51605

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 648340

Proj. ECN

2. ECN Category (mark one)
Supplemental ○
Direct Revision ●
Change ECN ○
Temporary ○
Standby ○
Supersedure ○
Cancel/Void ○

3. Originator's Name, Organization, MSIN, and Telephone No.
J.C. Henderson, Tank Farm Vadose Zone, H0-22, 372-9234

4. USQ Required? ○ Yes ● No

5. Date
7/6/99

6. Project Title/No./Work Order No.
Preliminary Site-Specific Work Plan Addendum for WMA S-SX

7. Bldg./Sys./Fac. No.
TWRS Vadose Zone

8. Approval Designator
N/A

9. Document Numbers Changed by this ECN (includes sheet no. and rev.)
HNF-4380, Rev. 0A

10. Related ECN No(s).
N/A

11. Related PO No.
N/A

12a. Modification Work
○ Yes (fill out Blk. 12b)
● No (NA Blks. 12b, 12c, 12d)

12b. Work Package No.
N/A

12c. Modification Work Completed
N/A
Design Authority/Cog. Engineer Signature & Date

12d. Restored to Original Condition (Temp. or Standby ECNs only)
N/A
Design Authority/Cog. Engineer Signature & Date

13a. Description of Change

13b. Design Baseline Document? ○ Yes ● No

Document revised based on review and resolution of comments from Washington Department of Ecology.

14a. Justification (mark one)
Criteria Change ●
Design Improvement ○
Environmental ○
Facility Deactivation ○
As-Found ○
Facilitate Const. ○
Const. Error/Omission ○
Design Error/Omission ○

14b. Justification Details
Changes required to incorporate comments on Rev 0 received from Washington State Department of Ecology.

15. Distribution (include name, MSIN, and no. of copies)
Central Files B1-C7
Vadose Zone Project Files H0-22
D.E. Olson H0-12
I. Yasek H0-12
J. Borneman H2-53
J.C. Henderson H0-22
D.L. Nichols B2-05
T. Knepp H0-22

DOE/RL Reading Room H2-53

RECEIVED
JUL 15 1999
DOE-RL/DIS

RELEASE STAMP
JUL 12 1999
DATE:
STA: 15
HANFORD RELEASE
ID: 21

A-7900-013-2 (10/97)

A-7900-013-1

ENGINEERING CHANGE NOTICE

Page 2 of 2

1. ECN (use no. from pg. 1)
648340

Design Verification Required
○ Yes
● No

17. Cost Impact

	ENGINEERING		CONSTRUCTION	
Additional	○ $	Additional	○ $	
Savings	○ $	Savings	○ $	

18. Schedule Impact (days)
Improvement ○
Delay ○

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 13. Enter the affected document number in Block 20.

SDD/DD ☐
Functional Design Criteria ☐
Operating Specification ☐
Criticality Specification ☐
Conceptual Design Report ☐
Equipment Spec. ☐
Const. Spec. ☐
Procurement Spec. ☐
Vendor Information ☐
OM Manual ☐
FSAR/SAR ☐
Safety Equipment List ☐
Radiation Work Permit ☐
Environmental Impact Statement ☐
Environmental Report ☐
Environmental Permit ☐

Seismic/Stress Analysis ☐
Stress/Design Report ☐
Interface Control Drawing ☐
Calibration Procedure ☐
Installation Procedure ☐
Maintenance Procedure ☐
Engineering Procedure ☐
Operating Instruction ☐
Operating Procedure ☐
Operational Safety Requirement ☐
IEFD Drawing ☐
Cell Arrangement Drawing ☐
Essential Material Specification ☐
Fac. Proc. Samp. Schedule ☐
Inspection Plan ☐
Inventory Adjustment Request ☐

Tank Calibration Manual ☐
Health Physics Procedure ☐
Spares Multiple Unit Listing ☐
Test Procedures/Specification ☐
Component Index ☐
ASME Coded Item ☐
Human Factor Consideration ☐
Computer Software ☐
Electric Circuit Schedule ☐
ICRS Procedure ☐
Process Control Manual/Plan ☐
Process Flow Chart ☐
Purchase Requisition ☐
Tickler File ☐
☐
☐

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number/Revision
N/A		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng.		7/8/99	PE		
Cog. Mgr.	A. J. Knepp	7/8/99	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

HNF-4380, Rev. 1

Preliminary Site-Specific SST Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX

J.C. Henderson
Lockheed Martin Hanford Corporation
Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 648340
Org Code: 73100
B&R Code: EW3130010
UC: 2010
Charge Code: 106501CA40
Total Pages: ~~270~~ 275 KN

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

Abstract: This Preliminary Site-Specific Waste Management Area S-SX Phase 1 RFI/CMS Work Plan Addendum addresses vadose zone and groundwater characterization activities in and near the WMA S-SX. Vadose zone characterization activities associated with decommissioning borehole 41-09-39, installation of a new borehole in the SX Tank Farm near SX-115, and installation of three RCRA groundwater monitoring wells are described.

JUL 12 1999
DATE:
STA: 15
HANFORD RELEASE
ID: 21

Karen S. Noland 7/12/99
Release Approval Date Release Stamp

Approved For Public Release

RECORD OF REVISION

(1) Document Number
HNF-4380

Page 1

Title
Preliminary 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 621750			
KN ~~1~~ 0A	Incorporated per ECN-648339 - Replaced page C-5			
KN ~~2~~ 1 RS	Complete revision per ECN-648340			7/8/99

A-7320-005 (10/97)

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

July 1999

Prepared for
U.S. Department of Energy

Prepared by
Lockheed Martin Hanford Corporation

CONTENTS

CONTENTS (cont'd)

APPENDICES

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
ARAR	applicable or relevant and appropriate requirement
bgs	below ground surface
CAR	corrective action requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	corrective measures study
CoC	contaminant of concern
CZT	cadmium zinc telluride
DOE	U.S. Department of Energy
DQO	data quality objective
DST	double-shell tank
DWR	Dangerous Waste Regulations
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
GIS	graphical information system
GW/VZ	groundwater/vadose zone
HLW	high-level waste
HPGe	high-purity germanium
HWMA	Hazardous Waste Management Act
ICM	interim corrective measures
ILAW	immobilized low-activity waste
LMHC	Lockheed Martin Hanford Corporation
MCL	maximum contaminant level
NaI	sodium iodide
PNNL	Pacific Northwest National Laboratory
Preliminary Addendum	Preliminary Site-Specific WMA S-SX Phase 1 RFI/CMS Work Plan Addendum
QA/QC	quality assurance/quality control
QAPjP	quality assurance project plan
QRA	qualitative risk assessment
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
REDOX	reduction-oxidation
RFI/CMS	RCRA Facility Investigation/Corrective Measures Study
SAP	sampling and analysis plan
SGLS	spectral gamma logging system
SST	single-shell tank
TBC	to be considered
Tri-Party Agreement	Hanford Federal Facility Agreement and Consent Order
TSD	treatment, storage, and/or disposal
TWRS	Tank Waste Remediation System
WAC	Washington Administrative Code
WMA	waste management area
WMFS	Waste Management Federal Services

This page intentionally left blank

1.0 INTRODUCTION

This Preliminary Site-Specific Waste Management Area (WMA) S-SX Phase 1 Resource Conservation and Recovery Act (RCRA) Facility Investigation/Corrective Measures Study (RFI/CMS) Work Plan Addendum (Preliminary Addendum) is prepared to enable initial field characterization efforts in and near WMA S-SX to commence in fiscal year 1999. This Preliminary Addendum is necessary to identify and plan initial characterization efforts as part of a RCRA Facility Investigation (RFI). The initial field characterization efforts include the collection of vadose zone and groundwater data from the following:

- Installation of a new borehole
- Decommissioning of borehole 41-09-39
- Vadose zone data from the installation of three proposed RCRA groundwater monitoring wells.

Documented in this Preliminary Addendum are the decisions made during negotiations between the Washington State Department of Ecology (Ecology) and U.S. Department of Energy (DOE) and a data quality objectives (DQO) process, the tasks, project responsibilities, and schedule.

1.1 BACKGROUND

Under the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1996) signed by Ecology, the U.S. Environmental Protection Agency (EPA), and DOE, more than 2,000 inactive waste disposal and unplanned release sites on the Hanford Site have been grouped into a number of treatment, storage, and/or disposal (TSD) units, WMAs, and operable units. Included in the WMAs are 149 single-shell tanks (SST) that are dangerous waste management units regulated under Washington's Hazardous Waste Management Act (HWMA) (Chapter 70.105 Revised Code of Washington [RCW]) and its implementing requirements (Washington's Dangerous Waste Regulations [DWR] in Chapter 173-303 Washington Administrative Code [WAC]).

The SSTs currently are operating under interim status pending closure. The tank farms will be closed as TSD units under the HWMA and Major Milestone series M-45-00 of the Tri-Party Agreement (Ecology et al. 1996). 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 investigation activities outlined in this Preliminary Addendum will be managed by the Tank Farm Vadose Zone Project as an integrated function of the Hanford Site Groundwater/Vadose Zone (GW/VZ) Integration Project. This Preliminary Addendum for WMA S-SX is a Tri-Party Agreement secondary document submitted to Ecology for review and approval pursuant to proposed Milestone M-45-52-T01 (DOE 1999a).

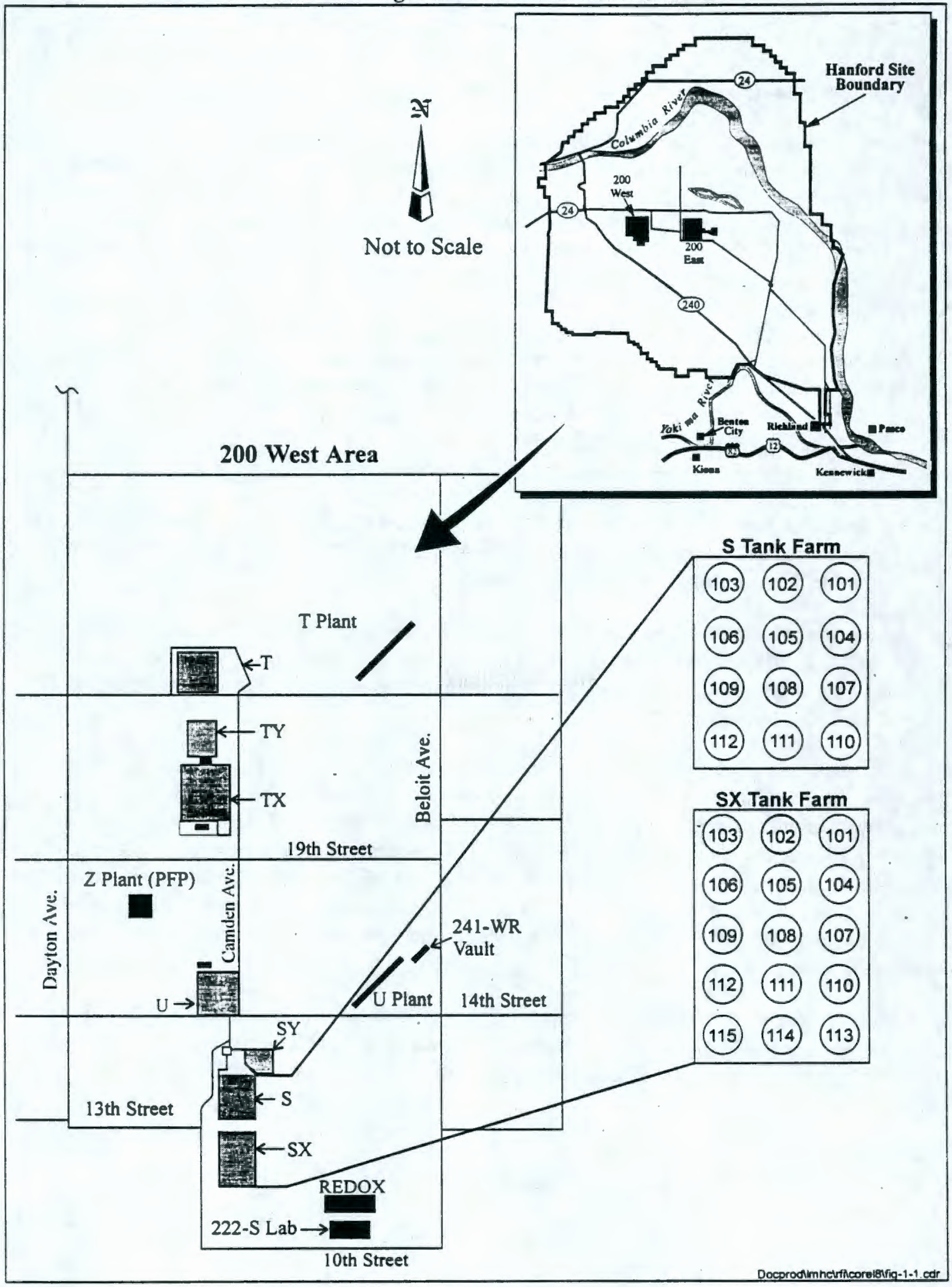
The WMA S and SX Tank Farms are regulated under RCRA interim status regulations (40 Code of Federal Regulations [CFR] 265, Subpart F) (Figure 1.1). The S and SX Tank Farms comprise the WMA S-SX, which was placed in assessment groundwater monitoring (40 CFR 265.93 [d]) in August 1996 because of elevated specific conductance and technetium-99, a non-RCRA co-contaminant, in downgradient monitoring wells (Caggiano 1996). 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 one well (299-W22-46), which is located at the southeast corner 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. This 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 (DOE-GJPO 1996) indicated contaminants cesium-137, cobalt-60, europium-152, and europium-154 at a maximum depth of 43 m (140 ft) below ground surface (bgs) near tank SX-102 and contaminants at depths of 39.6m (130 ft) bgs near tanks SX-108 and SX-109. The network of drywells installed around each tank was intended for leak detection and was generally installed between depths of 22.8 m and 42.7 m (75 to 140 ft) bgs, thus the maximum detection depth is limited by the drywell depth.

In 1996, an independent 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 1997). 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 (Myers et al. 1998). 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 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 (Agnew and Corbin 1998).

A groundwater assessment monitoring report that focused on contaminants in the underlying unconfined aquifer was completed (Johnson and Chou 1998). Major findings summarized in the report are as follows.

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



- 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 four to five times the EPA 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 (MCLs) since September 1998; however, chromium has not exceeded the MCLs.

- 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).

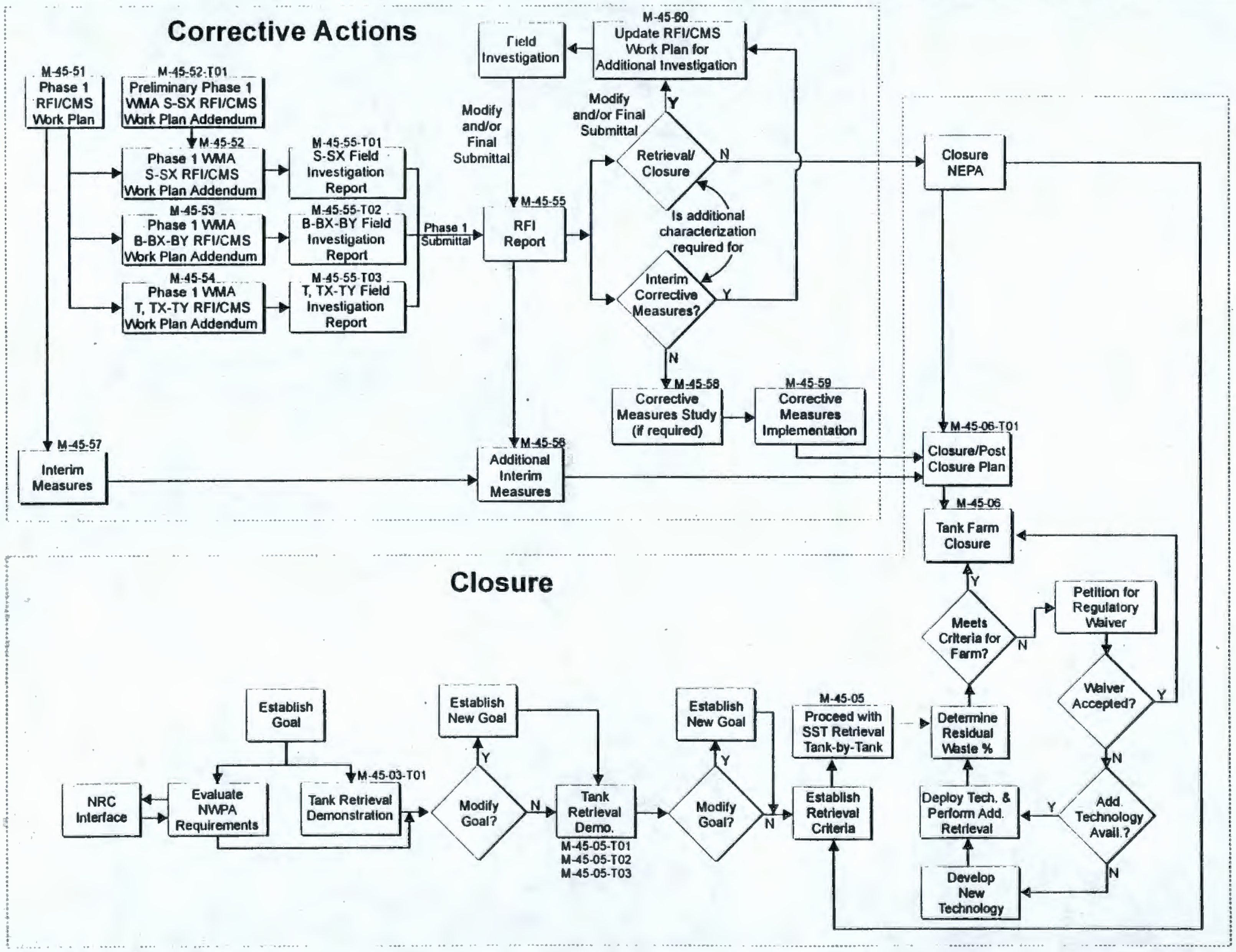
- Low but detectable strontium-99 and cesium-137 were found in one well (299-W23-7) located inside and between the S and SX Tank Farms. Additional investigation may be needed to determine if the low-level contamination is borehole related or more broadly distributed in the aquifer.

Based on the results of the groundwater assessment, on July 10, 1998, Ecology requested that DOE develop and submit a corrective action plan outside of the existing Tri-Party Agreement for the four WMAs with documented leaks (i.e., WMA S-SX, B-BX-BY, T, and TX-TY). Between September 1998 and January 1999, Ecology and DOE negotiated the proposed Tri-Party Agreement Change Control Form Number M-45-98-03 (DOE 1999a), which addresses the initial sequence of SST WMA investigations under corrective action and identifies the need for vadose zone and groundwater investigations and the need to integrate vadose zone and groundwater activities (Figure 1.2).

Pursuant to the proposed Tri-Party Agreement Change Control Form Number M-45-98-03 (DOE 1999a), the RCRA Corrective Action process is used to establish the framework within which vadose zone investigations are planned and carried out to support decisions including the following:

- Appropriate interim measures
- Appropriate interim corrective measures (ICM)
- SST waste retrieval
- Tank farm and WMA closure.

Figure 1.2. Documents Required by the Tri-Party Agreement and Decision Points for Corrective Actions and Closure

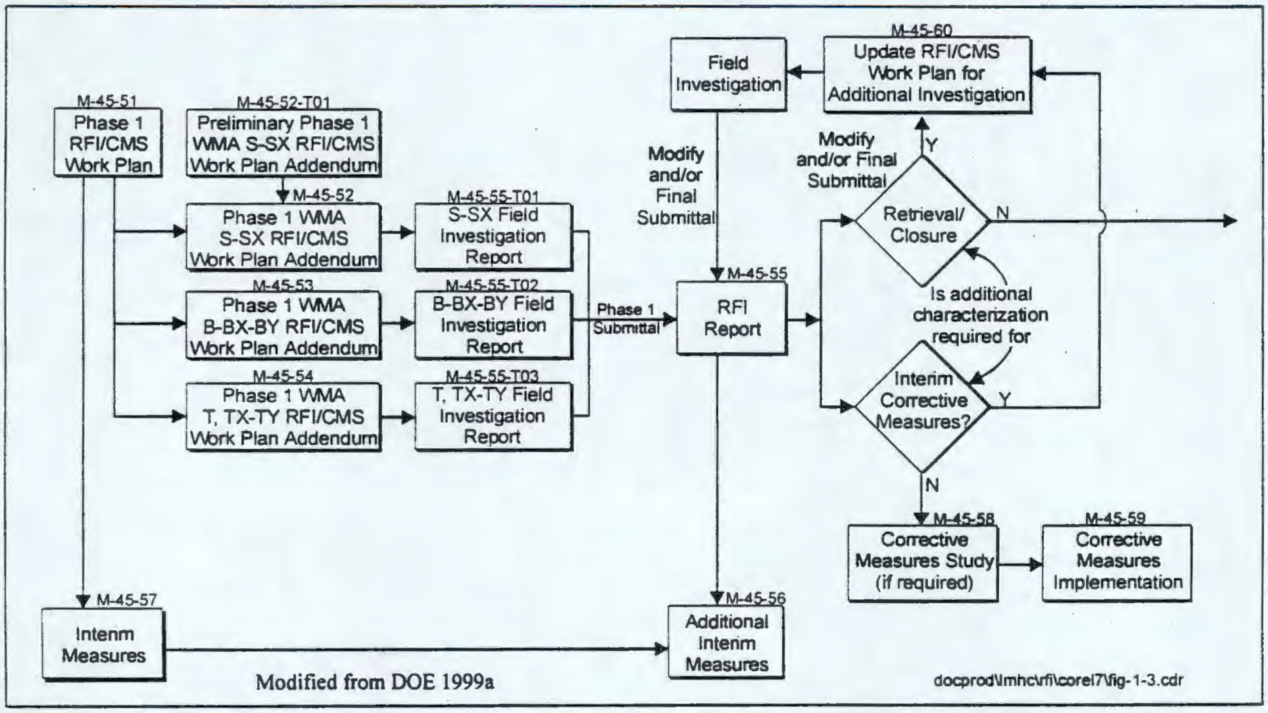


Modified from DOE 1999a

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

The initial sequence of investigations includes initiation of preliminary characterization efforts in fiscal year 1999 in WMA S-SX based on this Preliminary Addendum and characterization of the remainder of WMA S-SX followed by characterization of WMAs B-BX-BY, T, and TX-TY (Figure 1.3). All of these efforts will be based on a Phase 1 RFI/CMS Work Plan (proposed Milestone M-45-51) and site-specific WMA RFI/CMS Work Plan addenda (proposed Milestones M-45-52, M-45-53, and M-45-54). Following the completion of field activities for each of the WMAs, Field Investigation Reports will be prepared (proposed Milestones M-45-55-T01, M-45-55-T02, and M-45-55-T03). These reports will be the basis of the Phase 1 RFI Report, which will be submitted to Ecology (M-45-55) to support decisions on the implementation of additional interim measures (proposed Milestone M-45-56), corrective measures based on a Corrective Measures Study (CMS) (proposed Milestone M-45-58), additional field investigations (i.e., Phase 2), and/or tank waste retrieval and tank farm closure (DOE 1999a).

Figure 1.3. Proposed Tri-Party Agreement Milestones for Corrective Actions



Modified from DOE 1999a

docprod\mhc\rfi\corel7\fig-1-3.cdr

1.2 SCOPE OF ACTIVITIES

Negotiations between DOE and Ecology resulted in a plan in which preliminary characterization data will be collected beginning in fiscal year 1999 from WMA S-SX. In April 1999, DOE must submit a work plan addendum to "enable initial field work and borehole installation to commence in Fiscal Year 1999" (DOE 1999a). The work plan also must address the following:

> "locations and methods for sampling and analysis to meet work plan objectives... requirements for groundwater sampling from initial vadose zone boreholes and vadose zone sampling from planned groundwater monitoring wells" (DOE 1999a).

DOE and Ecology decided to proceed with initial characterization efforts in WMA S-SX 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 (LMHC 1998). Within WMA S-SX the most information is available regarding past releases within the SX Tank Farm (DOE-GJPO 1996, Agnew and Corbin 1998, Johnson and Chou 1998, Myers et al. 1998, and Jones et al. 1998). In addition, much more work has been done in the SX Tank Farm in evaluating historical data compared to any other tank farm. This, coupled with the work of the SX expert panel and recent investigations, allowed Ecology and DOE to proceed with initial characterization efforts before development of the Phase 1 RFI/CMS Work Plan (M-45-51). The rationale was that a better understanding of critical data needs was available to begin characterization work in the SX Tank Farm. Therefore, the initial field investigations at WMA S-SX addressed in this Preliminary Addendum are as follows:

- Decommissioning of borehole 41-09-39 within the SX Tank Farm
- Installation of a new borehole in the SX Tank Farm
- Integration with the Hanford Groundwater Program to collect vadose zone data for the installation of three RCRA groundwater monitoring wells downgradient of the SX Tank Farm.

1.3 PURPOSE AND OBJECTIVE

The negotiations between DOE and Ecology established the objectives of the characterization effort for the WMAs to include the following:

- Generation of GW/VZ characterization data/information necessary to:

  "(i) define the sources, nature, and extent of vadose zone and aquifer contamination, (ii) identify actual and potential receptors (via air, land, surface water, and groundwater pathways), (iii) determine the need for additional interim measure or interim corrective measures" (DOE 1999a)

- Support tank waste retrieval and tank farm closure of SST TSDs under HWMA and RCRA (DOE 1999a).

The negotiations also resulted in an agreement to develop a work plan addendum for interim characterization efforts at WMA S-SX based on "objectives developed through a data quality objectives process" (DOE 1999a). The DQO process was completed from February through April 1999 (Appendix E). The DQO process included participation by Ecology and DOE (the decision makers), Tribal Nations, Oregon Department of Energy, the Hanford Site Vadose Zone/ Groundwater Integration Project, Site experts, and a Tank Farm Vadose Zone Project Steering Group. Meetings held as part of the DQO process involved varying levels of involvement by all participants except Ecology and DOE. Early meetings addressing the definition of the problem, review of existing data, and input required to support decisions and sampling and analysis alternatives were attended by a broad range of participants. Later meetings were held between the decision makers with input from Site contractors and other DQO process participants.

The Tank Farm Vadose Zone Project created a Steering Group to provide input during and after the DQO process. The Steering Group consisted of Kevin Lindsey (D.B. Stevens and Associates), Vern Johnson (Pacific Northwest National Laboratory [PNNL]), Kent Reynolds (Waste Management Federal Services [WMFS]), Glendon Gee (PNNL), Louis Kovach (independent consultant), Charlie Cole (PNNL), and Jeff Serne (PNNL).

Because the characterization activities for fiscal year 1999 will be initiated before completion of the Phase 1 RFI/CMS DQO and Work Plan, the Steering Group recommended that the effort must:

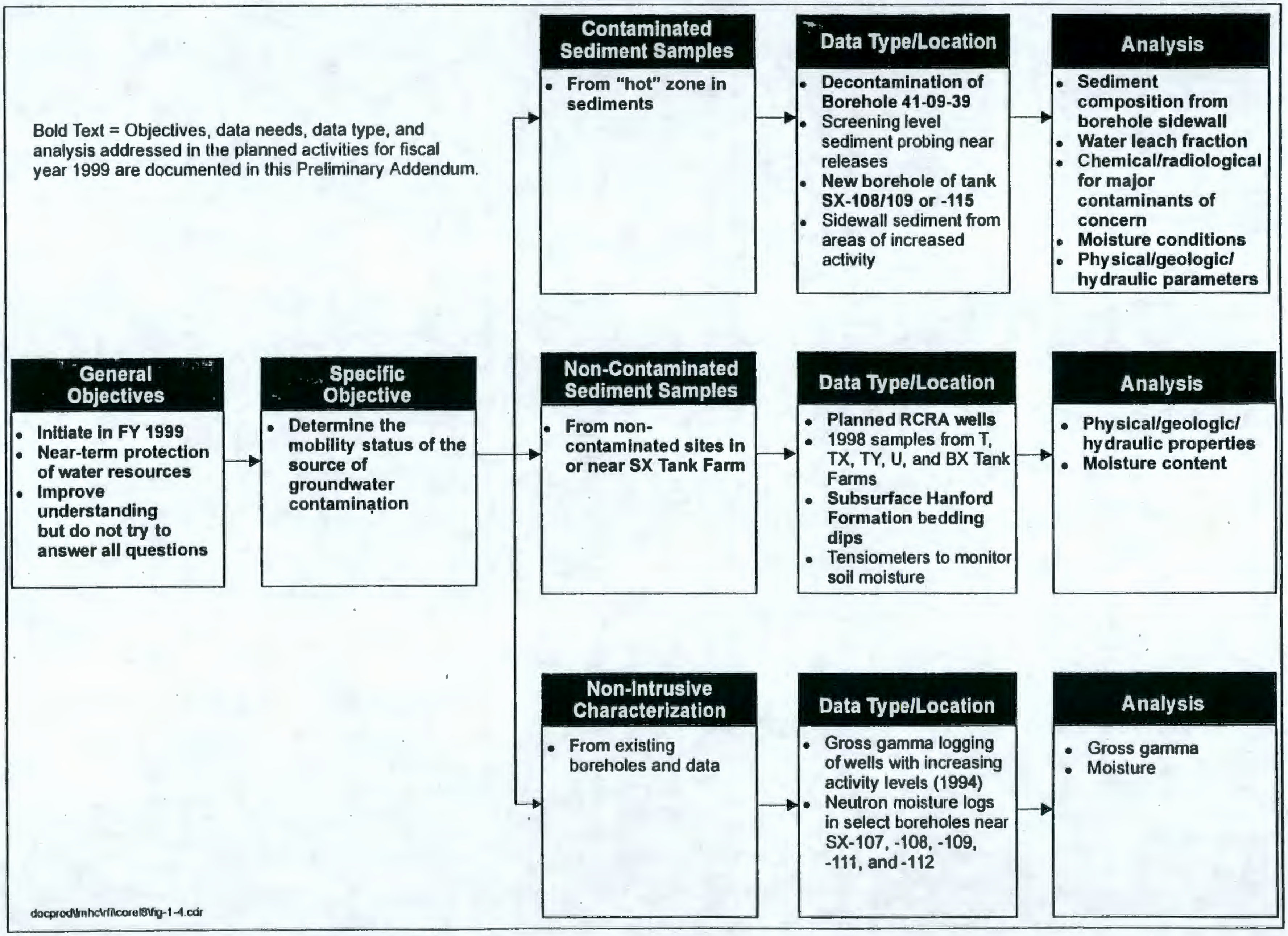
- Be attainable within fiscal year 1999
- Contribute to near-term water resource protection
- Not be required to answer all outstanding vadose zone characterization questions.

With these general objectives, the group concluded that the specific objective for the fiscal year 1999 characterization effort should be "determining the mobility status of the source of groundwater contamination" (Appendix F). The group recommended various data needs including data from contaminated and noncontaminated areas within and near the SX Tank Farm and data resulting from analysis of sediment samples collected using intrusive and nonintrustive techniques from existing and new boreholes and/or CPT deployments (Figure 1.4). The group suggested a range of radiological, chemical, and physical property analysis.

The Steering Group indicated that many of the data needs could be satisfied from existing boreholes (either extending the boreholes or from sidewall sampling) and the planned RCRA monitoring well installation. However, the group also suggested that CPT deployment and a new borehole may be required in fiscal year 1999 or as part of a subsequent WMA S-SX characterization effort. Among the locations for a new borehole indicated as having potential to contribute valuable data are near tank SX-115 and near tanks SX-108 and -109.

The DQO process resulted in identification of activities to collect vadose zone data to support the objectives outlined above. The process included meetings between the decision makers (DOE and Ecology) and others 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. Because the Preliminary Addendum precedes completion of the Phase 1 RFI/CMS Work Plan DQO process, the focus of the DQO process for the Preliminary 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.

Figure 1.4. Steering Group Recommended Objectives, Data Needs, and Data Type



The specific objectives of the investigation efforts identified in this Preliminary Addendum are as follows.

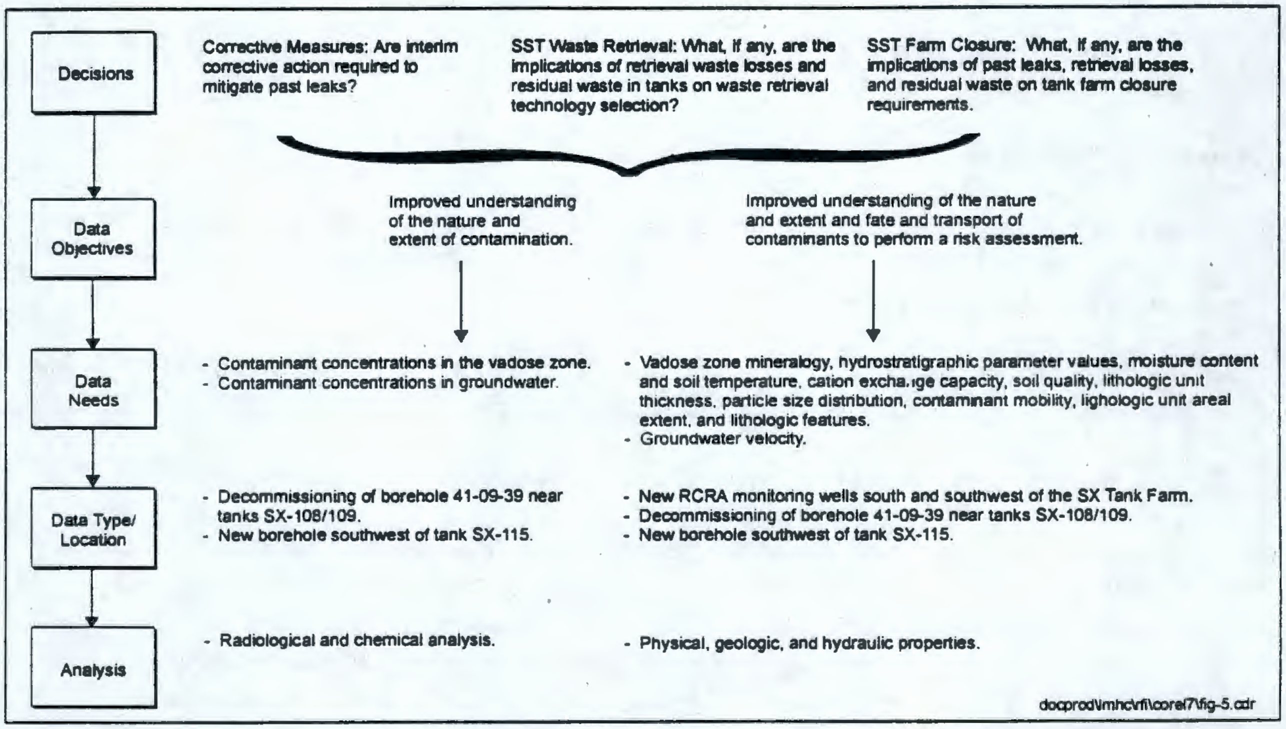
- Collect data to support an improved understanding of the nature and extent of contaminants in the vadose zone (and upper portion of the unconfined aquifer) from nominally 3 m (10 ft) bgs to the vadose zone/groundwater interface.
- Collect data to support an improved understanding of vadose zone parameters affecting contaminant fate and transport required to perform risk assessments.

1.4 BASIS FOR SELECTION OF FIELD ACTIVITIES

As indicated previously, Ecology and DOE determined that characterization activities should be: (1) initiated in fiscal year 1999, (2) focused on WMA S-SX, (3) data collection that would support decisions on additional interim measures or ICM, tank waste retrieval, and tank farm closure, and (4) characterization activities that would include installation of a new borehole and vadose zone data from new RCRA groundwater monitoring wells. These decisions, and the decision by DOE to proceed with the decommissioning of borehole 41-09-39, were the starting point for the DQO process. Based on input from Ecology and DOE, and input from the DQO participants, the initial characterization activities in support of the objectives and data needs identified for the SX Tank Farm are illustrated in Figure 1.5. The following summarize the decisions reached by Ecology and DOE based on the DQO process:

- Decommissioning of borehole 41-09-39 – This borehole was installed as a temporary borehole during two separate drilling campaigns, one beginning in December 1996 in which the borehole was driven to 40.1 m (131.5 ft) with a closed-end steel casing and one beginning in September 1997 in which the borehole was deepened to 69 m (225.3 ft). Following the completion of groundwater sampling activities conducted as part of the Hanford Groundwater Program, decommissioning activities will be started that will include a tracer test, borehole geophysical logging, sidewall sediment sampling of selected intervals, and removal of temporary materials and proper sealing of the hole in accordance with WAC requirements.
- Installation of a new exploratory borehole southwest of tank SX-115 – The DQO process resulted in the identification of several potential locations for the proposed new borehole (e.g., near tanks SX-108 and SX-115). A location southwest of tank SX-108 was a candidate for the initial field investigation, but it was determined during the DQO that resolution of technical and schedule uncertainties would put at risk the ability to initiate borehole installation field work in July 1999. For this reason, DOE and Ecology selected an alternative borehole location southwest of tank SX-115 for incorporation into this Preliminary Addendum. This location, like the location near tank SX-108, is near a past tank leak. The new borehole will be installed using a drive and drill dual-wall reverse air circulation rotary drilling technique while driving conductor casing with staged

Figure 1.5. DQO Objectives and Data Needs



(telescoping) casings to reduce the likelihood of cross contamination from penetrating through highly contaminated zones. Collection of split-spoon driven samples and drill cutting samples will be attempted from about 3 m (10 ft) bgs to just below the water table. The water table is expected to be encountered at a depth of 64 m (210 ft) bgs. Selected portions of the samples will be analyzed for chemical, radiological, and physical characteristics. A suite of geophysical surveys will be performed, and groundwater samples will be collected for chemical and radiological analysis. The new borehole is being installed as a temporary borehole and will require decommissioning. Decommissioning plans will not be developed until the results of the borehole installation have been evaluated.

- Collection of vadose zone characterization data from three proposed RCRA groundwater monitoring wells – Vadose zone samples will be collected during the installation of three proposed RCRA groundwater monitoring wells planned in support of the ongoing RCRA groundwater monitoring effort. The three RCRA groundwater monitoring wells are to replace existing RCRA groundwater monitoring wells because groundwater levels in the WMA S-SX area are declining by up to 0.6 m (2 ft) per year, and some of the existing monitoring wells are going dry. The southern-most proposed monitoring well is tentatively located about 50 m (164 ft) southeast of tank SX-113. From this well, the collection of continuous driven samples from about 6 m (20 ft) bgs to refusal (anticipated to be near the top of the Ringold Formation) will be attempted. Continuous drill cuttings will be collected from refusal to the water table. The other two RCRA groundwater monitoring wells are located east of WMA S-SX. Continuous drill cuttings will be collected and described from these two wells. Selected portions of the split-spoon driven samples and cuttings will be analyzed for physical, hydraulic, and chemical properties. A detailed description of the work associated with the installation of these monitoring wells is being developed by the Hanford Groundwater Program. Only details associated with the collection and analysis of driven samples and cuttings are provided in this work plan addendum.

1.5 ORGANIZATION OF THE PRELIMINARY ADDENDUM

Eight chapters and six appendices are included in this Preliminary Addendum. The addendum is structured to provide information necessary to initiate the field investigation in fiscal year 1999. The chapters include the following:

- Chapter 1.0: Introduction to the Preliminary 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 (CAR), and potential impacts to human health and the environment
- Chapter 4.0: Presentation of the rationale and approach for the initial field investigations
- Chapter 5.0: Presentation of the tasks and activities necessary to conduct initial field investigations
- Chapter 6.0: The schedule for the initial 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 initial field investigation activities, including responsibilities, organizational structure, and project tracking and reporting procedures
- Chapter 8.0: References used to develop the Preliminary Addendum.

Appendices to this Preliminary Addendum include supporting plans and information necessary to define, conduct, and control the initial field characterization activities. The appendices include the following:

- A – Sampling and Analysis Plan
- B – Health and Safety Plan
- C – Quality Assurance Project Plan

- D – Data Management Plan
- E – Data Quality Objectives Summary
- F – Steering Group Report on Initial Field Characterization Data Needs.

This page intentionally left blank

2.0 BACKGROUND AND SETTING

The 241-S and 241-SX tank farms SSTs are RCRA TSD units located in the southern portion of 200 West. Waste in the SSTs consists of liquid, sludges, and saltcake (i.e., crystallized salts). Over the years, much of the liquid stored in the SSTs has been evaporated or pumped to double-shell tanks (DSTs).

The 241-S and 241-SX tank farms comprise the Waste Management Area (WMA) S-SX and are interim status, TSD units pending closure that must be operated, permitted, and maintained in compliance with RCRA and Washington State's dangerous waste program regulations (WAC 173-303) and Tri-Party Agreement Milestone M-45-00 and proposed Milestones M-45-51, M-45-52, and M-45-52-T01 (Ecology et al. 1996; DOE 1999a). 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 the state's dangerous waste program, as specified in WAC 173-303-610. A SST closure work plan has been prepared but is scheduled for rewriting and resubmittal to Ecology (DOE 1996b). Sampling and analysis plans (SAP) are not included in the plan (DOE 1996b). 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 Action Plan (Ecology et al. 1996).

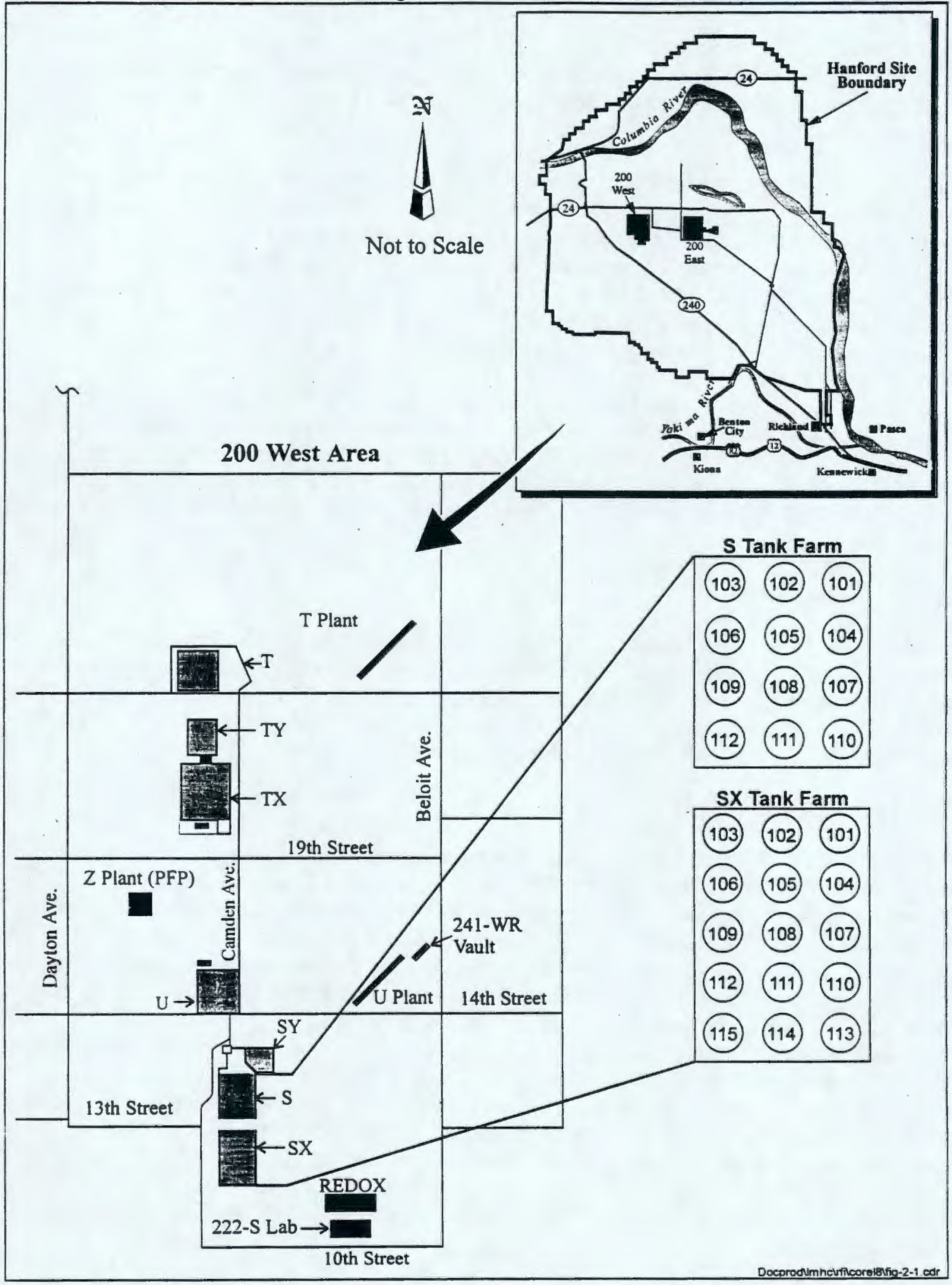
2.1 SITE DESCRIPTION

Information and data regarding the 241-S and 241-SX tank farm facility description were obtained from the Historical Tank Content Estimate for the Southwest Quadrant of the Hanford 200 West Area (WHC 1994). The location, history of operations, facility characteristics and identification, waste-generating processes, interaction with other facilities, and RCRA considerations are discussed in the following subsections.

2.1.1 Location

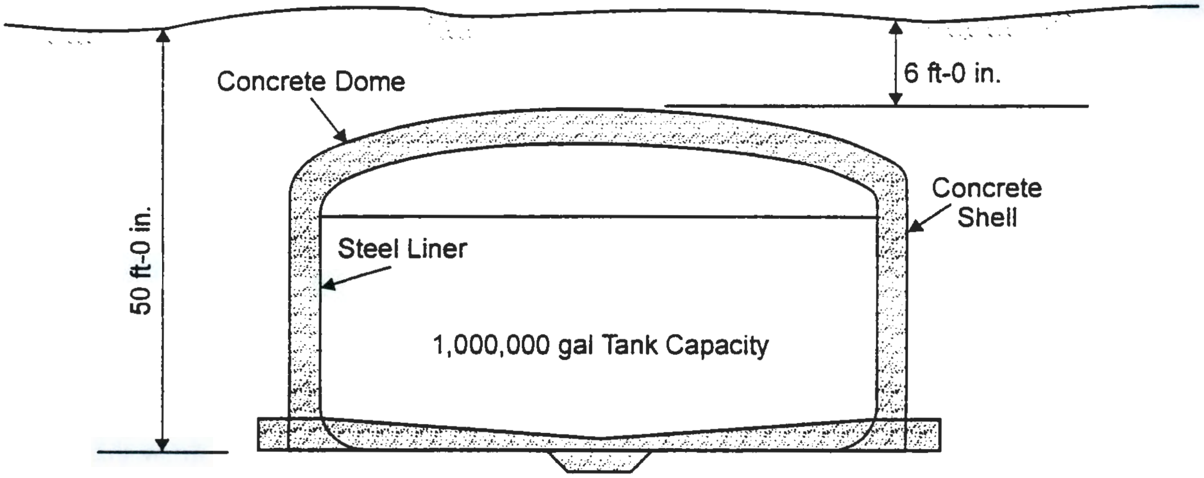
The 241-S and 241-SX tank farms are located in the southern portion of the 200 West Area, near the Reduction-Oxidation (REDOX) Plant (Figure 2.1). The 241-SX tank farm contains 15 SSTs, each with a 3,785,000-L (1,000,000-gal) capacity. The 241-S tank farm contains 12 SSTs, each with a 2,869,030-L (758,000-gal) capacity. These SSTs are 23 m (75 ft) in diameter.
The 241-S tank farm SSTs are approximately 11.4 m (37.25 ft) tall from base to dome, and the 241-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 241-S tank farm and 1.8 m (6 ft) at the 241-SX tank farm, respectively. All of these tanks have a dish-shaped bottom (Figure 2.2). The 241-SX tank farm SSTs were the first SSTs designed for self-boiling (self-concentrating) waste; however, the 241-S tank farm SSTs received self-boiling waste. The 241-S and 241-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 241-S tank farm: tanks S-101, -102, -103; tanks S-104, -105, -106; tanks S-107, -108, -109; and tanks S-110, -111, -112. At the 24-1-SX tank

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

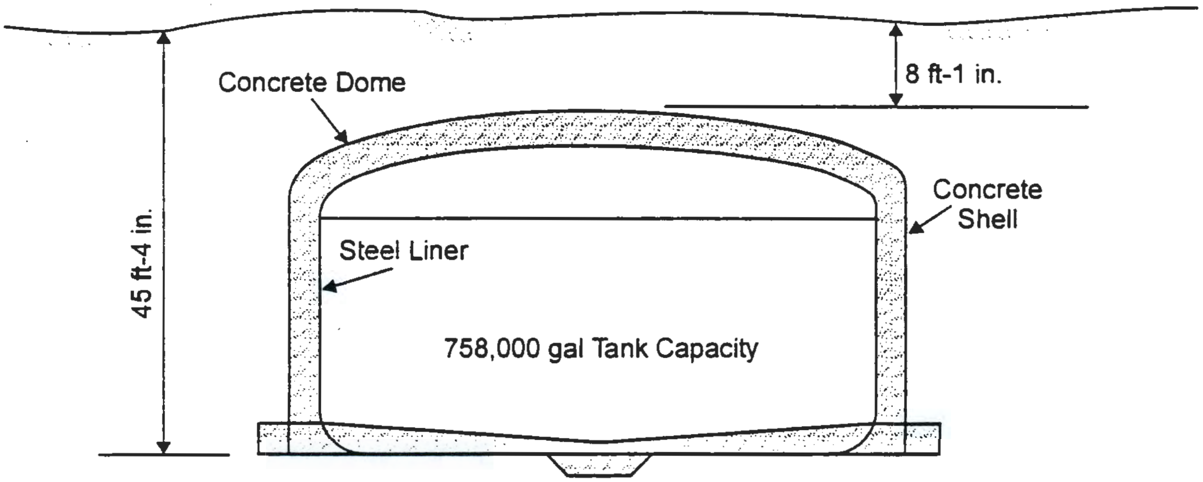


Docprod\lmhc\rfi\corel8\fig-2-1.cdr

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



75-ft Diameter Single-Shell Tank
Tank Farm: SX



75-ft Diameter Single-Shell Tank
Tank Farm: S

Not to Scale

(Adapted from Hanlon 1999)

Docprod\lm hc\rf\corel8\fig-2-2.cdr

farm, the three-tank series is comprised of the following tanks: SX-101, -102, -103; tanks SX-104, -105, -106, tanks SX-107, -108, -109, tanks SX-110, -111, -112; and tanks SX-113, -114, -115. The last tank in a three-tank cascade series was configured to overflow to a crib as necessary. Figure 2-3 shows SX Tank Farm SSTs and associated drywells.

2.1.2 History of Operations

The tanks in the 241-S and 241-SX tank farms received REDOX Plant waste, which was self-boiling or self-concentrating through evaporation of liquid. The 241-S tank farm was built between 1950 and 1951. The 241-SX tank farm was built between 1953 and 1954.

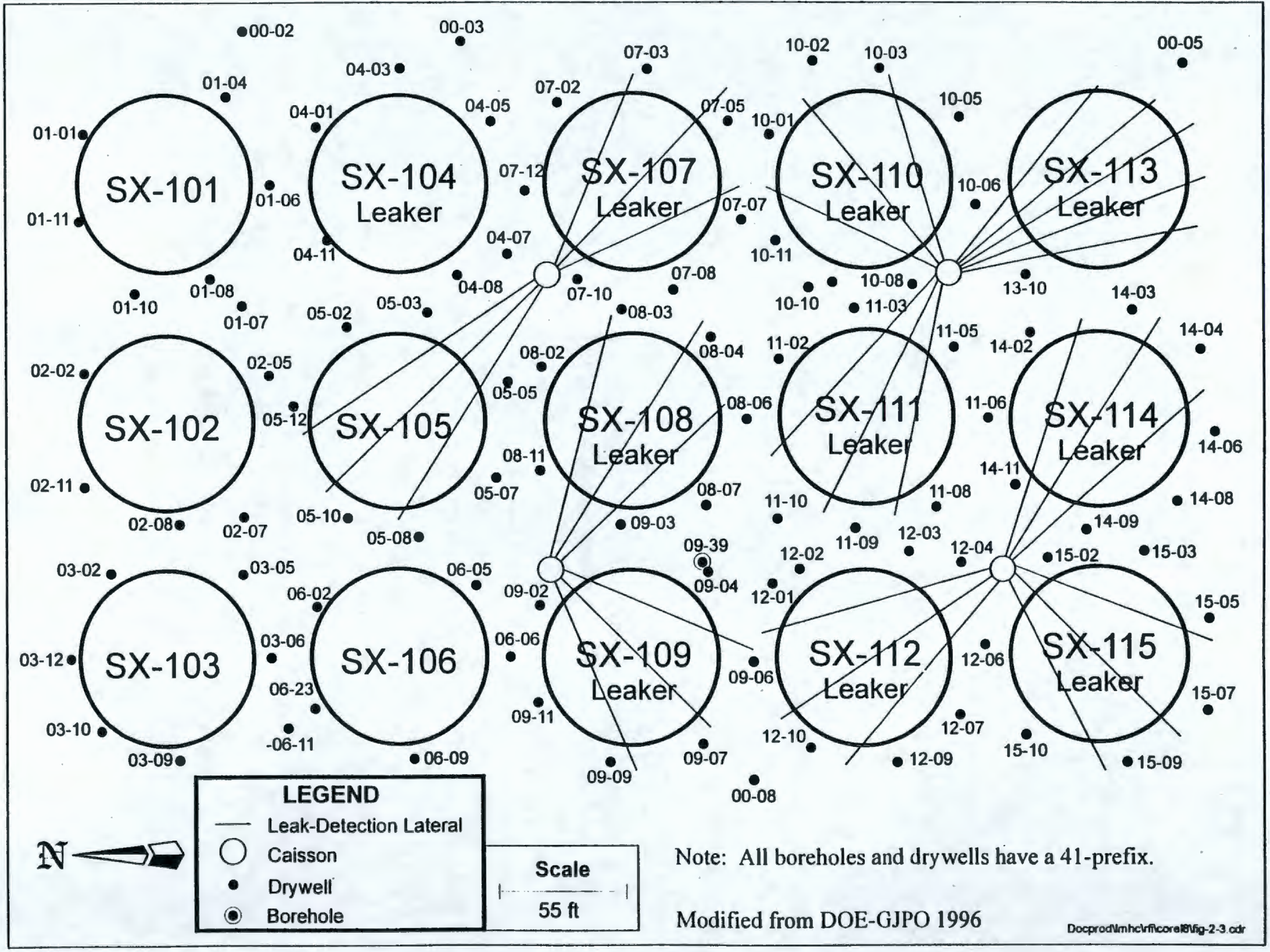
The 241-S tank farm operation began in 1951. The tanks were filled with liquids by 1953; however, the waste began self-boiling in the summer of 1952. A surface condenser was installed in 1953 to concentrate the waste and provide more tank space. The vapor condensate was disposed of in nearby cribs. Liquid 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/crystalizer 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 or early 1980s.

The 241-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 241-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. 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 241-SX-101 through SX-106 are one-half to two-thirds full of solids (mostly saltcake) 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.

2.1.3 Description of the Leak Detection System

The 241-SX tank farm has 98 leak detection wells currently 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. 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 241-SX tank farm layout showing drywell and lateral locations in reference to tanks is shown in Figure 2.3.

Figure 2.3. SX Tank Farm SSTs and Associated Drywells



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

Modified from DOE-GJPO 1996

Docprod\mhc\rf\corel8\fig-2-3.cdr

2.1.4 Relationship to Other Facilities

Various cribs, trenches, french drains, and the U 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 units and, therefore, are not part of the Hanford Site Groundwater Program; these units are monitored under the Sitewide groundwater monitoring program (PNNL 1998). 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, 241-S-151 diversion box, 241-SX-302 catch tank, and U Pond. Figure 2.4 shows the location of these facilities (except the U Pond, which is located west of WMA S-SX) with respect to WMA S-SX. A summary of the operation, vadose zone contamination, and groundwater contamination history for each of these facilities is described in DOE/Grand Junction Project Office (DOE-GJPO) (1996), Jones et al. 1998, and other documents.

2.2 PHYSICAL SETTING

The following sections describe the topography, geology, hydrogeology, surface water hydrology, meteorology, environmental resources, and human resources associated at the WMA S-SX. This discussion includes a brief overview of the larger setting, which provides the framework for the site-specific conditions.

2.2.1 Topography

A generalized east-west cross-section defining the Hanford Site's structure and topography is shown in Figure 2.5. The Tank Waste Remediation System (TWRS) sites are located in the 200 West and 200 East Areas on and near a broad, flat area of the Hanford Site commonly referred to as the Central Plateau. The Central Plateau is located within the Pasco Basin, which is a topographic and structural depression in the southwest corner of the Columbia Basin. The basin is characterized by generally low-relief hills with deeply incised river drainage (Figure 2.6). The Hanford Site is an area of generally low relief, ranging from 120 m (390 ft) above mean sea level (amsl) at the Columbia River to 230 m (750 ft) amsl in the vicinity of the TWRS sites. WMA S-SX is located in the 200 West Area.

Geologic processes that have formed the Hanford Site's topography over thousands of years include landslides, floods, and volcanic activity. Landslides are not a common occurrence in the 200 Areas because of flat topography, the deep water table, and the absence of any actively eroding streams. The nearest potential flooding source to the TWRS sites is Cold Creek, located in the southwest portion of the Hanford Site. Studies of the probable maximum flood show that Cold Creek's flooding effect would be limited to the southwestern corner of the 200 West Area (Cushing 1994). The most likely source of volcanic activity that could impact the TWRS sites would be in the Cascade Mountain Range, more than 100 km (60 mi) west of the Hanford Site. The 1980 eruption of Mount St. Helens is an example of such a volcanic event, causing ashfall at the Site but no other effects.

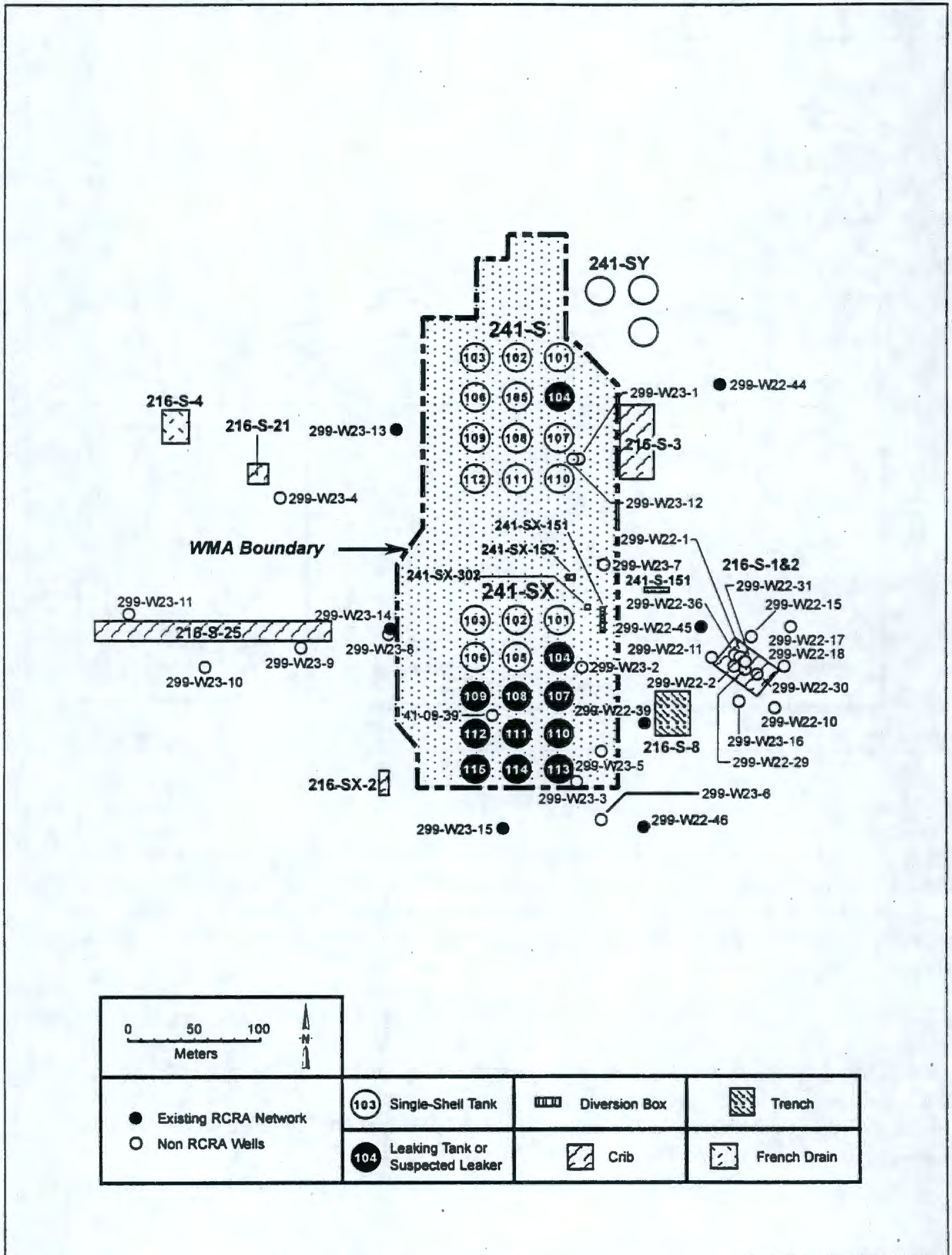
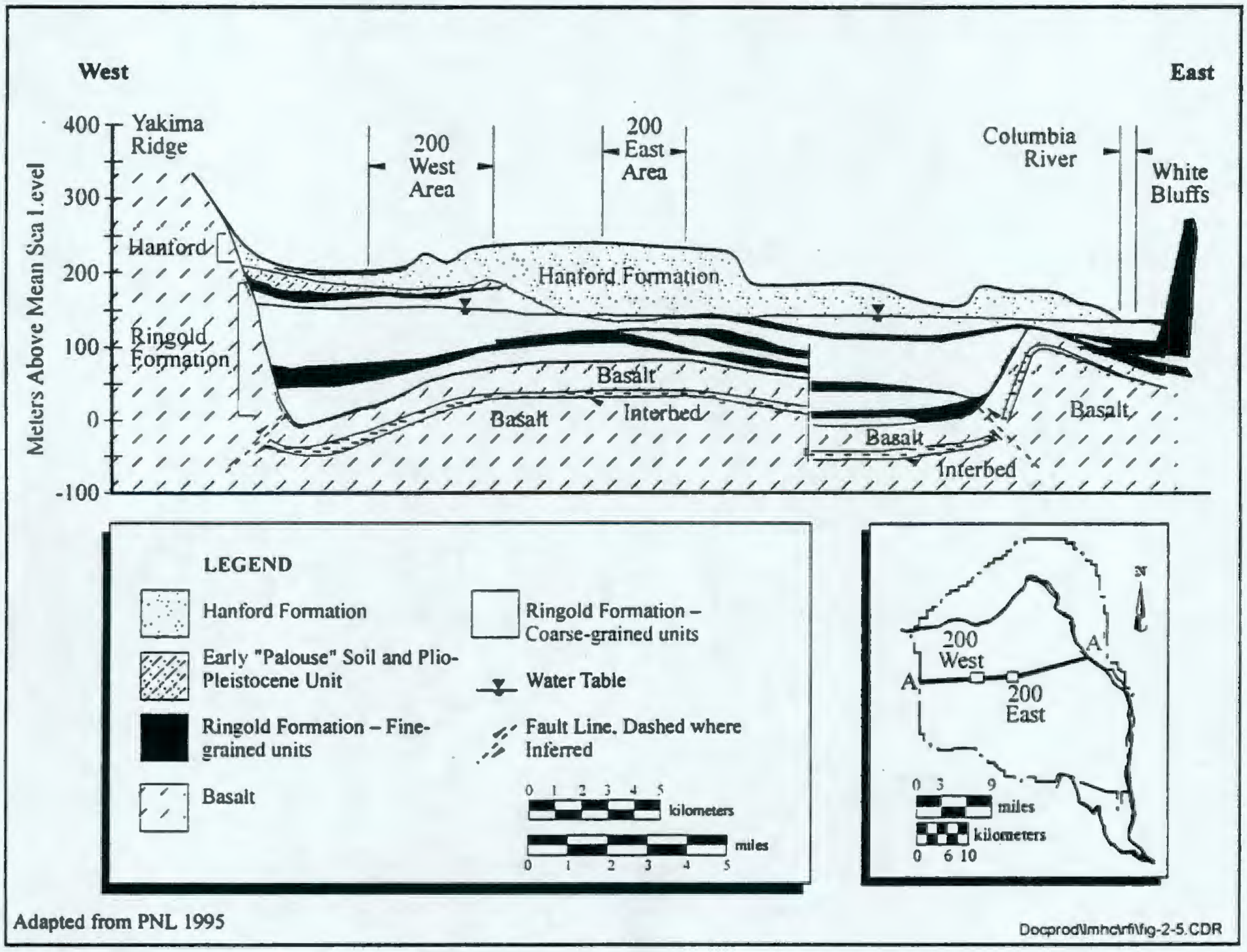


Figure 2.4. S-SX WMA and Surrounding Facilities

Docprod\mhc\rf\corel8\fig-2-4.cdr

Figure 2.5. Geologic Cross-Section of the Hanford Site



Adapted from PNL 1995

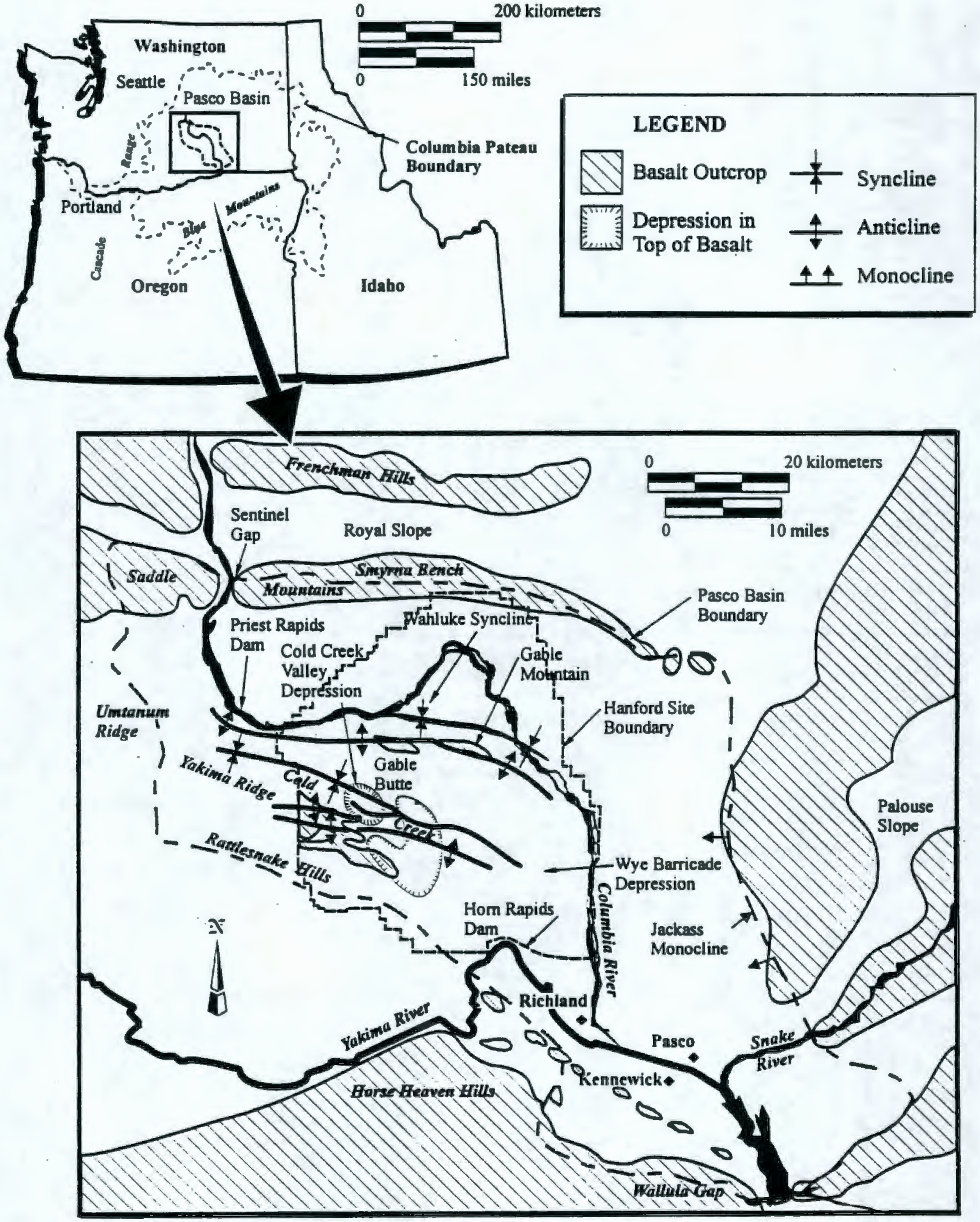
Docprod\lmhc\rfi\fig-2-5.CDR

2.2.2 Geology

The 200 Areas are situated between the Gable Mountain anticline and Cold Creek syncline. The Gable Mountain anticline is of particular importance to the groundwater flow. Portions of this anticline have been uplifted to a point where basalt is above the current water table. Basalt has a low hydraulic conductivity and acts as a barrier to horizontal groundwater flow in the unconfined aquifer.

