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Date Received for Clearance Process (MM/DD/YYYY): 12/07/2007

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B. Document Number SGW-33253, Rev. 0

C. Title
Data Quality Objectives Summary Report for Phase I-B Characterization of the 200-SW-2 Operable Unit Landfills

D. Internet Address

E. Required Information (MANDATORY)

1. Is document potentially Classified? (◉) No ( ) Yes
   L. R. Fitch [signature]
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9. Release Level? (◉) Public ( ) Limited

F. Complete for a Journal Article

1. Title of Journal

G. Complete for a Presentation

1. Title for Conference or Meeting ______
2. Group Sponsoring ______
3. Date of Conference ______
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5. Will Information be Published in Proceedings? ( ) No ( ) Yes
6. Will Material be Handed Out? ( ) No ( ) Yes

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(Print and Sign)

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L. R. Fitch [signature]
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A-6001-401 (REV 1)

Berlin, Gregory T

From: Berlin, Gregory T
Sent: Monday, December 10, 2007 4:54 PM
To: Aardal, Janis D
Cc: Berlin, Gregory T; Williams, Mark A
Subject: Document SGW-33253, Rev. 0

Janis -- The Information Clearance Form for the subject document will note Mark Williams' concurrence per the note below.

Thanks,

Greg

From: Williams, Mark A
Sent: Monday, December 10, 2007 11:35 AM
To: Berlin, Gregory T
Subject: RE: DQO

Greg,

I have reviewed the attached DQO document for Safeguards and Security related interests and find that it is suitable for release.

Thanks,

Mark Williams
PHMC Classification Office
373-9010

ADMINISTRATIVE DOCUMENT PROCESSING AND APPROVAL

DOCUMENT TITLE:	OWNING ORGANIZATION/FACILITY:
Data Quality Objectives Summary Report for Phase I-B Characterization of the 200-SW-2 Operable Unit Landfills	Fluor Hanford, Soil and Groundwater Remediation Project
Document Number: SGW-33253	**Revision/Change Number:** 0

DOCUMENT TYPE *(Check Applicable)*

☐ Plan ☒ Report ☐ Study ☐ Description Document ☐ Other

DOCUMENT ACTION ◉ New ○ Revision ○ Cancellation

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DOCUMENT CONTROL

Does document contain scientific or technical information intended for public use? ◉ Yes ○ No

Does document contain controlled-use information? ○ Yes ◉ No

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DOCUMENT REVISION SUMMARY

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APPROVAL SIGNATURES

		RELEASE / ISSUE
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Name: (Print) G. T. Berlin		
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SGW-33253
Revision 0

Data Quality Objectives Summary Report for Phase I-B Characterization of the 200-SW-2 Operable Unit Landfills

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

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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P.O. Box 1000
Richland, Washington

SGW-33253
Revision 0

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P.O. Box 1000
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J. D. Aardal 12/11/2007
Release Approval Date

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FIGURES

TABLES

TERMS

AEC	U.S. Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
$BiPO_4$	bismuth phosphate
CCDM	conceptual contaminant distribution model
CCU	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CH	contact-handled
COPC	contaminant of potential concern
CSM	conceptual site model
DDTS	Declassified Document Tracking System
DOE	U.S. Department of Energy
DPT	direct-push technology
DQO	data quality objective
DR	decision rule
DS	decision statement
Ecology	Washington State Department of Ecology
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
EQM	Environmental Quality Management, Inc.
ERT	electrical-resistance technology
FEP	feature, event, and process
FS	feasibility study
FFTF	Fast Flux Test Facility
GD	gravel-dominated
GPR	ground-penetrating radar
HAB	Hanford Advisory Board
HPGe	high-purity germanium
Implementation Plan	*200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, DOE/RL-98-28
LLBG	Low-Level Burial Ground
LLW	low-level waste
MFP	mixed-fission product
MLLW	mixed low-level waste
MSCM	mobile surface-contamination monitor
N/A	not applicable
NEPA	*National Environmental Policy Act of 1969*
NPH	normal paraffin hydrocarbon
ODOE	Oregon Department of Energy
OU	operable unit
OVA	organic-vapor analyzer
PCB	polychlorinated biphenyl

PCE	tetrachloroethylene (perchloroethylene)
PFP	Plutonium Finishing Plant
PNNL	Pacific Northwest National Laboratory
ppmv	parts per million by volume
PQL	practical quantitation limit
PSQ	principal study question
PUREX	Plutonium-Uranium Extraction Plant
RCRA	*Resource Conservation and Recovery Act of 1976*
R_E	Ringold Formation, Unit E
RECUPLEX	Recovery of Uranium and Plutonium by Extraction (Plant)
REDOX	Reduction-Oxidation Plant
RH	remote-handled
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
RSWIMS	*Richland Solid Waste Information Management System* database
RTD	removal, treatment, and disposal
SAP	sampling and analysis plan
SD	sand-dominated
SME	subject matter expert
SS	source and special
SVOC	semivolatile organic compound
SWITS	*Solid Waste Information and Tracking System* database
TBP	tributyl phosphate
TCE	trichloroethylene
TMF	total magnetic field
TPH	total petroleum hydrocarbon
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*, Ecology et al., 1989
TRU waste	Radioactive waste as defined in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*
TSD	treatment, storage, and/or disposal (unit)
UO_3	uranium trioxide
VOC	volatile organic compound
VPU	vertical pipe unit
WAC	*Washington Administrative Code*
WESF	Waste Encapsulation and Storage Facility
WIDS	*Waste Information Data System* database

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	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces (avoir)
pounds	0.453	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

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PREFACE

The data quality objectives (DQO) process is a strategic planning approach that is based on scientific methods and is used to prepare for a sampling data collection activity (EPA/600/R-96/055, *Guidance for the Data Quality Objectives Process*, EPA QA/G-4). The process provides a systematic procedure for defining the criteria that the data collection as designed should satisfy. The data collection design addresses when to collect samples, where to collect samples, the tolerable level of decision errors for the study, and the quantity of samples to collect.

This DQO summary report has been prepared in response to agreements made during collaborative discussions that were held between the U.S. Department of Energy, Richland Operations Office (RL) and the Washington State Department of Ecology (Ecology) in February and March 2005 (Ecology and DOE, 2005, *200-SW-1 and 200-SW-2 Collaborative Workshops, Agreement, Completion Matrix, and Supporting Documentation, Final Product*), concerning 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 (the "RI/FS work plan") as well as the additional agreements made between RL and Ecology in May 2007. In the 2005 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. Phase I-A of this approach was completed in 2006. In the May 2007 agreement, RL and Ecology made further commitments to pursuing a characterization approach consisting of additional phases. This next phase (Phase I-B) will consist of additional nonintrusive, limited intrusive fieldwork, and will be followed by two additional characterization phases (Phase II and Phase III) that would have a greater emphasis on intrusive characterization.

The scope of this DQO summary report includes 200-SW-2 Operable Unit waste sites; specifically, 25 waste sites (17 past-practice landfills and 8 other landfills that currently are managed as *Resource Conservation and Recovery Act of 1976* treatment, storage, and/or disposal unit landfills).

The nonintrusive investigative work that resulted from the initial, Phase I-A DQO process 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*) was viewed as a "preliminary investigation" that has been used to refine the conceptual site models so that the RI/FS work plan (DOE/RL-2004-60) can be finalized for Phase I-B.

The Phase I-B DQO activities will support further refinement of the conceptual site models for the waste sites and will support a future revision to the RI/FS work plan. The resulting remedial investigation scope for Phase I-B characterization as well as future characterization phases (i.e., Phases II and III) will enable the development of a feasibility study and proposed plan for the 200-SW-2 Operable Unit.

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1.0 STEP 1 – STATE THE PROBLEM

The purpose of data quality objectives (DQO) Step 1 is to state the problem clearly and concisely to ensure that the focus of the study is unambiguous. This chapter provides background information on the subject landfills and concludes with the Problem Statement.

1.1 INTRODUCTION

This Phase I-B DQO summary report has been developed to support ongoing characterization of 25 waste sites in the 200-SW-2 Radioactive Landfills and Dumps Group (200-SW-2) Operable Unit (OU). These 25 waste sites are located in the 200 East and 200 West Areas near the center of the Hanford Site in south-central Washington State. The 200 Areas are located within one of four areas (i.e., 100, 200, 300, and 1100 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). Where applicable, *Resource Conservation and Recovery Act of 1976* (RCRA), CERCLA, and *National Environmental Policy Act of 1969* processes will be coordinated to support closure and remedial decision-making and cleanup actions. The general CERCLA remedial investigation/feasibility study (RI/FS) process is described in EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final*, OSWER 9355.3-01. The application of the CERCLA RI/FS process in the 200 Areas is 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 200-SW-2 OU contains both past-practice sites and a RCRA treatment, storage, and/or disposal (TSD) unit, with the Washington State Department of Ecology (Ecology) designated as the lead regulatory agency. The scope of the 200-SW-2 OU does not contain Trenches 31 and 34 (currently permitted for operation) in the 218-W-5 Landfill or Trench 94 (currently permitted for operation) in the 218-E-12B Landfill.

The 25 landfills within the 200-SW-2 OU are located within the Central Plateau Core Zone[1] in the Hanford Site 200 East and 200 West Areas. The 200-SW-2 OU primarily includes the constructed/excavated sites (218-prefix landfills) that have received radioactive and/or mixed (radioactive and chemically hazardous) wastes.

Figure 1-1 shows a map of the Hanford Site, including the relative locations of the 200 Areas. Figures 1-2 and 1-3 show selected landfill waste sites within the 200 East and 200 West Areas of the Hanford Site.

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[1] The Core Zone is defined in the Tri-Parties (U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology) 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"), and in HAB, 2002, *Report of the Exposure Scenarios Task Force.*

Figure 1-1. Location of the Hanford Site.

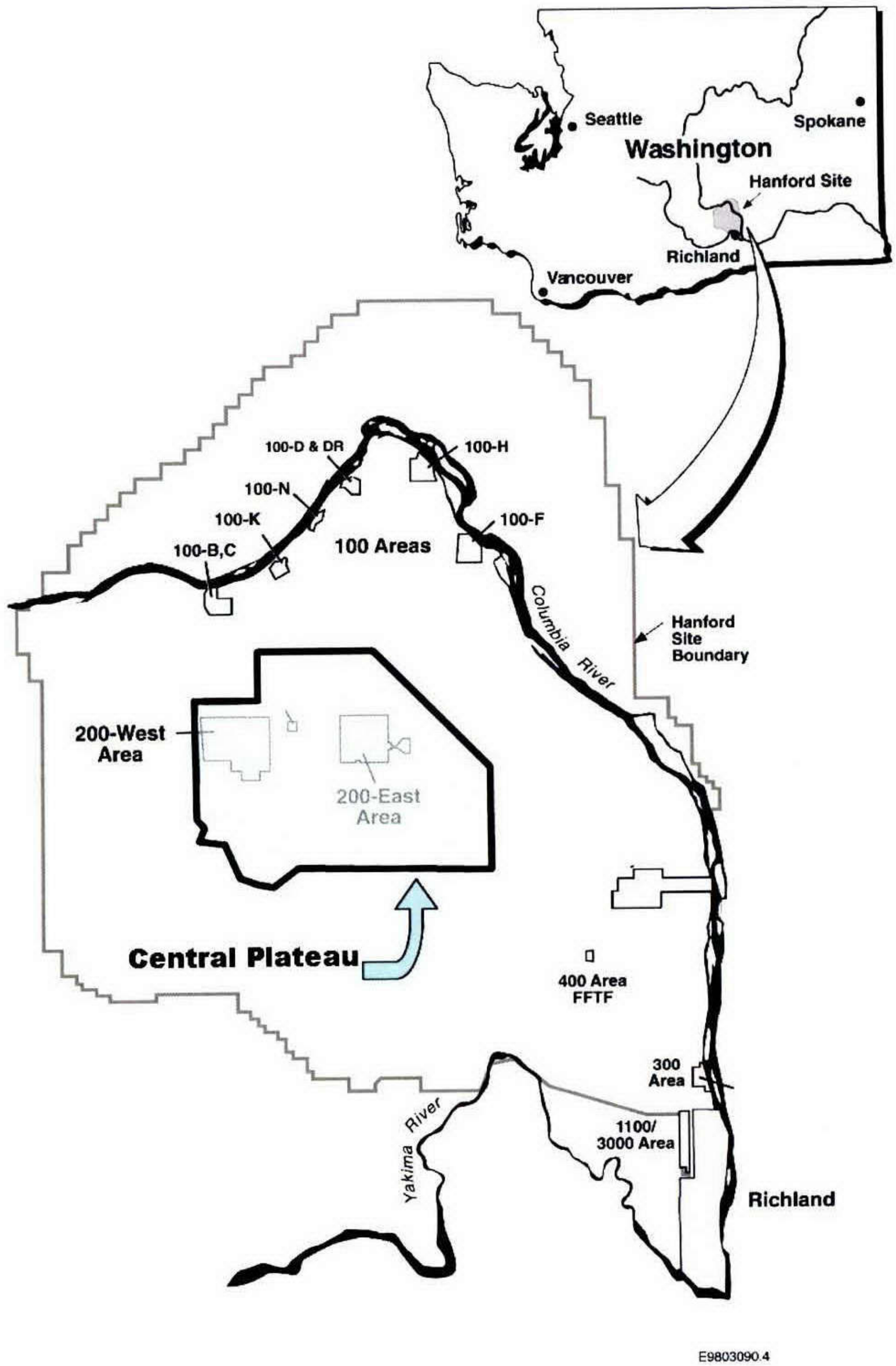


Figure 1-2. Location of 200-SW-2 Operable Unit Landfills in the 200 East Area.

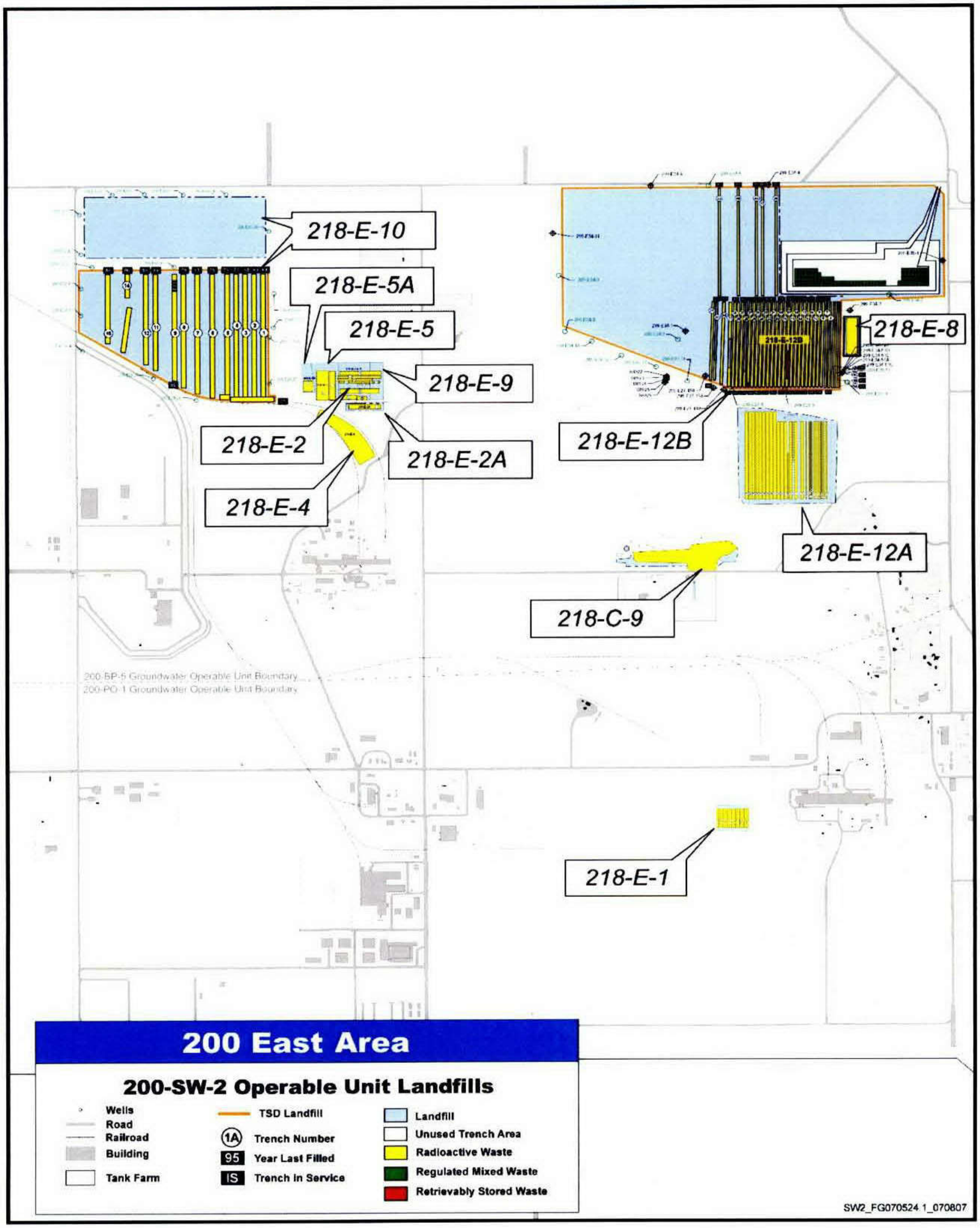
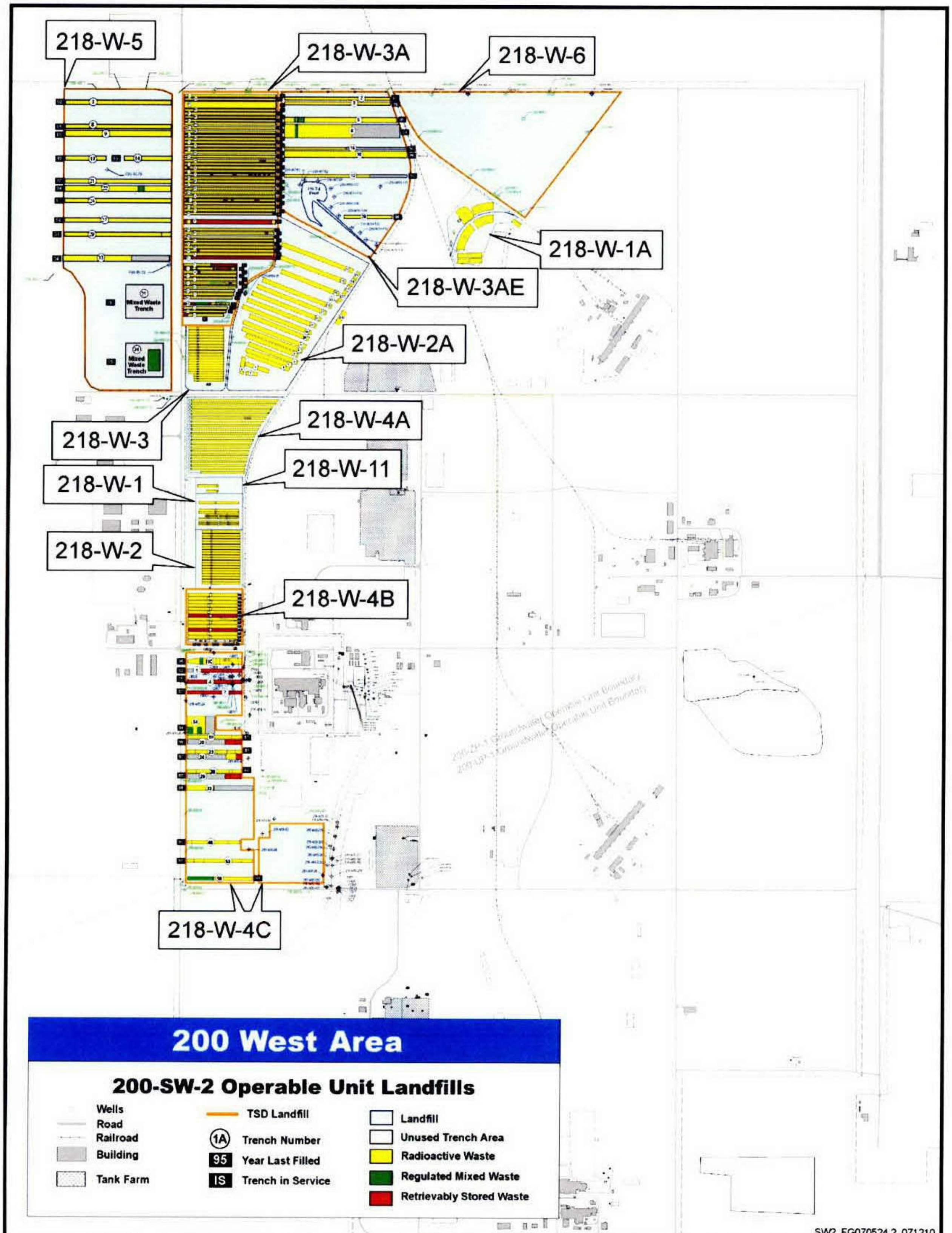


Figure 1-3. Location of 200-SW-2 Operable Unit Landfills in the 200 West Area.



The majority of the waste materials in the 200-SW-2 OU landfills originated from Hanford Site facilities in the 200 East and 200 West Areas. The landfills also contain some wastes that were received from the Hanford Site 100 and 300 Areas, as well as from offsite sources.

Before 1970,[2] low-level radioactive wastes (LLW), including LLW with transuranic constituents, were disposed of in common landfill trenches. Post-1970 wastes were segregated as LLW or materials contaminated with transuranic isotopes. At some post-1970 sites, wastes with significant inventories of transuranic constituents were placed into underground concrete caissons. Some 200-SW-2 OU landfills also are known to have received small volumes of packaged liquid wastes; typically stabilized with absorbent materials.

One RCRA TSD unit, known as the Low-Level Burial Grounds (LLBG) TSD unit, is located in the 200-SW-2 OU. This TSD unit contains eight landfills. Of these eight landfills, the 218-W-6 Landfill was reserved for future use and never has received waste. The LLBG closure process will use a combination of RCRA/CERCLA regulatory requirements to close the 200-SW-2 OU. The remaining seven landfills in this TSD unit, (i.e., 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, 218-E-10, and 218-E-12B Landfills) were used for planned disposal of LLW and mixed low-level waste (MLLW). Four of these landfills (the 218-E-12B, 218-W-3A, 218-W-4B, and 218-W-4C Landfills) were used to receive post-1970 retrievably stored suspect transuranic[3] (TRU) waste.

The LLBG landfills are among the largest waste sites at the Hanford Site, and contain more than 70 percent of the 200-SW-2 OU solid waste by volume. Unlike many highly contaminated waste sites at the Hanford Site, large amounts of bulk liquids are not expected to be present in the 200-SW-2 OU landfills.

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 (the "RI/FS work plan") a number of smaller waste sites that once resided in the 200-SW-2 OU were moved to the 200-MG-1 OU in accordance with Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) change requests. This migration of waste sites primarily affected Bin 1 and Bin 2, as described in the Draft A RI/FS work plan. Based on a reassessment of the 25 landfills that now remain in the 200-SW-2 OU, a new set of groupings or "bins" has been established for this DQO summary report. This new set of bins is presented in Section 1.2.

1.2 WASTE-SITE BINNING

The 25 landfills and the in-scope caissons in the 200-SW-2 OU have been sorted into a set of six groupings (bins) based on similar characteristics. The bins have been established based on a

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[2] Transuranic waste was segregated from other types of waste beginning in May 1970. See the history of transuranic waste definitions in Section 1.11.2.

[3] Radioactive waste as defined in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*.

number of factors including 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:

- *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.*

The following paragraphs provide a brief description of each bin.

- **Bin 1 – TSD Unit Landfills** – This bin includes landfills that are permitted as RCRA TSD units and are included in the LLBG Part A Permit (DOE/RL-88-20, *Hanford Facility Dangerous Waste Permit Application, Low-Level Burial Grounds*). 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 the OU. Sites in this bin include the 218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5, 218-W-6, 218-E-10, and 218-E-12B Landfills. The TSD unit landfills comprise roughly 71 percent of the total 200-SW-2 OU solid waste volume.

  This bin also includes sites for which available historical documentation indicates that no burials have been made and there is a low potential for contamination. The unused sites include annexes of the 218-W-4C and 218-E-10 Landfills, a western portion of the 218-E-12B Landfill, and all portions of the 218-W-6 Landfill.

- **Bin 2 – Industrial Landfills** – This bin includes past-practice landfills that received radioactive waste that was generally 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 more than 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 is at a minimum. Sites in this bin include 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. The Industrial landfills comprise roughly 13 percent of the total 200-SW-2 OU solid waste volume.

- **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 may contain at least 90 percent of the 200 Areas landfills' pre-1970 alpha inventory. Available historical documentation for the older landfills (218-W-1 and 218-W-2 Landfills) in this bin generally is sparse and lacks detail; these two landfills received waste in the 1940s and 1950s. Available historical documents for the newer landfills (218-W-3 and 218-W-4A) in this bin are more numerous; these landfills received waste in the mid-1950s to 1960s. The Dry Waste Alpha landfills comprise roughly 10 percent of the total 200-SW-2 OU solid waste volume.

- **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 sparse and lacks detail. Sites included in this bin include 218-E-1 and 218-E-12A Landfills. The Dry Waste landfills comprise roughly 4 percent of the total 200-SW-2 OU solid waste volume.

- **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 is likely also at a minimum. Documentation for the 218-C-9 Landfill is believed to be nearly complete for all burials; however, available historical documents for the 218-E-8 and 218-E-4 Landfills are few. The Construction landfills comprise roughly 2 percent of the total 200-SW-2 OU solid waste volume.

- **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 and possibly large-diameter well casings; the caissons in the 218-W-4B Landfill were made of corrugated metal and/or concrete. Documentation for the caissons in 218-W-4A Landfill generally is sparse and lacks detail, 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 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 218-W-4A and 218-W-4B Landfills that are believed to be empty/unused, according to available historical documentation. These include 218-W-4A-C4, 218-W-4A-C6, 218-W-4A-C7, and 218-W-4A-C8 Caissons and the 218-W-4B (UNI-2)

Caisson. The caissons comprise roughly one-hundredth of a percent of the total 200-SW-2 OU solid waste volume.

