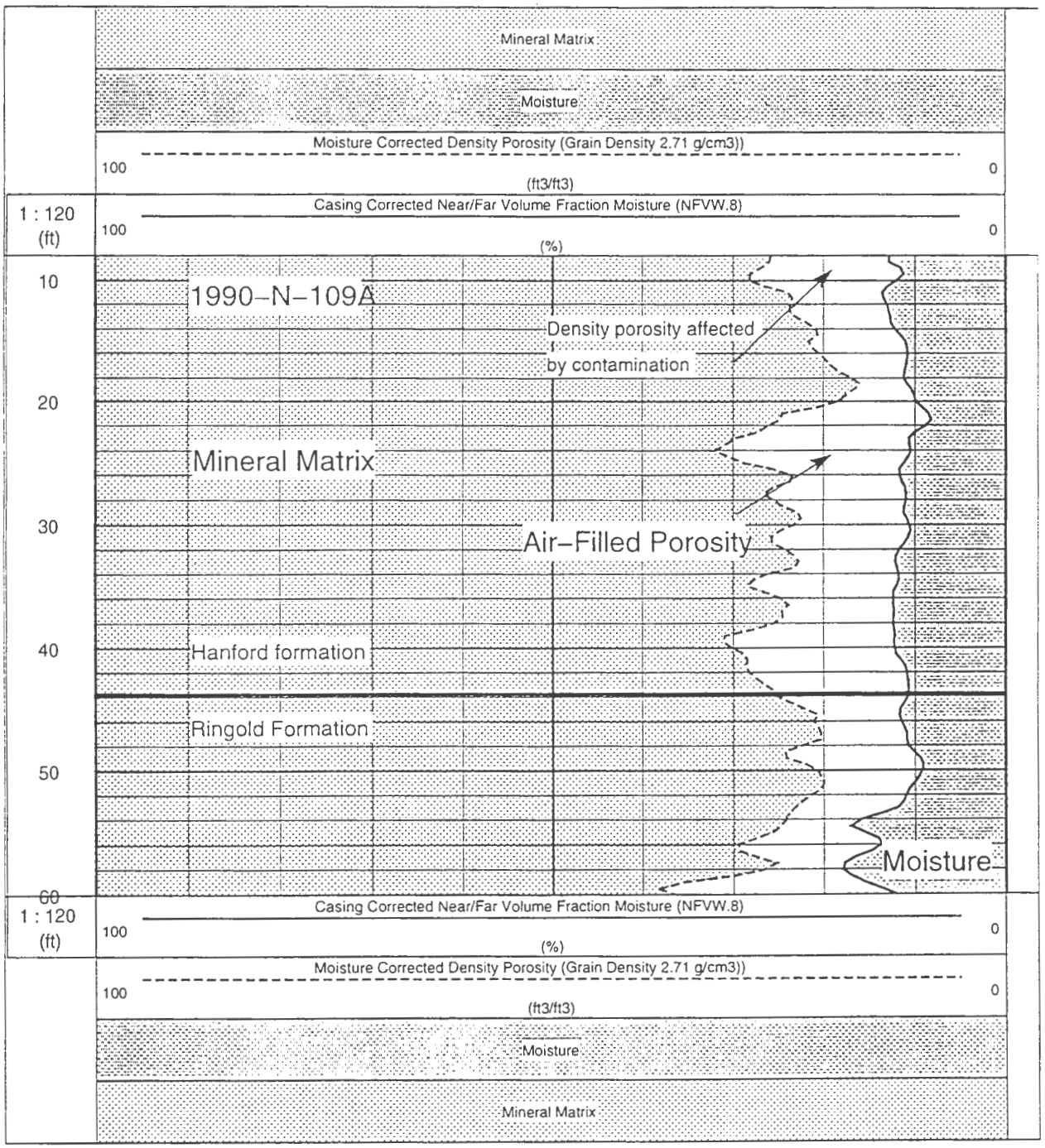


Figure B4-10. Schlumberger Moisture and Density Porosity Log Plots of Well 199-N-109A



APPENDIX C

TRAVEL TIME METHODOLOGY AND RESULTS

CONTENTS

C1.0 INTRODUCTION C-1

C2.0 ASSIGNMENT OF PHYSICAL PROPERTIES TO THE SOILS UNDER 1301-N AND 1325-N LIQUID WASTE DISPOSAL FACILITIES C-2

C3.0 CORRECT MOISTURE RETENTION DATA FOR GRAVEL FRACTION C-4

C-4.0 GENERATE MOISTURE CHARACTERISTIC CURVES C-5
- C4.1 CALCULATE VAN GENUCHTEN CURVE-FITTING PARAMETERS . . . C-5
- C4.2 CALCULATE RELATIVE UNSATURATED HYDRAULIC CONDUCTIVITY USING MUALEM'S MODEL AND VAN GENUCHTEN CURVE-FITTING PARAMETER (M) C-6
- C4.3 USE THE MODIFIED MUALEM'S MODEL AND MEASURED UNSATURATED HYDRAULIC CONDUCTIVITY TO CALCULATE ABSOLUTE UNSATURATED HYDRAULIC CONDUCTIVITY C-7

C5.0 TRAVEL TIMES THROUGH THE VADOSE ZONE C-8
- C5.1 CALCULATE WATER TRAVEL TIME THROUGH THE VADOSE ZONE C-9
- C5.2 CONTAMINANT TRANSPORT TRAVEL TIME THROUGH THE VADOSE ZONE C-11

C6.0 DISCUSSION AND COMPARISON TO OBSERVED DATA C-14

C7.0 REFERENCES C-16

FIGURES

C-1. Moisture Characteristic Curves for Sample BOGL72 . . . . . C-18
C-2. Moisture Characteristic Curves for Sample BOGL74 . . . . . C-19
C-3. Moisture Characteristic Curves for Sample BOGL80 . . . . . C-20
C-4. Moisture Characteristic Curves for Sample BOGL85 . . . . . C-21
C-5. Moisture Characteristic Curves for Sample BOGL98 . . . . . C-22
C-6. Moisture Characteristic Curves for Sample BOGLB0 . . . . . C-23
C-7. Moisture Characteristic Curves for Sample BOGLB2 . . . . . C-24
C-8. Moisture Characteristic Curves for Sample BOGLB7 . . . . . C-25

TABLES

C-1. Lithologic Units and Assigned Physical Property Sample Number C-4
C-2. Particle Density, Porosity, Soil Thickness and Volumetric Moisture Content at 0.2-, 2.0-, and 10-cm/yr Recharge for Wells N-107A, N-108A, and N-109A C-10
C-3. Travel Times to the 1995 Water Table for the Major Zones of Concern C-13

C1.0 INTRODUCTION

The vadose zone is the region above the water table in which the pore spaces of the soil are usually only partially filled with water. Movement of water and contaminants through the vadose zone to the water table is controlled by the depth to the water table; amount of natural and artificial recharge; thickness, lateral distribution, and dip of the underlying soils; moisture content of the soils; saturated and unsaturated hydraulic conductivities, porosity, and density for the soils; and bulk distribution coefficient for the contaminant of concern.

Although a variety of methods has been developed to measure soil hydraulic functions (Klute, 1986), these are often costly and time-consuming to implement. An alternative to direct measurement of unsaturated hydraulic conductivity over a range of volumetric moisture contents) is to use theoretical methods that predict the conductivity from soil water-retention data (Van Genuchten, 1991). The van Genuchten model (1980) was used to estimate the unsaturated hydraulic conductivity as a function of volumetric moisture content for physical property samples from the LFI boreholes. Once the unsaturated hydraulic conductivity is known, travel times through the vadose zone can be estimated using the unsaturated hydraulic conductivity and the recharge rate.

The following steps were taken to calculate the travel times for both water and radionuclides:

1. Correlated physical property samples taken from boreholes 199-N-108A and 199-N-109A to the different soil types underlying the Liquid Waste Disposal Facilities (LWDF)

2. Corrected the moisture retention data to include the gravel fraction because it is only possible to measure the moisture-retention data on the sieve-size fraction below 2 millimeters (mm)

3. Generated moisture characteristic curves

    a. Used Van Genuchten's RETC computer code to calculate curve-fitting parameters for the moisture-characteristic curve.

    b. Used the curve-fitting parameter (m) from RETC and Mualem's model (1976) to calculate relative unsaturated hydraulic conductivity as a function of volumetric moisture content.

    c. Used a measured, unsaturated hydraulic conductivity from nearby 100-Area wells and the modified Mualem's model to calculate the absolute unsaturated hydraulic conductivity as a function of volumetric moisture content.

4. Applied the unit gradient model assumptions to calculate travel times through the vadose zone.

   a. Used the recharge rate, volumetric moisture content for that recharge rate, and the thickness of the soil type over which the moisture-retention data apply to estimate a travel time for water.

   b. Used the contaminant-retardation equation to calculate a travel time for the contaminants of potential concern (COPC).

Once the travel times for both water and radionuclides are known, the decay equation can be used to estimate the concentration of the radionuclide when it reaches groundwater.

Using this methodology, the following assumptions apply:

1. The contaminant will move as plug flow.
2. Diffusion is ignored.
3. Dispersion is ignored.

C2.0 ASSIGNMENT OF PHYSICAL PROPERTIES TO THE SOILS UNDER 1301-N AND 1325-N LIQUID WASTE DISPOSAL FACILITIES

Boreholes 199-N-108A and 199-N-109A each had four physical property samples taken at discrete depths. Each of these four samples had physical properties (saturated hydraulic conductivity, density, and porosity) and moisture retention (moisture content as a function of suction head) measured in the laboratory. Since there were more than four soil horizons present in each borehole, the well-site geologist reviewed the geologic and geophysical logs from each borehole to estimate which soil type each sample represented. In borehole 199-N-107A no physical properties samples were collected, so data were extrapolated from samples taken in similar soil types found in borehole 199-N-108A. Borehole 199-N-108A had the most lithologic variability (sand to sandy gravel) while borehole 199-N-109A had the least lithologic variability (usually sandy gravel).

Borehole 199-N-108A encountered primarily silty sandy gravel of the Hanford Formation and silty sandy gravel of the Ringold Formation. Silty sandy gravel of the Hanford Formation was present from 0 to 6.4 m (0 to 21 feet ft) with the upper 2.4 m (8 ft) consisting of backfill material. A thin sand lens was encountered from 4.5 to 4.4 m (14 to 14.5 ft). Sample BOGL72 was collected from 4.6 to 4.7 m (15 to 15.5 ft) and represented the 0 to 6.4 m (0 to 21ft) interval. A distinct fine to very fine sand was present from 6.4 to 8.2 m (21 to 27ft); sample BOGL74 was collected from 7.3 to 7.4 m (24 to 24.5 ft) and represented this interval. From 8.2 to 11.9 m

(27 to 39 ft), the soil layer was primarily silty sandy gravel of the Hanford Formation. No moisture-retention sample was collected; however, sample BOGL72 was considered representative of this interval based on the geologic and geophysical logs. Silty sandy gravel of the "E" unit of the Ringold Formation was present from 11.9 m to 15.2 (39 to 50 ft); sample BOGL80 was collected from 13.1 to 13.2 m (43 to 43.5 ft). A distinct fine to very fine sand within the Ringold Formation was present from 15.2 to 18 m (50 to 59 ft), but no moisture-retention sample was collected from this interval. Sample BOGL74 was assumed to represent this interval since it appeared to represent a similar interval. Silty sandy gravel was present from 18 to 20.3 m (59 to 66.5 ft); sample BOGL85 was collected from 19.1 to 19.3 (62.8 to 63.3 ft). A very coarse to medium sand was present approximately from 20.3 to 20.9 m (66.5 to 68.5 ft), but no samples were collected. Sample BOGL72 was used to represent this interval even though the sample was from a finer sand. Silty sandy gravel was present from 20.9 to 22.1m (68.5 to 72.5 ft). Sample BOGL80 was used to represent this interval since no moisture-retention samples were collected, and the soil layers were similar.

The lithology identified in borehole 199-N-107A is similar to that found in 199-N-108A except the sand intervals are coarser grained. No physical properties samples were collected from 199-N-107A due to the high expected radionuclide content. Samples collected from borehole 199-N-108A were used to represent analogous intervals in 199-N-107A. Sediments from 0 to 8.5 m (0 to 28 ft) consisted primarily of silty sandy gravel of the Hanford Formation which were represented by sample BOGL72. Gravelly sand present from 8.5 to 11.6 m (28 to 38 ft) was represented by sample BOGL74. Sandy gravel from 11.6 to 12.8 m (38 to 42 ft) was represented by sample BOGL72. Silty sandy gravel of the "E" unit of the Ringold Formation was present from 12.8 to 14.6 m (42 to 48 ft) and was represented by sample BOGL80. A gravelly sand present from 14.6 to 15.9 m (48 to 52 ft) was represented by sample BOGL74. Silty sandy gravel from 15.9 to 23.2 m (52 to 76 ft) was represented by sample BOGL85.

The lithology identified in borehole 199-N-109A is primarily sandy gravel of the Hanford Formation and "E" unit of the Ringold Formation. It should be noted that the lithologic changes in this borehole were not very significant. All major intervals have representative moisture-retention samples collected from them except for the lowest interval. The first interval is from 0 to 3.4 m (0 to 11 ft) and is represented by sample BOGL98. The interval from 3.4 to 7.3 m (11 to 24 ft) was represented by sample BOGLB0. The interval boundary between these two samples did not reflect a change in lithology, and samples BOGLB0 and BOGL98 were similar. Intervals 7.3 to 12 m, 12 to 13.4 m, and 13.4 to 19.7 m (24 to 39 ft, 39 to 44 ft, and 44 to 64.5 ft) were represented by samples BOGLB2, BOGLB7, and BOGLB0, respectively. No moisture retention samples were collected from 13.4 to 19.7m (44 to 64.5 ft); however, samples BOGLB0 and BOGL98 were representative of this interval. Table C-1 provides a summary of the lithologic units for each borehole and the sample number assigned to that lithology.

Table C-1. Lithologic Units and Assigned Physical Property Sample Number

Start Depth (ft)	End Depth(ft)	Hf=Hanford RE=Ringold "E" Formation	General Lithology	HEIS Sample Basis	Comments
Well No. N-108A					
0	21	Hf	Silty, Sandy Gravel	BOGL72	Sample from 15 to 15.5 ft
21	27	Hf	Sandy	BOGL74	Sample from 24 to 24.5 ft
27	39	Hf	Silty, Sandy Gravel	BOGL72	Analog Sample from 15 to 15.5 ft
39	50	RE	Silty, Sandy Gravel	BOGL80	Sample from 43 to 43.5 ft
50	59	RE	Sand	BOGL74	Analog Sample from 24 to 24.5 ft
59	66.5	RE	Silty, Sandy Gravel	BOGL85	Sample from 62.8 to 63.3 ft
65.5	68.5	RE	Sand	BOGL72	Analog Sample from 15 to 15.5 ft
68.5	72.5	RE	Silty, Sandy Gravel	BOGL80	Analog Sample from 43 to 43.5 ft
Well No. N-107A*					
0	28	Hf	Silty, Sandy Gravel	BOGL72	Analog Sample from 17.5 to 18 ft
28	38	Hf	Gravelly Sand	BOGL74	Rough Analog Sample from N-108A 24 to 24.5 ft
38	42	Hf	Sandy Gravel	BOGL72	Analog Sample from N-108A 15 to 15.5 ft
42	48	RE	Silty, Sandy Gravel	BOGL80	Analog Sample from N-108A 43 to 43.5 ft
48	52	RE	Gravely Sand	BOGL74	Rough Analog Sample from N-108A 24 to 24.5 ft
52	76	RE	Silty, Sandy Gravel	BOGL85	Analog Sample from N-108A 62.8 to 63.5 ft
Well No. N-109A					
0	11	Hf	Sandy Gravel	BOGL98	Sample from 10.5 to 11 ft
11	24	Hf	Sandy Gravel	BOGLB0	Sample from 17.5 to 18 ft
24	39	Hf	Sandy Gravel	BOGLB2	Sample from 24 to 24.5 ft
39	44	Hf	Sandy Gravel	BOGLB7	Sample from 39.5 to 40 ft
44	64.5	RE	Sandy Gravel	BOGLB0	Analog Sample from 17.5 to 18 ft

*No moisture-retention data were measured for this borehole.

C3.0 CORRECT MOISTURE RETENTION DATA FOR GRAVEL FRACTION

Eight samples collected from the recent drilling at the 1301-N and 1325-N LWDFs had moisture retention data measured. Four samples came from borehole 199-N-108A and four from borehole 199-N-109A. For these samples, a primary drying curve, a main drying curve, a main wetting curve, saturated hydraulic conductivity, and particle-size distribution were measured. Since moisture-retention data were measured only on the size fraction < 2 mm, the moisture-retention data have to be corrected for gravel content before an analytic drying or wetting curve can be

fitted through the data. Khaleel and Freeman (1995) used the following equation to correct the moisture-retention data for the percentage of gravels in the sample:

$$\theta_b = \frac{W_f\,(\rho_b/\rho_w)}{1 + (m_g/m_f)} \tag{1}$$

where: θ_b = volumetric moisture content of bulk soil, including the gravel
W_f = laboratory-measured gravimetric moisture content of the fine fraction (<2 mm)
ρ_b = bulk density of the entire sample, including the gravel
ρ_w = density of water
m_g = dry mass of the gravels from the bulk field sample
m_f = dry mass of the fines from the bulk field sample

In the remainder of this appendix, it is assumed that all volumetric moisture contents have been appropriately corrected for gravel content and, henceforth, will drop the subscript (b) on θ. Thus, all values for θ specify volumetric moisture contents of the bulk soil sample, including gravel when present.

C4.0 GENERATE MOISTURE CHARACTERISTIC CURVES

The next three steps were used to generate the moisture-characteristic curves from the laboratory measured moisture-retention data. Moisture-characteristic curves show the functional relationships between the pressure head, volumetric water content, and unsaturated hydraulic conductivity.

