This document was too large to scan as a single document. It has been divided into smaller sections.

Section 1 OF 2

Document Information			
Document #	0402547/04-TPD-092		
Title	SUBMITTAL OF SINGLE-SHELL TANK (SST) SYS CLOSURE PLANS TO FULFILL REQUIREMENTS FOR HFFACO MILESTONES M-45-06B & M-45-06C		
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Originator	RJ SCHEPENS	Originator Co.	DOE-ORP
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Office of River Protection
P.O. Box 450
Richland, Washington 99352

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04-TPD-092

SEP 2 8 2004

Mr. Michael A. Wilson, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton Blvd.
Richland, WA 99352

RECEIVED
OCT 0 5 2004
EDMC

Dear Mr. Wilson:

SUBMITTAL OF SINGLE-SHELL TANK (SST) SYSTEM CLOSURE PLANS TO FULFILL REQUIREMENTS FOR HANFORD FEDERAL FACILITY AGREEMENT AND CONSENT ORDER (HFFACO) MILESTONES M-45-06B AND M-45-06C

Attached are the following documents to support completion of HFFACO Milestones M-45-06B and M-45-06C:

- Attachment 1 is RPP-19773, "Appendix D Waste Management Area S-SX Closure Action Plan, Revision 1."
- Attachment 2 is RPP-19774, "Attachment D-2 Single-Shell Tank 241-S-102 Component Closure Activity Plan, Revision 1."
- Attachment 3 is RPP-19775, "Attachment D-2 Single-Shell Tank 241-S-102 Component Closure Activity Plan, Revision 1."
- Attachment 4 is RPP-21596, "Risk Assessment for Waste Management Area S-SX Closure Plan, Revision 0."
- Attachment 5 is "Certification for the Hanford Facility Dangerous Waste Permit Application Documentation, Single Shell Tank System Closure Plan for Attachments 1 - 4."

Based on the successful completion of HFFACO Milestone M-45-05H for SST C-106, ORP anticipates additional guidance on closure plans from the State of Washington Department of Ecology. When this feedback is provided, these closure plans will be modified to address any additional information needs or concerns.

SEP 2 8 2004

If you have any questions, please contact me, or your staff may contact Roger A. Quintero, Tank Farms Programs and Projects Division, (509) 373-0421.

Sincerely,

Roy J. Schepens
Manager

TPD: RAQ

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Attachment 1
04-TPD-092

RPP-19773, Appendix D Waste Management Area S-SX Closure Action Plan, Revision 1

(Consisting of 97 pages,
including coversheet)

RPP-19773
Revision 1

APPENDIX D

WASTE MANAGEMENT AREA S-SX CLOSURE ACTION PLAN

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Date Published
September 2004

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Prepared for the U.S. Department of Energy
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PREFACE

This closure action plan is being submitted to the Washington State Department of Ecology (Ecology), under the provisions of the *Resource Conservation and Recovery Act* (RCRA), the Revised Code of Washington, Chapter 70.105 "Hazardous Waste Management Act of 1976" (HWMA) (RCW 70.105), and applicable requirements thereunder. Consequently, this plan addresses hazardous and dangerous wastes only (as defined by these statutes and regulations) and does not address waste classification determinations and radioactive waste-specific closure actions that the U.S. Department of Energy (DOE) may take under the *Atomic Energy Act of 1954* (AEA). To the extent that this plan provides data or discussions about materials regulated under the AEA, that information is provided for informational purposes only.

This document is one of a series of closure plan reports that collectively comprise the *Single-Shell Tank System Closure Plan.* Revision 0 of the *Single-Shell Tank System Closure Plan* (RPP-13774a) was initially submitted on December 19, 2002, pursuant to *Hanford Federal Facility Agreement Consent Order* (HFFACO) Milestones M-45-06A and M-45-05H. After submittal of Revision 0, the United States District Court, District of Idaho, issued a Judgment in *Natural Resources Defense Council, et al., v. Spencer Abraham, et al.*, Civ. No. 01-0413-S-BLW (July 3, 2003) holding invalid certain portions of DOE O 435.1, *Radioactive Waste Management*, relating to waste incidental to reprocessing. On August 27, 2003, DOE appealed this judgment to the U. S. Circuit Court of Appeals for the Ninth Circuit. This closure action plan does not address the waste incidental to the reprocessing evaluation process described in DOE O 435.1 and its accompanying Guidance and Manual. Revisions 1 and 2 (RPP-13774b) were later submitted in response to review comments submitted by Ecology and subsequent comment resolution.

The timing of certain actions contemplated in this plan, such as mixing grout with waste residuals during the closure process, may require decisions that must be made under the AEA and/or in accordance with other applicable requirements. Accordingly, even where apparently mandatory phrases such as "DOE will…" are used in this plan, the actions these phrases refer to are conditional based on the successful completion of required precursor actions which may be affected by the outcome of the litigation referred to above. No irreversible final closure actions will be taken for the RCRA purposes discussed in this plan unless and until they are shown to be consistent with radioactive waste management requirements DOE must address under the AEA, DOE orders, and any other applicable requirements. As a specific example, grout will not be added to stabilize tank waste residuals for RCRA purposes unless and until DOE has determined that the waste characteristics of the residuals are suitable for addition of grout in the tank under applicable requirements, and Ecology has issued the appropriate permits. In some cases, the paths forward to make the radioactive waste determinations are still under development and may impact schedule dates contemplated in this plan.

The *Single-Shell Tank System Closure Plan* (RPP-13774b) describes the process for closure of 149 single-shell tanks at the Hanford Site, Washington, including the tanks themselves, ancillary equipment, contaminated soil, and contaminated groundwater, in accordance with the requirements of applicable laws and regulations. RPP-13774b contains three main sections that are arranged in a hierarchy. The highest-level document (Tier 1) addresses closure topics and

issues pertaining to the single-shell tank system. Mid-level documents (Tier 2) address specific groupings of one or more single-shell tank farms known as waste management areas (WMA). The lowest level documents in the hierarchy (Tier 3) address closure activities for specific components within a particular WMA. The following summarizes the general content of the Tier 1, 2, and 3 documents for the *Single-Shell Tank System Closure Plan*:

- Tier 1 – *Framework Plan for Single-Shell Tank System Closure:* Referred to as the "Framework Plan," this document discusses the general overview of the single-shell tank system, describes the administrative and regulatory framework for single-shell tank closure, describes the process for incorporating Tier 2 and Tier 3 with soil and groundwater corrective actions, and provides single-shell tank closure performance standards, a risk evaluation, an overall closure schedule, and an overall description of the certification and post-closure process.

- Tier 2 – *Waste Management Area Closure Action Plans*: This tier consists of appendices to the Tier 1 Framework Plan, one for each of the seven single-shell tank farm WMAs at Hanford. The seven WMAs include A-AX; B-BX-BY; C; S-SX; T; TX-TY; and U. Each WMA closure action plan provides a general description of the WMA, a description of the WMA groundwater monitoring effort, a general description of closure activities, a risk evaluation for the WMA, a closure schedule for the WMA, and a description of the certification and post-closure process.

- Tier 3 – *Component Closure Activity Plans* (for specific WMA components): This tier of the *Single-Shell Tank System Closure Plan* consists of attachments to the *Tier 2 WMA Closure Action Plans* within a WMA. Each tier 3 *Component Closure Activity Plan* describes closure activities for one or more components within each WMA, such as for individual single-shell tanks or pieces or groupings of ancillary equipment.

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LIST OF TERMS

AEA	*Atomic Energy Act of 1954*
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CMI	corrective measures implementation
CMS	corrective measures study
COC	certificate of completion
COPC	chemical of potential concern
CPP	CERCLA past-practice
DOE	U.S. Department of Energy
DST	double-shell tank
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FIR	field investigation report
FY	fiscal year
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
HI	hazard index
HWIS	Hanford Well Information System
HWMA	"Hazardous Waste Management Act"
ILCR	incremental lifetime cancer risk
IS	interim stabilized
LDMM	leak detection monitoring and mitigation
MCL	maximum contaminant level
RCW	*Revised Code of Washington*
PA	performance assessment
RFI	RCRA facility investigation
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	reduction and oxidation extraction
RFI	RCRA facility investigation
RMIS	Hanford Records Management Information System
ROD	record of decision
RPP	RCRA past-practice
SAC	system assessment capability
SAP	sampling and analysis plan
SST	single-shell tank
TBD	to be determined
TSD	treatment, storage, and disposal
TWRWP	tank waste retrieval work plan
UPR	unplanned release
WAC	*Washington Administrative Code*
WMA	Waste Management Area

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1.0 INTRODUCTION

The Waste Management Area (WMA) S-SX is a dangerous waste management unit within the single-shell tank (SST) system. For the purposes of closure, the WMA S-SX components include numerous tanks, pits, transfer piping, diversion boxes, and vaults, as well as soil and groundwater contaminated by WMA S-SX operations. The boundary of the WMA S-SX is generally coincident with the 241-S and 241-SX tank farm fenceline. While most WMA S-SX components are physically located within the WMA, some components extend beyond the boundary (e.g., pipelines and groundwater) or are located outside of the WMA. Section 2.0 describes the WMA and its associated components.

The U.S. Department of Energy (DOE) plans to close WMA S-SX after all associated component closure activities have been completed. Closure of WMA S-SX will include disposition of all components including any corrective or remedial actions determined to be necessary to meet performance objectives for soil or groundwater contaminated with dangerous waste or dangerous waste constituents. To facilitate these closure decisions, background information on the condition of the vadose zone, the groundwater, and existing contamination is presented in sections 3.0, 4.0, and 5.0, respectively.

This closure action plan includes Washington Administrative Code (WAC) 173-303, "Dangerous Waste Regulations" requirements associated with clean closure of WMA S-SX as a tank system (173-303-640(8)(a)) and closure and post-closure actions associated with landfills (WAC 173-303-640(8)(b) and WAC 173-303-665(6)). In accordance with WAC 173-303-640(8)(c), closure and post-closure plans consistent with landfill requirements are required to be included in a closure plan for a tank system that does not comply with secondary containment (such as the SST system). This will occur after it has been demonstrated by DOE to not be practicable to achieve clean closure for either soil or tank/ancillary equipment or both. These landfill closure and post-closure plans must provide contingent actions should removal and decontamination activities performed for WMA S-SX components leave dangerous waste or dangerous waste constituents in excess of those identified in WAC 173-303-610(2)(b). Contingent actions may include design and installation of an engineered surface barrier in compliance with WAC 173-303-665(6)(a) performance standards (described in Sections 6.2. and 6.3) and performance of post-closure care requirements in compliance with WAC 173-303-665(6)(b) (described in Section 10.0).

1.1 WMA S-SX CLOSURE ACTION PLAN RATIONALE

DOE submits this plan to support the following:

- Closure in accordance with WAC 173-303-610 treatment, storage, and disposal (TSD) closure and post-closure requirements
- Closure actions for the components in WMA S-SX

- *Hanford Federal Facility Consent Order* (HFFACO) (Ecology et al. 1989) Milestone M-45-06, which directs closure of all WMAs by September 30, 2024

- HFFACO Milestone M-45-06-T03, which directs closure actions to proceed on a WMA basis

- HFFACO Milestone M-24-00, which specifies groundwater monitoring will occur in relation to the SSTs

- HFFACO Appendix I, "Single-Shell Tank System Waste Retrieval and Closure Process," which directs retrieval and closure activities.

This closure action plan describes waste characterization, removal, decontamination, treatment, and other such closure activities for the tanks, pits, piping, diversion boxes, vaults, soil, and groundwater of the WMA. It also describes actions that will be taken to support closure of the entire WMA, such as risk assessment, groundwater monitoring, planning for design of a final cover, and integration of the WMA-wide actions with adjacent and site-wide remediation and closure strategies. The closure action plan identifies specific activities, schedules, plans, documentation, and integration needs that can be identified at the present time. DOE expects successive revisions of this closure action plan as component closure activities generate data and reduce the uncertainties. DOE will not propose closure of WMA S-SX until all associated components have been addressed pursuant to component closure activity plans or alternative documentation (such as corrective measures, *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) action memoranda, or records of decision [ROD] upon approval), through incorporation into the *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste,* Rev. 7 (Ecology 2001, hereinafter referred to as the Site-Wide Permit).

A relative sequence for completion of component closure activities, including contingent closure activities for landfills, leading to closure of the WMA, as well as contingent post-closure activities is described in Section 6.0.

1.2 REGULATORY SETTING

A thorough discussion of applicable statutes and regulations (the Framework Plan) is presented in the *Single-Shell Tank System Closure Plan* (RPP-13774b). Closure of WMA S-SX is governed by the State of Washington "Hazardous Waste Management Act of 1976" (HWMA) (*Revised Code of Washington* [RCW] 70.105) and the HFFACO. The HFFACO establishes that WMA S-SX and the balance of the SST system will be closed in accordance with WAC 173-303-610, WAC 173-303-645, and the HFFACO Milestone M-45-00 series.

Closure will be carried out at the WMA level. Thus, the requirements for certification of closure and potentially post-closure care will apply to WMA S-SX and will be addressed in this closure action plan.

As specified in Section 6 of the HFFACO, the Framework Plan addresses all waste constituents that could potentially affect human health and/or the environment. Where information regarding treatment, management, and disposal of the radioactive source, byproduct material, and/or special nuclear components of mixed waste (as defined by the *Atomic Energy Act of 1954* [AEA]) has been incorporated into the Site-Wide Permit, it is not incorporated for the purpose of regulating such components under the authority of the Site-Wide Permit and the HWMA. To the extent that *Resource Conservation and Recovery Act of 1976* (RCRA)/HWMA requirements are inconsistent with requirements under the AEA, Section 1006 of RCRA provides that the inconsistent RCRA requirements yield to those of the AEA.

1.3 CLOSURE PLAN HIERARCHY

DOE is establishing a system for dispositioning individual components and the WMA, as contributory actions in closing the SST system. DOE has developed a tiered structure to integrate the various component closure activity plans and closure action plans and into the Site-Wide Permit, as shown in Figure 1-1. The following sections describe how this document (Tier 2) relates to each of the tiers.

1.3.1 Relationship to Framework Plan

The Framework Plan (Tier 1) describes the systems and site-wide integrated approach for closing the entire SST system through closure of the seven WMAs (A-AX, B-BX-BY, C, S-SX, T, TX-TY, U). This closure action plan (Tier 2) focuses on closure activities for this specific WMA. The approved Framework Plan and this closure action plan will be incorporated into Part V of the Site-Wide Permit.

1.3.2 Relationship to Component Closure Activity Plans

DOE intends to submit certified component closure activity plans (Tier 3) for the various components of WMA S-SX, such as individual or groups of tanks, ancillary equipment (e.g., piping), soil, and groundwater. The component closure activity plans, or equivalent documents, will be developed to be consistent with the overall WMA strategy for closure. Each approved component closure activity plan will become an attachment to this closure action plan (e.g., Attachments D1, D2, etc.). If equivalent documents are used, they will be approved through incorporation into the Site-Wide Permit.

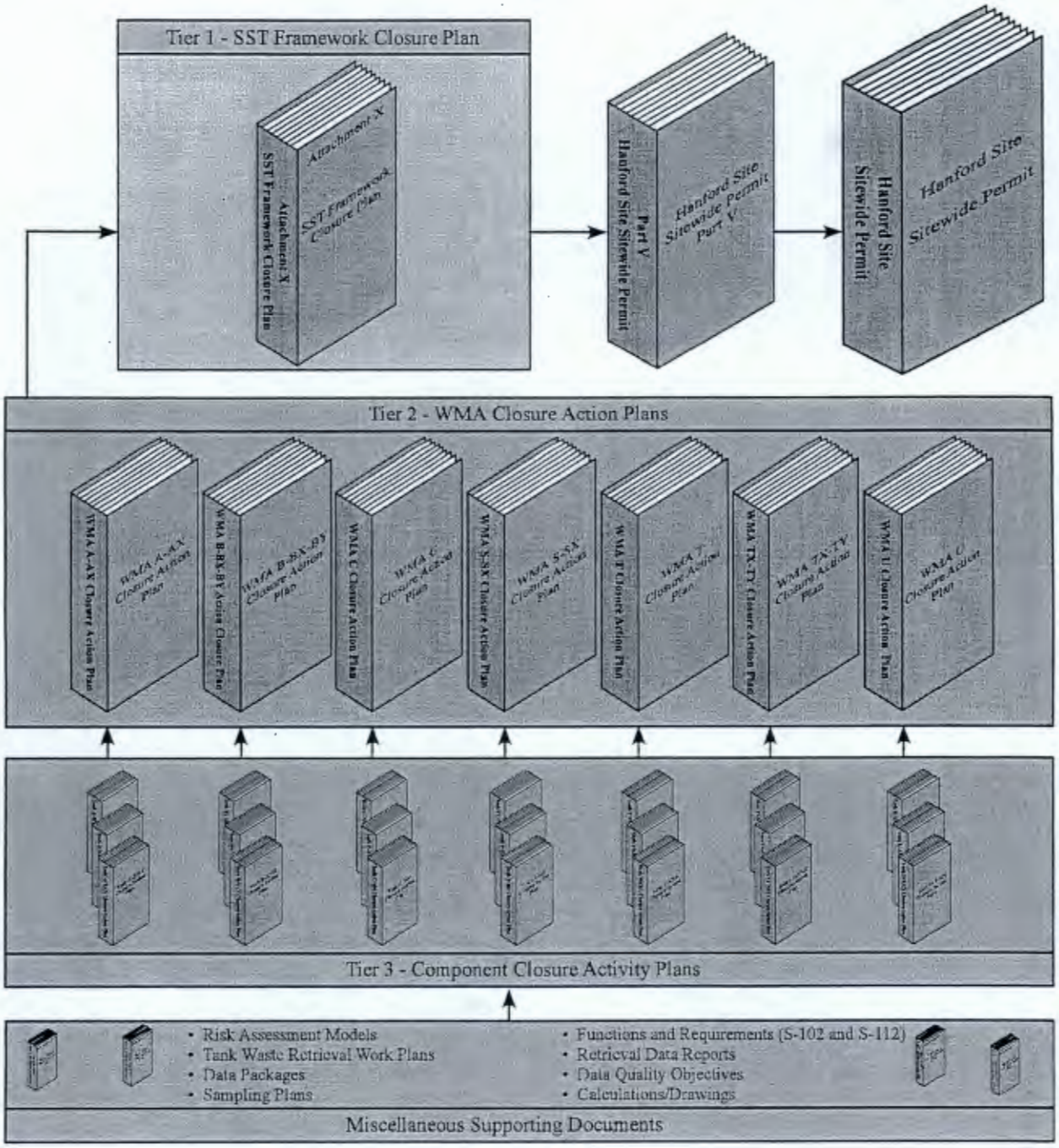
Contaminated soil and groundwater attributed to WMA S-SX operations may require remediation as part of closing WMA S-SX. Corrective actions for soil will be described either in a component closure activity plan or a RCRA field investigation/corrective measures study (RFI/CMS) pursuant to HFFACO Milestone M-45-60. Decisions regarding soil remediation will be incorporated in the Site-Wide Permit. Groundwater remediation decisions will be determined by U.S. Environmental Protection Agency (EPA), Washington State Department of Ecology

(Ecology), and DOE. If necessary, groundwater will be remediated as part of an integrated Site-Wide Permit action in accordance with a CERCLA ROD.

1.3.3 Relationship to Site-Wide Permit

All WMA closure action plans and component closure activity plans, including contingent plans for landfills in accordance with WAC 173-303-640(8)(c), will be incorporated through the permit modification process into Part V, "Unit-Specific Conditions for Units Undergoing Closure," of the Dangerous Waste Portion of the Site-Wide Permit as they are approved. At that time, they will become subject to the terms and conditions of the permit. Upon completion of all closure activities in the WMA, final post-closure requirements will be specified in a post-closure permit application for incorporation into Part VI of the Site-Wide Permit.

Figure 1-1. *Single-Shell Tank System Closure Plan* Document Structure.



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2.0 WMA S-SX DESCRIPTION

WMA S-SX is comprised of the S and SX tank farms. WMA S-SX is located in the southwest quadrant of the 200 West Area, near the Reduction and Oxidation Extraction (REDOX) Plant (Figures 2-1 and 2-2). In general, the WMA S-SX boundary is represented by the combined fenceline surrounding the S and SX tank farms.

Each of the 12 S tank farm tanks is 23 m (75 ft) in diameter, has a 30.5-cm (12-in.) dish bottom, a 7-m (23-ft) operating depth, approximately 11.4 m (37.3 ft) tall from base to dome, and an operating capacity of 2,880,400 L (758,000 gal) (WHC-SD-WM-ER-560, *Historical Vadose Zone Contamination of S and SX Tank Farms*). Each of the 15 SX tank farm tanks is 23 m (75 ft) in diameter with a 9-m (30-ft) operating depth, approximately 13.4 m (44 ft) tall from base to dome, and an operating capacity of 3,785,000 L (1,000,000 gal). Typical tank configuration and dimensions are shown in Figure 2-3. The tanks sit belowgrade with at least 2.5 m (8.1 ft) of soil at the S tank farm and 1.8 m (6 ft) of soil at the SX tank farm to provide shielding from radiation exposure to operating personnel.

S tank farm was constructed during 1950 and 1951. The S tanks were designed to withstand fluid temperatures up to 104 °C (220 °F). Construction of SX tank farm started in 1953 and was completed in 1955. The SX tanks were designed to hold self-boiling waste, with temperatures up to 121 °C (250 °F) for a period of 1 to 5 years. Both S and SX SSTs were constructed with cascade overflow lines in three-tank series to allow gravity flow of liquid waste between the tanks. However, these lines were not used in the SX tank farm.

The routing of liquid waste from the operations buildings to the tank farms was performed using underground piping (transfer lines) and diversion boxes. Numerous transfer lines and three diversion boxes have been identified for the WMA S-SX (Section 2.3). The diversion boxes housed the switching facilities through which waste could be routed from one transfer line to another. The diversion boxes are concrete boxes that were designed to contain any waste that leaked from the waste transfer line connections. Diversion boxes generally drained by gravity to nearby catch tanks where any spilled waste was stored and then pumped to SSTs (DOE/RL-92-04, *PUREX Source Aggregate Area Management Study Report*). Figure 2-4 shows a schematic of a typical diversion box.

Figure 2-1. Location Map of the 200 West Area and WMA S-SX at the DOE Hanford Site in Eastern Washington.

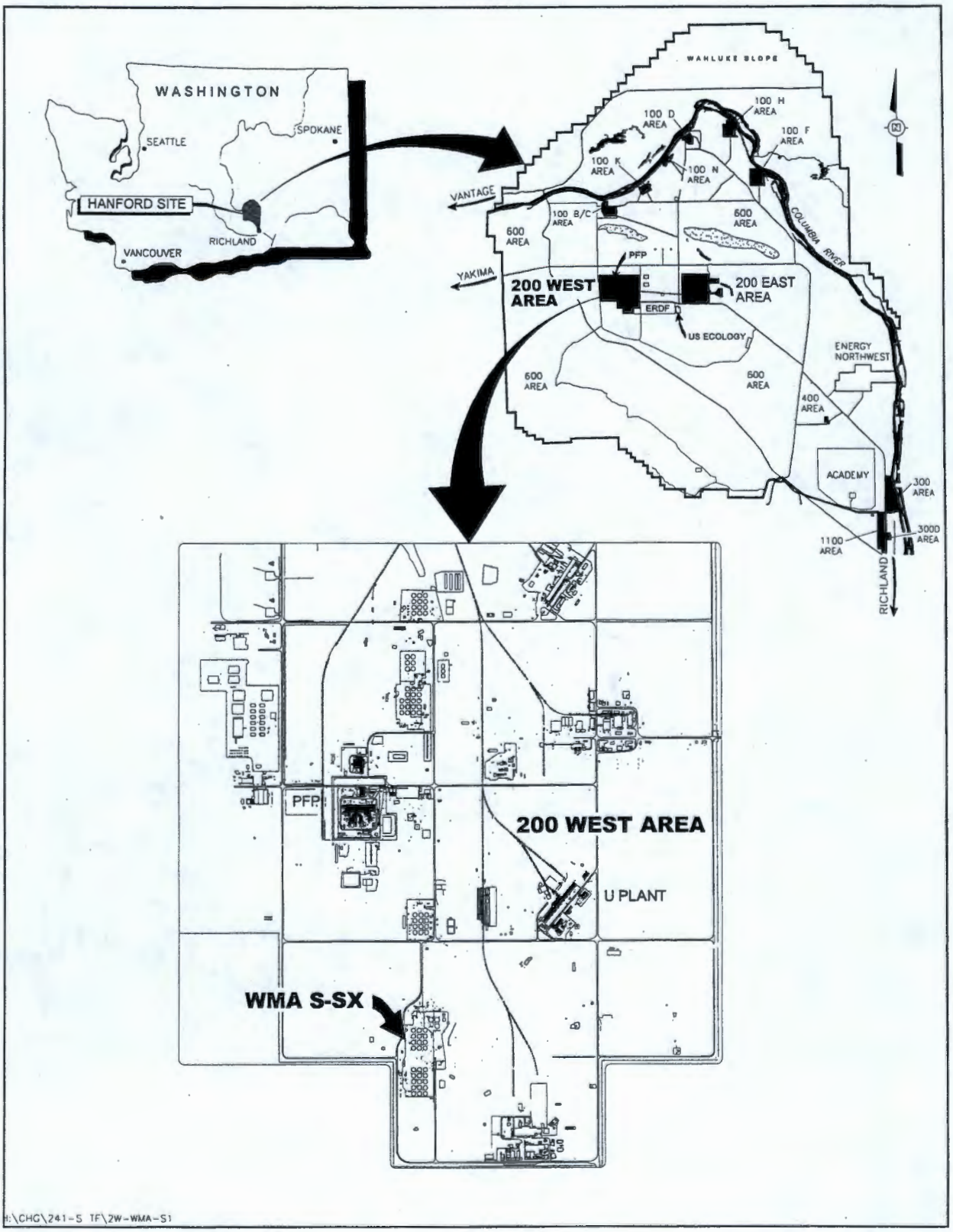


Figure 2-2. Map of WMA S-SX.

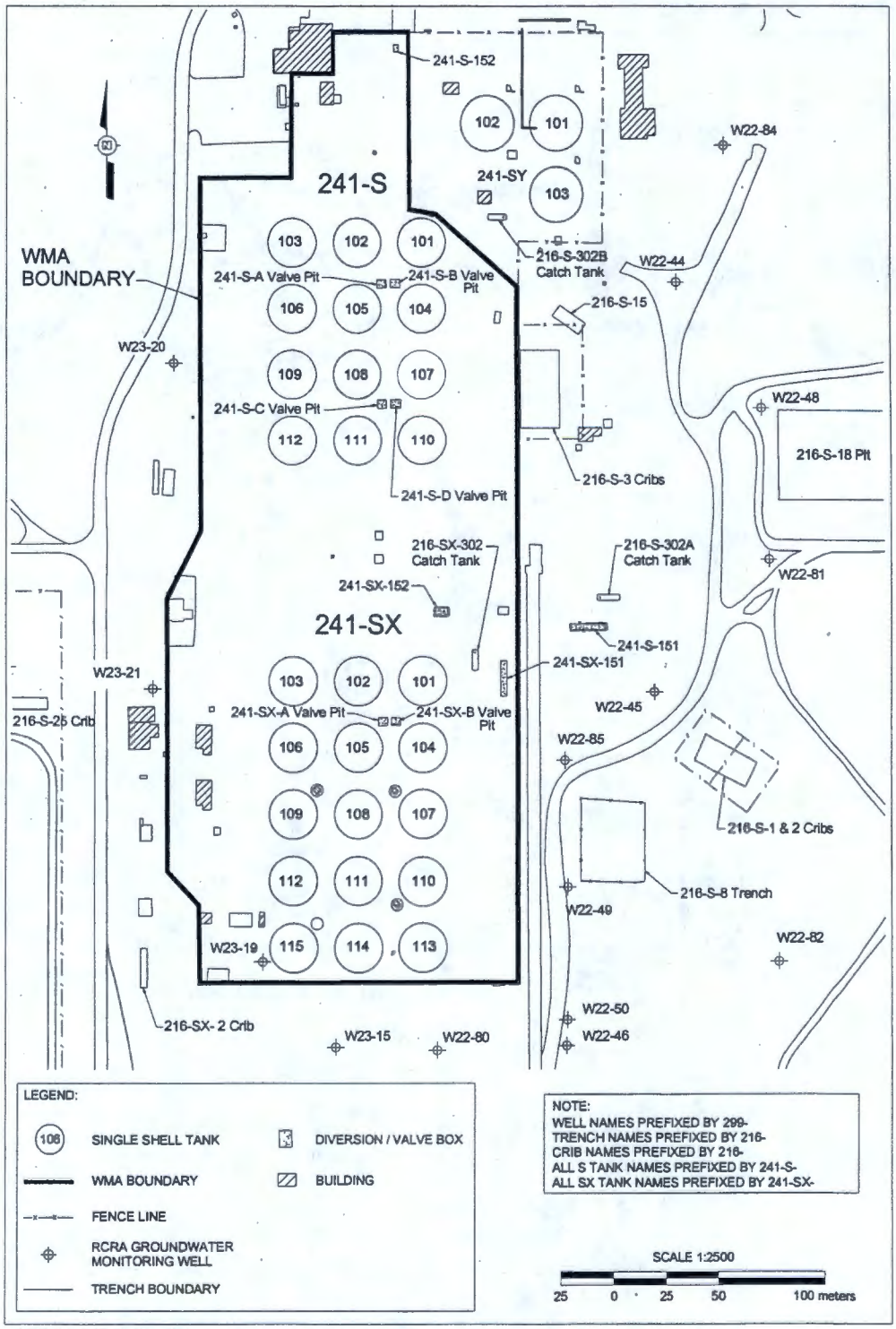


Figure 2-3. Typical Configuration and Dimensions of SSTs.

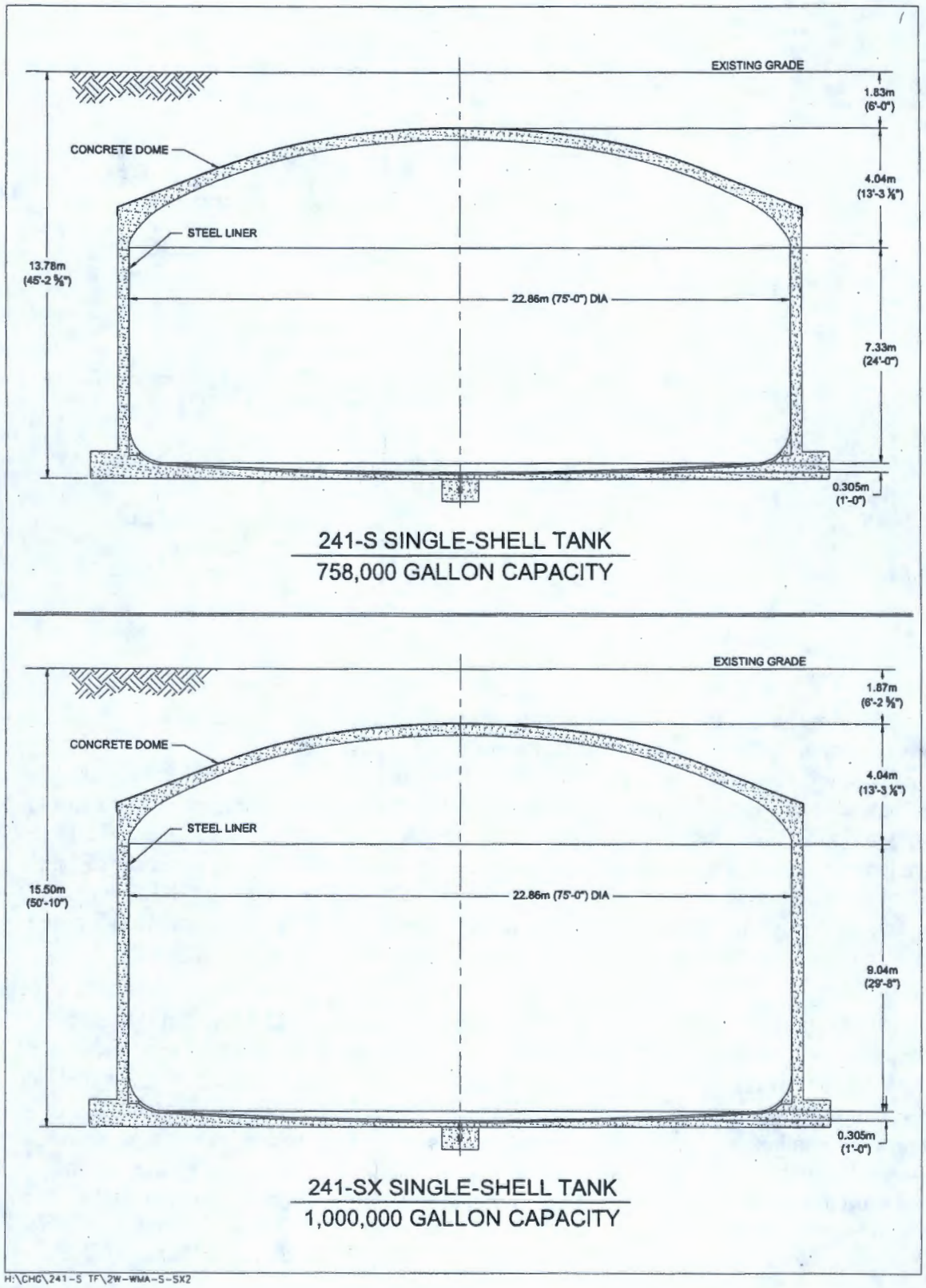


Figure 2-4. Schematic of a Typical Diversion Box Transfer System.

