SITE-SPECIFIC SST PHASE 1 RFI/CMS WORK PLAN ADDENDUM FOR WMA S-SX

Anthony J. Knepp (CH2M Hill Hanford Group, Inc.)
Phillip M. Rogers (Jacobs Engineering Group, Inc.)
Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 657715   UC: 2010
Org Code: 73500   Charge Code: 110168CA10
B&R Code: EW3130010   Total Pages: 130

Key Words: Vadose Zone, RFI/CMS Work Plan, WMA, S-SX, Characterization

Abstract: This Site-Specific Waste Management Area S-SX RFI/CMS Work Plan Addendum addresses vadose zone characterization plans for collecting and analyzing soil samples from WMA S-SX.

Printed in the United States of America. To obtain copies of this document, contact: Document Control Services, P.O. Box 950, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.

Karen G. Noland 2/23/2000
Release Approval   Date

FEB 23 2000
DATE:
STA: 15
HANFORD RELEASE
ID: 21
Release Stamp

Approved For Public Release

RECORD OF REVISION

(1) Document Number
HNF-5085

Page 1

(2) Title
SITE-SPECIFIC SST PHASE 1 RFI/CMS WORK PLAN ADDENDUM FOR WMA S-SX

Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) Initially released 4/26/99 on EDT 627984		A.J. Knepp
0A	Incorporated per ECN-657725		
1 RS	Complete revision, incorporated per ENC-657715	P.M. Rogers	A.J. Knepp 2/17/2003

SITE-SPECIFIC SST PHASE 1 RFI/CMS WORK PLAN ADDENDUM FOR WMA S-SX

February 2000

Prepared for
U.S. Department of Energy
Office of River Protection

Prepared by
CH2M Hill Hanford Group, Inc.

CONTENTS

CONTENTS (Cont'd)

APPENDIX

FIGURES

TABLES

LIST OF TERMS

bgs	below ground surface
CMS	corrective measures study
CoCs	contaminants of concern
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
HWMA	Hazardous Waste Management Act
ICM	interim corrective measures
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	reduction-oxidation
RFI	RCRA Facility Investigation
SAP	sampling and analysis plan
SST	single-shell tank
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TSD	treatment, storage, and/or disposal
WMA	waste management area

This page intentionally left blank.

1.0 INTRODUCTION

This Site-Specific Single-Shell Tank (SST) Phase 1 *Resource Conservation and Recovery Act of 1976* (RCRA) Facility Investigation/Corrective Measures Study (RFI/CMS) Work Plan Addendum for Waste Management Area (WMA) S-SX has been prepared to collect field characterization data in and near WMA S-SX to support RFI/CMS decision making. This WMA S-SX addendum is necessary to identify and plan characterization efforts as part of an RFI. The initial field characterization efforts implemented in fiscal year 1999 (HNF-4380) included the collection of vadose zone and groundwater data from the following:

- Installation of a new borehole southwest of tank SX-115 (well number B8809)
- Decommissioning of borehole 41-09-39
- The installation of three proposed RCRA groundwater monitoring wells.

Documented in this WMA S-SX addendum are the agreements made through a data quality objectives (DQO) process. These agreements include the tasks, project responsibilities, and schedule for the next characterization effort to fulfill proposed Milestone M-45-52 (Ecology et al. 1999). The field characterization efforts include the collection of vadose zone data from the following:

- Installation of a slant borehole under tank SX-108
- Shallow vadose zone soil investigations in the north end of the S tank farm.

1.1 BACKGROUND

The Hanford Federal Facility Agreement and Consent Order (Ecology et al. 1998), commonly referred to as the Tri-Party Agreement, that is signed by the Washington State Department of Ecology (Ecology), the U.S. Environmental Protection Agency, and the U.S. Department of Energy (DOE), addresses cleanup at more than 2,000 waste disposal and unplanned release sites on the Hanford Site. Some of these sites are treatment, storage, and/or disposal (TSD) units that have been grouped into WMAs for the purpose of groundwater monitoring. Included in the WMAs are 149 SSTs that are TSD units regulated under Washington's Hazardous Waste Management Act (HWMA) (Chapter 70.105 Revised Code of Washington) and its implementing requirements (Washington's Dangerous Waste Regulations in WAC 173-303).

The SSTs currently are operating under interim status pending closure. The tank farms will be closed under the HWMA and Major Milestone series M-45-00 of the Tri-Party Agreement (Ecology et al. 1998). The 149 SSTs are grouped into 12 SST farms, which are in turn grouped into 7 WMAs for purposes of HWMA groundwater assessment and monitoring. To date, tank leaks and past practice releases of tank waste including dangerous waste and dangerous waste constituents have resulted in groundwater contamination documented at four of the seven SST WMAs (i.e., WMA S-SX, B-BX-BY, T, and TX-TY). The DOE has initiated a corrective action program to address the impacts of past and potential future tank waste releases to the environment. A Phase 1 RFI/CMS work plan (DOE/RL-99-36) has been issued that establishes the overall framework and requirements for the program. This addendum presents details specific to WMA S-SX.

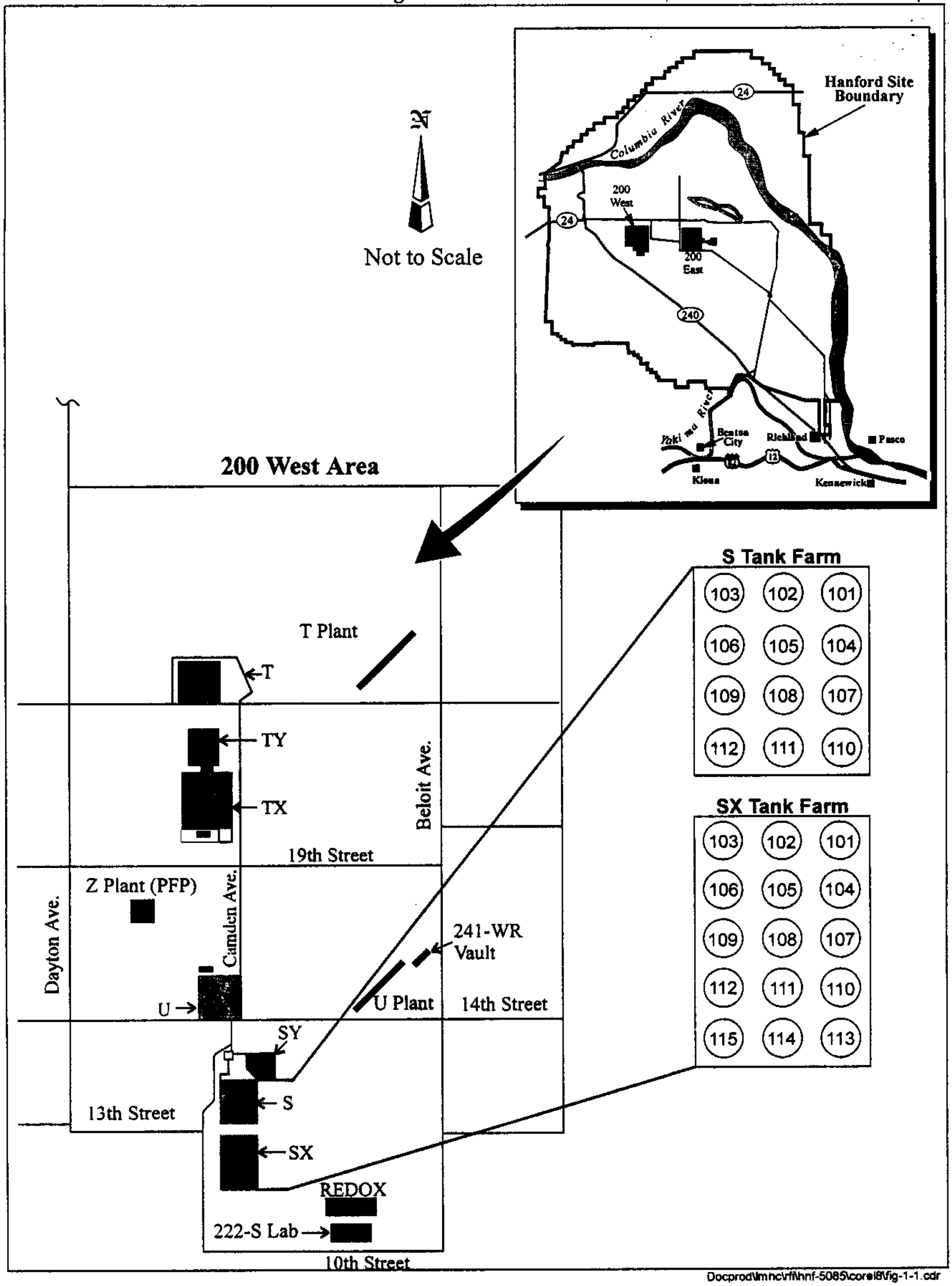
The investigation activities outlined in this WMA S-SX addendum will be managed by the Tank Farm Vadose Zone Project as an integrated function of the Hanford Site Groundwater/Vadose Zone Integration Project. This WMA S-SX addendum is a Tri-Party Agreement primary document submitted to Ecology for review and approval pursuant to proposed Milestone M-45-52 (Ecology et al. 1999).

The WMA S and SX tank farms are regulated under HWMA interim status regulations (WAC 173-303-400) (Figure 1.1). The S and SX tank farms comprise WMA S-SX, which was placed in assessment groundwater monitoring in August 1996 because of elevated specific conductance and technetium-99 in downgradient monitoring wells (WHC-SD-EN-AP-191). Technetium-99 and nitrate are the only constituents to have exceeded drinking water standards. The drinking water exceedances in the RCRA-compliant monitoring wells are currently limited to two wells (299-W22-45 and 299-W22-46) located along the southeast side of the SX tank farm (see Section 3.1.3).

In fiscal year 1995, spectral gamma logging (i.e., collection of baseline gamma-specific radioisotope information in the upper vadose zone) was completed at the SX tank farm. Spectral gamma logging was completed at the S tank farm in fiscal year 1996. The spectral gamma logging program builds on a previous program in which gross gamma data were collected as a means of leak detection from the SSTs. Both programs used the network of drywells installed around each tank in each SST farm. In July 1996, the final report on spectral gamma logging at the SX tank farm (GJPO-HAN-4) indicated contaminant cesium-137 at a maximum depth of 43 m (140 ft) below ground surface (bgs) near tank SX-102 and contaminants at depths of 39.6 m (130 ft) bgs near tanks SX-108 and SX-109. In February 1998, the final report on spectral gamma logging at the S tank farm (GJO-HAN-11) indicated contaminants cesium-137, cobalt-60, and europium-154 at a maximum depth of 18.3 m (60 ft) bgs near tank S-102 and cesium-137 at depths of 29 m (95 ft) bgs near tank S-104. The network of drywells installed around each tank was intended for leak detection and was generally installed between depths of 22.8 m and 45.7 m (75 to 150 ft) bgs, thus the maximum detection depth is limited by the drywell depth.

In 1996, a panel was formed to evaluate issues associated with vadose zone contamination in the tank farms. Following a review of available data, the panel recommended a series of measures to improve characterization of the vadose zone and recommended installation of new boreholes in the SX tank farm to address issues associated with contaminant migration through preferential pathways (e.g., boreholes) and through the formation (DOE/RL-97-49, DOE/RL-98-G7). Two new drywells were installed (drywells 41-12-01 and 41-09-39), and in 1997, drywell 41-09-39 was extended from 39.6 m (130 ft) to below the water table at a depth of 69 m (225 ft) bgs (HNF-2855). Spectral gamma surveying determined that drag down of contaminants in the initial drywell (41-12-01) was occurring during drilling and that the drag down could be reduced by modifying the drilling techniques. Improved drilling techniques were adopted for drywell 41-09-39, which minimized drag down. The extension of drywell 41-09-39 indicated that from 40 to 41 m (131 to 134 ft), the concentration of cesium-137 decreases by over four orders

Figure 1.1. Location Map of Single-Shell Tank WMA S-SX and Surrounding Facilities in the 200 West Area



Docprod\lmhc\rfi\hnf-5085\corel8\fig-1-1.cdr of magnitude and that the maximum concentration of technetium-99, in the interval from 39.6 m (130 ft) to the water table, is observed at a depth of 40.6 m (133 ft). Additionally, in 1996, an analysis of SX tank farm leak histories determined that past tank leaks from four of the SX tank farm SSTs (SX-108, -109, -111, and -112) could be much larger than previously estimated (LA-UR-96-3537). However, HNF-4756 provided evidence that the leak estimate numbers are not technically defensible.

A groundwater assessment monitoring report that focused on contaminants in the underlying unconfined aquifer was completed (PNNL-11810). Major findings summarized in the report are as follows.

- Distribution patterns for radionuclides and RCRA/dangerous waste constituents indicate WMA S-SX has contributed to groundwater contamination as observed in downgradient monitoring wells. Multiple source locations in the WMA are needed to explain spatial and temporal groundwater contamination patterns.

- Drinking water standards for nitrate and technetium-99 were exceeded in three wells. In RCRA-compliant wells located at the southeastern corner (299-W22-46) and south (299-W23-15) of the SX tank farm, technetium-99, the constituent with the highest concentration, was at 4 to 5 times the U.S. Environmental Protection Agency interim drinking water standard of 900 pCi/L. Technetium-99 also was found at just above the drinking water standard in an older noncompliant well (299-W23-1) inside the S tank farm.

- Based on data available at the time of the groundwater assessment, technetium-99, nitrate, and chromium concentrations in downgradient well 299-W22-46 (the well with the highest concentrations at the time of the groundwater assessment) appeared to be declining after reaching maximum concentrations in May 1997. Technetium-99 and nitrate have remained above maximum contaminant levels since September 1998; however, chromium has not exceeded the maximum contaminant levels.

- Cesium-137 and strontium-90, constituents of concern in SST waste, were not detected in any of the RCRA-compliant wells in the WMA monitoring network, including the well with the highest current technetium-99 concentrations (299-W22-46).

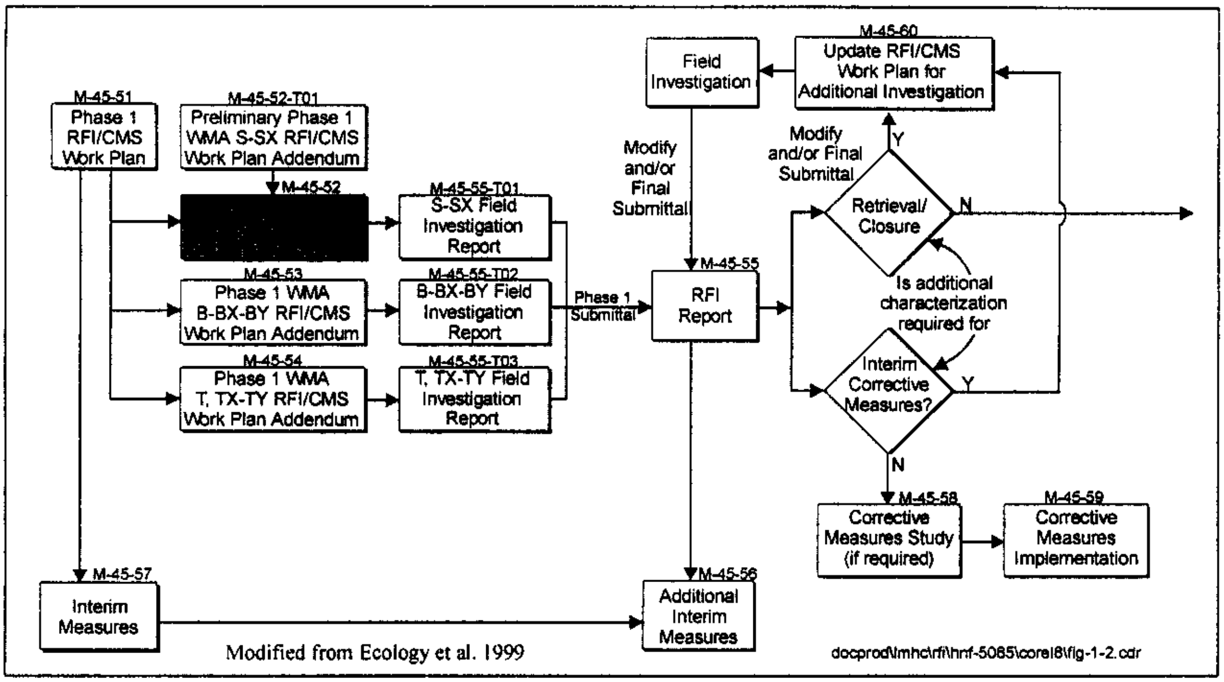
- Low but detectable concentrations of strontium-90 and cesium-137 were found in one well (299-W23-7) located inside and between the S and SX tank farms. Additional isotopic analyses are planned (PNNL-12086).

Based on the results of the groundwater assessment, on July 10, 1998, Ecology requested that DOE develop and submit a corrective action plan for the four WMAs with documented leaks (i.e., WMA S-SX, B-BX-BY, T, and TX-TY).

Pursuant to the proposed Tri-Party Agreement Change Control Form Number M-45-98-03 (Ecology et al. 1999) and Phase 1 RFI/CMS work plan (DOE/RL-99-36), the RCRA Corrective Action process is used to establish the framework within which vadose zone investigations are planned and carried out.

The initial sequence of investigations includes initiation of preliminary characterization efforts in fiscal year 1999 in WMA S-SX based on the preliminary addendum (HNF-4380) and characterization of the remainder of WMA S-SX (this addendum) (Figure 1.2) followed by characterization of WMAs B-BX-BY, T, and TX-TY. All of these efforts will be based on the Phase 1 RFI/CMS work plan (DOE/RL-99-36) and site-specific SST Phase 1 RFI/CMS work plan addenda for WMAs (proposed Milestones M-45-52, M-45-53, and M-45-54).

Figure 1.2. Proposed Tri-Party Agreement Milestones for Corrective Actions



Modified from Ecology et al. 1999

docprod\mhc\rfi\hnf-5085\corel8\fig-1-2.cdr

Negotiations between DOE and Ecology resulted in a plan in which preliminary characterization data were collected in fiscal year 1999 from WMA S-SX. In April 1999, Lockheed Martin Hanford Corporation submitted the preliminary work plan addendum to "enable initial field work and borehole installation to commence in Fiscal Year 1999" (HNF-4380).

- DOE and Ecology decided to proceed with characterization efforts in WMA S-SX first because, of the four WMAs, more information is available for WMA S-SX based on recent investigations and existing DOE plans including decommissioning of borehole 41-09-39 during fiscal year 1999 (HNF-SD-TRW-PD-001). Within WMA S-SX the most information is available regarding past releases within the SX tank farm (GJPO-HAN-11, HNF-2855, HNF-2603, LA-UR-96-3537, and PNNL-11810). In addition, much more work has been done in the SX tank farm in evaluating historical data compared to any other tank farm.

1.2 PURPOSE AND OBJECTIVE

The Phase 1 RFI/CMS work plan (DOE/RL-99-36) established the objectives of the characterization effort for the four WMAs that are a part of the RCRA corrective action process.

The objectives of the investigative efforts identified in this WMA S-SX work plan addendum are as follows:

- Collect data to support an improved understanding of the nature and extent of contaminants in the vadose zone from surface to approximately 39.6 m (130 ft) bgs or maximum depth of contamination, whichever is deeper.
- Collect data to support an improved understanding of vadose zone parameters affecting contaminant fate and transport required to perform risk assessments.
- Provide WMA-specific information on source, nature, and extent contamination for the planned activities in Section 1.3
- Provide WMA-specific characterization programs to address information gaps identified through a DQO process
- Support the Phase 1 RFI/CMS work plan objectives.

The DQO process was completed from August through September 1999 (HNF-5272). The DQO process included participation by Ecology and DOE (the decision makers), the Hanford Site Vadose Zone/Groundwater Integration Project, and Hanford contractors. Meetings held as part of the DQO process involved varying levels of involvement by all participants. Meetings were held between the decision makers with input from Site contractors and DQO process participants.

The DQO process (HNF-5272) resulted in identification of activities to collect vadose zone data to support the objectives outlined in Section 1.3 and in this section. The process included meetings to complete a review of existing data, define the problem, identify and prioritize decisions, identify the input required to make decisions, and boundaries for the decisions. The meetings also addressed decision rules and uncertainty and sampling and analysis alternatives. The focus of the DQO process for the WMA S-SX addendum was on sampling and analysis alternatives. These alternatives and the decisions made by Ecology and DOE based on the alternatives are documented in Chapter 4.0 and HNF-5272.

1.3 SCOPE OF ACTIVITIES

The follow-on characterization effort at WMA S-SX for this addendum will address the following:

- Slant borehole beginning from the northwest and directed under tank SX-108 to the southeast
- Installation of direct pushes in the northern portion of S tank farm for near-surface characterization.

This scope of activities supports the following objectives (1) ongoing characterization activities in the SX tank farm, (2) development of a best-estimate of the concentration and distribution of contaminants of concern (CoCs) in WMA S-SX, (3) refinement of a conceptual model for concentration, distribution, and mobility of contaminants in WMA S-SX, (4) quantifying the risks posed by migration of past tank releases to the groundwater if no interim corrective measures (ICMs) are implemented, and (5) determination whether interim measures or ICMs would effectively contribute to the mitigation of contaminant migration to groundwater to levels that would not pose unacceptable risk to human health and the environment before tank farm closure. Risk assessments conducted in support of retrieval and closure decisions will be performed in the future and will include the potential contribution or reduction in risk as a result of ICMs.

An implementation plan will be prepared to become part of *Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan for Single-Shell Tank Waste Management Areas* (DOE/RL-99-36). This implementation plan would bridge the gap between the generalities in DOE/RL-99-36 and the specifics of this addendum. The plan would elaborate on vadose zone data needs and potential characterization techniques and approaches that may be employed to fulfill those needs. Once accepted, the implementation plan would be added to DOE/RL-99-36. A similar plan would be provided for each WMA as work proceeds.

1.4 SELECTION OF FIELD ACTIVITIES

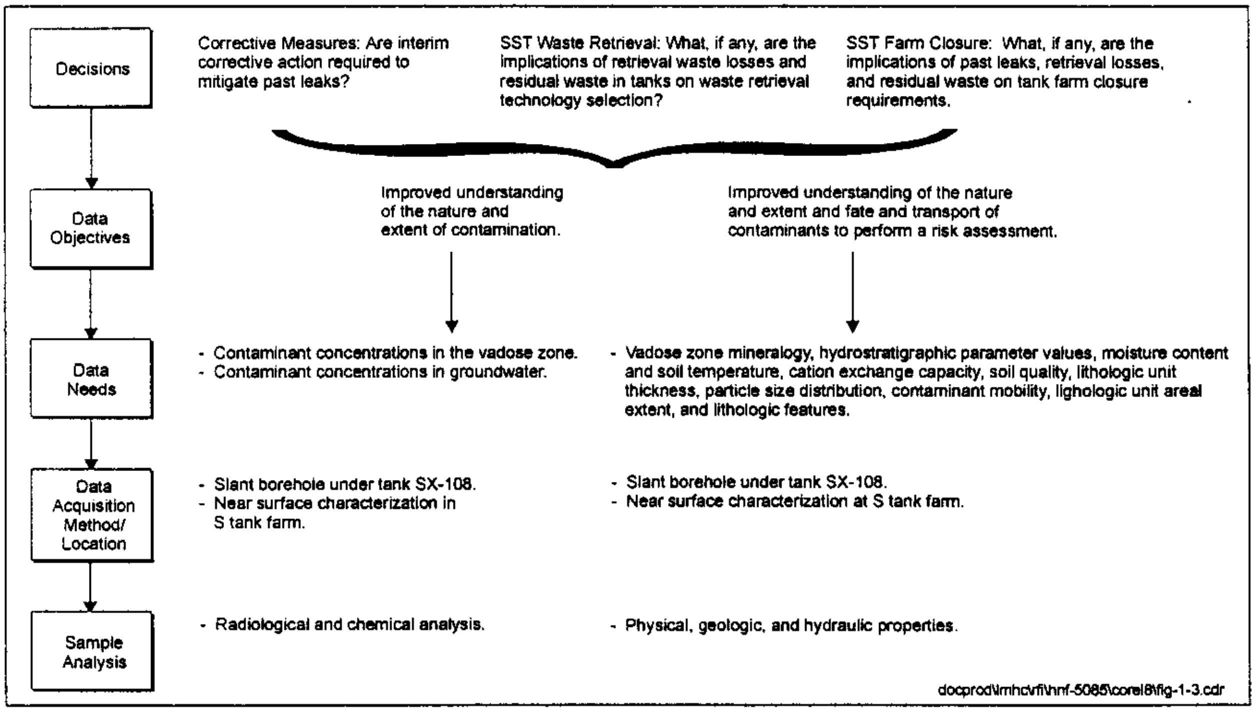
Based on input from Ecology and DOE, and input from the DQO participants, the characterization activities in support of the objectives and data needs identified for the WMA S-SX addendum are illustrated in Figure 1.3. The following summarize the decisions reached by Ecology and DOE based on the DQO process:

- **Shallow vadose zone soil investigation** – This investigation will collect sediment samples via direct push technology in the northern portion of the S tank farm. The shallow investigation will consist of collecting sediment samples at approximately nine areal locations between the ground surface and approximately 16.7 m (55 ft) bgs. The main emphasis will be on characterizing unplanned releases within these areas of concern. Further evaluation of historical data will be used to identify specific sampling target locations.

- **Installation of a slant exploratory borehole underneath tank SX-108** – The DQO process resulted in the identification of several potential locations for the proposed new borehole; however, until the analysis of the sediment from borehole 41-09-39 and the new borehole at tank SX-115 are completed, the options that would provide the most new information would be those that involve collecting samples from beneath a tank. Because of the large past leak associated with tank SX-108 and the high radiation content, this tank was identified as the best location during the DQO planning process. This borehole would be installed to the top of the Plio-Pleistocene unit (39.6 m [130 ft]) or maximum depth of contamination, whichever is deeper.

The rational and approach to these decisions are addressed in Section 4.0 of this work plan and in HNF-5272.

Figure 1.3. DQO Objectives and Data Needs



1.5 ORGANIZATION OF THE WMA S-SX ADDENDUM

Nine chapters and one appendix are included in this WMA S-SX addendum. The addendum is structured to provide information necessary to continue the field investigations at WMA S-SX in fiscal year 2000. The chapters and appendix include the following:

- **Chapter 1.0** – Introduction to the WMA S-SX addendum that provides an overview of the issues and technical approach detailed in the remainder of the addendum
- **Chapter 2.0** – Overview of the physical and environmental setting of WMA S-SX
- **Chapter 3.0** – Summary of the available data on potential contaminant exposure pathways that will be used to develop a conceptual exposure pathway model for WMA S-SX needed to assess compliance with Federal and state environmental standards, requirements, criteria, or limitations that may be considered potential corrective action requirements, and potential impacts to human health and the environment
- **Chapter 4.0** – Presentation of the rationale and approach for the field investigations
- **Chapter 5.0** – Presentation of the tasks and activities necessary to conduct field investigations

- **Chapter 6.0** – The schedule for the site-specific investigations focused on vadose zone-related aspects of WMA S-SX in accordance with the tasks and activities discussed in Chapter 5.0
- **Chapter 7.0** – Description of the project management tasks necessary to implement the field investigation activities, including responsibilities, organizational structure, and project tracking and reporting procedures
- **Chapter 8.0** – References used to develop the WMA S-SX addendum
- **Chapter 9.0** – Glossary of terms that are used in this addendum
- **Appendix A** – Sampling and Analysis Plan.

This page intentionally left blank.

2.0 BACKGROUND AND SETTING

The S and SX tank farm SSTs are HWMA TSD units located in the southern portion of the 200 West Area. Waste in the SSTs consists of liquid, sludges, and salt cake (i.e., crystallized salts). Over the years, much of the liquid stored in the SSTs has been evaporated or pumped to double-shell tanks.

The S and SX tank farms comprise WMA S-SX. The tanks are interim status TSD units pending closure that must be operated, permitted, and maintained in compliance with RCRA and Washington State dangerous waste program regulations (WAC 173-303) and Tri-Party Agreement Milestones M-45-00 and M-24-00 and proposed Milestones M-45-51, M-45-52, and M-45-52-T01 (Ecology et al. 1998 and 1999). WMA S-SX historically received hazardous or dangerous waste, but SSTs in WMA S-SX are out of service (i.e., no additional waste has been added) and will be closed in accordance with Tri-Party Agreement Milestone M-45-00, which specifies WAC 173-303-610. A SST closure work plan (DOE/RL-89-16) has been prepared but is scheduled for revision and resubmittal to Ecology. Sampling and analysis plans (SAPs) for closure are not included in the closure work plan. Post-closure permit applications would be required to support the closure plans submitted to Ecology. Post-closure permit applications may be required if dangerous waste is left in place (e.g., closure as a landfill) or if modified closure is required (Ecology 1998). The procedures are consistent with the Tri-Party Agreement (Ecology et al. 1998).

2.1 SITE DESCRIPTION

Information and data relevant to the RFI/CMS investigations at the S and SX tank farm facilities were recently provided in the preliminary WMA S-SX work plan addendum (HNF-4380) and were largely obtained from the Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Area (WHC-SD-WM-ER-352). This work plan updates and augments HNF-4380 with information from the subsurface condition for WMA S-SX (HNF-4936). The location, history of operations, leak detection systems, and interaction with other facilities are discussed in the following subsections.

2.1.1 Location

The S and SX tank farms are located in the southern portion of the 200 West Area, near the Reduction-Oxidation (REDOX) Plant (Figure 2.1). The SX tank farm contains 15 SSTs, each with a 3,785,000-L (1,000,000-gal) capacity, waste transfer lines, leak detection systems, and tank ancillary equipment. The S tank farm contains 12 SSTs, each with a 2.869,030-L (758,000-gal) capacity, waste transfer lines, leak detection systems, and tank ancillary equipment. The SSTs in both tank farms are 23 m (75 ft) in diameter. The S tank farm SSTs are approximately 11.4 m (37.25 ft) tall from base to dome, and the SX tank farm SSTs are approximately 13.4 m (44 ft) tall from base to dome. The sediment cover from the apex of the dome to ground surface is approximately 2.46 m (8.083 ft) at the S tank farm and 1.8 m (6 ft) at the SX tank farm, respectively. All of these tanks have a dish-shaped bottom (Figure 2.2). The SX tank farm SSTs were the first SSTs designed for self-boiling (self-concentrating) waste; however, the S tank farm SSTs received REDOX waste that self-boiled. The S and SX SSTs were constructed with cascade overflow lines in a three-tank series that allowed gravity flow of liquid waste between the tanks. The following tanks comprise the three-tank series for the S tank farm:

Figure 2.1. Location Map of Single-Shell Tank WMA S-SX and Surrounding Facilities in the 200 West Area

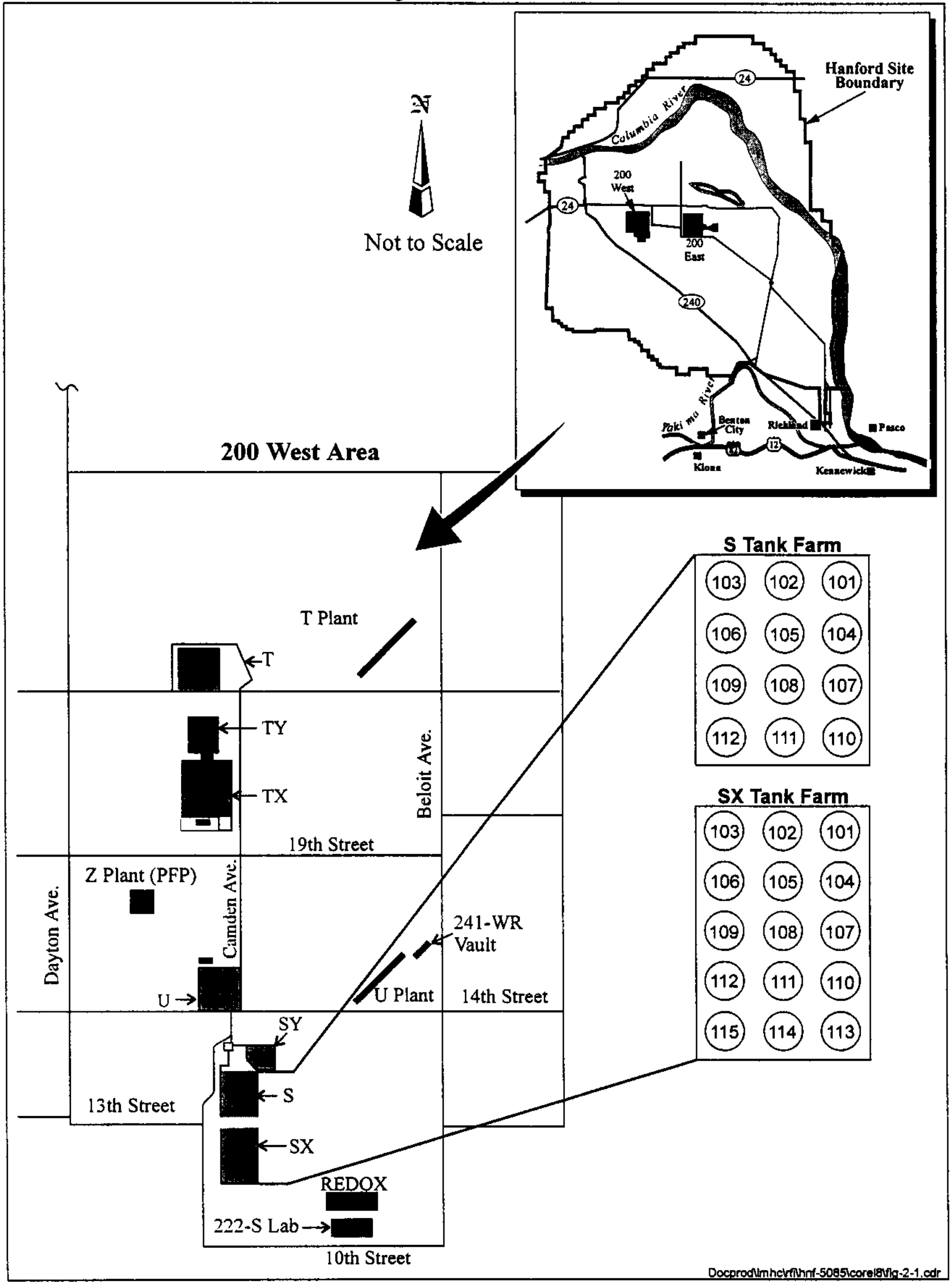
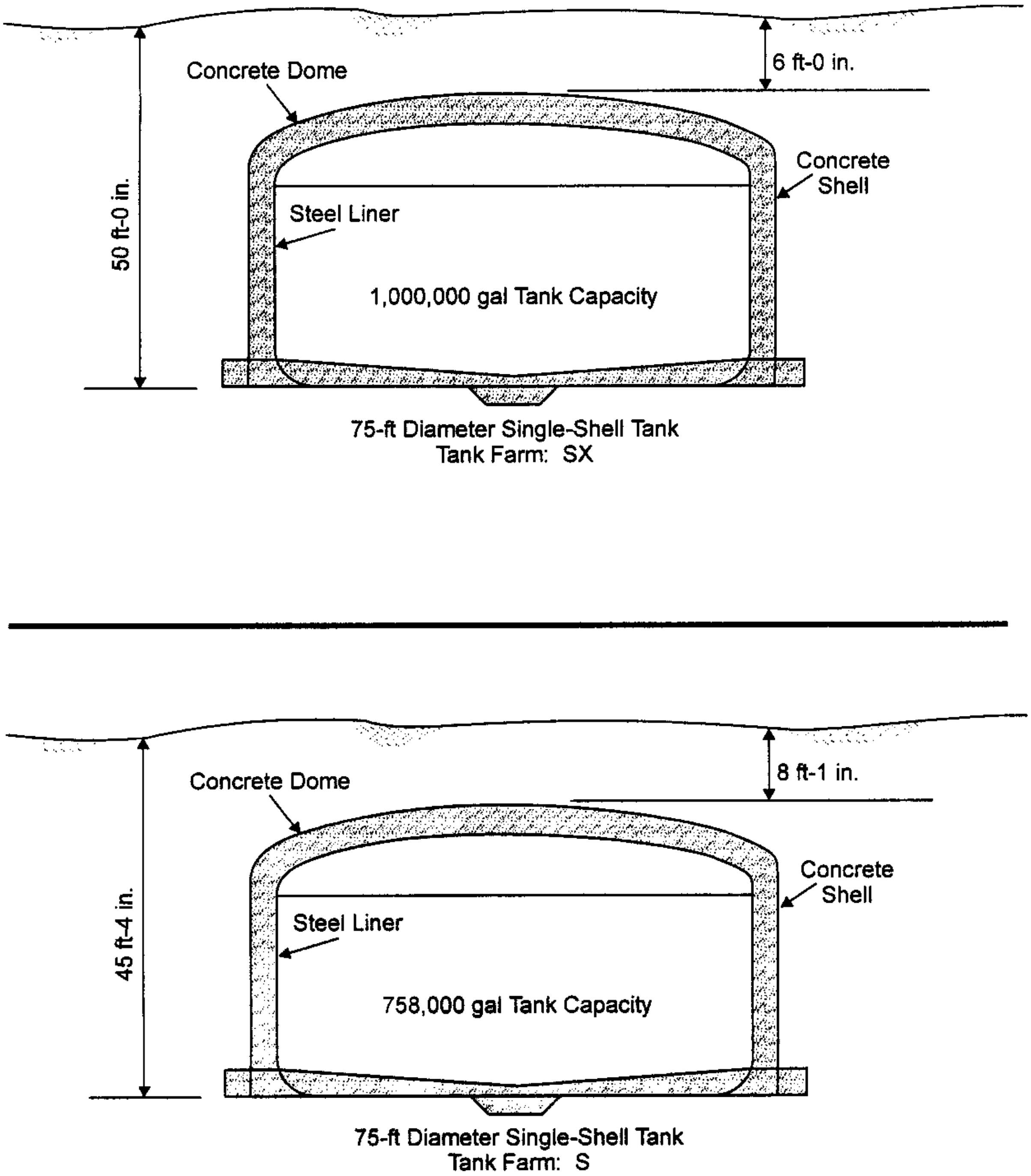


Figure 2.2. General Configuration of Tanks in WMA S-SX



Not to Scale

(Adapted from HNF-EP-0182-129)

Docprod\lmhc\rf\hnf-5085\corel8\fig-2-2.cdr

- Tanks S-101, -102, -103
- Tanks S-104, -105, -106
- Tanks S-107, -108, -109
- Tanks S-110, -111, -112.

