AR TARGET SHEET

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

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SECTION:	1 OF 3
DOCUMENT #:	07-AMCP-0198
TITLE:	Tanks/Lines/Pits/Boxes/Septic Tank and Drain Fields Waste Group OU Remedial Investigation/Feasibility Study (RI/FS) Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-IS-1 and 200-ST-1 OUs DOE/RL-2002-14 Rev1 Draft B

0073164

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

JUN 2 7 2007

07-AMCP-0198

Ms. Jane A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton
Richland, Washington 99354

Dear Ms. Hedges:

TANKS/LINES/PITS/BOXES/SEPTIC TANK AND DRAIN FIELDS WASTE GROUP OPERABLE UNIT REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS) WORK PLAN AND RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) TREATMENT, STORAGE, AND DISPOSAL (TSD) UNIT SAMPLING PLAN; INCLUDES: 200 IS-1 AND 200-ST-1 OPERABLE UNITS, DOE/RL-2002-14, REVISION 1, DRAFT B

The purpose of this letter is to transmit the Tanks/Lines/Pits/Boxes/Septic Tank and Drain Fields Waste Group Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes: 200-IS-1 and 200-ST-1 Operable Units, DOE/RL-2002-14, Revision 1, Draft B to the State of Washington Department of Ecology (Ecology) for review and comment. The work plan and sampling and analysis plans (SAPs) are submitted to complete Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-13-27. The work plan is the main document with the SAPs included as appendices. The work plan and SAPs are a joint effort between the U.S. Department of Energy, Richland Operations Office (RL) and U.S. Department of Energy, Office of River Protection Office (ORP) offices. This effort has resulted in a unified approach for investigating the inactive process waste pipelines and appurtenances on the Central Plateau.

Also attached is a draft Tri-Party Agreement Change Package M-13-07-01 proposing one Tri-Party Agreement Interim Milestone. When the work plan and SAPs are reviewed, the change package will be finalized and submitted to Ecology.

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

Sincerely,

Michael J. Weis
Acting Manager

AMCP:KDL

Attachments

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DOE/RL-2002-14
Revision 1
DRAFT B

Tanks/Lines/Pits/Boxes/Septic Tank and Drain Fields Waste Group Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes: 200 IS-1 and 200-ST-1 Operable Units

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

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

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2002-14
Revision 1
DRAFT B

Tanks/Lines/Pits/Boxes/Septic Tank and Drain Fields Waste Group Operable Unit RI/FS Work Plan and RCRA TSD Unit Sampling Plan; Includes: 200 IS-1 and 200-ST-1 Operable Units

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Assistant Secretary for Environmental Management

United States
Department of Energy
P.O. Box 550
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J. D. Aardal 05/24/2007
Release Approval Date

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TERMS

amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CMS	corrective measures study
COPC	contaminant of potential concern
CZ	contamination zone
DOE	U.S. Department of Energy
DQO	data quality objective
DST	double-shell tank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
Fluor Hanford	Fluor Hanford, Inc.
FS	feasibility study
GPR	ground-penetrating radar
HSTF	Hexone Storage and Treatment Facility
HWMA	Hazardous Waste Management Act (short title of RCW 70.105)
Implementation Plan	DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*
ITS	in-tank solidification
K_d	distribution coefficient
MIBK	methyl isobutyl ketone (hexone)
NPH	normal paraffin hydrocarbon or kerosene
ORP	DOE Office of River Protection
OU	operable unit
UO_3 Plant	Uranium Trioxide Plant
PFP	Plutonium Finishing Plant
PUREX	Plutonium-Uranium Extraction (Plant or process)
RCRA	*Resource Conservation and Recovery Act of 1976*
RE	Ringold Formation unit E
RECUPLEX	Recovery of Uranium and Plutonium by Extraction (process)
REDOX	Reduction-Oxidation (Plant or process)
RESRAD	RESidual RADioactivity
RFI	RCRA facility investigation
RFI/CMS	RCRA facility investigation/corrective measures study
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RL	DOE Richland Operations Office
ROD	record of decision
RPP	RCRA past practice

SAP	sampling and analysis plan
SST	single-shell tank
TBP	tributyl phosphate
TEDF	Treated Effluent Disposal Facility
TPH	total petroleum hydrocarbon
Tri-Parties	Ecology, EPA, and DOE
Tri-Party Agreement Action Plan	*Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b)
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a)
TSD	treatment, storage, and disposal
TWINS	*Tank Waste Information Network System* database
WIDS	*Waste Information Data System* database
WMA	waste management area

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	0.454	kilograms	kilograms	2.205	pounds (avoir)
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
tablespoons	15	milliliters	liters	2.113	pints
ounces (U.S., liquid)	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts (U.S., liquid)	0.946	liters	cubic meters	1.308	cubic yards
gallons (U.S., liquid)	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Centigrade	Centigrade	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

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1.0 INTRODUCTION

This work plan supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) activities for the 200-IS-1 Tanks/Lines/Pits/Boxes Waste Group Operable Unit (OU). As discussed in the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b) (Tri-Party Agreement Action Plan), the RI/FS work plan is prepared to present information on how the remedial investigation (RI) and feasibility study (FS) processes will be conducted and eventually lead to proposed remedies for the waste sites in an OU. This work plan also integrates the *Resource Conservation and Recovery Act of 1976* (RCRA) facility investigation/corrective measures study (RFI/CMS) requirements and uses the framework established in DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (hereinafter referred to as the Implementation Plan), which is the implementation plan for integrating the RCRA treatment, storage, and disposal (TSD) unit closure process with the OU CERCLA RI/FS process.

Revision 0 of this work plan (DOE/RL-2002-14, *Tanks/Lines/Pits/Boxes/Septic Tank and Drain Fields Waste Group Operable Unit RI/FS/Work Plan and RCRA TSD Unit Sampling Plan; Includes 200-IS-1 and 200-ST-1 Operable Units*) was submitted to the Washington State Department of Ecology (Ecology) in May 2003; however, Ecology did not approve the document. Ecology issued a letter to the U.S. Department of Energy (DOE) in August 2003 (Price, 2003, "Tanks/Lines/Pits/Boxes/Septic Tank and Drain Field Waste Group Operable Units Remedial Investigation/Feasibility Study Work Plan and RCRA TSD Unit Sampling Plan, DOE/RL-2002-14, Revision 0"), directing the DOE to include appropriate DOE, Office of River Protection (ORP)-owned 200-IS-1 OU waste sites with the DOE, Richland Operations Office (RL)-owned waste sites already in Revision 0 of the work plan. This work plan revision (Revision 1) satisfies Ecology's requirement for inclusion of the ORP-owned 200-IS-1 OU waste sites.

The DOE, Ecology, and the U.S. Environmental Protection Agency (EPA) recently concluded negotiations on milestone changes for completing the RI/FS process and the RCRA RFI/CMS process for 200 Area (Central Plateau) non-tank-farm OUs. The milestones were changed to allow additional site characterization to be completed before making several Central Plateau cleanup decisions. In addition, M-015 and M-013 interim milestones are added and existing milestones are modified.

The negotiations also identified that approximately 350 waste sites have shallow contamination that can be addressed by straightforward remove, treat, and dispose methods. These sites were shifted into two new OUs named MG-1 and MG-2. All the sites previously identified as 200-ST-1 were moved into the new MG-1 OU. As such, the 200-ST-1 OU is not discussed further in this document. Separate decision documents for the MG-1 and MG-2 OUs will be submitted to the EPA and Ecology.

The RCRA TSD tanks included in this work plan that require actions to comply with RCRA closure/postclosure requirements are the CX Tank System (Tanks 241-CX-70, 241-CX-71, and 241-CX-72) and the Hexone Storage and Treatment Facility (HSTF) (Tanks 276-S-141 and

276-S-142). Components of the RCRA TSD units associated with single-shell tank (SST) and double-shell tank (DST) systems, such as ancillary piping and equipment that is located outside tank farm waste management areas (WMA), also are addressed by this work plan.

Many pipelines and associated structures in the 200 Areas that potentially could be considered as 200-IS-1 OU waste sites currently are not included in this OU. Under the direction of RL and ORP, several programs and technical groups are reviewing available engineering drawings and documents to create comprehensive maps delineating the locations of the pipelines and related structures. Each pipeline will be given its own site code for identification and tracking purposes. Once the mapping activity is finished, the pipelines will be incorporated into the *Waste Information Data System* (WIDS) database. This activity will continue during the work plan and RI activities, with additional pipelines and related structures identified and added as waste sites through the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a) (Tri-Party Agreement) Milestone MP-14 procedures (RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)").

The data generated through investigations associated with the 200-IS-1 OU will support activities in other core projects in the RL and ORP offices. Integration of the data-collection activities with other projects on the Hanford Site will result in more efficient and consistent remediation processes.

1.1 SCOPE AND OBJECTIVES

The work plan presents background information, existing contaminant distribution data, and the approach that will be used for characterization and remedial decision making. The likely response scenarios, potentially applicable technologies, and the need for treatability study(ies) are discussed later in the document.

This work plan addresses the following:

- The 200-IS-1 OU, which includes:
  - Pipelines, diversion boxes, catch tanks, related structures, and associated unplanned releases to the soil
  - RCRA TSD tanks.

The work plan contains a sampling and analysis plan (SAP) for the Phase 1 characterization of the process-waste pipeline systems associated with facility process-waste streams (Appendix A) and an additional SAP for Phase 1 characterization of tank farm waste-transfer pipeline systems (Appendix B). The SAPs include a quality assurance project plan and the sampling specifications for the characterization activities in the field. Information from other OUs and/or projects that have generated information pertaining to the pipeline systems has been used in the development of this work plan. Data-gathering activities included compiling and reviewing existing process-knowledge information. Pertinent site-characterization data available for pipelines associated with liquid-waste disposal sites and tank farm WMA investigations also have been gathered and evaluated. This existing pipeline information and the new characterization data that will be acquired as part of the 200-IS-1 OU phased sampling approach will be used in the RI report. Information presented in the RI report will support the evaluation of the remedial alternatives and closure options that will be included in the FS and RCRA TSD unit closure plans.

The results from sampling and other characterization activities will be used to update the contaminant distribution models as needed and to support the remedial decision-making process. This work plan focuses on identifying and gathering the information that will be needed for selection of the preferred remedy(s). Key attributes associated with a process-waste transfer structure (e.g., pipelines, diversion boxes, catch tanks) are presented in the work plan. Results of the characterization activities will be used for evaluating risk to potential receptors and for the FS remedial alternative analyses.

To focus the activities needed for future remedy selection for the pipeline systems, this RI/FS work plan has incorporated the following.

1. A logic for binning (i.e., a methodology for grouping items with similar characteristics) is used for the process-waste pipeline systems that is suited for both characterization activities and subsequent remedial decisions. This binning logic uses waste-stream categories as a fundamental attribute associated with the pipelines.

2. Information-gathering activities are continuing, including location and characterization of pipelines, throughout the RI/FS process. A pipeline-systems location map and an attribute database are being created. Waste-site codes will be assigned to identified pipeline segments in accordance with RL-TPA-90-0001, Milestone MP-14 procedures and placed in the WIDS database. WIDS serves as the data-management tool listing current OU waste sites and providing site-specific information. As characterization results become available, they will be compared with information concerning operational history and construction details. This approach will allow for any subsequent data-collection needs to be adapted as needed. Data-gathering requirements are tailored to accommodate the characteristics of the entire network of underground process-waste pipelines that are disseminated throughout the Central Plateau.

3. Potential remedial alternatives are identified and described. Potential remedies associated with pipeline characteristics initially are identified in the work plan. Using the data collected and risk evaluations completed in the RI, a comprehensive remedial alternatives analysis will be completed in the FS.

The scope and approach for the other waste sites addressed in this work plan are summarized below.

<u>276-S-141 and 276-S-142 Tank System (Hexone Storage Tanks)</u>

Existing summary characterization information is presented for the 276-S-141 and 276-S-142 Hexone Storage Tank System. The closure plan prepared for the 276-S-141 and 276-S-142 Hexone Storage Tank System (DOE/RL-92-40, *Hexone Storage and Treatment Facility Closure Plan*) will be amended (as needed) and used to complete the closure process for these tanks. The tanks will be removed and the surrounding soil will be sampled and analyzed as described in the closure plan to verify RCRA clean closure and meet CERCLA site close-out requirements.

241-CX-70, 241-CX-71, and 241-CX-72 Tank System

The 241-CX-70 Storage Tank and the 241-CX-71 Neutralization Tank will be clean closed. Summary information concerning these tanks and the 241-CX-72 Storage Tank is provided. Waste characteristics of the remaining residue in the 241-CX-72 Storage Tank need to be determined. A SAP to determine the composition of residual waste present in the 241-CX-72 Storage Tank is included in Appendix C. A closure plan for the entire CX Tank System (241-CX-70, -71, and -72) will be submitted in accordance with Milestone M-020-54, "Submit Closure Plan for 241-CX-70, 241-CX-71, and 241-CX-72 Tanks for Regulatory Review by December 31, 2008."

1.1.1 Input from Data Quality Objectives Process for Pipeline Systems

The outcome of the recent 200-IS-1 data quality objectives (DQO) process (D&D-30262, *Data Quality Objectives Summary Report for the IS-1 Operable Unit Pipelines and Appurtenances*) forms the basis for development of a large portion of this work plan and the associated SAPs (Appendices A and B). Because of uncertainties associated with the process-waste pipelines, an outcome of the DQO process was a determination that a phased approach to data gathering would be the most effective mechanism to acquire the information needed to make remedial decisions. The strategy developed for characterization permits the integration of new data in a phased manner. Data-collection specifications are tailored for each phase to allow for efficient use of resources and are linked to the data-sufficiency requirements and the level of uncertainty that is acceptable for remedial decision making.

Because of the regulatory complexities and technical challenges associated with pipeline systems, the DQO process and work-plan development have been ongoing for several years. The initial DQO process conducted for the 200-IS-1 OU was completed in 2002; it resulted in defining radiological and nonradiological constituents to be characterized and specified the number, type, and location of samples to be collected for five RCRA TSD tank system units in the 200-IS-1 OU.

A second DQO process was undertaken in 2004, after receipt of a letter from Ecology (Price, 2003) requesting inclusion of the ORP-owned waste sites in a revised work plan. Although this DQO process was not documented as a formal DQO summary report, the assumptions made and conclusions generated in the process were used for development of a revised work plan. A meeting was held with Ecology on November 1, 2004, and a presentation was given outlining a revised work-plan approach and content.

Beginning in August 2005, a collaborative DQO activity was initiated and included participation by representatives from Fluor Hanford, Inc. (Fluor Hanford); CH2M HILL Hanford Group, Inc.; RL; ORP; and Ecology. A working group was assembled and meetings were conducted with input from all representatives to complete the DQO process and develop a DQO summary report

(D&D-30262). The content of the completed DQO report provides a basis and direction for development of this work plan and the SAPs. Specific elements of the DQO report used in the development of this work plan include the following:

- The binning strategy to group pipelines for further evaluation, based on the process-waste stream(s) handled by the lines
- Separate contaminants of potential concern (COPC) lists for facility pipeline versus tank farm pipeline sampling analytical requirements
- Sampling designs for two SAPs. One SAP is for the facility process-waste pipelines that are associated with liquid-waste disposal sites (i.e., cribs, trenches, french drains, ponds, injection/reverse wells), and another SAP is for process-waste pipeline systems associated with tank farm operations.

1.1.2 Pipeline Systems

The process-waste pipeline systems include the extensive network of pipelines, diversion boxes, catch tanks, valve pits, related infrastructure, and associated unplanned releases in surrounding soils. The pipeline systems were used to transport process waste from the separations facilities to the SSTs and DSTs and to control or divert flow to disposal waste sites that received liquid-waste streams. This work plan addresses the inactive process-waste pipeline systems in the Central Plateau area; it does not include evaluation of waterlines; utility lines; inert gas lines; sanitary sewer, storm water, and aboveground pipelines; or active pipelines. This includes those waste sites currently identified in the Tri-Party Agreement Action Plan, Appendix C (Ecology et al., 1989b), as part of the 200-IS-1 OU, as well as the new waste sites (i.e., pipelines, related infrastructure, and associated unplanned releases in surrounding soils) that will be added.

Most of the pipelines and associated structures in the Central Plateau currently have not been assigned to the 200-IS-1 OU through the regulatory procedures identified in the Tri-Party Agreement Action Plan; in particular, those pipelines connected to liquid-waste disposal sites that are associated with other OUs. Pipelines and associated structures that occur within the boundaries of tank farm WMAs will be addressed by the designated WMA RCRA closure or corrective actions. Many of the pipelines that are connected to the tank farms and extend outside the WMA currently are not assigned to a specific OU. Because both the tank farms and the 200 Areas process-facility operations used the pipeline network for waste-transfer operations, RL and ORP share responsibilities for the characterization and remedial actions for the pipeline system. Designation of these responsibilities for specific pipeline segments is based on whether the pipeline or associated structure is considered ancillary equipment associated with a tank farm RCRA TSD unit.

1.1.3 Pipeline Bins

Considerable process knowledge is available concerning the waste streams generated at the facilities in the 200 Areas. The 200 Areas have been the center for separations and concentration processes of plutonium. These separation and concentration processes can be grouped into six general processes:

1. Fuel processing
2. Plutonium isolation
3. Uranium recovery
4. Cesium/strontium recovery
5. Waste storage/treatment
6. Tank farm waste transfers.

DOE/RL-96-81, *Waste Site Grouping Report for 200 Areas Soil Investigations*, translated the first five general processes into logical waste-site groups based on waste-stream type (e.g., solid waste, cooling water, process waste), followed by waste-site type (e.g., burial ground, pond, trench, ditch, crib). Inventory estimates for the major radionuclide, inorganic, and organic constituents comprising the waste streams generated from the 200 Areas facilities and discharged to waste-disposal sites are presented in DOE/RL-96-81, Appendix A, and the soil inventory model (RPP-26744, *Hanford Soil Inventory Model, Rev. 1*).

The general waste-stream categories identified in DOE/RL-96-81, Section 3.2, and in DOE/RL-98-28, Appendix H, form the basis for the OU designations used for the Central Plateau liquid-waste disposal sites. These OU waste-stream categories also support a framework with which to organize the pipeline systems for characterization activities. The waste-stream categories share common radiological and chemical attributes and allow for a systematic approach with which to group or "bin" the pipelines that handled each type of process liquid. This grouping or "binning" logic relies on process knowledge associated with the facility operations and the fact that the pipelines in each designated bin conveyed liquid wastes that generally share common compositional attributes.

The bins for the pipeline systems are shown in Table 1-1. Summary information provided in this table includes the five bins, organized by OUs identified for the 200 Areas facilities waste sites, and a general description of the waste-stream characteristics. Information on the general characteristics of each of the waste streams was obtained primarily from DOE/RL-96-81, DOE/RL-98-28, and the results of completed RI reports for the associated OUs. Variations noted in the general waste-stream attributes also are identified in the table. A sixth bin is included for the tank-transfer waste streams. This sixth group is unique to the other five bins, because it contains pipeline systems that received waste from varying generating sources and therefore may not share common compositional attributes, as do the other bins. Process operations and waste-stream attributes for each of the bins are discussed in more detail in Chapter 2.0. Table 1-2 identifies the Hanford Site process-facility areas where the waste streams identified in Table 1-1 were conveyed by pipelines.

Table 1-1. Pipeline-System Waste-Stream Bins.

Bin Number	Waste Category	Waste Steam Description
1	Process Condensate and Process Waste (Waste streams associated with the 200-PW-1, -2, -3, -4, -5, and -6 OUs) Chemical-Laboratory Waste (Waste streams associated with the 200-LW-1 and -2 OUs)	• Process condensate generally is water condensed from the closed process system and that was in direct contact with radioactive and chemical materials. • Process waste is low-level and/or hazardous waste that directly contacted radioactive material and that may contain organic complexants that could enhance their mobility. • Potential transuranic waste associated with the 200-PW-1, -2, and -6 OU waste streams. • CCl_4 associated with the 200-PW-1 OU waste stream. • Laboratory process wastes and/or laboratory decontamination waste streams that generally are low in radionuclides, although some have significant inventories of plutonium, uranium, and fission products. Liquid volumes typically are lower. • Potential transuranic waste associated with some 200-LW-2 OU waste streams.
2	Steam Condensate and Cooling Water (Waste streams associated with the 200-CW-1, -2, -3, -4, and -5 OUs and the 200-SC-1 OU)	• These waste streams were run in a noncontact manner; i.e., a barrier separated the liquids in this category from contaminated process liquids, with little consequent potential for routine radiological contamination. However, contamination did enter these streams in generally negligible to very small quantities through pinhole leaks or through rare pipe ruptures. • Potential transuranic waste associated with the 200-CW-5 OU waste stream.
3	Chemical-Sewer Waste (Waste streams associated with the 200-CS-1 OU)	• Chemical-sewer waste sites received solvent-extraction waste that was generally low in all radiological contaminants.
4	Miscellaneous Waste (Waste streams associated with the 200-MW-1 OU)	• Generally consists of waste streams generally low in radionuclide and chemical constituents. Waste streams associated with plant ventilation and stack drainage, equipment decontamination, and a number of small- to medium-volume radioactive waste streams from multiple sources. • The relationship of the 216-A-4 Crib's high radiological-constituent levels to the general waste characteristics of this group is uncertain.
5	Tank/Scavenged Waste (Waste streams associated with the 200-TW-1 and -2 OUs)	• Consists of waste streams with relatively high concentrations of radiological constituents. These liquid wastes are associated directly or indirectly with tank wastes collected from the bismuth-phosphate process. • Potential transuranic waste associated with the 200-TW-2 OU waste stream.
6	Tank Farm Waste Transfers	• Multiple waste-stream compositions, generally consisting of high concentrations of radionuclides. • Variability in the waste-stream composition.

OU = operable unit.

Table 1-2. Identification of Process-Waste Pipeline Bins in 200 Areas Facility Areas.

Facility Area	Waste Streams Transferred Within Pipeline Systems					
	Bin 1 Process Condensate, Process Waste, and Chemical-Laboratory Waste	**Bin 2 Steam Condensate and Cooling Water**	**Bin 3 Chemical Sewer**	**Bin 4 Miscellaneous Waste**	**Bin 5 Tank/ Scavenged Waste**	**Bin 6 Tank Farm Waste Transfers**
200 East Area						
A Plant (PUREX)	X	X	X	X	---	X
B Plant	X	X	X	X	X	X
C Plant (Hot Semiworks)	X	X	---	X	X	X
200 West Area						
S Plant (REDOX)	X	X	X	X	---	X
T Plant	X	X	---	X	X	X
Z Plant (PFP)	X	X	---	X	---	X

X – Indicates that pipeline systems present in the facility area were used to transfer the specified waste stream.
--- Indicates that no pipeline system was identified that carried the waste stream.
PFP = Plutonium Finishing Plant.
REDOX = Reduction-Oxidation Plant.
PUREX = Plutonium-Uranium Extraction Plant.

1.1.4 Approach for Characterization and Remedial Decision Making

1.1.4.1 Pipeline Systems

A characterization approach has been identified that is directed toward determining whether residual contamination occurs within the pipelines and if the surrounding soil has been impacted by any leakage that may have occurred. To optimize data gathering, phased characterization will be used to accommodate two stages of evaluation and assessment of the data for decision making, if needed. The purpose of the first phase (Phase 1) of investigation is to gather characterization data in support of existing information. The characterization data collected will be used to determine whether contaminants are consistently at concentrations above preliminary cleanup levels and to support remedial decision making (other than the no-action alternative). Preliminary cleanup levels are based on potential applicable or relevant and appropriate requirements (ARAR) and preliminary remediation goals, which are regulatory thresholds and/or standards or derived risk-based thresholds. Preliminary cleanup levels also are established taking into account levels identified in previous Central Plateau cleanup actions (e.g., RPP-PLAN-23827-R1, *200-UW-1 Proposed Plan, Single-Shell Tank Sampling and Analysis Plan*). Preliminary cleanup levels provide the basis for establishing final cleanup levels in the CERCLA record of decision (ROD and dictate analytical performance levels (i.e., laboratory detection limit requirements).

Phase 1 activities will be a combination of intrusive and nonintrusive activities. This phase will consist of a biased sampling that targets specific pipelines and specific soil locations within or around the pipelines. If a suspected area of waste accumulation or contamination cannot be identified, then pipelines and surrounding soil locations will be selected randomly. Evaluation of the Phase 1 sampling data will be used to guide further activities in the RI/FS process. These data may be determined to be sufficient for proposing a streamlined remedial decision-making process (i.e., contingent remedy, plug-in-approach, focused package, or observational approach for remedial action).

Phase 2 characterization activities will be initiated when there is considerable uncertainty concerning whether contamination above a preliminary cleanup level is present. The Phase 2 investigation will be used if Phase 1 results show a range of concentration values both above and below or close to preliminary cleanup levels. Phase 2 sampling will be required if all remedial alternatives will be assessed, including the no-action alternative. Phase 2 will entail collection of a larger data set, to include the no-action alternative in decision making. The Phase 2 evaluation will include more laboratory analyses than Phase 1. Phase 2 data will support decision documents and RI/FS processes.

Information regarding the current condition of pipeline system appurtenances (e.g., catch tanks, diversion boxes, valve pits) is limited. These components have a higher degree of complexity with regard to access and sampling for conducting characterization. This complexity does not make these components amenable to the Phase 1 characterization. This current work plan focuses on characterization of pipelines. Pipeline system appurtenances will be addressed as part of the more rigorous Phase 2 sampling and analysis. Based on the results of Phase 1, the DQO report (D&D-30262) may be revised to address these components, or an existing approved SAP will be identified and modified, as needed, to support Phase 2 data collection and characterization requirements for pipeline system appurtenances.

1.1.4.2 241-CX-70 Storage Tank, 241-CX-71 Neutralization Tank, and Hexone Storage Tanks 276-S-141 and 276-S-142

Five RCRA TSD tanks in the 200-IS-1 OU are identified as interim-status units under WAC 173-303, "Dangerous Waste Regulations." These tanks are listed in two WA7890008967, *Hanford Facility Resource Conservation and Recovery Act Permit, Dangerous Waste Portion, Revision 8, for the Treatment, Storage, and Disposal of Dangerous Waste*, Part A, Form 3's: three tanks in the Part A, Form 3, for the 241-CX Tank System (241-CX-70, -71, and -72); and two tanks in the Part A, Form 3 for the HSTF (276-S-141 and 276-S-142).

Closure activities that have been initiated for the two hexone tanks include pumping out the tank contents (excluding the tank heels and sludge) and decontaminating the distillation system and railcars (temporarily used to store the distillate). The tanks will be removed, and surrounding soil will be evaluated during tank removal to determine if it is contaminated. As part of the removal process, soil sampling and analysis will be performed to verify that the remaining soil is clean. Sampling requirements and the closure strategy will be provided in the closure plan.

Waste removal has been undertaken for the 241-CX-70 Storage Tank, and decontamination flushes were undertaken for the limestone aggregate in the 241-CX-71 Neutralization Tank. A closure plan will be prepared to describe additional closure activities. The closure plan will recommend that the tanks be clean closed. Closure activities, including the sampling and analysis activities that will be performed to verify that the remaining soil is clean following removal of the tanks, will be presented in the closure plan.

1.1.4.3 241-CX-72 Storage Tank

Residual waste remaining in the 241-CX-72 Storage Tank will require sampling and analysis to determine its composition. This work plan contains a SAP (Appendix C) describing the sampling and laboratory analyses that will be completed. The analytical results will support decisions concerning health and safety and disposal options for the tank and the remaining residual-waste contents. The closure strategy for this tank will be included in the closure plan for the 241-CX-70 Storage Tank and the 241-CX-71 Neutralization Tank. Depending on the waste composition inside the tank and whether a release to surrounding soil has occurred, closure options include RCRA clean closure or RCRA protective closure (landfill).

1.2 WORK PLAN CONTENT AND STRUCTURE

The content and structure of this work plan follow the CERCLA format, with modifications to concurrently satisfy the additional RCRA requirements. Modifications to the M-013 series of Tri-Party Agreement (Ecology et al., 1989a) milestones for non-tank-farm past-practice waste-site investigations approved in June 2002 (02-RCA-0341, "Hanford Federal Facility Agreement and Consent Order [Tri-Party Agreement] Change Requests for the Central Plateau Project [CPP] Activities," contains Modifications M-013-02-01, M-015-02-01, M-016-02-01, and M-020-02-01) included an approach to investigate similar OUs in a single RI/FS process. The milestone modification reduced the number of non-tank-farm work plans, RI reports, and FSs.

The strategy developed for closure of the CX Tank System and the Hexone Storage Tank System is addressed in this work plan. The work plan also outlines the regulatory pathway to site closeout for existing and newly identified RL and ORP pipeline-system waste sites. Conceptual contaminant-distribution models have been developed and are presented for the pipeline system structures that portray potential release characteristics. Final presentation of all supporting characterization data that will be used for remedial decision making for the pipeline systems will be presented in the RI report.

1.2.1 200-IS-1 Operable Unit Waste Sites

The 200-IS-1 OU initially was defined to include the waste sites identified in WIDS as being associated with the transfer of high-activity liquid wastes between separations plants and tank farms. The waste sites currently identified as part of the 200-IS-1 OU are listed in the Tri-Party Agreement Action Plan, Appendix C (Ecology et al., 1989b).

The waste-site grouping report (DOE/RL-96-81) provided the initial description of those sites to be included in the Tanks/Lines/Pits/Boxes Waste Group. This grouping (later formalized as an OU) included the large number of structures used in the transfer of high-activity liquid wastes from separations plants to tank farms, reprocessing facilities, and evaporators. The waste sites associated with the 200-IS-1 OU, composed of the diversion boxes, catch tanks, pipelines, and unplanned releases associated with high-activity waste transfer operations outside the tank farm OUs, subsequently were further identified and discussed in the Implementation Plan (DOE/RL-98-28, Appendix G).

Since the time that the original set of waste sites was listed in the Tri-Party Agreement Action Plan, Appendix C, other waste sites (i.e., waste transfer structures and associated unplanned releases) have been identified for inclusion in the 200-IS-1 OU. Currently, the majority of these new waste sites have not been included in the Tri-Party Agreement Action Plan, Appendix C, or in the WIDS database; however, data-collection activities are under way to delineate pipelines and related structures and integrate them into WIDS as waste sites. This work plan addresses all process-waste-carrying pipelines, diversion boxes, catch tanks, valve pits, and related structures outside the tank farm WMAs.

Certain RCRA TSD tanks are part of the 200-IS-1 OU. These TSD tanks include the CX Tank System (the 241-CX-70 Storage Tank, 241-CX-71 Neutralization Tank, and 241-CX-72 Storage Tank), the HSTF tanks (276-S-141 and 276-S-142 Hexone Storage Tanks), and the 241-Z Treatment and Storage Tanks System (241-Z-D-4, 241-Z-D-5, 241-Z-D-7, and 241-Z-D-8 Storage and Treatment Tanks; 241-Z Sump; and 241-Z Tank Pit). Closure certifications were submitted to Ecology in December 2006 to grant the 241-Z Treatment and Storage Tank System clean closure and the completion of Tri-Party Agreement Milestone M-083-32.

Other structures listed in the Tri-Party Agreement Action Plan, Appendix C, as part of the 200-IS-1 OU include 216-TY-201 (Supernatant Disposal Flush Tank), 200-W-16 Storage Tank (292-T Underground Tanks), 241-WR Vault (Tanks-001 through 009, 241-WR Diversion Station Vault), and the Hot Semiworks Valve Pit. These structures will be addressed during the Phase 2 work plan/SAP.

In addition, SST and DST RCRA pipeline components occur outside of the WMAs that are considered ancillary equipment and, as such, are associated with the SST Dangerous Waste Permit Application, Part A Form and the DST draft Part B Permit Application (WA 7890008967).

The other waste sites currently identified as part of the 200-IS-1 OU are RCRA past practice (RPP) sites. Waste sites assigned to the 200-IS-1 OU, as documented in the Tri-Party Agreement Action Plan, Appendix C (Ecology et al., 1989b), are tracked in WIDS. Addition of new waste sites and reclassification of accepted waste sites will be conducted in accordance with RL-TPA-90-0001, TPA-MP-14 procedures.

1.2.2 Scope and Content of the Sampling and Analysis Plans

Two SAPs are presented in this work plan for the Phase 1 characterization of the pipeline systems. The Phase 1 sampling specifications for selected facility process-waste pipeline systems (Bins 1-5) are provided in Appendix A and for the tank-farm waste-transfer pipelines (Bin 6) in Appendix B. The sampling designs developed include evaluation of contaminant characteristics inside pipelines and for soils adjacent to pipelines.

The characterization activities identified in the SAPs will provide data to refine the conceptual contaminant distribution models, support an assessment of risk, and evaluate remedial alternatives. The site evaluations and sampling requirements described in these SAPs are based on implementing the sampling-design elements identified in the DQO process documented in D&D-30262.

The field activities include investigations of both the interiors of selected pipelines and the adjacent soil areas. Pipeline interiors will be sampled to determine whether contamination is present as residual sediment, scale, or sludge. Known and suspected releases from pipelines in adjacent soil areas will be investigated by radiological logging and soil sampling. Field-screening techniques will be used to identify selected radiological and nonradiological contaminants. Laboratory analysis will be conducted on a limited number of samples for analyses of radiological and nonradiological COPCs. Sampling for waste designation will be addressed through a waste designation DQO process before the field-characterization activities begin.

The SAP prepared for the 241-CX-72 Storage Tank (Appendix C) has a limited scope and focuses on characterization of the waste remaining in the tank. Sampling of remaining waste will be conducted to determine the composition and concentrations of radionuclide and nonradionuclide constituents. A single borehole will be completed through the grout fill present in the tank and into the underlying residual waste material. Analytical results will be used in the assessment of the disposal options for the remaining waste, if removal of the tank is performed.

1.2.3 Milestones

The characterization and remediation of waste sites at the Hanford Site are addressed in the Tri-Party Agreement (Ecology et al., 1989a). The schedule of work at the Hanford Site is governed by Tri-Party Agreement milestones. Major milestones applicable for preparing the 200-IS-1 OU RI/FS work plan are as follows.

- M-013-00M: Submit one 200 Areas RI/FS (RFI/CMS) work plan for the 200-IS-1 Tanks/Lines/Pits/Diversion Boxes OU (includes waste sites in the 200-ST-1 Septic Tank and Drain Fields OU) by December 31, 2002. (NOTE: This milestone has been completed.)

- M-013-27: Submit a revised RI/FS work plan for the 200-IS-1 and 200-ST-1 OUs to Ecology to identify likely response scenarios and potential applicable technologies, identify the need for treatability investigations, and include SAPs. In instances where RCRA authority requires investigation of past-practice units, Ecology agrees, pursuant to Ecology's Dangerous Waste Regulations, that DOE may satisfy the requirements for an RFI/CMS work plan by submitting an RI/FS work plan by June 30, 2007.

- M-020-00B: Submit closure/postclosure plans for the 216-A-10, 216-A-36B, 216-A-37-1, 207-A South Retention Basin, 216-S-10 Pond, 216-S-10 Ditch, 241-CX-70, 241-CX-71, and 241-CX-72 by December 31, 2008.

- M-020-54: Submit 241-CX-70 Storage Tank, 241-CX-71 Neutralization Tank, 241-CX-72 Storage Tank closure/postclosure plan to Ecology in coordination with the 200-IS-1 Tanks/Lines/Pits/Boxes and 200-ST-1 Septic Tank OUs work plan FS scheduled under M-013-00M by December 31, 2008.

- M-015-00: Complete the RI/FS process for all OUs. In instances where RCRA authority requires investigations of past-practice units, Ecology agrees, pursuant to Ecology's Dangerous Waste Regulations, that DOE may satisfy the requirements for an RFI/CMS report by submitting an RI/FS report by December 31, 2011.

- M-015-00C: Complete all 200 Area non-tank-farm OU site investigations under approved work plan schedules through submittal of FS reports and a recommended remedy(ies). In instances where RCRA authority requires investigation of past-practice units, Ecology agrees, pursuant to Ecology's Dangerous Waste Regulations, that DOE may satisfy the requirements for an RFI/CMS report by submitting an RI/FS report. The recommended remedy(ies) will be sufficiently comprehensive to satisfy the technical requirement of RCRA, Hazardous Waste Management Act[1] (HWMA), and CERCLA statutory authorities and respective regulations with respect to all hazardous substances, pursuant to the HFFACO,[2] Article IV, paragraph 178, and the Action Plan, Section 5.4, by December 31, 2011.

1.3 STREAMLINING APPROACHES TO THE CERCLA PROCESS

Five streamlining approaches to the CERCLA process have been identified as having application to the 200-IS-1 OU and are described below. The first four approaches also are discussed in the Implementation Plan (DOE/RL-98-28). The fifth approach, a graded approach, is a process that ensures that the level of analysis, documentation, and actions are appropriate for decision making associated with the pipelines. These streamlining approaches could be used to meet the requirements for site evaluations and/or for development of the ROD for the 200-IS-1 OU.

1. Contingent or alternate remedy: Developed for cases where uncertainty is associated with the preferred remedy. Use of a contingent or alternate remedy would be included in the ROD in the event that post-ROD confirmation sampling indicates that an alternate remedy is more appropriate for the site. Development of a ROD that permits use of contingent or alternate remedies may be applicable to some 200-IS-1 OU pipelines, diversion boxes, catch tanks, and related waste sites.

2. Plug-in approach: An approach geared toward implementing remedial actions for new sites identified and/or evaluated after a ROD has been issued. The plug-in approach is

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[1] RCW 70.105, "Public Health and Safety," "Hazardous Waste Management" (also known as the Washington State Hazardous Waste Management Act of 1976).

[2] *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a).

built into the ROD through the incorporation of criteria that must be met before a new site can "plug into" the selected remedy(s). Use of the plug-in approach may require additional sampling and evaluation to ensure that the criteria are met. This approach may be applicable to any new waste site identified post-ROD for inclusion in the 200-IS-1 OU. Confirmation sampling results would be used to substantiate that the waste site could "plug in" and be remediated by an approved remedy.

3. Focus package: Used for sites with minimal need for remediation, or where a remedial action would follow the path that already was followed at similar waste sites. The focus package provides evaluation, analyses, and documentation demonstrating that remedial alternatives are not required; provides site-specific information to complete the remedy selection process; and supports issuance of a proposed plan and new or modified ROD.

4. Observational approach: Uses real-time data collection associated with excavation activities. Provides the flexibility necessary to adapt to actual site conditions encountered during remedial actions by scaling the level of effort to the conditions encountered. This method of streamlining is considered to be more cost effective and time effective than traditional approaches that require substantial amounts of preremediation characterization data. The observational approach is expected to be applicable to the 200-IS-1 OU pipelines, diversion boxes, and associated waste sites that are identified for removal.

5. Graded approach: Integrates available data, process knowledge, expert opinion, professional judgment, probabilistic statistical data evaluations, and modeling (risk, fate and transport) to determine/define data requirements for remedial decisions. This integration allows for a graded approach in determination of the data needed for remedy selection and decision making. With this approach, remedial decisions can be made at any point at which criteria established for data sufficiency have been met.

1.4 WORK PLAN CHANGE CONTROL

Following approval of this work plan, the major elements (RI/FS steps) of the work plan are requirements that are not expected to change; therefore, the work plan should not change. Specific workscope elements might require modification or refinement as the work progresses. Changes that do not affect the overall intent of the approved work plan or schedule can be made using a change notice. Alternately, and if agreed to by RL, ORP, and the lead regulatory agency, unit managers' meetings or predecessor primary documents requiring RL and lead regulatory agency approval also can be used to document changes (e.g., the RI report can be used to document refinements to or focus the FS). Changes to the project schedule that affect assigned M-015 interim milestones will require approval through the Tri-Party Agreement (Ecology et al., 1989a) change control process.

2.0 BACKGROUND AND SETTING

This section includes descriptions of the 200-IS-1 OU waste sites, physical setting, and the general hydrogeologic conditions. The information presented in this section also identifies the waste-generating processes associated with the 241-CX-70 Storage Tank, 241-CX-71 Neutralization Tank, and 241-CX-72 Storage Tank, and the 276-S-141 and 276-S-142 Hexone Storage Tanks (RCRA TSD units) and the process-waste pipeline systems. A general description of each of the 200-IS-1 OU pipeline-system bins and the CX Tank System and Hexone Storage Tanks is provided. Additional site-specific information for 200-IS-1 OU pipeline-system waste sites is provided in Appendix D. Information in this section has been compiled from a number of sources, the most significant of which are as follows:

- D&D-30262
- DOE/RL-98-28
- DOE/RL-96-81
- PNNL-15670, *Hanford Site Groundwater Monitoring for Fiscal Year 2005*
- PNNL-16346, *Hanford Site Groundwater Monitoring for Fiscal Year 2006*
- WIDS
- Hanford Site engineering drawings
- *Tank Waste Information Network System* (TWINS) database.

2.1 SUMMARY OF HYDROGEOLOGIC CONDITIONS

This section summarizes the geology and hydrogeology associated with the 200 Areas inclusive of the 200-IS-1 OU. Additional information on the physical setting of this OU can be found in the Implementation Plan (DOE/RL-98-28) and in other documents as cited in the text. Detailed information on the hydrogeologic setting of the 200 Areas and vicinity can be found in PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, and PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington.*

2.1.1 Topography

The 200-IS-1 OU is located in the Central Plateau, which is a broad, relatively flat prominent terrace (Cold Creek Bar) that constitutes a local topographic high near the center of the Hanford Site. The Cold Creek Bar was formed about 13,000 years ago during the last cataclysmic flood from glacial Lake Missoula. The Cold Creek Bar trends generally east-west with elevations between 197 and 225 m (646 to 738 ft) above mean sea level (amsl) (NAVD88, *North American Vertical Datum of 1988*). The plateau drops off rather steeply to the north and northwest into a former flood channel with elevation changes of between 15 and 30 m (49 and 98 ft). The plateau gently decreases in elevation to the south into the Cold Creek valley and to the east toward the Columbia River. Most of the 200 West Area and the southern half of the 200 East Area are situated on the Cold Creek Bar, while the northern half of the 200 East Area lies within the former flood channel. A secondary flood channel running south from the main channel bisects the 200 West Area. The buried former river and flood channels may provide preferential pathways for groundwater and contaminant movement. More detail on the physical setting of the 200 Areas and vicinity is provided in DOE/RL-98-28, Appendix F.

The topography of the Central Plateau at the Hanford Site is shown in Figure 2-1. The 200 West Area occupies a relatively flat area in a secondary flood channel. Surface elevations range from approximately 200 to 220 m (656 to 722 ft) amsl (NAVD88), and the ground surface slopes gently to the southwest. The surface of the 200 East Area slopes gently to the northeast. Surface elevations in the 200 East Area range from approximately 180 m (590 ft) amsl (NAVD88) in the northeast corner of the area to about 230 m (755 ft) amsl (NAVD88) in the southeast corner of the area.

2.1.2 Geology

The 200-IS-1 OU is located in the Pasco Basin, one of several structural and topographic basins of the Columbia Plateau. Basalts of the Columbia River Basalt Group and a sequence of suprabasalt sediments underlie the 200 East and 200 West Areas. From oldest to youngest, the major geologic units present consist of the Elephant Mountain Member, the Ringold Formation, the Cold Creek unit, the Hanford formation, and surficial deposits. Figure 2-2 shows the generalized stratigraphic nomenclature used in the 200 Areas. Descriptions of the geologic units of interest are provided below.

Elephant Mountain Member. The Elephant Mountain Member is part of the Saddle Mountains Basalt, the uppermost formalized formation in the Columbia River Basalt Group. The Elephant Mountain Member is the uppermost basalt unit (i.e., bedrock) in the 200 Areas (DOE/RL-98-28, Appendix F). Except for a small area north of the 200 East Area, where it has been eroded away, exposing basalt of the Pomona Member of the Saddle Mountains Basalt, the Elephant Mountain Member is laterally continuous throughout the 200 Areas.

Ringold Formation. The Ringold Formation consists of an interstratified fluvial-lacustrine sequence of unconsolidated to semiconsolidated clay, silt, sand, and granule-to-cobble gravel deposited by the ancestral Columbia River (PNNL-12261, PNNL-13858). These sediments, shown in Figure 2-2, consist of four major units (from oldest to youngest): the fluvial gravel and sand of unit 9 (basal coarse, Ringold Unit A); the buried soil horizons, overbank, and lake deposits of unit 8 (Ringold Lower Mud); the fluvial sand and gravel of unit 5 (upper coarse, Ringold Unit E); and the lacustrine mud of unit 4 (upper fines, Upper Ringold). Units 9 and 5 consist of a silty-sandy gravel with secondary lenses and interbeds of gravelly sand, sand, and muddy sands to silt and clay.

Figure 2-1. Topographic Map of the Central Plateau at the Hanford Site.

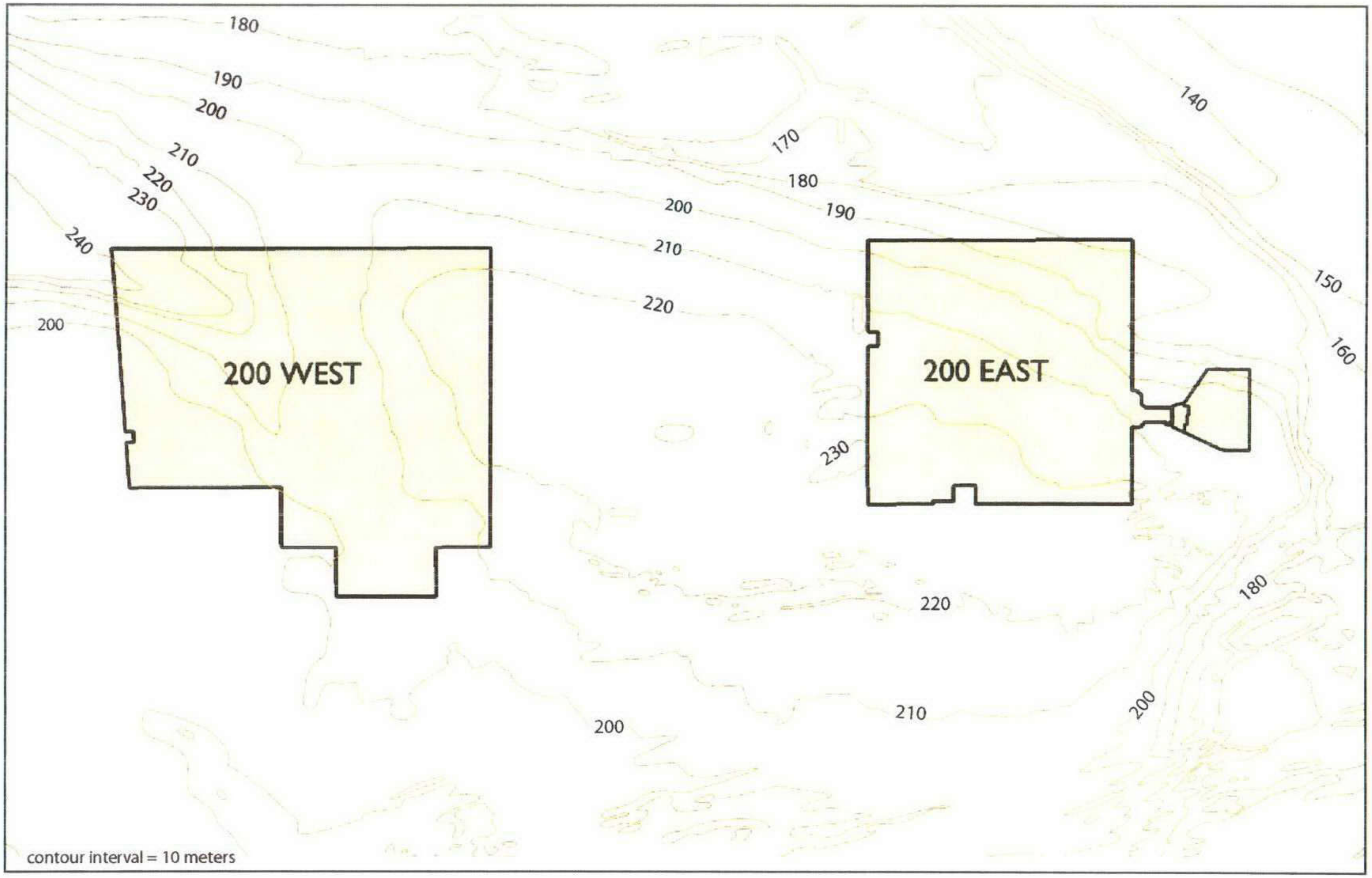
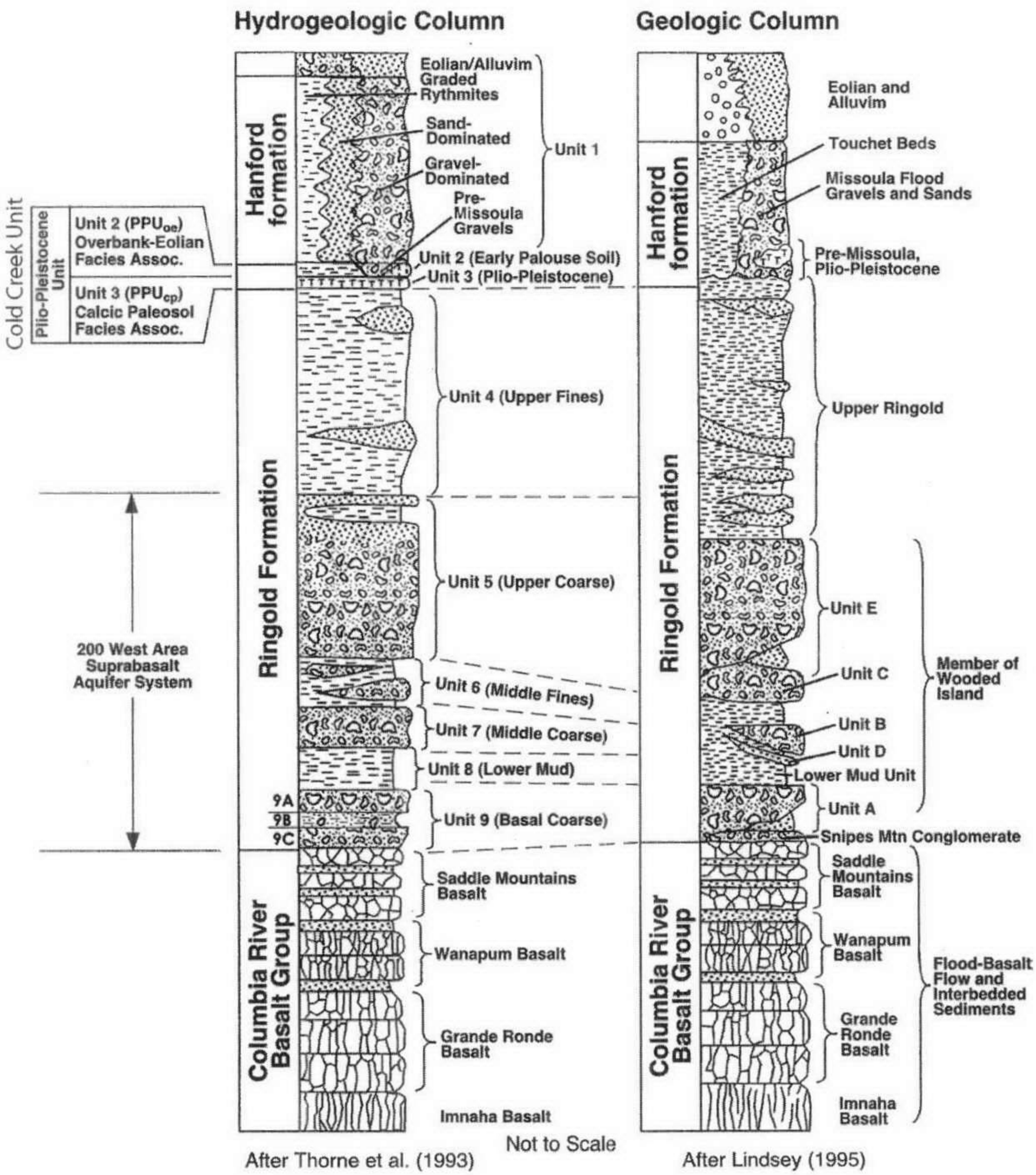


Figure 2-2. Generalized Stratigraphic Columns for the 200 Areas.

(From PNNL-12261, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*, and PNNL-13858, *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington*)



After Bjornstad et al. (2002)

Unit 8 consists mainly of silt and clay. Unit 4 consists of silty over-bank deposits and fluvial sand. Units 6 and 7 are not present beneath the 200 West and 200 East Areas (PNNL-12261, PNNL-13858).