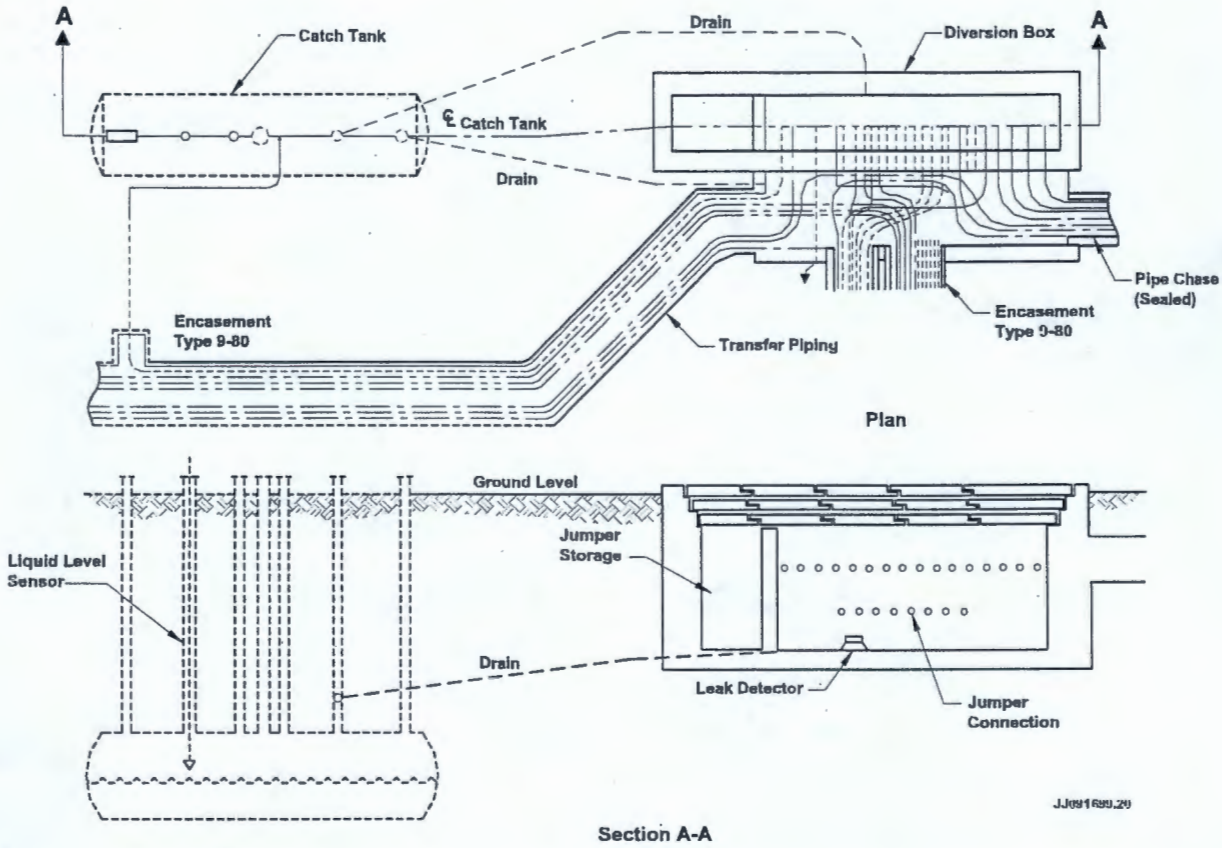


Table 2-1 provides the inventory and stabilization/isolation status of the SSTs in WMA S-SX. Inventories are updated on a quarterly basis. Because of the advanced age of the SSTs, most of the pumpable liquids have been removed from the SSTs and transferred to double-shell tanks (DST) as part of interim stabilization. The tanks in WMA S-SX have all been interim stabilized (IS) as of March 31, 2004, with the exception of five tanks. SSTs S-101, S-111, and SX-102 are being evaluated to confirm the interim stabilization criteria have been met. In accordance with the Third Amendment to Consent Decree (September 9, 2003), SSTs S-102 and S-112 were removed from the Consent Decree interim stabilization requirements, as the tanks are scheduled to undergo retrieval as a closure activity.

Interim stabilized (IS) means that the tank now contains less than 189,250 L (50,000 gal) of drainable interstitial liquid and less than 18,925 L (5,000 gal) supernatant liquid and, if a jet pump is used, the flow rate is below 0.05 gpm as provided in *State of Washington v. Department of Energy*, Consent Decree No. CT-99-5076-EES, U.S. District Court, Eastern District of Washington (September 30, 1999). The interstitial liquid volume for the waste phases of saltcake and sludge, assuming the waste is saturated, is calculated by multiplying the volume associated with the waste phase by the estimated porosity volume. Average saltcake and sludge porosity values are estimated to be 24% and 17%, respectively (HNF-2978, *Updated Pumpable Liquid Volume Estimates and Jet Pump Durations for Interim Stabilizations of Remaining*

Single-Shell Tanks). Waste volumes are updated on a quarterly basis in the best-basis inventory, and will document changes resulting from in-tank physical and chemical processes that may cause settling, condensing, stratification, and segregation of waste components. Retrieval designation "R" is given to tanks scheduled for removal of waste to the maximum extent practical, generally focusing on the removal of solids from the tank (HNF-EP-0182, *Waste Tank Summary Report for Month Ending March 31, 2004*).

Table 2-1. Inventory and Status by Tank as of March 2004[a].

Tank 241-	Stabilization/ isolation status	Total waste		Supernatant liquid		Sludge		Saltcake	
		L x 1000	gal x 1000	L x 1000	gal x 1000	L x 1000	gal x 1000	L x 1000	gal x 1000
S-101	IS	1329	351	0	0	890	235	439	116
S-102	R	1658	438	0	0	83	22	1575	416
S-103	IS/R	901	238	0	0	34	9	863	228
S-104	IS	1090	288	0	0	500	132	591	156
S-105	IS/R	1537	406	0	0	8	2	1529	404
S-106	IS/R	1722	455	0	0	0	0	1722	455
S-107	IS	1173	310	0	0	1074	283	99	26
S-108	IS	2082	550	0	0	19	5	2063	545
S-109	IS	2018	533	0	0	49	13	1968	520
S-110	IS	1473	389	0	0	363	96	1109	293
S-111	IS	1557	411	0	0	245	65	1151	304
S-112	R	1096	290	0	0	23	6	1073	283
SX-101	IS	1582	418	0	0	545	144	1037	274
SX-102	IS	1544	408	0	0	209	55	1335	353
SX-103	IS	1927	509	0	0	295	78	1632	431
SX-104	IS	1688	446	0	0	515	136	1173	310
SX-105	IS	1420	375	0	0	238	63	1181	312
SX-106	IS	1499	396	0	0	0	0	1499	396
SX-107	IS	360	95	0	0	299	79	61	16
SX-108	IS	276	73	0	0	276	73	0	0
SX-109	IS	912	241	0	0	220	58	693	183
SX-110	IS	212	56	0	0	110	29	102	27
SX-111	IS	435	115	0	0	288	76	148	39
SX-112	IS	284	75	0	0	212	56	72	19
SX-113	IS	72	19	0	0	72	19	0	0
SX-114	IS	587	155	0	0	155	41	431	114
SX-115	IS	15	4	0	0	15	4	0	0

Notes:

[a] per HNF-EP-0182, *2004, Waste Tank Summary Report for Month Ending March 31, 2004*, Rev. 192, CH2M HILL Hanford Group, Inc., Richland, Washington.

IS = interim stabilized.

R = retrieval.

2.1 OPERATIONAL HISTORY OF WMA S-SX

The S and SX tank farms were built to store REDOX plant waste, which was allowed to self-boil or self-concentrate. The S tank farm was built between 1950 and 1951. The SX tank farm was built between 1953 and 1954.

The S tank farm began operation in 1951. The tanks were filled with REDOX waste by 1953. The REDOX process was known to produce a high-heat load waste; however, the waste was not expected to produce enough heat to initiate boiling. However in the summer of 1952, the waste in the tanks began self-boiling because of the radioactive decay heat load in the REDOX waste. Surface condensers were installed to remove excess liquid in the tanks. The condensed vapor was disposed in the nearby cribs. Concentration of the waste was further aided by the 242-S Evaporator when it came on line in 1973. After REDOX plant was deactivated, the S tank farm tanks were used to store the bottom waste from the evaporator. The S tank farm was removed from service in the late 1970s and early 1980s.

The SX tank farm operation began in 1954 with the first six tanks (SX-101 through SX-106). The last nine tanks began operation in late 1955. The tanks received REDOX plant waste and first-cycle condensate, the remaining nine tanks received REDOX high-level boiling waste. The first two tanks (S-101 and S-102) were full by early 1954. SST SX-106 served as a slurry receiver and as a temporary storage repository for laboratory waste and, therefore, did not fill as quickly as the other tanks. SST SX-105 and SSTs SX-107 through SX-115 were designed to handle REDOX high-level boiling waste. Heat loads within the tanks were reduced by allowing supernatants to evaporate and, as needed, return as condensates to maintain desired liquid levels. Most of the tanks were filled with waste by 1955, and the waste self-concentrated in the following few years. During the 1960s and 1970s, nine tanks developed leaks and were removed from service.

Twenty-nine unplanned releases (UPR) have occurred within or adjacent to WMA S-SX. The following brief descriptions of the UPRs are summarized from *Historical Vadose Zone Contamination of S and SX Tank Farms* (HNF-SD-WM-ER-560) and represent the best information available on the nature and extent of releases. There exists uncertainty regarding the volume and content of UPRs from components within the WMA S-SX. A description of this inventory is given in Section 4.0. Estimates of contaminant release volumes and inventories for some UPRs are included in the WMA S-SX inventory data package associated with the risk assessment data presented in Section 7.0. These estimates will be revised as new information becomes available. The UPR sites will be addressed as potentially contributing sources to the soil component and will be part of the soil component investigation and cleanup.

- UPR-200-W-13 and UPR-200-W-15 occurred in 1952 at the 207-S basin. The cause of the contamination was the failure of the process coils inside the REDOX Plant. The 207-S basin was closed in April 1954 and backfilled, with the waste line rerouted around it.

- UN-200-W-20 contaminated a 93-m^2 (1,000-ft^2) area near the SX tank farm construction site in February 1953. The spill originated from the 241-S-151 diversion box. The area was covered with gravel and removed from radiation zone status in January 1971.

- UPR-200-W-36 occurred when casing ruptured while deepening test well 299-W22-3 through contaminated soil. The release occurred in August 1955 at the 216-S-1 and 216-S-2 cribs. The well was backfilled, and the 261-S-1 and 216-S-2 cribs were removed from service in January 1956.

- UPR-200-W-49 involves a 46-m^2 (500-ft^2) area located just outside the southeast corner of SX tank farm and occurred in July 1958. The source of contamination was not specified.

- UPR-200-W-50 comprises approximately 2 acres to the east of SX tank farm. The release occurred in August 1958, and the source was listed as SST SX-113.

- UPR-200-W-51 and UPR-200-W-52 both occurred in 1958 as a result of leaks from 241-S-151 diversion box. UPR-200-W-51 is described as a narrow strip of ground south of the diversion box. Unplanned release UPR-200-W-52 is an oval shaped 91-m (300-ft) wide area, from 241-S-151 diversion box to 10th Street, southeast of SX tank farm. The contaminated soil was saturated with water and turned over with a bulldozer.

- UPR-200-W-80 occurred at the 244-S constructions site in October 1978. The source of the contamination was listed as S and SX tank farms.

- UPR-200-W-81 resulted from airborne contamination that migrated between S and SX tank farms in January 1979. The area was cleaned and released. However, later monitoring detected more contamination, and the area was reposted as a radiation zone. The event is limited to the ground surface (DOE-GJPO, 1996, *Hanford Tank Farms Vadose Zone, S Tank Farm Report*).

- UPR-200-W-82 was contamination migration outside the boundary of the radiation zone surrounding the 241-S-151 diversion box and the 241-S-302A catch tank, and was reported in January 1980. The site was decontaminated.

- UPR-200-W-95 (UN-200-W-2) was the collective designation for a number of REDOX coil leaks that contaminated cooling water discharged to basin 207-S between 1952 and 1954. The basin was closed in April 1954. Upon closure, the basin was backfilled, and the waste line was rerouted around it.

- UPR-200-W-104 (UN-200-W-14), UPR-200-W-105 (UN-200-W-15), and UPR-200-W-106 (UN-200-W-16) were the designations given for planned overflow from the 216-U-10 pond. In August 1955, three overflow trenches were excavated eastward from the 216-U-10 pond, in the northwest corner of S tank farm, to provide additional leaching capacity for the pond.

- UPR-200-W-141 was a release of approximately 9,000 L (2,400 gal) of waste from SST SX-108 in 1962. This leak resulted in the tank being removed from service.

- UPR-200-W-145 was the reclassification of SST SX-113 from an assumed leaker to a confirmed leaker. The tank was classified as an assumed leaker in 1958, and was

removed from service that year. The reclassification to confirmed leaker occurred in 1962.

- UPR-200-W-140 was a release of approximately 19,000 L (5,000 gal) of waste from SST SX-107 in 1964. The contamination spread laterally. This leak resulted in the tank being removed from service.

- UPR-200-W-142 was a release of approximately 19,000 L (5,000 gal) of waste from SST SX-109 in 1965. This leak resulted in the tank being removed from service.

- UPR-200-W-146 was a release of approximately 189,000 L (50,000 gal) of waste from SST SX-115 in 1965. This leak resulted in the tank being removed from service.

- UPR-200-W-144 was a release of approximately 114,000 L (30,000 gal) of waste from SST SX-112 in 1969. This leak resulted in the tank being removed from service.

- UPR-200-W-108 was contamination water that was observed in January 1969 at the junction of the new line to 216-S-23 crib and the existing line from 216-S-9 crib during the construction of 216-S-23 crib. Excavation of the junction disclosed a severe expansion buckle of the line. The amount of waste discharged to the ground by this break is unknown.

- UPR-200-W-109 was contaminated water caused by an expansion buckle and line break from the 216-S-23 crib inlet line further upstream from unplanned release UPR-200-W-108, just inside the perimeter chain of the 218-W-9 solid waste burial site. The amount of waste discharged to the ground by this break is unknown.

- On November 14, 1973, waste from a loose tank riser flange leaked onto the ground during the transfer of waste from SST S-107 to SST S-102. The volume of waste was 3,300 L (8,660 gal) and contained 1,000 Ci of ^{137}Cs. No UPR number was assigned to this spill.

- UPR-200-W-143 was a release of approximately 8,000 L (2,000 gal) of waste from SST SX-111 in 1974. This leak resulted in the tank being removed from service.

- UPR-200-W-127 was a pool of liquid discovered on the ground on the east side of the 242-S Evaporator in February 1980. This area was covered with clean soil.

- UPR-200-W-114 was contamination discovered east of the SX tank farm, and included the 216-S-1 and 216-S-2 cribs. The contamination was found in September 1980, and the area was stabilized in 1993.

- UPR-200-W-115 was contamination discovered in September 1980, above a pipe encasement running north from the 242-S Evaporator to the U tank farm.

- UPR-200-W-165 was contamination of an area extending from the SY tank farm to the closed 216-S-23 trench. The release was discovered in 1985 and is of unknown origin.

In 1993, the contaminated soil was scraped and consolidated on top of the trench and covered with clean soil.

2.2 TANK INTEGRITY SUMMARY

In S tank farm, SST S-104 is the only tank that classified as an "assumed leaker". In SX tank farm, 10 out of 15 tanks are considered "assumed leakers" per HNF-EP-0182, *Waste Tank Summary Report for Month Ending November 30, 2002* (2002). The "assumed leaker" classification is assigned to a tank when vadose data or surveillance data indicates a potential loss of liquid attributed to a breach of integrity. Estimated leak volume and the impact to the vadose zone are provided in Section 4.0.

2.3 COMPONENTS OF WMA S-SX

The components that will be included in the WMA S-SX closure action are listed in Table 2-2. This list is extracted from Addendum 1 of the Framework Plan, which incorporates units listed on the RCRA Part A, Form 3, Rev. 8 permit application, in addition to RCRA Past Practice, CERCLA Past Practice, and Miscellaneous Storage Tank units. While most WMA S-SX components are physically located within the S and SX tank farm fenceline (also the WMA S-SX boundary), some components extend beyond (e.g., pipelines and groundwater) or are located outside of the WMA boundary. Closure actions for components extending or outside of the WMA boundary will be addressed through separate closure plans and modifications to the Hanford Site-Wide Permit.

For the purposes of closure, the SSTs are RCRA storage tanks. The diversion boxes are RCRA waste piles (it is estimated that each box contains 23 kg [50 lb] of lead). The regulatory designation of the other components will be determined as they are addressed in component closure activity plans.

1

Table 2-2. WMA S-SX Components. (8 Sheets)

Single-shell tanks				
Tank 241-	Constructed	Removed from service[a]	Constructed operating capacity L	(gal)
S-101	1950-1951	1980	2,880,400	(758,000)
S-102	1950-1951	1980	2,880,400	(758,000)
S-103	1950-1951	1980	2,880,400	(758,000)
S-104	1950-1951	1968	2,880,400	(758,000)
S-105	1950-1951	1974	2,880,400	(758,000)
S-106	1950-1951	1979	2,880,400	(758,000)
S-107	1950-1951	1980	2,880,400	(758,000)
S-108	1950-1951	1979	2,880,400	(758,000)
S-109	1950-1951	1979	2,880,400	(758,000)
S-110	1950-1951	1979	2,880,400	(758,000)
S-111	1950-1951	1972	2,880,400	(758,000)
S-112	1950-1951	1976	2,880,400	(758,000)
SX-101	1953-1954	1980	3,785,000	(1,000,000)
SX-102	1953-1954	1980	3,785,000	(1,000,000)
SX-103	1953-1954	1980	3,785,000	(1,000,000)
SX-104	1953-1954	1980	3,785,000	(1,000,000)
SX-105	1953-1954	1980	3,785,000	(1,000,000)
SX-106	1953-1954	1980	3,785,000	(1,000,000)
SX-107	1953-1954	1964	3,785,000	(1,000,000)
SX-108	1953-1954	1962	3,785,000	(1,000,000)
SX-109	1953-1954	1965	3,785,000	(1,000,000)
SX-110	1953-1954	1976	3,785,000	(1,000,000)
SX-111	1953-1954	1974	3,785,000	(1,000,000)
SX-112	1953-1954	1969	3,785,000	(1,000,000)
SX-113	1953-1954	1958	3,785,000	(1,000,000)
SX-114	1953-1954	1972	3,785,000	(1,000,000)
SX-115	1953-1954	1965	3,785,000	(1,000,000)

Miscellaneous tanks	
Facility number	Description
240-S-302 (RPP)	Catch tank
241-S-302A (DST[b], CPP)	Catch tank
241-SX-302 (aka 241-SX-304) (RPP)	Catch tank
241-S-304 (DST)	Catch tank
200-W-7 (aka 243-S-TK-1; aka 246-L) (RPP)	Catch tank

Table 2-2. WMA S-SX Components. (8 Sheets)

Diversion boxes	
Facility number	**Description**
241-S-302B (RPP)	Catch tank
240-S-151 (DST)	Diversion box
240-S-152	Diversion box
241-S-151 (DST)	Diversion box
241-S-152	Diversion box
241-SX-151	Diversion box
241-SX-152	Diversion box
Miscellaneous structures	
Facility number	**Description**
241-SX-401 (RPP)	Condenser shielding building
241-SX-402 (RPP)	Condenser shielding building
242-S (RPP)	Evaporator
Valve pits	
Facility number	**Description**
241-S-A (DST)	Valve pit
241-S-B (DST)	Valve pit
241-S-C	Valve pit
241-S-D	Valve pit
241-SX-A	Valve pit
241-SX-B	Valve pit
Single-shell tank pits	
Facility number	**Description**
241-S-02A	Pump Pit
241-S-03A	Pump Pit
241-S-04A	Pump Pit
241-S-05A	Pump Pit
241-S-06A	Pump Pit
241-S-08A	Pump Pit
241-SX-03A	Pump Pit
241-SX-04A	Pump Pit
241-SX-05B	Heel Pit
241-SX-06A	Pump Pit
241-SX-07A	Pump Pit
241-SX-08A	Pump Pit
241-SX-09A	Pump Pit
241-SX-10A	Pump Pit

Table 2-2. WMA S-SX Components. (8 Sheets)

Single-shell tank pits	
Facility number	**Description**
241-SX-11A	Pump Pit
241-SX-12A	Pump Pit
241-SX-13A	Pump Pit
241-SX-14A	Pump Pit
241-SX-15A	Pump Pit
241-S-02A	Pump Pit
241-S-03A	Pump Pit
241-S-04A	Pump Pit
241-S-05A	Pump Pit

Transfer lines		
Line number	**Connecting facility**	**Connecting facility**
103	241-SX-103-03-A	Capped
105	241-SX-105	241-SX-152
107	241-SX-107-07A-1	241-SX-152
108	241-SX-108-08A-1	241-SX-152
109	241-SX-109-09A-1	241-SX-152
110	241-SX-110-10A-1	241-SX-152
111	241-SX-111-11A-1	241-SX-152
112	241-SX-112-12A-1	241-SX-152
113	241-SX-113-13A-1	241-SX-152
114	241-SX-114-14A-1	241-SX-152
115	241-SX-115-15A-1	241-SX-152
234	241-S-102-02A-A	Unknown
235	241-S-102-02A-AA	Unknown
312	241-SX-102	Clean Out Boxes-15 through -22
318	241-SX-102	241-SX-A, SX-B Valve Pit
456	241-SX-152	Capped
540	241-S-107-07A	241-S-151-L18
703	241-TX-109-09A-A	241-T-151-U3
704	SN-249	241-TX-109-09A-D
704	SN-249	241-TY-103-A
704	SN-249	241-TY-102
704	SN-249	241-TY-105
1006	205-S	240-S-152-U2
1045	240-S-152-U1	204-S
1115	240-S-151-U6	202-S
1140	240-S-151-U15	202-S

Table 2-2. WMA S-SX Components. (8 Sheets)

Transfer lines		
Line number	**Connecting facility**	**Connecting facility**
1145	240-S-151-U9	202-S
1238	202-S	240-S-151-U10
1540	240-S-151-U14	202-S
1541	240-S-151-U5	202-S
3130	240-S-151-U1	202-S
3591	240-S-151-U18	202-S
3592	240-S-151-U19	202-S
3603	240-S-151-U7	Capped
3610	240-S-151-U16	202-S
3635	240-S-151-U11	202-S
3658	240-S-151-U4	202-S
3666	240-S-151-U2	202-S
4242	240-S-151-U13	202-S
Drain Line	241-S-102-02A-F	241-S-152
Drain Line	241-S-107	241-S-B Valve Pit
Drain Line	241-S-107	241-S-C Valve Pit
Drain Line	241-S-107	241-S-D Valve Pit
Drain Line	241-S-302-B	241-S-302-A
Flush Line	241-S-A-L8,-L17	241-S-A Valve Pit
Flush Line	241-S-B-R6,-R8-,R17	241-S-B Valve Pit
Flush Line	241-S-C-L8,-L17	241-S-C Valve Pit
Flush Line	241-S-D-R6,-R8,-R17	241-S-D Valve Pit
Flush Line	241-SX-A-L6,-L17	241-SX-A Valve Pit
Flush Line	241-SX-A-R6,-R17	241-SX-B Valve Pit
SL101	241-S-152-Nozzle 1	Blocked
SL115	241-S-A	241-S-C
SL116	211-S-B-R10	241-S-D-R3
SL117	241-S-C	241-SX-A
SL118	241-S-D	241-SX-B
SL119	241-S-103-03A-B	241-S-A-L7
SL120	241-S-106-B	241-S-A-L9
SL-121	241-S-101-01A-B	241-S-B-R5
SL122	241-S-105-05A	241-S-B-R9
SL123	241-S-109-09A-B	241-S-C-L7
SL124	241-S-108-08A-B	241-S-C-L5
SL125	241-S-112-12A-B	241-S-C-L9

Table 2-2. WMA S-SX Components. (8 Sheets)

Transfer lines		
Line number	**Connecting facility**	**Connecting facility**
SL126	241-S-D	None Identified
SL127	241-S-110-10A	241-S-D-R7
SL128	241-S-111-11A-B	241-S-D-R9
SL129	241-SX-103	241-SX-A
SL130	241-SX-102-02B-B	241-SX-A-L5
SL131	241-SX-106-06A-B	241-SX-151-L9
SL132	241-SX-105	241-SX-B-R9
SL133	241-SX-104-04A-B	241-SX-B-R7
SL134	241-S-A-L18	241-S-D-R18
SL137	241-SX-101-01A	241-SX-B-R5
SL138	241-S-152	242-S Evaporator
SL138	241-S	SL-175
SL139	241-S-152-4	Capped
SL139/SL114	242-S Evaporator	241-S-B
SL140	241-S-102	241-S-A
SL175	241-S-152-8	Failed
SL175	SL-138	241-SY-A
SL175/S138	241-SY-A-L3	242-S Evaporator
SL219	241-S-103-03A-A	241-S-A-L15
SN200	241-S-102	241-S-152-5
SN201	241-S-102	241-S-152-7
SN213	241-S-102	241-S-A-L1
SN214	241-S-102	241-SB-R1
SN215	241-S-A-L14	241-S-C-L1
SN216	241-S-152-9	Capped
SN216	241-S-B-R12	241-S-D-R1
SN216/SN282	241-U-D	241-SY-B
SN217	241-S-C-L12	241-SX-A-L1
SN218	241-S-D-R12	241-SX-B-R1
SN220	241-S-106-06A-A	241-S-A-L16
SN221	241-S-101-01A-A	241-S-B-R14
SN222	241-S-105-05A	241-S-B-R16
SN223	241-S-109-09A-A	241-S-C-L15
SN224	241-S-108-08A-A	241-S-C-L14
SN225	241-S-112-12A-A	241-S-C-L16
SN226	241-S-107-07A-A	241-S-D-R14

Table 2-2. WMA S-SX Components. (8 Sheets)

Transfer lines		
Line number	**Connecting facility**	**Connecting facility**
SN227	241-S-110-10A	241-S-D-R15
SN228	241-S-111-11A-A	241-S-D-R16
SN229	241-SX-103-03B-A	241-SX-A-L15
SN230	241-SX-102-02B-A	241-SX-A-L14
SN231	241-SX-106-06A-A	241-SX-A-L16
SN233	241-SX-104-04A-A	241-SX-B-R15
SN239	241-S-C-L19	241-S-D-R19
SN241	241-SX-101-01A-A	241-SX-B-R14
SN242	241-S-102-02A-U6	241-S-A-L12
SN245	241-S-107-07A	244-S-18
SN246	241-S-107-07A	244-S-17
SN246	241-S-107-07A-B	241-S-D-R2
SN247	241-S-107-07A	244-S-16
SN248	241-S-107-07A	244-S-15
SN249	241-S-107-07A	244-S-14
SN275	241-SY-A	241-S-A
SN276	241-SY-B	241-S-B
SN281	241-S-152-10	Failed
SN282	241-S-152-11	Failed
Unknown	241-S-102-BB/B	Flush Pit
Unknown	241-S-103	Clean Out Boxes-9,-10
Unknown	241-S-109	Clean Out Boxes-13,-14
Unknown	241-S-A-L19	241-S-B-R19
Unknown	241-S-C-L18	241-S-D-R18
Unknown	241-SX-106	Clean Out Boxes-24,-25
Unknown	241-SX-A-L18	241-SX-B-R18
Unknown	241-SX-A-L19	241-SX-B-R19
Unknown	242-S Evaporator	241-S-103
V455	241-U-151-L8	241-S-151-U13
V458	241-U-153-U1	240-S-151-L9
V459	241-U-153-U2	240-S-151-L15
V460	241-U-153-U3	240-S-151
V5006	241-S-104-04A	241-S-107-07A
V508	240-S-151-L17	241-S-151-U6
V509	240-S-151-L16	241-S-151-U7
V510	241-S-151-U8	241-S-304-13

Table 2-2. WMA S-SX Components. (8 Sheets)

Transfer lines		
Line number	**Connecting facility**	**Connecting facility**
V512	240-S-151-L13	241-S-151-U10
V513	240-S-151-L12	241-S-151-U11
V514	240-S-151-L6	Capped
V515	240-S-151-L9	241-S-151-U14
V516	240-S-151-L7	241-S-151-U15
V517	240-S-151	Capped
V517	202-S	241-S-151
V519	240-S-151-L2	241-S-151-U18
V521	241-S-151-B2	241-S-151-B1
V526	241-SX-151-U13	241-S-151-L4
V527	241-SX-151-U10	241-S-151-L5
V528	241-SX-151-U8	241-S-151-L6
V529	241-SX-151-U6	241-S-151-L7
V530	241-SX-151-U4	241-S-151-L5
V533	241-S-151-L11	Crib
V534	241-S-110	241-S-151-L12
V535	241-S-110	241-S-151-L13
V536	241-S-107	241-S-151-L14
V537	241-S-107	241-S-151-L15
V538	241-S-104	241-S-151-L16
V539	241-S-104	241-S-151-L17
V541	241-S-101/101 S Caisson	241-S-151-L19
V542	241-S-304	241-S-151
V543	241-S-304	241-S-151
V544	240-S-151-L1	216-S Swamp
V547	240-S-151-L8	216-S Crib
V548	240-S-151-L10	V544/216 S Swamp
V550	240-S-151	V544/216-S Swamp
V552	240-S-151-U3	240-S-152-L2
V553	240-S-151-U8	240-S-142-L3
V554	240-S-151-L12	241-S-302-CT
V555	240-S-152-L1	240-S-151-U17
V563	241-SX-151-U1	241S-302A
V564	241-SX-151-U11	241-SX-151-U2
V566	241-SX-151-U9	241-SX-151-U5
V567/V581	241-SX-151-U7	241-SX-152

Table 2-2. WMA S-SX Components. (8 Sheets)

Transfer lines		
Line number	**Connecting facility**	**Connecting facility**
V569	241-SX-302-A	241-SX-151-L1
V570	241-SX-110	241-SX-151-L2
V571	241-SX-111	241-SX-151-L2
V572	241-SX-112	241-SX-151-L4
V574	241-SX-109	241-SX-151-L6
V575	241-SX-108	241-SX-151-L7
V576	241-SX-107	241-SX-151-L8
V577	241-SX-151-L9	241-SX-152
V578	241-SX-101	241-SX-151-L10
V579	241-SX-102	241-SX-151-L11
V580	241-SX-103-03	241-SX-151-L12
V582	241-SX-106	241-SX-151-L14
V583	241-SX-105	241-SX-151-L15
V584	241-SX-104	241-SX-151-L16
V591	241-SX-114	241-SX-151-L23
V595	241-SX-302-A	241-SX-152
Overground transfer lines as of April 23, 2002		
From	**To**	**Status**
S-111-11A Pit	S-C Valve Pit	Active
S-109-09A Pit	S-A Valve Pit	Active
S-A Valve Pit	S-C Valve Pit	Active
S-C Valve Pit	SX-A Valve Pit	Inactive
SX-101-01A Pit	SX-A Valve Pit	Active
SX-102-02B Pit	SX-A Valve Pit	Active
SX-103-03B Pit	SX-A Valve Pit	Active
SX-105-05A Pit	SX-A Valve Pit	Active

Notes:

[a]The last year the tank was capable of receiving waste; the actual date of last waste receipt may have been earlier.