The following tanks comprise the three-tank series for the SX tank farm:

- Tanks SX-101, -102, -103
- Tanks SX-104, -105, -106
- Tanks SX-107, -108, -109
- Tanks SX-110, -111, -112
- Tanks SX-113, -114, -115.

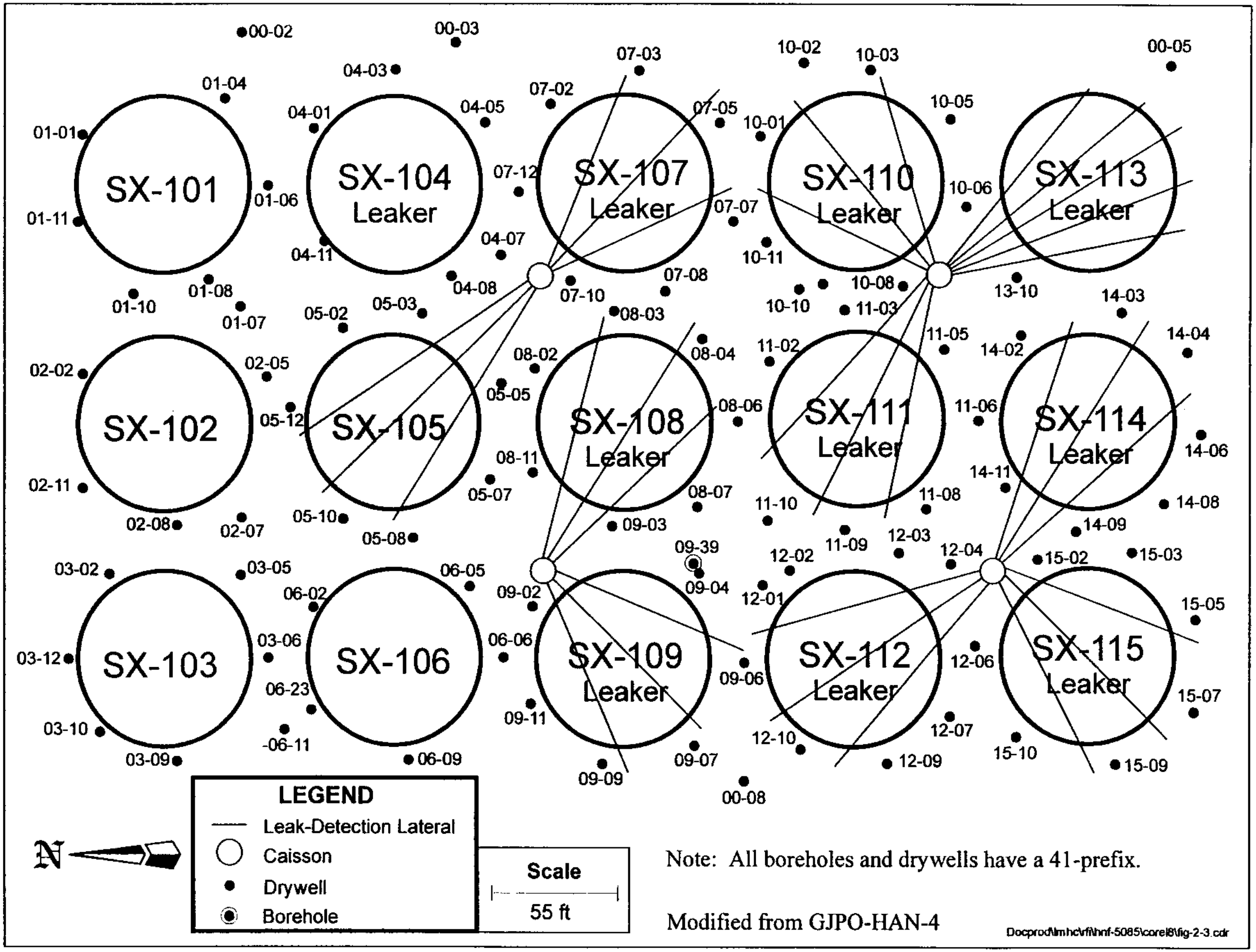
Figures 2.3 and 2.4 show S and SX tank farm SSTs and associated drywells.

2.1.2 History of Operations

The tanks in the S and SX tank farms received REDOX Plant waste, which was allowed to self-boil or self-concentrate through evaporation of liquid. The S tank farm was built between 1950 and 1951. The SX tank farm was built between 1953 and 1954 (WHC-SD-WM-ER-352).

The S tank farm operation began in 1951. The tanks were filled with liquids by 1953; however, the waste in the tanks began self-boiling in the summer of 1952 because of the radioactive decay heat load in the REDOX wastes. A surface condenser was installed in 1953 to concentrate the waste and provide more tank space. The vapor condensate was disposed of in nearby cribs. Liquid levels in the tanks fluctuated during the next 20 years, and then the tanks filled rapidly with solids. The change can be attributed to the startup of the 242-S evaporator because the tanks were used as receivers for evaporator waste products. When the tanks were filled with solids, little could be done with technology that had been developed to increase the service lives of the tanks. The tanks were removed from service in the late 1970s and early 1980s (WHC-SD-WM-ER-352). Tank S-104 is the only assumed leaker in the S tank farm.

The SX tank farm operation began in 1954 with the first six tanks. The last nine tanks began operation in late 1955. The first six tanks received REDOX Plant waste and first-cycle condensate; the other nine tanks received REDOX high-level boiling waste. The first six tanks were full of liquid by early 1954. Tank 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. Tanks SX-105 and SX-107 through SX-115 were designed to handle REDOX high-level boiling wastes. Heat loads within the tanks were reduced by allowing supernates to evaporate and, as required, return as condensates to maintain desired liquid levels. Tanks SX-104 and SX-107 through SX-115 are confirmed or assumed leakers. Most of the last nine tanks were filled with liquid during 1955, and the waste self-concentrated during the next few years. During the 1960s and 1970s, the last nine tanks developed leaks and were removed from service. Tanks SX-101 through SX-106 are one-half to two-thirds full of solids (mostly salt cake) and contain some sludge. All of the tanks were removed from service by 1980 (i.e., no new additions of waste) and have been interim isolated or partially interim isolated. Table 2.1 lists the volume of waste currently stored in the S and SX tanks (HNF-EP-0182-129).

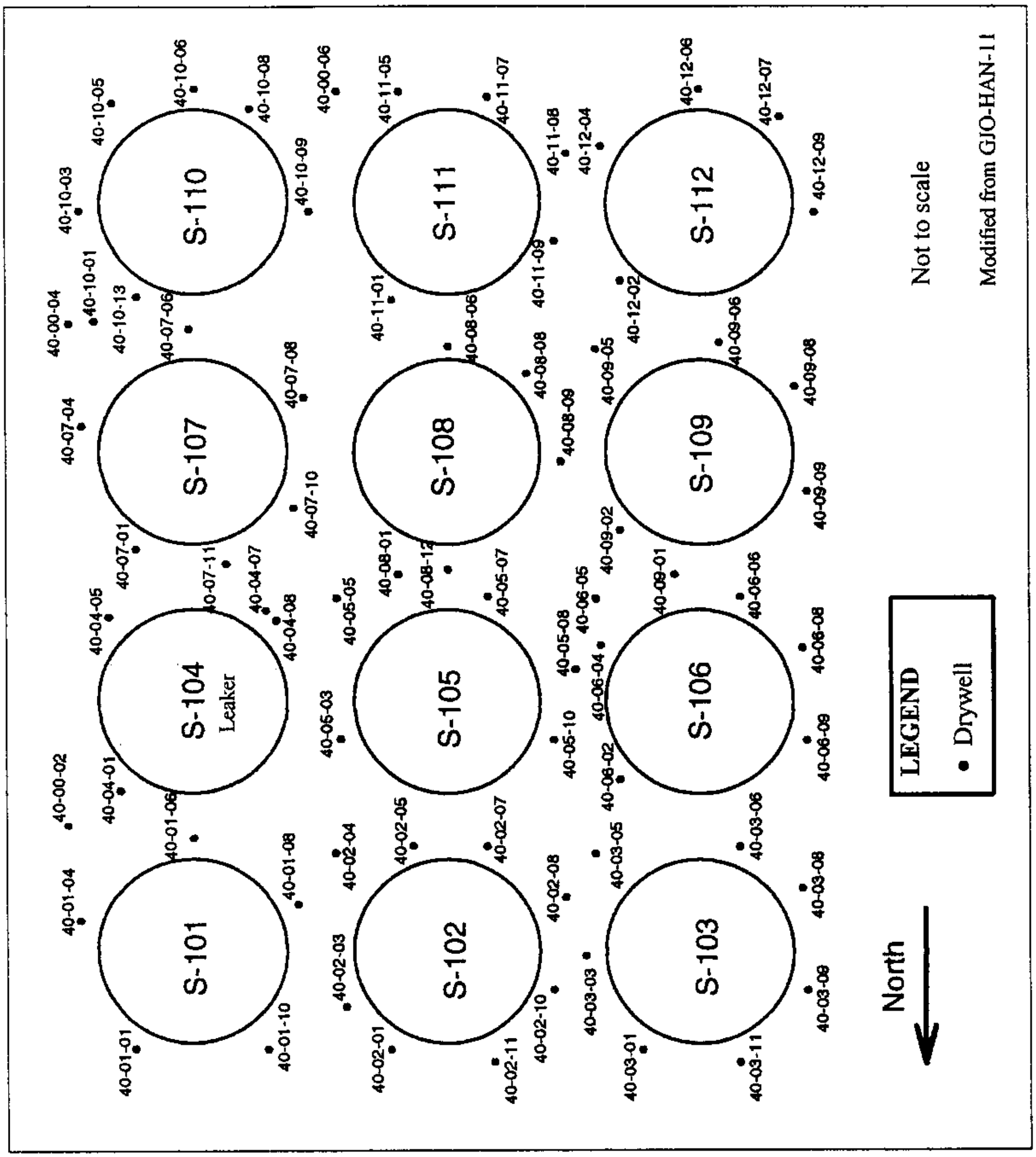


Note: All boreholes and drywells have a 41-prefix.

Modified from GJPO-HAN-4

Figure 2.3. SX Tank Farm SSTs and Associated Drywells

Figure 2.4. S Tank Farm SSTs and Associated Drywells



LEGEND

- ● Drywell

Not to scale

Modified from GJO-HAN-11

Table 2.1. Current Waste Volume in S and SX Farm Tanks

Tank Number	Total Waste Volume KL (Kgal)	Supernate KL (Kgal)	Salt Cake KL (Kgal)	Sludge KL (Kgal)
S-101	1616 (427)	45 (12)	772 (204)	799 (211)
S-102	2078 (549)	0 (0)	1681 (444)	397 (105)
S-103	939 (248)	64 (17)	840 (222)	34 (9)
S-104	1113 (294)	3.8 (1)	0 (0)	1109 (293)
S-105	1726 (456)	0 (0)	1718 (454)	7.6 (2)
S-106	1711 (452)	98 (26)	1612 (426)	0 (0)
S-107	1423 (376)	53 (14)	261 (69)	1109 (293)
S-108	1703 (450)	0 (0)	1688 (446)	15 (4)
S-109	1919 (507)	0 (0)	1870 (494)	49 (13)
S-110	1476 (390)	0 (0)	980 (259)	496 (131)
S-111	2044 (540)	87 (23)	1431 (378)	526 (139)
S-112	1980 (523)	0 (0)	1957 (517)	23 (6)
SX-101	1673 (442)	0 (0)	1189 (314)	485 (128)
SX-102	2055 (543)	0 (0)	1612 (426)	443 (117)
SX-103	2464 (651)	0 (0)	2029 (536)	435 (115)
SX-104	2210 (584)	0 (0)	1696 (448)	515 (136)
SX-105	2585 (683)	0 (0)	2309 (610)	276 (73)
SX-106	1881 (497)	685 (181)	999 (264)	197 (52)
SX-107	394 (104)	0 (0)	0 (0)	394 (104)
SX-108	329 (87)	0 (0)	0 (0)	329 (87)
SX-109	924 (244)	0 (0)	924 (244)	0 (0)
SX-110	235 (62)	0 (0)	0 (0)	235 (62)
SX-111	473 (125)	0 (0)	0 (0)	473 (125)
SX-112	348 (92)	0 (0)	0 (0)	348 (92)
SX-113	98 (26)	0 (0)	0 (0)	98 (26)
SX-114	685 (181)	0 (0)	0 (0)	685 (181)
SX-115	45 (12)	0 (0)	0 (0)	45 (12)

Previous evaluations have screened the universe of radiological and chemical constituents and identified those constituents potentially associated with the SST system. The results of those screenings are provided in Section 3.0 of the Phase 1 RFI/CMS work plan for SST WMAs (DOE/RL-99-36). The document includes tables listing the radiological and chemical constituents that are contaminants of potential concern for the SST system. These tables serve as the starting point for defining WMA S-SX-specific contaminants of potential concern and are discussed in greater detail in Chapter 3.0 of this work plan and HNF-5272, which contains a summary of WMA S-SX DQO.

2.1.3 Description of the Leak Detection System

The SX tank farm has 98 leak detection wells currently available to be used for leak detection monitoring that were drilled from 1954 to 1978. Laterals that are currently inaccessible also exist under 10 tanks as shown in Figure 2.3, approximately 3 m (10 ft) below the tank bottom. The laterals extend from four leak detection caissons. Currently, no plans have been prepared for use of the laterals (HNF-EP-0182-129). Gamma logging data from the drywells and laterals were used to ascertain the integrity of the tank. Two additional drywells were drilled and installed in 1996 and 1997. These drywells were 41-09-39, which was extended to groundwater in 1997, and drywell 41-12-01. The SX tank farm layout showing drywell, caisson, and lateral locations in reference to tanks is shown in Figure 2.3.

The S tank farm has 72 leak detection wells currently available to be used for leak detection monitoring that were drilled from 1952 to 1976. The depth ranges for these drywells are between 16.8 m (55 ft) and 45.7 m (150 ft) bgs. The S tank farm layout showing drywell locations in reference to tanks is shown in Figure 2.4.

2.1.4 Relationship to Other Facilities

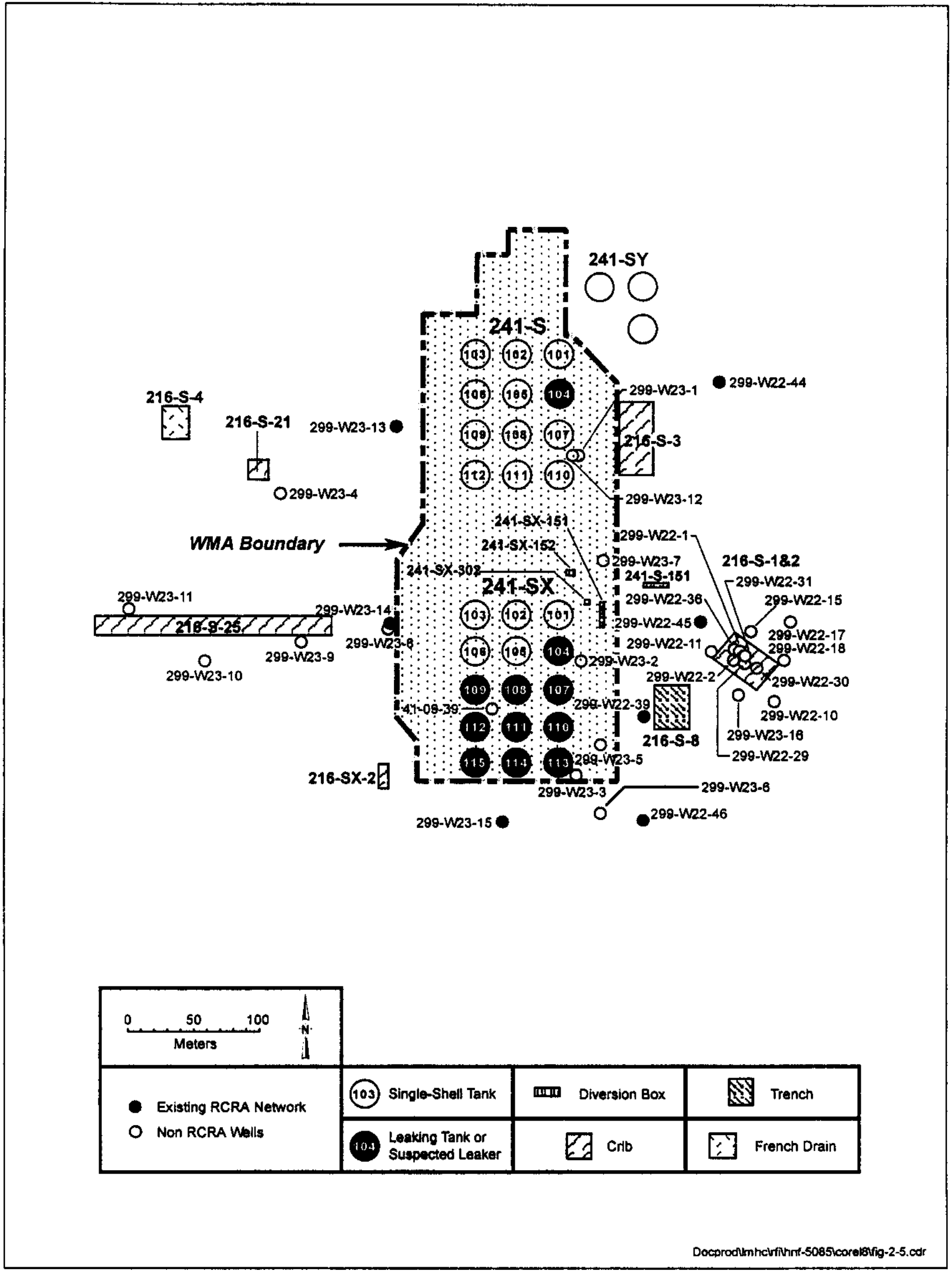
Various cribs, trenches, french drains, and the 216-U-10 pond that comprise associated facilities are located in the vicinity of WMA S-SX. Waste discharged to or stored at these facilities may have had an effect on the groundwater contamination at WMA S-SX. These sites are not RCRA TSD units and, therefore, are not part of the SST RCRA Groundwater Monitoring Program; these units are monitored under the Hanford Site Groundwater Monitoring Program (DOE/RL-99-36 and PNNL-11793). These facilities consist of:

- 216-S-1, 216-S-2, and 216-S-3 cribs
- 216-S-4 french drain
- 216-S-8 trench
- 216-S-21 crib
- 216-S-25 crib
- 216-SX-2 crib
- 216-U-10 pond
- 241-S-151 diversion box
- 241-SX-151 diversion box
- 241-SX-152 diversion box
- 241-SX-302 catch tank.

Figure 2.5 shows the location of these facilities (except the U pond, which is located 300 m (984 ft) west of WMA S-SX) with respect to WMA S-SX.

The cribs around WMA S-SX received large volumes of slightly contaminated water and other waste streams, such as excess condensate from the boiling waste tanks and cooling water from the condensers. Other additions to these cribs included discharges from the first cold REDOX start-up run and groundwater coming from the U-crib pump and treat operations in the

Figure 2.5. WMA S-SX and Surrounding Facilities



mid-1980s. Historical records indicate that tank wastes were not cascaded directly from the tanks into cribs. Discharge to cribs is discussed in more detail in Section 3.0; developing an understanding of the range and quantities of chemicals and radionuclides added to these cribs may be required to fully understand their potential impacts to groundwater. In addition, the 216-U-10 pond received about 167 billion L (44 billion gal.) of slightly contaminated water, a fraction of which included fluids generated by S and SX tank farm operations. The large additions of water to the 216-U-10 pond significantly impacted groundwater flow patterns under WMA S-SX.

Finally, a number of raw and potable water lines are present in and around WMA S-SX. Leaks from these lines could have contributed to tank waste migration in the vadose zone. It appears that leaks from these lines were not considered to have adverse impacts to tank farm operations. Thus, historical records are likely to be incomplete.

A summary of the operation, vadose zone contamination, and groundwater contamination history for each of these facilities is described in HNF-2603, HNF-4936, and other documents.

2.2 PHYSICAL SETTING

The following sections describe the topography, geology, hydrogeology, and surface water hydrology. Because the meteorology, environmental resources, and human resources associated with WMA S-SX are the same as the 200 Areas at the Hanford Site, the reader is referred to Section 3.0 of DOE/RL-99-36 for related information. For detailed information of the geology, the reader is referred to HNF-4380 and HNF-4936.

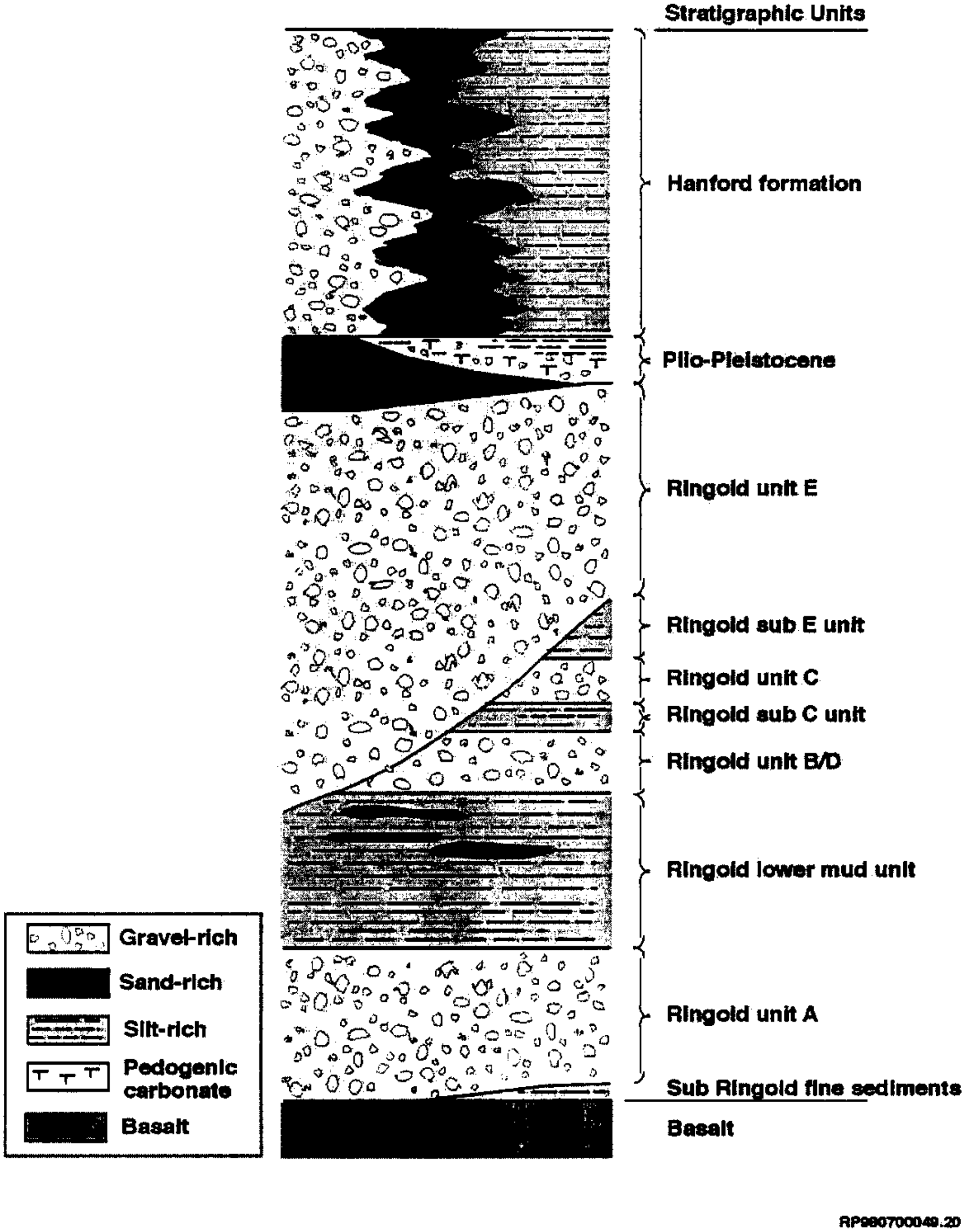
2.2.1 Topography

The S and SX tank farms lie within a shallow, north-south oriented topographic depression. The depression formed within the southwestern extent of a flood bar deposit known as the Cold Creek bar (DOE/RW-0164). This topographic feature, in combination with construction disturbances, is conducive to collection of surface runoff, especially along the south side of the SX tank farm and along the east side of S tank farm (HNF-4936). HNF-4936 provides more information.

2.2.2 Geology

The S and SX tank farms were constructed on a sequence of sediments that overlie the Columbia River Basalt Group on the north limb of the Cold Creek syncline as depicted in Figure 2.6. These sediments include the upper Miocene to Pliocene Ringold Formation, the Plio-Pleistocene unit, Pleistocene cataclysmic flood gravels and slack water sediments of the Hanford formation, and Holocene eolian deposits.

Figure 2.6. General Stratigraphy of the WMA S-SX



Source: HNF-4936

The Ringold Formation comprises sediments deposited by the Columbia River and its tributaries. The sediments were deposited between 8.5 and 3 million years ago and consist of clay, silt, fine- to coarse-grained sand, and granule to cobble gravel. The top of the unconfined aquifer under the tank farms is in Ringold conglomerates (DOE/RW-0164; WHC-SD-EN-TI-008). Ringold conglomerate occurs as a series of units designated A, B/D, C, and E that are separated by fine-grained overbank and lacustrine deposits (BHI-00184). The lowermost of the fine-grained sediments is the lower mud unit. The uppermost Ringold unit under the tank farms is called Unit E and consists of sandy gravels to gravelly sands. In the saturated and unsaturated zones, indurated Ringold conglomerate varies from cemented to uncemented. The result is highly variable permeability in the saturated zone.

The vadose zone beneath the S and SX tank farms is as much as 65-m (213-ft) thick and consists of the Pleistocene-aged Hanford formation, the Plio-Pleistocene unit, and the upper part of the Ringold Formation. At the tank farms, the Hanford formation and underlying Ringold Formation are separated by a relatively thin sequence of sediments called the Plio-Pleistocene unit.
The Plio-Pleistocene unit unconformably overlies a tilted and truncated Ringold Formation and consists of intercalated alluvium, basaltic alluvium, reworked Ringold sediments, eolian deposits, and calcium carbonate horizons deposited by small streams flowing from the surrounding higher elevations.

The Hanford formation is the informal name given to all glaciofluvial cataclysmic flood sediments of the Pleistocene Epoch. It consists of pebble- to boulder-gravel, fine- to coarse-grained sand, silty sand, and silt to clayey-silt. More information is provided in HNF-4936.

ARH-LD-133 and ARH-LD-134 were the original compilations of the geology of the S and SX tank farms after the dry well boreholes were completed in the early 1970s. The major stratigraphic units of the suprabasalt sediments present beneath the SX tank farm are the Ringold Lower Mud, Ringold Unit E, Plio-Pleistocene, and the Hanford formation (in ascending order) (HNF-4936). The sources of data on the geology of the suprabasalt sediments include:

- *Geology of the 200 West Area: An Update* (WHC-SD-EN-TI-008)
- *Geology of the 241-S Tank Farm* (ARH-LD-133)
- *Geology of the 241-SX Tank Farm* (ARH-LD-134)
- *Hydrogeologic Model for the 200 East Groundwater Aggregate Area* (WHC-SD-EN-TI-019)
- *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South Central Washington* (BHI-00184)
- *Subsurface Conditions of the S-SX Waste Management Area* (HNF-4936)
- *Supporting Information for the Scientific Basis for Establishing Dry Well Monitoring Frequencies* (RHO-RE-EV-4 P).

In general, ARH-LD-133 and ARH-LD-134 represent the first compilations of existing data on S and SX tank farm geology. HNF-2855 offers additional information gained from the drilling and sampling of borehole 41-09-39 in the SX tank farm. The vadose zone stratigraphy of the S and SX tank farms is discussed in HNF-4936.

2.2.2.1 Ringold Formation

The Ringold Formation is up to 125-m (410-ft) thick under WMA S-SX and thickens from east to west. The Ringold Formation consists of clay, silt, fine- to coarse-grained sand, and gravel. The vadose zone portion of the Ringold Formation thins from east to west approximately 16 m (50 ft) to about 13 m (40 ft) and consists primarily of a slightly silty coarse- to medium-grained sandy gravel (Ringold Unit E).

In WMA S-SX, Slate (1996) interprets the surface of the Ringold Formation as a trough trending northwest-southeast parallel to the Cold Creek syncline and plunging to the southeast (Figure 2.7). This trough contains two smaller troughs, one of which trends directly under the S and SX tank farms, and one south of 200 West Area. Both smaller troughs appear to merge further southeast. Slate (1996) interprets the trough as a paleo-Cold Creek drainage developed in the slow subsiding Cold Creek depression. Under the SX tank farm, the presence of a limb of the trough results in the surface of the Ringold Formation dipping to the southwest. Additional information is provided in HNF-4936.

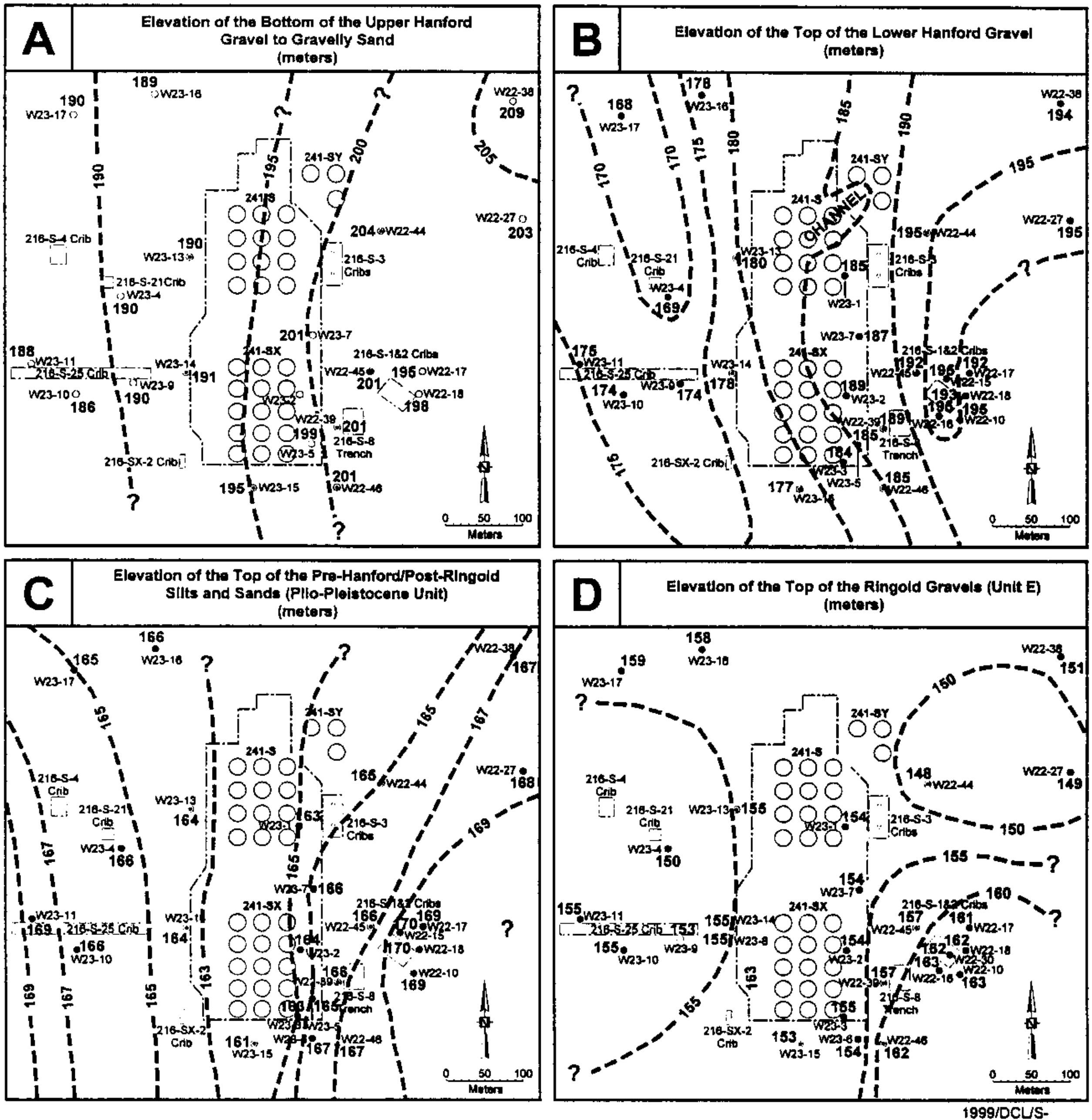
2.2.2.2 Plio-Pleistocene Unit

The Plio-Pleistocene unit is a compact, massive, yellow-brown silt and fine-grained sand with clay and some intercalated gravel. The Plio-Pleistocene unit is overlain by sands and silty sands of the Hanford formation that often make it difficult to identify the contact in driller's and geologist's log. The contact, however, is consistently marked by an increase in the gross gamma-ray activity or signature seen in geophysical logs and is, therefore, easily differentiated from the overlying Hanford formation. The Plio-Pleistocene unit also is distinguished from the Hanford formation by having a greater calcium carbonate content, and massive structure in core (DOE/RW-0164).

The Plio-Pleistocene unit consists mainly of quartz and feldspar with less abundant basalt, mica, smectite, and chlorite (RHO-ST-23). The unit thins from southwest to northeast across the tank farms and varies in thickness from about 14 to 6 m (45 to 20 ft). The Plio-Pleistocene unit contains a series of old, buried soil zones (paleosols) with calcium carbonate development typical of an arid environment (caliche zones and pedogenic carbonate) (Slate 1996). Only one principal caliche zone is present under the tank farms but it varies from a discrete zone that lies directly on the Ringold Formation to a diffuse zone occurring a few meters above the Ringold. The caliche zones are thought to have formed subarealy during hiatuses in deposition.

In the vicinity of WMA S-SX, the surface of the Plio-Pleistocene unit is a trough that resembles the surface of the Ringold Formation. Figure 2.7 illustrates the interpreted surface elevation of the top of the Plio-Pleistocene unit for WMA S-SX and vicinity based on recent data assimilation and interpretations (HNF-4936). From this figure, a trough is interpreted to pass through the WMA S-SX. Also, the top of the Plio-Pleistocene unit is interpreted to be dipping southwesterly beneath most of the tanks in the southern portion of the tank farm including tanks SX-107, -108, -109, -111, -112, -114, and -115. However, no obvious smaller troughs exist within the main trough as in the Ringold Formation, and the deepest part of the Plio-Pleistocene unit trough is located under WMA S-SX (HNF-4936).

Figure 2.7. Structural Contour Map (Surface Elevation) for the Top of Stratigraphic Units within WMA S-SX and Vicinity



Source: HNF-4936

Recently available geophysical data coupled with the older driller's logs allow greater refinement of the Plio-Pleistocene contact under the S and SX tank farms than was available in the past. The data show that under the tank farms a low amplitude, north-south oriented trough is superimposed on the larger NW-SE trough. Total relief across the trough in the tank farms and surrounding area is about 10 m (33 ft) (HNF-4936). HNF-4936 provides a detailed discussion of the Plio-Pleistocene unit and an illustration of the trough as it relates to WMA S-SX.

