0077016

DOE/RL-2007-15
REV 0

Excavation-Based Treatability Test Plan for the BC Cribs and Trenches Area Waste Sites

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

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

RECEIVED
MAY 05 2008
EDMC

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2007-15
REV 0

Excavation-Based Treatability Test Plan for the BC Cribs and Trenches Area Waste Sites

Date Published
February 2008

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

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

J. D. Aardal 02/21/2008
Release Approval Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy. Available in paper copy.

Printed in the United States of America

CONCURRENCE PAGE

Title: Excavation-Based Treatability Test Plan for the BC Cribs and Trenches Area Waste Sites

Approvals: D. A. Brockman
U. S. Department of Energy, Richland Operations Office

Signature | Date 3/19/08

R. A. Lobos
U. S. Environmental Protection Agency

Signature | Date 4/17/08

This page intentionally left blank.

EXECUTIVE SUMMARY

This treatability test plan has been prepared to describe the activities to be undertaken to support remedy selection at the BC Cribs and Trenches Area waste sites. The treatability test will assess field conditions related to removal, treatment, and disposal of near-surface contamination present in representative waste sites (as many as two trenches and one crib) within the BC Cribs and Trenches Area waste sites. After initial characterization of the selected trenches and crib, the remedial-action alternative of partial removal, treatment, and disposal of near-surface contamination will be tested. This treatability test will correlate the predicted radiation dose based on preexcavation characterization data with actual dose received during excavation activities. Using this approach, an overall dose estimate can be calculated for conducting removal, treatment, and disposal of the near-surface contamination at the remaining BC Cribs and Trenches Area waste sites. The calculation will use a combination of additional site-characterization data, waste-disposal records, and/or soil-inventory model data for those cribs and trenches that are not used in the excavation phases of the treatability test.

This test plan describes the activities to be conducted during the treatability test including data to be collected, management of data, the necessary materials and equipment, community relations, and reports that will be issued as the treatability test is conducted. The organization and content of this document is in accordance with EPA/540/R-92/071a, *Guide for Conducting Treatability Studies under CERCLA, Final.*[1]

The specific objective of the treatability test is to provide data that will support evaluation of the partial removal, treatment, and disposal alternative action described in DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*[2] The specific data collection objectives for the test are as follows.

---

[1] EPA/540/R-92/071a, 1992, *Guide for Conducting Treatability Studies under CERCLA, Final*, U.S. Environmental Protection Agency, Washington, D.C.

[2] DOE/RL-2004-66, 2005, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

- Obtain additional characterization data for the BC Cribs and Trenches Area waste sites to better define the nature and extent of contamination in the near-surface soil at the waste sites.

- Obtain data on the cost of conducting soil removal, treatment, and disposal to support cost estimates for this remedial-action alternative for all of the BC Cribs and Trenches waste sites.

- Correlate predicted dose information (obtained by modeling worker exposure using preexcavation site characterization data) to actual dose received during conduct of the treatability test.

- Enhance the removal, treatment, and disposal process to ensure that the dose to workers remains as low as reasonably achievable while conducting this remedial-action alternative.

- Refine the process for down-blending highly contaminated soil to ensure that the dose rate requirements specified in BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria,*[3] can be met while producing remediation wastes at a high production rate.

- Assess the integrity of remnant crib structure to evaluate the potential for subsidence, which could affect evaluation of remedial alternatives.

The proposed alternative actions for the BC Cribs and Trenches Area waste sites are presented in DOE/RL-2004-66. The focused feasibility study evaluates the potentially applicable remedial alternatives and the feasibility of each against nine criteria specified in the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*[4] to determine a preferred alternative for each of the BC Cribs and Trenches Area waste sites. One of the alternatives examined in the focused feasibility study is removal, treatment, and disposal of all (or a portion)

---

[3] BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

[4] *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*, 42 USC 9601, et seq.