[b]Listed on "Table of Disposition of Double-Shell Tank System Components Not In Use Beyond June 30, 2005," Administrative Order NWPKW-1250 and 1251, Corrective Measure 5 as double-shell tank system equipment that will be closed under RPP-13774b, 2004, *Single-Shell Tank System Closure Plan,* Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

aka = also known as.

CPP = CERCLA past practice unit.

DST = double-shell tank.

RPP = RCRA past practice unit.

3.0 PHYSICAL SETTING

The site topography, geology, vadose zone characteristics, and aquifer characteristics discussed in this section are based on information presented in the *Field Investigation Report for Waste Management Area S-SX* (RPP-7884, referred to as the Field Investigation Report [FIR]) and the *Hanford Site Groundwater Monitoring for Fiscal Year 2002* (PPNL-14187). Characterization information in the FIR is based on (1) historical waste processing information, (2) tank farm operational history, (3) historical groundwater monitoring and vadose-zone monitoring data, and (4) recent field investigation activities associated with the RCRA Corrective Action Program. Elevation values referenced in this section are based on the North American Vertical Datum of 1988 (NAVD 88). Ranges are provided for many vertical dimensions to reflect the variability of the strata underlying the large surface area (400 m x 150 m) [1300 ft x 500 ft] of the WMA. Stratigraphic nomenclature used in this section is consistent with the FIR and has not been upgraded with the recently standardized nomenclature for post-Ringold sediments as described in *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin* (DOE/RL-2002-39).

3.1 TOPOGRAPHY

The S-SX tank farms lie within a shallow, north-south trending topographic depression formed within the southwestern extent of the Cold Creek flood bar. This topographic feature, in combination with construction disturbance is conducive to collecting surface runoff, especially along the south side of the SX tank farm and the east side of S tank farm.

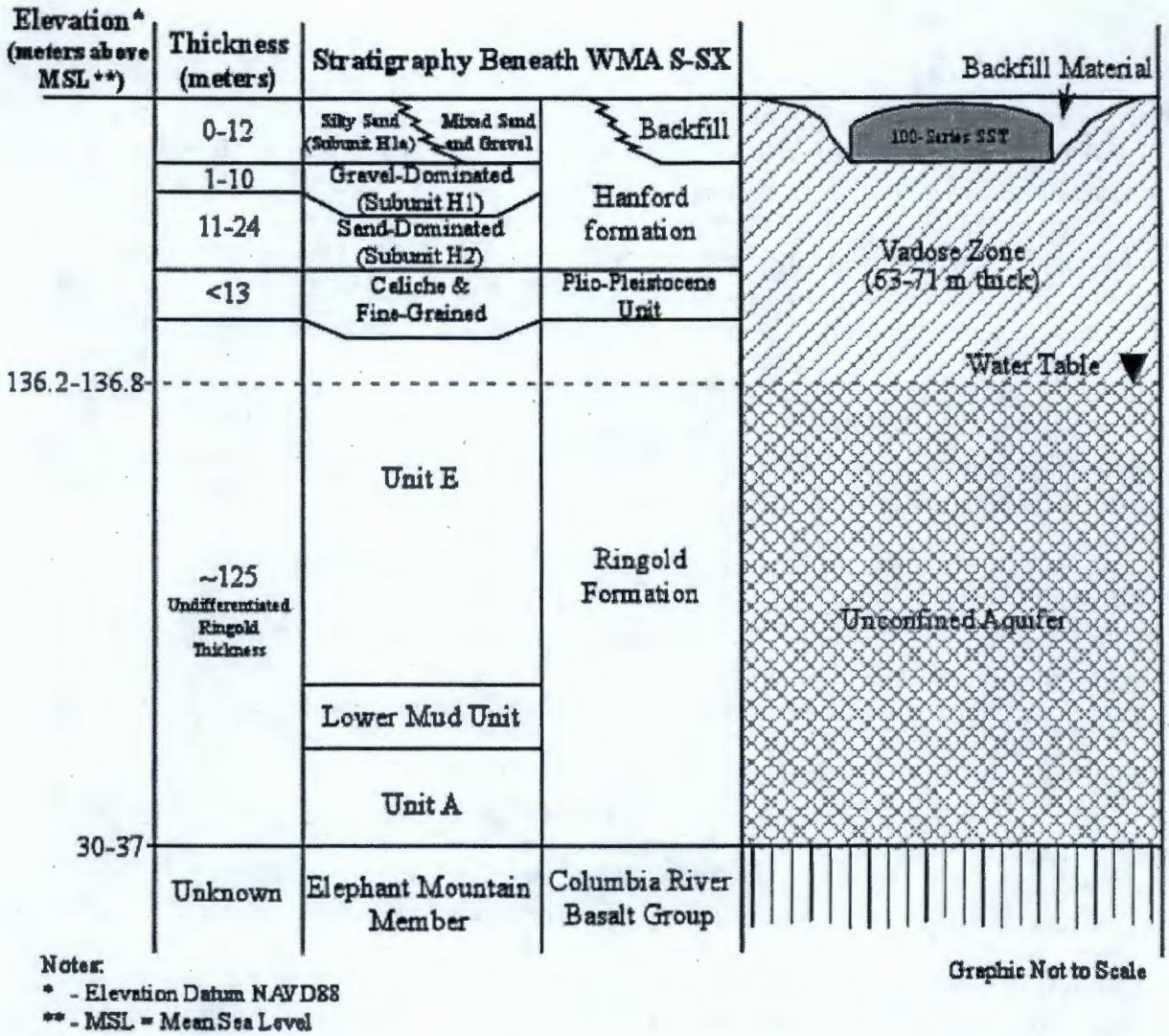
3.2 GEOLOGY

Figure 3-1 illustrates the generalized stratigraphic section for the WMA S-SX. The S and SX tank farms were excavated into the upper Hanford formation sediments that underlie the 200 West Area. Stratigraphic units in the vadose zone underlying or adjacent to these tank farms (in descending order) include backfill materials, sediments of the Pleistocene-age Hanford formation, the Plio-Pleistocene unit, and the Miocene- to Pliocene-age Ringold Formation.

The following description of geologic units beneath the WMA S-SX is summarized from the geology section of the FIR for WMA S-SX (RPP-7884):

Basalt - The Elephant Mountain Member of the Saddle Mountains Basalt Formation forms the bedrock below WMA S-SX. Boreholes associated with the WMA S-SX were not drilled deep enough to encounter the Elephant Mountain Member basalt; however the 200 West Area basalt surface map published in *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-West Area and Vicinity, Hanford Site, Washington* (PNNL-13858) depicts the top of basalt below WMA S-SX at 30 to 37 m (98.4 to 121.4 ft) elevation. This map indicates that the basalt surface slopes to the southwest.

Figure 3-1. Generalized Stratigraphy Beneath WMA S-SX.



Ringold Formation - The Ringold Formation lies directly on top of the Columbia River Basalt Group and is approximately 125 m (410 ft) thick beneath WMA S-SX. A relict erosional and weathered surface occurs at the top of the Ringold Formation beneath SX tank farm and dips to the southwest. The Ringold Formation locally consists of three principal stratigraphic units (Figure 3-1):

- Fluvial gravels of unit A
- Fine-grained, paleosol-lacustrine sequence referred to as the lower mud unit
- Fluvial gravels of unit E.

Ringold unit E contains the main unconfined aquifer beneath 200 West Area. In addition to the primary stratigraphic units described, clastic dikes may occur in the WMA S-SX vadose zone. Although clastic dikes have been observed in numerous locations in the vicinity of WMA S-SX, none have been recorded within WMA S-SX.

Plio-Pleistocene Unit - The Plio-Pleistocene unit sediments are divided into two distinct facies in WMA S-SX, the Plio-Pleistocene silt (PPlz) and the Plio-Pleistocene caliche (PPlc) subunits, in descending order. Subunit PPlz is characterized by an abundance of silt interstratified with fine sand and clay. Subunit PPlc is characterized by an abundance of pedogenic calcium-carbonate cement, often in multiple carbonate-cemented zones. The combined total thickness of the Plio-Pleistocene unit is up to 13.1 m (43 ft) in the vicinity of SX tank farm. Subunit PPlz is relatively thick (up to 10.7 m [35 ft]), compared to subunit PPlc, which measures only 1 to 4 m (4 to 13 ft) in thickness.

Hanford formation - The Hanford formation sediments are divided into three subunits in WMA S-SX (Figure 3-1). In ascending order, the subunits are H_2, H_1, and H_{1a}. Their characteristics are described as follows.

- **Subunit H_2** – Comprised predominantly of silty fine sand that ranges in thickness from about 24.3 m (80 ft) east of SX tank farm to approximately 10.7 m (35 ft) west of SX tank farm. The top of this subunit generally dips to the southwest, with some local relative highs and lows present throughout. The base of this subunit is indicated by a diagnostic increase in total gamma activity on borehole geophysical logs.

- **Subunit H_1** – Comprised primarily of a gravel to gravelly sand intercalated by coarse sand that appears to correlate beneath SX tank farm. This sequence ranges in thickness from 1 m (3 ft) to nearly 10 m (30 ft) beneath S tank farm. *Subsurface Interpretation of the SX Tank Farm Hanford Site, Washington Based on Gamma-Ray Logging* (Sobczyk 2000) reports subunit H1 to be thickest beneath SST S-102.

- **Subunit H_{1a}** – Comprised predominantly of interstratified slightly silty, medium to very fine sands, ranging in thickness from 0 m (0 ft), where it was removed during excavation of the S and SX tank farms, to about 9 to 12 m (30 to 40 ft) to the southwest. The top of this unit dips slightly to the southwest.

Backfill - Within WMA S-SX, the uppermost 12.2 m (40 ft) is backfill material consisting of mixed gravel, sand, and silt excavated from the eolian surficial deposits and Hanford formation during construction of the tank farms. The excavated soils were used to backfill the excavation and cover the tanks in the tank farms.

3.3 VADOSE ZONE DESCRIPTION

The vadose zone beneath WMA S-SX is approximately 63 to 71 m (207 to 232 ft) thick, based on December 2002 groundwater data (PNNL HydroDat Database 2002). Stratigraphic units in the vadose zone underlying or adjacent to WMA S-SX (in descending order) include backfill

materials and naturally occurring Hanford formation sediments, the Plio-Pleistocene unit, and the Ringold Formation. A brief description of each of these strata is in Section 3.1.

Directly beneath WMA S-SX, these strata tend to be of fairly uniform thickness and nearly flat-lying. Some units, such as the Hanford formation subunit H1 and the Plio-Pleistocene unit, dip gently to the southwest.

The subunit of particular importance to contaminant migration is a gravel-rich layer in the Hanford formation, subunit H1. This subunit lies close to the bottoms of SSTs SX-107, SX-108, and SX-109 and contains the majority of ^{137}Cs from leaks from these tanks.

The estimated vadose transit time for meteoric waters in S and SX tank farms ranges from 60 to 500 years dependant upon assumptions and model (RPP-7884). The vadose zone monitoring networks for S and SX tank farms are shown on Figures 4-1 and 4-2.

3.4 GROUNDWATER HYDROLOGY

Depth-to-groundwater measurements collected from 13 of the 17 WMA S-SX RCRA groundwater monitoring wells (Figure 5-1) on December 18, 2002, indicate that the elevation of the water table in the immediate vicinity of WMA S-SX ranges from 136.24 to 136.80 m (446.98 to 448.82 ft) (PNNL HydroDat Database 2002). Details on the nature of the unconfined, uppermost aquifer are provided in *RCRA Groundwater Quality Assessment Report for Waste Management Areas S-SX (November 1997 through April 2000)* (PNNL-13441) and the FIR (RPP-7884).

The water-table map for March 2001 (PNNL-13788, *Summary of Hanford Site Groundwater Monitoring for Fiscal Year 2001*) indicates that the direction of groundwater flow in the southern portion of the 200 West Area is primarily toward the east, with a slight southeastern component. The natural flow pattern in this area was altered by the formation of groundwater mounds created by the discharge of large volumes of wastewater at disposal facilities. The southeastern trend is more apparent in the area of the decommissioned U pond. Since the cessation of liquid discharge to U pond in 1985, these groundwater mounds are declining, and groundwater flow is gradually returning to pre-Hanford operational conditions. Measurements indicate that the water table is declining approximately 0.6 m/yr (2 ft/yr). This decline results in a shift to a more easterly flow direction and decreased flow rates as the gradient decreases. A water-table depth of about 71.6 to 73.2 m (235 to 240 ft) below ground surface (bgs) (approximately 129.88 to 131.48 m [426.13 to 431.38 ft] elevation) is anticipated when the groundwater mound completely dissipates (RPP-7884).

The unconfined aquifer in WMA S-SX resides in partially-cemented Ringold Formation sands and gravels of Ringold Unit E. The cementing is not present at greater depths. This may result in a more transmissive aquifer in the future as the water table continues to decline.

Hydraulic conductivities based on slug tests performed in WMA S-SX wells 299-W22-48, 299-W22-49, and 299-W22-50 range from 1.55 to 8.2 m/day (0.5 to 27 ft/day) (PNNL-13441). The effective porosity of aquifer materials beneath WMA S-SX ranges from 0.068 to 0.257

based on analysis of tracer tests conducted in the area (PNNL-13441). Hydraulic gradient, based on tracer test analysis, is about 0.002 whereas the groundwater velocity ranges from 0.013 to 0.374 m/day (0.04 to 1.2 ft/day) (PNNL-13441). Estimates of the rate of groundwater flow, using travel times for tritium between upgradient and downgradient wells in the vicinity of WMA S-SX, suggest groundwater flow rates of 25 to 50 m/yr or 0.07 to 0.14 m/day (82 to 164 ft/yr or 0.23 to 0.46 ft/day) (PNNL-12114, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*).

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4.0 CONTAMINATION ASSOCIATED WITH WMA S-SX

This section summarizes the known and suspected contamination associated with WMA S-SX. Additional information on the subsurface conditions beneath WMA S-SX are found in the FIR (RPP-7884) and the *Hanford Site Groundwater Monitoring for Fiscal Year 2002* (PNNL-14187).

4.1 POTENTIAL SOURCES

Vadose zone contamination in WMA S-SX is typically associated with spills and leaks associated with tank farm operations, tanks, and ancillary piping and equipment. Factors that affect contaminant movement include precipitation events and surface water run on, and leaked fluids originating from water supply pipe leaks, waste transfer pipe leaks, and liquid waste discharges. Section 2.1 contains a summary of the unplanned releases that have impacted the soil column within the WMA.

Contaminant movement may occur via preferential pathways along tank sidewalls, pipelines, unsealed boreholes, wells, and geological conditions. Interim measures have been initiated at WMA S-SX to minimize the infiltration from man-made water sources. These measures include capping monitoring wells, cutting water pipelines, and building berms around S and SX tank farm boundaries. Modeling performed for the WMA S-SX FIR produced results indicating that clastic dikes have a "negligible impact on solute peak concentrations and arrival times" at the WMA S-SX boundary. These conclusions suggest that clastic dikes do not represent a significant preferential pathway for contaminant migration in the vadose zone.

The current inventory of contamination in the vadose zone and the unconfined aquifer underlying WMA S-SX is derived from three primary sources: the historical record, gamma logging data, and radiochemical and chemical analyses of soils. Data from radiochemical and chemical analyses of groundwater also benefits our understanding of contaminant mobility in the vadose zone.

The FIR (RPP-7884) provides an in-depth analysis of the historical information and vadose-zone data collected through 2001. Based on this analysis, it was determined that three major areas of contamination exist in the vadose zone underlying WMA S-SX. These include the areas around the following tanks:

- SSTs SX-107, SX-108, SX-109
- SST SX-115
- SST S-104.

Evidence from the historical record suggests that the largest leaks in WMA S-SX came from these tanks or associated infrastructure and that the primary gamma-emitting radionuclide contained in the vadose zone soils is ^{137}Cs. Comparison of gamma data within these three areas shows ^{137}Cs to be much more extensively distributed both horizontally and vertically in the area around SSTs SX-107, SX-108, and SX-109. In the areas around SSTs SX-115 and S-104, ^{137}Cs is measured in one drywell very close to the side of each tank.

Table 4-1 summarizes tank leak volume, waste composition, and inventory estimates of tank waste lost to the soil column in WMA S-SX. Included in the table are the primary constituents determined to be in tank waste. The estimates are based on a combination of historical and field investigation information. Descriptions of the derivation of these estimates are found in *Inventory Estimates for Single-Shell Tank Leaks in S and SX Tank Farms* (RPP-6285) and the FIR (RPP-7884). Chemical speciation data have also been derived and are the preferred source for geochemical modeling studies. A summary of the speciation information is found in the FIR.

Table 4-1. Estimated Inventory Lost to Vadose Zone in the S and SX Tank Farms.

	Estimated inventory loss					
	SST S-104	**SST SX-107**	**SST SX-108**	**SST SX-109**	**SST SX-113**	**SST SX-115**
Leak Volume	**24,000 gal[a]**	**6,350 gal[b]**	**15,200 gal[b]**	**989 gal[b]**	**15,000 gal[a]**	**50,000 gal[a]**
Chemicals	***(kg)***	***(kg)***	***(kg)***	***(kg)***	***(kg)***	***(kg)***
Sodium	1.82E+04	9.90E+03	2.37E+04	1.54E+03	1.05E+04	1.57E+04
Aluminum	3.83E+03	2.00E+03	4.78E+03	3.11E+02	1.95E+03	4.24E+03
Chromium	7.81E+02	4.71E+02	1.13E+03	7.33E+01	5.08E+02	5.03E+02
Nitrate	1.70E+04	7.40E+03	1.77E+04	1.15E+03	9.96E+03	3.87E+03
Nitrite	6.87E+03	4.49E+03	1.07E+04	6.99E+02	3.50E+03	9.23E+03
Radionuclides	***(Ci)***	***(Ci)***	***(Ci)***	***(Ci)***	***(Ci)***	***(Ci)***
^{99}Tc	3.87E+00	5.03E+00	1.21E+01	7.84E-01	2.50E+00	5.52E+00
^{137}Cs	1.14E+04	1.71E+04	4.10E+04	2.67E+03	7.34E+03	1.88E+04

Notes:

[a]Leak volumes from HNF-EP-0182, 2002, *Waste Tank Summary Report for Month Ending November 30, 2002*, Rev. 176, CH2M HILL Hanford Group, Inc., Richland, Washington.

[b]Leak volumes estimated from kriging analysis of gamma logging data found in RPP-6285, 2000, *Inventory Estimates for Single-Shell Tank Leaks in S and SX Tank Farms*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

SST = single-shell tank.

Soil sample analyses provide the most direct means of quantifying specific contaminants and their concentrations in the vadose zone beneath WMA S-SX. Field characterization efforts conducted during fiscal years (FY) 1998 through 2000 included the collection of vadose zone sampling data from the following activities:

- Installation of groundwater wells 299-W23-19, 299-W23-48, 299-W23-49, and 299-W23-50
- Installation of an exploratory slant borehole beneath SST SX-108
- Sediment sampling and decommissioning of well 299-W23-234 (also known as borehole 41-09-39)
- Shallow vadose zone soil investigation around SST S-104.

A detailed discussion of these investigations and an analysis of the results are included in the FIR (RPP-7884). The major vadose zone-related findings from these investigations are summarized as follows:

- Tank leak constituents ^{99}Tc, ^{137}Cs, chromium, and nitrate were found in greater concentrations in soils within the SX tank farm boundary compared to soils outside the SX tank farm boundary. The elevated concentrations of ^{99}Tc, ^{137}Cs, chromium, and nitrate in the soil column inside the tank farm are attributed to waste leaks from SSTs SX-115 and SX-108.

- In the south end of SX tank farm, soil samples revealed that ^{99}Tc, ^{137}Cs, chromium, and nitrate are most concentrated in the lower subunits of the Hanford formation (H1 and H2) and the upper Plio-Pleistocene unit (PPlz). In these high concentration intervals, ^{99}Tc ranged from 95,000 to 237,000,000 pCi/L; ^{137}Cs ranged from 125,000 to 95,700,000 pCi/g; chromium ranged from 3 to 218,000 mg/L; and nitrate ranged from 6,000 to 994,000 mg/L.

4.2 VADOSE ZONE CONTAMINATION

Both gross gamma ray and spectral gamma logging methods have been performed in boreholes (drywells) within the WMA S-SX boundary. Figures 4-1 and 4-2 show the drywell logging locations for S and SX tank farms, respectively. In addition to the vertical drywells, 10 of the 15 tanks in SX tank farm have horizontal laterals (horizontal pipes radiating from a central caisson) installed approximately 3.1 m (10 ft) below the base of the tank. Except for SST SX-113, which has five laterals, each of the other nine tanks that contain horizontal laterals has three laterals radiating from a nearby caisson.

Gross gamma logging of the vertical drywells and horizontal laterals was performed to support secondary leak detection of the SSTs during the period 1961 to 1994. Readily useable gross gamma-logging data are available dating back to 1974. An assessment of the historic gross gamma-logging data collected from 1974 to 1994 determined that the data were useful in providing information about the potential movement of gamma-emitting radionuclides in the vadose zone (HNF-4220, *Analysis and Summary of Historical Dry Well Gamma Logs for S Tank Farm – 200 West;* HNF-3136, *Analysis Techniques and Monitoring Results, 241-SX Drywell Surveillance Logs*). No apparent movement of gamma-emitting radionuclides was identified in an examination of gross gamma-logging data for the period 1975 to 1994 in the S tank farm (HNF-3136); however, movement was observed in SX tank farm.

Figure 4-1. Vadose Zone Monitoring Network for S Tank Farm in WMA S-SX.

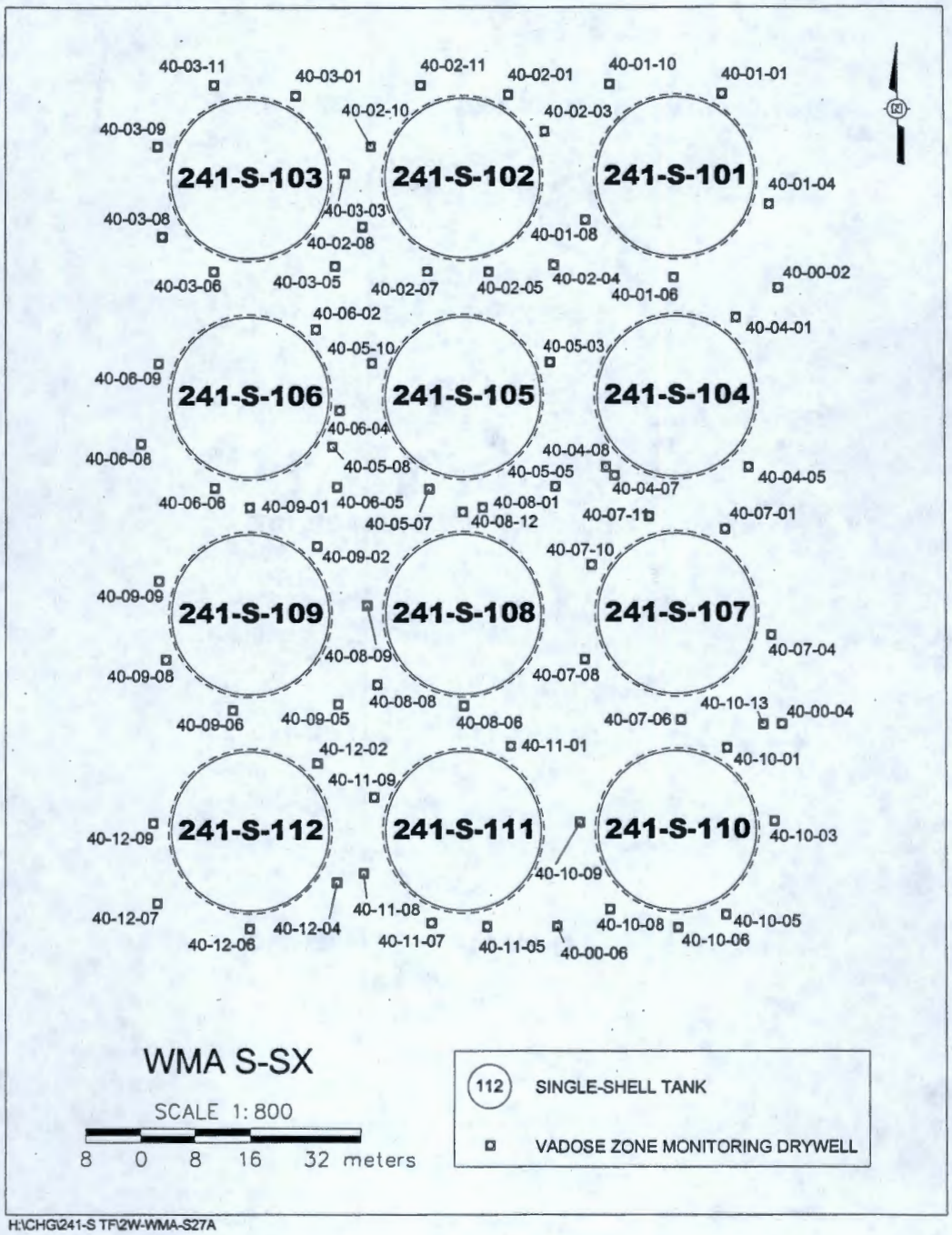
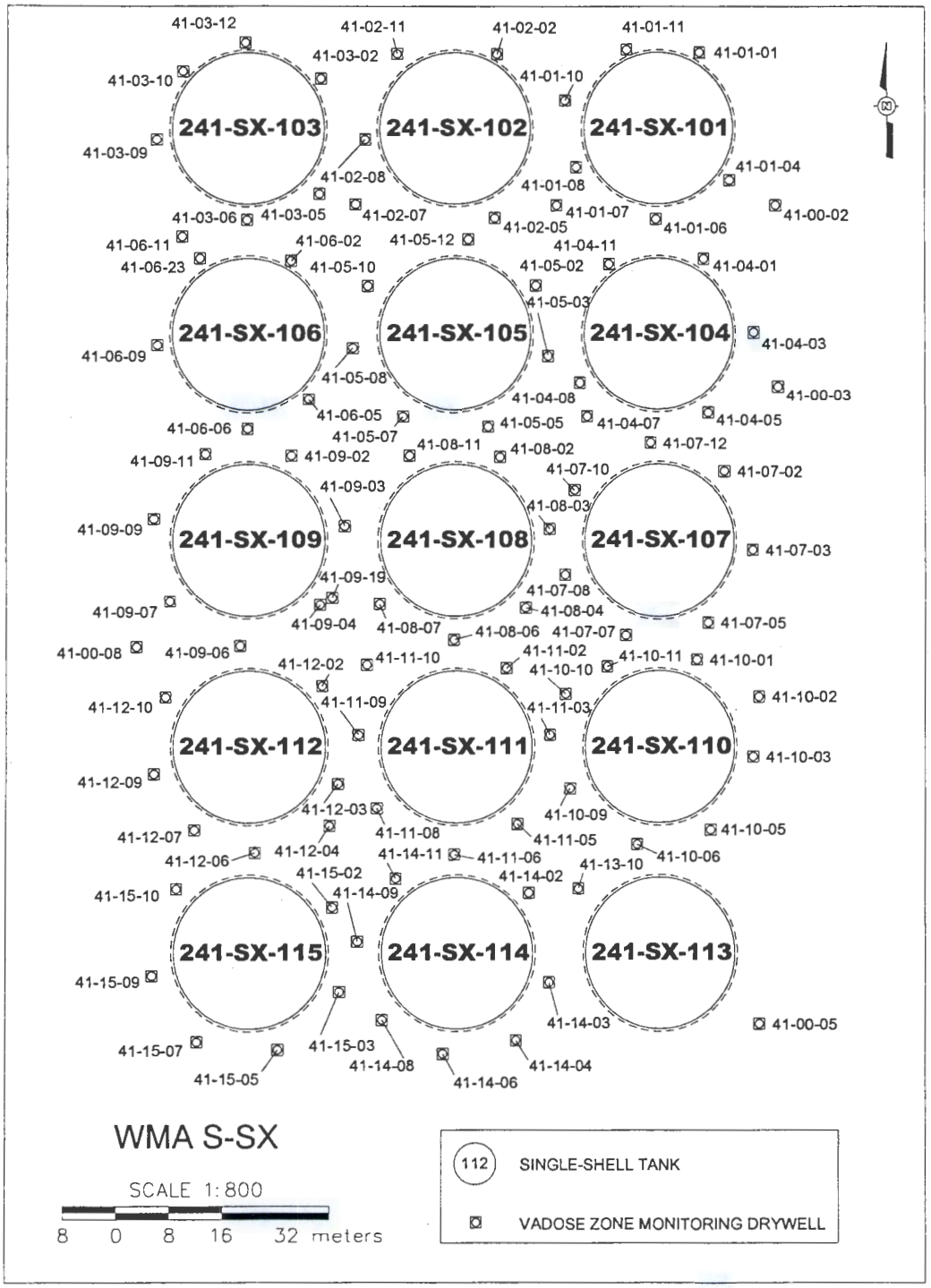


Figure 4-2. Vadose Zone Monitoring Network for SX Tank Farm in WMA S-SX.



4.2.1 WMA S-SX Baseline Vadose Zone Characterization

A baseline spectral gamma-logging program was initiated in 1994 to assess the nature and extent of gamma-emitting radionuclides in the tank farms' vadose zone (DOE-GJPO 1995, *Vadose Zone Characterization Project at the Hanford Tank Farms, Spectral Gamma-Ray Borehole Geophysical Logging Characterization and Baseline Monitoring Plan for the Hanford Single-Shell Tanks*). In 1995, 95 drywells were logged in SX tank farm and results were published in *Vadose Zone Characterization Project at the Hanford Tank Farms, SX Tank Farm Report* (DOE-GJPO 1996). In 1996, 68 drywells were logged in S tank farm and results were published in DOE-GJPO 1998. Results of the radionuclide concentration logs for individual boreholes were compiled and presented in the 15 individual tank summary data reports for SX tank farm and 12 individual tank summary data reports for S tank farm. References to the individual tank reports are found in characterization reports for each tank farm (DOE-GJPO 1996; DOE-GJPO 1998).

In 1999, repeat logging of selected borehole intervals, logging in new boreholes, and enhancements to the original baseline characterization data evaluation process were performed for drywells in WMA S-SX. This updated information is documented in the *Hanford Tank Farms Vadose Zone, Addendum to the S Tank Farm Report* (DOE-GJPO 2000a) and *Hanford Tank Farms Vadose Zone, Addendum to the SX Tank Farm Report* (DOE-GJPO 2000b).

Major findings from the baseline and follow-up logging efforts for S and SX tank farms are summarized below:

- S Tank Farm - The primary gamma-emitting contaminants detected in the vadose zone beneath S tank farm are ^{137}Cs and ^{60}Co. Cesium-137 and ^{60}Co occur at a maximum depth of 16.7 m (55 ft) bgs in drywell 40-02-08. Europium-154 was detected only around borehole 40-01-08 between ground surface and 3m (10 ft). The sources of these radionuclides in S tank farm have been attributed to surface spills, possible transfer line leaks, and leaks from SST S-104. In some instances, contaminants detected at depth were attributed to drilling dragdown or inside/outside casing contamination.

