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200-LW-1 300 Area Chemical Laboratory Waste Group Operable Unit RI/FS Work Plan

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United States Department of Energy

P.O. Box 550, Richland, Washington 99352

For External Review

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December 2001

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EXECUTIVE SUMMARY

This work plan supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) activities for the 200-LW-1 Chemical Laboratory Waste Group Operable Unit (OU). This work plan also integrates the *Resource Conservation and Recovery Act of 1976* (RCRA) facility investigation/ corrective measures study (RFI/CMS) requirements for the OU. The process outlined in the work plan follows the CERCLA format with modifications to concurrently satisfy RCRA requirements.

The 200-LW-1 OU is one of two OUs in the chemical laboratory waste category as described in the *Waste Site Grouping for 200 Areas Soil Investigations* report (DOE-RL 1997). The OU received liquid wastes resulting from 300 Area process laboratory operations that supported radiochemistry and metallurgical experiments. The wastes were transferred from the 300 Area to the 200-LW-1 OU waste sites in the 200 Areas for disposal. The other OU in this waste category, the 200-LW-2 200 Area Chemical Laboratory Waste Group OU, received liquid waste resulting mainly from 200 Area laboratory operations that supported the major chemical processing facilities and equipment decontamination from T Plant. Some 200-LW-2 sites, however, are known to have also received waste from 300 Area laboratories.

Recently the Tri-Parties (the U.S. Department of Energy, the Washington State Department of Ecology, and the U.S. Environmental Protection Agency) initiated negotiations to revise a number of legally enforceable milestone commitments that include modifying the number of 200 Area RI/FS work plans to be submitted. The negotiations are expected to formalize an agreement that has been reached among the Tri-Parties that 200 Area waste site characterization work may be focused on 12 OUs that are representative of the 23 OUs that currently have milestones for work plan submittals. A fundamental concept that supports this approach is that each of the major waste categories will have at least one OU characterized. The Tri-Parties anticipate agreement on draft milestone change requests by January 31, 2002. The 200-LW-1 OU has been selected as the representative OU for the chemical laboratory waste category.

The 200-LW-1 OU is located near the center of the Hanford Site in south-central Washington State. As originally defined in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (Implementation Plan) (DOE-RL 1999), the 200-LW-1 OU consisted of eight waste sites. Subsequent to the issuance of the Implementation Plan, 2 additional sites were added to the OU, increasing the current total to 10 waste sites.

Two waste sites in the 200-LW-1 OU, the 216-T-28 Crib and the 216-B-58 Trench, were identified in the Implementation Plan as representative waste sites for this OU. Two waste sites in the 200-LW-2 OU that received both 200 and 300 Area laboratory wastes, the 216-S-20 and the 216-Z-7 Cribs, were identified in the Implementation Plan as representative waste sites for this OU. The two representative sites from the 200-LW-2 OU are considered in this work plan along with the two representative sites from the 200-LW-1 OU to ensure that the characterization activities developed in this document are representative of the entire chemical laboratory waste category. The remedial investigation developed in this work plan, therefore, focuses on the representative sites from both OUs.

This work plan documents OU-specific background information, defines OU-specific characterization and assessment activities and schedules for the representative sites, based on the framework established in the Implementation Plan, and identifies the steps required to complete the RI/FS process for the OU. A data quality objectives (DQO) process was conducted for the OU to validate the selection of representative sites; define the radiological and nonradiological constituents to be characterized; and to specify the number, type, and location of samples to be collected at representative sites. The results of the DQO process form the basis for this work plan and the associated sampling and analysis plan (SAP) included in Appendix A. The SAP includes an OU-specific quality assurance project plan and a field sampling plan for implementing the characterization activities in the field.

A preliminary conceptual contaminant distribution model was developed in the *Waste Site Grouping for 200 Areas Soil Investigations* report (DOE-RL 1997). The preliminary model was

updated with conceptual contaminant distribution models of representative sites in this work plan based on physical conditions and the nature and extent of contamination at representative sites. The following statements are general conclusions regarding the conceptual contaminant distribution models:

- Effluents discharged to waste sites consisted of acidic to basic, low-salt, low-organic solutions that included radiological contaminants.

- Five of the twelve waste sites addressed in this work plan (ten sites from the 200-LW-1 OU and two sites from the 200-LW-2 OU) received enough effluent to potentially impact groundwater, including three representative sites (216-T-28, 216-S-20, and 216-Z-7).

- Effluents and contaminants migrated vertically beneath the waste sites after release. Lateral spreading of liquids and contaminants may occur associated with changes in site stratigraphy at the bottom of the crib/trench, the sand-dominated sequence of the Hanford formation, the Plio-Pleistocene unit (?)/early Palouse soil, and the upper Ringold Formation. Some lateral spreading appears to be present at the 216-T-28 and 216-Z-7 Cribs.

- Contaminants such as cesium and plutonium normally adsorb strongly onto Hanford Site sediments because they have large distribution coefficients (K_d) (i.e., low mobility). These contaminants should be detected near points of release in the vadose zone because of their large K_d value. Immobile contaminants will typically be detected high above the water table in the vadose zone. The concentration of contaminants with large K_d values will generally decrease with depth. Mobility of typical immobile contaminants may have been enhanced in the subsurface by the presence of a preferential pathway (e.g., the absence of annular seals in adjacent boreholes).

- Contaminants with low K_d values (e.g., nitrite and tritium) are not readily adsorbed on soil particles and migrate to greater depth within the vadose zone. These mobile contaminants

are expected at very low concentrations throughout the vadose zone. Concentrations may increase with depth.

- Waste sites in the 200-LW-1 OU no longer receive effluent and have generally been stabilized with a covering with clean soil. With the cessation of artificial recharge, the downward flux of liquid through the vadose zone has decreased. Residual liquid should continue to decrease in the vadose zone over time and equilibrate with the natural recharge rate, thus reducing the potential for future impacts to groundwater.

Potential receptors (human and ecological) may be exposed to the affected media through several exposure pathways, including inhalation, ingestion, and direct exposure to external gamma radiation. Potential human receptors include current and future site workers and visitors (occasional users). Potential ecological receptors include terrestrial plants and animals. Future impacts to humans are largely dependent on the land use. The type of future land use is not certain at this time, but some type of restricted land use for the 200 Areas is favored by the U.S. Department of Energy, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology (the Tri-Parties). All of the waste sites associated with the 200-LW-1 OU and the two representative sites from the 200-LW-2 OU are located within the 200 Area industrial exclusive land-use boundary line identified in the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999) and the associated "Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS), Hanford Site, Richland, Washington; Record of Decision (ROD)" (64 *Federal Register* 61615). These waste sites will be evaluated on the basis of future industrial uses.

A strategy to address ecological impacts in the 200 Areas has been developed and is being implemented. The strategy is phased and supports both 200 Area-wide and OU-specific evaluations. Phase I of the strategy consists of the compilation of existing 200 Area ecological data into an ecological summary report, which is scheduled to be completed in fiscal year 2002. Specific requirements for Phase II will be developed based on the results of the Phase I evaluation. For the 200-LW-1 OU, an ecological SAP will be prepared if waste site-specific soil samples are required to support an OU-specific ecological evaluation. The Phase II DQO is

planned for completion in fiscal year 2003, at which time the 200-LW-1 ecological SAP will be prepared and implemented, if needed.

RI/FS characterization activities planned to collect the required data identified in the DQO process include borehole drilling and soil sampling and geophysical logging using spectral gamma, gross gamma, and neutron moisture tools. Sample analysis will be conducted by an offsite laboratory under a contract-required quality program. The sampling strategy is designed to provide access to potentially contaminated subsurface areas. Sample collection will be guided by field screening and a sampling scheme that identifies critical sampling depths.

The SAP directs sampling and analysis activities that will be performed to characterize the vadose zone at the four representative waste sites. The data will be used to refine the conceptual contaminant distribution models, support an assessment of risk, and evaluate a range of remedial alternatives for waste sites in the 200-LW-1 OU and in the chemical laboratory waste category. The activities described in the SAP involve sampling and geophysical logging of deep boreholes and geophysical logging of existing boreholes to obtain additional information on the distribution of contamination. Boreholes will be drilled to groundwater at each of the representative sites and samples will be collected through the vadose zone for laboratory analyses. Soil samples will be analyzed for radiological and nonradiological contaminants of concern and physical property samples will be collected at major lithologic changes. The borehole locations for the 216-B-58 Trench and 216-Z-7 Crib will be determined from direct push holes that will be geophysically logged.

The boreholes will be geophysically logged for gamma-emitting radionuclides and neutron moisture content. Existing boreholes in the vicinity of these two sites will also be geophysically logged to provide additional information. A split-spoon sampler will be the primary sampling device used to collect the samples from the boreholes. Table ES-1 summarizes the sample collection requirements for the representative waste sites to be investigated.

Table ES-1. Summary of Projected Sample Collection Requirements for the 200-LW-1 Operable Unit.

	216-T-28 Crib	216-B-58 Trench	216-S-20 Crib	216-Z-7 Crib	Project Total
Chemical Parameters					
Maximum number of characterization samples	12	12	10	10	44
Field duplicates	1	1	1	1	4
Splits	1	1	1	1	4
Trip blanks	1	1	1	1	4
Equipment blanks	1	1	1	1	4
Approximate number of field QC samples	4	4	4	4	16
Approximate total number of samples	16	16	14	14	60
Physical Properties					
Bulk density, moisture content, particle size distribution	5	3	5	4	17

TABLE OF CONTENTS

1.0 INTRODUCTION 1-1

1.1 200 AREAS IMPLEMENTATION PLAN 1-2

1.2 SCOPE AND OBJECTIVES 1-3

1.3 CHANGE CONTROL 1-4

2.0 BACKGROUND AND SETTING 2-1

2.1 PHYSICAL SETTING 2-1

2.1.1 Topography 2-2
2.1.2 Geology 2-2
2.1.2 Vadose Zone 2-4
2.1.3 Groundwater 2-4
2.1.4 Summary of Hydrogeologic Conditions at Representative Sites 2-5

2.2 WASTE SITE DESCRIPTION AND HISTORY 2-6

2.2.1 Plant History 2-7
2.2.2 Process Information 2-12
2.2.3 Representative Sites 2-20

3.0 INITIAL EVALUATION OF REPRESENTATIVE SITES 3-1

3.1 KNOWN AND SUSPECTED CONTAMINATION 3-1

3.2 ENVIRONMENTAL MONITORING 3-2

3.3 NATURE AND EXTENT OF CONTAMINATION 3-3

3.3.1 216-B-58 Trench 3-3
3.3.2 216-T-28 Crib 3-4
3.3.3 216-S-20 Crib 3-6
3.3.4 216-Z-7 Crib 3-7
3.3.5 Conceptual Contaminant Distribution Models 3-8
3.3.6 Environmental Information 3-10

3.4 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT 3-12

3.4.1 Contaminant Sources and Release Mechanisms 3-13
3.4.2 Potential Receptors 3-13
3.4.3 Potential Impacts 3-13

3.5 DEVELOPMENT OF CONTAMINANTS OF CONCERN 3-14

4.0 WORK PLAN APPROACH AND RATIONALE 4-1

4.1 SUMMARY OF DATA QUALITY OBJECTIVE PROCESS 4-1

4.1.1 Data Uses 4-2
4.1.2 Data Needs 4-2
4.1.3 Data Quality 4-2
4.1.4 Data Quantity 4-3

4.2 CHARACTERIZATION APPROACH 4-4

4.2.1 Geophysical Logging Through Direct Push Holes 4-4
4.2.2 Drilling and Sampling 4-5
4.2.3 Field Screening 4-6
4.2.4 Analysis of Soil 4-6

4.3 GEOPHYSICAL LOGGING 4-7

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS 5-1

5.1 INTEGRATED REGULATORY PROCESS 5-2

5.2 ECOLOGICAL EVALUATION PROCESS 5-3

5.3 REMEDIAL INVESTIGATION ACTIVITIES 5-3

5.3.1 Planning 5-4
5.3.2 Field Investigation 5-4
5.3.3 Management of Investigation-Derived Waste 5-5
5.3.4 Laboratory Analysis and Data Validation 5-6
5.3.5 Remedial Investigation Report 5-6

5.4 FEASIBILITY STUDY 5-7

5.5 PROPOSED PLAN AND PROPOSED RCRA PERMIT MODIFICATION 5-10

5.6 POST-ROD ACTIVITIES 5-10

6.0 PROJECT SCHEDULE 6-1

7.0 REFERENCES 7-1

APPENDICES

A. SAMPLING AND ANALYSIS PLAN ..... A-i
B. WASTE CONTROL PLAN ..... B-i

FIGURES

1-1. Regulatory Process for the 200-LW-1 Operable Unit (Modified from DOE-RL 1999) 1-5
2-1. Generalized Stratigraphic Column for the 200 Areas. 2-25
2-2. Groundwater Map of the 200 East and 200 West Areas (Modified from PNNL 2001b). 2-26
2-3. Stratigraphy Near the 216-B-58 Trench. 2-27
2-4. Stratigraphy in the Vicinity of the 216-T-28 Crib. 2-28
2-5. Stratigraphy in the Vicinity of the 216-S-20 Crib. 2-29
2-6. Stratigraphy Near the 216-Z-7 Crib. 2-30
2-7. Index Map for Location of 200-LW-1 Operable Unit Waste Sites. 2-31
2-8. Location of the 200-LW-1 Operable Unit Waste Sites Adjacent to the 200 East Area. 2-32
2-9. Location of 200-LW-1 and 200-LW-2 Operable Unit Representative Waste Sites and Other 200 LW-1 Waste Sites Located Near T Plant and the Z Plant Complex in the 200 West Area. 2-33
2-10. Location of the 216-S-20 Representative Waste Site Located Near REDOX in the 200 West Area. 2-34
2-11. Waste Collection at the 340 Complex in the 300 Area. 2-35
2-12. 216-B-58 Trench Construction Diagram. 2-36
2-13. 216-T-28 Crib Construction Diagram. 2-37
2-14. 216-S-20 Crib Construction Diagram. 2-38
2-15. 216-Z-7 Crib Construction Diagram. 2-39
3-1. 216-B-58 Trench and Borehole Location Map. 3-17
3-2. Major Radiological Groundwater Plumes in the Vicinity of the 200 East Area (Modified from PNNL 2001b). 3-18
3-3. Major Nonradiological Groundwater Plumes in the Vicinity of the 200 East Area (Modified from PNNL 2001b). 3-19
3-4. 216-T-28 Crib and Borehole Location Map. 3-20
3-5. Major Radiological Groundwater Plumes in the Vicinity of the 200 West Area (Modified from PNNL 2001b). 3-21
3-6. Major Nonradiological Groundwater Plumes in the Vicinity of the 200 West Area (Modified from PNNL 2001b). 3-22
3-7. 216-S-20 Crib and Borehole Location Map. 3-23
3-8. 216-Z-7 Crib and Borehole Location Map. 3-24
3-9. 216-B-58 Trench Conceptual Contaminant Distribution Model. 3-25
3-10. 216-T-28 Crib Conceptual Contaminant Distribution Model. 3-26
3-11. 216-S-20 Crib Conceptual Contaminant Distribution Model. 3-27
3-12. 216-Z-7 Crib Conceptual Contaminant Distribution Model. 3-28

3-13. Conceptual Exposure Pathway Model. 3-29
4-1. Location of Planned and Existing Boreholes at the 216-T-28 Crib. 4-9
4-2. Location of Planned and Existing Boreholes at the 216-S-20 Crib. 4-10
4-3. Location of Planned and Existing Boreholes at the 216-B-58 Trench. 4-11
4-4. Location of Planned and Existing Boreholes at the 216-Z-7 Crib. 4-12
5-1. CERCLA Operable Unit RI/FS and Ecological Evaluation Integration. 5-11
6-1. Project Schedule for the 200-LW-1 Operable Unit. 6-2

TABLES

2-1. Summary of Information for the 200-LW-1 Operable Unit. 2-41
3-1. 1999 Soil and Vegetation Environmental Surveillance Data (pCi/g) for Sites in the Laboratory Waste Group. 3-31
3-2. 200-LW-1 Operable Unit Final COC List. 3-32

ACRONYMS

ANN	aluminum nitrate nonahydrate
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
BHI	Bechtel Hanford, Inc.
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CMS	corrective measures study
COC	contaminant of concern
COPC	contaminant of potential concern
CPP	CERCLA past-practice
CPT	cone penetrometer
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GRA	general response action
HASP	health and safety plan
HPGe	high-purity germanium
IDW	investigation-derived waste
K_d	distribution coefficient
MTCA	*Model Toxics Control Act*
NPL	National Priorities List
NAVD88	North American Vertical Datum of 1988
OU	operable unit
PRF	Plutonium Recovery Facility
PRG	preliminary remediation goal
PRTR	Plutonium Recycle Test Reactor
PUREX	Plutonium/Uranium Extraction
QRA	qualitative risk assessment
RAO	remedial action objective
RAWP	remedial action work plan
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR	remedial design report
REDOX	Reduction-Oxidation
RFI	RCRA facility investigation
RI	remedial investigation
RL	DOE, Richland Operations Office
ROD	record of decision
RPP	RCRA past-practice
RPS	Retention Process Sewer
RRLWS	Retired Radioactive Liquid Waste Sewer
SAP	sampling and analysis plan

Acronyms

SGL	spectral gamma-ray logging
TBP	tributyl phosphate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and disposal
UNH	uranyl nitrate hexahydrate
URP	Uranium Recovery Process
WESF	Waste Encapsulation and Storage Facility
WIDS	Waste Information Data System

1.0 INTRODUCTION

This work plan supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) activities for the 200-LW-1 Chemical Laboratory Waste Group Operable Unit (OU). This work plan also integrates the *Resource Conservation and Recovery Act of 1976* (RCRA) facility investigation/ corrective measures study (RFI/CMS) requirements for the OU. The process outlined in the work plan follows the CERCLA format with modifications to concurrently satisfy RCRA requirements.

The 200-LW-1 OU is one of two OUs in the chemical laboratory waste category as described in the *Waste Site Grouping Report for 200 Areas Soil Investigations* (DOE-RL 1997). The OU received liquid wastes resulting from 300 Area process laboratory operations that supported radiochemistry and metallurgical experiments. The wastes were transferred from the 300 Area to the 200-LW-1 OU waste sites in the 200 Areas for disposal. The other OU in this waste category, the 200-LW-2 200 Area Chemical Laboratory Waste Group OU, received liquid waste resulting mainly from 200 Area laboratory operations that supported the major chemical processing facilities and equipment decontamination from T Plant. Some 200-LW-2 sites, however, are known to have also received waste from 300 Area laboratories.

Recently the Tri-Parties (the U.S. Department of Energy [DOE], the Washington State Department of Ecology [Ecology], and the U.S. Environmental Protection Agency [EPA]) initiated negotiations to revise a number of legally enforceable milestone commitments that include modifying the number of 200 Area RI/FS work plans to be submitted. The negotiations are expected to formalize an agreement that has been reached among the Tri-Parties that 200 Area waste site characterization work may be focused on 12 OUs that are representative of the 23 OUs that currently have milestones for work plan submittals. A fundamental concept that supports this approach is that each of the major waste categories will have at least one OU characterized. The Tri-Parties anticipate agreement on draft milestone change requests by January 31, 2002. The 200-LW-1 OU has been selected as the representative OU for the chemical laboratory waste category.

The 200-LW-1 OU is located in the 200 Areas near the center of the Hanford Site in south-central Washington State. As originally defined in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (hereinafter referred to as the Implementation Plan) (DOE-RL 1999), the 200-LW-1 OU consisted of eight waste sites. Subsequent to the issuance of the Implementation Plan, 2 additional sites were added to the OU, increasing the current total to 10 waste sites.

Liquid wastes that were disposed to waste sites within the chemical laboratory waste category were generated from laboratories in the 200 and 300 Areas of the Hanford Site that provided analytical services and support for research and development activities. The 200-LW-1 OU waste sites received laboratory wastes from the 340 Building in the 300 Area. Two waste sites (216-T-28 and 216-B-58) were identified as representative waste sites for the 200-LW-1 OU. The 200-LW-2 OU waste sites received waste mainly from 200 Area laboratories with the

exception of two sites (216-S-20 and 216-Z-7) that received both 200 and 300 Area laboratory waste. It is these two waste sites that were identified as representative waste sites for the 200-LW-2 OU in the Implementation Plan (DOE-RL 1999). The data quality objectives (DQOs) process for 200-LW-1 considered waste sites in both OUs to ensure that the representative waste sites selected for characterization are representative of the chemical laboratory waste category.

The 200 Areas is one of four areas on the Hanford Site that are on the EPA's National Priorities List (NPL) under CERCLA. The application of the RCRA RFI/CMS and CERCLA RI/FS processes in the 200 Areas is described in the Implementation Plan (DOE-RL 1999); the Implementation Plan is summarized in Section 1.1 of this work plan. The data generated through investigation activities associated with this OU will support activities in other core projects in the DOE, Richland Operations Office's (RL) Groundwater/Vadose Zone Integration Project. Integration of the data collection activities with other projects results in a more efficient and consistent process.

The characterization and remediation of waste sites at the Hanford Site are addressed in the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1998). The schedule of work at the Hanford Site is governed by Tri-Party Agreement milestones. The milestone controlling the schedule for the 200-LW-1 OU is M-13-00L, "Submit 3 Operable Unit Work Plans," due December 31, 2001. All characterization work for nontank farm OUs in the 200 Areas is scheduled to be completed by December 31, 2008 (Tri-Party Agreement Milestone M-15-00C).

1.1 200 AREAS IMPLEMENTATION PLAN

The Implementation Plan outlines a strategy that is intended to streamline the characterization and remediation of waste sites in the 200 Areas, including CERCLA past-practice (CPP) sites; RCRA past-practice (RPP) sites; and RCRA treatment, storage, and/or disposal (TSD) units. The plan outlines the framework for implementing assessment activities and evaluation of remedial alternatives in the 200 Areas to ensure consistency in documentation, level of characterization, and decision making. A regulatory framework is established in the Implementation Plan to integrate the requirements of RCRA and CERCLA into one standard approach for cleanup activities in the 200 Areas. This approach is illustrated in Figure 1-1. The 200-LW-1 OU consists entirely of RPP sites, with Ecology as the lead regulatory agency. The OU does not include any TSD units. For the purposes of this document, the CERCLA terminology will be used consistent with the Implementation Plan.

The Implementation Plan consolidates much of the information normally found in an OU-specific work plan to avoid duplication of this information for each of the 23 OUs in the 200 Areas. The Implementation Plan also lists potential applicable or relevant and appropriate requirements (ARARs) and preliminary remedial action objectives (RAOs), and contains a discussion of potentially feasible remedial technologies that may be employed in the 200 Areas. This work plan references the Implementation Plan for further details on several topics, such as general information on the physical setting and operational history of 200 Area facilities, ARARs, RAOs, and post-work plan activities.

The Implementation Plan addressed more than 800 waste sites that were grouped into 23 process-based OUs, which in turn were grouped into 9 major waste categories (e.g., process waste, landfills, cooling water). This categorization facilitates the use of the analogous site approach, which was a fundamental concept under the Implementation Plan. As described in the Implementation Plan, the analogous site approach involves combining into groups waste sites with similar process histories, structures, and contaminants, and then choosing one or more representative sites for comprehensive field investigations, including sampling of environmental media during RI investigations. Findings from the RI at representative sites are then used to make remediation decisions for all of the wastes site in the OU. Sites for which field data have not been (or will not be) collected, referred to as "analogous sites," are assumed to have soil contamination characteristics similar to representative sites that are characterized. A record of decision (ROD) for the OU specifying remediation requirements will be obtained using data collected during the RI. The analogous sites will be addressed during post-ROD confirmatory sampling to ensure that the remedial action decision specified in the ROD is appropriate and to provide required engineering design data for implementing the remedial action.

The 200-LW-1 OU falls within the chemical laboratory waste category. This category is composed of waste sites that received liquid waste streams from 200 and 300 Area laboratory facilities. Experiments conducted in these laboratories were associated with the major processing facilities in the 200 Areas (e.g., T and B Plants, Plutonium-Uranium Extraction [PUREX] Facility, Reduction-Oxidation [REDOX] Facility).

The 200-LW-1 OU has been further identified as the representative OU for the chemical laboratory waste category. Data collected and remedial decisions made under the 200-LW-1 OU RI/FS process will be applied to the other analogous operable unit (200-LW-2) within the waste category. Confirmatory sampling of waste sites within the 200-LW-2 OU after remedy selection may be required to demonstrate analogous conditions exist and to support the remedial design process. As with the 200-LW-1 OU, the 200-LW-2 OU consists entirely of RPP sites, with the Ecology as the lead regulatory agency. The OU does not include any TSD units.

1.2 SCOPE AND OBJECTIVES

This work plan documents OU-specific background information, defines OU-specific characterization and assessment activities and schedule based on the framework established in the Implementation Plan, and identifies the steps required to complete the RI/FS process for the OUs. Operable unit-specific detail is presented in this work plan, including background information on the waste sites; existing data regarding contamination at the representative waste sites; and the approach that will be used to investigate, characterize, and evaluate the waste sites. A discussion of the RI planning and execution process is included, along with a schedule for the characterization work. Preliminary remedial action alternatives that are likely to be considered for this OU are identified in the work plan. These preliminary remedial alternatives will be further developed and agreed to in the FS, the proposed plan/proposed permit modification, and the eventual ROD and permit modification.

A DQO process was conducted for this OU to define the radiological and nonradiological constituents to be characterized and to specify the number, type, and location of samples to be collected at representative sites within the OU. The results of the DQO process form the basis for the work plan and the associated sampling and analysis plan (SAP) included in Appendix A. The SAP includes an OU-specific quality assurance project plan and a field sampling plan for implementing the characterization activities in the field.

After characterization data have been collected for the representative sites, results will be presented in a group-specific RI report. The RI report will include an evaluation of the characterization data for the representative sites, including an assessment of the accuracy of the conceptual exposure model and refinement of the contaminant distribution model. The RI report will support the evaluation of remedial alternatives that will be included in the group-specific FS. The FS will use the existing and newly collected data to evaluate a range of remedial actions for the representative sites and for the remaining sites within the OU that fall within the contaminant distribution model. Remedial alternatives may be applied at any or all of the waste sites in an OU, and different alternatives may be applied to different waste sites depending on site characteristics. The FS will ultimately support a group-specific proposed plan leading to a ROD for all the waste sites in the OU; the ROD will be incorporated by reference into the permit for the RPP sites, authorizing the RCRA actions at the 200-LW-1 OU. The schedule for assessment activities at the 200-LW-1 OU is presented in Section 6.0.

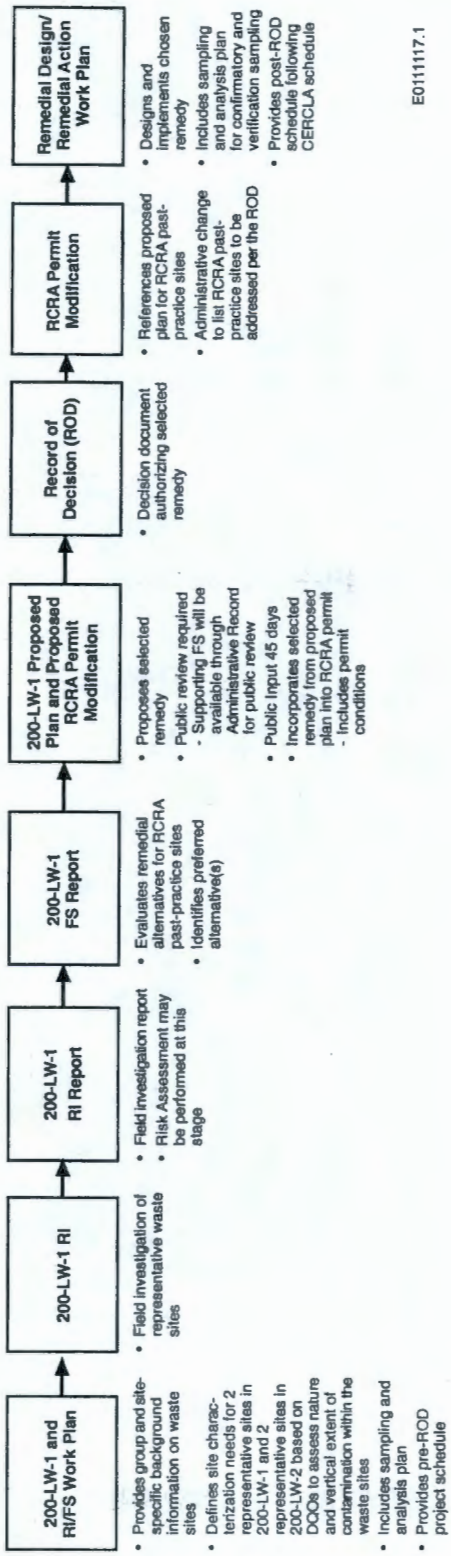
1.3 CHANGE CONTROL

Following approval of the work plan, the major elements of the work plan (RI/FS steps) are requirements that are not expected to change, and as a result, the work plan should not require modification. Specific work scope elements may require change or refinement as the work progresses. Changes that do not affect the overall intent of the approved work plan or schedule can be achieved using a change process agreed to by the Tri-Parties. Alternatively and if agreed to by RL and the lead regulatory agency, unit managers' meetings or predecessor primary documents requiring RL and lead regulatory agency approval can also be used to document changes (e.g., the RI report can be used to document refinements to or focus the FS). Changes to the project schedule that impact assigned M-15 interim milestones will require approval through the Tri-Party Agreement change control process.

Changes to the remedial investigation scope detailed in the SAP may be required because of unexpected field conditions, new information, health and safety concerns, or other conditions. Minor changes that have no adverse effect on achieving the DQOs for the job or schedule can be made in the field with the approval by the project manager or assigned task lead and documented in the field logbook and/or field summary reports. Changes that impact DQOs will require concurrence by RL and the lead regulatory agency and can be documented through unit managers' meetings. Alternatively, if substantial changes are required, the SAP can be revised and issued as a separate document requiring RL and regulator approval.

Additional discussion on work control can be found in Section 7.2.2 of the Implementation Plan (DOE-RL 1999).

Figure 1-1. Regulatory Process for the 200-LW-1 Operable Unit (Modified from DOE-RL 1999).



2.0 BACKGROUND AND SETTING

This section describes the 200-LW-1 300 Area Chemical Laboratory Waste Group OU. Waste site information and the hydrogeologic framework associated with this OU are described to provide a fundamental understanding of the physical setting and potential impacts on the environment. Background and setting information includes the physical setting, waste site description and history, and waste generating processes. The four representative sites are identified and discussed in Section 2.2.3. Summary information is provided for other OU waste sites that will not be immediately characterized but addressed in future planning efforts. Information in this section is summarized from numerous reports. The following list identifies significant documents and references:

- *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997)
- *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE-RL 1999)
- *B Plant Source Aggregate Area Management Study Report* (DOE-RL 1993a)
- *S Plant Source Aggregate Area Management Study Report* (DOE-RL 1992a)
- *T Plant Source Aggregate Area Management Study Report* (DOE-RL 1992b)
- *U Plant Source Aggregate Area Management Study Report* (DOE-RL 1992c)
- *Subsurface Conditions Description of the B-BX-BY Waste Management* (Wood et al. 2000)
- *Evaluation of Scintillation Probe Profiles from 200 Area Crib Monitoring Wells* (Fecht et al. 1977)
- *Inventory of Chemicals Used at Hanford Site Production Plants and Support Operations (1944 – 1980)* (WHC 1990)
- Duratek Inc., Geophysical Logging Project File
- *Remedial Investigation Data Quality Objectives Summary Report for the 200-LW-1 – 300 Area Laboratory Waste Group Operable Unit* (BHI 2001).

2.1 PHYSICAL SETTING

The following is a summary of the geology and hydrology associated with the 200 Areas inclusive of the 200-LW-1 OU. More detail on the physical setting of the 200 Areas and vicinity is provided in Appendix F of the Implementation Plan (DOE-RL 1999).

2.1.1 Topography

The 200-LW-1 OU includes wastes sites located in both the 200 East and 200 West Areas on the 200 Area Plateau. The 200 Area Plateau is the common reference used to describe the broad, flat area that constitutes a local topographic high around the 200 Areas at the Hanford Site. The plateau was formed approximately 13,000 years ago during the cataclysmic Missoula floods. The northern boundary of the 200 Area Plateau is defined by an erosional channel that runs east-southeast before turning south just east of the 200 East Area. This erosional channel formed during waning stages of flooding as floodwaters drained from the basin. The northern half of the 200 East Area lies within this ancient flood channel. A secondary flood channel running southward off the main channel bisects the 200 West Area. The buried former river and flood channels may provide preferential pathways for groundwater and contaminant movement.

Waste sites in the 200 West Area are situated in a relatively flat area in a secondary flood channel. Surface elevations range from approximately 205 m (673 ft) to 217 m (712 ft) (datum is the North American Vertical Datum of 1988 [NAVD88]), and the surface slopes gently to the west. Waste site surface elevations in the 200 East Area and vicinity range from approximately 189 m (620 ft) NAVD88 in the northern portion of the 200 Areas to 230 m (755 ft) at waste sites just south of the 200 East Area. The surface within the 200 East Area slopes gently to the northeast.

2.1.2 Geology

The 200-LW-1 OU is located in the Pasco Basin on the Columbia Plateau. It is underlain by basalt of the Columbia River Basalt Group and a sequence of suprabasalt sediments. From oldest to youngest, major geologic units of interest are the Elephant Mountain Basalt Member, the Ringold Formation, the Plio-Pleistocene unit, the Hanford formation/Plio-Pleistocene unit (?), and the Hanford formation. The fluvial-lacustrine Ringold Formation is informally divided into several informal units (from oldest to youngest): unit A, lower mud, unit E, and upper unit. It is overlain by a Plio-Pleistocene-aged unit in the 200 West Area consisting of a locally derived subunit that is interpreted to be a weathered surface that developed on the top of the Ringold Formation (WHC 1994, Bjornstad 1990) and an eolian facies (Slate 1996). The eolian facies was originally described as a separate unit called the early "Palouse soil." A recently identified unit of uncertain origin, referred to as the Hanford formation/Plio-Pleistocene unit (?), is reported in the northwest corner of the 200 East Area. This unit may be equivalent or partially equivalent to the Plio-Pleistocene or it may represent the earliest ice age flood deposits overlain by a locally thick sequence of fine-grained nonflood deposits (Wood et al. 2000). Glaciofluvial cataclysmic flood deposits of the Hanford formation are present in both the 200 East and 200 West Areas. Hanford formation deposits consist of gravel-dominated and sand-dominated sequences. A generalized stratigraphic column for the 200 Areas is shown in Figure 2-1.

The Elephant Mountain Basalt Member is a medium- to fine-grained tholeiitic basalt with abundant microphenocrysts of plagioclase (DOE 1988). Basalt is overlain by the Ringold Formation over most of the 200 East Area and all of the 200 West Area. This formation consists of an interstratified sequence of unconsolidated clay, silt, sand, and granule to cobble gravel

deposited by the ancestral Columbia River. These alluvial sediments consist of four major units; these are (from oldest to youngest) the fluvial gravel and sand of unit A, the buried soil horizons and lake deposits of the lower mud sequence, the fluvial sand and gravel of unit E, and the lacustrine mud of the upper Ringold.

Overlying the Ringold Formation in the 200 West Area is the locally derived subunit of the Plio-Pleistocene unit, which consists of poorly sorted, locally derived, interbedded reworked loess, silt, sand, and basaltic gravel (WHC 1994). The subunit consists of a lower carbonate-rich paleosol (caliche) and an upper eolian facies. The carbonate-rich section consists of interbedded carbonate-poor and carbonate-rich strata. The upper silty eolian facies was previously interpreted to be early Pleistocene loess and is referred to as the early Palouse soil (Bjornstad 1990). Generally, it is well-sorted quartz-rich/basalt-poor silty sand to sandy silt (BHI 1996).

Where the Ringold Formation and Plio-Pleistocene unit are not present, the Hanford formation/Plio-Pleistocene unit (?) and Hanford formation sediments overlie the basalt. The Hanford formation/Plio-Pleistocene unit (?) is made up of two facies and has only been identified in the 200 East Area near the B-BX-BY Tank Farms. The lower facies overlies basalt and is described in Wood et al. (2000) as loose, unconsolidated sandy gravel to gravelly sand. These gravels contain 50% to 70% basalt and are similar to and often indistinguishable from Hanford formation flood gravels in the absence of the second facies. The second facies consists of an olive brown to olive gray, well-sorted calcareous eolian/overbank silt with laminations, and pedogenic structures. However, it has also been observed to be massive and void of any sedimentary or pedogenic structures. The Hanford formation consists of unconsolidated gravel, sand, and silts deposited by cataclysmic floodwaters. These deposits consist of gravel-dominated and sand-dominated facies. The gravel-dominated facies consist of cross-stratified, coarse-grained sands and granule to boulder gravel. The gravel is uncemented and matrix poor. The sand facies consists of well-stratified fine- to coarse-grained sand and granule gravel. Silt in these facies is variable and may be interbedded with the sand. Where the silt content is low, an open-framework texture is common. An upper and lower gravel unit and a middle sand facies are present in the study area.

The cataclysmic floodwaters that deposited sediments of the Hanford formation also locally reshaped the topography of the Pasco Basin. The floodwaters deposited a thick sand and gravel bar that constitutes the higher southern portion of the 200 Areas, informally known as the 200 Area Plateau. In the waning stages of the ice age, these floodwaters also eroded a channel north of the 200 Areas in the area currently occupied by Gable Mountain Pond. These floodwaters removed all of the Ringold Formation from this area and deposited Hanford formation sediments directly over basalt.

Holocene-age deposits overlie the Hanford formation and are dominated by eolian sheets of sand that form a thin veneer across the site, except in localized areas where the deposits are absent. Surficial deposits consist of very fine- to medium-grained sand to occasionally silty sand. Silty deposits less than 1 m (approximately 3 ft) thick have also been documented at waste sites where fine-grained windblown material has settled out through standing water over many years.

2.1.2 Vadose Zone

The vadose zone is approximately 104 m (340 ft) thick in the southern section of the 200 East Area and thins to the north to as little as 0.3 m (1 ft) near West Lake (Figure 2-2). Sediments in the vadose zone are dominated by the Ringold and Hanford Formations. The Hanford formation/Plio-Pleistocene unit (?) may be present in a small area immediately above the basalt beneath the B-BX-BY Tank Farms. Because erosion during cataclysmic flooding removed much of the Ringold Formation north of the central part of the 200 East Area, the vadose zone is dominantly composed of Hanford formation sediments between the northern part of the 200 Areas and Gable Mountain. Areas of basalt also project above the water table north of the 200 East Area.

In the 200 West Area, the vadose zone thickness ranges from 40.2 m (132 ft) to 102 m (337 ft). Sediments in the vadose zone are the Ringold Formation, the Plio-Pleistocene unit, and the Hanford formation. Erosion during cataclysmic flooding removed some of the Ringold Formation and Plio-Pleistocene unit.

Perched water has historically been documented above the Plio-Pleistocene unit at locations in the 200 West Area. While liquid waste disposal facilities were operating, localized areas of saturation or near saturation were created in the soil column. With the reduction of artificial recharge in the 200 Areas, downward flux of liquid in the vadose zone beneath these waste sites has been decreasing. However, moisture content in the vadose zone is expected to remain elevated over pre-operational conditions for some time. As unsaturated conditions are reached, liquid flux at these disposal sites becomes increasingly less significant as a source of recharge and contaminant movement to groundwater. In the absence of artificial recharge, recharge from natural precipitation becomes the more dominant driving force for moving contamination remaining in the vadose zone to groundwater

2.1.3 Groundwater

The unconfined aquifer in the 200 Areas occurs within the Hanford formation/Plio-Pleistocene unit (?), the Hanford formation, or the Ringold Formation, depending on location. Groundwater in the unconfined aquifer flows from recharge areas where the water table is higher (west of the Hanford Site) to areas where it is lower, near the Columbia River (PNNL 2000b). In the northern half of the 200 East Area, the water table is present within the Hanford formation, except in areas where basalt extends above the water table. Near the B-BX-BY waste management area, the water table occurs within the Hanford formation/Plio-Pleistocene unit (?). In the central and southern sections of the 200 East Area, the water table is located near the contact between the Ringold and Hanford Formations.

Depth to groundwater in the 200 East Area and vicinity ranges from about 54 m (177 ft) near B Pond to about 104 m (340 ft) near the southern section. The water table across the 200 East Area is very flat (Figure 2-2), making it difficult to determine groundwater flow direction based on water level measurements from monitoring wells. The configuration of contaminant plumes, however, indicates that groundwater flows to the northwest in the northern half of the 200 East Area, and to the east/southeast in the southern half of the 200 East Area. Identifying the specific

location of the groundwater divide between the northern and southern sections is hampered by the flat water table. Highly transmissive Hanford formation sediments are the cause of the flat water table in the 200 East Area (PNNL 2000b). Since surface liquid discharges were terminated in the 200 East Area, the water table has been declining rapidly, at a rate of about 0.13 m/yr (0.4 ft/yr) based on water level measurements collected between March 1999 and April 2001 (PNNL 2001b).

Groundwater beneath the 200 West Area occurs primarily in the Ringold Formation. Depth to water varies from about 40.2 m (132 ft) to greater than 102 m (337 ft). Groundwater flow is predominately to the east (Figure 2-2). The surface elevation of the water table beneath the 200 West Area is currently dropping at a rate of 0.41 m/yr (1.3 ft/yr) (PNNL 2001b).

Recharge to the unconfined aquifer within the 200 Areas is from artificial sources and less significant natural precipitation. Estimates of recharge from precipitation range from 0 to 10 cm/yr (0 to 4 in./yr) and are largely dependent on soil texture and the type and density of vegetation. Zimmerman et al. (1986) report that between 1943 and 1980, 6.33×10^{11} L (1.67×10^{11} gal) of liquid wastes were discharged to the soil column. Most sources of artificial recharge were terminated in 1995. The artificial recharge that does continue is largely limited to liquid discharges from sanitary sewers, 2 state-approved land disposal structures, and 140 small-volume, uncontaminated miscellaneous liquid discharge streams. One of the approved land disposal structures, the Treated Effluent Disposal Facility (a liquid waste disposal facility), is located 600 m (2,000 ft) east of the 216-B-3C lobe and receives treated liquid wastes from the 200 East and 200 West Area facilities.

2.1.4 Summary of Hydrogeologic Conditions at Representative Sites

2.1.4.1 216-B-58 Trench. The 216-B-58 Trench is located south of the 200 East Area. Ground surface elevation at this site is approximately 228.5 m (749.7 ft) NAVD88. Stratigraphic units of interest beneath the site (in ascending order) consist of the Ringold Formation unit E and the Hanford formation gravel- and sand-dominated sequences. The stratigraphy near the 216-B-58 Trench is shown in Figure 2-3 and is based on the geology at nearby borehole 299-E13-10. Groundwater beneath the 216-B-58 Trench occurs within the Ringold Formation unit E about 103 m (338 ft) below ground surface (bgs).

2.1.4.2 216-T-28 Crib. The 216-T-28 Crib is located in a north-south-trending secondary flood channel in the 200 West Area (DOE-RL 1993a). The surface elevation at this site is approximately 205 m (672.6 ft) NAVD88. Stratigraphic units of interest beneath the site (in ascending order) consist of the Ringold Formation (unit E and upper Ringold), early Palouse soil/Plio-Pleistocene units, and the Hanford formation sand- and gravel-dominated sequences. The stratigraphy at the 216-T-28 Crib is shown in Figure 2-4 and is based on the geology at borehole C3102 (temporary borehole number assigned in 2001). Groundwater beneath the 216-T-28 Crib occurs within the Ringold Formation unit E about 69 m (226 ft) bgs.

2.1.4.3 216-S-20 Crib. The 216-S-20 Crib is located in a north-south-trending secondary flood channel in the 200 West Area (DOE-RL 1993a). Ground surface elevation at this site is approximately 205.6 m (674.6 ft) NAVD88. Stratigraphic units of interest near the site (in

ascending order) consist of the Ringold Formation (unit E and upper Ringold), early Palouse soil/Plio-Pleistocene units, and the Hanford formation sand- and gravel-dominated sequences. The stratigraphy near the 216-S-20 Crib is shown in Figure 2-5 and is based on the geology at borehole 299-W22-19. Groundwater beneath the 216-S-20 Crib occurs within the Ringold Formation unit E about 71 m (233 ft) bgs.

2.1.4.4 216-Z-7 Crib. The 216-Z-7 Crib is located in a north-south-trending secondary flood channel in the 200 West Area (DOE-RL 1993a). Ground surface elevation at this site is approximately 201.5 m (661.1 ft) NAVD88. Stratigraphic units of interest beneath the site (in ascending order) consist of the Ringold Formation unit E, early Palouse soil/Plio-Pleistocene units, and the Hanford formation sand- and gravel-dominated sequences. The stratigraphy near the 216-Z-7 Crib is shown in Figure 2-6 and is based on the geology at borehole 299-W15-763. Groundwater beneath the 216-Z-7 Crib occurs within the Ringold Formation unit E about 66 m (218 ft) bgs.

2.2 WASTE SITE DESCRIPTION AND HISTORY

Eight waste sites within the OU are listed in Appendix G of the Implementation Plan (DOE-RL 1999). This list was subsequently updated in the Waste Information Data System (WIDS) to a total of 10 sites. In the fall of 2001, an effort was initiated to evaluate the waste sites identified in the 200-LW-1 OU following the waste site reclassification process, as described in *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)" (DOE-RL 1998). As a result of that process, no waste sites were reclassified; thus, 10 total sites remained in the 200-LW-1 OU. However, during the DQO process for the 200-LW-1 OU (BHI 2001), it was determined that two additional representative sites from the 200-LW-2 (200 Area Chemical Laboratory Waste Group) OU would also be addressed and characterized based on the information provided in this work plan, making a total of 12 sites that are addressed in this work plan. These 12 sites are identified in Table 2-1.

Of the 12 waste sites, 8 are located in the 200 West Area and 4 waste sites are located in the 200 East Area. All of the 200-LW-1 waste sites are located within the 200 Area industrial exclusive land-use boundary as defined in the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999). Figures 2-7 to 2-10 depict the locations of the waste sites. The 200-LW-1 OU waste sites are all RPPs. The two representative sites added from the 200-LW-2 OU are also RPPs. Summary information for the 200-LW-1 OU waste sites and the 216-S-20 Crib and 216-Z-7 Crib is presented in Table 2-1.

In general, the waste sites received liquid wastes discharged from the following:

- 300 Area laboratory operations
- 200 Area laboratory operations
- 200 Area decontamination and equipment refurbishment activities.

Liquid wastes generated in the 300 Area were collected within the 340 Complex and transferred by rail tanker car or truck to cribs and trenches within the 200 Areas. Wastes from the 200 Area operations were routed to collection tanks/sumps through an underground transfer system. There, the wastes may have been evaporated (concentrated) and were often neutralized before disposal. The collection sumps/pits were used to settle the heavier constituents out of the liquid effluents, forming sludge. The liquid supernatants were ultimately discharged to the soil column via cribs and trenches (WIDS).

Cribs and drains were subsurface structures fed by underground pipelines designed to receive and percolate wastewater into the soil column without exposure to the open air. Cribs are shallow excavations that are either backfilled with permeable material or are subsurface voids created by wooden or concrete structures. Cribs and drains typically received low-level radioactive waste for disposal, and most were designed for a specific retention volume or radionuclide capacity (DOE-RL 1993a).

Trenches are shallow, long, narrow, unlined, open excavations. Often, several were built adjacent to one another to form a group of trenches. Trenches were generally open for a limited time and were fed by temporary surface piping connecting to pipelines, tanker truckers, and/or rail cars (DOE-RL 1993a).

2.2.1 Plant History

The following discussion summarizes historical information on facilities in the 300 and 200 Areas that were sources of liquid wastes disposed to the 200-LW-1 and/or 200-LW-2 sites.

2.2.1.1 300 Area Plant History. The 340 Complex and the Radioactive Liquid Waste Sewer (later renamed the 300 Area Retired Radioactive Liquid Waste Sewer system [300 RRLWS]) were completed in 1953. The 307 Retention Basins, the 307 Trenches, and the Retention Process Sewer (RPS) system were also completed in 1953 to manage the radioactive effluents in a controlled manner. Effluents exceeding concentrations of 55,000 pCi/L were routed to the 340 Complex via the RRLWS system. However, effluents with concentrations lower than this level were routed through the RPS to the 307 Retention Basin for possible disposal to the 307 Trenches, or to the process sewer for disposal to the process ponds in the 300 Area (Gerber 1992).

Facilities that discharged to the 300 RRLWS system during the time frame of interest (i.e., approximately 1953 through 1968) included the 308, 309, 324, 325, 326, 327, and 329 Buildings. The 300 RRLWS discharged into disposal tanks located in the 340 Complex. The missions that these facilities supported varied over the years of operation. The following is a summary of the types of operations that were ongoing during the periods of discharge to the 200-LW-1 OU waste sites.

308 Building. The facility was built in 1960 with the original intent to provide laboratory support and fabrication facilities for the development of reactor fuels containing plutonium. The first fuel mixtures produced were metallic which, within 5 years, were followed by ceramic fuel blends. Between 1966 and 1968, neptunium-aluminum alloy fuel target elements clad in

Zircaloy-2 were produced for tests at N Reactor. In the late 1960s lithium-aluminate fuel targets with Zircaloy-2 cladding were produced. By 1976, more than 2,000 different fuel configurations had been produced in the 308 Building.

309 Building. The plutonium recycle test reactor (PRTR) was completed in 1960 as an operating test reactor with criticality first reached in November 1960. The original core loading was a zone type, with natural uranium oxide fuel in the central and outer zones and plutonium-aluminum alloy driver fuel elements in the middle zones. Other operations in this facility in the mid-1960s included the Fuel Element Rupture Test Facility for testing fuel element designs and examining fuel element failures.

324 Building. This laboratory facility was completed in 1966 as a radiochemistry and radiometallurgical facility that contained numerous radiological hot cells originally designed to support work at the PRTR. In addition to the radiological hot cells, the 324 Building contained many other laboratory facilities. Among these were four engineering development laboratories, two designed for work with nonradioactive materials and two designed for radiological hot cell work. Because of a 1965 incident, the PRTR (309 Building) original program of analysis never materialized. Instead, beginning in 1966 the facility supported the Waste Solidification Engineering Project, one of the first high-level waste vitrification demonstration programs initiated. Relative to the 200-LW-1 waste sites, it is unlikely that any large amount of waste from this facility was received during the operational time frame of these waste sites.

325 Building. This radiochemistry facility was completed in 1953 and housed at least 11 hot cells and a large number of laboratory facilities designed to perform multi-curie-level chemical development work with high-activity materials. Initial missions included production support and process improvement for REDOX, improvements for the uranium metal recovery process, and studies of separations and waste treatment aimed at developing techniques to reduce high-level wastes to "cribbing tolerances." Other missions included production development for radioactive lanthanum, technical support to the bismuth phosphate process, support for tritium production studies, and basic investigations of plutonium chemistry. These missions, along with development of the PUREX, RECUPLEX, and Plutonium Recovery Facility (PRF) processes, occupied the 325 Building during its first decade of operations (1953 to 1963).

326 Building. This physics and metallurgy building was opened in 1953 to assist the continuity of reactor operations and to conduct additional "reactor pile" physics development work. Hot cell work was conducted to examine reactor components and fuel elements to evaluate their characteristics and performance. Work was performed on unirradiated uranium fuels. Fuel jacketing studies were also conducted using aluminum-silicon blends, beryllium-zirconium ratios, and other alloys. Plutonium and plutonium-oxide fuel experiments were also conducted in the 1960s.

327 Building. The radiometallurgy building opened in 1953 to house the facilities for examining and testing irradiated materials, particularly fuel elements and fuel cladding materials. Missions in the late 1950s and early 1960s included establishing specifications for N Reactor fuel rods and process tubes, conducting performance evaluations on N Reactor fuel rods and tubes after startup in 1963, and examining various isotope combinations. As part of waste

vitrification projects in the 1960s, analytical performance evaluations of components and glassified products were conducted. Fuel rod examinations for other facilities from around the country were also conducted in this facility.

329 Building. The Biophysics Laboratory was completed in 1953 to support environmental and bioassay programs. The original mission of the facility was to prepare and count radioactivity levels in air, vegetation, soil, wildlife, river, groundwater, and bioassay samples. This mission expanded over time to include monitoring and counting fallout from atmospheric nuclear bomb tests that were being conducted at the time.

2.2.1.2 200 Area Plant History. The 200 Area laboratory wastes originated from each of the analytical laboratories supporting the major 200 Area chemical processing facilities. The analytical laboratories for the B, T, U, and REDOX Plants were located in the respective 222 Buildings. The analytical laboratory for PUREX was located in the main processing canyon (202-A Building). The Z Plant complex was initially supported by analytical laboratories in the 231-Z Building; however, these laboratories were moved to the 234-5Z Building. The laboratories generated wastes from experimental operations and daily activities. Generally, their operations and activities included quality assurance/quality control (QA/QC) sampling of process products in operational stages, waste sampling to ensure proper routing to cribs or trenches, random soil and vegetation samples collected near process facilities and/or waste sites, analysis of tank waste samples, and process engineering bench scale experiments.

B Plant. B Plant was constructed in 1944. From 1945 to 1952, B Plant operations consisted of a batch-wise, inorganic chemical separation of weapons-grade plutonium from irradiated uranium. This was known as the bismuth phosphate/lanthanum fluoride process. From 1952 to 1965, B Plant was used for waste treatment operations. In 1963, the 221-B Building began recovering strontium, cerium, and rare earths as part of the phase I processing for the 221-B Building Waste Fractionalization Project. Phase I processing at the 221-B Building ended in June 1966 to accommodate phase II construction. The phase III waste fractionalization processing began at the 221-B Building in 1968. This process separated the long-lived radionuclides, strontium-90 and cesium-137, from high-level PUREX and REDOX wastes, and stored a concentrated solution of strontium-90 and cesium-137 at the 221-B Building. In 1968, B Plant underwent renovations and the Waste Encapsulation and Storage Facility (WESF) was added to concentrate, encapsulate, and store radioactive waste. Waste fractionalization and encapsulation efforts continued until 1986 (DOE-RL 1993a). The 222-B Laboratory supported operations at the 221-B Building complex and other 200 Area facilities from 1945 to 1952. After 1952, all laboratory analyses of B Plant operations were sent to the 222-S Laboratory. The liquid waste stream generated from the laboratory included sample disposal waste, hood, and radiological hot cell cleanup waste. Sampling and testing equipment, gloves, empty containers, and other materials were buried as solid waste and are not associated with 200-LW-1 waste sites.

T Plant. T Plant was constructed in 1944. From 1945 to 1956, T Plant operations consisted of a batch-wise, inorganic chemical separation of weapons-grade plutonium from irradiated uranium. This was known as the bismuth phosphate/lanthanum fluoride process. In 1957, the 221-T Building was converted to a decontamination and equipment refurbishment facility. The facility provided services in radioactive decontamination, reclamation, and decommissioning of

process equipment. It currently still serves the Hanford Site in this capacity. A series of testing programs by Pacific Northwest National Laboratory and the Westinghouse Hanford Company also occurred intermittently from 1964 to 1990 (DOE-RL 1993a, 1993c). The 222-T Laboratory supported operations at the 221-T Building from 1945 to 1956. After 1956, all laboratory analyses of T Plant operations were sent to the 222-S Laboratory. The liquid waste stream generated from the laboratory facility included sample disposal waste and hood and hot cell cleanup waste. Sampling and testing equipment, gloves, empty containers, and other materials were buried as solid waste and are not associated with 200-LW-1 waste sites (DOE-RL 2001a, 2001c).

U Plant. U Plant was constructed in 1944 and included the 221-U Canyon Building and the 224-U Building. U Plant was based on the design of T and B Plants and was initially used to train personnel for the bismuth/phosphate plutonium separation and purification operations. During the training phase, only water was used in the plant systems and no waste streams were generated. However, in 1951, U Plant was modified for the Uranium Recovery Process (URP). From 1952 to 1958, U Plant was used to recover uranium from bismuth/phosphate wastes stored in the single-shell tanks for reuse in the reactor plants. A later operation conducted at U Plant (1952-1958) was the "scavenging" or precipitation of long-lived fission products during the liquid waste settling process before discharge to the soil column. The 222-U Laboratory, located directly southeast of the 221-U Building, was used from about 1947 to 1970 for laboratory analysis in support of the uranium recovery process and the UO_3 process. Various small-scale experiments and soil tests were done inside the facility.

The final operation of U Plant involved converting uranyl nitrate hexahydrate (UNH) to uranium trioxide (UO_3). This operation was accomplished by calcining the UNH in a batch process within the 224-U Building. In 1957, the batch conversion of UNH to UO_3 was renovated. The operation was updated to a continuous flow, and the 224-U Building became known as the UO_3 Plant (DOE-RL 1992c). The UO_3 Plant operated from 1958 until 1972 when PUREX was put in "stand-down." During that time, the UO_3 Plant converted UNH (from PUREX and REDOX) to UO_3 powder. The UO_3 Plant resumed operations in 1984 to process UNH from the PUREX Plant. As the feed lines from REDOX and 221-U were no longer in use, they were disconnected and capped in the UO_3 Plant. Operations of the UO_3 Plant ceased in 1988 (DOE-RL 1992c, 2001a, 2001c).

REDOX Plant. The Reduction/Oxidation or REDOX Plant (also known as "S Plant") was the first continuous plutonium separation operation at the Hanford Site. Not only did REDOX separate weapons-grade plutonium from irradiated fuel rods, it recovered the uranium. REDOX was a solvent extraction process that used hexone and aluminum nitrate nonahydrate (ANN) in nitric acid to complete these separations. Plant operations began in 1952 and continued until 1967 (DOE-RL 1992a). The 222-S Laboratory is one of the primary waste generators in the S Plant Aggregate Area. It was constructed during 1950 and 1951 and is located immediately south of the 202-S Building. The laboratory provides high-level and low-level radiological and nonradiological analytical services for the operations in the 200 Areas. It continues to support Hanford Site operations with emphasis on waste management, offsite shipment certification, chemical processing, and environmental monitoring programs throughout the 200 West and 200 East Areas, including B Plant, U Plant, the tank farms, 242-A and 242-S Evaporators, waste

encapsulation storage facility, PUREX Plant, and Plutonium Finishing Plant (Z Plant) (DOE-RL 2001a).