of the contaminated soil in the BC Cribs and Trenches Area waste sites. Removal, treatment, and disposal of the contaminated soil is specified in the focused feasibility study as the preferred alternative for four of the trenches, the 200-E-114 Pipeline, and the 200-E-14 Siphon Tank in the BC Cribs and Trenches Area. This alternative is not selected for 16 of the trenches and the 6 cribs in the BC Cribs and Trenches Area, primarily because of the significant worker dose expected as removal, treatment, and disposal activities are accomplished. Because the nature and extent of the contamination associated with the BC Cribs and Trenches Area waste sites is not well known, a treatability test is required to aid in further defining the feasibility of this remedial-action alternative. The data collected during the treatability test will be used to ensure that the conceptual site model and conclusions of the focused feasibility study concerning removal, treatment, and disposal of contaminated soil at the BC Cribs and Trenches Area waste sites are accurate. Alternatively, the data collected will be used to revise the conclusions of the focused feasibility study before a record of decision is issued.

This page intentionally left blank.

CONTENTS

APPENDICES

FIGURES

TABLES

This page intentionally left blank.

TERMS

ALARA	as low as reasonably achievable
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DQA	data quality assessment
DQO	data quality objective
DS	decision statement
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FFS	*Focused Feasibility Study of Engineered Barriers for Waste Management Units in the 200 Areas* (DOE/RL-2004-66)
FFTF	Fast Flux Test Facility
MEI	maximally exposed individual
OU	operable unit
PUREX	Plutonium-Uranium Extraction (Plant or process) (tributyl phosphate solvent extraction)
SAP	sampling and analysis plan
TEDE	total effective dose equivalent
Tri-Parties	U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989)
WDOH	Washington Department of Health

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If you know	*Multiply by*	*To get*	*If you know*	*Multiply by*	*To get*
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.0929	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces (avoir)
pounds	0.454	kilograms	kilograms	2.205	pounds (avoir)
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
tablespoons	15	milliliters	liters	2.113	pints
ounces (U.S., liquid)	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts (U.S., liquid)	0.946	liters	cubic meters	1.308	cubic yards
gallons (U.S., liquid)	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Centigrade	Centigrade	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This treatability test plan addresses near-surface soil contaminated with radionuclides at the BC Cribs and Trenches Area waste sites. The treatability test is being performed to support remedy selection for these waste sites. The specific remedy being tested is the partial removal, treatment, and disposal of near-surface soil as described in DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites* (FFS). The organization and content of this document is in accordance with EPA/540/R-92/071a, *Guide for Conducting Treatability Studies under CERCLA, Final.*

Data collected during the treatability test will be used to provide additional characterization information for the trenches and crib selected for the test. These characterization data will enhance the conceptual site model for the BC Cribs and Trenches Area waste sites. Data generated to determine the nature and extent of near-surface contamination also will be used to calculate a predicted dose to remediation workers during the remediation activities. The predicted dose will be compared to actual personal monitoring measurements from the phases of the test during which soil removal, treatment, and disposal technologies are tested. Other data collected during conduct of the treatability test will be used to determine (1) if treatability test wastes meet the requirements of BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, (2) if the crib structures left in place are likely to result in subsidence, and (3) the costs for removing, treating, and disposing of contaminated soil in the BC Cribs and Trenches Area waste sites.

The BC Cribs and Trenches Area waste sites include 6 cribs, 20 trenches, a siphon tank, and a pipeline. All of these waste sites are included in the 200-BC-1 Operable Unit (OU). These waste sites received more than 117,000 m^3 (31 Mgal) of radioactive liquid waste that was discharged to the soil. The *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) requires remedial action for these 20 trenches, 6 cribs, one tank, and one pipeline. All but four of these waste sites were previously in the 200-TW-1 Scavenged Waste OU and received waste from the uranium recovery process and ferrocyanide processes. The other four waste sites were previously in the 200-LW-1 300 Area Chemical Laboratory Waste Group OU. The proposed alternative actions for the BC Cribs and Trenches Area waste sites are presented in the FFS (DOE/RL-2004-66). The FFS evaluates the potentially applicable remedial alternatives and the feasibility of each against nine criteria specified in CERCLA to determine a preferred alternative for each of the BC Cribs and Trenches Area waste sites. A treatability test is required to aid in further defining the feasibility of the partial removal, treatment, and disposal remedial-action alternative. The data collected during the treatability test will be used to ensure the accuracy of the FFS concerning removal, treatment, and disposal of contaminated soil at the waste sites. Alternatively, the data collected will be used to revise the conclusions of the FFS before a record of decision is issued for the OU.