- SX Tank Farm - The primary gamma-emitting contaminant detected in the vadose zone beneath SX tank farm is ^{137}Cs. Only minor quantities of ^{60}Co and ^{154}Eu were detected near the surface in isolated occurrences that could not be correlated among boreholes. These shallow occurrences are attributed to small surface spills and near-surface pipeline leaks. Cesium-137 and minor ^{60}Co occur at significant depths from just below the tank bottoms to at least 40 m (132 ft) bgs. This deep contamination occurs on the south side of SST SX-107, between SSTs SX-108 and SX-109, at the southwestern quadrant of SST SX-109, on the northeast side of SST SX-112, and around SST SX-102. Evaluation of repeat logging data and independent assessment of historical gross gamma data indicate that contaminant movement through the vadose zone in SX tank farm has occurred in the past and appears to be continuing. Figure 4-1 shows the drywells where contamination concentrations have increased and migration apparently continues.

4.2.2 WMA S-SX Routine Vadose Zone Monitoring

The current vadose zone monitoring program implemented at WMA S-SX is described in *Hanford Tank Farms Vadose Zone Monitoring Project Baseline Monitoring Plan* (GJO-HGLP 1.8.1). This plan describes the tasks and organizational requirements associated with routine vadose zone monitoring operations in the SST farms. Included in the plan are the methods and procedures associated with data evaluation, selection, and prioritization of individual borehole intervals to be logged, as well as the scheduling, data acquisition, and reporting procedures. The primary objectives of the routine monitoring project are: (1) monitoring known vadose zone plumes at a reasonable frequency; (2) logging each borehole at least once in a 5-year period; and (3) responding to special supplemental data requests.

4.2.3 WMA S-SX Special Vadose Zone Investigations

Drywells around SST S-112 were logged with spectral-gamma logging equipment in June 2002 to provide additional baseline information prior to planned waste retrieval operations. The new logging data was compared to the original baseline data collected in 1996. No changes in contaminant distribution were evident. The six drywells around S-112 will be placed on a 6-month logging frequency until retrieval monitoring requirements are defined.

4.3 GROUNDWATER CONTAMINATION

Groundwater beneath WMA S-SX is contaminated with nitrate, ^{99}Tc, and hexavalent chromium attributed to two general source areas within the WMA. One source area is to the north in the S tank farm and one is to the south in the SX tank farm. Tritium and carbon tetrachloride plumes are also present in groundwater beneath the WMA, but their sources are upgradient of the WMA. Specifically, tritium concentrations beneath WMA S-SX are attributed to the nearby 216-S-25 crib and carbon tetrachloride is associated with a regional groundwater plume originating from Plutonium Finishing Plant disposal facilities (i.e., cribs, ditches, and trenches).

The north plume with an apparent source in the S tank farm has migrated eastward through well 299-W22-48, where chromium and nitrate concentrations have leveled off at approximately 40 µg/L and 73 mg/L, respectively. Technetium-99, another constituent of the plume, has a trend similar to those of chromium and nitrate where concentrations have leveled off at approximately 4,500 pCi/L. The similar trends of these three constituents as shown in Figure 4-3 indicate that they likely have the same source. The bulk of the contaminant plume responsible for these observations is limited to an area between well 299-W22-44 on the north and well 299-W22-81 on the south. Chromium concentrations have been below or near the detection limit in both of these bounding wells, and nitrate concentrations have been at 25% to 50% of the levels found in well 299-W22-48. Technetium-99 concentrations in the two bounding wells remained at less than 15% of those concentrations found in well 299-W22-48. Both nitrate and ^{99}Tc concentrations in well 299-W22-44 increased similarly as they did in well 299-W22-48, but at lower concentrations. These observations indicate that the plume centerline may be between wells 299-W22-48 and 299-W22-44.

The contaminant plume located on the south portion of the WMA continues to slowly spread downgradient from its source near SST SX-115. This plume is comprised of nitrate, chromium, and ^{99}Tc, just like the S tank farm plume to the north. The shape of the plume has changed little during FY 2002, but the extent of the plume changed significantly on the downgradient margin and significant changes in constituent concentrations within the plume were detected in several of the monitoring wells. The extent of this south contaminant plume was delineated by monitoring wells on all margins at the start of FY 2002. During the year, the plume remained narrow in extent, but the downgradient migrating front, as indicated by nitrate and ^{99}Tc concentrations, has moved through and beyond the farthest downgradient monitoring well 299-W22-83 (Figure 4-4). Nitrate concentrations in well 299-W22-83 have nearly doubled to approximately 20 mg/L and ^{99}Tc concentrations have more than tripled to 1,750 pCi/L during FY 2002.

Within the south plume, concentrations of the major constituents used to define the plume, nitrate, ^{99}Tc, and chromium, changed significantly in the source area as represented by well 299-W23-19 (Figure 4-5) and in the middle of the plume as represented by well 299-W22-46 (Figure 4-6). In well 299-W23-19, both nitrate and ^{99}Tc increased from their lowest concentrations ever reported for the well in March 2002 to their highest concentrations ever reported in June 2002. Almost identical trends have been observed for calcium, magnesium, chloride, and nonradioactive strontium. There are no known changes in tank farm operations or water releases at the site that precede these large fluctuations and would thereby account for these changes in concentrations. Since multiple constituents with differing analytical techniques produce the same varying trend, analytical errors can be eliminated as the cause. An analysis of data collected during 2002 determined that constituent fluctuations observed in well 299-W23-19 are largely due to temporal variations in the plume, with some variation due to vertical plume stratification. Well 299-W23-19 is unique from other monitoring wells due to the fact that the sampling pump has to be lowered into the well for each sample event, creating the possibility that different sampling conditions might result from different placements of the pump. Pumps in other wells are dedicated and at stationary levels.

The south contaminant plume at WMA S-SX contains chromium, but historical concentrations in well 299-W23-19 do not follow the same trend as for nitrate, ^{99}Tc (Figure 4-5), or the other four constituents discussed previously. It appears that after March 2001, the chromium concentration trend in well 299-W23-19 began to deviate from the trend for the other constituents. At the same time, chromium began to increase in the middle of the plume, as indicated by well 299-W22-46, downgradient from well 299-W23-19 (Figure 4-6). These data indicate that chromium may be from a different source within WMA S-SX than the nitrate and ^{99}Tc.

Figure 4-3. Technetium-99, Chromium, and Nitrate Concentrations East of the S Tank Farm (from PNNL-14187).

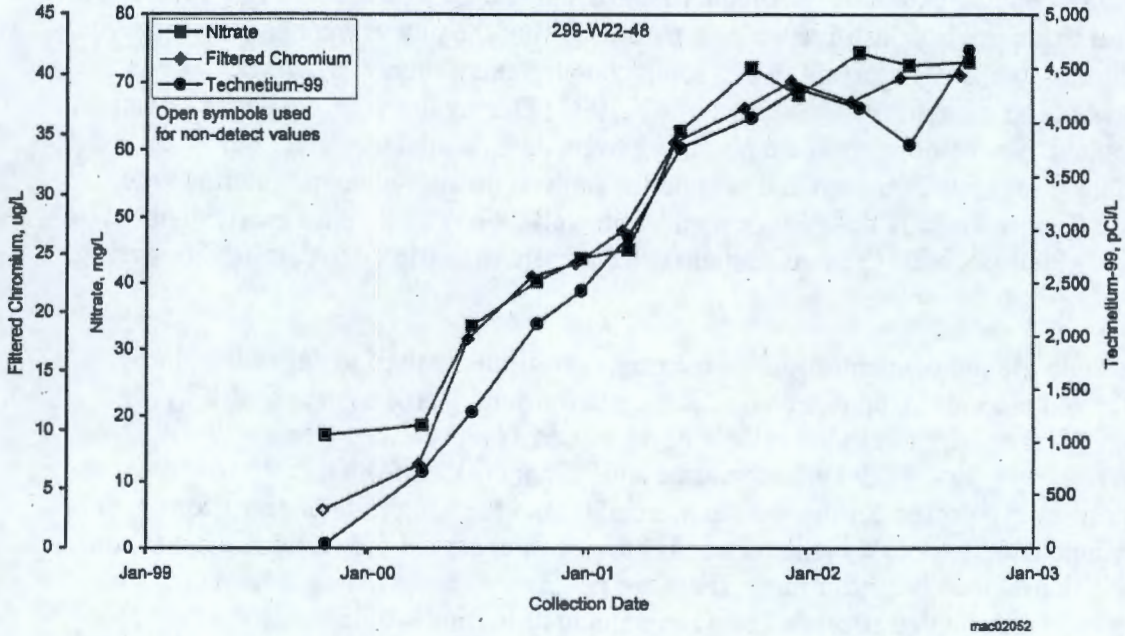


Figure 4-4. Technetium-99 and Nitrate Concentrations East of the SX Tank Farm (from PNNL-14187).

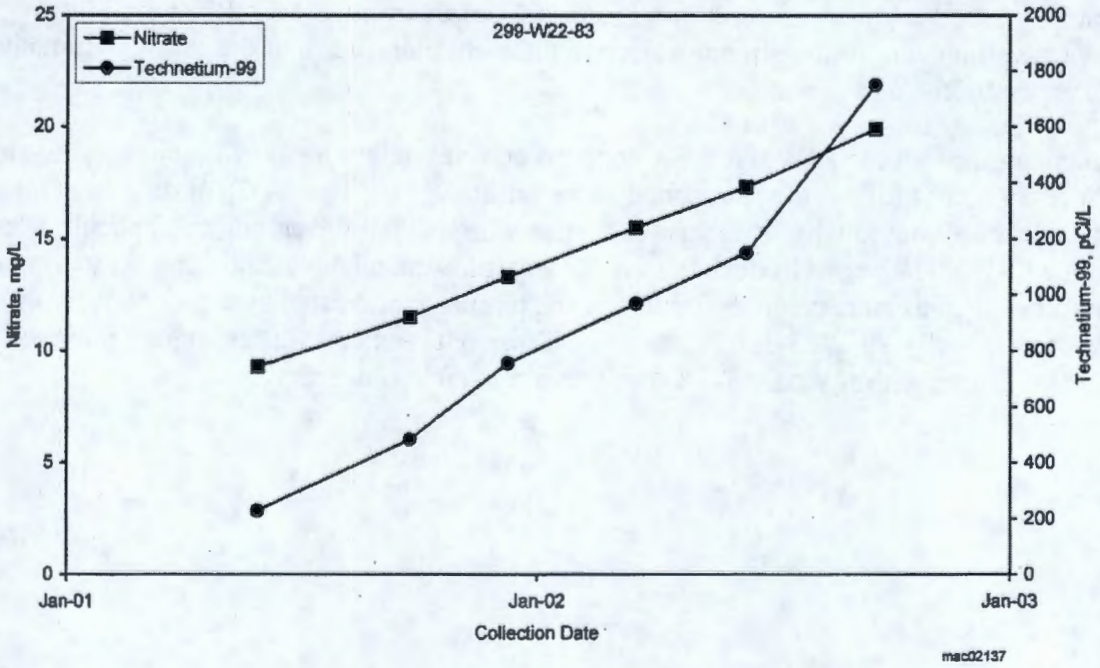


Figure 4-5. Technetium-99, Chromium, and Nitrate Concentrations inside the Southwest Corner of the SX Tank Farm (from PNNL-14187).

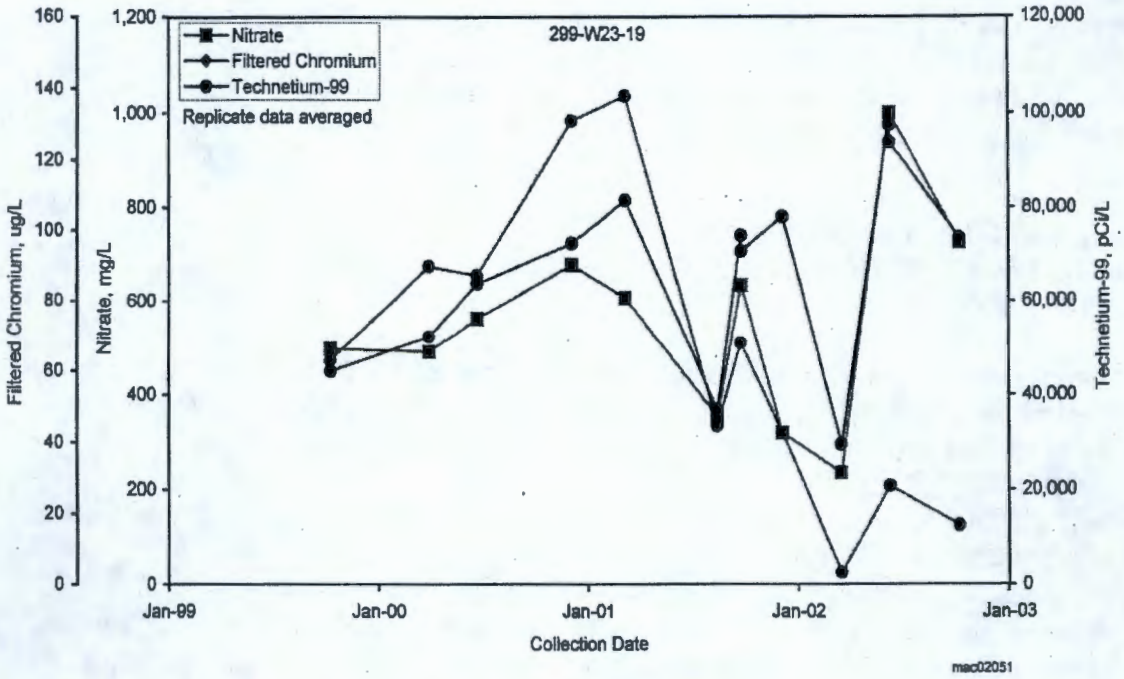
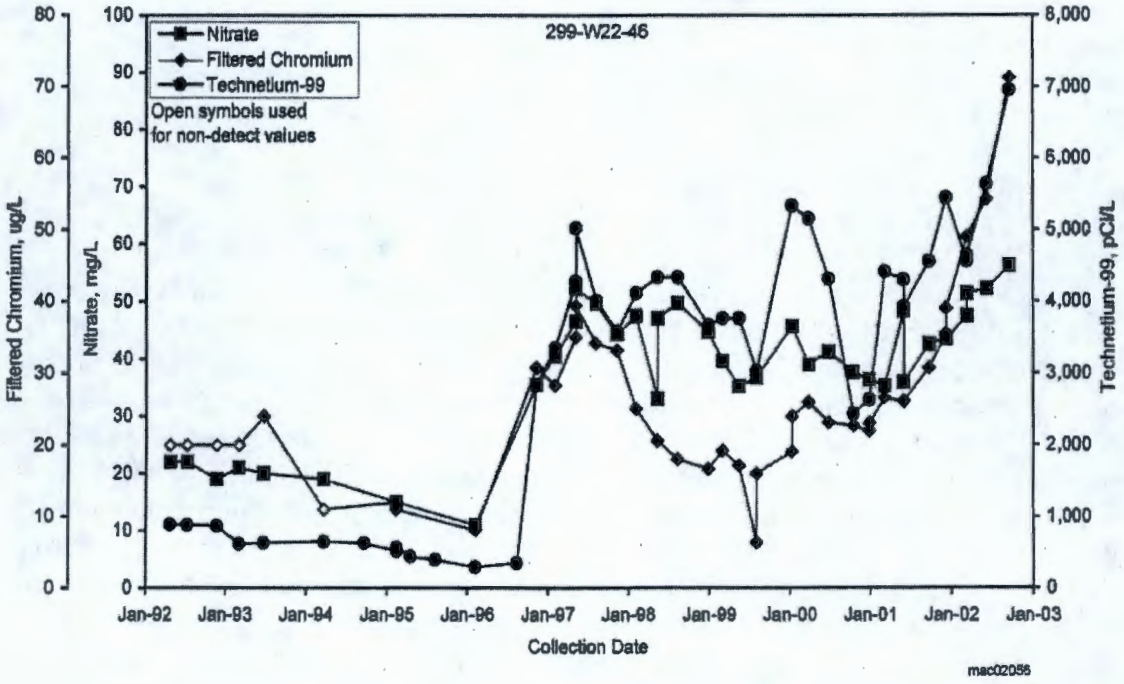


Figure 4-6. Technetium-99, Chromium, and Nitrate Concentrations in Well 299-W22-46 Southeast of WMA S-SX (from PNNL-14187).



5.0 GROUNDWATER MONITORING

In accordance with closure requirements outlined in WAC 173-303-610(3)(a)(vi) and the HFFACO, this section describes groundwater monitoring requirements and provides a description of the current groundwater monitoring network for WMA S-SX. A description of the well inspection and maintenance activities is also provided.

5.1 REGULATORY BASIS FOR GROUNDWATER MONITORING ACTIVITIES

DOE monitors groundwater at the Hanford Site pursuant to the HFFACO, and to fulfill a variety of state and federal regulations, including AEA, RCRA, CERCLA, and WAC. DOE manages groundwater monitoring activities through the Hanford groundwater monitoring project.

EPA, Ecology, and DOE agreed to implement a RCRA groundwater monitoring system in the HFFACO Milestone M-24-00 and M-45-00 series. The primary objectives of RCRA groundwater monitoring are to comply with regulatory requirements and agreements, assess potential impact on groundwater quality, and identify near-term corrective measures, if feasible, for the protection of human health and the environment. In conformance with interim status standards contained in Title 40 Code of Federal Regulations Part 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities,"(40 CFR 265) Subpart F (which was incorporated by reference into WAC 173-303-400), RCRA projects are monitored according to three levels of effort:

- Background monitoring
- Indicator evaluation
- Groundwater quality assessment.

WMA S-SX was placed into assessment status in 1996 at the direction of the Ecology because of elevated specific conductance in downgradient monitoring wells. A groundwater quality assessment plan (WHC-SD-EN-AP-191, *Assessment Groundwater Monitoring Plan for Single Shell Tank Waste Management Area S-SX*) was prepared in 1996 and the planned assessment work conducted in 1996 and 1997. This assessment determined that multiple sources within the waste management area had affected groundwater quality with elevated concentrations of nitrate and chromium in wells downgradient of the waste management area (PNNL-11810, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*). A second groundwater quality assessment plan (PNNL-12114) was prepared in 1999 to further evaluate the contamination. Since that time, two groundwater quality assessment reports (PNNL-13441; PNNL-11810) were published that cover the time period from November 1997 through December 2001. The assessment plan was revised twice to account for new wells added to the monitoring network and revisions to the sampling and analysis schedule. RCRA groundwater assessment monitoring results are included in quarterly reports to Ecology and annually, as required, in the groundwater monitoring annual reports (such as PNNL-14187).

Monitoring under the assessment-monitoring program will continue until the entire WMA is closed and post-closure monitoring is implemented or until such time that there is a shift in the monitoring status of the WMA. Changes in the monitoring program status will be documented in an approved groundwater monitoring plan.

5.2 RCRA GROUNDWATER MONITORING PROGRAM

At WMA S-SX, RCRA groundwater monitoring is performed according to the groundwater quality assessment plan (PNNL-12114). The plan was revised twice to account for new wells added to the network and revisions to the sampling and analysis schedule.

5.2.1 Groundwater Monitoring Well Network

The WMA S-SX groundwater monitoring network is shown in Figure 5-1. Currently, 17 groundwater monitoring wells are included in the WMA S-SX monitoring network. Three new wells were installed in 1999, six in 2000, and two in 2001 to improve spatial coverage and to replace wells going dry because of the declining water table. The current monitoring well network has a theoretical detection efficiency greater than 95% (PNNL-13441). This means that based on calculations using the MEMO model, 95% of any contamination plume originating within the WMA would be detected by the existing monitoring well network. Monitoring wells sampled in FY 2002 and constituents analyzed are listed in Table 5-1. Radionuclide concentrations are listed for information purposes only and are provided pursuant to AEA authority. Groundwater monitoring results, including historical trend analysis, are discussed in Section 4.2.

5.2.2 Groundwater Sampling and Analysis Plan Overview

The original WMA S-SX groundwater assessment monitoring plan published in 1996 (WHC-SD-EN-AP-191) and the subsequent assessment plan published in 1999 (PNNL-12114) as revised, provide the basis for groundwater monitoring at WMA S-SX. The purpose of the current assessment plan is to determine the mobility, extent, and concentrations of dangerous waste constituents hexavalent chromium and nitrate and radioactive constituent ^{99}Tc in groundwater. Procedures for groundwater sampling, sample documentation and preservation, shipment, and chain-of-custody requirements are described in *Sampling Services Procedure Manual* (ES-SSPM-001) and in the RCRA groundwater assessment plan (PNNL-12114).

Figure 5-1. Location Map of WMA S-SX RCRA Groundwater Monitoring Wells.

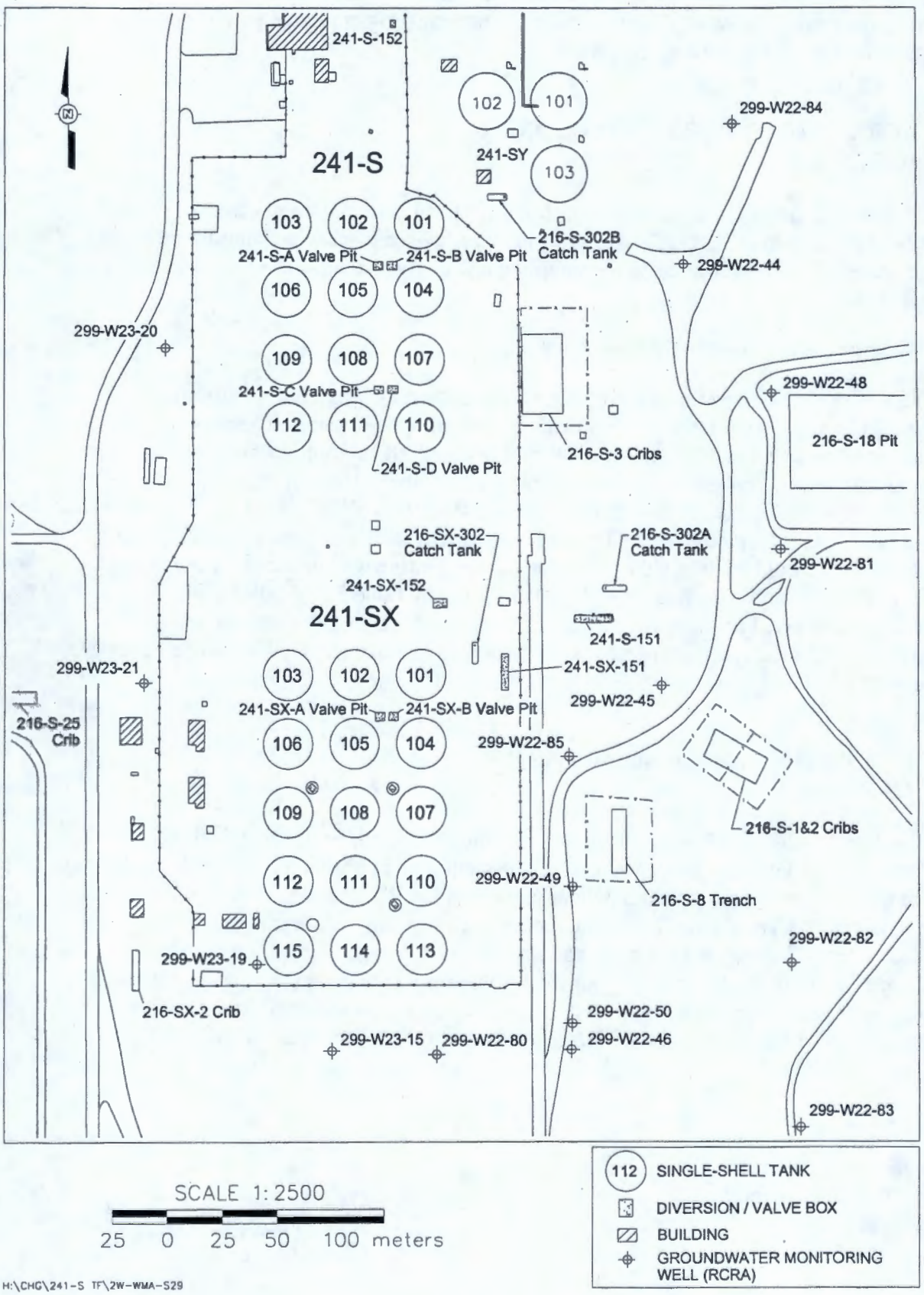


Table 5-1. WMA S-SX Groundwater Monitoring Wells Including Monitoring Frequencies and Analytical Parameters (PNNL-14187).

Well	Year installed	Aquifer monitored	Sampling frequency	Water-level measurement frequency
299-W22-44	1991	Top of unconfined	Quarterly	Quarterly
299-W22-45	1992	Top of unconfined	Quarterly	Quarterly
299-W22-46	1991	Top of unconfined	Quarterly	Quarterly
299-W22-48	1999	Top of unconfined	Quarterly	Quarterly
299-W22-49	1999	Top of unconfined	Quarterly	Quarterly
299-W22-50	1999	Top of unconfined	Quarterly	Quarterly
299-W22-80	2000	Top of unconfined	Quarterly	Quarterly
299-W22-81	2000	Top of unconfined	Quarterly	Quarterly
299-W22-82	2000	Top of unconfined	Quarterly	Quarterly
299-W22-83	2000	Top of unconfined	Quarterly	Quarterly
299-W22-84	2001	Top of unconfined	Quarterly	Quarterly
299-W22-85	2001	Top of unconfined	Quarterly	Quarterly
299-W23-15	1991	Top of unconfined	Quarterly	Quarterly
299-W23-19	1999	Top of unconfined	Quarterly	Quarterly
299-W23-20	2000	Top of unconfined	Quarterly	Quarterly
299-W23-21	2000	Top of unconfined	Quarterly	Quarterly
Contamination Indicator Parameters - pH (field), Specific Conductance (field), Total Organic Carbon[a]				
Site Specific Parameters[b] – Alkalinity, Anions[c], Gamma Scan (^{137}Cs)[b,d], Gross Beta[b,e], ICP Metals (filtered), ^{129}I[a,b], ^{99}Tc[b], Tritium[b], Turbidity, Uranium[b], Strontium-90[a,b]				

Notes:

[a] Analysis done only on wells 299-W22-84 and 299-W22-85 quarterly through FY 2002.

[b] Analyzed to support *Atomic Energy Act of 1954* monitoring. Radionuclide concentrations are listed for information purposes only and are provided pursuant to *Atomic Energy Act of 1954* authority.

[c] In all but four wells, bromide is included to monitor for tracer bromide.

[d] Analysis done only on wells 299-W22-84 and 299-W22-85 quarterly and well 299-W23-19 annually.

[e] Analysis done only on wells 299-W22-84, 299-W22-85, and 299-W23-19 quarterly.

ICP = inductively coupled plasma emission spectroscopy.

5.2.3 Inspection and Maintenance of Wells

Routine well inspection and maintenance is performed on groundwater monitoring wells to ensure compliance with WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." The *Hanford Well Maintenance and Inspection Plan* (BHI-01265) describes the procedures for well maintenance and inspection on the Hanford Site. Routine well maintenance and inspections are performed at least every 5 years, based on the drilling completion date and the date of the last routine maintenance, whichever is the most recent. Routine well maintenance consists of (1) checking the well pump function, (2) removing the pump, (3) performing a video

camera survey, (4) brushing/cleaning the screen or perforations, (5) redeveloping the well, (6) removing fill material and debris from the well bore, and (7) reinstalling the pump.

In addition to the scheduled routine maintenance activities, the well maintenance program addresses nonroutine well maintenance that is performed to keep the well operational (i.e., allow water sampling). Nonroutine well maintenance may consist of replacing sampling pumps, repairing or replacing well tubing, and removing foreign objects from wells. Problems requiring nonroutine maintenance are typically identified during well sampling activities.

Routine and nonroutine well maintenance and inspection activities are documented on forms specified in the *Hanford Site Well Management Plan* (DOE/RL-2003-13). Completed forms are entered into the Hanford Records Management Information System (RMIS) and also into the Hanford Well Information System (HWIS) database.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new well should be constructed or if an existing well should be substituted.

5.2.4 Plans for Groundwater Monitoring Network Modification and Additional Groundwater Characterization

One additional groundwater monitoring well is planned for construction at WMA S-SX. This well will be located southeast of the management area, due south of well 299-W22-46. Its purpose will be to better define the south boundary of the contaminant plume in the area. The schedule for installation of the monitoring well will be developed and detailed per HFFACO Milestone M-24-00 or the Site-Wide Permit.

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6.0 CLOSURE ACTIVITIES

The closure action for WMA S-SX involves conducting closure activities on individual components of the WMA. WMA S-SX is comprised of four primary types of components: (1) SSTs, (2) ancillary equipment (piping, diversion boxes, pump pits), (3) soil, and (4) groundwater. Component closure activity plans, or alternate decision documentation such as corrective measures studies or CERCLA RODs upon approval through incorporation into the Site-Wide Permit, will be developed to describe how the components or groups of components will be characterized, disconnected, dismantled, decontaminated, removed, and/or stabilized.

This section describes these component closure activities and presents a relative timeline for the completion of the WMA S-SX closure action, including contingent closure actions for closure as a landfill pursuant to WAC 173-303-640(8)(c). Component closure activities that will contribute to meeting the closure performance standards of WAC 173-303-610(2), WAC-173-303-640(8), and -645(3) and HFFACO Milestone M-45-00 are listed.

6.1 WMA S-SX COMPONENT CLOSURE ACTIVITY RELATIVE TIMELINE

Figure 6-1 presents a relative timeline for the major closure activities necessary to complete the WMA S-SX closure, contingent landfill closure, and contingent post-closure actions. The timeline depicts the relative sequence of the major component activities and the anticipated duration of these activities. Actual sequencing of activities is dependent on integration among all programs being conducted within the WMA, and will be covered in the WMA S-SX Integration Study. Key closure dates have been developed and are described in HFFACO Milestone M-45-00. The first three columns (left to right) presented in the timeline represent intervals during which closure activities associated with each tier of the SST system closure strategy occur. The fourth column represents DOE's long-term stewardship program for the Hanford Site. A general summary of each of the four columns follows. A more detailed discussion of the closure activities is presented in Section 6.2.

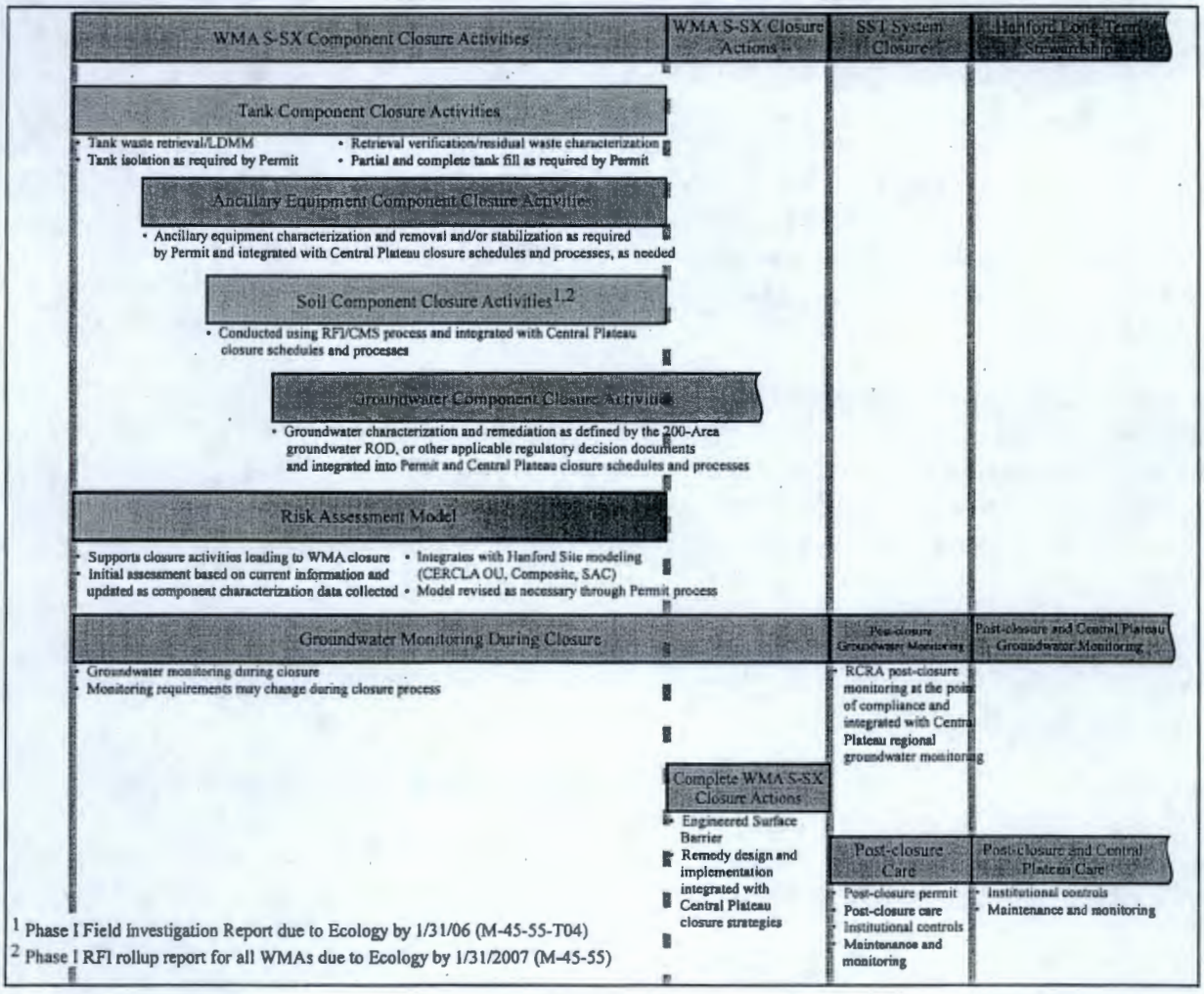
1. Column One: Performance of the major component closure activities is presented in column one. Initiation of these activities is currently underway with completion of the Phase I RCRA field investigation (RFI) vadose zone investigation and waste retrieval from selected tanks (Section 6.2.1). The relative starting points for the ancillary equipment, soil, and groundwater component closure activities are staggered to depict the order in which these activities will be initiated. The dotted vertical line on the right side of the column denotes that a final activity (such as implementation of the surface barrier) may be necessary to complete one or all of the component closure activities. Groundwater component closure activities extend beyond the dotted line because completion of this component activity is largely determined by programs outside the SST RCRA closure program (such as CERCLA Operable Unit corrective actions and the Central Plateau closure strategies) and can likely be implemented without impacting ongoing WMA S-SX closure actions.