1.3 PROJECT SCOPE

This Phase I-B DQO summary report addresses 25 landfills associated with the 200-SW-2 OU. The scope of this Phase I-B DQO process is to support the development of a sampling and analysis plan (SAP) for the landfills. In accordance with the May 2007 agreement between RL and Ecology (RL and Ecology, 2007), the SAP to be included in the RI/FS work plan (Draft B) primarily will be based on nonintrusive sampling techniques, but also will include limited intrusive techniques.

During collaborative negotiations between RL and Ecology (Ecology and DOE, 2005, *200-SW-1 and 200-SW-2 Collaborative Workshops, Agreement, Completion Matrix, and Supporting Documentation, Final Product*) (Collaborative Agreement), it was decided that an initial DQO process (Phase I-A DQO) would be performed using historical data and nonintrusive sampling techniques to support a subsequent DQO process, to reduce uncertainty, and to focus future intrusive activities on substantiated data gaps. Data collected during the Phase I-A DQO investigation have been incorporated into this Phase I-B DQO summary report.

1.4 PROJECT OBJECTIVES

The primary objective of the Phase I-B DQO process for the 200-SW-2 OU is to determine the environmental measurements necessary to support the CERCLA RI/FS process and remedial decision making, including refinement of the preliminary conceptual contaminant distribution models (CCDM) and providing a basis for future-phase intrusive activities and associated DQOs. Additionally, the DQO process supports development of an initial SAP for the remedial investigation, which will be included as an appendix to the RI/FS work plan.

This objective is further refined to include the following lower-tier objectives.

- The landfills and trenches in the 200-SW-2 OU are located within the Central Plateau Core Zone, which has been designated as U.S. Department of Energy (DOE) industrial-exclusive land use (e.g., an area suitable and desirable for treatment, storage, and/or disposal of hazardous, dangerous, radioactive, and nonradioactive wastes and related activities) for at least the next 50 years, and as industrial land use for the likely foreseeable future. These areas are intended for permanent disposal of the buried waste. Consequently, the ultimate characterization objective of the multi-phased approach is to determine if there have been or will be releases from the buried waste to support evaluation and selection of appropriate remedial actions.

- Characterization also will be performed to refine/confirm the expected contaminant distribution in the preliminary conceptual site models (CSM) for those waste types and factors (e.g., snowmelt or other induced flooding), including those identified in Ecology's "items of interest" list, that affect the CSM, and develop new CSMs where appropriate.

- Data may be collected through the 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 acceptable risk, based on anticipated land use.

1.5 PROJECT ASSUMPTIONS

Project assumptions for the Phase I-B DQO process include the following.

- The DQO process will follow EPA/600/R-96/055, *Guidance for the Data Quality Objectives Process*, EPA QA/G-4, as modified in this report format.

- 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 primarily represented by the contaminants associated with on-site waste 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 CCDM that require the use of multiple CSMs. For example, portions of 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. A portion of 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, obstructed 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 anticipated land use for the Central Plateau Core Zone will be DOE industrial-exclusive use for at least 50 years and industrial use afterwards for the foreseeable future. Industrial-exclusive is defined as an area suitable and desirable for TSD of hazardous, dangerous, radioactive, and nonradioactive wastes and related activities. The 200-SW-2 OU RI/FS work plan will collect the data necessary to support an industrial-exclusive land-use scenario, but will not preclude suitable remedial action and closure decisions.

- The RI/FS work plan will address likely response scenarios, including the following:

  - 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/stabilization (e.g., vitrification or grouting) of portions of individual landfills
- Some combination of the above
- No action with continued monitoring.

- The seven *Bin 1 – TSD Unit Landfills* will be closed using an integrated RCRA/CERCLA/*National Environmental Policy Act of 1969* process to avoid duplication of effort as outlined in the Tri-Party Agreement, Section 5.5 (Ecology et al., 1989). A crosswalk of CERCLA and RCRA substantive requirements for the 200-SW-2 OU has been prepared, and will be included in the RI/FS work plan, 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. 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 coordination 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 a remedial design/remedial action work plan for the CERCLA remedies.

- The landfills and caissons in Bins 1 through 6 are of interest to Ecology and stakeholders because of the following:

  - Large volume of waste
  - TRU materials (long-lived isotopes)
  - 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 the RI/FS work plan and will be addressed in the respective groundwater OUs and through the TSD permitting process.

- Retrievably stored waste will be handled in another RL program and is outside the scope 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 Phase I-B DQO process.

- The 25 waste sites in the 200-SW-2 OU listed in Table 1-1 represent all of the sites under consideration in this Phase I-B DQO process. The two nonradioactive landfills in the 200-SW-1 OU are not addressed in the scope of this report; however, these landfills will be addressed in the RI/FS work plan.

Table 1-1. 200-SW-2 Operable Unit Landfills. (2 Pages)

Site Code	Site Names/Aliases	Bin Identification*
218-E-10	218-E-10, 200 East Industrial Waste No. 10, Equipment Landfill #10, Industrial Burial Garden #10	*Bin 1 – TSD Unit Landfills*
218-E-12B	218-E-12B, 200 East Dry Waste No. 12B	*Bin 1 – TSD Unit Landfills*
218-W-3A	218-W-3A, Dry Waste No. 003A, Industrial Burial Garden #3	*Bin 1 – TSD Unit Landfills*
218-W-3AE	218-W-3AE, Industrial Waste No. 3AE, Dry Waste No. 3AE	*Bin 1 – TSD Unit Landfills*
218-W-4B	218-W-4B, Dry Waste No. 04B, Dry Waste Burial Garden #5	*Bin 1 – TSD Unit Landfills*
218-W-4C	218-W-4C, Dry Waste No. 004C	*Bin 1 – TSD Unit Landfills*
218-W-5	218-W-5, Dry Waste Landfill, Low-Level Radioactive Mixed Waste Landfill	*Bin 1 – TSD Unit Landfills*
218-W-6	218-W-6 Burial Ground	*Bin 1 – TSD Unit Landfills*
218-E-2A	218-E-2A, Regulated Equipment Storage Site No. 02A, Burial Trench	*Bin 2 – Industrial Landfills*
218-E-2	218-E-2, 200 East Industrial Waste No. 002, Equipment Landfill #2, 200 East Industrial Burial Garden #2	*Bin 2 – Industrial Landfills*
218-E-5	218-E-5, 200 East Industrial Waste No. 05, Equipment Landfill #5, Industrial Burial Garden #5	*Bin 2 – Industrial Landfills*
218-E-5A	218-E-5A, 200 East Industrial Waste No. 005A, Equipment Landfill #5A, Industrial Burial Garden #5A	*Bin 2 – Industrial Landfills*
218-E-9	218-E-9, 200 East Regulated Equipment Storage Site No. 009, Burial Vault (Hanford Inactive Site Survey), Regulated Equipment Storage Site #9	*Bin 2 – Industrial Landfills*
218-W-11	218-W-11, Regulated Storage Site, Regulated Storage Area	*Bin 2 – Industrial Landfills*
218-W-1A	218-W-1A, 200-W Area Industrial Waste Landfill #1, Equipment Landfill #1, Industrial Burial Garden #1	*Bin 2 – Industrial Landfills*
218-W-2A	218-W-2A, Industrial Waste No. 02A, Equipment Landfill #2, Industrial Burial Garden #2	*Bin 2 – Industrial Landfills*
218-W-1	218-W-1, 200-W Area Dry Waste No. 001, Solid Waste Landfill #1, Dry Waste Burial Garden #1	*Bin 3 – Dry Waste Alpha Landfills*

Table 1-1. 200-SW-2 Operable Unit Landfills. (2 Pages)

Site Code	Site Names/Aliases	Bin Identification*
218-W-2	218-W-2, 200-W Area Dry Waste No. 002, Dry Waste Landfill No. 2, Dry Waste Burial Garden #2	*Bin 3 – Dry Waste Alpha Landfills*
218-W-3	218-W-3, Dry Waste No. 003, Dry Waste Burial Garden #3	*Bin 3 – Dry Waste Alpha Landfills*
218-W-4A	218-W-4A, Dry Waste No. 04A, Dry Waste Burial Garden #4	*Bin 3 – Dry Waste Alpha Landfills*
218-E-1	218-E-1, 200 East Dry Waste No. 001, Dry Waste Burial Garden #1, Dry Waste Burial Garden #3	*Bin 4 – Dry Waste Landfills*
218-E-12A	218-E-12A, 200 East Dry Waste No. 12A	*Bin 4 – Dry Waste Landfills*
218-C-9	218-C-9, Dry Waste No. 0C9, 218-C-9 Landfill, 216-C-7, C-Canyon Excavation, Semiworks Swamp	*Bin 5 – Construction Landfills*
218-E-4	218-E-4, 200 East Minor Construction No. 4, Equipment Landfill #4, Minor Construction Burial Garden #4	*Bin 5 – Construction Landfills*
218-E-8	218-E-8, 200 East Construction Landfill, Construction Burial Garden	*Bin 5 – Construction Landfills*

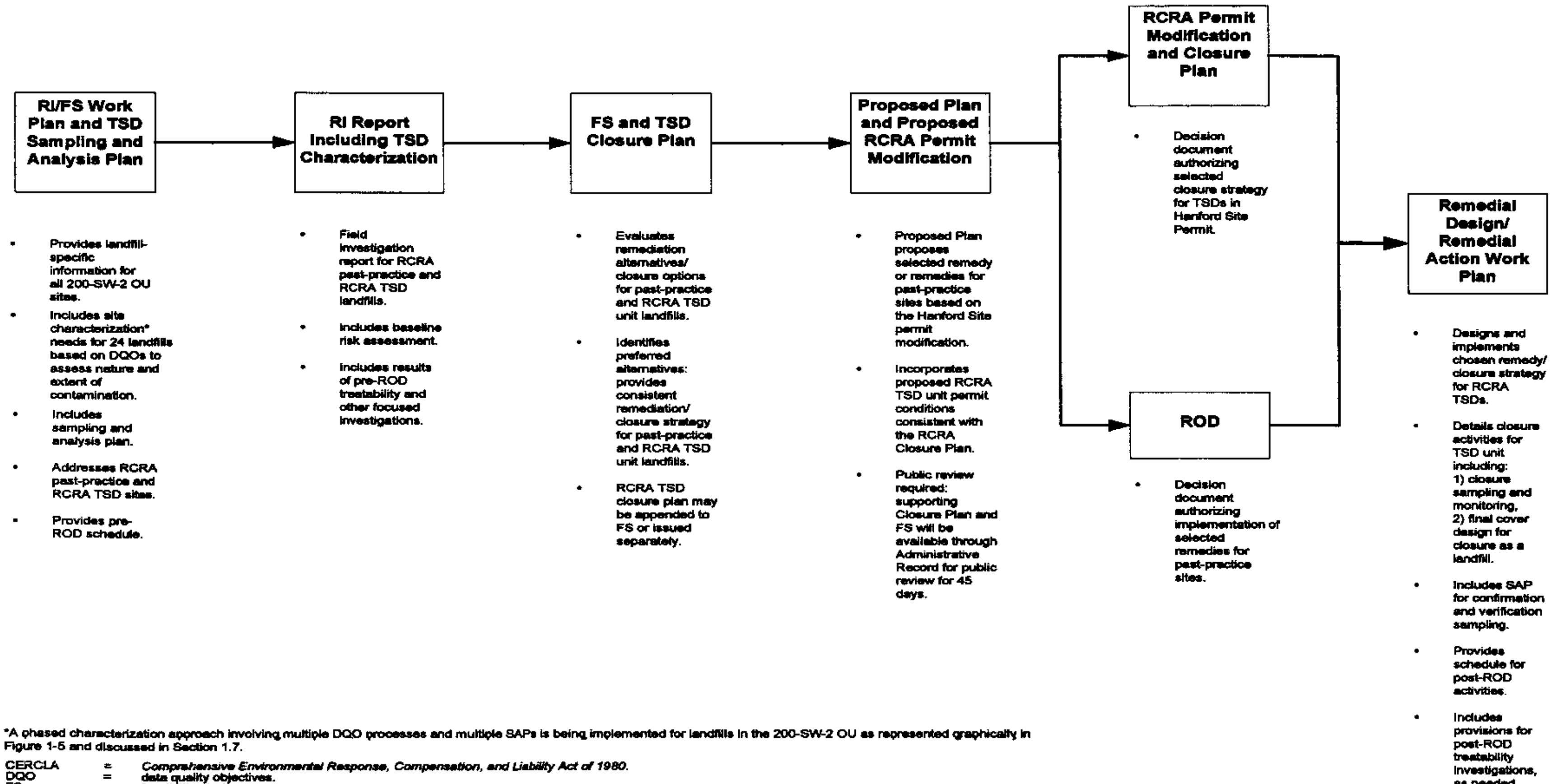
*Caissons (Bin 6) are included in the 218-W-4A and 218-W-4B Landfills. Refer to Section 1.2 for further information regarding caissons.

TSD = treatment, storage, and/or disposal (unit).

1.6 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/post closure 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 the Collaborative Agreement (Ecology and DOE, 2005) 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 the 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. Figure 1-4 illustrates the process. General facility background information, potential applicable or relevant and appropriate requirements, preliminary remedial-action objectives, and preliminary remedial technologies developed in the Implementation Plan will be incorporated by reference into the RI/FS work plan. Further detail regarding the coordinated regulatory approach will be presented in the RI/FS work plan.

Figure 1-4. Coordinated Regulatory Process for CERCLA, Past-Practice, and RCRA Treatment, Storage, and/or Disposal Unit Closure.



*A phased characterization approach involving multiple DQO processes and multiple SAPs is being implemented for landfills in the 200-SW-2 OU as represented graphically in Figure 1-5 and discussed in Section 1.7.

CERCLA	=	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
DQO	=	data quality objectives.
FS	=	feasibility study.
OU	=	operable unit.
RCRA	=	*Resource Conservation and Recovery Act of 1976.*
RI	=	remedial investigation.
RI/FS	=	remedial investigation/feasibility study.
ROD	=	record of decision.
SAP	=	sampling and analysis plan
TSD	=	treatment, storage, and/or disposal (unit).

1.7 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 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). These collaborative discussions and agreements revised the scope of the DQO to follow. The initial 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, this DQO process (Phase I-B) was initiated to support development of the RI/FS work plan, Draft B. This DQO process focuses on 25 landfills in the 200-SW-2 OU. This DQO and the resulting SAP 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 to determine the nature and extent of contamination. Further detail regarding the phased characterization approach for the 200-SW-2 OU landfills will be presented in the RI/FS work plan. The phased characterization approach is shown in Figure 1-5.

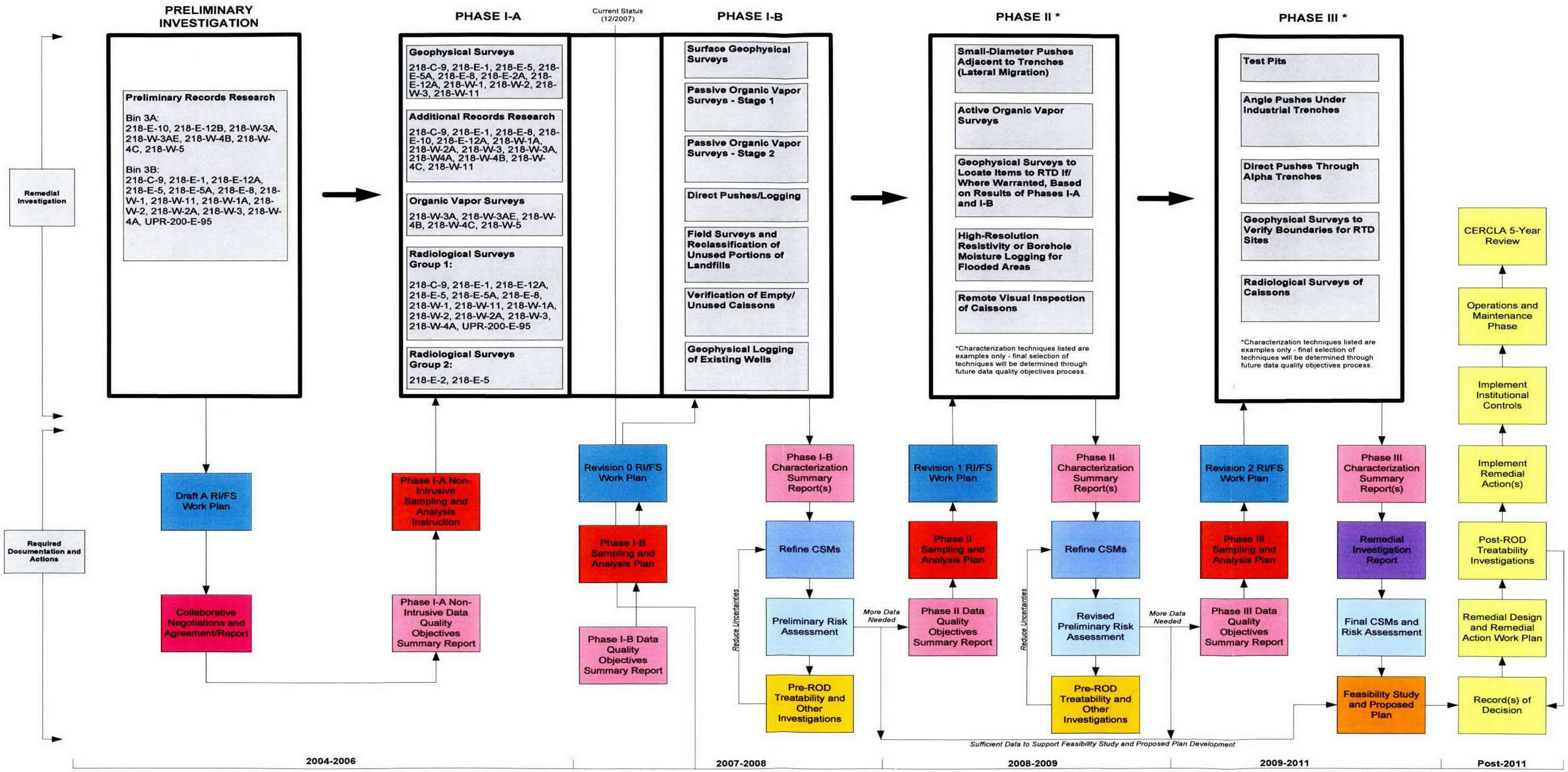
1.8 PROJECT ISSUES

Project issues include both the global issues that transcend the specific DQO process and the technical issues that are unique to the project. Both global and project technical issues have the potential to impact the sampling design or the DQOs for the project.

Global and Technical Issues

Global and technical issues have been compiled from the DQO interviews held with RL, Ecology, EPA, and interested stakeholders. In addition, other global and technical issues have resulted from decision-maker alignment meetings, as well as from DQO workshops held to date. The global and technical issues of concern are captured in Table 1-2. These global and technical issues were compiled as a result of the DQO interviews and decision-maker alignment meetings, all of which took place before development of the May 2007 Agreement regarding a phased characterization approach. The phased characterization approach design is to move systematically from nonintrusive to intrusive methods to collect information required to address global and technical issues. Phases I-A and I-B are primarily screening-level investigations that provide information to help focus subsequent intrusive phases to better understand the nature and extent of contamination in the 200-SW-2 OU landfills.

Figure 1-5. Phased Characterization Approach for the 200-SW-2 Operable Unit Landfills.



CERCLA = *Comprehensive Environmental Response, Liability, and Compensation Act of 1980.*
CSM = conceptual site model.
RI/FS = remedial investigation/feasibility study.
ROD = record of decision.
RTD = removal, treatment, disposal.

Table 1-2. 200-SW-2 Operable Unit Data Quality Objectives Global and Technical Issues. (3 Pages)

<table>
<tr><th>Forum in Which Issue was Raised</th><th>Issue</th></tr>
<tr><td colspan="2">Global Issue: The need to intrusively sample buried waste to determine specific locations of waste and the concentrations of contaminants.</td></tr>
<tr><td colspan="2">Resolution: This issue is unresolved at this phase of characterization. The issue will be addressed during future-phase DQO processes, which will employ the use of additional intrusive characterization methods.</td></tr>
<tr><td rowspan="2">DQO Interviews</td><td>Larry Romine (RL) stated that Fluor Hanford should focus on what needs to be achieved. A land-use plan was developed for the Central Plateau. So far, we have struggled to work toward this land use. Larry asked how we can do a better job of collecting information that the decision makers are comfortable with in making decisions. Larry went on to state that we often attempt to answer questions for which we may not need answers. Larry pointed out that the Central Plateau will have institutional controls in place, as well as being designated "industrial exclusive." This in of itself should steer us down a specific path. As an example, Larry stated that if we are successful at demonstrating that migration of contaminants out of the landfills is not an issue, then do we really need to exhaust resources to locate individual buried items, as we did in the Phase I-A DQO process?</td></tr>
<tr><td>Jennie Stults (Ecology) stated that the stakeholders want to see actual characterization data for the landfills. Jennie added that the stakeholders do not differentiate between TSD landfills and non-TSD landfills. The stakeholders are concerned that RL will cap all of the landfills with engineered barriers.</td></tr>
<tr><td>November 2006 Decision Maker Alignment Meeting</td><td>Expectations about intrusive sampling into trenches themselves. Ecology expects there will some intrusive sampling into trenches, whether by pushes/borings or test pits. What are DOE's expectations about amount, if any, of intrusive sampling into trenches?</td></tr>
<tr><td colspan="2">Global Issue: The need to perform test-pit characterization within the buried waste trenches to determine the condition of the waste, and/or to validate burial records.</td></tr>
<tr><td colspan="2">Resolution: This issue is unresolved at this phase of characterization. The issue will be addressed during future-phase DQO processes, which will employ the use of additional intrusive characterization methods.</td></tr>
<tr><td rowspan="2">DQO Interviews</td><td>Craig Cameron (EPA) asked EPA and Ecology personnel what was learned during their trips to the Idaho National Laboratory site. Dennis Faulk (EPA) stated the following points.
• Organic liquids, transuranic waste, and mobile contaminants were of main concern.
• Excavation was the best method of validating releases from the landfills.
• Records validation was emphasized.
• Certain waste forms can be left in place.
• Treatability tests should be performed.</td></tr>
<tr><td>Rod Lobos (EPA) stated that the condition of the waste in the landfills should be known for those areas that may be capped. Subsidence in these areas will be a concern. Dennis Faulk stated that compaction will be necessary in these areas to alleviate subsidence concerns.</td></tr>
</table>

Table 1-2. 200-SW-2 Operable Unit Data Quality Objectives Global and Technical Issues. (3 Pages)

Forum in Which Issue was Raised	Issue
	Dennis Faulk stated that excavation of waste in the 100 Areas was used to validate records. Dennis went on to state that often, the waste was excavated, validated, and re-buried in place, because the Environmental Restoration Disposal Facility had not yet been built. Rod Lobos emphasized that areas that lack good records should be validated with excavation. Dennis Faulk expanded on this thought by stating that validation also is important for those waste forms that only have generic information. Craig Cameron suggested that investigations also should include those areas in which we do not expect waste to be buried. Greg Berlin pointed out that this already has been done, to some extent, during the Phase I-A geophysical surveying.
Global Issue: Disposition of pre-1970s alpha-containing waste.	
Resolution: This issue is unresolved at this phase of characterization.	
DQO Interviews	Shelley Cimon (ODOE) stated that DOE should address pre-1970 transuranically contaminated material.
	Jennie Stults stated that pre-1970 transuranically contaminated material is a site-wide issue, as well as defining intruder/risk scenarios.
Global Issue: Determination to perform early RTD on some sites so that expensive remedial investigation characterization can be avoided.	
Resolution: This issue is unresolved at this phase of characterization. The issue will be addressed during future-phase DQO processes, which will employ the use of additional intrusive characterization methods that have the potential to locate waste forms that could require RTD.	
November 2006 Decision Maker Alignment Meeting	Discuss the distinction between RI/FS and remediation, when RI/FS could include "cleanup-like" activities including Observational Approach as described in the Implementation Plan (DOE/RL-98-28). Can RL and Ecology agree that some areas will require removal, treatment, and disposal (e.g., if a known cache of carbon tetrachloride drums is located [passive soil-gas sampling and records indicated drums with organics?]). If RL and Ecology agree for specific locations, can characterization sampling be avoided and that sampling budget retained for other locations?
Global Issue: Disposition of investigation-derived waste in the event that Ecology and RL agree to perform test pits.	
Resolution: This issue will be addressed in future-phase DQO processes, which will employ additional intrusive characterization methods that have the potential to generate waste.	
November 2006 Decision Maker Alignment Meeting	If RL and Ecology conclude that test pits are needed in some areas, how do we deal with the investigation-derived waste generated by test pits? Because it essentially would be identical to waste generated by post-decision remediation activities, we should plan to deal with it accordingly (this "blurs the line" between investigation and remediation).

Table 1-2. 200-SW-2 Operable Unit Data Quality Objectives Global and Technical Issues. (3 Pages)

Forum in Which Issue was Raised	Issue
Technical Issue: The LLBG Part A Permit should be evaluated to ensure that the constituents that the landfills are permitted to receive are captured in the contaminants of potential concern list.	
Resolution: Constituents associated with the LLBG Part A Permit will be evaluated during the Phase II DQO process.	
DQO Process/Workshops	A technical issue concerning the LLBG Part A Permit application has been identified. The DQO process needs to evaluate and document which, if any, of the 467 listed constituents in the LLBG Part A Permit application are disposed of in the 200-SW-2 OU landfills. If there are indications of these constituents, they will need to be added to the list of contaminants of potential concern in Section 1.9 of this document.
Technical Issue: Determination of the source(s) of groundwater contamination beneath the landfills.	
Resolution: This issue will be addressed in future-phase DQO processes that will employ additional intrusive characterization methods.	
DQO Interviews	Jennie Stults stated that we need information regarding the source of groundwater contamination. Jennie went on to point out that this is a major issue with the stakeholders.

DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program.*

DOE = U.S. Department of Energy.
DQO = data quality objective.
Ecology = Washington State Department of Ecology.
EPA = U.S. Environmental Protection Agency.
LLBG = Low-Level Burial Ground.
OU = operable unit.
ODOE = Oregon Department of Energy.
RI/FS = remedial investigation/feasibility study.
RL = U.S. Department of Energy, Richland Operations Office.
RTD = removal, treatment, and disposal.
TSD = treatment, storage, and/or disposal (unit).

1.9 DATA QUALITY OBJECTIVE TEAM PARTICIPANTS, KEY DECISION MAKERS, AND REGULATORY MILESTONES

The planning team included the RL and Fluor Hanford task leads, technical support staff, and regulators from the Tri-Party Agreement representatives for the site owners. The support staff on the Phase I-B DQO planning team were selected based on their technical backgrounds. The key decision makers include representatives from RL (site owner) and Ecology (lead regulatory agency). Tables 1-3 and 1-4 identify the DQO workshop participants and key decision makers, respectively. Table 1-5 outlines the regulatory milestones.

Table 1-3. Data Quality Objectives Process Participants. (2 Pages)

Name	Organization	Area of Expertise (Role)
Anderson, Jim	EQM, Inc.	Technical research
Bauer, Roy	Fluor Hanford, Inc.	Interview and Workshop Facilitator; DQO SME
Berlin, Greg	Fluor Hanford, Inc.	Task Lead – 200-SW-1/2 Operable Units

Table 1-3. Data Quality Objectives Process Participants. (2 Pages)

Name	Organization	Area of Expertise (Role)
Bond, Rick	Washington State Department of Ecology	Project Manager, 200-SW-2 Operable Unit
Cammann, Jerry	Fluor Government Group	Technical Lead, 200-SW-1/2 Operable Units
Cimon, Shelley	Oregon Department of Energy	ODOE Representative
Faulk, Dennis	U.S. Environmental Protection Agency	U.S. Environmental Protection Agency Representative
Haas, Chris	Polestar Applied Technology, Inc.	Document Production Lead
Huckaby, Alisha	Washington State Department of Ecology	Hydrogeology
Hyatt, Jeannette	Fluor Hanford, Inc.	RCRA Permitting/Low-Level Burial Grounds SME
Jensen, Jesse	Fluor Government Group	Technical Support, 200-SW-1/2 Operable Units
Lobos, Rod	U.S. Environmental Protection Agency	U.S. Environmental Protection Agency Representative
Mandis, Michelle	Washington State Department of Ecology	Chemist
Mills, Matt	Polestar Applied Technology, Inc.	RCRA Permitting SME
Ollero, Jennifer	Washington State Department of Ecology	Task Lead – Low-Level Burial Grounds treatment, storage, and/or disposal units
Ottley, Dave	Fluor Hanford, Inc.	Radiological protection SME
Price, John	Washington State Department of Ecology	Project Manager, 200-SW-1 Operable Unit
Roberts, John	Washington State Department of Ecology	Chemist
Roddy, Frank	U.S. Department of Energy, Richland Operations Office	U.S. Department of Energy, Richland Operations Office Task Lead
Rohay, Virginia	Fluor Hanford, Inc.	Organic sampling SME
Ruck, Fred	Fluor Hanford, Inc.	CERCLA SME
Seaver, Jennie	Washington State Department of Ecology	Task Lead, 200-SW-1/2 Operable Units
Shea, Jacqui	Washington State Department of Ecology	Hydrogeology
Singleton, Deborah	Washington State Department of Ecology	Project Manager, Low-Level Burial Grounds
Smith-Jackson, N'oel	Washington State Department of Ecology	Chemist
Welliver, Nancy	EQM, Inc.	Technical research

CERCLA = *Comprehensive Environmental Response, Compensation and Liability Act of 1980.*
DQO = data quality objective.
EQM = Environmental Quality Management, Inc.
ODOE = Oregon Department of Energy.
RCRA = *Resource Conservation and Recovery Act of 1976.*
SME = subject matter expert.

Table 1-4. Phase I-B Data Quality Objectives Key Decision Makers.

Name	Organization	Area of Expertise (Role)
Matt McCormick	U.S. Department of Energy, Richland Operations Office Task Lead	Assistant Manager
John Price	Washington State Department of Ecology	Project Manager, 200-SW-1/2 Operable Unit
Deborah Singleton	Washington State Department of Ecology[b]	Project Manager, Low-Level Burial Grounds

[a] Regulatory lead for 200-SW-1/2 Operable Unit.
[b] Regulatory lead for Low-Level Burial Grounds.

Table 1-5. Regulatory Milestones.

Milestone*	Due Date	Regulatory Driver
M-013-028	09/30/2007	Submit a revised work plan for 200-SW-1 and 200-SW-2 Operable Units to Washington State Department of Ecology to identify likely response scenarios and potentially applicable technologies; identify the need for treatability study investigations and include sampling and analysis plans (completed)
M-015-00C	12/31/2011	Complete all 200 Areas non-tank farm operable unit pre-record of decision site investigations under approved work plan schedules
M-016-00	12/31/2024	Complete remedial actions for all non-tank farm operable units

*Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order.*

1.10 OVERVIEW OF THE OPERABLE UNIT

National defense activities at the Hanford Site have generated solid waste since the inception of its defense mission in 1944. A significant volume of this waste and waste from other offsite generators has been disposed of, or stored in, the 200 East and 200 West Areas landfills.

The following sections provide a summary description of the 200-SW-2 OU and the sources of wastes that were disposed to these sites. The information in this section was derived from the descriptions found in the background information provided in the Implementation Plan (DOE/RL-98-28) and in WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*. Additional information is provided where appropriate to clarify issues relevant for the OU.

Overview of the 200-SW-2 Operable Unit

Sites included in the 200-SW-2 OU primarily are constructed or excavated sites (landfills uniquely numbered with a "218-" prefix) that received LLW, MLLW, pre-1970[4] waste containing transuranic isotopes, and/or post-1970 retrievably stored TRU waste. 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

[4] Transuranic waste was segregated from other types of waste beginning in May 1970. See history of transuranic waste definitions in Section 1.11.2.

laboratory or process waste, clothing, or tightly packed/sealed liquid wastes in radiological vessels. Before 1970, suspect waste containing transuranic isotopes and LLW were disposed to the same landfill trenches. After 1970, wastes were segregated according to their low-level or TRU designation. TRU waste was placed in underground concrete caissons as well as in trenches at landfills after 1970, as retrievably stored TRU waste. Wastes largely were solid materials and mostly were from on site; approximately 15 percent of the solid waste inventory is known to be from offsite sources. The radioactive inventories at the 200-SW-2 OU waste sites are shallowly buried (generally 1 to 2 m [3 to 6 ft] below grade), are mostly containerized, and have not been subjected to bulk liquids that may drive mobile contaminants deeper into the soil column.

Eight current or past-use 200-SW-2 OU landfills are covered by the LLBG TSD Part A RCRA Permit (DOE/RL-88-21, *Hanford Facility Dangerous Waste Part A Permit Application*) and are planned to be closed as landfills in accordance with the RCRA permit closure process (Bin 1).

Some 200-SW-2 OU waste sites (17) are non-TSD unit landfills (Bins 2–5), most with poorly defined inventories, and are candidates for characterization. In general, the inventory for all of these sites consists of materials shallowly buried (generally 1 to 2 m [3 to 6 ft] below grade). The sites vary considerably in size, age, and types of disposed material.

The remainder of this section describes TSD and non-TSD unit landfills in detail.

1.11 LANDFILL HISTORY

Hanford Site production processes and support activities used and disposed of a large variety of chemical and/or radioactively contaminated solid waste. When the Hanford Site began operations, each of the operational areas (100, 200 East, 200 West, and 300 Areas) had their own disposal facilities. With the exception of the 300 Area, each operational area had landfills within (or in proximity to) their perimeter fence.

From 1944 to 1970, low-level radioactive wastes were disposed of through shallow land burial, potentially including some wastes containing transuranic isotopes. These wastes sometimes were covered with less than 1.2 m (4 ft) of soil. Records and inventory of waste-disposal practices from this period are incomplete.

By 1970, increasing attention to reducing potential contamination to groundwater led to a decision to consolidate all low-level burials to facilities in the 200 Areas. The last 300 Area landfill (Burial Ground 618-7) ceased operations in 1972; the last 100 Area landfill ceased operations in 1973.

Figure 1-6 shows a timeline illustrating the operations periods for the various landfills, as well as relevant regulatory milestones and process activities.

1.11.1 Waste Management Practices

Waste management practices at Hanford Site landfills have varied over time. Record keeping was minimal in the early days of the Hanford Site, with little information recorded on the amounts and types of waste buried. Some documents on waste-disposal activities were issued in the 1950s and 1960s, but these are not complete. Beginning in the late 1960s, routine reports of low-level radioactive solid waste became more complete, often including the amount of land area used, volume of waste, curie content of the various radionuclides, and coordinates of the burial location, culminating in the current *Waste Information Data System* (WIDS) database. Since the late 1960s, contents of landfills have been tracked in a database currently known as the *Solid Waste Information Tracking System* (SWITS). Table 1-6 summarizes the progress in waste management practices over the years.

Waste-disposal practices also have varied over time, depending on the waste form and package. Containers were placed directly in earthen trenches. In some instances, plywood was placed between layers, beneath stacks of drums, and atop the stacks. Boxes have been placed directly in earthen trenches with plywood and dimensional lumber beneath them; large plywood boxes were emplaced using drag-off methods. Some containers were wrapped in polyethylene sheeting. Most container storage has fire-retardant plywood between layers and atop stacks and was covered with a tarp to prevent moisture entry. The LLW and TRU waste package types include the following:

<u>LLW and MLLW; Pre-1970 Waste Containing Transuranic Isotopes</u>

- Cardboard boxes – used for wastes slightly contaminated with pre-1970 waste containing transuranic isotopes, such as wiping tissue
- Plastic shrouds – failed equipment that could not be repaired was wrapped in sheet plastic and placed in the trench
- Steel drums – used for grossly contaminated pre-1970 waste, such as rags and small pieces of hardware, containing transuranic isotopes
- Wooden, concrete, and steel boxes – used for large equipment contaminated with pre-1970 waste containing transuranic isotopes, depending on size, weight, and radioactivity
- Casks – generally used for high-dose-rate material.

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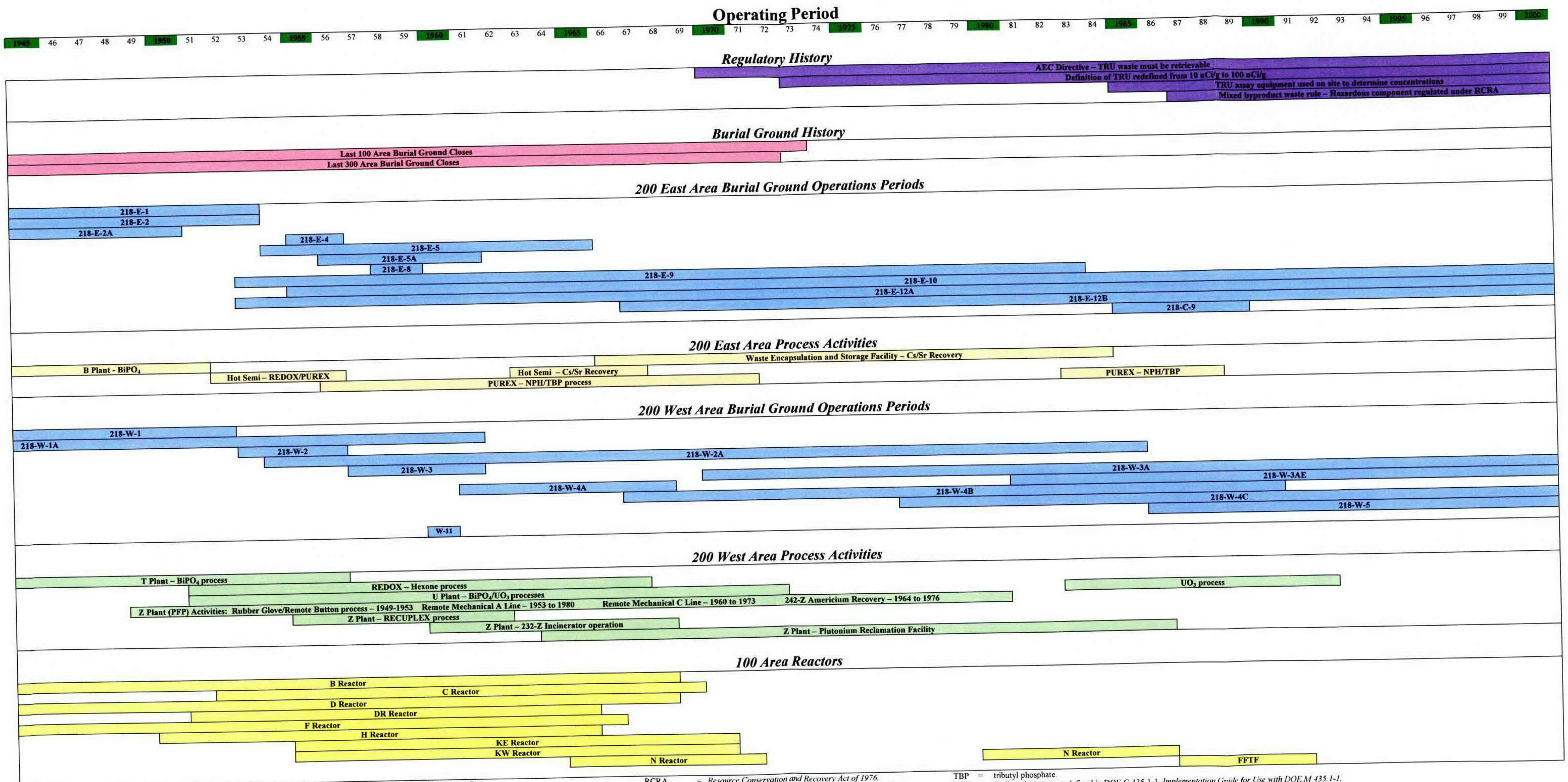
Figure 1-6. Timeline Illustrating Operations Periods for Landfills, with Key Milestones.



AEC = U.S. Atomic Energy Commission.
$BiPO_4$ = bismuth phosphate.
FFTF = Fast Flux Test Facility.
NPH = normal paraffin hydrocarbon.
PFP = Plutonium Finishing Plant.
PUREX = Plutonium-Uranium Extraction Plant.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RECUPLEX = Recovery of Uranium and Plutonium by Extraction Plant.
REDOX = Reduction-Oxidation Plant.
TBP = tributyl phosphate.
TRU = Radioactive waste as defined in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1.*
UO_3 = uranium trioxide.

Table 1-6. Landfill Management Practices.

Operations Period	Management Practices
1944–1954	No intensive waste segregation program. Radioactive wastes, including those containing hazardous and/or transuranic constituents, were commingled for disposal. Combustibles and noncombustibles were buried in the same trench. Burial records contain minimal information. Decentralized disposal; virtually all waste was buried near the point of origin.
195–1965	Alternate disposal methods and sites studied, documented, and, in some cases, implemented. Intentional burning of combustible low-level radioactive solid waste in landfill trenches began and ended in 1955. Records improved.
196–1973	Landfills centralized. Central Landfill constructed for sanitary solid waste. Measurement of burial materials volumes and inventories improved. Burial records were much more complete. Some segregation of waste by category. Beginning in 1968, increasing amounts of low-level radioactive solid waste were transported to the 200 Areas for disposal.
Post–1973	Sanitary solid waste disposed of at the Solid Waste Landfill until the facility closed in 1996. Nonradioactive Dangerous Waste Landfill accepted dangerous waste 1975–1985. All low-level radioactive solid waste was disposed of in the 200 Areas landfills. In 1986, low-level liquid organic waste was banned from land disposal. Central Waste Complex was placed in service in 1988. Environmental Restoration Disposal Facility was constructed in 1995.

From DOE/RL-98-48, Volume II: *Groundwater/Vadose Zone Integration Project Background Information and State of Knowledge*, and WHC-EP-0912, *The History of the 200 Area Burial Ground Facilities*.

TRU and TRU Mixed-Waste Retrievable Storage

- Steel and galvanized drums – used for miscellaneous small items containing or suspected of containing TRU waste for retrievable storage
- Steel boxes – used for contaminated equipment too large for drums
- Fiberglass-reinforced polyester-plywood double-walled boxes – special boxes used for large equipment being removed from shutdown facilities
- Fiberglass-reinforced polyester single-walled boxes – 1.2 by 1.2 by 2.1 m (4 by 4 by 7 ft) contained contaminated equipment too large for drums
- Plywood boxes – designed to transport waste from the Plutonium Finishing Plant to landfills; contained contaminated equipment too large for drums

- Casks – used to ship spent naval-reactor compartments and components that were heavily shielded, permitting placement in retrievable storage
- Cardboard boxes, plastic shrouds, dump trucks, other miscellaneous containers – used for containment of TRU waste in the early 1970s.

1.11.1.1 Disposal of Liquid Organic Waste in the Landfills

Nearly all contaminated liquids from Hanford Site processing facilities have been routed to ponds, cribs, ditches, underground storage tanks, and (in more recent times) to onsite liquid effluent treatment facilities. Historical landfill records reviewed to date (including SWITS, site drawings, and other documents) indicate that only a very small fraction of contaminated liquids, including some organic liquids, may have been packaged and disposed of in some 200 Areas landfills or specific trenches.

Because landfills were intended for solid-waste disposal, liquids disposed to landfills were contained and typically packaged with absorbents to immobilize liquids. Liquid wastes normally were directed to liquid-waste-disposal facilities, not landfills.

Existing records associated with potential disposal of liquids in landfills are complex and unique to each landfill. Evaluation of these records is complicated by several factors. For instance, records for wastes disposed of from 1944–1960 do not exist for all portions of the landfills that were active during that period. It is therefore impossible to determine with confidence if liquids have been disposed of in those landfills. However, certain field logbooks from the 1940s–1960s indicate the possible inclusion of liquids. In addition, the SWITS database includes data fields for solid/liquid waste, but the descriptions of chemical constituents were not entered in all cases. Also, while some of the engineering drawings for the landfills also identify portions of some trenches as "low-level waste and mixed waste with liquid" or as "transuranic and mixed waste with liquid," details on the chemical makeup of the buried liquids typically are not provided in the historical records.

Nevertheless, the strategy for identifying and locating liquid organics is through the literature sources, and to use the available resources to narrow the general category of "liquids" down to liquid organics if possible.

Although it is not currently known whether the landfills have received any significant volumes of liquid organic waste, it generally is understood that when organic liquids are discharged into the unsaturated zone, they will partition between the liquid and vapor state. Even if the soil absorbs all of the discharged liquid before it reaches the water table, the vapors may migrate through the vadose zone. If there is a migrating plume, it will continue to stay in vapor-liquid equilibrium, and the vadose zone above the plume will contain vapor. In addition, as the water table rises and falls, the organic liquids may be sorbed by the soil in a zone representing the annual cycle of the water table rise and fall. The residual saturation in this zone also will contribute soil vapors.

A regional carbon tetrachloride plume exists from nearby crib operations and may have possible implications on soil vapor in nearby landfills. Sampling beneath trenches during Phase II characterization activities may help to differentiate between this regional plume and any soil vapors potentially originating from the landfills.

1.11.1.2 History of Container-Venting Practices

Before 1976, there were no requirements for venting burial containers to allow for the release of built-up pressure. By 1976, vents were required on burial containers to protect against internal pressure buildup that could cause the container to breach. Such vents would be discharged through high-efficiency particulate air filters. By 1979, vent clips were installed in all onsite drums. The vent openings functioned as a positive seal when not in use. Offsite drums equipped with similar vent clips were received beginning in 1980. By 1983, limits on waste pressurization had been established; containers that could become pressurized to more than 48 kPa (7 lb/in^2 gage) within 25 years required venting through a high-efficiency particulate air filter; other wastes could be vented by a special filter, vent clips, or gaskets (WHC-EP-0845, *Solid Waste Management History of the Hanford Site*).

Specific mitigating measures for control of hydrogen from radiolytic decomposition or from biological decomposition also are outlined in HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria*. This document includes suggested use of palladium or platinum catalyst packs to control hydrogen in containers with the potential for radiolysis, or addition of slaked lime to containers holding readily biodegradable organic materials (e.g., animal waste, vegetation). A list of approved venting devices is provided in Appendix H of HNF-EP-0063. This document also states that vent clips are no longer an acceptable form of container venting.

1.11.2 Transuranic and TRU Waste

As noted above, since 1970 the DOE has managed TRU waste to allow for its retrieval. This program was not subject to CERCLA regulation. A brief overview of the TRU retrieval program is provided because the retrievable TRU is intermixed with waste in the 200-SW-2 OU landfills. In addition, the TRU retrieval program might generate information on contaminant-migration behavior that would be beneficial in addressing the scope of this DQO process.

TRU waste is further defined as contact-handled TRU and remote-handled TRU. The contact-handled TRU has a dose rate equal to or less than 200 mrem/h when measured at contact with the waste container. The remote-handled TRU has a dose rate greater than 200 mrem/h at contact with the container.

The four primary landfills for storage of contact-handled TRU are the 218-W-3A, 218-W-4B, 218-W-4C, and 218-E-12B Landfills. Storage containers are intermixed in some trenches; several contain both LLW and TRU waste. Burial trench locations are marked only by external survey marker monuments that typically are spaced every 7.6 m (25 ft) around the perimeter; markers are about 4.9 m (16 ft) above the trench floor (WHC-EP-0225, *Contact-Handled Transuranic Waste Characterization Based on Existing Records*).

U.S. Atomic Energy Commission (AEC) Immediate Action Directive 0511-21, *Policy Statement Regarding Solid Waste Burial*, issued in 1970, defined transuranic waste and directed that after May 1970 waste with known or detectable contamination of transuranic waste radionuclides must be segregated from other waste categories. AEC Manual Chapter 0511, *Radioactive Waste Management*, issued in 1973, established a segregation limit of 10 nCi/g (Smith, 1982, "A Review of the Risk Assessments for Defining the Alpha-Contaminated Wastes").

That definition was revised when DOE issued Order 5820.1, *Management of Transuranic Contaminated Material*, in 1982: "TRU-contaminated material includes alpha-emitting radionuclides of atomic number greater than 92 and half-life greater than 20 years in a concentration greater than 100 nCi/g." The concentration limit of TRU was raised from 10 to 100 nCi/g, based on the recommendations of the Alpha-Contaminated Waste Management Workshop (Smith, 1982). The recommendations were based on considerations of risk and practicality presented in numerous technical papers. DOE O 435.1, *Radioactive Waste Management*, superseded DOE Order 5820.1 in 1999. The following current definition of TRU waste is provided in DOE M 435.1-1, *Radioactive Waste Management Manual*, Attachment 2, "Definitions," as follows.

> "Transuranic waste. Transuranic waste is radioactive waste containing more than 100 nanocuries (3700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for:
>
> (1) high-level radioactive waste;
>
> (2) waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the Environmental Protection Agency, does not need the degree of isolation required by the 40 CFR Part 191[5] disposal regulations; or
>
> (3) waste that the Nuclear Regulatory Commission has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61." [6]

Beginning in May 1970, procedures were in place for recording waste generation, form, packaging, and placement to ensure that TRU waste could be located and retrieved. The data were entered into the *Richland Solid Waste Information Management System* (RSWIMS) database (precursor to the current *Solid Waste Information and Tracking System* [SWITS] database) via burial records.

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 retrievably as TRU between 1970 and 1985 was not assayed. Because material could not be assayed until 1985, and because of the upwardly changing definition of the TRU contamination limit, this implies that a portion of retrievably stored waste is likely to be LLW and not TRU waste. The actual nature of the waste (i.e., LLW, TRU, or other designations) will be determined by assay of the waste as it is retrieved. DOE M 435.1-1 clarifies that all retrievably stored waste is subject to current TRU definitions, regardless of its age, and that transuranic waste disposed of before implementation of AEC Immediate Action Directive 0511-21 in 1970 regarding retrievable storage of transuranic waste is not subject to the requirements of DOE O 435.1.

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[5] 40 CFR 191, "Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes."

[6] 10 CFR 61, "Licensing Requirements for Land Disposal of Radioactive Waste."

1.11.3 Mixed Waste

Where regulated chemical and radioactive constituents are combined in a waste form, the waste currently is termed "mixed waste." Mixed waste that meets the definition of LLW (as defined in DOE M 435.1-1) is termed MLLW. At the time when much of the mixed waste was generated, however, there were no definitions or regulations governing the chemical constituents. In 1986, low-level liquid organic waste was banned from land disposal at the Hanford Site landfills (WHC-EP-0912). Many of these organic constituents subsequently have been classified as hazardous or dangerous wastes by the EPA and Ecology. In 1987, the DOE issued a mixed-byproduct-waste rule stating that the hazardous components of mixed waste are regulated by RCRA (10 CFR 962, "Radioactive Waste, Byproducts Material Final Rule"; 52 FR 15937, "Radioactive Waste, Byproducts Material Final Rule"). In August 1987, the EPA authorized Ecology to regulate the hazardous constituents of mixed wastes at the Hanford Site. In 2003, the DOE and Ecology agreed that retrievably stored waste meeting the definition of TRU waste must be retrieved, assayed and examined, repackaged, and ultimately shipped to the Waste Isolation Pilot Plant in New Mexico for disposal. Retrieved waste found to be LLW or MLLW will be treated (if required) and disposed of on the Hanford Site.

1.11.4 High-Dose-Rate Materials

The term "high-radiation-dose-rate" has been defined consistently by the DOE and its predecessor agencies, 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," a high-radiation area is defined as greater than 100 mrem/h at 30 cm (1 ft). High-dose-rate material does not constitute high-level waste.

The LLBG and past-practice sites, over their history, have accepted high-radiation-dose-rate items. Of the approximately 120,000 non-transuranic (non-TRU) waste records (covering 1944-present) available for the 25 landfills covered by this DQO, about 7,500 records (~6 percent) indicate waste with a dose rate greater than 100 mrem/h at burial. The acceptance criteria have varied over time, but in general have been defined as follows (WHC-EP-0845).

- Before 1980, landfills generally were restricted from receiving waste with surface dose rates of more than 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.

- Since 1980, limits for surface dose rates of non-TRU CH 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 RH 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) 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 30 cm (1 ft) are acceptable. CH containers (see definitions below) exceeding these limits require container-specific review and approval.