Cold Creek unit. The Cold Creek unit is the recently standardized name applied to several post-Ringold Formation and pre-Hanford formation units present beneath the 200 East and 200 West Areas (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the Central Pasco Basin*). The Cold Creek unit includes the formations formerly described as the Plio-Pleistocene unit, caliche (unit 3), early Palouse soil (unit 2), Pre-Missoula gravels, and sidestream alluvial facies described in previous site reports. The Cold Creek unit has been divided into five lithofacies: fine-grained, laminated to massive (fluvial-overbank and/or eolian deposits [unit 2], formerly called the early Palouse soil); fine- to coarse-grained, calcium-carbonate cemented (calcic paleosol [unit 3], formerly called the caliche); coarse-grained, multilithic (mainstream alluvium, formerly called the Pre-Missoula gravels); coarse-grained, angular, basaltic (colluvium); and coarse-grained, rounded, basaltic (sidestream alluvium, formerly called the sidestream alluvial facies) (DOE/RL-2002-39).

Hanford formation. The Hanford formation (unit 1) is the informal stratigraphic name used to describe the Pleistocene cataclysmic flood deposits in the Pasco Basin (DOE/RL-2002-39). The Hanford formation consists predominantly of unconsolidated sediments that range from boulder-size gravel to sand, silty sand, and silt. The sorting ranges from poorly sorted (for gravel facies) to well sorted (for fine sand and silt facies). The Hanford formation is divided into three main lithofacies: interbedded sand- to silt-dominated (formerly called the Touchet beds or the slackwater facies); sand-dominated (formerly called the sand-dominated flood facies); and gravel-dominated (formerly called the Pasco gravels), which have been subdivided further into 11 textural-structural lithofacies (DOE/RL-2002-39). Beneath the waste sites of the 200-IS-1 OU, the Hanford formation includes all three facies. The gravel-dominated facies are cross-stratified, coarse-grained sands and granule-to-boulder gravel. The gravel is uncemented and matrix-poor. The sand-dominated facies are well-stratified fine- to coarse-grained sand and granule gravel. Silt in these facies is variable and may be interbedded with the sand. Where the silt content is low, an open-framework texture is common.

Clastic dikes are common in the Hanford formation but are rare in the Ringold Formation (DOE/RL-98-28; DOE/RL-2002-39). They appear as vertical to subvertical sediment-filled structures, especially within sand- and silt-dominated units.

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

Surficial Deposits. Surficial deposits include Holocene eolian sheets of sand that form a thin veneer over the Hanford formation across the site, except in localized areas where the deposits are absent. Surficial deposits consist of very fine- to medium-grained sand to occasionally silty sand. Silty deposits less than 1 m (approximately 3 ft) thick also have been documented at waste sites where fine-grained, wind-blown material has settled out through standing water over many years (DOE/RL-98-28, Appendix F).

2.1.3 Vadose Zone

The vadose zone is approximately 104 m (341 ft) thick in the southern section of the 200 East Area and thins to the north to as little as 0.3 m (1 ft) near West Lake, north of the 200 East Area. Vadose-zone hydrostratigraphic units in the 200 Areas include the Ringold Formation, Cold Creek unit, Hanford formation, and surficial deposits (see Figure 2-2).

The Cold Creek unit may be present in a small area immediately above the basalt. Because erosion during cataclysmic flooding removed much of the Ringold Formation north of the central part of the 200 East Area, the vadose zone predominantly is composed of Hanford formation sediments between the northern part of the 200 Areas and Gable Mountain. Basalt projects above the water table north of the 200 East Area (PNNL-12261), and the Ringold Formation unit 8 (Ringold Lower Mud) occurs at or above the water table east of the 200 East Area (PNNL-12261) and northeast of the 200 West Area, west of the 200 East Area (PNNL-13858). In the 200 West Area, the vadose-zone thickness ranges from 40.2 to 102 m (132 to 335 ft). Sediments in the vadose zone are the Ringold Formation, Cold Creek unit, and Hanford formation. Erosion during cataclysmic flooding removed some of the Ringold Formation and the Cold Creek unit.

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

2.1.4 Groundwater

The unconfined aquifer in the 200 Areas occurs within the Hanford formation, Cold Creek unit, or Ringold Formation, depending on location. The base of the unconfined aquifer is predominately the top of the Ringold Formation unit 8 (Ringold Lower Mud) in the 200 West Area and is predominately the top of basalt (Elephant Mountain Member) in the 200 East Area.

Regionally, groundwater in the unconfined aquifer flows from recharge areas where the water table is higher (west of the Hanford Site) to areas where it is lower, near the Columbia River (PNNL-13404, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*). Water-table maps for the 200 East and 200 West Areas, showing water-table elevations and general direction of flow, are presented in Figures 2-3 and 2-4, respectively.

Figure 2-3. Water-Table Map of the 200 East Area, July 2005.

(From PNNL-15070, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*)

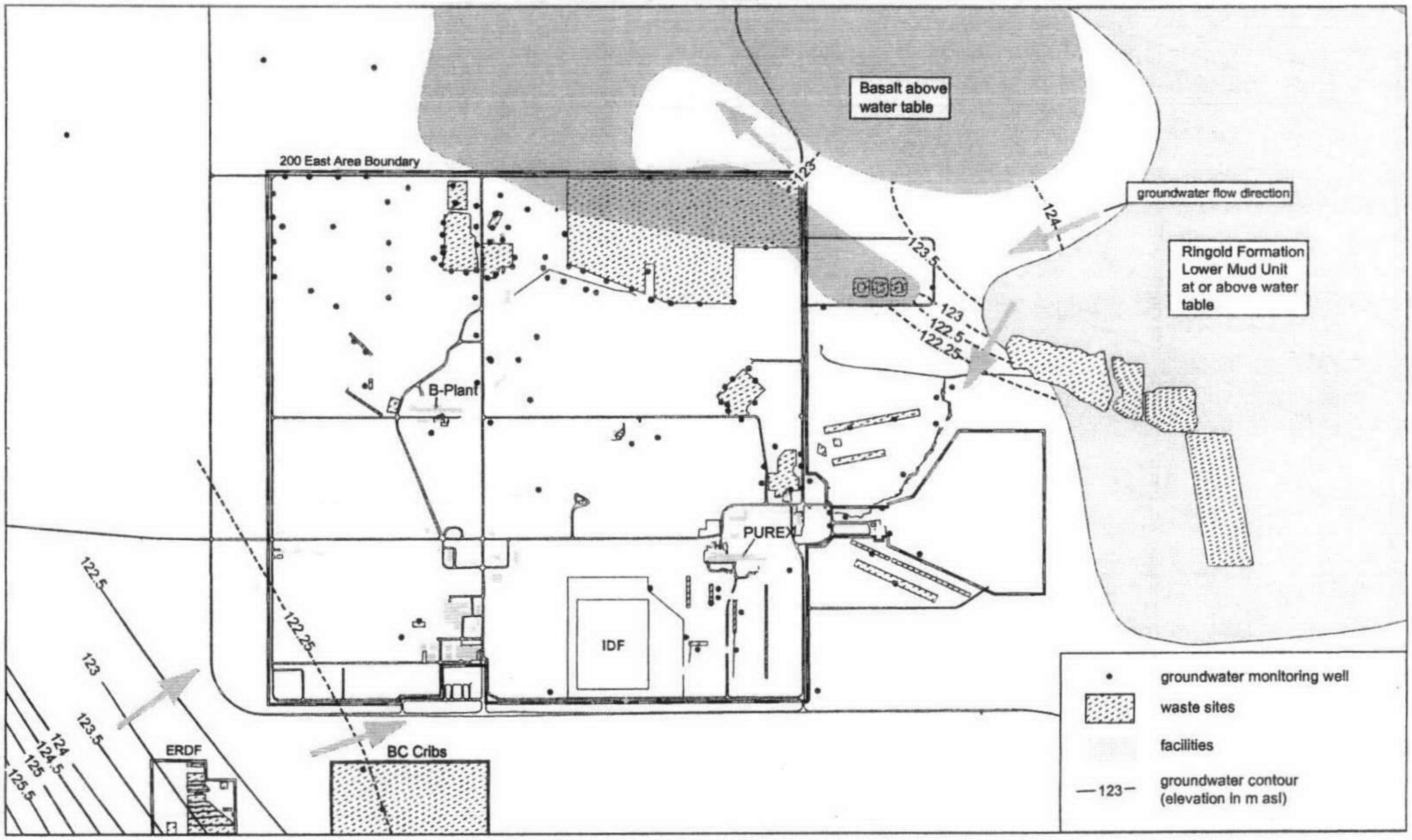
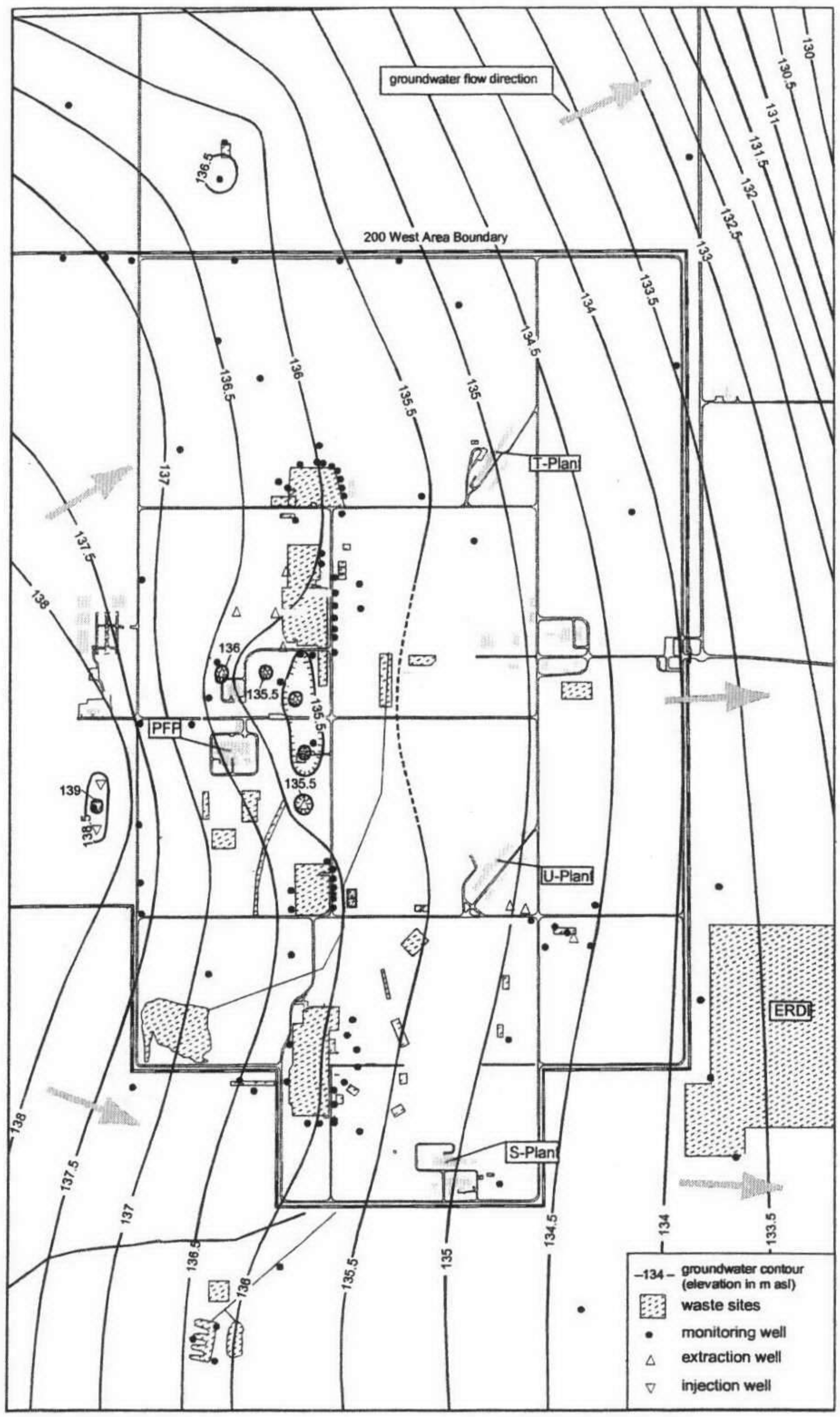


Figure 2-4. Water-Table Map of the 200 West Area, 2005.

(From PNNL-15070, *Hanford Site Groundwater Monitoring for Fiscal Year 2004*)



In the northern half of the 200 East Area, the water table primarily is present in the Hanford formation, except where basalt extends above the water table, resulting in the absence of the uppermost unconfined aquifer (PNNL-12261). In the north-central portion of the 200 West Area, the water table occurs in the Cold Creek unit. Both east and west of the 200 East Area, the Ringold Formation unit 8 (Ringold Lower Mud) occurs at an elevation that results in the absence of the uppermost unconfined aquifer. In the central and southern sections of the 200 East Area, the water table is located near the contact between the Ringold Formation and the Hanford formation.

Depth to groundwater in the 200 East Area and vicinity ranges from about 54 m (177 ft) below ground surface (bgs) near B Pond to about 104 m (341 ft) bgs to the south. The water-table surface across most of the 200 East Area generally is flat (Figure 2-3), making it difficult to determine the groundwater flow direction. The configuration of contaminant plumes, however, indicates that groundwater likely flows to the northwest in the northern half of the 200 East Area and to the east/southeast in the southern half of the 200 East Area (generalized contaminant plume maps are presented in Chapter 3.0). Identifying the specific location of the groundwater divide between the northern and southern sections is hampered by the flat water table. Highly transmissive Hanford formation sediments are the cause of the flat water table in the 200 East Area (PNNL-15670, PNNL-16346). Because of the complex hydrogeologic conditions in the 200 East Area, significant uncertainty exists with respect to the actual groundwater flow directions and gradients (PNNL-15070). Since surface liquid discharges were terminated in the 200 East Area, the water table has been declining rapidly, with a recent rate measured at about 0.13 m/yr (0.43 ft/yr), based on water-level measurements collected between March 2004 and March 2005 (PNNL-15670, PNNL-16346).

Groundwater beneath the 200 West Area occurs primarily in the Ringold Formation. Depth to water varies from about 40.2 m (132 ft) bgs to greater than 102 m (335 ft) bgs. Groundwater flow direction is more definitive in this area and is predominately to the east (Figure 2-4). The surface elevation of the water table beneath the 200 West Area currently is declining at a rate of 0.36 m/yr (1.2 ft/yr) (PNNL-15670). Currently, the water-table elevation is approximately 12 m (approximately 36 ft) above an estimated water-table elevation before the start of Hanford Site operations.

Recharge to the unconfined aquifer within the 200 Areas is primarily from artificial sources and, to a lesser extent, from natural precipitation. Estimates of recharge from precipitation are highly variable and locally range from 0 to a maximum of 10 cm/yr (0 to 4 in/yr) and are largely dependent on soil texture and the type and density of vegetation (PNNL-14702, *Vadose Zone Hydrogeology Data Package for the 2004 Composite Analysis*). PNL-5506, *Hanford Site Water Table Changes 1950 through 1980 – Data Observation and Evaluation*, reports that between 1943 and 1980, 6.33×10^{11} L (1.67×10^{11} gal) of liquid wastes were discharged to the soil column in the 200 East and 200 West Areas. Most sources of artificial recharge were terminated in 1995. The artificial recharge that does continue largely is limited to liquid discharges from sanitary sewers, two state-approved land-disposal structures, and 140 small-volume, uncontaminated miscellaneous liquid-discharge streams. One of the approved land-disposal structures is the Treated Effluent Disposal Facility (TEDF), a liquid-waste disposal facility that receives treated liquid wastes from the 200 East and 200 West Area facilities.

2.2 PROCESS OPERATION DESCRIPTIONS AND HISTORY

The waste streams handled by the 200-IS-1 OU pipeline systems relate directly to the operations conducted at the process facilities located in the 200 East and 200 West Areas. The primary facilities involved in the generation or storage of process wastes and involved use of pipelines include the following:

- B Plant
- T Plant
- U Plant and Uranium Trioxide (UO_3) Plant
- Reduction-Oxidation (REDOX) Plant (S Plant)
- Plutonium-Uranium Extraction (PUREX) Plant (A Plant)
- Z Plant Complex
- Hot Semiworks Facility (C Plant)
- Tank farms, evaporators, and ancillary facilities.

The U Plant and UO_3 Plant are listed here for completeness of information on process-waste operations. Pipelines located within the 200-UW-1 OU that are connected to disposal waste sites (e.g., cribs, trenches) are not part of the 200-IS-1 OU process-waste pipeline systems. Portions of the waste-transfer pipelines that extend outside the 200-UW-1 OU, such as tank farm waste-transfer lines, are addressed by the 200-IS-1 OU.

The pipeline systems received liquid waste from 200 Areas operations, including the following:

- Bismuth phosphate/lanthanum fluoride
- Uranium Recovery Process, UO_3 operations, and scavenging operations
- REDOX process
- PUREX process
- Isotope (strontium/cesium) separations, recovery, and storage operations
- Plutonium Finishing Plant operations, machining, and plutonium/americium scrap recovery processes (i.e., Recovery of Uranium and Plutonium by Extraction process [RECUPLEX], Plutonium Reclamation Facility, and americium recovery)
- Tank-waste evaporation/solidification operations.

The primary process operations that generated the waste streams that were transferred in the 200-IS-1 OU pipeline systems are discussed in the following subsections. This process discussion also links the waste streams generated to the process-waste-type categories that were established and used for the current OU designations within the 200 Areas. A summary of the general characteristics of the waste-stream categories that are encompassed by each of the pipeline bins is presented following the operational processes information.

2.2.1 Primary Processes

The 200 Areas operations included the following five primary processes:

- Fuel processing
- Plutonium isolation
- Uranium recovery
- Cesium/strontium recovery
- Waste storage/treatment.

Each of these processes generated a variety of waste streams. However, specific waste types were isolated at the point of generation and discharged to specific disposal sites. Four of the primary process streams identified above are discussed below. The Uranium Recovery Process was conducted at the U Plant Facility. Pipelines in the 200-UW-1 OU are not included in the scope of this work plan.

2.2.1.1 Fuel Processing

Fuel processing started in the mid-1940s using the batch-operation bismuth phosphate ($BiPO_4$) extraction process at the 221/224-B Plant and 221/224-T Plant. Starting in the late 1940s, technological improvements led to the development of the continuously operating hexone-based solvent-extraction (REDOX) process and, in the mid-1950s, to the tributyl phosphate (TBP) solvent-extraction (PUREX) processes at the 202-S Plant and 202-A Plant facilities, respectively. Solvent-extraction processes also were used to recover cesium and strontium from tank wastes at the 221-B Plant from the mid-1960s to mid-1970s. A number of other shorter term processes were established at various facilities to recover valuable radionuclides.

2.2.1.2 Plutonium Isolation

Plutonium was isolated and prepared for shipment at the 231-Z Plant in the mid- to late 1940s using a peroxide/nitrate-based batch process. New processes were developed to improve plutonium refining, and the 234-5Z Plutonium Finishing Plant Building was constructed to convert plutonium into an oxide or metal. The 234-5Z Plant was modified to recover scrap plutonium via the RECUPLEX process and, later, the Plutonium Reclamation Facility. Americium also was recovered from plant wastes. The TBP/carbon tetrachloride solvent extraction was the basis for the purification processes (DOE/RL-91-58, *Z Plant Source Aggregate Area Management Study Report*).

Plutonium production at the Hanford Site began with the delivery of cylindrical metal uranium billets to the 300 Areas. The metal was heated, forced through an extrusion die, and formed into a cylindrical rod, followed by air quenching and inspection. The rods were machined and cut into slugs. The slugs then were canned inside aluminum jackets and bonded to the material with an aluminum-silicon alloy (DOE/RL-98-28).

The slugs were placed in the reactor pile and irradiated. Following irradiation, the slugs were pushed out from the reactor pile and collected in basins for cooling. Next, the fuel rods were taken to the 200 East Area or the 200 West Area for processing in one of the separations plants (DOE/RL-98-28). The various separations processes are described in more detail in the

Implementation Plan (DOE/RL-98-28, Appendix G). All separations processes required decladding of the fuel slugs by caustic dissolution of the aluminum jacket or by basic dissolutions of the zirconium jacket. During this step, only the jacket was dissolved and lesser quantities of chemical and radiological constituents were generated.

Following that, the uranium fuel rod was dissolved in a bath of nitric acid in preparation for the particular separations process steps. The initial $BiPO_4$ process at the B and T Plants separated and concentrated plutonium from the rest of the dissolved material by multiple precipitations. The $BiPO_4$ preferentially attracted the plutonium from the rest of the solution and, as a precipitate, was physically separated by centrifuging. Repeated dissolution and precipitation, using both $BiPO_4$ and lanthanum fluoride, led to recovery of the plutonium and removal of the uranium and fission products. This process generated large volumes of uranium-rich and fission product-rich wastes (HW-23043, *Flow Sheets & Flow Diagrams of Precipitation Separations Process*). The waste types generated during these processes included those waste streams received at the 200-PW-2, 200-PW-4, and 200-PW-5 OU disposal sites. Most low-level liquid wastes generated as part of this process were sent to ponds. This included those waste streams associated with the 200-CW-1, 200-CW-4, and 200-SC-1 OU disposal sites. The B Plant operations of the $BiPO_4$ process ended in late 1952, and T Plant operations of the $BiPO_4$ process ended in late 1956. High-activity-waste storage was an operational concern for production facility operations throughout the 200 Areas. The $BiPO_4$ process generated large quantities of liquid waste, which necessitated construction of four additional tank farms. An initial approach to declining tank space was to pump the least contaminated low-activity supernatant of the stored-waste streams to nearby cribs (200-TW-1 and 200-TW-2 OU disposal sites). Next, evaporators were built in 1951 at the B and T Tank Farms to reduce the volume of liquids in storage.

The $BiPO_4$ process was a relatively slow stepwise approach to recovering plutonium and generated large volumes of liquid waste. Organic solvent-extraction processes were applied in 1951 with the implementation of the REDOX process at the 202-S Plant. Immediate benefits in production were observed because of the plant's ability to operate continuously. This plant used the organic compound methyl isobutyl ketone (MIBK or hexone) as a solvent to remove both plutonium and uranium from the dissolved fuel-rod solution. The process passed the dissolved-acid fuel-rod solution down tall columns by gravity flow, through a less dense, rising countercurrent of organic liquids. Through mixing, both plutonium and uranium were stripped out of the acid by the hexone, which was pulled off at the top of the column. Next, plutonium was removed from the uranium-rich hexone solution and purified, in this case using inorganic acids to reduce the plutonium to the extractable plutonium (III) valence state in similar countercurrent flow columns. Uranium was recovered using similar extraction processes in a separate set of process columns. Recovery and reuse of the solvent was achieved through this process (HW-18700-DEL, *REDOX Technical Manual*). High-fission-product wastes generated at the REDOX Plant were stored in the tank farms. Because it operated continuously, the plant also generated significant quantities of low-level wastes, which were discharged to ponds and cribs (200-CW-2 OU disposal sites). The REDOX process operated from 1951 to 1967, and the waste concentrators were active during the same time frame (DOE/RL-91-60, *S Plant Source Aggregate Area Management Study Report*).

2.2.1.3 Plutonium/Uranium Recovery

The PUREX process at the 202-A Plant Building was the final large-scale separations process developed. It used the same countercurrent flow principles of solvent extraction that were used at the REDOX Plant, but benefited from significant design and process improvements. Again, as at the REDOX Plant, both plutonium and uranium were recovered and purified, as were the solvents and acids. The plant used a much less flammable two-part organic mix, TBP in a normal paraffin hydrocarbon (NPH or kerosene), to separate plutonium and uranium from the nitric acid-dissolved fuel-rod solution. The TBP process was much more efficient in the rate of processing and was safer and cleaner in operation. The PUREX Plant began operation in late 1955 and ran continuously until 1972. Following an 11-year hiatus, the plant was restarted in 1983 and ran intermittently through 1988. High-fission-product wastes generated at the PUREX Plant were stored in tank farms. The plant also generated significant quantities of low-level wastes, which were discharged to ponds, cribs, and french drains (200-CW-1 and 200-SC-1 OU disposal sites) (BHI-00178, *PUREX Plant Aggregate Area Management Study Technical Baseline Report*).

The recovered, purified plutonium was refined to one of several forms, depending on the era. At the start of Hanford Site operations, plutonium was refined in the 231-Z Plutonium Isolation Facility, where it was converted to a nitrate paste before being shipped off site. Shortly thereafter, however, a more elaborate plant, the Plutonium Finishing Plant, was constructed with the capability to convert plutonium into metal, nitrate, or oxide forms. A number of process lines in the 234-5Z Plutonium Finishing Plant Building were used between 1949 and 1989. Initially, batch inorganic chemical steps were used to refine and convert plutonium to the desired form. Later, more elaborate extraction processes were developed. The Plutonium Finishing Plant also was used for reprocessing scrap plutonium, using solvent-extraction techniques based on TBP mixed with carbon tetrachloride. Processing operations resulted in waste stream discharges to 200-PW-1, 200-PW-3, 200-PW-6, and 200-SC-1 OU disposal sites (DOE/RL-91-58; HNF-EP-0924, *History and Stabilization of the Plutonium Finishing Plant (PFP) Complex, Hanford Site*).

2.2.1.4 Cesium/Strontium Recovery

In 1954, the cesium/strontium recovery process was found to reduce the amount of fission products (especially Sr-90) in the high-activity Uranium Recovery Process and PUREX process wastes by scavenging (precipitation through chemical additions), and the treated liquids were determined to be suitable for discharge to the soil column (200-PW-3 and 200-PW-4 OU waste sites) (ARH-564, *B Plant Recovery of Cesium from Current Acid Wastes by Phosphotungstate Precipitation*). At about the same time, more tank space was freed up in 1954-1955 by discharging another of the less contaminated high-activity waste-stream supernatants to the ground (200-TW-2 OU disposal sites).

Several waste fractionization campaigns were conducted between 1963 and 1983 to recover certain radionuclides, including Cs-137, Sr-90, and certain rare-earth isotopes for which specific uses or applications had been identified. The program was implemented at the 221-B Plant facility and used a variety of chemical processes, including solvent extraction and ion exchange, to recover target isotopes. Resulting waste streams were disposed of at 200-PW-3, 200-PW-4, and 200-PW-5 OU waste sites. The program was superseded by the Waste Encapsulation and Storage Facility, which concentrated cesium and strontium into dry-salt compounds. The powders then were placed in doubly welded capsules and stored in cooling pools. The waste streams generated were disposed of at 200-PW-4 and 200-PW-5 OU waste sites (DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*).

Many of the full-scale production processes described above were developed in laboratories at both experimental and bench-scale levels, using small quantities of nonradioactive elements or small quantities of radioactive isotopes. Before full plant implementation, tests were performed in near full-scale vessels and at working concentrations to examine problems in scaling up the chemical principles and processes. This "semiworks" scale of testing was conducted at one of two places. The earliest $BiPO_4$ developmental testing was conducted in the "head-end" section of the 221-T Plant Building. However, much more extensive development work for REDOX, Uranium Recovery Process, PUREX, and the fission-product fractionization processes was undertaken at the 201-C Plant Building, also known as the Hot Semiworks Facility. Wastes generated in these processes were disposed of at the 200-PW-2, 200-PW-3, 200-PW-4, and 200-PW-5 OU liquid-waste disposal sites (DOE/RL-2000-38).

2.2.1.5 Tank Farm Waste Transfers

Radioactive wastes that were generated by the separations plants discussed above were stored in 149 SSTs and 28 DSTs beginning in 1944. The 177 tanks were constructed in 12 SST and 6 DST tank farms. Each tank farm was designated with an alphabetic code (A, B, C, S, T, and U) that indicated the original processing plant from which the tank farm received waste.

The initial processing facilities included B Plant, T Plant, and U Plant. The B, C, T, and U Tank Farms were constructed in 1943 to receive waste from these plants. In 1947, the BX Tank Farm was built for added storage capacity. The operating capacity of these first-generation tank farms was quickly reached, and new second-generation tanks were constructed between 1948 and 1953 in the new BY, S, TX, and TY Tank Farms. Third-generation tanks were built between 1954 and 1963 at the A, AX, and SX Tank Farms.

Between 1966 and 1986, DSTs were constructed at the remaining SY, AN, AP, AW, AY, and AZ Tank Farms. These tanks provided an increased capacity and could handle high-heat loads associated with self-boiling high-level/high-activity wastes generated at the REDOX and PUREX Plants.

Waste transfers from the plants to the tank farms and between tank farms were accomplished using a pipeline system that consisted of a variety of pipelines and diversion boxes. Pipelines used to transfer high-level/high-activity wastes initially were buried directly in trenches, but because failures in these lines occurred in the 1940s, subsequent construction involved placement in concrete encasements. The encasements extended between diversion boxes and were designed so that any liquids lost from leaks or pipeline failure would drain to a drain in the diversion box, which conveyed the release to a catch tank. Pipe-in-pipe transfer lines also were installed in addition to the concrete encasement pipelines. The outer pipeline had a drain to a diversion box or pit.

The following is a summary of the tank farm system and the process wastes that were transferred into the tank farms. The previous discussion on specific facilities described the chemical processes and wastes generated that were transferred through the tank farm waste-transfer system. A more detailed description of the operation of tank farms is presented in the following documents:

- RPP-6072, *Site-Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMA B-BX-BY*
- HNF-4380, *Preliminary Site-Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX*
- RPP-16608, *Site-Specific Single Shell Tank Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan Addendum for Waste Management Areas C, A-AX, and U*
- RPP-7578, *Site-Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMAs T and TX-TY.*

<u>A Tank Farm System</u>

WMA A-AX is located in the south-central portion of the 200 East Area. WMA A-AX contains the A and AX Tank Farms. The A Tank Farm contains six SSTs that were constructed in 1954, put into service in 1955, and used to store and transfer waste until 1980. The AX Tank Farm contains four tanks that were constructed in 1963, put into service in 1964, and used to store and transfer waste until 1980. The A and AX Tank Farms received waste generated by PUREX Plant operations. The PUREX process produced three major waste streams: PUREX coating waste; PUREX acid waste, which contained about 99 percent of the fission products; and organic wash waste.

During its operational history, there were a number of confirmed or suspected waste-loss events in WMA A-AX. These included suspected tank leaks and known waste losses from piping systems. Currently, the pumpable liquid wastes have been removed from the WMA A-AX tanks, and all tanks have been interim stabilized (HNF-EP-0182, *Waste Tank Summary Report for Month Ending November 30, 2004*).

The current understanding of contaminant occurrences and environmental conditions at WMA A-AX is described in RPP-14430, *Subsurface Conditions Description of the C and A-AX Waste Management Area*. Historical information on soil-surface and vadose-zone contamination in WMA A-AX is provided in RPP-7494, *Historical Vadose Zone Contamination from A, AX, and C Tank Farm Operations*. The primary contamination zones currently identified in WMA A-AX are a localized Cs-137 activity zone near the bottom of the 241-A-104 and 241-A-105 Tanks and three unplanned releases near pipelines and diversion boxes.

<u>B Tank Farm System</u>

WMA B includes the SST B, BX, and BY Tank Farms, the 242-B Evaporator, five inactive miscellaneous underground storage tanks, and associated piping and support systems as well as various cribs, trenches, ponds, pipelines, and diversion boxes.

The B Tank Farm was constructed from 1943 to 1944 and began receiving waste in 1945. Waste sources include B Plant, REDOX Plant, N Reactor, PUREX Plant, and U Plant. The B-200 series SSTs also received waste from the 224-B Concentration Facility from 1946 to 1952. The SSTs stopped receiving waste by 1978. The B Tank Farm also includes the 242-B Evaporator.

The BX Tank Farm was constructed from 1946 to 1947 and began receiving waste in 1948. Waste sources include B Plant, REDOX Plant, N Reactor, U Plant, and PUREX Plant. The SSTs stopped receiving waste by 1980.

The BY Tank Farm was constructed from 1948 to 1949 and began receiving waste in 1950 as an extension of the BX Tank Farm. Waste sources include B Plant, U Plant, and coating waste and organic-wash waste from the PUREX process. The SSTs stopped receiving waste by 1974. The BY Tank Farm also includes In-Tank Solidification units 1 and 2 (ITS-1 and ITS-2), which performed in-tank evaporation of supernate wastes. The ITS-1 unit was located in the 241-BY-101 Tank and was moved to the 241-BY-102 Tank. The ITS-2 unit was located in the 241-BY-112 Tank.

C Tank Farm System

WMA C includes only the SST C Tank Farm, one inactive miscellaneous underground storage tank, and associated piping and support systems as well as various cribs, trenches, ponds, pipelines, diversion boxes, and other ancillary equipment.

The C Tank Farm was constructed from 1943 to 1944 and began receiving waste in 1945. Waste sources include B Plant, U Plant, PUREX Plant, and various experiments and operations conducted at the Hot Semiworks Chemical Engineering Laboratory. The C-100 series SSTs stopped receiving waste by the late 1970s.

S/U Tank Farm Systems

The S/U Tank Farms consist of the SST S, SX, and U Tank Farms, the 242-S Evaporator, the DST SY Tank Farm, eight inactive miscellaneous underground storage tanks, and associated piping and support systems as well as various cribs, trenches, ponds, pipelines, and diversion boxes.

The S Tank Farm was constructed in 1950 and began receiving waste in 1951 from the REDOX chemical separations plant. Some tanks in the S, SX, and U Tank Farms received evaporator bottoms from the 241-S Evaporator from 1973 to 1977. Some tanks in the U Tank Farm received evaporator bottoms from the 242-T Evaporator from 1975 to 1977. The SSTs stopped receiving waste and were filled with solids by the late 1970s.

The SX Tank Farm was constructed in 1953 and began receiving waste in 1954 from the REDOX Plant and the 242-S Evaporator.

The SY Tank Farm was constructed in 1976 and began receiving waste in 1977. Waste sources include the 242-S Evaporator; S, SX, T, and U Tank Farms; 222-S Laboratory; and T Plant. The three DSTs are still in service, with DST 241-SY-101 receiving waste removed from older SSTs and DST 241-SY-102 receiving waste from saltwell pumping operations in SSTs.

The U Tank Farm was constructed from 1943 to 1944 and began receiving waste in 1946. Waste sources include the REDOX Plant and the 242-S Evaporator. Portions of the U Tank Farm were decommissioned between 1959 and 1995.

T Tank Farm System

The T Tank Farm consists of the SST T, TX, and TY Tank Farms, the 242-T Evaporator, 10 inactive miscellaneous underground storage tanks, and associated piping and support systems as well as various cribs, trenches, ponds, pipelines, and diversion boxes.

The T Tank Farm was constructed from 1943 to 1944 and began receiving waste in December 1944 from T Plant. The T-100-series SSTs stopped receiving waste by 1979, and the T-200-series SSTs stopped receiving waste by 1952. The T-200-series SSTs received waste from the 224-T Process Unit. The TX Tank Farm was constructed from 1947 to 1948 and began receiving waste in 1949 from the T Plant. Other waste sources included PUREX Plant, B Plant, 221-U Uranium Recovery Process Plant, and the 242-T Evaporator. Tank 241-TX-118 received waste from the 234-5 Z Plant from 1973 to 1978 for mixing with caustic waste to neutralize the acidic Z Plant waste. The SSTs stopped receiving waste by the 1970s.

The TY Tank Farm was constructed from 1951 to 1952 and began receiving waste in 1953. Waste sources include T Plant, REDOX Plant, PUREX Plant, B Plant, 221-U Uranium Recovery Process Plant, and the 242-T Evaporator. The SSTs stopped receiving waste by 1979.

2.2.2 Waste Streams

The following subsections provide general information concerning the characteristics of the waste streams associated with each of the pipeline-system bins.

2.2.2.1 Bin 1 Waste Streams (Process Waste, Process Condensate, and Chemical-Laboratory Waste)

Process-waste streams were derived from solvent recovery, ion-exchange regeneration, and ammonia-scrubber distillation. The processing was done off line of a plant's major processing system. The waste stream generated from recovery/regeneration is referred to as process waste. Cold-startup wastes usually were contaminated with uranium, whereas process wastes derived from fuel reprocessing tended to have a much more varied and equally concentrated inventory of contaminants. Process condensates were condensed liquids that became contaminated from direct contact with the process materials. The laboratory-waste group includes laboratory wastes commonly associated with the 222-Laboratory buildings at the B, T, U, and S Plants, where disposal sites received various liquid-waste streams from laboratory operations. Laboratory-waste liquid-disposal sites also are known at the PUREX and Z Plants.

2.2.2.2 Bin 2 Waste Streams (Steam Condensate and Cooling Water)

The steam-condensate and cooling-water streams were intended to be noncontact in character, in that they either came from uncontaminated parts of the plants or were separated from contaminated process solutions by pipe or vessel walls. Large volumes of water were used to regulate the temperature at various stages of the separations and concentration processes. A pipe or vessel failure was necessary to contaminate the steam-condensate or cooling-water streams and sites.

2.2.2.3 Bin 3 Waste Streams (Chemical-Sewer Waste)

Chemical-sewer wastes were generated at many of the separation/concentration processes. Early chemical-sewer wastes were combined with the larger cooling-water and steam-condensate streams at the B, T, and U Plants. With the advent of REDOX, PUREX, and cesium/strontium recovery operations, separate chemical sewers and separate disposal sites were installed. The chemical-sewer system was designed to serve nonradioactive operations in plant areas such as operating galleys, service areas, aqueous-makeup galleries, and maintenance areas. The plants discharged out-of-specification chemical batches, noncontaminated floor-drain-waste liquids, nonradiological process wastes, nonprocess steam condensates, noncontaminated vessel-coil waste, and other miscellaneous waste streams into the chemical sewers.

2.2.2.4 Bin 4 Waste Streams (Miscellaneous Waste)

Miscellaneous waste consists of the remaining radioactive waste streams not encompassed by the major process operations. Miscellaneous-waste streams covers a combination of moderate-volume equipment-decontamination and ventilation-system wastes, plus small-volume waste streams commonly disposed to french drains. These waste streams are varied in terms of sources. No organic contaminants are documented in available inventory data, and only small quantities of inorganics are noted in the inventories.

2.2.2.5 Bin 5 Waste Streams (Tank/Scavenged Waste)

Tank and scavenged wastes generally are defined as liquids discharged directly from the high-activity, SST tank farms or as treated high-activity tank wastes. These waste types generally are characterized as relatively small when compared to the cooling-water volumes of liquid that have more highly concentrated contaminants than other waste streams.

2.2.2.6 Bin 6 Waste Streams (Tank Farm Waste Transfers)

Tank-waste transfer lines received radioactive waste from the majority of the 200 Areas processing and support facilities. While some transfer lines received discreet waste types, the majority have had extensive transfer and commingling of waste types from the processing facilities and from tank-to-tank transfers. The bulk of the constituents in tank-waste transfer lines (if residual waste is present) likely are sodium hydroxide; sodium salts of nitrate, nitrite, carbonate, aluminate, oxalate, sulfate and phosphate; and hydrous oxides of metals such as aluminum, iron, bismuth, lanthanum, and manganese. Heavy metals, including mercury, chromium, and lead, also likely are present in tank-waste transfer lines. Key radioactive components may include strontium, cesium, uranium, plutonium, thorium, technetium, iodine, and americium.

2.3 WASTE-SITE DESCRIPTIONS

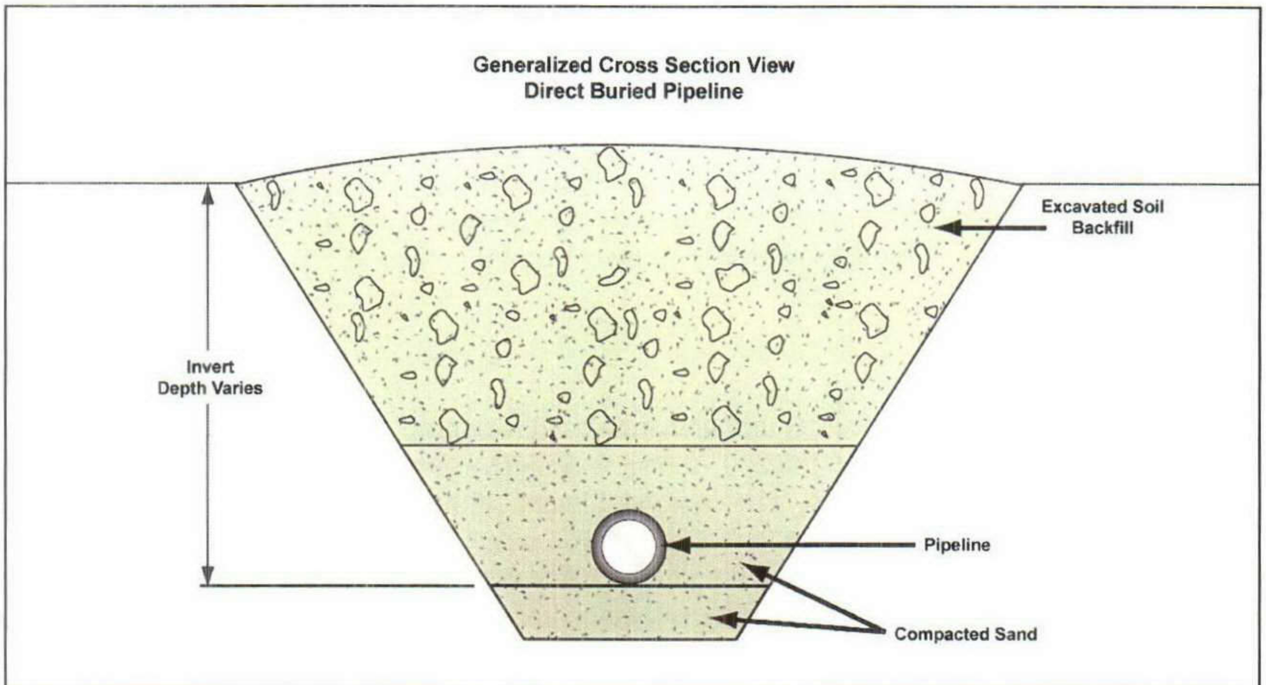
A general description of the waste sites addressed by this work plan is provided in this section. For the pipeline systems, the association with a waste-stream bin is carried forward through the remainder of the work plan. Specific information pertaining to individual pipelines being evaluated in each waste stream bin as part of the Phase 1 investigation is provided in the SAP for facility-process-waste pipeline systems (Appendix A). Summary information for the CX Tank System and the Hexone Storage Tanks also is provided in this section.

2.3.1 Pipeline Systems

Numerous pipelines and ancillary equipment were used in conjunction with processing operations and waste transfers in the 200 Areas. A complex network of pipelines was required to handle the different waste streams. The combined length of all of the pipelines in service is conservatively estimated to be more than 161 km (100 mi). WIDS has designated waste-site identification numbers for some of the pipelines outside the WMAs, but not for the complete pipeline network. The task of compiling, evaluating, and recording complete pipeline routing paths from points of inception (process facilities and/or tank farms) to disposal locations (e.g., trenches, cribs, ponds) or storage locations (tank farm WMAs) currently is proceeding but has not been completed. A database is being constructed that will delineate the mapped locations of the pipeline network. The complete mapped locations of the process-waste pipeline systems and assignment of waste-sites codes will support this work plan and provide information needed to update Appendix C of the Tri-Party Agreement (Ecology et al., 1989a).

In association with the processes performed by the plants in the Central Plateau area, the extensive network of pipelines, diversion boxes, catch tanks, valve pits, retention basins, vaults, and other related structures transferred liquid process wastes from the separations facilities to the SSTs and DSTs, evaporators, and effluent-discharge waste sites. During historical plant operations, the disposal or storage destination for a particular liquid-waste stream most often was determined by chemical characteristics and radiological activity levels. Waste-stream characteristics (e.g., corrosiveness, acidity, radiological activity) were considered during design of the pipeline network that was constructed at the Hanford Site. The waste stream's storage or disposal destination (e.g., tanks, cribs, trenches) determined whether the effluent needed to be transferred through the lines under pressure or could flow by gravity. Materials selected for constructing the pipelines depended on the anticipated waste stream's composition and characteristics. Although a number of materials were used for construction of the lines, all pipelines in process-waste stream Bins 1-5 were direct buried in the ground without use of additional exterior encasements. The initial tank farm waste-transfer pipelines installed in 1944-1945 were direct-buried pipelines, with some on concrete slabs. After 1947, all pipelines installed in the tank farms either were concrete encased or pipe-in-pipe encased. A generalized cross-sectional view of the burial characteristics of a single direct-buried pipeline is shown in Figure 2-5. Depth of burial of the pipelines varied with surface topographic conditions in the area. For the gravity flow lines, the burial depth along the pipe run was sufficient that the gradient permitted liquids to free flow. In general, burial depths averaged from 4.6 to 6.1 m (15 to 20 ft) bgs.

Figure 2-5. Generalized Cross-Sectional View of a Direct-Buried Single Pipeline.



The following discussion presents the general attributes of the pipelines and waste-stream constituents that are encompassed by Bins 1-6. Characteristics of the pipelines are provided for each bin. Table 2-1 summarizes the general physical attributes of the pipelines in each bin.

2.3.1.1 Bin 1 (Process Condensate, Process Waste, and Chemical-Laboratory Waste) Attributes

Pipelines included in Bin 1 are located throughout the 200 East and 200 West Areas and are associated with of all the processing-facilities operations. Waste fluids carried by these pipelines include process condensate, process waste, and chemical-laboratory waste.

Table 2-1. General Attributes of Pipelines in Each Bin.

Bin	Process-Waste Operable Units	Process-Waste Streams	Physical Attributes		200 Areas Facilities Where the Process-Waste Pipeline Bin Applies
			Pipe Material Types Included[a]	Pipe Diameters (in.)[a]	
1	200-PW-1/2/3/4/5/6, 200-LW-1/2	Process Condensate, Process Waste, and Chemical-Laboratory Waste	Vitrified clay, stainless steel, corrugated galvanized steel, carbon steel, and fiberglass-reinforced epoxy	1, 1.5, 2, 3, 3.5, 4, 5, 6, 8, 10, 14, and 16	All
2	200-CW-1/2/3/4/5, 200-SC-1	Steam Condensate and Cooling Water	Vitrified clay, stainless steel, carbon steel, reinforced concrete, corrugated metal, and cast iron	4, 6, 8, 10, 12, 15, 16, 18, 24, 30, 36, and 42	All
3	200-CS-1	Chemical-Sewer Waste	Vitrified clay, stainless steel, carbon steel, and corrugated metal	3, 8, 10, 12, 14, 15, 16, 36, 42, and 48	A Plant (PUREX), B Plant, and S Plant (REDOX)
4	200-MW-1	Miscellaneous Waste	Vitrified clay and black steel.	4, 6, and 8	All
5	200-TW-1/2	Tank/Scavenged Waste	Stainless steel and carbon steel	2, 3, 3.5, 4, 10, and 14	B Plant, Hot Semiworks, T Plant, and U Plant
6	Tank Farms	Tank Farm Waste Transfers	Carbon steel, stainless steel, vitrified clay,[b] and fiberglass-reinforced thermosetting resin[b]	1, 2, 3, 3.5, 4, 6, 10 (NOTE: The A, AX, AY, AZ, and SX Tank Farms also contain 20- and 24-in.-diameter carbon steel pipelines used for vapor headers.)	All

[a]The pipe materials and diameters listed are based on the current level of review of engineering drawings. This list may be revised as additional information is compiled and evaluated.

[b]These pipeline material types transferred lower concentrations of radionuclides than typically were transferred in tank farms carbon or stainless steel pipelines.

PUREX = Plutonium-Uranium Extraction (Plant or process).
REDOX = Reduction-Oxidation (Plant or process).

Process condensate generally is water that was condensed from the closed-process system and was in direct contact with radioactive and chemical materials. Process waste is low-level and/or hazardous waste that directly contacted radioactive material and may contain organic components that could enhance mobility. The condensates formed from heating of the process chemistry and were removed in the vapor space of a dissolver or concentrator vessel, condensed off line in a cooling vessel, treated as necessary, and disposed to the ground. The vaporized material mostly was water, but volatile chemicals and trace quantities of radionuclides were removed as well. Common contaminants included tritium, I-129, Cs-137, Sr-90, Ru-106, Tc-99, U-238, U-239/240, organics, nitrates, and a number of other inorganic components.

Each separations and concentration process in the 200 Areas had an associated laboratory designed to monitor the processes. Laboratory-waste streams generally are low in all radionuclides, although some have significant inventories of plutonium, uranium, and fission products. Sodium dichromate also is reported at several of the waste sites. Liquid volumes for the 200-LW-1 and 200-LW-2 waste streams typically are smaller than the other waste streams. Laboratory wastes differ from the process wastes only in the quantity of waste disposal.

These waste streams were routed from facilities to various liquid-waste disposal sites, including cribs, trenches, tile fields, french drains, and injection wells. Pipeline materials used to transfer the waste streams varied, and include carbon steel, stainless steel, fiberglass-reinforced epoxy, vitrified clay, and corrugated galvanized steel (corrugated metal). Available information indicates that pipeline diameters range from approximately 2.54 to 41 cm (1 to 16 in.). Waste streams were transferred by nonpressurized gravity flow in the pipelines included in Bin 1.

2.3.1.2 Bin 2 (Steam-Condensate and Cooling-Water) Attributes

Pipelines included in Bin 2 occur throughout the 200 Areas and were used with all of the primary 200 Areas processing facilities. Process fluids carried by these pipelines consisted of cooling water and steam condensate.

Both the steam-condensate and the cooling-water waste streams have been subdivided into a number of OU disposal sites, primarily based on geography and, to a lesser extent, on the potential differences in contaminants. Both of these two waste streams consisted predominately of water. The water would flow through a heat exchanger and then flow to a disposal site. Cooling-water pipelines conveyed significant inventories of contaminants because of the large volumes of slightly contaminated wastes discharged.

These waste streams generally were routed from facilities to ditches, ponds, trenches, and cribs. Steam-condensate waste streams from the solvent-extraction-process plants were recognized as having a greater potential for becoming contaminated and were discharged to cribs instead of ditches and ponds. Pipeline composition varies and includes carbon steel, stainless steel, vitrified clay, reinforced concrete, corrugated metal, and cast iron. The sizes of the pipelines associated with these waste streams are larger because of the need to handle larger volume flows, and they range from 10 to 107 cm (4 to 42 in.) in diameter. These pipelines transferred fluids using nonpressurized gravity flow.

2.3.1.3 Bin 3 (Chemical-Sewer Waste) Attributes

Pipelines comprising Bin 3 are located in both the 200 East and the 200 West Areas and are associated with the A Plant (PUREX), B Plant, and S Plant (REDOX) facilities. Process fluids carried by these lines consisted of chemical-sewer waste. This waste stream generally was routed from facilities to cribs, ditches, and ponds.

These chemical wastes received a quantity of raw water to dilute the chemical additions to the waste stream. These waste streams became contaminated with low levels of radionuclides at some unspecified time and by an unknown process. No reports of chemical contaminants in the chemical sewer have been found in the aggregate area management study reports, but the ditches and ponds receiving this category of waste have been designated as RCRA TSD units. Chemical-sewer contamination resulted from some form of process upset such as liquid draining back into an aqueous-makeup area. The waste compounds discharged by these pipelines are acidic in nature. Pipeline compositions include carbon steel, stainless steel, vitrified clay, and corrugated metal. Large pipelines often were used for this waste stream, to handle high-volume flows. Pipe diameters range from 7.6 to 122 cm (3 to 48 in.). These pipelines handled nonpressurized gravity-flow liquids.

2.3.1.4 Bin 4 (Miscellaneous-Waste) Attributes

These pipelines occur throughout the 200 Areas. Process fluids transferred in these pipelines consisted of miscellaneous waste streams. The liquid waste generally was routed a relatively short distance from the facilities to cribs, trenches, french drains, and injection wells.

Most miscellaneous-waste streams are low in radionuclides and chemicals, except for higher inventories of uranium, plutonium, fission products, and occasional reports of sodium dichromate attributed to the PUREX Plant ventilation system. Equipment decontamination wastes are associated with the decontamination mission of T Plant. There is one equipment decontamination site each at the 202-S Plant Building and the U Tank Farm. Decontamination wastes are lightly contaminated, high-volume streams, but are expected to be accompanied by detergents or cleaning agents that may have mobilized the contaminants. Miscellaneous wastes include a host of potentially contaminated small-volume waste streams, such as vacuum-pump seal-water wastes, fan-bearing cooling-water wastes, stack drainage, floor drainage from stack control rooms, and stack-condensate drainage. Pipeline composition currently is known to include only vitrified clay and black steel, with pipeline diameters ranging from approximately 10 to 20 cm (4 to 8 in.). These pipelines generally were operated as nonpressurized, gravity-flow lines.