2.2.2.3 Hanford formation

The Hanford formation is about 38 to 40 m (125 to 135 ft) thick at the S-SX tank farm and consists of massive sands and silty sands intercalated with beds of coarse sand and gravel and thin lens of silts and clayey silts. Cementation is very minor or absent. Five relatively laterally continuous sedimentary layers were identified in the study area–two gravelly units and three sandy units (HNF-4936). Because of the continuity of these layers (with the exception of the surface sandy unit) through the study area, they provide the best stratigraphy to describe the geologic framework of the Hanford formation. In addition, it has been recognized (as summarized in PNNL-11810) that sands overlying gravels can influence lateral spreading and downward migration of moisture. Therefore, the distribution and depth of the sand/gravel layers may be important to understanding contaminant movement at the tank farms.

The five stratigraphic layers (gravelly units A and B and three sandy units) that define the Hanford formation in the study area show west to east variations in the proportion of sand, silt, and gravel. For example, the sandy gravels on the west side of the tank farms transition to gravelly sands to slightly gravelly coarse sands on the east side. These transitions reflect a response to changing depositional conditions resulting from higher to lower energy floodwaters.

The Hanford formation consists of about 50% basalt and 50% felsic material (RHO-ST-23). The felsic component is composed of quartz and feldspar with some samples containing greater than 10% pyroxene, amphibole, mica, chlorite, ilmenite, and magnetite. The silt and clay sized fractions consist of quartz, feldspar, mica, and smectite.

Bed forms in the flood sediments vary but can only be observed in surface exposures. Cores can provide data on fine-scale bedding; however, no core was collected from the S-SX tank farm area. However, construction at the SY tank farm provided an opportunity to record typical bed forms in the upper 20 m (60 ft). In the pit wall finely bedded sand and sandy gravels with foreset bedding have been observed (RHO-ST-23; ARH-LD-139). ARH-LD-139 maps graded bedding, channel cut and fill structures, and cross-cutting clastic dikes. HNF-4936 provides more information about the Hanford formation in the vicinity of WMA S-SX.

2.2.2.4 Clastic Dikes

Clastic dikes are vertical to subvertical sedimentary structures that crosscut normal sedimentary layering. Clastic dikes are a common geologic feature of the Hanford formation in the 200 Areas. ARH-LD-139 maps four clastic dikes noted in pit walls during excavation of the SY tank farm just northeast of S tank farm. Clastic dikes also are known to occur in the 216-S-10 pond area southwest of the S and SX tank farms, suggesting that clastic dikes might also be present in the S and SX tank farms area. BHI-01103 and HNF-4936 provide more information.

2.2.3 Hydrogeology

Water level measurements (June 1998) indicated that the water table in the unconfined aquifer was at approximately 138-m (453-ft) above mean sea level (Figure 2.8). The unconfined aquifer is found in the Unit E gravels of the Ringold Formation and is approximately 62-m (205-ft) thick. The bottom of the unconfined aquifer is at approximately 76 m (250 ft) above mean sea level at the top of the Wooded Island member of the Ringold Formation (Ringold lower mud unit) (Figure 2.6). A calcareous to siliceous cemented zone has been encountered 9 to 12 m (30 to 40 ft) below the water table and may represent a boundary with distinct changes in hydraulic properties (PNNL-11810).

Groundwater flow historically has been to the southeast with a hydraulic gradient on the order of 1.5 m/305 m (5 ft/1,000 ft). Recent data from the south end of the SX tank farm, however, indicate a possible localized shift to the east. Water table elevations in the vicinity of WMA S-SX declined approximately 7 m (23 ft) between 1984 and 1995 (PNNL-11793). Well data indicate ongoing declines in the water table of approximately 0.5 m (1.6 ft) per year. The groundwater elevations for selected wells in WMA S-SX vicinity were projected to drop from approximately 147 m (482 ft) above mean sea level in 1996 to approximately 140 m (460 ft) above mean sea level in the year 2000, and 134 m (440 ft) above mean sea level by the year 2050 (PNNL-11793). More recent data, however, indicate that water levels are dropping at a more rapid rate. Table 2.2 provides well construction and water level data for the RCRA monitoring wells in this WMA. Numerous non-RCRA wells exist near the S and SX tank farms.

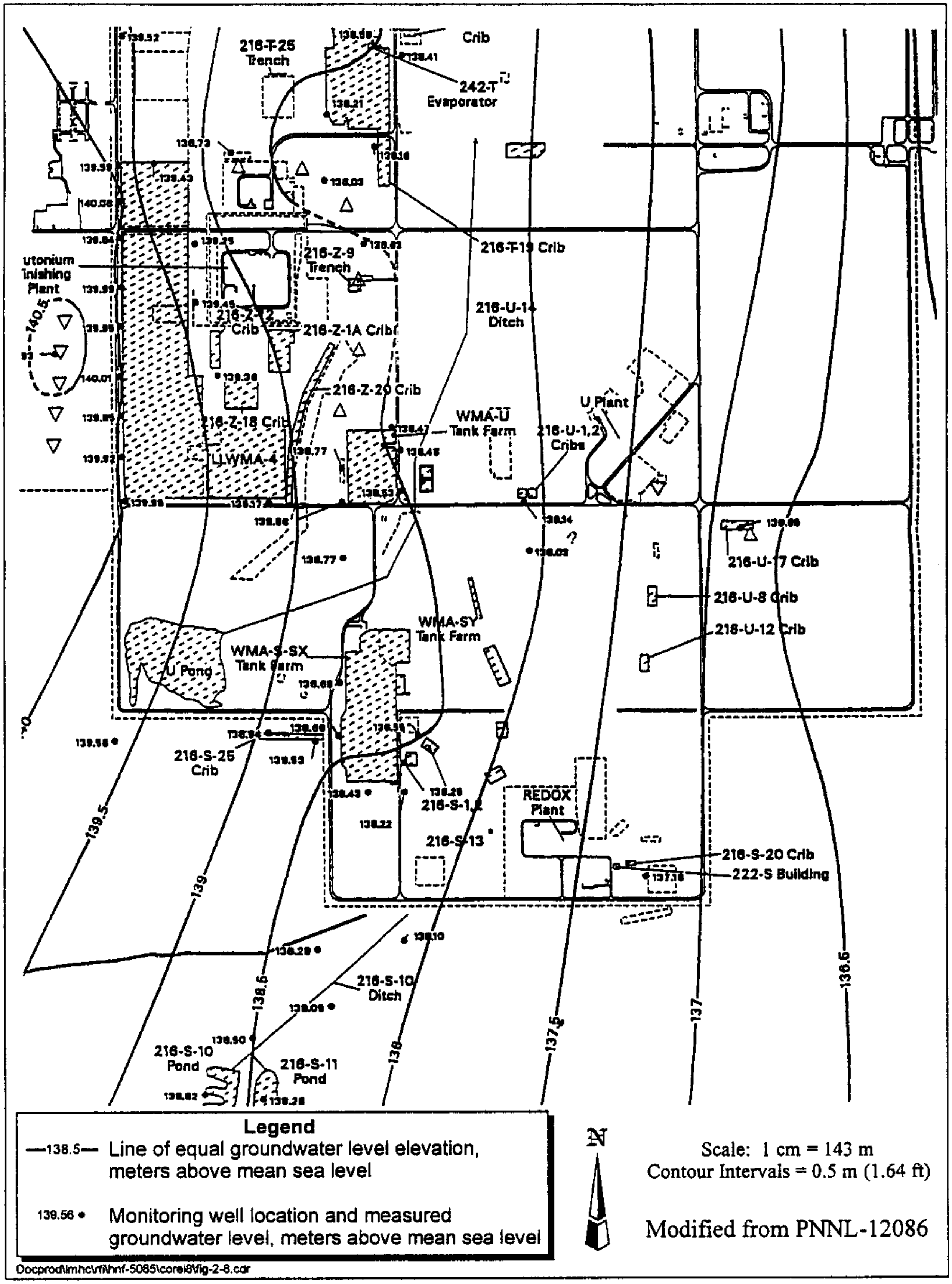
Table 2.2. RCRA Well Information for WMA S-SX

Well Number	Completion Date	Location	Surface Elevation m (ft)	Depth of Bottom of Screen m (ft)	Depth to Water at Completion m (ft)	Depth to Water 1998 m (ft)
299-W22-39	1991	Downgradient	202.77 (665.26)	67.45 (221.3)	61.72 (202.5)	66.50 (218.17)
299-W22-44	1991	Downgradient	205.67 (674.77)	73.82 (242.2)	64.16 (210.5)	69.44 (227.82)
299-W22-45	1992	Downgradient	202.07 (662.97)	71.29 (233.9)	64.10 (210.03)	65.75 (215.72)
299-W22-46	1991	Downgradient	203.48 (667.60)	69.77 (228.9)	62.76 (205.9)	67.42 (221.21)
299-W23-13	1990	Upgradient	202.19 (663.34)	66.20 (217.2)	60.32 (197.9)	65.48 (214.82)
299-W23-14	1991	Upgradient	207.47 (661.00)	65.62 (215.3)	60.02 (196.9)	64.79 (214.82)
299-W23-15	1991	Downgradient	198.73 (652.01)	67.79 (222.4)	57.85 (189.8)	62.42 (204.78)

2.2.3.1 Recharge

Recharge through the vadose zone is primarily controlled by the surface sediment type, vegetation type, topography, and spatial and temporal variations in seasonal precipitation at WMA S-SX. As used here, the recharge rate is the amount of precipitation that enters the sediment, is not removed by evaporation or transpiration, and eventually reaches the groundwater table. The recharge to the unconfined aquifer beneath the SX tank farm from infiltrating precipitation is an important parameter for calculating groundwater impacts from past tank leaks, future tank waste retrieval losses, and tank waste residual waste currently in the SSTs (Jacobs 1998).

Figure 2.8. 200 West Area Water Table Map, June 1998



Scale: 1 cm = 143 m
Contour Intervals = 0.5 m (1.64 ft)

Modified from PNNL-12086

Most of the precipitation at the Hanford Site occurs in the fall and winter months (September through February) when little to no evaporation or transpiration occurs. Recharge varies temporally and spatially. The temporal variation occurs with changes in temperature, plant activity, and precipitation. Both seasonal and long-term variations, as a result of climatic change, are important. The spatial variation occurs with changes in vegetation type, surficial sediment type, and human-made structures (e.g., paved parking lots). A lag time exists between a change in recharge rate from infiltration at the surface and a change in the flow field in the vadose zone as the water infiltrates through the ground.

Artificial recharge in the 200 West Area is associated with trenches, cribs, ditches, and drains that were used to dispose of approximately 1.7×10^{11} L (4.4×10^{10} gal) of waste water (DOE/RL-92-16). Leaking water lines are another source of artificial recharge in the tank farms. Higher infiltration rates are observed around the tank farms, which are covered with gravel and kept clear of vegetation.

2.2.3.1.1 Current Recharge Rates

Current estimated recharge rates for the S and SX tank farms are for a sand and gravel surface with no vegetation. This is the type of condition that has assumed to prevail from the time of tank construction. Several previous groundwater impact assessments involving contaminant transport through the vadose zone from a tank waste source used a constant annual recharge rate of 10 cm/yr (3.94 in./yr) to represent current conditions (DOE/EIS-0189; WHC-SD-WM-EE-004). Ten cm/yr (3.94 in./yr) is approximately 60% of the long-term annual precipitation (16.8 cm/yr [6.61 in./yr]) (PNNL-11107) and corresponds to lysimeter data that represent tank farm conditions (PNL-6403; Gee et al. 1992; Fayer et al. 1996).

Lysimeter data from the Field Lysimeter Test Facility show that the recharge rate ranges from 24% to 66% of the annual precipitation for years 1990 to 1994 for lysimeters with gravel over sand and bare vegetation conditions, which are typical of current tank farm ground conditions (PNL-10508). This is equivalent to approximately 4 to 11.1 cm/yr (1.57 to 4.37 in./yr) of recharge based on the long-term annual precipitation rate of 16.8 cm/yr (6.61 in./yr) (PNNL-11107). However, more recent lysimeter field measurements acquired during August 1995 to August 1996 from the Field Lysimeter Test Facility resulted in 16.06 cm/yr (6.32 in./yr) drainage, which is 66% of the actual precipitation over that period. These lysimeters were designed to simulate tank farm conditions on the 200 Area plateau.

Information in HNF-4936 addresses surface infiltration sources and events, subsurface discharges, and saturated zone response. Hydrologic properties of the vadose zone and saturated zone also are discussed.

2.2.3.1.2 Relationship Between Tank Leaks and Natural Recharge

Tank leaks occur under variably saturated conditions; natural recharge from meteoric water (from winter precipitation and snowmelt) and vadose zone hydrology are therefore important drivers for contaminant movement to groundwater. A summary-level discussion that focuses on the relevant vadose zone processes is provided in the following, which has been adapted from HNF-2603.

Tank farm surfaces are kept free of vegetation and covered with gravel; bare, gravel surfaces enhance net recharge of meteoric water. Recharge is further enhanced in tank farms because of the "umbrella" effect (i.e., the effect of percolating water being diverted by an impermeable, sloping surface), created by large, 23-m- (75-ft-) diameter, buried tank domes. Water shedding from the tank dome converges and flows down tank walls into underlying coarse sediments. Sediments adjacent to the tanks, while remaining unsaturated, can attain elevated moisture contents. Enhanced infiltration can mobilize a tank leak and can provide potential for faster transport to the water table. Information on the relationship between tank leaks and natural recharge is presented in HNF-4380, HNF-4936, and WHC-EP-0883.

2.2.4 Surface Water Hydrology

No flood plains exist in the 200 Areas or between the 200 East and 200 West Areas. Floods in Cold Creek and Dry Creek have occurred historically; however, there have been no observed flood events, nor is there evidence that flooding has reached the 200 Areas. Based on a probable maximum flood evaluation, no impact would occur at WMA S-SX. However, State Route 240 along the southwestern and western areas would not be useable (PNL-6415). Natural runoff generated onsite or from offsite upgradient sources is not known to occur in the 200 Areas (Newcomb et al. 1972 and PNNL-6415).

This page intentionally left blank.

3.0 INITIAL CONDITIONS AND CORRECTIVE ACTION REQUIREMENTS AND OBJECTIVES

The information on known and suspected contamination is presented in Section 3.1 and HNF-4936. A summary of this information is also provided in Section 3.0 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36). This information provided input to the discussion on the potential impacts to the public health and the environment described in Section 3.3. Additional data to support improved understanding of the nature and extent of contamination at the WMA will be collected during the field investigation described in the preliminary work plan addendum (HNF-4380) and in this work plan addendum for WMA S-SX.

3.1 KNOWN AND SUSPECTED CONTAMINATION

To effectively develop a characterization plan designed to collect data to support a determination of the presence and extent of contamination at a site caused by a given event or activity, a summary of available data and conditions is needed. A summary of available data regarding source, sediments, and groundwater contamination is presented in this section and in HNF-4936.

When interpreting the data in this section, it is important to note the amount of radioactive decay that has taken place since the data were gathered. For example, the half-life of cesium-137 is 30.2 years, approximately the time between 1968 and 1998. Thus, cesium-137 levels would, in 1998, be approximately half their 1968 values. Where possible, the dates for radionuclide inventories have been given, but calculations of the decayed inventories through the present time have not been made.

3.1.1 Sources

The source term for WMA S-SX is dependent upon nuclear and chemical aspects of the process that generated the waste. WHC-MR-0132 provides some information about the material in the tanks, which could be in the sediments. REDOX waste (R) was the high-level component of the process waste. Other waste associated with the REDOX Plant include coating waste and zircaloy-clad fuels (WHC-MR-0132).

Sources of releases include fluid discharges, tank waste through tank leaks, ancillary equipment leaks and failures, and cribs. These releases impacted the sediments. These releases are discussed in detail in HNF-4936. Estimated releases or leaks from the tanks in WMA S-SX are indicated in Table 3.1. These estimates were obtained from WHC-MR-0132, HNF-EP-0182-129, and LA-UR-96-3537. The uncertainty associated with the leak durations is even greater than that for the estimated tank leak volumes.

Throughout the operational history of the S and SX tank farms, fluids have been discharged, both deliberately and inadvertently. A summary of discharge events is provided in HNF-4936. Three types of fluid discharges associated with S and SX tank farm operations have occurred numerous times in and around WMA S-SX. These include (1) deliberate collection and routing of cooling water and tank condensate to cribs, (2) mechanical failure of tanks and leakage into the underlying soil column, and (3) periodic failure of ancillary equipment (primarily diversion boxes and valve pits) used to transfer liquids between tanks.

Table 3.1. Estimated Past Leak Losses from the S-SX SSTs from Various References

Tank	WHC-MR-0132 Estimated Leak Volume (gal)	HNF-EP-0182-129 Estimated Leak Volume (gal)	LA-UR-96-3537 Estimated Leak Volume (gal)
S-104	N/A	24,000	N/A
SX-104	N/A	6,000	N/A
SX-107	<500	<5,000	N/A
SX-108	2,400	2,400 to 35,000	203,000
SX-109	<500	<10,000	111,000
SX-110	0	5,500	N/A
SX-111	2,000	500 to 2,000	55,000
SX-112	30,000	30,000	44,000
SX-113	15,000	15,000	N/A
SX-114	0	8,000	N/A
SX-115	50,000	50,000	N/A
Totals	**100,400**	**156,400 to 190,500**	**413,000**

Notes:

NA = not available

Leaks from ancillary equipment were observed and recorded when sufficient fluid reached the surface from the buried, but near-surface, sources. The primary parts of the ancillary equipment system responsible for the surface spills appear to be the collection points for fluids being transferred around the tank farm (e.g., diversion boxes, valve pits, and catch tanks). Numerous pipes feed into these collection boxes. The pipes were frequently attached, detached, and reattached as part of normal operations. Diversion box 241-S-151 appears repeatedly as a probable source of leaks in the records.

Most of the S-SX cribs operated from the beginning of tank farm operations in 1952 until the early 1970s. During this time, the cribs received excess tank fluids, mostly in the form of steam or process condensates. With the start up of the 242-S Evaporator in 1973, all cribs except 216-S-25 were deactivated. At that time, crib 216-S-25 was activated and received condensate from the 242-S Evaporator.

Surface spills were recorded in two time periods: the first from 1953 to 1958 and the second in the early 1970s to the early 1980s. The latter time period coincides with the startup and operation of the 242-S Evaporator, a time in which large amounts of tank fluids were transferred back and forth between the evaporator and the tanks through the ancillary equipment. HNF-4936 provides more information on surface and near-surface spills.

A detailed discussion of the 11 tanks (10 SSTs in SX tank farm, 1 SST in S tank farm) that are assumed or confirmed leakers is provided in Section 3.3 of HNF-4936. The estimated volume of the leaks is provided in Table 3.1. Based on HNF-EP-0182-129 the four highest estimated volume releases ranked in order of highest to lowest would rank accordingly:

- SX-115 (189,250 L [50,000 gal])
- SX-108 (132,475 L [35,000 gal])
- SX-112 (113,550 L [30,000 gal)
- S-104 (90,840 L [24,000 gal]).

Three of these four tanks are the focus of the next characterization effort. Currently, characterization efforts are being conducted at tank SX-115.

3.1.2 Releases to Sediment

Releases of historical fluid discharges, tank waste through tank leaks, ancillary equipment, surface spills, and cribs to the sediment, along with evaluation of spectral and gross gamma surveys, are of direct interest to the field investigation.

Detailed information is provided in Section 3.0 of HNF-4936 on the spectral gamma surveying and historical gross gamma surveying conducted at S and SX tank farms. Spectral gamma logging data are available in separate reports for each tank farm (GJPO-HAN-4 and GJO-HAN-11). This evaluation has focused on identifying major areas of contamination (i.e., >10 pCi/g). Figures 3.1 and 3.2 are plan views of the S tank farm showing locations of tanks and associated drywells. Drywells showing relatively high contamination are in a larger font. Figure 3.1 shows high gamma readings at locations above a depth of 10.7 m (35 ft). Figure 3.1 highlights gamma intensities between 10 and 100 pCi/g, and shows locations of gamma intensity equal or greater than 100 pCi/g. Figure 3.2 shows the same split in gamma intensity for locations below 10.7 m (35 ft).

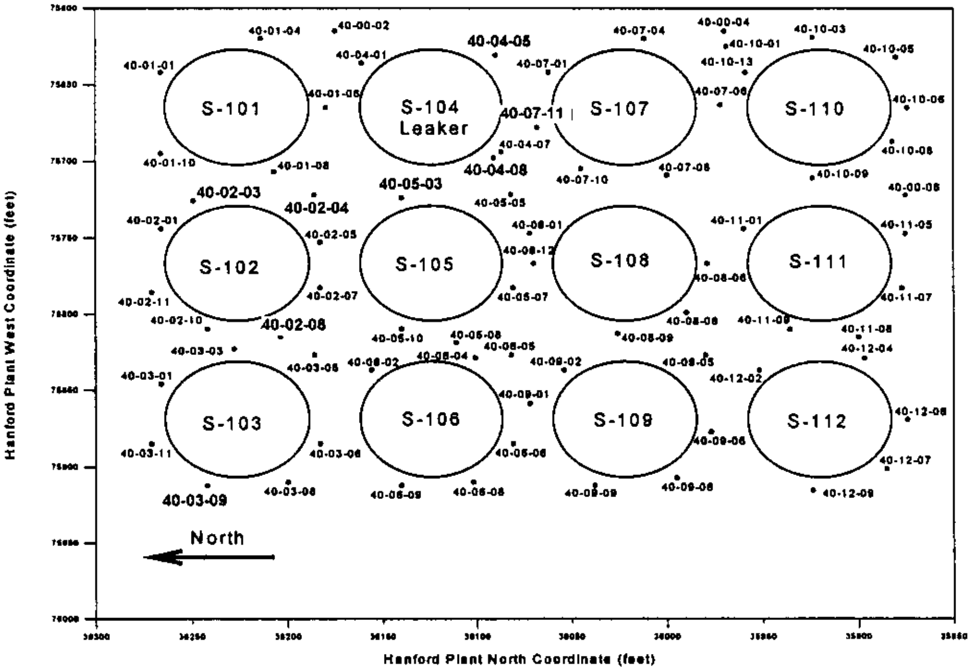
By considering all the S tank farm figures, a gross understanding of the three dimensional nature of high gamma locations beneath the S tank farm is shown. The data show limited contamination in the S tank farm, particularly below 10.7 m (35 ft). These locations are consistent with the historical record, which identifies a large surface leak from a junction box close to tank S-102 and a suspected leak from tank S-104. Drywell 40-04-05 in S tank farm is the only drywell that indicates contamination above 100 pCi/g below a depth of 10.7 m (35 ft).

Contamination in the SX tank farm is far more widespread, as shown in Figures 3.3 and 3.4. In general, the location and intensity of gamma readings in the northern part of the farm (tanks SX-101 through SX-106) are above 10.7 m (35 ft) and more often between 10 and 100 pCi/g. These characteristics are likely associated with surface leaks. Conversely, in the southern part of the farm (tanks SX-107 through SX-115) gamma readings are above 100 pCi/g and below 10.7 m (35 ft). These characteristics are consistent with tank leaks. Although not shown here, the highest levels of contamination are substantially greater than 100 pCi/g around tanks SX-108, -109, -111, and -112.

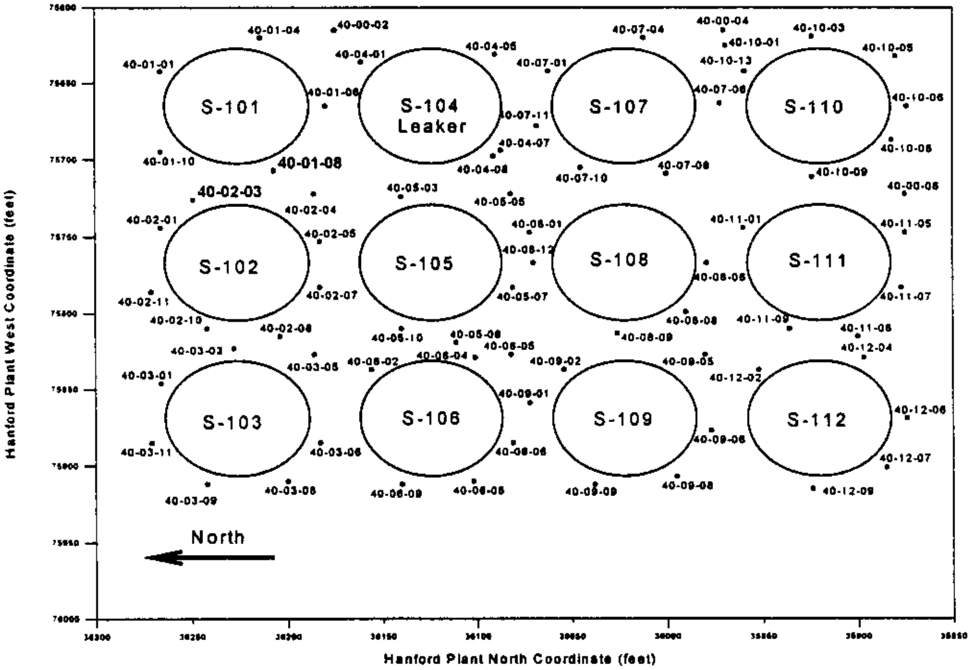
Recent Investigations

Two additional boreholes, borehole 41-09-39 and 41-12-01, were recently installed (Figure 2.3) in the SX tank farm near tanks SX-109 and SX-112, respectively. These boreholes were installed to depths of 39.6 m and 38.1 m (130 ft and 125 ft) below the ground surface, respectively. These wells are not shown in Figures 3.1 through 3.4. More information is provided in HNF-4380.

Figure 3.1. Location of Boreholes With Gamma Intensity Readings Between 10 p/Ci/g and 100 pCi/g and Above 10.7 m (35 ft) in S Tank Farm

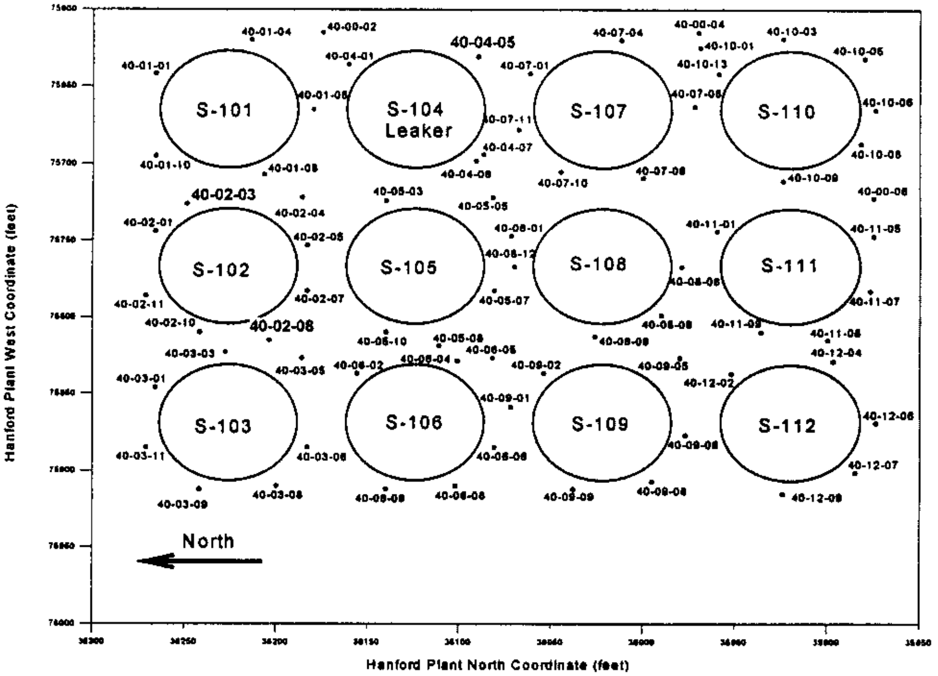


Gamma Contamination > 10 pCi/g and < 100 pCi/g between 0 and 35 ft.
Bold font represents contamination identified.

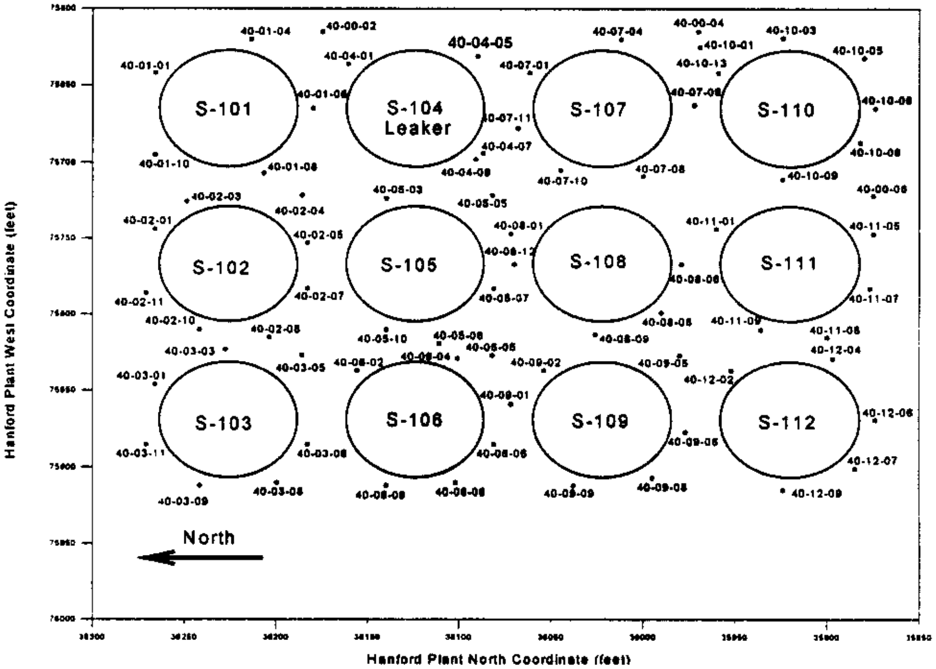


Gamma Contamination ≥ 100 pCi/g between 0 and 35 ft.
Bold fond represents contamination identified.

Figure 3.2. Location of Boreholes with Gamma Intensity Readings Above 10 pCi/g and Below 10.7 m (35 ft) in S Tank Farm

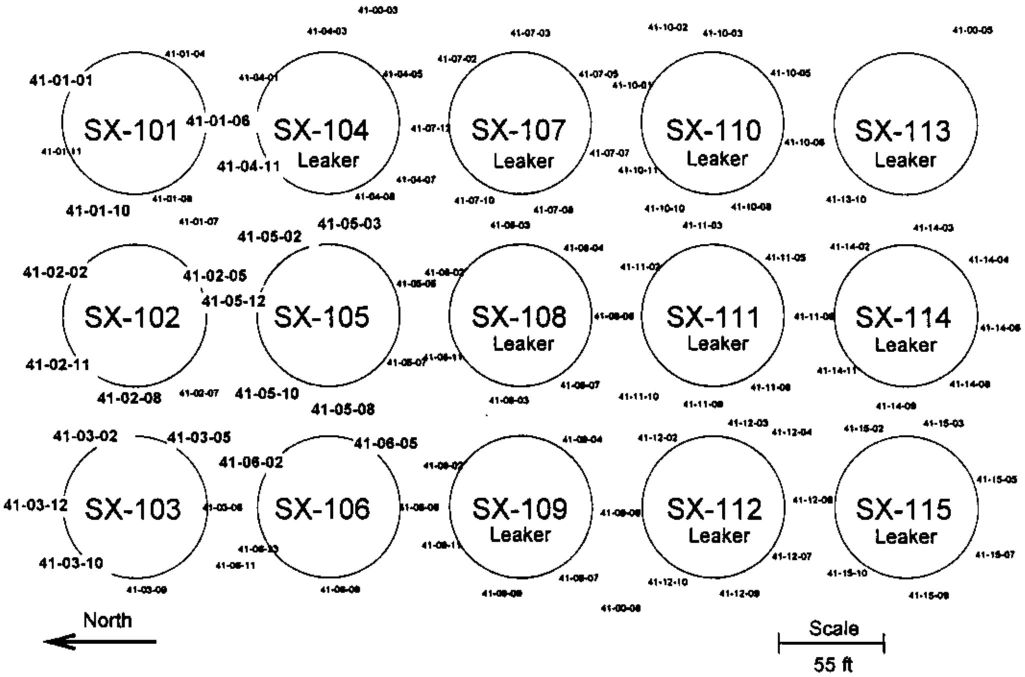


Gamma Contamination > 10 pCi/g and < 100 pCi/g below 35 ft.
Bold font represents contamination identified.

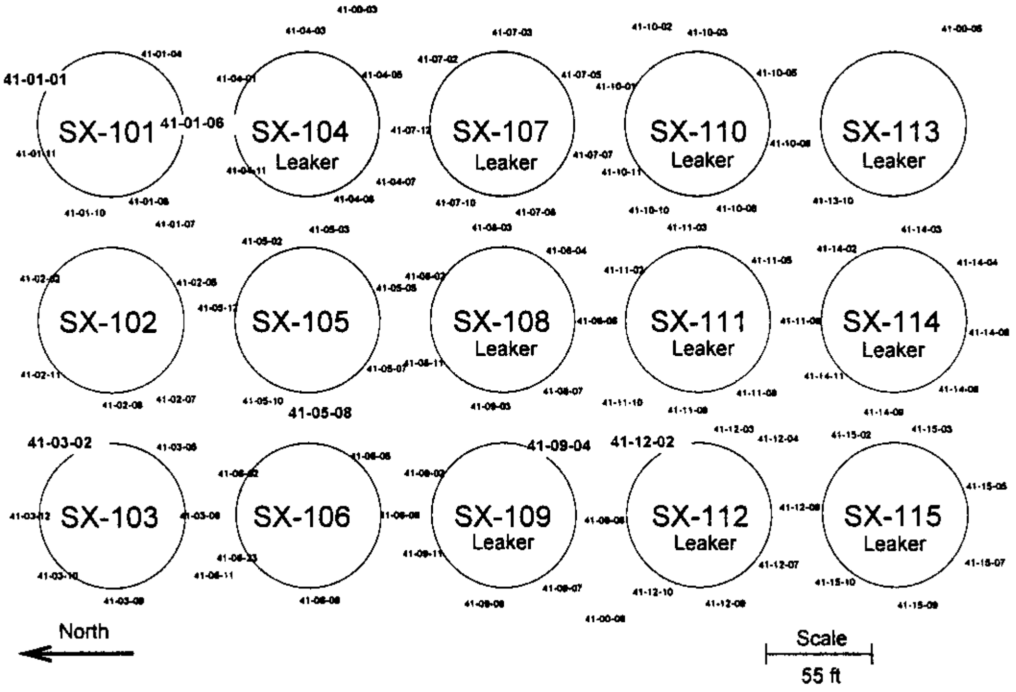


Gamma Contamination ≥ 100 pCi/g below 35 ft.
Bold font represents contamination identified.

Figure 3.3. Location of Boreholes With Gamma Intensity Readings Between 10 pCi/g and 100 pCi/g and Above 10.7 m (35 ft) in SX Tank Farm

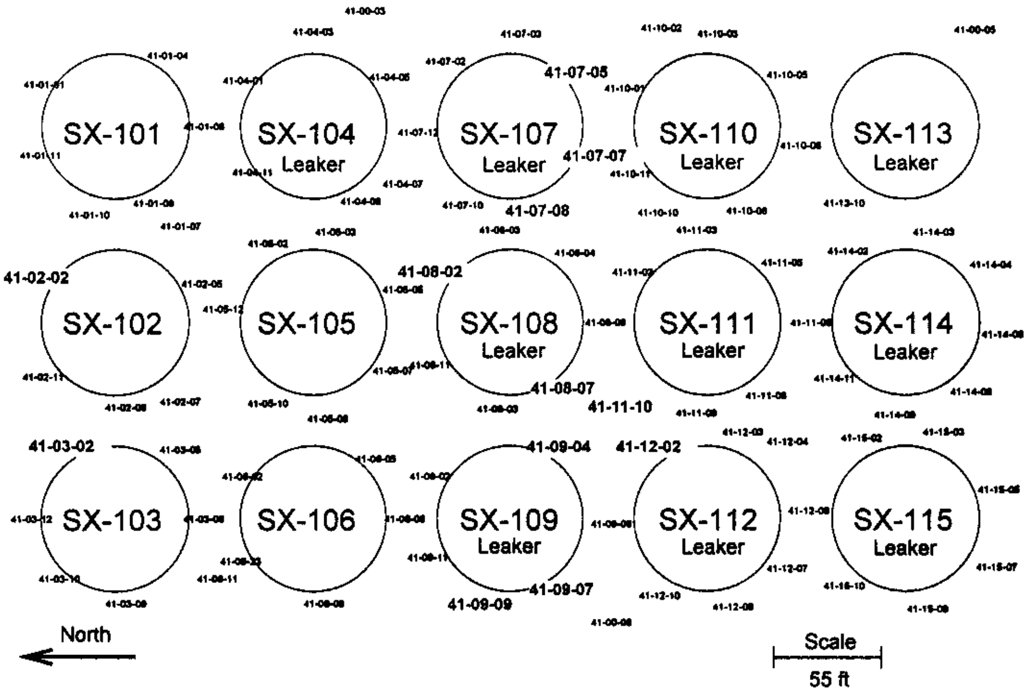


Gamma Contamination > 10 pCi/g and < 100 pCi/g between 0 and 35 ft.
Bold font represents contamination identified.

