AR TARGET SHEET

The following document was too large to scan as one unit, therefore, it has been divided into sections.

EDMC#:	0074015
SECTION:	1 OF 2
DOCUMENT #:	07-AMCP-0290
TITLE:	200-SW-1 Nonradioactive Landfills and Dumps Group OU and 200-SW-2 Radioactive Landfills and Dumps Group OU Remedial Investigation/Feasibility Study Work Plan, DOE/RL-2004-60 Draft B and TPA Interim Milestone M-13-07-03 Change Package

0074015

Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

07-AMCP-0290

SEP 28 2007

Ms. J. A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
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Mr. N. Ceto, Program Manager
Office of Environmental Cleanup
Hanford Project Office
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Addressees:

200-SW-1 NONRADIOACTIVE LANDFILLS AND DUMPS GROUP OPERABLE UNIT AND 200-SW-2 RADIOACTIVE LANDFILLS AND DUMPS GROUP OPERABLE UNIT REMEDIAL INVESTIGATION/FEASIBILITY STUDY WORK PLAN, DOE/RL-2004-60, DRAFT B AND TRI-PARTY AGREEMENT INTERIM MILESTONE M-13-07-03 CHANGE PACKAGE

The purpose of this letter is to transmit the 200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study Work Plan, DOE/RL-2004-60, Draft B for your review and approval. The U.S. Department of Energy, Richland Operations Office (RL) previously transmitted Draft A of this work plan to the State of Washington Department of Ecology (Ecology) on December 20, 2004, by letter (05-AMCP-0092).

This work plan completes Tri-Party Agreement Milestone M-013-28, "Submit a revised work plan for 200-SW-1 and 200-SW-1 Operable Units to Ecology to identify likely response scenarios and potentially applicable technologies, identify the need for treatability study investigations and include sampling and analysis plans." In accordance with the Tri-Party Agreement, please provide comments to RL by close of business on November 29, 2007.

Also attached is the Tri-Party Agreement Interim Milestone M-13-07-03 change package pertaining to the 200-SW-1 and 200-SW-2 Operable Units Work Plan as required by Section 11.6 of the Tri-Party Agreement Action Plan.

If you have any questions, please contact me, or your staff may contact Matt McCormick, Assistant Manager for the Central Plateau, on (509) 373-9971.

Sincerely,

David A. Brockman
Manager

AMCP:FMR

Attachments

cc w/attachs:
D. B. Bartus, EPA
F. W. Bond, Ecology
Administrative Record 200-SW-1/200-SW-2/M-013-28A
Environmental Portal

cc w/o attachs:
B. A. Austin, FHI
G. Bohnee, NPT
S. Harris, CTUIR
R. Jim, YN
S. L. Leckband, HAB
K. Niles, ODOE
S. L. Pedersen, FHI
R. E. Piippo, FHI
J. G. Vance, FFS

Change Number M-13-07-03	**Federal Facility Agreement and Consent Order** ***Change Control Form*** Do not use blue ink. Type or print using black ink.	**Date** 9/11/2007

Originator B. Charboneau **Phone** (509) 373-6137

Class of Change
[ ] I – Signatories [X] II – Executive Manager [ ] III – Project Manager

Change Title
Establishment of Hanford Federal Facility Agreement and Consent Order (Agreement) M-13 Interim Milestone for the 200-SW-1 and 200-SW-2 Operable Units.

Description/Justification of Change

Approval of this change package authorizes the establishment of one interim milestone for the initiation of small-diameter direct push technology characterization, passive-organic vapor sampling, and surface geophysics within 90 days of receiving approval of the 200-SW-1 and 200-SW-2 RI/FS Work Plan (Rev 0).

As specified in the Tri-Party Agreement, Section 11.6, work plans must specify interim milestones for the OU that identify completion dates for major tasks and deliverables specified in the work plans. The 200-SW-1 and 200-SW-2 Work Plan includes a project schedule with target project milestones. Based on this work plan schedule, the following interim milestone is proposed under the Tri-Party Agreement to implement the activities for the RI/FS process for the operable units.

Impact of Change

This change package adds one new interim milestone that does not adversely impact worker safety or the environment.

Affected Documents
The Hanford Federal Facility Agreement and Consent Order, as amended and Hanford Site internal planning management, and budget documents (e.g., Baseline Change Control documents; related work authorizations and directives).

Approvals

_______________ Ecology _______ Date _____ Approved _____ Disapproved

[signature] DOE-RL 9/25/07 Date X Approved _____ Disapproved

_______________ EPA _______ Date _____ Approved _____ Disapproved

(modifications to existing Tri-Party Agreement milestones are denoted with ~~strikeout~~; new milestone/text are denoted with shading.) :

Milestone	Description	Date
M-013-28A	**Initiate Small-Diameter Direct Push Technology Characterization, Passive-Organic Vapor Sampling, and Surface Geophysics Within 90-Days of Receiving Approval of the 200-SW-1/2 RI/FS Work Plan (Rev 0)**	TBD

DOE/RL-2004-60
DRAFT B

200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/ Feasibility Study Work Plan

Date Published
September 2007

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

United States Department of Energy
P.O. Box 550
Richland, Washington 99352

J. D. Aardal — Release Approval   09/11/2007 — Date

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PREFACE

The remedial investigation/feasibility study (RI/FS) process represents the methodology that the Superfund program has established for characterizing the nature and extent of risks posed by uncontrolled hazardous waste sites and for evaluating potential remedial options. This approach should be viewed as a dynamic, flexible process that can and should be tailored to specific circumstances of individual sites: it is not a rigid step-by-step approach that must be conducted identically at every site. The project manager's central responsibility is to determine how best to use the flexibility built into the process to conduct an efficient and effective RI/FS that achieves high quality results in a timely and cost-effective manner. A significant challenge project managers face in effectively managing an RI/FS is the inherent uncertainties associated with the remediation of uncontrolled hazardous waste sites. These uncertainties can be numerous, ranging from potential unknowns regarding site hydrogeology and the actual extent of contamination, to the performance of treatment and engineering controls being considered as part of the remedial strategy. While these uncertainties foster a natural desire to want to know more, this desire competes with the Superfund program's mandate to perform cleanups within designated schedules.

The objective of the RI/FS process is not the unobtainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears most appropriate for a given site. The appropriate level of analysis to meet this objective can only be reached through constant strategic thinking and careful planning concerning the essential data needed to reach a remedy selection decision. As hypotheses are tested and either rejected or confirmed, adjustments or choices as to the appropriate course for further investigations and analyses are required. These choices, like the remedy selection itself, involve the balancing of a wide variety of factors and the exercise of best professional judgment.

Source: EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, (Interim Final)*, OSWER 9355.3-01.

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EXECUTIVE SUMMARY

This remedial investigation/feasibility study (RI/FS) work plan supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*[1] (CERCLA) RI/FS activities for the 200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit (OU) and 200-SW-2 Radioactive Landfills and Dumps Group OU. This RI/FS work plan also integrates the *Resource Conservation and Recovery Act of 1976*[2] (RCRA) treatment, storage, and/or disposal (TSD) unit landfill-closure requirements for specific sites within the OUs. The process outlined in the RI/FS work plan follows the CERCLA format with modifications, as appropriate, to concurrently satisfy RCRA requirements. The application of these processes in the 200 Areas is described in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (Implementation Plan)[3].

This work plan has been prepared to satisfy Tri-Party Agreement Milestone M-013-028, "*Submit a revised work plan for 200-SW-1 and 200-SW-1 OUs to Ecology to identify likely response scenarios and potentially applicable technologies, identify the need for treatability study investigations and include sampling and analysis plans (due September 30, 2007).*"

Scope -- The scope of this work plan primarily is concerned with 26 solid-waste landfills that are located on the Hanford Site Central Plateau (12 landfills are in the 200 West Area, 12 landfills are in the 200 East Area, and 2 landfills are in the 600 Area). Collectively, these landfills have received nearly 500,000 m^3 of a heterogeneous mixture of solid waste during various operating periods that began in the mid-1940s. All waste included within the scope of the 200-SW-1 and 200-SW-2 OUs has been buried in unlined trenches that were designed and constructed to varying lengths, widths, and depths. These landfills cover a cumulative area of nearly 300 ha (740 ac), and the cumulative length of burial trenches exceeds 80 km (50 mi). The quantity and quality of burial records and/or relevant historical information varies greatly; information generally is sparse for the earlier years and more substantive for waste buried after the late

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[1] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq.

[2] *Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq.

[3] DOE/RL-98-28, 1999, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

1960s. About 60 percent of the waste buried in these landfills was from the Hanford Site 200 Areas processing facilities; some waste came from the 100 and 300 Areas, and a smaller fraction came from other Hanford Site areas and from various off-site generators. The waste form, waste packaging, and in-trench waste emplacement varied over time. Certain landfills were dedicated to smaller waste items, while some landfills were dedicated to large/industrial equipment, and others received primarily construction and/or demolition-related waste.

Work Plan History -- An earlier version of this RI/FS work plan (DOE/RL-2004-60, *200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/ Feasibility Study Work Plan*, Draft A)[4] was developed and transmitted by the U.S. Department of Energy (DOE), Richland Operations Office (RL) to the Washington State Department of Ecology (Ecology) in December 2004. In early 2005, RL and Ecology participated in a series of facilitated workshops to achieve better alignment of the parties' interests and objectives. These workshops resulted in a path forward, as documented in Ecology and DOE, 2005, *200-SW-1 and 200-SW-2 Collaborative Workshops, Agreement Completion Matrix, and Supporting Documentation, Final Product*[5]. Among other initiatives, the parties agreed to conduct remedial characterization in a phased manner and to suspend revision of the Draft A edition of the RI/FS work plan while the first phase of remedial characterization was completed. The parties then participated in a collaborative data quality objectives process as described in D&D-27257,

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[4] DOE/RL-2004-60, 2004, *200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study Work Plan*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

[5] Ecology and DOE, 2005, *200-SW-1 and 200-SW-2 Collaborative Workshops, Agreement, Completion Matrix, and Supporting Documentation, Final Product*, (Correspondence Control No. 0064527), Washington State Department of Ecology and U.S. Department of Energy, Richland Operations Office, Richland, Washington, April 18.

Data Quality Objectives Summary Report for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-1 and 200-SW-1 Operable Unit[6], and issued sampling instructions as described in D&D-28283, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*[7]. This first phase (Phase I-A) of characterization has been completed. The Phase I-A scope involved an extensive review, collection, reporting, and organization of the historical information (including hundreds of technical reports and over 147,000 burial records) as well as the completion of an extensive suite of surface geophysical surveys, passive organic-vapor surveys, and surface-radiation surveys. The results from the Phase I-A sampling were used to update the OU conceptual site models (CSM).

New Agreement on a Multi-Phased Remedial Investigation Approach -- Based on information gained from the Phase I-A characterization, an additional data quality objectives process was initiated in 2006. Because of the complexity in scope and issues associated with the 200-SW-1 and 200-SW-2 OUs, alignment meetings were held with Ecology and RL, resulting in another collaborative agreement (CCN 0073214, *Path Forward – 200-SW-1/2 RI/FS Work Plan Development, May 15, 2007*[8]) between RL and Ecology. This 2007 agreement embraced the concept that the RI/FS work plan and RI/FS approach should be structured in a manner that further implements a phased approach. Accordingly, this agreed-upon approach now involves multiple phases of characterization and future revisions to this RI/FS work plan and/or sampling and analysis plan after substantive portions of the next phase(s) of remedial investigation are completed.

Next Phase of Remedial Investigation (Phase I-B) -- This version of the RI/FS work plan is primarily focused on the next phase of characterization (hereinafter called Phase I-B). The Phase I-B remedial investigation consists of both nonintrusive and intrusive characterization.

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[6] D&D-27257, 2006, *Data Quality Objectives Summary Report for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*, Rev. 0 Reissue, Fluor Hanford, Inc., Richland, Washington.

[7] D&D-28283, 2006, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*. Rev. 0 Reissue, Fluor Hanford, Inc., Richland, Washington.

[8] CCN 0073214, 2007, *Path Forward – 200-SW-1/2 RI/FS Work Plan Development, May 15, 2007*, (agreement signed by Matthew S. McCormick, U.S. Department of Energy, Richland Operations Office, and John B. Price, Washington State Department of Ecology, Kennewick, Washington), at Richland, Washington.

The Phase I-B investigations allow for the collection of essential data and information that are needed for focusing the more costly vadose-zone soil sampling activities planned for Phases II and III. Phase II characterization activities will be defined in a future version of this RI/FS work plan and sampling and analysis plan, and will consist of focused intrusive investigations of the targeted items/locations resulting from characterization of Phase I-A and Phase I-B. It is assumed that additional characterization beyond Phase II (i.e., Phase III) will be required, stemming from the information and data as well as the results of modeling that will evaluate the human-health and ecological risk and migration to groundwater following the CERCLA RI/FS process. Scope in Phase III also may be needed to address areas that require particular caution to worker safety concerns (e.g., landfills, trenches containing elevated levels of plutonium).

The Phase I-B remedial investigation scope, as presented in this RI/FS work plan, includes the following activities:

- *Accelerated Closure of 200-SW-1 Landfills* – Closure plans have been written for the only two sites currently remaining in the 200-SW-1 OU (i.e., the Nonradioactive Dangerous Waste Landfill and the 600 Area Central Landfill). However, both of these closure plans are out of date. This RI/FS work plan includes activities to rewrite/reissue the plans for regulatory agency review/comment and approval. This RI/FS work plan describes a path forward that supports accelerated landfill-closure decisions and the integration of barrier designs for these two landfills.

- *Early Closure of Unused Landfill Areas* – Three of the seven RCRA TSD unit landfills in the 200-SW-2 OU (i.e., 218-W-4C, 218-E-10, and 218-E-12B Landfills) contain large areas that once were intended for buried waste but that are believed never to have been used. Collectively, these three areas account for over 40 ha (100 ac), or roughly 15 percent of the overall footprint of 200-SW-2 OU landfills. This RI/FS work plan outlines activities for gathering and presenting the necessary historical records and performing field activities to possibly support early decisions pursuant to Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action*

Plan, Section 6.3.3, Procedural Closure.[9] This process, if successful, should eliminate the need for allocating additional RI/FS resources to these areas.

- *Surface Geophysical Investigations* – Geophysical investigation methods (e.g., ground-penetrating radar, electromagnetic-induction, and total magnetic-field techniques) will be deployed to locate a variety of features including burial trench ends/edges and centerlines, location of buried waste or other significant features/anomalies, differentiation of waste types, and depth of soil cover. These investigation methods have been applied successfully to 13 of the 17 older landfills that generally lacked detailed burial records. Application of these methods to the 218-W-4A, 218-E-2, 218-E-4, and 218-E-9 Landfills will complete the geophysical-survey coverage for the entire suite of 17 past-practice landfills in the 200-SW-2 OU.

- *Passive Organic-Vapor Sampling* – Passive organic soil-vapor surveys will be performed to screen for the presence of buried volatile organic compounds. Results will be used to determine the locations of waste packages that may contain liquid organics and have breached their containment. Results from this nonintrusive sampling also will help determine locations for the more active soil-vapor sampling during the future Phase II intrusive sampling. This RI/FS work plan targets 293 specific locations for Phase I-B passive organic-vapor sampling. Most (207) sample locations are based on targeting 23 areas where volatile organic compounds were detected at a single location during the earlier (Phase I-A) passive soil-vapor surveys that were performed in the TSD unit landfills. The other individual sampling locations (86 total) are based on where buried metallic objects were identified during geophysical investigations that were conducted during the Phase I-A characterization.

- *Intrusive Geophysical Investigations* – Down-hole geophysical surveys will be performed using spectral-gamma and neutron-moisture logging systems. The spectral-gamma system can provide cost-effective information on the vertical and lateral distribution of gamma-emitting radionuclides. The neutron-moisture logging system will be used to

[9] Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

measure continuous vertical moisture in the vadose zone. Information from both logging systems will aid in geological interpretation of the subsurface stratigraphy and potential contaminant migration. The spectral-gamma and neutron-moisture logging systems will be deployed in existing accessible wells that are located near the 200-SW-2 OU landfill sites as well as in newly created, small-diameter direct-push technique holes that are targeted for installation near centers of each of the 24 200-SW-2 OU landfills. The target locations for direct pushes will be between trenches, so that the buried waste is not directly penetrated. Information resulting from these investigations will support refinement of the sites' CSMs and help to more effectively target the depths of future (Phase II and/or Phase III) and more costly soil sampling and analyses.

- *Remote Inspection of Potentially Unused Caissons* – Based on historical records, up to four caissons in the 218-W-4A Landfill and one caisson in the 218-W-4B Landfill may be empty. Phase I-B investigation activities will include surveys to locate these buried caissons, assessing methods for remote access, and deployment of radiation detection/monitoring and remote-visualization methods for assessing caisson contents. While Hanford Site drawings do include coordinates for potential caisson locations, the location of many of the caissons not evident from the ground surface and the burial records for actual caisson contents (if any) have not been located.

- *Treatability Investigations* – Treatability and other focused investigations will be conducted during Phase I-B (and future remedial investigation phases) to fill data gaps with information, to reduce uncertainties and to support better decision making and more cost-effective site remediation. The current listing of subjects that warrant focused investigations includes the location of large burial boxes and the potential for surface subsidence; cost of waste retrieval versus barrier construction; caisson characterization and remedial techniques; retrieval of spent fuel; assessment of acid-soaked material trenches; vadose-zone characterization and monitoring techniques; waste-trench compaction methods; in situ detection of transuranics; and soil-vacuum removal methods.

Coordination with other Groundwater Operable Units -- The groundwater OUs related to this RI/FS work plan are primarily the 200-ZP-1 and 200-BP-5 Groundwater OUs, and (to a lesser extent) the 200-PO-1 and 200-UP-1 Groundwater OUs. The scope of this RI/FS work plan does not include groundwater sampling; however, the integration of source, vadose zone, and groundwater information/data and field activities is recognized, and will be performed throughout the life cycle of this project.

Coordination with other Waste Retrieval Projects -- The 200-SW-1 and 200-SW-2 OUs project team also acknowledges the importance of exchanging technical information and lessons learned with other related projects at the Hanford Site and at other DOE sites. Such local projects include those supporting Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*[10], Milestone M-091-40 for the retrieval of post-1970 transuranic waste in the 200 West and 200 East Area landfills, the retrieval of buried waste from 100 Area and 300 Area landfills, and the upcoming remediation activities at the 618-10 and 618-11 Burial Ground sites.

No Presumed Remedies -- This work plan does not presume a remedy for the 200-SW-2 OU landfills. The CERCLA RI/FS process will be followed, and data/information will be gathered to support the evaluation of multiple remedial measures. In accordance with the agreements reached between RL and Ecology in 2005 and 2007, the likely response scenarios to be considered for these landfills will include the following:

- Excavation, treatment (as necessary), and disposal of waste from within individual burial grounds
- Excavation, treatment (as necessary), and disposal of waste from selected sections of individual burial grounds
- Capping of individual burial grounds
- In situ treatment (e.g., vitrification or grouting) of portions of individual burial grounds
- Some combination of the above
- No action, with continued monitoring.

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[10] Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, as amended.

Organization of this Document -- The enclosed RI/FS work plan is organized as follows:

- ***Chapter 1.0, Introduction,*** presents the RI/FS work plan scope and objectives, and project assumptions.
- ***Chapter 2.0, Background and Setting***, presents the physical setting for the 200-SW-1 and 200-SW-2 OUs, including information on geology and groundwater. This chapter also provides detailed descriptions of each of the 26 landfills within the scope of this work plan.
- ***Chapter 3.0, Initial Evaluation of Landfills***, presents known and suspected contamination for the in-scope landfills, the preliminary CSMs for each landfill group (or "bin"), information on groundwater monitoring, potential impacts to human health and the environment, and the contaminants of potential concern.
- ***Chapter 4.0, Work Plan Approach and Rationale***, presents a summary of the data quality objectives process, the characterization approach for each bin (or grouping of waste sites), and a description of the phased characterization approach.
- ***Chapter 5.0, Remedial Investigation/Feasibility Study Process***, presents a summary of the regulatory paths forward for the 200-SW-1 and 200-SW-2 OUs, a discussion of treatability investigations, a summary of cost-estimating processes that will be used in the feasibility study, and a description of the proposed plan and RCRA permit-modification process and the post-record-of-decision activities.
- ***Chapter 6.0, Project Schedule***, presents a schedule for completion of the 200-SW-2 OU RI/FS process (including TSD closure/postclosure care), as well as a schedule for closure activities associated with the 200-SW-1 OU landfills.
- ***Chapter 7.0, References***, provides the complete citation of documents referenced in this RI/FS work plan.
- ***Appendix A***, Sampling and Analysis Plan for the 200-SW-2 Operable Unit Landfills (Phase I-B)

- ***Appendix B***, Summary Descriptions and Figures of Waste Sites in the 200-SW-1 and 200-SW-2 Nonradioactive and Radioactive Landfills and Dumps Operable Units
- ***Appendix C***, Collaborative-Negotiations Completion Matrix Status
- ***Appendix D***, Data Collected to Support Characterization of Landfills in the 200-SW-2 Operable Unit
- ***Appendix E***, Initial Conceptual Site Models for the 200-SW-2 Operable Unit Landfills.

Readers of this document should find it helpful to first spend a few minutes reviewing the figures located in the main body of the document, and then review the CSMs in Appendix E to gain some initial familiarity with the six groupings (or "bins") that have been developed for the 200-SW-2 OU landfills. Appendix E also includes CSM descriptions and site-specific graphics for each of the 24 landfills.

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CONTENTS

APPENDICES

FIGURES

TABLES

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TERMS

600 CL	600 Area Central Landfill
AEC	U.S. Atomic Energy Commission
amsl	above mean sea level
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
COPC	contaminant of potential concern
CSM	conceptual site model
DOE	U.S. Department of Energy
DPT	direct-push technique
DQO	data quality objective
Ecology	Washington State Department of Ecology
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
ERAG	Ecological Risk Assessment Guidance for Superfund
ERT	electrical-resistance technology
FS	feasibility study
FUSRAP	Formerly Utilized Sites Remedial Action Program
GPR	ground-penetrating radar
HAB	Hanford Advisory Board
Hanford Facility RCRA Permit	WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8, for the Treatment, Storage, and Disposal of Dangerous Waste*
HASP	health and safety plan
HEIS	*Hanford Environmental Information System* database
HEPA	high-efficiency particulate air
HPGe	high-purity germanium
IDW	investigation-derived waste
Implementation Plan	*200 Areas Remedial Investigation/Feasibility Study Implementation Plan - Environmental Restoration Program* (DOE/RL-98-28)
LLBG	low-level burial ground
LLMW	low-level mixed waste
LLW	low-level waste
LLWMA	Low-Level Waste Management Area
MESC	maintain existing soil cover
MFP	mixed fission product
MLLW	mixed low-level waste
MNA	monitored natural attenuation
MSCM	Mobile Surface Contamination Monitor
N/A	not applicable
NEPA	*National Environmental Policy Act of 1969*
NRDWL	Nonradioactive Dangerous Waste Landfill

OU	operable unit
PNNL	Pacific Northwest National Laboratory
PRG	preliminary remediation goal
PUREX	Plutonium-Uranium Extraction
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RECUPLEX	Recovery of Uranium and Plutonium by Extraction
REDOX	Reduction-Oxidation
RESRAD	RESidual RADioactivity (dose model)
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
RSW	retrievably stored waste
RTD	removal, treatment, and disposal
SALDS	State-Approved Land Disposal Site
SAP	sampling and analysis plan
SLERA	screening-level ecological risk assessment
SVE	soil-vapor extraction
SWITS	*Solid Waste Information and Tracking System* database
TMF	total magnetic field
Tri-Parties	DOE, EPA, and Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic
TRUM	TRU mixed waste
TSD	treatment, storage, and/or disposal (unit)
UNI	United Nuclear Industries (obsolete)
VOC	volatile organic compound
VPU	vertical pipe unit
WAC	*Washington Administrative Code*
WIDS	*Waste Information Data System* database

GLOSSARY

Contact-Handled Waste – Packaged waste whose external surface dose rate does not exceed 200 mrem/h and does not create a high radiation area (>100 mrem/h at 30 cm). A few waste burials (~2 dozen) are designated as contact handled but have dose rates higher that 200 mrem/h. This may be caused by errors in the burial records.

Dangerous Waste – Solid waste designated in WAC 173-303-070 through WAC 173-303-100[11] as dangerous or extremely hazardous waste, or mixed waste. Wastes disposed of before August 19, 1987, are not designated as dangerous waste per the *Washington Administrative Code*, regardless of their current regulatory status.

Disposal – As used in this document, placement of waste with no intent of future retrieval; statutory or regulatory definitions may differ.

Dump – As used in this document, a dump is a disposal area not pre-planned, designed, and constructed as a solid waste disposal facility, but rather a disposal area in which refuse has been buried. (Such "dump" sites (or suspected dump sites) that once were included in the 200-SW-1 and 200-SW-2 Operable Units for remedial investigation (RI) now reside within the 200-MG-1 Operable Unit.)

Hazardous Waste – Solid waste that contains chemically hazardous constituents regulated under Subtitle C of the *Resource Conservation and Recovery Act of 1976* (RCRA)[12] , as amended (40 CFR 261, "Identification and Listing of Hazardous Waste"[13]), and regulated as a hazardous waste and/or mixed waste by the U.S. Environmental Protection Agency. Also may include solid waste designated by Washington State as dangerous waste. Hazardous constituents were not regulated until August 19, 1987, and they are not designated as hazardous waste unless they were disposed of after that date.

Landfill – A landfill is a disposal area designated for permanent burial of solid waste. Landfills, as described in this document, are planned, designed, and constructed in a manner intended to minimize effects on the environment. Refuse typically is compacted and covered with soil in landfills. Under today's regulations, landfills must be constructed with liners and leachate collection systems and must meet other standards.

Low-Level (Radioactive) Waste – Radioactive waste that is not high-level waste, spent nuclear fuel, TRU waste, byproduct material (as defined in Section 11e(2) of the *Atomic Energy Act of 1954*,[14] as amended), or naturally occurring radioactive material.

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[11]WAC 173-303-070 through 173-303-100, "Dangerous Waste Regulations," "Designation of Dangerous Waste," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

[12]*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq.

[13]40 CFR 261, "Identification and Listing of Hazardous Waste," Title 40, *Code of Federal Regulations*, Part 261.

[14]*Atomic Energy Act of 1954*, 42 USC 2011, et seq.

Mixed Low-Level Waste – Waste that meets the definition of low-level waste, and that also contains a hazardous component subject to the *Resource Conservation and Recovery Act of 1976* (RCRA), as amended, or Washington State Dangerous Waste Regulations. Mixed low-level waste is considered to be only waste that was disposed of after August 19, 1987.

Radioactive Waste – Waste that is managed for its radioactive content. Waste material that contains source, special nuclear, or byproduct material is subject to regulation as radioactive waste under the *Atomic Energy Act of 1954.*

Remedial Action – Activities conducted under CERCLA authority to reduce potential risks to people and/or harm to the environment from radioactive and/or hazardous substance (including radionuclide) contamination.

Remote-Handled Waste – Packaged radioactive waste for which the external dose rate exceeds that defined for contact-handled waste (generally 200 mrem/h at the container surface). These wastes require handling using remotely controlled equipment or placement in shielded containers to reduce the human exposures during routine waste management activities. About 1,000 burials are designated as remote handled but have dose rates much lower than 200 mrem/h. The great majority of these exceptions is caisson waste, which always was remotely handled.

Retrievably Stored Waste – Waste packaged and stored in a manner that allows retrieval at a future time. Transuranic waste was not retrievably stored until May 1970; to distinguish between retrievably stored TRU and pre-1970 transuranically contaminated material.

Transuranic Isotope – An isotope of any element having an atomic number greater than 92 (the atomic number of uranium).

Transuranic (TRU) Waste – Radioactive waste containing more than 100 nCi (3,700 Bq) of alpha-emitting transuranic isotopes per gram of waste with half-lives greater than 20 years, except for the following:

- High-level radioactive waste
- Waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the U.S. Environmental Protection Agency, does not need the degree of isolation required by the disposal regulations in 40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes"[15]
- Waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste"[16]

[15]40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," Title 40, *Code of Federal Regulations*, Part 191. Definition is found in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*, Chapter 3.

[16]10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste," Title 10, *Code of Federal Regulations*, Part 61.

- TRU waste includes radioactive waste as defined in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1.* TRU waste also may include hazardous constituents, in which case it may be referred to as mixed TRU waste or TRUM. TRUM has mixed-waste components disposed of after August 19, 1987.

Treatment, Storage, and Disposal landfill – A landfill where dangerous waste is placed in or on the land, as defined in WAC 173-303, "Dangerous Waste Regulations."

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If you know	*Multiply by*	*To get*	*If you know*	*Multiply by*	*To get*
Length			**Length**		
Inches	25.40	millimeters	millimeters	0.0394	inches
Inches	2.54	centimeters	centimeters	0.394	inches
Feet	0.305	meters	meters	3.281	feet
Yards	0.914	meters	meters	1.094	yards
miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.0929	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles [a]	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
Ac	0.405	hectares	hectares	2.471	ac
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces (avoir)
Pounds	0.454	kilograms	kilograms	2.205	pounds (avoir)
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
Teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
Tablespoons	15	milliliters	liters	2.113	pints
ounces (U.S., liquid)	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
Cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
Pints	0.473	liters	cubic meters	35.315	cubic feet
quarts (U.S., liquid)	0.946	liters	cubic meters	1.308	cubic yards
gallons (U.S., liquid)	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Centigrade	Centigrade	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
Picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

[a]One square mile = 640 ac.

1.0 INTRODUCTION

The 200-SW-1 Operable Unit (OU) includes two landfills located in the Hanford Site 600 Area, and the 200-SW-2 OU consist of 24 landfills located in Hanford Site 200 East and 200 West Areas. The 200 Areas are located near the center of the Hanford Site in south-central Washington State and are within one of three areas on the Hanford Site that are on the U.S. Environmental Protection Agency's (EPA) National Priorities List (40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List") under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). Figures 1-1, 1-2, 1-3, and 1-4 depict the location of the Hanford Site, the specific 200-SW-1 and 200-SW-2 OU landfill locations within the 200 East Area and 200 West Areas, and the specific 200-SW-1 OU locations within the 600 Area, respectively. Table 1-1 provides a summary listing of the 26 landfills included in the 200-SW-1 and 200-SW-2 OUs. Additional detail on each of these landfills is provided in Chapter 2.0.

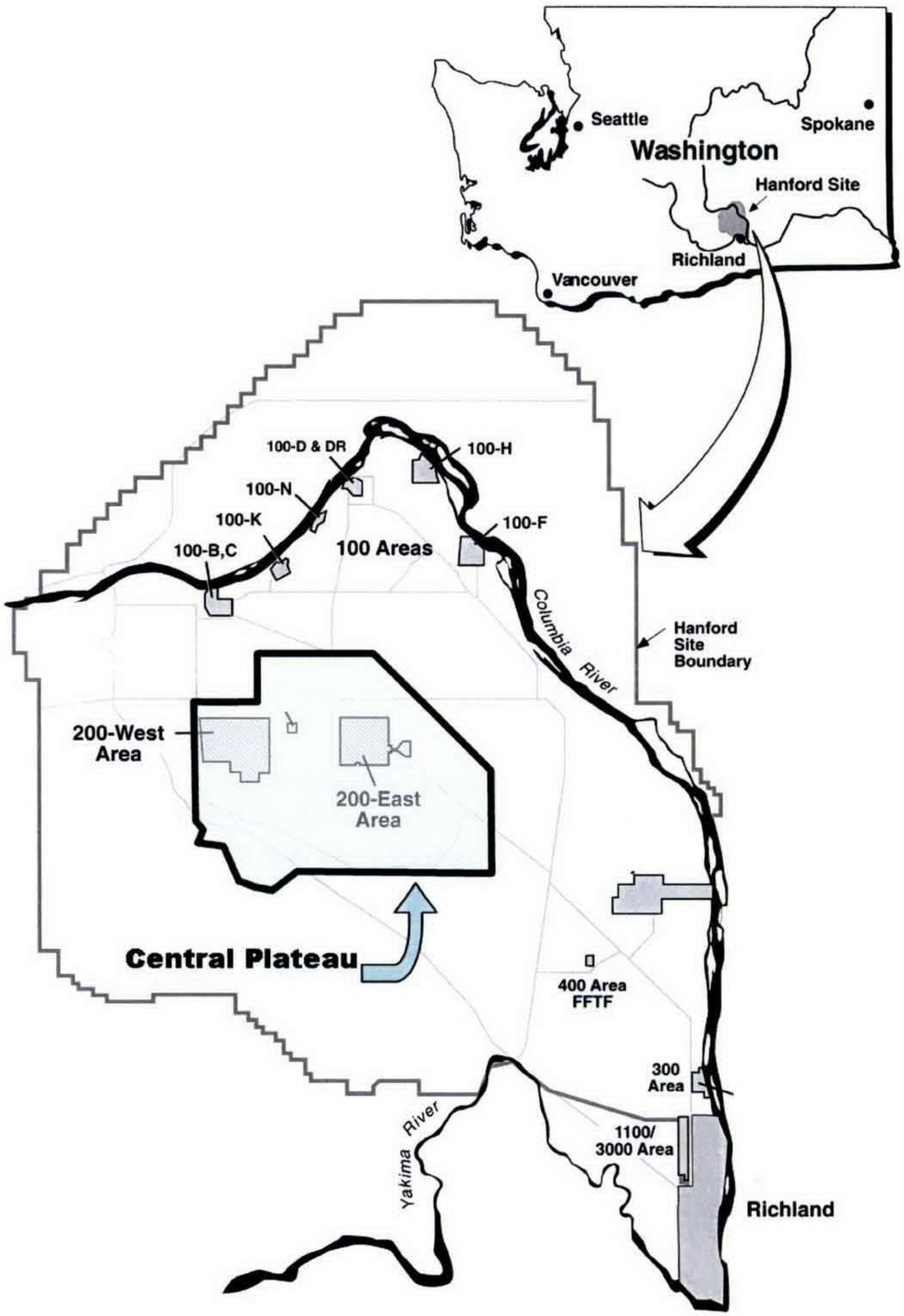
The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989a, as amended) identifies 800+ soil waste sites (and associated structures) resulting from the discharge of liquids and solids to the ground from 200 Areas processing facilities. These 800+ sites have been arranged into separate waste groups (or operable units) that are identified as either CERCLA past-practice OUs or *Resource Conservation and Recovery Act of 1976* (RCRA) past-practice OUs addressed through RCRA corrective-action authorities. Some OUs include RCRA treatment, storage, and/or disposal (TSD) units that will be closed in conjunction with OU activities.

In accordance with the Tri-Party Agreement, this remedial investigation/feasibility study (RI/FS) work plan has been prepared to present information on how the RI/FS process will be conducted and eventually will lead to proposed remedies for the waste sites in an OU. In accordance with the Tri-Party Agreement, the Washington State Department of Ecology (Ecology) has been designated as the lead regulatory agency for the 200-SW-1 and 200-SW-2 OUs. This RI/FS work plan follows the CERCLA documentation process, with modifications to concurrently satisfy RCRA corrective-action and TSD-unit closure requirements as described in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, (hereinafter referred to as the Implementation Plan). The Implementation Plan is summarized further in Section 1.3 of this RI/FS work plan.

This RI/FS work plan summarizes the CERCLA RI/FS and RCRA TSD-unit landfill closure activities for two of the Hanford Site's OUs, namely the 200-SW-1 Nonradioactive Landfills and Dumps Group OU and the 200-SW-2 Radioactive Landfills and Dumps Group OU (hereinafter referred to as the 200-SW-1 and 200-SW-2 OUs).

The majority of the waste disposed to the 200-SW-1 and 200-SW-2 OU landfills originated from the processing facilities located in the 200 East and 200 West Areas of the Hanford Site. The 200-SW-2 OU landfills also contain some wastes that originated from the Hanford Site's 100 and 300 Areas, as well as from offsite sources. Both of the OUs contain RCRA TSD units, which are discussed further in Chapter 5.0.

1 Figure 1-1. Location of the Hanford Site.



2

Figure 1-2. Location of 200-SW-2 Operable Unit Landfills in the 200 East Area.

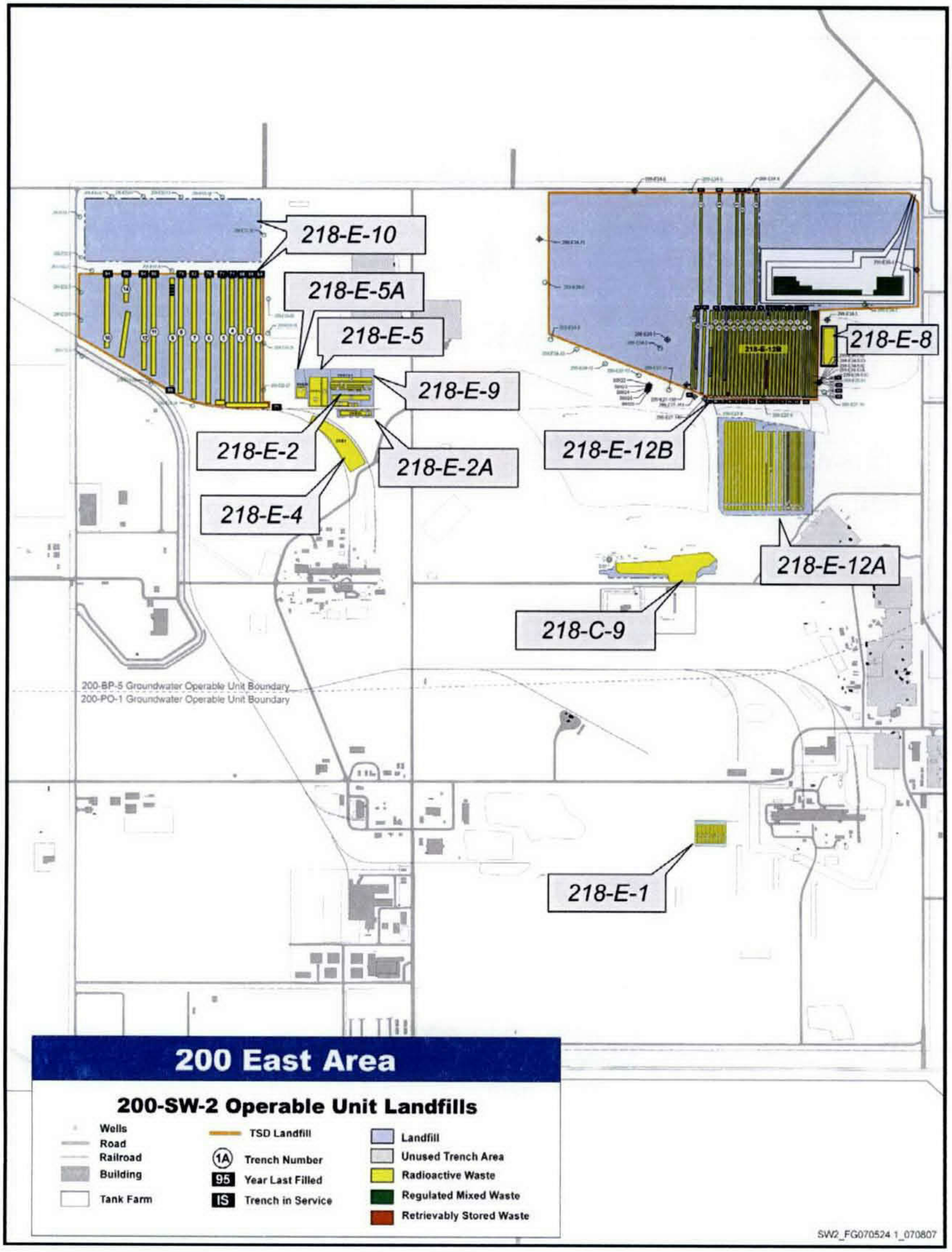


Figure 1-3. Location of 200-SW-2 Operable Unit Landfills in the 200 West Area.

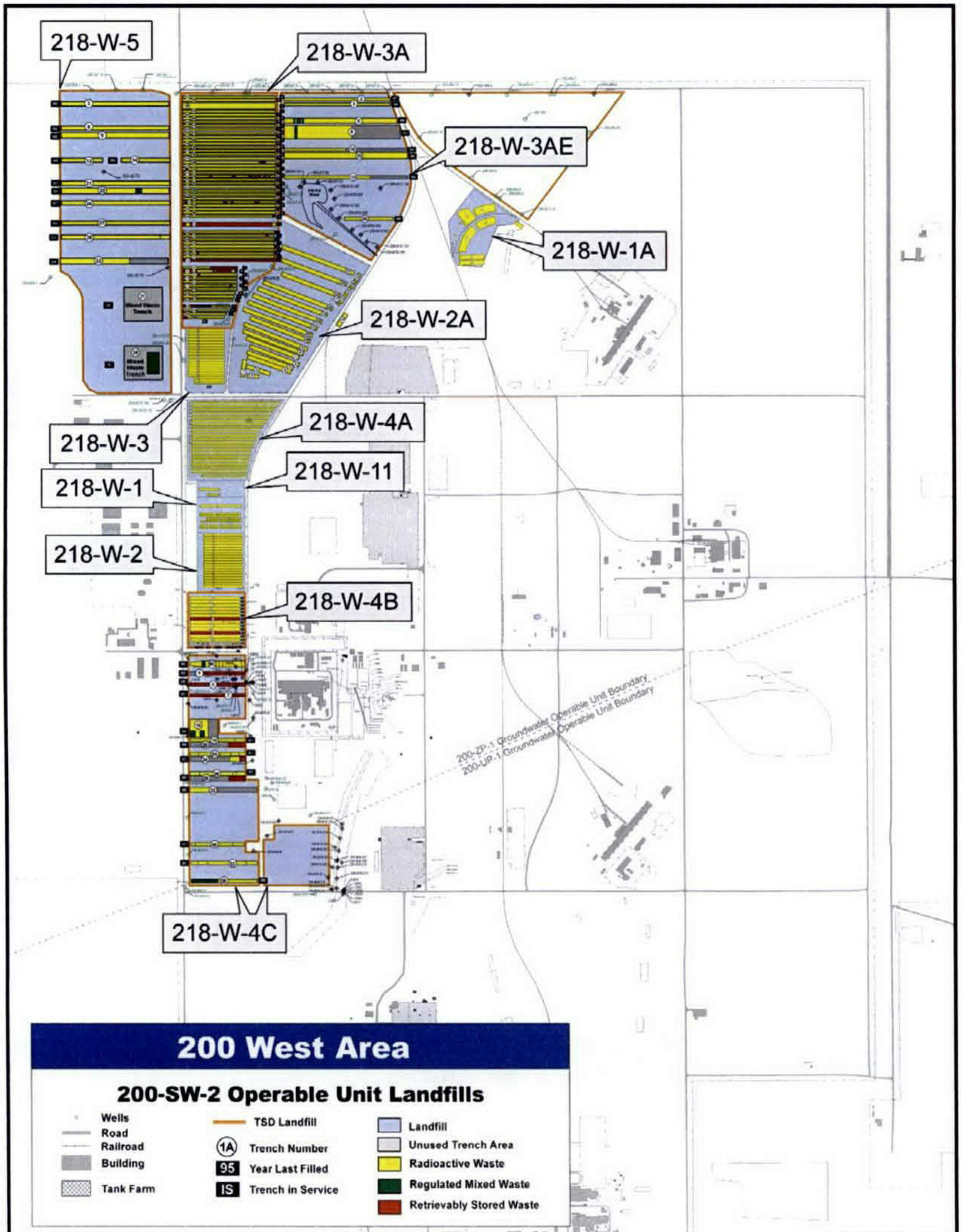


Figure 1-4. Location of 200-SW-1 Operable Unit Landfills in the 600 Area.

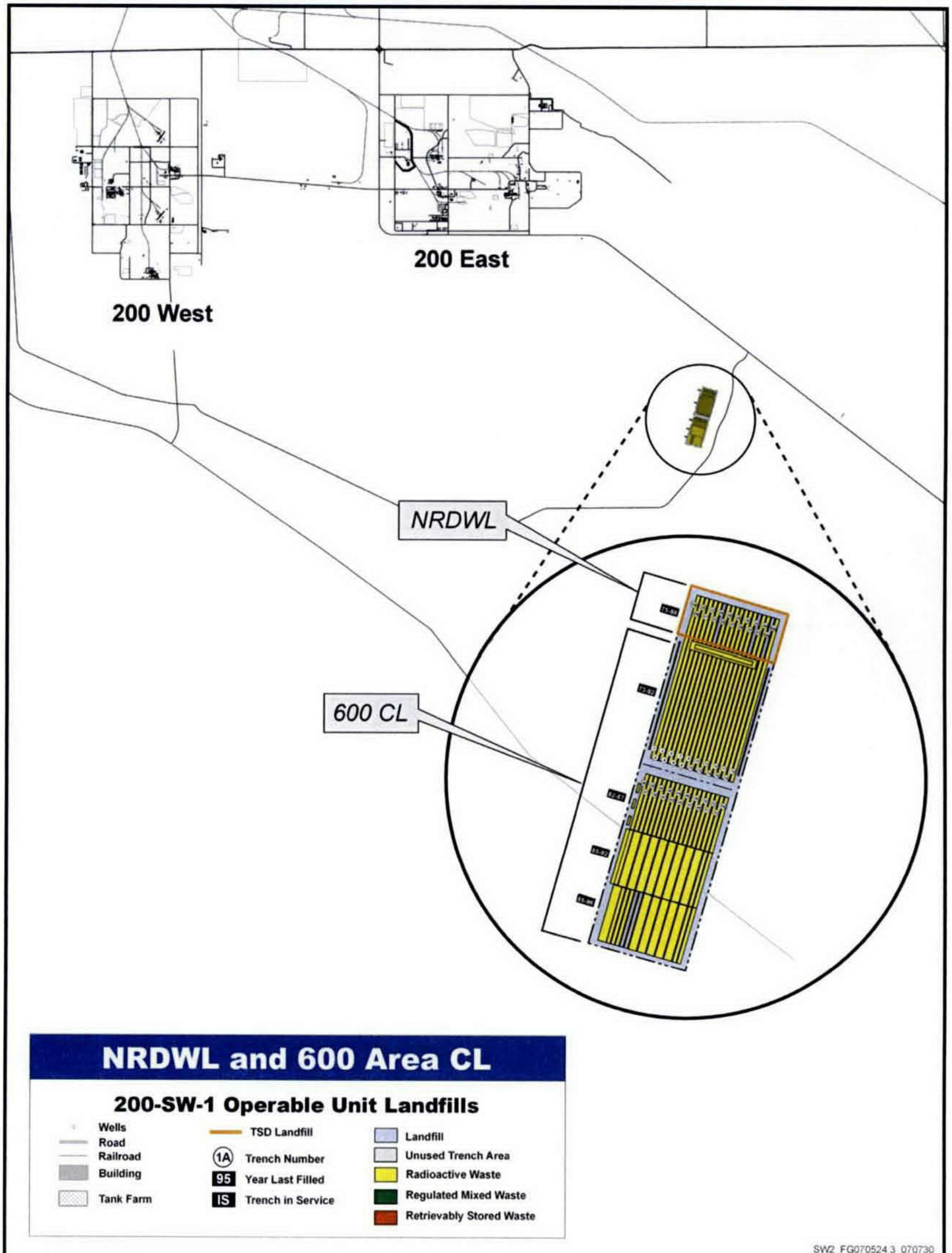


Table 1-1. Summary Information for the 200-SW-1 and 200-SW-2 Operable Unit Landfills.

Landfill	Number of Trenches	Total Length of Trenches (Cumulative)		Volume [a] of Buried Waste		Area [a]	
		km	mi	m^3	ft^3	m^2	ac
200-SW-1 Operable Unit (2 Landfills)							
600 CL	75	12.61	7.84	596,000	21,047,541	241,262	59.60
NRDWL[b]	16	2.02	1.26	141,000 (kg)	310,851 (lb)	37,506	9.26
Total	91	14.63	9.10	596,000	21,047,541	278,768	68.86
200-SW-2 Operable Unit (24 Landfills)							
218-C-9	1	0.44	0.27	7,573	267,421	18,060	4.46
218-E-1	15	0.91	0.57	3,030	106,999	9,601	2.37
218-E-10[b]	14	5.26	3.27	26,900	646,964	228,895	56.56
218-E-12A	28	7.76	4.82	15,400	543,845	121,298	29.97
218-E-12B[b]	39	11.90	7.40	65,086	2,298,453	735,362	181.71
218-E-2	8	0.72	0.45	9,033	318,996	20,476	5.10
218-E-2A	1	0.10	0.06	- -	- -	3,714	0.92
218-E-4	- -	- -	- -	1,586	55,999	13,810	3.41
218-E-5	2	0.21	0.13	3,172	112,018	10,893	2.69
218-E-5A	1	0.04	0.02	6,173	218,000	4,440	1.10
218-E-8	1	0.12	0.08	2,265	79,999	4,440	1.10
218-E-9	- -	- -	- -	- -	- -	- -	- -
218-W-1	15	1.24	0.77	7,164	252,997	33,148	8.19
218-W-11	2[c]	0.12	0.08	1,160	40,949	14,279	3.53
218-W-1A	12	0.54	0.33	13,700	483,810	48,605	12.01
218-W-2	20	2.85	1.77	8,240	290,996	34,455	8.51
218-W-2A	27	4.15	2.58	26,000	918,181	164,849	40.74
218-W-3	20	2.83	1.76	12,400	437,901	39,690	9.81
218-W-3A[b]	61	14.25	8.86	97,528	3,444,086	219,201	54.17
218-W-3AE[b]	8	2.91	1.81	34,240	1,209,150	229,193	56.63
218-W-4A	30	5.01	3.11	16,886	596,323	72,811	17.99
218-W-4B[b]	27	2.46	1.53	7,213	254,724	40,704	10.06
218-W-4C[b]	16	2.96	1.84	15,211	537,174	227,326	56.17
218-W-5	13	3.90	2.42	70,961	2,505,908	385625	95.29
Total	361	69.96	43.47	450,921	15,620,893	2,680,875	657.90
Grand Total	452	84.59	52.57	1,046,921	15,620,893	2,959,643	726.76

[a]All numbers are estimates based on historical information and include only the used portions of the landfills.
[b]Landfill is a permitted treatment, storage, and disposal landfill under the *Resource Conservation and Recovery Act of 1976*.
[c]Recent geophysical investigations suggest that there is only one trench. See Section 3.3.4.3 for details.
NRDWL = Nonradioactive Dangerous Waste Landfill.
600 CL = 600 Area Central Landfill.

1.1 SUMMARY DESCRIPTIONS OF THE 200-SW-1 AND 200-SW-2 OPERABLE UNITS

The following discussion provides an overview of the 200-SW-1 and 200-SW-2 OUs. These summaries are provided in the context of the preceding information to assist the reader in understanding the basis for their binning (Section 1.4).

1.1.1 Nonradioactive Landfills and Dumps Group – 200-SW-1 Operable Unit

The 200-SW-1 OU originally included a number of nonradioactive landfills and dump sites that were created during the construction and operation of the 200 Areas facilities. Although a few sites were excavated engineered structures, which were operated in a manner to contain waste releases, most sites were accumulation points for materials not regarded at the time to be potentially hazardous (DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*). The majority of these waste sites were transferred to the 200-MG-1 or 200-MG-2 OUs. The two remaining landfills included in this operable unit are the 600 Area Central Landfill (600 CL), and the Nonradioactive Dangerous Waste Landfill (NRDWL). Both are inactive and are located southeast of the 200 Areas.

1.1.2 Radioactive Landfills and Dumps Group – 200-SW-2 Operable Unit

Most of the 200 Areas landfills are inactive (units) and have been backfilled, surface stabilized with at least 0.6 m (2 ft) of clean dirt, and seeded with grasses. Before 1960, detailed inventory records were not maintained; specific information about the early landfills often is not available (DOE/RL-96-81). Logbook records exist for some burials that took place in the 200 West Area in the early 1960s. Before the 1970s, landfills and structures within the scope of this project in the 200 Areas generally were divided into the following four categories. These categories formed the basis for grouping the 24 landfills into the current bins. A discussion of the six bins in the scope of this RI/FS work plan is presented in Section 3.2.1:

- Dry-Waste Landfills – received radioactive waste packaged primarily in fiberboard boxes. All types of miscellaneous wastes, ranging from contaminated soils and potentially contaminated rags, paper, and wood to gloveboxes containing multigram quantities of plutonium, have been placed in these facilities

- Industrial Landfills – received radioactive waste that usually was packaged in large wooden or concrete boxes, containing large quantities of fission products. For the most part, these sites were restricted to burial of large pieces of failed or obsolete equipment from the chemical processing facilities, although some items came from the 100 Areas

- Construction Landfills – mainly limited to burial of low-activity wastes resulting from construction work on existing facilities

- Caissons or Vertical Pipe Units – used for disposal of hot-cell waste or high-dose rate plutonium waste in the 218-W-4A and 218-W-4B Landfills. The caissons in the 218-W-4A Landfills were made of welded 208.2 L (55-gal) drums or corrugated pipe and concrete (WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*; Hanford Site Drawing H-2-33692, *Dry Waste Disposal Caisson in 218-W4 Site*); the caissons in the 218-W-4B Landfill were made of corrugated metal and concrete (WHC-EP-0912).

All of the radioactive-waste landfills are located inside the 200 East and 200 West Area fenced boundaries. Each landfill consists of one or more trenches; sizes of landfills range from less than 0.4 to 70 ha (1 to 173 ac).

Chapters 1.0 through 6.0 comprise the main body of the RI/FS work plan and provide its essential elements. Contents of each of the chapters and appendices are briefly described here.

- ***Chapter 1.0, Introduction,*** presents the RI/FS work plan scope and objectives, background information, and project assumptions.

- ***Chapter 2.0, Background and Setting***, presents the physical setting for the 200-SW-1 and 200-SW-2 OUs, including information on geology and groundwater. This chapter also provides detailed descriptions of each of the 26 landfills within the scope of this RI/FS work plan.

- ***Chapter 3.0, Initial Evaluation of Landfills***, presents known and suspected contamination for the in-scope landfills, the preliminary conceptual site models for each landfill group (or "bin"), information on groundwater monitoring, potential impacts to human health and the environment, and the contaminants of potential concern (COPC).

- ***Chapter 4.0, Work Plan Approach and Rationale***, presents a summary of the data quality objectives (DQO) process, the characterization approach for each bin, and a description of the phased characterization approach.

- ***Chapter 5.0, Remedial Investigation/Feasibility Study Process***, presents a summary of the regulatory paths forward for the 200-SW-1 and 200-SW-2 OUs, a discussion of treatability investigations, a summary of cost-estimating processes that will be used in the feasibility study (FS), and a description of the proposed plan and RCRA permit modification process and the post-record-of-decision (ROD) activities.

- ***Chapter 6.0, Project Schedule***, presents a schedule for completion of the 200-SW-2 OU RI/FS process (including TSD closure/postclosure care), as well as a schedule for closure activities associated with the 200-SW-1 OU landfills.

- ***Chapter 7.0, References***, provides the complete citation of all documents referenced in this RI/FS work plan.

Appendices to this RI/FS work plan are listed below.

- ***Appendix A***, Sampling and Analysis Plan for the 200-SW-2 Operable Unit Landfills

- ***Appendix B***, Summary Descriptions and Figures of Waste Sites in the 200-SW-1 and 200-SW-2 Nonradioactive and Radioactive Landfills and Dumps Operable Units
- ***Appendix C***, Collaborative-Negotiations Completion Matrix Status
- ***Appendix D***, Data Collected to Support Characterization of Landfills in the 200-SW-2 Operable Unit
- ***Appendix E***, Initial Conceptual Site Models for the 200-SW-2 Operable Unit Landfills.

1.2 SCOPE AND OBJECTIVES FOR THIS RI/FS WORK PLAN

This RI/FS work plan presents 200-SW-1 and 200-SW-2 OU-specific details, including background information on the waste sites, existing data regarding contamination at the past-practice landfills and TSD-unit landfills, and the approach that will be used to investigate, characterize, and evaluate the landfills to support remedy selection and TSD closure/postclosure. A discussion of the remedial investigation (RI) planning and execution process is included, along with a schedule for the characterization work. Likely response scenarios that are to be considered for the 200-SW-2 OU landfills are identified in Chapter 4.0 of this RI/FS work plan. These likely response scenarios will be developed further and agreed to in the FS and eventual ROD(s).

A Phase I-A (D&D-27257, *Data Quality Objectives Summary Report for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*) process was completed in 2006. A follow-on Phase I-B DQO process (SGW-33253, *Data Quality Objectives Summary Report for Landfills in the 200-SW-1 and 200-SW-2 Operable Units*) was conducted to define the radioactive and nonradioactive constituents to be characterized and to specify the number, type, and location of samples to be collected at sites within the 200-SW-2 OU. The results of this DQO processes form the basis for the RI/FS work plan and the associated sampling and analysis plan (SAP) (Appendix A). The SAP includes a specific quality-assurance project plan and a field-sampling plan for implementing the field-characterization activities for the 200-SW-2 OU. A multiphased characterization approach will be employed to collect data to support remedial-action decision making. The phased characterization approach will require future revisions to this work plan and revised and/or additional SAPs. This phased approach is discussed in further detail in Section 5.3.

After all phases of characterization data have been collected for the landfills, results will be presented in an RI report. The RI report will include an evaluation of the characterization data for the TSD-unit landfills and past-practice units, including an assessment of the accuracy of the conceptual exposure model and refinement of the contaminant distribution model. During the FS, site-remediation alternatives will be evaluated against the nine CERCLA evaluation criteria (overall protection of human health and environment, applicable or relevant and appropriate requirements (ARAR) compliance, long-term effectiveness/permanence, reduction of toxicity/mobility/volume through treatment, short-term effectiveness, implementability, cost, state acceptance, and community acceptance). The RI report will support the evaluation of remedial alternatives that will be included in the FS or combined into a single RI/FS document.

The FS will use the existing and newly collected data to evaluate a range of remedial actions for the sites evaluated in the RI and for the remaining sites in the OUs that fall within the contaminant distribution model. As data are being collected and analyzed, work will proceed on the identification or development of suitable models to evaluate the cost and exposure (as-low-as-reasonably-achievable [ALARA]) aspects of the various remedial alternatives. Remedial alternatives may be applied at any or all of the past-practice units in the OUs, and different alternatives may be applied to different waste sites, depending on site characteristics. The FS ultimately will support a proposed plan leading to a ROD (with a closure/postclosure section) for of all the waste sites in the OU. The ROD will be reviewed, and a permit modification to WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8, for the Treatment, Storage, and Disposal of Dangerous Waste* (Hanford Facility RCRA Permit), will be proposed for the TSD unit (Low-Level Burial Grounds [LLBG]). Chapter 6.0 presents the schedule for assessment activities at the 200-SW-2 OU.

The information provided in this work plan reflects the most current, defensible data available at the time that it was prepared.

1.2.1 Coordinated Regulatory Approach

The RI/FS process will be used to reach a decision that will meet requirements for both National Priorities List cleanup and RCRA corrective action. TSD closure/postclosure for TSD-unit landfills within the boundaries of the 200-SW-2 OU will be coordinated with the RI/FS process. In addition, information from Ecology and DOE, 2005, *200-SW-1 and 200-SW-2 Collaborative Workshops, Agreement, Completion Matrix, and Supporting Documentation, Final Product* (Collaborative Agreement) will be considered in formulating the regulatory strategy for the 200-SW-2 OU. The coordinated regulatory process for characterization and remediation of the 200-SW-2 OU will use this RI/FS work plan in combination with the Implementation Plan (DOE/RL-98-28) to satisfy the requirements for both an RI/FS work plan and a RCRA field-investigation/corrective-measures study work plan. General facility background information, potential ARARs, preliminary remedial-action objectives (RAO), and preliminary remedial technologies developed in the Implementation Plan are incorporated by reference into this RI/FS work plan. Further detail regarding the coordinated regulatory approach can be found in Chapter 5.0.

1.2.2 Regulatory Approach for Closure of the Nonradioactive Dangerous Waste Landfill and the 600 Area Central Landfill

NRDWL and 600 CL are nonradioactive landfills that were operating at the time that the National Priorities List was developed for the 200 Areas. Therefore, these landfills were not originally included as waste sites that needed a CERCLA response action. However, because operations have ceased for the 600 CL, the landfill was included in Appendix C of Ecology et al., 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, (Tri-Party Agreement Action Plan). NRDWL was added to Appendix C to allow for the closure to be coordinated with the CERCLA RI/FS process. NRDWL and the 600 CL will have to be closed under WAC 173-303-610, "Closure and Post-Closure," and WAC 173-304-407, "Minimum Functional Standards for Solid Waste Handling," "General Closure and Post-Closure Requirements," respectively. Further detail regarding the regulatory approach for closure of the 200-SW-1 OU landfills can be found in Chapter 5.0.

1.2.3 Phased Characterization Approach for the 200-SW-2 Operable Unit Landfills

Because of the complexity of the 200-SW-2 OU landfills, a phased characterization approach will be employed to aid in remedial-action decision making. This approach was approved by the U.S. Department of Energy (DOE), Richland Operations Office (RL) and Ecology and documented in CCN 0073214, *Path Forward – 200-SW-1/2 RI/FS Work Plan Development, May 15, 2007.*

A preliminary investigation began in 2004 to perform a comprehensive review of existing documentation associated with the 200-SW-2 OU waste sites. In 2005, a collaborative negotiations process was held with DOE, EPA, and Ecology (the Tri-Parties). This process rescoped the focus of the DQO to follow. This DQO process (Phase I-A) focused on nonintrusive investigations of these waste sites, including geophysical, radiological, and organic-vapor surveys.

After Phase I-A field characterization activities were performed in mid-2006, a Phase I-B DQO process was performed to support development of this RI/FS work plan. The Phase I-B DQO process focused on 24 landfills in the 200-SW-2 OU. Additionally, two landfills in the 200-SW-1 OU were included in the DQO, as well as in this RI/FS work plan; however, it is proposed that these landfills be closed outside of the CERCLA process, and they are included in this documentation for information purposes only. The Phase I-B DQO and SAP (Appendix A) focus on additional nonintrusive characterization as well as intrusive characterization techniques.

Additional DQO processes (Phases II and III) will be held following completion of the Phase I-B field-characterization activities, as required. These future-phase DQO processes will further aid in characterizing the landfills and will focus on progressively more intrusive characterization techniques, as required. Further detail regarding the phased characterization approach for the 200-SW-2 OU landfills can be found in Chapter 5.0.

1.3 EXCLUSIONS FROM SCOPE OF WORK PLAN

1.3.1 Suspect Transuranic Waste

Before 1970, low-level waste (LLW) was disposed to the same landfill trenches as waste that would have contained transuranic elements and/or mixed fission products (MFP). After 1970, waste that was designated as TRU waste was segregated in either specified low-level burial ground (LLBG) trenches or underground concrete caissons in the LLBGs for future retrieval.

Several of the LLBG sites contain retrievably stored suspect TRU wastes. Retrieval of these wastes is out of the scope of this RI/FS work plan; this material will be retrieved in accordance with Tri-Party Agreement Milestones M-091-40 and M-091-41 (Ecology et al., 1989a).

Retrievably stored suspect TRU waste is located in specific locations within the 218-E-12B, 218-W-3A, 218-W-4B, and 218-W-4C Landfills. This includes four caissons in the 218-W-4B Landfill (218-W-4B-CA1, 218-W-4B-CA2, 218-W-4B-CA3, and 218-W-4B-CA4) that contain suspect TRU wastes only. A fifth caisson (218-W-4B-CA5) is believed to be empty, based on historical records; this will be confirmed through this RI/FS work plan.

Outside the scope of this RI/FS work plan, the suspect TRU retrieval program has developed separate DQOs and SAPs for substrate sampling at each of these four landfills in the LLBG, in accordance with Tri-Party Agreement Milestone M-091-40. The substrate sampling will occur in each trench segment following retrieval of the suspect TRU waste in that landfill. Retrieval of waste in accordance with Tri-Party Agreement Milestone M-091-40 is scheduled to be completed in 2010. As a result of this schedule, data generated from some of the substrate sampling may be available to evaluate the need for interim remedial measures before the RI/FS process for the 200-SW-2 OU is completed in 2011. However, some substrate sampling also will be conducted after the RI/FS process has been completed.

Data in this RI/FS work plan (e.g., waste volumes, contaminant inventories, trench lengths) may or may not include information related to retrievably stored TRU waste, depending on the context. Data presented, therefore, have been labeled with clarifications as to whether TRU waste or TRU waste-containing trenches are included in the data. None of the data presented in this report includes information related to the trenches currently used for disposal (218-E-12B-T94, 218-W-5-T31, and 218-W-5-T34).

1.3.2 Unused Portions of Treatment, Storage, and Disposal-Unit Landfills

The 218-W-6 Landfill was reserved for future use and never has received waste; it will not be evaluated during this investigative activity, because it was transferred in 2007 to the 200-MG-1 OU. Other portions of the LLBG sites that never have received waste also will not be evaluated. The unused portions of the 200-SW-2 OU landfills will be walked down, and geophysical surveys may be conducted to verify that they were never used.

1.3.3 Operating Trenches

Trench 94 in the 218-E-12B Landfill (within the LLBG TSD unit) is out of the scope of this RI/FS work plan, because the trench will be in use for disposal of U.S. Navy vessel reactor compartments beyond the timeframe (2024) that the Tri-Party Agreement specifies for remediation of the 200-SW-2 OU.

Trenches 31 and 34 in the 218-W-5 Landfill also are out of the scope of this RI/FS work plan, because these trenches are expected to receive waste beyond the timeframe when the FS and proposed plan for the 200-SW-2 OU are planned to be completed.

1.4 200 AREAS IMPLEMENTATION PLAN

The Implementation Plan (DOE/RL-98-28) outlines the framework for implementing assessment activities and the evaluation of remedial alternatives in the 200 Areas to ensure consistency in the documentation, the level of characterization, and decision making. A regulatory framework is established in the Implementation Plan to integrate the requirements of RCRA (for corrective actions and TSD units), CERCLA, Federal facility regulations, and the Tri-Party Agreement into one standard approach for cleanup activities in the 200 Areas. Special emphasis is given to Hanford Site-specific application of RCRA and CERCLA as specified in the Tri-Party Agreement, local policy and programmatic requirements, and the basis for integrating these requirements in the 200 Areas. This approach establishes use of the CERCLA process as the basis for assessment and remediation activities in the 200 Areas, with modification as necessary to concurrently satisfy requirements specific to RCRA corrective action for RCRA past-practice sites and RCRA closure of TSD units.

The Implementation Plan consolidates much of the information normally found in an OU-specific work plan to ensure consistency and avoid duplication of this information in each of the OU work plans for the 200 Areas. The Implementation Plan also lists potential ARARs and preliminary RAOs and contains a discussion of potentially feasible remedial technologies that may be employed in the 200 Areas. This RI/FS work plan references the Implementation Plan for further details on several topics, such as general information on the physical setting of the areas under consideration, the operational history of 200 Areas facilities, potential ARARs and RAOs, and post-work-plan activities.

The Implementation Plan addresses the more than 800 waste sites that were assigned to the process-based OUs, which in turn were grouped into major waste categories (e.g., process waste, landfills, cooling water). This categorization facilitates the use of streamlining approaches, which was a fundamental concept under the Implementation Plan. The 200-SW-1 and 200-SW-2 OUs fell within the Landfills and Dumps waste category. This category contains landfill sites and was subdivided into the following groups based on the radionuclide inventory.

- **Nonradioactive Landfills and Dumps Group (200-SW-1 OU).** This group covers two landfills, the NRDWL and the 600 CL. These landfills contain nonradioactive unused laboratory and plant chemicals, as well as sanitary waste and construction and demolition debris. Trenches in the 600 CL also received bulk liquid and sludge for disposal.

- **Radioactive Landfills and Dumps Group (200-SW-2 OU).** Sites included in this group primarily consist of constructed (e.g., vertical pipe units, caissons) or excavated sites (landfills) that received either LLW or mixed LLW (MLLW). The sites also were used for the storage of suspect and retrievably stored TRU wastes. Large landfills, each made up of a number of trenches, were used in the 200 East and 200 West Areas. While storage and retrieval activities are ongoing in multiple trenches, only three trenches continue to be used for disposal – the lined Trenches 31 and 34 in the 218-W-5 Landfill and Trench 94 in the 218-E-12B Landfill. The landfills received wastes such as contaminated equipment, solid laboratory or process waste, clothing, or tightly packed/sealed liquid wastes in radiological vessels. Before 1970, LLW was disposed to the same landfill trenches as waste that would have contained transuranic elements and/or MFPs. After 1970, waste that was designated as TRU waste was segregated in either specified LLBG trenches or underground concrete caissons in the LLBGs. Additional information regarding TRU waste can be found in Section 2.2.2. Wastes were largely solid materials and mostly from on site; but offsite and liquid wastes (tightly packed and sealed in drums) are known to have been placed in the landfills. The LLBG landfills are among the largest waste sites at the Hanford Site, and some cover many ac. Unlike many highly contaminated waste sites at the Hanford Site, large amounts of bulk liquids are not expected to be present to drive contamination throughout the soil column, although some volatile contaminants are capable of migrating through the soil without a driving force.

Subsequent to publication of DOE/RL-2004-60, *200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study Work Plan*, Draft A, a number of smaller waste sites that once resided in the 200-SW-2 OU were moved to the 200-MG-1 OU per Tri-Party Agreement change requests. This migration of waste sites primarily affected Bin 1 and Bin 2, as described in the Draft A work plan. Based on a reassessment of the 24 landfills that now remain in the 200-SW-2 OU, a new set of groupings or "bins" has been established for this version of the work plan. This new set of bins was established based on factors such as waste volume, waste type, waste form, disposal practices, periods of landfill operations, homogeneity of waste, and potential risk, among others. The new bins have been named as follows and will be identified as such throughout this document:

- *Bin 1 – TSD-Unit Landfills*
- *Bin 2 – Industrial Landfills*
- *Bin 3 – Dry Waste Alpha Landfills*
- *Bin 4 – Dry Waste Landfills*
- *Bin 5 – Construction Landfills*
- *Bin 6 – Caissons.*

1.5 PROJECT ASSUMPTIONS

Project assumptions for this RI/FS work plan include the following.

- Some of the waste materials in the 200-SW-2 OU landfills originated from offsite generators. The disposal records from the offsite generators are not complete. However, because of the wide variety of process activities at the Hanford Site, it is assumed that the constituents present in the offsite materials are adequately represented by the contaminants associated with onsite generation.

- The contaminants in the 200-SW-2 OU are expected to be located within 3 to 10 m (10 to 33 ft) of the ground surface, and at or near the bottom of the disposal unit (trench). There may be exceptions to this contaminant distribution model that require the use of multiple conceptual site models. For example, several sites (218-W-3A, 218-W-4B, and 218-W-4C Landfills) are reported to have been briefly "flooded" because of rapid snowmelt conditions after burials were made to the sites. One trench in the 218-E-12B Landfill (before waste disposal) was found to have been saturated from water seeping into the area from a nearby, breached ditch that transferred cooling water to the

200 Areas B Pond system. Portions of three additional sites (the 218-C-9, 218-W-2A, and 218-W-3AE Landfills) were used as cooling-water disposal sites (i.e., 216-C-9 and 216-T-4 Ponds) before burials were made. Potential contamination originating from the 216-C-9 Pond is being examined under the 200-MG-1 OU. Potential contamination originating from the 216-T-4 Pond system (216-T-4-1D Ditch, 216-T-4-2 Ditch, 216-T-4A Pond, and 216-T-4B Pond) will be investigated by the 200-CW-1 and 200-MG-2 OUs.

- The land use for the 200 Areas selected by the DOE through the NEPA process (DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*) and documented in 64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (CLUP EIS)" is industrial (exclusive). Most of the 200-SW-1 and 200-SW-2 OU landfills are located within the 200 Areas Central Plateau Core Zone boundary. Therefore, based on the land-use decision for the 200 Areas, potential impacts from the landfill contaminants within the 200 Areas would be to current and future site workers and to terrestrial biota using the sites. The land use for the sites outside the Core Zone boundary focuses on preservation, recreation, conservation, fill material, grazing, or industrial uses, depending on the location (DOE/EIS-0222-F).

- This RI/FS work plan will address likely response scenarios, including no action, removal, treatment, and disposal (RTD) of waste from within portions of individual landfills, capping of individual landfills, in situ treatment/stabilization (e.g., vitrification/grouting) of portions of individual landfills, maintain existing soil cover (MESC), monitored natural attenuation (MNA), or some combination of the above.

- The seven *Bin 1 – TSD-Unit Landfills* will be closed using an integrated RCRA/CERCLA/ *National Environmental Policy Act of 1969* (NEPA) process to avoid duplication of effort as outlined in the Tri-Party Agreement Action Plan, Section 5.5 (Ecology et al., 1989b). A crosswalk (Chapter 5.0, Table 5-6) of CERCLA and RCRA substantive requirements for the 200-SW-2 OU has been prepared to facilitate this coordination. Ecology will issue a draft permit modification for closure of the LLBG TSD units that will be separate from the CERCLA proposed plan. Ecology's proposed permit modification for the closure activities for the LLBG TSDs will be based on the closure documentation presented in the 200-SW-2 OU CERCLA FS and administrative record. The DOE will structure each CERCLA document "such that RCRA closure requirements can be readily identified for a separate review/approval process" in accordance with Section 5.5 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b). The closure will be accomplished in accordance with WAC 173-303, "Dangerous Waste Regulations." Coordination of the closure activities with the CERCLA actions will optimize timing and efficiency. RCRA-CERCLA integration is consistent with the provisions contained in the Tri-Party Agreement. To the extent that there are similarities in design and construction requirements for the CERCLA remedy and the LLBG TSD closure, Ecology proposes to implement closure activities for the LLBG TSD units by using the remedial design/remedial action work plan for the CERCLA remedies.

- The seven landfills in *Bin 1 – TSD-Unit Landfills* and the 17 landfills in Bins 2 through 5 and the caissons in Bin 6 (see Section 3.2.2 for a discussion of the bins) are of the highest interest to Ecology and Stakeholders because of the following:
  - Large volume of waste
  - Transuranic materials
  - Dates of disposal
  - High dose rate of some waste.
- The 200-SW-2 OU is a source OU. Issues related to groundwater characterization, monitoring, and remediation are not within the scope of this RI/FS work plan and will be addressed in the respective groundwater OUs and through the TSD permitting process. There are no indications that the landfills in the 200-SW-2 OU have impacted groundwater.
- The RI/FS work plan will focus on determining whether highly mobile contaminants or other contaminants with a potential to reach groundwater have migrated into the vadose zone beneath the buried waste.
- The anticipated land use for the Central Plateau will be DOE industrial-exclusive use for at least 50 years and industrial use afterwards for the foreseeable future.
- Data may be collected through this RI/FS work plan to evaluate the option of leaving high-dose rate waste in place, because the natural decay of the high-activity radionuclides will have subsided to levels of minor risk, based on anticipated land use.
- Retrievably stored waste (RSW) will be handled in the M-091 Program (outside of the 200-SW-2 OU). All other solid waste in the 200 Areas landfills (with the exception of Trenches 31 and 34 in the 218-W-5 Landfill and Trench 94 in the 218-E-12B Landfill) is within the scope of this RI/FS work plan.

1.6 CHANGE MANAGEMENT

Following finalization and issuance of this 200-SW-1 and 200-SW-2 OUs RI/FS work plan, Ecology or the DOE may seek to modify the document. Such modifications may require additional field work, pilot studies, computer modeling, or other supporting technical work. This normally results from a determination that the requested modification is necessary based on new information (i.e., information that became available or conditions that became known after the report was finalized). The requesting party may seek such a modification by submitting a concise written request to the appropriate project manager(s). In the event that a consensus on the need for a modification is not reached by the project managers, either the DOE or Ecology may invoke dispute resolution, in accordance with the provisions of the Tri-Party Agreement, to determine if such modification shall be made. Modification of this RI/FS work plan will be required only upon a showing that the requested modification could be of significant assistance in evaluating impacts on the public health or the environment, in evaluating the selection of remedial alternatives, or in protecting human health and the environment.

Nothing in this section is intended to alter Ecology's ability to request the performance of additional work in accordance with the provisions of the Tri-Party Agreement. If the additional work results in a modification to a final document, the review and comment process will be the same as for the original document. Minor changes to the approved RI/FS work plan that do not qualify as minor field changes can be made through use of a change notice. Minor field changes can be made by the person in charge of the particular activity in the field. Minor field changes are those that have no adverse effect on the technical adequacy of the job or the work schedule. Such changes will be documented in the daily log books that are maintained in the field.

The change notice will not be used to modify schedules contained within this work plan. Such schedule changes will be made in accordance with Section 12.0, Changes to the Agreement, of the Tri-Party Agreement Action Plan.

Minor changes include specific additions, deletions, or modifications to the scope and/or requirements that do not affect the overall intent of this RI/FS work plan or associated schedule (Chapter 6.0). Ecology will evaluate the need to revise this RI/FS work plan. If a revision is determined to be necessary, then Ecology will decide whether it can be accomplished through use of the change notice or if a full revision to the plan is required.

The change notice will be prepared by the DOE project manager and approved by the assigned project manager from Ecology. The approved change notice will be distributed as part of the next issuance of the project managers' meeting minutes. The change notice thereby will become part of the Administrative Record. The change notice form shall, as a minimum, include the following:

- Number and title of document affected
- Date document last issued
- Date of this change notice
- Change notice number
- Description of change
- Justification and impact of change (to include effect on completed or ongoing activities)
- Signature blocks for the DOE and Ecology project managers.

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2.0 BACKGROUND AND SETTING

This chapter describes the 200-SW-1 and 200-SW-2 Nonradioactive and Radioactive Landfills and Dumps Group OUs. It summarizes waste-site information and the hydrogeologic framework associated with these OUs to provide a fundamental understanding of the physical setting and potential impacts on the environment. Background and setting information includes the landfill descriptions and history, physical setting, and waste-generating processes.

To streamline this RI/FS work plan, much of the summary information for these OUs is included by reference to other documents. Section 2.2.10 of this document describes the individual landfills within the 200-SW-1 and 200-SW-2 OUs.

All disposal areas in the Hanford Site 200 Areas that are within the 200-SW-1 and 200-SW-2 OU scope have been designated with the "218" number prefix. Hanford Site disposal areas with the 218 number prefix typically are landfills that have been pre-planned, designed, constructed, and operated with the intention of long-term and permanent disposal of solid waste. While some of the disposal areas within the scope of the 200-SW-1 and 200-SW-2 OUs have had variety of alias names (e.g., *Burial Garden No. 1, Equipment Burial Ground #10, 200 East Minor Construction No.4, 200 East Construction Burial Grounds, 200 East Dry Waste No. 12A, Dry Waste No 003, and Burial Grounds*), this work plan uses the term "landfill" to more generically refer to these locations that have the "218" prefix. All of the waste in the 218-prefixed landfills within the scope of the 200-SW-1 and 200-SW-2 OUs has been disposed to unlined trenches that have been pre-planned, designed, constructed, and operated under site operating procedures. Furthermore, and as discussed in Sections 2.1.2 and 2.1.3, the landfills in the 200-SW-2 OU fall into two categories of RCRA TSD-unit landfills (7 total), and past-practice landfills (17 total).

Figures 1-2, 1-3, and 1-4 show the locations of the landfills in the 200 East, 200 West, and 600 Area, respectively.

2.1 DESCRIPTIONS OF WASTE SITES

The following sections provide a description of the 26 landfills in the 200-SW-1 and 200-SW-2 OUs.

In addition to the following sections, Table B-1 in Appendix B presents brief summaries for all 24 landfills in the 200-SW-2 OU and the two additional landfills in the 200-SW-1 OU. Appendix B, Table B-2 presents brief summaries for 15 unplanned releases associated with these sites.

2.1.1 600 Area Nonradioactive Dangerous Waste Landfill and 600 Area Central Landfill

The NRDWL is an inactive TSD-unit landfill. Although a NRDWL site closure plan was written in 1990, the closure plan has not been approved. Therefore, NRDWL is classified as "Active" in the *Waste Information Data System* (WIDS) database. The landfill provided a site for disposal of dangerous waste generated from process operations, research and development laboratories, maintenance activities, and transportation functions throughout the Hanford Site (WIDS). Figure 2-1 illustrates the present configuration of the trenches in the NRDWL, trench identification numbers, trench types, and operational dates.

The NRDWL is located about 5.6 km (2.5 mi) southeast of the 200 East Area on Army Loop Road, southwest of the Route 4 intersection and southeast of the 200 East Area. It began operation in 1975 and has an area of 4.5 hectares (11 ac). It consists of 19 parallel trenches, each 122 m (400 ft) long, 4.9 m (18 ft) wide at the base, and 4.6 m (15 ft) deep. A triangular column of undisturbed soil with approximately 1:1 side slopes separated the trenches as they were constructed. The final profile of the trench varied depending on the type of waste received.

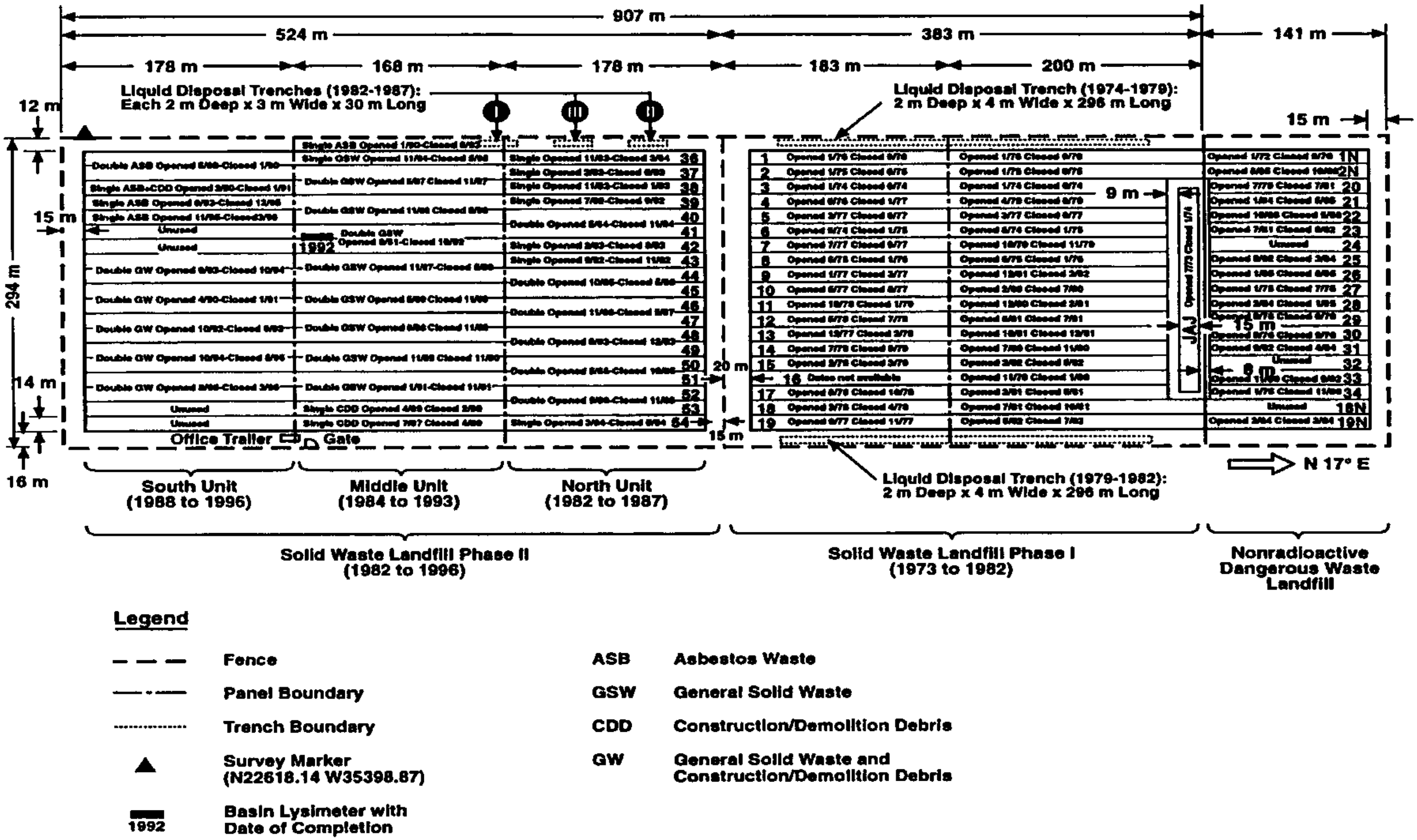
The trenches typically were backfilled and covered with 2 to 3 m (6 to 10 ft) of soil at the end of each operating day. Beginning in 1975, chemical waste was disposed of in six trenches, asbestos in nine trenches, nonhazardous solid waste in one trench, and three were unused. The last receipt of dangerous waste was in May 1985; the last receipt of asbestos occurred in May 1988. A permanent 2.4 m (8-ft-) high fence with lockable gates surrounds the NRDWL.