RH waste is acceptable at the LLBG if approved through both a waste-stream profile sheet and a container-specific shipment. RH waste must meet the applicable dose-rate restrictions of the U.S. Department of Transportation or an approved package-specific safety document for transport. RH waste is configured for unloading while maintaining personal exposures as low as reasonably achievable (ALARA).

Definitions for CH and RH waste from HNF-EP-0063:

> *Contact handled.* Packaged waste with a dose rate equal to or less than 200 mrem/h at contact with the container, except that packages larger than 55 gal could have a marked point on the bottom or side with a surface dose rate up to 1,000 mrem/h.
>
> *Remote handled.* Packaged waste with a dose rate greater than 200 mrem/h at contact with the container.

1.12 WASTE AND CONTAMINANT SOURCES

The 200 Areas have been the center of activity for processing plutonium at the Hanford Site since the mid-1940s. There are five general plant process groupings: (1) fuel processing, (2) plutonium isolation and finishing, (3) uranium recovery, (4) cesium/strontium recovery, and (5) waste storage/treatment. All of these plant processes generated solid waste that was disposed of in the 200-SW-2 OU waste sites. In addition, the 200-SW-2 OU waste sites contain solid waste generated in the 100 and 300 Areas of the Hanford Site and at other, non-Hanford, facilities.

The following subsections identify plant facilities, operations, and processes that are associated with some of the 200-SW-2 OU disposal operations. The Implementation Plan (DOE/RL-98-28) consolidated background information and provided a single, referenceable source of this information. This allowed the group-specific work plans to focus on waste group or waste site-specific information. The background information included in the Implementation Plan provides an overview of the 200 Areas facilities and processes, their operational history, contaminant migration concepts, and a list of contaminants of potential concern (COPC). It also documented and evaluated existing information to develop a site description and conceptual model of expected site conditions and potential exposure pathways.

1.12.1 Overview of Transuranic and TRU Waste Generators

Based on reviews of historical records, more than 90 percent of the pre-1970 solid waste that contains plutonium is located within four 200 West Area landfills (218-W-1, 218-W-2, 218-W-3, and 218-W-4A Landfills). These four landfills operated in sequence between 1944 and 1968. The Plutonium Finishing Plant was the primary generator of plutonium-bearing waste during these years. Other landfills containing pre-1970 uranium- and plutonium-bearing wastes include the 218-E-1, 218-E-5A, 218-E-10, 218-E-12A, 218-E-12B, 218-W-2A, and 218-W-4B Landfills. For all pre-1970 uranium- and plutonium-bearing wastes in the landfills, the main generators were the Plutonium Finishing Plant, Plutonium-Uranium Extraction Plant, 209-E Critical Mass Laboratory, 222-S Analytical Laboratory, 300 Area Facilities (308 Fuels Development Laboratory), 100 Area Facilities (mainly the 108-F Animal Research Facility), Reduction-Oxidation Plant, T Plant, U Plant, and offsite generators (mainly Sandia National Laboratory, Boeing, and Argonne National Laboratory). From the startup of the 200 Areas landfills until 1960, few records were kept concerning disposals or plutonium-uranium inventories. From 1960 to about 1967, records of the source and amount of material were kept, but not the amount of plutonium in the burials. The plutonium inventories for burials from 1944–1967 are therefore rough estimates made in ARH-2762, *Input and Decayed Values of Radioactive Solid Wastes Buried in the 200 Areas Through 1971*, in 1974, based on known disposal practices and decay rates.

The landfills containing post-1970 TRU waste are the 218-E-12B, 218-W-3A, 218-W-4B, and 218-W-4C Landfills. The 218-E-12B Landfill TRU waste was generated by the Plutonium-Uranium Extraction Plant in 1970–1971, and it may not all meet the current DOE definition of TRU waste. The TRU waste in the 218-W-3A, 218-W-4B, and 218-W-4C Landfills was generated mainly by the Plutonium Finishing Plant (>50 percent of the waste), offsite generators (~20 percent), 300 Area (~10 percent), 100 Areas (~5 percent), and 200 Areas (other than the Plutonium Finishing Plant) (~5 percent). Non-Plutonium Finishing Plant generators of TRU wastes in the 200 Areas include the Plutonium-Uranium Extraction Plant, T Plant, 222-S Analytical Laboratory, 233-S Plutonium Concentration Facility, 209-E Critical Mass Laboratory, and 2724-W Laundry Building. Offsite generators of post-1970 TRU waste (or suspect-TRU waste) included Battelle Columbus Laboratory, Argonne National Laboratory, Rocky Flats, Lawrence Radiation Laboratory, Sandia National Laboratory, General Electric, Bartlesville Energy Technology Center (Oklahoma), and United States military research.

During the latter part of 1979 and the early part of 1980, a heavy snowfall and rapid melting caused flooding within some of the 218-W-4C Landfill trenches. Drums containing TRU waste were observed to be floating in Trench 4 and were recovered undamaged (WHC-EP-0225). Rapid snow-melting events, resulting in surface ponding, also took place in the 218-W-3A and 218-W-4B Landfills.

1.12.2 Hanford Site Generators

The following Hanford Site facilities contributed to waste disposed of in the 200-SW-2 OU.

200 Areas:

- Plutonium isolation and finishing (Plutonium Finishing Plant, formerly the Z Plant Complex)
- Fuel processing (B Plant, T Plant, Reduction-Oxidation Plant, Plutonium-Uranium Extraction Plant [A Plant])

- Uranium recovery (U Plant, Hot Semiworks)
- Cesium-strontium recovery (B Plant)
- Waste storage and treatment (T Plant, B Plant, tank farms, evaporators).

100 Areas:

- Reactor operations (100-B, -C, -D, -DR, -F, -H, -KW, -KE, -N Areas).

300 Area:

- Laboratories (308 Fuels Development Laboratory, 309 Plutonium Recycle Test Reactor, 324 Chemical Engineering Building, 325 Radiochemical Processing Laboratory, 326 Materials Science Laboratory, 327 Post Irradiation Test Laboratory, and 329 Chemical Sciences Laboratory buildings).

400 Area:

- Experimental reactor (Fast Flux Test Facility).

As noted above, until the early 1970s, all operations areas managed their own waste disposal onsite. Wastes disposed to the 200 Areas landfills from 100 Area reactor activities predominantly consist of obsolete or failed reactor hardware. Contaminated protective clothing, tools, and miscellaneous process-related materials also were disposed of in these landfills.

The 200 Areas housed the chemical processing facilities at the Hanford Site. As from the reactor areas, contaminated process hardware was a significant source of solid waste. Additional waste streams included construction and demolition waste resulting from system upgrades, tools and protective clothing, and miscellaneous process materials. Contaminated soil and other materials from chemical spills and leaks also were included in the waste.

The 300 Area manufactured fuel elements for Hanford Site reactors from uranium stock. These processes generated contaminated hardware and tools, protective clothing, equipment, glassware, swipes, and other process-related materials. The waste stream also included uranium millings, shavings, and dust, as well as demolition debris from renovation activities. The 300 Area also generated waste from research and development activities in laboratory facilities, some of which had high dose rates requiring special handling (DOE/RL-98-48, *Groundwater/Vadose Zone Integration Project Background Information and State of Knowledge*, Volume II).

1.12.3 Offsite Waste Generators

Waste has been received from a variety of offsite generators throughout the history of the Hanford Site (WHC-EP-0912). The waste from offsite generators originated from a variety of government, educational institution, and private sector responsibilities, processes, and programs, including the following:

- Basic research
- Cleanup and restoration projects
- U.S. Department of Defense waste (from the U.S. Army and U.S. Navy)
- Accelerator waste from throughout the United States
- Animal studies that have been performed in various DOE facilities
- Reactor studies
- Irradiators and sources
- Fuels fabrication facilities
- Laboratory wastes
- Other miscellaneous wastes.

Sources of offsite waste are listed in Table 1-7; this list may not be complete, because of the absence of some waste receipt records for the early years.

Table 1-7. Offsite Sources of Wastes Disposed to the 200-SW-2 Operable Unit Landfills. (2 Pages)

AiResearch	Los Alamos National Laboratory
Albany Medical Research Center	Mare Island Ship Yard
Ames Laboratory	Morgantown Energy Technology Center
Ann Arbor (Michigan)	Mound Laboratories
Argonne National Laboratory East (Chicago, Illinois)	Naval Reactors
Army Corps of Engineers	New York Nuclear Industries
Babcock Wilcox	Oregon Metal Corporation
Bartlesville Energy Technology Center (Oklahoma)	Pacific Ecosolutions, Inc.
Battelle Columbus Laboratory	Paducah Gaseous Diffusion Plant
Bettis Atomic Power Laboratory	Pearl Harbor Naval Shipyard
Boeing Energy Technology Engineering Center	Permafix
Bonneville Power Administration	Pittsburgh Naval Reactor Office
Bremerton Ship Yards	Princeton University Reactor/Laboratory
Brookhaven National Laboratory	Quadrex
Bureau of Mines	Quanterra Labs
Ceer University Laboratory	Rensselaer Polytechnic Institute
Center for Energy and Environmental Research (Puerto Rico)	Rockwell International-Rocketdyne Division
Chem Nuclear Services	Rocky Flats
Chicago National Guard Armory	Sandia Corporation (Albuquerque, New Mexico)
Colony Site, New York	Sandia Livermore Systems Group

Table 1-7. Offsite Sources of Wastes Disposed to the 200-SW-2 Operable Unit Landfills. (2 Pages)

Coneville Power	Shippingport Station Decommissioning Project
Coors Ceramics Company	Stanford Linear Accelerator
Exxon Nuclear System	Three Mile Island Unit 2
Fermi Laboratories	TRW Defense TRW Incorporated
General Atomics, San Diego, California	University of Alaska
General Electric	University of California at Berkeley
Idaho Environmental Engineering Laboratory	University of California at Davis
International Atomic Energy Agency	University of California at Los Angeles
Kaman Sciences Corporation	University of Rochester
Kerr-McGee	University of Utah
Knolls Atomic Power Laboratory	University of Washington Food Irradiator
Lawrence Livermore National Laboratory	Ventron (Bechtel Oak Ridge)
Lawrence-Berkeley Laboratory	United Nuclear Corporation, Wood River Junction Fuel Facility
Lockheed (Sunnyvale, California)	

1.13 SUMMARY OF HISTORICAL DATA

Table 1-8 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 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
Aggregate Area Management Studies	
B Plant Aggregate Area Management Study Technical Baseline Report, BHI-00179, 1995	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/?content=findpage&AKey=D198038144
PUREX Plant Aggregate Area Management Study Technical Baseline Report, BHI-00178, 1995	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/?content=findpage&AKey=D198038126

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
S Plant Aggregate Area Management Study Technical Baseline Report, BHI-00176, 1995	Description of waste sites and processes within S Plant Aggregate Area. Includes composition of S Plant (Reduction Oxidation Plant) facilities wastes. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=D198038143
T Plant Aggregate Area Management Study Technical Baseline Report, BHI-00177, 1995	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/?content=findpage&AKey=D198038140
U Plant Aggregate Area Management Study Technical Baseline Report, BHI-00174, 1995	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/?content=findpage&AKey=D198038132
Z Plant Aggregate Area Management Study Technical Baseline Report, BHI-00175, 1995	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/?content=findpage&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, 2004	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/?content=findpage&AKey=D7030512 http://www2.hanford.gov/arpir/?content=findpage&AKey=D7030671 http://www2.hanford.gov/arpir/?content=findpage&AKey=D7030806
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.

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
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, and the dates trenches were dug.
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 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=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 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=D9023874
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 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=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

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
Chemical Processing Division Monthly Reports (too numerous to list individually). An example is *Chemical Processing Department Monthly Report for February 1957*, HW-48835-DEL, 1957	The monthly reports cover a wide variety of events (plutonium output, radiation occurrences). Of relevance to this DQO is the information regarding burials that often is found within the reports. The example report from February 1957 lists a PUREX cleanup effort of materials taken for burial that reduced dose rates within a portion of the deck from 20 R/h to 1 R/h. 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, and backfill. 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
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.

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
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/?content=findpage&AKey=D196039027 http://www2.hanford.gov/arpir/?content=findpage&AKey=D196039028 http://www2.hanford.gov/arpir/?content=findpage&AKey=D196039029
"Hanford Site Mixed Waste Disposal," K. M. McDonald et al., 2001	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/?content=findpage&AKey=D196006954 http://www2.hanford.gov/arpir/?content=findpage&AKey=D196006996 http://www2.hanford.gov/arpir/?content=findpage&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, and radiation levels.
Radioactive Contamination in Unplanned Releases to Ground Within the Chemical Separations Area Control Zone through 1970; Part 4, ARH-2015, 1971.	Documents the status of rails removed from 218-W-2A-T16.

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
Drawings of Trenches and Landfills 218-C-9 H-2-32523 (of 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 8.0.
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 laboratory 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

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
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
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-PT4, 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). The document covers the permitted low-level landfills only. The data fill 8 volumes and go through 1989. They are the same data that appear in the *Solid Waste Information and Tracking System* database. The 8 volumes are available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=D195066777 http://www2.hanford.gov/arpir/?content=findpage&AKey=D195066774 http://www2.hanford.gov/arpir/?content=findpage&AKey=D195066775 http://www2.hanford.gov/arpir/?content=findpage&AKey=D195066817 http://www2.hanford.gov/arpir/?content=findpage&AKey=D195066821 http://www2.hanford.gov/arpir/?content=findpage&AKey=D195066924 http://www2.hanford.gov/arpir/?content=findpage&AKey=D195066928 http://www2.hanford.gov/arpir/?content=findpage&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) For newer (post-1967) landfills, gives more extensive information, usually including burial coordinates, container type, trench number, date buried, source facility, and nonradioactive contaminants.

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
Solid Waste Management History of the Hanford Site, WHC-EP-0845, 1995	Summarizes the management of solid waste at the Hanford Site from 1944-1995. Topics covered are extensive and include container types, waste categories, disposal practices, waste-handling practices, documentation of buried waste, and laws and orders pertinent to waste disposal.
Source Data Records (too numerous to list individually). Example: *Burial Gardens Records Month End & Source Data October Through December 1970, FY1971*, 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 Site 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, and cables used. 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

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
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 and classified waste. Contains many photographs. In 2 volumes. Vol. 1 available at: http://www.osti.gov/energycitations/servlets/purl/827767-NOu75G/native/
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, and maximum radioactivity levels of buried material. 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, and maximum radioactivity levels of buried material. 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, and maximum radioactivity levels of buried material. 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/?content=findpage&AKey=D8532666

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
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, 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 O 435.1. Available at: http://gwmodeling.pnl.gov/reports/CAMplan.PDF
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 standards in DOE Order 5820.2A. (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 standards in DOE Order 5820.2A. (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/?content=findpage&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. Available at: http://www.hanford.gov/doe/eis/hraeis/hraeis.htm

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
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/?content=findpage&AKey=D196057317
Hanford Facility Dangerous Waste Part A Permit Application, DOE/RL-88-21, September 2002 (most recent version that includes Low-Level Burial Grounds)	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/?content=findpage&AKey=D9155786
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/?content=findpage&AKey=D196136029 http://www2.hanford.gov/arpir/?content=findpage&AKey=D196136305
200 West Groundwater Aggregate Area Management Study Report, DOE/RL-92-16, 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/?content=findpage&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 2006, PNNL-16346, 2007	Results of groundwater and vadose zone monitoring and remediation for fiscal year 2006 on the Hanford Site. Available at: http://groundwater.pnl.gov/reports/gwrep06/start.htm

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
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/?content=findpage&AKey=D195066506 http://www2.hanford.gov/arpir/?content=findpage&AKey=D195066592 http://www2.hanford.gov/arpir/?content=findpage&AKey=D195066599
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.pdf
Characterization Investigations	
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, DOE/RL-2006-51, 2007	Investigation of the 200-PW-1 OU collected passive organic vapor samples from 218-W-3A.
200-PW-1 Operable Unit Report on Step II Sampling and Analysis of the Dispersed Carbon Tetrachloride Vadose-Zone Plume, SGW-33829, 2007	Investigation of the 200-PW-1 OU collected passive organic vapor samples from 218-W-3A.
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, in process	Investigation of the 200-SW-2 OU collected passive organic vapor samples from a subset of the in-scope landfills.
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.

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
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 OU, and shows logic developed to support nonintrusive characterization (records search, passive vapor, geophysical investigations).
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 nonintrusive characterization (records search, passive vapor, geophysical investigations).
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, 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, electromagnetic induction, 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-30708, 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.
PNNL-16105, *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*, 2007	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, and nonintrusive.
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 OU waste sites. Available at: http://www2.hanford.gov/ddrs/common/findpage.cfm?AKey=D6831709
Safety Basis Documentation	
Active and Retired Radioactive 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, and package and records inspections. 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, 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]

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
Waste Management Project (WMP) Master Documented Safety Analysis (MDSA) for the Solid Waste Operations Complex (SWOC), HNF-14741, 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, 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, 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, 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.
Sampling Plan for Retrievably 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.
04-AMCP-0321, "Transmittal of the Burial Ground Sampling and Analysis Results for January – March 2004," 2004	M-091 Program quarterly letter reports documenting Step I sampling (vent risers and passive organic vapor).

Table 1-8. Existing Documents and Data Sources for the 200-SW-2 Operable Unit. (15 Pages)

Reference	Summary
07-AMCP-0166, "Burial Ground Sampling and Analysis Results for October – December 2006," 07-AMCP-0166, 2007	M-091 Program quarterly letter reports documenting Step I sampling (vent risers and passive organic vapor).

[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*.
Waste Information Data System Report, Hanford Site database.

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.
DQO = data quality objective.
EPA = U.S. Environmental Protection Agency.
NEPA = *National Environmental Policy Act of 1969*.
OU = operable unit.
PCE = tetrachloroethylene (perchloroethylene).
PUREX = Plutonium-Uranium Extraction Plant.
RCRA = *Resource Conservation and Recovery Act of 1976*.
SS = source and special.
TCE = trichloroethylene.
TRU = Radioactive waste as defined in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*.

1.14 CONTAMINANTS OF POTENTIAL CONCERN

A set of radiological and organic COPCs that may be present in the 200-SW-2 OU landfills was established during the Phase I-A DQO process, based on the following bulleted items.

- 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 Implementation Plan (DOE/RL-98-28).

In accordance with the May 2007 agreement (RL and Ecology, 2007), this DQO process primarily is focused on nonintrusive characterization techniques with limited intrusive techniques. As presented in Step 7, this includes the application of historical records, borehole logging (direct pushes and groundwater wells), unused caisson radiological surveys, and nonintrusive soil vapor and geophysical survey techniques (no soil samples will be collected during Phase I-B). As a result of the May 2007 agreement, the standard COPC development process and exclusion rationale do not apply for this phase of characterization. Instead, the COPC list is limited to contaminants that are readily detectable via nonintrusive soil-vapor survey or gross/spectral gamma-ray logging techniques. Table 1-9 lists the COPCs identified for the characterization techniques to be used during Phase I-B.

Table 1-9. 200-SW-2 Operable Unit Phase I-B Contaminants of Potential Concern List.

Contaminants of Potential Concern*	Rationale for Inclusion
Radioactive Constituents	
Americium-241 Cesium-137 Cobalt-60 Europium-152 Europium-154 Europium-155 Iodine-129 Neptunium-237 Technetium-99 Thorium-232 Uranium-234 Uranium-235 Uranium-238	Gamma-emitting isotopes with high-energy emissions that may be detected from within direct-push boreholes, existing groundwater monitoring wells, and caissons by radiological detection methods.
Volatile Organics	
Volatile organic compounds per manufacturers' specifications	Analytical results and measurements have demonstrated that vapor-phase volatile organic contaminants are found within the landfills (Phase I-A organics report). Volatile organic vapors may be detected in the subsurface trenches and/or soil by nonintrusive techniques.

*A portion of the listed contaminants may be calculated rather than directly measured.

As summarized in Step 7, nonintrusive soil vapor samples will be collected using commercially available glass vials containing an absorbent medium. The samplers will be placed in shallow holes in the soil for a prescribed length of time, after which they will be collected and sent to the manufacturer for analysis.

A limited number of intrusive direct-push boreholes will be installed and logged to acquire information regarding the presence/absence of gamma-ray-emitting radionuclides, soil moisture distribution with depth, and site stratigraphy adjacent to selected trenches in each landfill. These direct pushes will be completed to a depth of 30 m (100 ft) or until refusal. Borehole logging also will be conducted in selected upgradient and downgradient groundwater-monitoring wells existing around the periphery of landfills. Radiation surveys also will be conducted in caissons that are believed to be unused based on historical records.

Field instruments commonly used for detecting radiological contaminants in subsurface soils rely on the detection of gamma-ray emissions from radionuclides of potential concern. A number of intrusive techniques are applicable to provide access for subsurface detection of gamma-ray-emitting radionuclides. Direct-push slim-hole techniques are preferred due to their overall cost effectiveness. Typical direct-push slim-hole techniques include cone penetrometers, GeoProbes,[7] and hydraulic and diesel hammer rigs.

[7] GeoProbe is a registered trademark of GeoProbe Systems, Salinas, Kansas.

For many commonly encountered gamma-ray-emitting radionuclides of potential concern, there are slim-hole gross and spectral gamma-ray logging technologies available (e.g., sodium iodide, cesium iodide, bismuth germanate). For other radionuclides of potential concern that do not emit gamma rays, directly identifying the presence of these radionuclides in subsurface soils is difficult. Instead, they may be collocated with other gamma-ray-emitting radionuclides that can act as proxies or surrogates during borehole logging (e.g., Am-241 as a surrogate for Pu-241).

As discussed herein, both nonintrusive and intrusive techniques will be used to reduce spatial uncertainty and to more clearly identify subsurface regions where focused soil sampling will be conducted during future intrusive phases. A simple measurement of gross radioactivity is often times sufficient to determine the presence/absence of gamma-ray-emitting radionuclides. More detailed spectral gamma-ray logging can be conducted to determine specific radionuclides in areas where gross activity is detected.

1.15 CONCEPTUAL SITE MODELS

This section describes the development of the initial CSMs for the 200-SW-2 OU landfills. Information pertaining to contaminant sources, release mechanisms, transport media, exposure route, and receptors has been incorporated into the CSMs. This information forms the initial basis for an evaluation of potential human health and environmental risk.

Preliminary CSMs were first developed for the 200-SW-2 OU in DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*; 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 CCDMs have been developed. The CCDMs will be included in the RI/FS work plan, Draft B, as part of the overall CSMs for the bins and individual landfills. Additional work to create CSMs for the 200-SW-1 OU landfills will not be performed because these landfills are proposed to be closed independent of the CERCLA RI/FS process.

Figures 1-7 through 1-14 present the CCDMs for each of the six bins in the 200-SW-2 OU. These CCDMs provide a picture of the stratigraphy, waste type, trench depth, and possible contaminant migration of each bin. Also included is a CCDM (Figure 1-14) for the vertical pipe units and caissons in the 218-W-4A and 218-W-4B Landfills.

A comprehensive and systematic approach for developing and documenting Hanford Site-specific CSMs based on the features, events, and processes (FEP) methodology is described in 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* (OECD/NEA, *Features, Events, and Processes [FEPs] for Geologic Disposal of Radioactive Waste: An International Database [Radioactive Waste Management]*). A streamlined FEPs process was pursued in 2007 and will be further considered during future refinements to CSMs and risk assessments for the 200-SW-2 OU.

Further detail regarding this Hanford Site FEPs 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.

Figure 1-7. Conceptual Contaminant Distribution Model for Bin 1 – TSD Unit Landfills (200 West Area).

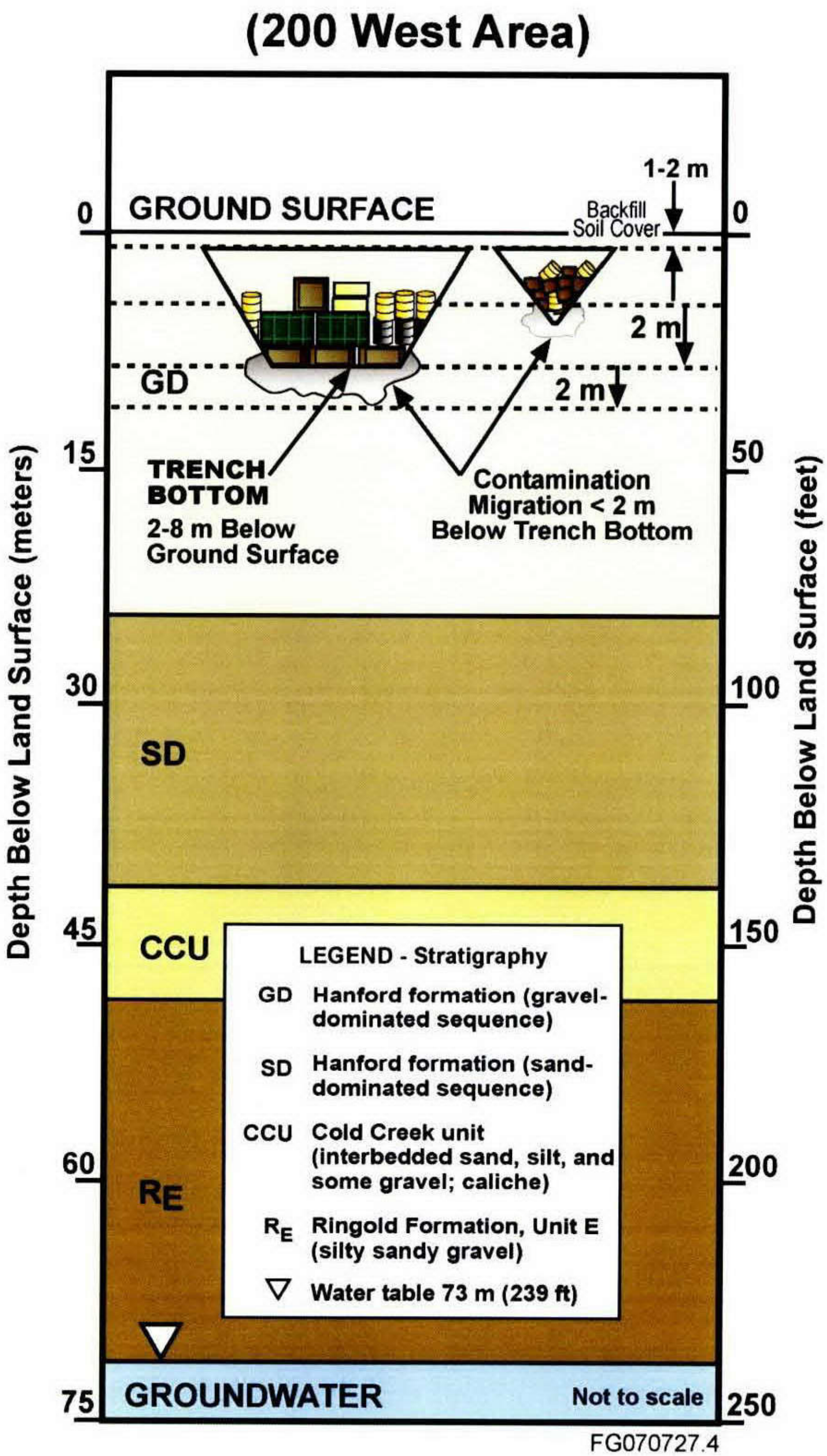

Figure 1-8. Conceptual Contaminant Distribution Model for Bin 1 – TSD Unit Landfills (200 East Area).