2.3.1.5 Bin 5 (Tank/Scavenged-Waste) Attributes

Pipelines that are part of Bin 5 are located in both the 200 East and the 200 West Areas and are associated with the B Plant, Hot Semiworks, T Plant, and U Plant facilities (pipelines in the 200-UW-1 OU area are not addressed by this work plan). Process fluids carried by these pipelines consisted of tank waste and scavenged waste. These waste streams generally were routed between tank farms, between facilities and tank farms, or from tank farms to cribs, trenches, french drains, and injection wells. Pipeline materials currently are known to include only carbon steel and stainless steel, with available information on pipeline diameters indicating a range from approximately 5.1 to 35.6 cm (2 to 14 in.). Waste streams in Bin 5 were either transferred by gravitational flow or pumped under pressure.

2.3.1.6 Bin 6 (Tank Farm Waste Transfers) Attributes

The tank-farm pipeline system consisted of a variety of pipelines and diversions boxes. Pipelines in the system include slurry lines, supernatant lines, cross-site lines, and jet-pump transfer lines. Approximately 350 transfer pipelines are associated with the 200-IS-1 OU, and there are more than 100 diversion boxes and associated catch tanks. Pipelines often are buried anywhere from 2.4 to 4.6 m (8 to 15 ft) bgs. Generally, the pipelines are carbon steel, which was joined by butt welding. The original pipelines installed in 1944-1945 were stainless steel (Cb 18-8) tubing. Pipelines used to transfer high-level/high-activity wastes initially were buried directly in trenches. As failures in these lines occurred in the 1940s, subsequent construction involved placement in concrete or pipe-in-pipe encasements. The encasements extended between diversion boxes or concrete pits on top of the SSTs (occasionally drywells) and were designed so that any liquids lost because of leaks or pipeline failure would drain to a drain in the bottom of a diversion box (or to the SST if from a concrete pit), which conveyed the release to a catch tank.

2.3.2 Pipeline Appurtenances

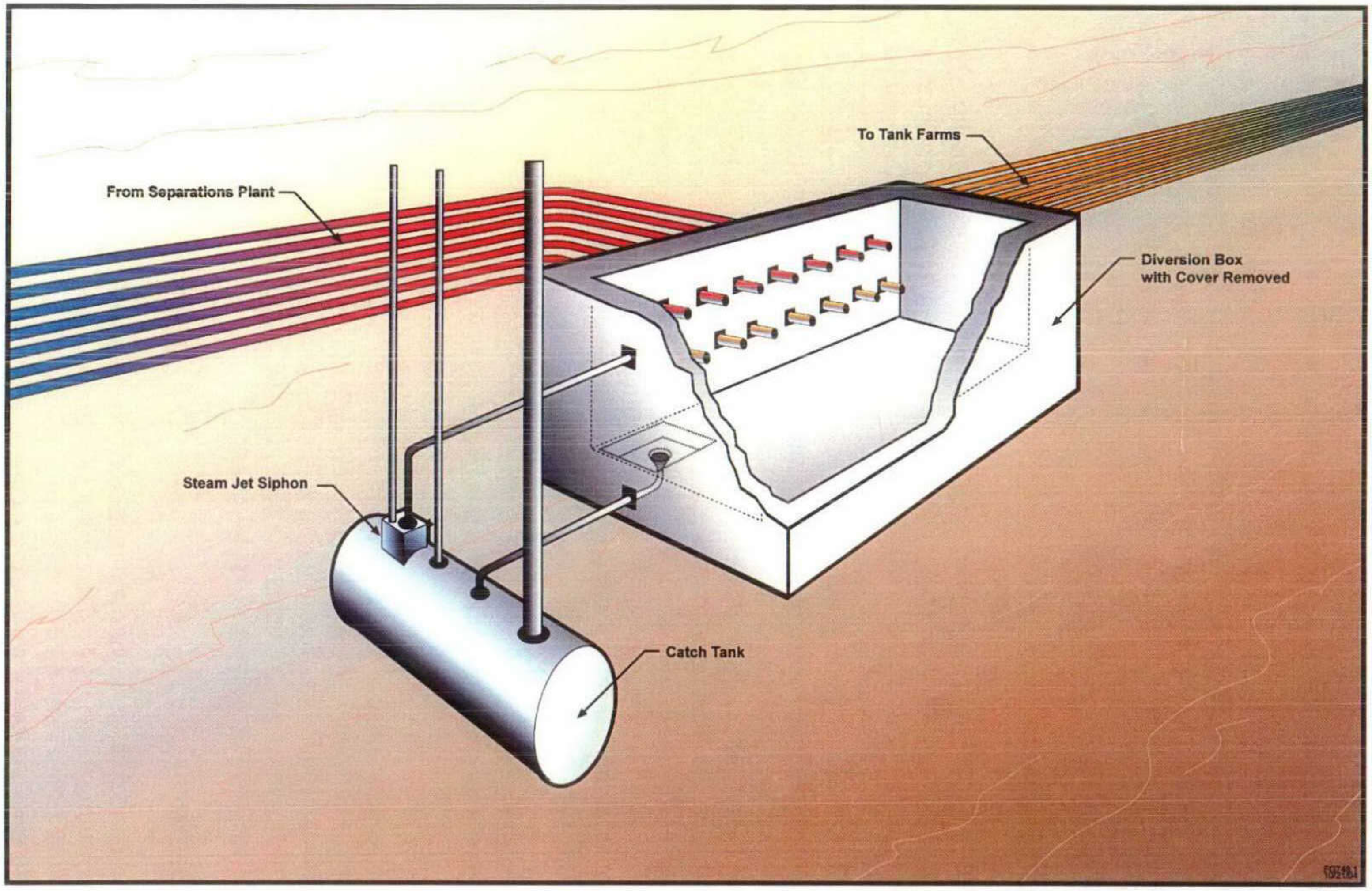
A general description of the major pipeline-system appurtenance structures is provided below. Another appurtenance type not described here is the diverter stations/diversion boxes and catch tanks (241-AX-151 and 241-AX-152). A description of these appurtenances can be found in RL-SEP-9, *PUREX AX Tank Farm and Waste Routing System Information Manual*, pages 8-10.

2.3.2.1 Diversion Boxes

Diversion boxes are reinforced-concrete structures that generally were constructed below grade. Waste-transfer lines are connected inside the diversion box by installing a jumper between connecting nozzles. Diversion boxes provided a flexible method of redirecting the liquid-waste flow path to various locations in the 200 East and 200 West Areas. They also provided containment for leaks in transfer pipes (which drain back to the boxes via concrete or pipe-in-pipe encasements) and leaks at jumper-nozzle connections. The boxes are large, covered, underground reinforced-concrete structures that received at least two (and up to four) sets of pipelines. The general configuration of a diversion box is shown in Figure 2-6. The pipe sets entered the diversion box at different levels through one wall. Each pipe had a special end fitting that permitted the secure attachment of either flexible or solid pipes, also known as jumpers.

All connections were made manually using remote equipment. Each jumper was fabricated to custom fit to the desired pair of incoming and outgoing pipes. To assist with gravity flow, pipelines coming in from the facility were located on the higher level of pipes, while lines leading to tank farms were on the lower level. Connections could be routed for flow in either direction, because several of the separations processes retrieved wastes from the tank farms and transferred the material to the facility.

Figure 2-6. Generalized Configuration of a Typical Diversion Box and Catch Tank.



Diversion boxes varied in size but typically were constructed 5.2 to 6.1 m (17 to 20 ft) deep, by 1.8 to 3.0 m (6 to 10 ft) wide, by 7.6 to 12.2 m (25 to 40 ft) long. All but the uppermost portion of a diversion box is below ground. Each diversion box is covered with a series of thick-stepped cover blocks, 30.5 to 35.6 cm (12 to 14 in.) in thickness, that prevented ready migration of contaminants out of the box. Cover blocks were removed when a routing change was required.

Connecting pipelines either were direct buried or were encased up to the outside wall of the diversion box. There they mated with preinstalled pipe that penetrated the box wall. Catch tanks were built at a level below that of the floor of the diversion box and collected liquid wastes that spilled in the box when routings were changed, thereby containing the release. The jumpers are thought to have been allowed to drain onto the floor when the connection was broken, leading to internal contamination of the box.

2.3.2.2 Catch Tanks

Catch tanks were built in conjunction with diversion boxes to contain high-activity wastes spilled during changes in pipeline routings. The tanks are direct-buried, underground-storage tanks, generally constructed of carbon steel (Figure 2-6). Sump pits in the diversion box collected the liquid and were connected by piping to the catch tank. With the advent of encased pipelines, leaks were anticipated, and a provision was made to collect the liquid released into the nearest downgradient catch tank. In some cases, a catch tank served more than one diversion box, particularly around tank farms. The catch tanks usually were located within 15.2 m (50 ft) of the diversion box. Catch tanks could be empted to diversion boxes through an underground pump-out line. Each catch tank is equipped with a liquid-level sensor and a pump-pit leak indicator. Activation of the leak-detection alarm causes a shutdown of transfer operations. Only a few of the catch tanks have liquid-level monitoring devices that are connected to the surveillance automated control system. Some of the catch tanks and miscellaneous underground storage tanks are not monitored.

Catch tanks range between 2.1 and 2.7 m (7 and 9 ft) in diameter and 7.6 to 10.7 m (25 to 35 ft) long, with storage capacities of 30,283 to 45,425 L (8,000 to 12,000 gal). Catch-tank designs changed as new diversion boxes were added to manage waste streams. Catch tanks were located at depths of 7.6 to 10.7 m (25 to 35 ft), considerably deeper than the floor of the diversion box, to provide complete drainage of a leak or spill. A series of risers extended to above the ground surface and were used to monitor liquid levels, collect samples, pump out tank contents, and permit chemical additions. Steam jets or in-tank pumps were added later with piping that led back to the diversion box for ready transfer to the facility or tank farm. Some catch tanks have been replaced because of leaks or vessel failure.

2.3.2.3 Valve Pits

A valve pit or box is a belowground reinforced-concrete structure used to route wastes between pipelines leading to two waste sites. For a very long crib (up to 427 m [1,400 ft]), valve pits also were used to more evenly distribute flow over both halves of the crib. These structures most commonly were associated with pipelines that relied on gravity flow of waste streams that discharged to cribs, ponds, or ditches. Valve pits have been used to direct process liquids encompassing waste streams included in pipeline Bins 1-6.

For some pits/boxes, pipelines passed through the structure with no open flow. Intersecting pipes were connected at tee or union fittings. Valves were built into the pipeline and were opened or closed to change flow routings. Other valve pits/boxes were designed to allow open wastewater flow within the pit. The incoming pipe terminated at the edge of the pit/box, and water then flowed through the box before exiting at another pipeline. Changes in routing were through a series of moveable dams, or stop logs, as well as slide gates that covered the opening of the receiving pipe. Valve and gate handles were extended through the pit/box cover to permit remote operation.

Valve pits generally were smaller structures than diversion boxes. Sizes ranged up to 4.6 by 3.0 m (15 by 10 ft) at the surface, and they were constructed to depths up to 3.7 to 4.6 m (12 to 15 ft), depending on the depth of the buried pipeline. These structures usually carried a "216-" series prefix and a designation that was associated with the waste site to which the flow was directed. The interiors of the valve pits could be accessed through hatches in the cover.

2.3.3 CX Tank System

The CX Tank System is located at the former Hot Semiworks Facility east of B Plant in the 200 East Area (Figure 2-7). The CX Tank System consists of three tanks: 241-CX-70 Storage Tank, 241-CX-71 Neutralization Tank, and 241-CX-72 Storage Tank. Although the Dangerous Waste Permit Application (Form 3) (WA7890008967) calls it the "241-CX tank system," these three tanks operated independently and served separate functions. These tanks no longer receive waste, and all three have been decommissioned. The 241-CX-70 Storage Tank, 241-CX-71 Neutralization Tank, and 241-CX-72 Storage Tank were evaluated (BHI-01018, *Environmental Restoration Contractor Management Plan for Inactive Miscellaneous Underground Storage Tanks [IMUSTS]*) and determined to be safely managed as inactive waste sites under existing surveillance and maintenance programs. Prior process uses and the status of each of these three tanks are summarized in the following discussion. A summary of the inventory information that has been complied for each tank is presented in Table 2-2.

2.3.3.1 241-CX-70 Storage Tank

This tank (Figure 2-8) was used from approximately early 1952 through 1957 to store high-level liquid-process waste from the REDOX Plant pilot studies (BHI-01018; BHI-01173, *Auditable Safety Analysis for Surveillance and Maintenance of the 214-CX Tank System*). The term "REDOX" was used for the reduction-oxidation chemical process used to separate plutonium and uranium from irradiated reactor fuel. The design capacity of the tank is 114,000 L (30,000 gal) (BHI-01173). Waste-removal activities for the contents of the 241-CX-70 Storage Tank were initiated in the summer of 1987 with the construction of a sluicing/pumping system. The sluicing/pumping system used large volumes of water to sluice the solid waste mixed from the bottom of the 241-CX-70 Storage Tank and pump it to the DST system.

1 Figure 2-7. CX Tank Farm System Area Plan View.

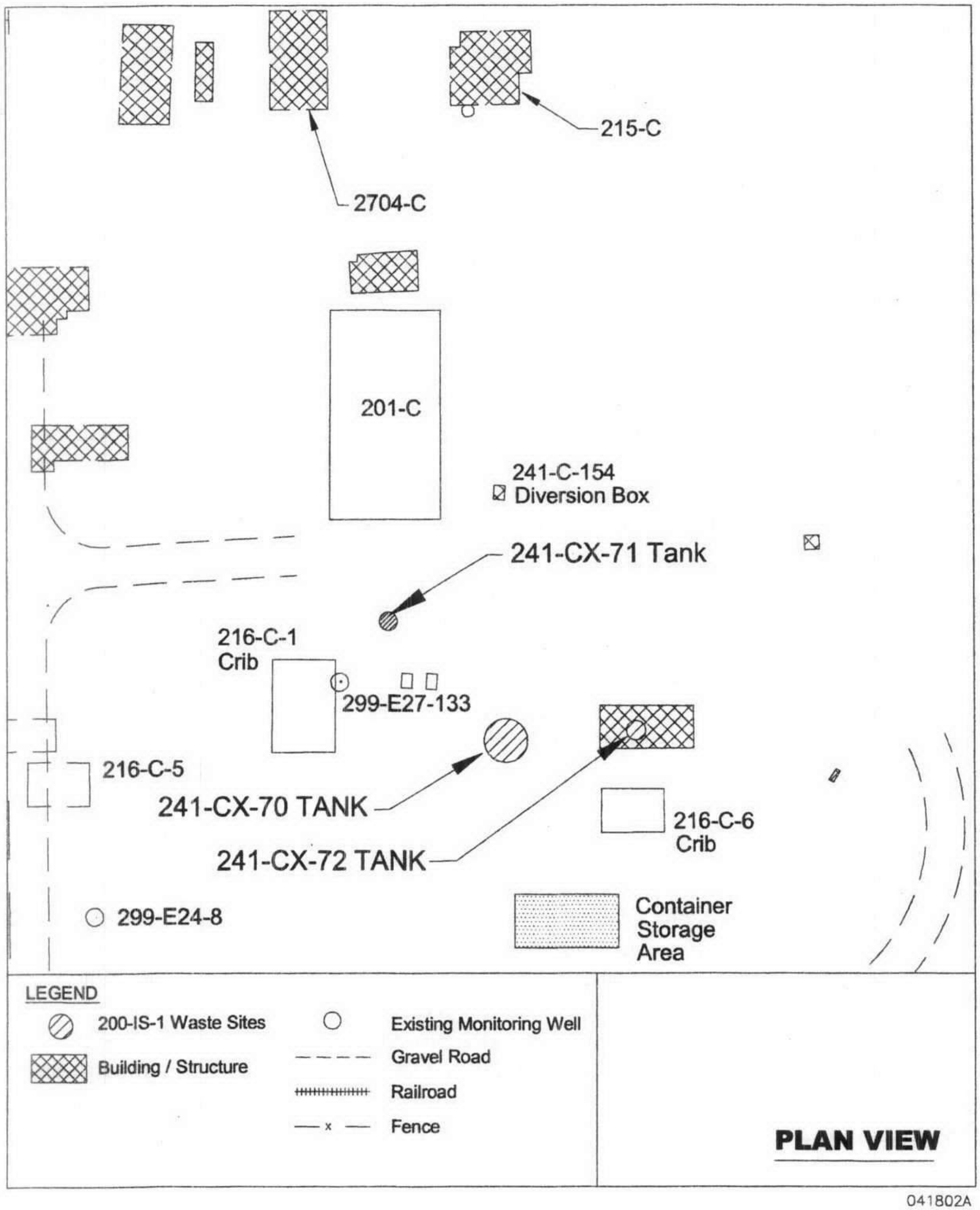


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Table 2-2. Summary Information for the CX Tank Farm System and Hexone Storage and Treatment Facility Tanks. (2 Pages)

Tank Identification	Facility Served	Tank Volume and Type	Tank Construction	Function	Tank Inventory (Based on Process Knowledge)			Tank Inventory (Based on Samples or Radiological Logging)		Status
					Nonradiological Constituents	Radiological Constituents	Volume Handled	Nonradiological Constituents	Radiological Constituents	
241-CX-70 Storage Tank	201-C Process Building, A cell	30,000-gal waste-handling underground storage tank[1]	1-ft concrete shell and top (bottom concrete 2 ft thick at edges, 9 in. thick at center) with 0.25-in. stainless steel liner; tank 20-ft inner diameter by 15 ft high. Top of tank is 11 ft bgs; bottom is 26 ft bgs.[1,7]	Designed, constructed, and used for high-level REDOX process waste[1,2] discharged from scrubber, oxidizer, dissolver, feed makeup, waste-receiver tanks, and waste-concentrator tank centrifuge.[3,24,25,26]	Negligible[4]	287 Ci Sr-90, 134 Ci Cs-137, 0.034 Ci Am-241, 0.116 Ci Pu-239[5]	106,000 L (28,000 gal)[6]	During sludge removal (1988): pH 13 in liquid phase;[7] 0.0009 wt% halogenated hydrocarbons (aliphatic amines or aliphatic alcohol[8])	Tank sludge remaining (1976): 4300 Ci Sr-90; 870 Ci Cs-137; 3.4 Ci transuranic content.[9] During sludge removal (1988): alpha readings from 390 to 690 nCi/g of filtered solids; transuranic content ~50 nCi/g.[10] 1992 interior dose readings ranged from 5 mrad/h beta at top to 15,000 mrad/h on the bottom.[10]	Empty[1]
241-CX-71 Neutralization Tank	201-C Process Building, hot shop	Approximately 3,800-gal neutralization underground tank[1]	Stainless steel; reported tank size is 9-ft diameter by 9 ft high. Top of tank is 3.5 ft bgs; bottom is 12.5 ft bgs.[1]	Designed, constructed, and used for neutralization (with limestone) of acidic REDOX hot-shop sink and process/condensate cooling-coil wastes containing low-level radioactive waste before discharging to 216-C-1 and 216-C-5 Cribs.[1,2,14,27,28,29]	Minor chemical residues in sludge/ aggregate[4]	(1990 estimate) 1,600 nCi/L of Cs-137, 2.46 E-8 g/L Pu; 43,000 nCi/L of Sr-89/90,[12] 6 Ci transuranic content, and 6,000 Ci beta.[9]	33 million L (8.8 Mgal)[6]	Sludge samples (1990): extremely low concentration of methyl ethyl ketone, xylene, toluene (7 to 54 parts per billion), and cyanide (21 parts per million)[11]	No sample results available	Capped with grout; 930 gal of limestone and sludge in bottom[2,13]
241-CX-72 Storage Tank	201-C Process Building, A and C cells	2,000- to 2,300-gal experimental underground concentration tank[1,2]	Tank is vertically oriented; 40-in. diameter by 35.8 ft high; 0.38-in. stainless steel plating with five stiffening rings around perimeter, connected by three rows of vertical guides; resting on concrete pad inside 6-ft-diameter steel caisson; cylindrical heater located just above each stiffening ring; top of tank sealed with plate that extends over and seals the caisson; bottom of caisson sealed with 12-in.-thick reinforced-grout plug that provides base for tank. Top of tank is 14 ft bgs; bottom is about 50 ft bgs.[1,2]	Designed, constructed, and used for terminal storage of waste associated with pilot PUREX waste-concentration studies performed in Cells A and C; tank also may have been used for fluids from decontamination of semiworks after separations projects; investigations of bumping phenomenon were conducted in the tank.[1,14,15,24,28,29]	Chemical residues in sludge/ aggregate; minor compared to radiological source term[4]	Upperbound estimate: 200 g Pu, 10,000 Ci Cs-137[12,15,16]	8,700 L (2,300 gal)[17]	Nondestructive assay (1989): fluorine compounds (see information in radiological constituents column)[15]	In-tank samples (1974): Pu (total), 1.13 E-8 g/gal; U (total) 2.43 E-3 g/gal; Sr-89/90 4.33 mCi/g; Cs-137 undetected;[6] (1988) 2,000 to 8,000 d/min alpha; 2640 to 5810 pCi gamma; beta/gamma ratio of 25:1; estimated 9,000 to 10,000 Ci Cs-137.[6] 1989 nondestructive assay (gamma spectroscopic, relative axial-neutron flux, neutron flux, axial-temperature profile, and axial dose-rate profile measurements) taken from periphery drywell (not direct samples): ~11 ft sediment layer consisting of fission products and transuranic isotopes at bottom of tank; suggested uniform distribution of activity in sludge layer, with likely higher concentration in bottom 2 to 3 ft of tank; activity layer is dry and does not contain hydrogenous materials to thermalize the neutrons generated within contents of the tank; axial temperature profile measurements of 60 to 72 °F indicated presence of heat-generating wastes; dose rates vary from 4 rem/h at 10 ft above sludge layer to 265 R/h at top of sludge layer, increasing to ~491 R/h at bottom of sludge layer; transuranic content likely is present in fluorides; plutonium content of sludge is between 150 and 200 g.[15]	Capped with grout; 650 gal of dried sludge in bottom[2,13]
276-S-141 Hexone Storage Tank	276-S Solvent Handling Facility	21,500-gal underground recovery/ storage tank[2]	Horizontal tank ~28 ft long by 12 ft diameter; 0.38-in. carbon steel, single shell. Top of tank is 2.5 to 3 ft bgs; bottom is 14.5 to 15 ft bgs.[2]	Designed, constructed, and used to store clean reagent-grade hexone for use in the REDOX Plant. Later received waste during REDOX Plant decontamination.[2]	(1992) Estimated to contain TBP, hexone, and total petroleum hydrocarbons[18]	Not applicable	~605,600 L (160,000 gal)[19]	In-tank samples (1976 and 1988): 98.4% hexone, 1.6% water.[20, 21] Tank sludge (2001): NPH, TBP, hexone, iron oxide.[18]	In-tank samples (1976 and 1988): 5460 pCi/L I-129, 7,470,000 pCi/L H-3 (estimated), <31 pCi/L total alpha, 4910 pCi/L total beta.[20, 21] Tank sludge (2001): Am-241, Pu, Sr-90, Cs-137. The sludge in the 276-S-142 Hexone Storage Tank contains about four times the amount of radioactive material in the sludge in the 276-S-141 Hexone Storage Tank.[18]	Grout fill with 132 gal tarry sludge heel in bottom[22]
276-S-142 Hexone Storage Tank	276-S Solvent Handling Facility	21,500-gal underground recovery/ storage tank[2]	Horizontal tank ~28 ft long by 12 ft diameter; 0.38-in. carbon steel, single shell. Top of tank is 2.5 to 3 ft bgs; bottom is 14.5 to 15 ft bgs.[2]	Designed, constructed, and used to store clean reagent-grade hexone for use in the REDOX Plant. Later received waste during REDOX Plant decontamination. Tank also was used to store kerosene and TBP during a one-time campaign to separate americium, curium, and promethium from Shippingport reactor blanket fuel.[2]	(1992) Estimated to contain TBP, hexone, and total petroleum hydrocarbons[18]	Not applicable	~980,000 L (256,000 gal)[23]	In-tank samples (1976 and 1988): 60% hexone, 25.2% NPH, 12.6% TBP, 1.7% water, 380 L (100 gal) sludge.[20, 21] Tank sludge (2001): NPH, TBP, hexone, iron oxide[18]	In-tank samples (1976 and 1988): 34,500 pCi/L I-129, 3,162,000 pCi/L H-3, 2,070,000 pCi/L total alpha, 871,000 pCi/L total beta.[20, 21] Tank sludge (2001): Am-241, Pu, Sr-90, Cs-137. The sludge in the 276-S-142 Hexone Storage Tank contains about four times the amount of radioactive material in the sludge in the 276-S-141 Hexone Storage Tank.[18]	Grout fill with 132 gal tarry sludge heel in bottom[22]

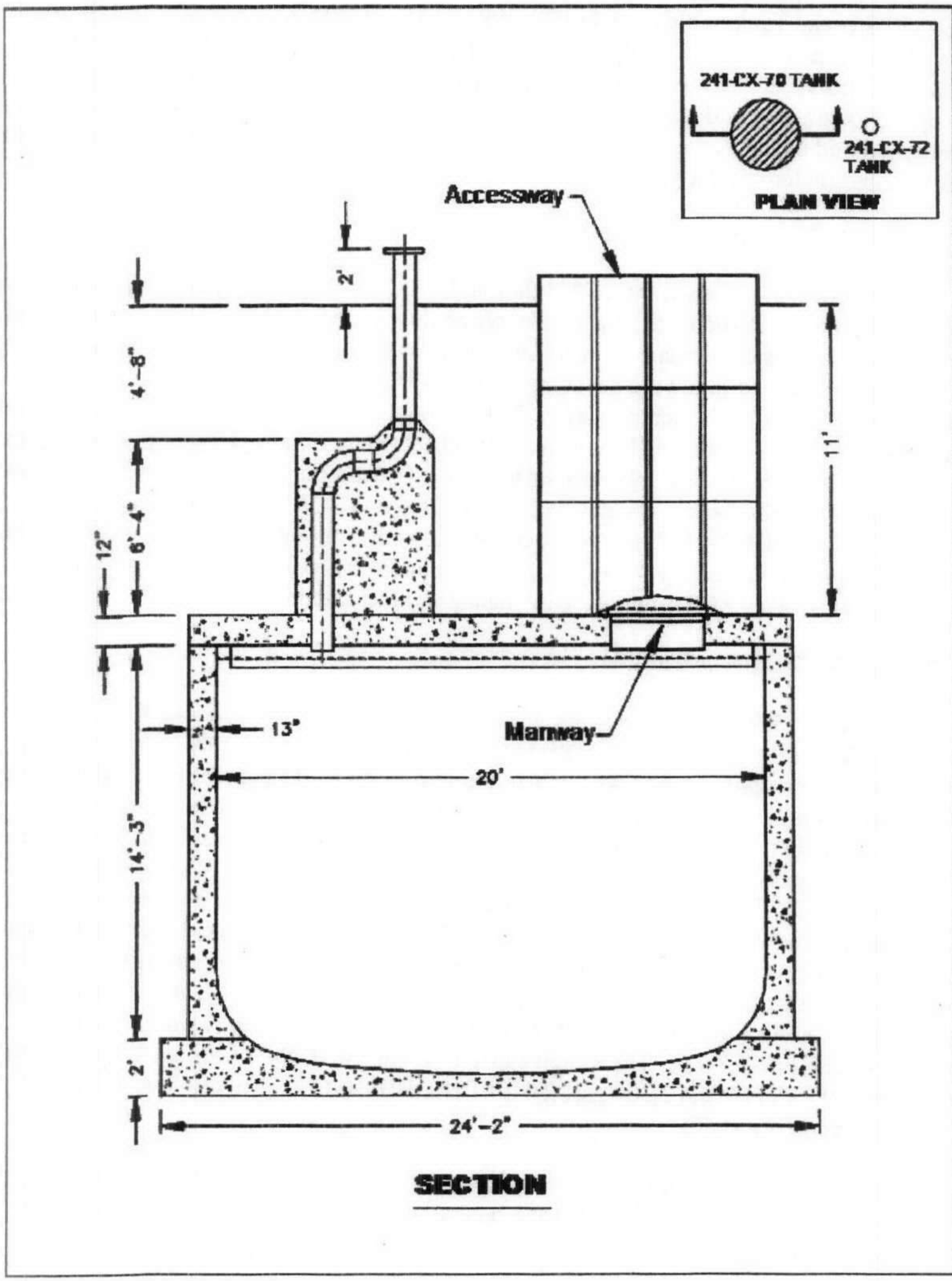
Table 2-2. Summary Information for the CX Tank Farm System and Hexone Storage and Treatment Facility Tanks. (2 Pages)

Tank Identification	Facility Served	Tank Volume and Type	Tank Construction	Function	Tank Inventory (Based on Process Knowledge)			Tank Inventory (Based on Samples or Radiological Logging)		Status
					Nonradiological Constituents	Radiological Constituents	Volume Handled	Nonradiological Constituents	Radiological Constituents	

[1]BHI-01173, *Auditable Safety Analysis for Surveillance and Maintenance of the 241-CX Tank System.*
[2]BHI-01018, *Environmental Restoration Contractor Management Plan for Inactive Miscellaneous Underground Storage Tanks (IMUSTS).*
[3]HW-31373, *PUREX Chemical Flowsheet HW Number 3 Chemical Development Unit Separations Technology Subsection Technical Sec Engineering Department.*
[4]DOE-RL-92-18, *Semiworks Plant Source Aggregate Area Management Study Report.*
[5]BHI-01087, *Preliminary Hazard Classification for the 241-CX Tank System.*
[6]AR00227, "Disposition and Isolation of Tanks 270-E-1, 270-W, 241-CX-70, 241-CX-71, and 241-CX-72."
[7]WHC-SD-DD-TI-034, *Tank 241-CX-70 Waste Removal Assessment.*
[8]12712-PCL88-019, *Analysis of Sludge Samples from Hot Semiworks Tank CX-70.*
[9]SD-WM-SAR-003, *Safety Analysis Report for the Decontamination and Decommissioning of the Strontium Semiworks Complex.*
[10]WHC-SD-DD-TI-071, *Facility Decommissioning Report for Tank 241-CX-70.*
[11]WHC-SD-DD-TI-058, *Tank 241-CX-71 Waste Characterization.*
[12]WHC-SD-DD-SAD-001, *Safety Evaluation for Interim Waste Management Activities in Tank 241-CX-70, Tank 241-CX-71, and Tank 241-CX-72.*
[13]WHC-MR-0144, *Plan and Approach for Completion of Decommissioning of Strontium Semiworks Plant.*
[14]WHC-SD-DD-TI-040, *Tank 241-CX-72 Preliminary Waste Characterization.*
[15]WHC-SD-CP-TI-148, *Radiological Evaluation of Hot Semiworks Tank 241-CX-72.*
[16]WHC-SD-DD-TI-051, *An Estimation of the Radionuclide Content of Tank 241-CX-72.*
[17]HW-52860, *Standby Status Report Hot Semiworks Facility.*
[18]BHI-01521, *Evaluation of Alternatives for the Interim Stabilization of the Hexone Tanks.*
[19]CCN 100786, "276-S-141/142 Hexone Storage Tank Sludge Sampling Results."
[20]ARH-CD-685, *Characterization of the Contents of Organic Waste Storage Tanks 276-S-141 and 276-S-142.*
[21]WHC-SP-0350, *Hexone Remediation Demonstration Plan for Tanks 276-S-141 and 276-S-142.*
[22]BHI-01142, *REDOX Facility Safety Analysis Report.*
[23]DOE/RL-96-82, *Hanford Facility Dangerous Waste Closure Plan, 241-Z Treatment and Storage Tanks.*
[24]H-2-4093, *Hot Semiworks Process Piping Plan A Cell.*
[25]H-2-4105, *Hot Semiworks Engineering Flow Sketch.*
[26]H-2-4335, *Hot Semiworks Waste Line Bldg 201-C to TK-70.*
[27]H-2-4010, *Strontium Semiworks & Vicinity Outside Lines Key Map.*
[28]H-2-4420, *Plot Plan Hot Semiworks Waste Self-Concentrator.*
[29]H-2-4535, *Site Plan & Underground Piping Strontium Facilities, Hot Semiworks.*

bgs = below ground surface.
NPH = normal paraffin hydrocarbon.
PUREX = Plutonium-Uranium Extraction (Plant or process).
REDOX = Reduction-Oxidation (Plant or process).
TBP = tributyl phosphate.

1 Figure 2-8. 241-CX-70 Storage Tank Construction Diagram.



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Approximately 530,000 L (140,000 gal) of water were used to reduce the original waste volume of 38,986 L (10,300 gal) to 2,800 L (750 gal). This volume of waste remained in the 241-CX-70 Storage Tank until December 20, 1991, at which time the waste was placed in approved containers and transferred to the 224-T Transuranic Assay Facility. As part of the 1991 waste-removal activity, excavation to the top of the tank occurred. Plywood was used to shore up the excavation and was left in place following waste-removal activities. The shoring has collapsed and obscures the view of the tank. The tank currently is empty (BHI-01173) and is being managed under interim status.

2.3.3.2 241-CX-71 Neutralization Tank

This tank (Figure 2-9) was used from 1952 thorough 1957 for neutralizing 201-C Hot Semiworks process condensate, hot-shop sink, and condenser cooling water. The 241-CX-71 Neutralization Tank received process condensate from REDOX process operations and also may have received decontamination flushed following the completion of PUREX process operations. The waste remaining in the 241-CX-71 Neutralization Tank contains process effluents that were passed through the tank to be neutralized by contact with a bed of limestone aggregate placed in the tank for this purpose. After the June 1957 decontamination flushes, the 241-CX-71 Neutralization Tank was taken out of service. The design capacity of the 241-CX-71 Neutralization Tank is 14,000 L (3,800 gal) (BHI-01173). Grout currently caps the limestone aggregate (BHI-01018; WHC-MR-0144, *Plan and Approach for Completion of Decommissioning of Strontium Semiworks Plant*). This RCRA unit is being managed under interim status.

2.3.3.3 241-CX-72 Storage Tank

This tank (Figure 2-10) was used to study the concentration of waste generated from the Hot Semiworks Facility pilot studies. This tank was used for approximately 1 year in 1956, when 8,725 L (2,305 gal) of waste was transferred into the tank. Decontamination flushes from the Hot Semiworks Facility also might have been sent to the 241-CX-72 Storage Tank. The waste in the tank then was heated until enough liquid evaporated that it was nearly dry. The 241-CX-72 Storage Tank remained idle from 1960 until it was taken out of service in 1967. In 1986, the 241-CX-72 Storage Tank was filled with 7.3 m (24 ft) of grout over a 3.4 m (11-ft) heel consisting of nonliquid mixed waste (BHI-01018, WHC-MR-0144) and decommissioned. Gamma spectroscopic, relative-axial neutron-flux profile, axial temperature profile, and axial dose-rate profile measurements were taken from a periphery drywell (see Table 2-2) to estimate the remaining radionuclide content (WHC-SD-CP-TI-148, *Radiological Evaluation of Hot Semi-Works Tank 214-CX-72*). The design capacity of the 241-CX-72 Storage Tank is between 7,600 and 8,700 L (2,000 and 2,300 gal) (BHI-01018, BHI-01173). This RCRA unit is being managed under interim status.

The RCRA Part A Permit Application (Form 3) was revised in 1994 and submitted to Ecology as Revision 3 (WA7890008967). The CX Tank System tanks are classified as dangerous-waste tank TSD units with the following waste codes:

- 241-CX-70 Storage Tank: "D002" (corrosive) because of sodium hydroxide, and "D007" and "WT02" (dangerous toxic) because of chromium

1 Figure 2-9. 241-CX-71 Neutralization Tank Construction Diagram.

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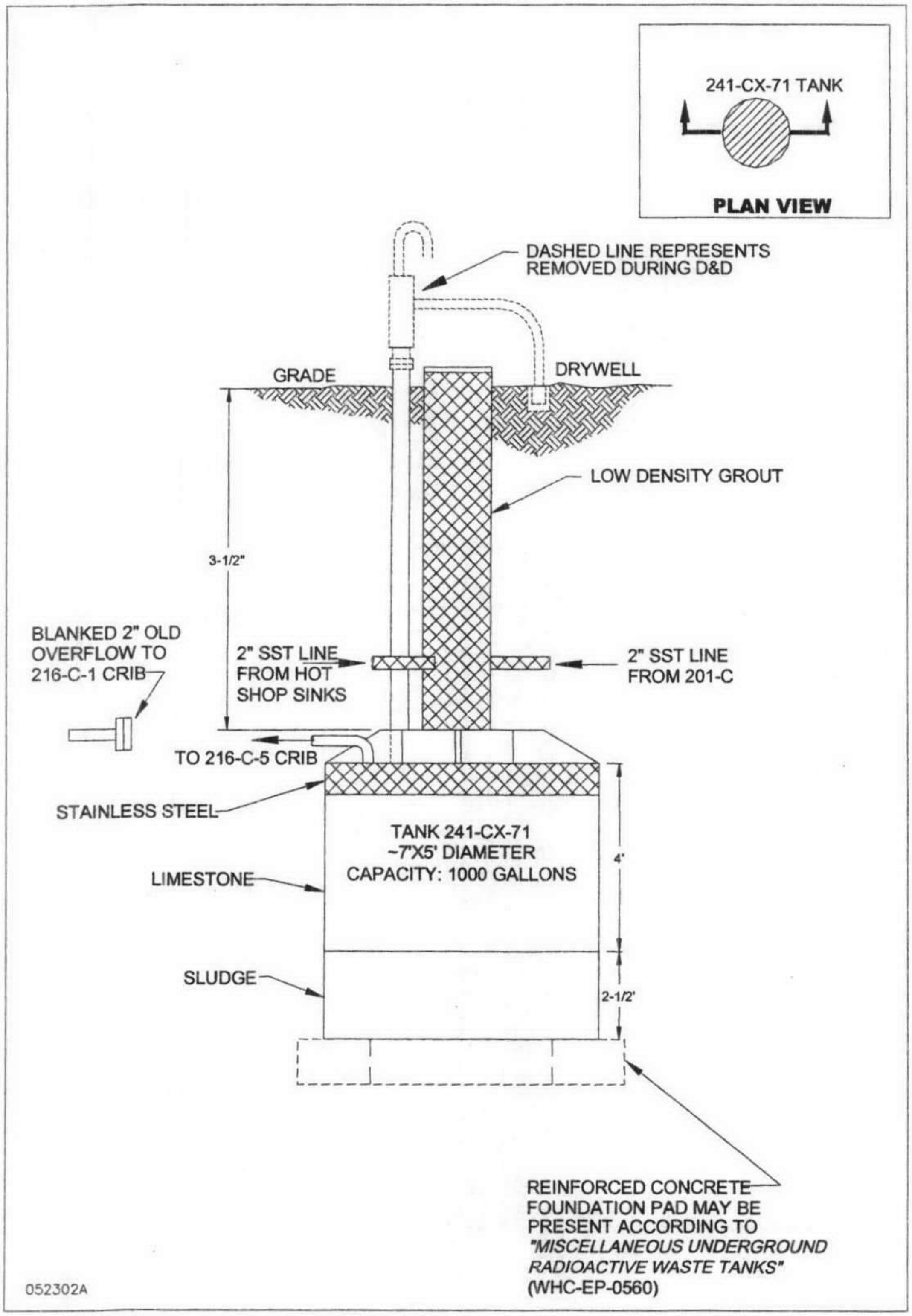
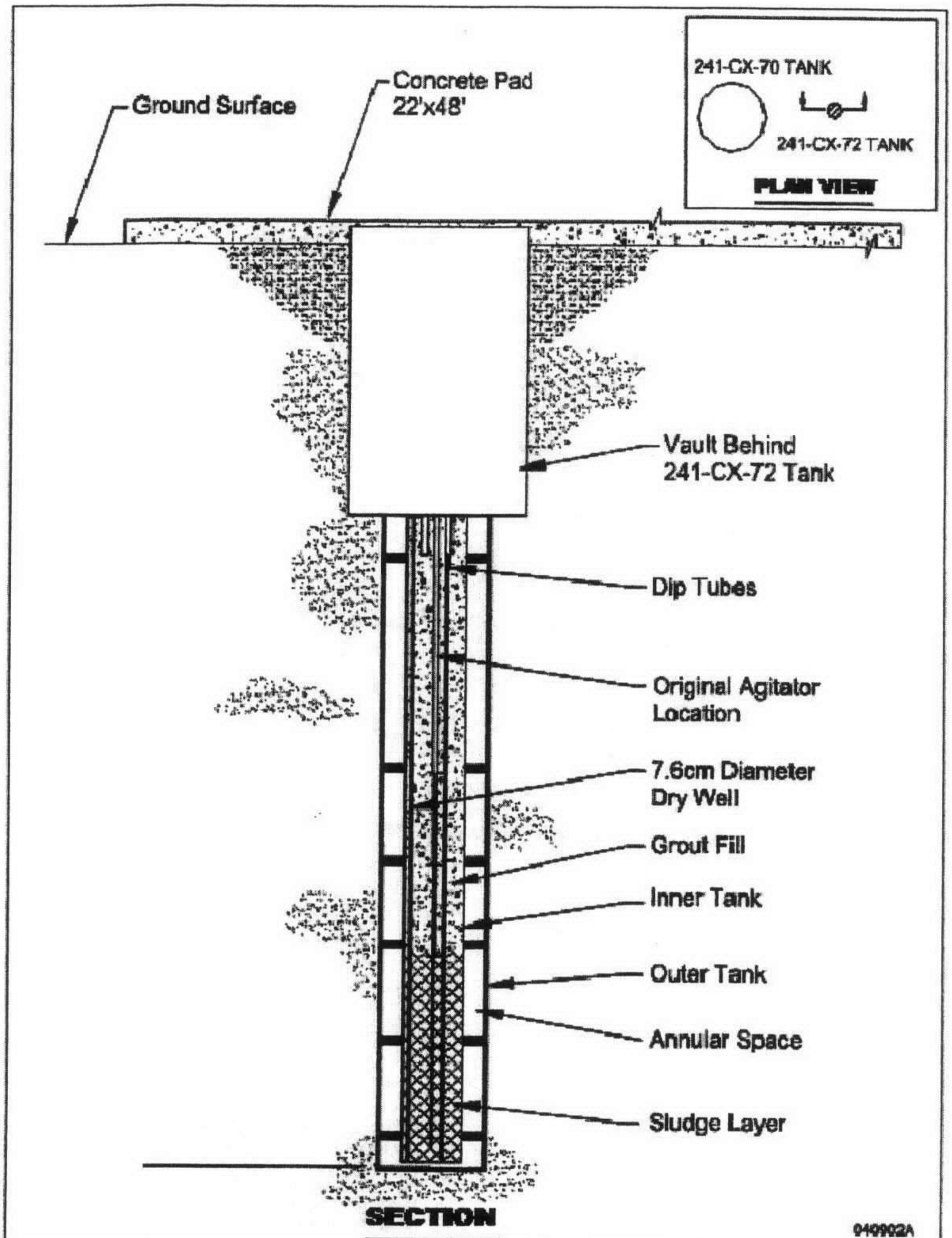


1 Figure 2-10. 241-CX-72 Storage Tank Construction Diagram.



2

- 241-CX-71 Neutralization Tank: "WT-02" (dangerous toxic – state only) because of cyanides and nitrates
- 241-CX-72 Storage Tank: "D002" (corrosive), "D004" (arsenic), "D005" (barium), "D006" (cadmium), "D007" (chromium), "D008" (lead), "D009" (mercury), "D010" (selenium), "D011" (silver), "WC02" and "WT01" (extremely hazardous toxic), and "WT02" (dangerous toxic – state only) because of cyanides and nitrates.

2.3.4 Hexone Storage and Treatment Facility

The HSTF is located in the southeast corner of the Hanford Site 200 West Area (Figure 2-11). The HSTF consisted of two 81,400 L (21,500-gal) belowgrade carbon-steel tanks (276-S-141 and 276-S-142 Hexone Storage Tanks) (Figure 2-12), a distillation system, and railroad tank cars. The HSTF received liquid mixed waste from the REDOX Plant and possibly the Hot Semiworks Facility. The HSTF was used from 1951 through 1967 to store reagent-grade MIBK for makeup as solvent for the REDOX Plant. After 1967, the HSTF contained distilled hexone, part or all of which had been used in the REDOX Plant. The 276-S-142 Hexone Storage Tank also contained NPH and TBP from a one-time campaign to separate americium, curium, and promethium from Shippingport reactor blanket fuel in 1966. Approximately 760 L (200 gal) of water were added to the 276-S-141 Hexone Storage Tank in 1988 (BHI-01018).

The 276-S-142 Hexone Storage Tank received approximately 5,000 L (1,300 gal) of water in 1967; 1,900 L (500 gal) in the mid-1970s; and 760 L (200 gal) in the mid-1980s. The combined storage design capacity of the 276-S-141 and 276-S-142 Hexone Storage Tanks is 163,000 L (43,000 gal) (BHI-01018). The treatment design capacity of the distillation system was 11,400 L (3,000 gal) of waste per day.

The mixed waste was pumped from the 276-S-141 and 276-S-142 Hexone Storage Tanks through a distillation system to decrease the radioactivity of the waste. The distilled waste was sent to temporary storage in railroad tank cars (located within the HSTF) until transfers to an offsite incinerator were completed in June 1992. The storage design capacity of the railroad tank cars was 152,000 L (40,000 gal). The railroad tank cars have been emptied, cleaned, and moved to another location. Three distillation vessels containing process residue have been sampled and are stored at the Hanford Site as mixed waste.

Grout has been added to the tanks over a heel of tarry sludge (see Table 2-2). The tank was grouted in two pours in March 2002, with a colored grout layer containing the heel in the bottom layer and uncolored grout completely filling the remainder of the void space in each tank (BHI-01142, *REDOX Facility Safety Analysis Report*).

Figure 2-11. 276-S-141 and 276-S-142 Hexone Storage Tanks Location Map.

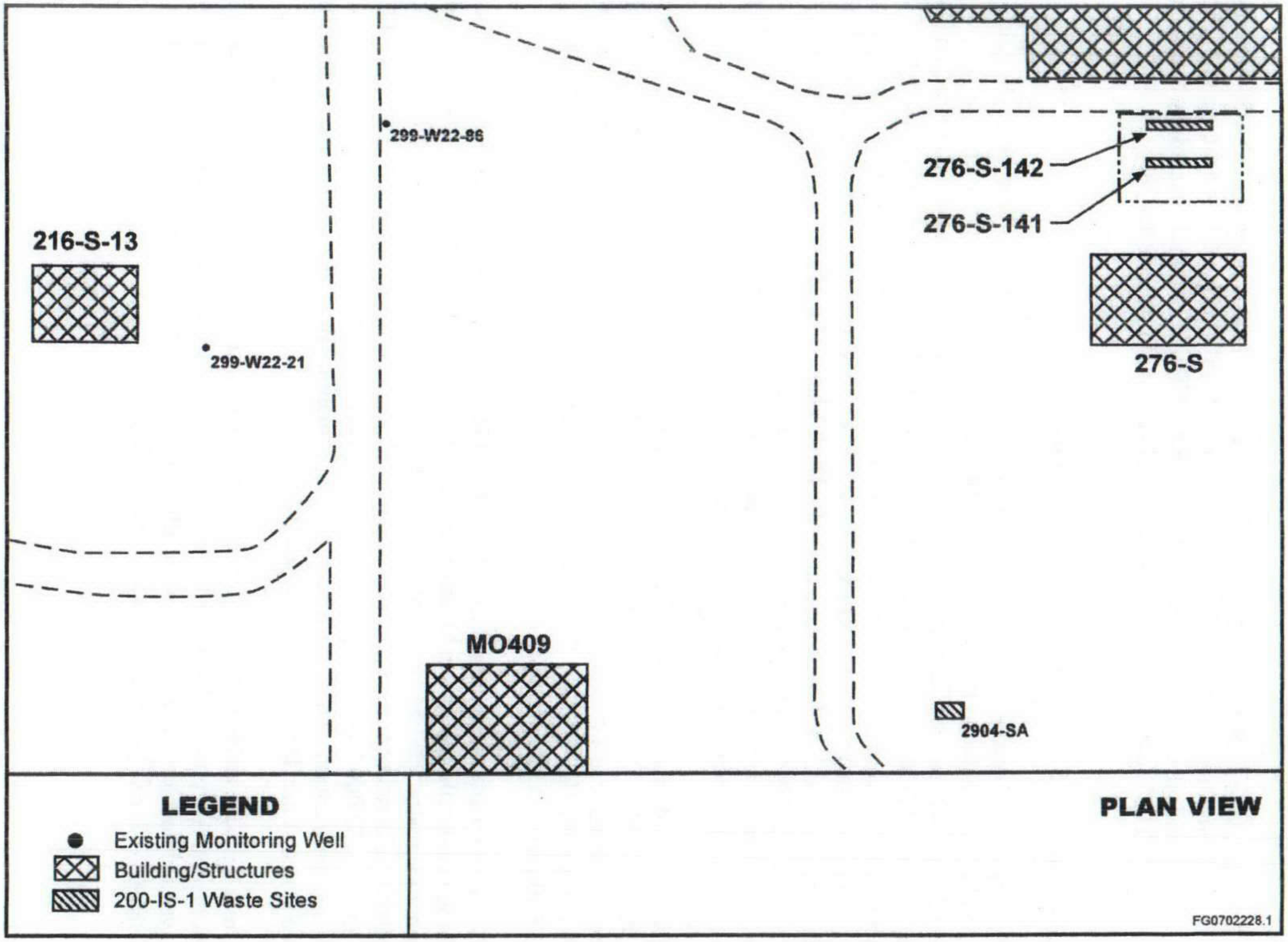
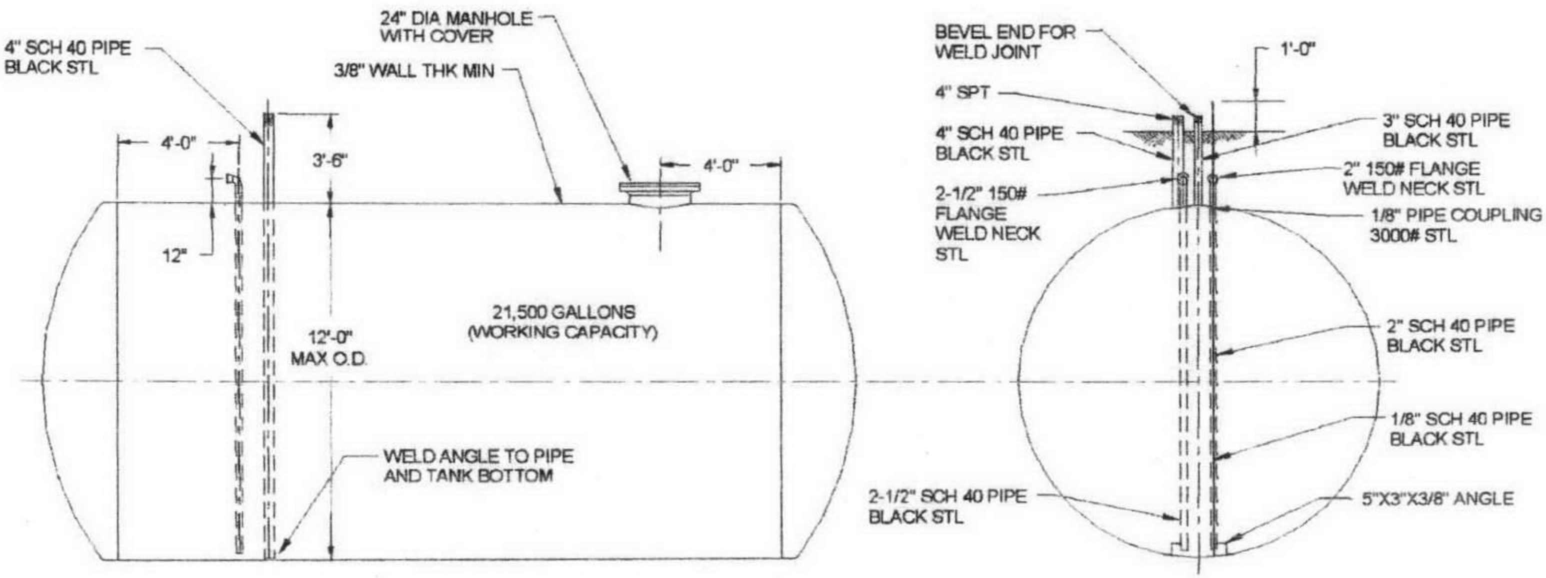


Figure 2-12. 276-S-141 and 276-S-142 Hexone Storage Tanks Construction Diagram.



side view

end view

A RCRA Dangerous Waste Permit Application (Form 3) for the hexone tanks was submitted to Ecology in December 1987 (WA7890008967). A RCRA closure plan for the tanks was submitted in November 1992 (DOE/RL-92-40). The tanks are regulated as dangerous-waste tank TSD units with waste codes "D001" (ignitability), "F003" (listed spent hexone solvent), and "WT02" (toxicity criteria).