C4.1 CALCULATE VAN GENUCHTEN CURVE-FITTING PARAMETERS

Once the gravel corrections on the moisture-retention date were applied, the computer program (RETC, Van Genuchten et al., 1991) saves a nonlinear, least-squares, curve-fitting routine to match the measured soil-retention data to the following equation.

$$\theta = \theta_r + \frac{(\theta_s - \theta_r)}{[1 + (\alpha\,\psi)^n]^m} \tag{2}$$

where:	θ	=	volumetric moisture content at specified matric potential
	θ_r	=	residual volumetric moisture content
	θ_s	=	saturated volumetric moisture content
	α	=	Van Genuchten's curve-fitting parameter (1/cm)
	ψ	=	suction head (-cm)
	n	=	Van Genuchten's curve-fitting parameter
	m	=	(1 - 1/n)

The input to RETC was laboratory-measured values of moisture content at specified suction head (moisture-retention data). The curve-fitting parameters alpha (α), residual moisture (θ_r), (n), and (m) were the results from the RETC. The curve-fitting parameter (m) will be used to calculate unsaturated hydraulic conductivity as a function of moisture content.

C4.2 CALCULATE RELATIVE UNSATURATED HYDRAULIC CONDUCTIVITY USING MUALEM'S MODEL AND VAN GENUCHTEN CURVE-FITTING PARAMETER (M)

The Mualem (1976) model was used to predict the hydraulic conductivity from the moisture-retention data:

$$K(S_e) = K_s S_e^{\ell} \left[\frac{f(S_e)}{f(1)} \right]^2 \tag{3}$$

where:

$$f(S_e) = \int_0^{S_e} \frac{1}{\psi(x)} dx \tag{4}$$

$$S_e = \frac{(\theta - \theta_r)}{(\theta_s - \theta_r)} \tag{5}$$

Where	K_s	=	Saturated hydraulic conductivity
	ℓ	=	pore-connectivity parameter estimated by Mualem (1976) to be optimally about 0.5 for many soils.

Using Mualem's model, Van Genuchten (1980) derived a closed-form analytic solution to Equation 3 to predict the relative hydraulic conductivity (K_{rel}) at a specified moisture content.

$$K_{rel} = S_e^{t}[1 - (1 - S_e^{1/m})^m]^2 \tag{6}$$

To calculate the unsaturated hydraulic conductivity at a specified volumetric moisture content, the relative hydraulic conductivity at a specified moisture content was multiplied by the saturated hydraulic conductivity.

$$K(\theta) = K_s \cdot K_{rel} \tag{7}$$

The saturated hydraulic conductivity is then the match point for that characteristic curve.

C-4.3 USE THE MODIFIED MUALEM'S MODEL AND MEASURED UNSATURATED HYDRAULIC CONDUCTIVITY TO CALCULATE ABSOLUTE UNSATURATED HYDRAULIC CONDUCTIVITY

Khaleel et al., (1995) demonstrated that using the K_s as the match point for coarse-grained soils found at Hanford is not realistic since K_s is a poor indicator of unsaturated K at low moisture content. They recommended using one laboratory measurement of unsaturated conductivity as the match point for predicting the unsaturated hydraulic conductivity over a range of volumetric moisture contents. They then redefined Mualem's model (Equation 3) to use a match point at some arbitrary moisture content θ_o, and associated unsaturated hydraulic conductivity (K_o) to be as follows:

$$K(S_e) = K(S_{eo})\left[\frac{S_e}{S_{eo}}\right]^{t}\left[\frac{f(S_e)}{f(S_{eo})}\right]^2 \tag{8}$$

where S_{eo} is given by

$$S_{eo} = S_{eo}(\theta_o) = \frac{(\theta_o - \theta_r)}{(\theta_s - \theta_r)} \tag{9}$$

For the restricted case where m = (1 - 1/n), Equation 8 simplifies to (Luckner et al., 1989):

$$K(S_e) = K(S_{eo})\left[\frac{S_e}{S_{eo}}\right]^{t}\left[\frac{1 - (1 - S_e^{1/m})^m}{1 - (1 - S_{eo}^{1/m})^m}\right]^2 \tag{10}$$

Using the relationships from Equations 2 and 10, the moisture-retention data can then be used to calculate moisture-characteristic curves for the eight samples taken for physical properties from

boreholes N-108A and N-109A. These characteristic curves are given in Figures C-1 to C-8. For each of these figures, the left-hand plot gives calculated suction head as a function of volumetric moisture content, the moisture retention data, and Van Genuchten curve-fitting parameters. The right hand plot shows the calculated unsaturated hydraulic conductivity as a function of the volumetric moisture content. The match point is based on a laboratory-measured, unsaturated hydraulic conductivity for a sample from a nearby 100-Area borehole (Khaleel, personal communication). The match point sample has a similar gravel content to the samples from boreholes N-108A and N-109A. The unsaturated hydraulic conductivity, along with its volumetric moisture content, sample number, location, and percentage of gravels for the match point is also given in the right-hand plot.

C5.0 TRAVEL TIMES THROUGH THE VADOSE ZONE

Water movement through the vadose zone can be described mathematically by Richard's (1931) extension to Darcy's Law, which added the provision that hydraulic conductivity is now a function of saturation [i.e., $K = K(\theta)$]:

$$q = K(\theta)\nabla H \tag{11}$$

where:

q	=	Darcy flux (cm/s)
K	=	hydraulic conductivity (cm/s)
θ	=	volumetric moisture content
∇H	=	vector differential operator, representing the three-dimensional operator in space (in this case the spatial gradient of the hydraulic head)

For a steady-state, one-dimensional, and vertically aligned unsaturated soil column, Equation 11 becomes

$$q = K(\theta)[1 + \frac{\partial\psi}{\partial z}(\theta)] \tag{12}$$

where:

ψ	=	matric potential [suction head (-cm)]
z	=	vertical Cartesian coordinate (cm)
∂	=	differential

Under the unit gradient assumption, only the force of gravity is considered, and all other forces are considered negligible. Therefore, the hydraulic gradient under a steady-state assumption becomes one,

$$[1 + \frac{\partial \psi}{\partial z}] \approx 1 \qquad because \qquad 1 \gg \frac{\partial \psi}{\partial z}(\theta) \tag{13}$$

and the hydraulic conductivity at a specified moisture content is equal to the Darcy flux:

$$q = K(\theta) \tag{14}$$

C5.1 CALCULATE WATER TRAVEL TIME THROUGH THE VADOSE ZONE

To calculate the travel time (t) through a layer of arbitrary thickness (L), one needs to know the velocity of groundwater

$$v_{gw} = \frac{q}{n_{effective}} \tag{15}$$

where:

	v_{gw}	=	groundwater velocity
	q	=	Darcy flux (cm/s)
	$n_{effective}$	=	effective porosity for saturated conditions

and the thickness of the soil layer to arrive at the travel time through that layer:

$$t = \frac{L}{v_{gw}} \tag{16}$$

For unsaturated conditions, the relationship between unsaturated hydraulic conductivity and moisture content for a particular sediment is known (see Figures C-1 through C-8). The unit-gradient assumption can be applied to estimate steady-state travel times for one-dimensional flow. One-dimensional flow is an appropriate assumption because these LWDFs no longer receive liquid effluent and the only recharge available is through natural recharge. Using Equations 14 and 15 and replacing q with $K(\theta)$ and $n_{effective}$ with θ in Equation 16, the travel time through the each unit is given by

$$t = \frac{(L \cdot \theta)}{K(\theta)} \tag{17}$$

and the total travel (T) through the vadose zone is

$$T = \sum_{i=1}^{N} \frac{L_i \cdot \theta_i}{K(\theta)} \qquad \textbf{(18)}$$

where: N = number of layers
i = index of soil layer

Travel time to the water table was calculated for the soil types observed in boreholes N-107A, N-108A, and N-109A for three different recharge rates 0.2 centimeter per year (cm/yr), 2.0 cm/yr, and 10 cm/yr. The 0.2-cm/yr recharge rate is from the *100-Area Source Operable Unit Focus Feasibility Study* (DOE, 1995), the 2.0 cm/yr is from Rockhold et al., (1995), and the 10 cm/yr is a high recharge supplied for comparative purposes. Since the recharge rate and the thickness of the unit are known, the volumetric moisture content for each layer can be interpolated from the right-hand plots on Figures C-1 through C-8. The line perpendicular to the Y-axis at the unsaturated hydraulic conductivity equal to the recharge rate intersects the characteristic curve at the volumetric moisture content read from the X-axis. Table C-2 shows the volumetric moisture content for these recharge rates along with the porosity and volumetric particle density for the major soil types from boreholes N-107A, N-108A, and N-109A. (All units reported from the laboratory are in the metric system. All field measurements are reported in the English system. The units in this table have not been converted to a single system but are in the original reported units.)

Table C-2. Particle Density, Porosity, Soil Thickness and Volumetric Moisture Content at 0.2-, 2.0-, and 10-cm/yr Recharge for Wells N-107A, N-108A, and N-109A (Page 1 of 2)

HEIS Sample Basis	Interval Depth (ft)	Thickness (ft)	Particle Density g/cc	Porosity	Volumetric Moisture Content at Recharge Rates		
					0.2 cm/yr	2.0 cm/yr	10 cm/yr
Well No. N-108A							
BOGL72	0-21	21	2.74	0.24	0.0478	0.0714	0.0934
BOGL74	21-27	6	2.71	0.35	0.1997	0.2749	0.3397
BOGL72	27-39	12	2.74	0.24	0.0478	0.0714	0.0934
BOGL80	39-50	11	2.73	0.26	0.0517	0.0738	0.0940
BOGL74	50-59	9	2.71	0.35	0.1997	0.2749	0.3397
BOGL85	59-66.5	7.5	2.72	0.28	0.0555	0.0843	0.1120
BOGL72	66-68.5	3	2.74	0.24	0.0478	0.0714	0.0934
BOGL80	68.5-72.5	4	2.73	0.26	0.0517	0.0738	0.0940
Well No. N-107A							
BOGL72	0-28	28	2.74	0.24	0.0478	0.0714	0.0934
BOGL74	28-38	10	2.71	0.35	0.1997	0.2749	0.3397
Well No. N-107A (continued)							

Table C-2. Particle Density, Porosity, Soil Thickness and Volumetric Moisture Content at 0.2-, 2.0-, and 10-cm/yr Recharge for Wells N-107A, N-108A, and N-109A (Page 2 of 2)

HEIS Sample Basis	Interval Depth (ft)	Thickness (ft)	Particle Density g/cc	Porosity	Volumetric Moisture Content at Recharge Rates		
					0.2 cm/yr	2.0 cm/yr	10 cm/yr
BOGL72	38-42	4	2.74	0.24	0.0478	0.0714	0.0934
BOGL80	42-48	6	2.73	0.26	0.0517	0.0738	0.0940
BOGL74	48-52	4	2.71	0.24	0.1997	0.2749	0.3397
BOGL85	52-76	24	2.72	0.28	0.0555	0.0843	0.1120
Well No. N-109A							
BOGL98	0-11	11	2.98	0.284	0.0308	0.0400	0.0472
BOGLB0	11-24	13	2.86	0.278	0.0661	0.0838	0.0964
BOGLB2	24-39	15	2.88	0.244	0.0297	0.0397	0.0484
BOGLB7	39-44	5	2.93	0.344	0.0288	0.0396	0.0486
BOGLB0	44-64.5	20.5	2.86	0.284	0.0661	0.0838	0.0964

Travel times for water from the bottom of each LWDF to the water table for each recharge rate are plotted as a function of elevation (left Y-axis) or depth (right Y-axis) on the left-hand graph in Figures 5-19 to 5-30. For the water-only plot in each of these figures, the sharp discontinuity in a line segment is caused by transition from one soil type to another. The travel time from particular elevation is read off the X-axis where the line perpendicular to the Y-axis intersects the recharge rate of interest.

C5.2 CONTAMINANT TRANSPORT TRAVEL TIME THROUGH THE VADOSE ZONE

To estimate contaminant transport time for the center of mass for the COPCs, a modified retardation equation for unsaturated flow was used to estimate the relative velocity of the contaminant to the groundwater velocity. From Freeze and Cherry (1979) the retardation of the contamination front relative to the bulk mass for saturated flow is described by the relation

$$\frac{v}{v_c} = 1 + \frac{(1 - n) \cdot \rho_p \cdot K_d}{n_{effective}} \qquad (19)$$

where:

v = average linear velocity of groundwater (cm/s)
v_c = the velocity for the center of mass for retarded constituent (cm/s)
ρ_p = particle density (g/cc)
K_d = bulk distribution coefficient for retarded constituent (ml/g)
n = total porosity

For unsaturated flow, $n_{effective}$ is replaced with the volumetric moisture content (θ). To calculate the radioactive COPCs travel time through the vadose zone, Equation 19 is multiplied by Equation 17 and then summed as in Equation 18. The bulk-distribution coefficients for the radioactive COPCs are 15 milliliters per gram (mL/g) for strontium-90 (Serne and LeGore, 1996), 200 mL/g for plutonium-239/240 (DOE, 1995), and 50 mL/g for both cobalt-60 and cesium-137 (DOE, 1995). Travel times for each of the COPCs from the bottom of each LWDF to the water table for each recharge rate are plotted as a function of elevation (left Y-axis) or depth (right Y-axis) on the right-hand graph in Figures 5-19 through 5-30. The water-only travel-time plots are given on the left-hand side of these figures for comparative purposes.

The water-only plots showed sharp discontinuities as the water entered different soil types while plots for the radioactive COPCs did not show these discontinuities. The discontinuities in the water-only plots were caused by the change in volumetric moisture content as the soils changed properties. When contaminant retardation was applied to the water velocity, the volumetric moisture content was in the denominator of the retardation equation. For water velocity, the volumetric moisture content was in the numerator. When these two terms were multiplied together, the volumetric moisture content essentially dropped out of the equation. Although one was added to this retardation portion, it was small when compared to the rest of the retardation equation. The following example shows this function:

Using a soil 10 cm (3.9 in.) thick and the soi properties from samples BOGL72 and BOGL74, the water travel time for the 2-cm/yr (0.79 in./yr) recharge (BOGL72 using the values in Table C-2) as follows:

$$t = \frac{(L \cdot \theta_{2cm/y})}{K(\theta_{2cm/y})} = \frac{10\,cm \cdot 0.0714}{2\,cm/y} = 0.357\,y \qquad \textbf{(20)}$$

Water travel time for the 2-cm/yr (0.79 in.\yr) recharge (BOGL74) is as follows:

$$t = \frac{(L \cdot \theta_{2cm/y})}{K(\theta_{2cm/y})} = \frac{10\,cm \cdot 0.275}{2\,cm/y} = 1.375\,y \qquad \textbf{(21)}$$

The water traveling through soils with physical properties similar to BOGL74 would take approximately 4 times longer to traverse the 10 cm (3.9 in.). This causes a discontinuity between soils on the water-only plots. To apply the retardation equation for strontium-90 for the same

samples, contaminant-transport travel time for the 2-cm/yr (0.79 in./yr)recharge (BOGL72) is as follows:

$$t = \frac{(L \cdot \theta_{2cm/y})}{K(\theta_{2cm/y})} \cdot [1 + \frac{(1 - n) \cdot \rho_p \cdot K_d}{\theta_{2cm/y}} = \quad (22)$$

$$t = \frac{(10\,cm/y \cdot 0.0714)}{2\,cm/y} \cdot [1 + \frac{(1 - 0.24) \cdot 2.74\,g/cm^3 \cdot 15.0\,cm^3/g}{0.0714}] = 156.6y \quad (23)$$

Contaminant-transport travel time for the 2-cm/yr (0.79 in./yr) recharge (BOGL74) is as follows:

$$t = \frac{(10\,cm/y \cdot 0.275)}{2\,cm/y} \cdot [1 + \frac{(1 - 0.35) \cdot 2.71\,g/cm^3 \cdot 15.0\,cm^3/g}{0.275}] = 132.1y \quad (24)$$

In this case, the travel times for contaminants were approximately the same between the soil types, and the discontinuity between soil types did not appear as distinctly in the retarded-contaminant travel-time plots in Figures 5-19 to 5-30. Table C-3 provides approximate travel times to the 1995 water table from major zones of concern. Major zones of concern would be at the bottom of the LWDF, top of the historic water-table mound (~125 m [~410 ft]), and at the high water table caused by the large releases occurring in early 1996.

Table C-3. Travel Times to the 1995 Water Table for the Major Zones of Concern (Page 1 of 2)

Recharge Rate cm/yr	Travel Times to the 1995 Water Table (yr)								
	1996 High Water Table (393			Historic Water Table Mound			Bottom of Facility		
	N-107A	N-108A	N-109A	N-107A	N-108A	N-109A	N-107A	N-108A	N-109A
Water									
10.0	3	3	2	10	14	6	29	28	12
2.0	10	10	7	38	57	26	113	111	53
0.2	68	66	54	254	407	206	789	781	416
Strontium-90									
10.0	725	772	513	2,226	2,241	2,106	5,379	5,143	5,063
2.0	3,600	3,860	2,566	11,120	11,190	10,528	26,864	25,684	25,306
0.2	36,100	38,564	25,644	111,073	111,733	105,221	268,295	256,513	255,000

Table C-3. Travel Times to the 1995 Water Table for the Major Zones of Concern (Page 2 of 2)

Recharge Rate cm/yr	Travel Times to the 1995 Water Table (yr)								
	1996 High Water Table (393			Historic Water Table Mound			Bottom of Facility		
	N-107A	N-108A	N-109A	N-107A	N-108A	N-109A	N-107A	N-108A	N-109A
Plutonium 239/240									
10.0	9,610	10,200	6,830	29,600	29,700	28,000	77,800	65,100	68000
2.0	48,000	51,500	34,000	149,000	148,000	140,000	389,000	323,500	339,500
0.2	480,000	515,000	341,000	1,480,0	1,485,0	1,400,0	3,890,0	3,235,0	3,400,00
Cobalt-60									
10.0	2,400	2,570	1,710	7,400	7,400	7,000	19,500	16,300	17,000
2.0	12,000	13,000	8,500	37,000	37,000	34,900	97,400	81,000	84,500
0.2	120,000	128,000	8,540	370,000	371,000	349,000	973,000	814,000	850,000
Cesium-137									
10.0	2,400	2,570	1,710	7,400	7,400	7,000	19,500	16,300	17,000
2.0	12,000	13,000	8,500	37,000	37,000	34,900	97,400	81,000	84,500
0.2	120,000	128,000	85,400	370,000	371,000	349,000	9,730,0	814,000	850,000

*Please note the numbers in this table are approximate. They were read from the curves present in Figures 5-19 to 5-30

C6.0 DISCUSSION AND COMPARISON TO OBSERVED DATA

The unit gradient approach combined with the retardation equation for contaminants was only a first approximation for travel time. It did not take into account multidimensional flow, nonuniform recharge, or a recharge rate that changes over time. The contaminant transport portion of the unit-gradient model did not take into account dispersion and/or diffusion. Under transient conditions, the unit-gradient approach would not work. The unsaturated hydraulic conductivity within a single soil type was dependent upon the wetting and drying paths within the hysteresis cycle, the moisture content estimated by those paths, and the amount of wetting and drying. Under these conditions, one might apply a multidimensional numerical model that would take into account the factors left out of a unit-gradient model.