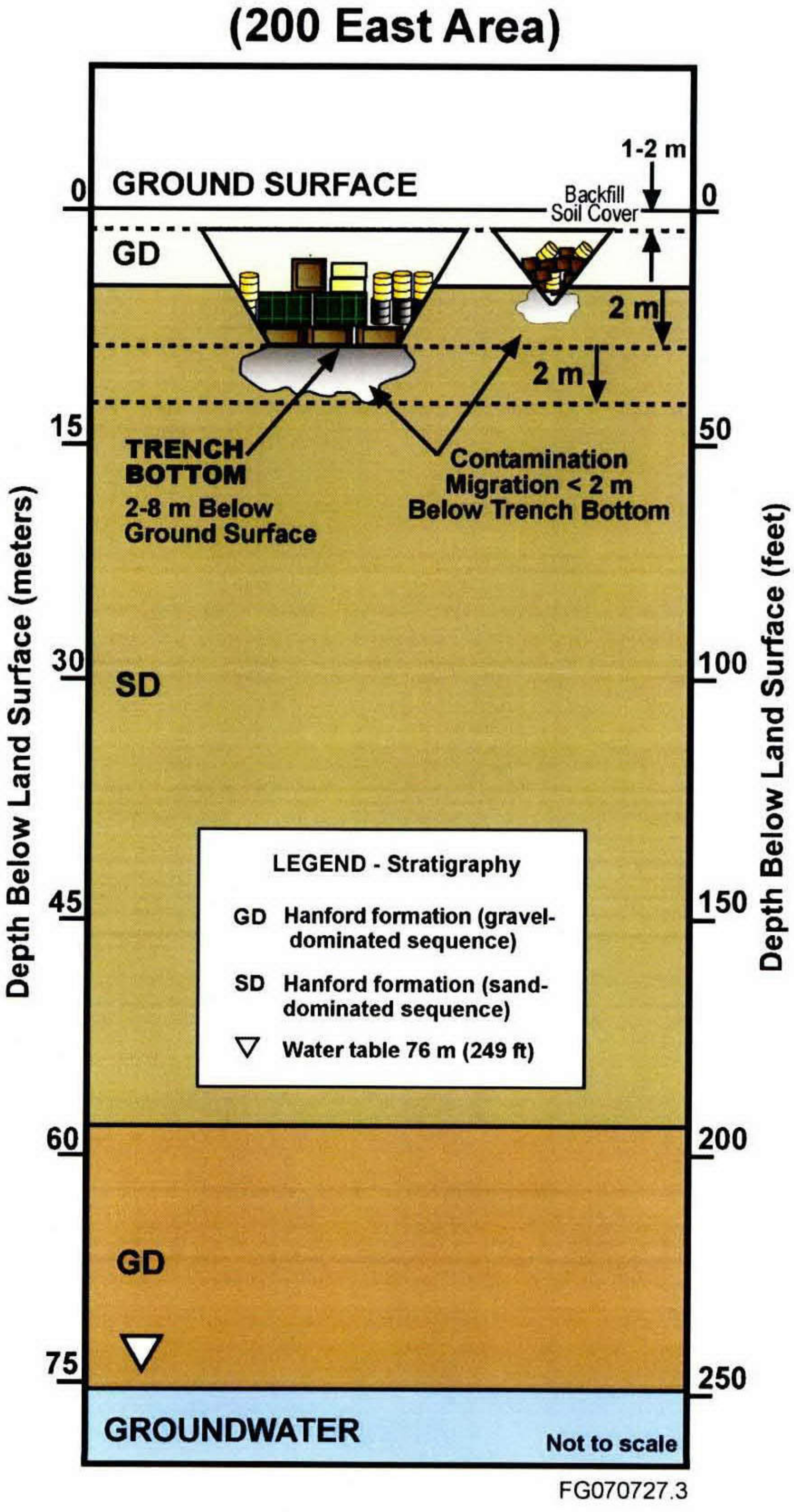

Figure 1-9. Conceptual Contaminant Distribution Model for Bin 2 – Industrial Landfills (200 West Area).

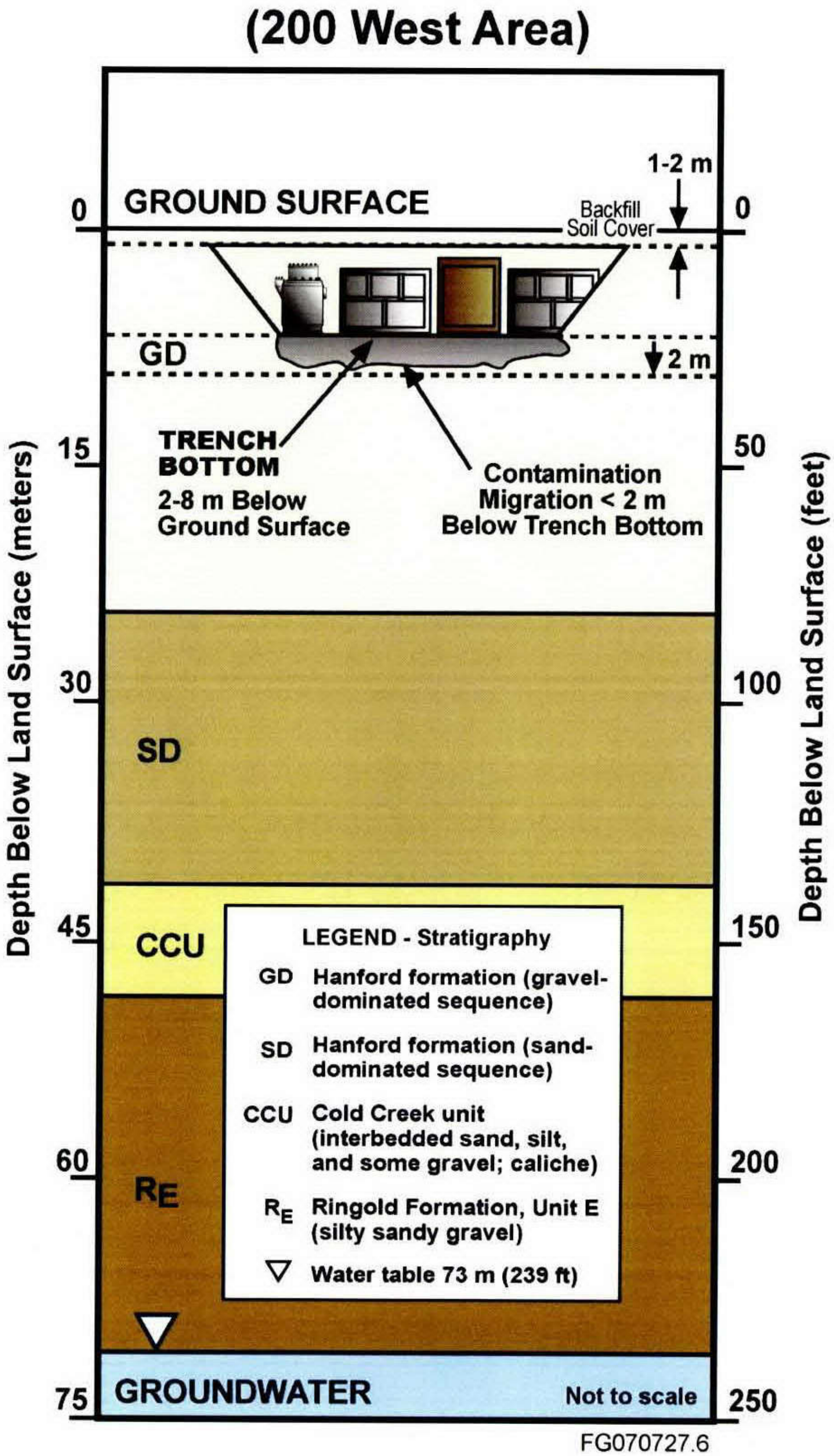

Figure 1-10. Conceptual Contaminant Distribution Model for Bin 2 – Industrial Landfills (200 East Area).

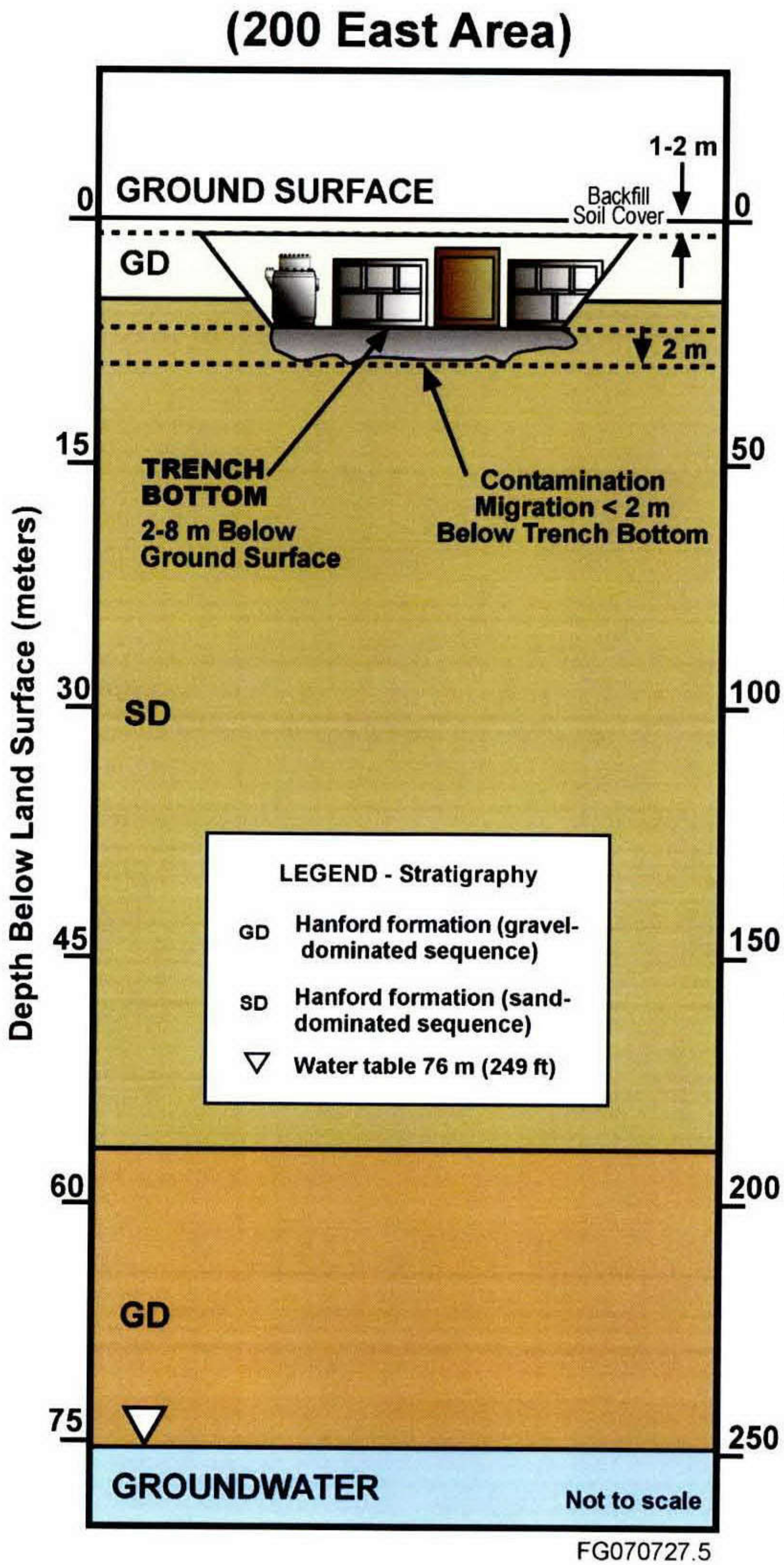

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Figure 1-11. Conceptual Contaminant Distribution Model for Bin 3 – Dry Waste Alpha Landfills.

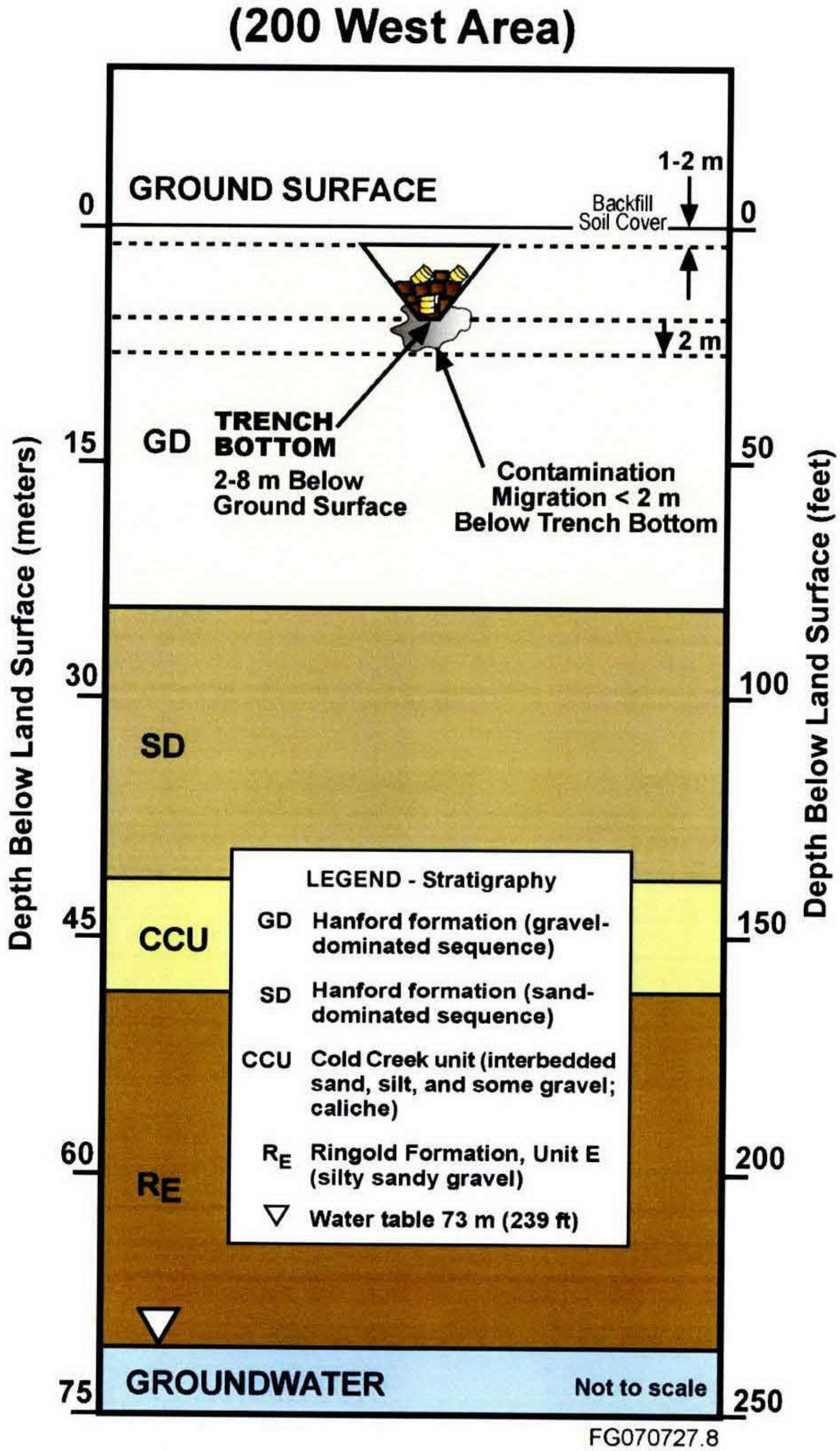

Figure 1-12. Conceptual Contaminant Distribution Model for Bin 4 – Dry Waste Landfills.

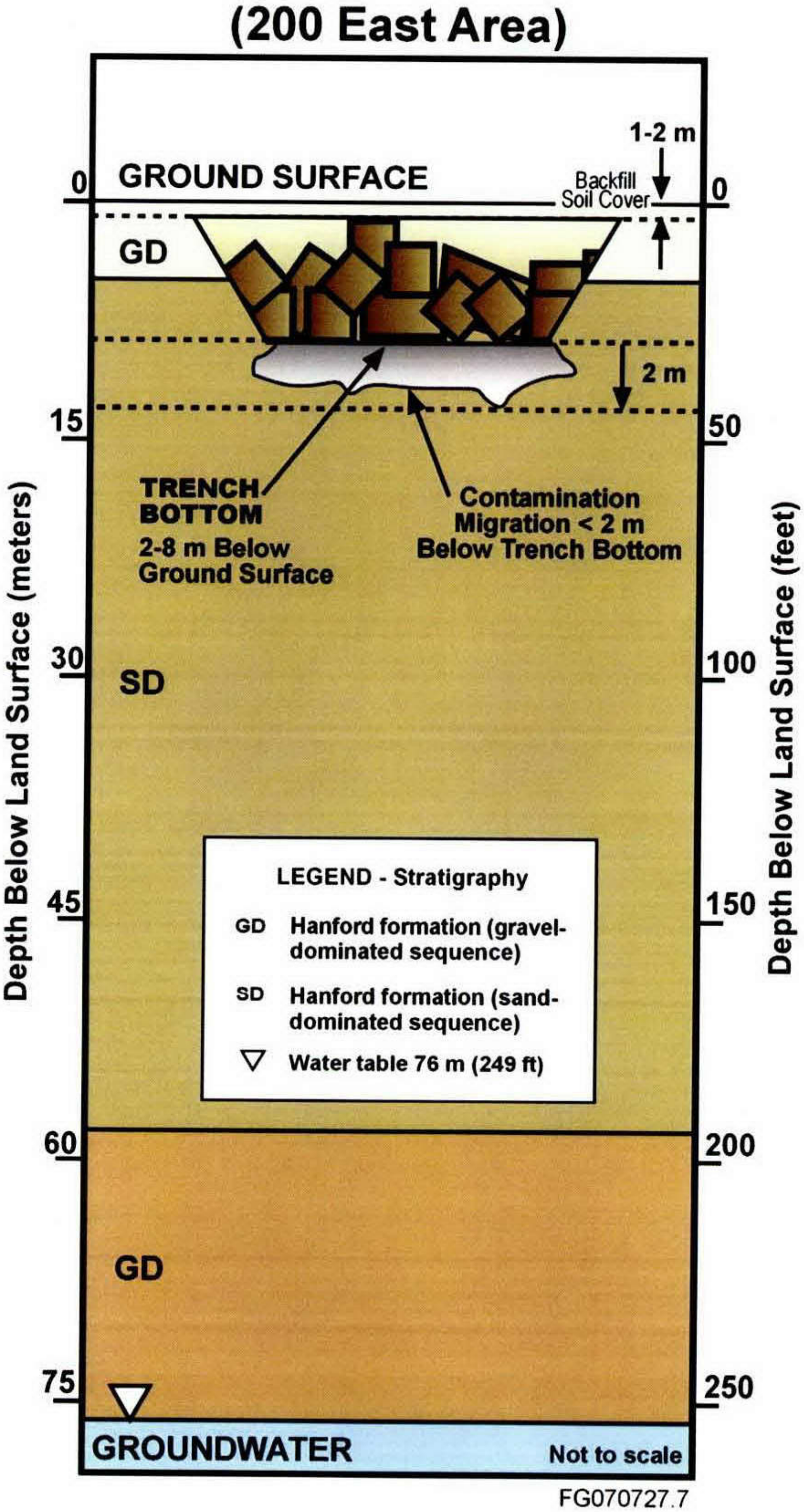

Figure 1-13. Conceptual Contaminant Distribution Model for Bin 5 – Construction Landfills.

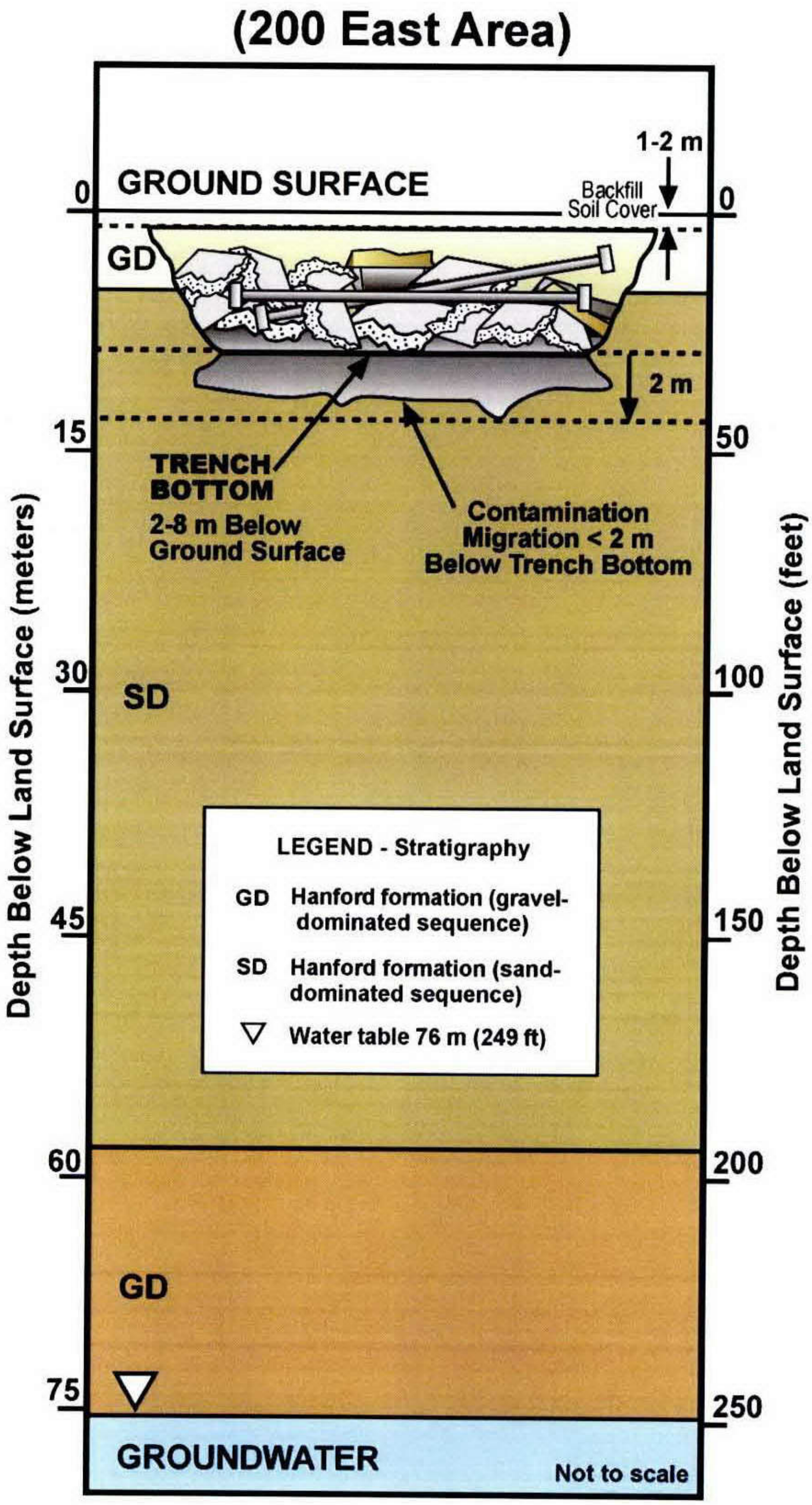

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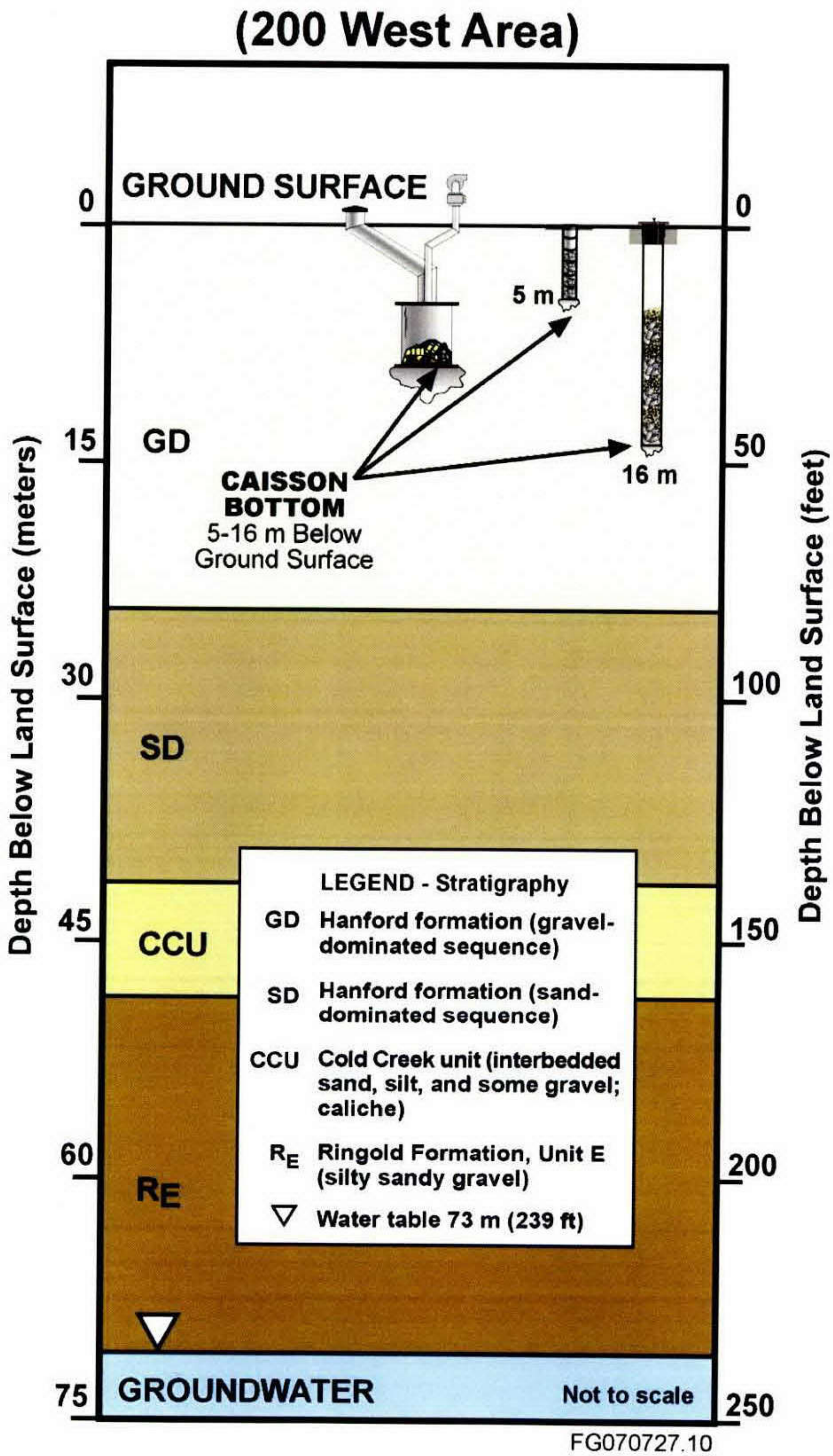
Figure 1-14. Conceptual Contaminant Distribution Model for Bin 6 – Caissons.