In April 2000, Ecology inspected the TSD unit encompassing the tanks. In May 2000, Ecology issued CCN 079387, "Notice of Correction for Stabilization of Hexone Storage and Treatment Facility," regarding their findings. The letter required that the hexone tanks be stabilized by removing all of the potential safety hazards posed to employees by no later than December 2001. It also required that the stabilization include removal or deactivation of the waste. If the tanks remain in place, provisions must be made for monitoring the tanks for oxygen and organic vapors and for intrusion of liquids.

In May 2001, Ecology issued CCN 089928, "Notice of Correction for Stabilization of the Hexone Storage and Treatment Facility," which revised the deadline for stabilizing the hexone tanks to the end of February 2002.

On December 13, 2001, Ecology approved grouting as the stabilization method for interim closure of the hexone storage tanks (CCN 095038, "Approval for Stabilization of the Hexone Storage and Treatment Facility"). Ecology stipulated that each tank be grouted in two pours. In March 2002, the tanks were filled with cement grout using the method authorized by Ecology for stabilization and to reduce flammability concerns associated with hexone vapors. In each tank, the first-pour grout covers the heel of waste with a distinctly colored grout. The first grout layer was allowed to solidify enough to introduce a cold joint between pours. After the first-pour grout solidified, the second layer of grout was poured into the tank. The second grout layer completely filled the tank's void space. The second pour consisted of uncolored grout that, in concert with the cold joint created between layers, provides a clear demarcation between the grout layers. The coloring and two-stage grouting processes facilitate closure of the tanks by separating the mixed-waste contents (tank bottom containing the heel and colored grout) from nonmixed-waste debris (upper tank and uncolored grout). The area is fenced off as a controlled access zone.

Ecology also requested that a revised closure plan for the hexone storage tanks be prepared for inclusion in future modifications to the Hanford Site's RCRA Sitewide Permit (WA7890008967).

3.0 INITIAL EVALUATION

This chapter presents the results of previous characterization activities conducted for the 200-IS-1 OU. Limited characterization of the pipeline systems has been completed to date. The information collected usually was obtained as part of previous investigations that focused on liquid-waste disposal sites. Current contaminant distribution in groundwater underlying the pipeline systems in the 200 Areas also is provided.

For the CX Tank System and the Hexone Storage Tanks, information on contaminant inventory, effluent volume, and available sampling data is presented. This chapter contains information that will be used for portions of the RCRA TSD closure plans, including the nature and extent of contamination, facility description, and current RCRA interim-status groundwater-monitoring requirements.

3.1 KNOWN AND SUSPECTED CONTAMINATION

The estimated composition of the primary radionuclides and nonradiological constituents that potentially may have been released to the vadose zone at waste sites in the 200-IS-1 OU was obtained from numerous sources. The process operations and waste streams generated at the 200 Areas facilities and handled by the structures associated with the 200-IS-1 OU are discussed in Chapter 2.0. Waste-source and inventory data for the process-waste pipeline systems are available from a number of sources, including the following:

- WIDS
- Aggregate area management study reports for the 200 Areas:
  - DOE/RL-92-05, *B Plant Source Aggregate Area Management Study Report*
  - DOE/RL-91-52, *U Plant Source Aggregate Area Management Study Report*
  - DOE/RL-92-04, *PUREX Plant Source Aggregate Area Management Study Report*
  - DOE/RL-91-60
  - DOE/RL-92-18
- DOE/RL-98-28
- DOE/RL-96-81
- RPP-26744
- TWINS database.

The radionuclide and nonradiological waste inventory transferred or stored during active operations associated with the 200-IS-1 OU was not fully documented in historical records. However, rough-order-of-magnitude estimates are provided in RPP-26744, DOE/RL-98-28, and WIDS, based on existing documentation. Additional sources of data regarding the composition of contaminants that were transferred through pipelines were obtained by reviewing analytical results for samples collected at the disposal sites (e.g., cribs, trenches, french drains, injection wells, ponds) that received the waste streams. Analytical results from disposal waste sites and inventory information, where available, indicate that primary constituents in many of the waste streams include Cs-137, Sr-90, uranium, plutonium, and nitrate (DOE/RL-96-81).

3.2 MONITORING

3.2.1 Environmental Monitoring

Current activities at the Hanford Site focus on environmental cleanup. Before the recent cleanup efforts began, monitoring was performed across the Hanford Site to measure and evaluate long-term trends in the environmental accumulation of radioactive contamination. Risks associated with unacceptable levels of contamination typically were addressed by stabilizing the waste sites with soil, concrete, and/or gravel backfill to minimize impact on human health and the environment.

Typically, the accumulation of radioactivity at liquid-waste disposal sites was evaluated through gathering and analyzing soil samples. Scintillation logging was commonly performed in boreholes adjacent to the liquid-waste disposal sites. The logs were used to determine the extent of radiological contamination in the subsurface; however, these logs are not quantitative and only generally indicate the presence of radiological contamination. Groundwater is monitored based on RCRA requirements and the objectives of the Hanford Site-wide groundwater-monitoring program.

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

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

Air, external radiation, soil, and vegetation are evaluated routinely in the 200 Areas as part of the Hanford Site Near-Facility and Environmental Monitoring Programs. Results of the Near-Facility and Environmental Monitoring Programs are presented in annual reports. The annual reports (e.g., PNNL-13230, *Hanford Site Environmental Report for Calendar Year 1999*; PNNL-13230, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1999*; PNNL-14687, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 2003*; PNNL-15222, *Hanford Site Environmental Report for Calendar Year 2004*) contain some data applicable to the 200-IS-1 OU. PNNL-14687, Appendix 2; PNNL-13230, Appendix 2; and PNNL-15892, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 2005*, focus on monitoring activities near facilities that have the potential to, or have, discharged, stored, or disposed of radioactive or hazardous materials, including those facilities in the 200 Areas. PNNL-13230, PNNL-15222, and PNNL-15892, *Hanford Site Environmental Report for Calendar Year 2005*, cover the entire Hanford Site, including those areas not associated with operations (e.g., the 600 Area). These annual reports examine the resources associated with the Hanford Site, including the media listed in the previous paragraph. Results of monitoring pertinent to the 200-IS-1 OU waste sites are presented in this chapter. The potential impacts of 200-IS-1 OU waste-site contamination on human health and the environment also are discussed.

Groundwater routinely is monitored site wide. More than 600 monitoring wells are sampled annually to characterize groundwater flow; groundwater contamination by metals, radionuclides, and nonradiological constituents; and the extent of contamination. Contaminated groundwater, ingestion risk, and dose also are assessed. Results of groundwater monitoring and remediation are presented in annual reports (e.g., PNNL-15670, PNNL-16346). The groundwater-monitoring reports also summarize vadose-zone characterization activities conducted on the Hanford Site as part of other projects.

3.2.2 Groundwater-Monitoring Results

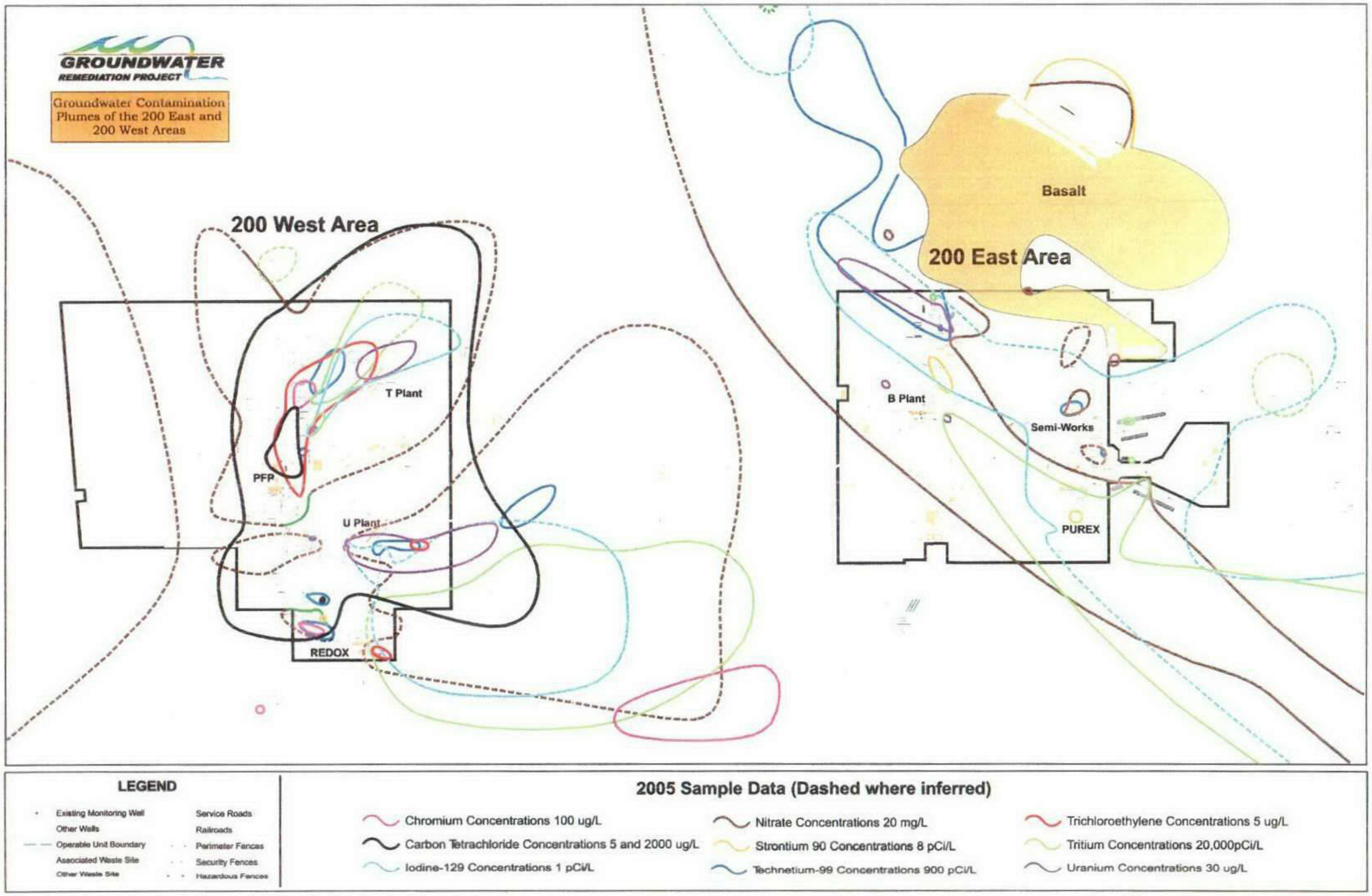
The process-waste pipeline systems extend across a large portion of the 200 East and 200 West Areas. This section summarizes the groundwater-contaminant conditions associated with the 200 Areas and vicinity underlying the 200-IS-1 OU pipeline systems, the CX Tank System and Hexone Storage Tanks. The information presented here primarily was taken from PNNL-15670 and PNNL-16346. The major radiological and nonradiological groundwater-contaminant plumes in the 200 Areas and vicinity are shown on Figure 3-1.

Some of the source areas for these groundwater plumes have been identified as a result of the RIs completed for the soil-waste sites in the 200 Areas and the tank farms investigations. Characterization studies completed in conjunction with the groundwater OUs also have resulted in determination of additional sources for some plumes. The groundwater OUs have the primary responsibility for characterization of groundwater conditions and the identification and delineation of the contaminant plumes.

The information presented in the following discussion provides an overview of the current delineation of primary-contaminant plumes in areas where the 200-IS-1 OU pipeline systems will be investigated and the impacts to groundwater assessed. This overview of groundwater conditions underlying the pipeline systems is provided to show the configuration of the primary plumes that have been identified beneath the Central Plateau. At this time, no relationship between the pipeline systems and any of the groundwater plumes has been identified. The information presented in this section will be used during the assessment of the potential impact to groundwater, if release locations in the soil are identified during the RI.

Figure 3-1. Groundwater Contaminant Plume in the 200 East and 200 West Areas.

(After PNNL-15670, *Hanford Site Groundwater Monitoring for Fiscal Year 2005*)



In the northern part of the 200 East Area and vicinity, contaminants identified in groundwater include tritium, uranium, I-129, Tc-99, Co-60, cyanide, Sr-90, Cs-137, Pu-239/240, and nitrate (PNNL-15670; PNNL-16346; and PNNL-14049, *Data Quality Objectives Summary Report – Designing a Groundwater Monitoring Network for the 200-BP-5 and 200-PO-1 Operable Units*). In the southern portion of the 200 East Area and to the south, contaminant plumes containing tritium, nitrate, I-129, Sr-90, and Tc-99 have been identified. Other contaminants detected include arsenic, chromium, manganese, vanadium, Co-60, and cyanide (PNNL-14049; PNNL-15670; and DOE/RL-2003-04, *Sampling and Analysis Plan for the 200-PO-1 Groundwater Operable Unit*).

In the northern and central parts of the 200 West Area, contaminant groundwater plumes containing carbon tetrachloride, chloroform, trichloroethene, nitrate, chromium, fluoride, tritium, I-129, Tc-99, and uranium are present (PNNL-15670, PNNL-16346). In the southern portion of the 200 West Area, plumes containing Tc-99, uranium, tritium, I-129, nitrate, and carbon tetrachloride have been delineated (PNNL-15670, PNNL-16346). Groundwater that exceeds drinking-water standards for Sr-90, trichloroethene, chloroform, chromium, cadmium, and arsenic also has been identified (PNNL-15670; PNNL-16346; and DOE/RL-92-76, *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit*). Groundwater sampling results have shown the presence of volatile organic compounds, metals, anions, ammonium ion, ammonia, cyanide, sulfide, cresols, phenols, total petroleum hydrocarbons (TPH, kerosene range), beta emitters (C-14 and Se-79), alpha emitters (Np-237 and Pa-231), and gamma emitters (Cs-137 and Co-60) in the 200 West Area (PNNL-15670, PNNL-16346, and DOE/RL-92-76).

3.2.2.1 Primary Radiological Groundwater Contaminant Plumes

<u>**Iodine-129**</u>

Iodine contamination in groundwater is present in the 200 East Area and vicinity and has been delineated as a large continuous plume. The portion of this plume that is above the I-129 drinking-water standard of 1 pCi/L extends to the northwest toward Gable Gap and also to the southeast through the 200 East Area and into the 600 Area. The northeastern limit of this plume has not passed beyond Gable Gap (PNNL-15670, PNNL-16346). The southeastern limit of this plume extends beyond the boundary of the map presented in Figure 3-1.

Three major I-129 plumes exist in the 200 West Area and vicinity. One plume originates from the U Plant area (near the 216-U-1/216-U-2 Cribs), and another plume originates from the REDOX Plant area in the southern part of the 200 West Area. These plumes merge downgradient (generally to the east) and become indistinguishable. The portion of this combined plume exceeding an iodine concentration of 1 pCi/L extends to the east and northeast a total distance of ~3.5 km. The third plume is in the vicinity of the Tank Farm WMA TX-TY and extends to the northeast. The portion of this plume that exceeds 1 pCi/L concentration now appears to extend to the 200 West Area boundary (PNNL-16346).

Strontium-90

Three major, although fairly localized, Sr-90 groundwater plumes exist in the 200 East Area and vicinity that have resulted from unique discharges settings within the vadose zone (PNNL-15670, PNNL-16346). One very localized plume occurs near the 216-B-5 Injection Well in the central part of the 200 East Area, and another plume is located along the northeastern edge of Gable Mountain Pond, north of the 200 East Area. Both of these plumes have levels of Sr-90 well above the drinking-water standard of 8.0 pCi/L. A third, small, plume has been identified near the 216-A-10 and 216-A-36B Cribs (south of the PUREX Plant) in the southeastern part of the 200 East Area. Only one monitoring well is located in this area with a Sr-90 level exceeding 8.0 pCi/L (PNNL-15670, PNNL-16346).

A fourth, very small, plume of Sr-90 is present in the 200 West Area, located south of the 216-S-1/216-S-2 Cribs. The very small size of this plume again is based on only one monitoring well located in this area with a Sr-90 level exceeding 8.0 pCi/L (PNNL-15670, PNNL-16346).

The localized distribution of Sr-90 is related to its low mobility. Mechanisms by which this radionuclide has reached groundwater are unique and include an unplanned release at Gable Mountain Pond, direct discharge of liquid waste streams to an injection well, and migration from a disposal site to an adjacent monitoring well and preferential vertical transport along the well casing.

Technetium-99

One major plume of Tc-99 exists in the 200 East Area, extending from the vicinity of WMA B-BX-BY and the BY Cribs (located in the northern part of the 200 East Area) to the northwest toward Gable Gap. A significant portion of the plume that exceeds the drinking-water standard of 900 pCi/L is located north of the 200 East Area boundary. Technetium-99 has been detected at levels lower than 900 pCi/L north of Gable Gap, indicating that Tc-99 has moved north into, and through, Gable Gap (PNNL-15670, PNNL-16346).

Seven Tc-99 plumes with concentrations exceeding 900 pCi/L exist in the 200 West Area and vicinity. One large plume is present downgradient from the 216-U-1/216-U-2 Cribs, with two small plumes near WMA S-SX and one plume at WMA U. The plume located downgradient from the 216-U-1/216-U-2 Cribs extends ~1.5 to 2 km east into the 600 Area. The two small plumes at WMA S-SX consist of a northern plume, originating from the S Tank Farm, and a southeastern plume, originating from the SX Tank Farm. The plume at the WMA U originates from the U Tank Farm, and the downgradient extent of the plume is not known. The remaining three plumes in the 200 West Area consist of one plume located downgradient of WMA T and two small plumes located downgradient of WMA TX-TY. The plume at WMA T extends from the east side of the WMA downgradient to the northeast. At WMA TX-TY, one very localized plume is present on the east side of the WMA, and one very localized plume is present at the south side of the WMA (PNNL-15670, PNNL-16346).

Tritium

A large tritium groundwater plume emanates to the southeast from the 200 East Area at concentrations exceeding the drinking-water standard of 20,000 pCi/L (Figure 3-1).

Another tritium plume extends from the southern part of the 200 West Area, near the REDOX Plant cribs, and extends ~5 km to the east and northeast into the 600 Area, approaching the 200 East Area. Two primary portions of this plume currently exceed the drinking-water standard of 20,000 pCi/L. One of these exists over a small area extending ~550 m to the east-southeast from near the 216-S-25 Crib.

Tritium contamination at levels exceeding 20,000 pCi/L are found in two plumes in the northern portion of the 200 West Area. One is a large plume extending northeast from waste-disposal facilities near WMAs T and TX-TY. Another small plume is located in the area immediately surrounding the State-Approved Land Disposal Site north of the 200 West Area (PNNL-15670, PNNL-16346).

Uranium

Four uranium plumes that exceed the drinking-water standard of 30 μg/L exist in the 200 East Area. One plume occurs as a narrow northwest-southeast band extending from WMA B-BX-BY to the northwest out of the 200 East Area. A small plume is located in the area immediately surrounding the southeastern end of the 216-B-62 Crib. The remaining two small plumes are located near the 216-B-5 Injection Well. One of these two plumes is located south of the 216-B-5 Injection Well, immediately surrounding well 299-E28-6. The other plume is located in the area immediately surrounding the 216-B-5 Injection Well (PNNL-15670, PNNL-16346).

Only one major uranium plume exists in the 200 West Area and vicinity that exceeds the drinking-water standard of 30 μg/L. This extensive plume is located downgradient from the 216-U-1/216-U-2 Cribs and extends ~1.5 km to the east and northeast into the 600 Area. A few wells in the 200 West Area have, at times, had uranium levels that have exceeded 30 μg/L. One well (299-W23-4) is located downgradient from the 216-S-21 Crib. Another well (299-W18-21), located near the southwest corner of Low-Level Waste Management Area 4, had uranium levels just above the drinking-water standard in the past, although these levels have dropped below 30 μg/L in recent sampling events. Well 299-W11-37, located in the northeast part of the 200 West Area, shows uranium levels exceeding 30 μg/L (PNNL-15670, PNNL-16346).

3.2.2.2 Nonradiological Groundwater Contaminant Plumes

Carbon Tetrachloride

Carbon tetrachloride groundwater contamination is found at levels exceeding the drinking-water standard of 5 μg/L in most of the 200 West Area, extending as far as ~1 km east into the 600 Area (Figure 3-1). The plume originated from waste-disposal sites associated with the Plutonium Finishing Plant, including the 216-Z Cribs and Trenches that received waste from the Plutonium Finishing Plant (PNNL-15670, PNNL-16346).

Trichloroethene

Trichloroethene is found in a plume in the 200 West Area exceeding the drinking-water standard of 5 μg/L in the vicinity of the 200-UP-1 OU pump-and-treat system. The distribution of trichloroethene is different from that of carbon tetrachloride and is thought to have a local source near the U Plant. The main trichloroethene plume extends north and northeast from the vicinity of the 216-Z Cribs and Trenches, with the 216-Z-9 Trench likely being a primary origination source (PNNL-15670, PNNL-16346).

Chromium

Chromium is found in the southern and eastern portions of the 200 West Area in four regions where chromium has been detected at levels exceeding the drinking-water standard of 100 μg/L. One plume emanates from the southern part of WMA S-SX, with the SX Tank Farm as the source, and extends locally to the east-southeast of the WMA. Chromium concentrations in this plume are increasing, and the extent of the plume has been increasing. Another, small, plume is located at the 216-S-10 Pond and Ditch, based on results from one well (299-W26-7) where chromium concentrations exceed 100 μg/L. The well has since gone dry, so no further sampling is possible. The extent of the plume appears to be small and stable, because chromium concentrations in downgradient and side-gradient wells are low to nondetectable. A third, small, plume occurs in the vicinity of the 216-S-20 Crib, based on chromium concentrations that exceed 100 μg/L in one well (299-W22-20) adjacent to the crib. The extent of this plume is not known, because no other downgradient monitoring wells are present in the immediate area. The fourth plume is located in the 600 Area, east and southeast of the 200 West Area, based on chromium concentrations that exceed 100 μg/L in one well (699-32-62) in this area. Chromium concentrations have declined slowly since this constituent was first analyzed at this well, and the sources and extent of this contamination are uncertain.

In the northern part of the 200 West Area, chromium contamination is found at levels exceeding 100 μg/L in the immediate vicinity of WMAs T and TX-TY. The chromium plume present at WMA T extends from the west and southwest part of the WMA to the area east of the WMA. Chromium was detected at levels above 100 μg/L in only two wells (299-W14-11 and 299-W14-13) at WMA TX-TY, indicating that the chromium contamination is limited to the immediate area surrounding the two wells. Chromium at lower levels extends downgradient toward or past the perimeter of the 200 West Area (PNNL-15670, PNNL-16346).

Nitrate

A nitrate plume exceeding the drinking-water standard of 45 mg/L (maximum contaminant level expressed as the concentration of NO_3 anion) originates in the 200 East Area and extends to the northwest toward Gable Gap and to the southeastern part of the 200 East Area (Figure 3-1). A second, small plume exceeding 45 mg/L is located along the northeastern edge of Gable Mountain Pond, north of the 200 East Area (PNNL-15670, PNNL-16346).

Nitrate plumes are widespread throughout the 200 West Area and are thought to have originated from both the U Plant and the REDOX Plant disposal sites. One large plume exceeding 45 mg/L, merged primarily from sources at the 216-U-1/216-U-2, 216-U-8, and 216-U-12 Cribs, extends to the east and northeast of the 200 West Area a total distance of ~4 km. Multiple small plumes exceeding 45 mg/L also are present. One plume is located in the immediate area surrounding well 299-W19-43 in the 200-UP-1 OU pump-and-treat area. Another plume extends from the west and southwest of Low-Level Waste Management Area 4 to the eastern side (downgradient) of WMA U. Nitrate levels exceeding 45 mg/L occur in two small plumes associated with REDOX Plant disposal facilities, with one near the 216-S-20 Crib and another near the 216-S-25 Crib. The plume from the 216-S-25 Crib merges with another plume emanating from WMA S-SX (PNNL-15670, PNNL-16346).

3.3 ECOLOGICAL INFORMATION

This section discusses DOE/RL-2001-54, *Central Plateau Ecological Evaluation*, and the ongoing Central Plateau ecological risk assessment (SGW-32847, *Reference Sites for the Central Plateau Ecological Risk Assessment*, in work), which serve as the basis for ecological evaluation activities in the Central Plateau. It also summarizes existing 200-IS-1 OU-specific ecological sampling and analysis information. Results from the current ecological evaluations and existing data are considered in the analysis of impacts to human health and the environment for the 200-IS-1 OU.

3.3.1 Central Plateau Ecological Evaluation and Central Plateau Terrestrial Ecological Risk Assessment

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

The document contains a compilation and evaluation of ecological sampling data that have been collected over many years from undisturbed and disturbed habitats in the Central Plateau. The ecological evaluation document helps answer questions about the ecological resources in the Central Plateau that are important to preserve and protect. The document also identifies ecological-data needs that can be addressed in future ecological-sampling activities on the Central Plateau.

DOE/RL-2001-54 contains descriptions of the habitats in the Central Plateau, including sensitive habitats and the plants and animals that inhabit them. The document identifies potential species of concern, including threatened and endangered species and new-to-science species. A detailed survey of the Central Plateau was conducted in 2000 and 2001, and the results are incorporated into the ecological evaluation document. The information from the survey provides a detailed description of the ecological setting of the Central Plateau and augments the ecological information presented in this work plan.

Ecological evaluation of the Central Plateau has continued since the preparation and issue of DOE/RL-2001-54. An evaluation of the ecological risk and assessment of additional data-collection needs is presented in WMP-29253, *Central Plateau Terrestrial Ecological Risk Assessment Data Quality Objects Summary Report – Phase III*. The ecological-risk assessment, supported by the Central Plateau ecological DQO documents, is one of several being performed on the Hanford Site to ensure that ecological risks have been properly evaluated in support of remedial-action decision-making (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*).

3.3.2 200-IS-1 Operable Unit Specific Ecological Data

Existing information pertaining to sampling of vegetation and biota in those areas associated with the pipeline systems is presented in this section. The available ecological data are considered in the discussion on potential impacts to human health and the environment, presented in Section 3.6.

A 1994 field investigation of the 200-UP-2 OU (BHI-00033, *Surface and Near Surface Field Investigation Data Summary Report for the 200-UP-2 Operable Unit*), which was conducted in conjunction with the 200-UP-2 OU limited field investigation (DOE/RL-95-13, *Limited Field Investigation for the 200-UP-2 Operable Unit*), examined surface-soil contamination and uptake of radionuclides and metals by vegetation near a vitrified clay pipeline (now officially known as waste site 200-W-42 in the WIDS database) leading to the 216-U-8 Crib. Although this pipeline is not a 200-IS-1 OU waste site, the ecological data gathered from this investigation can be applied to other pipelines in the 200-IS-1 OU that exhibit the same or similar attributes.

Vegetation samples were taken at the 216-U-8 Crib vitrified clay pipeline and analyzed for a series of metals and radionuclides. Analytical results for the radionuclides detected are listed in Table 3-1 can be found in BHI-00033, Appendix B. Radionuclides detected in vegetation samples near the 216-U-8 Crib vitrified clay pipeline included Cs-137, Pu-239/240, Tc-99, Th-232, total strontium, U-234, and U-238.

In a 1999 sampling activity described in the Hanford Site environmental report (PNNL-13230), 48 vegetation samples were collected in the 200 and 600 Areas. Vegetation samples were collected from one 200-IS-1 OU waste site, the 200-W-59 Diversion Box, under the Hanford Site Near-Facility Monitoring Program (e.g., PNNL-13230, Appendix 2). The vegetation samples were collected from station V021, located inside the 200-W-59 Diversion Box boundary. Vegetation concentrations of radionuclides for the V021 monitoring site are listed in Table 3-2. All vegetation samples contained radionuclide concentrations of less than 1.0 pCi/g.

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

Table 3-1. Detectable Radionuclide Concentrations in Vegetation at the 216-U-8 Vitrified Clay Pipeline.

Sample ID	Radionuclides (pCi/g)																	
	Ac-228	Be-7	Beta	Cs-137*	K-40	Pb-212	Pb-214	Pu-239/240*	Ra-224	Se-79	Tc-99*	Th-232*	Th-234	Tl-208	Total Sr*	U-234*	U-238*	U-238G	Total U
BOBFL8	(U)	1.89	817	0.158	9.28	0.024	NA	(U)	NA	NA	296	NA	NA	NA	328	0.0554	0.0474	NA	0.209
BOBFL9	NA	2.7	4,220	0.974	5.37	0.219	0.193	0.0708	0.234	2.66	117	0.185	NA	0.0425	1,380	0.198	0.189	0.193	0.752
BOBFM0	NA	2.3	879	17.2	3.67	0.0643	NA	0.0228	0.0686	1.44	49.5	0.152	NA	NA	492(J)	0.324	0.299	NA	0.782
BOBFM1	NA	2.21	614	6.32	3.43	0.0463	NA	(U)	0.0494	1.85	46.8	0.118	NA	0.037	426(J)	0.186	0.145	NA	0.613
BOBFM2	0.0414	2.02	24.8	0.579	5.29	0.0451	0.134	0.0239	0.0423	(U)	29.4	NA	NA	NA	10.4	(U)	(U)	0.134	0.126
BOBFM3	(U)	2.61	35.4	0.611	3.58	0.0448	NA	(U)	0.0479	(U)	28.7	NA	2.63	0.00774	10(J)	0.08	(U)	NA	0.106
Maximum	0.0414	2.7	4,220	17.2	9.28	0.219	0.193	0.0708	0.234	2.66	296	0.185	2.63	0.0425	1,380	0.324	0.299	0.193	0.782
Minimum	0.0414	1.89	24.8	0.158	3.43	0.024	0.134	0.0228	0.0423	1.44	28.7	0.118	2.63	0.0077	10	0.0554	0.0474	0.134	0.106
Avg. detectable concentration	0.0414	2.3	1,098.4	4.307	5.1	0.0739	0.1635	0.0392	0.0884	2.0	94.6	0.1517	2.63	0.0291	441.1	0.1687	0.1701	0.1635	0.4313

*Contaminants of concern for 200-PW-2 Operable Unit (BHI-00033, *Surface and Near-Surface Field Investigation Data Summary Report for the 200-UP-2 Operable Unit*).
Qualifiers: (U) = undetected; (J) = concentration is estimated, NA = not analyzed.
Undetected radionuclides: Cm-242, Cm-244, Cs-134, Co-60, Eu-152, Eu-154, Eu-155, I-129, Na-22, Np-237, Pu-238, Ru-106, and U-235.

Table 3-2. Vegetation Concentrations of Radionuclides for the V021 Monitoring Site Near the 200-W-59 Diversion Box.

Isotope	Vegetation (V021 Monitoring Site) (pCi/g)
Antimony-125	1.5 E-02
Cerium-144	5.9 E-02
Cobalt-60	1.8 E-02
Cesium-134	-1.3 E-02
Cesium-137	9.2 E-03
Europium-152	3.7 E-02
Europium-154	-1.7 E-02
Europium-155	7.1 E-03
Plutonium-238	6.4 E-03
Plutonium-239/240	3.7 E-03
Ruthenium-103	1.9 E-02
Ruthenium-106	4.2 E-03
Strontium-90	4.7 E-01
Tin-113	-5.3 E-02
Uranium-234	2.0 E-02
Uranium-235	3.8 E-03
Uranium-238	1.3 E-02
Zinc-65	7.0 E-02

Source: PNNL-13230, Appendix 2, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1999.*

Biological transport of contamination by ants also is a concern on the Hanford Site. Contaminated soil and anthills were identified both north and south of 7th Street and around the 241-ER-151 Diversion Box (part of the 200-IS-1 OU) in September 1998.

3.4 NATURE AND EXTENT OF CONTAMINATION

The following section describes the current assessment of the nature and extent of contamination associated with the 200-IS-1 OU pipeline systems and the CX Tank System and Hexone Storage Tanks. A summary of the historical characterization data, indicating contaminant distribution, is presented.

3.4.1 Process-Waste Pipeline Systems

A compilation and review of previously collected characterization data that was directed specifically to evaluating process-waste pipeline systems was undertaken for this work plan. Previous investigations primarily were focused on characterization of waste-disposal sites, but several of the studies included evaluations of the pipelines that connected to the waste sites. A listing of the documents that were reviewed and the characterization data found in the reports is summarized in tabular format and provided in Appendix D. This section provides additional details concerning the information presented in Appendix D and other data that were obtained from WIDS.

3.4.2 Historical Sampling and Analysis of Pipelines

The information presented in the following sections is organized and presented with reference to the process-waste pipeline bins. Discussions are differentiated between pipelines associated with the process facilities and those that are part of the tank-farm waste-transfer system.

3.4.2.1 Process-Facility Pipeline Systems

Limited existing characterization data were identified for the facility process-waste pipelines that are being evaluated under this work plan (pipelines in the 200-UW-1 OU are not included). At locations where unplanned releases or soil contamination zones (CZ) have been identified along a pipeline and are known or believed to be associated with a pipeline leak, no surface (soil or vegetation) samples have been collected and analyzed. No subsurface sampling or subsurface radiological-logging results were found to be directly related to any of the facility pipelines. Pipe interiors have not been radiologically surveyed, sampled, or viewed with remote video cameras (other than in the one instance, discussed in Section 3.4.3).

No prior sampling and analysis information is available for the pipelines in two of the five facility process-waste-stream bins: Bin 1, the Process-Condensate, Process-Waste, and Chemical-Laboratory-Waste streams; and Bin 4, the Miscellaneous-Waste streams (see Appendix D, Table D-1). For the other three facility pipeline bins: Bin 2, Steam Condensate and Cooling Water; Bin 3, Chemical-Sewer Waste; and Bin 5, Tank/Scavenged Waste), available information is summarized below.

At some locations where unplanned releases or soil CZs have been identified on the surface along a pipeline, and the release was known or believed to be caused by a pipeline leak, limited investigations have been conducted. Characterization activities generally have been restricted to surface radiological surveys, noting the maximum radiological-instrument counts and observations concerning the media contaminated (i.e., vegetation or soil). In some cases, an estimate also is available concerning the volume of effluent or quantity of radiological material that may have been released into the soil. Reported results are summarized in the following sections.

3.4.2.1.1 Characterization Information for Bin 2 Stream Condensate and Cooling Water Pipelines

Six pipelines in Bin 2, Steam Condensate and Cooling Water, have associated unplanned releases or CZs that have been identified along their paths and that are known or believed to be caused by leakage.

Three small soil CZs are located above the 200-E-127-PL Pipeline that extends from the PUREX Plant to the 216-A-25 (Gable Mountain Pond) waste site. In the areas of the CZs, the pipeline consists of 91 or 107 cm (36- or 42-in.)-diameter corrugated metal. The depth below ground surface to bottom of the pipeline (i.e., invert depth) ranges from approximately 1.8 to 2.3 m (6 to 7.5 ft) in the vicinity of the CZs. Little information is available about these CZs, except that records in WIDS indicate that radiologically contaminated tumbleweeds were present in these areas at one time. The three areas are outside and to the north of the 810 Gate. Currently they are surface stabilized. Two areas are posted as Contamination Areas, and the third is posted as an underground radioactive material area.

Two CZs are located along the 200-E-113-PL Pipeline from the PUREX Plant to the 216-A-6 and 216-A-30 Cribs. In the areas of the CZs, the pipeline consists of 41 cm (16-in.)-diameter steel. Depth of the pipeline below ground surface is uncertain. The larger CZ occupies an area of approximately 21 m^2 (230 ft^2) and is located further from the 216-A-30 Crib. The smaller CZ is only a few meters square and is next to the 216-A-42C Valve Box near the 216-A-30 Crib. Both areas are surface stabilized and posted as Contamination Areas. The wooden fence surrounding the area by the valve box is in disrepair. The maximum surface radiological survey count obtained for these two zones was 1,050 c/min beta/gamma in October 2000, measured on a tumbleweed growing in the CZ (Radiation Survey Report SS256115, *Vegetation Growth Above Posted Pipeline Associated with 216-A-42C and 216-A-30 Crib*).

Three CZs are located along the 200-W-79-PL Pipeline from the 241-T-151 Diversion Box to the 216-T-36 Crib. In the areas of the CZs, this pipeline consists of 10 cm (4-in.)-diameter vitrified clay. The depth below ground surface to the bottom of the pipeline ranges from approximately 2.4 to 3 m (8 to 9.5) ft in the vicinity of the CZs. The two CZ areas nearest the crib are roughly rectangular, while the third area is further from the crib and is irregular in shape. A portion of this third CZ is the result of contaminated vegetation built up along a fence, and this area is not considered related to the pipeline. The area of these CZs, including the unrelated lower portion, is approximately 1,600 m^2 (17,000 ft^2). All three CZs are surface stabilized and posted as underground radioactive material areas. The maximum surface radiological survey count measured in these CZs was 80,100 c/min beta/gamma in August 1998, obtained from rabbitbrush. The ground surface and several anthills also were surveyed along portions of the pipeline in these CZs (Radiation Survey Report SS248978, *Survey of Underground Transfer Lines*). The instrument counts for the anthills were at background. The maximum ground surface reading was 4,100 c/min beta/gamma.

An approximately 460 m^2 (5,000 ft^2), CZ (UPR-200-E-79) is located along the pipeline that extends from the 242-B Evaporator to the 207-B Retention Basin. In this area, the pipeline consists of 10 cm (4-in.)-diameter cast iron. Depth of the pipeline below ground surface is uncertain. The CZ was created when five leaks were detected in the pipeline in June 1953. The maximum surface radiological survey count for this CZ was 2,500 c/min (WIDS). It was estimated that approximately 10 Ci of mixed fission products were discharged into the soil in this CZ (RHO-CD-673, *Handbook 200 Areas Waste Sites*). The area is surface stabilized and posted as a high-contamination area.

Two unplanned release waste sites (UPR-200-E-80 and UPR-200-E-1) are located along the 200-E-112-PL Pipeline. This pipeline extends from the 221-B Plant Canyon Building through the 241-B-154 Diversion Box to the 207-B Retention Basin. Both unplanned release waste sites are near the 221-B Canyon Building. In this area, the pipeline consists of 61 cm (24-in.)-diameter cast iron. Depth below ground surface to the bottom of the pipeline is estimated to be approximately 3 m (10 ft). According to WIDS, the first release, associated with UPR-200-E-80, occurred in June 1946 when the line failed. A portion of the ground surface above the line caved in and the dose rate measured at the surface was 400 rad/h. It was estimated that about 10 Ci of fission products were released into the soil. A second release site, UPR-200-E-1, was identified in September 1946, located approximately 24 m (80 ft) from the 1946 leak, and was assumed to have resulted from liquid migration from the June leak. Surface radiation survey results are not reported for this second leak, but WIDS indicates that the area was covered with enough soil to reduce surface contamination readings to 2 mrad/h. The area is posted with radiation warning signs.

One CZ is has been identified along the 200-W-88-PL Pipeline between the 221-T Canyon Building and the 207-T Retention Basin. The CZ has an area of approximately 56 m^2 (600 ft^2). In the area of this CZ, the pipeline consists of 61 cm (24-in.)-diameter vitrified clay. Depth of the pipeline below ground surface is uncertain. Although tumbleweeds have been known to grow in this CZ, WIDS indicates that no radiological survey data could be found to describe the conditions inside the posted area or when it was posted. The zone is adjacent to a manhole associated with the pipeline and is posted with an Underground Radioactive Material Area sign.

3.4.2.1.2 Characterization Information for Bin 3 Chemical-Sewer-Waste Pipelines

One pipeline in the Chemical-Sewer Waste bin has associated CZs along its length that are known to be caused by leaks. Three CZs are located along the 200-E-188-PL Pipeline that extends from B Plant to the 216-B-2 Ditches and the 216-B-63 Ditch. The pipeline consists of 38 cm (15-in.)-diameter vitrified clay. The burial depth to the bottom of the pipeline varies along its length and is estimated to range from approximately 0.6 to 6 m (2 to 6.5 ft). All three CZs are surface stabilized and posted as Underground Radioactive Material Areas. The maximum surface radiological survey count for these CZs was 1,200 c/min beta/gamma in August 2000, obtained for a tumbleweed fragment (Radiation Survey Report SS255613, *Survey of Transfer Line Northeast of B Plant to 207-B*).

According to RHO-CD-1010, *B Plant Chemical Sewer System Upgrade*, and WHC-EP-0342, Addendum 6, *B Plant Chemical Sewer Stream-Specific Report*, pipeline leakage was documented in the 1970s and 1980s related to the 200-E-188-PL Pipeline and associated lines. The leakage was discovered while excavating in the area. Based on subsequent leak testing, it was estimated that approximately 1.1 million L/day (300,000 gal/day) may have been leaking into the soil. The releases were assumed to be occurring primarily along the feeder and collector pipelines. Major portions of chemical-sewer-system pipelines were relined in 1985.

3.4.2.1.3 Characterization Information for Bin 5 Tank/Scavenged-Waste Pipelines

Two pipelines in the Tank/Scavenged-Waste bin have associated unplanned releases or CZs along them that are suspected to be caused by leaks.

Two CZs are located along bends near the north end of the 200-E-114-PL Pipeline. This line extends from the BY Tank Farm to the BC Cribs and Trenches Area and to the 216-B-51 French Drain. In the area of the CZs, two 10 cm (4-in.)-diameter steel pipes comprise the line. The depth from ground surface to the bottom of the pipe is approximately 0.6 to 0.9 m (2 to 3 ft). The larger CZ is approximately 420 m^2 (4,500 ft^2) and is located near the connection from the main line to the 216-B-51 French Drain. The second CZ is at the next bend to the south along the line and is approximately 260 m^2 (2,800 ft^2) in area. The maximum radiological survey count for these two zones was 8,050 c/min beta/gamma in October 2000, obtained for a tumbleweed (Radiation Survey Reports SS253960, *Survey of B Plant Transfer Line*; SS256142, *Vegetation Growth in Posted CA Associated with UPR-200-E-144*). A later survey in May 2002 reported 72,500 c/min from an area in the second CZ (Radiation Survey Report SS261107, *Assessment Survey in a Posted CA South of 12th Street*). Both CZs are surface stabilized and posted as Underground Radioactive Material Areas.

Another CZ (UPR-200-E-7) is located along the 200-E-195-PL Pipeline that extends from B Plant to the 216-B-9 Crib. WIDS indicates that this CZ was created when leakage in the pipeline led to a cave-in in 1954. The pipeline consists of 9 cm (3.5-in.)-diameter stainless steel. Depth of burial to the bottom of the pipe ranges from approximately 0.8 to 1.4 m (2.7 to 4.7 ft) bgs. An estimated 19,000 L (5,000 gal) of liquid leaked into the soil. The maximum surface dose rate observed was 1.7 rad/h within a 2.8 m^2 (30 ft^2) area. While the cave-in was filled in and once was marked, its exact location no longer can be determined, according to WIDS.

3.4.2.2 Characterization Information for Bin 6 Tank Farm Waste-Transfer Pipelines

Pipeline failures both outside and inside of the tank farms have resulted in the release of high-activity waste streams into the soil. Many of these failures in the 200-IS-1 OU were reported in the period from 1945 through 1950, when direct-buried pipelines were used to transfer tank-farm waste. In most cases, the site was stabilized with gravel, asphalt, or shotcrete cover, and little characterization was undertaken.

While there is little history of pipeline sampling and analysis, known releases of liquid wastes from pipelines and appurtenances are documented through unplanned-release reports. Each unplanned release has a formal report associated with it that is retrievable from WIDS. This electronic database can be accessed over the Internet.

The unplanned-release descriptions indicate that ground subsidence usually occurred over a failed line and that liquids were observed pooling or moving over the ground surface. With the conversion to encasing transfer pipelines in covered concrete troughs, leaks to the soil column became less common. This design collected any liquid releases inside the encasement and drained the liquid to a downgradient diversion box and catch tank.

A review of the WIDS database for 200-IS-1 OU unplanned releases associated with tank farms indicates that although extensive surface contamination has occurred, with the exception of a few unplanned releases (located inside the C and B-BX-BY Tank Farms and not associated with 200-IS-1 OU), the volume of waste that has been released from the 200-IS-1 OU tank farm pipelines is a small fraction of the total volume of releases that have occurred in the tank farm system.

In a few cases, follow-up site-characterization activities of unplanned releases were conducted and provide some idea of contamination and waste distribution. In addition, a few pipelines have been studied as part of the RI process in other OUs. Other than the information presented in the WIDS and a few select studies, there has been little effort to further characterize unplanned releases or to understand pipeline contamination and releases.

The following is a summary of unplanned releases that have had characterization work to better define the nature and extent of pipeline releases.

- UPR-200-E-86 represents a 1969 pipeline leak assumed to be associated with a joint in the pipeline. Drilling in 1970 (ARH-1945, *B Plant Ion Exchange Feed Line Leak*) was conducted to determine the nature and extent of contaminant distribution following failure of a high-activity waste line. In 1971 and 1972, 14 shallow wells were drilled to assess the soils adjacent to and beneath UPR-200-E-86. Contamination was reported for three of these wells according to Metz, 1972, "PSS Line Leak (Line No. 812)," and RHO-CD-673. Elevated readings for cesium in the soil were reported from 0.3 to 5.5 m (1 to 18 ft) bgs. One of the wells was terminated at 1.8 m (6 ft), because the driller encountered radiation. The leak was approximately 66,000 L (17,000 gal), containing 25,000 Ci of Cs-137 and contaminating approximately 36 m^3 (1,300 ft^3) of soil. The 1972 study to define the extent of contamination found no contamination below 6 m (20 ft). The site is marked by concrete AC-540 marker posts at each corner. The WIDS database states that the surface has been covered with grout and is posted with Underground Radioactive Material Area signs.

The unplanned releases have been identified that are associated with encased pipelines but that seem to result from root penetration into the encasement (UPR-600-20) or from test or swab risers.

- Characterization activities were conducted around the 241-EW-151 Vent Station in 1988 when a routine quarterly survey detected contamination outside of an established contamination zone (80322-88-090, "Surface Contamination Investigation Report, Cross-Country Waste Transfer Line"). Laboratory analyses revealed 1,000 to 230,000 pCi/g of Cs-137, while field instruments indicated 100 to 27,000 pCi/g of Sr-90 in soil samples. Sagebrush samples contained 32 to 53 pCi/g of Cs-137 and 2,700 to 37,000 pCi/g of Sr-90. A drilling program was undertaken to determine if the encasement had leaked. Field investigations included two auger borings at each of four selected sites. One of the boring pairs was drilled along the centerline to the top of the encasement. A second hole was offset to miss the encasement and was drilled to a depth below the encasement. Continuous split-spoon soil samples were taken and analyzed for radionuclides, but none were found. It was concluded that the encasement had not leaked, and that the roots of sagebrush growing next to the encasement had penetrated to the interior of the encasement.

3.4.2.3 Characterization Information for Other Pipelines

Other pipelines that were not included within the bin structure being used in this work plan have had investigations conducted. In particular, there are pipelines being addressed as part of the 200-UW-1 OU that have had previous characterization activities conducted. UPR-200-W-163 was identified in 1995 as a zone of contaminated vegetation growing along the vitrified clay pipeline connecting the 221-U Plant to the 216-U-8 Crib. Characterization activities above and next to the pipeline were undertaken as part of the 200-UP-2 OU. The field investigation was conducted in conjunction with the 200-UP-2 OU limited field investigation (DOE/RL-95-13) and examined the surface-soil contamination and uptake of radionuclides and metals by vegetation at the 216-U-8 Crib. As part of the limited field investigation, an integrity investigation was conducted to determine the potential for the vitrified clay pipeline to have leaked, causing the soil contamination. The investigation consisted of surveying sections of pipeline with an in-line video camera and collecting 23 surface and near-surface soil samples to depths of 2 to 4 m (7 to 12 ft) (these depths represent the approximate location of the top of the pipeline). The samples were collected between Beloit Avenue and the 216-U-8 Crib. The pipeline-integrity investigation showed that in the vitrified-clay section of the pipeline many of the joints were dislodged, allowing silty, sandy material to enter the pipeline. The degree of dislodgment varied from minor to very serious. The stainless-steel sections of the pipe were shown to be in excellent condition and the joints were sound. Surface-soil samples collected during the pipeline investigation typically showed background levels of activity for analyzed-for constituents. The highest levels of contamination were detected in the subsurface near the vitrified clay pipeline. However, many constituents were distributed throughout the 4 m (12-ft) depth being investigated. The data also indicated that minor lateral spreading had occurred (no more than 1 to 2 m [3 to 5 ft]). The maximum concentrations detected were Am-241, 426 pCi/g; Cs-137, 49,100 pCi/g; Pu-239/240, 70.6 pCi/g; and Sr-90, 1,380 pCi/g. The highest strontium activity was detected in a vegetation sample.

To date only one pipeline has been removed within the Central Plateau industrial area under CERCLA authority. This action involved removing approximately 305 linear m (1,000 ft) of 15 cm (6-in.) vitrified clay pipe that comprises the 200-W-42 Pipeline. This pipeline carried process waste (Bin 1 waste stream) from the facility to the disposal cribs. The excavation of the pipeline was performed in two phases. Phase 1 included removal of the line from the 216-U-12 Crib to the 216-U-8 Crib. In Phase 2, excavation proceeded from the 216-U-8 Crib to the 221-U Building. The removal of the 200-W-42 Pipeline commenced in January 2006 and stopped in September 2006. Results of the pipeline removal action included the following.

- Little to no contamination was encountered during Phase 1. Contaminants detected included Cs-137 and uranium metal.
- Heavily contaminated areas from the 216-U-8 Crib to south of 16th Street were encountered in Phase 2.

- Minor areas of contamination were encountered from north of 16th Street to the U Plant termination point.
- One area along the pipeline showed extensive lateral contamination, with cesium, uranium, and nitrate being the major constituents present.
- It was determined that sloping the excavation has two benefits. First, it allows personnel access, if needed, and second, it minimizes side-slope sloughing.
- It was concluded that sampling should be performed as the project progresses.

Experience gained during this removal action will be used in the field planning for Phase 1 of the 200-IS-1 OU field work.

3.4.3 Historical Sampling and Analysis for Pipeline Appurtenances

The following sections summarize the historical characterization data that have been identified for pipeline-system appurtenances. Information for those appurtenances associated with process-facilities pipeline systems and data obtained for the tank-farm waste-transfer pipelines are differentiated and provided in separate sections.

3.4.3.1 Characterization Information for Process-Facility Pipeline-System Appurtenances

Historical sampling and analytical data for the process-facility pipeline-system appurtenances are limited. No prior sampling and analysis results were identified for appurtenances associated with three of the facilities-pipeline waste-stream bins: Bin 3, Chemical-Sewer Waste; Bin 4 Miscellaneous Waste; and Bin 5, Tank/Scavenged Waste (see Appendix D, Table D-1).

Characterization activities performed for Bin 1, Process Condensate, Process Waste, and Chemical-Laboratory Waste, waste-stream appurtenances consist of an evaluation conducted at the 200-W-59 Diversion Box in 1976. This structure directed the flow of process waste via the 241-Z-361 Settling Tank to the 216-Z-12 Crib. Four shallow wells (299-W-18-151, 299-W-18-154, 299-W-18-155, and 299-W-18-156) were drilled in 1976 between the 216-Z-12 Crib and the 200-W-59 Diversion Box to evaluate the near-surface soils. All of the wells showed plutonium contamination activity at approximately 5 m. The source of the contamination is thought to be unsealed joints of vitrified clay pipeline that extend from the south side of the diversion box to the crib. RHO-ST-21, *Report on Plutonium Mining Activities at 216-Z-9 Enclosed Trench*, states that engineering drawings did not specify seals to be used for the butted vitrified clay pipeline connections between the diversion box and the crib. The report also indicates that the vitrified clay pipeline sections were 3 m (10 ft) long. The log for well 299-W18-156 reported contamination at 5.3 to 5.5 m (17.5 to 18 ft) bgs. This well is approximately 3.7 m (12 ft) to the west of the 200-W-59 Diversion Box and is the closest of the four wells drilled.