The unit-gradient approach combined with field observations should be applied and analyzed before attempting a multidimensional model. If the unit-gradient approach does not agree with observed data, one might apply a more sophisticated model to calculate the travel times. In this case, the unit-gradient model indicated the travel times for all radionuclides with the possible exception for strontium-90 was long enough that radionuclides would decay away before reaching the water table. For strontium-90, the concentration on sediments directly above the 1995 water table did present a concern, especially if the water table rises in future like it did in

early 1996. Although the unit gradient indicated the radioactive COPCs in the vadose would decay away before reaching the water table, one must question if this conclusion is reasonable. To answer this question, a comparison using the unit gradient model could be made between the natural recharge and the artificial rechagre that took place during operations. When 1301-N LWDF was recieving liquid effluent, the rate water at which water was discharged to this facility was 2,100 gallons per minute. This is equivalent to an annual recharge rate of

$$2{,}100\ \frac{gal}{\min} \cdot 525{,}600\ \frac{\min}{y} \cdot 3{,}785\ \frac{cm^3}{gal} \ /\ 48{,}554{,}600\ cm^2\ (area\ of\ 1301\text{-}N\ LWDF) = 86{,}000\ cm/y$$

Data Quality Objectives Workshop Results for 1301-N and 1325-N Characterization (BHI, 1996) gives the area of the 1301-N LWDF over which artificial recharge was applied. This artificial recharge rate was higher than the measured saturated hydraulic conductivities for the borehole sediments. The high recharge rate indicated that ponding in the LWDF occurred along with lateral movement through the vadose zone, explaining why some contaminants were detected in the side borehole. When the recharge rate during operations was 86,000 cm/yr (33,858 in./yr) and compared to the concentrations from the drilling described in previous sections (Figures 5-3 through 5-6 and 5-11 through 5-14), it becomes obvious that cobalt-60, cesium-137, and plutonium-239/240 would stay in the upper vadose zone (i.e., close to the bottom of the LWDFs) under natural recharge conditions. These contaminants did not migrate very far downward under a recharge of 86,000 cm/yr; they would not migrate with a natural recharge of 2 cm/yr.

Strontium-90 did migrate downward with the artificial recharge; however, its K_d is three time less than that of cobalt-60 and cesium-137. It migrated when the artificial recharge rate was at least 2 to 3 orders of magnitude higher than the natural recharge rate. If the unit-gradient model is applied at the artificial recharge rates, it indicates the travel time from the bottom of the LWDF to the water table is on the order of one to five years. Historical records showed the groundwater underlying 1301-N LWDF was contaminated with strontium-90, indicating the unit-gradient model is valid as a first approximation for travel times for radionuclides underlying the 100-N LWDFs.

C7.0 REFERENCES

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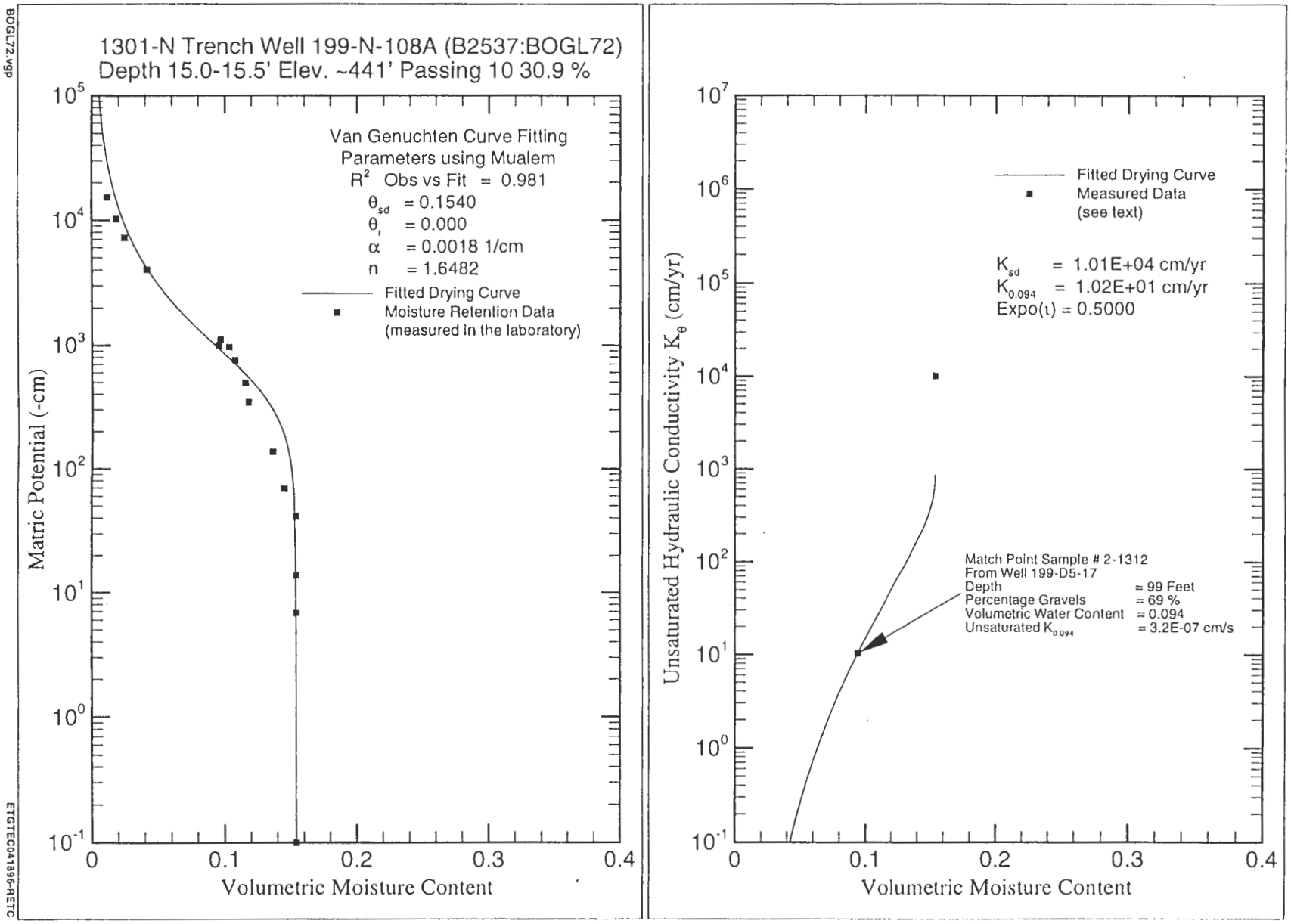