The 600 CL is a non-RCRA solid-waste landfill adjacent to NRDWL on the south side. It is a larger facility (27 ha [67 ac]) that received principally solid waste, including paper, construction debris, asbestos, and lunchroom waste. It also received up to 5,000,000 L (1,320,000 gal) of sewage and 380,000 L (100,000 gal) of garage wash water. The liquid waste was discharged to east-west oriented trenches at the perimeter of the main solid-waste area, along the northeast and northwest boundaries of the 600 CL. The 600 CL is not a RCRA landfill; rather this landfill is regulated by WAC 173-304, "Minimum Functional Standards for Solid Waste Handling." It is included in this section because of its collocation with the NRDWL.

The two landfills (NRDWL and 600 CL) were operated as a single landfill, originally known as the Central Landfill. Because of the presence of dangerous waste in the chemical trenches, the 19 northernmost trenches (1N, 2N, 18N, 19N, and 20-34) were designated as the NRDWL under the Hanford Facility RCRA Permit (WA7890008967). The southern two-thirds of the area later was designated as the Solid Waste Landfill or 600 CL, which is not a TSD unit. The boundary line separating the NRDWL from the SWL is located halfway between the trench designated as "JA Jones" and the southern border of NRDWL (DOE/RL-90-17, *Nonradioactive Dangerous Waste Landfill Closure/Postclosure Plan*).

A geophysical survey of the NRDWL was conducted in 2000. It was noted that some of the trench centers vary significantly from previous documentation and, in some locations, the buried debris is covered by only 0.6 m (2 ft) of fill. Unused portions of Trenches 19N and 26 have remained open since 1985.

Figure 2-1. Nonradioactive Dangerous Waste Landfill and Solid Waste Landfill.



Trenches 18N, 24, and 32 were not used for disposal. Trenches 19N, 26, 28, 31, 33, and 34 received an unknown volume of liquid waste consisting of laboratory chemicals, bulk organic waste, solvent waste, paints, paint thinners, waste oils, and empty containers. The chemical trenches were constructed with an access ramp to the bottom of the trench to allow transfer vehicles to access the working face. A 20 to 30.5 cm (8- to 12-in.) layer of gravel and cobble was placed over the bottom of the trench to form a temporary roadbed. The containerized chemical waste was off-loaded from transport trucks that had backed down the access ramp and up to the working face of the trench. Placement of the waste was supervised by a landfill operator. Containers (the majority of which were 208.2 L [55-gal] lab packs) were arranged in rows, standing end-to-end in the bottom of the trenches. Containers normally were placed in a single layer along the bottom of the trench; however, when a large shipment of drums was received, drums were stacked two high. At the end of the day, a portion of the spoil pile was pushed over the waste containers with a crawler/tractor to form the operational cover. Typically, the operational cover for the chemical trenches was approximately 3 m (10 ft) thick. When drums were stacked two high, the cover was reduced to approximately 2 m (6 ft) (DOE/RL-90-17).

Trenches 2N, 20, 21, 22, 23, 25, 27, 29, and 30 received friable and nonfriable asbestos solid waste from building demolitions/renovations. Miscellaneous trash and debris from offices, lunchrooms, and construction/demolition activities were disposed of in Trench 1N, and approximately 5,300 L (1,400 gal) of nondangerous/nonradioactive septic-tank sludge was disposed to Trench 34. Waste at the asbestos and sanitary-waste trenches was unloaded at the base of the working face (as was done with the chemical trenches) or at the top edge of the working face. When waste was unloaded at the top edge, a tractor was used to push the waste into the trench to the desired height. In both cases, at the end of a day of operation, a portion of the spoil pile was pushed over the refuse to form an operational cover. The cover typically was 1.2 m (4 ft) thick, but varied from about 1.2 to 2 m (4 to 6 ft), depending on the thickness of the waste layer (DOE/RL-90-17).

Reportedly, no bulk liquids or free liquids (other than lab packs packed with absorbents) have been allowed into this landfill. All dangerous wastes were containerized, with the exception of asbestos and sanitary solid wastes, before going to disposal (WIDS).

2.1.2 200-SW-2 Operable Unit Treatment, Storage, and/or Disposal Unit Landfills

One RCRA TSD unit is associated with the 200-SW-2 OU. The RCRA TSD unit (consisting of seven radioactive landfills and one unused landfill), as noted in Chapter 1.0, is called the LLBG TSD unit. This unit includes the 218-E-10, 218-E-12B, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, and 218-W-5 Landfills in the 200-SW-2 OU, and the 218-W-6 Landfill in the 200-MG-1 OU. The unit is described in detail in the following sections. Copies of the most recently approved Part A Permit applications for the TSD unit are contained in DOE/RL-91-28, *Hanford Facility Dangerous Waste Permit Application*, Rev. 7. Publicly available portions of this document are available on the DOE Richland Operations Office website, http://www.hanford.gov/docs/rl-91-28/rl91-28chp_02.htm#2.2.1.2.

2.1.2.1 218-E-10 Landfill

This landfill began service in 1955, covers 36.5 ha (90 ac), and contains remote-handled and contact-handled unsegregated waste and LLW. These dimensions include an unused annex of this landfill. The total area of this landfill that has been used for disposal of waste is 23 ha (57 ac). Most of the waste buried before 1990 is in concrete boxes, while waste buried later mainly was direct-dumped from trucks (*Solid Waste Information and Tracking System* [SWITS] database). One source (HNF-SD-WM-ISB-002, *Solid Waste Burial Grounds Interim Safety Basis*) reports that this landfill contains one concrete box of suspect post-1970 remote-handled TRU waste (Trench 4). There is no retrievably stored waste under Tri-Party Agreement Milestone M-091-40 in the 218-E-10 Landfill.

The 218-E-10 Landfill is located approximately 610 m (2,000 ft) northwest of the B Plant and directly west of the 218-E-5A Landfill. The 218-E-10 Landfill consists of 13 trenches running north to south and one trench running east to west. Trench 1 is 7.3 m (24 ft) deep with surface dimensions of 430 m (1,420 ft) long by 18 m (60 ft) wide. Trenches 2 through 9, 11, 12, 14, and 16 are 4.6 m (15 ft) deep, 18 m (60 ft) wide at the surface, and vary in length from 264 to 433 m (865 to 1,420 ft). The backfilled trench running east-west has surface dimensions of 165 m (540 ft) long by 17 m (55 ft) wide (WIDS).

As of September 2005, the 218-E-10 Landfill, also known as 200 East Industrial Waste No. 10, had received approximately 26,900 m^3 (35,200 yd^3) of waste, mostly from the Plutonium-Uranium Extraction (PUREX) Plant, B Plant, T Plant, offsite (mainly Formerly Utilized Sites Remedial Action Program [FUSRAP] waste), and the 100 Area (mainly N Reactor waste). Waste forms include failed equipment and mixed industrial wastes (e.g., concrete-canyon cover blocks, centrifuge blocks, tubing bundles, jumper vessels, pumps, columns, filters). The trenches contain low-level radiological waste, MLLW, and unsegregated remote-handled waste. Trench 9 currently is identified as containing MLLW disposed of after the effective date of mixed-waste regulation, August 19, 1987. The disposal of MLLW to Trench 9 will be confirmed; it is believed that some of the waste so identified may no longer be regulated, because it is contaminated only with lead shielding and dioctyl phthalate (used for testing efficiencies of high-efficiency particulate air [HEPA] filters).

In 1960, a partially covered burial box containing PUREX tube bundles caused an airborne contamination spread (UPR-200-E-23, UPR-200-E-24). In 1961, a wooden burial box containing process jumpers collapsed as it was covered with soil (UPR-200-E-30, previously assigned to the 218-E-12A Landfill but now known to have occurred in the 218-E-10 Landfill). An already remediated unplanned release site (UPR-200-E-61) is located at the railroad right-of-way within the 218-E-10 Landfill. It is contamination found after a concrete burial box was off-loaded from railroad cars to landfills in 1981. The site was decontaminated within a few days after discovery. The southeastern section of the 218-E-10 Landfill (Trenches 1 through 5) was backfilled, surface stabilized, and revegetated with grasses in 1980. The northern annex portion of this landfill never has been used for waste disposal (WIDS).

These landfill trenches are contained within the proposed groundwater-monitoring system for the low-level landfills. Airborne-radionuclide monitoring is performed routinely, and a perimeter radiological survey is performed annually (WIDS).

Hanford Site Drawings that describe this landfill include H-2-92004, *Industrial Burial Ground 218-E-10 Site Plan and Details* (site plan), and H-2-821555, Sheet 4, *Subsidence Drawing Burial Ground 218-W-3AE* (stabilization).

2.1.2.2 218-E-12B Landfill

This landfill began service in 1967 (WIDS), covers 73.7 ha (182 ac), and contains unsegregated waste, LLW, three trenches of suspect retrievably stored TRU, and defueled U.S. Navy vessel reactor compartments in Trench 94 (DOE REG-0271, *Low-Level Burial Grounds Fact Sheet*). This landfill is located approximately 305 m (1,000 ft) north of the C Tank Farm.

The 218-E-12B Landfill, Trench 94, is currently receiving defueled U.S. Navy vessel reactor compartments as an active RCRA TSD unit (DOE/RL-98-28). Trench 94 is not addressed in this document, because operations are expected to continue beyond the beginning of the scheduled time period for remedial actions in the 200-SW-2 OU.

The original landfill was designed to have 29 trenches. An expansion to the north and west enlarged this landfill to include the potential for 138 trenches oriented in a north-south direction. Only 36 trenches were filled completely, and an additional two were partially filled.

The in-scope trenches vary in length from 288 to 381 m (944 to 1,250 ft). The first six trenches (1A-1D, 3, and 7) are 0.9 m (3 ft) wide and 1.2 m (4 ft) deep. The rest of the trenches were designed to be 4.8 m (16 ft) deep and 11 m (37 ft) wide at the surface. The landfill is marked and radiologically posted (WIDS).

As of September 2005, the 218-E-12B Landfill, not including Trench 94, had received 65,086 m^3 (85,129 yd^3) of solid unsegregated waste and LLW generated mostly from facilities located in the 200 East Area, including tank farms, B Plant, and PUREX general trash, failed equipment, vent risers, filter boxes, liquid-level risers from the 216-B-14 Crib, and Sr-90 contaminated soil dredged from the 216-B-63 Crib after UPR-200-E-138 occurred (DOE/RL-92-05, *B Plant Source Aggregate Area Management Study Report*). Most of the in-scope waste in this site was direct-dumped from trucks or buried in cardboard cartons (SWITS). This waste volume does not include post-1970 retrievably stored TRU, which is out of the scope of this work plan. The 218-E-12B Landfill is the second landfill of four in priority under Tri-Party Agreement Milestone M-091-40 that are scheduled to have the stored retrievable TRU waste removed.

The southeastern portion of this landfill (Trenches 1 to 17) was interim-stabilized in 1981 with 46 to 61 cm (18 to 24 in.) of uncontaminated soil. Surveillance and maintenance of the stabilized portion are performed periodically. In January 2000, two contaminated tumbleweeds were removed from the landfill. The source of contamination likely was plant-root uptake of contamination from the buried waste. The tumbleweeds read from 29,000 to 59,000 d/min per 100 cm^2 beta/gamma and less than 20 d/min alpha. In addition, 13 tumbleweed fragments read from 2,500 to 399,000 d/min per 100 cm^2 beta/gamma.

Hanford Site Drawings that describe this landfill include H-2-821555, Sheet 2, *Subsidence Drawing Burial Ground 218-W-3A* (subsidence), and H-2-96660, *East Area Dry Waste Burial Ground* (site plan).

2.1.2.3 218-W-3A Landfill

This landfill was placed in service in 1970, covers 22 ha (54 ac), and contains unsegregated waste, LLW, MLLW, TRU, and TRU mixed waste (TRUM) (SWITS).

The 218-W-3A Landfill is an active TSD unit located on Dayton Avenue and 27th Street, immediately southeast of their intersection. It is west of the 221-T Building and immediately north of the 218-W-3 Landfill. The landfill is 380 m (1,250 ft) long and of irregular shape (H-2-34880, *Dry Waste Burial Ground 218-W-3A*).

This landfill was designed to contain 61 dry- and industrial-waste trenches running in an east-west direction. However, four trenches never were constructed, and the unit presently consists of 57 trenches of varying sizes ranging from 127 m to 284 m (417 to 930 ft) long. The side slopes are 1:1 or as required to match the natural angle of repose. Trench depths range from 3.7 to 5.8 m (12 to 19 ft) (BHI-00175, *Z Plant Aggregate Area Management Study Technical Baseline Report*).

As of September 2005, this landfill contained approximately 97,500 m^3 (127,500 yd^3) of unsegregated waste, post-1987 MLLW, and LLW. Trenches 1, 4, 5, 6, 8, 10, 15, 17, 23, 30, 32, 34, 6S, and 9S contain post-1970 retrievably stored TRU, which is out of the scope of this work plan. The 218-W-3A Landfill is the third landfill of four in priority under Tri-Party Agreement Milestone M-091-40 that are scheduled to have the retrievable stored TRU waste removed. Most of the post-1970 TRU-containing trenches also contain unsegregated wastes and/or LLW.

Trenches 3S, 6S, and 19 currently are identified as containing the MLLW disposed of after the effective date of mixed-waste regulation at the Hanford Site (August 19, 1987).

Most of the in-scope waste in this unit is from the 100 Area (21 percent by volume), various facilities in the 200 West Area (34 percent), the 300 Area (23 percent), and the tank farms (14 percent). Less than 3 percent by volume is from offsite facilities, and the remaining 5 percent is from Hanford Site facilities in the 200 East Area and other miscellaneous site locations. Trench 7 contains waste from the clean-up at the Three Mile Island Nuclear Plant. Trench 14 contains 10 large concrete burial boxes of radioactive soil from the S Tank Farm that was generated from a salt-waste spill from Tank 241-S-102 transfer piping in 1973. Dose rates at the site of the spill before the contaminated soil was removed ranged to a maximum of 9 R/h (WIDS).

This landfill was flooded in the winter of 1979 - 1980, when several inches of snow on top of solidly frozen ground were followed by a quick warming and rapid snow melt. The landfill was covered with standing water that was almost continuous from the dirt road on the east side to the asphalt road on the west side of the landfill.

On January 21, 1997, a radiological control technician discovered contamination levels (in a posted Underground Radioactive Material Area) to 60,000 d/min beta-gamma (no alpha) per 100 cm^2 in pieces of wind-blown tumbleweed at Trench 26. Two unplanned releases have been consolidated (WIDS) to this landfill. First, UPR-200-W-84 reported that in July 1980 a liquid spill occurred in the 218-W-3A Landfill during burial operations of a pump. This spill resulted in contamination of the truck transporting the pump and the ground around the truck. Second, UPR-200-W-134 reported in October 1975 that an improper burial occurred in the 218-W-3A Landfill of a waste drum labeled "Transuranic" (Grubb and Lust, 1975, *Hanford Engineering Development Laboratory Unusual Occurrence Report 38-75*). The drum contained plutonium, uranium, and fissile materials. Applicable standards were not met for the handling and safe storage of this waste drum from the 325 Building. The trench section where it was buried was redesignated as transuranic and will be dispositioned by the M-091 Program.

Hanford Site Drawings that describe this landfill include H-2-34880, Sheets 1 and 2 (site plan); and H-2-821555 (stabilization).

2.1.2.4 218-W-3AE Landfill

This landfill covers approximately 23 ha (57 ac) and began receiving waste in 1983. It contains MLLW and LLW including large equipment.

The 218-W-3AE Landfill is located directly east of and adjacent to the 218-W-3A Landfill in the 200 West Area. The landfill has received 34,300 m^3 (44,900 yd^3) of waste as of September 2005. The waste is mainly from the 100 Area (23 percent by volume), 200 East and West Areas (13 percent), 300 Area (16 percent), and other miscellaneous Hanford Site areas and facilities such as the tank farms and the 1100 Area (22 percent). The remaining 26 percent is from offsite generators, the major contributors being Energy Systems Group, Argonne National Laboratory, Fermi National Accelerator Laboratory, and Battelle Columbus.

The irregularly shaped unit consists of eight trenches of varying sizes. Each trench location is identified by a concrete post with a brass name plate (BHI-00175).

This landfill includes Trenches 5 and 8, which are wide-bottom stacking trenches and contain large equipment such as portions of rail cars, and Trench 26, which was dug with a wide bottom to dispose of large tanks. The landfill has been receiving miscellaneous wastes such as rags, paper, rubber gloves, disposable supplies, and broken tools, and industrial waste such as failed equipment, tanks, pumps, ovens, agitators, heaters, hoods, jumpers, and accessories. All trenches have received remote-handled LLW.

The location designated as the 218-W-3AE Landfill includes an area that previously had been the 216-T-4B seepage ponds for T Plant condensate effluent. The pond area often was dry, because the majority of the effluent was absorbed in the 216-T-4-2 Ditch.

In the summer of 2000, contaminated tumbleweeds were found growing in the 216-T-4B seepage pond area. As of 2007, no burial trenches have been excavated into this portion of the designated landfill property, nor are any planned.

Trenches 5 and 8 have received MLLW disposed of after the effective date of mixed waste regulation at the Hanford Site (August 19, 1987). The disposal of MLLW to Trenches 5 and 8 will be confirmed. There is no retrievably stored TRU waste in the 218-W-3AE Landfill, under Tri-Party Agreement Milestone M-091-40. A small amount of remote-handled TRU is stored at this landfill; it will be removed and repackaged for disposal by the M-091 Program. Hanford Site Drawings that describe this landfill include H-2-75351, Sheets 1, 2, and 3, *Dry Waste Burial*

Ground 218-W-3AE (site plan), and H-2-821555 (subsidence). Typical trench cross sections are described on H-2-75351, Sheet 2.

2.1.2.5 218-W-4B Landfill

This landfill began receiving wastes in 1970. It covers 4 ha (10 ac) and contains unsegregated waste, LLW, and TRU (SWITS).

The 218-W-4B Landfill is located in the central portion of the 200 West Area, about 150 m (500 ft) northwest of the 234-5Z Building, directly west of the 231-Z Building. It consists of 14 trenches (one containing 12 caissons, of which 4 caissons contain suspect TRU waste). The trenches are approximately 177 m (580 ft) long and 3.1 to 3.7 m (10 to 12 ft) deep (H-2-33055, *Dry Waste Burial Ground 218-W-4B*).

The landfill received miscellaneous radioactive waste from the 100, 200, and 300 Areas as well as offsite shipments from 1967 to 1990. As of September 2005, the landfill had received 10,500 m^3 (13,700 yd^3) of waste, of which 7,220 m^3 (9,440 yd^3) is waste in the scope of this work plan. Solid waste disposed of at the landfill consists of rags, paper, cardboard, plastic, pumps, tanks, process equipment, and other miscellaneous high-dose-rate and TRU dry waste (BHI-00175). The waste within the scope of this project mainly is from the 200 West Area (53 percent by volume) and the 300 Area (35 percent). The remaining 12 percent is from the 100 Area (3 percent), offsite generators (4 percent), and the tank farms (5 percent).

This landfill also contains 3,240 m^3 (4,240 yd^3) of retrievable (post-1970) TRU waste (SWITS). No trenches in this landfill contain MLLW or TRUM that was disposed of after the effective date of mixed-waste regulation at the Hanford Site (August 19, 1987). The 218-W-4B Landfill is the fourth landfill of four in priority under Tri-Party Agreement Milestone M-091-40 that is scheduled to have the retrievably stored TRU waste removed.

A series of documents published around 1980 describes the number of trenches and the number and contents of the caissons, but not consistently. A 1980 Rockwell Hanford Operations internal letter report (RHO-65463-80-126, "Inconsistencies in 218-W-4B Site Data") addresses the inconsistencies and indicates that to the author's best knowledge the 218-W-4B Landfill is composed of 13 trenches and one row (Trench 14) of 12 caissons. All of the trenches in this landfill are covered with earth (DOE/EIS-0286F, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*).

Trench 6 contains LLW only. Trenches 7 and 11 and the four alpha caissons in Trench 14 contain post-1970 suspect TRU waste. Trenches 1 to 5 and 8 to 12 contain unsegregated waste. Of these, Trenches 2, 3, 4, 8, 9, 10, 12, and 13 contain some packages of waste that are suspected to contain over 100 nCi/g of pre-1970 transuranics (SWITS).

A small volume of liquid was disposed of in the form of tritium contained in metal cylinders, or plutonium liquid. Known quantities of liquid are noted in RHO-65462-80-035, "Description of Waste Buried in Site 218-W-4B." This document contains an inventory of caisson and trench contents for the period between May 1, 1968, through May 1, 1970.

Trench 14 contains 12 caissons that are underground storage structures for the disposal of 3.8 to 18.9 L (1 to 5 gal) cans of remote-handled waste (DOE/EIS-0286F). The caisson wastes were received from 200 Areas facilities, the 300 Area, and the 100-N Area (DOE/RL-96-81). Caissons C1, C2, C3, and C4 contain some packages of waste that are suspected to contain over 100 nCi/g of pre-1970 transuranics (SWITS). As noted above, the four filled alpha caissons contain post-1970 suspect TRU wastes.

This landfill was flooded in the winter of 1979 to 1980. Several inches of snow, followed by quick warming and rapid snow melt, caused the landfills to flood (WHC-EP-0912).

Trenches 1 through 6 were backfilled and surface stabilized with clean fill in 1983. The surface was revegetated with grass. Trench 7 is covered with a 1.2 m (4 ft) soil mound. The remaining trenches were backfilled after use and stabilized with clean gravel in 1995. Stabilization of surfaces with clean gravel (rather than revegetation with grasses) has been shown to increase natural recharge to up to 80 percent of the annual precipitation because of a lack of moisture removal by evaporation and plant transpiration. Trenches stabilized with clean gravel would be a good location for initial investigations of subsurface moisture distributions with direct pushes. This landfill is monitored for surface contamination and for subsidence. The caissons are monitored for airborne radionuclides. A radiological survey is performed annually.

This landfill appears today as a fenced field with an apparently undisturbed surface. It has been seeded with field grass, and some rabbit brush growth has occurred. No unplanned releases are known to have occurred at this landfill. The fenced area includes the 218-W-1, 218-W-2, 218-W-4A, 218-W-4B, and 218-W-11 Landfills (BHI-00175).

Hanford Site Drawing H-2-33055 describes the trench layout; H-2-74640, *Installation – Filtered & Shielded Caisson Covers – Dry Waste Burial Ground 218-W-4B*, describes caisson installation; and H-2-821555 describes stabilization.

2.1.2.6 218-W-4C Landfill

The 218-W-4C Landfill started receiving waste in 1978. It covers approximately 23 ha (56 ac) and contains TRU (some combustible) and test-reactor-fuel waste (DOE REG-0271).

The largest portion of the 218-W-4C Landfill is located west and southwest of the Plutonium Finishing Plant, east of Dayton Avenue. A smaller section is located directly south of the plant, and north of 16th Street. The unit was designed to contain up to 65 trenches. Forty-eight trenches run east-west. Twenty-four of these are 184 m (602 ft) long, 19 are 220 m (719 ft) long, 4 are 180 m (594 ft) long, and 1 trench is 91 m (300 ft) long. Seventeen trenches run north-south. Of these, 14 trenches are 200 m (665 ft) long, and 3 trenches are 155 m (508 ft) long. Only 15 trenches ranging from 91 to 219 m (300 to 719 ft) long have been used for waste storage and/or disposal.

The 218-W-4C Landfill began accepting packaged waste materials from 200 West Area operations, other Hanford Site areas, and from offsite sources in 1974 (WIDS). According to burial records, the 218-W-4C Landfill currently contains approximately 21,916 m^3 (28,665 yd^3) of low-level, TRU, and mixed waste. TRU waste has been segregated from other landfill waste since 1970 and placed in separate burial trenches and/or areas of burial trenches where the packages are retrievably stored. The volume of waste within scope of this RI/FS work plan is 15,200 m^3 (19,881 yd^3).

Trenches 1, 4, 7, 20, 29, and the east end of Trench 24 contain retrievably stored suspect TRU waste. Trenches NC, 14, 19, 23, 28, 33, 48, 53, and 58, and the remainder of Trench 24 received buried LLW. In addition, some wastes in Trenches NC, 14, and 58 currently are identified as MLLW disposed after the effective date of mixed-waste regulation at the Hanford Site (August 19, 1987).

The northernmost trench (Trench NC) contains a number of core barrels originating from the U.S. Department of the Navy. Trench 1 contains drums generated from mining the 216-Z-9 Crib/Trench and approximately 500 cans of ash received in the early 1980s. The ash was generated by the 232-Z Waste Incinerator Facility, which incinerated miscellaneous waste (e.g., rubber gloves, rags, paper, spent solvent, cutting oils).

Trench 7 is at the location of a former waste site. The Z Plant Burning Pit was a disposal site for combustible nonradioactive construction, office, and nonhazardous laboratory waste, including unnamed chemicals. The burning pit is reported to have received 2,000 m^3 (2,600 yd^3) of waste for burning, including less than 1,000 m^3 (1,300 yd^3) of laboratory chemicals. The burning pit was 15 m (50 ft) long, 12 m (40 ft) wide, and 3 m (10 ft) deep. The burning pit was used from 1950 to 1960 (WIDS; BHI-00175). UPR-200-W-37 has been consolidated (WIDS) with this landfill. UPR-200-W-37 reported that in June 1955 contamination resulted when three boxes containing high-activity dry waste were mistakenly placed in a burn pit in the 200 West Area. When the mistake was rectified, it was noted that one of the boxes had released contamination at levels of 100 mR/h as a result of being broken open during placement, while the other two boxes had remained sealed. The boxes were removed and the pit was decontaminated. Through historical research, this pit where the incident occurred was identified as the Z Plant Burning Pit.

The waste in the 218-W-4C Landfill that is within the scope of this project is mainly from the 200 West Area (24 percent by volume), the 100 Area (12 percent), the 300 Area (9 percent) and offsite generators (47 percent). The remaining 8 percent is from miscellaneous Hanford Site areas and the tank farms. The eastern annex portion of this unit never has received waste.

During the latter part of calendar year 1979 and the early part of 1980, a heavy snowfall and rapid melting caused flooding within some of the 218-W-4C Landfill trenches. Transuranic drums were observed to be floating in the landfill. Workers retrieved the drums undamaged (WHC-EP-0912, WHC-EP-0225, *Contact-Handled Transuranic Waste Characterization Based on Existing Records*). Despite the volume of water observed during the flood, there has been no impact on groundwater, as shown in the groundwater monitoring data presented in Section 3.4.4.4. Perched water was detected beneath the 218-W-4C Landfill in 1991. The perched water was no longer detected in 1994. The source of the water was not identified.

Areas of the TRU-retrievable-waste trenches are known to have subsided, or to have the potential to subside, after placement of the waste containers. The condition of the waste containers in these subsidence areas is unknown. Interface has been established with the M-091 Program to better understand the condition of waste containers in subsidence areas as they are retrieved for processing; including opportunistic sampling, as appropriate.

These units are contained within the proposed groundwater monitoring system for LLBGs. Routine airborne radionuclide monitoring is performed. Radiological surveys of the perimeter site boundaries also are performed annually.

No unplanned releases are associated with this landfill. Hanford Site Drawings that describe this landfill include H-2-37437, Sheets 1 through 4, *Dry Waste Burial Ground 218-W-4C*, and H-2-821555 (stabilization).

2.1.2.7 218-W-5 Landfill

In 1979, a large area adjacent to the northwest corner of the 200 West Area was annexed and designated the Central Waste Complex and the 218-W-5 Landfill. The annexed area extended north from 16th Street to 27th Street and westward to coordinates E564176/N137630. Within the large annex, 34 ha (84 ac) currently are permitted as low-level waste landfills. Original plans called for the area to contain 18 LLW trenches and 4 MLLW trenches. The landfill was expanded by annexing land to the west and north and was designed to contain 56 trenches, all oriented east-west. Of these, 11 unlined trenches have been constructed and have had wastes placed in them, and an additional two lined trenches (out of scope of this RI/FS work plan) were constructed.

The landfill is at the southwest corner of the intersection of 27th Street and Dayton Avenue. This landfill began receiving waste on August 29, 1986. It covers 38.5 ha (95 ac). Two trenches (Trenches 31 and 34), which are large rectangular excavations in the southwest corner of the 218-W-5 Landfill, currently are operated as disposal units for MLLW. The trenches are constructed with polyethylene liners and leachate collection system. These active trenches are described in detail in Section 2.2.4. Operations at Trenches 31 and 34 are expected to end before the time that CERCLA remedial actions are scheduled to begin.

The trenches (other than the currently active MLLW trenches) range from 4.6 m (15 ft) to 12 m (40 ft) wide at the bottom and from 5.2 to 6.1 m (17 to 20 ft) deep. The length of the trenches varies from 350 m (1,160 ft) to 130 m (430 ft) long. The volume of waste within scope of this RI/FS work plan is 71,000 m^3 (92,865 yd^3).

A reported 204 kg (450 lb) of lead is buried in Trench 21, and 1,684 kg (3,710 lb) in Trench 9 (BHI-00175). An unused expansion area is located in the northwest section (BHI-00175).

The 218-W-5 Landfill is contained within the proposed groundwater-monitoring system for LLBGs. Routine airborne-radionuclide monitoring is performed.

No unplanned releases are associated with this landfill.

Trench 22 currently is identified as containing MLLW disposed of after the effective date of mixed-waste regulation at the Hanford Site (August 19, 1987). The disposal of MLLW to Trench 22 will be confirmed.

Hanford Site Drawings that describe this landfill include H-2-94677, *Dry Waste Burial Ground 218-W-5* (site plan), and H-2-821555 (stabilization).

2.1.2.8 218-W-6 Landfill

The 218-W-6 Landfill, although included in the LLBG Part A Permit (DOE/RL-88-20, *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds*), never has received waste. It is located east of and across the railway tracks from the 218-W-3AE Landfill. This landfill is roughly triangular in shape, with outside dimensions of 420 m north to south and 768 m east to west (1,376 by 2,519 ft). The Hanford Site Drawing that describes this landfill is H-2-99933, *Dry Waste Burial Ground 218-W-6*. Because the 218-W-6 Landfill never has received waste, it was moved to the 200-MG-1 OU and, therefore, no longer is in the scope of this investigation.

2.1.3 200-SW-2 Operable Unit Past-Practice Landfills

Seventeen radioactive past-practice landfills are within the scope of this project. They are the 218-C-9, 218-E-1, 218-E-2, 218-E-2A, 218-E-4, 218-E-5, 218-E-5A, 218-E-8, 218-E-9, 218-E-12A, 218-W-1, 218-W-1A, 218-W-2, 218-W-2A, 218-W-3, 218-W-4A, and 218-W-11 Landfills. All of the waste in these landfills is within the scope of this work plan. These landfills are described in detail in the following sections.

2.1.3.1 218-C-9 Landfill

The 218-C-9 Landfill is a past-practice construction landfill located north of 7th Street and north of the C Plant/Hot Semiworks Plant. The landfill's reported dimensions have varied widely from source to source over time. Dimensions based on SWITS data and paper burial records, corrected for obvious errors such as transposed burial coordinates, are 108 by 337 m (353 by 1109 ft). Dimensions based on WIDS data show an area of only 76 by 66 m (250 by 217 ft). Photographs of the landfill as it looked when it was stabilized show a smaller disturbed area (about 76 by 66 m) and a larger disturbed area (about 108 by 337 m) to the north.

Waste volume in the 218-E-1 Landfill is approximately 3,030 m^3 (3,963 yd^3). The landfill covers approximately 0.96 ha (2.4 ac).

Before its use as a landfill, the location was the foundation excavation for a planned plutonium separations building, 221-C, whose construction never was completed. Next the excavation for the 221-C foundation was used as a liquid-waste disposal site, designated as the 216-C-9 Pond. For 30 years (1953 to 1983) it received approximately one billion liters (264 Mgal) of mildly radioactive steam-condensate liquid discharge from source facilities, the 209-E Critical Mass Laboratory and the Hot Semiworks (201-C). Two years after liquid discharges to the site had ceased, solid wastes were disposed to this previously used pond area for a four-year period (1985 to 1989). This included 7,580 m^3 (9,920 yd^3) of miscellaneous debris and soil (SWITS). A large portion of the 216-C-9 Pond area was assigned the facility designation of "218-C-9" to signify its use as a solid-waste landfill. Debris at the landfill consists of radiologically contaminated concrete rubble, large equipment, roofing material, metal scrap, and other Hot Semiworks demolition wastes. Contaminated soil from UPR-200-E-37 and UPR-200-E-98 also was placed in the 218-C-9 Landfill. If vadose-zone contamination exists, it likely will be as a result of pond operations over 3 decades. This landfill is not a typical dry-waste landfill, because it received a large volume of mildly radioactively contaminated liquids (as a pond). Site remediation decisions likely will be driven by its prior use as a pond rather than its limited use as a solid-waste landfill, possibly making the remedial action "atypical" for solid-waste landfills. Disposition of the soil contaminated as a result of past pond use will be coordinated with the appropriate OU for ponds.

The entire 218-C-9 Landfill has been backfilled and surface stabilized with fly ash from the 284-E Powerhouse Ash Pit. While fly ash is an effective medium to control plant intrusion, it was difficult to conduct geophysical surveys of the site in support of nonintrusive investigations. A routine radiological survey is performed annually.

No Hanford Site Drawings have been found that describe the 218-C-9 Landfill. Drawings that show the location of the landfill and describe the former 216-C-9 Pond include H-2-4010, *Strontium Semiworks & Vicinity Outside Lines Key Map*, and H-2-4606, *216-C-9 Pond Modifications*.

2.1.3.2 218-E-1 Landfill

The 218-E-1 Landfill is a past-practice landfill that originally was called the Dry Waste Burial Garden #1. This landfill received packaged waste materials from the B Plant complex from 1945 to March 1953. It is located approximately 150 m (500 ft) west of PUREX. Although some literature sources report 21 trenches (e.g., RHO-CD-673, *Handbook 200 Areas Waste Sites*), both a 1982 Rockwell Hanford Operations letter (RHO-72710-82-167, "Final Report: 218-E-1 Dry Waste Burial Ground Characterization Survey") and a more recent geophysics survey performed in 2006 (D&D-30708, *Geophysical Investigations Summary Report; 200 Areas Burial Grounds: 218-E-1, 218-E-2A, 218-E-8, 218-E-12A, 218-W-1, 218-W-2, 218-W-3, and 218-W-11*) show 15 trenches running north-south, approximately 60 m (200 ft) long, consistent with the site reference drawings. Waste trenches were filled to ground level with cinders from the nearby 284-E Powerhouse Ash Disposal Pile (cinder pile). The cinders make a comparatively sterile seed bed, which acts as a deterrent against plant growth that could take up some of the radioactivity through the roots. Gravel-covered surfaces that are denuded of vegetation induce recharge (up to 80 percent of annual precipitation based on Hanford Site studies), increasing the possibility of mobile-contaminant migration in the vadose zone. Planned direct pushes in this landfill are expected to provide data on moisture contents at depth. The surface of the cinders was covered with coarse gravel to guard against wind erosion, and a dry moat was bladed around the zone perimeter inside the post line to discourage vehicle travel over the surface of the landfill (WHC-EP-0912). The landfill was surface stabilized in 1981 with 0.5 m (1.5 ft) of clean fill, revegetated, and load tested. UPR-200-E-53 has been consolidated (WIDS) with this landfill. UPR-200-E-53 reported that in October 1978 contamination was spread by a bulldozer when shallow-buried contaminated waste was unearthed during backfilling activities. The area of UPR-200-E-53 is approximately 15 by 46 m (50 ft by 150 ft) and is located at the south end of the 218-E-1 Landfill.

The site plan reference drawing for this landfill is Hanford Site Drawing H-2-00124, *218-E-1 Dry Waste Burial Ground.*

2.1.3.3 218-E-2 Landfill

The 218-E-2 Landfill is a past-practice site. The service dates are 1945 to 1953 (WIDS). The landfill consists of 8 industrial trenches. The trench lengths vary from 27 to 142 m (90 to 465 ft). The landfill received unsegregated material contaminated with mixed-fission product (WIDS), uranium, and plutonium (SWITS). The landfill contains approximately 9,000 m^3 (11,772 yd^3) of waste and covers approximately 2 ha (5 ac). The landfill is collocated with the 218-E-2A, 218-E-4, 218-E-5, 218-E-5A, and 218-E-9 Landfills. The unit was surface stabilized in 1979 with 0.3 m (1 ft) of clean backfill material and vegetated with wheat grass (WIDS).

The reference drawing for this landfill is Hanford Site Drawing H-2-55534, *218-E2, E2A, E4, E5, E5A, & E9 Industrial Burial Ground Plan & Details.*

2.1.3.4 218-E-2A Landfill

The 218-E-2A Landfill is a past-practice site that originally was called the Regulated Equipment Storage Site #2A. This landfill was used for the aboveground storage of equipment that since has been removed. Service dates are not known, but are estimated as 1955 to 1965, with the landfill definitely retired by 1975 (WHC-EP-0845, *Solid Waste Management History of the Hanford Site*). The landfill is located directly south of the 218-E-2 Landfill, across the railroad tracks, north of the B Plant. The drawings conflict slightly in their depictions of trench location. The trench is about 14 m (46 ft) wide. No records or burial inventories are available to indicate that this landfill ever was used as a disposal facility, and waste volumes are not known. On February 21, 1978, an inspection of the burial trench disclosed a number of sink holes along the center line of the trench, indicating that the trench had been dug and used for dry-waste burials. In the summer of 1979, at least 0.3 m (1 ft) dirt was used to fill the burial trench to ground level (WHC-EP-0912).

The 218-E-2A Landfill is associated with UPR-200-E-95, a railroad spur located south of the 218-E-2 and 218-E-5 Landfills and north of the 218-E-2A Landfill, north of the B Plant. The contaminated area was established as an unplanned release site in September of 1980. It became contaminated over time as a result of contaminated equipment (mainly from the B Plant and PUREX) being stored on railroad flat cars on the spur. The contamination likely is the accumulation of many small releases over time. In 1998, the tracks were covered with gravel and posted as an Underground Radioactive Material Area. The site is approximately 250 by 5 m (820 by 16 ft). A 1996 perimeter survey report reported less-than-detectable levels of contamination. A 1991 survey reported general rail contamination of 3,000 to 6,000 d/min beta, with a maximum of 350,000 d/min beta in one spot (WIDS). This unplanned release has been transferred to the 200-MG-1 OU and, therefore, is out of the scope of this investigation.

The reference drawing for this landfill is Hanford Site Drawing H-2-55534.

2.1.3.5 218-E-4 Landfill

The 218-E-4 Landfill is a past-practice landfill that historically has been called 200 East Minor Construction No. 4 and Equipment Landfill #4. The landfill received repair and construction waste from the 221-B modifications. The landfill is collocated with the 218-E-2, 218-E-2A, 218-E-5, 218-E-5A, and 218-E-9 Landfills.

The service dates are estimated as 1955 to 1956. The landfill is a wedge-shaped polygon located between two railroad tracks and north of B Plant. The exact number of trenches remains unknown. It is believed that two trenches run parallel to the railroad tracks (HW-28471, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*). 1,586 m^3 (2,074 yd^3) of mainly construction debris is buried at the landfill, which covers an area of 1.4 ha (3.4 ac). All waste is unsegregated.

The 218-E-4 Landfill was affected by UPR-200-E-23. In June 1960, this unplanned release occurred in the 218-E-10 Landfill; some of the contamination drifted into the 218-E-4 Landfill and contaminated the area to a maximum reading of 1 rad/h one year after the incident (WIDS).

The landfill was surface stabilized in 1980 and is posted as an Underground Radioactive Material Area. A radioactive survey is performed annually.

The reference drawing for this landfill is Hanford Site Drawing H-2-55534.

2.1.3.6 218-E-5 Landfill

The 218-E-5 Landfill is a past-practice landfill originally called Industrial Burial Garden #5. This landfill received miscellaneous contaminated equipment from the tank farm Uranium Recovery Process and PUREX. The landfill was used from 1954 to 1957 and now is inactive. It is contiguous with the western boundary of the 218-E-2 Landfill, north of the B Plant.

Extensive research was conducted during 1979 to determine the location of all of the burial trenches within the bounds of the 218-E-2, 218-E-5, 218-E-5A, and 218-E-9 Landfills. This research was performed to support interim site stabilization. The research included viewing aerial photographs and construction drawings, analyzing plant growth patterns, and load testing the ground surface. Four previously unrecorded trenches were identified; these trenches are now numbered 1, 2, 4, and 5 on Hanford Site Drawing H-2-55534. The trenches in the 218-E-2, 218-E-5, 218-E-5A, and 218-E-9 Landfills were stabilized with the addition of 0.3 m (1 ft) of soil (WHC-EP-0912). The 218-E-5 Landfill covers 0.4 ha (1.1 ac) and contains 6,173 m^3 (8,074 yd^3) of waste.

The reference drawing for this landfill is Hanford Site Drawing H-2-55534. Source literature (RHO-CD-673) indicates that trench locations for this landfill may not be accurately represented on the drawing. Geophysics data collected in 2006 (D&D-28379, *Geophysical Investigations Summary Report; 200 Area Burial Grounds: 218-C-9, 218-E-2A, 218-E-5, 218-E-5A, 218-E-8, 218-W-1A, 218-W-2A, and 218-W-11*) suggest that the trench locations are slightly different than depicted on Hanford Site Drawing H-2-55534.

2.1.3.7 218-E-5A Landfill

The 218-E-5A Landfill is a past-practice site that originally was called Industrial Burial Garden #5A. This landfill received failed equipment and industrial waste that consisted of three or four very large (15 by 4.6 by 5.5 m, or 50 by 15 by 18 ft) wooden burial boxes containing a PUREX K-2 column package, a PUREX L cell package, and a PUREX J-2 pulse column package. The boxes were partially buried in 1958 and backfilled in 1961. Most literature sources indicate that this landfill was used from 1956 to 1959.

The landfill is located contiguous with the western boundary of the 218-E-5 Landfill, north of the B Plant. The landfill reference drawing is Hanford Site Drawing H-2-55534. Exact trench locations are not known, although the large-box burial locations are well documented and photographed. The photographs show foaming used during the backfilling operation to contain contamination because of a box collapse.

In 1979, the landfill was stabilized with 0.3 m (1 ft) of dirt and load tested with 40 tons. The burial location is a 30 by 37 m (100 by 120-ft) rectangular area.

2.1.3.8 218-E-8 Landfill

The 218-E-8 Landfill is a past-practice site once known as the Construction Burial Garden (originally no number was assigned to it). This landfill received contaminated equipment and material in 1958-1959 during construction of the 293-A PUREX Dissolver Offgas Building, and removal of the PUREX temporary ventilation barrier during the PUREX second crane addition. The 218-E-8 Landfill is located at the northwest edge of the 200 East Area Burn Pit, north of PUREX. The location and number of trenches in this landfill are not known. Older source literature (HW-60807, *Unconfined Underground Radioactive Waste and Contamination In The 200 Areas – 1959*) shows a different size and location for the landfill than do current site maps (for example, Hanford Site Drawing H-2-821555, Sheet 5) and WIDS. Recent geophysical surveys (D&D-28379 and D&D-30708) suggest that the location of the landfill per current site drawings may closely border other burials in the nearby 200 East Area Burn Pit, a nonradioactive waste site. There is no known explanation for the discrepancy in the literature sources or the geophysical data.

This landfill covers 0.4 ha (1.1 ac) and contains 2,265 m^3 (2,963 yd^3) of waste.

On February 21, 1979, residue from tumbleweed fragments blown in along the west boundary line of this landfill was found to be reading greater than 100,000 c/min beta-gamma activity (WHC-EP-0912). In 1979, the landfill was stabilized with at least 0.5 m (1.5 ft) of backfill. There are no known individual drawings of the landfill; however, drawings of the 218-E-12B Landfill (for example, Hanford Site Drawing H-2-821555, Sheet 5) often show the 218-E-8 Landfill, which is in the southeast corner of the 218-E-12B Landfill.

2.1.3.9 218-E-9 Landfill

The 218-E-9 Landfill is a past-practice landfill originally known as East Regulated Equipment Storage Site No. 009. The landfill was used from 1953 to 1958 and now is inactive. It was used as an aboveground storage site for fission-product equipment that became contaminated in the Uranium Recovery Process operations at the tank farms. It is not certain that it ever was used for burials; sinkholes were noticed in the landfill in the late 1970s, indicating the likelihood that it had been. The landfill is collocated with the 218-E-2, 218-E-2A, 218-E-4, 218-E-5, and 218-E-5A Landfills and was stabilized in 1980. The landfill was restabilized in 1991 when contaminated vegetation was found. The landfill is approximately 130 by 30 m (427 by 100 ft).

The landfill reference drawing is Hanford Site Drawing H-2-55534.

2.1.3.10 218-E-12A Landfill

The 218-E-12A Landfill is a past-practice landfill originally known as Dry Waste Burial Garden #12. This landfill was active from 1953 to 1967. Unpublished logbooks from the 1960s suggest that much of the waste at this landfill consists of bulk trash from PUREX, placed in fiberboard boxes or direct-dumped from trucks. Other recorded items buried include tank farm pumps, animal carcasses from the 108-F Biology Laboratory, metal drums of depleted uranium from offsite generators, and miscellaneous construction waste. This landfill contains 28 trenches 137 to 311 m (450 to 1020 ft) long. Hanford Site Drawing H-2-32560, *As-Built Dry Waste Burial Site #218-E-12A*, indicates that trenches 4-11, 15-16, and 26-28 contain acid-soaked material, but little is understood about the nature of this material. However, interviews with former PUREX workers indicate that this waste is likely to be rags that were once saturated with a nitric acid solution and used to decontaminate equipment in the PUREX facility. These acid-soaked material trenches are narrower (1.5 to 3.7 m or 5 to 12 ft wide) and presumably shallower than other trenches (9.2 m [30 ft] wide) in this landfill. UPR-200-E-30 has been consolidated (WIDS) with this landfill. UPR-200-E-30 reported contamination being released in April 1961, when a large wooden drag-off box collapsed as it was being backfilled in place in the 218-E-12A Landfill. The majority of the contamination was located within the landfill.

The landfill is located north of the B Plant, approximately 30 m (100 ft) northwest of the C Tank Farm. In 1979-1980, and again in 1994, the landfill was stabilized with 0.5 to 0.6 m (1.5 to 2.0 ft) of backfill.

The drawing that best describes this landfill is Hanford Site Drawing H-2-32560.

2.1.3.11 218-W-1 Landfill

The 218-W-1 Landfill is a past-practice landfill containing pre-1970 transuranic and solid wastes. It is located on the east side of Dayton Avenue, approximately west of the TX Tank Farm. It is about 460 m (1500 ft) northwest of the 234-5Z Building and lies between the 218-W-2 and 218-W-11 Landfills.

The 218-W-1 Landfill operated from 1944 until 1953 to receive more than 7,000 m^3 (9,200 yd^3) of miscellaneous dry wastes. Photographic evidence suggests that the landfill received wastes packaged mainly in small wooden boxes or fiberboard containers or wrapped in heavy brown paper. Property disposal records from the 1940s and 1950s indicate that wastes disposed to this landfill include small- to medium-sized equipment -- items such as dip tubes, lab-sample cups, and laundry machines. It also may contain tools, air filters, and protective clothing such as masks. Wastes with dose rates of up to 35 rem/h at the container surface were reported in early source literature (HW-28471).

The landfill is 3.3 ha (8.2 ac), contains 7,164 m^3 (9,370 yd^3) of waste, and consists of 15 trenches that run east to west. Twelve of these are 2.4 m (8 ft) deep and 73 m (240 ft) long. The other three are 2.7 m (9 ft) deep and 149 m (488 ft) long. It appears as a fenced field with an apparently undisturbed flat surface. It has been seeded with field grass. A small area near the center of the landfill once contained contaminated mulch with a maximum reading of 12,000 d/min. Evidence exists that waste boxes once were buried less than 1.2 m (4 ft) from the surface. The landfill is fully fenced with chain-link fencing and is marked with permanent concrete posts and brass name plates (BHI-00175). Two unplanned releases have been consolidated (WIDS) with this landfill; the noted unplanned releases are UPR-200-W-11 and UPR-200-W-16 (WIDS). UPR-200-W-16 is a duplicate number for the occurrence reported in UPR-200-W-11. UPR-200-W-11 reported a 1952 fire that occurred in the waste boxes, spreading plutonium (alpha) contamination to the north and south sides of the trench and outside of the 218-W-1 Landfill. UPR-200-W-11 location was reported incorrectly in the Z Plant Technical Baseline Report (BHI-00175). The correct location for the UPR-200-W-11 / UPR-200-W-16 site was confirmed by the map in HW-54636, *Summary of Environmental Contamination Incidents at Hanford 1952-1957.*

The landfill was surface stabilized in 1983. Trench arrangement and dimensions are shown in detail on Hanford Site Drawing H-2-75149, *Dry Waste Burial Ground 218-W-1.*

2.1.3.12 218-W-1A Landfill

The 218-W-1A Landfill is a past-practice site originally called Industrial Burial Garden #1 and Industrial Waste No. 1. The landfill contains 13,700 m^3 (17,919 yd^3) of waste and covers 4.9 ha (12 ac). In addition to process equipment and process waste buried in 10 trenches, pieces of equipment were stored above ground that later were removed. This landfill was the first large-equipment burial site in the 200 West Area. Literature indicates burials of Reduction-Oxidation Plant (REDOX) pots, silver reactors, condensers (HW-30372, *Manufacturing Dept Radiation Incident Investigation Class I No 94*), tank samplers from Oak Ridge National Laboratory, and general trash from chemical separations plants in the 200 West Area.

Most of the equipment was buried in wooden boxes with a double liner of waterproof paper (HW-30372). The boxes tended to collapse and cause settling of the ground surface. Most of the sink holes were filled with dirt in 1975, but a number of deep sink holes remained, north of the railroad tracks (WIDS). HW-28471 discusses a 1949 contamination spread averaging 7 mrem/h (ARH-780, *Chronological Record of Significant Events in Chemical Separations Operations*), with spots of up to 100 mrem/h (HW-28471) from T Plant to the 218-W-1A Landfill during discard of a burial box. ARH-780 discusses the 1953 burial of a failed H-4 oxidizer from REDOX with a high dose rate, during burial, of 250 mrem/h at 152 m (500 ft).

A large number of 2 m (6-ft-) thick concrete cell blocks were stored above ground south of the railroad tracks, but eventually they were disposed of. Nearly all of the surface radioactive contamination that was on the blocks when they were stored in the landfill has since decayed (WHC-EP-0912). The ground surface is currently free of contamination (WIDS).

This landfill was active from 1944 to March 1954. It is located 600 m (2,000 ft) northwest of T Plant. A railroad spur passed through the central portion of this landfill. UPR-200-W-26 has been consolidated (WIDS) with this landfill. UPR-200-W-26 reported that in November 1953, the wind dispersed contamination while a box of used connectors was being unloaded from a flatcar. Contamination spread onto the flatcar and onto the surrounding ground.

The drawing that best describes this landfill is Hanford Site Drawing H-2-02516, *Industrial Burial Ground 218-W-1A.*

2.1.3.13 218-W-2 Landfill

The 218-W-2 Landfill is a past-practice landfill originally called Dry Waste Burial Garden #2. The landfill covers 3.4 ha (8.5 ac) and contains 8,240 m^3 (10,778 yd^3) of waste. This landfill received packaged waste materials from the 200 West Area. No material was stored above ground. This landfill was active from January 1953 to December 1956. It is contiguous with the south boundary of the 218-W-1 Landfill. Early literature sources do not distinguish between the 218-W-1 and 218-W-2 Landfills; for example, HW-28471 refers to the 218-W-1 and 218-W-2 Landfills as "Solid Waste Landfill," and indicates a total of 18 trenches as of the time of publication (1953). HW-41535, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*) (1956) indicates a total of 24 trenches. The wastes disposed to the 218-W-2 Landfill likely are similar to those in the 218-W-1 Landfill. Wastes of up to 35 rem/h at the container surface are reported (HW-28471).

Some of the trenches at this landfill did not receive the required 1.2 m (4 ft) of overfill before stabilization, when waste boxes were observed to be within 0.5 m (18 in.) of the ground surface. Routine radiation surveys of the surface of the trenches have found that contaminated Russian thistle grows mostly along the edges of the trenches. Sink holes were filled in 1974 (WHC-EP-0912).

The drawing that best describes this landfill is Hanford Site Drawing H-2-02503, *218-W-2 Dry Waste Burial Ground.*

2.1.3.14 218-W-2A Landfill

The 218-W-2A Landfill is a past-practice site originally called Industrial Burial Garden #2. The landfill covers 16.5 ha (40.7 ac) and contains 26,000 m^3 (34,007 yd^3) of waste. This landfill was active from March 1957 to 1985. It is located northeast of the corner of 23rd Street and Dayton Avenue. Interim-stabilization activities were initiated in the landfill during the summer and fall of 1979 and completed in 1980. The purpose of the work was to eliminate the hazards of subterranean voids, reduce wind-surface erosion, remove ground-surface contamination, and establish deterrents against the growth of undesirable vegetation.

Records suggest that most of the waste in this landfill was direct-dumped to the trenches via dump truck or was packaged in concrete or wooden boxes.

This landfill received contaminated soil, debris, and process equipment including laboratory equipment and waste from the 300 Area, some with dose rates up to 500 R/h, failed REDOX equipment, contaminated rails, a 1951 International Harvester panel truck used in solid-waste operations, filters from B Plant, and tube bundles from PUREX. Based on logbook records and SWITS, much of the waste in this landfill – at least 20 percent by volume – is contaminated soil from remediation of the 216-T-4 Ditch and Pond (Trench 27), U Tank Farm, and the 216-U-14 Laundry Ditch. Cell cover blocks, 2 m (6 ft) thick, were buried in the 218-W-2A Landfill along the west side of the railroad tracks in Trenches 12-15 (ARH-2757, *Radioactive Contamination In Unplanned Releases To Ground Within the Chemical Separations Area Control Zone Through 1972 (Exclusive of Liquid Waste Storage Tank Farms)*).

Historical records (e.g., HW-41535) indicate that in 1954, two sections of railroad track contaminated during the fall of 1954 to maximum dose rates of 350 mrem/h were buried in Trench 16, which is located outside and across the railroad tracks from the 218-W-2A Landfill. ARH-2015, *Radioactive Contamination in Unplanned Releases to Ground Within the Chemical Separations Area Control Zone through 1970*, Part 4, Appendix A, indicates that the rails were removed in 1971. Geophysics survey results in 2006 (D&D-28379), which did not indicate the presence of rails in Trench 16, corroborate this.

Trenches 17, 18, 19, 25, and 26 never were excavated or used.

UPR-200-W-53 has been consolidated (WIDS) with this landfill. UPR-200-W-53 reported that in January 1959 a collapse of a burial box that contained REDOX cell jumpers in the 218-W-2A Landfill occurred during backfilling operations, releasing fission-product contamination.

The best drawing that describes this landfill is Hanford Site Drawing H-2-32095, *218-W-2A Industrial Burial Ground & 218-W-3 Dry Waste Burial Ground.*

2.1.3.15 218-W-3 Landfill

The 218-W-3 Landfill is a past-practice landfill originally called Dry Waste Burial Garden #3. This landfill covers 4 ha (9.8 ac) and contains 12,400 m^3 (16,219 yd^3) of waste. This landfill was active from January 1957 to July 1961. It is located northeast of the corner of 23rd Street and Dayton Avenue. It is west of the 218-W-2A Landfill. According to the current Hanford Site Drawing (H-2-32095, Sheet 1), the landfill is composed of 20 trenches running east to west. Trenches 1 through 3 are 120 m (400 ft) in length. Trenches 4 through 20 are approximately 145 m (475 ft) in length. However, trench configurations as depicted on the current site drawing (H-2-32095, Sheet 1) are based on field observations of sink holes made during stabilization work in the early 1980s. Geophysics data collected in 2006 (D&D-30708) and unpublished logbook notations suggest that the trench locations, lengths, orientations, and numbering systems are different than those indicated on the drawing.

Logbooks suggest that much of the waste in this landfill is packaged in fiberboard containers and that the sources of the waste include the Plutonium Finishing Plant (about 50 percent by volume) and other 200 West facilities (38 percent), the 108-F Biology Laboratory (5 percent), the 300 Area (5 percent), and offsite generators (2 percent). Known items buried at the landfill include miscellaneous small to medium equipment, process hoods, tools, contaminated laundry, a 1951 International Harvester panel truck once used for transporting waste within the landfills, metal drums of depleted uranium from offsite generators, and building debris such as ductwork and lumber.

Wastes from the Plutonium Finishing Plant that are heavily contaminated with plutonium and organics may be disposed of at this landfill. HW-59645, *Disposition of Plutonium to Burial*, describes 149 cardboard boxes (approximately 0.112 m^3 or 4 ft^3 per box) disposed to burial. The burial location is not specified, but from the source facility location (200 West Area), time period (1959), and type of waste (dry waste), the burial location may be surmised as the 218-W-3 Landfill. The waste is described as rubber gloves, plastic, and paper cartons that may have been damp with carbon tetrachloride and/or tributyl phosphate and, to a lesser extent, with nitric and hydrofluoric acid. The boxes initially were stored at the Plutonium Finishing Plant and at Gable Mountain, where they decomposed. Upon discovery of the decomposition, the boxes were wrapped in plastic and disposed of. The boxes were estimated to contain a total of 795 g plutonium with a counting error of plus or minus 50 percent. It is not known if the plutonium in these boxes is accounted for in the current site total reported in SWITS.

This landfill did not show evidence of radioactivity by plant-root penetration (WHC-EP-0912). The landfill was stabilized in 1983; the north end was restabilized with fill and gravel in 2001.

The drawing that best describes this landfill is Hanford Site Drawing H-2-32095, Sheet 1. However, as noted above, trench configurations shown in current drawings probably do not correspond to their actual locations.

2.1.3.16 218-W-4A Landfill

The 218-W-4A Landfill is a past-practice landfill located southeast of the intersection of 23rd Street and Dayton Avenue. The site covers 7.3 ha (18 ac) and contains 16,900 m^3 (22,104 yd^3) of waste. Source facilities include uranium drums from offsite sources; equipment from 231-Z, 234-5Z, the facility for Recovery of Uranium and Plutonium by Extraction (RECUPLEX), REDOX, 222-U, and the 300 Area Laboratories. The landfill contains miscellaneous waste, including 500 drums of depleted uranium, failed equipment, and plutonium-contaminated laboratory waste. It received waste from 1961 to 1968 (WIDS). This landfill contains 21 miscellaneous dry-waste trenches oriented east to west and 6 or 8 vertical pipe units or drywells. The landfill also contains an unnumbered burial trench oriented north-south. It is near the east end of Trench 11 and contains a REDOX column (H-2-32487). The landfill also contains an unnumbered burial trench oriented north-south. It is near the east end of Trench 11 and contains a REDOX column (H-2-32487, *218-W-4A Dry Waste Burial Site*). All trenches are 9 m (30 ft) wide and range in length from 149 to 295 m (490 to 696 ft). The site covers 1.4 ha (3.5 ac) and contains 1,160 m^3 (1,517 yd^3) of waste.

Burial records suggest that about two-thirds of the waste in this landfill is packaged in fiberboard containers. Trenches 16 and 20 received high-level plutonium wastes from the Plutonium Finishing Plant. Trench 19 is marked as RECUPLEX on Hanford Site Drawing H-2-32487. In July 1952, a fire in the landfill spread contamination and is recorded as UPR-200-W-16. Small areas of contamination were released during operations in November 1953 (UPR-200-W-26). In January 1959, a box containing REDOX cell jumpers collapsed (UPR-200-W-53), and in October 1975, a release of previously buried waste occurred (UPR-200-W-72). UPR-200-W-72 has been consolidated (WIDS) with this landfill. The landfill was stabilized in 1983 (WIDS).

Hanford Site Drawing H-2-32487 describes this landfill and lists the trench contents in detail.

2.1.3.17 218-W-11 Landfill

The 218-W-11 Landfill is a past-practice site originally used as an aboveground regulated storage area for low-level contaminated equipment. The stored materials have been removed from the landfills. The landfill was used as an aboveground storage site before burials took place. It is located between the 218-W-1 and 218-W-4A Landfills.

Literature sources conflict regarding the number and length of trenches. Geophysics data (D&D-30708) suggest that one burial trench in the landfill runs 45 m (150 ft) east and west and corresponds approximately in location with the northernmost trench in Hanford Site Drawing H-2-94250, *Dry Waste Burial Ground 218-W-11*. There also may be a burial pit to the east of this trench (D&D-30708). The trench was used in 1960 for burial of low-level contaminated sluicing equipment that had been used in the Uranium Recovery Process. Some of the equipment later was removed from the trench and was used in the Strontium-Cesium Recovery Process (WHC-EP-0912).

The drawing that best describes this landfill is Hanford Site Drawing H-2-94250; however, as noted above, this drawing likely is not accurate.

2.2 PHYSICAL SETTING

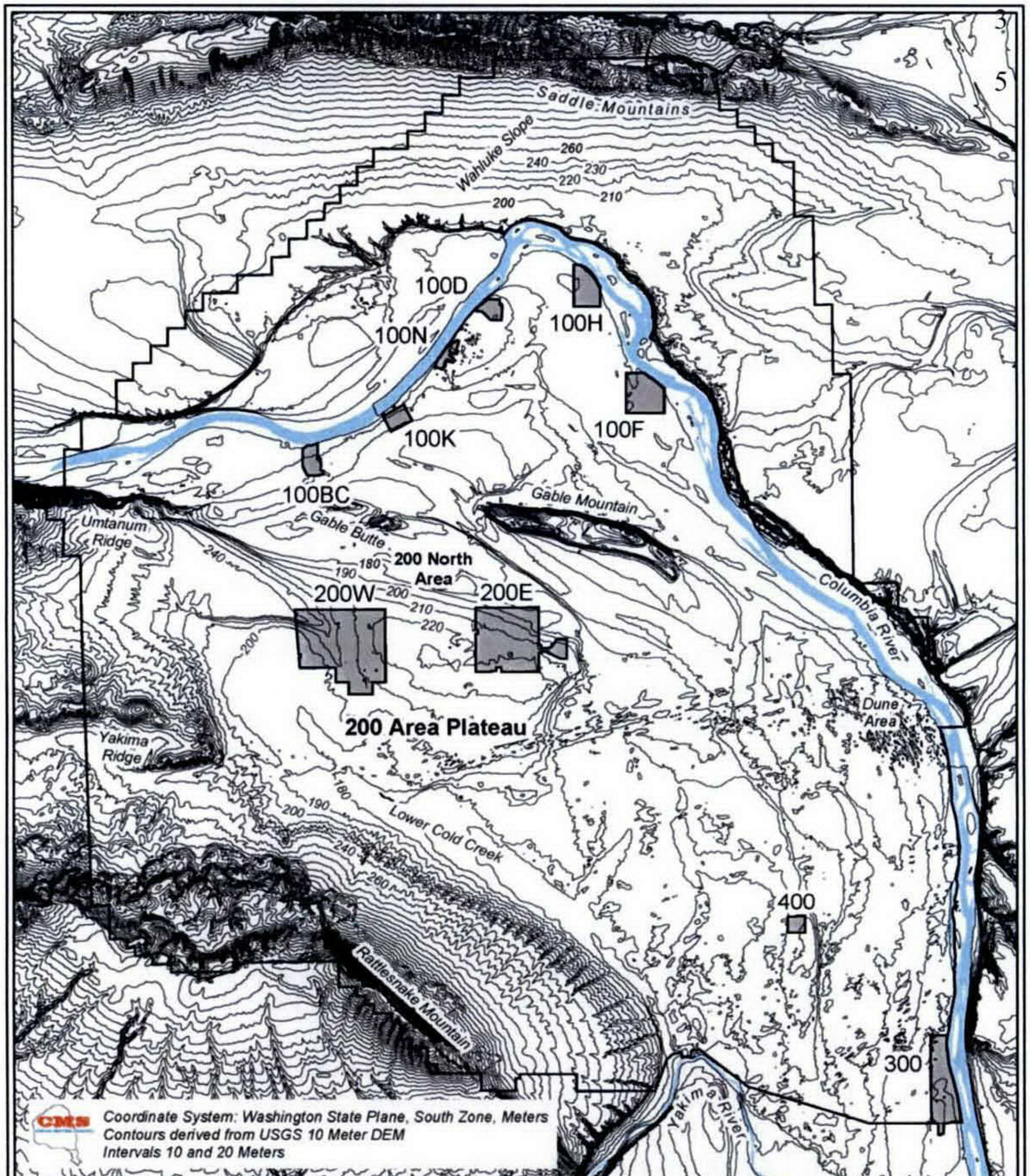
This section summarizes the hydrogeology for the 26 landfills in the 200-SW-1 and 200-SW-2 OUs. The section begins with a description of site topography and geologic units present beneath the central Hanford Site. Subsequent sections describe the stratigraphy, vadose zone, uppermost aquifer, groundwater flow, and contaminant plumes beneath the landfills. Primary references for this section were PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System 200-East Area and Vicinity, Hanford Site, Washington*; PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*; and the annual groundwater-monitoring reports for the Hanford Site (e.g., PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*). Additional references are cited as appropriate. Depth to the water table and estimates of aquifer thickness for the 200 Areas landfills are based on well logs from RCRA monitoring wells and water levels measured in the fall of 2006 or January 2007.

2.2.1 Topography

The 200 Areas, which contain all of the 200-SW-2 OU landfills, are located in the Pasco Basin of the Columbia Plateau. The 200 Areas Plateau is the term commonly used to describe the Cold Creek flood bar that was formed during the last cataclysmic flood from glacial Lake Missoula, about 13,000 years ago (Figures 2-2 and 2-3). The cataclysmic flood waters that deposited sediments of the Hanford formation also locally reshaped the topography of the Pasco Basin. The flood waters deposited the thick sand and gravel deposits of the Cold Creek flood bar and also eroded a channel between the 200 Areas and Gable Mountain. The northern half of the 200 East Area is located within this ancient flood channel. The southern half of the 200 East Area and most of the 200 West Area are situated on the Cold Creek Bar. A secondary flood channel runs south from the main channel and bisects the 200 West Area.

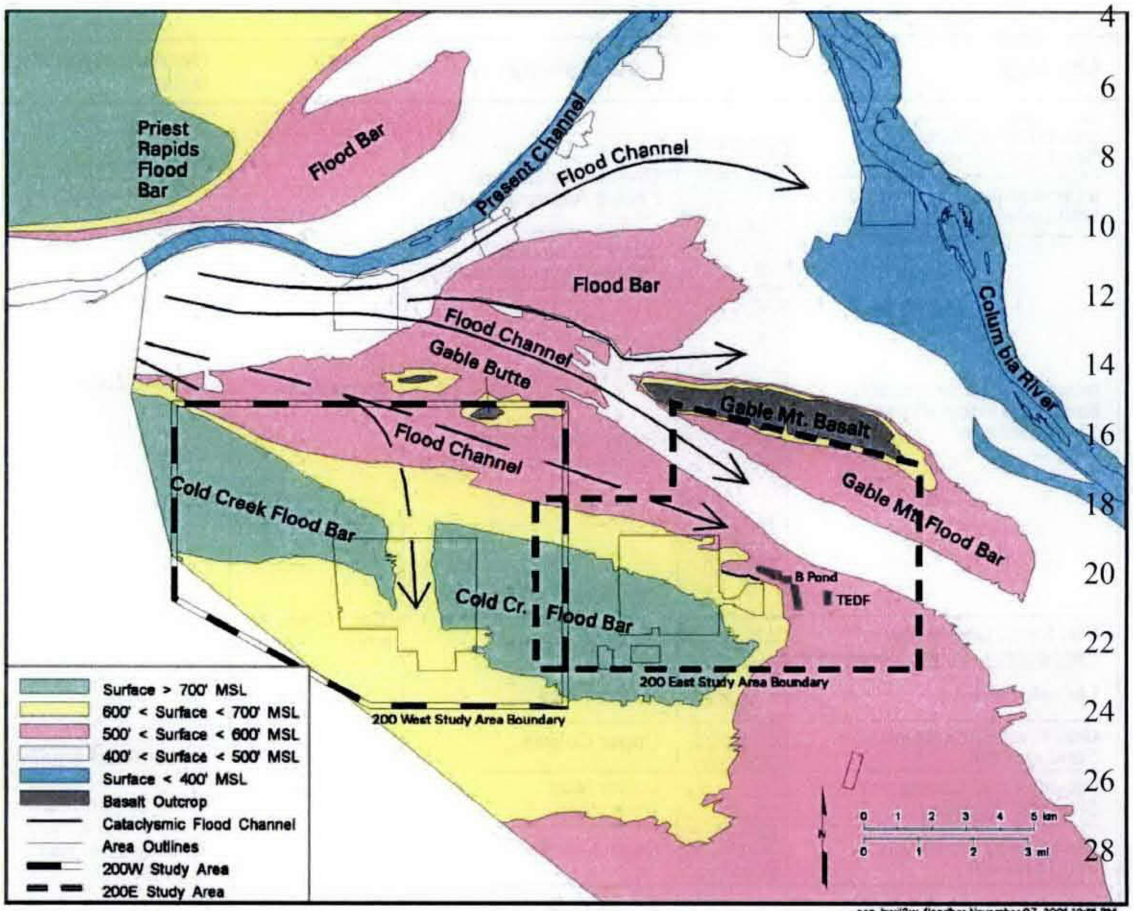
The 200-SW-1 and 200-SW-2 OU landfills are located in or near the 200 East and 200 West Areas on the plateau. Surface elevations of the landfills in the 200 West Area range from 200 to 214 m (656 to 702 ft) above mean sea level (amsl). Landfills surface elevations in the 200 East Area range from approximately 180 m (590 ft) amsl in the northeast part to 210 m (689 ft) in the western part.

Figure 2-2. Topographic Map of the Hanford Site.



System\Projects\OperableUnits\200CS1\031203_Webb_Remedial_Investigation\Maps\040106_Topo_Plateau_2N_ap.mxd Rev. 0 dhf 1/6/04

Figure 2-3. Topographic Illustration of Pleistocene Flood Channels in the Central Hanford Site (modified from PNNL-13858).



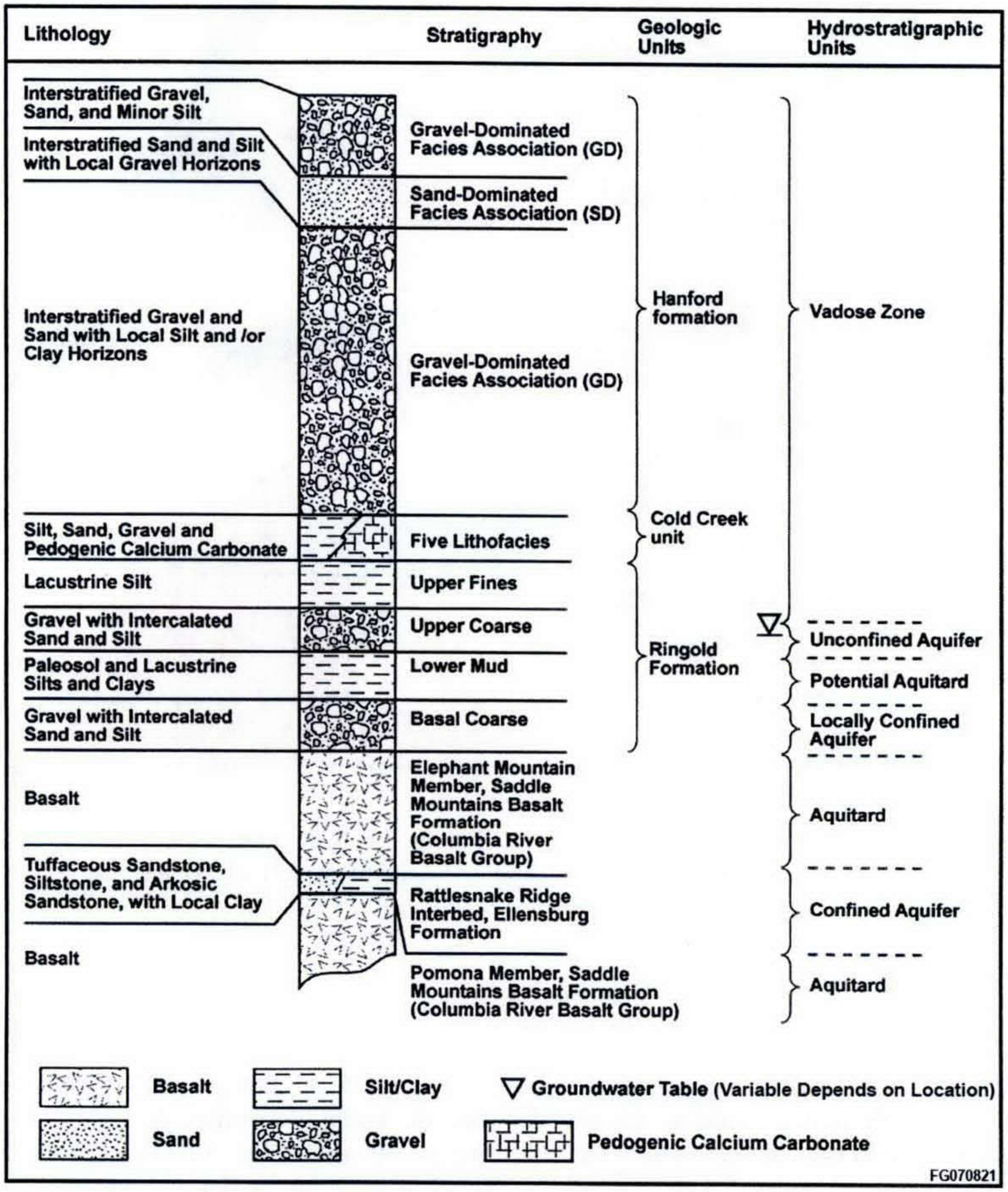
The NRDWL and 600 CL (200-SW-1) are located in the 600 Area southeast of the 200 Areas. Surface elevations at this landfill range from about 162 to 165 m (531 to 541 ft) amsl.

2.2.2 Geology

The 200-SW-1 and 200-SW-2 OUs are located in the Pasco Basin, one of several structural and topographic basins of the Columbia Plateau. A sequence of sediments and basalts of the Columbia River Basalt Group underlie the 200-SW-1 and 200-SW-2 OU landfills. From shallowest to deepest, the units are surficial deposits, the Hanford formation, the Cold Creek unit, the Ringold Formation, and the Elephant Mountain Member of the Columbia River Basalt Group. Figure 2-4 depicts the generalized stratigraphic column for the Hanford Site. Figure 2-13 in Section 2.2.3.6 depicts a stratigraphic column for the location of the NRDWL and 600 CL.

The following paragraphs briefly describe the geologic units, the overlying surficial deposits, and the underlying basalt.

Figure 2-4. Generalized Stratigraphic Column for the Hanford Site.



Surficial deposits. Surficial deposits include Holocene eolian sheets of sand that form a thin veneer over the Hanford formation 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. Fill material was placed in and over various landfills as cover and for contamination control. The fill consists of reworked Hanford formation sediments and/or surficial sand and silt.

Hanford formation. The Hanford formation is the informal stratigraphic name used to describe the Pleistocene cataclysmic flood deposits within the Pasco Basin. The Hanford formation predominantly consists of unconsolidated sediments that range from boulder-size gravel to sand, silty sand, and silt. The sorting ranges from poorly sorted (for gravel facies) to well sorted (for fine sand and silt facies). The Hanford formation is divided into three main lithofacies: interbedded sand- to silt-dominated (formerly Touchet beds or slackwater facies); sand-dominated (formerly sand-dominated flood facies); and gravel-dominated (formerly Pasco gravels), which have been further subdivided into 11 textural-structural lithofacies (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the Central Pasco Basin*). The gravel-dominated facies are cross-stratified, coarse-grained sand and granule-to-boulder gravel. The gravel is uncemented and matrix-poor. The sand-dominated facies are 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. Clastic dikes are common in the Hanford formation but rare in the Ringold Formation (DOE/RL-2002-39). They appear as vertical to subvertical sediment-filled structures, especially within sand- and silt-dominated units.

Cold Creek unit. This unit includes several post-Ringold Formation and pre-Hanford formation units present within the central Pasco Basin (DOE/RL-2002-39). The Cold Creek unit includes the units formerly referred to as the Plio-Pleistocene unit, caliche, early Palouse soil, pre-Missoula gravels, and sidestream alluvial facies described in previous site reports. The Cold Creek unit has been divided into five lithofacies: fine-grained, laminated to massive (fluvial-overbank and/or eolian deposits, formerly the early Palouse soil); fine- to coarse-grained, calcium-carbonate cemented (calcic paleosol, formerly the caliche); coarse-grained, multilithic (mainstream alluvium, formerly the pre-Missoula gravels); coarse-grained, angular, basaltic (colluvium); and coarse-grained, rounded, basaltic (sidestream alluvium, formerly sidestream alluvial facies) (DOE/RL-2002-39). The Cold Creek unit present beneath the 200 West Area waste sites and the 600 Area waste sites west and south of the 200 West Area includes the overbank/eolian, calcic paleosol, and sidestream alluvial facies. The Cold Creek unit present beneath part of the 200 East Area, and the 600 Area landfills southeast of the 200 East Area is the mainstream alluvium (DOE/RL-2002-39).

Ringold Formation. The Ringold Formation comprises an interstratified fluvial-lacustrine sequence of unconsolidated to semiconsolidated clay, silt, sand, and granule-to-cobble gravel deposited by the ancestral Columbia River. These sediments consist of four major lithofacies (from shallowest to deepest; see Figure 2-4):

- **Upper fines**: lacustrine mud; silty over-bank deposits and fluvial sand
- **Upper coarse**: fluvial sand and gravel; silty-sandy gravel with secondary lenses and interbeds of gravelly sand, sand, and muddy sand to silt and clay

- **Lower mud**: buried soil horizons, overbank, and lake deposits; mainly silt and clay
- **Basal coarse**: fluvial gravel and sand; silty-sandy gravel with secondary lenses and interbeds of gravelly sand, sand, and muddy sand to silt and clay.

Elephant Mountain Member. The Elephant Mountain Member is the uppermost basalt unit (i.e., bedrock) in the majority of the OU areas. Except for the Gable Gap area (between Gable Butte and Gable Mountain) where it has been eroded away, the Elephant Mountain Member is laterally continuous throughout the OUs.

2.2.3 Groundwater Operable Units

The Hanford Site is divided into 12 separate groundwater OUs, as depicted in Figure 2-5. The two 200-SW-1 OU landfills overlie the 200-PO-1 Groundwater OU. Depending on location, the twenty-four 200-SW-2 OU landfills overlie one of four groundwater OUs, including 200-ZP-1, 200-UP-1, 200-BP-5, and 200-PO-1. Groundwater contaminant plumes are attributed primarily to past operations of land-based liquid-waste disposal facilities (e.g., ponds, ditches, cribs) and other liquid-waste management facilities (e.g., reverse wells, leaking underground storage tanks). The solid-waste landfills primarily received dry waste and are not expected to have impacted the groundwater.

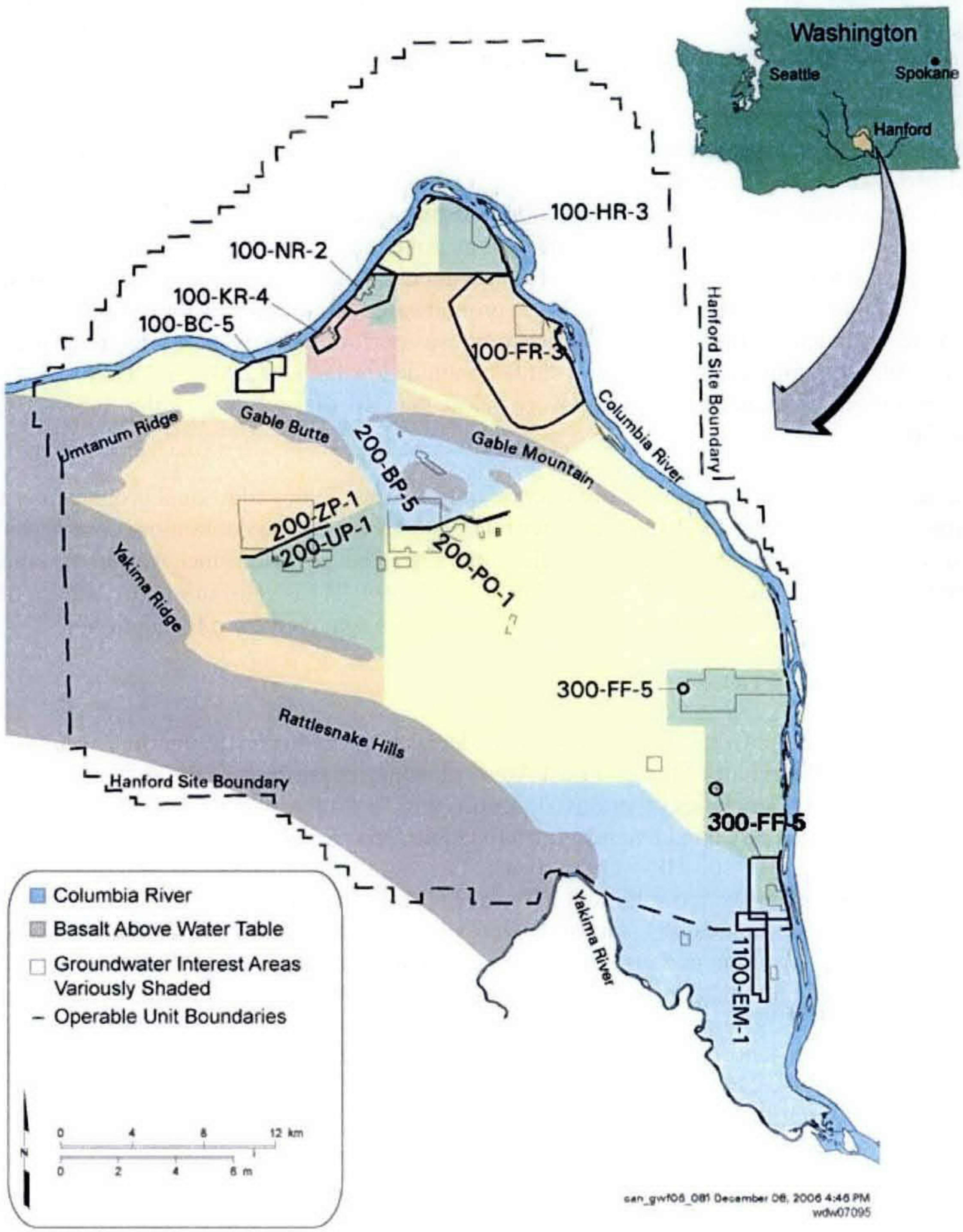
2.2.3.1 200 West Area

The 200-ZP-1 Groundwater OU includes the northern and central parts of the 200 West Area and the western 600 Area. Groundwater is monitored to assess the performance of an interim-action pump-and-treat system for carbon tetrachloride contamination, to track other contaminant plumes, and to support RCRA TSD units and the State-Approved Land Disposal Site (SALDS). Data from facility-specific monitoring also are integrated into CERCLA groundwater investigations. The groundwater contamination plumes of interest in this area include carbon tetrachloride, chloroform, trichloroethene, nitrate, chromium, fluoride, tritium, I-129, Tc-99, and uranium.

Twelve solid-waste landfills overlie the 200-ZP-1 Groundwater OU. These include the 218-W-1, 218-W-1A, 218-W-2, 218-W-2A, 218-W-3, 218-W-3A, 218-W-3AE, 218-W-4A, and 218-W-4B Landfills, all but the southeast corner of the 218-W-4C Landfill, and the 218-W-5 and 218-W-11 Landfills.

A pump-and-treat system is operating in the 200-ZP-1 Groundwater OU to contain and capture the high-concentration portion of the carbon tetrachloride plume located north of the Plutonium Finishing Plant. The plume originated from discharges to the 216-Z-9 Trench, 216-Z-1A Tile Field, and 216-Z-18 Crib and has moved north and east of the waste sites. The pump-and-treat system was implemented as an interim remedial measure in three phases starting in 1996. The RAOs for the pump-and-treat system are to capture the high-concentration area of the carbon tetrachloride plume at the water table, to reduce contaminant mass, and to gather information to support future RI/FS decisions. The high-concentration plume is defined by the 2,000 to 3,000 μg/L plume contour, which initially was centered beneath the Plutonium Finishing Plant and related waste sites. In 2005, concentrations of carbon tetrachloride exceeding the 2,000 μg/L remedial action goal were reported at wells west of the TX and TY Tank Farms. Four monitoring wells were converted to extraction wells and connected to the 200-ZP-1 Groundwater OU pump-and-treat system. Pumping began there in late July 2005 and continued through fiscal year 2006.