Of the alternatives examined for the BC Cribs and Trenches Area waste sites, the FFS specifies removal, treatment, and disposal as the preferred alternative for 4 of the 20 trenches (the former 200-LW-1 OU waste sites), the 200-E-14 Siphon Tank, and the 200-E-114 Pipeline. However, the FFS recommends capping as the preferred alternative for the remaining 16 trenches and the 6 cribs, primarily because of the significant worker dose expected as the removal, treatment, and disposal activities are accomplished.

Although the cribs and trenches are similar in that both are liquid-waste disposal sites, they have distinct differences. The cribs are relatively small (12.2 m [about 40 ft] square at the bottom) and were designed to disperse the liquid waste evenly throughout the crib. They received waste in large quantities (approximately 42,000 L [about 11,000 gal] at a time) from the 200-E-14 Siphon Tank, which functioned as a large "toilet." When full, the siphon tank automatically flushed its contents through a 36 cm (14-in.) diameter pipe to the crib. In contrast, the trenches typically were 153 m (500-ft) long narrow, open excavations that were fed liquid waste through a network of above-ground 5.1 cm (2-in.) diameter pipes placed at infrequent intervals along the length of the trench. Thus, the trenches received uneven contamination distribution along their length.

Figure 1-1 shows the locations of the 200 West Area and 200 East Area on the Hanford Site and the location of the BC Cribs and Trenches Area waste sites. Figure 1-2 shows the layout of these waste sites within the BC Cribs and Trenches Area. Figure 1-3 illustrates general features of the cribs, trenches, and 200-E-14 Siphon Tank.

Figure 1-1. Location of the 200 West Area and 200 East Area and the BC Cribs and Trenches Area Waste Sites on the Hanford Site.