Figure C-1. Moisture Characteristic Curves for Sample BOGL72

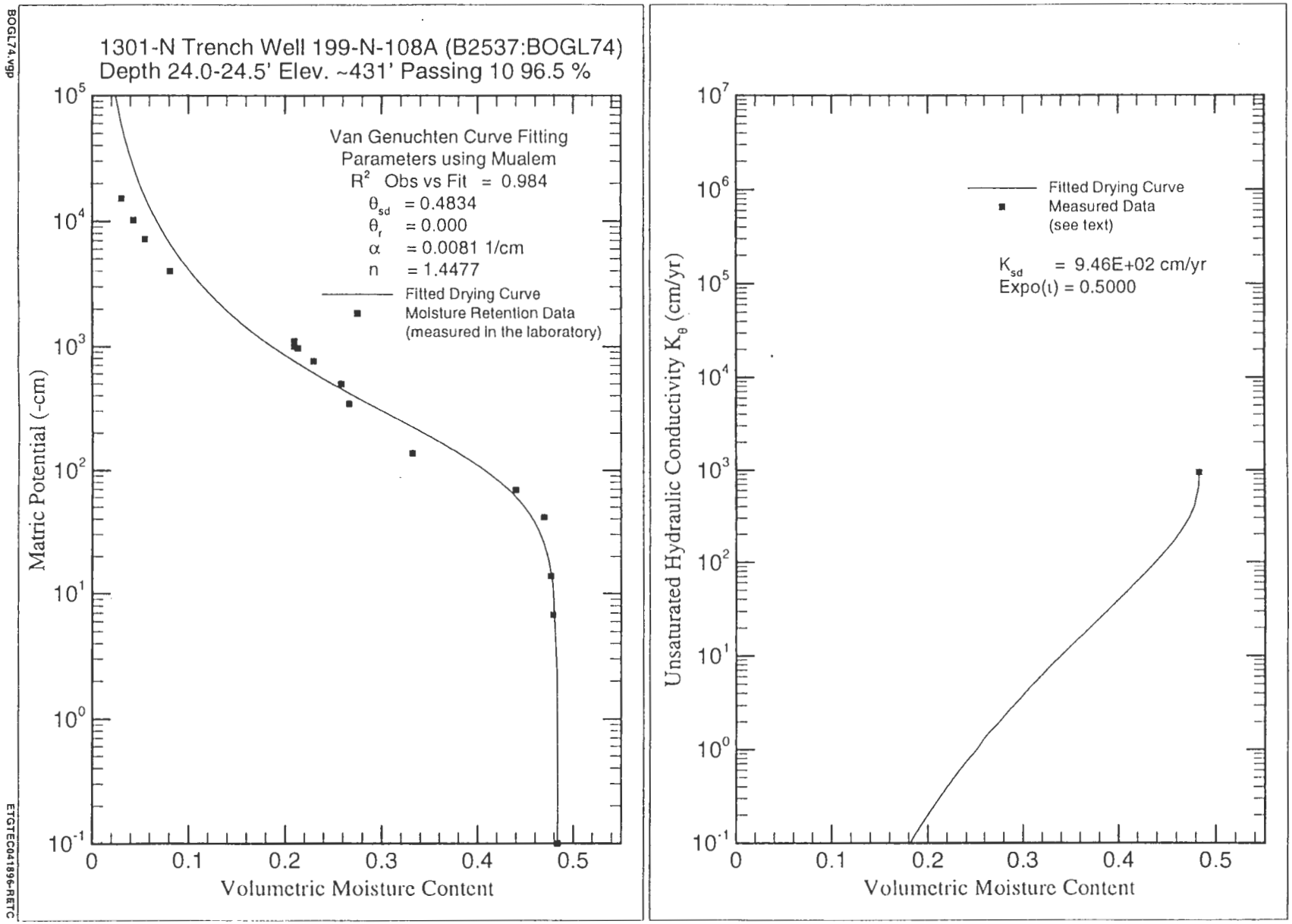


Figure C-2. Moisture Characteristic Curves for Sample BOGL74

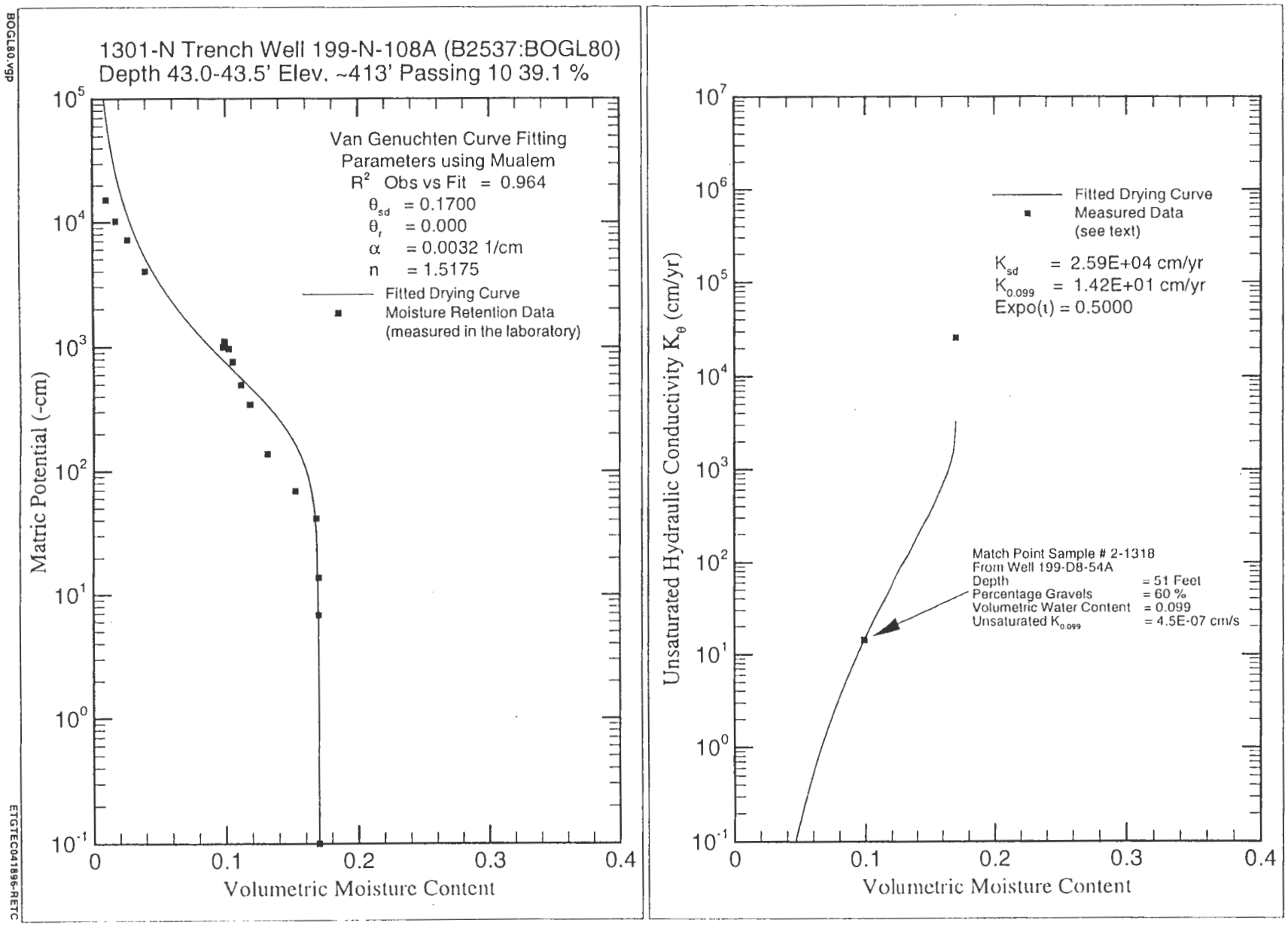


Figure C-3. Moisture Characteristic Curves for Sample BOGL80

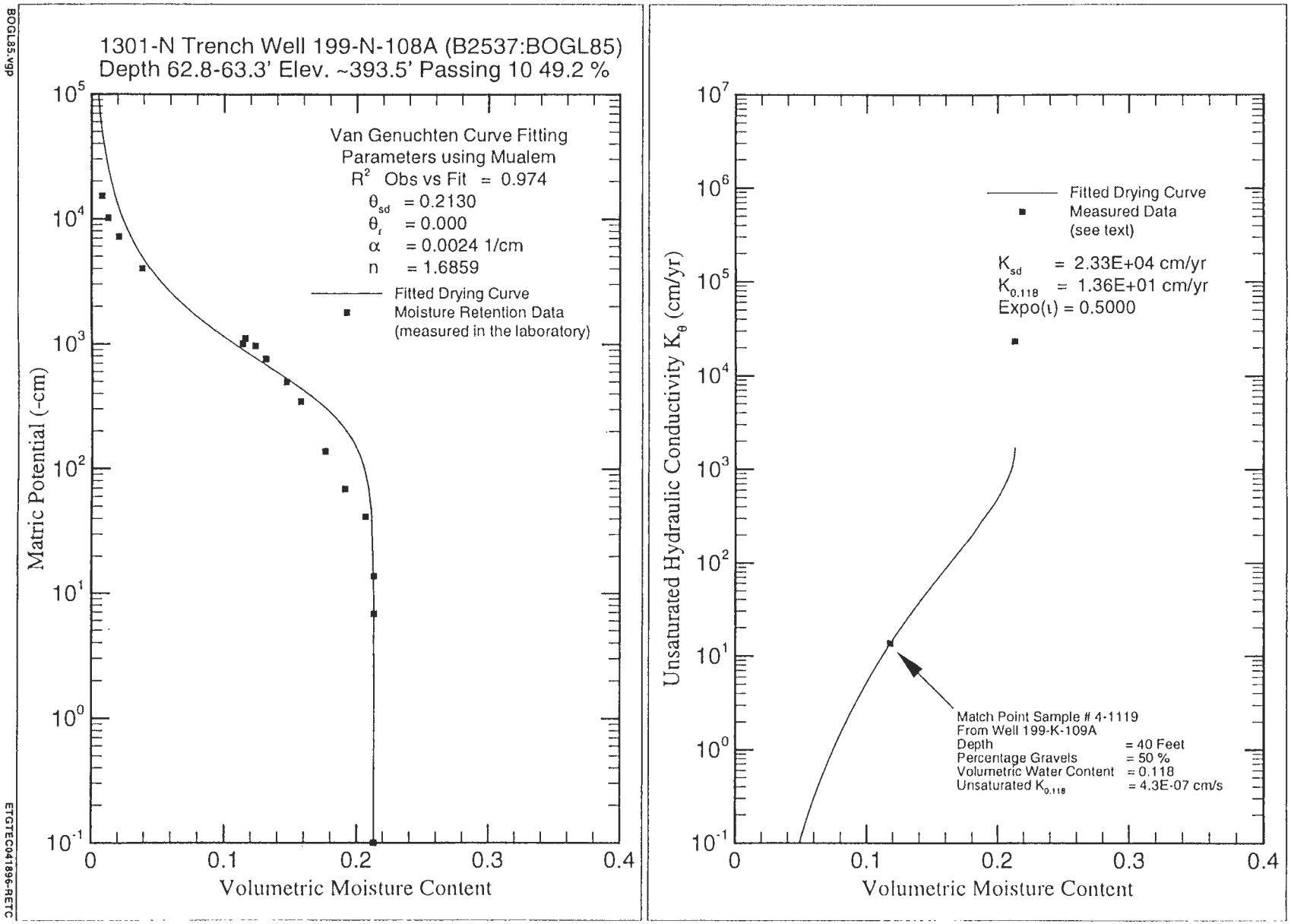


Figure C-4. Moisture Characteristic Curves for Sample BOGL85

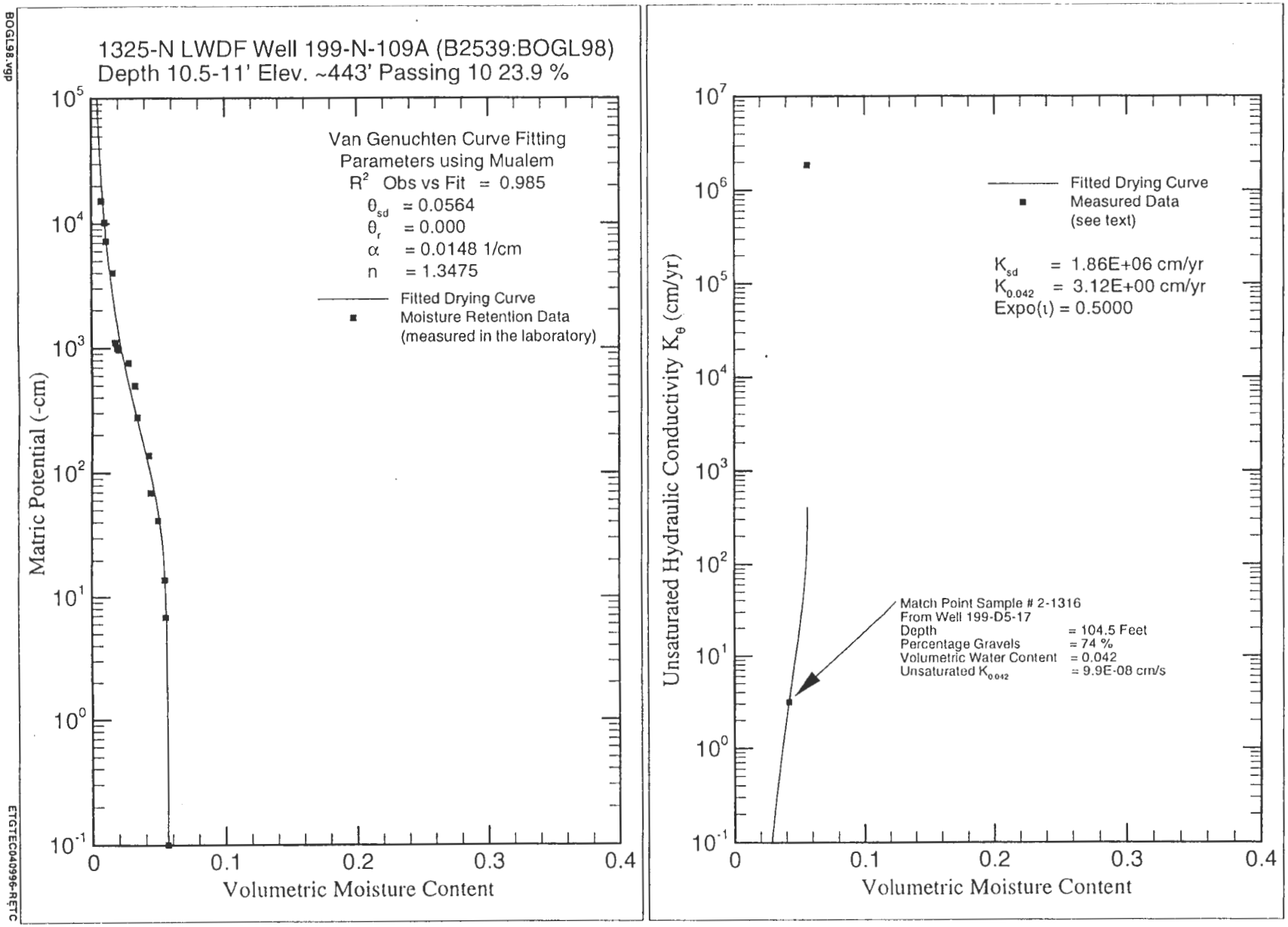


Figure C-5. Moisture Characteristic Curves for Sample BOGL98

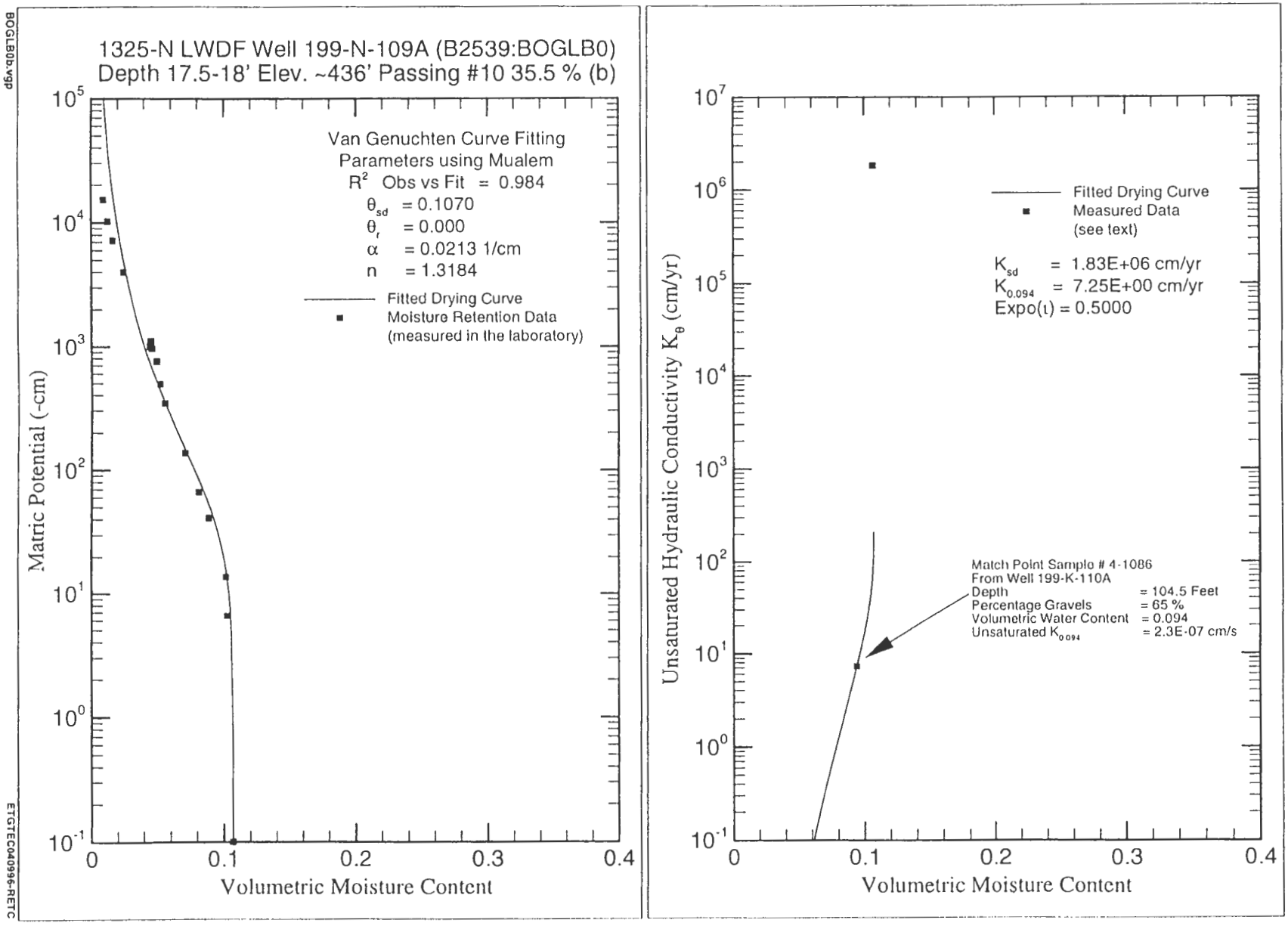
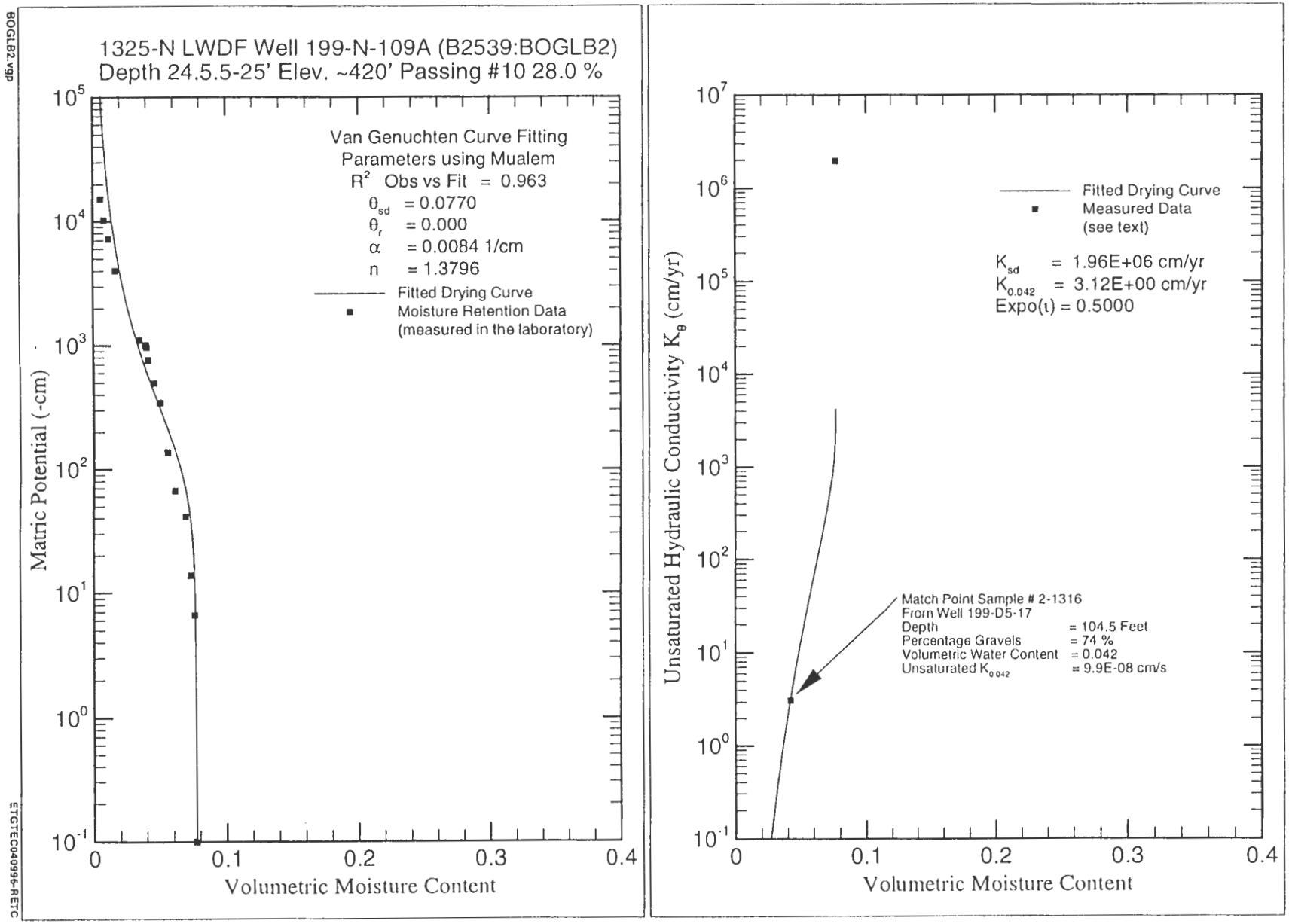


Figure C-6. Moisture Characteristic Curves for Sample BOGLB0

Figure C-7. Moisture Characteristic Curves for Sample BOGLB2



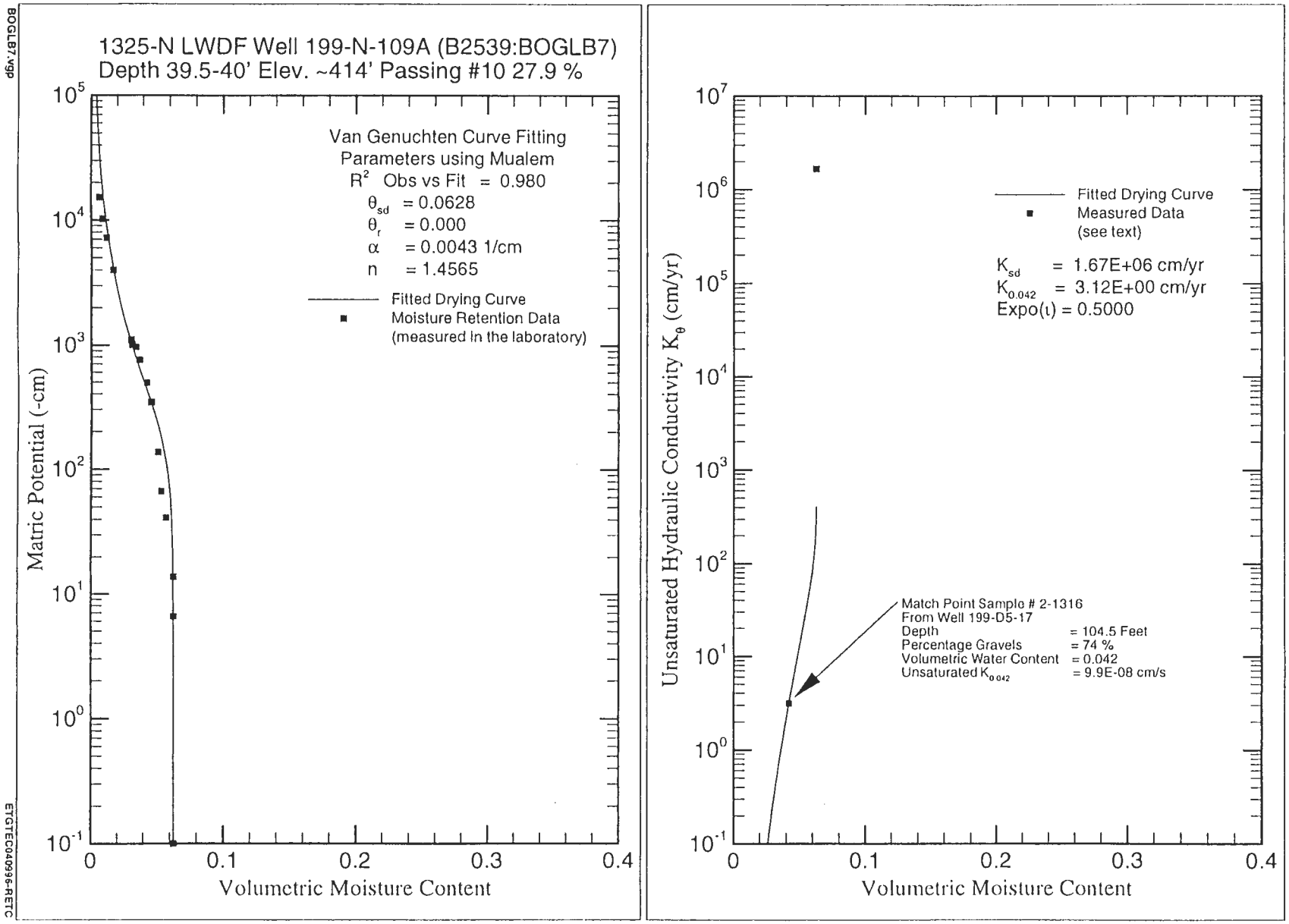


Figure C-8. Moisture Characteristic Curves for Sample BOGLB7

APPENDIX D

THE RESRAD OUTPUTS

Table D-1. Rural-Residential Scenario (Page 1 of 17)

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 1
Summary : 1301 residential File: 1310RES.DAT

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 5
Summary of Pathway Selections 10
Contaminated Zone and Total Dose Summary 11
Total Dose Components
Time = 0.000E+00 12
Time = 1.000E+00 13
Time = 3.000E+00 14
Time = 1.000E+01 15
Time = 1.400E+01 16
Time = 2.200E+01 17
Time = 1.000E+02 18
Time = 1.000E+03 19
Dose/Source Ratios Summed Over All Pathways 20
Single Radionuclide Soil Guidelines 20
Dose Per Nuclide Summed Over All Pathways 22
Soil Concentration Per Nuclide 23

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 2
Summary : 1301 residential File: 1310RES.DAT

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC.BIN

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Co-60	2.190E-04	2.190E-04	DCF2(2)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(3)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(4)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(5)
B-1	Pu-240	4.290E-01	4.290E-01	DCF2(6)
B-1	Ra-228+D	5.080E-03	5.080E-03	DCF2(7)
B-1	Sr-90+D	1.310E-03	1.310E-03	DCF2(8)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(9)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(10)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(11)
B-1	U-236	1.250E-01	1.250E-01	DCF2(12)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Co-60	2.690E-05	2.690E-05	DCF3(2)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(3)

Table D-1. Rural-Residential Scenario (Page 2 of 17)

D-1	Pa-231	1.060E-02	1.060E-02	DCF3(4)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(5)
D-1	Pu-240	3.540E-03	3.540E-03	DCF3(6)
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(7)
D-1	Sr-90+D	1.530E-04	1.530E-04	DCF3(8)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(9)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(10)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(11)
D-1	U-236	2.690E-04	2.690E-04	DCF3(12)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(2,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(2,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(2,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(3,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(3,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(4,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(4,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(4,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(5,3)
D-34				

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 3
Summary : 1301 residential File: 1310RES.DAT

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

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D-34	Pu-240 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Pu-240 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Pu-240 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(6,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(7,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(7,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(7,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(8,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(8,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(8,3)
D-34				

Table D-1. Rural-Residential Scenario (Page 3 of 17)