Available information for Bin 2, Steam Condensate and Cooling Water, waste-stream appurtenances was obtained from DOE/RL-2003-11, *Remedial Investigation for the*

200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-CS-1 Steam Condensate Group Operable Units. Interior sampling and analysis was performed for two pipelines that emptied into the Z Ditches, one pipeline from the 231-Z Plutonium Isolation Facility (200-W-125-PL Pipeline) and the other from the 234-5 Plutonium Finishing Plant (no WIDS pipeline site code defined at this time). As part of the investigation, in situ gamma measurements and smear samples were collected. The gamma measurements were collected by lowering a sodium-iodide gamma detector within 15 cm (6 in.) of the bottom of the selected manholes. The smear samples were obtained by affixing two smear pads on either side of a foam paintbrush that was attached to the end of an extendable metal pole. Swipes were made in both directions across the bottom of the pipe and manhole. The condition of each pipe was documented with a video camera. Air sampling and volatile-organic-compound and radiation monitoring were performed for the entire length of the investigation.

The smear samples were analyzed for 17 radionuclides. In both instances, 14 radionuclides were undetected. For the pipeline from the 231-Z Plutonium Isolation Facility to the Z Ditches, 23.5 pCi of Pu-238, 1,210 pCi of Pu-239, and 226 and 813 pCi of Am-241 were detected. For the pipeline from the 234-5 Plutonium Finishing Plant to the Z Ditches, 2.45 pCi of Pu-238, 94.6 pCi of Pu-239, and 19.5 and 23.5 pCi of Am-241 were detected.

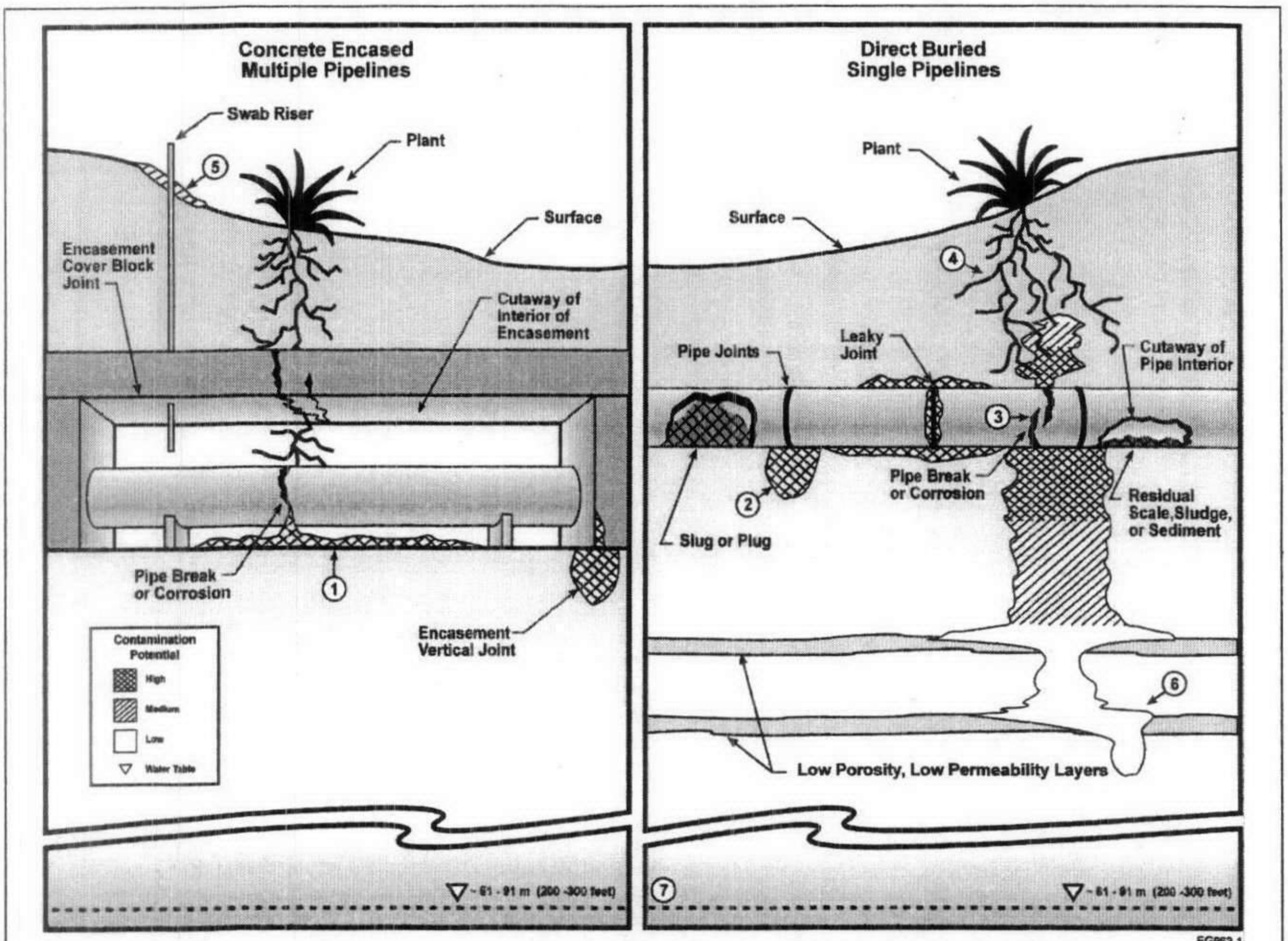
3.4.3.2 Characterization Information for Tank-Farm Pipeline Appurtenances

Diversion boxes and catch tanks also are associated with a number of unplanned releases. Significant opportunities exist for releases at these sites because of the operations required to change routings inside the box. Most of the unplanned releases actually are releases that occur when cover blocks are removed, which exposes the interior to winds and the atmosphere. Speck contamination is blown out and deposited on the ground surface. In some cases, equipment removed from a diversion box or catch tank spreads contamination to the ground. In a few cases, a failed jumper or misrouting of a jumper has flooded a diversion box or catch tank and resulted in a spill to the ground surface. In at least one instance a pipeline connection at the exterior of a diversion box failed (UPR-200-W-113), resulting in a spill to the subsurface. Several catch tanks have been replaced because of unspecified failures. As with pipeline releases, there has been limited characterization of unplanned releases associated with tank-farm appurtenances. The available information concerning those unplanned releases that have been identified and associated with tank farm diversion boxes and catch tanks is presented in Appendix D (Table D-2).

3.4.4 Conceptual Contaminant-Distribution Models for Pipelines and Appurtenances

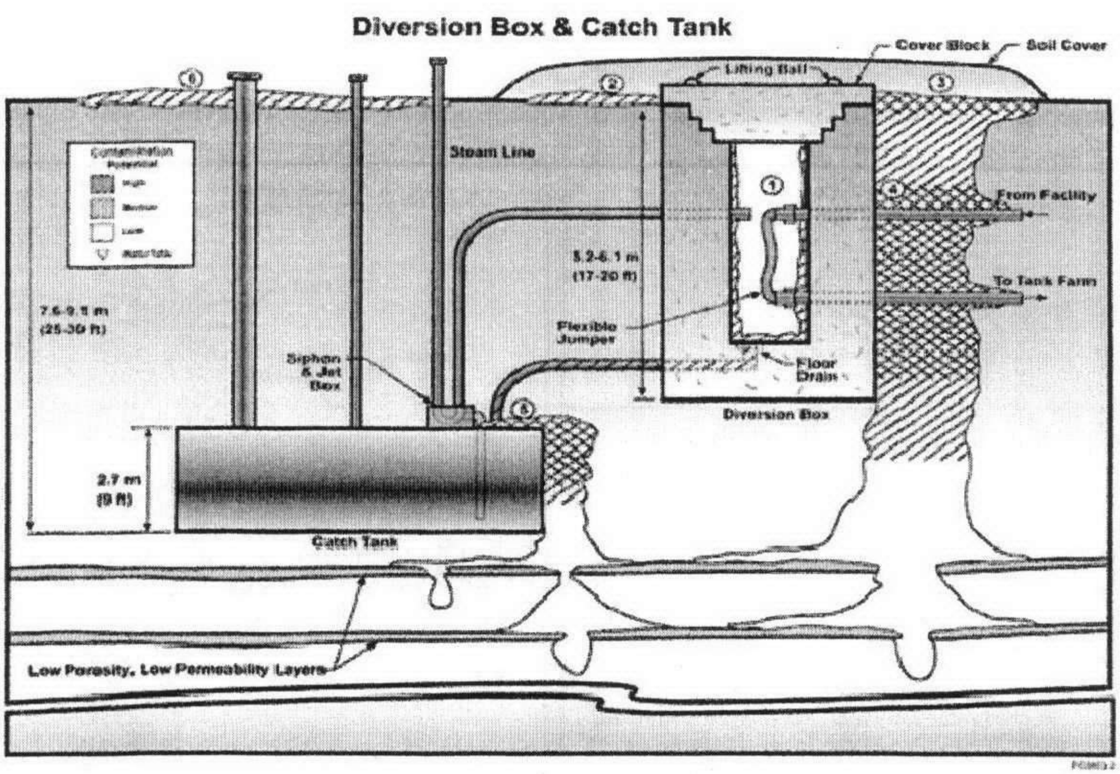
Information pertaining to contaminant sources, release mechanisms, and transport media was considered during development of the conceptual contaminant-distribution models for pipelines and appurtenances. A conceptual contaminant-distribution model for encased and single-buried pipelines is provided in Figure 3-2. The conceptual contaminant distribution model for a waste-transfer diversion box and catch tank is provided in Figure 3-3. These models will support an evaluation of the potential risk to human health and the environment. The conceptual exposure-pathway model that indicates potential exposure routes and receptors is included with the discussion concerning potential impacts to human health and the environment in Section 3.6.

Figure 3-2. Conceptual Contaminant-Distribution Model for Buried Process-Waste Pipelines.



1. Pipeline leaks have occurred within some concrete encasements. Process liquids that are released may accumulate and pool in the bottom of the encasement.
2. Pipe connection locations such as joints and fittings are susceptible to leakage. The releases are characterized as low-volume leaks and most likely are attributed to faulty or degraded seals, joints, or fittings. The effluent and contaminants move according to the permeability of surrounding soils at various points of release. Low-mobility contaminants such as cesium and plutonium sorb near points of release, and concentrations decrease with depth.
3. Fractures, cracks, and breaks are more prevalent in some pipelines such as those constructed of vitrified clay. Pipe breakage may have occurred in some cases as the result of loading and differential settling of surrounding soils. Larger breaks where flow was under pressure may have resulted in releases that extend both above and below the pipe into surrounding soil.
4. Contamination extends above the pipeline to the surface in some places because of uptake by vegetation (or possible animal intrusion).
5. Surficial dispersion of contaminants may occur around some swab risers, caused by vent releases or sampling activities.
6. Mobile contaminants such as nitrate and tritium migrate with the moisture front to greater depths.
7. Process fluids and contaminants may or may not impact groundwater, depending on the volume of releases

Figure 3-3. Conceptual Contaminant-Distribution Model for a Diversion Box and Catch Tank.



1. Leaks into the interior of the diversion box occur when jumper connections are changed or during a misrouting. Although most of the spill drains to the catch tank, some contamination remains on the interior floor or sides of the box.
2. During routing changeouts or maintenance activities, cover blocks are removed, exposing the diversion box interior to the environment. Winds, remote-handling activities, and removal of equipment generate unplanned releases on the ground surface around the structure. This is the most common type of unplanned release at these structures and usually is stabilized with a cover of clean soil. Vegetation uptake or animal activities may remobilize the contamination.
3. During a misrouting, in some cases, waste liquids fill the diversion box and flow onto the ground around the structure. The liquid drains into the soil, and contaminants are distributed according to respective distribution coefficient (K_d) values, chemistry of the solution, volume of the release, and soil characteristics. Relatively immobile contaminants such as plutonium and cesium remain close to the point of release; mobile contaminants such as technetium-99 and nitrate migrate with the moisture front. This type of unplanned release is very rare for these structures. The contaminated soil is covered with clean soil, shotcrete, or asphalt.
4. Pipe connections may fail at the diversion box exterior wall. Liquid is released to the soil column below ground and flows away from the break. Depending on the volume of the release, liquid flow may induce localized ground subsidence, with contaminated liquids emerging at the ground surface or in the depression (not shown). Contaminants are retained in the soil column according to respective K_d values, chemistry of the solution, and soil characteristics. Immobile contaminants such as plutonium and cesium generally remain close to the point of release; mobile contaminants such as technetium-99 and nitrate migrate with the moisture front. The area of surface contamination is covered with clean soil, shotcrete, asphalt, or other material.
5. Failure at a pipe fitting, or failure of the tank itself, leads to a loss of waste to the subsurface. The volume of waste lost is assumed to be low, because most releases to catch tanks are assumed to be the sum of multiple jumper contents lost when routings were broken. Liquids move down through the soil column, while contaminants are retained in the soil according to respective K_d values, chemistry of the solution, and soil characteristics. Relatively immobile contaminants such as plutonium and cesium remain close to the point of release; mobile contaminants such as technetium-99 and nitrate migrate with the moisture front. This type of failure is rare, but several replacement catch tanks have been installed at diversion boxes.
6. Surface releases around catch tank risers occur primarily when access to the tank is required for liquid-level measurement, sampling, or pumping. Opening the system to the environment allows vapors to escape or wind to mobilize contaminants in the riser. Sampling devices and pumps lowered into the tank to remove liquids entrain contaminants to the surface when removed, and contaminants are scattered by leaks, drips, or wind. Rarely, overflows at diversion box/catch tank pairs lead to releases through catch tank risers. Liquids move down through the soil column, while contaminants are retained in the soil according to respective K_d values and soil characteristics. Relatively immobile contaminants such as plutonium and cesium remain close to the point of release; mobile contaminants such as technetium-99 and nitrate migrate with the moisture front. Releases are covered with clean soil to prevent spread of the radionuclides.

The following assumptions are included with the conceptual contaminant-distribution models for the process-waste pipelines and appurtenances.

- Residual waste material inside pipelines and appurtenances, if present, may occur as scale, corrosion products, sludge, and/or sediment. Residual levels of contamination are expected to be related to the waste-stream characteristics and pipeline materials. Pipeline materials such as vitrified clay may have more readily sorbed waste-stream constituents.
- The major COPCs are the radionuclides Cs-137, Sr-90, Pu-239/240, Tc-99, and tritium, and the nonradionuclides nitrate and uranium metal.
- Contaminants such as Cs-137, Sr-90, and the plutonium isotopes have high distribution coefficients (K_ds) and therefore normally sorb strongly onto shallow-zone Hanford Site sediments. These less mobile contaminants should be detected near points of release in the vadose zone. Contaminants with low K_d values (e.g., nitrate, Tc-99, and tritium) are not readily adsorbed on soil particles and migrate to greater depth within the vadose zone.
- Both vertical migration and lateral spreading of liquids and contaminants may have occurred into surrounding soil at release points. The extent of migration or spreading will be dependent on a number of factors, including volume of liquid released and local hydrogeologic conditions.
- Mobile contaminants may or may not have reached groundwater. The volume of contaminated liquid that may have been released at points of leakage generally is unknown. For pipelines and appurtenances where inadvertent liquid releases to the surrounding soil have occurred, the contaminant distribution may be limited to the shallow-zone soil interval (i.e., the interval from the ground surface to a depth of 4.6 m [15 ft]) and could extend to a deeper depth. Liquid releases at pipeline-failure locations may display simple or complex concentration distributions within the impacted soil area, depending on the characteristics of the waste stream and physical composition and chemistry of the soil.

3.4.5 CX Tank System

Information is presented here that was compiled relating to sources of the waste managed in the CX Tanks, volume of waste managed, and available sampling and analyses results indicating contaminant distribution outside the tanks. Historical sampling results for the waste contained in the tanks is presented here and also summarized in Table 2-2.

3.4.5.1 241-CX-70 Storage Tank Sources of Waste Contributions

The 201-C Process Building, A cell, was reported as discharging waste to the 241-CX-70 Storage Tank. According to HW-31373, *PUREX Chemical Flowsheet HW Number 3 Chemical Development Unit Separations Technology Subsection Technical Sec Engineering Department*, Figure 2, and Hanford Site drawings (i.e., H-2-4093, *Hot Semiworks Process Piping Plan A Cell*; H-2-4105, *Hot Semiworks Engineering Flow Sketch*; and H-2-4335, *Hot Semiworks Waste Line Bldg 201-C to TK-70*), the following equipment discharged waste from A cell to the 241-CX-70 Storage Tank: steam transfer jets and piping that connected the scrubber, oxidizer, dissolver, feed makeup, waste-receiver tanks, and waste-concentrator centrifuge.

3.4.5.1.1 Volume of Waste Managed

According to HW-52860, *Standby Status Report Hot Semiworks Facility*, the total estimated effluent volume received was 95,000 L (25,000 gal) of non-neutralized REDOX process waste. However, in May 1974, the material-level measurements indicated that 4.3 m (14 ft) of liquid and sludge remained in the tank (AR00227, "Disposition and Isolation of Tanks 270-E-1, 270-W, 241-CX-70, 241-CX-71, and 241-CX-72"). Based on the 1974 material level reported, the 241-CX-70 Storage Tank contained approximately 11,000 L (2,900 gal) more volume than it reportedly received in 1957, for a total of 106,000 L (28,000 gal).

3.4.5.1.2 Historical Sampling and Analysis

Limited information is available to evaluate the nature and extent of potential contamination in the soil surrounding the 241-CX-70 Storage Tank. No information was identified regarding soil samples or radiological surveys for the vadose zone in the CX Tank area. Whether liquid might have been released into the soil column is unknown, but comparing liquid-level data in the tank from July 1974 to the data from a later date (not specified) indicated that the tank had not leaked.

The 241-CX-70 Storage Tank was designed and constructed specifically for storing high-level process waste in support of the Hot Semiworks processes. In April 1976, analysis of the remaining sludge in the 241-CX-70 Storage Tank reported that fission products totaled approximately 4,300 Ci of Sr-90, 870 Ci of Cs-137, and 3.4 Ci transuranic content (SD-WM-SAR-003, *Safety Analysis Report for the Decontamination and Decommissioning of the Strontium Semiworks Complex*).

Sludge-removal activities began in the summer of 1987 with the construction of a sluicing/ pumping system. Grab samples collected on August 17, 1988, showed alpha readings ranging from 390 to 690 nCi/g of filtered solids. The transuranic content of the sludge was approximately 50 nCi/g, with a pH of 13 in the liquid phase. Halogenated hydrocarbons were recorded at 0.0009 wt%. In addition, as reported in 12712-PCL88-019, *Analysis of Sludge Samples from Hot Semiworks Tank CX-70*, qualitative identification classified the organics as aliphatic amines or possibly aliphatic alcohol. The waste was removed later, and the tank is now empty.

The groundwater gradient is indeterminate in most of the 200 East Area (see Figure 2-3), including the region surrounding the 241-CX-70 Storage Tank. Well 299-E27-5, located approximately 77 m (253 ft) east of the 241-CX-70 Storage Tank, reported a depth to groundwater for March 2002 at 87 m (284 ft) bgs. The status of groundwater contamination near the 241-CX-70 Storage Tank is illustrated in Figure 3-1 (tank is not shown on figure). A groundwater plume containing I-129 at concentrations exceeding groundwater protection standards occupies a large portion of the 200 East Area and encompasses the waste site. Groundwater wells in the immediate area are sparse and provide limited analytical information. No historical analytical information is available for the nearest well, 299-E27-133 (see Figure 2-7), located 22 m (72 ft) from the tank. The 2004 groundwater-sampling records for well 299-E24-8, located 63 m (210 ft) from the 241-CX-70 Storage Tank, reported 2.28 pCi/L gross alpha and 14.8 pCi/L gross beta.

3.4.5.2 241-CX-71 Neutralization Tank Sources of Waste Contributions

The 201-C Process Building hot shop routed condensate, coil, and condenser cooling waters containing low-level radioactivity waste from the hot sinks to the 241-CX-71 Neutralization Tank before discharging the waste to the 216-C-1 and 216-C-5 Cribs, according to WHC-SD-DD-TI-040, *Tank 241-CX-72 Preliminary Waste Characterization*, and Hanford Site Drawings H-2-4010, *Strontium Semiworks & Vicinity Outside Lines Key Map*; H-2-4420, *Plot Plan Hot Semiworks Waste Self-Concentrator*; and H-2-4535, *Site Plan & Underground Piping Strontium Facilities, Hot Semiworks.*

3.4.5.2.1 Volume of Waste Managed

The total estimated effluent volume received was approximately 33 million L (8.8 Mgal) of waste (AR00227).

3.4.5.2.2 Historical Sampling and Analysis

Limited information is available to evaluate the nature and extent of potential contamination in soil surrounding the 241-CX-71 Neutralization Tank. No information was available regarding soil samples or radiological surveys in the vadose zone in the CX Tank area. No leaks from the tank or connecting piping have been documented.

The 241-CX-71 Neutralization Tank was designed and constructed for the neutralization of acidic low-level radioactive waste. This stainless-steel tank was in operation for less than 3 years. Approximately "8.8 million gallons" of decontamination wastes may have passed through the tank (WHC, 1990, *201-C Strontium Semiworks Project Rebaseline, UE-003-90*). As reported in WHC-SD-DD-SAD-001, *Safety Evaluation for Interim Waste Management Activities in Tank 241-CX-70, Tank 241-CX-71, and Tank 241-CX-72*, it is estimated that waste discharged to the 241-CX-71 Neutralization Tank contained 2.46×10^{-8} g/L of plutonium; 43,000 nCi/L of Sr-89/90; and 1,600 nCi/L of Cs-137. Several estimates have been made concerning the radionuclide inventory retained in the tank and the values have varied widely. The maximum inventory estimated included 6 Ci of plutonium and 6,000 Ci beta (BHI-01173).

During October 1990, gas, liquid, and sludge samples were collected from the 241-CX-71 Neutralization Tank. Extremely low concentrations of methyl ethyl ketone, xylene, and toluene ranging from 7 to 54 ppb were measured. Cyanide was measured in the sludge at 21 ppm.

The groundwater gradient is indeterminate in most of the 200 East Area (see Figure 2-10), including the region surrounding the 241-CX-71 Neutralization Tank. Well 299-E27-5, located approximately 95 m (311 ft) east of the 241-CX-71 Neutralization Tank, reported groundwater depth for March 2002 at 87 m (284 ft) bgs. The status of groundwater contamination near the 241-CX-71 Neutralization Tank is illustrated in Figure 3-1 (tank is not shown on figure). A groundwater plume containing I-129 that exceeds groundwater-protection standards occupies a large portion of the 200 East Area and encompasses the waste site. Groundwater wells in the area are sparse and provide limited analytical information. No analytical information is available for the nearest well, 299-E27-133, located approximately 10 m (33 ft) from the 241-CX-71 Neutralization Tank (Figure 2-3). Well 299-E24-8, located 62 m (203 ft) from the tank, reported 2.28 pCi/L gross alpha and 14.8 pCi/L gross beta for samples collected in 2004.

3.4.5.3 241-CX-72 Storage Tank Sources of Waste Contributions

According to WHC-SD-DD-TI-040 and Hanford Site Drawings H-2-4093, H-2-4420, and H-2-4535, only the A and C cells in the 201-C Process Building discharged waste to the 241-CX-72 Storage Tank. According to WHC-SD-CP-TI-148, the tank also may have been used for fluids from the decontamination of the Hot Semiworks after separations projects. Investigations of bumping phenomena were conducted in the tank (WHC-SD-CP-TI-148).

3.4.5.3.1 Volume of Waste Managed

According to HW-52860, the estimated effluent volume received was 8,700 L (2,300 gal) of liquid waste.

3.4.5.3.2 Historical Sampling and Analysis

Limited information is available to evaluate the nature and extent of potential contamination in the soil surrounding the 241-CX-72 Storage Tank. No information was identified regarding soil samples or radiological surveys for the vadose zone in the area of the tank. Whether any effluent has leaked from the tank to the soil column is unknown, but the probability of contamination spread from this site is estimated to be zero to very low. The assumption that contaminant distribution outside the tank would be none to limited is consistent with the fact that the tank has double-wall construction (refer to Figure 2-10), only a relatively small volume of liquid waste originally was present in the tank for a short period of time, and the waste that was handled consisted of radionuclides that have low mobility in the soil. The tank received only 8,700 L (2,300 gal) of liquid waste (HW-52860) during its one year in use. Material-level measurements indicated that 188.0 cm (74 in.) of sludge and 2.5 cm (1 in.) of liquid were present in the tank in July 1974, and 193.0 cm (76 in.) of sludge and 2.5 cm (1 in.) of liquid were present in November 1974.

The 241-CX-72 Storage Tank was designed and constructed specifically for the concentration and terminal storage of waste from the pilot PUREX Plant studies. In the 1974 letter AR00227, sampling results for a clear, light-brown solution with a pH of 9.5 and a trace of solids were reported as follows:

- Total plutonium: 1.13×10^{-8} g/gal
- Total uranium: 2.43×10^{-3} g/gal
- Sr-89/90: 4.33 mCi/g
- Cs-137: analysis performed, but not detected.

In 1989, nondestructive assays were performed to evaluate the radiological content of the 241-CX-72 Storage Tank. Three smears were collected from an agitator rod that was inadvertently removed from the tank. WHC-SD-CP-TI-148 reported alpha activity between 2,000 and 8,000 d/min, gamma activity between 2.64×10^3 and 5.81×10^3 pCi, and a beta-to-gamma ratio of 25:1. The report concluded that the residual waste material contains 150 to 200 g of plutonium. WHC-SD-DD-TI-051, *An Estimation of the Radionuclide Content of Tank 241-CX-72*, estimated that between 9,000 and 10,000 Ci of Cs-137 would be present, based on data presented in WHC-SD-CP-TI-148. The sludge never was removed from the tank.

The groundwater gradient is indeterminate in most of the 200 East Area, including the region surrounding the 241-CX-72 Storage Tank. Well 299-E27-5, located approximately 59 m (193 ft) east of the 241-CX-72 Storage Tank, reported a depth to groundwater for March 2002 at 87 m (284 ft) bgs. The status of groundwater contamination in the area of the 241-CX-72 Storage Tank is illustrated in Figure 3-1 (tank is not shown). Reported groundwater concentrations of I-129 exceed groundwater-protection standards beneath the waste site. Groundwater wells in the area are sparse and provide limited analytical information. No analytical information is available for the nearest well, 299-E27-133, located approximately 43 m (141 ft) from the tank (Figure 2-3). Groundwater sampling results at well 299-E24-8, located 86 m (282 ft) away, showed 2.28 pCi/L gross alpha and 14.8 pCi/L gross beta in 2004.

3.4.5.4 Path Forward for Tanks 241-CX-70, 241-CX-71, and 241-CX-72

The 241-CX-70 Storage Tank and 241-CX-71 Neutralization Tank will be removed and clean closed. Waste characteristics of the remaining residue in the 241-CX-72 Storage Tank needs to be determined. A closure plan for the entire CX Tank System (241-CX-70, 241-CX-71, and 241-CX-72) will be submitted.

3.4.6 Hexone Storage and Treatment Facility

Information is presented here that was compiled relating to sources of the waste managed in the 276-S-141 and 276-S-142 Hexone Storage Tanks, the volume of waste managed, and available sampling and analyses results indicating contaminant distribution outside the tanks.

3.4.6.1 276-S-141 Hexone Storage Tank Sources of Waste Contributions

Essentially pure hexone waste was transferred to the 276-S-141 Hexone Storage Tank from the 276-S Solvent Handling Facility (located to the south of the tank), as shown on Hanford Site Drawing H-2-5304, *276 Organic-Solvent Make-Up Storage Piping*. The tank also received waste during decontamination of the REDOX Plant.

3.4.6.1.1 Volume of Waste Managed

The estimated volume of hexone received by the 276-S-141 Hexone Storage Tank was 606,000 L (160,000 gal). This estimate is based on CCN 100786, "276-S-141/142 Hexone Storage Tank Sludge Sampling Results," which reported that 76,000 L (20,000 gal) of essentially pure hexone was discharged annually to the 276-S-141 Hexone Storage Tank.

3.4.6.1.2 Historical Sampling and Analysis

Limited information is available to evaluate the nature and extent of potential contamination in soil surrounding the 276-S-141 Hexone Storage Tank. In April 1976, ARH-CD-639, *Integrity of Tanks 276-S-141 and 276-S-142,* reported the integrity of the tank as good. The tank's average wall thickness was 0.83 to 0.92 cm (0.327 to 0.363 in.). The only nearby location with reported soil-sampling data is monitoring well 299-W22-86, which was installed and completed in 2006 and is located about 92 m (300 ft) west-northwest of the 276-S-141 Hexone Storage Tank.

The tank was constructed specifically to store clean hexone. The tank was sampled three times, and the results were reported in ARH-CD-685, *Characterization of the Contents of Organic Waste Storage Tanks 276-S-141 and 276-S-142*; WHC-SP-0350, *Hexone Remediation Demonstration Plan for Tanks 276-S-141 and 276-S-142*; and BHI-01521, *Evaluation of Alternatives for the Interim Stabilization of the Hexone Tanks*. The 1976 analytical work characterized the material in the 276-S-141 and 276-S-142 Hexone Storage Tanks and included preliminary distillation tests (ARH-CD-685). The 1988 work obtained fully representative concentrations with the goal of determining a practical means for treating and disposing of the waste (WHC-SP-0350). The results reported in BHI-01521 are discussed below. The sampling results from these three activities are consistent with the operator-based knowledge of process information.

The 1976 and 1988 sampling results indicated that the 276-S-141 Hexone Storage Tank contained the following:

- Hexone: 98.4%
- Water: 1.6%
- Total alpha: <31 pCi/L
- Total beta: 4,910 pCi/L
- I-129: 5,460 pCi/L
- Tritium: 7,470,000 pCi/L (estimate).

Pumpable liquids were removed from the tank in 1991, after which it contained approximately 950 L (250 gal) of residual tar-like sludge. The sludge was collected and analyzed in March 2001. The principal chemical components of the sludge were NPH, TBP, iron oxide, and hexone. The principal radionuclides were Am-141, plutonium isotopes, Sr-90, and Cs-137 (CCN 100786).

The direction of groundwater flow (see Figure 2-4) in the vicinity of the 276-S-141 Hexone Storage Tank generally is west to east. Depth to water measured in May 2006 at the nearest well (299-W22-86, see Figure 2-11) was 71.3 m (234 ft) bgs. The status of groundwater contamination near the 276-S-141 Hexone Storage Tank is illustrated in Figure 3-1 (tank is not shown). No contaminant plumes have been delineated beneath this waste site. Groundwater-monitoring results for 2006 from well 299-W22-86, located about 92 m (302 ft) west of the 276-S-141 Hexone Storage Tank, showed up to 2,000 pCi/L of Tc-99, 10,700 pCi/L of tritium, and 1.39 pCi/g of U-238.

3.4.6.2 276-S-142 Hexone Storage Tank Sources of Waste Contributions

According to Hanford Site Drawing H-2-5304, the 276-S-142 Hexone Storage Tank originally was used to store reagent-grade hexone from the 276-S Solvent handling Facility, located to the south of the tank. The tank also received waste during decontamination of the REDOX Plant. The tank later was used to store NPH and TBP during a one-time separations activity involving fuel from the Shippingport reactor (BHI-01018).

3.4.6.2.1 Volume of Waste Managed

The total estimated effluent volume received by the 276-S-142 Hexone Storage Tank was 980,000 L (256,000 gal) of mainly reagent-grade hexone. This volume is based on the information in DOE/RL-96-82, *Hanford Facility Dangerous Waste Closure Plan, 241-Z Treatment and Storage Tanks*, which reported that 61,000 L (16,000 gal) of hexone waste was discharged annually to the 276-S-142 Hexone Storage Tank.

3.4.6.2.2 Historical Sampling and Analysis

Limited information is available to evaluate the nature and extent of potential contamination in soil surrounding the 276-S-142 Hexone Storage Tank. ARH-CD-639 stated that the integrity of the tank is good. The tank's average wall thickness was 0.89 to 0.91 cm (0.350 to 0.357 in.). The only nearby location with reported soil-sampling data is monitoring well 299-W22-86, which was installed and completed in 2006 and is located about 92 m (300 ft) west-northwest of the 276-S-142 Hexone Storage Tank.

The tank was designed and constructed specifically to store clean hexone. The tank contents were sampled three times. The sampling results from these three activities are consistent with the operator knowledge of process information. The 1976 analytical work characterized the material in both tanks and included preliminary distillation tests (ARH-CD-685). The 1988 analytical work obtained fully representative concentrations, with the goal of determining a practical means for treating and disposing of the waste (WHC-SP-0350). Results reported in BHI-01521 are presented below.

The 1976 and 1988 sampling data indicated that the 276-S-142 Hexone Storage Tank contained the following:

- 7,600 L (2,000 gal) of water
- 53,000 L (14,000 gal) of the following mixture:
  - 60% hexone
  - 25.2% NPH
  - 12.6% TBP and 1.7% water
  - 380 L (100 gal) tarry sludge resting on the base of the tank.

The radionuclide inventory in the liquid media consisted of the following:

- Total alpha: 2,070,000 pCi/L
- Total beta: 871,000 pCi/L

- Iodine-129: 34,500 pCi/L
- Tritium: 3,162,000 pCi/L (estimated).

After the pumpable liquids were removed from the tank in 1991, it contained approximately 950 L (250 gal) of residual, tar-like sludge. The sludge was collected and analyzed in March 2001. The principal chemical components of the sludge were NPH, TBP, iron oxide, and hexone. The principal radionuclides were Am-141, plutonium isotopes, Sr-90, and Cs-137 (CCN 100786).

The direction of groundwater flow (see Figure 2-4) in the vicinity of the 276-S-142 Hexone Storage Tank generally is west to east. Depth to water measured in May 2006 at the nearest well (299-W22-86, see Figure 2-11) was 71.3 m (234 ft) bgs. The status of groundwater contamination near the 276-S-142 Hexone Storage Tank is illustrated in Figure 3-1 (tank is not shown). No contaminant plumes have been delineated beneath this waste site. An upgradient groundwater well, 299-W22-86, located about 92 m (302 ft) west-northwest of the 276-S-142 Hexone Storage Tank, was sampled in 2006 and reported up to 2,000 pCi/L of Tc-99, 10,700 pCi/L of tritium, and 1.39 pCi/g of U-238.

3.4.6.2.3 Combined Hexone Storage Tank Sampling

In March 2001, the 276-S-141 and 276-S-142 Hexone Storage Tanks were sampled, and the samples were analyzed in accordance with DOE/RL-2000-73, Rev. 0, *Sampling and Analysis Plan for the 276-S-141/142 Hexone Tank Stabilization/Characterization Project.* The sampling event included deploying a video camera into the tanks through the 0.61 m (2-ft)-diameter riser to visually survey the inside of the tank and guide the survey activities. Samples were collected through the 0.61 m (2-ft)-diameter riser and the 10 cm (4-in.)-diameter risers of each tank.

The video survey showed that the volume of residual material in each tank was approximately 494 L (130 gal). No free liquid was observed in either tank. The sludge appeared to be a uniform tar-like layer extending the length of the tank across the bottom with a dried, cracked crust. The sludge depth appeared to be approximately equal to the 8.25 cm (3.25-in.) diameter of the sample tool (beaker).

The video survey showed both tanks to be structurally sound. The internal surfaces of the tanks appeared rusted, but had no apparent pits or voids. No evidence was present to suggest that either tank had leaked; however, no soil samples were taken from around the tanks. More details are provided in CCN 088368, "Hexone Tanks 276-S-141 and 142, VHS Videotape Notes."

Analytical results for the sludge samples from the 276-S-141 and 276-S-142 Hexone Storage Tanks are presented in CCN 100786. CCN 100786, Table 2, contains results for sludge collected from the 276-S-141 Hexone Storage Tank; Table 3 contains results for sludge collected from the 276-S-142 Hexone Storage Tank; and Table 4 summarizes the transuranic analytical results for both tanks.

The sludge collected from the 276-S-141 and 276-S-142 Hexone Storage Tanks can be characterized as a dark-colored, mildly acidic phosphate tar. The pH of the sludge samples ranged from 3.2 to 4.8 (standard units). Sludge collected on the west ends of the tanks was less viscous, with densities of 0.97 and 0.91 g/mL for the 276-S-141 and 276-S-142 Hexone Storage

Tanks, respectively. Sludge collected from the east ends of the tanks was more granular in texture, with densities of 1.21 and 1.20 g/mL for the 276-S-141 and 276-S-142 Hexone Storage Tanks, respectively. The pH of the sludge samples ranged from 3.2 to 4.8 (standard units). The principal chemical components of the sludge are NPH, TBP, iron oxide, and hexone. The principal radionuclides detected in the sludge samples are Am-141, plutonium isotopes, Sr-90, and Cs-137. The sludge in the 276-S-142 Hexone Storage Tank contains approximately four times the amount of radioactive material that is in the sludge in the 276-S-141 Hexone Storage Tank. The estimated average amount of transuranic constituents in the 276-S-141 Tank sludge was calculated to be 14.1 nCi/g. In the 276-S-142 Tank sludge, transuranic constituents were estimated to consist of 58.9 nCi/g.

3.4.6.2.4 Path Forward for the Hexone Storage Tanks

The closure plan prepared for the 276-S-141 and 276-S-142 Hexone Storage Tanks (DOE/RL-92-40) will be amended (as needed) and used to complete the closure process for these tanks. The tanks will be removed, and the surrounding soil will be sampled and analyzed as described in DOE/RL-92-40 to verify RCRA clean closure and meet CERCLA site close-out requirements.

3.5 RCRA TREATMENT, STORAGE, AND DISPOSAL UNIT INTERIM-STATUS GROUNDWATER MONITORING

Neither the CX Tank System nor the HSTF is involved in interim-status groundwater monitoring. Pertaining to the tank-farm waste-transfer pipeline system, the EPA, Ecology, and DOE agreed to implement a RCRA groundwater-monitoring system around the SST WMAs in accordance with the Tri-Party Agreement (Ecology et al., 1989a) Milestone M-024 and M-045 series. RCRA groundwater-monitoring wells are located outside the WMA fencelines. The wells are intended to monitor groundwater contamination attributable within the entire WMA, but they not outside of these boundaries.

3.6 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

This section presents the conceptual exposure model developed to identify potential impacts to human health and the environment from waste sites in the 200-IS-1 OU. Information pertaining to contaminant sources, release mechanisms, transport media, exposure routes, and receptors is discussed to develop a conceptual understanding of potential risks and exposure pathways. Assumptions concerning potential receptors are based on current and anticipated future use of land and groundwater. This information will be used to support an evaluation of potential human health and environmental risk in the RI/FS to be prepared following the investigation.

3.6.1 Land and Groundwater Use

Current and anticipated future uses for land and groundwater in the areas where the 200-IS-1 OU waste sites occur is discussed below. Land- and groundwater-use information is applied as appropriate in conjunction with the identification of potential exposure routes and receptors.

3.6.1.1 Current Land Use

Current land-use activities associated with the 200 Areas and the Central Plateau are industrial in nature. The facilities located in the Central Plateau were built to process irradiated fuel from the plutonium production reactors in the 100 Areas. Most of the facilities directly associated with fuel reprocessing are inactive now and awaiting final disposition. The Plutonium Finishing Plant has encapsulated plutonium and currently is storing it. Several waste management facilities operate in the 200 Areas, including permanent waste-disposal facilities such as the Environmental Restoration Disposal Facility, Low-Level (radioactive waste) Burial Grounds, and a RCRA-permitted, mixed-waste trench. Construction of tank-waste treatment facilities in the 200 Areas began in 2002, and the 200 East Area is the planned disposal location for the vitrified low-activity tank wastes. Other Federal agencies, such as the U.S. Department of the Navy, use the Hanford Site 200 East Area for disposal of TSD units. In addition, a commercial low-level radioactive-waste disposal facility currently is operated by US Ecology, Inc., on a 100-acre tract of land at the southeast corner of the 200 East Area that is leased to the State of Washington.

3.6.1.2 Anticipated Future Land Use

The reasonably anticipated future land use for the 200 Areas is continued industrial activities for the foreseeable future. This land-use assumption is applied to the pathway and receptor considerations in risk calculations for the waste sites.

3.6.1.3 Current Groundwater/Surface-Water Uses

Groundwater in the 200 Areas currently is contaminated and is not withdrawn for beneficial uses. The Columbia River is the second largest river in the contiguous United States in terms of total flow and is the dominant surface-water body on the Hanford Site. The Columbia River is the principal source of drinking water for the Tri-Cities and the Hanford Site. Regionally, it also is used extensively for irrigation and for recreation, which includes fishing, hunting, boating, water skiing, diving, and swimming.

3.6.1.4 Potential Future Groundwater/Surface-Water Uses

Washington State cleanup regulations define groundwater as a "potential future source of drinking water" based on yield, natural quality, and pumpability (WAC 173-340-720[2], "Ground Water Cleanup Standards," "Potable Ground Water Defined"). Based on these technical standards, groundwater underlying the 200 Areas may be considered a potential future drinking-water source. In addition, groundwater underlying the 200 Areas is hydraulically connected to groundwater systems that currently are used for drinking water and irrigation, and it ultimately discharges to the Columbia River. In accordance with 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," the goal is to restore the groundwater at the

Hanford Site to maximum beneficial uses, if practicable. The groundwater-protection remedial action objective for the 200-IS-1 OU will be based on the WAC 173-340-720, "Ground Water Cleanup Standards," and 40 CFR 141, "National Primary Drinking Water Regulations." Given the local hydrogeology at the 200-IS-1 OU, protection of the groundwater from the contaminants, by design, also will result in protection of the Columbia River. It is anticipated that current uses of the Columbia River will continue in the future.

3.6.2 Contaminant Sources and Release Mechanisms

The primary sources of contamination for the process-waste pipeline systems are liquid waste releases to surrounding soils from tanks, lines, pits, diversion boxes, and associated structures. The waste generally was released to the vadose zone through unplanned releases (e.g., leaks). Releases to the environment from the primary contaminant sources have produced contaminated surface soils and subsurface soils beneath waste sites. These are secondary sources that can spread contaminants through the environment by infiltration, resuspension of contaminated soil, volatilization, biotic uptake, leaching, and external radiation. During the periods when unplanned releases to the environment occurred, the dominant mechanism of contaminant transport was infiltration. After a liquid release from a structure ceased, the liquids continued to move through the soil column for an undetermined period. Currently, the dominant mechanism of contaminant transport through the vadose zone is from residual effluent moisture and natural recharge.

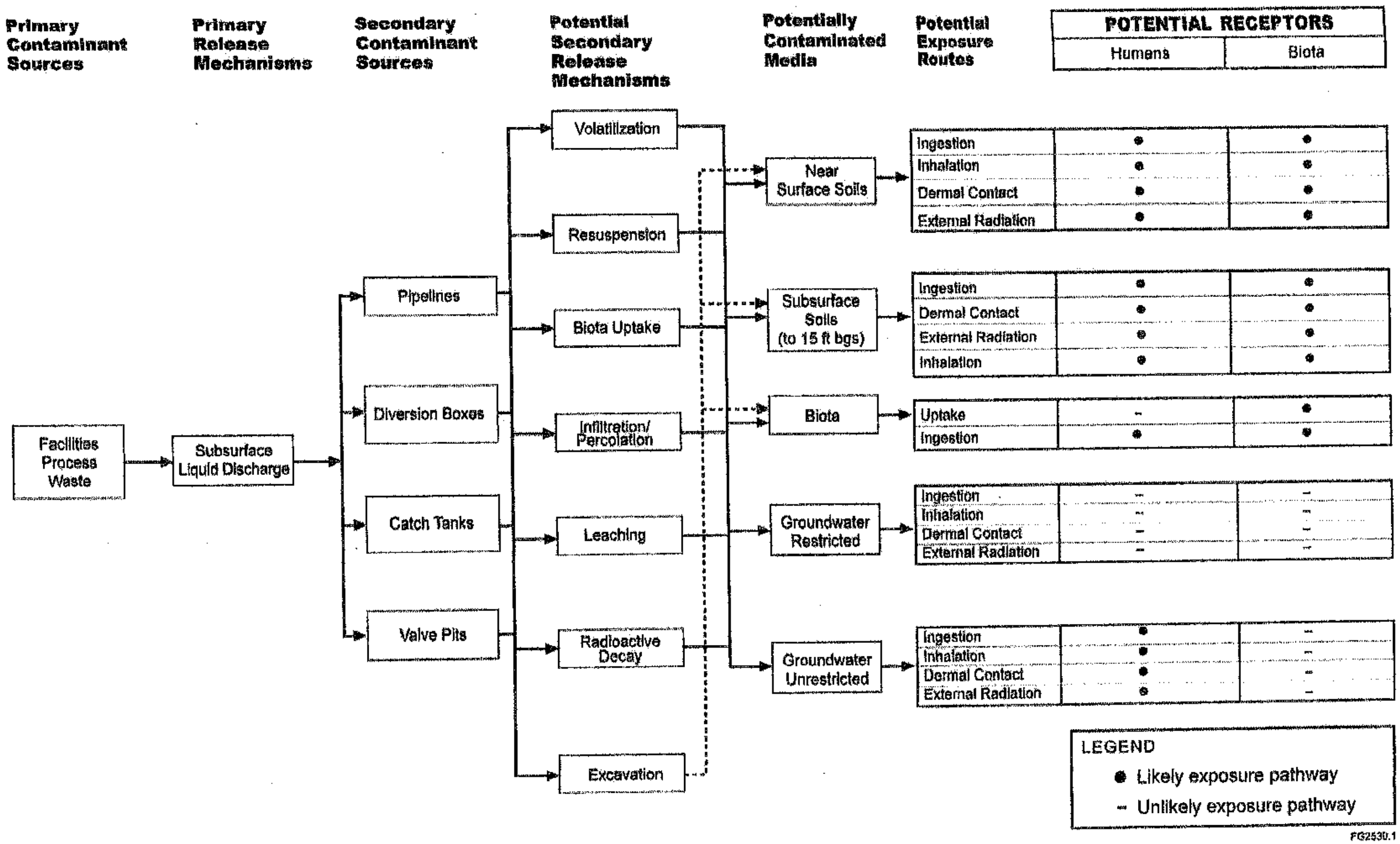
3.6.3 Potential Receptors

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

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

Potential human receptors include current and future Site workers and Site visitors (i.e., occasional users). Under a restricted future-land-use scenario, site worker and visitor exposure pathways primarily would involve incidental soil and sediment ingestion, inhalation of contaminants, dermal contact with contaminated soils and sediments, and external gamma radiation (Figure 3-4). Potential ecological receptors include terrestrial plants and animals inhabiting the site. Site biota exposures primarily would result from incidental soil and sediment ingestion, plant uptake, ingestion of contaminated plants or animals (e.g., grazing or predation), dermal contact with contaminated soils and sediments, and external gamma radiation.

Figure 3-4. Conceptual Exposure-Pathway Model.



3.6.4 Potential Impacts

Potential contaminant exposures and health impacts to humans depend largely on allowable land uses. The land use inside the core zone selected by the DOE is industrial (exclusive). Outside the core zone, the selected land use is conservation (mining). The DOE determined these land-use designations through the *National Environmental Policy Act 1969* process; the designations are identified in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, and documented in 64 FR 61615, "Record of Decision: Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS)." Most of the 200-IS-1 OU is located in the core zone. Therefore, based on the land-use decision for the 200 Areas, potential impacts from the waste-site contaminants in the core zone would be to current and future Site workers and to terrestrial biota inhabiting the sites. Potential impacts from waste-site contaminants for portions of the pipelines systems that are located outside the core zone would be assessed based on unrestricted land use.

Ecological receptors have been identified, and potential impacts to those receptors have been evaluated at waste sites in the 200 Areas (PNL-2253, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*; WHC-SD-EN-TI-216, *Vegetation Communities Associated with the 100-Area and 200-Area Facilities on the Hanford Site*). The vegetation cover on the Central Plateau is predominantly a rabbitbrush-cheatgrass and sagebrush-cheatgrass association with incidence of herbaceous and annual species. Many areas are disturbed and nonvegetated or sparsely vegetated with annuals and weedy species such as Russian thistle. Potential ecological-contaminant exposures at the waste sites are minimized because of past site-stabilization activities. DOE/RL-2001-54 presents a more recent evaluation of habitats on the Central Plateau and provides a screening-level risk assessment, including an evaluation of threatened and endangered and new-to-science species that may be associated with the Central Plateau.

Existing characterization data and the proposed sampling and analysis activities (Phases 1 and 2) are expected to be sufficient to address potential impacts to human health and the environment. Results of the risk assessment will be presented in the RI report.

3.7 DEVELOPMENT OF CONTAMINANTS OF CONCERN

As part of the DQO process completed for process-waste pipeline systems (D&D-30262), a master list was prepared of all COPCs that could have been associated with the process-waste pipeline systems. This unconstrained or master list of COPCs was developed based on operational process information available for the facilities in the 200 Areas. This master list is presented in the DQO summary report (D&D-30262). The master constituent list was reduced by applying rationale to exclude those constituents that would not be needed for waste-site characterization. The exclusion rationale is presented below. In addition, based on waste-stream characteristics and the binning process developed in the DQO process, separate COPC lists were prepared for facility process-waste-stream pipelines and the tank-farm process-waste transfer lines. Although the waste streams share some common attributes and compositional similarities, separate lists were developed because of the sufficient differences and are presented here.

3.7.1 Use of Exclusion Rationale and Refinement of the Contaminants of Potential Concern

A summary of the rationale used to exclude selected constituents from the comprehensive master COPC list is presented below. The COPCs in the following categories were excluded from further consideration in development of the COPC list proposed for characterization activities:

- Short-lived radionuclides
- Radionuclides that constitute less than 1 percent of the fission-product inventory, and for which historical sampling indicates nondetection
- Naturally occurring isotopes that were not created as a result of Hanford Site operations
- Constituents with atomic mass numbers greater than 242, which represent less than 1 percent of the actinide activities
- Progeny radionuclides that build insignificant activities within 50 years, and/or for which parent/progeny relationships exist that permit progeny estimation
- Chemicals that have no known carcinogenic or toxic effects
- Constituents that have been diluted, neutralized, and/or decomposed by high volumes of water discharged and/or the presence of acids and bases
- Chemicals that are unlikely to be present in toxic or high concentrations because of significant dilution during cooling water discharges
- Chemicals that are not persistent in the environment.

Because of known differences in process waste-stream attributes, separate COPC lists were developed for (1) the pipeline systems associated with those effluent wastes discharged from facilities to liquid-disposal waste sites and (2) the pipelines that handled process wastes sent to, transferred between, or transferred out of the tank farms. Comprehensive COPC lists were developed for both the facilities and the tank-farm waste-transfer pipelines to accommodate the diversity of waste-stream attributes associated with different stages of process operations. It was recognized that further refinement of these COPCs may be appropriate as characterization data become available.

3.7.2 List of Contaminants of Potential Concern for Facilities Process-Waste Pipeline Systems

Numerous characterization investigations have been conducted to date to determine contaminant levels at the process-waste disposal sites that received liquid effluent generated by the facilities in the Central Plateau. The DQO process was conducted in conjunction with each of these waste-site investigations to determine the list of COPCs that would require analyses at these waste sites. For development of the 200-UR-1 OU DQO summary report, the COPC lists that had been prepared for the liquid-waste disposal sites were compiled, reviewed, and refined into one comprehensive list. Because this comprehensive list encompasses the COPC evaluation process conducted for the process waste-stream-based OUs, it was determined to be well suited for use in evaluating process-waste pipeline systems. The pipeline systems have been in contact with the same waste streams received by the disposal sites. This COPC list encompasses all constituents that are considered the primary target analytes for the laboratory analysis needed to characterize the facilities process-waste pipeline systems. Several additional analytes have been included with the original list at the request of Ecology. The facilities process-waste pipeline systems COPC list is presented in Table 3-3.