PUREX Plant. The separation process used at the PUREX Plant (also known as "A Plant") replaced the REDOX separation process. The PUREX process used a recoverable salting agent (nitric acid) that proved to be economically more feasible, generated less waste, and operated more safely than the REDOX process. The construction of the PUREX was completed in late 1955. The PUREX Plant operated continuously from November 1955 until 1972, separating plutonium and uranium products from irradiated fuel. PUREX was put on standby from 1972 until 1983. PUREX restarted in 1983 and continued operations until 1985 when it was deactivated. The 202-A Laboratory supported PUREX operations at the 202-A Building from 1955 to 1972, and again from 1983 to 1988. However, other samples from the PUREX facility were also sent to 222-S Laboratory for analysis (DOE-RL 1993b, 2001a).

The Z Plant Complex (231-Z). From 1945 until 1990, the Z Plant complex was used to isolate and purify plutonium solutions, produce metallic plutonium and plutonium oxides, and recover plutonium and americium from plutonium scrap materials. Throughout its lifetime, the Z Plant complex (Plutonium Finishing Plant [PFP]) received different types of processed (uranium and fission products removed) plutonium solutions from each of the 200 Area separations facilities. Beginning in 1944, plutonium from T and B Plants was refined and converted to a nitrate paste in the 231-Z Building prior to shipment offsite. In 1949, after the 234-5Z Building was constructed and operating, plutonium nitrate pastes were no longer produced. The 231-Z Building was then converted into a plutonium metallurgy laboratory and operated in this capacity during the 1950s until the 1970s. The research included tensile strength, stress testing, coating, and other material science properties of plutonium and plutonium alloys. Beginning in the 1960s, the Atomic Energy Commission's Division of Military Application began design, development, and fabrication of experimental weapons that supported the weapons testing program at the Nevada Test Site. Other projects including "state of the art" sampling methods for plutonium buttons, new coating processes, and development work in reactor fuels containing plutonium and other alpha-emitting materials were completed at the 231-Z Building in the late 1960s and early 1970s. In 1975, the Division of Military Application experimental work was phased out (DOE-RL 2001a).

Semi-Works Aggregate Area. The Semi-Works Aggregate Area was composed of two primary facilities: the 201-C Process Building and the Critical Mass Laboratory (209-E Building). The 201-C Process Building was the main processing facility for the Semi-Works Aggregate Area. During its history the 201-C Process Building went through three distinct operational modes. The 201-C Process Building was constructed in 1949 as a pilot plant for reprocessing reactor fuel using the REDOX (S Plant) chemical process and later the PUREX (A Plant) chemical process in 1954. In 1961, it was again converted to recover strontium from fission product waste. Cerium, technetium, and promethium, as well as minor amounts of americium and curium in the final production run, were also extracted. This facility operated until 1967. The facility remained in safe storage mode until decommissioning began in 1983. The Critical Mass Laboratory (209-E Building) was operated from 1960 to 1987 by Pacific Northwest Laboratory. Criticality experiments and research were conducted at this location (DOE-RL 1993c).

2.2.2 Process Information

The chemical laboratory waste category sites received wastes that originated from 200 and 300 Area laboratory processes and/or 200 Area operations. Most of the waste discharged to the soil column in the 200-LW-1 and 200-LW-2 OUs was generated at the major 300 Area laboratories that supported radiochemistry and metallurgical experiments. The 200 Area laboratories supported the major chemical processing facilities and equipment decontamination from T Plant from 1952 to 1972. The laboratories provided analytical services and supported research and development activities for the 200/300 Area operations. This support was provided in the following ways (RHO 1985):

- Quality assurance/quality control during operational stages and "trouble shooting" during process eruptions
- Preparing and characterizing radiochemical standards
- Liquid scintillation counting
- Preparation work for solvent extraction tests
- Sampling and analysis of waste to ensure it was properly routed to cribs or trenches
- Environmental analysis of soil and vegetation samples collected near process facilities and/or waste sites
- Analysis of tank waste samples.

Table 1-5 of the DQO summary report for the 200-LW-1 OU (BHI 2001) lists all the chemicals and reagents known to have been used or stored in the laboratory areas. Exact quantities of these chemicals and reagents are not known. Three general types of liquid wastes were produced by the laboratories, including the following (GE 1951a):

- Laboratory process wastes (including "prepared" sample solutions)
- Used or discarded analytical reagents and chemicals
- Wastewater from laboratory sinks and emergency showers.

Laboratory process wastes were characterized as slightly acidic to alkaline, radioactive wastes with a low salt and organic content. These wastes were often routed through settling tanks or sumps to cribs and trenches. The pH of these wastes may have been adjusted from slightly acidic to basic in the tanks/sumps prior to disposal (GE 1951a, WIDS). Nonradiological laboratory sinks and emergency showers in the laboratory areas drained to sanitary and/or cooling water/chemical sewer wastewater systems. The contents of the wastewater are not known, but were likely to have included intermittent releases from laboratory processes, glassware cleaning, and chemical spills.

2.2.2.1 300 Area Process Information. Laboratory wastes that were higher in radiological content (activities greater than 55,000 pCi/L) from 300 Area facilities were routed to the 340 Waste Complex where they were collected, sampled, and sent to the 200 Areas via tanker truck or rail car. Waste sites in the 200 Areas that received 300 Area wastes included 216-S-20, 216-Z-7, and all of the 200-LW-1 waste sites. Wastes from these facilities were generated by various experimental operations including (Young et al. 1990) the following:

- Development of plutonium-based reactor fuels
- Plutonium Recycle Test Reactor
- Radiometallurgical and radiochemistry laboratories supporting the development of 200 Area process operations including bismuth/phosphate, lanthanum/fluoride, uranium recovery, REDOX, PUREX, and plutonium reclamation processes along with several experiments including tritium production, uranium, plutonium, and thorium studies
- Biophysics laboratory.

Figure 2-11 is a graphical representation of the wastes collected at the 340 Complex by the 300 Area laboratories. Wastes generated by the 300 Area processes and/or projects are described below.

308 Building. Development of Plutonium-Based Reactor Fuels: Wastes comprised mostly plutonium oxide and plutonium-uranium oxide blends(including metallic, ceramic, and cement forms) as well as multiple laboratory and fuel fabrication chemicals, acids, neutralizers, degreasers, reagents, and cleansers.

309 Building. Plutonium Recycle Test Reactor: Radioactive liquid wastes generated during operations in the reactor facility were directed through three tanks (i.e., 309-TW-1, 309-TW-2, and 309-TW–3) into the 300 RRLWS. In addition to normal operational wastes, liquid wastes likely included uranium oxide, plutonium oxide, cobalt-60, tritium, and other fission products. On September 29, 1965, a major contamination event occurred when a process tube failed. The release grossly contaminated the PRTR's primary and secondary coolant systems with fission products from the Fuel Element Rupture Test Facility, which was a part of the 309 Facility. Nearly 1 million gallons of secondary coolant were contaminated initially, but the total rose to nearly 14 million gallons as cooling water was added for many days afterward. In response to the release, tanker trucks (18,927-L [5,000-gal]) disposed of the contaminated effluent to the 200-LW-1 waste sites on an around-the-clock basis.

In addition to the fission products released in the original event, subsequent decontamination activities included the use of buffered oxalic acid-peroxide solutions, alkaline permanganate, and sulfamic acid. Depending on contamination levels, these chemicals may have been sent to the 340 Complex through the 300 RRLWS and subsequently to the 200 Areas, or they may have been sent to the process sewer.

324 Building. Radiometallurgical and Radiochemistry Support Laboratory: Chemical wastes generated in the 324 Building have included the components of many laboratory processes, as well as exchange column resins and cell cleansers, reagents, drying agents, and other substances. In general, waste vitrification, a major 324 Building process, was not considered a chemically intensive operation.

325 Building. Radiochemistry Laboratory: Missions conducted at the 325 Building included production development for radioactive lanthanum, technical support to the bismuth phosphate process, support studies for tritium production, and basic investigations of plutonium chemistry. These missions, along with development of the PUREX, RECUPLEX, and PRF processes occupied the 325 Building during its first decade of operations. All of the radionuclides and nonradiological constituents associated with these processes were present in the waste streams generated by this facility. Additionally, PRF process development introduced dibutyl butyl phosphonate into 325 Building waste streams. Cell decontamination chemicals and reagents including nitric acid, ethanol, acetone, many commercial products of the Turco Corporation, and other cleansers were blended into the high-activity waste streams that eventually were piped through the 300 RRLWS to the 340 Complex before transfer to the 200 Areas.

326 Building. Physics and Metallurgy Building: Wastes generated by metallurgical work in the 326 Building consisted primarily of chemicals and heavy metals. The etching experiments used many acids, including hydrofluoric, nitric, sulfuric, aqua regia (a concentrated mixture of hydrochloric and nitric acids), and picric acid. Sodium hydroxide and potassium hydroxide were the principal caustics used. Many reagents and industrial cleansers including carbon tetrachloride, acetone, ethanol, and various commercial products were used. A 1976 survey of pipe trench sediment found evidence of uranium-235/238, thorium-231/234, radium-223/226, lead-211, protactinium-231, and other isotopes. Soil samples taken near a leak in the 326/329 Building diverter line to the RLWS in 1976 indicated the presence of cesium-137, with lesser amounts of cesium-134, cerium-praseodymium-144, europium-155, americium-241, actinium-228, and other radionuclides in trace quantities.

327 Building. Radiometallurgy Building: Liquid waste from this facility included irradiated materials in dissolved and/or particulate form and an array of chemical reagents and cell cleansers including carbon tetrachloride, acetone, ethanol, kerosene, and many commercial products.

329 Building. Biophysics Laboratory: Wastes and contamination in the facility resulted from the chemicals used to separate isotopes before analysis and counting could be done and from occasional spread of fission product activity from contaminated samples brought in from the field. During the 1950s, many chemicals were used routinely, including acids (e.g., nitric, hydrochloric, hydrofluoric, boric, sulfuric, tartaric), sodium thiosulfate, hydroxylamine hydrochloride, ammonium chloride, hydrogen peroxide, sodium sulfate, magnesium perchlorate, aluminum nitrate, sodium fluoride, lanthanum fluoride, sodium iodide, acetone, thenoyltrifluoracetone, thenoyltrifluoracetone-benzene solutions, lanthanum nitrate, potassium permanganate, silver nitrate, carbon tetrachloride, cupric oxide, copper nitrate, arsenic nitrate, ferric chloride, zinc nitrate, cupferron, and many other generic and commercial products. During the 1960s, several commercial products were added as well as formalin, several acids (citric,

acetic, and oxalic), carrier agents (gallium chloride, strontium nitrate, zirconium nitrate, yttrium nitrate, ferric nitrate), and various carriers for iodine, manganese, arsenic, and other substances.

2.2.2.2 200 Area Process Information. The 200 Area laboratory wastes included wastes from several 200 Area processes generated by experimental operations including QA/QC sampling of process products in operational stages, sampling of waste to ensure proper routing to cribs or trenches, random soil and vegetation samples collected near process facilities and/or waste sites, and analysis of tank waste samples. Additional information for the processes listed below can be found in other 200 Area work plans (DOE-RL 2001a, 2001b, 2001c). The key 200 Area processes/facilities include the following:

- Bismuth/phosphate and lanthanum/fluoride
- Uranium recovery and scavenging operations
- REDOX
- PUREX
- Semi-Works
- Strontium/cesium separations, recovery, and storage operations/WESF
- Plutonium isolation processes (oxalate/fluoride precipitations, rubber glove, remote mechanical line A and C [RG, RMA/RMC] operations). Plutonium/americium scrap recovery processes (RECUPLEX, PRF, and americium recovery) and several experiments, including tritium production, uranium, plutonium, and thorium studies.

200 Area decontamination wastes included wastes from the T Plant complex after it was converted to a decontamination and equipment refurbishment facility in 1957. The 221-T Building used steam for heating the canyon area and decontamination activities (steam cleaning with the addition of phosphate-based soaps and complexants). Heavy equipment and vehicles were steam-cleaned in the 2706-T Building.

The processes conducted in the 200 Area facilities (i.e., B/T, WESF, U/UO_3, REDOX, PUREX, Semi-Works Plants, and the Z Plant complex) that generated the primary waste streams into the 200-LW-1 OU waste sites included the following.

B and T Plants. The bismuth/phosphate process was an inorganic, step-wise, precipitation process that separated plutonium from uranium and fission products. This process occurred in the 221-B/T canyon building and used sodium hydroxide to remove aluminum cladding and concentrated nitric acid to dissolve the fuel rods. Bismuth phosphate and bismuth oxynitrate were used to support precipitation of plutonium, while hydrogen peroxide, sodium dichromate, ferrous hydroxide, and ferrous ammonium sulfates were used to change the plutonium valence during the oxidation reactions. Phosphoric, sulfuric, and nitric acids were added to dissolve the

precipitants formed. The bismuth/phosphate process preferentially attracted plutonium from the solution and, as a precipitate, was physically separated by centrifuging.

The lanthanum/fluoride process was performed in the 224-B/T Building and further purified the dilute plutonium solution created in the last step of the bismuth/phosphate process. The dilute plutonium nitrate supernatant was oxidized with sodium metabismuthate. Phosphoric acid was added to precipitate impurities and the resulting solution treated with oxalic and hydrofluoric acids and lanthanum salt. As a result, lanthanum fluoride and plutonium fluorides were co-precipitated. The lanthanum and plutonium fluoride solids were then converted to hydroxides by the addition of a hot potassium hydroxide solution. The hydroxides were washed with water, dissolved in nitric acid, and heated to form a concentrated plutonium nitrate solution. This solution was sent to the isolation building (231-Z) for further purification treatments and evaporation. A concentrated plutonium nitrate paste was the final product. For every batch (760 L [200 gal]) of dilute, unpurified plutonium solution entering the 224-B/T Building, an estimated 30 L (8 gal) of purified concentrated weapons-grade plutonium was produced (GE 1944). Laboratory liquid wastes were directed to other waste sites in the waste category from 1945 to 1952.

Waste Recovery/Fractionalization/WESF. From 1963 to 1966, strontium, cerium, and rare earths were recovered using an acid-side, oxalate-precipitation process. The waste recovery/fractionalization process included a thermal evaporation to concentrate process wastewaters prior to disposal. This system was used to concentrate low-level radioactive waste once the cesium and strontium waste fractionalization process was shut down in 1984. Double-shell tank waste was received at the 221-B Building to be processed through the low-level waste concentrator from 1968 to 1986. Other sources of low-level waste included miscellaneous sumps and drains in WESF, which diverted decontamination waste solutions generated in the WESF process cells. Another contributor was a liquid collection system located beneath the 40 cells in the 221-B Building that collected cell drainage from decontamination work and water washdowns in the processing section of the 221-B Building. The concentrator also processed wastes produced by the cleanout process vessels at the 221-B Building and WESF from 1968 to 1986 (DOE-RL 1993a). Process samples from WESF operations were often analyzed at the 222-S Laboratory. Liquid waste effluents derived from analysis at 222-S were routed to 216-S-20 and other sites in the waste category.

Uranium Recovery Process (URP) U/UO_3 Plant and Scavenging Operations. The URP was implemented at U Plant to recover the spent uranium from the metal waste and first-cycle waste streams generated in T and B Plants for reuse in weapons-grade plutonium production. The URP was performed in three phases. The first phase included the removal of bismuth/phosphate waste (metal waste, first-cycle supernatants, and cell 5 and 6 drainage) from T, TX, TY, B, BX and BY Tank Farms and preparation of the sludge/slurry solution using nitric acid to dissolve the uranium metal and jet it into the plant. The second phase consisted of the separation of the uranium from remaining plutonium, fission products, and nonradiological constituents by a solvent extraction process. The counter-current solvent extraction process used tributyl phosphate (TBP) in a normal paraffin hydrocarbon diluant such as AMSCO or kerosene to bond with the uranium. Sulfamic acid and ferrous ammonia sulfate were used to ensure the correct valence state was obtained. The separated UNH was then sent to the 224-U Building or the

UO_3 Plant where it was calcined or heated to 400°F to drive off nitrate, resulting in UO_3. The UO_3 powder was removed from the vessels, packaged, and shipped offsite to Oak Ridge, Tennessee; converted to uranium metal; and sent back to the 300 Area at the Hanford Site to be reincorporated into the uranium fuel rod production (GE 1951b).

In 1953, tests to further treat URP aqueous waste streams generated at T, U, and B Plants during the bismuth/phosphate campaign proved successful. The "scavenging" process separated the long-lived fission products (including strontium-90 and cesium-137) from the waste solutions by precipitation. The order of operations was often modified throughout the duration of the scavenging process. After URP processing, TBP column wastes were sent to a neutralization tank at U Plant where the pH was adjusted to 9 ± 1. Chemicals used to scavenge fission products included potassium and sodium derivatives of the metal/ferrocyanide complex ion. The most notable and widely used metals (used to assist precipitation) were iron, nickel, and cobalt. Calcium nitrate and/or strontium nitrate were often added to enhance the precipitation of strontium-90. Phosphate ions were also added to aid the soil retention of strontium-90. After the TBP waste had been scavenged, it was returned to the B, BX, BY, T, TX, and TY Tank Farms to allow the solids (containing the fission products and scavenging chemicals) to settle. The waste was sampled from the tanks at various depths and analyzed before the liquid effluent was sent to cribs and/or trenches (pending the concentrations of cesium-137 and strontium-90) or was rerouted to other nearby tanks where settling continued. The U/UO_3 and scavenging operations process samples were analyzed at the 222-U or 222-S Laboratories. Liquid waste was disposed from the 222-U Laboratory to other sites in the waste category.

REDOX. The REDOX process, used until 1967, was a solvent-extraction process that extracted plutonium and uranium from dissolved fuel rods into a methyl isobutyl ketone (or hexone) solvent. The solvent-extraction process was based on the preferential distribution of uranyl nitrate and the nitrates of plutonium between an aqueous phase and an immiscible organic phase (DOE-RL 1992a). The REDOX process included fuel decladding with boiling sodium hydroxide/sodium nitrate solution or a boiling solution of ammonium fluoride and ammonium nitrate. Feed dissolution using concentrated nitric acid and plutonium oxidation was completed simultaneously with potassium permanganate and sodium dichromate. The prepared feed entered the packed counter-current solvent extraction column where acidified hexone was fed to the bottom of the column and the aqueous phase (ANN scrub solution or salting agent) was fed to the column from the top. The aqueous solubility of the uranium and plutonium nitrates was reduced by increasing the nitrate concentration in the aqueous phase. The uranium and plutonium were extracted into the organic phase and routed to the second extraction column while the fission products remained in the aqueous phase. Uranium and plutonium (present in the organic phase) were chemically separated in the second extraction column using ferrous sulfamate solution containing ANN to reduce the plutonium to the +III valence state. Further purification cycles of uranium and plutonium were conducted during operations using the same chemical constituents. The solvent was recovered and recycled back into the process after sampling and analysis. Waste generated in the 202-S Building was also treated and routed to cribs after sampling and analysis. Radioactive and radioactive mixed liquid wastes from the laboratory were treated in the 219-S Waste Handling Facility. Laboratory wastewater (along with wastewater from the 291-S Stack Complex and 219-S Waste Handling Facility) was then directed through the 207-SL Retention Basin and ultimately to the 216-S-20 Crib and other sites

in the waste category. The 222-SA Chemical Standards Laboratory contributed nonradiological, nonhazardous wastewater downstream of the 207-SL Retention Basin.

PUREX. The PUREX process was an advanced solvent extraction process that replaced the REDOX process. PUREX used a recyclable salting agent, nitric acid (which greatly lessened costs and amount of waste generated), and TBP in a normal paraffin hydrocarbon solution as a solvent. The main purpose of the PUREX facility (202-A) was to extract, purify, and concentrate plutonium, uranium, and neptunium contained in irradiated uranium fuel rods discharged from Hanford Site reactors. Fuel decladding was performed with a boiling sodium hydroxide/sodium nitrate solution or a boiling solution of ammonium fluoride and ammonium nitrate. Feed dissolution used concentrated nitric acid and ANN. The prepared feed entered the pulsing, counter-current solvent extraction column where TBP in a normal paraffin hydrocarbon diluant was fed to the bottom of the column and the aqueous phase (sodium nitrite/nitric acid salting agent solution) was fed to the column from the top. Dilute nitric acid, ferrous sulfamate, and sulfamic acid descended from the top of the second column to remove uranium and neptunium from plutonium. Chemical separation processes were based on conducting multiple purification operations on the resulting aqueous nitrate solution containing each of the separated products. The driving forces for the separations consisted of varying partition coefficients between aqueous and organic phases, controlled by valence state changes of the element of interest (DOE-RL 1993b). The solvent and salting agent (nitric acid) were both recovered, treated, and recycled back into the process operations. An analytical laboratory was also housed within the 202-A Building. Waste generated by the 202-A Laboratory operations were routed to 216-S-20 and other sites in the waste category.

The Z Plant Complex (231-Z). The 231-Z Building had several missions throughout its operation. From 1945 to 1949, it further decontaminated plutonium product from both T and B Plants before shipment offsite. This process consisted of adding ammonium nitrate to the plutonium nitrate solution and thus changing the valence state. Next, sulfates and peroxide were added to the mixture, causing plutonium to precipitate as plutonium peroxide. Nitric acid was added to this precipitate, forming a more concentrated plutonium nitrate solution. This product was placed in small shipping containers and boiled using hot air to form a wet plutonium nitrate paste prior to shipment offsite. In 1949, the 231-Z Building was converted into a plutonium metallurgy laboratory and operated in this capacity from the 1950s until the 1970s. The research included tensile strength, stress testing, coating, and other material science properties of plutonium and plutonium alloys. Beginning in the 1960s, the Atomic Energy Commission's Division of Military Application began design, development, and fabrication of experimental weapons that supported the weapons testing program at the Nevada Test Site. Other projects including "state of the art" sampling methods for plutonium buttons, new coating processes, and development work in reactor fuels containing plutonium and other alpha-emitting materials were also completed at the 231-Z Building in the late 1960s and early 1970s. In 1975, the experimental work performed by the Division of Military Application was phased out (Gerber 1997). The 216-Z-7 Crib received process waste from the 231-Z Building via the 231-W-151 Sump from 1947 to 1967. The 216-Z-7 Crib replaced the 216-Z-5 Crib. It also received Hanford Site laboratory waste from the 231-Z Building, via the 231-W-151 Sump. In addition, the site received waste from Pacific Northwest Laboratory operations in the 231-Z Building and 300 Area laboratory waste from the 340 Facility (DOE-RL 1992d).

Semi-Works. The 201-C Process Building and 209-E Critical Mass Laboratory comprise the Semi-Works Plant. During its history, the 201-C Process Building went through three distinct operational modes. These operations included pilot-plant testing for REDOX, PUREX, and the strontium recovery process. The strontium recovery process was performed via solvent extraction using a complexant di-2-ethyl-hexyl phosphoric acid to extract strontium from acid solutions of waste fuels. The Critical Mass Laboratory (209-E Building) conducted criticality experiments from 1960 to 1983 using plutonium nitrate and enriched uranium solutions. Criticality research was also conducted with solid nuclear materials and fuels such as plutonium blocks, uranium blocks and slabs, and fuel assemblies from the Fast Flux Test Facility, and other reactors (DOE-RL 1993c). Process samples from Semi-Works operations were often sent and analyzed at the 222-S Laboratory. Liquid waste effluents derived from this analysis at the 222-S Laboratory were routed to the 216-S-20 Crib and other sites in the waste category.

200 Area Decontamination Wastes. Two types of decontamination operations were conducted in the 200 West Area. These included decontamination and refurbishment of highly contaminated process equipment and the decontamination of heavy equipment and vehicles. Typical decontamination efforts involved chemical and water flushes. Techniques other than water and chemical flushes were also used. Sand blasting and ultrasonic cleaning were used when considered suitable.

The decontamination and refurbishment of highly contaminated process equipment was conducted in the 221-T/221-U Buildings. Decontamination of large immovable pieces of equipment sometimes took place in the plant where it was used. The immovable objects were typically flushed and decontaminated with chemical solutions to the extent possible. Hot solutions of nitric acid, caustics, and complexing agents (tartrate, oxalic acid, and permanganate) were used. Easily movable equipment such as pumps, agitators, and smaller process vessels were taken to a centralized facility (221-T/U). Pumps and agitators were immersed in thimble tanks, which permitted simultaneous immersion of the equipment and the operation of the equipment in the decontaminating solutions. A typical decontamination cycle included successive treatments with 15% to 25% caustic solutions containing an oxidizing agent, a water flush, a flush with 10% to 25% nitric acid solutions containing a reducing agent, and then another water flush (GE 1963, Kingsley and Short 1960). Stainless steel components were treated with a water flush, 5% versene (ethylenediamine tetraacetic acid), 1% sodium nitrate, and 5% sodium hydroxide. This cycle was repeated at least four times (Kingsley and Short 1960). In several instances, larger process equipment such as vessels from the REDOX facility were decontaminated and repaired. Chemical flushing with solutions of nitric acid, oxalic acid, and commercial cleaners interspersed with numerous water flushes were used to reduce the radiation within the vessels.

Over the course of equipment decontamination and refurbishment operations at the various facilities, numerous chemical compounds including phosphate-based soaps and complexants were used. Tables in WHC (1990) provide a listing of compounds that were used at either 221-T or at U Plant over the period from 1961 through 1980. Decontamination wastes from 221-T were routed through tanks and ultimately to the 216-T-27 and 216-T-28 Cribs.

Contamination of heavy equipment, railcars, and vehicles usually consisted of particles of fission products (e.g., ruthenium, zirconium, niobium, iodine). These particles were drawn into the radiator and other engine components and became attached to oily surfaces of the engine compartment. To continue use of this equipment, a decontamination facility was established at the 269-W garage. Removal of contamination was accomplished using commercial cleaners (Actresol, Kerful Cleaner, Aeso Wash) and a steam jet spray on the radiators, engines, and undercarriages. Painted automobile surfaces and all interior surfaces and materials were hand cleaned using mild detergents such as Calgon. Sometimes external surfaces required more stringent methods, such as aggressive chemicals like Kleeno Bowl and other harsh acids and caustics, and occasional sandblasting (Kingsley and Short 1960).

These decontamination operations initially were performed outdoors in open pit areas such as the 216-U-13 Trench (1952 to 1956) and the 216-T-13 Trench (1954 to 1988). These sites had limited facilities for handling steam and water. Provisions for waste collection, drainage, and disposal were considered unsatisfactory. Cold and inclement weather further complicated the work. In 1964, a new decontamination facility, the 2706-T Building (originally known as 2706-W), was completed. This facility provided improved steam, high-pressure water, and chemical cleaning capabilities for all of the site's railroad equipment and heavy and light duty automotive equipment. Means for adding chemicals to the steam spray or high-pressure water were made available. Adequate waste collection, drainage, and disposal facilities were provided. Commercial chemicals were tested for their application to this decontamination work. Among the waste sites used for disposal of decontamination wastes from the 2706-T Building were the 216-T-33 Crib in the 200-MW-1 OU and the 216-T-27 and 216-T-28 Cribs in the 200-LW-1 OU. After the pipeline to the 216-T-33 Crib plugged in February 1963, waste was routed to the 216-T-28 Crib. The 216-T-27 and 216-T-28 Cribs were active from February 1960 to December 1966.

2.2.3 Representative Sites

The concept and rationale for using analogous sites to streamline the site characterization and evaluation efforts required to support remedial action decision making are discussed in the Implementation Plan (DOE-RL 1999). The analogous site approach relies on first grouping sites with similar waste site history and contaminants, and then choosing one or more representative sites for comprehensive field investigations, including environmental sampling. Findings from site investigations at representative sites apply to other sites in the waste group or waste category that were not characterized. Sites for which field data have not been collected are assumed to have similar contamination characteristics to the sites that were characterized. Confirmatory investigations of limited scope, rather than full characterization efforts, can then be performed later at the analogous sites.

Data from representative sites are used to evaluate remedial alternatives and to select a preferred alternative(s) to apply to the entire waste group or waste category. Confirmatory sampling of the analogous sites after remedy selection may be required and is built into the remedial design planning to demonstrate that analogous conditions exist. Although a degree of uncertainty exists in employing the analogous site concept, substantial benefit is realized in the early selection of a remedy that allows early cleanup action.

As defined in the waste site groupings report (DOE-RL 1997), two waste sites were initially proposed as representative sites that may be indicative of conditions in the 200-LW-1 OU. All of the waste sites in the OU were evaluated during DQO sessions for consideration as representative sites. The DQO process (BHI 2001) verified the selection of the 216-B-58 Trench and the 216-T-28 Crib as appropriate representative sites in the 200-LW-1 OU.

The 216-T-28 Crib was selected as a representative site because it received the largest inventory of uranium, cesium, and nitrate in the OU, significant amounts of plutonium and strontium, and the largest effluent volume compared to other waste sites in the OU. In addition, available characterization efforts (borehole geophysical log data) indicate that the vertical extent of contamination of cesium-137 (typically an immobile contaminant) is >45.7 m (>150 ft). Based on the available data, the 216-T-28 Crib is the worst-case site in the OU in terms of radiological and nonradiological inventory, effluent volume received, and extent of vadose zone contamination. The 216-B-58 Trench was selected as a representative site because it has an inventory typical of the OU and little or no radiological/nonradiological and geologic data have been collected in the vicinity of the BC Cribs. Therefore, it provided an opportunity to improve representative site knowledge concerning the 200-LW-1 OU.

The chemical laboratory waste category includes the 200-LW-1 and 200-LW-2 OUs and their waste sites. During the DQO process, two representative sites from the 200-LW-2 OU were added to this work plan to provide characterization data that better defines conditions in the category. The 200-LW-2 OU waste sites received waste from 200 and 300 Area laboratories and from 200 Area decontamination efforts (DOE-RL 1999).

The 216-Z-7 Crib was selected as a worst-case site in the 200-LW-2 OU based on high inventories of plutonium, cesium, and strontium. The 216-S-20 site was selected as a typical case site because it was used for the longest duration and contains significant inventories of radionuclides (plutonium, cesium, and strontium) and known inorganic waste.

The following sections describe the representative sites in detail. This information was obtained from the WIDS database and WIDS historical files, unless otherwise noted.

2.2.3.1 216-B-58 Trench. The 216-B-58 Trench is located in the BC Controlled area (Figure 2-8), south of the 216-B-54 and 216-B-53B Trenches. It trends east-west, and is 60 m (200 ft) long, 3 m (10 ft) wide, and 3 m (10 ft) deep (Maxfield 1979). Earthen dams divide the 216-B-58 Trench into 8-m (25-ft) sections (Figure 2-12). The trench was covered with eight wooden cover frames covered by "sisalkraft" paper, 5.5 m (18 ft) wide by 8.5 m (28 ft) long. There is believed to be a corrugated 122-cm (48-in.)-diameter steel pipe that was placed along the bottom of the trench. The trench also includes a wooden cover that may create a collapse potential during characterization work. The low height of the structure, the small size of the wood used, and the age, combined with its probable collapse during backfilling, suggests that the current collapse potential is minimal (DOE-RL 1993a).

The site was active from 1965 to 1967. The 216-B-58 Trench received 413,000 L (109,103 gal) of liquid waste from the 340 complex. The waste is low salt and neutral/basic. Material

discharged to the site reportedly included 9.1 kg (20 lb) of uranium, 5.0 g (0.01 lb) of plutonium, 4.4 Ci of cesium-137, 5.5 Ci of strontium-90, and 10 kg of nitrates (DOE-RL 1997).

When the calculated specific retention capacity of the soils in the vadose zone beneath the trench was reached, it was deactivated by disconnecting the short section of above-ground piping from the permanent underground line (see Figure 2-12). The deactivated trench was then backfilled with gravel to grade and stabilized by adding 0.6 m (2 ft) of topsoil that was seeded with thickspike, Siberian, and crested wheatgrass. The area was surface stabilized with clean dirt in 1982.

2.2.3.2 216-T-28 Crib. The 216-T-28 Crib, the southernmost of the 216-T-26, 216-T-27, and 216-T-28 Crib series (Figure 2-9), is located 91 m (300 ft) north of 22nd Street and 61 m (200 ft) east of Camden Avenue. The unit is a 200-LW-1 OU site and consists of a 36-cm (14-in.) steel inlet pipe reducing to a 25.4-cm (10-in.) steel pipe, 2.4 m (8 ft) below grade (Figure 2-13). The pipe branches to four 20.3-cm (8-in.) steel pipes, each one extending to a 1.2-m (4-ft)-long by 1.2-m (4-ft)-diameter, open-end, vertically-oriented, concrete sewer pipe. This structure rests in an excavation that is 4.6 m (15 ft) deep by 9 by 9 m (30 by 30 ft). The excavation is filled with 2.4 m (8 ft) of gravel and 2.1 m (7 ft) of earth. The crib is enclosed within a light chain barricade and is marked with underground contamination warning signs (DOE-RL 1992b).

The 216-T-28 Crib was active from February 1960 until February 1966. During that time, it received 4,230,000 L (1,117,450 gal) of liquid mixed waste containing 387 kg (850 lb) of uranium, 70 g (0.15 lb) of plutonium, 193 Ci of cesium-137, 106 Ci of strontium-90, and 10,000 kg (22,050 lb) of nitrates (DOE-RL 1997). The waste constituents included steam condensate decontamination waste, miscellaneous effluent from the 221-T Building, decontamination waste from the 2706-T Building, and 300 Area laboratory waste from the 340 Building (DOE-RL 1997).

An underground pipeline to the 241-T Tank Farm was used to transfer waste from T Plant (after it cascaded through tanks 241-T-110, 241-T-111 and 241-T-112) to the 216-T-26, 216-T-27, and 216-T-28 Cribs. The tanks contained steam condensate and process decontamination waste from T Plant along with 2607-T equipment decontamination waste (DOE-RL 1992b).

In 1964, 300 Area waste was added to the 216-T-28 and 216-T-27 Cribs via a vent riser from tanker trucks. Waste site 200-W-82 is a liquid waste truck unloading station for unloading 300 Area liquid wastes for disposal to the 216-T-28 Crib. T Plant waste that was discharged to the 216-T-27 and 216-T-28 Cribs was routed from the 241-T Tank Farm. Effluent was temporarily diverted to the 216-T-27 Crib in November 1965. The crib was deactivated in December 1966 when the prescribed radionuclide disposal limit was reached. Deactivation consisted of blanking the pipeline from the tank farms to the 216-T-26 through 216-T-28 Crib series and the 216-T-28 vent riser (WIDS).

From 1969 to 1979, a few contaminated Russian thistles were found growing on the surface of this area. Most of the thistles were removed as they were found, but some had deteriorated, causing contamination of the ground surface. A radiation survey done in May 1975 identified spotty surface contamination to a maximum of 30,000 cpm. Remedial action in June and

July 1975 included removing 15 cm (6 in.) of soil from affected areas and disposing it in the 200 West Dry Burial Ground. The site was then covered with clean fill to its original level (WIDS).

2.2.3.3 216-S-20 Crib. The 216-S-20 Crib is located 93 m (305 ft) southeast of the 202-S Building and 91 m (300 ft) north of 10th Street (Figure 2-10). The unit has a side slope of 1H:1V (Horizontal:Vertical) and contains two 3.7- by 3.7- by 2.7-m (12- by 12- by 9-ft) (L x W x H) wooden structures, 15 m (50 ft) apart, with the crib top of each located 5.5 m (18 ft) below grade (Figure 2-14). The bottom of each wooden structure is suspended in a gravel fill that is 1.2 m (4 ft) above the bottom of the unit (DOE-RL 1992a). The outer area of the crib is barricaded with a light chain with surface contamination warning signs and a concrete post marker. The surface is sand and gravel with a slight depression around the riser vents. Within the outer barricade are two inner barricades around each of the metal riser vents. The inner chains are posted with underground radioactive material and cave-in potential signs at each corner (DOE-RL 1992c).

The 216-S-20 Crib began operating in January 1952 and was retired in May 1973. The unit received 135,000,000 L (35,663,200 gal) of waste containing 38.7 kg (85 lb) of uranium, 171 g (0.4 lb) of plutonium, 56.5 Ci of cesium-137, 22.7 Ci of strontium-90, and 20,000 kg (44,000 lb) of nitrates (DOE-RL 1997). Until July 1953, the crib received miscellaneous waste from laboratory hoods and decontamination sinks from 202-S via the 207-SL Retention Basin and the 219-S Retention Building. From July 1953 to September 1963, the crib received the above effluent via pipelines from the 207-SL Retention Basin, 219-S Retention Building, and 300 Area laboratories via a tanker truck through a manhole located south of the unit. From September 1963 to January 1969, the crib received miscellaneous waste from laboratory hoods and decontamination sinks in the 222-S Laboratory via the 219-S Retention Building. After January 1969, 300 Area laboratory wastes were sent to the 216-T-28 Crib. From January 1969 to November 1972, the 216-S-20 Crib was inactive due to surface subsidence. The 219-S Retention Building and 207-SL Retention Basin pipelines were valved out from the site. The 222-S Laboratory effluent was rerouted to 202-S Building concentrators for boildown and discharge to the underground storage (DOE-RL 1992c, GE 1951a).

The 216-S-20 Crib has had a history of subsidence. Since the completion of stabilization in December 1974, sink holes have been filled on three different occasions. No cavities are likely to remain below the ground surface (Maxfield 1979). It is approximated that the 216-S-20 Crib has received a total covering of 0.3 m (1 ft) of stabilization soil. Thus, 9.8 m (32 ft) is the total depth of the unit from the surface. No known unplanned releases are associated with this crib.

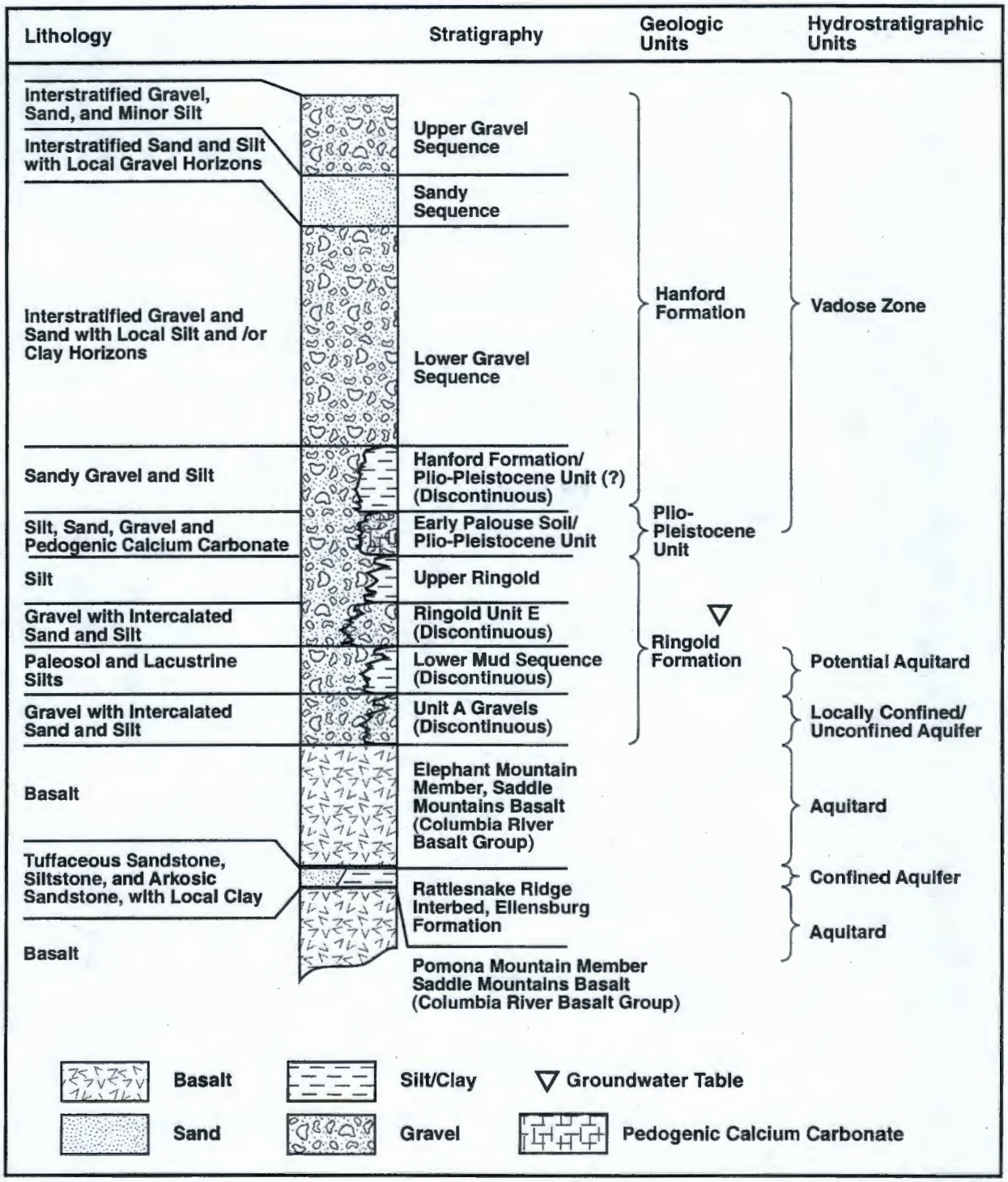
2.2.3.4 216-Z-7 Crib. The 216-Z-7 Crib is an inactive waste site located approximately 153 m (500 ft) east of the 231-Z Building and about 137 m (450 ft) north of 19th Street (Figure 2-9). The 216-Z-7 Crib consists of two parallel wooden structures 45.7 m (150 ft) long by 1.5 m (5 ft) wide by 0.6 m (2 ft) high, placed in a 1.5-m (5-ft)-deep excavation (Figure 2-15). However, the entire 216-Z-7 area surrounding the crib was excavated to approximately 3 m (10 ft). Surface stabilization of 0.6 m (2 ft) is assumed for this site. Thus, the total depth from the current 216-Z-7 Crib surface to the bottom of the structure is approximately 3.6 m (12 ft). Each wooden structure was constructed of three overlapping tiers. A 45.8-m (150-ft)-long 7.5- or 10-cm

(3- or 4-in.)-diameter perforated distribution pipe ran above the second tier. Each of the two trenches was covered by 503 m (1,650 ft) of 5-cm (2-in.) of planking topped with tar paper. The excavation was backfilled with gravel (DOE-RL 1992d).

The 216-Z-7 Crib received process waste from the 231-Z Building via the 231-W-151 Sump from 1947 to 1967. A riser on the west side of the crib received 300 Area liquid waste from the 340 Facility via tanker trucks. In total, the site received an estimated 79,900,000 L (21,100,000 gal) of liquid waste containing 4.46 kg (10 lb) of uranium, 2,000 g (4 lb) of plutonium, 200 Ci of cesium-137, 200 Ci of strontium-90, and 20,000 kg (44,000 lb) of nitrates (DOE-RL 1997).

When the facility was retired in 1967, deactivation was accomplished by blanking the pipeline west of the 231-Z-151 Sump and the distribution piping. No unplanned releases were associated with this crib (WIDS).

Figure 2-1. Generalized Stratigraphic Column for the 200 Areas.



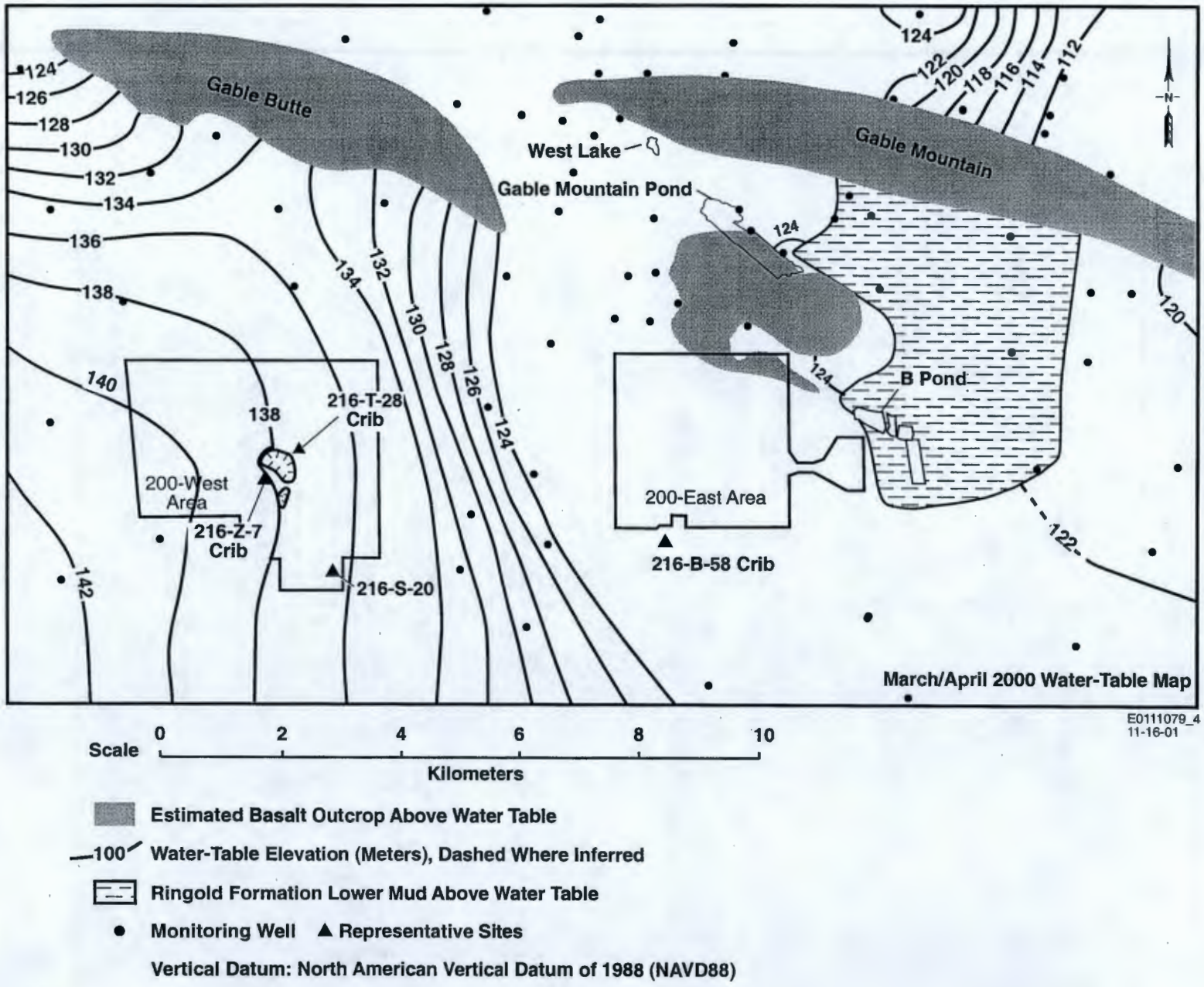


Figure 2-2. Groundwater Map of the 200 East and 200 West Areas (Modified from PNNL 2001b).

Figure 2-3. Stratigraphy Near the 216-B-58 Trench.

Well 299-E13-10

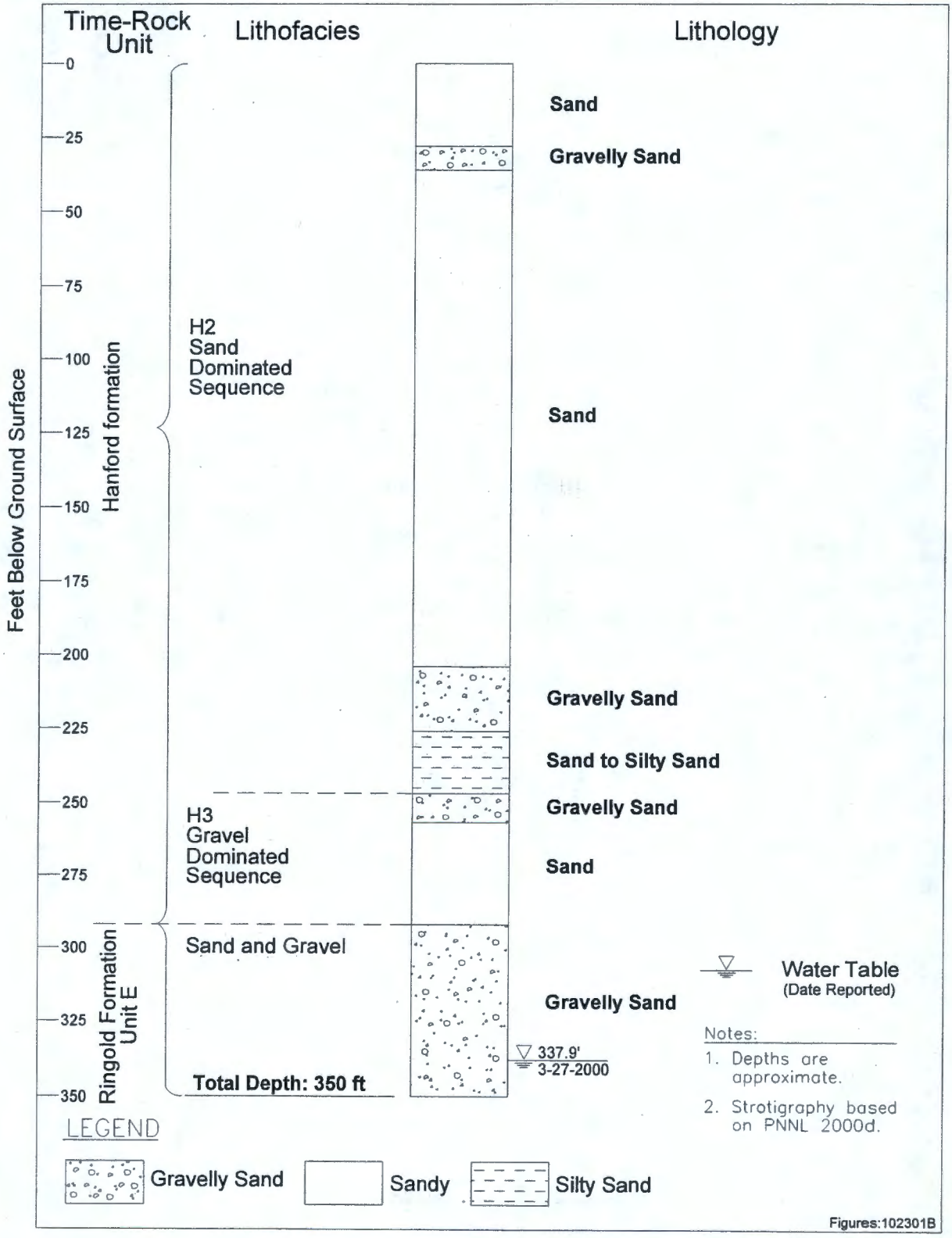


Figure 2-4. Stratigraphy in the Vicinity of the 216-T-28 Crib.

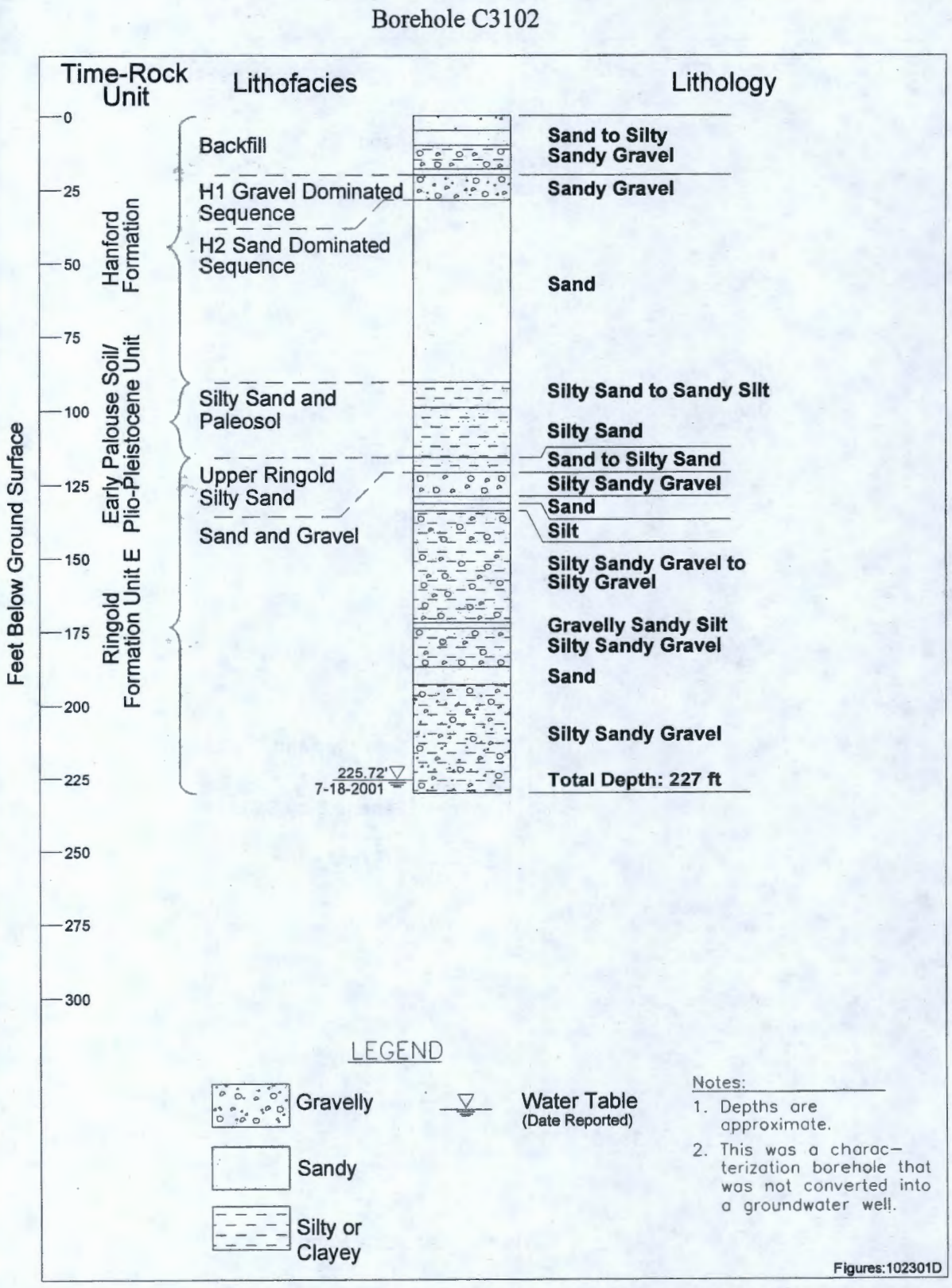


Figure 2-5. Stratigraphy in the Vicinity of the 216-S-20 Crib.

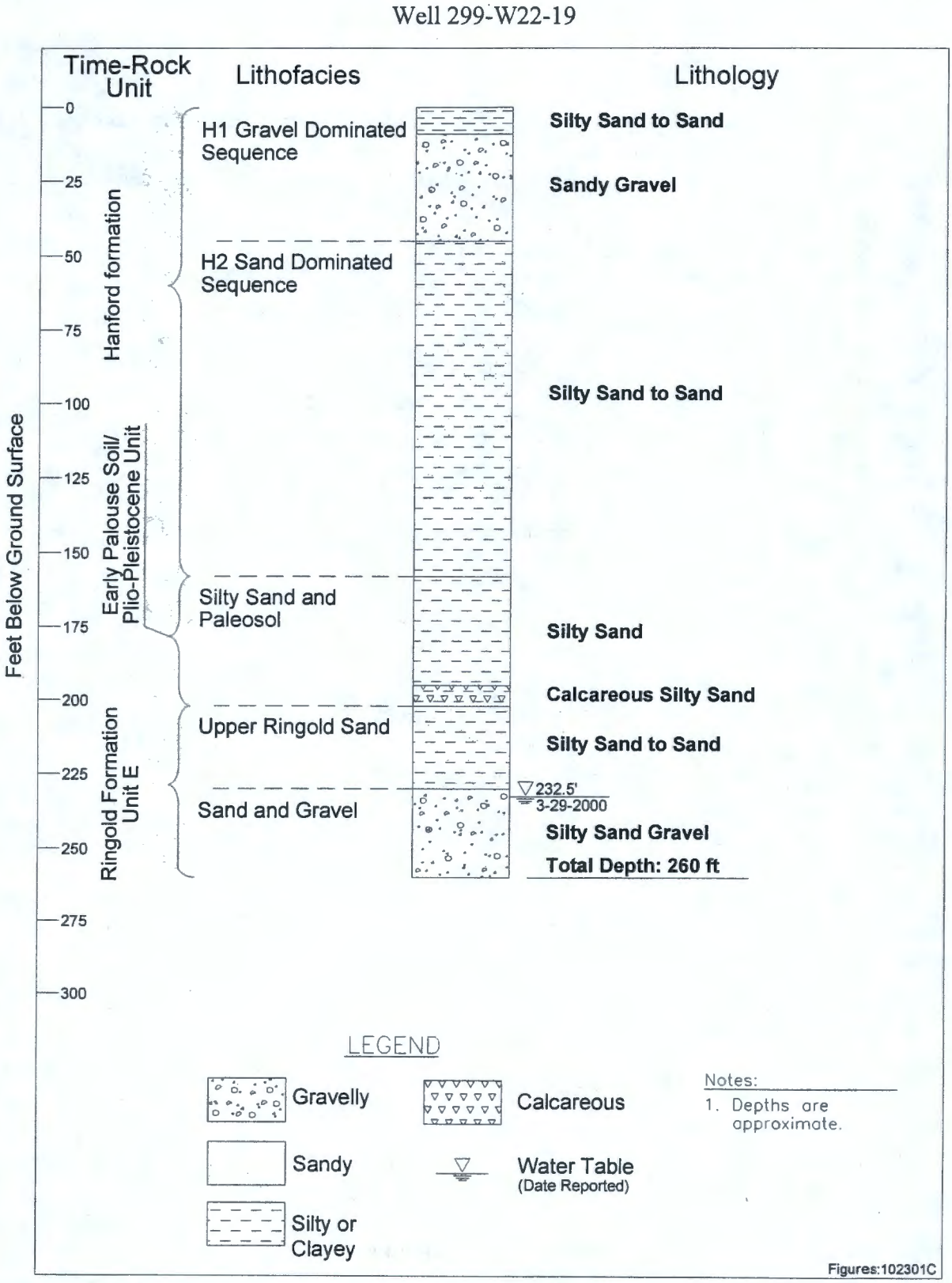


Figure 2-6. Stratigraphy Near the 216-Z-7 Crib.