2. Column Two: The second column represents the period during which all WMA S-SX closure activities are completed. This period begins when all of the SSTs within a WMA have been retrieved, isolated, and filled, and the ancillary equipment and soils have been characterized and appropriately dispositioned. Completion of the WMA closure action occurs when the final remedy (such as an engineered surface barrier) for the WMA has been implemented.

3. Column Three: The third column represents the period during which the final WMA remedy has been implemented and the WMA post-closure activities, if required, are initiated. A contingent post-closure plan will be developed to define these activities. During this period, other WMA closure actions within the SST system may be ongoing. The period ends when all seven WMA closure action are completed, and any outlying closure activities are completed.

4. Column Four: The fourth column indicates the period in which any SST post-closure activities with the Hanford Site long-term stewardship program. Because the SST WMAs are located in the 200 Areas, the post-closure activities will be integrated as specified in the Site-Wide Permit with the Central Plateau closure strategies currently under development by Ecology, EPA, and DOE.

Figure 6-1. Relative Timeline of Major Activities for Closure of WMA S-SX.



6.2 COMPONENT CLOSURE ACTIVITY DESCRIPTIONS

The following section describes the component closure activities associated with the WMA S-SX closure and post-closure actions. Future characterization activities within WMA S-SX will produce new information. Information pertinent to making closure decisions will be provided as necessary in accordance with the WAC 173-303-830 permit modification process.

6.2.1 Tank Component Closure Activities

The tank components consist of twenty-seven 100-series SSTs. Physical tank descriptions and historical process knowledge associated with WMA S-SX tanks are provided in Section 2.0.

Closure of the individual tanks occurs in three major steps (1) tank waste retrieval and characterization, (2) physical and administrative isolation of the tank, and (3) tank filling. Each of these steps will be described in the respective component closure activity plans. A general description of these steps follows.

6.2.1.1 Tank Retrieval. HFFACO Milestone M-45-00 states:

> *"closure will follow retrieval of as much tank waste as technically possible, with waste residues not to exceed 360 cubic feet (cu. ft.) in each of the 100-series tanks, 30 cu. ft. in each of the 200-series tanks, or the limit of waste retrieval technology capability, whichever is less."*

Following retrieval activities, DOE will use in-tank survey methods to determine whether retrieval volume criteria have been met. Also as part of this milestone a retrieval data report will be submitted to Ecology to demonstrate completion of retrieval in accordance with HFFACO Milestone M-45-00. In addition, the residual will be characterized to support disposal decisions and risk assessments.

If the residual waste in individual tanks meets the retrieval criteria and risk metrics related to the residual waste are accepted, DOE will modify the closure activity plan and submit modifications for the Site-Wide Permit, if necessary, and then proceed with implementing the approved component closure activity plan. If residual waste exceeds the retrieval criteria, DOE will either attempt additional retrieval or request an exception to the retrieval criteria. This request will be prepared pursuant to the procedure in HFFACO, Appendix H, Attachment 2.

Section 8.0 lists the current HFFACO Milestones associated with retrieval and closure operations for tanks within the WMA S-SX. The retrieval sequence for the remaining WMA S-SX tanks will be updated bi-annually in accordance with HFFACO Milestone M-45-02.

Current waste retrieval and leak detection monitoring and mitigation (LDMM) plans for SSTs S-112 and S-102 are described in the *Single-Shell Tank S-112 Full Scale Saltcake Waste Retrieval Technology Demonstration Functions and Requirements* (RPP-7825) and the *S-102 Initial Waste Retrieval Functions and Requirements* (RPP-10901), respectively. According to

these functions and requirements documents, retrieval of SSTs S-112 and S-102 will demonstrate a dissolution process that introduces water in a controlled fashion to dissolve and mobilize waste solids. This retrieval methodology minimizes the free liquid in the tank and, thus, minimizes the potential for leak/loss during retrieval.

The *Process Control Plan for Saltcake Dissolution Retrieval Demonstration in Tank 241-S-112* (RPP-15085) and the *Process Control Plan for Retrieval of Waste from Tank 241-S-102 by Saltcake Dissolution and Modified Sluicing* (RPP-17043) describe the process and technical operating controls for waste retrieval and transfer of liquid wastes from the S-102 and S-112 to the DST system. In the future, a tank waste retrieval work plan (TWRWP) will govern retrievals. The TWRWPs will include a description of tank conditions, waste conditions, major equipment, overall process operating strategy, responses to off-normal conditions, and LDMM during retrieval.

6.2.1.2 Tank Isolation. Physical and administrative isolation of the tanks will occur before and after the tank retrieval and tank stabilization activities. Physical isolation refers to filling (such as by grouting*) and/or capping of pipelines, drains, ducting, pits, risers, or other openings into the tank structure to prevent inadvertent liquid introduction. Physical isolation will occur progressively as individual tanks near final stabilization. Administrative isolation controls tank access through procedural actions, such as lock and tag. Specific detail on implementation of tank isolation for each tank will be documented in its respective component closure activity plan.

6.2.1.3 Tank Filling. Tank filling involves filling the tank with grout* in order to stabilize any remaining tank waste and debris and to physically stabilize the tank structure. Commencement of tank filling can occur once the waste retrieval criteria are met and risks associated with remaining contaminants are determined acceptable by Ecology. Tank filling activities will not proceed until the closure permit is issued and effective and the tank closure environmental impact statement (EIS) is completed.

Cementitious grout will be produced onsite at a grout mixing plant, which will be located outside of and adjacent to the WMA. Generally, tank filling consists of adding grout* through existing risers. DOE proposes the addition of three primary grout* layers as follows (represented in Figure 6-2):

Phase I Layer

- Will involve adding a 30- to 150-cm (12- to 60-in.) base layer of sufficient volume to cover the residual waste
- Will be of sufficient compressive strength to provide structural support to the Phase II and Phase III fill layers

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* See Preface.

- Will completely cover the residual waste and tank-bottom debris
- Some in-tank debris (e.g., pumps and risers) may protrude above the Phase I layer
- Will reduce the leachability of the contaminants of concern.

Phase II Layer

- Will fill the majority of the tank volume in order to provide structural stability to the tank
- May be placed in approximately 150-cm (60-in.) lifts
- Will provide sufficient compressive strength to maintain structural integrity of the tank wall
- Will create a cover of grout to mitigate liquid infiltration that could mobilize remaining residuals.

Phase III Layer

- Will fill the remaining void space within the top of the tank
- Will be a high-compressive-strength grout designed to discourage or prevent future inadvertent intruder access
- As the Phase III grout nears the top of the tank dome, the grout will partially fill risers penetrating the tank dome
- Complete filling of dome penetrating risers will be performed as part of the component closure activities, or at the time of WMA S-SX closure.

Bench scale tests (WSRC-TR-2003-00447, *Grout Formulation for Closing Hanford High-Level Waste Tanks – Bench-Scale Study*) and scale-up tests (WSRC-TR-2003-0556, *Grout Placement and Property Evaluation for Closing Hanford High-Level Tanks – Scale-Up Testing*) completed by Savannah River Technology Center have provided a tank fill formulation for the Phase I, II, and III grout layers. Each phase will consist of various volumes of Portland Cement, slag, fly ash, sand, water, KelcoCrete[1] and ADVATMflow. In general, each of the grout layers is designed to be free-flowing, self-leveling, self-compacting, and low-shrinking. The specific grout mix design specifications are defined in the *Hanford Grout Specification for High-Level Waste Tank Closure* (RPP-20588).

6.2.1.4 Land Disposal Restrictions Compliance. Retrieval of as much waste as technically possible will be pursued according to HFFACO requirements; however, DOE may leave some

[1] KelcoCrete is a registered trademark of the Kelco Division, Merck & Company, Inc., San Diego, California.

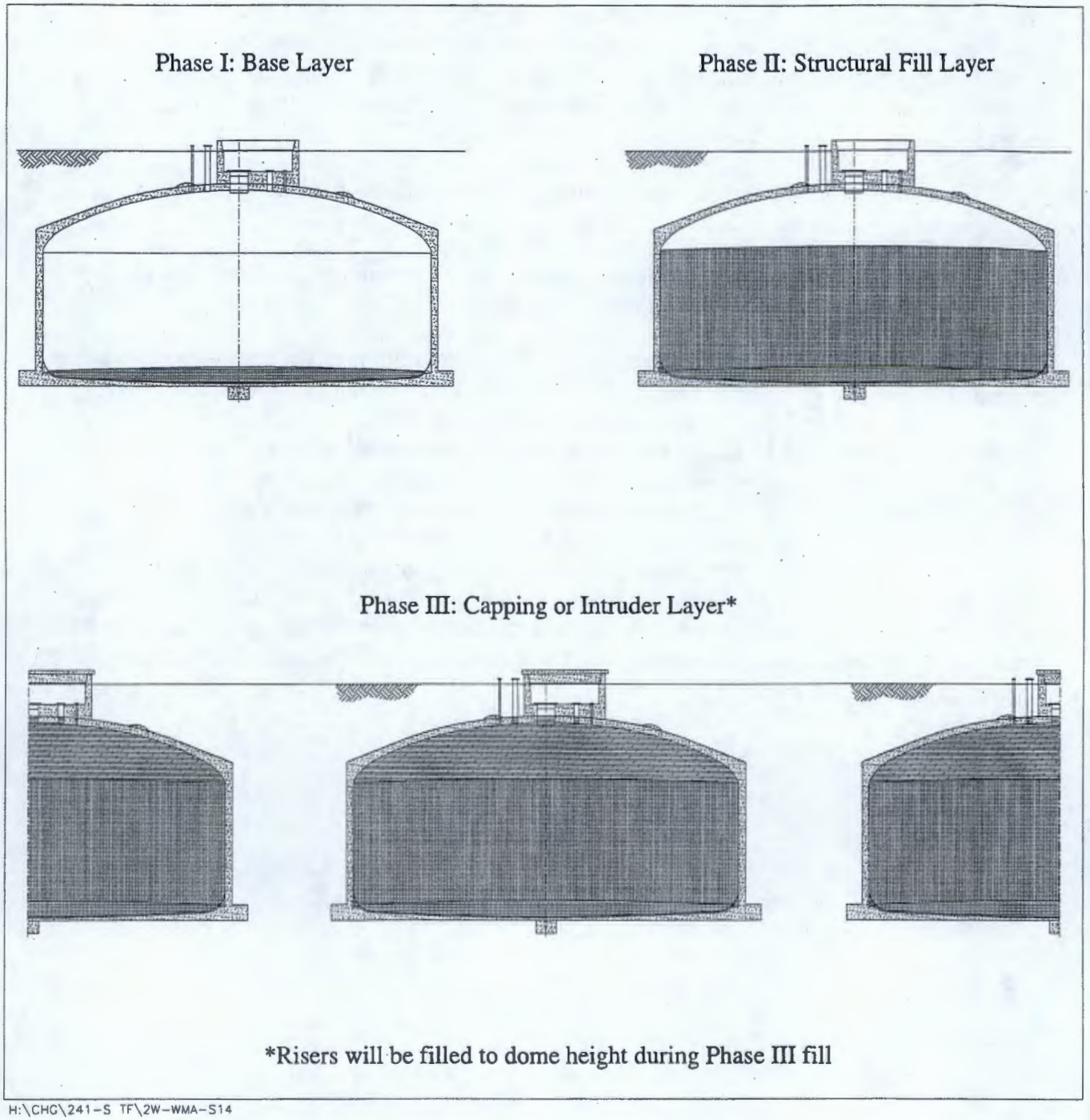
waste residuals in place at closure. In the event that waste residuals remain in a tank following completion of retrieval, the RCRA land disposal restrictions (LDR) treatment standards (WAC 173-303-140 and Title 40, *Code of Federal Regulations*, Part 268, "Land Disposal Restrictions" [40 CFR 268]) apply. A site-specific treatability variance is needed to allow an alternative approach to protecting human health and the environment from the land disposal of dangerous waste (to be approved by Ecology separately from this closure plan) for the following reasons:

- Treatment of residual waste to performance-based treatment levels for applicable waste codes is unachievable.
- 40 CFR 268.48 universal treatment standards are unachievable in the short-term for the debris (tank structure and abandoned equipment).

Grout filling is the proposed treatment action for SSTs. Grout filling is achieved through placement of a Phase I cemetitious grout* fill and the Phase II structural fill followed by the Phase III intruder fill as described above. The grout fill will stabilize the outer surface of the residuals and debris, form a reduced-permeability layer to protect the residual waste from contact with potential infiltrating water, and form a buffered high-pH environment over the residual waste. Application of the grout fill material will reduce the potential for migration of hazardous contaminants by substantially reducing the mobility of the waste and the solubility of waste constituents through the high-pH buffering capacity of the grout monolith. The proposed treatment action complies with the requirements for a treatability variance (40 CFR 268.44(m)) in that it minimizes the threat to human health and the environment, and it is part of an integrated approach to meeting closure performance standards of WAC 173-303-610(2) during the component closure activities.

* See Preface

Figure 6-2. Schematic of Proposed Tank Filling.



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6.2.1.5 Time Period After Component Closure. DOE will provide care for the tanks between the time component closure activities are completed on a tank and the time DOE closes WMA S SX. While conducting closure actions under HFFACO schedules of compliance and permit requirements, the tank system must continue to comply with interim-status standards.

DOE will maintain control over WMA S-SX for the foreseeable future. Roadways to the unit and site access will remain administratively restricted to use by authorized personnel only. Posted warning signs restrict access from the Columbia River. A chain-link fence surrounds WMA C. The 200 Areas are under 24-hour security surveillance. DOE will inspect security systems and controls on a routine basis.

The current vadose zone and groundwater monitoring programs will continue after component closure activities are completed. Current restrictions ensuring that groundwater is not used as a drinking water source in the 200 Areas will continue after component closure activities.

6.2.2 Ancillary Equipment Closure Activities

Ancillary equipment refers to steel, concrete, electrical, and other equipment both internal and external to the tank including pipelines, conduit, pits, diversion boxes, ventilation systems, electrical/service connections, tank risers, pumps, measuring equipment (such as liquid level detection systems, thermocouples), shield plugs, and dip legs. A list of external ancillary equipment associated with WMA S-SX is included in Table 2-2.

The level of contamination contained in ancillary equipment and the potential difficulties in accessing buried equipment are unknown at this time. Disposition of in-tank ancillary equipment (such as in-tank measuring equipment and tank risers) will be described in the respective tank component closure activity plans. Much of the in-tank equipment will be dispositioned as in-tank debris during the tank closure activity. Disposition of ex-tank ancillary equipment (such as pipelines, diversion boxes, and cascade lines) will be described in either an ancillary equipment component closure activity plan, tank component closure activity plan, or other alternate decision documentation such as a corrective measures study or ROD upon approval through incorporation into the Site-Wide Permit.

Ancillary equipment closure activities will be integrated as appropriate with soil and groundwater component closure activities and with the Ecology, EPA, and DOE Central Plateau regional closure strategies currently under development. This integration will be coordinated via an integration study to be developed for WMA S-SX.

6.2.3 Soils Component Closure Activities

The two primary steps in the WMA C soil component closure activities are (1) characterizing the nature, extent, and mobility of the contamination in the soil column, and (2) performing necessary cleanup in accordance with WAC 173-303-610 and –645.

Soil investigations at WMA S-SX are currently underway as part of the RFI/CMS process. The *Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan for Single-Shell Tank Waste Management Areas* (DOE/RL-99-36) describes the overall RFI/CMS process. HFFACO Milestones M-45-55 through M-45-60 establish the schedule for completion of the RFI/CMS activities targeted for the SST system WMAs.

The *Preliminary Site-Specific SST Phase I RFI/CMS Work Plan Addendum for WMA S-SX* (HNF-4380) and the *Site-Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX* (HNF-5085) describe the investigative approach specific to WMA S-SX. Results of the Phase 1 vadose zone investigation for WMA S-SX are documented in RPP-7884 and major findings are summarized in Section 4.0 of this plan.

Consolidated results from the four Phase I RFI investigations (for WMAs S-SX; B-BX-BY; T-TX-TY; and combined A-AX, C, and U) will be presented in a Phase I RFI report (hereinafter referred to as the RFI report). The focus of the RFI report will be to address cumulative risks from the WMAs, identify interim stabilization measures, identify additional characterization needs if necessary, and present plans for the CMS. The CMS will develop and evaluate corrective measure alternatives for implementation. The selected corrective measure is typically incorporated into the Site-Wide Permit (DOE/RL-99-36).

Following completion of the CMS, a work plan will be developed to guide the corrective measures implementation (CMI) process. The CMI process includes design, construction, operation, maintenance, and performance monitoring of the selected corrective measure(s).

DOE has already completed interim stabilization measures to control surface water run-on at WMA S-SX. Most of the interim stabilization measures were identified in the engineering report *Single-Shell Tank Farms, Interim Measures to Limit Infiltration Through the Vadose Zone* (RPP-5002). The interim stabilization measures at WMA S-SX were completed to minimize or eliminate vadose zone contaminant migration conducted by natural and man-made onsite and offsite surface water originating from sources inside and outside the tank farm fenceline. The completed interim stabilization measures are summarized as follows:

- Upgraded well caps on drywells to make leak-tight, thereby eliminating the potential for surface water entering the borehole
- Constructed surface water control features including berms, drainage swales, curbs, and gutters to minimize water run-on from normal (seasonal precipitation) and catastrophic (water line rupture, rapid snowmelt) events
- Cut and capped leaking raw and potable water lines to eliminate surface water infiltration source
- Leak-tested raw and potable water lines still in service to ensure lines were not a source of surface water infiltration. The lines passed the leak test.

Soil characterization and corrective measures activities will be integrated as appropriate with ancillary equipment and groundwater component closure activities and with the Ecology, EPA,

and DOE Central Plateau regional closure strategies currently under development. This integration will be coordinated via an integration study to be developed for WMA S-SX. After regional closure strategies are finalized, the WMA S-SX closure plan will be modified in accordance with WAC 173-303-830.

6.2.4 Groundwater Component Closure Activities

The two primary steps in groundwater component closure activities are (1) characterizing the nature and extent of contamination and (2) performing the necessary corrective measures. Characterization of groundwater will involve an assessment of groundwater conditions based on existing groundwater monitoring data and supplemental groundwater data obtained throughout the course of field investigations. Groundwater characterization will be conducted as a groundwater component closure activity and may be coordinated with soil component characterization efforts. Characterization information will be used to assess the relative risk associated with the groundwater component. A corrective measures alternatives analysis based on the WMA S-SX risk assessment will be conducted to define the appropriate corrective measures.

If it is determined that groundwater corrective measures are necessary, groundwater remediation may be performed pursuant to a RCRA corrective action or CERCLA ROD developed for the 200-UP-1 groundwater operable unit upon approval through incorporation into the Site-Wide Permit. Groundwater monitoring and response actions are integrated within the context of HFFACO Milestones M-24-00 and M-45-00 and, as feasible, will be integrated with the Central Plateau regional closure strategy. After groundwater regional strategies are finalized, the WMA S-SX closure plan will be modified in accordance with WAC 173-303-830 to incorporate and/or change WMA S-SX groundwater monitoring network and/or program description.

6.2.5 Sampling and Analysis Plan

An SAP supports the various component characterization activities performed during closure of the WMA. The WMA S-SX SAP will be included as Addendum D1 of this report when it is completed. The SAP provides direction and specifies requirements for sampling methodology, laboratory analysis, quality control, and data reporting. The content of the SAP will be consistent with associated data quality objectives as established to support characterization of various components within the WMA.

The objectives of the WMA S-SX SAP are as follows:

- Determine the chemical characteristics and volume of waste remaining in the tanks at the completion of the retrieval actions.

- Depending on results of the WMA Integration Study, determine the chemical characteristics and volume of wastes remaining in ancillary equipment and pipelines within and adjacent to the WMA.

- If necessary, determine the nature and extent of contamination in the soils within the WMA to augment information gathered during the WMA S-SX Phase I field investigation and documented in the FIR (RPP-7884).

Data obtained during closure-related sampling activities will be used to augment the WMA performance assessment modeling and to determine when compliance with closure requirements has been met.

6.2.6 Waste Management

Retrieved waste from SSTs will be pumped to the DSTs for storage pending treatment in the waste treatment plant and subsequent disposal at permitted geologic repository. Wastes generated from fill and isolation activities may include personal protection equipment and tools and equipment used during the execution of component closure activities. Materials will be decontaminated and reused, or packaged and disposed of appropriately. Decontamination of equipment will be conducted in accordance with standard tank farm procedures. Disposal will follow approved waste acceptance criteria for the appropriate storage and/or disposal facility. Wastes expected from other component closure activities (ancillary equipment, soil, groundwater) are not known at this time. When the closure activities are identified, description of the expected wastes and how they will be managed will be added to this section of the closure action plan.

6.2.7 Risk Assessment Model

As described in Section 7.0 and depicted in the relative timeline (Figure 6-1), the risk assessment model developed for the WMA S-SX will be used to support the decision-making processes during the various component closure activities described above. The purpose of the WMA S-SX risk assessment is to demonstrate that planned closure conditions meet closure performance objectives. The risk assessment strategy will be implemented at the WMA level in a manner that will allow evaluation of risk contribution from individual components (such as individual tanks, groups of tanks, soil, ancillary equipment, and groundwater) or the entire WMA. The initial assessment will be performed based on current information, such as the BBI for the tank waste, geophysical vadose zone data, and groundwater monitoring data. The initial assessment will be refined by incorporating the results of new field and engineering data obtained as the WMA closure action matures. An iterative approach will allow the level of uncertainty in risk estimates to be progressively reduced as closure activities move from single component activities to eventual closure of the WMA S-SX. New data generated from the major characterization efforts (such as tank residual waste and soil) will be documented in data reports (i.e., retrieval data reports and field investigation reports) that will support updating the risk assessment.

The SST performance assessment (PA) is currently being developed for the entire SST system. The PA will address multiple regulatory requirements including DOE O 435.1. The WMA S-SX risk assessment is the foundation for the PA in the 200 West Area. The WMA C risk assessment is the foundation for the PA in the 200 East Area.

The WMA S-SX risk assessment will be integrated with other Hanford Site modeling efforts, such as those supporting nearby CERCLA-related characterization and cleanup, Central Plateau strategy development, and the composite analysis.

The System Assessment Capability (SAC) is a computational tool for use in preparing the Hanford site-wide composite analysis of long-term impacts to groundwater. The WMA S-SX risk assessment will be integrated with the SAC by preparing a constituent breakthrough curve for constituents at the water table underlying the WMA. This data set will be inserted into the SAC computations to represent the WMA as a point source in the composite analysis, as available. This will allow the localized fate and transport analysis performed at the WMA level to be directly integrated into the large-scale analysis performed by the SAC. However, output from the SAC will not make any of the cleanup levels for WMA S-SX any less stringent than the regulatory requirements.

6.2.8 Groundwater Monitoring

The current groundwater monitoring program is discussed in Section 5.0. During the time that WMA S-SX component closure activities are underway and until WMA closure is achieved, groundwater monitoring will be conducted according to the current groundwater monitoring plan (PNNL-12114) or future modifications to that plan. It is recognized that groundwater monitoring at WMA S-SX may support numerous environmental and regulatory data needs, including evaluating the sources of groundwater and vadose contamination, the fate and transport of existing and potential future releases, and long-term risk assessment for purposes of developing component closure performance standards and post-closure care requirements. Groundwater monitoring will be coordinated with these activities, CERCLA remediation, and other site-wide activities as feasible. In addition, those monitoring wells deemed no longer useful (for regulatory purposes or because of a declining water table) will be decommissioned as necessary.

Prior to closure of WMA S-SX, a post-closure groundwater-monitoring plan will be developed as part of the future modifications to the post-closure care plan (WAC 173-303-665(6)(b)(iv)). Post-closure groundwater monitoring will be integrated with the groundwater monitoring approach currently being developed by DOE, EPA, and Ecology as part of the Hanford Site groundwater strategy.

6.2.9 Final WMA Closure Actions

After completion of the tank, ancillary equipment, and soil component closure activities, any remaining closure activities for WMA S-SX will be implemented. Several factors will be considered for planning the completion of the WMA S-SX closure action:

- Additional actions necessary to comply with the closure performance standards and extent of removal or decontamination of dangerous wastes, waste residues, equipment, and soils and groundwater containing or contaminated with dangerous waste or waste residue, as discussed in Section 6.3

- Groundwater monitoring at the WMA S-SX point of compliance as necessary to comply with groundwater protection standards
- Characterization and/or remedial design information from contiguous waste sites
- 200 Area CERCLA RODs, as applicable
- Central Plateau closure strategies, as applicable.

Should removal or decontamination of dangerous waste constituents not be achievable at WMA S-SX, the proposed contingent final remedy for WMA S-SX is closure in accordance with WAC 173-303-665 with the installation of an engineered surface barrier.

Engineered surface barriers are constructed to cover contaminated waste sites to minimize infiltration of precipitation and inhibit contact of moisture with contaminated media, and thus reduce or eliminate potential leaching of contamination to groundwater. In addition to their hydrological performance, barriers function to prevent intrusion by human and ecological receptors, limit wind and water erosion, and attenuate radiation from covered contaminants. The closure performance standards for barriers under the requirements of WAC 173-303-665 are discussed in Section 6.3. Surface barrier designs developed for application to waste sites located within the Hanford Site 200 Areas will meet or exceed RCRA design criteria, as well as incorporate established long-term performance and maintenance objectives, appropriate regulatory requirements and specified engineering design criteria. A site-specific evaluation will be performed to ensure that a surface barrier design candidate is appropriate for specific WMA S-SX characteristics and will be ultimately incorporated into the Site-Wide Permit.

Technical guidance pertaining to surface barrier design for various RCRA TSD scenarios at the Hanford Site are currently defined in *Focused Feasibility Study of Engineered Barriers for Waste Management Units in 200 Areas* (DOE/RL-93-33). Based on current knowledge of waste sources associated with WMA S-SX, it is anticipated that the minimum design criteria required for the waste site would be the modified RCRA Subtitle C Barrier, as defined in DOE/RL-93-33. However, any final barrier design will be incorporated into this permit prior to installation. Additional factors that may be considered in barrier design are aspects of risk and performance assessment modeling.

Contingent actions for barrier design and installation of the surface barrier over WMA S-SX would be integrated with Central Plateau regional closure strategies. Additionally, barrier design criteria may need to be modified if the barrier cover encompasses multiple contiguous waste sites.

When the construction of the WMA S-SX engineered surface barrier is complete, the barrier and surrounding disturbed area would be revegetated to further enhance evapotranspiration, limit erosion, and blend the site area into the surrounding landscape of the Central Plateau.

6.2.10 Post-Closure Care

Post-closure care activities would commence at completion of the final remedy for the WMA (such as the engineered surface barrier) if necessary, and would be defined in a post-closure permit. These activities would also satisfy groundwater protection standards. These activities would be integrated with the Hanford Site long-term stewardship program and the Central Plateau closure strategies. Future post-closure activities are discussed in Section 10.0.

Performance monitoring will be implemented to ensure the surface barrier is performing as designed. Monitoring the continued integrity of the surface barrier would be accomplished through visual inspection and will be supplemented by other assessment techniques, as needed. The long-term effectiveness of the surface barriers in the Central Plateau depends on maintaining each barrier throughout the natural attenuation of contaminants under its cover to prevent exposure to potential receptors. Maintenance activities would include erosion repairs and possible vegetation maintenance. Subsidence is not considered a major factor in maintenance activities for Central Plateau waste site barriers.

6.3 DETERMINATION OF COMPLIANCE WITH CLOSURE PERFORMANCE STANDARDS

The component closure activities and WMA closure actions are intended to satisfy the general closure performance standard (WAC 173-303-610(2)), the tank closure standards (WAC 173-303-640(8)), and the landfill closure standards (WAC 173-303-665(6)) should removal or decontamination of dangerous waste constituents not comply with closure standards specified in WAC 173-303-610(2)(b). The key regulatory language is set forth below. The corresponding actions that DOE will undertake to meet the standards are shown in italics preceded by checkmarks.

WAC 173-303-610 (2) Closure performance standard. The owner or operator must close a facility in a manner that:

(a)(i) Minimizes the need for further maintenance

- ✓ *Retrieval of waste from WMA tanks*
- ✓ *Stabilization and isolation of WMA tanks*
- ✓ *Ancillary equipment removal, isolation, and/or stabilization, as required*
- ✓ *Contaminated soil remediation, as required*
- ✓ *Surface barrier placement, if required*

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

- ✓ *Retrieval of waste from WMA tanks*
- ✓ *Stabilization and isolation of WMA tanks*

- ✓ *Ancillary equipment removal, isolation, and/or stabilization, as required*
- ✓ *Contaminated soil remediation , as required*
- ✓ *Surface barrier placement, if required*
- ✓ *Groundwater closure actions (coordinated with CERCLA groundwater operable unit remediation)*

(iii) 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.

- ✓ *Actions may include recontouring and revegetation, or placement of manmade surfaces depending on the nature of the land use determined appropriate following closure*
- ✓ *Surface barrier placement, if required*

(b) Where the closure requirements of this section, or of WAC 173-303-630(10), 173-303-640(8), 173-303-650(6), 173-303-655(6), 173-303-655(8), 173-303-660(9), 173-303-665(6), 173-303-670(8), 173-303-680(2) through (4), or 40 CFR 264.1102 (incorporated by reference at WAC 173-303-695) call for the removal or decontamination of dangerous wastes, waste residues, or equipment, bases, liners, soils or other materials containing or contaminated with dangerous wastes or waste residue, then such removal or decontamination must assure that the levels of dangerous waste or dangerous waste constituents or residues do not exceed:

(i) For soils, ground water, surface water, and air, the numeric cleanup levels calculated using residential exposure assumptions according to the Model Toxics Control Act Regulations, chapter 173-340 WAC as now or hereafter amended. Primarily, these will be numeric cleanup levels calculated according to MTCA Method B, although MTCA Method A may be used as appropriate, see WAC 173-340-700 through 173-340-760, excluding WAC 173-340-745; and

- ✓ *Contaminated soil remediation, as required*
- ✓ *Groundwater closure actions (coordinated with CERCLA groundwater operable unit remediation)*

(ii) For all structures, equipment, bases, liners, etc., clean closure standards will be set by the department on a case-by case basis in accordance with the closure performance standards of WAC 173-303-610 (2)(a)(ii) and in a manner that minimizes or eliminates post-closure escape of dangerous waste constituents.