Table 3-3. Facilities Process-Waste Pipeline Systems Contaminants of Potential Concern. (2 Pages)

Radionuclide Constituents	
Americium-241	Niobium-94[a]
Carbon-14	Plutonium-238
Cesium-137	Plutonium-239/240
Cobalt-60	Strontium-90
Europium-152	Technetium-99
Europium-154	Tritium
Europium-155	Uranium-233/234
Neptunium-237	Uranium-235/236
Nickel-63	Uranium-238
Chemical Constituents – Metals	
Antimony	Lead
Arsenic	Mercury
Barium	Nickel
Beryllium	Selenium
Cadmium	Silver
Chromium	Uranium
Hexavalent Chromium	Vanadium
Copper	Zinc
Chemical Constituents – Other Inorganics	
Cyanide	Nitrate/nitrite
Fluoride	Sulfate
Chemical Constituents – Volatile Organics	
Acetone	Halogenated hydrocarbons
Acetonitrile	Hexane
Benzene	Methyl ethyl ketone
n-Butyl benzene	Methyl isobutyl ketone (MIBK)

Table 3-3. Facilities Process-Waste Pipeline Systems Contaminants of Potential Concern. (2 Pages)

1-Butanol (n-butyl alcohol)	Perchloroethylene
2-Butanone (MEK)	Tetrahydrofuran
Carbon tetrachloride	Toluene
Chlorobenzene	1,1,1 Trichloroethane (TCA)
Cis-1,2-dichloroethylene	1,1,2 Trichloroethane
Cyclohexane	Trans-1,2-dichlorotheylene
1,1-dichloroethane	Tetrachloroethylene (PCE)
1,2-dichloroethane	Trichloroethylene (TCE)
1,1-dichloroethylene	Vinyl chloride
Dichloromethane (methylene chloride)	Xylene
Ethylbenzene	
Chemical Constituents – Semivolatile Organics[d]	
AMSCO[b] tributyl phosphate dilutant	Normal paraffin hydrocarbon
Cyclohexanone	Polyaromatic hydrocarbons (and associated World Health Organization congeners)
Diesel fuel[c]	Paint thinner
Dodecane	Phenol
Hydraulic fluids (greases)	Polychlorinated biphenyls
Kerosene	Shell E-2342 (naphthalene and paraffin)
Naphthylamine	Soltrol-170 ($C_{10}H_{22}$ to C_6 to H_{34}; purified kerosene)
Dibutylphosphate*	Tributyl phosphate and derivatives (mono, bi)
Monobutylphosphate*	Formate*
Oxalate*	Glycolate*

*Added to list as requested by the Washington State Department of Ecology (chelators or extractants used in processes).

[a]Contaminant of potential concern applicable to Plutonium Finishing Plant area only.

[b]Allen Maintenance Supply Company Inc.

[c]Analyzed as total petroleum hydrocarbons-diesel range; other total petroleum hydrocarbon analyses will include gasoline range.

[d]Trademarks and registered trademarks are the property of their respective owners. All product names mentioned are listed for contaminant potential only; such listing does not imply ownership and does not constitute endorsement.

As presented in Chapter 2.0, waste-stream characteristics varied within and between facilities, depending on the stage or phase of the extraction or recovery process. Waste streams were generated as the result of both direct-process operations (i.e., plutonium and uranium extraction) and indirect noncontact operations (i.e., steam condensate and cooling water). Therefore, not all of the COPCs identified in this comprehensive list of constituents are assumed to occur in every waste stream handled by the facilities process-waste pipeline systems. As analytical data become available following the sampling and analysis of the pipeline systems, further refinement of the COPC list may be appropriate. Use of the existing characterization data available for the liquid-waste disposal-site soils, and newly obtained data for the associated pipelines, are seen as a means of focusing or further refining the radionuclide and nonradionuclide analyte lists. With the characterization of pipeline systems being performed using a phased approach, refinement of the COPC list will be evaluated as appropriate, based on available data.

3.7.3 List of Contaminants of Potential Concern for Tank Farms Process-Waste Pipeline Systems

A separate DQO process has been completed that establishes the COPC list for residual process waste remaining in the SST tank farms following waste retrieval (RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*). RPP-23403 was developed to ensure that appropriate data would be collected to support the component closure activities for all SSTs and to cover all sampling and analytical activities for that purpose. While RPP-23403 did not address soil sampling and analysis or any characterization actions associated with ancillary equipment, it did develop a comprehensive approach based on the use of analytical methods to ensure that the wide range of constituents potentially present in SSTs would be addressed. The approach used in RPP-23403 for identification of COPCs and determination of analytical requirements was incorporated into the DQO process completed for the process waste-transfer pipeline systems associated with the tank farms.

This strategy identifies specific or "primary" constituents (03-ED-009, "Hanford Facility Dangerous Waste Part A Permit Application Form 3, Revision 8, for the Single-Shell Tank (SST) System," Attachment: *Hanford Facility Dangerous Waste Part A Permit Application Form 3, Revision 8 for the Single-Shell Tank System*; and underlying hazardous constituents and radionuclides from 10 CFR 61.55, "Licensing Requirements for Land Disposal of Radioactive Waste," "Waste Classification") for analyses performed by selected analytical methods. Development of this primary constituent list is correlative in purpose and use to the COPC list that was prepared for the facilities process-waste pipeline systems. RPP-23403 also includes a strategy for reporting secondary constituents. Primary radionuclide, inorganic, and organic constituents identified for the tank-farm process-waste pipeline systems are presented in Table 3-4. Not all of these constituents are assumed to occur in every waste stream handled by the tank-farm process-waste transfer pipelines. As analytical data gathered through the sampling and analysis of tanks and pipelines become available, further refinement of these analyte lists may be appropriate. Use of these characterization data as they become available is seen as a possible means of focusing or further reducing these analyte lists.

Table 3-4. Tank-Farms Process-Waste Pipeline Systems Constituents List. (3 Pages)

Radioactive Constituents	
Antimony-125	Nickel-63
Americium-241	Plutonium-238
Carbon-14	Plutonium-239/240
Cesium-137	Plutonium-241
Cobalt-60	Selenium-79
Curium-242	Strontium-90
Curium-243	Technetium-99

Table 3-4. Tank-Farms Process-Waste Pipeline Systems Constituents List. (3 Pages)

Curium-244	Thorium-228
Europium-152	Thorium-230
Europium-154	Thorium-232
Europium-155	Tin-126
Neptunium-237	Tritium
Nickel-63	Uranium-233/234
Iodine-129	Uranium-235/236
Neptunium-237	Uranium-238
Chemical Constituents – Metals	
Aluminum	Lead
Antimony	Manganese
Arsenic	Mercury
Barium	Nickel
Beryllium	Selenium
Cadmium	Silver
Chromium III/Chromium (total)	Strontium
Cobalt	Thallium
Copper	Uranium
Hexavalent Chromium	Vanadium
Iron	Zinc
Chemical Constituents – Other Inorganics	
Acetate	Nitrite
Cyanide (includes ferrocyanide)	Nitrogen in nitrate/nitrite
Fluoride	Oxalate
Formate	Sulfide
Glycolate	Ammonia (NH_3)
Nitrate	Ammonium (NH_4)
Chemical Constituents – Volatile Organics	
Acetate	1,1,1-Trichloroethane (TCA)
Acetone	1,1,2-Trichloroethane
Benzene	Tetrachloroethane; 1,1,2,2-
Carbon disulfide	Tetrachloroethene; 1,1,2,2- (PCE)
Carbon tetrachloride	Toluene
Chlorobenzene	trichloro-1,2,2-trifluoroethane; 1,1,2-
Chloroform (trichloromethane)	Butanol; n- (n-butyl alcohol)
1,2-Dichloroethane	Isobutyl alcohol (Isobutanol)
1,1-Dichloroethylene	methylphenol; 2,6-Bis(tert-butyl)-4-
Dichloromethane (methylene chloride)	Trichloroethylene (TCE)
Dichloropropene; 1,3,- (trans-)	Trichlorofluoromethane
Ethyl acetate	Vinyl chloride
Ethyl ether	Xylenes

Table 3-4. Tank-Farms Process-Waste Pipeline Systems Constituents List. (3 Pages)

Ethyl benzene	Xylene; m-
Methyl isobutyl ketone (MIBK hexone)	Xylene; o-
Methyl ethyl ketone (MEK)	Xylene; p-
Nitropropane; 2-	
Chemical Constituents – Semivolatile Organics	
Acrylic acid*	n-nitrosomethyl amine*
Acetonitrile*	n-nitrosomethylethyl amine*
Cyclohexanone	Trimethylamine*
Hexachloroethane	Nitrobenzene
Acenaphthene	Nitrophenol; o-
Bis-2-ethylhexyl phthalate (Dioctylphthalate)	Nitroso-di-n-propylamine; N-
Butylbenzylphthalate	1,2,4 - Trichlorobenzene
Butadiene;1,3-*	Nitrosomorpholine; N-
Chlorophenol; 2-	Pyrene
Cresol; m + p (3- and 4-Methylphenol)	Pyridine
Cresol; o- (2-Methylphenol)	Trichlorophenol; 2,4,5-
Cresylic acid (cresol, mixed isomers)	Trichlorophenol; 2,4,6-
Dibutylphthalate (Di-n-butylphthalate)	Tributyl phosphate
Di-n-octylphthalate	Aroclor-1016[a]
Dichlorobenzene; 1,2- (ortho-)	Aroclor-1221
Dinitrotoluene; 2,4-	Aroclor-1232
Ethoxyethanol; 2-	Aroclor-1242
Fluoranthene	Aroclor-1248
Hexachlorobutadiene	Aroclor-1254
methylphenol; 4-Chloro-3- (p-Chloro-m-cresol)	Aroclor-1260
Naphthalene	

*Additional analyte added as requested by the Washington State Department of Ecology (constituent detected in tank vapor samples).

[a]Aroclor is an expired trademark.

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4.0 WORK PLAN APPROACH AND RATIONALE

4.1 SUMMARY OF DATA QUALITY OBJECTIVES PROCESSES FOR THE 200-IS-1 OPERABLE UNIT

The RI needs for assessing potential human-health and environmental impacts from the process-waste pipeline systems in the 200-IS-1 OU were developed in accordance with EPA/600/R-96/055, *Guidance for Data Quality Objectives Process*, EPA QA/G-4. This guidance has since been superseded by EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4. The DQO process is a seven-step planning approach used to develop data-collection strategies consistent with data uses and needs. Additional data needs to support the assessment of potential ecological impacts are being evaluated through a separate Central Plateau Ecological Risk DQO process (WMP-20570, WMP-25493, and WMP-29253).

The DQO process for the 200-IS-1 OU was implemented by a team of subject-matter experts who contributed to the development of the characterization and data-gathering approach outlined in the 200-IS-1 OU DQO summary report (D&D-30262). The participants provided input on project objectives, regulatory issues, operational history, and the sampling and analysis approach. The DQO process and the involvement of the team of experts and decision makers provide a high degree of confidence that the key information and data-collection requirements are identified in support of remedial decisions concerning the 200-IS-1 OU.

In the DQO process it was recognized that the technical and regulatory approach would need to include requirements for both (1) the pipelines associated with process-operations facilities and liquid-waste disposal sites and (2) the tank-farm pipelines, diversion boxes, and associated waste sites located outside of the WMAs that are part of the SST and DST waste-transfer infrastructure. Addressing both of these groups of pipelines and related structures resulted in the development of separate lists for COPCs (discussed in Chapter 3.0), tailored characterization strategies specific to each group, and a comprehensive integrated approach to fulfill RCRA and CERCLA regulatory requirements.

Recognizing both the differences and commonality between certain process-waste streams handled by the pipeline systems, a strategy for grouping or binning of pipelines by shared common chemical-waste-stream attributes was identified as a logical strategy for use in the characterization approach. This grouping or binning logic is based on shared characteristics of the waste streams carried by each group of pipelines. The groups or bins of process-waste pipelines encompass all potential waste-stream and pipeline conditions. Selected pipelines in each process-waste bin will be identified for characterization.

The DQO processes undertaken for the 241-CX-72 Storage Tank, including determining sampling objectives and approach, were based on previous input provided in Revision 0 and Revision 1, Draft A, of this document (DOE/RL-2002-14, Appendix B). Recent consideration of proceeding with closure actions for this tank, which included a review of existing tank-content data, resulted in identifying the need to collect analytical data characterizing the remaining waste contents.

4.1.1 Approach for Data Collection and Decision Making

The approach for data collection identified in D&D-30262 for the pipeline systems was to prepare separate characterization plans and implement separate characterization activities for those pipeline systems that are associated with 200 Areas facilities process operations and those pipelines that are part of the tank farms waste-transfer operations. Characterization results will be used as needed to address those regulatory-data requirements that apply to each set of pipelines. General data-collection uses and needs, along with the requirements for quality and quantity of data, that are applicable to both sets of pipelines, are presented in the following sections. Those activities or other elements that are specific to tank-farm lines and appurtenances are identified separately. Discussion pertaining to the 241-CX-72 Storage Tank is presented independently of the pipelines.

The primary objectives of the DQO process for the process-waste pipeline systems include the following.

- Determine the environmental measurements necessary to support the RI/FS process and remedial decision making.
- Identify data needed for development of the RI/FS work plan and SAP.
- Identify evaluation and preliminary-remediation strategies that are inclusive of both RCRA and CERCLA requirements for the 200-IS-1 OU pipelines.
- Develop preliminary conceptual contaminant-distribution model(s) that reflect the physical characteristics of the process-waste pipeline systems and surrounding soil and the anticipated distribution of contaminants. Data collection will support refinement of the model(s).

During the DQO process, tank-farm waste-transfer lines and appurtenances and associated soils were identified for field investigations and sampling during RI activities. A two-phase sampling approach, with different data-collection objectives and requirements for each phase, was identified for the process-waste pipeline systems. Appurtenances will be characterized beginning with the Phase 2 investigation. This does not preclude the potential for further sampling, should this be required for remedial alternative analysis post-Phase 2 data collection.

4.1.2 Data Acquired for Process-Waste Pipeline Systems

4.1.2.1 Data Uses

Data collected during the RI will be used for several purposes, including (1) determine if the process-waste pipeline systems are contaminated above remedial action levels, (2) support an initial evaluation of potential human-health and environmental risks, (3) support the evaluation of remedial alternatives and/or closure strategies, and (4) verify or refine the preliminary conceptual contaminant-distribution models, and (5) identify the need for treatability studies.

Phase 1 sampling will gather data to determine if waste residue within the interior of a pipeline or in the soil around a pipeline is contaminated at concentrations above preliminary cleanup levels. These data will be used to decide if additional Phase 1 sampling is required, if Phase 2 sampling should be initiated, or if the data are sufficient to select and implement a remedial action (other than the no-action alternative).

Phase 2 sampling will be used for evaluation of those pipelines and associated structures where there is considerable uncertainty concerning whether contamination exceeds action levels. Proceeding directly to Phase 2 sampling would be appropriate for those pipelines where existing information indicates that contamination will not be present and/or where considerable variability exists in results. Phase 2 sampling will be required if all remedial alternatives need to be assessed, including the no-action alternative. Phase 2 sampling requires a larger data set for decision making.

Determination of the lateral and vertical extent of contamination in soil surrounding the pipelines will be evaluated using the data gathered by geophysical logging in addition to soil-sampling results. If deep contamination is indicated (potentially extending to groundwater) after initial data gathering, subsequent evaluations (Phase 2) will include plans for vadose-zone soil sampling and analysis to be completed to groundwater.

4.1.2.2 Data Needs

For most of the process-waste pipeline systems, information is available concerning location, construction design, and type of waste received or distributed through the structure. However, specific site conditions, such as residual contaminant levels inside pipelines or diversion boxes, extent of releases to surrounding soils, and current concentrations or activities for those contaminants that may be present, has not been determined for most of the pipeline systems. Data are needed to support a risk evaluation, based on exposure to radionuclides and nonradionuclide constituents and an assessment of impact to groundwater, using modeling to simulate fate and transport of contaminants through the vadose zone. These data and evaluations are needed to support remedial decision making for the process-waste pipeline systems. While pertinent existing information was used to develop the general conceptual contaminant-distribution models for the pipeline systems, data also are needed to verify and/or refine the contaminant-distribution model and conceptual exposure-pathway model.

4.1.2.3 Data Quality

Data quality was addressed during the DQO process. Analytical performance criteria were established by evaluating potential applicable or ARARs and preliminary remediation goals, which are regulatory thresholds and/or standards or derived risk-based thresholds. These potential ARARs and preliminary remediation goals represent chemical-, location-, and action-specific requirements that must be met to protect human health and the environment. Regulatory thresholds and/or standards, or preliminary cleanup levels, provide the basis for establishing analytical performance levels (i.e., laboratory detection-limit requirements).

Detection-limit requirements and standards for precision and accuracy are used to define data quality. To provide the necessary data quality, detection limits should be lower than preliminary cleanup levels. Additional data quality is gained by establishing specific policies and procedures for the generation of analytical data and field quality-assurance/quality-control requirements. These requirements are discussed in detail in the SAPs for the pipeline systems (Appendices A and B). Analytical performance requirements are specified in the DQO summary report (D&D-30262).

4.1.2.4 Data Quantity

Data quantity refers to the number of samples collected. For Phase 1, the number of samples needed to refine the site conceptual model and make remedial decisions is based on a biased sampling approach. Biased sampling is the intentional location of a sampling point, based on existing information such as process knowledge and the expected behavior of the COPCs. This sampling approach is defined in Section 6.2.2 of the Implementation Plan (DOE/RL-98-28). Using this approach, sampling locations can be selected that increase the chance of encountering contamination.

Sample locations for pipelines are based on the preliminary conceptual models of contaminant distribution presented in the DQO summary report (D&D-30262). For Phase 1, two pipelines in each of the process-waste stream bins (Bins 1-5) were identified for sampling and analysis. The locations selected for sampling were based on a goal of intersecting potential areas of contamination and to determine the type and extent of contamination at different points along a pipeline. Soil-sample locations adjacent to pipelines were biased toward known or suspected release locations. Release locations are indicated by soil contamination in the vicinity of the pipeline, as documented in radiological survey reports provided in WIDS, and by radiological signs and fenced areas present in the field. If no known contaminated-soil areas are present along a pipeline selected for sampling, potential leak locations such as pipe bends and junctions were selected. This biased sampling approach was designed to provide the data needed to meet DQO for Phase 1.

The Phase 1 pipeline SAPs (Appendices A and B) define specific data quantity requirements based on pipelines to be sampled, geographic location of the sample, access limitations, and current information available about contamination at the sample site. Following review of the initial Phase 1 sampling results, additional sampling may be specified.

Phase 2 SAPs will be developed based on historical knowledge and Phase 1 sampling results. Phase 2 SAPs will be developed separately for Bin 1-5 pipelines and Bin 6 pipelines. Data quantity for pipelines identified for Phase 2 data collection will require a sufficient number of samples so that a statistical data evaluation can be completed. Calculation of a 95 percent upper confidence level of the mean will be determined using the Phase 2 analytical results. Sample quantities will be defined in the Phase 2 SAPs.

4.1.3 Data Acquired for the 241-CX-72 Storage Tank

4.1.3.1 Data Uses

Analytical data from samples collected from the residual waste in the 241-CX-72 Storage Tank will be used to determine the composition and concentrations of radionuclides and nonradionuclides in the remaining waste. Analytical results will support closure decisions and RCRA waste reporting requirements.

4.1.3.2 Data Needs

Characterization data are needed from the 241-CX-72 Storage Tank to determine the composition of residual waste. The data are required to determine health and safety requirements, waste codes, and disposal-path options. The waste analyses are needed to support the closure decision for the tank and RCRA reporting requirements.

4.1.3.3 Data Quality

Analytical performance criteria for analysis of residual waste in the 241-CX-72 Storage Tank were established by evaluating potential ARARs and preliminary remediation goals. Detection-limit requirements and standards for precision and accuracy are used to define data quality. To provide the necessary data quality, detection limits are defined that are lower than preliminary cleanup levels. These requirements are discussed in detail in the SAP for the 241-CX-72 Storage Tank (Appendix C).

4.1.3.4 Data Quantity

Four samples will be obtained for analysis of the contents of the 241-CX-72 Storage Tank. The sampling objective is to determine concentrations of radionuclide and nonradionuclide constituents in the tank. Two discrete samples will be taken from within the grout overlying the waste material to determine if mixing with the waste has occurred. Two discrete samples will be collected within the 3.4 m (11-ft)-thick layer of residual waste to evaluate potential stratification in content and concentrations. One sample will be collected near the top and one near the bottom of the remaining waste.

4.2 CHARACTERIZATION APPROACH

This section provides an overview of the characterization approach that will be used for collecting the data identified in the DQO process. Characterization activities include evaluation of the interior of pipelines and adjacent vadose-zone soil. Within the interior of pipelines, samples of residual waste in the form of sediment, sludge, or scale will be collected. For the vadose-zone soil, sampling and geophysical logging using spectral and gross-gamma, passive-neutron, and active-neutron (moisture) detectors will be performed. Direct-push technology (e.g., GeoProbe[1] or equivalent equipment) will used for vadose-zone soil sampling and to provide access for geophysical logging. Sample analysis will be conducted by a laboratory under a contract-required quality program. The sampling strategy is designed to provide focused evaluations on potentially contaminated locations and media inside the pipelines and in adjacent subsurface soils where leakage may have occurred. Samples will be collected within pipelines if sufficient residual waste material is present. Selection of samples in soils used for laboratory analysis will be guided by field-screening results. Field-screening results will assist in identifying the sample depths where the most extensive contamination occurs.

Before intrusive activities are implemented, surface geophysical and radiation surveys will be conducted at all sampling locations. The one exception is the 241-CX-72 Storage Tank. Geophysical surveys are not necessary to obtain a sample. The surface geophysical surveys will be conducted using ground-penetrating radar and/or electromagnetic induction and will aid in verifying buried pipeline locations, other buried utilities, and subsurface anomalies. Surface radiation surveys will identify areas of surface contamination that might impact the intrusive activities and health and safety requirements.

Characterization of the pipeline systems will be conducted in two phases. Phase 1 activities will be a combination of intrusive and nonintrusive activities. This phase consists of biased sampling that targets specific pipelines and specific locations in and around the pipelines. If known or suspected areas of waste accumulation cannot be identified, then pipelines and surrounding soil locations are selected randomly. Evaluation of the Phase 1 sampling data will be used to determine the current contaminant conditions inside the pipelines and in adjacent soils. The Phase 1 SAP for the facility process-waste pipelines is included in Appendix A. The Phase 1 SAP for the tank-farm waste-transfer pipelines is provided in Appendix B. The specific pipelines selected for investigation as part of Phase 1 are identified in each SAP.

Phase 2 characterization activities will be initiated if there is considerable uncertainty concerning whether contamination above a preliminary cleanup level is present. The Phase 2 investigation will be initiated if Phase 1 results show a range of concentration values that are both above and below or close to preliminary cleanup levels. Phase 2 sampling will be required if all remedial alternatives need to be assessed, including the no-action alternative. Phase 2 will require a larger data set for decision making. The Phase 2 evaluation will entail more extensive sampling and laboratory analyses. Phase 2 data will support development of decision documents and completion of the RI/FS processes. Selection of pipelines for Phase 2 sampling will be made after Phase 1 results have been reviewed.

Information regarding the current condition of tank-farm waste-transfer pipeline appurtenances (e.g., catch tanks, diversion boxes, valve pits) is limited. These components have a higher degree of complexity with regard to access and sampling for conducting characterization. This complexity does not make these components amenable to the Phase 1 characterization. Based on the results of Phase 1 for the tank-farm waste-transfer pipelines systems, the DQO report

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[1] GeoProbe is a registered trademark of GeoProbe Systems, Salina, Kansas.

(D&D-30262) may be revised to address these components, or an existing approved SAP will be identified and modified, as needed, to support Phase 2 data collection and characterization requirements for the tank-farm appurtenances.

A biased sampling approach will be used for sample collection in the 241-CX-72 Storage Tank. Samples will be taken from within the grout cap and from the residual waste that underlies the grout.

4.2.1 Characterization of Pipeline Systems

The following discussion outlines the approach that will be used to optimize the collection of data and determine which samples will be selected for laboratory analyses. The investigation of the pipelines and collection of data will be completed using a systematic sequence of steps. Data results will be reviewed at selected points in the process to determine the subsequent actions to be taken. Integration of the activities associated with collection of data and samples in the interior of the pipelines and in the surrounding soil is included in this approach. A description of the data collection steps is presented below.

The site investigation steps are as follows.

1. Conduct surface geophysical surveys at the proposed pipeline-investigation location if needed to verify the exact position of the pipeline, and to determine whether undocumented buried utilities or subsurface anomalies are present in the immediate area.

2. Identify and stake the locations adjacent to the buried pipeline where subsurface soil sampling will occur. All pipeline locations where intrusive activities will be conducted will have two direct-push installations completed. The direct-push locations will be positioned as close to the pipeline as possible, with a lateral distance not to exceed 3 m (10 ft) from each side of the pipeline. Specific conditions such as interfering buried utilities or high-exposure hazards may warrant adjusting locations in some instances.

3. Geophysical logging will be conducted at each direct-push location. The logging suite will consist of gross gamma, spectral gamma, passive neutron, and active neutron. Logging results should be reviewed before any subsequent activities are initiated. Radiological logging data will be used for several purposes, depending on the location.

   – At pipeline locations requiring excavation to gain access for interior pipe sampling: Logging results should be reviewed prior to excavating soil and exposing pipelines for collecting interior samples. Dose and radiological levels determined by logging will be reviewed to determine the potential-worker level of protection, site controls, and waste-handling requirements. Alternate sampling locations can be used if existing site conditions restrict proposed subsequent activities.

   – At pipeline locations identified for soil sampling: Logging results will provide information on the vertical distribution of radionuclide activity and concentration data for major gamma-emitter radionuclides (e.g., Cs-137) in proposed sample intervals. These results will be used in the selection of the sample interval for laboratory analysis. Dose and radiological levels determined by logging will be reviewed to determine the potential-worker level of protection, site controls, and waste-handling requirements. Alternate sampling locations can be used if existing site conditions restrict proposed subsequent activities.

4. Conduct soil sampling at designated locations along the pipeline. A direct-push dual tube sampling system will be used to collect samples from designated intervals. Soil-sample material will be used initially to conduct field-screening analyses. Target constituents or classes of compounds (e.g., nitrate, mercury, polyaromatic hydrocarbons, polychlorinated biphenyls, hydrocarbons, volatile organic compounds) identified for field screening will be based on available process information and analytical results (if available) for the pipeline and the disposal site connected to the pipeline. All designated sample intervals will have samples analyzed by field-screening techniques. At a minimum, one sample per sampling location will be used for laboratory analyses. Field-screening results will be used to select the sample for laboratory analysis. The sample interval with the overall largest number of positive detections by field screening at the highest levels will be used for laboratory analysis of COPCs. Based on the results of field screening and as directed by the remediation task lead or designated field personnel, additional samples may be obtained for laboratory analysis.

5. Perform interior-pipeline sample collection at locations that do not require excavation for access. Locations with easier access, such as manholes and sampler pits, will be evaluated initially. Limited sampling material (sediment, sludge, or scale) may be available. If sufficient material is available for use of field-screening test kits and laboratory analysis, both will be performed. If not, only instrument field screening will be conducted (i.e., radiological meters and organic vapor analyzer). If radiological screening levels (gamma, beta, and/or alpha) are greater than three times background, available sample material will be allocated to radiological constituents. In the second tier of screening assessment, if volatile organic compound screening results are greater than 1 ppm, as measured with the hand-held organic vapor analyzer, additional material will be used for analysis of organic constituents (volatile organic compounds, semivolatile organic compounds, and other organics). If volatile organic compound levels are less than 1 ppm, available sample material will be used for inorganic analysis (e.g., metals, nitrates, and other inorganic constituents).

6. Pipelines requiring excavation to gain access for interior sample collection will be evaluated last. These locations potentially pose the greatest logistical concerns. Test-pit excavations to expose the pipe section may involve using sloping, shoring, or trench boxes. The specific configuration of the pipe location and the anticipated hazards will be considered in selecting the technique. Excavated soil will be field screened with radiological instrumentation and an organic vapor analyzer during the removal process to determine if contamination is present. Additional field-screening analyses may be performed (e.g., using test kits) based on results of instrument screening and visual observations (e.g., soil discoloration or staining).

7. Exposed pipelines initially may be screened remotely with instrumentation attached to the excavator to determine radiological activity. Liquid waste could be present inside

some pipeline locations selected for sampling. An opening in the top of the pipe will be completed to assess whether liquid is present. A plan for handling released liquids, including notification to regulatory authorities within 24 hours will be developed. Pipe sampling may need to be conducted outside of the excavation, to limit worker risks during this operation. A section or sections of pipe, not to exceed 3.0 m (10 ft) in length, will be removed from the excavation and accessed to acquire sample material. When limited sample material is available, the process described in step 5 will be followed.

4.2.2 Analysis of Pipe Interiors

Inspection of the interiors of pipelines will be conducted at specified locations. Evaluations will include both visual inspections and sampling activities. Inspections will be used to determine if breaks, breaches, or cracks occur in the pipeline; to determine if there is residual waste causing blockage along a pipeline segment; and to characterize the residual waste, if present. Visual inspections will be conducted directly or remotely, depending on access availability and a hazard assessment. Pipeline-interior evaluations may include camera surveys, radiological monitoring, and sampling. Those evaluations or analyses that are applicable for Phases 1 or 2 are identified below. Specific characterization activities that will be used in Phases 1 and 2 are identified in the SAPs.

4.2.2.1 Visual Inspections and Camera Surveys

Examination of the interior of pipelines will be performed using a camera only for selected pipeline segments where access is available and exposure hazards are manageable. This investigative technique will provide real-time information on the current conditions within buried pipelines. Camera surveys/inspections will be used for several purposes. For those pipelines where leakage has been verified to have occurred, a camera survey will be used to assess the locations and the number of release points along certain segments. Areas where leakage has occurred will be visible as cracks, breaks, or gaps in pipe connections. Additional conditions such as the extent of corrosion, debris, or waste residue present also will be noted. Camera surveys also will be used to document pipelines that are fully intact, open and dry, and show no signs of past failure or leakage. Camera surveys currently are planned only for use during Phase 2 for Bins 1-5.

4.2.2.2 Handheld and Deployed Instrument Radiological Surveys

Radiological surveys of pipeline interiors will be used to provide information concerning the presence or absence of residual radiological contamination. A number of deployment systems are available; some include a configuration with camera survey equipment. Alpha, beta, and gamma radiation detectors can be used with some systems. Equipment and survey specifications will be presented in the SAP(s).

4.2.2.3 Sampling Pipe Scale, Sediment, or Sludge (Field Screening and Laboratory Analyses)

Residual build-up of scale, sediment, or sludge may be present in the interiors of some pipelines. Sampling and analysis of this material will be required to determine constituent composition for risk calculations, remedial decisions, and/or disposal considerations. Grab samples will be collected, depending on the evaluation and constituent of interest.

4.2.3 Surface Geophysical Techniques for Pipeline Evaluations

Several geophysical techniques are available and will be used as needed to gather information on buried pipelines. Additional discussion on surface geophysical techniques is provided in EPA/625/R-92/007, *Use of Airborne, Surface, and Borehole Geophysical Techniques at Contaminated Sites: A Reference Guide.*

4.2.3.1 Magnetometry

Magnetometers permit rapid, noncontact surveys to locate buried metallic objects or features. This technique is applicable for use with buried metal pipelines. Portable (one-person) field units can be used virtually anywhere that a person can walk, although they can be sensitive to local interferences such as fences and overhead wires. Field-portable magnetometers may be single or dual sensor. Dual-sensor magnetometers are called gradiometers; they measure gradient or the magnetic field; single-sensor magnetometers measure total field. Magnetic surveys typically are run with two separate magnetometers. One magnetometer is used as the base station to record the earth's primary field. The other magnetometer is used as the rover to measure the spatial variation of the earth's field. The rover magnetometer is moved along a predetermined linear grid laid out at the site.

4.2.3.2 Ground-Penetrating Radar and Electromagnetic Induction

Surface geophysical surveys using ground-penetrating radar (GPR) and electromagnetic-induction techniques will be used to verify the locations of pipelines as needed. GPR uses a transducer to transmit frequency-module electromagnetic energy into the ground. Interfaces in the ground, defined by contrasts in dielectric constants, magnetic susceptibility, and, to some extent, electrical conductivity, reflect the transmitted energy. The GPR system measures the travel time between transmitted pulses and the arrival of reflected energy. The reflected energy provides the means for mapping subsurface features of interest. The display and interpretation of GPR data are similar to those used for seismic-reflection data. When numerous adjacent profiles are collected, often in two orthogonal directions, a plan-view map showing the location and depth of underground features can be generated.

The electromagnetic-induction technique is a noninvasive method of detecting, locating, and/or mapping shallow subsurface features. It complements GPR because of its response to metallic subsurface anomalies and because it provides reconnaissance-level information over large areas to help focus GPR activities. The electromagnetic-induction techniques are used to determine the electrical conductivity of the subsurface and generally are used for shallow investigations.

The method is based on a transmitting coil radiating an electromagnetic field that induces eddy currents in the earth. A resulting secondary electromagnetic field is measured at a receiving coil as a voltage that is linearly related to the subsurface conductivity.

4.2.3.3 Resistivity

The resistivity method is based on the capacity of earth materials to conduct electrical current. Earth resistivity is a function of soil type, porosity, moisture, and dissolved salts. The concept behind applying the resistivity method is to detect and map changes or distortions in an imposed electrical field that are caused by heterogeneities in the subsurface. Resistivity is a volumetric property measured in ohm-meters. Because it is not possible to know the exact volume of the mass of earth being measured under field conditions, readings are in terms of apparent resistivity. Field data are acquired using an electrode array. A four-electrode array employs an electric current injected into the earth through one pair of electrodes (transmitting dipole) and measuring the resultant potential by the other pairs (receiving dipole). High-resolution resistivity methods generally employ a "pole-pole" array. For a pole-pole array, the two rover or "active" electrodes are incrementally spaced from 5 to 400 m apart. This geophysical technique may be useful in delineating the extent of a liquid release(s) associated with some pipelines that have leaked.

4.2.4 Evaluation of Associated Soils

Investigations for the presence of contaminants in the soils surrounding pipelines will be conducted using both indirect and direct evaluation techniques. Subsurface investigations will include geophysical logging and soil sampling.

4.2.4.1 Direct-Push Investigative Techniques

Subsurface investigations using direct-push installations will be employed as part of the assessment for soil surrounding selected pipeline locations. This technology can be used to install casing and collect samples with minimal to no excess-waste soil generated. Installations will be used to obtain information relating to a number of in situ soil characteristics including gamma radiological levels and soil moisture. Discrete sample intervals will have soil collected for field screening and laboratory analyses. This technology will work well in the unconsolidated sediments and fill material adjacent to buried pipelines.

4.2.4.2 Geophysical Logging Through Direct-Push Casing

Radioactivity levels will be measured in soils using geophysical logging instrumentation. Radioactive contamination generally is expected to be primarily represented by gamma emitters (e.g., Cs-137). Driven small-diameter casing will be installed and used for down-hole logging with gamma-logging tools. The depth of a driven casing will be limited by the subsurface conditions (e.g., cobbles, gravel). Gross-gamma and passive-neutron logging probes will be used to determine areas of potentially high Am-241 and Pu-239/240 concentrations. The small-diameter gross-gamma and passive-neutron probe system uses bismuth-germanium detector instrumentation for gross counting of the gamma-emitting radionuclides in the soil as a function of depth. The passive-neutron logging instrument with a He-3 detector can be configured to detect the neutron flux present in the below-ground soil environment. Active neutron logging will be used to determine soil-moisture content. Soil moisture will be reported as a percent volume fraction.

4.2.4.3 Analysis of Soil (Field Screening and Laboratory Analyses)

Soil samples will be collected for nonradiological and radiological analysis. The list of analytes for laboratory analysis was developed based on an evaluation of all potential contaminants. Development of this list of COPCs is presented in the DQO summary report (D&D-30262). The SAPs (Appendices A and B) provide details regarding the analytical methods and holding times for each contaminant. Designated soil samples will be analyzed for the complete list of COPCs.

Field-screening techniques will be used as part of the soil-sample collection process to determine which samples to use for laboratory analyses. Soil will be obtained for use in screening from four sample intervals from each direct-push hole. Screening analyses for radiological and nonradiological constituents will be performed. Target constituents for screening will be identified based on the process information and disposal-site data associated with the pipeline being evaluated. Soil from the sample interval with the greatest number of positive detections at the highest values will be used for laboratory analysis of the complete list of COPCs. The specific pipelines identified for sampling in each SAP (Appendices A and B) have accompanying information supporting the selection of the target constituents for which screening analyses will be performed.

4.2.5 Test-Pit Excavations

Test-pit excavations will be used to expose sections of those buried pipelines selected for interior sample collection. Test-pit excavations to expose the pipe section may involve sloping, shoring, or trench boxes. The specific configuration of the pipe location and the anticipated hazards will be considered in selecting the technique. Excavated soil will be field screened with radiological instrumentation and an organic vapor analyzer during the removal process to monitor contaminant levels and determine worker-protection requirements. Excavated soil removed to expose and examine the pipeline will be returned to the hole following sampling activities.

4.2.6 Characterization of the 241-CX-72 Storage Tank

4.2.6.1 Drilling and Sampling

The drilling technique for sample collection from the 241-CX-72 Storage Tank will be selected to accommodate health and safety requirements for the drilling crew, site geologist, and other support personnel on site. The properties of matrixes to be drilled, grout and semi-consolidated radioactive sludge, and worker-exposure concerns will require a tailored drilling configuration. Core drilling without the use of liquids currently is anticipated.

4.2.6.2 Field Screening

Cuttings, cored material, and the sludge samples will be field screened with radiological instrumentation. Dose and count data will be collected for gamma, beta, and alpha-emitting radionuclides.

4.2.6.3 Laboratory Analyses

Samples will be analyzed for the complete list of radiological and nonradiological COPCs identified in the SAP (Appendix C).

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5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS

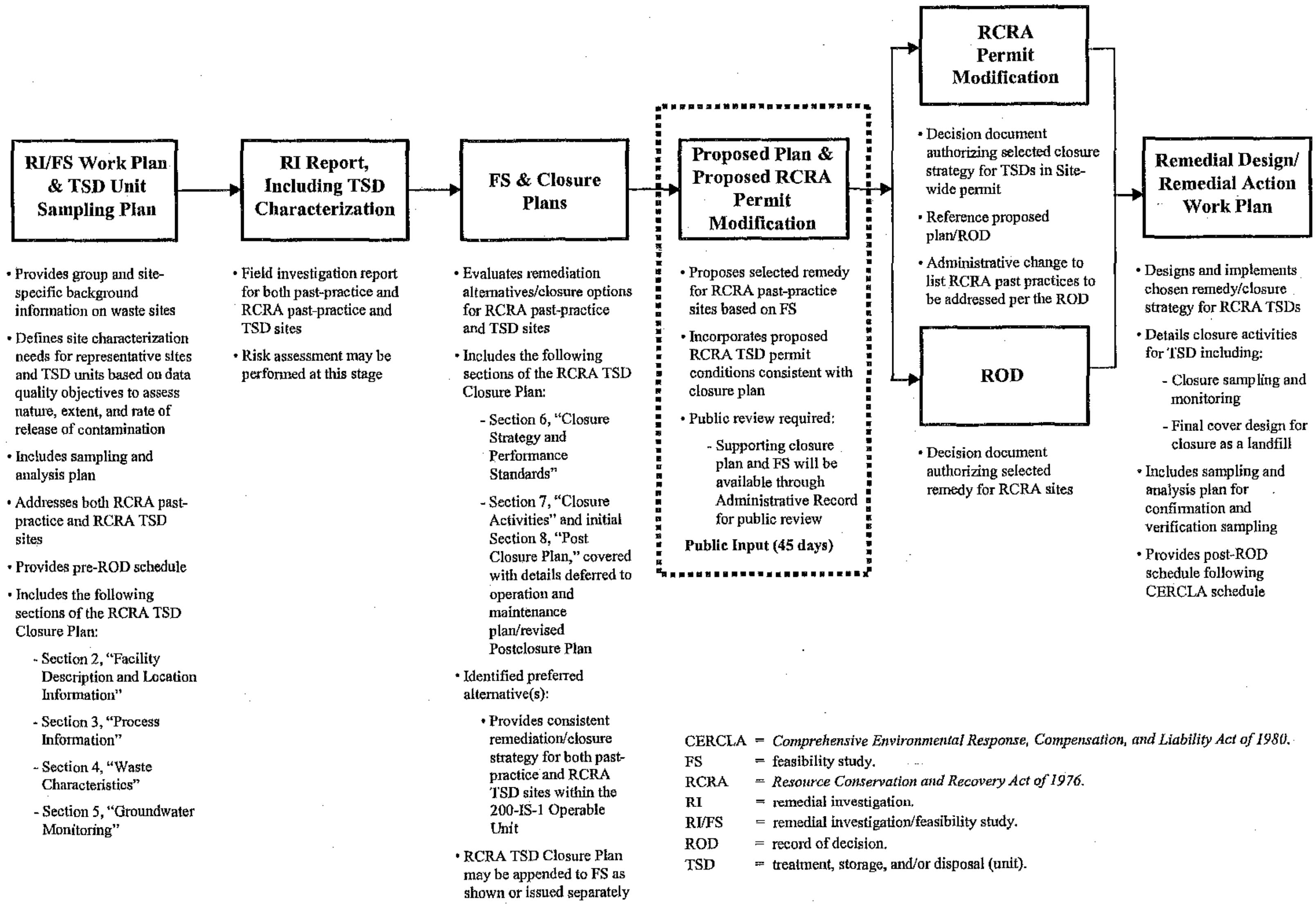
This chapter describes the RI/FS (investigation/assessment) process for the 200-IS-1 OU pipeline systems. Included in this description of RI/FS activities for the 200-IS-1 OU is the CX Tank System and HSTF units. The development of and rationale for the RI/FS process is provided in DOE/RL-98-28 and is summarized in Figure 5-1. The process follows the CERCLA remedial-documentation process, with modifications to satisfy the requirements specific to RCRA TSD units undergoing remediation and RPP waste sites undergoing closure. Section 5.1 summarizes the integrated regulatory process for CERCLA and RCRA. Section 5.2 outlines the activities to be completed during the RI phase. Section 5.3 summarizes the evaluation of Phase 1 data. Section 5.4 outlines tasks to be completed as part of preparing the RI report. RI tasks are designed to document investigation results and satisfy the DQOs identified in Chapter 4.0.

The RI will present information concerning the nature and extent of contamination associated with the waste sites, contaminant concentrations, and potential transport of contaminants. The RI report also will provide data that will be used to determine the need for and type of remediation. Data collected in Phases 1 and 2 of the pipeline-systems evaluation will be used to support these analyses. Phase 1 characterization activities for the pipeline systems are described in the SAPs included in Appendices A and B of this work plan. The results of Phase 1 will be reviewed before the Phase 2 SAP(s) are developed. Data-collection objectives for Phase 2 were identified in the DQO process (D&D-30262) and are discussed in Chapter 4.0 of this work plan. Tasks to be completed following the RI include preparation of an FS with applicable RCRA TSD unit closure plan(s) (Section 5.5). The FS and closure plan(s) will evaluate remedial closure alternatives and recommend a preferred alternative. A proposed plan and proposed RCRA Permit (WA7890008967) modification for RCRA TSD units will be issued to the public for review and comment. Once the public-review process has been completed, the decision on the remedies selected for 200-IS-1 OU waste sites will be documented in a ROD and RCRA Permit modification (as appropriate) (Section 5.6).

Project management occurs throughout the RI/FS process. Project management is used to direct and document project activities so that the objectives of the work plan are met and the project remains within budget and on schedule. The initial project management activity will be to assign individuals according to roles established in Section 7.2 of DOE/RL-98-28. Other project-management activities include day-to-day supervision of and communication with project staff and support personnel; meetings; control of cost, schedule, and work; records management; progress and final reports; quality assurance; health and safety; and community relations.

DOE/RL-98-28, Appendix A, provides the overall quality assurance framework that was used to prepare an OU-specific quality assurance project plan for the RI. DOE/RL-98-28, Appendix B, includes a review of data-management activities that apply to the RI and describes the process for the collection/control of data, records, documents, correspondence, and other information associated with RI/FS activities.

Figure 5-1. Integrated Regulatory Process for CERCLA, RCRA Past-Practice, and RCRA Treatment, Storage, and Disposal Unit Closure.



CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
FS = feasibility study.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RI = remedial investigation.
RI/FS = remedial investigation/feasibility study.
ROD = record of decision.
TSD = treatment, storage, and/or disposal (unit).

5.1 INTEGRATED REGULATORY PROCESS

An important part of the Tri-Party Agreement (Ecology et al., 1989a) is the integration of RCRA corrective-action and CERCLA remedial-action activities whenever practicable. In the Tri-Party Agreement, the "Parties intend to integrate DOE's CERCLA response obligations and RCRA corrective action obligations which relate to the release(s) of hazardous substances, hazardous wastes, pollutants and contaminants covered by this Agreement. Therefore, the Parties intend that activities covered by Part Three of this Agreement will achieve compliance with CERCLA, 42 U.S.C. Section 9601 et seq.; will satisfy the corrective action requirements of the HWMA, Sections 3004(u) and (v) of RCRA, 42 U.S.C. Section 6924(u) and (v), for a RCRA permit, and Section 3008(h), 42 U.S.C. Section 6928(h); and will meet or exceed all applicable or relevant and appropriate federal and state requirements to the extent required by Section 121 of CERCLA, 42 U.S.C. Section 9621."

The 200-IS-1 OU consists of RPP waste sites and RCRA TSD units and components (e.g., 241-CX-70 Storage Tank, 241-CX-71 Neutralization Tank, and 241-CX-72 Storage Tank; and the SST pipelines and diversion boxes). The final disposition of the TSD tank-farm components (i.e., RCRA-regulated pipelines and diversion boxes) will have to meet both CERCLA remedial-action and RCRA TSD closure requirements. Integrating RCRA corrective actions and CERCLA remedial actions allows for the integration of cleanup options for disposal, closure, removal, and/or remedial actions. By allowing flexibility in final-disposal options, DOE, Ecology, and the EPA intend to minimize disposal costs to the extent possible while remaining fully protective of human health and the environment.

An integration of CERCLA RI/FS work-plan and RCRA RFI/CMS work-plan requirements was used to develop this RI/FS work plan, which satisfies the content requirements of both regulations. This work plan provides RCRA TSD unit closure-plan information such as facility description, location, and process information (Section 2.1), waste characteristics (Section 3.4), and groundwater monitoring (Section 3.2). Following completion of the work plan, the RI will be conducted, which will satisfy the requirements for an RFI and will provide the data needed to support the selection of a closure strategy for RCRA TSD units, components, and ancillary equipment. The RI will include an evaluation of 200-IS-1 OU RPP waste sites and the TSD units, components, and ancillary features.

Concurrent with completion of the RI report, the remedial alternatives and closure strategies will be evaluated and compared against performance standards. The integration process for the evaluation-of-remedial-alternatives phase of the RI/FS process includes preparing a CERCLA FS, which evaluates remedial alternatives, and a proposed plan that contains the preferred remedial alternative. These documents will satisfy the requirements for a CMS report and a RCRA TSD unit closure plan. The recommended alternative, which generally is included in the CMS, is in the proposed plan under CERCLA. The FS also will include a section that provides corrective action recommendations for RPP sites. Additional discussion of the FS/closure plan work scope is provided in Section 5.5.

The RCRA closure options (i.e., landfill, modified, and clean closure, as defined in Condition II.K. of the Hanford Facility RCRA Permit [WA7890008967]) will be integrated with the CERCLA options and based on the alternative selected and the amount of cleanup that can be accomplished by the alternative. Landfill closure under RCRA will include the construction of an engineered barrier over the unit and equates to what typically is termed as a "containment alternative" under CERCLA. A modified closure option includes alternatives that leave contaminants in place above WAC 173-340-740, Method B cleanup standards in soil, debris, or groundwater (WAC 173-340-740(3)(b)(iii)(A), "Method B Soil Cleanup Levels for Unrestricted Land Use," "Standard Method B Soil Cleanup Levels," "Human Health Protection," "Ground Water Protection"; WAC 173-303-610(2)(b)(ii), "Closure and Post-Closure"; WAC 173-340-740(3)(b)(iii)(B), "Method B Soil Cleanup Levels for Unrestricted Land Use," "Standard Method B Soil Cleanup Levels," "Human Health Protection," "Soil Direct Contact"). A clean-closure option requires that all contaminated material and media be removed and decontaminated to levels below WAC 173-340-740, Method B, unrestricted use standards.

The lead regulatory agency (Ecology) will prepare the CERCLA ROD following completion of the public-involvement process for the proposed plan, which, after signature by the signatories to the Tri-Party Agreement, will authorize the selected remedial action. The closure decisions for the RCRA TSD units that were contained in the CERCLA proposed plan and ROD will be administratively documented in the Hanford Facility RCRA Permit (WA7890008967). The DOE will issue a letter declaring that the closure of the RCRA TSD units/components is finished, once the selected remedies have been implemented and a closure certification has been prepared and attached to the letter. The modification of the Hanford Facility RCRA Permit will consist of adding a section that will include an explanation stating that the required closure information is included in the CERCLA documentation. Additional discussion concerning the proposed plan/proposed RCRA Permit modification is provided in Section 5.6, with Section 5.7 providing additional detail relating to post-ROD and/or permit modifications and postclosure activities.

For the implementation phase, the remedial-design report/remedial-action work plan will contain the required information concerning verification sampling and design of the remedies for the CERCLA waste sites and the RCRA TSD units/components. Finally, the operations and maintenance plan will contain the information, if needed, for surveillance, inspections, monitoring, etc., for the remedies implemented for the CERCLA waste sites and RCRA TSD units/components with contamination left in place. If postclosure requirements are needed for the RCRA TSD components for waste left in place, then a section will be added to the Hanford Facility RCRA Permit to include a statement that postclosure information is included in the CERCLA documentation.

During the CERCLA remedial-action process, there may be an opportunity to implement a remedy for a certain category of waste sites by performing a removal action separate from the remedial action for the 200-IS-1 OU. This removal action will be documented in an engineering evaluation/cost analysis document and either attached to one of the remedial-action documents or issued separately. The categories of waste sites that may be considered for a separate removal action may include TSD units/components. A closure plan will be prepared and attached to the engineering evaluation/cost analysis document that will describe how the implementation of the remedy will satisfy RCRA closure requirements. An action memorandum is issued to document the removal-action decision, and a removal-action work plan is prepared to implement the removal action. Similar steps would be conducted, as previously described, to administratively include closure information in the Hanford Facility RCRA Permit. The Hanford Facility RCRA Permit information would indicate that the closure information is contained in the engineering evaluation/cost analysis document.

This integration process fully addresses each technical and procedural element of RCRA and CERCLA so that redundant work is not required when remediating these waste sites. The CERCLA public-involvement process, including public notice and opportunity to comment, will be enhanced as necessary to concurrently satisfy the public-involvement requirements for the RCRA closure and corrective-action processes. The public will be given an opportunity to review and comment on the proposed permit conditions that will be contained in the proposed plan. The proposed plan, with a draft permit modification, will be issued for a minimum 45-day public review and comment period. Supporting documents, including the FS and closure plan(s), will be made available to the public for review at the same time. A combined public meeting/public hearing may be held during the comment period to provide information on the proposed action and permit modification and to solicit public comment.

The document sections from a RCRA closure plan that have been integrated into the CERCLA documentation are outlined below:

- 200-IS-1/200-ST-1 OU RI/FS work plan, containing TSD unit/component(s) information applicable to the following closure-plan chapters:
  - Chapter 2.0, "Facility Description and Location Information"
  - Chapter 3.0, "Process Information"
  - Chapter 4.0, "Waste Characterization"
  - Chapter 5.0, "Groundwater Monitoring"
- 200-IS-1 OU RI report, which contains the following TSD unit/component(s) closure information:
  - TSD unit characterization data
- 200-IS-1 OU FS, containing TSD unit/component(s) information applicable to closure-plan sections:
  - Chapter 6.0, "Closure Strategy and Performance Standards"
  - Chapter 7.0, "Closure Activities"
  - Chapter 8.0, "Postclosure Plan"
- 200-IS-1 OU proposed plan:
  - Discusses TSD units/components and proposed actions
  - Contains crosswalk showing where TSD unit closure information can be found in CERCLA documents (e.g., RI/FS work plan, RI report, FS).

- Hanford Facility RCRA Permit modification:
  - Add section for TSD unit(s)/component(s)
  - TSD units/components section contains explanation that closure information is contained in the CERCLA documents
  - CERCLA documents will not be attached or appended to the permit
  - TSD units/components section contains explanation that postclosure information is contained in the CERCLA documents (e.g., remedial-design report/remedial-action work plan, operations and maintenance plan)
- 200-IS-1 OU remedial-design report/remedial-action work plan, which describes final remedies selected for TSD units/components:
  - Includes a SAP for confirmation/verification sampling for both waste sites and TSD units/components
- 200-IS-1 OU operations and maintenance plan:
  - Details postremediation and closure operations, inspection, and/or monitoring activities, as needed.

However, if deemed practicable, separate closure plan(s) may be prepared and submitted to Ecology meeting the requirements specified in WAC 173-303-610 and the Hanford Facility RCRA Permit (WA7890008967).