Figure 2-5. Hanford Site Groundwater Operable Units and Areas of Interest.



Since the pump-and-treat system was started in August 1996, over 10,197 kg of carbon tetrachloride have been removed from almost 3.19 billion liters of groundwater.

The 200-UP-1 Groundwater OU interest area addresses groundwater contaminant plumes beneath the southern third of the 200 West Area and adjacent portions of the surrounding 600 Area. Technetium-99, uranium, tritium, I-129, nitrate, and carbon tetrachloride are the contaminants of greatest significance in groundwater and form extensive plumes within the region. Only the southeast corner of the 218-W-4C Landfill overlies the 200-UP-1 Groundwater OU. Contaminant plumes underlying the 200 West Area are depicted in Figure 2-6.

An interim remedial-action pump-and-treat system operated in the central part of the 216-U-1 and 216-U-2 Cribs plumes from 1994 until early 2005. Operation of this system caused the plume to bifurcate into a high-concentration portion captured by the pump-and-treat system and a lower concentration portion outside the capture zone that has continued to migrate into the 600 Area. The remediation was successful in reducing concentrations below the remedial action goal of 9,000 pCi/L. During January 2005, groundwater extraction was terminated and a rebound study was initiated. Monthly sampling was performed to assess plume response to the termination of pumping. The rebound study concluded in January 2006, and Tc-99 concentrations at all monitoring wells were below the remedial action goal throughout fiscal year 2006.

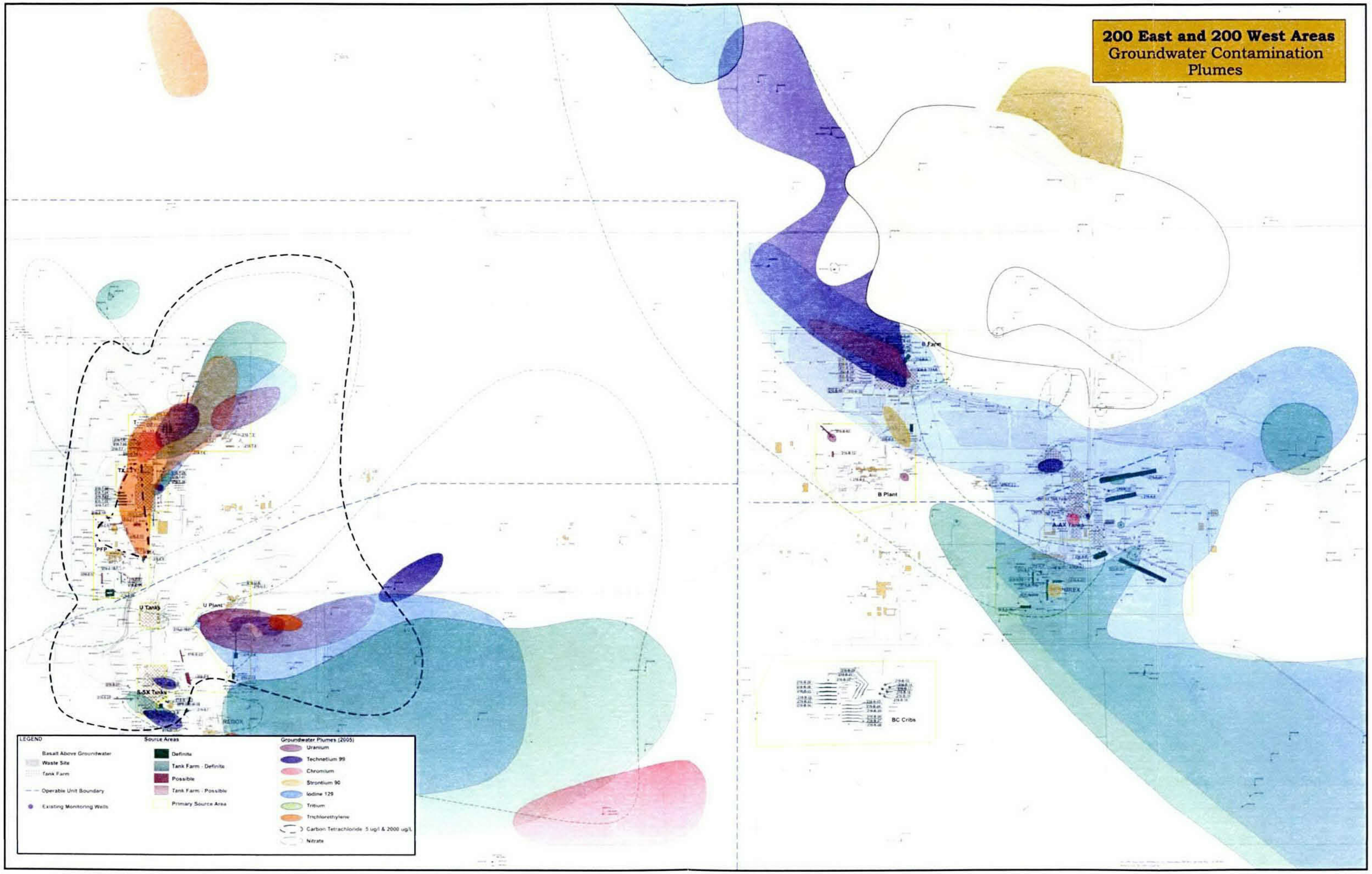
Because the treatment system did not operate in fiscal year 2006, additional groundwater was not extracted from the 200-UP-1 Groundwater OU plume area, and no contaminant mass was removed from the aquifer. Over 853 million liters have been treated since startup of remediation activities in fiscal year 1994. A total of 118.8 g of Tc-99, 211.8 kg of uranium, 34.6 kg of carbon tetrachloride, and 34,716 kg of nitrate have been removed from the aquifer.

2.2.3.2 200 East Area

The 200-BP-5 Groundwater OU interest area addresses groundwater contaminant plumes beneath the northern half of the 200 East Area and adjacent portions of the surrounding 600 Area. This OU includes several RCRA units and CERCLA past-practice sites in the north part of the 200 East Area and extends north to Gable Gap. Technetium-99 is the contaminant of greatest concern in the 200-BP-5 Groundwater OU, because of its mobility and broad areal extent. Uranium, though more limited in terms of areal distribution, also has been recognized recently as an important COPC. Groundwater is monitored in this OU to define the regional extent of Tc-99, uranium, and other significant contaminants across the OU, as well as the local extent of contamination associated with specific RCRA TSD units in the area.

Eleven solid waste landfills overlie the 200-BP-5 Groundwater OU. These include the 218-E-2, 218-E-2A, 218-E-4, 218-E-5, 218-E-5A, 218-E-8, 218-E-9, 218-E-10, 218-E-12A, 218-E-12B, and 218-C-9 Landfills.

Figure 2-6. 200 East and 200 West Area Groundwater Contamination Plumes.



The 200-PO-1 Groundwater OU interest area addresses groundwater contaminant plumes beneath the southern portion of the 200 East Area and a large triangle-shaped portion of the Hanford Site extending to the Hanford townsite. Tritium, nitrate, and I-129 are the contaminants with the largest plumes in groundwater. Other COPCs in more localized areas include Sr-90 and Tc-99. COPCs also include arsenic, chromium, manganese, vanadium, Co-60, cyanide, and uranium. Only one solid waste landfill, the 218-E-1 Landfill, overlies the 200-PO-1 Groundwater OU. Contaminant plumes underlying the 200 East Area are depicted in Figure 2-6.

2.2.3.3 Groundwater Flow

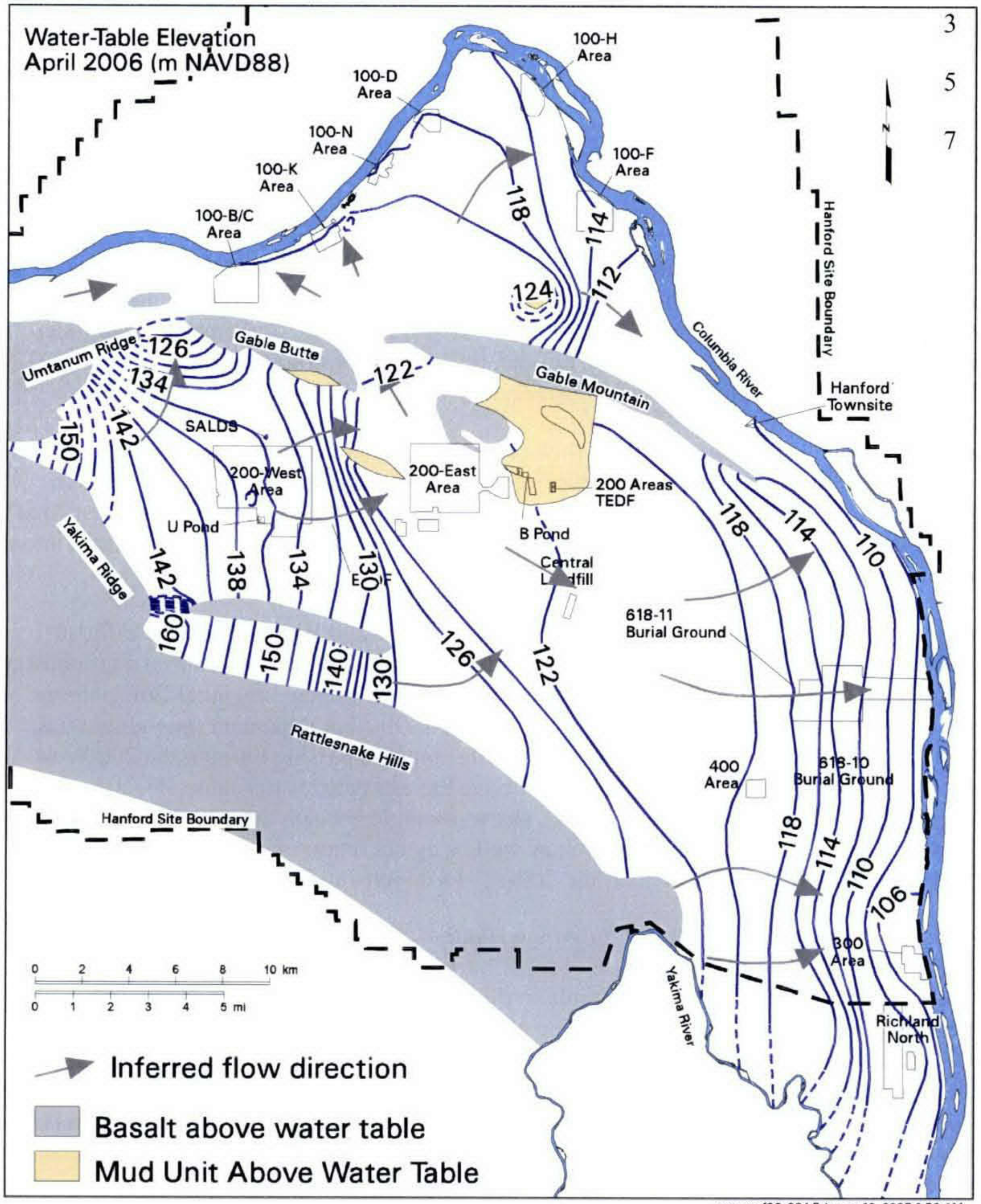
Moisture in the vadose zone typically is concentrated along high-contrast bed interfaces, as well as along finer grained layers. Precipitation and waste-water discharges may migrate downward along discordant features such as clastic dikes, or spread laterally, sometimes in a stair-step fashion, along overlapping series of anisotropic, discontinuous strata (Bjornstad et al., 2003, "Hydrogeology of the Hanford Site Vadose Zone").

Groundwater in the unconfined aquifer flows from areas where the water table is higher (west of the Hanford Site) to areas where it is lower (toward the Columbia River) (Figure 2-7). In general, groundwater flows eastward through the 200 Areas Plateau, from the 200 West Area to the 200 East Area; from there it flows east to southeast through the 600 Area to discharge into the Columbia River.

Groundwater generally flows from west to east beneath the 200 West Area. Past effluent discharges at the former U Pond and other liquid-waste disposal facilities caused a groundwater mound to form beneath the 200 West Area that significantly affected regional flow patterns in the past. These discharges largely ceased by the mid-1990s, but a remnant mound remains, which is apparent from the shape of the water-table contours passing through the 200 West Area. Currently, the water table elevation is ~12 m above the estimated water-table elevation from before the start of Hanford Site operations. The water table beneath the 200 West Area is locally perturbed by discharges from the SALDS, as well as by operation of a groundwater pump-and-treat remediation system at the 200-ZP-1 Groundwater OU.

Groundwater flow in the central portion of the Hanford Site, encompassing the 200 East Area, may be affected by the presence of one or more buried flood channels, which trend northwest to southeast (see Figure 2-3). The water table in this area is very flat because of the high permeability of the Hanford formation. The hydraulic gradient is approximately 1×10^{-5} (i.e., the top of the water table drops one unit of vertical distance for every 100,000 equivalent units of horizontal distance). The Hanford formation fills the ancient flood channels (see Section 2.2.2) and forms the upper portion of the unconfined aquifer. Groundwater flow in this region is affected significantly by the presence of low permeability sediment of the Ringold Formation at the water table east and northeast of the 200 East Area, as well as basalt above the water table. These features constitute barriers to groundwater flow.

Figure 2-7. Hanford Site Water Table Map for April 2006 (PNNL-16346).



The extent of the basalt units above the water table continues to increase slowly because of the declining water table, resulting in an even greater effect on groundwater flow in this area. In the past, liquid discharges to the former 216-B-3 Pond (1945 to 1997) created a large water table mound and reversed groundwater flow directions. The mound has dissipated, but the water table beneath the 200 East Area remains ~2 m higher than the estimated pre-Hanford Site conditions. Simulations of equilibrium conditions after site closure suggest that the water table in the 200 East Area will be near its pre-Hanford Site elevation (PNNL-14753, *Groundwater Data Package for Hanford Assessments*).

The flat nature of the water table (i.e., very low hydraulic gradient) in the 200 East Area and vicinity makes determination of the flow direction difficult. This is because the uncertainty in the water-level elevation measurements is greater than the actual relief present on the water table. Therefore, determining the groundwater flow direction based on these data is problematic, so other evidence is used to infer flow directions. Water enters the 200 East Area and vicinity from the west and southwest, as well as from beneath the mud units to the east and from the underlying aquifers where the confining units have been removed or thinned by erosion. The flow of water divides, with some migrating to the north through Gable Gap and some moving southeast toward the central part of the Site. The specific location of the groundwater flow divide currently is not known. It is known that groundwater flows north through Gable Gap, because the hydraulic gradient is steep enough to be determined using water-level-elevation data (the gradient averages 1.5×10^{-4} along a north flow direction). Groundwater is known to flow southeast within the region between the 200 East Area and the Central Landfill, because the average water-level elevation at the landfill (121.96 m NAVD88, *North American Vertical Datum of 1988*, for May 2006) is ~0.13 m less than the average elevation in the 200 East Area (122.09 m NAVD88 for April 2006). This yields a regional hydraulic gradient ranging from 1×10^{-5} to 2×10^{-5}.

The Hanford Site has a semiarid climate with annual precipitation of approximately 15 cm (6 in.). Estimates of recharge from precipitation range from 0 to 10 cm/yr (0 to 4 in/yr) and largely are dependent on soil texture and the type and density of vegetation. Recharge also can be affected by seasonal variations and associated changes in the amount of precipitation, and recycling of that precipitation to the atmosphere by evaporation and plant transpiration. Artificial recharge occurred when effluent such as cooling water and liquid wastes from Hanford Site process operations were disposed to the ground via ponds, ditches, and cribs. Most sources of artificial recharge have been halted.

Sections 2.2.3.4 through 2.2.3.5 discuss site-specific groundwater flow.

2.2.3.4 200 West Area Hydrogeology

This section describes the stratigraphy, vadose zone, uppermost aquifer, groundwater flow, and contaminant plumes beneath the landfills located in the 200 West Area. The sections first discuss the hydrogeology of the landfills in the northwest, then in the southwest. PNNL-14058, *Prototype Database and User's Guide of Saturated Zone Hydraulic Properties for the Hanford Site*, compiles estimates of hydraulic properties based on aquifer testing of wells near these landfills.

2.2.3.4.1 218-W-1A, 218-W-2A, 218-W-3, 218-W-3A, 218-W-3AE, 218-W-4A, and 218-W-5 Landfills

These landfills are located in the northwestern part of the 200 West Area. The following summary is from the investigations and groundwater monitoring conducted at the 218-W-3A, 218-W-3AE, and 218-W-5 Landfills, also known as Low-Level Waste Management Area 3 (LLWMA-3).

Figure 2-8 is a west-east cross section passing through the northern part of the 200 West Area. LLWMA-3 would be just west of well 299-W6-3 in the cross section. These landfills are underlain by the Hanford formation, the Cold Creek unit, and the Ringold Formation. The depth to the water table is ~69 to 78 m (~227 to 255 ft) below ground surface, and the aquifer thickness ranges from ~60 to ~73 m (~197 to ~240 ft) thick. The unconfined aquifer is entirely within the upper coarse gravels of the Ringold Formation. The base of the aquifer is the Ringold Formation lower mud, except where this unit is not present in the northern portions of LLWMA-3; there the aquifer base is the top of basalt.

The groundwater flow beneath LLWMA-3 is toward the east-northeast, with a calculated gradient[17] of 0.0018 in April 2006. The flow direction is returning to the pre-Hanford Site conditions and will continue to change until the direction is predominately west to east.

Regional groundwater-contaminant plumes of carbon tetrachloride and nitrate underlie portions of LLWMA-3 at levels exceeding their drinking water standards. Trichloroethene and chloroform also are elevated, but do not exceed standards. Radionuclide concentrations are low or undetectable. There is no evidence to suggest that the LLWMA-3 landfills have contributed to the regional groundwater-contaminant plumes.

2.2.3.4.2 218-W-1, 218-W-2, 218-W-4B, 218-W-4C, and 218-W-11 Landfills

These landfills are located in the west-central part of the 200 West Area. The following summary is from the investigations and groundwater monitoring conducted at the 218-W-4B and 218-W-4C Landfills, also known as LLWMA-4.

Figure 2-9 is a west-east cross section passing through the southern part of the 200 West Area. Well 299-W18-1 in the cross section represents LLWMA-4. These landfills are underlain by the Hanford formation, the Cold Creek unit, and the Ringold Formation. The depth to the water table is ~67 to 76 m (~219 to 249 ft) below ground surface, and the aquifer thickness ranges from ~64 to ~69 m (~210 to ~226 ft) thick. The unconfined aquifer is entirely within the upper coarse gravels of the Ringold Formation, and the base of the aquifer is the Ringold Formation lower mud.

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[17] Gradient, or hydraulic gradient, is essentially the slope of the water table and is calculated between two wells in a monitoring network as the difference in elevation of the water levels divided by the distance between the wells.

Figure 2-8. Schematic Hydrogeologic Cross Section Passing West-to-East Beneath the Northern 200 West Area and Vicinity (PNNL-13858).

The horizon labeled "Plio-Pleistocene" is the Cold Creek unit. LLWMA-3 lies just west of well 299-W6-3.

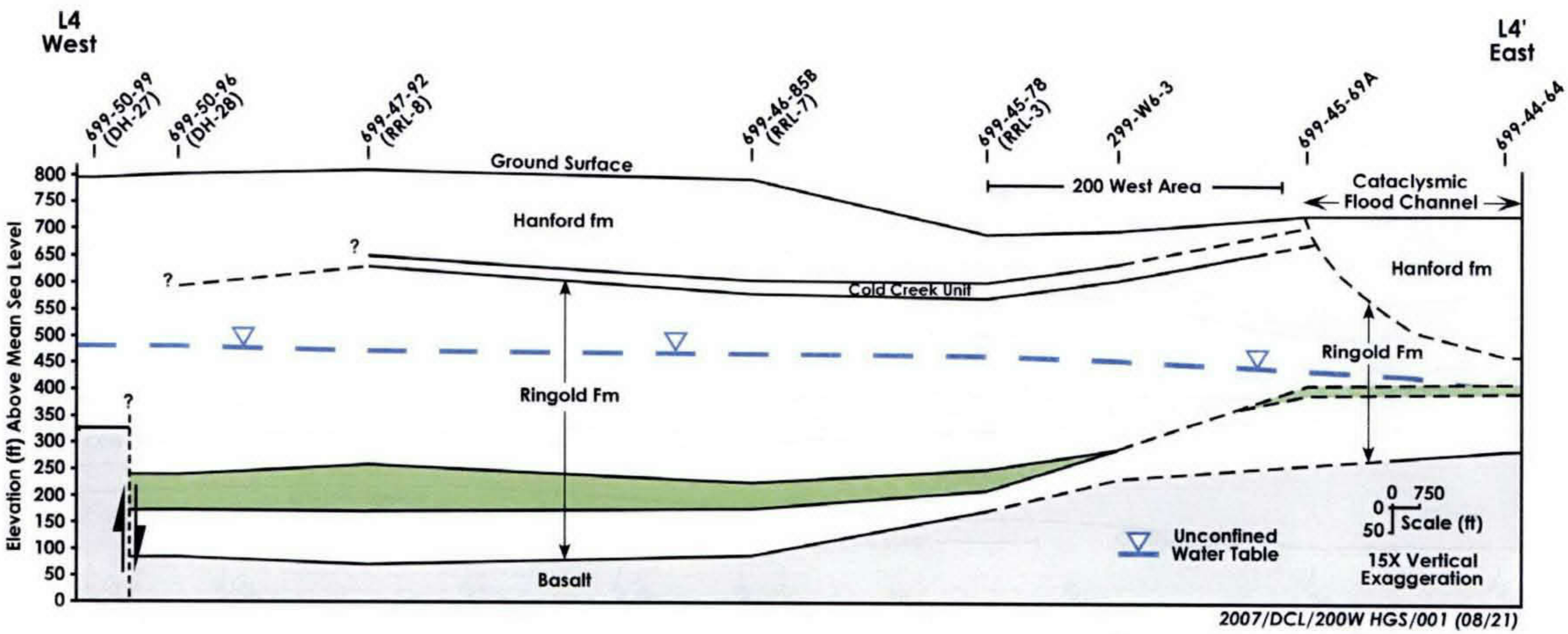
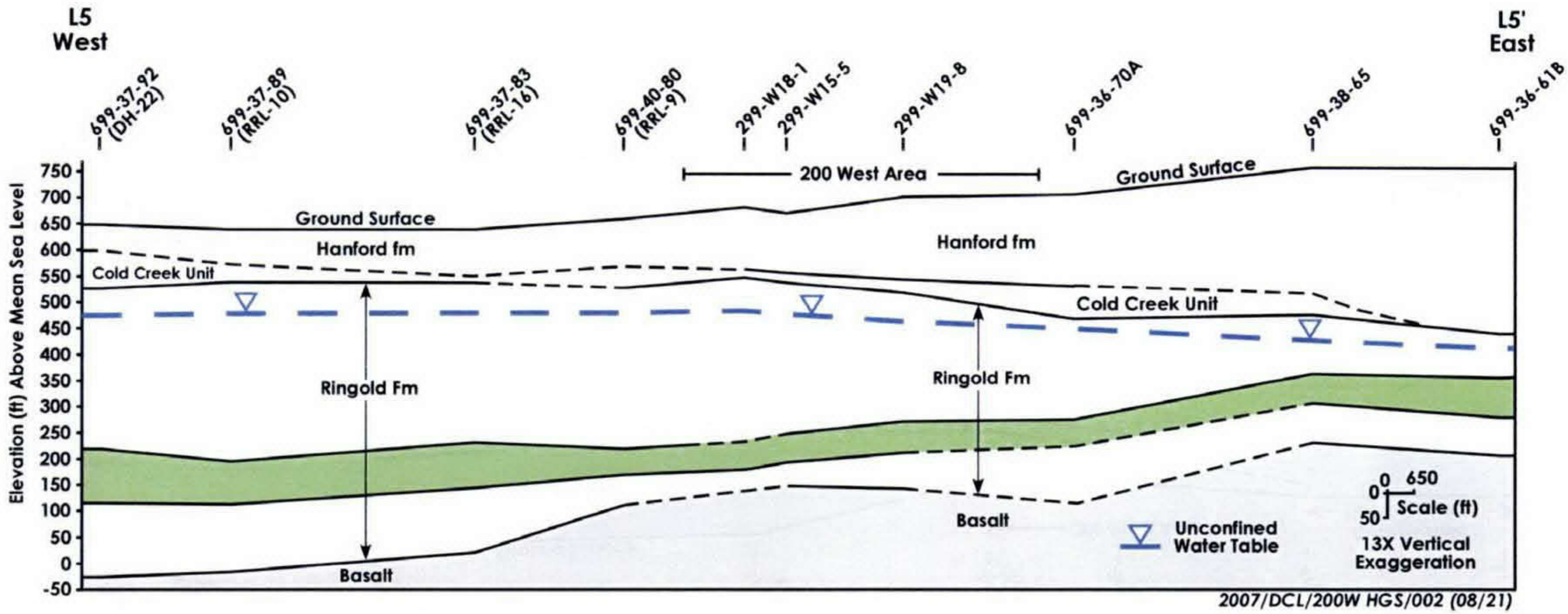


Figure 2-9. Schematic Hydrogeologic Cross Section Passing West-to-East Beneath the Southern 200 West Area and Vicinity (PNNL-13858).

The horizon labeled "Plio-Pleistocene" is the Cold Creek unit. Well 299-W18-1 represents LLWMA-4.



The groundwater flow beneath these landfills is generally to the east, with a gradient of 0.004 in July/August 2006. The groundwater flow is affected to a large degree by the 200-ZP-1 Groundwater OU pump-and-treat system, which has extraction wells to the east and injection wells to the west of these landfills.

Regional contaminant plumes of carbon tetrachloride and nitrate underlie portions of LLWMA-4 at levels exceeding their drinking water standards. Trichloroethene and chloroform also are elevated, but do not exceed standards. Uranium concentrations are elevated and increasing in a well in the southwest corner of LLWMA-4 (upgradient). In fiscal year 2006 levels remained below the drinking water standard. All of these contaminants appear to have sources at liquid-waste disposal sites in the 200 West Area.

Perched water historically has been documented above the Cold Creek unit at locations in the 200 West Area. While the liquid-waste disposal facilities were operating, many localized areas of saturation or near saturation were created in the soil column. One former monitoring well at the 218-W-4C landfill monitored a perched zone above the Cold Creek unit from 1991 to 1994, when it went dry.

2.2.3.5 200 East Area Hydrogeology

This section describes the stratigraphy, vadose zone, uppermost aquifer, groundwater flow, and contaminant plumes beneath the landfills located in the 200 East Area. The sections separately discuss the hydrogeology of three portions of the 200 East Area: northwest, northeast, and east-central. PNNL-14058 compiles estimates of hydraulic properties based on aquifer testing of wells near these landfills.

2.2.3.5.1 218-E-2A, 218-E-5, 218-E-5A, and 218-E-10 Landfills

These landfills are located in the northwestern corner of the 200 East Area. The following summary is from the investigations and groundwater monitoring conducted at the 218-E-10 Landfill, also known as LLWMA-1. Wells 299-E28-26 and 299-E33-29 shown in Figure 2-10 and 299-E33-34 in Figure 2-11 represent LLWMA 1.

These sites are underlain by the Hanford formation. The depth to the water table ranges between 71 and 88 m (233 and 289 ft) below ground surface, and the unconfined aquifer is 2.0 to ~11.6 m (~6.6 to ~38 ft) thick. The thin, unconfined aquifer is contained in the sand and gravel of the Hanford formation, which directly overlies the basalt.

Groundwater flow is believed to be toward the north (PNNL-16346), but considerable uncertainty remains, because differences in water level elevation are within the range of measurement error.

Regional contaminant plumes underlie portions of LLWMA-1. Uranium and Tc-99 exceed their drinking water standard in the northeast corner of the site. Iodine-129 exceeds its standard beneath the north and east portions of LLWMA 1, and tritium is elevated but below the drinking water standard. Nitrate also exceeds its drinking water standard. All of these contaminants appear to have sources at liquid-waste disposal sites in the 200 East Area.

Figure 2-10. Schematic Hydrogeologic Cross Section Passing West-to-East Beneath the Northwestern 200 East Area and Vicinity (PNNL-12261).

Wells 299-E33-29 and 299-E33-43 represent LLWMA-1, and well 299-E34-11 represents LLWMA-2.

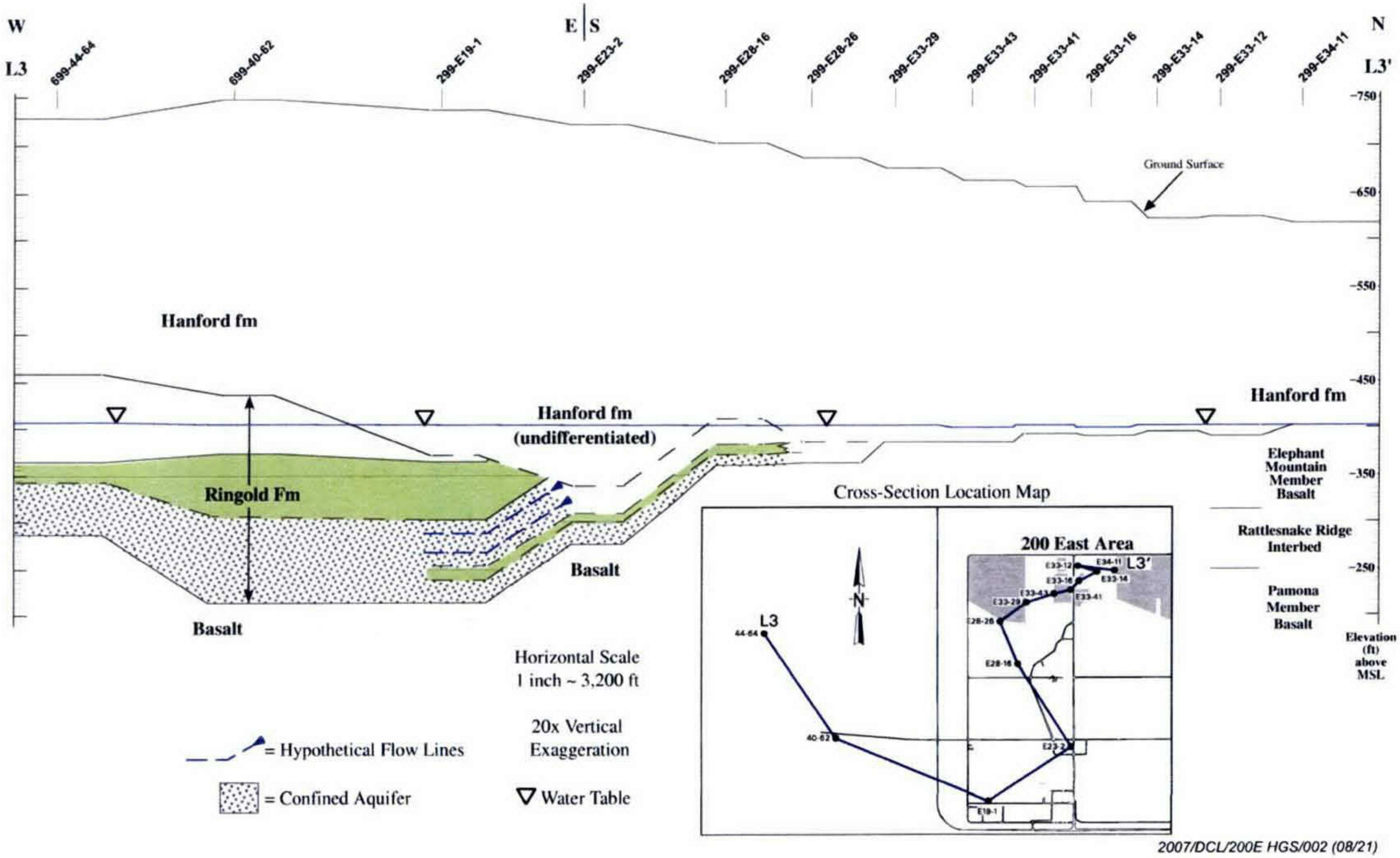
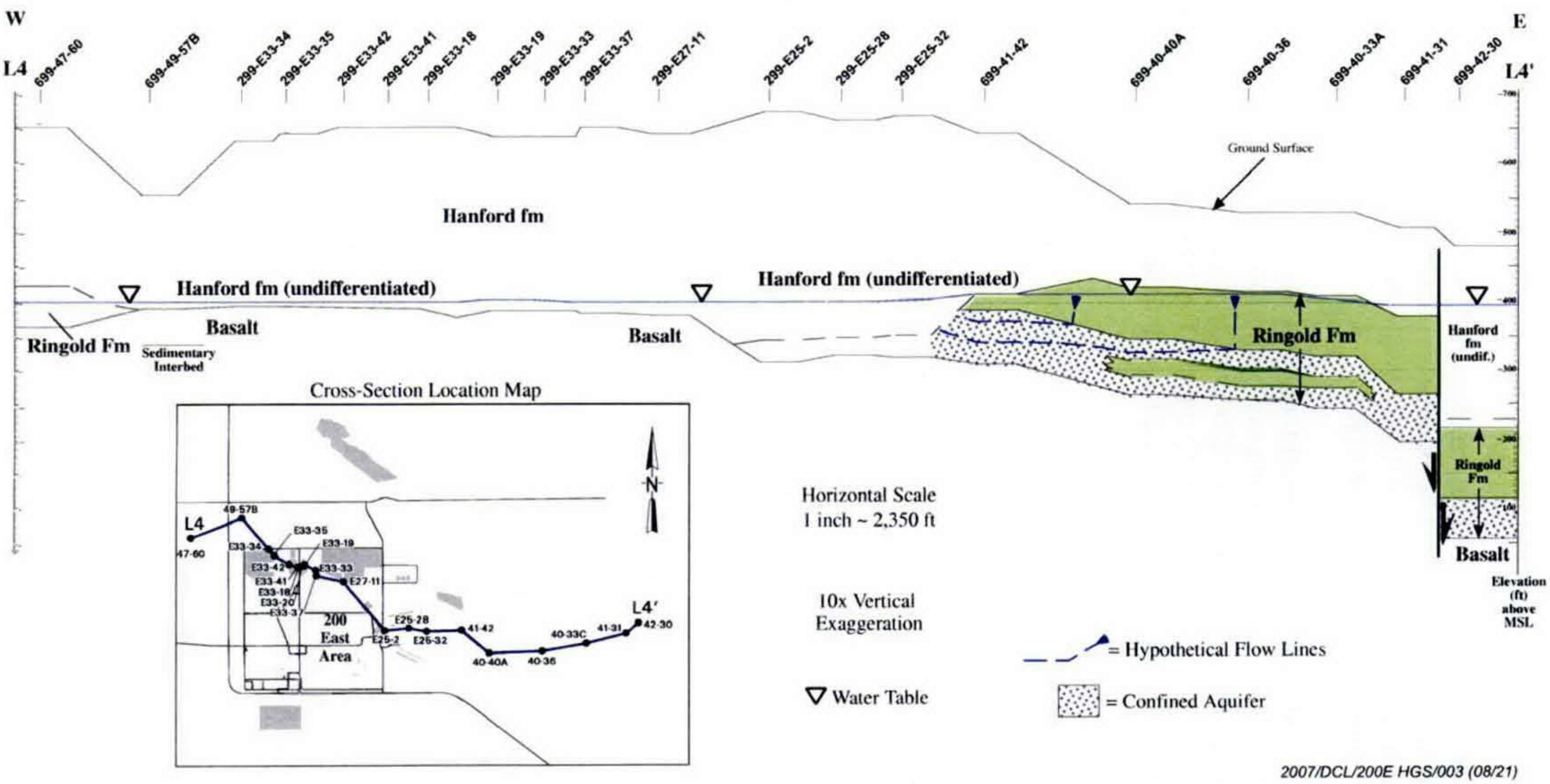


Figure 2-11. Schematic Hydrogeologic Cross Section Passing Northwest-to-Southeast Beneath the Northern 200 East Area and Vicinity (PNNL-12261).

Well 299-E33-34 represents LLWMA-1, and well 299-E27-11 represents LLWMA-2.



2.2.3.5.2 218-E-8, 218-E-12A, and 218-E-12B Landfills

These landfills are located in the northeastern corner of the 200 East Area. The following summary is from the investigations and groundwater monitoring conducted at the 218-E-12B Landfill, also known as LLWMA-2. Wells 299-E34-11 in Figure 2-10 and 299-E27-11 in Figure 2-11 represent LLWMA-2.

These landfills are underlain by the Hanford formation. The Ringold Formation is absent beneath the landfills but is present west and east of the 200 East Area (see Figures 2-8 and 2-9). The depth to the water table is 74 to 69 m (226 to 243 ft) below ground surface, and the aquifer thickness ranges from 0 to ~3 m (0 to ~10 ft) thick at the 218-E-12B Landfill (LLWMA-2). Wells in the north portion of LLWMA-2 are all dry, and the water table has dropped below the top of the basalt.

Where present, the unconfined aquifer is contained in the sand and gravel of the Hanford formation, which directly overlies the basalt.

The groundwater gradient in this part of the 200 East Area is almost flat, making the determination of groundwater-flow direction difficult. Groundwater appears to flow generally to the west or southwest. The presence of basalt above the water table in the north portion of LLWMA-2 restricts groundwater flow.

Regional groundwater-contaminant plumes of I-129 and nitrate exceed drinking water standards in wells monitoring LLWMA-2. There is no evidence to suggest that the LLWMA-2 landfills have contributed to the groundwater-contaminant plumes.

2.2.3.5.3 218-C-9 and 218-E-1 Landfills

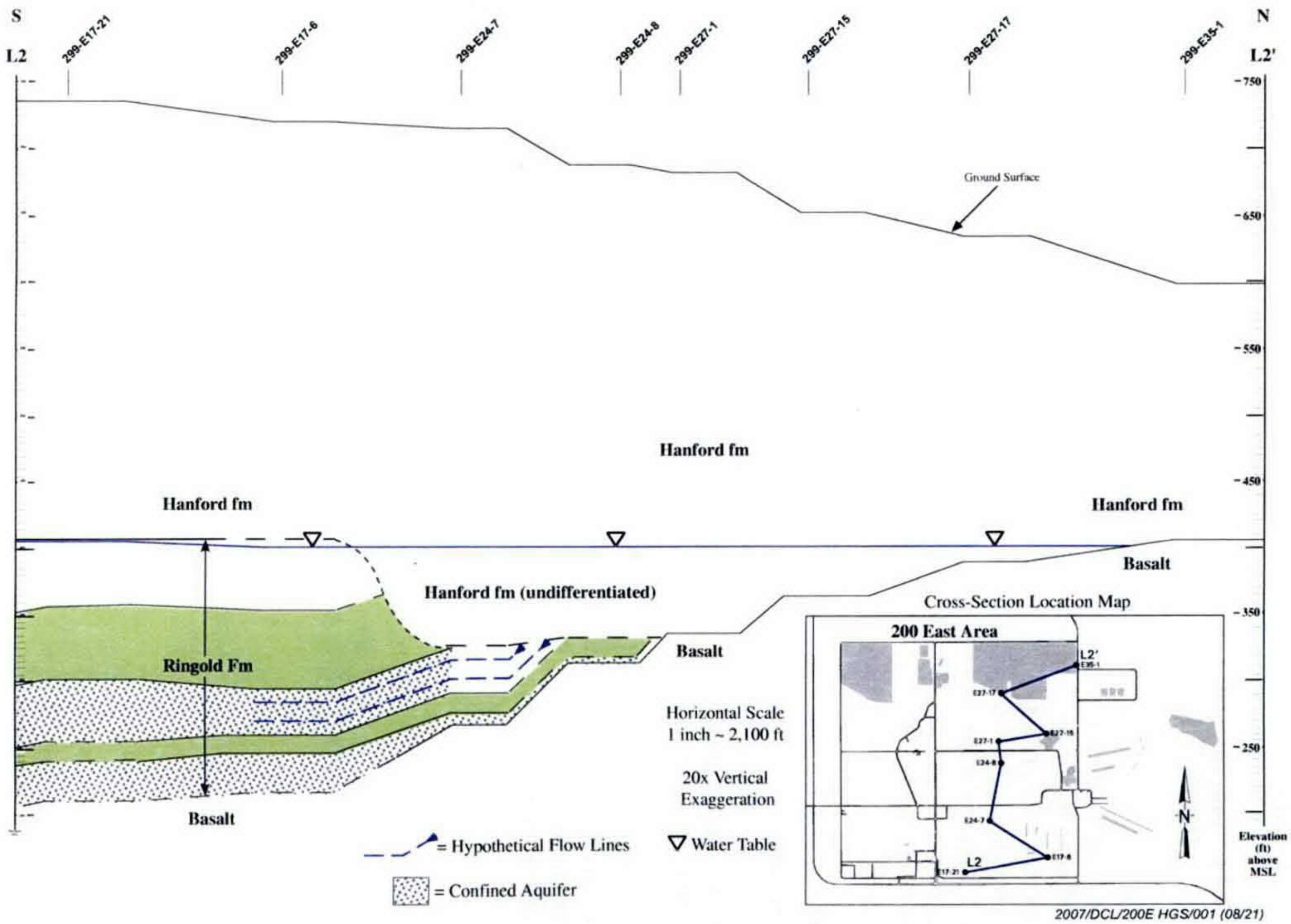
These landfills are located south of LLWMA-2, where the aquifer is thicker. Interpretations in this section are primarily from PNNL-12261. Figure 2-12 is a cross-section showing the geology beneath these sites. Wells 299-E24-8 and 299-E27-1 represent the 218-C-9 Landfill and well 299-E24-7 and approximate the conditions beneath the 218-E-1 Landfill.

The uppermost aquifer beneath the 218-C-9 Landfill is in the sand and gravel of the Hanford formation. The base of the aquifer is either a fine-grained portion of Ringold basal coarse or the basalt surface (see Figure 2-12), at an elevation of ~100 m (305 ft) amsl. Hydraulic head was ~122 m (400 ft) amsl in March 2007, so the aquifer is ~22 m (72 ft) thick. Flow direction is difficult to determine because of the flat water table. At nearby Waste Management Area C, flow direction is interpreted to be toward the southwest (PNNL-16346).

The uppermost aquifer beneath the 218-E-1 Landfill is in the sand and gravel of the Hanford formation and perhaps Ringold basal coarse (see Figure 2-12). The base of the aquifer is inferred to be a fine-grained portion of Ringold basal coarse at an elevation of ~88 m (290 ft) amsl. Hydraulic head is ~122 m (400 ft) amsl at this location (PNNL-16346), so the aquifer is 34 m (112 ft) thick. Flow direction is difficult to determine because of the flat water table. At the nearby Integrated Disposal Facility, flow direction is interpreted to be toward the east or southeast (PNNL-16346).

Figure 2-12. Schematic Hydrogeologic Cross Section Passing North-to-South Beneath the Eastern 200 East Area (PNNL-12261).

Well 299-E24-7 represents the 218-E-1 Landfill, and wells 299-E24-8 and 299-E27-1 represent the 218-C-9 Landfill.



Regional groundwater-contaminant plumes in the east-central 200 East Area at levels above drinking water standards include I-129, tritium, and nitrate. There is no evidence to suggest that the LLWMA-2 landfills have contributed to the groundwater-contaminant plumes.

2.2.3.6 Nonradioactive Dangerous Waste Landfill and 600 Area Central Landfill Hydrogeology

The NRDWL and 600 CL (also called the Solid Waste Landfill) are located in the central part of the Hanford Site about 5.5 km (3.4 mi) southeast of the 200 East Area. These landfills are underlain by the Hanford formation and the Ringold Formation (Figure 2-13). The uppermost unconfined aquifer is within the Hanford formation and the upper fines of the Ringold Formation. The base of the uppermost unconfined aquifer is a 1 to 4 m (3 to 13 ft) thick clayey silt layer in the Ringold Formation upper fines, at an elevation of ~100 m amsl (PNNL-12227, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill*). The depth to the water table is ~41 m (~135 ft) below ground surface, and the uppermost aquifer is ~22 m (72 ft) thick (May 2006 data).

The direction of groundwater flow is difficult to determine from water-table maps because of the extremely low hydraulic gradient. The best indicators of flow direction are the major plumes of I-129, nitrate, and tritium that originated from liquid-waste disposal sites in the 200 Areas. These plumes flow to the southeast in the vicinity of the landfills. Regional plumes of I-129, tritium, and nitrate exceed drinking water standards in wells monitoring these landfills.

In addition to the 24 landfills considered in the Phase I-B DQO process, historical information for an additional 15 unplanned release waste sites was evaluated, because the sites were contained within or near the in-scope 200-SW-2 OU landfills. None of the unplanned release sites are/were within the 200-SW-1 OU landfills. In 13 cases (i.e., UPR-200-E-24, UPR-200-E-30, UPR-200-E-53, UPR-200-W-11, UPR-200-W-37, UPR-200-W-134, UPR-200-E-23, UPR-200-W-16, UPR-200-W-26, UPR-200-W-53, UPR-200-W-72, UPR-200-W-84, and Z PLANT BP), the unplanned release site has been classified as "Consolidated"[18] in WIDS, because either it was a duplicate of another unplanned release or it was considered to be contained within the footprint of one of the 200-SW-2 OU landfills and will be addressed via the RI/FS process for the landfill.

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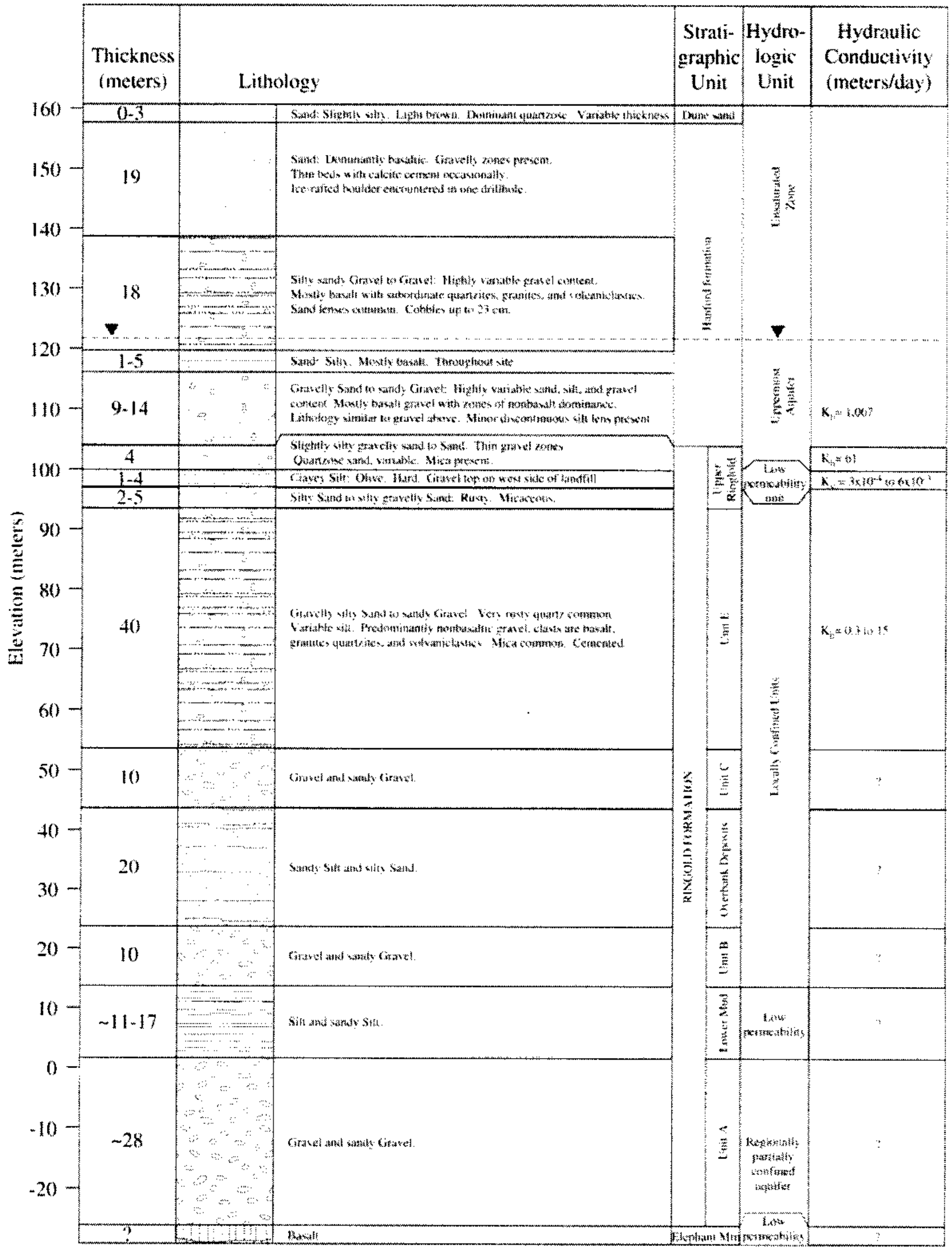
[18] According to RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures,* Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," Rev. 1, p. 1, 01/18/07, consolidated means "a reclassification status indicating a WIDS site is a duplicate of, physically located within, or adjacent to another WIDS site and will be dispositioned as part of that other WIDS site."

Figure 2-13. Stratigraphic Column at the Nonradioactive Dangerous Waste Landfill and 600 Area Central Landfill (PNNL-12227).



In one case, the waste site (UPR-200-W-45) was reclassified in WIDS as a "No-Action" site. The other unplanned release waste site (UPR-200-E-61) has been reclassified as "Rejected."[19] Note that although sites may be classified as "No-Action" or "Consolidated," these sites must be carried through completion of the RI/FS process. "No-Action" sites need to be included in the RI/FS documentation with an explanation included as to why the sites do not require action. "Consolidated" sites need to be included in the RI/FS documentation and need to be taken into consideration during the selection of the preferred alternative, remedial decision, or action. Only the "Rejected" sites do not require further documentation.

A listing and brief summary description of the 24 landfills in the 200-SW-2 OU, as well as site descriptions of the two 200-SW-1 OU landfills (i.e., NRDWL and 600 CL) are provided in Appendix B, Table B-1. Brief summary descriptions for the 15 unplanned release waste sites are presented in Appendix B, Table B-2.

2.2.4 History of Facilities Generating Solid Waste

The sources of wastes (both Hanford Site and offsite operations) that contributed to the inventory of the landfills varied over time. The following section provides an overview of the various process activities that contributed waste to the 200-SW-1 and 200-SW-2 OU landfills.

2.2.4.1 200 Areas History

The process history of the 200 Areas facilities changed over time; consequently the chemical and radionuclide waste streams produced by the specific facilities changed. Three chemical extraction methods were used to recover plutonium during 45+ years of process operations:

- The bismuth phosphate batch process at the 221/224-B and -T Plants
- The REDOX continuous solvent-extraction process at the 202-S Plant
- The PUREX continuous solvent-extraction process at the 202-A Plant.

All processes were characterized by the initial dissolution of the fuel rod jackets: (1) sodium hydroxide was used for aluminum-clad fuels; (2) ammonium nitrate/ammonium fluoride was used for zirconium-clad fuels; and (3) the plutonium-bearing uranium fuel rods were dissolved using concentrated nitric acid.

The chemical extraction of plutonium from the fuel rod solution then proceeded on either a batch or continuous basis, depending on the plant. Multiple steps usually were required to separate

[19] Per RL-TPA-01-0001, Guideline Number TPA-MP-14, no action means "a reclassification status indicating a waste site does not require any further remedial action under RCRA Corrective Action, CERCLA, or other cleanup standards based on an assessment of quantitative data collected for the waste site." Rejected means "a reclassification status indicating a waste site does not require remediation under RCRA Corrective Action, CERCLA, or other cleanup standards based on qualitative information such as a review of historical records, photographs, drawings, walkdowns, ground penetrating radar scans, and shallow test pits. Such investigations do not include quantitative measurements."

plutonium from the associated uranium and fission products (DOE/RL-98-28). Fuel decladding wastes were processed and routed to underground tank storage. A detailed discussion of the 200 Areas processing operations may be found in Appendix H of the Implementation Plan (DOE/RL-98-28).

About 65 percent (by waste volume) of the waste burials in the 200 Areas trenches in the scope of this project originated in the 200 Areas (SWITS). Types of solid waste varied greatly and included the following materials:

- Large contaminated vehicles, debris, and equipment (such as railway cars, pipes or ducts, tanks, ovens, pumps, columns, and other failed or outdated processing equipment)
- Small contaminated wastes such as filters, rags, small tools, paint cans, rubber gloves, and clothing
- Metals and dry chemicals such as depleted uranium and lead
- Contaminated soil and vegetation from cleanups of unplanned releases and contamination found during routine surveys
- Small amounts of liquid wastes (usually sealed in drums with stabilizers and/or absorbents) such as liquid plutonium or tritium solutions
- Small amounts of highly radioactive wastes packaged in 3.9 and 18.9 L (1-and 5-gal) cans (usually from laboratory operations) and stored in caissons.

2.2.4.2 100 Areas History

Nine graphite-moderated, light-water-cooled reactors were constructed near the Columbia River in the Hanford Site 100 Areas over a period of 20 years, commencing in 1943. The reactors were used to produce plutonium by irradiating metallic uranium fuel elements with neutrons during the fission reaction in the reactor core. The first eight reactors at the Hanford Site, designated 105-B, -C, -D, -DR, -F, -H, -KW, and -KE, were similar in design, using a once-through light-water cooling system. The ninth reactor, 105-N, used a closed-loop light water cooling system. In addition to the reactors, a radiobiology facility, the 108-F Biology Laboratory, in the 100 Areas, sent a small amount of biological wastes to be buried in the 200 Areas.

Although 100 Area wastes typically were disposed to trenches and landfills in the 100 Area until the mid-1970s, about 10 percent by volume of the waste burials in 200 Areas trenches within the scope of this project originated in the 100 Area (SWITS). They include fuel spacers and canisters; ion-exchange columns and modules; dummy slugs; asbestos insulation removed from pipes; equipment such as ladders, tools, and muffle furnaces; HEPA filters; gloveboxes; boron balls; miscellaneous demolition waste such as ductwork, concrete, telephone poles, and soil; groundwater slurries solidified with absorbents; concrete powder; steel shot; tanker trailers and rail cars; a cement mixer; lead shielding; and depleted uranium (SWITS).

More detailed histories, including descriptions of facilities and waste sites in the 100 Areas, may be found in technical baseline reports that were written for the 100-B, 100-D, 100-H, 100-K, and 100-N Areas. The reports (BHI-00127, *100-H Area Technical Baseline Report*; WHC-SD-EN-TI-181, *100-D Area Technical Baseline Report*; WHC-SD-EN-TI-220, *100-B Area Technical Baseline Report*; WHC-SD-EN-TI-239, *100-K Area Technical Baseline Report*; and WHC-SD-EN-TI-251, *100-N Area Technical Baseline Report*) are listed in the reference section of this work plan.

2.2.4.3 300 Area History

The 300 Area contains facilities, particularly laboratories, that placed solid wastes in 200-SW-2 OU landfills. These facilities include the 308, 309, 324, 325, 326, 327, and 329 Buildings. The missions that these facilities supported varied. A summary of the types of operations that were ongoing when solid wastes from the 300 Area facilities were sent to waste sites may be found in DOE/RL-2001-66, *Chemical Laboratory Waste Group Operable Units RI/FS Work Plan, Includes: 200-LW-1 and 200-LW-2 Operable Units.* A small amount of 300 Area wastes were disposed to the 200 Areas in the 1940s through 1960s. Radioactive waste burials were stopped in the 300 Area in 1972; since then 300 Area wastes have been disposed to the 200 Areas.

About 10 percent by volume of the waste burials in 200 Areas trenches within the scope of this project originated in the 300 Area (SWITS). Burials from all time periods include laboratory wastes such as hot-cell and airlock wastes, laboratory furnishings such as cabinets, Plutonium Recycle Test Reactor wastes, ion-exchange columns, HEPA filters, tools and equipment, depleted uranium, tritium waste, water tower pieces, construction and demolition wastes, solidified liquid wastes, contaminated equipment and clothing, and miscellaneous trash (SWITS).

2.2.4.4 Offsite Sources

The amount of wastes accepted by the Hanford Site from offsite generators is about 10 percent by volume of the waste burials in trenches within the scope of this project. These generators include a variety of government processes and programs. The majority of offsite waste is from FUSRAP and from other DOE complex sites such as Argonne National Laboratory and the Fermi National Accelerator Laboratory.

A detailed discussion of offsite wastes, their source, location, volume, type, and history may be found in WHC-EP-0912, WHC-EP-0845, and WHC-EP-0225.

2.2.4.5 Other Hanford Site Sources

The amount of waste burials in trenches within the scope of this project from Hanford Site sources other than those discussed above (100, 200, and 300 Areas and offsite sources) is about 5 percent by volume. These sources include effluent and water-treatment facilities and miscellaneous structures on the Hanford site. The wastes include dewatered sludge, well casings, and soil (SWITS).

2.2.5 Overview of Solid-Waste Operations

Hanford Site production processes and support activities used and disposed of a large variety of chemical and/or radioactively contaminated waste (WHC-SA-2772-FP, *History of Solid Waste Packaging at the Hanford Site*). When the Hanford Site began operations, each of the operational areas (100, 200 East, 200 West, and 300 Areas) had its own disposal facilities. With the exception of the 300 Area, each had landfills within or in the proximity of their perimeter fence. The 300 Area facilities were as far away as the current location of the Energy Northwest generating plant and close to the 400 Area.

2.2.5.1 Transuranic Waste

From 1944 to 1970, waste was not segregated (and is referred to as unsegregated waste in this RI/FS work plan). Unsegregated radioactive wastes were disposed of through shallow land burial, including some alpha-contaminated wastes. Records and inventories of waste-disposal practices from this period are incomplete. The records that exist indicate the general types of wastes disposed, an estimate of uranium and plutonium inventories, and a very general indication of some of the types of currently regulated materials that potentially may have been disposed to a particular site, such as silver, boron, nitrate, uranium, and lead. The disposal site was considered to be the location for final disposition of solid wastes. Packaging was designed for transport, with little regard for long-term integrity; early radiological waste, including most early alpha-contaminated waste, was wrapped in burlap or paper or contained in wooden or cardboard boxes. Early industrial wastes with high dose rates such as process tubes and jumpers often were packaged in concrete boxes or large concrete tombs to mitigate dose to workers. Some smaller, lower dose rate wastes were direct-dumped from trucks into trenches with no packaging. Early wastes were more rarely packaged in 208.2 L (55-gal) drums or steel boxes and cans; the practice of using durable containers rather than cardboard or wooden boxes became more common over time. The use of cardboard boxes for disposal to the landfills was discontinued in 1984 (WHC-EP-0912). The waste was considered dry waste and did not contain significant volumes of liquid (see, e.g., HW-77274, *Burial of Hanford Radioactive Wastes*). There were numerous alternatives for disposal of large volumes of liquid (e.g., cribs, trenches, ditches, underground storage tanks, reverse wells); therefore, it is unlikely that the early landfills were used for disposal of bulk liquids. Occasionally, small volumes of bottled, highly contaminated liquids were placed inside a 208.2 L (55-gal) drum, and the drum was filled with concrete to provide shielding and to stabilize the liquid waste (DOE/RL-96-81). These wastes often were covered with less than 1.2 m (4 ft) of soil cover.

After 1967, all alpha-contaminated wastes from the 105-N Reactor and the 300 Area were sent to the 200 Areas for disposal (DOE/RL-96-81). In the early 1970s, increasing attention to reducing potential contamination to groundwater led to a decision to send all LLW from all Hanford Site facilities for burial within the 200 Areas, 60 to 90 m (200 to 300 ft) above ground water. The last 300 Area landfill (the 618-7 Burial Ground) was closed in 1972. The last 100 Area landfill closed in 1973 (WHC-EP-0912). Figure 2-14 shows a timeline illustrating the operational periods for the various landfills and processes, as well as key regulatory milestones.

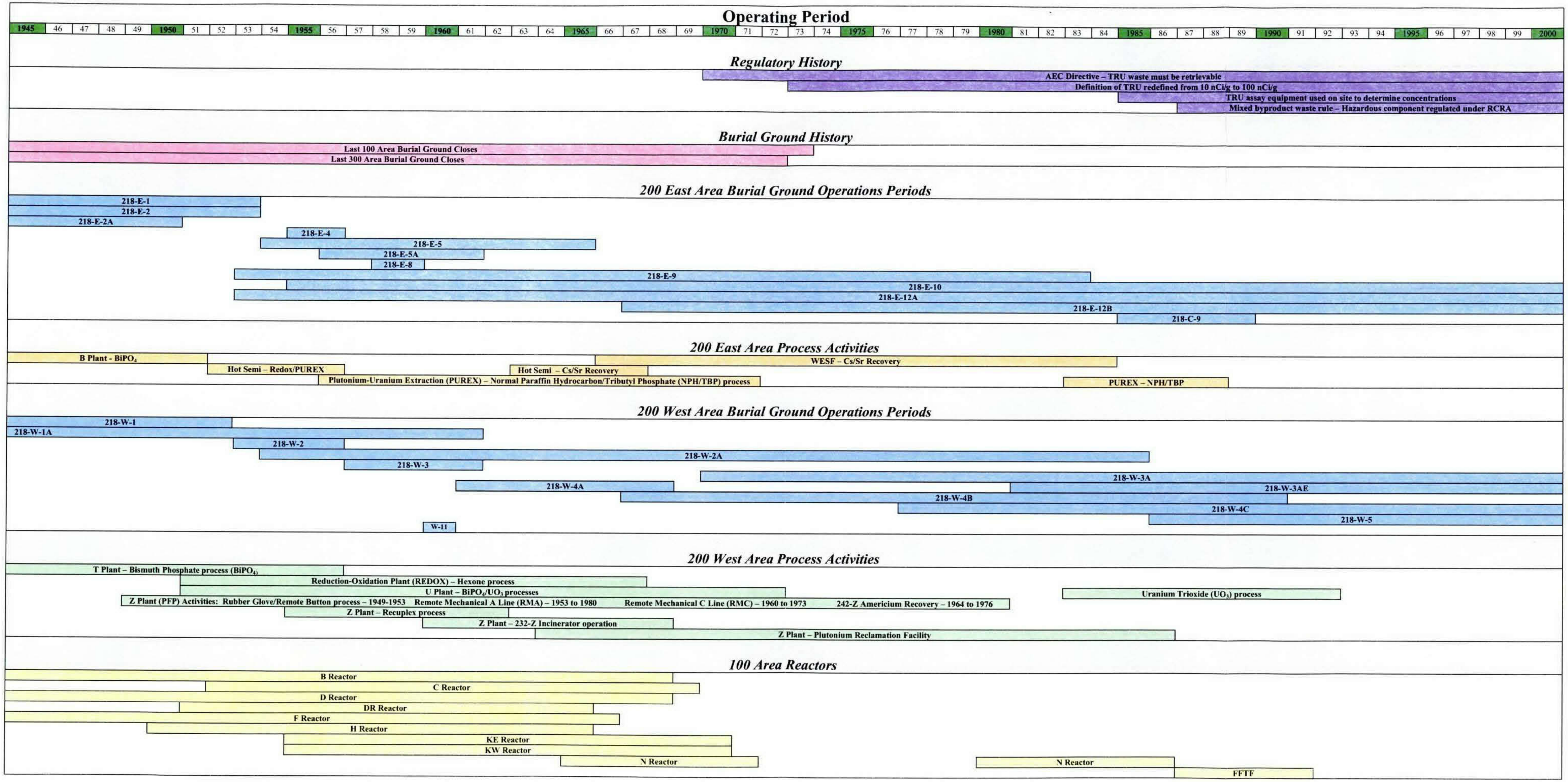
In 1970, the U.S. Atomic Energy Commission (AEC) defined TRU waste (waste with known or detectable contamination of transuranium nuclides) as a separate waste category and declared that it must be stored in a retrievable form in contamination-free packages designed to last for 20 years, pending a decision on permanent disposal (AEC Immediate Action Directive 0511-21, *Policy Statement Regarding Solid Waste Burial*). The TRU waste category created in 1970 designated 10 nCi/g as the lower limit for TRU. AEC Manual Chapter 0511, *Radioactive Waste Management*, issued in 1973, established the segregation limit for TRU waste at 10 nCi/g. Waste with TRU content greater than that limit was stored as retrievable TRU waste, and waste with TRU content less than that limit was buried as LLW in the Hanford Site landfills. Subsequent to 1970, procedures were developed for recording waste generation, form, packaging, and placement to ensure that TRU waste could be located and retrieved. The data were entered into what is now the SWITS database via parent (shipment) records. In 1982, the TRU limit was revised upward to the present value of 100 nCi/g. The equipment required to assay waste against the 100 nCi/g limit was not installed in the TRU Storage and Assay Facility until 1985. Thus, a portion of the waste stored between 1970 and 1985 was not assayed and is believed to be LLW and not TRU waste, because of the different criteria that were applied initially and the lack of assay equipment. Retrievable stored TRU waste that is removed from the landfills will be assayed to determine if it is LLW or TRU.

2.2.5.2 RCRA Waste

At the time that many of the Hanford Site's wastes were generated, however, there were no definitions or regulations governing the chemical constituents. In the early 1980s, low-level liquid organic waste was banned from land disposal at the Hanford Site landfills (WHC-EP-0912). Although many of these constituents subsequently have been classified as hazardous or dangerous wastes by the EPA and Ecology, only waste disposed of after RCRA regulations went into effect is subject to active management as mixed, hazardous, or dangerous. Where regulated chemical and radioactive constituents are combined in a waste form, waste disposed of (after RCRA regulations went into effect) is subject to management as "mixed waste." Ecology has regulated mixed waste since August 19, 1987, the date that RCW 70.105.109, "Regulation of Wastes with Radioactive and Hazardous Components," went into effect.

In 1987, the DOE issued the so-called byproduct rule, which clarified its position on the hazardous components of mixed waste to be regulated by RCRA (10 CFR 962, "Byproduct Material," and 52 FR 15937, "Radioactive Waste, Byproducts Material Final Rule"). On November 23, 1987, the EPA authorized Ecology to regulate the hazardous constituents of mixed wastes at the Hanford Site (52 FR 35556, "Final Authorization of State Hazardous Waste Management Program; Washington"). In 2003, the DOE and Ecology signed a tentative agreement (04-RCA-0037, "Notification of Completion of Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Settlement and Tentative Agreement Interim Milestone M-091-40, Requirement for DOE to "Initiate Retrieval at Its Burial Ground 218-W-4C No Later Than November 15 2003" ") that retrievably stored waste containing suspect TRU elements would be retrieved, repackaged, and ultimately shipped offsite for disposal. Tri-Party Agreement Milestone M-091 subsequently was established to formally document this agreement.

Figure 2-14. Timeline Illustrating Operations Periods for Landfills with Key Milestones.



Retrieved waste found not to meet the current definition of TRU will be appropriately disposed of within the Hanford Site. TRU waste containing hazardous components (TRUM) may require treatment before shipment offsite). As of August 31, 2007, 6,226 m^3 of post-1970 suspect-TRU waste has been retrieved. Most of this waste was retrieved from the 218-W-4C Landfill, and a smaller fraction was from the 218-W-4B Landfill. As of August 2007, 53 percent of the 208.2 L (55-gal) drums and 68 percent of the non-drum containers retrieved have been determined to be TRU waste. As older containers are retrieved from the 218-W-4B, 218-W-3A, and 218-E-12B Landfills, the percentages of containers designating as TRU waste is likely to be lower because of the historical changes in the definition of TRU waste since 1970. Retrieval activity in the 218-W-3A and 218-E-12B Landfills is expected to begin in 2008.

Management practices have changed over the years, as shown in Table 2-1. Since the late 1960s, the contents of landfills have been tracked on databases, culminating in the current SWITS.

Table 2-1. Liquid- and Animal-Waste Packaging Practices.

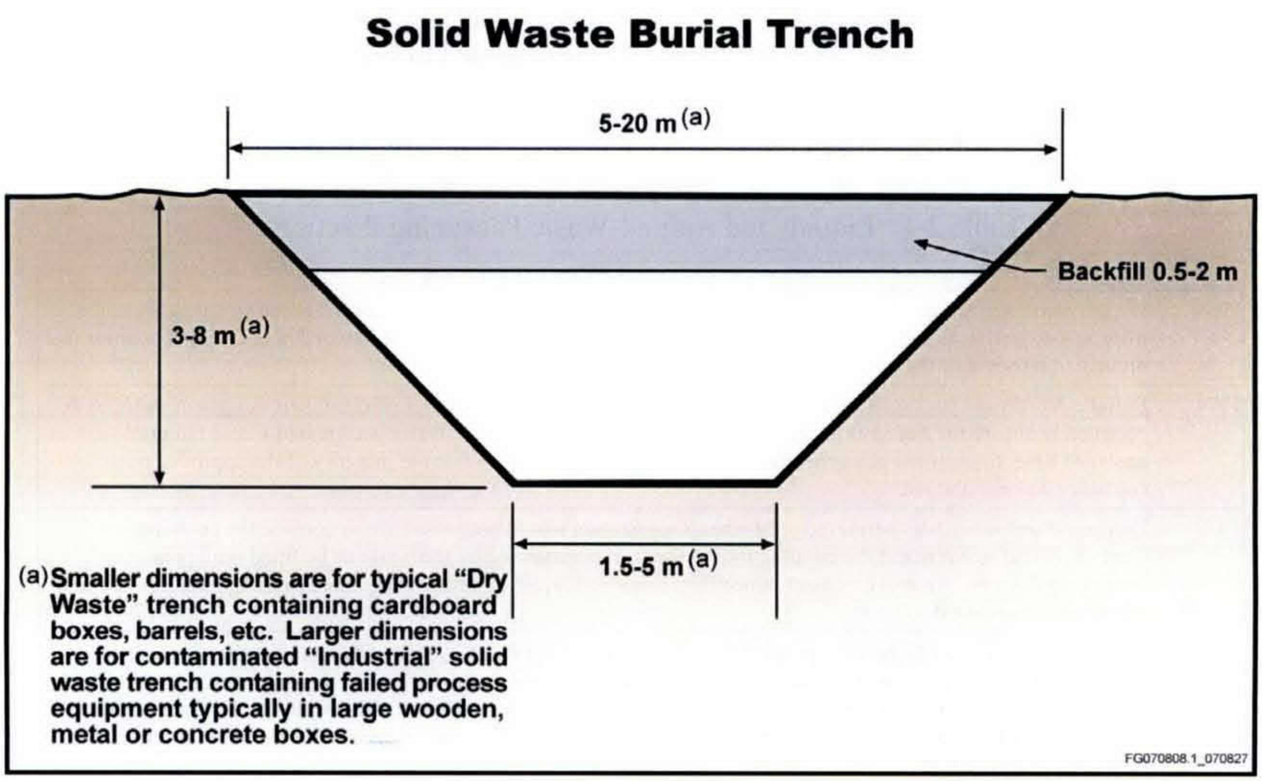
Date	Packaging Procedures
1967	Liquid waste was accepted when absorbed by an inert absorbent material. Deceased laboratory animals or other materials attractive as food for wildlife had to be sealed in plastic and packaged in wooden or metal containers that prevented retrieval of the buried material by wildlife.
1974	Battelle-Northwest packaged carcasses in a waterproof inner container with sufficient inert absorbent material to completely absorb the liquid as the carcasses decayed. Additionally, the waste was treated with a material such as unslaked lime, to suppress gas generation during decay, thus ensuring that the integrity of the approved outer container was maintained.
1977	Damp and wet waste was permitted only when vaporization would not pressurize or corrode the container. Containers had to withstand the credible internal pressures generated by the waste or be fitted with pressure modifying devices. Animal carcasses, since they contained liquid organics, were considered organic liquid waste and were not accepted.
1980	Liquid organic waste (flashpoint greater then 150 °F) was acceptable for retrievably stored waste if properly packaged. Liquid organic waste was to be placed unabsorbed into a seal-tight container (preferably 19 to 38 L [5 to 10 gal]). The inner container was overpacked into a 208.2 L (55-gal) drum with a rigid 4 mil polyethylene liner. The drum was filled to the top with acceptable absorbent necessary to completely absorb the liquid if the inner container was breached.
1982	To meet specifications, no more than 1.7 L of organic waste were transferred to a polybottle. The polybottle was vented and contained two absorbent pads. The filled polybottles were sealed into vented and filtered polyethylene bags. The bagged polybottles then were packaged for 20-year retrievable storage.
1987	A volume of diatomaceous earth was added equaling 4 times the estimated volume of a liquid.

2.2.6 Historical Disposal Practices and Facilities

Landfills were used at the Hanford Site beginning in 1944. They generally consist of one or more types of burial trench(es) and/or solid-waste disposal facilities such as caissons (discussed below). From 1944 to August 19, 1987 (effective date of mixed waste regulation), it was common practice for solid LLW and waste containing components that currently are regulated under WAC 173-303 to be disposed of in unlined burial trenches in the 200 Areas landfills. In the mid-1990s disposal of MLLW took place in TSD-unit landfills in the 200 West Area, while LLW continued to be disposed of in unlined burial trenches. Retrievable TRU wastes originally were (from 1970) stored in retrievable storage units in unlined trenches until 1998, when they began to be sent directly to the Waste Receiving and Processing Facility for repackaging to be sent to an offsite disposal facility.

Before construction of TSD-unit landfills in the 1990s, most of the wastes sent to the 200 Areas Landfills were disposed of, or retrievably stored, in trenches. A typical solid-waste burial trench is shown in Figure 2-15. Non-TRU waste (LLW, waste containing components that currently are regulated under WAC 173-303, nonradioactive waste) typically was disposed to unlined earthen trenches approximately 4 to 5 m (12 to 16 ft) deep; some TRU trenches are up to 7.6 m (25 ft) deep.

Figure 2-15. Diagram of a Typical Solid-Waste Burial Trench.



The Hanford Site soil, which consists largely of gravel and sand, sloughs off to an angle of repose of about 45 degrees during excavation. This required the movement of significant volumes of earth for the preparation and backfilling of waste trenches. The wide top and relatively narrow bottom of the resulting trench, coupled with the practice of covering all radioactive wastes by the end of the day, has resulted in a low ratio of waste volume to land area (BHI-00175). Volumes of radioactive buried waste (200-SW-2 OU) recorded in SWITS, compared with trench volumes, suggest that an average of 21 percent of the trench volume is waste packages; the remainder is backfill.

Burial trench locations are marked only by external survey marker monuments every 7.6 m (25 ft) around the perimeter; markers are about 4.9 m (16 ft) above the trench floor (WHC-EP-0225).

Records were not kept on the amount and types of radionuclides buried as solid waste in the early days of the Hanford Site project. BHI-00175 indicates that only a few incomplete records on waste disposal activities from the 1950s and 1960s still exist. A few handwritten logbook records have been found, dating from the early 1960s, showing details of some burials in the 200 West Area. Since the late 1960s, routine reports of radioactive waste disposal in the 100 and 200 Areas have been more complete, including the land area, the volume of waste, the number of curies of the specific radionuclides, and the coordinates of the burial sites. Studies have been made that estimate volume and radioactivity of previously unrecorded waste buried in the 100 and 200 Areas, based on the ratio of the various radionuclides present in the fuel elements and on other known and deduced waste-generation and -disposal information. Inventories of plutonium and uranium have been kept on the SWITS database and its predecessors since the late 1960s. The best available records suggest that as of 2005, the 200 Areas landfills contained a total of 513 kg of plutonium in approximately 458,000 m^3 (599,000 yd^3) of waste. The 200-SW-2 landfill trenches in the scope of this work plan are estimated to contain 366 kg of plutonium in 443,000 m^3 (580,000 yd^3) of waste. The 15,000 m^3 difference in waste volume and differences in plutonium quantity primarily represent the post-1970 TRU and suspect TRU waste that is being retrieved in support of the Tri-Party Agreement M-091-40 and M-091-41 milestones. Errors in accountability procedures suggest that as much as an additional 200 kg of plutonium may have been disposed of in the 200-Area landfills (RHO-CD-194, *A Study of the 234-5 Building Inventory Difference for the Years 1956 through 1966*).

2.2.6.1 Hanford Site Waste-Acceptance Criteria

In the late 1960s, the first waste-acceptance criteria documents were written for the 200 and 300 Areas. These documents provided specifications and standards for industrial wastes, as well as for chemical-hazards control with respect to the landfills. Waste generators were required to segregate their waste according to compatibility and content. During this time, small materials were packaged in fiber drums, liquid wastes were acceptable only if absorbed by an inert absorbent material, and organic matter had to be sealed in plastic and packaged in wooden or metal containers. Equipment was buried in wooden boxes when available and, if a wooden box could not be provided, the equipment was buried without a protective covering. If it was determined that the equipment had levels of contamination and/or radiation dose too high to bury without confinement, the equipment was wrapped in plastic before it was placed in a burial box for disposal. Equipment also was placed in concrete boxes for disposal.

In 1970, a new specifications and standards document, ARH-1842, *Specifications and Standards for the Burial of ARHCO Solid Wastes*, was released shortly after the AEC directed the segregation of TRU wastes. This document stated that generators and operators must segregate and package waste materials containing or suspected of containing plutonium or other TRU radionuclides for containment and retrievability.

ARH-3032, *Specifications and Standards for the Packaging, Storage, and Disposal of Richland Operations Solid Waste*, which was released in 1974, superseded the earlier document, ARH-1842. This document classified wastes into four different segregation groups: nonradioactive, nonhazardous, combustible wastes; low-level, non-TRU wastes; TRU wastes; and high-dose-rate wastes. Packages that contained less than 200 c/min of beta/gamma and less than 500 d/min of alpha contamination were classified as nonradioactive and disposed of in the

Central Landfill Facility. Solid wastes containing less than 10 nCi/g of plutonium and/or other transuranic radionuclides were considered LLW and were further divided into combustible and noncombustible wastes, which were packaged separately. Solid wastes containing or suspected of containing greater than 10 nCi/g plutonium and/or other transuranic radionuclides were considered to be TRU waste. Today, the standard is greater than 100 nCi/g of plutonium and/or other transuranic radionuclides that are considered to be TRU waste. Failed equipment and large items contaminated with transuranic radionuclides also were included in this category.

The five revisions of RHO-MA-222, *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, issued between 1980 to 1988, established new definitions for waste classes, placed restrictions on waste contents, provided new specifications for container designs, and included other key elements that directly impacted the waste classification system and segregation requirements.

Before the late 1960s, there were no state or Federal regulations on segregation requirements for packaging waste for burial at the Hanford Site. There were attempts to package waste to minimize personnel exposure and prevent the spread of uncontained radioactivity to the environment; however, these were not set guidelines and were done at the discretion of the generator.

2.2.6.1.1 Low-Level Waste

In the 1960s, LLWs that were small in size were placed in plastic-lined cardboard boxes or wrapped in grease-proof paper and placed in cardboard boxes. Large waste items were wrapped in plastic shrouds. Grossly contaminated MFPs were packaged in high-integrity containers. The most common method of depositing wastes in trenches during the 1960s was to dump boxes of solid waste directly into the burial trenches. Wood or concrete boxes that contained bulky or highly contaminated materials were dragged from railroad cars into the trench by bulldozers using long cables. Before 1970, the primary concerns during burial operations were to ensure confinement of contaminated materials during transport, minimize exposure to operating personnel, confine radioactive or chemical materials to prevent releases to the environment, and protect public health.

The packaging of waste materials was designed to maintain safety until the material was securely buried; once buried, the containers were considered permanently disposed of. Because of the favorable hydrological conditions, concern was not given to whether the containers remained intact after burial. Until the mid-1970s, there were no requirements for venting burial containers to allow for the release of built-up pressure. If waste materials were known to generate gases, they were placed within containers constructed of a material known to collapse under the weight of backfilling. Once the integrity of the container was no longer intact, it was considered vented.

Beginning in 1970, in addition to fiber drums and metal containers that were used to containerize waste, iron or galvanized steel drums and boxes constructed of fiber-reinforced polyester, plywood, or concrete were used for packaging small waste items. ARH-CD-353, *Design Criteria for Transuranic Dry Waste Steel and Reinforced Concrete Burial Containers*, released in 1976, stated that burial containers were provided with vents if there was a requirement that they be protected against variations in internal pressure. With the initial release of RHO-MA-222 in 1980, each container was required to be capable of being fitted with an air or vacuum hose or a gaseous diffusion vent. Wood, steel, and/or concrete boxes continued to be used for the burial of process equipment during this timeframe. It also was around 1980 that the U.S. Department of Transportation-compliant 208.2 L (55-gal) galvanized drums were declared to be the required packaging for TRU waste. The nongalvanized drums were used for non-TRU waste shipments.

2.2.6.1.2 TRU Waste

To indicate the segregation of TRU waste from LLW, some facilities used painted drums; for a period, yellow drums were used to package LLWs, and black drums contained TRU waste. At the 200 Areas, color-coding of drum lids was done to indicate the segregation of hood waste from room waste. Hood wastes were wastes generated inside processing hoods and were considered highly contaminated with plutonium. Room wastes were wastes generated from operations outside the processing hoods and were considered potentially contaminated with plutonium. Solid wastes were segregated into combustible hood waste, combustible room waste, and noncombustible room and hood waste. Combustible hood waste was composed of material such as plastic, rubber, rags, and cardboard. Combustible hood waste was placed in drums with yellow lids, combustible room waste was stored in drums topped with silver domes, and noncombustible hood and room waste was collected in drums topped with red domes.

For safe storage, TRU wastes were segregated into combustible and noncombustible. Small TRU items were segregated from larger TRU items or equipment pieces. Separate storage facilities and burial trenches were designed for TRU waste storage. Solid TRU waste was packaged, stacked, and stored in trenches with an earth, gravel, plywood, or asphalt pad foundation. Small items were stored on asphalt pads, in underground trenches, or in caissons, whereas larger items were stored primarily in burial trenches. The TRU wastes that were unsuitable for asphalt pad or caisson storage because of size, chemical composition, security requirements, or surface radiation were packaged in reinforced wood, concrete, or metal boxes. High-dose-rate solid wastes were defined as wastes that emitted high levels of beta and gamma radiation. This waste did not contain TRU radionuclides and typically included failed equipment from B Plant, tank farm operations, and other activities. Small high-dose-rate items were transported to the caissons or burial trenches, while large items or failed equipment were buried in the industrial waste trenches.

In the late 1970s, more-specific packaging-procedure requirements were introduced. Multiple containment barriers were required in the packaging of waste. In addition, more concern was given to void spaces left in waste packages and the increased used of filler materials. As time passed, the regulations became more focused, and the disposal of waste followed more rigorous standards.

2.2.6.2 Containment Barriers

In the early years, waste at the Hanford Site was disposed of in the landfills using only a single containment barrier. This barrier was the package in which the waste was placed. Typical packages were concrete boxes, cardboard boxes, plywood boxes, or drums. As time passed, it was observed that some waste was escaping the single-containment barrier. This could lead to harmful effects for the environment and decreased personnel safety. Therefore, requirements for the number of containment barriers increased, as listed below.

- In 1968, wastes containing contamination that was easily airborne were contained by an inner container (e.g., sheet plastic).

- In 1978, a second polyethylene drum liner was placed inside the first polyethylene drum liner.

- In 1979, 208.2 L (55-gal) barrels used at Z Plant to store radioactive wastes were lined with a polyethylene drum liner, 99 x 137 cm and 4 mil thick.

- In 1980, solid radioactive waste containing asbestos had to be packaged within at least one layer of 6-mil polyethylene film. TRU solid waste was packaged inside at least two containment barriers, the storage container and an inner sealed liner.

- In 1981, it was stated that polyethylene liners were to be "horsetailed"[20] and then taped shut before the drum lid was installed.

- In 1985, all LLW determined to be radioactive mixed waste was packaged with at least three containment barriers.

- In 1993, Pacific Northwest Laboratory determined that a 90-mil high density polyethylene inner liner was required for liquid remote-handled waste to be stored at the Central Waste Complex. A 10-mil nylon reinforced plastic liner was required for solid remote-handled waste. For liquid radioactive mixed waste, inner containers were almost always glass, with a capacity of 18.9 L or less.

2.2.6.3 Filler Materials

Filler materials became important around the early 1980s. At this time attention was focused on the void space left inside some packages and the benefits obtained by reducing this volume. The addition of nonradioactive materials to radioactive waste resulted in improved heat transfer, radionuclide immobilization, and increased physical support. The following list gives an overview of the void-space limitations.

- From 1978 to 1984, waste package contents were not to exceed 80 percent of the active volume of the waste container.

- In 1984, it was stated that to prevent subsidence in Hanford Site landfills, interior void spaces in non-TRU packages were to be minimized. However, void spaces did not need to be filled in containers that were to expected to collapse during the initial backfilling process (e.g., plastic-wrapped equipment).

- From 1985 to 1986, interior void spaces for LLW were not to exceed 20 percent of the active volume of the waste container.