- ✓ *Retrieval of waste from WMA tanks*
- ✓ *Ancillary equipment removal, isolation, and/or stabilization, as required*

The closure requirements for tank systems, WAC 173-303-640(8), read as follows:

(a) At final closure of a tank system, the owner or operator must remove or decontaminate all waste residue, contaminated containment system components (liners, etc.), contaminated soils, and structures and equipment contaminated with waste and manage them as dangerous waste, unless WAC 173-303-070(2)(a) applies.

The closure plan, closure activities, cost estimates for closure, and financial responsibility for tank systems must meet all of the requirements specified in WAC 173-303-610 and 173-303-620.

- ✓ *Retrieval of waste from WMA tanks*
- ✓ *Ancillary equipment removal, isolation, and/or stabilization, as required*
- ✓ *Contaminated soil remediation, as required*
- ✓ *Groundwater closure actions (coordinated with CERCLA groundwater operable unit remediation)*
- ✓ *Waste removed from tanks will be managed as dangerous waste and sent for storage, treatment, and disposal at a permitted disposal facility.*

(b) If the owner or operator demonstrates that not all contaminated soils can be practicably removed or decontaminated as required in (a) of this subsection, then the owner or operator must close the tank system and perform post-closure care in accordance with the closure and post-closure care requirements that apply to landfills (see WAC 173-303-665(6)). In addition, for the purposes of closure, post-closure, and financial responsibility, such a tank system is then considered to be a landfill, and the owner or operator must meet all of the requirements for landfills specified in WAC 173-303-610 and 173-303-620.

- ✓ *Surface barrier design and placement*
- ✓ *Submittal and approval of Post-closure Permit Application through modification of the Site-Wide Permit*
- ✓ *Post-closure maintenance and monitoring*
- ✓ *Institutional controls*

(c) If an owner or operator has a tank system that does not have secondary containment that meets the requirements of subsection 4(b) through (f) of this section and is not exempt from the secondary containment requirements in accordance with subsection 4(g) of this section, then:

(i) The closure plan for the tank system must include both a plan for complying with (a) of the subsection and a contingent plan for complying with (b) of this subsection.

- ✓ *Approval of SST System Closure Plan and modification of the Site-Wide Permit*
- ✓ *Further modification of the Site-Wide Permit to include future component closure activities, soil corrective measures, and groundwater remedial actions*

(ii) A contingent post-closure plan for complying with (b) of this subsection must be prepared and submitted as part of the permit application.

- ✓ *Submittal and approval of Post-closure Permit Application through modification of the Site-Wide Permit*

(iii) The cost estimates calculated for closure and post-closure care must reflect the costs of complying with the contingent closure plan and the contingent post-closure plan, if those costs are greater than the costs of complying with the closure plan prepared for the expected closure under (a) of this subsection (not applicable).

(iv) Financial assurance must be based on the cost estimates in (c)(iii) of this subsection (not applicable).

(v) For the purposes of the contingent closure and post-closure plans, such a tank system is considered to be a landfill, and the contingent plans must meet all of the closure, post-closure, and financial responsibility requirements for landfills under this chapter (WAC 173-303-610 and 173-303-620).

- ✓ *Surface barrier design and placement*
- ✓ *Submittal and approval of Post-closure Permit Application through modification of the Site-Wide Permit*
- ✓ *Post-closure maintenance and monitoring*
- ✓ *Institutional controls*

The closure requirements for landfills, WAC 173-303-665(6), read as follows:

(a) At closure of the landfill or upon closure of any cell, the owner or operator must cover the landfill or cell with a final cover designed and constructed to:

(i) Provide long-term minimization of migration of liquids through the closed landfill.

- ✓ *Surface barrier design and placement*

(ii) Function with minimum maintenance.

- ✓ *Surface barrier design and placement*

(iii) Promote drainage and minimize erosion or abrasion of the cover.

- ✓ *Surface barrier design and placement*

(iv) Accommodate settling and subsidence so that the cover's integrity is maintained.

- ✓ *Surface barrier design and placement*

(v) Have a permeability less that or equal to the permeability of any bottom liner system or natural subsoils present.

- ✓ *Surface barrier design and placement*

(b) After final closure, the owner or operator must comply with all post-closure requirements contained in WAC 173-303-610(7), (8), (9), and (10), including maintenance and monitoring throughout the post-closure care period. The owner or operator must:

(i) Maintain the integrity and effectiveness of the final cover, including making repairs to the cap as necessary to correct the effects of settling, subsidence, erosion, or other events.

✓ *Post-closure maintenance and monitoring*

(ii) Maintain and monitor the leak detection system in accordance with subsections (2)(h) and (4)(c) of this section, where such a system is present between double liner systems. (not applicable)

(iii) Continue to operate the leachate collection and removal system until leachate is no longer detected. (not applicable)

(iv) Maintain and monitor the groundwater monitoring system and comply with all other applicable requirements of WAC 173-303-645.

✓ *Post-closure groundwater monitoring system*

(v) Prevent run-on and run-off from eroding or otherwise damaging the final cover.

✓ *Post-closure maintenance and monitoring*

(vi) Protect and maintain surveyed benchmarks used in complying with subsection (5) of this section.

✓ *Post-closure maintenance and monitoring*

The post-closure care requirements for dangerous waste facilities are specified in WAC 173-303-610(7):

Post-closure care for each dangerous waste management unit subject to post-closure requirements must begin after completion of closure of the unit and continue for thirty years after that date and must consist of at least the following:

Groundwater monitoring and reporting as required by WAC 173-303-645, 173-303-650, 173-303-655, 173-303-660, 173-303-665, 173-303-680, and

✓ *Post-closure groundwater monitoring system*

Maintenance and monitoring of waste containment systems as applicable.

✓ *Post-closure maintenance and monitoring*

(d) Post-closure use of property on or in which dangerous wastes remain after partial or final closure must never be allowed to disturb the integrity of the final cover, liner(s) or any other components of any containment systems,

✓ *Post-closure maintenance and monitoring*

✓ *Institutional controls*

✓ *Deed restrictions*

7.0 WMA RISK EVALUATION

This section presents a summary of the initial long-term human health risk estimates associated with the planned closure of the Waste Management Area S and SX (Addendum D-2). The risk assessment for WMA S-SX was conducted prior to the completion of any waste retrieval activities to support closure. Significant limitations and uncertainties are associated with the risk assessment of WMA S-SX. Therefore, the inventory estimates, release mechanisms and parameters selected to estimate groundwater concentrations, and the exposure assumptions are considered biased high which results in conservative risk and dose estimates. A summary of the uncertainties associated with this risk assessment are listed in Table 7-1 of Addendum D-2.

7.1 DESCRIPTION OF SOURCE TERMS AND RELEASE MECHANISMS

Four separate source terms were considered for this risk assessment and consist of the following: (1) past leaks and spills, (2) potential leakage during retrieval, (3) residual waste from tanks following closure, and (4) residual waste from tank ancillary equipment (or pipe systems) following closure.

Past leaks represent tank waste that has leaked into the vadose zone and has migrated through the vadose zone for a number of years. The simulations for past leaks and spills do not attempt to model a waste release; instead, they model the potential risk posed by the existing vadose zone contamination footprint. Only tanks for which there is evidence of contamination in the vadose zone through borehole logs and contaminant sampling and for which there is a vadose zone inventory is included in the past leak analyses.

Retrieval leakage refers to release to the vadose zone that could occur during waste retrieval operations using water-based sluicing. For the purposes of this risk assessment, it was assumed that all tanks would experience an equal leak loss volume of 8,000 gal per tank. A lower leakage loss of 4,000 gal per tank was also used as a sensitivity case.

Releases from residual wastes (both from tank and tank ancillary equipment) would typically occur over an extended period of time following closure of the tank farm when infiltrating water would enter the tank or tank ancillary equipment, dissolve contaminants, and migrate into the vadose zone and subsequently the groundwater. Modeling efforts for the risk assessment assume that waste from all tanks in WMA S-SX will be retrieved to the HFFACO goal of 360 ft^3. For residual tank wastes and residual ancillary equipment wastes, actual release mechanisms are unknown at this time. Four different release scenarios were examined for contaminant release from tank wastes and tank ancillary equipment; however the diffusion-controlled release scenario was selected for the risk assessment.

Infiltration (recharge) can vary greatly depending on factors such as climate, vegetation, surface condition, and soil texture. For the purpose of this risk assessment, a base case recharge rate of 100 mm/yr was used before closure. A modified RCRA Subtitle C Barrier is assumed to be in place by the year 2050 and is assumed to function to its design estimate of 500 years. The

recharge rate during this time period was assumed to be 0.5 mm/yr. After 500 years, the barrier is assumed to degrade and the recharge rate increases from 0.5 mm/yr to 3.5 mm/year through the end of the 10,000 year simulation period. For all time periods, the selected recharge rates exceed recommended values (RPP-13033, *Tank Farms Documented Safety Analysis*) and reasonable bounding conditions.

7.2 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Chemicals of potential concern (COPC) in the WMA S-SX tanks are considered mobile long-lived contaminants that could migrate and impact groundwater at concentrations greater than the federal drinking water standards or maximum contaminant levels (MCL). COPCs are defined as those constituents that should be carried forward into the risk assessment process. The following 15 constituents were identified as COPCs because they exceeded their respective risk screening threshold values:

- **tritium**
- **^{14}C**
- **^{99}Tc**
- **^{129}I**
- **^{232}U**
- **^{233}U**
- **^{234}U**
- **^{235}U**
- **^{236}U**
- **^{238}U**
- **total chromium**
- **fluoride**
- **nitrate**
- **nitrite**
- **total uranium**

A complete listing of inventories for all contaminants can be found in *241-S-SX Waste Management Area Inventory Data Package* (RPP-20420). RPP-20420 also provides revised tank leak estimates for inventory given in RPP-6285. Inventories for COPCs can be found in Tables 3-4 through 3-11 of Addendum D-2.

7.3 PREDICTED GROUNDWATER CONCENTRATIONS FOR WMA S-SX

Groundwater concentrations at the WMA S-SX fenceline were estimated using the numerical simulator STOMP (*STOMP Subsurface Transport Over Multiple Phases, Version 2.0, Theory Guide* [PNNL-11216]). Groundwater concentrations at downgradient calculation points (Core Zone Boundary and Columbia River) were estimated using an analytical/streamtube approach. The results for each source and each tank are then summed, using the principle of superposition, to produce a contaminant breakthrough curve at the fenceline or downgradient.

Groundwater flow is assumed to occur in an east-west direction, thus impacts to groundwater are evaluated on a tank row-by-tank row basis as the tank rows are oriented east to west. Commingling of plumes between rows is assumed to be negligible because the results of the three-dimensional (3-D) simulation indicated that 99% of the contaminants at the fenceline remained within 20 m (65.6 ft) of the plume centerline (PNNL-14334).

7.3.1 Peak Groundwater Concentrations at the Fenceline

Peak groundwater concentrations were predicted for the S tank farm and SX tank farm from all sources evaluated in this risk assessment. Peak groundwater concentrations and associated arrival times were calculated for all radiological and non-radiological COPCs and all tank rows at the WMA S-SX fenceline. The following sections summarize the trends observed for each tank farm.

7.3.1.1 Peak Cumulative Groundwater Concentrations at S Tank Farm. Maximum groundwater concentrations occur along the row of tanks containing S-110, S-111, and S-112 which is contributed primarily from hypothetical retrieval leaks. Peak groundwater concentrations for ^{99}Tc, ^{129}I, and chromium are 5,100 pCi/L, 8.1 pCi/L, and 0.15 mg/L, respectively. Groundwater concentrations peak at approximately year 2060 and decreases through the end of the simulation period following the emplacement of the surface barrier at year 2050.

When hypothetical retrieval leaks are excluded, maximum groundwater concentrations of ^{99}Tc, ^{129}I, and total chromium at the fenceline are considerably reduced. Groundwater concentrations reported from tank rows S-104, S-105, and S-106 is representative of vadose zone contamination that is currently present. None of the other tank rows possess sufficient inventory to produce groundwater concentrations in excess of the MCLs for any COPCs when retrieval losses are excluded from the analysis. These results emphasize the importance of minimizing the losses that occur during retrieval actions at the S tank farm.

7.3.1.2 Peak Cumulative Groundwater Concentrations at SX Tank Farm. Maximum groundwater concentrations occur along the row of tanks containing SX-107, SX-108, and SX-109 which is contributed from vadose zone contamination that is currently present from all three tanks. Peak groundwater concentrations for ^{99}Tc, ^{129}I, tritium, ^{14}C, chromium, nitrate, and nitrite are 210,000 pCi/L, 400 pCi/L, 37,000 pCi/L, 26,000 pCi/L, 20 mg/L, 310 mg/L, and 190 mg/L, respectively. Groundwater concentrations peak at approximately year 2060 and decrease through the end of the simulation period following the emplacement of the surface barrier at year 2050.

Inventory from hypothetical retrieval leaks is not the primary contributor to elevated groundwater concentrations as it is at the S tank farm. Inventory from contamination currently existing in the vadose zone at SX tank farm is the primary contributor to elevated groundwater concentrations. When hypothetical retrieval leaks are excluded, predicted groundwater concentrations remain relatively unchanged because of the large inventories from past leaks at tank rows SX-107, SX-108, SX-109, SX-113, SX-114, and SX-115. When hypothetical retrieval leaks are excluded from tank rows without existing contamination, then maximum groundwater concentrations at the fenceline are reduced. The emplacement and efficacy of the surface barrier does not impact the results at SX tank farm to the same degree as the S tank farm. Because future groundwater concentrations modeled from past leaks and hypothetical retrieval leaks peak close to the time of barrier installation at year 2050; it does not appear that future concentrations are affected by the emplacement of the surface barrier.

7.4 PERFORMANCE OBJECTIVES

For each exposure scenario considered, incremental lifetime cancer risk (ILCR) and hazard index (HI) were calculated for evaluating potential carcinogenic and noncarcinogenic health effects from exposure to radiological and nonradiological constituents. Dose (mrem/yr) estimates were calculated for evaluating potential health effects from exposure to radiological constituents for only the all pathways farmer.

For the purposes of this risk assessment, the potential for unacceptable human health risk is identified using the following risk and dose thresholds:

- If the multi-chemical aggregate risk for radiological and nonradiological constituents exceeds an ILCR of 1×10^{-5}; or a noncancer HI of 1 (WAC 173-340-745) for industrial land use, or if any individual radiological or nonradiological constituents exceeds and ILCR of 1×10^{-5}, then the major risk-contributing chemicals will be identified as certificates of compliance (COC).

- If the multi-chemical aggregate risk for radiological and nonradiological constituents exceeds an ILCR of 1×10^{-6}; or a noncancer HI of 1 (WAC 173-340-740) for unrestricted land use, or if any individual radiological or nonradiological constituents exceeds and ILCR of 1×10^{-6}, then the major risk-contributing chemicals will be identified as COCs.

- If the multi-chemical aggregate risk for radiological and nonradiological constituents is outside the EPA ILCR risk range of 1×10^{-4} to 1×10^{-6} or a noncancer HI of 1 (EPA 1991; EPA 2001), the major risk-contributing chemicals will be identified as COCs.

- If the dose from radiological constituents to representative members of the public exceeds 25 mrem/yr total EDE from all exposure pathways (DOE G 435.1-1), then the major dose contributing constituents will be identified as COCs.

- If groundwater concentrations for alpha emitters, ^{226}Ra plus ^{228}Ra exceeds 5 pCi/L or 15 pCi/L for all others (excluding uranium) (40 CFR 141.66), then the radiological constituent will be identified as a COC.

- If groundwater concentrations for beta and photon emitters exceed 4 mrem/yr total body or organ dose (40 CFR 141.66), then the major dose contributing constituents will be identified as a COC.

7.5 SUMMARY OF THE S-SX RISK ASSESSMENT RESULTS

Risk to offsite receptors was estimated using the HSRAM industrial and HSRAM residential exposure scenarios and dose to offsite receptors was estimated using the all pathways farmer exposure scenario. Each scenario estimates potential human health impacts from exposure to radiological and nonradiological COPCs. Additionally, groundwater concentrations were compared to the national primary drinking water standards, as codified in "National Primary

Drinking Water Regulations" (40 CFR 141). The resulting risk and dose estimates were then compared to appropriate performance objectives. Risk and dose were also estimated at locations downgradient from WMA S-SX including the proposed core zone boundary and the Columbia River. Finally, cumulative effects from all source terms were evaluated.

7.5.1 Summary of Risk Estimates for the HSRAM Industrial and Residential Scenarios

7.5.1.1 HSRAM Industrial Scenario.

S Tank Farm. The radiological ILCR from past leaks, residual tank waste, and the S tank farm pipe system was either less than the lower EPA threshold value of 1×10^{-6} (pipe system) or within the EPA risk range of 1×10^{-4} to 1×10^{-6} (past leaks and residual tank waste) and did not exceed the threshold value of 1×10^{-5} recommended in WAC 173-340-745 for industrial land use.

For potential retrieval leaks, the radiological ILCR from both soil and water at year 2060 is 8.0×10^{-5}. The primary contributor to the ILCR is ^{99}Tc. The ILCR reported for potential retrieval leaks is within the EPA risk range of 1×10^{-4} to 1×10^{-6} and is greater than the threshold value of 1×10^{-5} recommended in WAC 173-340-745 for industrial land use.

The nonradiological ILCR from each source evaluated was either less than the lower EPA threshold value of 1×10^{-6} (past leaks, residual tank waste, and pipe system) or within the EPA risk range of 1×10^{-4} to 1×10^{-6} (potential retrieval leaks) and did not exceed the threshold value of 1×10^{-5} recommended in WAC 173-340-745 for industrial land use. The HI reported from each source evaluated was less than EPA and WAC recommended threshold value of 1.

Locations Downgradient from S Tank Farm. The radiological and nonradiological ILCR from each source and each downgradient location evaluated is less than the EPA lower risk threshold of 1×10^{-6} and is less that the threshold value of 1×10^{-5} recommended in WAC 173-340-745 for industrial land use. Additionally, the HI from each source and each downgradient location evaluated are less than the EPA and WAC recommended threshold value of 1.

SX Tank Farm. The radiological and nonradiological ILCR from residual tank waste and the SX tank farm pipe system was either less than the lower EPA threshold value of 1×10^{-6} (pipe system) or within the EPA risk range of 1×10^{-4} to 1×10^{-6} (residual tank waste) and did not exceed the threshold value of 1×10^{-5} recommended in WAC 173-340-745 for industrial land use.

For past leaks, the radiological ILCR from both soil and water at year 2062 is 3.4×10^{-3} and the nonradiological ILCR from soil is 2.9×10^{-4}. The primary contributors to ILCR include ^{99}Tc, ^{129}I, ^{14}C, and Cr^{+6}. For potential retrieval leaks, the radiological ILCR from both soil and water at year 2060 is 1.3×10^{-4} and the nonradiological ILCR from soil is 4.2×10^{-6}. The primary contributors to risk include ^{99}Tc, ^{129}I, and Cr^{+6}. The ILCR reported for past leaks and potential retrieval leaks are either greater than the EPA upper risk threshold of 1×10^{-4} (radiological

constituents) or within the EPA risk range of 1×10^{-4} to 1×10^{-6} (nonradiological constituents) and are greater than the threshold value of 1×10^{-5} recommended in WAC 173-340-745 for industrial land use.

The HI reported from residual tank waste and the SX tank farm pipe system were less than the EPA and WAC recommended threshold value of 1. For past leaks, the HI reported from soil and water exposure pathways is 95; the primary contributors include Cr, NO_2, and NO_3. For potential retrieval leaks, the HI reported from the water and soil exposure pathways is 1.7; the primary contributor is Cr^{+6}.

Locations Downgradient from SX Tank Farm. The radiological and nonradiological ILCR from each source and each downgradient location evaluated is less than the EPA lower risk threshold of 1×10^{-6} and is less that the threshold value of 1×10^{-5} recommended in WAC 173-340-745 for industrial land use. Additionally, the HI from each source and each downgradient location evaluated is less than the EPA and WAC recommended threshold value of 1.

7.5.1.2 HSRAM Residential Scenario.

S Tank Farm. For residual tank waste and the S tank farm pipe system, the radiological ILCR is within the EPA risk range of 1×10^{-4} to 1×10^{-6} and is greater than the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use.

For residual tank waste and the S tank farm pipe system, the nonradiological ILCR is either less than (pipe system) or slightly greater than (residual tank waste) the EPA lower risk threshold value of 1×10^{-6} and is less than or slightly greater than the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use.

For past leaks and potential retrieval leaks, the ILCR for radiological constituents is greater than the EPA upper risk threshold of 1×10^{-4}, the ILCR for nonradiological constituents is within the EPA risk range of 1×10^{-4} to 1×10^{-6}, and both are greater than the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use. For past leaks, the radiological ILCR from both soil and water at year 2062 is 1.3×10^{-4} and the nonradiological ILCR from soil is 1.2×10^{-6}. For potential retrieval leaks, the radiological ILCR from both soil and water at year 2060 is 1.8×10^{-3} and the nonradiological ILCR from soil is 3.5×10^{-5}. The primary contributors to ILCR from both past and potential retrieval leaks include ^{99}Tc, ^{129}I, ^{14}C, and Cr^{+6}.

The HI reported for residua tank waste and the S tank farm pipe system was less than the EPA and WAC recommended threshold value of 1. For past leaks, the HI reported from the soil and water exposure pathways is 3.1; the primary contributor is NO_2. For potential retrieval leaks, the HI reported from the water and soil exposure pathways is 5.7; the primary contributors are Cr^{+6} and NO_2.

Locations Downgradient from S Tank Farm. The radiological and nonradiological ILCR from each source and each downgradient location evaluated is less than the EPA lower risk threshold of 1×10^{-6} and is less that the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use. Additionally, the HI from each source and each

downgradient location evaluated is less than the EPA and WAC recommended threshold value of 1.

SX Tank Farm. For residual tank waste, the radiological and nonradiological ILCR is within the EPA risk range of 1×10^{-4} to 1×10^{-6} and both are greater than the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use. The primary contributors to risk include ^{99}Tc and Cr^{+6}.

For the SX tank farm pipe system, the radiological ILCR is within the EPA risk range of 1×10^{-4} to 1×10^{-6} and the nonradiological ILCR is less than the EPA lower risk threshold value of 1×10^{-6}; only the radiological ILCR is greater than the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use. The primary contributor to risk is ^{99}Tc.

For past leaks, the ILCR for radiological and nonradiological constituents is greater than the EPA upper risk threshold of 1×10^{-4} and both are greater than the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use. The radiological ILCR from both soil and water at year 2062 is 7.3×10^{-2} and the nonradiological ILCR from soil is 6.7×10^{-4}. The primary contributors to risk include ^{99}Tc, ^{129}I, ^{14}C, and Cr^{+6}.

For potential retrieval leaks, the ILCR for radiological constituents is greater than the EPA upper risk threshold of 1×10^{-4}, the ILCR for nonradiological constituents is within the EPA risk range of 1×10^{-4} to 1×10^{-6}, and both are greater than the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use. The radiological ILCR from both soil and water at year 2060 is 2.8×10^{-3} and the nonradiological ILCR from soil is 9.8×10^{-6}. The primary contributors to risk include ^{99}Tc, ^{129}I, ^{14}C, and Cr^{+6}.

The HI reported for the SX tank farm pipe system is less than the EPA and WAC recommended threshold value of 1. For past leaks, residual tank waste, and potential retrieval leaks, the HI reported from the soil and water exposure pathways is 587, 1.8, and 10, respectively. The primary contributors include Cr^{+6} (all sources), NO_2 (past leaks and potential retrieval leaks), and NO_3 (past leaks).

Locations Downgradient from SX Tank Farm. With the exception of radiological risk from past leaks at the core zone boundary and the Columbia River, the radiological and nonradiological ILCR from each source and each downgradient location evaluated are less than the EPA lower risk threshold of 1×10^{-6} and is less that the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use. Radiological risk from past leaks at the core zone boundary and the Columbia River are within the EPA risk range of 1×10^{-4} to 1×10^{-6} and are greater than the threshold value of 1×10^{-6} recommended in WAC 173-340-740 for unrestricted land use. Additionally, the HI from each source and each downgradient location evaluated are less than the EPA and WAC recommended threshold value of 1.

7.5.2 Summary of Dose Estimates for the All Pathways Farmer Scenario

S Tank Farm. The total EDE dose from both soil and water for each source evaluated is less than the threshold value of 25 mrem/yr for representative members of the public.

SX Tank Farm. With the exception of past leaks, the total EDE dose from soil and water for each source evaluated were less than the threshold value of 25 mrem/yr for representative members of the public.

For past leaks, a total EDE dose of 702 mrem/yr was reported from both soil and water and greater than the DOE recommended threshold value of 25 mrem/yr for representative members of the public. The primary contributors to dose are ^{99}Tc, ^{129}I, and ^{14}C.

Locations Downgradient from WMA S-SX. The total EDE dose from each source and each downgradient location evaluated are less than the threshold value of 25 mrem/yr for representative members of the public.

7.5.3 Comparison to Maximum Contaminant Levels

S Tank Farm. For radiological constituents, only ^{129}I and ^{99}Tc groundwater concentrations from past leaks and ^{129}I groundwater concentrations from potential retrieval leaks were above the MCL-derived concentration. All remaining concentrations of radiological constituents were below their respective MCL derived concentration. For nonradiological constituents, all concentrations from each source evaluated were less their respective MCL.

SX Tank Farm. For past leaks, all radiological groundwater concentrations were greater than their respective MCL derived concentration and Cr, NO_3, and NO_2 groundwater concentrations were greater than their respective MCLs. For residual tank waste and the SX tank farm pipe system, all radiological and nonradiological groundwater concentrations were less than respective MCL derived concentration or MCL, respectively. For potential retrieval leaks, concentrations of ^{99}Tc, ^{129}I, Cr, and NO_2 in groundwater were greater than their respective MCL derived concentration or MCLs, respectively.

7.5.4 Cumulative Effects of All Source Terms

A composite curve was generated showing the total cumulative risk from all sources. Four distinct peaks are associated with the composite curve; the first peak is associated with the early release of mobile contaminants followed by a much smaller second peak arriving approximately 1,000 years into the future. A third peak arrives approximately 3,000 years into the future, which is associated with residual tank waste, and finally the fourth curve is associated with the early releases of less mobile contaminants.

7.5.4.1 HSRAM Industrial Scenario. The cumulative radiological HSRAM industrial ILCR contributed from all sources within the WMA is provided in the upper plot of Figure D1-2. The

cumulative ILCR from all early releases (i.e., past leaks and potential retrieval leaks) is greater than the EPA upper risk threshold of 1×10^{-4} and also greater than the WAC 173-340-745 risk threshold of 1×10^{-5} for industrial land use. The ILCR from late releases (i.e., tank residuals) are within the EPA risk range of 1×10^{-4} to 1×10^{-6} and less than the WAC 173-340-745 risk threshold of 1×10^{-5} for industrial land use.

The cumulative HSRAM industrial hazard index contributed from all sources within the WMA is provided in upper plot of Figure D1-3. The cumulative HI from early releases is greater than the EPA and WAC 173-340-745 threshold value of 1.0. The cumulative HI from late releases is less than the EPA and WAC 173-340-745 threshold value of 1.0.

7.5.4.2 HSRAM Residential Scenario. The cumulative radiological HSRAM residential ILCR contributed from all sources within the WMA is provided in the lower plot of Figure D1-2. The cumulative ILCR from all early releases (i.e., past leaks and potential retrieval leaks) is greater than the EPA upper risk threshold of 1×10^{-4} and also greater than the WAC 173-340-740 risk threshold of 1×10^{-6} for unrestricted land use. The ILCR from late releases (i.e., tank residuals) are within the EPA risk range of 1×10^{-4} to 1×10^{-6} and greater than the WAC 173-340-740 risk threshold of 1×10^{-6} for unrestricted land use.

The cumulative HSRAM residential hazard index contributed from all sources within the WMA is provided in the lower plot of Figure D1-3. The cumulative HI from early releases is greater than the EPA and WAC 173-340-745 threshold value of 1.0. The cumulative HI from late releases is less than the EPA and WAC 173-340-745 threshold value of 1.0.

7.5.4.3 All Pathways Farmer Scenario. The cumulative total radiological dose for the all pathways farmer contributed from all sources within the WMA is provided in the upper plot of Figure D1-4. The cumulative total EDE dose from early releases is above the performance objective of 25 mrem/yr required by DOE O 435.1. The cumulative total EDE dose from late releases is below the performance objective of 25 mrem/yr required by DOE O 435.1.

7.5.4.4 Drinking Water Target Organ Dose. The cumulative total radiological dose (target) from all sources within the WMA is provided in the lower plot of Figure D1-4. The cumulative total target organ dose from early releases is above the performance objective of 4 mrem/yr as required by 40 CFR 141.66. The cumulative total target organ dose from late releases is below the performance objective of 4 mrem/yr required by 40 CFR 141.66.

Note: The text for this section, including reference citations, was taken from RPP-21596, *Risk Assessment for Waste Management Area S-SX Closure Plan.*

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8.0 CLOSURE SCHEDULE FOR WMA S-SX

The timeline presented in Section 6.0, Figure 6-1, depicts the relative sequence of closure activities associated with the WMA closure and post-closure actions.

The HFFACO M-45-00 series (draft revised change number M-45-04-01) milestones define major, interim, and target dates for the SST system closure. As of March 1, 2004, the following are the milestones and target dates specific to WMA S-SX component closure activities and general milestones applicable to the WMA S-SX closure action:

- M-45-03C– Complete SST S-112 full-scale saltcake waste retrieval technology demonstration. Milestone date 3/31/2005.
- M-45-03D– Complete SST S-112 full-scale saltcake waste retrieval technology demonstration design. Milestone date 5/31/2003. (complete)
- M-45-03E– Complete SST S-112 full-scale saltcake waste retrieval technology demonstration construction. Milestone date 9/30/2004.
- M-45-05A– Complete initial waste retrieval from SST S-102. Milestone date 3/31/2005.
- M-45-05B– Complete initial SST S-102 waste retrieval project design. Milestone date 3/31/2004. (complete)
- M-45-05C– Complete SST S-102 initial waste retrieval project construction. Milestone date 3/31/2004. (complete)
- M-45-06B – Submit a certified S-112 component closure activity plan as an application for a modification to the Hanford site-wide hazardous waste facility permit to Ecology. Milestone date 9/30/2004.
- M-45-06C – Submit a certified S-102 component closure activity plan as an application for a modification to the Hanford site-wide hazardous waste facility permit to Ecology. Milestone date 9/30/2004.
- M-45-13 – Interim completion of SST S-112 waste retrieval and closure demonstration project. Milestone date 12/31/2005.
- M-45-13-T01 – Final completion of SST S-112 waste retrieval and closure demonstration project. Milestone date 12/30/2006.
- M-45-15 – Interim completion of SST S-102 waste retrieval and closure demonstration project. Milestone date 12/31/2005.
- M-45-15-T01 – Final completion of SST S-102 waste retrieval and closure demonstration project. Milestone date 12/31/2006.

- M-45-56 – Complete implementation of agreed-to interim measures. Milestone date to be determined (TBD).

- M-45-58 – Submit a CMS for interim corrective measures. Milestone date TBD pending Milestone M-45-55.

- M-45-59 – Control surface water infiltration pathways as needed to control likelihood of migration of subsurface contamination to groundwater at the WMAs. Milestone date TBD pending Milestone M-45-58 and implementation of other interim corrective measures.

- M-45-60 – Submit to Ecology for review and approval as an agreement primary document DOE's RFI/CMS work plan for SST WMAs. Milestone date 9/30/2007.

- M-45-00 – Complete closure of all SST farms in accordance with approved closure/post-closure plan(s). Milestone date 9/30/2024.

DOE will work closely with the regulators to develop a detailed schedule of activities to meet HFFACO milestones and target dates for WMA S-SX.

9.0 CLOSURE CERTIFICATION, NOTICE IN DEED, AND SURVEY PLAT

In accordance with WAC 173-303-610(6), "Certification of Closure," within 60 days of completing the final closure of WMA S-SX, DOE will submit to Ecology by registered mail, a certification that WMA S-SX has been closed according to the specifications in this closure action plan. The certification will be signed by DOE and an independent qualified registered professional engineer.