D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(9,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(9,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(9,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(10,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(10,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(10,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(11,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(11,3)
D-34				
D-34	U-236 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(12,1)
D-34	U-236 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(12,2)
D-34	U-236 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(12,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(2,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(2,2)
D-5				
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(3,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(4,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(5,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(5,2)
D-5				
D-5	Pu-240 , fish	3.000E+01	3.000E+01	BIOFAC(6,1)
D-5	Pu-240 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(6,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(7,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(7,2)
D-5				

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 4
Summary : 1301 residential File: 1310RES.DAT

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

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D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(8,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(9,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(9,2)

Table D-1. Rural-Residential Scenario (Page 4 of 17)

D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(10,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(10,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(11,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(12,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(12,2)

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 5
Summary : 1301 residential File: 1310RES.DAT

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	1.000E+02	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.400E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	2.200E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Co-60	1.000E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Cs-137	1.000E+00	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.000E+00	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Pu-240	1.000E+00	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): Sr-90	1.000E+00	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Pu-240	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(8)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ

Table D-1. Rural-Residential Scenario (Page 5 of 17)

R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.900E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	1.000E+06	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	1.000E-03	1.000E-03	---	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 6
Summary : 1301 residential File: 1310RES.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	1	1	---	NS
R015	Unsat. zone 1, thickness (m)	4.000E+00	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	1.500E+00	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	4.000E-01	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	2.000E-01	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	5.300E+00	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.600E-07	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.600E-07	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Pu-239				

Table D-1. Rural-Residential Scenario (Page 6 of 17)

R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.999E-08	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Pu-240				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.999E-08	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.310E-06	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 7
Summary : 1301 residential File: 1310RES.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.949E-06	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.192E-06	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.281E-06	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(9)

Table D-1. Rural-Residential Scenario (Page 7 of 17)

R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.667E-09	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for daughter Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.667E-09	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.192E-06	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for daughter U-236				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.192E-06	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	2.000E-04	---	MLINH

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 8
Summary : 1301 residential File: 1310RES.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	5.000E-01	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	2.500E-01	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	1 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)

Table D-1. Rural-Residential Scenario (Page 8 of 17)

R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	1.600E+02	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	1.400E+01	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	9.200E+01	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	6.300E+01	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	3.650E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	1.000E+00	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	1.000E+00	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	-1	-1	0.500E+00	FPLANT
R018	Contamination fraction of meat	-1	-1	0.500E+00	FMEAT
R018	Contamination fraction of milk	-1	-1	0.500E+00	FMILK

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 9
Summary : 1301 residential File: 1310RES.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Livestock fodder intake for meat (kg/day)	6.800E+01	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	5.500E+01	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	5.000E+01	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	1.600E+02	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	5.000E-01	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	1.000E-04	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	9.000E-01	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW

Table D-1. Rural-Residential Scenario (Page 9 of 17)

R019	Irrigation fraction from ground water	1.000E+00	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	1.400E+01	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	1.000E+00	1.000E+00	---	STOR_T(2)
STOR	Milk	1.000E+00	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	2.000E+01	2.000E+01	---	STOR_T(4)
STOR	Fish	not used	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	not used	7.000E+00	---	STOR_T(6)
STOR	Well water	1.000E+00	1.000E+00	---	STOR_T(7)
STOR	Surface water	1.000E+00	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	4.500E+01	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 10
Summary : 1301 residential File: 1310RES.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Table D-1. Rural-Residential Scenario (Page 10 of 17)

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	active
4 -- meat ingestion	active
5 -- milk ingestion	active
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 11
Summary : 1301 residential File: 1310RES.DAT

Contaminated Zone Dimensions

Area: 10000.00 square meters
Thickness: 5.00 meters
Cover Depth: 0.00 meters

Initial Soil Concentrations, pCi/g

Co-60	1.000E+00
Cs-137	1.000E+00
Pu-239	1.000E+00
Pu-240	1.000E+00
Sr-90	1.000E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 15 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
TDOSE(t):	1.824E+01	1.691E+01	1.466E+01	9.791E+00	8.232E+00	6.348E+00	2.142E+00	1.363E+00
M(t):	1.216E+00	1.127E+00	9.775E-01	6.527E-01	5.488E-01	4.232E-01	1.428E-01	9.086E-02

0Maximum TDOSE(t): 1.824E+01 mrem/yr at t = 0.000E+00 years
1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 12
Summary : 1301 residential File: 1310RES.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	9.147E+00	0.5013	1.607E-04	0.0000	0.000E+00	0.0000	1.864E-01	0.0102	9.850E-02	0.0054	1.195E-02	0.0007	7.364E-04	0.0000
Cs-137	1.915E+00	0.1050	2.341E-05	0.0000	0.000E+00	0.0000	1.739E-01	0.0095	1.517E-01	0.0083	4.959E-02	0.0027	1.369E-03	0.0001
Pu-239	1.700E-04	0.0000	3.149E-01	0.0173	0.000E+00	0.0000	3.101E-01	0.0170	6.355E-03	0.0003	9.063E-05	0.0000	9.691E-02	0.0053
Pu-240	8.723E-05	0.0000	3.149E-01	0.0173	0.000E+00	0.0000	3.101E-01	0.0170	6.355E-03	0.0003	9.063E-05	0.0000	9.691E-02	0.0053
Sr-90	1.476E-02	0.0008	9.615E-04	0.0001	0.000E+00	0.0000	3.990E+00	0.2187	8.025E-01	0.0440	2.386E-01	0.0131	4.188E-03	0.0002
Total	1.108E+01	0.6071	6.309E-01	0.0346	0.000E+00	0.0000	4.970E+00	0.2724	1.065E+00	0.0584	3.003E-01	0.0165	2.001E-01	0.0110

0

Table D-1. Rural-Residential Scenario (Page 11 of 17)

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.444E+00	0.5177
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.292E+00	0.1256
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.285E-01	0.0399
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.284E-01	0.0399
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.051E+00	0.2769
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.824E+01	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 13
Summary : 1301 residential File: 1310RES.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Co-60	8.019E+00	0.4743	1.409E-04	0.0000	0.000E+00	0.0000	1.634E-01	0.0097	8.637E-02	0.0051	1.048E-02	0.0006	6.456E-04	0.0000
Cs-137	1.871E+00	0.1107	2.288E-05	0.0000	0.000E+00	0.0000	1.699E-01	0.0100	1.482E-01	0.0088	4.846E-02	0.0029	1.337E-03	0.0001
Pu-239	1.700E-04	0.0000	3.149E-01	0.0186	0.000E+00	0.0000	3.101E-01	0.0183	6.355E-03	0.0004	9.062E-05	0.0000	9.690E-02	0.0057
Pu-240	8.722E-05	0.0000	3.148E-01	0.0186	0.000E+00	0.0000	3.101E-01	0.0183	6.354E-03	0.0004	9.062E-05	0.0000	9.690E-02	0.0057
Sr-90	1.441E-02	0.0009	9.389E-04	0.0001	0.000E+00	0.0000	3.896E+00	0.2304	7.837E-01	0.0463	2.330E-01	0.0138	4.090E-03	0.0002
Total	9.905E+00	0.5858	6.308E-01	0.0373	0.000E+00	0.0000	4.850E+00	0.2868	1.031E+00	0.0610	2.921E-01	0.0173	1.999E-01	0.0118

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.280E+00	0.4897
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.239E+00	0.1324
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.285E-01	0.0431
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.283E-01	0.0431
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.932E+00	0.2917
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.691E+01	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 14
Summary : 1301 residential File: 1310RES.DAT

Table D-1. Rural-Residential Scenario (Page 12 of 17)

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	6.165E+00	0.4204	1.083E-04	0.0000	0.000E+00	0.0000	1.256E-01	0.0086	6.639E-02	0.0045	8.055E-03	0.0005	4.963E-04	0.0000
Cs-137	1.787E+00	0.1219	2.185E-05	0.0000	0.000E+00	0.0000	1.622E-01	0.0111	1.415E-01	0.0097	4.627E-02	0.0032	1.277E-03	0.0001
Pu-239	1.700E-04	0.0000	3.149E-01	0.0215	0.000E+00	0.0000	3.101E-01	0.0211	6.354E-03	0.0004	9.062E-05	0.0000	9.690E-02	0.0066
Pu-240	8.720E-05	0.0000	3.148E-01	0.0215	0.000E+00	0.0000	3.100E-01	0.0211	6.353E-03	0.0004	9.060E-05	0.0000	9.688E-02	0.0066
Sr-90	1.374E-02	0.0009	8.952E-04	0.0001	0.000E+00	0.0000	3.715E+00	0.2534	7.472E-01	0.0510	2.222E-01	0.0152	3.900E-03	0.0003
Total	7.966E+00	0.5432	6.307E-01	0.0430	0.000E+00	0.0000	4.623E+00	0.3153	9.678E-01	0.0660	2.767E-01	0.0189	1.994E-01	0.0136

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Dependent Pathways
0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.366E+00	0.4341
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.138E+00	0.1458
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.284E-01	0.0497
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.282E-01	0.0497
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.703E+00	0.3207
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.466E+01	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 15
Summary : 1301 residential File: 1310RES.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	2.456E+00	0.2508	4.315E-05	0.0000	0.000E+00	0.0000	5.003E-02	0.0051	2.645E-02	0.0027	3.208E-03	0.0003	1.977E-04	0.0000
Cs-137	1.520E+00	0.1552	1.858E-05	0.0000	0.000E+00	0.0000	1.380E-01	0.0141	1.204E-01	0.0123	3.936E-02	0.0040	1.086E-03	0.0001
Pu-239	1.699E-04	0.0000	3.148E-01	0.0321	0.000E+00	0.0000	3.100E-01	0.0317	6.353E-03	0.0006	9.060E-05	0.0000	9.688E-02	0.0099
Pu-240	8.713E-05	0.0000	3.145E-01	0.0321	0.000E+00	0.0000	3.098E-01	0.0316	6.348E-03	0.0006	9.053E-05	0.0000	9.680E-02	0.0099
Sr-90	1.163E-02	0.0012	7.578E-04	0.0001	0.000E+00	0.0000	3.145E+00	0.3212	6.325E-01	0.0646	1.881E-01	0.0192	3.301E-03	0.0003
Total	3.987E+00	0.4072	6.301E-01	0.0644	0.000E+00	0.0000	3.953E+00	0.4037	7.920E-01	0.0809	2.308E-01	0.0236	1.983E-01	0.0202

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
0 Water Dependent Pathways

Table D-1. Rural-Residential Scenario (Page 13 of 17)

0

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.535E+00	0.2590
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.819E+00	0.1858
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.283E-01	0.0744
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.277E-01	0.0743
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.981E+00	0.4066
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	9.791E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 16
Summary : 1301 residential File: 1310RES.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Co-60	1.451E+00	0.1763	2.550E-05	0.0000	0.000E+00	0.0000	2.957E-02	0.0036	1.563E-02	0.0019	1.896E-03	0.0002	1.168E-04	0.0000
Cs-137	1.386E+00	0.1684	1.694E-05	0.0000	0.000E+00	0.0000	1.258E-01	0.0153	1.098E-01	0.0133	3.588E-02	0.0044	9.905E-04	0.0001
Pu-239	1.699E-04	0.0000	3.148E-01	0.0382	0.000E+00	0.0000	3.100E-01	0.0377	6.352E-03	0.0008	9.059E-05	0.0000	9.687E-02	0.0118
Pu-240	8.710E-05	0.0000	3.144E-01	0.0382	0.000E+00	0.0000	3.096E-01	0.0376	6.345E-03	0.0008	9.049E-05	0.0000	9.676E-02	0.0118
Sr-90	1.058E-02	0.0013	6.890E-04	0.0001	0.000E+00	0.0000	2.859E+00	0.3473	5.751E-01	0.0699	1.710E-01	0.0208	3.001E-03	0.0004
Total	2.848E+00	0.3460	6.299E-01	0.0765	0.000E+00	0.0000	3.634E+00	0.4415	7.131E-01	0.0866	2.089E-01	0.0254	1.977E-01	0.0240

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
Water Dependent Pathways

0

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.498E+00	0.1820
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.658E+00	0.2015
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.282E-01	0.0885
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.273E-01	0.0884
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.619E+00	0.4397
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.232E+00	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 17
Summary : 1301 residential File: 1310RES.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.200E+01 years

0 Water Independent Pathways (Inhalation excludes radon)

Table D-1. Rural-Residential Scenario (Page 14 of 17)

0

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Co-60	5.068E-01	0.0798	8.906E-06	0.0000	0.000E+00	0.0000	1.033E-02	0.0016	5.458E-03	0.0009	6.622E-04	0.0001	4.080E-05	0.0000
Cs-137	1.152E+00	0.1815	1.408E-05	0.0000	0.000E+00	0.0000	1.046E-01	0.0165	9.124E-02	0.0144	2.983E-02	0.0047	8.233E-04	0.0001
Pu-239	1.699E-04	0.0000	3.147E-01	0.0496	0.000E+00	0.0000	3.099E-01	0.0488	6.351E-03	0.0010	9.057E-05	0.0000	9.685E-02	0.0153
Pu-240	8.702E-05	0.0000	3.141E-01	0.0495	0.000E+00	0.0000	3.094E-01	0.0487	6.340E-03	0.0010	9.042E-05	0.0000	9.668E-02	0.0152
Sr-90	8.742E-03	0.0014	5.695E-04	0.0001	0.000E+00	0.0000	2.363E+00	0.3723	4.753E-01	0.0749	1.413E-01	0.0223	2.481E-03	0.0004
Total	1.668E+00	0.2627	6.294E-01	0.0991	0.000E+00	0.0000	3.097E+00	0.4879	5.847E-01	0.0921	1.720E-01	0.0271	1.969E-01	0.0310

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.200E+01 years
Water Dependent Pathways

0

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.233E-01	0.0824
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.378E+00	0.2171
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.280E-01	0.1147
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.267E-01	0.1145
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.992E+00	0.4713
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.348E+00	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 18
Summary : 1301 residential File: 1310RES.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Co-60	1.779E-05	0.0000	3.127E-10	0.0000	0.000E+00	0.0000	3.625E-07	0.0000	1.916E-07	0.0000	2.325E-08	0.0000	1.432E-09	0.0000
Cs-137	1.900E-01	0.0887	2.323E-06	0.0000	0.000E+00	0.0000	1.725E-02	0.0081	1.505E-02	0.0070	4.920E-03	0.0023	1.358E-04	0.0001
Pu-239	1.695E-04	0.0001	3.140E-01	0.1466	0.000E+00	0.0000	3.092E-01	0.1444	6.337E-03	0.0030	9.036E-05	0.0000	9.663E-02	0.0451
Pu-240	8.631E-05	0.0000	3.116E-01	0.1455	0.000E+00	0.0000	3.068E-01	0.1433	6.288E-03	0.0029	8.968E-05	0.0000	9.588E-02	0.0448
Sr-90	1.365E-03	0.0006	8.891E-05	0.0000	0.000E+00	0.0000	3.690E-01	0.1723	7.421E-02	0.0347	2.207E-02	0.0103	3.873E-04	0.0002
Total	1.916E-01	0.0895	6.256E-01	0.2921	0.000E+00	0.0000	1.002E+00	0.4680	1.019E-01	0.0476	2.717E-02	0.0127	1.930E-01	0.0901

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Dependent Pathways

0

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.

Table D-1. Rural-Residential Scenario (Page 15 of 17)

Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.837E-05	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.274E-01	0.1062
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.264E-01	0.3392
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.207E-01	0.3365
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.671E-01	0.2181
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.142E+00	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 19
Summary : 1301 residential File: 1310RES.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	1.769E-10	0.0000	2.163E-15	0.0000	0.000E+00	0.0000	1.606E-11	0.0000	1.401E-11	0.0000	4.581E-12	0.0000	1.265E-13	0.0000
Pu-239	1.656E-04	0.0001	3.059E-01	0.2245	0.000E+00	0.0000	3.013E-01	0.2211	6.174E-03	0.0045	8.805E-05	0.0001	9.415E-02	0.0691
Pu-240	7.845E-05	0.0001	2.832E-01	0.2078	0.000E+00	0.0000	2.789E-01	0.2046	5.715E-03	0.0042	8.163E-05	0.0001	8.715E-02	0.0639
Sr-90	6.749E-13	0.0000	4.396E-14	0.0000	0.000E+00	0.0000	1.824E-10	0.0000	3.669E-11	0.0000	1.091E-11	0.0000	1.915E-13	0.0000
Total	2.440E-04	0.0002	5.891E-01	0.4322	0.000E+00	0.0000	5.802E-01	0.4257	1.189E-02	0.0087	1.697E-04	0.0001	1.813E-01	0.1330

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
0 Water Dependent Pathways
0

Radio-	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.117E-10	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.078E-01	0.5193
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.551E-01	0.4807
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.309E-10	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.363E+00	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 20
Summary : 1301 residential File: 1310RES.DAT

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
Co-60	Co-60	1.000E+00	9.444E+00	8.280E+00	6.366E+00	2.535E+00	1.498E+00	5.233E-01	1.837E-05	0.000E+00

Table D-1. Rural-Residential Scenario (Page 16 of 17)

0Cs-137	Cs-137	1.000E+00	2.292E+00	2.239E+00	2.138E+00	1.819E+00	1.658E+00	1.378E+00	2.274E-01	2.117E-10
0Pu-239	Pu-239	1.000E+00	7.285E-01	7.285E-01	7.284E-01	7.283E-01	7.282E-01	7.280E-01	7.264E-01	7.078E-01
Pu-239	U-235	1.000E+00	0.000E+00	5.868E-10	1.758E-09	5.859E-09	8.201E-09	1.289E-08	5.849E-08	5.766E-07
Pu-239	Pa-231	1.000E+00	0.000E+00	1.333E-13	1.184E-12	1.309E-11	2.564E-11	6.328E-11	1.305E-09	1.283E-07
Pu-239	Ac-227	1.000E+00	0.000E+00	1.217E-15	2.970E-14	1.014E-12	2.686E-12	9.784E-12	5.690E-10	9.356E-08
Pu-239	ΣDSR(j)		7.285E-01	7.285E-01	7.284E-01	7.283E-01	7.282E-01	7.280E-01	7.264E-01	7.078E-01
0Pu-240	Pu-240	1.000E+00	7.284E-01	7.283E-01	7.282E-01	7.277E-01	7.273E-01	7.267E-01	7.207E-01	6.551E-01
Pu-240	U-236	1.000E+00	0.000E+00	4.900E-09	1.464E-08	4.872E-08	6.819E-08	1.071E-07	4.846E-07	4.615E-06
Pu-240	Th-232	1.000E+00	0.000E+00	1.112E-18	1.001E-17	1.112E-16	2.179E-16	5.379E-16	1.109E-14	1.073E-12
Pu-240	Ra-228	1.000E+00	0.000E+00	2.494E-19	6.335E-18	1.944E-16	4.838E-16	1.573E-15	5.388E-14	6.051E-12
Pu-240	Th-228	1.000E+00	0.000E+00	1.479E-20	9.996E-19	7.209E-17	2.118E-16	8.173E-16	3.579E-14	4.241E-12
Pu-240	ΣDSR(j)		7.284E-01	7.283E-01	7.282E-01	7.277E-01	7.273E-01	7.267E-01	7.207E-01	6.551E-01
0Sr-90	Sr-90	1.000E+00	5.051E+00	4.932E+00	4.703E+00	3.981E+00	3.619E+00	2.992E+00	4.671E-01	2.309E-10