- In 1987, the list was expanded of items that were exempt from being filled. Items that were not to be filled were HEPA filters, which posed hazards to personnel during filling,

[20] Horsetailed refers to twisting the ends of the liner and tying them off to form a seal.

waste packages with a total internal void space less than 0.042 m^3 (1.5 ft^3), and any specially designed reinforced-concrete burial boxes with a design life in excess of 300 years under burial conditions expected in the Hanford Site landfills. All low-level mixed waste (LLMW) packages accepted for storage were exempt from requirements for filling void spaces.

Before 1990, no specific list was provided for approved filler materials. The following list contains materials that were approved for use as void-space filler in 1990:

- Diatomaceous earth
- Soil, sand, lava rock
- Tightly packed cellulose matter
- Clay
- Concrete, cement, grout
- Gravel.

2.2.6.4 Specific Waste-Packaging Practices

With an increased knowledge about certain types of waste, new, more specific packaging practices were developed for these waste types.

2.2.6.4.1 Process Equipment

Process equipment consisted of equipment used by several of the large plants at the Hanford Site. Disposal of the equipment proved problematic. Because of the large size and odd shape of the majority of the process equipment, special measures had to be taken for burial. In the early years, the equipment was buried in wooden boxes. Sometimes a wooden box could not be provided, and the equipment was buried with no protective covering. When it was determined that the equipment was too hazardous to bury without confinement, the equipment was wrapped in plastic before it was buried.

In addition, large pieces of process equipment were cut into smaller sections and packaged before it was buried. Following are different packaging techniques for process equipment.

- Failed process equipment generally was packaged in concrete boxes, however, large wooden boxes also were used. Process equipment from the PUREX Plant that was too large to bury was stored in special railroad tunnels adjoining the plant.

- Metal containers were used to bury failed equipment from the PUREX Plant and the Plutonium Finishing Plant. Some items of failed equipment, such as 12 to 15 m (39 to 49-ft-) long pumps used to transfer wastes from underground storage tanks, were flushed and packaged in plastic before they were buried.

- Large radioactive waste items from the PUREX Canyon Building were packaged in burial boxes of precast, reinforced concrete slabs with a concrete slab lid held in place by its own weight. A steel-liner box sometimes was inserted, depending on the waste being packaged. Box configurations varied depending on the waste being packaged, but the most commonly used size had a void volume of 50 m^3.

- Old glove boxes were packaged in intact burial boxes or other packages. For a brief period of time they were sent to the 231-Z Facility to be cut up into smaller pieces. The pieces then were packaged in steel culverts, steel boxes, and plywood boxes, and some of the smaller pieces were placed in 208.2 L (55-gal) drums.
- A large number of fiberglass-reinforced polyester boxes also were used for packaging gloveboxes and other equipment.

2.2.6.4.2 Class B Poisons

Class B poisons were a main focus of disposal because of the effects the poisons had on the environment and personnel safety. Solid waste containing Class B poisons was packaged in double containment. Small quantities were placed in small containers, which then were placed in storage or disposal containers, and the small containers were fixed or surrounded by concrete on all sides. In 1980, it was determined that packaging for larger quantities would be approved on a case-by-case basis. In the mid-1980s mercury, a specific Class B poison was confined in a concrete culvert, and the culvert then was placed in a drum. It was common to fill the space around the culverts with bagged polybottles and other items. In 1992, Pacific Northwest Laboratory packaged liquid metallic mercury in a polyethylene or glass container with a screw-type lid.

2.2.6.4.3 Sodium and Alkali Metals

Before 1977, there were no documented packaging requirements for sodium and alkali metals. Beginning in 1977, special approval was required of any waste package containing sodium or other alkali metal. Unreacted alkali metal in solid waste was not accepted for disposal. The shipper had to specify quantities, concentrations, and contamination levels of each alkali metal to ensure that the appropriate methods of handling, storage, and/or disposal were used. The requirements established in 1977 are being observed today.

2.2.6.4.4 Oxidizing and Corrosive Materials

Oxidizing and corrosive materials are of special interest, because they break down the integrity of the container in which they are packaged. In addition, during the breakdown of the containers, gases are generated. It was not until the late 1960s that oxidizing material was prohibited from being packaged with combustible wastes or in combustible containers. Rags used to clean up oxidizing materials had to be well rinsed to remove all oxidizing materials before they were discarded. Beginning in 1984, wastes containing corrosives were to be treated to eliminated their corrosive properties and to form a chemically stable compound, or they were packaged such that the storage container was not exposed to the corrosive agent during its 25-year design life. To enhance the corrosive protection, the interior and exterior of the waste containers were galvanized or painted with a two-component epoxy-polyamide paint system or functionally equivalent paint.

2.2.6.4.5 Tritiated Waste

Beginning in the early 1980s, procedures were introduced for packaging tritium wastes. Tritiated waste, including tritium oxide in liquid form, was to be packaged in steel or concrete containers. Waste containing tritium or tritium oxide was absorbed on silica gel, packaged in leak-tight 3.8 L (1-gal) metal cans, surrounded by asphalt, and packaged in 208.2 L (55-gal) drums. Waste packages with heat output greater than 3.53 W/m^3 required a special thermal analysis to determine whether special separation distances were required for the waste in the landfill trench. In 1993, the tritium waste was defined as waste containing greater than 20 mCi of tritium/m^3 of waste and its disposal requirements changed as follows.

- Tritiated waste with less than 100 Ci tritium/m^3 in either absorbed liquids or solids was to be sealed in one layer of 4-mil (nominal) or thicker polyethylene and disposed of in a steel or concrete package.
- Tritiated waste with greater than 100 Ci tritium/m^3 in either absorbed liquids or solids was to be sealed in one layer of 4-mil (nominal) or thicker polyethylene and disposed of in a steel or concrete package. Containment systems for tritiated waste with greater than or equal to 100 Ci tritium/m^3 were to be documented in the storage/disposal approval record.

2.2.6.4.6 Liquid and Animal Wastes

Because of the increased knowledge about the waste and the better packaging techniques, the guidelines for liquid and animal wastes have changed throughout time. Table 2-1 summarizes the changes in packaging since 1967.

2.2.7 Caissons

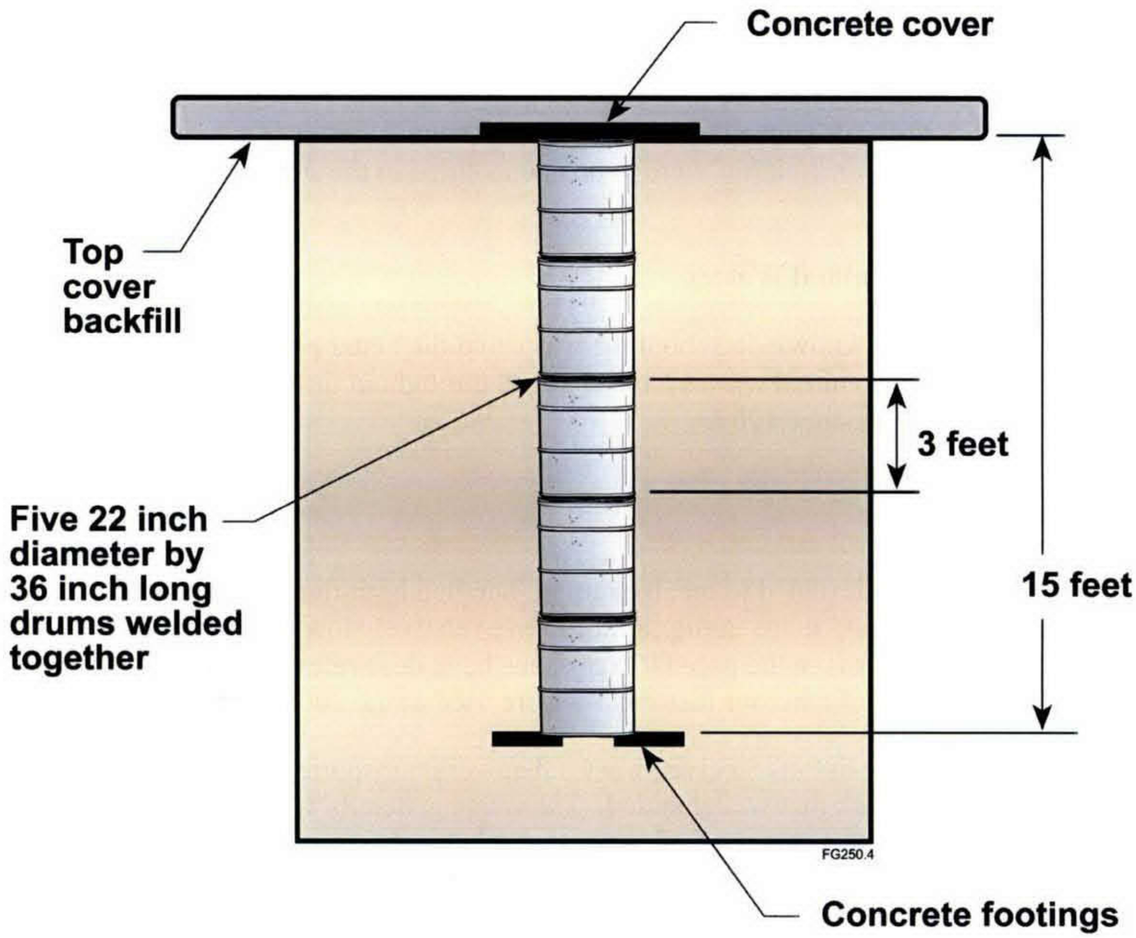
Caissons typically were designed to receive remote-handled high-dose-rate and TRU wastes. However, in practice, many items in the caissons have relatively low dose rates; approximately 750 of the 1,000 or so items in the non-TRU caissons have dose rates of less than 200 mrem/h (SWITS). Several types of caissons historically were used in the 200 Areas at the Hanford Site.

- Alpha and MFP caissons received wastes that were transported to the caisson in a truck-mounted cask that was shielded. The waste generally was packaged in 19 L (5-gal) paint cans. Caissons consisted of concrete/steel chambers set below ground surface, with an associated off-set steel riser pipe through which waste packages were dropped into the caisson. Caissons typically are ventilated to reduce exposures to the personnel depositing the waste packages. The off-set steel riser pipes also provided protection from direct radiation exposure from the waste below.
- A type of caisson called a vertical pipe unit was configured in one of two ways: as a 14.6 m (48-ft-) below grade, 76 cm (2.5-ft-) diameter vertical steel casing (e.g., those in the 218-W-4A Landfill, near the end of Trench 18) or by welding together two to five open-ended 208.2 L (55-gal) drums end-to-end and setting them vertically in the ground (e.g., those in the 218-W-4A Landfill, Trench 16) (BHI-00175).

2.2.7.1 Vertical Pipe Units in the 218-W-4A Landfill

The 218-W-4A landfill contains 21 miscellaneous dry-waste trenches oriented east to west and 6 or 8 vertical pipe units or caissons. The vertical pipe units were installed near the east end of Trench 16 and consist of two to five 208.2 L (55-gal) drums welded together with the lids and bottoms removed. They were placed 4.6 m (15 ft) below ground surface. Two deeper caissons may be located between Trenches 17, 18, and 19. Figure 2-16 depicts a typical vertical pipe unit configuration.

Figure 2-16. Diagram of Vertical Pipe Unit.



2.2.7.2 Caissons in the 218-W-4B Landfill

The caissons in the 218-W-4B Landfill were used for the disposal of alpha- and MFP-containing waste. These caissons are further detailed in the following paragraphs. This information is judged (RHO-65463-80-126) to be the most accurate at the current time, based on the available information.

- Six general caissons (also called dry waste or MFP caissons), 218-W-4B-C1 through 218-W-4B-C6 in the 218-W-4B Landfill that contains LLW, were filled from 1968 to 1979. Dry waste or MFP-type caissons are 2.4 m (8 ft) in diameter and 3.1 m (10 ft) high. According to the WIDS database, two of these caissons were constructed the same way as the alpha caissons, but with corrugated metal instead of steel and concrete. The last shipment of caisson waste to the 218-W-4B Landfill was deposited into MFP Caisson #6 in 1990 (Figure 2-17).

- Caissons 218-W-4B-CA1 through 218-W-4B-CA5 (also called alpha caissons) were planned for TRU waste. From 1970 to 1988, retrievably stored TRU waste was placed in four of the five. The caissons have been isolated; one caisson (Alpha #5) never has been used. The five alpha caissons are approximately 2.7 to 3 m (8.75- to 10-ft-) diameter, 3 m (10-ft-) high concrete-and-steel covered vaults with steel lifting lugs and a 0.9 m (3-ft-) diameter access chute. The alpha caissons weigh approximately 11,800 kg (26,000 lb) (Figure 2-18)

- One caisson, 218-W-4B-CU1, is referred to in the literature as a United Nuclear Industries (UNI) below-grade silo-type caisson, used for high activity N Reactor waste. The UNI silo-type caisson is 3 m (10 ft) in diameter and 9 m (30 ft) tall with corrugated pipe containers placed on a concrete foundation with a top concrete shielding slab. It has a 1.1 m (3.5-ft-) diameter access chute. Waste is placed beneath a concrete slab 4.6 m (15 ft) below grade. The chute of this caisson was plugged shortly after it began receiving waste; it was taken out of service after the plugging event occurred, and it contains only two waste packages (SWITS; WHC-EP-0912) (not pictured).

All three caisson types in the 218-W-4B Landfill are equipped with air-filter systems (Figures 2-17, 2-18, and the UNI caisson, which is not pictured).

Starting from the southeast corner of the landfill, the caissons in order are: 218-W-4B-C1, 218-W-4B-C2, 218-W-4B-CU1, 218-W-4B-C6, 218-W-4B-CA3, 218-W-4B-C5, 218-W-4B-C3, 218-W-4B-CA4, 218-W-4B-CA2, 218-W-4B-CA5, 218-W-4B-CA4, and 218-W-4B-CA1 (DOE/EIS-0286F). Although sources conflict on the placement of the caissons, this order is based on the literature consensus. No additional waste placement is planned for any of these caissons.

Figure 2-17. Diagram of Caisson with Blower.

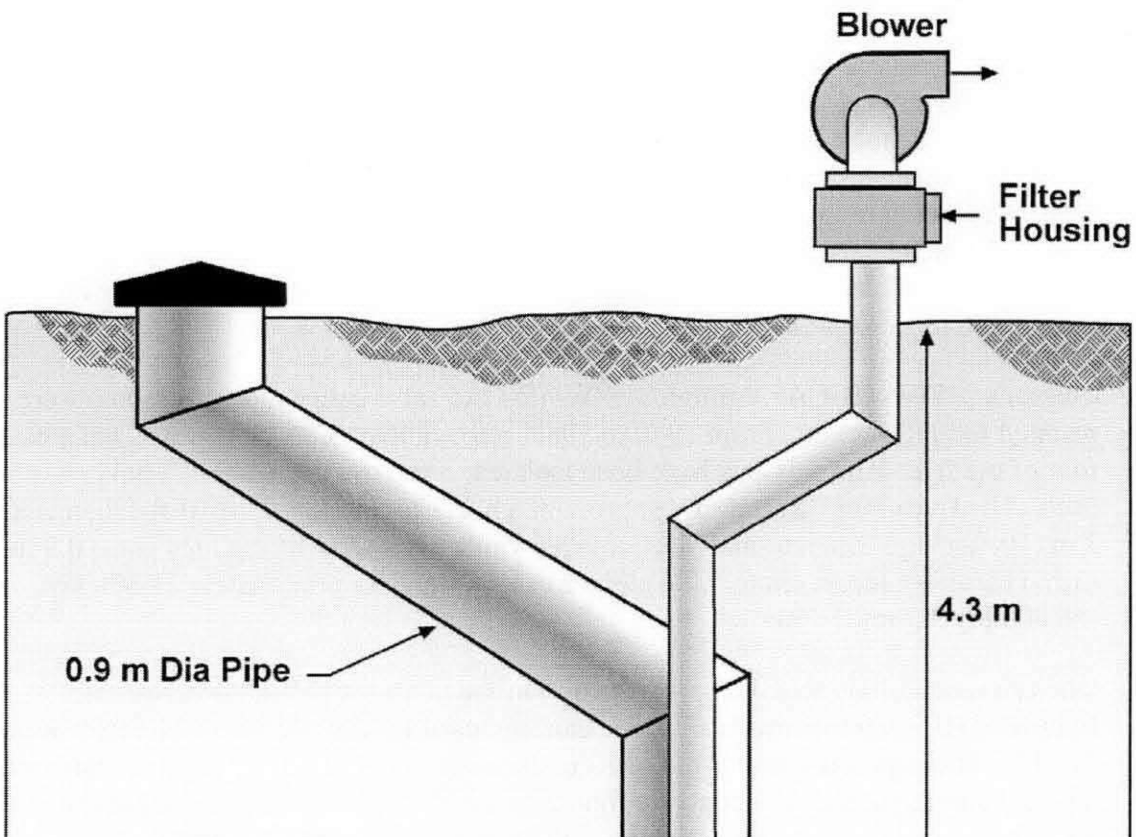
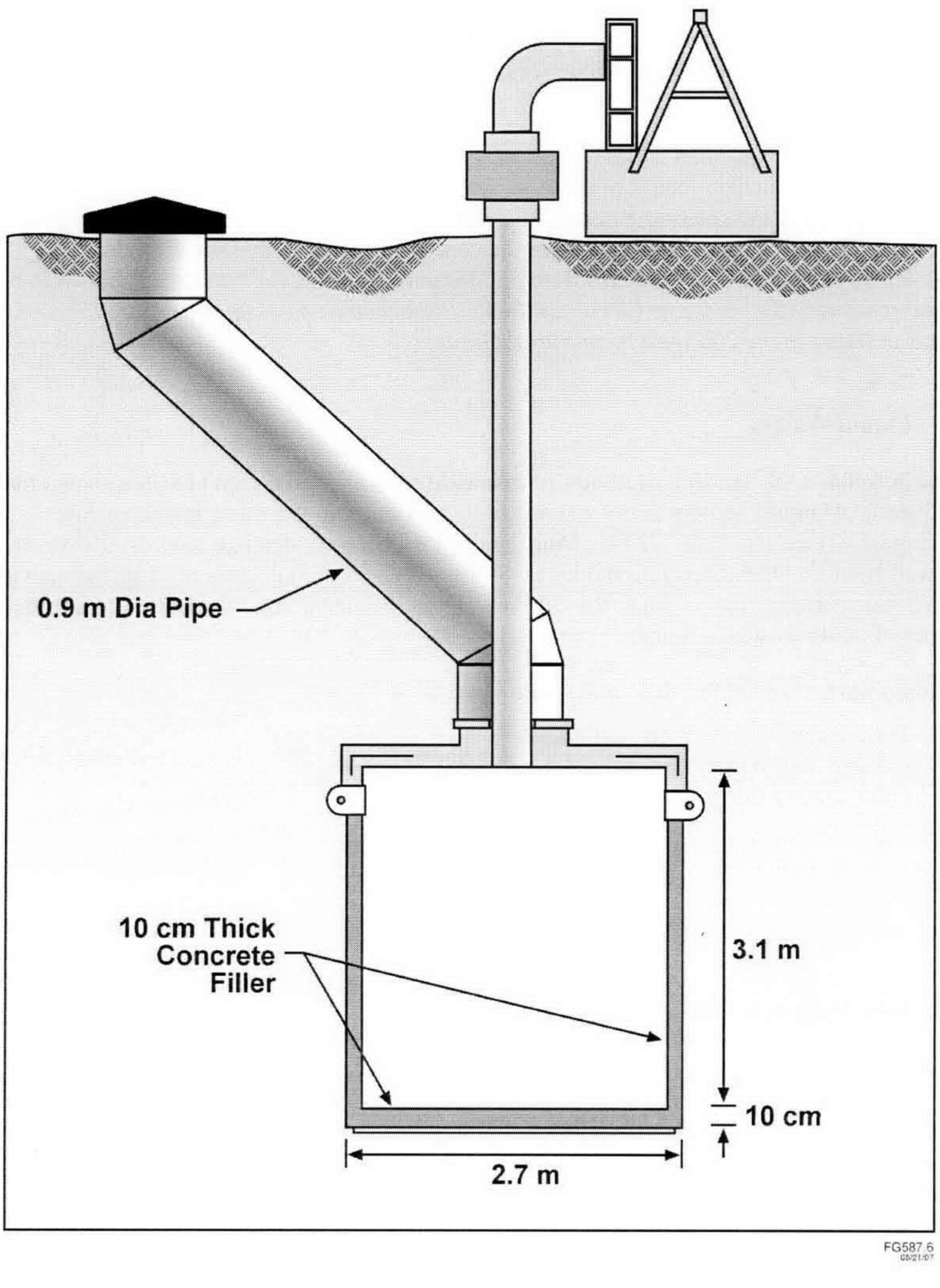


Figure 2-18. Diagram of Caisson.



2.2.8 Drag-Off Boxes

Drag-off boxes were used from the earliest days at the Hanford Site. The first boxes were made of wood, placed in the trench, and covered with soil. Drag-off disposals were performed in landfills next to railroad tracks. A cable was connected to a box at the location where the waste was generated and stretched along spacer cars, which were used to keep the train crew at a safe distance from the radioactive box. When the train reached the burial site, a tractor in the landfill dragged the box to the end of a trench.

The early wooden boxes often collapsed after disposal. In cases where a large radiation field was present, this occurrence could overexpose workers. Some drag-off boxes failed while they were being pulled to the end of the trench, also potentially overexposing workers. The boxes were redesigned and eventually upgraded to the concrete burial box that became standard (WHC-EP-0912). The concrete boxes were not designed for retrieval, but were intended to be the final repository for the waste (WHC-EP-0645, *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*).

2.2.9 Liquid Wastes

For the 200-SW-2 OU landfills, a review of historical records (WIDS, SWITS) has shown that bulk disposal of liquid waste was not a significant contributor to the waste loading at sites receiving LLW (see also HW-77274). Most landfills do not have detailed records. However, a Rockwell Hanford Operations internal letter (RHO-65462-80-035) documents disposal activities over a 3-year period (1968-1970) at the 218-W-4B Landfill, including the disposal of minimal volumes of liquid wastes in drums.

The liquid waste consisted mostly of the following:

- Tritium contained in metal cylinders
- Lithium co-product (tritium) target elements
- Plutonium liquids in cartons.

A total volume of about 6 m^3 (including the solid material associated with the liquids) was recorded. In all known cases, the volumes of liquid historically were small, because until 1973 bulk liquids could be disposed more conveniently to cribs, trenches, and underground storage tanks.

2.2.10 High-Radiation Dose-Rate Waste

The term "high-radiation dose rate" has been defined consistently by the DOE and its predecessor agencies, the Energy Research and Development Administration and the AEC, and its sister agency the U.S. Nuclear Regulatory Agency, since 1957. As currently stated (10 CFR 835.2[a], "Occupational Radiation Protection," "Definitions"), "High radiation area means any area, accessible to individuals, in which radiation levels could result in an individual receiving a deep dose equivalent in excess of 0.1 rem (0.001 sievert) in 1 hour at 30 centimeters from the radiation source or from any surface that the radiation penetrates."

Over time, the LLBG and past-practice sites have accepted high-radiation dose-rate items. Of the approximately 117,000 non-TRU waste records (covering 1944 to the present) available for the 24 radioactive landfills covered by this RI/FS work plan, about 7,500 records (~6 percent) indicate waste with a dose rate greater than 100 mrem/h at burial. The waste-acceptance criteria have varied over time but in general have been defined as follows (WHC-EP-0845).

- Before 1980, dry-waste landfills generally were restricted from receiving waste with surface dose rates over 100 mrem/h. However, packages were evaluated on an individual basis, depending on container integrity and method of handling, and some surface dose rates are considerably higher. Industrial-waste landfills typically received waste with surface dose rates over 100 mrem/h.

- Since 1980, limits for surface dose rates of non-TRU contact-handled waste in the landfills varied from 200 to 500 mrem/h (the limit varied over time and was dependent on the container type and size).

- Since 1980, limits for surface dose rates of non-TRU remote-handled waste in the landfills varied from 3,000 to 5,000 mrem/h (the limit was dependent on the transport vehicle).

Current waste-acceptance criteria (HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*) for the LLBG states that containers with dose rates less than or equal to 200 mrem/h at contact and less than 100 mrem/h at 0.3 m (1 ft) are acceptable at the LLBG. Contact-handled containers (see definitions below) exceeding these limits require container-specific review and approval.

Remote-handled waste is acceptable at the LLBG if approved through both a waste stream profile sheet and a container-specific shipment. Remote-handled waste must meet the applicable dose-rate restrictions of the U.S. Department of Transportation or an approved package-specific safety document for transport. Remote-handled waste must be configured for unloading such that personnel exposures are maintained ALARA. The definitions for contact-handled and remote-handled waste from HNF-EP-0063 are as follows.

- <u>*Contact-handled waste.*</u> Packaged waste whose external surface dose rate does not exceed 200 mrem/h, except that packages larger than 208.2 L (55 gal) could have a marked point on the bottom or side with a surface dose rate up to 1,000 mrem/h.

- <u>*Remote-handled waste.*</u> Packaged waste whose external surface dose rate exceeds the limits for contact-handled waste.

2.2.11 Current Disposal Practices

In 1987, the State of Washington, through WAC 173-303, began enforcing the EPA's hazardous-waste program for mixed waste at the Hanford Site. Before this time, some burial records contained information on some nonradiological constituents, but these records are incomplete. Records after 1987 included a list of regulated constituents; the record quality steadily improved from 1987 to the present so that recently (from the mid-1990s onward) the records included inventories (amounts) of these constituents as well as other (nonregulated) constituents and more complete descriptions of the waste burials.

No landfill trenches currently are operating within the scope of the 200-SW-1 and 200-SW-2 OU landfills. However, as noted earlier in Section 1.4, and in the following two paragraphs, three trenches within two 200-SW-2 OU landfills currently are in operation but considered as "out of scope" for this RI/FS work plan, because they will continue to operate for a period of time extending beyond the RI/FS process.

While storage and retrieval activities are ongoing in multiple trenches, only three trenches continue to be used for disposal. The RL operates the lined MLLW disposal trenches as RCRA Subtitle C land-disposal units. These two trenches (Trench 31 and Trench 34) are located at the southern end of the 218-W-5 Landfill in the 200 West Area and are permitted for both storage and disposal activities. Permitted treatment activities in these two trenches are being considered. These trenches are constructed with double liners and a leachate-collection system. In September 1999, storage ended and disposal began of MLLW (predominantly macroencapsulated debris) in Trench 34, constituting the first disposal of Hanford Site-generated MLLW at the Hanford Site (McDonald et al., 2001, "Hanford Site Mixed Waste Disposal"). These two trenches are outside the scope of this work plan.

In addition, RL operates Trench 94, an MLLW disposal trench, which accepts defueled U.S. Navy vessel reactor compartments. The trench is located at the northeastern end of the 218-E-12B Landfill in the 200 East Area. Trench 94 is part of a TSD unit landfill and is out of the scope of this RI/FS work plan, because the trench will be used beyond the timeframe (2024) that the Tri-Party Agreement specifies for remediation of the 200-SW-2 OU.

3.0 INITIAL EVALUATION OF LANDFILLS

The purpose of this chapter is to present a summary of existing knowledge and the results of previous characterization activities at the landfills in the 200-SW-1 and 200-SW-2 OUs and to provide an understanding of conditions at the landfills. The contaminant inventories, waste volumes, and current understanding of the distribution of contamination are discussed for each of the past-practice and TSD-unit landfills.

3.1 KNOWN AND SUSPECTED CONTAMINATION

As discussed in Chapter 2.0, landfills in these OUs received solid waste (bulk quantities of trash, construction debris, soiled clothing, failed equipment, and laboratory and process waste) placed in designated burial trenches and covered with soil. Wastes in burial trenches were either placed directly in the landfills or packaged in cardboard, wooden, or fiber-reinforced polyester boxes, steel drums, concrete burial vaults, or other containers. Some wastes were contaminated with radionuclides, organics, and/or inorganic chemicals from various facilities, mainly from the Hanford Site 200 Areas. Relatively small amounts of wastes from the 100 and 300 Areas and from offsite sources also were placed in some of the landfills, particularly the LLBG TSD unit. The estimated inventory of the main radionuclides and chemicals that were disposed in the 200-SW-1 and 200-SW-2 OU landfills was obtained primarily from the following sources:

- *Hanford Environmental Information System* (HEIS) database
- SWITS database
- WIDS database
- ARH-2762, *Input and Decayed Values of Radioactive Solid Wastes Buried in the 200 Areas Through 1971*
- BHI-01115, *Evaluation of the Soil-Gas Survey at the Nonradioactive Dangerous Waste Landfill*
- DOE/RL-96-81
- RHO-CD-78, *Assessment of Hanford Burial Grounds and Interim TRU Storage*
- RHO-CD-673
- WHC-EP-0125-1, *Summary of Radioactive Solid Waste Received in the 200 Areas During Calendar Year 1988*
- WHC-EP-0912.

The following sections provide an overview of the potential contaminants.

3.1.1 Nonradioactive Landfills – 200-SW-1 Operable Unit

Only two landfills remain in this OU, the 600 CL and the NRDWL. These landfills received nonradioactive waste. Waste disposal practices having the potential for contamination at these sites are summarized in the following paragraphs.

The 600 CL, which was active until 1996, has an estimated inventory of approximately 596,000 m^3 (779,539 yd^3) of solid waste. In addition, up to 5,000,000 L (1,320,000 gal) of sewage and an estimated 380,000 L (100,000 gal) of wastewater from 1100 Area vehicle maintenance catch tanks were disposed to the liquid-waste trenches.

The NRDWL is adjacent to the 600 CL and received primarily dangerous waste materials from laboratories and asbestos. The NRDWL received approximately 141,000 kg (310,851 lb) of waste. Records indicate that the site received liquid wastes packed in 208.2 L (55-gal) drums and laboratory packs filled with absorbents.

3.1.2 Radioactive Landfills – 200-SW-2 Operable Unit

Sources of information on contaminant inventory vary widely among the different landfills. The number of available reference sources containing inventory information, and the amount and type of information in each source, vary. Since 2004, an ongoing attempt is being made to reconcile and combine sources of data to obtain data based on the best knowledge available.

Computer inventory records of waste were not maintained before 1968. Handwritten logbook records exist for some sites for the early 1960s. Other data on early burials exist in various documents, many of them unpublished. Burial data, particularly hand-written and early computer records, often contained only limited information on waste descriptions and contaminants. Later burial records tended to contain more detailed information. Of the approximately 117,000 records of individual containers that are within the scope of this project, nearly 100 percent contain estimated or known plutonium and uranium inventories, 42 percent contain a list of other radiological contaminants, 43 percent contain a general description of the waste components (e.g., plastic, wood, paper), and 36 percent contain a detailed description of the waste (such as "failed dissolver from REDOX" or "drums of depleted uranium"). In addition, approximately 12 percent of the in-scope individual records list nonradiological contaminants that currently are, or once were, regulated. One reason for this smaller percentage is that most waste packages with good records do not contain regulated constituents. Additionally, although a variety of chemical wastes may have been disposed to these landfills, chemical inventories were not consistently maintained until the mid-1980s.

Before 1970, wastes were designated as either dry or industrial wastes; there generally was no segregation of materials within either of these major categories. Industrial waste trenches received large items, often packaged in drag-off boxes. Drag-off boxes routinely had a dose associated with their waste of up to 200 mrem/h at 61 m (200 ft). Records indicate that a box was disposed of with a reading of 250 mrem/h at 152 m (500 ft) on October 21, 1953; another box in 1975 read 4 R/h at about 21 m (70 ft); and a third showed 2.8 R/h at 15 m (50 ft). Dry wastes have been disposed in trenches both in containers (e.g., cardboard boxes, drums) and unpackaged. Many of these trenches contain wastes that could result in ALARA concerns; wastes with dose rates over 1,000 R/h at contact have been disposed to these trenches (SWITS).

Cover requirements for landfill wastes varied over the years. Because of shallow burial in the earlier landfills, some wastes were exposed by wind erosion. There are a number of recorded incidents of burial boxes collapsing and dispersing radioactive contamination across wide areas of the site. In addition, shallow burial resulted in uptake from plants whose roots penetrated into the waste packages. Most of these issues have been resolved through compaction of soils at landfills, removal of deep-rooted vegetation over some landfills, and, for other landfills, the addition of soil with shallow-rooted vegetation cover to stabilize existing soils. Site maintenance programs also include the application of selective and nonselective herbicides, by licensed applicators, to control deep-rooted plant growth on stabilized burial grounds.

3.2 HISTORY OF THE RI/FS WORK PLAN

3.2.1 Waste Sites in the 200-SW-1 and 200-SW-2 Operable Units

The 200-SW-1 OU once consisted of 69 sites. The Implementation Plan (DOE/RL-98-28) originally described 37 sites. Then, as a result of reassignments and additions before the RI/FS process, 32 sites were added to the 200-SW-1 OU. The 69 waste sites were updated further in accordance with guideline RL-TPA-90-0001 for reclassification of sites to "Rejected"[21] or "No Action"[12] status.

Historical information indicated that 30 of the sites in the 200-SW-1 OU were not waste-management units. The majority of the 30 sites that were not waste-management units had involved locations where the records indicated no history of disposal of waste that requires remediation. If a small volume was released, the affected media were cleaned up immediately. Other sites were removed from the list of waste-management units because they were duplicated by, or consolidated with, another waste site. The reclassification of these sites resulted in 39 sites in the 200-SW-1 OU remaining for consideration through the RI/FS process. However, with the creation of the new Model Group OUs, all but two sites have been migrated to either the 200-MG-1 or the 200-MG-2 OU in 2007. Currently, only the NRDWL and 600 CL remain in the 200-SW-1 OU. Table 3-1 provides a list of all of the original site classifications when this RI/FS work plan was drafted in 2004, as well as the OU in which each waste site now resides.

The 200-SW-2 OU consisted of 50 sites in the Implementation Plan (DOE/RL-98-28). Eight sites were reassigned or added before the RI/FS process, totaling 58 sites as listed in WIDS. Twenty-three sites were reclassified (Table 3-1), as described above, leaving 35 sites in the 200-SW-2 OU for evaluation. A combined total of 74 sites in the 200-SW-1 and 200-SW-2 OUs were evaluated in Draft A of this RI/FS work plan. However, with the creation of the new Model Group OUs, all but 24 sites have been migrated to either the 200-MG-1 or 200-MG-2 OU. The 200-MG-1 and 200-MG-2 OUs both contain waste sites that are expected to have generally

[21] See footnote number 10.

shallow contaminants. The lead regulatory agency for the 200-MG-1 OU is Ecology, while the lead regulatory agency for the 200-MG-2 OU is the EPA. Table 3-1 provides a list of all of the original site classifications from when this RI/FS work plan was drafted in 2004, as well as where each waste site now resides.

Table 3-1. 200-SW-1 and 200-SW-2 Operable Unit Waste Sites Crosswalk. (4 Pages)

Site Code	Site Name	Operable Unit, Draft A Work Plan (2004) [a]	Operable Unit, Draft B Work Plan (2007) [b]	WIDS Reclassification Status [c]
200 CP	200 Area Construction Pit	200-SW-1	200-MG-1	Accepted
200-E BP	200-E Burn Pit	200-SW-1	200-MG-1	Accepted
200-E PAP	200-E Powerhouse Ash Pit and Ash Disposal Pile	200-SW-1	200-SW-1	No Action
200-E-1	284-E Landfill	200-SW-1	200-MG-1	Accepted
200-E-10	Paint/Solvent Dump South of Sub Trenches	200-SW-1	200-SW-1	No Action
200-E-12	Sand Piles from RCRA General Inspection 200E FY 95 Item #5	200-SW-1	200-SW-1	Rejected
200-E-122	Construction Forces Bullpen	200-SW-1	200-SW-1	No Action
200-E-13	Rubble Piles	200-SW-1	200-MG-1	Accepted
200-E-2	Soil Stains at the 2101M SW Parking Lot, MO-234 Parking Lot	200-SW-1	200-MG-1	Accepted
200-E-20	218-E-10 Borrow Pit	200-SW-2	200-SW-2	Rejected
200-E-21	218-E-12A and 218-E-12B Borrow Pit	200-SW-2	200-SW-2	Rejected
200-E-3	Toluene Dump Site	200-SW-1	200-SW-1	Consolidated (200-E-10)
200-E-46	Solid Debris	200-SW-1	200-MG-1	Accepted
200-E-47	RCRA Permit General Inspection #200E FY 96 Item #7	200-SW-1	200-SW-1	Rejected
200-E-48	RCRA Permit General Inspection #200E FY 96 Item #15	200-SW-1	200-SW-1	Rejected
200-E-52	200 East Powerhouse Coal Pile	200-SW-1	200-SW-1	No Action
200-N-3	200-N-3 Ballast Pits	200-SW-1	200-MG-1	Accepted
200-W ADB	200-W Ash Disposal Basin	200-SW-1	200-MG-1	Accepted
200-W BP	200-W Burn Pit	200-SW-1	200-MG-1	Accepted
200-W CSLA	200-W Construction Surface Laydown Area	200-SW-1	200-SW-1	Rejected
200-W PAP	200-W Powerhouse Ash Pit	200-SW-1	200-SW-1	No Action
200-W-1	REDOX Mud Pit West	200-SW-1	200-MG-1	Accepted
200-W-10	Item 10 (RCRA General Inspection) Grout Wall Test	200-SW-1	200-SW-1	No Action
200-W-101	Contaminated Material W of 216-S-12 Crib	200-SW-2	200-MG-1	Accepted
200-W-103	201-W Concrete Silo	200-SW-1	200-SW-1	Rejected
200-W-11	S-Farm Concrete Foundation	200-SW-1	200-MG-1	Accepted
200-W-12	201-W Soil Mound and Plastic Pipe	200-SW-1	200-MG-1	Accepted
200-W-17	S-Plant Project W087 Aluminum Silicate Discovery	200-SW-1	200-SW-1	Rejected
200-W-18	S-Plant Project W087 Aluminum Oxide Discovery	200-SW-1	200-SW-1	Rejected
200-W-2	REDOX Berms West	200-SW-1	200-MG-1	Accepted
200-W-3	2713-W North Parking Lot, 220-W-1	200-SW-1	200-MG-1	Accepted
200-W-30	218-W-1A Borrow Pit	200-SW-2	200-SW-2	Rejected
200-W-31	218-W-2A Borrow Pit	200-SW-2	200-SW-2	Rejected
200-W-32	216-Z-19 Borrow Pit	200-SW-2	200-SW-2	Rejected
200-W-33	Solid Waste Dumping Area	200-SW-1	200-MG-1	Accepted
200-W-35	Various Sites North of 201-W	200-SW-1	200-SW-1	No Action
200-W-4	U-Farm Landfill	200-SW-1	200-SW-1	No Action
200-W-41	200-W-41, Abandoned Drums, Drums found East of T Plant	200-SW-1	200-SW-1	No Action

Table 3-1. 200-SW-1 and 200-SW-2 Operable Unit Waste Sites Crosswalk. (4 Pages)

Site Code	Site Name	Operable Unit, Draft A Work Plan (2004) [a]	Operable Unit, Draft B Work Plan (2007) [b]	WIDS Reclassification Status [c]
200-W-5	Landfill/Burning Pit, U Plant Burning Pit, UPR-200-W-8	200-SW-2	200-SW-2	Rejected
200-W-55	Dump N of 231Z	200-SW-1	200-MG-1	Accepted
200-W-6	200-W Painter shop paint solvent disposal area	200-SW-1	200-MG-1	Accepted
200-W-62	200 West Powerhouse Coal Pile	200-SW-1	200-SW-1	No Action
200-W-68	RCRA General Inspection Report 200W FY 99 Item #3, Historic Disposal Site	200-SW-1	200-SW-1	Rejected
200-W-70	Old Burn Pit Southeast of Z-Plant, 200 West Original Burn Pit	200-SW-1	200-SW-1	Rejected
200-W-75	Rad Logging System Silos	200-SW-2	200-MG-2	Accepted
200-W-92	Soil Mound W of TY Farm	200-SW-2	200-MG-1	Accepted
218-C-9	Dry Waste & 216-C-9 Pond	200-SW-2	200-SW-2	Accepted
218-E-1	Dry Waste #1	200-SW-2	200-SW-2	Accepted
218-E-10	Equip Burial #10	200-SW-2	200-SW-2	Accepted
218-E-12A	Dry Waste #12A	200-SW-2	200-SW-2	Accepted
218-E-12B	Dry Waste #12B	200-SW-2	200-SW-2	Accepted
218-E-2	Equip Burial #2	200-SW-2	200-SW-2	Accepted
218-E-2A	Regulated Equip Storage	200-SW-2	200-SW-2	Accepted
218-E-3	Construction Scrap Pit	200-SW-2	200-SW-2	Accepted
218-E-4	Equip Burial #4	200-SW-2	200-SW-2	Accepted
218-E-5	Equip Burial #5	200-SW-2	200-SW-2	Accepted
218-E-5A	Equip Burial #5A	200-SW-2	200-SW-2	Accepted
218-E-6	B Stack Shack Burning Pit	200-SW-1	200-SW-1	No Action
218-E-7	222B Vaults	200-SW-2	200-MG-1	Accepted
218-E-8	200E Construction Burial	200-SW-2	200-SW-2	Accepted
218-E-9	200E Regulated Equipment Storage Site No. 009, Burial Vault (Hanford Inactive Site Survey)	200-SW-2	200-SW-2	Accepted
218-W-1	Solid Waste Burial #1	200-SW-2	200-SW-2	Accepted
218-W-11	Regulated Storage Site	200-SW-2	200-SW-2	Accepted
218-W-1A	Equip Burial #1	200-SW-2	200-SW-2	Accepted
218-W-2	Dry Waste #2	200-SW-2	200-SW-2	Accepted
218-W-2A	Equip Burial #2	200-SW-2	200-SW-2	Accepted
218-W-3	Dry Waste #3	200-SW-2	200-SW-2	Accepted
218-W-3A	Dry Waste #3A	200-SW-2	200-SW-2	Accepted
218-W-3AE	Dry Waste #3AE	200-SW-2	200-SW-2	Accepted
218-W-4A	Dry Waste #4A	200-SW-2	200-SW-2	Accepted
218-W-4B	Dry Waste #4B	200-SW-2	200-SW-2	Accepted
218-W-4C	Dry Waste #4C	200-SW-2	200-SW-2	Accepted
218-W-5	Low Level Radioactive Mixed Waste Landfill	200-SW-2	200-SW-2	Accepted
218-W-6	218-W-6 Landfill	200-SW-1	200-MG-1	Accepted
218-W-7	222S Vaults	200-SW-2	200-MG-1	Accepted
218-W-8	222T Vaults	200-SW-2	200-MG-1	Accepted
218-W-9	Dry Waste Burial #9	200-SW-2	200-MG-1	Accepted
291-C-1	291C Stack Burial Trench	200-SW-2	200-MG-1	Accepted
600 BPHWSA	600 Area Batch Plant HWSA, Hazardous Waste Storage Area	200-SW-1	200-SW-1	Rejected
600 CL	600 Area Central Landfill	200-SW-1	200-SW-1	Accepted
600 ESHWSA	600 Area Exploratory Shaft Hazardous Waste Storage Area	200-SW-1	200-SW-1	Rejected
600 NRDWL	600 Area Non Radioactive Dangerous Waste Landfill	200-SW-1	200-SW-1	Accepted

Table 3-1. 200-SW-1 and 200-SW-2 Operable Unit Waste Sites Crosswalk. (4 Pages)

Site Code	Site Name	Operable Unit, Draft A Work Plan (2004) [a]	Operable Unit, Draft B Work Plan (2007) [b]	WIDS Reclassification Status [c]
600 OCL	600 Original Central Landfill	200-SW-1	200-MG-1	Accepted
600-146	Steel Structure NW of Gable Mt	200-SW-1	200-MG-1	Accepted
600-218	H-61 Anti-Aircraft Dump	200-SW-1	200-MG-1	Accepted
600-220	H-51 Anti-Aircraft Dump	200-SW-1	200-MG-1	Accepted
600-222	H-60 Gun Site	200-SW-1	200-MG-1	Accepted
600-223	Military Camp South of 200 W, H-50 Gun Site Pit	200-SW-1	200-SW-1	Rejected
600-226	H-42 Gun Site	200-SW-1	200-MG-1	Accepted
600-228	H-40 Gun Site	200-SW-1	200-MG-1	Accepted
600-236	Soil Cell 607 Site, Petroleum Contaminated Soil, Bioremediation Site	200-SW-1	200-SW-1	Rejected
600-25 [d]	Susie Junction	200-SW-2	200-SW-2	Rejected
600-266	Trash Dump West of Gate 117-A	200-SW-1	200-SW-1	Rejected
600-268	200 East Pipe Yard Drum Accumulation Area	200-SW-2	200-SW-2	Rejected
600-281	Scattered Debris South of Army Loop Road	200-SW-1	200-MG-1	Accepted
600-36	Ethel Railroad Siding Burn Pit	200-SW-1	200-MG-1	Accepted
600-38	Susie Junction	200-SW-1	200-MG-1	Accepted
600-40	W of W Lake Dumping Area	200-SW-1	200-MG-1	Accepted
600-51	Chemical Dump	200-SW-1	200-MG-1	Accepted
600-65	607 Batch Plant Drum Site	200-SW-1	200-MG-1	Accepted
600-66	607 Batch Plant Orphan Drums	200-SW-1	200-MG-1	Accepted
600-70	Solid Waste Management Unit #2	200-SW-1	200-MG-1	Accepted
600-71	607 Batch Plant Burn Pit	200-SW-1	200-MG-1	Accepted
622-1	Construction and Demolition Debris	200-SW-1	200-SW-1	Rejected
628-2	100 Fire Station Burn Pit	200-SW-1	200-MG-1	Accepted
OCSA	Old Central Shop Area	200-SW-1	200-MG-1	Accepted
UPR-200-E-106	Contamination at a Burning Ground, UN-200-E-106	200-SW-1	200-MG-1	Consolidated (200-E-BP)
UPR-200-E-23	Burial Box Collapse at 218-E-10, UPR-200-W-158	200-SW-2	200-SW-2	Consolidated (218-E-10)
UPR-200-E-24	Contamination Plume from the 218-E-10 Landfill, UN-200-E-24	200-SW-2	200-SW-2	Consolidated (218-E-10)
UPR-200-E-30	Contamination within 218-E-10, UN-200-E-20	200-SW-2	200-SW-2	Consolidated (218-E-10)
UPR-200-E-35	Buried Pipe, Contaminated	200-SW-2	200-MG-1	Accepted
UPR-200-E-53	Contamination at 218-E-1	200-SW-2	200-SW-2	Consolidated (218-E-1)
UPR-200-E-61	Radioactive Contamination from Railroad Burial Cars	200-SW-2	200-SW-2	Rejected
UPR-200-E-95	Ground Contamination on Railroad Spur Between 218-E-2A and 218-E-5	200-SW-2	200-MG-1	Accepted
UPR-200-W-11	218-W-1 Landfill Fire	200-SW-2	200-SW-2	Consolidated (218-W-1)
UPR-200-W-134	Improper Drum Burial at 218-E-3A	200-SW-2	200-SW-2	Consolidated (218-W-3A)
UPR-200-W-137	218-W-7, UN-200-W-137	200-SW-2	200-MG-1	Consolidated (218-W-7)
UPR-200-W-16	Fire at 218-W-1 Landfill	200-SW-2	200-SW-2	Consolidated (218-W-1)
UPR-200-W-26	Contamination Spread During Burial Operations	200-SW-2	200-SW-2	Consolidated (218-W-1A)
UPR-200-W-37	Contaminated Boxes found in a Burn Pit (Z-Plant Burn Pit)	200-SW-1	200-SW-2	Consolidated (218-W-4C)

Table 3-1. 200-SW-1 and 200-SW-2 Operable Unit Waste Sites Crosswalk. (4 Pages)

Site Code	Site Name	Operable Unit, Draft A Work Plan (2004) [a]	Operable Unit, Draft B Work Plan (2007) [b]	WIDS Reclassification Status [c]
UPR-200-W-45	Burial Box Collapse	200-SW-2	200-SW-2	No Action
UPR-200-W-53	Burial Box Collapse	200-SW-2	200-SW-2	Consolidated (218-W-2A)
UPR-200-W-63	Contamination S. Shoulder 23rd St.	200-SW-2	200-MG-1	Accepted
UPR-200-W-70	Contamination Found at the 200 West Burning Ground East of Beloit Ave.	200-SW-1	200-MG-1	Accepted
UPR-200-W-72	Contamination at 218-W-4A	200-SW-2	200-SW-2	Consolidated (218-W-4A)
UPR-200-W-84	Ground Contamination During Burial Operation at 218-W-3A	200-SW-2	200-SW-2	Consolidated (218-W-3A)
Z PLANT BP	Z-Plant Burning Pit	200-SW-1	200-SW-2	Consolidated (218-W-4C)

[a] DOE/RL-2004-60, *200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study Work Plan*, Draft A.
[b] DOE/RL-2004-60, *200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study Work Plan*, Draft B.
[c] The site codes in parentheses represent consolidated sites (i.e., the consolidated site is within the footprint of the listed site; see footnote number 9).
[d] 600-25 is a duplicate of 600-38 and has therefore been reclassified as 'rejected.'
600 OCL = 600 Area Original Central Landfill. WIDS = *Waste Information Data System* database.

Table 3-2 further summarizes those sites from Table 3-1 that have the 'Accepted' classification in WIDS and have migrated to either the 200-MG-1 or 200-MG-2 OU. Table 3-3 summarizes those sites within the 200-SW-1 and 200-SW-2 OUs from Table 3-1 that have the 'No Action, 'Rejected', or 'Consolidated' classification in WIDS. The 'No Action' and 'Rejected' sites require no further action and are listed here only for completeness. Those sites that have the 'Consolidated' classification are contained within the footprint of some of the 200-SW-2 OU landfills. Because they are within the footprint of the landfills, it is assumed that the remedial action for the landfill also will remediate the 'Consolidated' waste site. A description of those sites that are consolidated within 200-SW-2 OU landfills is presented in Table 3-4.

Table 3-5 summarizes those sites from Table 3-1 that are within the scope of this investigation. This table also lists the proposed bin (Section 3.2.1) for each site. The NRDWL and 600 CL are listed in this table for completeness; it is proposed that these sites undergo closure outside of the CERCLA process and this RI/FS work plan.

Table 3-2. Accepted Sites Migrated out of the 200-SW-1 and 200-SW-2 Operable Units. (3 Pages).

Site Code	Site Name	Former Operable Unit	Current Operable Unit
200 CP	200 Area Construction Pit	200-SW-1	200-MG-1
200-E BP	200-E Burn Pit	200-SW-1	200-MG-1
200-E-1	284-E Landfill	200-SW-1	200-MG-1
200-E-13	Rubble Piles	200-SW-1	200-MG-1

Table 3-2. Accepted Sites Migrated out of the 200-SW-1 and 200-SW-2 Operable Units. (3 Pages).

Site Code	Site Name	Former Operable Unit	Current Operable Unit
200-E-2	Soil Stains at the 2101M SW Parking Lot, MO-234 Parking Lot	200-SW-1	200-MG-1
200-E-46	Solid Debris	200-SW-1	200-MG-1
200-N-3	200-N-3 Ballast Pits	200-SW-1	200-MG-1
200-W ADB	200-W Ash Disposal Basin	200-SW-1	200-MG-1
200-W BP	200-W Burn Pit	200-SW-1	200-MG-1
200-W-1	REDOX Mud Pit West	200-SW-1	200-MG-1
200-W-101	Contaminated Material W of 216-S-12 Crib	200-SW-2	200-MG-1
200-W-11	S-Farm Concrete Foundation	200-SW-1	200-MG-1
200-W-12	201-W Soil Mound and Plastic Pipe	200-SW-1	200-MG-1
200-W-2	REDOX Berms West	200-SW-1	200-MG-1
200-W-3	2713-W North Parking Lot, 220-W-1	200-SW-1	200-MG-1
200-W-33	Solid Waste Dumping Area	200-SW-1	200-MG-1
200-W-55	Dump N of 231Z	200-SW-1	200-MG-1
200-W-6	200-W Painter shop paint solvent disposal area	200-SW-1	200-MG-1
200-W-75	Rad Logging System Silos	200-SW-2	200-MG-2
200-W-92	Soil Mound W of TY Farm	200-SW-2	200-MG-1
218-E-7	222B Vaults	200-SW-2	200-MG-1
218-W-6	218-W-6 Landfill	200-SW-1	200-MG-1
218-W-7	222S Vaults	200-SW-2	200-MG-1
218-W-8	222T Vaults	200-SW-2	200-MG-1
218-W-9	Dry Waste Burial #9	200-SW-2	200-MG-1
291-C-1	291C Stack Burial Trench	200-SW-2	200-MG-1
600 OCL	600 Original Central Landfill	200-SW-1	200-MG-1
600-146	Steel Structure NW of Gable Mt	200-SW-1	200-MG-1
600-218	H-61 Anti-Aircraft Dump	200-SW-1	200-MG-1
600-220	H-51 Anti-Aircraft Dump	200-SW-1	200-MG-1
600-222	H-60 Gun Site	200-SW-1	200-MG-1
600-226	H-42 Gun Site	200-SW-1	200-MG-1
600-228	H-40 Gun Site	200-SW-1	200-MG-1
600-281	Scattered Debris South of Army Loop Road	200-SW-1	200-MG-1
600-36	Ethel Railroad Siding Burn Pit	200-SW-1	200-MG-1
600-38	Susie Junction	200-SW-1	200-MG-1
600-40	W of W Lake Dumping Area	200-SW-1	200-MG-1
600-51	Chemical Dump	200-SW-1	200-MG-1

Table 3-2. Accepted Sites Migrated out of the 200-SW-1 and 200-SW-2 Operable Units. (3 Pages).

Site Code	Site Name	Former Operable Unit	Current Operable Unit
600-65	607 Batch Plant Drum Site	200-SW-1	200-MG-1
600-66	607 Batch Plant Orphan Drums	200-SW-1	200-MG-1
600-70	Solid Waste Management Unit #2	200-SW-1	200-MG-1
600-71	607 Batch Plant Burn Pit	200-SW-1	200-MG-1
628-2	100 Fire Station Burn Pit	200-SW-1	200-MG-1
OCSA	Old Central Shop Area	200-SW-1	200-MG-1
UPR-200-E-35	Buried Pipe, Contaminated	200-SW-2	200-MG-1
UPR-200-E-95	Ground Contamination on Railroad Spur Between 218-E-2A and 218-E-5	200-SW-2	200-MG-1
UPR-200-W-63	Contamination S. Shoulder 23rd St.	200-SW-2	200-MG-1
UPR-200-W-70	Contamination Found at the 200 West Burning Ground East of Beloit Ave.	200-SW-1	200-MG-1

Table 3-3. No-Action, Rejected, or Consolidated Sites. (2 Pages).

Site Code	Site Name	Current Operable Unit	WIDS Reclassification Status
200-E PAP	200-E Powerhouse Ash Pit and Ash Disposal Pile	200-SW-1	No Action
200-E-10	Paint/Solvent Dump South of Sub Trenches	200-SW-1	No Action
200-E-12	Sand Piles from RCRA General Inspection 200E FY 95 Item #5	200-SW-1	Rejected
200-E-122	Construction Forces Bullpen	200-SW-1	No Action
200-E-20	218-E-10 Borrow Pit	200-SW-2	Rejected
200-E-21	218-E-12A and 218-E-12B Borrow Pit	200-SW-2	Rejected
200-E-3	Toluene Dump Site	200-SW-1	Consolidated (200-E-10)
200-E-47	RCRA Permit General Inspection #200E FY 96 Item #7	200-SW-1	Rejected
200-E-48	RCRA Permit General Inspection #200E FY 96 Item #15	200-SW-1	Rejected
200-E-52	200 East Powerhouse Coal Pile	200-SW-1	No Action
200-W CSLA	200-W Construction Surface Laydown Area	200-SW-1	Rejected
200-W PAP	200-W Powerhouse Ash Pit	200-SW-1	No Action
200-W-10	Item 10 (RCRA General Inspection) Grout Wall Test	200-SW-1	No Action
200-W-103	201-W Concrete Silo	200-SW-1	Rejected
200-W-17	S-Plant Project W087 Aluminum Silicate Discovery	200-SW-1	Rejected
200-W-18	S-Plant Project W087 Aluminum Oxide Discovery	200-SW-1	Rejected
200-W-30	218-W-1A Borrow Pit	200-SW-2	Rejected
200-W-31	218-W-2A Borrow Pit	200-SW-2	Rejected
200-W-32	216-Z-19 Borrow Pit	200-SW-2	Rejected
200-W-35	Various Sites North of 201-W	200-SW-1	No Action
200-W-4	U-Farm Landfill	200-SW-1	No Action
200-W-41	200-W-41, Abandoned Drums, Drums found East of T Plant	200-SW-1	No Action
200-W-5	Landfill/Burning Pit, U Plant Burning Pit, UPR-200-W-8	200-SW-2	Rejected
200-W-62	200 West Powerhouse Coal Pile	200-SW-1	No Action
200-W-68	RCRA General Inspection Report 200W FY 99 Item #3, Historic Disposal Site	200-SW-1	Rejected

Table 3-3. No-Action, Rejected, or Consolidated Sites. (2 Pages).

Site Code	Site Name	Current Operable Unit	WIDS Reclassification Status
200-W-70	Old Burn Pit Southeast of Z-Plant, 200 West Original Burn Pit	200-SW-1	Rejected
218-E-6	B Stack Shack Burning Pit	200-SW-1	No Action
600 BPHWSA	600 Area Batch Plant HWSA, Hazardous Waste Storage Area	200-SW-1	Rejected
600 ESHWSA	600 Area Exploratory Shaft Hazardous Waste Storage Area	200-SW-1	Rejected
600-223	Military Camp South of 200 W, H-50 Gun Site Pit	200-SW-1	Rejected
600-236	Soil Cell 607 Site, Petroleum Contaminated Soil, Bioremediation Site	200-SW-1	Rejected
600-25	Susie Junction	200-SW-2	Rejected
600-266	Trash Dump West of Gate 117-A	200-SW-1	Rejected
600-268	200 East Pipe Yard Drum Accumulation Area	200-SW-2	Rejected
622-1	Construction and Demolition Debris	200-SW-1	Rejected
UPR-200-E-106	Contamination at a Burning Ground, UN-200-E-106	200-MG-1	Consolidated (200-E-BP)
UPR-200-E-23	Burial Box Collapse at 218-E-10, UPR-200-W-158	200-SW-2	Consolidated (218-E-10)
UPR-200-E-24	Contamination Plume from the 218-E-10 Landfill, UN-200-E-24	200-SW-2	Consolidated (218-E-10)
UPR-200-E-30	Contamination within 218-E-10, UN-200-E-20	200-SW-2	Consolidated (218-E-10)
UPR-200-E-53	Contamination at 218-E-1	200-SW-2	Consolidated (218-E-1)
UPR-200-E-61	Radioactive Contamination from Railroad Burial Cars	200-SW-2	Rejected
UPR-200-W-11	218-W-1 Landfill Fire	200-SW-2	Consolidated (218-W-1)
UPR-200-W-134	Improper Drum Burial at 218-E-3A	200-SW-2	Consolidated (218-W-3A)
UPR-200-W-137	218-W-7, UN-200-W-137	200-MG-1	Consolidated (218-W-7)
UPR-200-W-16	Fire at 218-W-1 Landfill	200-SW-2	Consolidated (218-W-1)
UPR-200-W-26	Contamination Spread During Burial Operations	200-SW-2	Consolidated (218-W-1A)
UPR-200-W-37	Contaminated Boxes found in a Burn Pit (Z-Plant Burn Pit)	200-SW-2	Consolidated (218-W-4C)
UPR-200-W-45	Burial Box Collapse	200-SW-2	No Action
UPR-200-W-53	Burial Box Collapse	200-SW-2	Consolidated (218-W-2A)
UPR-200-W-72	Contamination at 218-W-4A	200-SW-2	Consolidated (218-W-4A)
UPR-200-W-84	Ground Contamination During Burial Operation at 218-W-3A	200-SW-2	Consolidated (218-W-3A)
Z PLANT BP	Z-Plant Burning Pit	200-SW-2	Consolidated (218-W-4C)

WIDS = *Waste Information Data System* database.

Table 3-4. Unplanned Release Sites Consolidated within 200-SW-2 Operable Unit Landfills. (3 Pages)

WIDS Site Code	Site Name(s)	Site Description	Landfill with Consolidated Site
UPR-200-E-53	UPR-200-E-53, UN-200-E-53, Contamination in	Contamination spread by bulldozer when shallow buried contaminated waste was unearthed during backfilling activities. The area is approximately 15 meters by 46 meters and is located at the south end of 218-E-1.	218-E-1

Table 3-4. Unplanned Release Sites Consolidated within 200-SW-2 Operable Unit Landfills. (3 Pages)

WIDS Site Code	Site Name(s)	Site Description	Landfill with Consolidated Site
	218-E-1	Contamination at levels of up to 150 mR/hr was recorded at this site. Status: Inactive	
UPR-200-E-23	UPR-200-E-23, UPR-200-W-158, Burial Box Collapse at 218-E-10	Airborne contamination spread over the 218-E-10 Landfill when a burial box containing two PUREX process steam tube bundles collapsed during backfill operations. Three days after partially backfilling, the landfill was found generally contaminated with levels ranging from 10 to 60 mR/hr. Initially, this site was in WIDS under the alias UPR-200-W-158 before being determined the event took place in 200 East. Status: Inactive	218-E-10
UPR-200-E-24	UPR-200-E-24, UN-200-E-24, Contamination Plume from the 218-E-10 Landfill	This site is associated with UPR-200-E-23 due to the same incident occurring but documents the large plume of contamination that resulted. Airborne contamination was generated due to a burial box containing two PUREX process steam tube bundles collapsing during backfill operations within the 218-E-10 Landfill. Status: Inactive	218-E-10
UPR-200-E-30	UPR-200-E-30, UN-200-E-30, Contamination within 218-E-10	Contamination occurred when a large wooden drag-off box collapsed as it was being backfilled in place within the 218-E-10 Landfill. The majority of contamination was located within the landfill. Contamination was spread over 400,000 sq/ft at a maximum of 500 mR/hr. Status: Inactive	218-E-10
UPR-200-W-16	UPR-200-W-16, Fire at 218-W-1 Landfill	This is a duplicate of the occurrence described in UPR-200-W-11. It was incorrectly reported in the Z-Plant Technical Baseline Report (BHI-00175). The correct location (UPR-200-W-16) was confirmed by the map in Selby and Soldat (1958). A fire occurred within the waste boxes spreading plutonium (alpha) contamination. Maximum contamination levels were found to be 20,000 disintegrations within the 218-W-1 Landfill and 30,000 disintegrations outside of the landfill. Contamination outside of the landfill boundaries is not within the scope of this RI/FS work plan. Status: Inactive	218-W-1
UPR-200-W-11	UPR-200-W-11, UN-200-W-11, UPR-200-W-16, 218-W-1 Landfill Fire	This is a duplicate of the occurrence described in UPR-200-W-16. The correct location (UPR-200-W-16) was confirmed by the map in Selby and Soldat (1958). A fire occurred within the waste boxes spreading plutonium (alpha) contamination. Maximum contamination levels were found to be 20,000 disintegrations within the 218-W-1 Landfill and 30,000 disintegrations outside of the landfill. Status: Inactive	218-W-1
UPR-200-W-26	UPR-200-W-26, Contamination Spread During Burial Operation	Wind dispersed contamination while a box of used connectors was being unloaded from a flatcar. Contamination spread onto the flatcar and onto the surrounding ground. This release is probably associated with the 218-W-1A Landfill, near T Plant. Radiation Incident Investigation at the time did not report any recommendations for reducing contamination at the landfill. Status: Inactive	218-W-1A
UPR-200-W-53	UPR-200-W-53, Burial Box Collapse	Collapse of a burial box in 218-W-2A containing REDOX cell jumpers occurred during backfilling operations releasing fission product contamination. Contamination levels ranged from 50 mR/hr at the landfill to 60,000 cpm at T Plant. Status: Inactive	218-W-2A
UPR-200-W-84	UPR-200-W-84, Ground Contamination During Burial Operation at 218-W-3A	A liquid spill occurred in the 218-W-3A Landfill during burial operations of a pump. This spill resulted in contamination of the truck transporting the pump and the ground around the truck. Some confusion has occurred in other documents associating this event with the 218-W-1 Landfill. The occurrence report for this incident did not take place at the same time 218-W-1 was in operation. Status: Inactive	218-W-3A
UPR-200-W-134	UPR-200-W-134, Improper Drum Burial at 218-W-3A	Occurrence Report 38-75 documented improper burial in the 218-W-3A Landfill of a waste drum labeled "TRANSURANIC." The drum contained plutonium, uranium and fissile materials. Applicable standards were not met for the handling and safe storage of this waste drum from the 325 Building.	218-W-3A

Table 3-4. Unplanned Release Sites Consolidated within 200-SW-2 Operable Unit Landfills. (3 Pages)

WIDS Site Code	Site Name(s)	Site Description	Landfill with Consolidated Site
		Status: Inactive	
UPR-200-W-72	UPR-200-W-72, Contamination at 218-W-4A	Soil erosion occurred in the 218-W-4A Landfill resulting in contaminated laboratory waste, with gross alpha and mixed fission product contamination to be released to the surrounding ground surface. Speculation that disposal depth requirements were not met resulted in waste exposure. Status: Inactive	218-W-4A
UPR-200-W-37	UPR-200-W-37, Contaminated Boxes Found in a Burn Pit (Z Plant Burn Pit)	Contamination resulted when three boxes containing high-level dry waste were mistakenly placed in a burn pit in the 200 West Area. When the mistake was rectified it was noted that one of the boxes had released contamination levels of 100 mR/hr due to being broken open during placement while the other two boxes had remained sealed. Upon removal of the boxes the pit was decontaminated. Through historical research this pit where the incident occurred was identified as the Z Plant Burning Pit. The Z Plant Burning Pit is located within the boundary of the 218-W-4C Landfill. Status: Inactive	218-W-4C
Z PLANT BP	Z PLANT BP, Z Plant Burning Pit, Z Plant Burn Pit	A burn pit in the 200 West Area used as a disposal site for combustible nonradioactive construction, office and non-hazardous lab waste, including unnamed chemicals. An estimated 2000 cubic meters of waste was burned which included less than 1000 cubic meters of lab chemicals. Located in the 218-W-4C Landfill, this site was exhumed during the excavation of Trench 7. Status: Inactive	218-W-4C

WIDS = *Waste Information Data System* database.

Table 3-5. Accepted Sites in the Scope of the RI/FS Work Plan/ Site Binning Approach. (2 Pages)

Site Code	Site Name	Operable Unit	Bin ID
600 CL	600 Area Central Landfill	200-SW-1	N/A
600 NRDWL	600 Area Non Radioactive Dangerous Waste Landfill	200-SW-1	N/A
218-C-9	Dry Waste & 216-C-9 Pond	200-SW-2	*Bin 5 – Construction Landfills*
218-E-1	Dry Waste #1	200-SW-2	*Bin 4 – Dry Waste Landfills*
218-E-10	Equip Burial #10	200-SW-2	*Bin 1 – TSD Unit Landfills*
218-E-12A	Dry Waste #12A	200-SW-2	*Bin 4 – Dry Waste Landfills*
218-E-12B	Dry Waste #12B	200-SW-2	*Bin 1 – TSD Unit Landfills*
218-E-2	Equip Burial #2	200-SW-2	*Bin 2 – Industrial Landfills*
218-E-2A	Regulated Equip Storage	200-SW-2	*Bin 2 – Industrial Landfills*
218-E-4	Equip Burial #4	200-SW-2	*Bin 5 – Construction Landfills*
218-E-5	Equip Burial #5	200-SW-2	*Bin 2 – Industrial Landfills*
218-E-5A	Equip Burial #5A	200-SW-2	*Bin 2 – Industrial Landfills*
218-E-8	200E Construction Burial	200-SW-2	*Bin 5 – Construction Landfills*
218-E-9	200E Regulated Equipment Storage Site No. 009, Burial Vault (Hanford Inactive Site Survey)	200-SW-2	*Bin 2 – Industrial Landfills*
218-W-1	Solid Waste Burial #1	200-SW-2	*Bin 3 – Dry Waste Alpha Landfills*
218-W-11	Regulated Storage Site	200-SW-2	*Bin 2 – Industrial Landfills*
218-W-1A	Equip Burial #1	200-SW-2	*Bin 2 – Industrial Landfills*
218-W-2	Dry Waste #2	200-SW-2	*Bin 3 – Dry Waste Alpha Landfills*
218-W-2A	Equip Burial #2	200-SW-2	*Bin 2 – Industrial Landfills*
218-W-3	Dry Waste #3	200-SW-2	*Bin 3 – Dry Waste Alpha Landfills*
218-W-3A	Dry Waste #3A	200-SW-2	*Bin 1 – TSD Unit Landfills*
218-W-3AE	Dry Waste #3AE	200-SW-2	*Bin 1 – TSD Unit Landfills*
218-W-4A	Dry Waste #4A	200-SW-2	*Bin 3 – Dry Waste Alpha Landfills*

Table 3-5. Accepted Sites in the Scope of the RI/FS Work Plan/
Site Binning Approach. (2 Pages)

Site Code	Site Name	Operable Unit	Bin ID
(includes caissons)	Caissons: W-4A-C1, W-4A-C2, W-4A-C3 and W-4A-C5	200-SW-2	*Bin 6 – Caissons*
	Unused Caissons: W-4A-C4, W-4A-C6, W-4A-C7, W-4A-C8	200-SW-2	*Bin 6 – Caissons Unused*
218-W-4B (includes caissons)	Dry Waste #4B	200-SW-2	*Bin 1 – TSD Unit Landfills*
	Caissons: W-4B-C1, W-4B-C2, W-4B-C3, W-4B-C4, W-4B-C5, W-4B-C6 and W-4B-CU1	200-SW-2	*Bin 6 – Caissons*
	Unused Caisson: W-4B-CA5	200-SW-2	*Bin 6 – Caissons Unused*
218-W-4C	Dry Waste #4C	200-SW-2	*Bin 1 – TSD Unit Landfills*
218-W-5	Low Level Radioactive Mixed Waste Landfill	200-SW-2	*Bin 1 – TSD Unit Landfills*

N/A – these sites are proposed to be closed independent of this RI/FS work plan.

Copies of the most recently approved Part A Permit applications for the two TSD units are contained in DOE/RL-91-28, Rev. 7.

In 2005, when the Phase I-A DQO (D&D-27257) was prepared, the original focus was on the 22 waste sites from Bins 3A and 3B, as established from the collaborative discussions held with DOE, EPA, and Ecology (the Tri-Parties) in early 2005. A total of 22 waste sites were included in the 200-SW-2 OU scope.

For the Phase I-B DQO (SGW-33253) and this document, the scope was changed to include 26 landfills from the 200-SW-1 and 200-SW-2 OUs combined. The scope now includes 24 landfills from the 200-SW-2 OU and 2 landfills from the 200-SW-1 OU.

In December 2006, a Tri-Party Agreement change package was submitted to migrate the majority of the 200-SW-1 OU waste sites to the newly created 200-MG-1 and 200-MG-2 OUs. Table 3-3 indicates the waste sites that have been moved out of 200-SW-1 OU and into the 200-MG-1 and 200-MG-2 OUs. Currently, two sites remain in the 200-SW-1 OU, the 600 CL, and NRDWL.

In addition, the 24 landfills have been re-binned based on current knowledge and similarity of waste types, locations, and burial configurations. The binning splits the original 200-SW-2 OU Bins 3A and 3B, from the Phase I-A DQO, into six new bins. These new bins are presented in Table 3-5 and are described below in Section 3.2.2.

The binning approach provides the basis for RIs. A SAP has been prepared (Appendix A) based on the sampling design developed through the Phase I-B DQO process. The sampling design specifies the field investigation techniques for each bin, including the following:

- Sampling and analyses required for characterization
- Methods to support the observational approach.

The criteria for placement of sites in different bins are discussed in Section 4.2.

Since Draft A of this RI/FS work plan was submitted, all of the original Bin 1 and Bin 2 waste sites have been migrated to other OUs (Table 3-1). The 24 remaining landfills in the 200-SW-2 OU were sorted into five main categories/bins based on similar characteristics. This sorting is anticipated to aid in choosing appropriate remedial paths, based primarily on the results of the FS and evaluation of candidate remedial alternatives against the nine CERCLA criteria. Because of their uniqueness, a sixth main category/bin was added to address caissons. The six main categories/bins included in the scope of this RI/FS work plan are described in the following subsections and summarized in Table 3-5.

3.2.2.1 Bin 1 Sites

- ***Bin 1 -- TSD Unit Landfills*** – This bin includes landfills that are permitted as RCRA TSD units and are included in the LLBG Part A (DOE/RL-88-20). This bin coincides with the original Bin 3A grouping from the Phase I-A DQO. The majority of available historical documentation is associated with these sites (approximately 110,000 of 147,000 total documents); the sites, therefore, are considered the best documented sites in the scope of this RI/FS work plan. Sites in this bin include the 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, 218-E-10, and 218-E-12B Landfills. These are sites for which available historical documentation indicates that no burials have been made and there is a low potential for contamination, but some questions remain. Sites in this bin include annexes of the 218-W-4C and 218-E-10 Landfills and unused portions of the 218-E-12B Landfill.

3.2.2.2 Bin 2 through 5 Sites

- ***Bin 2 -- Industrial Landfills*** – This bin includes past-practice landfills that received radioactive waste that was usually packaged in large wooden or concrete boxes, containing large quantities of fission products. For the most part, these sites were restricted to burial of large pieces of failed or obsolete equipment from the chemical processing facilities, although some items came from the 100 Areas. Many of these sites contain burials made over 50 years ago. Historical burial documentation is good for the 218-W-2A and 218-E-5A Landfills; however, historical burial documentation for the remaining sites (218-E-2, 218-E-5, 218-E-9, 218-W-1A, and 218-W-11 Landfills) is at a minimum. Sites in this bin include the 218-W-2A, 218-E-5A, 218-E-2, 218-E-2A, 218-E-5, 218-E-9, 218-W-1A, and 218-W-11 Landfills.

- ***Bin 3 -- Dry Waste Alpha Landfills*** – This bin includes past-practice landfills that received radioactive waste packaged primarily in fiberboard or small wooden boxes, wrapped in heavy brown paper or burlap, or placed in the trench without packaging. A small proportion of the waste is packaged in metal drums. All types of miscellaneous wastes, including contaminated soils and potentially contaminated rags, paper, wood, and small pieces of equipment such as tools, have been placed in these sites. Some larger equipment (e.g., motor vehicles, large canyon-processing equipment) is known to have been disposed to these sites. Available historical documentation indicates that these sites contain at least 90 percent of the 200 Areas landfill pre-1970 alpha inventory. Available historical documentation for the older landfills (the 218-W-1 and 218-W-2 Landfills) in this bin generally is poor, because these landfills received waste in the 1940s and 1950s.

Available historical documents for the newer landfills (the 218-W-3 and 218-W-4A Landfills) in this bin are more numerous, because these landfills received waste in the mid-1950s to 1960s.

- ***Bin 4 -- Dry Waste Landfills*** – This bin includes past-practice landfills that received radioactive waste packaged primarily in fiberboard or small wooden boxes, wrapped in heavy brown paper or burlap, or placed in the trench without packaging. A small proportion of the waste is packaged in metal drums. All types of miscellaneous wastes, including contaminated soils and potentially contaminated rags, paper, and wood have been placed in these sites. These sites also contain a few pieces of large equipment such as tank farm pumps. Available historical documentation for these sites generally is poor. Sites in this bin include the 218-E-1 and 218-E-12A Landfills.

- ***Bin 5 -- Construction Landfills*** – This bin includes past-practice landfills that mainly were limited to burial of wastes resulting from construction work on existing facilities or demolition of surplus facilities. Wastes in these sites are believed to contain very little alpha contamination; beta-gamma contamination likely also is at a minimum. Documentation for the 218-C-9 Landfill is believed to be nearly complete; however, available historical documents for the 218-E-8 and 218-E-4 Landfills are few.

3.2.2.3 Bin 6 Sites

- ***Bin 6 -- Caissons*** – This bin includes caissons and vertical pipe units used for disposal of hot-cell waste or high plutonium concentration waste in the 218-W-4A and 218-W-4B Landfills. The vertical pipe units in the 218-W-4A Landfill were made of welded 208.2 L (55-gal) drums or corrugated pipe and concrete; the caissons in the 218-W-4B Landfill were made of metal and/or concrete. Documentation for the caissons in the 218-W-4A Landfill generally is poor, while the documentation for the caissons in the 218-W-4B Landfill generally is more numerous (150 to 250 documents per caisson). Caissons located in this bin include the 218-W-4B-C1, 218-W-4B-C2, 218-W-4B-C3, 218-W-4B-C4, 218-W-4B-C5, 218-W-4B-C6, 218-W-4B-CU1, 218-W-4A-C1, 218-W-4A-C2, 218-W-4A-C3, and 218-W-4A-C5 Caissons. This bin also includes caissons in the 218-W-4A and 218-W-4B Landfills that are believed to be empty/unused, according to available historical documentation. These include the 218-W-4A-C4, 218-W-4A-C6, 218-W-4A-C7, and 218-W-4A-C8 Caissons. Additional caissons exist; however, these caissons contain RSW and will be dispositioned by the M-091 Program.

3.3 NATURE AND EXTENT OF CONTAMINATION

The following discussion provides a summary of known contamination at the Bins 1 through 6 sites, based on existing records and the results of Phase I-A field-sampling activities. The Bin 1 sites (TSD-unit landfills), which have been characterized to a greater extent than the Bin 2 through 6 sites, are discussed in this section. Because few investigations have been conducted for the Bin 2 through 6 sites, little or no data are available to describe existing contamination for these sites.

Because the nature of the material disposed of in the solid-waste burial grounds was predominantly dry, or was sorbed onto media to reduce mobility, or was activated metal, the likelihood of contaminant migration below the trenches is expected to be low. Consideration of low annual precipitation and recharge rates further reduces the likelihood for contaminant migration, because infiltration is the driving mechanism. The four burial grounds where larger volumes of water were present because of episodic events (i.e., rapid snow melt/ponding and drainage ditch seepage) and gravel-covered landfill surfaces denuded of vegetation may have experienced contaminant migration caused by the increased possible driving force. This is the premise embodied in the direct-push characterization strategy and the number and location of boreholes planned.

Groundwater well monitoring results are discussed in Section 3.5. Groundwater wells installed at landfills after approximately 1990 generally are not sampled for specific contaminants but are sampled for contaminant indicators such as conductivity and total organic carbon. Also, little information from gamma logging or soil samples is available for these sites. Monitoring wells installed since about 1990 typically were sampled during installation only for moisture content and particle size, not contaminants. Fine-grained sediments with high moisture contents would be a good place to look for mobile radionuclides and chemicals. Most of the more recent well installations were for monitoring conditions beneath tank farms, not landfills.

A few of the historical reference sources present information on geophysical results or sediments obtained during installation of wells and are briefly summarized as follows.

- PNL-6820, *Hydrogeology of the 200 Areas Low-Level Burial Grounds – An Interim Report*, presents groundwater and geophysical results from samples collected during the installation of some monitoring wells in the 200 Areas. This information is suitable for the records review process in conjunction with site characterization as discussed in Section 4.2.

- WHC-MR-0204, *200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary Report*, summarizes the results of 11 wells drilled in the 200 East and 200 West Areas in fiscal year 1989. Selected sediment samples from the installation of these 11 wells were tested for physical and hydrogeologic properties. The sediment samples also were analyzed for contaminant indicator parameters (total organic carbon, anions, low-energy alpha emission, and beta emission). In addition, the sediment samples were analyzed for volatile organic compounds. Samples were collected at each location from surface to groundwater, which was at about 75 m (240 ft); the samples were collected at roughly 6 m (20-ft) intervals. Of the anions analyzed, the highest concentration detected was sulfate at 130 mg/kg in well 299-W7-7 (at the north border of the 218-W-3AE Landfill) at a depth of 12.2 m (40 ft). All other anions either were not detected or were detected at values below 130 mg/kg. The most significant beta count was 29.1 pCi/g at well 299-W7-8 (at the northeast corner of the 218-W-3AE Landfill), at a depth of 9.3 m (30.5 ft). Alpha readings all were below 15.4 pCi/g. Total organic carbon analyses detected a concentration of 85 mg/kg at well 299-W7-7 at a depth of 24.4 m (80 ft). Other concentrations of total organic carbon were below this value in all samples collected. The volatile organic compound concentrations were similarly low in all samples collected. Carbon tetrachloride was detected in well 299-W15-19 (at the north border of the 218-W-4B Landfill) at a concentration of 8.1 μg/kg at a depth of 75 m (240 ft). Details of the physical and hydrogeologic properties of the samples collected can be found in Appendix C of WHC-MR-0204.

- WHC-MR-0205, *Borehole Completion Data Package for Low-Level Burial Grounds – 1990*, summarizes the installation of six new monitoring wells in the 200 East and 200 West Areas in fiscal year 1990. Selected sediment samples were collected during installation of each well and analyzed for volatile organics, anions, total organic carbon, and gross alpha, and gross beta. Physical properties analysis results also were obtained. Chemical and radionuclide data can be found in Appendix B of WHC-MR-0205. Samples were collected from each well in zones that had one or more of the following: (1) higher than background photoionizer readings during drilling, (2) higher than background radiation readings during drilling, (3) zones of higher moisture content, (4) located within 12.2 m (40 ft) of the water table (3 from each well), and (5) high silt and clay content. The results from analysis of these samples were substantially similar to those results presented in WHC-MR-0204. All results for all constituents were at least two orders of magnitude below the potential preliminary remediation goals (PRG) established in the DQO.

- WHC-SD-EN-TI-290, *Geologic Setting of the Low-Level Burial Grounds*, describes regional and site-specific geology for the LLBGs. It incorporates data from boreholes across the entire 200 Areas, integrating the geology of this area into a single framework. Geologic cross-sections, isopach maps, and structure contour maps of all major geologic units are presented. The physical properties and characteristics of the major suprabasalt sedimentary units are described.

3.3.1 200-SW-1 Operable Unit (Nonradioactive Dangerous Waste Landfill and 600 Area Central Landfill)

This subsection summarizes the known information regarding the nature and extent of contamination in the 200-SW-1 OU landfills.

BHI-01115 reports volatile organics in low concentrations in soil-gas samples collected in 1993 and 1997. Concentrations reported in Appendix D are the maximum reported at shallow and deep concentrations for each sampling event and are reported in parts per million by volume.

WHC-SD-EN-DP-064, *Data Package for Geophysical Investigation of Nonradioactive Solid Waste Landfill (NRDWL)*, contains survey data obtained with electromagnetic induction (EMI) instruments and ground-penetrating radar (GPR).

FS0419, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, June 25, 2001*, summarizes quarterly volatile organic analyses from samples collected at the 600 CL, adjacent to the NRDWL. All reported values are at or below 1.0 ppmv.

FS0438, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, October 18, 2001*, and FS0473, *Data Package Summary Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, March 4, 2001*, summarize quarterly soil-gas and methane monitoring conducted at the 600 CL. All values reported in this survey are at or below 1.02 ppmv for all constituents monitored.

FS0508, *Data Package Summary Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, July 8, 2002*, and FS0529, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, July 10, 2002*, summarize quarterly soil-gas and methane monitoring conducted at the 600 CL. All values reported in this survey are at or below 1.0 ppmv for all constituents monitored.

FP0015, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Sampling, September 17, 2002*, summarizes quarterly soil gas and methane monitoring conducted at the 600 CL. All values reported in this survey are at or below 1.09 ppmv for all constituents monitored. The various references differ on their interpretation of contaminant sources. DOE/RL-96-81 indicates that volatile organic contamination primarily is attributed to the 1100 Area vehicle maintenance catch-tank liquids disposed to liquid trenches in the 600 CL. BHI-01115 associates contaminants with the chemical trenches in the eastern half of NRDWL.

3.3.2 200-SW-2 Operable Unit

The following subsections summarize the known information regarding the nature and extent of contamination in the 200-SW-2 OU landfills. This information resulted from field-sampling activities that took place as part of the Phase I-A DQO process, as well as other projects including the TRU waste-retrieval project, characterization of the 200-PW-1 OU, and the Central Plateau Ecological Risk Assessment. Much of the sampling activities were guided by the historical records review that occurred before and during the Phase I-A DQO process. The field-sampling activities in Phase I-A employed nonintrusive sampling and surveying techniques. The detailed results of these investigations are provided in Appendix D of this RI/FS work plan.