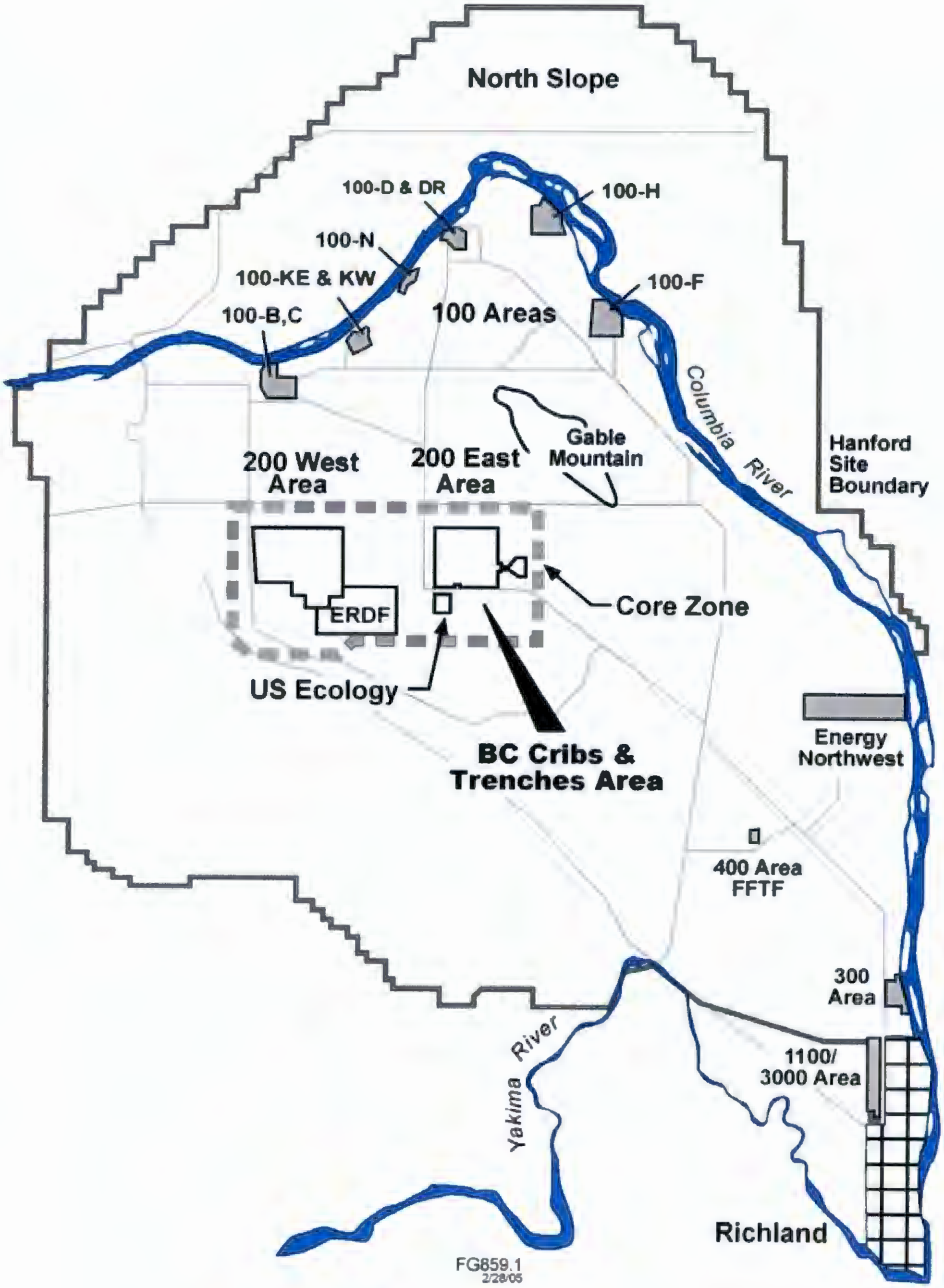
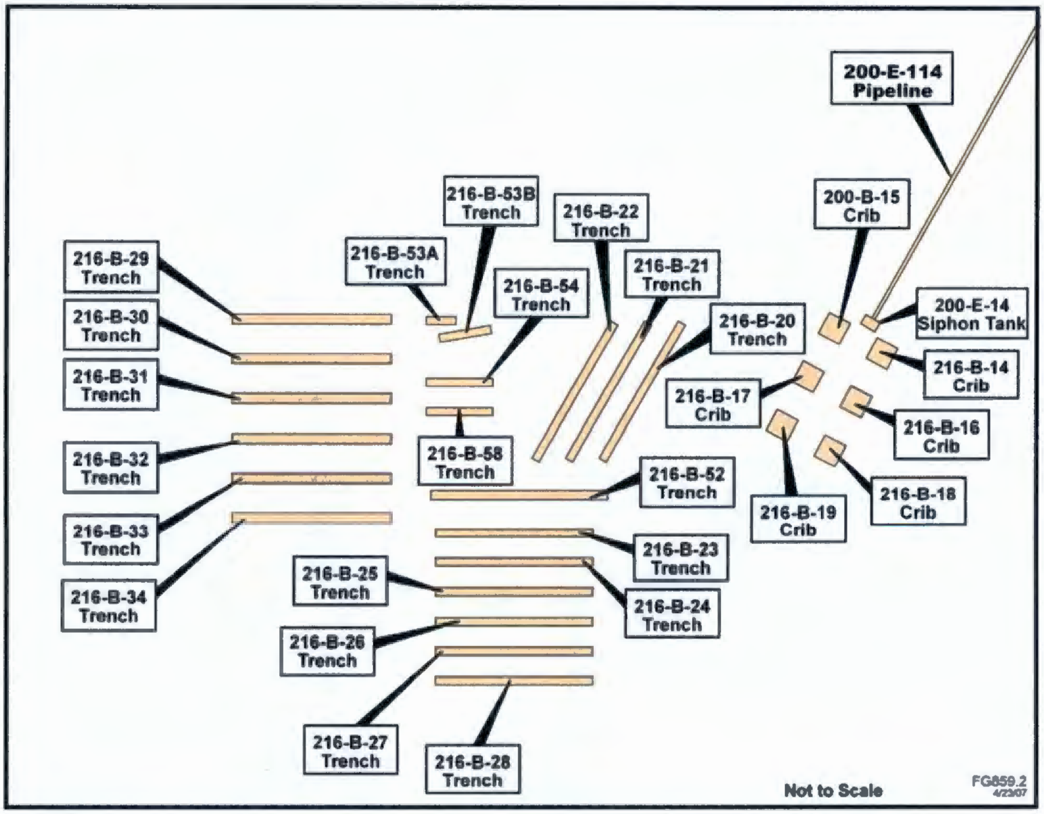