In accordance with WAC 173-303-610(9) and (10), "Notice to local land authority," and "Notice in deed to property," no later than the date of submission of the certification of closure of WMA S-SX, DOE will provide a survey plat to Benton County indicating the location and dimensions of the closed dangerous waste units with respect to permanently surveyed benchmarks. The survey plat will be prepared and certified by a professional land surveyor. After the final closure, the survey plat of the WMA will be submitted to Benton County and Ecology. In addition, any restrictive covenants on the use of the land will be submitted to Benton County for attachment to the property deed, as necessary.

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10.0 POST-CLOSURE CARE PLAN

In accordance with WAC 173-303-640(8)(c)(ii), a contingent post-closure plan is required to be included in a closure plan for a tank system that does not comply with secondary containment, such as the SST system. This post-closure plan must provide for contingent post-closure care in accordance with the requirements for landfills contained in WAC 173-303-665(6). Further details regarding post-closure care will be developed on completion of a WMA S-SX surface barrier design. This information will be submitted in modifications to the WMA S-SX closure action plan prior to final closure as described in the relative timeline (Figure 6-1) and if required should removal or decontamination actions leave dangerous waste constituents in place above clean closure standards.

The DOE will provide to Ecology an amended WMA S-SX Closure Action Plan if DOE determines that WMA S-SX must be closed as a landfill. Should this determination be made, the contingent post-closure plan provided in this section would be amended to become the WMA S-SX post-closure plan.

10.1 CONTINGENT POST-CLOSURE PLAN

After completing final closure activities and if closed with waste in place, WMA S-SX will enter a post-closure care period. When this occurs, the post-closure requirements for WMA S-SX will be incorporated into Part VI, "Unit-Specific Conditions for Units in Post-closure," of the Site-Wide Permit.

10.1.1 Groundwater Monitoring

Prior to closure of WMA S-SX, an RCRA-compliant post-closure groundwater monitoring plan will be developed as identified in Figure 6-1. Post-closure groundwater monitoring will be integrated with the Central Plateau regional groundwater monitoring system. At that time, a description of the planned groundwater monitoring activities, frequencies at which they will be performed, and reporting requirements as required by WAC 173-303-645 and -665 will be included.

10.1.2 Maintenance Activities

Barrier performance monitoring and maintenance activities, including inspections, will be performed as part of post-closure care of dangerous waste units (WAC 173-303-610(7)) and of tanks closed as landfills (WAC 173-303-665(6)). WMA inspection activities will be developed to include inspecting the institutional controls, the surface barrier (after final closure action), security elements, benchmarks, subsurface monitoring systems, groundwater monitoring wells, and other equipment that may be installed as part of post-closure monitoring. Surface barrier inspections will monitor such things as the condition of the vegetation, signs of intrusion, and run-on/run-off control. Maintenance will be scheduled when a problem is discovered during the

inspections. Maintenance activities would include repairs to the surface barrier as necessary to correct the effects of settling, subsidence, erosion, or other effects.

10.1.3 Institutional Controls

Institutional controls generally include nonengineered restrictions on activities and access restrictions to land, groundwater, surface water, waste sites, waste disposal areas, and other areas or media that contain hazardous substances. The institutional controls are grouped into five main types of controls in the *Sitewide Institutional Control Plan for Hanford CERCLA Response Actions* (DOE/RL-2001-41). These five types of controls are warning notices or signs, entry restrictions, land-use management, groundwater-use management, and waste site information management. Entry restrictions include fencing and procedural requirements for access, and land-use management includes land-use and real property controls, and excavation permits.

Institutional controls will be implemented following WMA remedial measures if the endstate of the selected remedy cannot support unrestricted human use and unlimited human exposure (DOE/RL-2001-41). The institutional controls required will be specified in the post-closure permit for WMA S-SX. The scope and duration of institutional controls will be based on an evaluation of residual contamination, the location of that material, reasonably anticipated future human land uses and environmental impacts.

10.1.4 Post-closure Contact

DOE will be the official contact for WMA S-SX during the post-closure activities at the following address:

U.S. Department of Energy
P.O. Box 450 (H6-60)
Richland, Washington 99352

10.2 CERTIFICATION OF COMPLETION OF POST-CLOSURE CARE

No later than 60 days after completion of the established post-closure care period for WMA S-SX, DOE will submit to Ecology, by registered mail, a certification that the post-closure care period for WMA S-SX was performed in accordance with the specifications in the approved post-closure plan. The certification will be signed by DOE and an independent registered professional engineer. Documentation supporting the independent registered professional engineer's certification will be furnished to Ecology on request.

11.0 REFERENCES

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Attachment 2
'04-TPD-092

RPP-19774, Attachment D-2 Single-Shell Tank 241-S-102
Component Closure Activity Plan, Revision 1

(Consisting of 35 pages,
including coversheet)

RPP-19774
Revision 1

ATTACHMENT D-2

SINGLE-SHELL TANK 241-S-102 COMPONENT CLOSURE ACTIVITY PLAN

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Prepared for the U.S. Department of Energy
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PREFACE

This *Single-Shell Tank 241-S-102 Component Closure Activity Plan* is being submitted to the State of Washington, Department of Ecology (Ecology), under the provisions of the *Resource Conservation and Recovery Act of 1976* (RCRA), the *Revised Code of Washington,* Chapter 70.105, "Hazardous Waste Management Act of 1976" (RCW 70.105), and applicable requirements thereunder. Consequently, this plan addresses hazardous and dangerous wastes only (as defined by these statutes and regulations) and does not address waste classification determinations and radioactive waste-specific closure actions that the U.S. Department of Energy (DOE) may take under the *Atomic Energy Act of 1954* (AEA). To the extent that this plan provides data or discussions about materials regulated under the AEA, that information is provided for informational purposes only.

This component closure activity plan is one of a series of closure plan documents that collectively comprise the *Single-Shell Tank System Closure Plan.* Revision 0 of the *Single-Shell Tank System Closure Plan* (RPP-13774a) was initially submitted to Ecology on December 19, 2002, pursuant to the *Hanford Federal Facility Agreement and Consent Order* Milestone M-45-06A (Ecology et al. 1989). After submittal of Revision 0, the United States District Court, District of Idaho, issued a Judgment in *Natural Resources Defense Council, et al., v. Spencer Abraham, et al.*, Civ. No. 01-0413-S-BLW (July 3, 2003) holding invalid certain portions of DOE O 435.1, *Radioactive Waste Management*, relating to waste incidental to reprocessing. On August 27, 2003, DOE appealed this judgment to the U. S. Circuit Court of Appeals for the Ninth Circuit. This component closure activity plan does not address the waste incidental to the reprocessing evaluation process described in DOE O 435.1 and its accompanying Guidance and Manual. Revisions 1 and 2 (RPP-13774b) were later submitted in response to review comments submitted by Ecology and subsequent comment resolution.

The timing of certain actions contemplated in this closure activity plan, such as mixing grout with residual wastes during the closure process, may require decisions that must be made under the AEA and/or in accordance with other applicable requirements. Accordingly, even where apparently mandatory phrases such as "DOE will…" are used in this plan, the actions these phrases refer to are conditional and based on the successful completion of required precursor actions that may be affected by the outcome of the litigation referred to above. No irreversible final closure actions will be taken for the RCRA purposes discussed in this plan unless and until they are shown to be consistent with the radioactive waste management requirements DOE must address under the AEA, DOE orders, and any other applicable requirements. As a specific example, grout will not be added to stabilize tank residual wastes for RCRA purposes unless and until DOE has determined that the waste characteristics of the residuals are suitable for addition of grout in the tank under applicable requirements and Ecology has issued the appropriate permits. In some cases, the paths forward to make the radioactive waste determinations are still under development and may impact schedule dates contemplated in this plan.

RPP-13774b describes the process for closure of 149 single-shell tanks at the Hanford Site, Washington, including the tanks themselves, ancillary equipment, contaminated soil, and contaminated groundwater, in accordance with the requirements of applicable laws and

regulations. The *Single-Shell Tank System Closure Plan* consists of three main documents that are arranged in a hierarchy. The highest-level document (Tier 1) addresses closure topics and issues pertaining to the single-shell tank system. Mid-level documents (Tier 2) address specific groupings of one or more single-shell tank farms known as Waste Management Areas (WMA). The lowest level documents in the hierarchy (Tier 3) address closure activities for specific components within a particular WMA. Tier 2 and 3 level documents will be submitted as separate documents to Ecology. The following summarizes the general content of the Tier 1, 2, and 3 documents that comprise the *Single-Shell Tank System Closure Plan*:

- Tier 1 – *Framework Plan for Single-Shell Tank System Closure:* Referred to as the "Framework Plan," this document is the main body of the text of RPP-13774b. It discusses the general overview of the single-shell tank system, describes the administrative and regulatory framework for single-shell tank closure, describes the process for incorporating Tier 2 and Tier 3 with soil and groundwater corrective actions, and provides single-shell tank closure performance standards, a risk evaluation, an overall closure schedule, and an overall description of the certification and post-closure process.

- Tier 2 – *Waste Management Area Closure Action Plans*: This tier consists of appendices to the Tier 1 Framework Plan, one for each of the seven single-shell tank farm WMAs at the Hanford Site. The seven WMAs include A-AX; B-BX-BY; C; S-SX; T; TX-TY; and U. Each WMA closure action plan will provide a general description of the WMA, a description of the WMA groundwater monitoring effort, a general description of closure activities, a risk evaluation for the WMA, a closure schedule for the WMA, and a description of the certification and post-closure process.

- Tier 3 – *Component Closure Activity Plans* (for specific WMA components): This tier of the *Single-Shell Tank System Closure Plan* consists of attachments to the Tier 2 *WMA Closure Action Plans* for components within a WMA. Each Tier 3 *Component Closure Activity Plan* describes closure activities for one or more components within each WMA, such as for individual single-shell tanks or pieces or groupings of ancillary equipment.

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LIST OF TERMS

AEA	*Atomic Energy Act of 1954*
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
ECN	engineering change notice
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
HFFACO	*Hanford Federal Facility Agreement and Consent Order*
LDR	land disposal restrictions
PUREX	plutonium-uranium extraction
RCRA	*Resource Conservation and Recovery Act of 1976*
RCW	*Revised Code of Washington*
RDR	retrieval data report
REDOX	reduction-oxidation
ROD	record of decision
SAP	sampling and analysis plan
SEPA	*State Environmental Policy Act*
SST	single-shell tank
SST S-102	single-shell tank 241-S-102
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*
WMA	Waste Management Area

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1.0 INTRODUCTION

This document describes component closure activities for single-shell tank (SST) 241-S-102 (hereinafter referred to as SST S-102). SST S-102 is a tank containing mixed waste located in Waste Management Area (WMA) S-SX of the Hanford Site. SST S-102 will be closed as part of the accelerated retrieval and closure of SSTs in accordance with the *Hanford Federal Facility Agreement and Consent Order* (HFFACO) Milestone M-45-00 (Ecology et al. 1989). This component closure activity plan will comply with regulatory requirements including, but not limited to, the HFFACO Milestones, *Washington Administrative Code* (WAC) 173-303, "Dangerous Waste Regulations," and the *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste,* Rev. 7 (Ecology 2001), hereafter referred to as the "Site-Wide Permit."

"Closure of SST S-102 will follow retrieval of tank waste" and be achieved by the characterization of residual waste, tank isolation, and stabilization of the tank. Closure will comply with SST closure performance standards, including land disposal restrictions (LDR) set forth in WAC 173-303. Characterization of the tank contents will be performed by gathering in-tank measurements and analyses of residual solid waste after retrieval. After characterization, the tanks will be filled and stabilized with grout* or other structural material in layers. Isolation of tanks will be implemented and maintained with administrative controls. Closure performance standards will be implemented to minimize the need for further maintenance, control the post closure escape of tank waste to protect human health and the environment, and return land to appearance of surrounding land area.

The SST S-102 tank component closure activities will supplement knowledge on closure activities, regulatory processes, and provide lessons learned to accelerate future SST component and WMA closure actions. As additional components within WMA S-SX undergo closure activities, corresponding component closure activity plans will be developed as attachments to the *Waste Management Area S-SX Closure Action Plan* (RPP-19773), which is Appendix D to the *Single-Shell Tank System Closure Plan* (RPP-13774b). Each component closure activity plan will require a modification to the Site-Wide Permit. Closure decisions made under corrective actions for past practices (Part IV of the Site-Wide Permit) or a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (1980) Record of Decision (ROD) will be approved through incorporation into the Site-Wide Permit.

This component closure activity plan summarizes retrieval of tank waste, tank characterization, the post-retrieval risk evaluation, efforts to isolate SST S-102 from the SST system, and SST closure performance standards. Background information, conceptual tank stabilization, and general closure information for this tank are provided in RPP-19773.

---

* See Preface.

1.1 PURPOSE

This plan identifies activities that will accomplish the component closure of SST S-102 conforming to the applicable requirements of WAC 173-303; HFFACO Milestones M-45-00 and M-45-06C; and Section 6 of the HFFACO.

1.1.1 Scope of Plan

The scope of this component closure activity plan is SST S-102, including tank risers, in-tank equipment, and debris. This plan does not include closure activities for any equipment or ancillary piping external to the tank, and does not include any corrective measures that may be needed for soil or groundwater contamination. Retrieval activities will have occurred for SST S-102 prior to modification of the Site-Wide Permit and approval of this closure plan. The plan for waste retrieval is described in the HFFACO Milestone M-45-05-T-16: *S-102 Initial Waste Retrieval Functions and Requirements* (RPP-10901). The *Process Control Plan for Retrieval of Waste from Tank 241-S-102 by Saltcake Dissolution and Modified Sluicing* (RPP-17043) describes the process and technical operating controls for waste retrieval and transfer of liquid wastes from the tanks to the double-shell tank system.

According to HFFACO Appendix I, retrieval and characterization results shall be described in the retrieval data report (RDR) for SST S-102. Upon completion of the work described in RPP-10901 (or the Appendix H request, as appropriate), the U.S. Department of Energy (DOE) will have met the retrieval goals set forth in Milestone series M-45-00 and Milestone M-45-05A. Subsequent component closure activity plans and RPP-19773 will address the remaining components in the WMA S-SX. The SST S-102 component closure activities will not preclude future closure activities for other components.

Retrieval of SST waste constitutes a key SST system closure action. SST S-102 retrieval actions have been approved through the HFFACO and scheduled, in advance, through HFFACO Milestone series M-45-00. Because retrieval actions are significant closure actions, summaries of those actions will be provided in Section 3.0 when available.

The major component closure activities shall only occur after retrieval of as much waste as technically possible with tank waste residues not to exceed 360 ft^3 or the limit of waste retrieval technology capability, whichever is less, and retrieval to safe storage of approximately 490 curies of long-lived radioisotopes in accordance with HFFACO Milestones M-45-00 and M-45-05A. The SST S-102 component closure activities identified will occur in phases pursuant to approval by the Washington State Department of Ecology (Ecology) of the Site-Wide Permit as follows:

- Retrieval of remaining waste to the extent technically possible in accordance with HFFACO Milestone series M-45-00
- Characterization of tank contents. These efforts will be documented in an RDR (i.e., retrieval performance, sampling and analysis of residual waste, post-retrieval risk evaluation)

- Isolation of the tank

- Grout* fill to form a monolith consisting of three phases designed to (1) cover the residuals and debris, (2) provide structural stabilization, and (3) fill the tank and risers to the top of the dome and provide a protective layer against inadvertent intrusion. Grout fill will contribute to treatment of the residual waste and debris and will provide the basis for a variance to LDR treatment standards.

HFFACO Milestone M-45-06A required DOE to submit to Ecology "a certified (Framework) SST System Closure Plan" by December 19, 2002, "as a Hanford site-wide hazardous waste facility permit modification...". The milestone required DOE to include a characterization approach for residual wastes and a risk assessment methodology in the plan. These submittals were provided to Ecology. HFFACO Milestone M-45-06C required DOE to "submit to Ecology a certified component closure activity plan" by September 30, 2004, "as an application for a modification to the Hanford site-wide hazardous waste facility permit...". In addition, a *State Environmental Policy Act* (SEPA) Checklist is being submitted concurrently with the application for modification of the Site-Wide Permit to support the SST S-102 component closure activities (*Revised Code of Washington*, Chapter 43.21C, "Washington State Environmental Policy Act," [RCW 43.21C]).

HFFACO Milestone M-45-15 states criteria for interim completion of the SST S-102 waste retrieval and closure demonstration project that must be met by December 31, 2005. One criterion is "The S-102 demonstration SST closure plan has been submitted by DOE and approved by Ecology." Incorporation of this component closure activity plan into the Site-Wide Permit through the permit modification process will meet this criterion. The other criteria are "Full scale waste retrieval has been completed in accordance with applicable regulatory requirements including Washington Hazardous Waste Management Act and requirements set by this agreement [HFFACO] (DOE will document project data and results in a waste retrieval and closure demonstration report [i.e., retrieval data report])"; "Remaining wastes have been adequately characterized, and a risk assessment, approved by Ecology, has been completed for residuals remaining in the tank"; and "If appropriate, DOE has requested and Ecology has approved, an exception to waste retrieval criteria pursuant to Agreement Appendix H."

HFFACO Milestone M-45-15-T01, *Final Completion of Tank S-102 SST Retrieval and Closure Demonstration Project*, states "Completion of the tank S-102 retrieval and closure demonstration project is defined as the completion of necessary field project actions required by the approved SST closure plan for S-102." This milestone will be fulfilled when all actions described in this component closure activity plan and required by the Site-Wide Permit are completed. The date for completion of all project activities is December 31, 2006. Table 5-3 lists the milestones for SST S-102 retrieval and component closure. Figure 5-2 shows the major SST S-102 component closure activities.

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* See Preface.

1.2 REGULATIONS AND STANDARDS APPLICABLE TO SST S-102 COMPONENT CLOSURE ACTIVITY

The SST S-102 retrieval and component closure activities are regulated by several requirements. Drivers include a state-federal agreement, federal and state statutes and regulations, and DOE directives and orders. A discussion of these requirements is contained in RPP-13774b.

Ecology regulates the SSTs as dangerous waste storage and treatment units under WAC 173-303, which implements the *Resource Conservation and Recovery Act of 1976* (RCRA). SST S-102 contains mixed waste and is included in the RCRA dangerous waste permit application, Part A, Form 3, submitted for the SST system.

1.2.1 SST Closure Performance Standards

The HFFACO requires that all treatment, storage, and disposal (TSD) units, regardless of permit status, be closed under WAC 173-303. DOE will close the SST system in compliance with the performance standards set out in WAC 173-303-610(2)(a) and -640(8). The activities described in this component closure activity plan are consistent with closure of the SST system in compliance with these performance standards. However, the SST S-102 component closure activities described in this plan will only partially meet the closure performance standards for the WMA S-SX and SST system (see RPP-13774b, Section 3.0). Full compliance with closure performance standards will occur for the WMA S-SX after all tanks are retrieved and closed, and ancillary equipment, contaminated soil, and groundwater are remediated. Isolation activities and subsequent placement of fill layers into SST S-102 will initiate the process of complying with the closure performance standards for the SST system.

According to HFFACO Milestone M-45-15-T01, "Completion of the tank S-102 retrieval and Closure demonstration project is defined as completion of necessary field project actions required by the approved S-102 waste retrieval and closure demonstration plan". Retrieval shall "retrieve as much waste as technically possible, with a remaining residual of no more than 360 cubic feet (cu. ft.)." If the retrieval goal of 360 ft^3 is not met, DOE will request an exception to the criteria as specified in Appendix H of the HFFACO. This HFFACO requirement is one of the most significant tank-related performance standards. Retrieval of waste in accordance with these requirements, along with the other closure activities described in this plan, will make significant progress toward meeting closure performance standards at the WMA S-SX and the SST system.

The three general closure performance standards defined in WAC 173-303-610(2)(a) are described in this component closure activity plan in Sections 1.2.1.1 through 1.2.1.3. Removal or decontamination standards defined in WAC 173-303-610(2)(b) and WAC 173-303-640(8) are described in Section 1.2.2. In addition, LDR that pertain to WAC 173-303-140 and Title 40, *Code of Federal Regulations,* Part 268, "Land Disposal Restrictions" (40 CFR 268) are described in RPP-19773, Section 6.0.

1.2.1.1 Minimize Need for Further Maintenance. Component closure activities planned for SST S-102 are designed to minimize the maintenance required after the activities are complete. Waste will be retrieved from SST S-102 to meet HFFACO retrieval goals, and the tank will be isolated from the system. If the tank is filled as part of closure field activities, DOE will conduct annual visual inspections of the tank farm surface in the tank vicinity. If the tank is not filled as part of closure field activities, DOE will conduct annual visual inspections of WMA S-SX surface in the tank vicinity and will continue to operate any existing liquid detection or monitoring device, i.e., Enraf[1]. Other activities, such as capping lines and risers, covering the tank, and providing run-on controls will serve to minimize the need for further maintenance.

1.2.1.2 Control the Post-closure Escape of Tank Waste to Protect Human Health and the Environment. SST S-102 will be retrieved to the extent technically possible in accordance with criteria set forth in Milestone M-45-00 and Appendix H of the HFFACO. Component closure activities will include stabilizing any remaining wastes, complete filling of the tank for structural integrity and intrusion prevention, and isolating SST S-102 from the SST system and the environment. Stabilization, filling, and intrusion prevention are described in RPP-19773, Section 6.0. Tank isolation activities will include administrative actions and physical actions sealing off all pipes or other pathways between SST S-102 and the balance of the SST system. All of these activities will serve to control the post-closure escape of remaining dangerous waste constituents. At a later point in the overall closure of the SST system, DOE will undertake final closure of WMA S-SX. Individual actions will be assessed for their impact on long-term cumulative risk (i.e., WMA S-SX together with other adjacent or nearby non-tank risk sources).

1.2.1.3 Return Land to Appearance of Surrounding Land Areas. This closure performance standard will be met as part of closure of WMA S-SX and is not a part of this SST S-102 tank component activity plan.

1.2.2 Removal or Decontamination Standards

SST S-102 component closure activities will comply with WAC 173-303-610 (closure and post-closure) and WAC 173-303-640(8) (tank system closure and post-closure care) requirements. WAC 173-303-640(8)(a) requires DOE to demonstrate removal or decontamination of tank waste residuals and structures to the extent practicable. Per WAC 173-303-610(2)(b)(ii), such removal or decontamination must assure on a case-by-case basis that levels of dangerous waste or dangerous waste constituents or residues do not exceed those established by Ecology and in accordance with the closure performance standard of WAC 173-303-610(2)(a)(ii) for controlling, minimizing, or eliminating post-closure escape of dangerous waste constituents to the environment. These levels are identified as clean closure standards. Ecology's *Clean Closure Guidance* (Ecology 1994) states that clean closure decontamination levels for metal tanks are generally considered to be met upon meeting the performance treatment standards contained in 40 CFR 268.45, Table 1 (debris rule treatment standards).

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[1] Enraf - Nonius Series 854 is a trademark of Enraf-Nonius, N.V. Verenigde Instrumentenfabrieken, Enraf-Nonius Corporation Netherlands, Rontegenweg 1, Delft, Netherlands.

WAC 173-303-640(8)(b) requires that, if removal and decontamination of all contaminated soils is not practicable, post-closure care must be performed. The owner or operator must close the tank system and perform post-closure care in accordance with the closure and post-closure care requirements that apply to landfills (WAC 173-303-665(6)).

WAC 173-303-640(8)(c) requires that the closure plan for any tank system that does not have secondary containment include a contingent closure and post-closure plan. Because SST S-102 closure activities described in this plan do not constitute full closure of the entire tank system (WMA S-SX), a contingent post-closure plan is not included as part of this SST S-102 component closure activity plan. Instead, the contingent post-closure plan will be submitted as part of RPP-19773, to which this plan is attached.

Retrieval and closure activities described in this plan and RPP-10901 will attempt to remove or decontaminate SST S-102 to the extent technically possible in accordance with HFFACO Milestone series M-45-00 and to meet clean closure standards. In addition, as part of this milestone, a retrieval data report will be submitted to Ecology to demonstrate completion of retrieval in accordance with Milestone series M-45-00. The tank closure environmental impact statement (EIS) under development will evaluate removal of a tank as a closure alternative.

Land use options available for tank system closure (including landfill and clean closure options) and the evaluation of environmental impacts for closure end-state alternatives will be addressed in the tank closure EIS during fiscal year 2005. Ecology, as a cooperating agency, will play a key role in this process.

2.0 SST S-102 UNIT DESCRIPTION

SST S-102 is one of twenty-seven 100-series SSTs located in WMA S-SX. SST S-102 is classified as a "sound" tank in the *Waste Tank Summary Report* (HNF-EP-0182). The "sound" tank classification is assigned to a tank when surveillance data indicates no loss of liquid attributed to a breach of integrity (HNF-EP-0182). A description of the 100-series tanks, inclusive of SST S-102, is provided in RPP-19773, Section 2.0. Figures 2-1 and 2-2 show the location of WMA S-SX and SST S-102, respectively. The configuration of SST S-102 (cross-section) is shown in Figure 2-3.

2.1 ANCILLARY EQUIPMENT AND SUPPORTING INFRASTRUCTURE

SST S-102 has eleven associated pipelines. These include the cascade lines from SST S-101 and to SST S-103, the main feed from the drain line from the flush pit to the SST S-102 pump pit, a water dilution line, and distribution lines to the 241-S-A and 241-S-B valve pits. SST S-102 pipelines are discussed further in Section 5.2 with respect to isolation from the SST system. SST S-102 has risers of varying diameters and lengths of protrusion into the tank. Each of the risers is connected to various in-tank equipment or serves a specific purpose listed below and as numbered on the tank (Table 2-1). (The risers are shown in Figure 5-1.)

Table 2-1. Riser Use Designation for SST S-102[a].

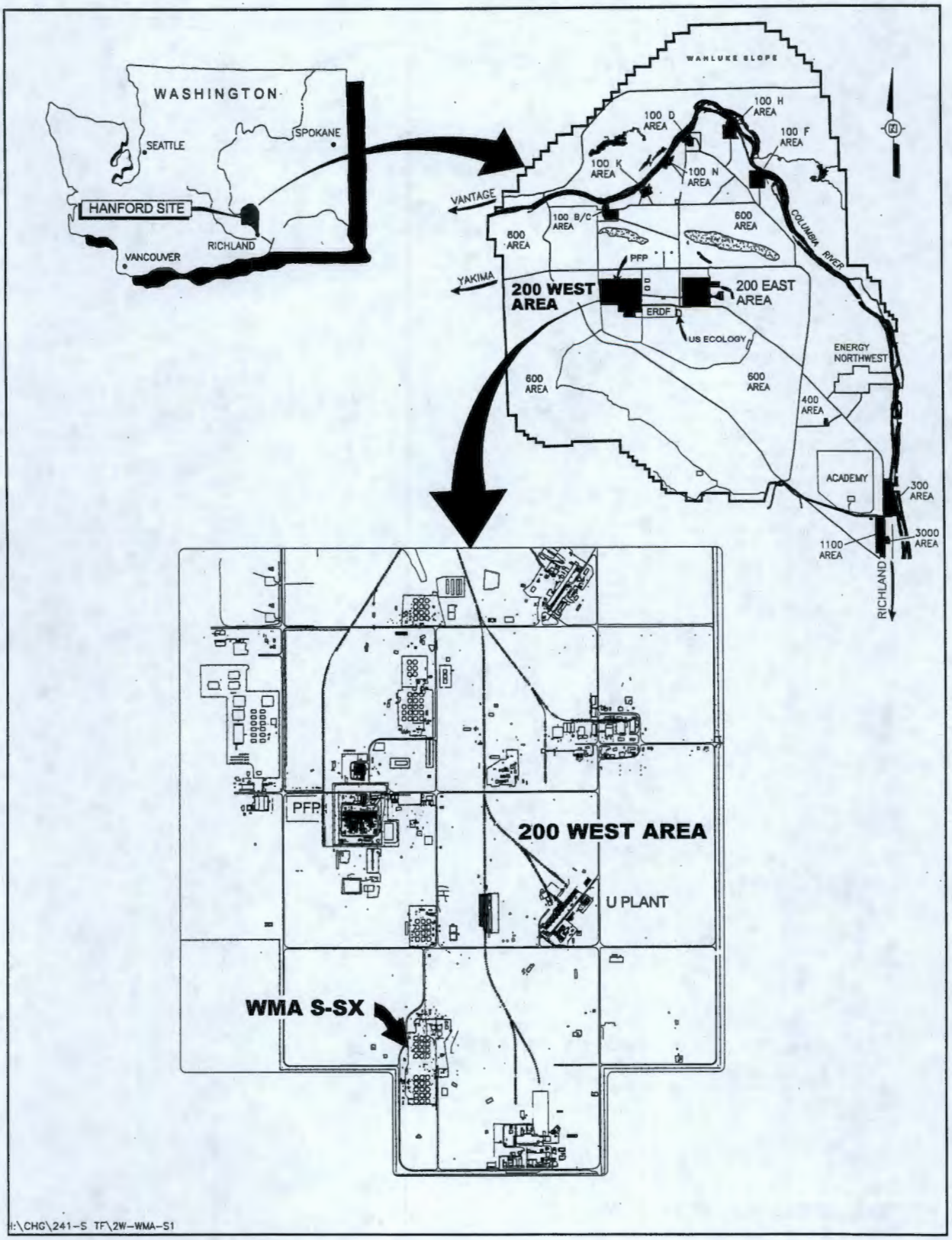
Riser number	Designation of use
R1	Camera, grouting, or ventilation
R2	Camera, grouting, or ventilation
R3	Camera, grouting, or ventilation
R4	Temperature probe
R5	Alternate risers for sampling
R6	Alternate risers for sampling
R7	Alternate risers for sampling
R8	Pump mount
R9	Sampling
R11	Alternate risers for cameras, ventilation, and grouting
R13	Saltwell screen and pump
R14	Alternate risers for cameras, ventilation, and grouting
R16	Alternate risers for cameras, ventilation, and grouting

Notes:

[a] Information taken from RPP-16795, 2003, *Engineering Evaluation of Interim Isolation of Hanford Single Shell Tanks*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Risers were not numbered sequentially, thus R-10, R-12, and R-15 do not exist.

Figure 2-1. Location Map of WMA S-SX and Surrounding Facilities in the 200 West Area.