Additional field-sampling activities are planned, as part of the TRU retrieval project, after trench segments are emptied of waste. "Opportunistic" sampling also will be conducted, as appropriate, in cooperation with the TRU retrieval project, to obtain insights into wastes adjacent to the waste being retrieved. As sample data become available, the data will be collected and incorporated into future revisions to this RI/FS work plan and the RI report.

3.3.2.1 Organic-Vapor Sampling

The organic-vapor sampling presented in this section applies to out-of-scope TRU waste that will be retrieved as part of the Tri-Party Agreement M-091 Program. However, as requested by Ecology, these data will be integrated into this RI/FS work plan and the RI report and will be evaluated during the FS process to determine their applicability to the overall characterization of the 200-SW-2 OU landfills.

Sampling for organic vapors has been performed in landfills containing vent risers that extend from just above the bottom of the landfill trench to above the landfill surface. Vent-riser sampling has been performed in the 218-W-3A, 218-W-4B, and 218-W-4C Landfills.

Additional organic-vapor sampling was conducted by the 200-PW-1 OU team to characterize the dispersed CCl_4 vadose-zone plume and the M-091 Program to characterize soil vapors potentially generated from buried retrievably stored waste. A few reference sources present information on analytical results from characterization of the dispersed CCl_4 vadose plume and M-091 Program characterization activities. These characterization activities include vent-riser sampling, passive soil-vapor sampling, soil-vapor sampling in the vadose zone, and soil-vapor extraction (SVE) sampling. These references are briefly summarized as follows.

- SGW-33829, *200-PW-1 Operable Unit Report on Step II Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose-Zone Plume*, summarizes the sampling methodology and the analytical results from the Step II RI of the 200-PW-1 OU dispersed CCl_4 vadose-zone plume. The Step II RI was conducted between August 2003 and October 2006. Characterization was performed in accordance with Appendix D of DOE/RL-2001-01, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*. The Step II investigation of the 218-W-3A Landfill included a passive soil-vapor survey of two trenches and vapor sampling of all existing vent risers in engineered trenches in the landfill. The most recent sampling events are summarized in the following sections. Analytical data can be found in Appendix D of this RI/FS work plan.

- In the 218-W-4C Landfill vent riser, sampling was initiated on October 15, 2003, by the M-091 Program, in accordance with DOE/RL-2003-48, *218-W-4C Burial Ground Sampling and Analysis Plan*. Eighty-nine vapor samples were collected in Tedlar[22] bags or SUMMA[23] canisters between October 15 and October 22, 2003. The vapor samples in Tedlar bags were analyzed for CCl_4 using field-screening instruments.

- An SVE system was operated at Trench 4 from November 2003 through April 2004. The SVE system was operated to remove CCl_4 from the landfill trench to minimize release to the environment. Sample results associated with the SVE system are documented in WMP-26178, *Performance Evaluation Report for Soil Vapor Extraction Operations at the 200-PW-1 Carbon Tetrachloride Site, Fiscal Year 2004.*

- CP-13514, *200-PW-1 Operable Unit Report on Step I Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose Zone Plume*, summarizes the results of the Step I investigation for the 200-PW-1 OU, located in the 200 West Area. The results of the 200-PW-1 OU RI are summarized in DOE/RL-2006-51, *Remedial Investigation Report for the Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units.*

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[22] Tedlar is a registered trademark of E. I. du Pont de Nemours and Company, Wilmington, Delaware.

[23] SUMMA is a trademark of Moletrics, Inc., Cleveland, Ohio.

Soil-vapor sampling and analysis was used to explore the upper vadose zone in the vicinity of the Plutonium Finishing Plant. Relatively high concentrations of CCl_4 (maximum 1,760 ppmv) were detected within the east end of Trench 4 in the 218-W-4C Landfill in May 2002. Further detail of sampling events are summarized in Subsection 3.3.3.3. Analytical data can be found in Appendix D of this RI/FS work plan.

3.3.2.1.1 218-W-3A Landfill

In 2005, the vent risers in the 218-W-3A Landfill were sampled in accordance with DOE/RL-2001-01, Appendix D, Table D-1, for concentrations of volatile organic compounds, as part of Step II of the RI of the CCl_4 vadose-zone plume. The 2005 vent-riser samples were collected near the base of the trench, which typically is approximately 5 m (16 ft) below the engineered surface overlying the trench. Vapor samples from the 17 vent risers present in portions of trenches 9S, 3S, 05, and 08 were collected and analyzed using field-screening instruments. All of the vent risers in trenches 9S (1 riser), 3S (3 risers), and 05 (6 risers) were sampled in August 2005, and all of the vent risers in trench 08 (7 risers) were sampled in September 2005. A sample location number (trench and riser) was established and recorded for each vent riser. The vent risers in each trench were numbered sequentially from west to east. The only concentrations of CCl_4 (5 to 36 ppmv) were detected in the western part of trench 08 (SGW-33829). Trench 08 also had elevated levels of tetrachloroethene (PCE) (20 to 460 ppmv), 1,1,1-trichloroethane (1.4 to 18.8 ppmv), and methyl chloride (21 to 186 ppmv).

Sampling of the vent risers in portions of the 218-W-3A Landfill trenches containing retrievably stored waste was required by DOE/RL-2004-71, *218-W-3A Burial Ground Sampling and Analysis Plan*. Nine of the 17 vent risers (2 in Trench 05 and 7 in Trench 08) also were sampled for the 218-W-3A Landfill environmental release investigation. DOE/RL-2004-71 required field screening plus additional analysis of vapor samples in the laboratory. All of the vent risers were sampled once for field screening during the sampling for the 200-PW-1 OU RI. For the risers covered by DOE/RL-2004-71, additional sampling was conducted for laboratory analysis (SGW-33829).

SUMMA canister samples for laboratory analysis were collected from vent risers T-05-02, T-08-03, and T-08-05 in September 2005. A duplicate SUMMA canister sample was collected from vent riser T-08-05. Based on the field screening, the vapor samples from vent risers T-05-02 and T-08-03 contained the highest volatile organic compound concentrations in trenches 05 and 08, respectively. An additional SUMMA canister sample and a duplicate sample were collected from vent riser T-08-05. The additional and duplicate SUMMA canister samples were collected from a vent riser with slightly lower volatile organic compound concentrations to reduce the potential that the highest volatile organic compound concentrations would exceed calibration standards and make the duplicate analysis of little value. Based on the laboratory analysis, the sample from vent riser T-08-03 contained the highest concentration of perchloroethylene. During field screening, the highest concentration of perchloroethylene also was detected in the sample from vent riser T-08-03 (SGW-33829).

Field-screening and SUMMA-canister laboratory results (SGW-33829) for the vapor samples collected through the vent risers in the 218-W-3A Landfill trenches are provided in Appendix D. These results also are entered in HEIS.

3.3.2.1.2 218-W-4B Landfill

In 2006, the vent risers in trench 07 were sampled in accordance with DOE/RL-2004-70, *218-W-4B Burial Ground Sampling and Analysis Plan*, for concentrations of volatile organic compounds, as part of the environmental release investigation in support of Tri-Party Agreement Milestone M-091-40. The vent risers sampled in 2006 were collected near the base of the trench, which typically is approximately 5 m (16 ft) below the engineered surface overlying the trench. Based on field screening, the highest concentrations were detected in the western portion of trench 7. Seventeen vent risers are present in trench 7 in the 218-W-4B Landfill. Vapor samples were collected from 14 of these vent risers. The other three vent risers could not be sampled in September 2006 because of health and safety risks to workers, based on elevated vapor levels. However, supplemental vapor samples were collected through the three additional existing vent risers in trench 7 and the vertical duct at the west end of trench V7 in November 2006.

SUMMA canister samples for laboratory analysis were collected from vent risers T-07-4 and T-07-6 in September 2006. A duplicate SUMMA canister sample was collected from vent riser T-07-6. Vapor samples from vent riser T-07-4 contained the highest volatile organic compound concentrations, based on field screening, in trench 7. The additional SUMMA canister sample and the duplicate sample were collected from vent riser T-07-6, which had slightly lower volatile organic compound concentrations, to reduce the potential that the highest volatile organic compound concentrations would exceed calibration standards and make the duplicate analysis of little value. A summary of the analytical results (SGW-33829) for vent-riser samples collected in 2006 is provided in Appendix D, Table D-2. These results also are entered in HEIS.

3.3.2.1.3 218-W-4C Landfill

Numerous studies have been conducted at the 218-W-4C Landfill in support of volatile-organics characterization, resulting in a multitude of data sets presented in this section. Information on contamination in the 218-W-4C Landfill is summarized below from CP-16886, *Data Quality Objectives Summary Report for the 218-W-4C Burial Ground Contaminant Release Investigation*, written to develop a sampling design to determine whether contaminants have been released to the vadose zone from retrievably stored waste in the unit.

Groundwater monitoring wells have been installed on the eastern and western perimeters of the 218-W-4C Landfill to comply with RCRA groundwater monitoring requirements. During well drilling along the western perimeter in 1990, CCl_4 was detected in soil and soil-vapor samples (DOE/RL-91-32, *Expedited Response Action Proposal (EE/CA & EA) for 200 West Area Carbon Tetrachloride Plume*).

Vent risers in trenches 1, 4, 7, and 20 were sampled in 1996 for concentrations of volatile organic compounds. All of the vent risers sampled in 1996 showed elevated amounts of several chlorinated volatile organic vapors including CCl_4 and degradation products, trichloroethylene and degradation products, and chlorofluorocarbons. Alcohols, ketones, and aromatic compounds also were detected, but at much lower concentrations (HNF-SD-WM-RPT-309, *Report on Sampling and Analysis of Air at Trenches 218-W-4C and 218-W-5 #31 of the Low-Level Burial Grounds*).

Vent risers in trenches 1, 4, and 7 also were sampled in 2002 for concentrations of CCl_4 to support the 200-PW-1 OU RI (DOE/RL-2001-01). The vent risers sampled for chloroform and CCl_4 in 2002 were collected near the base of the trench, which typically is approximately 5 m (16 ft) below the engineered surface overlying the trench. Carbon tetrachloride was detected at all but one of the 27 vent risers sampled. Most of the detections were less than 10 ppmv, but a distinct "hot spot" (maximum concentration of 1,760 ppmv) was detected at the east end of trench 4. The sample results do not indicate the source of the carbon tetrachloride. The source may be the buried waste or may be the vadose-zone plume in this area. A summary of the CCl_4 and chloroform analytical results (CP-13514) for vent-riser samples collected in 2002 is provided in Appendix D, Table D-3.

Soil-vapor samples for chloroform and CCl_4 were collected from the vadose zone adjacent to trenches 1, 4, and 7 and analyzed for CCl_4 in 2002 as part of the 200-PW-1 OU investigation (CP-13514). The analytical results are provided in Appendix D, Table D-5. Carbon tetrachloride was detected in soil-vapor samples collected along the east end of trench 4, near the location of vent risers at which elevated concentrations of CCl_4 were detected in 2002 (CP-13514). Three temporary soil-gas probes were installed near trench 4 and sampled between 2002 and 2004 to confirm the 2002 results. A summary of the CCl_4 and chloroform analytical results (SGW-33829) for the three samples taken between 2002 and 2004 is provided in Appendix D, Table D-4.

The presence of volatile organic compounds in vapor samples collected inside the trenches through vent risers suggests that organic contaminants, in a liquid and/or vapor phase, are able to migrate outside of the waste containers. The CCl_4 in soil-vapor samples collected adjacent to trench 4 appears to have resulted from release of CCl_4 from the waste containers (CP-13514). Specifically, the range of CCl_4 and chloroform detected in soil gas for this landfill from vadose-zone samples reported in CP-13514 for August 2002 is provided in Appendix D.

In 2003, the vent risers were sampled again in trenches 1, 4, 7, 20, and 29 for concentrations of volatile organic compounds, in addition to CCl_4 and chloroform, as part of the environmental release investigation in support of M-091-40 (DOE/RL-2003-48). This sampling included samples for field screening and samples in SUMMA canisters for laboratory analysis. A summary of the volatile organic compound analytical results for vent-riser samples collected in 2003 is provided in Appendix D, Table D-6 (04-AMCP-0321, "Transmittal of the Burial Ground Sampling and Analysis Results for January – March 2004"). Additional results were collected in 2006 (07-AMCP-0166, "Burial Ground Sampling and Analysis Results for October – December 2006"). These results are entered in HEIS.

Passive soil-vapor sampling also was performed in the unused annex of the 218-W-4C Landfill in support of the Central Plateau Ecological Risk Assessment. Artificial animal burrows were created in twelve locations in the unused annex of this landfill. Passive soil-vapor samplers were placed in the artificial burrows. The artificial burrows were sampled using SUMMA canisters (D&D-32015, *Sampling and Analysis Instruction for Artificial Animal Burrows, in Support of the Central Plateau Ecological Risk Assessment*).

3.3.2.2 Phase I-A Field-Sampling Activities

The Phase I-A DQO summary report (D&D-27257), and sampling and analysis instruction (D&D-28283, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*) were prepared in response to agreements made during collaborative discussions that were held between the RL and Ecology in February and March 2005 (Ecology and DOE, 2005) concerning this RI/FS work plan, Draft A. In the collaborative discussions, Ecology and RL agreed to a phased characterization approach with an initial phase focused on additional records research, nonintrusive sampling, and waste-site boundary definition. Nonintrusive sampling techniques used included surface-radiation surveys, passive soil-vapor samples for organic liquids, and geophysical surveys. The following subsections provide a summary-level of detail regarding this sampling.

In contrast to the organic-vapor sampling that was described in Section 3.3.3, the organic-vapor sampling described in Section 3.3.2.2.1 directly applies to in-scope trenches.

3.3.2.2.1 Passive Organic-Vapor Sampling

This section presents descriptions and results of the passive organic-vapor sampling that was performed during the months of June and July 2006 in support of the 200-SW-2 OU characterization. The purpose of this section is to provide an overview of the organic-vapor sampling process and present a summary of the laboratory results. Sampling results are presented in Appendix D, Tables D-7 through D-11.

Information on the passive organic-vapor sampling conducted in support of the 200-SW-2 OU characterization is provided in SGW-32683, *Results from Passive Organic Vapor Sampling, Performed in Selected 200-SW-2 Operable Unit Landfills (218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, and 218-W-5) in June-July 2006*. SGW-32683 summarizes the sampling methodology and the organic-vapor sampling process and presents a summary of the laboratory results. The rationale for selection of the specific sampling locations is more fully described in, and driven by, D&D-28283.

More than 150 passive organic-vapor samples were collected from selected segments of burial trenches in the 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, and 218-W-5 Landfills, located in the Hanford Site 200 West Area. In accordance with the approved sampling and analysis instruction (D&D-28283), the sampling locations either were target/individual spots above a single/known burial in a given trench or were placed at targeted locations within a specific segment in a given trench. Survey coordinates were preestablished for each isolated sample location and each location within a trench segment. Sample coordinates were established along the centerline of a given trench; samples coordinates within a trench segment were established at a distance not to exceed approximately 10 m (30 ft). The specific sampling locations were chosen based on detailed reviews of engineering drawings, historical documents, and waste-burial-record information located in the SWITS database. Specific trench locations were sampled if the historical records indicated a presence of liquid organic wastes or liquids that might be organic (but that did not include enough information to conclude whether a liquid was or was not an organic liquid). Samples were analyzed for the presence of 28 organic compounds identified to be COPCs.

Laboratory data revealed that 14 of the 28 compounds were detected at levels above the laboratory's practical quantitation limit (25 ng per sample). One or more of the 28 organic COPCs were noted at 59 of the 151 total sample locations at levels greater than 25 ng per sample.

Organic compounds with elevated readings include CCl_4 maximum of 87,204 ng; tetrachlorethene maximum of 145,911 ng; trichlorethene maximum of 846 ng; 1,1,1-trichlorethane maximum of 21,153 ng; 1,1-dichlorethane maximum of 4,025 ng; 1,1-dichlorethene maximum of 2,712 ng; 1,2-dichlorethane maximum of 1,980 ng; chloroform maximum of 9,370 ng; and 1,1,2-trichloro-1,2,2-trifluoroethane maximum of 13,788 ng.

3.3.2.2.2 Radiological Surveys

This section summarizes the results of nonintrusive radiological soil measurements performed on a small area that straddles the 218-E-2 and 218-E-5 Landfills in the 200 East Area. The radiological soil measurements performed were used to evaluate landfill conditions and to support conceptual site models for the 200-SW-2 OU. In addition, this section briefly discusses the Mobile Surface Contamination Monitor (MSCM) technique used annually in the past-practice landfills to detect surface contamination.

Information on the nonintrusive radiological soil measurements performed in support of the 200-SW-2 OU characterization is presented in PNNL-00157, *Soil Measurements at 218-E-2 and E-5 Burial Grounds*. PNNL-00157 summarizes sampling methodology, sample locations, and results of the soil measurements in the 218-E-2 and 218-E-5 Landfills. In addition, this report includes measurement data, spectrum analysis results, and other supplemental information. The most recent sampling events are summarized in this section. Survey data can be found in Appendix D, Table D-12.

In September 2006, radiological soil measurements at the 218-E-2 and 218-E-5 Landfills were performed in support of the 200-SW-2 OU nonintrusive characterization. Eight survey locations (hot spots) were selected for further radiological soil measurements in and around the two landfills, based on previously collected MSCM data. The MSCM, consists of an array of plastic gamma scintillators with an electronics package that is combined with a differential corrected Global Positioning System and a computerized Geographic Information System/data storage package mounted on a large tractor.

With the results of the MSCM surveys, each of the eight (hot-spot) locations was staked in the field. Areas around and within an approximate 1.8 m (6 ft) radius of each stake were surveyed with a micro-rem and Geiger-Müller[24] counter to determine whether any of the eight hot-spot targets should be repositioned to represent a location of even higher gamma signal. No variation in strength was detected. Also, no surface contamination was found. Results of the surveys are presented in Appendix D.

[24] Geiger-Müller is not a trademark.

3.3.2.2.2.1 Field Measurements

The actual field measurements were conducted on September 13, 2006. Measurements 30 minutes long were performed at all eight locations marked with stakes. Measurements at all locations were performed under the same conditions. In addition to the predetermined eight locations, a few additional measurements were performed in other impromptu-selected locations. One extra 30-minute-long measurement was performed for verification purposes right after the measurement at location 1 showed lower radiation intensity, because it was expected to be the hottest spot. Three 10-minute-long measurements anticipated to be used as "background" were conducted in addition to the eight 30-minute-long measurements and one extra 30-minute-long measurement.

3.3.2.2.2.2 Results

All gamma spectra collected showed a presence of various-intensity Cs-137 peaks, accompanied with multiple peaks originated from prominent naturally occurring radionuclides. Considering uniform distribution of the naturally occurring nuclides in the soil, the analysis of the gamma spectra to estimate their concentrations was performed separately from that of Cs-137 activity. The analysis results showed that the gamma-spectra concentration appears to be the same in all measurement locations.

Although no data are available on Cs-137 contamination distribution in soil, the historical records indicate that a large contamination incident was associated with these two landfills or neighboring landfills in April 1961 (UPR-200-E-30). Also, it is reasonable to assume that animal intrusion is a possible cause of contamination spread in the general area. Further, it is known that the area was covered with 0.3 m (1 ft) of clean soil in 1979/80.

Transmission of Cs-137 gammas of 661.6 keV through a 0.3 m (1-ft-) thick layer of soil with a density of 1.7 g/cm^3 is less than 2 percent of the total amount of gamma present. It may be assumed that the cesium contamination is very close to the surface. Therefore, the following models were accepted to generate detector efficiency curves and quantify the Cs-137 concentration.

- First Model: The contamination layer was assumed to be 15 cm (6 in.) thick, lying 0.3 m (1 ft) deep under clean uncontaminated soil.
- Second Model: The contamination layer 15 cm (6 in.) thick is right on the top.

As the results indicate, a consideration of 0.3 m (1 ft) of soil as an absorber results in the increase in concentration values of approximately two orders of magnitude. In addition, measurement results (Appendix D) indicated that locations 1 and 4 show the lowest concentration values that are independent on the model used for analysis, in contrast to what was expected based on MSCM data. Also, Cs-137 concentration value for location 9 is statistically the same as that determined for location 1. Both of these facts may imply that "hot spots" identified by MSCM data might not be located at the staked locations. Thus, two conclusions can be derived from the measurement results.

- Because anticipated hot spots, identified based on MSCM data, contradict the relative results obtained during these measurements, no correlation can be applied to characterize the whole area.
- Cesium contamination appears to be close to the surface and probably not directly related to the landfills. It may be caused by some radiological accident and/or related animal intrusions. There is no information about the contamination distribution, and therefore it is difficult to model and quantify the measurements.

3.3.2.2.3 Geophysical Investigations

This section summarizes the results of two geophysical investigations that were conducted as part of the Phase I-A DQO process for the 200-SW-2 OU. Results of the investigations also are depicted in the initial conceptual site models (CSM) in Appendix E of this RI/FS work plan.

The following two references present information on the geophysical investigations performed in support of the 200-SW-2 OU characterization and are briefly summarized.

- D&D-28379 documents the first phase of geophysical investigations performed at eight landfills in August and September 2005. Data from the first phase of geophysical investigations indicated that three of the eight landfills investigated (the 218-E-2A, 218-E-8, and 218-W-11 Landfills) may have areas where the burial trenches extend beyond the areas initially surveyed.
- D&D-30708 documents the second phase of geophysical investigations performed in June 2006 at eight landfills. The second phase of geophysical investigations was designed to resolve the potential trench boundary discrepancies identified in the first phase (D&D-28379). In addition, new geophysical investigations were performed at five older/inactive landfills the 218-E-1, 218-E-12A, 218-W-1, 218-W-2, and 218-W-3 Landfills).

The most recent sampling events for the 2005 and 2006 geophysical investigations are summarized in the following subsections. The geophysical surveys for both investigations were reconnaissance-type surveys that were aimed at defining the following characteristics:

- Locations of landfill trench edges, ends, and centerlines
- Locations of buried waste or other significant features/anomalies
- Presence and extent of voids within a given trench
- Definition of most likely waste-container type (for example, wood, metal boxes, metal drums, cardboard, and/or waste item)
- Differentiation between different types of waste containers within a given trench

- Depth of soil cover above waste items
- Depth to trench bottom (where possible).

Graphical depictions of the geophysical surveys are presented in Appendix D of this work plan.

3.3.2.2.3.1 Geophysical Methods

The geophysical techniques used in the 2005 and 2006 investigations were EMI, total magnetic field (magnetic) methods, and GPR. These methods were selected because they are cost effective and nonintrusive and have been successful in similar waste-characterization projects conducted at the Hanford Site.

The selected geophysical-survey methods are capable of recording accurate and precise quantitative measurements when used in accordance with manufacturer's recommendations and procedures. However, the final results are based on the subjective interpretation and understanding of the data by trained and qualified geophysicists. The ultimate test of accuracy can be validated through excavation/drilling or surveys of sites with known contents and locations. Future phases of geophysical surveys may address portions of landfill trenches with good burial records and provide a degree of "ground truthing" and calibration under Hanford Site conditions. Furthermore, a geophysical-survey instrument-calibration facility exists at the Hazardous Materials Management and Emergency Response Facility and can be used to perform instrument calibrations, as necessary.

Several factors can affect the reliability of the interpretations. These factors generally fall into two groups. One group is independent of the geophysicist and includes soil conditions, topography, accuracy of existing site drawings, and "cultural" interferences from metallic objects not intended for detection (e.g., fences, buried pipelines, buried electrical cable). The second group of factors is more dependent on the geophysicist and project goals and includes skill of the data interpreter, experience in the survey area, and density of the data.

The following summarizes each of the geophysical techniques.

3.3.2.2.3.1.1 Frequency-Domain Electromagnetic Induction

The frequency-domain EMI instrument used is designed to measure the apparent electrical conductivity of soil and to detect ferrous and nonferrous metal objects to a depth of approximately 3 to 4 m (in ideal situations).

3.3.2.2.3.1.2 Total Magnetic Field / Vertical Gradient

A magnetometer measures the intensity of the earth's magnetic field. The presence of ferrous material, man-made or natural, creates local variations in the strength of the earth's overall magnetic field.

3.3.2.2.3.1.3 Ground-Penetrating Radar

GPR uses a transducer to transmit frequency modulation electromagnetic energy into the ground. Interfaces in the ground, defined by contrasts in dielectric constants, magnetic susceptibility, and, to some extent, electrical conductivity, reflect the transmitted energy. The GPR system then measures the travel time between transmitted pulses and the arrival of reflected energy. Buried objects (such as pipes, barrels, foundations, wires) can cause all or a portion of the transmitted energy to be reflected back toward a receiving antenna.

3.3.2.2.3.2 Geophysical Investigation Results – August and September 2005

Eight landfills (listed below) were surveyed in August and September 2005. The geophysical survey results are summarized in the following subsections:

- 218-W-1A Landfill
- 218-W-2A Landfill
- 218-W-11 Landfill
- 218-C-9 Landfill
- 218-E-2A Landfill
- 218-E-5 Landfill
- 218-E-5A Landfill
- 218-E-8 Landfill.

3.3.2.2.3.2.1 218-W-1A Landfill

This landfill contains a large number of small, scattered shallow anomalies that confound the interpretation of distinct burial trenches in the GPR data. For this reason, concentrations of buried debris are inferred primarily from EMI and magnetic data. Although no distinct trench boundaries are evident in the geophysical data, the pattern of anomalies in the EMI and magnetic data agree somewhat with the locations and orientations of trenches/pits shown on Hanford Site Drawing H-2-2516. No geophysical evidence was detected for one trench (5A) shown on this drawing. Additional trenches/pits were detected that were not on the drawing.

3.3.2.2.3.2.2 218-W-2A Landfill

The geophysical data indicate that there are burial trenches at most of the locations shown for trenches on Hanford Site Drawing H-2-32095. There is no geophysical evidence for buried waste at some of the trench locations shown on the drawing. One burial trench was interpreted in the geophysical data at a location that was not indicated on the drawing (Trench A, see below). Most of the debris or objects in the trenches have a ferrous metal content; some have a significant ferrous content. More specific details are listed below for the trenches as depicted on Hanford Site Drawing H-2-32095:

- **Trench 1** – A northwest-southeast trending trench that is located in southwest corner of the landfill. The trench location correlates well with its location shown on site drawings

- **Trenches 2, 9, 25, and 26** – There was no geophysical evidence of a trench in this location

- **Trench 3** – This is the southern-most east-west trending trench that was identified in the investigation. The trench location correlates well with its location shown on site drawings

- **Trenches 4 - 10, and 20 - 24** – These are east-west trending trenches that correlate well with their locations shown on site drawings
- **Trenches 11 - 15** – Parallel the west side of the railroad tracks. The geophysical data indicate that buried debris extends roughly 100 m further to the south than shown on site drawings
- **Trench 16** – The only trench documented as being located on the eastern half of the railroad tracks
- **Trench 17 - 19** – No trenches with these numbers are shown on site drawings
- **Trench 27** – At this trench location, GPR data indicate a relatively short, irregular excavation at the eastern end, and another section on the western edge of the landfill that does not line up with the first section
- **Trench A** – An undocumented trench that parallels the west side of the railroad tracks in the southeast corner of the landfill.

3.3.2.2.3.2.3 218-W-11 Landfill

The geophysical data indicate that the investigation area contains two concentrations of buried debris or objects. The locations of the interpreted trenches/pits coincide reasonably well with the location of the northernmost of the two trenches shown on Hanford Site Drawing H-2-94250. There is no geophysical evidence of the other trench shown in the drawing. A small amount of data was collected immediately north of the investigation area that indicates that multiple burial trenches/pits are located in this area. However, the buried debris within this area was not fully mapped or characterized. Additional geophysical surveys were performed on this area and are discussed in Section 3.4.2.3.21.

3.3.2.2.3.2.4 218-C-9 Landfill

The geophysical data indicate that this landfill does not appear to contain large, continuous concentrations of buried objects or debris in well-defined trenches or pits. Several large metallic objects or concentrations of smaller metallic debris are buried in several somewhat-discrete locations across the landfill, primarily through the center and southwestern portion of the landfill. No Hanford Site drawing was located for the 218-C-9 Landfill.

3.3.2.2.3.2.5 218-E-2A Landfill

The geophysical data indicate that there is a single burial trench at this landfill with a series of isolated objects and/or a number of groups of smaller objects with relatively clean fill in between. GPR data were not successful at detecting all of the buried debris/objects whose presence is interpreted from the EMI and magnetic data.

3.3.2.2.3.2.6 218-E-5 and 218-E-5A Landfills

The 218-E-5 and 218-E-5A Landfills are contiguous and were investigated as a single landfill. The data indicate that there are two trenches in the 218-E-5 Landfill and one in the 218-E-5A Landfill, which is consistent with Hanford Site Drawing H-2-55534. The following is a discussion of each of these landfills.

Two trenches are documented in the 218-E-5 Landfill, as shown on Hanford Site Drawing H-2-55534. The geophysical data show a trench that is roughly the same length and width as trench 2 shown on the drawing. However, the center of the trench appears to be roughly 20 m to the west of its documented location. In the eastern half of the landfill, a second trench was detected that correlates well with the documented location of trench 3 shown on Hanford Site Drawing H-2-55534.

The geophysical data for the 218-E-5A Landfill indicate that it is an oblong-shape trench or pit containing a significant amount of metallic debris or objects. The location correlate well with the location shown on Hanford Site Drawing H-2-55534.

3.3.2.2.3.2.7 218-E-8 Landfill

The geophysical data for this landfill show no clear indications of any distinct trenches or large concentrations of buried debris. Most of the landfill shows a scattering of anomalies of variable concentrations. Most anomalies appear to be from buried debris, but some may represent changes in the character of the soil.

3.3.2.2.3.3 Geophysical Investigation Results - June 2006

Eight landfills were surveyed in June 2006. The geophysical survey results are summarized in the following subsections:

- 218-E-1
- 218-E-2A
- 218-E-8
- 218-E-12A
- 218-W-1
- 218-W-2
- 218-W-3
- 218-W-11.

3.3.2.2.3.3.1 218-E-1 Landfill

The geophysical data indicate that the 218-E-1 Landfill contains 15 trenches, with variable amounts of metallic material contained in each. The buried material does not appear to be continuous throughout the entire length of most trenches. Based on Hanford Site Drawing H-2-00124, the original landfill includes 15 trenches, which correlates with the geophysical data.

3.3.2.2.3.3.2 218-E-2A Landfill

The investigation conducted in the 218-E-2A Landfill was an expansion of the area covered in the first phase of geophysical investigations (D&D-28379). Results of the previous investigation appeared to show anomalies extending beyond the edge of the landfill boundary to the west. The newly collected EMI and magnetic data show no anomalies of significance west of the western boundary of the landfill. Hanford Site Drawing H-2-55534 indicates one east-west-oriented trench in the 218-E-2A Landfill. The geophysical data indicate a large buried object that is located just inside the landfill boundary. This caused the anomaly that appears to extend beyond the western edge of the landfill. No buried debris or objects are interpreted to be west of the landfill boundary.

3.3.2.2.3.3.3 218-E-8 Landfill

The investigation conducted in the 218-E-8 Landfill was an expansion of the area covered in the first phase of geophysical investigations (D&D-28379). The geophysical data collected in the expansion area, immediately east of the 218-E-8 Landfill boundary, indicate that there are buried objects and/or debris outside of the marked landfill. Near the landfill boundary is one buried object (or concentration of smaller objects) that may be associated with the landfill.

A significant pit of buried debris, not fully characterized by this investigation, was located approximately 60 m east of the landfill. In addition, EMI data strongly indicate a buried utility along the northern boundary of the investigation area, although this was not corroborated by any other method or on any engineering drawings.

3.3.2.2.3.3.4 218-E-12A Landfill

The ability to locate and map trenches at the 218-E-12A Landfill in the 200 East Area was heavily influenced by the width of the trench, the type of waste that is buried in the trench, and the changing soil conditions. Fifteen trenches were documented as containing dry waste in Hanford Site Drawing H-2-32095. Pockets of debris were located and mapped in each of the dry-waste trenches. In all of the dry-waste trenches, concentrations of metallic waste were identified. Because of the depth of burial of the debris in trenches and the marginally favorable soil conditions, it is assumed that there is more debris in the trenches than was detected in the data. Each of the following trenches was identified and mapped with the geophysical data:

- Dry Waste Trenches - 1, 2, 3, 12, 13, 14, 17, 18, 19, 20, 21, 22, 23, 24, and 25.

The remaining 13 trenches are documented as containing acid-soaked material and are shown on Hanford Site Drawing H-2-32560. All of the acid-soaked material trenches are documented as being in the eastern half of the landfill, where the soil conditions are least favorable to GPR. There are a few pockets of anomalies; they may fall within a trench but also might be scattered surface debris that is unrelated to a trench. This suggests that most of the debris in these apparently narrow, shallow acid-soaked material trenches is nonmetallic. Each of the following trenches was identified and mapped with the geophysical data:

- Acid-Soaked Material Trenches - 4, 5, 6, 7, 8, 9, 10, 11, 15, 16, 26, 27, and 28.

3.3.2.2.3.3.5 218-W-1 Landfill

The geophysical data for the 218-W-1 Landfill indicates pockets of debris in each of the identified trenches. Discrete concentrations of metallic waste were identified in most of the trenches. Nonmetallic waste is interpreted to be mixed with the metallic waste. Most of the trenches were clearly evident in the data, with the exception of Trenches 1, 1A, 4A, and 6. Based on Hanford Site Drawing H-2-75149, and given the proximity of the trenches in the 1 through 6 series, it is quite possible that a trench could have been constructed and not be apparent in the geophysical data.

Three east-west-oriented trenches were identified that are not shown on Hanford Site Drawing H-2-75149. They are north of the northernmost trench shown on the drawing (Trench 9) and south of the 218-W-11 Landfill. They have a character similar to that of the other trenches in the 218-W-1 Landfill. Additionally, two pit-like areas not shown on the drawing also were identified in this northern area; one of the pits has significant metallic content.

3.3.2.2.3.3.6 218-W-2 Landfill

All 20 of the trenches shown on Hanford Site Drawing H-2-02503 for the 218-W-2 Landfill were clearly evident in the geophysical data. The geophysical data indicate that pockets/zones of debris are located and mapped in each of the identified trenches. Discrete concentrations of metallic waste were identified in most of the trenches.

3.3.2.2.3.3.7 218-W-3 Landfill

Hanford Site Drawing H-2-32095 shows 20 regularly spaced trenches at this landfill, although a note on the drawing states that centerlines and locations were based on ground indications and judgment after the trenches were filled and covered. In contrast, the geophysical data for the 218-W-3 Landfill indicate that there are approximately 14 east-west-oriented trenches containing varying amounts of metallic debris. In addition, one north-south-oriented trench was interpreted along the eastern edge of the site, although this may be an artifact in the data caused by the gravel road located there. Other than the two southernmost trenches, the interpreted trench locations do not correlate with the locations shown on the drawing. Also, historical logbooks have different trench numbers than the numbers indicated on the drawing.

3.3.2.2.3.3.8 218-W-11 Landfill

As reported in the 2005 geophysical investigation, one trench and one "pit" about 18 m east of the trench, make up the 218-W-11 Landfill. The trench location correlates very well with the trench location identified in Hanford Site Drawing H-2-31268, *Solid Waste Burial Grounds Plot Plan*, and with the northernmost trench depicted in Hanford Site Drawing H-2-94250, which shows two east-west-oriented trenches. The pit is not depicted on any available drawings. Given the quality of the geophysical data at this site, it is believed that the southern trench shown in Hanford Site Drawing H-2-94250 does not exist and that the older Hanford Site Drawing H-2-31268, which shows only one trench at this landfill, is more accurate, although it does not depict the pit.

The 2006 geophysical investigation was an expansion of the area covered in the first phase of geophysical investigations (D&D-28379); the investigation resurveyed the area covered in the 2005 investigation and continued to the area just north of the 218-W-11 Landfill (i.e., toward the southern portion of the 218-W-4A Landfill). The only anomalies located were five trenches that align with those in the southern part of the 218-W-4A Landfill. This second geophysical investigation confirmed the results from the original investigation; the 218-W-11 Landfill most likely contains only one trench and one pit (contrary to the most recent Hanford Site drawing).

3.4 ENVIRONMENTAL MONITORING

This section discusses current environmental monitoring at the Hanford Site Central Plateau. The Central Plateau includes the 200 East Area, 200 West Area, and 200 North (industrial) Area and portions of the largely undisturbed 600 Area. This section also summarizes existing OU-specific environmental information.

Environmental monitoring at the Hanford Site consists of effluent monitoring, environmental surveillance, groundwater monitoring, investigative sampling, and select characterization within the vadose zone. Investigative sampling of air, external radiation, soil, vegetation, and biota is conducted in the 200 Areas as part of the Hanford Site near-facility and environmental monitoring programs. The purpose of the investigative sampling is to confirm the absence or presence of radioactive and/or hazardous contaminants where known or suspected contaminants are present or to verify radiological conditions at specific project sites. Media sampled include air, surface water and sediment, drinking water, food and farm products, external radiation, soil, vegetation, nests (bird, wasp, ant), mammal feces (rabbit, coyote), mammals (mice, bats), and insects (fruit flies). Investigative wildlife samples are used to monitor and track the effectiveness of measures designed to deter animal intrusion. Wildlife-related materials, including nests, carcasses, and feces, are collected as part of the integrated pest-management program or when encountered during a radiological survey. Samples are analyzed for radionuclides and/or other hazardous substances, with disposal contingent on the level of contamination present. Results of investigative sampling are reported in the annual Hanford Site Environmental Surveillance Data Report. The most recent of these annual reports is PNNL-15892, Appendix 1, *Hanford Site Environmental Surveillance Data Report for Calendar Year 2005*. PNNL-15892 covers the entire Hanford Site, including those areas not associated with operations (such as the 600 Area).

Groundwater also is routinely monitored sitewide. More than 600 monitoring wells are sampled annually to characterize groundwater flow, groundwater contamination by metals, radionuclides and chemical constituents, and the area of contamination. Groundwater remediation, ingestion risk, and dose also are assessed. Results of groundwater monitoring and remediation are presented in an annual report, the most recent of which is PNNL-16346.

For purposes of groundwater monitoring, the LLBGs are grouped into four LLWMAs: (LLWMA-1, LLWMA-2, LLWMA-3, and LLWMA-4), described further in Section 3.5. Groundwater monitoring is performed at or near the LLWMAs for past-practice purposes or CERCLA. LLWMA-1 and LLWMA-2, in the 200 East Area, fall within the 200-BP-5 Groundwater OU. LLWMA-3 and LLWMA-4, in the 200 West Area, fall within the 200-ZP-1 Groundwater OU (a small part of LLWMA-4 is technically within the 200-UP-1 Groundwater OU).

PNNL-14859, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, describes the monitoring required under the RCRA as implemented by the State of Washington dangerous waste regulations (WAC 173-303). The plan is revised periodically to reflect the current groundwater-monitoring-well network. Final status monitoring is expected to replace this plan upon incorporation of the LLBGs into the Hanford Facility RCRA Permit (WA7890008967).

Wells are sampled semiannually for indicators of groundwater contamination including pH, specific conductance, total organic carbon, and total organic halides (total organic halogen) as required by 40 CFR 265.92, "Sampling and Analysis." Wells are sampled semiannually for groundwater-quality parameters including chloride, iron, manganese, sodium, and sulfate, and annually for phenols. Annual analysis is the minimum required for these parameters under 40 CFR 265.92. The monitoring frequency for alkalinity, lead, mercury, and polychlorinated biphenyls has been reduced. Dissolved oxygen has been added as a field measurement to provide an indication of oxidation state in the aquifer.

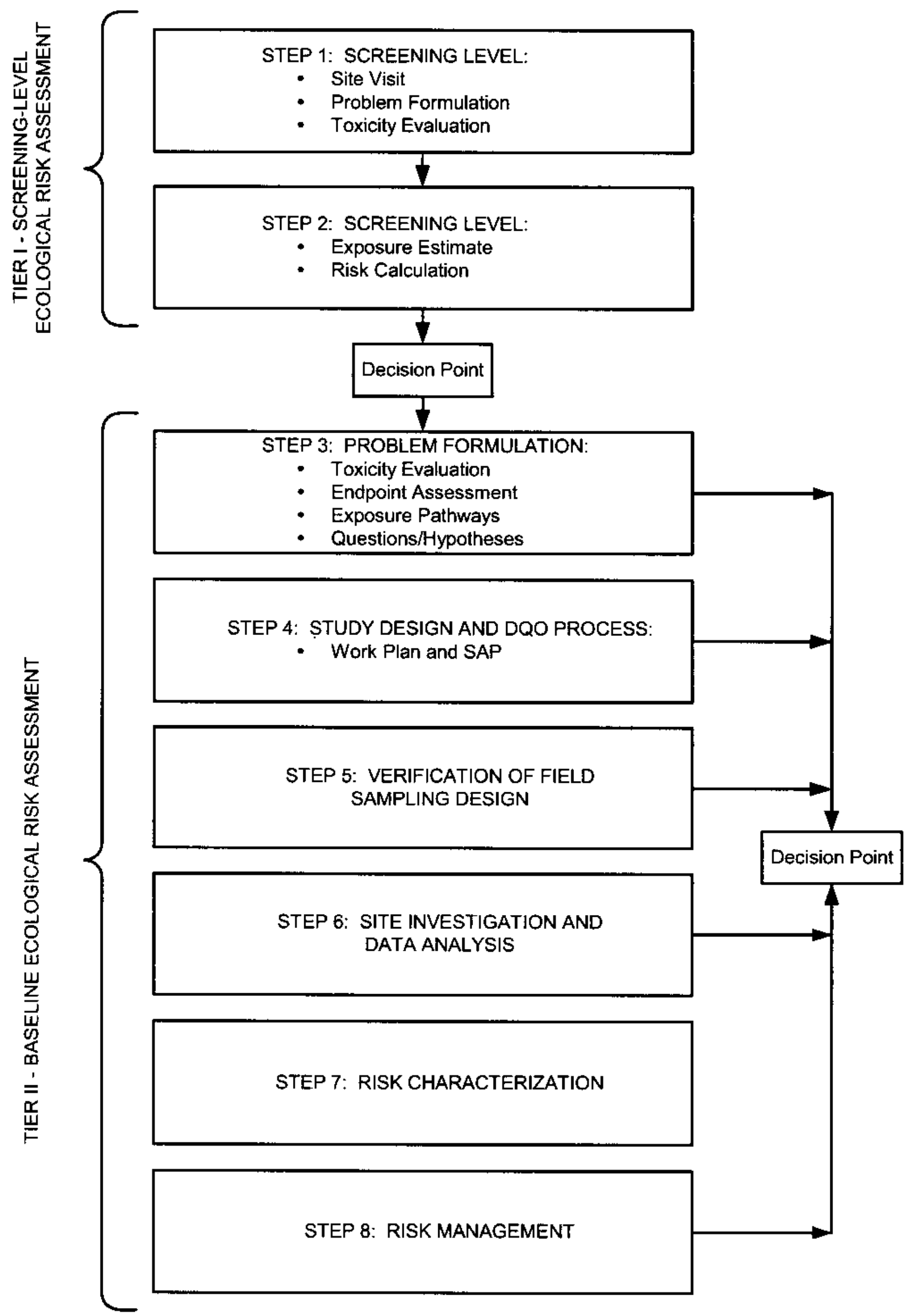
The groundwater beneath LLWMA-1 is impacted by regional contamination. The most significant chemical contaminants identified are nitrate and cyanide from the vicinity of the BY Cribs to the east (and may include some contamination from the B-BX-BY Tank Farms and other nearby cribs). Relatively few regional chemical-contaminant plumes affect the groundwater beneath LLWMA-2. Nitrate contamination is found at levels below the drinking-water standard in several locations and at levels above the drinking-water standard in several upgradient wells. The groundwater beneath much of LLWMA-3 is impacted by contamination from upgradient sources. This contamination includes carbon tetrachloride, chloroform, trichloroethene, and nitrate. LLWMA-4 is affected by regional volatile organic-compound contamination, and the northern part is within the capture zone of the 200-ZP-1 Groundwater OU interim-action pump-and-treat remediation system. Carbon tetrachloride is the major contaminant in the plume, but chloroform, trichloroethene, and tetrachloroethene also are present, along with nitrate contamination.

Detection monitoring at the LLWMAs is hindered by gaps in the well network. Many of the wells previously monitored as part of the RCRA monitoring systems at LLWMA-2, LLWMA-3, and LLWMA-4 have gone dry because of regional declines in water levels. These declines are related to elimination of liquid-waste discharges to the soil column through ponds, ditches, and cribs, and associated reductions in artificial recharge mounds. At LLWMA-2, the water table has declined below the top of the basalt, so replacement wells are not practical. The schedule for installation of new monitoring wells across the site is under the purview of Tri-Party Agreement Milestone M-024. This milestone is reassessed annually.

3.4.1 Ecological Evaluation Report and Terrestrial Ecological Risk Assessment

DOE/RL-2001-54, *Central Plateau Ecological Evaluation*, was prepared to support ecological evaluations under the RI/FS process for Central Plateau waste sites. DOE/RL-2001-54 completes a screening-level ecological risk assessment (SLERA) for the Central Plateau in accordance with the eight-step EPA ecological risk-assessment process presented in EPA 540/R-97/006, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final)*. The first two steps of the process (the screening-level assessment), are shown in Figure 3-1.

Figure 3-1. U.S. Environmental Protection Agency Two-Tier, Eight-Step Ecological Risk-Assessment Process (adapted From EPA/540/R-97/006).



The Central Plateau Ecological Risk Assessment complements several others being performed on the Hanford Site to ensure that human health and ecological risks are properly evaluated in support of remedial-action decision-making. Although originally focused on CERCLA waste sites, the scope of the Central Plateau Ecological Risk Assessment expanded to include the contiguous Central Plateau in the four-phased activity described below:

1. Phase I - Central Plateau CERCLA waste sites (fiscal year 2004)
   - Ecological risk-assessment guidance for Superfund (ERAGS) DQO process for Phase I CERCLA waste sites
   - Sampling and analysis plan development
   - Radiological and Global Positioning System surveys of the Phase I waste sites
   - Soil and biota sample collection and analysis
   - Assessment of West Lake characterization data and additional data quality requirements
2. Phase II - Tank Farms, West Lake, US Ecology Site, and BC Controlled Area (fiscal year 2005)
   - ERAGS DQO process for Phase II waste sites (ultimately focused on the BC Controlled Area)
   - Sampling and analysis plan development
   - Radiological and Global Positioning System surveys of 3-hectare plots in the BC Controlled Area
   - Soil and biota sample collection and analysis
3. Phase III - Nonoperational habitat around the 200 East and 200 West Areas (fiscal year 2006)
   - Validate Phase I and Phase II characterization data
   - Data quality assessment of Phase I and Phase II characterization data
   - ERAGS DQO process for Phase III habitat areas and evaluation of additional data needs for the Phase I and Phase II waste sites
   - Completion of the West Lake DQO
   - Evaluation of the ecological impacts of the 200 West Area dispersed CCl_4 vapor plume on burrowing animals
   - Sampling and analysis plan development
   - Radiological and Global Positioning System surveys of soil sampling areas
   - Soil, water, vapor, and biota sample collection and analysis
4. Phase IV - Final Ecological Risk Assessment (fiscal years 2007-2008)
   - Validate Phase III data
   - Perform data quality assessment on Phase III characterization data
   - Develop final risk-assessment report, including
     - Problem formulation including assessment endpoints
     - Analysis of phase results: exposure and effects information
     - Risk characterization: discuss weight of evidence for each assessment endpoint

- Data quality assessment for the Phase I/II/III data and other relevant studies
- Develop ecological PRGs for the Central Plateau.

The document contains a compilation and evaluation of ecological sampling data that have been collected over many years from undisturbed and disturbed habitats on the Central Plateau. The document describes the habitats on the Central Plateau, including sensitive habitats and the plants and animals that inhabit them. It identifies potential species of concern, including threatened and endangered species and new-to-science species. A detailed survey of the Central Plateau performed in 2000 and 2001 is incorporated into DOE/RL-2001-54, which provides a current, detailed description of the ecological setting of the Central Plateau and augments the ecological information presented in this RI/FS work plan.

DOE/RL-2001-54 helps answer questions about Central Plateau ecological resources that are important to preserve and protect. The document also identifies ecological data needs that can be addressed in future ecological sampling activities on the Central Plateau.

The SLERA in DOE/RL-2001-54 is a conservative evaluation of risk to the ecological receptors that are unique to the Central Plateau from stressors—in this case, introduction of contaminants and habitat elimination. The SLERA identifies pathways for ecological receptors to be exposed to the contamination and evaluates potential risk from those exposures.

This leads to the problem formulation stage of a baseline ecological risk assessment. During problem formulation, the risk managers and others consider the toxicity evaluation, conceptual model exposure pathways, and assessment endpoints to support cleanup decisions. As a result, they are able to better define the initial risks and to determine direction for the DQO process, if needed.

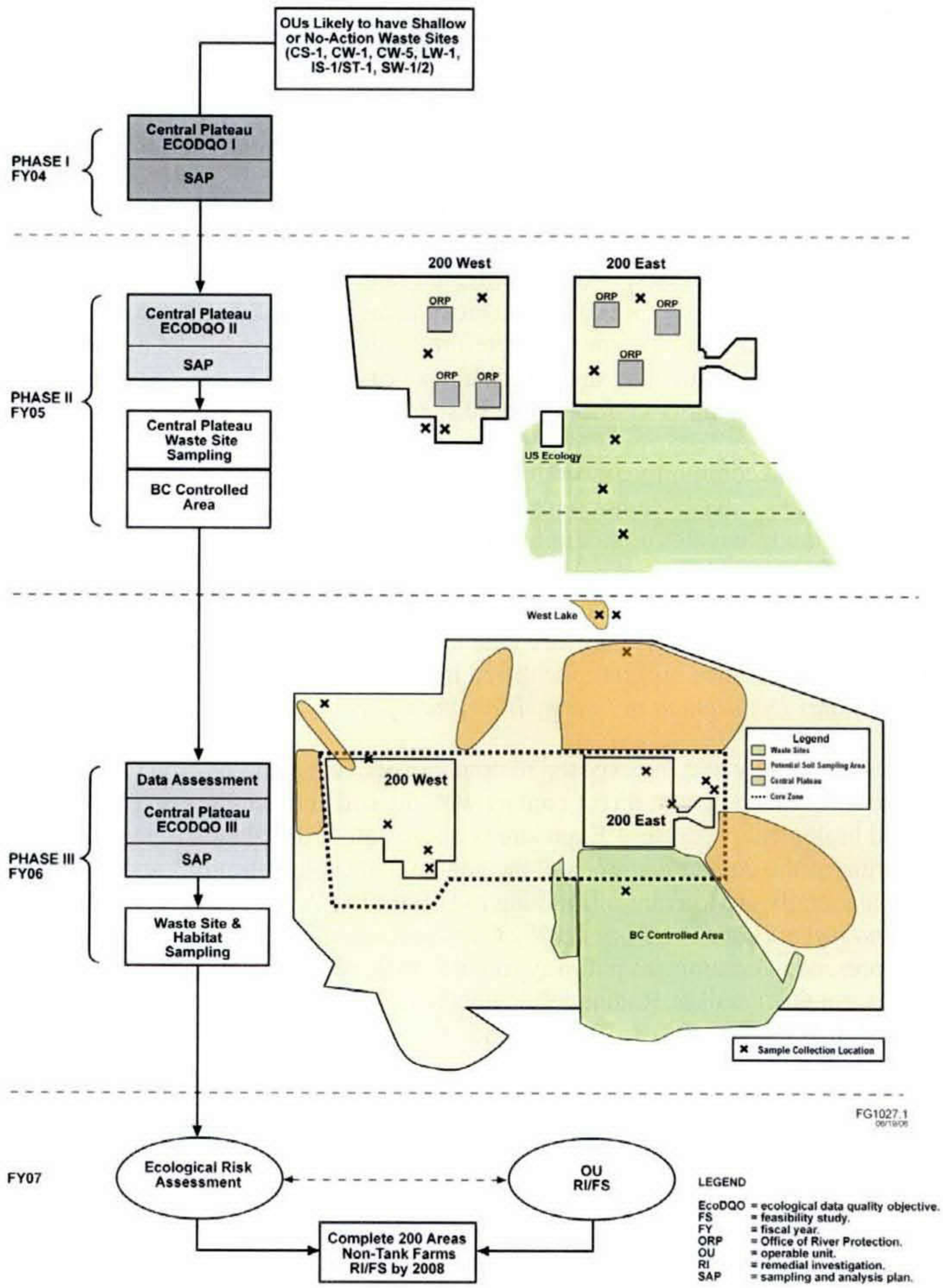
The SLERA in DOE/RL-2001-54 concluded that there were indications of potential risk and uncertainty for several contaminants on the Central Plateau that justified performance of a baseline ecological risk assessment, which would complete the ERAGS process beyond the screening level. This conclusion was supported by RL, the EPA, Ecology, the Hanford Advisory Board, the Hanford Natural Resource Trustees, and public participants, resulting in the Central Plateau Ecological Risk Assessment, which began in July 2003.

The final ecological risk assessment report will support the RI/FS process for the Central Plateau OU FSs with an assessment of the ecological risks and PRGs to be applied to the Central Plateau waste sites. The ecological risk assessment process for the Central Plateau is depicted graphically in Figure 3-2.

3.4.2 200-SW-1 and 200-SW-2 Operable Unit-Specific Environmental Information

A summary of ecological resources for the 200 Areas is provided in Chapter 8.0 of Appendix F of the Implementation Plan (DOE/RL-98-28). Available information pertaining to sampling of vegetation and biota within the 200 East and 200 West Areas is presented in this section to summarize existing ecological data and as input to Section 3.5 on potential impacts to human health and the environment.

Figure 3-2. Phased Central Plateau Ecological Risk Assessment.



Eighty-five environmental monitoring records of wildlife and vegetation at the 200 East and 200 West Areas, collected since 1965, were reviewed and summarized in WHC-MR-0418, *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site*. The report indicates that areas in the vicinity of the LLBG sites were sampled between 1965 and 1993. About 4,500 individual cases of monitoring for radionuclide uptake or transport in biota in the 200 Areas environs were included in the documents reviewed in WHC-MR-0418. Approximately 2,400 samples were collected from near the operations areas, and only about 120 samples (i.e., approximately 5 percent) exceeded radionuclide concentrations of 10 pCi/g. Roughly 2,100 biotic samples were collected during special investigations at known or suspected contaminated sites, and about 1,800 (i.e., approximately 86 percent) exceeded concentrations of 10 pCi/g, indicating that radionuclide contamination has remained relatively localized even though it has spread beyond the intended landfill boundaries. WHC-MR-0418 further states that the routine monitoring is targeted to detect potential radioactive contamination at nuclear facilities and landfills, and the special investigative samples usually are targeted at known incidents of biotic uptake and transport. Therefore, both results are biased toward detection of radioactivity. These radionuclide transport or uptake cases were distributed among 45 species of animals (mostly small mammals), feces, and 30 species of vegetation.

Wildlife species most commonly associated with uptake of radioactive contamination in the 200 Areas historically have been house mice and deer mice, but other animals such as birds (including waterfowl), coyotes, cottontail rabbits, mule deer, and elk have been sampled (WHC-MR-0418; PNNL-15892, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 2005*). Deer, elk, and rabbits are monitored routinely outside the fence in the vicinity of the 200 East and 200 West Areas as part of the Surface Environmental Surveillance program identified in DOE/RL-91-50, *Environmental Monitoring Plan United States Department of Energy Richland Operations Office*.

Plant species potentially may be exposed to contaminated soils and/or groundwater present in the 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 generally are tolerant of ionizing radiation (IAEA 332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*), but potentially present a contaminant pathway to wildlife through the consumption of contaminated seeds, leaves, roots, or stalks. Radionuclide uptake by plants within the 200 Areas was demonstrated in WHC-MR-0418. The vegetative species most commonly associated with the contamination was the Russian thistle.

In a 2001 sampling described in PNNL-13910, *Hanford Site Environmental Report for Calendar Year 2001*, 57 soil samples and 49 vegetation samples were collected in the 200/600 Areas. Soil samples consisted of a composite of five plugs of soil, each 2.5 cm (1 in.) deep, and 10 cm (4 in.) in diameter, from each sampling location. Two sites in the 200-SW-1 and 200-SW-2 OUs were sampled for soil contamination in 2000 and 2001. Perennial vegetation samples consisted of the current year's growth of leaves, stems, and new branches collected from sagebrush and rabbitbrush. Vegetation from two locations in the 200-SW-1 and 200-SW-2 OUs were sampled in 2000 and 2001. Surveillance of perennial vegetation in 1998 generally confirmed observations of past sampling. Radionuclide analysis indicated that Sr-90, Cs-134, Cs-137, and uranium were detectable in soil; Sr-90 and uranium were detectable in vegetation. Fission products were most common in the 200 Areas. Thirty-one sitewide investigative vegetation samples were analyzed for radionuclides in 2001. Of the samples analyzed, 27 showed measurable levels of activity. Eight tumbleweed fragments showed elevated field readings, with five of the eight samples originating from the 218-E-12B Landfill (part of the 200-SW-2 OU) in the 200 East Area (PNNL-13910).

Investigative wildlife sampling was used to monitor and track the effectiveness of measures designed to deter animal intrusion. Wildlife-related materials, including nests, carcasses, and feces, were collected as part of the integrated pest-management program or when encountered during a radiological survey. Samples were analyzed for radionuclides and/or other hazardous substances, with disposal contingent on the level of contamination present. In 2001, five wildlife samples were submitted for analysis. The maximum radionuclide activities in 2001 were in mouse feces collected near the 241-TX-155 Diversion Box (part of the 200-IS-1 OU) in the 200 East Area. Contaminants included Sr-89/90, Cs-137, Eu-154, Pu-238, and Pu-239/240 (PNNL-13910). The number of animals found to be contaminated with radioactivity, their radioactivity levels, and the range of radionuclide activities were within historical levels (PNNL-13910).

As described in WHC-MR-0418, a sample of mouse feces collected at the 218-E-12A Landfill (part of the 200-SW-2 OU) in 1985 had a Sr-90 concentration of 400 million pCi/g; the 218-E-12A Landfill was interim stabilized in 1994. Noticeable improvements in reducing the uptake and transport of radionuclide contaminants by biota have been observed in areas where interim-stabilization activities have taken place (WHC-MR-0418).

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 landfills, have shown extreme resistance to radioactive sources (Gano, 1980, "Mortality of the Harvester Ant (Pogonomyrmex owyheei) After Exposure to 137Cs Gamma Radiation"). In a contamination area, ants are capable of bringing radioactive materials to the surface, where they potentially could become available to other means of transport by wind, plant uptake, birds, or mammals. The biological transport of contamination by harvester ants was noted during an annual radiological survey at UPR-200-E-64 in 1985. The source of contamination was assumed to be a small-diameter pipe visible on the west side of the 216-B-64 Retention Basin, near the 270-E-1 Neutralization Tank. In 1985, the pipe had a dose rate of 30 mrad/h. 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 ac), and it currently is posted as a soil contamination area. Additional contaminated soil and ant hills were identified both north and south of 7^{th} Street and around the 241-ER-151 Diversion Box in September 1998.

3.5 RCRA TREATMENT, STORAGE, AND DISPOSAL UNIT GROUNDWATER MONITORING

This section describes groundwater monitoring at the RCRA TSD units in the 200-SW-1 and 200-SW-2 OUs. The purpose of this section is to present current groundwater monitoring information that can be referenced or included in FS/closure/postclosure plans developed for each of the TSD units. Subsections for each TSD or waste-management area provide a brief history of RCRA monitoring, a description of the monitoring network and well design, and recent results of monitoring. Section 2.1 provides aquifer identification for each site.

3.5.1 Overview of RCRA Monitoring

RCRA groundwater monitoring is required by WAC 173-303-400, "Interim Status Facility Standards," and 40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring." Following are the current RCRA groundwater monitoring plans for the applicable 200-SW-1 and 200-SW-2 Landfills:

- PNNL-14859-ICN-2, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington*, Interim Change Notice
- PNNL-12227, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill.*

In addition to the RCRA monitoring, DOE O 435.1, *Radioactive Waste Management*, requires performance-assessment monitoring at LLWMAs 1 through 4 (DOE/RL-2000-72, *Performance Assessment Monitoring Plan for the Hanford Site Low-Level Burial Grounds*). This program uses the same monitoring networks that the RCRA program doe, but monitors for radionuclides, which are excluded under RCRA.

The 600 CL is adjacent to the NRDWL and is regulated under WAC 173-304. PNNL-13014, *Groundwater Monitoring Plan for the Solid Waste Landfill*, describes the monitoring program.

The LLBG RCRA Part B Permit Application first was submitted to Ecology in December 1989 (DOE/RL-88-20) to meet Tri-Party Agreement Milestone M-020-06. DOE submitted the most recent version of the Part B Permit Application to Ecology in June 2002. Chapter 5 of the Part B Permit Application contains groundwater monitoring requirements. Notice of Deficiency workshops are continuing to refine the groundwater information needs. Results of the Notice of Deficiency workshops will be appropriately considered and used to determine remedial actions under this work plan.

DOE submitted the NRDWL closure/postclosure plan in August 1990 (DOE/RL-90-17) to meet Tri-Party Agreement Milestone M-020-07. The Notice of Deficiency process was not completed for this closure/postclosure plan. DOE will use activities under the 200-SW-1 OU CERCLA process to develop groundwater information data to support the NRDWL closure/postclosure plan.

DOE has prepared quarterly RCRA groundwater monitoring reports since 1986 (e.g., SGW-33492, *Quarterly Groundwater Monitoring Data for the Period October through December 2006*). RCRA annual reports commenced in 1988. The RCRA annual reports have been integrated with Hanford Site groundwater monitoring reports since 1997 (e.g., PNNL-16346).

The RCRA interim-status regulations require semiannual comparisons of upgradient and downgradient groundwater results to determine whether the TSD units have adversely impacted groundwater quality. The comparisons are conducted for four contaminant-indicator parameters: pH, specific conductance, total organic carbon, and total organic halides.

3.5.2 218-E-10 Landfill (LLWMA-1) Groundwater Monitoring

The 218-E-10 Landfill comprises LLWMA-1, located in the northwestern corner of the 200 East Area.

3.5.2.1 History

The monitoring wells have been sampled since 1988 for contaminant-indicator parameters, groundwater-quality parameters, drinking-water parameters, and site-specific parameters as required by WAC 173-303-400(3), "Interim Status Facility Standards," "Standards," which incorporates by reference 40 CFR 265, Subpart F.

3.5.2.2 Well Locations and Design

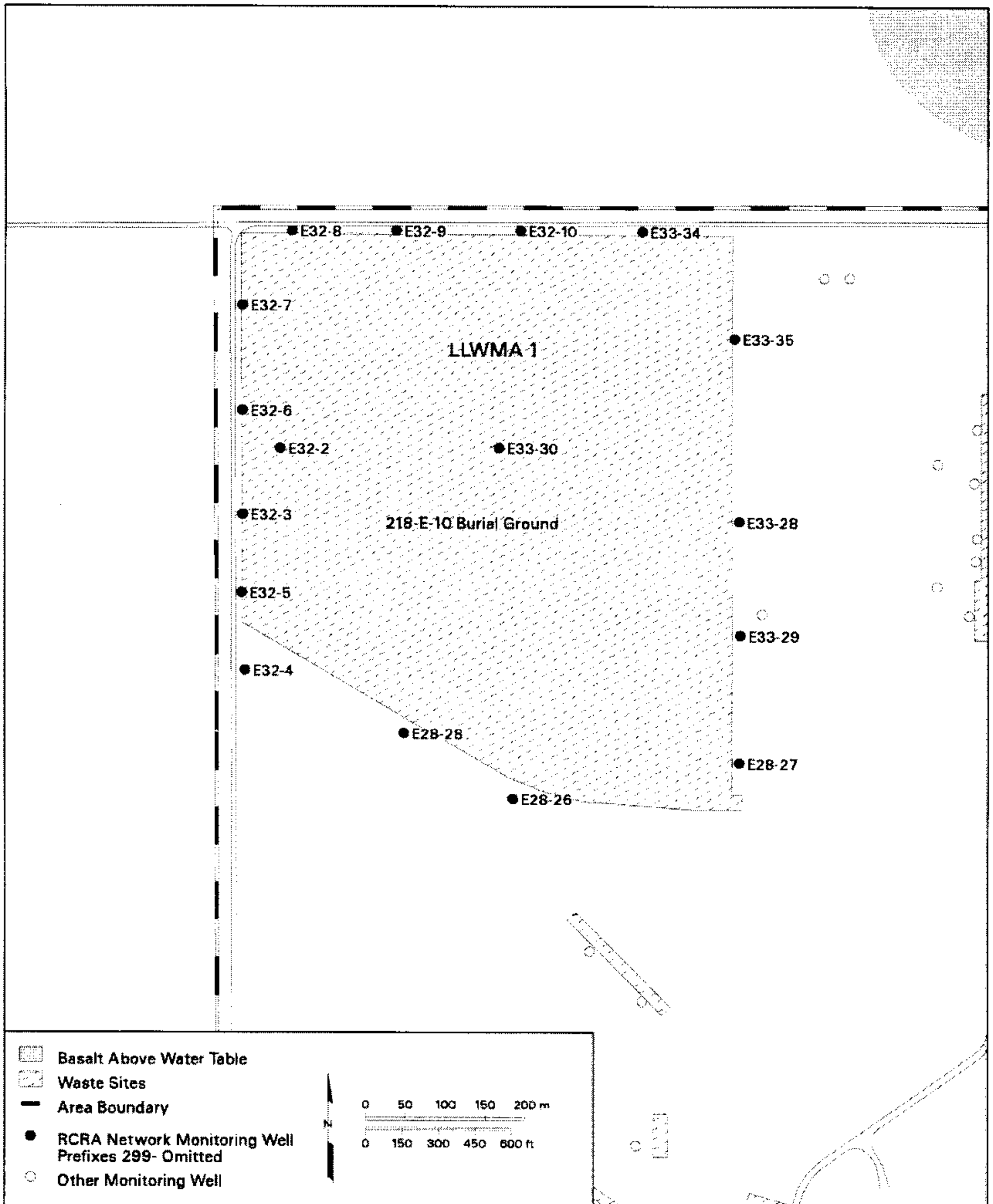
The original RCRA monitoring plan for LLWMA-1 (WHC-SD-EN-AP-015, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*) included four upgradient wells and nine downgradient wells. Because the unconfined aquifer is thin in this region (see Section 2.1), all of the wells monitor the top of the unconfined aquifer, and several are screened across the entire aquifer thickness. Casings and screens are stainless steel, and annular spaces are sealed with bentonite.

The monitoring-well network in 2007 includes 7 upgradient wells and 10 downgradient wells. No new wells for LLWMA-1 are included in recent versions of Tri-Party Agreement Milestone M-024. The groundwater monitoring well network at this landfill is shown in Figure 3-3.

3.5.2.3 Results of Groundwater Monitoring

Specific conductance of groundwater has increased in some LLWMA-1 wells since 1998 and exceeded the upgradient/downgradient comparison value in downgradient well 299-E33-34 in fiscal year 2006 (PNNL-16346). Specific conductance has exceeded the comparison value in another downgradient well, 299-E32-10, in the past. The exceedances are related to a regional nitrate plume and not LLWMA-1. Other indicator parameters were below comparison values in fiscal year 2006.

Figure 3-3. Groundwater Monitoring Wells at the 218-E-10 Landfill (LLWMA-1) (PNNL-16346).



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3.5.3 218-E-12B Landfill (LLWMA-2) Groundwater Monitoring

The 218-E-12B Landfill comprises LLWMA-2, located in the northeastern corner of the 200 East Area.

3.5.3.1 History

The monitoring wells have been sampled since 1988 for contaminant-indicator parameters, groundwater-quality parameters, drinking-water parameters, and site-specific parameters as required by WAC 173-303-400(3), which incorporates by reference 40 CFR 265, Subpart F.

3.5.3.2 Well Location and Design

The original monitoring plan for LLWMA-2 (WHC-SD-EN-AP-015) included four upgradient wells and eight downgradient wells. The monitoring network was subsequently expanded to include 16 wells, but as of fiscal year 2007, seven of these wells had gone dry. The water table has declined below the top of the basalt surface in the north half of LLWMA-2, leaving no unconfined aquifer (Section 2.1). Consequently, no replacement wells are proposed. Deeper aquifers are isolated from this landfill by the low-permeability basalts.

Because the unconfined aquifer is thin in this region, monitoring wells are screened across the entire aquifer thickness. Casings and screens are stainless steel, and annular spaces are sealed with bentonite. The groundwater monitoring-well network at this landfill is shown in Figure 3-4.

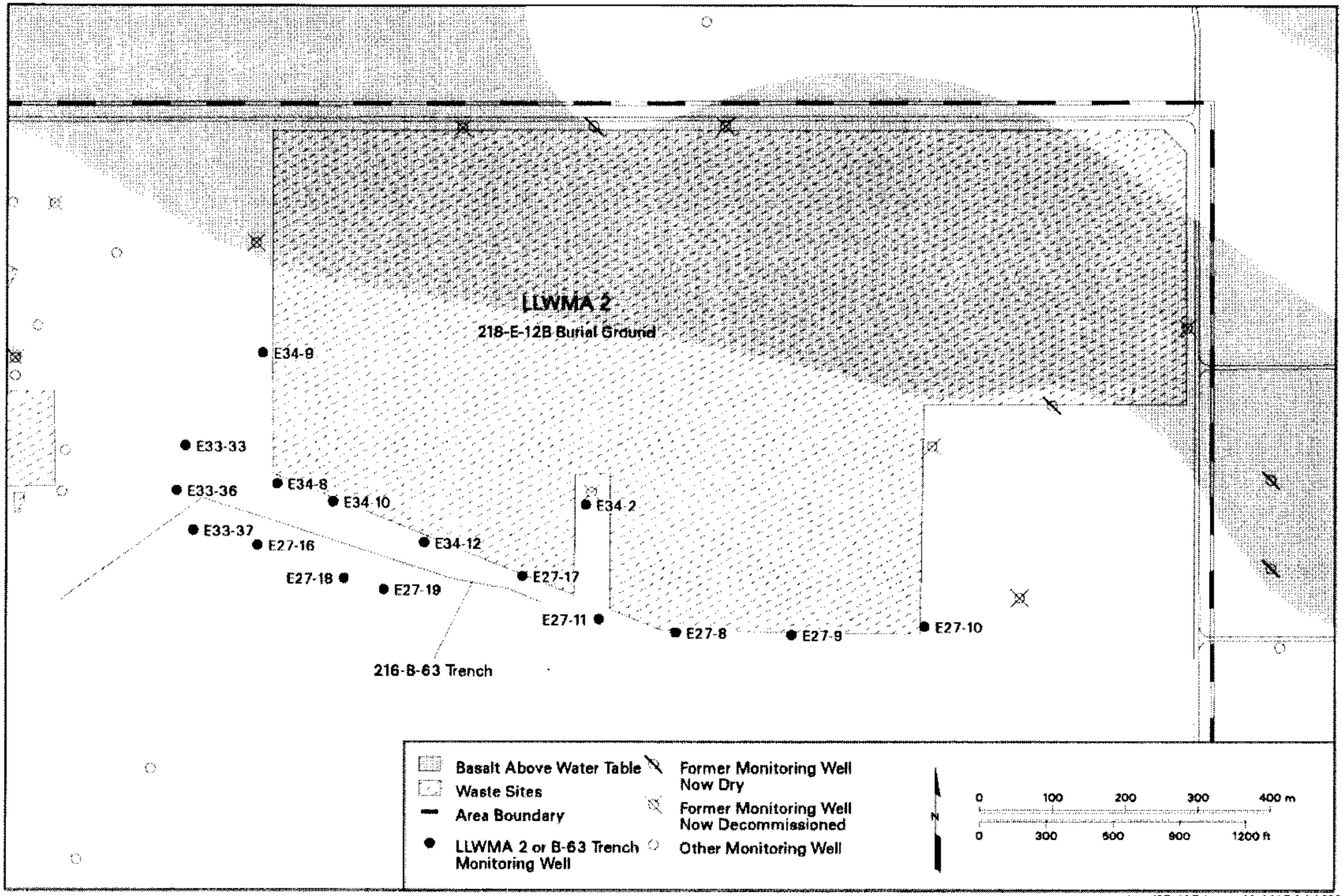
3.5.3.3 Results of Groundwater Monitoring

Indicator parameters did not exceed comparison values in fiscal year 2006 (PNNL-16346). Specific conductance has been increasing for several years in wells monitoring the southeast portion of the site. Groundwater in these wells has elevated sulfate, chloride, nitrate, and calcium. Similar chemistry was seen in former upgradient well 299-E34-7, which went dry in 2006. The source of this chemistry is not clear, but may be caused by leaching or infiltration processes within the vadose zone. Total organic carbon and total organic halides also are elevated in the southeast wells, although levels were below the upgradient/downgradient comparison value. Because these constituents also were elevated in the former upgradient well, the source does not appear to be LLWMA-2.

3.5.4 218-W-3A, 218-W-3AE, and 218-W-5 Landfills (LLWMA-3) Groundwater Monitoring

The 218-W-3A, 218-W-3AE, and 218-W-5 Landfills, located in the north-central part of the 200 West Area, comprise LLWMA-3.

Figure 3-4. Groundwater Monitoring Wells at the 218-E-12B Landfill (LLWMA-2) (PNNL-16346).



3.5.4.1 History

The monitoring wells have been sampled since 1988 for contaminant-indicator parameters, groundwater-quality parameters, drinking-water parameters, and site-specific parameters as required by WAC 173-303-400(3), "Standards," which incorporates by reference 40 CFR 265, Subpart F.

3.5.4.2 Well Location and Design

The original RCRA monitoring plan for LLWMA-3 (WHC-SD-EN-AP-015) included 2 shallow upgradient wells, 11 shallow downgradient wells, and 2 deep monitoring wells (one upgradient and one downgradient). The shallow wells were designed to monitor the top portion of the unconfined aquifer and were completed with 6.1 m (20-ft) screens that extended approximately 4.6 m (15 ft) below and 1.5 m (5 ft) above the water table. The deep wells were installed with 6 m (20-ft) screened intervals at the bottom of the unconfined aquifer. Well casings and screens are stainless steel, and annular spaces are sealed with bentonite. The monitoring-well network subsequently was expanded to include 20 wells, but 16 of the shallow wells went dry as a result of declining water table levels from reduced artificial recharge associated with elimination of liquid-waste discharges to the soil column.

DOE installed three downgradient wells in 2006. These newer wells are completed with 10.8 m (35-ft) screens to extend their useful lives as the water table declines. New upgradient wells and additional downgradient wells have been proposed and are included in the Tri-Party Agreement M-024 Milestone priority list. The groundwater monitoring-well network at the LLWMA-3 landfills is shown in Figure 3-5.

3.5.4.3 Results of Groundwater Monitoring

Currently there are no monitoring wells on the upgradient (west) side of LLWMA-3. For this reason, statistical upgradient/downgradient comparisons have been suspended until new upgradient wells are installed and background statistics are reestablished (PNNL-16346).

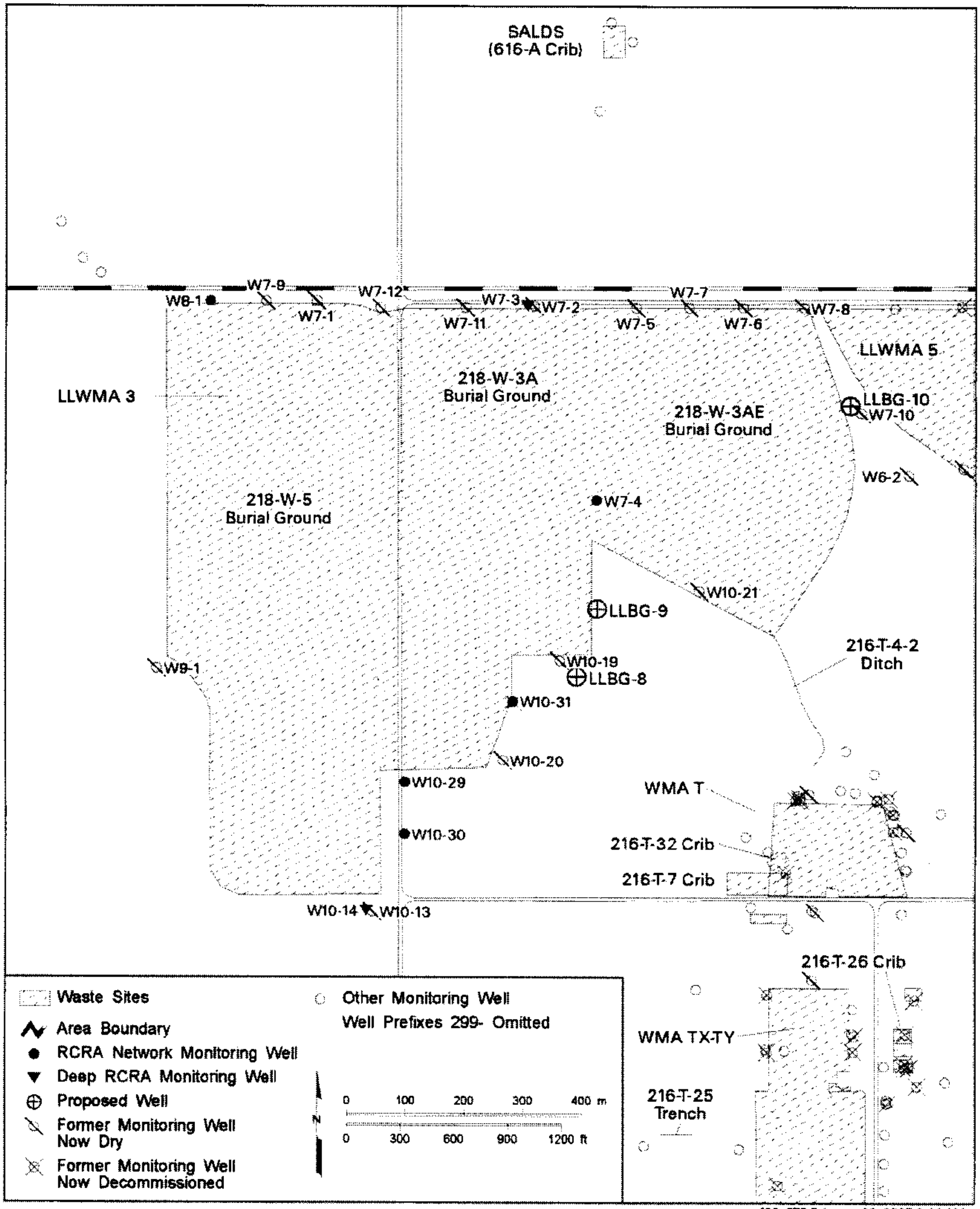
3.5.5 218-W-4B and 218-W-4C Landfills (LLWMA-4) Groundwater Monitoring

The 218-W-4B and 218-W-4C Landfills, located in the south-central part of the 200 West Area, comprise LLWMA-4.

3.5.5.1 History

The monitoring wells have been sampled since 1988 for contaminant-indicator parameters, groundwater-quality parameters, drinking-water parameters, and site-specific parameters as required by WAC 173-303-400(3), which incorporates by reference 40 CFR 265, Subpart F

Figure 3-5. Groundwater Monitoring Wells at the 218-W-3A, 218-W-3AE, and 218-W-5 Landfills (LLWMA-3) (PNNL-16346).



3.5.5.2 Well Location and Design

The original monitoring plan for LLWMA-4 (WHC-SD-EN-AP-015) included three shallow upgradient wells, nine shallow downgradient wells, and two deep monitoring wells (one upgradient and one downgradient). The shallow wells were designed to monitor the top portion of the unconfined aquifer and were completed with 9.1 m (30-ft) screens that extended approximately 7.6 m (25 ft) below and 1.5 m (5 ft) above the water table. The deep wells were installed with 3 to 9.1 m (10- to 30-ft) screened intervals at or near the bottom of the aquifer. Well casings and screens are stainless steel, and annular spaces are sealed with bentonite.

The network was expanded to 19 wells, but 12 of them went dry because of declining water table levels. DOE installed four wells in 2005 and 2006. These newer wells are completed with 10.7 m (35-ft) screens to extend their useful lives as the water table declines. Additional locations for new wells have been identified and prioritized under Tri-Party Agreement M-024 Milestone. The current groundwater monitoring network at the LLWMA-4 Landfills is shown in Figure 3-6.

3.5.5.3 Results of Groundwater Monitoring

RCRA monitoring provides no evidence that LLWMA-4 has contaminated the groundwater. In fiscal year 2006, several downgradient wells exceeded the critical mean for total organic halides, a continuation of previous exceedances (PNNL-16346). The elevated total organic halides are attributed to CCl_4. Concentrations of CCl_4 in LLWMA-4 wells are consistent with the regional plume that originated from other 200 West Area liquid-waste disposal sites. However, air sampling of vent risers from trenches in LLWMA-4 indicated the presence of CCl_4 in 2002. Subsequent soil-gas sampling was performed to determine if CCl_4 contamination is present in the vadose zone (CP-13514).

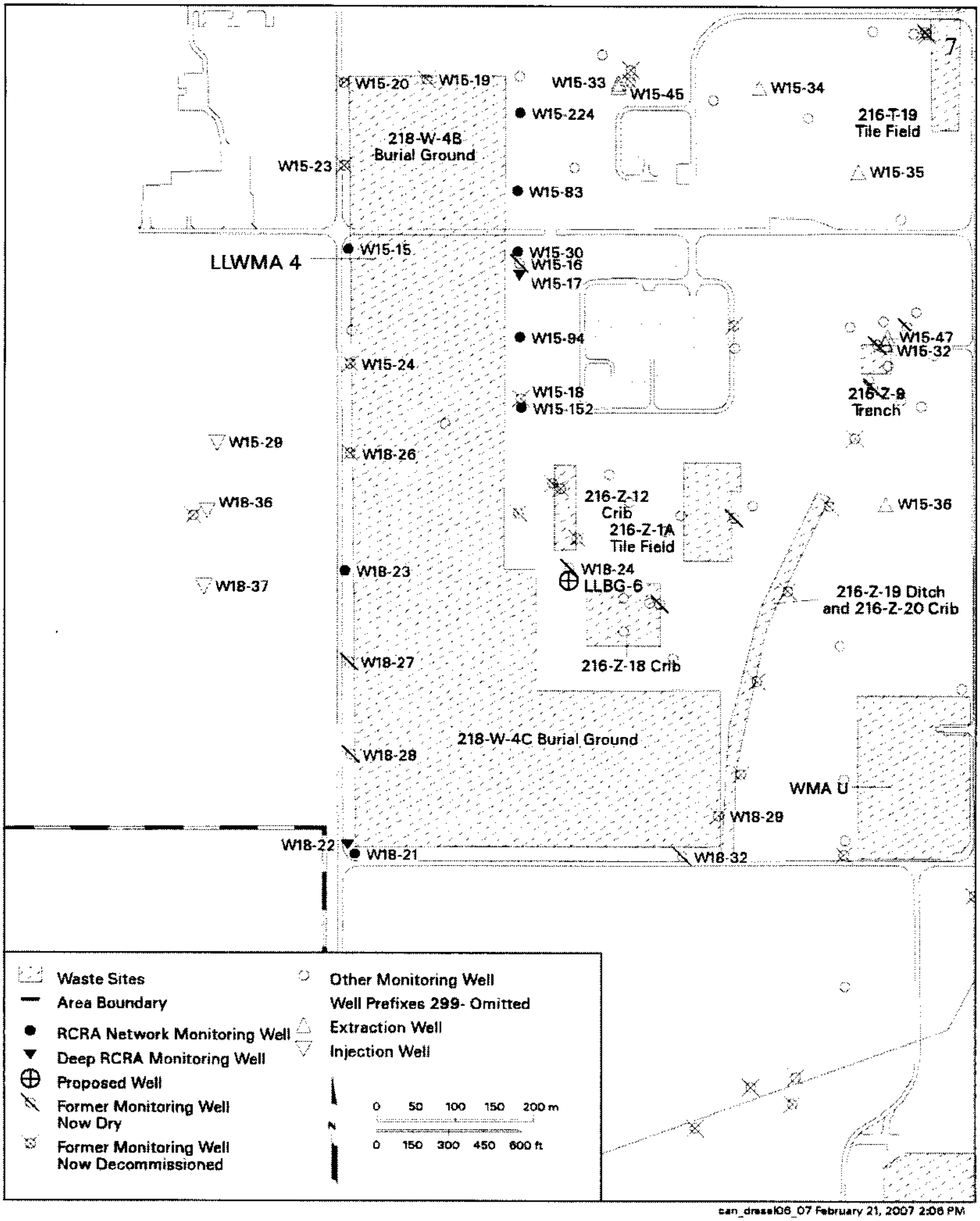
3.5.6 Nonradioactive Dangerous Waste Landfill Groundwater Monitoring

The NRDWL is located in the central part of the Hanford Site about 5.5 km (3.4 mi) southeast of the 200 East Area.