1.16 STATEMENT OF THE PROBLEM

Table 1-10 provides a concise statement of the problem.

Table 1-10. Concise Problem Statement.

To refine the conceptual site models, and scope Phase II intrusive characterization activities, additional data are required.

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2.0 STEP 2 – IDENTIFY THE DECISION

The purpose of DQO Step 2 is to define the principal study questions (PSQ) that need to be resolved to address the problems identified in DQO Step 1 and the alternative actions that would result from resolution of the PSQs. The PSQs and alternative actions then are combined into decision statements that express a choice among the alternative actions. The following section presents the PSQs, alternative actions, and resulting decision statements.

2.1 PRINCIPAL STUDY QUESTIONS

The PSQs (Table 2-1) are basic DQO questions that require review of existing measurements or collection of new measurements (e.g., physical, chemical, or radiological data) to resolve the problem statements (Table 1-10). The PSQs for the Phase I-B DQO include the following.

Table 2-1. Principal Study Questions.

PSQ #	Principal Study Question
1	Do metallic objects (e.g., tanks, drums) identified during Phase I-A geophysical investigations contain liquid organics?
2	Do the portions of the landfills that indicated organic vapor detections in Phase I-A contain sources of organic vapors?
3	Do the 218-E-2, 218-E-4, 218-E-9, and 218-W-4A Landfills* contain well-defined boundaries, disturbed soils, and/or dense or metallic materials?
4	Have unique events (rapid snowmelt/ponding conditions or seepage from nearby wastewater ditches) in the landfills caused migration of contaminants away from the buried waste?
5	Do caissons identified in historical documentation as potentially being empty/unused contain buried waste?
6	Do unused portions and annexes of treatment, storage, and/or disposal unit landfills contain buried waste?

*These are the four remaining past-practice landfills that were not surveyed during Phase I-A activities.
PSQ = principal study question.

2.2 ALTERNATIVE ACTIONS

Table 2-2 identifies the alternative actions that could be taken after the PSQs have been resolved. All of the possible actions are listed in Table 2-2.

The DQO process template normally includes a qualitative assessment of the severity of the consequences of taking an alternative action, if it is incorrect. This assessment is performed to assist in later decision making in Step 6 for the selection of a sampling design based on professional judgment or a statistically derived sampling design. Because this is a Phase I-B activity to support future phase DQO processes, the error consequences have no human health, environmental, and political, economic, or legal ramifications. Therefore, severity of the consequences of erroneous alternative actions will not be included in this phase of the DQO process.

Table 2-2. Alternative Actions.

PSQ #	Principal Study Question	Alternative Actions
1	Do metallic objects (e.g., tanks, drums) identified during Phase I-A geophysical investigations contain liquid organics?	1a – If organic vapors are detected, evaluate empirical data against the historical information in the CSMs and refine/update the CSMs as appropriate.
		1b – If organic vapors are not detected, evaluate the need for additional characterization in Phase II.
2	Do the portions of the landfills that indicated organic vapor detections in Phase I-A contain sources of organic vapors?	2a – If organic vapors are detected, evaluate empirical data against the historical information in the CSMs, and refine/update the CSMs as appropriate.
		2b – If organic vapors are not detected, evaluate the need for additional characterization in Phase II.
3	Do the 218-E-2, 218-E-4, 218-E-9, and 218-W-4A Landfills* contain well-defined boundaries, disturbed soils, and/or dense or metallic materials?	3a – If trench boundaries, disturbed soils, and/or dense or metallic materials are detected, evaluate empirical data against the historical information in the CSMs, and refine/update the CSMs as appropriate.
		3b – If trench boundaries, disturbed soils, and/or dense or metallic materials are not detected, CSMs are limited to historical data.
4	Have unique events (rapid snowmelt/ponding conditions or seepage from nearby wastewater ditches) in the landfills caused migration of contaminants away from the buried waste?	4a – If logging provides information regarding moisture and contaminant migration, evaluate empirical data against the historical information in the CSMs, and refine/update the CSMs as appropriate.
		4b – If logging does not provide information regarding moisture and contaminant migration, evaluate the need for additional characterization in Phase II.
5	Do caissons identified in historical documentation as potentially being empty/unused contain buried waste?	5a – If remote camera and radiological surveys of the interiors of the potentially empty/unused caissons do not detect the presence of waste, evaluate the need for additional characterization in Phase II.
		5b – If remote camera and radiological surveys of the interiors of the potentially empty/unused caissons detect the presence of waste, refine/update the CSMs as appropriate, and evaluate the need for additional characterization in Phase II.
6	Do unused portions and annexes of TSD unit landfills contain buried waste?	6a – If historical information reviews, site walkdowns, and/or surface geophysical surveys of unused portions and annexes of TSD unit landfills do not detect the presence of waste, pursue a "rejected" reclassification in WIDS.
		6b – If historical information reviews, site walkdowns, and/or surface geophysical surveys of unused portions and annexes of TSD unit landfills detect the presence of waste, evaluate the need for additional characterization in Phase II.

*These are the four remaining past-practice landfills that were not surveyed during Phase I-A activities.
CSM = conceptual site model.
PSQ = principal study question.
TSD = treatment, storage, and/or disposal (unit).
WIDS = *Waste Information Data System* database.

2.3 DECISION STATEMENTS

Table 2-3 lists each of the six decision statements associated with this project.

Table 2-3. Decision Statements.

DS #	Decision Statement
1	Determine if metallic objects (e.g., tanks, drums) identified during Phase I-A geophysical investigations contain liquid organics. If organic vapors are detected, evaluate empirical data against the historical information in the CSMs, and refine/update the CSMs as appropriate, or alternately, if organic vapors are not detected, evaluate the need for additional characterization in Phase II.
2	Determine if the portions of the landfills that indicated organic vapor detections in Phase I-A contain sources of organic vapors. If organic vapors are detected, evaluate empirical data against the historical information in the CSMs, and refine/update the CSMs as appropriate, or alternately, if organic vapors are not detected, evaluate the need for additional characterization in Phase II.
3	Determine if the 218-E-2, 218-E-4, 218-E-9, and 218-W-4A Landfills* contain well-defined boundaries, disturbed soils, and/or dense or metallic materials. If trench boundaries, disturbed soils, and/or dense or metallic materials are detected, evaluate empirical data against the historical information in the CSMs, and refine/update the CSMs as appropriate, or alternately, if trench boundaries, disturbed soils, and/or dense or metallic materials are not detected, CSMs are limited to historical data.
4	Determine if unique events (rapid snowmelt/ponding conditions or seepage from nearby wastewater ditches) in the landfills caused migration of contaminants away from the buried waste. If logging provides information regarding moisture and contaminant migration, evaluate empirical data against the historical information in the CSMs, and refine/update the CSMs as appropriate, or alternately, if logging does not provide information regarding moisture and contaminant migration, evaluate the need for additional characterization in Phase II.
5	Determine if caissons identified in historical documentation as potentially being empty/unused contain buried waste. If remote camera and radiological surveys of the interiors of the potentially empty/unused caissons do not detect the presence of waste, evaluate the need for additional characterization in Phase II, or alternately, if remote camera and radiological surveys of the interiors of the potentially empty/unused caissons detect the presence of waste, refine/update the CSMs, as appropriate, and evaluate the need for additional characterization in Phase II.
6	Determine if unused portions and annexes of TSD unit landfills contain buried waste. If historical information reviews, site walkdowns, and/or surface geophysical surveys of unused portions and annexes of TSD unit landfills do not detect the presence of waste, pursue a "rejected" reclassification in WIDS, or alternately, if historical information reviews, site walkdowns, and/or surface geophysical surveys of unused portions and annexes of TSD unit landfills detect the presence of potentially regulated waste, evaluate the need for additional characterization in Phase II.

*These are the four remaining past-practice landfills that were not surveyed during Phase I-A activities.
CSM = conceptual site model.
DS = decision statement.
PSQ = principal study question.
TSD = treatment, storage, and/or disposal (unit).
WIDS = *Waste Information Data System* database.

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3.0 STEP 3 – IDENTIFY INPUTS TO THE DECISION

The purpose of DQO Step 3 is to identify the types of data needed to resolve each of the DSs identified in DQO Step 2. The data already may exist or may be derived from computational or surveying/sampling and analysis methods. Analytical performance requirements (e.g., practical quantitation limit [PQL], precision, and accuracy) also are provided in this step for any new data that need to be collected.

3.1 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table 3-1 lists the titles of the tables that follow in Step 3. The paragraphs that follow Table 3-1 provide an introductory description to the remaining tables within this step.

Table 3-1. Inputs to the Decision Tables.

Table Number	Title
3-2	Summary of Nonintrusive Characterization Performed During Phase I-A
3-3	Required Information and Basis – 200 East Area Landfills
3-4	Required Information and Basis – 200 West Area Landfills
3-5	Data-Gap Analysis for Ecology's Items of Interest
3-6	Potentially Appropriate Analytical Measurement Methods
3-7	Field Screening Analytical Performance Requirements

After the Phase I-A DQO process was completed, a 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)* was prepared to guide field surveys. Table 3-2 summarizes the field surveys performed during implementation of the sampling and analysis instruction.

Table 3-2. Summary of Nonintrusive Characterization Performed During Phase I-A. (2 Pages)

Nonintrusive Survey Technique	Landfill
Radiological surveys (MSCM)	218-E-2A, 218-E-5, 218-E-8
Geophysical surveys (GPR, EMI, and TMF)	218-C-9, 218-E-1,218-E-5, 218-E-5A, 218-E-8, 218-E-2A, 218-E-12A, 218-W-1, 218-W-1A, 218-W-2, 218-W-2A, 218-W-3, 218-W-11
Passive organic vapor surveys (EMFLUX*)	218-W-3A, 218-W-3AE, 218-W-4B, 218-W-4C, 218-W-5

Table 3-2. Summary of Nonintrusive Characterization Performed During Phase I-A. (2 Pages)

Nonintrusive Survey Technique	Landfill
Additional records research	218-C-9, 218-E-1, 218-E-8, 218-E-10, 218-E-12A, 218-W-1A, 218-W-2A, 218-W-3, 218-W-3A, 218-W4A, 218-W-4B, 218-W-4C, 218-W-11

*EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.
EMI = electromagnetic induction.
GPR = ground-penetrating radar.
MSCM = mobile surface-contamination monitor.
TMF = total magnetic field.

Tables 3-3 and 3-4 summarize the evaluation of information (data) needs required to resolve each of the DSs. For existing data (both historical and recent empirical), the data have been provided with a qualitative assessment as to whether or not the data are of sufficient quality to resolve the corresponding DSs. Information that supported the qualitative assessment also is included in the tables.

Table 3-5 outlines Ecology's items of interest that were provided to RL and Fluor Hanford during the collaborative discussions held in early 2005. This table provides a description of each item of interest; which intrusive or nonintrusive characterization technique that could be used to attempt to locate these items; and a qualitative analysis of the potential threat posed by each item with respect to human health, work safety, and the environment.

Table 3-6 lists intrusive and nonintrusive survey techniques that may be used in the field and the potential limitations of these techniques. Table 3-7 lists the analytical performance requirements for the intrusive and nonintrusive survey techniques in Table 3-6, as appropriate.

The information summarized in Tables 3-3 and 3-4 are used to determine the landfills that require intrusive or nonintrusive field characterization to be performed. The results of this evaluation of data are presented in Step 7 of this DQO summary report.

3.2 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.

Table 3-3. Required Information and Basis – 200 East Area Landfills. (4 Pages)

Required Data	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-10	218-E-12A	218-E-12B	Basis
Are Available Data of Sufficient Quality to Support CSMs? (Y/N)[a] / Are Additional Data Required to Support CSMs? (Y/N)[a]													
Organic vapor survey data to determine if metal objects (e.g., tanks, drums) identified during Phase I-A characterization activities contain liquid organics.	Y/N	N/Y	Y/N	N/Y	Y/N	N/Y	N/Y	N/Y	Y/N	Y/N	N/Y	Y/N	Applicable to those landfills that showed metallic signatures based on surface geophysical surveys performed during Phase I-A characterization activities.
Organic vapor survey data to determine locations of buried organic liquids.	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Applicable to those landfills that were surveyed for organic vapors as part of Phase I-A characterization activities, and had recorded detection levels above 25 ng/sample.

Table 3-3. Required Information and Basis – 200 East Area Landfills. (4 Pages)

Required Data	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-10	218-E-12A	218-E-12B	Basis
Are Available Data of Sufficient Quality to Support CSMs? (Y/N)[a] / Are Additional Data Required to Support CSMs? (Y/N)[a]													
Surface geophysical survey data to determine landfill/trench boundaries, disturbed soil, and/or dense or metallic materials.	Y/N	Y/N	N/Y	Y/N	N/Y	Y/N	Y/N	Y/N	N/Y	Y/N	Y/N	Y/N	Applicable to the five past-practice landfills that were not surveyed using surface geophysical techniques during Phase I-A characterization activities. All other landfills (TSD unit landfills) that were not surveyed during Phase I-A have the highest quality and quantity of burial records and drawings, and do not require surface geophysical surveys.
Geophysical logging data from existing monitoring wells near landfills.	N/Y	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	N/Y	N/Y	N/Y	Applicable to those landfills that have existing monitoring wells that are available for logging within 50 m (164 ft) of the landfill boundary.

Table 3-3. Required Information and Basis – 200 East Area Landfills. (4 Pages)

Required Data	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-10	218-E-12A	218-E-12B	Basis
Are Available Data of Sufficient Quality to Support CSMs? (Y/N)[a] / Are Additional Data Required to Support CSMs? (Y/N)[a]													
Geophysical logging data to determine stratigraphy, moisture content, and radiological contamination levels beneath the landfills.	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	Applicable to all 200 East Area landfills, because stratigraphy, moisture content, and radiological contamination levels beneath the landfill trenches have not been previously investigated. Those landfills that have documented past occurrences of rapid snowmelt/ponding or seepage of liquid from nearby wastewater ditches will receive additional pushes to determine moisture content and potential vertical contaminant migration.
Remote visual and radiological survey data to determine if caissons identified in historical documentation as being potentially empty/unused contain buried waste.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Not applicable to 200 East Area landfills, because there are no caissons in these landfills that are believed to be empty/unused.

Table 3-3. Required Information and Basis – 200 East Area Landfills. (4 Pages)

Required Data	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-10	218-E-12A	218-E-12B	Basis
Are Available Data of Sufficient Quality to Support CSMs? (Y/N)[a] / Are Additional Data Required to Support CSMs? (Y/N)[a]													
Visual inspection, historical record, and/or surface geophysical survey data to determine if unused portions and annexes of TSD unit landfills contain buried waste.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/Y	N/A	N/Y	Applicable to those landfills that contain portions or annexes that are believed to be unused and free of buried waste.
Gamma and moisture logging data to determine if radiological contaminants have been mobilized beneath the trench bottoms due to past occurrences of rapid snowmelt/ponding or seepage from nearby wastewater ditches.	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/Y	Applicable to those landfills that have documented occurrences of rapid/snowmelt or seepage of liquid from nearby wastewater ditches.

[a] A "no" response to either question does not preclude additional characterization in future phases. The response only applies to Phase I-B.

[b] Although the response to this question is "no," it should be noted that direct pushes will be performed on all landfills to determine stratigraphy, moisture content, and radiological contamination levels.

CSM = conceptual site model.
N/A = not applicable.
TSD = treatment, storage, and/or disposal (unit).

Table 3-4. Required Information and Basis – 200 West Area Landfills. (5 Pages)

Required Data	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-6	218-W-11	Basis
Are Available Data of Sufficient Quality to Support CSMs? (Y/N)[a] / Are Additional Data Required to Support CSMs? (Y/N)[a]														
Organic vapor survey data to determine if metal objects (e.g., tanks, drums) identified during Phase I-A characterization activities contain liquid organics.	N/Y	N/Y	N/Y	N/Y	N/Y	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	N/A	N/Y	Applicable to those landfills that showed metallic signatures based on surface geophysical surveys performed during Phase I-A characterization activities.
Organic vapor survey data to determine locations of buried organic liquids.	Y/N	Y/N	Y/N	Y/N	Y/N	N/Y	N/Y	Y/N	N/Y	N/Y	N/Y	N/A	Y/N	Applicable to those landfills that were surveyed for organic vapors as part of Phase I-A characterization activities, and had recorded detection levels above 25 ng/sample.

Table 3-4. Required Information and Basis – 200 West Area Landfills. (5 Pages)

Required Data	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-6	218-W-11	Basis
Surface geophysical survey data to determine landfill/trench boundaries, disturbed soil, and/or dense material.	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	N/Y	Y/N	Y/N	Y/N	N/A	Y/N	Applicable to the five past-practice landfills that were not surveyed using surface geophysical techniques during Phase I-A characterization activities. All other landfills (TSD unit landfills) that were not surveyed during Phase I-A have the highest quality and quantity of burial records and drawings, and do not require surface geophysical surveys.
Geophysical logging data from existing monitoring wells near landfills.	N/A	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/A	N/Y	N/Y	N/Y	N/Y	N/A	Applicable to those landfills that have existing monitoring wells that are available for logging within 50 m (164 ft) of the landfill boundary.

Table 3-4. Required Information and Basis – 200 West Area Landfills. (5 Pages)

Required Data	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-6	218-W-11	Basis
Geophysical logging data to determine stratigraphy, moisture content, and radiological contamination levels beneath the landfills.	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/Y	N/A	N/Y	Applicable to all 200 East Area landfills, because stratigraphy, moisture content, and radiological contamination levels beneath the landfill trenches have not been previously investigated. Those landfills that have documented past occurrences of rapid snowmelt/ponding or seepage of liquid from nearby wastewater ditches will receive additional pushes to determine moisture content and potential vertical contaminant migration.

Table 3-4. Required Information and Basis – 200 West Area Landfills. (5 Pages)

Required Data	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-6	218-W-11	Basis
Remote visual and radiological survey data to determine if caissons identified in historical documentation as being potentially empty/unused contain buried waste.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/Y	N/Y	N/A	N/A	N/A	N/A	Applicable to landfills containing caissons that are believed to be empty/unused based on historical documentation.
Visual inspection, historical record, and/or surface geophysical survey data to determine if unused portions and annexes of TSD unit landfills contain buried waste.	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/Y	N/A	N/Y	N/A	Applicable to those landfills that contain portions or annexes that are believed to be unused and free of buried waste.
Gamma and moisture logging data to determine if radiological contaminants have been mobilized beneath the trench bottoms due to past occurrences of rapid snowmelt/ponding or seepage of liquid from nearby wastewater ditches.	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/N[b]	N/Y	N/N[b]	N/N[b]	N/Y	N/Y	N/N[b]	N/A	N/N[b]	Applicable to those landfills that have documented occurrences of rapid/snowmelt or seepage of liquid from nearby wastewater ditches.

Table 3-4. Required Information and Basis – 200 West Area Landfills. (5 Pages)

Required Data	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-6	218-W-11	Basis

[a]A "no" response to either question does not preclude additional characterization in future phases. The response only applies to Phase I-B.

[b]Although the response to this question is "no," information is needed from all landfills to better define stratigraphy, moisture content, and radiological contamination levels to support Phase II soil sampling.

CSM = conceptual site model.
N/A = not applicable.
TSD = treatment, storage, and/or disposal (unit).

The items of interest list has been 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 3-5. 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 intrusive and nonintrusive reconnaissance-level radiological, geophysical, and soil-gas surveys in landfill areas not previously addressed in the Phase I-A DQO summary report. The items of interest covered by nonintrusive survey portions of this DQO summary report and associated SAP (to be included in the RI/FS work plan) include suspect caisson locations, D-2 Column from the Plutonium-Uranium Extraction (PUREX) K-Cell, shallow-buried waste, cell cover blocks, potential organic waste, and large tanks.

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.

Items of interest addressed by the Phase I-B DQO summary report are shaded/bolded in Table 3-5. Remaining items of interest may require more intrusive investigations within landfill trenches and will be addressed in later site investigation phases.

Table 3-6 provides a compilation of potentially appropriate analytical measurement methods that may be used during the landfill investigation. Analytical methods shaded/bolded in Table 3-6 are planned for use during Phase I-B investigations. The remaining analytical methods or other methods may be used in subsequent phases, as appropriate. Details regarding targeted items of interest for the Phase I-B investigation will be provided in the SAP (Appendix A of the RI/FS work plan). Additional characterization technologies that may be applicable to this or future DQO processes are detailed in PNNL-16105, *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.*

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.

Table 3-5. Data-Gap Analysis for Ecology's Items of Interest. (7 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 laboratory-packed liquid waste	Plastic gamma scintillators; high-purity germanium detectors; DPT using gamma logging	High-dose-rate laboratory-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 laboratory-packed liquid waste with DPT techniques.	**Low** – Potential threat to human health, worker safety, and/or the environment only if waste is unearthed.
Remote-handled LLW	Plastic gamma scintillators; high-purity germanium detectors; DPT using gamma logging	Remote-handled LLW 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 LLW 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, and/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 using gamma logging GPR; EMI; TMF DPT using 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, and/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 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 the effectiveness of these techniques.**	**Low – Historical information indicates that these caissons did not receive waste. Characterization will focus on locating and verifying that the caissons are empty.**

Table 3-5. Data-Gap Analysis for Ecology's Items of Interest. (7 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
Burial boxes containing remote-handled and contact-handled LLW	Plastic gamma scintillators; high-purity germanium detectors; DPT using gamma logging	Burial boxes containing remote-handled LLW 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 LLW difficult. Contact-handled LLW, which is expected to have a lower dose rate than remote-handled LLW, 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, and/or the environment only if remote-handled waste is unearthed. Contact-handled LLW is expected to have a significantly lower dose rate and therefore would not pose a threat to human health, worker safety, and/or the environment.
Areas of highly contaminated tumbleweeds	Plastic gamma scintillators; high-purity germanium detectors; DPT using 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 likely were 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 safety, and/or the environment.
Fuel element clips and spacers	Plastic gamma scintillators; high-purity germanium detectors; DPT using 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 safety, and/or the environment.
Irradiated fuel elements	Plastic gamma scintillators; high-purity germanium detectors; DPT using 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, and/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.

Table 3-5. Data-Gap Analysis for Ecology's Items of Interest. (7 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
Ten large concrete burial boxes of soil from the S Tank Farm	GPR, EMI, TMF Plastic gamma scintillators; high-purity germanium detectors; DPT using 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 are not expected to be issues.
Reactor fuel waste	Plastic gamma scintillators; high-purity germanium detectors; DPT using 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 safety, and/or the environment.
Drums of test reactor and isotope production fuel waste	Plastic gamma scintillators; high-purity germanium detectors; DPT using 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 safety, and/or the environment.
Areas of the landfills that were flooded with standing water[b]	**Electrical-resistance technologies (ERT); records review** **DPT moisture logging**	**Location in landfills is 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[c]	**ERT; records review** **DPT moisture logging**	**Location in landfills is 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. However, vadose-zone plumes resulting from these previous pond areas will be managed under a separate operable unit.**

Table 3-5. Data-Gap Analysis for Ecology's Items of Interest. (7 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**
Suspect TRU or contact-handled LLW-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. An interface between the M-091 Program and the 200-SW-2 Operable Unit has been established to share data and lessons learned.
Pre-1970s transuranically contaminated material	Records review; xenon daughter product detection; copper foil activation; Am-241 detection; passive neutron detection; prompt fission neutron	Location in landfills is not likely to be confirmed using nonintrusive sampling/surveying techniques. Xenon daughter product detection, copper foil activation, passive neutron detection, prompt fission neutron, 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 safety, and/or the environment. May be an inadvertent intruder concern; however, institutional controls will be in place.
D-2 Column from PUREX K Cell[b]	**GPR, EMI, TMF, DPT using gamma logging**	**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 mobile 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, and/or the environment.**
Shallow-buried waste[b]	**GPR, EMI, TMF; records review** **Plastic gamma scintillators; high-purity germanium detectors; DPT using 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.**

Table 3-5. Data-Gap Analysis for Ecology's Items of Interest. (7 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
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 is 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, VPUs	Plastic gamma scintillators; high-purity germanium detectors; DPT using gamma logging GPR, EMI, TMF	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, and/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 using 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, and/or the environment only if waste is unearthed.
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 safety, and/or the environment.**

Table 3-5. Data-Gap Analysis for Ecology's Items of Interest. (7 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
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 organics 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 were 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 Hanford, Inc., to delineate the tritium groundwater plume at the 618-11 Burial Ground (see RL, 2001, 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.
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 mobile 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 safety, and/or the environment. 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.