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 15 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
Co-60	1.588E+00	1.811E+00	2.356E+00	5.916E+00	1.001E+01	2.867E+01	8.166E+05	*1.131E+15
Cs-137	6.546E+00	6.699E+00	7.015E+00	8.247E+00	9.045E+00	1.088E+01	6.598E+01	7.085E+10
Pu-239	2.059E+01	2.059E+01	2.059E+01	2.060E+01	2.060E+01	2.060E+01	2.065E+01	2.119E+01
Pu-240	2.059E+01	2.059E+01	2.060E+01	2.061E+01	2.062E+01	2.064E+01	2.081E+01	2.290E+01
Sr-90	2.970E+00	3.041E+00	3.190E+00	3.768E+00	4.144E+00	5.014E+00	3.211E+01	6.495E+10

*At specific activity limit

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 21
Summary : 1301 residential File: 1310RES.DAT

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

0Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Co-60	1.000E+00	0.000E+00	9.444E+00	1.588E+00	9.444E+00	1.588E+00
Cs-137	1.000E+00	0.000E+00	2.292E+00	6.546E+00	2.292E+00	6.546E+00
Pu-239	1.000E+00	0.000E+00	7.285E-01	2.059E+01	7.285E-01	2.059E+01
Pu-240	1.000E+00	0.000E+00	7.284E-01	2.059E+01	7.284E-01	2.059E+01
Sr-90	1.000E+00	0.000E+00	5.051E+00	2.970E+00	5.051E+00	2.970E+00

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 22
Summary : 1301 residential File: 1310RES.DAT

Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Table D-1. Rural-Residential Scenario (Page 17 of 17)

ONuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
Co-60	Co-60	1.000E+00	9.444E+00	8.280E+00	6.366E+00	2.535E+00	1.498E+00	5.233E-01	1.837E-05	0.000E+00
0Cs-137	Cs-137	1.000E+00	2.292E+00	2.239E+00	2.138E+00	1.819E+00	1.658E+00	1.378E+00	2.274E-01	2.117E-10
0Pu-239	Pu-239	1.000E+00	7.285E-01	7.285E-01	7.284E-01	7.283E-01	7.282E-01	7.280E-01	7.264E-01	7.078E-01
0U-235	Pu-239	1.000E+00	0.000E+00	5.868E-10	1.758E-09	5.859E-09	8.201E-09	1.289E-08	5.849E-08	5.766E-07
0Pa-231	Pu-239	1.000E+00	0.000E+00	1.333E-13	1.184E-12	1.309E-11	2.564E-11	6.328E-11	1.305E-09	1.283E-07
0Ac-227	Pu-239	1.000E+00	0.000E+00	1.217E-15	2.970E-14	1.014E-12	2.686E-12	9.784E-12	5.690E-10	9.356E-08
0Pu-240	Pu-240	1.000E+00	7.284E-01	7.283E-01	7.282E-01	7.277E-01	7.273E-01	7.267E-01	7.207E-01	6.551E-01
0U-236	Pu-240	1.000E+00	0.000E+00	4.900E-09	1.464E-08	4.872E-08	6.819E-08	1.071E-07	4.846E-07	4.615E-06
0Th-232	Pu-240	1.000E+00	0.000E+00	1.112E-18	1.001E-17	1.112E-16	2.179E-16	5.379E-16	1.109E-14	1.073E-12
0Ra-228	Pu-240	1.000E+00	0.000E+00	2.494E-19	6.335E-18	1.944E-16	4.838E-16	1.573E-15	5.388E-14	6.051E-12
0Th-228	Pu-240	1.000E+00	0.000E+00	1.479E-20	9.996E-19	7.209E-17	2.118E-16	8.173E-16	3.579E-14	4.241E-12
0Sr-90	Sr-90	1.000E+00	5.051E+00	4.932E+00	4.703E+00	3.981E+00	3.619E+00	2.992E+00	4.671E-01	2.309E-10

BRF(i) is the branch fraction of the parent nuclide.

1RESRAD, Version 5.61 T½ Limit = 0.5 year 04/24/96 10:50 Page 23
Summary : 1301 residential File: 1310RES.DAT

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

ONuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
Co-60	Co-60	1.000E+00	1.000E+00	8.768E-01	6.740E-01	2.685E-01	1.587E-01	5.541E-02	1.945E-06	0.000E+00
0Cs-137	Cs-137	1.000E+00	1.000E+00	9.772E-01	9.330E-01	7.937E-01	7.236E-01	6.015E-01	9.921E-02	9.238E-11
0Pu-239	Pu-239	1.000E+00	1.000E+00	1.000E+00	9.999E-01	9.997E-01	9.996E-01	9.994E-01	9.971E-01	9.715E-01
0U-235	Pu-239	1.000E+00	0.000E+00	9.848E-10	2.954E-09	9.847E-09	1.378E-08	2.166E-08	9.833E-08	9.692E-07
0Pa-231	Pu-239	1.000E+00	0.000E+00	1.042E-14	9.377E-14	1.042E-12	2.042E-12	5.041E-12	1.040E-10	1.023E-08
0Ac-227	Pu-239	1.000E+00	0.000E+00	1.097E-16	2.915E-15	1.023E-13	2.723E-13	9.966E-13	5.834E-11	9.606E-09
0Pu-240	Pu-240	1.000E+00	1.000E+00	9.999E-01	9.997E-01	9.989E-01	9.985E-01	9.977E-01	9.894E-01	8.993E-01
0U-236	Pu-240	1.000E+00	0.000E+00	2.960E-08	8.879E-08	2.959E-07	4.141E-07	6.505E-07	2.944E-06	2.804E-05
0Th-232	Pu-240	1.000E+00	0.000E+00	7.302E-19	6.571E-18	7.299E-17	1.430E-16	3.531E-16	7.276E-15	7.043E-13
0Ra-228	Pu-240	1.000E+00	0.000E+00	2.848E-20	7.254E-19	2.226E-17	5.540E-17	1.802E-16	6.170E-15	6.929E-13
0Th-228	Pu-240	1.000E+00	0.000E+00	2.417E-21	1.634E-19	1.166E-17	3.431E-17	1.326E-16	5.813E-15	6.891E-13
0Sr-90	Sr-90	1.000E+00	1.000E+00	9.765E-01	9.311E-01	7.881E-01	7.165E-01	5.923E-01	9.247E-02	4.572E-11

BRF(i) is the branch fraction of the parent nuclide.

Table D-2. Recreational Scenario (Page 1 of 17)

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 1
Summary : 1301 recreational File: 1301REC.DAT

Table of Contents

Part I: Mixture Sums and Single Radionuclide Guidelines

Dose Conversion Factor (and Related) Parameter Summary ... 2
Site-Specific Parameter Summary 5
Summary of Pathway Selections 10
Contaminated Zone and Total Dose Summary 11
Total Dose Components
Time = 0.000E+00 12
Time = 1.000E+00 13
Time = 3.000E+00 14
Time = 1.000E+01 15
Time = 1.400E+01 16
Time = 2.200E+01 17
Time = 1.000E+02 18
Time = 1.000E+03 19
Dose/Source Ratios Summed Over All Pathways 20
Single Radionuclide Soil Guidelines 20
Dose Per Nuclide Summed Over All Pathways 22
Soil Concentration Per Nuclide 23

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 2
Summary : 1301 recreational File: 1301REC.DAT

Dose Conversion Factor (and Related) Parameter Summary
File: DOSFAC.BIN

0 Menu	Parameter	Current Value	Default	Parameter Name
B-1	Dose conversion factors for inhalation, mrem/pCi:			
B-1	Ac-227+D	6.720E+00	6.720E+00	DCF2(1)
B-1	Co-60	2.190E-04	2.190E-04	DCF2(2)
B-1	Cs-137+D	3.190E-05	3.190E-05	DCF2(3)
B-1	Pa-231	1.280E+00	1.280E+00	DCF2(4)
B-1	Pu-239	4.290E-01	4.290E-01	DCF2(5)
B-1	Pu-240	4.290E-01	4.290E-01	DCF2(6)
B-1	Ra-228+D	5.080E-03	5.080E-03	DCF2(7)
B-1	Sr-90+D	1.310E-03	1.310E-03	DCF2(8)
B-1	Th-228+D	3.450E-01	3.450E-01	DCF2(9)
B-1	Th-232	1.640E+00	1.640E+00	DCF2(10)
B-1	U-235+D	1.230E-01	1.230E-01	DCF2(11)
B-1	U-236	1.250E-01	1.250E-01	DCF2(12)
D-1	Dose conversion factors for ingestion, mrem/pCi:			
D-1	Ac-227+D	1.480E-02	1.480E-02	DCF3(1)
D-1	Co-60	2.690E-05	2.690E-05	DCF3(2)
D-1	Cs-137+D	5.000E-05	5.000E-05	DCF3(3)

Table D-2. Recreational Scenario (Page 2 of 17)

D-1	Pa-231	1.060E-02	1.060E-02	DCF3(4)
D-1	Pu-239	3.540E-03	3.540E-03	DCF3(5)
D-1	Pu-240	3.540E-03	3.540E-03	DCF3(6)
D-1	Ra-228+D	1.440E-03	1.440E-03	DCF3(7)
D-1	Sr-90+D	1.530E-04	1.530E-04	DCF3(8)
D-1	Th-228+D	8.080E-04	8.080E-04	DCF3(9)
D-1	Th-232	2.730E-03	2.730E-03	DCF3(10)
D-1	U-235+D	2.670E-04	2.670E-04	DCF3(11)
D-1	U-236	2.690E-04	2.690E-04	DCF3(12)
D-34	Food transfer factors:			
D-34	Ac-227+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(1,1)
D-34	Ac-227+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,2)
D-34	Ac-227+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-05	2.000E-05	RTF(1,3)
D-34				
D-34	Co-60 , plant/soil concentration ratio, dimensionless	8.000E-02	8.000E-02	RTF(2,1)
D-34	Co-60 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	2.000E-02	2.000E-02	RTF(2,2)
D-34	Co-60 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(2,3)
D-34				
D-34	Cs-137+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(3,1)
D-34	Cs-137+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.000E-02	3.000E-02	RTF(3,2)
D-34	Cs-137+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	8.000E-03	8.000E-03	RTF(3,3)
D-34				
D-34	Pa-231 , plant/soil concentration ratio, dimensionless	1.000E-02	1.000E-02	RTF(4,1)
D-34	Pa-231 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	5.000E-03	5.000E-03	RTF(4,2)
D-34	Pa-231 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(4,3)
D-34				
D-34	Pu-239 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(5,1)
D-34	Pu-239 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(5,2)
D-34	Pu-239 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(5,3)
D-34				

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 3
Summary : 1301 recreational File: 1301REC.DAT

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

0 Menu	Parameter	Current Value	Default	Parameter Name
D-34	Pu-240 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(6,1)
D-34	Pu-240 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(6,2)
D-34	Pu-240 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-06	1.000E-06	RTF(6,3)
D-34				
D-34	Ra-228+D , plant/soil concentration ratio, dimensionless	4.000E-02	4.000E-02	RTF(7,1)
D-34	Ra-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-03	1.000E-03	RTF(7,2)
D-34	Ra-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	1.000E-03	1.000E-03	RTF(7,3)
D-34				
D-34	Sr-90+D , plant/soil concentration ratio, dimensionless	3.000E-01	3.000E-01	RTF(8,1)
D-34	Sr-90+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	8.000E-03	8.000E-03	RTF(8,2)
D-34	Sr-90+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	2.000E-03	2.000E-03	RTF(8,3)
D-34				

Table D-2. Recreational Scenario (Page 3 of 17)

D-34	Th-228+D , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(9,1)
D-34	Th-228+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(9,2)
D-34	Th-228+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(9,3)
D-34				
D-34	Th-232 , plant/soil concentration ratio, dimensionless	1.000E-03	1.000E-03	RTF(10,1)
D-34	Th-232 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	1.000E-04	1.000E-04	RTF(10,2)
D-34	Th-232 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	5.000E-06	5.000E-06	RTF(10,3)
D-34				
D-34	U-235+D , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(11,1)
D-34	U-235+D , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(11,2)
D-34	U-235+D , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(11,3)
D-34				
D-34	U-236 , plant/soil concentration ratio, dimensionless	2.500E-03	2.500E-03	RTF(12,1)
D-34	U-236 , beef/livestock-intake ratio, (pCi/kg)/(pCi/d)	3.400E-04	3.400E-04	RTF(12,2)
D-34	U-236 , milk/livestock-intake ratio, (pCi/L)/(pCi/d)	6.000E-04	6.000E-04	RTF(12,3)
D-5	Bioaccumulation factors, fresh water, L/kg:			
D-5	Ac-227+D , fish	1.500E+01	1.500E+01	BIOFAC(1,1)
D-5	Ac-227+D , crustacea and mollusks	1.000E+03	1.000E+03	BIOFAC(1,2)
D-5				
D-5	Co-60 , fish	3.000E+02	3.000E+02	BIOFAC(2,1)
D-5	Co-60 , crustacea and mollusks	2.000E+02	2.000E+02	BIOFAC(2,2)
D-5				
D-5	Cs-137+D , fish	2.000E+03	2.000E+03	BIOFAC(3,1)
D-5	Cs-137+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(3,2)
D-5				
D-5	Pa-231 , fish	1.000E+01	1.000E+01	BIOFAC(4,1)
D-5	Pa-231 , crustacea and mollusks	1.100E+02	1.100E+02	BIOFAC(4,2)
D-5				
D-5	Pu-239 , fish	3.000E+01	3.000E+01	BIOFAC(5,1)
D-5	Pu-239 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(5,2)
D-5				
D-5	Pu-240 , fish	3.000E+01	3.000E+01	BIOFAC(6,1)
D-5	Pu-240 , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(6,2)
D-5				
D-5	Ra-228+D , fish	5.000E+01	5.000E+01	BIOFAC(7,1)
D-5	Ra-228+D , crustacea and mollusks	2.500E+02	2.500E+02	BIOFAC(7,2)
D-5				

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 4
Summary : 1301 recreational File: 1301REC.DAT

Dose Conversion Factor (and Related) Parameter Summary (continued)
File: DOSFAC.BIN

0 Menu	Parameter	Current Value	Default	Parameter Name
D-5	Sr-90+D , fish	6.000E+01	6.000E+01	BIOFAC(8,1)
D-5	Sr-90+D , crustacea and mollusks	1.000E+02	1.000E+02	BIOFAC(8,2)
D-5				
D-5	Th-228+D , fish	1.000E+02	1.000E+02	BIOFAC(9,1)
D-5	Th-228+D , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(9,2)

Table D-2. Recreational Scenario (Page 4 of 17)

D-5				
D-5	Th-232 , fish	1.000E+02	1.000E+02	BIOFAC(10,1)
D-5	Th-232 , crustacea and mollusks	5.000E+02	5.000E+02	BIOFAC(10,2)
D-5				
D-5	U-235+D , fish	1.000E+01	1.000E+01	BIOFAC(11,1)
D-5	U-235+D , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(11,2)
D-5				
D-5	U-236 , fish	1.000E+01	1.000E+01	BIOFAC(12,1)
D-5	U-236 , crustacea and mollusks	6.000E+01	6.000E+01	BIOFAC(12,2)

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 5
Summary : 1301 recreational File: 1301REC.DAT

Site-Specific Parameter Summary

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R011	Area of contaminated zone (m**2)	1.000E+04	1.000E+04	---	AREA
R011	Thickness of contaminated zone (m)	5.000E+00	2.000E+00	---	THICK0
R011	Length parallel to aquifer flow (m)	not used	1.000E+02	---	LCZPAQ
R011	Basic radiation dose limit (mrem/yr)	1.500E+01	3.000E+01	---	BRDL
R011	Time since placement of material (yr)	0.000E+00	0.000E+00	---	TI
R011	Times for calculations (yr)	1.000E+00	1.000E+00	---	T(2)
R011	Times for calculations (yr)	3.000E+00	3.000E+00	---	T(3)
R011	Times for calculations (yr)	1.000E+01	1.000E+01	---	T(4)
R011	Times for calculations (yr)	1.400E+01	3.000E+01	---	T(5)
R011	Times for calculations (yr)	2.200E+01	1.000E+02	---	T(6)
R011	Times for calculations (yr)	1.000E+02	3.000E+02	---	T(7)
R011	Times for calculations (yr)	1.000E+03	1.000E+03	---	T(8)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(9)
R011	Times for calculations (yr)	not used	0.000E+00	---	T(10)
R012	Initial principal radionuclide (pCi/g): Co-60	1.000E+00	0.000E+00	---	S1(2)
R012	Initial principal radionuclide (pCi/g): Cs-137	1.000E+00	0.000E+00	---	S1(3)
R012	Initial principal radionuclide (pCi/g): Pu-239	1.000E+00	0.000E+00	---	S1(5)
R012	Initial principal radionuclide (pCi/g): Pu-240	1.000E+00	0.000E+00	---	S1(6)
R012	Initial principal radionuclide (pCi/g): Sr-90	1.000E+00	0.000E+00	---	S1(8)
R012	Concentration in groundwater (pCi/L): Co-60	not used	0.000E+00	---	W1(2)
R012	Concentration in groundwater (pCi/L): Cs-137	not used	0.000E+00	---	W1(3)
R012	Concentration in groundwater (pCi/L): Pu-239	not used	0.000E+00	---	W1(5)
R012	Concentration in groundwater (pCi/L): Pu-240	not used	0.000E+00	---	W1(6)
R012	Concentration in groundwater (pCi/L): Sr-90	not used	0.000E+00	---	W1(8)
R013	Cover depth (m)	0.000E+00	0.000E+00	---	COVER0
R013	Density of cover material (g/cm**3)	not used	1.500E+00	---	DENSCV
R013	Cover depth erosion rate (m/yr)	not used	1.000E-03	---	VCV
R013	Density of contaminated zone (g/cm**3)	1.600E+00	1.500E+00	---	DENSCZ
R013	Contaminated zone erosion rate (m/yr)	1.000E-03	1.000E-03	---	VCZ
R013	Contaminated zone total porosity	4.000E-01	4.000E-01	---	TPCZ
R013	Contaminated zone effective porosity	2.000E-01	2.000E-01	---	EPCZ
R013	Contaminated zone hydraulic conductivity (m/yr)	1.000E+01	1.000E+01	---	HCCZ