3.5.6.1 History

The monitoring wells have been sampled since 1986 for contaminant-indicator parameters, groundwater-quality parameters, drinking-water parameters, and site-specific parameters as required by WAC 173-303-400(3), which incorporates by reference 40 CFR 265, Subpart F.

Figure 3-6. Groundwater Monitoring Wells at the 218-W-4B and 218-W-4C Landfills (LLWMA-4) (PNNL-16346).



3.5.6.2 Well Location and Design

The revised monitoring plan for the NRDWL (PNNL-12227) included two shallow upgradient wells, five shallow downgradient wells, and two deeper monitoring wells (one upgradient and one downgradient) that are screened at the base of the uppermost unconfined aquifer. The shallow wells were designed to monitor the top portion of the unconfined aquifer and were completed with 6 to 12 m (20- to 40-ft) screened intervals. The deeper wells were installed with 3 m (10-ft) screened intervals. Well casings and screens are stainless steel, and annular spaces are sealed with bentonite. The groundwater monitoring well network at the NRDWL is shown in Figure 3-7.

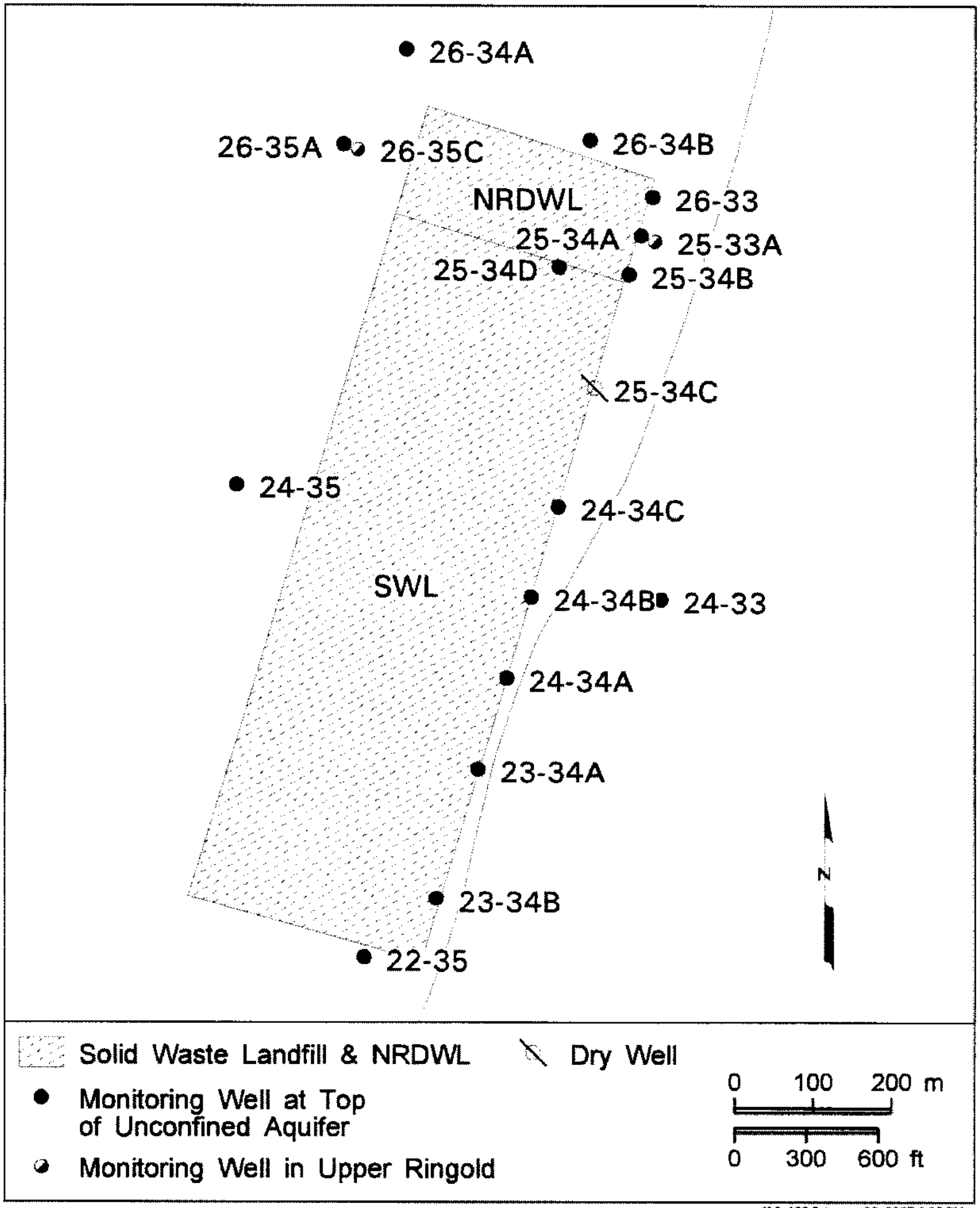
3.5.6.3 Results of Groundwater Monitoring

The values for RCRA indicator parameters at the NRDWL did not exceed their upgradient/downgradient comparison values in fiscal year 2006 for three of the indicator parameters: pH, total organic carbon, and total organic halides. However, specific conductance exceeded its comparison value in four downgradient wells, a continuation of previous exceedances (PNNL-16346). The increased specific conductance most likely is caused by increases in the concentrations of nonhazardous constituents (bicarbonate, calcium, manganese, and sulfate) from the adjacent 600 CL (Figure 3-7) to the south.

3.6 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 landfills in the 200-SW-1 and 200-SW-2 OUs. Existing information pertaining to contaminant sources, release mechanisms, transport media, exposure routes, and receptors is discussed to develop a preliminary conceptual understanding of potential risks and exposure pathways. This information will be used to support further evaluation of potential human-health and environmental risk, based on the RI results, as part of the RI/FS documents for the 200-SW-2 OU. Landfills in the 200-SW-1 OU will be closed independently of the RI/FS process.

Figure 3-7. Groundwater Monitoring Wells at the Nonradioactive Dangerous Waste Landfill and 600 Area Central Landfill (Solid Waste Landfill) (PNNL-16346).



3.6.1 Contaminant Sources and Release Mechanisms

As mentioned in Section 2.2.1, the primary sources of contaminants at the 200-SW-1 and 200-SW-2 OU landfills were the major facilities (e.g., T Plant, 222-S Laboratory, tank farms, U Plant, REDOX, PUREX, B Plant, Hot Semiworks Plant) and support operations in the 200 East and 200 West Areas. Many of the pieces of equipment from these facilities have a high dose rate associated with them (see, e.g., HW-63703, *Disposition of Contaminated Processing Equipment at Hanford Atomic Products Information 1958 - 1959*). The packaged waste from operations also contains significant radionuclide activity from the cesium and strontium components of the waste (ARH-2762). Releases of contaminants from the 200-SW-1 and 200-SW-2 OU sites can occur through infiltration (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 vertical contaminant transport in the 200-SW-1 and 200-SW-2 OUs is from infiltration and leaching, with rainwater or snowmelt as driving forces, because the volumes of liquids discharged at the 200-SW-1 and 200-SW-2 OU sites were very small. It is not likely that groundwater has been impacted from these landfills.

3.6.2 Development of Contaminants of Potential Concern

A set of radiological and organic COPCs that may be present in the 200-SW-2 OU waste sites is currently under development for the 200-SW-2 OU landfills, independent of the Phase I-B DQO process. This set of COPCs will be based on the following:

- 200 Areas plant operations as identified in various DQO documents for the 200 Areas OUs, including the 200-CW-1, 200-CS-1, 200-CW-5, 200-LW-1, 200-LW-2, 200-MW-1, 200-PW-1, 200-PW-2, 200-PW-4, 200-TW-1, and 200-TW-2 OUs

- The ecological risk-assessment DQOs for the 200 Areas (WMP-20570, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*; WMP-25493, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase II*); WMP-29253, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase III*

- As outlined in the 200 Areas Implementation Plan (DOE/RL-98-28).

Because this Phase I-B DQO process is focused on application of historical records and nonintrusive survey techniques (no soil samples will be collected during Phase I-B), the standard COPC development process and exclusion rationale do not apply at this time. Instead, the COPC list is limited to contaminants that are readily detectable via nonintrusive survey techniques. Nevertheless, a comprehensive list of COPCs for the 200-SW-2 OU will be documented during the Phase II DQO process to support intrusive characterization. Table 3-6 lists the COPCs identified for the characterization techniques to be used during Phase I-B.

Table 3-6. 200-SW-2 Operable Unit Phase I-B Contaminants of Potential Concern List.

Contaminants of Potential Concern	Rationale for Inclusion
	Radioactive Constituents
Cesium-137 Cobalt-60 Europium-152 Europium-154	Gamma-emitting isotopes with high energy emissions that may be detected from within caissons by nonintrusive radiological detection methods.
	Volatile Organics
Volatile organics listed in Appendix A of this RI/FS work plan.	Analytical results and measurements in various trenches in the 200-SW-2 OU landfills have detected numerous different volatile organic compounds in soil-vapor samples. Volatile organics release vapors that may be detected in the soil by nonintrusive techniques.

3.6.2.1 Potential Human and Ecological Receptors

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

- Ingestion of contaminated soils, sediments, or biota
- Inhalation of contaminant dusts, vapors, or gases
- Dermal contact with contaminated soils or sediments
- Direct exposure to external gamma radiation in site soils and sediments or exposed waste.

Potential human receptors include site workers (current and future) and site visitors (occasional users), including intruders. Site worker and visitor exposure pathways primarily would involve incidental soil/sediment ingestion, inhalation of contaminants, 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 were presented in Section 3.3.2. Site biota exposures primarily would 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. A summary of the contaminant types, exposure mechanisms, and principal receptors for the 200-SW-1 and 200-SW-2 OUs is provided in Table 3-7. The conceptual exposure pathway model is presented graphically in Appendix E.

Table 3-7. Summary of Contaminants, Sources, Receptors, and Exposure Mechanisms for the 200-SW-1 and 200-SW-2 Operable Units.

Contaminant Category	Sources	Potential Exposure Mechanisms	Receptors
Radionuclides [a]	Soil	Ingestion, inhalation (fugitive dust), direct dermal contact, and external exposure	Workers, intruders, visitors, plants, and animals
Metals	Soil	Ingestion and inhalation (fugitive dust)	Workers, intruders, visitors, plants, and animals
Organic compounds (volatile and semivolatile compounds)	Soil, air	Ingestion, inhalation	Workers, intruders, visitors, plants, and animals
Asbestos	Soil, air	Inhalation	Workers

[a]Only applies to the 200-SW-2 Operable Unit landfills.

3.6.2.2 Potential Impacts

This section discusses potential impacts to human and ecological receptors based on existing information. Potential contaminant exposures and health impacts to humans largely are dependent on land use.

A remediation pathway at the historical landfills that involves excavation and repackaging of waste could result in significant worker impacts. The 200-SW-2 OU RI and FS will explore the decision between the potentially high-dose, short-term risk of removal and the potentially lower dose, longer term effects if the waste is remediated with other options. Data collected to evaluate impacts to work safety will be balanced against consideration for reducing impacts to future intruders.

A SLERA for the Central Plateau landfills was developed in 2002. Based on the results of this SLERA, the full EPA eight-step ecological risk-assessment process was initiated in 2003. The DOE expects to complete the ecological risk assessment in conjunction with the ongoing RI/FS processes for the 200 Areas. The ecological risk-assessment process may identify additional characterization needs. Those needs could include soil sampling and analysis, biological studies (including sampling and analysis), or other studies. Any data needs may apply to one or more OUs. Ecological receptors have been identified and potential impacts to those receptors have been evaluated at landfills in the 200 Areas (PNNL-13230, *Hanford Site Environmental Report for Calendar Year 1999* (including some historical and early 2000 information); PNL-2253, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*; and WHC-SD-EN-TI-216, *Vegetation Communities Associated with the 100-Area and the 200-Area Facilities on the Hanford Site*). The vegetation cover on the Central Plateau predominantly is a rabbitbrush-cheatgrass and sagebrush-cheatgrass in association with the incidental presence of herbaceous and annual species. Many areas are disturbed and void of vegetation or sparsely populated with annuals and weedy species such as Russian thistle. The contamination pathways to ecological exposures for the landfills are minimized by the stabilization activities that have been conducted.

3.6.3 Conceptual Site Models

Preliminary CSMs first were initially developed for the 200-SW-1 and 200-SW-2 OUs in DOE/RL-96-81; these CSMs were generalized models at the OU scale. Using landfill-specific information based on the historical-records research and results from the Phase I-A investigations, updated CSMs have been developed. Bin-level and site-specific CSMs are presented in Appendix E. Additional work to create CSMs for the 200-SW-1 OU landfills will not be performed, because these landfills likely will be closed independent of the RI/FS process.

The conceptual-exposure pathway model is included in Appendix E to develop an understanding of potential risks and exposure pathways associated with the 200-SW-2 OU landfills. This information forms the basis for an evaluation of potential human-health and environmental risk.

3.6.3.1 Hanford Site Feature, Event, and Process Methodology

PNNL-SA-36387, *A Comprehensive and Systematic Approach to Developing and Documenting Conceptual Models of Contaminant Release and Migration at the Hanford Site*, and PNNL-SA-42671, *A Systematic Approach for Developing Conceptual Models of Contaminant Transport at the Hanford Site*, described a comprehensive and systematic approach for developing and documenting Hanford Site-specific CSMs based on the features, events, and processes methodology used in scenario development for nuclear-waste-disposal programs (OECD/NEA, *Features, Events, and Processes [FEPs] for Geologic Disposal of Radioactive Waste: An International Database [Radioactive Waste Management]*). Given the large number of factors potentially applicable to conceptual site models for the 200-SW-2 OU landfills, application of the features, events, and processes analysis methodology was applied to help focus the conceptual site models in support of the RI/FS process for the 200-SW-2 OU.

The features, events, and processes methodology facilitates identification and screening/prioritization of factors that can be assembled into a limited number of scenarios or conceptual models to describe the potential risk sources, migration, and impacts relevant to the decisions made. Together with an understanding of the level of uncertainty about the most dominant factors, the relative effect of those factors on the decision errors can be analyzed. This, in turn, can help to focus the RI data collection by targeting the most dominant factors with the greatest level of uncertainty, which could contribute the most to the decision errors.

If, through field sampling, it is determined that the level of uncertainty can be reduced (e.g., sampling results are within the envelope of expected conditions), then a subsequent reduction in the decision errors can be expected. If, however, the results are outside the expected envelope of expected conditions, then uncertainty goes up as do the decision errors.

The streamlined approach for application of the Hanford Site features, events, and processes methodology to the 200-SW-2 OU consisted of two main phases. The initial phase was aimed at screening the Hanford Site features, events, and processes list against the existing conceptual site models to evaluate completeness and to record current project assumptions and technical arguments. Most of the primary Hanford Site features, events, and processes that are considered most relevant and important (and their interrelationships) were graphically portrayed on a process-relationship diagram developed in PNNL-SA-34515, *Use of Process Relationship Diagrams in Development of Conceptual Models*. Identification and prioritization (dominance) of these primary Hanford Site features, events, and processes was generated through a series of meetings held with representatives of the DQO team and other technical experts.

The second phase included an evaluation of all primary Hanford Site features, events, and processes previously identified as potentially relevant to Hanford Site clean-up (WMP-22922, *Prototype Hanford Features, Events, and Processes [HFEP] Graphical User Interface*). This evaluation included a subjective analysis and prioritization (based on a consensus of professional judgments) of those components of the conceptual site models (Hanford Site features, events, and processes) considered potentially dominant vs subordinate with respect to their impacts on remediation decision errors.

Using the process-relationship diagram developed for the 200-SW-2 OU and other supporting documentation on conceptual site model components, a methodical screening was conducted of the primary and the lower Hanford Site features, events, and processes. During this screening, some additional primary Hanford Site features, events, and processes were identified and incorporated into the primary list. This resulted in a total of 240 primary Hanford Site features, events, and processes. Of these, 81 were identified as potentially dominant to RI and clean-up of the 200-SW-2 OU, 78 were identified as subordinate, and 81 were identified as not being applicable.

Further analysis of the lower tiered Hanford Site features, events, and processes associated with the primary Hanford Site features, events, and processes considered potentially applicable to the 200-SW-2 OU yielded a total of 90 individual (primary and/or lower tiered) Hanford Site features, events, and processes considered potentially dominant. Likewise, analysis of the lower tiered Hanford Site features, events, and processes yielded 87 potentially subordinate Hanford Site features, events, and processes.

Further detail regarding this Hanford Site features, events, and processes analysis can be found in SGW-34462, *Application of the Hanford Site Feature, Event, and Process Methodology to Support Development of Conceptual Site Models for the 200-SW-2 Operable Unit Landfills.*

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4.0 WORK PLAN APPROACH AND RATIONALE

This chapter presents an overview of the approach that is planned to conduct additional investigations of the 200-SW-2 OU. The 200-SW-1 OU landfills are not included in this chapter, because no further characterization of these sites is planned at this time. Additional characterization likely will be required in support of the cover design during the post-ROD phase. These landfills are proposed to undergo closure as described in Chapter 5.0 of this RI/FS work plan.

4.1 SUMMARY OF DATA QUALITY OBJECTIVE PROCESS

The RI needs for the 200-SW-2 OU were developed in accordance with the DQO process (EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4). The DQO process is a seven-step planning approach that is used to develop a data-collection strategy consistent with data uses and needs. The goals of the process are to identify the data required to refine the preliminary site conceptual model and support remedial decisions.

The Phase I-B DQO process to support the RI/FS work plan 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 the DOE, Ecology, and EPA participated in the process to develop the characterization approach outlined in the Phase I-B DQO summary report (SGW-33253). The DQO process and involvement of the team of experts and decision makers provide a high degree of confidence that the right type, quantity, and quality of data are collected to fulfill the informational needs of the RI decisional process. The DQO summary report presents the results of the DQO process for characterization of the landfills in the 200-SW-2 OU.

Objectives identified for the 200-SW-2 OU DQO process incorporated into the RI/FS work plan approach include the following.

- Determine the environmental measurements necessary to support the RI/FS process and remedial decision-making.
- Identify the data needed for development of the RI/FS work plan and SAP.
- Develop preliminary conceptual site models that reflect the physical characteristics of the landfills and the anticipated distribution of contaminants known to date. Data collection will support refinement of the models.
- Identify evaluation and preliminary remediation strategies that are inclusive of both RCRA and CERCLA requirements for the 200-SW-2 OU landfills.

The DQO process determined that the complexity of the landfills in the 200-SW-2 OU argue in favor of developing a binning approach to support characterization and remedial-action decisions for the sites. Bins were developed based on conceptual site models for sites, using existing site knowledge. A description of the six site bins is provided in Chapter 3.0 of this work plan.

In addition to site binning, the Phase I-B DQO process determined that characterization of the 200-SW-2 OU landfills should be performed in a phased manner, beginning with additional nonintrusive characterization techniques, then progressively moving to more intrusive characterization techniques in future phases. The DQO process determined that the most appropriate method to evaluate the landfills in all six bins is through an approach that first uses historical records (e.g., logbooks, burial records) to focus the locations for nonintrusive field characterization work. In turn, the results of the intrusive and nonintrusive characterization work will be used to further refine the preliminary conceptual site models and focus future phase (Phases II and III) characterization. This approach will help to ensure that remediation activities are performed at sites where there is a potential risk to human health or the environment because of the presence of contamination above remediation standards. This approach initially will require survey or field screening (or both) of the landfills within a bin to determine the presence of contamination. The surveys and screening methods will involve the use of field instrumentation to evaluate the levels of radioactive and chemical COPCs. The results from the surveys and screening will provide a basis for determining the need for, and the extent of, further intrusive investigation. This phased approach to characterization is discussed in further detail in Section 5.3, and depicted graphically in Figure 5-2 in Chapter 5.0 of this RI/FS work plan.

Data used to make decisions regarding the remediation of the 200-SW-2 OU landfills will be collected and managed in accordance with DQOs to ensure data quality. The DQO process ensures that the data collected are of a type, quantity, and quality commensurate with the importance and intended use of the data. DQOs and quality-assurance objectives ensure that decisions made using the data are technically and scientifically sound and legally defensible.

The SAP (Appendix A) describes site-investigation activities. The SAP includes a quality assurance project plan, which defines the processes used to produce quality data and ensure that operations are fully compliant with applicable requirements. Sampling and sample handling are performed in accordance with approved Fluor Hanford procedures.

The data-quality assessment process compares completed field-sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project DQOs to support the decision-making process. The data-quality assessment is conducted in accordance with approved Fluor Hanford procedures.

4.1.1 Data Uses

Existing information, as provided through the ongoing records research process for the 200-SW-2 OU landfills, was used to perform the initial grouping or binning of the sites. The waste inventory information compiled to date also was used to establish and refine specific details for each waste site. This information includes any available disposal history for the site that will assist the field team to do the following:

- Establish the locations of burial trenches
- Identify the primary COPCs
- Focus on a subset of the COPCs
- Provide a basis for estimating the lateral and vertical extent of contamination
- Provide a basis for focusing future-phase intrusive sampling
- Determine the stratigraphy beneath the landfills.

The landfill boundaries (surface area and depth) must be determined to support the selection and evaluation of appropriate site remediation technologies. The geophysical methods (i.e., EMI, total magnetic field, and GPR) used during Phase I-A and planned in Phase I-B investigations are recognized industry standards and provide necessary levels of site interrogation to determine the surface area and depth of buried wastes. Additionally, the geophysical methods can differentiate between metallic and nonmetallic materials, giving some indication of the type of waste buried at a location. Data collected from geophysical investigations will be used to guide future intrusive characterization activities to understand the physical, chemical, and radiological nature of the waste and the extent of subsurface contamination. This understanding is necessary to identify suitable retrieval, in situ treatment, and capping technologies for evaluation during the FS.

The 200-SW-2 OU landfills may contain many different radioactive and hazardous chemical constituents; therefore, it is important to screen COPCs for risk assessments. Often this screening is done as part of a screening assessment, the purpose of which is to evaluate the available data, identify data gaps, and screen COPCs. Screening may be accomplished by using a set of toxicological benchmarks. These benchmarks are helpful in determining whether contaminants warrant further assessment or are at a level that requires no further attention. If a chemical concentration or the reported detection limit exceeds a lower benchmark, further analysis is needed to determine the hazards posed by that chemical. If, however, the chemical concentration falls below the lower benchmark value, the chemical may be eliminated from further study. Concentrations exceeding an upper screening benchmark indicate that the chemical in question is clearly of concern and may require remedial actions. Existing chemical-use records, process flowsheets, waste-disposal records, and other historical information were reviewed to support development of the list of COPCs discussed in Chapter 3.0.

Knowledge of the lateral and vertical extent of contamination is important to the identification, evaluation, and selection of remediation technologies. Based on historical records, the 200-SW-2 OU landfills received dry waste for the most part. Although historical records indicate disposal of small volumes of liquids in some landfill trenches, the liquids typically were sorbed and containerized. Understanding the COPCs is important to the lateral and vertical extent of contamination because of retardation factors (R_d) and distribution coefficients (K_d) affecting contaminant fate and transport through the vadose zone. Some contaminants (e.g., technetium) have K_ds and R_ds such that they migrate with infiltrating moisture. Other contaminants (e.g., plutonium) move very little in surrounding soils, unless they are in the presence of complexing agents, low pH, or other conditions favorable to plutonium migration. Still other contaminants (e.g., carbon tetrachloride) are dense nonaqueous-phase liquids that can move independent of soil moisture in either the liquid or gaseous phase. Phase I-B of the site investigations involves a limited number of direct pushes near the center of each landfill, with additional direct pushes in portions of landfills known to have been flooded in the past. These reconnaissance-level investigations will provide initial data in targeted areas to begin evaluating the presence of contamination and its lateral and vertical extent in the vadose zone. In addition, Phase I-B activities provide direction for future intrusive investigations to better define the nature and extent of vadose-zone contamination.

The stratigraphy beneath the 200-SW-2 OU landfills will have an impact on contaminant fate and transport and on the effectiveness of site-remediation technologies. Fine-grained sediment layers tend to retard the downward migration of liquids and are conducive to lateral spreading. Conversely, coarse-grained sediment layers provide little impediment to the downward flow of liquids. Existing lithologic logs from groundwater wells surrounding the periphery of the 200-SW-2 OU landfills will be reviewed, and geologic cross-sections will be prepared. The limited number of direct pushes conducted during Phase I-B of the site investigation will provide data to evaluate the lateral continuity of geologic layers beneath the 200-SW-2 OU landfills and help to focus future intrusive site investigations.

Existing information was reviewed for the landfills to determine the dimensions of the sites, operating history, and potential waste inventory and forms. This information was used in the Phase I-A characterization to focus the nonintrusive characterization. Results of the Phase I-A characterization are used to further focus the characterization in Phase I-B. This combined information was used to develop the sampling approach for the landfills and to develop site-specific characterization activities for individual landfills in Phase I-B.

Data generated during the characterization of landfills will consist of output from field-screening instruments and nonintrusive surveys. These data will be used to focus future-phase intrusive sampling within the landfills and the vadose zone to support evaluation of the nature and extent of contamination, potential risks, need for interim remedial measures, and evaluation of remedial alternatives.

Data generated during Phase I-B characterization of the landfills will consist of analytical results for contaminants obtained from inside the landfills (direct pushes between the trenches) and from logging/surveys in adjacent soils. These data will be used to refine current information associated with the nature and extent of radiological and nonradiological contamination, support an initial evaluation (baseline) of potential human-health risks, assist in the evaluation and selection of a remedial alternative(s), and help to focus future intrusive site-investigation activities during subsequent phases. By defining the type and distribution of contamination, the preliminary conceptual models for contaminant distribution can be verified and refined. Determination of the lateral and vertical extent of contamination in soil surrounding the landfills will be evaluated using the data gathered by geophysical logging, limited direct pushes, and soil-vapor surveys from this and future phases of site investigation.

Determination of the lateral and vertical extent of contamination will require more extensive intrusive direct-push sampling and analysis using some combination of sodium-iodide spectral-gamma, passive-neutron, prompt fission neutron, thermal decay time, pulsed-neutron multimode gamma-ray spectroscopy, and moisture logging during future phases, and other tools deployable by direct-push techniques. The geophysical logging, limited direct pushes, and vapor surveys conducted during Phase I-B will aid in identifying target locations for intrusive sampling and analysis during future phases of site investigation. If deep contamination is indicated (potentially extending to groundwater) after initial data gathering, subsequent evaluations (Phases II and III) will include plans for vadose-zone soil sampling and analysis to be completed to groundwater. Given the depth to groundwater (~76 m or 250 ft) and limitations of direct-push sampling technology (~30 m or 100 ft), "completion to groundwater" could be an expensive proposition and likely will require conventional drilling methods and handling of investigation-derived waste (IDW). With direct-push methods, knowledge of local geology will be used to determine the depth of sampling/characterization. Mobile contaminants (radiological and chemical) will tend to concentrate in fine-grained sediment layers beneath the burial trenches (~10 to 30 m or 50 to 100 ft). Initial direct-push wells will be logged for moisture to identify flow-restricting layers for more detailed sampling and analysis, using the dual-string sampling capability of the direct-push technology.

4.1.2 Data Needs

A considerable amount of information has been presented in Chapters 2.0 and 3.0 of this RI/FS work plan regarding background information and existing characterization data. However, the existing data are not sufficient to determine the nature and extent of contamination for the 200-SW-2 OU landfills. Pertinent existing information was used to develop the preliminary conceptual site models for the landfills. Additional information collected in Phase I-B and future phases will be used to further refine the CSMs and support development of a baseline risk assessment. For the majority of the landfills, information is available regarding location, construction design, and types of waste handled. But the data needed to verify and/or refine the conceptual contaminant-distribution model and conceptual exposure-pathway model are limited.

As stated in Section 4.1.1, data are needed to establish landfill boundaries, identify preliminary COPCs, focus on a subset of COPCs, provide a basis for estimating the lateral and vertical extent of contamination, provide a basis for determining future-phase intrusive sampling, and provide an understanding of the stratigraphy beneath the landfills. These data and evaluations are needed to support remedial decision making for the landfills and to help focus future intensive site-investigation activities during subsequent phases.

Further, data collection is needed for the landfills to support an evaluation of remedial alternatives based on the nine CERCLA criteria during the FS process. Because of the size of the landfills and complexity of the decisions concerning potential remedial alternatives, the data-collection strategy for the landfills is to use results of nonintrusive, surface-based sampling methods and field screening analyses, couples with direct pushes and well logging, to guide selection of locations for intrusive soil sampling and laboratory analyses or direct pushes (Phases II and III) to provide progressively more data.

Finally, additional data needs will be satisfied through focused treatability investigations. Pre-ROD treatability investigations will provide additional information for detailed analysis of site-remediation alternatives during the FS process in support of the proposed plan and subsequent ROD. Post-ROD treatability investigations will provide additional information to support the remedial design and implementation of the remedial action. Separate DQOs, work plans, health/safety plans, and SAPs will be prepared for treatability investigations.

4.1.3 Data Quality

Data quality was addressed during the DQO process. Analytical performance criteria were established by evaluating potential ARARs and 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. The potential ARARs and PRGs for the landfills that were considered in determining the detection-limit requirements are presented in the DQO summary report (SGW-33253). Regulatory thresholds and/or standards or preliminary cleanup levels provide the basis for establishing cleanup levels and dictate analytical performance levels (i.e., laboratory detection-limit requirements). Potentially applicable preliminary cleanup levels were identified and listed in the DQO summary report.

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 cleanup 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 the DQO summary report (SGW-33253).

To provide the necessary data quality to support project requirements, detection limits should be lower than potential PRGs when possible. Analytical detection-limit tables provided in the SAP define the minimum detection limit, human-health action levels, quantitation limit, precision, and accuracy requirements for each analytical method. Clean-up levels protective of ecological receptors also are defined in the tables to verify that analytical detection limits can meet additional potential data-collection requirements. Additional data quality is gained by establishing the specific policies and procedures to be followed and specifying field quality-assurance/quality-control requirements. These procedures and requirements are discussed in detail in the SAP.

4.1.4 Data Quantity

Data quantity refers to the number of samples collected. Screening data were collected as part of the Phase I-A characterization activities and will be collected during Phase I-B characterization activities to provide an overview of site conditions and direction for future-phase site-investigation activities. An adequate number of survey points will be established based on an evaluation of site-specific conditions to ensure that the site is characterized sufficiently to support a basis for decisions. Because radioactive contamination survey and other field-screening results at the 200-SW-2 OU landfills will provide a significant amount of onsite data, the number of samples needed for laboratory analysis can be reduced. For Phase I-B activities, the number of samples needed to refine the preliminary conceptual site models and make decisions regarding future-phase site-investigation activities is based on a biased sampling approach.

Biased sampling is the intentional location of a sampling point based on existing information such as process knowledge, existing field-characterization data, and the expected behavior of the COPCs. This sampling approach is defined in Section 6.2.2 of the Implementation Plan (DOE/RL-98-28). Using this approach, sampling locations can be selected that increase the chance of encountering worst case areas of contamination.

Sample locations for landfills are based on the preliminary conceptual models of contaminant distribution presented in the DQO summary report (SGW-33253) and are presented in the SAP (Appendix A).

Because the 200-SW-2 OU landfills will be characterized using a phased approach, numbers of survey and sampling points will be determined based on information gathered during the previous phase. Each set of survey locations and associated data will be used to refine the conceptual site models and support remedial decision making in the feasibility study. The number and location of survey points currently defined for collection of data during Phase I-B characterization are presented in the SAP (Appendix A).

4.2 CHARACTERIZATION APPROACH

This section provides an overview of the phased characterization approach planned to meet the data needs for the 200-SW-2 OU landfills, as determined during the DQO process. The overall strategy for site characterization is to use an approach that progresses from less intrusive to more intrusive techniques to develop an adequate definition of site conditions to support a decision. The first step for all sites was to reassess the detailed, site-specific historical information and data gathered during Phase I-A characterization activities. The documentation in some cases will provide sufficient information to support the design of a site-survey plan. Field instruments and nondestructive-analysis equipment can provide an overview of site condition, such as the types and levels of contamination present and location and configuration of wastes. Results from these studies will be used to provide a basis for the next steps in the characterization (e.g., determination of locations requiring special attention, whether additional field screening or surveys are required, and/or whether samples should be collected). Additional characterization needs will be defined on a site-specific basis.

Phase I-B characterization activities within selected landfills will include passive soil-vapor surveys, radiological surveys, geophysical investigations, and visual inspection (caissons and unused portions of landfills). For the vadose-zone soils, borehole geophysical logging using spectral and gross-gamma, passive-neutron, and active-neutron (moisture) detectors, and other tools deployable by direct-push techniques will be performed. Small-diameter well casings will be driven to a depth of 30 m (100 ft) using direct-push technology (e.g., GeoProbe[25], hydraulic hammer, or equivalent equipment). Well casings will be logged to determine regions of high moisture that also are likely areas for accumulation of mobile COPCs. High-moisture horizons will be logged with gross and spectral-gamma detectors and passive-neutron detectors to determine the presence of radioactive COPCs. Dual string casing will be driven into high-moisture zones to collect samples for analysis. Other tools deployable by direct-push

[25]GeoProbe is a registered trademark of Kejr, Inc., Salina, Kansas.

techniques and capable of in situ volatile organic compound sampling/analysis also are being considered.

The sampling strategy is designed to provide focused evaluations on potentially contaminated locations and media inside the landfills and in adjacent subsurface soils where migration may have occurred. Sampling and survey locations will be focused on various areas, based on the historical records research, as well as on the results of the Phase I-A nonintrusive characterization work.

Before intrusive activities are implemented, surface geophysical and radiation surveys will be conducted at all sampling locations. The surface geophysical surveys will be conducted using total magnetic field, GPR, and/or EMI and will aid in verifying buried utilities and subsurface anomalies. Furthermore, necessary excavation permits will be obtained in support of intrusive activities that will be conducted in previously disturbed areas within the landfills. Surface radiation surveys will identify areas of surface contamination that might impact the intrusive activities and health and safety requirements.

Further characterization of 200-SW-2 OU landfills is expected to be conducted in three phases. Phase I-B activities will be a combination of intrusive and nonintrusive activities. This phase consists of biased sampling that targets specific locations within and around the landfills. If known or suspected areas of waste accumulation cannot be identified, then locations will be selected randomly. Evaluation of the Phase I-B sampling data will be used to determine the current contaminant conditions inside the landfills and in adjacent soils at the direct-push locations. The specific landfills and sampling locations selected for investigation as part of Phase I-B are identified in the SAP.

The Phase II and III investigations will be initiated in out-years if Phase I-B results show COPC concentration values exceeding preliminary cleanup levels, or if data are inconclusive and cannot provide enough detail to support refinement of the conceptual site models and baseline risk assessment. Phases II and III likely will involve more intrusive investigations and require a larger data set for decision making. The Phase II and III evaluations are expected to entail more extensive sampling and laboratory analyses. Phase II and III data will support development of decision documents and completion of the RI/FS process. Selection of locations for Phase II and III sampling will be made after review of Phase I-B results. Phase II and III activities will be conducted under a separate DQO and a revision to this RI/FS work plan and SAP.

Phase I-B characterization activities are summarized in the following bullets, and described in more detail in the SAP (Appendix A).

- **Nonintrusive geophysical investigations** will be performed on the 218-E-2, 218-E-4, 218-E-8, and 218-W-4A Landfills. All other landfills were surveyed with geophysical techniques as part of Phase I-A characterization activities.

- **Passive organic-vapor surveys** will be performed in the 218-W-3, 218-W-3AE, 218-W-4B, and 218-W-5 Landfills. These landfills showed high concentrations of organic vapors when surveyed during Phase I-A characterization activities in 2006. Additional organic-vapor surveys are needed to focus the locations for potential active organic-vapor sampling using direct-push techniques beneath the trenches during future phases.

- **Passive organic-vapor surveys** will be performed in the 218-E-1, 218-E-2A, 218-E-5, 218-E 5A, 218-E-8, 218-E-12A, 218-W-1, 218-W-1A, 218-W-2, 218-W-2A, 218-W-3, and 218-W-11 Landfills. Organic-vapor surveys will be focused on those areas that showed a strong metallic signature during geophysical investigations performed as part of Phase I-A characterization activities. Passive organic-vapor surveys will be used to determine if containers of organic liquids may have been disposed in these landfills. Organic liquids were used in large quantities at the Plutonium Finishing Plant and fuel reprocessing facilities during their operating history. Future phases may deploy direct-push techniques to perform organic-vapor sampling beneath the trenches to differentiate the regional carbon tetrachloride plume from possible contributions from directly within the trenches.

- **Direct-push techniques** will be used in the centers of each of the 24 landfills. Pushes will be placed in areas between trenches, so that the buried waste is not penetrated. In addition to the center pushes, additional pushes will be performed in those landfills that have experienced historical events, such as rapid snow melt or infiltration of water, that could have provided a mechanism to cause contaminant migration. The direct pushes will employ gamma logging and moisture logging. Direct pushes also will be used to assess the stratigraphy under the landfills and to direct future-phase soil samples.

- **Intrusive inspection of the interiors of caissons** that are believed to be unused/empty will be conducted at the 218-W-4A and 218-W-4B Landfills. Evaluations will include both visual inspections and radiological-survey activities. Inspections will be used to determine if waste is present in the caissons. Caisson interior evaluations will include remote-camera surveys and radiological monitoring.

- **Borehole spectral logging** will be performed in a number of accessible boreholes and groundwater wells near the landfills, based on review of the most recent logging data and its applicability to Phase I-B site-investigation activities. Site well-status records indicate that wells may be accessible and are appropriately configured for geophysical logging. These wells are listed in the SAP (Appendix A). These wells represent data-collection points in the vicinity of the landfills. Logging of these wells will provide additional current site-specific information on contaminant distribution, both laterally and vertically, for comparison to previous surveys. Sodium-iodide spectral logging also will be conducted in the direct-push boreholes placed in the centers of each landfill, as discussed above.

- **Visual inspection** of unused portions and annexes of landfills will be performed during site walkdowns, coupled with review of aerial photographs, to locate disturbed soil within these areas. Areas that appear to be disturbed may be surveyed using geophysical techniques and/or radiological surveys to determine whether waste may be buried in these areas. After field surveys are completed, and if determined to be free of buried waste, these areas of unused landfills may be administratively reclassified in the WIDS database, and permit changes will be initiated. The steps required to reclassify these areas are described in Chapter 5.0 of this RI/FS work plan.

4.3 INVESTIGATION TECHNIQUES

The following sections detail the proposed sampling and survey techniques to be used during Phase I-B characterization activities.

4.3.1 Surface Geophysical Surveys

Several nonintrusive geophysical techniques are available and will be used as needed to gather information on buried waste. The geophysical surveys will be conducted in accordance with equipment manufacturers' recommendations and procedures using properly trained and qualified subcontractor personnel. Additional discussion on surface geophysical techniques is provided in EPA/625/R-92/007, *Use of Airborne, Surface, and Borehole Geophysical Techniques at Contaminated Sites: A Reference Guide*. Specific characterization locations and activities that will be used in Phase I-B are identified in the SAP (Appendix A).

4.3.1.1 Magnetometry

Magnetometers permit rapid, noncontact surveys to locate buried metallic objects or features. This technique is applicable for use with buried metal waste forms or packages. Portable (one-person) field units can be used virtually anywhere that a person can walk, although they can be sensitive to local interferences such as fences and overhead wires. Field-portable magnetometers may be single or dual sensor. Dual-sensor magnetometers are called gradiometers, and they measure gradient of the magnetic field; single-sensor magnetometers measure total field. Magnetic surveys typically are run with two separate magnetometers. One magnetometer is used as the base station to record the earth's primary field. The other magnetometer is used as the rover to measure the spatial variation of the earth's field. The rover magnetometer is moved along a predetermined linear grid laid out at the site.

4.3.1.2 Ground-Penetrating Radar and Electromagnetic Induction

Surface geophysical surveys using GPR and EMI techniques will be used to verify the locations of metallic or dense objects disposed of in the landfills. GPR uses a transducer to transmit frequency modulated electromagnetic energy into the ground. Interfaces in the ground, defined by contrasts in dielectric constants, magnetic susceptibility, and, to some extent, electrical conductivity, reflect the transmitted energy. The GPR system measures the travel time between transmitted pulses and the arrival of reflected energy. The reflected energy provides the means for mapping subsurface features of interest. The display and interpretation of GPR data are similar to those used for seismic-reflection data. When numerous adjacent profiles are collected, often in two orthogonal directions, a plan-view map showing the location and depth of underground features can be generated.

The EMI technique is a nonintrusive method of detecting, locating, and/or mapping shallow subsurface features. It complements GPR because of its response to metallic subsurface anomalies and because it provides reconnaissance-level information over large areas to help focus GPR activities. The EMI techniques are used to determine the electrical conductivity of the subsurface and generally are used for shallow investigations. The method is based on a transmitting coil radiating an electromagnetic field that induces eddy currents in the earth. A resulting secondary electromagnetic field is measured at a receiving coil as a voltage that is linearly related to the subsurface conductivity.

4.3.2 Detection of Organic Vapors

Passive soil-vapor samplers will be installed and collected to screen selected areas in the 200-SW-2 OU landfills for the presence of volatile organic compounds. Results will be used to profile contamination in the landfills and determine the location of waste packages that may contain liquid organics that have breached their containment. Specific characterization locations and activities that will be used in Phase I-B are identified in the SAP (Appendix A).

Passive soil-vapor samplers, such as EMFLUX[26] or GORE-SORBER[27], will be used to collect soil-vapor samples. These samplers consist of a small glass vial with an absorbent medium used to collect soil vapors. These samplers typically are placed in a shallow hole in the soil and left for a prescribed length of time, after which they are collected and sent to the manufacturer for analysis.

Whatever the relative concentration of source and associated soil gas, best results are realized when the ratio of soil-vapor measurements to actual subsurface concentrations remains as close to constant as possible. It is the reliability and consistency of this ratio, not the particular units of mass (e.g., nanograms), that determine usefulness. Therefore, follow-on intrusive sampling is required at points that show relatively high soil-vapor measurements, to obtain corresponding concentrations of buried contaminants. These values form the basis for approximating the required ratio. Once the ratio is established, it can be used in conjunction with the soil-vapor measurements (regardless of the units adopted) to estimate subsurface contaminant concentrations across the area surveyed. Specific conditions at individual sample points, including barometric pressure, soil porosity and permeability, and depth to contamination, can have significant impact on soil-vapor measurements at those locations.

The data can provide information that can be used to focus intrusive sampling and provide a list of expected volatile organic compounds.

4.3.3 Evaluation of Vadose-Zone Soils

Intrusive investigations for the presence of contaminants in focused areas of the soils surrounding the landfills will be conducted using both indirect and direct evaluation techniques.

[26] EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.

[27] GORE-SORBER is a trademark of W. L. Gore and Associates, San Francisco, California.

Subsurface investigations will include geophysical logging. Specific characterization locations and activities that will be used in Phase I-B are identified in the SAP (Appendix A).

4.3.3.1 Direct-Push Investigative Techniques

Subsurface investigations using direct-push installations will be employed as part of the assessment for soil surrounding selected landfills. This technology can be used to install casing and collect samples with minimal to no excess waste soil generated. Installations will be used to obtain information relating to a number of in situ soil characteristics including gamma radiological levels, alpha-emitting radionuclides through neutron measurement, organic-vapor concentrations, and soil moisture. This technology will work well in the unconsolidated sediments and fill material adjacent to buried waste. However, direct-push techniques vary considerably and range from static load rigs with hydraulic-push capabilities (e.g., cone penetrometers) to dynamic load rigs with hydraulic hammers (e.g., GeoProbe, EuroDrill[28]). Hanford Site experience favors the hydraulic hammer rigs over cone penetrometers because of their ability to "hammer through" consolidated material. The hydraulic hammer rigs also have the capability to rotate the drill string to facilitate rod insertion and extraction. Cone penetrometers, in contrast, tend to bend rods when encountering consolidated materials (i.e., compacted soil layers, rocks, caliche).

4.3.3.2 Geophysical Logging

Radioactivity levels will be measured in soils using geophysical-logging instrumentation. With the exception of *Bin 3 -- Dry Waste Alpha Landfills*, radioactive contamination generally is expected to be represented primarily by gamma emitters (e.g., Cs-137). Driven small-diameter casing will be installed and used for down-hole logging with gamma-logging tools. The depth of a driven casing will be limited by the subsurface conditions (i.e., cobbles or gravel), amount of driving force applied, and friction along the length of the casing. Gross-gamma and passive-neutron logging probes will be used to determine areas of potentially high Am-241 (surrogate for plutonium) and Pu-239/240 concentrations. The small-diameter gross-gamma and passive-neutron-probe system uses bismuth-germanium-detector instrumentation for gross counting of the gamma-emitting radionuclides in the soil as a function of depth. The passive-neutron logging instrument with a He-3 detector can be configured to detect the neutron flux present in the below-ground soil environment. Active neutron logging will be used to determine soil-moisture content. Soil moisture will be reported as a percent volume fraction. Organic vapors present in the soil also can be detected using vapor instrumentation.

Spectral-gamma logging also will be performed in accessible boreholes and groundwater wells near the landfills. Site-well status records indicate that wells may be accessible and are appropriately configured for geophysical logging. A list of wells available for logging is presented in the SAP (Appendix A). Sodium-iodide spectral-gamma logging also may be performed in the direct-push boreholes.

Borehole-logging equipment currently in use for vadose-zone characterization at the Hanford Site includes spectral-gamma logging, neutron-moisture logging, and passive-neutron logging.

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[28] Eurodrill is owned by Colcrete Eurodrill, Derbyshire, United Kingdom.

The spectral-gamma logging systems typically use either a cryogenically cooled, high-purity germanium (HPGe) crystal, or sodium-iodide or bismuth-germanate crystals to detect, identify, and quantify gamma-emitting radionuclides in the subsurface. While the HPGe detector is capable of higher "energy-peak" resolution, a minimum borehole inner diameter of 26 cm (4 in.) is required to deploy the HPGe detector because of the on-board cryogenic cooling system. Direct-push techniques typically do not accommodate 26 cm (4-in.-) diameter casings without much greater cost and much larger equipment, when compared to 13 cm (2-in.) and smaller casing typical of most direct-push techniques. An 18 cm (7-in.) casing was driven to the caliche layer (42.6 to 45.7 m or 140 to 150 ft bgs) in the 200 West Area in support of tank farms characterization in the SX, T, TX, and TY Tank Farms. The sodium-iodide and bismuth-germanate detectors are conducive to slim-hole applications. Of the two, the bismuth-germanate detector has a higher density and therefore higher efficiency. The bismuth-germanate also is more susceptible to being "swamped out" in high-radiation fields.

The neutron-moisture logging system uses a 50-mCi americium/beryllium source and H-3 detector. Neutrons emitted from the source are scattered back to the detector after impinging on the surrounding materials. The dominant scattering mechanism in soil involves interaction with hydrogen atoms. The count rate at the detector is a function of the amount of hydrogen in the formation and can be correlated to soil-moisture content. Neutron-moisture logs are useful for stratigraphic correlations because of the tendency for fine-grained sediments to hold moisture and mobile contaminants.

Passive-neutron logging measures ambient neutron flux in the borehole and is a qualitative indicator of the presence of alpha-emitting radionuclides. Alpha particles emitted from the decay of transuranic elements (e.g., Pu-239, Am-241) interact with light elements in the soil (primarily oxygen), generating secondary neutrons by (alpha, n) reactions.

4.3.4 Inspection and Survey of Unused Caisson Interiors

Intrusive inspection of the interiors of caissons that are believed to be unused/empty will be conducted at two of the 200-SW-2 OU landfills. Evaluations will include both visual inspections and radiological-survey activities. Inspections will be used to determine if waste is present in the caissons. Visual inspections will be conducted directly or remotely, depending on access availability and a hazard assessment. Caisson interior evaluations may include remote-camera surveys, and radiological monitoring. Those evaluations or surveys that are applicable for Phase I-B are identified below. Specific characterization locations and activities that will be used in Phase I-B are identified in the SAP (Appendix A).

4.3.4.1 Visual Inspections and Camera Surveys

Examination of the interior of suspect unused/empty caissons will be performed using a remote camera for selected caissons, where access is available and exposure hazards are manageable. This investigative technique will provide real-time information on the current conditions within these caissons. Conditions such as the extent of corrosion, debris, and waste present (if any) will be noted. Remote-camera surveys also will be used to document caissons that are fully intact, dry, and show no signs of past failure.

4.3.4.2 Hand-Held and Deployed Instrument Radiological Surveys

Intrusive radiological surveys of unused/empty caisson interiors will be used to provide information concerning the presence or absence of radiological contamination. A number of deployment systems are available; some include a configuration with camera-survey equipment. Alpha, beta, and gamma radiation detectors can be used with some systems. Equipment and survey specifications are presented in the SAP.

4.4 ITEMS OF INTEREST

During one of the Phase I-A DQO workshops, Ecology noted a desire to verify, through historical records research and nonintrusive investigations, the ability to identify and locate items on the items of interest list that was provided to RL during the 200-SW-2 OU collaborative discussions. An agreement was reached that, in part, requested RL to summarize the items of interest based on waste form and to focus on logic to support decisions on the items of interest. This list was included in the Phase I-A DQO summary report and was evaluated through a data-gap analysis to determine those items that could be located using nonintrusive survey techniques.

The items of interest list was carried forward into the Phase I-B DQO process and again evaluated to determine those items that could be located using the nonintrusive and intrusive characterization techniques proposed for use during the Phase I-B investigation. The results of this evaluation and the resulting data-gap analysis are provided in Table 4-1. This table lists the items of interest, those nonintrusive and intrusive surveying/sampling techniques that have the potential to locate these items, the potential limitations of these surveying/sampling techniques, and the expected threat of release presented by each waste form.

Phase I-B investigations continue nonintrusive reconnaissance-level radiological, geophysical, and soil-gas surveys in landfill areas not previously addressed in the Phase I-A DQO summary report, as discussed in Section 4.2. The items of interest covered by nonintrusive survey portions of this work plan and associated SAP include suspect caisson locations, D-2 column from PUREX K-cell, shallow-buried waste, cell cover blocks, potential organic waste, and large tanks.

As discussed in Section 4.2, limited intrusive investigations will be conducted during Phase I-B using direct pushes near the centers of all landfills, to better understand the lateral continuity of geologic layers, based on lithologic logs from surrounding groundwater-monitoring wells. Fine-grained sediment layers are of particular interest, because they tend to impede the downward movement of moisture and mobile contaminants through the vadose zone. Additional direct-push investigations will be performed in portions of landfills potentially impacted by atypical excess moisture. These direct pushes address the items of interest related to landfills that previously flooded and contained pond disposal areas.

Items of interest addressed by the Phase I-B work plan and SAP are highlighted in Table 4-1. Remaining items of interest may require intrusive investigations within landfill trenches and will be addressed in later site investigation phases.

Table 4-1. Data-Gap Analysis for Ecology's Items of Interest. (6 Pages)

Items of Interest	Characterization Techniques that Have a Potential for Locating Items of Interest	Potential Limitations of Characterization Techniques	Potential Threat to Human Health, Worker Safety, and/or Environment
High-dose-rate lab-packed liquid waste	Plastic gamma scintillators; high-purity germanium detectors; direct-push technologies (DPT) utilizing gamma logging	High-dose-rate lab-packed liquid waste may be detected using nonintrusive radiological survey techniques; however, the amount of shielding provided by the container and soil overburden may make locating this waste type difficult. DPT gamma logging may indicate the presence of this waste, assuming the location can be identified with some accuracy. Care must be exercised to avoid penetrating high dose rate lab packed liquid waste with DPT techniques.	**Low** – Potential threat to human health, worker safety, or the environment only if waste is unearthed.
Remote-handled low-level waste	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging	Remote-handled low-level waste may be detected using nonintrusive radiological survey techniques; however, the amount of shielding provided by the container and soil overburden may make locating remote-handled low-level waste difficult. DPT gamma logging may indicate the presence of this waste, assuming the location can be identified with some accuracy.	**Low** – Potential threat to human health, worker safety, or the environment only if waste is unearthed.
Caissons used to receive remote-handled high-dose-rate and transuranic (TRU)[a] waste	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging Ground-penetrating radar (GPR); electromagnetic induction (EMI); total magnetic field (TMF) DPT utilizing gamma and neutron logging	Caissons may be detected using nonintrusive radiological survey techniques; however, the amount of shielding provided by the container and soil overburden may make locating caisson waste difficult. Locations of caissons in the landfills may be determined using GPR, EMI, or TMF survey techniques. Interferences caused by fines, or nearby buildings and utilities, may limit the effectiveness of these techniques. DPT gamma and neutron logging may indicate the presence of high-dose rate waste and TRU waste within caissons, assuming the locations can be identified with some accuracy.	**Low** – Potential threat to human health, worker safety, or the environment only if waste is unearthed. Records indicate that the waste does not contain liquids in quantities that could affect groundwater. Post-1970 TRU waste within caissons will be retrieved via the Tri-Party Agreement Milestone M-091 program.
Suspect caisson locations[b]	GPR, EMI, TMF Visual and radiological surveys (Plastic gamma scintillators; high-purity germanium detectors) to determine if waste is present.	Locations of caissons in the landfills may be determined using records research or GPR, EMI, and/or TMF survey techniques. Interferences caused by fines, or nearby buildings and utilities may limit these techniques' effectiveness.	**Low** – Records indicate that these caissons did not receive waste. Characterization will focus on locating and verifying that the caissons are empty.

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Items of Interest	Characterization Techniques that Have a Potential for Locating Items of Interest	Potential Limitations of Characterization Techniques	Potential Threat to Human Health, Worker Safety, and/or Environment
Burial boxes containing remote-handled and contact-handled low-level waste	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging	Burial boxes containing remote-handled low-level waste may be detected using nonintrusive radiological survey techniques; however, the amount of shielding provided by the container and soil overburden may make locating burial boxes containing remote-handled low-level waste difficult. Contact-handled low-level waste, which is expected to have a lower dose rate than remote-handled low-level waste, may be difficult to locate through the soil with either nonintrusive or intrusive techniques. DPT gamma logging may indicate the presence of remote handled waste, assuming the location can be identified with some accuracy.	**Low** – Potential threat to human health, worker safety, or the environment only if remote handled waste is unearthed. Contact-handled low-level waste is expected to have a significantly lower dose rate and therefore would not pose a threat to human health, worker safety, or the environment.
Areas of highly contaminated tumbleweeds	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging	Landfills containing buried tumbleweeds may be detected using nonintrusive radiological survey techniques; however, the amount of shielding provided by the soil overburden may make locating tumbleweeds difficult. DPT gamma logging may indicate the presence of highly contaminated tumbleweeds, assuming the location can be identified with some accuracy.	**Low** –Tumbleweeds were likely not containerized and contamination is expected to be co-mingled with the surrounding soil. However, without a mechanism to drive the contamination, this waste form is not expected to be a threat to human health, worker, or groundwater.
Fuel element clips and spacers	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging	Fuel element clips and spacers may be detected using nonintrusive radiological survey techniques, however, the amount of shielding provided by the container and soil overburden may make locating fuel element clips and spacers difficult. DPT gamma logging may indicate the presence of fuel element clips and spacers, assuming the location can be identified with some accuracy.	**Low** – Fuel element clips and spacers are expected to consist of activated metal, rather than spent fuel. Therefore this waste form is not expected to be a threat to human health, worker, or groundwater.
Irradiated fuel elements	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging	Irradiated fuel elements may be detected using nonintrusive radiological survey techniques, however, the amount of shielding provided by the container and soil overburden may make locating Irradiated fuel elements difficult. DPT gamma logging may indicate the presence of irradiated fuel elements, assuming the location can be identified with some accuracy.	**Low** – Potential threat to human health, worker safety, or the environment only if spent fuel is unearthed. Spent fuel may be designated as remote-handled TRU and retrieved as part of the M-091 Program. Few references to irradiated fuel in burial records.
Ten large concrete burial boxes of soil from the S Tank Farm	GPR, EMI, TMF Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging	Location of concrete boxes in the landfills may be determined using GPR, EMI, or TMF survey techniques. Interferences caused by fines, or nearby buildings and utilities may limit the effectiveness of these techniques. DPT gamma logging may indicate the presence of this waste, assuming the location can be identified with some accuracy.	**Low** – Records indicate that the waste soil is low dose rate. Worker safety and human health is not expected to be an issue.

Table 4-1. Data-Gap Analysis for Ecology's Items of Interest. (6 Pages)

Items of Interest	Characterization Techniques that Have a Potential for Locating Items of Interest	Potential Limitations of Characterization Techniques	Potential Threat to Human Health, Worker Safety, and/or Environment
Reactor fuel waste	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging	Reactor fuel waste may be detected using nonintrusive radiological survey techniques, however, the amount of shielding provided by the container and soil overburden may make locating this waste difficult. DPT gamma logging may indicate the presence of this waste, assuming the location can be identified with some accuracy.	**Low** – Reactor fuel waste is expected to consist of activated metal, rather than spent fuel. Therefore this waste form is not expected to be a threat to human health, worker, or groundwater.
Drums of test reactor and isotope production fuel waste	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging	Fuel element clips and spacers may be detected using nonintrusive radiological survey techniques, however, the amount of shielding provided by the container and soil overburden may make locating fuel element clips and spacers difficult. Location of metal drums in the landfills may be determined using GPR, EMI, or TMF survey techniques. Interferences caused by fines, or nearby buildings and utilities may limit the effectiveness of these techniques. DPT gamma logging may indicate the presence of fuel element clips and spacers, assuming the location can be identified with some accuracy.	**Low** – Fuel element clips and spacers are expected to consist of activated metal, rather than spent fuel. Therefore this waste form is not expected to be a threat to human health, worker, or groundwater.
Areas of the landfills that were flooded with standing water[b]	Electrical-resistance technologies (ERT); Records review DPT moisture logging	Location in landfills not likely to be confirmed using nonintrusive sampling/surveying techniques, however records research can provide information to locate these areas. ERT or moisture logging may be used to indicate areas of past flooding events.	**Med** – Excessive water in landfills can provide a mechanism for contaminant transport to groundwater.
Pond disposal area, 216-T-4B Pond[b]	ERT; Records review DPT moisture logging	Location in landfills not likely to be confirmed using nonintrusive sampling/surveying techniques, however records research can provide information to locate these areas. ERT or moisture logging may be used to indicate areas of ponding.	**Med** – Excessive water in landfills can provide a mechanism for contaminant transport to groundwater.
Suspect TRU or contact-handles low-level waste-TRU in TSD units[a]	N/A – out of scope	N/A – out of scope.	**N/A** - TRU waste is not in the scope of this investigation. The M-091 Program is tasked with retrieval of this waste form.
Pre-1970s transuranically contaminated material	Records review; Xenon daughter product detection; Copper foil activation; Am-241 detection; passive neutron detection	Location in landfills not likely to be confirmed using nonintrusive sampling/surveying techniques. Xenon daughter product detection, copper foil activation, passive neutron detection, and/or Am-241 detection methods have the potential to locate and quantify transuranic elements in soil, however the location must be determined with some accuracy for these methods to be effective.	**Med** – Lacks transport mechanism. Therefore this waste form is not expected to be a threat to human health, worker, or groundwater.

Table 4-1. Data-Gap Analysis for Ecology's Items of Interest. (6 Pages)

Items of Interest	Characterization Techniques that Have a Potential for Locating Items of Interest	Potential Limitations of Characterization Techniques	Potential Threat to Human Health, Worker Safety, and/or Environment
D-2 Column from PUREX K Cell[b]	GPR, EMI, TMF	Location of the PUREX D-2 Column in the landfills may be determined using GPR, EMI, or TMF survey techniques. Interferences caused by fines, or nearby buildings and utilities may limit the effectiveness of these techniques. DPT gamma logging may indicate the presence of the D-2 Column, assuming the location can be identified with some accuracy.	**Low** - Potential for release only if the column contained a liquid heel containing significant concentrations of COPCs. Standard practices at Hanford Site facilities included flushing of equipment to mitigate contamination and for product recovery, therefore column contents would not likely be a threat to human health, worker safety, or groundwater.
Shallow buried waste[b]	GPR, EMI, TMF; Records review Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging	Locations of shallow-buried waste in the landfills may be determined using GPR, EMI, or TMF survey techniques. Interferences caused by fines, or nearby buildings and utilities may limit the effectiveness of these techniques. Shallow buried waste may be detected using nonintrusive radiological survey techniques, however, the amount of shielding provided by the container may make locating waste difficult.	**Med** - Potential threat of release if waste is unearthed by human or biological intruders or erosion.
Rotten wooden boxes	Records review noting areas of subsidence; no-walk and no-drive zones established in landfills; visual inspection for surface depressions	Location in landfills not likely to be confirmed using nonintrusive sampling/surveying techniques.	**Med** - Threat of release based on loss of integrity of burial container. However, without a mechanism to drive contaminants, the threat to groundwater is expected to be minimal. Personnel safety associated with subsidence.
Drywells, vertical pipe units (VPU)	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma logging GPR, EMI, TMF DPT utilizing gamma logging	VPUs may be detected using nonintrusive radiological survey techniques; however, the amount of shielding provided by the container and soil overburden may make locating VPU waste difficult. Locations of VPUs in the landfills may be determined using GPR, EMI, or TMF survey techniques. Interferences caused by fines, or nearby buildings and utilities, may limit the effectiveness of these techniques. DPT gamma logging may indicate the presence of high-dose rate waste within VPUs, assuming the locations can be identified with some accuracy.	**Low** – Potential threat to human health, worker safety, or the environment only if waste is unearthed. Records indicate that the waste does not contain liquids in quantities that could affect groundwater.
High-activity Plutonium Finishing Plant waste	Plastic gamma scintillators; high-purity germanium detectors; DPT utilizing gamma and neutron logging	PFP waste materials do not contain gamma emitters of sufficient energy to be detected at the surface; DPT gamma and neutron logging may indicate the presence of this waste, assuming the location can be identified with some accuracy.	**Low** – Potential threat to human health, worker safety, or the environment only if waste is unearthed.

Table 4-1. Data-Gap Analysis for Ecology's Items of Interest. (6 Pages)

Items of Interest	Characterization Techniques that Have a Potential for Locating Items of Interest	Potential Limitations of Characterization Techniques	Potential Threat to Human Health, Worker Safety, and/or Environment
Acid-soaked waste trenches	Records review DPT techniques with soil sampling and in situ pH analysis	Location in landfills is known based on historical records, however no other information is available regarding the waste form or concentrations of contaminants. Waste form and concentrations of contaminants are not likely to be confirmed using nonintrusive sampling/surveying techniques.	**Med -** historical records indicate that the acid-soaked waste was buried in shallow trenches; therefore, the potential for release is greater because of the possibility of biological intrusion or erosion of overburden; acidic environments are known to mobilize otherwise immobile COPCs (e.g., plutonium).
Cell cover blocks[b]	GPR, EMI, TMF	Locations of cell cover blocks in the landfills may be determined using records research or GPR, EMI, and/or TMF survey techniques. Interferences caused by fines, or nearby buildings and utilities may limit the effectiveness of these techniques.	**Low -** cell cover blocks, unless grossly contaminated, do not present a threat to human health, worker, or groundwater.
Potential organic waste[b]	Passive soil-gas or Active soil-gas sample techniques (DPT)	If the liquids are organic, detection is possible using intrusive or nonintrusive soil-gas sampling techniques. However, detection of organic vapors at the surface of the landfills is dependent on the liquids having breached their containment. Organic liquids contained within drums or boxes with no loss of integrity likely will not be detected using intrusive or nonintrusive sampling techniques. Care must be exercised to avoid penetrating intact containers with DPT.	**Med -** potential for release if integrity of containers is compromised. Depending on the volumes of contaminated liquid organics present and the packaging, the threat of release may be higher. Liquid organic may present a groundwater threat if they are present in large volumes.
Potential liquid waste containing tritium	Tritium detectors	Tritium, or helium-3/helium-4 ratio, analysis can be performed on soil-gas samples; however, all identified fully developed methods are intrusive. Soil-gas samples collected for other analyses could be used, but no reports/literature was found to indicate that the results would correlate to tritium concentrations below grade. Intrusive soil-gas sampling methods have been used in this manner: PNNL developed and used such methods with Bechtel Hanförd Inc., to delineate the tritium groundwater plume at the 618-11 Burial Ground (see RL, 2001, *Helium Isotope Analysis for Soil Gas to Delineate Tritium Plumes*, Technology Deployment Benefit Analysis Fact Sheet, and PNNL-13675	**Low -** Potential for release if integrity of containers is compromised. Based on the small volumes of liquids noted in the historical records, this waste likely is not a threat to groundwater.

Table 4-1. Data-Gap Analysis for Ecology's Items of Interest. (6 Pages)

Items of Interest	Characterization Techniques that Have a Potential for Locating Items of Interest	Potential Limitations of Characterization Techniques	Potential Threat to Human Health, Worker Safety, and/or Environment
Large tanks[b]	GPR, EMI, TMF	Locations of large tanks in the landfills may be determined using records research or GPR, EMI, and/or TMF survey techniques. Interferences caused by fines, or nearby buildings and utilities may limit the effectiveness of these techniques.	**Low -** Potential for release only if the tanks contained liquid heels containing significant concentrations of COPCs. Standard practices at Hanford Site facilities included flushing of equipment and tanks to mitigate contamination and for product recovery, therefore tank contents would not likely be a threat to human health, worker, or groundwater; large tanks provide a future potential for subsidence as the tanks deteriorate.
Pre-August 1987 laboratory waste	Records review; Passive soil-gas or Active soil-gas sample techniques; DPT (soil vapor samples)	Location in landfills is not likely to be confirmed using nonintrusive sampling/surveying techniques. DPT (soil vapor) may be used to detect the presence of laboratory waste, if the location of the waste can be determined with some accuracy.	**Low** - Potential for release if integrity of container is compromised.
Mixed LLW disposal pre-1987	Records review; Passive soil-gas or Active soil-gas sample techniques; DPT (soil vapor samples)	Location in landfills is not likely to be confirmed using nonintrusive sampling/surveying techniques. DPT (soil vapor) may be used to detect the presence of mixed waste, if the location of the waste can be determined with some accuracy.	**Low** - Potential for release if integrity of container is compromised.
Z Plant Burning Pit Waste	Records review; Passive soil-gas or Active soil-gas sample techniques; DPT (soil vapor samples)	Location in landfills is not likely to be confirmed using nonintrusive sampling/surveying techniques. DPT (soil vapor) may be used to detect the presence of waste residues, if the location of the waste can be determined with some accuracy.	**Low -** Waste burned in the pit was not containerized; therefore, only chemical residue is expected.

[a]TRU waste will be dispositioned through the TRU Retrieval Project and is not in the scope for the 200-SW-2 Operable Unit.

[b]Highlighted items of interest will be addressed during Phase I-B investigations using nonintrusive soil-vapor or geophysical surveys and limited intrusive direct pushes. Remaining items of interest may require intrusive methods within landfill trenches and will be addressed in subsequent remedial investigation phases.

PNNL-13675, *Measurement of Helium-3/Helium-4 Ratios in Soil Gas at the 618-11 Burial Ground.*
RL, 2001, *Helium Isotope Analysis for Soil Gas to Delineate Tritium Plumes*, Technology Deployment Benefit Analysis Fact Sheet.

COPC = contaminant of potential concern.
DPT = direct-push technology.
EMI = electromagnetic induction.
ERT = electrical-resistance technology
GPR = ground-penetrating radar.
LLW = low-level waste.
N/A = not applicable.
PNNL = Pacific Northwest National Laboratory.
PUREX = Plutonium-Uranium Extraction Plant.
TMF = total magnetic field.
TRU = transuranic waste.
TSD = treatment, storage, and/or disposal.
VPU = vertical pipe unit.

Table 4-2 provides a compilation of potentially appropriate analytical measurement methods that may be used during the landfill investigation. Analytical methods highlighted in Table 4-2 are planned for use during Phase I-B investigations. The remaining analytical methods or other methods will be used in subsequent phases, as appropriate. Details regarding targeted items of interest for the Phase I-B investigation are provided in the SAP (Appendix A). Additional potential characterization technologies are detailed in PNNL-16105, *Technology Survey to Support Revision to the RI/FS Work Plan for the 200-SW-2 OU at the U.S. Department of Energy's Hanford Site*.

The data-gap analysis for the items of interest will be carried forward again into future-phase DQO processes and evaluated against those characterization techniques proposed for the appropriate phase investigation.

4.5 OTHER SOURCES OF CHARACTERIZATION DATA

Other projects being performed on the Hanford Site Central Plateau have the potential to provide useful data that may be applied to the overall characterization of the 200-SW-2 OU landfills. Some of these projects directly overlap the characterization work being performed to support landfill characterization. These projects include the TRU waste-retrieval work being performed in support of Tri-Party Agreement Milestone M-091, characterization work associated with the Central Plateau Ecological Risk Assessment, characterization and remediation activities associated with the 618-10 and 618-11 Burial Grounds, and characterization work to support the 200-PW-1 OU. All data collected from these related projects will be integrated and presented in the RI report for consideration during the FS. Additionally, information and lessons learned from other DOE sites addressing the remediation of radioactive solid-waste landfills (e.g., Idaho National Laboratory) will be closely monitored and applied, where appropriate.

Table 4-2. Potentially Appropriate Analytical Measurement Methods. (4 Pages)

Variable	Potentially Appropriate Measurement Method [a]	Possible Limitations or Reservations
Radiological screening[m]	Mobile surface-contamination monitor. Static HPGe detectors.	Because of shielding, buried sources may be difficult to detect [b].
Tritiated Liquid	Tritium monitor	Tritium, or helium 3/helium 4 ratio, analysis can be performed on soil-gas samples; however, all identified fully developed methods are intrusive. Soil-gas samples collected for other analyses could be used, but no reports/literature was found that indicates that the results would correlate to tritium concentrations below grade. Intrusive soil-gas sampling methods have been used in this manner, and PNNL developed and used such methods with Bechtel Hanford Inc., to delineate the tritium groundwater plume at Burial Ground 618-11 (see RL, 2001, and PNNL-13675). Further research may uncover a method to correlate nonintrusive soil-gas measurements to tritium concentrations, however at this time it appears that this method should be considered as an intrusive method.

Table 4-2. Potentially Appropriate Analytical Measurement Methods. (4 Pages)

Variable	Potentially Appropriate Measurement Method [a]	Possible Limitations or Reservations
Metallic objects, Disturbed soil, trench/landfill boundaries[m]	Ground penetrating radar (GPR) [c]	GPR is a radar-reflection surface geophysical survey technique that detects contrasts in dielectric constants in the below grade environments from the surface. Requires subjective interpretation of the reflected signals. Lack of reflective below grade surfaces or the presence of interfering matrices can complicate or invalidate the findings. The presence of nearby buildings and utilities can interfere with reflected signals. Fines (e.g., clay, heavy fly ash) can act as a reflector to the radar signal.
Metallic objects, Disturbed soil, trench/landfill boundaries[m]	Electromagnetic induction (EMI) [c]	EMI is a surface geophysical survey technique that measures electrical conductivity in below grade soils, based on detected changes in electrical fields. The results of EMI generally are used to support the interpretation of GPR surveys and identify buried metal objects. Typical methods include EM-34, EM-61[k]. Nearby buildings and utilities can cause interferences.
Metallic objects, Disturbed soil, trench/landfill boundaries[m]	Total magnetic field (TMF) [c]	TMF is a system used to perform examinations of potentially contaminated soil or buried objects. TMF uses electromagnetic analysis to differentiate and classify the unique electromagnetic signature of contaminants. The technique has a limited use history and is unproven for many contaminants.
VOCs[m]	Passive soil gas	Passive soil gas measurement is a method whereby a hydrophobic collector (e.g., EMFLUX® or GORE-SORBER™) [d, e] is placed on the ground surface or buried in a shallow hole with direct exposure to the soils for a period of 72 hours or more. The collector then is retrieved and analyzed in the laboratory, using standard analytical methods, to determine the presence of chemical contamination. Can test for a wide variety of chemicals in a single test and can be integrated for a large area and time to determine chemical presence. Results can be influenced by barometric pressure changes and weather events.
VOCs	Colorimetric tube	Tube capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. Requires collection of a sample medium for use.
VOCs	Flame ionization detector (e.g., Foxboro OVA 128) [f]	Detection limit (1 to 5 mg/kg, methane-equivalent). Instrument capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. Limited to hydrogen-containing compounds. Requires collection of a sample medium for use.
VOCs	Photoacoustic infrared analyzer (e.g., B&K 1302)[g]	Instrument capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. Requires collection of a sample gas volume.
VOCs	Photoionization detector (e.g., thermo analytical organic-vapor monitor)	Detection limit (1 to 5 mg/kg, isobutylene-equivalent). Instrument capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. Limited to photoionizing compounds at 10.6 eV. Requires collection of a sample gas volume, but may be accomplished at the soil surface.
VOCs	Portable gas chromatograph with photoionization detector (e.g., Photovac 10S Plus) [h]	Detection limit (sub-mL/m^3 levels, depending on VOC of interest). Instrument capability must be compared to the site-specific need to determine if field detection limits would be sufficient for the VOC of interest. Need to know specific VOCs of interest. Limited to photoionizing compounds at 11.7 eV. Requires collection of a sample gas volume.
VOCs	Transportable mass spectrometer	Instrument use requires extensive training. Capital cost and setup is high; operational cost is moderate. Requires collection of a sample gas volume.

Table 4-2. Potentially Appropriate Analytical Measurement Methods. (4 Pages)

Variable	Potentially Appropriate Measurement Method [a]	Possible Limitations or Reservations
VOCs	MIRAN SapphiIRe Ambient Air Analyzer [j]	Instrument uses infrared absorption spectra to determine compound concentration. Single compound selection can create false positives if another compound is present that has an absorption spectra of the target compound.
Gamma emissions	Cone penetrometer; sodium-iodide detector logging	A closed-end rod is pushed into the soil to the desired depth. A small-diameter sodium-iodide detector (or other suitable detector) is used to log the gross gamma response with depth. The cone penetrometer is not effective in cobbly or rocky soils, or compacted fine-grained sediments.
Gamma emissions[m]	Direct push; sodium-iodide detector logging	A small-diameter casing is pushed into the soil to the desired depth. A small-diameter sodium-iodide detector (or other suitable detector) is used to log the gamma response with depth. Direct-push methods (e.g., GeoProbe™, hydraulic hammer) may be ineffective in cobbly or rocky soils given their hydraulic hammering and rotational capabilities.
Fission products	Borehole spectral gamma logging with HPGe detector	Gamma-ray logging provides the concentration profiles of gamma-emitting radionuclides such as Am-241, Pu-239, and many fission products in a borehole environment. It is considered by some to be more accurate than sampling and laboratory assay because the assay is performed in situ with less disturbance of the sample, there is higher vertical spatial resolution, and the sample size is much larger. This method may also be more economical than traditional sampling and analysis. This method does not assess radionuclides or daughter products that do not emit gamma rays. The gamma energies from these isotopes are at the low end of the spectrum, which results in high numerical minimum detectable activities and possible matrix effects from other isotopes. This technique requires the use of a single casing (installed by drilling or driving) in contact with the soil formation.
Plutonium	Borehole passive neutron logging	Passive neutron logging provides indication of the presence of alpha-emitting isotopes. Because of the very low incidence of spontaneous plutonium fission and alpha-N reactions, the passive neutron profile is orders of magnitude lower than the gamma emissions.
Transuranics	Borehole passive/active neutron-logging methods	This technique uses source materials or generators to release neutrons into the soil formation. Passive detectors measure the response to the neutron flux as a means of detecting specific transuranic constituents. Logistical problems can arise with the handling of intense sources or generators.
Areas of known flooding or past use as a pond[m]	Borehole neutron-neutron moisture logging	N-N moisture logs can be used to determine current moisture content profiles of the subsurface through new or existing boreholes. The moisture profiles are often directly correlated to contaminant concentrations, sediment grain size, composition, or subsurface structural features. For this project, the moisture profile may be useful for helping determine the location of contamination and/or the location of the ditch and establish geologic conditions to support contaminant fate and transport modeling. It may also be correlated to reflections identified in ground-probing radar surveys.

Table 4-2. Potentially Appropriate Analytical Measurement Methods. (4 Pages)

Variable	Potentially Appropriate Measurement Method [a]	Possible Limitations or Reservations

[a] Other methods may be identified and implemented in conjunction with technology development.
[b] The tenth-value layer for Cs-137 in soil is about 25 cm (10 in.) So roughly for each 30 cm (1 ft) that a source is buried underground, the dose rate is reduced by an order of magnitude. Waste often was covered with a minimum of 1.2 m (4 ft) of soil. To be detected, the source strength at the surface has to be 10 μR/h, then at 1.2 m (4-ft) depth it would have to have been 10 mrem/h.
[c] Details of geophysical surveys performed in 2005 are contained in D&D-28379.
[d] EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.
[e] GORE-SORBER is a trademark of W. L. Gore and Associates, San Francisco, California.
[f] Foxboro and OVA 128 are trademarks of The Foxboro Company, Foxboro, Massachusetts.
[g] B&K is a trademark of Brüel and Kjær, S&V, Nærum, Denmark.
[h] Photovac 10S Plus is a trademark of Photovac, Inc., Waltham, Massachusetts.
[j] MIRAN and the SapphIRe Ambient Air Analyzer are registered trademarks of Thermo Electron Corporation, Franklin, Massachusetts.
[k] EM34 and EM61 are trademarks of Geonics Limited, Mississauga, Ontario, Canada.
[m] Highlighted analytical methods are planned for use during Phase I-B investigations. Subsequent phase investigations may use the remaining or other analytical methods, as appropriate. Final methods will be determined through the appropriate data-quality objectives process for each phase.
NOTE: There is no footnote for the letters (i) and (l).

D&D-28379, *Geophysical Investigations Summary Report; 200 Area Burial Grounds: 218-C-9, 218-E-2A, 218-E-5, 218-E-5A, 218-E-8, 218-W-1A, 218-W-2A, and 218-W-11.*
PNNL-13675, *Measurement of Helium-3/Helium-4 Ratios in Soil Gas at the 618-11 Burial Ground.*
RL, 2001, *Helium Isotope Analysis for Soil Gas to Delineate Tritium Plumes*, Technology Deployment Benefit Analysis Fact Sheet.
™ GeoProbe is a registered trademark of GeoProbe Systems, Salinas, Kansas.

EMI = electromagnetic induction.
GPR = ground-penetrating radar.
HPGe = high-purity germanium.
PNNL = Pacific Northwest National Laboratory.
TMF = total magnetic field.
VOC = volatile organic compound.

Although information contained in Sections 4.5.1, 4.5.2, 4.5.3, and Appendix D are not part of planned scope under this RI/FS work plan and are being conducted by others, the data have direct applicability and utility to the 200-SW-2 OU RI. Sampling and analysis of near-surface soils following retrieval of waste by the M-091 Program provides valuable insights into the possible migration of contaminants from leaking drums into the vadose zone beneath landfill trenches (a condition possible in the 200-SW-2 OU landfills). Vadose-zone sampling and analysis for carbon tetrachloride under the 200-PW-1 OU RI provides valuable insights into the regional source of carbon tetrachloride (i.e., discharge of carbon tetrachloride to Plutonium Finishing Plant cribs rather than materials disposed into 200-SW-2 OU landfill trenches). Finally, organic-vapor samplers placed on unused portions of the 218-W-4C Landfill in support of ecological risk-assessment sampling provides valuable data necessary to support administrative reclassification of this area in the WIDS database based on its lack of use.

Data from other programs will be leveraged whenever appropriate in support of the 200-SW-2 OU landfills RI report and the FS. Coordination and integration of similar activities and sharing of data, where possible, provide cost-effective and timely support to the overall RI/FS process.

Information associated with the characterization and retrieval of waste from the 618-10 and 618-11 Burial Grounds may provide useful data that may be applied to the characterization of the 200-SW-2 OU landfills. Some of the key reference documents include the following:

- WMP-20394, *Design Basis/Design Criteria Report 618-10 And 618-11 Burial Ground Remedial Action Project*
- WMP-17684, *618-10 and 618-11 Burial Ground Remedial Design Technical Workshop Summary Report*
- PNNL-13656, *Enhanced Site Characterization of the 618-4 Burial Ground*
- EPA/ROD/R10-01/119, *Declaration of the Interim Record of Decision for the 300-FF-2 Operable Unit*
- DOE/RL 88-31, *Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1 Operable Unit, Hanford Site, Richland, Washington.*

4.5.1 TRU Waste Retrieval

Sampling is being conducted in conjunction with the TRU waste-retrieval activities. This sampling has been divided into three steps. The first step, which was completed before waste retrieval, involved organic-vapor sampling at the vent risers in the TRU waste trenches within the 218-W-3A, 218-W-4B, and 218-W-4C Landfills. In addition, passive organic-vapor soil samplers were placed at the 218-E-12B Landfill, because the TRU waste trenches in this landfill lack vent risers. Additional detail regarding TRU waste-retrieval activities can be found in Section 3.3.

Step 2 of the sampling is being conducted after the TRU or suspect-TRU waste has been removed from the trenches. This activity involves a radiological survey of the trench bottom, a survey of the perimeter of the asphalt pad (if present), and 1.8 to 3.7 m (6 to 12-ft) direct pushes every 6 m (20 ft) around the trench perimeter to collect vapor samples.

Step 3 will involve, as applicable, removal of soil samples for laboratory analysis. The locations of soil samples will be determined by the results of the Step 2 surveys.

Results of sampling performed to date are included in Appendix D of this RI/FS work plan.

The 200-SW-2 OU Project will continue to maintain close coordination with the TRU Waste Retrieval Project to identify "opportunistic sampling" events to support 200-SW-2 OU Project data needs in support of the RI/FS process.

4.5.2 200-PW-1 Operable Unit

The RI for the 200-PW-1 OU included soil-vapor sampling and analysis used to explore the dispersed carbon tetrachloride plume in the vadose zone in the 200 West Area. Sampling being conducted in support of characterization at the 200-PW-1 OU includes passive and active organic-vapor sampling. Active vapor sampling has been performed at the vent risers in the 218-W-3A and 218-W-4C Landfills. Passive soil-vapor sampling has been performed in the 218-W-3A landfill. Active soil-vapor sampling was performed using direct-push technology around the perimeter of the 218-W-4C Landfill. Data collected from the 200-PW-1 OU will be evaluated for applicability in the FS.

Results of sampling performed to date are included in Appendix D of this RI/FS work plan.

4.5.3 Ecological Risk Assessment Sampling

Passive organic-vapor samplers were placed on the Central Plateau, including at the unused annex of the 218-W-4C Landfill, as part of investigation activities to support development of the Central Plateau Ecological Risk Assessment.

Results of sampling performed to date indicate no detectable levels of organics in the unused annex of the 218-W-4C Landfill.

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS

This chapter describes the RI/FS (investigation/evaluation) process for the 200-SW-2 OU landfills and the closure approach for the 200-SW-1 OU (NRDWL and 600 CL) landfills. A summary of the coordinated regulatory process for the 200-SW-2 OU landfills is provided in Section 5.1. Section 5.2 outlines the 200-SW-1 OU closure approach for the NRDWL and the 600 CL.

The development of, and rationale for, the RI/FS process is consistent with the Implementation Plan (DOE/RL-98-28). The purpose of the Implementation Plan is to define the framework for implementing soil-characterization activities in the 200 Areas to ensure consistency in applying regulatory and documentation requirements and in defining characterization requirements and reaching remedial-action decisions. The CERCLA RI/FS process has been followed for this OU and also meets the requirements of RCRA corrective action. In addition, these CERCLA RI/FS activities will be coordinated with the RCRA TSD closure activities.