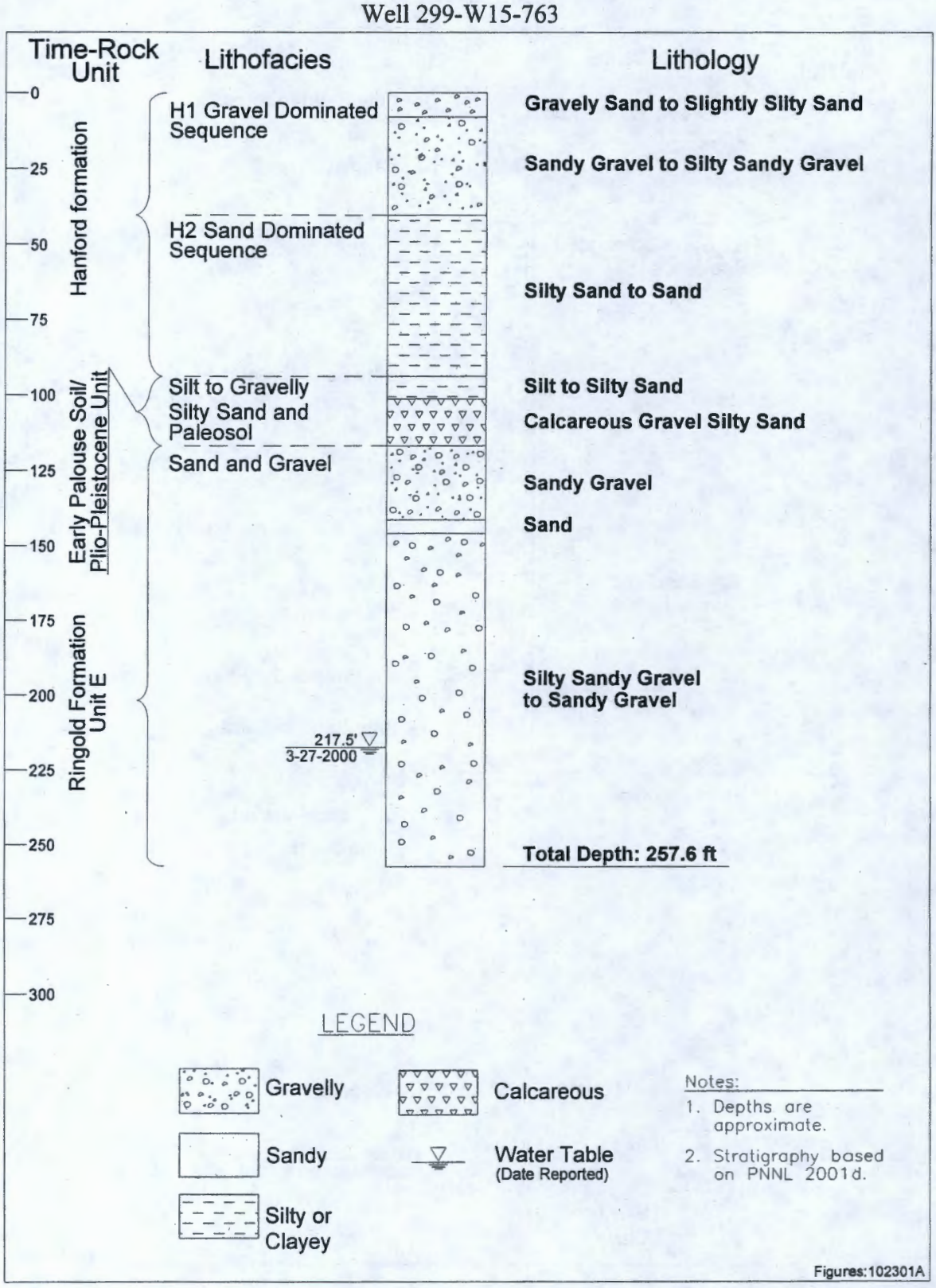
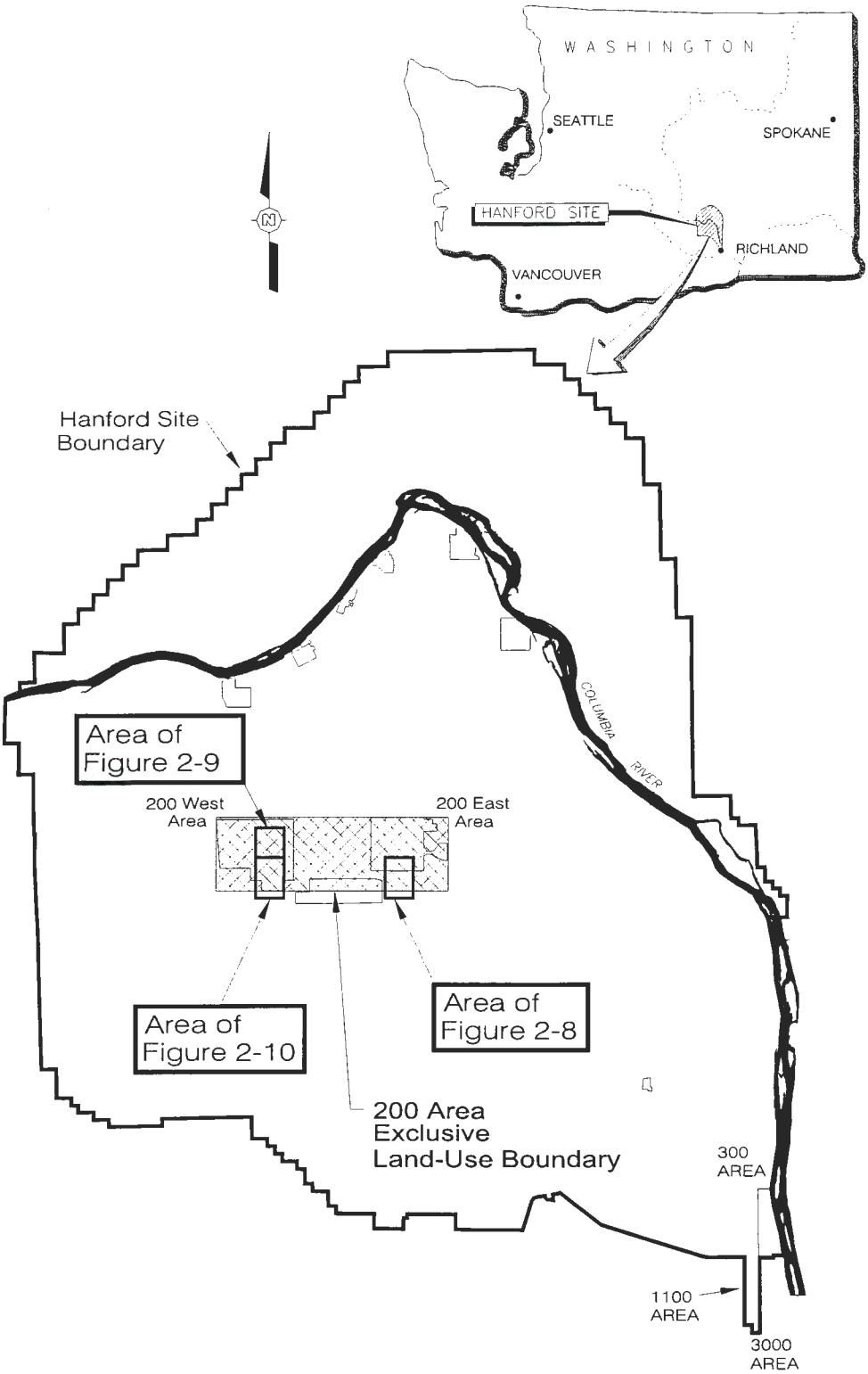
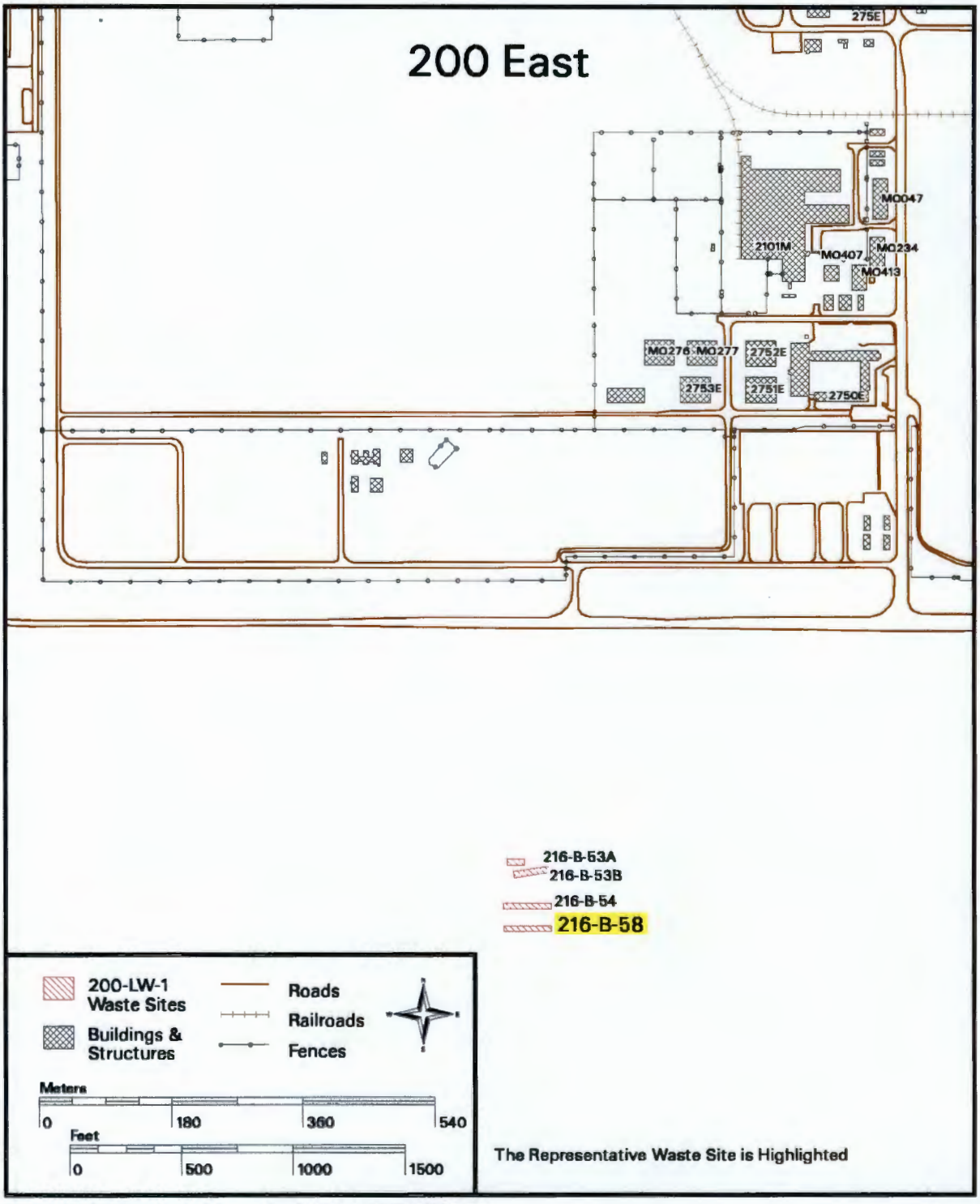


Figure 2-7. Index Map for Location of 200-LW-1 Operable Unit Waste Sites.



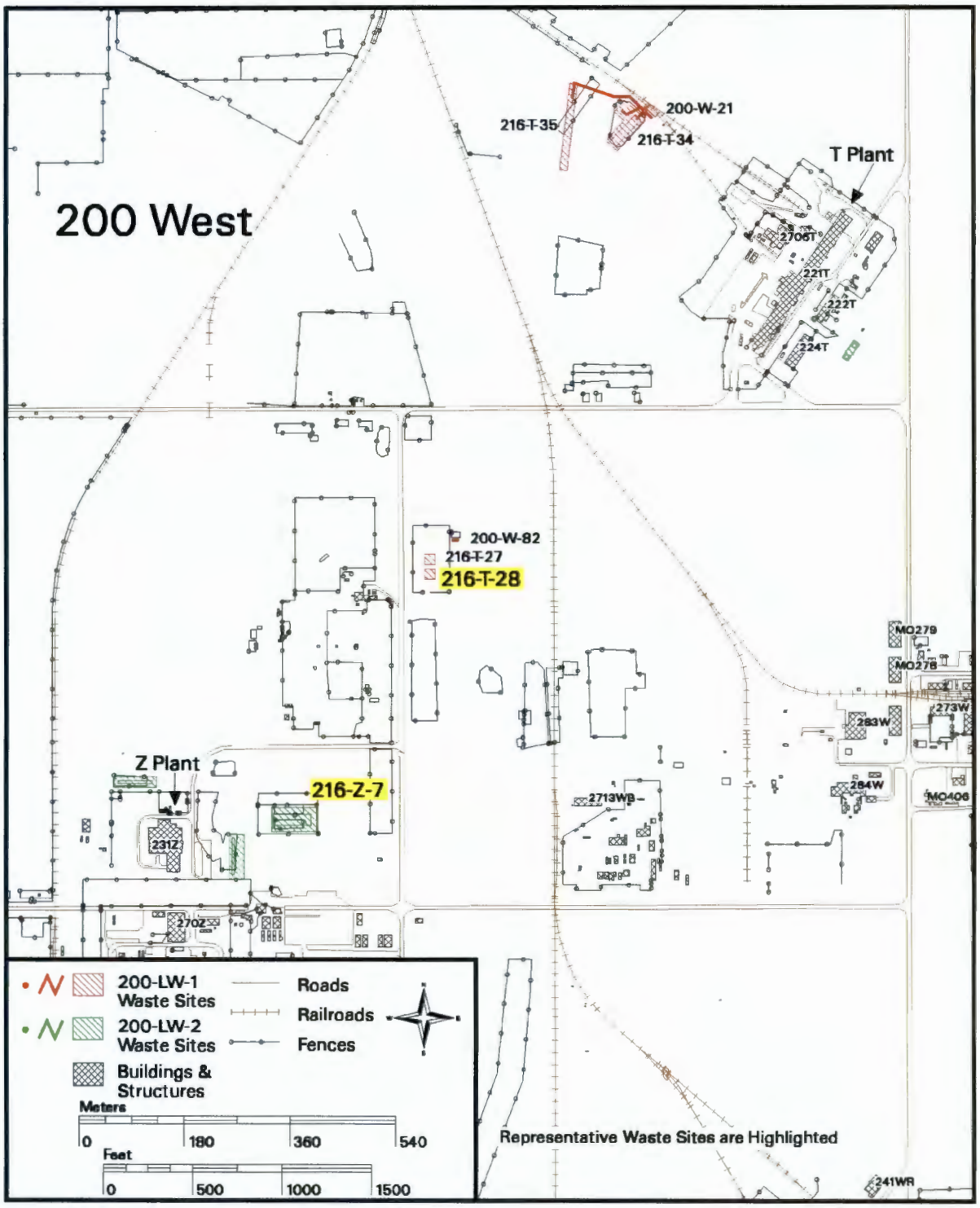
G:\Maps\110701E.DWG

Figure 2-8. Location of the 200-LW-1 Operable Unit Waste Sites Adjacent to the 200 East Area.



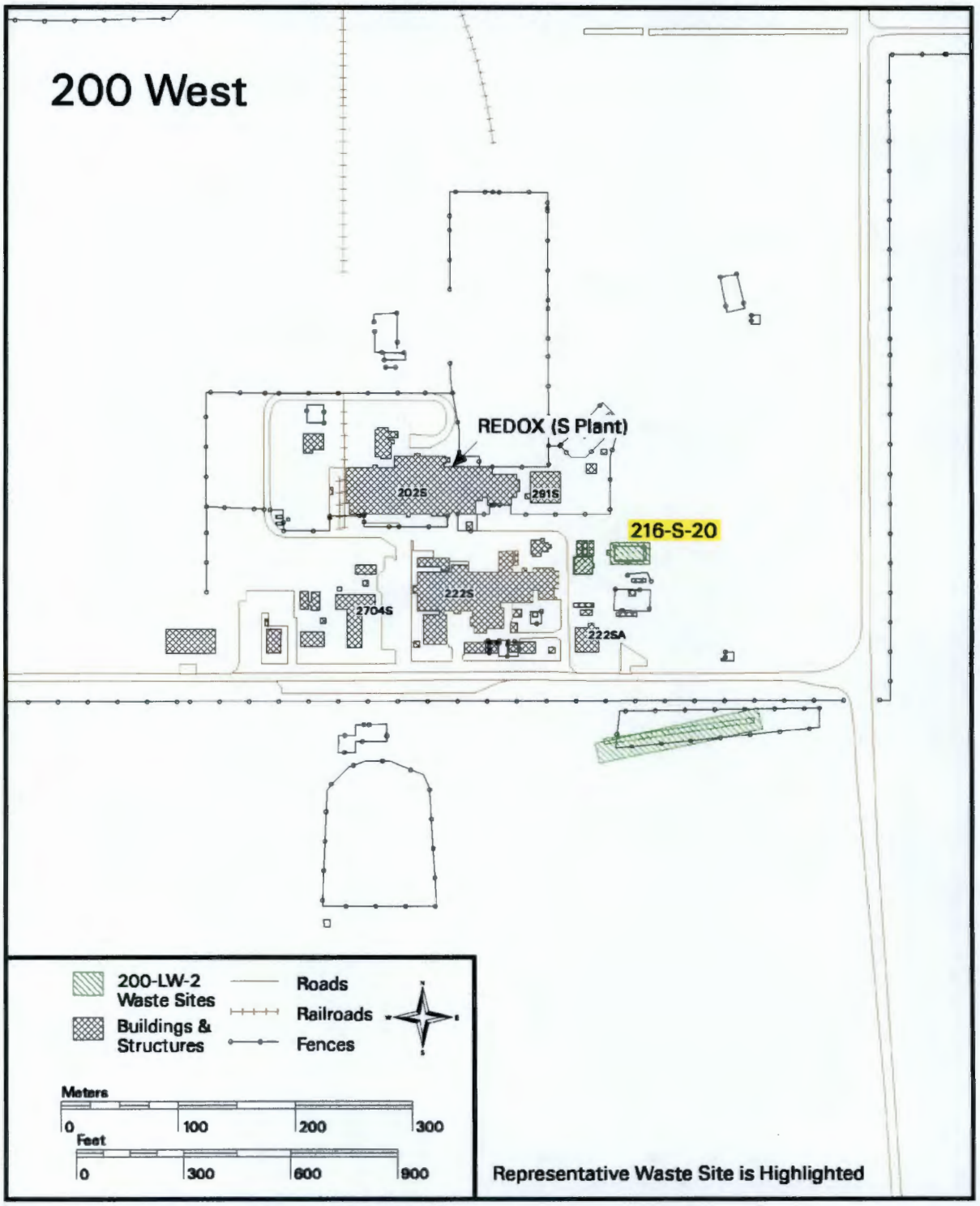
BHI:maa 10/18/01 /home/maa/amls/lw_casts3.aml Database: 03-DEC-2001

Figure 2-9. Location of the 200-LW-1 and 200-LW-2 Operable Unit Representative Waste Sites and Other 200-LW-1 Waste Sites Located Near T Plant and the Z Plant Complex in the 200 West Area.



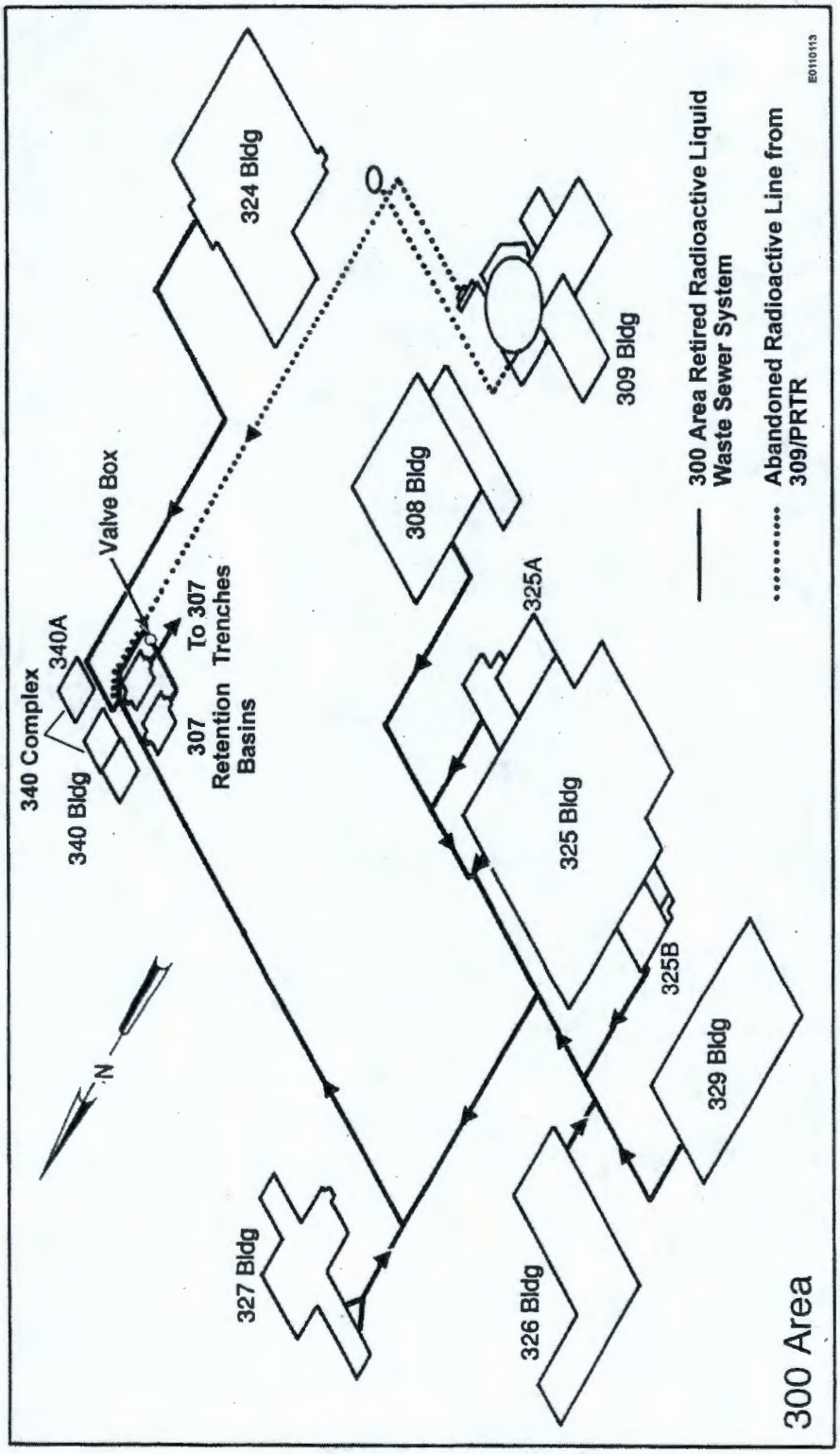
BHI:maa 10/18/01 /home/maa/amls/lw_wests1.aml Database: 03-DEC-2001

Figure 2-10. Location of the 216-S-20 Representative Waste Site Located Near REDOX in the 200 West Area.



BHI:maa 10/18/01 /home/maa/amls/lw_wcsts2.aml Database: 03-DEC-2001

Figure 2-11. Waste Collection at the 340 Complex in the 300 Area.



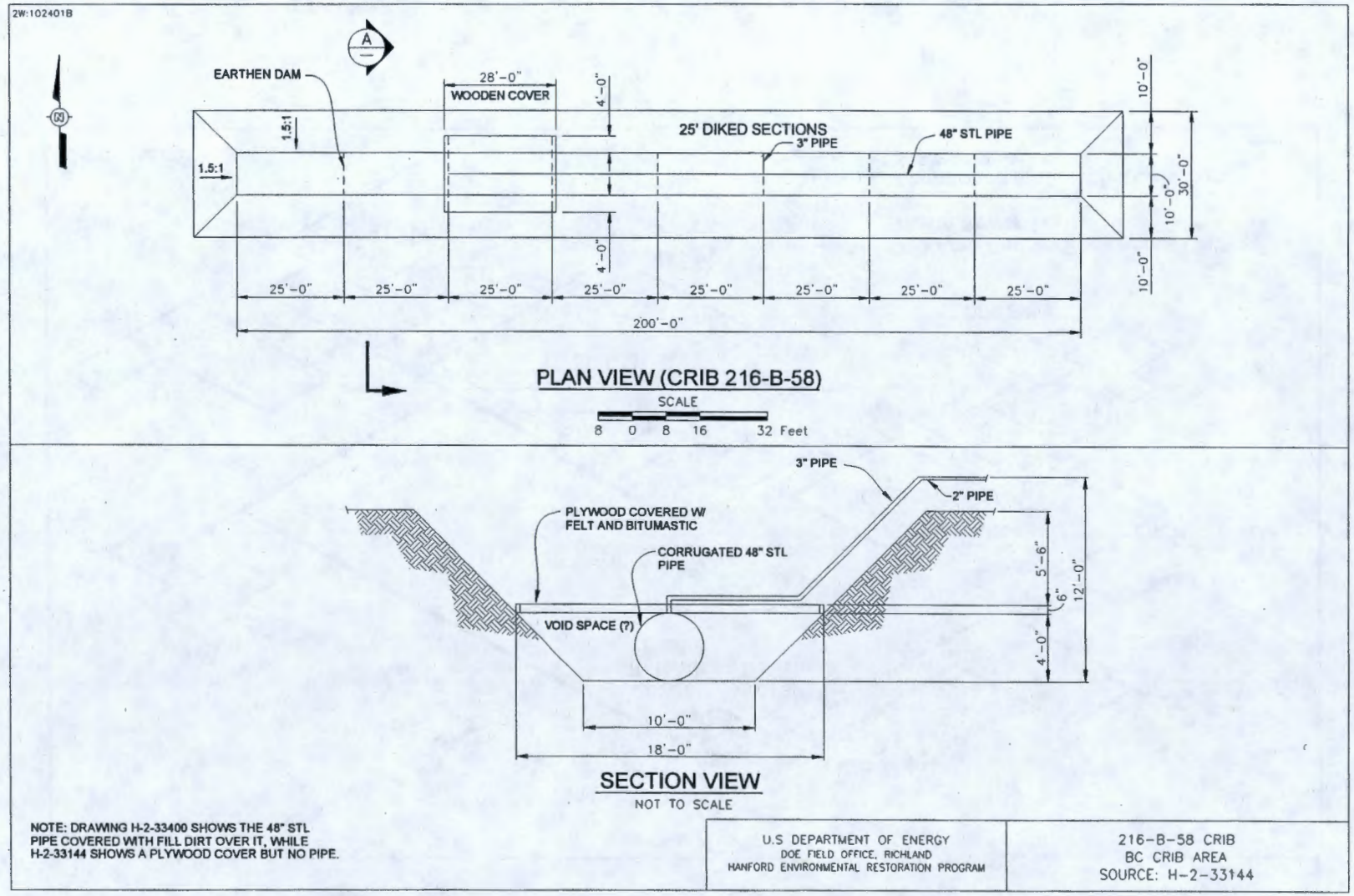


Figure 2-12. 216-B-58 Trench Construction Diagram.

Figure 2-13. 216-T-28 Crib Construction Diagram.

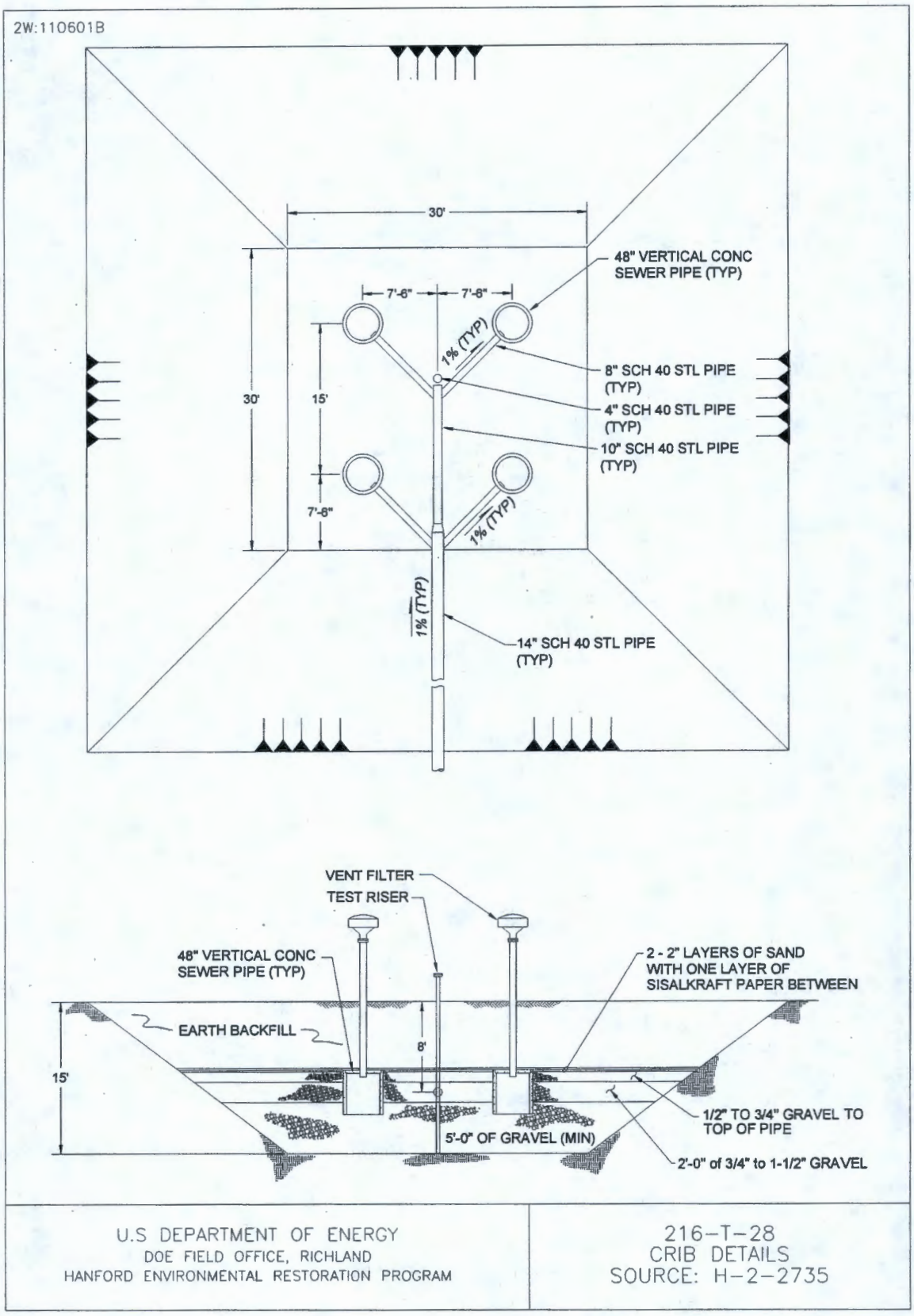
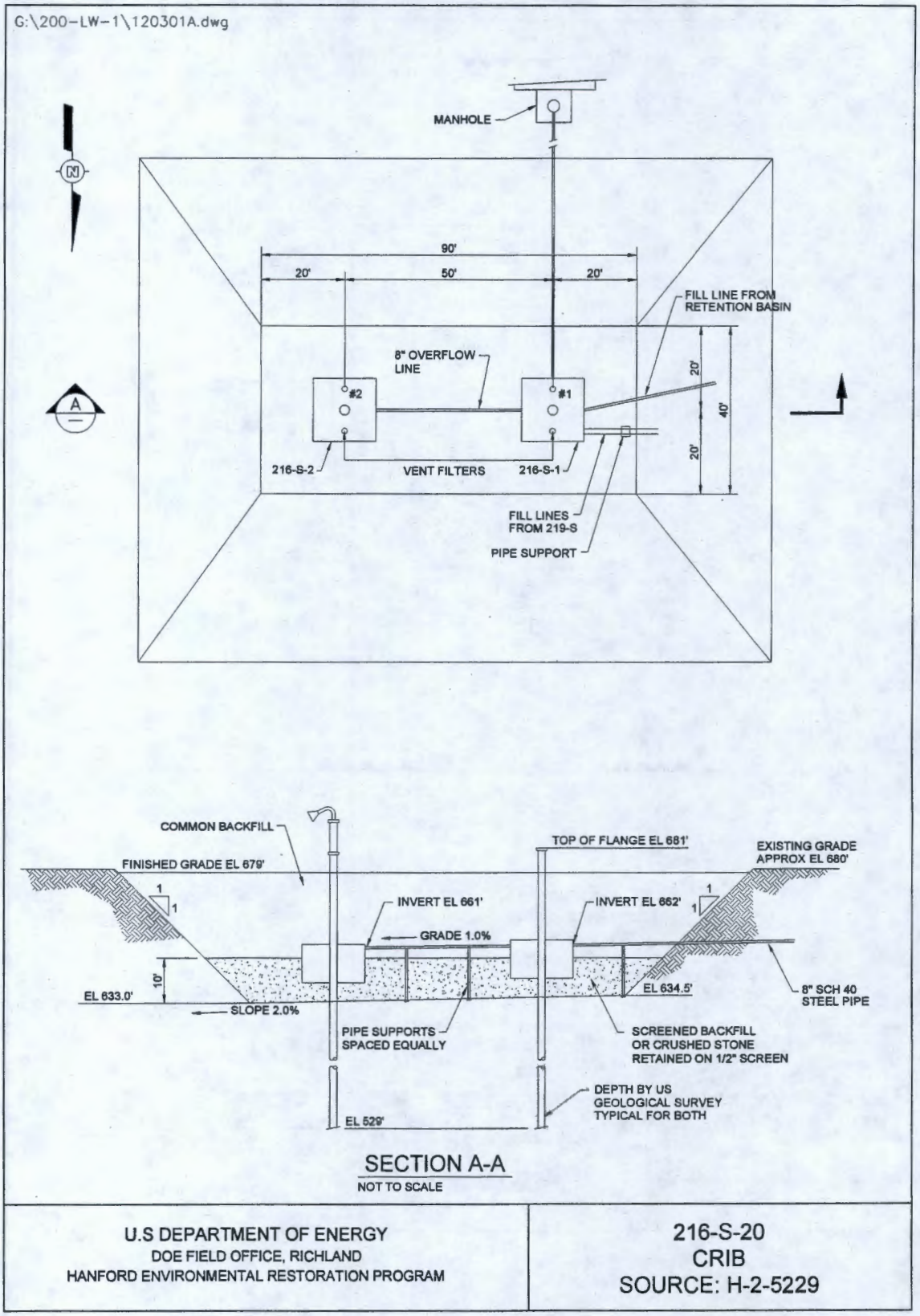


Figure 2-14. 216-S-20 Crib Construction Diagram.



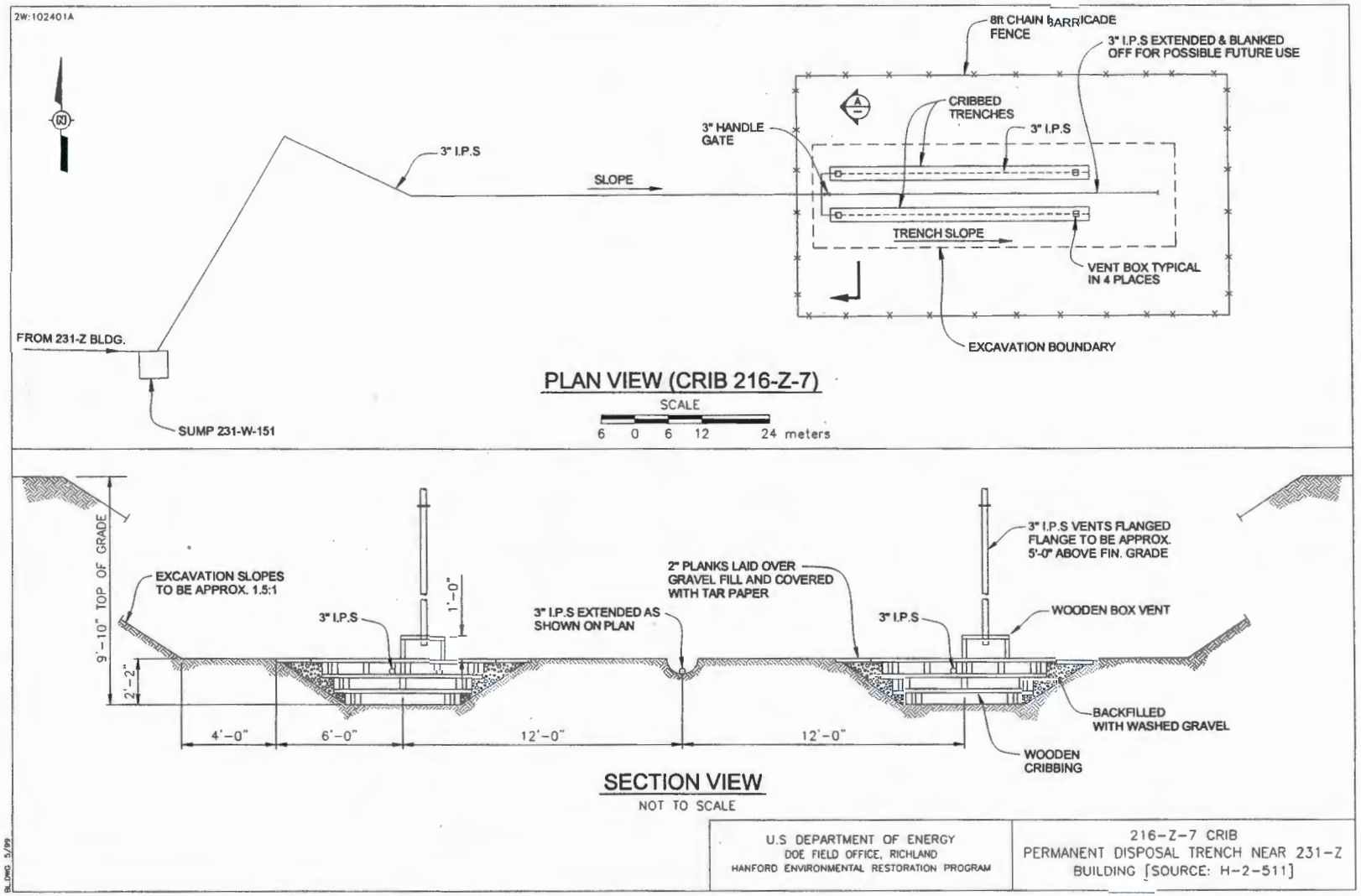


Figure 2-15. 216-Z-7 Crib Construction Diagram.

Table 2-1. Summary of Information for the 200-LW-1 Operable Unit. (7 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-B-53A Trench	216-B-53A, 216-B-53A Trench, PRTR Trench	South of the 200 East Area inside the BC Controlled Area	1965	Liquid waste from 300 Area 309 Building Plutonium Recycle Test Reactor (PRTR) process tube failure cleanup that was shipped to site.	549,000 L with 23 kg U; 100 g Pu; 5.38×10^{-2} Ci Cs-137; 5.59×10^{-2} Ci Sr-90; 1 kg NO_3	3 m (10 ft) Over-burden	18 m x 3 m (60 ft x 10 ft)	The trench was active during October and November 1965. It was divided into two sections by an earthen dam at the center. The dam was 1.5 m (4.9 ft) high and 0.1 m (0.3 ft) wide at the top. The side slope of the open trench was 1.75 H:1 V. Of all the "specific retention" trenches at this location, only 216-B-53A is considered a transuranic waste site with the potential to exceed the definition for transuranic waste due to anticipated concentrations of plutonium. On September 29, 1965, a process tube in the PRTR failed, which contaminated secondary cooling water with residual plutonium fuel and fission products. The total contaminated liquid volume was nearly 53 million liters (14 million gallons). The contaminated liquid was transferred by piping to the 340 Facility and then transported by tanker trucks to the 200 Areas for disposal in this trench. Use of the trench discontinued when specific retention capacity was reached. The BC Trenches were surface stabilized as a unit in 1969 and again in 1982.
216-B-53B Trench	216-B-53B, 216-B-53 Trench, 216-B-53B Trench	South of the 200 East Area inside the BC Controlled Area	1962 to 1963	Liquid waste from the 300 Area laboratory facilities to the 340 Complex by process sewer. Routed to 200 Areas by tanker truck.	15,100 L with 9.1 kg U; 5.0 g Pu; 3.7 Ci Cs-137; 5 Ci Sr-90; 100 kg NO_3	3 m (10 ft) Over-burden	46 m x 3 m (150 ft x 10 ft)	The trench was divided into two sections by an earthen dam at the center. The dam was 1.5 m (4.9 ft) high and 0.1 m (0.3 ft) wide at the top. The side slope is 1.75 H:1 V. When the specific retention capacity of the trench was reached, it was deactivated by disconnecting the short section of above-ground piping connecting it to the permanent underground line. This site was surface stabilized in 1969 by adding 0.6 m (2 ft) of topsoil and was restabilized in 1982.
216-B-54 Trench	216-B-54, 216-B-54 Trench	South of the 200 East Area within the BC Controlled Area	1963	Liquid waste from the 300 Area laboratory facilities to 340 Complex by process sewer. Routed to 200 Areas by tanker truck.	999,000 L with 9.1 kg U; 5.0 g Pu; 0.05 Ci Cs-137; 0.05 Ci Sr-90; 100 kg NO_3	2 m (7 ft) Over-burden	61 m x 3 m (200 ft x 10 ft)	The site was active from March to October 1963. It was divided into two sections by an earthen dam at the center. The dam was 1.5 m (4.9 ft) high and 0.1 m (0.3 ft) wide at the top. When the specific retention capacity of the trench was reached, it was deactivated by disconnecting the short section of above-ground piping connecting it to the permanent underground line. This site was surface stabilized in 1969 by adding 0.6 m (2 ft) of topsoil and was restabilized in 1982.

Table 2-1. Summary of Information for the 200-LW-1 Operable Unit. (7 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-B-58[a] Trench	216-B-58, 216-B-58 Trench, 216-B-59 Crib	South of the 200 East Area inside the BC Controlled Area	1965 to 1967	Liquid waste from the 300 Area to the 340 Complex by process sewer. Routed to 200 Areas by tanker truck.	413,000 L with 9.1 kg U; 6.7 g Pu; 4.4 Ci Cs-137; 5.6 Ci Sr-90; 10 kg NO_3	0.6 m (2 ft) Over-burden 3 m (10 ft) to the bottom of the trench	60 m x 3 m (200 ft x 10 ft)	Earthen dams divide the site into 8-m (25-ft) sections, each of which was covered by a "sisalkraft" cover (a wooden frame consisting of 1 x 2's and 2 x 4's covered with sisal-kraft roofing paper) while in operation. It is believed that a corrugated 122-cm (48-in.) STL pipe is placed along the bottom. Surface geophysics will verify that this pipe exists. When the specific retention capacity of the trench was reached, it was deactivated by disconnecting the short section of above-ground piping connecting it to the permanent underground line. This site was surface stabilized in 1969 by adding 0.6 m (2 ft) of topsoil and was restabilized in 1982.
216-T-27 Crib	216-T-27, 216-TY-2 Cavern, 216-TY-2 Crib, 216-TX-2 Cavern, 216-TX-2 Crib	Inside the 200 West Area, south of 23rd Street and east of Camden Avenue	1965	221-T steam condensate, process decontamination and 2607-T equipment decontamination waste from T Plant after it cascaded through tanks 241-T-110, 241-T-111, and 241-T-112. Also included 300 Area laboratory facilities waste from the 340 Complex via truck, as well as waste from 309 (PRTR) rupture incident.	7,190,000 L with 5.94 kg U; 13.0 g Pu; 55.9 Ci Cs-137; 75.3 Ci Sr-90; 1000 kg NO_3	5 m (16 ft)	9 m x 9 m (30 ft x 30 ft)	The site operated from September 1965 through November 1965. It was constructed of steel pipes leading to vertical, open-ended sewer pipes, but the piping is 2.4 m (8 ft) below grade and has an earthen backfill of 2.1 m (7 ft). An underground pipeline was used to transfer waste from T Plant to the 216-T-27 and 216-T-28 Cribs. Diversion of wastes to this crib was initiated following the breakthrough of strontium and cesium to the groundwater under the 216-T-28 Crib. Remedial action in June and July 1975 included removing 15 cm (6 in.) of soil from affected areas and disposing of it in the 200 West Dry Waste Burial Grounds. The ground surface was covered with clean fill dirt to its original level. The 216-T-26, 216-T-27, and 216-T-28 Cribs were all surface stabilized in May 1990. The 216-T-26, 216-T-27, and 216-T-28 Cribs are enclosed within a common steel post and chain barricade that is posted "Underground Radioactive Material." This site is monitored by groundwater wells 299-W14-2 and 299-W14-3.

Table 2-1. Summary of Information for the 200-LW-1 Operable Unit. (7 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-T-28[b] Crib	216-T-28, 216-TY-3 Cavern, 216-TY-3 Crib, 216-TX-3 Cavern, 216-TX-3 Crib	Inside the 200 West Area, south of 23rd Street and east of Camden Avenue	1960 to 1966	221-T steam condensate and process decontamination, 2607-T equipment decontamination waste from T Plant after it cascaded through tanks 241-T-110, 241-T-111, and 241-T-112 and the 300 Area laboratory facilities from the 340 Complex.	42,300,000 L with 387 kg U; 70 g Pu; 193 Ci Cs-137; 106 Ci Sr-90, 10,000 kg NO_3	4.6 m (15 ft)	9 m x 9 m (30 ft x 30 ft)	The unit consists of a 36-cm (14-in.) steel inlet pipe reducing to a 25.4-cm (10 in.) steel pipe, 2.4 m (8 ft) below grade. The pipe branches to four 20.3-cm (8-in.) steel pipes, each one extending to a 1.2-m (4-ft)-long by 1.2-m (4-ft)-diameter, open-end concrete sewer pipe. This structure rests in an excavation that is 4.6 m (15 ft) deep by 9 x 9 m (30 x 30 ft). The excavation is filled with 2.4 m (8 ft) of gravel and 2.1 m (7 ft) of earth. An underground pipeline was used to transfer waste from T Plant to the 216-T-27 and 216-T-28 Cribs. In 1964, 300 Area waste was combined with the T Plant waste that was discharged to the 216-T-27 and 216-T-28 Cribs. Effluent was temporarily diverted to the 216-T-27 Crib in November 1965. Remedial action in June and July 1975 included removing 15 cm (6 in.) of soil from affected areas and disposing of it in the 200 West Dry Waste Burial Grounds. The ground surface was covered with clean fill dirt to its original level. The 216-T-26, 216-T-27, and 216-T-28 Cribs were all surface stabilized in May 1990. They are enclosed within a common steel post and chain barricade that is posted "Underground Radioactive Material."

Table 2-1. Summary of Information for the 200-LW-1 Operable Unit. (7 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-T-34 Crib	216-T-34, 216-T-34 Crib	Northwest of the 221-T Building, on the east side of the 216-T-35 Crib	1966 to 1967	300 Area laboratory waste from the 340 Building via tanker trucks and rail cars.	17,300,000 L with 5.94 kg U; 107 g Pu; 157 Ci Cs-137; 178 Ci Sr-90; 1,000 kg NO_3	5 m (16 ft)	61 m x 9 m (200 ft x 30 ft)	The crib is located in an excavation 61 m (200 ft) long, 9 m (30 ft) wide, and 4.9 m (16 ft) deep. The unit has a side slope of 1.5H:1V. The dispersal system consists of 128 m (420 ft) of perforated 20.3-cm (8-in.) line in a 4.6- x 59-m (15- x 195-ft) rectangular structure with a 15.2-cm (6-in.) perforated line extending 15.2 m (50 ft) into the unit, all 3.7 m (12.2 ft) below grade. A 1.5-m (5-ft) layer of washed gravel is in the excavation. The site provided subsurface liquid disposal for waste from the 340 Building in the 300 Area. The waste was transported to the 200 West Area in railroad tank cars and 18,927-L (5,000-gal) tank trucks. The pipelines northwest of the unit were capped when the unit reached its prescribed radionuclide disposal capacity after only 5 months of use. The waste was rerouted to the 216-T-35 Crib in February 1967. Residual contamination remained near the ground surface at the unloading station. This crib was interim stabilized in July 1990. It is surrounded by a light chain barricade and posted with underground contamination warning signs. Two gage well risers and one filter riser are visible at the surface. Groundwater wells 299-W11-15 and 299-W11-16 monitor this site.
216-T-35 Crib	216-T-35, 216-T-35 Crib	West of the 221-T Building and west of the 216-T-34 Crib	1967 to 1968	300 Area laboratory waste from the 340 Building via tanker trucks and rail cars.	5,720,000 L with 47.6 kg U; 66.2 g Pu; 11.7 Ci Cs-137; 11.4 Ci Sr-90; 1000 kg NO_3	5 m (16 ft)	137 m x 3 m (450 ft x 10 ft)	The site consists of a perforated 15.2-cm (6-in.) distribution line 30.4 m (100 ft) long and a parallel line 137 m (450 ft) long are placed 2.9 m (9.5 ft) below grade. These lines are covered by 1.5 m (5 ft) of gravel and 1.4 m (4.5 ft) of backfill. The slope of the excavation is 2H:1V. The site provided the same services as that of the 216-T-34 Crib. Waste was rerouted to this site after the 216-T-34 Crib was interim stabilized in July 1990. Wells 299-W11-17, 299-W11-18, 299-W11-19, 299-W11-20, and 299-W11-21 monitor this unit. Two gage well risers and one vent riser are visible at the surface.

Table 2-1. Summary of Information for the 200-LW-1 Operable Unit. (7 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
200-W-21 Pump Station	200-W-21, 204-T Unloading Station, T Plant Waste Railcar Unloading Facility	West of 221-T at the north end of the 216-T-34 Crib	1966 to 1968	The platform structures were used to unload 300 Area liquid laboratory waste sent in railroad tanker cars from the 340 Facility. The waste was pumped into the adjacent 216-T-34 and 216-T-35 Cribs.	N/A	N/A	N/A	The unloading station consisted of two unloading platforms. The area has a short railroad siding extending from the main rail line into T Plant. The platform structures and equipment supported the unloading of liquid waste from the 300 Area into the 216-T-34 and 216-T-35 Cribs. In 1967, approximately 30 m^3 (40 yd^3) of contaminated soil was removed from the base of the unloading station. In 1989, the area was partially surface stabilized by removing the pump and piping and pouring concrete into the drain pads. In 1996, additional stabilization work removed the platform structures, storage shed, and light fixtures. The contaminated area was covered with 15 cm (6 in.) of gravel and reposted as an "Underground Radioactive Material" area.
200-W-82 Product Piping	200-W-82, Risers East of 216-TY-201 and 216-T-26, 216-T-27, and 216-T-28 Cribs, Crib Unloading Station	East of Camden Avenue, east of the 216-TY-201 Flush Tank and 216-T-26, 216-T-27, and 216-T-28 Cribs	1960 to 1966	The unloading station was built to accommodate tanker trucks unloading 300 Area liquid laboratory and PRTR wastes into the 216-T-27 and 216-T-28 Cribs.	N/A	N/A	12 m x 6 m (39 ft x 20 ft) Two concrete pads	The site consists of two concrete pads with flanged risers, which are located east of a blanked pipeline. The blanked pipe extended eastward from the 216-T-26, 216-T-27, and 216-T-28 Crib lines at a point just south of the 216-TY-201 Flush Tank. The unloading station jetted waste from the trucks to the cribs and was capable of unloading two trucks at a time. It appears the pipe tee was originally designed to allow the construction of three additional cribs to receive wastes from the 216-TY-201 Flush Tank. The site is now surrounded by contamination area postings.

Table 2-1. Summary of Information for the 200-LW-1 Operable Unit. (7 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-S-20[c] Crib	216-S-20, 216-SL-1&2 Crib, 216-SL-2	Southeast of the 202-S (REDOX) Facility	1952 to 1972	Liquid waste from 222-S Laboratory hoods and 300 Area laboratory waste via a manhole located on the south side of the crib. Also received 300 Area laboratory waste via a manhole located on the south side of crib.	135,000,000 L with 38.7 kg U; 171 g Pu; 56.5 Ci Cs-137; 22.7 Ci Sr-90; 20,000 kg NO_3	0.3 m (1 ft) Stabil-ization 5.5 m (18 ft) Depth to top of crib 2.7 m (9 ft) Depth of crib struct. 1.2 m (4 ft) Gravel fill	27 m x 12 m (89 ft x 40 ft) Excavation 3.7 x 3.7 x 2.7 m (12 x 12 x 9 ft) Each crib	The unit contains two 3.7 x 3.7 x 2.7-m (12 x 12 x 9-ft) (LxWxH) wooded structures that are 15 m (49 ft) apart. The bottom of each wooden crib box is filled with 1.2 m (4 ft) of gravel. Each wooden crib box has two risers extending from the top of the box to above ground. The crib boxes are connected in series with one box overflowing into another via a pipe. The site was deactivated in December 1974. The unit has had a history of subsidence. Sink holes have been filled in on three different occasions with several cubic yards of fill dirt. Two areas inside the URM are marked with post and chain and "cave-in potential" signs.

Table 2-1. Summary of Information for the 200-LW-1 Operable Unit. (7 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Contaminant Inventory/Volume Released	Depth	Waste Site Dimensions	General Description
216-Z-7[d] Crib	216-Z-7, 231-W Crib, 231-W Trench, 216-Z-6	East of the 231-Z Building and north of 19th Street	1947 to 1967	Process waste from the 231-Z Building via the 231-Z-151 Sump and 231-Z Building laboratory waste via the 231-W-151 Sump. It also received 300 Area laboratory waste from the 340 Facility.	79,900,000 L with 4.46 kg U; 2000 g Pu; 200 Ci Cs-137; 200 Ci Sr-90; 20,000 kg NO_3;	0.6 m (2 ft) Surface stabil-ization 3 m (10 ft) Exca-vation	51 m x 15 m (167 ft x 49 ft) Excavation	The site consists of two parallel wooden structures 45.7 m (150 ft) long by 1.5 m (5 ft) wide by 0.6 m (2 ft) high, placed in a 1.5-m (5-ft) deep excavation. Each wooden structure was constructed of three overlapping tiers. A 45.8-m (150-ft)-long, 7.5- or 10-cm (3- or 4-in.)-diameter perforated distribution pipe runs above the second tier. Each of the two trenches is covered by 503 m (1,650 ft) of 5-cm (2-in.) planking, then tar paper. The excavation was backfilled with gravel. The crib was built to replace the 216-Z-5 Crib. Deactivation was accomplished in 1967 by blanking the pipeline west of the 231-Z-151 Sump and backfilling the excavation. The site was interim stabilized in 1990. This unit is ranked as a high-priority site, with a significant potential for a release. Seven monitoring wells surround this structure. Monitoring results indicate potential radionuclide contamination in the vadose zone.

[a]216-B-58 was selected as a representative site for the 200-LW-1 work plan. It is a typical-case scenario waste site of the 200-LW-1 Operable Unit.
[b]216-T-28 was selected as a representative site for the 200-LW-1 work plan. It is a worst-case scenario waste site of the 200-LW-1 Operable Unit.
[c]216-S-20 was selected as a representative site for the 200-LW-1 work plan. It is a typical-case scenario waste site of the 200-LW-2 Operable Unit.
[d]216-Z-7 was selected as a representative site for the 200-LW-1 work plan. It is a worst-case scenario waste site of the 200-LW-2 Operable Unit.
N/A = not available

3.0 INITIAL EVALUATION OF REPRESENTATIVE SITES

The purpose of this section is to present the results of previous characterization efforts at the 200-LW-1 and 200-LW-2 representative waste sites. The contaminant inventory effluent volumes, available soil data, and current understanding of the distribution of contamination are also discussed for each representative site.

3.1 KNOWN AND SUSPECTED CONTAMINATION

As discussed in Section 2.0, waste sites in this category received analytical laboratory waste discharged from various 200 Area and 300 Area facilities. The 300 Area waste was routed to the 340 Building and then to the 200 Areas via railcar or tanker truck. The 300 Area analytical laboratory wastes were similar to the 200 Area process wastes, and the wastes were disposed to the vadose zone through cribs and trenches. The estimated inventory of the primary radionuclides and nonradiological constituents that were discharged to representative sites was obtained from the following sources:

- WIDS
- Aggregate area management study reports for the 200 Areas (e.g., DOE-RL 1993a)
- Implementation Plan (DOE-RL 1999)
- *Waste Site Grouping for 200 Areas Soil Investigations* (DOE-RL 1997)
- PUREX and REDOX Plant Technical Operating Manuals (WHC 1989, GE 1951a)
- *Uranium Recovery Technical Manual* (U Plant) (GE 1951b)
- *Hanford Engineer Works Technical Manual (T/B Plants)* (GE 1944)
- *Inventory of Chemicals Used at Hanford Site Production Plants and Support Operations (1944 – 1980)* (WHC 1990).

In general, the waste generated by operations associated with the chemical laboratory waste category were a variety of liquid effluents, containing mixed fission products, activation products, transuranics, and inorganics that were acidic to basic pH with low amounts of salts, semi-volatile, and volatile organic chemicals.

3.2 ENVIRONMENTAL MONITORING

Current efforts at the Hanford Site focus on environmental cleanup. Prior to recent cleanup efforts, monitoring was performed across the Hanford Site to measure and evaluate long-term trends in the environmental accumulation of radioactivity. Risks associated with unacceptable levels of contamination were typically addressed by surface stabilizing (covering with soil, concrete, and/or gravel) the area of concern to minimize impact on human health and the environment.

The accumulation of radioactivity at disposal sites was typically evaluated through sampling and analysis of soil samples during the period of operation. These samples were generally collected directly from the bottom of the receiving sites. The accumulation of radioactivity was the principal focus of monitoring; therefore, samples were routinely collected less than 0.3 m (1 ft) below the bottom of a waste site. Samples were collected on an annual basis; however, the number of samples collected was limited and sample locations were not always documented. Therefore, little or no information is typically available to evaluate the lateral and vertical extent of contamination in the vadose zone during active periods of discharge. Nonradioactive constituents were not commonly analyzed. Scintillation logging was commonly performed in boreholes adjacent to waste sites. The logs were used to determine the extent of radiological contamination in the subsurface; however, these logs are not quantitative and provide only a general indication of the presence of radiological contamination. Groundwater is monitored for some constituents at sites through RCRA requirements and the sitewide groundwater monitoring program.

Currently, environmental monitoring at the Hanford Site consists of effluent monitoring, groundwater and vadose zone monitoring, and environmental surveillance. Environmental surveillance is conducted for the following media:

- Air
- Surface water and sediments
- Drinking water
- Farm and farm products
- Soil and vegetation
- External radiation.

Air, external radiation, soil, and vegetation are routinely evaluated in the 200 Areas as part of the Hanford Site near-facility and environmental monitoring programs (e.g., PNNL 2001a, 2001c). Results of the near-facility and environmental monitoring programs are presented in annual reports. The most recent of these annual reports are the *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 2000* (PNNL 2001c) and the *Hanford Site Environmental Report for Calendar Year 2000* (PNNL 2001a). The near-facility document focuses on monitoring activities near facilities that have potential to or have discharged, stored, or disposed of radioactive or nonradioactive materials, including the 200 East and 200 West Areas. The Hanford Site environmental report covers the entire Hanford Site, including those areas not associated with operations (such as the 600 Area). This document examines the

resources associated with the Hanford Site, including those media listed above as well as groundwater. Results of these monitoring efforts for the representative waste sites are summarized in Section 3.3. The potential impacts of contamination in these waste sites on human health and the environment are discussed in Section 3.4.