Table D-2. Recreational Scenario (Page 5 of 17)

R013	Contaminated zone b parameter	5.300E+00	5.300E+00	---	BCZ
R013	Humidity in air (g/cm**3)	not used	8.000E+00	---	HUMID
R013	Evapotranspiration coefficient	9.900E-01	5.000E-01	---	EVAPTR
R013	Precipitation (m/yr)	1.600E-01	1.000E+00	---	PRECIP
R013	Irrigation (m/yr)	0.000E+00	2.000E-01	---	RI
R013	Irrigation mode	overhead	overhead	---	IDITCH
R013	Runoff coefficient	2.000E-01	2.000E-01	---	RUNOFF
R013	Watershed area for nearby stream or pond (m**2)	not used	1.000E+06	---	WAREA
R013	Accuracy for water/soil computations	not used	1.000E-03	Zero shows Simpson's rule.	EPS
R014	Density of saturated zone (g/cm**3)	1.500E+00	1.500E+00	---	DENSAQ
R014	Saturated zone total porosity	4.000E-01	4.000E-01	---	TPSZ
R014	Saturated zone effective porosity	2.000E-01	2.000E-01	---	EPSZ
R014	Saturated zone hydraulic conductivity (m/yr)	1.000E+02	1.000E+02	---	HCSZ
R014	Saturated zone hydraulic gradient	2.000E-02	2.000E-02	---	HGWT
R014	Saturated zone b parameter	5.300E+00	5.300E+00	---	BSZ
R014	Water table drop rate (m/yr)	1.000E-03	1.000E-03	---	VWT

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 6
Summary : 1301 recreational File: 1301REC.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R014	Well pump intake depth (m below water table)	1.000E+01	1.000E+01	---	DWIBWT
R014	Model: Nondispersion (ND) or Mass-Balance (MB)	ND	ND	---	MODEL
R014	Well pumping rate (m**3/yr)	2.500E+02	2.500E+02	---	UW
R015	Number of unsaturated zone strata	not used	1	---	NS
R015	Unsat. zone 1, thickness (m)	not used	4.000E+00	---	H(1)
R015	Unsat. zone 1, soil density (g/cm**3)	not used	1.500E+00	---	DENSUZ(1)
R015	Unsat. zone 1, total porosity	not used	4.000E-01	---	TPUZ(1)
R015	Unsat. zone 1, effective porosity	not used	2.000E-01	---	EPUZ(1)
R015	Unsat. zone 1, soil-specific b parameter	not used	5.300E+00	---	BUZ(1)
R015	Unsat. zone 1, hydraulic conductivity (m/yr)	not used	1.000E+01	---	HCUZ(1)
R016	Distribution coefficients for Co-60				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(2)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(2,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(2)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.600E-07	ALEACH(2)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(2)
R016	Distribution coefficients for Cs-137				
R016	Contaminated zone (cm**3/g)	1.000E+03	1.000E+03	---	DCNUCC(3)
R016	Unsaturated zone 1 (cm**3/g)	not used	1.000E+03	---	DCNUCU(3,1)
R016	Saturated zone (cm**3/g)	not used	1.000E+03	---	DCNUCS(3)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	1.600E-07	ALEACH(3)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(3)
R016	Distribution coefficients for Pu-239				

Table D-2. Recreational Scenario (Page 6 of 17)

R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(5)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(5,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(5)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.999E-08	ALEACH(5)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(5)
R016	Distribution coefficients for Pu-240				
R016	Contaminated zone (cm**3/g)	2.000E+03	2.000E+03	---	DCNUCC(6)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+03	---	DCNUCU(6,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+03	---	DCNUCS(6)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.999E-08	ALEACH(6)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(6)
R016	Distribution coefficients for Sr-90				
R016	Contaminated zone (cm**3/g)	3.000E+01	3.000E+01	---	DCNUCC(8)
R016	Unsaturated zone 1 (cm**3/g)	not used	3.000E+01	---	DCNUCU(8,1)
R016	Saturated zone (cm**3/g)	not used	3.000E+01	---	DCNUCS(8)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	5.310E-06	ALEACH(8)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(8)

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 7
Summary : 1301 recreational File: 1301REC.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R016	Distribution coefficients for daughter Ac-227				
R016	Contaminated zone (cm**3/g)	2.000E+01	2.000E+01	---	DCNUCC(1)
R016	Unsaturated zone 1 (cm**3/g)	not used	2.000E+01	---	DCNUCU(1,1)
R016	Saturated zone (cm**3/g)	not used	2.000E+01	---	DCNUCS(1)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	7.949E-06	ALEACH(1)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(1)
R016	Distribution coefficients for daughter Pa-231				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(4)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(4,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(4)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.192E-06	ALEACH(4)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(4)
R016	Distribution coefficients for daughter Ra-228				
R016	Contaminated zone (cm**3/g)	7.000E+01	7.000E+01	---	DCNUCC(7)
R016	Unsaturated zone 1 (cm**3/g)	not used	7.000E+01	---	DCNUCU(7,1)
R016	Saturated zone (cm**3/g)	not used	7.000E+01	---	DCNUCS(7)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.281E-06	ALEACH(7)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(7)
R016	Distribution coefficients for daughter Th-228				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(9)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(9,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(9)

Table D-2. Recreational Scenario (Page 7 of 17)

R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.667E-09	ALEACH(9)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(9)
R016	Distribution coefficients for daughter Th-232				
R016	Contaminated zone (cm**3/g)	6.000E+04	6.000E+04	---	DCNUCC(10)
R016	Unsaturated zone 1 (cm**3/g)	not used	6.000E+04	---	DCNUCU(10,1)
R016	Saturated zone (cm**3/g)	not used	6.000E+04	---	DCNUCS(10)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	2.667E-09	ALEACH(10)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(10)
R016	Distribution coefficients for daughter U-235				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(11)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(11,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(11)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.192E-06	ALEACH(11)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(11)
R016	Distribution coefficients for daughter U-236				
R016	Contaminated zone (cm**3/g)	5.000E+01	5.000E+01	---	DCNUCC(12)
R016	Unsaturated zone 1 (cm**3/g)	not used	5.000E+01	---	DCNUCU(12,1)
R016	Saturated zone (cm**3/g)	not used	5.000E+01	---	DCNUCS(12)
R016	Leach rate (/yr)	0.000E+00	0.000E+00	3.192E-06	ALEACH(12)
R016	Solubility constant	0.000E+00	0.000E+00	not used	SOLUBK(12)
R017	Inhalation rate (m**3/yr)	8.400E+03	8.400E+03	---	INHALR
R017	Mass loading for inhalation (g/m**3)	2.000E-04	2.000E-04	---	MLINH

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 8
Summary : 1301 recreational File: 1301REC.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R017	Dilution length for airborne dust, inhalation (m)	3.000E+00	3.000E+00	---	LM
R017	Exposure duration	3.000E+01	3.000E+01	---	ED
R017	Shielding factor, inhalation	4.000E-01	4.000E-01	---	SHF3
R017	Shielding factor, external gamma	7.000E-01	7.000E-01	---	SHF1
R017	Fraction of time spent indoors	0.000E+00	5.000E-01	---	FIND
R017	Fraction of time spent outdoors (on site)	1.920E-02	2.500E-01	---	FOTD
R017	Shape factor flag, external gamma	1.000E+00	1.000E+00	1 shows circular AREA.	FS
R017	Radii of shape factor array (used if FS = -1):				
R017	Outer annular radius (m), ring 1:	not used	5.000E+01	---	RAD_SHAPE(1)
R017	Outer annular radius (m), ring 2:	not used	7.071E+01	---	RAD_SHAPE(2)
R017	Outer annular radius (m), ring 3:	not used	0.000E+00	---	RAD_SHAPE(3)
R017	Outer annular radius (m), ring 4:	not used	0.000E+00	---	RAD_SHAPE(4)
R017	Outer annular radius (m), ring 5:	not used	0.000E+00	---	RAD_SHAPE(5)
R017	Outer annular radius (m), ring 6:	not used	0.000E+00	---	RAD_SHAPE(6)
R017	Outer annular radius (m), ring 7:	not used	0.000E+00	---	RAD_SHAPE(7)
R017	Outer annular radius (m), ring 8:	not used	0.000E+00	---	RAD_SHAPE(8)
R017	Outer annular radius (m), ring 9:	not used	0.000E+00	---	RAD_SHAPE(9)
R017	Outer annular radius (m), ring 10:	not used	0.000E+00	---	RAD_SHAPE(10)

Table D-2. Recreational Scenario (Page 8 of 17)

R017	Outer annular radius (m), ring 11:	not used	0.000E+00	---	RAD_SHAPE(11)
R017	Outer annular radius (m), ring 12:	not used	0.000E+00	---	RAD_SHAPE(12)
R017	Fractions of annular areas within AREA:				
R017	Ring 1	not used	1.000E+00	---	FRACA(1)
R017	Ring 2	not used	2.732E-01	---	FRACA(2)
R017	Ring 3	not used	0.000E+00	---	FRACA(3)
R017	Ring 4	not used	0.000E+00	---	FRACA(4)
R017	Ring 5	not used	0.000E+00	---	FRACA(5)
R017	Ring 6	not used	0.000E+00	---	FRACA(6)
R017	Ring 7	not used	0.000E+00	---	FRACA(7)
R017	Ring 8	not used	0.000E+00	---	FRACA(8)
R017	Ring 9	not used	0.000E+00	---	FRACA(9)
R017	Ring 10	not used	0.000E+00	---	FRACA(10)
R017	Ring 11	not used	0.000E+00	---	FRACA(11)
R017	Ring 12	not used	0.000E+00	---	FRACA(12)
R018	Fruits, vegetables and grain consumption (kg/yr)	not used	1.600E+02	---	DIET(1)
R018	Leafy vegetable consumption (kg/yr)	not used	1.400E+01	---	DIET(2)
R018	Milk consumption (L/yr)	not used	9.200E+01	---	DIET(3)
R018	Meat and poultry consumption (kg/yr)	not used	6.300E+01	---	DIET(4)
R018	Fish consumption (kg/yr)	not used	5.400E+00	---	DIET(5)
R018	Other seafood consumption (kg/yr)	not used	9.000E-01	---	DIET(6)
R018	Soil ingestion rate (g/yr)	2.520E+01	3.650E+01	---	SOIL
R018	Drinking water intake (L/yr)	not used	5.100E+02	---	DWI
R018	Contamination fraction of drinking water	not used	1.000E+00	---	FDW
R018	Contamination fraction of household water	not used	1.000E+00	---	FHHW
R018	Contamination fraction of livestock water	not used	1.000E+00	---	FLW
R018	Contamination fraction of irrigation water	not used	1.000E+00	---	FIRW
R018	Contamination fraction of aquatic food	not used	5.000E-01	---	FR9
R018	Contamination fraction of plant food	not used	-1	---	FPLANT
R018	Contamination fraction of meat	not used	-1	---	FMEAT
R018	Contamination fraction of milk	not used	-1	---	FMILK

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 9
Summary : 1301 recreational File: 1301REC.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R019	Livestock fodder intake for meat (kg/day)	not used	6.800E+01	---	LFI5
R019	Livestock fodder intake for milk (kg/day)	not used	5.500E+01	---	LFI6
R019	Livestock water intake for meat (L/day)	not used	5.000E+01	---	LWI5
R019	Livestock water intake for milk (L/day)	not used	1.600E+02	---	LWI6
R019	Livestock soil intake (kg/day)	not used	5.000E-01	---	LSI
R019	Mass loading for foliar deposition (g/m**3)	not used	1.000E-04	---	MLFD
R019	Depth of soil mixing layer (m)	1.500E-01	1.500E-01	---	DM
R019	Depth of roots (m)	not used	9.000E-01	---	DROOT
R019	Drinking water fraction from ground water	1.000E+00	1.000E+00	---	FGWDW
R019	Household water fraction from ground water	not used	1.000E+00	---	FGWHH
R019	Livestock water fraction from ground water	not used	1.000E+00	---	FGWLW

Table D-2. Recreational Scenario (Page 9 of 17)

R019	Irrigation fraction from ground water	not used	1.000E+00	---	FGWIR
C14	C-12 concentration in water (g/cm**3)	not used	2.000E-05	---	C12WTR
C14	C-12 concentration in contaminated soil (g/g)	not used	3.000E-02	---	C12CZ
C14	Fraction of vegetation carbon from soil	not used	2.000E-02	---	CSOIL
C14	Fraction of vegetation carbon from air	not used	9.800E-01	---	CAIR
C14	C-14 evasion layer thickness in soil (m)	not used	3.000E-01	---	DMC
C14	C-14 evasion flux rate from soil (1/sec)	not used	7.000E-07	---	EVSN
C14	C-12 evasion flux rate from soil (1/sec)	not used	1.000E-10	---	REVSN
C14	Fraction of grain in beef cattle feed	not used	8.000E-01	---	AVFG4
C14	Fraction of grain in milk cow feed	not used	2.000E-01	---	AVFG5
STOR	Storage times of contaminated foodstuffs (days):				
STOR	Fruits, non-leafy vegetables, and grain	not used	1.400E+01	---	STOR_T(1)
STOR	Leafy vegetables	not used	1.000E+00	---	STOR_T(2)
STOR	Milk	not used	1.000E+00	---	STOR_T(3)
STOR	Meat and poultry	not used	2.000E+01	---	STOR_T(4)
STOR	Fish	not used	7.000E+00	---	STOR_T(5)
STOR	Crustacea and mollusks	not used	7.000E+00	---	STOR_T(6)
STOR	Well water	not used	1.000E+00	---	STOR_T(7)
STOR	Surface water	not used	1.000E+00	---	STOR_T(8)
STOR	Livestock fodder	not used	4.500E+01	---	STOR_T(9)
R021	Thickness of building foundation (m)	not used	1.500E-01	---	FLOOR
R021	Bulk density of building foundation (g/cm**3)	not used	2.400E+00	---	DENSFL
R021	Total porosity of the cover material	not used	4.000E-01	---	TPCV
R021	Total porosity of the building foundation	not used	1.000E-01	---	TPFL
R021	Volumetric water content of the cover material	not used	5.000E-02	---	PH2OCV
R021	Volumetric water content of the foundation	not used	3.000E-02	---	PH2OFL
R021	Diffusion coefficient for radon gas (m/sec):				
R021	in cover material	not used	2.000E-06	---	DIFCV
R021	in foundation material	not used	3.000E-07	---	DIFFL
R021	in contaminated zone soil	not used	2.000E-06	---	DIFCZ
R021	Radon vertical dimension of mixing (m)	not used	2.000E+00	---	HMIX
R021	Average annual wind speed (m/sec)	not used	2.000E+00	---	WIND
R021	Average building air exchange rate (1/hr)	not used	5.000E-01	---	REXG
R021	Height of the building (room) (m)	not used	2.500E+00	---	HRM
R021	Building interior area factor	not used	0.000E+00	---	FAI
R021	Building depth below ground surface (m)	not used	-1.000E+00	---	DMFL
R021	Emanating power of Rn-222 gas	not used	2.500E-01	---	EMANA(1)

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 10
Summary : 1301 recreational File: 1301REC.DAT

Site-Specific Parameter Summary (continued)

0 Menu	Parameter	User Input	Default	Used by RESRAD (If different from user input)	Parameter Name
R021	Emanating power of Rn-220 gas	not used	1.500E-01	---	EMANA(2)

Table D-2. Recreational Scenario (Page 10 of 17)

Summary of Pathway Selections

Pathway	User Selection
1 -- external gamma	active
2 -- inhalation (w/o radon)	active
3 -- plant ingestion	suppressed
4 -- meat ingestion	suppressed
5 -- milk ingestion	suppressed
6 -- aquatic foods	suppressed
7 -- drinking water	suppressed
8 -- soil ingestion	active
9 -- radon	suppressed

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 11
Summary : 1301 recreational File: 1301REC.DAT

Contaminated Zone Dimensions		Initial Soil Concentrations, pCi/g	
Area:	10000.00 square meters	Co-60	1.000E+00
Thickness:	5.00 meters	Cs-137	1.000E+00
Cover Depth:	0.00 meters	Pu-239	1.000E+00
		Pu-240	1.000E+00
		Sr-90	1.000E+00

0

Total Dose TDOSE(t), mrem/yr
Basic Radiation Dose Limit = 15 mrem/yr
Total Mixture Sum M(t) = Fraction of Basic Dose Limit Received at Time (t)

t (years):	0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
TDOSE(t):	3.849E-01	3.474E-01	2.853E-01	1.580E-01	1.215E-01	8.370E-02	3.624E-02	2.835E-02
M(t):	2.566E-02	2.316E-02	1.902E-02	1.053E-02	8.100E-03	5.580E-03	2.416E-03	1.890E-03

0Maximum TDOSE(t): 3.849E-01 mrem/yr at t = 0.000E+00 years
1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 12
Summary : 1301 recreational File: 1301REC.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
Nuclide	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	2.927E-01	0.7604	6.858E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.302E-05	0.0000
Cs-137	6.128E-02	0.1592	9.990E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.419E-05	0.0001
Pu-239	5.439E-06	0.0000	1.343E-02	0.0349	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.713E-03	0.0044
Pu-240	2.791E-06	0.0000	1.343E-02	0.0349	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.713E-03	0.0044
Sr-90	4.723E-04	0.0012	4.102E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.403E-05	0.0002
Total	3.545E-01	0.9209	2.692E-02	0.0699	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.537E-03	0.0092