Table 3-5. Data-Gap Analysis for Ecology's Items of Interest. (7 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
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]Bolded/shaded 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.

[c]The T Pond site will be characterized by another operable unit. This site is included in this table for completeness only.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*.

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.
PFP = Plutonium Finishing Plant.
PNNL = Pacific Northwest National Laboratory.
PUREX = Plutonium-Uranium Extraction Plant.
TMF = total magnetic field.
TRU = Radioactive waste as defined in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1*.
TSD = treatment, storage, and/or disposal (unit).
VPU = vertical pipe unit.

Table 3-6. Potentially Appropriate Analytical Measurement Methods. (3 Pages)

Variable	Potentially Appropriate Measurement Method [a]	Possible Limitations or Reservations
Radiological screening[b]	**Static HPGe detectors.**	**Because of shielding, buried sources may be difficult to detect. [c]**
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 were found to indicate 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 the 618-11 Burial Ground (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.
Metallic objects, disturbed soil, trench/landfill boundaries[b]	**Ground penetrating radar (GPR) [d]**	**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[b]	**EMI [d]**	**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. Nearby buildings and utilities can cause interferences.**
Metallic objects, disturbed soil, trench/landfill boundaries[b]	**TMF [d]**	**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[b]	**Passive soil gas**	**Passive soil gas measurement is a method whereby a hydrophobic collector (e.g., EMFLUX or GORE-SORBER) is placed on the ground surface or buried in a shallow hole with direct exposure to the soils for 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)	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)	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.

Table 3-6. Potentially Appropriate Analytical Measurement Methods. (3 Pages)

Variable	Potentially Appropriate Measurement Method [a]	Possible Limitations or Reservations
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)	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 gas chromatograph/ mass spectrometer	Instrument use requires extensive training. Capital cost and setup is high; operational cost is moderate. Requires collection of a sample-gas volume.
VOCs	MIRAN SapphiIRe Ambient Air Analyzer	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[b]	**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 more effective 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 also may 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 neutron sources or generators.**

Table 3-6. Potentially Appropriate Analytical Measurement Methods. (3 Pages)

Variable	Potentially Appropriate Measurement Method [a]	Possible Limitations or Reservations
Areas of known flooding or past use as a pond[b]	**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 often are directly correlated to contaminant concentrations, sediment grain size, composition, or subsurface structural features. For this project, the moisture profile may be useful to help determine the location of contamination and/or the location of the ditch and to establish geologic conditions to support contaminant fate and transport modeling. It also may be correlated to reflections identified in GPR surveys.**

[a] Other methods may be identified and implemented in conjunction with technology development.
[b] 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.
[c] 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.
[d] Details of geophysical surveys performed in 2005 are contained in D&D-28379 and surveys performed in 2006 in D&D-30708.
B&K is a trademark of Brüel and Kjær, S&V, Nærum, Denmark.
EM34 and EM61 are trademarks of Geonics Limited, Mississauga, Ontario, Canada.
EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.
Foxboro and OVA 128 are trademarks of The Foxboro Company, Foxboro, Massachusetts.
GORE-SORBER is a trademark of W. L. Gore and Associates, San Francisco, California.
MIRAN and the SapphIRe Ambient Air Analyzer are registered trademarks of Thermo Electron Corporation, Franklin, Massachusetts.
Photovac 10S Plus is a trademark of Photovac, Inc., Waltham, Massachusetts.

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.*
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.
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.

Table 3-7. Field Screening and Laboratory Analytical Performance Requirements. (2 Pages)

Variable	Method	Target Detection Limit	Precision	Accuracy
Field Screening				
Metallic objects, disturbed soil, trench/landfill boundaries	Ground penetrating radar	+/- 1 meter	+/-10%	90 – 110%
Metallic objects, disturbed soil, trench/landfill boundaries	Electromagnetic induction	+/- 1 meter	+/-10%	90 – 110%
Metallic objects, disturbed soil, trench/landfill boundaries	Total magnetic field	+/- 1 meter	+/-10%	90 – 110%

Table 3-7. Field Screening and Laboratory Analytical Performance Requirements. (2 Pages)

Variable	Method	Target Detection Limit	Precision	Accuracy
Gamma emissions	Sodium-iodide detector logging	Total gamma activity including background. Minimum detectable activity associated with an anomaly depends on background level and count time. Precision also depends on count rate and count time. Accuracy unspecified.		
Fission products	Borehole spectral gamma logging with HPGe detector	1 pCi/g [a]	+/-20% [b]	[d]
Transuranics	Borehole passive neutron logging	This log is qualitative only [c]		
Transuranics	Borehole passive-spectral gamma methods	50 to 100 nCi/g [a]	+/-20% [b]	[d]
Transuranics	Borehole active neutron logging	10 nCi/g [a]	+/-20% [b]	[d]
Areas of known flooding or past use as a pond	Borehole neutron-neutron moisture logging	1% volumetric moisture content	+/- 20% [b]	[d]
Laboratory Analytical				
Organic vapors	Gas chromatograph/ mass spectrometer (EMFLUX or GORE-SORBER)	Compound specific	+/- 25%	75 – 125%

[a] Actual detection limit depends on specific radionuclide, count time, and background level. Minimum detectable level can be calculated and reported for each data point for specific radionuclides.

[b] Based on net activity (gross – background) from pre- and post-run verification source. Actual precision is assessed through repeat sections over at least 10% of the logged interval. For each measurement, counting error is reported in concentration units.

[c] Any detectable neutron activity is an indication of plutonium or other TRU. Detector may be subject to interference in zone of extreme gamma activity. Precision can be estimated from repeat sections, but accuracy is unknown.

[d] Logging detectors are calibrated assuming an infinite, uniform distribution of the target radionuclide or parameter. In practice, most of the zones of interest occur as thin beds. This means that there will be a degree of error, depending on the degree to which actual conditions deviate from calibration assumptions. Although the volume of investigation is not precisely defined, logs provide a bulk average value over a volume on the order of 0.1 m^3 (4 ft^3), whereas laboratory analyses of soil samples typically are conducted on volumes of 500 mL (0.0005 m^3, or 0.02 ft^3). Therefore, any definition of "accuracy" with respect to laboratory samples must take into account the degree of spatial variability with respect to sample volumes.

EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.
GORE-SORBER is a trademark of W. L. Gore and Associates, San Francisco, California.

HPGe = high purity germanium.
ppmv = parts per million by volume.
TRU = Radioactive waste as defined in DOE G 435.1-1, *Implementation Guide for Use with DOE M 435.1-1.*

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4.0 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

The primary objectives of DQO Step 4 are to identify the population of interest, define the spatial and temporal boundaries that apply to each DS, establish the scale of decision making, and identify any practical constraints (i.e., hindrances or obstacles) that must be taken into consideration in the sampling design. Implementing this step ensures that the sampling design will result in the collection of data that reflect the condition of the sites under investigation.

4.1 POPULATION OF INTEREST

Before defining the spatial and temporal boundaries of the site under investigation, first it is necessary to clearly define the populations of interest that apply for each DS (Table 2-3). The intent of Table 4-1 is to identify the attributes that make up each population of interest by stating them in a way that makes the focus of the study unambiguous.

Table 4-1. Characteristics that Define the Populations of Interest.

DS #	Populations of Interest	Characteristics
1	Metallic objects (e.g., tanks, drums) identified during Phase I-A characterization activities potentially containing organic liquids.	Presence of organic vapors associated with metallic objects (e.g., tanks, drums).
2	Vapor-sample locations with elevated levels of organic vapors identified during Phase I-A characterization activities.	Presence of organic vapors associated with previous vapor detections.
3	Physical boundaries of the landfills/trenches, disturbed soil, and/or dense or metallic materials.	Physical boundaries, disturbed soil, and/or dense or metallic materials in the landfills.
4	Areas of past occurrences of rapid snowmelt/ponding or seepage from nearby wastewater ditches potentially causing migration of contaminants away from the buried waste.	Elevated levels of soil moisture and/or radiological contamination beneath the landfills.
5	Caissons that are noted in historical documentation as potentially unused/empty.	Presence or absence of buried waste in caissons believed to be free of buried waste.
6	Annexes and portions of landfills that are noted in historical documentation as unused.	Presence or absence of buried waste in areas of landfills believed to be free of buried waste.

DS = decision statement.

4.2 GEOGRAPHIC BOUNDARIES

Table 4-2 identifies the geographic boundaries that apply to each DS. Limiting the geographic boundaries of the study area ensures that the investigation does not expand beyond the original scope of the task.

Table 4-2. Geographic Boundaries of the Investigation.

DS #	Geographic Boundaries of the Investigation
All	The geographic boundaries for the investigation are the boundaries of the landfills/trenches, including the vadose zone.

DS = decision statement.

4.3 ZONES WITH HOMOGENEOUS CHARACTERISTICS

When appropriate, the population is divided into zones that have relatively homogeneous characteristics. The DQO team must systematically evaluate process knowledge, historical data, and waste-site configurations to present evidence of a logic that supports alignment of the population into zones with homogeneous characteristics. Table 4-3 identifies the zones with homogeneous characteristics.

Table 4-3. Landfill Trench Zones with Homogeneous Characteristics. (2 Pages)

DS #	Population of Interest	Landfill Trench Zone	Homogeneous Characteristic Logic
1	Metallic objects (e.g., tanks, drums) identified during Phase I-A characterization activities potentially containing organic liquids.	Landfill trench zones noted in Phase I-A geophysical surveys as containing metallic objects.	Zones contain metallic objects (e.g., tanks, drums) that could contain organic liquids.
2	Vapor-sample locations with elevated levels of organic vapors identified during Phase I-A characterization activities.	Landfill trench zones identified in Phase I-A with detectable results from passive vapor samplers.	General locations of potential sources of organic liquids identified in Phase I-A.
3	Physical boundaries of the landfills/trenches, disturbed soil, and/or dense or metallic materials.	Landfill trench zones where boundaries of landfills/trenches, disturbed soil, and/or dense or metallic materials are identified in historical documentation.	Historical records of physical boundaries, disturbed soil, and/or dense or metallic materials that may or may not be present.

Table 4-3. Landfill Trench Zones with Homogeneous Characteristics. (2 Pages)

DS #	Population of Interest	Landfill Trench Zone	Homogeneous Characteristic Logic
4	Areas of past occurrences of rapid snowmelt/ponding or seepage from nearby wastewater ditches potentially causing migration of contaminants away from the buried waste.	Zones beneath the landfill trenches that may contain elevated soil moisture or radiological contaminants.	Historical records of past occurrences of rapid snowmelt/ponding or seepage from nearby wastewater ditches that could affect migration of contaminants into the vadose zone beneath the trenches.
5	Caissons that are noted in historical documentation as potentially unused/empty.	Caissons that are noted in historical documentation as potentially unused/empty.	Historical records of caissons expected to be unused/empty.
6	Annexes and portions of landfills that are noted in historical documentation as unused.	Annexes and portions of the 218-W-4C, 218-E-10, and 218-E-12B Landfills.	Historical records of annexes and portions of landfills expected to be unused.

DS = decision statement.

4.4 TEMPORAL BOUNDARIES

Table 4-4 identifies temporal boundaries that may apply to each DS. The temporal boundary refers to the timeframe over which each DS applies (e.g., number of years) and when the data optimally should be collected (e.g., season, time of day, weather conditions).

Table 4-4. Temporal Boundaries of the Investigation.

DS #	Timeframe	When to Collect Data
All	Not applicable	Seasonal or process-related limitations include the following. • Collection of organic vapors is most effective if collection units are left in place for at least 3 days to take advantage of daily changes in barometric pressure. • Precipitation events are not likely to affect organic sampling unless the soil becomes saturated to the point that vapor cannot pass through the soil. • Geophysical surveys should be avoided during times of snow accumulation.

DS = decision statement.

4.5 SCALE OF DECISION MAKING

In Table 4-5, the scale of decision making has been defined for each DS. The scale of decision making is defined by joining the population of interest and the geographic and temporal boundaries of the area under investigation.

Table 4-5. Scale of Decision Making. (2 Pages)

DS #	Population of Interest	Geographic Boundary	Temporal Boundary		Spatial Scale of Decision Making
			Timeframe	When to Collect Data	
1	Metallic objects (e.g., tanks, drums) identified during Phase I-A characterization activities potentially containing organic liquids.	The geographic boundaries for the investigation are the boundaries of the landfills/trenches, including the vadose zone.	N/A	See Table 4-4.	Individual landfill/ trench locations identified in Phase I-A geophysical surveys as containing metallic objects.
2	Vapor-sample locations with elevated levels of organic vapors identified during Phase I-A characterization activities.	The geographic boundaries for the investigation are the boundaries of the landfills/trenches, including the vadose zone.	N/A	See Table 4-4.	Individual landfill/ trench locations identified in Phase I-A with detectable results from passive vapor samplers.
3	Physical boundaries of the landfills/ trenches, disturbed soil, and/or dense or metallic materials.	The geographic boundaries for the investigation are the boundaries of the landfills/trenches, including the vadose zone.	N/A	See Table 4-4.	Individual landfill/ trench locations with boundaries, disturbed soils, and/or dense or metallic materials identified in historical documentation.
4	Areas of past occurrences of rapid snowmelt/ponding or seepage from nearby wastewater ditches potentially causing migration of contaminants away from the buried waste.	The geographic boundaries for the investigation are the boundaries of the landfills/trenches, including the vadose zone.	N/A	See Table 4-4.	Vadose zone soils beneath landfills/ trenches with potential for elevated soil moisture levels and/or detectable radiological contaminants from snowmelt/ponding, or seepage from nearby wastewater ditches.
5	Caissons that are noted in historical documentation as potentially unused/ empty.	The geographic boundaries for the investigation are the boundaries of the landfills/trenches, including the vadose zone.	N/A	See Table 4-4.	Caissons noted in historical documentation as potentially unused/empty.

Table 4-5. Scale of Decision Making. (2 Pages)

DS #	Population of Interest	Geographic Boundary	Temporal Boundary		Spatial Scale of Decision Making
			Timeframe	When to Collect Data	
6	Annexes and portions of landfills that are noted in historical documentation as unused.	The geographic boundaries for the investigation are the boundaries of the landfills/trenches, including the vadose zone.	N/A	See Table 4-4.	Annexes and portions of landfills noted in historical documentation as not containing waste.

DS = decision statement.
N/A = not applicable.

4.6 PRACTICAL CONSTRAINTS

Table 4-6 identifies the practical constraints that may impact the data collection. These constraints include physical barriers, difficult sample matrices, or other applicable conditions that will need to be taken into consideration in the design and scheduling of the sampling program.

Table 4-6. Practical Constraints on Data Collection. (2 Pages)

<u>Sampling/Surveying</u>

- Nonintrusive and intrusive investigation techniques have limitations, as discussed in Tables 3-5 and 3-6, that may prevent their use at certain sites and with particular analytes.
- Soil matrices may render data meaningless for certain nonintrusive survey techniques (e.g., ground-penetrating radar is affected by the reflection from fly ash that was used for surface stabilization on some trenches/landfills).
- Contamination transferred as a result of biological activities may be indistinguishable from buried waste without further investigation.
- Shielding provided by the soil cover can limit the usefulness of some nonintrusive methods, because results may be skewed by the type and quantity of cover present.
- Soil vapor can migrate laterally and vertically within the vadose zone. Barometric pumping also may affect soil-vapor sample collection. Soil-vapor sampling may produce false negative results or transient results. The known carbon tetrachloride plume in the 200 West Area might confound the nonintrusive measurements in that area.
- Certain soil types may prevent direct-push techniques from reaching the targeted depth.
- The presence of above- and below-ground utilities in the vicinity of the landfills may limit access to some areas during fieldwork activities.
- The presence of pyrophoric materials in the buried waste may cause worker safety issues if these materials are disturbed during intrusive sampling activities.
- The presence of high-activity zones in some areas of the landfills may prevent access to these areas due to worker safety concerns.

Table 4-6. Practical Constraints on Data Collection. (2 Pages)

Site Access
• Topography and graded surfaces may constrain sampling/surveying locations.
• Access to sites may be constrained for issues such as worker health and safety, security restrictions, cultural, and/or infrastructure intrusion. No-walk and no-drive zones (due to subsidence potential) are known to exist in the 200-SW-2 Operable Unit landfills.
• Overlapping project work may limit access to some locations.
• The potential for collapse of burial boxes or non-standard containers may restrict worker and equipment access.

5.0 STEP 5 – DEVELOP A DECISION RULE

The purpose of DQO Step 5 initially is to define the statistical parameter of interest (i.e., mean or 95 percent upper confidence level) that will be used for comparison against the action level. The statistical parameter of interest specifies the characteristic or attribute that the decision maker would like to know about the population. DQO Step 5 also identifies the final action level for each of the COPCs. When this is established, a decision rule (DR) is developed for each DS in the form of an "IF…THEN…" statement that incorporates the parameter of interest, the scale of decision making, the action level, and the alternative actions that would result from resolution of the decision. Note that the alternative actions and the scale of decision making were identified earlier in DQO Steps 2 and 4, respectively.

5.1 INPUTS NEEDED TO DEVELOP DECISION RULES

Tables 2-3 and 5-1 present the information needed to formulate the DRs identified in Section 5.2. This information includes the DSs and alternative actions identified earlier in DQO Step 2, the scale of decision making identified in DQO Step 4, the statistical parameter of interest, and the detection limits for each of the COPCs.

Table 5-1. Inputs Needed to Develop Decision Rules. (2 Pages)

DS #	Population of Interest	Parameter of Interest	Detection Limit
1	Metallic objects (e.g., tanks, drums) identified during Phase I-A characterization activities potentially containing organic liquids.	Maximum detected sample value.	25 ng/sample*
2	Vapor-sample locations with elevated levels of organic vapors identified during Phase I-A characterization activities.	Maximum detected sample value.	25 ng/sample*
3	Physical boundaries of the landfills/trenches, disturbed soil, and/or dense or metallic materials.	Definable trench boundaries, disturbed soils, and/or dense or metallic materials.	N/A; action levels for the physical boundaries of the landfills/trenches, disturbed soils, and/or dense or metallic materials are the same as the parameter of interest.
4	Areas of past occurrences of rapid snowmelt/ponding or seepage from nearby wastewater ditches potentially causing migration of contaminants away from the buried waste.	Detectable moisture.	Moisture levels above estimated normal soil moisture levels for the Hanford Site.

Table 5-1. Inputs Needed to Develop Decision Rules. (2 Pages)

DS #	Population of Interest	Parameter of Interest	Detection Limit
5	Caissons that are noted in historical documentation as potentially unused/empty.	Each potentially unused/ empty caisson.	Waste detectable by visual or radiological survey.
6	Annexes and portions of landfills that are noted in historical documentation as unused.	Each grid unit.	Visually detected waste.

*Detection limit provided by manufacturers' specification.
DS = decision statement.
N/A = not applicable.

5.2 DECISION RULES

Table 5-2 presents waste-site DRs that correspond to each of the DSs identified in Table 2-3.

Table 5-2. Decision Rules. (2 Pages)

DS #	Decision Rule
1	If the true maximum (as estimated by the maximum detected sample value) of the organic vapors in surface samples in the vicinity of metallic objects (e.g., tanks, drums) identified during Phase I-A geophysical investigations from the landfills exceeds 25 ng/sample, then map out the locations and evaluate empirical data against the historical information in the CSMs, refine/update CSMs as appropriate, and evaluate the need for further characterization in Phase II. Otherwise, evaluate the need for further characterization in Phase II.
2	If the true maximum (as estimated by the maximum detected sample value) of the organic vapors in surface samples from the landfills exceeds 25 ng/sample, then map out the locations and evaluate empirical data against the historical information in the CSMs, refine/update CSMs as appropriate, and evaluate the need for further characterization in Phase II. Otherwise, evaluate the need for further characterization in Phase II.
3	If individual surface geophysical survey results performed on the landfills show definable trench boundaries, disturbed soils, and/or dense or metallic materials using interpretive assessment methods in conjunction with historical records, then map out the indicated presence of boundaries, disturbed soils, and/or dense or metallic materials and evaluate empirical data against the historical information in the CSMs, refine/update CSMs as appropriate, and evaluate the need for further characterization in Phase II. Otherwise, the CSMs are limited to historical data.
4	If individual geophysical logging locations show that unique events (rapid snowmelt/ponding conditions or seepage from nearby wastewater ditches) in the landfills caused soil moisture levels above estimated normal soil moisture levels for the Hanford Site using interpretive assessment methods in conjunction with historical logging results, then map out the data and evaluate empirical data against the historical information in the CSMs, refine/update CSMs as appropriate, and evaluate the need for further characterization in Phase II. Otherwise, evaluate the need for further characterization in Phase II.

Table 5-2. Decision Rules. (2 Pages)

DS #	Decision Rule
5	If radiological and remote camera surveys indicate the presence of waste within each potentially unused/empty caissons, then map out indications of waste and evaluate empirical data against the historical information in the CSMs, refine/update CSMs as appropriate, and evaluate the need for further characterization in Phase II. Otherwise, evaluate the need for further characterization in Phase II.
6	If each grid unit within unused portions and annexes of treatment, storage, and/or disposal unit landfills is verified to be free of buried waste using nonintrusive or intrusive characterization techniques, then pursue a "rejected" reclassification in WIDS. Otherwise, evaluate the need for additional characterization in Phase II.

CSM = conceptual site model.
DS = decision statement.
WIDS = *Waste Information Data System* database.

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6.0 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

Because analytical data only can estimate the true condition of the site under investigation, decisions that are made based on measurement data potentially could be in error (i.e., decision error). For this reason, the primary objective of DQO Step 6 is to determine which DSs (if any) require a statistically based sample design. For those DSs requiring a statistically based sample design, DQO Step 6 defines tolerable limits on the probability of making a decision error.

6.1 STATISTICAL VERSUS NONSTATISTICAL SAMPLING DESIGN

Table 6-1 provides a summary of the information used to support the selection between a statistical versus a nonstatistical sampling design for each DS. The factors that were taken into consideration in making this selection included the timeframe over which each of the DSs applies, the qualitative consequences of an inadequate sampling design, and the accessibility of the site if resampling is required.

Table 6-1. Statistical Versus Nonstatistical Sampling Design.

DS #	Timeframe (Years)	Qualitative Consequences of Inadequate Sampling Design (Low/Moderate/ Severe)	Resampling Access After Remedial Investigation (Accessible/Inaccessible)	Proposed Sampling Design (Statistical/ Nonstatistical)
All	Not applicable	Low	Accessible	Nonstatistical

DS = decision statement.

6.2 NONSTATISTICAL DESIGNS

A biased (or focused) sampling approach, based on the results of a historical-records search, is considered appropriate for the 25 landfills, including caissons, which are the subject of this DQO process. Field sampling will be focused on those areas that require additional data to refine the CSMs, areas where discrepancies in historical records have been noted, and areas that may contain items of interest.

Reconnaissance investigation and site-screening investigations require knowledge of the burial sites (historical data) and involve intentional sample biasing; i.e., collection of samples from "hot spots" and/or worst-case conditions. Waste packaging, accuracy of historical data, and the impact of the hydrologic system on the buried waste sites, define the sampling approach.

The "gray region" and tolerable limits on decision error will not be developed in this DQO process, because they only apply to statistical sampling designs. The nature of the waste sites to be investigated supports the use of focused sampling, as identified in Ecology 94-49, *Guidance on Sampling and Data Analysis Methods*. This guidance document defines "focused sampling" as selective sampling of areas where potential or suspected contaminants reliably can be expected to be found using nonintrusive or intrusive survey techniques. This guidance, coupled with the comprehensive historical-records search, will serve to focus the sampling to those areas that lack sufficient information.

7.0 STEP 7 – OPTIMIZE THE DESIGN

7.1 PURPOSE

The purpose of DQO Step 7 is to develop the most effective sampling/characterization design for generating data to support decisions.

This DQO is limited to mostly nonintrusive sampling/characterization methods, with limited intrusive methods. When an optimal design is being determined, the following activities should be performed.

1. Review the DQO outputs from the previous DQO steps and the existing environmental data.
2. Develop general data-collection design alternatives.
3. Select the sampling design (e.g., techniques, locations, or numbers/volumes) that most cost effectively satisfies the project's goals.
4. Document the operational details and theoretical assumptions of the selected design.

7.2 CHARACTERIZATION/SAMPLING APPROACH

The following discussion presents the approach that will be used to characterize the 200-SW-2 OU sites listed in Table 1-1 during Phase I-B.

Characterization Activities

The sampling design for the 25 landfills includes the following activities.

- Passive Soil-Vapor Surveys: If the data for an individual site indicate a strong potential for organic-liquid constituents to have been disposed of, a systematic sampling approach will be applied to evaluate the presence of these liquids. Specific areas within the landfills may be screened for volatile organic chemicals using passive soil-gas surveys (e.g., EMFLUX[8] or GORE-SORBER[9]). The results of the surveying will be recorded for use in characterizing the landfills in conjunction with the other samples/surveys.
- Surface Geophysical Surveys: For those sites that do not have well-defined boundaries, geophysical surveys may be used to better identify the physical boundaries of the landfills and trenches. The results of the surveying will be recorded for use in characterizing the landfills in conjunction with the other samples/surveys. Geophysical

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[8] EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.

[9] GORE-SORBER is a trademark of W. L. Gore and Associates, San Francisco, California.

surveys also may be used to confirm the presence of large metallic objects disposed of in the landfills, depth of soil cover, depth to trench bottom, identification of voids in trenches, and differentiation between waste container types.