In Figure 2.7, the relationship between the various stratigraphic units and hydrogeologic units of the suprabasalt sediments in the Central Plateau is shown. Basalt flows more than 3,000-m (10,000-ft) thick, called the Columbia River Basalt Group, lie beneath the Hanford Site. The suprabasalt sediments are a sedimentary sequence up to 230-m (750-ft) thick overlying the Columbia River Basalt Group and include the Ringold Formation, Plio-Pleistocene Unit, Early-Palouse sediment, and Hanford formation (DOE 1993b).

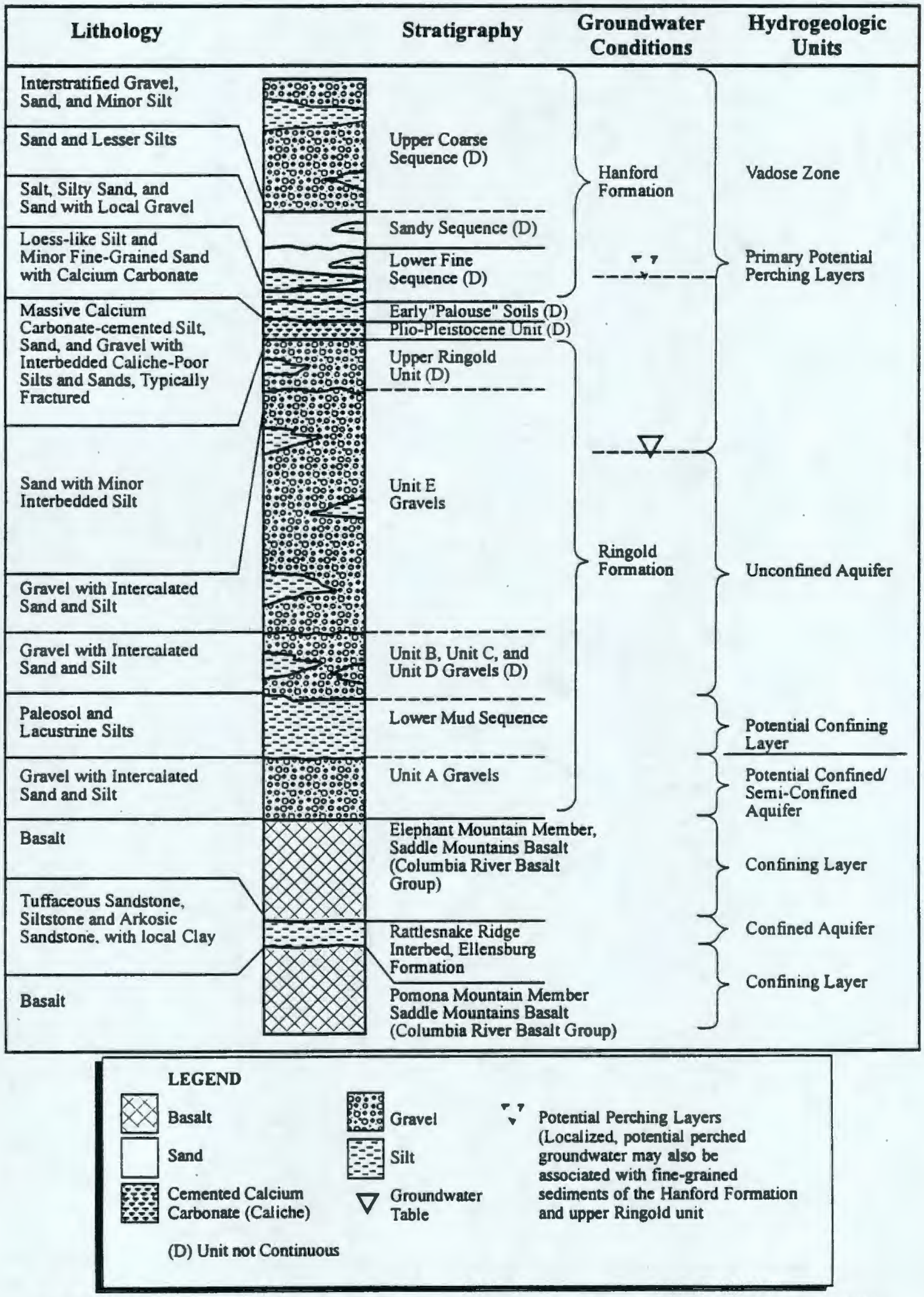
Figure 2.6. Geographic Setting and General Structural Geology of the Pasco Basin and Hanford Site



Modified from Lindsey 1992

Docprod\lmhc\rfi\corel6\fig-2-6.cdr

Figure 2.7. Conceptual Hydrologic Column for the Hanford Site



SOURCE: Lithology, stratigraphy, and groundwater condition based on data from Lindsey 1992 and Delany et al. 1991.

docprod\lmhc\rfi\corel8\fig-2-7.cdr

Price and Fecht (1976) originally compiled the geology of the 241-SX Tank Farm 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 (including Early Palouse), and the Hanford formation (in ascending order). The sources of data on the geology of the suprabasalt sediments include Lindsey and Law (1993), Lindsey (1992), Connelly et al. (1992), Issacson (1982), and Price and Fecht (1976). In general, Price and Fecht (1976) represent on of the most complete synthesis of existing data on SX Tank Farm geology and Myers et al. (1998) offer an update based on additional information gained from the drilling and sampling of borehole 41-09-39. The vadose zone stratigraphy of the 241-S and 241-SX tank farms is illustrated in an east-to-west cross-section (Figure 2.8) through the central portion of the 241-SX tank farm, and a northwest-southeast cross-section (Figure 2.9) through the 241-SX tank farm.

2.2.2.1 Ringold Formation

The Ringold Formation is up to 185-m (600-ft) thick in the deepest part of the Cold Creek syncline, south of the 200 West Area. The Ringold Formation consists of clay, silt, fine- to coarse-grained sand, and gravel. The Ringold Formation is delineated by several different types of sediments associated with fluvial (river-related) sands and gravel, floodplain and lake deposits, and alluvial fan deposits (DOE 1993b). The vadose zone portion of the Ringold Formation thins from east to west approximately 16 m (50 ft) to about 0 m (0 ft) and consists primarily of a slightly silty coarse- to medium-grained sandy gravel (Ringold Unit E) and Taylor Flat (upper Ringold).

In the WMA S-SX, Slate (1996) interpreted the surface of the Ringold Formation as a trough-like trending northwest-southeast parallel to the Cold Creek syncline and plunging to the southeast. This trough contains two smaller troughs, one of which trends directly under the 241-S and 241-SX tank farms, and one south of 200 West Area. Both smaller troughs appear to merge further southeast. Slate (1996) interpreted 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.

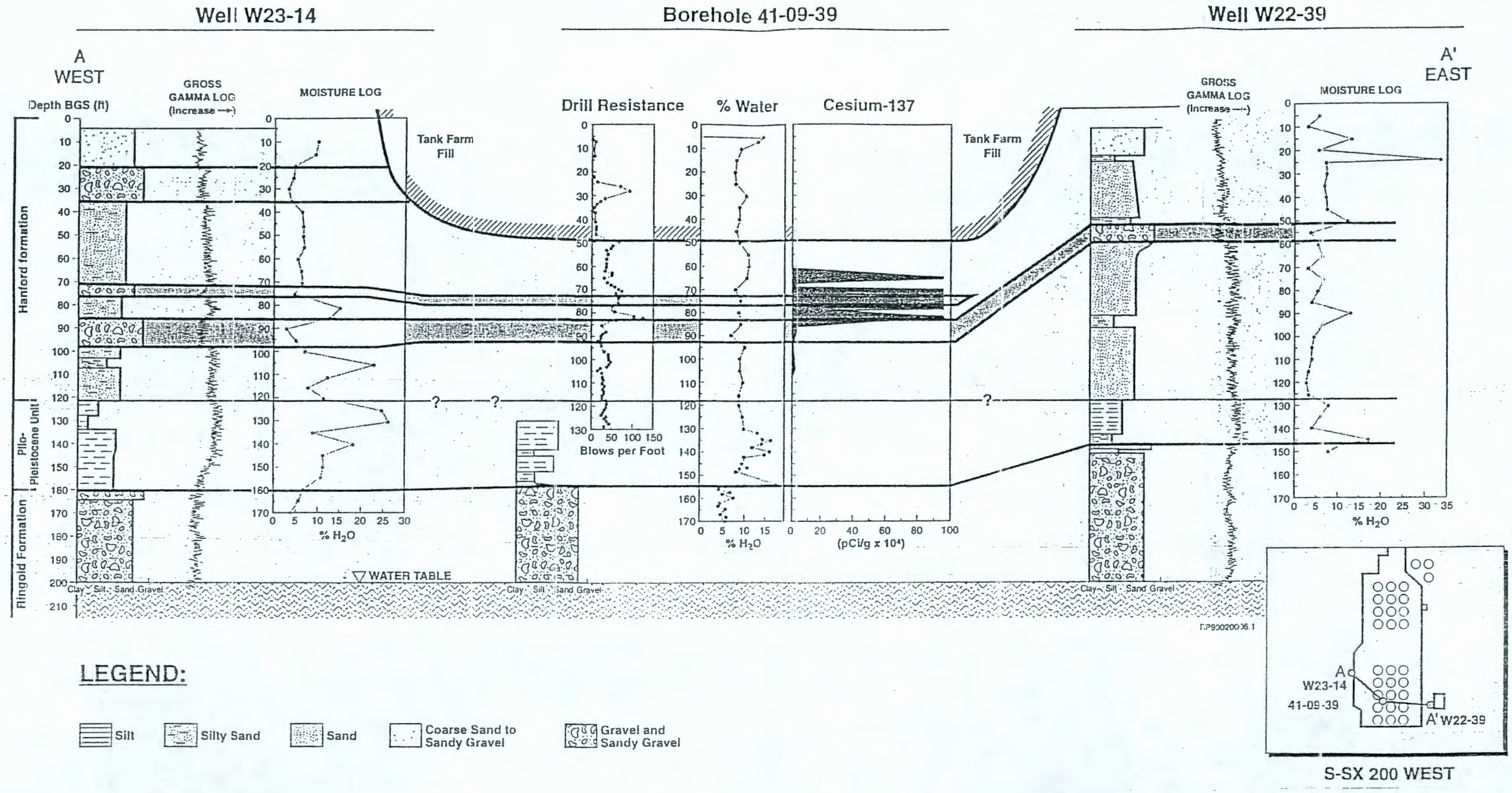
2.2.2.2 Plio-Pleistocene Unit and Early Palouse Sediment

The Plio-Pleistocene Unit is up to 13-m (40-ft) thick and consists of massive, brown yellow, and compact, silt and minor fine-grained sand and clay. Slate (1996) includes a gravel facies, which occurs south of the 200 West Area in the Plio-Pleistocene Unit. Granule-sized grains consisting primarily of basalt commonly occur in the unit. The unit is differentiated from overlying graded rhythmites (i.e., the Hanford formation) by greater calcium carbonate content, massive structure in core, and high natural gamma response in geophysical logs of the early Palouse sediment (DOE 1988).

The facies relationship in the Plio-Pleistocene Unit have been interpreted by Slate (1996) as indicating deposition along a northwest-to-southwest trending stream channel. The gravel facies is restricted to the central portion of the trough. The eastern edge of the gravel facies occurs along the southwest boundary of the 200 West Area. The SMA S-SX lies above the finest

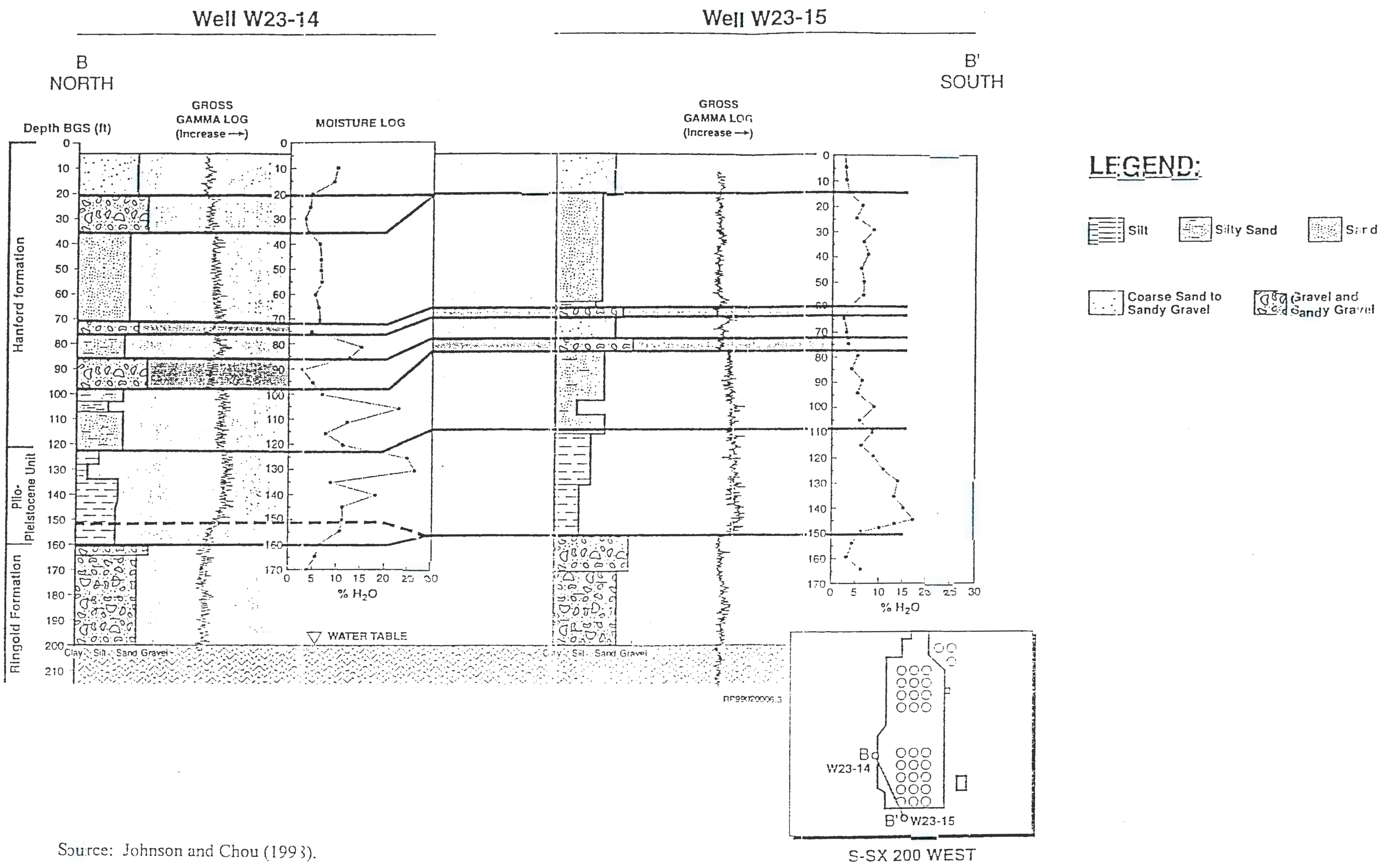
This page intentionally left blank

Figure 2.8. East-to-West Geologic Cross-Section Through SX Tank Farm



Source: Johnson and Chou (1998).

Figure 2.9. Northwest-to-Southeast Geologic Cross-Section Through SX Tank Farm



Source: Johnson and Chou (1993).

grained facies, which probably represent overbank deposits. It consists of mainly silty to very-fine silty sand and clay deposits. The Plio-Pleistocene Unit thins from southwest to northeast and varies from about 6 to 13 m (20 to 40 ft) in thickness across the WMA. This unit contains a series of paleosols with pedogenic carbonate (caliche) zones (Slate 1996). The pedogenic carbonate zones are assumed to have formed in the subsurface during hiatuses in deposition. The carbonate zones may be up to 20 m (66 ft) thick, typically including individual carbonate beds that range from a few to 10's of centimeters thick. Beneath the WMA S-SX, only one carbonate zone has been recognized. This zone is between 154 to 156 m (505 to 512 ft) amsl (Myers et al. 1998). In the vicinity of the WMA S-SX, the surface of the Plio-Pleistocene Unit is a trough that resembles the surface of the Ringold Formation. Figure 2-10 illustrates the interpreted surface elevation of the top of the carbonate zone for the SX Tank Farm and vicinity based on recent assimilation and interpretations (Lindsey 1999). From this figure, a trough in the carbonate zone surface is interpreted to pass through the SX Tank Farm. Also, the carbonate surface 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 the WMA S-SX. Slate (1996) interpreted this trough as resulting from a combination of erosion by Cold Creek and post-depositional erosion by the Missoula floods. Continued subsidence in the Cold Creek depression probably also contributed to the growth of the feature.

The early Palouse sediment consists of loess-like silt and minor sand up to 20-m (65-ft) thick overlying the Plio-Pleistocene Unit. Early Palouse sediment has a high calcium carbonate content and high natural gamma response (Trent 1992).

2.2.2.3 Hanford formation

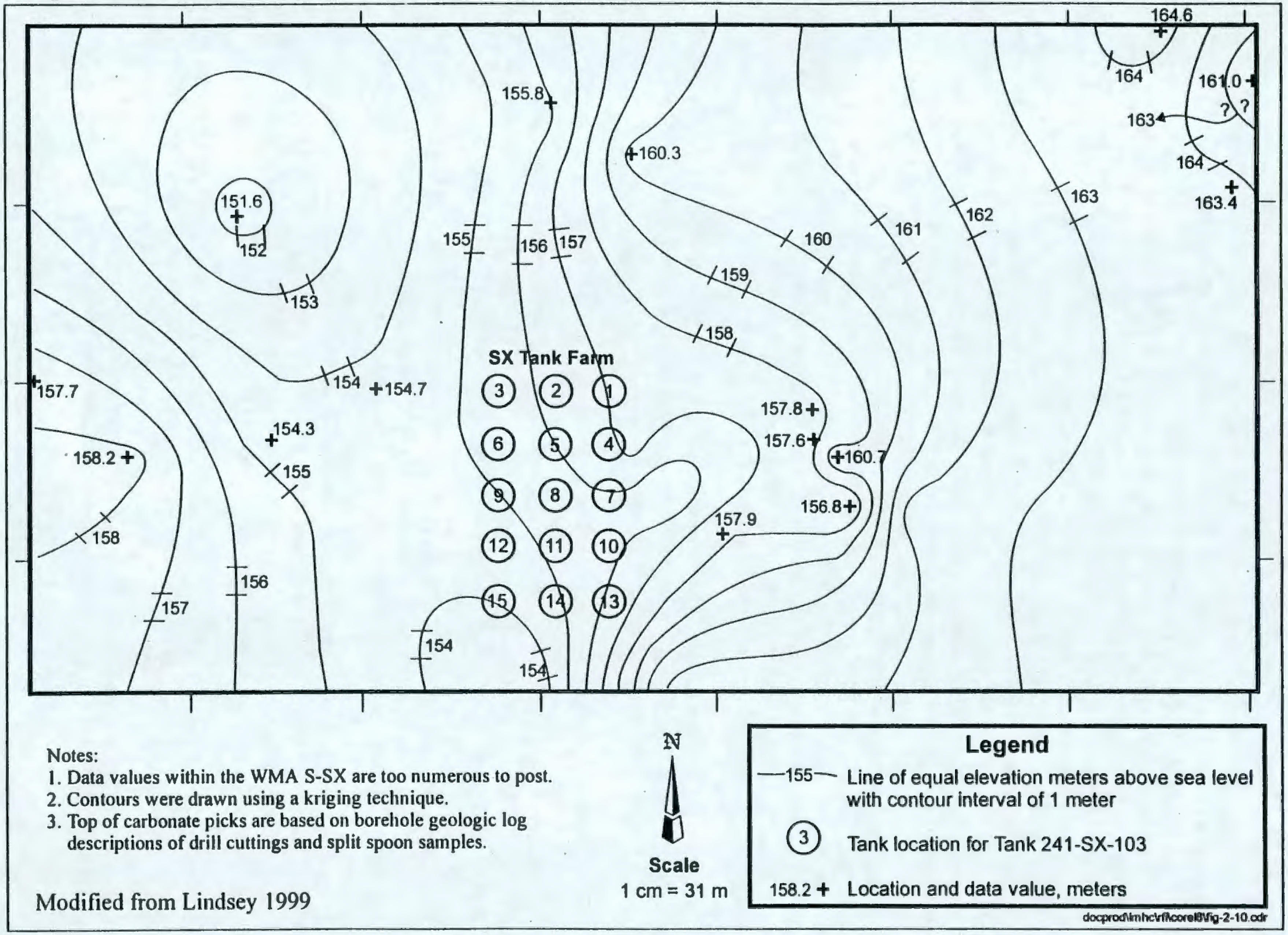
The Hanford formation consists of pebble-to-boulder gravel, fine-to-coarse grained sand, and silt. The Hanford formation, which is thickest in the vicinity of the Central Plateau (up to 65-m [210-ft] thick), was deposited by cataclysmic floodwaters during glacial times.

Gravel dominates the Hanford formation in the northern part of the Central Plateau (Trent 1992). Sand-dominated material is found most commonly in the central to southern parts of the Central Plateau. The silty materials are found within and south of the Central Plateau (Trent 1992).

In the WMA S-SX, the Hanford formation consists of a series of primarily sand intercalated with beds of coarse sand and gravel and thinner lenses of silts and clay silts. The basal portion of the unit consists of sand to silty sands. Gravel lenses dominate the middle portion, which is overlain by principally coarser sands with minor silt and gravel lenses.

The lower portion consists primarily of sands-to silty-sands. This sequence thins from east to west across the 241-S and 241-SX tank farms, which may be the result of later scouring. A prominent silt clay bed is found at relatively the same stratigraphic position on both the west and east sides of the 241-SX tank farm; it is not currently known how far the clay bed extends under the tank farm and if it is continuous (Johnson and Chou 1998).

Figure 2.10. Structural Contour Map (Surface Elevation) for the Top of the Carbonate for the SX Tank Farm and Vicinity



Notes:
1. Data values within the WMA S-SX are too numerous to post.
2. Contours were drawn using a kriging technique.
3. Top of carbonate picks are based on borehole geologic log descriptions of drill cuttings and split spoon samples.

Modified from Lindsey 1999

The lower sandy sequence is bounded above by one to two gravel lenses and intercalated sands that can be correlated under the tank farms. Two gravel lenses exist to the west, but they either merge or the upper one pinches out to the east. The sequence ranges in thickness from 3 m to 10 m (10 to 30 ft) in the 241-SX tank farm, but little thinning is seen under the 241-S tank farm. In the 241-S tank farm, this gravel sequence was intersected during tank excavation and is now in contact with the backfill material.

Above the gravel lenses lies an upper sand to silty-sand sequence. This sequence thins to the east. A thin, sandy silt, 1- to 1.5-m (3- to 5-ft) thick directly overlying the gravel forms the base of this sequence on the east and north side of the tank farms. A thin, coarse sandy unit about 3.0 m (10 ft) above the gravel is intercalated with this sequence on the west side only.

Holocene surficial deposits consisting of silt, sand. and gravel form a thin (less than 10-m [33-ft]) surface layer across much of the Hanford Site that overlies the Hanford formation. These surficial materials were deposited by a mix of eolian (wind) and alluvial (flowing water) processes (DOE 1993b).

2.2.3 Hydrogeology

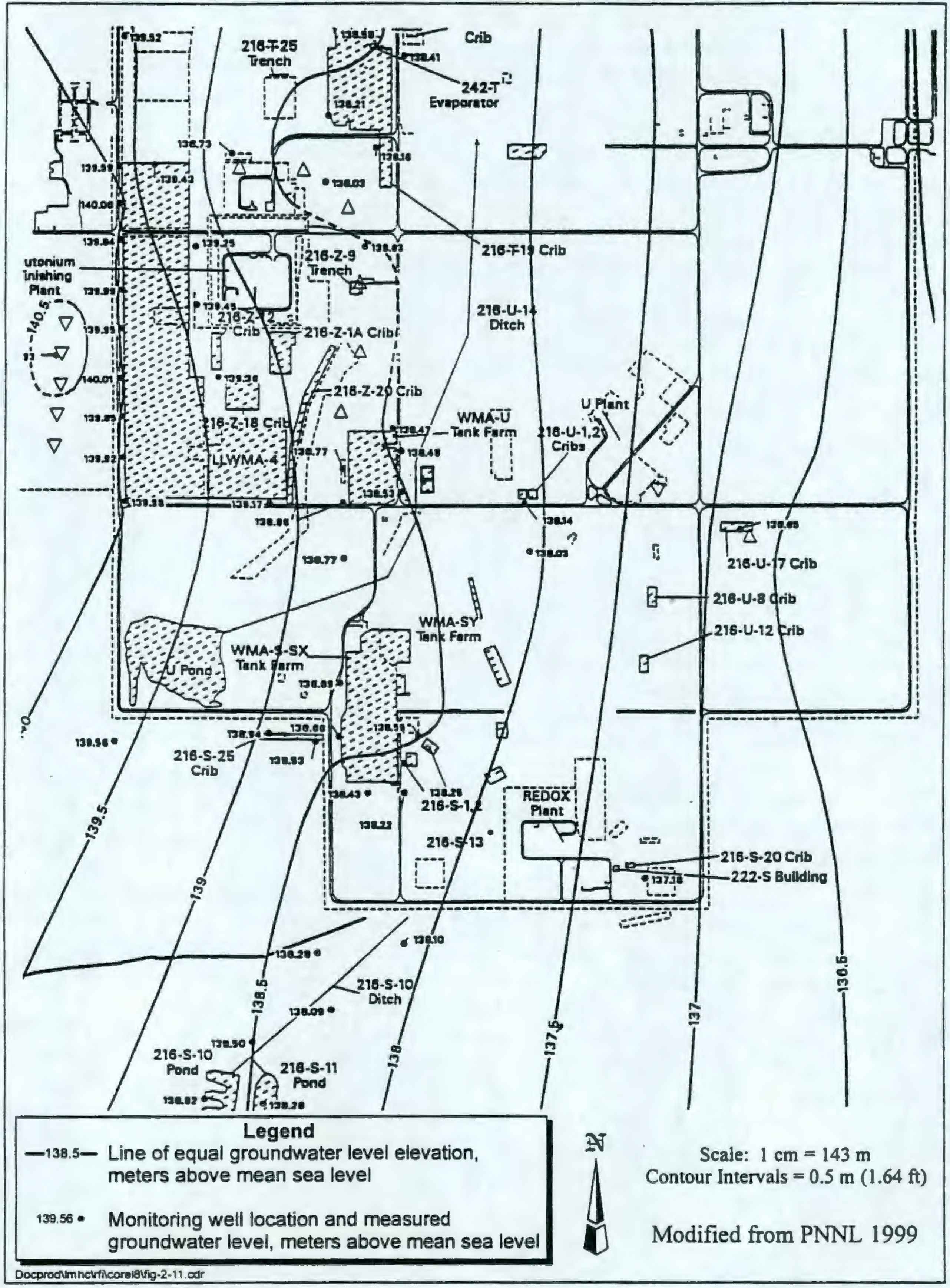
Groundwater of the unconfined aquifer occurs throughout the Hanford Site in the sediment layers above the basalt known as the suprabasalt sediments.

Water level measurements (June 1998) indicated that the water table in the unconfined aquifer was at approximately 138 m (453 ft) amsl (Figure 2.11). 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) amsl at the top of the Lower Mud Sequence (Figure 2.7). 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 (Johnson and Chou 1998).

The confined aquifers are found primarily within the Columbia River Basalt. The relationship between the various stratigraphic units and the hydrogeologic units of the Central Plateau is shown in Figure 2.7.

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 241-SX tank farm, however, indicate a possible localized shift to the east. Water table elevations in the vicinity of the WMA S-SX declined approximately 7 m (23 ft) between 1984 and 1995 (PNNL 1998). 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 the WMA S-SX vicinity were projected to drop from approximately 147 m (482 ft) amsl in 1996 to approximately 140 m (460 ft) amsl in the year 2000, and 134 m (440 ft) amsl by the year 2050 (PNNL 1998). More recent data, however, indicate that water levels are dropping at a more rapid rate. Table 2.1 provides well construction and water level data for the RCRA monitoring wells in this WMA. Numerous non-RCRA wells exist near the 241-S and 241-SX tank farms.

Figure 2.11. 200 West Area Water Table Map, June 1998



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

Modified from PNNL 1999

Docprod\lmhc\rfi\corel8\fig-2-11.cdr

Table 2.1. 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 the 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).

Artificial recharge in the 200 West Area is associated with trenches, cribs, ditches, and drains that were used to dispose of approximately 1.7E+11 L (4.4E+10 gal) of wastewater. Higher infiltration rates are observed around the tank farms, which are covered with gravel and kept clear of vegetation.

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 seasonally 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 percolates into the ground.

2.2.3.1.1 Pre-Tank Anticipated Recharge

Before construction of the 241-SX tank farm in 1953, it is assumed that a shrub-steppe type of ground cover existed with a sand-loam sediment because this was typical of the 200 Areas before the Hanford Site. A range of recharge rates from approximately 0 to 8.6 mm/yr (0.34 in./yr) has been reported for such conditions (Rockhold et al. 1995; Fayer and Walters 1995).

Lysimeter studies have shown that for this type of ground cover, either very little or no recharge occurs, even when precipitation has been enhanced by two to three times the long-term average (Rockhold et al. 1995). Based on current climatic conditions, studies (Fayer and Walters 1995) at the nearby Fitzner-Eberhardt Arid Lands Ecology Reserve indicate that recharge rates vary from 3.4 mm/yr (0.13 in./yr) to 8.6 mm/yr (0.34 in./yr) for shrub-steppe ground cover and are dependant upon sediment type. The 3.4-mm/yr (0.13-in./yr) recharge rate is based on silt loam sediment type, while the 8.6-mm/yr (0.34-in./yr) rate is based on sand sediment type.

Where the vegetative cover is not shrub (i.e., sagebrush), the recharge rate has been observed to increase. Modeling studies have shown that the change from sagebrush to cheatgrass would increase recharge rates by two orders of magnitude (Rockhold et al. 1995).

2.2.3.1.2 Current Recharge Rates

Current recharge rates for the SX tank farm 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 in 1953. 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 1996a; Kincaid et al. 1995). Ten cm/yr (3.94 in./yr) is approximately 60% of the long-term annual precipitation (16.8 cm/yr [6.61 in./yr]) (Hoitink and Burk 1994) and corresponds to lysimeter data that represent tank farm conditions (Gee 1987; Gee et al. 1992).

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 (Rockhold et al. 1995). 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) (Hoitink and Burk 1994). 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 Areas Plateau. When additional moisture was applied by irrigation, the percentage of drainage observed in the lysimeters increased to 75% (Fayer 1997). In a 3-yr study at the Field Lysimeter Test Facility under ambient precipitation conditions, a total of 592 mm (23.3 in.) of precipitation occurred from 1990 to 1993, of which 47% or 278 mm (10.9 in.) of recharge (drainage) were recorded (Fayer 1997). Enhanced precipitation (1,440 mm [56.7 in.]) during this same time span accounted for 62.5% recharge (900 mm [35.4 in.]). Waugh et al. (1991) reported that 50% of the annual precipitation has resulted in recharge at the Small-Tube Lysimeter Facility during 1988 and 1989.

A previous study conducted by Smoot et al. (1989) simulated infiltration of meteoric water to 2 m (6.56 ft) below the surface at the 241-T tank farm for SST 241-T-106. Using UNSAT-H, the simulation produced a recharge rate of 13.07 cm/yr (5.15 in./yr), which is 77% of the precipitation. The precipitation was an average obtained over a 74-yr period (from 1947 to 2020). The material at the surface was silty sandy gravel (backfill). For the simulation, the hydraulic properties associated with sample AP-1g from the 241-AP tank farm were used for the entire 2-m (6.56-ft) depth. When the sediment hydraulic properties were changed to represent a

15-cm (5.9-in.) cover of clean gravel (similar to certain tank farms at the Hanford Site), an increase from 77% to 96% (13.1 to 15.5 cm/yr [5.16 to 6.1 in./yr]) of the annual precipitation reached a depth of 2 m (6.56 ft). In addition, Smoot et al. (1989) varied the hydraulic properties of the backfill by two orders of magnitude and the simulation indicated recharge ranged from 12.06 to 14.9 cm/yr (4.75 to 5.87 in./yr) (68% to 86% of the annual precipitation). Rockhold et al. (1995) recommends a recharge rate of 75 mm/yr (7.5 cm/yr), or 47% of the annual recharge for use in performance assessments for rock side slopes. This value is based on the recharge rate that occurred at lysimeters with a clean graveled surface and no vegetation.

2.2.3.1.3 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 Jones et al. (1998).

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, shed 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.

In general, two types of moisture movement can occur in vadose zones beneath tank farms: piston flow and preferential flow. Piston flow refers to uniform moisture movement through the sediment matrix whereby infiltrated water displaces initial water. Under piston-like flow conditions most, if not all, preexisting water ("old" water) is displaced and moved ahead of the "new" infiltration water added from above. Under natural recharge conditions, the medium-to-coarse-grained sands at tank farm sites are expected to be quite conducive to piston flow. Preferential pathways can be natural (e.g., clastic dikes) or man-made (e.g., unsealed monitoring wells). Other potential preferential pathways during tank leaks include wetting front instability or "fingering" flow. Wetting front instability, reported in petroleum literature, is a special case of interface instability during immiscible fluid displacement in porous media. The phenomenon is triggered by unfavorable differences between the viscosities and densities of two fluids across their interface – a condition that can potentially exist during tank leaks.

Under natural recharge conditions, the vadose zone water content profiles are at quasi-equilibrium with the recharge rate. A field study (Sisson and Lu 1984) in 200 East Area south of PUREX demonstrated the effect of geologic heterogeneities on water contents in a natural arid setting; the higher observed water content values were strongly correlated with fine sediment layers. In addition, the observed profiles were remarkably similar for the 15-year interval between measurements at the field site (Fayer et al. 1995). This suggests that, in the absence of artificial recharge, the "natural" moisture contents of the sediments are essentially determined by the nature of geologic heterogeneities. This is also demonstrated by the moisture content profiles in borehole 299-W10-196 near Tank 241-T-106 in 200 West Area; the data collected in 1993 show a much higher moisture content in the Plio-Pleistocene and Upper Ringold layers than in the Hanford formation (Freeman-Pollard et al. 1994).

The dominance of lateral movement is a unique feature of unsaturated flow, especially in an arid setting. Horizontal stratification enhances such movements, since at high tension (i.e., dry sediment), hydraulic conductivities of fine-textured materials are relatively high and the fluid prefers to spread laterally in the fine media than to move vertically through the coarse media. Such a phenomenon is referred to as moisture-dependent anisotropy, and can potentially be a dominant "funneled" flow mechanism for situations where a fine layer overlies a coarse layer along an inclined bed. For tank leaks, this has important implications on contaminant arrivals at the water table.

A description of geologic heterogeneities as well as sediment hydraulic properties (i.e., moisture content versus matric potential and unsaturated hydraulic conductivity versus moisture content relationships) is needed to evaluate the storage and flow properties of tank farm sediments. Furthermore, assessing the ability of the vadose zone to act as a buffer requires properly accounting for conditions whereby the tank leak chemistry itself may affect sediment hydraulic properties and therefore the mobility of contaminants. Khaleel and Freeman (1995) compiled available data on hydraulic properties for the principal formations and sediment types in the 200 Areas plateau.

2.2.4 Surface Water Hydrology

Two ephemeral creeks, Cold Creek and Dry Creek, traverse the uplands of the Hanford Site southwest and south of the 200 Areas. These creeks drain southeasterly toward the Yakima River, located south of the Hanford Site. Surface runoff from the uplands is minor, and creek flows only during and shortly after rainfall and snowmelt. The Columbia River is at least 11 km (7 mi) downgradient from the 200 Areas and forms the eastern boundary of the Hanford Site. The Columbia River comprises the base level and receiving water for groundwater and surface water in the region.

No floodplains 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. Natural runoff generated onsite or from offsite upgradient sources is not known to occur in the 200 Areas (Newcomb et al. 1972).

2.2.5 Meteorology

The Hanford Site is located in a semi-arid region. The Cascade Mountains to the west greatly influence the Hanford Site's climate by providing a rainshadow effect. The Cascade Mountains also serve as a source of cold air drainage, which has a considerable effect on the Site's wind regime. The following meteorology discussion is based on Hanford climatological summaries (Stone et al. 1972; PNL 1994) and information compiled by Cushing (Cushing 1994; 1995).

Prevailing winds at the Hanford Meteorological Station, which is located between the 200 East and West Areas, are from the west-northwest and northwest during all months of the year.

Monthly average wind speeds are the lowest during December, averaging approximately 10 km/hr (6 mi/hr), and are the highest during June, averaging approximately 15 km/hr (9 mi/hr).

From 1961 through 1990, average monthly temperatures varied from -1°C (30°F) in January to 24°C (76°F) in July, with a yearly average of 12°C (53°F). On the average, 51 days during the year have maximum temperatures higher than or equal to 32°C (90°F), and 12 days have a maximum higher than or equal to 38°C (100°F). An average of 25 days during the year have maximum temperatures lower than 0°C (32°F), and 106 days per year have minimum temperatures lower than 0°C (32°F).

The average annual precipitation is 16 cm (6.5 in.), with over half of this amount occurring from November through February. December, the wettest month, averages 2.5 cm (1 in.) of precipitation, while July, the driest month, averages 0.5 cm (0.2 in.) of precipitation. The annual average snowfall is 38 cm (15 in.).

Although fog has been recorded throughout the year, nearly 90% of the occurrences are during the late fall and winter months. Other phenomena that restrict visibility to 10 km (6 mi) or less include dust and smoke (typically from wildfires, orchard smudging, and agricultural field burning). Reduced visibility from blowing dust occurs an average of 5 days per year, and reduced visibility resulting from smoke occurs an average of 2 days per year.

Severe high winds often are associated with thunderstorms. On average, the Hanford Site experiences ten thunderstorms per year, most frequently (80%) during May through August.

Good atmospheric dispersion conditions exist at the Hanford Site about 57% of the time during the summer (PNL 1994). Less favorable dispersion conditions occur when the wind speed is light and the mixing layer is shallow. These conditions are most common during the winter, when moderately to extremely stable stratification exists about 66% of the time. The probability of an inversion period (e.g., poor dispersion conditions) extending for longer than 12 hours varies from a low of about 10% in May and June to a high of about 64% in September and October (Holzworth 1972).

2.2.6 Environmental Resources

Approximately 600 different plant species exist on the Hanford Site (Neitzel 1997). Historically, the predominant plant in the area was big sagebrush with an understory of perennial bunch grasses. Following Euro-American settlement that began in the early 1800s, grazing and agriculture disrupted the native vegetation and opened the way for invader species such as Russian thistle and cheatgrass. The Central Plateau vegetation predominantly consists of shrub-steppe.

Over 100 plant species occur on the Central Plateau. Common species include big sagebrush, rabbitbrush, cheatgrass, and Sandberg's bluegrass. Much of the land surface of the 200 Areas has been disturbed by human activities (58%). Introduced species (e.g., Russian thistle and cheatgrass) are common in these disturbed areas, with cheatgrass providing half of the plant cover (Neitzel 1997).

Species of concern on the Hanford Site include Federally listed threatened and endangered species, Federal candidate species (50 CFR 17), Washington State threatened or endangered species, Washington State candidate species, monitor species, and sensitive plant species.

No Federally listed threatened or endangered plant or animal species are known to occur on the Hanford Site (Sackschewsky et al. 1992). Neitzel (1997) provides a list of the Washington State threatened or endangered plants and a list of the wildlife species of concern on the Central Plateau and vicinity.

Further information on environmental resources will be provided in the Phase 1 RFI/CMS work plan and in the addendum S-SX work plan.

2.2.7 Human Resources

This section describes the demography, cultural resources, and community relations of the Hanford Site.

2.2.7.1 Demography

No residences exist on the Hanford Site. Approximately 258,000 people live within an 80-km (50-mi) radius of the WMA S-SX. The primary population centers are the cities of Richland, Kennewick, Pasco, and West Richland, which are located southeast of the Hanford Site.

2.2.7.2 Cultural Resources

Cultural resources are provided in Nietzel (1997) and will be discussed in the Phase 1 RFI/CMS work plan.

2.2.7.3 Community Relations

Community relations plan will be provided in the Phase 1 RFI/CMS work plan.

3.0 INITIAL CONDITIONS AND CORRECTIVE ACTION REQUIREMENTS AND OBJECTIVES

The information on known and suspected contamination is presented in Section 3.1 based on available data. 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 improving understanding of the nature and extent of contamination at the WMA will be collected during the field investigation described in this preliminary addendum and in the work plan for the WMA S-SX.

For the four SST WMAs currently under RCRA corrective action in accordance with the proposed Tri-Party Agreement Milestone Change Control Form Change Number M-45-98-03 (DOE 1999a), the WMA S-SX contains the most information based on past investigations conducted at these WMAs. Although past investigations have been conducted at T Tank Farm, and WMA B-BX-BY, recent investigations have been conducted at the WMA S-SX. Two recent investigations include the RCRA facility groundwater assessment conducted by Johnson and Chou (1998) and the installation of two additional drywells at the SX Tank Farm, with one borehole (41-09-39) extended to groundwater in 1997. In addition, an independent panel of experts has conducted extensive reviews of progress in relation to SX Tank Farm (DOE 1999b, DOE-RL 1997) including spectral gamma surveys of SX Tank Farm drywells (DOE-GJPO 1996) and installation of two new drywells with one extended to groundwater (borehole 41-09-39) (Myers et al. 1997). Therefore, Ecology and DOE concluded during negotiations on proposed Change Control Form Number M-45-98-03 that this Preliminary Addendum should focus on the SX Tank Farm for initial characterization efforts in fiscal year 1999.

3.1 KNOWN AND SUSPECTED CONTAMINATION

To determine 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.

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 yr, 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 both nuclear and chemical aspects of the process that generated the waste based on tank construction and operating conditions. Anderson (1990) 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.

The manner in which the waste entered the sediment column is also important in understanding potential sources within the WMA and the likelihood of mobile tank waste constituents reaching the groundwater. Numerous direct sources are available from the WMA to enter the environment, such as tank leaks, spills from diversion boxes and transfer lines, and post-practice releases to cribs from operation activities. Estimated releases or leaks from the tanks in WMA S-SX are indicated in Table 3.1. These estimates were obtained from reports by Anderson (1990), Hanlon (1999), and Agnew and Corbin (1998). Releases related to tank leaks are better documented. A summary of all waste releases from the tanks to the sediment and of the releases associated with SX tank farm includes the following:

- Tank SX-107 – released 19,000 L (5,000 gal), resulting in the migration of contamination as deep as 17 to 18 m (55 to 60 ft) bgs in 1964 (DOE 1991).

- Tank SX-108 – estimated releases vary from 9,100 L (2,400 gal) to 132,475 L (35,000 gal) of supernatant containing REDOX high-level waste (HLW) between 1962 and 1964 based on WHC (1992a), to 768,400 L (203,000 gal) based on Agnew and Corbin (1998). Tank SX-108 was suspected of leaking in December 1962. It was thought to have self-sealed, and the tank was kept in service. Tank SX-108 was observed to have leaked 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 ranging from 9,084 to 132,475 L (2,400 to 35,000 gal), the 1965 supernate analysis and decay calculations to 1-1-91, the radionuclides in contaminated sediment under the tank are between 10,000 and 140,000 Ci of cesium-137 (WHC 1992a).

- SST SX-109 – estimated releases vary from approximately 37,850 L (10,000 gal) of REDOX high-level liquid waste in January 1965 based on WHC (1992b), to 420,100 L (111,000 gal) based on Agnew and Corbin (1998). In 1965, the tank was confirmed to be leaking and was removed from service. Liquid was not immediately removed from the tank, as the leak was thought to have self-sealed. During the third quarter of 1969 and the fourth quarter of 1971, some liquid was transferred out of the tank. In the fourth quarter of 1973, the tank was pumped down to minimum level. As of 1994, increases in radioactivity in the drywells and laterals were still being observed, which is presumed to be a result of movement of material that had leaked earlier. Based on the assumption that the liquid that had leaked from tank SX-109 had the same composition as the liquid leaking from tank SX-108, the radionuclides in the contaminated sediment under the tank are 40,000 Ci of cesium-137 (or less) as of January 1, 1992 (WHC 1992b).

- Tank SX-115 – released 190,000 L (50,000 gal) of REDOX HLW condensate in March 5, 1965. The tank was immediately confirmed to be leaking and all pumpable liquid was removed on March 8, 1965. Approximately 190,000 L (50,000 gal) of sodium nitrate solution leaked from the tank the week before the leak was discovered (DOE 1991; WHC 1992c). The leaked solution contained approximately 40,000 Ci of cesium-137 (Raymond and Shdo 1966). Allowing for radioactive decay, the leakage plume now contains approximately 21,000 Ci, nearly all cesium-137 (WHC 1992c). Earlier investigators Raymond and Shdo (1966) located about 60% of the leaked volume in three areas of contamination from 1.8 to 3 m (6 to 10 ft) below the tank. Some of the leaked liquid may have penetrated deeper into the sediments below Lateral 3. This speculation is supported by the high radiation readings that persist in this lateral during 1992 (WHC 1992c).

- SST SX-104 – released 22,800 L (6,000 gal) in 1988 (Hanlon 1999).
- Tank SX-110 – released 20,818 L (5,500 gal) in 1976 (Hanlon 1999).
- Tank SX-111 – estimated releases vary from 1,893 and 7,570 L (500 and 2,000 gal) of REDOX HLW and ion-exchange liquid waste in 1974 based on Hanlon (1999), to 208,180 L (55,000 gal) based on Agnew and Corbin (1998).
- Tank SX-112 – estimated releases vary from 114,000 L (30,000 gal) of REDOX HLW in 1969 based on Hanlon (1999), to 166,540 L (44,000 gal) based on Agnew and Corbin (1998).
- Tank SX-113 – released 56,775 L (15,000 gal) of REDOX HLW in 1962 (Hanlon 1999).
- Tank SX-114 – released 30,280 L (8,000 gal) in 1972 (Hanlon 1999).

Agnew and Corbin (1998) provide month-to-month leak rate volumes. Agnew and Corbin (1998) do not account for self-sealing leaks, although Agnew and Corbin (1998) do show the duration of leaks. Table 3.1 illustrates some of the uncertainty in leak volume as derived from different investigators. Table 3.2 provides the dates the tanks were declared leakers and for four tanks, the estimated leak duration. The uncertainty associated with the leak durations is even greater than that for the estimated tank leak volumes.

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

Tank	Anderson (1990) Estimated Leak Volume (gal)	Hanlon (1999) Estimated Leak Volume (gal)	Agnew and Corbin (1998) 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

Table 3.2. SX Tank Leak Volumes and Dates

241-SX Tank	Hanlon (1999) Agnew and Corbin (1998) Estimated Leak Volume (gal)	Anderson (1990) Estimated Leak Date	Hanlon (1999) Date Declared Assumed or Confirmed Leaker	Agnew and Corbin (1998) Estimated Leak Duration
SX-104	6,000	1973	1988	N/A
SX-107	<5,000	1964	1964	N/A
SX-108	2,400 to 35,000 **102,000 to 203,000**	1967	1962	1959.5-1967.5
SX-109	<10, 000 **56,000 to 111,000**	1967	1965	1960.0-1969.7
SX-110	5,500	N/A	1976	N/A
SX-111	500 to 2,000 **14,000 to 55,000**	1974	1974	1972.5-1975.0
SX-112	30,000 **22,000 to 44,000**	1969	1969	1969.0-1970.0
SX-113	15,000	1958	1962 (probably 1958)	N/A
SX-114	8,000	N/A	1972	N/A
SX-115	50,000	1965	1965	N/A

Notes:

Bold values represent Agnew and Corbin (1998) leak volume ranges.
N/A = not available

3.1.2 Releases to Sediment

Releases of tank waste to the sediment that are of direct interest to the initial field investigation include releases from tanks SX-115 and SX-114 and from tanks SX-108 and SX-109.

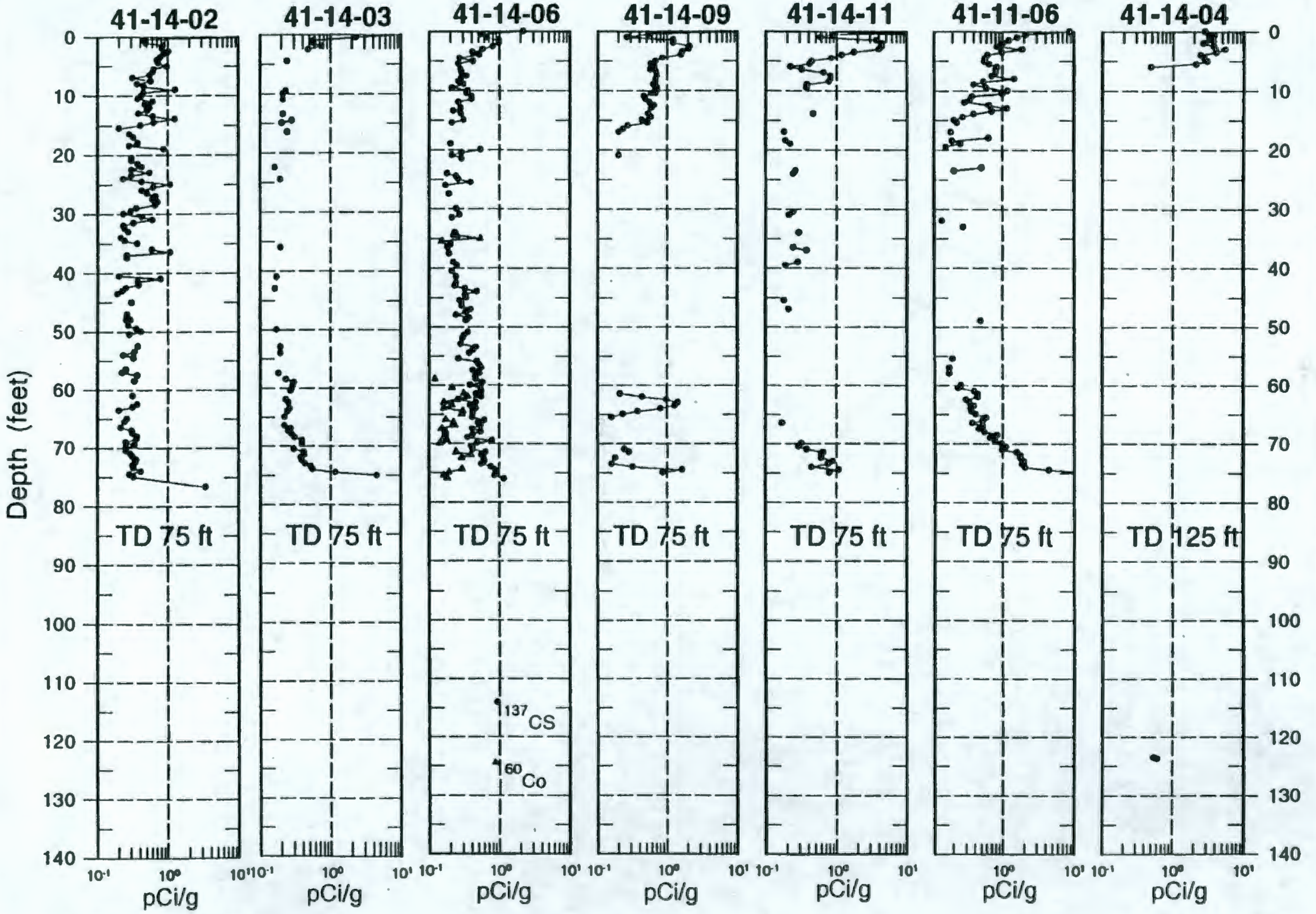
SX-114 and -115

Tank SX-114 was declared as leaking in 1972 when contamination was detected in the laterals and perimeter monitoring boreholes with the gross gamma-logging systems. The estimated leak volume of 30,280 L (8,000 gal) is highly uncertain because it is based on the average of the postulated total volume of leaks from eighteen tanks (DOE 1991; Hanlon 1999). The 30,280 L (8,000 gal) leak estimate is based on the assumption, as stated in Hanlon (1999), that the SX-114 leak was an average of the cumulative leakage from a total of eighteen tanks. Gross gamma logging of the laterals indicates little contamination. Data are not available for depths greater than 22.86 m (75 ft) bgs, the greatest depth of the boreholes (Figure 3.1).

Tank SX-115 was identified as leaking in 1965 on the basis of a liquid level decrease of at least 0.45 m (1.5 ft) and a liquid loss of about 190,000 L (50,000 gal.) This leak volume is one of the highest estimated leaks of all the leaking SSTs; only tanks T-106 (435,275 L [115,000 gal]), A-105 (37,850 to 1,048,445 L [10,000 to 277,000 gal]), and U-104 (208,175 L [55,000 gal]) are listed with leak estimates of higher volumes (Hanlon 1999).

Contamination was detected under the tank by gross gamma logging of the laterals shortly after the leak was detected by a drop-in liquid-level test. A special project was conducted in 1965 to characterize the distribution of the contamination from the leak (Raymond and Shdo 1966; WHC 1992c). This investigation involved drilling small-diameter sampling boreholes and

Figure 3.1. Correlation Plot of Cesium-137 Concentrations in Boreholes Surrounding Tank SX-114



Source: DOE-GJPO 1996

Docprod\lmhc\ffi\corel6\fig-3-1.cdr

assaying the samples in the laboratory. The distribution of cesium-137 is illustrated in Figure 3.2. As illustrated in Figure 3.2, three areas of contaminant releases were identified by Raymond and Shdo (1966):

- Zone 1 is a 1.2-m (4-ft)-thick contaminated layer from 17.7 to 18.9 m (58 to 62 ft) bgs. The waste entered the ground at or near the tank's bottom edge in the area enclosed by the 100 µCi/g contour (Figure 3.2).
- Zone 2 is a 0.6-m (2-ft)-thick contaminated layer at an average depth of 18.3 to 18.9 m (60 to 62 ft) bgs.
- Zone 3 is a 1.2-m (4-ft)-thick layer extending from 58 to 62 ft (extent and concentration of contamination is highly subjective) (Raymond and Shdo 1966).

Recent spectral gamma logging around SX-115 (DOE-GJPO 1996) indicates only one small zone of contamination (10 pCi/g) on the southwest side of tank SX-115 based on the anomaly at 57 ft in borehole 41-15-07 (Figure 3.3). The existing drywells are not located directly where Raymond and Shdo sampled and determined the plume location (WHC 1992c).

The cesium-137 distribution around tank SX-115 indicates that although a large volume of waste leaked from the tank, the gamma contaminant did not migrate extensively in the horizontal or vertical directions (based on spectral gamma logging) (DOE-GJPO 1996).

The depth of the cesium-137 contamination under tank SX-115 is unknown beyond 22.8 to 38.1 m (75 to 125 ft) bgs, but minimal horizontal migration of the contamination has occurred at this location based on spectral gamma and gross gamma logging (DOE-GJPO 1996).

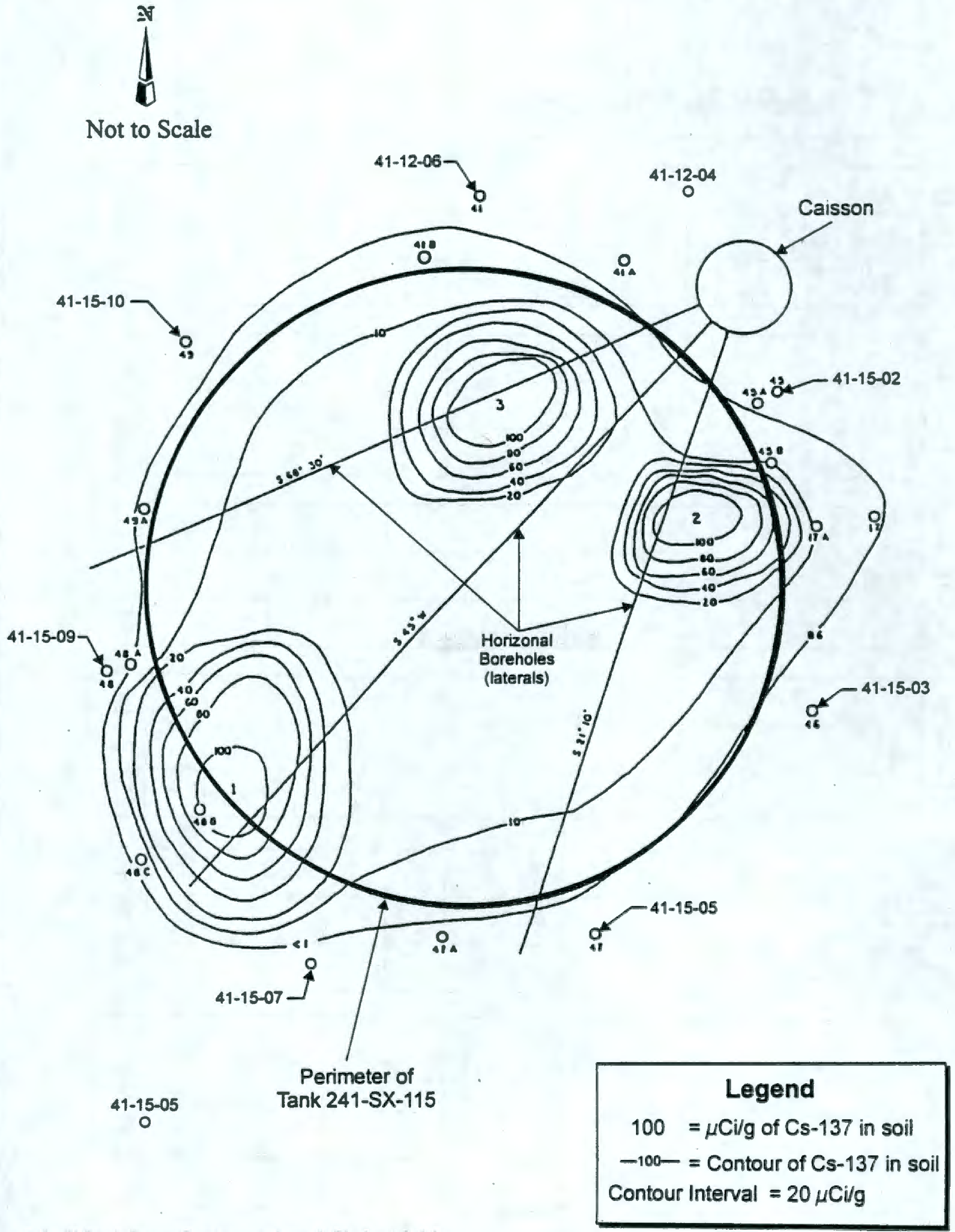
SX-108 and SX-109

Two additional boreholes, borehole 41-09-39 and 41-12-01, were recently installed (Figure 2.3) in the 241-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) bgs, respectively.

The spectral gamma logging of borehole 41-09-39 was correlated with borehole 41-09-04 (DOE-GJPO 1997). The following discussion is from the conclusions of DOE-GJPO (1997). The boreholes are located 1.6 m (5.4 ft) apart. The purpose of borehole 41-09-39 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). Borehole 41-09-39 was geophysically logged with the spectral gamma logging system (SGLS), a temperature probe, a moisture assay tool, a low-efficiency sodium iodine (NaI) logging tool, and a very low-efficiency cadmium zinc telluride (CZT) gamma detector. The data were plotted next to a drilling resistance log (Figure 3.4). Borehole 41-09-04 was logged with the very low-efficiency CZT gamma detector and the temperature probe.