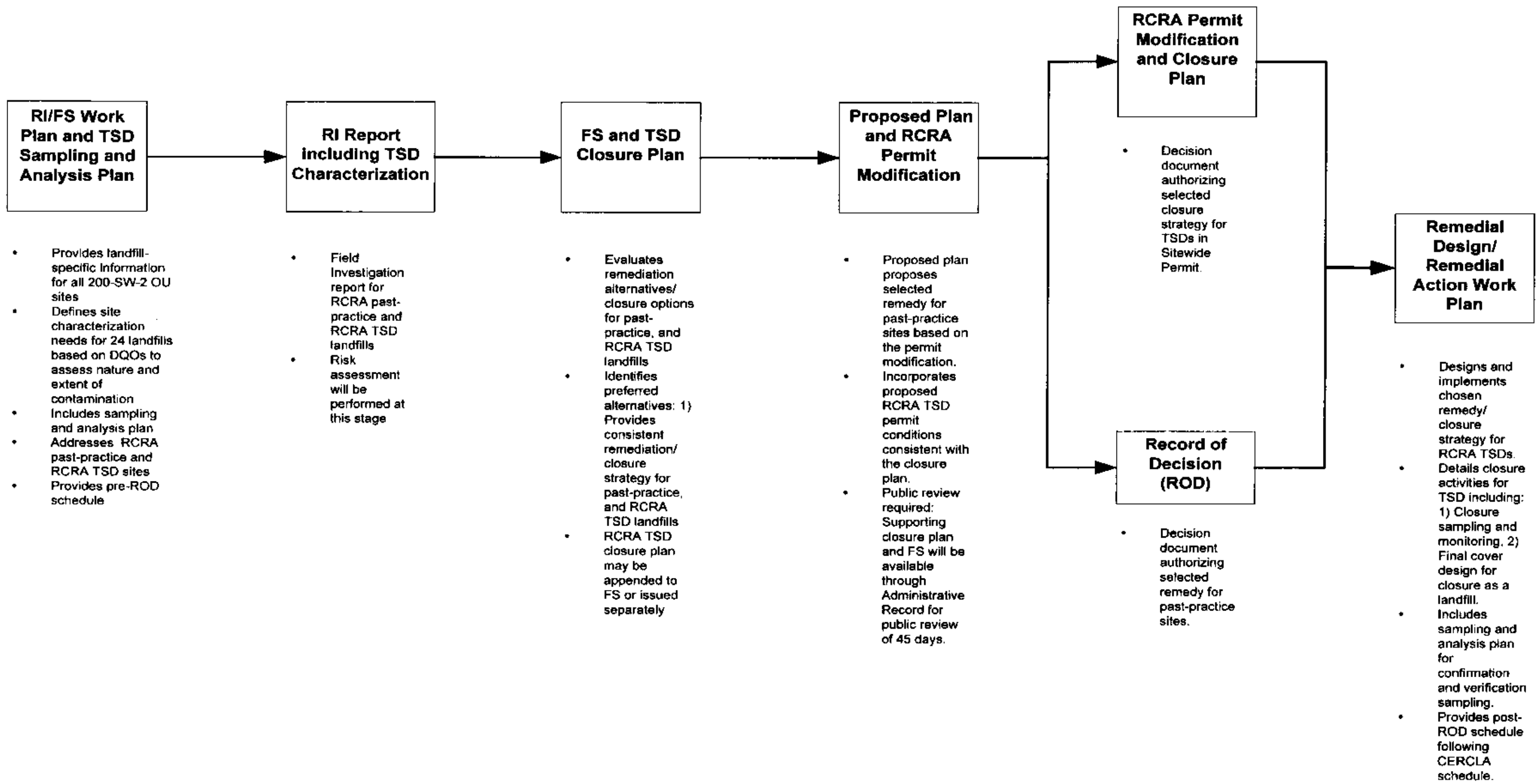
Section 5.3 outlines the tasks to be completed during the RI phase, including planning and conducting field sampling activities and preparing the RI report. These tasks are designed to effectively manage the work, satisfy the DQOs (identified in Chapter 4.0), document the results of the RI, and manage the waste generated during field activities. The general purpose of the RI is to characterize the nature, extent, 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 phase include preparing an FS, proposed plan, and ROD for the CERCLA remedial actions. In parallel, a proposed modification to the Hanford Facility RCRA Permit (WA7890008967) will be conducted for the RCRA TSD-unit landfills. Following issuance of the ROD, the remedial design/remedial action is implemented. Post-record-of-decision treatability investigations may be conducted in support of the remedial design and subsequent remedial action, if necessary. Figure 5-1 illustrates the process.

Project management occurs throughout the RI/FS process. Project management is used to direct and document project activities (so that the objectives of the work plan are met) and to ensure that the project is kept within budget and on schedule. The initial project management activity will be to assign individuals to roles established in Section 7.2 of the Implementation Plan (DOE/RL-98-28). Project management activities also include the following:

- 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
- Community relations.

Figure 5-1. Coordinated Regulatory Process for RCRA Past-Practice, and RCRA Treatment, Storage, and/or Disposal Unit Closure.



Appendix A of the Implementation Plan (DOE/RL-98-28) provides the overall quality assurance framework that was used to prepare an OU-specific quality-assurance project plan for the 200-SW-2 RI (Appendix A, Section A2.0). Appendix C of the Implementation Plan reviews data management activities that are applicable to the 200-SW-2 OU RI/FS and describes the process for the collection/control of data, records, documents, correspondence, and other information associated with OU activities.

5.1 COORDINATED REGULATORY PROCESS FOR THE 200-SW-2 OPERABLE UNIT

The CERCLA regulations of 40 CFR 300 require an RI/FS process for proposing cleanup action at sites listed on the National Priorities List (40 CFR 300, Appendix B). The Tri-Party Agreement constitutes the required interagency agreement between the DOE and the EPA for implementation of National Priorities List cleanup at the Hanford Site. The Tri-Party Agreement also includes the agreed-upon approach between DOE and Ecology to implement RCRA corrective-action requirements during National Priorities List cleanup. Under separate provisions, the Tri-Party Agreement implements the approach that DOE will follow for permitting and closure of Hanford Site TSD units.

Ecology has jurisdiction through RCW 70.105, "Hazardous Waste Management," over waste with chemical constituents (in particular, dangerous waste and dangerous-waste constituents) and the chemical component in mixed waste (i.e., mixtures of dangerous waste and radiological contaminants) that exceed regulated concentrations under RCRA or WAC 173-303. RCRA and RCW 70.105 do not provide jurisdiction over waste with radiological contaminants only. CERCLA authority, however, encompasses not only hazardous/dangerous chemical wastes and mixtures, but also radionuclides. By applying CERCLA authority concurrently with RCRA closure and corrective-action requirements, cleanup will be addressing all regulatory and environmental obligations at the 200-SW-2 OU as effectively and efficiently as possible. Additional options for disposal of closure, corrective-action, and remedial-action wastes at the Environmental Restoration Disposal Facility are possible by applying CERCLA authority jointly with that of RCRA. The Environmental Restoration Disposal Facility ROD Amendment allows for disposal of RCRA wastes in addition to CERCLA wastes. By allowing flexibility in final-disposal options, the DOE intends to minimize disposal costs as much as possible while remaining fully protective of human health and the environment.

The RI/FS process will be used to reach a decision that will meet requirements for both National Priorities List cleanup and RCRA corrective action. TSD closure/postclosure for TSD-unit landfills within the boundaries of the 200-SW-2 OU will be coordinated with the RI/FS process. In addition, information from DOE and Ecology, 2005 (Collaborative Agreement) must be considered in formulating the regulatory strategy for the 200-SW-2 OU. The coordinated regulatory process for characterization and remediation of the 200-SW-2 OU will use this RI/FS work plan in combination with the Implementation Plan (DOE/RL-98-28) to satisfy the requirements for both an RI/FS work plan and a RCRA field investigation/corrective measures study work plan. General facility background information, potential ARARs, preliminary RAOs, and preliminary remedial technologies developed in the Implementation Plan are incorporated by reference into this RI/FS work plan.

This RI/FS work plan and subsequent CERCLA documentation and processes that are developed will refine the basic information provided in the Implementation Plan to meet the site-specific needs for the 200-SW-2 OU. This RI/FS work plan also will provide RCRA TSD-unit landfill closure-plan information addressing facility description, location and process information (Sections 2.1 and 2.2), waste characteristics (Section 3.1), and groundwater monitoring (Section 3.4). Following the completion of all phases of characterization, a RI report summarizing the results of the RI will be prepared and issued including the characterization information required for RCRA TSD-unit landfill closure decisions. The RI and FS will build on the basic information provided in the Implementation Plan to identify and evaluate remedial technologies and ARARs.

The following subsections summarize regulatory drivers used to implement the 200-SW-2 OU coordinated regulatory process. Table 5-1 summarizes the key points made in Sections 5.1.1 through 5.1.7.

5.1.1 Regulatory and Tri-Party Agreement Drivers for Closure of TSD-Unit Landfills

The 200-SW-2 OU contains RCRA-permitted TSD-unit landfills. Landfills that received hazardous and/or mixed waste after the relevant effective date of regulation are subject to regulation as TSD-unit landfills. General TSD closure standards of WAC 173-303-610, and specific landfill closure requirements of WAC 173-303-665(6), "Landfills," "Closure and Post-Closure Care," are applicable to these landfills. The TSD closure standards simultaneously apply to these landfills independent of, and pursuant to, the Tri-Party Agreement. This is because WAC 173-303 applies to Hanford Site TSD-unit activities as a matter of Washington State law, while at the same time as a matter of agreement between RL and Ecology.

The Tri-Party Agreement requires land-disposal unit closure to follow applicable closure standards. The TSD-unit landfills are land-disposal units and, as such, are subject to the provisions of the Tri-Party Agreement Action Plan, Section 6.3.2 (Ecology et al., 1989b). The Tri-Party Agreement does not require TSD units to be subject to the past-practice process. The Tri-Party Agreement Action Plan, Section 3.2, addresses permitting and closure of TSD units at the Hanford Site. TSD units identified for closure concurrent with past-practice activities nevertheless still are subject to closure in accordance with WAC 173-303 and are not subject to the past-practice process in lieu of or in addition to those requirements. Coordination of TSD-unit closure with OU work essentially means to organize the work performed to meet RCRA closure standards with the work performed to reach past-practice unit decisions to minimize duplication of effort and prevent overlap. The closure standards for landfills do not require or address removal of wastes or soils. Under WAC 173-303, landfills are TSD units designed for the permanent disposal of dangerous wastes.

Table 5-1. Summary of Key Regulatory and Tri-Party Agreement Requirements.

Regulatory and Tri-Party Agreement Drivers for Treatment, Storage, and Disposal Closure	Requirements for Characterization Data for Treatment, Storage, and Disposal Landfills	Regulatory and Tri-Party Agreement Drivers for Past-Practice Landfills	Requirements for Characterization Data for Past-Practice Landfills	Regulatory Requirements for Cleanup of Pre-1970 Buried Waste	Regulatory Requirements for Disposal of Mixed Waste Post-August 19, 1987	Summary of Commitments Made in the Collaborative Agreement
• TSD-unit burial grounds are RCRA landfills. • The closure regulations apply irrespective of the Tri-Party Agreement. • The Tri-Party Agreement does not require TSD units to be subject to the past-practice process. • The Tri-Party Agreement requires land disposal unit closure to follow applicable closure standards. • The closure standards for landfills do not require or address removal of wastes or soils. • The closure standards are specific regarding when waste is expected to be removed. • Alternate requirements can be applied to TSD-unit closure if a release has occurred. • There are no known releases from TSD-unit landfills.	• The need for field characterization is driven by the need for removal or decontamination. • The closure standard for landfills does not include removal or decontamination. • The integration of TSD units with cleanup must follow the Tri-Party Agreement Action Plan, Section 5.5. • The Tri-Party Agreement Action Plan, Section 5.5 requires TSD-unit closures to follow WAC 173-303. • Any sampling at TSD-units should be for the purpose of closure under WAC 173-303. • Sampling and analysis for TSD-unit landfill closure should be for purposes of the cover. • The Tri-Party Agreement Action Plan, Section 5.3 requires TSD units to be closed pursuant to WAC 173-303-610.	• TSD closure standards are not directly applicable to past-practice units. • Past-practice units at Hanford are subject to the CERCLA remedial action process. • Past-practice units are potentially subject to RCRA corrective action. • The Tri-Party Agreement seeks to accomplish the objectives of both programs for all operable unit work. • Some TSD-units are listed in the Tri-Party Agreement for closure concurrent with past-practice work.	• Characterization needs at past - practice units are driven by the remedial investigation/feasibility study process. • TSD-unit closure standards do not automatically apply to past-practice landfills. • Characterization efforts should be commensurate with acceptable levels of uncertainty. • In addition to meeting applicable or relevant and appropriate requirements, a remedy must be determined to be protective.	• Pre-1970 buried waste is not subject to environmental rules for active management. • The U.S. Department of Energy plans to address pre-1970 buried wastes in accordance with the CERCLA process. • Decisions regarding pre-1970 transuranic buried waste will depend on results of the evaluation.	• Mixed waste disposed after August 19, 1987, is subject to regulation as a TSD unit. • Inadvertent Mixed Waste disposal after August 19, 1987, when discovered is discussed with Ecology and actions taken as appropriate.	• The work plan agreement constitutes a comprehensive working agreement. • The work plan agreement addresses sampling at TSD units during investigation. • The scope of certain agreement aspects is questionable. • The commitment to identify sources of authority can be useful. • Some aspects of the work plan agreement seem to clearly extend beyond regulations.

CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
RCRA = *Resource Conservation and Recovery Act of 1976.*
Tri-Party Agreement = *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989a).
Tri-Party Agreement Action Plan = *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al. 1989b).
WAC 173-303 = "Dangerous Waste Regulations."
WAC 173-303-610 = "Closure and Post-Closure."

After the RI is complete, remedial alternatives/closure strategies will be developed and evaluated against WAC 173-303-610(2), "Closure Performance Standard," performance standards and evaluation criteria. The integration process for the evaluation of remedial alternatives includes the preparation of an FS/closure plan that will satisfy the requirements for a corrective-measures study report. Both documents are required to include identification and development of corrective measures/remedial alternatives and an evaluation of those alternatives. The corrective-measures study generally also includes a recommended alternative, which typically is the purpose of the proposed plan under CERCLA. The FS will include a section that provides corrective action recommendations for past-practice units and a closure plan that will address the RCRA TSD units in this OU. The FS also will include further evaluation and refinement of potential ARARs that were identified in the Implementation Plan (DOE/RL-98-28).

5.1.2 Characterization Data Requirements for TSD-Unit Landfill Closure

The Tri-Party Agreement Action Plan, Section 3.2 states, "some TSD groups/units, primarily land disposal units, are included within operable units…, and will be addressed concurrently with past-practice activities as defined in Section 5.5." The Tri-Party Agreement Action Plan, Section 5.5, defines the interface between TSD units and past-practice units. Section 5.5 includes discussion about SAPs that outline the manner in which RCRA closure/postclosure plan requirements will be met in the work plan and subsequent documents. Per Section 5.5, proposed closure/postclosure activities are intended to (1) meet RCRA closure standards and requirements, (2) be consistent with closure requirements specified in the *Hanford Facility RCRA Permit*, and (3) be coordinated with the recommended remedial action(s) for the associated operable unit. Sampling at TSD-unit landfills should be for the purpose of closure under WAC 173-303.

Coordinating closure or permitting with the past-practice investigation and remediation is deemed necessary to preclude overlap and duplication of work. Section 5.5 indicates that the disposition of TSD units must be in accordance with Chapter 6.0. Chapter 6.0 drives TSD closure to follow the requirements of WAC 173-303, which does not require removal of wastes for landfill closures. WAC 173-303-610(4)(a), "Closure; Time Allowed for Closure," indicates that at closure the owner or operator "must treat, remove from the unit or facility, or dispose of on site, all dangerous wastes in accordance with the approved closure plan." WAC 173-303-610(5), "Disposal or Decontamination of Equipment, Structures, and Soils," states that "all contaminated equipment, structures and soils must be properly disposed of or decontaminated unless otherwise specified in WAC 173-303-640(8), WAC 173-303-650(6), WAC 173-303-655(8), WAC 173-303-660(9),WAC 173-303-665(6), or under the authority of WAC 173-303-680(2) and (4)." Thus, the closure standard for landfills does not include waste removal or site decontamination.

The Tri-Party Agreement Action Plan, Section 6.5, states that "in some instances, RCRA TSD units are included in OUs and are scheduled for investigation and closure." Sampling and analysis for TSD-unit landfill closure should be for purposes of the cover. Dangerous waste placed into a RCRA landfill is intended, by regulation, to remain disposed after closure. Notwithstanding, sampling and analysis needs at landfills should be established using the DQO process. Because TSD-unit landfills do not require removal of dangerous waste at closure, the need for and level of sampling during their closure should be based on the DQO process. Some characterization may be necessary to support design and implementation of a landfill cover, if appropriate for compliance with the closure standards. The closure performance standard for landfills is design and construction of a final cover meeting the requirements of WAC 173-303-665(6)(a)(i) through (v). There are no requirements in WAC 173-303-665(6) for removal or decontamination of wastes or soils and hence no clear regulatory driver for field characterization during closure of landfills.

5.1.3 Regulatory and Tri-Party Agreement Drivers for Remediation of RCRA Past-Practice Landfills

Landfills that are not TSD units are classified in the Tri-Party Agreement as past-practice units. Past-practice units (including landfills) identified in the Tri-Party Agreement Action Plan, Appendix C are listed on the National Priorities List. Consequently, they are subject to CERCLA remedial action as implemented through the Tri-Party Agreement. Landfills cannot be simultaneously classified as TSD units and past-practice units. However, TSD units and past-practice units can be simultaneously addressed to meet the requirements of the respective individual authorities. The Tri-Party Agreement intent is to meet the objectives of both the RCRA and CERCLA past-practice processes for all OU work.

The Tri-Party Agreement Action Plan contains provisions for investigation and management of TSD units in conjunction with past-practice units. The intent is to provide the information necessary for performing TSD closure in coordination with the RI/FS documents. This does not mean that departure from the TSD closure standards is necessary. Coordination requires that past-practice units be evaluated using the RI/FS process, and TSD closure is attained in accordance with TSD closure standards, but efforts are made to perform and document the respective activities concurrently, as appropriate.

TSD closure standards are not applicable to landfills that did not receive hazardous and/or mixed waste after the relevant effective dates of regulation. However, past-practice units potentially are subject to RCRA corrective action. Past-practice units are potentially subject to the provisions of RCRA corrective action, because TSD operations occur at the Hanford Site. The regulations for implementing Washington's corrective-action program are found in WAC 173-303-64610, "Closure and Post-Closure," "Purpose and Applicability." These regulations would be used in their entirety for remediation performed using the RCRA past-practice process and require, at a minimum, application of certain portions of WAC 173-340, "Model Toxics Control Act – Cleanup," in the performance of corrective action. Only the substantive requirements deemed to be ARAR to the selected remedy would be used for remediation performed using the CERCLA past-practice process.

The requirements of RCRA corrective action are not precluded by a site's listing on the National Priorities List, nor are Federal facilities excluded from the requirements of RCRA corrective action. All TSD facilities are required to initiate RCRA corrective action at their facilities, as appropriate. RCRA corrective action is intended to address releases to the environment that contain dangerous constituents, even if the material released was not dangerous or mixed waste.

By statute, RCRA corrective-action provisions (as appropriate) must be addressed in all RCRA permits.

5.1.4 Characterization Data Requirements for RCRA Past-Practice Remediation

The RI/FS process drives characterization needs at past-practice units. Field characterization generally is required at various stages in the RI/FS process. During the scoping phase, existing data are assembled and evaluated and are used to formulate initial CSMs. This information is used to support the logic for the associated work plan and is included in the work plan. During the RI, field sampling usually is necessary to support understanding of the nature and extent of contamination and refinement of CSMs. This information, in turn, is used to support further development of the remedial action. In addition, activities necessary to characterize and assess risks of exposure are intended for further development during the FS.

The general purpose of site characterization under CERCLA is to increase understanding of the level, type, and distribution of contamination at a site. Methods proposed for characterization must be appropriate for the level of uncertainty that will be acceptable for the identified end use of the site. Site-characterization work plans should begin with identification of COPCs and unique site conditions. As information is gathered to support risk-informed decision-making, balance between uncertainty and any benefit derived from further data collection/characterization should be sought. Often, uncertainty can be addressed by making conservative assumptions in selecting models and their parameters.

Past-practice units are subject to the RI/FS process that requires the gathering of adequate information to support evaluation of feasible alternatives for remedial action. This process is by design intended to explore various alternatives in the context of a predetermined criteria set. ARARs must be identified for each alternative that is considered as a potential remedy. Non-TSD-unit landfills received many of the same wastes as TSD-unit landfills, but TSD-unit closure standards do not automatically apply to past-practice landfills. A feasible alternative for remediation of non-TSD-unit landfills is closure as a TSD landfill. This option, if selected, would be implemented by identifying the TSD-unit landfill closure standards as relevant and appropriate, based on the nature and circumstances of the disposal activities. After completion of the RI/FS process and development of a proposed plan, the ARARs for the preferred remedy would be identified.

In addition to meeting ARARs, a remedy must be determined to be protective. It is important to note that although the identification of ARARs for a response action provides for the backbone of the cleanup, consideration also must be given to the level of protectiveness provided by the ARARs, so that additional provisions can be made, if necessary. For landfills that were operated in a manner similar to TSD-unit landfills, it may be protective from a RCRA perspective to initiate landfill closure in accordance with TSD-unit landfill standards. Depending on the circumstances, the presence of radionuclides not subject to the RCRA closure standards could be cause for further evaluation under CERCLA to ensure that the selected remedy is protective.

5.1.5 Regulatory Requirements for Pre-1970 Buried Waste

DOE waste that was disposed of in the past is not automatically subject to today's waste-disposal standards. From a RCRA perspective, waste disposed of before the relevant effective date would not be subject to RCRA generator or TSD standards unless and until the waste is exhumed and actively managed.[29] However, solid waste (as defined by RCRA) is subject to the RCRA corrective-action requirements at facilities (such as the Hanford Site) that engage in TSD activities, irrespective of the date of disposal. This means that pre-1970 buried waste potentially is subject to the Washington RCRA corrective-action program, as well as CERCLA remedial action.

Although environmental laws and regulations pertaining to active management do not directly apply to pre-1970 buried wastes, current DOE plans may include characterization of many older past-practice disposal sites under CERCLA or RCRA corrective action. Such evaluation would be performed in the same manner, using the same criteria as for other hazardous substances.

DOE assumes that post-1970 retrievably-stored TRU waste will be shipped to the Waste Isolation Pilot Plant. Decisions regarding pre-1970 buried radioactive waste that may contain transuranic elements will be made through the Tri-Party Agreement using the CERCLA or RCRA past-practice process in collaboration with the EPA and/or Ecology.[30]

5.1.6 Regulatory Requirements for Mixed Waste Disposed of After August 19, 1987

Mixed waste disposed of after the effective date of regulation[31] is subject to the RCRA TSD standards. Mixed wastes disposed to the RCRA landfills after the effective date of regulation historically have been coded on RCRA Part A Permit application maps with the color green. These disposal locations have been referred to as "green islands." Technically, "green islands" are subject to regulation as RCRA landfills.

Mixed wastes that were disposed of after the effective date, in accordance with all applicable standards, should be regulated in the same manner as other TSD-unit landfills (i.e., there is no requirement to remove wastes at closure). However, post-effective date wastes that were disposed of in a manner that is inconsistent with regulatory requirements that were applicable at the time of disposal potentially are subject to enforcement action, possibly including

[29] The EPA has defined active management as "physically disturbing the accumulated wastes within a management unit or disposing additional hazardous wastes into existing waste management units containing previously disposed wastes." [54 FR 36597, "Radioactive Waste, Byproducts Material Final Rule"] See also the EPA, 1964, memo, dated April 6, 1994, for clarification regarding the concept of active management at closing disposal facilities.

[30] Source, special nuclear, byproduct material, as defined by the *Atomic Energy Act of 1954*, is not subject to WAC 173-303, including RCRA corrective action.

[31] The State of Washington has informed the U.S. Department of Energy via letter (Ecology 1996) that the effective date for mixed waste regulation in the State of Washington is August 19, 1987.

investigation and cleanup to standards that exceed TSD-unit landfill closure standards. In other words, mixed wastes disposed of after the effective date of regulation are required to be disposed of in compliance with standards that are applicable at the time of disposal (e.g., land-disposal restrictions and minimum technical requirements).

5.1.7 Summary Assessment of Commitments in the Collaborative Agreement

The Collaborative Agreement (Ecology and DOE, 2005) was entered into between RL and Ecology in an effort to resolve, "...substantial differences between RL and Ecology in their respective understandings of the required scope of the work plan" for the 200-SW-1 and 200-SW-2 OUs. The resultant document and its appendices constitute a comprehensive working agreement between RL and Ecology. The Collaborative Agreement includes language for conducting RI in a phased manner. This language addresses sampling at TSD and non-TSD units that includes site-survey and -screening activities discussed in the Tri-Party Agreement Action Plan, Section 7.3.2. Section 7.3.2 specifically states that, "...the sampling instruction will acknowledge WAC 173-303 as related to the TSD Units." This provision would not add any new requirements for sampling. As discussed in Section 5.1.3 above, sampling for TSD-unit landfill closure should be in accordance with WAC 173-303-665(6), and to support design and implementation of a landfill cover, if appropriate for compliance with the closure standards.

5.2 CLOSURE OF THE NONRADIOACTIVE DANGEROUS WASTE LANDFILL AND THE 600 AREA CENTRAL LANDFILL

The 200-SW-1 OU originally was a process-based OU composed of various nonradioactive landfills, dumps, and pits. In June 2002, RL and Ecology signed Tri-Party Agreement change requests concerning modification to 200 Areas OU cleanup milestones. The change requests established a CERCLA RI/FS process for the 200-SW-1 OU that included coordination of the closure of the NRDWL, a RCRA TSD unit, with the RI/FS process. The waste sites in the 200-SW-1 OU, along with the 200-SW-2 OU, which contained radioactive waste sites, were submitted for RI under DOE/RL-2004-60, Draft A, in 2004.

In 2006, a supplemental characterization DQO process was conducted to provide for additional RI needs for waste sites on the Central Plateau. As a result of this DQO process, the Tri-Parties agreed to establish new OUs grouped by similarity of remedial decision. Two of these new OUs (the 200-MG-1 and 200-MG-2 OUs) were developed to include waste sites that already have sufficient data that have been evaluated and that the determination has been made that a remedial decision for the site is straightforward and the remedy is readily implementable, such as remove/treat/dispose, monitored natural attenuation, or no action for shallow waste sties. Most of the waste sites in 200-SW-1 OU have been reassigned to the 200-MG-1 and 200-MG-2 OUs. The two waste sites in the 200-SW-1 OU that were not reassigned are the NRDWL and the 600 CL.

The following conclusions were made for the closure of NRDWL (the RCRA TSD unit) and 600 CL (the nonhazardous solid-waste landfill) to support the basis for closing these landfills outside the RI/FS process.

- NRDWL and 600 CL are nonradioactive landfills that were operating at the time that the National Priorities List was developed for the 200 Areas. Therefore, these landfills were not originally included as waste sites that needed a CERCLA response action. However, because operations have ceased for the 600 CL, the landfill was included in Appendix C of the Tri-Party Agreement Action Plan. NRDWL was added to Appendix C to allow for the closure to be coordinated with the CERCLA RI/FS process.
- NRDWL and the 600 CL will have to be closed under WAC 173-303-610 and WAC 173-304-407, respectively
- Any characterization at RCRA TSD-unit landfills undergoing closure should be limited in purpose to information necessary to achieve closure standards (e.g., installation of a cap)
- A Tri-Party Agreement Change Request will be needed to document the removal of these two landfills from Appendix C of the Tri-Party Agreement Action Plan
- All hazardous substances that may be COPCs are addressed under the landfill-closure requirements. Additional benefits afforded under a CERCLA remedial-action process for certain COPCs, such as remediation of radionuclides, are not necessary to close these landfills
- Previous closure documents have been prepared for these landfills. These documents need to be updated and resubmitted.

5.2.1 Regulatory Basis for Closure Decisions

NRDWL and the 600 CL were operating under existing environmental regulations that apply to landfills, WAC 173-303-610, "Closure and Post-Closure," and WAC 173-304-407, respectively. These environmental regulations contain requirements for closure and postclosure care that are protective of human health and the environment, and their use is agreed upon by the Tri-Parties. Before updated and revised closure plans for both NRDWL and the 600 CL are submitted, the 200-SW-2 OU project will evaluate and take advantage of efficiencies that could be realized from a single closure plan that integrates both sites. Efficiencies could be seen in three phases: (1) one closure plan for both sites, (2) design of an integrated barrier, and (3) construction of the integrated barrier. Full collaboration and approval from Ecology on a single closure plan will take place before submittal.

CERCLA response actions address those inactive waste sites that have had a release or a potential for release that threatens human health and/or the environment at the Hanford Site. Waste sites were evaluated, and hazard ranking scores were developed and aggregated into areas, and were listed on the National Priorities List in 1987. NRDWL was an active TSD unit in 1987 and, as such, was not included when the 200 Areas National Priorities List was developed.

Therefore, there are no CERCLA statutory requirements that have to be met when closing this landfill as a RCRA TSD unit. A Tri-Party Agreement change request will be needed to remove the landfill from Appendix C of the Tri-Party Agreement Action Plan, because there no longer will be a need to coordinate the closure activities with CERCLA remedial activities.

The 600 Area CL also was operating when the original National Priorities List was developed and was not included in the list of waste sites. However, because operation ceased in 1996, the 600 Area CL was added to Appendix C of the Tri-Party Agreement Action Plan. Appendix C contains the list of waste sites that require RI or action under Section 120 of CERCLA (i.e., the CERCLA RI/FS process) (Tri-Party Agreement Action Plan, Section 3.5). Therefore, to close the landfill separate from the CERCLA RI/FS process, a Tri-Party Agreement change request needs to be prepared to remove this waste site from the appendix. The Tri-Party Agreement change request should provide the justification that, as a nonhazardous solid-waste landfill, closing the 600 Area CL under the existing regulations (WAC 173-304) will satisfactorily protect human health and the environment.

Both NRDWL and the 600 CL received only nonradioactive waste during their operating life. No radioactive contamination has been found during past operations and groundwater monitoring. All hazardous substances that may become COPCs are addressed under the existing landfill closure requirements, either WAC 173-303-610 for NRDWL closure as a RCRA TSD or WAC 173-304-407 for 600 CL closure as a solid-waste landfill. Additional benefits afforded under a CERCLA remedial-action process for certain hazardous substances, such as radionuclides, are not necessary to close these landfills.

Because there are no longer any waste sites in the 200-SW-1 OU, the OU designation no longer is needed and can be deleted from Appendix C of the Tri-Party Agreement Action Plan through a change request. Under CERCLA, OUs are developed to organize waste sites that have common characteristics, to assist in the RI/FS process. Because there no longer will be any waste sites in the 200-SW-1 OU, there is no need for the OU to exist.

The environmental documentation required for closing NRDWL under WAC 173-303-610 and the 600 CL under WAC 173-304-407 is presented in Table 5-2.

Table 5-2. Documentation Required to Close the Nonradioactive Dangerous Waste Landfill and the 600 Area Central Landfill.

Nonradioactive Dangerous Waste Landfill	600 Area Central Landfill
Tri-Party Agreement Change Request	Tri-Party Agreement Change Request
Closure/Postclosure Plan[a]	Closure/Postclosure Plan[a]
Hanford Facility RCRA Permit Modification Part V – Closure Part VI – Postclosure	Not applicable
Final Status Groundwater Monitoring Plan[b]	Groundwater Monitoring Plan[b]
NEPA Documentation	NEPA Documentation
SEPA Checklist	SEPA Checklist

[a]Efficiencies will be evaluated for a single, combined closure plan.
[b]The groundwater monitoring plans will be included in the closure plan.
NEPA = *National Environmental Policy Act of 1969*.
SEPA = State Environmental Policy Act (RCW 43.21C).

5.3 PHASED CHARACTERIZATION APPROACH

Because of the complexity of the 200-SW-2 OU landfills, a phased characterization approach will be employed to aid in remedial-action decision making. This approach was approved by RL and Ecology and documented in CCN 0073214.

A preliminary investigation began in 2004 to perform a comprehensive review of existing documentation associated with the 200-SW-1 and 200-SW-2 OU waste sites. A large quantity of records were compiled and reviewed, and a database was created to capture information that could be used to focus future field-characterization activities. In 2005, a collaborative negotiations process was held with the Tri-Parties. This process rescoped the focus of the DQO to follow. The focus was changed to 22 waste sites in the 200-SW-2 OU. These waste sites included the original Bin 3A and Bin 3B sites and consisted of 21 landfills and one unplanned release. This DQO process (Phase I-A) focused on nonintrusive investigations of these waste sites, including geophysical, radiological, and organic-vapor surveys.

After Phase I-A field characterization activities were performed in mid-2006, a Phase I-B DQO process was performed to support development of this RI/FS work plan. The Phase I-B DQO process focused on 24 landfills in the 200-SW-2 OU. Additionally, two landfills in the 200-SW-1 OU were included in the DQO, as well as in this RI/FS work plan; however, it is proposed that these landfills be closed outside of the CERCLA process and are included in this documentation for informational purposes only. A proposed regulatory path forward for closure of these landfills is presented in Chapter 5.0 of this RI/FS work plan. The Phase I-B DQO and SAP (Appendix A) focuses on additional nonintrusive characterization, as well as intrusive characterization techniques. The proposed phased characterization process for the 200-SW-2 OU landfills is presented in Figure 5-2.

Additional DQO processes will be held following completion of the Phase I-B field characterization activities, as required. These potential future phase DQO processes will further aid in characterizing the landfills and will focus on progressively more intrusive characterization techniques, as required. Information gathered from all phases, including treatability investigations, will be used to support risk assessments, further refinement of the preliminary conceptual site models, and ultimately choosing a remedial-action alternative.

5.4 COMMUNITY RELATIONS

One of the useful and important aspects of the RI/FS process is to establish effective community relations. Community relations activities serve to keep communities informed of the activities at the site and help the DOE and regulatory agencies anticipate and respond to community concerns. A community relations plan has been developed for the Hanford Site to provide a framework for overall community relations and public involvement in activities under the purview of the Tri-Party Agreement. Community relations activities are conducted in accordance with *Hanford Site Tri-Party Agreement Public Involvement Community Relations Plan, Hanford Federal Facility Agreement and Consent Order* (DOE et al., 2002).

The community relations plan provides guidelines for future community relations activities at the Hanford Site. The plan provides a site mailing list, a conveniently located place for access to public information about the site, an opportunity for a public meeting when the FS and proposed plan are issued, and a summary of public comments on the FS and proposed plan and Ecology's response to those comments.

The community relations plan intends to fulfill applicable state and Federal laws regarding development of community involvement and public participation plans. The plan also serves as one of the overall public participation plans guiding public involvement at the Hanford Site. The Tri-Parties recognize that people nationwide are concerned and affected by the Hanford Site.

5.5 REMEDIAL-INVESTIGATION ACTIVITIES

This section summarizes the planned tasks that have been and/or will be performed during the RI phase for the 200-SW-2 OU, including the following:

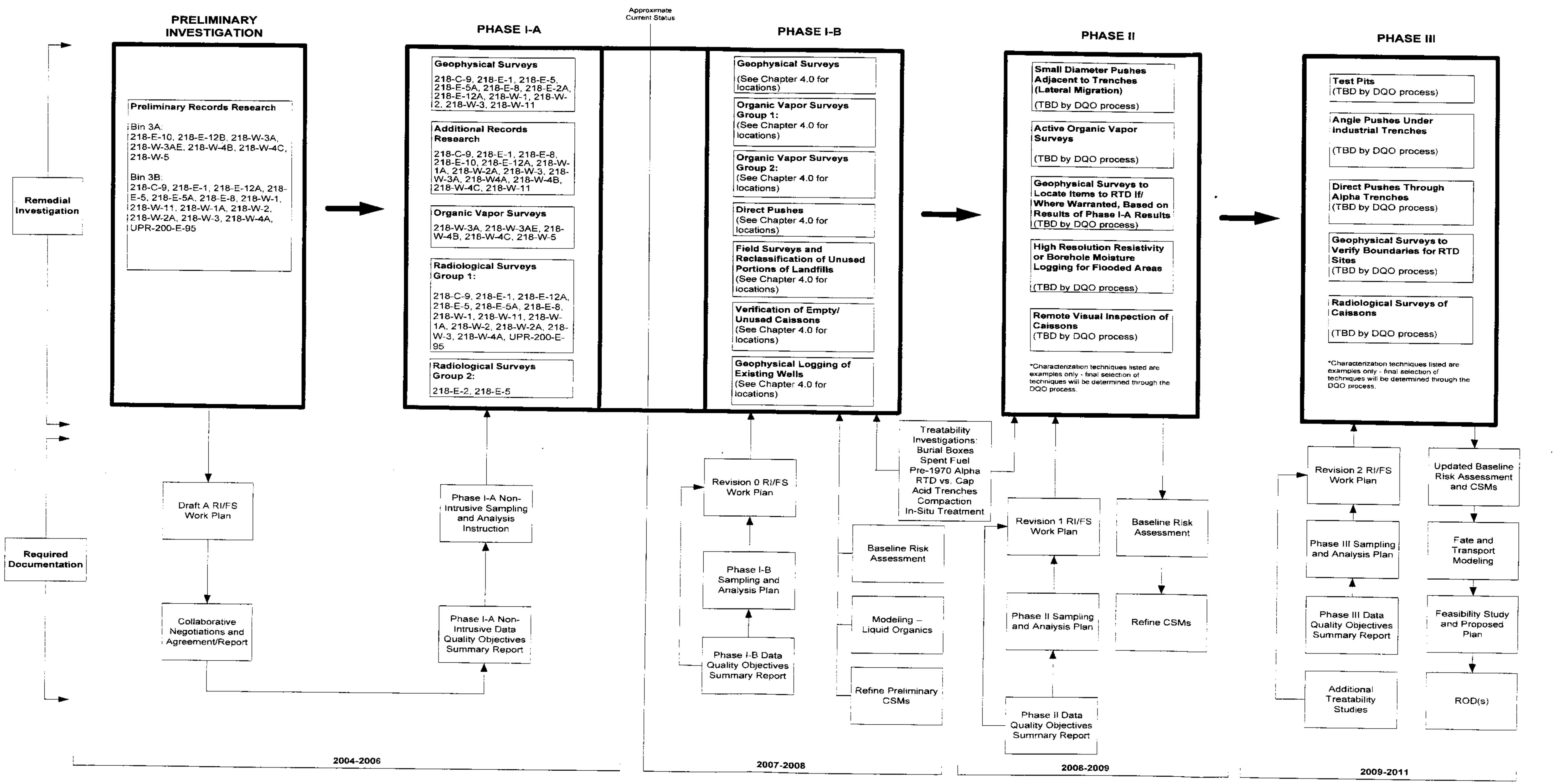
- Records review
- Planning
- Field investigation
- Site surveys
- Data integration and modeling
- Laboratory analysis and data validation
- Preparing an RI report.

These tasks and subtasks reflect the work breakdown structure that will be used to manage the work and to develop the project schedule discussed in Chapter 6.0. In addition, concurrent with the RI activities describe above, the project will identify or develop the appropriate models to support an evaluation of the personnel exposure levels (ALARA) associated with the various remedial alternatives and the cost for implementing those alternatives.

5.5.1 Historical Information Review

A historical information review was performed to determine the level of existing detail regarding the 200-SW-2 OU landfills. This information review was performed based on recommendations made by Ecology before and during the collaborative-negotiations process. Ecology recommended that a historical information review of burial records and other information pertaining to the 200-SW-2 OU landfills could be used to focus nonintrusive and intrusive surveys and sampling to aid in characterization of the landfills.

Figure 5-2. Phased Characterization Strategy for the 200-SW-2 Operable Unit Landfills.



Existing information varies significantly in terms of completeness for the 200-SW-2 OU landfills. The initial step for all landfills was to assess the available documentation of site history to establish a basis for investigative needs. This information was reviewed and incorporated into the Phase I-A DQO process. The sampling and analysis instruction (D&D-28283) that was developed as a result of the Phase I-A DQO focused field surveys on those areas that were identified as requiring additional investigation (e.g., areas that may contain organic liquids, discrepancies in the historical information). The Phase I-B DQO process builds on information that was gathered as part of the Phase I-A DQO process and on an ongoing historical information review.

5.5.1.1 Information Sources

Historical information research initially focused on the following information sources:

- Declassified Document Retrieval System
- DOE Public Reading Room at the Consolidated Information Center, Washington State University-Tri-Cities
- Documents listed in the references for DOE/RL-2004-60, Draft A
- Hanford Site Records Management Information System for documents that were electronically scanned
- Hanford Site Records Holding Area for documents that were archived and stored
- The WIDS database and library
- Past MSCM survey data
- The SWITS database.

The research encompassed many thousands of documents available through these systems. The Declassified Document Retrieval System contains over 125,000 documents, and the Records Management Information System contains over 1,000,000 documents. Approximately 50 boxes of older documents from the Records Holding Area archives were ordered and examined. The 24 landfills are represented by about 100 maps and engineering drawings. A number of documents stood out as being the most valuable. The WIDS database and site maps and drawings defined general site characteristics, site locations, trench boundaries, and (in many cases) individual items of buried waste. Finally, a series of documents from the 1950s found in the Declassified Document Retrieval System described many of the landfills "as they were" at the time that those documents were published.

The SWITS database offered the most comprehensive and useful information of all the sources, with respect to individual burials. Several landfill logbooks from the 1950s, 1960s, and 1970s were located in the Records Holding Area and in the WIDS library. These logbooks offered long lists of individual burials for past-practice (non-TSD) landfills. Property disposal records from the 1940s and 1950s were located in the Declassified Document Retrieval System, the Records Holding Area, and the WIDS library and also included lists of individual burials.

Information from currently known sources for individual burials has been, and will continue to be, captured in a project records database throughout the RI process; if more logbooks or other records are discovered in the future, they too may be added to the database. Other future historical research may include the following:

- Reconciliation of historical records with information collected via other characterization methods
- Obtaining information regarding standards (such as limits on types of waste buried, types of burial boxes typically used) in effect at each landfill over its operating history
- Obtaining the basis for the plutonium and uranium inventories in older landfills.

Table 5-3 lists existing documents and data collected from previous investigations that are key resources for the 200-SW-2 OU RI/FS process and provides a summary of the pertinent information contained in each reference.

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
AGGREGATE AREA MANAGEMENT STUDIES	
B Plant Aggregate Area Management Study Technical Baseline Report, BHI-00179, Rev 00	Description of wastes sites and processes within the B Plant Aggregate Area. Includes composition of B Plant facilities wastes and descriptions of Landfills 218-E-2A, 218-E-5, 218-E-5A, and 218-E-9. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D198038144
PUREX Aggregate Area Management Study Technical Baseline Report, BHI-00178, Rev 00	Description of waste sites and processes within PUREX Aggregate Area. Includes composition of PUREX facilities wastes and descriptions of Landfills 218-E-1, 218-E-8, 218-E-12A, 218-E-12B. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D198038126
S Plant Aggregate Area Management Study Technical Baseline Report, BHI-00176, Rev 00	Description of waste sites and processes within S Plant Aggregate Area. Includes composition of S Plant (REDOX) facilities wastes. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D198038143
T Plant Aggregate Area Management Study Technical Baseline Report, BHI-00177, Rev 00	Description of waste sites and processes within T Plant Aggregate Area. Includes composition of T Plant facilities wastes. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D198038140

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
U Plant Aggregate Area Management Study Technical Baseline Report, BHI-00174, Rev 00	Description of waste sites and processes within U Plant Aggregate Area. Includes composition of U Plant facilities wastes. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D198038132
Z Plant Aggregate Area Management Study Technical Baseline Report, BHI-00175, Rev 00	Description of waste sites and processes within Z Plant Aggregate Area. Includes composition of Z Plant (Plutonium Finishing Plant) facilities wastes and descriptions of Landfills 218-W-1, 218-W-1A, 218-W-2, 218-W-2A, 218-W-3, 218-W-3A, 218-W-3AE, 218-W-4A, 218-W-4B, 218-W-4C, 218-W-5, 218-W-11. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D198038137
CONTENTS, INVENTORIES, AND DESCRIPTIONS OF LANDFILLS	
200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/ Feasibility Study Work Plan, DOE/RL-2004-60, Draft A	Lists all sites in the 200-SW-1 and 200-SW-2 Operable Units at the time of publication. Gives brief descriptions of all waste sites. Lengthy descriptions (history, hydrogeology, physical attributes) of the 22 sites in the former Bin 3. Gives description of the logic used for binning the sites, and lists sites according to bin. Describes characterization logic for site investigation. Also gives synopsis of history of the landfills. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D7030512
Burial Ground Characterization Engineering Report, RHO-D0101ER0101, 1980	Stabilization plans and activities; trench surveys giving centerlines and end coordinates; general information such as location, radiation levels; for most past-practice sites.
Burial Ground Log Books from Records Holding Area Box 85617 (1958-1964) (GE 1964)	Record books, informal memos from this box for Landfills 218-E-5, 218-E-5A, 218-E-10, 218-E-12A, 218-W-2A, 218-W-3, 218-W-4A, 218-W-4B. They show trench contents, location of items, when trenches were dug, etc.
Burial of Equipment and Material and Instruments 01/09/1947 Through 12/29/1947, DDTS-GENERATED-5635 (GE 1947)	Informal memos listing property disposed of by burial; giving facility source. Can deduce that the material from 200 Area listed was buried in Landfill 218-W-1, 218-W-1A, or 218-E-1 by the dates. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D9023872
Burial of Equipment and Material and Instruments 01/14/1948 Through 12/21/1948, DDTS-GENERATED-5636 (GE 1948)	Informal memos listing property disposed of by burial, giving facility source. Can deduce that the material from 200 Area listed was buried in Landfill 218-W-1, 218-W-1A, or 218-E-1 by the dates. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D9023874

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Burial of Equipment and Material and Instruments 03/01/1946 Through 12/27/1946, DDTS-GENERATED-5634 (GE 1946)	Informal memos listing property buried; giving facility source. Can deduce that the material from 200 Area listed was buried in Landfill 218-W-1, 218-W-1A, or 218-E-1 by the dates. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D9023859
Burial of Hanford Radioactive Wastes, HW-77274, 1963	Then-current (as of 1963) policies and procedures governing the landfills. Includes size/location of then-existing sites. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8504146
Burial of Material 01/03/1949 Through 05/09/1949, DDTS-GENERATED-5640 (GE 1949a)	Informal memos listing property disposed of by burial, giving facility source. Can deduce that the material from 200 Area listed was buried in Landfills 218-W-1, 218-W-1A, or 218-E-1 by the dates. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D9023886
Chemical Processing Division Monthly Reports (too numerous to list individually). An example is *Chemical Processing Division Monthly Report for February 1957*, HW-48835, 1957	The monthly reports cover a wide variety of events (plutonium output, radiation occurrences, etc.). Of relevance to this DQO is the information regarding burials that often are found within the reports. The example report from February 1957 lists a PUREX clean up effort of materials taken for burial that reduced dose rates within a portion of the deck from 20 R/hr to 1 R/hr. The landfill receiving the material may be inferred from the type of waste and date buried. Example report available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D199145682
Criteria For Design Of Equipment Burial Containers, HW-83959, 1964	Standards in effect in 1964 for equipment burials – weight limits, shielding, containment, backfill, etc. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8377050
Description of Waste Buried in Site 218-W-4B, RHO-65462-80-035, 1980	Describes areas of trenches with low-level waste suitable for demonstrations of remediation; describes specific items disposed of by trench; describes high-activity, large/heavy, and liquid items. This reference is in the *Waste Information Data System* library.
Disposition of Contaminated Government Property 05/10/1949 Through 10/31/1949, DDTS-GENERATED-5637 (GE 1949b)	Informal memos listing property disposed of by burial, giving facility source. Can deduce that the material from 200 Area listed was buried in Landfills 218-W-1, 218-W-1A, or 218-E-1 by the dates. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D9023882
Disposition Of Contaminated Processing Equipment At Hanford Atomic Products Operation 1958-1959, (01/01/1958 through 12/31/1959), HW-63703, 1960	Lists equipment buried in 1958-1959, drawing number, size and dose rate. Does not give burial location. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8388213

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Disposition of Plutonium to Burial, HW-59645, 1959.	Discusses organically-contaminated plutonium waste generated at the Z-Plant complex. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8342063
Final Report 218-E-1 Dry Waste Burial Ground Characterization Survey, RHO-72710-82-167, 1982	Includes a summary of the historical data available up to the time of the survey, results from the ground penetrating radar and drilling work characterization performed in 1982, conclusions as to where the trenches in Landfill 218-E-1 are located and whether they were filled, and recommendations for confirmatory studies. This reference is in the *Waste Information Data System* library.
Handbook 200 Areas Waste Sites, RHO-CD-673, 1979	Descriptions of radioactive waste sites within the 200 Areas, excluding tank farms. This document also contains summary level descriptions and/or maps of most 200-SW-2 Operable Unit landfills (some did not yet exist at time of publication). In 3 volumes, available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196039027 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196039028 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196039029
Hanford Site Mixed Waste Disposal, Published Presentation, *Waste Management Conference 2001*, February 25 – March 1, 2001, Tucson, Arizona, by K. M. McDonald, D. E. McKinney, and T. A. Shrader	Describes the mixed-waste trenches in Landfill 218-W-5 and the general waste acceptance criteria for these trenches. Available at: http://www.wmsym.org/Abstracts/2001/59/59-8.pdf
Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford, PNL-6456, 1988	Comprehensive listing of all Hanford CERCLA sites with risk ranking and capsule summaries. Does not include permitted low-level landfills. In 3 volumes, available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196006954 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196006996 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196007000
Inconsistencies in 218-W-4B Site Data, RHO-65463-80-126, 1980	Describes and offers reconciliation of inconsistencies among information sources (such as locations and types of caissons and locations of unsegregated waste types). This reference is in the *Waste Information Data System* library.
Individual Burial Records (too numerous to list individually).	Paper burial records, initiated at time of burial. Copies kept on paper in archive and on microfiche, and recently converted to digital format. Contains burial location, date, generating facility, material contents, container description and volume, contaminants, radiation level, etc.
Radioactive Contamination in Unplanned Releases to Ground Within the Chemical Separations Area Control Zone through 1970, ARH-2015 Part 4, 1971.	Documents the status of rails removed from 218-W-2A-T16.

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Drawings of Trenches and Landfills 218-C-9 H-2-32523 (of the Pond 216-C-9; no drawing of landfill has yet been located) 218-E-1 H-2-124 218-E-2A H-2-55534 (WHC-EP-0912 notes that the trench should be drawn farther north) 218-E-5 H-2-55534 218-E-5A H-2-55534 218-E-8 H-2-33276 Rev. 17, Sheet 1 of 24 218-E-9 H-2-55534 218-E-12A H-2-32560 218-E-12B H-2-96660 218-W-1 H-2-75149 218-W-1A H-2-2516 218-W-2 H-2-2503 218-W-2A H-2-32095, Sheets 1 & 2 218-W-3 H-2-32095, Sheet 1 218-W-3A H-2-34880, Sheets 1 & 2 218-W-3AE H-2-75351, Sheet 1 218-W-4A H-2-32487, layout and contents 218-W-4B H-2-33055, layout H-2-74640, caisson installation 218-W-4C H-2-37437 and other drawings, mainly of the waste configuration in TRU trenches 218-W-5 H-2-94677 218-W-11 H-2-94250 UPR-200-E-95 (no engineering maps available; the site is included but not marked in H-2-55534)	Location, design, configuration, dimensions, and some contents of trenches and landfills. Complete reference citations for these drawings are included in Chapter 7.0.
Input and Decayed Values of Radioactive Solid Wastes Buried in the 200 Areas Through 1971, ARH-2762, 1974	Short report giving volume, radionuclide inventories, areas of landfills, caissons, and other 200-SW-2 Operable Unit sites such as lab vaults. Radionuclide inventories were estimated by a computer model, as described in the report. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8604385
Radioactive Contamination in Liquid Wastes Discharged to Ground Within the Chemical Separations Area Control Zone Through 1969, ARH-1608, 1970	Summary of radioactive liquid wastes discharged to ground. Gives initial radioactivity levels in landfills built at sites of former ponds. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8603996

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Radioactive Contamination In Unplanned Releases To Ground Within The Chemical Separations Area Control Zone Through 1972 (Exclusive of Liquid Waste Storage Tank Farms), ARH-2757, 1973	Reports on unplanned releases. Includes the location, radiation levels, and burial depths of some individual trenches such as the T Plant canyon block burials in 218-W-2A, and the status of removal of rails in 218-W-2A-T16. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8604174.
Low-Level Burial Grounds Database, WHC-MR-0008, 1989.	Contains voluminous inventory information (waste volume, total plutonium, uranium, beta-gamma, sometimes other isotopes, burial coordinates, container type, trench number, date buried, source facility, etc.). The document covers the permitted low-level landfills only. The data fill 8 volumes and go through 1989. It is the same data as in the *Solid Waste Information and Tracking System* database. The 8 volumes are available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066777 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066775 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066774 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066817 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066821 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066924 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066928 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066948
Scrap & SS Material Waste For Burial At Richland, HAN-95462, 1966	Lists property buried; gives facility source. Can deduce the most likely recipient site by the dates. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D196095555
Solid Waste Information and Tracking System, Hanford Site database	Gives inventory information (waste volume, total plutonium, uranium, beta-gamma, etc.) For newer (post-1967) landfills, gives more extensive information, usually including burial coordinates, container type, trench number, date buried, source facility, nonradioactive contaminants, etc.
Solid Waste Management History of the Hanford Site, WHC-EP-0845, 1995	Summarizes the management of solid waste at Hanford from 1944-1995. Topics covered are extensive and include container types, waste categories, disposal practices, waste handling practices, documentation of buried waste, laws and orders pertinent to waste disposal, etc.

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Source Data Records (too numerous to list individually). Example: *Burial Gardens Records FY1971 Month End & Source Data 10/1970 Through 12/1970*, ARH-1913-2, 1970	The source data records contain many referrals to buried waste, often with brief waste descriptions and burial coordinates. The example document, p. 39, lists "Canyon Hood, Room Waste, Heater Element" and other items, and gives the waste site name (218-W-4B) and Hanford coordinates at which the items were buried. Example document available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8668489
Summary of Radioactive Solid Waste Burials in the 200 Areas During 1976, ARH-CD-744-4Q, 1977	Inventory information – waste volume, total plutonium, uranium, and other isotopes. Some information on size of site, offsite sources, burial locations. Covers vaults and caissons as well as landfills. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8604568
Various historical photos - too numerous to be listed separately. Examples of publicly available photos are: *Burial of Equipment,* 9973-NEG-[A-I] (GE 1954)	Historical photographs of aerials of waste sites or surface shots of equipment burial showing burial box, trench construction, crane operations, cables used, etc. Examples available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0004409 http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0004410 http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0004411 http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0004412 http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0004413 http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0004414 http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0004415 http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0004416 http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=N1D0004417
The History of the 200 Area Burial Ground Facilities, WHC-EP-0912, 1996	Describes the landfill history from the inception of the landfills to 1996. Includes short descriptions of each landfill; historical landfill practices (such as digging of trenches, use of caissons), historical events in landfills (such as flooding, caisson plugging); the effects of DOE orders and state/Federal laws on burial practices; lists of offsite generators, classified waste, etc. Contains many photographs. In two volumes. Vol. 1 available at: http://www.osti.gov/energycitations/servlets/purl/827767-NOu75G/native/

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Unconfined Underground Radioactive Waste and Contamination in the 200 Areas, HW-28471, 1953	Gives short descriptions of the landfills that existed in 1953, including location of landfills, trench descriptions, maximum radioactivity levels of buried material, etc. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D198128641
Unconfined Underground Radioactive Waste and Contamination in the 200 Areas, HW-41535, 1956	Gives short descriptions of the landfills that existed in 1956, including location of landfills, trench descriptions, maximum radioactivity levels of buried material, etc. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D199155779
Unconfined Underground Radioactive Waste and Contamination in the 200 Areas - 1959, HW-60807, 1959	Gives short descriptions of the landfills that existed in 1959, including location of landfills, trench descriptions, maximum radioactivity levels of buried material, etc. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D8517123
Waste Information Data System, Hanford Site database reports	For all 200-SW-1 and 200-SW-2 Operable Unit sites. Summarizes site names, locations, types, status, site and process descriptions, associated structures, cleanup activities, environmental monitoring description, access requirements, references, regulatory information, and waste information (e.g., type, category, physical state, description, stabilizing activities).
ENVIRONMENTAL PLANNING FOR REMEDIATION AND CLOSURE	
200 Areas Remedial Investigation/Feasibility Study Implementation Plan-Environmental Restoration Program, DOE/RL-98-28, 1999	Background waste site information and generic strategy for 200 Areas waste site investigations. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D199153696
Closure Plan for Active Low-Level Burial Grounds, DOE/RL-2000-70, 2000	Approach to closure; hydrogeology under individual landfills; radionuclide and waste volume inventories. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D8532666
Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site, PNNL-11800, 1998	Provides an estimate of the cumulative radiological impacts from active and planned low-level radioactive waste disposal actions and other potentially interacting radioactive waste disposal sources that will remain following Hanford Site closure. Based on DOE O 435.1. Available at: http://gwmodeling.pnl.gov/ca98/start.htm
Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington, DOE/RL-2000-29, Rev. 1, 2000	Document describes the plan for maintaining the composite analysis that estimates the cumulative radiological impacts from active and planned low-level radioactive waste disposal actions and other potentially interacting radioactive waste disposal sources that will remain following Hanford Site closure. Based on DOE Order 435.1. Available at: http://gwmodeling.pnl.gov/reports/CAMplan.PDF

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds, WHC-EP-0645, 1995	Performance assessment analysis for the disposal of low-level waste in the 200 West Area based on DOE Order 5820.2A standards (Note: DOE Order 5820.2A has been superseded by DOE O 435.1 since publication). Waste exposure limits are calculated from the *Clean Air Act of 1990* and EPA drinking water standards. Includes hydrogeology, waste characteristics and generators, disposal practices, disposal facilities, conceptual models, intruder scenario, groundwater pathways, dose analysis, and sensitivity analysis.
Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds, WHC-SD-WM-TI-730, 1996	Performance assessment analysis for the disposal of low-level waste in the 200 East Area based on DOE Order 5820.2A standards (Note: DOE Order 5820.2A has been superseded by DOE O 435.1 since publication). Waste exposure limits are calculated from the *Clean Air Act of 1990* and EPA drinking water standards. Includes hydrogeology, waste characteristics and generators, disposal practices, disposal facilities, conceptual models, intruder scenario, groundwater pathways, dose analysis, and sensitivity analysis.
Waste Site Grouping for 200 Areas Soil Investigations, DOE/RL-96-81, 1997	Conceptual site models; description of waste group; known and suspected contamination; representative waste sites. Available at: http://www2.hanford.gov/ARPIR/common/findpage.cfm?AKey=D197197143
ENVIRONMENTAL - RCRA AND NEPA DOCUMENTATION	
Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement, DOE/EIS-0222-F, 1999	Land-use plan for the Hanford Site. It is available in 6 sections: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D199158842 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D199158843 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D199158844 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D199158845 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D199158846 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D199158847
Hanford Facility Dangerous Waste Part A Permit Application, DOE/RL-88-21, older versions.	Older versions of the permit; e.g., Release 6, show maps of the low-level landfills with proposed and filled trenches. Release 6 available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196057317
Hanford Facility Dangerous Waste Part A Permit Application, DOE/RL-88-21, September 2002 (most recent version that includes LLBGs).	Hazardous waste codes and maps of the permitted low-level landfills showing the areas where regulated mixed waste is stored. The maps do not show the trenches. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D9155786.

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Revised Draft Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, DOE/EIS-0286D2, 2003 *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*, DOE/EIS-0286F, 2004 Hanford Site Solid Waste records of decision	Provides a comprehensive analysis of the impacts of the proposed action and alternatives for managing radioactive and hazardous waste on the Hanford Site. Applies to permitted low-level landfills, not to past-practice sites. An overview is available at: http://www.hanford.gov/doe/eis/sweis/overview.htm
HYDROGEOLOGY AND GROUNDWATER MONITORING	
200 East Groundwater Aggregate Area Management Study Report, DOE/RL-92-19, 1993	Description of waste management units impacting groundwater; surface hydrology and geology, preliminary site conceptual model, health and environmental concerns, potential ARARs, and recommendations for remediation in the 200 East Area. In 2 volumes, available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196136029 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196136305
200 West Groundwater Aggregate Area Management Study Report, DOE/RL-92-16, Rev. 0, 1993	Description of waste management units impacting groundwater; surface hydrology and geology, preliminary site conceptual model, health and environmental concerns, potential ARARs, and recommendations for remediation in the 200 West Area. Available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D196125315
Geologic Setting of the Low-Level Burial Grounds, WHC-SD-EN-TI-290, 1994	General geologic setting and hydrogeology of 200 East and West Areas; hydrogeology of Landfills 218-E-10, 218-E-12B, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5. Incorporates data from boreholes across the 200 Areas.
Hanford Site Groundwater Monitoring For Fiscal Year 2005, PNNL-15670, 2005	Results of groundwater and vadose zone monitoring and remediation for fiscal year 2004 on the Hanford Site. Available at: http://groundwater.pnl.gov/reports/gwrep05/start.htm
Hydrogeology of the 200 Areas Low Level Burial Grounds, an Interim Report, PNL-6820, 1989	Hydrogeology of the 200 Areas; results and analysis of information from 35 groundwater monitoring wells around Landfills 218-E-10, 218-E-12B, 218-W-3A, 218-W-3AE, 218-W-4C, and 218-W-5. Information was collected between May 20, 1987, and August 1, 1988. In 3 volumes, available at: http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066506 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066592 http://www2.hanford.gov/arpir/common/findpage.cfm?AKey=D195066599

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington, PNNL-12261, 2001	Hydrogeology and conceptual groundwater flow model for the 200 East Area and vicinity. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-12261.PDF
Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington, PNNL-13858, 2002	Hydrogeology and conceptual groundwater flow model for the 200 West Area and vicinity. Available at: http://www.pnl.gov/main/publications/external/technical_reports/PNNL-13858/13858.pdf
CHARACTERIZATION INVESTIGATIONS	
200-PW-1 Operable Unit Report on Step I Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose Zone Plume, CP-13514, 2003	Investigation of carbon tetrachloride plume under 200-PW-1 Operable Unit waste sites. Describes GeoProbe [a] and cone penetrometer operations and results at Landfill 218-W-4C, Trenches 1, 4, and 7, and other locations during 2002.
Report on Sampling and Analysis of Air at Trenches 218-W-4C and 218-W-5 #31 of the Low-Level Burial Grounds, HNF-SD-WM-RPT-309, 1997	Results of sampling and analysis of air samples to determine type and concentration of volatile organics. Samples were taken from Landfill 218-W-4C, Trenches 1, 4, 7, and 20; and Landfill 218-W-5, Trench 31. The Landfill 218-W-4C samples showed significant concentrations of 1,1,1-trichloroethane, TCE, PCE, carbon tetrachloride, and chloroform.
Data Quality Objectives Summary Report for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit, D&D-27257, 2006	Developed to support characterization of the former Bin 3A/3B waste sites in the 200-SW-2, and shows logic developed to support non-intrusive characterization (records search, passive vapor, geophysical investigations, etc.)
Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit, D&D-28283, 2006	Developed to support characterization of the former Bin 3A/3B waste sites in the 200-SW-2, and directs specifics of non-intrusive characterization (records search, passive vapor, geophysical investigations, etc.)
Geophysical Investigations Summary Report: 200 Area Burial Grounds: 218-C-9, 218-E-2A, 218-E-5, 218-E-5A, 218-E-8, 218-W-1A, 218-W-2A, and 218-W-1, D&D-28379, 2006	This document summarizes the results of geophysical investigations conducted at eight past-practice sites. The geophysical techniques used in the investigations were ground-penetrating radar (GPR), electromagnetic induction (EMI), and total magnetic field methods. Maps of inferred buried objects superimposed on H-2 drawings are provided.
Geophysical Investigations Summary Report: 200 Area Burial Grounds: 218-E-1, 218-E-2A, 218-E-8, 218-E-12A, 218-W-1, 218-W-2, 218-W-3, and 218-W-11, D&D-28379, 2006	Information is provided on the ground-penetrating radar, electromagnetic induction, and magnetic data collected, along with details of the investigation, for each past-practice site discussed in this document. Maps of inferred buried objects superimposed on H-2 drawings are provided.
Solid Waste Stream Hazardous and Dangerous Components Study, WHC-SD-WM-RPT-056, 1992	Documents the results from characterizing some of the hazardous/dangerous chemicals and materials believed stored or disposed of in the 200 Areas Landfills. Materials were selected based on their probable frequency of occurrence in solid waste containers and the associated potential safety risk to onsite and offsite individuals. Covers wastes since 1970.
Technology Survey to Support Revision to the Remedial Investigation/Feasibility Study Work Plan for the 200-SW-2 Operable Unit at the U.S. Department of Energy's Hanford Site, Draft Report, 2006.	A survey of technologies was conducted to provide a thorough survey of remediation and characterization options to enable this DQO process to consider the full range of potential alternatives. Technologies considered include in-situ, ex-situ, analytical, intrusive, non-intrusive, etc.

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Alternatives to Control Subsidence at Low-Level Radioactive Waste Burial Sites, RHO-LD-172, 1981	Explores alternatives to address subsidence; includes sites that are now 200-SW-2 waste sites. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D6831709
SAFETY BASIS DOCUMENTATION	
Active and Retired Solid Waste Burial Grounds Safety Analysis Report, SD-WM-SAR-038, 1984	Gives waste disposal specifications (as of 1984) including backfill, hazardous materials separations, dose limits, package and records inspections, etc. Also gives a list of documents governing landfill operations. Shows detailed trench and caisson design.
Solid Waste Burial Grounds Interim Safety Basis, HNF-SD-WM-ISB-002, Rev. 3B, 2001	Intended to cover TRU retrieval efforts, but covers all low-level landfills (218-E-10, 218-E-12B, 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, and 218-W-5), regardless of whether they contain post-1970 TRU [b].
Waste Management Project (WMP) Master Documented Safety Analysis (MDSA) for the Solid Waste Operations Complex (SWOC), HNF-14741, Rev. 2A, 2005	Current authorization basis covering work in the Low-Level Landfills.
TRANSURANIC WASTE RETRIEVAL	
Contact Handled Transuranic Waste Characterization Based on Existing Records, WHC-EP-0225, Rev. 1, 1991	Contains the results of characterizing the retrievably stored, contact-handled transuranic waste based on existing records. Data were derived from *Richland Solid Waste Information Management System* database and supporting documents and interviews with knowledgeable individuals.
Phase 2 Solid Waste Retrieval Trench Characterization, WHC-SD-W221-DP-001, Rev. 0, 1994	Includes Landfills/trenches 218-E-12B-T17, 218-E-12B-T27, 218-W-3A-TS6, 218-W-3A-TS9, 218-W-3A-T01, 218-W-3A-T04, 218-W-3A-T05, 218-W-3A-T06, 218-W-3A-T08, 218-W-3A-T10, 218-W-3A-T15, 218-W-3A-T17, 218-W-3A-T23, 218-W-3A-T30, 218-W-3A-T32, 218-W-3A-T34, 218-W-4B-T07, 218-W-4B-TV7, 218-W-4B-T11, 218-W-4C-T01, 218-W-4C-T04, 218-W-4C-T07, 218-W-4C-T19, 218-W-4C-T20, 218-W-4C-T29. Available at: http://www.osti.gov/bridge/servlets/purl/10192685-RRV5FS/webviewable/10192685.pdf
Radioisotopic Characterization of Retrievably Stored Transuranic Waste Containers at the Hanford Site, WHC-SD-WM-TI-517, Rev. 1, 1993	Provides a common source of material with which to characterize the nature of the TRU solid waste to be retrieved and disposed of from trenches, based on existing documentation (in 1993). Provides a basis for analyzing accidents and reducing conservatism, as well as providing a more accurate assessment of operational risk. Emphasis is on 55-gal drums, because they are the predominant container, but also addresses other container types. Only addresses wastes stored since May 1, 1970, in the 200 West Area and Landfill 218-E-12B through June 1993. Does not include caissons.

Table 5-3. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (13 Pages)

Reference	Summary
Sampling Plan for Retrieval of Stored Contact-Handled Transuranic Waste at the Hanford Site, WHC-EP-0226, 1989	Assesses the integrity of retrievable waste containers; provides baseline information to support the Waste Receiving and Packaging facility design, including nondestructive analysis; and provides information to support equipment design for full-scale retrieval.
The Hanford Environment as Related to Radioactive Waste Burial Grounds and Transuranic Waste Storage Facilities, ARH-ST-155, 1977	Discusses the effect of Hanford Site climate and geology on the integrity of waste packaging.
"Description of TRU Waste Buried in Site 218-W-4B," letter, RHO-65462-80-036, 1980	Describes areas of trenches with post-1970 TRU; gives descriptions of trench construction and containers used; describes specific items disposed of, by trench. This reference is in the *Waste Information Data System* library.

[a] GeoProbe is a registered trademark of GeoProbe Systems, Salina, Kansas.
[b] Radioactive waste as defined in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*.

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.
DDTS = Declassified Document Tracking System.
DOE = U.S. Department of Energy.
EPA = U.S. Environmental Protection Agency.
NEPA = *National Environmental Policy Act of 1969*.
PUREX = Plutonium-Uranium Extraction (Plant).
RCRA = *Resource Conservation and Recovery Act of 1976*.
REDOX = Reduction-Oxidation (Plant).
SS = source and special.
TRU = Radioactive waste as defined in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*.

5.5.2 Planning

The planning subtask includes activities and documentation that need to be completed before field activities can begin. Planning activities will be more or less complex, depending on the completeness of available records reviewed, the nature and extent of site contamination, and the anticipated remedial path forward. Activities include the preparation of a job-hazard analysis and a site-specific health and safety plan (HASP), radiation work permits, excavation permits and supporting surveys (e.g., cultural, radiological, wildlife, and utilities), work instructions, personnel training, and the procurement of materials and services (e.g., laboratory support, drilling, and geophysical-logging services).

Appendix B of the Implementation Plan (DOE/RL-98-28) provides a general HASP that outlines health and safety requirements for RI activities. Site-specific HASPs will be prepared. Initial surface radiological surveys will be performed to document any radiological surface contamination and the background levels[32] in and around the sampling locations. This information will be used to document initial site conditions and prepare HASPs and radiation work permits.

Some of the landfills have access restrictions because of the potential for subsidence (see HNF-2030, *Subsidence Potential in the Burial Grounds*). These landfills should be identified

[32]Background levels in this instance are determined for purposes of the HASP and are not to be used to determine background levels for screening against limits as prescribed in various sections of WAC 173-340, "Model Toxics Control Act – Cleanup."

early in the planning process to determine possible restrictions on access for field characterization and to develop a strategy to work around the restrictions, if possible.

5.5.3 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 (Appendix A). The scope includes site surveys with field instruments and geophysical, organic vapor, and direct-push techniques to gather data to aid in characterization of the 200-SW-2 OU landfills. Other activities include work-zone setup, mobilization and demobilization of equipment, equipment decontamination, and field/laboratory analyses.

Major subtasks associated with the field investigation include the following:

- Collection of data from chemical and radioactive contamination surveys
- Preparation of a field report.

5.5.3.1 Collection of Data from Field Surveys

Planned field analyses include geophysical, organic-vapor, and direct-push techniques. An initial step in the investigations will be to perform a field screening to determine the exposure potential at sites and to establish areas with concentrations of radionuclides significantly above background. Radiological data will be used to establish radiation-control measures and to ensure worker health and safety. Further detail regarding field surveys is presented in Section 4.2 and Appendix A of this RI/FS work plan.

5.5.3.2 Data Integration and Modeling

The project will screen the list of COPCs developed for the OU against the anticipated inventories at the landfills, to determine which sites have the highest potential for releases to the environment or personnel exposure. Samples will be collected in Phases II and III from locations that show the highest concentrations of contamination, based on surface geophysics and intrusive and/or nonintrusive evaluations of radionuclide and chemical inventories. The resulting data will be input to model the exposure potential, with accepted models commonly used to assess exposure at the Hanford Site.

5.5.3.3 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. The report will include geophysical, organic-vapor, and direct-push data-collection locations; the number and types of samples collected and associated HEIS numbers; and any chemical field-screening results.

5.5.3.4 Management of Investigation-Derived Waste

Waste-designation DQOs will be established before intrusive-characterization activities begin to ensure that the information collected during the field activities supports the designation of all

IDW for the project. During the IDW DQO process, any listed waste issues will be resolved. Any additional sampling requirements or analytes needed to support waste-designation activities will be identified, and the requirements will be implemented through the waste-designation DQO summary report that will be prepared at that time.

Waste generated during the RI phase will be managed in accordance with a waste-control plan to be prepared for the sampling activities. DOE/RL-98-28, Appendix E, 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. Further, the plan identifies governing procedures and discusses types of waste expected to be generated, the waste-designation process, and the final-disposal location. The IDW management task begins when IDW is first generated at the start of the field investigation and continues through waste designation and disposal.

5.5.3.5 Laboratory Analysis and Data Validation

Soil samples collected will be analyzed for a suite of nonradioactive constituents identified as COPCs during the DQO and defined in the SAP. The SAP lists the analytes, methods, and associated target detection limits. This task includes the laboratory analysis of samples, compilation of laboratory results into data packages, and validation of a representative number of laboratory data packages.

5.6 EVALUATION OF PHASE I-A AND PHASE I-B DATA

All Phase I-A and I-B characterization data will be compiled and reviewed at the completion of field operations and receipt of laboratory results. Field-screening results, geophysical-logging data, radiological surveys, organic-vapor surveys, and laboratory analyses will be included. Results will be tabulated, and maps and plots will be prepared to show the contaminant distribution. Based on the results of Phases I-A and I-B, an assessment will be completed concerning the need for additional data collection for each of the bins. If the need for additional data collection is determined to be required to support risk-assessment evaluations and remedial decision-making, planning for Phase II will be initiated.

Phase II will entail gathering additional data to support remedial decisions. Additional characterization data will be acquired to allow for a statistical analysis of the data set. The data set may be used to determine a 95 percent upper confidence limit of the mean concentration for the COPCs. The uncertainty in the calculated values, based on the proposed total number of analyses that will be used, will be presented in the Phase II SAP. Results of all phases of characterization will be presented in the RI report.

5.7 REMEDIAL INVESTIGATION REPORT

This section summarizes data-evaluation and interpretation subtasks leading to the production of a RI report. The primary activities include a data-quality assessment; 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 risk assessment. These activities will be performed as part of the RI report preparation task.

5.7.1 Data Quality Assessment

A data-quality assessment will be performed on the analytical data to determine if they are the right type, quality, and quantity for their intended use. The data-quality assessment 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 determine if they meet the analytical-quality criteria outlined in the DQO and are adequate to evaluate the decision rules in the DQO.

5.7.2 Data Evaluation and Conceptual-Model Refinement

This task will include evaluating the information collected during the investigation. The chemical and radionuclide data obtained from samples will be compiled, tabulated, and statistically evaluated to gain as much information as possible to satisfy the data needs. For RCRA TSD units, the data collected during the RI will be evaluated against WAC 173-303-610 performance standards.

If contaminants not identified as COPCs 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.

5.7.3 Baseline Human-Health Risk Assessment

For the 200-SW-2 OU, a quantitative baseline human-health risk assessment will be prepared as part of the RI report. The baseline risk assessment will evaluate risk to human receptors from potential exposure to contaminants in accessible surface sediments and shallow subsurface soils. The risk assessment also will evaluate the potential for contaminants currently in the vadose-zone soil to impact groundwater in the future. Risks from current groundwater contamination will not be evaluated; that evaluation will be conducted as part of the RI/FS process for the groundwater OUs.

A baseline risk analysis for those COPCs detected in the landfills also will be completed. Initial screening will consider the constituents to be directly accessible to potential receptors. Modeling of future exposure risks, as the waste containers degrade and constituents actually become available to surrounding soil, also will be completed.

The risk assessment presented in the RI report will use data collected from the Phases I-A and I-B sampling and will allow for initial quantification of risk. Human-health risks are evaluated based on a reasonably anticipated future land use for the Central Plateau, which is based on criteria consistent with the Tri-Parties' response (Klein et al., 2002, "Consensus Advice #132:

Exposure Scenarios Task Force on the 200 Area,") to Hanford Advisory Board (HAB) Advice #132 (HAB 132, "Exposure Scenarios Task Force on the 200 Area").

The Tri-Parties undertook the task of developing a risk framework to support risk assessments in the Central Plateau. This included a series of workshops completed in 2002 with representatives from DOE, EPA, Ecology, the HAB, the Tribal Nations, the State of Oregon, and other interested stakeholders. The workshops focused on the different programs involved in activities in the Central Plateau and the need for a consistent application of risk-assessment assumptions and goals.

The following items summarize the risk-framework description from the Tri-Parties' response to the HAB.

- The Core Zone (200 Areas including B Pond [main pond] and S Ponds) will have an industrial scenario for the foreseeable future.

- The Core Zone will be remediated and closed, allowing for "other uses" consistent with an industrial scenario (environmental industries) that will maintain an active human presence in this area, which in turn will enhance the ability to maintain the institutional knowledge of waste left in place for future generations. Exposure scenarios used for this zone should include a reasonable maximum exposure to a worker/day user, to possible Native American users (possible because of long-lived radionuclides and uncertainty regarding future land use), and to intruders.

- The DOE will follow the required regulatory processes for groundwater remediation (including public participation) to establish the points of compliance and RAOs. It is anticipated that groundwater contamination under the Core Zone will preclude beneficial use for the foreseeable future, which is at least the period of waste management and active institutional controls (150 years). It is assumed that the tritium and I-129 plumes beyond the Core Zone boundary will exceed the drinking water standards for the next 150 to 300 years (less for the tritium plume).

- No drilling for water use or otherwise will be allowed in the Core Zone. An intruder scenario will be calculated for assessing the risk to human health and the environment.

- Waste sites outside the Core Zone but within the Central Plateau (200 North Area, Gable Mountain Pond, BC Controlled Area) will be remediated and closed based on an evaluation of multiple land-use scenarios to optimize institutional-control cost and long-term stewardship.

- An Industrial land-use scenario will set cleanup levels on the Central Plateau. Other scenarios (e.g., residential, recreational) may be used for comparison purposes to support decision making, especially for the following:
  - The post-institutional controls period (>150 years)
  - Sites near the Core Zone perimeter, to analyze opportunities to "shrink the site"
  - Early (precedent-setting) closure/remediation decisions.

- This framework does not consider the tank-waste-retrieval decision.

More recent publications, including *Record of Decision, 221-U Facility (Canyon Disposition Initiative), Hanford Site, Washington* (Ecology, 2005), state that land-use controls (i.e., active institutional controls) will be maintained indefinitely, until such time that the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure. The 221-U Record of Decision also states that groundwater underlying the 200 Areas may be considered a potential future drinking-water source and is, in any case, hydraulically connected to groundwater that currently is used for drinking water and irrigation purposes.

Following are other assumptions used in the human-health risk evaluation:

- Land use will be industrial-exclusive for the next 50 years (through 2050)
- Land use will be industrial (non-DOE worker) for 100 years after 2050
- Land use will be industrial after 150 years.

The human-health risk assessment will be conducted in accordance with appropriate subsections of WAC 173-340 and with the following DOE and EPA guidance documents:

- DOE/RL-91-45, Rev. 3, *Hanford Site Baseline Risk Assessment Methodology*
- EPA/540/1-89/002, *Risk Assessment Guidance for Superfund (RAGs), Volume I – Human Health Evaluation Manual, Part A (Interim Final)*
- EPA, 1991, *Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, (Interim Final)*, OSWER Directive 9285.6-03
- EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors*
- EPA/540/R-99/005, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final*
- EPA/600/P-92/003C, *Proposed Guidelines for Carcinogen Risk Assessment*
- EPA, 1992, *Supplemental Guidance to RAGS: Calculating the Concentration Term*, OSWER Publication 9285.7-081.

After completion of all phases of characterization, risks initially will be evaluated by comparison to risk-based standards such as WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties" or WAC 173-340-740, "Unrestricted Land Use soil Cleanup Standards," depending on the location of the site with respect to the Central Plateau land-use boundary. Contaminants present at concentrations exceeding these risk-based standards will be considered further in the risk-assessment process. Risks from nonradiological noncarcinogens will be evaluated by calculating hazard quotients for individual constituents and a hazard index for cumulative risk. Risks from nonradiological carcinogens and radionuclides will be evaluated by calculating incremental cancer risks for individual constituents and a cumulative cancer risk.

The RESidual RADioactivity (RESRAD) computer program (ANL, 2002, *RESRAD for Windows*, Version 6.21, or later update) will be used to obtain risk and dose estimates from direct-contact exposure to radiological constituents present in the shallow zone of the waste sites. The RESRAD transport model also will be used as a screening tool to assess potential impacts to the groundwater from residual radionuclides in the vadose zone. Additional analysis may be performed using other appropriate fate and transport models (e.g., PNNL-12034, *STOMP, Subsurface Transport Over Multiple Phases, Version 2.0, User's Guide*) to assess near-field impact to the groundwater from chemicals and radionuclides in the vadose zone.

In addition, the waste inventories at the 200-SW-1 and 200-SW-2 OUs will be evaluated to determine the risks to workers associated with remedial alternatives. These risks include, for example, dose related to direct exposure to gamma-emitting radionuclides and inhalation risk from alpha- and beta-emitting particles.

Risk assessment will be performed for an industrial-exposure scenario to establish the baseline risk. As part of the FS, additional risk assessment may be performed to evaluate other scenarios, such as a Native American scenario or an intruder scenario, to evaluate postremediation residual risks.

5.7.4 Ecological Evaluation and Risk Assessment

A conservative evaluation will be made of risk to ecological receptors from stressors, in this case introduction of contaminants and habitat elimination. The SLERA identifies pathways for ecological receptors to be exposed to the contamination and evaluates potential risk from those exposures.

The conceptual site model presented in Chapter 3.0 of DOE/RL-2001-54 provides an understanding of the ecological resources and the ways that receptors may be exposed. The model shows where chemicals and radionuclides from the waste sites are likely to come into contact with receptors in the environment. The exposure pathways that are expected to be complete at most waste sites include the following:

- Direct contact with, or ingestion of, soil by invertebrates (e.g., beetles and ants) and burrowing mammals
- Uptake of contaminants in soil by vegetation
- Bioaccumulation through ingestion of food items (e.g., food-chain effects) consumed by wildlife that may forage at the waste sites.

The ecological risk assessment being performed for the Central Plateau will stand as the baseline ecological risk assessment for the 200-SW-2 OU. Nevertheless, the 200-SW-2 OU RI will include an evaluation of contaminants against wildlife ecological soil-screening values. Contaminants unique to the 200-SW-2 OU waste sites with potential ecological exposure pathways will be evaluated in a screening assessment in the 200-SW-2 OU FS.

Only terrestrial-wildlife risks will be evaluated for the 200-SW-2 OU landfills because of their location within the Central Plateau Core Zone boundary. This is consistent with WAC 173-340-7490(3)(b), "Terrestrial Ecological Evaluation Procedures," "Goal," which specifies that for industrial or commercial properties, current or potential for exposure to soil contamination need only be evaluated for terrestrial wildlife protection. Plants and biota need not be considered unless the species is protected under the Federal *Endangered Species Act of 1973*. No Federally listed threatened or endangered species are known to exist in the area occupied by the 200-SW-2 OUs. Ecological surveys conducted before field activities begin will confirm the presence or absence of protected species.

5.8 FEASIBILITY STUDY/RCRA TREATMENT, STORAGE, AND/OR DISPOSAL UNIT CLOSURE PLAN

After the RI and pre-ROD treatability investigations are completed, remedial alternatives/closure strategies will be developed and evaluated against CERCLA performance standards and evaluation criteria in the FS/closure plan. Closure and corrective actions for RCRA TSD units will be evaluated against the appropriate dangerous-waste performance standards. The FS process consists of several steps:

1. Defining RAOs and RCRA closure and RCRA corrective-action performance standards
2. Identifying general response actions to satisfy RAOs
3. Identifying potential technologies and process options associated with each general response action
4. Screening process options to select a representative process for each type of technology, based on its effectiveness, implementability, and cost
5. Assembling viable technologies or process options into a range of treatment and containment alternatives plus the no-action alternative
6. Evaluating alternatives and presenting information needed to support remedy selection and RCRA closure of the unit as a landfill pursuant to Hanford Facility RCRA Permit Condition II.K (WA7890008967).

5.8.1 Remedial-Action Alternatives

Likely response scenarios form a basis for identifying potentially viable remedial alternatives and associated technologies. Formal development and evaluation of likely response scenarios and associated remedial alternatives for the 200-SW-2 OU will occur during preparation of the FS. The following potential remediation alternatives were identified in the Implementation Plan:

- No action
- Institutional controls
- Engineered surface barriers with or without vertical subsurface barriers
- Excavation and disposal with or without ex situ treatment
- Excavation, ex situ treatment, and geologic disposal of soil with TRU
- In situ grouting or stabilization of soil

- In situ vitrification of soil
- In situ vapor extraction of volatile organic compounds
- Monitored natural attenuation.

The Collaborative Agreement (Ecology and DOE, 2005), and the follow-up path forward (DOE and Ecology, 2007, *Path Forward, 200-SW-1/2 RI/FS Work Plan Development*) identified the following likely response scenarios as being potentially applicable to the 200-SW-2 Operable Unit:

- Excavation, treatment (as necessary), and disposal of waste from within individual landfills
- Excavation, treatment (as necessary), and disposal of waste from selected sections of individual landfills
- Capping of individual landfills
- In situ treatment (e.g., vitrification, grouting) of portions of individual landfills
- Some combination of the above
- No action with continued monitoring.