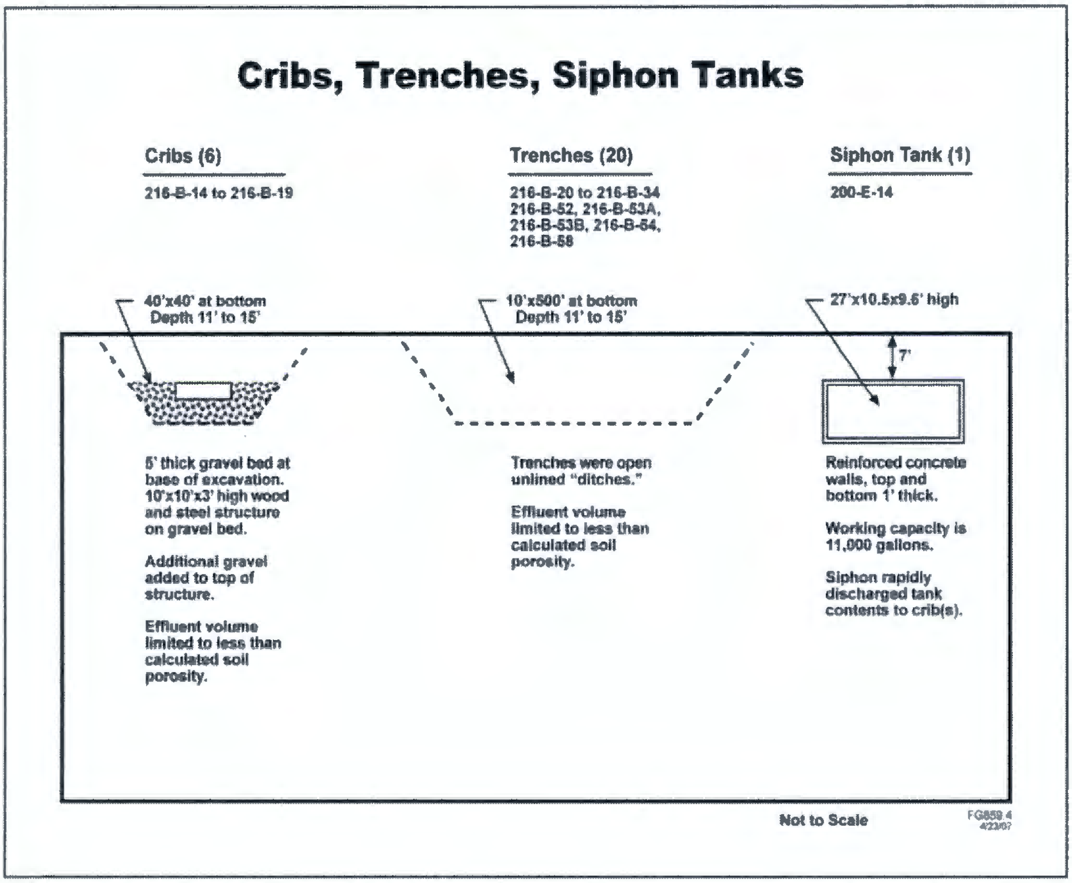
Figure 1-2. Distribution and Layout of the BC Cribs and Trenches Area Waste Sites.