Contamination was not detected in borehole 41-09-39 between the bottom of the near surface contamination at 1.8 m (6 ft) and the bottom of the tanks at about 15.2 m (50 ft.) However, fairly significant levels of contamination were detected in borehole 41-09-04 in this region (as much as 300 pCi/g). Comparison of the CZT logs from boreholes 41-09-04 and 41-09-39 shows similarities between 18.3 and 27.4 m (60 and 90 ft) interval (Figure 3.4). Both plots show a high

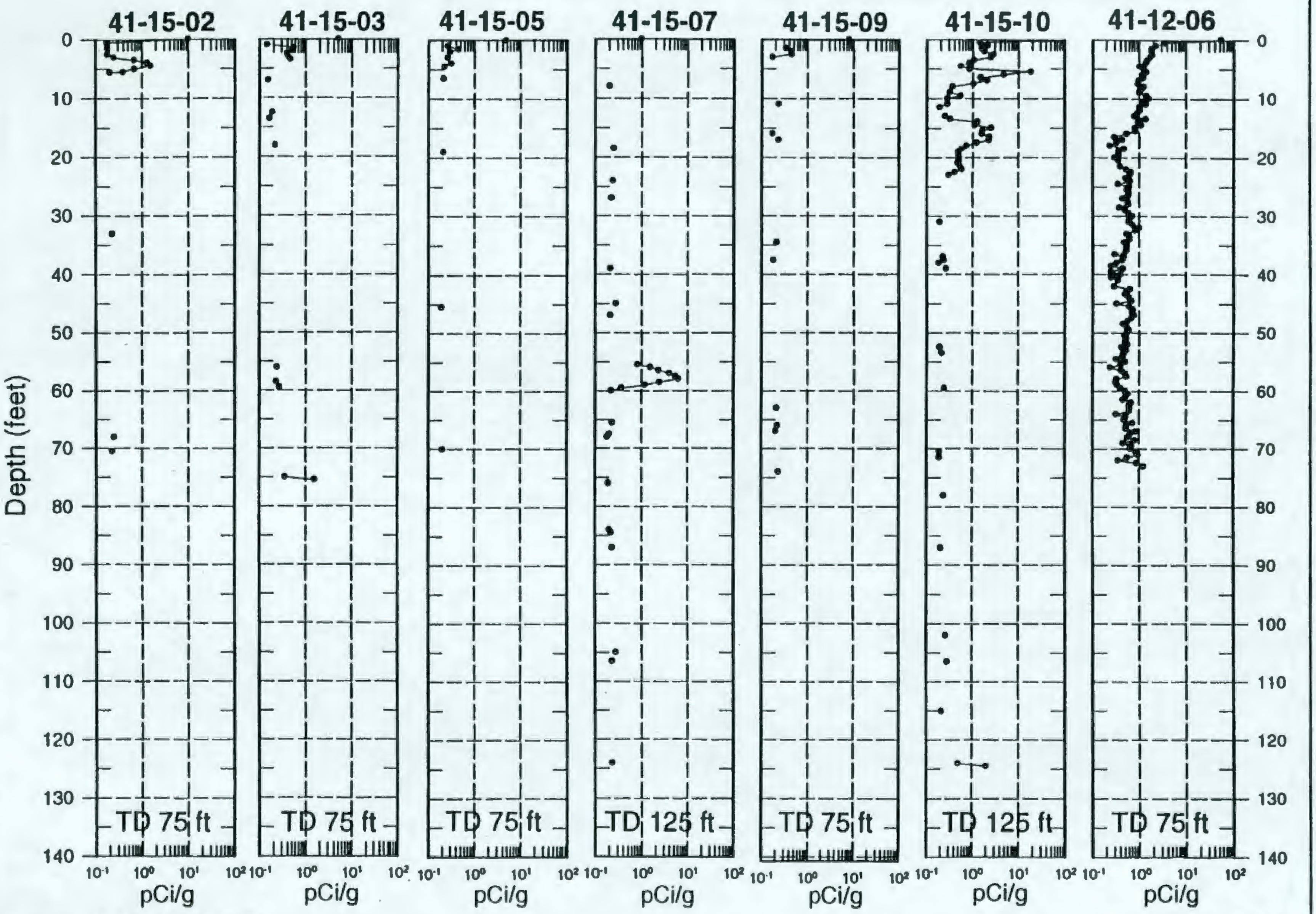
Figure 3.2. Tank 241-SX-115 Subsurface Cesium-137 Contamination



Modified from Raymond and Shdo 1966

Docprod\mhc\fl\corel8\fig-3-2.cdr

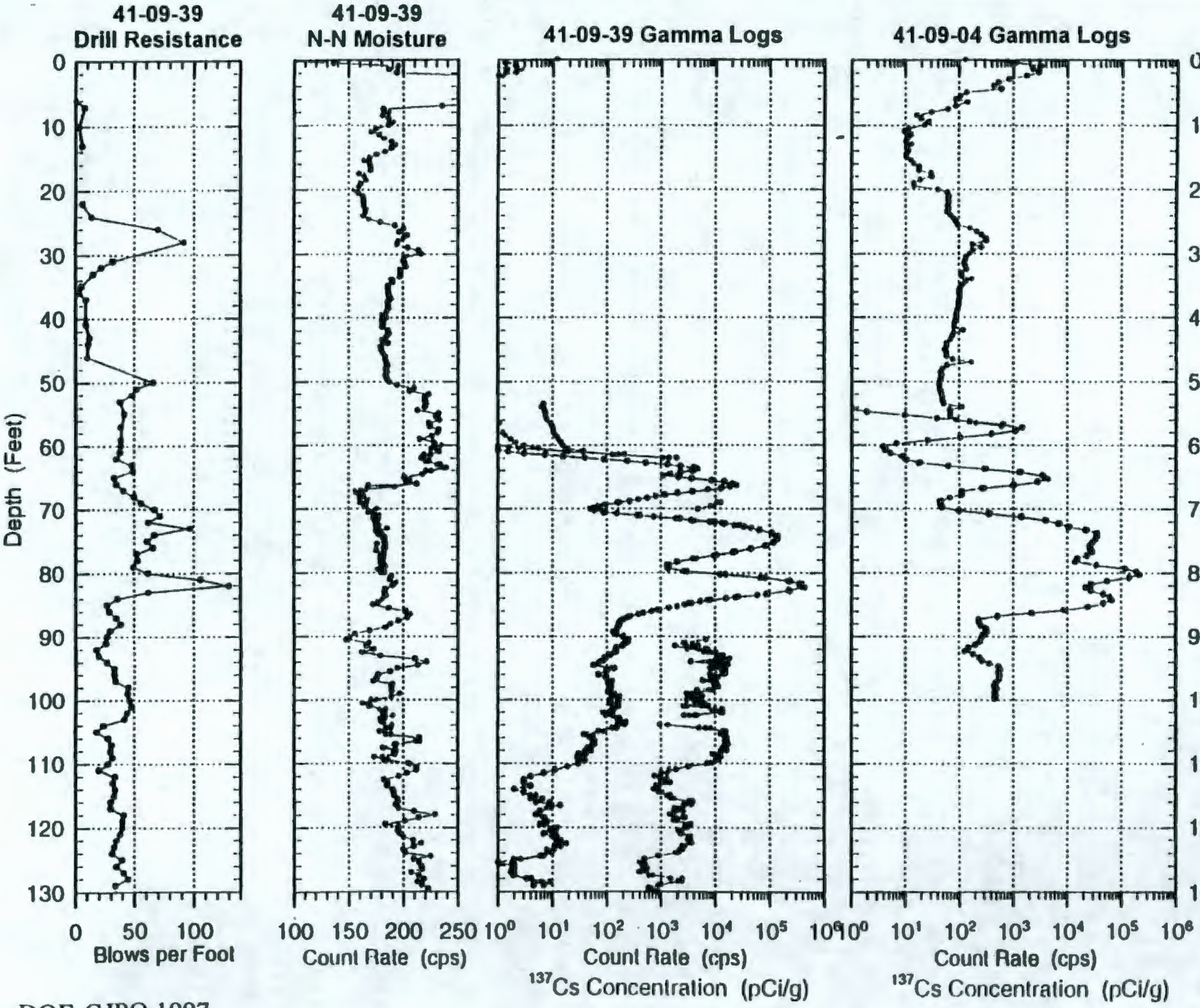
Figure 3.3. Correlation Plot of Cesium-137 Concentrations in Boreholes Surrounding Tank SX-115



Source: DOE-GJPO 1996

Docprod\lmhc\rf\corel8\fig-3-3.cdr

Figure 3.4. Correlation of Log Data for Boreholes 41-09-39 and 41-09-04



Source: DOE-GJPO 1997

Docprod\lmhc\rfi\corel8\fig-3-4.cdr

concentration peak at 20.7 m (68 ft), although data from borehole 41-09-04 show an additional peak above that level at 18 m (59 ft). Both plots show a concentration low at 21.3 m (70 ft). The largest contamination plume is located between 22 and 26.8 m (72 and 88 ft); borehole 41-09-39 shows an additional concentration low at 24.2 m (79.5 ft) within the major plume. Below 26.8 m (88 ft) to 30.4 m (100 ft), both boreholes show the contamination level decreasing by at least two orders of magnitude, although the contamination level still remains relatively high.

The bottom of borehole 41-09-04 was extended from 22.9 to 32.0 m (75 to 105 ft). A small decrease in contamination concentrations occurs at 32.0 m (105 ft) in borehole 41-09-39, and a larger decrease occurs at 33.8 m (111 ft) levels of contamination detected in borehole 41-09-39 (DOE-GJPO 1997).

Interpretation of the SGLS data indicated that there was apparently no contamination drag-down during the hammer drilling of borehole 41-09-39, which differed considerably from the results with the first percussion hammer-drilled borehole (borehole 41-12-01) (DOE-GJPO 1997). Although both boreholes were constructed by using a percussion hammer to drive an extra heavy casing with 15-cm (6-in.) ID and 1.3-cm (0.5-in.) wall thickness, there was a significant difference in the way the conical tip was attached, which affected dragdown. On 41-12-01 the weld bead between the tip and the casing protruded beyond the outer diameter of the casing. On 41-09-39, this bead was ground off flush with the casing. In 41-12-01, a zone of very high cesium-137 contamination was encountered at about 20 to 21.5 m (66 to 70 ft) depth. From about 23 m (75 ft) to total depth, the observed contamination appears to be the result of dragdown, as indicated by movement between successive runs as the hole was advanced. SGLS data from 41-09-39 shows cesium-137 below a depth of 15 m (50 ft), with detector saturation between 19 to 21 m (62 to 68 ft) and 21.3 to 27.4 m (70 to 90 ft). From 27.4 to 33.5 m (90 to 110 ft), cesium-137 concentrations are about 10,000 pCi/g. Concentrations vary between about 1,000 and 4,000 pCi/g between 33.5 and 39.6 m (110 and 130 ft). Comparison of successive logs made as the hole was advanced show little evidence of movement associated with dragdown as observed in 41-12-01.

The shape factor analysis results for 41-09-39 reported by MACTEC-ERS during the DQO meetings (March 4, 1999 in Appendix E) apply only to the borehole extension from 39.6 to 68.6 m (130 to 225 ft), which was drilled using cable tool methods after the casing tip had been drilled out. Both the shape factor analysis and comparison of successive runs as the hole was advanced indicate that cesium-137 observed between 40.8 m (134 ft) and the bottom of the hole is the result of dragdown. In summary, the data suggest that the weld bead helped to mobilize some of the contamination and drive it down with the drill stem (DOE-GJPO 1997).

The only human-made gamma-emitting radionuclide detected was cesium-137 in borehole 41-09-39 (DOE-GJPO 1997). The SGLS was saturated (i.e., gamma emissions exceeded the upper limit for which the SGLS was designed and calibrated to operate), except for a small interval near 21.0 m (69 ft) bgs. From 27.4 to 39.6 m (90 to 130 ft), moderate to high cesium-137 levels were detected, with the highest concentration in the region being about 2,000 pCi/g (DOE-GJPO 1997).

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 Myers et al. (1998), which is summarized in the following discussion.

Cesium-137 distribution is present only above the caliche-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 caliche-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 (Johnson and Chou 1998). 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 (Johnson and Chou 1998) 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).

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 caliche-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 1994).

3.1.3 Groundwater

A groundwater investigation has indicated contamination in downgradient RCRA monitoring wells is attributed to the WMA S-SX. Johnson and Chou (1998) have conducted a groundwater assessment for the WMA. Their findings confirmed that the WMA has released contaminants to the groundwater. Johnson and Chou's (1998) findings are outlined below:

- Distribution patterns for radionuclides and RCRA/dangerous waste constituents (nitrate and chromium) in the vicinity of WMA S-SX indicate that this WMA has contributed to the groundwater contamination observed in downgradient monitoring wells.

- Multiple sources in the WMA are needed to explain historical and recent groundwater contamination (Figure 3.5). At least two WMA source areas are needed to explain the technetium-99 transients observed from 1985 through 1987 in well 299-W23-1 and the more recent events observed in wells 299-W23-15 and 299-W22-46.

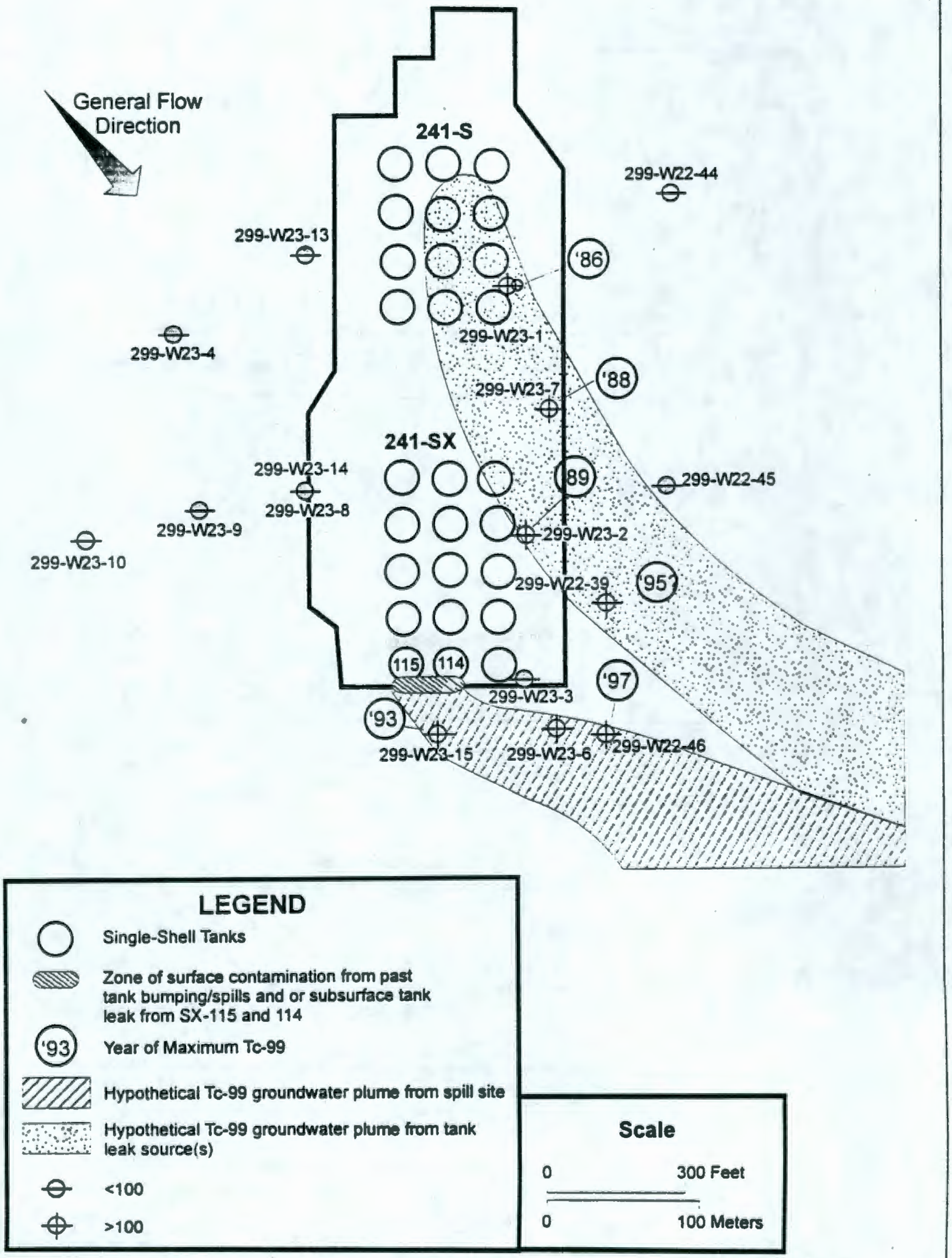
- The drinking water standard for technetium-99 has been exceeded but is currently limited to two wells at the southeast corner of the 241-SX tank farm (Wells 299-W23-6 and 299-W22-46) and one well 299-W23-1 located along the east side of the 241-S tank farm. Technetium-99, the constituent with highest concentration relative to a standard, is currently four to five times the EPA interim drinking water standard of 900 pCi/L in well 299-W22-46. The drinking water standard for nitrate has been exceeded and is currently limited to one well, 299-W22-46, with concentrations at or slightly above the 45,000 μg/L standard (Figure 3.6).

- Technetium-99, nitrate, and chromium concentrations in downgradient well 299-W22-46 (the well with the highest current concentrations) appear to be declining after reaching maximum concentrations in May 1997. Observations during the next four quarters are needed to confirm the apparent declining trend in this well.

- Circumstantial evidence suggests that short-term contaminant transients in multiple wells occurring at different times between 1985 and the present may have been caused by leaking water lines, rupture events, and/or ponded snow-melt water adjacent to and within the WMA. The 1985 date indicates when the condenser water lines were turned off. Before 1985, pressurized water lines were operated inside and outside the tank farm. After 1985, only pressurized feeder lines for fire hydrants entered the S and SX tank farm. The fire protection water lines inside the farms theoretically were valved out as part of a program to eliminate all water sources to the tank farms (circa 1990-1994). However, the line passing along the south fenceline of SX tank farm apparently was repressurized for other reasons (It was unexpectedly found to be pressurized when checked in the fall of 1996 in connection with the S-SX Phase I groundwater assessment. There was no record of when the main supply line was reopened). Thus, development of a possible water leak overlying subsurface contamination from spills or tank leaks in the southwest corner of SX tank farm hypothetically could have occurred and caused the technetium-99 transient (and related co-contaminants) in well W23-15. Data obtained from this preliminary investigation and subsequent investigations may provide an answer to whether contaminant migration that impacted groundwater was enhanced by water line leaks. Continuing efforts are underway to identify and eliminate potential water sources within or around the tank farms.

- Cesium-137 and strontium-90 were not detected in any of the RCRA-compliant monitoring wells. This observation supports the expected retention or retardation of these radionuclides in Hanford Site sediments and/or aquifer sediments.

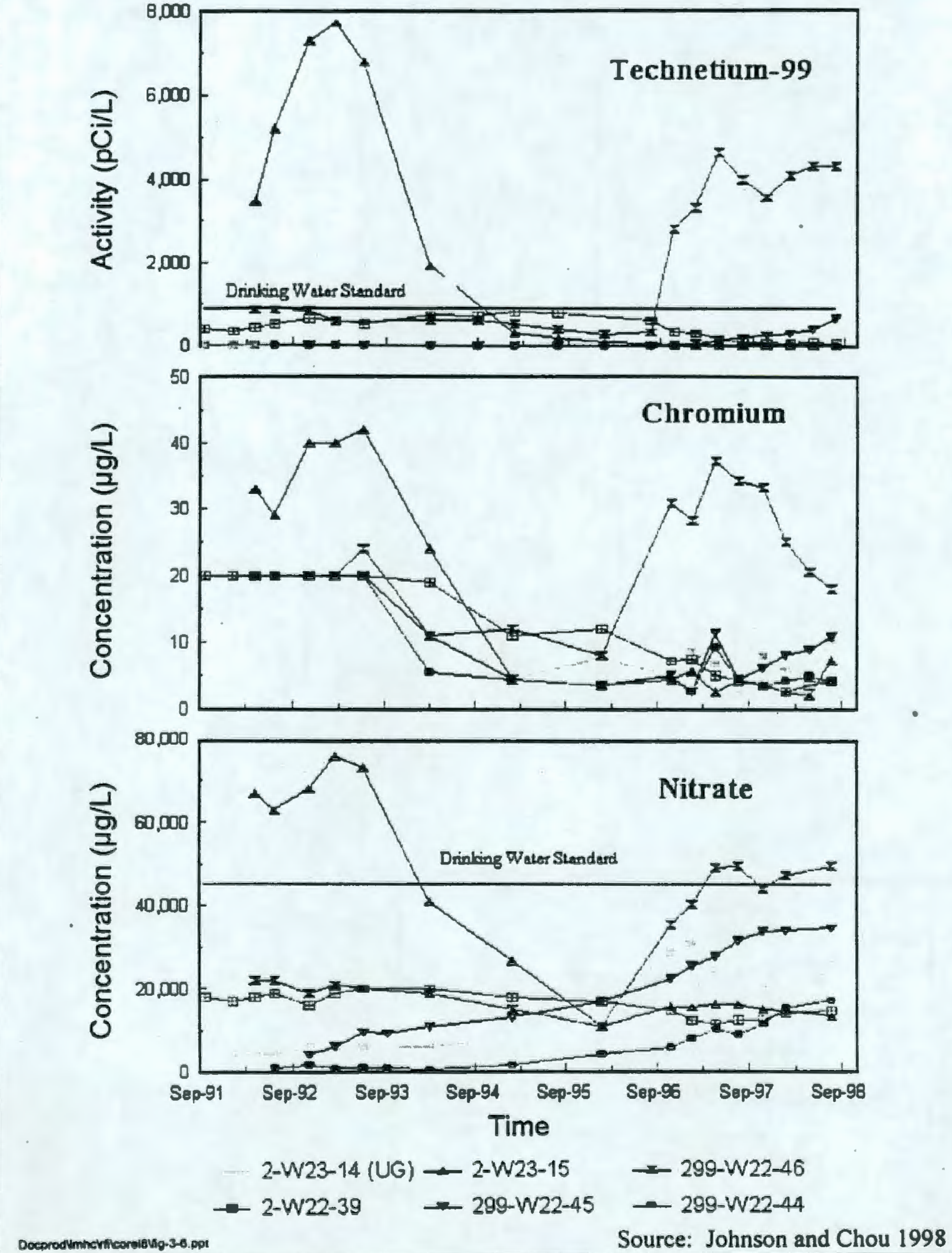
Figure 3.5. Spatial and Temporal Correlation of Observed Technetium-99 in Groundwater and Possible Contaminant Source Areas in WMA S-SX (1986-1997)



Source: Johnson and Chou (1998)

Docprod\mhc\rf\corel\fig-3-5.cdr

Figure 3.6. Technetium-99, Chromium, and Nitrate Concentrations vs. Time in the WMA S-SX Monitoring Well Network



Source: Johnson and Chou 1998

Docprod\mhc\rfi\corel8\fig-3-6.ppt

- Low but detectable strontium-90 and cesium-137 levels were found in one old well (299-W23-7) located inside and between the 241-S and 241-SX tank farms. Whether this occurrence represents a breakthrough from a vadose zone source to the groundwater or is a result of faulty well construction has not been completely evaluated.

- Results for groundwater samples collected from a new borehole (41-09-39), drilled through the primary contaminant zone down to the groundwater in the 241-SX tank farm, suggest that little (if any) tank waste reached the water table at this location (Table 3.3). Gross alpha and gross beta concentrations, 2.3 ± 0.7 and 16.6 ± 4.0 pCi/L (based on 10 sample results), respectively, are within the range of Hanford Site natural background levels, and hexavalent chromium (a RCRA dangerous waste constituent and indicator of mobile constituents in tank waste) was not detected (<10 µg/L).

- A Phase 2 investigation is needed to determine the nature, extent, and source(s) of recurrent groundwater contamination attributable to WMA S-SX.

Table 3.3. Groundwater Results for Borehole 41-09-39

	Sample Depth[b]		
Constituent[a]	**0.02 m (0.066 ft)**	**0.5 m (1.64 ft)**	**3 m (9.84 ft)**
NO_3 (mg/L)	17	15.5	14.4
^{99}Tc (pCi/L)	N/A	38 ± 6	25 ± 6
Cr (µg/L)	< 3	< 3	< 3
EC (µS/cm)	258	267	248
Cl (mg/L)	9.0	3.6	3.4
^{3}H (pCi/L)	171,000	149,000	142,000
U (µg/L)	N/A	3.3	3.1

Notes:

[a] ^{90}Sr, ^{137}Cs, ^{237}Np, ^{241}Am, $^{239/240}$Pu and ^{129}I were not detected.

[b] 0.02 m (Kabis pump, 4/7/98); 0.5 m and 3 m (Hydrostar pump, 1/13/98).

Based on the assumption of multiple sources, two sources could be postulated, one at the far south end of the 241-SX tank farm near the vicinity of tanks SX-114 and SX-115, and a source from the 241-S tank farm (Figure 3.5). For the latter, the plume path deviates from a southerly flow to a southeasterly flow to accommodate the occurrences of technetium-99. Arrival times in the groundwater of technetium-99 maxima at the downgradient monitoring wells (e.g., 299-W22-39) from the 241-S tank farm source seem reasonable based on estimated flow rates for this area (approximately 25 to 50 m/yr [82 to 164 ft/yr]). The last well in the hypothetical flow path, 299-W22-39, however, is inconsistent with a flow rate of 25 to 50 m/yr, (82 to 164 ft/yr) if all four monitoring wells must intercept the same source (Johnson and Chou 1998).

With a hypothetical plume path originating in the southwest corner of the WMA, the observed technetium-99 occurrences in wells 299-W23-15, 299-W23-6, and 299-W22-46 are spatially and temporally consistent (e.g., distance between wells 299-W23-15 and 299-W22-46 is about 125 m

[410 ft]). The indicated travel time of the technetium-99 peak between the two wells is approximately 5 years, or 25 m/yr (assuming that the sharp upward trend in 299-W22-46 will peak in 1998) (Figures 3.6 and 3.7). This estimated flow rate is consistent with the low hydraulic conductivity in this area (Johnson and Chou 1998).

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.

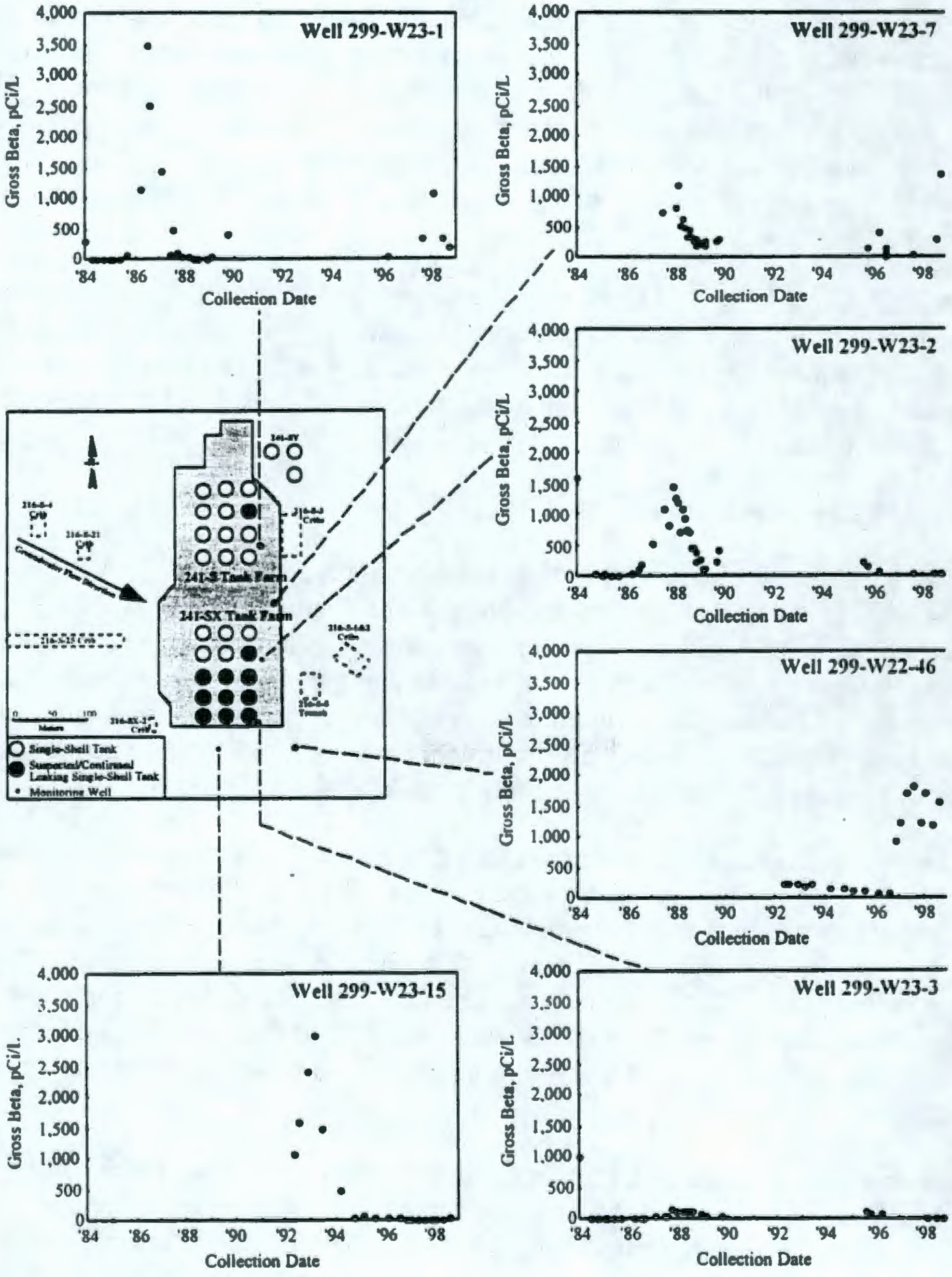
3.2 POTENTIAL CORRECTIVE ACTION REQUIREMENTS

This Preliminary Addendum will enable initial field characterization efforts in and near the WMA S-SX to commence in fiscal year 1999. As stated in Chapter 1.0, the RCRA corrective action process is used to establish the framework within which vadose zone investigations at the WMA S-SX are planned and conducted. As such, any required corrective action at the WMA S-SX will be required to comply with Federal and state environmental laws and promulgated standards, requirements, criteria, and limitations that are legally applicable or relevant and appropriate requirements (ARARs) under the circumstances presented by the release or threatened release of dangerous substances, pollutants, or contaminants. Site-specific and plateau-wide potential CARs will be identified and discussed in the proposed Site-Specific Phase 1 RFI/CMS work plan addendum for WMA S-SX, which is being prepared pursuant to proposed Tri-Party Agreement Milestone M-45-52, and the Phase 1 RFI/CMS work plan being prepared pursuant to proposed Tri-Party Agreement Milestone M-45-51 (DOE 1999a). Both of these documents are Tri-Party Agreement primary documents. The discussions provided in these two documents will include identification of potential corrective action standards for protection of human health and the environment. EPA's RCRA regulation (40 CFR 264.100), WAC 173-303-646, and RCRA guidance (EPA 1989) pertaining to ARARs will be used as the basis for identifying potential RCRA CARs.

Three categories of potential CARs will be evaluated in the Site-Specific Phase 1 RFI/CMS work plan addendum for WMA S-SX and the Phase 1 RFI/CMS work plan: contaminant-specific CARs, location-specific CARs, and action-specific CARs. When requirements in each of these categories are identified, a determination will be made whether those requirements are applicable or relevant and appropriate. A requirement is applicable if the specific terms (or jurisdictional prerequisites) of the law or regulations directly address the circumstances at a site. If not applicable, a requirement may nevertheless be relevant and appropriate if circumstances at the site are, based on best professional judgment, sufficiently similar to the problems or situations regulated by the requirements.

The Site-Specific Phase 1 RFI/CMS work plan addendum for WMA S-SX and the Phase 1 RFI/CMS work plan will also include a discussion on to-be-considered (TBC) information. The TBC information includes nonpromulgated advisories or guidance issued by Federal or state governments that are not legally binding and do not have the status of potential CARs; however, in some circumstances, the TBC information will be considered along with CARs to determine the corrective action necessary for protection of human health and the environment. The TBCs complement the CARs in determining what is protective at a site or how certain actions should be implemented. As an example, drinking water MCLs do not exist for all contaminants, and TBCs may be helpful for defining appropriate corrective action goals.

Figure 3.7. Gross Beta Time Series Plots in Selected Wells for WMA S-SX



1999/DCL/S-SX/004

Source: Johnson and Chou 1998

Docprod\mhc\rfi\corel8\fig-3-7.ppt

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 Preliminary Addendum. The vadose zone conceptual model is an 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 revisited in an effort to refine and improve the conceptual model.

The Site-Specific Phase 1 RFI/CMS work plan addendum for WMA S-SX, which will be prepared pursuant to proposed Tri-Party Agreement Milestone M-45-52, will focus on all potential exposure pathways, including groundwater (DOE 1999a). 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

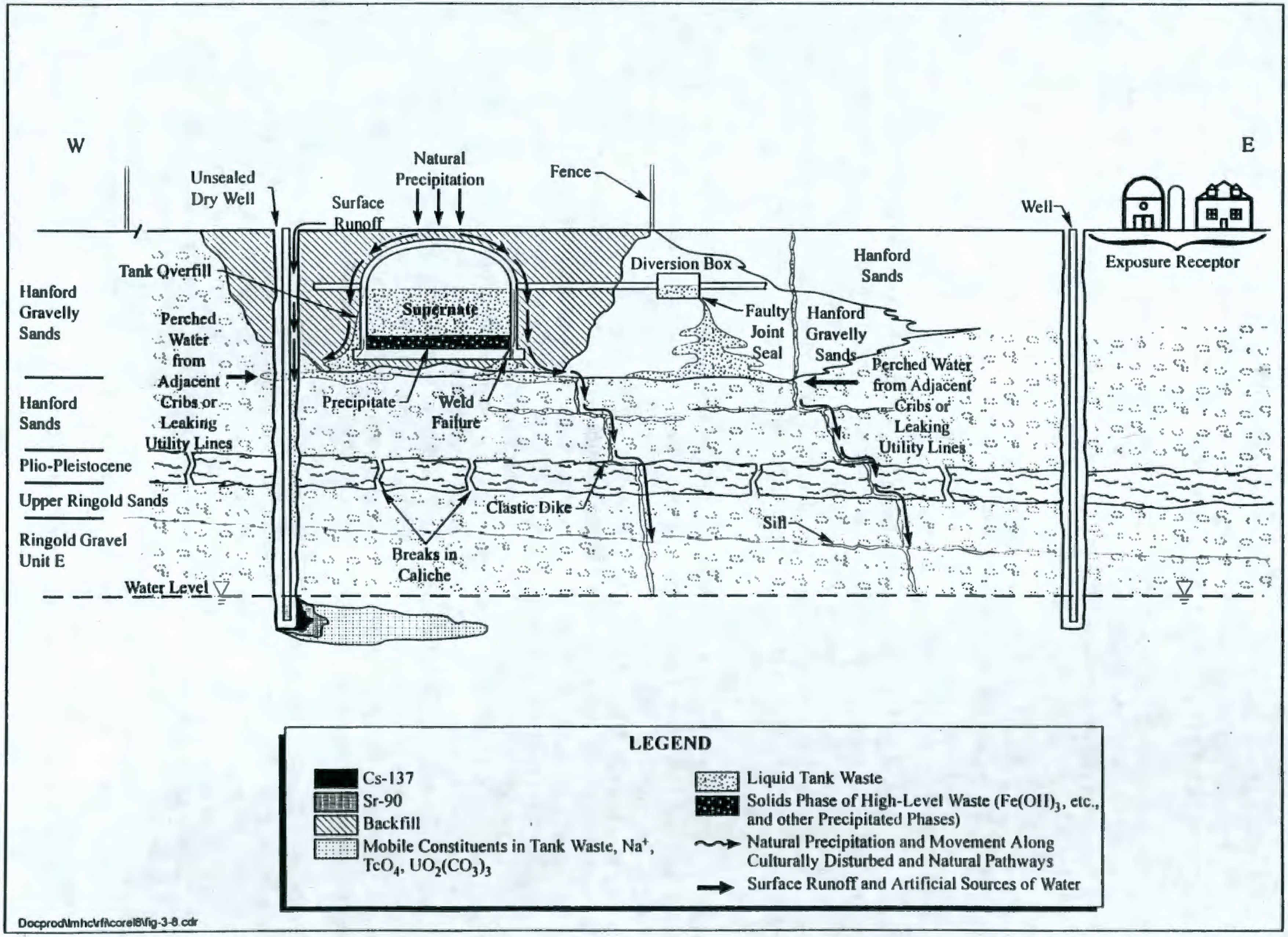
This section presents a preliminary vadose zone conceptual model for the WMA S-SX. The conceptual model is based on information presented in Chapter 2.0 and Section 3.1 and is, therefore, intended to be preliminary. The exposure pathway in this conceptual model is limited to near-surface releases associated with the waste tanks and transport in the vadose zone and is shown conceptually in Figure 3.8. Through the Corrective Action process, the concepts illustrated in Figure 3.8 must ultimately be confirmed, disproved, or shown to be inconsequential in the context of the retrieval and closure, including the WMA S-SX endstate.

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 work plan addendum for WMA S-SX based on evaluation of the data collected under this Preliminary Addendum and the continued evaluation of existing data.

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 3.8. The schematic illustrated on this figure, together with estimates of 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 work plan addendum for WMA S-SX. The vadose zone conceptual model is used in this Preliminary Addendum to qualitatively express the best understanding of the following:

Figure 3.8. Preliminary WMA S-SX Vadose Zone Conceptual Model



- 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 Preliminary Addendum are summarized in the following sections.

3.3.1.1 Sources

Chemical processing. The following discussion has been largely extracted from Johnson and Chou (1998). 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 (Agnew 1997). 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 CWR 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. The high pH also resulted in formation of precipitates of uranium, heavy metals, and strontium-90 that eventually settled to the bottom of the tanks.

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 farm (Chapter 2.0) were unique. The bottom edge of the walls of these tanks were welded directly to the floor of the tanks. Other tanks in the S and SX Tank Farms were constructed with a curved bottom edge. The welds in the former case 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 1997).

The subject tanks were operated in a self-boiling mode to reduce tank waste volumes. This involved condensing the water vapor, driven off as tritiated steam, from exit ports at the top of the tanks. The condensate was discharged to upgradient cribs; no high salt tank waste supernate was discharged to adjacent disposal facilities.

The vadose zone conceptual model for this Preliminary Addendum focuses on those contamination sources in the vicinity of SX-241-108 and -109 SSTs where sample and logging activities will occur in conjunction with the decommissioning of borehole 41-09-39, southern portion of the 241-SX tank farm and primarily in the vicinity of the 241-SX–114 and –115 SSTs where the new borehole is planned, and south and east of the WMA S-SX in the vicinity of the planned RCRA groundwater wells. As discussed in Section 3.1 and illustrated in Figure 3.5, one hypothesis for the observed contaminants in the RCRA groundwater monitoring wells (i.e., wells 299-W23-15, 299-W23-6, and 299-W22-46) is that contaminants from the 241-SX-114 and –115 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. The three tanks have released a total of approximately 277,000 L (73,200 gal) based on estimates documented in Hanlon (1999) (refer to Section 3.1 for additional details). An WMA S-SX-wide discussion of the contaminant inventory and volume will be provided in the proposed Site-Specific Phase 1 RFI/CMS work plan addendum for WMA S-SX being prepared pursuant to proposed Tri-Party Agreement Milestone M-45-52 (DOE 1999a); however, it is certain that the leaks from these three tanks 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.

3.3.1.2 Geologic Conceptual Model

Price and Fecht (1976) originally compiled the geology of the 241-SX tank farm after the dry well boreholes were completed in the early 1970s. The major stratigraphic units of the suprabasalt sediments present beneath the 241-SX tank farm are the Ringold Lower Mud, Ringold Unit E, Plio-Pleistocene (including Early Palouse), and the Hanford formation (in ascending order) (see Chapter 2.0). The sources of data used in evaluating valid conceptual model(s) for the 241-SX tank farm geology include Johnson and Chou (1999), Ward et al. (1997), Lindsey and Law (1993), Lindsey (1992), Connelly et al. (1992), and Price and Fecht (1976). Potential structural control or influence on contaminant migration in the vadose zone is of particular interest. A structural contact map of the carbonate zone within the Plio-Pleistocene Unit was presented in Figure 2.10. The carbonate surface is interpreted to dip toward the southwest beneath most of the tanks in the southern portion of the tank farm including tanks SX-108, -109, -111, -112, -114, and –115. Thus, the location of the new borehole southwest of SX-115 is well-suited to provide information on the potential effects of geologic structure on contaminant flow given the past tank leaks that have occurred up-dip of the new borehole location.

Clastic dikes, illustrated conceptually in Figure 3.8, are lenses or tabular bodies, relatively narrow at 18 to 38 cm (7 to 15 in.) (Fecht and Weekes 1996), with textural characteristics similar to the host sediment (clay and sand). They are included in the geologic conceptual model however the limited data suggest that these features have little impact on vadose zone moisture and contaminant flux (Jones et al. 1998) and thus would not be significant with respect to groundwater contamination. 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. Discussion of such features and associated data needs and investigation plans are deferred to the Site-Specific Phase 1 RFI/CMS work plan addendum for WMA S-SX being prepared pursuant to proposed Tri-Party Agreement Milestone M-45-52 (DOE 1999a). The geologic cross-sections provided in Section 2.2 represents the preliminary working geologic conceptual model for this Preliminary Work Plan.

3.3.1.3 Hydrologic Properties

Hydrologic parameter values will be refined as the Corrective Action process continues. Preliminary values will be provided in the Site-Specific Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX being prepared pursuant to proposed Tri-Party Agreement Milestone M-45-52 (DOE 1999a).

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.

Because of the absence of nearby residences, the most likely potential for current human exposure to the WMA S-SX contaminants is to onsite workers. Most, if not essentially all, of the contamination is now beneath the ground surface; therefore, the workers with the greatest potential for exposure are those who will be involved in collecting environmental samples and conducting corrective action activities for this project.

The remnants of the past leaks (i.e., contaminants that are still in the vadose zone) form a source term within the vadose zone. The current mechanism of contaminant release from this source term is through infiltration of meteoric water and from other water sources (e.g., leaky water lines), which creates a driving force that results in downward and lateral spreading of contaminants in the vadose zone that may ultimately reach the underlying groundwater. The long-lived mobile contaminants (e.g., technetium-99) in this groundwater eventually discharges into the Columbia River where it can contaminate the sediments and has the potential to impose adverse impacts upon local biota. The conceptual exposure pathway model will be refined and tested during the RFI as additional data provide a better understanding of the WMA.

3.4 PRELIMINARY CORRECTIVE ACTION OBJECTIVES AND CORRECTIVE ACTION ALTERNATIVES

This Preliminary Addendum is prepared to enable initial field characterization efforts in and near the WMA S-SX to commence in fiscal year 1999 under the RCRA corrective action process (DOE 1999a). As such, both interim and final preliminary corrective action objectives, general response actions, corrective technologies and process options, and a range of preliminary corrective action alternatives for each group of prioritized facilities within the WMA S-SX must be considered and evaluated. It is anticipated that these evaluations would be provided in the Site-Specific Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX or Phase 1 RFI/CMS work plan, being prepared pursuant to proposed Tri-Party Agreement Milestones M-45-52 and M-45-51, respectively (DOE 1999a). They would be based on available site data, use of the qualitative risk assessment (QRA), and the conceptual exposure pathway model. It is also anticipated that general interim actions would be identified and would represent broad classes of corrective actions that may be appropriate to achieve the corrective action objectives. 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. Recommendations would be made as to the range of preliminary corrective action alternatives that will be considered and more fully developed in a CMS that will be addressed as part of the Site-Specific Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX.

This page intentionally left blank

4.0 RATIONALE AND APPROACH

The RFI/CMS process is the 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 preliminary 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 (DOE 1999a).

The proposed commitments were negotiated in response to evidence that past tank leaks have resulted in groundwater contamination at WMA S-SX and several other SST WMAs (i.e., WMA B-BX-BY, WMA T, and WMA TX-TY). Through Change Control Form Number M-45-98-03, the parties have agreed to use the RCRA corrective action process, including the preparation of RFI/CMS work plans, to guide data collection, decision making, and initial corrective actions at these WMAs. In addition, the RCRA corrective action process will be used to provide a framework within which groundwater and vadose zone investigations will be planned and carried out to support decisions on interim measures, corrective measures, SST waste retrieval, and SST farm closure.

A central part of the corrective action strategy agreed to by the parties in Change Control Form Number M-45-98-03 is the preparation of a series of RFI/CMS work plan addenda for the SST WMAs (DOE 1999a). A RFI/CMS work plan containing work elements common to all WMAs will be submitted to Ecology in August 1999 under proposed Milestone M-45-51 (DOE 1999a). This will be followed by WMA-specific work plan addenda to the RFI/CMS work plan that describe the detailed work elements for each SST WMA. The site-specific addendum for WMA S-SX will be submitted to Ecology in October 1999 under proposed Milestone M-45-52 (DOE 1999a).

Before preparation of the RFI/CMS work plan and the site-specific addendum for WMA S-SX, proposed Target Date Milestone M-45-52-T01 (DOE 1999a) requires the submission of this *preliminary* site-specific work plan addendum for WMA S-SX to Ecology in April 1999. The purpose of this Preliminary Addendum is to support initial field characterization work to commence in fiscal year 1999. It is anticipated that additional data beyond that collected through the initial fiscal year 1999 efforts will be needed to support full implementation of the corrective action process at WMA S-SX. The additional data needs will be identified and collected in accordance with the RFI/CMS work plan (proposed Milestone M-45-51) and the site-specific WMA S-SX addendum (proposed Milestone M-45-52) to be developed in the future.

4.1 RATIONALE

An understanding of subsurface conditions and contaminant migration processes is required to support decision making on ICMs, SST waste retrieval, and tank farm closure. A comprehensive list of data needs to support these decisions has not yet been developed. 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 preliminary characterization activities through this Preliminary Addendum before completing the Phase 1 RFI/CMS work plan. The data collected through the preliminary characterization effort combined with additional Phase 1 data will be used to:

- Quantify the risk posed by migration of past tank releases to the groundwater if no ICMs are implemented
- Determine whether specific 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.

Additional objectives and data needs for WMA S-SX will be developed during the DQO processes that will be carried out for the Phase 1 RFI/CMS work plan and the site-specific Phase 1 RFI/CMS work plan addendum for WMA S-SX. Because these two documents are scheduled to be completed after the initiation of field characterization activities identified in this Preliminary Addendum. A separate DQO process was conducted to support the development of this document.

4.1.1 Data Quality Objectives Process

The DQO process is a planning tool to aid in the determination of the type, quantity, and quality of data needed to characterize 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 Preliminary Addendum is described in this section.

Before initiating meetings to discuss preliminary characterization activities to be conducted in the fiscal year 1999 timeframe, the Lockheed Martin Hanford Company (LMHC) 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. Subsurface data needs have been the subject of numerous meetings in recent years, some of which culminated in data collection (Myers et al. 1998), and others that did not.

A series of DQO meetings with a large group of participants was held in February and April, 1999 that focused specifically on the data needs for the fiscal year 1999 preliminary field characterization efforts at WMA S-SX. These meetings served to identify: (1) existing data and what is currently known about the WMA S-SX, (2) options for data collection during the decommissioning of borehole 41-09-39, (3) options for data collection from planned RCRA groundwater monitoring wells, and (4) options for additional characterization activities.
The DQO meetings included representatives from Ecology, DOE, Yakama and Nez Perce Tribal Nations, Hanford Site contractors, Hanford Site Vadose Zone/Groundwater Integration Project, Oregon Department of Energy, and a Tank Farm Vadose Zone Steering Group made up of Site subject matter experts. Minutes from the meetings, including a list of participants, are provided

in Appendix E. Identification of the Vadose Zone Steering Group members along with a letter report outlining the Groups recommendations for characterization is provided in Appendix F.

Meetings held as a part of the DQO process involved varying levels of involvement by all participants except Ecology and DOE. Early meetings addressing the definition of the problem, review of existing data, input required to support decisions, and sampling and analysis alternatives were attended by a broad range of participants. Later meetings were held between the decision makers, with input from Site contractors and other DQO participants as required. The early 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 preliminary field investigation is to initiate vadose zone characterization activities during fiscal year 1999 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 preliminary characterization effort will not answer all questions but will provide data that, when combined with characterization data to be collected in the future, will improve the ability to make informed corrective measures, waste retrieval, and tank farm closure decisions.

4.2 DATA NEEDS

To prioritize data needs for inclusion in the fiscal year 1999 effort, a review of the available information on the current state of knowledge of WMA S-SX subsurface contamination was conducted by the LMHC technical team (e.g., Johnson and Chou 1998; Jones et al. 1998), and other data and analysis projects, and summarized in the DQO meetings. Current understandings 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) (DOE/GJPO 1996). However, there is limited data on the distribution of non-gamma-emitting mobile tank waste contaminants (e.g., technetium-99, iodine-129, plutonium-238, and nitrate). While there is emerging data on the distribution and movement of tank waste contamination in the groundwater, the data is not sufficient to indicate specific sources of contaminant releases within the tank farms responsible for specific groundwater contamination data.

During the DQO process, it was determined that the primary focus of the fiscal year 1999 data collection effort at WMA S-SX should be directed toward improving the understanding of contaminant transport pathways 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 such as those recommended by the TWRS Vadose Zone Steering Group, were considered (see Appendix F). Because the current understanding of the distribution of radionuclides in the leak-contaminated vadose zone is limited and is based primarily on indirect evidence, the focus of the fiscal year 1999 data collection program at WMA S-SX will be on sampling the vadose zone soils in areas of known tank leaks and analyzing the samples for a range of contaminants of interest. Additional data needs identified for the fiscal year 1999 characterization efforts are to better determine site-specific geologic and soil hydrogeologic properties. The objectives, data needs, quantity, and quality for the preliminary characterization effort are summarized in Table 4.1.

4.3 APPROACH

The purpose of characterizing the vadose zone is to provide data and information to begin to understand the location and transport pathways of contamination in the subsurface to support evaluation of potential corrective actions to reduce impacts to the groundwater from contamination currently in the vadose zone that resulted from past leaks and spills. Corrective actions are intended to reduce or minimize groundwater impacts before taking final closure action. To assess future potential groundwater impacts from past releases and evaluate potential corrective actions, the contaminant sources, location, distribution, transport pathways, and migration processes must be understood. No single characterization effort (e.g., single borehole) will provide sufficient data to address all of these issues in WMA S-SX. Information obtained from vadose zone characterization activities will be used to develop conceptual and numeric models to predict potential groundwater concentrations. This data and information will also support future decisions regarding SST waste retrieval, and tank closure, and tank farm closure.

Characterizing vadose zone contamination sources involves targeting characterization activities at or near the locations where the tanks are believed to have leaked. Boreholes A and B in Figure 4.1 are provided as examples of source characterization. Data from these locations would then provide a basis for estimating contaminant inventories and processes that would control the migration of contaminants. Existing data such as historic gamma and spectral gamma logging data can be used to target sampling locations most likely impacted by leaks. Source characterization involves identifying what contaminants are present and subsequently the potential contaminants of concern (CoC) for corrective action, retrieval, and closure decisions. The CoCs are generally those constituents in the tank waste that are mobile, persistent, and present at levels that could adversely impact potential receptors. One of the goals of characterizing tank leaks near the source is to evaluate 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. 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. Source characterization would also include 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.

Table 4.1. Data Objectives, Associated Data Needs, Quantity, and Quality

Environmental Media	Data Objectives [f]	Data Needs	Data Quantity	Data Quality
Vadose Zone	Improve Understanding of Nature and Extent of Contamination	Contaminant Concentrations	New borehole: Geophysical survey of entire depth. Chem/rad sample analysis dependant on contaminant distribution (see criteria for sample analysis in Appendix A) Borehole 41-09-39: Geophysical survey of entire depth, Chem/rad sample analysis dependant on contaminant distribution (see sample criteria flow chart in Appendix A) RCRA groundwater wells: N/A	Field and laboratory screening/specified laboratory analysis
	Improve Understanding of Contaminant Fate and Transport Mechanisms [g]	Hydrostratigaphic parameter values (i.e., porosity, unsaturated K vs. moisture content (gravimetric), saturated K, bulk density, moisture retention, matric potential)	RCRA well No. 3: one analysis per lithologic unit New borehole and borehole 41-09-39: dependent on contaminant distribution. See criteria in Appendix A RCRA groundwater wells No. 1 and 2: N/A	Specified laboratory analysis (Note b)
		Moisture Content and Soil Temperature (geophysical)	Moisture Content: New borehole and borehole 41-09-39: all samples RCRA groundwater well No. 3: one analysis per lithologic unit RCRA groundwater wells No. 1 and 2: N/A Temperature: New borehole and 41-09-39: geophysical survey of entire depth	Specified laboratory analysis and field surveys (Note d, e)
		Cation Exchange Capacity	New borehole: see criteria for sample analysis in Appendix A Borehole 41-09-39: see sample criteria flow chart in Appendix A RCRA groundwater wells: N/A	Specified laboratory analysis (Note b)
		Soil quality (contaminant chemistry and pH)	RCRA wells: (pH only). New borehole and borehole 41-09-39: dependent on contaminant distribution results (see criteria in Appendix A)	Specified laboratory analysis

Table 4.1. Data Objectives, Associated Data Needs, Quantity, and Quality (cont'd)

Environmental Media	Data Objectives (F)	Data Needs	Data Quantity	Data Quality
		Lithologic unit thickness	Geologic log of each well	Note a
		Particle size distribution	New borehole and RCRA groundwater well No 3: One analysis per lithologic unit. Borehole 41-09-39 dependent on contaminant distribution (see Appendix A for criteria) RCRA groundwater wells No. 1 and 2: N/A	Specified laboratory procedure (Note b)
		Contaminant mobility (i.e., solubility, Kd)	New borehole and borehole 41-09-39: dependant on contaminant distribution see Appendix A for criteria. RCRA groundwater wells: N/A	Screening and specified laboratory analysis
		Lithologic unit areal extent	Geologic log of each well and boring	Note a
		Lithologic features	Geologic log of each well and boring	Note a
		Mineralogy	New borehole and 41-09-39: See criteria in Appendix A. RCRA groundwater wells No. 1, 2 and 3: N/A	Specified laboratory analysis
Groundwater	Improve Understanding of Nature and Extent of Contamination	Contaminant concentration	New borehole: one sample at the groundwater vadose zone interface and 1.5 m below the interface. RCRA groundwater wells: Sample and analysis per Hanford Groundwater Program.	Field and laboratory screening/validated laboratory
	Improve Understanding of Contaminant Fate and Transport Mechanisms(g)	Velocity	One tracer test with injection into groundwater at 41-09-39	Note c

Notes:

[a] Determined by a qualified geologist

[b] Analysis performed by a qualified laboratory using appropriate ASTM procedures or others as approved.

[c] Experimental procedure and test of opportunity performed under guidance of PNNL.

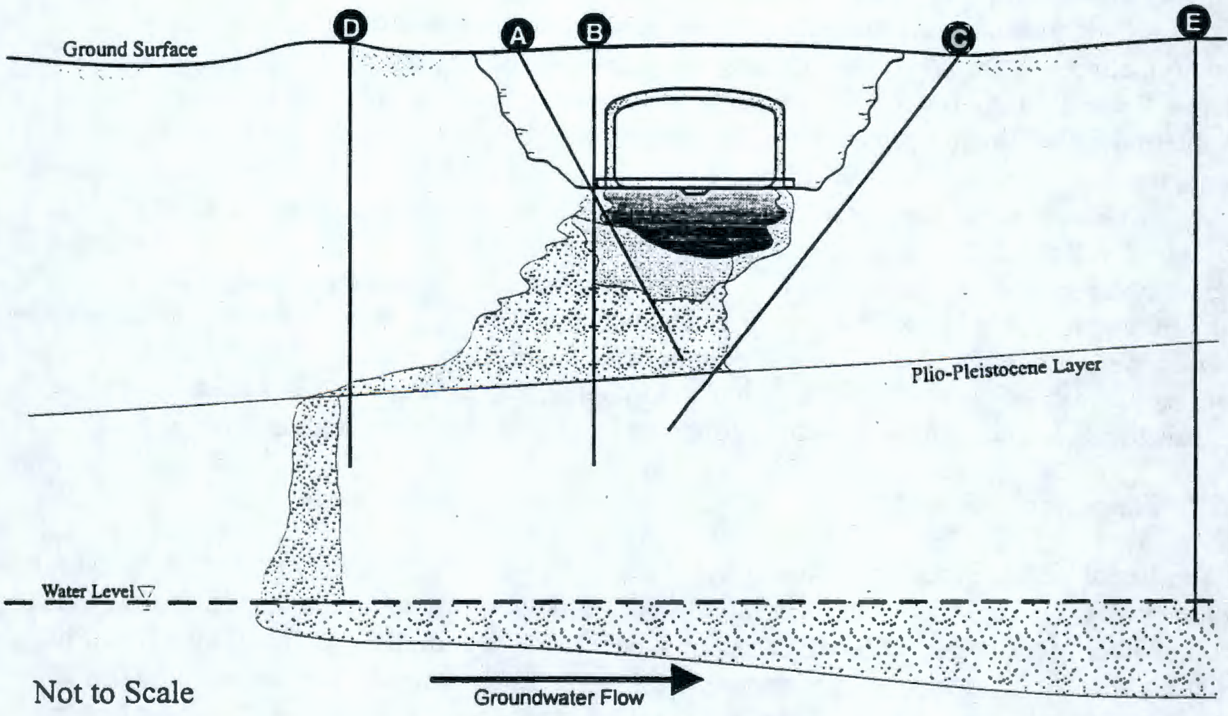
[d] Geophysical survey and survey analysis performed by a qualified geophysicist with approved equipment and procedures.

[e] Geophysical surveying of RCRA groundwater wells provides background conditions.

[f] Long-term data uses (i.e., those needed for subsequent phases of the WMA S-SX RFI/CMS investigations) also include those for human health risk assessment and the support of retrieval and closure.

[g] Required data types for the contaminant fate and transport data use also includes those listed for the nature and extent of contamination data use.

Figure 4.1. Borehole Location Options to Meet Different Characterization Objectives



Characterization Objective	Borehole Location Option
Source Characterization - collection and analysis of samples at or near tank leak locations in highly contaminated regions	A and B
Transport Pathways and Contaminant Distribution - collection and analysis of vadose zone samples in areas removed from the source and in the projected contaminant pathway.	C and D
Confirm Groundwater Contamination Sources - collection and analysis of groundwater samples downgradient of tank leaks in an attempt to establish a tie between tank releases and groundwater contamination. Collection of vadose zone physical property data from an uncontaminated area.	E

Docprod\lmhc\rf\corel8\fig-4-1.cdr

Characterization of transport pathways and contaminant distribution involves targeting characterization activities in areas that are removed from the source and are in the projected pathway of contaminants as they migrate away from the source. Boreholes C and D in Figure 4.1 are provided as examples of characterizing pathways and the distribution of contamination. Characterization of transport pathways and contaminant distribution can be accomplished by targeting contaminant plumes in the vadose zone or in groundwater. Evaluating contaminant plumes in the vadose zone can be used to assess lateral spread or migration along geologic controlled pathways. Targeting specific locations in groundwater can be used to better refine sources of observed groundwater contamination. Borehole E in Figure 4.1 is provided as an example of using groundwater data to identify, confirm, or infer vadose zone sources. Establishing a tie between vadose zone sources and groundwater contamination would allow location-specific corrective actions to be evaluated. The difficulty in characterizing transport pathways and contaminant distribution is the uncertainty associated with intercepting a specific contaminant plume. Borehole E can also be used as a means to refine vadose zone geologic and hydrologic properties in an area that is uncontaminated.

4.3.1 Characterization Options

A number of characterization options were considered for the preliminary characterization effort in the WMA S-SX. These characterization options included vadose zone sampling from RCRA groundwater monitoring wells, installing new boreholes, decommissioning and/or extending existing boreholes, using cone penetrometer (both vertically from the surface and horizontally from the existing caissons), and using electrical resistance tomography (ERT). These options and potential deployment locations were evaluated in terms of the type of information that could be provided, as well as the technical and schedule risk associated with deployment during fiscal year 1999. Although all of the options considered would 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 and/or schedule risk for the preliminary characterization effort to be implemented in fiscal year 1999. The list of options considered for characterization activities during the DQO process, in addition to the sampling efforts of 41-09-39 and the proposed RCRA groundwater monitoring wells, is provided in Table 4.2.

Based on the evaluation of options presented in Table 4.2 and an evaluation of technical and schedule risks, the cone penetrometer, ERT, and caissons were dropped as candidate characterization technologies for the preliminary characterization effort. These technologies will be pursued for future characterization activities (e.g., current plans include demonstration of the cone penetrometer).

The decommissioning of borehole 41-09-39, characterization associated with the new RCRA groundwater monitoring wells, and the new borehole are discussed in the following sections.

Table 4.2. S-SX Preliminary Characterization Options[1,2]

Question/Hypothesis	Slant Borehole Beneath SX-108[7]	Vertical Borehole at SX-108[6]	Cone Penetrometer[5]	Slant Borehole Beneath SX-115[3,7]	Vertical Borehole at SX-115[4,7]	Vertical Borehole at SX-109[7]	ERT[6]	Caissons[8]
Where is the Tc-99 (shallow)	+	√	√	√	√	√	-	√
Where is the Tc-99 (deep)	+	√	-	√	√	√	-	-
Horizontal extent of contamination	√	√	+	√	√	√	√	√
Influence of geologic structures	√	√	+	√	√	√	-	-
Is the Kd model adequate	+	√	+	√	√	√	-	-
Where are the leak locations	√	√	√	√	√	-	√	+
What is the driving potential (moisture content)	+	+	√	+	+	+	√	√
Solidified waste is present in the sediments near the leak location	+	√	-	√	-	-	-	√
Umbrella effect of the tanks on recharge	+	√	√	+	√	√	+	+
Desiccation	+	√	√	√	√	√	√	+
Depth of SX-115 plume (vertical extent)	-	-	√	√	√	-	√	-
Depth of SX-108 plume (vertical extent)	√	√	√	-	-	-	√	-
Ancillary equipment leaks	√	√	+	√	√	√	√	-
Correlation of contamination to sediment size	√	√	√	√	√	√	-	-
Do contaminants move together	+	√	√	√	√	√	-	-
Contaminants affecting moisture properties	+	√	√	√	√	√	-	√
Role of the Plio Pleistocene in contaminant migration	+	+	√	+	+	√	-	-
Colloids are significant in contaminant migration	√	√	-	√	√	√	-	√
Groundwater contamination	√	√	-	√	√	√	-	-

Notes:

[1] Options are in addition to decommissioning 41-09-39 and new RCRA groundwater wells.

[2] Evaluation Scale - Provides little or no information; √ provides some information; + potentially provides substantive information.

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

[4] The vertical well at SX-115 is assumed to be at the SW.

[5] The cone penetrometer deployment is assumed to include multiple pushes (approximately 20 pushes that reach 30 m (100 ft) depth and 2 that reach the Plio Pleistocene Unit.

[6] Assumed that the ERT array will work through the steel casing and approximately 20 arrays are installed.

[7] All boreholes are assumed to go to groundwater.

[8] The caisson approach uses the cone penetrometers with rods to collect samples and are pushed with a slight downward angle to reach a vertical depth approximately 6.1 m (20 ft) below the base of the tanks.

4.3.1.1 Decommissioning of Borehole 41-09-39

One of the characterization options considered and selected during the DQO process was the collection of sediment samples from the upper portion of borehole 41-09-39 during decommissioning. Samples have been previously collected and analyzed from the lower portion of the borehole and as a result sample collection focused on the upper portion of the borehole that was installed as a closed end drive borehole. Data obtained from the decommissioning of borehole 41-09-39 will provide information on the transport pathways and contaminant distribution at a location near the source of a tank leak. Based on the assessments of historical gamma data, the gamma contamination at borehole 41-09-39 is from a postulated gamma plume associated with a leak from tank SX-108. Because of the borehole's location (see Figure 2.3), the data collected during the decommissioning are expected to begin to address a number of questions related to source characterization, 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?
- Are the contaminants thought to be more mobile than cesium-137 (e.g., technetium-99) co-located with the cesium-137 in the soil samples or have the contaminants migrated faster and deeper than the cesium-137?
- What are the mechanisms that effect the mobility of the CoCs (e.g., water leachable fraction) given the unique tank leak characteristics at tanks SX-108 and SX-109?
- What are the potential drivers (e.g., sediment moisture profile) in the upper portion of borehole 41-09-39 that could control the migration of contaminants? Note: The upper portion of the borehole was not sampled during the initial borehole installation.

Additional issues will be evaluated with samples obtained during decommissioning of borehole 41-09-39 depending upon the success of the sidewall sampling methodology being developed for the decommissioning effort. At locations where sufficient sample recovery and representative samples are obtained, gamma-energy analysis will be conducted in the laboratory over the length of the sample in an attempt to address borehole effects or dragdown.

Uncertainties associated with the sidewall sampling methodology were identified during the DQO meetings. It was agreed that even if the sidewall sampling device was not able to collect a sample (e.g., formation collapse or interference from cobbles) that composite samples could be collected by other methods. One method proposed for collection of a composite sample in the event the sidewall sampler were to fail would be to use a scraper to collapse a portion of the exposed formation and then use a split spoon sampler to collect a composite sample. This backup method of sample collection would reduce the value of the samples primarily from the standpoint of addressing the questions of borehole effects or dragdown previously identified, but would still be valuable in addressing some key questions such as what contaminants are present and at what concentrations.

4.3.1.2 RCRA Monitoring Well Characterization

The DQO addressed collection of vadose zone data during installation of the planned RCRA groundwater monitoring wells. The installation of RCRA groundwater monitoring wells near the WMA S-SX provides the opportunity to collect vadose zone sediment samples from a location near the tank farms in a clean or uncontaminated area. The potential benefit of using sediment samples from the RCRA wells is to develop a site-specific representative set of physical property data for the WMA. This representative set of physical property data would then be used in developing and refining conceptual models and in future contaminant fate and transport modeling activities. This is a cost-effective approach to collecting physical property data and eliminates the difficulty of trying to obtain physical property data from contaminated sediment samples obtained from within the tank farm.

4.3.1.3 Installation of a New Borehole

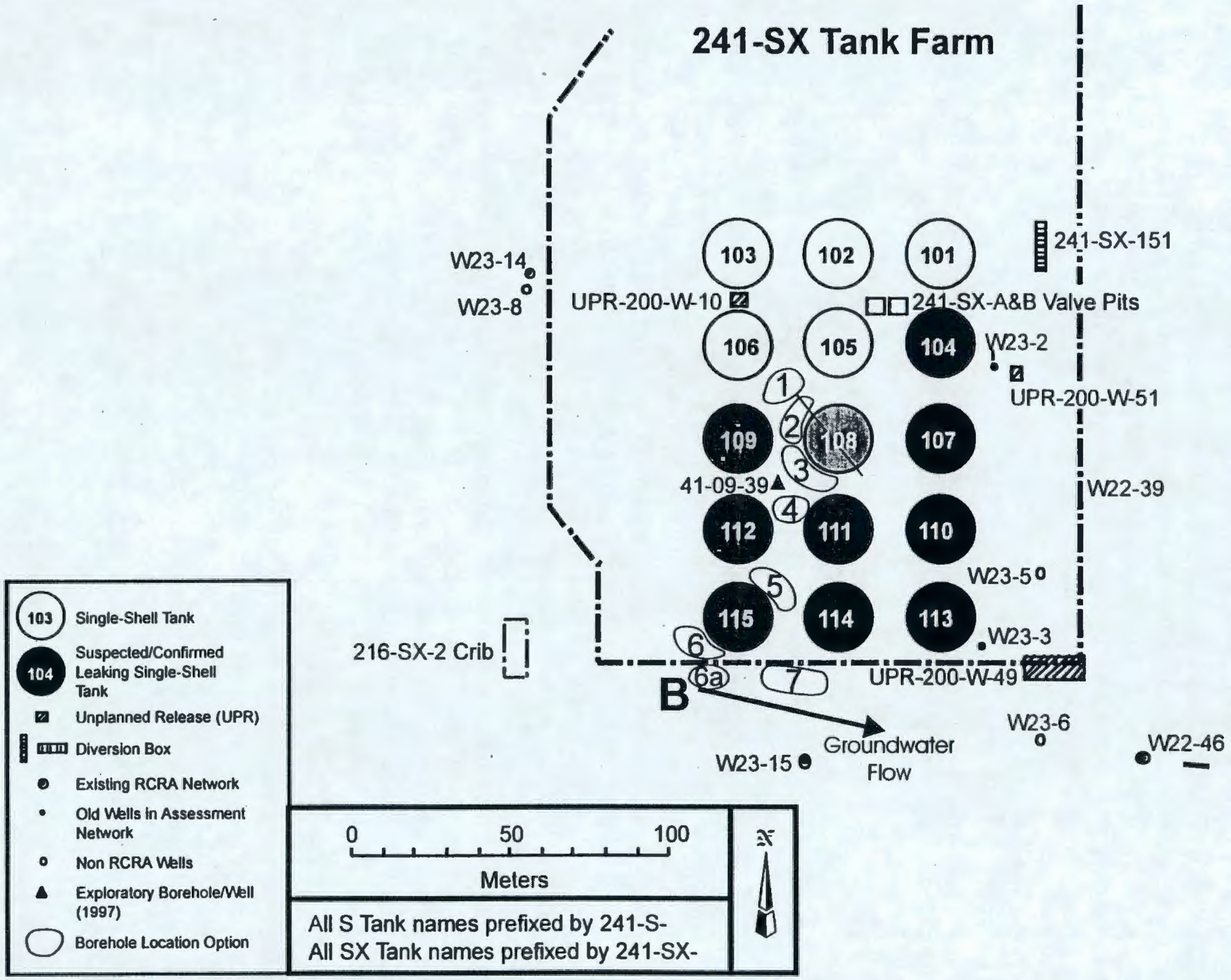
In addition to data collection from the decommissioning of borehole 49-09-39, several options were considered for installation of a new borehole in the SX Tank Farm as identified in Table 4.2.