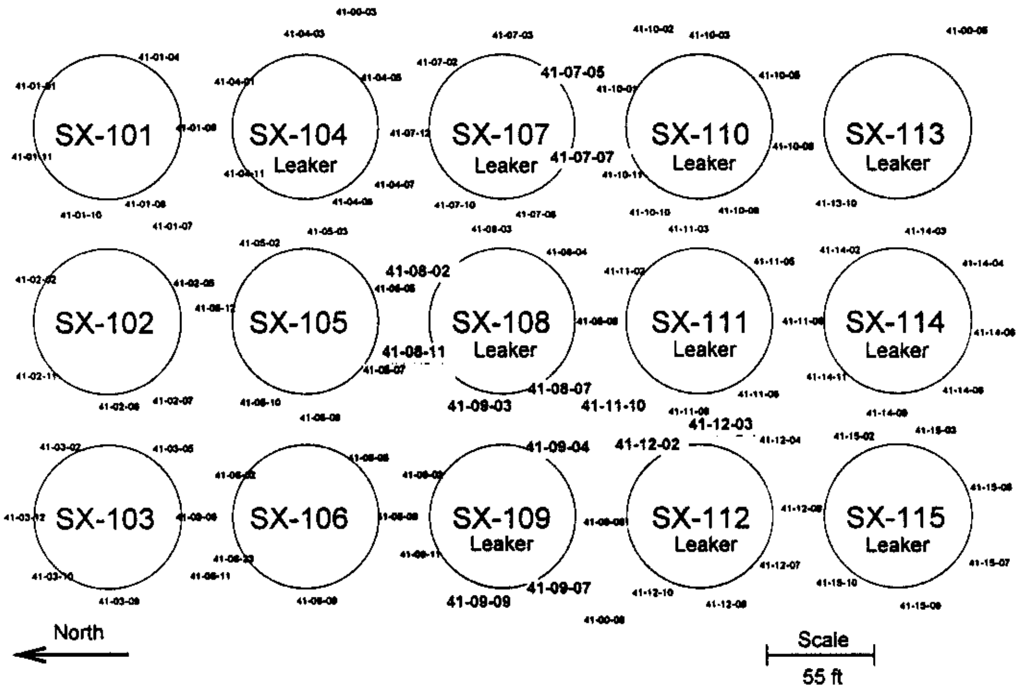


Gamma Contamination ≥ 100 pCi/g between 0 and 35 ft.
Bold font represents contamination identified.

Figure 3.4. Location of Boreholes With Gamma Intensity Readings Between 10 pCi/g and 100 pCi/g and Below 10.7 m (35 ft) in SX Tank Farm



Gamma Contamination > 10 pCi/g and < 100 pCi/g below 35 ft.
Bold font represents contamination identified.



Gamma Contamination ≥ 100 pCi/g below 35 ft.
Bold font represents contamination identified.

The spectral gamma logging of borehole 41-09-39 was correlated with borehole 41-09-04 (GJPO-HAN-9). The purpose was to determine if the contamination previously detected in borehole 41-09-04 was in the formation or was simply local to the borehole (i.e., borehole contamination). The spectral gamma data confirmed the formation. More discussion of the findings is provided in HNF-4380.

Borehole 41-09-39 Extension

In 1997, borehole 41-09-39 was extended to the groundwater using the cable tool-drilling method. The findings of the extension are discussed in HNF-2855, which is summarized in the following discussion.

Cesium-137 was present only above the carbonate-rich zone in the Plio-Pleistocene unit. Concentrations of cesium-137 decreased rapidly with increasing depth and, other than material attributed to drag-down or slough from the interior of the casing, cesium was not found at depths below the carbonate-rich zone. Determining distribution coefficients by desorption confirmed that Hanford Site sediments play a dominant role in restricting cesium-137 movement.

Technetium-99 was not found to be distributed throughout the vadose zone. The samples collected and analyzed associated with the extension of borehole 41-09-39 did not confirm the conceptual model of technetium-99 movement through the vadose zone or groundwater as identified by elevated spikes in technetium-99 concentrations over time (PNNL-11810). This radionuclide was believed to follow the moisture front and to essentially move through with any percolating water. The maximum concentration of technetium-99 was 350 pCi/g (40.6 m [133.2 ft]) in the sediments (less than would be anticipated based on downgradient groundwater concentrations). Below the carbonate-rich zone, technetium-99 was undetected, with one exception at 56.3 m (184.6 ft), which correlates to the historic high groundwater level. Technetium-99 detected in nearby monitoring wells (PNNL-11810) either resulted from a different source area or followed an indirect pathway to reach the groundwater. Technetium-99 distribution coefficient test results were highly uncertain but did indicate a greater-than-zero value (typically distribution coefficients in numerical modeling use zero for a value) (HNF-2855).

Sodium, calcium, and nitrate were analyzed to determine their distributions and concentrations. Sodium-to-calcium ratios determined from sample analyses indicate that the front of these contaminants resides higher in the vadose zone. Correlating the sodium-to-calcium ratios with the nitrate analyses suggests that the leading edge of identifiable tank waste constituents is at about 47 m (135 ft). The maximum sodium concentrations occurred at a depth of 48.1 m (157.7 ft) immediately above the carbonate-rich zone. A zone of enhanced calcium and magnesium concentrations was noted at a depth of 47.7 m (156.4 ft), which indicates that cation-exchange processes are operating and have not been overpowered by leak events. Nitrate concentrations showed a dramatic (approximately 50%) decrease in concentration below 41.4 m (135.9 ft); the highest technetium concentration occurred from a sample at 40.6 m (132.2 ft). Based on the technetium-to-nitrate migration for SST T-106, maximum migration occurs at approximately the same depth (BHI-00061). The upper portion of borehole 41-09-39 has been sampled. The analytical results are not available as of September 1999. The borehole has been decommissioned. Borehole B8809 has been completed to groundwater. Sediment samples and groundwater samples have been collected, and analyses will be conducted in fiscal year 2000.

3.1.3 Groundwater

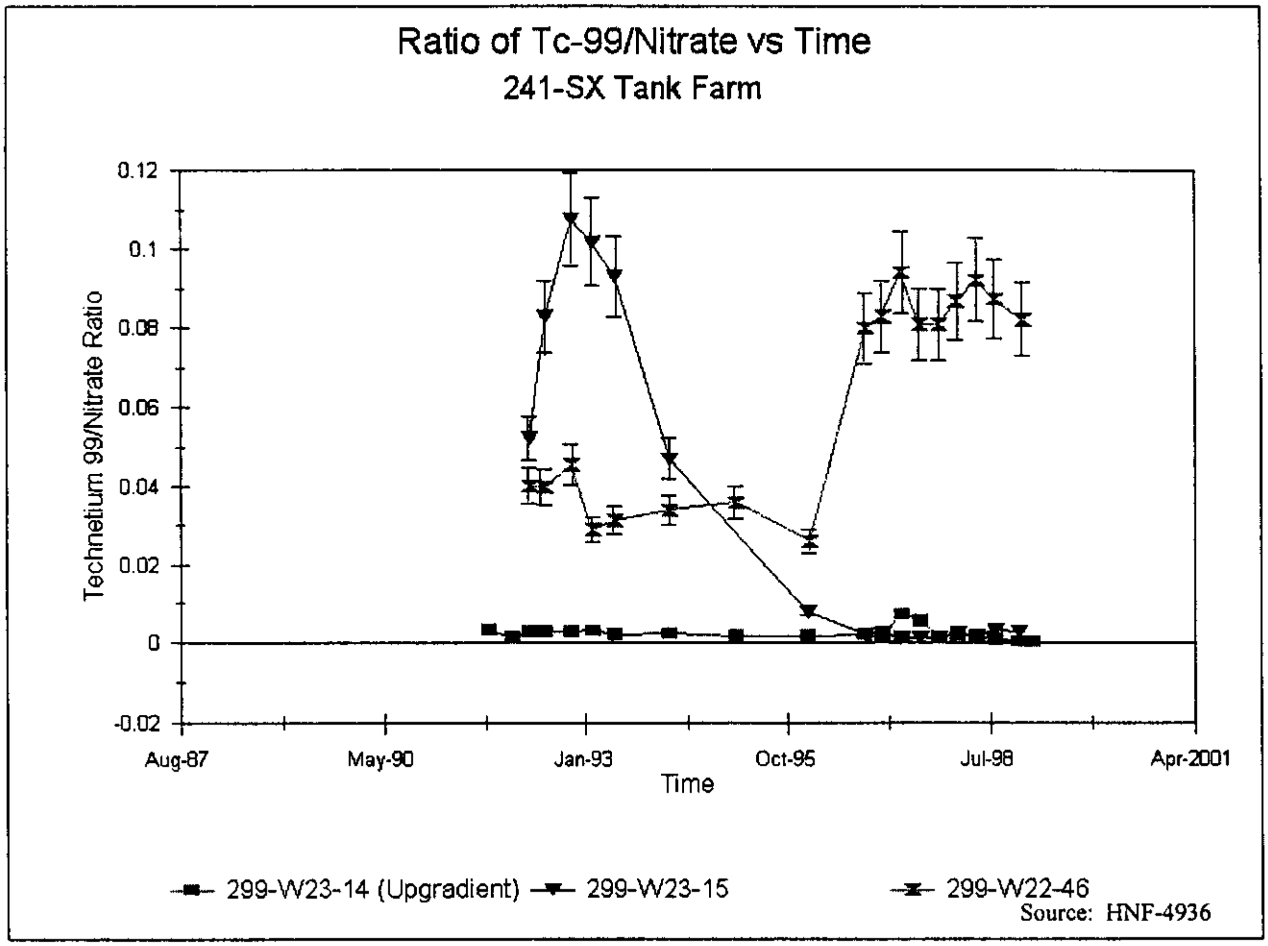
A groundwater investigation has indicated contamination in downgradient RCRA monitoring wells is attributed to the WMA S-SX. PNNL-11810, HNF-4380, and HNF-4936 document the groundwater assessment for the WMA. The findings confirmed that the WMA has released contaminants to the groundwater.

Additional information has been provided for groundwater interpretations by using the ratios between technetium-99 and nitrate. The concentration ratios of contaminants may be useful to evaluate spatial relationships between contaminant occurrences and to distinguish upgradient sources from tank waste sources. For example, if contaminant occurrences in different wells have a similar ratio, a common source is implied. The ratio should remain constant even though concentrations may vary over a wide range. When this information is combined with flow direction and other factors, it may be possible to narrow down the approximate location of the vadose zone contaminant source based on the groundwater observations.

Figure 3.5 illustrates some spatial and temporal variation in the technetium-99/nitrate ratios for upgradient and downgradient wells at the SX tank farm. Although potential changes in technetium-99 are depicted in Figure 2.1 of PNNL-11810, the peak ratios are only about two-fold lower than expected (based on estimated technetium and nitrate in tanks SX-108, -109 and -115) than if no chemical fractionation occurred. Even if technetium were depleted relative to the nitrate inside the tanks and/or in the soil column, the ratio should be relatively stable once the constituents are in the groundwater and moving through the aquifer assuming steady-state conditions.

The technetium/nitrate ratio plots shown in Figure 3.5 demonstrate that the ratios for the upgradient well are dramatically different (lower, indicating a different source type) than those for the downgradient SX wells where high technetium-99, nitrate and chromium concentrations have been observed (wells 299-W23-15 and 299-W22-46). Also, it was hypothesized (PNNL-11810) that the source that passed well 299-W23-15 accounted for the contaminant occurrences in downgradient well 299-W22-46 and that a single source near the southwest corner of the SX tank farm might account for the observed groundwater contamination in these two wells. However, the shape of the ratio plots for 299-W23-15 and 299-W22-46 suggest the hypothesized source from the southwest corner of SX tank farm may mix with another source on the southeast side of SX farm. The shape of the chromium versus nitrate and technetium-99 plots (HNF-4936) also suggests there are two different sources. For example, the chromium concentration declines more rapidly than the nitrate and technetium-99 in well 299-W22-46 as compared to well 299-W23-15 (i.e., a low chromium/high technetium-nitrate source appears to overlap with a high chromium-technetium-nitrate source).

Figure 3.5. ^{99}Tc/Nitrate Ratios in Groundwater at SX Tank Farm



Source: HNF-4936

Correlation with Possible Sources

Figure 3.11 of HNF-4936 summarizes tank leaks and spill events (sources), natural precipitation events (driving forces), groundwater contamination events (observations), and changes in groundwater flow direction over time. The precipitation events noted are the above normal events as retrieved from the site meteorological records. Total precipitation (rain and snow) is the primary information consistently available. The amount of rapidly melting snow (inches in 24 hours) is available from 1981. Tank leak history is from various sources as indicated in the figure's footnotes.

The groundwater contaminant occurrences seem to be preceded by some type of natural precipitation event. There were very few abnormal (wet) years during the time period when most of the tank leaks and or spills apparently occurred. The long gap for groundwater data in the mid portion of the time line indicates where there are no historical data in the HEIS database (HNF-4936).

The changes in groundwater flow direction are a result of changes in wastewater discharge history in the 200 West Area. During the early 1950s the flow direction in the vicinity of S and

SX tank farms was to the south due to the dominance of discharges to T pond at the northwest corner of 200 West Area. When most of the wastewater was routed to U pond in the mid-1950s, the groundwater flow direction was shifted to a more southeasterly direction beneath S and SX tank farms. The direction is now becoming more easterly as the water table continues to decline.

The earliest contamination events (wells 299-W23-2 and 299-W23-3) seem to have occurred over a very short interval and soon after or coincident with abnormally high precipitation. Both of these wells are located immediately adjacent to tank waste spills (UPR-200-W-51 and UPR-200-W-49, respectively) that existed prior to the groundwater contamination following the precipitation event. Because the wells are very close to the spill sources, groundwater flow direction is less of a consideration in making a connection between source and receptor in these two cases. Rapid movement of water down the outside of the unsealed casings of these wells would be consistent with the short-term transient observed. Contamination events also occurred more recently (approximately 1987 and 1994) following above-normal precipitation. In the latter cases, however, the transient is longer in duration than the 1955 through 1961 events. This could in part reflect the results of attempts to grout-seal the older wells inside the tank farms in the mid 1970s.

From 1984 to present, contaminant occurrences appear to follow abnormal precipitation, but extend over a longer time period. Flow directions also are favorable for upgradient sources to pass more than one well. However, the technetium-99/nitrate ratios (Figure 3.5) do not suggest a common source.

In addition to the abnormal precipitation events in 1996, a water line rupture occurred in September 1996 that released an estimated 500,000 gallons of raw water (Columbia River water) over a 1-hour period. Water from this event flowed into the north end of the S tank farm and ran south along the eastern boundary in a shallow depression. Most of the water infiltrated along the east side of the S tank farm. Although speculative, this artificial infiltration event may help explain the transient observed in well 299-W23-1 that peaked in early 1998. There is no obvious large source of contamination upgradient from this well. However, there is generally widespread surface contamination in this area (GJO-HAN-11). HNF-4936 provides a detailed figure (Figure 3.11) and more information.

3.1.4 Surface Water and River Sediment

Surface water and river sediment contamination have not occurred related to contamination releases from WMA S-SX.

3.2 POTENTIAL CORRECTIVE ACTION REQUIREMENTS

This addendum will enable field characterization efforts in the vicinity of WMA S-SX to continue in fiscal year 2000. The RCRA corrective action process as specified in Section 7 of the Tri-Party Agreement is used to establish the framework within which vadose zone investigations at the WMA S-SX are planned and conducted. Based on Section 7.5 of the Tri-Party Agreement, any required corrective action at the WMA S-SX will be conducted to comply with federal and state environmental laws and promulgated standards, requirements, criteria, and limitations that are legally applicable or relevant and appropriate requirements under the circumstances presented by the release or threatened release of dangerous substances, pollutants, or contaminants. Site-specific and plateau-wide potential applicable or relevant and appropriate requirements are identified and discussed in Section 2.0 and Appendix F of the Phase 1 RFI/CMS work plan (DOE/RL 99-36) that was prepared pursuant to proposed Tri-Party Agreement Milestone M-45-51 (Ecology et al. 1999). The Phase 1 RFI/CMS work plan includes identification of potential corrective action standards for protection of human health and the environment.

Only two potentially applicable or relevant and appropriate requirements from the list in Appendix F are not applicable or relevant and appropriate requirements for this addendum. These are related to emissions of asbestos-related material during disposal or demolition and renovation activities (40 CFR 61 Subpart M).

3.3 POTENTIAL IMPACTS TO PUBLIC HEALTH AND THE ENVIRONMENT

This section presents a preliminary conceptual model of the vadose zone portion of the groundwater exposure pathway because the vadose zone is the focus of this addendum. The vadose zone conceptual model is a set of working hypotheses made up of elements of tank waste characteristics, past leak characteristics, geology, hydrogeology, and driving forces that include infiltration from precipitation and human sources of water. The data, both existing and data to be collected, are used to test these hypotheses. If the hypotheses are consistent with the data then that would initially be deemed an endorsement. If they are not consistent then they (the hypotheses) would be revised in an effort to refine and improve the conceptual model.

The Phase 1 RFI/CMS work plan (DOE/RL-99-36) focuses on all potential exposure pathways, including groundwater (Ecology et al. 1999). The conclusions in this section are based on preliminary data and are tentative; they will be subject to refinement as data are gathered during the RFI/CMS process.

3.3.1 Conceptual Exposure Pathway Model

This section presents a preliminary vadose zone conceptual model for WMA S-SX. The conceptual model is based on information presented in Chapter 2.0 and Section 3.1 and is, therefore, intended to be preliminary. The exposure pathway in this conceptual model is limited to near-surface releases associated with the waste tanks and transport in the vadose zone and is shown conceptually in Figure 3.6. Through the corrective action process, the concepts illustrated in Figure 3.6 must ultimately be confirmed, disproved, or shown to be inconsequential in the context of the retrieval and closure, including the WMA S-SX endstate. A generalized conceptual model is provided in the Phase 1 RFI/CMS work plan and identifies the preliminary conceptual model in Section 4.0.

The data and evaluations previously discussed are integrated and summarized in this section in the form of a preliminary vadose zone conceptual model. The conceptual model is a preliminary working effort because the data are not complete, not all the data have been evaluated, and in many cases, the data are not validated. The purpose of the vadose zone conceptual model is to help focus the preliminary field data collection. The vadose zone conceptual model will be refined in the site-specific Phase 1 RFI/CMS field investigation report for WMA S-SX based on evaluation of the data collected under this addendum and the continued evaluation of existing data.

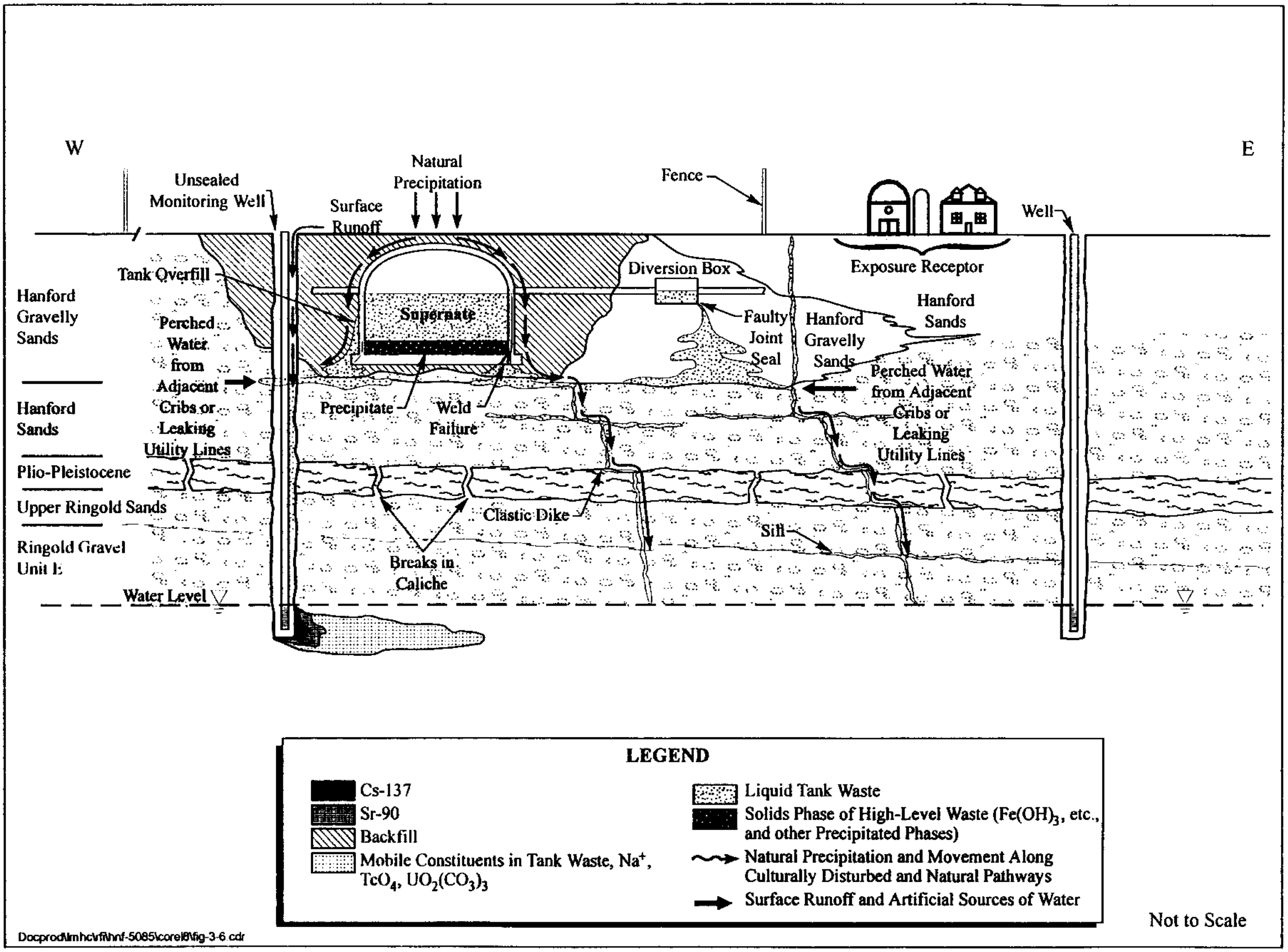


Figure 3.6. Preliminary WMA S-SX Vadose Zone Conceptual Model

The contaminant sources, mechanisms for these contaminants to be released into other environmental media, potential types of movement through the vadose zone, and one type of potential receptor are shown conceptually in Figure 3.6. The schematic illustrated on this figure, together with estimates of values for key parameters (e.g., contaminant concentrations), are a part of the basis for assessing initial human risks associated with the various contaminants and receptors.

This assessment will be provided in the site-specific Phase 1 RFI/CMS field investigation report for WMA S-SX. The vadose zone conceptual model is used in this addendum to qualitatively express the current understanding of the following:

- Pathways that contaminants may follow to the groundwater, based on the integration of contaminants, hydrochemical, hydrogeologic, and geologic data (inferences are made on relatively sparse and unevenly distributed data)
- Contaminant sources with most of the available data for source locations for the upper 40 m (130 ft) of the vadose zone (inference is made to the presence of contaminants in the lower vadose zone based on groundwater contamination and historic records of water levels).

Key aspects of the WMA S-SX vadose zone conceptual model required to support this addendum are summarized in the following sections.

3.3.1.1 Sources

Chemical processing. The following discussion has been largely extracted from PNNL-11810. Irradiated nuclear fuel from the Hanford plutonium production reactors contained fission products and lesser amounts of neutron activation products as well as the unspent uranium and transuranic radionuclides. The plutonium was chemically extracted from the fuel matrix at T Plant and S Plant in the 200 West Area and B Plant and A Plant in the 200 East Area.

The S and SX tank farms contain aqueous waste generated from the REDOX process that was conducted in S Plant from 1952 to 1966 (LA-UR-96-3860). The aluminum cladding was first removed from the fuel with caustic in the dissolver vessel. Waste from this step is referred to as coating waste or cladding waste REDOX waste. Some fission product activity and uranium were associated with this waste type, but less than generated during the subsequent dissolution of the declad fuel with concentrated nitric acid. After the initial dissolution of the fuel, ozone, permanganate and dichromate were used to adjust the oxidation state of the plutonium to facilitate its separation in solvent extraction columns. Aluminum nitrate was also added to enhance the transfer of plutonium ('salting out') from the aqueous to the organic phase.
The highly acidic waste stream was then over neutralized with sodium hydroxide and routed to tanks in the S and SX tank farms. This process generated a much smaller volume of waste than was generated by the older bismuth phosphate process used at T Plant. Thus, fission product concentrations were higher in the S Plant waste.

Tank related considerations. The SSTs are constructed of a single layer of carbon steel surrounded by a layer of reinforced concrete, which forms the roof and sidewall support.

The tanks declared leakers in the SX tank farm (Chapter 2.0) were unique. The tanks declared leakers in the SX tank farm apparently failed because of accelerated corrosion and/or physical stress induced by buckling beneath the center regions of the tank bottoms. The buckling caused the floor to pull away from the wall at the welded seam. The buckling was attributed to decay heat that generated intense pressures between the concrete base and the carbon steel floor. This condition may have also contributed to expulsion of superheated steam and liquid waste into the surrounding sediment (DOE/RL-97-49).

The vadose zone conceptual model for this addendum focuses on those contamination sources in the vicinity of SSTs 241-SX-108 and -109, between the S and SX tank farms, the northern portion of both S and SX tank farms, where surface contamination exists, and the vicinity of SST S-104. As discussed in Section 3.1 and HNF-4936, one hypothesis for the observed contaminants in the RCRA groundwater monitoring is that contaminants from tank leaks have migrated downward through the vadose zone and then traveled in a southeasterly direction consistent with the local groundwater flow direction. Releases from these tanks could represent a significant present contamination source in the vadose zone. It is certain that the leaks from tanks S-104, SX-108, and SX-109 contained several radioisotopes and chemicals commonly found in tank waste (e.g., cesium-137, technetium-99, sodium, and nitrate). Thus, contaminants (i.e., technetium-99 and nitrate) that are remnants of these past leaks may be still present in the vadose zone, especially southwest within the Plio-Pleistocene unit. Section 4.0 of HNF-4936 provides a discussion of the contaminated areas in WMA S-SX.

3.3.1.2 Geologic Conceptual Model

The geology of the S and SX tank farms was documented after the drywell boreholes were completed in the early 1970s (ARH-LD-133 and ARH-LD-134). The major stratigraphic units of the suprabasalt sediments present beneath the SX tank farm are the Ringold Lower Mud, Ringold Unit E, Plio-Pleistocene, and the Hanford formation (in ascending order) (see Chapter 2.0). The sources of data used in evaluating valid conceptual model(s) for the S and SX tank farms geology include ARH-LD-133, ARH-LD-134, BHI-00184, HNF-2603, HNF-4936, WHC-SD-EN-TI-008, PNNL-11463, PNNL-12114, and WHC-SD-EN-TI-019. Potential structural control or influence on contaminant migration in the vadose zone is of particular interest. Elevation maps of the various stratigraphic units are presented in Figure 2.7 and HNF-4936 and will be used as a source for this information.

Clastic dikes, illustrated conceptually in Figure 3.6 and in HNF-4936, are lenses or tabular bodies, relatively narrow at 18 to 38 cm (7 to 15 in.) (BHI-00230 and BHI-01103), with textural characteristics typically comprising clay and sand. Their localized effect on contaminant movement over the scale of a few meters is an unknown and could account for some observations of relatively immobile contaminants (e.g., cesium-137) deeper in the vadose zone than would be expected under nonpreferential flow conditions. The geologic cross-sections provided in HNF-4936 represents the preliminary working geologic conceptual model for this work plan.

3.3.1.3 Hydrologic Properties

Preliminary values will be provided in the site-specific Phase 1 RFI/CMS field investigation report for WMA S-SX that will be prepared pursuant to proposed Tri-Party Agreement Milestone M-45-55 (Ecology et al. 1999).

3.3.1.4 Receptors

Receptors are organisms that have the potential for exposure to the released contaminants and include both biota and humans.

A likely point of exposure for terrestrial biota is in the plant root zone where flora could absorb buried contaminants. Terrestrial animals (especially burrowing animals) may be exposed by direct contact, inhalation, and ingestion of contaminated sediment, water, plants, and animals.

For the receptors, the site-specific Phase 1 RFI/CMS field investigation report for WMA S-SX will use the Model Toxics Control Act Methods B and C exposure scenarios at the WMA boundary to evaluate human health risks.

The modified Model Toxics Control Act (WAC 173-340) Method B residential scenario is a combination of the risk equations specified in WAC 173-340-720 through 173-340-750 and the corresponding exposure pathways for residential use found in the Department of Health's Hanford Guidance for Radiological Cleanup (WDOH/320-015). The modified Model Toxics Control Act Method C industrial scenario is a combination of the risk equations specified in WAC 173-340-720 through 173-340-750 and the corresponding exposure pathways for industrial/commercial found in WDOH/320-015. WAC 173-340-730 is not applicable to either scenario as it is not expected that the site or any remedial activity under consideration will impact surface water. Ecology also asks that the modified Method C scenario specifically include groundwater ingestion at the rate of 500 L/yr and that the soil contaminant transfer to groundwater as specified in WAC 173-340-740 (4)(b) evaluated. The addition of groundwater intake to the modified Method C scenario represents a change to the WDOH/320-015 pathways that currently does not include this parameter. The soil contaminant transfer to groundwater evaluation is included to ensure consistency with similar scenarios evaluated elsewhere.

3.4 PRELIMINARY CORRECTIVE ACTION OBJECTIVES AND CORRECTIVE ACTION ALTERNATIVES

Interim and final corrective action objectives, general response actions, corrective technologies and process options, and a range of preliminary corrective action alternatives are provided in the Phase 1 RFI/CMS work plan (DOE/RL-99-36). These objectives and alternatives are based on available site data, use of the qualitative risk assessment, and the conceptual exposure pathway model. General interim actions are identified and represent broad classes of corrective actions that may be appropriate to achieve the corrective action objectives in Section 5.0 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36). Corrective action objectives may change or be refined as additional site data are gathered and evaluated during the field investigation and implementation of interim measures or ICMs.

4.0 RATIONALE AND APPROACH

The RFI/CMS process is the RCRA-specified method by which risks from releases to the environment are characterized and corrective action alternatives are evaluated and implemented, if required to minimize potential risks to human health and the environment. Objectives and data needs must be identified before designing a data collection program to support the RFI/CMS process. The data collected are used as a basis for making an informed risk management decision regarding the most appropriate corrective action(s) to implement. The data needs for field characterization efforts at WMA S-SX were identified through a DQO process that was executed based on the requirements established in the proposed Tri-Party Agreement commitments identified in Change Control Form Number M-45-98-03 (Ecology et al. 1999) and in Section 6.0 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36).

A preliminary site-specific addendum for WMA S-SX, proposed Target Date Milestone M-45-52-T01 (Ecology et al. 1999) required the submission of a preliminary site-specific work plan addendum for WMA S-SX to Ecology in April 1999. The purpose of the preliminary addendum was to support initial field characterization work to commence in fiscal year 1999. Additional data beyond that collected through the initial fiscal year 1999 efforts to support full implementation of the corrective action process at WMA S-SX is provided in this site-specific work plan for WMA S-SX. The additional data needs identified in the DQO planning process will be collected in accordance with the RFI/CMS work plan (proposed Milestone M-45-51) and this site-specific WMA S-SX addendum (proposed Milestone M-45-52).

4.1 RATIONALE

An understanding of subsurface conditions and contaminant migration processes is required to support decision making on interim measures and ICMs, SST waste retrieval, and tank farm closure. A comprehensive list of data needs to support these decisions has been developed based on the current level of understanding. However, it is generally recognized on both a technical and regulatory basis that uncertainties regarding existing contaminant inventory, distribution from past leaks, and uncertainties associated with contaminant migration processes are of primary importance to future decision making. The need to reduce these uncertainties through field and laboratory investigations serves as the basis for initiating characterization activities through this addendum.

Characterization objectives and data needs for WMA S-SX were developed during the DQO planning process that was carried out for the Phase 1 RFI/CMS work plan and this work plan addendum for WMA S-SX. A separate DQO process (HNF-5272) was conducted to support the development of this document.

The DQO process is a planning tool to aid in the determination of the type, quantity, and quality of data needed to take the next step in the iterative process of characterizing a contaminated site or area. There are a number of possible approaches to implementing the DQO process.
The planning process used to identify data collection activities in this addendum is described in Section 6 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36) and summarized in this section and HNF-5272.

Before initiating meetings to discuss characterization activities to be conducted in the fiscal year 2000 timeframe, the Tank Farm Vadose Zone Project technical team conducted a review of existing information that included published and unpublished reports, interpretations of historical and recent geophysical survey data, and information from previous DQO meetings. To prioritize data needs for inclusion in the fiscal year 2000 effort, a review of the available information on the current state of knowledge of WMA S-SX subsurface contamination was conducted by the Tank Farm Vadose Zone Project technical team. The review results were incorporated into HNF-4936 and summarized in the DQO summary report (HNF-5272). Subsurface data needs have been the subject of numerous meetings in recent years, some of which culminated in data collection (HNF-2855), and others that did not.

Based on information to be obtained from data collected in fiscal year 1999, a series of DQO meetings were held in August and September, 1999 that focused specifically on the data needs for the next field characterization efforts to be conducted at WMA S-SX. These meetings served to identify: (1) existing data and what is currently known about WMA S-SX, (2) data needs that will likely be satisfied by fiscal year 1999 characterization activities, and (3) options for data collection from the additional characterization activities. The DQO meetings included representatives from Ecology, DOE, Hanford Site contractors, and Hanford Site Vadose Zone/ Groundwater Integration Project as indicated in HNF-5272.

Meetings held as a part of the DQO process involved varying levels of involvement by all participants. The DQO meetings provided a foundation of existing information and identification of characterization options for consideration by the decision makers.

Through the DQO process, it was determined that the primary goal of the WMA S-SX field investigation is to continue the implementation of vadose zone characterization activities that will support the iterative process of improving the understanding of inventory (i.e., nature and extent of past releases) and contaminant migration processes (fate and transport) necessary to support risk assessments. Additional characterization data are needed to support near-term corrective measures decisions and SST waste retrieval and tank farm closure decisions.
The characterization effort will provide data that, when combined with historical data and data currently being collected, in addition to the planned characterization activities in this addendum, will improve the ability to make informed corrective measures, waste retrieval, and tank farm closure decisions.

4.2 DATA NEEDS

Current understanding of the nature and extent of contamination at WMA S-SX is based largely on order-of-magnitude estimates of past leak volumes and inventories and on historical information on the distribution of gamma-emitting radionuclides measured to a depth of 33 to 45.7 m (100 to 150 ft) in drywells located around the tanks. Historical drywell and lateral gross gamma data was collected from 1974 to 1994; however, analysis of the gross gamma data has only recently been conducted. Spectral gamma information has recently been collected in the drywells to provide greater insight into the distribution and movement of specific gamma contaminants (e.g., cesium-137) (GJPO-HAN-4, GJO-HAN-11). However, there is limited data on the distribution of non-gamma-emitting mobile tank waste contaminants (e.g., technetium-99, iodine-129, hexavalant chromium, and nitrate). While there is emerging data on the distribution and movement of tank waste contamination in the groundwater, the data are not sufficient to indicate specific sources of contaminant releases within the tank farms responsible for specific groundwater contamination data.

During the DQO process, the participants determined that the primary focus of the fiscal year 2000 data collection effort at WMA S-SX should be directed toward characterizing the source close to the probable largest leak in terms of inventory in WMA S-SX, which is from tank SX-108. This effort should improve the understanding of tank leak inventory and distribution to support testing and refining a site-specific conceptual model for tank leaks and contaminant migration processes. A number of characterization technologies, including screening techniques were considered. Because the current understanding of the distribution of radionuclides in the leak-contaminated vadose zone is still limited and is based primarily on indirect evidence, the focus of the fiscal year 2000 data collection program at WMA S-SX will be on sampling the vadose zone soils in areas of known tank leaks underneath the tanks, shallow surface and subsurface spills within the tank farms, and analyzing the samples for a range of contaminants of interest.

4.3 CHARACTERIZATION OPTIONS

Based on data needs identified in Section 5 of HNF-4936 and the DQO meetings, a number of characterization options were considered for future characterization efforts in the WMA S-SX. These characterization options included installing new boreholes, decommissioning and/or extending existing boreholes, using direct push technology (e.g., cone penetrometer or geoprobe) (both vertically from the surface and horizontally from the existing caissons), using auger drilling, and using nonintrusive geophysical techniques. These options are based on characterization techniques and innovative technologies identified in Section 6.3 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36) for characterizing methods that have been successfully used at the Hanford Site. These options and potential deployment locations were evaluated in terms of the type of information that could be provided, as well as the technical risk associated with deployment during fiscal year 2000. Although all of the options considered would potentially provide valuable data that would serve to improve the understanding of subsurface contamination, a number of the options were considered to be of lesser value or not feasible from a technical risk for the characterization effort to be implemented in fiscal year 2000. The list of 28 options considered for characterization activities during the DQO process is provided in Table 4.1 and HNF-5272. The list of options was evaluated for each of the questions/hypotheses which are listed in hierarchial order from highest to lowest. The higher the number the higher the probability of obtaining data to answer the question.