Groundwater is routinely monitored sitewide. More than 600 monitoring wells are sampled annually to characterize groundwater flow; groundwater contamination by metals, radionuclides, and nonradiological constituents; and the extent of contamination. Groundwater remediation progress, ingestion risk, and dose are also assessed. The results of groundwater monitoring and remediation status are presented in annual reports, the most recent of which is the *Hanford Site Groundwater Monitoring for Fiscal Year 2000* (PNNL 2001b). The groundwater monitoring reports also summarize vadose zone characterization activities conducted on the site through other projects.

3.3 NATURE AND EXTENT OF CONTAMINATION

The following sections describe the nature and extent of contamination at the four representative waste sites.

3.3.1 216-B-58 Trench

Very little information is available to evaluate the nature and extent of contamination beneath the 216-B-58 Trench. The closest borehole (299-E13-16) is located about 27 m (90 ft) west of the trench. The available data from the borehole consist of scintillation log data collected in 1959, 1963, 1968, and 1976 (Fecht et al. 1977). A slightly elevated zone of contamination was detected between 5 and 15 m (16 and 49 ft) bgs with this method.

To obtain a better understanding of the specific radionuclides present and their distribution beneath the trench, spectral gamma data were evaluated from borehole 299-E13-61. This borehole, which is located within 6 m (20 ft) of the 216-B-53A Trench, was logged in 1999. The 216-B-53A Trench is located about 91 m (300 ft) north of the 216-B-58 Trench and considered analogous in terms of waste disposal history. Contaminants detected included cesium-137 and cobalt-60. These contaminants were encountered less than 10 m (33 ft) bgs and did not exceed 1.5 pCi/g. The location of the borehole is shown in Figure 3-1.

The vadose zone soil column pore volume beneath the footprint of the 216-B-58 Trench is estimated to be greater than the volume of effluent discharged to the ground (DOE-RL 1997). This suggests that there was likely no impact to groundwater when the trench received effluent. Soil pore volume estimates suggest that only 7% of the soil column was affected by releases to the trench. This would indicate that effluent may have initially migrated to a maximum depth of about 11 m (35 ft) in the soil column. Groundwater plumes in the vicinity of the 216-B-58 Trench (Figures 3-2 and 3-3) also suggest no impact to the aquifer from this waste site. Although tritium and chromium concentrations exceed groundwater protection standards/guidelines in the vicinity of the trench, their crossgradient location suggests no impact from the trench.

3.3.2 216-T-28 Crib

Scintillation probe profiles and spectral gamma-ray log data were used to evaluate the nature and extent of contamination in the vicinity of the 216-T-28 Crib. Spectral gamma and scintillation logs are available from four boreholes (299-W14-1, 299-W14-2, 299-W14-3, and 299-W14-4). A borehole location map is shown in Figure 3-4. The subject boreholes were constructed between 1954 and 1961 without annular seals. In 1983, the boreholes were perforated and grouted to seal potential preferential pathways to groundwater. Boreholes 299-W14-2 and 299-14-3 are located within the waste site boundary, while boreholes 299-W14-1 and 299-W14-4 are located adjacent to the site.

Scintillation profiles were collected between 1959 and 1976 and presented in Fecht et al. (1977). The conclusions presented in the 1977 report indicate the following:

- Radioactivity was detected throughout the log interval (i.e., near the surface to the water table).
- No measurable migration of radionuclides has been detected since disposal of waste to the ground was terminated.
- Significant lateral spreading may have occurred to the southeast (toward borehole 299-W14-1).

Spectral gamma-ray logs were collected in 1992 and 1993. Borehole 299-W14-2 was logged with the scintillation probe to a depth of approximately 65 m (213 ft) in 1959, 1963, 1970, and 1976. Higher levels of contamination (i.e., gamma-emitting radiation) were detected in the four log runs from near the surface to a depth of approximately 35 m (115 ft). Contamination generally decreased with depth below 35 m (115 ft).

The distribution of contamination was confirmed with spectral gamma-ray logging (SGL) in 1993, and specific radionuclides were identified. Higher levels of contamination (mainly cesium-137) were detected between 1.5 and 33 m (5 and 107 ft) bgs. Cesium-137 activity (>5,000 pCi/g) saturated the spectral gamma system to 32.6 m (107 ft) and then generally decreased with depth to the bottom of the borehole. Cesium-137 contamination was detected down to about 60 m (195 ft) bgs. Other contaminants detected include cobalt-60 and europium-154. Less than 5 pCi/g of cobalt-60 and europium-154 were detected at the bottom of the borehole. Of the available borehole data, the level of contamination was greatest in borehole 299-W14-2.

Borehole 299-W14-3 was logged with the scintillation probe to a depth of approximately 78 m (255 ft) in 1963 and 1976. Higher levels of contamination were detected near the surface to a depth of approximately 30 m (98 ft). Contamination generally decreased with depth to the end of the log run.

The distribution of contamination in this borehole was confirmed with SGL in 1993. The highest levels of contamination detected with the spectral gamma tool were from about 2 to 8 m

(8 to 25 ft) bgs. Cesium-137 activity saturated (>5,000 pCi/g) the SGL system to 8 m (25 ft) and then generally decreased with depth to the bottom of the borehole. The maximum vertical extent of cesium-137 contamination was 71 m (234 ft) bgs. Other contaminants detected include cobalt-60, europium-152, europium-154, and antimony-126. Cobalt was detected (<10 pCi/g) from 1 to 71 m (3.5 ft to 234 ft) bgs. Less than 10 pCi/g antimony-126 were detected from 9 to 11 m (28 to 35 ft) bgs. Europium-152 was encountered from 16 to 36 m (52 to 119 ft) bgs; its maximum activity (15 pCi/g) was at 25 m (83 ft). Europium-154 was encountered 8 to 37 m (27 to 120 ft) bgs with a maximum activity of 900 pCi/g at 25 m (83 ft).

Borehole 299-W14-4 was logged with the scintillation probe to a depth of approximately 57 m (187 ft) in 1967 and in 1976. The highest levels of contamination were detected from near the surface to a depth of approximately 25 m (82 ft). Contamination generally decreased with depth to the end of the log run.

This distribution of contamination was confirmed with the SGL in 1995. Contaminants detected included cesium-137, cobalt-60, europium-152, and europium-154. Cesium-137 was detected at higher concentrations from 10.4 to 18 m (34 and 59 ft) bgs and extended throughout the log interval. The maximum cesium-137 concentration of 2,000 pCi/g was detected 12 m (40 ft) bgs. Cobalt-60 and europium-154 were also detected throughout the log interval, and their maximum concentrations were 3 pCi/g and 100 pCi/g, respectively. The maximum concentrations of cobalt-60 and europium-154 occurred at 12 m (40 ft) and 30 m (97 ft) bgs. Less than 2 pCi/g of europium-152 were detected from 26 to 32 m (85 to 105 ft) bgs.

Borehole 299-W14-1 is located about 38 m (125 ft) southeast of the 216-T-28 Crib. In 1963, 1967, and 1976, this borehole was logged with the scintillation probe to a depth of approximately 70 m (230 ft). The log profiles in Fecht et al. (1977) indicate that radioactivity was detected about 2 m (8 ft) bgs to the bottom of the borehole. The report also implies that the 216-T-28 Crib is the source of the contamination and significant lateral spreading has occurred. Most of the contamination was detected from 2 to 31 m (8 to 101 ft) bgs and generally decreased with depth to the bottom of the borehole. Borehole 299-W14-1 was logged with the spectral gamma tool in 1995. Contaminants detected were cesium-137, cobalt-60, and europium-154. Cesium-137 was detected at or near the threshold of detection (approximately 1 pCi/g) throughout the survey. Two zones of higher cesium-137 activity were identified from 0 to 1 m and from 44 to 52 m (0 to 3 ft and 144 to 170 ft) bgs. The maximum cesium-137 activity encountered was 20 pCi/g at a depth of 0.3 m (1 ft). Cobalt-60 and europium-154 were detected to a depth of 21 m (69 ft bgs). The maximum activity for the radionuclide was <2 pCi/g.

During the summer of 2001, the nature and vertical extent of contamination beneath the 216-T-26 Crib were characterized by sampling soils from and geophysically logging borehole C3102. The 216-T-26 Crib is located approximately 52 m (170 ft) north of the 216-T-28 Crib. This crib is briefly mentioned in this section because of its proximity to the 216-T-28 Crib and the amount of recently collected characterization data. Although the waste stream chemistry and history are somewhat different at the two waste sites, construction information, hydrogeologic framework, and inventories are similar. More than 2,000 pCi/g of cesium-137 were detected with the SGL system beneath the 216-T-26 Crib at depths between 4.6 and 18.2 m (15 and 60 ft). Low levels (<5 pCi/g) of cobalt-60 and europium-154 were also detected to a depth of 40.2 m

(132 ft). Data from the 216-T-26 Crib were considered in the development of the 216-T-28 Crib conceptual model.

The effluent volume discharged at the 216-T-28 Crib was greater than the soil pore volume beneath the footprint of the waste site to the groundwater table. This indicates that effluent may have reached groundwater at this site. The current status of groundwater contamination in the vicinity of the 216-T-28 Crib is described in PNNL (2001b). The report indicates that nitrate, carbon tetrachloride, trichloroethylene, iodine-129, and tritium exceed groundwater protection standards/guidelines in the vicinity of the crib. Of these contaminants, only nitrate, iodine-127, and tritium may be associated with waste disposal practices at the crib. Groundwater plumes in the vicinity of the 200 West Area and the 216-T-28 Crib are shown in Figures 3-5 and 3-6.

3.3.3 216-S-20 Crib

Very little information is available to evaluate the nature and extent of contamination beneath the 216-S-20 Crib, although a significant amount of drilling has been performed near the crib. Four usable boreholes (299-W22-20, 299-W22-61, 299-W22-63, 299-W22-74) are present near the crib (Figure 3-7). Two boreholes (299-W22-61, 299-W22-63) are located within the waste site boundary. One additional borehole, 299-W22-65, is also located inside of the waste site boundary. However, it has been decommissioned, and no data are available from the borehole.

The available data used to evaluate the nature and extent of contamination at the 216-S-20 Crib include scintillation and gross gamma log profiles from borehole 299-W22-20 and spectral gamma data from borehole 299-W22-74. Fecht et al. (1977) indicates that borehole 299-W22-20, which is 35 m (115 ft) downgradient, monitors the 216-S-20 Crib. As such, the borehole was logged with a scintillation probe in 1963, 1968, and 1976. Near-background levels of radioactivity were detected over most of the log interval. At a depth of about 48 to 50 m (157 to 164 ft) bgs, the radiation intensity was elevated in 1963. This radiation intensity was due to releases of total beta that occurred between 1961 and 1963 (Fecht et al. 1977). A gamma log run in 1994 showed near-background levels of radioactivity in the borehole.

Only very low levels of cobalt-60 were detected in borehole 299-W22-74 using the SGL. This borehole is located about 3.4 m (11 ft) north of the crib. Cobalt-60 was detected from 78 to 12 m (26 to 40 ft) bgs at a maximum activity of 2 pCi/g.

The effluent volume discharged at this site was greater than the soil pore volume beneath the footprint of the waste site to the groundwater table. This indicates that effluent may have reached groundwater at this site. The current status of groundwater contamination in the vicinity of the 216-S-20 Crib and 200 West Area is described by PNNL (2001b). The report indicates that nitrate, carbon tetrachloride, iodine-129, uranium, and tritium exceed groundwater protection standards/guidelines in the vicinity of the crib. Of these contaminants, only nitrate, iodine-127, and tritium may be associated with waste disposal practices at the crib. Groundwater plumes in the vicinity of the 200 West Area and the 216-S-20 Crib are shown in Figures 3-5 and 3-6.

3.3.4 216-Z-7 Crib

Scintillation and spectral gamma log data were used to evaluate the nature and extent of contamination at the 216-Z-7 Crib. Spectral gamma logs, scintillation profiles, or both log types are available from seven boreholes (299-W15-7, 299-W15-62, 299-W15-63, 299-W15-64, 299-W15-76, 299-W15-77, 299-W15-78) located near the crib. Only borehole 299-W15-7 is located within the waste site boundary. A borehole location map is shown in Figure 3-8.

Scintillation profiles were collected from the seven boreholes (Fecht et al. 1977). Review of the logs shows that radioactivity was detected in all profiles. Contamination within the crib boundary (299-W15-7) was detected from 7.3 m (24 ft) bgs to the water table and indicates breakthrough of contaminants and effluent to groundwater. Logs from adjacent boreholes suggest significant lateral spreading of contaminants. Contamination in adjacent boreholes was detected from 13 to 44 m (42 to 143 ft) bgs.

Boreholes 299-W15-7, 299-W15-63, 299-W15-64, 299-W15-76, and 299-W15-77 were logged with the SGL in 1995. The spectral gamma logs confirm the vertical and lateral extent of contamination suggested by the scintillation log profiles. In borehole 299-W15-7 cesium-137, cobalt-60, and europium-154 were detected. Cobalt-60 and europium-154 were detected throughout the vadose zone from a depth below approximately 6.4 m (21 ft). Maximum cobalt-60 and europium-154 concentrations (20 pCi/g and 10.1 pCi/g, respectively) were detected about 26 m (85 ft) bgs. Higher concentrations (37 pCi/g and 22 pCi/g, respectively) were detected in the aquifer. The aquifer is estimated to have been about 58 to 61 m (190 to 200 ft) bgs in 1995. Very little cesium-137 (<2 pCi/g) was detected in the borehole. The maximum vertical extent of cesium-137 contamination was 5 m (16 ft) bgs.

One or more of the following contaminants (cesium-137, cobalt-60, and europium-154) were also detected adjacent to the crib in boreholes 299-W15-63, 299-W15-64, 299-W15-76, and 299-W15-77. Cesium concentrations did not exceed 3 pCi/g and were typically detected at less than 2 m (6 ft) bgs. The maximum vertical extent of cesium-137 contamination (<1 pCi/g) was detected in borehole 299-W15-64 at 50 m (164 ft) bgs.

Cobalt-60 and europium-154 were the dominant contaminants detected adjacent to the crib. Cobalt-60 was found 14.6 to 44 m (48 to 147 ft) bgs in boreholes adjacent to the crib. The maximum concentration (20 pCi/g) was detected in borehole 299-W15-63 at a depth of 29.6 m (97 ft), although concentrations were typically less than 2 pCi/g. The distribution of europium-154 was similar to cobalt-60. Europium-154 was detected from 17 to 44 m (56 to 147 ft) bgs in boreholes 299-W15-63 and 299-W15-76 adjacent to the crib. The maximum concentration (10 pCi/g) was detected in borehole 299-W15-63 at a depth of about 30 m (97 ft). Europium-154 concentrations were typically less than 2 pCi/g.

The effluent volume discharged at this site was greater than the soil pore volume beneath the footprint of the waste site to the groundwater table. This indicates that effluent may have reached groundwater at this site. The current status of groundwater contamination in the vicinity of the 216-Z-7 Crib is described by PNNL (2001b). The report indicates that nitrate, carbon tetrachloride, trichloroethylene, technetium-99, iodine-129, and tritium exceed groundwater

protection standards/guidelines in the vicinity of the crib. Of these contaminants, only nitrate and tritium may be associated with waste disposal practices at the crib. Major groundwater plumes in the vicinity of the 200 West Area and the 216-Z-7 Crib are shown in Figures 3-5 and 3-6.

3.3.5 Conceptual Contaminant Distribution Models

A preliminary conceptual contaminant distribution model was developed for the 200-LW-1 OU in the waste site grouping report (DOE-RL 1997). The preliminary model is updated with conceptual contaminant distribution models of representative sites in this section. The revised conceptual contaminant distribution models are based on data collected at representative sites and knowledge gained by evaluating other 200 Area waste sites. As little data were available to evaluate the nature and extent of contamination beneath the 216-S-20 and 216-Z-7 Cribs, conceptual contaminant distribution models for the two sites were developed based more on an understanding of contaminant fate and transport than actual contaminant data. Conceptual contaminant distribution models for the representative sites are shown in Figures 3-9 through 3-12.

Information pertaining to contaminant sources, release mechanisms, transport media, exposure routes, and receptors have also been incorporated into the discussion of the conceptual contaminant distribution models in this section. The conceptual exposure pathway model is included to develop an understanding of potential risks and exposure pathways (Figure 3-13). This information will support an evaluation of potential human health and environmental risk.

Releases to the environment from primary sources have produced contaminated surface soils, subsurface soils, and groundwater beneath waste sites. Contaminated media can impact the environment by infiltration, resuspension of contaminated soil, volatilization, biotic uptake, leaching, and external radiation. When waste sites were receiving effluent, the dominant mechanism of contaminant transport was infiltration. After this practice ceased, residual liquids continued to move through the soil column by gravity drainage for an undetermined period of time. Currently, the dominant mechanism of contaminant transport is assumed to be residual moisture from the effluents and infiltration of precipitation.

The following statements are general conclusions regarding the conceptual contaminant distribution model for the 200-LW-1 OU:

- Effluents discharged to waste sites in the OU consisted of acidic to basic low-salt, low-organic solutions that included radiological contaminants. Primary contaminants of potential concern (COPCs) include americium, cesium, plutonium, strontium, technetium, uranium, and nitrate.

- Five of the twelve waste sites addressed in this work plan received enough effluent to impact groundwater. Soil pore volumes (pore volume of soil column beneath the footprint of the waste site to the groundwater table) were exceeded at three representative sites (216-T-28, 216-S-20, and 216-Z-7) in the OU. Effluent and contaminants are not expected to extend more than 7.6 m (25 ft) below the bottom of the 216-B-58 Trench.

- Effluents and contaminants migrated vertically beneath the waste sites after release. Lateral spreading of liquids and contaminants may occur associated with changes in site stratigraphy at the bottom of the crib/trench, the sand-dominated sequence of the Hanford formation, the Plio-Pleistocene unit/early Palouse soil, and the upper Ringold Formation. Some lateral spreading appears to be present at the 216-T-28 and 216-Z-7 Cribs.

- Contaminants such as cesium and plutonium normally adsorb strongly onto Hanford Site sediments because they have large distribution coefficients (K_d) (i.e., low mobility). These contaminants should be detected in high concentrations near points of release in the vadose zone because of their large K_d value. The concentration of high K_d contaminants are generally expected to decrease with depth. Contaminants such as nitrite and tritium with low K_d values (i.e., greater mobility) are not readily adsorbed on soil particles and migrate to greater depth within the vadose zone. For example, cesium-137 ($K_d > 2{,}000$ mL/g) may be concentrated near the point of release, with strontium-90 ($K_d = 0.4$ to 50 mL/g) and uranium ($K_d = 1$ mL/g) present at greater depths. Contaminants with a K_d value equal to 0, such as tritium, will migrate downward with the extent of the wetting moisture front. Mobile contaminants are expected at very low concentrations throughout the vadose zone. Concentrations may increase with depth.

- Mobility of typically immobile contaminants may be enhanced in the subsurface if a preferential pathway is present.

- The distribution of cesium-137, a typically immobile contaminant, at the 216-T-28 Crib supports the possibility of enhanced mobility, as it is present to a depth of 71 m (234 ft). The distribution of cesium-137 deep within the vadose zone may be due to the lack of annular seals placed in boreholes in and adjacent to the crib during well construction. The annulus in the subject boreholes were grouted in 1983 to mitigate contaminant migration.

- Contaminants detected above maximum contaminant levels (MCLs) in the groundwater near representative sites are tritium, uranium, iodine-129, nitrate, carbon tetrachloride, chromium, and trichloroethene. Waste sites in the 200-LW-1 OU no longer receive effluent. Sites in this OU have generally been stabilized and covered with clean soil. With the cessation of artificial recharge, the downward flux of liquid through the vadose zone has decreased. Residual liquid should continue to decrease in the vadose zone over time and equilibrate with the natural recharge rate, thus reducing the potential for impacts to groundwater.

Potential receptors (human and ecological) may be exposed to the affected media through several exposure pathways, including inhalation, ingestion, and direct exposure to external gamma radiation. Potential human receptors include current and future site workers and visitors (occasional users). Potential ecological receptors include terrestrial plants and animals.

3.3.6 Environmental Information

A summary of ecological resources for the 200 Areas is provided in Appendix F, Sections F8.0 and F9.0 of the Implementation Plan (DOE-RL 1999). Information on these resources is also included in the annual environmental monitoring reports (e.g., PNNL 2000a, 2000c).

This section of the work plan summarizes available ecological sampling and monitoring data in the vicinity of 200-LW-1 and 200-LW-2 OU waste sites. The data consulted and researched to provide this summary included the following:

- *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site* (Johnson et al. 1994)
- *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1999* (PNNL 2000c) (and previous annual reports).

Investigative sampling of soil and biota is conducted as part of the Hanford Site environmental monitoring program to confirm the absence or presence of radioactive and/or nonradioactive contaminants, or to verify radiological conditions at specific project sites. Detection of contamination in wildlife species may indicate that wildlife are entering contaminated areas (e.g., burrowing into waste burial grounds) or that materials are moving out of contaminated areas through blowing dust or food chain transport.

Historically, much of the contamination in the 200 Area wildlife was related to contamination in surface water ponds. Decommissioning the surface water ponds has reduced opportunities for wildlife exposure to radionuclides (Poston and Cooper 1994). In recent years, the frequency and amount of biological (wildlife) sampling has significantly diminished. Several radionuclides that were monitored in the past have not been detected in recent samples because they were no longer present in the environment in sufficient amounts to accumulate in wildlife, or did not accumulate in the wildlife tissues of interest (PNNL 2000a). In recent years, sampling in the 200 Areas has been limited to terrestrial biota such as elk and rabbits (PNNL 2000a).

Analytes sampled under the radionuclide monitoring program include gamma-emitting radionuclides, strontium isotopes, uranium isotopes, and plutonium isotopes. Media sampled include soil, vegetation, nests (bird, wasp, ant), mammal feces (rabbit, coyote), mammals (mice, bats), and insects (fruit flies). Results of investigative sampling are reported in annual Hanford Site Environmental Monitoring Reports (e.g., PNNL 2000a, 2000c). While radionuclide data exist as a result of the annual monitoring program, nonradiological constituents have not been analyzed.

Wildlife species most commonly associated with uptake of radioactive contamination in the 200 Areas are house mice and deer mice, but other animals such as birds (including waterfowl), coyotes, cottontail rabbits, mule deer, and elk have been sampled (Johnson et al. 1994, PNNL 1999). In 1999, PNNL sampled elk, geese, and rabbits for gamma emitters and strontium-90. Samples of elk muscle, bone, liver, heart, kidney, intestine, and feces were collected from animals struck on Highway 240 and from individuals sampled on the 200 Area Plateau.

Cesium-137 was undetected in all elk samples. Poston and Cooper (1994) reported a consistent decline in cesium-137 concentration in elk since 1983. Geese were sampled from the Hanford Reach near Vernita Bridge. Only one of the eight geese sampled showed a cesium-137 concentration above analytical detection. Eight rabbit samples consisting of jackrabbit and cottontail muscle and bone were taken from the 200 Areas in 1999. One of the eight rabbits sampled showed a cesium-137 concentration above analytical detection. Strontium-90 was detected in bones of all eight samples; however, according to the *Hanford Site Environmental Report for Calendar Year 1999* (PNNL 2000a), the results from animals sampled near the 200 Areas did not suggest significant exposure attributable to Hanford Site operations.

Plant species may be potentially exposed to contaminated soils and/or groundwater present in shallow vadose zone soil. Plants live in direct contact with the soil and can take up contaminants through physical and biological processes. Exposure is a function of the plant species, root depth, physical nature of the contamination, and the contaminant concentrations and distributions in the soil. Plants are generally tolerant of ionizing radiation (IAEA 1982), but present a potential contaminant pathway to wildlife through the consumption of contaminated seeds, leaves, roots, or stalks.

Johnson et al. (1994) demonstrated radionuclide uptake by 200 Area plants. Unless noted otherwise, the following information is a summary of Johnston et al. (1994). Eighty-five environmental monitoring records of wildlife and vegetation at the 200 East and 200 West Areas since 1965 were also reviewed and summarized. About 4,500 individual cases of monitoring for radionuclide uptake or transport in biota in the 200 Area environs. Approximately 1,900 (42%) of these biota had radionuclide concentrations in excess of 10 pCi/g. These radionuclide transport or uptake cases were distributed among 45 species of animals (mostly small mammals and feces) and 30 species of vegetation.

The largest numbers and levels of radionuclide uptake or transport occurred at several sites unrelated to the 200-LW-1 OU, including the 216-Z Ditches, 216-B-3 Ditches, 216-BC Cribs, 241-B Tank Farm, and 241-BX/BY Tank Farms. Much of the sampling data were collected prior to stabilization activities at the individual waste sites. Noticeable reductions in the uptake and transport of radionuclide contaminants by biota were observed in areas where interim stabilization activities have taken place.

Ecological sampling data specific to the 200-LW-1 and 200-LW-2 OUs is limited. Vegetation at four sites within the 200-LW-1 and 200-LW-2 OUs (i.e., 216-S-20 Crib, 216-Z-7 Trench, 216-T-34 Crib, and 216-T-35 Crib) and one site near a 200-LW-1 OU waste site (i.e., 216-T-1 Ditch near the 200-W-21 waste site) were field surveyed or analytically sampled between 1965 and 1993. The vegetative species most commonly associated with the contamination was Russian thistle. In a monitoring effort by Wheeler and Law (1979), the survey of a composite terrestrial vegetation sample at the 216-S-20 Crib revealed a radionuclide activity of 5,000 cpm. Radionuclide activities in Russian thistle at the 216-Z-7 Trench were 3,000 cpm and up to 20 mrad/h in 1983 and 1986, respectively (Price et al. 1984, Jacques 1987). In 1986, a field survey of Russian thistle at the 216-T-34 and 216-T-35 Cribs produced a reading of 5 mrad/h (Jacques 1987). Additional terrestrial vegetation samples collected at the 216-T-35 Crib contained concentrations of 0.033 pCi/g cesium-137, 0.082 pCi/g strontium-90,

0.0051 pCi/g plutonium-239, and 0.05 pCi/g uranium (WHC 1992). Terrestrial vegetation samples collected at the 216-T-1 Ditch, which is located near the 200-W-21 waste site, contained average radionuclide concentrations of 0.137 pCi/g cesium-137, 0.0675 pCi/g strontium-90, 0.0064 pCi/g plutonium-239, and 0.02 pCi/g uranium.

In a 1999 sampling effort described in the Hanford Site Environmental Report (PNNL 2000a), 55 soil samples and 48 vegetation samples were collected in the 200/600 Areas. However, vegetation and soil samples were collected on or near only three 200-LW-1 waste sites under the Hanford Site Near-Facility Monitoring Program (e.g., PNNL 2000c), including the 216-T-35 Crib, 216-T-27 Crib, and the 216-T-28 Crib. Soil and vegetation samples were collected from station D019/V019 located within the 216-T-35 Crib and station D035/V035 located in the 216-T-26, 216-T-27, and 216-T-28 Crib area. Soil and vegetation concentrations of radionuclides for both the D019/V019 and D035/V035 monitoring sites are listed in Table 3-1. All but two soil samples contained radionuclide concentrations of less than 1.0 pCi/g. Cesium-137 was detected in soil at concentrations of 1.4 pCi/g and 1.2 pCi/g, respectively, from the 216-T-35 Crib and the 216-T-25, 216-T-27, and 216-T-28 Crib area. Radionuclide analysis indicated that strontium-90, cesium-134, cesium-137, plutonium-239/240, and uranium were consistently detectable in both soil and vegetation. Radionuclide concentrations in vegetation were less than 1 pCi/g in both locations.

Biological transport of contamination by ants is a source of concern on the Hanford Site. Harvester ants, which are present on the disturbed soils associated with waste sites, have shown extreme resistance to radioactive sources (Gano 1980). In a contamination area, ants are capable of bringing radioactive materials to the surface, where they could potentially become available to other means of transport by wind, plant uptake, birds, or mammals. The biological transport of contamination by harvester ants was documented during an annual radiological survey at the UPR-200-E-64 site in 1985. The source of contamination was assumed to be a small-diameter pipe visible on the west side of the 216-B-64 Basin, near tank 270-E-1 in the 200-CS-1 OU. In 1985, the pipe had a dose rate of 30 mrad/hr. Surrounding contamination was transported to the surface by harvester ants, and further spread by wind. The size of the area of contamination in 1995 was approximately 8,100 m^2 (2 acres), and is currently posted as a soil contamination area. Additional contaminated soil and ant hills were identified both north and south of 7th Street and around the 241-ER-151 Diversion Box in September 1998. No soil contamination as a result of burrowing has been identified at 200-LW-1 OU waste sites.

3.4 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

This section presents and discusses the conceptual exposure model developed to identify potential impacts to human health and the environment from waste sites in the 200-LW-1 OU. Information pertaining to contaminant sources, release mechanisms, transport media, exposure routes, and receptors is discussed to develop a conceptual understanding of potential risks and exposure pathways. This information will be used to support an evaluation of potential human health and environmental risk in the RI/FS documents for the 200-LW-1 OU.

3.4.1 Contaminant Sources and Release Mechanisms

As discussed in Section 2.0, the primary sources of contamination at waste sites in this waste category were the analytical laboratories that supported all of the 200 Area's major facilities and several 300 Area analytical laboratories. Effluents related to these facilities were routinely discharged to cribs and trenches where the wastewater infiltrated into the soil. Unplanned releases of contaminants also occurred.

Releases to the environment from primary sources have resulted in secondary contaminant sources, such as the contaminated soils beneath the stabilized waste sites and unplanned release sites in this waste category. Secondary releases can occur through infiltration (continued movement of wastewater through the soil), resuspension of contaminated soil (erosion or mechanical disturbances), volatilization (movement of organic chemicals through the soil and into the air), biotic uptake (plant uptake or animal ingestion), leaching (contaminant release from rain or snowmelt exposure), and external radiation (gamma). The dominant mechanism of contaminant transport is from infiltration and leaching with rainwater or snowmelt as driving forces. Residual effluent contamination at the waste sites has the potential to impact groundwater.

3.4.2 Potential Receptors

Potential receptors (i.e., human and ecological) may be exposed to the affected media through several exposure pathways, including the following:

- Ingestion of contaminated soils (including dust inhalation), sediments, or biota
- Dermal contact with contaminated soils or sediments
- Direct exposure to external gamma radiation in site soils and sediments.

Potential human receptors include site workers (current and future) and site visitors (occasional users). Site worker and visitor exposure pathways would primarily involve incidental soil/sediment ingestion (including dust inhalation), dermal contact with contaminated soils/sediments, and external gamma radiation. Potential ecological receptors include terrestrial plants and animals using the sites. More details on these specific receptors are presented in Section 3.3.9. Site biota exposures would primarily involve incidental soil/sediment ingestion, biota ingestion (e.g., coyotes eating prey that live on the site or deer consuming plants growing on the site), dermal contact with contaminated soils/sediments, and external gamma radiation. The conceptual exposure pathway model for the 200-LW-1 OU is shown in Figure 3-13.

3.4.3 Potential Impacts

Potential contaminant exposures and health impacts to humans are largely dependent on land use. The land use for the 200 Areas selected by DOE through the *National Environmental Policy Act of 1969* process (DOE 1999) and documented in a ROD (64 FR 61615) is industrial (exclusive). Outside the 200 Area boundary, the selected land use is conservation (mining). The 200-LW-1 sites are located within the 200 Area exclusive land-use boundary.

Ecological receptors and potential impacts to those receptors have been evaluated at waste sites within the 200 Areas (Perkins et al. 2000, Rogers and Rickard 1977, Stegen 1993). The vegetation cover within the 200 Area Plateau is dominantly a rabbitbrush/cheatgrass and sagebrush/cheatgrass association with incidence of herbaceous and annual species. Many areas are disturbed and nonvegetated, or sparsely vegetated with annuals and weedy species such as Russian thistle. The contamination pathway to ecological exposures for the waste sites is minimized due to stabilization activities that have been conducted.

Soil characterization data previously collected, and information to be obtained from the proposed borehole sampling to be conducted at representative waste sites as part of this work plan, will be sufficient to address potential impacts to human health during characterization operations.

Based on the minimal amount of ecological data collected from previous investigations and surveys (e.g., annual near-facility environmental surveys), additional OU-specific ecological data are considered necessary to address potential impacts to the environment at this time. However, it is an expectation that an assessment for the 200 Areas is needed that would further evaluate ecological impacts for the 200 Area Central Plateau in a more holistic manner (see Section 5.2).

3.5 DEVELOPMENT OF CONTAMINANTS OF CONCERN

The development of the list of COPCs and refinement to the list of contaminants of concern (COCs) was a major focus of the DQO process (BHI 2001). The preliminary list of COPCs included the complete set of contaminants that were potentially discharged to this waste group from facilities discussed in Section 2.2. This master list of COPCs was generated by process information gathered and evaluated against a set of exclusion criteria and past sampling/characterization events to enable the development of a final COC list. Chemical characteristics such as toxicity, persistence, and chemical behavior in the environment were considered. The criteria for exclusion of certain constituents, as detailed in the DQO summary report (BHI 2001), are as follows:

- Short-lived radionuclides with half-lives less than 3 years
- Radionuclides that constitute less than 1% of the fission product inventory and for which historical sampling indicates nondetection
- Naturally occurring isotopes that were not created as a result of Hanford Site operations
- Constituents with atomic mass numbers equal to or greater than 242 that represent less than 1% of the actinide activities
- Progeny radionuclides that build insignificant activities within 50 years and/or for which parent/progeny relationships exist that permit progeny estimation
- Constituents that would be neutralized and/or decomposed by facility processes

- Chemicals in a gaseous state that cannot accumulate in soil media
- Chemicals used in minute quantities relative to the bulk production chemicals consumed in the normal processes; these chemicals have no suspected introduction to waste streams except in incidental quantities
- Chemicals that are not persistent in the environment due to biological degradation or other natural mitigating features.

The exclusion process resulted in a final list of COCs for the waste category, which is presented in Table 3-2. The preliminary list of COPCs, the excluded analytes, and the rationale for exclusion are presented in the DQO summary report (BHI 2001).

Figure 3-1. 216-B-58 Trench and Borehole Location Map.

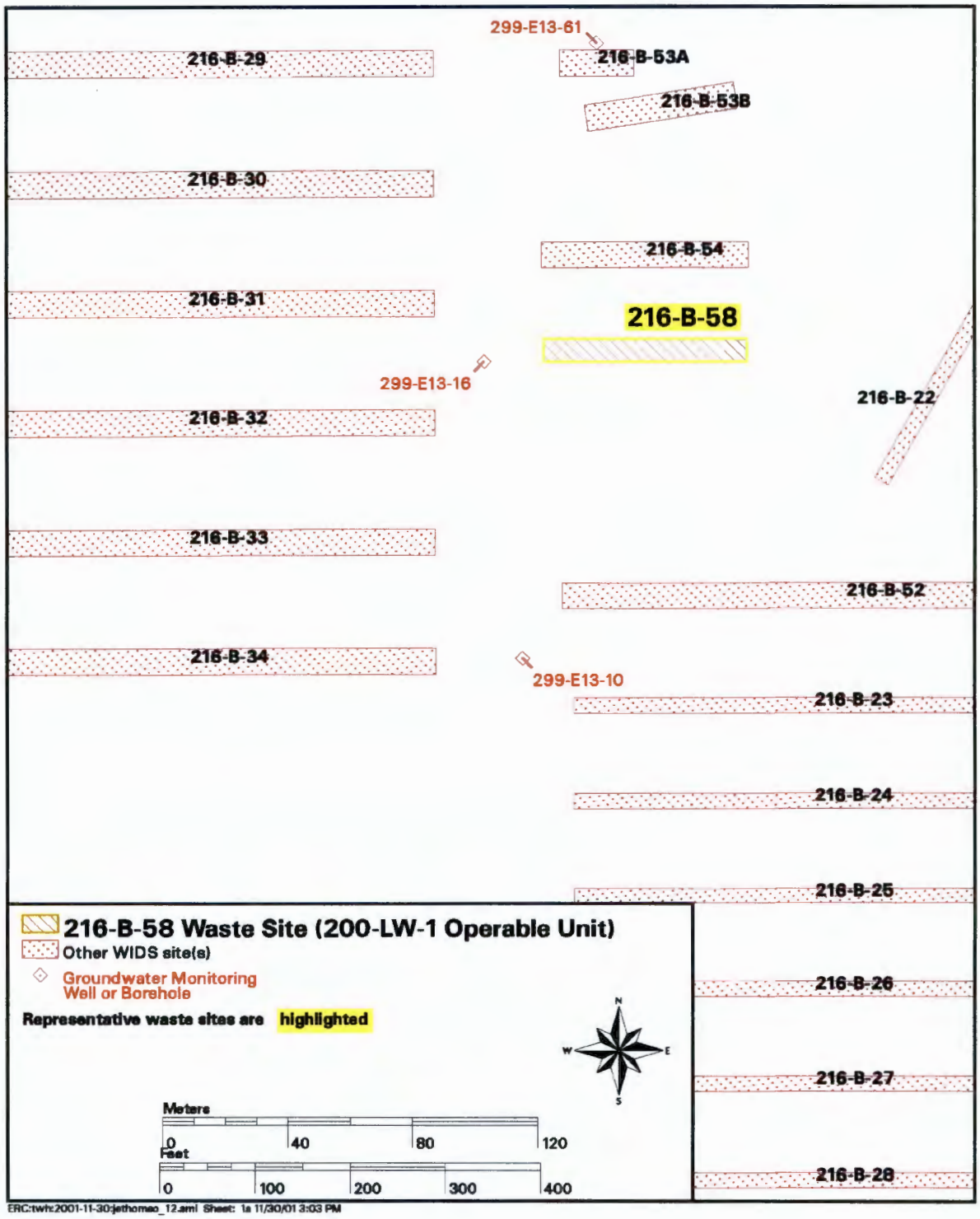
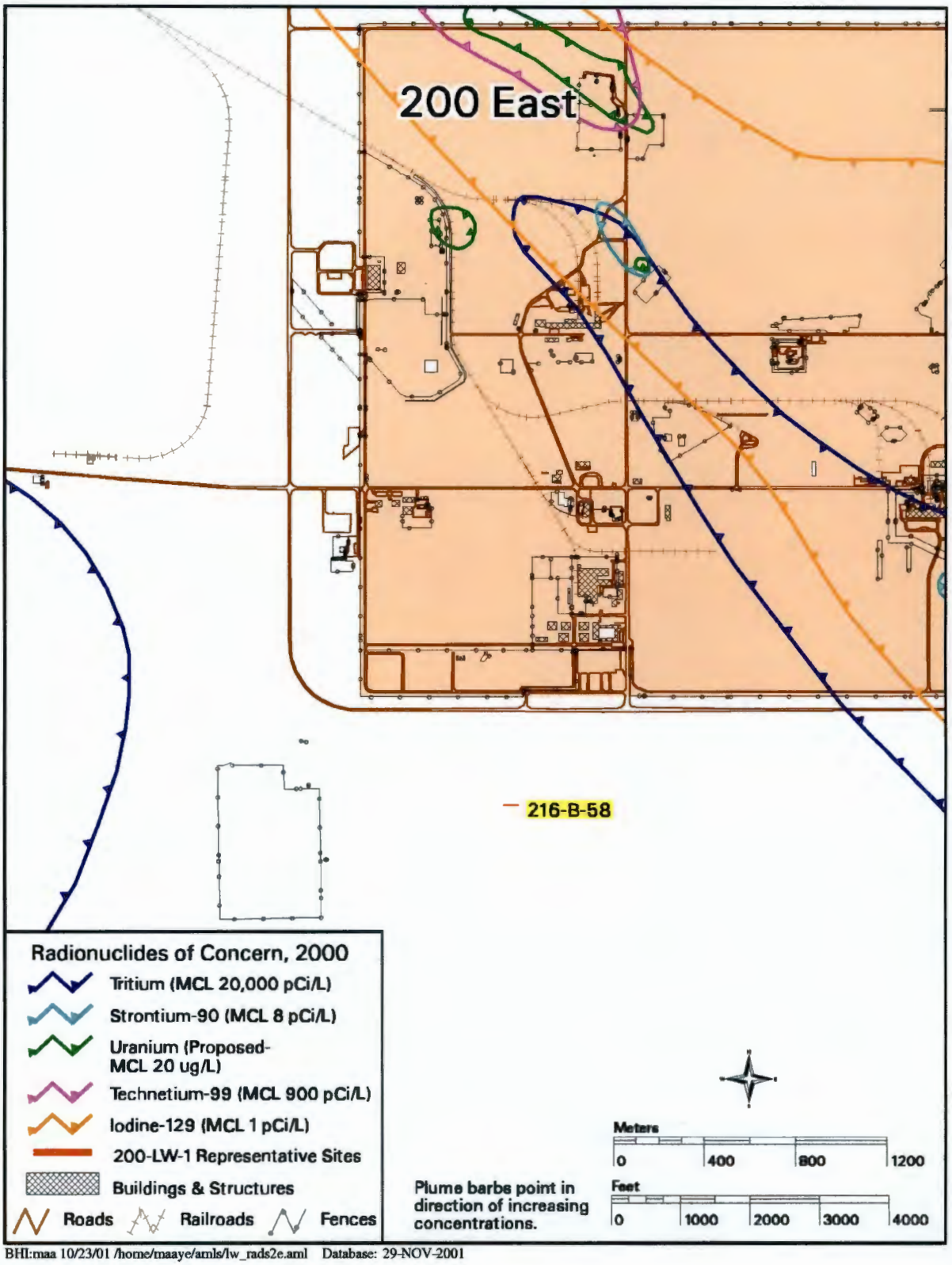
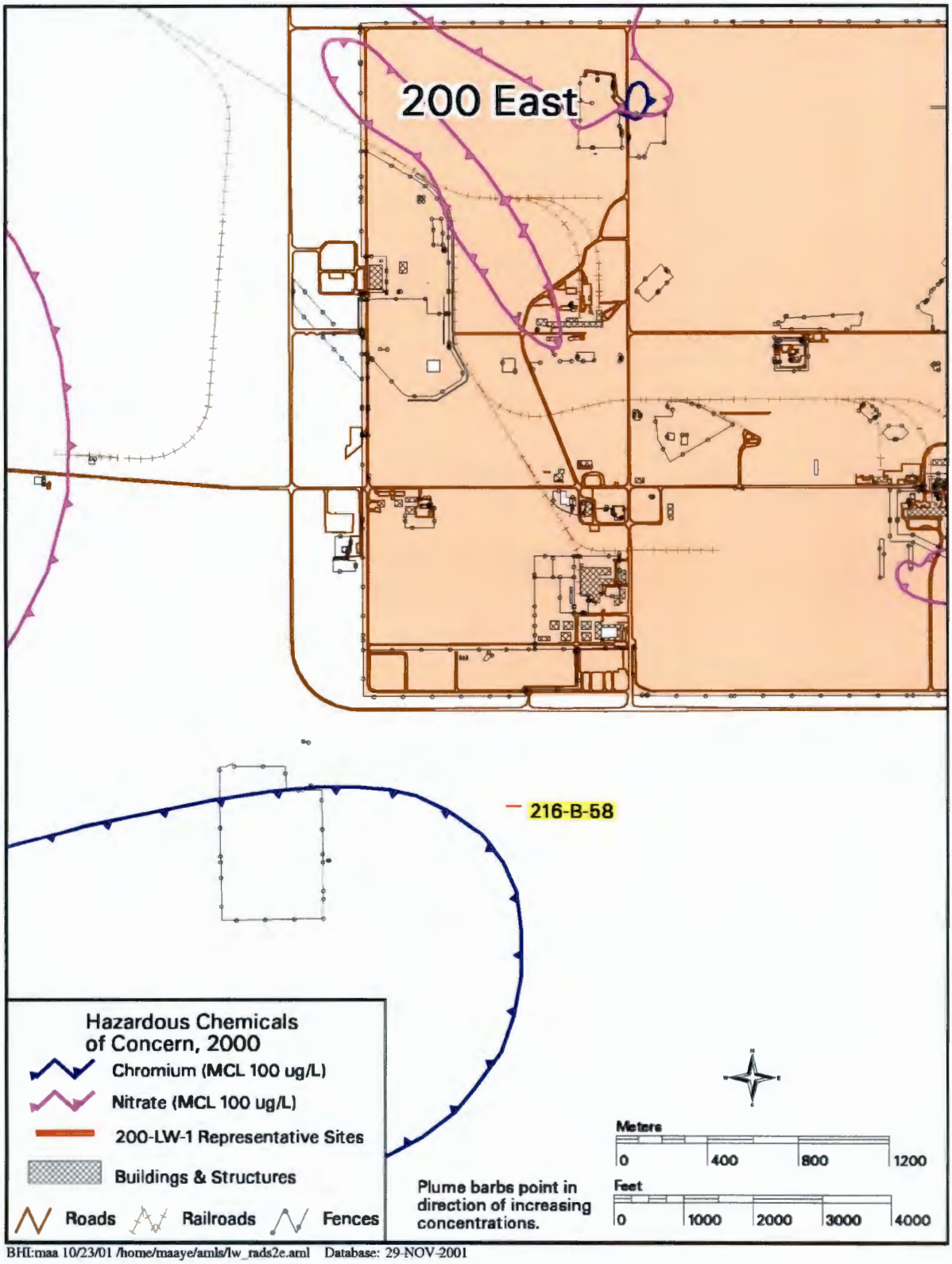


Figure 3-2. Major Radiological Groundwater Plumes in the Vicinity of the 200 East Area (Modified from PNNL 2001b).



BHI:maa 10/23/01 /home/maaye/amls/lw_rads2e.aml Database: 29-NOV-2001

Figure 3-3. Major Nonradiological Groundwater Plumes in the Vicinity of the 200 East Area (Modified from PNNL 2001b).



BHI:maa 10/23/01 /home/maaye/amls/lw_rads2e.aml Database: 29-NOV-2001

Figure 3-4. 216-T-28 Crib and Borehole Location Map.

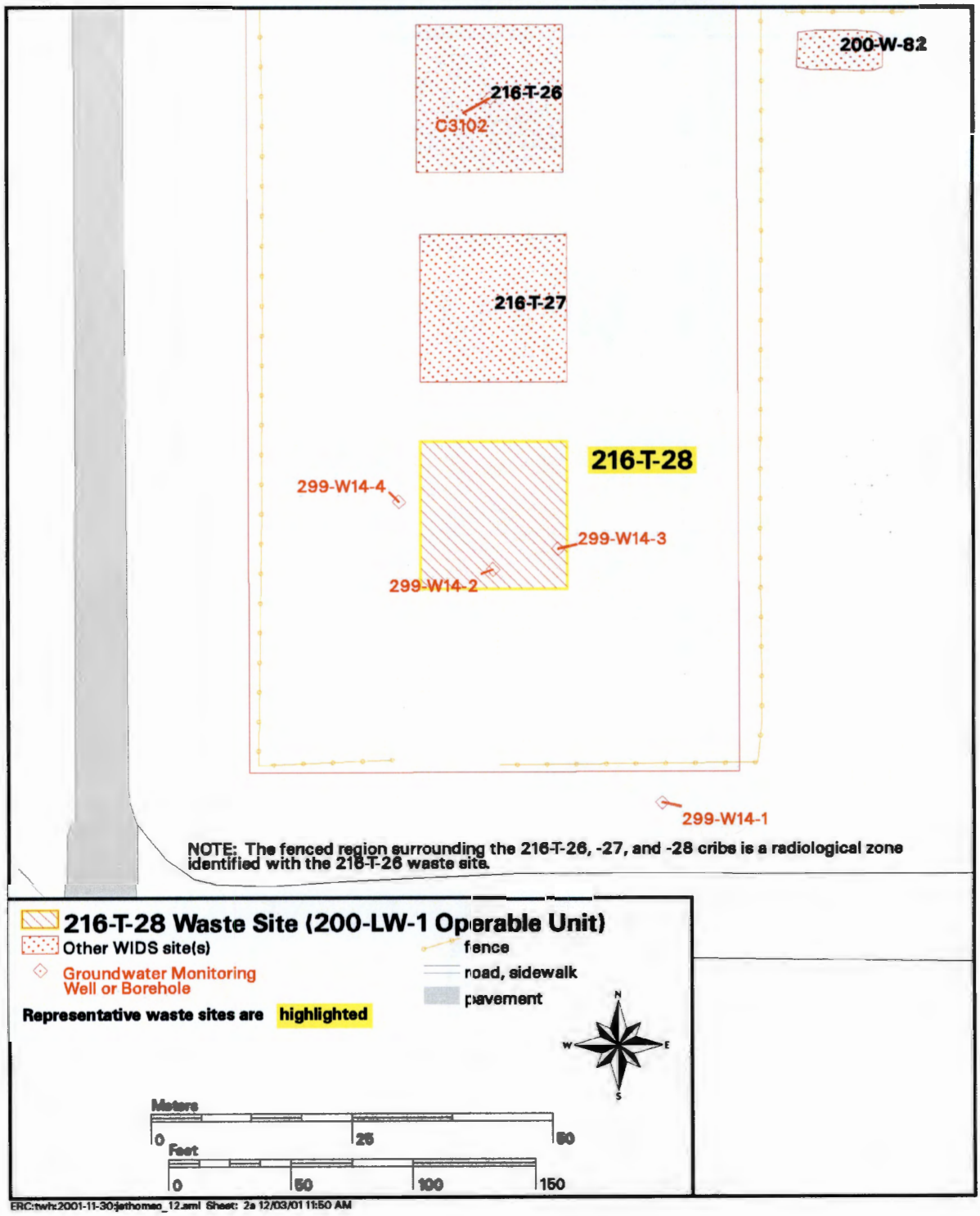
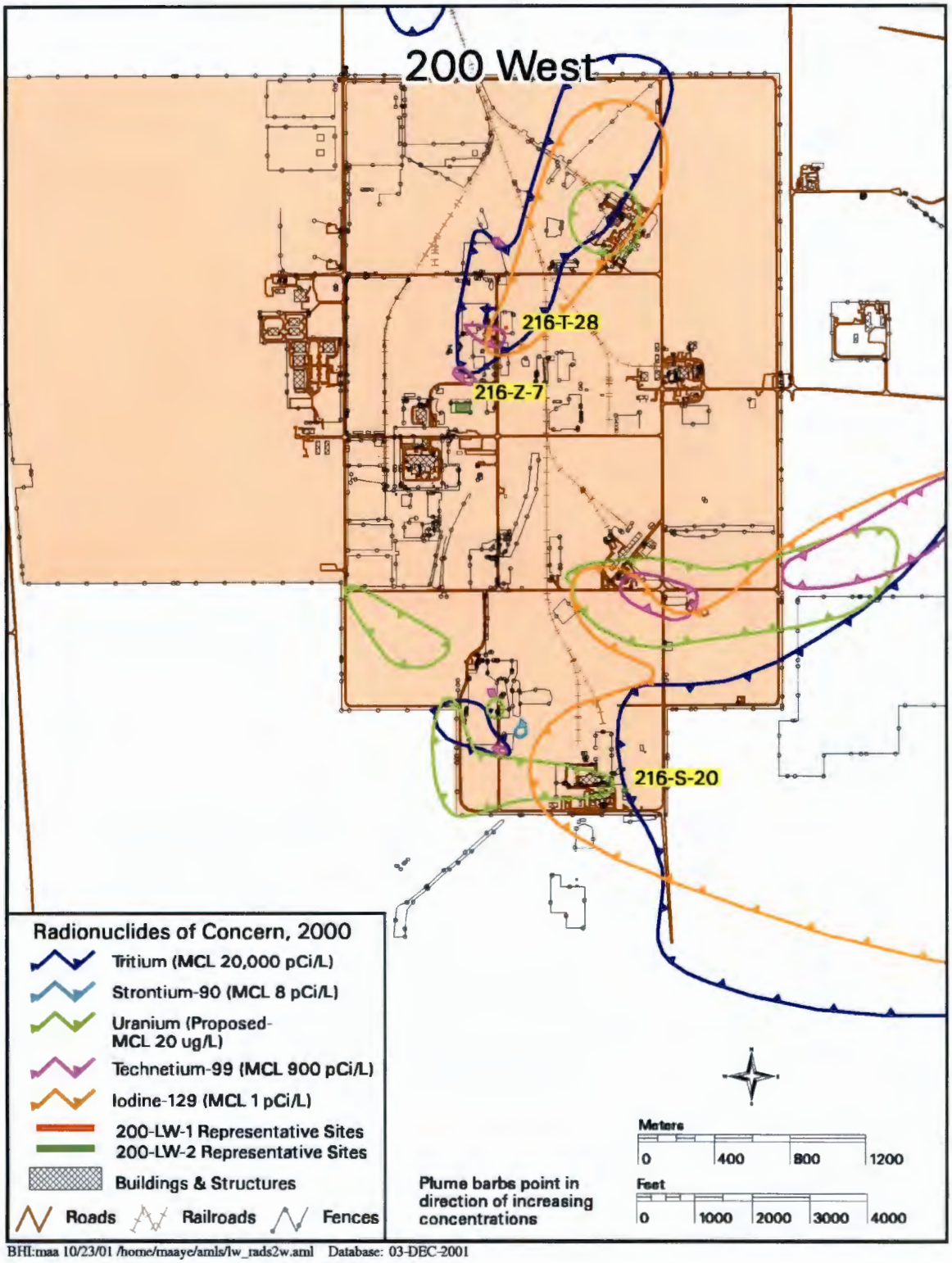
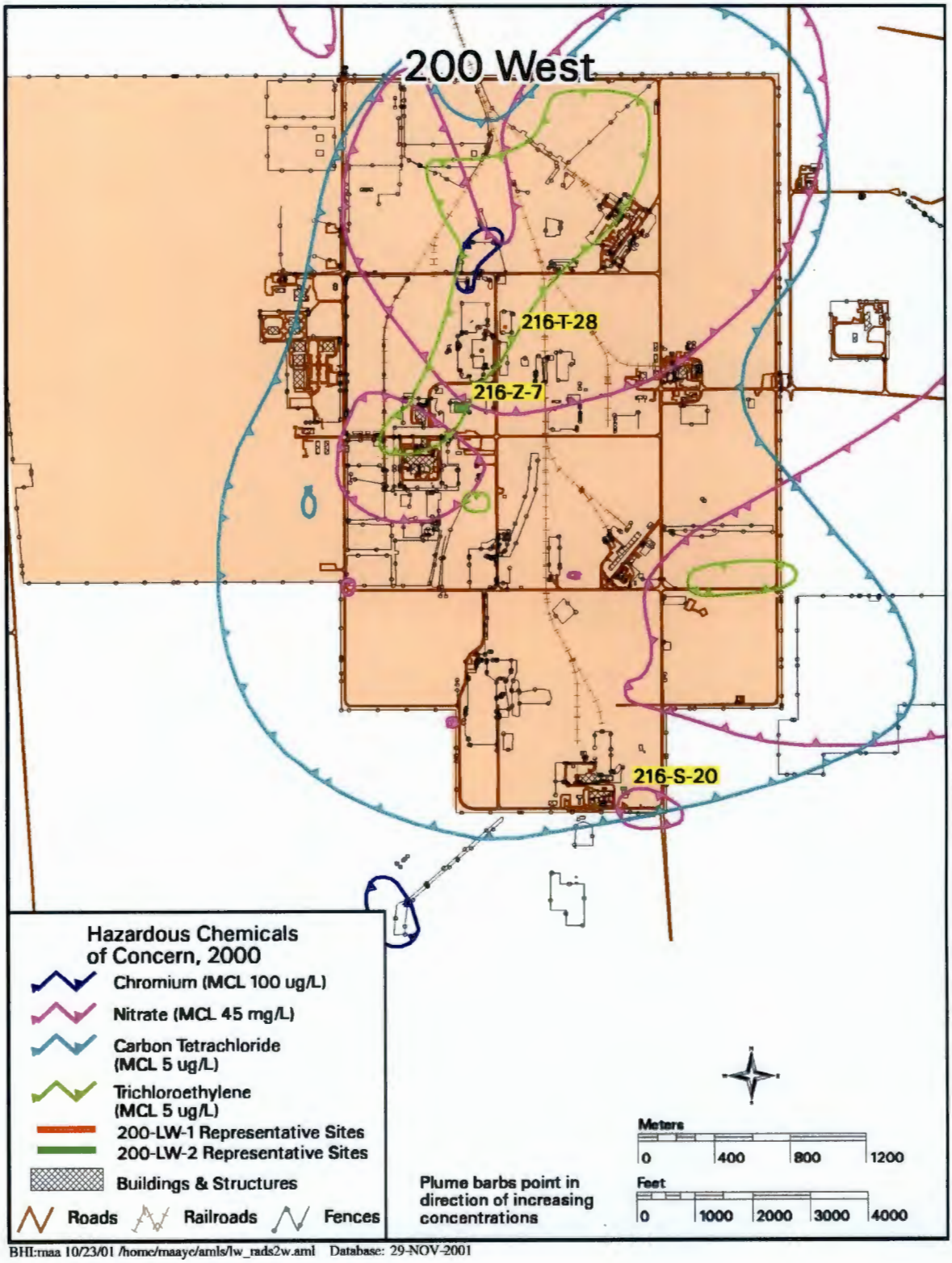


Figure 3-5. Major Radiological Groundwater Plumes in the Vicinity of the 200 West Area (Modified from PNNL 2001b).



BHI:maa 10/23/01 /home/maaye/amls/lw_rads2w.aml Database: 03-DEC-2001

Figure 3-6. Major Nonradiological Groundwater Plumes in the Vicinity of the 200 West Area (Modified from PNNL 2001b).



BHI:maa 10/23/01 /home/maayc/amls/lw_rads2w.aml Database: 29-NOV-2001

Figure 3-7. 216-S-20 Crib and Borehole Location Map.