Borehole Location

Potential locations for a new borehole were identified based on historical knowledge of the WMA S-SX, such as leak history, previous vadose zone characterization efforts, historical logging data, recent spectral gamma logging data, and RCRA groundwater assessment findings. Two primary areas considered for the preliminary characterization effort were the area near tank SX-108 and the area near tank SX-115. 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 alone based on the source of the leak estimate). The area surrounding tank SX-115 is of interest because of the large 190,000 L (50,000 gal) leak that occurred from the tank and the observed groundwater contamination in the RCRA groundwater monitoring wells located on the southern end of the 241-SX tank farm near tank SX-115. This leak occurred over a relatively short duration and is better understood than other tank leaks within the WMA S-SX. Approximately 60% of the leak inventory (cesium-137) has been accounted for in previous characterization efforts (Raymond and Shdo 1966). The area around SX-115 is also supported by the Vadose Zone Steering Group (Appendix F).

Seven of the options considered in the DQO process are illustrated in Figure 4.2. Each of these options were evaluated as candidates for the preliminary 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). A description and the purpose of each of the options are provided in Table 4.3.

Figure 4.2. Options Considered for Locating a New Borehole



All S Tank names prefixed by 241-S-
All SX Tank names prefixed by 241-SX-

Modified from Johnson and Chou (1998)

Docprod\mhc\rf\corel8\fig-4-2.cdr

Table 4.3. Options Considered for New Borehole Locations

Location Number	Description	Purpose
1	Slant borehole extending underneath tank SX-108 from a northwest to a southeast direction targeted at the area of highest gamma contamination.	The primary purpose of this borehole would be to characterize the source associated with the tank SX-108 leak. This borehole would provide data from the most highly impacted location in the WMA S-SX. This highly impacted location likely has the largest alteration of soil properties. This location is believed to be the largest source of contamination in the WMA and represents one of the largest data gaps in terms of source characterization.
2	Vertical borehole on the northwest side of tank SX-108.	The purpose of this borehole would be to characterize the source associated with the tank SX-108 leak. The area northwest of the tank corresponds to observations of horizontal spread of gamma contamination as shown in the recent spectral gamma logging results and, based on historical logging of the laterals under the tank, is the area where tank SX-108 is believed to have leaked.
3	Vertical borehole on the southwest side of tank SX-108.	The purpose of this borehole would be to characterize the source associated with the tank SX-108 leak. The area southwest of the tank corresponds to the area where the highest observed gamma contamination in any of the vertical boreholes has been documented and corresponds to the observations of horizontal spread of gamma contamination based on drywell logging data.
4	Vertical borehole southwest of tank SX-108 near borehole 41-11-10 within the postulated plume of gamma contamination from the tank SX-108 leak.	The purpose of this borehole would be to characterize the transport pathways and distribution of the postulated contamination plume from tank SX-108 (and potentially tank SX-111). The location near borehole 41-11-10 was selected based on evaluation of spectral gamma logging results and observed instability in borehole 41-11-10 historical gross gamma logs. This location also is structurally down dip (i.e., subsurface geologic structures slope to the S-SW) from the tank and provides the opportunity to evaluate geologic controls on contaminant migration. Borehole 41-11-10 shows a gamma peak at 21 m (70 ft) bgs that is stable and a peak at 25 m (82 ft) bgs that is migrating laterally. This indicates that cesium-137 is moving horizontally at the 25-m (82-ft) level, which is not consistent with conceptual models for cesium-137 migration in the subsurface assuming undisturbed conditions.
5	Vertical borehole on the northeast side of tank SX-115.	The purpose of this borehole would be to characterize the source associated with the tank SX-115 leak. The northeast side of the tank corresponds to observations of horizontal spreading of gamma contamination from the northeast quadrant of the tank footprint (Raymond and Shdo 1966).
6	Vertical borehole on the southwest side of tank SX-115.	The purpose of this borehole would be to characterize the pathways and potential distribution of contamination at a location near the source associated with the tank SX-115 leak. The southwest side of the tank corresponds to observations of horizontal spreading of gamma contamination from the southwest quadrant of the tank footprint (Raymond and Shdo 1966).
6a	Vertical borehole on the southwest side of tank SX-115 outside of the fenceline.	The purpose of this borehole would be to characterize the pathways and potential distribution of contamination at a location down dip from the SX-115 leak.
7	Vertical borehole outside the tank farm fenceline in a region to the south of tank SX-115 as near the fence as possible.	The purpose of this borehole would be to characterize the pathways and potential distribution of contamination from the tank SX-115 leak. Location of this borehole would be outside of the fence and provide the opportunity to refine the source of groundwater contamination observed in the RCRA groundwater monitoring wells and potentially establish a tie between tank farm releases and groundwater contamination levels.

Additional considerations in evaluating the seven options included potential schedule and programmatic risk (i.e., risk to the program if the preliminary characterization effort were unsuccessful) associated with a fiscal year 1999 deployment. The rationale was that those characterization activities with significant schedule risk could be deferred to follow-up characterization activities that would be defined in a site-specific work plan for WMA S-SX in October 1999. This approach would also allow the Tank Farm Vadose Zone Project to reduce technical uncertainties associated with deployment in the tank farms by performing development and demonstration testing outside of the tank farms.

Each of these seven 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 (location number 1 in Table 4.1), is a primary characterization target. However, there are a number of technical and schedule uncertainties associated with attempting to install a slant borehole beneath tank SX-108 during fiscal year 1999.

Technical uncertainties are based primarily on anticipated gamma activity levels beneath the tank. Borehole construction methods would require driving a closed-end casing through the highly contaminated region requiring sampling of the highly contaminated region using a sidewall sampler as the casing was removed during borehole decommissioning.

The uncertainties associated with the slant borehole include the following:

- Personnel safety issues (radiological) associated with sampling highly contaminated zones
- Performance of the sidewall sampler on a slant hole
- Construction of the slant hole at the angle and size necessary to get under the tank and permit sidewall sampling.
- Potential schedule impact with performing the necessary tank farm safety documentation reviews and changes.

In addition to these technical uncertainties, a number of other constraints influenced the evaluation of borehole installation near SX-108. Above and below surface infrastructure and ancillary equipment would limit access to potential borehole locations near SX-108 and air permitting requirements could potentially delay initiation of field work beyond July 1999.

Given these uncertainties and constraints, it was decided that the slant borehole would be deferred to follow-up characterization efforts. 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, pending the outcome of the DQO for site-specific characterization. Given that the slant borehole beneath tank SX-108 is a potential primary target for future characterization effort, it was decided that the two vertical boreholes near tank SX-108 (location numbers 2 and 3 in Table 4.1 and Figure 4.2) should be deferred until the data from the slant borehole could be evaluated and the need for additional source characterization at tank SX-108 was established.

A new vertical borehole near borehole 41-11-10 (location number 4 in Table 4.1) 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 should 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.

The two vertical boreholes located near tank SX-115 (location numbers 5 and 6 in Table 4.1) would potentially provide data to characterize the source associated with the leak at SX-115. Boreholes at either of these locations could be placed directly in, or in the likely path of, contaminants identified in previous characterization of the soils at tank SX-115 (Raymond and Shdo 1966).

A vertical borehole located outside of the tank farm near tank SX-115 tank (location number 7 in Table 4.1) would potentially provide data to assess potential ties between the tank SX-115 leak and the contamination observed in the RCRA groundwater monitoring wells. This location also would potentially provide data to characterize the pathway and distribution of mobile contaminants resulting from the tank SX-115 leak. This location is consistent with one of the potential groundwater contamination sources identified in the RCRA assessment (Johnson and Chou 1998). One of the limitations of locating the borehole at this location is that data are not available to target the location of the borehole to intercept an area of known contamination. It is possible that limited vadose zone contamination would be encountered in a borehole located in this area. A borehole located southwest of tank SX-115 would be located near a past tank leak. The proposed borehole is down dip of past tank leaks, thus, potentially enabling data collection that may further the understanding of the pathways and distribution of contamination in the vadose zone, and it is accessible within the required time frame.

Based on the evaluation of borehole location options the preliminary characterization activity proposed in WMA S-SX is to install a vertical borehole near tank SX-115 extended to groundwater. This is consistent with recommendations for the location of a new borehole to groundwater made by the Tank Farm Vadose Zone Project Steering Group (Appendix F).

The options for locations around tank SX-115 and the rationale for the proposed location are described in Section 4.2.2. Sample collection from the new borehole will include continuous driven samples collected during construction of the borehole, coupled with an air-assisted drilling technique selected to specifically address sample representativeness and data quality. This drill-and-drive technique would use reverse circulation air-assisted drilling methods that have not been used in the tank farms. This drilling method provides for optimum sample quality (see Appendix A for discussion on this drilling method and the sampling techniques). Three regions around tank SX-115 have been tentatively identified for placement of the new borehole.

These regions and the issues associated with selecting one of the regions, are discussed in Section 4.2.2.

Similar to the slant borehole, there are a number of uncertainties associated with installation of a vertical borehole within the tank farm using air rotary drilling methods. However, unlike the slant borehole, the uncertainties associated with the vertical borehole are believed to be manageable within the preliminary characterization time frame. These uncertainties are mainly associated with not having deployed this drilling technique in the tank farms. These uncertainties are currently being worked through the permitting process (e.g., Notice of Construction) and the tank farms authorization basis and are not expected to constrain installation of a borehole near tank SX-115.

4.3.1.4 Other Activities

In addition to the new borehole, borehole decommissioning, and RCRA monitoring well data collection efforts, a number of demonstrations are being pursued to reduce the technical uncertainties and to provide a basis for future deployment in the tank farms. Cone penetrometer demonstrations are being planned that include demonstrations in the 200 East and West Areas and possible deployment in a tank farm. The cone penetrometer is a potentially valuable tool for performing screening level characterization and for defining the lateral extent of contamination in the upper part of the vadose zone. A slant well demonstration is also being planned that would be similar in terms of features and approach to sediment sampling as the borehole planned at tank SX-108.

4.3.2 Proposed Specific Tank SX-115 Borehole Location

The specific location of the proposed new borehole near tank SX-115 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.

4.3.2.1 Leak History

Waste in tank SX-115, which was put into service in 1958, began boiling in 1959. In 1964, the aged waste was pumped out of the tank and condensate was added to dissolve sodium nitrate from the residual solids. In March 1965, tank SX-115 was determined to have leaked about 189,250 L (50,000 gal), and 10 test wells were drilled around the tank in August 1965 (Raymond and Shdo 1966). Data from the test wells and data from existing drywells and laterals were used to define and characterize the contaminated area under the tank. Approximately 40,000 Ci of cesium-137 were lost to the soil column during this leak. Three separate areas of contamination were found. One contamination area was located completely under the tank; the other two areas were closer to the edge of the tank, with the contaminated zones primarily under the tank. The data are the latest available for soil samples in the tank SX-115 leak area.

The 189,250-L (50,000-gal) leak volume estimate was based on liquid-level measurements in the tank, and the leak occurred over a relatively short period time. The liquid-level measurements are thought to be the most reliable leak-volume indicator (particularly with liquids in the tank). The Raymond and Shdo (1966) data suggest that the cesium-137 sorbed on the soil, as is expected for the liquid waste type present in the tank. The nature of the liquids leaked from tank SX-115 were substantially different than those from tank SX-108. The liquids that leaked from tank SX-115 would be more characteristic of a typical liquid waste (e.g., without the effects of high temperature, density, and salt content). Little is known about the mobile long-lived radionuclides (i.e., technetium-99) or moisture profiles around tank SX-115. The waste concentrations in the tank SX-115 leak were approximately one order of magnitude lower than the tank SX-108 leak. This indicates that alteration of the sediments as a result of the tank SX-115 leak would not be expected to the same degree as near tank SX-108.

It is reasonable to assume tank SX-115 lost its containment integrity (failed) while storing the self-boiling REDOX Plant waste because low levels of gamma activity were detected in the laterals before the 1965 leak had occurred (WHC 1992c). The initial leak could have self-sealed, as was reported for other boiling-waste tanks in the 241-SX tank farm (Raymond and Shdo 1966; Womack and Larkin 1971; WHC 1992c). Experiments have shown that high levels of dissolved solids in the tank supernatant liquid from the REDOX process would tend to plug tank leaks (Nelson and Knoll 1958). If a tank leak had self-sealed and condensate was added to the tank to recover sodium nitrate, self-sealed leaks would be expected to re-open because the soluble salts (i.e., the salt plug) would be expected to re-dissolve. As the sodium nitrate solution leaked from the steel liner, the sodium nitrate would be expected to transport any concentrated waste outside of the steel liner into the soil column. This leak scenario is consistent with reported data.

4.3.2.2 Borehole Location Options Near Tank SX-115

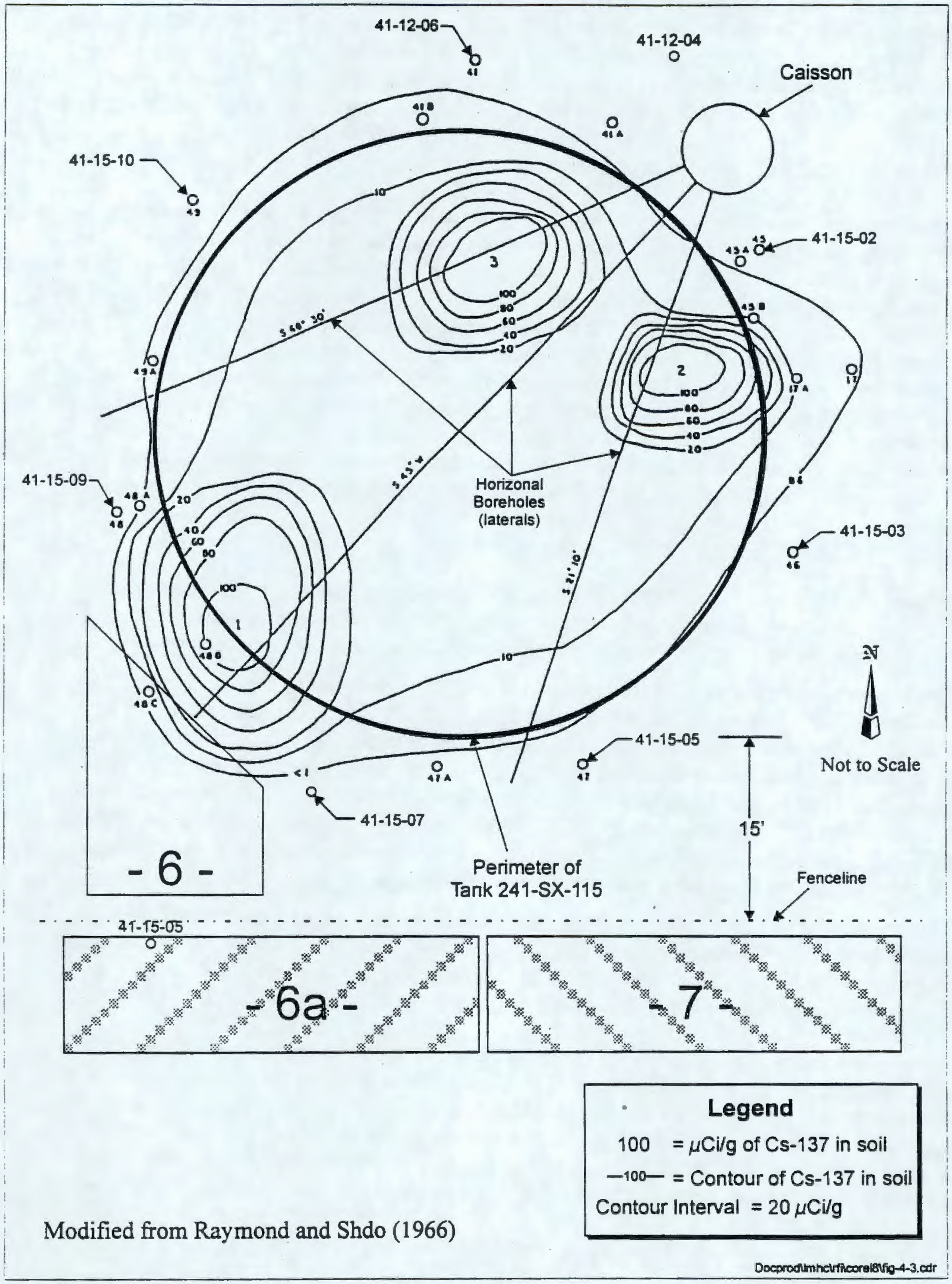
The specific location of the borehole in relation to tank SX-115 has not yet been established. The opportunities for gathering information and the trade-offs between the specific locations have been evaluated to optimize the data and information provided by the borehole.

Three regions around tank SX-115 have been identified as potential targets for locating a new characterization borehole, as identified in Figure 4.3. These locations are southwest of tank SX-115 inside the tank farm (Area 6), south-southwest of tank SX-115 outside of the tank farm fence line (Area 6a), and southeast of tank SX-115 outside of the tank farm fence line (Area 7). An evaluation of the questions and the hypothesis that could be evaluated with data obtained from the three locations are summarized in Table 4.4 and are discussed in greater detail in the following paragraphs. Based on this evaluation and meetings held with DOE and Ecology (Appendix E), Area 6 has been selected as a primary location for the new borehole.

The recent spectral gamma logging in the boreholes surrounding tank SX-115 indicated low levels of cesium contamination (see Figure 3.3). As shown in Figure 4.3, this is because plume location, as described by Raymond and Shdo (1966), is between drywells 41-15-07 and 41-15-09 that were used for spectral gamma logging.

A location southwest of tank SX-115, both inside and outside the tank farm, provides the opportunity to test a variety of hypotheses of the movement of contaminants and moisture, as well as the role of the geologic system in controlling that movement. Questions and hypothesis addressed at different tank SX-115 borehole locations are presented in Table 4.4. Area 6a is located in the vicinity of an identified water line leak (Johnson and Chou 1998) that has been postulated as providing a mobilizing force to move contaminants through the vadose zone to the groundwater.

Figure 4.3. Tank 241-SX-115 Borehole Location Options



Modified from Raymond and Shdo (1966)

Docprod\mhc\rfi\corel8\fig-4-3.cdr

Table 4.4. Questions and Hypothesis Addressed at Different Tank SX-115 Borehole Locations

Questions/Hypothesis	SW of Tank SX-115 Outside Fence Line (Area 6a)	SE of Tank SX-115 Outside Fence Line (Area 7)	S-SW of Tank SX-115 Inside Fence Line (Area 6)
What is the recharge distribution (moisture profile) in an area analogous to the tank farm?	X	X	X
What are the concentrations of potentially mobile contaminants (Tc and NO_3) in the vadose zone due to leak plume and down dip direction?	X		X
What is the moisture content in area of water line leak?	X		
Deploy desired drilling method for future characterization.	X	X	X
Can dragdown be assessed using microspheres?	X	X	X
What are the contaminant concentrations in groundwater samples taken close to a tank known to have leaked a large volume?	X		X
What are the contaminant concentrations in groundwater samples taken close to a tank known to have leaked a large volume in a downgradient groundwater location?		X	
Additional data can be used to refine the understanding of the geology (slope of Plio-Pleistocene unit and carbonate zone).	X	X	X
What are the concentrations of CoCs in vadose zone samples taken from an area with known gamma contamination based on historical data?			X

A borehole in Area 6 or 6a would enhance understanding of the physical geologic properties and the fate and transport of contaminants needed to support risk assessment. The advantage to Area 6 over Area 6a 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 anticipated concentrations of gamma contamination. In support of the requirements of the Notice of Construction (DOE/RL 1999) the proposed drilling method (air rotary) will be limited based on the cesium concentrations in the sediment and the number of planned boreholes to be installed on an annual basis. The following information can be developed and the hypotheses tested by a borehole located southwest of tank SX-115.

- Moisture distribution – the site is the equivalent of a tank farm surface, essentially devoid of significant vegetation. The vertical distribution of moisture in the vadose zone near the region of enhanced recharge, from both artificial and natural sources, can be determined.

- A hypothesis has been offered that the top of the Plio-Pleistocene Unit or the carbonate-rich zone may control the movement of moisture and associated contaminants with depth (Jones et al. 1998). The surface of this unit has been postulated to dip (i.e., slope) to the southwest. A borehole located southwest of tank SX-115 will provide a much needed data point to further describe this surface and its role in controlling contaminant migration. The data from this site, used with the data from the fiscal year 1999 RCRA groundwater wells, would provide additional information on the distribution of this surface.

- 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 (Jones et al 1998). 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 unit 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.

- Johnson and Chou (1998) postulated that an observed cottonwood tree adjacent to a visible pipeline was evidence that significant moisture was entering the vadose zone. They further hypothesized that this moisture could lead to a significant increase in the migration rate of mobile contaminants. A borehole at this location would provide samples for moisture content analyses that could be compared with equivalent horizons to be sampled and analyzed in the fiscal year 1999 RCRA groundwater wells to be drilled adjacent to 241-SX tank farm. The cottonwood tree has been removed. For additional discussion, see Johnson and Chou (1999).

- A borehole extended to the groundwater at this location would provide a sampling opportunity in close proximity to a tank known to have released a significant inventory of contaminants to the vadose zone.

A borehole located southeast of tank SX-115 in Area 7 would provide some of the same information as would a borehole located southwest of the tank. Enhancement of the understanding of the fate and transport of tank waste would be limited to basic geologic and hydraulic parameter determination by a borehole at this location. Information that would be included from this borehole is listed below:

- Moisture distribution – the site is the equivalent of a tank farm surface, essentially devoid of significant vegetation. The moisture distribution near the region of enhanced natural recharge under tank farm surface conditions can be determined.

- A hypothesis has been offered that the top of the Plio-Pleistocene Unit or carbonate-rich zone may control the movement of moisture and associated contaminants with depth. This unit has been postulated to dip to the south-southwest (see Chapter 2.0). A borehole located southeast of tank SX-115 will provide a data point to further describe this surface and its role in controlling contaminant migration. The data from this site, used with data from the fiscal year 1999 RCRA groundwater wells, would provide additional information on the distribution of this surface.

- A borehole extended to the groundwater at this location would provide a sampling opportunity in close proximity to a tank known to have released a significant inventory of contaminants to the vadose zone. There is uncertainty as to the degree of horizontal migration of mobile contaminants and whether a borehole in this direction would intercept a contaminant plume from the tank SX-115 leak.

- A borehole at this location could be used to test the possible source of groundwater contamination, as shown in Johnson and Chou (1999).

4.3.3 Investigative Sampling and Analysis and Data Validation

Data will be collected during borehole 41-09-39 decommissioning by sampling and analyzing sediment from the driven portion of the borehole (40 m [130 ft]) to ground surface) as the casing is withdrawn and by conducting geophysical surveying as described in Appendix A. Sediment samples will be collected using a sidewall-sampling tool at 16 intervals in the borehole. All samples will be field screened for radiation and organic vapors, 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 new vertical borehole near tank SX-115, a combination of driven sediment samples collected ahead of the driven casing using standard split-spoon sampling techniques and drill cuttings will be collected to provide nearly continuous coverage of the vadose zone. Sample lengths will be reduced if necessary when penetrating known hot zones to reduce worker exposures. All samples will be field screened for radiation and organic vapors, containerized, and retained for possible analysis. Geophysical logging will be conducted to monitor for dragdown (e.g., evidence of gamma contamination moving down the borehole as the casing is advanced). Sample intervals will be selected for analysis above the tank base elevation. Below the tank base elevation, samples will be selected for analysis based on the geophysical logs from the 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 evidence that the waste has altered the sediments. Specific data quality and analysis methods were not extensively discussed in the DQO process. The approach used in developing the SAP relied on using standard laboratory methods and a "best practices" approach, utilizing lessons learned from the sampling and analysis of the borehole 41-09-39 extension. Groundwater from the uppermost part of the unconfined aquifer will also be sampled and analyzed for radiological and chemical constituents, as described in the SAP (Appendix A).

For the planned RCRA groundwater monitoring wells, data will be collected to refine the geologic conceptual model and develop site-specific physical property data for the vadose zone. Sample collection and planned analyses are described in Chapter 5.0 and Appendix A.

Data from the new borehole and decommissioning of borehole 41-09-39 will be validated in accordance with Section C.8.0 of the quality assurance project plan (QAPjP) in Appendix C. The quality assurance/quality control (QA/QC) requirements for the data collected from borehole 41-09-39 and the new borehole were developed for the preliminary characterization activity using a "best practices" approach.

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 Preliminary Addendum is to provide a summary of the tasks that will be performed for the initial investigation. A detailed description of these tasks is provided in Appendix A, Sampling and Analysis Plan. 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 preliminary field investigation for the RFI. Environmental monitoring requirements for protecting the health and safety of onsite investigators are described in the health and safety plan (Appendix B).

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 the QAPjP (Appendix C).

5.1 RCRA FACILITY INVESTIGATION TASKS

5.1.1 Preliminary Field Investigation

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 Groundwater Investigation
- Task 4 Data Evaluation.

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. As a result of the previous investigation conducted at borehole 41-09-39, the amount of information and the level of detail planning for the decommissioning of this borehole is greater than that available for the new borehole. Decommissioning of borehole 41-09-39 was addressed in the DQO process and the decommissioning activity plan is under development, thus more detailed information is provided for the decommissioning effort.

5.1.1.1 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. The initial project management activity will be to assign individuals to the roles established in Chapter 7.0. Specific subtasks that will occur throughout the preliminary RFI and RFI/CMS include the following:

Subtask 1a	General Management
Subtask 1b	Meetings
Subtask 1c	Cost Control
Subtask 1d	Schedule Control
Subtask 1e	Work Control
Subtask 1f	Data Management
Subtask 1g	Progress and Final Reports
Subtask 1h	Quality Assurance Subtask
Subtask 1i	Health and Safety Subtask.

Each of these subtasks is described in Chapter 7.0, Project Management. Further detail on schedule control, cost control, meetings, and reporting can be found in the Action Plan in the proposed Tri-Party Agreement Change Control Form Number M-45-98-03 (DOE 1999a).

5.1.1.2 Task 2 – Geologic and Vadose Zone Investigation

The geologic and vadose zone investigation will further characterize the geology of the WMA 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
- Groundwater flow
- Release and movement of contaminants
- Initial Development of ICM alternatives
- Initiate data collection for support of retrieval and closure activities.

The geologic and vadose zone investigation for the WMA S-SX will consist of compiling pertinent existing data and collecting data from drilling activities in the vadose zone and from groundwater monitoring wells, as defined in the proposed Tri-Party Agreement Change Control Form Number M-45-98-03 (DOE 1999a). The data will be added to a geographical information system (GIS). The types of data needed from the surface, vadose zone, and unconfined aquifer 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 and groundwater.

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

Subtask 2a	Data Compilation
Subtask 2b	Field Activities (logging and sampling of a new borehole, sediment sampling and decommissioning of borehole 41-09-39, and vadose zone sediment sampling of the proposed RCRA groundwater monitoring wells)

- Subtask 2c Laboratory Analysis
- Subtask 2d Data Evaluation.

5.1.1.2.1 Subtask 2a – Data Compilation

Existing data on regional and site-specific geology of the 200 West Area and WMA S-SX and radiological and chemical concentrations in sediment and groundwater potentially affected by tank operations will be compiled. This ongoing subtask is focusing on collecting and interpreting existing geologic literature, maps, and borehole geologic and geophysical logs.

5.1.1.2.2 Subtask 2b – Field Activities

Field activities will include geologic and geophysical logging associated with the new borehole and decommissioning of borehole 41-09-39 and sediment samples from driven samples and drill cuttings associated with the proposed WMA S-SX RCRA groundwater monitoring wells. The tentative locations of the planned new borehole and three new RCRA monitoring wells are provided in Figure 5.1 in addition to the location of borehole 41-09-39.

The requirements for geologic and geophysical surveying and sediment sampling for physical parameters in the vadose zone borings and groundwater monitoring wells are provided in Appendix A, Sampling and Analysis Plan. Information and data will be collected from the surface downward to within the unconfined aquifer of the Ringold Formation. Geologic logging will be performed concurrently with the drilling operations, unless highly radioactive sediments require removal of samples at a separate sample extraction facility.

New Borehole (Well Number B8809)

The following activities are planned for the new borehole.

- Measure formation and casing temperature in the open borehole face after the casing is advanced and after cleaning the borehole during drilling has been completed.

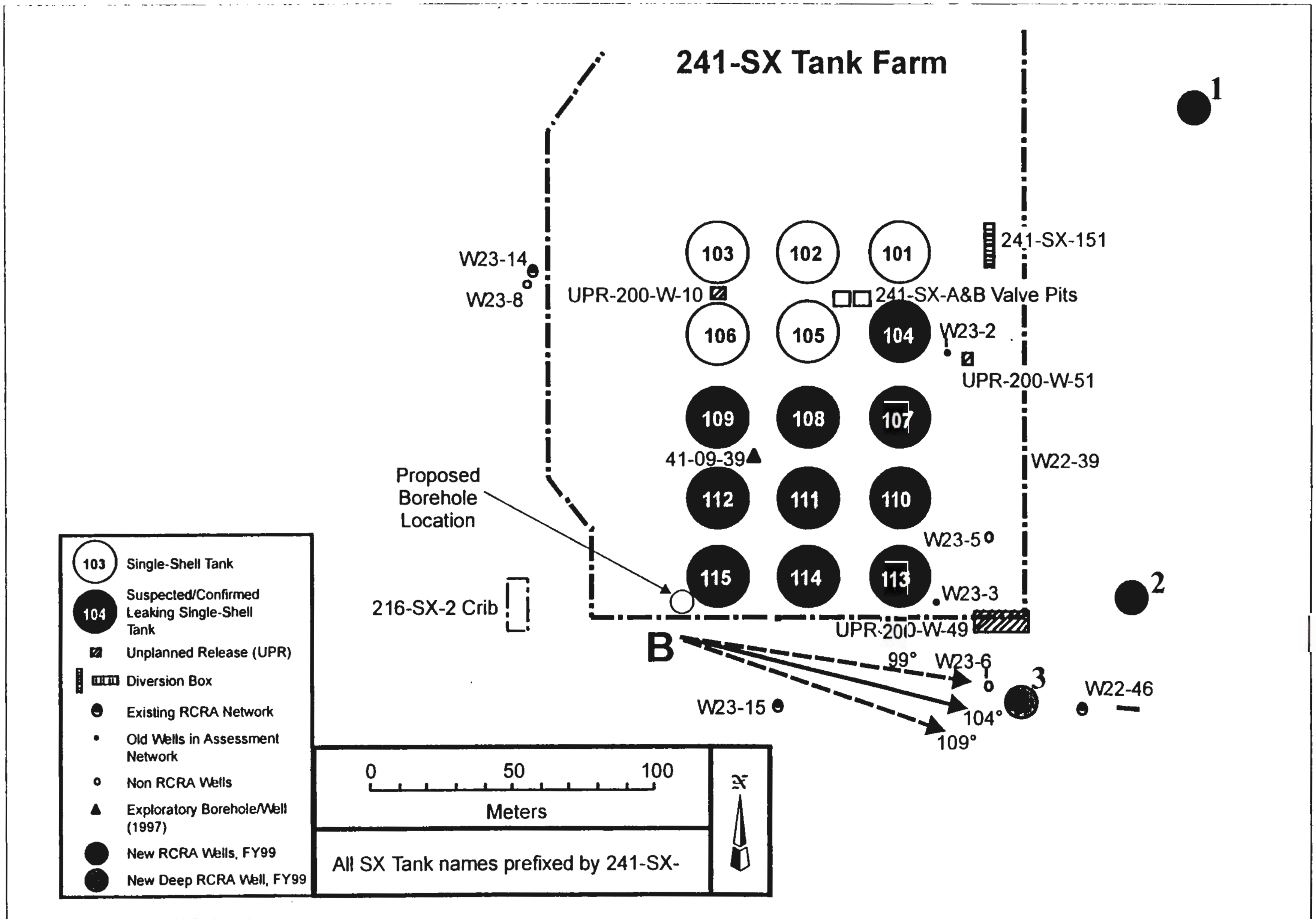
- Conduct borehole geophysical surveying and analysis (moisture, neutron, gross gamma, spectral gamma and enhanced neutron spectral gamma analysis).

- Perform spectral gamma logging and evaluate the potential use of microspheres to support attempt to determine the occurrence of dragdown during drilling.

- 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. Proposed Locations for the New Borehole and RCRA Groundwater Monitoring Wells



docprod\lmhc\rfi\corel8\fig-5-1.cdr

The new borehole will be advanced in conjunction with split-spoon sampling techniques through regions of interest with samples being acquired in advance of the conductor casing. Then, the boring will be cleaned out (i.e., drilled to expand the borehole diameter to approximately the drill pipe and conductor casing diameter while the conductor casing is being driven downward to the bottom of the last sample interval). The reverse-air circulation drill and drive method will be used for this task because of the ease of drilling through gravels, cobbles, and boulders common to the WMA geology. Also, the quantity of drilling residuals (cuttings) is minimal with this technique, washout zones are significantly reduced or eliminated, and more representative formation and water samples can be obtained (Driscoll 1986) compared to previously used methods.

Subsurface conditions are variable and the process of installing the new borehole must be flexible. Some or all of the work described in Appendix A may require modification. This Preliminary 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.

As a result of the first time use of the drill and drive drilling method in the tank farms, this endeavor may need modification based on permitting compliance with the Washington State Department of Health. Air used in the drilling process will need to be contained per the Washington State Department of Health. Appropriate permits and Notice of Construction (NOC) permits will be acquired before drilling operations for inside the tank farm. The proposed 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.

Decommissioning of Borehole 41-09-39

Decommissioning of borehole 41-09-39 will be conducted with sidewall sampling occurring in the upper portion (39.6 m [130 ft] bgs to surface) of the borehole as described in Appendix A. The lower portion of this borehole was sampled in 1997 and 1998.

Borehole 41-09-39 was driven to 40.1 m (131.5 ft) in December 1996 in the 241-SX tank farm. A 17.8 cm (7-in.) outside diameter by 16.5-cm (6.5-in.) inside diameter well casing was placed from ground surface to 39.8 m (130.5 ft). The casing was initially closed at the bottom with a steel plug. The bottom plug was milled out and borehole 41-09-39 was deepened to 69 m (225.3 ft) in September 1997. A second 11.43-cm (4.5-in.) outside diameter by 9.84-cm (3.875-in.) inside diameter casing string was installed inside the 7-in. casing. The casing is 65 m (214 ft) in length by 11.43-cm (4.5-in.) outside diameter steel pipe, with a 3-m (10-ft) by 8.9-cm (3.5-in.), 0.010-slot stainless-steel screen with a 0.3-m (1-ft) by 8.9-cm (3.5-in.) blank for a total length of 69 m (225 ft). There is no annular seal in either section of casing strings.

During the decommissioning of borehole 41-09-39, the following field activities are planned:

- Perform a tracer test that might clarify path, direction, and rate of groundwater flow.
- Measure formation and casing temperature in the open borehole face as the casing is removed and in the casing prior to removal, respectively.
- Conduct borehole geophysical logging and analysis (moisture, neutron spectral gamma, and high-purity germanium [HPGe] analysis).
- Sample intervals in the driven portion of the borehole to try to determine if drag down from original drilling may be the cause of contamination found during geophysical analysis.
- Obtain sediment samples to analyze for the presence and concentration of contaminants and to evaluate alterations of the sediments from waste chemistry effects and support preparation of the geologic log of the borehole.
- Respond to Ecology/WAC requirements to abandon the well in a compliant manner.

The process of decommissioning the borehole is not completely known. Some or all of the work described in Appendix A may require modification. This Preliminary Addendum is intended to serve as a guideline and is designed to allow for changes depending upon conditions encountered within the borehole. Any change will be recorded on the appropriate field documentation, memoranda, or letters. Some of the actions described also require Ecology's approval or variance, such as leaving the screen within the hole or allowing an open hole to conduct tests. Ecology approval will be obtained and documented before work is commenced. A complete documented record of activities will be maintained for preparation of a final summary report.

Pre-job activities are planned in April or May 1999 on a shallow test hole at the immobilized low-activity waste (ILAW) site in preparation of abandonment of borehole 41-09-39. The purpose of the work is to test a casing cutter on heavy wall pipe and a bottom-casing sidewall sampling device before use and to train personnel involved in the decommissioning process before entry into the tank farm site. The ILAW site was picked because the shallow geologic material is similar to the horizons that will be sampled at the 241-SX tank farm. Work will consist of augering a 17.8-cm (7-in.)-diameter hole 6.1 m (20 ft) bgs. A 7.6-m (25-ft) section of 17.8-cm (7-in.) outside diameter steel pipe with 1.5 m (5 ft) of stickup will be installed. The sidewall-sampling tool will be tested in the bottom of the hole to determine the ability to take a sample in the undisturbed side wall. The tool will be tested to determine penetration distance and sample quantity and the ability to return the sample to the surface. The casing will be jacked up to practice cutting using a low-profile clamshell Model 608SB casing cutter from Tri Tool Inc. A second sidewall sample is planned to be taken at about 3 m (10 ft) bgs to confirm ability to meet sampling requirements. The remainder of the casing will be removed and the hole will be abandoned in accordance with WAC 173-160. These pre-job activities will provide an understanding of the procedures necessary to control the work, sample-handling equipment, casing cutting and handling equipment, waste disposal planning and requirements, tank farm work package preparation, and sample and analysis plan preparation.

Vadose Zone Sediment Sampling of the Proposed RCRA Groundwater Monitoring Wells

The following activities are planned for the vadose zone sediment sampling of the proposed RCRA groundwater monitoring wells.

- Obtain sediment samples to determine physical properties including moisture content that will be used to support development of background and/or baseline conditions
- 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.

Data collection from the three proposed RCRA groundwater wells (Figure 5.1) include the following:

- Southernmost well (number 3)
    - Continuous split-spoon driven samples from 6 m (20 ft) bgs to refusal
    - Continuous collection of cuttings from driven sample refusal depth to groundwater
    - Experienced geologist (see Appendix A) logs all cuttings and split-spoon driven samples to finest resolution possible
    - Analyze for hydraulic parameters on select segments, retain subsamples cuttings and split-spoon driven samples for future analysis.
- Other WMA S-SX RCRA groundwater wells (numbers 1 and 2)
    - Continuous collection of samples from the cuttings between the surface and groundwater
    - Experienced geologist (see Appendix A) logs all cuttings to finest resolution possible.

Groundwater sampling from these RCRA wells is discussed in Section 5.1.1.3 and Appendix A and will be conducted under the Hanford Groundwater Program (Johnson and Chou 1999).

5.1.1.2.3 Subtask 2c – 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 and all groundwater samples. Also, physical and hydrologic analysis of selected sediment samples will be performed.

5.1.1.2.4 Subtask 2d – Data Evaluation

The geologic vadose zone data for the WMA will be evaluated under this subtask. Data from well and borehole geological logs and geophysical surveys, and analytical results (i.e., radiological, chemical, and physical analyses) will be used to refine geologic and vadose zone conceptual models.

5.1.1.3 Task 3 – Groundwater Investigation

Groundwater sampling will be conducted under the Hanford Groundwater Program for the new borehole, borehole 41-09-39, and the proposed RCRA groundwater monitoring wells and is described in that work plan (Johnson and Chou 1999) and the subsequent work plans for those activities.

5.1.1.4 Task 4 – Data Evaluation

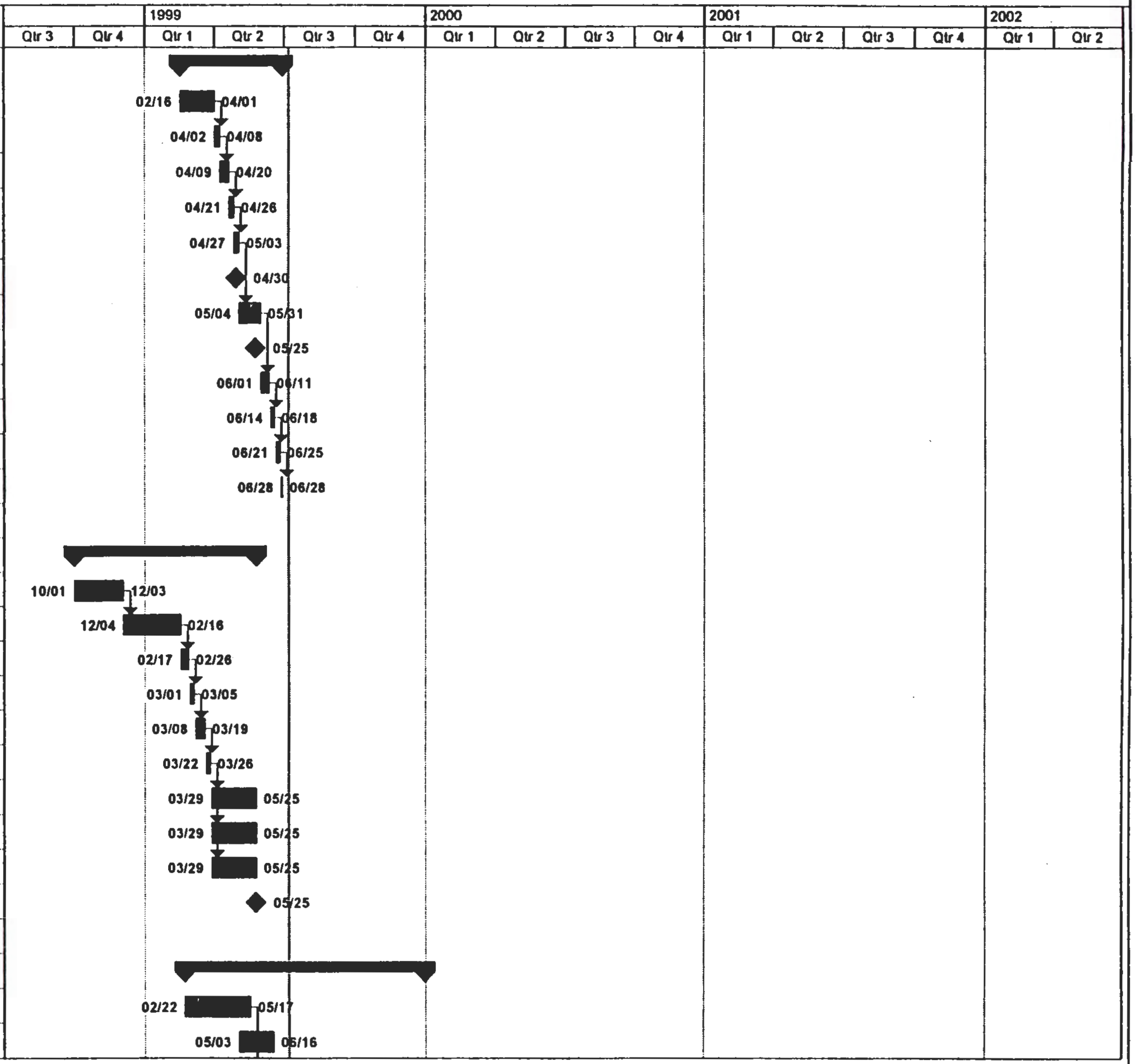
Data generated during the field investigation will be integrated and evaluated, coordinated with RFI activities, and presented in an ongoing manner to allow decisions to be made regarding any necessary rescoping during the course of the project. The results of these evaluations will be made available 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 Preliminary Addendum were initiated before completion of the Phase 1 SST RFI/CMS work plan, with the understanding that additional characterization activities in WMA S-SX would be documented in a site-specific work plan addendum that will be developed to meet proposed Tri-Party Agreement Milestone M-45-52 to be completed by October 1999.

The activities identified in Figure 6.1 were taken from the Tank Farm Vadose Zone Project schedule that is maintained under configuration control by the Tank Farm Vadose Zone 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.

Figure 6.1 Preliminary Characterization Schedule



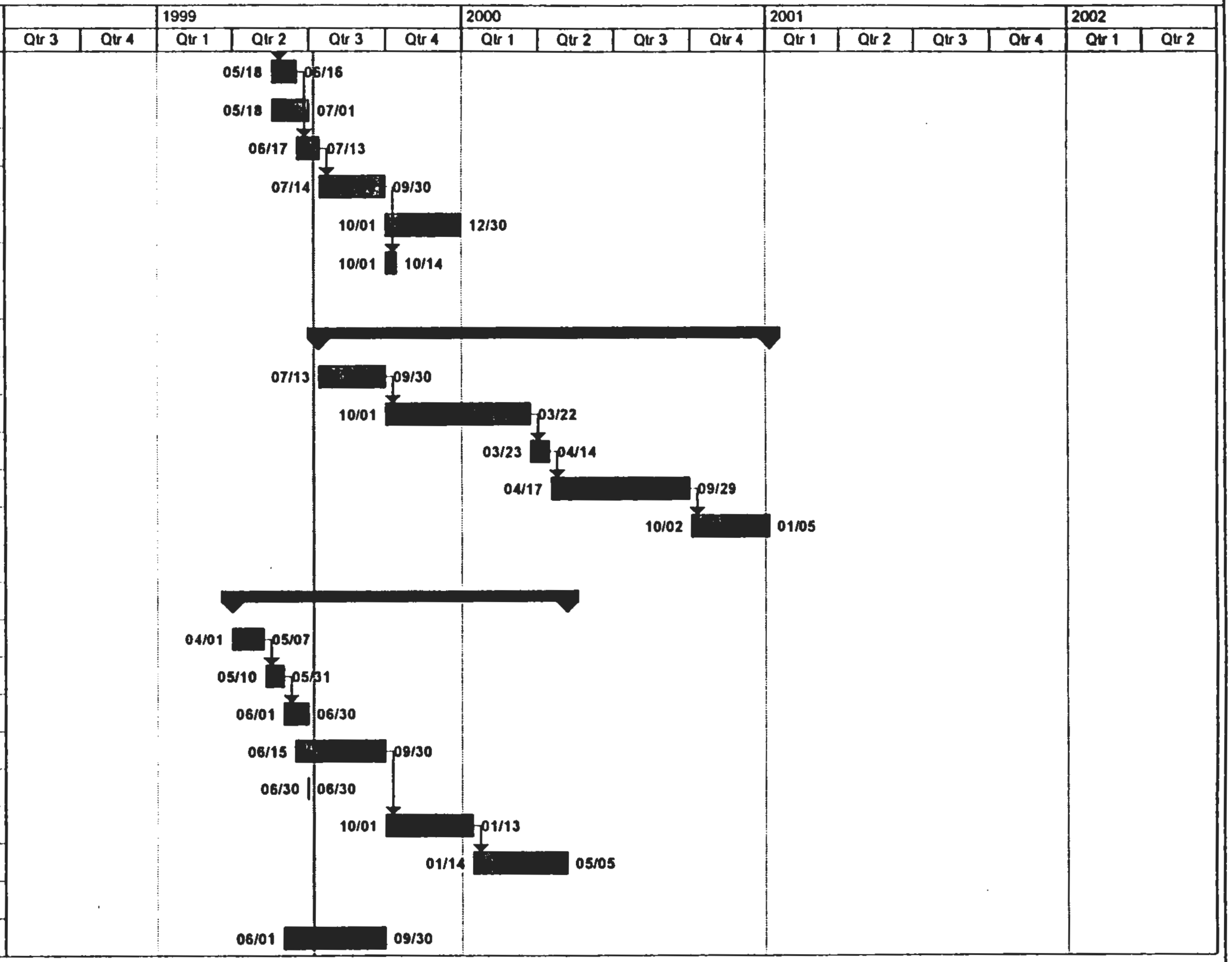
ID	Task Name		
1	**Site Specific Work Plan S-SX (1.01.04.01.03.03.19.03)**		
2	Prepare Prelim Draft WP Addenda	02/16	04/01
3	Review of Prelim Draft WP Addenda	04/02	04/08
4	Incorp Comments, Prepare Prelim WP Addenda	04/09	04/20
5	Transmit Prel Draft WP Addenda to DOE	04/21	04/26
6	DOE transmit Prel Draft WP Addenda to Ecology	04/27	05/03
7	TPA Milestone M-45-52-T01		04/30
8	Ecology review of Prelim Draft WP Addenda	05/04	05/31
9	Ecology Approval of 41-09-39 decommissioning plan		05/25
10	Inc Comments, Revise Prelim. WP Addenda	06/01	06/11
11	Transmit Prelim WP Addenda to DOE	06/14	06/18
12	DOE Transmit Prelim. WP Addenda to Ecology	06/21	06/25
13	Ecology Approve Prelim WP Addenda	06/28	06/28
14			
15	**Notice of Construction (1.01.04.01.03.03.18.06)**		
16	Prepare NOCs (Rad & Non-Rad)	10/01	12/03
17	Review NOCs	12/04	02/16
18	Incorporate Comments from NOC Review	02/17	02/26
19	Transmit NOCs (Rad & Non-Rad) to DOE	03/01	03/05
20	DOE Review/Approve NOCs	03/08	03/19
21	Transmit NOCs to DOH, EPA, & Ecology	03/22	03/26
22	EPA Review and Approve NOC (Rad)	03/29	05/25
23	DOH Review and Approve NOC (Rad)	03/29	05/25
24	Ecology Review and Approve NOC (non-Rad)	03/29	05/25
25	NOCs Approved		05/25
26			
27	**Drilling and Sampling S-SX (1.01.04.01.03.03.19.04)**		
28	Planning (field/lab)	02/22	05/17
29	Prepare Work Package	05/03	06/16

Project: fig6_1
Date: Tue 07/06/99

Task	▬	Summary	▬	Rolled Up Progress	▬	Project Summary	▬
Progress	▬	Rolled Up Task	▬	Split	┈		
Milestone	◆	Rolled Up Milestone	◇	External Tasks	▨		

Figure 6.1 Preliminary C terization Schedule

ID	Task Name		
30	Place Contracts (field/lab)	05/18	06/16
31	Readiness Assessment	05/18	07/01
32	Drilling Mobilization & Training	06/17	07/13
33	Drill and Sample	07/14	09/30
34	Decommission & Waste Disposal	10/01	12/30
35	Demobilization	10/01	10/14
36			
37	**Laboratory Analysis (1.01.04.01.03.03.19.05)**		
38	Initial Lab Analysis (FY99)	07/13	09/30
39	Initial Lab Analysis (FY00)	10/01	03/22
40	Select Samples for Detailed Analysis	03/23	04/14
41	Conduct Detail Analysis (FY00)	04/17	09/29
42	Conduct Detail Analysis (FY01)	10/02	01/05
43			
44	**Decommissioning and Sampling 41-09-39 (1.01.04.01.03.03.19.08)**		
45	Readiness Review/Assessment	04/01	05/07
46	Initiate Decommissioning and Soil Sampling Training and Preparation	05/10	05/31
47	Decommissioning and Soil Sampling	06/01	06/30
48	Sample Analysis (FY99)	06/15	09/30
49	Complete Decommissioning	06/30	06/30
50	Sample Analysis (FY00)	10/01	01/13
51	Prepare Field/Lab Report	01/14	05/05
52			
53	Install RCRA Groundwater Wells Outside S-SX WMA	06/01	09/30



Project: fig6_1
Date: Tue 07/06/99

Task	▬	Summary	▬	Rolled Up Progress	▬	Project Summary	▬
Progress	▬	Rolled Up Task	▬	Split	....		
Milestone	◆	Rolled Up Milestone	◇	External Tasks	▨		

FIG6_1.MPP

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 necessary to manage activities described in this Preliminary 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. 1996). 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 will be described in the Phase 1 SST RFI/CMS Work Plan.

7.1.1 General Management

This subtask includes the day-to-day supervision of and communication with project staff and subcontractors. Throughout the project, daily communications between office and field personnel will be maintained, as well as periodic communications with subcontractors, in order to assess progress and exchange information. This constant exchange of information will be necessary to assess the progress of the project and to identify potential problems early enough to make necessary corrections to keep the project focused on its objectives, on schedule, and within budget.

7.1.2 Meetings

Meetings will be held, as necessary, with members of the project staff, subcontractors, regulatory agencies, and other appropriate entities to communicate information, assess project status, and resolve problems. Monthly meetings will be held to report progress, resolve problems, and address changes in work scope, as necessary.

The WMA project coordinators and others will meet periodically to share information and to discuss progress and problems. The frequency of additional meetings will be determined based on need and on schedules.

7.1.3 Cost Control

Project costs, including labor, other direct costs, and subcontractor expenses, will be tracked monthly. The budget-tracking activity will be computerized and will provide the basis for invoice preparation, review, and preparation of progress reports.

7.1.4 Schedule Control

Scheduled milestones will be tracked monthly during each task for each phase of the project. Schedule control will be performed in conjunction with cost tracking.

7.1.5 Work Control

The level of detail provided in this work plan is adequate for the preliminary RFI effort. 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 provided before initiating field work. Where appropriate, the work package will reference Sampling and Services Procedures Manual Well Services Procedures, and Standards Based Management System (SBMS) Manual rather than listing the entire procedure for a task. These manuals for field activities and laboratory analysis also are referenced in the QAPjP (Appendix C) and are in accordance with HASQARD (DOE-RL 1998). Any reference to the QAPjP as a source of additional information is inclusive of these manuals referenced.

The work package shall be prepared in accordance with LMHC work control procedures and the procedures listed in QAPjP. 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 Sampling Services Procedures Manual, Well Services Procedures Manual, and SBMS (WMN 1998a, WMN 1998b). Identify any field screening equipment to be used that is not described in the relevant Waste Management Federal Services (WMFS) procedures (WMN 1998a, WMN 1998b).
- Include the frequency of measurement.
- Identify the applicable WMFS procedures and SBMS procedures needed to conduct the work. If an WMFS procedure and SBMS 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 WMFS and SBMS 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.

7.1.6 Records Management

The project file will be kept organized, secured, and accessible to the appropriate project personnel. All field reports, field logs, health and safety documents, quality assurance/quality control (QA/QC) documents, laboratory data, memoranda, correspondence, and reports will be logged into the file on receipt or transmittal. This subtask also provides the mechanism for ensuring that data management procedures documented in the data management plan (Appendix D) are carried out appropriately.

7.1.7 Progress and Final Reports

Monthly progress will be documented at meetings. Meeting minutes will be prepared, distributed to the appropriate personnel and entities (e.g., project managers, coordinators, contractors, and subcontractors), and entered into the project file.

All field investigation, RFI/CMS reports, and work plans will be categorized as either primary or secondary documents. The process for document review and comment is outlined in the Tri-Party Agreement Action Plan (Ecology et al. 1996). Administrative records must be maintained as described in Section 9.4 of the Action Plan (Ecology et al. 1996).

7.1.8 Quality Assurance

The specific planning documents required to support the RFI/CMS have been developed within the overall QA program structure mandated by the DOE for all activities at the Hanford Site. Within that structure, the documents are designed to meet current EPA guidelines for format and content and are supported and implemented through the use of standard operating procedures drawn from the existing program or through procedures that have been developed specifically for environmental investigations.

To ensure that the objectives of this RFI/CMS are met in a manner consistent with the DOE order, all work conducted by Lockheed Martin Hanford Corporation (LMHC) will be performed in compliance with existing QA manuals and the LMHC QA program plan that specifically describe the application of manual requirements to environmental investigations. The WMA S-SX QAPjP (Appendix C) supports the field investigation described in this section. The QAPjP defines the specific means to be used to ensure that the sampling and analytical data are defensible and will effectively support the purposes of the investigation. The QAPjP will be implemented by this subtask.

7.1.9 Health and Safety

The health and safety plan (Appendix B) will be used to implement standard health and safety procedures for LMHC employees and contractors engaged in RFI/CMS activities in the WMA S-SX.

7.1.10 Interface of Regulatory Agencies and the U.S. Department of Energy

The WMA S-SX consists of interim status TSD units to be remediated and closed under RCRA. Ecology has been designated the lead regulatory agency, as defined in the Tri-Party Agreement.

Accordingly, Ecology is responsible for overseeing corrective action activity at this unit and ensuring that the applicable authorities of both EPA and Ecology are applied. The specific responsibilities of the EPA, Ecology, and DOE are detailed in the Tri-Party Agreement Action Plan (Ecology et al. 1996).

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. 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 264.100. Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Releases from Solid Waste Management Units Corrective Action Program. U. S. Code of Federal Regulations, as amended.

40 CFR 265 (Subpart F). Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, Groundwater Monitoring. U.S. Code of Federal Regulations, as amended.

50 CFR 17. Endangered and Threatened Wildlife and Plants. U.S. Fish and Wildlife Service, U.S. Department of Interior. Code of Federal Regulations, as amended.

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

Agnew and Corbin 1998. Agnew, Stephen F., and Robert A. Corbin. Analysis of SX Farm Leak Histories–Historical Leak Model (HLM). LA-UR-96-3537. Los Alamos National Laboratory. Los Alamos, New Mexico. 1998.

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

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

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

Comprehensive Environmental Response, Compensation, and Liability Act. Public Law 96-150. 94 Stat. 2767. Title 26. December 11, 1980.

Connelly et al. 1992. Connelly, M.P., J.V. Borghese, C.D. Delaney, B.H. Ford, J.W. Lindberg, and S.J. Trent. Hydrogeologic Model for the 200 East Groundwater Aggregate Area. WHC-SD-EN-TI-019, Rev. 0. Westinghouse Hanford Company. Richland, Washington. 1992.

Cushing 1995. Cushing, C.E. Hanford Site National Environmental Policy Act (NEPA) Characterization. PNL-6415, Rev. 7. Pacific Northwest National Laboratory. Richland, Washington. September 1995.

Cushing 1994. Cushing, C.E. Hanford Site National Environmental Policy Act (NEPA) Characterization. PNL-6415, Rev. 6. Pacific Northwest National Laboratory. Richland, Washington. July 1994.

Delany et al. 1991. Delany, C.D. Geology and Hydrology of the Hanford Site: A Standardized Text for use in Westinghouse Hanford Company Documents and Reports. WHC-SD-ER-TI-003. Westinghouse Hanford Company. Richland, Washington. 1991.

Driscoll 1986. Driscoll, Fletcher G. Well Drilling Methods. Groundwater and Wells 2nd Edition. pp. 301-307. Johnson Division. St. Paul, Minnesota. 1986.

DOE 1999a. 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. January 1999.

DOE 1999b. Vadose Zone Expert Panel Meeting – Meeting Closeout Report. DOE/RL-98-G7, Rev. 0. Richland, Washington. January 1999.

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

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

DOE 1993a. 200 East Groundwater Aggregate Area Management Study Report. DOE/RL-92-19, Rev. 0. U.S. Department of Energy. Richland, Washington. 1993.

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

DOE 1991. U. S. Department of Energy. S Plant Aggregate Area Management Study Report , DOE/RL-91-60, Rev. 0. U. S. Department of Energy. Richland, Washington. 1991.

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

DOE-GJPO 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. GJO-HAN-9. U. S. Department of Energy, Grand Junction Projects Office. Grand Junction. Colorado. March 1997.

DOE-GJPO 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. September 1996.

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

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

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

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. February 1998.

Ecology et al. 1996. Hanford Federal Facility Agreement and Consent Order, Fifth and Sixth Amendment. Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy. Olympia, Washington. February 1996.

EPA 1989. Interim Final RCRA Facility Investigation (RFI) Guidance, Development of an RFI Work Plan and General Considerations for RCRA Facility Investigations. EPA 530/SW-89-031. U.S. Environmental Protection Agency Waste Management Division, Office of Solid Waste. Washington, D. C. May 1989.

EPA 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA; Interim Final. EPA-540/G-89/004. U. S. Environmental Protection Agency, Office of Emergency and Remedial Response. Washington, D.C. 1988.

Fayer 1997. Fayer, M.J. Personal Communications. July 18, 30, and 31, 1997.

Fayer et al. 1995. Fayer, M.J., R.E. Lewis, R.E. Engelman, A.L. Pearson, C.J. Murray, J.L. Smoot, R.R. Randall, W.H. Wegener, and A.H. Lu. Re-Evaluation of a Subsurface Injection Experiment for Testing Flow and Transport Models. PNL-10860. Pacific Northwest National Laboratory. Richland, Washington. 1995.

Fayer and Walters 1995. Fayer, M.J. and T.B. Walters. Estimated Recharge Rates at the Hanford Site. PNL-10285. Pacific Northwest National Laboratory. Richland, Washington. 1995.

Fecht and Weekes 1996. Fecht, K.R. and D.C. Weekes. Geologic Field Inspection of the Sedimentary Sequence at the Environmental Restoration Disposal Facility. BHI-00230. Bechtel Hanford, Inc. Richland, Washington. April 1996.

Freeman-Pollard et al. 1994. J.R. Freeman-Pollard, J.A. Caggiano, and S.J. Trent. Engineering Evaluation of the GAO-RCED-89-157, Tank 241-T-106 Vadose Zone Investigation. BHI-00061. Bechtel Hanford, Inc. Richland, Washington. 1994.

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

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

Hanlon 1999. Hanlon, B.M. Waste Tank Summary Report for Month Ending December 31, 1998. WHC-EP-0182-129. Westinghouse Hanford Company, Richland, Washington. February 1999.

Hoitink and Burk 1994. Hoitink, D.J. and K.W. Burk. Climatological Data Summary 1993 with Historical Data. PNL-11107. Pacific Northwest National Laboratory. Richland, Washington. 1994.

Holzworth 1972. Holzworth, G.C. Mixing Heights, Windspeed, and Potential for Urban Air Pollution Throughout the Continuous United States. U.S. Environmental Protection Agency. Research Triangle Park, North Carolina. 1972.

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

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

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

Johnson and Chou 1998. Johnson, V.G. and C.J. Chou. Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas S-SX at the Hanford Site. PNNL-11810. Prepared for the U.S. Department of Energy. 1998.

Jones et al. 1998. Jones, T.E., R. Khaleel, D.A. Myers, J.W. Shade, and M.I. Wood. A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination. HNF-2603. Lockheed Martin Hanford Corporation. Richland, Washington. December 1998.

Khaleel and Freeman 1995. Khaleel, R. and E.J. Freeman. Variability and Scaling of Hydraulic Properties for 200 Area Soils, Hanford Site. WHC-EP-0883. Westinghouse Hanford Company. Richland, Washington. 1995.

Kincaid et al. 1995. Kincaid, C.T., J.W. Shade, G.A. Whyatt, M.G. Piepho, K. Rhoads, J.A. Voogd, J.H. Westsik, Jr., M.D. Freshley, K.A. Blanchard, B.G. Lauzon. Performance Assessment of Grouted Double-Shell Tank Waste Disposal at Hanford. WHC-SD-WM-EE-004, Rev. 1. Westinghouse Hanford Company. Richland, Washington. 1995.

Lindsey 1999. Personal communication. Provided draft top of Carbonate drawing for Figure 2.10.

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

Lindsey and Law 1993. Lindsey, K.A. and A.G. Law. Geohydrologic Setting, Flow and Transport Parameters for the Single-Shell Tank Farms. WHC Internal Memo 81231-93-060. Westinghouse Hanford Company. Richland, Washington. 1993.

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

Myers et al. 1998. Myers, D.A., D.L. Parker, G. Gee, V.G. Johnson, G.V. Last, J. Serne, and D.J. Moak. Findings of the Extension of Borehole 41-09-39, 241-SX Tank Farm. HNF-2855. Lockheed Martin Hanford Corporation. Richland, Washington. 1998.

Neitzel 1997. Neitzel, D.A. (ed.). Hanford Site National Environmental Policy Act (NEPA) Characterization. Pacific Northwest National Laboratory. PNNL-6415, Rev. 9. Richland, Washington. August 1997.

Nelson and Knoll 1958. Movement of REDOX High-Level Waste into Soils. HW-58110 in Neilsen, E.H., ed. Tank 241-SX-108 Supporting Documentation-Miscellaneous Reports, Memoranda, and Data. WHC-MR-0300, Supplement 1. Westinghouse Hanford Company. Richland, Washington. 1992.

Newcomb et al. 1972. Newcomb, R.C., J.R. Strand, and F.J. Frank. Geology and Groundwater Characteristics of the Hanford Reservation of the U.S. Atomic Energy Commission, Washington. Paper 7171. U.S. Atomic Energy Commission. 1972.

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

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

PNL 1995. Hanford Site Environmental Report for Calendar Year 1994. PNL-10574. Pacific Northwest Laboratory. Richland, Washington. 1995.

PNL 1994. Hanford Site Climatological Data Summary, 1993, with Historical Data. PNL-9809. Pacific Northwest Laboratory. Richland, Washington. June 1994.

Price and Fecht 1976. Price, W.H. and K.R. Fecht. Geology of the 241-SX Tank Farm. ARH-LD-134. Atlantic Richfield Hanford Company. Richland, Washington. 1976.

Raymond and Shdo 1966. Raymond, J.E. and E.G. Shdo. Characterization of Subsurface Contamination in the SX Tank Farm. BNWL-CC-701. Battelle Northwest. Richland, Washington. June 1966.

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

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

Rockhold et al. 1995. Rockhold, M.L., M.J. Fayer, C.T. Kincaid, and G.W. Gee. Estimation of Natural Ground Water Recharge for the Performance Assessment of a Low-Level Waste Disposal Facility at the Hanford Site. PNL-10508. Pacific Northwest National Laboratory. Richland, Washington. 1995.

Sackschewsky et al. 1992. Sackeschwsky, M.R., D.S. Landeen, J.L. Downs, W.H. Rickard, and G.I. Baird. Vascular Plants of the Hanford Site. WHC-EP-0554. Westinghouse Hanford Company. Richland, Washington. July 1992.

Sisson and Lu 1984. Sisson, J.B. and A.H. Lu. Field Calibration of Computer Models for Application to Buried Liquid Discharges: A Status Report. RHO-ST-46P. Rockwell Hanford Operations. Richland, Washington. 1984.