- Downhole Geophysical Logging: Logging data from existing monitoring wells will be reviewed for applicability to 200-SW-2 OU landfills. Information regarding soil moisture content with depth, site stratigraphy, and the presence of radionuclides or other contaminants is of particular interest in support of efforts to determine the nature and extent of contamination.

- Direct-Push Technologies (DPT) and Logging: DPT and logging use a pushing method, such as a diesel hammer, hydraulic hammer, cone penetrometer, or GeoProbe, to penetrate the vadose zone to obtain downhole geophysical data. Logging, as described in Section 7.4.2.1, will be performed within the DPT casings.

- Intrusive Inspection of the Interiors of Caissons: Radiological screening of caisson interiors will be conducted in addition to remote camera inspections using a fiber-optic camera or an equivalent. These intrusive inspections will be used to investigate those caissons that are believed to be unused based on historical documentation. Caissons to be investigated include those 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.

- Visual Inspections and Historical Information Reviews for Unused Portions of Landfills: The historical data and available records for the annexes and unused portions of Landfills 218-E-12B, 218-E-10, and 218-W-4C will be reviewed to evaluate the available information regarding conditions at these unused sites. This historical information review will be coupled with visual inspections to confirm the information that no waste has been disposed of at these sites. Additional review of potentially available historical records may be performed.

7.3 SAMPLING OBJECTIVES

The PSQs identified in Table 2-1 are used to develop sampling objectives. The objective of the sampling design is to provide the appropriate quantity and quality of data required to allow development of a baseline risk assessment, and to focus future-phase of intrusive investigations in support of an evaluation of each remedial-action alternative with respect to the nine CERCLA criteria in a feasibility study.

In DQO Step 3, Tables 3-3 and 3-4, it was concluded that the historical characterization data available for a portion of the landfills met the data quality needs for this early phase of the RI/FS process. The project characterization objectives were identified in Section 1.3.

1. Determine intrusive and nonintrusive techniques that can be used to locate and identify targeted buried waste.

2. Verify select information obtained from historical records through intrusive and nonintrusive survey methods.

3. Identify locations in the landfills that can be targets of additional intrusive characterization in Phase II.

7.4 SAMPLING DESIGN/DATA-COLLECTION TECHNIQUES

A variety of sample methods and measurements may be applicable to data-collection activities identified for Phase I-B characterization. The data needs identified through this DQO require sampling and surveys, including the following:

- Passive soil vapor
- Surface geophysics
- Logging of existing wells
- Direct pushes
- Radiological surveys
- Visual inspections.

This DQO summary report includes a range of data-collection techniques that will be used to obtain further characterization information. Data-collection techniques used will be both intrusive (i.e., penetrate the vadose zone deeper than 30 cm [1 ft]) and nonintrusive. The following subsections present intrusive and nonintrusive techniques that will be used under this DQO.

7.4.1 Nonintrusive Data-Collection Techniques

Nonintrusive techniques include a broad range of geophysical, radiological, and field-screening applications that can provide data on radionuclides, physical parameters, chemicals, vapors, and other characteristics that add to the understanding of the nature and extent of contamination. Analytical performance requirements for nonintrusive data-collection techniques can be found in Table 3-7.

7.4.1.1 Passive Soil-Vapor Surveys

Passive soil-vapor surveys will be used to screen the landfills for the presence of volatile organic compounds. Results will be used to provide a qualitative indication of contamination in the landfills and determine the general location of waste packages that may contain liquid organics that have breached their containment.

The utility of passive soil-vapor surveys is directly proportional to their accuracy in reflecting and representing changes in the subsurface concentrations of source compounds. Passive soil-vapor surveys are collected from the vapor phase emanating from the source. The vapor phase is merely a fractional trace of the source; therefore, the units used in reporting detection values from passive soil-vapor surveys are smaller than those employed for source compound concentrations.

Possible impacts from the regional carbon tetrachloride plume in the 200 West Area may affect survey results from within the landfills. However, later phases of intrusive characterization beneath the trench bottoms are expected to provide data needed to help differentiate between the regional plume and possible contributions from buried waste in the landfills. The regional carbon tetrachloride plume will be evaluated as part of the overall RI/FS process for the 200-SW-2 OU.

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 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 compounds.

7.4.1.1.1 Passive Soil-Vapor Samplers

A passive soil-vapor sampler (EMFLUX or GORE-SORBER) consists of a glass vial containing hydrophobic adsorbent cartridges with a length of wire or string attached to the vial for retrieval. The sampler is placed in a shallow, vertical hole in the soil. The sampler is covered with soil, and the location of the sampler is recorded.

At the end of the exposure period, the samplers are withdrawn and sent to the appropriate laboratory for analysis.

7.4.1.1.2 Sampling Design for Passive Soil Vapor

A two-stage sampling design has been developed for this project for the detection of organic vapors.

- The Stage 1 passive organic vapor surveys will be performed in the 218-W-3, 218-W-3AE, 218-W-4B, and 218-W-5 Landfills. Specific locations in these landfills showed high concentrations (greater than 25 ng/sample) of organic vapors when surveyed during Phase I-A characterization activities. Additional organic vapor surveys are needed to focus locations for potential active organic vapor sampling. Passive organic vapor samplers will be placed in a cross pattern around the point that showed an elevated concentration during the Phase I-A surveys. Nine vapor samplers per Phase I-A sample location will be spaced approximately 9.1 m (30 ft) apart in a cross pattern to ensure vapor detection in accordance with the manufacturers' specification. The landfills in which Stage 1 surveys will be performed, as well as trench numbers, and specific coordinates for sampler placement will be presented in the SAP.

- The Stage 2 passive 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 of in these landfills. The vapor samplers will be spaced approximately 9.1 m (30 ft) apart in a cross pattern. The number of samples per location will vary depending on the size and shape of the geophysical signature. The landfills in which Stage 2 surveys will be performed, as well as trench numbers, and specific coordinates for sampler placement will be presented in the SAP.

7.4.1.1.3 Positional Surveying

All sampling locations established during this sampling activity will be surveyed after the sampling and decommissioning activities are completed. Surveys will be performed according to approved procedures. Data will be recorded in the *North American Vertical Datum of 1988* (NAVD88) and the Washington State Plane (South Zone) *North American Datum of 1983* (NAD83), with the 1991 adjustment for horizontal coordinates. All survey data will be recorded in meters and feet.

7.4.1.2 Surface Geophysical Surveys

The geophysical techniques used in previous investigations at the 200-SW-2 OU landfills in 2005 and 2006 were the GPR, EMI, and TMF methods. 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. These same methods may be used for the scope addressed in this DQO; however, other methods also may be considered for application. Brief descriptions of the GPR, EMI, and TMF methods are provided in the following subsections.

Landfills selected for surface geophysical investigations are the 218-E-2, 218-E-4, 218-E-9, and 218-W-4A Landfills. The SAP will present the number of trenches (if known), as well as total surface area of the landfill to be surveyed. The total surface area may be reduced if no-walk or no-drive zones are present in these landfills; these zones could limit access by workers and survey equipment.

7.4.1.2.1 Frequency-Domain Electromagnetic Induction

The Geonics EM31 Terrain Conductivity Meter[10] is a frequency-domain EMI instrument 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 (10 to 12 ft) (in ideal situations). The EM31 consists of a transmitter coil and receiver coil at either end of a 4 m (12 ft) long

[10] Geonics EM31 is a trademark of Geonics Limited, Mississauga, Ontario, Canada.

boom. The transmitter generates pulses of electromagnetic energy (the primary field) at regular intervals, which are transmitted into the ground where they induce eddy currents in electrically conductive material (soil and/or metal objects). The induced eddy currents generate their own electromagnetic field (the secondary field), which transmits back toward the instrument. The receiver coil on the EM31 measures and records the strength of the secondary field both in phase and out of phase with the primary field transmitter. The in-phase component of the measurement is most strongly influenced by the presence of metallic objects in the subsurface, while the out-of-phase component is directly related to the electrical conductivity of the surrounding soil.

The normal mode of operation is to mark out regularly spaced data-collection lines and then walk down the lines with the instrument held at hip height, collecting data at regularly spaced intervals. Both the in-phase and the out-of-phase (terrain conductivity) measurements are collected and plotted for analysis. The instrument is most useful for locating large concentrations of buried metallic objects and for detecting subtle shifts in background soil properties. While the EM31 is capable of detecting drum-size metallic objects to a depth of 3 to 4 m (10 to 12 ft) in ideal situations, the lateral resolution of the position of detected objects is on the order of +/-1 m.

Conditions that limit the detection capability of the EM31 include high-background soil conductivities and proximity to cultural interference such as buildings and fences. High soil conductivities have the effect of limiting the depth of investigation of the instrument, because they significantly attenuate the propagation of the primary and secondary fields. This same phenomenon limits GPR depth of investigation in areas of high soil conductivity. Large, metallic surface features effectively can skew the results of the data. Sites with a significant number of buried utilities also may generate data that are difficult to interpret.

7.4.1.2.2 Total Magnetic Field/Vertical Gradient

A magnetometer measures the intensity of the earth's magnetic field. The presence of ferrous material, manmade or natural, creates local variations in the strength of the earth's overall magnetic field. These variations are proportional to several factors, including the mass of the ferrous material and the distance between the ferrous material and the detector. The distance is significant, because it changes the response by a factor of one over the distance cubed. The primary measurement that will be collected is the TMF intensity. The TMF, as the name implies, is a summation of all of the magnetic variables around the sensor. When the ferromagnetic sources are close to the detector, large variations in the TMF can occur. Therefore, it often is difficult to differentiate individual anomalies based on the TMF alone.

To improve the resolution of a magnetic survey, the magnetic gradient also can be measured. This is accomplished by making two simultaneous TMF measurements at each data point, using two sensors separated by a fixed vertical distance. The difference between the two measurements is the vertical magnetic gradient (referred to in this document as the magnetic gradient). The response to ferrous material falls off at a rate of one over the distance to the fourth power. Because of this, the magnetic gradient measurement should help differentiate individual anomalies and waste boundaries better than the TMF alone. Both the TMF and gradient values typically are displayed on contour maps for analysis.

7.4.1.2.3 Ground-Penetrating Radar

The GPR system uses a transducer to transmit 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. Geologic features such as cross-bedding, lateral and vertical changes in soil properties, and rock interfaces also can cause reflections of a portion of the electromagnetic energy.

The velocity of the electromagnetic energy primarily is controlled by the dielectric constant and magnetic susceptibility of the medium. For calculating depth, values of electromagnetic velocities are determined by measurement, experience in an area, ties to known buried reflectors, and knowledge of the subsurface medium.

The effective depth of investigation is a function of the transmitted power, receiver sensitivity, frequency of the antenna, and attenuation of the transmitted energy from the geologic medium. The maximum depth of investigation may vary significantly as a result of changing soil conditions. High attenuation and, therefore, smaller penetration depths of the electromagnetic energy typically occur where the soil conductivity is elevated and/or in areas with numerous reflective interfaces. Depth of investigation also is affected by highly conductive material, such as metal drums or pipes that essentially reflects all of the energy. The method cannot "see" directly below areas of highly reflective material, because all of the energy is reflected.

The reflected energy provides the means for mapping the subsurface features of interest, whether synthetic or geologic.

7.4.1.2.4 Survey Grid Parameters

Civil survey coordinates shown on the site drawings will be used to develop base grids at each site. Base grids will be created on centers of a chosen distance throughout the individual sites. The coordinates of the nodes will be supplied to Fluor Hanford civil survey personnel, who will use Global Positioning System instrumentation to stake the grids in the field. Personnel then will mark data collection lines at set intervals between the nodes.

The geophysical data plots will be presented in local grid coordinates. The local grids generally are established by assigning, to the southwestern-most grid node, the arbitrary location of North 100, East 100 (N100/E100). Positions then can be measured from this position. In some instances, the grids may be expanded after establishment and therefore may have coordinates less than N100/E100. The interpretation drawings for each site will show Washington State Plane coordinates (in meters) for selected grid nodes, allowing a tie between them and the local grid coordinates.

7.4.1.2.5 Sampling Design for Surface Geophysical Surveys

Surface geophysical investigations will be performed as reconnaissance-type surveys that are 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 (e.g., wood, metal boxes, metal drums, cardboard, waste item)
- Differentiation between different types of waste containers in a given trench
- Depth of soil cover above waste items
- Depth to trench bottom (where possible).

The depth of investigation for the geophysical instruments used in this work is limited to approximately 3 to 4 m (10 to 12 ft). Geophysical survey locations will be provided in the SAP. Unless otherwise noted, the entire landfill will be surveyed using geophysical techniques.

7.4.1.3 Visual Inspections and Historical Information Reviews for Unused Portions of Landfills

Portions of three of the RCRA TSD-unit landfills within the 200-SW-2 OU never have received buried waste. Annexes of the 218-W-4C and 218-E-10 Landfills, as well as unused portions of the 218-E-12B Landfill, were intended to be used for future disposal of waste; however, no waste disposals are known to have taken place in these areas. In addition, the 218-W-6 Landfill is not known to have received waste.

Visual inspection of unused landfills and 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 and suggest a likelihood of waste burial may be surveyed using geophysical techniques and/or radiological surveys to ensure that no waste is buried in these areas. Other historical information also may be reviewed to determine if waste has been buried at these sites.

After field surveys are completed, these unused areas will be administratively reclassified in the *Waste Information Data System* database. Those steps required to reclassify these areas will be described in Chapter 5.0 of the RI/FS work plan.

7.4.2 Intrusive Data-Collection Techniques

Intrusive characterization techniques to be used during Phase I-B consist of geophysical logging of existing monitoring wells, direct pushes within the boundaries of the landfills, and remote camera and radiological surveys of potentially unused caissons. These techniques can provide data on radionuclides, physical parameters, chemicals, and other characteristics that add to the understanding of the nature and extent of contamination. The following subsections describe the techniques to be used in Phase I-B. Analytical performance requirements for intrusive data-collection techniques can be found in Table 3-7.

7.4.2.1 Downhole Geophysical Logging

Existing logging data from nearby monitoring wells will be reviewed for applicability to 200-SW-2 OU landfills. Information regarding soil moisture content with depth, site stratigraphy, and the presence of radionuclides or other contaminants is of particular interest in support of efforts to determine the nature and extent of contamination. Phase I-B characterization will provide preliminary information and support site investigation scoping for subsequent intrusive phases that will be focused on determining the nature and extent of contamination. At least one upgradient and one downgradient monitoring well will be logged with a high-resolution spectral gamma-ray logging system to provide continuous vertical logs of gamma-emitting radionuclides, and with a neutron-moisture logging system to identify moisture changes (additional wells may be logged depending on the results from the upgradient and downgradient wells). The spectral gamma logging of existing wells in the vicinity of a landfill can be a cost-effective method of providing data on the vertical and lateral distribution of gamma-emitting radionuclides. The spectral gamma-logging system uses instrumentation to identify and quantify gamma-emitting radionuclides in wells as a function of depth.

The spectral gamma-logging system uses laboratory-grade high-purity germanium detectors or sodium iodide detectors to collect gamma energy spectra at discrete depth increments. Radionuclide identification and assay are based on characteristic gamma emissions associated with decay. At each depth increment, the gamma energy spectrum is analyzed to detect peaks, and to determine net count rate, counting error, and minimum detectable activity for each peak. The energy resolution capability of the detector varies between approximately 2 and 4 keV, depending on energy level and background activity. Net counts from individual gamma energy peaks are processed with the detector calibration function, dead time correction, casing correction, and water correction to determine the bulk concentration, analytical error, and minimum detectable level. All quantities are reported in picocuries per gram. For selected radionuclides, specific regions of interest can be "forced" to determine the minimum detectable activity even when no peak is detected. Thus, the minimum detectable activity and analytical error are calculated on a point-by-point basis and shown on the log plot. The minimum detectable activity depends on the intensity (yield) of the characteristic gamma ray, detector efficiency, casing thickness, and background activity level.

A logging system consists of a unique combination of downhole sonde (detector) and logging system (cable, winch, power supply, control system, and data acquisition system). The spectral gamma-logging system and the neutron-moisture logging system are calibrated on an annual basis, or after any significant repairs or modifications to either the sonde or the logging system. Calibration measurements are made at the Hanford Calibration Facility, located near the central weather station, just east of the Hanford Site 200 West Area. Each calibration is documented with a calibration certificate.

The neutron-moisture logging system, which measures moisture, employs a weak americium beryllium neutron source and neutron detector to provide a direct reading of hydrogen atom distribution in the soil surrounding the borehole. This detector will be used to measure continuous vertical moisture in the vadose zone. The spectral gamma logs will be used to aid in determining the vertical distribution of radionuclides in the vadose zone beneath the landfills and to aid in geological interpretation of subsurface stratigraphy.

The spectral gamma-logging equipment calibration is conducted annually, and the data acquired during the calibrations are used to derive factors that convert measured peak-area count rate to radionuclide concentrations in picocuries per gram. Corrections are applied to the data to compensate for the gamma ray attenuation by the casing.

7.4.2.1.1 Sampling Design for Geophysical Logging of Existing Wells

Wells within 50 m (164 ft) of the 25 landfills in the scope of this DQO that are currently available for logging will be provided in the RI/FS work plan and SAP. Following review of the existing logging data and determination of applicability and utility in determining site stratigraphy, soil moisture content, and presence of contamination, the logging techniques listed in the section above will be used to log at least one upgradient and one downgradient well if no information exists.

Geophysical logging data will be collected in the *Hanford Environmental Information System* database; a summary report also will be prepared by the logging contractor to document the logging activity and results. The logging summary reports will be documented in the field summary report so they can be referenced in the RI report and other documents as necessary.

7.4.2.2 Direct-Push Technologies and Logging

The DPTs use a pushing method, such as a diesel hammer, hydraulic hammer, cone penetrometer, or GeoProbe, to penetrate the vadose zone to obtain downhole geophysical data (e.g., small-diameter spectral gamma, moisture). These methods generally are limited in the depth of penetration and in sample volume as compared to borehole drilling; they generally are less expensive than drilling. In general, these methods do not generate drill cuttings, thereby minimizing personnel exposure to contamination and minimizing the volume of investigation-derived waste.

Direct-push holes will be installed to obtain spectral gamma, neutron-moisture, and/or passive neutron logs as discussed in the following section. Direct-push holes are decommissioned in the same manner as standard boreholes, in accordance with appropriate state regulations. Maximum depth for these techniques is near 30 m (100 ft), based on experience at the Hanford Site.

7.4.2.2.1 Sampling Design for Direct-Push Technologies

The DPT will be used in the centers of each of the 25 landfills. The pushes will be located at the coordinates presented in the SAP. Pushes will be placed in areas between trenches, so that the buried waste is not penetrated. Logging, as described in Section 7.4.2.1, will be performed from within the DPT casings.

In addition to the center pushes, additional pushes will be performed in those landfills that have experienced historical events, such as rapid snowmelt or infiltration of water that could have provided a mechanism to cause contaminant migration. The coordinates for this pushes are presented in the SAP. Logging, as described in Section 7.4.2.1, will be performed from within the DPT casings.

Direct pushes will be driven to a maximum depth of 30 m (100 ft) or to refusal. The vertical direct pushes described above will be used to assess the stratigraphy under the landfills and radiological conditions, and to direct future phase soil samples.

Logging data will be collected in the *Hanford Environmental Information System* database; a summary report also will be prepared by the logging contractor to document the logging activity and results. The logging summary reports will be documented in the field summary report so they can be referenced in the RI report and other documents as necessary.

7.4.3 Investigation of Potentially Unused Caissons

The following sections describe the intrusive characterization techniques that will be used to investigate caissons that are potentially unused. This investigation will determine if the suspect caissons contain waste, or are in fact empty, as indicated by historical information.

7.4.3.1 Radiological Surveys

Radiological screening of caisson interiors will be conducted by the radiological control technician or other qualified personnel for evidence of radioactive contamination.
A pre-investigation background radiological survey will be performed around the caissons to document the background radiological conditions in the area. Surveys of the caisson interiors will be conducted using standard Hanford Site radiological survey equipment such as Geiger-Mueller[11] counters and/or sodium iodide detectors for beta-gamma emitting radionuclides and portable alpha monitors for alpha-emitting radionuclides. Results of the radiological surveys will be documented on a Radiological Survey Report for each caisson investigated.

Caissons to be investigated include those 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, 218-W-4A-C8 Caissons, and the 218-W-4B (UNI-2) Caisson.

7.4.3.2 Remote Camera Inspections

Remote camera inspections using a fiber-optic camera or an equivalent, in conjunction with adequate lighting equipment, will be performed in conjunction with the radiological surveys described above to investigate those caissons that are believed to be unused based on historical documentation. These techniques will verify that the caissons are free of waste, which will allow administrative closure activities to be performed. Closure activities may

[11] Geiger-Mueller is not a trademark.

include a reclassification in the *Waste Information Data System* database to a "rejected or no-action" status.

7.5 SAMPLING DESIGN – SUMMARY OF SAMPLING ACTIVITIES

A summary of the key features of the sampling design activities and the basis for the sampling design required to support Phase I-B characterization of the 200-SW-2 OU landfills is presented in Table 7-1.

Table 7-1. Key Features of the Sampling Design. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
	Passive Organic Vapor Surveys – Stage 1	
Passive soil-vapor samplers (EMFLUX or GORE-SORBER)	The Stage 1 passive organic vapor surveys will be performed in the 218-W-3, 218-W-3AE, 218-W-4B, and 218-W-5 Landfills. Passive organic vapor samplers will be placed in a cross pattern around the point that showed an elevated concentration as a result of the Phase I-A surveys. Nine vapor samplers per Phase I-A sample location will be spaced approximately 9.1 m (30 ft) apart in a cross pattern.	Specific locations in the landfills listed to the left showed high concentrations (greater than 25 ng/sample) of organic vapors when surveyed during Phase I-A characterization activities. Additional organic vapor surveys are needed to focus locations for potential active organic vapor sampling in future characterization phases.
	Passive Organic Vapor Surveys – Stage 2	
Passive soil-vapor samplers (EMFLUX or GORE-SORBER)	The Stage 2 passive organic vapor surveys will be focused on those areas of 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-3, and 218-W-11 Landfills that showed a strong metallic signature during geophysical investigations performed as part of Phase I-A characterization activities. The vapor samplers will be spaced approximately 9.1 m (30 ft) apart in a cross pattern. The number of samples per location will vary depending on the size and shape of the geophysical signature.	Passive organic vapor surveys will be used to determine if containers of organic liquids may have been disposed of in these landfills. Organic liquids were used in large quantities at the Plutonium Finishing Plant and other facilities during their operating history.

Table 7-1. Key Features of the Sampling Design. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
Surface Geophysical Surveys		
Surface geophysical surveys using GPR, EMI, and TMF methods	Surface geophysical investigations will be performed at the 218-E-2, 218-E-4, 218-E-9, and 218-W-4A Landfills as reconnaissance-type surveys that are 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 (e.g., wood, metal boxes, metal drums, cardboard, waste item) • Differentiation between different types of waste containers in a given trench • Depth of soil cover above waste items • Depth to trench bottom (where possible).	The geophysical survey methods effectively and nonintrusively obtain the needed information.
Visual Inspections and Historical Information Reviews for Unused Portions of Landfills		
Visual inspection; historical information reviews	Visual inspection of unused landfills and 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 and suggest a likelihood of waste burial may be surveyed using geophysical techniques and/or radiological surveys to ensure that no waste is buried in these areas. Other historical information also may be reviewed to determine if waste has been buried at these sites.	Portions of three and the entire area of one of the RCRA TSD-unit landfills within the 200-SW-2 Operable Unit never have received buried waste. The 218-W-6 Landfill was intended for future disposal of waste, but never was used. Annexes of the 218-W-4C and 218-E-10 Landfills, as well as unused portions of the 218-E-12B Landfill, were intended to be used for future disposal of waste; however, no waste disposals are known to have taken place in these areas. To administratively reclassify these areas, these methods will be used to verify the absence of waste.

Table 7-1. Key Features of the Sampling Design. (3 Pages)

Sample Collection Methodology	Key Features of Design	Basis for Sampling Design
	Geophysical Logging of Existing Wells	
High-resolution spectral gamma-ray logging system	At least one upgradient and one downgradient well will be logged in the absence of existing data. Existing logging data will be compiled to determine applicability and utility for site stratigraphy, soil moisture content, and presence of contamination.	Logging of existing monitoring within 50 m (164 ft) of the 200-SW-2 Operable Unit landfills is a cost-effective method of gathering data to aid in determining site stratigraphy, soil moisture, and the presence of radiological contamination.
	Direct-Push Techniques and Logging	
Diesel/hydraulic hammer, cone penetrometer, or GeoProbe High-resolution spectral gamma-ray logging system; neutron-neutron logging	A pushing method (e.g., diesel hammer, hydraulic hammer, cone penetrometer, or GeoProbe) will be used in the centers of each of the 25 landfills. Small-diameter probes will be installed in areas between trenches, so that the buried waste is not penetrated. DPTs will be installed in landfills that have experienced historical events, such as rapid snowmelt or infiltration of water. DPTs will be installed to depths of 30 m (100 ft) or to refusal. High-resolution spectral gamma-ray and/or neutron-neutron logging will be used.	Logging of direct pushes within the landfills will gather data to aid in determining site stratigraphy, soil moisture, and the presence of radiological contamination.
	Investigation of Potentially Unused Caissons	
Radiological and remote camera surveys	A pre-investigation background radiological survey will be performed around the caissons. A remote camera probe will be installed for visual inspection of interior spaces in caissons. Radiological screening of caisson interiors will be conducted for evidence of radioactive contamination.	Caissons to be investigated include those 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, 218-W-4A-C8 Caissons, and the 218-W-4B (UNI-2) Caisson. To administratively reclassify these caissons, these methods will be used to verify the absence of waste. The background radiological conditions will be documented.

EMFLUX is a registered trademark of Beacon Environmental Services, Inc., Bel Air, Maryland.
GeoProbe is a registered trademark of GeoProbe Systems, Salina, Kansas.
GORE-SORBER is a trademark of W. L. Gore and Associates, San Francisco, California.

DPT = direct-push technology.
EMI = electromagnetic induction.
GPR = ground-penetrating radar.
RCRA = *Resource Conservation and Recovery Act of 1976.*
TMF = total magnetic field.

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