Waste Site	Structure Type	Waste Site	Structure Type
216-B-14 [a]	Crib	216-B-28	Trench
216-B-15	Crib	216-B-29	Trench
216-B-16	Crib	216-B-30	Trench
216-B-17	Crib	216-B-31	Trench
216-B-18	Crib	216-B-32	Trench
216-B-19	Crib	216-B-33	Trench
216-B-20	Trench	216-B-34	Trench
216-B-21	Trench	216-B-52	Trench
216-B-22	Trench	216-B-53A [a, b]	Trench
216-B-23	Trench	216-B-53B [b]	Trench
216-B-24	Trench	216-B-54 [b]	Trench
216-B-25	Trench	216-B-58 [b]	Trench
216-B-26 [a]	Trench	200-E-14	Siphon Tank
216-B-27	Trench	200-E-114	Pipeline

[a] The 216-B-26 Trench, 216-B-53A Trench, and 216-B-14 Crib will be used for this treatability test.
[b] This waste site was formerly included in the 200-LW-1 Operable Unit.

Figure 1-3. Features of the BC Cribs and Trenches Area Waste Sites.



1.2 PROJECT ACTIVITIES

This test plan describes the methodologies that will be used to assess field conditions in the trenches and crib in the BC Cribs and Trenches Area that were selected for the test. This test plan also defines the methodology that will be used to test the remedy of partial removal, treatment, and disposal of near-surface soil at the selected waste sites. The scope of this project is to support remedy selection for the BC Cribs and Trenches Area waste sites. The treatability test is being conducted to ensure that feasibility study decisions concerning remedy selection are valid. The treatability test will be conducted in four phases.

- In Phase 1, data will be collected in the 216-B-26 Trench concerning the nature and extent of the near-surface Cs-137 contamination; the near surface is the region of highest Cs-137 and Sr-90 contamination. Section 4.1 provides a description of this trench. A data quality objectives (DQO) process was undertaken to determine the data required to characterize the nature and extent of contamination in the trenches and to select the trench for this phase of the test. The DQO process is documented in Appendix A of this test plan and includes the basis for selection of the 216-B-26 Trench for Phase 1 of the test. The data collected during Phase 1 will be used to estimate the amount of material requiring removal (i.e., define the lateral and vertical extent of the excavations) and to calculate a predicted external dose that remediation workers will receive in Phase 2 of the treatability test. Phase 1 data collection is described in DOE/RL 2007-14, *Sampling and Analysis Plan for Phase 1 of the BC Cribs and Trenches Area Waste Sites Excavation-Based Treatability Test*. Data from this phase of the test also will be used to correlate the total inventory of Cs-137 in the 216-B-26 Trench, determined by measurements and estimates of contaminated volume, with the inventory predicted in RPP-26744, *Hanford Soil Inventory Model, Rev. 1*.

- Phase 2 of the treatability test will involve excavation in the 216-B-26 Trench to test the process of partial removal, treatment, and disposal of the high near-surface soil contained in that trench that could contribute to high dose. Phase 2 of the test will begin with excavation of one-third of the total length of the 216-B-26 Trench. Data will be collected to ensure that Environmental Restoration Disposal Facility (ERDF) waste-acceptance criteria are met and to validate dose estimates calculated using the data collected during Phase 1. The process of soil treatment (down-blending) to meet the ERDF waste-acceptance criteria will be refined during this phase of the test. Phase 2 of the treatability test will include the option to cease excavation activities in the trench if the data collected from excavation of a portion of the trench are sufficient to allow the decision makers from the DQO process (see Appendix A, Table A-2) to assess the feasibility of partial removal, treatment, and disposal for trenches in the BC Cribs and Trenches Area.

- Phase 3 of the treatability test will involve characterization, similar to that conducted in Phase 1, followed by excavation of the high dose near-surface soil from one of the cribs. During the DQO process, the 216-B-14 Crib was selected for Phase 3 of the test. Data will be collected for the same purposes as those described in Phase 1 and Phase 2 and to establish whether the contaminant distribution in the cribs differs from that in the trenches. In addition, the potential for surface subsidence at the BC Cribs caused by failures of the crib structures will be evaluated.