Slate 1996. Slate, J.L. 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. 1996.

Smoot et al. 1989. Smoot, J.L., J.E. Szecsody, B. Sagar, G.W. Gee, and C.T. Kincaid. Simulations of Infiltration of Meteoric Water and Contaminant Plume Movement in the Vadose Zone at Single-Shell Tank 241-T-106 at the Hanford Site. WHC-EP-0332. Westinghouse Hanford Company. Richland, Washington. 1989.

Stone et al. 1972. Stone, W.A., D.E. Jenne, and J.M. Thorp. Climatology of the Hanford Area. BNWL-1605. Pacific Northwest National Laboratory. Richland, Washington. 1972.

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

WAC 173-160. Minimum Standards for the Construction and Maintenance of Wells. Washington Administrative Codes, as amended. Olympia, Washington.

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

WAC 173-303-646. Corrective Action. Dangerous Waste Regulations, Washington Administrative Code. Olympia, Washington. 1998.

Ward et al. 1997. Ward, A.L., G.W. Gee, and M.D. White. A Comprehensive Analysis of Contaminant Transport in the Vadose Zone Beneath Tank SX-109. PNNL-11463. Pacific Northwest National Laboratory. Richland, Washington. 1997.

Waugh et al. 1991. Waugh, W.J., M.E. Thiede, L.L. Cadwell, G.W. Gee, H.D. Freeman, M.R. Sackschewsky, and J.F. Relyea. Small Lysimeters for Documenting Arid Site Water Balance. In Proceedings of the Conference on Lysimeters for Evapotranspiration and Environmental Measurements. Irrigation Division. American Society of Civil Engineers. pp. 151-159. Honolulu, Hawaii. July 23-25, 1991.

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

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

WHC 1992b. Tank 241-SX-109 Leak Assessment. WHC-MR-0301. Westinghouse Hanford Company, Richland, Washington. August 1992.

WHC 1992c. Tank 241-SX-115 Leak Assessment. WHC-MR-0302. Westinghouse Hanford Company, Richland, Washington. November 1992.

WMN 1998a. Waste Management Northwest 1998, Sampling Services Procedures Manual. ES-SSPM-001. Waste Management Northwest, Richland, Washington. August 1998.

WMN 1998b. Waste Management Northwest 1998, Well Services Procedures Manual. ES-WSPM-001. Waste Management Northwest. Richland, Washington. February 1998.

Womack and Larkin 1971. Investigation and Evaluation of 102-BX Tank Leak. ARH-2035. Atlantic Richfield Hanford Company. Richland, Washington. 1971.

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 Blanks: Field blanks for water analyses consist of pure deionized, distilled water, transferred to a sample container at the site and preserved with the reagent specified for the analyses of interest. They are used to check for possible contamination originating with the reagent or the sampling environment.

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

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 boreholes will occur in the vicinity of the SX Tank Farm to meet the objectives of this investigation. Operations of the SX Tank Farm began in 1954, with the storage of reduction oxidation (REDOX) plant waste, first-cycle condensate waste, and REDOX high-level boiling waste in the tanks. During the 1960's and 1970's, many of the tanks developed leaks and were removed from service. Since that time, the contaminants in these leaks have migrated into the vadose zone and have contributed to groundwater contamination in the area. Various cribs, trenches, and French drains are located in the vicinity of the WMA S-SX (see Section 2.1) and also may have had an effect on the groundwater contamination.

Because of anomalous trends in technetium-99 and elevated specific conductance measurements near the WMA S-SX, a groundwater assessment program has been conducted. Based on the results of this groundwater assessment, corrective action has been required in accordance with proposed Tri-Party Change Control Form Number M-45-98-03 (DOE 1999a).

A.1.2 PURPOSE AND OBJECTIVE

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

- Installation of an exploratory borehole southwest of tank SX-115. Continuous driven split-spoon samples will be attempted from about 3 m (10 ft) below ground surface (bgs) to the top of the Ringold Formation. Two additional driven split-spoon samples will be attempted at the historic highwater mark and just above the water table in the capillary fringe zone. Drill cuttings will be collected where split-spoon samples are not taken. The water table is expected to be at 64 m (210 ft) bgs. Selected portions of the driven samples will be analyzed for their chemical, radiological, and physical characteristics. Drill cuttings will be analyzed for their chemical and radiological characteristics. A suite of geophysical surveys will be performed, and groundwater samples will be collected for chemical and radiological analysis. This borehole will require decommissioning. Following completion of groundwater sampling, the borehole will be decommissioned per Washington Administrative Code (WAC) requirements.

- Decommissioning of borehole 41-09-39 within the SX Tank Farm. This borehole was installed as a borehole during two separate drilling campaigns, one beginning in December 1996 in which the borehole was driven to 40.1 m (131.5 ft) with a closed-end steel casing and one beginning in September 1997 in which the borehole was deepened to 69 m (225 ft) with cable tool drilling method. The decommissioning will include a tracer test, borehole geophysical surveying, sidewall sediment sampling at selected intervals, and removal of temporary materials and proper sealing of the hole in accordance with WAC requirements.

- Sediment drive samples and drill cutting samples collected in conjunction with the installation of three proposed RCRA groundwater monitoring wells. The southern-most monitoring well (number 3) is proposed to be located about 50 m (164 ft) southeast of tank SX-113. From this well, continuous sediment drive samples from about 6 m (20 ft) bgs to refusal (anticipated to be near the top of the Ringold Formation) will be collected. Drill cuttings will be collected from refusal to the total depth of the water table. The other two proposed RCRA groundwater monitoring wells are located east of the S and SX Tank Farms, respectively. Drill cuttings will be collected from these two wells. Selected portions of the drive samples and cuttings will be analyzed for chemical and physical characteristics. A detailed description of the work associated with the installation of these monitoring wells is being developed and, once the Washington State Department of Ecology (Ecology) comments are incorporated, will supercede the draft Johnson and Chou (1999). Only details associated with sampling and analysis of sediment samples and cuttings are addressed in this SAP.

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

Part I – Installation of a new exploratory borehole (well number B8809)

Part II – Decommissioning of borehole 41-09-39 (well number 299-W23-234)

Part III – Sediment sampling performed in conjunction with the installation of three proposed RCRA groundwater monitoring wells.

Technical procedures or specifications that apply to this work include Waste Management Federal Services (WMFS) sampling and geophysical surveying procedures, Sample and Mobile Laboratories Procedures (WMFS 1997), and Vadose Zone Characterization at the Hanford Tank Farms, High-Resolution Passive Spectral Gamma-Ray Logging Procedures (DOE-GJPO 1995). 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 1998). 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 both vadose zone sampling and analysis and groundwater sampling and analysis. This SAP addresses the requirements of the vadose zone sampling and analysis; activities associated with groundwater sampling and analysis will be managed by the Hanford Groundwater Program and are described in Johnson and Chou (1999).

The quality assurance project plan (QAPjP), Appendix C of this work plan, is an integral part of the SAP and they must be used jointly. The QAPjP 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, is also critical during field sampling, because it specifies procedures for the occupational health and safety protection of project field personnel. The Data Management Plan, Appendix D, denotes the requirements for field and laboratory data storage.

PART I

INSTALLATION OF NEW BOREHOLE (WELL NUMBER B8809)

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

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

Project management controls field activities; however, there are no field activities for the project management task.

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 2b-Field Activities and Subtask 2c-Laboratory Analysis. The following subsections describe each of these subtasks.

A.3.1 FIELD ACTIVITIES (SUBTASK 2B 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, groundwater sampling, and reporting activities.

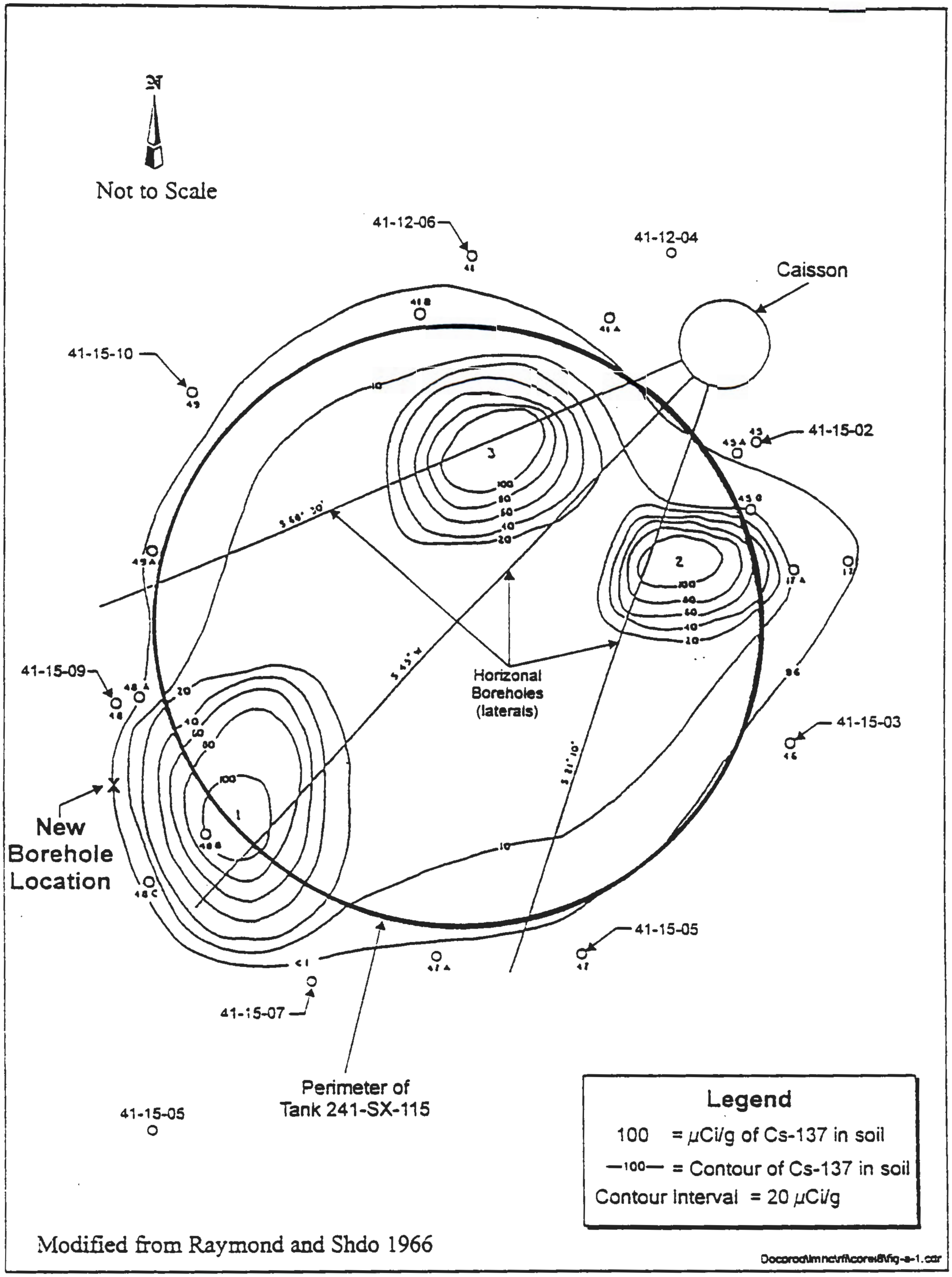
A.3.1.1 Drilling Activities

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 (WMFS 1998a). The work package will contain such information as sampling technique, radiation protection, and cuttings and air containment. 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 (ALARA) in compliance with regulatory requirements.

Current plans are to drill a vertical borehole, southwest of tank SX-115 within the SX Tank Farm. The location of the borehole is 3 m (10 ft) south of drywell 41-15-09 at coordinates Northing 134166.72 and Easting 566759.19, and is shown in Figure A.1. The boring will extend from the surface to just below the water table, which is approximately 64 m (210 ft) bgs to allow for groundwater sampling.

The borehole will be advanced using a drill and drive reverse air circulation dual-wall drilling method and split-spoon samplers (see Chapter 4.0 for contingencies on sample collection). No drilling fluid other than air will be introduced down the borehole.

Figure A.1. SX Tank Farm Borehole Sampling Locations



Split-spoon samplers will be 0.6 to 1.5 m (2 to 5 ft) in length, with a nominal 10-cm (4-in.) inside diameter. All split-spoon samples will be collected in advance of the casing being driven. The drill casing will be a nominal 25-cm (10-in.) outside diameter. For driven split-spoon samples attempted from 3 m (10 ft) to 12.2 m (40 ft) bgs, the drill pipe and conductor casing are to be advanced in 1.5-m (5-ft) intervals. For driven split-spoon samples attempted from 12.2 m (40 ft) to 50.3 m (165 ft) bgs (top portion of the Ringold Formation), the drill pipe and conductor casing will be advanced only as far as split-spoon samples have been collected or attempted. Standard techniques will be used to remove that portion of the sediment column that remains in the drill casing once it is driven to the sample depth. If refusal of the split-spoon sampler occurs, the hole will be drilled ahead 0.3 m (1 ft), and continuous split-spoon sampling will resume. From the depth of 50.3 m (165 ft) to total depth of the borehole, the drill pipe and conductor casing will be advanced while collecting drill cuttings, except at the historic high water level (approximately 56.4 m [185 ft] bgs) and at the capillary fringe zone (approximately 64 m [208 ft] bgs). The casing is to be driven to total sample depth and the hole is to be cleaned at the end of each day's drilling effort. All drilling tools are to be removed. All split-spoon samplers are to be used with new Lexan liners. Split-spoon samplers will be new or decontaminated before reuse. Procedures for decontamination of sampling equipment are contained in WP 2-2, "Field Cleaning and/or Decontamination of Equipment" (WMFS 1998b). One new, unused sampler will be retained in reserve and used for the last sampling episode where the water table may be penetrated.

The depth of the vadose zone boring will be to just below groundwater, unless perched water is encountered while drilling. Drilling will cease if saturated, contaminated water is encountered before reaching the unconfined aquifer, and a water sample will be collected for analysis. The borehole could be decommissioned at that depth. A waiver from Ecology would be required to continue the borehole past this level. If saturated sediments are encountered above the anticipated depth of the capillary zone (approximately 64 m [208 ft] bgs), drilling will be terminated and the borehole decommissioned with approved material, unless a waiver is granted by Ecology. In this case, decommissioning will commence immediately following final geophysical logging of the borehole. Based on a waiver from Ecology, the borehole will apply telescoping techniques (i.e., smaller drill pipe and conductor casing diameter inside existing drill pipe and conductor casing) at either the maximum gamma-emitting location or the bottom of the Plio-Pleistocene Unit.

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. Organic vapor monitors, hexavalent chromium test kits or other appropriate methods, including visual screening, also may be used for field screening.

In addition to the borehole geologic logging, radiation measurements will be made using hand-held instruments on each segment of sample recovered during sampling and on the drill cuttings during cleaning out the borehole. Blow count measurements will be collected during all drive samples collected while advancing the split-spoon sampler. 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 WMFS procedures.

If contamination is determined through daily geophysical surveying to be actively migrating along the bore, drilling will be stopped, and the data will be analyzed to determine if the migration is caused by drag down of the sediments or by the migration of contaminated water. If contaminated water is the cause of the migration, drilling will cease and the borehole will be sealed. If contamination is determined to be caused by dragdown, telescoping techniques of the drill pipe and conductor casing will be performed to stop dragdown and drilling will resume.

As a result of the first time use of the drill and drive drilling method in the tank farms, this endeavor may need modification based on permitting compliance with the Washington State Department of Health. Air used in the drilling process will need to be contained per Washington State Department of Health. Appropriate permits and Notice of Construction (NOC) permits will be acquired prior to drilling operations for inside the tank farm. The proposed drilling method will comply with the requirements of the Washington State Department of Health for the notice of construction permit and other pertinent requirements. The proposed drilling method will utilize double containment, negative pressure, and appropriate engineered systems to prevent possible contaminated air from being released to the environment.

An on-site geologist will geologically log the new borehole, based on drill cuttings and the split-spoon samples. Borehole geologic logs will be prepared in accordance with approved procedures. The geologic log will include lithologic descriptions, sampling intervals, Health Physics Technician (HPT) hand-held instrument readings, screening results, evidence of any alteration of sediments, and any general information the geologist thinks is pertinent to the characterization of subsurface conditions. Drill cuttings and split-spoon driven samples will be continually screened with hand-held instruments for radiation, volatile organic compounds and other compounds 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.

Sediment cuttings containing unknown, low-level mixed radioactive waste and/or hazardous waste will be contained, stored, and disposed of according to WMFS procedure WP 2-1 "Waste Management" and specified in the QAPjP and will be documented in the field activity reports. Sediment drill cuttings not used as samples will be disposed of in 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 HPT as elevated in radiological contaminants, instrument readings will be noted and the depth represented by those readings, and specific information concerning borehole completion.

The new borehole will be abandoned at a future date after completion of the geophysical surveying and groundwater sampling. 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 that work package. These procedures will comply with U.S. Environmental Protection Agency (EPA) requirements and Chapter 173-160 WAC.

A.3.1.2 Geophysical Surveying Activities

Downhole spectral-gamma or gross gamma geophysical logging will be conducted to ascertain the gamma-emitting radionuclide concentrations and assess contaminant drag-down during advancement of the casing. The spectral-gamma or gross gamma logging frequency will be directed by LMHC. The planning basis for spectral-gamma or gross gamma logging frequency will include logging every 6.1 to 9.2 m (20 to 30 ft) that the borehole is advanced. If the radiological screening performed by the site health physics technician indicates a zone of high contamination has been penetrated, a log should be run within 4.6 m (15 ft) of passing through that zone.

A full suite of geophysical logs should be run any time the casing size is changed and at the completion of the borehole. This will provide some flexibility and provide for logging on average every 2 days following Waste Management Northwest's (WMNW) planning basis of advancing the hole 3 m (10 ft) per day.

The following logging techniques will be used for the new 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 degree of saturation distribution
- Neutron-enhanced spectral gamma logging for correlation of high salt tank waste and moisture content with spectral gamma and neutron probes, respectively
- Infrared temperature gage for measuring sediment temperature.

The existing equipment and procedures for gross-gamma and spectral-gamma logging in use at the Hanford Site provide acceptable data (DOE-GJPO 1995).

The borehole will be decommissioned following completion of the groundwater sampling described in Section A.3.1.4. All steel casing will be removed and transferred to an appropriate disposal facility or controlled decontamination facility, and each boring will be pressure-grouted from the bottom up, using a Portland cement/bentonite slurry. The procedures will comply with EPA requirements and WAC 173-160.

A.3.1.3 Sediment Sampling Activities

Borehole sampling will be performed to define the depth of contamination. The borehole will serve to establish the general lithology of the sediments lying below the site and to give indications of how radionuclides and other contaminants have migrated. 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.

There is some question as to the geographical extent of the effect of the Hanford Site operations on sediment quality. There are uncertainties as to the extent of the effect of the site activities; therefore, a background sample (i.e., above the base of the tank) will be obtained from the drilling of the borehole at SX Tank Farm. As with all samples, this sample will be field screened using alpha, beta, gross gamma, and spectral gamma scans. The results from this sample will be evaluated and compared to data from onsite borings to determine whether there has been any significant impact on the sediment below the WMA S-SX from the Hanford Site operations. Because the background sample will be taken 9 m (30 ft) bgs, any surface contamination present in the drilling location is not expected to alter the constituent results.

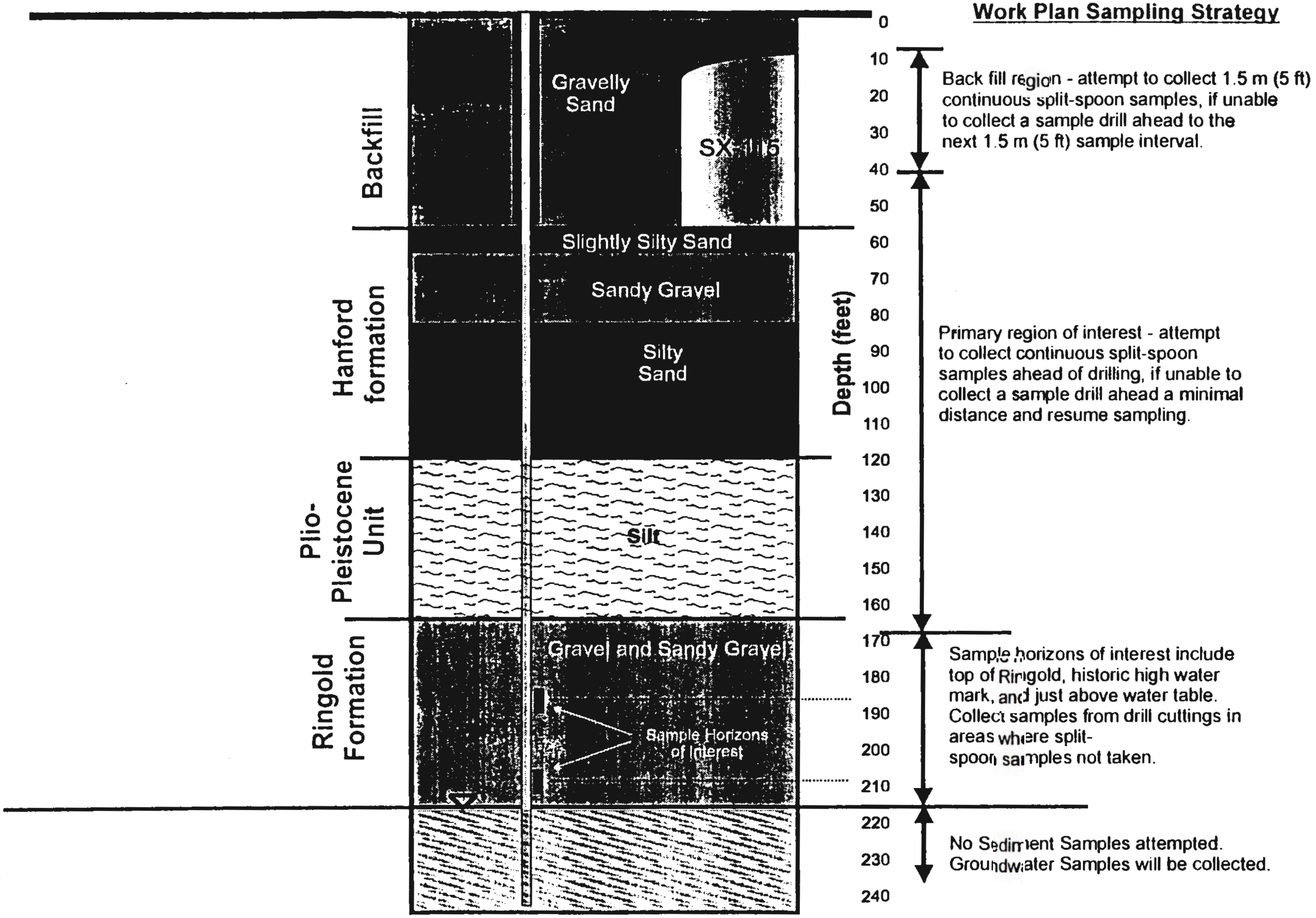
For the new borehole, split-spoon drive sampling will begin at 3 m (10 ft) bgs to allow for a limited open borehole and placement of a sealed surface casing to prevent air contamination from occurring. Drilling and sampling will continue until groundwater is reached. Figure A.2 shows the proposed sampling strategy for the new borehole. The boring will extend to just below the water table to permit installation of the Kabis sampler for groundwater sampling in accordance with guidance from the Hanford Groundwater Program.

After the split-spoon sediment samples and drill cutting samples are screened, these samples will be transported to the Pacific Northwest National Laboratory (PNNL) (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 (QC) samples also will be submitted for the full spectrum of chemical and radionuclide analyses. These QC samples will consist of the following (see Section C.9.0):

- 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.
- Field blanks: One blank per borehole drilling activity.
- Equipment rinseate blanks: One equipment rinseate blank per borehole drilling activity or, if multiple types of samplers are used, once per type of sampler.
- Volatile organic analysis (VOA) trip blanks: One trip blank per batch of sample containers shipped to the sampling facility. The trip blanks will be analyzed for VOAs only.

Figure A.2. New Borehole Sampling Strategy



Work Plan Sampling Strategy

Back fill region - attempt to collect 1.5 m (5 ft) continuous split-spoon samples, if unable to collect a sample drill ahead to the next 1.5 m (5 ft) sample interval.

Primary region of interest - attempt to collect continuous split-spoon samples ahead of drilling, if unable to collect a sample drill ahead a minimal distance and resume sampling.

Sample horizons of interest include top of Ringold, historic high water mark, and just above water table. Collect samples from drill cuttings in areas where split-spoon samples not taken.

No Sediment Samples attempted. Groundwater Samples will be collected.

Docprod\mhc\rfi\corel8\Fig-A-2.cdr

A.3.1.4 Groundwater Sampling Activities (Task 3 of Chapter 5.0)

The sampling of groundwater will be conducted by the Hanford Groundwater Program as described in Johnson and Chou (1999).

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 per approved WMFS procedures. 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 completion.

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

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

The following sections describe the laboratory analyses required for the samples collected from the new borehole. Laboratory analyses will be performed on sediment samples in accordance with this SAP. Groundwater analyses will be governed by Johnson and Chou (1999).
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" (WMFS 1998a) and in accordance with Chapter C.4.0 of the QAPjP (Appendix C). All samples for laboratory analysis will be transported under chain of custody in accordance with SP 1-1, "Chain of Custody/Sample Analysis Request" (WMFS 1998a) and Chapter C.5.0 of the QAPjP.

Sediment cuttings containing low-level and mixed radioactive waste will be contained, stored, and disposed of according to procedures to be developed. Sediment cuttings containing hazardous waste and those containing unknown waste will be contained and disposed of in accordance with WP 2-1, "Waste Management" (WMFS 1998b) at the Mixed Waste Burial Grounds. Storage of archive samples will be done until approval to dispose of the samples is provided by the Lockheed Martin Hanford Corporation (LMHC) technical representative.

A.3.2.1 Sediment Sample Analysis

Although geologic logging is conducted in the field as a part of tank farm operations, geologic logging for this borehole event will be conducted at the laboratory. The same process as was used with the borehole 41-09-39 extension should be used in this event. Specifically, once sample material from the new 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, when the split-spoon sleeves are opened, the geologic structure and make-up 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.

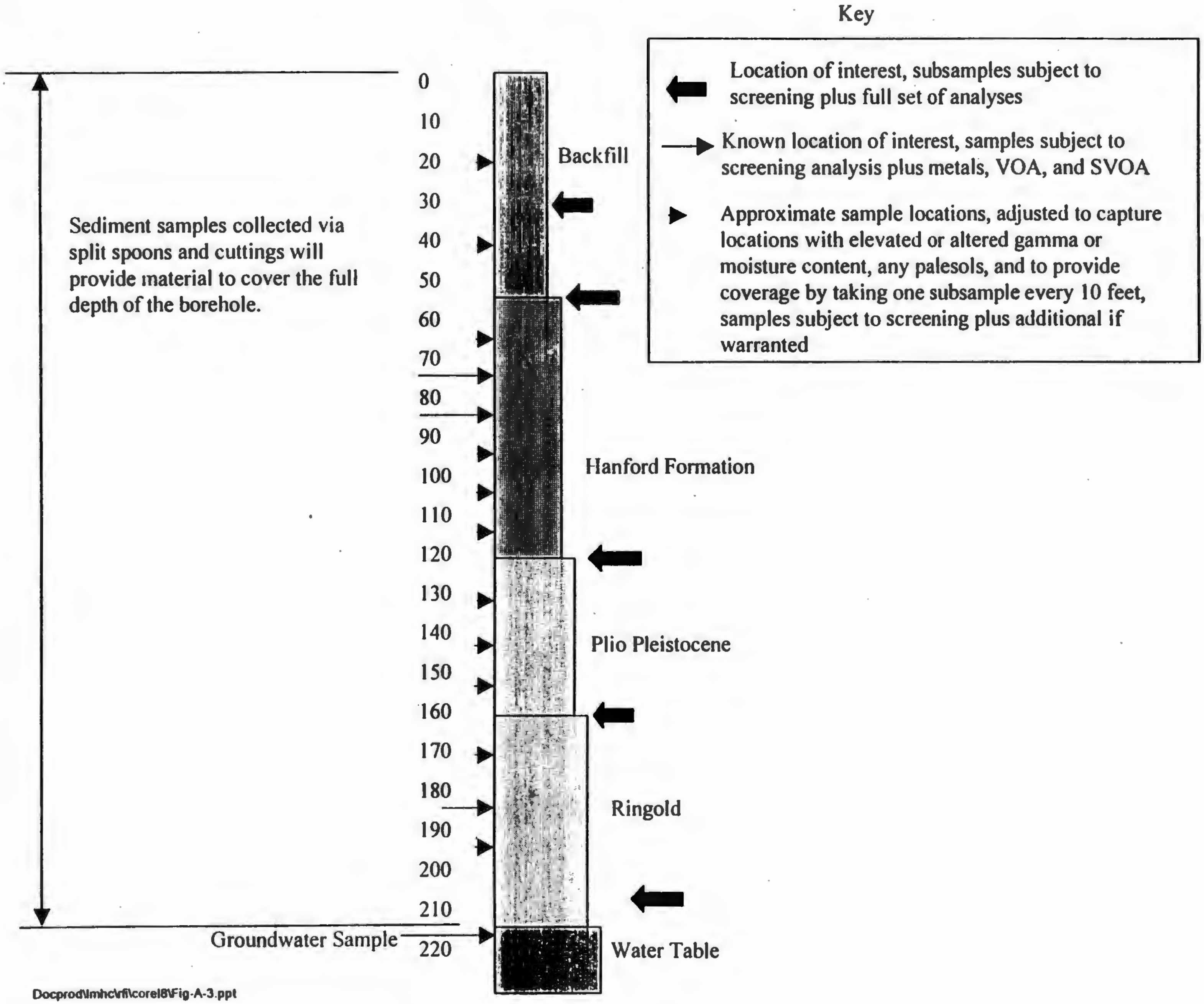
Sediment subsamples for laboratory analysis will be defined by location in the sample after the field screening and geologic logging have been completed and indication of contamination locations have been identified. Approximately 22 sediment subsamples from the borehole will be chosen for screening analysis. The following criteria will be used to identify subsamples for laboratory analysis based on concurrence with Ecology:

- One background subsample will be taken at 9 m (30 ft) bgs.
- One subsample will be taken at 17 m (55 ft) bgs, at the level of the tank bottom.
- Two 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, and one subsample will be obtained at the Ringold Formation and Plio-Pleistocene Unit contact.
- One subsample will be taken just above the water table in the capillary fringe zone.
- One subsample will be taken at the historic high water table at approximately 56 m (185 ft) bgs.
- Subsamples will be taken of any paleosols seen in the split-spoon drive samples.
- Subsamples will be taken in locations where elevated or altered gamma surveying or moisture content was measured during the geological and geophysical borehole logging process.
- 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.

Figure A.3 shows the subsamples identified for laboratory analyses. All subsamples shall undergo screening analyses, which consist of nitrate analysis by the colorimetric method, pH measurement, electrical conductance measurement, and gamma energy analysis (GEA). These analyses, along with the gamma surveying and moisture content measurements performed during the field geophysical surveys and the laboratory 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., ICP or VOA), all constituents identified will be reported. Regulatory hold times shall be met, where appropriate.

Because the purpose of the new borehole analysis is to both 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 organic, inorganic, and radiochemical constituents in full conformance with HASQARD and with no modifications to methods (as defined by HASQARD) without concurrence from the LMHC 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 QC criteria do not apply to this level, compliance with the other quality assurance (QA) requirements of HASQARD must still be met and research analysis will be initiated only following review and approval of the activities by the LMHC technical representative.

Figure A.3. SX-115 Borehole Subsample Analyses Strategy



Key

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

Known location of interest, samples subject to screening analysis plus metals, VOA, and SVOA

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

Sediment samples collected via split spoons and cuttings will provide material to cover the full depth of the borehole.

Docprod\lmhc\rfi\corel8\Fig-A-3.ppt

Table A.1. Constituents and Methods for New Borehole Sediment Sample Analyses and Borehole 41-09-39 Decommissioning Samples

Analysis/ Constituent	Preparation Method	Preparation Procedure Number	Analytical Method	Analytical Procedure Number
^{137}Cs	Bulk sediment	N/A	GEA	PNL-RRL-001
^{14}C	Bulk sediment	N/A	Total combustion	ASTM D 4129-82
	Water extract	Methods of Soil Analysis, Part 2; 62-1.3.2.2	LSC method in review based on:	PNL-ALO-476
^{152}Eu	Bulk sediment	N/A	GEA	PNL-RRL-001
^{237}Np ^{239}Pu ^{240}Pu ^{241}Am	Acid leach	PNL-ALO-106	ICP-MS	PNL-ALO-211
	Fusion	PNL-ALO-235		
^{90}Sr	Acid leach	PNL-ALO-106	LSC	PNL-ALO-476
	Fusion	PNL-ALO-235		
^{60}Co	Bulk sediment	N/A	GEA	PNL-RRL-001
^{99}Tc	Acid leach	PNL-ALO-106	ICP-MS	PNL-ALO-211
	Fusion	PNL-ALO-235		
^{3}H	Water extract	Methods of Soil Analysis, Part 2; 62-1.3.2.2	LSC	PNL-ALO-476
^{129}I	Acid leach	PNL-ALO-106	ICP-MS	PNL-ALO-211
^{79}Se	Note 2	Note 2	Note 2	Note 2
Total uranium	Water extract	Methods of Soil Analysis, Part 2; 62-1.3.2.2	ICP-MS	PNL-ALO-211
	Fusion	PNL-ALO-235		
Metals	Water extract	Methods of Soil Analysis, Part 2; 62-1.3.2.2	ICP-MS	PNL-ALO-211
	Acid leach	PNL-ALO-106		
	Fusion	PNL-ALO-235		
VOA	Bulk sediment	Note 1	GC/MS	SW846-8260
SVOAs with TICs	Bulk sediment	Note 1	CG/MS	SW846-8270
pH	Water extract	Methods of Soil Analysis, Part 2; 62-1.3.2.2	Electrometric	Methods of Soil Analysis; 60-3.4
Anions	Water extract	Methods of Soil Analysis, Part 2; 62-1.3.2.2	IC ISE Colorimetric	PNL-ALO-212 US EPA Method 300.0A Orion-720a Hach procedure

Table A.1. Constituents and Methods for New Borehole Sediment Sample Analyses and Borehole 41-09-39 Decommissioning Samples (cont'd)

Analysis/ Constituent	Preparation Method	Preparation Procedure Number	Analytical Method	Analytical Procedure Number
Cation exchange capacity	Bulk sediment	N/A	Cation exchange capacity	Methods of Soil Analysis Part 2; 9-3.1
Particle size distribution	Bulk sediment	N/A	Particle size distribution	ASTM D 422-63 ASTM D 854-83
Mineralogy	Bulk powder/clay	JEA-2. Rev. 0	XRD/SEM/TEM	JEA-3. Rev. 0
Electrical conductance	Water extract	Methods of Soil Analysis. Part 2; 62-1.3.2.2	Electrometric	PNL-MA-567-FA-2
Moisture content	Gravimetric	N/A	Moisture content	PNL-MA-567-SA-7
Matric potential	Filter paper suction	N/A	Matric potential	PNL-MA-567-SA-10
K_d	Bulk sediment	N/A	Methods for determining radionuclide retardation factors, 1980	PNL-3349 USC-70
Bulk density	Gravimetric/volume	N/A	Bulk density	PNL-MA-567-SA-8
Moisture retention	Bulk sediment	N/A	Moisture retention	ASTM D 2325-68
Saturated hydraulic conductivity	Bulk sediment	N/A	Saturated hydraulic conductivity	ASTM D18.21 (draft in review) Methods of Soil Analysis. Part 2: 13-3.2 and 13-3.3

Notes:

GEA = gamma energy analysis
IC = ion chromatography
ISE = ion selective electrode
LSC = liquid scintillation
SEM = scanning electron microscopy
SVOA = semi-volatile organic analysis
TEM = transmission electron microscopy
TIC = tentatively identified compounds
TOC = total organic carbon
VOA = volatile organic analysis
XRD = x-ray diffraction

Note 1: Preparation/extraction procedures for VOA and SVOA analysis will depend on the types of organic compounds present in the sediment.

Note 2: Procedures for analysis of ^{79}Se are being prepared: this analysis does not apply to the new borehole.

The background sample, backfill – Hanford formation contact sample, the two samples obtained at the Hanford formation and Plio-Pleistocene Unit contact, and the Plio-Pleistocene Unit and Ringold Formation contact, and the sample obtained just above the water table in the capillary fringe zone will be analyzed for the following constituents:

- Gamma-emitting radioisotopes by gamma energy analysis (GEA)
- Carbon-14
- Metals and radioisotopes by inductively coupled plasma–mass spectroscopy (ICP-MS)
- Volatile and semi-volatile organic compounds, including tentatively identified compounds
- Anions
- Tritium and strontium-90 by the liquid scintillation (LSC) method
- Particle size distribution.

The remaining subsamples will be analyzed for specific constituents listed in Table A.1 depending on the results of the nitrate, electrical conductivity, 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. The screening criteria and associated analytical requirements are identified as follows.

- Gamma-emitting radioisotopes by GEA
- Carbon 14
- Metals and radioisotopes by ICP-MS
- Tritium and strontium 90 by the LSC method
- Particle size distribution
- Volatile and semi-volatile organic analysis, including tentatively identified compounds.

A minimum of two subsamples collected within the Hanford formation will be analyzed for volatile and semi-volatile organic compounds, including tentatively identified compounds and metals.

The data obtained from the above analyses will be used to evaluate the location of contamination plumes in the sediment column. If isolated peaks or unusual results are found, additional samples from the archived drive sample may be obtained and analyzed. 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 PNNL geochemist, with concurrence from the LMHC technical representative and Ecology. The following analyses would be performed as additional analyses:

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

Table A.1 identifies 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 (ASTM) standards. The requested constituents may be analyzed by laboratory-specific procedures, provided that the procedures are validated and conform to HASQARD. Both the SW-846 (EPA 1986) methods and the PNNL methods listed in Table A.1 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 QAPjP (Appendix C).

A.3.2.2 Groundwater Sample Analysis (Task 3 of Chapter 5.0)

If the new borehole penetrates the groundwater table, samples of groundwater will be collected and analyzed in accordance with guidance provided in Stewart (1997).

PART II

DECOMMISSION OF BOREHOLE 41-09-39 (WELL NUMBER 299-W23-234)

The following is a discussion of the field tasks and associated subtasks required for the sampling, sample analysis, and decommissioning associated with the existing borehole 41-09-39.
The tasks are generally parallel to those addressed for the new borehole, except additional detail is available concerning field implementation of the work.

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

Project management controls field activities; however, there are no field activities associated with the project management task.

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

As with installation of the new borehole, the geologic and vadose zone investigation task for the decommissioning has four subtasks: Subtask 2a-Data Compilation (no associated field activities), Subtask 2b-Field Activities, Subtask 2c-Laboratory Analysis, and Subtask 2d-Geologic Data Evaluation (no associated field activities). The following subsections describe each of the subtasks with a field activity component.

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

The field activities addressed in this subtask that are required to support the geologic and vadose zone investigation are groundwater sampling, tracer injection, temporary casing removal, geophysical sampling, sediment sampling (sidewall), and reporting. There are some uncertainties associated with the decommissioning and sampling that may require in-field modification. However, in an effort to anticipate the many details involved in the decommissioning, a stepwise approach has been developed as follows.

A.5.1.1 Removal of a Kabis sampler stuck in the well screen

The Kabis sampler is 10.2 cm (4 in.) in diameter and is assumed to be stuck at the top of the 7.6-cm (3-in.) well screen section. The sampler will be fished using appropriate techniques. The sampler, if damaged or otherwise unusable, will be packaged and disposed of properly. After removing the sampler; the 11.43-cm (4.5-in.) casing will be brushed and swabbed to improve the ability to gather high-purity germanium (HPGe) logging runs.

A.5.1.2 Injection of tracer into the aquifer

The purpose of the tracer injection is to measure direction and flow rate of the groundwater from the center of the farm to monitoring wells surrounding the 241-SX tank farm. The tracer is sodium bromide powder dissolved in 15.140 L (4,000 gal) of water to obtain a 50-ppm bromide solution. The screen assembly will remain in the borehole to ensure that the hole stays open and to provide better control over the injection zone and the rate of injection for the tracer test.

Removal of the screen could cause unknown risk, keep personnel in the radiation zones longer, and may create down hole conditions that could prevent completion of tracer testing and complicate the decommissioning process. A variance request to leave the screen in the borehole will be obtained from Ecology.

A.5.1.3 Removal of the 11.43-cm (4.5-in.) outer diameter temporary casing

The total 11.43-cm (4.5-in.) outside diameter casing to be removed is 63.4 m (208 ft). The casing shoe has a 13-cm (5-in.) outside diameter. No sampling is required in the 68.6 to 39.6 m (225 to 130 ft) bgs interval. Abandonment of the interval will be in compliance with WAC 173-160 requirements.

A.5.1.4 Remove the 17.8-cm (7-in.) outside diameter steel casing and sample borehole sediments as casing is being withdrawn using a sidewall sampling device as specified in the DQO. Decommission the borehole according to WAC-173-160 requirements.

Sixteen sample locations have been identified in accordance with the data quality objective (DQO) process. Prior to sample collection, comparison of the geophysical surveys obtained from Section A.5.1.5 to the surveys utilized in the DQO meeting will be done to verify sample locations. If the geophysical surveys indicate movement of the gamma contamination or changes in moisture content the sample horizons shall be adjusted with the concurrence of the LMHC technical representative. The locations are identified in Table A.2. Three samples will be taken in a 120-degree radial pattern at each sample horizon at the bottom of the 11.43-cm (4.5-in.) casing for a total of 48 aliquots. Samples will be retrieved using a sidewall sampler shown in Figure A.4. The device consists of a rigid polyvinyl chloride (PVC) liner with a bottom guide shoe and a guide tube that directs an elastomer-covered tight-coiled spring with a drive sample barrel approximately 60° to the drill rod (Figure A.4). The tool is centered in the casing by the stabilizer drive shaft. The rod is pushed and rotated, which directs the bit through the guide shoe and tube out to the formation wall. Continued pushing and rotation fills the sample barrel with approximately 100 g of side wall material. The bit and drive sample barrel is pulled out of the guide tube and brought to the surface for sample collection.

All sample tubes will be sleeved and initial counting will be performed by a health physics technician to determine final handling protocol. All samples will be the responsibility of WMFS. Work will be conducted under existing tank farm wind restrictions. Sampling, packaging, and disposal requirements are provided in Appendix C.

It may be difficult to obtain samples from locations where the geologic medium is characterized as coarse. If sampling the sidewall produces no sample or limited sample collection as a result of sidewall collapse or poor retrieval as a result of field conditions, a split-spoon sample will be collected if sidewall collapse occurs. If limited sample volume collection occurred, another sample will be attempted at an appropriate location above the first attempted sample location, unless interference will occur for the next specified sample.

Table A.2. Sample Number, Sample Interval and Geologic Medium for Sampling During Decommissioning of Borehole 41-09-39 as Determined in the DQO Process

Sample Number	Sample interval bgs (ft)[1]	Geologic Medium
1	39.9 - 40.2 m (131 - 132)	Plio-Pleistocene - silt
2	35.7 - 36.0 m(117- 118)	Silty sand - Hanford formation
3	34.1 - 34.4 m(112- 113)	Silty sand - Hanford formation
4	32.9 - 33.2 m (108- 109)	Silty sand - Hanford formation
5	31.1 - 31.4 m (102- 103)	Silty sand - Hanford formation
6	29.0 - 29.3 m (95 -96)	Sandy gravel - Hanford formation
7	27.1 - 27.4 m (89 - 90)	Sandy gravel - Hanford formation
8	25.0 - 25.3 m (82 - 83)	Gravelly sand - Hanford formation
9	24.1 - 24.4 m (79 - 80)	Gravelly sand - Hanford formation
10	22.6 - 22.9 m (74 - 75)	Gravelly sand - Hanford formation
11	21.0 - 21.3 m (69 - 70)	Gravelly sand - Hanford formation
12	19.8 - 20.1 m (65 - 66)	Slightly silty sand - Hanford formation
13	18.6 - 18.9 m (61 - 62)	Slightly silty sand- Hanford formation
14	17.4 - 17.7 m (57 - 58)	Slightly silty sand- Hanford formation
15	13.7 - 14.0 m (45 - 46)	Gravelly sand - original backfill Sample will be as a clean control
16	7.6 - 7.9 m (25 - 26)	Gravelly sand - original backfill Sample will be as a clean control

[1] Subject to change based on new geophysical surveying.

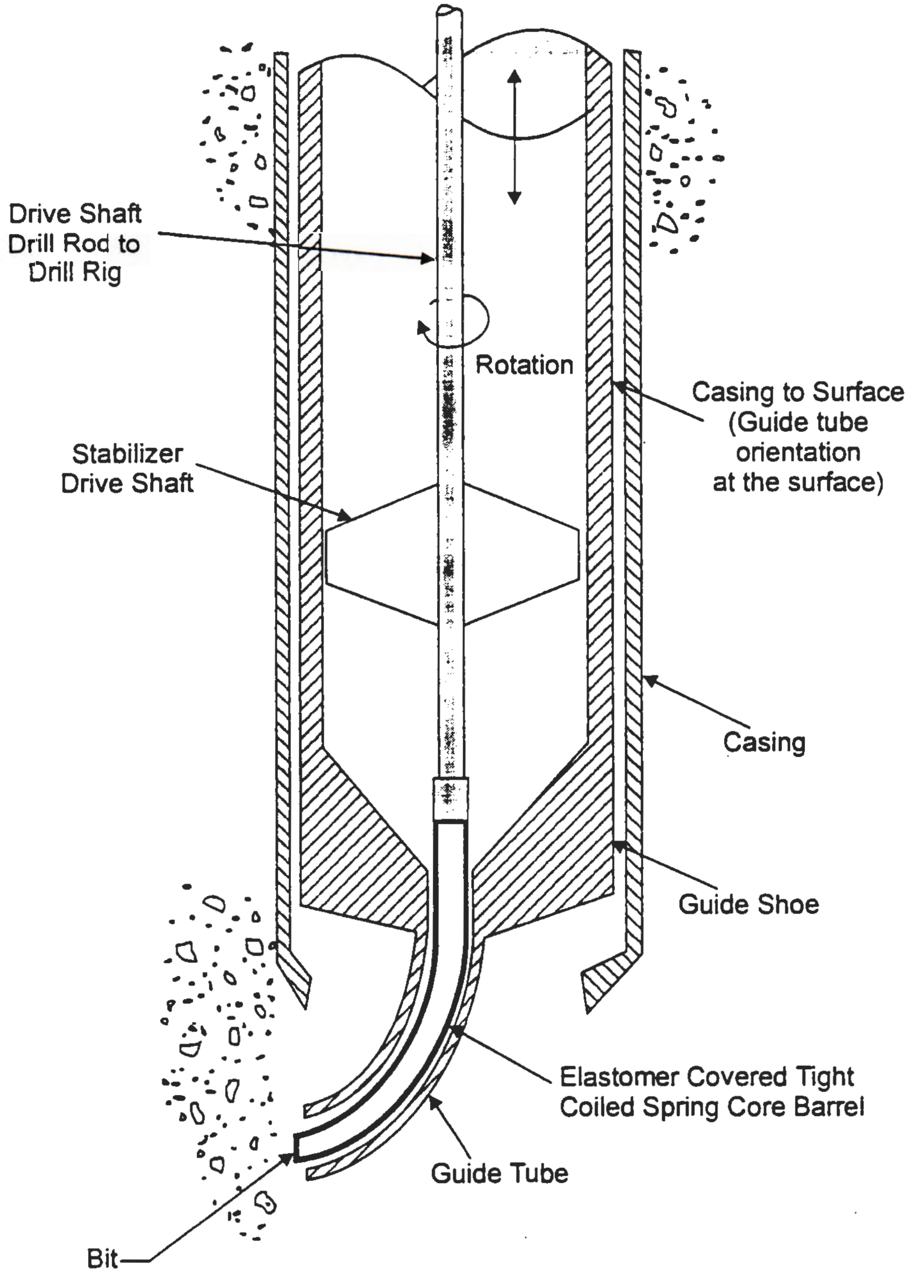
A.5.1.5 Field Quality Control

After the samples are screened, these samples will be transported to the PNNL (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 QC samples also will be submitted for the full spectrum of chemical and radionuclide analyses. These QC samples will consist of the following (see Section C.9.0):

- 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.
- Field blanks: One blank per borehole drilling activity.

Figure A.4. Sidewall Sampling Device for Borehole 41-09-39



docprod\mhc\rf\corel8\fig-a-4.cdr

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

- VOA trip blanks: One trip blank per batch of sample containers shipped to the sampling facility. The trip blanks will be analyzed for VOAs only.

A.5.1.6 Geophysical Surveying Activities

Prior to abandonment, borehole 41-09-39 will be geophysically surveyed prior to removal of the 11.43-cm (4-in.) casing and in the upper portion of the borehole prior to removal of the 17.8-cm (7-in.) casing to provide additional characterization information to supplement the sediment sampling data for the entire borehole. After the initial geophysical survey for the entire borehole, downhole spectral gamma geophysical surveying will be conducted on a daily basis to ascertain the gamma-emitting radionuclide concentration in the surrounding sediments during the abandonment process. The following geophysical surveying techniques will be used during the decommissioning of borehole 41-09-39:

- Gross-gamma logging to identify confining layers and for stratigraphic correlation

- Spectral-gamma logging for measuring the distribution of selected radionuclides

- Neutron log for measuring the saturation distribution

- Neutron enhanced spectral gamma logging for correlation of high salt tank waste and moisture content with spectral gamma and neutron probes, respectively

- Infrared temperature gage for measuring sediment temperature (this logging will be conducted both inside and outside the conductor casing for future correlation analysis).

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

After the decommissioning, all steel casing will be removed and transferred to an appropriate disposal facility or controlled decontamination facility.

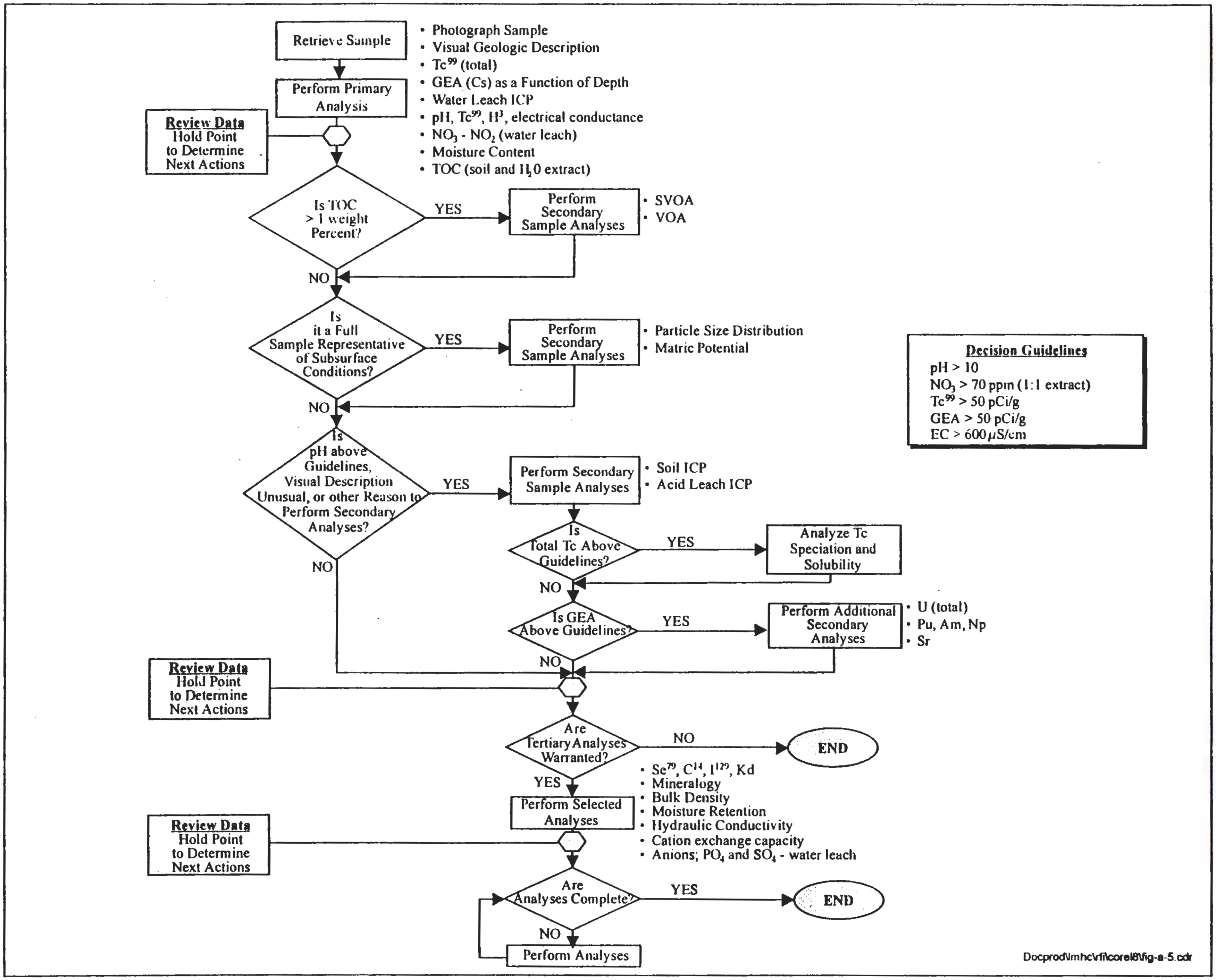
A.5.2 LABORATORY ANALYSIS (SUBTASK 2C OF CHAPTER 5.0)

The following sections describe the laboratory analyses required for the samples collected from the new decommissioning of borehole 41-09-39.

A.5.2.1 Borehole 41-09-39 Decommissioning Sediment Sample Analysis Requirements

A total of 16 sample locations have been identified for the decommissioning of borehole 41-09-39. Three aliquots will be attempted in a 120° radial pattern at each sample horizon. Once received at the laboratory, these samples shall undergo the analysis scheme identified in Figure A.5, using the analytical methods listed in Table A.1. This analysis event is expected to be highly sample-limited. Therefore, hold points have been inserted into the process to allow the laboratory and LMHC technical staff to collaborate and review data before each new round of analyses. Analyses may be reprioritized because of the results found from other measurements.

Figure A.5. Analytical Scheme for Analysis of Borehole 41-09-39 Samples



Based on the results of the primary analyses, spectral gamma surveys, and moisture content measurements performed during the field geophysical surveys and the geologic logging and field notes, geological technical experts, LMHC technical staff, the laboratory technical staff, and decision-makers (Ecology and DOE) will convene to determine what analyses should be conducted. Some of the determining criteria will be the amount and integrity of the remaining sample, primary analytical results, and regulatory requirements. Based on these decisions, the secondary and tertiary analyses will be performed.

A.5.2.2 Borehole 41-09-39 Groundwater Analyses (Task 3 of Chapter 5.0)

The collection and analysis of groundwater samples from 41-09-39 will be completed before initiating decommissioning activities described in this work plan. Therefore, details of this work are not addressed in this SAP. Information regarding groundwater analyses may be found in Johnson and Chou (1999).

PART III

SAMPLING PERFORMED IN CONJUNCTION WITH THE INSTALLATION OF THREE RCRA GROUNDWATER MONITORING WELLS

A.6.0 PROPOSED RCRA GROUNDWATER MONITORING WELL SEDIMENT SAMPLE ANALYSIS (SUBTASK 2B OF CHAPTER 5.0)

Continuous split-spoon driven samples and drill cutting samples will be collected in conjunction with the installation of three RCRA groundwater monitoring wells. The southern-most monitoring well is to be located about 50 m (164 ft) southeast of tank SX-113. From this well, continuous sediment split-spoon driven samples from about 6 m (20 ft) bgs to refusal (anticipated to be near the top of the Ringold Formation) will be collected. Drill cuttings will be collected from refusal to the total depth of the water table. The other two RCRA groundwater monitoring wells are located east of the S and SX Tank Farms respectively. Drill cuttings will be collected from these two wells. Selected portions of the driven samples and cuttings will be analyzed for its chemical and physical characteristics. A detailed description of the work associated with the installation of these monitoring wells is being developed and, once Ecology comments are incorporated, will supercede the draft Johnson and Chou (1999). Only details associated with analysis of sediment split-spoon driven samples and cuttings are addressed in this SAP.

Continuous driven samples will be taken from the vadose zone during construction of one well (southernmost), and the samples will be made available for hydrologic properties analysis. The analyses required for this sample are listed in Table A.3.

Table A.3. Required Analyses on RCRA Well Sediment Samples

Analysis/ Constituent	Preparation Method	Preparation Procedure Number	Analytical Method	Analytical Procedure Number
pH	Water extract	Methods of Soil Analysis, Part 2: 62-1.3.2.2	Electrometric	Methods of Soil Analysis: 60-3.4
Particle size distribution	Bulk sediment	N/A	Particle size distribution	ASTM D 422-63 ASTM D 854-83
Moisture Content	Gravimetric	N/A	Moisture content	PNL-MA-567-SA-7
Matric Potential	Filter paper suction	N/A	Matric potential	PNL-MA-567-SA-10
Bulk density	Gravimetric/volume	N/A	Bulk density	PNL-MA-567-SA-8
Moisture retention	Bulk sediment	N/A	Moisture retention	ASTM D 2325-68
Saturated hydraulic conductivity	Bulk sediment	N/A	Saturated hydraulic conductivity	ASTM D 18.21 (draft in review) Methods of Soil Analysis, Part 2: 13-3.2 and 13-3.3

Table A.3. Required Analyses on RCRA Well Sediment Samples (cont'd)

Analysis/ Constituent	Preparation Method	Preparation Procedure Number	Analytical Method	Analytical Procedure Number
Anions	Water extract	Methods of Soil Analysis. Part 2: 62-1.3.2.2	IC	PNL-ALO-212 US EPA Method 300.0A
			ISE	Orion-720a
			Colorimetric	Hach procedure
Metals	Water extract	Method of Soil Analysis. Part 2: 62-1.3.2.2	ICP-MS	PNL-ALO-211
	Acid leach	PNL-ALO-106		
	Fusion	PNL-ALO-235		
Cation exchange capacity	Bulk sediment	N/A	Cation exchange capacity	Methods of Soil Analysis Part 2: 9-3.1

Samples for analysis will be from each stratigraphic unit, stratigraphic contacts, weathered bedding structures and lithologic facies changes.

A.7.0 REFERENCES

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

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

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

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

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

Stewart 1997. Change Authorization #1: Work Order BE2822 and Sampling Plan for Borehole 41-09-39, Tank SX-109. Letter from D.L. Stewart to A.T. Broady. December 23. 1997.

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

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

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

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

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

This page intentionally left blank

APPENDIX B

HEALTH AND SAFETY PLAN FOR THE PRELIMINARY SITE-SPECIFIC SST PHASE 1 RFI/CMS WORK PLAN ADDENDUM FOR WMA S-SX

This page intentionally left blank

B.1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS

B.1.1 INTRODUCTION

The purpose of this Health and Safety Plan (HSP) is to establish standard health and safety procedures for Lockheed Martin Hanford Corporation (LMHC) employees and contractors engaged in Resource Conservation and Recovery Act of 1976 (RCRA) facility investigation activities in and near the vicinity of the Waste Management Area (WMA) S-SX. These activities will include surface investigation, drilling and sampling boreholes, environmental sampling in areas of known chemical and radiological contamination and decommissioning of borehole 41-09-39. The objectives and a more detailed description of the tasks that will be performed for the investigation is provided in Section 5.1 and the Sampling and Analysis Plan (Appendix A). Appropriate site-specific safety documents (e.g., Hazardous Waste Operations Permit [HWOP] and Radiation Work Permit [RWP] will be written for each task or group of tasks.

All employees of LMHC or other contractors who are participating in onsite facility investigation activities shall do the following.

- Read and document having read the HSP and attend a pre-job safety meeting to review and discuss the HSP.
- Follow all health and safety procedures specified in this document and in the applicable HWOP and RWP.

A mandatory 'tailgate' safety meeting will be held before startup each day. Additional tail-gate safety meetings or safety briefings will be held any time it is deemed necessary by the site safety officer, the health physics technician, or the field team leader. Employees are encouraged to bring any questions or concerns to the attention of the field team leader, site safety officer, or a health physics representative.

The information in this HSP provides a reference for developing site- and task-specific HWOPs before engaging in onsite activities. The HWOP will identify the specific hazards and procedures for the site and associated tasks. The HWOP will include the following information:

- Inventory of suspected chemical and/or radiological hazards with associated Material Safety Data Sheets (MSDS)
- Discussion of existing and potential physical hazards
- Specific monitoring equipment and methods to evaluate hazardous contaminants
- Methods for mitigating known and potential site-specific hazards

- Special medical surveillance or training needs based on specific hazards
- Site-specific decontamination procedures.

Each HWOP must be signed by all involved project personnel. Each HWOP will be reviewed and approved by: the operable unit technical lead, the field team leader, the site safety officer, Industrial Safety and Fire Protection (IS&FP), Health Physics representative, Environmental Health and Pesticide Services Section, the technical lead's manager, and the manager of other LMHC personnel with work responsibilities at the site, as related to the particular HWOP. The HWOP will also be reviewed and signed for concurrence by any non-LMHC contractors whose personnel are participating at the job site.

In addition to the HWOP, a task-specific RWP must be obtained for each operation conducted within a radiation zone or where work with radioactive materials or contaminants is, or could be, reasonably expected to occur. The RWP will be the primary tool for controlling exposures in radiation zones. The RWP will specify radiological site conditions, radiological air monitoring requirements, personal protection equipment, and action levels. In addition, an as-low-as-reasonably-achievable (ALARA) plan must be prepared indicating the task-specific procedures that will be employed to keep radiation exposure in compliance with Federal regulatory requirements. The ALARA plan must be read and signed by project personnel.

The levels of protection and procedures specified in this HSP are based on the best information available at this time and represent the minimum health and safety requirements to be observed at all times by LMHC employees and contractors while engaged in tasks associated with this project. The levels of protection stated in this HSP may differ from those required in the site-specific HWOP and RWP because of additional information not available at the time the HSP was written. In such cases, the HWOP will take precedence over the HSP. Should any situation arise that is obviously beyond the scope of the monitoring, personal protection, and decontamination procedures specified here or in the HWOP or RWP, work activities will be halted and all employees will be withdrawn from the exclusion zone as directed by the field team leader, site safety officer, and Health Physics technician. After review of the situation, the site safety officer will determine the need to upgrade the level of protection specified in the HWOP or to revise the health and safety procedures for that activity.

B.1.2 DESIGNATED SAFETY PERSONNEL

The project manager controls all aspects of the remedial investigation, including safety and health. However, the field team leader, site safety officer, and Health Physics technician are directly responsible for safety and health at the work site. Specific individuals will be assigned on a task-by-task basis by project management, and their names will be properly recorded before the task is initiated.

All activities onsite must be cleared through the field team leader. The field team leader shall do the following.

- Allocate and administer resources to successfully comply with all technical and health and safety requirements
- Verify that all permits, supporting documentation, and clearances are in place (e.g., electrical outage requests, welding permits, excavation permit, HSP, HWOP, sampling plan, RWP, onsite/offsite radiation shipping records)
- Provide technical advice during routine operations and emergencies
- Inform the appropriate site management and safety personnel of the activities to be performed each day
- Coordinate resolution of any conflicts that may arise between RWPs and implementation of the HWOP with HP personnel
- Handle any emergency response situations that may arise
- Conduct pre-job, tailgate, and periodic safety meetings
- Permit visitors (i.e., anyone other than a LMHC or contractor employee) at work sites only at the direction of and with the permission of responsible LMHC personnel (visitors to abide by the requirements specified in this HSP and, when possible, to be restricted from areas of potential exposure to hazardous substances).

The site safety officer shall assist the field team leader by monitoring and coordinating industrial safety and health procedures and is primarily responsible for implementing the HSP and HWOP at the site and will be trained in the use of the monitoring instruments and the basics of site safety. The site safety officer is specifically required to do the following.

- Monitor chemical, physical, and (in conjunction with the Health Physics technician) radiological hazards to assess the degree of hazard present; monitoring shall specifically include vapor detection, radiation screening, and confined space entry evaluation, where appropriate.
- Ensure that proper chemical/industrial personal protective equipment specified in the HWOP is available and worn by onsite personnel; ensure that personal protective equipment and other equipment is maintained and properly stored.
- Monitor site conditions during operations to determine whether any changes in work zones or personal protective equipment are required; make determinations in conjunction with Health Physics technician.
- Monitor performance of all personnel to ensure that the required safety procedures are followed, including those in the HSP and the HWOP.

- Halt operations immediately, if necessary, because of safety and/or health concerns; order the evacuation of LMHC and/or contractor employees from any work site when conditions posing an unacceptable risk arise through the course of work.
- Monitor LMHC and contractor operations for the existence of hazardous conditions; monitor personnel for symptoms of exposure, heat stress, fatigue.
- Require any LMHC or contractor employee to obtain immediate medical attention in case of an injury or illness.
- Deny access to LMHC and/or contractor personnel to the site or any work site in the event that to enter such an area would pose an unacceptable risk.
- Ensure that environmental and personnel monitoring operations are ongoing and in accordance with technical specifications, procedures, and project instructions.
- Conduct work site safety briefings as necessary.

The Health Physics technician is responsible for supporting the field team leader by ensuring that all radiological monitoring and protection procedures are being followed as specified in the RWP. The Health Physics technician will be responsible for the following activities.

- Remain cognizant of site radiological conditions and inform the field team leader as to those conditions.
- Ensure that personnel adhere to the requirements of the RWP.
- Deny work site access to LMHC and/or contractor personnel in the event that to enter such an area would pose an unacceptable radiological exposure.
- Provide radiological monitoring for site personnel during operations; ensure that personnel are properly surveyed before they leave work site.
- Monitor site radiological conditions during operations to determine whether changes in work zones or personnel protection are required.
- Oversee use of proper radiological personal protective equipment and dosimetry devices by onsite personnel.
- Determine in conjunction with the site safety officer whether changes to the levels of personal protective equipment are necessary to ensure the safety of personnel
- Recommend changes in personal protective equipment to the Health Physics technician's supervisor.