5.2 REMEDIAL INVESTIGATION ACTIVITIES

The following sections summarize the planned tasks that will be performed during the RI phase for the process-waste pipeline systems. Planned tasks include the following:

1. Planning
2. Field investigation
3. Management of investigation-derived waste
4. Laboratory analysis and data validation.

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

5.2.1 Planning

The planning subtask includes tracking and coordinating activities to be completed and documentation that must be completed before RI field activities can begin. This includes interfacing with other organizations and/or project managers who will be providing information for presentation in the 200-IS-1 OU RI report. It also includes the preparation of a site-specific health and safety plan in accordance with 40 CFR 300.430(b)(6), "Remedial Investigation/Feasibility Study and Selection of Remedy," "Scoping," and 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," and a preliminary hazard classification. If required, a final hazard classification and safety analysis will be performed in accordance with approved procedures. Radiological work permits, excavation permits, supporting surveys (e.g., cultural, radiological, wildlife, utilities), work instructions, personnel training, and the procurement of materials and services (e.g., drilling and geophysical logging services) also will be required. In addition, characterization locations identified in the SAPs (Appendices A and B) will be located using a global positioning satellite system.

DOE/RL-98-28, Appendix B, provides a general health and safety plan that outlines health and safety requirements for RI activities. A site-specific health and safety plan will be prepared for characterization activities, following requirements of the general health and safety plan. Initial surface radiological surveys will be performed to document any radiological surface contamination and background levels in and around the sampling locations. This information will be used to document initial site conditions.

5.2.2 Field Investigation

The field-investigation task involves performing data-gathering activities in the field that are required to satisfy the project DQOs. The field-characterization approach is summarized in Section 4.2 and detailed in the SAPs provided in Appendices A and B of this work plan. The scope includes collection of sediment/sludge/scale samples inside of pipelines and geophysical logging and soil sampling and analysis to characterize the vadose-zone soil at selected locations adjacent to pipelines. Major subtasks associated with the field investigation include the following:

- Test-pit excavations to expose pipelines and provide access for inspection and internal sample collection
- Direct-push installations for geophysical logging and soil-sample collection
- Preparation of a field report.

5.2.2.1 Pipeline Systems

Under this work plan, Phase 1 characterization of the pipeline systems will be implemented. Phase 2 characterization of the pipeline systems will be specified after review of the Phase 1 results either in a revision to this work plan or in a separate work plan. A general description of the characterization methods that may be applied during each phase is presented in Chapter 4.0. Phase 1 characterization activities are presented in Appendix A for the facility pipelines and in Appendix B for the tank-farm waste-transfer pipelines. Phase 2 activities will be specified after the Phase 1 results have been reviewed. Subtasks to be completed under Phase 1 are discussed below.

Pipeline Internal Evaluation

Phase 1 pipeline sample locations will be selected using a focused approach. Field-investigation locations are expected to be selected based on the assumption that residual wastes in the pipelines would accumulate in certain locations (e.g., bends, low pipeline segments). In addition, areas of known or suspected unplanned-release sites will be targeted for sampling. As-built drawings will be used for generally locating pipelines in the field, and surface geophysical techniques (e.g., GPR, conductivity, and/or magnetometer) will be used to define a lines-specific location.

Evaluating interiors of pipelines involves accessing the inside of selected pipelines at designated locations to gather samples for field screening and laboratory analyses. Access to pipelines to collect samples will be gained by either excavating a test pit or if an appropriate technique is available by constructing a borehole down to the pipeline. Certain pipelines with direct internal access points such as manholes or sampler pits may be sampled without excavation. Sampling techniques at any specific locations will be dependent upon the site's physical characteristics including interferences. Radiological monitoring of soils will occur during excavation activities. All exposed pipeline segments will have their external surface field screened for radiological contamination. Accessing the interior of the pipeline may involve penetrating the pipe by drilling a hole into it so that a probe can be inserted or by cutting out a segment of pipe. Once internal access is acquired, visual inspections of the interior of the pipe will be accomplished either by personnel inspection or via remote video equipment. This inspection will provide information on the presence of waste in the pipeline at the sample location and information on the condition of the pipeline. Observations such as occurrence of breaks, cracks, misaligned joints, corrosion, and internal buildup of sediment, sludge, and/or scale will be recorded. Available residual waste material present inside the lines will be sampled. Field screening for radiological and nonradiological constituents will be performed if sufficient material is available.

Soil Adjacent to Pipelines

Known and suspected unplanned release sites along selected pipelines will be sampled. When two pipeline segments of dissimilar material are joined, the potential exists for a failure at this joint. As part of the focused-sampling approach, sampling will be conducted at some of these locations. At suspected release sites, surface surveys of the area would be conducted prior to any excavation. Direct-push installations will be completed adjacent to pipelines to perform geophysical logging and collect samples for field screening and laboratory analysis. Contaminated soil along pipelines that are suspect leakage areas have been identified for characterization. Small-diameter casing will be installed using direct-push equipment for use in geophysical logging. Geophysical logging will be completed primarily to provide information on the distribution of gamma-emitting radionuclides. Passive-neutron logging may be performed to evaluate whether plutonium is present at high-activity levels. Active-neutron logging will be used to measure moisture distribution in the soil. Logging results will be reviewed before any sampling activities are initiated. At the completion of sampling, the direct-push casing will be removed and decontaminated (if possible). The borehole will be abandoned, and initial site conditions will be reestablished.

A small-diameter direct-push split-spoon sampler will be used for soil-sample collection. Field-screening analysis for radiological and nonradiological constituents will be completed for each interval sampled. Samples selected for laboratory analysis, based on field-screening results, will be packaged for shipment to an offsite laboratory if radiation levels permit. Otherwise, samples will be shipped to an onsite laboratory. At the completion of sampling, the direct-push casing will be removed and decontaminated (if possible). The borehole will be abandoned, and initial site conditions will be reestablished.

Other activities include work-zone setup, mobilization/demobilization of equipment, and equipment decontamination. Radiological field screening will assist in establishing radiation-control measures and ensure worker health and safety.

Preparation of Field Report

At the completion of the field investigation, a field report will be prepared to summarize the activities performed and information collected in the field, including survey data for direct-push locations, the number and types of samples collected and associated *Hanford Environmental Information System* database numbers, inventory of investigation-derived waste containers, geological logs, field-screening results, and geophysical-logging results.

5.2.2.2 241-CX-72 Storage Tank

Task to be completed for the 241-CX-72 Storage Tank include borehole drilling, sample collection, and laboratory analysis. Samples obtained from the residual waste material in the tank will be sent to a laboratory for analysis of radiological and nonradiological constituents. Radionuclide concentrations may require analysis by an onsite laboratory.

5.2.3 Management of Investigation-Derived Waste

Waste-designation DQOs will be established before the characterization activities are begun, to ensure that the information collected during the field activities supports the designation of all investigation-derived waste for the project. During the investigation-derived waste DQO process, any listed waste issues will be resolved. Any additional sampling requirements or analytes needed to support waste-designation activities will be identified and the requirements implemented through the waste-designation DQO summary report that will be prepared at that time.

Waste generated during the RI will be managed in accordance with a waste-control plan to be prepared for the sampling activity. DOE/RL-98-28, Appendix E, provides general waste management processes and requirements for the investigation-derived waste and forms the basis for activity-specific waste-control plans. The site-specific waste-control plan addresses the handling, storage, and disposal of investigation-derived waste generated during the RI phase. Further, the plan identifies governing procedures and discusses types of waste expected to be generated, the waste-designation process, and the final-disposal location. The investigation-derived waste management task begins when investigation-derived waste is first generated at the start of the field investigation and continues through waste designation and disposal.

5.2.4 Laboratory Analysis and Data Validation of Process-Facility Pipelines

Samples collected from within the pipelines and from adjacent soil will be analyzed for a suite of radionuclides and nonradionuclide constituents identified during the DQO process. The list of analytes, laboratory methods, associated target-detection limits, and quality assurance and quality control requirements for Phase 1 sampling of Process-Facility pipelines is provided in the SAP (Appendix A). This task includes the laboratory analysis of samples, the compilation of laboratory results in data packages, and the validation of a representative number of laboratory data packages.

5.2.5 Laboratory Analysis and Data Validation of Tank-Farm Pipeline-System Samples

Samples collected from within the pipelines and from adjacent soil will be analyzed for a suite of radionuclides and nonradionuclide constituents identified during the DQO process. The list of analytes, methods, and associated target-detection limits is provided in the Phase 1 SAP (Appendix B). The SAP also specifies the quality-assurance, quality-control, and data-reporting requirements for the laboratory analysis. Validation of a representative number of laboratory data packages will be performed. Data review and validation will be completed in accordance with best-basis inventory procedures.

5.3 EVALUATION OF PHASE I DATA

All Phase 1 characterization data will be compiled and reviewed at the completion of field operations and receipt of laboratory results. Field-screening results, geophysical-logging data, and laboratory analyses will be included. Results will be tabulated and maps and plots prepared to show the contaminant distribution. Based on the results of Phase 1, an assessment will be completed concerning the need for additional data collection for each of the process-waste pipeline bins. If the need for additional data collection is determined to be required to support risk-assessment evaluations and remedial decision making, planning for Phase 2 will be initiated.

Phase 2 will entail gathering additional data to support remedial decisions, including no action. Additional characterization data will be acquired to allow for a statistical analysis of the data set. The data set will be used to determine a 95 percent upper confidence limit of the mean concentration for the COPCs. The uncertainty in the calculated values, based on the proposed total number of analyses that will be used, will be presented in the Phase 2 SAP. Results of both phases of characterization will be presented in the RI report.

5.4 REMEDIAL INVESTIGATION REPORT

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

5.4.1 Data-Quality Assessment

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

5.4.2 Data Evaluation and Conceptual-Model Refinement

This task will consist of evaluating the information that has been collected. The nonradiological and radiological data associated with the samples taken from within the pipeline structures and surrounding subsurface soil will be compiled, tabulated, and evaluated to satisfy data needs. Data-evaluation tasks may include the following.

- Perform initial screening for contamination by evaluating the data with respect to background, using simple comparisons of maximum values to background concentrations.
- Compare the data to potential cleanup levels.
- Describe the distribution of contamination within the pipelines, based on field-screening and laboratory analytical results for sludge, sediment, or scale samples taken from within the pipelines.
- Describe the vertical and lateral distribution of contamination in soil adjacent to pipelines, based on geophysical-logging results and analytical data for soil samples.
- Construct data diagrams and plots to evaluate spatial correlations within and between sampled media (inside pipelines and surrounding soil). This evaluation will be used to assess whether contamination is concentrated in a particular area, in relationships between contaminant levels and locations inside the pipelines, and in surrounding soil.
- If sufficient data are available, perform statistical analyses. This step has many facets, including determining the distribution of the data and selecting the appropriate statistical tests.

If available data are not sufficient for statistical analysis, maximum concentrations will be used in the data evaluation process.

The combined chemical and geophysical data will be used for refining the preliminary conceptual contaminant-distribution models and as inputs to the risk assessment. Phase 1 results also will be used to determine Phase 2 data needs.

5.4.3 Baseline Risk Assessment

For the 200-IS-1 OU, a quantitative, baseline risk assessment will be prepared as part of the RI report for all potential pathways: human-health direct contact, ecological, and protection of groundwater. It is important to note that for the baseline risk assessment, completed risk assessments conducted for process facilities liquid-waste disposal sites, tank farms, and other applicable waste sites also will be evaluated, with input parameters and results included as appropriate, to support the 200-IS-1 OU analyses. Results of these other risk assessments will be integrated and used to support an evaluation of the risk posed by residual waste associated with pipeline structures and associated soil.

The baseline risk assessment will evaluate risk to human and ecological receptors from potential exposure to contaminants in accessible surface sediments and shallow subsurface soils. The risk assessment also will evaluate the potential for contaminants that are currently in the vadose-zone soil to impact groundwater in the future. Risks from current groundwater contamination will not be evaluated; this evaluation will be conducted as part of the RI/FS process for the Central Plateau respective groundwater OUs.

A baseline risk analysis for those COPCs detected within the pipelines also will be completed. Initial screening will consider the constituents to be directly accessible to potential receptors. Modeling of future exposure risks, as the pipelines degrade and constituents actually become available to surrounding soil, also will be completed. These modeling results will be considered in the risk evaluations associated with various potential leave-in-place remedial alternatives (e.g., no action, decontamination flushes, grouting).

5.4.3.1 Risk Framework

Ecology, EPA, and DOE, cumulatively known as the Tri-Parties, undertook the task of developing a risk framework to support risk assessments in the Central Plateau. This included a series of workshops completed in 2002 with representatives from DOE, EPA, Ecology, the Hanford Advisory Board, the Tribal Nations, the State of Oregon, and other interested stakeholders. The workshops focused on the different programs involved in activities in the Central Plateau and the need for a consistent application of risk-assessment assumptions and goals. The results of the risk framework are documented in letter HAB 132, "Exposure Scenarios Task Force on the 200 Area"; in the Tri-Parties' response to HAB 132, (Klein et al., 2002, "Consensus Advice #132: Exposure Scenarios Task Force on the 200 Area"); and in HAB, 2002, *Report of the Exposure Scenarios Task Force.*

The risk assessment presented in the RI report will use data collected from the pipeline structures and surrounding soil and will be sufficient to allow quantification of risk. Human-health risks are evaluated according to reasonably anticipated future land use for the Central Plateau, based on criteria consistent with Klein et al., 2002. The land surrounding the 200 East and 200 West Areas was designated as industrial-exclusive in DOE/EIS-0222-F.

The following items identify the risk framework description from Klein et al., 2002.

- The Core Zone (200 Areas including B Pond [main pond] and S Ponds) will have an industrial scenario for the foreseeable future.

- The Core Zone will be remediated and closed, allowing for "other uses" consistent with an industrial scenario (environmental industries) that will maintain an active human presence in this area, which in turn will enhance the ability to maintain the institutional knowledge of waste left in place for future generations. Exposure scenarios used for this zone should include a reasonable maximum exposure to a worker/day user, to possible Native American users (possible because of long-lived radionuclides and uncertainty regarding future land use), and to intruders.

- The DOE will follow the required regulatory processes for groundwater remediation (including public participation) to establish the points of compliance and remedial-action objectives. It is anticipated that groundwater contamination under the Core Zone will preclude beneficial use for the foreseeable future, which is at least the period of waste management and institutional controls (150 years). It is assumed that the tritium and I-129 plumes beyond the Core Zone boundary will exceed the drinking-water standards for the next 150 to 300 years (less for the tritium plume).

- No drilling for water use or otherwise will be allowed in the Core Zone. An intruder scenario will be calculated for assessing the risk to human health and environment.

- Waste sites outside the Core Zone but within the Central Plateau (200 N Area, Gable Mountain Pond, BC Controlled Area) will be remediated and closed based on an evaluation of multiple land-use scenarios to optimize institutional-control cost and long-term stewardship.

- An industrial land-use scenario will set cleanup levels on the Central Plateau. Other scenarios (e.g., residential, recreational) may be used for comparison purposes to support decision making, especially for the following:

  - The post-institutional controls period (>150 years)
  - Sites near the Core Zone perimeter to analyze opportunities to "shrink the site"
  - Early (precedent-setting) closure/remediation decisions.

- This framework does not consider the tank-waste retrieval decision.

More recent publications, including the 221-U Canyon Building ROD (EPA, 2005, *Record of Decision, 221-U Facility (Canyon Disposition Initiative), Hanford Site, Washington*), state that land-use controls (i.e., institutional controls) will be maintained indefinitely, until such time as the concentration of hazardous substances in the soil and groundwater are at such levels to allow for unrestricted use and exposure. The 221-U ROD also states that groundwater underlying the 200 Areas may be considered a potential future drinking-water source and is, in any case, hydraulically connected to groundwater that is currently used for drinking water and irrigation purposes.

Other assumptions used in the human-health risk evaluation include the following:

- Land use will be industrial-exclusive for the next 50 years
- Land use will be industrial (non-DOE worker) for 100 years after 2050
- Land use will be industrial after 150 years.

5.4.3.2 Standards, Guidance Documents, and Computer Codes

The human-health risk assessment will be conducted in accordance with appropriate subsections of WAC 173-340 and with the following DOE and EPA guidance documents:

- DOE/RL-91-45, *Hanford Site Baseline Risk Assessment Methodology*
- EPA/540/1-89/002, *Risk Assessment Guidance for Superfund (RAGs), Volume I – Human Health Evaluation Manual, (Part A) Interim Final*, OSWER 9285.7-01A
- EPA, 1991, *Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors, (Interim Final)*, OSWER Directive 9285.6-03
- EPA/600/P-95/002Fa, *Exposure Factors Handbook Volume 1: General Factors*
- EPA/540/R-99/005, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final*
- EPA/600/P-92/003C, *Proposed Guidelines for Carcinogen Risk Assessment*
- EPA, 1992, *Supplemental Guidance to RAGS: Calculating the Concentration Term*, OSWER Publication 9285.7-081.

Risks initially will be evaluated by comparison to risk-based standards such as WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties," or WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards," depending on the location of the site with respect to the Central Plateau land-use boundary and consideration for the site containing TSD components. Contaminants present at concentrations exceeding these risk-based standards will be considered further in the risk-assessment process. Risks from nonradiological noncarcinogens will be evaluated by calculating hazard quotients for individual constituents and a hazard index for cumulative risk. Risks from nonradiological carcinogens and radionuclides will be evaluated by calculating incremental cancer risks for individual constituents and a cumulative cancer risk.

The RESidual RADioactivity (RESRAD) computer program (ANL, 2002, *RESRAD for Windows*, Version 6.21) will be used to obtain risk and dose estimates from direct-contact exposure to radiological constituents present in the shallow zone of the waste sites. The RESRAD transport model also will be used to obtain risk and dose estimates for the protection of the groundwater pathway. Additional analysis may be performed using other appropriate fate and transport models (e.g., PNNL-12028, *STOMP Subsurface Transport Over Multiple Phases, Version 2.0, Application Guide*) to assess impact to the groundwater from chemicals and radionuclides in the vadose zone (in accordance with WAC 173-340-747(8), "Deriving Soil Concentrations for Ground Water Protection," "Alternative Fate and Transport Models").

5.4.3.3 Additional Risk-Assessment Information

For those 200-IS-1 OU pipeline systems and waste sites located inside the Core Zone, risk assessment will be performed for an industrial-exposure scenario to establish the baseline risk. As part of the FS, additional risk assessment for informational purposes may be performed to evaluate other scenarios, such as a Native American scenario or an intruder scenario, to evaluate postremediation residual risks.

The pipelines (including interior contents) and surrounding soil composing each process waste-stream bin will be evaluated in the risk assessment. The pipelines in each bin, with the exception of tank-farm waste-transfer pipelines, will be considered as one entire unit in risk calculations. Tank farm waste-transfer pipelines are considered too heterogeneous for unit risk application. Subdivision of Bins 1-5 may be necessary in some instances because of unique, facility-specific, heterogeneity.

Contaminant concentrations, distribution, and pathway availability will be evaluated. Analytical data and hydrogeologic information used in risk calculations include the following:

- Laboratory analytical results from sampled media
- Waste-site configuration and construction (multiple pipelines within a sealed encasement or direct-buried single pipelines)
- Depth of burial (above or below the 4.6 m [15-ft] direct human-exposure point of compliance) (in accordance with WAC 173-340-745(5)(b), "Soil Cleanup Standards for Industrial Properties," "Method C Industrial Soil Cleanup Levels," or WAC 173-340-740(3)(b), "Unrestricted Land Use Soil Cleanup Standards," "Method B Soil Cleanup Levels for Unrestricted Land Use," "Standard Method B Soil Cleanup Levels," as appropriate).
- Known or estimated volume of a waste stream released in relation to the available pore volume of soil underlying the pipeline
- Types and amounts of contaminants transferred by the pipeline and associated structure; contaminant inventory
- Release mechanism (minor isolated cracks or breaks or major discontinuities and breaks throughout the line)
- Expected distribution of contamination based on configuration of the pipeline structure
- Geological setting

- Neighboring waste sites, structures, or utilities
- Potential for hydrologic and contaminant impacts to groundwater.

Information and assessments completed for each pipeline bin as part of the RI will be incorporated into the FS. Results of the risk assessment will be used to support the evaluation and selection of the appropriate remedial action. The characterization data that will be compiled during Phases 1 and 2 of the RI should provide sufficient information to select remedies for each pipeline-system bin. Following remedial action, additional data collection will be performed as needed to verify achievement of cleanup goals. For sites that are candidates for a removal action, final verification sampling results will provide sufficient data to document that cleanup levels specified in the ROD have been achieved.

5.4.4 Ecological Evaluation and Risk Assessment

The screening-level ecological risk assessment in DOE/RL-2001-54 is meant to be a conservative evaluation of risk to ecological receptors from stressors, in this case, introduction of contaminants and habitat elimination. The screening-level ecological risk assessment identifies pathways for ecological receptors to be exposed to the contamination and evaluates potential risk from those exposures.

While the 200-IS-1 OU RI will include the screening of contaminants against ecological soil protection values, the ecological risk assessment being performed for the Central Plateau will stand as the ecological risk assessment for the 200-IS-1 OU.

5.4.5 Treatability Studies Needs

In conjunction with the RI data compilation and assessment, the FS activities will be initiated and will include the identification of applicable remedial alternatives. The need to conduct treatability studies will be evaluated as part of the RI process. Treatability studies may be required to verify the feasibility of a technology, cost of a remedy, or applicability of a technology or action under different site conditions. An initial treatability study need was identified. Costs for implementation of the remedial actions being considered will be obtained from completed projects in other parts of the Hanford Site (e.g., 100 or 300 Areas, 200-UW-1 OU pipeline removal) or at other DOE facilities.

Facilities Process-Waste Pipelines

Phase 1 RI characterization activities are expected to provide additional information that may contribute or be used in lieu of treatability studies needed to complete the FS. Information obtained during Phase 1 characterization activities will provide important information concerning the existing condition of the buried pipelines, level of effort and costs to acquire data, and worker-exposure conditions that will be associated with certain remedies.

5.5 FEASIBILITY STUDY/CLOSURE PLAN

After completion of the RI, remediation alternatives and closure strategies identified in this work plan will be more fully developed and will be evaluated against RCRA closure performance standards and the CERCLA nine criteria (40 CFR 300.430(e)(9)(iii), "Remedial Investigation/Feasibility Study and Selection of Remedy," "Feasibility Study," "Detailed Analysis of Alternatives," "Nine Criteria for Evaluation") in the FS and appended RCRA TSD unit closure plans. The FS process consists of the following steps.

1. Define remedial-action objectives and RCRA closure and RCRA corrective action performance standards.
2. Identify general response actions to satisfy remedial-action objectives.
3. Identify potential technologies and process options associated with each general response action.
4. Screen the process options to select a representative process for each type of technology based on its effectiveness, implementability, and cost.
5. Assemble viable technologies or process options into alternatives representing a range of treatment and containment, plus a no-action alternative.
6. Evaluate alternatives and present information needed to support remedy selection and RCRA closure of the unit, pursuant to Hanford Facility RCRA Permit, Condition II.K (WA 7890008967).

5.5.1 Remedial-Action Alternatives

Potential remedial-action alternatives that have been identified for the 200-IS-1 OU waste sites include the following:

- No-action alternative
- Excavation and disposal of waste
- Excavation with treatment and disposal
- In situ treatment (stabilization)
- Maintain existing soil cover/institutional controls/monitored natural attenuation.

Sections of pipelines and many of the diversion boxes that are part of the 200-IS-1 OU are located in areas where the use of a cap/barrier may be proposed for remedial actions that will be undertaken by another OU or project to address facilities, WMAs, and/or other waste sites. Evaluation of remedial alternatives for the 200-IS-1 OU waste sites will consider the benefits of these proposed barriers and how remedial strategies and decisions can be integrated.

A summary of each of these potential alternatives as it would apply to the 200-IS-1 OU waste sites is provided below. Two principal categories of remedial alternative currently are identified, those actions that require removal and those that entail in-place remedies. In-place remedies would include in situ treatment (stabilization), or maintaining an existing soil cover if already present, with institutional controls.

5.5.1.1 No Action

Title 40 CFR 300 requires that a no-action alternative be evaluated as a baseline for comparison with other remedial alternatives. The no-action alternative represents a situation where no legal restrictions, access controls, or active remedial measures are applied to the site. No action implies allowing the wastes to remain in the current configuration, thus being affected only by natural processes. No maintenance or other activities will be instituted or continued. Selecting the no-action alternative would require that a waste site pose no unacceptable threat to human health or the environment.

5.5.1.2 Maintain Existing Soil Cover/Institutional Controls/Monitored Natural Attenuation

Under this alternative, the existing soil cover on a waste site is maintained and/or augmented as needed to provide protection from intrusion by biological receptors, along with legal barriers (e.g., deed restrictions, excavation permits) and physical barriers (e.g., fencing) that would mitigate contaminant exposure. Radioactive contaminants remaining beneath the clean soil cover are allowed to decay in place (i.e., to attenuate naturally), thereby reducing risk until remediation goals are met. This alternative may be preferable in the following circumstances:

- When contaminant concentrations are very close to remedial goals
- For contaminants that naturally attenuate and are not mobile in the environment
- For contaminants that may be mobile but attenuate/decay before impacting the environment
- When the cost to remediate does not gain a comparable amount of risk reduction
- When the cost for active remediation (e.g., remove and dispose, capping) is prohibitive.

For sites having a clean soil cover of less than 4.6 m (15 ft), more stringent institutional controls (e.g., physical and legal barriers, biological monitoring, removal of deeply rooted plants, control of deep-burrowing animals) will need to be implemented. Water- and land-use restrictions also will be used to prevent exposure.

Natural attenuation relies on natural processes to lower contaminant concentrations until cleanup levels are met. Monitored natural attenuation includes sampling and/or environmental monitoring, consistent with EPA/540/R-99/006, *Radiation Risk Assessment at CERCLA Sites: Q&A*, OSWER 9200.4-31P, to verify that contaminants are attenuating as expected and to ensure that contaminants remain isolated (e.g., will not lead to degradation of groundwater or be released to air or biota). Attenuation monitoring activities could include monitoring of the vadose zone using geophysical logging methods or groundwater monitoring to verify that natural attenuation processes are effective. Monitoring of groundwater may be required near sites with mobile contaminants left in place, to verify that groundwater is not being impacted.

5.5.1.3 Removal, Treatment, and Disposal

Remedial alternatives will be evaluated that may involve different combinations of remove, treat, and dispose actions, depending on site conditions. Consideration of radionuclide composition and activity, remediation-worker exposure hazards, and available disposal pathways will have a significant influence on remedy selection. Removal activities will involve excavation of soil and structures. Treatment may include in situ or ex situ operations. Treatment technologies involving in-place stabilization or postremoval stabilization will be evaluated. Additional discussion on the application of these potential actions is discussed below.

- Removal and Disposal:

  Structures and soil with contaminant concentrations above the preliminary remediation goals would be removed using conventional techniques and would be disposed of at an approved disposal facility, most likely the Environmental Restoration Disposal Facility, or at an offsite facility if transuranic constituents are involved. The depth and, therefore, the volume of soil removed largely will depend on which categories of preliminary remediation goals are exceeded. For example, if human-health direct-contact or ecological preliminary remediation goals are exceeded, removals would be conducted to a maximum of 4.6 m (15 ft). Conversely, if groundwater protection is required, soils (to the extent practicable) would be removed to meet groundwater-protection preliminary remediation goals. A decision logic would be developed, with criteria used to determine if belowgrade structures (e.g., pipelines, diversion boxes, catch tanks) that extend deeper than 4.6 m (15 ft) would be removed. Decision inputs would include results of fate and transport modeling (in accordance with WAC 173-340-747(8), risk assessment, and regulatory requirements).

  The remediation of sites under the remove-and-dispose alternative would be guided by the observational approach. The observational approach is a method of planning, designing, and implementing a remedial action that relies on information (e.g., samples) collected during remediation to guide the direction and scope of the activity. Data collected are used to assess the extent of contamination and to make real-time decisions in the field. Targeted (or hot-spot) removals could be considered under this alternative if contamination is localized in only a portion of a waste site.

  Radioactive waste will require special-handling protocols. Remote-controlled equipment and containment structures may be necessary if removal actions involve high-activity waste. Removal actions using the observational approach do not require that the precise extent of contamination be known before excavation; rather, the extent of contamination is assessed as the excavation proceeds, and the extent of remediation is adjusted accordingly. In this alternative, soils will be removed until the preliminary remediation goals are achieved to a maximum depth of 4.6 m (15 ft). In some cases, deeper depths of removal, as agreed upon with the regulators, may be required where removal of an engineered structure is required. If previously unanticipated contamination above the preliminary remediation goals is discovered, the extent of remediation may be increased following consultation with the Tri-Parties. A decision to excavate to a greater depth to protect groundwater (i.e., if required to meet groundwater maximum contaminant levels) would depend on factors such as the cost of further remediation, amount of risk reduction achieved, volume of soil generated, availability of disposal-facility capacity, impacts on cultural and ecological resources, logistics and interference with other onsite activities/structures, worker safety issues, and implementability of the excavation for the deeper contamination.

- Removal with Ex Situ Treatment and Disposal:

  Low-level radioactive waste and/or hazardous waste are acceptable for disposal at the Environmental Restoration Disposal Facility in accordance with the waste-acceptance criteria (BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*). For certain removal actions involving moderate- or high-activity radiological or mixed waste, ex situ treatment may be required to meet disposal requirements. For this waste, treatment technologies will be identified to meet potential disposal requirements.

- In Situ Treatment with Removal and Disposal:

  Stabilization of residual liquids in pipelines may be required before removal actions are initiated at some waste sites. Injection or pumping of specially formulated grout mixtures designed to encapsulate and stabilize any residual liquids will be considered as a remedial alternative. In situ treatment before removal also will be evaluated for worker-safety, waste-handling, and waste-disposal considerations.

- In Situ Treatment:

  Some pipeline segments may have attributes where application of an in situ treatment technology would be an appropriate remedy. This remedy may be applicable to pipelines that have sorbed contaminants (e.g., vitrified clay pipeline) or that have accumulated a significant build-up of scale or other residual material inside the pipe that would be difficult to remove. Leaking pipelines also may have a localized accumulation of contaminated soil concentrated near the structure. Currently identified in situ treatment technologies consist of grout injection/pumping into a pipeline and/or the surrounding soil and vitrification. For grouting, chemical fixation agents would be mixed with the grout and used to stabilize local contamination. In situ vitrification techniques will be evaluated for situations where a mechanism needs to be considered to stabilize high-activity and/or transuranic-containing materials. These stabilization techniques would be remedial alternatives for those locations where the exposure-pathway assessment identified groundwater as a potentially impacted medium.

  Placement of a plug of material is anticipated to be sufficient to isolate the structure in some pipeline locations. These situations currently are being associated with those pipelines that have been identified where a segment of the line will be positioned under a proposed barrier.

  Certain pipeline segments where the constructed materials have shown no tendency to sorb chemical constituents (e.g., stainless-steel pipelines) only may require application of a decontamination procedure. Flushing of residual constituents (e.g., liquids, sediments, sludge) may be sufficient action to remove contaminants and eliminate future exposure concerns.

5.5.2 Remedial Alternatives, Performance Standards, and Selection Criteria

During the detailed analysis, each alternative will be evaluated against the following CERCLA criteria (40 CFR 300.430(e)(9)(iii)):

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

The first two criteria are considered threshold criteria, which the remedial alternatives being evaluated must meet. The next five criteria are considered balancing criteria, which are used to assist in selecting the most appropriate remedial alternative. The last two criteria are considered modifying criteria, which are used to assist in finalizing the selection of a remedial alternative. The modifying criterion of State acceptance will be documented in the ROD. The final modifying criterion, community acceptance, will be applied following the FS during the proposed plan and ROD phase.

The *National Environmental Policy Act of 1969* values will be evaluated and incorporated into the FS as part of DOE's statutory responsibility under the *National Environmental Policy Act of 1969*. These values include impacts to natural, cultural, and historical resources; socioeconomic aspects; and irreversible and irretrievable commitments of resources.

The RCRA closure performance standards (WAC 173-303-610[2], "Closure and Post-Closure," "Closure Performance Standard") will be used to evaluate the ability of alternatives to comply with RCRA closure requirements. These standards require the closure of TSD units in a manner that achieves the following:

- Minimizes the need for further maintenance

- Controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, postclosure escape of dangerous waste, dangerous-waste constituents, leachate, contaminated run-off, or dangerous-waste decomposition products to the ground, surface water, groundwater, or the atmosphere

- Returns the land to the appearance and use of surrounding land areas to the degree possible, given the nature of the previous dangerous-waste activity.

In addition, RCRA corrective-action performance standards (WAC 173-303-64620, "Closure and Post-Closure," "Corrective Action," "Requirements") will be used to evaluate how well the alternatives comply with RCRA corrective-action requirements. These standards state that corrective action must achieve the following:

- Protect human health and the environment for all releases of dangerous waste and dangerous constituents, including releases from all solid-waste management units at the facility
- Occur regardless of the time at which waste was managed at the facility or placed in such units, and regardless of whether such facilities or unit were intended for the management of solid or dangerous waste
- Be implemented by the owner/operator beyond the facility boundary where necessary to protect human health and the environment.

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

- Summarize the RI, including the nature and extent of contamination, the contaminant-distribution models, and an assessment of the risks to help establish the need for remediation and to estimate the volume of contaminated media.
- Refine the conceptual exposure-pathway model to identify pathways that might need to be addressed by remedial action.
- Provide a detailed evaluation of potential ARARs, beginning with potential ARARs identified in the Implementation Plan (DOE/RL-98-28, Chapter 4.0).
- Refine potential remedial-action objectives and preliminary remediation goals identified in the Implementation Plan (DOE/RL-98-28, Chapter 5.0), based on the results of the RI, ARAR evaluation, and current land-use considerations.
- Refine the list of remedial alternatives, identified in the Implementation Plan (DOE/RL-98-28, Appendix D) and in this section, based on the RI.
- Provide corrective-action recommendations for RPPs to fulfill the requirements for a CMS report.
- Include as appendices or separate documents, closure plans to address RCRA TSD units in the OU. The closure plans may incorporate, by reference, specific sections of the work plan or RI report containing specific closure-plan information. The closure plans will include closure performance standards, a closure strategy, general closure activities including verification sampling, and a general postclosure plan.

Additional RCRA integration guidance for preparing an FS/closure plan is provided in DOE/RL-98-28, Section 2.4.

5.6 FEASIBILITY STUDY/CLOSURE PLAN

Remedial actions in the Central Plateau are being investigated and evaluated on an OU-by-OU basis, as defined in 40 CFR 300, 40 CFR 300.430, and the Tri-Party Agreement Acton Plan (Ecology et al., 1989b). To provide flexibility for implementing remedial actions, alternative methods for remediation of Central Plateau waste-site groupings will be considered. Several alternatives currently are under consideration, some of which may be used for the waste sites addressed in this work plan. Three alternatives have been identified to provide flexibility in the decision-making process, facilitate early action, and remediate and close specific areas or zones. Examples of these remedial alternatives are presented below: high-risk waste sites identified by grouping, regional-site closure, and waste-site grouping by characteristics or hazards.

5.6.1 Waste Sites Identified for Early Action

This remedial alternative accelerates the start of remedial actions and closure of waste sites that present an ongoing or expected future threat to groundwater. Some Central Plateau high-risk sites already have been identified for early actions near the U Plant, PUREX Plant, and Plutonium Finishing Plant. These sites will be included in proposed plans and RODs that promote early action. Waste sites also may be identified that would be appropriate for implementing an expedited response action. A "Time Critical Removal Action" could be used to streamline the cleanup and close-out process for selected waste sites. This approach has been used at the U Plant for the 200-W-42 Pipeline removal.

5.6.2 Regional-Site Closure

Waste-site remedial decision making may be adjusted under a regional-closure strategy that aligns waste sites into groups defined by geographical zones. Under this strategy, waste sites in a geographical area may be remediated as a group, even though they may be in different OUs. A strategy to implement this regional-closure alternative is being developed for the Central Plateau and has been completed for the U Plant.

5.6.3 Waste-Site Grouping by Characteristics or Hazards

A third example of a remedial alternative is based on a specific characteristic or hazard that mandates additional requirements, such as supplemental ARARs or more robust remedial alternatives. For example, some pipelines and structures in the 200-IS-1 OU are suspected to contain concentrations of transuranic radionuclides in excess of the 100 nCi/g concentration limit for designation as transuranic constituents. Sites containing concentrations of transuranic radionuclides above 100 nCi/g may require selective removal actions or more protective barrier designs to prevent intrusion, based on this particular hazard. Such alternatives might not be required for other process-condensate or process-waste pipelines in the 200-IS-1 OU, where only low-to-moderate levels of radionuclides occur. Grouping certain pipelines or structures (e.g., diversion boxes, catch tanks) with similarly contaminated soil sites (e.g., cribs and trenches) in other OUs could streamline the decision-making process and tailor the requirements and alternatives to these specific hazards.

Along with the completion of the FS/closure plan, a proposed plan will be prepared that identifies the preferred remedial alternative for the OU. The preferred remedial alternative will include RCRA-closure and corrective-action requirements. In addition to identifying the preferred alternative, the proposed plan will serve the following purposes.

- Summarize the completed RI/FS.
- Provide criteria by which waste sites in the OU will be evaluated after issuance of the ROD to confirm that the contaminant distribution model for the site is consistent with the preferred alternative. Contingencies to move a waste site to a more appropriate waste group also will be developed.
- Identify performance standards and ARARs applicable to the OUs.

After the public-review process is complete, the lead regulatory agency will make a final decision on the remedial action to be taken. The decision will be documented in a ROD and the Hanford Facility RCRA Permit (WA7890008967) will be modified to incorporate the ROD (and subsequent amendments) by reference, authorizing the RCRA actions.

5.7 REMEDY SELECTION, RECORD OF DECISION, RCRA PERMIT MODIFICATION, AND POST-RECORD OF DECISION ACTIVITIES

5.7.1 Remedy Selection, Record of Decision, RCRA Permit Modification

Once the FS process for remedial-alternative evaluation for the waste sites in the 200-IS-1 OU has been completed, a proposed plan will be developed that contains a summary of the key elements of the FS and presents the recommended selected remedies for the OU. The proposed plan will indicate that a draft permit modification also is being conducted, with unit-specific permit conditions for RPPs and the RCRA TSD units and components for incorporation into the Hanford Facility RCRA Permit (WA7890008967).

This proposed plan will undergo a public review and comment process (40 CFR 300.430(f)(3), "Remedial Investigation/Feasibility Study and Selection of Remedy"). After the public-comment period has been completed, a ROD will prepared (40 CFR 300.430(f)(5), "Remedial Investigation/Feasibility Study and Selection of Remedy," "Selection of Remedy," "Documenting the Decision") that documents the remedial-action decisions for the OU and the responses to the public comments. Development of a ROD that supports elements of the "plug-in" approach and use of a contingent or alternate remedy will be evaluated. Design of the ROD will be consistent with use of a process where waste-site attributes are confirmed before a remedial response is implemented.

The draft RCRA permit modification will go through a public involvement process as specified in WAC 173-303-830, "Permit Changes," in conjunction with the proposed plan. The draft permit modification will contain the closure plan for TSD units and the proposed selected remedy for RPP waste sites.

5.7.2 Post-Record of Decision Activities

After the ROD and Hanford Facility RCRA Permit (WA7890008967) modification have been issued, a remedial-design report and remedial-action work plan will be prepared to detail the scope of the remedial action, which will include RCRA closure and corrective-action requirements. As part of this activity, DQOs will be established and SAPs will be prepared to direct verification sampling and analysis. Before remediation begins, data necessary for the remedial design and to support future risk assessments will be obtained. Verification sampling will be performed after the remedial action is complete to determine if the ROD requirements have been met and if the remedy was effective. Additional guidance for verification sampling is provided in DOE/RL-98-28, Section 6.2.

The remedial-design report and remedial-action work plan will contain an integrated schedule of remediation activities for the OU, including the schedule for RCRA TSD unit closures, and will satisfy the requirements for an RPP corrective-measures implementation work plan and design report. The remedial-design report/remedial-action work plan, along with the proposed Tri-Party Agreement milestones, will be submitted 180 days after the ROD is signed. Remediation activities will be designed to ensure integration of CERCLA cleanup activities and RCRA corrective actions and closure. Following the completion of the remediation, closeout activities will be performed as specified in the ROD, remedial-design report and remedial-action work plan, and the Hanford Facility RCRA Permit.

Enforceable sections of the closure plan will be identified in the Hanford Facility RCRA Permit modification. The RCRA closure activities and schedules will be defined in the Hanford Facility RCRA Permit Modification and will be consistent with the closure plan. Certification of closure in accordance with WAC 173-303-610(6), "Closure and Post-Closure," "Certification of Closure," will be performed after cleanup actions are complete. The site will be restored as appropriate for future land use. If clean closure is not attained at a TSD unit, postclosure care requirements will be met. These requirements will include final-status groundwater monitoring, maintenance and monitoring of institutional controls and/or surface barriers, and certification of postclosure at the completion of the postclosure.

Fieldwork to implement the post-ROD SAPs and remediation of the waste site will follow the schedule as outlined in the remedial-design report and remedial-action work plan. An operations and maintenance plan will be prepared for implemented remedies that, while still protective of human health and the environment, leave contamination in place. Finally, closeout reports will be prepared to document that all of the remedial activities for the OU have been implemented in accordance with the approved CERCLA documents.

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The draft RCRA permit modification will go through a public involvement process as specified in WAC 173-303-830, "Permit Changes," in conjunction with the proposed plan. The draft permit modification will contain the closure plan for TSD units and the proposed selected remedy for RPP waste sites.

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After the ROD and Hanford Facility RCRA Permit (WA7890008967) modification have been issued, a remedial-design report and remedial-action work plan will be prepared to detail the scope of the remedial action, which will include RCRA closure and corrective-action requirements. As part of this activity, DQOs will be established and SAPs will be prepared to direct verification sampling and analysis. Before remediation begins, data necessary for the remedial design and to support future risk assessments will be obtained. Verification sampling will be performed after the remedial action is complete to determine if the ROD requirements have been met and if the remedy was effective. Additional guidance for verification sampling is provided in DOE/RL-98-28, Section 6.2.

The remedial-design report and remedial-action work plan will contain an integrated schedule of remediation activities for the OU, including the schedule for RCRA TSD unit closures, and will satisfy the requirements for an RPP corrective-measures implementation work plan and design report. The remedial-design report/remedial-action work plan, along with the proposed Tri-Party Agreement milestones, will be submitted 180 days after the ROD is signed. Remediation activities will be designed to ensure integration of CERCLA cleanup activities and RCRA corrective actions and closure. Following the completion of the remediation, closeout activities will be performed as specified in the ROD, remedial-design report and remedial-action work plan, and the Hanford Facility RCRA Permit.

Enforceable sections of the closure plan will be identified in the Hanford Facility RCRA Permit modification. The RCRA closure activities and schedules will be defined in the Hanford Facility RCRA Permit Modification and will be consistent with the closure plan. Certification of closure in accordance with WAC 173-303-610(6), "Closure and Post-Closure," "Certification of Closure," will be performed after cleanup actions are complete. The site will be restored as appropriate for future land use. If clean closure is not attained at a TSD unit, postclosure care requirements will be met. These requirements will include final-status groundwater monitoring, maintenance and monitoring of institutional controls and/or surface barriers, and certification of postclosure at the completion of the postclosure.

Fieldwork to implement the post-ROD SAPs and remediation of the waste site will follow the schedule as outlined in the remedial-design report and remedial-action work plan. An operations and maintenance plan will be prepared for implemented remedies that, while still protective of human health and the environment, leave contamination in place. Finally, closeout reports will be prepared to document that all of the remedial activities for the OU have been implemented in accordance with the approved CERCLA documents.

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6.0 PROJECT SCHEDULE

The project schedule for activities discussed in this work plan are provided in Table 6-1. This schedule was prepared using periods outlined in the Tri-Party Agreement (Ecology et al., 1989a) and a two-phase field-investigation approach.

The schedule will be evaluated to identify efficiencies; however, the duration of the Phase 2 work will not be known until the Phase 1 data are evaluated. This schedule will serve as the baseline for the work-planning process and will be used to measure the progress of implementing this work plan. The portions of the schedule most germane to this work plan and the attached SAPs are fiscal year 2008 and fiscal year 2009. The schedule concludes with the submittal of the Phase 2 work plan. The Hanford Facility RCRA Permit (WA7890008967) will be modified after the ROD is issued, during Ecology's annual modification process.

This schedule covers the following:

- Submittal of the Revision 1 Draft B RI/FS work plan
- Review and approval of the work plan(s)
- Field work associated with the characterization of the 200-IS-1 OU waste units for Phase 1
- Laboratory analysis for Phase 1
- Management of investigation-derived waste for Phase 1
- Submittal of a modified work plan/SAP for Phase 2 facilities pipelines and associated soil
- Closure plan for the 241-CX-70, 241-CX-71, and 241-CX-72 Tanks.

Interim milestones to be designated under the Tri-Party Agreement will be established through negotiations among the Tri-Parties. A Class II change form will be submitted to Ecology to request the addition of any interim milestones. Any updates to the project schedule or associated milestones will be discussed at the monthly unit managers' meeting prior to implementing the updates. One of the Tri-Party Agreement milestones (M-020-27) associated with this project was met on November 25, 1992. Submission of this work plan meets Tri-Party Agreement Milestone M-013-27, "Submit a revised RI/FS work plan for the 200-IS-1 and 200-ST-1 OUs to Ecology to identify likely response scenarios and potentially applicable technologies, identify the need for treatability investigations, and include sampling and analysis plans by June 30, 2007."

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Table 6-1. Project Schedule for 200-IS-1 Operable Unit Pipelines.

Activity	Start	Finish
Project Management	10/01/06	12/31/11
Work Plan	10/01/06	02/08/08
Issue Rev. 1 Draft B Work Plan – Tri-Party Agreement Milestone M-013-27		06/30/07
Ecology Review Work Plan	07/01/07	08/29/07
Comment Resolution	08/30/07	09/28/07
Finalize Work Plan and Obtain Ecology Approval	10/01/07	01/14/08
Phase 1 Field Investigation	01/21/08	09/18/09
Pipelines and Soils Investigations	01/21/08	08/31/09
241-CX-72 Storage Tank Investigation	01/21/08	06/06/08
Management of Investigation-Derived Waste	01/21/08	11/18/09
Lab Analysis and Data Validation Pipeline and Soils	01/21/08	10/31/09
Lab Analysis and Data Validation 241-CX-72 Storage Tank	01/21/08	10/22/08
Submit 241-CX-70, 241-CX-71, and 241-CX-72 Tank Closure Plan – Tri-Party Agreement Milestone M-020-54	06/01/08	12/31/08
Modify Existing Work Plan and/or Sampling and Analysis Plan(s) Phase 2 Pipelines and Associated Soil	12/19/08	12/31/09
Issue Phase 2 Work Plan for Review	12/19/08	12/31/09

Ecology = Washington State Department of Ecology.
Tri-Party Agreement = *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989a).

Other Tri-Party Agreement milestones associated with this work plan are as follows:

- M-020-54, "Submit Closure Plan for 241-CX-70, 241-CX-71, and 241-CX-72 Tanks for Regulatory Review: December 31, 2008"
- M-015-00, "Complete RI/FS (or RFI/CMS) Process for All Operable Units: December 31, 2011."

The following is the proposed project milestone-completion date for the key activity:

- Modify Existing Work Plan and/or Sampling and Analysis Plan(s) for Facilities Phase 2 Pipelines and Associated Soil: December 31, 2009.

A separate closure plan for the 241-CX-70 Storage Tank, 241-CX-71 Neutralization Tank, and 241-CX-72 Storage Tank will be submitted. An RI/FS report for process pipelines and appurtenances and a proposed plan will be generated for the 200-IS-1 OU. The report will meet the site-specific RI/FS objectives. In general, the RI/FS will assess data that have been collected at the time of report preparation (generally, it is anticipated that available information will include Phase 1 and available Phase II characterization information). The assessment will be used to define source areas of contamination; to assess the potential pathways of migration and the potential receptors and associated exposure pathways to the extent necessary to determine whether, or to what extent, a threat to human health or the environment exists; and to develop/evaluate remedial alternatives (including the no-action alternative). The RI/FS will present alternatives that will provide decision makers with a range of options and information to compare alternatives against one another. A general description of ranges for source-control response actions will be developed based on the site-specific information available. A detailed and comparative analysis of remedial alternatives will be assessed against available site-specific information. This information will be used to develop various conceptual models (i.e., pre-defined conditions, such as concentrations, depth, and treatability of contaminants, for various pipeline groups) that will be applied to the remedial alternatives. Through the comparative analysis of alternatives, it is expected that these conceptual models may result in selection of different remedies for different pipeline groupings (e.g., removal, treatment and leave-in place, or leave-in-place). The RI/FS also may define how the determination of the selected remedy will be made at each site, such as through amendments to the ROD.

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7.0 REFERENCES

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10 CFR 61.55, "Licensing Requirements for Land Disposal of Radioactive Waste," "Waste Classification," Title 10, *Code of Federal Regulations*, Part 61.55, as amended.

29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response," Title 29, *Code of Federal Regulations*, Part 1910.120, as amended.

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40 CFR 300.430(e)(9)(iii), "Remedial Investigation/Feasibility Study and Selection of Remedy," "Feasibility Study," "Detailed Analysis of Alternatives," "Nine Criteria for Evaluation," Title 40, *Code of Federal Regulations*, Part 300.430(e), as amended.

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APPENDIX A

SAMPLING AND ANALYSIS PLAN FOR THE PHASE 1 CHARACTERIZATION OF THE FACILITY PROCESS-WASTE PIPELINE SYSTEMS

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CONTENTS

ATTACHMENT

FIGURES

TABLES

TERMS

AA	alternative action
AEA	alpha energy analysis
aG	amber glass
ALARA	as low as reasonably achievable
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CI	cast iron
CM	corrugated metal
COPC	contaminant of potential concern
CS	carbon steel
CUL	cleanup level
CVAA	cold vapor atomic absorption
CZ	contamination zone
d/min	disintegrations per minute
DP	diversion pit
DQO	data quality objective
DR	decision rule
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FRE	fiberglass-reinforced epoxy
FS	feasibility study
G	glass
GC	gas chromatograph
GS	gamma spectroscopy
HEIS	*Hanford Environmental Information System* database
HPGe	high-purity germanium
IC	ion chromatograph
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma/mass spectrometry
IDW	investigation-derived waste
LSC	liquid scintillation counter
M-2	stainless steel
M-35	carbon steel
MEK	methyl ethyl ketone
MH	manhole
N/A	not applicable
NAD83	*North American Datum of 1983*
NaI	sodium iodide
NWTPH	Northwest total petroleum hydrocarbon
OU	operable unit
P	plastic
PCB	polychlorinated biphenyl

PFP	Plutonium Finishing Plant
PL	pipeline
PSQ	principal study question
PUREX	Plutonium-Uranium Extraction (Plant or process)
QAPjP	quality assurance project plan
QC	quality control
REDOX	Reduction-Oxidation (Plant or process)
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
SAP	sampling and analysis plan
SGL	spectral gamma logging
SP	sampler pit
SS	stainless steel
SST	single-shell tank
Stl	steel
SVOA	semivolatile organic analyte
TBD	to be determined
TBP	tributyl phosphate
TOC	total organic carbon
TPH	total petroleum hydrocarbon
URMA	Underground Radioactive Management Area
VC	vitrified clay
VOA	volatile organic analyte
VOC	volatile organic compound
WAC	*Washington Administrative Code*
WIDS	*Waste Information Data System* database
WMA	waste management area

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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APPENDIX A

SAMPLING AND ANALYSIS PLAN FOR THE PHASE 1 CHARACTERIZATION OF THE FACILITY PROCESS-WASTE PIPELINE SYSTEMS

A1.0 INTRODUCTION

This sampling plan and analysis plan (SAP) encompasses the first phase of a two-phased sampling approach for the 200-IS-1 Operable Unit (OU) pipeline systems. This Phase 1 SAP directs the characterization activities for the interior of selected pipelines and vadose-zone soil adjacent to pipelines associated with facility process-waste pipelines. Sampling and analysis requirements for tank-farm waste-transfer pipelines are discussed in the SAP included in Appendix B.