Characterization associated with direct push technology and a slant borehole under tank SX-108 were the most viable options and are discussed in the following sections. Rationale of other options that received high numbers but were not selected are discussed in the following paragraph.

Table 4.1. The 28 S-SX Characterization Options[a], [b], [e] (4 Sheets)

Question/Hypothesis	OPTIONS									
	1. Slant Borehole beneath SX-108[h]	2. Slant borehole beneath SX-108 (depth limited to the Plio)[h]	3. Slant Borehole at SX-109	4. Slant borehole beneath SX-107	5. Slant Borehole beneath SX-115[c]	6. Vertical borehole near S-104[i]	7. Caissons beneath SX-108[f]	8. Direct Push Technology (between farms)[d]	9. Direct Push Technology S Farm near S-104[d]	10. Direct Push Technology SX Farm[d]
Where are the CoPCs in backfill	1	1	1	1	1	2	0	4	4	4
Where are the CoPCs backfill through Plio	4	4	3	2	2	1	2	0	0	0
Where are the CoPCs below Plio	2	0	2	3	1	1	0	0	0	0
Horizontal extent of CoPCs	3	3	2	2	3	1	4	4	4	4
Influence of geologic structures	1	1	1	2	1	2	0	1	0	0
Is the Kd model adequate	4	4	3	1	3	2	4	0	2	2
What are the driving potentials (moisture content/leak volume/solidified waste/thermal effects)	4	4	4	3	3	3	3	3	2	2
Do contaminants move together	4	4	2	3	2	2	2	1	1	1
Groundwater contamination	1	0	1	2	1	1	0	0	0	0
TOTAL	**24**	**21**	**19**	**19**	**17**	**15**	**15**	**13**	**13**	**13**

Table 4.1. The 28 S-SX Characterization Options(a), (b), (c) (Cont'd)

Question/Hypothesis	OPTIONS								
	11. Vertical borehole outside tank farm at S-25 Crib(j)	12. Out of farm nonintrusive neutron enhanced spectral gamma	13. Out of farm nonintrusive gamma logging	14. Vertical Borehole at tank SX-108	15. Vertical Borehole at tank SX-109	16. Vertical borehole near tank SX-112(g)	17. Vertical borehole near tank SX-111(g)	18. Vertical borehole near tank SX-107	19. In Farm nonintrusive neutron enhanced spectral gamma
Where are the CoPCs in backfill	2	2	2	1	1	1	1	0	2
Where are the CoPCs backfill thru Plio	2	2	2	1	1	1	1	1	2
Where are the CoPCs below Plio	2	2	2	1	1	1	1	1	0
Horizontal extent of CoPCs	0	2	2	1	1	1	1	1	1
Influence of geologic structures	1	0	2	1	1	1	1	1	0
Is the Kd model adequate	1	0	0	1	1	1	1	1	0
What are the driving potentials (moisture content/leak volume/solidified waste/thermal effects)	1	2	0	2	1	1	1	1	2
Do contaminants move together	2	1	0	1	1	1	1	1	1
Groundwater contamination	1	0	0	1	1	1	1	1	0
TOTAL	**12**	**11**	**10**	**10**	**9**	**9**	**9**	**8**	**8**

Table 4.1. The 28 S-SX Characterization Options (Cont'd)

Question/Hypothesis[(1), (2)]	OPTIONS								
	20. Out of farm nonintrusive moisture logging	21. Sidewall sample region of stable gamma – borehole 41-12-01[(k)]	22. In Farm nonintrusive moisture logging	23. Extend existing drywell (41-08-07)[(k)]	24. Sidewall sample region of unstable gamma borehole 41-11-10[(k)]	25. Sidewall sample region of stable gamma – borehole 41-08-07[(k)]	26. In Farm nonintrusive temperature logging	27. In Farm nonintrusive gamma logging	28. Out of farm nonintrusive temperature logging
Where are the CoPCs in backfill	0	0	0	0	0	0	0	0	0
Where are the CoPCs backfill thru Plio	1	2	1	0	2	1	0	0	0
Where are the CoPCs below Plio	1	0	0	1	0	0	0	0	0
Horizontal extent of CoPCs	1	0	1	1	0	0	0	0	0
Influence of geologic structures	1	0	1	0	0	0	0	0	0
Is the Kd model adequate	0	1	0	1	1	1	0	0	0
What are the driving potentials (moisture content/leak volume/solidified waste/thermal effects)	3	1	3	1	1	1	2	0	0
Do contaminants move together	0	2	0	0	1	2	0	0	0
Groundwater contamination	0	0	0	1	0	0	0	0	0
TOTAL	**7**	**6**	**6**	**5**	**5**	**5**	**2**	**0**	**0**

Table 4.1. The 28 S-SX Characterization Options (Cont'd)

Notes:

[a] The scale is from 0 to 5 with 0 being no information and 5 having a high probability of obtaining data to evaluate the question/hypothesis.

[b] The valuation of these characterization options is not time independent and represents the technical teams' judgement on prioritizing the next characterization activities in the WMA S-SX recognizing that ongoing data collection and analysis from 41-09-39 decommissioning and the new borehole near tank SX-115 is underway and is not yet available to support the current characterization planning effort.

[c] The slant well at tank SX-115 is assumed to go from the NE toward the SW.

[d] The direct push deployment is assumed to include multiple pushes (approximately 6 locations that reach approximately 35 feet).

[e] Boreholes go to groundwater except as noted.

[f] The caisson approach uses the direct push technology with rods to collect samples and are pushed with a slight downward angle to reach a vertical depth approximately 20 ft below the base of the tanks. The feasibility of using the caisson will be evaluated in FY00.

[g] Slant holes at tanks SX-111 and SX-112 were considered but not evaluated in the chart because existing laterals data does not warrant consideration of a slant hole at these tanks.

[h] The planning basis for installing a slant borehole beneath a tank includes a demonstration outside the tank farms.

[i] The vertical borehole at tank S-104 is assumed to be at the SE quadrant.

[j] The location of the borehole in the S-25 crib has not been identified.

[k] Sidewall sampling from existing boreholes is based on cutting out a section of the casing (i.e., a window) and collect a sidewall sample using a technique similar to that used for the 41-09-39 borehole.

CoPCs = contaminants of potential concern.
Plio = Plio-Pleistocene unit.

The slant borehole to groundwater was not selected because (1) going to groundwater would not provide any additional information than was obtained from borehole 41-09-39, and (2) a potential increased risk of creating a pathway with high contamination to the groundwater.

The option to install a vertical borehole southeast of tank S-104 was not selected because the type of tank leak appears to be confined to the uppermost portion of the vadose zone according to gamma contamination in drywell 40-04-05. The planned near-surface characterization should provide the information required for this area related to the tank leak.

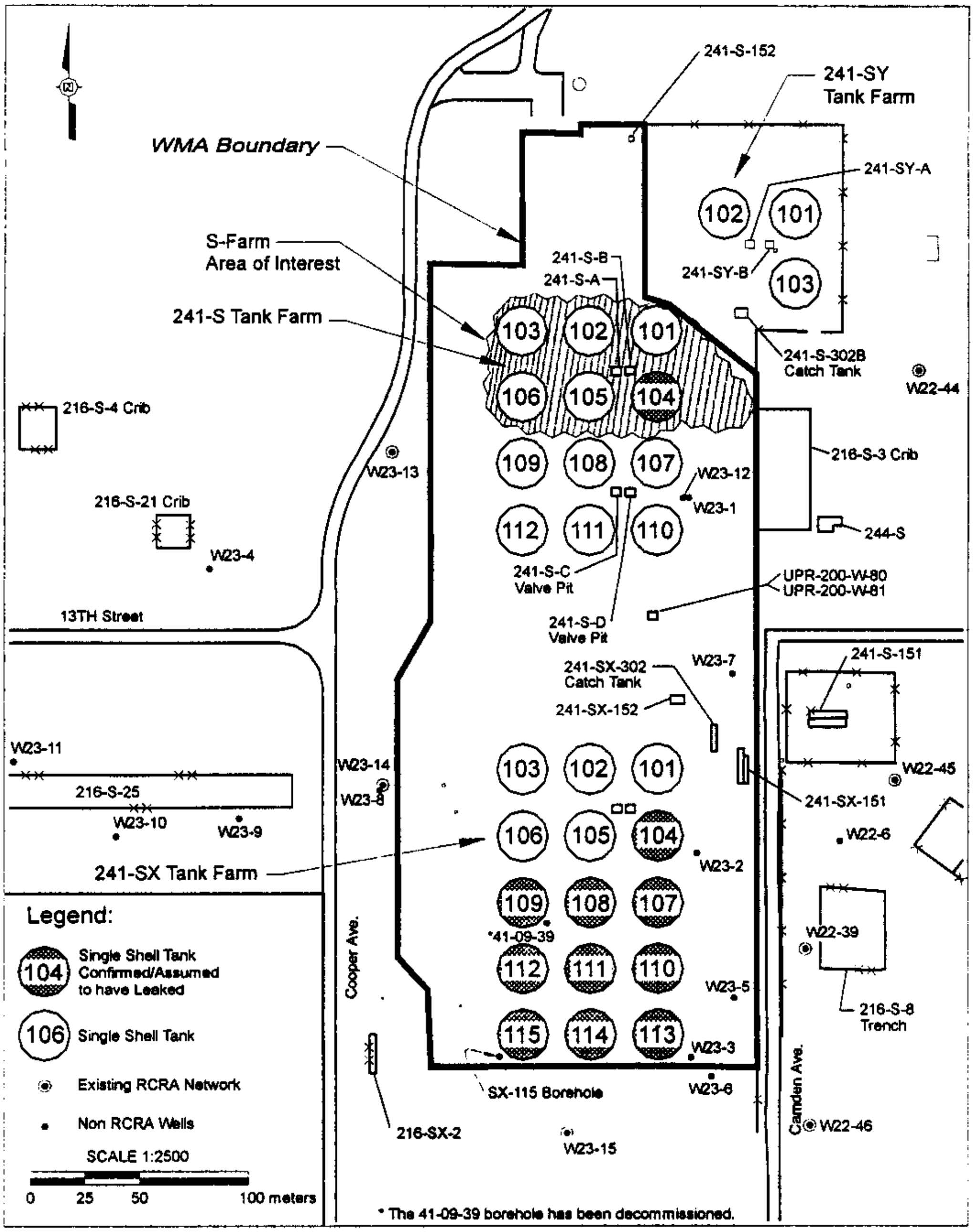
Following selection of the slant borehole under tank SX-108 for deep vadose zone characterization, the other slant and vertical borehole options identified in Table 4.1 would be on hold until the results of ongoing and proposed characterization activities were evaluated and a determination on the need for additional data made. Although a number of characterization options were identified, the two selected for implementation in fiscal year 2000 provide a balance between filling the largest data gaps and available characterization resources.

4.3.1 Near-Surface Characterization

One of the characterization options considered and selected during the DQO process was the collection of sediment samples from the upper portion of the vadose zone using direct push technology. Direct push technology is the preferred method for defining the lateral extent of contamination in the upper part of the vadose zone. The near-surface characterization would be implemented in areas of known leaks or spills indicated by gamma contamination at the S tank farm (Figure 4.1). A two-phased approach will be used for near-surface characterization. Shallow soil characterization will be carried out using a truck-mounted cone penetrometer based system. At specific sites cleared for access (underground piping and electrical services identified) and for which an excavation permit has been approved, the first phase will be to interrogate with a gross-gamma/spectral gamma cone penetrometer probe. The depth of investigation will be determined by the depth to which the probe can be advanced using a standard deployment truck. The probe will be deployed using the gross gamma mode with the tool advanced at approximately 2 cm/sec (0.8 in./sec). If, in the upper 5 m (15 ft) the downhole instrument indicates a potential cesium-137 concentration of 3.7 pCi/g or greater, logging will be shifted to the spectral mode to determine the presence and level of concentration of cesium-137; below 5 m (15 ft) the threshold limit for spectral gamma determinations will be 20 pCi/g. In zones where cesium-137 is present at concentrations greater than 20 pCi/g, spectral gamma readings will be taken at 0.5 m (1.5 ft) intervals. In all cases, gross gamma measurements are to be taken while the probe is advanced.

The second phase will use the graphical log developed using the gross and spectral gamma measurements to select intervals to be sampled. The sampling push is to be made in a location that is no more than 0.7 m (2 ft) from the site of the gamma push. A single point sampler will be used to collect the required samples. Sampling intervals will be selected from those horizons with a cesium-137 concentration of 20 pCi/g or greater. In the event that horizons are penetrated that would yield samples having a greater that 50 mrem/hr dose rate at 30 cm (12 in.) (based on calculations using sampler size and cesium-137 concentration) a sample will be collected from the first interval below the high rate zone having a dose rate of less than 50 mrem/hr. The

Figure 4.1. Waste Management Area S-SX (Shallow Soil Areas of Interest)



* The 41-09-39 borehole has been decommissioned.

Docprod\lmhc\rfl\hnf-5085\corel8\Fig-4-1.cdr sediment samples collected using direct push technology may require multiple pushes if sufficient material for analysis of CoCs was not collected from the initial push. Direct push technology has been successfully deployed south of the SX tank farm to depths deeper than is proposed for this investigation. Deployment of the direct push technology at these locations would be expected to begin to address a number of questions related to the concentration and distribution of contaminants, including the following:

- What contaminants are present that are routinely identified as CoCs from a groundwater impact standpoint (e.g., technetium-99, nitrates)?
- What are the concentration/inventory correlations between the CoCs and cesium-137 in soil samples and with the tank contents?
- What is the vertical extent of the CoCs in the backfill material?
- What is the horizontal extent of the CoCs across the areas of interest?
- What are the potential drivers (e.g., sediment moisture profile) in the upper portion of the vadose zone that could control the migration of contaminants?

The benefits and uncertainties associated with direct push technology were identified during the DQO meetings (HNF-5272). Direct push technology has not been previously deployed in the tank farms. Direct push technologies are limited to approximately 16.7 m (55 ft) bgs in geology similar to the tank farms. However, the authorization basis for using one type of direct push technology, the cone penetrometer, has been completed (HNF-SD-WM-HIE-012).

The benefits and uncertainties associated with auger drilling were also identified during the DQO meetings as a contingency to direct push technology. The maneuverability of the auger rig and support vehicles has not been determined for dome loading. The amount of contaminated material that would potentially be brought to the surface would require engineering controls. The authorization basis for using the auger drilling method within WMA S-SX would need to be evaluated before this technique could be used. Auger drilling would be maintained as a back-up to the direct push technology for collecting near-surface samples.

The uncertainties associated with near-surface characterization are believed to be manageable and would support deployment within fiscal year 2000. The uncertainties are mainly associated with not having deployed these technologies in the tank farm and are not expected to constrain future deployment of these characterization efforts.

4.3.2 Installation of a Slant Borehole

In addition to data collection from near-surface characterization several options were considered for collection of deeper vadose zone data. The preferred option included installation of a slant borehole in WMA S-SX as identified in Table 4.1, sampling of the vadose zone from beneath a tank associated with past leaks, and sampling near-vertical features from a non-vertical approach to improve the opportunity to intercept these near-vertical features. This option was selected because a slant borehole would provide source characterization along with distribution of contaminants underneath tank SX-108. Source characterization would:

- Provide a basis for estimating contaminant inventories and processes that would control the migration of contaminants
- Support evaluation of the correlations between concentrations of CoCs and existing gamma data, and potentially evaluating relationship between the CoCs in the soil and the concentrations of CoCs present in the tanks at the time the leak was believed to occur
- Support assessing contaminant mobility, potential drivers (e.g., moisture content), and the effects of tank leaks on soil properties to support predictive modeling efforts necessary to evaluate potential future groundwater impacts
- Provide information on the second largest source via the tank leak in the SX tank farm from tank SX-108.

Source characterization efforts also would involve identifying what contaminants are present and subsequently the potential CoCs for corrective action, retrieval, and closure decisions.
If correlations between the CoCs and available gamma data can be established, there is a potential that the wealth of existing gross gamma and spectral gamma data can be used to better understand the location and distribution of CoCs in the vadose zone.

Borehole Location

Potential locations for a new borehole were identified based on historical knowledge of WMA S-SX, such as leak history, previous vadose zone characterization efforts, historical gross gamma logging data, recent spectral gamma logging data, and RCRA groundwater assessment findings. Two primary areas considered for the characterization effort were the area near tank SX-108 and the area near tank S-104. Based on the information provided in Chapter 3.0, the area under tank SX-108 and between tanks SX-108, -109, -111, and -112 is of interest because it is impacted by one of the largest leaks (in terms of inventory and potentially volume based on leak volume uncertainty) in WMA S-SX (from 132,000 to 678,000 L [35,000 to 203,000 gal] from SX-108). The area surrounding tank S-104 is of interest because of the large 90,840 L (24,000 gal) leak that occurred from the tank and the observed groundwater contamination in the RCRA groundwater monitoring wells located on the eastern end of the S tank farm.

Options considered in the DQO process are presented in HNF-5272 and Table 4.1. Each of these options was evaluated as a candidate for the characterization effort. Each of the options was identified because samples from these locations would potentially provide data to address source characterization (i.e., nature of contamination), location and distribution (i.e., extent of contamination), and transport pathways and processes (i.e., contaminant fate and transport).

Additional considerations in evaluating the options included potential programmatic risk (i.e., risk to the program if the characterization effort were unsuccessful) associated with a fiscal year 2000 deployment.

Each of these options would potentially provide data to address a number of different questions and data gaps. In terms of source characterization, the potential value of information provided by characterizing the source at tank SX-108, and in particular the slant borehole under tank SX-108 (Figure 4.2) is a primary characterization target.

The current planning basis is to pursue installation of the slant borehole under tank SX-108 as the next characterization effort in WMA S-SX. Given that the slant borehole beneath tank SX-108 is a potential primary target for the characterization effort, the DQO participants decided that additional vertical boreholes in the SX tank farm should be deferred until the data from the the preliminary characterization efforts could be evaluated and the need for additional source characterization data from a vertical borehole in the SX tank farm was established.

A new vertical borehole near borehole 41-11-10 potentially would provide data near the leading edge of the postulated gamma contamination plume resulting from the leak at tank SX-108. Because of the other tank leaks in the area (tanks SX-108, -109, -111, and -112), it is likely that some level of commingling of leaks from different tanks has occurred. Much of the information that would be gained from placing a new borehole in this area would be similar to the information that will be gained from the extension and decommissioning of borehole 41-09-39. Both of these locations are in the path of the postulated gamma plume from tank SX-108 in the same general direction (southwest) from the tank. The horizontal distance between the borehole 41-11-10 and borehole 41-09-39 is approximately 11 m (35 ft). Based on this information, a decision to install a new borehole near borehole 41-11-10 will be deferred until the data from decommissioning of borehole 41-09-39 are available and the need for additional characterization in this area is established.

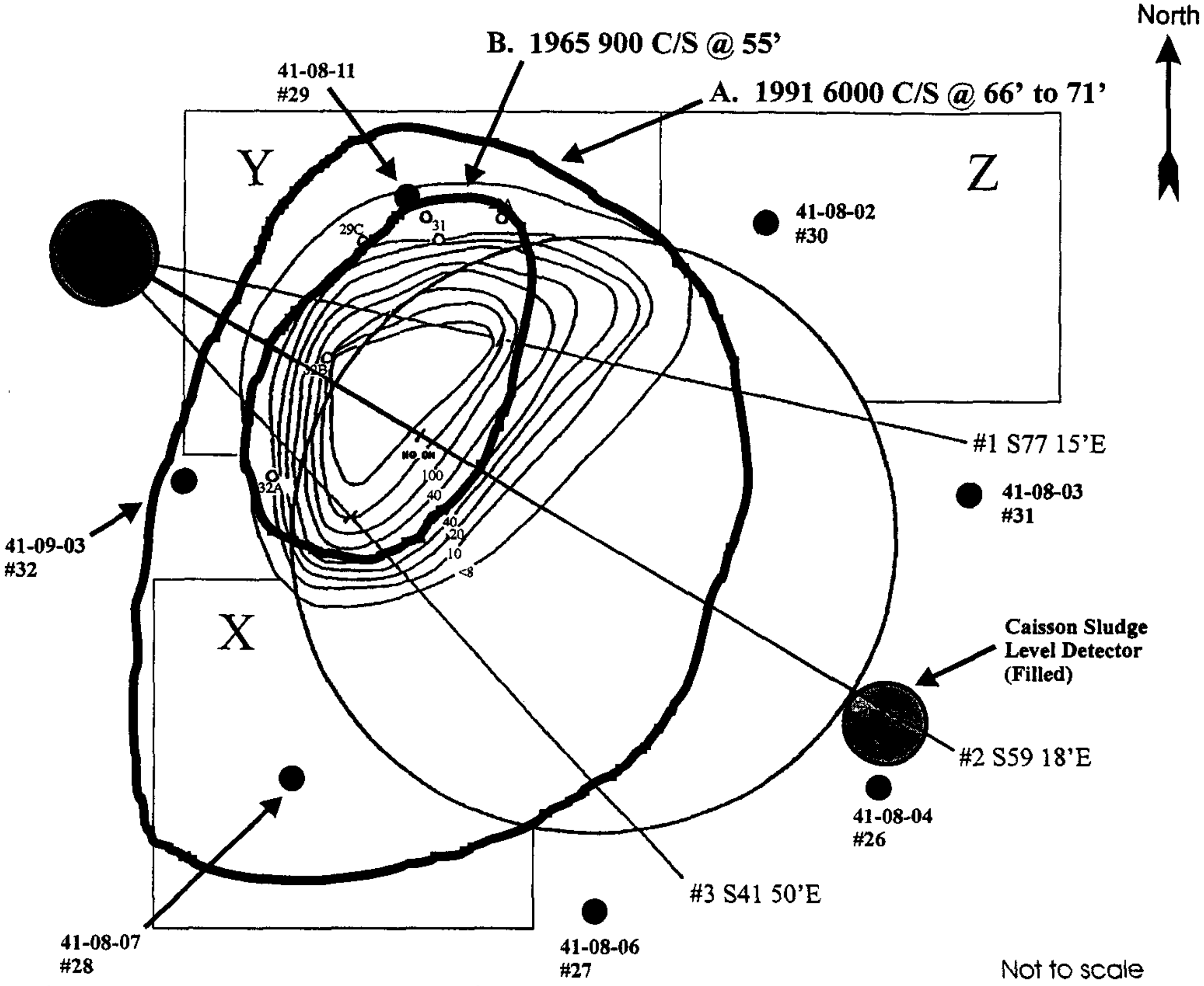
Based on the evaluation of borehole location options the characterization activity proposed in WMA S-SX is to install a slant borehole under tank SX-108 extended to the top of the Plio-Pleistocene unit. This is consistent with recommendations for the location of a new borehole made by the SX Expert Panel (DOE/RL-97-49).

Borehole Construction and Sampling Methodology

Installation of a slant borehole under tank SX-108 targeted to intercept the tank leak plume would encounter highly contaminated sediments. Based on historical logging data the slant borehole would likely encounter regions with cesium-137 concentrations as high as 10^6 to 10^8 pCi/g. These concentrations raise significant worker safety and air emissions concerns for any drilling or sampling method that brings material to the surface. Because of the anticipated contaminant concentrations the slant borehole would be constructed by driving a closed-end casing. The advantage of this borehole construction method is that no cuttings would be brought to the surface during well construction. Additionally, at the anticipated contaminant concentration levels a closed end driven well would be the only construction method allowable in the current Notice of Construction (DOE/RL-99-34).

Two options have been identified for collecting sediment samples from a closed end driven borehole. The two options include collecting a driven split-spoon sample ahead of the borehole casing or collecting a sidewall sample during borehole decommissioning. Due to the anticipated radiation levels standard split-spoon sampling equipment cannot be used for the proposed slant

Figure 4.2. Tank 241-SX-108 Borehole Location Options



LEGEND

●	Drywell
41-08-06	Drywell number
#27	Number used in BNWL-CC-701 characterization study
▬	Counts per second. Inside bold line represents 1965 data at 900 counts per second at 17 m (55 ft). Outside bold line represents 1991 data at 6000 counts per second at 20.1 to 21.6 m (66 to 71 ft).
—	Contour lines represent constant Cs-137 concentrations in µCi/g in mid-1965.

Source: WHC-MR-0300

Docprod\mhc\rfi\hnf-5085\corel8\fig-4-2.cdr borehole. The split-spoon sampler would be specially designed to limit sample volume and provide radiation shielding. Collection of split-spoon samples ahead of the borehole casing would be conducted by removing the drive tip at locations of interest, collecting the split-spoon sample, and reinstalling the drive tip to advance the borehole to the next sampling location. There are a number of advantages and disadvantages to both sampling options. The major advantages of collecting split-spoon samples ahead of the casing include the ability to collect a representative sample of sufficient size to allow all anticipated laboratory analyses to be conducted.

The proposed sampling methodology to be used during construction of the tank SX-108 slant hole is to collect driven split-spoon samples ahead of the casing. There are a number of uncertainties associated with application of this sampling methodology at the tank SX-108 location. The primary uncertainty is associated with the potential worker doses resulting from handling hot samples. Additional uncertainties include sample handling in the laboratory and interfaces between the field and the lab. Limitations associated with collecting split-spoon samples from the slant borehole include having to sample without the benefit of gamma ray logging to identify radiation levels. Because of this limitation the details of the sampling plan will be developed assuming that each sample has the potential to be highly contaminated.

The proposed sampling methodology will be demonstrated outside the tank farm to verify the approach prior to deployment in the tank farm. Backup sampling techniques will be evaluated in the event that the split-spoon sampling technique will not work in the high radiation environment in the tank farm. The sidewall sampling technique will be maintained as a back up or secondary sample collection technique.

4.3.3 Other Activities

In addition to the slant borehole and near-surface characterization activities, engineering studies and demonstrations are being pursued to reduce the technical uncertainties and to provide a basis for future characterization deployments in the tank farms. A feasibility evaluation for utilizing the caissons will be conducted in fiscal year 2000. If using the caissons proves feasible, collecting sediment samples under tanks in the SX tank farm could be accomplished using the caissons instead of installing a slant borehole. A slant borehole demonstration is also being planned outside of the tank farms that would be similar in terms of features and approach to sediment sampling as the borehole planned at tank SX-108 prior to implementation in the SX tank farm.

4.4 PROPOSED SPECIFIC TANK SX-108 BOREHOLE LOCATION

The specific location of the proposed slant borehole under tank SX-108 is based on tank leak history information. Based on this information, criteria have been developed for the selection of the specific location from among three potential sites near the tank.

4.4.1 Leak History

The leak history for tank SX-108, which contains REDOX high-level waste, is documented (WHC-MR-0300, BNWL-CC-701). Estimated releases from tank SX-108 vary from 9,084 L

(2,400 gal) to 132,475 L (35,000 gal) of supernate between 1962 and 1964 based on WHC-MR-0300 to 768,355 L (203,000 gal) based on LA-UR-96-3537. Tank SX-108 was suspected of leaking in December 1962; however, it was thought to have self-sealed and the tank was kept in service. Tank SX-108 was observed to have leaked again in August 1964. By late 1965, the leak was thought to have self-sealed, but, in March 1967, the tank was confirmed to be leaking and was taken out of service. Based on a leak volume ranging from 9,084 L (2,400 gal) to 132,475 L (35,000 gal), the 1965 supernate analysis, and decay calculations (January 1991), the radionuclides in contaminated sediment under the tank are estimated to be between 10,000 and 140,000 Ci of cesium-137 (WHC-MR-0300).

4.4.2 Borehole Location Options Near Tank SX-108

The specific location of the borehole in relation to tank SX-108 has not yet been established. The opportunities for gathering information and the trade-offs between the specific locations have been evaluated to optimize the data and information provided by the borehole.

Three regions around tank SX-108 have been identified as potential targets for locating a new characterization borehole, as identified in Figure 4.2. These locations are southwest of tank SX-108 (Area X), northwest of tank SX-108 (Area Y), and northeast of tank SX-108 (Area Z). An evaluation of the questions and the hypothesis that could be evaluated with data obtained from the three locations are discussed in greater detail in the following paragraphs. Based on this evaluation (HNF-5272), Area Y has been selected as a preferred location for the slant borehole. Based on gamma activity as shown in Figure 4.2, the slant borehole would be drilled from the northwest corner to the southeast and go underneath the tank.

The current planning basis for the slant borehole beneath tank SX-108 includes the following:

- The borehole enters the ground at approximately the 11 o'clock position 12.2 m (40 ft) from the edge of the tank nominally 30° off vertical, heading directly underneath the center of the tank (toward the 5 o'clock position). A preliminary investigation of surface and subsurface interference has identified this as a potentially viable location. The borehole depth would be limited to the Plio-Pleistocene unit or to the maximum depth of contamination, whichever is greater.

- Driven samples would be collected ahead of the casing. The samples would be transported to the laboratory and analyzed for the CoCs identified in Appendix A. Nominally, 10 horizons would be sampled based on nearby borehole geophysical logs or this borehole geophysical logs or the need to provide depth coverage as identified in Appendix A.

As a contingency, should a 30° off vertical slant borehole inside the tank farm not be attainable, a near-vertical to vertical borehole closer to the tank will be implemented. This would still provide data in regards to the contaminant plume without jeopardizing the schedule or requiring reevaluation of the authorization basis for a new borehole.

This location, northwest of tank SX-108 provides the opportunity to test a variety of hypotheses on the movement of contaminants and moisture, and the role of the geologic system in controlling that movement.

A slant borehole started northwest of tank SX-108 would enhance understanding of the fate and transport of contaminants needed to support risk assessment. The advantage to northwest over northeast is a higher probability of collecting vadose zone samples that contain contaminants from the tank leak. One issue that will affect final siting of the borehole is the potential interference from existing tank farm infrastructure. Based on the sampling methodology employed, the following information may be developed and the hypotheses tested by a borehole located northwest of tank SX-108.

- A hypothesis has been offered that mobile contaminants (e.g., tritium, nitrate, and technetium) will move vertically until a hydraulic barrier causes them to move laterally (HNF-2603). This lateral movement would likely be preferential along the sloping Plio-Pleistocene unit-Hanford formation contact. The Plio-Pleistocene unit is finer-grained than the Hanford formation and also contains carbonate-rich zones both of which may be important factors in this hypothesis. Vertical movement would likely be enhanced if the sediments became saturated due to either the waste itself or through the addition of moisture from other sources.

- This location allows for the contamination immediately below the tank to be sampled. This provides conditions for sediments affected by tank waste directly under the tank (i.e., depth of 18.3 to 21.3 m [60 to 70 ft] bgs) to be evaluated.

- The slant borehole will enable access to both between (contaminated) tank conditions and under tank conditions. Contaminated sediment from these two conditions could be examined for fate and transport considerations.

- Vertical distribution and concentrations of ^{99}Tc, nitrate, and chromium, particularly in the most concentrated gamma zone

- Identification and distribution of other contaminants and their concentrations

- Comparison of cesium-137 distribution versus other contaminants

- In-situ moisture content

- Contaminant leachability in the highest concentrated gamma zone

- Mineralogical, chemical reactivity, density and porosity changes in soil from interactions with tank fluid in the highest gamma concentration zone

- Chemistry of extracted pore water (pH, inorganic and organic concentrations)

- Cation exchange capacity of soils.

A slant borehole located northeast of tank SX-108 would provide most of the same information as would a slant borehole located northwest of the tank except penetrating the contaminant plume has a lesser chance of occurring.

- The slant borehole will enable access to both between (contaminated) tank conditions and under tank conditions. Contaminated sediment from these two conditions could be examined for fate and transport considerations.
- Starting point allows traverse through uncontaminated area before reaching edge of tank. This would reduce the concern for worker safety at the beginning of the drilling operations.

A borehole located southwest of tank SX-108 would provide most of the same information as would a slant borehole located northwest of the tank; however based on Figure 4.2, the tank leak appears to have occurred in the northwest quadrant. Therefore, a slant borehole northwest of tank SX-108 has a higher probability of success.

4.5 INVESTIGATIVE SAMPLING AND ANALYSIS AND DATA VALIDATION

Samples and data will be collected during the slant borehole investigation while driving the casing and by conducting geophysical surveying as described in Appendix A. Sediment samples will be collected ahead of the driven casing using split-spoon sampling techniques modified with shielding to accommodate the high radiation levels in the borehole. All samples will be field screened for radiation, sealed, refrigerated, and shipped for analysis. Laboratory analyses will be performed on the sediment samples for radiological and geochemical constituents, as described in the SAP presented in Appendix A. Limited analysis for physical parameters (e.g., moisture retention and hydraulic conductivity) may also be performed on sediments that show visible evidence of being altered by the tank leak chemistry (e.g., cementation, discoloration).

For the near-surface characterization, sediment samples from discrete zones will be collected from the upper vadose zone using direct push technology. All samples will be field screened for radiation, containerized, and retained for possible analysis. Geophysical logging will be used in conjunction with the direct push technology to monitor for evidence of gamma contamination and target sample locations prior to sediment sample collection. Samples will be selected for analysis based on the geophysical logs from the initial push or completed borehole and as needed to fill in gaps consistent with the overall objective of identifying the distribution of radiological and chemical species with depth. Laboratory analyses will be performed on the sediment samples for radiological and geochemical constituents and parameters, as described in the SAP (Appendix A). Additionally, physical and hydrological analyses will be performed on selected samples if there is visible or geochemical evidence that the waste has altered the sediments.

Data from the slant borehole and near-surface characterization determined by project management to be relevant for the purpose of validation will be made available by the primary laboratory on request. Validation will be performed in accordance with the quality assurance project plan in the Phase 1 RFI/CMS work plan (DOE/RL-99-36).

This page intentionally left blank.

5.0 RCRA FACILITY INVESTIGATION/CORRECTIVE MEASURES STUDY TASKS AND PROCESS

The primary purpose of Chapter 5.0 of this addendum is to provide a summary of the tasks that will be performed for the investigation. A detailed description of these tasks is provided in the SAP (Appendix A). Section 5.1 outlines the tasks to be conducted during the field investigation for the RFI. Tasks are designed to provide information needed to meet the DQOs identified in Chapter 4.0. A SAP is provided in Appendix A for the field investigation for the RFI. Environmental monitoring requirements for protecting the health and safety of onsite investigators are described in the Phase 1 RFI/CMS work plan (DOE/RL-99-36).

Following approval, this work plan will not be modified without approval from Ecology and DOE. Any changes to the scope of work that may be needed will be documented through change requests in accordance with the procedures identified in Appendix A of the Phase 1 RFI/CMS work plan (DOE/RL-99-36).

To satisfy the data needs and DQOs specified in Chapter 4.0, the following tasks will be performed during the RFI:

- Task 1 Project Management
- Task 2 Geological and Vadose Zone Investigation
- Task 3 Data Evaluation.

No groundwater investigation is planned for the proposed investigation in this work plan. A separate plan (PNNL-12114) covers groundwater investigations at WMA S-SX. This plan has been released (September 1999) and references back to the Phase 1 RFI/CMS work plan. The tasks and their component subtasks and activities are outlined in the following sections. Information is provided on each task to allow estimation of the project schedule (Chapter 6.0) and costs.

5.1 TASK 1 – PROJECT MANAGEMENT

The project management objectives throughout the course of the WMA S-SX RFI/CMS are to direct and document project activities so the data and evaluations generated meet the goals and objectives of the work plan and to ensure that the project is kept within budget and on schedule. General project management is addressed in Section 7.0 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36). The project management activity will be to assign individuals to the roles established in Chapter 7.0. Specific subtasks that will occur throughout the RFI and RFI/CMS are addressed in Section 7.0 of the Phase1 RFI/CMS work plan (DOE/RL-99-36).

5.2 TASK 2 – GEOLOGIC AND VADOSE ZONE INVESTIGATION

The geologic and vadose zone investigation will further characterize the geology of WMA S-SX and provide additional information on the nature and extent of contamination and the potential migration paths.

The geologic and vadose zone information will be evaluated to determine their influence on the following:

- WMA conceptual vadose zone model
- Release and movement of contaminants
- Development of ICM alternatives
- Initiate data collection for support of retrieval and closure activities.

The geologic and vadose zone investigation for WMA S-SX will consist of compiling pertinent existing data and collecting data from drilling activities in the vadose zone. The types of data needed from the surface and vadose zone include the following:

- Thickness and areal extent of geologic units
- Lithology, bedding types, facies geometry, particle size, and sorting
- Presence, concentration, and nature of contaminants in sediments.

The following two subtasks have been established to gather geologic and vadose zone data:

- Subtask 2a Field Activities (logging and sampling of a slant borehole, and sediment sampling of the backfill materials in the S tank farm
- Subtask 2b Laboratory Analysis.

5.2.1 Subtask 2a – Field Activities

Field activities will include geologic and geophysical logging associated with the slant borehole and direct pushes or auger drilling in the S tank farm and between the S and SX tank farms for near-surface characterization. The tentative locations of the planned slant borehole and direct push are provided in Figures 5.1 and 5.2.