Industrial Safety and Fire Protection and Health Physics personnel will provide safety overview and technical assistance and perform periodic onsite inspections throughout the project.

Downwind sampling for hazardous materials and radiological contamination may be requested from appropriate contractor personnel as required.

The ultimate responsibility and authority for employee health and safety lies with the employee and the employee's colleagues. Each employee is responsible for exercising the utmost care and good judgement in protecting personal health and safety and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the appropriate health and safety personnel as designated above. In the event of an immediately dangerous or life-threatening situation, the employee automatically has temporary 'stop-work' authority and the responsibility to immediately notify the field team leader or site safety officer. When work is temporarily halted because of a safety or health concern, personnel will exit the exclusion zone and meet at a predetermined place in the support zone. The field team leader, site safety officer, and Health Physics technician will determine the next course of action.

B.1.3 MEDICAL SURVEILLANCE

All field team members engaged in operable unit activities at sites governed by a HWOP must have baseline physical examinations and be participants in LMHC (or an equivalent) hazardous waste worker medical surveillance program.

Medical examinations will be designed to identify any pre-existing conditions that may place an employee at high risk and will verify that each worker is physically able to perform the work required by this work plan without undue risk to personal health. The physician shall determine the existence of conditions that may reduce the effectiveness or prevent the employee's use of respiratory protection. The physician also shall determine the presence of conditions that may pose undue risk to the employee while performing the physical tasks of this work plan using Level B personal protection equipment. This would include any condition that increases the employee's susceptibility to heat stress. This information should be provided to the field team leader and site safety officer.

The examining physician's report will not include any nonoccupational diagnoses unless directly applicable to the employee's fitness for the work required.

B.1.4 TRAINING

All employees entering the work site must have the necessary qualifications and training to perform the assigned task in a safe manner. Before performing work on the site, each employee will attend training as specified in the Work Site Safety and Health Orientation. The initial training includes Hanford Site Orientations and/or Hanford General Employee Training.
The topics covered in these training sessions include company and employee rights and responsibilities, alcohol and drug abuse policies, accident and incident reporting, emergency warning systems, and basic fire protection. Performing tasks in a radiation area or an exclusion zone will require the employee to have completed a variety of training requirements as described in the RWP and HWOP.

Before engaging in any onsite RCRA facility investigation activities, each team member is required to have received 40 hours of health and safety training related to hazardous waste site operations and at least 8 hours of refresher training each year thereafter as specified in 29 Code of Federal Regulations (CFR) 1910.120. In addition, each inexperienced employee (never having performed site characterization) will be supervised directly by a trained/experienced person for a minimum of 24 hours of field experience.

The field team leader and the site safety officer shall receive an additional 8 hours of supervisory training (in addition to the refresher training discussed).

In addition, U.S. Department of Energy (DOE) Order 5480.11, Radiation Protection for Occupational Workers, requires all personnel, including contractor personnel, to have radiation worker training before engaging in onsite activities. Such training shall be coordinated with LMHC.

B.1.5 TRAINING FOR VISITORS

For the purposes of this plan, a visitor is defined as any person visiting the Hanford Site who is not a LMHC employee or a LMHC contractor directly involved in the RCRA facility investigation activities, including but not limited to those engaged in surveillance, inspection, or observation activities.

Visitors who must, for whatever reason, enter a controlled (either contamination reduction or exclusion) zone, shall be subject to all of the applicable training, respirator fit testing, and medical surveillance requirements previously discussed. All visitors shall be informed of potential hazards and emergency procedures by their escorts.

B.1.6 RADIATION DOSIMETRY

All personnel engaged in onsite activities shall be assigned dosimeters according to the requirements of the RWP applicable to that activity. As a minimum, all visitors shall be assigned basic dosimeters that will be exchanged annually.

B.1.7 REQUIREMENTS FOR THE USE OF RESPIRATORY PROTECTION

All employees of LMHC and subcontractors who may be required to use air-purifying or air-supplied respirators must be included in the medical surveillance program and be approved for the use of respiratory protection by the Hanford Environmental Health Foundation (HEHF) or other licensed physician. Each team member must be trained in the selection, limitations, and proper use and maintenance of respiratory protection (existing respiratory protection training may be applicable towards the 40-hour training requirement).

Subcontractors must provide evidence to LMHC that personnel are participants in a medical surveillance and respiratory protection program that complies with 29 CFR 1910.120 and 29 CFR 1910.134, respectively.

B.2.0 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. A hazardous waste site poses a multitude of health and safety concerns because of the variety and number of hazardous substances present. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by all job-site employees at all times.

B.2.1 GENERAL WORK SAFETY PRACTICES

B.2.1.1 Work Practices

The following practices must be observed.

- Eating, chewing, drinking, smoking, taking certain medications, and similar activities are prohibited in the exclusion zone. Avoid all hand-to-mouth contact where contamination of clothing or body is possible. Any open wounds must be covered with an airtight bandage; ideally, someone with an open wound should not enter a work site. Persons with lesions or sores in the mouth, eyes, or nose shall not enter the work site.

- All sanitation facilities shall be located outside the exclusion zone, and decontamination is required before using such facilities.

- Personnel shall avoid direct contact with contaminated materials unless necessary for sample collection or required observation. Remote handling of such items as casings and auger flights will be practiced whenever practical.

- Practice contamination avoidance. Never sit down or kneel, never place equipment on contaminated surfaces, avoid obvious sources of contamination such as puddles, avoid unnecessary contact with onsite objects.

- Do not handle soils, waste samples, or any other potentially contaminated items unless wearing the protective gloves specified in the HWOP.

- While operating in the controlled zone, personnel shall use the 'buddy system' or be in visual contact with someone outside the controlled zone.

- No employee may enter potentially hazardous work sites without prior approval or alone; no one should leave another individual alone at a potentially hazardous work site. Special work tasks may require that an individual work alone. In such cases, a procedure shall be established in the HWOP delineating emergency response and communication activities and responsibilities.

- The 'buddy system' will be used where appropriate for manual lifting.

- Requirements of LMHC radiation protection and the RWP shall be followed for all work involving radioactive materials or conducted within a radiologically controlled area.

- Onsite work operations shall be carried out only during daylight hours unless the entire control zone is adequately illuminated with artificial lighting. A new tour (shift) will operate the drilling rig after completion of each shift.

- Facial hair that may interfere with the satisfactory fit of respiratory protective equipment will not be allowed. Personnel with beards will not be allowed to perform hazardous waste work.

- Personnel may not wear loose, ragged, or poorly fitted clothing, dangling jewelry, or rings when working around equipment or tools. Long hair must be restrained so that it does not get caught in moving parts. Any of these items can become snagged in moving equipment and result in serious injury.

- Keep track of weather conditions and wind direction when working outside.

- Whenever possible, stand upwind of excavations, boreholes, well casings, and drilling spoils as indicated by an onsite windsock.

- Stand clear of trenches during excavation. Always approach an excavation from upwind.

- Be alert to potentially changing exposure conditions as evidenced by perceptible odors, unusual appearance of excavated soils, and oily sheen on water.

- Do not enter any test pit or trench greater than 1.2 m (4 ft) in depth unless in accordance with procedures specified below.

- Do not, under any circumstances, enter or ride in or on any backhoe bucket, materials hoist, or any other similar device not specifically designed for carrying human passengers.

- Only trained and experienced operators shall operate heavy equipment onsite.

- All drilling team members must make a conscientious effort to remain aware of their own and others' positions in regard to rotating equipment, cat heads, and u-joints, and be extremely careful when assembling, lifting, and carrying flights or pipe to avoid pinch point injuries and collisions.

- Tools and equipment will be kept off the ground whenever possible to avoid tripping hazards and the spread of contamination.

- Personnel not involved in operation of the drill rig or monitoring activities shall remain a safe distance from the rig, as indicated by the field team leader.

- Catalytic converters on the underside of vehicles are sufficiently hot to ignite dry prairie grass. Team members should not drive over dry grass that is higher than the ground clearance of the vehicle and should be aware of the potential fire hazard posed by catalytic converters at all times. Never allow a running vehicle to sit in a stationary location over dry grass or other combustible materials.

- Team members will attempt to minimize truck tire disturbance of all stabilized sites, and stay on roads where possible.
- Do not start or maintain an open flame of any type unless authorized.
- Decontaminate known sources of contamination (such as gloves and boots) at the location established for decontamination. Remove equipment only after decontamination or containerization onsite.
- Plan activities thoroughly ahead of time; enter work sites by a designated route only to get to a designated point for a specific purpose.
- Shower thoroughly (when required by the site safety officer) as soon as possible after removing protective equipment and before leaving for home.
- Wash hands thoroughly on leaving any area of suspected contamination.
- All personnel shall examine personal safety equipment before and after use. Discard as necessary.
- All personnel who will enter a work site should wear secure identification (e.g., badge with photo and name on a breakaway attachment around the neck, name on clothing). A name on the hard hat is not secure identification.
- Be alert to any unusual behavior on the part of other workers that might indicate distress, disorientation, or other ill effects. Be alert to any unusual changes in your own condition; never ignore warning signs or hesitate to report them at once. Inform each other of symptoms of nausea, dizziness, headache, or respiratory or eye irritation.
- Label raw materials, debris, scrap, waste, intermediates, and contaminated clothing with appropriate and understandable precautionary labels.
- Follow all provisions of each site-specific cutting and welding permit.
- All team personnel are required to attend a pre-job safety meeting before the start of the campaign, read the site work plan document(s), and sign off on attending this meeting.
- A mandatory tailgate meeting will be conducted on a daily basis before each field operation.
- Alcohol and/or drugs will not be used at the site.

B.2.1.2 Personal Protective Equipment

- Personal protective equipment will be selected specifically for the hazards identified in the HWOP. The site safety officer, in conjunction with Health Physics and Industrial Hygiene and Safety, is responsible for choosing the appropriate type and level of protection required for different activities at the job site.
- Levels of protection shall be appropriate to the hazard to avoid either excessive exposure or additional hazards imposed by excessive levels of protection. The HWOP will contain provisions for adjusting the level of protection as necessary. These personal protective equipment specifications must be followed at all times, as directed by the field team leader, Health Physics technician, and site safety officer.
- Each employee must have a hard hat, safety glasses, and substantial protective footwear available to wear as specified in the HWOP.
- The exclusion zone around drilling or other noisy operations will be posted 'Hearing Protection Required,' and team members will have noise control training and comply with hearing protection requirements.
- Personnel should maintain a high level of awareness of the limitations in mobility, dexterity, and visual impairment inherent in the use of Level B and Level C personal protective equipment.
- Personnel should be alert to the symptoms of fatigue, heat stress, and cold stress and their effects on the normal caution and judgment of personnel.

B.2.1.3 Personal Decontamination

The HWOP will describe in detail methods of personnel decontamination, including the use of contamination control corridors and step-off pads when appropriate. The following decontamination procedures must be observed.

- Thoroughly wash hands and face before eating or putting anything in the mouth to avoid hand-to-mouth contamination.
- At the end of each work day or each job, disposable clothing shall be removed and placed in (chemical contamination) drums, plastic-lined boxes, or other containers as appropriate. Clothing that can be cleaned may be sent to the laundry facility that is contracting laundry services for LMHC.
- Individuals are expected to thoroughly shower before leaving the work site if directed to do so by the health physics technician, site safety officer, or field team leader.

B.2.1.4 Site Sanitation Facilities

Personal sanitation facilities (e.g., bathrooms, hand wash stations) must be provided at or near the work site. In addition, personnel must have access to safety and decontamination facilities (e.g., eyewash stations, showers).

B.2.1.5 Emergency Preparation

The following emergency preparations shall be arranged.

- A multipurpose dry chemical fire extinguisher, fire shovel, complete field first-aid kit, and portable pressurized spray wash unit shall be available at the site where there is potential for personnel contamination.
- Prearranged hand signals or other means of emergency communication will be established when respiratory protection equipment is to be worn, because this equipment seriously impairs speech.
- The Hanford Fire Department shall be initially notified before the start of the site investigation project. This notification shall include the location and nature of the various types of field work activities as described in the work plan. A site location map shall be included in this notification.

B.2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES

The identified RCRA facility investigation activities in the WMA S-SX should not require confined space entry. Nevertheless, the hazards associated with confined spaces are of such severity that all employees should be familiar with the safe work discussed in the following paragraphs.

The following procedures apply to the entry of any confined space, which for the purpose of this document shall be defined as any space having limited egress (access to an exit) and the potential for the presence or accumulation of a toxic or explosive atmosphere. This includes personholes, certain trenches (particularly those through waste disposal areas), and all test pits greater than 1.2 m (4 ft) deep. If confined spaces are to be entered as part of the work operations, a hazardous work permit (filled out for confined space entry) must be obtained from Industrial Safety and Fire Protection.

No employee shall enter any test pit or trench deeper than 1.2 m (4 ft) unless the sides are shored or laid back to a stable slope as specified in Occupational Safety and Health Administration (OSHA) 29 CFR 1926.652 or equivalent state occupational health and safety regulations.

When an employee is required to enter a pit or trench 1.2 m (4 ft) deep or more, an adequate means of access and egress, such as a slope of at least 2:1 to the bottom of the pit or a secure ladder or steps shall be provided.

Before entering any confined space, including any test pit the atmosphere will be tested for flammable gases, oxygen deficiency, and organic vapors. If other specific contamination, such as radioactive materials or other gases and vapors may be present, additional testing for those substances shall be conducted. Depending on the situation, the space may require ventilation and retesting before entry.

An employee entering a confined or partially confined space must be equipped with an appropriate level of respiratory protection in keeping with the monitoring procedures discussed previously and the action levels for airborne contaminants (see 'Warnings and Action Levels' in HWOP).

No employee shall enter any test pit requiring the use of Level B protection unless a backup person also equipped with a pressure-demand self-contained breathing apparatus (SCBA) is present. No backup person shall attempt any emergency rescue unless a second backup person equipped with an SCBA is present, or the appropriate emergency response authorities have been notified and additional help is on the way.

B.3.0 SITE BACKGROUND

Specific details on the WMA S-SX background, including known and suspected contamination are presented in Chapters 2.0 and 3.0. The WMA S-SX is located in the SX Tank Farm within the 200 West Area of the Hanford Site, in the south central portion of the state of Washington. The 200 West Area is located in Benton County on the Central Plateau in the central part of the Hanford Site.

B.4.0 SCOPE OF WORK AND POTENTIAL HAZARDS

While the information presented in Section 3.1 is believed to be representative of the constituents and quantities of waste at the time of discharge, the present chemical nature, location, extent, and ultimate fate of this waste in and around WMA S-SX are largely unknown. The emphasis of the RCRA facility investigation in the WMA S-SX will be to characterize contamination in the vadose (unsaturated subsurface soil) zone.

B.4.1 WORK TASKS

Work tasks are described in Chapter 5.0.

B.4.2 POTENTIAL HAZARDS

Onsite tasks will involve intrusive soil sampling either directly in or immediately adjacent to areas known or suspected to contain potentially hazardous chemical substances, toxic metals, and radioactive materials. The potential hazards of primary concern will be radiological contamination, fugitive dust, direct exposure to hazardous chemical and radiological materials, and the industrial hazards associated with drilling and sampling. The degree of potential occupational risk is expected to be similar for each of the designated tasks. In addition, volatile organics also may be associated with certain underground storage tanks.

Potential hazards include the following:

- External radiation (gamma and to a lesser extract, beta) from radioactive materials in the soil
- Internal radiation resulting from radionuclides present in contaminated soil entering the body by ingestion or through open cuts and scratches
- Internal radiation resulting from inhalation of particulate (dust) contaminated with radioactive materials
- Inhalation of toxic vapors or gases such as volatile organics or ammonia
- Inhalation or ingestion of particulate (dust) contaminated with inorganic or organic chemicals and toxic metals
- Dermal exposure to soil or groundwater contaminated with radionuclides
- Dermal exposure to soil or groundwater contaminated with inorganic or organic chemicals and toxic metals
- Physical hazards such as noise, heat stress, and cold stress
- Slips, trips, falls, bumps, cuts, pinch points, falling objects, other overhead hazards, crushing injuries, and other hazards typical of a construction-related job site
- Penetrating unknown or unexpected underground utilities
- Biological hazards such as snakes and spiders.

B.4.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS

Significant exposure to external radiation will be monitored and controlled by limiting exposure time, increasing distance, and employing shielding as required.

Internal radiation by inhalation or inadvertent ingestion of contaminated dust is a realistic concern and must be evaluated continuously by the health physics technician. Appropriate respiratory protection, protective clothing, and decontamination procedures will be implemented as necessary to reduce potential inhalation, ingestion, and dermal exposure to acceptable levels.

Dermal exposure to toxic chemical substances is not expected to pose a significant problem for the identified tasks given the use of the designated protective clothing. The appropriate level of personal protective clothing and respiratory protection will be followed. Levels of protection will be specified in the HWOP and RWP, as appropriate, prior to initiating work. These levels of protection will be upgraded where appropriate based on real-time hazard evaluation.

Chemical exposure through inhalation of contaminated dust is not expected to pose a significant hazard because of the relatively low concentrations of chemicals in soil and low concentration of dust in the ambient air. Activities that result in high concentrations of airborne particulates (e.g., dusty operations) may require dust control, respiratory protection, or both, which will be designated in the HWOP.

Similarly, airborne concentrations of toxic gases or vapors are not expected to exceed applicable permissible exposure limits. However, the interactions and fate of these compounds are not well characterized. The site safety officer periodically will monitor airborne levels of volatile organic vapors and gases and other specific contaminants as appropriate for the anticipated hazards. A detailed monitoring plan including frequency and location of measurements, specific chemical hazards, and type and mode of detection instrument will be included in the HWOP or other appropriate health and safety documentation for that task. Air monitoring with direct-reading instruments will be conducted continuously in the event of the detection of breathing zone concentrations greater than background levels when appropriate. Respiratory protection will be employed as appropriate. Warning levels and action levels will be designated in the HWOP.

Should the work crew encounter an unanticipated underground utility, work shall be halted until the nature and status of the line is determined.

B.5.0 ENVIRONMENTAL AND PERSONAL MONITORING

The site safety officer or authorized delegate shall be present at all times during work activities that require an HWOP and shall be in charge of all industrial monitoring equipment. The Health Physics technician shall be present during all activities involving or potentially involving radiological contamination and shall be in charge of radiological monitoring equipment. They shall ensure that all necessary monitoring equipment in sufficient numbers is available before work initiation. Other equipment deemed necessary by the site safety officer or Health Physics technician before work initiation shall be obtained at their direction. They shall ensure that these instruments are used only by persons who know their limitations. No work shall be done unless this instrumentation is available and in proper working order.

An air quality monitoring program and a radiological monitoring program shall be established to provide adequate warning and facilitate appropriate preventive action before potentially excessive exposure to contaminants in the work environment. The air monitoring program will consist of monitoring air for contaminant vapors/gases in the vicinity of boreholes and in employee breathing zones. The radiological monitoring program will consist of monitoring the general area for radiation and monitoring core samples to determine levels of radioactivity and occupational risks before actual sample collection.

A preliminary survey of existing air quality and radiological conditions will be performed before any work activities to establish baseline levels. This survey will focus on the following areas:

- Contamination reduction zone upwind from drilling activities, excavation, and other work activities

- Locations where workers may assemble or congregate
- Confined spaces or areas where gases may be trapped.

At a minimum, periodic monitoring shall be conducted whenever there is any indication that exposure levels may have risen since previous monitoring. Situations where it shall be assumed that the possibility exists that exposures have risen are as follows: (a) when work begins on a different portion of the site, (b) when contaminants other than those previously identified are being handled, (c) when a different type of operation is initiated (e.g., drum opening as opposed to exploratory well drilling), and (d) when employees are handling leaking drums or containers or working in areas with obvious liquid contamination (e.g., a spill or lagoon).

As indicated previously, the decision to modify the level of personal protection will be made by the site safety officer and the Health Physics technician (with appropriate Health Physics management involvement). The decision will be based on, but not limited to, the following:

- Interpretation of organic vapor and radiation detection instrument readings by site safety personnel and Health Physics technicians
- Visual observation such as wind-blown dust or discolored soil
- Unusual odors or odors characteristic of contaminants
- Results of monitoring with other sampling devices for combustible gas levels, oxygen deficiency, hydrogen sulfide or hydrogen cyanide
- Information specific to the individual sites (i.e., known or suspected chemical contaminants and levels of each)
- Physical characteristics of the work environment, such as temperature and pH.

A reduction or elimination of personal protective equipment required in the RWP must be done in accordance with established LMHC procedures.

Air sampling may be required downwind of the referenced waste sites to monitor particulates and vapors before job start up. Siting of such sampling devices will be determined by the site safety officer, Health Physics personnel, and the HEHF (if appropriate). Anytime that personnel exposure monitoring, other than radiological, is required to determine exposure levels, it must be done by HEHF. Discrete sampling of ambient air within the work zone and breathing zones will be conducted using direct reading instruments as specified in the HWOP, and other methods as deemed appropriate (e.g., organic vapor analyzer, pumps with tubes, O_2 meters).

The following standards will be used in determining critical levels:

- Radionuclide Concentrations in Air, DOE Order 5480.1b Chapter XI
- Occupational Radiation Protection, 10 CFR 835

- Air Contaminants-Permissible Exposure Limits, 29 CFR 1910.1000
- Threshold Limit Values and Biological Exposure Indices for 1989-1990 (ACGIH 1991)
- Occupational Safety and Health Standards, 29 CFR 1910.120
- Pocket Guide to Chemical Hazards, National Institute for Occupational Safety and Health (NIOSH 1991), recommended exposure limits for substances that do not have either a threshold limit value or a permissible exposure limit.

B.5.1 VOLATILE ORGANIC COMPOUNDS MONITORING

The site safety officer shall have a direct reading instrument, as specified in the HWOP, onsite at all times and will establish 'background readings' upwind of any excavation, spoils pile, or borehole.

Instruments used by the site safety officer will be calibrated as specified in the HWOP. Instruments used to monitor organic vapors and gases will be checked for calibration daily before and after use, according to the manufacturer's or approved method, with certified calibration gas. Calibration information will be recorded in the field logbook at the time of calibration. Field instruments will be calibrated at the field ambient temperature. Conditions such as unusual humidity or temperatures that may affect instrument performance will be recorded in the field logbooks.

Each HWOP will contain action levels based on the hazards identified for that activity. Warning and action levels will be based on criteria referenced in U.S. Department of Energy, Richland Operations Office (DOE-RL) Order 5480.10A.

B.5.2 AIRBORNE RADIOACTIVE MATERIALS AND RADIATION MONITORING

The radiological monitoring program will be established by the Health Physics technician in accordance with the RWP. The Health Physics technician will monitor airborne radioactive contamination levels and external radiation levels. The program will allow the Health Physics technician to observe action levels and procedures specified in the RWP and appropriate ALARA plans. Action levels will be consistent with derived air concentrations and applicable guidelines as specified in the Hanford Site Radiological Control Manual (DOE 1994).

Appropriate respiratory protection shall be required when conditions are such that the airborne contamination levels may exceed an 8-hr derived air concentration (i.e., the presence of high levels of uncontained, loose contamination on exposed surfaces or operations that may raise excessive levels of dust contaminated with airborne radioactive materials such as excavation and/or drilling under extremely dry conditions).

Specific conditions requiring the use of respiratory protection because of radioactive materials in the air will be incorporated into the RWP. If, in the judgement of the Health Physics technician, any of these conditions arise, work shall cease until appropriate respiratory protection is provided.

B.6.0 PERSONAL PROTECTIVE EQUIPMENT

The level of personal protective equipment required initially at the site during excavation, drilling, and sampling activities will be specified in the HWOP for each job within the operable unit. Personal protective clothing and respiratory protection shall be selected to limit exposure to anticipated chemical and radiological hazards. Work practices and engineering controls as described in the HWOP will also be used to control exposure. The following will be used to specify personal protective equipment, based on the potential hazards identified in the HWOP:

- Occupational Safety and Health Standards, 29 CFR 1910.120
- Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities.

B.7.0 SITE CONTROL

The field team leader, assisted by the site safety officer and the Health Physics technician, is designated to coordinate access control and security on the site. A clearly marked temporary exclusion zone will be established at the drilling location. If a radiological hazard is present or suspected, the area is to be posted accordingly, using signs such as "Controlled Area" (radiological hazard may be present), or "Surface Contamination Area" (radiological contamination hazard does exist). In addition, radiologically controlled areas must be marked with either radiation boundary rope (for areas established for less than 90 days) or radiation boundary chain (for areas established for greater than 90 days).

The size and shape of the exclusion zone will be dictated by the types of hazards expected, the climactic conditions, and the specific drilling and sampling operations required. The RWP and the contractor's standard operating procedures will also dictate the boundary size and shape. The ground surface of the area immediately around the drill hole, the corridors to the command post, the decontamination area, and the escape route will be covered with appropriate material to reduce contamination of personnel and equipment when necessary. Exclusion zone boundaries will be increased or decreased based on results of field monitoring, environmental changes, or work technique changes. Portable sanitation facilities will be located outside the exclusion zone.

No unauthorized person shall be allowed within the exclusion zone. No authorized person shall be allowed in the exclusion zone unless they are properly equipped with the required level of personal protective clothing and respiratory protection. All personnel who enter the exclusion zone will be required to go through decontamination procedures (radiological and chemical) before leaving the zone as required by the site safety officer, the Health Physics technician, and the field team leader. All team members must be surveyed for radioactive contamination on leaving the exclusion zone if it is also a radiologically controlled area.

The onsite command post and staging area will be established near the exclusion zone on the upwind side, as determined by an onsite windsock, if physically possible. The exact location for the command post is to be determined just before start of work. Vehicle access, availability of utilities (power and telephone), wind direction, and proximity to sample locations should be considered in establishing command post location.

B.8.0 DECONTAMINATION PROCEDURES

Remedial investigation activities will require entry into areas of known chemical and radiological contamination. Consequently, it is possible that personnel and equipment could be contaminated with hazardous chemical and radiological substances.

During drilling and sampling activities at the site, potential sources of contamination include, but are not limited to, airborne vapors, gases, dust, mists, and aerosols; splashes and spills; walking through contaminated areas; and handling contaminated equipment. All personnel who enter the exclusion zone will be required to go through the appropriate decontamination procedures on leaving the zone.

Decontamination areas shall be located upwind of the work area (based on the recorded predominant wind direction) and shall be sufficiently distant from the work site to allow for errant gusts, which may occasionally blow in from the work site.

Specific decontamination procedures will be provided in the HWOP. Unless otherwise specified in the HWOP, it is assumed that decontamination procedures for potential radiological contamination will also provide adequate decontamination for chemical contamination. Decontamination procedures shall be consistent with Level B and Level C decontamination protocol. The following are examples of equipment and facilities that may be used for decontamination:

- Decontamination garbage/dirty equipment bags
- Decontamination pad/corridor cover
- Emergency response pressurized water tank with wand and adjustable spray nozzle
- Bagging and taping material
- Emergency water deluge/detergent, brush, and bucket
- Barrels
- Step-off pads
- Sponges, wipes, and rags
- Detergent, brushes, and buckets
- Tables and stands.

All wash liquids must be properly disposed of in accordance with applicable state and federal regulations.

B.8.1 PERSONNEL DECONTAMINATION

All personnel who enter the exclusion and contamination reduction zones of the project will pass through appropriate decontamination at the end of any given work shift or any other time they leave the respective zones. A decontamination corridor will be established within the exclusion zone for each task of the campaign. Clothing that is disposable will be removed in such a manner that outer layers are removed first and placed in containers, which will be sealed when full or at the end of the day. Nondisposable clothing that can be cleaned (such as special work procedure coveralls) will be removed, bagged, and sent to the laundry facility that is contracting laundry services for LMHC.

After removing outer protective clothing, each team member must undergo radiological survey, if required, before proceeding to an uncontrolled area. If radiological contamination is detected before leaving, the individual involved shall be escorted to an appropriate decontamination area by the Health Physics technician. At the Health Physics technician's discretion, nasal smears may be taken for counting/analysis. Health Physics Dosimetry shall also be notified, and the determination for further bio-assay, if needed, will be made at that time. Site-specific radiation decontamination procedures will be provided in the RWP or as specified by the onsite Health Physics technician.

B.8.2 EQUIPMENT DECONTAMINATION

Equipment decontamination methods will generally consist of washing or steam cleaning with a detergent/water or other decontamination solution as specified in the Field Sampling Plan. Rinsing with a dilute nitric acid solution may be necessary to remove metal oxides and hydroxides. Where applicable, field decontamination of drilling equipment shall be performed within impoundments in the decontamination zone to ensure that all wash liquids are captured. Appropriately sized decontamination pads will be constructed and used as necessary.

Downhole drilling equipment shall be decontaminated before use on another borehole and/or as required to ensure the safety of personnel and prevent cross-contamination of samples.

Equipment that is radiologically contaminated beyond the limits specified in the RWP shall not be decontaminated in the field. Such equipment shall be double-bagged and transported to the 2705-T Building in the 200 West Area for decontamination before reuse.

B.8.3 SAMPLING AND MONITORING EQUIPMENT

All possible measures should be taken by personnel to prevent or limit the contamination of any sampling and monitoring equipment used. In general, air monitoring instruments will not be contaminated by chemicals unless splashed or set down on contaminated areas. Any delicate instrument that cannot easily be decontaminated should be protected while it is being used by placing it in a bag and using tape to secure it around the instrument. Openings in the bag can be made for sample intake, exhaust, or electrical connections. Personnel performing field maintenance procedures on monitoring instruments should be aware that instruments may become contaminated internally if air containing high concentrations of radioactive particulate is drawn through the instrument.

Foreign material that collects within the probe tip and on the face of detectors may be chemically or radioactively contaminated and should be handled appropriately when disassembling the probe or cleaning the detector. Whenever possible, a prefilter should be placed in the sampling line. All instruments and equipment must be surveyed by the Health Physics technician for the purpose of radiological contamination control before removal from the radiation zone. Items with detectable levels of radiological contamination will be controlled as specified in DOE Order 5480.11.

Sampling devices require special cleaning and decontamination and will be detailed in the HWOP. When appropriate, disposable sampling equipment will be used to eliminate the need for decontamination liquids.

B.8.4 RESPIRATORY PROTECTION EQUIPMENT

Respiratory protection equipment will be specified in the HWOP. There is a high potential for hoses to become contaminated; therefore, where possible and necessary, hoses should be covered with plastic. If grossly contaminated, they may have to be discarded. Cleaning and decontamination of face pieces will be performed by Solid Waste Management at the 2705-T Building in the 200 West Area. Maintenance of special respiratory protection equipment (i.e., SKA PAK[1]) is performed by the Personal Protective Equipment Unit in MO-412, 200 West Area.

B.9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS

The following procedures have been established to address emergency situations that might occur during drilling or sampling operations. As a general rule, in the event of an unanticipated, potentially hazardous situation as indicated by instrument readings, visible contamination, or unusual or excessive odors, team members shall temporarily cease operations and move to a predesignated, safe upwind area.

A two-way radio will be operational and will be operated by the field team leader to maintain contact with the team's base station. Personnel in the exclusion zone will maintain line-of-sight with the field team leader. Any failure of radio communications will require evaluation by the site safety officer and field team leader of whether personnel shall leave the exclusion zone. In addition, a series of three 1-second horn blasts from a truck in the support zone is the emergency signal for all personnel to leave the exclusion zone.

---

[1] SKA PAK is a trademark of Figgie International.

The following standard hand signals will be used in all cases.

Hand Signal	**Meaning**
Hand gripping throat	Out of air, cannot breathe
Grip partner's wrist or both hands around waist	Leave area immediately
Hands on top of head	Need assistance
Thumbs up	OK, affirmative
Thumbs down	No, negative

The site safety officer is directly responsible for providing safety recommendations on the site to the site emergency coordinator. The site emergency coordinator for the facility investigation operations will be the field team leader or other person designated in the HWOP.

The site emergency coordinator will be responsible for the evacuation, emergency treatment, emergency transport of field personnel as necessary, and notification of the appropriate Hanford Facility emergency response units and management staff.

Individuals leaving a radiologically controlled area shall be released by the Health Physics technician, before going to first aid or the hospital. If this cannot be accomplished, for whatever reason, the Health Physics technician must accompany the individual to the first aid station or hospital, with appropriate survey instruments.

Professional medical help is provided by the HEHF for the entire Hanford Site. Doctors and nurses from HEHF are available for emergency assistance at all times. The medical personnel are trained to work with injured personnel who have been contaminated from a radioactive source and who may have been exposed to hazardous materials. Emergency call lists ensure availability of professional medical care at all times. A nurse is on duty in each of the 100, 200, and 300 Areas at all times. During hours when the nurse is not on duty in the 400 Area, the 300 Area nurse will respond to first aid emergencies.

Severely contaminated, injured patients will be cared for in the Emergency Decontamination Facility, which provides both isolation and decontamination. The Emergency Decontamination Facility, adjacent to the Kadlec Medical Center in Richland, Washington, is available with unique equipment for performing surgery and decontamination. The only exception is if the injury is so severe that immediate medical attention can only be provided in a hospital. Hospital service is available at Kadlec Medical Center. Kennewick General Hospital in Kennewick, Washington, and Our Lady of Lourdes Health Center of Pasco, Washington, serve as backup hospitals for Kadlec Medical Center.

Ambulance service is provided by the Hanford Fire Department, which has qualified emergency medical technicians as attendants. This service is available from each area fire station on a 24-hr basis. Additional ambulances are available when needed from other fire stations and from other local fire departments under the memoranda of understanding.

In addition, memoranda of understandings have been established with Washington Public Power Supply System (WPPSS) and the City of Richland for providing backup ambulance service.

Emergency communications will be maintained during all onsite field activities by two-way radio contact. If an emergency occurs such as fire or explosion, all onsite personnel should exit the site in an upwind direction and assemble in a predesignated area. Site-specific emergency response procedures will be covered in the tail-gate meeting with the HWOP. If an onsite injury occurs, team members should employ the general procedures detailed in the following sections.

B.9.1 PROCEDURE FOR PERSONNEL INJURY IN THE EXCLUSION ZONE

Designated emergency response members of the field team shall be trained and certified in first aid and cardiopulmonary resuscitation. If an injury occurs, the designated team members will provide appropriate assistance. Only trained, certified personnel should attempt first aid. If able, the injured person should be decontaminated, if necessary, then taken to the nearest available source of first aid.

On notification of a serious injury in the exclusion zone, the emergency signal of three 1-sec horn blasts will be sounded. All site personnel will assemble at the decontamination line. The site safety officer, field team leader, and Health Physics technician should evaluate the nature of the injury and the extent of decontamination possible before moving the injured person to the support area. No person should re-enter the exclusion zone until the cause of the injury is determined and measures taken to prevent recurrence.

B.9.2 PROCEDURE FOR PERSONNEL INJURY IN THE SUPPORT AREA

On notification of an injury in the support area, the field team leader and the site safety officer will assess the situation. If the cause of the injury or loss of the injured person does not affect the performance or safety of site personnel, operations may continue, with initiation of first aid and summoning of medical assistance as discussed previously. If the injury increases the risk to others, the emergency signal of three 1-sec horn blasts will be sounded and all site personnel shall move to the decontamination area for further instructions. Activities onsite will stop until the hazardous condition (if any) is evaluated and reduced to an acceptable level.

B.9.3 PROCEDURES FOR FIRE AND EXPLOSIONS

The dry chemical fire extinguishers required on all field vehicles are effective for fires involving ordinary combustibles (e.g., wood and grass), flammable liquids, and electrical equipment. They are appropriate for small, localized fires such as a drum of burning refuse, a small burning gasoline spill, or a vehicle engine fire. No attempt should be made to use the provided extinguishers for well-established fires or large areas or volumes of flammable liquids.

In the case of fire, prevention is the best contingency plan. Smoking in the exclusion zone is strictly prohibited and smoking materials, where permitted, should be extinguished with care.

In the event of a fire or explosion, the following steps should be taken.

- Immediately notify site emergency personnel and the local fire department by contacting the Hanford Patrol (811) or by radio (Station 1) to relay message.
- If the situation can be readily controlled with available resources without jeopardizing the health and safety of yourself or other site personnel, take immediate action to do so.

If the fire cannot be readily controlled, take the following actions.

- On discovery of the fire or explosion onsite, the emergency signal of three 1-second horn blasts will be sounded and all site personnel will assemble upwind of the fire at the decontamination line. Site emergency personnel and the fire department will be contacted by calling the Hanford Patrol (811) and all personnel will move to a safe distance from the involved area. Again, based on the individual tailgate meetings, a decision to send all personnel immediately out of the exclusion zone may be an option.
- Isolate the fire to prevent spreading, if possible.
- Clear the area of all personnel working in the immediate vicinity.

B.9.4 PROCEDURE FOR PERSONAL PROTECTIVE EQUIPMENT FAILURE

If any site worker experiences a failure or alteration of protective equipment that may jeopardize the level of protection provided by that equipment, that person and his or her buddy shall immediately proceed through decontamination and leave the exclusion zone. In the event of respiratory protection failure, the primary concern will be getting the person to breathable air, and decontamination will be secondary. Re-entry shall not be permitted until the equipment has been repaired or replaced, and the conditions leading to the problem are adequately evaluated and corrected.

B.9.5 PROCEDURE FOR FAILURE OF OTHER EQUIPMENT

If onsite monitoring equipment fails to operate properly, the field team leader, site safety officer, and the Health Physics technician shall be notified and determine the effect of the failure on continuing operations. If the failure may compromise the health and safety procedures or jeopardize the safety of personnel, all personnel shall leave the exclusion zone until the equipment is repaired or replaced.

B.9.6 EMERGENCY ESCAPE ROUTES

In the event that an emergency situation prevents exiting the exclusion zone by way of the decontamination area, exit the exclusion zone in any direction, preferably upwind, avoiding any barriers. Site-specific situations will be covered in more detail in the HWOP.

B.9.7 RESPONSE ACTION TO CHEMICAL EXPOSURE

Responses of this nature will be covered in the HWOP. Designated first aid field team members will be briefed on these procedures from the HWOP, and only those designated individuals will treat the exposed person. The site safety officer and the field team leader should be notified of any chemical exposure incidents as soon as possible, so that appropriate actions may be taken to prevent further exposure.

B.9.8 EMERGENCY TELEPHONE NUMBERS

Local Resources	Hanford Emergency Response Team	811
Ambulance	Hanford Fire Department will dispatch the ambulance	811
Hospital	Kadlec Hospital, Richland	(509) 946-4611
Police (local or state)	Hanford Patrol	811
Fire Department	Hanford Fire Department	811
Poison Control Center		800-572-5842

B.10.0 REFERENCES

10 CFR 835. Occupational Radiation Protection. U.S. Department of Energy. Code of Federal Regulations, as amended. 1998.

29 CFR 1926. Safety and Health Regulations for Construction. Occupational Safety and Health Administration, U.S. Department of Labor. Code of Federal Regulations, as amended. 1998.

29 CFR 1910. Occupational Safety and Health Standards. Occupational Health and Safety Administration, U.S. Department of Labor. Code of Federal Regulations, as amended. 1995.

ACGIH 1991. Threshold Limit Values and Biological Exposure Indices for 1990 1991. American Conference of Governmental Industrial Hygienists. Cincinnati, Ohio. 1991.

DOE 1994. Hanford Site Radiological Control Manual, HSRCM-1. U.S. Department of Energy. Richland, Washington. 1994.

DOE 1986. Environment, Safety & Health Program for DOE Operations. DOE Order 5480.1B. U.S. Department of Energy. Washington, D.C. 1986.

DOE Order 5480.11. Radiation Protection for Occupational Workers. U.S. Department of Energy. Washington, D.C. May 1992.

NIOSH 1991. Pocket Guide to Chemical Hazards, National Institute for Occupational Safety and Health. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control. Washington, D.C. 1991.

This page intentionally left blank

APPENDIX C

QUALITY ASSURANCE PROJECT PLAN (QAPjP) FOR THE PRELIMINARY SITE-SPECIFIC SST PHASE 1 RFI/CMS WORK PLAN ADDENDUM FOR WMA S-SX

This page intentionally left blank

C.1.0 PROJECT DESCRIPTION

C.1.1 PROJECT OBJECTIVE

The objectives of preliminary field characterization in the waste management area (WMA) S-SX are defined in Section 1.3. Analytical data resulting from the sampling portion of the investigation will be validated and/or verified and evaluated to determine the most feasible options for additional investigation and evaluation of correction measures.

C.1.2 BACKGROUND INFORMATION

The WMA S-SX is located within the 200 West Area of the Hanford Site in the vicinity of the Reduction-Oxidation (REDOX) Plant. Detailed background information regarding the history and present use of the tank farm is provided in Chapter 2.0.

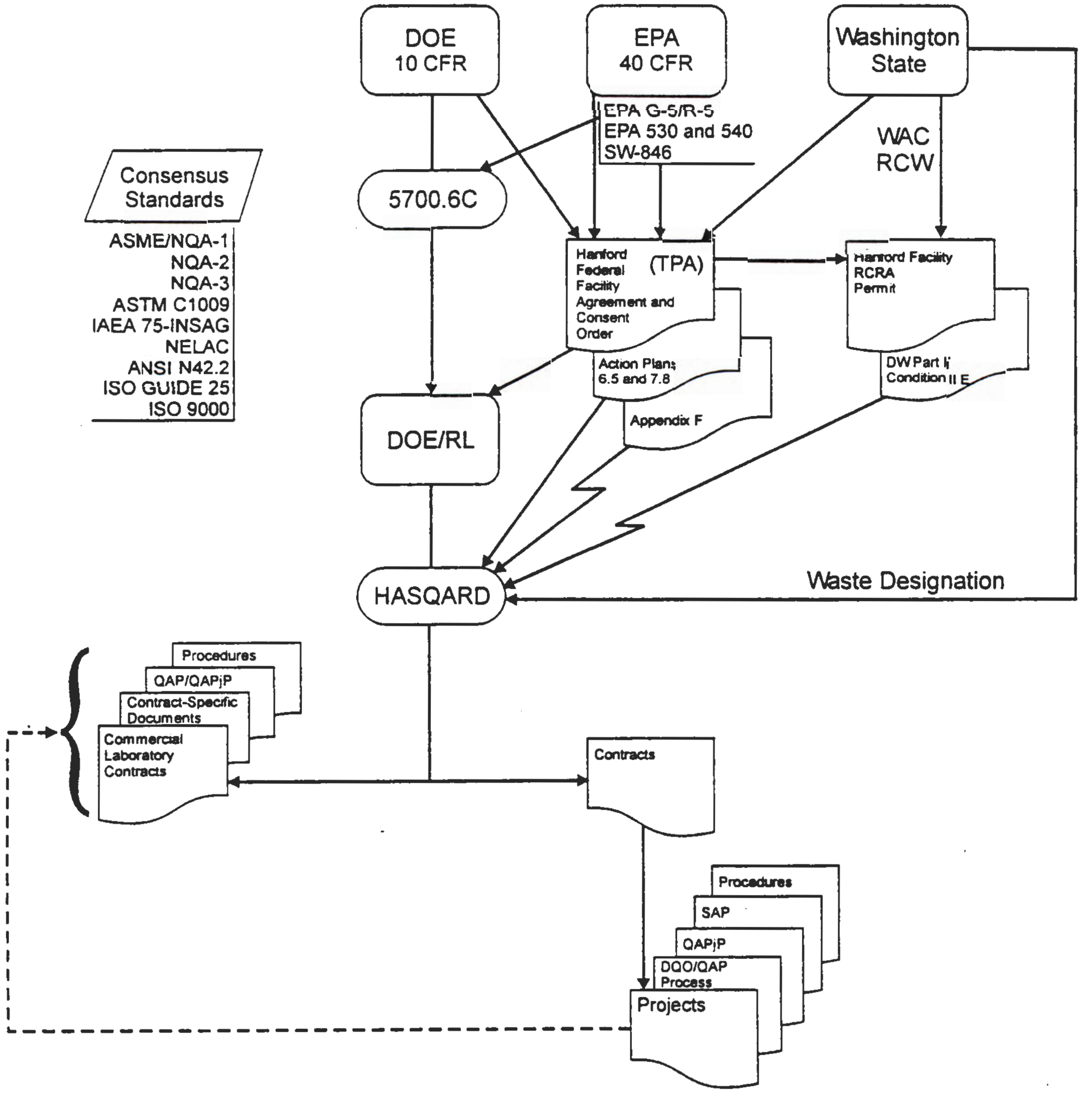
C.1.3 QUALITY ASSURANCE PROJECT PLAN SCOPE AND RELATIONSHIP TO LOCKHEED HANFORD CORPORATION QUALITY ASSURANCE PROGRAM PLAN

This quality assurance project plan (QAPjP) applies specifically to the field activities and laboratory analyses performed for characterization of a new borehole, decommissioning of borehole 41-09-39, and vadose zone sediment sampling of proposed RCRA groundwater monitoring wells discussed in this preliminary work plan. It is prepared specifically for the Preliminary Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) of the WMA S-SX, and is consistent with the overall quality program requirements of the Project Hanford Management Contractor (PHMC) and the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) (Ecology et al. 1996). The requirements contained herein are in accordance with the Hanford Analytical Services Quality Assurance Requirements Document (HASQARD) (DOE-RL 1998), which encompasses the requirements of U.S. Department of Energy (DOE) Order 5700.6C, Quality Assurance; 10 Code of Federal Regulations (CFR) 830.120, Quality Assurance Requirements; and the EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations (EPA 1994). Figure C.1 shows the relationships between these documents and HASQARD. Distribution and revision control of the work plan and QAPjP will comply with procedure HNF-PRO-224, Document Control.

C.1.4 PROJECT ACTIVITIES

The activities to be conducted in the WMA S-SX are described in Chapter 5.0. Procedures directly applicable to the tasks described here are discussed in Chapter C.4.0 of the QAPjP. Drilling activities are planned to begin in fiscal year 1999. Decommissioning activities are also planned to begin in fiscal year 1999 following completion of the characterization activities.

Figure C.1. Document Hierarchy Flow Diagram



Source: DOE-RL 1998

docprod\lmhc\rf\corel6\fig-c-1.cdr

C.2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

C.2.1 QUALITY ASSURANCE OFFICER RESPONSIBILITIES

The Quality Assurance Officer is responsible for coordination and/or oversight of performance to the QAPjP requirements by means of internal auditing and surveillance techniques. The Quality Assurance Officer has the necessary organizational independence and authority to identify conditions adverse to quality and to inform the technical lead of needed corrective action.

C.2.2 TECHNICAL LEAD RESPONSIBILITIES

The Tank Farm Vadose Zone Project function of Lockheed Martin Hanford Corporation (LMHC) has primary responsibilities for conducting the RFI. External participant contractors or subcontractors shall be evaluated and selected for certain portions of task activities at the direction of the technical lead and in compliance with approved LMHC procedures. All contractor or subcontractor plans and procedures shall be approved before their use, and shall be available for regulatory review after LMHC approval.

C.2.3 ANALYTICAL LABORATORIES

The field sampling team will be responsible for screening all samples for radioactivity in compliance with approved Waste Management Federal Services (WMFS) procedures.

The total activity of the samples will be measured by the field sampling team. If the radioactivity levels exceed those specified in the job-specific work package, samples shall be packaged and routed to a contractor or subcontractor laboratory equipped and qualified to handle the analysis of radioactive samples. Samples that do not exceed either of the above criteria may be routed to any approved participant contractor or subcontractor analytical laboratory.
All analyses shall be coordinated through LMHC and shall be performed in compliance with HASQARD and HASQARD-compliant analytical procedures. All analytical laboratories shall be subject to the assessment activities in accordance with HASQARD. For subcontractors or participant contractors, applicable quality requirements shall be invoked as part of the approved procurement documentation or work order; see Section C.3.0 and C.4.1.2 of this QAPjP. Services of alternate qualified laboratories shall be procured for radioactive sample analysis if onsite laboratory capacity is not available, and/or for the performance of split sample analysis at the technical lead's discretion. If such an option is selected, the alternate laboratory shall provide objective evidence of appropriate Nuclear Regulatory Commission (NRC) or state radioactive materials handling licenses. The alternate laboratory shall perform work in compliance with HASQARD.

C.2.4 SUPPORT CONTRACTORS

Procurement of all other field services and supporting items, materials, or equipment shall comply with HASQARD and company-specific procurement procedures. Applicable quality requirements shall be invoked as part of the approved procurement documentation or work order as noted in Section C.4.1.

C.2.5 HEALTH PHYSICS

The Health Physics group is responsible for radiological control technician coverage for the RFI. Other duties include preparing Radiological Work Permit (RWP) documentation and overseeing work performed in controlled areas under an RWP.

C.2.6 TRANSPORTATION LOGISTICS

LMHC or a selected contractor shall provide guidance and instruction for the transport of samples. This shall include direction concerning proper shipping paperwork, marking, labeling, and packaging requirements.

C.3.0 OBJECTIVES FOR MEASUREMENTS

The rationale for establishing data quality objectives (DQO) and data needs for this investigation is presented in Sections 4.1.1 and 4.1.2.

All analytical parameters that have been selected for the vadose zone investigation are listed in Table C.1, cross-referenced to analytical method requirements and maximum detection or quantitation limit values and maximum acceptable ranges for precision and accuracy. The requirements of this table apply only to the sediment analyses; analyses for groundwater samples are not addressed in this SAP. For organic, inorganic, and radiochemical analytical parameters, detection limits and precision and accuracy ranges shall be considered maximum values that can be reliably achieved by analytical laboratories under routine conditions. The best achieved method detection limits for the collected samples will be reported. Therefore, the requirements of Table C.1 shall be considered a minimum performance standard, and shall be incorporated into the agreements for services established with individual participant contractor or subcontractor analytical laboratories. These quality control (QC) requirements apply only to the baseline level of analysis needed for RCRA compliance (see Appendix A). They do not apply to analyses performed as part of the general understanding of fate and transport mechanisms. Any HASQARD-defined modification of Table C.1 requirements shall be in accordance with HASQARD, which identifies the requirements associated with procedure modifications.

Goals for data representativeness will be addressed qualitatively by the specification of sampling depths and intervals in this preliminary work plan. Sampling locations will be specified in Chapter 5.0 or Appendix A of this work plan. Procedure numbers associated with the analyses in Table C.1 are provided in Tables A.1 and A.2. Objectives for the completeness of this investigation shall require that contractually or procedurally established requirements for precision and accuracy be met for at least 90 percent of the organic, inorganic, and radiological determinations. Failure to meet this criterion shall be documented and evaluated in the validation process described in Section C.8.0; corrective action shall be taken as warranted, as described in Section C.13.0. Because of the nature of the physical and hydraulic measurements, no precision and accuracy limits have been specified. It is expected that the laboratory will provide a best effort analysis.

Table C.1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the WMA S-SX

Analytical Category	Analytical Parameters	Detection Limit	Precision[3]	Accuracy[3]
Inorganics	Metals	10-25 ppb	± 20	75-125
	Anions	3-5 ppm	± 20	75-125
Organics	TOC	0.2 wt%	± 20	75-125
	SVOAs w/TICS	Varies	Note 1	Note 1
	VOAs w/TICS	Varies	Note 1	Note 1
Radionuclides	Carbon-14	Unknown	± 20	80-120
	Tritium	5 pCi/g	± 20	80-120
	Strontium-90	40 pCi/g	± 20	80-120
	Radioisotopes by ICP-MS	10 ppb	± 20	80-120
	Gamma-Emitting Isotopes	10 pCi/g	± 20	80-120
Hydraulic and Physical Properties	pH	N/A	Note 2	Note 2
	Cation Exchange Capacity	Method-dependent	Note 2	Note 2
	Particle Size Distribution	N/A	Note 2	Note 2
	Mineralogy	N/A	Note 2	Note 2
	Electrical Conductivity	10 microsiemens/cm	Note 2	Note 2
	Moisture Content	1.0 wt%	Note 2	Note 2
	Matric Potential	N/A	Note 2	Note 2
	Kd	N/A	Note 2	Note 2
	Bulk Density	Method-dependent	Note 2	Note 2
	Moisture Retention	N/A	Note 2	Note 2
	Saturated hydraulic Conductivity	N/A	Note 2	Note 2

Notes:

[1] Precision and accuracy related to VOA and SVOA analyses should be in accordance with HASQARD.

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

[3] Precision is expressed as Relative Percent Difference (RPD); accuracy is expressed as percent recovery (%R). These limits apply to sample results greater than 5 times the detection limit. If these limits cannot be met, documentation of this fact must be presented in the data report.

C.4.0 SAMPLING PROCEDURES

C.4.1 PROCEDURE APPROVALS AND CONTROL

All procedures required for vadose zone sampling activities shall be approved and shall comply with applicable LMHC and/or PHMC procedures. Where WMFS procedures are referenced, the latest approved version shall be used. Procedures to be used for the groundwater sampling may be found in Johnson and Chou (1999).

The procedures cited in this QAPjP include WMFS procedures to be used during sampling operations. Procedure approval, revision, and distribution control requirements applicable to these procedures are addressed in HASQARD; requirements applicable to approval, revision, and distribution of functional procedures are addressed in the HNF-PRO-224, Document Control. The various procedures and manuals identified in the QAPjP are available for regulatory review on request, at the direction of the LMHC technical representative.

As previously noted in Section C.2.4, participant contractor and/or subcontractor services shall be procured under the applicable requirements of HASQARD and company-specific procedures Requirements for submittal of procedures for LMHC review and approval before use may be included in the procurement document or work order, as applicable, when such services require procedural controls. All participant contractor or subcontractor procedures, plans, and/or manuals shall be retained as project records in compliance with the HASQARD and company-specific procedures. All such documents are available for regulatory review on request, at the direction of the LMHC technical representative.

C.4.2 SAMPLING PROCEDURES

This section describes procedures related to collecting samples for geological, hydrochemical, and other investigations.

C.4.2.1 Sample Acquisition

All sediment sampling shall be performed in accordance with the Sampling Services Procedures Manual, ES-SSPM-001 (WMFS 1998a). All drilling activities shall be in compliance with the Well Services Procedures Manual, ES-WSPM-001 (WMFS 1998b).

Sampling procedures in the Sampling Services Procedures Manual (WMFS 1998a) that are applicable to the geological and vadose zone investigation (Task 2) include:

- Chain of Custody/Sample Analysis Request, SP 1-1
- Project and Sample Identification for Sampling Services, SP 1-2
- Control of Certificates of Analysis, SP 1-3
- Sample Storage Units, SP 1-4
- Field Logbooks, SP 1-5
- Bottle Preservation, SP 2-1
- Sample Packaging and Shipping, SP 2-6
- User Calibration of Measuring and Test Equipment, SP 2-7
- Soil and Sediment Sampling, 4-1
- Control of Monitoring Instruments, 6-1.

Drilling procedures in the Well Services Procedures Manual (WMFS 1998b) that are applicable to the geological and vadose zone investigation (Task 2) include:

- Record Processing, WP 1-1
- Training, WP 1-2

- Waste Management, WP 2-1
- Field Cleaning and/or Decontamination of Equipment, WP 2-2
- Well Services Support, WP 3-1
- Decommissioning Wells, WP 4-1.

Procedures controlling the groundwater investigation (Task 3) will be identified by Pacific Northwest National Laboratory (PNNL) at a future date.

C.4.2.2 Sample Container Selection

Sample container types, preservation requirements, preparation requirements, and special handling requirements are defined in approved WMFS procedures.

C.4.3 OTHER INVESTIGATIVE AND SUPPORTING PROCEDURES

Other procedures that will be required in this phase of the investigation shall be in compliance with the requirements of HASQARD are identified and referenced to individual tasks as applicable. If it is determined that other procedures are required that have not already been identified in this QAPjP, they will be identified in the appropriate task plan. Documentation requirements shall be addressed within individual procedures. Analytical procedures required for this investigation are listed in Table C.l.

C.4.4 PROCEDURE CHANGES

Should deviations from established procedures be required to accommodate unforeseen field situations, they may be authorized by the field team leader. Other types of procedure change requests shall be documented as required by WMN procedures governing their preparation.

C.5.0 SAMPLE CUSTODY

All samples obtained during the course of this investigation shall be controlled as required by HASQARD from the point of origin to the analytical laboratory. Laboratory chain-of-custody procedures shall be reviewed and approved as required by PHMC procurement control procedures and shall ensure the maintenance of sample integrity and identification throughout the analytical process. At the direction of the technical lead, requirements for the return of residual sample materials after completion of analysis shall be defined in accordance with procedures described in the procurement documentation to subcontractor or participant contractor laboratories. Chain-of-custody forms shall be initiated for returned residual samples as required by the approved procedures applicable within the laboratory. All analytical results shall be controlled as permanent project quality records as required by HASQARD and company-specific procedures.

C.6.0 CALIBRATION PROCEDURES

All field measuring and test equipment, whether in existing inventory or purchased for this investigation, shall be calibrated in compliance with the requirements of HASQARD and with

HNF-PRO-490, Control of Measuring and Test Equipment and Nondata Test Equipment. Equipment that requires user calibration or field adjustment shall be calibrated as required by standard procedures for user calibration.

All calibration of laboratories measuring and test equipment shall meet the minimum requirements of HASQARD. Laboratory quality assurance (QA) plans shall address laboratory equipment to be calibrated and the calibration schedules.

C.7.0 ANALYTICAL PROCEDURES

All analytical methods that have been selected for this investigation are listed in Table C.1, cross-referenced to the parameters of interest and the maximum detection or quantitation limit values and maximum acceptable ranges for precision and accuracy. The applicable requirements of Table C.1 shall be considered minimum performance standards that shall be incorporated into the agreements for services established with individual LMHC participant contractor, or subcontractor analytical laboratories. As previously noted in Section C.3, any modification of Table C.1 requirements shall be in accordance with HASQARD, which identifies the requirements associated with procedure modifications.

All analytical procedures approved for use in this investigation shall require the use of the standard units specified by the analytical methods referenced in Table A.1, in order to facilitate the comparability of data sets in terms of precision and accuracy. All approved procedures shall be retained in the project quality records and shall be available for review on request. Analytical laboratories shall be required to submit the current version of their internal QA program plans, in addition to analytical procedures, at the discretion of the LMHC technical representative. All analytical laboratory plans and procedures shall be in conformance with HASQARD requirements.

C.8.0 DATA REDUCTION, VALIDATION, AND REPORTING

Analytical data from sampling activities will be used primarily to determine the presence and concentrations of analytes of interest in the sampled locations or intervals. Analytical laboratories shall be responsible for the internal laboratory verification and examination of analytical results to the extent appropriate. The requirements discussed in this chapter shall be invoked, as appropriate, in procurement documentation prepared in compliance with standard PHMC procedures. Results from all analyses shall be summarized by the laboratory in a report and supported by recovery percentages, QC checks, equipment calibration data, chromatograms, spectrograms, or other validation data if requested.

All reports and supporting data may be subjected to a detailed technical review by a qualified reviewer designated by the LMHC technical representative. All reports, technical review, and supporting data shall be retained as permanent project QA records in compliance with HNF-PRO-222, Quality Assurance Records, and HNF-PRO-224, Document Control.

Validation shall be performed on completed data packages by qualified LMHC sample management personnel or by a qualified independent contractor. Validation shall consist of verifying required deliverables, requested versus reported analyses, and transcription errors. Validation shall also include the evaluation and qualification of results based on holding time, method blanks, matrix spikes, laboratory control samples, laboratory duplicates, and chemical and tracer recoveries as appropriate to the methods used. No other validation or calculation checks will be performed. At least 10% of all data shall be validated. Validation requirements identified in this section are consistent with Level C validation, as defined in data validation procedures (WHC 1993a,b). No validation for physical or hydraulic properties data will be performed.

Data errors or procedural discrepancies related to laboratory analytical processes shall prompt data requalification by the validator, requests for reanalysis, or other appropriate corrective action by the responsible laboratory as required. If sample holding time requirements are compromised, insufficient sample material is available for reanalysis, or any other condition prevents compliance with governing analytical methods and data validation protocols, the situation shall be formally documented as a nonconformance in compliance with approved nonconformance reporting system. If problems are observed with validated data, either as part of the data assessment process described in Section C.12 of this QAPjP or if separately observed by any of the RCRA facility investigation managers, the data shall be documented as a nonconformance.

C.9.0 FIELD AND LABORATORY QUALITY CONTROL

These sections identify the quality control samples required for this investigation. Both field sample collection and laboratory work shall be in accordance with HASQARD.

C.9.1 FIELD QUALITY CONTROL SAMPLES

Unless otherwise specified in the approved statements of work or work orders for sampling activities, or in applicable procedures, the following minimum field quality control requirements shall apply.

Field duplicate samples. For each shift of sampling activity under an individual sampling subtask, a minimum of five percent of the total collected samples shall be duplicated, or one duplicate shall be collected for every 20 samples, whichever is greater. Duplicate samples shall be retrieved from the same sampling location using the same equipment and sampling technique, and shall be placed into two identically prepared and preserved containers. All field duplicates shall be analyzed independently to provide an indication of gross errors in sampling techniques.

Split samples. Upon specific LMHC or regulator request, and at the technical representative's direction, field or field duplicate samples may be split in the field and sent to an alternative laboratory as a performance audit of the primary laboratory.

Blind samples. At the technical representative's discretion, blind reference samples may be introduced into any sampling round as a quality control check of the primary laboratory. Blind sample type shall be as directed by the technical representative.

Field blanks. Field blanks shall consist of pure deionized distilled water, transferred into a sample container at the site and preserved with the reagent specified for the analyses of interest (see Section A.3.1.3). Field blanks are used as a check on reagent and environmental contamination. One field blank shall be collected per borehole drilling activity.

Equipment rinseate blanks. Equipment blanks shall consist of pure deionized distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures. One blank shall be collected per borehole drilling activity, per type of sampler.

Volatile organic analysis VOA trip blanks. Volatile organic analysis (VOA) trip blanks consist of pure deionized distilled water added to one clean sample container, accompanying each batch (cooler) of containers shipped to the sampling facility. Trip blanks shall be returned unopened to the laboratory, and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage or site conditions. The trip blank shall be analyzed for volatile organic compounds only, as shown in Table A.1. In compliance with standard procurement procedures, requirements for trip blank preparation shall be included in procurement documents of work orders to the sample container supplier and/or preparer.

C.9.2 LABORATORY QC SAMPLES

Unless otherwise specified in approved analytical methods, internal quality control checks performed by analytical laboratories shall meet, where appropriate for the method, the following minimum requirements in conformance with HASQARD.

- Matrix-spike/matrix-spike duplicate samples. Matrix-spiked samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage and as a test of analytical precision. The spike shall be made in a replicate of a field duplicate sample. Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations shall be in accordance with HASQARD. One sample shall be spiked per analytical batch, or once every 20 samples, whichever is more frequent.

- Quality control reference samples. A quality control reference sample shall be prepared in accordance with HASQARD requirements. Reference samples are required as an independent check on analytical technique and methodology, and shall be analyzed in accordance with specific method requirements.

Other requirements specific to laboratory analytical equipment calibration are included in Section C.6.0 of this QAPjP. The frequency of quality control samples such as analytical blanks is method-dependent; refer to HASQARD for these requirements.

C.10.0 PERFORMANCE AND SYSTEM ASSESSMENTS

Acceptable performance for this project is defined as compliance with the requirements of this QAPjP, its implementing procedures and appendices, HASQARD, and other applicable PHMC QA program plans. All activities addressed by this QAPjP are subject to surveillances of project performance and systems adequacy. Surveillances shall be conducted in accordance with HASQARD and shall be scheduled at the discretion of the cognizant quality engineer or technical lead.

C.11.0 PREVENTIVE MAINTENANCE

All measurement and testing equipment used in the field and laboratories that directly affect the quality of the analytical data shall be subject to preventive maintenance measures. These measures are designed to minimize measurement system downtime and corresponding schedule delays. Laboratories shall be responsible for performing or managing the maintenance of their analytical equipment; maintenance requirements, spare parts lists, and instructions shall be included in individual methods or in laboratory QA plans. All QA plans shall be subject to PHMC review and approval at the discretion of the LMHC technical representative.

C.12.0 CORRECTIVE ACTION

C.12.1 GENERAL REQUIREMENTS FOR CORRECTIVE ACTION

Corrective action requests required as a result of surveillance reports, nonconformance reports, assessment activities, or as a result of the specific request of the LMHC technical representative, shall be documented and dispositioned by the LMHC technical representative and QA Coordinator. Corrective action reports prepared under procedure HNF-PRO-052, Corrective Action Management, shall identify during the data validation process the affected requirement, the probable cause of the deviation, any data which may have been affected by the deviation, and the corrective action required both to resolve the immediate situation and to reduce or preclude its recurrence. Corrections of plans or procedures related to the overall measurement system that do not constitute nonconformances, but may be required as a result of data validation, data assessment, or routine review processes, shall be resolved as required by their governing procedures or shall be referred to the LMHC technical representative for resolution and appropriate management action. All documentation related to surveillance, audits, and corrective action shall be maintained in compliance with procedures HNF-PRO-224, Document Control and routed to the project quality records upon completion or closure for retention and shall be made available for RCRA facility investigation manager review upon request through the LMHC technical representative.

C.12.2 CORRECTIVE ACTION REQUIREMENTS RELATED TO CALIBRATION ERRORS

Field measuring and test equipment found to be out of calibration shall be documented as a nonconformance in compliance with procedure HNF-PRO-052, Corrective Action Management.

Nonconforming items shall be tagged, removed from service, and segregated pending resolution of the nonconformance and initiation of appropriate corrective action. Calibration errors related to laboratory analytical processes that may be observed in the data validation activities described in Section C.8 shall prompt requests for reanalysis or other appropriate corrective action by the responsible laboratory as required. If sample holding time requirements are compromised, insufficient sample material is available for reanalysis, or any other condition prevents compliance with governing analytical methods and data validation protocols, the situation shall be initiated in compliance with the requirements of HNF-PRO-052, Correction Action Management, and brought to the attention of the LMHC technical representative and QA Coordinator for their appropriate action.

C.12.3 CORRECTIVE ACTION RELATED TO PROCEDURAL DEVIATIONS

A process for planned procedural deviations shall be established as required by HASQARD. Unplanned procedural deviations observed during system surveillance, or program assessment activities shall be documented as required by HASQARD.