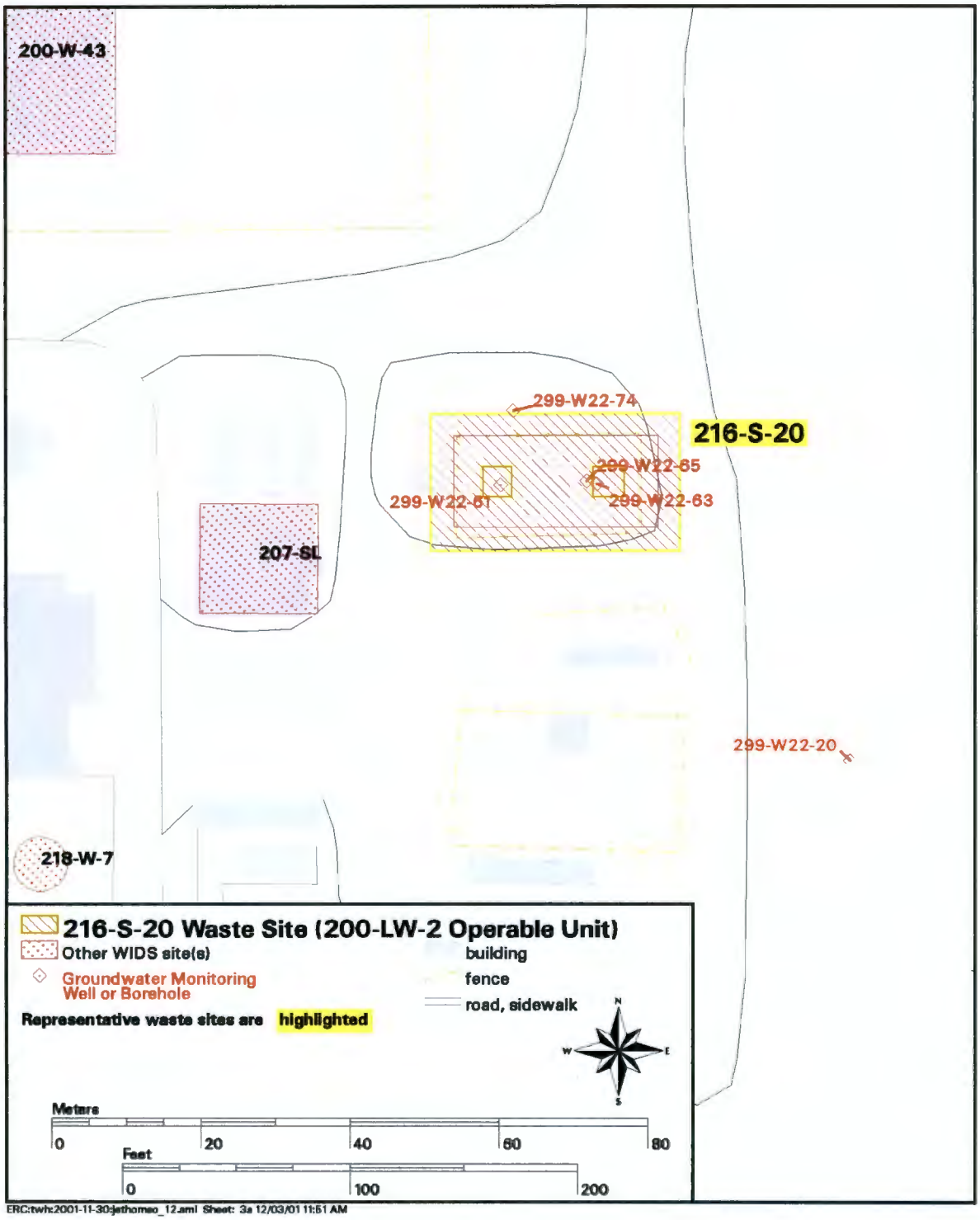


Figure 3-8. 216-Z-7 Crib and Borehole Location Map.

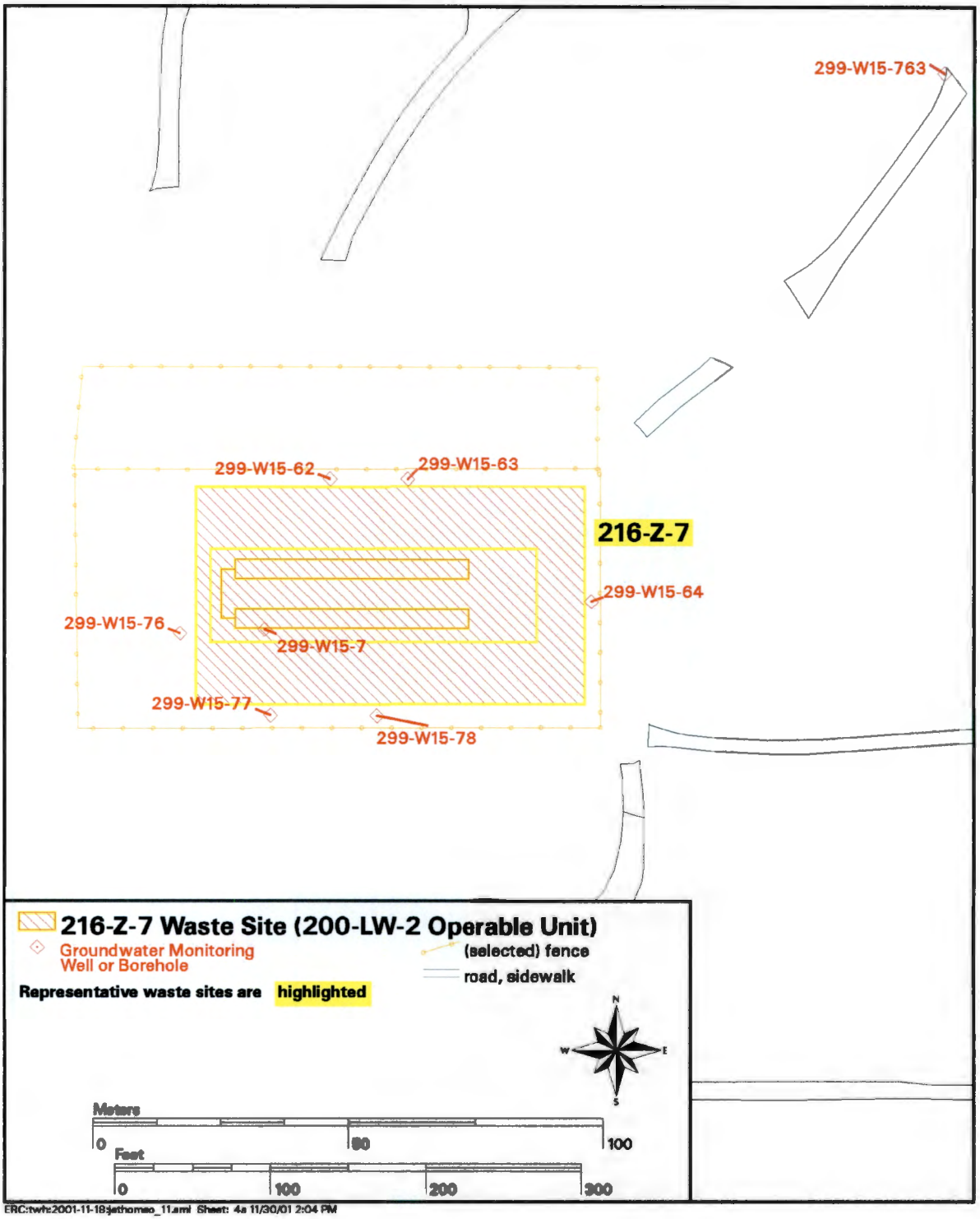
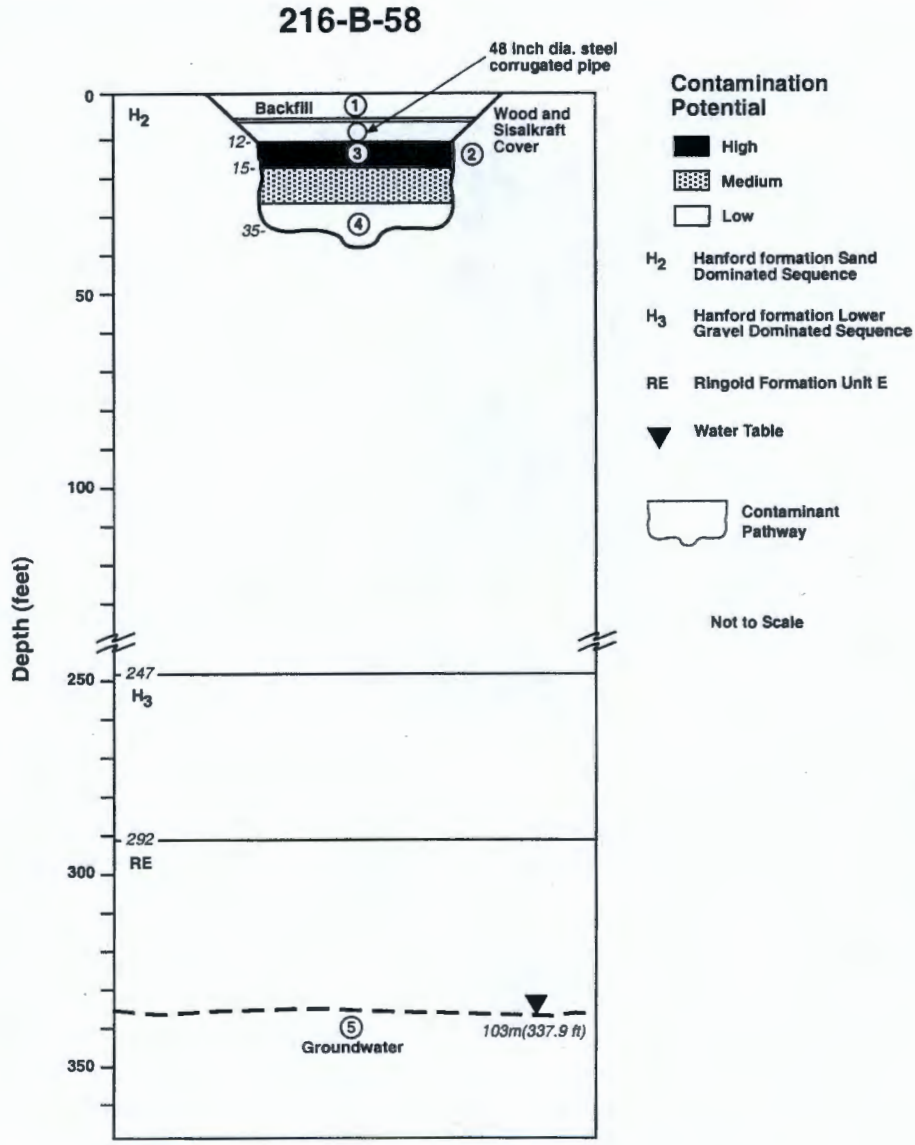


Figure 3-9. 216-B-58 Trench Conceptual Contaminant Distribution Model.



① Acidic to basic, low salt, low organic liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90, uranium, nitrate, and other contaminants were discharged to the 216-B-58 trench between 1965 and 1967. The trench received a total volume of 413,000 L (109,032 gallons) of effluent. Very little data are available to evaluate the contaminant distribution at this site.

② Once discharged, wastewater and contaminants migrate vertically downward beneath the trench within H2. Little or no lateral spreading occurs.

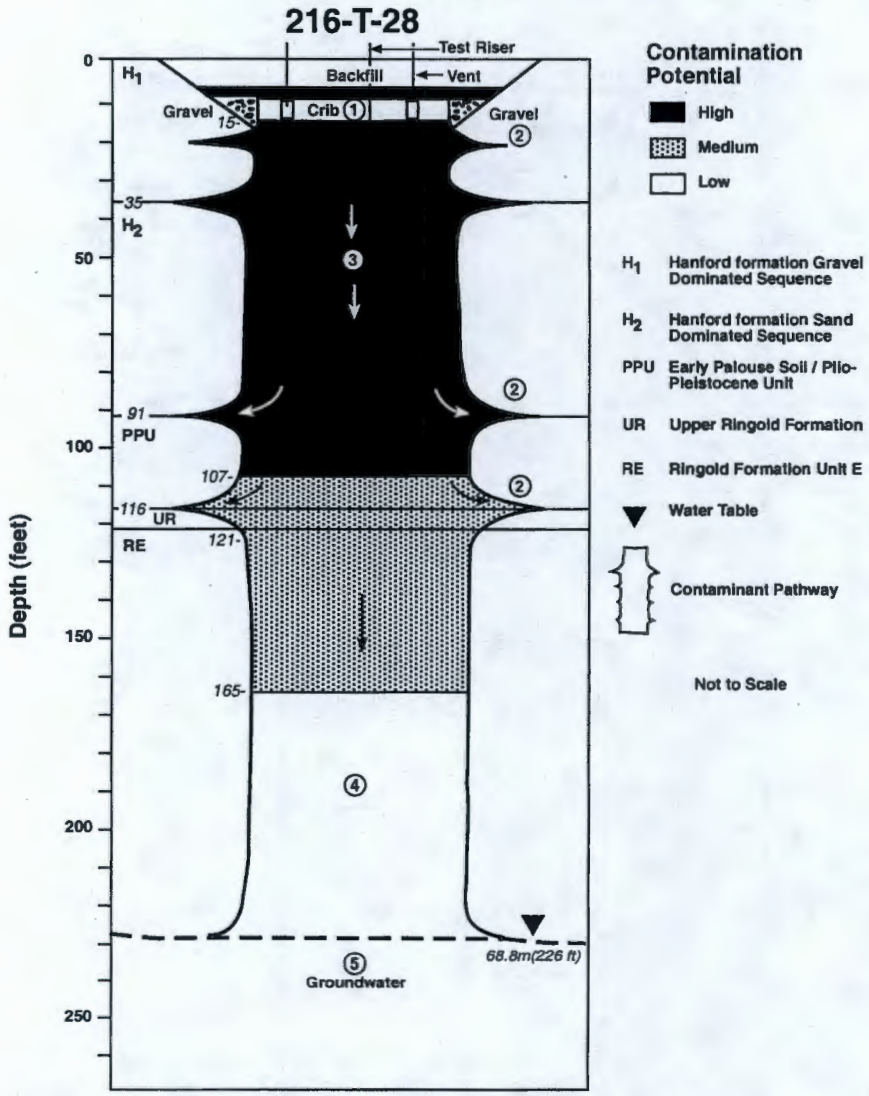
③ Immobile contaminants such as cesium-137 normally sorb near the point of release in high concentrations approximately 10 ft bgs. Concentrations decrease with depth.

④ Mobile contaminants like nitrate migrate with the moisture front and may be detected in low concentrations to 35 ft ±15ft. Concentrations may increase with depth. Based on the amount of effluent discharged, contamination is expected to a maximum depth of 35 ft ± 15 ft.

⑤ Wastewater and contaminants from the trench suggest no impact to groundwater since the effluent volume discharged to the soil column (423m³) is less than the soil column pore volume (5640m³). There are no groundwater plumes in the immediate area of the trench.

E0111003.4

Figure 3-10. 216-T-28 Crib Conceptual Contaminant Distribution Model.



① Acidic to basic, low salt, low organic liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90, uranium, nitrate, and other contaminants were discharged to the 216-T-28 crib between 1960 and 1966. The crib received a total volume of 42,300,000 L (11,167,200 gallons) of wastewater.

② Once discharged, wastewater and contaminants migrate vertically downward beneath the crib. Lateral spreading of wastewater occurs associated with the bottom of the crib, H2, the PPU, and UR. Contaminant impacts are significant in boreholes 299-W14-2, 299-W14-3, 299-W14-4 which are located in the crib. 125 ft southeast of the crib, low levels of contamination were detected in a borehole 299-W14-1 which monitors the crib. Concentrations near the crib may in part be associated with contamination from adjacent waste sites 216-T-26 and 216-T-27.

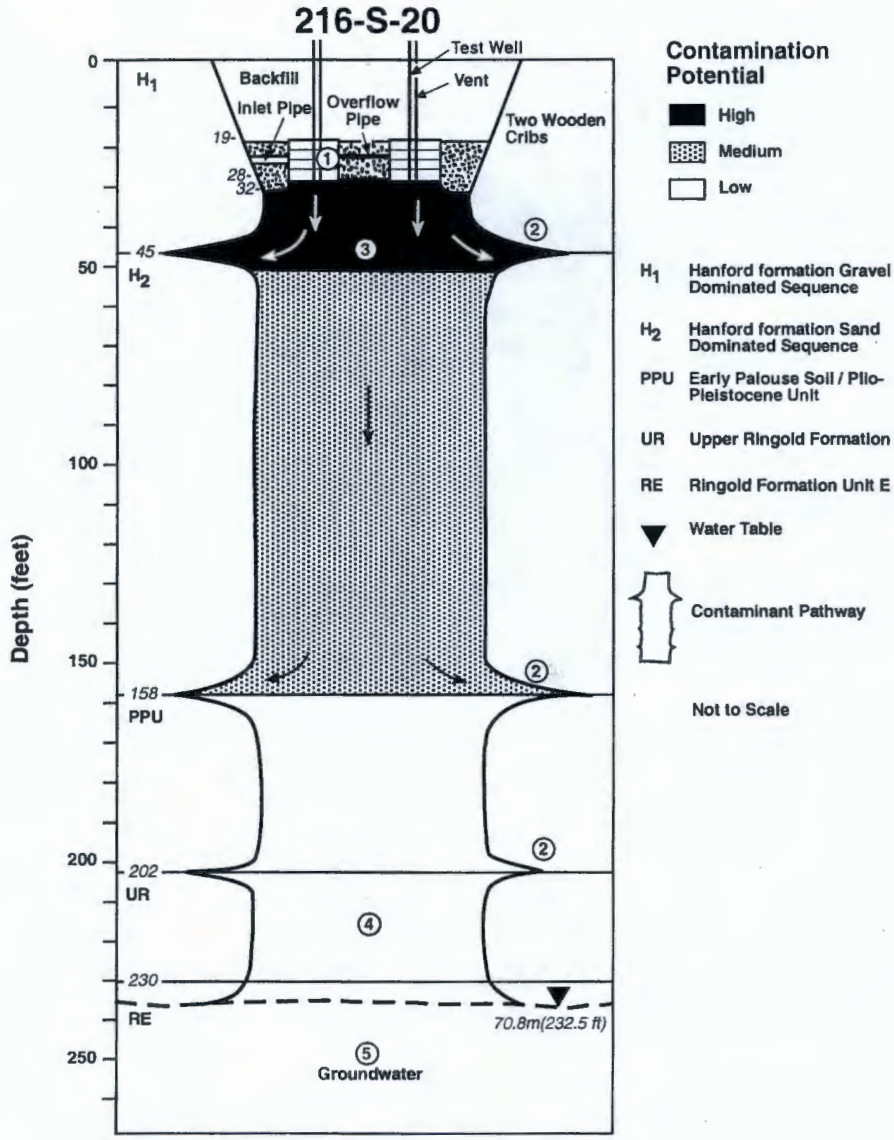
③ Immobile contaminants such as cesium-137 normally sorb near the point of release of high concentrations. Beneath the crib, cesium-137 concentrations are >5000 pCi/g to a depth of 107 ft. based on spectral gamma data. Contaminant concentrations decrease to < 10 pCi/g at a depth of 165 ft. Enhanced mobility of contaminants may be due to the presence of a preferential pathway (i.e., lack of a well seal) prior to remediation of the borehole in 1983.

④ Mobile contaminants like nitrate migrate with the moisture front and may be detected in low concentrations to the water table.

⑤ Wastewater and mobile contaminants likely impact groundwater since the effluent volume discharged to the soil column (42,300m^3) is greater than the soil column pore volume (680m^3). Nitrate, carbon tetrachloride, trichloroethylene, iodine-129, and tritium exceed groundwater protection standards near the crib.

E0111003.3

Figure 3-11. 216-S-20 Crib Conceptual Contaminant Distribution Model.



① Acidic to basic, low salt, low organic liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90, uranium, nitrate, and other contaminants were discharged to the 216-S-20 crib between 1952 and 1972. The crib received a total volume of 135,000,000 L (35,640,000 gallons) of wastewater. Very little data are available to evaluate the contaminant distribution at this site.

② Once discharged, wastewater and contaminants migrate vertically downward beneath the crib. Minor lateral spreading of wastewater may occur associated with H2, the PPU, and UR. The available data suggest that lateral spreading is not significant beneath the crib.

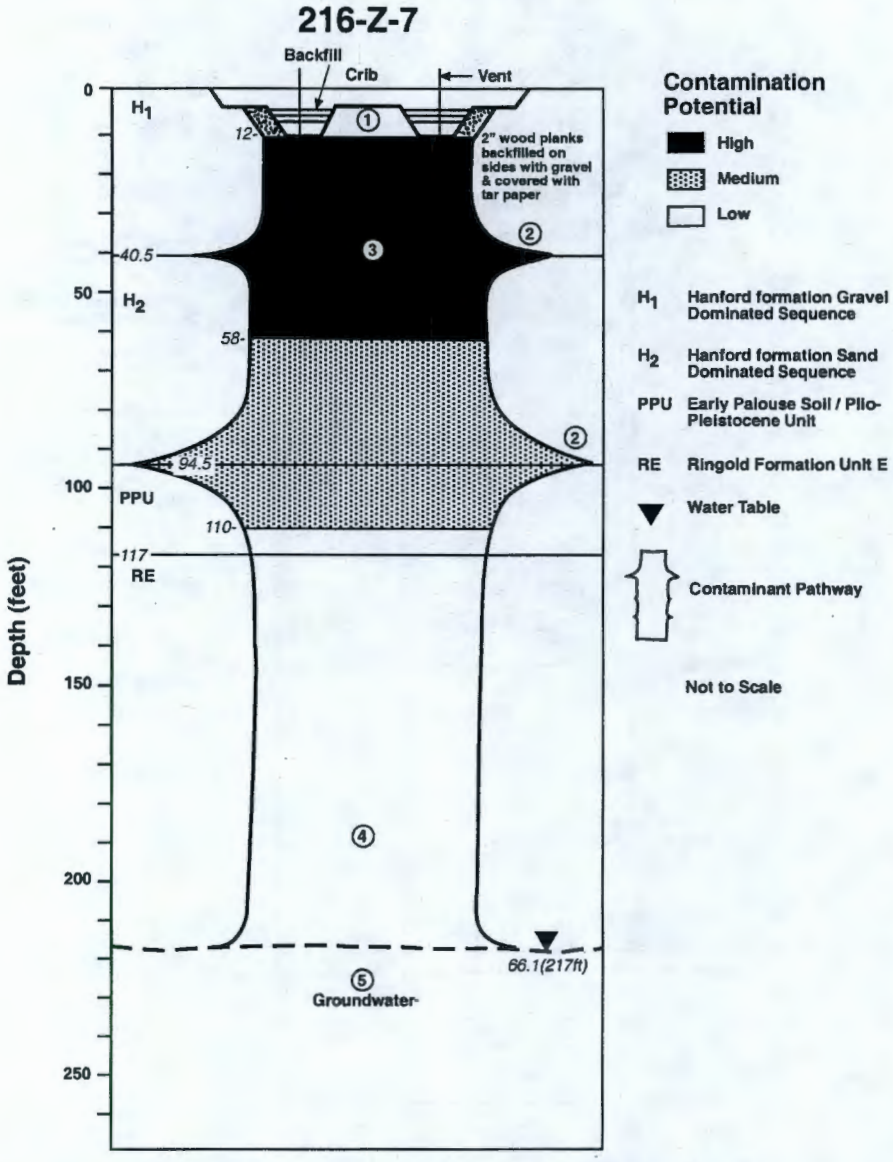
③ Immobile contaminants such as cesium-137 normally sorb near the point of release in high concentrations. Contaminant concentrations decreased with depth.

④ Mobile contaminants like nitrate migrate with the moisture front and may be detected in low concentrations to the water table.

⑤ Wastewater and mobile contaminants likely impact groundwater since the effluent volume discharged to the soil column (135,300m^3) is greater than the soil column pore volume (6020m^3). Nitrate, carbon tectrachloride, iodine-129, and tritium exceed groundwater protection standards near the crib.

E0111003.1

Figure 3-12. 216-Z-7 Crib Conceptual Contaminant Distribution Model.



① Acidic to basic, low salt, low organic liquid waste containing cesium-137, cobalt-60, plutonium-239/240, strontium-90, uranium, nitrate, and other contaminants were discharged to the 216-Z-7 crib between 1947 and 1967. The crib received a total volume of 79,000,000 L (21,093,600 gallons) of wastewater. Very little data are available to evaluate the contaminant distribution at this site.

② Once discharged, wastewater and contaminants migrate vertically downward beneath the crib. Minor lateral spreading of wastewater may occur associated with H2, and the PPU. The available data suggest that lateral spreading is not significant beneath the crib.

③ Immobile contaminants such as cesium-137 normally sorb near the point of release in high concentrations. Contaminant concentrations decreased with depth.

④ Mobile contaminants like nitrate migrate with the moisture front and may be detected in low concentrations to the water table.

⑤ Wastewater and mobile contaminants likely impact groundwater since the effluent volume discharged to the soil column (79,000m^3) is greater than the soil column pore volume (30,000m^3). Nitrate, carbon tetrachloride, trichloroethylene, techetium-99, iodine-129, and tritium exceed groundwater protection standards near the crib.

E0111003.2

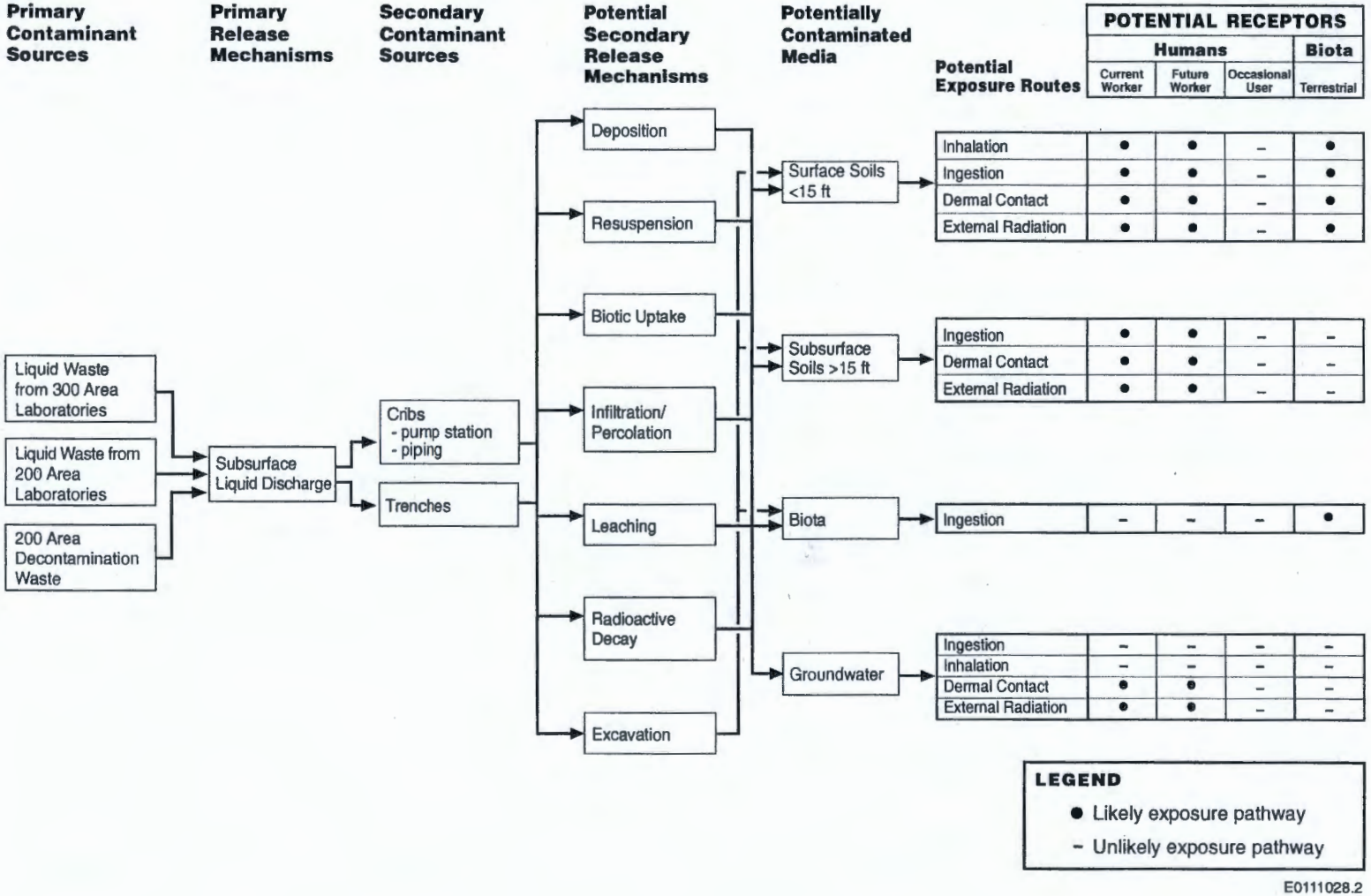


Figure 3-13. Conceptual Exposure Pathway Model.

Table 3-1. 1999 Soil and Vegetation Environmental Surveillance Data (pCi/g) for Sites in the Laboratory Waste Group.

Isotope	216-T-35 Crib		216-T-26, 216-T-27, and 216-T-28 Crib Area	
	Soil (D019)	Vegetation (V019)	Soil (D035)	Vegetation (V035)
Ce-144	-2.30E-02	-3.10E-02	-1.60E-02	-4.50E-02
Co-60	1.70E-03	-1.50E-03	-8.40E-04	1.50E-02
Cs-134	1.10E-02	2.40E-02	1.10E-02	-7.20E-03
Cs-137	1.40E+00	4.00E-02	1.20E+00	7.70E-02
Eu-152	-9.90E-03	-4.10E-02	-2.10E-03	-5.20E-02
Eu-154	2.40E-02	1.80E-02	-6.00E-03	-3.50E-03
Eu-155	9.40E-03	9.70E-03	2.30E-03	-1.30E-02
Pu-238	4.20E-02	9.40E-04	-1.70E-02	1.20E-02
Pu-239/240	3.50E-02	3.80E-03	2.90E-02	8.60E-04
Ru-103	7.00E-03	-1.30E-02	-1.00E-03	-2.70E-03
Ru-106	3.40E-02	-3.50E-02	-2.20E-02	1.60E-01
Sb-125	3.60E-03	-2.00E-02	-2.40E-03	-1.30E-02
Sn-113	-2.20E-03	7.10E-03	4.10E-04	-1.20E-02
Sr-90	3.20E-01	9.30E-02	6.10E-01	1.20E-01
U-234	1.90E-01	1.70E-02	2.50E-01	3.10E-02
U-235	3.20E-02	6.00E-03	2.60E-02	-1.10E-03
U-238	1.90E-01	1.70E-02	2.30E-01	1.60E-02
Zn-65	3.40E-03	1.80E-02	-4.60E-03	-1.10E-02

Source: *Hanford Site Near Facility Environmental Monitoring Data Report for Calendar Year 1999* (PNNL 2000c).

Table 3-2. 200-LW-1 Operable Unit Final COC List.

Radiological Constituents	
Americium-241	Plutonium-238
Carbon-14	Plutonium-239/240
Cesium-137	Strontium-90
Cobalt-60	Technetium-99
Europium-152	Thorium-232
Europium-154	Tritium
Europium-155	Uranium-233/234
Neptunium-237	Uranium-235/236
Nickel-63	Uranium-238
Nonradiological Constituents – Metals	
Antimony	Copper
Arsenic	Lead
Barium	Mercury
Beryllium	Nickel
Cadmium	Selenium
Chromium	Silver
Hexavalent chromium	
Nonradiological Constituents – General Inorganics	
Ammonia/ammonium	Nitrate/nitrite
Chloride	Phosphate
Cyanide	Sulfate
Fluoride	Sulfide
Volatile Organics	
1,1-dichlorethane (DCA)	Ethylene glycol
1,2-dichlorethane (DCA)	2-butanone (methyl ethyl ketone)
1,1,1-trichloroethane	Methyl isobutyl ketone (MIBK) (hexone)
Acetone	Methylene chloride
Benzene	n-butyl benzene
Butanol	Trans-1,2-dichlorotheylene
Carbon tetrachloride	Tetrachloroethylene (PCE)
Cis-1,2-dichloroethylene	Trichloroethylene (TCE)
Chlorobenzene	Toluene
Chloroform	Xylene
Ethylbenzene	
Semi-Volatile Organics	
AMSCO[a]	Phenol
Dodecane[a]	Polychlorinated byphenyls (PCBs)
Greases	Tributyl phosphate and derivatives (mono, bi)
Normal paraffin hydrocarbon[a]	

[a]Analyzed as kerosene by nonhydrogenated volatile organic analyte via 8015 method, total petroleum hydrocarbons - diesel to oil range, or total petroleum hydrocarbons - gasoline range.

4.0 WORK PLAN APPROACH AND RATIONALE

4.1 SUMMARY OF DATA QUALITY OBJECTIVE PROCESS

The RI needs for the 200-LW-1 OU were developed in accordance with the DQO process (EPA 1994; BHI-EE-01, *Environmental Investigations Procedures*, Procedure 1.2). The DQO process is a seven-step planning approach used to develop a data collection strategy consistent with data uses and needs. The goals of the 200-LW-1 OU process are to provide the data needed to refine the conceptual contaminant distribution models and support remedial decisions.

The DQO process was implemented by a team of subject matter experts and key decision makers. Subject matter experts provided input on regulatory issues, the history and physical condition of the sites, and sampling and analysis methods. Key decision makers from DOE and Ecology participated in the process to develop the characterization approach outlined in the DQO summary report. The DQO process and involvement of the team of experts and decision makers provides a high degree of confidence that the right type and quality of data are collected to fulfill informational needs of the 200-LW-1 decisional process. Results of the DQO process for characterization of the representative sites in the 200-LW-1 OU are presented in the *Remedial Investigation Data Quality Objectives Summary Report for the 200-LW-1 300 Area Laboratory Waste Group Operable Unit* (BHI 2001). As part of the DQO process, two representative sites from the 200-LW-1 OU that were initially identified in the waste site grouping report (DOE-RL 1997) were reviewed and determined to be adequate for representing the waste sites in this OU. In addition, two sites from the 200-LW-2 OU were also reviewed. In an effort to adequately characterize the chemical laboratory waste category, the 216-S-20 Crib and the 216-Z-7 Crib from the 200-LW-2 OU were included in this RI/FS work plan for the RI. As discussed in Section 3.0, characterization activities outlined in this work plan focus on the 216-T-28 Crib, the 216-B-58 Trench, the 216-S-20 Crib, and the 216-Z-7 Crib.

The nature of the waste sites to be investigated in the RI permit the use of focused sampling as identified in *Washington State Department of Ecology Toxics Cleanup Program Guidance on Sampling and Data Analysis Methods* (Ecology 1995). This guidance document defines focused sampling as selective sampling of areas where potential or suspected soil contamination can reliably be expected to be found if a release of a hazardous substance has occurred. The relatively small crib structures to be investigated released contaminants in a point-source fashion. Contaminants released through a small crib would likely impact the soil immediately beneath the crib with minimal lateral spread; therefore, sampling through the crib will ensure sample collection in the area of greatest impact associated with the discharge. Contaminant distributions are expected to follow relatively predictable patterns based on the nature of the COCs, process knowledge, and existing environmental data. Because the 216-B-58 Trench and 216-Z-7 Crib are somewhat larger than the other two sites identified for RI, additional data on gamma-emitting radionuclides may be needed to determine the worst-case location within these sites.

4.1.1 Data Uses

Data generated during characterization of the representative sites will consist mainly of soil contaminant data. These contaminant data will be used to define the nature and vertical extent of radiological and nonradiological contamination, support an initial evaluation of potential human health and ecological risks, and assist in the evaluation and selection of a remedial alternative. By defining the type and vertical distribution of contamination, the conceptual model for contaminant distribution can be verified or refined. The lateral extent of contamination is assumed to be primarily confined within the site boundaries, but may be evaluated through geophysical logging results. Additional evaluation of the lateral extent of contamination will be done during the confirmatory sampling phase as necessary to support remedial design. Verification of the current conceptual contaminant distribution models will direct the application of the analogous site concept at the remaining 200-LW-1 and 200-LW-2 waste sites. A limited amount of data will be collected to characterize the physical properties of soils that will be used to support an initial assessment of risk dose model (e.g., RESidual RADioactivity [RESRAD] or other risk modeling and fate and transport modeling, as required). Soil contaminant and physical property data will be obtained by sampling and analyzing soils from the vadose zone.

4.1.2 Data Needs

A considerable amount of information has been presented in Sections 2.0 and 3.0 regarding the 200-LW-1 representative waste sites. Some existing data are available for the representative waste sites; however, these data are insufficient to complete the RI/FS process. The most pertinent existing information was used to develop site-specific conceptual contaminant distribution models for the 216-T-28, 216-B-58, 216-S-20, and 216-Z-7 representative sites (Section 3.0). For the representative waste sites (and the other waste sites in the OU in general), information is available regarding location, construction design, and major types of waste disposed. However, the data needed to verify and/or refine the site conceptual contaminant distribution models are limited. Additional data are needed to support remedial decision making at these sites and any analogous sites. As defined by the DQO process, the focus of the RI is to determine the nature and vertical extent of contamination in the vadose zone within the boundary of the representative waste sites. Specifically, determinations of the type, concentration (particularly the highest concentration), and vertical distribution of radiological and nonradiological contamination in the vadose zone at all four of the representative waste sites are the major data needs.

4.1.3 Data Quality

Data quality was addressed during the DQO process. Existing data quality and quantity were determined to be insufficient to support the RI/FS process for the OU; therefore, additional data collection is needed through the RI process.

The process of identifying potential COCs is summarized in Section 3.5. Analytical performance criteria were established by evaluating potential ARARs and preliminary remediation goals (PRGs), which are regulatory thresholds and/or standards or derived risk-

based thresholds. These potential ARARs and PRGs represent chemical-, location-, and action-specific requirements that are protective of human health and the environment. Regulatory thresholds and/or standards or preliminary action levels provide the basis for establishing cleanup levels and dictate analytical performance levels (i.e., laboratory detection limit requirements). Detection limit requirements and standards for precision and accuracy are used to define data quality.

To provide the necessary data quality, detection limits should be lower than preliminary action levels. Additional data quality is gained by establishing specific policies and procedures for the generation of analytical data and field quality assurance/quality control requirements. These requirements are discussed in detail in the SAP (Appendix A). Analytical performance requirements are specified in Table 3-6 of the DQO summary report (BHI 2001). The potential ARARs and PRGs for 200 Area waste sites are discussed in Sections 4.0 and 5.0 of the Implementation Plan (DOE-RL 1999).

4.1.4 Data Quantity

Data quantity refers to the number of samples collected. The number of samples needed to refine the site conceptual model and make remedial decisions is based on a biased sampling approach. Biased sampling is the intentional location of a sampling point within a waste site based on process knowledge of the waste stream and expected behavior of the potential COC(s). It is the preferred sampling approach as defined in this section and in Section 6.2.2 of the Implementation Plan (DOE-RL 1999) for the RI phase. Using this approach, sampling locations can be selected that increase the chance of encountering the highest contamination in the local soil column.

Sample locations at the representative sites were selected based on the preliminary conceptual models of contaminant distribution presented in the DQO summary report (BHI 2001). Four locations in four representative sites were selected for sampling. The locations were selected with the goal of intersecting the areas of highest contamination and to determine the type and vertical extent of contamination at the representative sites. Because the 216-T-28 Crib and 216-S-20 Crib are small point-source-type sites, the lateral extent of contamination within the site boundaries is not considered necessary for remedial decision making. For the 216-B-58 Trench and the 216-Z-7 Crib, which are longer, linear-type waste sites, the lateral extent of contamination within the site boundaries will be evaluated by geophysically logging cased or direct push holes. Because these waste sites received significant inventories of gamma-emitting radionuclides (e.g., cesium-137), this geophysical logging will provide a good indication of the location of these indicator contaminants in the direct push holes and will be used to locate deep boreholes. Soil samples will be taken at each representative site from a deep borehole (to near the groundwater table) and will be collected from different depths at the waste site to evaluate the vertical extent of contamination. Extra soil samples may be collected as warranted by observations such as changes in lithology, visual indications of contamination, and field screening results.

4.2 CHARACTERIZATION APPROACH

This section provides an overview of characterization plans for collecting the data identified in the DQO process. These plans include vadose zone borehole drilling, soil sampling, and geophysical logging using spectral or gross gamma, gross gamma and passive neutron, and neutron moisture tools. Sample analysis will be conducted by an offsite laboratory under a contract-required quality program. The sampling strategy is designed to provide access to potentially contaminated subsurface soils. Sample collection will be guided by field screening conducted during the RI and a sampling scheme that identifies critical sampling depths.

The deep samples are intended to represent deep contaminants in the vadose zone that could potentially impact groundwater or that may have been impacted by past elevated water table levels. The 4.6- and 7.6-m (15- and 25-ft) sample intervals are significant for defining contamination profiles for remedial designs. For excavation and disposal sites, the decision-making depth is 4.6 m (15 ft), as directed by *Model Toxics Control Act* (MTCA) direct exposure requirements. A critical sample is also identified at the bottom of the waste site where effluents were released to the soil.

Prior to borehole drilling activities, surface geophysical and radiation surveys will be conducted at all sites. The surface geophysical surveys will be conducted using ground-penetrating radar and/or electromagnetic induction and will aid in verifying waste site construction and geometry and in selecting borehole locations to avoid subsurface obstructions. The surface radiation surveys will identify areas of surface contamination that might impact the drilling activities and health and safety.

4.2.1 Geophysical Logging Through Direct Push Holes

The 216-B-58 Trench is a segmented trench; berms were constructed within the trench, forming disposal compartments. The actual discharge to individual segments is unknown; a review of existing drawings and literature did not yield sufficient information to identify the segment of highest potential contamination within the trench. Therefore, locating the borehole for this site requires some preliminary geophysical logging to target the area of highest contamination. A series of up to eight direct push (e.g., GeoProbe®, drive casings, or cone penetrometer [CPT]) holes will be installed and logged with spectral or gross gamma tools. The location of the borehole will be based on the results of this logging effort. The depth of direct push holes is limited based on subsurface conditions (i.e., cobbles, gravel). The holes will be pushed as deep as possible, but a maximum depth of approximately 10.7 m (35 ft) bgs is assumed for investigation planning. If contamination extends beyond this depth and additional data past this depth are needed to locate the borehole, additional casings may be driven into the subsurface to allow geophysical logging of deeper zones in this trench (see Section 4.2.2).

The 216-Z-7 Crib is also a linear-type waste site. The site consists of two 61-m (200-ft)-long wooden structures that supported perforated discharge pipes. To provide additional information

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on the distribution of contaminants in this site, a series of up to three direct push holes will be installed on each side of the crib and geophysically logged with spectral or gross gamma and, potentially, passive neutron tools. The location of the borehole will be identified based on the results of this logging. Because of potentially deeper contamination at this site, the direct push holes are planned to be installed to approximately 18 m (60 ft) bgs.

Direct push holes are not required at the 216-T-28 and 216-S-20 Cribs because these are small sites.

4.2.2 Drilling and Sampling

The 216-T-28 Crib and 216-S-20 Crib boreholes will be drilled and sampled from locations near the center of each crib (Figures 4-1 and 4-2, respectively) to a depth just above the groundwater table. The 216-B-58 Trench and 216-Z-7 Crib deep boreholes will be located near the direct push hole in each waste site with the maximum indication of contamination based on the geophysical logging, as described in Section 4.2.1 (Figures 4-3 and 4-4, respectively). These sampling locations were chosen to target the areas of maximum contamination within each site. Therefore, the deep soils that will be collected should provide a worst-case scenario for maximum contamination levels at depth.

The sample collection strategy has been designed to thoroughly characterize the vadose zone materials beneath the sites to the top of the groundwater table. Sampling will generally begin at the first sign of radiological contamination, as determined by field measurements. This contamination is expected to begin at the historic bottom of the site (i.e., crib or trench bottom), but if contamination is detected in backfill materials above the waste site bottom, the backfill materials will also be sampled. Borehole samples will typically be collected at a more frequent interval from the effluent release point (i.e., the bottom of the crib or trench), and then at decreasing frequency with depth. Samples that were identified as critical during the DQO process will be collected at 4.6 m (15 ft) bgs and at the base of the waste site structure. A 7.6-m (25-ft) bgs sample is also identified as critical for determining the cost effectiveness of placing a barrier over a waste site versus excavating contaminants. A detailed sample plan for each borehole is presented in the SAP (Appendix A). Additional samples may be collected and analyzed at the discretion of the field engineer/geologist, based on field conditions, measurements, or observations made during the conduct of remedial investigations (e.g., changes in lithology). In addition, samples may be collected at the surface if needed to support ecological assessments.

All drilling will be via a procedure approved by Bechtel Hanford, Inc. (BHI) and will conform to site-specific technical specifications for environmental drilling services. The drill rig generally will require a 23-m (75-ft)-square pad with a 5-m (16-ft)-wide access road. Cleaning and decontamination requirements will also be performed according to BHI-approved procedures.

Likely drilling methods for this project include cable tool, sonic, and diesel hammer. The drilling method must allow the use of a 13-cm (5-in.) outside-diameter split-spoon sampler. Use of a split-spoon sampler will necessitate compositing the sample over at least 0.3 m (1 ft) to

obtain enough soil for analysis. The drilling method must not use any system that circulates air or water. Air-based drilling methods may compromise the sample collection and data quality for volatile constituents through the introduction of air to the soils. Controlling contamination with these methods is difficult, potentially increasing risks to workers. In addition, the air circulated in these methods may dry out the formation and negatively impact the moisture logging activities. Sonic drilling may heat soils and adversely affect moisture logging activities.

All four boreholes will be drilled to the top of the water table. The approximate total depth of the investigation below ground surface is as follows: the 216-T-28 Crib will be 68.9 m (226 ft), the 216-B-58 Trench will be 103 m (338 ft), the 216-S-20 Crib will be 70.9 m (232.5 ft), and the 216-Z-7 Crib will be 66.3 m (217.5 ft). In the boreholes, the presence of water-saturated soils will indicate the end of the borehole and will be determined by the site geologist. Perched water is not anticipated; however, if encountered, the borehole may be terminated at that point. An evaluation will be made in the field if perched water is encountered. Up to three strings of casing may be telescoped to the proposed depth to minimize the transport of contaminants in the vadose zone from the drilling operations. The casings will be of sufficient size to accommodate a split-spoon sampler to the bottom of the borehole. Downsizing the casing will be commensurate with the expected decrease in contamination levels with depth. Actual conditions during drilling may warrant changes; the changes may be implemented only after consulting with the task lead and the subcontract technical representative. All casings will be removed from the boreholes when drilling and sampling are completed. If required to support Hanford Site groundwater monitoring needs, boreholes may be completed as wells. Otherwise, the borehole will be backfilled and decommissioned in accordance with *Washington Administrative Code* 173-160, "Minimum Standards for Construction and Maintenance of Wells."

4.2.3 Field Screening

All samples and/or cuttings from the boreholes will be field screened for evidence of radionuclides. Radioactive soil screening will assist in the selection of sampling intervals (besides those already identified as critical sampling depths).

4.2.4 Analysis of Soil

Soil samples will be collected for nonradiological and radiological analysis and the determination of select soil properties. The list of analytes for this investigation was developed based on an evaluation of all potential contamination that was discharged to the waste sites. Development of this list of COCs is presented in Section 3.4, Table 3-2, and in the DQO summary report (BHI 2001). Tables A-3 and A-4 of the SAP (Appendix A) list details of the analytical methods, holding times, and quality assurance and quality control procedures for each contaminant. A limited number of samples will also be analyzed to determine soil physical properties such as moisture content and particle size.

4.3 GEOPHYSICAL LOGGING

The four new boreholes (described in Section 4.2.1) will be logged with a high-resolution SGL system to provide continuous vertical logs of gamma-emitting radionuclides and with a neutron moisture logging system to identify moisture changes with depth. SGL is also proposed in existing boreholes near the representative waste sites (see the SAP, Table A-11) as a cost-effective method of providing supplemental data on the vertical and lateral distribution of gamma-emitting radionuclides, provided that the boreholes are located sufficiently close to the waste site and are appropriately constructed (e.g., single borehole casing in contact with the formation).

The SGL system uses standard laboratory high-purity germanium (HPGe) detector instrumentation to identify and quantify gamma-emitting radionuclides in boreholes as a function of depth. The HPGe detector is calibrated to National Institute of Standards and Testing requirements and includes corrections for environmental conditions that deviate from the standard calibration condition. The HPGe detector has been used to locate, identify, and monitor the distribution and movement of contaminants in more than 600 boreholes at the Hanford Site. The precision of this detector is such that movement of mobile constituents in the subsurface can be identified to as little as 0.07 m (0.25 ft) at depths of up to 167.6 m (550 ft). The detector requires constant cooling with liquid nitrogen and was designed to operate while completely submerged in water.

The neutron moisture logging system employs a weak radioactive americium-beryllium neutron source and neutron detector to provide a direct reading of hydrogen atom distribution in the soil surrounding the borehole. This detector can be used to measure continuous vertical moisture in the vadose zone.

Passive neutron detectors take advantage of a discernable neutron response in the presence of buried transuranic-contaminated materials. These detectors can be used in small-diameter boreholes to locate areas of high transuranic contaminants and can be used in conjunction with (or to augment) gamma logging tools.

The SGL logs will be used to supplement the laboratory radionuclide data to determine the vertical distribution of radionuclides in the vadose zone beneath the units and aid in geological interpretation of subsurface stratigraphy. The deep boreholes will be logged through the casing prior to the addition of a new casing string and after the borehole has reached total depth. The SGL equipment calibration is conducted annually, and the data acquired during the calibrations are used to derive factors that convert measured peak area count rate to radionuclide concentrations in pCi/g. Corrections are applied to the data to compensate for the gamma-ray attenuation by the casing. A list of existing boreholes to be logged is identified in the SAP (Appendix A).

All geophysical logging will be in accordance with Waste Management Northwest's *Sampling and Services Procedure Manual,* WMNW-CM-004, Section 17 ("Geophysical Logging"), and Section 18 ("Geophysical Logging Analysis") (WMNW 1998). Applicable detection limits,

analytical methods, and accuracy and precision requirements are defined in the documents governing borehole logging. The site geologist will record the types of geophysical logs and the depth intervals of initial and repeat runs on the Well Construction Summary Report form.

Logging runs will be made prior to changing casing sizes and at the total depth of the borehole. The downhole tools and cable will be subject to the same rules as the drill rig and equipment. The downhole tools and cable will be cleaned between boreholes. The upper part of each borehole will be the most contaminated and will be logged first.

Figure 4-1. Location of Planned and Existing Boreholes at the 216-T-28 Crib.

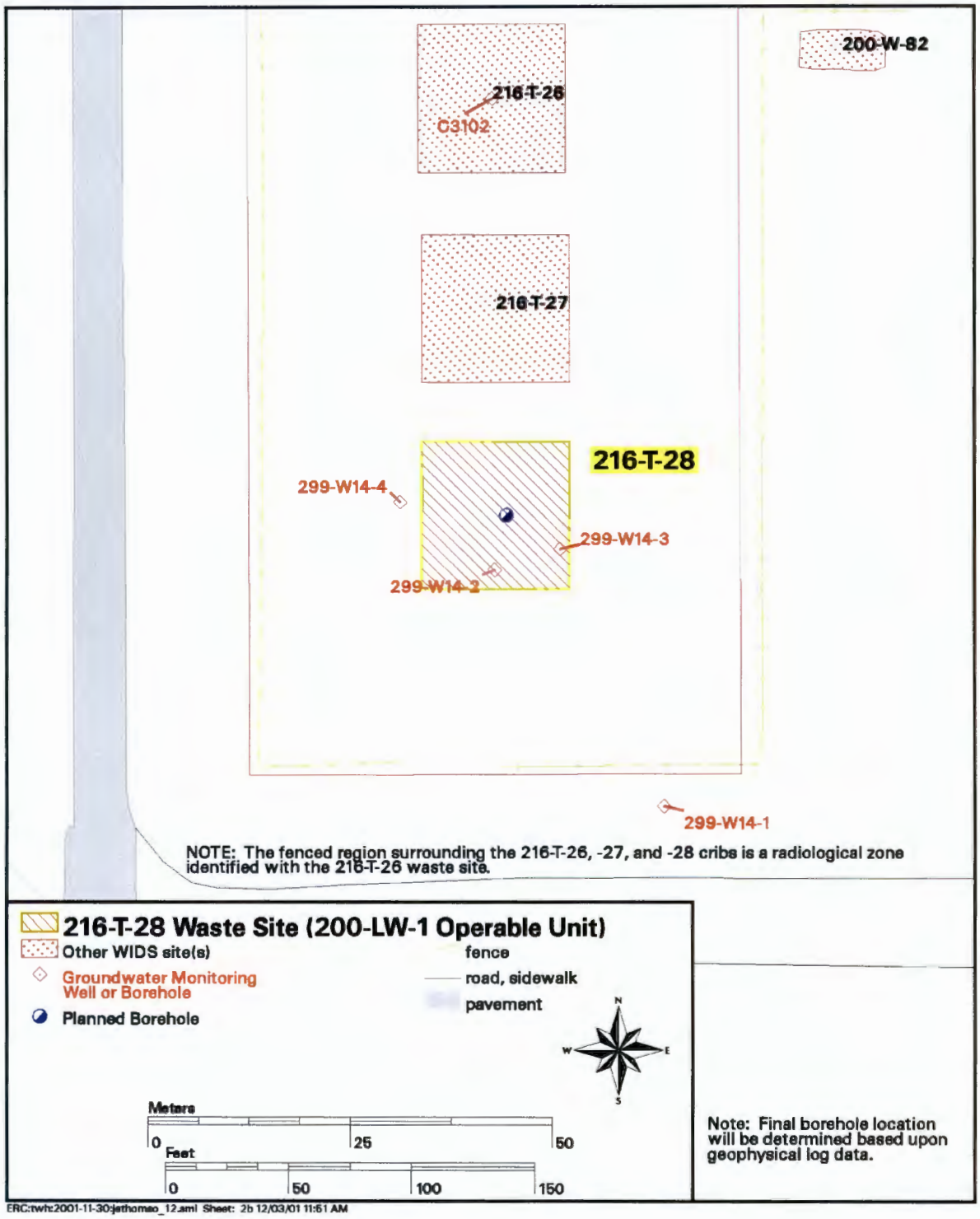


Figure 4-2. Location of Planned and Existing Boreholes at the 216-S-20 Crib.

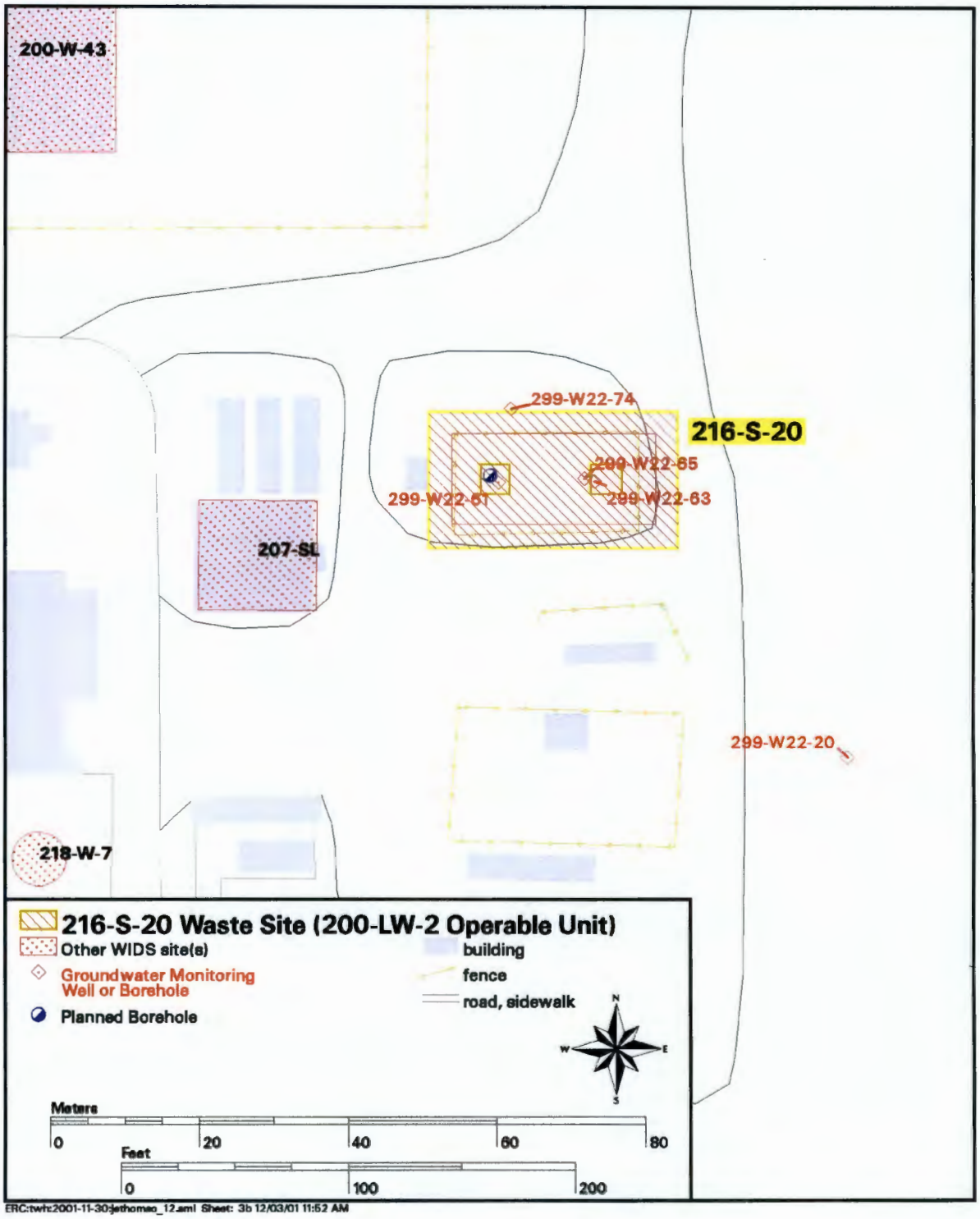


Figure 4-3. Location of Planned and Existing Boreholes at the 216-B-58 Trench.