The requirements for geologic and geophysical surveying and sediment sampling for physical and laboratory analytical parameters in the vadose zone borings are provided in Appendix A. Information and data will be collected from the surface downward to the top of the Plio-Pleistocene unit or the depth to which contamination is present. Geologic logging will be performed.

5.2.1.1 Slant Borehole

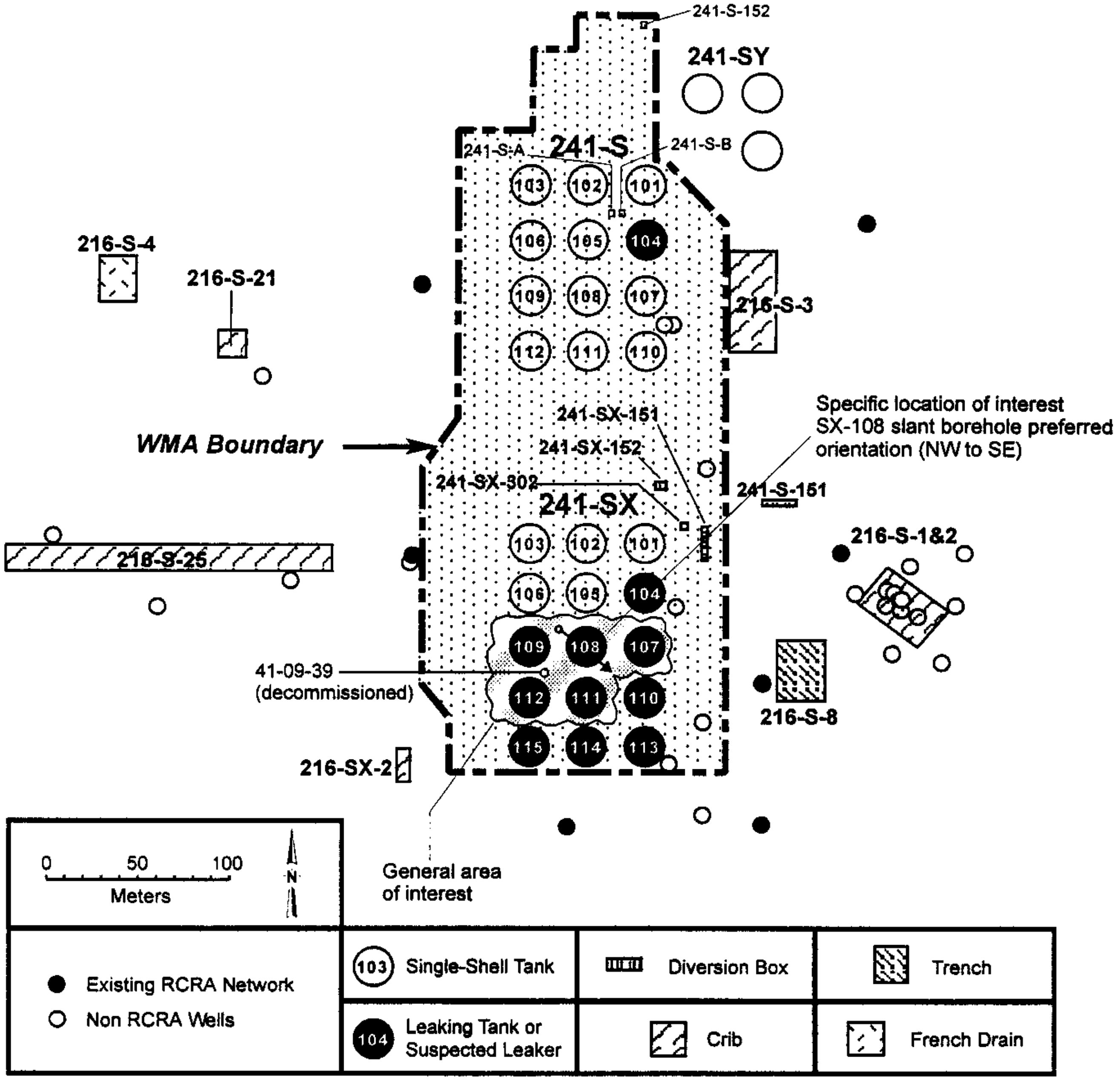
The following activities are planned for the slant borehole.

- Conduct borehole geophysical surveying and analysis (moisture, neutron, gross gamma, spectral gamma and neutron-enhanced spectral gamma analysis).

- Obtain sediment samples to analyze for the presence and concentration of contaminants and to evaluate alterations of the sediments from waste chemistry effects.

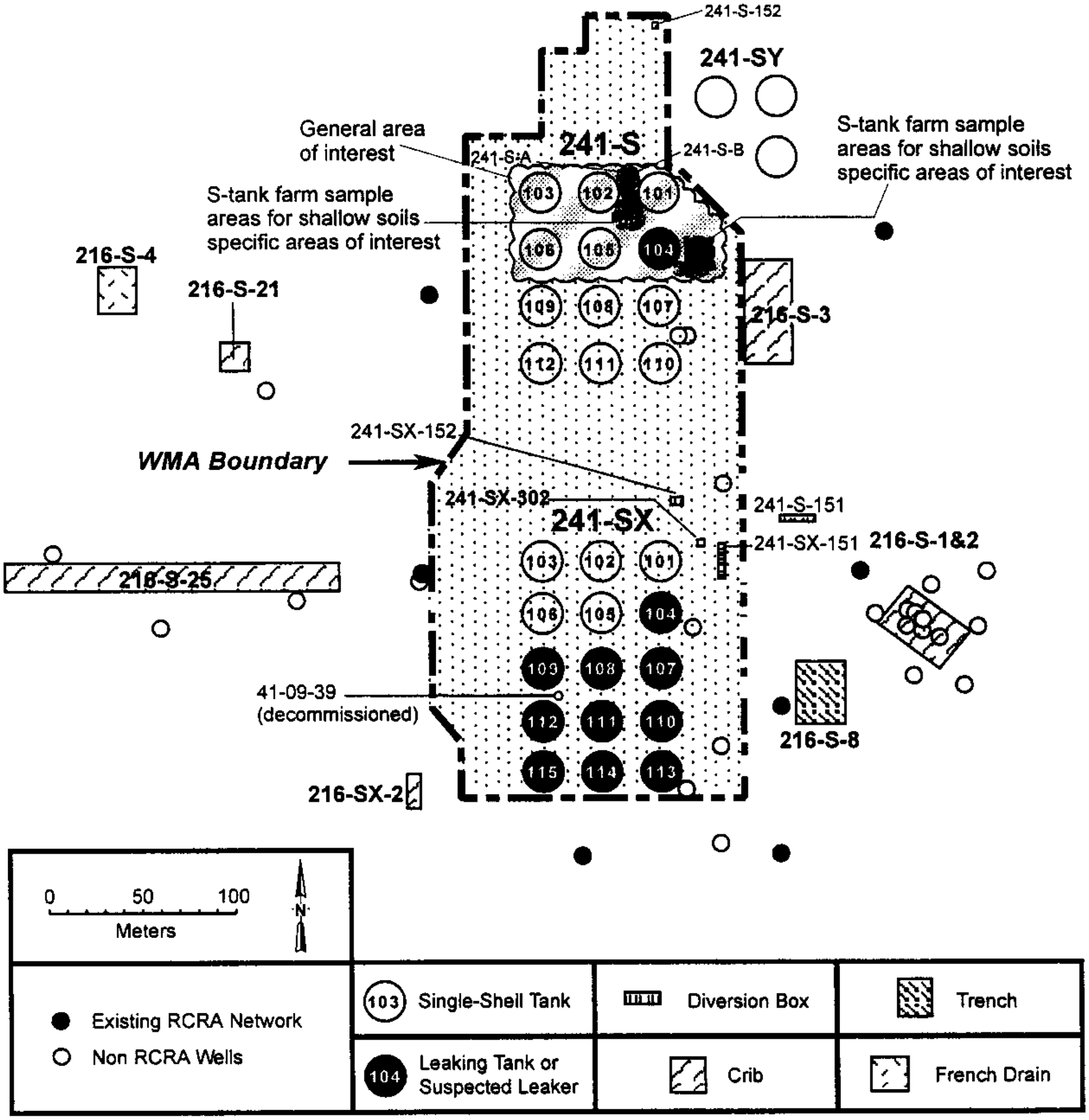
- Obtain sediment samples to support preparation of the borehole geologic logs and stratigraphic and lithologic contact correlation with other boreholes/wells in the WMA S-SX vicinity.

Figure 5.1. Waste Management S-SX Vadose Zone Soil Sampling Locations



Docprod\mhc\rfi\hnf-5085\corel8\Fig-5-1.cdr

Figure 5.2. Waste Management S-SX Shallow Soil Sampling Locations



Docprod\lmhc\rfi\hnf-5085\corel8\Fig-5-2.cdr

The final design for the slant borehole under tank SX-108 has not been completed. One of the primary constraints on sample collection from the "hot" zone under tank SX-108 is the potential radiation level (>500 mrem/hr) which will limit the sample volumes that can be brought to the surface. To reduce the uncertainties associated with placing a slant borehole under tank SX-108, a demonstration is planned outside of the tank farms to evaluate the techniques for installing the borehole and collecting samples. This demonstration will help refine the borehole angle and the sample collection methods. The current planning basis for the slant borehole beneath tank SX-108 includes the following:

- The borehole enters the ground at approximately the 11 o'clock position 40 feet from the edge of the tank nominally 30° off vertical, heading directly underneath the center of the tank (toward the 5 o'clock position). A preliminary investigation of surface and subsurface interference has identified this as a potentially viable location. The borehole depth would be limited to the Plio-Pleistocene unit or to the maximum depth of contamination, whichever is greater.
- Driven samples would be collected ahead of the casing. The samples would be transported to the laboratory and analyzed for the CoCs identified in Appendix A. Nominally, 10 horizons would be sampled based on the geophysical surveys or the need to provide depth coverage as identified in Appendix A.

Subsurface conditions are variable and the process of installing the slant borehole must be flexible. A planned demonstration will determine the methodology for conducting the drilling activity. Some or all of the work described in Appendix A may require modification. This addendum is intended to serve as a guideline and is designed to allow for changes depending on conditions encountered in the field and borehole. Any change will be recorded on the appropriated field documentation, memoranda, or letters. A complete documented record of activities will be maintained for preparation of a final summary report.

Appropriate permits and compliance with the Notice of Construction (NOC) permit (DOE/RL-99-34) will be maintained during the drilling operations for inside the tank farm. The selected drilling method will comply with the requirements of the Washington State Department of Health for the notice of construction permit and other pertinent requirements and appropriate engineering systems to prevent the possible contaminated air from being released to the environment.

5.2.1.2 Shallow Vadose Soil Investigation

Two areas have been identified as regions of interest for the Phase 1 characterization of the shallow vadose zone soil. These areas are within the north end of the S tank farm. The S tank farm areas of interest include:

- Unplanned release near diversion box 241-S-B
- East of tank S-104 near the fence (in the drainage path of the unplanned release that occurred in the SY tank farm and flowed into the S tank farm).

For the purpose of the DQO, the shallow investigation of these areas would consist of collecting samples between the tank farm surface and approximately 16.7 m (55 ft) bgs using direct push technology at nine locations within either or both of these two areas.

Shallow soil characterization will be carried out using a truck-mounted cone penetrometer-based system. Specific sites cleared for access (underground piping and electrical services identified) and with an approved excavation permit will be interrogated with a gross-gamma/spectral gamma cone penetrometer probe. The depth of investigation will be determined by the depth to which the probe can be advanced using a standard deployment truck. The probe will be deployed using the gross gamma mode with the tool advanced at approximately 2 cm/sec (0.8 in./sec). If, in the upper 5 m (15 ft) the downhole instrument indicates a potential cesium-137 concentration of 3.7 pCi/g or greater, logging will be shifted to the spectral mode to determine the presence and level of concentration of cesium-137; below 5 m (15 ft) the threshold limit for spectral gamma determinations will be 20 pCi/g. In zones where cesium-137 is present at concentrations greater than 20 pCi/g, spectral gamma readings will be taken at 0.5 m (1.5 ft) intervals. In all cases, gross gamma measurements are to be taken while the probe is advanced.

The graphical log developed using the gross and spectral gamma measurements will be used to select intervals to be sampled. The sampling push is to be made in a location that is no more than 0.7 m (2 ft) from the site of the gamma push. A single point sampler will be used to collect the required samples. Sampling intervals will be selected from those horizons with a cesium-137 concentration of 20 pCi/g or greater. In the event that horizons are penetrated that would yield samples having a greater that 50 mrem/hr dose rate at 30 cm (12 in.) (based on calculations using sampler size and cesium-137 concentration) a sample will be collected from the first interval below the high rate zone having a dose rate of less than 50 mrem/hr.

Two separate areas are to be characterized. The areas consist of the vicinity of tank S-102 and the vicinity of tank S-104. These two sites exhibit separate instances of cesium-137 in vadose zone dry wells that may be indicative of near-surface sources. In addition, the region to the east of tank S-104 has potentially been impacted by a tank overfill event in the 241-SY double-shell tank farm. A total of nine push sites have been identified. An average of four samples per site will be collected.

5.2.1.3 241-S-104 Site

The highest recorded levels of cesium-137 contamination associated with this site are in borehole 40-04-05 in the southeast quadrant of the tank. Contamination is estimated at about 10^6 pCi/g at a depth of about 14 m (48 ft) bgs. Up to five sets of gamma probe and sampling pushes may be made to investigate this site. The pushes include the following.

- Adjacent to the 40-04-05 drywell, between the drywell and the tank. This location will be to ascertain if there is a vertical gradient between the push location and the identified elevation of contamination in 40-04-05 and to collect a sample from below the contaminated zone to determine if mobile contaminants are moving ahead of the cesium-137 hot spot.

- Adjacent to tank S-104 at the 5 o'clock position. This location is to be as close to the tank as the push-truck can be positioned within dome-load restrictions. The S tank farm tanks are constructed with a spare inlet port at this point. Experience in other farms has shown that these spare inlet ports are subject to failure if a tank is overfilled. This push will test the hypothesis that the contamination adjacent to the tank is due to an overfill event.

- Adjacent to the normal fill line at the 3 o'clock position. This location is to be within 3 to 4.5 m (10 to15 ft) of the tank and as close to the fill line as safety considerations allow. This location will be used to determine the horizontal and vertical extent of the contamination found in the 40-04-05 borehole.

- Adjacent to the S tank farm fence line. This location will be used to determine the impact to shallow soils due to the surface release and subsequent ponding that occurred in the SY tank farm.

- Midway between the previous two pushes. This location would only be interrogated if positive determinations of contamination were found in one of the two previous pushes.

5.2.1.4 241-S-102 Site

The highest recorded levels of cesium-137 contamination associated with this site are in borehole 40-02-03 in the northeast quadrant of the tank. Contamination is estimated at about 10^6 pCi/g at a depth of about 6 m (20 ft) bgs. Four sets of gamma probe and sampling pushes are planned to investigate this site. The pushes include the following.

- Adjacent to tank S-102, northwest of drywell 40-02-03. Because no contamination is detected in drywell 40-02-01, this push will be used to determine the extent of contamination in a northwesterly direction from borehole 40-02-03. The push will be situated about midway between the boreholes and as near the tank as safety considerations allow.

- Along the line projected between 40-02-01 and 40-02-03, north of the cascade line between tanks S-101 and S-102. This location will provide information on the extent on contamination known to exist at 40-02-03 and assess the depth of movement of that contamination.

- Along the line projected between 40-02-01 and 40-02-03, south of the cascade line between tanks S-101 and S-102, and near the 241-S-A diversion box. This location will provide information as to the extent and general direction of movement of contaminants for this site. In addition the accumulation pit associated with the 241-S-A will be assessed as a possible contributor to the contamination.

- Adjacent to the 241-S-B diversion box. The potential for contamination in this region to be related to operation of the 241-S-B accumulation pit will be assessed.

5.2.1.5 Additional Pushes

Additional pushes may be made based on the information developed during the initial campaign or decisions of the River Protection Project Vadose Zone Project management. These additional pushes will be determined based on the determined extent of contamination and (1) the availability of both the cone penetrometer truck and crew and (2) availability of budget and support personnel.

The samples would be transported to the laboratory and analyzed for the CoCs identified in Appendix A.

Following approval of the general plan outlined in this addendum, a detailed field work plan would be prepared to identify the number and location of samples to be collected. The detail necessary for this plan has not yet been completed. The physical and operational constraints will require evaluation prior to identifying specific target locations.

5.2.2 Subtask 2b – Laboratory Analysis

Laboratory analyses for the geologic and vadose zone investigation are described in Appendix A. These analyses include radiological and chemical analysis of selected sediment samples. Also, physical and hydrologic analysis of selected sediment samples will be performed.

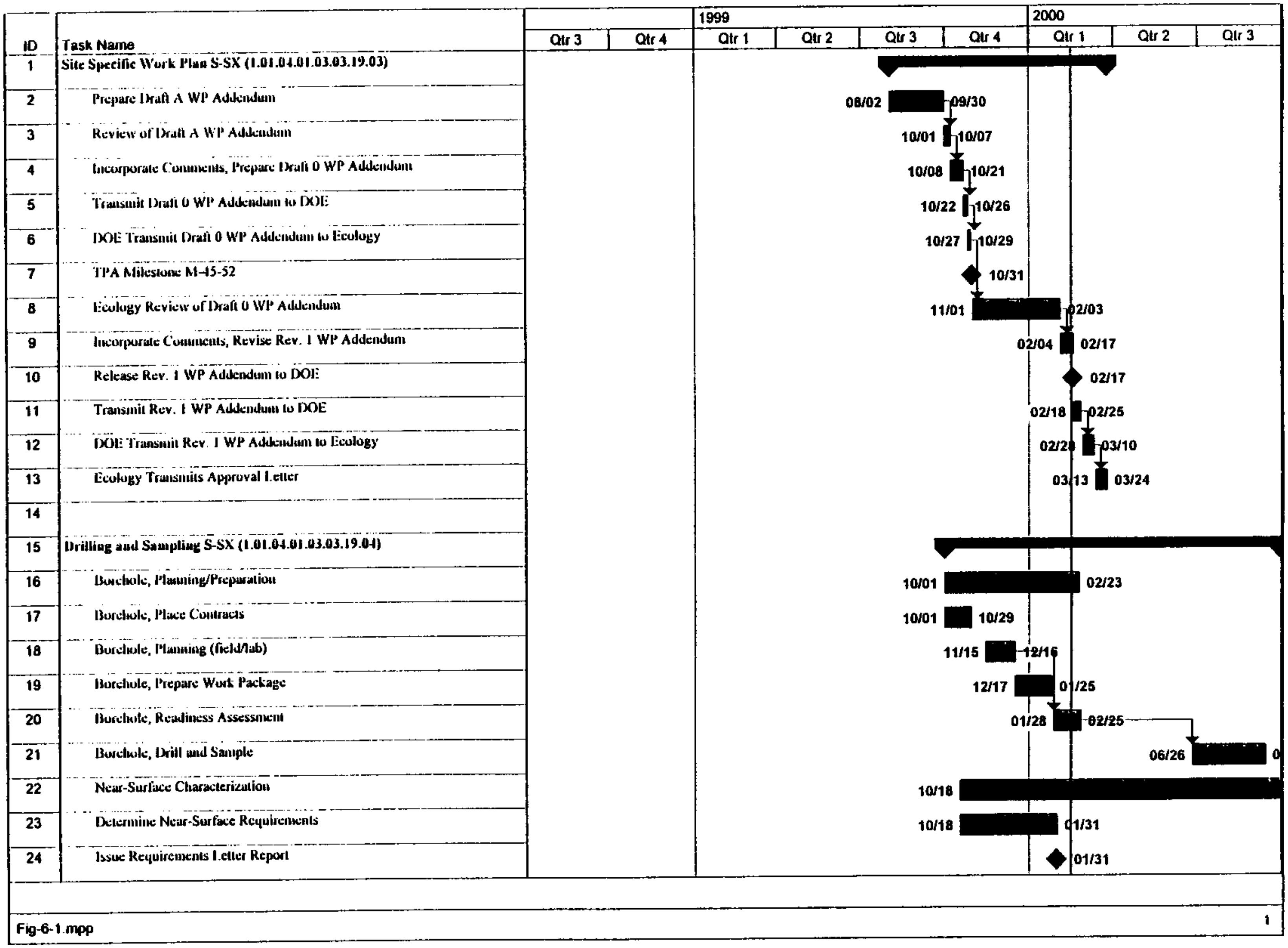
5.3 TASK 3 – DATA EVALUATION

Data generated during the field investigation will be integrated and evaluated, coordinated with RFI activities, and presented in an ongoing manner to allow decisions to be made regarding any necessary rescoping during the course of the project. The results of these evaluations will be made available to project management personnel to keep project staff informed of progress being made. The interpretations developed under this task will be used in refining the conceptual model and determining whether interim measures or ICMs are warranted for this WMA.

6.0 SCHEDULE

The schedule for developing plans and conducting field activities details the work described in Chapter 5.0 of this work plan. The schedule, shown in Figure 6.1, is the baseline that will be used to measure progress. The characterization activities described in this WMA S-SX addendum were identified during a DQO process to fulfill proposed Tri-Party Agreement Milestone M-45-52 to be completed by October 1999. Activities were planned using the work breakdown structure and project milestones defined in Section 7.0 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36).

Based on DOE guidance for establishing a baseline scope, schedule, and budget document, the use of a multi-year work plan was adopted. The activities identified in Figure 6.1 were taken from the multi-year work plan, which is updated annually and describes the specific details associated with each proposed project. The multi-year work plan incorporates milestones defined in the Tri-Party Agreement (Ecology et al. 1998) and reflects the schedule and commitments made therein. The multi-year work plan defines the scope, schedule, and budget to a level of detail that will be adequate for the planning and management of that project. The work breakdown schedule numbers and activity identification numbers are included in Figure 6.1 to correspond with the schedule maintained by the Tank Farm Vadose Zone Project.



ID	Task Name		
1	Site Specific Work Plan S-SX (1.01.04.01.03.03.19.03)		
2	Prepare Draft A WP Addendum	08/02	09/30
3	Review of Draft A WP Addendum	10/01	10/07
4	Incorporate Comments, Prepare Draft 0 WP Addendum	10/08	10/21
5	Transmit Draft 0 WP Addendum to DOE	10/22	10/26
6	DOE Transmit Draft 0 WP Addendum to Ecology	10/27	10/29
7	TPA Milestone M-45-52		10/31
8	Ecology Review of Draft 0 WP Addendum	11/01	02/03
9	Incorporate Comments, Revise Rev. 1 WP Addendum	02/04	02/17
10	Release Rev. 1 WP Addendum to DOE		02/17
11	Transmit Rev. 1 WP Addendum to DOE	02/18	02/25
12	DOE Transmit Rev. 1 WP Addendum to Ecology	02/28	03/10
13	Ecology Transmits Approval Letter	03/13	03/24
14			
15	Drilling and Sampling S-SX (1.01.04.01.03.03.19.04)		
16	Borehole, Planning/Preparation	10/01	02/23
17	Borehole, Place Contracts	10/01	10/29
18	Borehole, Planning (field/lab)	11/15	12/16
19	Borehole, Prepare Work Package	12/17	01/25
20	Borehole, Readiness Assessment	01/28	02/25
21	Borehole, Drill and Sample	06/26	0
22	Near-Surface Characterization	10/18	
23	Determine Near-Surface Requirements	10/18	01/31
24	Issue Requirements Letter Report		01/31

Figure 6.1. Preliminary Characterization Schedule

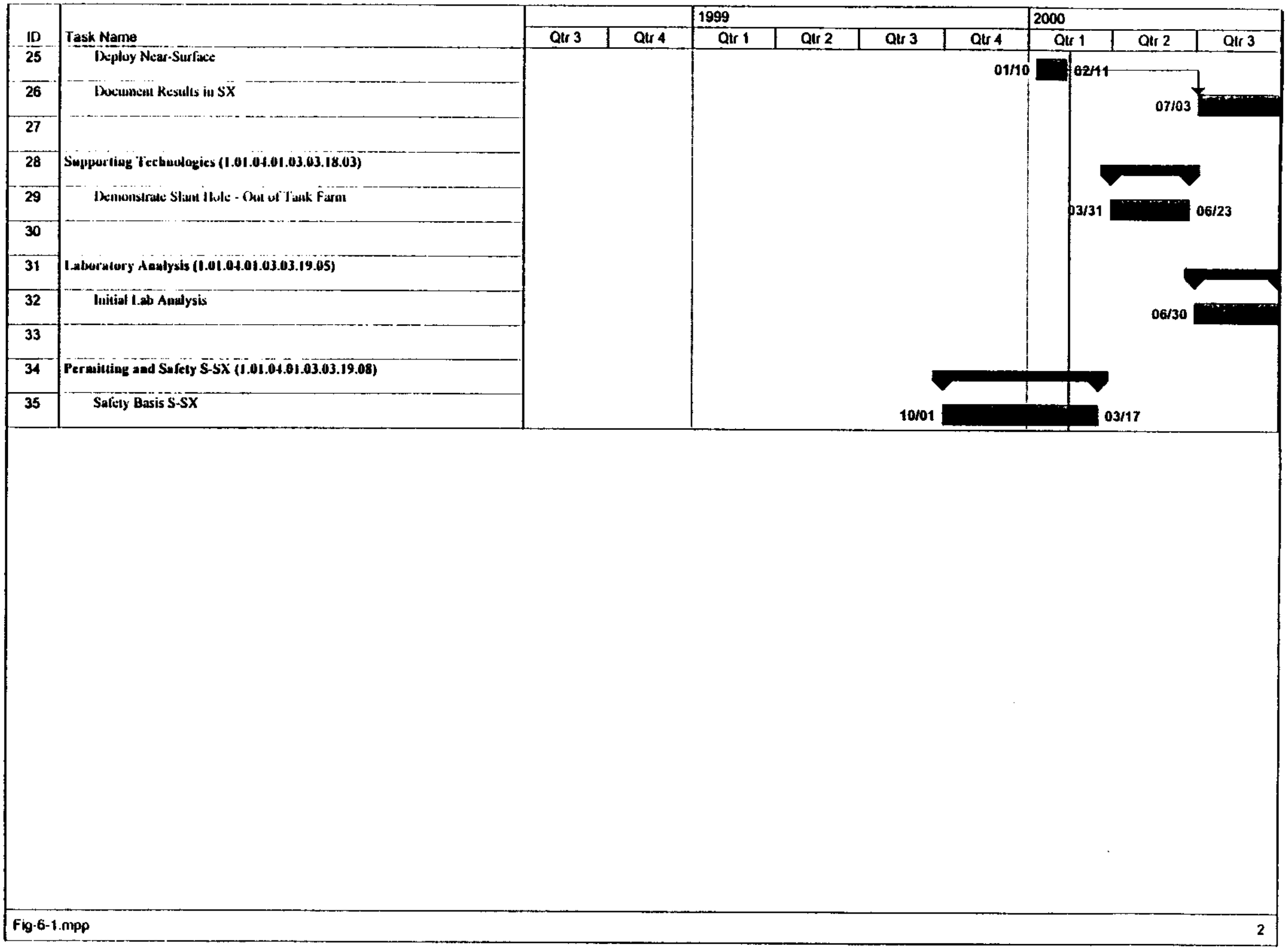


Figure 6.1. Preliminary Characterization Schedule (Cont'd)

This page intentionally left blank.

7.0 PROJECT MANAGEMENT

This chapter defines the administrative and institutional tasks necessary to support the RFI/CMS process for WMA S-SX and manage activities described in this WMA S-SX addendum (Chapter 5.0). This chapter also defines the responsibilities of the various participants, organizational structure, and project tracking and reporting procedures. This chapter is in accordance with the provisions of the Tri-Party Agreement action plan (Ecology et al. 1998). Any revisions to the Tri-Party Agreement action plan that would result in changes to the project management requirements would supersede the provisions of this chapter.

7.1 PROJECT ORGANIZATION AND RESPONSIBILITIES

The project organization and responsibilities are described in Section 7.2 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36). Discussion of SST Program Manager, Tank Farm Vadose Zone Project Manager, work control, cost control, schedule control, meetings, records management, progress and final reports, quality assurance, health and safety, and community relations are addressed in Section 7.2 of the Phase 1 RFI/CMS work plan (DOE/RL-99-36). This work plan will follow the structure outlined in DOE/RL-99-36 except where more detail is required.

This task is described in the Phase 1 RFI/CMS work plan (DOE/RL-99-36). Detailed information in the form of a work package defining the site-specific activities and instructions needed to carry out the investigative tasks discussed in this chapter will be developed before initiating field work. Where appropriate, the work package will reference the appropriate procedure or standards rather than listing the entire procedure for a task and will be in accordance with HASQARD (DOE/RL-96-68). Any reference to the quality assurance project plan provided in the Phase 1 RFI/CMS work plan (Appendix A of DOE/RL-99-36) as a source of additional information will be referenced.

The work package shall be prepared in accordance with CH2M HILL Hanford Group, Inc. work control procedures and the procedures listed in Appendix A of DOE/RL-99-36. The work package must satisfy the following requirements:

- Include a scope of work introductory section.
- Include the DQOs (as specified in the work plans) for each type of activity.
- Identify the proposed locations for sampling and the criteria for selecting those locations. A map, at a scale appropriate to locate the sites in the field, should be included.
- Identify any field screening activities not described in the work plan or in the relevant procedures. Identify any field screening equipment to be used that is not described in the relevant procedures.
- Include the frequency of measurement.

- Identify the applicable procedures needed to conduct the work. If a procedure includes several different ways to accomplish the work, the work package should specify the method of choice or reference the specific procedure.
- Identify any calibrating standards and frequencies not included in the relevant procedures.
- Describe any data collection procedures, chain-of-custody procedures, sample container size and preparation, holding times, type of analysis, number of split samples, number of duplicate samples, number of blank samples, and data reporting requirements not included in the relevant procedures.
- Provide an estimate of the proposed field activity schedule, including sampling periods.
- Include provisions to document any field changes using a project change form and submit the form to Ecology within 10 working days of the change.

7.2 DOCUMENTATION AND RECORDS

All RFI/CMS plans and reports will be categorized as either primary or secondary documents, as described by Section 9.1 of the Tri-Party Agreement action plan (Ecology et al. 1998). The process for document review and comment will be as described in Section 9.2 of the action plan. If necessary after finalization of any document, revisions will be in accordance with Section 9.3 of the Tri-Party Agreement action plan. Changes in the work schedule, as well as minor field changes, can be made without having to process a formal revision. The process for making these changes will be as stated in Chapter 12.0 of the Tri-Party Agreement action plan.

Administrative records, which must be maintained to support Hanford Site RCRA activities, will be in accordance with Section 9.4 of the Tri-Party Agreement action plan.

8.0 REFERENCES

40 CFR 61 Subpart M, "National Emissions Standards for Asbestos," *Code of Federal Regulations*, as amended.

ARH-LD-133, 1976, *Geology of the 241-S Tank Farm*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-LD-134, 1976, *Geology of the 241-SX Tank Farm*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-LD-139, 1976, *Generalized Geology of the 241-SY Tank Farm*, Atlantic Richfield Hanford Company, Richland, Washington.

BHI-00061, 1994, *Engineering Evaluation of the GAO-RECD-89-157, Tank 241-T-106 Vadose Zone Investigation*, Rev. 0, Bechtel Hanford Inc, Richland, Washington.

BHI-00184, 1995, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*, Bechtel Hanford Inc., Richland, Washington.

BHI-01103, 1998, *Clastic Injection Dikes of the Pasco Basin and Vicinity*, Rev. 0, Bechtel Hanford Inc., Richland, Washington.

BHI-00230, 1996, *Geologic Field Inspection of the Sedimentary Sequence at the Environmental Restoration Disposal Facility*, Bechtel Hanford, Inc., Richland, Washington.

BNWL-CC-701, 1966, *Characterization of Subsurface Contamination in the SX Tank Farm*, Battelle Northwest Laboratory, Richland, Washington.

DOE/EIS-0189, 1996, *Tank Waste Remediation System, Hanford Site, Richland Washington, Final Environmental Impact Statement*, U.S. Department of Energy, Richland, Washington.

DOE/RL-89-16, 1996, *Single-Shell Tank Closure Work Plan*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-92-16, 1993, *200 West Groundwater Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-96-68, 1998, *Hanford Analytical Services Quality Assurance Requirements Document*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-97-49, 1997, *TWRS Vadose Zone Contamination Issue, Expert Panel Status Report*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-98-G7, 1999, *Vadose Zone Expert Panel Meeting – Meeting Closeout Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-99-34, 1999, *Notice of Construction for Tank Waste Remediation System Vadose Zone Characterization*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-99-36, 1999, *Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan for Single-Shell Tank Waste Management Areas*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RW-0164, 1988, *Consultation Draft Site Characterization Plan: U. S. Department of Energy*, 9 volumes, U.S. Department of Energy, Radioactive Waste, Washington, D.C.

Ecology, EPA, and DOE, 1999, *Federal Facility Agreement and Consent Order Change Control Form Change No. Draft M-45-98-03. Agreement Commitments Regarding Initial Single-Shell Tank Waste Management Area (WMA) Corrective Actions, Vadose Zone and Groundwater Characterization, Assessment, and the Integration of Vadose Zone and Groundwater Activities at specified Associated Sites*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, EPA, and DOE, 1998, *Hanford Federal Facility Agreement and Consent Order*, 89-10 Rev. 5, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Ecology, 1998, *Dangerous Waste Portion of the RCRA Permit for the Treatment, Storage, and Disposal of Dangerous Waste Hanford Site-Wide Permit*, Rev. 4a, Washington State Department of Ecology, Olympia, Washington.

Fayer, M.J., G.W. Gee, M.L. Rockhold , M.D. Freshely, and T.B. Walters, 1996, "Estimating Recharge Rates for a Groundwater Model Using a GIS," *J. Environmental Quality*, 25:510-518.

Gee, G.W., M.J. Fayer, M.L. Rockhold, and M.D. Campbell, 1992, "Variation in Recharge at the Hanford Site," *Northwest Science*, 60(4): 237-250.

GJO-HAN-11, 1998, *Hanford Tank Farms Vadose Zone S Tank Farm Report*, GJO-97-13-TAR, U.S. Department of Energy, Grand Junction Projects Office, Grand Junction, Colorado.

GJPO-HAN-4, 1996, *Vadose Zone Characterization Project at the Hanford Tank Farms: SX Tank Farm Report*, DOE/ID/12584.268, U.S. Department of Energy, Grand Junction Projects Office, Grand Junction, Colorado.

GJPO-HAN-9, 1997, *Vadose Zone Characterization Project at the Hanford Tank Farms Assessment of Log Data for Borehole 41-09-39 and Correlation With Borehole 41-09-04 in the SX Tank Farm*, U.S. Department of Energy, Grand Junction Projects Office, Grand Junction, Colorado.

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

HNF-2603, 1998, *A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination*, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-2855, 1998, *Findings of the Extension of Borehole 41-09-39, 241-SX Tank Farm*, Lockheed Martin Hanford Corporation, Richland, Washington.

HNF-4380, 1999, *Preliminary Site-Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX*, Rev. 1A, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-4756, 1999, *Assessment of Historical Leak Model Methodology as Applied to REDOX High-Level Waste Tank SX-108*, Lockheed Martin Hanford Corporation, Richland Washington.

HNF-4936, 1999, *Subsurface Conditions for S-SX Waste Management Area*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-5272, 1999, *Data Quality Objectives Report for Waste Management Area S-SX*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-EP-0182-129, 1999, *Waste Tank Summary Report for Month Ending December 31, 1998*, Westinghouse Hanford Company, Richland, Washington.

HNF-SD-WM-HIE-012, 1997, *Hazard Identification and Evaluation for Deploying the Cone Penetrometer in the Tank Farm for Vadose Zone Characterization*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

HNF-SD-TRW-PD-001, 1998, *TWRS Vadose Zone Program Plan*, Rev. A, Lockheed Martin Hanford Corporation, Richland, Washington.

Jacobs, 1998, *SX Tank Farm Vadose Zone Screening Analysis for the Retrieval Performance Evaluation Criteria Assessment*, Jacobs Engineering Group Inc., Richland, Washington.

LA-UR-96-3537, 1998, *Analysis of SX Farm Leak Histories–Historical Leak Model (HLM)*, Los Alamos National Laboratory, Los Alamos, New Mexico.

LA-UR-96-3860, 1997, *Hanford Defined Wastes: Chemical and Radionuclide Compositions*, Rev. 4, Los Alamos National Laboratory, Los Alamos, New Mexico.

Newcomb, R.C., J.R. Strand, and F.J. Frank, 1972, "Geology and Groundwater Characteristics of the Hanford Reservation of the U.S. Atomic Energy Commission, Washington," U.S. Geological Survey Professional Paper 717, U.S. Atomic Energy Commission, Washington, D.C.

PNL-6403, 1987, *Recharge at the Hanford Site: Status Report*, Pacific Northwest National Laboratory, Richland, Washington.