A summary of each of these potential alternatives as they would apply to the 200-SW-2 OU landfills is provided below. Two principal categories of remedial alternative currently are identified, those actions that require removal and those that entail in-place remedies. In-place remedies would include in situ treatment (stabilization), placement of an engineered barrier system over the site, or maintaining an existing soil cover if already present, with institutional controls.

5.8.1.1 No Action

It is required by 40 CFR 300, that a "no-action" alternative be evaluated as a baseline for comparison with other remedial alternatives. The no-action alternative represents a situation where no legal restrictions, access controls, or active remedial measures are applied to the site. No-action implies allowing the wastes to remain in the current configuration, thus being affected only by natural processes. No maintenance or other activities would be instituted or continued. Selecting the no-action alternative would require that a waste site poses no unacceptable threat to human health or the environment.

5.8.1.2 Maintain Existing Soil Cover/Monitored Natural Attenuation/Institutional Controls

Under this alternative, existing soil cover that has been placed on a waste site would be maintained and/or augmented as needed to provide protection from intrusion by biological receptors, along with institutional controls, such as legal barriers (e.g., deed restrictions, excavation permits) and physical barriers (e.g., fencing) that would mitigate contaminant exposure. Radioactive contaminants remaining beneath the clean-soil cover would be allowed to decay in place (i.e., to attenuate naturally), thereby reducing risk until remediation goals are met. This alternative may be preferable in the following circumstances:

- When contaminant concentrations are very close to remedial goals
- For contaminants that naturally attenuate and are not mobile in the environment
- When the cost to remediate does not gain a comparable amount of risk reduction
- When the cost for active remediation (e.g., remove and dispose, capping) is prohibitive.

For sites having a clean soil cover of <4.6 m [15 ft], more stringent institutional controls (e.g., physical and legal barriers, biological monitoring, control of deeply rooted plants, control of deep-burrowing animals) would need to be implemented. Water- and land-use restrictions also would be used to prevent exposure.

Natural attenuation relies on natural processes to lower contaminant concentrations until cleanup levels are met. Monitored natural attenuation would include sampling and/or environmental monitoring, consistent with EPA guidance (EPA 540/R-99/006, *Radiation Risk Assessment at CERCLA Sites: Q&A*, OSWER Directive No. 9200.4-31P) to verify that contaminants are attenuating as expected and to ensure that contaminants remain isolated (e.g., will not lead to degradation of groundwater or be released to air or biota). Attenuation-monitoring activities could include monitoring of the vadose zone using geophysical logging methods or groundwater monitoring to verify that natural-attenuation processes are effective. Monitoring of groundwater may be required near sites with mobile contaminants left in place, to verify that groundwater is not being impacted. Although not required by current regulations, vadose-zone monitoring may be conducted to provide early indications of contaminant movement and enable implementation of appropriate corrective actions before the groundwater is impacted.

5.8.1.3 Removal/Treatment/Disposal

Remedial alternatives will be evaluated that may involve different combinations of removal, treatment, and disposal actions, depending on site conditions. Consideration of radionuclide composition and activity, remediation-worker exposure hazards, and available disposal pathways will have a significant influence on remedy selection. Removal activities would involve excavation of buried waste and soil. Treatment may include in situ or ex situ operations.

5.8.1.4 Capping/Barriers

Capping consists of constructing a surface barrier over contaminated waste sites to control the amount of water that infiltrates into contaminated media to reduce or eliminate leaching of contamination to groundwater. In addition to their hydrological performance, barriers also may function as physical barriers to prevent intrusion by human and ecological receptors, limit wind and water erosion, and shield radiation. Institutional controls are required to prevent intrusion to the capped area and to prevent activities that might alter the effectiveness of the cap. Institutional controls (including legal, administrative, or physical controls such as deed restrictions, excavation permits, and fencing) are required to minimize the potential for exposure to contamination. Performance monitoring is associated with this alternative to ensure that the cap is performing as expected and groundwater is protected.

The Implementation Plan (DOE/RL-98-28) identified surface barriers that are engineered for arid climates (i.e., alternative barriers) as a viable remediation alternative for containment of waste, as opposed to conventional surface barriers (e.g., standard RCRA, Subtitle C barrier design). Conventional barriers are multilayered systems that rely on geomembranes, clay layers, or a combination of both to form a hydraulic barrier to prevent the vertical movement of water. The clay layers in conventional surface-barrier designs have been shown to desiccate and crack if optimum moisture contents established during construction are not maintained. More recently, alternative barriers have been gaining acceptance, particularly for use in semiarid and arid climates such as the Hanford Site. Alternative barriers that predominantly rely on evaporation and plant transpiration to recycle incipient moisture to the atmosphere and near-surface water balance and recharge are referred to as evapotranspiration barriers. Some alternative surface-barrier designs also incorporate low-permeability layers (e.g., fluidized asphalt) deeper in the profile to control water infiltration and landfill gas emissions.

In situations where surface barriers are constructed over biodegradable and/or collapsible waste, dynamic compaction and/or grout injection can be used to control subsidence potential and minimize potential future impacts on surface-barrier integrity and performance.

5.8.2 Remedial Alternatives, Performance Standards, and Selection Criteria

During the detailed analysis, each alternative will be evaluated against the following CERCLA criteria (40 CFR 300.430, "Remedial Investigation/Feasibility Study and Selection of Remedy"):

- 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 addressed following issuance of the FS and proposed plan but before the ROD is issued.

The NEPA values also will be evaluated as part of DOE's responsibility under this authority. These NEPA values include impacts to natural, cultural, and historical resources; socioeconomic aspects; and irreversible and irretrievable commitments of resources. NEPA values are discussed in further detail in Section 5.7.2.1.

The RCRA closure performance standards (WAC 173-303-610[2]) will be used to evaluate the ability of alternatives to comply with RCRA closure requirements. These standards require the closure of TSD units in a manner that achieves the following:

- Minimizes the need for further maintenance

- Controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, postclosure escape of dangerous waste, dangerous-waste constituents, leachate, contaminated run-off, or dangerous-waste decomposition products to the ground, surface water, groundwater, or the atmosphere

- Returns the land to the appearance and use of surrounding land areas to the degree possible, given the nature of the previous dangerous-waste activity.

In addition, RCRA corrective-action performance standards (WAC 173-303-64620, "Closure and Post-Closure," "Corrective Action," "Requirements") will be used to evaluate how well the alternatives comply with RCRA corrective-action requirements. These standards state that corrective action must achieve the following:

- Protect human health and the environment for all releases of dangerous waste 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 units 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/closure plan also will 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 might need to be addressed by remedial action
- Provide a detailed evaluation of potential ARARs, beginning with potential ARARs identified in the Implementation Plan (DOE/RL-98-28, Chapter 4.0)
- Refine potential RAOs and PRGs identified in the Implementation Plan (DOE/RL-98-28, Chapter 5.0), 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 (DOE/RL-98-28, Appendix D) and in this section, based on the RI
- Include, as appendices, closure plans to address RCRA TSD units in the OU. The closure plans will incorporate, by reference, specific sections of the work plan or RI report containing specific closure-plan information. The closure plans will include closure performance standards, a closure strategy, and general closure activities including a general postclosure plan.

Additional RCRA coordination guidance for preparing an FS/closure plan is provided in DOE/RL-98-28, Section 2.4.

5.8.2.1 National Environmental Policy Act of 1969 Values

NEPA values will be evaluated as part of DOE's responsibility. NEPA and its implementing regulations: DOE Order 451.1B, *National Environmental Policy Act Compliance Program*; *DOE Policies on Application of NEPA to CERCLA and RCRA Actions*, Memorandum, July 11, 2002 (DOE, 2002); and DOE G 430.1-4, *Decommissioning Implementation Guide*, require that NEPA values be incorporated into decisions and documents as part of the CERCLA process. These values include, but are not limited to, cumulative, ecological, cultural, historical, and socioeconomic impacts and irreversible and irretrievable statements, in lieu of preparing separate NEPA documentation. The impacts of these aspects of the human environment usually are not otherwise addressed within the CERCLA process. This integration provides a more comprehensive analysis of potential impacts resulting from the proposed 200-SW-2 OU cleanup activities. To support the CERCLA decision-making process, NEPA value analysis will be addressed in the FS and in the resulting CERCLA decision documents.

5.8.3 Treatability Investigations

The purpose of the FS process is to identify and evaluate alternatives for waste-site remediation in support of the proposed plan and subsequent ROD. Treatability and other focused investigations are conducted to fill data gaps with information required to reduce uncertainties and support better decision making and more cost-effective site remediation. Historically, treatability investigations have been conducted post-ROD. However, pre-ROD treatability investigations can provide valuable information regarding the effectiveness, implementability, and cost of candidate remedial technologies in support of detailed evaluation during the FS process. Closure and corrective actions for RCRA TSD units will be evaluated against appropriate dangerous waste performance standards. Under RCRA corrective action, treatability investigations are conducted during the corrective-measures study but are not identified as a separate step in the RCRA process. The FS process has several steps in support of remedial-alternatives identification and evaluation:

- Define RAOs and RCRA closure/corrective-action performance standards
- Identify general response actions to satisfy RAOs
- Identify potential technologies and process options associated with each general-response action
- Assess screening-process options to select a representative process for each type of technology, based on its effectiveness, implementability, and cost
- Assemble viable technologies or process options into alternatives representing a range of removal/treatment/ disposal and containment methods plus the no-action alternative.

SGW-34463, *Treatability Investigations Supporting the 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit*, (Treatability Investigations Report) was prepared to evaluate potential treatability investigations that may be used to support characterization and remediation of the 200-SW-2 OU landfills. SGW-34463 provides a detailed discussion of the treatability-investigation process and descriptions of proposed treatability investigations to be considered during the RI process.

5.8.3.1 Technology Prescreening in Support of the RI/FS Process

A technology prescreening document (PNNL-16105) relevant to the 200-SW-2 OU was prepared to support revision of this RI/FS work plan and to address, in part, comments documented in the Collaborative Agreement. A full range of remediation and characterization technologies were evaluated to support revision of this RI/FS work plan, preparation of DQOs and SAPs, and performance of treatability investigations.

The technology prescreening also served to update and expand remediation technology evaluations previously conducted in the Implementation Plan. Primary areas of technology expansion included methods for containment, removal, ex situ treatment, and in situ treatment. Information was assembled to update the descriptions of potential remediation technologies and support the technology basis for likely remedial-response scenarios. Information for each technology is presented with respect to maturity, effectiveness, implementability, and cost. Based on the maturity of technologies, the need for treatability investigations is indicated. Updated remediation-technology information also reflects site-remediation activities at the 618-10 and 618-11 solid-waste Burial Grounds.

The prescreening also addressed potentially applicable characterization technologies. The following eight categories of information relevant to the characterization of the 200-SW-2 OU were addressed:

- Distribution of debris and physical boundaries of burial trenches (intrusive and nonintrusive)
- Distribution of heavy metals/inorganic compounds (intrusive and nonintrusive)
- Distribution of organic compounds (intrusive and nonintrusive)
- Lateral distribution of radionuclides (intrusive and nonintrusive)
- Vertical distribution of radionuclides (intrusive only)
- Identification of transuranic radionuclides (intrusive and nonintrusive)
- Enabling technologies (analytical)
- Enabling technologies (subsurface access).

The characterization technology prescreening considered activities at the 618-10/618-11 solid-waste Burial Grounds, other Hanford Site projects, and other DOE sites. Discussions are provided with respect to the advantages, disadvantages, limitations, uncertainties, maturity, and relative cost of potentially viable characterization technologies. Remediation and characterization technology experts from Pacific Northwest National Laboratory, Idaho National Engineering Laboratory, and Oak Ridge National Laboratory provided technical review and input to the technology screening activities.

Table 5-4 provides a composite listing of likely response scenarios for the 200-SW-2 OU, based on the Implementation Plan, Collaborative Agreement, and the technology prescreening report (PNNL-16105). Also included are potential site-remediation technologies and an indication of whether treatability investigations are recommended to support evaluation of remedial alternatives during preparation of the FS.

Table 5-4. Likely Response Scenarios. (2 Pages)

Likely Response Scenario	Supporting Technologies	Treatability Investigation Needed?
	Applicable Within a Landfill	
Surface and Subsurface Barriers	Arid climate engineered barrier	No
	Asphalt, concrete, cement-type cap	Yes (E)
	RCRA cap	No
	Slurry walls	No
	Grout curtains	No
	Dynamic compaction	No
Removal/Treatment/Disposal for all or portions of an individual landfill	Conventional	No
	Remote processes	No
	Stabilization and retrieval	Yes (E,I,C)
	Soil vacuum	No
	Vitrification	No
	In-container vitrification	No
	Soil Washing	No
	Mechanical separation	No
	Solidification/stabilization	No
	Automated segregation based on rad	No
In situ solidification and stabilization for all or portions of an individual landfill	Vitrification	No
	Grout injection	Yes (E)
	Soil mixing	Yes (E)
	Applicable in the Vadose Zone Beneath a Landfill	
In situ solidification and stabilization	Grout injection	Yes (E)
	Supersaturated grouts	Yes (E)
	Soil desiccation	Yes (E)
	Reactive gases	Yes (E)
	Nanoparticles	Yes (E,I,C)
Contaminant extraction	Soil flushing	Yes (E)

Table 5-4. Likely Response Scenarios. (2 Pages)

Likely Response Scenario	Supporting Technologies	Treatability Investigation Needed?
	Electrokinetics	Yes (E)
Natural attenuation	Monitored natural attenuation	No

Additional information may be needed to support the feasibility study in the area of effectiveness (E), implementability (I), or cost (C). Some technologies not listed as requiring treatability investigations may still need site-specific design information as part of the remedial design report/remedial action work plan activities following determination of the record of decision.

RCRA = *Resource Conservation and Recovery Act of 1976.*

Consistent with the phased RI/FS approach discussed herein, treatability investigations are proposed for phased implementation, given the current lack of information regarding the nature and extent of contamination surrounding the burial trenches. The DOE complex and others have conducted a significant body of work to develop and demonstrate technologies potentially applicable to the characterization and remediation of radioactive and nonradioactive solid-waste landfills. This work ranges from in-place isolation and stabilization using surface and subsurface barrier technologies, to waste retrieval, treatment, and disposal. The majority of the DOE complex work has been conducted at the Hanford Site and Idaho National Engineering Laboratory.

Initial efforts will focus on the compilation of information to help focus pre-ROD treatability investigations to address specific areas of interest. These areas of interest are listed in Section 5.7.4.2 and primarily are paper studies.

As solid-waste landfill nonintrusive and intrusive investigations proceed, and more becomes known about the nature and extent of contamination, focused treatability investigations can be conducted to determine the effectiveness, implementability, and cost of site-remediation technologies, based on likely response scenarios to address the nature and extent of contamination. This approach minimizes the likelihood of unnecessarily investing in treatability investigations for technologies that may not be required, once the nature and extent of contamination is known.

Following completion of the RI/FS process, the results of the detailed alternatives analysis and risk assessment become the basis and rationale for selecting the preferred alternative. Once a preferred alternative is selected, a proposed plan is prepared in support of the ROD. Once the ROD is issued, additional treatability investigations may be required to support the remedial design and subsequent remedial actions. Furthermore, if new technologies emerge during the execution of the RI/FS process, they will be considered as appropriate. If additional treatability investigations are deemed necessary to support evaluation of emerging technologies, then test plans and other supporting documentation will be prepared at that time.

The technology prescreening conducted to date evaluated potential technologies from the standpoint of their applicability (1) within a landfill, and (2) within the vadose zone beneath a landfill. SGW-34463 describes recommended treatability and other investigations (paper studies not requiring field work) that may be performed in support of the 200-SW-2 OU. Technologies not requiring treatability investigations were identified as such because it was determined that their level of maturity was such that sufficient information exists with respect to effectiveness, implementability, and cost to support detailed analysis during the FS process.

5.8.4 Feasibility Study Cost Estimating

The National Contingency Plan and CERCLA require a detailed analysis of all the alternatives presented in an FS. The cost estimate is one part of the detailed analysis. The cost estimate will reflect a level of detail based on the data collected during the RI. Typically, the cost estimate is a "study level" cost estimate. The intent of the estimate is to prepare the estimate at relatively low cost within an accuracy of minus 30 to plus 50 percent (-30 to +50). In addition, the cost estimate will identify capital, operations, and maintenance costs for each alternative. The accuracy is specified in EPA/540/R-00/002, *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study*, OSWER 9355.0-75. The cost estimates provide a discriminator for deciding between similar protective and implementable alternatives for a specific waste site. Therefore, the costs are relational, not absolute, costs for the evaluation of the alternatives. Cost estimates by landfill will be developed using cost models developed by the Fluor Hanford Project Controls organization.

The cost models do not evaluate the economies associated with implementing multiple landfills or groups with a common alternative or aggregated remediation. They will be considered in the future as part of long-range planning and through the post-ROD activities, such as remedial design. Potential areas of cost sharing to reduce overall remediation costs include the following:

- Remediating all waste sites with a common preferred alternative at the same time
- Sharing mobilization/demobilization costs
- Sharing surveillance and maintenance costs
- Sharing barrier-performance monitoring costs.

Present net-worth costs will be estimated using the real discount rate published in Appendix C of OMB Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*. The types of costs include the following: (1) capital costs, including both direct and indirect costs (2) annual operations and maintenance costs; and (3) net present value of capital and operation and maintenance costs (40 CFR 300.430(e)(9)(iii)(G), "Feasibility Study," "Detailed Analysis of Alternatives," "Nine Criteria for Evaluation," "Cost").

Nondiscounted costs will be calculated because of recommendations presented in EPA/540/R-00/002. Nondiscounted constant dollar costs demonstrate the impact of a discount rate on the total present-value cost. The nondiscounted costs will be presented for comparison purposes only.

5.8.4.1 Cost for Treatability Investigations

Many cost elements are applicable to all tiers of treatability investigations (remedy screening, remedy selection, remedial design/remedial action); however, some will increase from one tier to another. Some cost elements only will be applicable to a particular tier. For example, vendor-equipment rental is a key cost element in the performance of remedial design/remedial action testing. Most vendors have established daily, weekly, and monthly rates for the use of their treatment systems. Site preparation and logistics costs include costs for planning and management, site design and development, equipment and facilities, health and safety equipment, soil excavation, feed homogenization, and feed handling. Costs associated with the majority of these activities normally are incurred only with remedial design/remedial action testing of mobile field-scale units; however, some cost elements also are incurred in bench- and pilot-scale remedy-selection testing. Analytical costs apply to all tiers and have significant impact on the total project costs. Several factors affect the cost of the analytical program, including the performing laboratory, the analyte list, number of samples, turnaround time, quality assurance/quality control, radiological dose factors, and reporting. Transportation and disposal of residuals are important elements that must be budgeted in all treatability investigations. Depending on the technologies involved, a number of residuals will be generated.

Treatability investigations are laboratory or field tests conducted to provide data needed to evaluate and implement remedial treatment technologies. The EPA has developed a three-tiered approach to aid the planning and performance of cost-effective, on-time, and scientifically sound treatability investigations. Table 5-5 presents a general comparison between the three tiers of treatability investigations; namely remedy screening, remedy selection, and remedial design/remedial action.

Table 5-5. Comparative Summary of the Three Tiers.

Tier	Study Scale	Type of Data Generated	Number of Replicates	Process Type	Waste Stream Volume	Time Required (Test Duration Only)	Cost ($K)
Remedy Screening	Bench	Qualitative	Single or Duplicate	Batch	Small	Days	10 to 50
Remedy Selection	Bench or Pilot	Quantitative	Duplicate or Triplicate	Batch or Continuous	Medium	Days to Weeks	50 to 100
	Pilot or Full (onsite or offsite)	Quantitative	Duplicate or Triplicate	Batch or Continuous	Large	Weeks to Months	50 to 250
Remedial Design/Remedial Action	Full (onsite)	Quantitative	Duplicate or Triplicate	Batch or Continuous	Large	Weeks to Months	250 to 1,000

Summary level information is provided below for each of the three tiers. Detailed discussions of the treatability investigation process may be found in SGW-34463.

5.8.4.1.1 Remedy Screening

Remedy screening provides gross performance data needed to determine the potential feasibility of technologies for treating contaminants and matrices of concern. Remedy-screening treatability investigations may not be necessary when available technical literature contains adequate data to assess the feasibility of a technology. The results of a remedy screening are used to determine whether more-detailed treatability investigations should be performed at the remedy-selection tier.

5.8.4.1.2 Remedy Selection

Remedy-selection treatability investigations verify whether a process option can meet the OU's cleanup criteria and at what cost. This tier generates the critical performance and cost data necessary for remedy evaluation in the detailed analysis of alternatives during the FS.

5.8.4.1.3 Remedial Design/Remedial Action

Remedial design/remedial action treatability investigations generate detailed design, cost, and performance data to optimize and implement the selected remedy. Remedial design/remedial action treatability investigations are conducted post-ROD. These treatability investigations are performed to (1) select among multiple vendors and processes within a prescribed remedy (prequalification), (2) implement the most appropriate remedy prescribed in a contingency ROD involving multiple remedies, and (3) support detailed-design specifications and the design of treatment trains.

5.8.4.2 Other Focused Investigations

In addition to technology-based treatability investigations, other focused investigations are required to provide information needed in support of the overall RI/FS process. This information tends to be site-specific in nature, but has general applicability to all landfills where similar conditions exist. For the most part, these focused investigations involve research and compilation of information from available databases, other similar projects, and available literature. The results of these focused investigations will provide information to support refinement of conceptual site models, likely response scenarios, and remedial alternatives evaluated during the RI/FS process. Furthermore, some focused investigations will provide information important to site-characterization activities conducted during the RI/FS process.

The following bullets list the focused investigations envisioned in support of the RI/FS process. As site characterization information is obtained through the RI/FS process, the need for focused investigations may be expanded in response to newly identified information needs, and there may be a need for additional technology-based treatability investigations.

- Locations of large burial boxes
- Cost of waste retrieval vs barrier construction
- Caisson characterization and remedial techniques
- Retrieval of spent fuel
- Direct-push technology through or near waste trenches
- Acid-soaked material trenches
- Vadose-zone characterization and monitoring
- Compaction methods
- In situ detection of transuranics
- Soil vacuum removal methods.

5.8.5 Information and Data Management

SGW-35016, *Information and Data Management Plan for the 200-SW-2 Operable Unit* (Information Management Plan), has been prepared to compile and manage information specific to the 200-SW-1 and 200-SW-2 OUs. Implementation of this plan will establish a project record in support of the RI/FS and/or RCRA closure process for remediating the landfills in these two OUs. Data management also is discussed in Appendix C of DOE/RL-98-28 (Implementation Plan).

The Information Management Plan describes how the RL prime contractor will manage data and other documentation for remedial projects under the 200-SW-1 and 200-SW-2 OUs. The scope of these projects includes collection and interpretation of historical records, as well as collection of data through sampling, surveying, and other techniques. The objective of the management of this information is to provide a technical and defensible basis for the remedial actions chosen for each landfill in these OUs, support implementation of those remedial actions, facilitate availability of project history, and facilitate the flow of information into information systems per Fluor Hanford requirements and procedures, which ultimately are driven by DOE orders, other Federal and state requirements, and the Tri-Party Agreement.

Although work elements associated with the TSD-unit landfills and past-practice landfills are collecting data and information necessary to support individual objectives, some of the elements identified under the Information Management Plan are not readily available in current document and data-management systems. The primary goal of the Information Management Plan is to systematically consolidate 200-SW-1 and 200-SW-2 OU project information needed for historical documentation, waste profiling, closure verification, nuclear-safety verification, endpoint verification, completion of removal actions, and support for future remedial decisions. In addition, the Information Management Plan will ensure that the data and information are readily available to all qualified Hanford Site personnel and regulators when needed, via widely available data- and document-management vehicles.

Requirements for information management are driven by higher level documents (e.g., DOE directives, *Code of Federal Regulations*) as well as RL prime contractor requirements and procedures. These procedures are discussed briefly in the Information Management Plan; however, the focus of the plan is the implementation.

Information management, as a process for the 200-SW-1 and 200-SW-2 OUs, still is under development and will be an ongoing process until final remediation of the landfills has occurred. Therefore, the following information-management activities may be subject to adjustment during the initial stages of data collection at the 200-SW-1 and 200-SW-2 OUs.

The overall purpose of the Information Management Plan is to collect and manage information specifically for the 200-SW-1 and 200-SW-2 OUs for the following purposes:

- Provide a readily available and continuous project history
- Establish a historical record of waste-management practices and waste disposed to individual waste sites within the OUs
- Establish a record of waste-designation activities to support the appropriate disposal of waste from remediation activities associated with the OUs

- Manage documentation required to support historic-preservation requirements for specific facilities at the OUs
- Ensure completion/control of closure-verification packages
- Provide links to nuclear-safety documentation and communicate effectively during work planning, hazards analysis, and other safety functions
- Document end-point verification information
- Document the remedial- or removal-action completion
- Record end-state conditions at the conclusion of completed activities as the project progresses, to support future activities and remedial decisions.

The plan does not apply to information collected from within the OUs that will require special handling for security purposes. All information archived per the Information Management Plan will be contained within the Hanford Site Integrated Data Management System.

5.9 PROPOSED PLAN AND PROPOSED RCRA-PERMIT MODIFICATION

The decision-making process for the 200-SW-2 OU will be based on the use of a proposed plan, ROD, with modification to the Hanford Facility RCRA Permit (WA7890008967), as appropriate. The decision-making process for the 200-SW-1 OU will be based on the use of a closure plan that will result in a modification to the Hanford Facility RCRA Permit for the NRDWL and the appropriate closure documentation for the 600 CL, in conjunction with WAC 173-304-407 requirements.

The proposed plan will include information on the draft permit modifications. The draft permit modifications will include unit-specific conditions for the RCRA TSD units for incorporation into the Hanford Facility RCRA Permit

During the RI/FS process, a number of options for development of decision documents to support remediation as quickly as possible will be evaluated. Remedial decisions may proceed on an OU-by-OU basis, but it also is likely that alternative site groupings will be considered for waste sites in the Central Plateau. Several alternatives currently are under consideration, some of which may be used for the landfills addressed in this RI/FS work plan.

Three alternatives to the OU-by-OU remediation approach have been identified to provide flexibility in the decision-making process, facilitate early action, and remediate and close specific areas or zones. Examples of these alternatives are presented below.

5.9.1 High-Risk Waste Sites Identified for Early Action

This alternative accelerates the start of remedial actions and closure of waste sites that present an ongoing or expected future threat to groundwater. Some high-risk sites already have been identified for early actions within the BC Controlled Area and near U Plant, PUREX, and the Plutonium Finishing Plant. These sites will be included in a proposed plan and ROD that promote early action. None of the landfills from the 200-SW-1 and 200-SW-2 OUs have been identified as high-risk sites, and it is not anticipated that any findings from this RI/FS process will change their status in this regard. However, if high-risk items (i.e., containerized liquid organics) are located during RI activities, removal/treatment/disposal of these waste forms may be performed as an early action.

5.9.2 Regional Site Closure

Waste-site remedial decision making may be adjusted under a regional closure strategy that aligns wastes sites into groups defined by geographical zones. Under this strategy, waste sites in a geographical area may be remediated as a group, even though they may be in different OUs. A strategy to implement this regional closure strategy is documented in CP-22319-DEL, *Plan for Central Plateau Closure*.

5.9.3 Waste-Site Grouping by Characteristics or Hazards

A third example of remedial decision-making strategies is based on a specific characteristic or hazard that mandates additional requirements, such as supplemental ARARs, or more robust remedial alternatives. Grouping waste sites with other similarly contaminated soil sites in other OUs could streamline the decision-making process and tailor the requirements and alternatives to these specific hazards.

Following the completion of the FS/closure plan, a proposed plan will be prepared that identifies the preferred remedial alternative for the OUs (which will include RCRA closure and corrective-action requirements). In addition to identifying the preferred alternative, the proposed plan also will serve the following purposes:

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

The proposed plan also will include a draft permit modification for incorporation of closure/postclosure plans into the Hanford Facility RCRA Permit (WA7890008967). After the public review process is complete, Ecology (as the lead regulatory agency), in concert with the DOE and EPA, will make a final decision on the remedial action to be taken, which is documented in a ROD. The ROD will be covered by the Hanford Facility RCRA Permit in accordance with Condition II.Y.2.a to satisfy RCRA corrective action requirements. If alternative decision-making strategies are employed, lead regulatory agency realignments may be considered in consultations between the DOE, EPA, and Ecology.

5.9.4 RCRA TSD-Unit Closure Performance Standards and Closure Strategy

Because the RCRA TSDs cannot be clean closed in accordance with WAC 173-303-610(2)(b), the TSDs will be closed as a landfill in accordance with WAC 173-303-665(6). This closure strategy is consistent with the requirements specified in WAC 173-303-665(6); the land-disposal unit closure requirements of the Tri-Party Agreement, Section 6.3.2; and the landfill closure requirements of Condition II.K.4 of the Hanford Facility RCRA Permit. The RCRA permit modification will specify the closure requirements for the TSD as well as a compliance schedule specifying the submittal of a postclosure plan and groundwater-monitoring plan at a later date.

Postclosure requirements will ensure that the engineered barrier is maintained (that is, repaired), that it is monitored to ensure that it is performing as expected, and that water run-on/runoff is managed. Postclosure activities will be coordinated with the operations and maintenance organization for the 200-SW-2 OU.

A draft closure-permit modification will be prepared in accordance with Sections 5.5 and 6.3 of the Tri-Party Agreement. After the public review and comment period, a revised draft closure permit will be incorporated into the Hanford Facility RCRA Permit.

Table 5-6 illustrates the RCRA TSD closure requirements and indicates from which documents the supporting materials will be collected. This table will be used as a crosswalk to orchestrate required components for a RCRA "landfill" closure plan, in coordination with a CERCLA remedial decision.

Table 5-6. Crosswalk Between RCRA Treatment, Storage, and Disposal Closure Plan Requirements and Supporting Documentation. (2 Pages)

RCRA TSD Closure Plan Section	Information Contained	Location in Supporting Documents
1.0 Introduction	Permitting history	DOE/RL-88-20, Chapter 2.0
	Closure strategy	DOE/RL-2004-60, Section 5.1
	Part A Permit Application	DOE/RL-88-21, Section 4.2.3.1
2.0 Facility Description and Location	Location maps and discussion	DOE/RL-88-21, Section 4.2.3.1 DOE/RL-2004-60, Section 2.2.6
	Operational history	DOE/RL-88-20 DOE/RL-2004-60, Section 2.2.6

Table 5-6. Crosswalk Between RCRA Treatment, Storage, and Disposal Closure Plan Requirements and Supporting Documentation. (2 Pages)

RCRA TSD Closure Plan Section	Information Contained	Location in Supporting Documents
3.0 Process Information	Process history for waste streams discharged to the TSD	DOE/RL-88-20, Chapter 4.0 DOE/RL-2004-60, Section 2.2.1
4.0 Waste Characteristics	Waste types and characteristics discharged to the TSD	DOE/RL-88-20 FS (TBD),
5.0 Groundwater Monitoring	Groundwater impacts and monitoring activities	Groundwater monitoring requirements will be contained in the groundwater monitoring plan, DOE/RL-88-20, Chapter 5.0; and FS (TBD)
6.0 Closure Performance Standards	Closure strategy and performance standards	DOE/RL-2004-60, Section 5.4.4 FS (TBD)
7.0 Closure Activities	Sampling and analysis; closure alternatives and closure requirements; includes schedule and certification of closure	DOE/RL-2004-60, Chapter 5.0 DOE/RL-2004-60, Appendix A (SAP) Closure alternatives and requirements evaluated through FS (TBD) (Chapters 5.0 through 7.0) Closure schedule will be included in the remedial design report/remedial action work plan and closure certification through the actual remediation and closeout verification process,
8.0 Postclosure Plan	Groundwater monitoring, cover design, surveillance and maintenance, inspection plan, if needed when clean closure is not achieved	Will be incorporated through the 200-SW-2 Operable Unit Operations and Maintenance Plan, as necessary. Groundwater monitoring requirements will be contained in the groundwater monitoring plan, DOE/RL-88-20, Chapter 5.0.

DOE/RL-88-20, *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds.*
DOE/RL-88-21, *Hanford Facility Dangerous Waste Part A Permit Application.*
DOE/RL-2004-60, *200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study Work Plan*, Draft B.
FS (TBD) = feasibility study for the 200-SW-2 Operable Unit.
RCRA = *Resource Conservation and Recovery Act of 1976.*
SAP = sampling and analysis plan.
TSD = treatment, storage, and/or disposal (unit).

5.9.4.1 Closure of Unused Portions of RCRA Landfills

Portions of three of the RCRA TSD-unit landfills (i.e., the 218-W-4C, 218-E-10, and 218-E-12B Landfills) were intended to be used for future disposal of waste; however, preliminary evaluation indicates that no waste disposals are known to have taken place in these areas. Because these portions are part of a RCRA TSD unit, procedural closure pursuant to the Tri-Party Agreement Action Plan, Section 6.3.3, "Procedural Closure," will be evaluated in lieu of developing a closure plan under WAC 173-303-610(3), "Closure Plan; Amendment of Plan." The procedural closure pathway, as described in the Tri-Party Agreement Action Plan, is intended for sites (such as these) that originally were classified as being TSD units but never actually were used to treat, store, or dispose of hazardous waste including mixed waste. Work plan activities will gather records and perform field activities to support the conclusion required for certification pursuant to the Tri-Party Agreement Action Plan, Section 6.3.3. These activities are described further in Appendix A.

5.10 POST-RECORD OF DECISION ACTIVITIES

After the ROD and modification to the Hanford Facility RCRA Permit have been issued, the implementation of the selected remedial actions will be documented in a remedial design/remedial action work plan. The remedial design/remedial action work plan will be prepared to detail the scope of the remedial action (which will identify RCRA closure and corrective-action requirements that address TSD remedial work that is overlapped by the CERCLA decision). Additional post-ROD treatability investigations may be performed in support of the remedial design and remedial action. As part of this activity, DQOs will be established and SAPs will be prepared to direct confirmatory and verification sampling and analysis efforts. Before remediation begins, confirmation 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 the OUs, to collect data necessary for the remedial design, and to support final cumulative risk assessments for the 200 Areas National Priorities List site. Verification sampling will be performed after the remedial action is complete to determine if ROD requirements have been met and if the remedy was protective of human health and the environment. Additional guidance for confirmatory and verification sampling is provided in Section 6.2 of the Implementation Plan (DOE/RL-98-28).

The remedial design/remedial action work plan will include an integrated schedule of remediation activities for the OUs, including a coordinated schedule for RCRA TSD-unit closure, and will satisfy the technical requirements of a past-practice corrective-measures-implementation work plan and corrective-measures design report. The available options for remedy implementation throughout the 200 Areas will be explored during the course of the RI/FS process and may be reflected in the remedial design/remedial action work plan. Following the completion of the remediation, closeout activities will be performed as specified in the ROD, remedial design/remedial action work plan, and the Hanford Facility RCRA Permit. The RCRA closure activities and schedules will be defined in the closure plan and will be coordinated with those activities and schedules in the remedial design/remedial action work plan. Enforceable sections of the closure plan will be stated in the modification to the Hanford Facility RCRA Permit (WA7890008967). Certification of closure in accordance with WAC 173-303-610(6), "Certification of Closure," will be performed after completion of cleanup actions. The site will be restored as appropriate for future land use. If clean closure is not attained at a TSD-unit, postclosure care requirements will be met. These requirements will include final-status groundwater monitoring, maintenance and monitoring of institutional controls and/or surface barriers, and certification of postclosure at the completion of the postclosure period.

6.0 PROJECT SCHEDULE

Figure 6-1 illustrates the overall schedule for the implementation of the RI/FS work plan, SAP, and FS for the 200-SW-2 OU, and the closure schedule for the NRDWL and 600 CL in the 200-SW-1 OU. Figure 6-2 illustrates the required steps for closure of the NRDWL and 600 CL in more detail. The information presented in Figure 6-1 is based on the critical assumption that DQO processes, SAPs, and RI/FS work plan revisions can be developed and approved within the specified timeframes. The review and comment periods for primary documents assume standard durations as specified in Section 9.0 of the Tri-Party Agreement Action Plan. Extended review and comment periods may warrant schedule change(s). The project schedule will be refined during each revision to the phased RI/FS work plan.

The comprehensive strategy for the 200 Areas radioactive landfills includes elements that will contribute to the RI and the remediation of the 200-SW-2 OU landfills, but that are not currently within the scope of the CERCLA RI/FS activities or coordinated RCRA closure activities, included in this RI/FS work plan. The following additional activities are related to characterization or remediation of solid-waste landfills.

- As noted in Section 1.3, the 218-E-12B, 218-W-3A, 218-W-4B, and 218-W-4C Landfills contain retrievably stored suspect TRU waste. The suspect TRU waste includes both contact-handled suspect TRU waste and remote-handled suspect TRU waste. The vast majority (94 percent of TRU containers) of contact-handled suspect TRU waste is stored in metal drums, with the remainder stored in a variety of container types. The remote-handled suspect TRU waste (about 4 percent of all TRU waste containers at the Hanford Site) is stored in a variety of containers such as casks, metal drums, boxes, and metal cans inside caissons. Activities associated with this scope of work that will contribute to the RI of these landfills include the following:
  - Contact-handled suspect TRU waste is being retrieved from four landfills in the LLBG TSD unit in accordance with Tri-Party Agreement Interim Milestone M-091-40, Requirement 1.
  - As retrieval of contact-handled suspect TRU waste proceeds, trench substrates will be sampled and analyzed in accordance with Tri-Party Agreement Interim Milestone M-091-40, Requirement 2. The purpose of the sampling is to evaluate whether contaminants have been released to the environment and, if so, the nature and extent of the contamination. A separate DQO summary report and SAP have been developed and are described in Section 3.3 for substrate sampling at each of the four landfills. Interface will be established between the 200-SW-2 OU Project and the M-091 Program to explore opportunistic sampling events during preparation of the DQO and SAP to provide information supportive of the 200-SW-2 OU RI/FS process.
  - Remote-handled suspect TRU waste will be retrieved from four landfills in accordance with Tri-Party Agreement Interim Milestone M-091-41, Requirement 1.

Figure 6-1. Project Schedule for the 200-SW-2 Operable Unit RI/FS and 200-SW-1 Operable Unit Closure Process.

ID	Task Name	Start	Finish
1	Project Management FY08	10/1/2007	9/29/2008
2	Project Management FY09	10/1/2008	9/30/2009
3	Project Management FY10	10/1/2009	9/30/2010
4	Project Management FY11	10/1/2010	9/30/2011
5	Data Management/Modeling FY08	10/1/2007	9/29/2008
6	Data Management/Modeling FY09	10/1/2008	9/30/2009
7	Data Management/Modeling FY10	10/1/2009	9/30/2010
8	Data Management/Modeling FY11	10/1/2010	9/30/2011
9	DQO Phase I-B (Collaborative)	10/1/2007	12/31/2007
10	DQO Phase II	1/1/2009	6/30/2009
11	DQO Phase III	4/1/2010	9/30/2010
12	RI/FS Work Plan/SAP Revision 0	10/1/2007	6/30/2008
13	RI/FS Work Plan/SAP Revision 1	4/1/2009	12/31/2009
14	RI/FS Work Plan/SAP Revision 2	7/1/2010	3/30/2011
15	Phase I-B Nonintrusive Characterization	1/1/2008	12/31/2008
16	Phase II Nonintrusive Characterization	10/1/2009	3/30/2010
17	Phase III Nonintrusive Characterization	1/3/2011	3/30/2011
18	Phase I-B Intrusive Characterization	4/1/2008	3/30/2009
19	Phase II Intrusive Characterization	10/1/2009	6/30/2010
20	Phase III Intrusive Characterization	1/3/2011	6/30/2011
21	Treatability Investigations FY08	1/1/2008	9/30/2008
22	Treatability Investigations FY09	10/1/2008	9/30/2009
23	Treatability Investigations FY10	10/1/2009	9/30/2010
24	NRDWL and 600 CL Closure	10/1/2007	9/30/2010
25	RI/FS Report	1/1/2008	9/30/2011
26	Proposed Plan	1/3/2011	12/30/2011

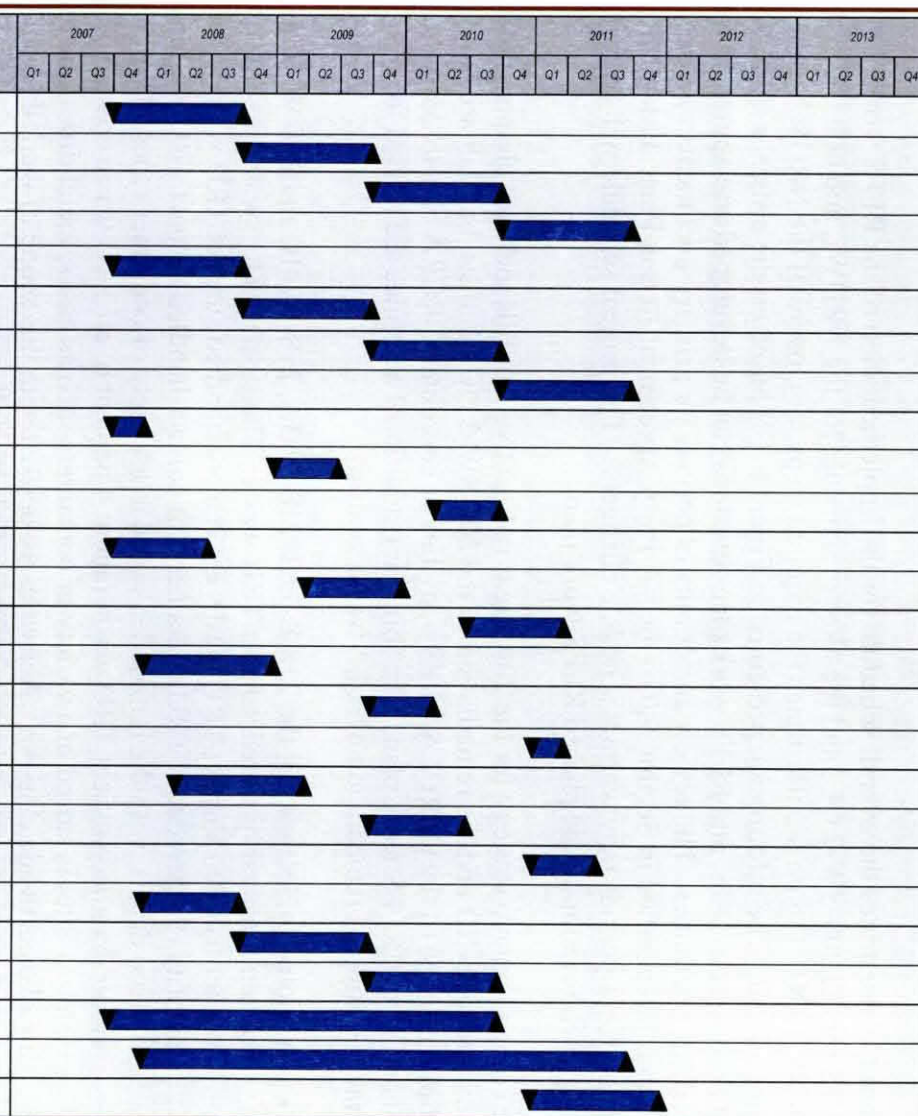
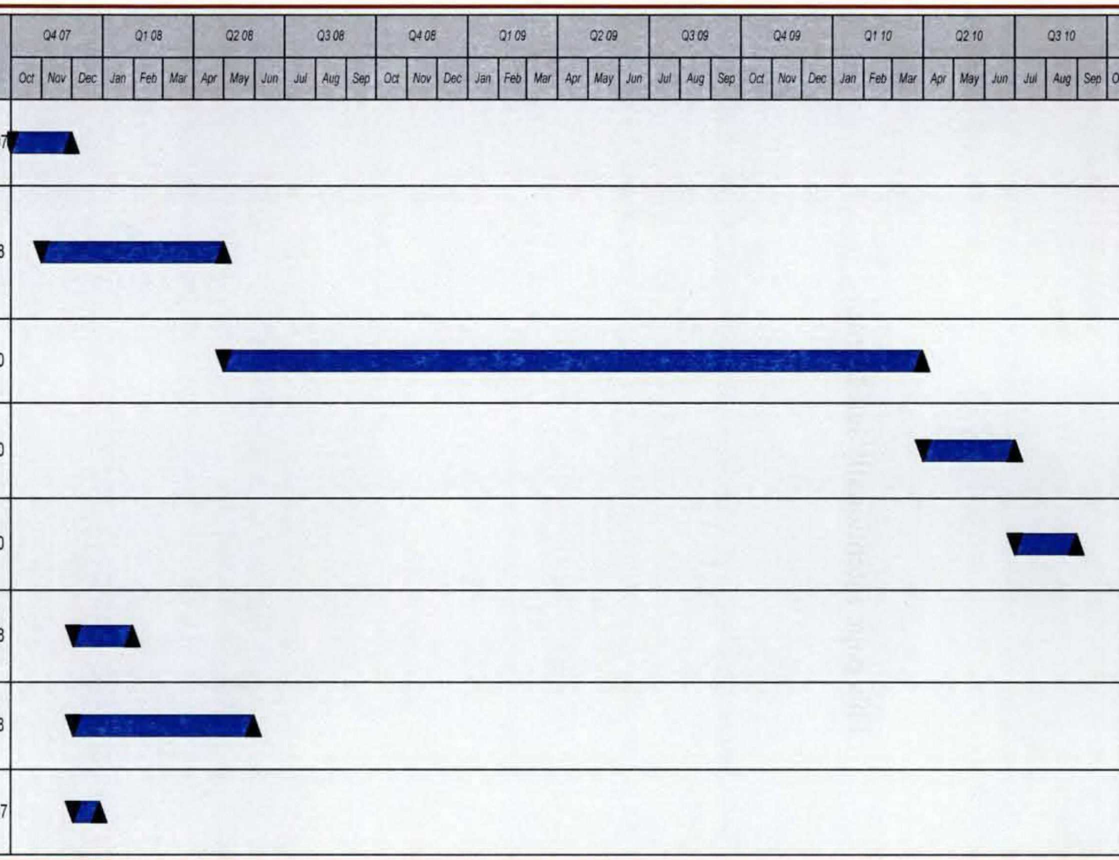


Figure 6-2. Schedule for Closure Activities at the 200-SW-1 Operable Unit.

ID	Task Name*	Start	Finish
1	Prepare TPA Change Request	10/1/2007	11/30/2007
2	Prepare closure/post closure plans (including groundwater monitoring plans)**	11/1/2007	4/30/2008
3	NOD Cycle	5/1/2008	3/30/2010
4	Prepare permit modification (NRDWL)	4/1/2010	6/30/2010
5	Support public involvement for permit mod (NRDWL)	7/1/2010	8/30/2010
6	Prepare revised Part A (NRDWL)	12/3/2007	1/30/2008
7	Prepare Environmental Assessment***	12/3/2007	5/30/2008
8	Prepare SEPA Checklists	12/3/2007	12/28/2007



*Unless otherwise specified, the task is for documents/actions needed for both the Nonradioactive Dangerous Waste Landfill and the 600 Area Central Landfill.

**The cost and schedule include document preparation, submittal to the U.S. Department of Energy, Richland Operations Office, comment incorporation, and submittal to the Washington State Department of Ecology (Ecology). Schedule for resolutions of notices of deficiency and approval of the closure plan from Ecology will follow Figure 9-2 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b). While the 600 Area Central Landfill closure plan normally would not follow Figure 9-2 but rather Figure 9-1 of the Tri-Party Agreement Action Plan as a primary document, following the same notice of deficiency schedule for both documents would allow for better integration and coordination of closure activities between the two landfills.

***Environmental assessment is needed if the action is over $5 million and longer than 5 years. If the action is below these conditions, then a categorical exclusion may be appropriate.

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7.0 REFERENCES

04-AMCP-0321, 2004, "Transmittal of the Burial Ground Sampling and Analysis Results for January – March 2004," (letter to Michael A. Wilson, Program Manager, Nuclear Waste Program, Department of Ecology, Kennewick, Washington, from Matthew S. McCormick, Assistant Manager for the Central Plateau), U.S. Department of Energy, Richland Operations Office, Richland, Washington, June 4.

04-RCA-0037, 2003, "Notification of Completion of Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Settlement and Tentative Agreement Interim Milestone M-91-40, Requirement for DOE to "Initiate Retrieval at Its Burial Ground 218-W-4C No Later Than November 15, 2003"," (letter to Michael A. Wilson, Program Manager, Nuclear Waste Program, Department of Ecology, Kennewick, Washington, from J. Hebdon), U.S. Department of Energy, Richland Operations Office, Richland, Washington, December 22.

07-AMCP-0166, 2007, "Burial Ground Sampling and Analysis Results for October – December 2006," (letter to Jane A. Hedges, Program Manager, Nuclear Waste Program, Department of Ecology, Kennewick, Washington, from Matthew S. McCormick, Assistant Manager for the Central Plateau), U.S. Department of Energy, Richland Operations Office, Richland, Washington, April 24.

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

10 CFR 835.2, "Occupational Radiation Protection," "Definitions," Title 10, *Code of Federal Regulations*, Part 835.2.

10 CFR 962, "Byproduct Material," Title 10, *Code of Federal Regulations,* Part 962.

40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," Title 40, *Code of Federal Regulations*, Part 191.

40 CFR 261, "Identification and Listing of Hazardous Waste," Title 40, *Code of Federal Regulations,* Part 261.

40 CFR 265, Subpart F, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," Subpart F, "Ground-Water Monitoring," Title 40, *Code of Federal Regulations*, Part 265, Subpart F.

40 CFR 265.92, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," "Sampling and Analysis," Title 40, *Code of Federal Regulations*, Part 265.92.

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," Appendix B, "National Priorities List," Title 40, *Code of Federal Regulations*, Part 300, Appendix B.

40 CFR 300.430, "Remedial Investigation/Feasibility Study and Selection of Remedy," Title 40, *Code of Federal Regulations*, Part 300.430.

40 CFR 300.430(e)(9)(iii)(G), "Remedial Investigation/Feasibility Study and Selection of Remedy," "Feasibility Study," "Detailed Analysis of Alternatives," "Nine Criteria for Evaluation," "Cost," Title 40, *Code of Federal Regulations*, Part 300.430(e)(9)(iii)(G).

52 FR 15937, "Radioactive Waste, Byproducts Material Final Rule," *Federal Register*, Vol. 52, p. 15937, May 1, 1987.

52 FR 35556, "Final Authorization of State Hazardous Waste Management Program; Washington," *Federal Register*, Vol. 52, p. 35556, September 22, 1987.

54 FR 36597, "40 CFR Part 261, Mining Waste Exclusion; Final Rule," *Federal Register*, Vol. 54, p. 36597, Sept 1, 1989.

64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)," *Federal Register*, Vol. 64, No. 218, pp. 61615-61625, November 12, 1999.

AEC Immediate Action Directive 0511-21, 1970, *Policy Statement Regarding Solid Waste Burial*, U.S. Atomic Energy Commission, Washington, D.C., March 20, 1970.

AEC, 1973, Atomic Energy Commission Manual Chapter 0511, *Radioactive Waste Management*, U.S. Atomic Energy Commission, Washington, D.C.

ANL, 2002, *RESRAD for Windows*, Version 6.21, Environmental Assessment Division, Argonne National Laboratory, Argonne, Illinois.

ARH-780, 1968, *Chronological Record of Significant Events in Chemical Separations Operations*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-1608, 1970, *Radioactive Contamination in Liquid Wastes Discharged to Ground Within the Chemical Separations Area Control Zone Through 1969*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-1842, 1970, *Specifications and Standards for the Burial of ARHCO Solid Wastes*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-2015, 1971, *Radioactive Contamination in Unplanned Releases to Ground Within the Chemical Separations Area Control Zone through 1970; Part 4*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-2757, 1973, *Radioactive Contamination In Unplanned Releases To Ground Within the Chemical Separations Area Control Zone Through 1972 (Exclusive of Liquid Waste Storage Tank Farms)*, Part 4, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-2762, 1974, *Input and Decayed Values of Radioactive Solid Wastes Buried in the 200 Areas through 1971*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-3032, 1974, *Specifications and Standards for the Packaging, Storage, and Disposal of Richland Operations Solid Waste*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-CD-353, 1976, *Design Criteria for Transuranic Dry Waste Steel and Reinforced Concrete Burial Containers*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-CD-744-4Q, 1977, *Summary of Radioactive Solid Waste Burials in the 200 Areas During 1976*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-ST-155, 1977, *The Hanford Environment as Related to Radioactive Waste Burial Grounds and Transuranic Waste Storage Facilities*, Atlantic Richfield Hanford Company, Richland, Washington.

Atomic Energy Act of 1954, 42 USC 2011, et seq.

BHI-00127, 1995, *100-H Area Technical Baseline Report*, Bechtel Hanford, Inc., Richland, Washington.

BHI-00174, 1995, *U Plant Aggregate Area Management Study Technical Baseline Report*, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI-00175, 1995, *Z Plant Aggregate Area Management Study Technical Baseline Report*, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI-00176, 1995, *S Plant Aggregate Area Management Study Technical Baseline Report*, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI-00177, 1995, *T Plant Aggregate Area Management Study Technical Baseline Report*, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI-00178, 1995, *PUREX Plant Aggregate Area Management Study Technical Baseline Report*, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI-00179, 1995, *B Plant Aggregate Area Management Study Technical Baseline Report*, Rev. 00, Bechtel Hanford, Inc., Richland, Washington.

BHI-01115, 1997, *Evaluation of the Soil-Gas Survey at the Nonradioactive Dangerous Waste Landfill,* Bechtel Hanford, Inc., Richland, Washington.

Bjornstad, B. N., G. V. Last, and D. G. Horton, 2003, "Hydrogeology of the Hanford Site Vadose Zone," in *Abstracts with Programs: November 2-5, 2003*, Annual Meeting of the Geological Society of America, Seattle, Washington.

CCN 0073214, 2007, *Path Forward – 200-SW-1/2 RI/FS Work Plan Development, May 15, 2007*, (agreement signed by Matthew S. McCormick, U.S. Department of Energy, Richland Operations Office, and John B. Price, Washington State Department of Ecology, Kennewick, Washington), at Richland, Washington.

Clean Air Act of 1990, 42 USC 7401, et seq., Pub. L. 101-549.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

CP-13514, 2003, *200-PW-1 Operable Unit Report on Step I Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose Zone Plume*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

CP-16886, 2003, *Data Quality Objectives Summary Report for the 218-W-4C Burial Ground Contaminant Release Investigation*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

CP-22319-DEL, 2004, *Plan for Central Plateau Closure*, Fluor Hanford, Inc., Richland, Washington.

D&D-27257, 2006, *Data Quality Objectives Summary Report for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*, Rev. 0 Reissue, Fluor Hanford, Inc., Richland, Washington.

D&D-28283, 2006, *Sampling and Analysis Instruction for Nonintrusive Characterization of Bin 3A and Bin 3B Waste Sites in the 200-SW-2 Operable Unit*, Rev. 0 Reissue, Fluor Hanford, Inc., Richland, Washington.

D&D-28379, 2006, *Geophysical Investigations Summary Report; 200 Area Burial Grounds: 218-C-9, 218-E-2A, 218-E-5, 218-E-5A, 218-E-8, 218-W-1A, 218-W-2A, and 218-W-11*, Rev. 1, prepared by CH2M HILL, Inc., for Fluor Hanford, Inc., Richland, Washington.

D&D-30708, 2006, *Geophysical Investigations Summary Report; 200 Areas Burial Grounds: 218-E-1, 218-E-2A, 218-E-8, 218-E-12A, 218-W-1, 218-W-2, 218-W-3, and 218-W-11*, Fluor Hanford, Inc., Richland, Washington.

D&D-32015, 2007, *Sampling and Analysis Instruction for Artificial Animal Burrows, in Support of the Central Plateau Ecological Risk Assessment, Rev. 0,* Fluor Hanford, Inc., Richland, Washington.

DOE G 430.1-4, *Decommissioning Implementation Guide*, U.S. Department of Energy, Washington, D.C.

DOE G 435.1-1, 1999, *Implementation Guide for Use with DOE M 435.1-1*, U.S. Department of Energy, Washington, D.C.

DOE M 435.1-1, *Radioactive Waste Management Manual,* as amended, U.S. Department of Energy, Washington, D.C.

DOE O 435.1, *Radioactive Waste Management*, as amended, U.S. Department of Energy, Washington, D.C.

DOE O 451.1B, *National Environmental Policy Act Compliance Program*, as amended, U.S. Department of Energy, Washington, D.C.

DOE Order 5820.2A, *Radioactive Waste Management*, as amended, U.S. Department of Energy, Washington, D.C. (now superseded by DOE O 435.1).

DOE, 2002, *DOE Policies on the Application of NEPA to CERCLA and RCRA Cleanup Actions*, DOE Memorandum, Office of NEPA Policy and Compliance, Washington, D.C., July 11.

DOE/EIS-0222-F, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Washington, D.C.

DOE/EIS-0286D2, 2003, *Revised Draft Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement,* U.S. Department of Energy, Washington, D.C.

DOE/EIS-0286F, 2004, *Final Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement, Richland, Washington*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE REG-0271, 2002, *Low-Level Burial Grounds Fact Sheet*, U.S. Department of Energy, Richland Operations Office, Richland Washington. available at: http://www.hanford.gov/wastemgt/doe/files/LLBG_Fact_Sheet_Final_2_10.pdf

DOE/RL-88-20, 1997, *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-88-21, 1990, *Hanford Facility Dangerous Waste Part A Permit Application*, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-88-21, 2002, *Hanford Facility Dangerous Waste Part A Permit Application*, Rev. 31, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL 88-31, 1992, *Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1 Operable Unit, Hanford Site, Richland, Washington*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-90-17, 1990, *Nonradioactive Dangerous Waste Landfill Closure/Postclosure Plan*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-91-28, 2004, *Hanford Facility Dangerous Waste Permit Application*, Rev. 7, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-91-32, 1991, *Expedited Response Action Proposal (EE/CA & EA) for 200 West Area Carbon Tetrachloride Plume*, Draft B, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-91-45, 1995, *Hanford Site Baseline Risk Assessment Methodology*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-91-50, 2000, *Environmental Monitoring Plan United States Department of Energy Richland Operations Office*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-05, 1993, *B Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-16, 1993, *200 West Groundwater Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-19, 1993, *200 East Groundwater Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-81, 1997, *Waste Site Grouping for 200 Areas Soil Investigations*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-98-28, 1999, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2000-29, 2000, *Maintenance Plan for the Composite Analysis of the Hanford Site, Southeast Washington*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2000-70, 2000, *Closure Plan for Active Low-Level Burial Grounds*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2000-72, 2000, *Performance Assessment Monitoring Plan for the Hanford Site Low-Level Burial Grounds*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-01, 2004, *Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit RI/FS Work Plan, Includes: 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*, Rev. 0, Reissue, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-54, 2005, *Central Plateau Ecological Evaluation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-66, 2002, *Chemical Laboratory Waste Group Operable Units RI/FS Work Plan, Includes: 200-LW-1 and 200-LW-2 Operable Units*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2002-39, 2002, *Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the Central Pasco Basin*, U.S. Department of Energy, Richland, Washington.

DOE/RL-2003-48, 2003, *218-W-4C Burial Ground Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland, Operations Office, Richland, Washington.

DOE/RL-2004-60, 2004, *200-SW-1 Nonradioactive Landfills and Dumps Group Operable Unit and 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit Remedial Investigation/Feasibility Study Work Plan*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-70, 2006, *218-W-4B Burial Ground Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-71, 2006, *218-W-3A Burial Ground Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2006-51, 2007, *Remedial Investigation Report for the Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*, Draft B, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE and Ecology, 2007, *Path Forward, 200-SW-1/2 RI/FS Work Plan Development*, U.S. Department of Energy, Richland Operations Office and U.S. Environmental Protection Agency, Richland, Washington, May 15.

DOE, EPA, and Ecology, 2002, *Hanford Site Tri-Party Agreement Public Involvement Community Relations Plan, Hanford Federal Facility Agreement and Consent Order,* U.S. Department of Energy, U.S. Environmental Protection Agency, Washington State Department of Ecology, Richland, Washington, January.

Ecology, 1996, (concerning the effective date for mixed-waste regulation), (letter to Patrick W. Willison, Office of Chief Counsel, U.S. Department of Energy, Richland Operations Office, from Tanya Barnett, Assistant Attorney General), Attorney General of Washington, Ecology Division, Lacy, Washington, September 26.

Ecology, 2005, *Record of Decision, 221-U Facility (Canyon Disposition Initiative), Hanford Site, Washington*, [Final Remedial Action Between the United States Department of Energy and the United States Environmental Protection Agency, with Concurrence by the Washington State Department of Ecology], Nuclear Waste Program, Washington State Department of Ecology, Olympia, Washington. Available on the Internet at http://yosemite.epa.gov/R10/CLEANUP.NSF/9f3c21896330b4898825687b007a0f33/9193b1bfe7feb192882565920054de57/$FILE/cdiROD.pdf.

Ecology and DOE, 2005, *200-SW-1 and 200-SW-2 Collaborative Workshops, Agreement, Completion Matrix, and Supporting Documentation, Final Product*, (Correspondence Control No. 0064527), Washington State Department of Ecology and U.S. Department of Energy, Richland Operations Office, Richland, Washington, April 18.

Ecology, EPA, and DOE, 1989a, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, and DOE, 1989b, *Hanford Federal Facility Agreement and Consent Order Action Plan*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Endangered Species Act of 1973, 16 USC 1531, et seq.

EPA, 1991, *Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, (Interim Final)*, OSWER Directive 9285.6-03, Office of Emergency and Remedial Response, Toxics Integration Branch, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1992, *Supplemental Guidance to RAGS: Calculating the Concentration Term*, OSWER Publication 9285.7-081, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA/240/B-06/001, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

EPA/540/1-89/002, 1989, *Risk Assessment Guidance for Superfund (RAGS), Volume I -- Human Health Evaluation Manual, (Part A) Interim Final,* OSWER 9285.7-01A, U.S. Environmental Protection Agency, Washington, D.C.

EPA/540/G-89/004, 1988, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, OSWER 9355.3-01, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA/540/R-97/006, 1997, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Interim Final)*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

EPA/540/R-92/071a, 1992, *Guidance for Conducting Treatability Studies under CERCLA - Final,* U.S. Environmental Protection Agency, Washington, D.C.

EPA/540/R-99/005, 2004, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final,* U.S. Environmental Protection Agency, Washington, D.C.

EPA/540/R-99/006, 1999, *Radiation Risk Assessment At CERCLA Sites: Q & A,* Directive 9200.4-31P, Office of Emergency and Remedial Response, Office of Radiation and Indoor Air, U.S. Environmental Protection Agency, Washington, D.C. Available on the Internet at http://www.epa.gov/oerrpage/superfund/resources/radiation/pdf/riskq&a1.pdf .

EPA/540/R-00/002, 2000, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, OSWER 9355.0-75, U.S. Environmental Protection Agency, Washington, D.C.

EPA/600/P-92/003C, 1996, *Proposed Guidelines for Carcinogen Risk Assessment,* U.S. Environmental Protection Agency, Washington, D.C.

EPA/600/P-95/002Fa, 1997, *Exposure Factors Handbook Volume 1: General Factors,* U.S. Environmental Protection Agency, National Center for Environmental Assessment, Washington, D.C.

EPA/625/R-92/007, 1993, *Use of Airborne, Surface, and Borehole Geophysical Techniques at Contaminated Sites: A Reference Guide*, Office of Research and Development, U.S. Environmental Protection Agency, Washington, D.C.

EPA/ROD/R10-01/119, 2001, *Declaration of the Interim Record of Decision for the 300-FF-2 Operable Unit*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington.

FP0015, 2002, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Sampling, September 17, 2002,* Fluor Hanford, Inc., Richland, Washington.

FS0419, 2001, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, June 25, 2001,* Fluor Hanford, Inc., Richland, Washington.

FS0438, 2001, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, October 18, 2001,* Fluor Hanford, Inc., Richland, Washington.

FS0473, 2001, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, March 4, 2001*, Fluor Hanford, Inc., Richland, Washington.

FS0508, 2002, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, July 8, 2002,* Fluor Hanford, Inc., Richland, Washington.

FS0529, 2002, *Data Package Summary, Analytical Laboratory Solid Waste Landfill Soil Gas and Methane Monitoring Round 1 Sampling, July 10, 2002,* Fluor Hanford, Inc., Richland, Washington.

Gano, K. A., 1980, "Mortality of the Harvester Ant (Pogonomyrmex owyheei) After Exposure to 137Cs Gamma Radiation," *Environmental Entomology*, 10:39-44.

GE, 1946, *Burial of Equipment and Material and Instruments 03/01/1946 Through 12/27/1946*, DDTS-GENERATED-5634, General Electric Company, Richland, Washington.

GE, 1947, *Burial of Equipment and Material and Instruments 01/09/1947 Through 12/29/1947*, DDTS-GENERATED-5635, General Electric Company, Richland, Washington.

GE, 1948, *Burial of Equipment and Material and Instruments 01/14/1948 Through 12/21/1948*, DDTS-GENERATED-5636, General Electric Company, Richland, Washington.

GE, 1949, *Burial of Material 01/03/1949 Through 05/09/1949*, DDTS-GENERATED-5640, General Electric Company, Richland, Washington.

GE, 1949, *Disposition of Contaminated Government Property 05/10/1949 Through 10/31/1949*, DDTS-GENERATED-5637, General Electric Company, Richland, Washington.

GE, 1954, *Burial of Equipment*, 9973-NEG-[A-I], General Electric Company, Richland, Washington.

GE, 1964, *Burial Ground Log Books from Records Holding Area Box 85617 (1958-1964)*, General Electric Company, Richland, Washington.

Grubb, F. W. and L. F. Lust, 1975, *Hanford Engineering Development Laboratory Unusual Occurrence Report 38-75*, Atlantic Richfield Hanford Company, Richland, Washington, October 30.

HAB, 2002, *Report of the Exposure Scenarios Task Force*, Hanford Advisory Board, Richland, Washington.

HAB 132, 2002, "Exposure Scenarios Task Force on the 200 Area," (letter to K. Klein, H. Boston, J. Iani, and T. Fitzsimmons from T. Martin), Hanford Advisory Board Consensus Advice #132, Richland, Washington, June 7.

HAN-95462, 1966, "Scrap & SS Material Waste For Burial At Richland," (U.S. Government Memorandum to G. F. Penn, Fuels & Metallurgy Branch, Production Division RL, from H. V. Werner, SS Materials Representative, SAN), U.S. Atomic Energy Commission, Richland, Washington, August 31.

Hanford Environmental Information System, Hanford Site database.

Hanford Site Drawings:

- H-2-00124, *218-E-1 Dry Waste Burial Ground*
- H-2-02503, *218-W-2 Dry Waste Burial Ground*
- H-2-2516, *Industrial Burial Ground 218-W-1A*
- H-2-4010, *Strontium Semiworks & Vicinity Outside Lines Key Map*
- H-2-4606, *216-C-9 Pond Modifications*
- H-2-31268, *Solid Waste Burial Grounds Plot Plan*
- H-2-32095, *218-W-2A Industrial Burial Ground & 218-W-3 Dry Waste Burial Ground*
- H-2-32487, *218-W-4A Dry Waste Burial Site*
- H-2-32523, *"C" Plant Liquid Waste Disposal Sites, 216 "C" Series*
- H-2-32560, *As-Built Dry Waste Burial Site #218-E-12A*
- H-2-33055, *Dry Waste Burial Ground 218-W-4B*
- H-2-33276, Sheets 1 and 2, *Dry Waste Burial Ground 218-E-12B*
- H-2-33692, *Dry Waste Disposal Caisson in 218-W4 Site*
- H-2-34880, Sheets 1 and 2, *Dry Waste Burial Ground 218-W-3A*
- H-2-37437, Sheets 1 through 4, *Dry Waste Burial Ground 218-W-4C*
- H-2-55534, *218-E2, E2A, E4, E5, E5A, & E9 Industrial Burial Ground Plan & Details*
- H-2-74640, *Installation – Filtered & Shielded Caisson Covers – Dry Waste Burial Ground 218-W-4B*
- H-2-75149, *Dry Waste Burial Ground 218-W-1*
- H-2-75351, Sheets 1, 2, and 3, *Dry Waste Burial Ground 218-W-3AE*
- H-2-92004, Sheets 1 and 2, *Industrial Burial Ground 218-E-10 Site Plan and Details*
- H-2-94250, *Dry Waste Burial Ground 218-W-11*
- H-2-94677, Sheets 1 and 2, *Dry Waste Burial Ground 218-W-5*
- H-2-96660, *East Area Dry Waste Burial Ground*
- H-2-99933, *Dry Waste Burial Ground 218-W-6*
- H-2-821555, Sheets 1 and 2, *Subsidence Drawing Burial Ground 218-W-3A*
- H-2-821555, Sheets 4 and 5, *Subsidence Drawing Burial Ground 218-W-3AE*

HNF-2030, 1998, *Subsidence Potential in the Burial Grounds*, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-EP-0063, 2006, *Hanford Site Solid Waste Acceptance Criteria*, Rev. 13 (Reissue), Fluor Hanford, Inc., Richland, Washington.

HNF-SD-WM-ISB-002, 2002, *Solid Waste Burial Grounds Interim Safety Basis,* Rev. 3C, Fluor Hanford, Inc., Richland, Washington.

HNF-SD-WM-RPT-309, 1997, *Report on Sampling and Analysis of Air at Trenches 218-W-4C and 218-W-5 #31 of the Low-Level Burial Grounds*, Fluor Daniel Hanford, Inc., Richland, Washington.

HW-28471, 1953, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*, General Electric Company, Richland, Washington.

HW-30372, 1953, *Manufacturing Dept Radiation Incident Investigation Class I No 94*, General Electric Company, Richland, Washington.

HW-41535, 1956, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas*, General Electric Company, Richland, Washington.

HW-54636, 1958, *Summary of Environmental Contamination Incidents at Hanford 1952-1957*, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.

HW-59645, 1959, *Disposition of Plutonium to Burial*, General Electric Company, Richland, Washington.

HW-60807, 1959, *Unconfined Underground Radioactive Waste and Contamination in the 200 Areas - 1959*, General Electric Company, Richland, Washington.

HW-63703, 1960, *Disposition of Contaminated Processing Equipment at Hanford Atomic Products Operation 1958 - 1959*, (01/01/1958 through 12/31/1959), General Electric Company, Richland, Washington.

HW-77274, 1963, *Burial of Hanford Radioactive Wastes*, General Electric Company, Richland, Washington.

HW-83959, 1964, *Criteria for Design of Equipment Burial Containers*, UNC Nuclear Industries, Richland, Washington.

IAEA 332, 1992, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*, Technical Report Series No. 332, International Atomic Energy Agency, Vienna, Austria.

Klein, K. A., D. R. Einan, and M. A Wilson, 2002, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area," (letter to Mr. Todd Martin, Hanford Advisory Board, from Keith A. Klein, U.S. Department of Energy; David R. Einan, U.S. Environmental Protection Agency; and Michael A. Wilson, State of Washington, Department of Ecology, 02-HAB-0006), Richland, Washington, July 11.

McDonald, K. M., D. E. McKinney, and T. A. Shrader, 2001, "Hanford Site Mixed Waste Disposal," *Waste Management Conference 2001*, February 25 – March 1, Tucson, Arizona.

National Environmental Policy Act of 1969, 42 USC 4321, et seq.

NAVD88, 1988, *North American Vertical Datum of 1988*, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland.

OECD/NEA, 2000, *Features, Events, and Processes (FEPs) for Geologic Disposal of Radioactive Waste: An International Database (Radioactive Waste Management),* Nuclear Energy Agency, Organisation For Economic Co-operation and Development (OECD) Publications, Paris, France.

OMB Circular No. A-94, 2002, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs,* Office of Management and Budget, Washington, D.C., as revised.

PNL-2253, 1977, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*, Pacific Northwest Laboratory, Richland, Washington.

PNL-6456, 1988, *Hazard Ranking System Evaluation of CERCLA Inactive Waste Sites at Hanford*, 3 vols., Pacific Northwest Laboratory, Richland, Washington.

PNL-6820, 1989, *Hydrogeology of the 200 Areas Low Level Burial Grounds, An Interim Report*, Pacific Northwest Laboratory, Richland, Washington.

PNNL-00157, 2006, *Soil Measurements at 218-E-2 and E-5 Burial Grounds*, letter report to Greg Berlin, Fluor Hanford, from Andrey Mozhayev, Pacific Northwest Laboratory, Richland, Washington, September 27.

PNNL-11800, 1998, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-12034, 2000, *STOMP, Subsurface Transport Over Multiple Phases, Version 2.0, User's Guide*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-12227, 1999, *Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-12261, 2001, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13014, 2000, *Groundwater Monitoring Plan for the Solid Waste Landfill*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13230, 2000, *Hanford Site Environmental Report for Calendar Year 1999*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13656, 2001, *Enhanced Site Characterization of the 618-4 Burial Ground*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13675, 2001, *Measurement of Helium-3/Helium-4 Ratios in Soil Gas at the 618-11 Burial Ground*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13858, 2002, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13910, 2002, *Hanford Site Environmental Report for Calendar Year 2001*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-14058, 2002, *Prototype Database and User's Guide of Saturated Zone Hydraulic Properties for the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-14753, 2006, *Groundwater Data Package for Hanford Assessments*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-14859-ICN-2, 2007, *Interim Status Groundwater Monitoring Plan for Low-Level Waste Management Areas 1 to 4, RCRA Facilities, Hanford, Washington.* Pacific Northwest National Laboratory, Richland, Washington, January 19.

PNNL-15892, Appendix 1, 2006, *Hanford Site Environmental Surveillance Data Report for Calendar Year 2005*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-15892, Appendix 2, 2006, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 2005*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-16105, 2007, *Technology Survey to Support Revision to the Remedial Investigation/Feasibility Study Work Plan for the 200-SW-2 Operable Unit at the U.S. Department of Energy's Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-16346, 2007, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-SA-34515, 2001, *Use of Process Relationship Diagrams in Development of Conceptual Models*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-SA-36387, 2004, *A Comprehensive and Systematic Approach to Developing and Documenting Conceptual Models of Contaminant Release and Migration at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Published in *Journal of Stochastic Environmental Research and Risk Assessment*, Volume 18(2):109-116.

PNNL-SA-42671, 2004, *A Systematic Approach for Developing Conceptual Models of Contaminant Transport at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington. Published in *Eos Trans. AGU*, 85(47), Fall Meeting, Supplement, Abstract H13A-0386.

RCW 43.21C, "State Government – Executive," "State Environmental Policy," Title 43, Chapter 21C, *Revised Code of Washington*, as amended, Washington State, Olympia, Washington.

RCW 70.105, "Public Health and Safety," "Hazardous Waste Management," Title 70, Chapter 105, *Revised Code of Washington*, as amended, Washington State Department of Ecology, Olympia, Washington.

RCW 70.105.109, "Public Health and Safety," Chapter 105, "Hazardous Waste Management," Section 109, "Regulation of Wastes with Radioactive and Hazardous Components," *Revised Code of Washington*, as amended, Washington State Department of Ecology, Olympia, Washington.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

RHO-65462-80-035, 1980, "Description of Waste Buried in Site 218-W-4B," from V. L. Hale, (internal letter report RHO-65462-80-035 to Distribution List), Rockwell Hanford Operations, Richland, Washington, September 10.

RHO-65462-80-036, 1980, "Description of TRU Waste Buried in Site 218-W-4B," from V. L. Hale, (letter RHO-65462-80-036 to Those Listed), Technology Development, Rockwell Hanford Operations, Richland, Washington, September 10.

RHO-65463-80-126, 1980, "Inconsistencies in 218-W-4B Site Data," from W. G. Jasen (internal letter report RHO-65463-80-126 to G. D. Forehand), Rockwell Hanford Operations, Richland, Washington, December 9.

RHO-72710-82-167, 1982, "Final Report: 218-E-1 Dry Waste Burial Ground Characterization Survey," (letter to W. F. Heine, Environmental Control, from R. B. Kasper, Hydrogeology Unit), Rockwell Hanford Operations, Richland, Washington, November 10.

RHO-CD-78, 1977, *Assessment of Hanford Burial Grounds and Interim TRU Storage*, Rockwell Hanford Operations, Richland, Washington.

RHO-CD-194, 1977, *A Study of the 234-5 Building Inventory Difference for the Years 1956 through 1966,* Rockwell Hanford Operations, Richland, Washington.

RHO-CD-673, 1979, *Handbook 200 Areas Waste Sites*, 3 vols., Rockwell Hanford Operations, Richland, Washington.

RHO-D0101ER0101, 1980, *Burial Ground Characterization Engineering Report*, Rockwell Hanford Operations, Richland, Washington.

RHO-MA-222, 1980, *Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements*, Rockwell Hanford Operations, Richland, Washington.

Richland Solid Waste Information Management System database.

RL, 2001, *Helium Isotope Analysis for Soil Gas to Delineate Tritium Plumes*, Technology Deployment Benefit Analysis Fact Sheet, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

RL-TPA-90-0001, 1998, *Tri-Party Agreement Handbook Management Procedures,* Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," U.S. Department of Energy, Richland Operations Office, Richland, Washington, as revised.

SD-WM-SAR-038, 1984, *Active and Retired Radioactive Solid Waste Burial Grounds Safety Analysis Report*, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

SGW-32683, in process, *Results from Passive Organic Vapor Sampling, Performed in Selected 200-SW-2 Operable Unit Landfills (218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, and 218-W-5) in June-July 2006*, Fluor Hanford, Inc., Richland, Washington.

SGW-33253, in process, *Data Quality Objectives Summary Report for Landfills in the 200-SW-1 and 200-SW-2 Operable Units*, Fluor Hanford, Inc., Richland, Washington.

SGW-33492, 2007, *Quarterly Groundwater Monitoring Data for the Period October through December 2006*, Fluor Hanford, Inc., Richland, Washington.

SGW-33829, in process, *200-PW-1 Operable Unit Report on Step II Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose-Zone Plume*, Fluor Hanford, Inc., Richland, Washington.

SGW-34462, in process, *Application of the Hanford Site Feature, Event, and Process Methodology to Support Development of Conceptual Site Models for the 200-SW-2 Operable Unit Landfills*, Fluor Hanford, Inc., Richland, Washington.

SGW-34463, in process, *Treatability Investigations Supporting the 200-SW-2 Radioactive Landfills and Dumps Group Operable Unit*, Fluor Hanford, Inc., Richland, Washington.

SGW-35016, in process, *Information and Data Management Plan for the 200-SW-2 Operable Unit*, Fluor Hanford, Inc., Richland, Washington.

Solid Waste Information and Tracking System, Hanford Site database.

Solid Waste Information Management System, Hanford Site database.

WA7890008967, 2004, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8, for the Treatment, Storage, and Disposal of Dangerous Waste,* Washington State Department of Ecology, Richland, Washington, as amended.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-070 through 173-303-100, "Designation of Dangerous Waste," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-400, "Dangerous Waste Regulations," "Interim Status Facility Standards," *Washington Administrative Code,* as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-400(3), "Dangerous Waste Regulations," "Interim Status Facility Standards," "Standards," *Washington Administrative Code,* as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-610, "Dangerous Waste Regulations," "Closure and Post-Closure," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-610(2), "Dangerous Waste Regulations," "Closure and Post-Closure," "Closure Performance Standard," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-610(3), "Dangerous Waste Regulations," "Closure and Post-Closure," "Closure Plan; Amendment of Plan," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-610(4), "Dangerous Waste Regulations," "Closure and Post-Closure," "Closure; Time Allowed for Closure," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-610(5), "Dangerous Waste Regulations," "Closure and Post-Closure," "Disposal or Decontamination of Equipment, Structures, and Soils," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-610(6), "Dangerous Waste Regulations," "Closure and Post-Closure," "Certification of Closure," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-640(8), "Dangerous Waste Regulations," "Tank Systems," "Closure and Post-Closure Care," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-650(6), "Dangerous Waste Regulations," "Surface Impoundments," "Closure and Post-Closure Care," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-655(8), "Dangerous Waste Regulations," "Land Treatment," "Closure and Post-Closure Care," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-660(9), "Dangerous Waste Regulations," "Waste Piles," "Closure and Post-Closure Care," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-665(6), "Dangerous Waste Regulations," "Landfills," "Closure and Post-Closure Care," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-680(2), "Dangerous Waste Regulations," "Miscellaneous Units," "Environmental Performance Standards," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-680(4), "Dangerous Waste Regulations," "Miscellaneous Units," "Post-Closure Care," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-64610, "Dangerous Waste Regulations," "Closure and Post-Closure," "Purpose and Applicability," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303-64620, "Dangerous Waste Regulations," "Closure and Post-Closure," "Corrective Action," "Requirements," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-304, "Minimum Functional Standards for Solid Waste Handling," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-304-407, "Minimum Functional Standards for Solid Waste Handling," "General Closure and Post-Closure Requirements," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340, "Model Toxics Control Act – Cleanup," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340-7490(3), "Terrestrial Ecological Evaluation Procedures," "Goal," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

Waste Information Data System, Hanford Site database.

WHC-EP-0125-1, 1989, *Summary of Radioactive Solid Waste Received in the 200 Areas During Calendar Year 1988*, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0225, 1991, *Contact-Handled Transuranic Waste Characterization Based on Existing Records*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0226, 1989, *Sampling Plan for Retrievably Stored Contact-Handled Transuranic Waste at the Hanford Site*, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0645, 1995, *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds*, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0845, 1995, *Solid Waste Management History of the Hanford Site*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-EP-0912, 1996, *The History of the 200 Area Burial Ground Facilities*, 2 vols., Westinghouse Hanford Company, Richland, Washington.

WHC-MR-0008, 1989, *Low-Level Burial Grounds Database*, Westinghouse Hanford Company, Richland, Washington.

WHC-MR-0204, 1990, *200-East and 200-West Areas Low-Level Burial Grounds Borehole Summary Report*, Westinghouse Hanford Company, Richland, Washington.

WHC-MR-0205, 1990, *Borehole Completion Data Package for Low-Level Burial Grounds - 1990*, Westinghouse Hanford Company, Richland, Washington.

WHC-MR-0418, 1994, *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site*, Westinghouse Hanford Company, Richland, Washington.

WHC-SA-2772-FP, 1996, *History of Solid Waste Packaging at the Hanford Site*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-AP-015, 1989, *Revised Ground-Water Monitoring Plan for the 200 Areas Low-Level Burial Grounds*, prepared by Pacific Northwest Laboratory for Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-DP-064, 1993, *Data Package for Geophysical Investigation of Nonradioactive Solid Waste Landfill (NRDWL),* Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-181, 1993, *100-D Area Technical Baseline Report*, Westinghouse Hanford, Company, Richland, Washington.

WHC-SD-EN-TI-216, 1994, *Vegetation Communities Associated with the 100-Area and 200-Area Facilities on the Hanford Site*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-220, 1994, *100-B Area Technical Baseline Report*, Westinghouse Hanford Company, Richland, Washington

WHC-SD-EN-TI-239, 1994, *100-K Area Technical Baseline Report*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-248, 1994, *Conceptual Model of the Carbon Tetrachloride Contamination in the 200 West Area at the Hanford Site*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-251, 1994, *100-N Area Technical Baseline Report*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-290, 1994, *Geologic Setting of the Low-Level Burial Grounds*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-W221-DP-001, 1994, *Phase 2 Solid Waste Retrieval Trench Characterization,* Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-RPT-056, 1992, *Solid Waste Stream Hazardous and Dangerous Components Study*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-517, 1993, *Radioisotopic Characterization of Retrievably Stored Transuranic Waste Containers at the Hanford Site*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-TI-730, 1996, *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Burial Grounds*, Westinghouse Hanford Company, Richland, Washington.

WMP-17684, 2003, *618-10 and 618-11 Burial Ground Remedial Design Technical Workshop Summary Report*, Rev. 0, Fluor Hanford, Richland, Washington.

WMP-20394, 2004, *Design Basis/Design Criteria Report 618-10 And 618-11 Burial Ground Remedial Action Project*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

WMP-20570, 2005, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase I*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

WMP-22922, 2004, *Prototype Hanford Features, Events, and Processes (HFEP) Graphical User Interface*, Rev. 0, Fluor Hanford, Inc., Richland, Washington. Prepared as PNNL-14874.

WMP-25493, 2005, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase II*, Fluor Hanford, Inc., Richland, Washington.

WMP-26178, 2005, *Performance Evaluation Report for Soil Vapor Extraction Operations at the 200-PW-1 Carbon Tetrachloride Site, Fiscal Year 2004*, Rev. 0, Westinghouse Hanford, Inc., Richland, Washington.

WMP-29253, 2007, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objectives Summary Report – Phase III*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

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