0

Table D-2. Recreational Scenario (Page 11 of 17)

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 0.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.927E-01	0.7605
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.131E-02	0.1593
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.515E-02	0.0394
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.515E-02	0.0394
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.874E-04	0.0015
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.849E-01	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 13
Summary : 1301 recreational File: 1301REC.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Independent Pathways (Inhalation excludes radon)

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Co-60	2.566E-01	0.7386	6.013E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.141E-05	0.0000
Cs-137	5.988E-02	0.1724	9.762E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.364E-05	0.0001
Pu-239	5.439E-06	0.0000	1.343E-02	0.0387	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.713E-03	0.0049
Pu-240	2.791E-06	0.0000	1.343E-02	0.0387	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.713E-03	0.0049
Sr-90	4.612E-04	0.0013	4.006E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.229E-05	0.0002
Total	3.170E-01	0.9124	2.691E-02	0.0775	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.533E-03	0.0102

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+00 years
Water Dependent Pathways

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.566E-01	0.7387
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.991E-02	0.1724
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.515E-02	0.0436
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.515E-02	0.0436
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.736E-04	0.0017
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.474E-01	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 14
Summary : 1301 recreational File: 1301REC.DAT

Table D-2. Recreational Scenario (Page 12 of 17)

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	1.973E-01	0.6914	4.623E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.772E-06	0.0000
Cs-137	5.718E-02	0.2004	9.321E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.257E-05	0.0001
Pu-239	5.438E-06	0.0000	1.343E-02	0.0471	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.713E-03	0.0060
Pu-240	2.790E-06	0.0000	1.343E-02	0.0471	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.712E-03	0.0060
Sr-90	4.398E-04	0.0015	3.820E-05	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.892E-05	0.0002
Total	2.549E-01	0.8933	2.691E-02	0.0943	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.525E-03	0.0124

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 3.000E+00 years
0 Water Dependent Pathways
0

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.973E-01	0.6914
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.720E-02	0.2005
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.515E-02	0.0531
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.515E-02	0.0531
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.469E-04	0.0019
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.853E-01	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 15
Summary : 1301 recreational File: 1301REC.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	7.858E-02	0.4974	1.841E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.494E-06	0.0000
Cs-137	4.864E-02	0.3079	7.929E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.920E-05	0.0001
Pu-239	5.437E-06	0.0000	1.343E-02	0.0850	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.712E-03	0.0108
Pu-240	2.788E-06	0.0000	1.342E-02	0.0849	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.711E-03	0.0108
Sr-90	3.723E-04	0.0024	3.233E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.834E-05	0.0004
Total	1.276E-01	0.8076	2.689E-02	0.1702	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.504E-03	0.0222

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+01 years
0 Water Dependent Pathways

Table D-2. Recreational Scenario (Page 13 of 17)

0

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.858E-02	0.4974
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.866E-02	0.3080
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.515E-02	0.0959
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.513E-02	0.0958
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.629E-04	0.0029
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.580E-01	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 16
Summary : 1301 recreational File: 1301REC.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
0 Water Independent Pathways (Inhalation excludes radon)
0

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Co-60	4.644E-02	0.3822	1.088E-06	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.065E-06	0.0000
Cs-137	4.435E-02	0.3650	7.229E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.751E-05	0.0001
Pu-239	5.437E-06	0.0000	1.343E-02	0.1105	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.712E-03	0.0141
Pu-240	2.787E-06	0.0000	1.341E-02	0.1104	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.710E-03	0.0141
Sr-90	3.384E-04	0.0028	2.940E-05	0.0002	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.304E-05	0.0004
Total	9.113E-02	0.7500	2.688E-02	0.2212	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.495E-03	0.0288

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.400E+01 years
0 Water Dependent Pathways
0

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.644E-02	0.3822
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.436E-02	0.3651
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.515E-02	0.1247
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.513E-02	0.1245
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.209E-04	0.0035
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.215E-01	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 17
Summary : 1301 recreational File: 1301REC.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.200E+01 years
0 Water Independent Pathways (Inhalation excludes radon)

Table D-2. Recreational Scenario (Page 14 of 17)

0

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Co-60	1.622E-02	0.1937	3.800E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	7.211E-07	0.0000
Cs-137	3.686E-02	0.4404	6.009E-07	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.455E-05	0.0002
Pu-239	5.436E-06	0.0001	1.343E-02	0.1604	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.712E-03	0.0205
Pu-240	2.785E-06	0.0000	1.340E-02	0.1601	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.709E-03	0.0204
Sr-90	2.797E-04	0.0033	2.430E-05	0.0003	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	4.384E-05	0.0005
Total	5.337E-02	0.6376	2.685E-02	0.3208	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.480E-03	0.0416

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 2.200E+01 years
Water Dependent Pathways

0

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.622E-02	0.1938
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.688E-02	0.4406
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.514E-02	0.1809
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.512E-02	0.1806
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.479E-04	0.0042
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	8.370E-02	1.0000

0*Sum of all water independent and dependent pathways.
1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 18
Summary : 1301 recreational File: 1301REC.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Independent Pathways (Inhalation excludes radon)

0

Radio-Nuclide	Ground mrem/yr	Ground fract.	Inhalation mrem/yr	Inhalation fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	Soil mrem/yr	Soil fract.
Co-60	5.693E-07	0.0000	1.334E-11	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.532E-11	0.0000
Cs-137	6.080E-03	0.1678	9.911E-08	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.400E-06	0.0001
Pu-239	5.425E-06	0.0001	1.340E-02	0.3697	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.708E-03	0.0471
Pu-240	2.762E-06	0.0001	1.329E-02	0.3668	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.695E-03	0.0468
Sr-90	4.368E-05	0.0012	3.794E-06	0.0001	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.846E-06	0.0002
Total	6.132E-03	0.1692	2.669E-02	0.7366	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.412E-03	0.0942

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+02 years
Water Dependent Pathways

0

Radio-Nuclide	Water mrem/yr	Water fract.	Fish mrem/yr	Fish fract.	Radon mrem/yr	Radon fract.	Plant mrem/yr	Plant fract.	Meat mrem/yr	Meat fract.	Milk mrem/yr	Milk fract.	All Pathways* mrem/yr	All Pathways* fract.

Table D-2. Recreational Scenario (Page 15 of 17)

Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.693E-07	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	6.082E-03	0.1678
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.511E-02	0.4170
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.499E-02	0.4137
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.432E-05	0.0015
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.624E-02	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 19

Summary : 1301 recreational File: 1301REC.DAT

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Independent Pathways (Inhalation excludes radon)

0

0

Radio-Nuclide	Ground		Inhalation		Radon		Plant		Meat		Milk		Soil	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	5.662E-12	0.0000	9.229E-17	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.235E-15	0.0000
Pu-239	5.298E-06	0.0002	1.305E-02	0.4605	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.664E-03	0.0587
Pu-240	2.510E-06	0.0001	1.208E-02	0.4262	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.540E-03	0.0543
Sr-90	2.160E-14	0.0000	1.876E-15	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.385E-15	0.0000
Total	7.808E-06	0.0003	2.513E-02	0.8867	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	3.204E-03	0.1130

0

Total Dose Contributions TDOSE(i,p,t) for Individual Radionuclides (i) and Pathways (p)
As mrem/yr and Fraction of Total Dose At t = 1.000E+03 years
Water Dependent Pathways

0

0

Radio-Nuclide	Water		Fish		Radon		Plant		Meat		Milk		All Pathways*	
	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.	mrem/yr	fract.
Co-60	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000
Cs-137	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	5.664E-12	0.0000
Pu-239	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.472E-02	0.5193
Pu-240	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	1.363E-02	0.4807
Sr-90	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.686E-14	0.0000
Total	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	0.000E+00	0.0000	2.835E-02	1.0000

0*Sum of all water independent and dependent pathways.

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 20

Summary : 1301 recreational File: 1301REC.DAT

Dose/Source Ratios Summed Over All Pathways
Parent and Progeny Principal Radionuclide Contributions Indicated

0Parent (i)	Product (j)	Branch Fraction	DSR(j,t) (mrem/yr)/(pCi/g) t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
Co-60	Co-60	1.000E+00	2.927E-01	2.566E-01	1.973E-01	7.858E-02	4.644E-02	1.622E-02	5.693E-07	0.000E+00

Table D-2. Recreational Scenario (Page 16 of 17)

0Cs-137	Cs-137	1.000E+00	6.131E-02	5.991E-02	5.720E-02	4.866E-02	4.436E-02	3.688E-02	6.082E-03	5.664E-12
0Pu-239	Pu-239	1.000E+00	1.515E-02	1.515E-02	1.515E-02	1.515E-02	1.515E-02	1.514E-02	1.511E-02	1.472E-02
Pu-239	U-235	1.000E+00	0.000E+00	1.755E-11	5.264E-11	1.755E-10	2.456E-10	3.859E-10	1.752E-09	1.727E-08
Pu-239	Pa-231	1.000E+00	0.000E+00	5.074E-16	4.566E-15	5.073E-14	9.942E-14	2.455E-13	5.064E-12	4.979E-10
Pu-239	Ac-227	1.000E+00	0.000E+00	2.787E-17	7.409E-16	2.599E-14	6.921E-14	2.533E-13	1.483E-11	2.441E-09
Pu-239	ΣDSR(j)		1.515E-02	1.515E-02	1.515E-02	1.515E-02	1.515E-02	1.514E-02	1.511E-02	1.472E-02
0Pu-240	Pu-240	1.000E+00	1.515E-02	1.515E-02	1.515E-02	1.513E-02	1.513E-02	1.512E-02	1.499E-02	1.363E-02
Pu-240	U-236	1.000E+00	0.000E+00	1.198E-10	3.595E-10	1.198E-09	1.677E-09	2.634E-09	1.192E-08	1.135E-07
Pu-240	Th-232	1.000E+00	0.000E+00	3.847E-20	3.462E-19	3.846E-18	7.537E-18	1.861E-17	3.833E-16	3.711E-14
Pu-240	Ra-228	1.000E+00	0.000E+00	3.103E-21	7.905E-20	2.426E-18	6.037E-18	1.963E-17	6.723E-16	7.550E-14
Pu-240	Th-228	1.000E+00	0.000E+00	4.733E-22	3.200E-20	2.282E-18	6.718E-18	2.596E-17	1.138E-15	1.349E-13
Pu-240	ΣDSR(j)		1.515E-02	1.515E-02	1.515E-02	1.513E-02	1.513E-02	1.512E-02	1.499E-02	1.363E-02
0Sr-90	Sr-90	1.000E+00	5.874E-04	5.736E-04	5.469E-04	4.629E-04	4.209E-04	3.479E-04	5.432E-05	2.686E-14

Branch Fraction is the cumulative factor for the j'th principal radionuclide daughter: CUMBRF(j) = BRF(1)*BRF(2)* ... BRF(j).
The DSR includes contributions from associated (half-life ≤ 0.5 yr) daughters.

0

Single Radionuclide Soil Guidelines G(i,t) in pCi/g
Basic Radiation Dose Limit = 15 mrem/yr

0Nuclide (i)	t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
Co-60	5.125E+01	5.845E+01	7.603E+01	1.909E+02	3.230E+02	9.249E+02	2.635E+07	*1.131E+15
Cs-137	2.447E+02	2.504E+02	2.622E+02	3.083E+02	3.381E+02	4.068E+02	2.466E+03	2.648E+12
Pu-239	9.899E+02	9.899E+02	9.900E+02	9.902E+02	9.903E+02	9.905E+02	9.928E+02	1.019E+03
Pu-240	9.901E+02	9.902E+02	9.904E+02	9.911E+02	9.915E+02	9.924E+02	1.001E+03	1.101E+03
Sr-90	2.554E+04	2.615E+04	2.743E+04	3.240E+04	3.564E+04	4.312E+04	2.762E+05	*1.365E+14

*At specific activity limit

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 21
Summary : 1301 recreational File: 1301REC.DAT

Summed Dose/Source Ratios DSR(i,t) in (mrem/yr)/(pCi/g)
and Single Radionuclide Soil Guidelines G(i,t) in pCi/g
at tmin = time of minimum single radionuclide soil guideline
and at tmax = time of maximum total dose = 0.000E+00 years

0Nuclide (i)	Initial pCi/g	tmin (years)	DSR(i,tmin)	G(i,tmin) (pCi/g)	DSR(i,tmax)	G(i,tmax) (pCi/g)
Co-60	1.000E+00	0.000E+00	2.927E-01	5.125E+01	2.927E-01	5.125E+01
Cs-137	1.000E+00	0.000E+00	6.131E-02	2.447E+02	6.131E-02	2.447E+02
Pu-239	1.000E+00	0.000E+00	1.515E-02	9.899E+02	1.515E-02	9.899E+02
Pu-240	1.000E+00	0.000E+00	1.515E-02	9.901E+02	1.515E-02	9.901E+02
Sr-90	1.000E+00	0.000E+00	5.874E-04	2.554E+04	5.874E-04	2.554E+04

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 22
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Individual Nuclide Dose Summed Over All Pathways
Parent Nuclide and Branch Fraction Indicated

Table D-2. Recreational Scenario (Page 17 of 17)

ONuclide (j)	Parent (i)	BRF(i)	DOSE(j,t), mrem/yr t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
Co-60	Co-60	1.000E+00	2.927E-01	2.566E-01	1.973E-01	7.858E-02	4.644E-02	1.622E-02	5.693E-07	0.000E+00
0Cs-137	Cs-137	1.000E+00	6.131E-02	5.991E-02	5.720E-02	4.866E-02	4.436E-02	3.688E-02	6.082E-03	5.664E-12
0Pu-239	Pu-239	1.000E+00	1.515E-02	1.515E-02	1.515E-02	1.515E-02	1.515E-02	1.514E-02	1.511E-02	1.472E-02
0U-235	Pu-239	1.000E+00	0.000E+00	1.755E-11	5.264E-11	1.755E-10	2.456E-10	3.859E-10	1.752E-09	1.727E-08
0Pa-231	Pu-239	1.000E+00	0.000E+00	5.074E-16	4.566E-15	5.073E-14	9.942E-14	2.455E-13	5.064E-12	4.979E-10
0Ac-227	Pu-239	1.000E+00	0.000E+00	2.787E-17	7.409E-16	2.599E-14	6.921E-14	2.533E-13	1.483E-11	2.441E-09
0Pu-240	Pu-240	1.000E+00	1.515E-02	1.515E-02	1.515E-02	1.513E-02	1.513E-02	1.512E-02	1.499E-02	1.363E-02
0U-236	Pu-240	1.000E+00	0.000E+00	1.198E-10	3.595E-10	1.198E-09	1.677E-09	2.634E-09	1.192E-08	1.135E-07
0Th-232	Pu-240	1.000E+00	0.000E+00	3.847E-20	3.462E-19	3.846E-18	7.537E-18	1.861E-17	3.833E-16	3.711E-14
0Ra-228	Pu-240	1.000E+00	0.000E+00	3.103E-21	7.905E-20	2.426E-18	6.037E-18	1.963E-17	6.723E-16	7.550E-14
0Th-228	Pu-240	1.000E+00	0.000E+00	4.733E-22	3.200E-20	2.282E-18	6.718E-18	2.596E-17	1.138E-15	1.349E-13
0Sr-90	Sr-90	1.000E+00	5.874E-04	5.736E-04	5.469E-04	4.629E-04	4.209E-04	3.479E-04	5.432E-05	2.686E-14

BRF(i) is the branch fraction of the parent nuclide.

1RESRAD, Version 5.61 T½ Limit = 0.5 year 05/20/96 14:06 Page 23
Summary : 1301 recreational File: 1301REC.DAT

Individual Nuclide Soil Concentration
Parent Nuclide and Branch Fraction Indicated

ONuclide (j)	Parent (i)	BRF(i)	S(j,t), pCi/g t= 0.000E+00	1.000E+00	3.000E+00	1.000E+01	1.400E+01	2.200E+01	1.000E+02	1.000E+03
Co-60	Co-60	1.000E+00	1.000E+00	8.768E-01	6.740E-01	2.685E-01	1.587E-01	5.541E-02	1.945E-06	0.000E+00
0Cs-137	Cs-137	1.000E+00	1.000E+00	9.772E-01	9.330E-01	7.937E-01	7.236E-01	6.015E-01	9.921E-02	9.238E-11
0Pu-239	Pu-239	1.000E+00	1.000E+00	1.000E+00	9.999E-01	9.997E-01	9.996E-01	9.994E-01	9.971E-01	9.715E-01
0U-235	Pu-239	1.000E+00	0.000E+00	9.848E-10	2.954E-09	9.847E-09	1.378E-08	2.166E-08	9.833E-08	9.692E-07
0Pa-231	Pu-239	1.000E+00	0.000E+00	1.042E-14	9.377E-14	1.042E-12	2.042E-12	5.041E-12	1.040E-10	1.023E-08
0Ac-227	Pu-239	1.000E+00	0.000E+00	1.097E-16	2.915E-15	1.023E-13	2.723E-13	9.966E-13	5.834E-11	9.606E-09
0Pu-240	Pu-240	1.000E+00	1.000E+00	9.999E-01	9.997E-01	9.989E-01	9.985E-01	9.977E-01	9.894E-01	8.993E-01
0U-236	Pu-240	1.000E+00	0.000E+00	2.960E-08	8.879E-08	2.959E-07	4.141E-07	6.505E-07	2.944E-06	2.804E-05
0Th-232	Pu-240	1.000E+00	0.000E+00	7.302E-19	6.571E-18	7.299E-17	1.430E-16	3.531E-16	7.276E-15	7.043E-13
0Ra-228	Pu-240	1.000E+00	0.000E+00	2.848E-20	7.254E-19	2.226E-17	5.540E-17	1.802E-16	6.170E-15	6.929E-13
0Th-228	Pu-240	1.000E+00	0.000E+00	2.417E-21	1.634E-19	1.166E-17	3.431E-17	1.326E-16	5.813E-15	6.891E-13
0Sr-90	Sr-90	1.000E+00	1.000E+00	9.765E-01	9.311E-01	7.881E-01	7.165E-01	5.923E-01	9.247E-02	4.572E-11

BRF(i) is the branch fraction of the parent nuclide.

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