PNL-10508, 1995, *Estimation of Natural Ground Water Recharge for the Performance Assessment of a Low-Level Waste Disposal Facility at the Hanford Site*, Pacific Northwest Laboratory, Richland, Washington.

PNNL-6415, 1999, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, Rev. 11, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-11107, 1996, *Climatological Data Summary 1995 with Historical Data*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-11463, 1997, *A Comprehensive Analysis of Contaminant Transport in the Vadose Zone Beneath Tank SX-109*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-11793,1998, *Hanford Site Groundwater Monitoring for Fiscal Year 1997*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-11810, 1998, *Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas S-SX at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-12086, 1999, *Hanford Site Groundwater Monitoring for Fiscal Year 1998*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-12114, 1999, *RCRA Assessment Plan for Single-Shell Tank Waste Management Area S-SX at the Hanford Site*, Pacific Northwest National Laboratory, Richland, Washington.

Resource Conservation and Recovery Act of 1976, Public Law 94-580, 90 Stat. 2795, 42 USC 901 et seq.

RHO-RE-EV-4 P, 1982, *Supporting Information for the Scientific Basis for Establishing Dry Well Monitoring Frequencies*, Rockwell Hanford Operations, Richland, Washington.

RHO-ST-23, 1979, *Geology of the Separation Areas, Hanford Site, South-Central Washington*, Rockwell Hanford Operations, Richland, Washington.

Slate, J.L., 1996, "Buried Carbonate Paleosols Developed in Pliocene-Pleistocene Deposits of the Pasco Basin, South-Central Washington, U.S.A.," *Quarternary International*, Vol. 34-36, pp. 191-196.

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

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

WDOH/320-015, 1997, *Hanford Guidance for Radiological Cleanup*, Rev. 1, Washington Department of Health, Richland, Washington.

WHC-EP-0883, 1995, *Variability and Scaling of Hydraulic Properties for 200 Area Soils, Hanford Site*, Westinghouse Hanford Company, Richland, Washington.

WHC-MR-0132, 1990, *A History of the 200 Area Tank Farms*, Westinghouse Hanford Company, Richland, Washington.

WHC-MR-0300, 1992, *Tank 241-SX-108 Leak Assessment*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-AP-191, 1996, *Groundwater Water Quality Assessment Monitoring Plan for Single-Shell Tank Waste Management Area S-SX*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-008, 1992, *Geology of the 200 West Area: An Update*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-EN-TI-019, 1992, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-EE-004, 1995, *Performance Assessment of Grouted Double-Shell Tank Waste Disposal at Hanford*, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC-SD-WM-ER-352, 1994, *Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Area*, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

This page intentionally left blank.

9.0 GLOSSARY

Accuracy: Accuracy may be interpreted as the measure of the bias in a system. Analytical accuracy is normally assessed through the evaluation of matrix-spiked samples, reference samples, and split samples.

Audit: Audits are considered to be systematic checks to verify the quality of operation of one or more elements of the total measurement system. In this sense, audits may be of two types: (1) performance audits, in which quantitative data are independently obtained for comparison with data routinely obtained in a measurement system, or (2) system audits, involving a qualitative onsite evaluation of laboratories or other organizational elements of the measurement system for compliance with established quality assurance program and procedure requirements. For environmental investigations at the Hanford Site, performance audit requirements are fulfilled by periodic submittal of blind samples to the primary laboratory, or the analysis of split samples by an independent laboratory. System audit requirements are implemented through the use of standard surveillance procedures.

Bias: Bias represents a systematic error that contributes to the difference between a population mean of a set of measurements and an accepted reference or true value.

Blind Sample: A blind sample refers to any type of sample routed to the primary laboratory for performance audit purposes, relative to a particular sample matrix and analytical method. Blind samples are not specifically identified as such to the laboratory. They may be made from traceable standards, or may consist of sample material spiked with a known concentration of a known compound. See the glossary entry for Audit.

Borehole: A circular hole made by boring; esp. a deep vertical hole of small diameter, such as a shaft, a well (an exploratory oil well or a water well), or a hole made to ascertain the nature of the underlying formations, to obtain samples of the rocks penetrated, or to gather other kinds of geologic information.

Comparability: Comparability is an expression of the relative confidence with which one data set may be compared with another.

Completeness: Completeness may be interpreted as a measure of the amount of valid data obtained compared to the total data expected under correct normal conditions.

Conceptual Model: A tool designed to represent a simplified version of reality based on a set of working hypotheses. For instance, the vadose zone conceptual model includes the simplified elements of tank waste characteristics, past leak characteristics, geology, hydrogeology, and driving forces that include infiltration from precipitation and human sources of water.

Deviation: Deviation refers to an approved departure from established criteria that may be required as a result of unforeseen field situations or that may be required to correct ambiguities in procedures that may arise in practical applications.

Dip: The angle that a structural surface makes with the horizontal, measured perpendicular to the strike of the structure.

Down dip: A direction that is downwards and parallel to the dip of a structure or surface.

Drywell: A hollow cylinder of reinforced concrete, steel, timber or masonry constructed in a pit or hole in the ground that does not reach the water table and is used principally for monitoring in the unsaturated zone.

Equipment Blanks: Equipment blanks consist of pure deionized, distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. They are used to verify the adequacy of sampling equipment decontamination procedures.

Field Duplicate Sample: Field duplicate samples are samples retrieved from the same sampling location using the same equipment and sampling technique, placed in separate, identically prepared and preserved containers, and analyzed independently. Field duplicate samples are generally used to verify the repeatability or reproducibility of the dataset.

Laboratory Duplicate Sample: Laboratory duplicate samples are two aliquots removed from the same sample container in the laboratory and analyzed independently.

Matrix-Spiked Samples: Matrix-spiked samples are a type of laboratory quality control sample. They are prepared by splitting a sample received from the field into two homogenous aliquots (i.e., replicate samples) and adding a known quantity of a representative analyte of interest to one aliquot in order to calculate the percentage of recovery of that analyte.

Maximum Contaminant Level: The maximum permissible level of a contaminant in water that is delivered to any user of a public water system.

Nonconformance: A nonconformance is a deficiency in the characteristic, documentation, or procedure that renders the quality of material, equipment, services, or activities unacceptable or indeterminate. When the deficiency is of a minor nature, does not effect a permanent or significant change in quality if it is not corrected and can be brought into conformance with immediate corrective action, it shall not be categorized as a nonconformance. If the nature of the condition is such that it cannot be immediately and satisfactorily corrected, however, it shall be documented in compliance with approved procedures and brought to the attention of management for disposition and appropriate corrective action.

Operable Unit: A group of land disposal sites placed together for the purposes of doing a Remedial Investigation/Feasibility Study and subsequent cleanup actions. The primary criteria for placement of a site into an operable unit includes geographic proximity, similarity of waste characteristics and site type, and the possibility for economics of scale.

Out of Service: No longer authorized to receive waste.

Past-practice Units (sites): A waste management unit where waste or substances (intentionally or unintentionally) have been disposed of and that is not subject to regulation as a treatment, storage, and/or disposal unit.

Precision: Precision is a measure of the repeatability or reproducibility of specific measurements under a given set of conditions. The Relative Percent Difference (RPD) is used to assess the precision of the sampling and analytical method. RPD is a quantitative measure of the variability. Specifically, precision is a quantitative measure of the variability of a group of measurements compared to their average value. Precision is normally expressed in terms of standard deviation, but may also be expressed as the coefficient of variation (i.e., relative standard deviation) and range (i.e., maximum value minus minimum value). Precision is assessed by means of duplicate/replicate sample analysis.

Quality Assurance: Quality Assurance refers to the total integrated quality planning, quality control, quality assessment and corrective action activities that collectively ensure that the data from monitoring and analysis meets all end user requirements and/or the intended end use of the data

Quality Assurance Project Plan: The QAPjP is an orderly assembly of management policies, project objectives, methods and procedures that defines how data of known quality will be produced for a particular project or investigation.

Quality Control: Quality Control refers to the routine application of procedures and defined methods to the performance of sampling, measurement and analytical processes.

Range: Range refers to the difference between the largest and smallest reported values in a sample, and is a statistic for describing the spread in a set of data.

Reference Samples: Reference samples (e.g., laboratory control standards, independent calibration verification standard) are a type of laboratory quality control sample prepared from an independent, traceable standard at a concentration other than that used for analytical equipment calibration, but within the calibration range.

Removed from Service: No longer authorized to receive waste.

Representativeness: Representativeness may be interpreted as the degree to which data accurately and precisely represent a characteristic of a population parameter, variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of a sampling program.

Split Sample: A split sample is produced through homogenizing a field sample and separating the sample material into two equal aliquots. Field split samples are usually routed to separate laboratories for independent analysis, generally for purposes of auditing the performance of the primary laboratory relative to a particular sample matrix and analytical method. See the glossary entry for Audit. In the laboratory, samples are generally split to create matrix-spiked samples (see the glossary entry).

Strike: The direction or trend that a structural surface takes as it intersects the horizontal.

TSD Unit: A unit used for treatment, storage and disposal of hazardous waste and is required to be permitted (for operation and/or postclosure care) and /or closed pursuant to RCRA requirements under the Washington State Dangerous Waste Regulations (173-303 WAC) and the applicable provisions of Hazardous and Solid Waste Amendment of 1984.

Up-Dip: A direction that is upwards and parallel to the dip of a structure or surface.

VOA Trip Blanks: Volatile Organics Analysis (VOA) trip blanks are a type of field quality control sample, consisting of pure deionized distilled water in a clean, sealed sample container, accompanying each batch of containers shipped to the sampling site and returned unopened to the laboratory. Trip blanks are used to identify any possible contamination originating from container preparation methods, shipment, handling, storage or site conditions.

Validation: Validation refers to a systematic process of reviewing data against a set of criteria to provide assurance that the data are acceptable for their intended use. Validation methods may include review of verification activities, editing, screening, cross-checking or technical review.

Verification: Verification refers to the process of determining whether procedures, processes, data or documentation conform to specified requirements. Verification activities may include inspections, audits, surveillance or technical review.

APPENDIX A

SAMPLING AND ANALYSIS PLAN

This page intentionally left blank.

TABLE OF CONTENTS

FIGURES

TABLES

LIST OF TERMS

bgs	below ground surface
CMS	corrective measures study
CHG	CH2M HILL Hanford Group, Inc.
Ecology	Washington State Department of Ecology
HASQARD	Hanford analytical services quality assurance requirements document
RFI	*Resource Conservation and Recovery Act of 1976* Facility Investigation
SAP	sampling and analysis plan
UPR	unplanned release
WMA	waste management area

This page intentionally left blank.

A.1.0 INTRODUCTION

The focus of this Sampling and Analysis Plan (SAP) is vadose zone investigation of the Waste Management Area (WMA) S-SX, which contains the S and SX tank farms. Sampling and analysis of vadose zone sediments will occur in the vicinity of the S and SX tank farms to meet the objectives of this investigation.

A.1.1 PURPOSE AND OBJECTIVE

This plan details the field and laboratory activities to be performed in support of the investigation of vadose zone contamination in WMA S-SX and is designed to be used in conjunction with the work plan and referenced procedures. The field investigations at WMA S-SX addressed in this SAP are as follows.

- Installation of a slant exploratory borehole, under tank SX-108 starting northwest of tank SX-108 and extending underneath the tank. Sediment samples will be attempted from about 16 m (50 ft) below ground surface (bgs) to the top of the Plio-Pleistocene unit or maximum depth of contamination, whichever is greater. Selected portions of the sediment samples will be analyzed for their chemical, radiological, and physical characteristics. A suite of geophysical surveys will be performed depending on the degree of contamination on the inside of casing following sampling. This borehole will require decommissioning. Following completion of the field investigation, the borehole will be decommissioned per Washington Administrative Code requirements.

- Deployment of direct push technology for the near-surface characterization in the north portion of S tank farm. Two areas have been identified for the Phase 1 characterization. These areas include the north end of the S tank farm in the vicinity of tanks S-102 and S-104. The S tank farm areas of interest include: southeast of the S-104 tank, the unplanned release (UPR) near diversion box 241-S-B, and the area east of tank S-104 near the fence (in the drainage path of the UPR that occurred in the SY tank farm and flowed into the S tank farm). Sediment samples would be collected between the tank farm surface and approximately 16.7 m (55 ft) bgs using direct push technology. Although near-surface characterization is focused typically on the upper 4.6 m (15 ft), the sampling method has the capability to sample deeper and provide additional data for the characterization activities.

This SAP describes two distinct field scope elements; thus, it is divided into two parts:

Part I – Installation of a slant exploratory borehole

Part II – Near-surface characterization between the tank farms and S tank farm.

Technical procedures or specifications that apply to this work include Waste Management Federal Services sampling and geophysical surveying procedures (SML-EP-001), sample and mobile laboratories procedures (SML-EP-001), and vadose zone characterization at the Hanford tank farms, high-resolution passive spectral gamma-ray logging procedures (P-GJPO-1783). All field and laboratory work prescribed by this SAP shall also be in conformance with Hanford analytical services quality assurance requirements document (HASQARD) (DOE/RL-96-68). Field and laboratory personnel should be familiar with these documents, as appropriate, and maintain a copy for guidance during work activities.

The field activities related to this investigation consist of vadose zone sampling and sample analysis. This SAP addresses the requirements of the vadose zone sampling and analysis.

The quality assurance project plan, Appendix A of the Phase 1 *Resource Conservation and Recovery Act of 1976* Facility Investigation/corrective measures study (RFI/CMS) work plan (DOE/RL-99-36), is an integral part of the SAP and they must be used jointly. HNF-5272, data quality objectives workbook of WMA S-SX, references the sampling analytical quality assurance and quality control requirements that must be used to obtain representative field samples and measurements. Knowledge of the health and safety plan, Appendix B of DOE/RL-99-36, is required by those involved in the field sampling, because it specifies procedures for the occupational health and safety protection of project field personnel. The data management plan, Appendix C of DOE/RL-99-36, denotes the requirements for field and laboratory data storage. The waste management plan, Appendix D of DOE/RL-99-36, denotes the requirements for the management of investigative-derived waste and the appropriate collection, characterization, and designation of waste produced by the characterization activities.

PART I

INSTALLATION OF SLANT BOREHOLE (WELL NUMBER TBD)

The following is a discussion of the field tasks and associated subtasks required for the drilling, sampling, and sample analysis associated with the slant borehole.

A.2.0 PROJECT MANAGEMENT (TASK 1 OF CHAPTER 5.0)

Project management will be followed as described in the Phase 1 RFI/CMS work plan (DOE/RL-99-36).

A.3.0 GEOLOGIC AND VADOSE ZONE INVESTIGATION (TASK 2 OF CHAPTER 5.0)

The geologic and vadose zone investigation task has two subtasks relevant to the installation of the new borehole: Subtask 2a-Field Activities and Subtask 2b-Laboratory Analysis. The following subsections describe each of these subtasks.

A.3.1 FIELD ACTIVITIES (SUBTASK 2A OF CHAPTER 5.0)

The field activities addressed in this subtask required to support the geologic and vadose zone investigation are drilling, geophysical logging, sediment sampling, and reporting activities.

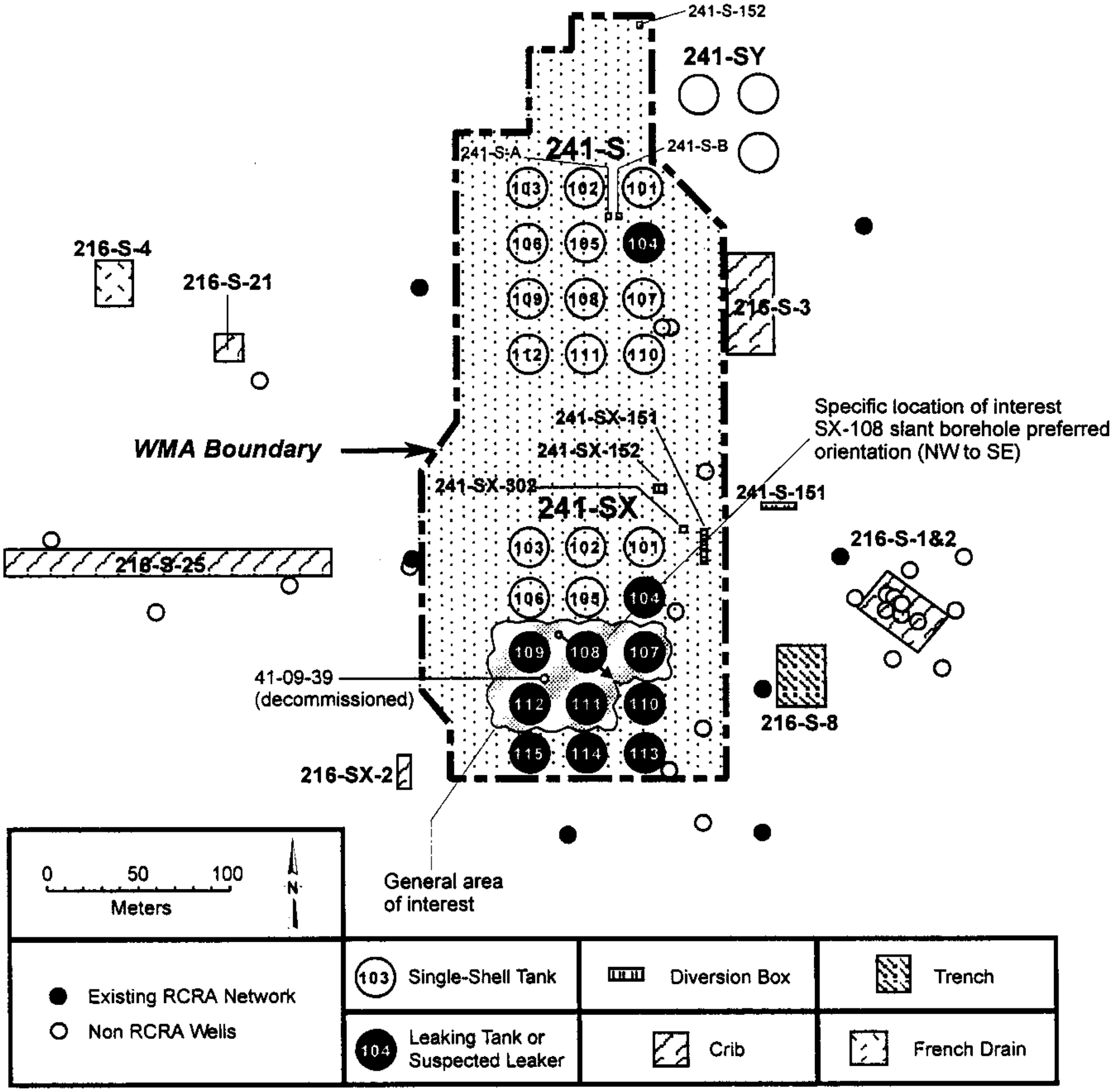
A.3.1.1 Drilling Activities

Drilling will be conducted using specifications and guidance in accordance with WAC 173-160. Drilling operations will also conform to SP 4-1, "Soil and Sediment Sampling," WP 2-2, "Field Cleaning and/or Decontamination of Equipment," and the task-specific work package that will be generated for these field activities (ES-SSPM-001). The work package will contain such information as borehole construction, sampling technique, and radiation protection. All waste will be handled in accordance with the requirements of the dangerous waste regulations (WAC 173-303) and/or the site-specific waste control plan. These techniques are based on minimizing the exposure of field personnel to both radiation and chemical pollutants, which is the application of as low as reasonably achievable in compliance with regulatory requirements.

The planned location of the slant borehole is northwest of tank SX-108 extending under tank SX-108 within the SX tank farm. The location of the borehole is shown in Figure A.1.

The final design for the slant borehole under tank SX-108 has not been completed. One of the primary constraints on sample collection from the "hot" zone under tank SX-108 is the anticipated radiation level (>500 mrem/hr [based on cesium-137 concentrations of 10^8 to 10^{10} pCi/g]) which will limit the sample volumes that can be brought to the surface.

Figure A.1. Waste Management S-SX Vadose Zone Soil Sampling Locations



Docprod\lmhc\rfi\hnf-5085\corel8\Fig-A-1.cdr

The proposed technique for collecting sediment samples will be a removable tip in conjunction with a split-spoon sampler to allow driven samples to be collected ahead of the casing. The removable tip concept would likely lead to contamination problems on the inside of the borehole casing and would require the tip to be replaced with a new one each time it was removed and limit the ability to geophysical log the borehole. The split-spoon sampler that would be used would be approximately 2-in. diameter by 2 ft-long with a 4-in.-diameter shielded lead casing around the sampler. The hole would result in being 4-in. in diameter after the sample was collected, but only a 2-in. sample would be collected and brought to the surface. The 2-ft sample would allow for the depth of penetration to be beyond potential disturbed sediments below the end of the hole and would bring sediments unable to be handled to the surface. This approach is still in the developmental stages and would be one that would be demonstrated outside the tank farms prior to implementation inside the tank farms. This method would collect enough sediment sample to be analyzed, and provide the least amount of disturbance therefore providing a sample that is as close as possible to representative sample.

There are backup approaches that could be taken to collect sediment samples during casing extraction if collecting a split-spoon sample is found to be impractical. These options include using a sidewall sampling tool and scraping or under-reaming the hole and collecting the material with a split spoon sampler.

In case the sidewall sampling technique will be maintained in the event that split-spoon sampling cannot be implemented or additional sampling horizons are identified. The prototype spring sampler initially proposed for sample collection during decommissioning of borehole 41-09-39 had little success and a number of design modifications were made during the course of the decommissioning. It became apparent during this process that development of sampling tools while working in the tank farm is cost prohibitive and that unexpected field conditions warrant having alternative sampling techniques available. A drop-arm sampler was fabricated as a backup to the spring sampler and after being effectively deployed became the main sampling tool throughout the 41-09-39 decommissioning effort. Samples were recovered from every sampling horizon attempted. Drawbacks with all of the sidewall sampling techniques are sample volume and the depth of penetration into the formation. Because sample volume is limited, multiple sampling attempts at each horizon of interest are necessary. The depth of penetration is an issue relative to the dragdown argument with the idea being if a representative sample of sufficient penetration can be collected then a gamma energy analysis conducted along the length of the sample could be used to assess near-borehole contamination versus contamination in the formation. The drop arm sampler penetrates approximately 4 in. into the formation whereas the spring sampler is designed to penetrate approximately 6 in. into the formation.

Contaminant dragdown during drilling and sampling activities is unavoidable and has been observed in recent sampling activities. Different drilling/sampling techniques will impact dragdown to varying degrees. Because the objective of the characterization activities identified in the data quality objectives is to safely sample in and below the "hot" zone in a region of known leakage and not to tag the leading edge of a contaminant plume, the dragdown issue is a secondary concern.

To reduce the uncertainties associated with placing a slant borehole under tank SX-108, a demonstration is planned outside of the tank farms to evaluate the techniques for installing the borehole, implementing all sampling method techniques, and collecting samples. This demonstration will help refine the borehole angle and the sample collection methods. The sampling method that provides the best results through implementation and scheduling issues (i.e., time management) will be deployed. The current planning basis for the slant borehole beneath tank SX-108 includes the following:

- The borehole enters the ground at approximately the 11 o'clock position 12.2 m (40 ft) from the edge of the tank nominally 30° off vertical, heading directly underneath the center of the tank (toward the 5 o'clock position) at nominally 30° off vertical. A preliminary investigation of surface and subsurface interference has identified this as a potentially viable location. The borehole depth would be limited to the Plio-Pleistocene unit or to the maximum depth of contamination, whichever is deeper.

- Sediment samples would be collected using a split-spoon sampler ahead of the borehole casing. The samples would be transported to the laboratory and analyzed for the contaminants of concern identified in Tables A.1 and A.2. Nominally, 10 horizons would be sampled based on existing logging and the need to provide depth coverage.

An optional method for collecting samples from the area of interest under tank SX-108 involves a direct push (or some other alternative sample collection method) out horizontally from an existing caisson. This option has the potential to collect the necessary samples within and below the hot zone; however, there are a number of issues associated with the caissons that require further evaluation. A task has been identified in the fiscal year 2000 plan to evaluate the feasibility of using the caissons for sample collection under tank SX-108.

Procedures for decontamination of sampling equipment are contained in WP 2-2, "Field Cleaning and/or Decontamination of Equipment" (ES-WSPM-001).

The depth of the vadose zone boring will be to the maximum depth of contamination or the top of the Plio-Pleistocene unit, whichever is deeper unless perched water is encountered. If the U.S. Department of Energy desires to continue the borehole through a perched water zone, then a waiver from the Washington State Department of Ecology (Ecology) would be required. If the U.S. Department of Energy does not seek a waiver or if it is sought but denied by Ecology then, drilling will be terminated and the borehole decommissioned with approved material. In this case, decommissioning will commence immediately following final geophysical logging of the borehole.

The use of field screening instruments will be used for evaluating alpha-, beta-, and gamma-emitting radionuclides. Radiological screening is expected to be effective in determining the initial extent of contamination.

Table A.1. Constituents and Methods for Slant Borehole Sediment Sample Analyses and Near-Surface Characterization Samples

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Americium-241	14596-10-2	3.10E+01	2.10E+02	Americium Isotopic - Alpha Energy Analysis (AEA)	1	400	1	4000	+-20%	70-130%	+-35%	70-130%
Carbon-14	14762-75-5	*5.20E+00*	*3.31E+04*	Carbon-14 - Liquid Scintillation	200		50	NA	+-20%	70-130%	+-35%	70-130%
Cesium-137	10045-97-3	6.20E+00	2.50E+01	Gamma Energy Analysis	15	200	0.1	2000	+-20%	70-130%	+-35%	70-130%
Cobalt-60	10198-40-0	1.40E+00	5.20E+00	Gamma Energy Analysis	25	200	0.05	2000	+-20%	70-130%	+-35%	70-130%
Europium-152	14683-23-9	3.30E+00	1.20E+01	Gamma Energy Analysis	50	200	0.1	2000	+-20%	70-130%	+-35%	70-130%
Europium-154	15585-10-1	3.00E+00	1.10E+01	Gamma Energy Analysis	50	200	0.1	2000	+-20%	70-130%	+-35%	70-130%
Europium-155	14391-16-3	*1.25E+02*	*4.49E+02*	Gamma Energy Analysis	50	200	0.1	2000	+-20%	70-130%	+-35%	70-130%
Neptunium-237	13994-20-2	*2.50E+00*	*6.22E+01*	Neptunium-237 - AEA	1		1	8000	+-20%	70-130%	+-35%	70-130%
Nickel-63	13981-37-8	*4.03E+03*	*3.01E+06*	Nickel-63 - Liquid Scintillation	15	NA	30	NA	+-20%	70-130%	+-35%	70-130%
Plutonium-238	13981-16-3	*3.74E+01*	*4.73E+01*	Plutonium Isotopic - AEA	1	130	1	1300	+-20%	70-130%	+-35%	70-130%
[illegible]	PU-239/240	3.39E+01	*4.37E+02*	Plutonium Isotopic - AEA	1	130	1	1300	+-20%	70-130%	+-35%	70-130%
Total radioactive Strontium or Sr-90	SR-RAD or 10098-97-2	4.50E+00	2.50E+03	Total Radioactive Strontium or Strontium Isotopic - Gas Proportional Counting (GPC)	2	80	1	800	+-20%	70-130%	+-35%	70-130%
Technetium-99	14133-76-7	5.70E+00	4.10E+05	Technetium-99 - Liquid Scintillation	15	400	15	4000	+-20%	70-130%	+-35%	70-130%
Thorium-232	TH-232	*1.00E+00*	*5.10E+00*	Thorium Isotopic - AEA (pCi) ICPMS (mg)	1	.002 mg/L	1	0.02 mg/Kg	+-20%	70-130%	+-35%	70-130%
Uranium-234	13966-29-5	1.60E+02	1.20E+03	Uranium Isotopic - AEA (pCi) ICPMS (mg)	1	.002 mg/L	1	0.02 mg/Kg	+-20%	70-130%	+-35%	70-130%
Uranium-235	15117-96-1	2.60E+01	1.00E+02	Uranium Isotopic - AEA (pCi) ICPMS (mg)	1	.002 mg/L	1	0.02 mg/Kg	+-20%	70-130%	+-35%	70-130%
Uranium-238	U-238	8.50E+01	4.20E+02	Uranium Isotopic - AEA (pCi) ICPMS (mg)	1	.002 mg/L	1	0.02 mg/Kg	+-20%	70-130%	+-35%	70-130%

Table A.1. Constituents and Methods for Slant Borehole Sediment Sample Analyses and Near-Surface Characterization Samples (Cont'd)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Polychlorinated biphenyls (PCBs)	1336-36-3	5.00E+02	6.50E+04	PCBs - 8082^c - GC	0.5	5	16.5	100	e	e	e	e
Cyanide	57-12-5	2.00E+04	2.00E+04	Total Cyanide - 9010 - Colorimetric	5	5	500	500	e	e	e	e
Lead	7439-92-1	3.53E+05	3.53E+05	Metals - 6010 - ICP	100	200	10000	20000	e	e	e	e
Lead	7439-92-1	3.53E+05	3.53E+05	Metals - 6010 - ICP(TRACE)	10	NA	1000	NA	e	e	e	e
Mercury	7439-97-6	N/A	N/A	Mercury - 7470 - CVAA	0.5	5	N/A	N/A	e	e	e	e
Mercury	7439-97-6	3.30E+02	3.30E+02	Mercury - 7471 - CVAA	N/A	N/A	200	200	e	e	e	e
Nickel	7440-02-0	3.20E+04	7.00E+04	Metals - 6010 - ICP	40	40	4000	4000	e	e	e	e
Silver	7440-22-4	8.00E+03	1.00E+04	Metals - 6010 - ICP	20	20	2000	2000	e	e	e	e
Silver	7440-22-4	8.00E+03	1.00E+04	Metals - 6010 - ICP(TRACE)	5	NA	500	NA	e	e	e	e
Antimony	7440-36-0	3.20E+04	1.40E+06	Metals - 6010 - ICP	60	120	6000	12000	e	e	e	e
Antimony	7440-36-0	3.20E+04	1.40E+06	Metals - 6010 - ICP(TRACE)	10	NA	1000	NA	e	e	e	e
Arsenic	7440-38-2	6.50E+03	6.50E+03	Metals - 6010 - ICP	100	200	10000	20000	e	e	e	e
Arsenic	7440-38-2	6.50E+03	6.50E+03	Metals - 6010 - ICP(TRACE)	10	NA	1000	NA	e	e	e	e
Barium	7440-39-3	1.32E+05	2.45E+05	Metals - 6010 - ICP	200	200	20000	20000	e	e	e	e
Barium	7440-39-3	1.32E+05	2.45E+05	Metals - 6010 - ICP(TRACE)	5	NA	500	NA	e	e	e	e
Beryllium	7440-41-7	1.51E+03	1.51E+03	Metals - 6010 - ICP	5	10	500	1000	e	e	e	e
Cadmium	7440-43-9	5.00E+02	5.00E+02	Metals - 6010 - ICP	5	10	500	1000	e	e	e	e
Cadmium	7440-43-9	5.00E+02	5.00E+02	Metals - 6010 - ICP(TRACE)	5	NA	500	NA	e	e	e	e
Chromium (total)	7440-47-3	1.60E+06	3.50E+06	Metals - 6010 - ICP	10	10	1000	2000	e	e	e	e
Chromium (total)	7440-47-3	1.60E+06	3.50E+06	Metals - 6010 - ICP(TRACE)	10	NA	1000	NA	e	e	e	e
Cr VI	18540-29-9	8.00E+03	1.75E+04	Chromium (hex) - 7196 - Colorimetric	10	4000	500	200000	e	e	e	e
Copper	7440-50-8	5.92E+04	1.30E+05	Metals - 6010 - ICP	25	25	2500	2500	e	e	e	e
Selenium	7782-49-2	5.00E+03	5.00E+03	Metals - 6010 - ICP	100	200	10000	20000	e	e	e	e
Selenium	7782-49-2	5.00E+03	5.00E+03	Metals - 6010 - ICP(TRACE)	10	NA	1000	NA	e	e	e	e
Uranium (total)	7440-61-1	2.40E+05	1.05E+07	Uranium Total - Kinetic Phosphorescence Analysis	0.1	20	1000	200	+-20%	70-130%	+-35%	70-130%

Table A.1. Constituents and Methods for Slant Borehole Sediment Sample Analyses and Near-Surface Characterization Samples (Cont'd)

[illegible]	CAS [illegible]	Action Levels		[illegible]	[illegible]				[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]				
Ammonia-ammonium	7664-41-7	2.72E+07	5.95E+07	Ammonia - 350.N[d]	50	800000	500	8000000	e	e	e	e
Phosphate	14265-44-2	N/A	N/A	Anions - 9056 - IC	500	15000	5000	40000	e	e	e	e
Nitrate	14797-55-8	4.40E+06	4.40E+06	Anions - 9056 - IC	250	10000	2500	40000	e	e	e	e
Nitrite	14797-65-0	3.30E+05	3.30E+05	Anions - 9056 - IC	250	15000	2500	20000	e	e	e	e
Nitrate/nitrite as N	NO3+N02-N	3.30E+05	3.30E+05	Nitrate/Nitrite - 353.N[d]	75	NA	750	NA	e	e	e	e
Sulfate	14808-79-8	2.50E+07	2.50E+07	Anions - 9056 - IC	500	15000	5000	40000	e	e	e	e
Chloride	16887-00-6	2.50E+07	2.50E+07	Anions - 9056 - IC	200	5000	2000	5000	e	e	e	e
Fluoride	16984-48-8	9.60E+04	2.00E+05	Anions - 9056 - IC	500	5000	5000	5000	e	e	e	e
Sulfides	18496-25-8	N/A	N/A	Sulfide - 9030 - Colorimetric	500	NA	5000	NA	e	e	e	e
Bromide	24959-67-9	N/A	N/A	Anions - 9056 - IC	250	NA	2500	NA	e	e	e	e
pH	pH	N/A	N/A	pH - 9045 - Electrode	N/A	N/A	N/A	N/A	e	e	e	e
TOC/TC	TOC/TC	N/A	N/A	ASTM D4129-82 - total combustion/colorimetric	1 ppm	1 ppm	1 ppm	1 ppm	e	e	e	e
Cation exchange capacity	CEC	N/A	N/A	Cation exchange capacity/Methods of Soil Analysis Part 2; 9-3.1	N/A	N/A	N/A	N/A	f	f	f	f
Particle size distribution	N/A	N/A	N/A	Particle size distribution/ASTM D 422-63, ASTM D 854-83	N/A	N/A	N/A	N/A	f	f	f	f
Mineralogy	N/A	N/A	N/A	XRD/SEM/TEM/JEA-3, Rev. 0	N/A	N/A	N/A	N/A	f	f	f	f
Electrical conductance	EC	N/A	N/A	Electrometric/PNL-MA-567-FA-2	N/A	N/A	N/A	N/A	f	f	f	f
Moisture content	N/A	N/A	N/A	Moisture content/ PNL-MA-567-SA-7	N/A	N/A	N/A	N/A	f	f	f	f
Matric potential	N/A	N/A	N/A	Matric potential/ PNL-MA-567-SA-10	N/A	N/A	N/A	N/A	f	f	f	f
Distribution Coefficient	K_d	N/A	N/A	Methods for determining radionuclide retardation factors, 1980/PNL-3349 USC-70	N/A	N/A	N/A	N/A	f	f	f	f
Bulk density	N/A	N/A	N/A	Bulk density/PNL-MA-567-SA-8	N/A	N/A	N/A	N/A	f	f	f	f

Table A.1. Constituents and Methods for Slant Borehole Sediment Sample Analyses and Near-Surface Characterization Samples (Cont'd)

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Moisture retention	θ_r	N/A	N/A	Moisture retention/ ASTM D 2325-68	N/A	N/A	N/A	N/A	f	f	f	f
Saturated hydraulic conductivity	K_s	N/A	N/A	Saturated hydraulic conductivity/ASTM D18.21 (draft in review) Methods of Soil Analysis, Part 2; 13-3.2 and 13-3.3	N/A	N/A	N/A	N/A	f	f	f	f

Note: For the chemical and radiological constituents the preferred methods are those listed in EPA SW-846 or the ASTM Standards (ASTM 1998).

[a] RR - Rural Residential C/I - Commercial Industrial Values from WDOH *Hanford Guidance for Radiological Cleanup* (WDOH/320-015). Italicized values are calculated using the same parameters as the WDOH guidance.

[b] Water values for sampling QC (e.g. equipment blanks/rinses) or drainable liquid (if recovered)

[c] All 4 digit numbers refer to *Test Methods for Evaluating Solid Waste* (EPA SW-846)

[d] *Methods of Analysis of Water and Waste* (EPA-600/4-79-020)

[e] Precison and Accuracy Requirements as identified and defined in the referenced EPA procedures.

[f] Precision and accuracy for these measurements are not required because of the nature of the measurement.