C.12.4 CORRECTIVE ACTION REQUIREMENTS RELATED TO PURCHASED MATERIALS, ITEMS, OR EQUIPMENT

Purchased materials, items, and equipment found to be out of compliance with their governing procurement specifications shall be documented in accordance with HASQARD and company-specific procedures. Nonconforming items shall be tagged and segregated pending resolution of the nonconformance and initiation of appropriate corrective action in compliance with HASQARD and company-specific procedures.

C.13.0 QUALITY ASSURANCE REPORTS

As previously stated in Chapters C.10.0 and C.13.0, project activities shall be regularly assessed by surveillance and program assessments. Surveillance, nonconformance, assessment and corrective action documentation shall be routed to the project quality records on completion or closure of the activity. A report summarizing corrective action and instruction change authorization activity, as well as any associated corrective actions, shall be prepared for the field or laboratory technical lead by their QA at the completion of the field and laboratory investigations in accordance with HASQARD.

C.14.0 REFERENCES

10 CFR 830.120. Quality Assurance Requirements. Code of Federal Regulation, as amended.

DOE Order 5700.6C. Quality Assurance. U.S. Department of Energy. Washington, D.C.

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

Ecology et al. 1996. Hanford Federal Facility Agreement and Consent Order. Two volumes. Washington State Department of Ecology, Olympia, Washington, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Operations Office. Olympia, Washington. 1996.

EPA 1994. EPA Requirements of Quality Assurance Project Plans for Environmental Data Operations. QA/R-5. U.S. Environmental Protection Agency, Quality Assurance Division. Washington, D.C. 1994.

HNF-PRO-052. Corrective Action Management. Fluor Daniel Hanford, Inc. Richland, Washington.

HNF-PRO-222. Quality Assurance Records. Fluor Daniel Hanford, Inc. Richland, Washington.

HNF-PRO-224. Document Control. Fluor Daniel Hanford, Inc. Richland, Washington.

HNF-PRO-490. Control of Measuring and Test Equipment and Nondata Test Equipment. Fluor Daniel Hanford, Inc. Richland, Washington.

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

WHC 1993a. WHC Radiological Control Manual. WHC-CM-1-6. Westinghouse Hanford Company. Richland, Washington. 1993.

WHC 1993b. Data Validation Procedures for Radiological Analysis. WHC-SD-EN-SPP-001, Rev. 1. Westinghouse Hanford Company. Richland, Washington. 1993.

WMFS 1998a. Sampling Services Procedures Manual. ES-SSPM-01. Waste Management Federal Services. Richland, Washington. August 1998.

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

This page intentionally left blank

APPENDIX D

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

This page intentionally left blank

D.1.0 INTRODUCTION AND OBJECTIVES

This Data Management Plan (DMP) is prepared to support the Preliminary Site-Specific WMA S-SX Phase 1 RFI/CMS Work Plan Addendum (Preliminary Addendum) investigation efforts. The Preliminary Addendum enables initial field characterization efforts in and near Waste Management Area (WMA) S-SX to commence in fiscal year 1999. The Preliminary Addendum is very focused on the initial investigations as is this DMP. Additional WMA S-SX investigations are anticipated. The rationale, objectives, and detailed approaches, including expanded data management activities, for the future anticipated investigations will be provided in the following two documents:

- The Phase 1 Resource Conservation and Recovery Act (RCRA) Facility Investigation/Corrective Measures Study (RFI/CMS) Work Plan being prepared pursuant to proposed Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) Milestone M-45-51 as a Tri-Party Agreement primary document. The work plan will provide the overall framework within which each site-specific single-shell tank (SST) WMA RFI/CMS Work Plan addenda will be prepared including requirements for the initial investigation of SST WMAs under RCRA assessment (i.e., the S-SX, B-BX-BY, T, and TX-TY WMAs). The work plan will describe the overall DMP that will be adopted to allow for efficient storage, retrieval, and integration of the expected extensive amount of data that will be collected to support the Corrective Action process for the four WMAs. The proposed Milestone date for this document is August 1999.

- The Site-Specific S-SX WMA Phase 1 RFI/CMS Work Plan addendum that will be prepared pursuant to proposed Tri-Party Agreement Milestone M-45-52 as an Tri-Party Agreement primary document. The addendum to the Phase 1 work plan will provide a description and schedule for the gathering of specific information for the WMA S-SX necessary to meet the objectives specified in the Phase 1 RFI/CMS work plan. The addendum will include a DMP that will focus on the anticipated WMA S-SX data to be collected to support the Corrective Action process. The proposed milestone date for this document is October 1999.

The initial field characterization efforts addressed in the Preliminary Addendum include the collection of vadose zone data from the installation of the new borehole, the decommissioning of borehole 41-09-39, and the vadose zone sampling prior to installation of three proposed RCRA groundwater monitoring wells. A discussion of the tasks associated with the initial field characterization efforts is provided in Chapter 5.

This DMP describes the process for the data collection and control procedures for validated data, records, documents, correspondence, and other information associated with the work plan.

D.2.0 TYPES OF DATA

D.2.1 DATA FORMS

General data types include the following:

- Field logbooks
- Verified sample analyses
- Historic data
- Chain of custody forms
- Quality assurance/quality control (QA/QC) data
- Reports, memoranda/meeting minutes
- Telephone conversations
- Archived samples
- Raw sample data
- Magnetic media and supporting documentation
- Personnel training records
- Exposure records
- Respiratory protection fitting records
- Personnel health and safety records
- Compliance and regulatory data.

D.2.2 DATA COLLECTION, STORAGE, AND ACCESS

Waste Management Federal Services (WMFS) will collect, maintain, and control the field data in accordance with the sampling and analysis plan (SAP) (Appendix A), quality assurance project plan (QAPjP) (Appendix C), Work Package, and Hanford Analytical Services Quality Assurance Requirements Document (HASQARD) (DOE-RL 1998). WMFS will transfer the samples to the Pacific Northwest National Laboratory (PNNL) laboratory in accordance with the Chain of Custody/Sample Analysis Request, SP 1-1 (WMFS 1998). PNNL will collect the laboratory data in accordance with the SAP (Appendix A), QAPjP (Appendix C), Work Package, and HASQARD (DOE-RL 1998). PNNL will maintain and control the laboratory data in accordance with Standard Based Management System (SBMS) and HASQARD. These data will be maintained under a research paradigm until a final report is prepared. The report and associated data will be provided directly to the Project Hanford Management Contractor's (PHMC's) technical point of contact (specified in the letter of intent). The PHMC project lead will disseminate the data to various organizations such as the Office of Sample Management (OSM) and the Environmental Data Management Center (EDMC). Technical reports and progress reports will be published by WMFS and PNNL for field sample data and laboratory data respectively, at designated times as found in the letter of intent. Within the reports, data and QA/QC information will be available. Permanent maintenance and control of all field sample data and laboratory data will be deferred to the Site-Specific S-SX WMA Phase 1 RFI/CMS Work Plan Addendum.

D.2.3 DATA QUANTITY

Data quantities can be inferred from the task descriptions described in Chapter 5.0. Many data quantities cannot be estimated at this stage of the RFI/CMS process and will be provided in the Site-Specific WMA S-SX Phase 1 RFI/CMS Work Plan Addendum.

D.3.0 REFERENCES

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

WMFS 1998. Sample Services Procedures Manual ES-SSPM-001. Waste Management Federal Services, Inc., Northwest Operations. Richland, Washington. 1998.

This page intentionally left blank

APPENDIX E

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

This page intentionally left blank

E.1.0 INTRODUCTION

A DQO process was initiated on February 12, 1999 to identify data needs from preliminary characterization activities to be initiated in fiscal year 1999. This planning effort was decoupled from the overall RFI/CMS process being implemented for the SST WMAs under RCRA assessment in accordance with WAC 173-303-646 in order to enable characterization of the WMA S-SX to be initiated during fiscal year 1999. It was acknowledged in the DQO meetings that additional characterization needs would be developed and documented in future DQO meetings and in site-specific work plans. This appendix summarizes the proceedings of the DQO meetings for the Preliminary Addendum. A DQO report will be developed that will incorporate the DQO results identified in this appendix along with the results obtained from a site-specific DQO meeting to be held beginning in June 1999. The DQO report for the WMA S-SX will be completed in August 1999.

The Tank Farm Vadose Zone Project created a Steering Group to provide input during and after the DQO process. The Steering Group consisted of Kevin Lindsey (D. B. Stevens and Associates), Vern Johnson (Pacific Northwest National Laboratory [PNNL]), Kent Reynolds (Waste Management Federal Services [WMFS]), Glendon Gee (PNNL), Louis Kovach (independent consultant), Charlie Cole (PNNL), and Jeff Serne (PNNL).

Because the characterization activities for fiscal year 1999 will be initiated before completion of the Phase 1 RFI/CMS DQO and Work Plan, the Steering Group recommended that the effort must:

- Be attainable within fiscal year 1999
- Contribute to near-term water resource protection
- Not be required to answer all outstanding vadose zone characterization questions.

With these general objectives, the group concluded that the specific objective for the fiscal year 1999 characterization effort should be "determining the mobility status of the source of groundwater contamination" (Appendix F). The group recommended various data needs including data from contaminated and noncontaminated areas within and near the SX Tank Farms and data resulting from analysis of sediment samples collected using intrusive and nonintrustive techniques from existing and new boreholes and/or CPT deployments (Figure 1.4). The group suggested a range of radiological, chemical, and physical property analysis.

The Steering Group indicated that many of the data needs could be satisfied from existing boreholes (either extending the boreholes or from sidewall sampling) and the planned RCRA monitoring well installation. However, the group also suggested that CPT deployment and a new borehole may be required in fiscal year 1999 or as part of a subsequent WMA S-SX characterization effort. Among the locations for a new borehole indicated as having potential to contribute valuable data are near tank SX-115 and near tanks SX-108 and -109.

E.2.0 SCOPE OF THE DQO MEETINGS

The DQO meetings conducted in support of the preliminary characterization of the WMA S-SX addressed decommissioning of existing borehole 41-09-39, identification of vadose zone data needs from planned RCRA groundwater monitoring wells to be installed outside of the WMA S-SX fence line, and the location and identification of vadose zone and groundwater data needs from a new borehole at the WMA S-SX.

The definition of the activities involved with collection of groundwater data from the new borehole at the WMA S-SX and from collection of vadose zone data from planned RCRA groundwater wells is not within the scope of this work plan addendum. The data needs identified through the DQO process for collecting vadose zone data from the planned RCRA groundwater wells and the collection of groundwater data from the planned new borehole will be provided to the responsible organizations for incorporation into the work plans and documentation for those activities (Johnson and Chou 1999).

E.3.0 DQO DECISIONS

This section provides a summary of the decisions made based on the DQO process that form the basis of the activities described in Chapter 5.0 of this work plan addendum.

E.3.1 DECOMMISSIONING BOREHOLE 41-09-39

Through the DQO process it was determined that borehole 41-09-39 would be fully decommissioned in accordance with WAC 173-160 and that samples would be taken from 16 horizons in the upper 40 m (130 ft) of the borehole. The following decisions were made relative to decommissioning the 41-09-39 borehole:

- Prior to initiating decommissioning, groundwater sampling would be completed and a tracer test initiated.

- The lower portion of the borehole (from 40 m [130 ft] bgs to total depth of the well) will be logged using spectral gamma, moisture, temperature, and enhanced neutron spectral gamma probes.

- Following decommissioning of the lower portion of the borehole and removal of the inner casing, the upper portion of the borehole will be logged using spectral gamma, moisture, temperature, and enhanced neutron spectral gamma probes.

- Based on the logs from the upper portion of the borehole, sample locations will be confirmed against the 16 preliminary sample locations defined in the DQO meetings. If the log results are unchanged, the 16 sample locations will remain the same.

- During decommissioning of the upper portion of the borehole, temperature measurements of the casing and the formation below the casing will be attempted at the sampling locations.

- Video photographs of the formation will be attempted using a video camera at the sampling locations prior to taking samples.

- At each of the 16 sample locations, a total of 3 aliquots will be attempted. If sample collection using the sidewall sampling device is not possible (formation collapse) alternate means to collect a sample will be attempted and documented (Chapter 5.0 of this Preliminary Addendum).

The analysis methodology developed for the samples obtained during decommissioning of borehole 41-09-39 includes screening analyses to identify major CoCs and indications of tank waste constituents in the sample. The primary analyses that would be conducted on all samples include the following:

- Visual geologic description
- Analysis for total technetium-99
- Gamma energy analysis as a function of the sample length to potentially evaluate borehole effects or dragdown
- Water leach ICP for metals and radionuclides
- Water leach pH, technetium-99, tritium, nitrate/nitrite, and electrical conductance
- Total organic carbon (soil and water extract) as a screen for conducting volatile and semivolatile analysis.

Following the primary analysis, additional analyses would be conducted based on results of the primary analysis and visual examination of the samples that indicated sediments had been altered or impacted by tank waste constituents. Additional analyses would be conducted to evaluate additional CoCs that would be expected to be present in the sample only if positive results were obtained from the primary analyses. The detailed analysis methodology is presented in Appendix A.

E.3.2 DATA COLLECTION FROM PLANNED RCRA GROUNDWATER WELLS

Three new RCRA groundwater monitoring wells will be installed outside of the WMA S-SX during 1999. The installation of these wells provides an opportunity for the vadose zone program to collect physical property data at a location near the tank farm on relatively clean or uncontaminated samples. These data would serve as a representative site-specific dataset for future contaminant transport modeling efforts. The following decisions were made relative to collecting vadose zone data from the planned RCRA monitoring wells:

Southern-most well located near the southeast corner of the SX Tank Farm

- Collect continuous core from 6 m (20 ft) bgs to the point of refusal (believed to be in the Ringold Formation). Continuous collection of samples from cuttings from the point of refusal to groundwater.
- Log the cuttings and core to the finest resolution possible using an experienced geologist.
- Analyze hydraulic parameters (e.g., moisture content, hydraulic conductivity) from selected segments of the major geologic units.

- Retain all cuttings and core for future analysis.

Remaining two RCRA groundwater monitoring wells

- Continuous collection of samples from the cuttings from ground surface to groundwater

- Log the cuttings to the finest resolution possible using an experienced geologist

- Retain all samples for future analysis.

If contamination were to be detected during installation of any of the RCRA groundwater monitoring wells at a level that would require relocation of the monitoring well, the Tank Farm Vadose Zone Project would like the opportunity to collect contaminated vadose zone samples prior to abandoning the well.

The analysis methodology developed for sediment samples obtained from the new RCRA groundwater monitoring well (southern most well only) is based on obtaining a representative set of vadose zone physical property data at a location near the WMA S-SX. The following analyses were identified for selected subsamples:

- pH
- Particle size distribution
- Moisture content
- Matric potential
- Bulk density
- Moisture retention
- Saturated hydraulic conductivity
- Water extract anion analysis.

E.3.3 NEW CHARACTERIZATION ACTIVITIES

In support of the preliminary characterization effort, a number of DQO meetings were dedicated to discussion of existing information and data for the WMA S-SX. Available documentation was identified and summarized that included:

- Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination (data gaps) (Jones et al. 1998)

- SX-108 Leak Assessment Report (WHC 1992a)

- SX-109 Leak Assessment Report (WHC 1992b)

- Findings of the 41-09-39 borehole extension (Myers et al. 1998)

- Meeting minutes from previous DQO meetings regarding vadose zone characterization

- Spectral Gamma Logging Report for the SX Tank Farm (DOE-GJPO 1996)

- SX RCRA Groundwater Assessment Report (Johnson and Chou 1998)

- SX Expert Panel Reports (DOE 1999b)
- SX Screening Analysis for the Retrieval Performance Evaluation (Jacobs 1998).

A number of meetings were then dedicated to discussing the objectives of the preliminary characterization effort. Difficulty in obtaining consensus on the objectives of the preliminary characterization effort was due in part to the number of attendees and the decoupling of the preliminary characterization effort from the overall RFI/CMS process. The participants agreed to allow the process to move forward and the language from the Draft Tri-Party Agreement change package (DOE 1999a) would be adopted as the objective for the preliminary characterization effort.

A number of characterization options both in terms of technologies and locations were discussed in the meetings. The LMHC technical team recommended placing a slant borehole under the SX-108 tank for the preliminary characterization effort. This location was considered optimum in terms of the amount of data that would be provided to answer a large number of questions and test hypothesis relative to characterizing the source near the most highly contaminated region in the WMA S-SX.

A number of issues and uncertainties were identified for this location relative to installation of the borehole during fiscal year 1999. LMCH acknowledged these uncertainties but felt that the schedule was achievable. Ecology, DOE, and LMHC met to address these uncertainties and finalize the location of the new borehole. The outcome of this meeting was the agreement that the slant borehole beneath the SX-108 tank was a desirable target for characterization but given the schedule risk could not be supported for the fiscal year 1999 effort. It was then agreed that a vertical borehole southwest of tank SX-108 was an achievable goal that would provide data in the region impacted by the postulated gamma contamination plume extending from the SX-108 tank leak.

Subsequent to this meeting the LMHC technical staff determined that due to the short distance from the proposed new hole location and the existing 41-09-39 borehole much of the same information would likely be obtained from a new borehole at this location and the information obtained from decommissioning of borehole 41-09-39. Based on this the LMHC technical team concluded that the need for new borehole in this location should be evaluated following evaluation of the data obtained from decommissioning of borehole 41-09-39.

As a result the previously identified characterization options were evaluated in an attempt to identify an alternate strategy for the preliminary characterization. Additional meetings between DOE and Ecology representatives, with input from various DQO process participants, were held. The outcome of these meetings resulted in locating a borehole near the SX-115 tank for the preliminary characterization. The details of the rationale and the location are discussed in Chapters 4.0 and 5.0.

The following decisions were made for collecting samples from the new borehole:

- Continuous or near-continuous split spoon sampling will be attempted from 3 m (10 ft) below ground surface to the water table.

- The borehole will be extended to just below the water table to allow for groundwater sampling.
- Subsamples will be taken from the split-spoon samples based on the following criteria:
  - One subsample at 9 m (30 ft) below ground surface
  - One subsample at 17 m (55 ft) below ground surface corresponding to the elevation of the base of the tank
  - One subsample taken just above the Plio-Pleistocene Unit
  - One subsample taken just above the Ringold Formation
  - One subsample taken just above the water table
  - One subsample taken at the historic high water (groundwater) mark
  - Subsample any observed paleosols
  - Subsample locations where elevated or altered gamma or moisture content is observed in borehole geophysical surveys.

Following collection of the subsamples identified, additional subsamples will be taken to ensure that subsamples are taken at a minimum of every 3 m (10 ft) between the elevation of the base of the tank and the water table to provide adequate vadose zone coverage.

The analysis methodology developed for the new borehole is based on screening analyses conducted on the approximately 25 subsamples taken from the split spoons. The screening analyses would consist of the following:

- Nitrate analysis
- pH measurement
- Electrical conductance measurement
- Total organic carbon analysis.

Four of the samples (background sample and samples taken just above the Plio-Pleistocene, Ringold, and water table) would be subject to the following:

- Gamma energy analysis
- Carbon-14 analysis
- Metals and radioisotopes by ICP-MS
- Volatile and semi-volatile organics
- Anions
- Tritium and strontium-90
- Particle size distribution.

The remaining samples would be subject to the same set of analyses identified previously for the four samples based on the results of the nitrate, pH, and TOC screening analyses.

Additional analyses would be performed to evaluate contaminant transport data and mechanisms based on the results of the previous analyses. Additional analyses that potentially would be performed based on expert judgement include:

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

E.4.0 DQO MEETING MINUTES

The DQO meeting minutes are summarized in this section. Individual meeting minutes have been reformatted to improve readability and eliminate duplicate information. Copies of the individual meeting minutes are maintained in the project files.

E.4.1 ATTENDEES AND PARTICIPANTS

The following list identifies the individuals who were involved in the DQO meetings held between February 16, 1999 and March 11, 1999:

Charlie Cole – PNNL*
Dwayne Crumpler – JEG
Suzanne Dahl – Ecology
Roberta Day – CH2M Hill
Dave Foust – LMHC
Glendon Gee – PNNL*
Dib Goswami – Ecology
Carolyn Haass – LMHC
Colin Henderson – JEG
Rich Holten – DOE-RL
Linda Johnson – CH2M Hill
Vern Johnson – PNNL*
Tom Jones – MACTEC-Meier
Raz Khaleel – FDNW
A. J. Knepp – BHI
J. L. Kovach – Independent Consultant*
Doug Larsen – LMHC
Stan Leja – Ecology
Kevin Lindsey – D.B. Stephens and Associates*
Zelma Maine-Jackson – Ecology
Fred Mann – FDNW
Rick McCain – MACTEC-ERS
Peggy McCarthy – LATA
Dave Myers – IT
David Olson – DOE-RL
Roger Ovink – CH2M Hill
Kent Reynolds – WMFS*
Wade Riggsbee –YIN
Phil Staats – Ecology
R. Jeff Serne – PNNL*
Stan Sobczyk – Nez Perce Tribe (ERWM)
Ralph Wilson – CH2M Hill
Tony Valero – Ecology
Marc Wood – WMFS
Robert Yasek – DOE-RL
Jerry Yokel – Ecology
John Zachara – PNNL

* Steering Group members (see Appendix F for Steering Group recommendations).

The following list identifies the individuals who were involved in one or more of the DQO meetings held subsequent to the main DQO meetings between March 11, 1999 and April 5, 1999.

Lucinda Borneman – FDH
Harry Boston – LMHC
Suzanne Dahl – Ecology
Dib Goswami – Ecology
Carolyn Haass – LMHC
Colin Henderson – JEG
Vern Johnson – PNNL
Tom Jones – MACTEC-Meir
Stan Leja – Ecology
Peggy McCarthy – LATA
David Olson – DOE-RL
Jim Poppiti – DOE-RL
Ruth Schreiber – JEG
R. Jeff Serne – PNNL
Phil Staats – Ecology
Tony Valero – Ecology
John Williams – FDH
Marc Wood – WMFS
Jerry Yokel – Ecology

The following list of individuals attended one or more of the DQO meetings to present information or observe the process.

Steve Anderson – MACTEC-Meier
Stan Blacker – MACTEC, Inc.
Susan Coleman – Informatics
Dirk Dunning – ODOE
Ed Fredenburg – LMHC
Daniel Goodman – Montana State University
Michael Graham – BHI
Carl Grando – WMFS
Rich Holten – DOE-RL
James Kelly – MACTEC-Meier
Jim Poppiti – DOE-RL
Russ Randall - Three Rivers Sci.
Ron Smith – PNNL
Terri L. Stewart – PNNL
William J. Stokes – LMHC

E.4.2 FEBRUARY 12 MEETING – DQO KICKOFF

Roger Ovink and David Olson opened the meeting with welcome statements and led the introductions of participants/attendees.

Ed Fredenburg presented a summary of the TPA negotiations, site-specific Work Plan development, and RFI/CMS process. At the conclusion of his presentation, Mr. Fredenburg attempted to show how the DQO process was relevant to society today.

At 8:50 a.m., Roger Ovink gave a presentation of the DQO process. Mr. Ovink stated that the process used will be a modified version of the Lockheed Martin Hanford Company procedure. Mr. Ovink showed examples of DQO flow diagrams for the ERC DQO implementation process and the PHMC process.

During a roles and responsibilities discussion, Dr. Louis Kovach introduced his team and stated that the TWRS Vadose Zone Steering Committee is not an independent review team but will attempt to provide technical verification of the activities the participants decide. Dr. Kovach provided a flow diagram that his team will use to evaluate the DQO results in an attempt to provide his team's expectations in advance (attached).

Roger Ovink then reviewed the ground rules for the meetings, the schedule for the S-SX DQO effort, and the expectation that everyone will come to the meetings prepared.

Colin Henderson discussed the goal of decoupling and the meaning of decoupling the S-SX DQO from the RFI/CMS development. He also addressed the regulatory types of decisions needed to provide information for operations personnel to perform the characterization effort. The first two characterization efforts (i.e., boreholes) will tie back to the big picture, and the discussion needs to include how to tie these efforts back to the overall tank farm mission.

Colin Henderson distributed the February 16, 1999 briefing package and discussed the material, specifically the document list.

Colin Henderson stated that the participants should discuss the consequences/conditions that would impose constraints/interim corrective measures.

Dr. Kovach stated that he still was not comfortable with the starting points. He stressed that he wants to see the technical justification before drilling the boreholes. However, Dirk Dunning believes that drilling is necessary to provide the technical justification. Dr. Kovach also stated that he would like assurance that tank farm operations believe that the drilling schedule (1st borehole) is realistic. Will an operational readiness activity be necessary and if so, was it figured into the schedule.

Tony Knepp asked Suzanne Dahl if a borehole must be used the first time or if alternatives can be discussed. Suzanne stated that Ecology's concern was that in-field characterization must be pursued. Ecology is not requiring "a new borehole."

E.4.3 FEBRUARY 16 MEETING – BACKGROUND AND OBJECTIVES

The purpose of the February 16 meeting was to provide background information on the WMA S-SX to the DQO participants and to discuss the problem statement.

Colin Henderson presented Preliminary Site-Specific Characterization Background and Objectives.

Question arose on the role of the Groundwater/Vadose Zone Integration Project Scope. Tony Knepp replied that the expert panel (subsection of expert panel [4 people] who will review the DQO report.

Charlie Cole asked integration project (applies also to science integration support) needs to be part of the problem statement. Glendon Gee agrees with this statement.

The second question related to second bullet on Identify Decisions: How does new borehole data or borehole closeout data support retrieval decisions? Colin explained that this will be defined later in the presentation.

The third question was how does this link initial activities to the larger picture? Need to be explicit about this.

Tom Jones presented Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination. Historically, tank evaporators were used to reduce tank liquids that caused the tank waste to commingle, which would compound deriving which source the vadose zone waste originated. Also, there is confusion between tank leaks and other liquid disposal sites in the 200 Areas (i.e., cribs, trenches, and ditches). Historical gamma logs were gross gamma logs and did not allow for isotope-specific identification. More recent geophysical logging allows isotope-specific identification. SX waste was a viscous salt solution, difficult to move around and solidified in transfer lines if got too cool. Various conceptual models are not simple. They involve chemistry, geology/hydrology, and natural processes. Waste is tending to solidify making their movement small. Other waste movement drivers include water leaks, and recharge through precipitation, etc.

New Action: Tom Jones to obtain George Jansen documents on heat transfer. Mel Piepho working on expert panel questions – Borehole casing temperature and linking to soil temperature profile. Could temperature be used to predict heat-generating contaminant locations in the vadose zone? Geological formation versus borehole effect.

Need sediment data less than 130 feet – part of borehole decommission?

Hard to extract cesium from the deep sediments, either some added chemical activity occurring or we have got cross-contamination.

SX was chosen for the following reasons: 1) most data, 2) largest recorded leaks, 3) could support models, 4) most exotic waste (high temperatures, up to 10 molar ionic strength), 5) furthest from the river.

MACTEC-ERS Presentation

New Action: Shape factor analysis – another expert panel recommendation. Rick McCain will get early version out to group. Specific dispersion; decide from this data if the cesium is on the casing or out in the formation. Not a black and white tool; and open to interpretation but shape factor and drilling knowledge can aid in the interpretation. 41-09-39 well is near another borehole that showed high cesium at depth. No/little drag down noted during construction. Bottom of all boreholes showed cesium contamination.

New Action: Rick McCain will provide original 41-09-39 report.

Question: Shape factor analyses for SX should be completed in the next few months. Borehole-to-borehole correlation is key and time consuming.

Question: Vernon Johnson asked what is the lowest contour interval, because 0.1 is too low. Next runs need to be higher contour interval - not 0.1. This contour interval shows cesium everywhere. Reply: Revised SX Report will back out drag down data for the various boreholes based on shape factor analysis for SX and is using a minimum contour value >0.1.

Vern Johnson Presentation on RCRA Groundwater Assessment

Currently, seven RCRA wells are used plus other sample points for groundwater giving a total of 13 sampling points. Three new RCRA wells are proposed for fiscal year 1999; two in the southeast corner of SX area and one east side to monitor S Farm. Low conductivity/specific conductance area suggests water line leaks around the tank farms. There is an anomaly at the northeast corner of SX tank farm. Groundwater levels are dropping 1.5 feet per year. Currently the wells have 3 feet of aquifer screened at most of the wells.

Technetium, chromium, and nitrate currently are detected in SX Tank Farm and are the mobile constituents. There were no findings of cesium and strontium in groundwater using typical methods of detection. Highly concentrated samples may be analyzed using laboratory methods, if they were diluted (1,000 times).

Borehole 41-09-39 shows tritium (from upgradient crib source) but nothing else. If not for tritium, water would be drinking water quality.

Fluor document (Data Gap document) tried to identify all water lines and transfer lines in the SX Tank Farm. Currently, a possible plume from the north tank farm is heading more south than southeast and joining the SX plume. No current evidence exists to support a southward groundwater flow from the S Tank Farm to the SX Tank Farm along the eastern boundary of the tank farm; however it appears the evidence of physical systems (local geological heterogeneity and cemented gravels/etc.) may cause this to occur. No site-specific data indicate this flow pattern is justified. Local patterns could be different than regional groundwater flow movement.

Proposed groundwater activities include: 1) continue monitoring at 13 wells, 2) science research of colloids (Woods Hole), large volume samples, ICP-MS, and TIMS, 3) install new RCRA wells, 4) depth distribution of COCs in the aquifer, 5) flow rate/flow direction using tracers or slug tests, 6) Well 299-W23-7 anomaly investigation; however, this well is dry, and there is an integration opportunity with 41-09-39 closure/soil analyses.

David Olson asked what conclusions could be drawn from all the data available? What do we know? No response was given.

New Action: Suggested we get the S Plant AAMs Report to evaluate the amount of liquids disposed of to other facilities around the tanks. Roger Ovink is the assignee.

E.4.4 FEBRUARY 18 MEETING – PROBLEM STATEMENT

The purpose of the February 18 meeting was to continue discussions on the problem statement and objectives of the preliminary characterization effort and to review the MACTEC-Meier 3-D visualization work.

Presentation of Problem/Decision table with problems 1) Interim Corrective Measures, 2) Retrieval and 3) Closure. Discussion focused on problem definition and objectives. It was realized last Tuesday (February 16, 1999) that people needed to synthesize the information as well as problem definition and objectives. Revisit of the problem definition and objectives were presented.

Acknowledge preliminary field activity is a small piece of a large problem. We must keep the large picture in mind (e.g., RFI/CMS Workshop, and SST WMA DQOs and Workplans).

Problem defined and need to start obtaining data based on data needs and objectives. What are the data needs and objectives?

This accelerated effort only involves the abandonment of borehole 41-09-39 and a subsurface characterization effort (i.e., installation of one borehole) and how they support the interim corrective measures, retrieval and closure.

Phil Staats recommended the following changes to the Problem/Decision table.

Problem #1: Should include vadose zone and all other media

Need to determine the action levels, point-of-compliance (POC), or some determination if a problem exists, (e.g., conservative assumption)

Phil Staats requested adding the term vadose zone with groundwater for impacts.

What is conceptual model?

Groundwater per Vern Johnson

Vadose Zone: Physical Subsurface model/Data Gap document

Lockheed Martin individuals who are over the various disciplines.

SST Retrieval Tank Lead: Bill Stokes

Interim Corrective Measures: Carolyn Haass

Closure: Ed Fredenburg

Phil and Zelma define a POC for this discussion for the purposes (for the purposes of this DQO only) in the southeast corner outside the fenceline near SST SX-113 and the land use as an industrial scenario.

Discussions about POC with Ecology, Carolyn Haass, Wade Riggsbee, and Linda M. Johnson occurred. Wade Riggsbee states Tribes prefer the fence line versus a specific point. Misunderstanding over the POC being a line vs. a point. Final understanding is that for this DQO meeting the POC will be defined as a point.

Good discussion followed on other Areas' designation of point of compliance and land use scenario. Ed Fredenburg is concerned with POC decision.

300 Area is designated industrial land use to protect the River, ER 200 Areas are designated industrial land use and residential groundwater use at the boundary of the POC.

Groundwater integration question of project from D. Olson is integration dealing with POC and land use issues. Yes, per Tony Knepp and Phil Staats.

Stan Blacker and Daniel Goodman presented the MACTEC-Meiers 3-D visualization.

E.4.5 FEBRUARY 23 MEETING – DATA NEEDS AND RECOMMENDATIONS

The purpose of the February 23 meeting was to identify data needs and refine the problem statement.

Colin Henderson presented Preliminary Site-Specific Characterization Data Needs and Recommendations. Tom Jones presented the Hypothetical Sources and Potential Pathways to Groundwater (conceptual model cartoon).

Physical pathways include: 1) preferential path through unsealed monitoring wells – possible example is well 23-1 in the S Tank Farm. Per Dave Myers (LMHC), an engineering study is being done to evaluate wells that may not have been constructed adequately to prevent direct pathway to the groundwater; 2) tank overfill – port connections were not well sealed and may be leaking; 3) Weld failure at the liner between the base and sidewall; and4) surface leaks identified as a driving force (e.g., SY-102). Other drivers may exist, however, these were identified on the conceptual model cartoon.

Per Rick McCain (MACTEC-ERS), construction compaction at base and throughout backfill with possible miscellaneous construction debris in backfill are possible pathways as indicated from gamma geophysical logging. Glendon Gee indicated perched water may exist at the Plio-Pleistocene. Need to add to the subsurface physical model for WMA S-SX. T Farm has neutron log indicating perch water on top of the Plio-Pleistocene Unit. Charlie Cole indicated the temperature/vapor recirculation effects need to be included in the CSM and down dip in caliche layer and sloping beds would move contaminants down dip from initial leak migration.

Because of the heat of tanks (350°+), soil around tank was very dry. Leaks would have migrated to these dry areas. The heat would cause the soil to further dry.

Conceptual model pathways are appropriate as shown on the conceptual model cartoon, but there may be additional sources (i.e., U Pond effects and other U facilities).

John Zachara identified that geochemical aspects were not depicted on the conceptual model presented.

New Action: John Zachara will provide a geochemical conceptual model for the tank farms per Vernon Johnson's request.

David Olson mentioned that the Subsurface Physical Model, which has yet to be built, should address these various conceptual model concepts.

Tom Jones presented data and analysis gaps document summary. This included 1) generic model developed for tank leaks and subsequent contaminant migration that included a number of uncertainties; 2) radionuclide distribution in the vadose zone; 3) geohydrologic properties; 4) geochemical changes induced by leaked tank waste; 5) recharge conditions; and 6) thermal effects. Data uncertainty – can you limit (i.e., reduce) uncertainty through knowledge of water movement, location, solubility vs. Kd differences?

Colin Henderson presented Identifying Data Needs and Sources (Corrective Action). Phil Staats asked for a definition of the "Define 'Acceptable'" box. It was decided this would be part of the RFI/CMS Work Plan. Based on an action from last week, the current definition includes a point-of-compliance and industrial scenario.

Next discussion focused on the 200 Areas ER Program future work to characterize cribs, ditches, and trenches with the potential to obtain additional information.

New Action: Roberta Day to obtain presentation on 200 Areas ER Program characterization effort during RFI/CMS Workshop.

Problem/Decision table includes modification from last week. Phil Staats remains uncomfortable with the wording of Decision 1B.

New Action: Off-line discussion with Phil Staats (Ecology) on this statement. This action was tabled until RFI/CMS Workshop.

Concern about understanding process of moving from Problem/Decision table to Problem Statement. Fundamental problem is acceptable tool to define impacts – next step is deciding on the data needed and the appropriate way to obtain this data. Various participants thought the decision statement presented by Colin Henderson was more like the problem statement. What is our real problem?

Stan Leja referred to the July 10, 1998 letter addressing corrective action; the S-SX Expert Panel's concerns about corrective action, that started back in 1996; and referenced the vadose zone program plan and stated the major problem statement should be,

What we need to know about contaminant distribution and migration for making retrieval, human health risk, and ultimately closure decisions that comply with interim status requirements, actual and potential receptors, interim corrective measures, retrieval and closure.

David Olson expressed the need to decide if immediate interim corrective measures are required and to also include retrieval and closure data needs in the collection of data objectives for this accelerated activity.

David Olson presented a slide overview of the RFI/CMS Work Plan Development Process for the General Process and Preliminary Work Plan Process. He stated the Field and Laboratory Investigation under the Preliminary Work Plan Process will include three (3) new RCRA monitoring wells, 41-09-39 borehole decommissioning, and a new characterization effort as outlined in the Tri-Party Agreement Change Package.

Preliminary Characterization Objective: The SST WMA RFI/CMS Work Plan will be designed to meet regulatory objectives that include the following: (1) compliance with interim status corrective action requirements of the HWMA and RCRA, (i.e., requirements applicable in the instance of releases from a TSD facility); (2) the generation of groundwater/vadose zone characterization data/information necessary to: (i) define the sources, nature, and extent of vadose zone and aquifer contamination, (ii) identify actual and potential receptors (via air, land, surface water and groundwater pathways), (iii) determine the need for additional interim measures or interim corrective measures; and (3) support closure of SST TSDs under the HWMA and RCRA.

However, the Preliminary Site-Specific SST WMA Phase 1 RFI/CMS Work Plan Addendum for the WMA S-SX will address the following:

"Draft TPA milestone M-45-52-T01. The Preliminary site-specific SST WMA Phase 1 RFI/CMS Work Plan Addendum for WMA S-SX will enable initial fieldwork and borehole installation to commence in fiscal year 1999. This plan will describe and schedule the gathering of specific information for WMA S-SX Tank farms necessary to meet the objectives developed through a data quality objectives process. The plan will also define specific locations and methods for sampling and analysis to meet work plan objectives. This plan will identify requirements for groundwater sampling from initial vadose zone boreholes and vadose zone sampling from planned groundwater monitoring wells."

The group adopted TPA Change Package language for the Preliminary Work Plan addendum as the problem statement for the preliminary characterization activity.

E.4.6 FEBRUARY 25 MEETING – BOREHOLE DECOMMISSIONING

The purpose of the February 25 meeting was to discuss decommissioning of borehole 41-09-39 and decide if and what types of sampling and analysis should be performed.

Dave Myers presented 41-09-39 decommissioning process and explained why this effort/ borehole is best for decommissioning before other borehole/wells in the SX Tank Farm. Borehole 41-09-39 extends to groundwater and must be decommissioned per regulations (i.e., to protect the aquifer). Other boreholes are over 30 years old and have thinner metal casings that are welded together; therefore, they have a lower percentage of success for pulling the casing and decontaminating. In addition, it would be unlikely to receive good data as a result. One other borehole (41-12-01) would be a candidate for valuable information, but does not reach groundwater. Borehole 41-09-39 would still require decommissioning if another borehole was decommissioned.

An inquiry was made regarding the confidence of the existing data obtained from borehole 41-09-39 in the lower portion of the borehole. Ecology, Steering Committee, and DOE consensus is that this is representative and inspires confidence.

A recommendation was made to use a video camera in the borehole before taking samples.

An inquiry was made about cesium dragdown and if data from 41-09-39 extension are good. Kent Reynolds stated the top samples versus the bottom samples collected with the split-spoon sampler for the extension of 41-09-39 indicate low cesium content; therefore, they are representative.

An inquiry was made about what can be collected from the lower portion (130 feet to groundwater). Glendon Gee (PNNL) suggested tensiometers be installed to collect moisture content data. Dave Myers indicated spectral gamma relogging, moisture gage, temperature, and neutron-enhanced spectral gamma logging would be conducted in the lower portion the borehole. The same four geophysical logging analyses will be conducted in the upper portion of the borehole (0 to 130 ft below ground surface) after the inner casing is removed.

An inquiry was made regarding the sidewall coring sampling. Kent Reynolds drew a picture of the sidewall coring tool. The tool would be inserted into the borehole wall at a 30-degree angle, extending 10 inches into the sidewall. Based on trigonometry, the horizontal extent would be 6 inches. The inside diameter of the sampling tool is 1 inch. Based on physical limitations (e.g., casing diameter) samples cannot be taken from the lower 95 feet.

Stan Leja asked Jeff Serne the size of sample required for analysis, which was determined to be 25 to 50 grams. Sample size of the tool at maximum capacity would be 325 grams.

Sampling locations for the decommissioning of 41-09-39 decided on following points based on the spectral gamma logging in early 1997:

25-26 feet	Midpoint of tank/drill resistance/shallowest depth because of tank equipment

45-46 feet	Backup to 25-26 sample and provides a verification sample for background.
57-58 feet	Bottom of the tank/increased saturation
61-62 feet	Peak and Gamma Saturation Zone
65-66 feet	Peak and increased drill resistance
69-70 feet	Valley
74-75 feet	Peak and Increased Moisture Zone and Gamma Saturation
79-80 feet	Valley and High Drill Resistance and Gamma Saturation Zone
82-83 feet	Highest Peak and Gamma Saturation Zone
89-90 feet	Low moisture content/Base of Hot Zone
95-96 feet	Midpoint Coverage
102-103 feet	Gamma Saturation Zone
108-109 feet	Gamma Saturation Zone
112-113 feet	Increase moisture content/Low cesium concentration
117-118 feet	Midpoint Coverage
130-132 feet	End of Hole/Dragdown of contaminants.

Three 1-inch-diameter samples can be obtained from each sample depth location. Analytical sampling will include gamma energy analysis, Tc-99 total, 1:1 water extract for analysis of nitrate, tritium, technetium, pH, and electrical conductivity. These will be acquired through the screening analysis (initial analysis).

Hydraulic parameters will not be taken for analysis because of small sample size.

Detailed analysis was presented. However, the audience was unclear what criteria are used to determine when detailed analysis is appropriate. Action: Dave Myers to present the rationale of going from initial analysis to detailed analysis at the next DQO meeting.

Prioritization of sampling protocol was unclear during the presentation; therefore, the prioritization of analysis was requested by Phil Staats. Jeff Serne to provide this information at the next DQO meeting (Tuesday March 2, 1999)

A request was made for a summary of the data collected during the 41-09-39 extension.
Dave Myers will present this information at the next DQO meeting (Tuesday March 2, 1999).

John Zachara noted that it may be advantageous to sample vertically as close as possible at one or more sample locations to assess vertical variability.

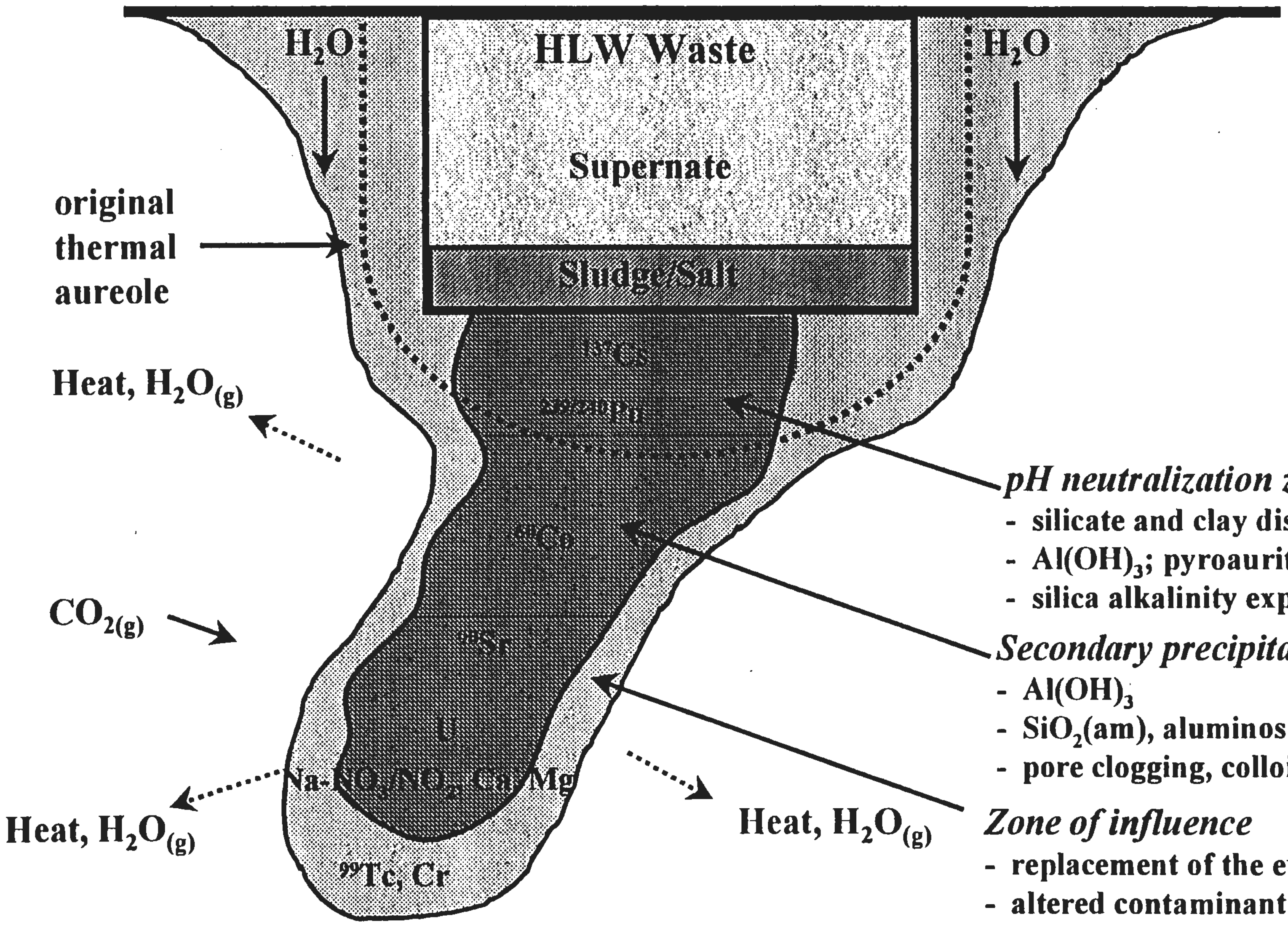
Action 19. Zelma Jackson requested equipment calibration for spectral gamma logging.
Rick McCain will provide the information.

Recommendation was made to take a temperature reading below the bottom of the casing before collecting samples.

Pre-meeting discussion (i.e., what will we be talking about next meeting?) for Tuesday, March 2, 1999. Vern Johnson will complete his presentation on the RCRA wells providing information on cost change for additional coring of the vadose zone, contaminants of concern, and sampling and prioritization of analytical analysis similar to the decommissioning of borehole 41-09-39.
Dave Myers will present a summary of extension of the borehole, prioritized laboratory analysis, rationale from initial to detailed analysis, and a logic flowchart decision tree.

A strawman of the initial field characterization will be provided to expedite the discussion for the Thursday, March 5, 1999 DQO meeting.

Hypothetical Geochemical Model of a Leaker



pH neutralization zone
- **silicate and clay dissolution**
- **$Al(OH)_3$; pyroaurite precipitation**
- **silica alkalinity export, complexation**

Secondary precipitation zone
- **$Al(OH)_3$**
- **SiO_2(am), aluminosilicates, zeolites**
- **pore clogging, colloids, coprecipitation**

Zone of influence
- **replacement of the exchange complex**
- **altered contaminant reactivity**
- **hydrochemical and physical changes**

Migration path determined by artificial recharge, geologic heterogeneities, and density gradient

E.4.7 MARCH 2 MEETING – DECOMMISSIONING 41-09-39 AND NEW RCRA WELLS

The purpose of the March 2 meeting was to review sampling and analysis recommendations from the previous DQO meeting and discuss vadose zone data needs from the three new RCRA groundwater monitoring wells to be installed outside of the WMA S-SX.

Vernon Johnson stated that per Ron Smith (PNNL), the RCRA Groundwater Program does not need to continuous core the vadose zone; therefore, if continuous core is required, TWRS must request this type of drilling method and provide the funding. No objections were made to continuous coring of the vadose zone, however, the RCRA Groundwater program will not finance this effort. At the conclusion of the February 25, 1999 RFI DQO meeting, an off-line discussion pertaining to contamination outside the fence near 216-S-8 trench and RCRA well W22-39 occurred. Based on this discussion, Vernon Johnson stated that no gamma contamination was evidenced from historical gamma logging information in this area. However, gamma logging information may not indicate near-surface contamination or surface spill gamma information, because the logging effort usually begins at some depth below the surface to reduce near-surface interference.

Vernon Johnson presented a summary of the RCRA groundwater sampling and analysis during drilling of new RCRA monitoring wells at WMA S-SX. Special groundwater sampling includes low-level gamma (Cs-137) at a detection limit of 2 pCi/L, hexavalent chromium and filtered and unfiltered chromate. As part of the national laboratories studies, special samples of light isotopes, low-level transuranics, and stable fission products will be collected for colloid data and other information.

Zelma Jackson requested the steering group provide recommendations for sampling and analyses that should be conducted for the vadose zone during drilling of the new RCRA groundwater wells. John Zachara and Glendon Gee, along with others agreed on multiple core for correlation, but that it definitely required one borehole/well to be cored to obtain physical properties, fine-grained sediments, and subsurface geology/stratigraphy. The current drill plan would provide variable results. Continuous core would provide good geology/stratigraphy and physical sampling outside the fence. Kevin Lindsey stated all boreholes should be continuously cored to provide highest quality correlation information. However, if prioritization is required, the order of priority for coring to water table would be: well number 3, followed by well number 2 and then well number 1. This prioritizes in a south-to-north trend.

Additional cost would be $30,000 per well additional compared to straight drilling. There is a projected 20 to 30% additional cost for coring versus straight drilling as currently proposed by the RCRA Groundwater Program.

Charlie Cole suggested analysis of the mobilized contaminants of concern, (i.e., nitrate and other chemicals, technetium and other radionuclides), and soil moisture should be analyzed to provide background information to compare to inside the tank farm conditions.

Kevin Lindsey suggested that from a hydrogeological/geological perspective, as much physical property information as possible should be obtained from outside the fence as compared to inside the fence because of contamination and sample handling constraints. Tank farm operations would be more comfortable with as much information as possible obtained outside the fence than inside the fence related to vadose zone issues of contaminant migration and physical properties.

Carolyn Haass brought to everyone's attention that the steering group will provide recommendations to Lockheed Martin along with other sources and Lockheed (i.e., Technical Team) will consider these recommendations of analysis and drilling methods to the DQO Group at a future date.

John Zachara, Charles Cole, Marc Wood, and Jeff Serne concurred that physical properties, chemical constituents, especially mobile constituents and moisture contents, should be acquired outside the fence to provide background/baseline conditions.

New Action: Technical Team will present recommendations for data collection from the planned RCRA wells to the DQO group for discussion and resolution.

Dave Myers presented 41-09-39 decommissioning sampling depths per Stan Leja's suggestions with the justifications. Sixteen zones were chosen for sampling, with three aliquot subsamples to be attempted for collection at each zone.

The logic chart was presented. A considerable discussion ensued over definition of the terms 'high', 'representative', and 'Unusual' initiated by Phil Staats. It was determined that the screening primary analysis will be conducted on all samples. These include: visual geologic description, total Tc, GEA (Cs), water leach for ICP metals, pH, EC, NO_3-NO_2, Tc-99, tritium and moisture content. Kevin Lindsey inquired how would we determine dragdown issues or wall effects. One way is to sample the aliquot with GEA along its length to determine if contamination is concentrated along borehole wall or mixed into formation drag down or drag along for sidewall samples. How does one reach the secondary sample analyses and tertiary sample analyses? After considerable discussion, holding points were incorporated into the flow chart below the "Perform Primary Analyses" and above the "Is the Sample Representative" and before the "Are Tertiary Analyses Warranted." Reworking of the logic diagram also was requested and the new logic chart will be presented at the next DQO meeting (Thursday, March 4, 1999).

Therefore, if the primary analyses indicate further analyses, a group of scientist, Ecology representatives, and DOE representatives will decide collectively.

Phil Staats stated he was still not satisfied that no definition to the 'High' terminology was provided. Therefore, numbers were initially assigned for each analyte.

$pH \geq 10$
$NO_3 \geq 70$ mg/L
Total Tc ≥ 70 pCi/g
Cs ≥ 50 pCi/g

If the analytes exceed these limits, they will be a candidate for further analysis.

Tony Knepp stated, "These limits will provide a guideline for reevaluation prior to making a decision." The decision-making will be done among scientists, DOE, and Ecology with a joint decision by the majority ruling. The preliminary analyses will be the basis to make the decisions on further analyses (secondary or tertiary).

Summary of today's meeting was conducted.

New Actions included Lockheed Martin providing a recommendation for RCRA groundwater wells vadose zone sampling and analyses.

New Action: Revise the logic chart presented today for the next DQO meeting on Thursday, March 4, 1999.

New Action: Distribute a handout of a strawman discussing the proposed field characterization effort to expedite the discussion for the Thursday, March 4, 1999 DQO meeting.

E.4.8 MARCH 4 MEETING – PRELIMINARY CHARACTERIZATION

The purpose of the March 4 meeting was to discuss options for new characterization activities and review the LMHC technical teams recommendation for the preliminary characterization effort.

Rick McCain presented information on calibration and verification of the spectral gamma logging and shape factor presentation. Request was made for handouts of the presentation.

Dave Myers presented the revised logic chart for sampling and analyses of decommissioning borehole 41-09-39. Charlie Cole asked what would be a value for the electrical conductivity associated with the hot zone, and would it be anomalous. Sampling strategy would be to determine fine-grained/coarse-grained interface. Kevin Lindsey indicated targeting samples to detect where the fine-grained/coarse-grained texture would occur would be highly uncertain. Jeff Serne provided a value of 600 μS/cm for the electrical conductivity guideline value.

Dave Myers stated that the decision-making group that would determine which samples would be subjected to secondary and tertiary analyses would consist of scientists including Jeff Serne, Glendon Gee, Raz Khaleel, Tom Jones, Marc Wood, Kevin Lindsey, Dave Myers, an Ecology representative(s), and a Tribal Nation representative. Decisions would be made by consensus.

At 8:55, Phil Staats requested a break for Ecology representatives to convene to discuss the logic diagram.

At 9:20, the DQO group reconvened. Phil Staats stated Ecology members would meet and resolve issues on COC guidelines and issues regarding who makes the secondary and tertiary decisions at the next DQO meeting.

New Action: Ecology to present rationale of secondary and tertiary analyses of contaminants of concern and the decision makers for what samples to analyze in the secondary and tertiary analyses.

Fred Mann presents the Preliminary WMA S-SX Characterization.

Characterization Objectives stated, "Provide data that tests understandings at most impacted location(s) that can be reached safely to define vertical/horizontal extent, ratios of key contaminants, and tank/waste impacts on soil characteristics (hydrology, geochemistry)

Data can be obtained from 1) existing "dry" wells, 2) cone penetrometer, and 3) new borehole

Lockheed Martin recommends a new borehole.

Lockheed Martin recommends a new borehole be drilled inside the SX Tank Farm northwest at 11 o'clock location of tank SX-108, which supports the SX expert panel recommendation and builds on previous characterization efforts in the groundwater and vadose zone.

Question: Why SX-108? According to Glendon Gee, based on the Agnew report, less than 1 % of the waste has been accounted for at SX-108. Based on the Ebasco report, 7% of the waste has been accounted for in the estimated leak volumes. This presents a large uncertainty. The SX-115 tank has a historic mass balance of the past inventory leak, which can be correlated back and aids in reducing the uncertainty. Another problem at SX-108 is the past leak has commingled with past leaks associated with tanks SX-109, SX-111, and SX-112. All these past leaks make the characteristic of the leak difficult to delineate to validate hypotheses related to a conceptual model. SX-115 is somewhat isolated from other leaking tanks, excluding SX-112 to the north; therefore, SX-115 would be a better choice.

Charlie Cole asked, What type of past leak occurred and what was the duration of the leak? The SX-108 leak was a slow leak, while SX-115 was a fast leak. The rate of the leak and the total volume released influences how the tank waste interacts with the soil. Understanding this relationship will help in understanding retrieval leakage loss criteria.

Glendon Gee refers to the fact that SX-115 past leak inventory is supported by a mass balance conducted by Raymond and Shdo, which could be analogous to an accounting problem. Tank SX-108 does not have this type of information and if so, the leak has commingled with the other leaks around the tank and cannot be correlated. Fred Mann asserts that one would expect the biggest impacts to the vadose zone and groundwater with the biggest leak and need to test this hypothesis.

Marc Wood stated multiple concerns can not be addressed for all the issues with the first borehole effort. Glendon Gee iterates that if you want to put two things together for Tc, SX-115 is the best example. The leak inventory is accountable and the leak is associated with a Tc-type leak versus a gamma-type leak.

A considerable discussion pursued about whether a borehole drilled around Tank SX-108 or SX-115 is the best. Roger Ovink tabled the discussion for later in the meeting.

A discussion of whether the cost would be cheaper at SX-115 because drilling could start outside of the tank farm; however, according to Dave Foust (Radcon), the cost increase is the same once the drilling activity crosses under the fence into the SX Tank Farm.

Lockheed Martin recommended a slant borehole vs. a vertical or the existing caissons. Existing caissons presents a worker health and safety issue. Permits to enter the caissons are not anticipated to be complete by the end of the fiscal year for fieldwork.

Slant borehole recommendation is to drill at a 30° angle, starting 35 to 40 ft north-northwest of SX-108, come 5 feet within the bottom of the tank, cross the Plio-Pleistocene 35 ft from the outer edge of the tank underneath the tank. The borehole would be drilled approximately 8 ft below the laterals, and extend 11 ft beyond the tank to the south-southeast at approximately 5 o'clock in an areal view into the groundwater.

Question arose where SX-108 is buckled at the base.

New Action: Tom Jones to provide photographs where SX-108 is buckled at next meeting.

Stan Leja questioned the angle. Stan had talked with U.S. Ecology about a slant borehole they drilled and found the cost break to be at an angle of 20° from vertical. Fred Mann understands this cost break occurs at 30° from vertical.

Lockheed Martin recommends extending to groundwater, with a slant borehole resulting in the direction of groundwater flow (SE). Also, this slant hole direction will be a down gradient contact relative to 41-09-39, and the laterals information can be used in supporting analyses.

Lockheed Martin recommends close-end drilling through the Plio-Pleistocene or end-of-gamma contamination (whichever is deeper), then air rotary and collecting samples from this point on to groundwater. Sampling of the zone from the end-of-gamma contamination upward would be conducted during decommissioning. The rationale is that the material would be too radioactive to handle at the surface with all the soil associated with that drilling.

Immediate discussion of what good is the data through the upper zone. Is this good data, because it has been altered by pushing the closed-end drill pipe through this zone that is similar to borehole 41-09-39. Lessons-learned on borehole 41-09-39 would indicate sampling this zone to during drilling would give more valuable data.

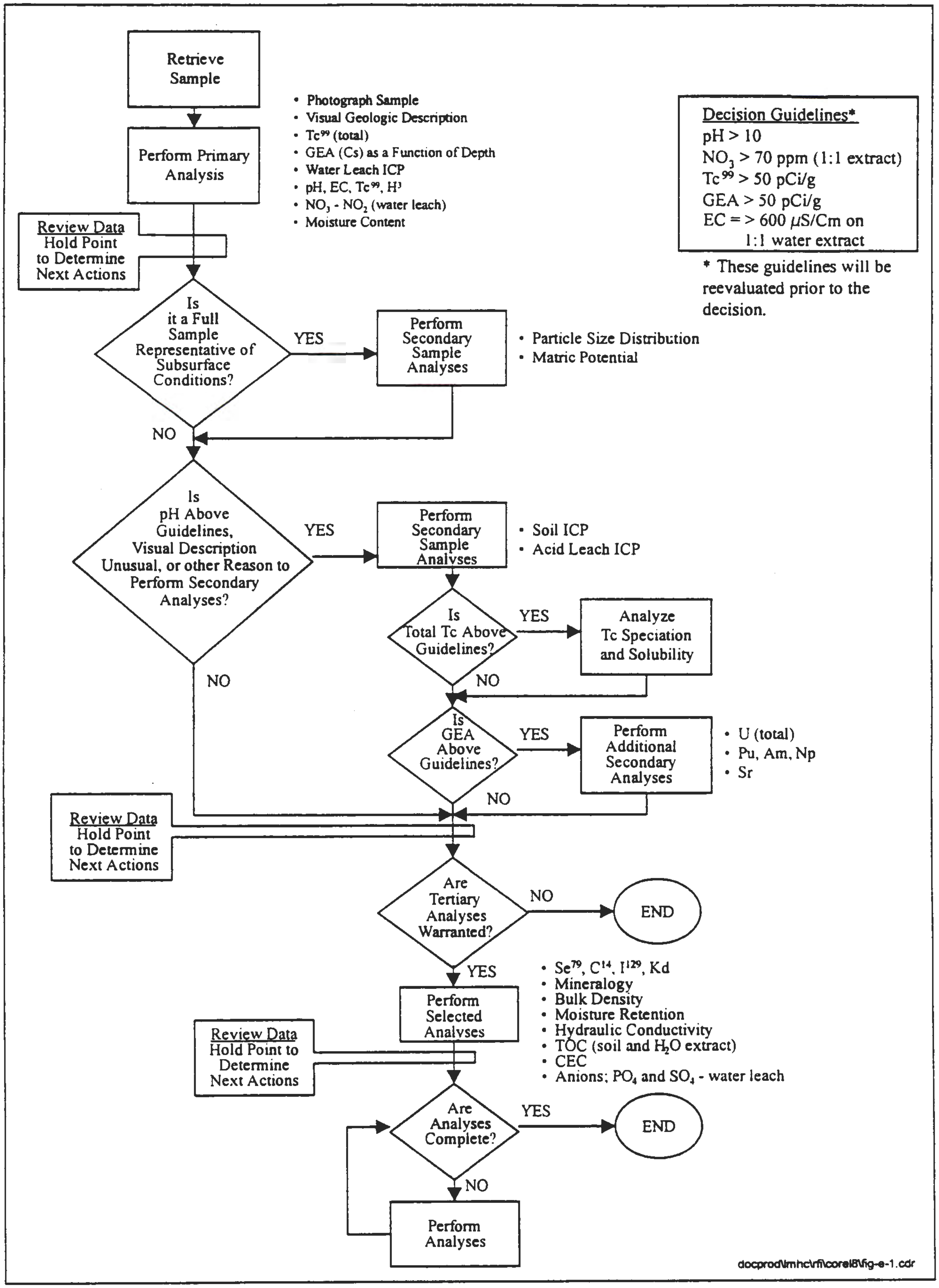
Discussion on how they are able to take waste samples from the tank, yet unable to take samples from the soils during drilling. Jeff Serne explains that the sorption of the waste to the soil, in particular cesium, increases the concentration to 10^{10}. Dave Foust believes this would be the maximum concentration and is somewhat unlikely. Stan Leja does not understand the decision on the safety consideration of collecting a sample with a split-spoon versus sidewall coring versus the health and safety. How is one able to collect from inside the tank and not from the soil column.

Dave Olson questioned the value of collecting samples on the way out of the hole with a whipstock on a slanted borehole. Is the technology good enough to collect this data coming out? A slant hole would be more challenging, reducing the chance of collecting samples. If trying to drill through the hottest zone, why not use cone penetrometer for locating the maximum contamination in the upper 100 ft. Dave Myers stated the cone penetrometer is not ready for deployment. David Olson and Tony Knepp understood that the cone penetrometer contractor was ready for deployment in the tank farms.

Sampling and analysis plan is discussed. Because the sampling and analysis follows the same procedure as the borehole 41-09-39 decommissioning and Ecology is not satisfied with this procedure, the sampling and analysis plan will be revised based on the presentation Ecology gives next DQO meeting (Tuesday, March 9, 1999).

Colin Henderson asked if anyone approved of the recommendation presented for the new borehole. Charlie Cole, Kevin Lindsey, and Glendon Gee stated there was a disconnect on the objectives. How does the Characterization Objective relate to inventory and define impacts? If collecting samples in the upper portion of the borehole is going to be conducted going out of the hole, then the data quality is mucked (compromised). Charlie Cole and others would prefer to see factors why SX-115 versus SX-108, why drill in the direction chosen versus with the deposition of the vadose zone to the southwest. Unable to follow the logic of the presentation.

Request a clear delineation of the objectives, leak characterization based on duration and the relationship and making the plan to address conceptual model validation and data collection objectives.