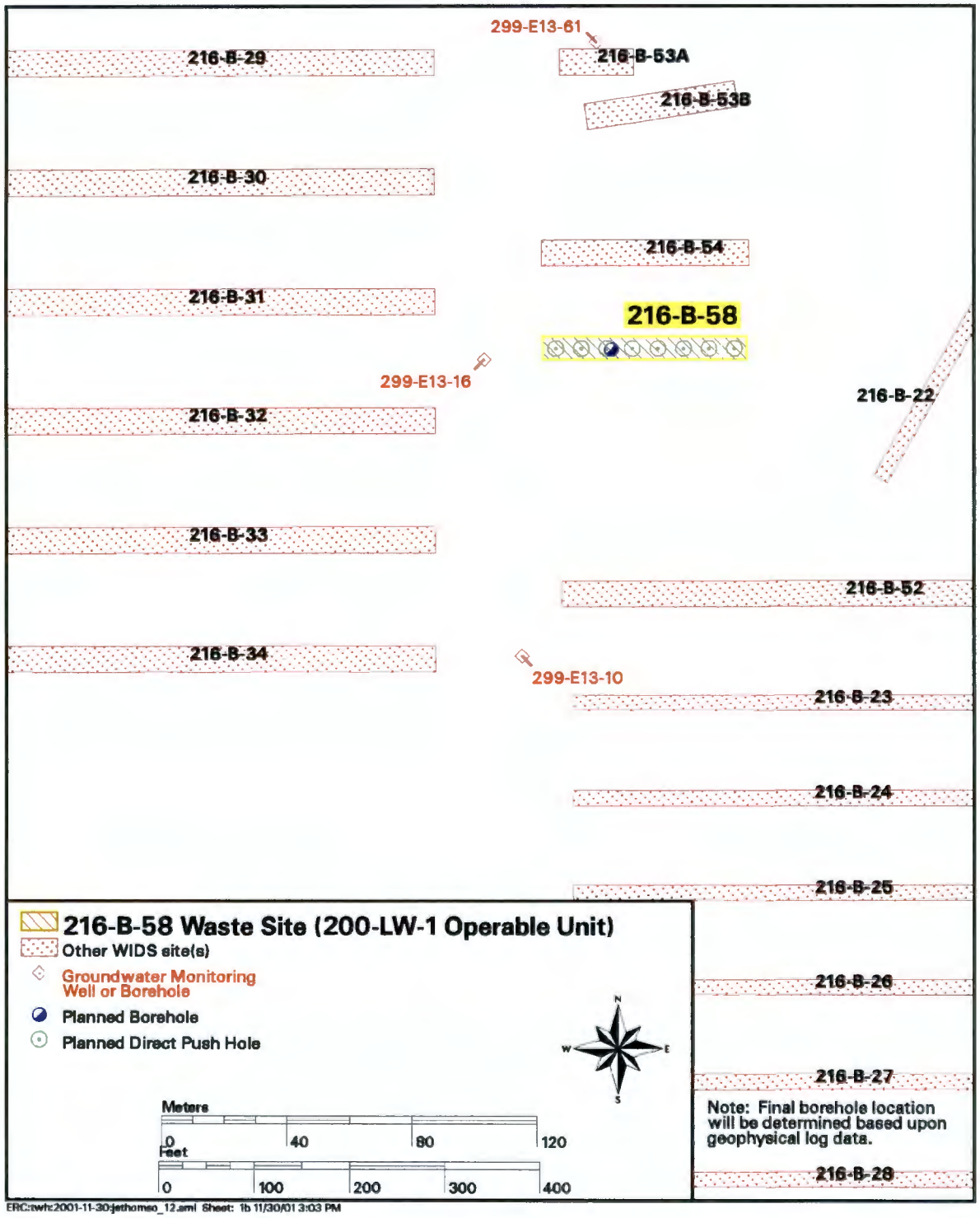
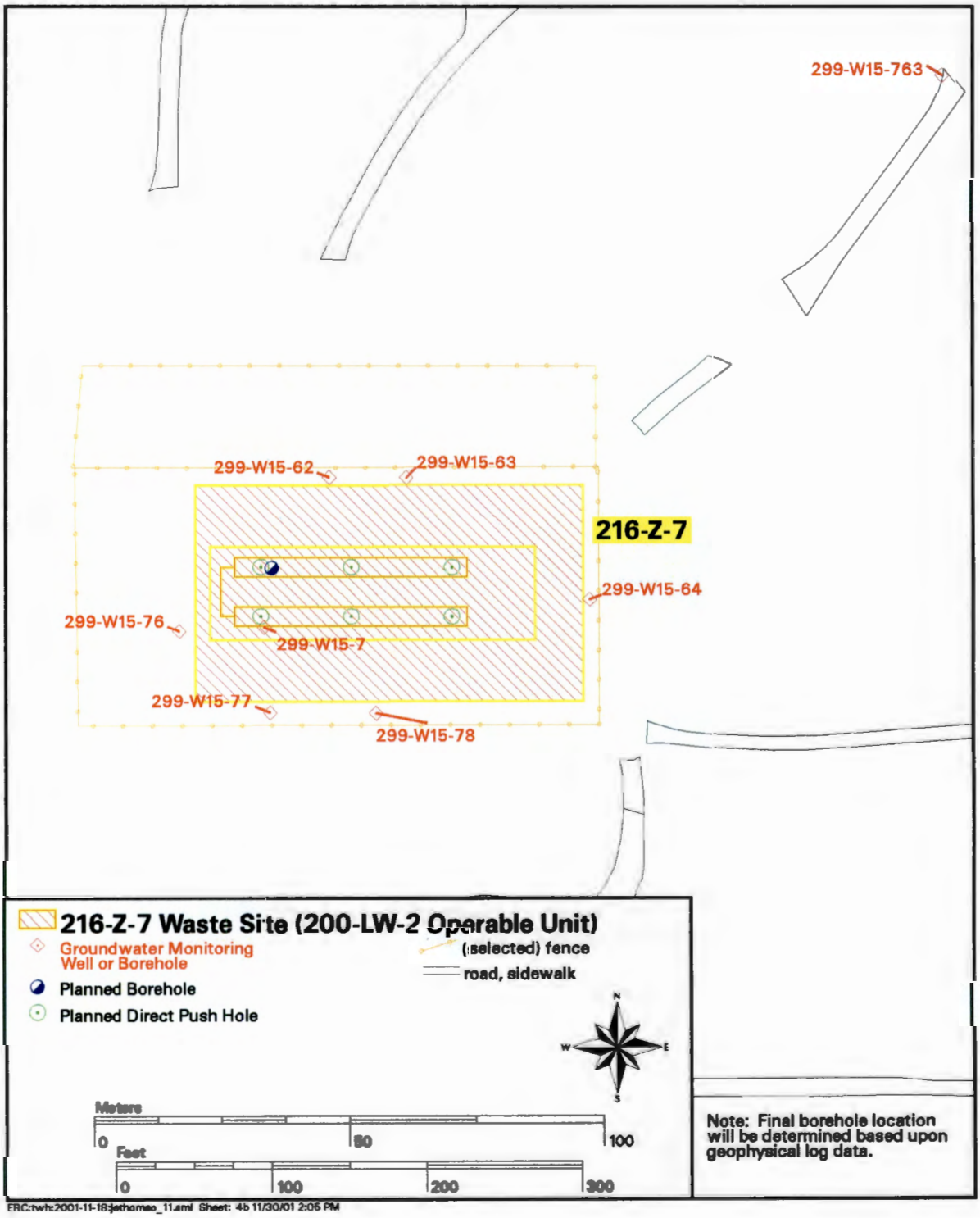


Figure 4-4. Location of Planned and Existing Boreholes at the 216-Z-7 Crib.



5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS

This section describes the RI/FS (assessment) process for the 200-LW-1 OU. The development of and rationale for this process are provided in the Implementation Plan (DOE-RL 1999) and is summarized in Figure 1-1. The process for this OU will follow the CERCLA format with modifications to concurrently satisfy the requirements specific to RPP waste sites. The CERCLA terminology will be used, as described in the Implementation Plan. A summary of the integrated regulatory process is provided in Section 5.1.

Section 5.2 outlines the tasks to be completed during the RI phase, including planning and conducting field sampling activities and preparation of the RI report. These tasks are designed to effectively manage the work, satisfy the DQOs identified in Section 4.0, document the results of the investigation, and manage waste generated during field activities. The general purpose of the RI is to characterize the nature, the vertical extent, and in some cases the lateral extent within the confines of the waste site; concentration; and potential transport of contaminants and to provide data to determine the need for and type of remediation. The detailed information that will be collected to carry out these tasks is presented in the SAP (Appendix A).

Tasks to be completed following the RI include an FS, a proposed plan, and a ROD. A proposed permit modification will also be prepared. The RCRA permit will be modified to incorporate the ROD (and any subsequent amendments) by reference, authorizing the RCRA actions at the 200-LW-1 OU.

Project management occurs throughout the RI/FS process. Project management is used to direct and document project activities so that objectives of the work plan are met and the project is kept within budget and schedule goals. The initial project management activity will be to assign individuals to roles established in Section 7.2 of the Implementation Plan (DOE-RL 1999). Other project management activities include day-to-day supervision of and communication with project staff and support personnel; meetings; control of cost, schedule, and work; records management; progress and final reports; quality assurance; health and safety; and community relations.

Appendix A of the Implementation Plan (DOE-RL 1999) provides the overall quality assurance framework that was used to prepare an OU-specific quality assurance project plan for the RI (Appendix A, Section A.2). Appendix B of the Implementation Plan includes a review of data management activities that are applicable to the investigation activities at this OU and describes the process for the collection/control of data, records, documents, correspondence, and other information associated with OU activities.

5.1 INTEGRATED REGULATORY PROCESS

RCRA closure and corrective action authorities have clear jurisdiction over waste with nonradiological constituents (in particular, dangerous waste and dangerous constituents) and "mixed wastes" (mixtures of dangerous waste and radiological contaminants), but not over waste with only radiological contaminants. By applying CERCLA authority concurrently with RCRA corrective action requirements through integration, cleanup actions will address all regulatory and environmental obligations at this OU as effectively and efficiently as possible. Also, by applying CERCLA authority jointly with that of RCRA, additional options for disposal of corrective action and remedial action wastes at the Environmental Restoration Disposal Facility are possible. By allowing flexibility in final disposal options, the Tri-Parties intend to minimize disposal costs as much as possible while remaining fully protective of human health and the environment.

The integrated process for characterization of the 200-LW-1 uses this RI/FS work plan (CERCLA requirement) in combination with the Implementation Plan (DOE-RL 1999) to satisfy the requirements for an RFI/CMS work plan (RCRA requirement). General facility background information, potential ARARs, preliminary RAOs, and preliminary remedial technologies developed in the Implementation Plan are incorporated by reference into this work plan. Following the completion of the work plan, an RI will be performed that will satisfy the requirements of a RCRA RFI. The RI will be limited to the investigation of representative waste sites. An RI report summarizing the results of the RI will then be prepared that will satisfy the requirements for an RFI report.

After the RI is complete, remedial alternatives/corrective actions will be developed and evaluated against performance standards and evaluation criteria. The integration process for the evaluation of remedial alternatives includes the preparation of an FS that will satisfy the requirements for a CMS report. Both documents are required to include identification and development of corrective measures/remedial alternatives and an evaluation of those alternatives. The CMS generally also includes a recommended alternative, which is typically the purpose of the proposed plan under CERCLA. Therefore, the FS for 200-LW-1 will include a section that provides corrective action recommendations for RPP sites.

The decision-making process for the 200-LW-1 OU, as defined in the Implementation Plan, will be based on the use of a proposed plan and a ROD. Based on the group-specific FS, a proposed plan will be prepared that identifies the preferred remedial alternative(s). The lead regulatory agency (Ecology) will prepare the CERCLA ROD following completion of the public involvement process for the proposed plan and the proposed permit modification, which, after signature by the Tri-Parties, will authorize the selected remedial action. The remedy selected in the ROD will be incorporated into the Hanford Facility RCRA Permit as the corrective action for 200-LW-1 after issuance of the public notice and comment process.

The technical and procedural elements of RCRA and CERCLA are each addressed in full in this process. The CERCLA public involvement, including public notice and opportunity to comment, will be enhanced, as necessary, to concurrently satisfy the public involvement

requirements for the RCRA past-practice process. The public will be given an opportunity to review and comment on the proposed plan and the proposed permit modification. The proposed plan will be issued for a minimum 45-day public review and comment period. Supporting documents, including the FS, will also be made available to the public for review at this time. A combined public meeting/public hearing may be held during the comment period to provide information on the proposed action and permit modification and to solicit public comment.

5.2 ECOLOGICAL EVALUATION PROCESS

A strategy to address ecological impacts has been developed and is being implemented in the 200 Areas. The process for integrating ecological evaluations into the RI/FS process is shown in Figure 5-1. The strategy is phased and supports both 200 Area-wide and OU-specific evaluations. Phase I of the strategy consists of the compilation of existing 200 Area –wide ecological data (e.g., surface soil sample data, radiological survey data, biota data) into an ecological summary report, which is scheduled to be completed in fiscal year 2002. The report will include summaries of existing documents and compilation of data to support development of conceptual ecological exposure models. Maps will be developed showing current habitat types, and data will be compared to available standards to support identification of data gaps.

Specific requirements for Phase II will be developed based on the results of the Phase I evaluation. The objectives of Phase II are to verify the conceptual biological exposure models generated during Phase I, to develop ecological remedial action objectives, and to collect field data as needed. For future work plans, a 200 Area-wide DQO process will be conducted to identify ecological data needs for both the 200 Areas in general and for specific OU waste sites. For the 200-LW-1 OU, an ecological SAP will be prepared if waste site-specific soil samples are identified during the DQO process to support an OU-specific ecological evaluation. Biota sampling will be performed as part of a 200 Area-wide investigation. The Phase II DQO is planned for completion in fiscal year 2003, at which time the 200-LW-1 ecological SAP will be prepared and implemented, if needed.

5.3 REMEDIAL INVESTIGATION ACTIVITIES

This section summarizes the planned tasks that will be performed during the RI phase for the 200-LW-1 OU, including the following:

- Planning
- Field investigation
- Management of investigation-derived waste (IDW)
- Laboratory analysis and data verification
- Data evaluation and reporting.

These tasks and subtasks reflect the work breakdown structure that will be used to manage the work and to develop the project schedule provided in Section 6.0.

5.3.1 Planning

The planning subtask includes activities and documentation that need to be completed before field activities can begin. These include the preparation of an activity hazards analysis and site-specific health and safety plan (HASP), radiation work permits, excavation permits and supporting surveys (e.g., cultural, radiological, surface geophysical, wildlife, and utilities), work instructions, personnel training, and the procurement of materials and services (e.g., drilling and geophysical logging services). In addition, planned boreholes identified in Figures 4-1 through 4-4 will be located using a Global Positioning Satellite system.

Appendix B of the Implementation Plan (DOE-RL 1999) provides a general HASP that outlines health and safety requirements for RI activities. A site-specific HASP will be prepared for drilling activities, following requirements of the general HASP. Surface geophysical surveys will be conducted to aid in verifying waste site construction and geometry and in selecting borehole locations to avoid subsurface obstructions. Initial surface radiological surveys will be performed to document any radiological surface contamination and background levels in and around the sampling locations. This information will be used to document initial site conditions and prepare the HASP and radiation work permits.

5.3.2 Field Investigation

The field investigation task involves data-gathering activities performed in the field that are required to satisfy the project DQOs. The field characterization approach is summarized in Section 4.2 and detailed in the SAP provided in Appendix A of this work plan. The scope includes soil sampling and analysis to characterize the vadose zone at the representative waste sites 216-T-28 Crib, 216-B-58 Trench, 216-S-20 Crib, and 216-Z-7 Crib; no additional sampling is proposed at these locations. Major subtasks associated with the field investigation include the following:

- Borehole drilling, sampling, and associated data from direct push holes, and geophysical logging
- Preparation of a field report.

5.3.2.1 Borehole Drilling and Sampling. This subtask involves the drilling of boreholes for the purpose of collecting soil samples and geophysical logging of new and existing boreholes. Under this work plan, four boreholes are planned to collect samples down to the top of the groundwater table through the 216-T-28 Crib, the 216-B-58 Trench, the 216-S-20 Crib, and the 216-Z-7 Crib. Casings may be driven in up to eight additional locations in the 216-B-58 Trench and up to six additional locations in the 216-Z-7 Crib for geophysical logging to provide additional information on the distribution of gamma-emitting radionuclides within the boundary of the waste sites.

Samples will be collected with split-spoon samplers and packaged for shipment to an offsite laboratory if radiation levels permit. Otherwise, samples will be shipped to an onsite laboratory.

At the completion of sampling, the boreholes will be abandoned and initial site conditions reestablished. Alternatively, the boreholes may be completed as groundwater monitoring wells, if needed by the Hanford Site groundwater monitoring program. Other activities include work zone setup, mobilization/demobilization of equipment, equipment decontamination, and field analyses. Planned field analyses include radiological field screening, geologic logging, and geophysical logging of boreholes.

All samples and drill cuttings will be field screened for radionuclides to provide additional characterization data, assist in the selection of sample intervals (e.g., hot spots), assist in establishing radiation control measures, and ensure worker health and safety.

Geophysical logging will be used to gather in situ radiological and moisture data, from the direct push holes, from the planned boreholes, and from several existing boreholes (specified in Table A-11 of the SAP). Geophysical logging will include high-resolution SGL to assess the distribution of gamma-emitting radionuclides. Neutron logging will also be performed for moisture content distribution over the planned boreholes.

5.3.2.2 Preparation of Field Report. At the completion of the field investigation, a field report will be prepared to summarize activities performed and information collected in the field, including survey data for borehole locations, the number and types of samples collected and associated Hanford Environmental Information System numbers, inventory of IDW containers, geological logs, field screening results, and geophysical logging results.

5.3.3 Management of Investigation-Derived Waste

A waste designation DQO effort will be performed before the initiation of the characterization activities to ensure that the proper information is collected during the field effort to support the designation of all project IDW. During the DQO effort for waste designation, any listed waste issues will also be resolved. Any additional sampling requirements or analytes needed to support designation activities will be identified and implemented through the waste designation DQO summary report that will be prepared at that time.

Waste generated during the RI will be managed in accordance with a waste control plan prepared for the OU. Appendix E of the Implementation Plan (DOE-RL 1999) provides general waste management processes and requirements for this IDW and forms the basis for activity-specific waste control plans. The site-specific waste control plan addresses the handling, storage, and disposal of IDW generated during the RI phase. Furthermore, the plan identifies governing Environmental Restoration Contractor procedures and discusses types of waste expected to be generated, the waste designation process, and the final disposal location. The IDW management task begins at the start of the field investigation, when IDW is first generated, through waste designation and disposal.

5.3.4 Laboratory Analysis and Data Validation

Soil samples collected via boreholes will be analyzed for a suite of radionuclides and nonradiological constituents identified during the DQO process, and for select physical properties based on established DQOs and as defined in the SAP. The list of analytes, methods, and associated target detection limits are provided in Tables A-3 and A-4 of the SAP (Appendix A). This task includes the laboratory analysis of samples, the compilation of laboratory results in data packages, and the validation of a representative number of laboratory data packages.

5.3.5 Remedial Investigation Report

This section summarizes data evaluation and interpretation subtasks leading to the production of an RI report. The primary activities include a data quality assessment (DQA); evaluating the nature, extent, and concentration of contaminants based on sampling results; assessing contaminant fate and transport; refining the site conceptual models; and evaluating risks through a qualitative risk assessment (QRA). These activities will be performed as part of the RI report preparation task.

5.3.5.1 Data Quality Assessment. A DQA will be performed on the analytical data to determine if they are the right type, quality, and quantity to support their intended use. The DQA completes the data life cycle of planning, implementation, and assessment that began with the DQO process. In this task, the data will be examined to see if they meet the analytical quality criteria outlined in the DQO and are adequate to evaluate the decision rules in the DQO.

5.3.5.2 Data Evaluation and Conceptual Model Refinement. This task will include evaluating the information collected during the investigation. The nonradiological and radiological data obtained from the boreholes will be compiled, tabulated, and statistically evaluated to gain as much information to satisfy the data needs as possible. Data evaluation tasks may include the following:

- Graphically evaluating the data for vertical distribution of contamination within each borehole.

- Stratifying the data and computing basic statistical parameters such as mean and standard deviation for individual levels (when sufficient data are available). This can provide an indication of contaminant distribution.

- Constructing contour diagrams and variograms to evaluate spatial correlations within each stratum. This will indicate if contamination is concentrated in a particular area (e.g., near the influent end for trenches).

- Performing statistical tests on the data to evaluate the presence or absence of contamination. There are many facets to this step, including determining the distribution of the data and selecting the appropriate statistical tests. The initial screening for contamination should

evaluate the data with respect to background, by using simple comparisons of an upper bound of the data to background concentrations (e.g., MTCA tests), or through more complex comparisons, such as nonparametric hypothesis tests (e.g., Wilcoxon Rank Sum Test). These tests may also compare the data to appropriate cleanup levels.

All of these statistical evaluations will aid in refining the conceptual model for this OU and selecting the remedial alternative. However, because the sites within this OU represent point-source-type releases, statistical analysis may not always be possible. Single boreholes are planned at the sites. If the data are not sufficient for statistical analysis, maximum or average concentrations will be used in the data evaluation process.

Data on the soil physical properties will be used to determine the soil type, which will assist in choosing the proper unsaturated hydraulic conductivity/moisture retention curve. Identification of the soil type and soil moisture will allow the determination of unsaturated hydraulic conductivity, which will be used as needed in modeling flow and transport (see Section 5.2.5.3).

The chemical, physical, and geophysical data will be used for correlating subsurface data, for further refinement of the preliminary conceptual contaminant distribution models, and as inputs to a QRA.

5.3.5.3 Qualitative Risk Assessment. The application of risk assessment in the characterization and remediation of the 200 Areas will follow a graded approach as described in Section 5.5 of the Implementation Plan. A QRA will be performed as part of the RI report and FS. Once additional data are available for all the sites in an OU, a more quantitative risk assessment may be performed. A quantitative, cumulative risk assessment will be used to evaluate remedial actions and close out the sites in the 200 Areas.

QRAs will be prepared to evaluate risk to human receptors from potential exposure to contaminants in accessible surface and shallow subsurface soils. The QRAs will also evaluate the impact to groundwater that may result from contaminants migrating to the water table through the vadose zone underlying wastes sites in this OU.

The computer program RESRAD will be used to model radionuclide dose at the surface. The STOMP model will be used to evaluate potential impacts to groundwater from contaminants. The physical characterization data obtained in this study will be used in RESRAD along with input parameters appropriate to the land use. As waste sites in this OU are inside the 200 Area boundary, QRAs will be done for industrial land use. The input parameters recommended by the Washington State Department of Health (WDOH 1997) may be used for this effort.

5.4 FEASIBILITY STUDY

After the RI is complete, remedial alternatives will be developed and evaluated against performance standards and evaluation criteria in the FS. The FS process consists of several steps:

1. Defining RAOs and RCRA corrective action performance standards.
2. Identifying general response actions (GRAs) to satisfy RAOs.
3. Identifying potential technologies and process options associated with each GRA.
4. Screening process options to select a representative process for each type of technology based on their effectiveness, implementability, and cost.
5. Assembling viable technologies or process options into alternatives representing a range of treatment, containment, and no action.
6. Evaluating alternatives and presenting information needed to support remedy selection.

Although some refinement is expected during the FS, Appendix D of the Implementation Plan satisfies the requirements for the screening phase (steps 1 through 6) of the FS process. The preliminary RAOs, PRGs, GRAs, and the screening-level analysis of alternatives are incorporated by reference into this work plan. As a result of the work completed in the Implementation Plan, the FS report will focus on the final phase of the FS consisting of refining and analyzing in detail a limited number of alternatives identified in the screening phase. Remedial action alternatives considered to be applicable to the 200-LW-1 OU include the following:

- No action alternative (no institutional controls)
- Engineered multimedia barrier
- Excavation and disposal of waste
- Excavation, ex situ treatment, and geologic disposal of transuranic soil
- In situ vitrification of soil
- In situ grouting or stabilization
- Monitored natural attenuation (with institutional controls).

During the detailed analysis, each alternative will be evaluated against the following CERCLA criteria (40 *Code of Federal Regulations* 300.430):

- Overall protection of human health and the environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability

- Cost
- State acceptance.

One additional modifying criterion, community acceptance, will be applied following the FS at the proposed plan and ROD phase.

National Environmental Policy Act of 1969 values will also be evaluated as part of DOE's responsibility under this authority. *National Environmental Policy Act of 1969* values include impacts to natural, cultural, and historical resources; socioeconomic aspects; and, irreversible and irretrievable commitments of resources.

The RCRA corrective action performance standards (*Washington Administrative Code* 173-303-646[2]) will be used to evaluate alternative compliance with RCRA corrective action requirements. These standards state that corrective action must:

- Protect human health and the environment for all releases of dangerous wastes and dangerous constituents, including releases from all solid waste management units at the facility

- Occur regardless of the time at which waste was managed at the facility or placed in such units and regardless of whether such facilities or unit were intended for the management of solid or dangerous waste

- Be implemented by the owner/operator beyond the facility boundary, where necessary to protect human health and the environment.

The FS will also include supporting information needed to complete the detailed analysis and meet regulatory integration needs, including the following:

- Summarize the RI, including the nature and extent of contamination, the contaminant distribution models, and an assessment of the risks to help establish the need for remediation and to estimate the volume of contaminated media

- Refine the conceptual exposure pathway model to identify pathways that may need to be addressed by remedial action

- Provide a detailed evaluation of ARARs, starting with potential ARARs identified in the Implementation Plan (Section 4.0, DOE-RL 1999)

- Refine potential RAOs and PRGs identified in the Implementation Plan (Section 5.0, DOE-RL 1999), based on the results of the RI, ARAR evaluation, and current land-use considerations

- Refine the list of remedial alternatives identified in the Implementation Plan (Appendix D, DOE-RL 1999), based on the RI

- Provide corrective action recommendations for RPP sites to fulfill the requirements for a CMS report.

5.5 PROPOSED PLAN AND PROPOSED RCRA PERMIT MODIFICATION

The decision-making process for the 200-LW-1 OU will be based on the use of a proposed plan, ROD, and modification to the RCRA Hanford Facility Permit. Following the completion of the FS, a proposed plan will be prepared that identifies the preferred remedial alternative for the OU (which will include RCRA corrective action requirements). In addition to identifying the preferred alternative, the proposed plan will:

- Provide a summary of the completed RI/FS
- Provide criteria by which analogous waste sites within the OU not previously characterized will be evaluated after the ROD to confirm that the contaminant distribution model for the site is consistent with the preferred alternative. Contingencies to move a waste site to a more appropriate waste group will also be developed
- Identify performance standards and ARARs applicable to the OU.

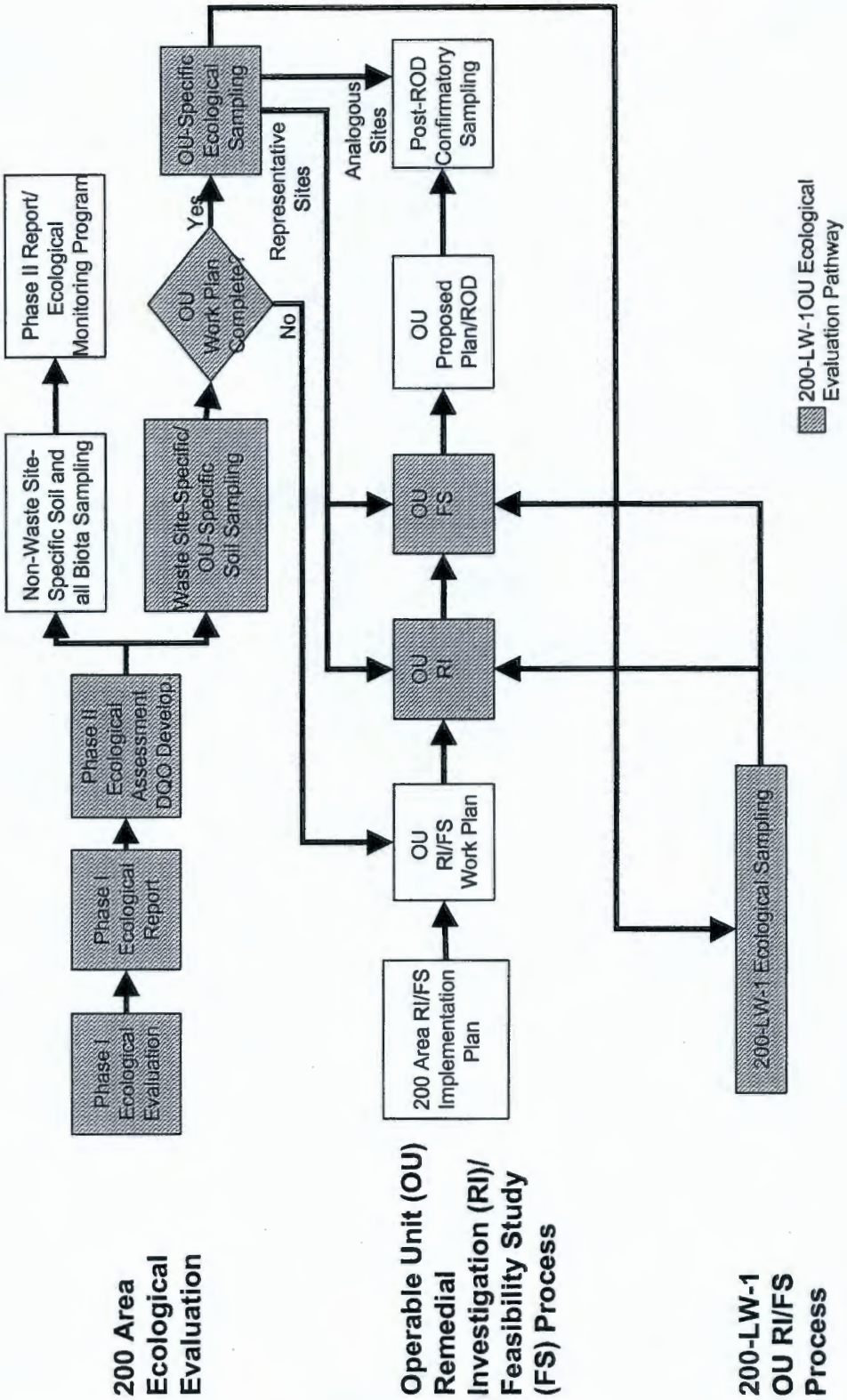
The proposed plan will also include a draft permit modification with unit-specific permit conditions for RPP sites for incorporation into the Hanford Facility RCRA Permit. After the public review process is complete, Ecology, as the lead regulatory agency for 200-LW-1 OU, will make decisions on the preferred remedial action that will be documented in a ROD. The Hanford Facility RCRA Permit will subsequently be modified by Ecology to incorporate the ROD (and subsequent amendments) by reference, authorizing the RCRA actions at the 200-LW-1 OU.

5.6 POST-ROD ACTIVITIES

After the ROD and modification to the RCRA Hanford Facility Permit have been issued, a remedial design report (RDR) and remedial action work plan (RAWP) will be prepared to detail the scope of the remedial action (which will include RCRA closure and corrective action requirements). As part of this activity, DQOs will be established and SAPs prepared to direct confirmatory and verification sampling and analysis efforts. Prior to the start of remediation, confirmatory sampling will be performed to ensure that sufficient characterization data are available to confirm that the selected remedy is appropriate for all waste sites within each OU, to collect data necessary for the remedial design, and to support future risk assessments, if needed. Sites that are not appropriate to the remedy will be reassigned to different, more appropriate OUs. Verification sampling will be performed after the remedial action is complete to determine if ROD requirements have been met and if the remedy was effective. Additional guidance for confirmatory and verification sampling is provided in Section 6.2 of the Implementation Plan (DOE-RL 1999).

The RDR and RAWP will include an integrated schedule of remediation activities for the OU and satisfy the requirements for a RPP corrective measures implementation work plan and corrective measures design report. The OU-specific schedules will be developed considering closure/corrective action activities associated with the tank farms so that the OU and tank farm activities can be integrated as appropriate. Following the completion of the remediation effort, closeout activities will be performed as specified in the ROD, RDR, RAWP, and the Permit.

Figure 5-1. CERCLA Operable Unit RI/FS and Ecological Evaluation Integration.



6.0 PROJECT SCHEDULE

The project schedule for activities discussed in this work plan for the 200-LW-1 OU is shown in Figure 6-1. This schedule will serve as the baseline for the work planning process and will be used to measure the progress of the implementation of this process. The schedule for field activities and the preparation, review, and issuance of the RI report, the FS, and the proposed plan/proposed permit modification is also shown in Figure 6-1. The schedule concludes with the preparation of a ROD.

One Tri-Party Agreement milestone (M-13-00L) is associated with this OU and it requires submittal of three OU work plans by December 31, 2001. This document fulfills the submittal requirements for one of these work plans.

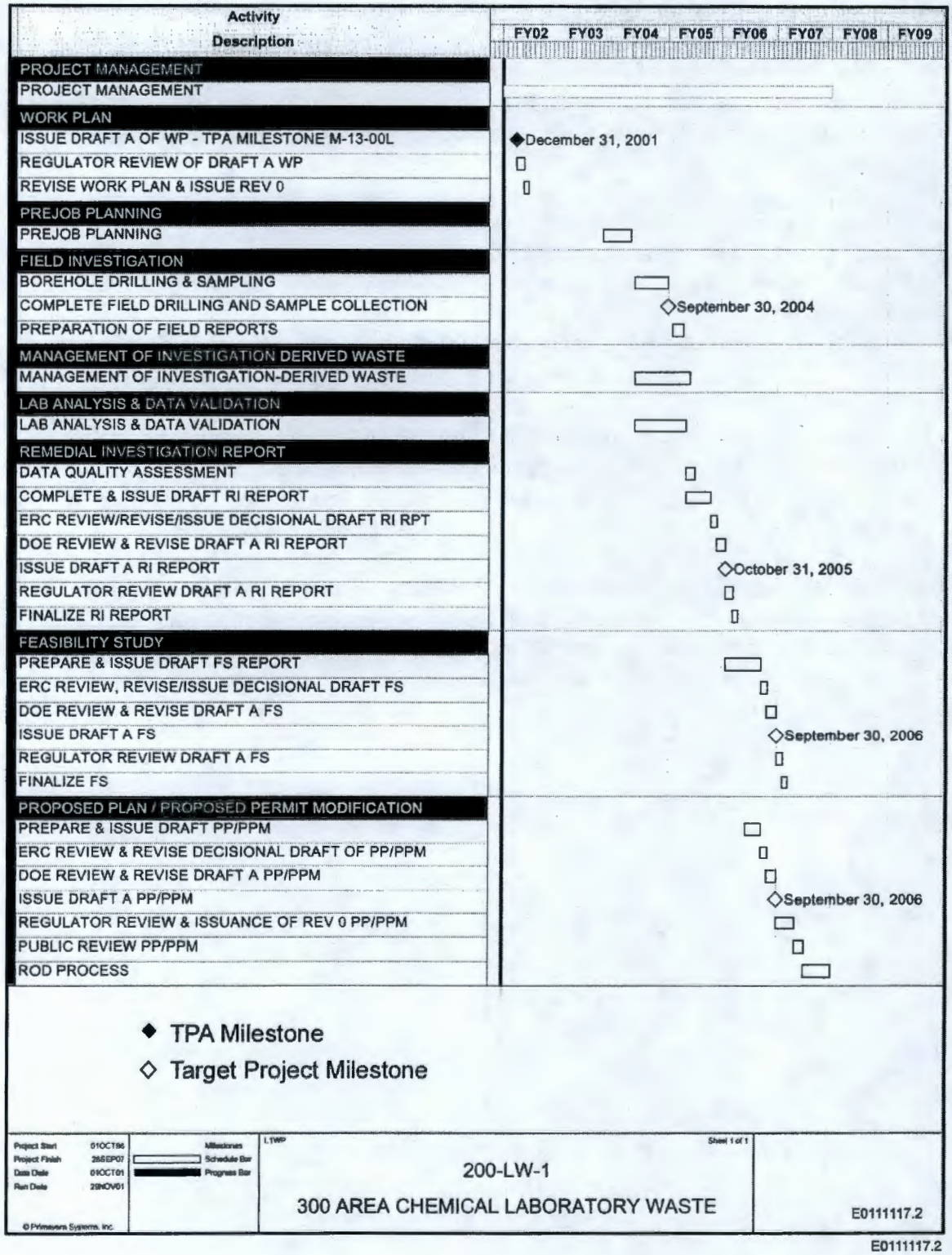
The following are proposed project milestone completion dates for key activities at the 200-LW-1 OU:

- Complete fieldwork through drilling and sample collection – *September 30, 2004**
- Submit Draft A RI report for regulator review – *October 31, 2005**
- Submit Draft A FS and Draft A proposed plan/permit modification for regulator review – *September 30, 2006**.

Interim milestones to be designated under the Tri-Party Agreement will be established through negotiations among the Tri-Parties. A Class II change form will be submitted to Ecology and EPA to request the addition of any interim milestones. Any updates to the project schedule or associated milestones will be reflected in the annual work planning process. Currently, only fiscal year 2002 activities are funded.

**Target project milestone*

Figure 6-1. Project Schedule for the 200-LW-1 Operable Unit.



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APPENDIX A

SAMPLING AND ANALYSIS PLAN

TABLE OF CONTENTS

A SAMPLING AND ANALYSIS PLAN A-1

A.1 INTRODUCTION A-1

A.1.1 Background A-1
A.1.2 Waste Site Locations A-2
A.1.3 Site Description and History A-2
A.1.4 Contaminants of Concern A-3
A.1.5 Data Quality Objectives A-3

A.2 QUALITY ASSURANCE PROJECT PLAN A-11

A.2.1 Field Quality Control A-12
A.2.2 Quality Objectives and Criteria for Measurement Data A-13
A.2.3 Sample Preservation, Containers, and Holding Times A-13
A.2.4 Onsite Measurements Quality Control A-14
A.2.5 Data Management A-14
A.2.6 Validation and Verification Requirement A-14
A.2.7 Technical Procedures and Specifications A-14

A.3 FIELD SAMPLING PLAN A-26

A.3.1 Sampling Objectives A-26
A.3.2 Field Measurements A-26
A.3.3 Soil Sampling and Analysis A-27
A.3.4 Geophysical Logging A-28
A.3.5 Surveying A-29
A.3.6 Waste Management Sampling A-29

A.4 HEALTH AND SAFETY A-42

A.5 MANAGEMENT OF INVESTIGATION-DERIVED WASTE A-43

A.6 REFERENCES A-44

FIGURES

A-1. Location of Planned and Existing Boreholes at the 216-B-58 Trench. A-30
A-2. Location of Planned and Existing Boreholes at the 216-T-28 Crib. A-31
A-3. Location of Planned and Existing Boreholes at the 216-S-20 Crib. A-32
A-4. Location of Planned and Existing Boreholes at the 216-Z-7 Crib. A-33
A-5. Approximate Sampling Intervals in the 216-B-58 Borehole. A-34
A-6. Approximate Sampling Intervals in the 216-T-28 Borehole. A-35
A-7. Approximate Sampling Intervals for the 216-S-20 Borehole. A-36
A-8. Approximate Sampling Intervals for the 216-Z-7 Borehole. A-37

TABLES

A-1. Final COC List A-6
A-2. Decision Rules A-10
A-3. Analytical Performance Requirements – Shallow and Deep Zone Soils. A-19
A-4. Sample Preservation, Container, and Holding Time Guidelines A-24
A-5. Field Screening Methods A-38
A-6. 216-B-58 Trench Sampling Plan. A-38
A-7. 216-T-28 Crib Sampling Plan. A-39
A-8. 216-S-20 Crib Sampling Plan. A-39
A-9. 216-Z-7 Crib Sampling Plan. A-40
A-10. Summary of Projected Sample Collection Requirements. A-40
A-11. List of Boreholes for Spectral Gamma-Ray Logging. A-41

ACRONYMS

ASTM	American Society for Testing and Materials
BHI	Bechtel Hanford, Inc.
bgs	below ground surface
CFR	*Code of Federal Regulations*
COC	contaminant of concern
COPC	contaminant of potential concern
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
ERC	Environmental Restoration Contractor
FS	feasibility study
HEIS	Hanford Environmental Information System
OU	operable unit
QAPjP	quality assurance project plan
QC	quality control
RCT	radiological control technician
RESRAD	RESidual RADioactivity Dose Model
RI	remedial investigation
SAP	sampling and analysis plan
TRU	transuranic
VOA	volatile organic analyte

APPENDIX A

SAMPLING AND ANALYSIS PLAN

A.1 INTRODUCTION

This sampling and analysis plan (SAP) directs sampling and analysis activities that will be performed to characterize the vadose zone at four waste sites: the 216-T-28 Crib, the 216-B-58 Trench, the 216-S-20 Crib, and the 216-Z-7 Crib. These waste sites are part of the 200-LW-1 300 Area Chemical Laboratory Waste Group and 200-LW-2 200 Area Chemical Laboratory Waste Group Operable Units (OUs) in the 200 Areas of the Hanford Site. The sampling and analyses described in this document will provide soil data to refine the preliminary conceptual contaminant distribution models, support an assessment of risk, and evaluate a range of remedial alternatives for waste sites. Characterization activities described in this plan are based on the implementation of the data quality objectives (DQOs) process as documented in the *Remedial Investigation Data Quality Objectives Summary Report for the 200-LW-1 – 300 Area Laboratory Waste Group Operable Unit* (BHI 2001).

The scope of activities described in this SAP involves sampling and geophysical logging of four deep boreholes to be drilled at four waste sites. Geophysical logging will also be conducted at existing boreholes to provide additional information and at the direct push holes at the 216-B-58 Trench and 216-Z-7 Crib to help locate the boreholes. Boreholes will be drilled to groundwater at the 216-T-28 Crib, the 216-B-58 Trench, the 216-S-20 Crib, and the 216-Z-7 Crib. Soil samples will be collected and analyzed for radiological and nonradiological contaminants of concern (COCs) and selected physical properties.

A.1.1 Background

The 10 waste sites associated with the 200-LW-1 OU received liquid waste originating from 300 Area laboratories and from T Plant decontamination and decommissioning activities. The 200-LW-2 OU waste sites received liquid waste from 200 and 300 Area laboratories. These effluents typically contained significant concentrations of contaminants, both radiological and nonradiological. The waste ranged from slightly acidic to basic in pH and contained a high amount of salts and a low amount of organic constituents. Significant amounts of radionuclides, including uranium, plutonium, and fission products, were released to these waste sites. Contamination has likely penetrated the vadose zone and reached the aquifer beneath some of the waste sites.

Two representative waste sites within the 200-LW-1 OU will be characterized to determine the nature and vertical extent of contamination. In addition, two representative waste sites from the 200-LW-2 OU will also be characterized to provide information on the laboratory waste category as a whole. Knowledge gained from characterizing these sites will be used to refine the preliminary conceptual contaminant distribution models and facilitate the use of the analogous site approach in reaching remedial action decisions for all the waste sites in these OUs.

The analogous site approach is described in detail in the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (Implementation Plan) (DOE-RL 1999).

A.1.2 Waste Site Locations

The 200-LW-1 OU is located on the Hanford Site in southeastern Washington State, in the vicinity of the 200 East and 200 West Areas. All waste sites are located within the land-use boundary identified in the *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement* (DOE 1999). Figures 2-7 through 2-10 in the work plan show the specific locations of the waste sites.

A.1.3 Site Description and History

The following sections provide brief descriptions of the four waste sites that will be investigated. More detail is provided in Section 2.2 of the work plan. Section 3.3 of the work plan contains information on the nature and extent of contamination and previous investigations.

A.1.3.1 216-B-58 Trench. The 216-B-58 Trench received liquid laboratory waste from the 340 Complex in the 300 Area. The trench operated from 1965 to 1967. The trench is located south of the 200 East Area, across Route 4S, in the BC Cribs and Trenches Area. The BC Cribs and Trenches area was stabilized with gravel in 1969 and with additional soil in 1982. The area is marked as "Underground Radioactive Material" and the trench is within the posted Radiologically Controlled Area.

A.1.3.2 216-T-28 Crib. The 216-T-28 Crib received steam condensate and process decontamination waste via tank 241-T-112 in the 241-T Tank Farm, 2607-T equipment decontamination waste, and 300 Area laboratory waste. The crib operated from 1960 to 1966. The crib is located south of 23rd Street and east of Camden Avenue in the 200 West Area. From 1969 to 1979, contaminated Russian Thistles caused surface contamination in the area of the crib. In 1975, 15 cm (6 in.) of soil was scraped and removed from the waste site. The site was backfilled to its original level with clean soil at that time and was surface stabilized with additional clean fill in 1990. The 216-T-26, 216-T-27, and 216-T-28 Cribs have been stabilized together and are enclosed within a common steel post and chain barricade that is posted "Underground Radioactive Material."

A.1.3.3 216-S-20 Crib. The 216-S-20 Crib received liquid waste from the 222-S Building and 300 Area laboratories. The crib operated from 1952 to 1972. The crib is located south of the 202-S (REDOX) Building. The site has a history of subsidence, and sinkholes have been filled on at least three occasions with several cubic yards of dirt. However, any remaining cavities below the ground surface are doubtful. The site is posted with "Underground Radioactive Material" and "Cave-In Potential" signs.

A.1.3.4 216-Z-7 Crib. The 216-Z-7 Crib received process waste from the 231-Z Building and 300 Area liquid laboratory waste. The crib operated from 1947 to 1967. The crib is located east

of the 231-Z Building and north of 19th Street. The site was backfilled upon retirement and was interim stabilized in 1990.

A.1.4 Contaminants of Concern

Step 1 of the DQO process identifies the need to develop a list of contaminants of potential concern (COPCs) for the 200-LW-1 OU waste sites. Development of the COPCs is an essential step towards refining the preliminary conceptual contaminant distribution models. From an investigation of historical sources including process documents, logbooks, original plant technical manuals, and interviews of plant operators, a list of potential contaminants was identified. Screening of this list was conducted during the DQO process to arrive at a final list of 67 COCs. Development of this list is described in the 200-LW-1 DQO summary report (BHI 2001) and is summarized in Section 3.4 of the work plan. The final COCs are identified in Table A-1.

If contaminants not identified as COCs are detected during laboratory analysis, the data will be evaluated against regulatory standards, or risk-based levels if exposure data are available, and existing process knowledge in support of remedial action decision making.

A.1.5 Data Quality Objectives

The U.S. Environmental Protection Agency (EPA) document, *Guidance for the Data Quality Objectives Process* (EPA 1994b), was used to support the development of this SAP. The DQO process is a strategic planning approach that provides a systematic process for defining the criteria that a data collection design should satisfy. Using the DQO process ensures that the type, quantity, and quality of environmental data used in decision making will be appropriate for the intended application.

This section summarizes the key outputs resulting from the implementation of the seven-step DQO process. Additional details are included in the DQO summary report (BHI 2001).

A.1.5.1 Statement of the Problem. The 200-LW-1 OU consists of 10 waste sites that received 300 Area chemical laboratory waste. All of these sites are *Resource Conservation and Recovery Act of 1976* past-practice waste sites. Vadose zone soils and the aquifer have been impacted by effluent released to the 200-LW-1 waste sites. In addition, two waste sites from the 200-LW-2 OU are also considered in the DQO. These waste sites (216-S-20 Crib and 216-Z-7 Crib) received waste from both 200 and 300 Area chemical laboratories.

The objective of the DQO process for this OU is to determine the environmental measurements necessary to support the remedial investigation/feasibility study (RI/FS) process and remedial decision making, including refinement of the preliminary conceptual contaminant distribution model. Additionally, the DQO process supports development of this SAP.

Possible alternatives identified in the Implementation Plan (DOE-RL 1999) include the following:

- No action alternative (no institutional controls)
- Engineered multimedia barrier
- Excavation and disposal of waste
- Excavation, ex situ treatment, and geologic disposal of transuranic (TRU) soil
- In situ vitrification of soil
- In situ grouting or stabilization
- Monitored natural attenuation (with institutional controls).

A.1.5.2 Decision Rules. Decision rules are developed from the combined results of DQO Steps 2, 3, and 4. These results include the principal study questions, decision statements, remedial action alternatives, data needs, COC action levels, analytical requirements, and scale of the decision(s). Decision rules are generally structured as "IF…THEN" statements that indicate the action that will be taken when a prescribed condition is met. Decision rules incorporate the parameters of interest (e.g., COCs), the scale of the decision (e.g., location), the preliminary action level (e.g., COC concentration), and the resulting action(s). The 200-LW-1 decision rules are summarized in Table A-2.

A.1.5.3 Error Tolerance and Decision Consequences. The consequence of selecting an inadequate nonstatistical sampling design is not considered severe. Based on Section 6.0 of the DQO summary report (BHI 2001), the sampling design rigor requirements are not significant because of the combination of low severity and accessibility after remedial investigation sampling. If the sampling design is determined to be inadequate, additional sampling can be performed because the sites will be still accessible. Section 5.2 of the work plan summarizes the sampling activities that are planned after the evaluation of initial characterization efforts that are described in this SAP.

A.1.5.4 Sample Design Summary. A nonstatistical sampling design (i.e., professional judgement) was used to select sample locations at the waste sites. This biased (or focused) sampling approach was selected based on process knowledge, expected behavior of COPCs, the observed distribution of contamination, waste site configuration, and the conceptual contaminant distribution models developed for the waste sites. Using this approach, sample locations are selected that increase the likelihood of encountering the worst-case conditions or maximum concentrations of contaminants.

The total number of samples for the waste sites are selected based on the conceptual contaminant distribution models and the physical setting of the waste sites. The models suggest that the highest contaminant concentrations should be detected near the bottom of the crib or trench and decrease with depth. Therefore, a greater frequency of sampling is planned in the zone immediately below the release point of the contaminants (i.e., the bottom of the crib or trench). Sampling frequency will decrease with depth based on the expected distribution of contamination. Additional samples will be collected at the discretion of the site geologist based on the field screening data and geological conditions encountered during drilling. All material

excavated will be screened as described in Section A.3.2.2. Field screening will be performed to reduce the potential of overlooking zones of significant contamination. The optimal sample design for this initial phase of characterization is presented in Section A.3.

Changes to the work scope detailed in the SAP may be required because of unexpected field conditions, new information, health and safety concerns, or other conditions. Minor changes that have no adverse effect on the technical adequacy of the job (i.e., DQOs) or schedule can be made in the field with the approval of the project manager or assigned task lead and documented in the daily field logbook and/or field summary reports. Changes that impact DQOs will require concurrence by the U.S. Department of Energy, Richland Operations Office and the lead regulatory agency and can be documented through unit managers' meetings. Alternatively, if substantial changes are required, the SAP can be revised and issued as a separate document requiring U.S. Department of Energy, Richland Operations Office and regulator approval.

Table A-1. Final COC List. (4 Pages)

Final COCs	Rationale for Inclusion
Radiological Constituents	
Americium-241	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Carbon-14	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Cesium-137	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Cobalt-60	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Europium-152	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Europium-154	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Europium-155	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Hydrogen-3 (Tritium)	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Neptunium-237	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nickel-63	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Plutonium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Plutonium-239/240	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Strontium-90	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Technetium-99	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Thorium-232	Fuel components for several Hanford Site operations (Kupfer et al. 1997).
Uranium-233/234	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Uranium-235/236	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Uranium-238	Known constituent produced by various Hanford Site operations (Kupfer et al. 1997).
Nonradiological Constituents – Metals	
Antimony	Metal byproduct from uranium fuel rod (GE 1951).
Arsenic	Analytical results from sediment samples collected within the 241-Z-361 Tank (FH 2000).
Barium	Metal byproduct from uranium fuel rod (GE 1951).
Beryllium	Metal used in brazes to seal end of fuel rod (GE 1951).
Cadmium	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944, Section A).
Chromium	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990).
Chromium (VI)	Due to sodium/potassium dichromate added during first- and second-cycle decontamination and concentration operations of bismuth-phosphate process (GE 1944 [Section C], WHC 1990).
Copper	Metal used in triple-dip process of cladding and cladding waste stream (1944 to 1952) (GE 1944, Section A).

Table A-1. Final COC List. (4 Pages)

Final COCs	Rationale for Inclusion
Lead	Metal used in lead-dipped cladding and cladding waste stream (1952 to 1956) (GE 1944, Section A). Lead oxide was added as an oxidizing agent to the first- and second-cycle decontamination operations of bismuth-phosphate process (GE 1944, Section C).
Mercury	Several uses in bismuth-phosphate campaign including addition to cladding and metal waste streams to prevent gaseous generations and miscellaneous laboratory uses. Listed based on knowledge gained by interviews and via tank farm integration (Agnew et al. 1997).
Nickel	Experimental additions of nickel sulfate added during the bismuth-phosphate process to serve as a scavenging agent. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991) and extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes (GE 1951).
Selenium	Several uses in bismuth phosphate campaign including filtering of gases generated in the 1950s and miscellaneous laboratory uses. Listed by the basis of knowledge gained by previous sampling efforts in the 200 Areas.
Silver	Several uses in bismuth-phosphate campaign including filtering of gases generated (1950s) and miscellaneous laboratory uses. Listed based on knowledge gained by interviews.
Nonradiological Constituents – General Inorganics	
Ammonia/ammonium	Several compounds contained ammonium. The most widely used included ammonium silica fluoride, which was used as a cleaning and decontamination compound based on the ability to dissolve metals and fission products (GE 1944 [Section C], 1951; HEW 1945).
Chloride	Several compounds contained chloride. The most widely used included ferrous chloride, which was used as a carrier and potassium/sodium chloride used as salting agents during the bismuth-phosphate process (GE 1944 [Section C], 1951; HEW 1945).
Cyanide	Extensive use (1954 to 1958) as nickel ferro/ferric cyanide during scavenging and recovery processes. Listed as a result of tank farm integration (Agnew et al. 1997, Borsheim and Simpson 1991, GE 1951).
Fluoride	Several compounds contained fluoride. The most widely used included lanthanum fluoride (which was used during the concentration operations of the bismuth-phosphate process) and ammonium silica fluoride (which was used as a cleaning and decontamination compound based on ability to dissolve metals and fission products) (GE 1944 [Section C], 1951; HEW 1945).
Nitrate/nitrite	Several compounds contained nitrates/nitrites the most widely used included sodium nitrite, a salting agent during the cladding removal, nitric acid, used throughout the bismuth-phosphate process and uranium recovery process (URP), and bismuth subnitrate, which was used to create the bismuth-phosphate/plutonium solid during the first and second decontamination cycles (GE 1944 [Section C], 1951; HEW 1945).
Phosphate	Several compounds contained phosphate. The most widely used included phosphoric acid, which was used throughout bismuth-phosphate process (GE 1944 [Section C], HEW 1945).
Sulfate	Several compounds contained sulfate. The most widely used included sulfuric acid, which was used in dissolving the fuel rods during the bismuth-phosphate process (GE 1944 [Section C], 1951; HEW 1945). Other sulfate complexes were used as carriers for various metals.
Sulfide	Hydrogen sulfide was used in the 329 Radiochemical Laboratory from 1952 to 1976 (WHC 1990).

Table A-1. Final COC List. (4 Pages)

Final COCs	Rationale for Inclusion
Volatile Organics	
1,1-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
1,2-dichloroethane (DCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
1,1,1-trichloroethane (TCA)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Acetone	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Butanol	Degradation product of tributyl phosphate (TBP) used in various processes and experiments including URP and PUREX operations. (GE 1951, WHC 1990).
Carbon tetrachloride	Carbon tetrachloride was widely used as a dilutant for TBP and dibutyl butyl phosphonate (DBBP) in the RECUPLEX, Plutonium Recovery Facility, and americium-241 recovery processes. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
Cis-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Chlorobenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Chloroform	Chloroform is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose (Rohay 1994).
Ethylbenzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Ethylene glycol	Antifreeze component used as a coolant for equipment.
2-butanone (methyl ethyl ketone, MEK)	Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone (Rohay 1994).
Methyl isobutyl ketone (MIBK, hexone)	Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone (Rohay 1994). Used as a solvent for solvent extraction of uranium and plutonium from fission products. Present in process drainage and possibly in process condensates. (GE 1951).
Methylene chloride	Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone (Rohay 1994).
n-butyl benzene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Trans-1,2-dichloroethylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Tetrachloroethylene (PCE)	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).

Table A-1. Final COC List. (4 Pages)

Final COCs	Rationale for Inclusion
Trichloroethylene (TCE)	TCE is a degradation product of carbon tetrachloride. Analytical results and measurements have illustrated that this contaminant is prevalent throughout the vadose zone and has impacted groundwater (Rohay 1994).
Toluene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Xylene	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Semi-Volatile Organics	
AMSCO[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in the URP (GE 1951).
Dodecane[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in the URP (GE 1951).
Greases	Used for equipment in laboratory (Mandis 2001). (Only an oil/grease separation analysis will be performed.)
Normal paraffins hydrocarbons[a]	Extensive use (1953 to 1957) in solvent extraction operation as the dilutant for TBP in URP (GE 1951).
Phenol	Analytical results and measurements have illustrated that this contaminant is found throughout the vadose zone (Rohay 1994).
Polychlorinated biphenyls (PCBs)	Various types of normal paraffins were used as milling, cutting, and washing solutions during the production of plutonium buttons/rods. These solutions almost always contained PCBs (discussions/publications with David A. Dodd, PFP Chemist [Mandis 2001]). Analytical results from sediment samples collected within the 241-Z-361 Tank (FH 2000).
TBP and derivatives (mono, bi)	Extensive use (1953 to 1957) in solvent extraction operation as the bismuth-phosphate complexant in the URP (GE 1951).

[a]Analyzed as kerosene by nonhalogenated volatile organic analyte via 8015 Method, total petroleum hydrocarbons – diesel to oil range, or total petroleum hydrocarbons – gasoline range.

Table A-2. Decision Rules.

DR #	Decision Rule
1	If the true maximum (as estimated by the maximum detected sample values) activity of radionuclides within the soil samples in each of the applicable strata[a] is greater than or equal to 100 nCi/g (transuranic) or the greater than Class C definition, evaluate special remedial alternatives in a FS; otherwise, evaluate conventional remedial alternatives in a FS.
2	If the true maximum (as estimated by the maximum detected sample values) activity of radionuclides within the soil samples in each of the applicable strata[a] results in a radiological dose greater than or equal to 15 to 100 mrem/yr above background, evaluate remedial alternatives in a FS; otherwise, evaluate the site for closure with no remedial action.
3	If the true maximum (as estimated by the maximum detected sample values) concentration of chemical constituents within the soil samples in each of the applicable strata[a] is greater than or equal to the preliminary action levels in Table 3-6 of the DQO summary report, evaluate remedial alternatives in a FS; otherwise, evaluate the site for closure with no remedial action.

[a] The applicable strata include the highest contaminant concentration layers, the moderate-to-low contaminant concentration layers, and the low contaminant concentration layers.

A.2 QUALITY ASSURANCE PROJECT PLAN

The quality assurance project plan (QAPjP) establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The overall QAPjP for Environmental Restoration waste sites in the 200 Areas is included in Appendix A of the Implementation Plan (DOE-RL 1999). The QAPjP complies with the requirements of the following:

- U.S. Department of Energy Directive CRD 414.1A, *Quality Assurance*
- *Code of Federal Regulations* (CFR), 40 CFR 830.120, "Quality Assurance Requirements"
- *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA 1994a)
- *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE-RL 1996).

The Implementation Plan provides the general framework of technical and administrative requirements that apply to OUs in the 200 Areas.

To meet the site-specific needs for the 200-LW-1 OU, this QAPjP identifies supplemental requirements developed during the DQO process and described in the group-specific SAP. These requirements are listed below:

- **Analytical Performance.** Requirements for detection limits, precision, and accuracy are presented in Table A-3. The analytical methods are also shown in this table.
- **Field Quality Control.** The frequency and type of quality control (QC) samples to be collected are addressed in Section A.2.1.
- **Sample Preservation, Containers, and Holding Time.** The requirements for the specific test/laboratory methods are addressed in Section A.2.3 and in Table A-4.
- **Onsite Measurements Quality Control.** The specific types of QC samples for onsite measurements and the frequency of collection are addressed in Section A.2.4.
- **Data Validation and Usability.** Specific validation requirements, including the frequency and level of validation, are addressed in Section A.2.6.