1 Figure 2-2. Location of SST S-102 within WMA S-SX.

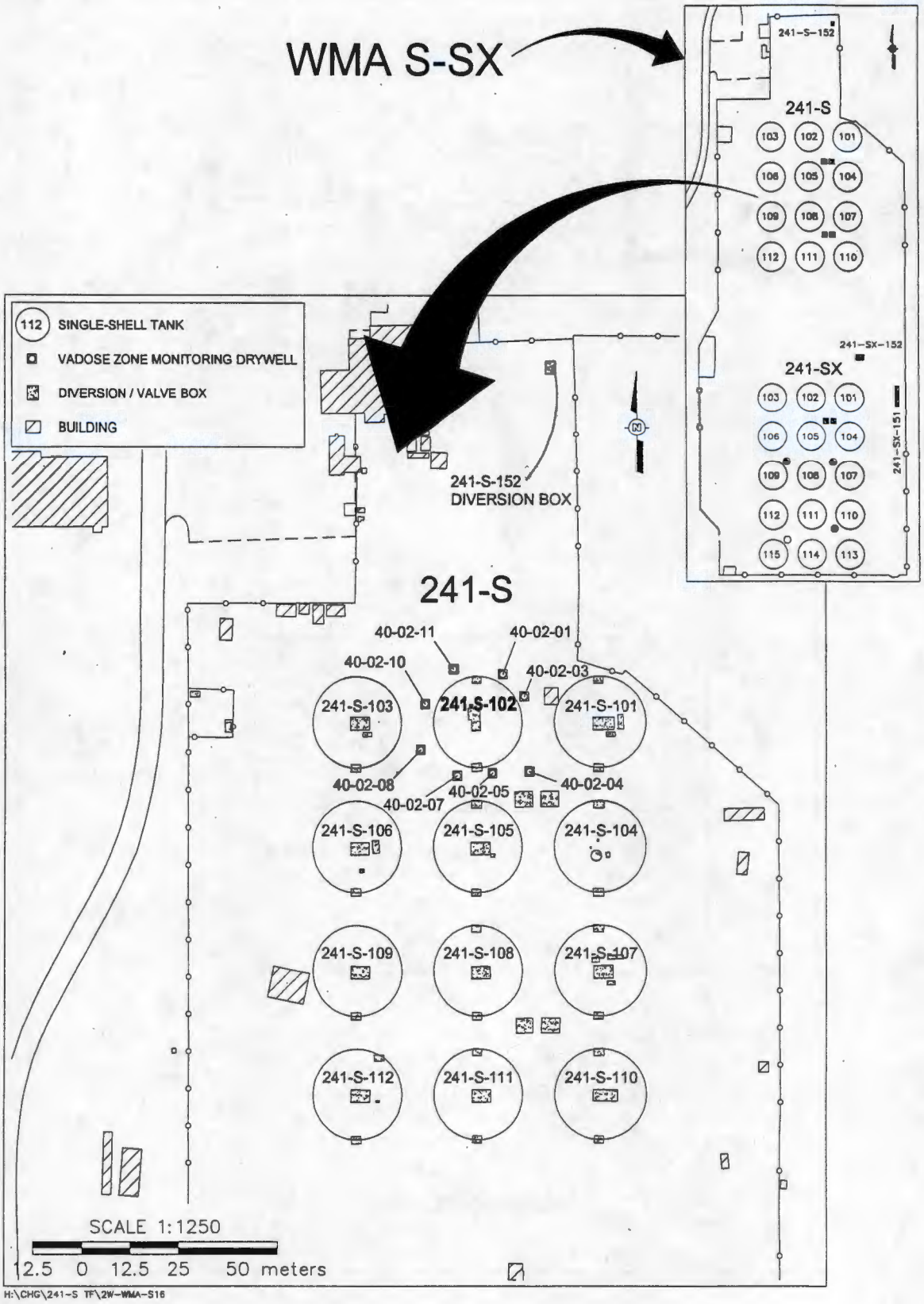
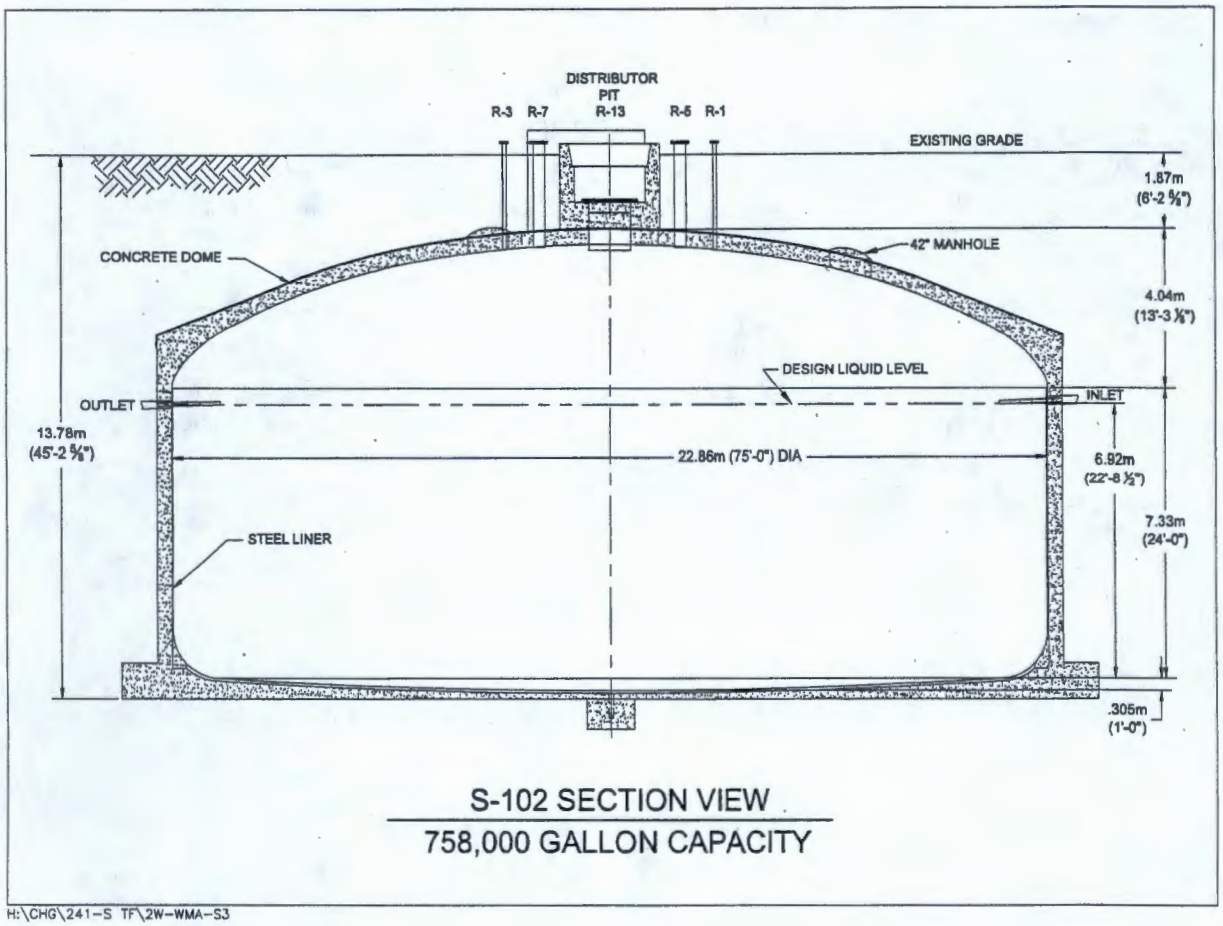


Figure 2-3. Configuration of SST S-102 (cross-section).



H:\CHG\241-S TF\2W-WMA-S3

2.2 SST S-102 OPERATIONS HISTORY

During the third quarter of 1953, SST S-102 received reduction-oxidation (REDOX) high-level waste from S Plant. From the fourth quarter of 1953 to the third quarter of 1955, REDOX high-level waste cascaded from SST S-101 to SST S-102. This was the last waste addition to SST S-102 for the rest of the 1950s and the 1960s. Waste additions to SST S-102 from SST S-101 did not occur again until the fourth quarter of 1973 and continued intermittently until the second quarter of 1979.

Because SST S-102 was the 242-S Evaporator feed tank from 1973 until 1976, frequent transfers were made to SST S-102 from other tanks during this period. The following waste types are an example of what was transferred to SST S-102: REDOX high-level waste, B Plant high-level waste, B Plant low-level waste, REDOX low-level waste, Plutonium-Uranium Extraction (PUREX) Plant low-level waste, Battelle Northwest Laboratory waste, evaporator bottoms, and terminal liquor.

After 1976, SST S-102 received mostly evaporator bottoms and evaporator feed from SST SY-102, SST T-101, SST TX-102, SST TX-104, and SST TX-105. In 1979, additions of

$HNO_3/KmnO_4$ were received from an unknown source. These receipts were probably associated with evaporator operations that use $HNO_3/KmnO_4$ in the partial neutralization process. Large, intermittent transfers of waste were added to the tank from 1972 through 1976 (WHC-SD-WM-ER-611, *Tank Characterization Report for Single-Shell Tank 241-S-102*). Throughout its service life, SST S-102 received and stored REDOX waste and 242-S Evaporator/Crystallizer waste streams. SST S-102 was removed from service in 1980 and was partially isolated in 1982 (WHC-SD-WM-ER-352, *Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Area*).

There were three occurrence reports and two deviation reports written for waste-level increases in SST S-102. It is possible that the rise in liquid level could be the result of increased gas accumulation within the slurry. An occurrence report was generated after it was discovered that a subsurface pipeline connected to the SST S-102 pump pit was severely corroded by acidic waste. It is not known why acid waste was in the pipeline, because waste was normally neutralized before being added to the tank (Cashman 1977, Occurrence Report, 77-40).

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3.0 SST S-102 RETRIEVAL AND CHARACTERIZATION

This section is a placeholder for a summary of SST S-102 retrieval and characterization efforts. Initial SST S-102 retrieval is scheduled to be complete on December 14, 2004, and will be followed by sampling, analysis, and evaluation for compliance with Milestones M-45-00 and M-45-05A. A detailed description of SST S-102 retrieval and characterization (e.g., estimated volume and nature of the waste remaining) will be documented in an RDR according to HFFACO Appendix I, Section 2.1.7, "Retrieval Data Report." Data from the RDR will be used by Ecology and DOE in making WMA-, tank-, and component-specific closure decisions. The RDR will address the following:

- Residual tank waste volume measurement, including associated calculations
- Results of residual tank waste characterization
- Retrieval technology performance documentation
- DOE's updated post-retrieval risk assessment
- Discussion of feasibility/viability of other available retrieval technologies, the feasibility of developing additional retrieval technologies, associated detailed cost estimates, and amount of additional waste that could be removed
- Opportunities and actions being taken to refine or develop tank waste retrieval technologies, based on lessons learned
- Leak detection, monitoring, and mitigation performance results
- DOE's recommendation for further action and proposed schedule(s).

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4.0 CLOSURE RISK ASSESSMENT RESULTS

This section is a placeholder for a summary of the SST S-102 risk assessment. Estimates of the post-retrieval long-term risk associated with closure activities for SST S-102 will be prepared following the approach described for tank closure risk assessment described in RPP-19773, Section 7.0. Sampling and analysis conducted for the risk assessment will be conducted in accordance with the WMA S-SX sampling and analysis plan (SAP), which will be Addendum D1 of RPP-19773. A detailed description of the risk assessment will be provided in the RDR.

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5.0 COMPONENT CLOSURE ACTIVITIES

The objective of the component closure activities for SST S-102, which is a subunit of the SST system, is to contribute in part to the closure of the dangerous waste management units and SST system closure in accordance with WAC 173-303-610, HFFACO, and the Site-Wide Permit. Retrieval is the initial closure activity that will be performed on SST S-102 followed by residual waste characterization, isolation, and stabilization activities. Because of the timing of retrieval and characterization, Ecology approval of these activities will occur prior to approval of the remaining closure activities (the latter being approved through incorporation into the Site-Wide Permit). Ecology has already approved the SST S-102 functions and requirements document (RPP-10901), which will direct retrieval activities. Ecology also will approve characterization activities as defined in the WMA S-SX SAP. When prepared, the WMA S-SX SAP will be Addendum D1 to RPP-19773. Results of retrieval and characterization activities will be contained in the RDR for SST S-102. Following retrieval and characterization, closure activities for SST S-102 and risers will be achieved by isolation and stabilization of the tank as well as complying with SST closure performance standards (see Section 1.2). Stabilization of tanks is described in detail in RPP-19773. The following section describes isolation of tank infrastructure from ancillary/support equipment, permitting for stabilization, LDR compliance, schedule, and reporting.

5.1 ISOLATION OF TANK INFRASTRUCTURE FROM ANCILLARY/SUPPORT EQUIPMENT

During the period after retrieval of SST S-102 until the completion of the WMA S-SX closure action, tank isolation will be maintained through both physical and administrative controls. Without the implementation of appropriate controls, there is potential for the inadvertent re-introduction of waste into SST S-102 through various pathways. In addition, without controls, it is possible to prematurely introduce grout into adjacent tanks through interconnecting pathways, while grouting SST S-102. SST S-102 has been isolated from the original waste transfer pipeline network installed when the tanks were constructed. Isolation has been documented on the drawings and engineering change notices (ECN).

Twenty-seven pathways enter SST S-102 or its associated pits. The pathways include lines, risers, pit drains, and ventilation ducts. Eighteen pathways into SST S-102 have already been isolated, as shown on Table 5-1. DOE will take isolation actions on remaining pathways, as shown on Table 5-2 to prevent introduction of new wastes or the intrusion of other liquids into the tank. DOE will use isolation methods based on engineering analysis that do not preclude future remediation. Actions will be implemented via established ECN and work control processes. Figure 5-1 illustrates the line and riser locations into and around SST S-102, along with their current use.

The only direct tank penetrations are the risers and the seven associated pipelines that include the cascade lines from SST S-101 to SST S-103, the waste transfer lines from 241-S-152, drain lines, and the waste transfer lines from 241-S-A valve pit and 241-S-B valve pit. The associated

pipelines will be capped at the high hydraulic end to prevent accidental waste transfers to the tanks. The end of the inlet and outlet cascade lines will be covered/plugged with grout when the tank is filled. The grout will be allowed to set for a short period of time to form a solid cap in the end. This will isolate these pipelines. Water infiltration controls will continue to be maintained following isolation until the WMA closure action plan is completed in the event of water infiltration through deteriorated pipelines or the tank structure.

Table 5-1. Single-Shell Tank S-102 Previously Isolated Lines. (2 sheets)

Line	Description	Tank waste transfer line?	Isolation technique and status	Verification
DR-324	Drain line	No	Plug in floor drain in diversion box	H-2-73182
SN-234	Waste transfer line	Yes	Capped west of 242-S building	H-2-37777
SN-235	Waste transfer line	Yes	Capped west of 242-S building	H-2-37777
SN-237	Waste transfer line	Yes	Isolated in common manifold with SN-200, SN-201, SN-213, and SN-214	H-2-73182
R/W Line	Raw water line	No	Capped for thread protection	H-2-46525
SN-242	Waste transfer line	Yes	Sealed in 241-S-A	H-2-73182
Flushing	Water line	No	Blanked in flush pit	H-2-73182
Flushing	Water line	No	Blanked in flush pit	H-2-73182
R/W Line	Water line to distributor pit	No	Capped for thread protection	H-2-46525
Nozzles C-1	Spare nozzle	No	Capped at building of tank, never used	H-2-1774 H-2-1791
Nozzles C-2	Spare nozzle	No	Capped at building of tank, never used	H-2-1774 H-2-1791
Nozzles C-3	Spare nozzle	No	Capped at building of tank, never used	H-2-1774 H-2-1791
Nozzles C-4	Spare nozzle	No	Capped at building of tank, never used	H-2-1774 H-2-1791
SL-140	Waste transfer line	Yes	Isolate in 244-S catch station	H-2-73178
SN-213	Waste transfer line	Yes	Sealed in 241-S-A	H-2-73182
SN-214	Waste transfer line	Yes	Sealed in 241-S-B	H-2-73182
SN-200	Waste transfer line	Yes	Blanked at connecter 5 in 241-S-152	H-2-73182
SN-201	Waste transfer line	Yes	Blanked at connecter 7 in 241-S-152	H-2-73182

Table 5-1. Single-Shell Tank S-102 Previously Isolated Lines. (2 sheets)

Line	Description	Tank waste transfer line?	Isolation technique and status	Verification

Notes:

H-2-1774, 1973, *General Layout Waste Disposal Facility 241-S*, Rev. 6, General Electric Company, Hanford Works, Richland, Washington.

H-2-1791, 1951, *75 Foot Tank Nozzle Riser & Piping Assemblies*, Rev. 1, Hanford Engineer Works, Richland, Washington.

H-2-37777, 1993, *Piping Plan 241-SY-Tank Farm 242-S Building Area*, Rev. 7, Westinghouse Hanford Company, Richland, Washington.

H-2-46525, 1978, *Piping Pump Pit 02A & Distributor Pit 02B*, Rev. 1, Vitro Engineering, Richland, Washington.

H-2-73178, 1985, *Piping Waste Tank Isolation 241-S Farm Plot Plan & Diversion Box Plan*, Rev. 3, Vitro Engineering Corporation, Richland, Washington.

H-2-73182, 2002, *Piping Waste Tank Isolation TK-241-S-102*, Rev. 6, CH2M HILL Hanford Group, Inc., Richland, Washington.

Table 5-2. Single-Shell Tank S-102 Currently Open Lines.

Line	Description	Tank waste transfer line	Planned isolation technique
Drain line	Drain line between flush and pump pits	No	Plug drain in flush pit
Flush line manifold	Water line	No	Cut and cap water line
C-5	Cascade line from SST S-101	Yes	Administrative controls on SST S-101. Leave line open until tank fill blocks line
C-6	Cascade line to SST S-103	Yes	Administrative controls on SST S-103. Leave line open until tank fill of SST S-103 blocks line
Water dilution	Dilution water line to Riser R-13	No	Cut and cap water line
DR 300	Drain line from COB to Riser R-1	No	Plug 241-SA and 241-SB drain to isolate DR-300
DR-303	Drain line from valve pit A to Riser R-1	No	Plug in floor drain in 214-S-A
DR-389	Drain line from valve it B to Riser R-1	No	Plug in floor drain in 214-S-B
Exhauster	Portable exhauster used during retrieval	No	Remove and replace with breather assembly

Notes:

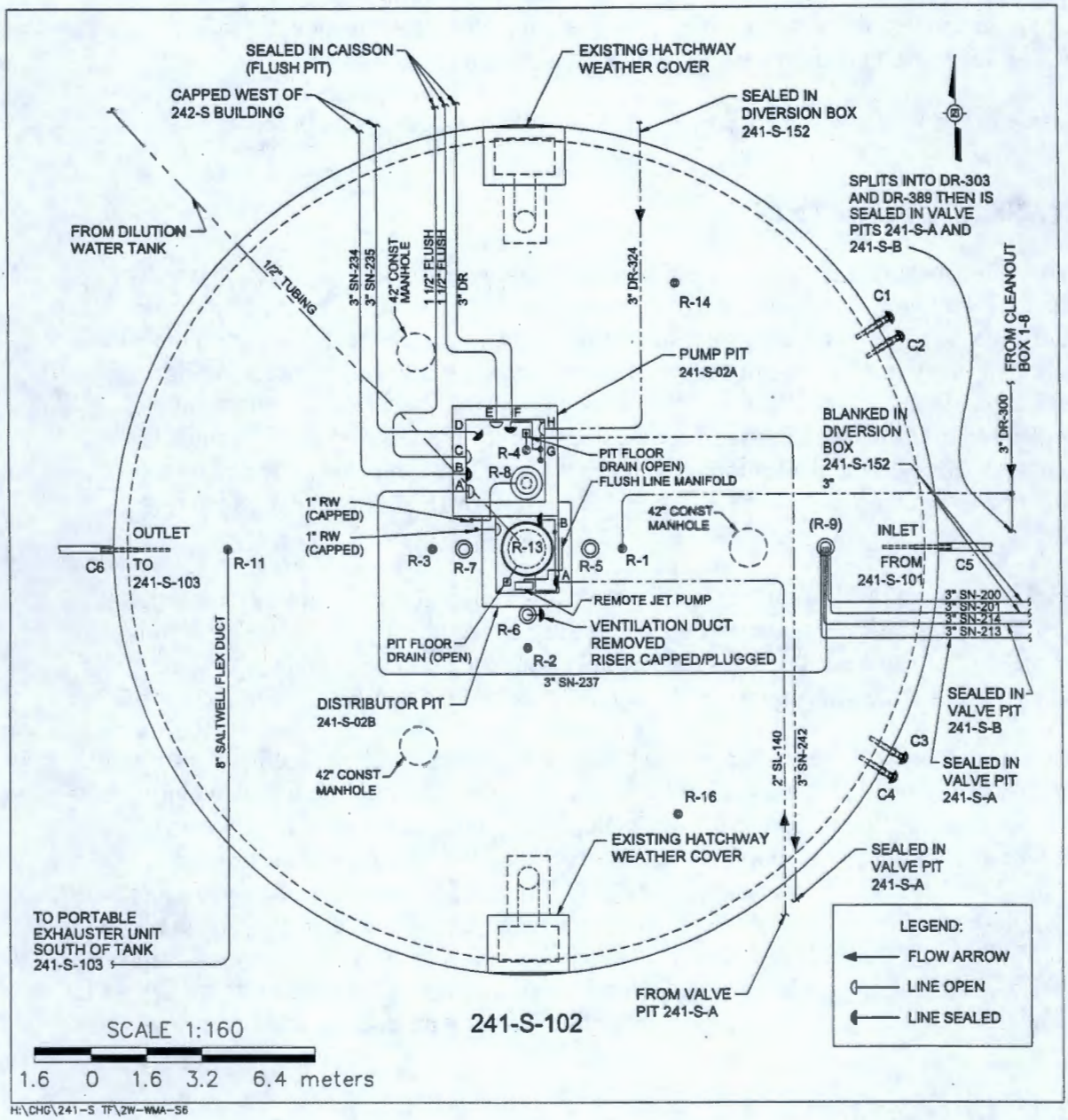
All over ground transfer lines will be removed prior to tank closure.

Water, portable exhausters, and other utilities required for retrieval will also be removed prior to tank closure.

COB = clean-out box.

SST = single-shell tank.

1 Figure 5-1. Configuration of SST S-102 (plan view).



Contaminated equipment removed from the tank will be disposed as mixed waste, and fill equipment may be cleaned using water, which will then be disposed. The contaminated equipment is considered listed waste. It is treated per the alternative treatment standards (40 CFR 268.45, Table 1) and disposed of on the Hanford Site.

Final closure of the WMA will be documented in the WMA S-SX closure process.

5.2 TANK STABILIZATION

Tank stabilization occurs after retrieval activities are completed. Tank stabilization involves filling the tank with grout in order to stabilize any remaining tank waste, in-tank equipment, and debris and to physically stabilize the tank structure. In-tank equipment and debris on the bottom of the tank will likely include thermocouples, manual tapes, piping, and pumps. During characterization, data will be collected with video equipment to better detail equipment and debris remaining the tank. The Phase I base stabilization layer should cover all or most equipment and debris on the tank floor. Any portion that is not completely covered by the Phase I layer will be completely covered when the Phase II or III fill layers are added to the tanks.

Commencement of tank filling can occur once the waste retrieval criteria are met and risks associated with remaining contaminants are determined acceptable by Ecology. Tank filling activities will not proceed until the closure permit is issued and effective and the tank closure EIS is completed. Further discussion of the tank fill is contained in RPP-19773, Section 6.2.

Ventilation with a high-efficiency particulate air filtration system will be used during grouting activities to control potential release of emissions to the environment. The following air permits have been obtained for this project to control radiological and toxic emissions: *Notice of Construction Application for Installation and Operation of Waste Retrieval Systems in Single-Shell Tanks 241-U-107, 241-S-102, 241-S-112 for the Department of Energy Richland*, (Ecology 2003), and *Department of Health Radioactive Air Emissions Notice of Construction Approval for Project Title: 241-S-102 Installation and Operation of Waste Retrieval Systems* (DOH 2003). Information will be obtained during the placement of the Phase I layer of grout on how operations are affected, such as impact on high-efficiency particulate air filter change-out.

5.3 LAND DISPOSAL RESTRICTIONS COMPLIANCE

Residual waste is expected to remain in place after closure. Therefore, the RCRA LDR treatment standards (WAC 173-303-140 and 40 CFR 268) will apply. A site-specific treatability variance is needed to allow an alternative approach to protecting human health and the environment from the land disposal of dangerous waste for the following reasons:

- Treatment to performance-based treatment levels for other applicable waste codes is likely unachievable.

- 40 CFR 268.48 universal treatment standards are expected to be unachievable in the short term for the tank and abandoned equipment.

The site-specific LDR treatability variance request for WMA S-SX tanks will be prepared based largely on the SST C-106 treatability variance request when approved by Ecology.

5.4 SST S-102 COMPONENT CLOSURE ACTIVITY SCHEDULE

The current schedule for SST S-102 component closure activities are contained in the HFFACO Milestone M-45 series and will be modified, if needed, according to the HFFACO change process. Table 5-3 lists the HFFACO Milestones associated with the SST S-102 retrieval and component closure activities.

Following retrieval, characterization and a preliminary evaluation for compliance with Milestones M-45-00 and M-45-05A, DOE will either complete and submit to Ecology its RDR or a request for exception to the retrieval criteria. Ecology and DOE will use information in the RDR to make WMA-, tank-, and component-specific closure decisions. Placement of grout will commence after the ROD for the tank closure EIS is issued and passed through a 30-day review and this component closure activity plan is approved and incorporated in the Site-Wide Permit. Figure 5-2 shows the major SST S-102 component closure activities.

Table 5-3. HFFACO Milestones for Single-Shell Tank S-102 Component Closure.

Milestone	Activity	Date
M-45-00	Complete closure of all SSTs	9/30/2024
M-45-06C	Submittal to Washington State Department of Ecology of certified component closure activity plan for SST S-102	9/30/2004
M-45-05A	Complete initial waste retrieval from SST S-102 of 490 curies of mobile long-lived radioisotopes	3/31/2005
M-45-15	Interim completion of SST S-102 waster retrieval and closure project	12/31/2005
M-45-15-T01	Final completion of tank S-102 SST retrieval and closure demonstration project	12/30/2006

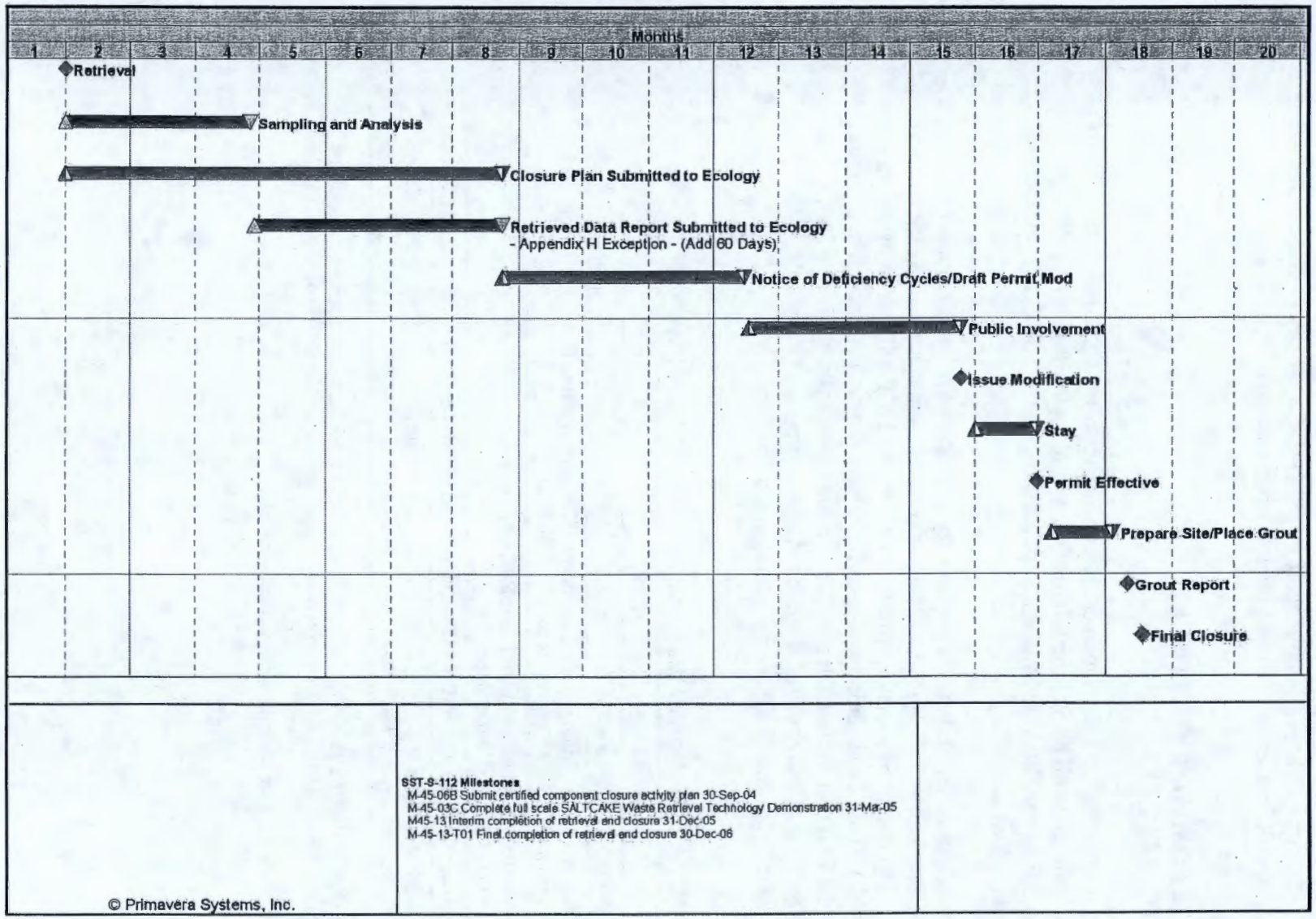
Notes:

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

HFFACO = *Hanford Federal Facility Agreement and Consent Order.*

SST = single-shell tank.

Figure 5-2. Major SST S-102 Component Closure Activities.



5.5 FUTURE AMENDMENT OF SST S-102 COMPONENT CLOSURE ACTIVITY PLAN

This component closure activity plan will be amended whenever changes in component closure activities occur that would constitute a Class 1, 2, or 3 modification to the permit (WAC 173-303-830).

5.6 REPORT OF SST S-102 COMPONENT CLOSURE ACTIVITIES

Within 60 days of the completion of each phase of activities at SST S-102, DOE will submit to Ecology a letter documenting activities that have been conducted in accordance with the specifications contained within the approved plan, as amended, and as contained in the permit.

6.0 REFERENCES

40 CFR 268, "Land Disposal Restrictions," *Code of Federal Regulations*, as amended.

Atomic Energy Act of 1954, 42 USC 2011 et seq., as amended.

Cashman, J.M., 1977, Occurrence Report, 77-40, Rockwell Hanford Operations, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Public Law 96-150, 94 Stat. 2767, 42 USC 9601 et seq.

DOE O 435.1, 2001, *Radioactive Waste Management*, U.S. Department of Energy, Washington, D.C.

DOH, 2003, *Department of Health Radioactive Air Emissions Notice of Construction Approval for Project Title: 241-S-102 Installation and Operation of Waste Retrieval Systems*, AIR-03-708, State of Washington Department of Health, Olympia, Washington.

Ecology, 1994, *Clean Closure Guidance*, F-HTWR-94-144, Washington State Department of Ecology, Olympia, Washington.

Ecology, 2001, *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*, Rev. 7, Permit 7890008967, Washington State Department of Ecology, Olympia, Washington.

Ecology 2003, *Notice of Construction Application for Installation and Operations of Waste Retrieval Systems in Single-Shell Tanks 241-U-107, 241-S-102, 241-S-112 for the Department of Energy Richland*, DE-03NWP-001, Washington State Department of Ecology, Olympia, Washington.

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

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H-2-73178, 1985, *Piping Waste Tank Isolation 241-S Farm Plot Plan & Diversion Box Plan*, Rev. 3, Vitro Engineering Corporation, Richland, Washington.

H-2-73182, 2002, *Piping Waste Tank Isolation TK-241-S-102*, Rev. 6, CH2M HILL Hanford Group, Inc., Richland, Washington.

HNF-EP-0182, 2004, *Waste Tank Summary Report for Month Ending December 31, 2003*, Rev. 189, CH2M HILL Hanford Group, Inc., Richland, Washington.

Natural Resources Defense Council, et al., v. Spencer Abraham, et al., Civ. No. 01-0413-S-BLW (July 3, 2003), U.S. District Court, District of Idaho.

RCW 43.21C, "Washington State Environmental Policy Act (SEPA)," *Revised Code of Washington*, as amended.

RCW 70.105, "Hazardous Waste Management Act of 1976," *Revised Code of Washington*, as amended.

Resource Conservation and Recovery Act of 1976, Public Law 94-580, 90 Stat. 2795, 42 USC 6901, et. seq.

RPP-10901, 2004, *S-102 Initial Waste Retrieval Functions and Requirements*, Rev. 1C, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13774a, 2002, *Single-Shell Tank System Closure Plan*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-13774b, 2004, *Single-Shell Tank System Closure Plan*, Rev. 2, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-16795, 2003, *Engineering Evaluation of Interim Isolation of Hanford Single Shell Tanks*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-17043, 2003, *Process Control Plan for Retrieval of Waste from Tank 241-S-102 by Saltcake Dissolution and Modified Sluicing*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-19773, 2004, *Waste Management Area S-SX Closure Action Plan*, Rev. 1, CH2M HILL Hanford Group, Inc., Richland, Washington.

WAC 173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

WHC-SD-WM-ER-352, 1995, *Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Area*, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-611, 1996, *Tank Characterization Report for Single-Shell Tank 241-S-102*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.