Retrieve Sample
Perform Primary Analysis
• Photograph Sample
• Visual Geologic Description
• Tc^{99} (total)
• GEA (Cs) as a Function of Depth
• Water Leach ICP
• pH, EC, Tc^{99}, H^3
• NO_3 - NO_2 (water leach)
• Moisture Content
Decision Guidelines*
pH > 10
NO_3 > 70 ppm (1:1 extract)
Tc^{99} > 50 pCi/g
GEA > 50 pCi/g
EC = > 600 μS/Cm on 1:1 water extract
* These guidelines will be reevaluated prior to the decision.
Review Data Hold Point to Determine Next Actions
Is it a Full Sample Representative of Subsurface Conditions?
YES
Perform Secondary Sample Analyses
• Particle Size Distribution
• Matric Potential
NO
Is pH Above Guidelines, Visual Description Unusual, or other Reason to Perform Secondary Analyses?
YES
Perform Secondary Sample Analyses
• Soil ICP
• Acid Leach ICP
NO
Is Total Tc Above Guidelines?
YES
Analyze Tc Speciation and Solubility
NO
Is GEA Above Guidelines?
YES
Perform Additional Secondary Analyses
• U (total)
• Pu, Am, Np
• Sr
NO
Review Data Hold Point to Determine Next Actions
Are Tertiary Analyses Warranted?
NO
END
YES
Perform Selected Analyses
• Se^{79}, C^{14}, I^{129}, Kd
• Mineralogy
• Bulk Density
• Moisture Retention
• Hydraulic Conductivity
• TOC (soil and H_2O extract)
• CEC
• Anions; PO_4 and SO_4 - water leach
Review Data Hold Point to Determine Next Actions
Are Analyses Complete?
YES
END
NO
Perform Analyses
docprod\mhc\rfi\corel8\fig-e-1.cdr

PRIMARY SAMPLE ANALYSES

	Analysis	Justification	Conditions for Analysis	Detection Limits	Sample Size
Primary Analyses	Photograph Sample	Visual record of sample for future reference	None	N/A	N/A
	Visual Geologic Description	Qualitative evaluation of the sample characteristics to determine if tank waste has affected the sediments	None	N/A	N/A
	Tc-99 (total)	Present in source, long-term risk driver, mobile, and has impacted the groundwater	None	0.2 pCi/g –low contamination 1 to 5 pCi/g – high contamination	1-5g
	Tc-99 (water leach)	Soluble fraction of total Tc-99	None	10 ppb	Same sample as water leach ICP
	Gamma Energy Analysis (Cesium) as a function of distance along sample	Evaluate the correlation between analysis results and the spectral gamma data	None	0.02 pCi/g for Cs-137 and other gammas 0.5 pCi/g if not swamped by Cs-137	1-5g
	Water Leach ICP (want data for all elements instrument is calibrated for: Ca, Cr, Co, Cu, Ni, Zn, Mg, Na, K, Al, Si)	Analyze for chromium and sodium, two constituents in the leak source.	None	10 ppb (10-25 ppt if use ICP-MS)	20-50g (more depending on subsequent needs)
	pH and Electrical Conductivity	Standard analyses, used to compare against background and interpret analysis results	None	NA (problem if pH is between 13 and 14) 5 microSiemens/cm	Same sample as water leach ICP
	Nitrate and nitrite – water leach	Present in the source, hazardous chemical, mobile	None	1 ppm by IC, 3 ppm by colorimetric	10-25g
	Moisture Content	Driver for contaminant migration, correlation with Tc data	If a dry drilling technique is used then analyze moisture content	0.05% by weight	10g
	Tritium (water extract)	Can be used to help determine waste source in the groundwater	None	20 pCi/kg leached moist soil (for 10 to 25 mls) depends on sample size	Same sample as water leach ICP

SECONDARY SAMPLE ANALYSES

	Analysis	Justification	Conditions for Analysis	Detection Limits	Sample Size
Secondary Analyses	Particle Size Distribution	Provides correlation with existing data for contaminant transport modeling	If sample is representative then analyze particle size distribution	0.02 wt.% cutoff for any fraction	25-100g
	Matric Potential	Driver for contaminant migration processes	If sample is representative then analyze matric potential	Filter paper method 0.05% by weight	10g
	Soil ICP (standard suite)	Determine the concentration of metals (Cr, Na, and Al) tank waste components	If pH is high and the visual description is unusual then perform the Soil ICP standard analysis	0.05% on macros and 10 ppm on most trace constituents	1-5g
	Acid leach ICP ~~(standard~~ suite)	Determine the presence and concentration of aluminum in the sample to evaluate chemical effects of tank leaks on the sediment	If pH is high and the visual description is unusual then perform the acid leach ICP analysis	5 ppm	1-5g
	Uranium (total)	Present in source, relatively mobile, potential impact	If Tc, GEA, and NO3 analyses are high then analyze sample for total Uranium	5 ppm in soil 10 ppt in water leachate	Same sample as soil ICP
	Pu, Am, Np	Present in source, waste classification concern, Np is a potential long-term concern for groundwater impact	If Tc, GEA, and NO3 analyses are high then analyze for Pu, Am, and Np	Method dependent (ICP-MS 10 ppb)	Same sample as soil ICP
	Sr-90	Major tank waste constituent, moderately mobile, potential for chemically enhanced mobility	If Tc, GEA, and NO3 analyses are high then analyze for Sr-90	0.5 pCi/g	1-5g
	Tc-99 speciation/solubility	Reduce the uncertainty in ~~assessing~~ impacts from Tc. Current modeling efforts based on conservative assumptions for the form of Tc.	If total Tc analysis results are high then perform speciation and solubility/desorption analyses.	Unknown, can detect 10 ppb Tc in liquids by ICP-MS	10-25g

TERTIARY ANALYSES (JUDGEMENT BASED)

	Analysis	Justification	Conditions for Analysis	Detection Limits	Sample Size
Tertiary Analyses	Se-79	Difficult to analyze, relatively mobile, long-lived, potential long-term human health risk concern	If a number of the primary and secondary analyses indicate a substantial influence from tank waste then analyze sample for Se-79	Unknown	10-25g
	C-14	Difficult to analyze, relatively mobile, long-lived, potential long-term human health risk concern	If a number of the primary and secondary analyses indicate a substantial influence from tank waste then analyze sample for C-14	Unknown	10-25g
	I-129	Difficult to analyze, relatively mobile, long-lived, potential long-term human health risk concern	If a number of the primary and secondary analyses indicate a substantial influence from tank waste then analyze sample for I-129	25 ppb in fluids (4 nCi/L) with ICP-MS	Same sample as Tc-99 total
	Distribution Coefficient (Kd) testing	Evaluate the mobility of contaminants to determine migration potential	If the primary and./or secondary analyses indicate need	Depends on contaminant, concentration, and matrix	10-25g
	Mineralogy	Evaluate the effect of tank waste on vadose zone sediments	If primary and secondary Tc analyses indicate high Tc concentrations and high Al concentrations and the visual evaluation of the sample indicates that the sediments have been altered then analyze sample mineralogy	Crystalline material at 5%. Chemical extraction of amorphous materials such as Al gels, hydrous oxides 0.02% by weight	Same sample as particle size distribution
	Bulk Density	Input to flow and transport modeling for sediments in the tank farm that have been altered by tank waste chemistry	If the primary analyses results indicate high concentrations of Tc, and Al (odd sample chemistry) and the available sample size is at least 100g then analyze sample bulk density (or particle density on disturbed samples)	Dependent on sampling method	Whole sample in sample holder

TERTIARY ANALYSES (JUDGEMENT BASED) (Cont)

	Analysis	Justification	Conditions for Analysis	Detection Limits	Sample Size
Tertiary Analyses	Moisture Retention	Input to flow and transport modeling for sediments in the tank farm that have been altered by tank waste chemistry	If the primary analyses results indicate high concentrations of Tc, and Al (odd sample chemistry) and the available sample size is at least 100g then analyze sample moisture retention	N/A	50-100g
	Hydraulic Conductivity	Input to flow and transport modeling for sediments in the tank farm that have been altered by tank waste chemistry	If the primary analyses results indicate high concentrations of Tc, and Al (odd sample chemistry)		50-100g (assumes UFA method)
	Total Organic Carbon (TOC) – soil	Evaluate potential for organic complexants to enhance the mobility of COCs	If mineralogy is analyzed then analyze for TOC in the soil	~0.1% by weight	1-5g
	TOC – water extract	Evaluate potential for organic complexants to enhance the mobility of COCs	If mineralogy is analyzed then analyze for TOC in the water extract	1 ppm	Same sample as water leach ICP
	Cation Exchange Capacity	Evaluate the capacity of soils to sorb ions, geochemical conceptual model consideration	If Kd testing is performed then perform CEC analysis	0.03 meq/100 gm soil. Most Hanford sediments range from 3 to 20 meq/100 gm soil.	5-10g
	Ion Chromatography for all detectable anions – water leach	Analyze for PO_4 and SO_4 - Geochemical conceptual model consideration	If Kd testing or mineralogy analysis performed then analyze sample for phosphate and sulfate	0.3 to 1 ppm dependent on mix of anions	Same sample as water leach ICP

E.4.9 MARCH 9 MEETING – PRELIMINARY CHARACTERIZATION WRAP-UP

The purpose of the March 9 meeting was to review options considered for the new characterization effort and the LMHC technical team's recommendation.

Ecology presented the analyte list for decommissioning borehole 41-09-39 (attached). The analyte list is not prioritized. After the Ecology presentation of the analyte list, Carolyn Haass requested a break.

At 9:00 a.m., the meeting reconvened. Lockheed Martin agreed to compare Ecology's analyte list with the analyte list presented in the logic chart (See March 4, 1999 DQO meeting minutes) and present on March 11, 1999 a prioritized listing based on technical approach followed by cost.

Ecology presented the next slide that referenced sample analysis locations for the analyte list. For borehole 41-09-39, these include all 16 sample points as defined in the meeting on February 25, 1999. A complete sample recovery would be required for the analysis. Clarification was made that the 16 sample points represent depth intervals and not the associated 3 aliquots at each depth interval. Composite analysis of the three aliquots may be made depending on the amount of material collected from each sample point.

For the new borehole, continuous core from 0 to 60 ft below ground surface, sample at every 5 feet and analyze at the 30-ft depth and 55-ft depth interval. From 60 to 90 ft below ground surface, sample at every 3 ft, and analyze ten samples. At a depth from 90 to 210 ft below ground surface, sample at every 5 ft. The number of analyses from 90 to 210 ft below ground surface will be determined. Gamma logging field screening will be conducted on all of the samples.

Kent Reynolds stated, "This type of sampling program could be achieved but not in the timeframe to be in the field by the end of fiscal year 1999 because the samples would be too hot to handle and exposure to workers would be extreme." Another issue would be all this hot material would be at the surface presenting handling, exposure and disposal safety issues. Safety analysis would be too large to accomplish in the targeted schedule.

Phil Staats requested a comparison to N Springs based on his knowledge of the N Springs work. Kent Reynolds responded by stating he could not give Phil a comparison at this time, but design of remote tools for handling this proposed sampling and analysis plan would be required before going to the field and the timeframe to design and construct these tools would prohibit deployment in the field until after the fiscal year 1999. Approximately 7,500 ft^3 of screaming hot material would be brought to the surface under this proposed sampling and analysis plan and Kent Reynolds stated he would not participate in this work if this plan was implemented.

Phil Staats still wanted a comparison or the rationale for the 400-rem/hr number for exposure. Carolyn Haass stated she would provide an expert to explain the possible dose rates associated with tank waste. Kent Reynolds added drilling could be done, but would exceed worker safety.

Charlie Cole suggested that other alternatives to drilling should be explored. A specific activity to find the peak gamma concentration and the targeted zones could be accomplished. A phased approach or integrated approach should be evaluated. Questions arose whether an integrated approach would meet the TPA change package milestone. Various individuals were concerned about the technical issues of a slant borehole and its feasibility on an accelerated schedule.

Dave Myers presented the recommendations for data collection from the planned RCRA groundwater wells.

Colin Henderson presented the recommendation from the March 4, 1999 meeting for preliminary characterization rankings. A list of the various questions/hypotheses related to characterization objectives was presented with various characterization location and method options. What gives the most information for answering questions/hypotheses is the slant borehole at SX-108, followed by a slant borehole at SX-115, a vertical borehole at SX-108, cone penetrometer pushes, a vertical borehole at SX-115, a vertical borehole at SX-109, caissons (existing), and ERT. A question regarding drilling at SX-115 versus SX-108 was asked. The consensus was that SX-115 presented no correlated technetium information because residual waste is all that remained in SX-115. Based on the characterization options ranking, SX-108 provides one order of magnitude increase in the information related to technetium versus SX-115.

Glendon Gee initiated a discussion about the investigation location based on the gamma data at the drywells versus gamma data in the laterals. Gamma radiation is increasing along the west side of SX-109 for unknown reasons. Drywell 41-11-10 gamma radiation increased at a depth of 83 feet in 1995. In SX Tank Farm, eight (8) drywells show gamma instability. Questions arose to what influence the southwest dipping vadose zone has with the gamma migration shown as instability within the drywells. A source of information could be extending borehole 41-12-01 and then decommissioning. The extension could begin as early as one month to 6 weeks. However, past leak contaminant plumes have mixed at the location of borehole 41-12-01; and borehole 41-09-39 indicated no deep movement of technetium.

Questions arose about focusing on gamma information and how it moves through the vadose zone or focusing on technetium and how it moves and its associated source (from what tank). Louis Kovach asked if the data acquired from decommissioning 41-09-39 would help for determining where and what depth to sample for the slant borehole at SX-108. Cannot wait for decommissioning of borehole 41-09-39 data because characterization effort to begin in July. Questions arose about investigating the source or migration of contaminants first. Based on the characterization activity, Lockheed Martin prioritized nature or source over migration. That prioritization can easily be changed.

What information will the slant borehole provide? Lockheed Martin replied that the slant borehole can provide information on the umbrella effect moisture content.

Question arose on the feasibility of the technical issues of sampling the slant borehole presented for sidewall coring in the zone above 130 ft below ground surface. Is this a safety issue for drilling this hole for permit approvals? Carolyn Haass responded that a USQ screening would need to occur. If a yes were found at this screening level, a determination would need to be made. Currently, cable tool drilling and the cone penetrometer pushes are all that is covered under the BIO. The determination would require at least 2 to 3 months based on a predetermined location. A determination could be achieved during this fiscal year.

A question arose as to why we would drill the slant borehole to the southeast versus the southwest, which is the dip direction of the vadose zone geologic strata. This would aid in providing information for the conceptual model. Is information being obtained to help answer questions associated with the multiple conceptual models? Is sampling at sufficient intervals going to collect the optimal technetium data? Interval of sampling would require at least 2 to 3 feet spacing for a vertical hole. What would be the required spacing interval for a slant borehole? What are the risks associated with sidewall coring a vertical hole versus a slant hole? The slant hole would have a higher risk of collecting quality data. No way to quantify the higher risk without first doing sidewall coring on a slant borehole. A sample could be acquired; however, it may be difficult or impossible to correlate it to specific zone or its representativeness. Caving in would be a technical problem that would not provide a representative sample. The work plan should require a practice slant borehole to be drilled and sidewall cored to determine the feasibility of acquiring a sidewall core sample from a slant borehole. Stan Leja stated that data quality was key. A collapsed wall would not provide the kind of data necessary to resolve some of the questions associated with drag down and other issues.

It was decided that some primary objective needs to be determined for the new characterization effort.

Phil Staats asked, "Why drill the hole toward the southeast, when the vadose zone contamination migrated to the southwest? Why not drill the slant borehole to the southwest to follow the leak migration plume (from SX-108 to SX-112)." Fred Mann said the same zone would be encountered because of the geometry of the slant borehole. Borehole length would be the same. The conceptual model presented by Vern Johnson has been changed. One of the conceptual models contaminant plumes has been shifted to the east in the groundwater.

Vernon Johnson presented for the first time his new findings based on conversations with Louis Kovach and comparing Tc-NO_3 ratios. The Tc-NO_3 ratios are different in all locations where technetium has reached the groundwater. This is a possible indication of multiple sources, which was hypothesized by Stan Leja two years ago. The ratios indicate that potentially not all of the technetium is reaching groundwater or leaving the tanks. Fred interjected that the slant borehole could provide this information.

Carolyn Haass reiterated that the prioritization of nature or source was made over migration pathway. She proposed that two characterization activities be pursued, 1) slant borehole under SX-108 to determine source and 2) a slant borehole in the dip direction of the vadose zone units, neither one has to extend to groundwater. Another option is a slant borehole to the southeast and cone penetrometer work for the extent of contamination to the southwest of SX-108.
Louis Kovach stated that sometime or another, the technetium in the vadose zone needs to connect with the technetium in the groundwater component.

Colin Henderson stated that ranking the various strategies provided that the slant borehole at SX-108 would provide the most information for the characterization activity compared to a vertical borehole at SX-108, a slant borehole at SX-115, a vertical borehole at SX-108, cone penetrometer pushes, a vertical borehole at SX-115, a vertical borehole at SX-109, ERT, and caissons.

David Olson requested the ranking sheets for the slant versus the vertical boreholes.

Zelma Jackson inquired who will be addressing the data quality assurance/quality control part of the new characterization effort. Colin Henderson replied that Jacobs will provide that information as part of the accelerated site-specific work plan.

Colin Henderson went on to say that the preliminary work plan is due April 1st and the site-specific characterization activities are to begin in May, so a determination on what this characterization effort is and how it will be implemented needs to be decided this week. It was decided that Thursday, March 11, 1999 will be the last DQO meeting. It was suggested a determination or agreement list be created to list the prioritization of the various activities.

An agreement list was generated.

For decommissioning of borehole 41-09-39:

1. Decommissioning and sampling will be conducted.

2. Sixteen sample depth intervals will be collected with three attempts to collect aliquot subsamples at each depth interval.

3. Two analyte lists will be combined and prioritized by Lockheed and Ecology. Louis Kovach will provide Colin Henderson the rationale on the radionuclides listed in the Regulatory DQO document.

For the three (3) RCRA groundwater wells:

1. As proposed, core and collect cutting samples.

2. Analysis will be conducted for hydraulic parameters.

3. Should contamination be encountered, the borehole will be held open until a sample is acquired and analyzed. Contamination will be based on gamma screening of the core samples and cuttings conducted by HPT.

New Characterization Effort:

1. No location has been determined.

2. No COCs have been determined, could be based on 41-09-39 analyte list.

3. No agreement to the primary objective has been determined.

4. No depth intervals for sampling have been determined.

5. No method for collecting the sample (i.e., cone penetrometer, borehole) has been determined.

6. Gamma logging of the borehole or cone penetrometer hole will be conducted.

Primary objectives to be considered include: 1) collecting groundwater data, 2) beginning in fiscal year 1999, 3) BIO limitations, 4) Worker safety and disposal issues, and 5) satisfying DOE and Ecology needs.

Washington State Department of Ecology's Analyte Table
Presented at the DQO meeting (March 9, 1999)

Purpose of Sampling

1. No requirements for physical testing.
2. Three objectives for Characterization Activity
    - a. Determine nature and extent of contamination.
    - b. Understand the mechanisms of contaminant fate and transport.
    - c. Provide data for risk calculations.

Reasons and kinds of Analyses

If one borehole, no predecisional criteria for performing analyses.

First Analyses

1. Cation Exchange Capacity (CEC)
2. Particle size distribution
3. Mineralogy
    - a. zeolites
    - b. weathered clays
4. Tank waste constituents are unknown

Therefore, based on Regulatory DQO

1. Radionuclides
    - a. alpha-emitters
    - b. beta-emitters
    - c. gamma-emitters
2. Semivolatiles
3. Metals
4. pH
5. Anions
    - a. Nitrate-Nitrite
    - b. Phosphate
    - c. Sulfate
    - d. Chloride
    - e. Fluoride.

Washington State Department of Ecology's Recommended Sampling Interval Table
Presented at the DQO meeting (March 9, 1999)

Borehole 41-09-39

Sixteen sample points (depth intervals)
Entire analyses

New Borehole

Continuous Core

Elevation from 0 to 60 feet

- Sample every 5 feet
- Analyze 1 sample at 30 feet and 1 sample at 55 feet.

Elevation from 60 to 90 feet

- Sample every 3 feet
- Analyze 10samples.

Elevation from 90 to 210 feet

- Sample every 5 feet
- Analyze ?

E.4.10 MARCH 11 MEETING – ISSUE RESOLUTION

The purpose of the March 11 meeting was to resolve action items from the previous meeting and discuss issues and concerns related to the recommended approach for the preliminary characterization effort.

The list of prioritized COCs were tabled for borehole 41-09-39.

Colin Henderson recommended SX-108 slant borehole to groundwater. Carolyn Haass stated, "BIO safety will not be an issue through confirmation with Lockheed management. Lockheed management is committed that the new characterization effort will begin in the field in FY 99."

Colin Henderson resumed recommendations discussion. Three objectives for the Lockheed Martin Technical Team are: 1) provide data at most impacted location, especially for inventory; 2) hypothetical find REDOX waste that has leaked out and solidified underneath the tanks, and 3) gather data to test the 'umbrella effect' of moisture content adjacent to and underneath the tanks. An additional objective is to determine the impact of the REDOX waste on the soils. The first objective will be to try to answer the question whether the technetium is with the cesium or below the cesium with the other mobile constituents by determining Tc/Cs ratios.

Questions that address various approach issues were asked of the Technical Team. These various approach issues are attached along with options associated with the characterization effort. This attachment includes all approach issues and options raised during the entire meeting, not specifically at this juncture of the meeting.

Rick McCain stated, "Need to understand the dose rate in the hot zone underneath the tanks to determine what we are dealing with for future characterization activities." A need to determine what is there (i.e., cesium contamination concentration) is required to establish future drilling method(s) to protect workers during future drilling activities in the SX Tank Farm.
No determination or resolution on this question was reached.

Dave Foust presented a slide (attached) that provides levels of contamination and the related radiological controls to be performed. The anticipated maximum expected contaminated soil to be retrieved is between 10^6 and 10^{10} pCi/g. The 10^6 to 10^8 pCi/g range is the level typically encountered with in-tank samples.

Wade Riggsbee asked if streaming or shine phenomena were considered. Dave Foust's reply was that it would be similar to work associated with an open riser, and yes, it was considered.

Carolyn Haass stated that the recommendation by Lockheed Martin is to drill a slant borehole to groundwater in the northwest quadrant of SX-108 and decommission and sample borehole 41-09-39.

The Steering Committee was asked to provide their input and summary of the meetings. Louis Kovach as the chairperson was first to address the meeting.

Louis Kovach assessed the reason the DQO failed was logic was applied to an illogical problem. Slant borehole will provide data closer to the source term, but not necessarily at the source. Possibility exists that the entire source may be missed, because location of the leak is unknown. The source has changed over time from initial release based solely on heat loss from initial leak. No existing sampling data to apply logic exercise for future characterization. Do the best possible with information or lack of information available. Information obtained from decommissioning borehole 41-09-39 would help to provide data to determine sampling and analyses plan, but schedule will not permit this activity from occurring before characterization effort.

Kevin Lindsey agreed with Louis Kovach and added a different way to determine nature and extent. TPA forced action before applying logical approach. The existing data have not been summarized fully and analyzed before trying another characterization activity.
Borehole 41-09-39 and the RCRA groundwater well strategies are well founded, but the preliminary characterization effort is premature.

Charlie Cole added other activities can be done: screening effort of gamma logging, cone penetrometer, ERT, etc. for a better understanding of initial conditions or existing gamma data under the tanks and in the tank farm other than a drilling effort. Need to find a target zone through other intrusive activities to determine the optimal location for drilling a borehole.

Jeff Serne stated, "Geochemical data is needed. A large data gap exist for chemical data.
A good knowledge of gamma data through the spectral gamma logging exists, but chemical data within the vadose zone are largely nonexistent."

Kevin Lindsey stated, "I feel like we are trying to determine the nature and extent of the universe."

Stan Leja stated, "Need nature and extent down the road. Currently, need to determine the mechanism of transport leading to risk on a short-term goal. Short-term need to know mobile constituents and where they are located in the vadose zone and groundwater. An answer is required by 2003 for basis of retrieval leakage determination.

Vernon Johnson stated. "Water leach tests would provide a fingerprint tool to aid in the location of technetium and its mobility versus cesium relationship. What is the mobility status of radiological components?" This borehole will only make a single point determination.

Glendon Gee stated that a clear resolution of how to collect the sample to potentially prevent compromised sample quality. Determination of the utility and interpretation of sample is warranted. The location of sampling for the slant location vs. ERT and cone penetrometer work should be evaluated.

Kent Reynolds stated that determining how the movement through the vadose zone to groundwater for the mobility of contaminants was needed. What is moving? Not certain how a solid mass of contamination and waste under tank has to do with mobile constituents and groundwater?

Fred Mann stated that determining Tc/Cs ratio for under the tank with that at borehole 41-09-39 would provide multiple points in comparison to Louis Kovach's statement of only a single point. Louis Kovach's reply was that we still do not know if that is representative of which tank leak inventory.

Marc Wood stated that the objectives need to be defined to determine what we are looking for under this preliminary activity. If it is technetium migration and mobile constituents, this priority is not related to high impact zones.

David Olson stated that some data are better than no data.

Louis Kovach closed by stating, "Slant borehole in relation to other activities is a narrow scope compared to overall objective. Don't ask the Steering Committee for justification of the slant borehole."

Meeting was adjourned. DOE/Ecology/Lockheed Martin met to decide the preliminary characterization effort, location, and sampling and analysis plan.

SX Tank Farm Characterization
Radiological Control Considerations

Maximum Expected ^{137}Cs Contaminated Soil to be Retrieved	<10^2 pCi/g	10^2 - 10^6 pCi/g	10^6 - 10^8 pCi/g	10^8 - 10^{10} pCi/g
Expected Whole Body Dose Rates	< 1 mR/hr	1 - 100 mR/hr	> 100 mR/hr	> 500 mR/hr

Radiological Contamination

Estimated Radiological Control Cost Factor	x1 - x2	x2 - x5	x5 - x10	x10 - x?

Radiological Controls

Radiological Controls	Radiological Worker II Training Possible Anti-Cs Intermittent HPT Coverage Near Limit of Detection for Field RadCon Instrumentation	Anti-Cs Standard contamination control techniques Continuous HPT Coverage RadCon ALARA Review Enhanced Work Planning	Supplemental dosimetery Consider Respiratory Protection Containments Possible High Radiation Area Controls Mock-ups Consider Remote Tools & Shielding Job specific training Management ALARA Review	Extensive Job Specific Training Extensive Mock-ups Shielding & Remote Tools Required High Radiation Area Controls Probable Respiratory Protection Total Ventilated Containments Notice of Construction Operational Readiness Review

Table E.1. New Characterization Effort Objectives, Options, and Proposed Approach Issues Prepared at the DQO Meeting (March 11, 1999)

Objectives	Options	Proposed Approach Issues
Inventory under tank	Collect groundwater sample (secondary driver)	"Dragdown" problems (compromise representative sample)
REDOX waste location	Don't sample in highest radiation zone(s) due to sample handling/worker safety issue and decision-based on new gamma log data.	Ability to sample with sidewall core device
Test "umbrella" effect	Limited sample size/volume to meet health and safety needs.	Ability to collect adequate sample volume
Impact of REDOX waste on soils.	Better review of existing data to support characterization planning.	Worker safety (dose) concerns/planning.
	Phased sampling approach to help plan future characterization.	Might miss tank hot spot (plume) [location/borehole angle issue and difference of opinion over conceptual model)]
	Alternative borehole locations	Schedule constraints
	Alternative sampling methods (cone penetrometer, continuous coring, and ERT)	Characterization sequencing (41-09-39; RCRA groundwater wells)
		Mobility of contamination.

Washington State Department of Ecology's Prioritized Analyte Table
Presented at the DQO meeting (March 11, 1999)

Purpose of Sampling

No requirements for physical testing.

Three objectives for Characterization Activity

1. Determine nature and extent of contamination.
2. Provide data for risk calculations.
3. Understand the mechanisms of contaminant fate and transport.

Reasons and Kinds of Analyses

If one borehole, no predecisional criteria for performing analyses.

First Analyses

Tank waste constituents are unknown; therefore, based on Regulatory DQO

Constituents

1. Radionuclides – 237Np, 137Cs, 14C, 152Eu, 241Am, 239/40Pu, 90Sr, 60Co, 99Tc, U and gross alpha-emitters, beta-emitters, and gamma-emitters.
2. Metals total analysis by inductively coupled plasma-mass spectroscopy (ICP-MS) (by inductively coupled argon plasma [ICAP])
3. Semivolatiles with tentatively identified compounds (TICs)
4. pH
5. Anions
    a. Nitrate-Nitrite
    b. Phosphate
    c. Sulfate
    d. Chloride
    e. Fluoride.
6. Cation Exchange Capacity (CEC), Particle size distribution, Mineralogy (zeolites, weathered clays)

E.4.11 MARCH 11 MEETING – ISSUE RESOLUTION: UNCERTAINTIES

The purpose of the March 11 follow-on meeting was to discuss options for moving forward with the preliminary characterization given the issues and concerns raised in DQO meetings. The follow-on meeting was conducted with a subset of the DQO participants that consisted mainly of the decision-makers.

The preliminary characterization effort was discussed. The recommendation presented by the LMHC team was discussed, and it was agreed that the rationale for characterizing under SX-108 has merit for beginning to answer a number of questions about the largest inventory within the WMA S-SX. However, a number of uncertainties identified with moving forward with the slant borehole during fiscal year 1999 were discussed, and Ecology's position was that these uncertainties were too great to pursue the slant borehole for this preliminary characterization effort. Some of the uncertainties identified included the following:

- Uncertainty associated with sidewall sampling from a slant borehole
- Representativeness of the sidewall samples
- Safety issues with samples from the hot zone
- Inability to fully use the information and experience gained in decommissioning borehole 41-09-39.

The programmatic importance of success with this preliminary characterization effort was discussed.

Ecology recommended a vertical borehole in the down dip region (southwest) of SX-108. The proposed borehole would extend to groundwater and include collection of continuous driven samples. This proposal was discussed and the benefits identified included the following:

- Increasing the probability of success (a mid-July deployment for borehole installation) for the preliminary characterization effort
- Reduced uncertainty associated with sample collection
- Allow time to further plan and develop methods for sampling beneath SX-108.

A path forward for the preliminary characterization effort was agreed on that included constructing a vertical borehole in the region southwest of tank SX-108. This location is in the area of contamination (within the postulated leak plume from SX-108); therefore, the chances of going through a contaminated zone are high. Additionally, the cesium-137 concentrations are at a level that should allow samples (4-in. diameter) to be contact handled.

Table E.2 New Borehole Location Options
Prepared at the DQO Follow-On Meeting (March 11, 1999)

1. Slant Borehole at SX-108	Too many problems. Sample collection and data quality, tentative location (SX-108) may not be correct.
2. Borehole SX-108	(near to DOE borehole) close hole with sidewall sampling during decommissioning. Same technical issues as with option 1.
3. Extension of borehole 41-12-01 Decommission from 125 feet.	Not in hot zone? 80-85 feet may be hot zone- again same technical issues as with option 1.
4. Extension of borehole 41-08-07 (70-75 feet)	DOE nixed because it may go through hot zone and it may be too close to tank. same technical issues as with option 1 and safety issues.
5. Extension of borehole 41-11-10	Edge of plume plus same as 08-07.
6. Cone penetrometer/ERT	Unless a physical sample retrieved, little useful chemical data, moisture data. Not enough new and useful data. Existing drywells prove the same information.
7. Borehole downdip of SX-108	Good location in view of uncertainties in data. location is downdip. Known technology; likely to hit contamination but not to hot to handle. Assume large initial casing diameter to allow telescoping and prevent dragdown. (preferred of good future data)?
8. Borehole near SX-115	Also viable for same reason as option 7.
9. Borehole in S Farm	Also viable for same reason as option 7.

E.4.12 MARCH 26 MEETING – ISSUE RESOLUTION: CHARACTERIZATION OPTIONS

The purpose of this meeting was to review the options identified for the first sampling location in the WMA S-SX and the characterization strategy for fiscal year 1999 and assure that there was a logical and technically defensible basis for the preliminary characterization plans.

Three general objectives for conducting vadose zone characterization were identified and discussed. These objectives included characterization of the source, location and distribution, and transport pathways and processes. The purpose of characterizing the source was identified as determining "what" is in the vadose zone. The location and distribution objectives are necessary to determine "where" the contaminants are at. The transport pathways and processes are related to addressing "how" and through what pathway the contaminants are moving.

Plans for sampling and analysis during decommissioning of borehole 41-09-39 were reviewed. LMHC identified that the data obtained from this characterization effort would provide a wealth of information relative to characterizing transport pathways near the SX-108 source (in a downdip direction).

A subset of the options for a new characterization effort were discussed in terms of different characterization objectives (e.g., source, transport and distribution) and in terms of which ones are feasible during fiscal year 1999 and which ones have the potential to add the most value during fiscal year 1999. The options discussed included slant and vertical boreholes near the SX-108 tank oriented towards characterizing the source near SX-108, a vertical borehole down dip of SX-108 oriented towards transport pathways and distribution, vertical boreholes near the SX-115 tanks oriented towards characterizing the source near SX-115, and a vertical borehole outside of the tank farm fence line near the SX-115 tank oriented at addressing transport pathways and potentially refining the source of groundwater contamination.

The option of locating the new characterization borehole near the SX-115 tank was recommended by LMHC. This general location provides the opportunity to collect data near the source of the SX-115 leak. The general location towards the south east of tank SX-115 outside of the tank farm fence line was discussed as a location that could be used to potentially explain the source of groundwater contamination observed in the RCRA monitoring wells. A location to the south east of SX-115 would be upgradient (groundwater) of the Tc-99 hits in the groundwater and down gradient (groundwater) of the SX-115 tank. This location would provide vadose zone samples in an area of high recharge (similar surface conditions to the tank farm) for collecting hydrologic, geologic, and chemical property data. Additionally this location would provide the opportunity to deploy the reverse air rotary drilling method outside the tank farm and demonstrate the air control equipment to meet department of health requirements. Ecology took an action to discuss this location off line and provide feedback to LMHC.

E.4.13 APRIL 1 MEETING – ISSUE RESOLUTION: SAMPLING AND ANALYSIS METHODOLOGY

The purpose of the April 1 meeting was to discuss the sampling and analysis methodology for the 41-09-39 borehole decommissioning and the new borehole. The objectives were to resolve differences between the COC lists developed by the LMHC technical team and the list developed by Ecology and to resolve differences in the logic chart discussed in prior DQO meetings.

The need to develop a logic chart or screening methodology for the analysis was discussed in terms of the number of the project not being able to fund analyses for all possible COCs on all samples.

Ecology stated that they believed that the 41-09-39 borehole decommissioning was more of a research effort as compared to the new borehole and that the analysis logic used for the decommissioning effort was not an area of concern. Ecology stated that the logic diagram was acceptable for the decommissioning effort but they would likely not approve the logic diagram for the new borehole.

Alternative approaches were discussed and Jeff Serne identified an approach where a full suite of analyses would be run on a limited number of samples and screening analyses run on all samples. The results of these analyses could then be used to refine the location of additional samples and more detailed analyses to more efficiently describe the contaminant plume if present.

Ecology representatives refrained from stating whether this approach would be acceptable but recommended that the approach be put in writing and submitted for consideration.

Ecology requested that volatile organic analysis be conducted in addition to semivolatile organic analysis. A discussion followed regarding the use of screening analysis using total organic carbon (TOC) analysis results as a trigger for conducting volatile and semivolatile analysis. It was agreed that TOC could be used as a screen for conducting volatile and semivolatile analysis. Jerry Yokel took the action to determine what an appropriate TOC trigger level would be.

The need to analyze gross alpha and gross beta was discussed and with respect to the radionuclide analysis Ecology deferred to the LMHC technical team. It was determined that analyses for specific radionuclides of concern could be conducted in lieu of gross alpha and gross beta analyses.

E.4.14 APRIL 5 MEETING – ISSUE RESOLUTION: BOREHOLE LOCATION

The purpose of the April 5 meeting was to provide additional background data on the SX-115 tank and review the available options for borehole locations. Following the March 26 meeting feedback was received from Ecology indicating that they were interested in maximizing the potential of obtaining vadose zone samples in an area impacted by a tank leak. Historical data relating to the SX-115 leak event was discussed and the follow on characterization work performed by Raymond and Shdo in 1965. Cesium contamination plumes in the vadose zone were reviewed and discussed as well as the more recent spectral gamma logs for this tank. A map of the top of the carbonate layer developed in previous DQO meetings by Kevin Lindsey was reviewed and discussed to better visualize the geologic features and the south westerly slope that may be influencing contaminant migration in the SX Tank Farm. Two conceptual models for groundwater contamination sources developed by Vern Johnson in the RCRA assessment report were reviewed and discussed as two of many possible explanations for what has been detected in the groundwater. Both of the conceptualizations included a source near the SX-114 and -115 tanks.

Three regions near the SX-115 tank were discussed as potential locations for the new characterization borehole as a refinement to the general location discussed in the March 26 meeting. The three locations include a region to the south east of the tank outside the tank farm fence line, a location to the south-southwest of the tank outside of the tank farm fenceline, and a location to the southwest of the tank within the tank farm. The location inside the tank farm was near the cesium plume identified by Raymond and Shdo.

The types of questions and hypothesis that could potentially be evaluated with data obtained from these three locations was discussed as shown in Table E.1. Both locations south west of the tank have the best chance of finding mobile contaminants in the vadose zone due to the initial spread of the leak (Raymond and Shdo work) and the potential geologic controls (e.g., south westerly dip). The location inside the tank farm improves the chances of finding mobile contaminants in the vadose zone to begin addressing questions related to transport pathways and contaminant distribution. It was agreed that the most optimal of the three regions discussed was the location within the tank farm southwest of the tank. This location within the tank farm had been reviewed by tank farm operations and there were no surface structures or obvious interferences in this location. It was acknowledged that additional subsurface investigation (ground penetrating radar) would be required prior to final siting of the borehole. Additional activities such as the Notice of Construction and the safety evaluation that need to be completed prior to starting drilling in the farm were briefly discussed.

Table E.3. Questions and Hypothesis Addressed at Different SX-115 Borehole Locations

Questions/Hypothesis	SW of SX-115 outside the fence line	SE of SX-115 outside of the fence line	S-SW of SX-115 inside the fence line
Recharge distribution (moisture profile) analogous to the tank farm	X	X	X
Potentially locate mobile contaminants (Tc and NO_3) in vadose zone due to leak plume and down dip direction	X		X
Moisture content and analysis in area of water line leak	X		
Deploy desired drilling method for future characterization	X	X	X
Assessment of dragdown using microspheres	X	X	X
Groundwater samples close to a tank known to have leaked a large volume	X		X
Groundwater samples close to a tank known to have leaked a large volume in a down gradient groundwater location		X	
Provide data to refine geology (slope of Plio-Pleistocene and carbonate)	X	X	X
Obtain vadose zone samples in area with known gamma contamination based on historical data			X

E.5.0 REFERENCES

DOE 1999a. 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. January 1999.

DOE 1999b. Vadose Zone Expert Panel Meeting – Meeting Closeout Report. DOE/RL-98-G7, Rev. 0. Richland, Washington. January 1999.

DOE-GJPO 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. September 1996.

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

Johnson and Chou 1998. Johnson, V.G. and C.J. Chou. Results of Phase I Groundwater Quality Assessment for Single-Shell Tank Waste Management Areas S-SX at the Hanford Site. PNNL-11810. Prepared for the U.S. Department of Energy. 1998.

Jones et al. 1998. Jones, T.E., R. Khaleel, D.A. Myers, J.W. Shade, and M.I. Wood. A Summary and Evaluation of Hanford Site Tank Farm Subsurface Contamination. HNF-2603. Lockheed Martin Hanford Corporation. Richland, Washington. December 1998.

Myers et al. 1998. Myers, D.A., D.L. Parker, G. Gee, V.G. Johnson, G.V. Last, J. Serne, and D.J. Moak. Findings of the Extension of Borehole 41-09-39, 241-SX Tank Farm. HNF-2855. Lockheed Martin Hanford Corporation. Richland, Washington. 1998.

Raymond and Shdo 1966. Raymond, J.E. and E.G. Shdo. Characterization of Subsurface Contamination in the SX Tank Farm. BNWL-CC-701. Battelle Northwest. Richland, Washington. June 1966.

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

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

WHC 1992b. Tank 241-SX-109 Leak Assessment. WHC-MR-0301. Westinghouse Hanford Company, Richland, Washington. August 1992.

APPENDIX F

TANK FARM VADOSE ZONE PROJECT STEERING GROUP RECOMMENDATIONS

This page intentionally left blank

TWRS VADOSE ZONE CHARACTERIZATION STEERING GROUP RECOMMENDATIONS

Kevin Lindsey, Vern Johnson, Kent Reynolds, Glendon Gee, Louis Kovach, Charlie Cole, and Jeff Serne

April 2, 1999

Introduction

The purpose of this letter report is to present the TWRS Vadose Zone Steering Group's comments and recommendations for the preliminary, FY99 SX tank farm characterization DQO. We compiled these comments from various communications and discussions between steering group members and notes from individual members compiled during the sequence of DQO meetings held between 2/16 and 3/11, 1999. We divide this report into the following sections:

- FY99 vadose zone characterization objective
- Analytical needs
- Sampling locations
- Sampling methods, including alternative ideas
- Recommendations and conclusions

The comments and recommendations included in this report attempt to integrate decoupled FY99 characterization activities with potential characterization activities that will be carried out in subsequent years. Consequently, our ideas are based on implicit assumptions such as: (1) FY99 characterization is part of a logical, more extensive characterization pathway, (2) the results of FY99 characterization will contribute to focusing subsequent efforts, and (3) FY99 characterization is not tied to a location arbitrarily selected outside the entire characterization process.

Proposed FY99 Vadose Zone Characterization Objectives

Before characterization activities can be chosen and carried out, characterization objectives need to be identified. Characterization objectives provide the guidance needed to identify and determine the scope of specific characterization activities needed for the project. The following discussion reviews our understanding of the specific objectives most readily met during FY99 characterization.

High Level Objective

The primary problem in obtaining a consensus on the "decoupled" FY99 characterization work for the SX tank farm was the lack of a clear statement of objectives specific to the proposed project and how the proposed work will support higher level objectives. The basic objective for TWRS vadose zone characterization is tied to the TPA milestones and the regulatory language related to the RCRA Facility Investigation -Corrective Measures Study (RFI-CMS). Within the TPA and RFI-CMS framework, the end or ultimate objective is water resource protection (groundwater and the river).

The decoupled FY99 work must support the requirement to identify the nature and extent of the contamination within the study boundary for the RFI as defined in the corresponding TPA milestone. However, the decoupled FY99 characterization work proposed for the SX tank farm exists in part outside the RFI-CMS characterization framework which has yet to be determined. Given this uncertainty, the steering group members asked themselves and each other, how can decoupled FY99 characterization best support yet to be determined S-SX waste management area characterization activity. We concluded that the decoupled FY99 SX tank farm characterization effort must: (1) be attainable within the short time frame remaining for FY99, (2) contribute to near term water resource protection activities which probably are fundamental to any RFI-CMS activities that will occur, and (3) not be required to answer all outstanding vadose zone characterization questions.

Specific SX Characterization Objective for FY99

Based on the water resource protection objectives noted above, we concluded that decoupled FY99 characterization should focus on determining the mobility status of the source of ground water contamination.

Contaminated soil samples from key sites are needed to address this issue. Since post emplacement mobility of tank liquor and/or associated contaminants is a primary concern, water leach tests on recovered material within and near the contaminated soil should be a high priority. This information would be used to find out if enhanced infiltration is likely to continue leaching mobile contaminants from the suspected "hot zones" and thus continue contributing to future ground water contamination. By determining both the total sediment composition and the water leach fraction, some idea about the physical and chemical status of the waste can be deduced.

Laboratory derived release rates for major contaminants of concern (using actual source material) can be combined with estimates of infiltration rate or moisture migration rates which in turn can be compared to observed groundwater data. Comparisons of both the dynamics and key constituent ratios can be used to either confirm a connection to the source or show that there is no logical connection between observed groundwater contamination and the largest known leak volume site in S-SX. This is fundamental information that can be used to help decide whether any additional interim corrective actions or measures are needed other than best management practices.

The issue of extent and/or distribution of contaminants throughout the vadose zone and the location of immobile contaminants should be deferred until after the RFI-CMS workplan has been developed. This will provide time to assimilate the initial results of the decoupled FY99 characterization and reevaluate previously collected information in light of new information. The point of this is, that the information obtained supports the objective of the RFI and TPA by identifying controls on contaminant mobility and extent. This is needed to support actions deemed appropriate to reduce or eliminate the source of groundwater contamination.

Analysis Needs

Chemical, radiochemical, and physical analyses are required to meet the ultimate goals of the SX tank farm RFI-CMS. When collecting the data needed to support FY99 objectives we need to ask ourselves, what do we need to know to make the right decisions? When we ask this question we need to then ask, how much of this can we get from previously completed and/or ongoing work and how much new data will we need to collect? To answer these questions we also need to factor into them the cost in time, money, and safety of collecting the information versus its likely influence on the eventual results, e.g., is it cost effective to collect certain information? In addition, for all of the characterization that may be done we must continually ask ourselves how much of the natural complexity of the vadose zone system under the farm do we need to understand and model in order to make the right decisions.

For the near term FY99 objective the assumption is that the most important data to collect should focus on the impact of mobile contaminants. This data is necessary in the short term to identify whether or not interim corrective actions are needed, and if so, what they might be. In the longer term (FY2000 and beyond), these data when combined with previously collected data will: (1) be used to focus succeeding characterization efforts on collecting data needed to meet project objectives and (2) contribute to efforts to build technically defensible models of how mobile contaminants move through the vadose zone to ground water and the potential risk to environmental and human health. The following briefly discusses the major analytical needs as we interpret them given the immediate objectives of FY99 characterization and potential future activities.

Chemical

Many analytes of interest have been identified. Hazardous and/or dangerous waste category constituents should be given prime importance (hexavalent chromium, a listed waste; nitrate, aluminum, and others). The mobility status of these and other constituents of interest can be assessed with the water leach method. The mobility potential of the soil contaminants as solutes and/or colloidal is needed to address the higher level objective of water resource protection (groundwater and the river). Doing a complete physical and chemical characterization on a selected number of samples is more effecient than dividing the effort and obtaining less comprehensive sample media characterization on multiple borehole samples(one or more new holes).

Radiochemical

How many radionuclides (alpha, beta and gamma emitters) should be analyzed? The most significant issue here is how to narrow down the potentially large list of radionuclides. A relative hazard index approach has been used elsewhere to narrow down such lists to only a few key radionuclides. For example, the tank waste envelope (average best estimate composition of single shell tank waste) was used for this purpose for the TWRS Phase I (glass plant site) environmental baseline. This analysis indicated that five radionuclides accounted for >99% of the relative hazard (ingestion exposure route): Sr/Y-90, Cs-137, Am-241 and Pu-239 and U. This approach could be combined with judgement to formulate a short list which could include additional constituents such as Tc-99 and I-129 which the approach outlined above did not identify.

The importance of some isotopes other than major concern gamma emitters, needs to be emphasized. From all available information Tc-99 is a preeminent concern for all. To better understand what is happening with this isotope we urgently need better analytical techniques for the various species of technetium. From other work we have already identified organic complexed and lower valence insoluble Tc-99 species, which would migrate differently than pertechnetate. Presently there are no clearly established sample gathering, sample preparation and analytical techniques for the various Tc species. Based on some Canadian work, very low concentrations of oxygen (reducing conditions) can significantly affect the Tc retention. The potential presence of such conditions beneath the SX tank farm should be evaluated.

It can be also futile to blindly search for Tc-99 when we do not have reliable data for Tc species movement in relation to the more easily detectable gamma emitters. An alternative effort could be correlating Tc-99 to gamma emitters (e.g., Cs-137) in an area where known releases occurred (like in the T farm area). Once this correlation is established, this technique can be used to identify the potential presence of Tc-99 in the vadose zone based on the presence of gamma emitters.

Physical analyses

For FY99, physical property analyses can be generated from a mix of previously collected, and potentially soon to be collected, indirect and direct observations.

- Indirect observations such as those collected by borehole geophysical logs and remote sensing have been collected in the past and should be collected from boreholes suitable for employment of these tools.
- Direct observation of moisture conditions can be collected from 09-39 samples, borehole moisture logs, CPT samples, and, if they are installed, tensiometers.
- A wealth of previously collected borehole geologic information exists, in addition any new sampling will contribute to this knowledge base.

A systematic investigation and interpretation of SX farm subsurface conditions can be carried out in FY99 using already collected and soon to be collected geophysical logs and physical geology/hydrology information (data, logs, archived samples old and new, outcrop analogues). Such an effort would help resolve the physical hydrogeologic controls on vadose moisture/contamination at a scale finer than geologic formation/member identification without new sampling. This would then form the basis for integrating the soon to be collected information into a single picture and focusing future sampling for physical properties in the full characterization effort.

Sample Locations

Based on the analysis needs we identified in the previous sections several options for

FY99 sampling locations are available.

Borehole 41-09-39

Borehole 41-09-39 will be decommissioned in FY99. It is in an ideal location to obtain samples to analyze for physical and chemical characteristics of waste that probably originated from Tank SX-108 and seem stagnant (no apparent movement of Cs-137 based on time series gamma logs). We concur with the sampling intervals, locations, and needs as they were developed in the DQO meetings. This analysis should be used to provide a basis for determining if additional characterization is needed in near tank waste and/or under specific tanks.

Areas of Potential Contaminant Movement

In contrast to borhole 41-09-39, gross gamma logs from several wells on the west side of tank SX-109 suggests continued lateral movement of waste constituents at an approximate depth of 70 ft. This leads to questions such as:

- What is the chemistry like at this location?
- Is there still high salt brine moving and carrying Cs-137 with minimal sorption?
- Is waste still emanating from one or more SX tanks?
- Does the rising gamma activity show that Cs-137 is being accumulated at a fine-grained layer where fixation of Cs is occurring in micaceous or clay-like minerals?
- What are the soil moisture conditions?

Answering these questions will help establish if gross gamma logs can be used as an indicator for the possible presence of other mobile contaminants.

If the fluids in the area of potential movement are dilute (suggesting for example a source from leaking water lines) then this type of mobilization can be corrected by eliminating the driving force (replace buried water lines used in the tank farm with over ground lines). If high salt waste is encountered at the point of gamma buildup, then this may imply that waste is still seeping from tank SX-109 (the nearest tank). This would suggest this tank should receive the highest priority for saltwell pumping.

Additional and/or Alternative Characterization Locations

There are additional options for characterization in and near the SX tank farm during FY99. These options, several of which were discussed during the DQO meetings, are listed below:

- Use the planned RCRA drilling near the farm to obtain samples to analyze for physical properties and for identification of stratigraphic intervals and lithologies that influence movement and distribution of moisture and contamination in the vadose zone. This will add to the understanding of the physical environment under the farm, especially the presence or absence of preferred migration pathways through the vadose zone.

- Also, use one of the planned RCRA boreholes to test drilling, sampling, and dust and cuttings control systems that would potentially be used for future subsurface characterization activities within the tank farm.

- FY98 RCRA samples at the T, TX, TY, U, and BX tank farms from 1:1 water extracts (pH, EC, cations, and anions) and the ammonium acetate extract (CEC and monovalent cations versus divalent cation ratios) have proven useful. However, additional profiles and analyses of known contamination and known clean sediments are needed, especially for fine grained Hanford formation and Plio-Pleistocene sediments.

- Based on knowledge of estimated Hanford formation bedding dips, the sub-surface structures of the top of Plio-Pleistocene carbonate under the farm, and the dry well data reviews, several dry wells in the probable migration path could be targeted for additional sampling. In addition, screening level soil probing, probably using CPT, at various locations where mobile contaminants may be present and at locations where near tank wastes may be present should be initiated.

Sample Methods, Including Alternative Ideas

Because of the short time available for conducting fieldwork at the SX tank farm in FY 99, characterization approaches should focus on an achievable and limited set of objectives. Given the decoupled objective for FY99, determining mobility of contaminants for assessing mitigation measures and sampling within the tank farm should stress ascertaining contaminant properties and mobility. Sampling for physical property analyses is probably best suited to the RCRA boreholes that are currently planned for drilling in FY99 outside the tank farm boundary.

Non-Intrusive Characterization

Other than 41-09-39, non-intrusive methods should be used to the maximum extent possible within the tank farm to gain additional information prior to any major new drilling program. Examples include:

- Reinstate dry well gross gamma logging monthly or quarterly for wells that showed increasing activity levels at the end of the dry well data (1994). This would ideally consist of logging of the active wells and those near the active wells monthly with a fast scan type of gamma logging. This data would then be calibrated to correlate to historical gross gamma logs. High speed logging (approximately 3.5 to 4.5 ft/min) is presently being conducted in the C farm monthly by WMNW and could easily be done for those areas the dry well review analysis has shown as being recently active. These high-speed scans could be followed up with HPGe logging as deemed necessary. Serious consideration should also be given to reactivating gross gamma logging in laterals.

- Neutron moisture and N gamma logs should be run in key boreholes at SX-107, -108, -109, -111. and -112. These are the areas where analysis of gross gamma logs revealed potential contamination movement up to the end of measurements in 1994. If movement is occurring because of wash down from a water source (or actual leakage from a tank) high moisture contents should be observed.

- Representative physical characterization data will be difficult to collect within the tank farm from anything but a "regular" drilled boring. As stated above, for FY99 this type of data is probably best collected from planned SX tank farm RCRA boreholes. Future in-farm sampling for comprehensive, detailed, physical analysis is probably best left to the more detailed follow up characterization efforts. In the interim, physical data (geologic and hydrologic properties) already exists and it should be integrated with the initial characterization.

- Resolve the issue of inventory and leak volume. The 1992 Ebasco report suggests that the leak volume ranges from 2.4Kgal to 35Kgal and concluded that the leak volume was closer to 2.4Kgal than 35Kgal. In contrast, Agnew and Corbin (1997 Analysis of SX Farm Leak Histories-Historical Leak Model [HLM], LA-UR-96-3537) estimated leak volumes ranging from 102Kgal to 203Kgal. The range of uncertainty is a factor of nearly 100. Such uncertainty precludes a quantitative (mass balance) accounting of the leakage, which puts into question the utility of any meaningful study of nature and extent in the area surrounding this tank until the issue of leak volume is resolved. One borehole and all the sampling related to it will not resolve the mass balance or inventory question.

Intrusive Characterization

Several options exist for intrusive sampling/characterization activities that probably could be done in FY99. For example:

- If limited borehole geophysical logging shows there is still an increasing trend in gamma activity in the 5-6 boreholes that have previously shown increasing trends, then obtaining sample media from the zone where this is occurring would be indicated. Such samples would allow determination of the chemical characteristics of the waste matrix and reaction products in the zone where gamma activity is increasing. An option for obtaining this information could be to cut the borehole casing and "sidewall" sample using the whipstock approach to recover small samples. Other options include sidewall sampling at the bottom of borehole and CPT sampling next to a borehole where increasing contamination is identified.

- A CPT deployment utilizing sampling, moisture detection, and gamma logging tools could be used as a rapid, inexpensive technique to screen the upper vadose zone from zero to 140 ft for plume detection, indications of mobile contaminants for identification of potential targets for a drilling effort, and assessing potential co-mingling of plumes from multiple tanks.

- Determine the feasibility of using ERT if screening level work such as described above demonstrates potential areas of moisture and contaminant movement. Systems of this type have been economically placed utilizing cone penetrometer techniques. This monitoring will provide data that is directly applicable to targeting future drilling and sampling in zones potentially containing high salt waste and/or moisture fluxes.

- Tensiometers could be placed in the farm and surrounding area to monitor and quantify subsurface moisture conditions. In the near term, borehole SX-49-12-01 should be evaluated for abandonment and installation of tensiometers.

The intrusive and nonintrusive characterization activities listed above comprise a list of activities we feel will fulfill FY99 characterization objectives by providing information needed for near term resource protection actions. In addition, these activities will contribute to building a technically sound basis for longer term characterization objectives by providing screening level information needed to focus future efforts, consolidating all relevant information into a site specific physical model, and reducing uncertainty about the mobility of contaminant plumes.

Recommendations and Conclusions

The consensus of the steering group was that the decoupled vadose characterization work was not amenable to a logical process that ends with clearly defined data quality objectives. Nevertheless, we concluded that meaningful characterization work could be accomplished during FY99. This work could contribute to the higher level objectives (water resource protection) and would support interim corrective measures, retrieval and closure decisions.

To meet FY99 characterization objectives as we understand them, the decoupled FY99 characterization activities should stress chemical and radiochemical analyses in areas where mobile contaminants are potentially moving and impacting ground water. The eventual characterization target of the "ore" body of high level waste is best addressed in subsequent years once sampling and handling techniques have been perfected under less hazardous conditions. In addition, for FY99 collection of an extensive suite of samples for physical analysis is best left to boreholes drilled outside the tank farm. Physical analyses within the tank farm should center on an integrated analysis of existing relevant data, and only once these two activities are completed should physical analysis needs from samples within the tank farm be explored.

For FY99, characterization objectives within the tank farm should focus on a limited set of objectives, such as:

- Mobility issues
- Activities that currently are planned to occur (41-09-39 decommissioning and RCRA drilling) that should be used to the greatest extent possible to collect data
- The assumption that FY99 activities will be part of a logical characterization process and contribute to defining the scope of future efforts

Examples of specific activities we recommend be considered that would meet these general criteria for FY99 includes:

- Obtain maximum amount possible of technically defensible information from 41-09-39. No new "hot" borehole should be attempted. Decommissioning and sampling of 41-09-39 will be difficult enough considering the sample handling problems. The information and experience gained in dealing with hot samples can be used to plan FY2000 work.

- Maximize vadose zone information from the RCRA monitoring wells to be installed in FY99. Fine structure (sedimentary layering) is not well defined in the study area and cannot be adequately assessed without continuous or semi-continuous intact samples (split spoons or cores). Also, the possible presence of subsurface contaminant movement is potentially important information since significant surface contamination occurred where the new monitoring wells must be drilled. If downward movement occurred due to enhanced infiltration (disturbed surfaces with gravel), it should be evident in intact samples. The additional physical and chemical parameter measurements for future performance assessment purposes would also benefit from additional intact samples of the deeper vadose zone near the tank farms. Researchers (e.g., EMSP) have also requested good quality intact samples for testing purposes. There is an opportunity here to obtain significant new subsurface physical descriptive information that will benefit the overall RFI effort which includes both past-practice disposal sites and the single shell tanks.

- Integrate with the planned RCRA drilling to evaluate and demonstrate drilling, sampling, and cuttings and dust control techniques that could potentially be used in future drilling within the tank farm.

- Conduct a critical re-analysis of existing data. This task is already identified in the TPA milestone for the RFI-CMS workplan development for S-SX (Subsurface Physical Model development). A draft report is due in June. The outcome of this effort should help focus subsequent vadose characterization that could be conducted in FY99. Because of the short lead time and importance of this task, a concerted effort is needed immediately.

- Conduct non-intrusive vadose zone borehole characterization in selected or key locations. This field work should follow the data review. The recommended activities include application of advanced geophysical logging at those boreholes that continue to exhibit upward trends in gross gamma activity. Gross gamma, neutron moisture, and neutron activation logs in selected wells would provide initial data to assess the nature of the waste at those sites where movement is apparently still occurring. The neutron activation logs would address tank liquor salt distribution and/or reaction products (Ca, Al) versus the observed cesium-137 distribution.

- Use SX-49-12-01 for placement of tensiometers for monitoring of the water suction profile. This would be a step toward defining the direction and flow of the contaminant plume that is presently only speculation.

- Evaluate drilling out and sampling beneath dry wells where reinstituted gamma logging suggests movement has continued since 1994 to build a better gamma mobility picture. Also, investigate feasibility of sampling selected dry wells through the casing (by cutting casing) to gain more info on high radiation intervals, or other geophysical features of interest.

- Investigate use of CPT for screening level sampling in the zero to 140 ft depth range before near tank high-level contamination sampling is done. Screening level sampling could also be done to better delineate plume shapes and potential co-mingling of plumes from different tanks.

- Determine feasibility of placing ERT to begin delineating actual contaminant plume dimensions.

- Initiate the selection of model(s) that will be used to interpret vadose zone conditions, moisture movement, and contaminant migration.

Additional work could be started in FY99. This includes collection of thermal data, a comprehensive water content and water suction measurement program, collection of site specific in situ hydrologic property data, and direct measurement of moisture flux. However, given practical limitations on what can be done in the last half of FY99 by TWRS, we are not recommending these be done solely by TWRS at this time. Instead, we recommend these additional activities be evaluated for their potential incorporation into the ITRD effort specific in DOE-RL Change Order M-45-98-03, Interim Milestones M-45-58 and M-45-59. These ideas, and other longer term characterization ideas are expanded upon briefly in Appendix A.

We believe the activities we recommend for FY99 are achievable and accomplish the TPA milestone goal of moving forward with meaningful near-term field work. The information gained from the proposed activities will be invaluable for development of a sound RFI/CMS work plan, directly support interim action decisions, and contribute to a solid basis for making future characterization decisions and modeling interpretations in the S-SX Waste Management Area.

Appendix A
Longer Term Characterization Activities

Boreholes to Ground Water

One or more boreholes to ground water will probably be drilled within the confines of the tank farm at some point in the future. Selection of initial drilling locations should focus on areas with the least uncertainty regarding what happened in the past. Sampling in an area to improve understanding has the least chance for success in an area where there is the greatest uncertainty regarding what might have happened in the past. In this regard the leak at SX-115 (~60% of inventory accounted for) is a much better understood leak event than at SX-108 (only a small percentage of the inventory can be accounted for). The short duration and large volume attributed to the SX-115 leak makes it the most likely to have penetrated to greater depths. Additionally the conceptual model of water accumulating on the fine/coarse-grained interfaces would lead one to expect the greatest accumulation of a vertical driving force from waters infiltrating through the gravel cover of the tank farm to be in the southwest corner of the farm. Given the down dip (i.e., southwest) migration theory and the Tc-99 hits observed in 299-W23-15, the most likely place to be able to correlate TC-99 observations in the groundwater with the Tc-99 in the vadose zone is around SX-115.

If other considerations drive the future characterization effort toward understanding the SX-108 leak and subsequent migration of the leaked fluids to groundwater, then the approach still needs to honor the relevant conceptual model(s) and the need to understand the movement of the mobile (probably not the gamma emmitters) contaminants. While there is a need to develop some understanding of the processes/mechanisms associated with the past high concentration, high temperature leaks, this information is not as important as information on the remobilization and migration processes. We need to understand and document how the most mobile of these leaked wastes are re-mobilized by infiltrating meteoric waters and how they subsequently move to groundwater. With this in mind, documenting how the mobile and less mobile constituents separate with increasing migration distance is a key part of this effort which would probably include multiple wells located along the interpreted, plan-view, centerline of the gamma plume. However, none of these wells necessarily need to be completed to groundwater. If only one hole can be completed to groundwater, then the most down gradient well should be the target, not the well located at the source.

If or when the first of these is drilled, we recommend that it be placed at a location where it will most probably penetrate mobile waste/contaminant. This location should be identified using the types of near term investigations we have recommended for FY99 characterization. Additional boreholes would be located as needed to best support ongoing investigations of current and future contaminant impacts as they are related to interim action mitigation, waste retrieval, and tank closure. Given the operational challenges inherent to working within the tank farm, we recommend that this future drilling be preceded by activities such as we described in the body of this report that allow refinement of the drilling, sampling, and dust and cuttings control techniques needed to work efficiently and safely. Those future boreholes drilled to ground water could provide ground water sampling to further refine the potential foot print of the area of the water table impacted by past and current contaminant migration, potentially help narrow down sources of contamination, and add to the understanding of vadose zóne mechanics and contaminant movement mechanisms.

Near Tank Waste Inventory

There is some value in obtaining samples from a near-tank location to better correlate between the tank inventory and the nearby waste inventory. We can only surmise what actually leaked from the tank, i.e., high solid or high liquid content waste. Sampling and characterization of waste near a tank (SX-108, SX-109, or SX-115 for example) would be one method of better establishing what actually leaked. Characterization of near tank contaminants and comparing these results to tank contents will provide additional insights into what actually leaked from tanks.

ITRD

Additional, longer term work to support TWRS could be done through the ITRD process specified in Milestones M-45-58, M-45-59. The quantification of hydraulic profiles (water contents, water suctions, hydraulic and thermal characteristics) could be funded jointly between the two efforts but should be an integral part of each. Any modeling effort, any wraparound science activity, any characterization effort and any monitoring effort should have as a minimum: the water content profiles, the water suction profiles, the hydraulic and thermal characterization completed for a given study site (SX-108 and vicinity, etc.). These are discussed briefly below:

Water Content Profiles

There is a need to monitor the water content over a large spatial extent and to document perched water bodies, if they exist under the SX tanks. One single core or even a set of cores will not provide this information. Multiple wells need to be sampled. A rigorous monitoring plan needs to be initiated that will provide extensive profiling the subsurface water contents throughout the entire vadose zone with the most penetrating device available to extend the spatial resolution of the water content profiles. The initial water contents can be used subsequently to do conditional simulations of transport of contaminants. In situ monitoring of the water content to document changes around and underneath the tank of interest should be part of any serious characterization effort. Placement of in situ water content sensors from surface to groundwater would be an extremely useful effort if the water content sensors were coupled with water suction measurements (see below).

Water Suction Profiles

There is a need to monitor the water suction (water potential) in situ in the vadose zone. The water flux and subsequent transport will not be predictable until such measurement are made in situ. Use of advanced tensiometry needs to be part of any measurement or characterization effort. Measurements of perched water bodies (if any) will assist in defining flow and direction for the contaminant plumes. Placement of sensors at the bottom of a number of the dry wells would provide spatial measurements of the soil suction that could help identify the direction of flow and the changes in capillary pressures that dictate vadose zone transport.

Hydraulic Property Data Measured In Situ

Open bottom dry wells may be appropriate for using disk permeameters or other physics-based devices for measuring the hydraulic properties of the vadose zone sediments in place. Cone penetrometer techniques have been proposed for Hanford sediments to measure saturated an unsaturated hydraulic properties and air permeabilites. These devices should be evaluated for measurements of the critical in situ hydraulic properties that are needed in the flow and transport models to predict plume migration rates (i.e., fate and transport).

Direct Measurement of Water Flux

Fate and transport analysis depends on a knowledge of the driving forces involved. A conceptual model of a tank leak scenario suggests that after the initial leak volume displaced what soil water (if any) remained near the tanks after heating, there has been a subsequent cooling and re-condensing of water in the vicinity of the tanks. Leaking water lines have been documented at the perimeter of the tank farm and massive water spills have been know to occur. Fire hydrants have leaked. Details related to the contributions of specific impacts of these sources on SX tank farm plumes are speculative. However another more persistent driving force is at play in the SX tank farm, e.g., meteoric water. Over the long haul, the amount of water infiltrated through the soil surface from winter rains and snowmelt, during the past 35 years is estimated to be over 30 million gallons. This is more than 50 times the largest estimate of the combined tank leakage at the SX tank farm. While highly variable, the average annual input of water from meteoric sources is estimated to be more than all of the combined tank leakage (<500K gal) for the SX tank farm. Extreme winter precipitation has caused surface ponding of water at SX tank farm in the past and there appears to be more than a casual connection between winter precipitation and Tc-99 peaks in ground water. In any case, the meteoric water source has not been shut off and continues to infiltrate and potentially carry contaminants to groundwater.

At present, there is no direct measure of the fluxes in and around the tanks. As the tanks cool more and more of this water will be effective in moving deeper into the vadose zone and carry contaminants to groundwater. The mobility of the contaminant should be documented and chemistry is important for identifying the potential groundwater COCs. However, a direct measure of the water flux should be part of the characterization effort. Such measurements are possible and techniques are available for quantifying the water flux at the edge of the tank and within a reasonable distance of the tank perimeter. Near surface measurements and measurements at depth should be attempted. Monitoring of fluxes in decommissioned boreholes should be considered as at least one possibility of depth measurements. Near surface measurements (1.5 to 2 m depth) should be made as soon as possible and be a part of the characterization effort.

This page intentionally left blank