This SAP includes specifications for the evaluation of 30 interior pipeline locations, 68 direct-push soil locations for geophysical logging, and 40 soil-sampling locations. Contaminant levels will be evaluated in the interior of each pipeline at three separate locations along its length. To evaluate whether contamination in surrounding soil has occurred, geophysical logging and sampling will be conducted in two areas along each selected pipeline. Direct-push technology will be used to drive small-diameter casing needed for soil investigations. Each soil-sampling area includes completion of two direct-push installations, one on each side of the pipeline. The objective of Phase 1 characterization is to determine if contaminant concentrations are above preliminary cleanup levels.

Both field-screening techniques and laboratory analytical methods will be used for analysis. As part of the preparation of this SAP, information was compiled concerning waste-stream characteristics (chemical and radiological composition) and analytical results from samples collected at the disposal sites that received waste through those pipelines that are under investigation. This information, summarized in the Attachment, was used to identify specific constituents (e.g., hexavalent chromium, mercury, nitrate, Cs-137) or classes of compounds (e.g., volatile organic compounds [VOC], polyaromatic hydrocarbons, polycholorinated biphenyls [PCB]) that would be appropriate target compounds for field-screening analyses.

A second phase of sampling and analyses will be undertaken if additional data are needed for the 200-IS-1 OU pipelines after review of the Phase 1 results. The field-investigation objectives for Phase 2 entail collection of sufficient data for remedial decision-making, including a no-action decision. Data-collection objectives for both phases were developed during the data quality objectives (DQO) process for 200-IS-1 OU pipeline systems. The sampling design for this subsequent phase will be presented in a Phase 2 SAP that will be included as an amendment to this Phase 1 SAP.

The sampling and analyses described in this document will provide data to refine the conceptual contaminant-distribution models, support an assessment of risk, and evaluate remedial alternatives for the facility process-waste pipeline systems. Characterization activities described in this SAP are based on implementing the DQO process. General sampling-design parameters and the objectives for Phase 1 are presented in D&D-30262, *Data Quality Objectives Summary Report for the 200-IS-1 Operable Unit Pipelines and Appurtenances*.

Chapter A1.0 of this SAP provides an overview of the characterization activities to be completed and descriptions of the pipelines and adjacent soil areas to be investigated. Chapter A2.0 includes the content identified for inclusion in a Quality Assurance Project Plan (QAPjP), as outlined in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5. The structure and headings in Chapter A2.0 follow the format defined in the U.S. Environmental Protection Agency (EPA) guidance. Chapter A3.0 presents the field-sampling plan, which describes the sampling objectives, characterization approach, and field investigations to be performed. Chapter A4.0 discusses health and safety, and Chapter A5.0 provides information on the management of investigation-derived waste (IDW).

A1.1 PIPELINE DESCRIPTIONS AND HISTORY

The 200-IS-1 OU includes pipelines and appurtenance located in the 200 East and 200 West Areas on the Hanford Site in south-central Washington State. The majority of the pipelines being evaluated in this SAP are located within the exclusive land-use boundary identified in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*.

The following subsections provide a listing and brief description and history of the pipelines being evaluated in this SAP. The organization for the descriptions is by process waste-stream bin, indicating the primary and alternate pipelines that have been identified for evaluation. Information provided includes process-waste characteristics, general features of the pipeline, and summary information related to the liquid-waste disposal site that received the process waste via the pipeline. Historical information on operations pertaining to the disposal site often is pertinent to the attached pipeline that carried the waste. Process-waste streams associated with each pipeline bin are summarized in Table A-1. Figures A-1 (200 East Area) and A-2 (200 West Area) show the general locations of all of the pipelines discussed in this SAP and provide the figure numbers for the sample location maps. The detailed sample-location maps for each of the pipelines are presented in Chapter A2.0.

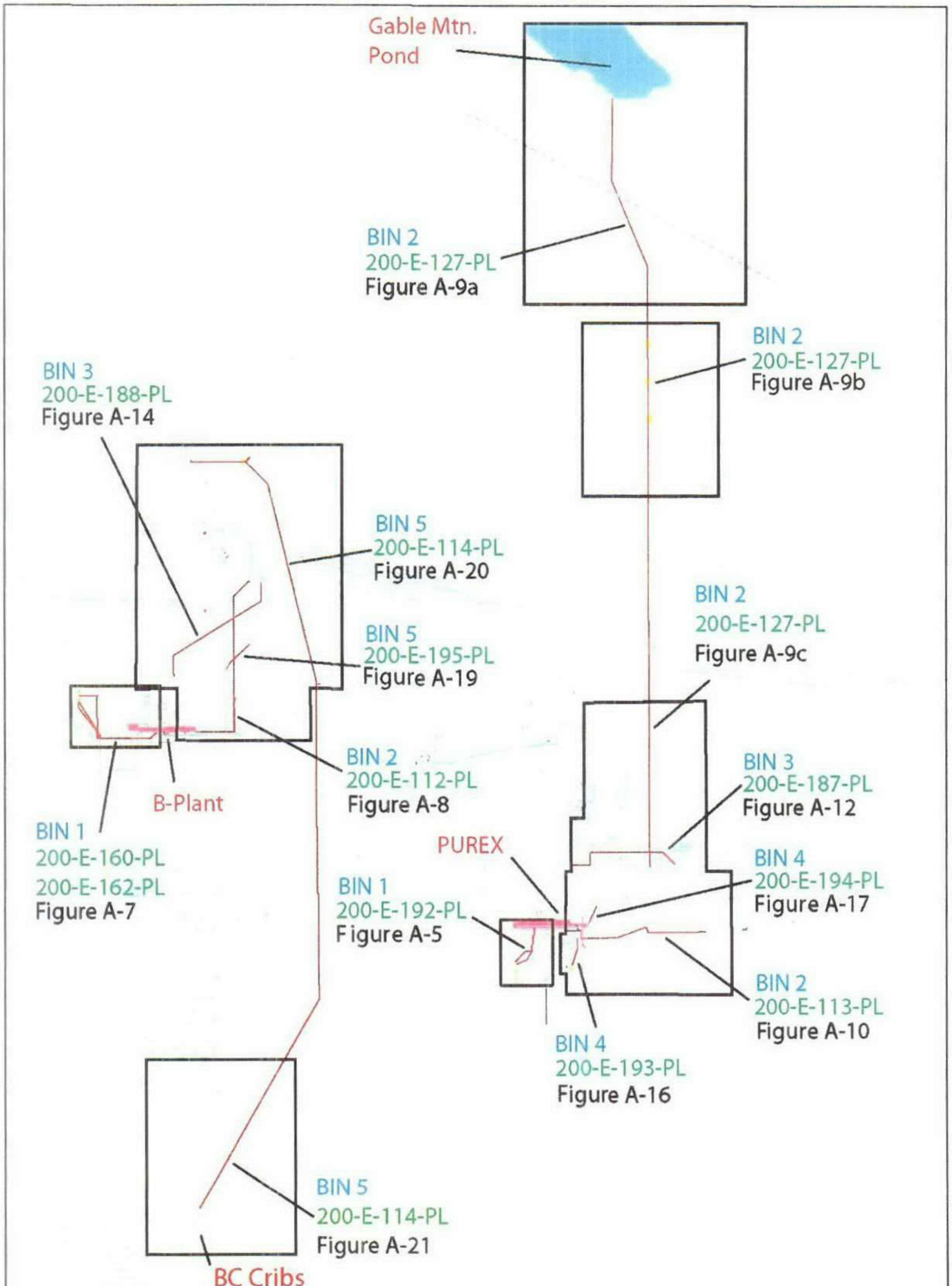
For each pipeline bin, alternate pipelines for characterization are indicated. The alternate pipelines are included to address the potential for encountering field conditions that would result in the candidate primary lines not being able to be investigated. Circumstances such as undocumented buried obstacles and worker health and safety issues could require use of the alternate pipelines for evaluation.

Up to four pipelines are identified per process waste-pipeline bin to accommodate the separate characterizations objectives for the interior of pipelines and for surrounding soils and inclusion of alternate pipelines.

Table A-1. Process Waste-Stream Bins for Facility Pipelines.

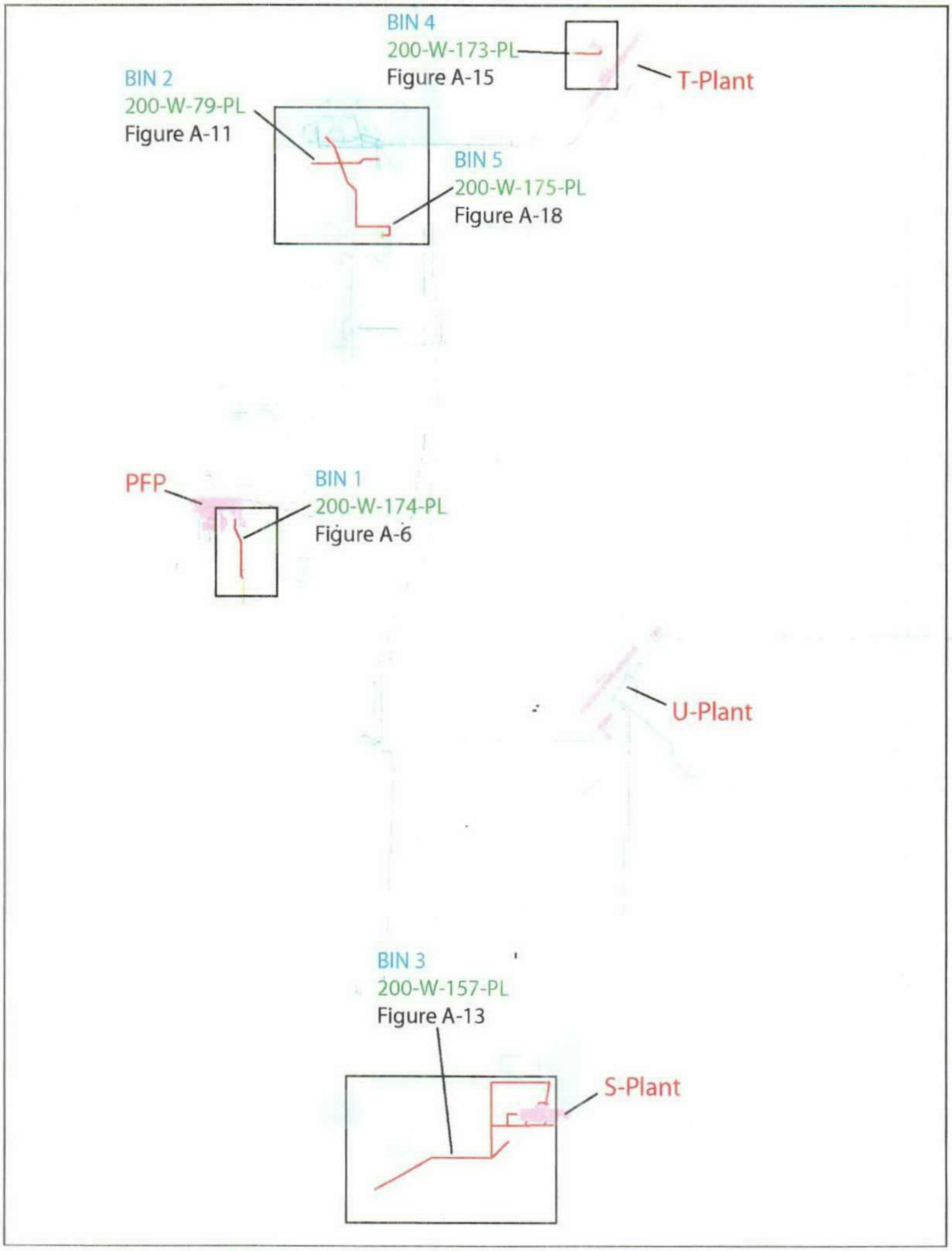
Bin Number	Waste Category	Waste Steam Description
1	Process Condensate and Process Waste (Waste streams associated with the 200-PW-1, -2, -3, -4, -5, and -6 Operable Units) Chemical Laboratory Waste (Waste streams associated with the 200-LW-1 and -2 Operable Units)	• Process condensate generally is water condensed from the closed process system and that was in direct contact with radioactive and chemical materials. • Process waste is low-level and/or hazardous waste that directly contacted radioactive material and that may contain organic complexants that could enhance their mobility. • Potential transuranic waste associated with the 200-PW-1, -2, and -6 Operable Unit waste streams. • CCl_4 associated with the 200-PW-1 Operable Unit waste stream. • Laboratory process wastes and/or laboratory decontamination waste streams that generally are low in radionuclides, although some have significant inventories of plutonium, uranium, and fission products. Liquid volumes typically are lower. • Potential transuranic waste associated with some 200-LW-2 Operable Unit waste streams.
2	Steam Condensate and Cooling Water (Waste streams associated with the 200-CW-1, -2, -3, -4, and -5 Operable Units and the 200-SC-1 Operable Unit)	• These waste streams were run in a noncontact manner; that is, a barrier separated the liquids in this category from contaminated process liquids, with little consequent potential for routine radiological contamination. However, contamination did enter these streams in generally negligible to very small quantities through pinhole leaks or through rare pipe ruptures. • Potential transuranic waste associated with the 200-CW-5 Operable Unit waste stream.
3	Chemical Sewer Waste (Waste streams associated with the 200-CS-1 Operable Unit)	• Chemical-sewer waste sites received solvent-extraction waste that was generally low in all radiological contaminants.
4	Miscellaneous Waste (Waste streams associated with the 200-MW-1 Operable Unit)	• Generally consists of waste streams low in radionuclide and chemical constituents. Waste streams associated with plant ventilation and stack drainage, equipment decontamination, and a number of small- to medium- volume radioactive waste streams from multiple sources. • The relationship of the 216-A-4 Crib's high radiological-constituent levels to the general waste characteristics of this group is uncertain
5	Tank/Scavenged Waste (Waste streams associated with the 200-TW-1 and -2 Operable Units)	• Consists of waste streams with relatively high concentrations of radiological constituents. These liquid wastes are associated directly or indirectly with tank wastes collected from the bismuth-phosphate process. • Potential transuranic waste associated with the 200-TW-2 Operable Unit waste stream.

1 Figure A-1. Index Map for Pipelines to be Sampled in the 200 East Area.



2

Figure A-2. Index Map for Pipelines to be Sampled in the 200 West Area.



A1.1.1 Pipelines Being Evaluated in Bin 1 (Process Condensate, Process Waste, and Laboratory Waste)

Pipeline Number: **200-E-192-PL**

Pipeline Sampling: Primary pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: PUREX 202-A Canyon Building; acidic (pH 1.0 to 2.5) process distillate/condensate discharge generated from two product concentrators.

Associated Liquid-Waste Site and OU: 216-A-10 Crib (200-PW-2)

Pipeline Description: This pipeline, located south of the PUREX Plant in the 200 East Area, is made up of two separate segments with separate pipeline identification numbers. One segment (200-E-192-PL:1) is an 8-in. vitrified clay (VC) pipe that extends from Proportional Sampler Pit #4 to the northern end of the 216-A-10 Crib, where it connects to the center-crib distribution line. The second pipeline segment (200-E-192-PL:2) is an 8-in. stainless steel (SS) pipe that extends from Proportional Sampler Pit #4 to near the northern part of the 216-A-10 Crib, where it connects to a second distribution line, east of the center-crib distribution line. The approximate combined total length of the two pipeline segments being evaluated is 173 m (568 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste disposal site (216-A-10 Crib) was operational from 1956 to 1987. In 1956, the site was used for testing purposes, using only nonradioactive water. From 1956 to November 1961, it was inactive. Beginning in November 1961, the site began receiving contaminated waste (process condensate) from the 202-A Canyon Building. On April 19, 1962, the clay distributor pipe to the crib collapsed and caused a surface depression. A new distributor (replacement) line was installed parallel to the collapsed line. The replacement line failed in 1966. The crib was active until January 1978, and then was inactive until October 1981, when it again began receiving acidic process condensate from the 202-A Canyon Building. The site stopped receiving waste on March 3, 1987, and was deactivated that month (Waste Information Data System [WIDS]).

Analytical results for soil samples collected from the 216-A-10 Crib are summarized in DOE/RL-2004-25, *Remedial Investigation Report for the 200-PW-2 Uranium-Rich Process Waste Group and 200-PW-4 General Process Condensate Group Operable Units*. Constituents and the maximum detected concentrations in the 216-A-10 Crib include Pu-238 (316 pCi/g), Pu-239/240 (7,100 pCi/g), Am-241 (1,320 pCi/g), Cs-137 (2,950 pCi/g), U-238 (1 pCi/g), Sr-90 (45 pCi/g), H-3 (835 pCi/g), oil & grease (59,400 mg/kg), tributyl phosphate (TBP) (2,000 mg/kg), and a few VOCs (less than 1 mg/kg) (see Table ATT-2).

Pipeline Number: **200-W-174-PL**

Pipeline Sampling: Primary pipeline for interior-pipe characterization and alternate pipeline for exterior-soil characterization.

Waste Stream, Source(s): Z Plant 234-5Z, 236-Z, and 242-Z facility operations; process-waste discharge (aqueous organic, americium, and uranium wastes).

Associated Liquid-Waste Site and OU: 216-Z-1A Tile Field (200-PW-1)

Pipeline Description: This waste-site pipeline is located south of the Plutonium Finishing Plant (PFP) in the 200 West Area, and extends from the PFP facility, at Building 234-5Z, to the northern end of the 216-Z-1A Tile Field. It primarily is made up of two 2-in. SS pipelines running in parallel. The two parallel SS pipes convert to one 8-in. VC pipe just north of the entry to the 216-Z-1A Tile Field. The approximate length of pipeline being evaluated is 173 m (568 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from 1949 to 1969. Originally it was constructed to receive liquid-waste overflow from the 216-Z-1 and 216-Z-2 Cribs. Later the cribs were bypassed, and the waste was routed directly to the 216-Z-1A Tile Field. The tile field was deactivated in 1969 (WIDS).

Analytical data for soil samples taken from the 216-Z-1A Tile Field are summarized in DOE/RL-2006-51, *Remedial Investigation Report for the Plutonium/Organic-Rich Process Condensate/Process Waste Group Operable Unit: Includes the 200-PW-1, 200-PW-3, and 200-PW-6 Operable Units*. Constituents and the maximum detected concentrations in the 216-Z-1A Tile Field include Pu-239/240 (38,200,000 pCi/g), Am-241 (2,590,000 pCi/g), Cs-137 (23 pCi/g), chromium (22 mg/kg), nitrate (250 mg/kg), carbon tetrachloride (7 mg/kg), chloroform (3.6 mg/kg), methylene chloride (20 mg/kg), and a few other VOCs and semivolatile organic compounds (SVOC) (less than 1 mg/kg) (see Table ATT-2).

Pipeline Numbers: **200-E-160-PL and 200-E-162-PL**

Pipeline Sampling: Primary pipelines for exterior-soil characterization and alternate pipelines for interior-pipe characterization.

Waste Stream, Source(s): 221-U Canyon Building and 224-U UO_3 Building (via cross-site transfer line) and 221-B Canyon Building; process condensate and construction waste. The waste was low in salt and is neutral to basic.

Associated Liquid-Waste Site and OU: 216-B-12 Crib (200-PW-2)

Pipeline Description: The waste pipeline, located west of B Plant in the 200 East Area, is a 6-in. VC pipeline that extends from the 270-E-1 Neutralization Tank Pit, located west of the 221-B Canyon Building, to the southern end of the 216-B-12 Crib, where it connects to the center-crib distribution line. The 200-E-162-PL Pipeline is made up of two waste pipelines. The first pipeline (200-E-162-PL:1) extends from a sampler pit, located south of the 221-B Canyon Building, to the southeastern end of the 216-B-62 Crib. The 200-E-162-PL:1 Pipeline is made up of 4-in. carbon steel (CS), M-2 (SS), M-35 (CS), and fiberglass-reinforced epoxy (FRE) pipes. The second pipeline (200-E-162-PL:2) is a 4-in. FRE pipe that extends from a diversion pit, located east of the 216-B-12 Crib along pipeline 200-E-162-PL:1, to the eastern side of the 216-B-12 Crib, where it connects to the center-crib distribution line. The portion of the 200-E-162-PL:1 Pipeline that extends north from the diversion pit (at the connection with 200-E-162-PL:2) to the 216-B-62 Crib is not part of this investigation. A third pipeline may exist and appears to extend from near the 270-E-1 Neutralization Tank Pit to the southern end of the 216-B-12 Crib. This pipeline is constructed of unknown materials, and the pipe diameter also is unknown. The approximate combined total length of the pipelines being evaluated is 886 m (2,907 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from 1952 to 1973. From November 1952 to December 1957, the 216-B-12 Crib received process condensate from the TBP uranium recovery processes at the 221-U and 224-U Buildings as well as B Plant condensate. From December 1957 to May 1967, the site was inactive. From May 1967 to November 1967, the site received construction waste from the 221-B Building. After November 1967, the site received process condensate from the 221-B Building (WIDS).

Analytical data for soil samples were taken from DOE/RL-2004-25. Constituents and the maximum detected concentrations in the 216-B-12 Crib include Pu-239/240 (4 pCi/g), Am-241 (2 pCi/g), Cs-137 (61,900 pCi/g), U-238 (12 pCi/g), Sr-90 (12,700 pCi/g), H-3 (8 pCi/g), total uranium (28 mg/kg), chromium (30 mg/kg), nitrate as N (165 mg/kg), ammonia (404 mg/kg), TBP (2 mg/kg), and Aroclor-1254[1] (less than 1 mg/kg) (see Table ATT-2).

Associated Contamination-Zone Information: A contamination zone (CZ) is located relatively near the 216-B-12 Crib, next to the 200-E-160-PL Pipeline and directly in line with the location of the third pipeline that also may extend to the waste site. While no radiological survey information is available for the CZ, its size, shape, and approximate location have been estimated. The CZ is surface stabilized and posted (WIDS).

A1.1.2 Pipelines Being Evaluated in Bin 2 (Steam Condensate and Cooling Water)

Pipeline Number: **200-E-112-PL**

Pipeline Sampling: Primary pipeline for interior-pipe characterization.

Waste Stream, Source: B Plant; process effluent and cooling water normally containing small amounts of radioactivity (see *Pipeline and Associated Waste Site History*, below).

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[1] Aroclor is an expired trademark.

Associated Liquid-Waste Site(s) and OU: 216-B-2 Ditches and 216-B-3 Ditches (200-CW-1), and possibly the 216-B-63 Ditch (200-CS-1) via the 207-B Retention Basin (200-CW-1) and 200-E-191-PL.

Pipeline Description: This pipeline is located east and northeast of B Plant in the 200 East Area, and extends from the south side of the 221-B Canyon Building, to the west side of the 207-B Retention Basin. The pipeline primarily is made up of a 24-in. VC pipe, although a section of 24-in. cast iron (CI) pipe extends from B Plant eastward to a manhole where the pipeline changes direction to the north. Numerous manholes are present along this pipeline. The approximate length of pipeline being evaluated is 659 m (2,162 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from 1945 to 1997. In November 1963, a coil developed a leak in Tank 6-1 (Rare Earth Storage Tank) inside the 221-B Canyon Building and released approximately 30 Ci of Ce-144 into the process sewer (see unplanned release UPR-200-E-32) (WIDS).

Analytical results for soil samples taken from the 216-B-2-2 Ditch are summarized in DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report*. Constituents and the maximum detected concentrations in the 216-B-2-2 Ditch include Pu-239/240 (less than 1 pCi/g), Am-241 (1 pCi/g), Cs-137 (721 pCi/g), Sr-90 (12,100 pCi/g), mercury (less than 1 mg/kg), nitrate (330 mg/kg), Aroclor-1260 (9 mg/kg), and a few SVOCs (less than 1 mg/kg) (see Table ATT-2).

Associated Contamination-Zone Information: Two unplanned releases (UPR-200-E-80 and UPR-200-E-1) are located along the 200-E-112-PL Pipeline. Both releases are near the 221-B Building. The first release, UPR-200-E-80, occurred in June 1946 when the line failed, a portion of the area above the line caved in, the dose rate at the surface was 400 rad/h, and it was estimated that about 10 Ci of fission products were released into the soil. The second "release," UPR-200-E-1, occurred in September 1946, approximately 24 m (80 ft) from the first leak, and was assumed to be caused by migration from the June leak. Radiation survey results are not reported for the second leak, but the area was covered with enough soil to reduce surface contamination readings to 2 mrad/h. The area of these leaks is posted with radiation warning signs (WIDS).

Pipeline Number: **200-E-127-PL**

Pipeline Sampling: Primary pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: PUREX 202-A Building and B Plant operations; cooling water.

Associated Liquid-Waste Site and OU: 216-A-25 Gable Mountain Pond (200-CW-1)

Pipeline Description: This pipeline extends from the 216-A-42 Retention Basin, in the 200 East Area, to the 216-A-25 Gable Mountain Pond, north of the 200 East Area. The pipeline is made up of a corrugated metal (CM) pipe, and pipe diameters are 30, 36, and 42 in. Many manholes are present along this pipeline. The approximate length of pipeline being evaluated is 5,830 m (19,127 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from 1957 to 1987. From 1957 until May 1958, the pond received 202-A Canyon Building waste. In May 1958, it began receiving cooling water from the 241-A-431 Process Building contact condenser. In 1960, it began receiving cooling water from the 241-A-401 Building surface condenser. In November 1967, it began receiving cooling water from the 284-E Powerhouse wastewater. In January 1968, it began receiving cooling water and steam condensate from the 244-AR Vault. In March 1969, the 241-A-431 line was valved out. In March 1977, the pond also began receiving steam condensate cooling water from the 242-A Evaporator. In June 1964, a PUREX Plant tank developed a coil leak, releasing ~10,000 Ci of fission products into the cooling-water stream. Three quarters of this release went to the 216-A-25 Pond (see UPR-200-E-34) (WIDS).

Analytical data for soil samples taken from the 216-A-25 Gable Mountain Pond are summarized in DOE/RL-2000-35. Constituents and the maximum detected concentrations in the 216-A-25 Gable Mountain Pond include Pu-239/240 (less than 1 pCi/g), Am-241 (less than 1 pCi/g), Cs-137 (7,180 pCi/g), Sr-90 (59 pCi/g), chromium (24 mg/kg), nitrate (500 mg/kg), and ammonia as N (77 mg/kg) (see Table ATT-2).

Associated Contamination-Zone Information: Little information is available about the three known CZs located over the 200-E-127-PL Pipeline. WIDS indicates that contaminated tumbleweeds were a problem in these CZs at one time. These three areas are outside and to the north of the 810 Gate. They are roughly rectangular and are surface stabilized. Two of the CZs are posted as Contaminated Areas, and the other is posted as an Underground Radioactive Material Area (URMA) (WIDS).

Pipeline Number: **200-E-113-PL**

Pipeline Sampling: Alternate pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: PUREX Plant, steam condensate, equipment-disposal-tunnel floor drainage and water-filled door drainage, and the slug storage basin overflow waste from the 202-A Canyon Building. The waste was low in salt and is neutral to basic.

Associated Liquid-Waste Sites and OU: 216-A-30 Crib and 216-A-6 Crib (200-SC-1)

Pipeline Description: This pipeline is located east of the PUREX Plant in the 200 East Area, and is a 16-in. steel pipeline that extends from the PUREX Plant toward the 216-A-6 Crib (where it once ended), then on to the northwestern end of the 216-A-30 Crib, where it connects to the center-crib distribution line. The approximate length of pipeline being evaluated is 535 m (1,755 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from 1961 to 1992. It received 202-A waste from 1961 until November 1965, and again from

January 1970 to June 1992. The steam-condensate stream was shut down in June 1992, and all discharges to the crib were discontinued. The crib was permanently isolated in 1995 (WIDS). No analytical sampling data were identified for the cribs associated with this pipeline.

Associated Contamination-Zone Information: Two known CZs are located over the 200-E-113-PL Pipeline. One is a larger (~230 ft^2) and roughly triangular CZ, and another is a small (a few square meters), roughly square CZ next to the 216-A-42C Valve Box, nearer the 216-A-30 Crib. Both sites are surface stabilized and posted as Contaminated Areas, although the site next to the valve box is much older. The maximum radiation survey count for these two CZs was 1,050 c/min beta/gamma in October 2000, obtained for a tumbleweed growing in the area (Radiation Survey Report SS256115, *Vegetation Growth Above Posted Pipeline Associated with 216-A-42C and 216-A-30 Crib*).

Pipeline Number: **200-W-79-PL**

Pipeline Sampling: Primary pipeline for exterior-soil characterization.

Waste Stream, Source: 221-U Canyon Building, 221-T Canyon Building, and 2706-T Decontamination Facility; steam condensate, equipment decontamination, and miscellaneous waste. Some waste contained sodium hydroxide.

Associated Liquid-Waste Site and OU: 216-T-36 Crib (200-SC-1)

Pipeline Description: This pipeline is located south of the T Tank Farm in the 200 West Area, and is a 4-in. VC pipeline that extends from a connection point south of the T Tank Farm to the eastern end of the 216-T-36 Crib, where it connects to the center-crib distribution line. The approximate length of pipeline being evaluated is 193 m (633 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from May 1967 until around 1973. The end date for this liquid-waste site is unclear. However, it appears to have to have been site shut down between 1970 and 1973, based on available documentation (WIDS). No analytical sampling data were identified for the crib associated with this pipeline.

Associated Contamination-Zone Information: Three CZs are located over the 200-W-79-PL Pipeline. The two areas nearest the crib are roughly rectangular; the area further from the crib also is basically rectangular, but has an irregular-shaped portion below the main area. This lower portion was created when contaminated vegetation built up along a fence, and it is not considered related to the pipeline. The entire CZ area is ~17,000 ft^2, including the unrelated portion. All three sites are surface stabilized and posted as URMAs. The maximum radiological survey count measured within these CZs was 80,100 c/min beta/gamma in August 1998, obtained from rabbitbrush. The ground surface and several anthills were surveyed along portions of the pipeline in these CZs (Radiation Survey Report SS248978, *Survey of Underground Transfer Lines*). The instrument counts for the anthills were at background. The maximum ground-surface reading was 4,100 c/min beta/gamma (Radiation Survey Report SS248978).

A1.1.3 Pipelines Being Evaluated in Bin 3 (Chemical Sewer Waste)

Pipeline Number: **200-E-187-PL**

Pipeline Sampling: Alternate pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: PUREX 202-A Building; chemical sewer, acid-fractionator condensate and cooling water.

Associated Liquid Waste Site and OU: 216-A-29 Ditch (200-CS-1)

Pipeline Description: This pipeline is located north and northeast of the PUREX Plant in the 200 East Area, and extends from the north side of the PUREX Plant, at Building 202-A, to the discharge point into the 216-A-29 Ditch. The pipeline is made up primarily of a 12-in. VC pipe, although a newer section of 15-in. CS pipe extends from a manhole near the northeast corner of the AW Tank Farm. Many manholes are present along this pipeline. The approximate length of pipeline being evaluated is 432 m (1,417 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from 1955 to 1991. It originally received condenser cooling water and chemical-sewer waste from the 202-A Canyon Building. Beginning in December 1957, the process cooling water was rerouted to the 216-A-25 Gable Mountain Pond. Beginning in February 1958, the liquid-waste site also received acid-fractionator condensate from the 202-A Canyon Building. Beginning in December 1962, it also received seal cooling water from air-sampler vacuum pumps in the 202-A Canyon Building. From December 1963 to January 1966, the vacuum-pump cooling water was rerouted to the 216-A-35 French Drain. The head end of the ditch was modified in 1983, during the construction of the AP Tank Farm (WIDS).

Analytical results for soil samples taken from the 216-A-29 Ditch are summarized in DOE/RL-2004-17, *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit*. Constituents and the maximum detected concentrations in the 216-A-29 Ditch include Pu-239/240 (667 pCi/g), Am-241 (145 pCi/g), Cs-137 (98 pCi/g), Sr-90 (less than 1 pCi/g), H-3 (7 pCi/g), chromium (37 mg/kg), hexavalent chromium (9 mg/kg), mercury (5 mg/kg), nitrate as N (210 mg/kg), ammonia (9 mg/kg), Aroclor-1254 (9 mg/kg), TBP (less than 1 mg/kg), and a few other VOCs and SVOCs (less than 1 mg/kg) (see Table ATT-2).

Pipeline Number: **200-W-157-PL**

Pipeline Sampling: Primary pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: Reduction-Oxidation (REDOX) (202-S Canyon Building and high water tower); chemical-sewer waste and overflow from high water tower. Waste stream included hazardous waste salts including sodium nitrite and sodium hydroxide.

Associated Liquid-Waste Site and OU: 216-S-10 Ditch (200-CS-1)

Pipeline Description: This pipeline generally is located west and southwest of the S Plant (REDOX) in the 200 West Area, and extends from the north, west, and south sides of the 202-S Canyon Building, to the discharge point into the 216-S-10 Ditch. The pipeline is made up of 8-in. and 12-in. VC pipe. Numerous manholes are present along this pipeline. The approximate length of pipeline being evaluated is 911 m (2,989 ft), including the ancillary lines to the south of the S Plant.

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from August 1951 to 1991. Until 1965, it received chemical-sewer waste from the 202-S Canyon Building and overflow from the high water tower. No dangerous wastes have been discharged to the ditch since February 1987 (WIDS).

Analytical results for soil samples collected from the 216-S-10 Ditch are summarized in DOE/RL-2004-17. Constituents and the maximum detected concentrations in the 216-S-10 Ditch include Pu-239/240 (3 pCi/g), Am-241 (less than 1 pCi/g), Cs-137 (9 pCi/g), Sr-90 (less than 1 pCi/g), chromium (813 mg/kg), hexavalent chromium (14 mg/kg), mercury (4 mg/kg), Aroclor-1254 (4 mg/kg), and several VOCs and SVOCs (less than 1 mg/kg) (see Table ATT-2).

Pipeline Number: **200-E-188-PL**

Pipeline Sampling: Primary pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: 221-B Canyon Building; chemical sewer waste.

Associated Liquid Waste-Site and OU: 216-B-2 Ditches (200-CW-1), and 216-B-63 Ditch (200-CS-1)

Pipeline Description: This pipeline is located north and northeast of the B Plant in the 200 East Area and extends from the north side of the B Plant facility, at the 221-B Canyon Building, to the east side of the of the 207-B Retention Basin (bypassing the 207-B Retention Basin), then to the 216-B-2 Ditches and later to the 216-B-63 Ditch. The pipeline is made up of a 15-in. VC pipe. Many manholes are present along this pipeline. The approximate length of pipeline being evaluated is 436 m (1,430 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from 1945 to 1992. Pipeline leakage was documented in the 1970s and 1980s. The leakage was discovered during excavation in the area. Subsequent testing showed that ~1.1 ML (~300,000 gal/d) was leaking from the pipe into the soil, primarily in feeder lines and connector lines, before it reached the measuring station. Major portions of the line were relined in 1985 (RHO-CD-1010, *B Plant Chemical Sewer System Upgrade*; WHC-EP-0342, Addendum 6, *B Plant Chemical Sewer Stream-Specific Report*). An unplanned release also is associated with this pipeline. On March 22, 1970, UPR-200-E-138 resulted in the release of ~1000 Ci of Sr-90 into the chemical-sewer line. The dose rate in the B Plant gallery was 500 R/h at a distance of 4 in. on March 23, 1970 (WIDS).

Analytical data for soil samples taken from the 216-B-63 Ditch are provided in DOE/RL-2004-17. Constituents and the maximum detected concentrations in the 216-B-63 Ditch include Am-241 (less than 1 pCi/g), Cs-137 (4 pCi/g), Sr-90 (30 pCi/g), chromium (22 mg/kg), nitrate as N (188 mg/kg), Aroclor-1254 (less than 1 mg/kg), and a few VOCs (less than 1 mg/kg) (see Table ATT-2).

Associated Contamination-Zone Information: Three roughly rectangular CZs are located over the 200-E-188-PL Pipeline. All three sites are surface stabilized and posted as URMAs. The maximum rad survey count for these CZs was 1,200 c/min beta/gamma in August 2000, obtained for a tumbleweed fragment (Radiation Survey Report SS255613, *Survey of Transfer Line Northeast of B Plant to 207-B*).

A1.1.4 Pipelines Being Evaluated in Bin 4 (Miscellaneous Waste)

Pipeline Number: **200-W-173-PL**

Pipeline Sampling: Primary pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: T Plant, 2706-W Decontamination Building; decontamination liquid waste. The waste is low in salt, neutral to basic, and contains sodium hydroxide.

Associated Liquid Waste-Site and OU: 216-T-33 Crib (200-MW-1)

Pipeline Description: This pipeline is located northwest of the T Plant in the 200 West Area and consists mainly of 8-in.-diameter VC that extends from the southeast side of the 2706-T Building, in the northwestern part of the T Plant facility, to the eastern end of the 216-T-33 Crib, where it connects to the center-crib distribution line. A short section of 6-in. VC pipe runs from the 2706-T Building connection point to a weir pit, located at the southeast corner of the same building. The approximate length of pipeline being evaluated is 80 m (262 ft). Analytical results for soil samples collected from the 216-T-33 Crib are provided in DOE/RL-2005-62, *Remedial Investigation Report for the 200-MW-1 Miscellaneous Waste Group Operable Unit*. Constituents and the maximum detected concentrations in the 216-T-33 Crib include Am-241 (2 pCi/g), Pu-239/240 (63 pCi/g), Cs-137 (33 pCi/g), Sr-90 (49 pCi/g), chromium (34 mg/kg), nitrate (254 mg/kg), oil & grease (842 mg/kg), Aroclor-1254 (9 mg/kg), Aroclor-1260 (4 mg/kg), and a few VOCs (less than 1 mg/kg) (see Table ATT-2).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from January to February 1963, when the pipeline to the waste site plugged. Operating management believed that the line to the unit retained all of the waste. Sections of the line were removed (WIDS).

Pipeline Number: **200-E-193-PL**

Pipeline Sampling: Primary pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: PUREX 202-A, 293-A, and 291-A facilities; sump waste, laboratory-cell drainage, stack drainage. The waste is low in salt and is neutral to basic.

Associated Liquid Waste-Site and OU: 216-A-21 Crib (200-MW-1)

Pipeline Description: This pipeline is located south of the PUREX Plant in the 200 East Area, and is a 6-in. VC pipeline that extends from the eastern side of Building 293-A, in the southern part of the PUREX Plant, to the northern end of the 216-A-21 Crib, where it connects to the center-crib distribution line. The approximate length of pipeline being evaluated is 114 m (374 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from October 1957 to June 1965. Until June 1958, the site received sump waste from the 293-A Building. In June 1958, this pipeline failed, and the liquid-waste site was taken out of service until a new distribution system could be installed. The unit was brought back into service in December 1958. From December 1958 to June 1965, it received laboratory-cell drainage from the 202-A Canyon Building and 291-A Stack drainage (WIDS). No analytical sampling data were identified for the waste site associated with this pipeline.

Pipeline Number: **200-E-194-PL**

Pipeline Sampling: Alternate pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: PUREX 202-A Building, miscellaneous liquid waste containing less than 1 Ci of total beta activity.

Associated Liquid Waste-Site and OU: 216-A-32 Crib (200-MW-1)

Pipeline Description: This pipeline is located northeast of the PUREX Plant in the 200 East Area and is a 6-in. VC pipeline that extends from the east side of the PUREX Plant, at Building 202-A, to the southwestern end of the 216-A-32 Crib, where it connects to the center-crib distribution line. The pipe diameter is 6 in. The approximate length of pipeline being evaluated is 83 m (272 ft).

Pipeline and Associated Disposal Waste-Site History: The liquid-waste site was operational from January 1959 to 1972. The crib received floor, sink, and shower drainage from the 202-A Canyon Building. BHI-00178, *PUREX Plant Aggregate Area Management Study Technical Baseline Report*, indicates that Isochem Corporation intended to dispose of 24,600 L (6,500 gal) of a product containing kerosene into the crib, but reports that investigators were unable to verify whether the proposed disposal took place (WIDS). No analytical sampling data were identified for the waste site associated with this pipeline.

A1.1.5 Pipelines Being Evaluated in Bin 5 (Tank/Scavenged Waste)

Pipeline Number: **200-W-175-PL**

Pipeline Sampling: Primary pipeline for interior-pipe characterization and an alternate pipeline for exterior-soil characterization.

Waste Stream, Source: T Plant; first-cycle scavenged supernatants (flowing into the 216-T-26 Crib), 221-T steam condensate and process-decontamination waste and equipment-decontamination waste from 2706-T (flowing to the 216-T-27 Crib), and steam condensate and process decontamination waste from the 241-T-112 Tank in the T Tank Farm and from 2706-T (flowing to the 216-T-28 Crib) (WIDS). A portion of the pipeline also carried cooling water from the 242-T Evaporator to the 207-T Retention Basin (see 200-W-167-PL discussion below).

Associated Liquid-Waste Site and OU: the 216-T-26 Crib (200-TW-1) and the 216-T-27 and 216-T-28 Cribs (200-MW-1)

Pipeline Description: This pipeline generally is located west and southwest of the T Plant in the 200 West Area. It is a 3-, 3.5-, and 4-in. steel pipeline that extends from the southern portion of the T Tank Farm, at the 241-T-112 Tank, to the northern end of the 241-TY-201 Flush Tank, where the associated waste was subsequently sent to the 216-T-26 Crib. The approximate length of pipeline being evaluated is 405 m (1,329 ft).

It should be noted that the blank ends of two other previously connected pipelines (from the TX Tank Farm and the 207-T Retention Basin) occur near two locations at the northern and southern ends of the 4-in. section of this pipeline (200-W-175-PL). Before it was disconnected at these two locations, the 4-in. section of this pipeline was used as part of another waste pipeline site, 200-W-167-PL. Another pipeline from TY Tank Farm was disconnected in 1955 at the southern end of the 4-in. section of this pipeline (200-W-175-PL) That pipeline previously was connected to the 3-in. section of this pipeline (200-W-175-PL) leading to the 241-TY-201 Flush Tank.

Pipeline and Associated Disposal Waste-Site(s) History: The liquid-waste sites were operational from 1955 to 1966. From August 1955 until November 1956, the pipeline was used to carry first-cycle scavenged supernatant from the TY Tank Farm, and later from the 241-T-112 Tank, to the 216-T-26 Crib. This waste contained ferrocyanide, fluoride, nitrate, nitrite, phosphate, sodium, sodium aluminate, sodium hydroxide, sodium silicate, and sulfate. From September 1965 to November 1965, the pipeline carried 221-T Canyon Building steam condensate and process-decontamination waste and equipment-decontamination waste from 2706-T to the 216-T-27 Crib. From February 1960 through February 1963, the 200-W-175-PL Pipeline carried steam condensate and process-decontamination waste from the 241-T-112 Tank in the T Tank Farm to the 216-T-28 Crib. In 1963, the pipeline also began carrying 2706-T steam condensate and process-decontamination waste to the 216-T-28 Crib. The 216-T-28 Crib was deactivated in December 1966 (WIDS).

Analytical data for soil samples taken from the 216-T-26 Crib are summarized in DOE/RL-2002-42, *Remedial Investigation Report for the 200-CS-1 Chemical Sewer Group Operable Unit*. Constituents and the maximum detected concentrations in the 216-T-26 Crib include Am-241 (227 pCi/g), Pu-239/240 (6,320 pCi/g), U-238 (21 pCi/g), Cs-137 (47,900 pCi/g), Sr-90 (49,100 pCi/g), H-3 (2,650 pCi/g), total uranium (61 mg/kg), chromium (94 mg/kg), hexavalent chromium (4 mg/kg), nitrate as N (693 mg/kg), ammonia (95 mg/kg), fluoride (168 mg/kg), TBP (91 mg/kg), acetone (less than 1 mg/kg), and xylenes (less than 1 mg/kg) (see Table ATT-2).

Pipeline Number: **200-E-195-PL**

Pipeline Sampling: Primary pipeline for exterior-soil characterization and alternate pipeline for interior-pipe characterization.

Waste Stream, Source: 221-B Canyon Building, cell drainage and other liquid waste. The waste is low in salt, neutral to basic, and contains transuranic and fission products.

Associated Liquid-Waste Site and OU: 216-B-9 Crib (200-TW-2)

Pipeline Description: This pipeline is located northeast of the B Plant in the 200 East Area and is a 3.5-in. SS pipeline that extends from the connection point with Line 204 (from B Plant), east of the 241-B-361 Settling Tank, to the southwestern end of the 216-B-9 Crib, where it connects to the center-crib distribution line. The approximate length of pipeline being evaluated is 145 m (476 ft).

Pipeline and Associated Disposal Waste-Site History: The waste site was operational from August 1948 to July 1951, receiving cell drainage and other liquid waste via Tank 5-6 in the 221-B Canyon Building (WIDS). No sampling analytical data were identified for the waste site associated with this pipeline.

Associated Contamination-Zone Information: A CZ (UPR-200-E-7) is located over the pipeline from the 221-B Canyon Building to the 216-B-9 Crib. WIDS indicates that the CZ was caused by leakage in the waste line that led to a cave-in in 1954. An estimated 19,000 L (5,000 gal) of waste leaked into the soil at the time, and the maximum surface dosage rate observed was 1.7 rad/h over a 30 ft^2 area. While the cave-in was filled in and once was marked, its exact location no longer can be determined, according to WIDS.

Pipeline Number: **200-E-114-PL**

Pipeline Sampling: The northern and southern portions of the 200-E-114-PL Pipeline were selected as a primary pipeline for both interior-pipe and exterior-soil characterization.

Waste Stream, Source: 221-U Canyon Building; scavenged TBP supernatant waste from uranium recovery operations containing Cs-137, Sr-90, and uranium isotopes. The waste was high in salt and neutral to basic. It also contained inorganic compounds such as ferrocyanide, nitrate, and phosphate.

Associated Liquid-Waste Site and OU: BC Cribs and Trenches Area and 216-B-51 French Drain (200-TW-1). The 216-B-46 Crib received the same liquid-waste stream from the BY Tank Farm that the northern portion of the 200-E-114-PL Pipeline received. Waste-stream disposal data available for the 216-B-46 Crib are considered indicative of the liquid-waste transferred through 200-E-114-PL.

Pipeline Description: Two portions of the 200-E-114-PL Pipeline were identified for investigation. In the northern section, the part of the line that extends from the north side of the BY Tank Farm to the junction with the C Tank Farm line was selected. The eastern segment of the pipeline that connects with C Tank Farms was not included. The southern area being evaluated includes the portion of line near the BC Cribs. The 200-E-114-PL Pipeline consists of two 4-in. carbon steel lines running in parallel. The operational history of this pipeline is complex. This pipeline received waste streams from several sources and served multiple waste sites. The approximate length of the pipeline being evaluated is 3,415 m (11,201 ft).

Pipeline and Associated Disposal Waste-Site History: This pipeline was used to transfer liquid waste to the BC Cribs and Trenches Area (216-B-14, 216-B-15, 216-B-16, 216-B-17, 216-B-18, and 216-B-19 Cribs) from January 1956 through December 1957. The 216-B-51 French Drain, located along the 200-E-114-PL Pipeline nearer the BY Tank Farm, received liquid waste from January 1956 to January 1958. The 216-B-46 Crib, associated with the same waste stream, received liquid waste from September to December 1955 (WIDS).

Analytical data for soil samples taken from the 216-B-46 Crib are provided in DOE/RL-2002-42. Constituents and the maximum detected concentrations in the 216-B-46 Crib include Pu-239/240 (227 pCi/g), Cs-137 (364,000 pCi/g), Sr-90 (353,000 pCi/g), H-3 (53 pCi/g), total uranium (44 mg/kg), chromium (30 mg/kg), nitrate and N/N as N (5,470 mg/kg), and TBP (19 mg/kg) (see Table ATT-2).

Associated Contamination-Zone Information: Two CZs are located over the northern portion of the 200-E-114-PL Pipeline, with a larger (~4500 ft^2), roughly square CZ at or near the connection to the 216-B-51 French Drain and a smaller (~2800 ft^2), roughly rectangular CZ further from the tank farms, at or near a bend in the line. Both sites are surface stabilized and posted as URMAs. The maximum radiation survey count for these two CZs was 8,050 c/min beta/gamma in October 2000, obtained for a tumbleweed in the area (Radiation Survey Reports SS253960, *Survey of B Plant Transfer Line*; and SS256142, *Vegetation Growth in Posted CA Associated with UPR-200-E-144*). A later, May 2002, radiation survey reported 72,500 c/min from an area in the second CZ (Radiation Survey Report SS261107, *Assessment Survey in a Posted CA South of 12th Street*).

Table A-2 provides a summary of the information presented in the previous pipeline discussions. The process facilities, associated liquid-disposal waste sites and operable units, and physical characteristics of the pipelines are provided.

Table A-2. Pipeline Summary Information. (2 Pages)

Bin	Pipeline Number	Area/Assoc. Facility	Associated Liquid Waste Disposal Site	Operable Unit	Pipeline Physical Attribute Summary		Breakout of Pipe Materials and Diameters									
					Pipe Materials[a]	Pipe Diameters (in.)[a]	Stl	SS	CS	M-2	M-35	CM	VC	FRE	CI	Other
1	200-E-192-PL	200 East/ PUREX	216-A-10 Crib	200-PW-2	Stainless steel and vitrified clay	8		8					8			
	200-W-174-PL	200 West/ Plutonium Finishing Plant	216-Z-1A Tile Field	200-PW-1	Stainless steel and vitrified clay	2, 3, and 8		2, 3					8			
	200-E-160-PL; 200-E-162-PL	200 East/ B Plant and U Plant	216-B-12 Crib	200-PW-2	Vitrified clay, M-2, M-35, carbon steel, fiberglass reinforced epoxy, and unknown	4, 6, and unknown			4	4	4		6	4		Unk
2	200-E-112-PL	200 East/ B Plant	216-B-2-2 Ditch	200-CW-1	Vitrified clay and cast iron	24							24		24	
	200-E-127-PL	200 East/ PUREX and B Plant	216-A-25 Gable Mountain Pond	200-CW-1	Corrugated metal	30, 36, and 42						30, 36, 42				
	200-E-113-PL	200 East/ PUREX	216-A-30 Crib	200-SC-1	Steel	16	16									
	200-W-79-PL	200 West/ T Plant and U Plant	216-T-36 Crib	200-SC-1	Vitrified clay								4			
3	200-E-187-PL	200 East/ PUREX	216-A-29 Ditch	200-CS-1	Vitrified clay and carbon steel	12 and 15			15				12			
	200-W-157-PL	200 West/ S Plant (REDOX)	216-S-10 Ditch	200-CS-1	Vitrified clay	8 and 12							8, 12			
	200-E-188-PL	200 East/ B Plant	216-B-63 Ditch	200-CS-1	Vitrified clay	15							15			

Table A-2. Pipeline Summary Information. (2 Pages)

Bin	Pipeline Number	Area/Assoc. Facility	Associated Liquid Waste Disposal Site	Operable Unit	Pipeline Physical Attribute Summary		Breakout of Pipe Materials and Diameters									
					Pipe Materials[a]	Pipe Diameters (in.)[a]	Stl	SS	CS	M-2	M-35	CM	VC	FRE	CI	Other
4	200-W-173-PL	200 West/ T Plant	216-T-33 Crib	200-MW-1	Vitrified clay	6 and 8							6, 8			
	200-E-193-PL	200 East/ PUREX	216-A-21 Crib	200-MW-1	Vitrified clay	6							6			
	200-E-194-PL	200 East/ PUREX	216-A-32 Crib	200-MW-1	Vitrified clay	6							6			
5	200-W-175-PL	200 West/ T Plant	216-T-26 Crib	200-TW-1	Steel		3, 3.5, 4									
	200-E-195-PL	200 East/ B Plant	216-B-9 Crib	200-TW-2	Stainless steel			3.5								
	200-E-114 PL	200 East/ B Plant	216-B-46 Crib[b]	200-TW-1	Carbon steel	4			4							

[a]The pipe materials and diameters listed are only for pipelines selected for sampling and are based on the current level of review of engineering drawings (see Table ATT-1). This listing is subject to change, should additional information become available.

[b]Because of its complex operational history, the 200-E-114-PL Pipeline has been associated with many liquid-waste disposal sites. The 216-B-46 Crib was selected as the best candidate for association with the northern portion of this pipeline that is being evaluated as part of this investigation.

CI = cast iron.
CM = corrugated metal.
CS = carbon steel.
FRE = fiberglass reinforced steel.
M-2 = stainless steel.
OU = operable unit.
PL = pipeline.
M-35 = carbon steel.
PUREX = Plutonium-Uranium Extraction Plant.
REDOX = Reduction-Oxidation Plant.
SS = stainless steel.
Stl = steel (unknown).
VC = vitrified clay.

Table ATT-1 in the Attachment lists the engineering drawings that were reviewed to determine the pipeline locations, materials, and pipe diameters. These drawings provide additional pipeline construction details and should be referenced if additional information is needed during the field investigation.

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