AEA - alpha energy analysis
ASTM - American Society for Testing and Materials
CVAA - cold vapor atomic absorption
IC - ion chromatography
ICP - inductively coupled plasma
ICPMS - inductively coupled plasma mass spectrometry
N/A - not applicable NA - not available
SEM - scanning electron microscopy
TEM - transmission electron microscopy
TOC/TC - total organic carbon/total carbon
WDOH - Washington Department of Health
XRD - x-ray diffraction

Table A.2. Constituents and Methods for Organic Analysis of Borehole Sediment Samples

Analysis/Constituent	Preparation Method	Preparation Procedure Number	Analytical Method	Analytical Procedure Number
VOA	Bulk Sediment	Note 1	GC/MS	SW846-8260
SVOAs with TICs	Bulk Sediment	Note 1	GC/MS	SW846-8270
PCBs (Note 2)	Bulk Sediment	Note 1	GC	GW846-8082

Note 1: Preparation/extraction procedures for VOA and SVOA analysis will depend on the types of organic compounds present in the sediment.
Note 2: Analyzed on selected samples collected from the near-surface characterization effort.

GC = gas chromatography
MS = mass spectrometry
PCBs = polychlorinated biphenyls
SVOA = semi-volatile organic analysis
VOA = volatile organic analysis

In addition to the borehole geologic logging, radiation measurements will be made using hand-held instruments on each segment of sample recovered during sampling. General observation will be noted as to drilling progress and problems. All of this information will be included in each borehole geologic log. Borehole geologic logs and well summary sheets will be prepared in accordance with approved or standard methods procedures.

A geologist will prepare a geological log for the slant borehole, based on the sediment samples. Borehole geologic logs will be prepared in accordance with approved procedures. The geologic log will include lithologic descriptions, sampling intervals, health physics technician hand-held instrument readings, screening results, evidence of any alteration of sediments, and general information and observations deemed relevant by the geologist to the characterization of subsurface conditions. Sediment samples will be screened with hand-held instruments for radiation, as appropriate, using techniques and procedures defined in the work package. Screening results and general observations as to drilling progress and problems will be included in each borehole log.

Waste containing unknown, low-level mixed radioactive waste and/or hazardous waste will be contained, stored, and disposed of according with Appendix D of DOE/RL-99-36 and specified in the quality assurance project plan (Appendix A of DOE/RL-99-36) and will be documented in the field activity reports. Waste will be disposed of in accordance with Appendix D of DOE/RL-99-36 and the Mixed Waste Burial Grounds. All important information will be recorded on a field activity report forms per approved procedures. Field activity report form includes borehole number, site location drawings, drawing of the downhole tool strings, site personnel, sampling types and intervals, zones noted by the health physics technician as elevated in radiological contaminants, instrument readings will be noted and the depth represented by those readings, and specific information concerning borehole completion.

The slant borehole will be abandoned following completion of the geophysical surveying. All steel casing will be removed and transferred to an appropriate disposal facility or controlled decontamination facility and the borehole will be pressure-grouted from the bottom up, using a Portland cement/bentonite slurry or other appropriate material in accordance with WAC 173-160. Specific procedures for borehole abandonment will be documented in the field work package. These procedures will comply with U.S. Environmental Protection Agency requirements and WAC 173-160.

A.3.1.2 Geophysical Surveying Activities

Based on sampling and construction methods, downhole spectral-gamma or gross gamma geophysical logging will be conducted to ascertain the gamma-emitting radionuclide concentrations. The spectral-gamma or gross gamma logging frequency will be directed by CH2M HILL Hanford Group, Inc. (CHG).

A full suite of geophysical logs will be run any time the casing size is changed and at the completion of the borehole. Because the proposed sampling method involves pulling split-spoon samples up through the borehole there is a high probability that the inner bore of the casing will become contaminated. Following completion of the sampling the contamination levels will be evaluated and a determination will be made on the utility of geophysically logging the borehole.

The following logging techniques could be used for the slant borehole:

- Gross-gamma logging to support correlation of confining layers and stratigraphy
- Spectral-gamma logging for measuring the distribution of selected radionuclides
- Neutron log for measuring the relative moisture content
- Neutron-enhanced spectral gamma logging for correlation of high salt tank waste and moisture content with spectral gamma and neutron probes, respectively.

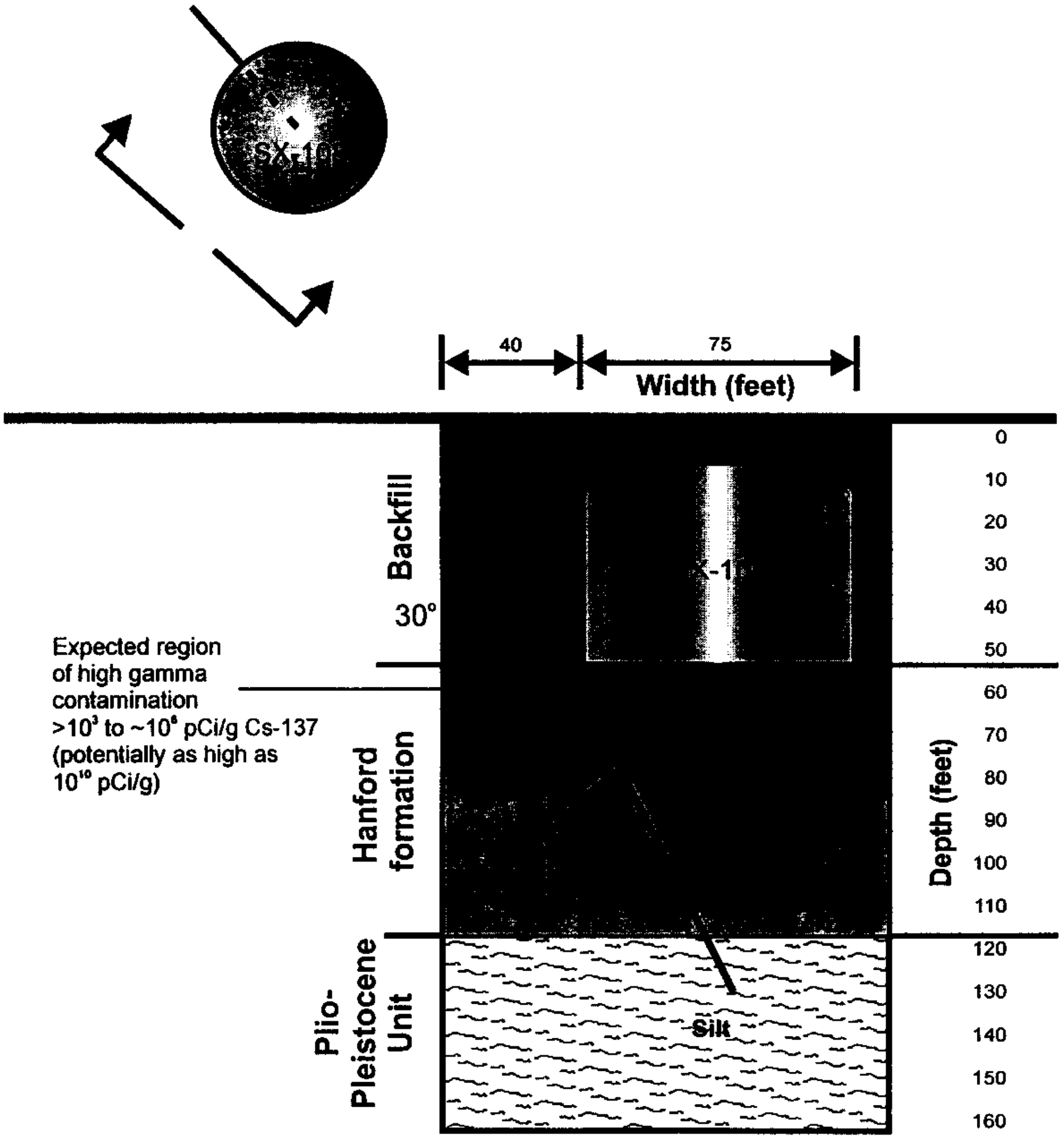
The existing equipment and procedures for gross-gamma and spectral-gamma logging in use at the Hanford Site provide acceptable data (P-GJPO-1783).

A.3.1.3 Sediment Sampling Activities

Borehole sampling will be performed to define the nature of contamination. Data from the borehole samples and analyses may provide evidence concerning how radionuclides and other contaminants migrate in the vadose zone and will support refinement of the general lithology and hydrostratigraphy of the sediments lying below the site. It also will provide sediment samples for determination of sediment chemistry and vadose zone properties. This SAP is specific to this borehole sampling event, and is not applicable to future borehole sampling events.

For the slant borehole, sediment sampling will be conducted beginning at 16.7 m (55 ft) bgs and will continue at discreet intervals of approximately 1.5 m (5 ft) until maximum depth of contamination or the Plio-Pleistocene unit is reached. Figures A.2 and A.3 show the proposed sampling strategy for the slant borehole.

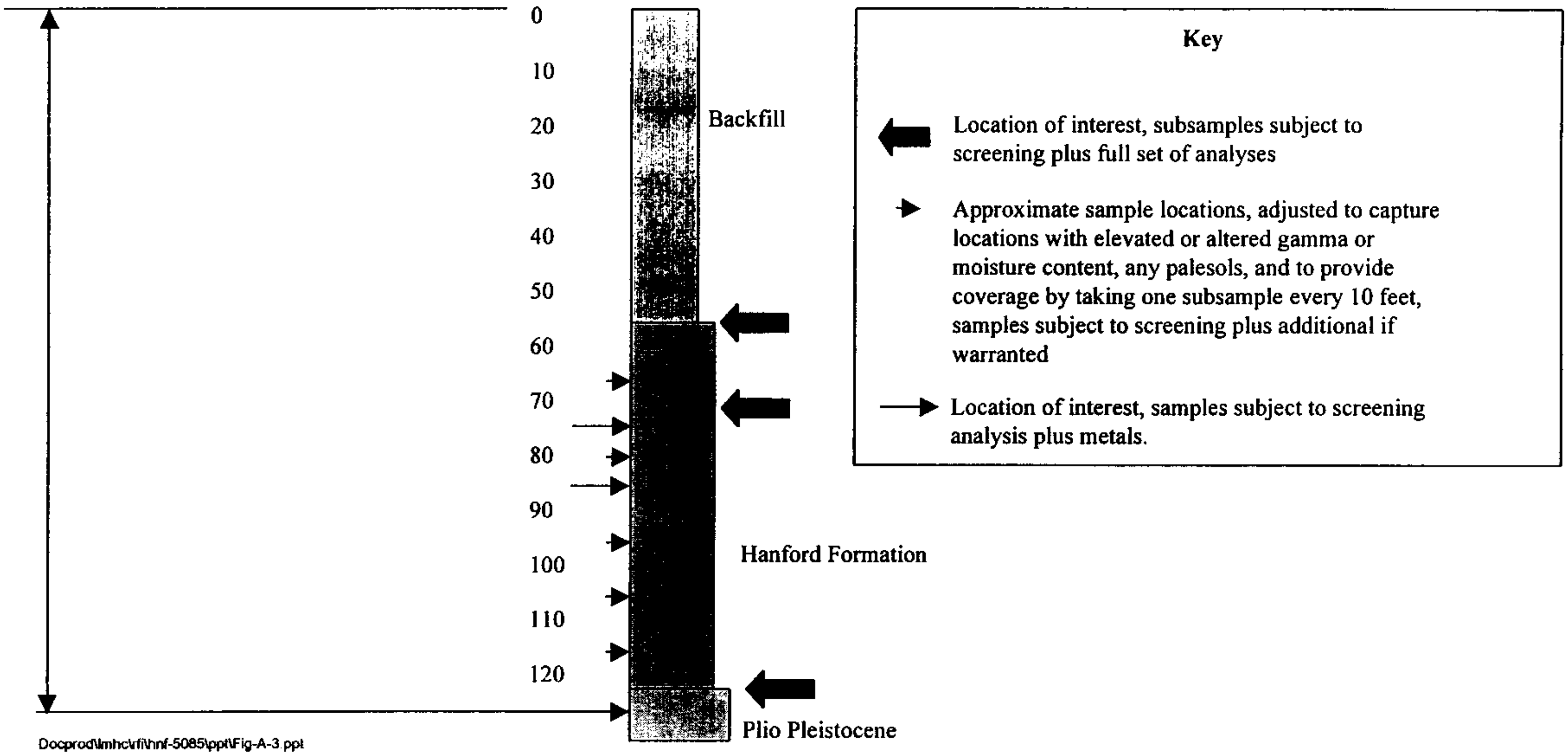
Figure A.2. SST SX-108 Slant Borehole



Expected region of high gamma contamination >10^3 to ~10^6 pCi/g Cs-137 (potentially as high as 10^{10} pCi/g)

Docprod\m hc\rf\hnf-5085\corel8\Fig-A-2.cdr

Figure A.3. SX-108 Borehole Subsample Analyses Strategy



⬅ Location of interest, subsamples subject to screening plus full set of analyses

➔ Approximate sample locations, adjusted to capture locations with elevated or altered gamma or moisture content, any palesols, and to provide coverage by taking one subsample every 10 feet, samples subject to screening plus additional if warranted

⟶ Location of interest, samples subject to screening analysis plus metals.

Docprod\lmhc\rfi\hnf-5085\ppt\Fig-A-3.ppt

After the sediment samples are screened, these samples will be transported to the Pacific Northwest National Laboratory (Applied Geology and Geochemistry group) for analysis. All material removed from the borehole will be sent to the laboratory for possible future analysis. Samples will be contained in airtight sample containers after their initial screening by the health physics technician and are to be kept under refrigeration. This process is used to retain sediment moisture in as close to field condition as possible. All samples will be transported to the laboratory under refrigeration to further limit alteration of sediment moisture.

Field quality control samples also will be submitted for the full spectrum of chemical and radionuclide analyses. These quality control samples will consist of the following:

- Field duplicate samples: A minimum of 5% of the total collected samples shall be duplicated, or one duplicate for every 20 samples, whichever is greater.

- Equipment rinseate blanks: One equipment rinseate blank per borehole drilling activity or, if multiple types of samplers are used, once per type of sampler.

A.3.1.4 Groundwater Sampling Activities

No sampling of groundwater will be conducted for this characterization effort.

A.3.1.5 Field Reporting Activities

Field logs will be maintained to record all observations and activities conducted. A site representative will record the activities on a field activity report. Items for entry will include the following:

- Borehole number
- Site location drawings
- Drawings of the downhole tool strings
- Site personnel present
- Sampling types and intervals
- Zones noted by the health physics technician as elevated in radiological contaminants
- Instrument readings and the depth represented by those readings
- Specific information concerning borehole progress and completion.

All completed field records will be maintained and processed in accordance with approved CHG procedures.

A.3.2 LABORATORY ANALYSIS (SUBTASK 2B OF CHAPTER 5.0)

The following sections describe the laboratory analyses required for the samples collected from the slant borehole. Laboratory analyses will be performed on sediment samples in accordance with this SAP. All analytical work prescribed by this SAP will be performed by qualified laboratories with approved quality assurance plans. If the primary contracting laboratory is unable to complete the analyses, it is the primary contracting laboratory's responsibility to subcontract the laboratory work to a qualified secondary laboratory. Samples for laboratory analysis will be placed in appropriate containers and properly preserved in accordance with

SP 4-1, "Soil and Sediment Sampling" (ES-SSPM-001) and in accordance with the quality assurance project plan (Appendix A of DOE/RL-99-36). All samples for laboratory analysis will be transported under chain of custody in accordance with the quality assurance project plan (Appendix A of DOE/RL-99-36).

Sediment cuttings containing low-level and mixed radioactive waste will be contained, stored, and disposed of according to procedures defined in Appendix D of the Phase 1 RFI/CMS work plan (DOE/RL-99-36). Sediment cuttings containing hazardous waste and those containing unknown waste will be contained and disposed of in accordance with Appendix D of the Phase 1 RFI/CMS work plan (DOE-RL-99-36) at the Mixed Waste Burial Grounds. Storage of archive samples will be done until approval to dispose of the samples is provided by the CHG technical representative.

A.3.2.1 Sediment Sample Analysis

Geologic logging for this borehole will be conducted as it was for the borehole 41-09-39 extension. Specifically, once sample material from the slant borehole is received at the laboratory, it will be geologically logged by an assigned geologist in general conformance with standard procedures. The assigned geologist will photograph the samples and describe the geologic structure, texture, and lithology of the recovered samples. Special attention is to be paid to the presence of contaminant alteration. If such a phenomenon is noted, that sample will be noted, preserved for more detailed physical, chemical, and mineralogic analyses, and recorded in the laboratory notebook.

Sediment samples for laboratory analysis will be defined by location in the sample after the field screening and geologic logging have been completed and indication of contamination locations have been identified. Approximately 10 sediment samples from the borehole will be chosen for screening analysis. Screening analyses consist of:

- Nitrate
- Electrical conductivity
- Total organic carbon/total carbon
- pH.

The following criteria will be used to identify samples for laboratory analysis based on concurrence with Ecology.

- One subsample will be taken at approximately 17 m (55 ft) bgs, at or near the base of the tank.
- Subsamples will be taken at the major lithology changes in the Hanford formation.
- One subsample will be taken at the Plio-Pleistocene unit and Hanford formation contact.
- Subsamples will be taken in locations where elevated or altered gamma surveying was measured during the geological and geophysical borehole logging process based on nearby geophysical drywell logging.

- At least one subsample will be taken every 3 m (10 ft) if samples have not already been taken, based on the above criteria to ensure continuous distribution and lithologic completeness.

Worker safety considerations may limit the collection of samples at certain intervals. Figure A.3 shows the subsamples identified for laboratory analyses. A 1:1 water extract of all subsamples shall undergo screening analyses, which consist of nitrate analysis by the colorimetric method, pH measurement, and electrical conductance measurement. In addition each subsample will be directly measured for gamma emitters by gamma energy analysis. These analyses, along with the gamma surveying and moisture content measurements performed during the field geophysical surveys and the geologic logging, will be used to determine the extent of further subsample analysis. Table A.1 identifies the full complement of analyses and their respective laboratory preparation and analytical methods. This paragraph and the remainder of Appendix A identifies which analysis will be conducted on which sample. If more than one preparation or analytical method is listed, the expertise of the laboratory geochemistry staff will be used to determine which methods will produce the best results and will provide the best understanding of the chemistry involved. For those methods that produce multiple constituents (i.e., inductively coupled plasma), all constituents identified will be reported. Every effort is to be made to meet regulatory holding times where appropriate.

Because the purpose of the slant borehole analysis is to gain an understanding of the nature and extent of contamination, the fate and transport of the contaminants in the vadose zone, and to produce RCRA-compliant data, the analysis of these subsamples consists of two levels. The baseline level involves analysis of inorganic and radiochemical constituents in full conformance with HASQARD and with no modifications to methods (as defined by HASQARD) without concurrence from the CHG technical representative and from Ecology. Substitutions and deviations to methods as defined by HASQARD will not require concurrence from Ecology. The second level involves a research-type approach to the analyses. In this level, procedures may be modified or developed to gain a more comprehensive understanding of the dynamics involved. Although specific quality control criteria do not apply to this level, compliance with an approved quality assurance plan provided by the primary laboratory will be performed and research analysis will be initiated following notification and approval of the activities by the CHG technical representative.

The backfill – Hanford formation contact sample, peak gamma concentration sample and the sample obtained at the Hanford formation and Plio-Pleistocene unit contact will be analyzed for the constituents and properties identified in Table A.1. It is recognized that conditions may occur when all of the analyses identified in Table A.1 are not warranted (e.g., limited potential for data) and these occurrences will be evaluated on a case-by-case basis.

One sample from at or near the base of the tank will be analyzed for volatile organics identified in Table A.2.

The remaining samples will be analyzed for specific constituents listed in Table A.1 depending on the results of the nitrate, electrical conductivity, total organic carbon/total carbon, and pH screening analyses. A review of the screening analyses results with technical representatives along with Ecology will be conducted prior to performing additional analyses. Screening analysis may be used to determine whether alternative analytical techniques with lower detection limits should be used for specific radionuclides of concern. The screening criteria and associated analytical requirements are identified as follows.

- Gamma-emitting radioisotopes by gamma energy analysis
- Metals and radioisotopes by inductively coupled plasma-mass spectrometry
- Tritium and strontium 90 by the liquid scintillation method
- Particle size distribution
- Carbon 14.

A minimum of two samples collected within the Hanford formation will be analyzed for metals as identified in Table A.1.

The data obtained from the above analyses will be used to evaluate the location of contamination plumes in the sediment column. The results of the above analyses will also be used to determine if additional analyses are warranted. Additional analyses would be performed based on the judgement and expertise of the responsible Pacific Northwest National Laboratory geochemist, with concurrence from the CHG technical representative and Ecology. The following analyses would be performed as additional analyses:

- Cation exchange capacity
- Mineralogy
- Matric potential
- K_d (distribution coefficient)
- Bulk density
- Moisture retention
- Saturated hydraulic conductivity.

Tables A.1 and A.2 identify the analyses and laboratory methods to be used for the sample analyses. For the chemical and radiological constituents, the preferred methods are those listed in SW-846 (EPA 1986) or the American Society for Testing Materials standards (ASTM 1998). The requested constituents may be analyzed by laboratory-specific procedures, provided that the procedures are validated and conform to HASQARD. Both the EPA SW-846 methods and the Pacific Northwest National Laboratory methods listed in Tables A.1 and A.2 are based on techniques from "Methods of Soil Analysis." Therefore, these procedures should be comparable. The detection limit, precision, and accuracy guidelines for the parameters of interest are listed in the data quality objectives workbook for WMA S-SX (HNF-5272).

PART II

NEAR-SURFACE CHARACTERIZATION

The following is a discussion of the field tasks and associated subtasks required for the sampling and sample analysis associated with the near-surface characterization in the northern portion of S tank farm. The tasks are generally parallel to those addressed for the slant borehole.

A.4.0 PROJECT MANAGEMENT (TASK 1 OF CHAPTER 5.0)

Project management will be followed as described in the Phase 1 RFI/CMS work plan (DOE/RL-99-36).

A.5.0 GEOLOGIC AND VADOSE ZONE INVESTIGATION (TASK 2 OF CHAPTER 5.0)

As with installation of the slant borehole, the geologic and vadose zone investigation task for the near-surface characterization has two subtasks: Subtask 2a-Field Activities and Subtask 2b-Laboratory Analysis. The following subsections describe each of the subtasks with a field activity component.

A.5.1 FIELD ACTIVITIES (SUBTASK 2A OF CHAPTER 5.0)

The field activities addressed in this subtask that are required to support the geologic and vadose zone investigation are geophysical surveying, sediment sampling, and reporting.

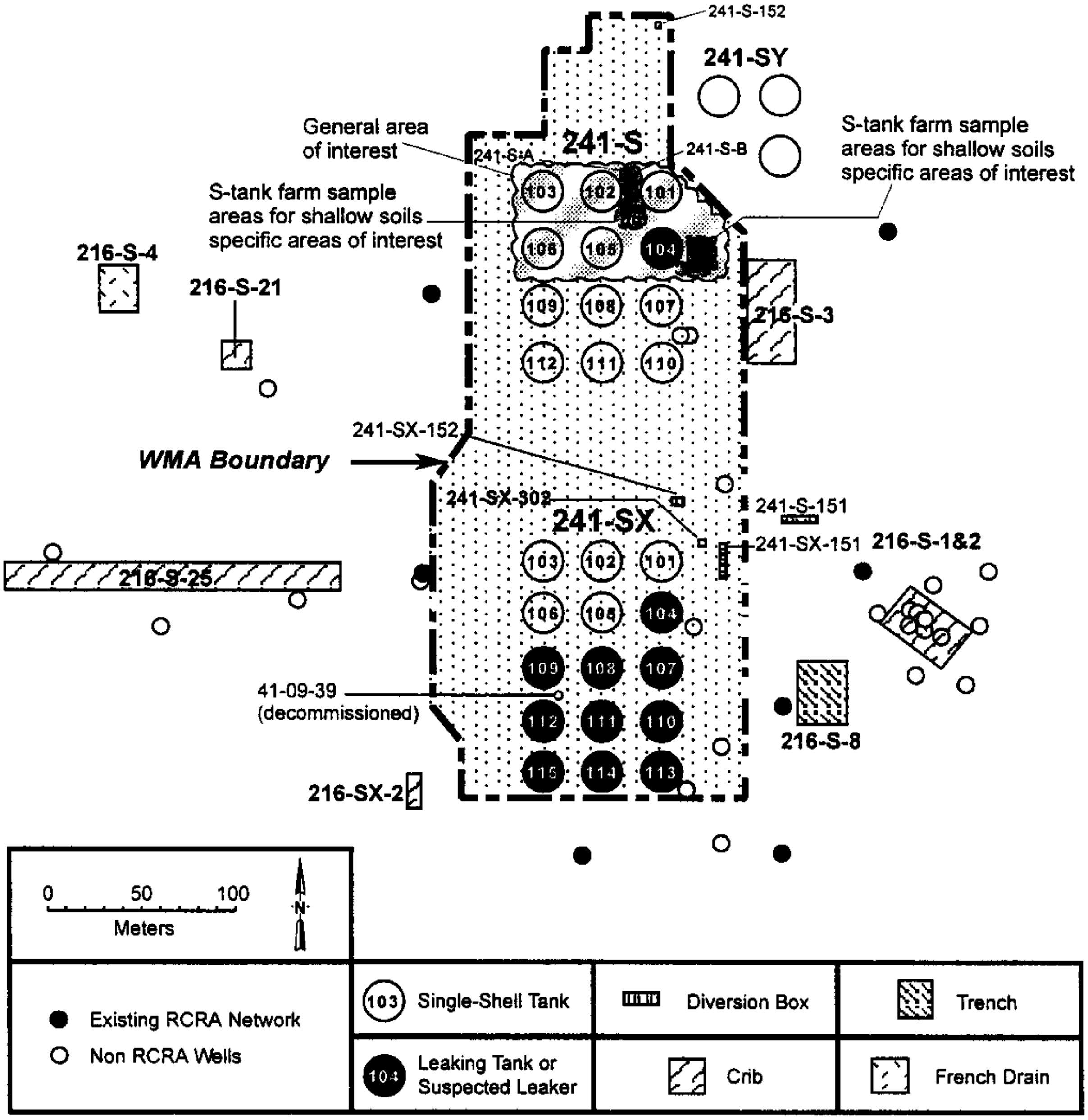
A.5.1.1 Exploratory Activity

Two areas have been identified for the Phase 1 shallow vadose zone soil characterization. These areas are within the north end of the S tank farm. The S tank farm areas of interest include: southeast of tank S-104, the UPR near diversion box 241-S-B, and the area east of tank S-104 near the fence (in the drainage path of the UPR that occurred in the SY tank farm and flowed into the S tank farm). For the purpose of the data quality objectives, the shallow investigation of these areas would consist of collecting samples at approximately nine locations. The general sampling locations are identified on Figure A.4. Sediment samples would be attempted from the tank farm surface to approximately 16.7 m (55 ft) bgs using direct push technology. Although near-surface characterization is focused typically on the upper 4.6 m (15 ft), both sampling methods have the capability to sample deeper and provide additional data for the characterization effort.

Direct push deployment at the shallow zone characterization locations would include the following.

- Shallow soil characterization will be carried out using a truck-mounted cone penetrometer-based system.

Figure A.4. Waste Management S-SX Shallow Soil Sampling Locations



Docprod\lmhc\rfi\hnf-5085\corel6\Fig-A-4.cdr

- Deployment and interrogation with a gross-gamma/spectral gamma cone penetrometer probe. The depth of investigation will be determined by the depth to which the probe can be advanced using a standard deployment truck. The probe will be deployed using the gross gamma mode with the tool advanced at approximately 2 cm/sec (0.8 in./sec). If, in the upper 5 m (15 ft) the downhole instrument indicates a potential cesium-137 concentration of 3.7 pCi/g or greater, logging will be shifted to the spectral mode to determine the presence and level of concentration of cesium-137; below 5 m (15 ft) the threshold limit for spectral gamma determinations will be 20 pCi/g. In zones where cesium-137 is present at concentrations greater than 20 pCi/g, spectral gamma readings will be taken at 0.5 m (1.5 ft) intervals. In all cases, gross gamma measurements are to be taken while the probe is advanced.

- The graphical log developed using the gross and spectral gamma measurements will be used to select intervals to be sampled.

- The sampling push is to be made in a location that is no more than 0.7 m (2 ft) from the site of the gamma push.

- A single point sampler will be used to collect the required samples. Sampling intervals will be selected from those horizons with a cesium-137 concentration of 20 pCi/g or greater. In the event that horizons are penetrated that would yield samples having a greater that 50 mrem/hr dose rate at 30 cm (12 in.) (based on calculations using sampler size and cesium-137 concentration) a sample will be collected from the first interval below the high rate zone having a dose rate of less than 50 mrem/hr.

- The samples would be transported to the laboratory and analyzed for the contaminants of concern identified in Table A.1.

As a contingency if direct push technology was not feasible, a hollow-stem auger deployment at the shallow zone characterization locations would be implemented.

The samples selected for analysis would be subject to screening analyses, which consist of nitrate analysis by colorimetric method, pH, electric conductance, and gamma energy analysis. Based on the results of the screening, the samples would be analyzed for the remaining contaminants of concern identified in Table A.1.

Two separate areas are to be characterized. The areas consist of the vicinity of tank S-102 and the vicinity of tank S-104. These two sites exhibit separate instances of cesium-137 in vadose zone dry wells that may be indicative of near-surface sources. In addition, the region to the east of tank S-104 has potentially been impacted by a tank overfill event in the SY double-shell tank farm. A total of nine push sites have been identified. An average of four samples per site will be collected.

A.5.1.1.1 241-S-104 Site

The highest recorded levels of cesium-137 contamination associated with this site are in borehole 40-04-05 in the southeast quadrant of the tank. Contamination is estimated at about 10^6 pCi/g at a depth of about 14 m (48 ft) bgs. Up to five sets of gamma probe and sampling pushes may be made to investigate this site. The pushes include the following.

- Adjacent to the 40-04-05 drywell, between the drywell and the tank. This location will be to ascertain if there is a vertical gradient between the push location and the identified elevation of contamination in 40-04-05 and to collect a sample from below the contaminated zone to determine if mobile contaminants are moving ahead of the cesium-137 hot spot.

- Adjacent to tank S-104 at the 5 o'clock position. This location is to be as close to the tank as the push-truck can be positioned within dome-load restrictions. The S tank farm tanks are constructed with a spare inlet port at this point. Experience in other farms has shown that these spare inlet ports are subject to failure if a tank is overfilled. This push will test the hypothesis that the contamination adjacent to the tank is due to an overfill event.

- Adjacent to the normal fill line at the 3 o'clock position. This location is to be within 3 to 4.5 m (10 to 15 ft) of the tank and as close to the fill line as safety considerations allow. This location will be used to determine the horizontal and vertical extent of the contamination found in the 40-04-05 borehole.

- Adjacent to the S tank farm fence line. This location will be used to determine the impact to shallow soils due to the surface release and subsequent ponding that occurred in the SY tank farm.

- Midway between the previous two pushes. This location would only be interrogated if positive determinations of contamination were found in one of the two previous pushes.

A.5.1.1.2 241-S-102 Site

The highest recorded levels of cesium-137 contamination associated with this site are in borehole 40-02-03 in the northeast quadrant of the tank. Contamination is estimated at about 10^6 pCi/g at a depth of about 6 m (20 ft) bgs. Four sets of gamma probe and sampling pushes are planned to investigate this site. The pushes include the following.

- Adjacent to tank S-102, northwest of drywell 40-02-03. Because no contamination is detected in drywell 40-02-01, this push will be used to determine the extent of contamination in a northwesterly direction from borehole 40-02-03. The push will be situated about midway between the boreholes and as near the tank as safety considerations allow.

- Along the line projected between 40-02-01 and 40-02-03, north of the cascade line between tanks S-101 and S-102. This location will provide information on the extent on contamination known to exist at 40-02-03 and assess the depth of movement of that contamination.

- Along the line projected between 40-02-01 and 40-02-03, south of the cascade line between tanks S-101 and S-102, and near the 241-S-A diversion box. This location will provide information as to the extent and general direction of movement of contaminants for this site. In addition the accumulation pit associated with the 241-S-A will be assessed as a possible contributor to the contamination.

- Adjacent to the 241-S-B diversion box. The potential for contamination in this region to be related to operation of the 241-S-B accumulation pit will be assessed.

A.5.1.1.3 Additional Pushes (Optional)

Additional pushes may be made based on the information developed during the initial campaign or decisions of River Protection Project Vadose Zone Project management. These additional pushes will be determined based on the determined extent of contamination and (1) the availability of both the cone penetrometer truck and crew and (2) availability of budget and support personnel.

A.5.1.2 Field Quality Control

After the samples are screened, these samples will be transported to the Pacific Northwest National Laboratory (Applied Geology and Geochemistry group) for analysis. All material removed from the push holes will be sent to the laboratory for possible future analysis. Samples will be contained in airtight sample containers after their initial screening by the health physics technician and are to be kept under refrigeration. This process is used to retain sediment moisture in as close to field condition as possible and prevent chemical and physical changes from occurring. All samples will be transported to the laboratory under refrigeration to further limit alteration of sediment moisture.

Field quality control samples also will be submitted for the full spectrum of chemical and radionuclide analyses. These quality control samples will consist of the following:

- Field duplicate samples: A minimum of 5% of the total collected samples shall be duplicated, or one duplicate for every 20 samples, whichever is greater.

- Equipment rinseate blanks: One equipment rinseate blank per direct push or, if multiple types of samplers are used, once per type of sampler.

A.5.1.3 Geophysical Surveying Activities

Prior to sediment sampling using the direct push, downhole gross gamma and spectral gamma geophysical surveying will be conducted to ascertain the gamma-emitting radionuclide concentration in the surrounding sediments. After each push with the direct push or each borehole with the hollow-stem auger, decommissioning will occur.

A.5.1.4 Field Reporting Activities

Field logs will be maintained to record all observations and activities conducted. A site representative will record the activities on a field activity report. Items for entry will include the following:

- Direct push or borehole number
- Site location drawings, including distances from known locations
- Drawings of the downhole tool strings for direct push or auger drilling
- Site personnel present
- Sampling types and intervals
- Zones noted by the health physics technician as elevated in radiological contaminants
- Instrument readings and the depth represented by those readings
- Specific information concerning borehole completion.

All completed field records will be maintained and processed in accordance with approved CHG procedures.

A.5.2 LABORATORY ANALYSIS (SUBTASK 2C OF CHAPTER 5.0)

The following sections describe the laboratory analyses required for the samples collected from the near-surface characterization.

A.5.2.1 Near-Surface Characterization Sediment Sample Analysis Requirements

A total of approximately nine site locations have been identified for the near-surface characterization effort. Once received at the laboratory, these samples shall undergo analysis using the analytical methods listed in Table A.1. This analysis may be sample-limited. Therefore, hold points have been inserted into the process to allow the laboratory and CHG technical staff to collaborate and review data before each new round of analyses. Analyses may be reprioritized based on the results of other measurements.

Based on the results of the screening analyses that was identified in the slant borehole, and spectral gamma surveys performed during the field geophysical surveys, and the geologic logging and field notes, geological technical experts, CHG technical staff, the laboratory technical staff, and decision-makers (Ecology and the U.S. Department of Energy) will convene to determine what, if any, additional analyses should be conducted. Some of the determining criteria will be the amount and integrity of the remaining sample, screening analytical results, and regulatory requirements. Based on these decisions, additional analyses will be performed.

A.6.0 REFERENCES

ASTM, 1998, *Standard Test Methods for Materials*, American Society for Testing and Materials, West Conshohochen, Pennsylvania.

DOE/RL-96-68, 1998, *Hanford Analytical Services Quality Assurance Requirements Document*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-99-36, 1999, *Phase 1 RCRA Facility Investigation/Corrective Measures Study Work Plan for Single-Shell Tank Waste Management Areas*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-99-34, 1999, *Notice of Construction for Tank Waste Remediation System Vadose Zone Characterization*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA SW-846, 1986, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Office of Solid Waste, U.S. Environmental Protection Agency, Washington, D.C.

ES-SSPM-001, 1998, *Sampling Services Procedures Manual*, Waste Management Federal Services, Richland, Washington.

ES-WSPM-001, 1998, *Well Services Procedures Manual*, Waste Management Federal Services, Richland, Washington.

HNF-5272, 1999, *Data Quality Objectives Report for Waste Management Area S-SX*, Rev. 0, Fluor Daniel Hanford, Inc., Richland, Washington.

P-GJPO-1783, 1995, *Vadose Zone Characterization at the Hanford Tank Farms, High-Resolution Passive Spectral Gamma-Ray Logging Procedures*, Rev. 1, U.S. Department of Energy, Grand Junction Projects Office, Grand Junction, Colorado.

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

SML-EP-001, 1997, *Sample and Mobile Laboratories Procedures*, Waste Management Federal Services, Richland, Washington.

WAC 173-160, "Minimum Standards for the Construction and Maintenance of Wells," *Washington Administrative Code*, as amended.

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

WDOH/320-015, 1997, *Hanford Guidance for Radiological Cleanup*, Rev. 1, Washington Department of Health, Olympia, Washington.

This page intentionally left blank.