The following sections describe the supplemental waste group quality requirements and the procedural controls applicable to this investigation. The 200 Areas QAPjP (Appendix A of the Implementation Plan [DOE-RL 1999]) and this section of the SAP will serve as the QAPjP for the 200-LW-1 RI.

A.2.1 Field Quality Control

Field QC samples shall be collected to evaluate the potential for cross-contamination and laboratory performance. Field QC for sampling in the 200-LW-1 OU will require the collection of field duplicate, field split, trip, and equipment rinsate blank samples. The QC samples are described in this section with the required frequency of collection.

QC samples will not be collected from zones within the boreholes that are expected to contain TRU-contaminated soils because of the extreme cost and handling requirements associated with TRU materials.

A.2.1.1 Field Duplicates. Field duplicates shall each be retrieved from the sample interval using the same equipment (collected from one split spoon) and sampling technique. Field duplicates for soil are collected and homogenized before being divided into two samples in the field. If volatile organic analyte (VOA) samples are required, they should be collected prior to homogenization. The duplicate samples shall be sent to the primary laboratory in the same manner as the routine site samples. Field duplicates provide information regarding the homogeneity of the sample matrix and may also provide an evaluation of the precision of the analysis process.

A minimum of 5% of the total collected soil samples will be duplicated (i.e., 1 field duplicate will be collected for every 20 samples). At least one field duplicate shall be collected from each representative waste site to be investigated. The duplicates should generally be collected from an area that is expected to have some contamination, so that valid comparisons between the samples can be made (i.e., at least some of the COCs will be above detection limit). The duplicate samples shall be suitable for analysis by an offsite laboratory and shall be analyzed for all of the COCs listed in Table A-3.

A.2.1.2 Field Splits. Field split samples will be collected from each representative site to be sampled in the RI. The split samples shall each be retrieved from the same sample interval using the same equipment (collected from one split spoon) and sampling technique. Samples shall be homogenized, split into two separate aliquots in the field, and sent to two independent laboratories. If VOA samples are required, they should be collected prior to homogenization. The splits will be used to verify the performance of the primary laboratory.

The split samples will be obtained from sample media that is expected to have some contamination and which is suitable for analysis in an offsite laboratory and shall be analyzed for all of the COCs listed in Table A-3.

A.2.1.3 Equipment Rinsate Blanks. Equipment rinsate blanks shall be collected at the same frequency as duplicate samples and are used to verify the adequacy of sampling equipment decontamination procedures. The field geologist may request that additional equipment blanks be taken. Equipment blanks shall consist of pure deionized water washed through decontaminated sampling equipment and placed in containers identified in the Sample Authorization Forms.

Equipment rinsate blanks shall be analyzed for the following:

- Gross alpha
- Gross beta
- Metals (excluding hexavalent chromium and mercury)
- Anions (except cyanide)
- Volatile organic analytes of interest.

These analytes are considered to be the best indicators of decontamination effectiveness.

A.2.1.4 Trip Blanks. The volatile organic trip blanks will constitute approximately 5% of all volatile organic compound samples. A total of four trip blanks are expected to be collected. Trip blanks are prepared at the 3728 Sample Storage and Shipping Facility and shall consist of laboratory-grade deionized water that is added to clean sample containers. The trip blanks shall travel to the field with their associated bottle sets and will be returned to the laboratory with those samples. They will remain unopened during their transport and handling. Trip blanks are prepared as a check for possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for volatile organic compounds only.

A.2.1.5 Prevention of Cross-Contamination. Special care should be taken to prevent cross-contamination of soil samples. Particular care will be exercised to avoid the following common ways in which cross-contamination or background contamination may compromise the samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting them on or near potential contamination sources, such as uncovered ground
- Handling bottles or equipment with dirty hands
- Improperly decontaminating equipment before sampling or between sampling events.

A.2.2 Quality Objectives and Criteria for Measurement Data

Quality objectives and criteria for soil measurement data are presented in Table A-3 for radiological and nonradiological analytes, as well as physical properties of interest. Analysis of soil physical properties will be performed according to American Society for Testing and Materials (ASTM) procedures, if applicable.

A.2.3 Sample Preservation, Containers, and Holding Times

Soil sample preservation, containers, and holding times for radiological and nonradiological analytes of interest and physical property test are presented in Table A-4. Final sample collection requirements will be identified on the Sampling Authorization Form.

A.2.4 Onsite Measurements Quality Control

The collection of QC samples for onsite measurements is not applicable to field-screening techniques described in this plan. Field-screening instrumentation will be calibrated and controlled according to the procedures identified in Section A.2.7.

A.2.5 Data Management

Data resulting from the implementation of this QAPjP will be managed and stored by the Environmental Restoration Contractor (ERC) organization responsible for sampling and characterization, in accordance with BHI-EE-01, *Environmental Investigations Procedures*, Section 2.0, "Sample Management." At the direction of the task lead, all analytical data packages will be subject to final technical review by qualified personnel before their submittal to regulatory agencies or inclusion in reports. Electronic data access, when appropriate, will be via a database (e.g., Hanford Environmental Information System [HEIS] or a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1998).

A.2.6 Validation and Verification Requirement

Validation will be performed on completed data packages by qualified Bechtel Hanford, Inc. (BHI) Sample Management personnel or by a qualified independent contractor. Validation will consist of verifying required deliverables, requested versus reported analyses, and transcription errors. Validation will also include the evaluation and qualification of results based on holding time, method blanks, matrix spikes, laboratory control samples, laboratory duplicates, and chemical and tracer recoveries, as appropriate to the methods used. No other validation or calculation checks will be performed. At least 5% of all data will be validated.

Assuming that about 60 samples will be collected during the 200-LW-1 OU representative site investigations (including full QC sets, but exclusive of discretionary samples; see Tables A-6 through A-9), approximately 15 to 25 sample delivery groups will be submitted to the laboratory containing between 3 and 5 samples in each sample delivery group. Validation requirements identified in this section are consistent with Level C validation, as defined in *Data Validation Procedure for Radiochemistry Analysis* (BHI 2000a) and *Data Validation Procedure for Chemical Analysis* (BHI 2000b). No validation for physical property data will be performed.

A.2.7 Technical Procedures and Specifications

Soil sampling and onsite environmental measurements will be performed according to approved procedures. Sampling and field measurements will be conducted according to BHI-EE-01, *Environmental Investigations Procedures*; BHI-EE-05, *Field Screening Procedures*; and other approved procedures listed below. Individual procedures that may be used during performance of this SAP include the following:

- BHI-EE-01, *Environmental Investigations Procedures*

Section 1.0, General Information

- Procedure 1.5, "Field Logbooks"
- Procedure 1.6, "Survey Requirements and Techniques"

Section 2.0, Sample Management

- Procedure 2.0, "Sample Event Coordination"
- Procedure 2.1, "Sampling Documentation Processing"

Section 3.0, General Sampling

- Procedure 3.0, "Chain of Custody"
- Procedure 3.1, "Sample Packaging and Shipping"
- Procedure 3.2, "Field Decontamination of Sampling Equipment"

Section 4.0, Soil, Groundwater, and Biotic Sampling

- Procedure 4.0, "Soil and Sediment Sampling"
- Procedure 4.2, "Sample Storage and Shipping Facility"

Section 6.0, Drilling

- Procedure 6.2, "Field Cleaning and/or Decontamination of Geoprobe and Drilling Equipment"

Section 7.0, Geologic and Hydrologic Data Collection

- Procedure 7.0, "Geologic Logging"
- Procedure 7.2, "Geophysical Survey Work"

- BHI-EE-02, *Environmental Requirements*

  - Procedure 14.0, "Drilling, Maintaining, Remediating, and Decommissioning Resource Protection Wells, Geoprobe™, and Geotechnical Soil Borings"

- BHI-EE-05, *Field Screening Procedures*

  - Procedure 1.0, "Routine Field Screening"
  - Procedure 2.5, "Operation of Mobile Surface Contamination Monitor II"
  - Procedure 2.7, "Operation of Aptec Gamma Spectroscopy System"
  - Procedure 2.11, "Portable Environmental Survey Instrument Operation"
  - Procedure 2.14, "Radiological Counting Facility Quality Control"
  - Procedure 2.22, "Operation of Global Positioning Environmental Radiological Surveyor (GPERS-II)"
  - Procedure 2.27, "Calibration of the Aptec Gamma Spectroscopy System"

- Procedure 2.32, "Radiological Counting Facility Sample Analysis and Reporting"
- Procedure 2.38, "Radiological Counting Facility Instrument Preventative Maintenance"

- BHI-EE-10, *Waste Management Plan, Part II*

  - Procedure 9.0, "Control of CERCLA and Other Past-Practice Investigation-Derived Waste"

Work shall also be performed in accordance with the following manuals:

- BHI-EE-02, *Environmental Requirements*, Section 11.0, "Solid Waste System Operations"
- BHI-QA-01, *ERC Quality Program*
- BHI-QA-03, *ERC Quality Assurance Program Plans*

  - Plan 5.1, "Field Sampling Quality Assurance Program Plan"
  - Plan 5.2, "Onsite Measurements Quality Assurance Program Plan"
  - Plan 5.3, "Environmental Radiological Measurements Quality Assurance"

- BHI-MA-02, *ERC Project Procedures*
- BHI-SH-01, *ERC Safety and Health Program*
- BHI-SH-02, *Safety and Health Procedures*, Volumes 1 through 4
- BHI-SH-05, *Industrial Hygiene Work Instructions*
- BHI-EE-10, *Waste Management Plan*
- BHI-RC-01, *Radiation Protection Program Manual*
- BHI-RC-04, *Radiological Control Work Instructions*
- Specification for environmental drilling services specific to 200-LW-1
- *Sampling Services Procedures Manual*, ES-SSPM-001, Rev. 0, Procedure 2-5, "Laboratory Cleaning of Sampling Equipment," Waste Management Northwest (WMNW 1998).

A.2.7.1 Sample Location. Boreholes will be staked and labeled by the technical lead or field team leader assigned by the project manager. After the locations have been staked, minor adjustments to the location may be made to mitigate unsafe conditions, avoid structural interferences, or bypass utilities. Locations will be identified during or after sampling following BHI-EE-01, Procedure 1.6, "Survey Requirements and Techniques." Changes in sample locations that do not impact the DQOs will require approval of the project manager. However,

changes to sample locations that result in impacts to the DQOs will require Washington State Department of Ecology concurrence.

Prior to borehole drilling activities, surface geophysical and radiation surveys will be conducted at all sites. The surface geophysical surveys will be conducted using ground-penetrating radar and/or electromagnetic imaging and will aid in verifying waste site construction and geometry and in selecting borehole locations to avoid subsurface obstructions. The surface radiation surveys will identify areas of surface contamination that might impact the drilling activities and health and safety.

A.2.7.2 Sample Identification. The ERC Sample and Data Tracking database will be used to track the samples through the collection and laboratory analysis process. The HEIS database is the repository for the laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project in accordance with BHI-EE-01, Procedure 2.0, "Sample Event Coordination." Each radiological/nonradiological and physical properties sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook.

Each sample container will be labeled with the following information using a waterproof marker on firmly affixed, water-resistant labels:

- HEIS number
- Sample collection date/time
- Name/initials of person collecting the sample
- Analysis required
- Preservation method, if applicable.

A.2.7.3 Field Sampling Log. All information pertinent to field sampling and analysis will be recorded in bound logbooks in accordance with BHI-EE-01, Procedure 1.5, "Field Logbooks." The sampling team will be responsible for recording all relevant sampling information including, but not limited to, the information listed in Appendix A of Procedure 1.5. Entries made in the logbook will be dated and signed by the individual who made the entry.

A.2.7.4 Sample Custody. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples (cooler) shipped to any laboratory in accordance with BHI-EE-01, Procedure 3.0, "Chain of Custody." The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time responsibility for custody of the sample changes, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and transmit it to ERC Sample Management within 24 hours of shipping, as detailed in BHI-EE-01, Procedure 2.1, "Sampling Documentation Processing."

A custody seal (i.e., evidence tape) shall be affixed to the lid of each sample jar. The container seal will be inscribed with the sampler's initials and the date sealed. For any sample jars

collected inside the glovebag or glovebox to control radiological contamination and are "bagged out," the evidence tape may be affixed to the seal of the bag to demonstrate that tampering has not occurred. This will eliminate problems associated with contaminated soils adhering to the custody tape while inside the glovebox.

A.2.7.5 Sample Containers and Preservatives. Level I EPA pre-cleaned sample containers will be used for soil samples collected for radiological and nonradiological analysis. Container sizes may vary depending on laboratory-specific volumes needed to meet analytical detection limits. If, however, the dose rate on the outside of a sample jar or the curie content exceeds levels acceptable by an offsite laboratory, the sampling lead and task lead can send smaller volumes to the laboratory after consultation with ERC Sample Management to determine acceptable volumes. Preliminary container types and volumes are identified in Table A-4. Final types and volumes will be provided in the Sample Authorization Form.

A.2.7.6 Sample Shipping. The outside of each sample jar will be surveyed by the radiological control technician (RCT) to verify that the container is free of smearable surface contamination. The RCT will also measure the radiological activity on the outside of the sample container (through the container) and will mark the container with the highest contact radiological reading in either dpm or mrem/hr, as applicable. Total activity analysis performed by the Radiological Counting Facility, 222-S Laboratory, or another suitable onsite laboratory will be used for determining U.S. Department of Transportation shipping criteria. This information, along with other data that may pre-qualify the samples, will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation regulations (49 CFR) and to verify that the sample can be received by the offsite analytical laboratory in accordance with the laboratory's acceptance criteria. The sampler will send copies of the shipping documentation to ERC Sample Management within 24 hours of shipping, as detailed in BHI-EE-01, Procedure 2.1, "Sampling Documentation Processing."

As a general rule, samples with activities <1 mrem/hr will be shipped to an offsite laboratory. Samples with activities greater than 1 mrem/hr may be shipped to an offsite laboratory; these samples with activities in this range will be evaluated on a case-by-case basis by ERC Sample Management. If no offsite laboratory can be identified for high-activity samples, the samples will be sent to an onsite laboratory arranged by Sample Management.

Table A-3. Analytical Performance Requirements – Shallow and Deep Zone Soils. (5 Pages).

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology[i]	Required Target Quantitation Limits[c]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		15 mrem/yr[b] (pCi/g)	500 mrem/yr[b] (pCi/g)	GW Protection[b] (pCi/g)		Water Low Activity (pCi/L)	Water High Activity (pCi/L)	Soil-Other Low Activity (pCi/g)	Soil-Other High Activity (pCi/g)				
Americium-241	14596-10-2	335	112,000	N/A	Americium isotopic – AEA	1	400	1	4,000	±20%	80-120%	±35%	65-135%
Carbon-14	14762-75-5	33,100	1,100,000	291	Carbon-14 - liquid scintillation	200	N/A	50	N/A	±20%	70-130%	±35%	70-130%
Cesium-137	10045-97-3	23.4	780	N/A	GEA	15	200	0.1	2,000	±20%	80-120%	±35%	65-135%
Cobalt-60	10198-40-0	4.90	164	N/A	GEA	25	200	0.05	2,000	±20%	80-120%	±35%	65-135%
Europium-152	14683-23-9	11.4	388	N/A	GEA	50	200	0.1	2,000	±20%	70-130%	±35%	70-130%
Europium-154	15585-10-1	10.3	345	N/A	GEA	50	200	0.1	2,000	±20%	70-130%	±35%	70-130%
Europium-155	14391-16-3	426	14,200	N/A	GEA	50	200	0.1	2,000	±20%	70-130%	±35%	70-130%
Neptunium-237	13994-20-2	59.2	1,980	N/A	Neptunium-237 – AEA	1	N/A	1	8,000	±20%	80-120%	±35%	65-135%
Nickel-63	13981-37-8	4,026	3,008,000	N/A	Nickel-63 - liquid scintillation	15	N/A	30	N/A	±20%	70-130%	±35%	70-130%
Plutonium-238	13981-16-3	470	15,700	N/A	Plutonium isotopic – AEA	1	130	1	1,300	±20%	80-120%	±35%	65-135%
Plutonium-239/240	Pu-239/240	425	14,200	N/A	Plutonium isotopic – AEA	1	130	1	1,300	±20%	80-120%	±35%	65-135%
Strontium-90	Rad-Sr	2,410	80,300	N/A	Total radioactive strontium – GPC	2	80	1	800	±20%	80-120%	±35%	65-135%
Technetium-99	14133-76-7	412,000	13,700,000	171	Technetium-99 – liquid scintillation	15	400	15	4,000	±20%	80-120%	±35%	65-135%
Thorium-232	TH-232	4.8	160	N/A	Thorium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%
Tritium (H-3)	10028-17-8	66,900	2,230,000	4,100	Tritium – liquid scintillation	400	400	400	400	±20%	80-120%	±35%	65-135%
Uranium-233/234	13966-29-5	2,660	88,800	39.5	Uranium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%
Uranium-235/236	15117-96-1	101	3,370	3.92	Uranium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%
Uranium-238	U-238	504	16,800	38.1	Uranium isotopic – AEA (pCi) ICPMS (mg)	1	0.002 mg/L	1	0.02 mg/kg	±20%	80-120%	±35%	65-135%

Table A-3. Analytical Performance Requirements – Shallow and Deep Zone Soils (5 Pages).

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology	Required Target Quantitation Limits[c]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		MTCA Method C[d] (mg/kg)	GW Protection[e] (mg/kg)	Terrestrial Biota Protection[f] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Metals													
Antimony	7440-36-0	1,400	N/A	5	Metals – 6010 – ICP	0.06	0.2	6	20	g	g	g	g
Arsenic	7440-38-2	87.5	20[h]	20[h]	Metals – 6010 – ICP	0.1	0.2	10	20	g	g	g	g
					Metals – 6010[j] – ICP (trace)	0.01	N/A	1	N/A	g	g	g	g
Barium	7440-39-3	245,000	282[j]	132[h]	Metals – 6010 – ICP	0.2	0.2	20	40	g	g	g	g
Beryllium	7440-41-7	104[k]	N/A	10	Metals – 6010 – ICP	0.005	0.01	0.5	1	g	g	g	g
Cadmium	7440-43-9	139[k]	0.81[h]	4	Metals – 6010 – ICP	0.005	0.01	0.5	1	g	g	g	g
					Metals – 6010[j] – ICP (trace)	0.005	N/A	0.5	N/A	g	g	g	g
Chromium (total)	7440-47-3	Unlimited	2,000[j]	42	Metals – 6010 – ICP	0.01	0.01	1	2	g	g	g	g
					Metals – 6010 – ICP (trace)	0.01	N/A	1	N/A	g	g	g	g
Chromium VI	18540-29-9	21[k]	7.7[l]	42	Chromium (hex) – 7196 – colorimetric	0.01	4	0.5	200	g	g	g	g
Copper	7440-50-8	130,000	22[h]	50	Metals – 6010 – ICP	0.025	0.025	2.5	2.5	g	g	g	g
Lead	7439-92-1	1,000[m]	840[l]	50	Metals – 6010 – ICP	0.1	0.2	10	20	g	g	g	g
					Metals – 6010 – ICP(trace)	0.01	N/A	1	N/A	g	g	g	g
Mercury	7439-97-6	1,050	0.33[h]	0.33[h]	Mercury - 7470 – CVAA	0.0005	0.005	N/A	N/A	g	g	g	g
					Mercury - 7471 – CVAA	N/A	N/A	0.2	0.2	g	g	g	g
Nickel	7440-02-0	70,000[n]	130.4[j]	30	Metals – 6010 – ICP	0.04	0.04	4	4	g	g	g	g
Selenium	7782-49-2	17,500	1[l]	0.78[h]	Metals - 6010 – ICP	0.1	0.2	10	20	o	o	o	o
Silver	7440-22-4	17,500	9.4[l]	2	Metals – 6010 – ICP	0.02	0.02	2	2	g	g	g	g
					Metals – 6010 – ICP (trace)	0.005	N/A	0.5	N/A	g	g	g	g
Uranium (total)	7440-61-1	10,500[n]	115	5	Uranium total – kinetic phosphorescence analysis	0.0001	0.02	1	0.2	±20%	80-120%	±35%	65-135%

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		MTCA Method C[d] (mg/kg)	GW Protection[e] (mg/kg)	Terrestrial Biota Protection[f] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Inorganics													
Ammonia/ ammonium	7664-41-7	Unlimited	Unlimited	N/A	Ammonia – 350.N°	0.05	800	0.5	8,000	[g]	[g]	[g]	[g]
Chloride	16887-00-6	N/A	N/A	N/A	Anions – 300.0 – IC	0.2	5	2	5	[g]	[g]	[g]	[g]
Cyanide	57-12-5	70,000	0.80[j]	N/A	Total cyanide - 9010 – colorimetric	0.005	0.005	0.5	0.5	[g]	[g]	[g]	[g]
Fluoride	16984-48-8	210,000	16[j]	N/A	Anions – 300.0 – IC	0.5	5	5	5	[g]	[g]	[g]	[g]
Nitrate	14797-55-8	Unlimited	40[j]	N/A	Anions – 300.0 – IC	0.25	10	2.5	40	[g]	[g]	[g]	[g]
Nitrite	14797-65-0	350,000	4[j]	N/A	Anions – 300.0 – IC	0.25	15	2.5	20	[g]	[g]	[g]	[g]
Phosphate	14265-44-2	N/A	N/A	N/A	Anions – 300.0 – IC	0.5	15	5	40	[g]	[g]	[g]	[g]
Sulfate	14808-79-8	N/A	1,000[j]	N/A	Anions – 300.0 – IC	0.5	15	5	40	[g]	[g]	[g]	[g]
Sulfide	18496-25-8	N/A	N/A	N/A	Sulfide 9030	0.5	15	5	40	[g]	[g]	[g]	[g]
Organics													
Acetone (2-propanone)	67-64-1	350,000	3.21	N/A	Volatile organics – 8260 – GCMS	0.02	0.02	0.02	0.02	[g]	[g]	[g]	[g]
Benzene	71-43-2	2,390	2.42	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Butanol; n-	71-36-3	350,000	6.62	N/A	GC Organic - 8015	5	5	5	5	[g]	[g]	[g]	[g]
Butyl benzene; n	104-51-8	N/A	N/A	N/A	Volatile Organics – 8260 – GCMS	0.005	N/A	0.005	N/A	N/A	N/A	N/A	N/A
Carbon tetrachloride	56-23-5	1,010	0.0031	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Chlorobenzene	108-90-7	70,000	1.4	40	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Chloroform	67-66-3	21,500	0.0382	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Dichloroethane; 1,I	75-34-3	350,000	4.37	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	[g]	[g]	[g]	[g]
Dichloroethane; 1,2	107-06-2	1,440	0.00232	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	[g]	[g]	[g]	[g]
Dichloroethylene; 1,2- (mixed isomers)	540-59-0	31,500	0.4	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	[g]	[g]	[g]	[g]

Table A-3. Analytical Performance Requirements – Shallow and Deep Zone Soils (5 Pages).

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		MTCA Method C[d] (mg/kg)	GW Protection[e] (mg/kg)	Terrestrial Biota Protection[f] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Ethylene glycol	107-21-1	Unlimited	N/A	N/A	GC Organic 8015	5	5	5	5	g	g	g	g
Ethylbenzene	100-41-4	350,000	6.91	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	g	g	g	g
Methyl ethyl ketone (MEK; 2-butanone)	78-93-3	Unlimited	N/A	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	g	g	g	g
Methyl isobutyl ketone (MIBK hexone)	108-10-1	280,000	N/A	N/A	Volatile organics – 8260 – GCMS	0.01	0.01	0.01	0.01	g	g	g	g
Methylene chloride (dichloromethane)	75-09-2	17,500	0.0254	N/A	Volatile Organics – 8260 – GCMS	0.005	0.005	0.005	0.005	g	g	g	g
Phenol	108-95-2	Unlimited	43.9	30	Semi-volatiles – 8270 – GCMS	0.01	0.1	0.33	3.3	g	g	g	g
PCBs	1336-36-3	10[m]	0.21[j]	0.65	PCBs – 8082 – GC	0.0005	0.005	0.0165	0.1	g	g	g	g
Tetrachloroethylene	127-18-4	2,570	0.0091	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	g	g	g	g
Toluene	108-88-3	70,000	11.6	200	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	g	g	g	g
Tributyl phosphate	126-73-8	N/A	N/A	N/A	Semi-volatiles – 8270 – GCMS	0.1	0.5	3.3	5	g	g	g	g
Trichlorethane; 1,1,1	71-55-6	Unlimited	57	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	g	g	g	g
Trichloroethylene	79-01-6	11,900	0.0263	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	g	g	g	g
Xylene (total)	1330-20-7	Unlimited	135	N/A	Volatile organics – 8260 – GCMS	0.005	0.005	0.005	0.005	g	g	g	g
Total petroleum hydrocarbons – diesel to oil range (kerosene)	68334-30-5	2,000[m]	2,000[m]	200	WTPH-D	0.5	0.5	5	5	g	g	g	g
Total petroleum hydrocarbons – gasoline range	8006-61-9	30[m]	30[m]	100	WTPH-G	0.5	0.5	5	5	g	g	g	g
Normal paraffin hydrocarbons	8008-20-6	2,000[m]	2,000[m]	200	Nonhalogenated VOA – 8015M – GC modified for hydrocarbons	0.5	0.5	5	5	g	g	g	g
Hydraulic fluids (grease; heavy oils)	8008-20-6	2,000[m]	2,000[m]	N/A	Oil and grease (total recoverable) – 413.N	2	N/A	200	N/A	g	g	g	g

Table A-3. Analytical Performance Requirements – Shallow and Deep Zone Soils (5 Pages).

COCs	CAS #	Preliminary Action Level[a]			Name/Analytical Technology	Required Target Quantitation Limits[c]				Precision Water	Accuracy Water	Precision Soil	Accuracy Soil
		MTCA Method C[d] (mg/kg)	GW Protection[e] (mg/kg)	Terrestrial Biota Protection[f] (mg/kg)		Water Low Conc. (mg/L)	Water High Conc. (mg/L)	Soil-Other Low Conc. (mg/kg)	Soil-Other High Conc. (mg/kg)				
Field Screening Measurements													
pH	N/A	N/A	N/A	N/A	TBD	TBD		TBD		TBD	TBD	TBD	TBD
Soil Physical Properties													
Bulk density	N/A	N/A	N/A	N/A	D2937, or BHI-EE-05, Procedure 3.9	N/A		wt%		N/A	N/A	N/A	N/A
Lithology	N/A	N/A	N/A	N/A	BHI-EE-01, Procedure 7.0	N/A		Descriptive		N/A	N/A	N/A	N/A
Moisture content	N/A	N/A	N/A	N/A	D2216	N/A		wt%		N/A	N/A	N/A	N/A
Particle size distribution	N/A	N/A	N/A	N/A	D422	N/A		wt%		N/A	N/A	N/A	N/A

[a] The preliminary action level is the regulatory or risk-based value used to determine appropriate analytical requirements (e.g., detection limits). Remedial action levels will be proposed in the FS, will be finalized in the record of decision, and will drive remediation of the sites.
[b] 15 mrem/yr = nonrad worker industrial exposure scenario; 2,000 hrs/yr on-site, 60% indoors, 40% outdoors. 500 mrem/yr = rad-worker industrial scenario; 2,000 hrs/yr on-site, 60% indoors, 40% outdoors. GW = groundwater protection radionuclide values based on RESRAD modeling of drinking water exposure with the entire vadose zone presumed to be contaminated.
[c] Water values for sampling quality control (e.g., equipment blanks/rinses) or drainable liquid (if recovered). For both water and soil mediums, matrix affects may impact on specific sample basis.
[d] MTCA Method C industrial soil values for direct exposure from the CLARC Version 3.1 tables, updated November 2001.
[e] MTCA Method B soil values for groundwater protection from the CLARC Version 3.1 tables, updated November 2001, except as noted.
[f] Value is the lowest concentration for each analyte (adjusted for background) from Tables 749-2 and 749-3 of WAC 173-340-900, amended February 12, 2001.
[g] Precision and accuracy requirements as identified and defined in the referenced EPA procedures implemented by laboratory analysis and QA procedures.
[h] Cleanup value is less than Hanford Site soil background. Therefore, the soil background concentration is used as the preliminary action level.
[i] All four-digit numbers refer to *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* (EPA 1986).
[j] Calculated using MTCA Method B drinking water standards as inputs to the MTCA 3-phase model for protection of drinking water [WAC 173-340-747(4), amended February 12, 2001], except as noted.
[k] Calculated using MTCA air cleanup standards from WAC 173-340-750(3)(a)(ii)(B), page 210, equation 750-2, with WDOH mass loading of particulates in air of 10^{-4} g/m^3.
[l] Calculated using standards for surface water protection (40 CFR 131 and WAC 173-201A-040) as inputs to the MTCA 3-phase model for protection of drinking water [WAC 173-340-747(4), February 12, 2001].
[m] Based upon MTCA Method A values from Tables 740-1 and 745-1 of WAC 173-340-900, amended February 12, 2001.
[n] Value based upon nickel or uranium soluble salts value.
[o] From *Methods of analysis of Water and Waste* (EPA 1983).

AEA = alpha energy analysis
CAS = Chemical Abstract Service
CVAA = cold vapor atomic absorption
GC = gas chromatograph
GCMS = gas chromatograph/mass spectrometry
GPC = gas proportional counter
IC = ion chromatography
ICPMS = inductively coupled plasma mass spectrometer
N/A = not applicable
TBD = to be determined
TOC = total organic carbon

Table A-4. Sample Preservation, Container, and Holding Time Guidelines. (2 Pages)

Analytes	Analytical Priority	Matrix	Bottle		Amount[a,b,c]	Preservation	Packing Requirements	Holding Time
			Number	Type				
Radionuclides								
Americium-241	7	Soil	1	G/P	10-1000 g	None	None	6 months
Carbon-14	11	Soil	1	G/P	10-1000 g	None	None	6 months
Cesium-137	1	Soil	1	G/P	100-1500 g	None	None	6 months
Cobalt-60	1	Soil	1	G/P	100-1500 g	None	None	6 months
Europium-152	1	Soil	1	G/P	100-1500 g	None	None	6 months
Europium-154	1	Soil	1	G/P	100-1500 g	None	None	6 months
Europium-155	1	Soil	1	G/P	100-1500 g	None	None	6 months
Neptunium-237	6	Soil	1	G/P	10-1000 g	None	None	6 months
Nickel-63	6	Soil	1	G/P	10-1000 g	None	None	6 months
Plutonium-238	5	Soil	1	G/P	10-1000 g	None	None	6 months
Plutonium-239/240	5	Soil	1	G/P	10-1000 g	None	None	6 months
Strontium-90	2	Soil	1	G/P	10-1000 g	None	None	6 months
Technetium-99	11	Soil	1	G/P	10-1000 g	None	None	6 months
Thorium-232	6	Soil	1	G/P	10-1000 g	None	None	6 months
Tritium – H3	19	Soil	1	G	100-500 g	None	None	6 months
Uranium-233/234	3	Soil	1	G/P	10-1000 g	None	None	6 months
Uranium-235/236	3	Soil	1	G/P	10-1000 g	None	None	6 months
Uranium-238	3	Soil	1	G/P	10-1000 g	None	None	6 months
Chemicals								
Ammonia/ ammonium – 350.1	12	Soil	1	G/P	50-500 g	None	Cool 4°C	28 days
IC 353.1 and EPA 300.0	8	Soil	1	G/P	50-500 g	None	Cool 4°C	28 days/ 48 hours
ICP metals – 6010A (Add-on)	4	Soil	1	G/P	10-500 g	None	None	6 months
ICP metals – 6010A (TAL)	4	Soil	1	G/P	10-500 g	None	None	6 months
Chromium hex – 7196	15	Soil	1	G/P	5-500 g	None	Cool 4°C	30 days
Mercury – 7471 – (CV)	14	Soil	1	G	5-125 g	None	None	28 days
Total cyanide – 9010	16	Soil	1	G	10-1000 g	None	Cool 4°C	14 days
Sulfides – 9030	17	Soil	1	G	40 g	None	Cool 4°C	7 days
pH (soil) – 9045	18	Soil	1	G/P	10-250 g	None	None	ASAP
VOA – 8260	9	Soil	1	G	125 g	None	Cool 4°C	14 days
Nonhalogenated VOA – 8015M	9	Soil	1	G	10-50 g	None	Cool 4°C	14 days
Nonhalogenated VOA – 8015M-GC modified for hydrocarbon (normal paraffin hydrocarbon)	10	Soil	1	G	125-250 g	None	Cool 4°C	14 days
WTPH - Diesel	10	Soil	1	G	50-150 g	None	Cool 4°C	14 days
WTPH - Gasoline	10	Soil	1	G	50-150 g	None	Cool 4°C	14 days

Table A-4. Sample Preservation, Container, and Holding Time Guidelines. (2 Pages)

Analytes	Analytical Priority	Matrix	Bottle		Amount[a,b,c]	Preservation	Packing Requirements	Holding Time
			Number	Type				
Oil and grease	10	Soil	1	G	200 g	None	Cool 4°C	28 days
SVOA – 8270A (TCL)	10	Soil	1	G	125-1000 g	None	Cool 4°C	14/40 days
PCBs – 8082	13	Soil	1	G	10-50 g	None	Cool 4°C	14 days
Physical Properties								
Bulk density – D2937	20	Soil	1	Liner	1,000 g	None	None	None established for analysis
Moisture content – ASTM D2216	21	Soil	1	Moisture Tin[d]	250 g	None	None	None established for analysis
Particle size distribution – ASTM D422	22	Soil	1	G/P	TBD	None	None	None established for analysis

[a]Optimal volumes, which may be adjusted downward to accommodate the possibility of retrieval of small amount of sample. Minimum sample size will be defined in the Sampling Authorization Form.
[b]Should samples be liquid rather than soils, the following volumes need to be collected: *Radionuclides*-4 L (preserved in nitric acid) for all radionuclides (except carbon-14 and tritium require no preservation, and technetium-99 must be preserved in hydrochloric acid; they require approximately 500 mL each sample); *Chemicals*-all liquid samples require the amount as listed for soil samples.
[c]Mixed soil samples may be obtained and submitted to the analytical laboratory for analyses for specific analytes including: *Radionuclides*-100 g of soil for all radionuclides (except carbon-14, tritium, and technetium-99; they require approximately 10 g each sample); *Chemicals*-a 10-g soil sample is required for all ICP analysis, 10-g soil sample is required for IC anion analysis, 5-g soil sample for hexavalent chromium analysis, 10-g soil sample for CA analysis, 10-g soil sample for 8015 analysis, and 125-g soil samples for 8270 analyses.
[d]Vessel must be sealed.

aG = amber glass
ASAP = as soon as possible
CV = cold vapor
G = glass
NWTPH = Northwest Total Petroleum Hydrocarbons
P = plastic
SVOA = semi-volatile organic analyte
TAL = target analyte list
TBD = to be determined
TCL = target compound list
VOA = volatile organic analyte

A.3 FIELD SAMPLING PLAN

A.3.1 Sampling Objectives

The primary objective of the field sampling plan is to clearly identify and describe sampling and analysis activities that will be conducted to resolve decision rules identified in Step 5 of the DQO process (see Section A.1.5.2). Decision rule statements indicate that remedial action may be necessary if preliminary action levels and annual exposure protection limits are exceeded. The field sampling plan uses the sampling design proposed in Step 7 of the DQO process and describes pertinent elements of the sampling program. Sample methods, procedures, locations, frequencies, parameters of interest, and bottle requirements are identified in this section.

A borehole will be drilled through each of the representative sites identified in the DQO as needing additional data to support the RI/FS process: the 216-T-28 Crib, the 216-B-58 Trench, the 216-S-20 Crib, and the 216-Z-7 Crib. The borehole locations for the 216-B-58 Trench and 216-Z-7 Crib will be determined from direct push holes that will be geophysically logged. The boreholes will be drilled to groundwater and soil samples will be collected through the vadose zone for laboratory analysis. Physical property samples will be collected at major lithologic changes. The boreholes will be geophysically logged for gamma-emitting radionuclides and neutron moisture content. A split-spoon sampler will be the primary sampling device used to collect the soil samples from the boreholes. The locations of planned boreholes with respect to existing boreholes are shown in Figures A-1 through A-4.

A.3.2 Field Measurements

A.3.2.1 Surface Radiation Survey. A surface radiation survey will be performed at each waste site to be investigated to document existing surface contamination and to support preparation of supporting health and safety documentation. Surface radiation surveys will be conducted by qualified RCTs in accordance with applicable health and safety procedures. A survey report will be prepared for each site. Surveys will be performed according to BHI-EE-05, Procedure 2.5, "Operation of Mobile Surface Contamination Monitor II," or other applicable approved procedures. A post-sampling survey will also be performed at each sampling site to ensure that sampling activities have not contributed to surface contamination.

A.3.2.2 Soil Screening. All samples and cuttings from boreholes will be field screened for evidence of radioactive contamination by the RCT or other qualified personnel. Surveys of these materials will be conducted with field instruments and visual observations. Potential screening instruments are listed in Table A-5 with their respective detection limits. The RCT will record all field measurements, noting the depth of the sample and the instrument reading.

Prior to drilling, a local area background reading will be taken with the field screening instruments at a background site to be selected in the field. Field screening and interpretations of geologic conditions will be used to identify the bottom of the waste site (i.e., crib/trench) and adjust sampling points if needed, assist in determining sample shipping requirements, and support worker health and safety monitoring. The site geologists will use professional judgment,

screening data, and the information provided in Tables A-6 through A-9 to finalize sampling decisions.

The field action level for radionuclide screening is twice background. Intervals above this field action level will be assessed for sampling by the field geologist. Samples exceeding 0.5 mrem/hr will be stored at a temporary radioactive material storage area at the drilling location until shipment to the laboratory. Samples less than 0.5 mrem/hr will be stored at the 3728 Sample Storage and Shipping Facility until shipped to the laboratory.

Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer's specifications and other approved procedures. The field geologist will record field screening results on the borehole log.

A.3.3 Soil Sampling and Analysis

The following sections discuss the details of sampling soil from boreholes.

A.3.3.1 Borehole Sampling and Analysis. Nonradiological and radiological samples will be collected from four deep boreholes. The borehole location at the 216-Z-7 Crib will be determined through a series of up to six direct push holes. Because of potentially deeper contamination at the site, the direct push holes are planned to be installed to approximately 18 m (60 ft) below ground surface (bgs). The borehole location at the 216-B-58 Trench will be determined through a series of up to eight direct pushes. The holes will be pushed as deep as possible, but a maximum depth of approximately 10.7 m (35 ft) bgs is assumed for investigation planning. The direct pushes will be installed and geophysically logged to determine the area within each site with the highest contamination from gamma-emitting radionuclides. The logging may also include passive neutron tools. This step is necessary as sufficient historical information is not available concerning the release of effluent to these sites. Borehole sample collection will be guided by the sampling approaches outlined in Tables A-6 through A-9. Actual sampling intervals may vary from these approaches depending on the thickness of clean soil cover placed over the cribs and trench.

The intent of the sampling design is to begin sample collection at the crib/trench bottom and continue sampling intermittently (based on the site's conceptual contaminant distribution model, results of nearby borehole logging events, and professional judgement of the field geologist) until a significant decrease in contamination is noted. The zone of highest expected contamination will likely contain low mobility contaminants. Additional samples above and below this zone of highest contamination will be collected based on characteristics exhibited during the field screening activities and geologic observations. Figures A-6 through A-9 illustrate hypothetical sampling intervals in boreholes. Additional samples may be collected and analyzed at the discretion of the field engineer/geologist, based on field conditions, measurements, or observations made during the conduct of remedial investigations.

The bottoms of the waste sites are considered critical sample points because the highest levels of contamination are expected to begin at this location. Samples from 4.6 m (15 ft) bgs and 7.6 m (25 ft) bgs are also considered critical sampling points to evaluate exposure scenarios and

remedial alternatives. Sample from depths greater than 7.6 m (25 ft) bgs will be used to verify the conceptual contaminant distribution models and to evaluate remedial action alternatives and groundwater impacts. Drilling and sampling will stop when the regional water table is encountered.

Sampling will be performed in accordance with BHI-EE-01, Procedure 4.0, "Soil and Sediment Sampling," using a split-spoon sampler. The split-spoon samplers will be equipped with four separate stainless steel or lexan liners. Site personnel will not overdrive the sampling device. With the exception of the volatile organic analyte samples, soil will be transferred to a pre-cleaned, stainless steel mixing bowl, homogenized, then containerized in accordance with the sampling procedure. Radiological and nonradiological analytes of interest are presented in Table A-3. If sample volume requirements cannot be met, samples will be collected according to the priority presented in Table A-4. Radiological and nonradiological samples will always take precedence over physical property samples.

Physical property samples will be collected from the boreholes to provide site-specific values to support RESidual RADioactivity (RESRAD) dose model or other modeling efforts. Soil properties of interest are moisture content, grain-size distribution, and soil density. Samples for soil density shall generally be collected with a split-spoon sampler equipped with four separate stainless steel or lexan liners. Physical samples will be analyzed in accordance with ASTM methods, listed in Table A-3 (ASTM 1993), or in accordance with ERC procedures identified in Table A-3. The physical property samples will be collected from lithologies that represent the major facies in the vadose zone as identified in Tables A-6 and A-9. The samples will be collected coincident with nonradiological and radiological split-spoon sample intervals, where possible. Additional samples may be obtained with the approval of the project manager.

Investigation-derived waste generated during this activity will be handled according to procedures in Section A.5 and the waste control plan.

A.3.3.2 Pre-Shipment Sample Screening. A representative portion of each sample to be shipped to an offsite laboratory will be submitted to the Radiological Counting Facility, 222-S Laboratory, or other suitable onsite laboratory for total activity analysis prior to shipment. Total activities will be used for sample pre-shipment characterization. Samples that slightly exceed the offsite laboratory criterion discussed in Section A.3.2.2 may be reduced in volume to allow offsite shipment. Onsite and offsite laboratories will be identified prior to initiating field activities and will be mutually acceptable to the ERC's Sample Management group and to the task lead.

A.3.3.3 Summary of Sampling Activities. A summary of the number and types of samples to be collected at all four waste sites is presented in Table A-10.

A.3.4 Geophysical Logging

The planned boreholes and selected existing boreholes will be geophysically logged with the high-resolution spectral gamma-ray logging system to determine the vertical distribution and concentration of gamma-emitting radionuclides. Soil moisture will also be determined using a

neutron logging tool. These methods are described in Section 4.3 of the work plan. The new boreholes will be logged prior to telescoping of casing and before abandonment. The starting point for logging will be recorded; this is usually ground surface or top of casing. The site geologist will witness logging runs and verify before and after field calibrations and repeat log intervals. The list of boreholes and wells that will be logged with the radionuclide logging system is presented in Table A-11. These boreholes represent data collection points in the vicinity of the individual waste sites. Logging of these boreholes will provide additional, updated, site-specific information on contaminant distribution, both laterally and vertically in the area of the waste sites.

A.3.5 Surveying

The location of all planned boreholes will be surveyed after the sampling and abandonment activities are completed. Surveys will be performed according to BHI-EE-01, Procedure 1.6, "Survey Requirements and Techniques." Data will be recorded in the North American Vertical Datum of 1988 (NAVD 1988) and the Washington State Plane (South Zone) North American Datum of 1983 (NAD 1983), with the 1991 adjustment for horizontal coordinates. All survey data will be recorded in meters and feet.

A.3.6 Waste Management Sampling

A waste designation DQO effort will be performed before the initiation of the characterization activities to ensure that the proper information is collected during the field effort to support the designation of all project investigation-derived waste. During the DQO effort for waste designation, any listed waste issues will also be resolved. Any additional sampling requirements or analytes needed to support designation activities will be identified and implemented through the waste designation DQO summary report that will be prepared at that time.

Figure A-1. Location of Planned and Existing Boreholes at the 216-B-58 Trench.

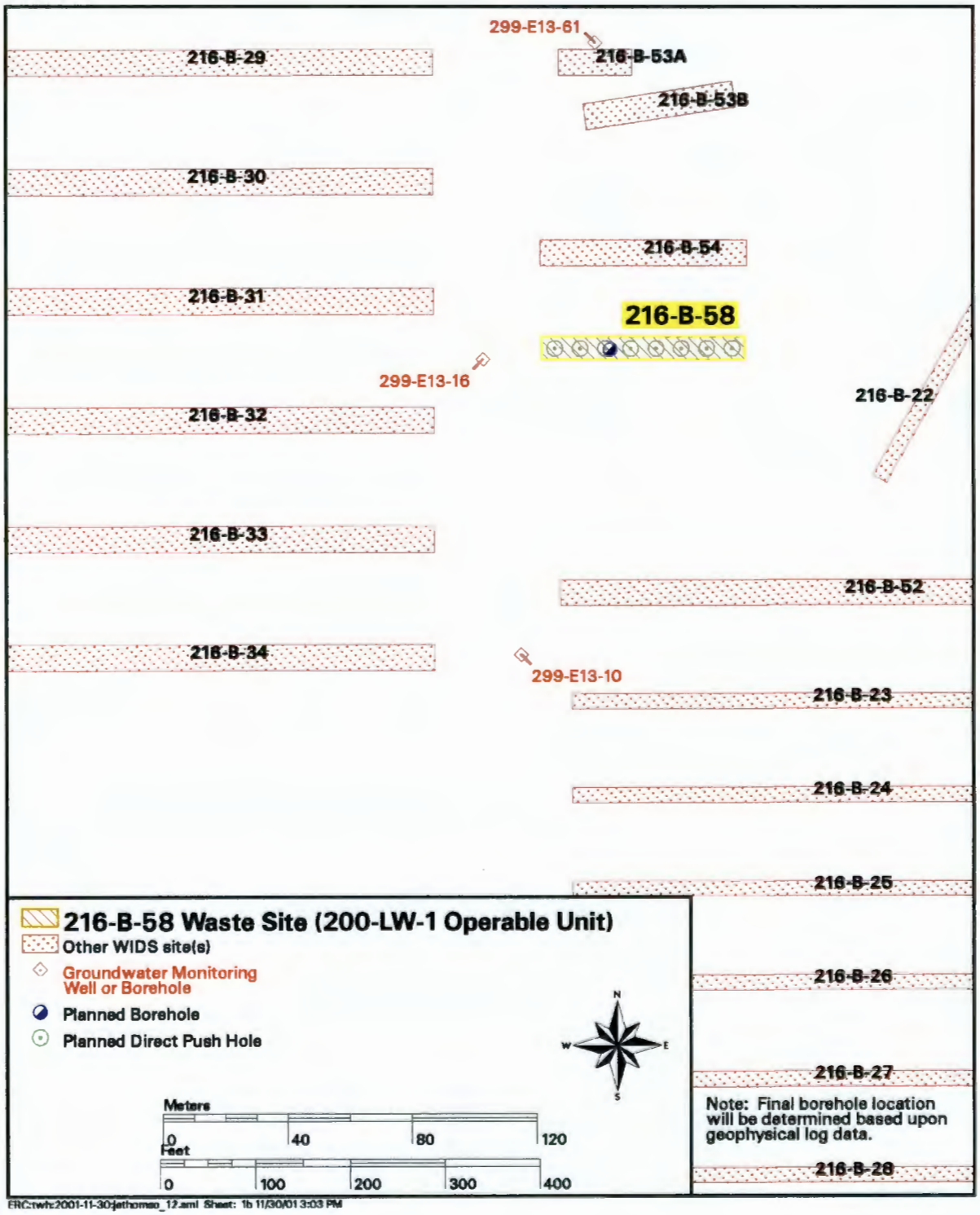

Figure A-2. Location of Planned and Existing Boreholes at the 216-T-28 Crib.

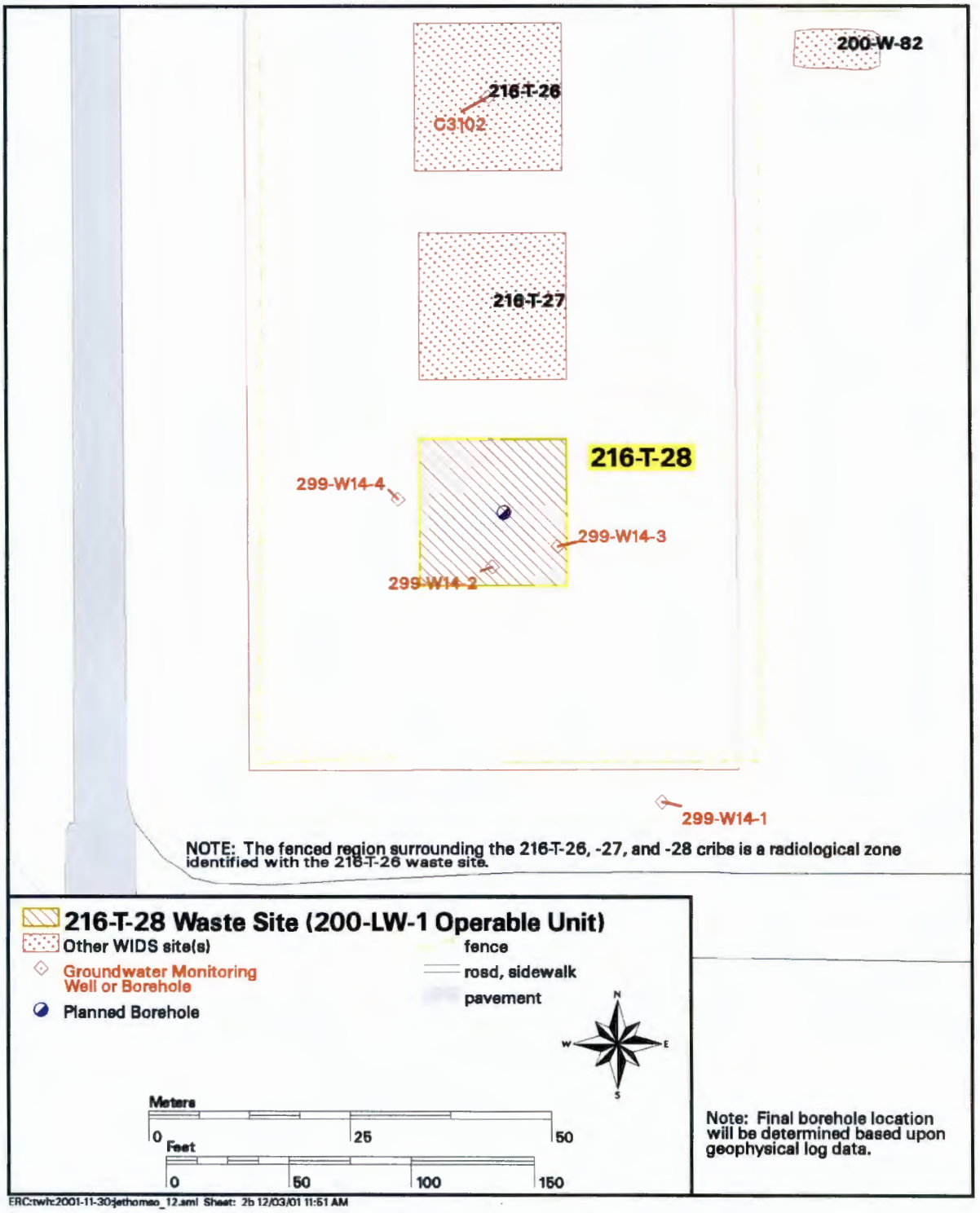

Figure A-3. Location of Planned and Existing Boreholes at the 216-S-20 Crib.

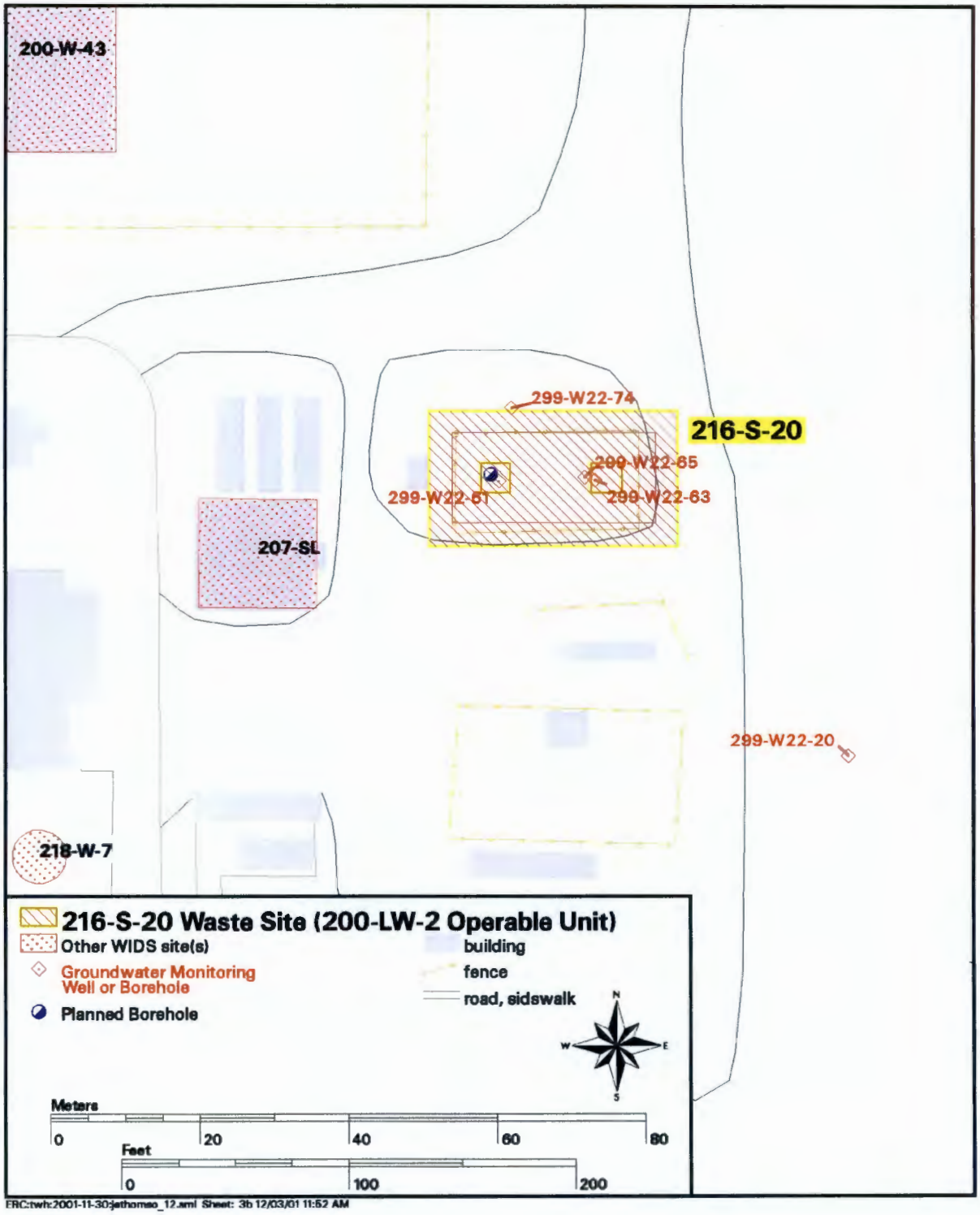

Figure A-4. Location of Planned and Existing Boreholes at the 216-Z-7 Crib.

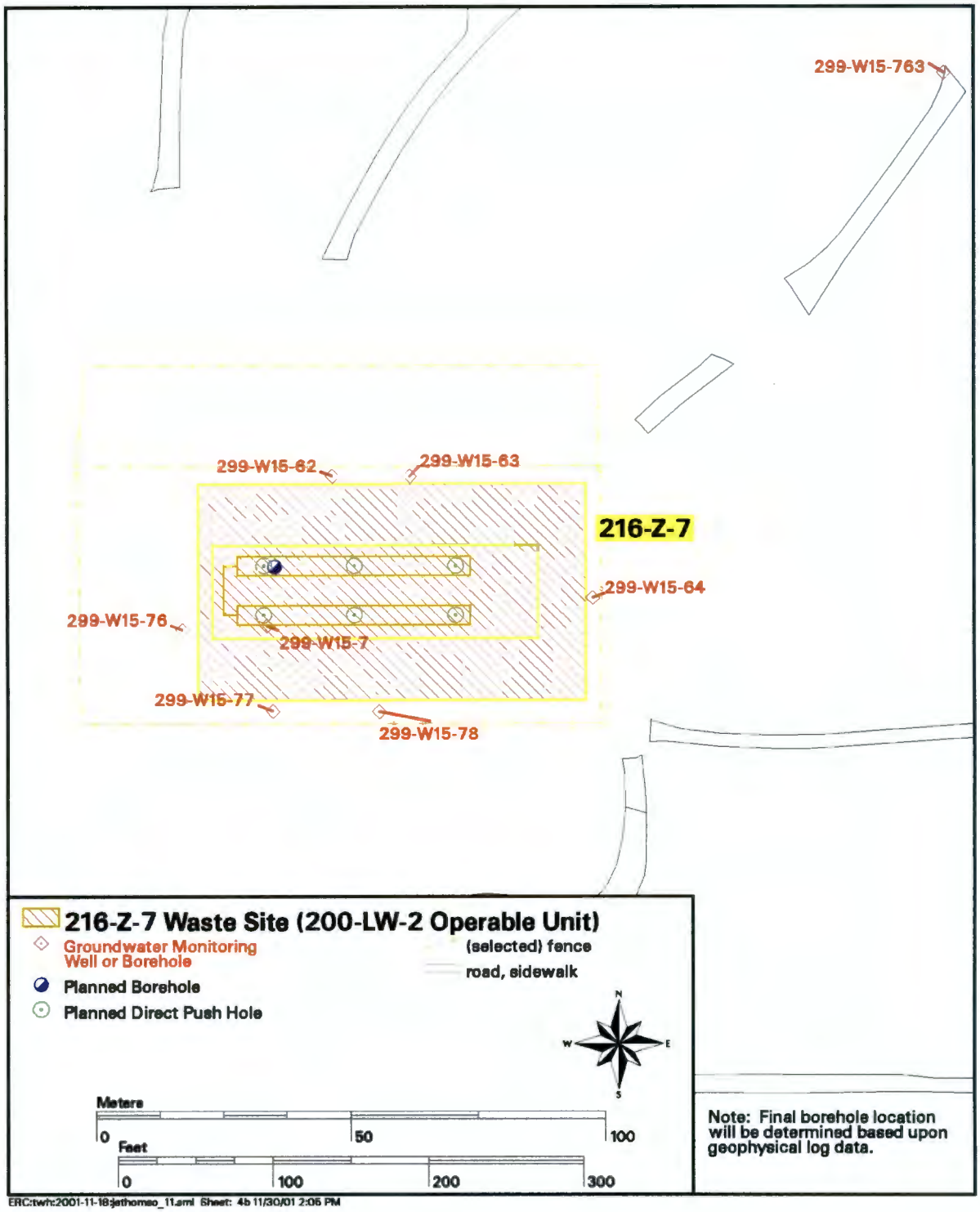

Figure A-5. Approximate Sampling Intervals in the 216-B-58 Borehole.

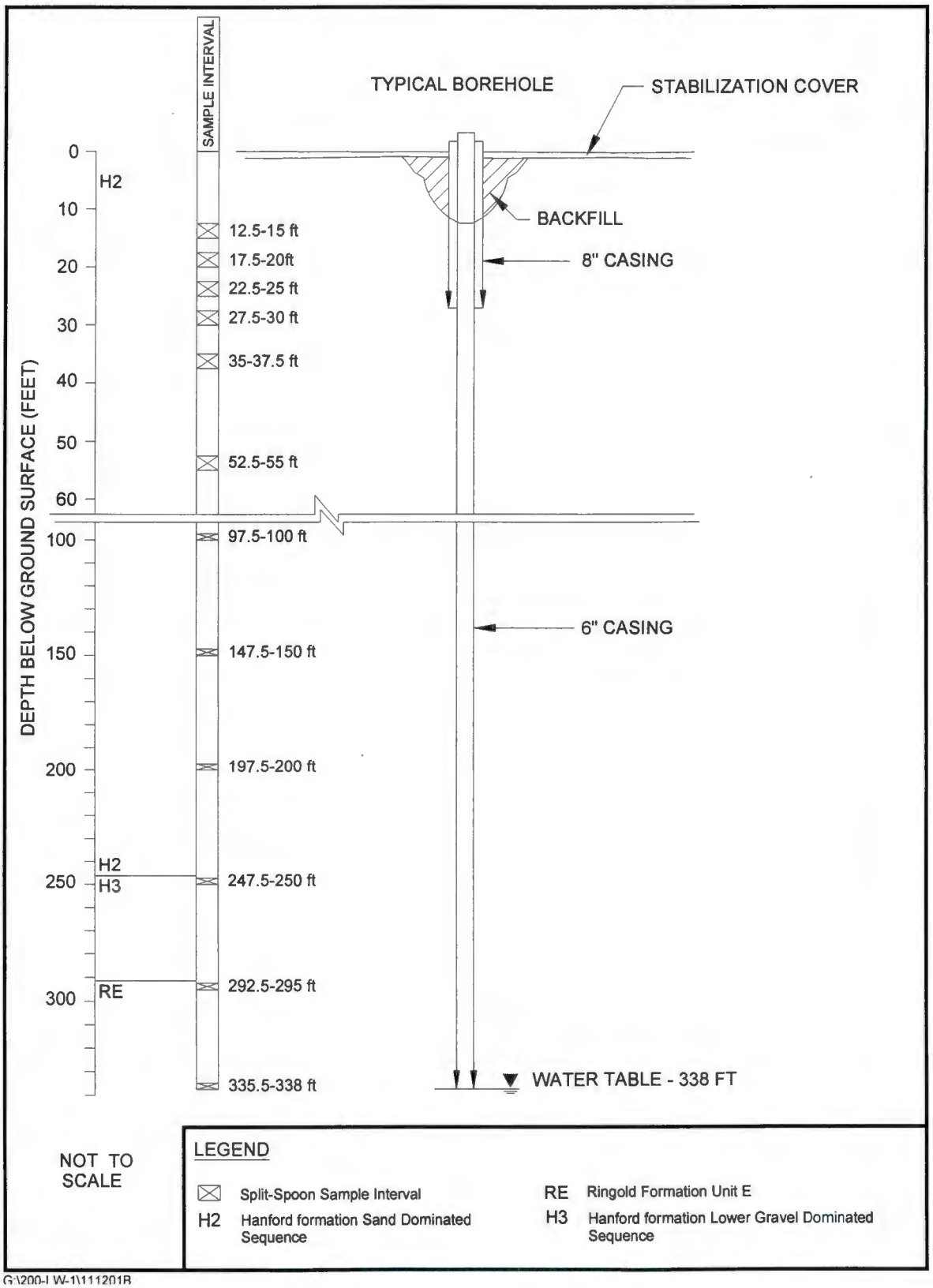

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Figure A-6. Approximate Sampling Intervals in the 216-T-28 Borehole.

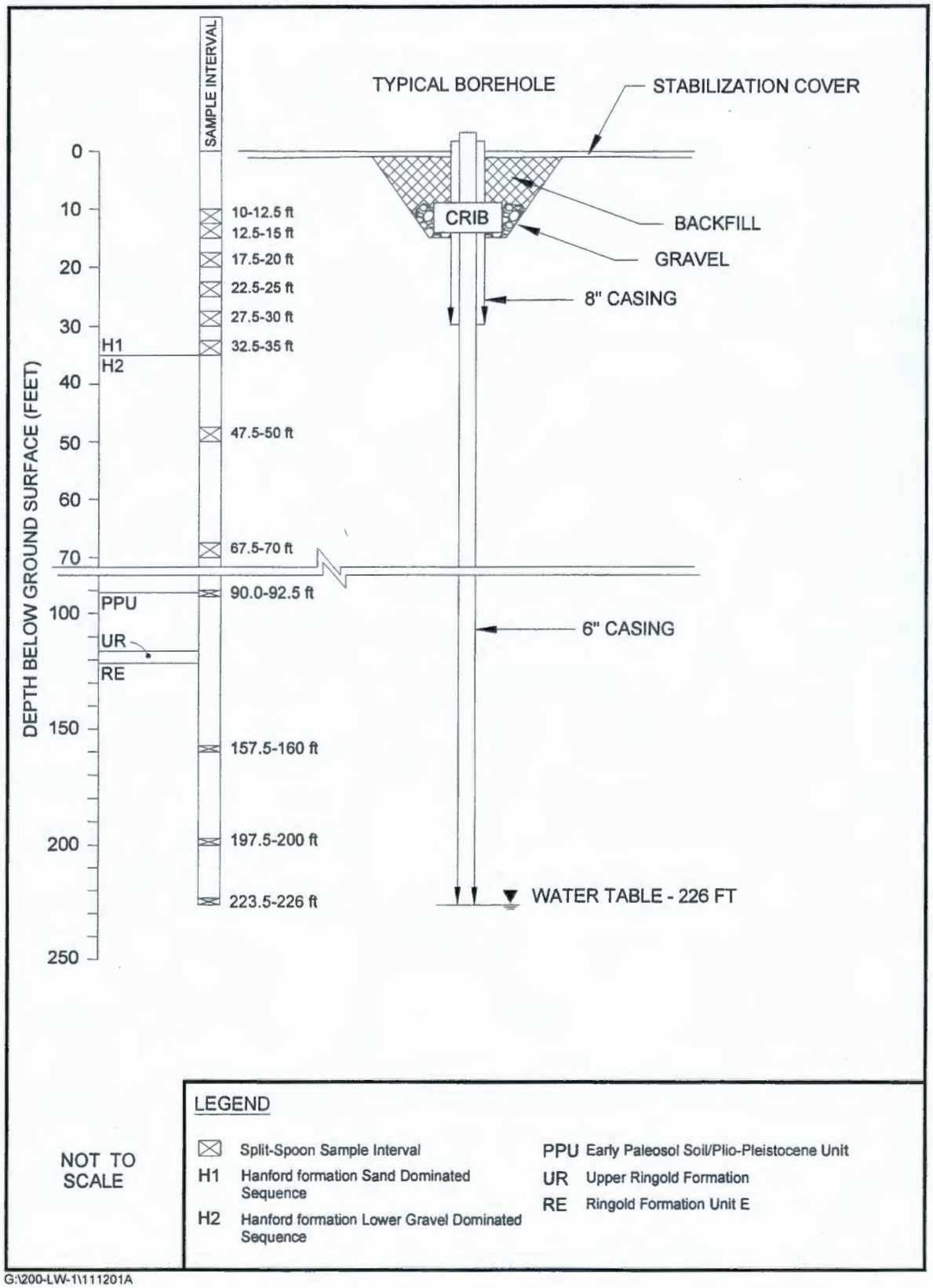

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Figure A-7. Approximate Sampling Intervals for the 216-S-20 Borehole.

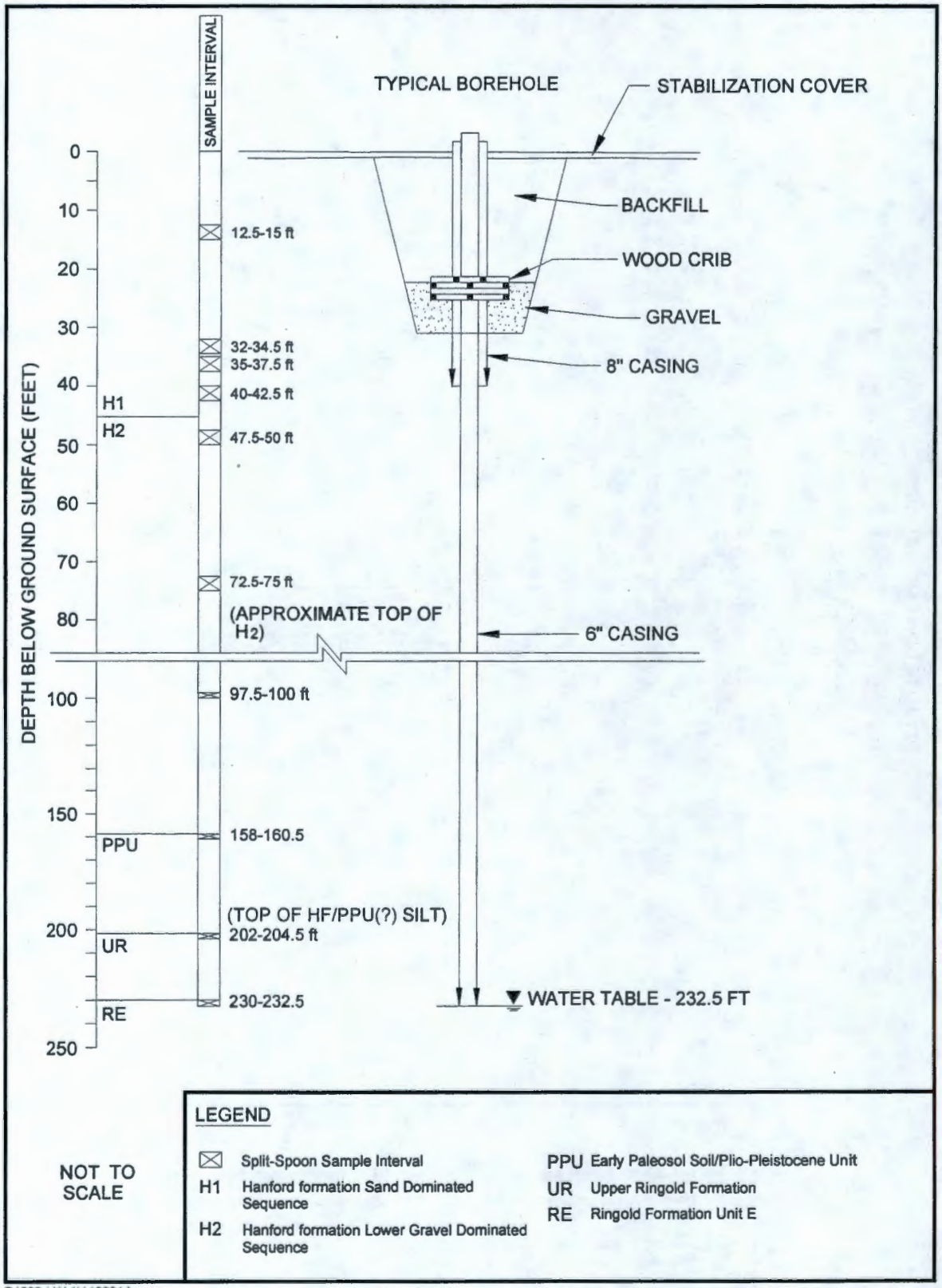

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Figure A-8. Approximate Sampling Intervals for the 216-Z-7 Borehole.

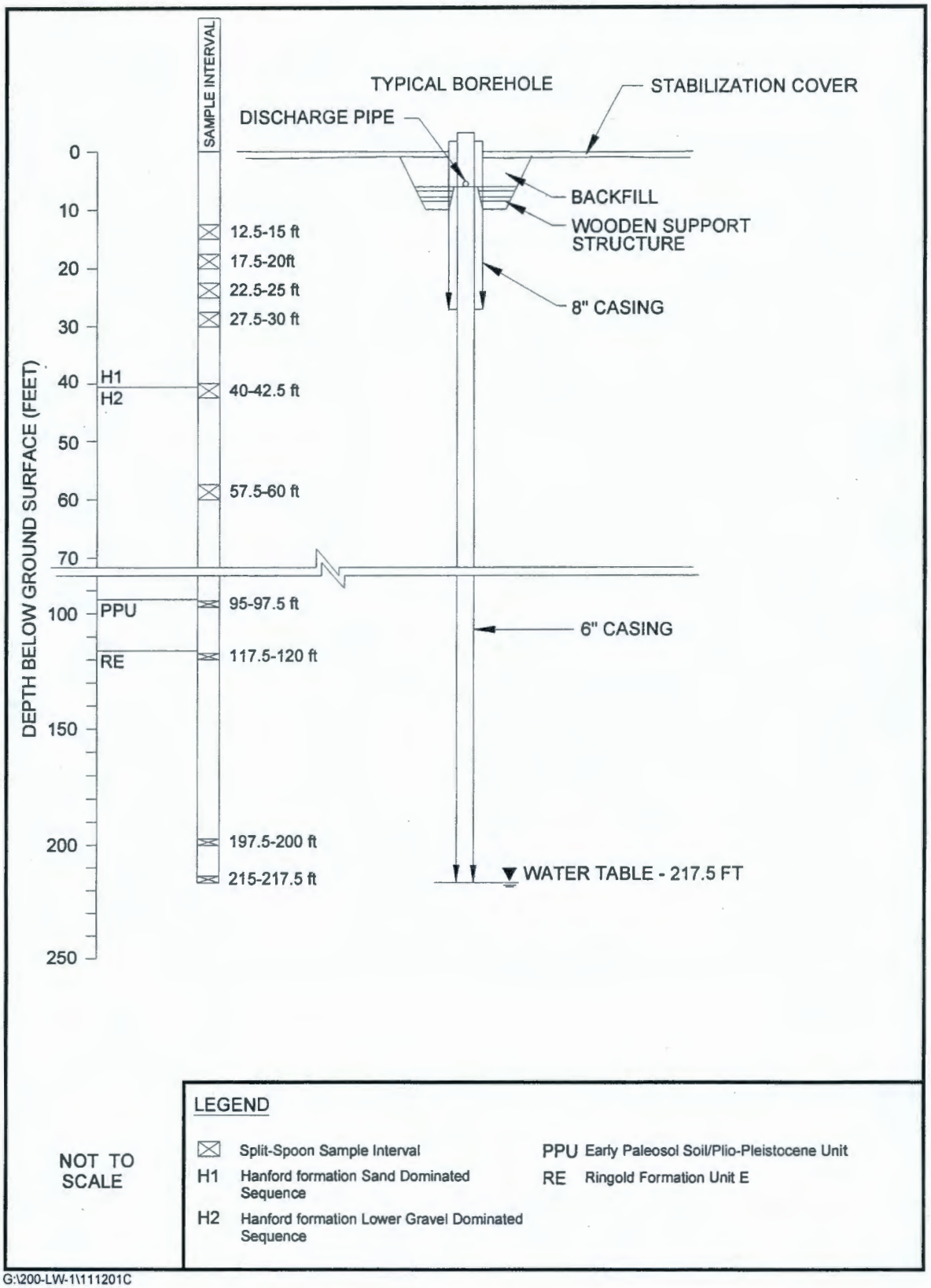

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Table A-5. Field Screening Methods.

Measurement Type	Emission Type	Method/Instrument	Detection Limit
Exposure/Dose Rate	Beta/gamma	RO-20/RO-03 portable ionization chamber	0.5 mrem/hr
Contamination Level	Alpha/beta-gamma	E-600 ratemeter with a SHP380-A/B scintillation probe	100 dpm α 1,921 dpm β–γ

Table A-6. 216-B-58 Trench Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft) bgs	Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Borehole	Borehole through trench	338 ft	12.5-15, 17.5-20, 22.5-25, 27.5-30, 35-37.5, 52.5-55, 97.5-100, 147.5-150, 197.5-200, 247.5-250, 292.5-295, 335.5-338	Table A-3	1 sample from each of the following: • H_2 • H_3 • Ringold Unit E	Bulk density, moisture content, particle size distribution
Maximum Number of Samples		12				
Approximate Number of Field QC Samples		4[b]				
Approximate Total Number of Samples		16				

bgs = below ground surface
H_2 = Hanford formation sand-dominated sequence
H_3 = Hanford formation lower gravel-dominated sequence
[a] See Table A-3 for detection limits and other analytical parameters.
[b] See Table A-10 for details of QC samples.

Table A-7. 216-T-28 Crib Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft) bgs	Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Borehole	Through crib	226 ft bgs	10-12.5, 12.5-15, 17.5-20, 22.5-25, 27.5-30, 32.5-35, 47.5-50, 67.5-70, 90.0-92.5, 157.5-160, 197.5-200, 223.5-226	Table A-3	1 sample from each of the following: • H_1 • H_2 • PPU • Upper Ringold • Ringold Unit E	Bulk density, moisture content, particle size distribution
Maximum Number of Samples		12				
Approximate Number of Field QC Samples		4[b]				
Approximate Total Number of Samples		16				

bgs = below ground surface
H_1 = Hanford formation upper gravel sequence
H_2 = Hanford formation sandy sequence
PPU = Plio-Pleistocene unit
[a] See Table A-3 for detection limits and other analytical parameters.
[b] See Table A-10 for details of QC samples.

Table A-8. 216-S-20 Crib Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft) bgs	Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Borehole	Borehole through crib	232.5 ft	12.5-15, 32.0-34.5, 35.0-37.5, 40.0-42.5, 47.5-50, 72.5-75, 97.5-100, 158-160.5, 202-204.5, 230-232.5	Table A-3	1 sample from each of the following: • H_1 • H_2 • PPU • Upper Ringold • Ringold Unit E	Bulk density, moisture content, particle size distribution
Maximum Number of Samples		10				
Approximate Number of Field QC Samples		4[b]				
Approximate Total Number of Samples		14				

bgs = below ground surface
H_1 = Hanford formation upper gravel sequence
H_2 = Hanford formation sandy sequence
PPU = Plio-Pleistocene unit
[a] See Table A-3 for detection limits and other analytical parameters.
[b] See Table A-10 for details of QC samples.

Table A-9. 216-Z-7 Crib Sampling Plan.

Sample Collection Methodology	Sample Location	Maximum Depth of Investigation	Sample Interval Depth (ft) bgs	Analyte List[a]	Physical Properties	
					Sample Interval (bgs)	Parameters
Borehole	Borehole through crib	217.5 ft	12.5-15, 17.5-20, 22.5-25, 27.5-30, 40-42.5, 57.5-60, 95-97.5, 117.5-120, 197.5-200, 215-217.5	Table A-3	1 sample from each of the following: • H_1 • H_2 • PPU • Ringold Unit E	Bulk density, moisture content, particle size distribution
Maximum Number of Samples		10				
Approximate Number of Field QC Samples		4[b]				
Approximate Total Number of Samples		14				

bgs = below ground surface
H_1 = Hanford formation upper gravel sequence
H_2 = Hanford formation sandy sequence
PPU = Plio-Pleistocene unit
[a] See Table A-3 for detection limits and other analytical parameters.
[b] See Table A-10 for details of QC samples.

Table A-10. Summary of Projected Sample Collection Requirements.

	216-T-28 Crib	216-B-58 Trench	216-S-20 Crib	216-Z-7 Crib	Project Total
Chemical Parameters					
Maximum number of characterization samples	12	12	10	10	44
Field duplicates	1	1	1	1	4
Splits	1	1	1	1	4
Trip blanks	1	1	1	1	4
Equipment blanks	1	1	1	1	4
Approximate number of field QC samples	4	4	4	4	16
Approximate total number of samples	16	16	14	14	60
Physical Properties					
Bulk density, moisture content, particle size distribution	5	3	5	4	17

Table A-11. List of Existing Boreholes for Spectral Gamma-Ray Logging.

Borehole Number	Approximate Location	Coordinates (Wash. State Plane, NAD83[91])	
		Northing	Easting
TBD[a]	Within the boundaries of the 216-T-28 Crib	TBD	TBD
TBD[a]	Within the boundaries of the 216-B-58 Trench; will also log direct push holes to help define borehole location	TBD	TBD
TBD[a]	Within boundaries of the 216-S-20 Crib	TBD	TBD
TBD[a]	Within the boundaries of the 216-Z-7 Crib; will also log direct push holes to help define borehole location	TBD	TBD
299-W14-1	South edge of 216-T-28	136392.107	566932.165
299-W14-2	South edge of 216-T-28	136392.107	566932.165
299-W14-3	South edge of 216-T-28	136392.107	566932.165
299-W14-4	North edge of 216-T-28	136407.518	566933.853
299-E13-16	Southeast of 216-B-58	136719.127	573794.205
299-W22-20	Adjacent to 216-S-20	136730.748	573781.892
299-W22-61	Southeast of 216-S-20	136727.768	573785.436
299-W22-63	Northwest of 216-S-20	136736.730	573776.927
299-W22-74	Northeast of 216-S-20	137422.659	573847.630
299-W15-7	East of 216-Z-7	137397.913	573847.598
299-W15-62	East of 216-Z-7	135949.766	566688.703
299-W15-63	East of 216-Z-7	135949.782	566703.896
299-W15-64	East of 216-Z-7	135925.733	566739.895
299-W15-76	Northwest of 216-Z-7	137388.475	573797.295
299-W15-77	South of 216-Z-7	137379.963	573802.064
299-W15-78	North of 216-Z-7	137412.003	573795.536

NOTE: Initial selection of existing boreholes was based on a review of well construction as-built diagrams. A single casing in contact with the formation is the preferred configuration for logging. A field inspection of the borehole configuration will be performed for final selection of boreholes.
[a]Planned boreholes, numbers will be assigned during the RI characterization planning efforts.
TBD = to be determined

A.4 HEALTH AND SAFETY

All field operations will be performed in accordance with BHI health and safety requirements outlined in BHI-SH-01, *ERC Safety and Health Program.* In addition, appropriate documentation will be prepared per BHI-EE-02 procedures for drilling activities. This documentation will include an activity hazard analysis, site-specific health and safety plan, and applicable radiological work permits.

The sampling procedures and associated activities will take into consideration exposure reduction and contamination control techniques that will minimize the radiation exposure to the sampling team as required by BHI-QA-01, *ERC Quality Program*, BHI-SH-01, and BHI-RC-01, *Radiation Protection Program Manual.*

A.5 MANAGEMENT OF INVESTIGATION-DERIVED WASTE

Investigation-derived waste generated by characterization activities will be managed in accordance with BHI-EE-10, *Waste Management Plan*, and Appendix E of the Implementation Plan. Containment, labeling, and tracking requirements are specified in BHI-EE-10, Part II, Procedure 9.0, "Control of CERCLA and Other Past Practice Investigation Derived Waste." These procedures have been prepared to implement the requirements of the Washington State Department of Ecology, found in *Strategy for Management of Investigation Derived Waste* (Ecology et al. 1999). Management of investigation-derived waste, minimization practices, and waste types applicable to 200-LW-1 waste control will be described in a waste control plan.

Unused samples and associated laboratory waste for the analysis will be dispositioned in accordance with the laboratory contract, which in most cases will allow the laboratory to dispose of this material. The approval of the remedial project manager is required before returning unused samples or waste from offsite laboratories.

A waste designation DQO effort will be performed before the initiation of the RI characterization activities to ensure that the proper information is collected during the field effort to support the designation of all project investigation-derived waste. During the waste designation DQO effort, any listed waste issues will also be resolved. Any additional sampling requirements or analytes needed to support designation activities will be identified and implemented through the waste designation DQO summary report that will be prepared at that time.

A.6 REFERENCES

40 CFR 131, "Water Quality Standards," *Code of Federal Regulations*, as amended.

40 CFR 830.120, "Quality Assurance Requirements," *Code of Federal Regulations*, as amended.

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BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.

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BHI-EE-05, *Field Screening Procedures*, Bechtel Hanford, Inc., Richland, Washington.

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BHI-MA-02, *ERC Project Procedures*, Bechtel Hanford, Inc., Richland, Washington.

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BHI-QA-03, *ERC Quality Assurance Program Plans*, Bechtel Hanford, Inc., Richland, Washington.

BHI-RC-01, *Radiological Protection Program Manual*, Bechtel Hanford, Inc., Richland, Washington.

BHI-RC-04, *Radiological Control Work Instructions*, Bechtel Hanford, Inc., Richland, Washington.

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APPENDIX B

WASTE CONTROL PLAN

WASTE CONTROL PLAN

Work Scope Description: 200-LW-1 300 Area Chemical Laboratory Waste Group Operable Unit (OU) characterization. Characterization will be performed at 200-LW-1 waste sites. The scope of activities includes the drilling of deep boreholes at the 216-B-58 Trench, 216-S-20 Crib, 216-T-28 Crib, and 216-Z-7 Crib. Soil samples from the vadose zone will be collected and analyzed for radiological and nonradiological contaminants of concern and physical properties of interest. Geophysical logging will also be conducted at the 200-LW-1 waste sites. See Attachment 1 for additional information.

List Constituents of Concern: Contaminants of concern at the 200-LW-1 OU consist of radionuclides, metals, anions, volatile organics, and semi-volatile compounds (see DOE/RL-2001-66, Table A-2).

Site Description: The 200-LW-1 OU waste sites are located in the 200 East and 200 West Areas of the Hanford Site in southeastern Washington State. The 200-LW-1 OU has a total of 12 waste sites; 10 waste sites received laboratory wastes from the 340 Building in the 300 Area and two waste sites (216-S-20 and 216-Z-7) in the 200-LW-2 OU received both 200 and 300 Area laboratory waste. The data quality objective (DQO) process for 200-LW-1 considered waste sites in both OUs to ensure that the representative waste sites selected for investigation are representative of the chemical laboratory waste category.

Attachments 2, 3, 4, and 5 show the locations of the waste sites to be characterized; waste generated during characterization activities will be managed as investigation-derived waste (IDW). IDW will also be generated at during borehole geophysical logging at the four waste sites, as well as at other 200-LW-1 OU waste sites. Additional information on each of the four sites is presented in the *200-LW-1 300 Area Chemical Laboratory Waste Group Operable Unit RI/FS Work Plan* (DOE/RL-2001-66) and the Sampling and Analysis Plan (Appendix A of the work plan).

Reference: 200-LW-1 Work Plan (DOE/RL-2001-66)_____ **Rev** CHI Draft **Date Approved**

Preparer: _____ Date _____

PRINT/SIGN NAME

Impact Level
N/A

Project Task Lead _____ **IDW Coordinator:** _____

Planned Start and Finish Dates: From TBD_____ **To** TBD_____

Waste Storage Facility ID Number(s) N/A _____

Field Screening Methods

Method	Frequency	Reference	Detection Range	Analyst
PID, 11-7 eVV lamp	Continuous	DOE/RL-2001-66, Appendix A	0 to 1,000 ppm	SSO
Alpha/beta/gamma detector	Continuous	DOE/RL-2001-66, Appendix A	100 dpm alpha probe/1,921 dpm beta-gamma probe	RCT
Dose rate, beta-gamma	Continuous	DOE/RL-2001-66, Appendix A	0.5 mR/hr	RCT

Laboratory Methods (Constituents of concern)

Method	Frequency	Reference	Detection Range	Analyst
See Table A-2	See Tables A-5 through A-8	DOE/RL-2001-66, Appendix A	See Table A-2	Offsite Laboratory

HI-EE-241 (09/29/2000)

WASTE CONTROL PLAN

Drill Site Coordinate Location: 216-B-58 Trench – E573234.406, N134350.836. 216-T-28 Crib – E566932.500, N136347.156. 216-S-20 Crib – E567546.022, N133917.212. 216-Z-7 Crib - E566698.853, N135933.568.

Waste Container Storage Area(s) Coordinate Location(s): 216-B-58 Trench waste: refer to Attachment 2; 216-T-28 Crib waste: refer to Attachment 3; 216-S-20 Crib waste: refer to Attachment 4; and 216-Z-7 Crib waste: refer to attachment 5. Geophysical logging IDW may also be located at these storage areas.

Requirements for Soil Pile Sampling (if any): Not applicable – Soils will be drummed and the waste will be dispositioned using borehole analytical data.

Nonregulated Material Disposal Location(s): A Subtitle D landfill. Nonregulated soil and liquid (decontamination fluid) may be returned/disposed to the ground at or near point of excavation, the location of which will be documented in the field logbook.

Sketch of Work Site: Attachments 2, 3, 4 and 5 identify sample locations and waste container storage area(s) at the 216-B-58 Trench, 216-T-28 Crib, 216-S-20 Crib, and 216-Z-7 Crib, respectively.

APPROVALS (Print/Sign Name and Date)

Lead Regulatory Agency Representative	**IDW Coordinator**
DOE-RL	**Cognizant Field Engineer**

BHI-EE-241 (09/29/2000)

APPENDIX B

WASTE CONTROL PLAN

ATTACHMENT 1: NARRATIVE

DESCRIPTION OF WORK

This waste control plan governs the management of investigation-derived waste (IDW) for the representative sites to be investigated under the 200-LW-1 300 Area Chemical Laboratory Waste Group Operable Unit (OU) (DOE-RL 2001). These waste sites include the 216-B-58 Trench, 216-T-28 Crib, 216-S-20 Crib, and 216-Z-7 Crib. All of the sites are *Resource Conservation and Recovery Act of 1976* past-practice waste sites. Characterization of these sites will provide data needed to refine the preliminary conceptual contamination distribution models, support an assessment of risk, and select a preferred remedial action(s). The scope of work involves vadose zone characterization activities that include the drilling of four boreholes for soil sampling and borehole geophysical logging (i.e., spectral gamma, passive neutron, and neutron logging). Soil samples will be collected and analyzed for potential radiological and nonradiological contaminants of concern and physical properties. This waste control pan does not address sampling for waste designation, which will be addressed at the startup of remedial investigations.

Direct-push boreholes will be installed at the 216-B-58 Trench and 216-Z-7 Crib to permit additional spectral gamma logging within the waste site. Drill cuttings will be containerized as IDW, and the casing may require management and disposal as IDW if decontamination procedures are not effective in removing contamination.

Additional borehole geophysical logging may also be conducted at other waste sites associated with the 200-LW-1 OU as identified in Attachment 6. During the investigation, other boreholes within the 200-LW-1 OU may be found that are configured in a way that allows for geophysical logging. These boreholes would then be added to this scope. No drilling or sampling will be conducted at these waste sites; only IDW associated with personal protective equipment and other miscellaneous solid waste (MSW) will be generated. The IDW from geophysical logging activities will be designated using the waste disposal profiles generated for the characterization activities, by sampling the waste, or by process knowledge.

Management of wastes generated from this project will be in accordance with BHI-EE-10, *Waste Management Plan*, Part II, Procedure 9.0, "Control of CERCLA and Other Past-Practice Investigation-Derived Waste," which identifies the requirements and responsibilities for containment, labeling, and tracking of IDW. Procedure 9.0 was developed to comply with the *Strategy for Management of Investigation Derived Waste* (Ecology et al. 1999), or as amended. An overview of the waste management strategy for the 200 Area waste sites is presented in Appendix E of the *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (DOE-RL 1999). This waste control plan provides the relevant information mandated in Section 7.1.1, "Waste Control Plan," of Procedure 9.0, but

does not restate the applicable requirements detailed throughout the procedure. Exceptions, clarifications, or additions to the requirements of Procedure 9.0 are identified in this narrative portion of this waste control plan.

Additional guidance to the control of soil and decontamination fluid and other IDW associated with the soil borings is detailed in BHI-EE-01, *Environmental Investigations Procedures*, Procedure 1.11, "Purgewater Management," and Procedure 6.2, "Field Cleaning and/or Decontamination of Geoprobe and Drilling Equipment," and in BHI-EE-02, *Environmental Requirements*, Section 14.0, "Drilling, Maintaining, Remediating, and Decommissioning Resource Protection Wells, Geoprobe and Geotechnical Soil Borings." Purgewater will not be generated during these characterization activities.

Prior to remedial investigations, a data quality objectives (DQO) effort will be conducted to support waste designation. Any additional sampling requirements needed for designation will be identified at that time. Process history associated with 200-LW-1 waste sites will be reviewed and listed waste contaminants associated with the processes that discharged to these waste sites will be identified. Listed waste constituents, however, will be retained as analytes of interest because of issues associated with waste designation and compliance with land disposal restrictions.

Waste Minimization

Minimize waste nonregulated soils (below applicable radionuclide concentration limits, dangerous waste limits, and the *Model Toxics Control Act* [MTCA] soil cleanup standards) to the ground at or near the waste site, decontaminating equipment for reuse, and compacting (through nonmechanical means) MSW, as defined in the *Environmental Restoration Program Strategy for Management of Investigation Derived Waste* (Ecology et al. 1999), to the extent practicable.

Waste Streams

Expected wastes include contaminated soils, decontamination fluids, contaminated drive casings (if decontamination is not possible), and MSW such as disposable personal protective equipment, sampling equipment, wipes, rags, paper, and plastic. Materials will be screened in the field with instruments, and wastes will be segregated and managed in accordance with requirements presented below.

Waste Generation and Management

All waste generated will be recorded in a logbook, including such details as the location and type of waste, depth of sample, date of initial placement into container, date the container was sealed, and Package Identification Number (PIN).

Wastes will be stored at site-specific waste container storage areas until analytical data are evaluated for proper waste designation. Waste from these sites may be consolidated into one container storage area, if necessary. The preferred method of disposal of waste is at the Environmental Restoration Disposal Facility (ERDF) if it meets the waste acceptance criteria.

Disposition transuranic (TRU) wastes to the Hanford Central Waste Complex for storage. Designate and characterize waste destined for the Project Hanford Management Contractor in accordance with the *Hanford Site Solid Waste Acceptance Criteria* (FH 2001).

IDW generated will be managed and labeled with the appropriate listed waste codes that are associated with each particular waste site. The applicable listed waste codes will be determined as part of the IDW data quality objectives assessment and will be incorporated into the final waste control plan prior to the initiation of the field activities and regulatory approval.

If, after characterization of the waste is completed, the waste must be stored for longer than six months, the U.S. Department of Energy, Richland Operations Office, will obtain concurrence from the lead regulatory agency on the current storage, treatment, and disposal options and schedule for disposition of the waste.

Details on the types and management of expected wastes are provided in the following subsections.

Miscellaneous Solid Waste

Manage MSW as "Suspect Dangerous" or "Suspect Mixed" waste as detailed in BHI-EE-10, Part II, Procedure 9.0. Place MSW into plastic bags and taped closed. Label the bags with the borehole number where the waste was generated and place in appropriately labeled drums or boxes in the designated storage area. Disposition containers of MSW using analytical results or process knowledge associated with the contaminated media contacted.

Vadose Zone Drill Cuttings

Screen drill cuttings using field instruments and containerize in mid-performance coated drums with 10-mil reinforced plastic liners as required for potentially mixed waste. If screening levels indicate that the cuttings may be characterized as TRU waste, fit the containers of drill cuttings with vented lids. Contaminated soil is expected to be intercepted in discrete intervals in each of the boreholes, the field screening results will be used to segregate the waste. The containers will be staged at the designated storage areas and dispositioned using analytical results/process knowledge.

Decontamination Fluids

Fluids (water) will generally be used to field decontaminate excavation and drilling equipment and sampling tools. Discharge aqueous waste generated from the decontamination of equipment to the ground if sample analysis of the decontamination water confirms the waste meets the criteria established in the Hanford Site Purgewater Agreement (Izatt 1990), or as amended. If the waste exceeds those criteria, the disposal options include the Hanford Site Purgewater Treatment and Storage Facility or the Hanford Site Effluent Treatment Facility.

Management of Waste Containers

Store IDW inside the applicable waste storage area. Mark and label containers awaiting analytical results. Conduct inspections of "Suspect/Dangerous or Mixed Wastes" weekly to assess container integrity, container marking/labeling, physical container placement, storage area boundaries/identification/warning signs, and spill control. Document inspections on a Waste Inspection Check Sheet (form BHI-EE-244). At a minimum inspect all other containers monthly and document the inspections on form BHI-EE-244. Containers showing signs of deterioration will be identified on form BHI-EE-244 and immediately overpacked or repackaged. Report spills or releases in accordance with BHI-MA-02, *ERC Project Procedures*. In the event of a spill or release, take appropriate immediate action to protect human health and the environment.

Final Disposal/Storage

Store all IDW inside appropriate waste container storage areas until receipt of analytical results from the remedial investigation and during the completion of the waste profiling. Waste profiles document waste stream characterization. The profiles are reviewed against the receiving facilities' waste acceptance criteria. Conduct characterization and designation in accordance with Attachment 1 of BHI-EE-10. This activity requires determination on the following criteria: listed dangerous waste (*Washington Administrative Code* [WAC] 173-303-080, -081, and -082), toxic dangerous waste (WAC 173-303-100[5]), persistent waste (WAC 173-303-100), regulated for land disposal, applicability of characteristic waste codes (WAC 173-303-090[2]-[8]), and presence of polychlorinated biphenyls (*Toxic Substances Control Act of 1976* and WAC 173-303-9904). Final disposal and storage must be in accordance with the select treatment storage and disposal facility's waste acceptance criteria. The preferred treatment, storage, and disposal facility for IDW generated during this investigation is ERDF. Process knowledge may be used to include/exclude a radiological or nonradiological contaminant from the project and must be documented in an auditable manner. Determine the acceptability of near-surface (onsite) disposal of radiological wastes in accordance with the concentrations of radionuclides specified in Table B-1 or column 3 of Table 2 of Section 61.55 of 10 *Code of Federal Regulations* 61.

The IDW will be radiologically released when the waste meets applicable release levels detailed in BHI-EE-10, Part II, Procedure 8.0, "Release of Non-Radioactive Waste." Nonradiologically contaminated dangerous waste may be shipped to an offsite facility, contingent upon the waste meeting the offsite disposal facilities' waste acceptance criteria and offsite determination of acceptability by the U.S. Environmental Protection Agency. IDW that cannot be treated to meet acceptance criteria for the approved disposal facility will remain on the waste site or in a centralized storage area pending disposal at an approved facility. Waste above radiological release levels that meets the ERDF waste acceptance criteria will be transported to ERDF for disposal (ERDF is an approved waste disposal facility).

Any TRU waste generated will be sent to the Central Waste Complex for storage and will be designated/characterized in accordance with the Hanford Site Solid Waste Acceptance Criteria (FH 2001). Return soil sample(s) designated as TRU waste into the stored drum associated with the interval from which the sample was taken.

Dispose of nonradioactive geologic IDW containing hazardous waste constituents below dangerous waste designation limits and MTCA Method B soil cleanup standards to the ground at or near the point of generation and document in a field logbook. Waste that exceeds dangerous waste release or MTCA Method B limits and meets the ERDF waste acceptance criteria will be disposed at ERDF. IDW that does not meet the ERDF waste acceptance criteria will remain at the centralized storage area pending disposal at an appropriate facility. A case-by-case disposal determination will be made in instances where IDW exceeds the ERDF waste acceptance criteria. Any required treatment of IDW prior to disposal requires approval by the lead regulatory agency.

MSW that does not require disposal at ERDF will be disposed in an appropriate solid waste disposal facility (Subtitle "D" landfill).

Records

Forward original copies of all sampling and waste inventory documentation to the assigned waste transportation specialist to be included in the waste file and to initiate waste tracking in the Solid Waste Information Tracking System. Submit the waste file to Document and Information Services for inclusion into the project file following final waste disposition.

Estimate of IDW Quantities

Estimates of the amount of waste that will be generated during this field investigation are as follows:

- Soil Cuttings 105 (55-gal) containers
- MSW 30 (55-gal) containers
- Decon Fluids 6 (55-gal) containers
- Drill Casing 570 linear ft

REFERENCES

10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," *Code of Federal Regulations*, as amended.

BHI-EE-01, *Environmental Investigations Procedures*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-02, *Environmental Requirements*, Bechtel Hanford, Inc., Richland, Washington.

BHI-EE-10, *Waste Management Plan*, Bechtel Hanford, Inc., Richland, Washington.

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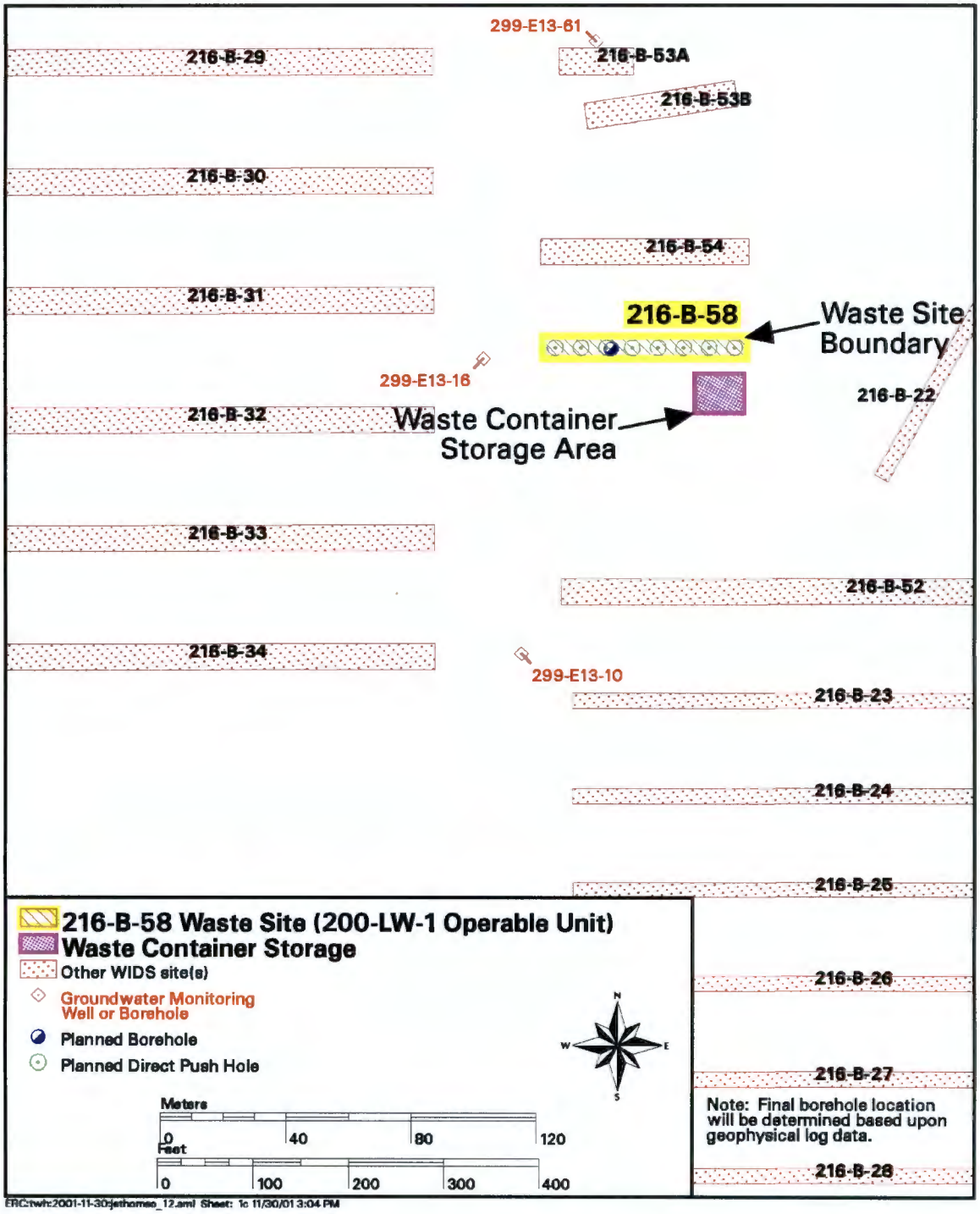
WAC 173-340, "Model Toxics Control Act - Cleanup," *Washington Administrative Code*, as amended.

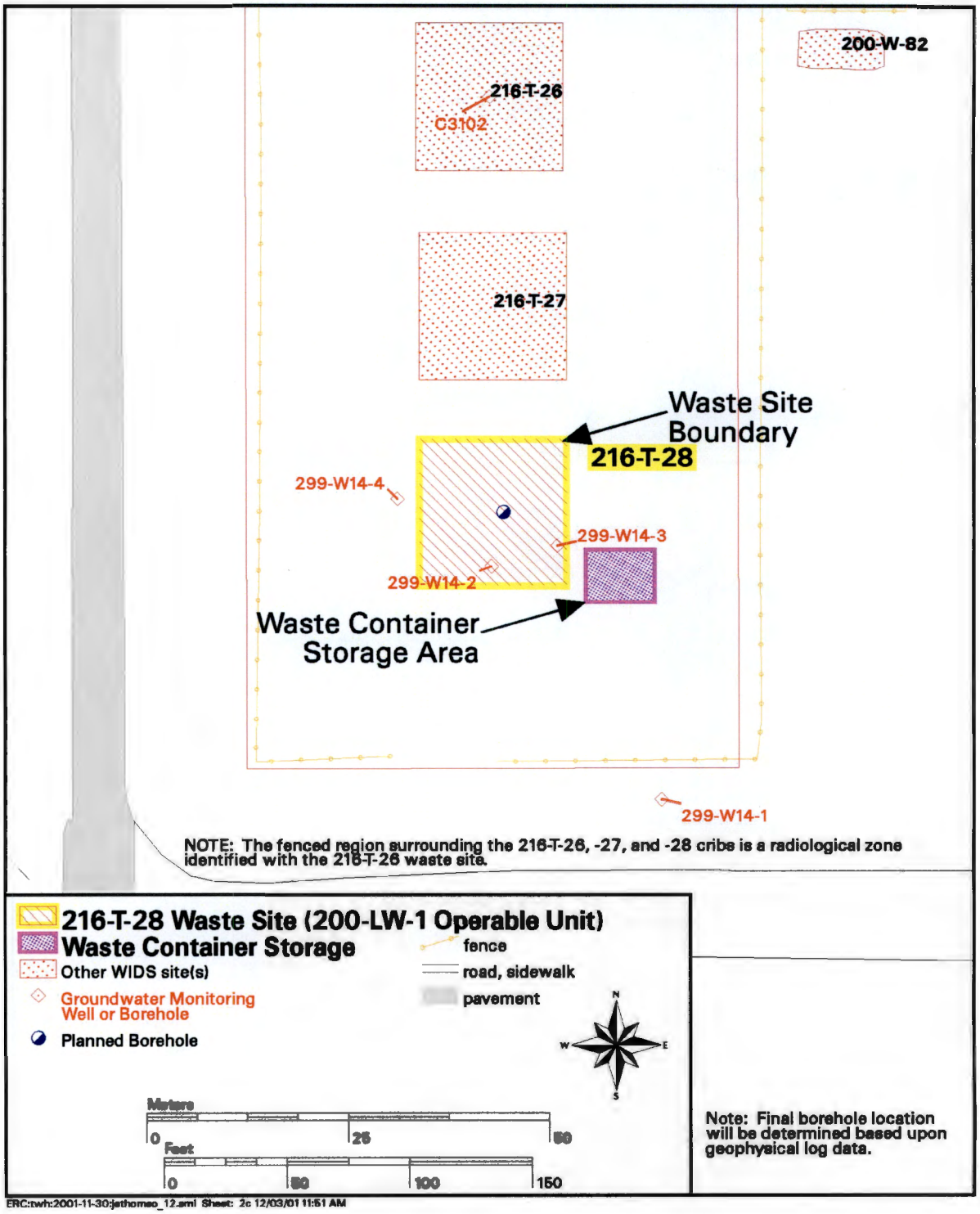
ATTACHMENT 2:

216-B-58 Trench Location Map and Waste Container Storage Area



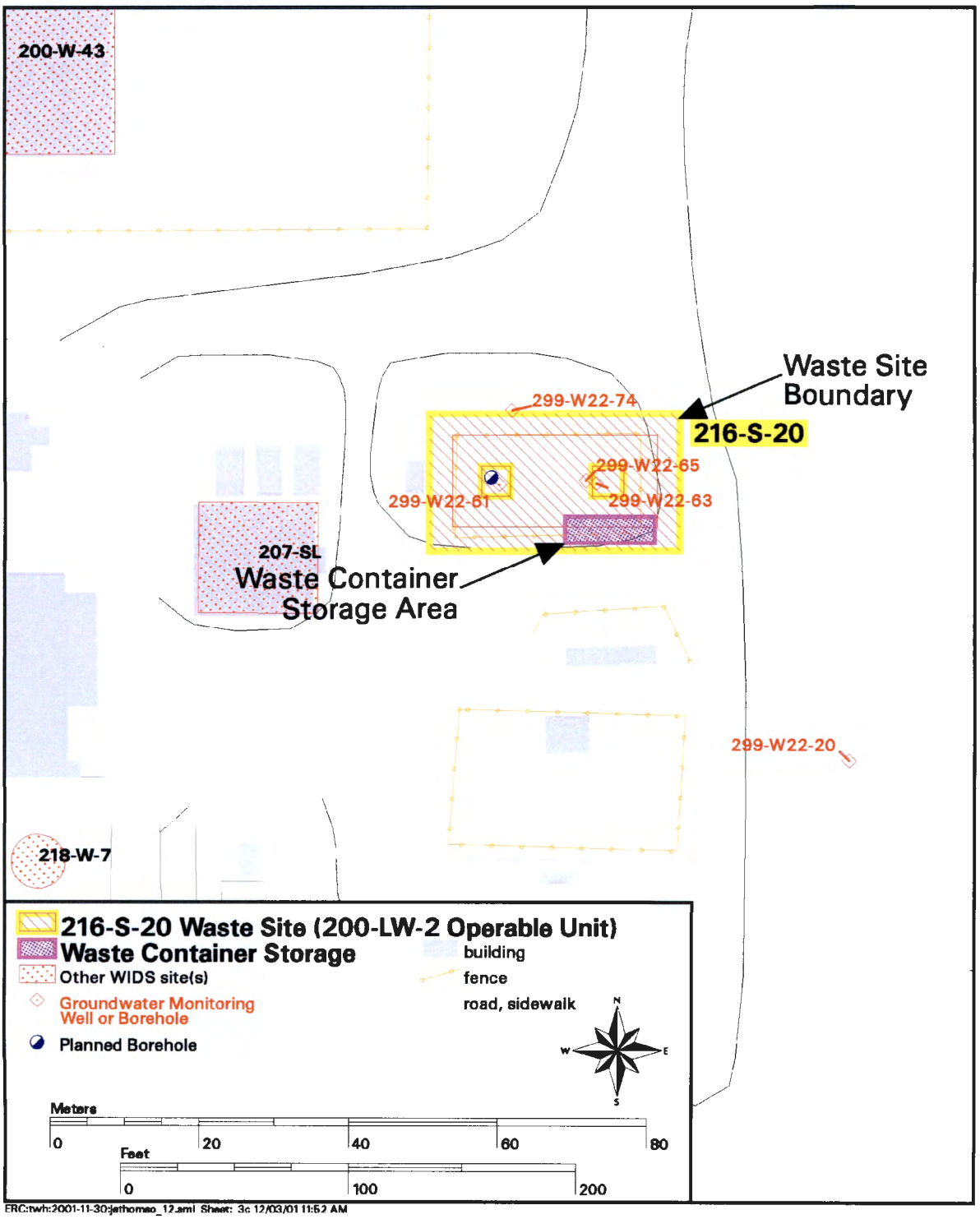
ATTACHMENT 3:

216-T-28 Crib Location Map and Waste Container Storage Area



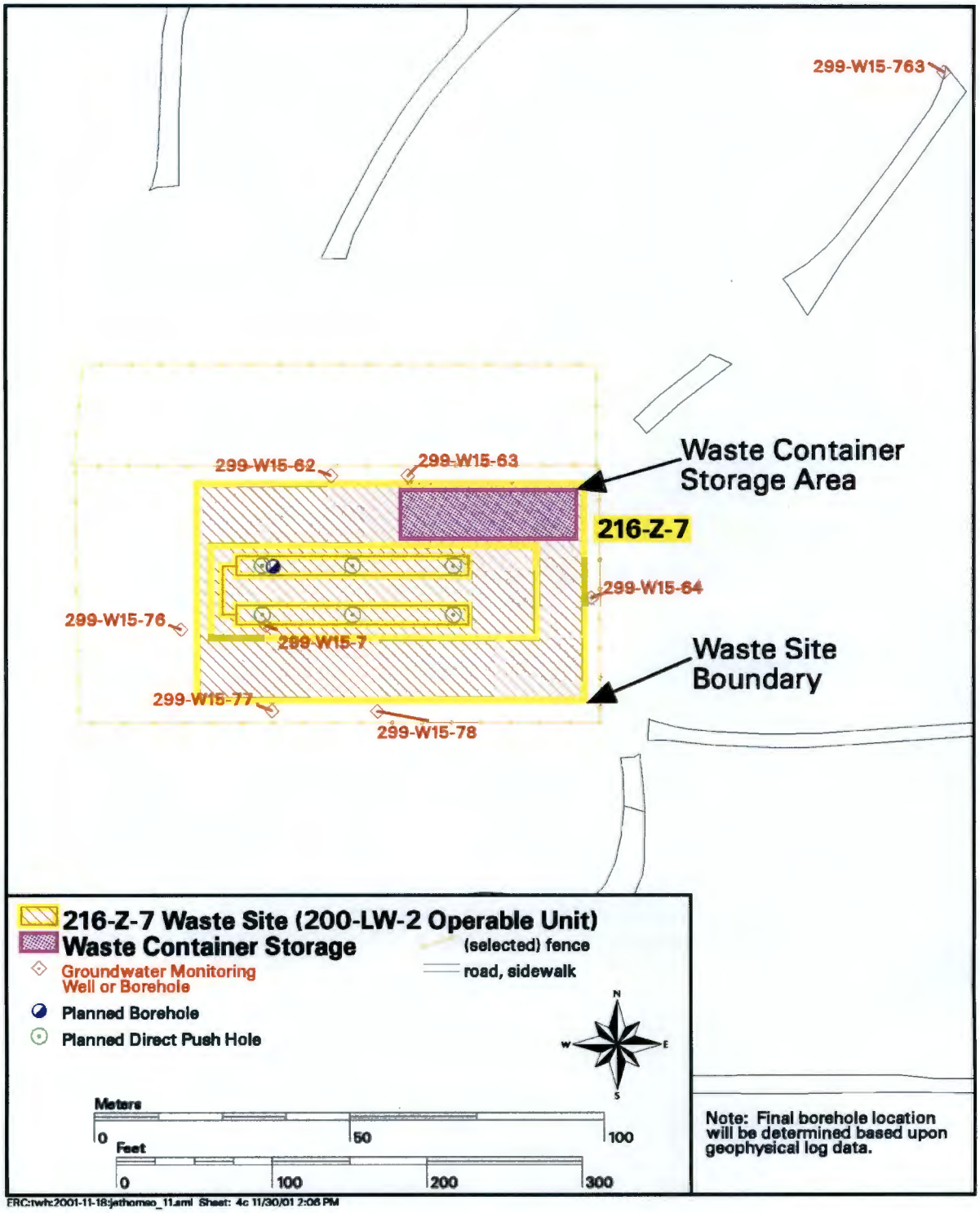
ATTACHMENT 4:

216-S-20 Crib Location Map and Waste Container Storage Area



ATTACHMENT 5:

216-Z-7 Crib Location Map and Waste Container Storage Area



ATTACHMENT 6:

200-LW-1 Geophysical Data Collection Well List

Area	Operable Unit	Waste Site Code	Site Type	Hanford Well Name	Hanford Well ID
200W	200-LW-1	216-T-27	Crib	299-W14-53	A7337
200W	200-LW-1	216-T-27	Crib	299-W14-62	A7346
200W	200-LW-1	216-T-28	Crib	299-W14-1	A4913
200W	200-LW-1	216-T-28	Crib	299-W14-2	A7328
200W	200-LW-1	216-T-28	Crib	299-W14-3	A7329
200W	200-LW-1	216-T-28	Crib	299-W14-4	A7330
200E	200-LW-1	216-B-53A	Trench	299-E13-61	A5876
200W	200-LW-1	216-T-34	Crib	299-W11-15	A7281
200W	200-LW-1	216-T-34	Crib	299-W11-16	A7282
200W	200-LW-1	216-T-34	Crib	299-W11-19	A4904
200W	200-LW-1	216-T-35	Crib	299-W11-17	A7283
200W	200-LW-1	216-T-35	Crib	299-W11-18	A7284
200W	200-LW-1	216-T-35	Crib	299-W11-20	A7285
200W	200-LW-1	216-T-35	Crib	299-W11-21	A7286
200W	200-LW-2	216-Z-16	Crib	299-W15-10	A4916
200W	200-LW-2	216-Z-16	Crib	299-W15-11	A5474
200W	200-LW-2	216-Z-16	Crib	299-W15-25	A9831
200W	200-LW-2	216-Z-16	Crib	299-W15-33	NA
200W	200-LW-2	216-Z-17	Trench	299-W15-204	A7502
200W	200-LW-2	216-Z-7	Crib	299-W15-7	A5476
200W	200-LW-2	216-Z-7	Crib	299-W15-35	NA
200W	200-LW-2	216-Z-7	Crib	299-W15-62	A7363
200W	200-LW-2	216-Z-7	Crib	299-W15-63	A7364
200W	200-LW-2	216-Z-7	Crib	299-W15-64	A7365
200W	200-LW-2	216-Z-7	Crib	299-W15-76	A7377
200W	200-LW-2	216-Z-7	Crib	299-W15-77	A7378
200W	200-LW-2	216-Z-7	Crib	299-W15-78	A7379
200W	200-LW-2	216-S-20	Crib	299-W22-20	A7843
200W	200-LW-2	216-S-20	Crib	299-W22-61	A7868
200W	200-LW-2	216-S-20	Crib	299-W22-63	A7870
200W	200-LW-2	216-S-20	Crib	299-W22-74	A7878
200W	200-LW-2	216-S-26	Crib	299-W27-1	A8062
200W	200-LW-2	216-T-8	Crib	299-W11-3	A5473
200W	200-LW-2	216-U-4 & 4A	Inj./Rev. Well	299-W19-55	A7755
200E	200-LW-2	216-B-6	Inj./Rev. Well	299-E28-51	A6802
200E	200-LW-2	216-B-10B	Crib	299-E28-17	A4820

NA = not available