- Phase 4 of the test will involve characterization followed by excavation of the plutonium-contaminated near-surface soil in the 216-B-53A Trench. The 216-B-53A Trench was selected because of the significant plutonium inventory received in that trench and because its waste stream was unique. Data collected in Phase 4 also will support initial site characterization and waste characterization and will validate dose measurements with predicted dose.

The decision makers will review data as they are collected in each phase of the test. When sufficient data are collected to complete the assessment of the feasibility of the partial removal, treatment, and disposal remedial alternative, the treatability test may be concluded without completion and/or initiation of one or more of the phases listed.

The data-collection design described in the DQO summary report (Appendix A) was used to develop the sampling and analysis plan (SAP). The DQO summary report provides the basis for developing the sampling design used to collect data in support of the treatability test plan. The

SAP describes the specific activities required to obtain data of the quality required to meet the DQO. Requirements for characterization of the 216-B-26 Trench during Phase 1 of the treatability test are provided in DOE/RL-2007-14, *Sampling and Analysis Plan for Phase 1 of the BC Cribs and Trenches Area Waste Sites Excavation-Based Treatability Test.* Appendix B provides the sampling and analysis requirements for the remaining phases of the treatability test. The experimental design for the phases of this treatability test is described more fully in Chapter 4.0 of this test plan.

This page intentionally left blank.

2.0 TREATMENT TECHNOLOGY DESCRIPTION

The treatment being tested is partial removal, treatment, and disposal of near-surface soil contaminated with radionuclides. The technology to be demonstrated will involve excavating the selected trenches and crib with standard excavation equipment. The standard excavation equipment may require increased shielding for the operator because of the levels of radioactivity expected to be encountered during treatability test activities. It is expected that some in-place soil, if placed directly into ERDF waste containers, would have high dose levels that will fail the ERDF waste-acceptance criteria without treatment.

The treatment to be tested will involve down-blending highly contaminated soil that is associated with high dose rates with less contaminated soil in the area of contamination before the ERDF waste containers are loaded. A remote-handling capability to blend less contaminated soil with high dose soil has been demonstrated in previous excavations of trenches at the Hanford Site. Down-blending was performed in situ using the excavator bucket to mix less contaminated soil with highly contaminated soil. However, the blending process demonstrated at other project locations involved lower levels of radioactivity that required less down-blending than the levels of radioactivity expected in soil from the BC Cribs and Trenches Area. Therefore, a continuous process-improvement strategy will be necessary for the down-blending, to maximize efficiency during excavation. In addition to efforts aimed at refining the down-blending process, similar effort will be directed toward minimizing worker dose. For example, it is expected that the area of exposed contaminated soil will be minimized.

This page intentionally left blank.

3.0 TEST OBJECTIVES

The activities performed during this treatability test are required to characterize the field conditions and materials removed from the BC Cribs and Trenches Area waste sites. The results of the test will refine the estimates of worker dose and cost for removal of all near-surface contamination at the BC Cribs and Trenches Area waste sites. The data collected will support the remedy selection process, which will be documented in a revision to the FFS and ultimately in the record of decision issued by the U.S. Environmental Protection Agency (EPA) and U.S. Department of Energy, Richland Operations Office. The specific data-collection objectives for the test are as follows.

- Obtain additional characterization data for the BC Cribs and Trenches Area waste sites to better define the nature and extent of contamination in the near-surface soil at the waste sites.
- Obtain data on the cost of conducting soil removal, treatment, and storage to support cost estimates for this remedial-action alternative for all of the BC Cribs and Trenches waste sites.
- Correlate predicted dose information (obtained by modeling worker exposure using preexcavation site-characterization data) to actual dose received during conduct of the treatability test.
- Enhance the removal, treatment, and disposal process to ensure that the dose to workers remains as low as reasonably achievable (ALARA) while conducting this remedial-action alternative.
- Refine the process for down-blending high dose soil with less contaminated material to ensure that the ERDF waste-acceptance criteria can be met while producing remediation wastes at a high production rate.
- Assess the integrity of remnant crib structure to evaluate the potential for subsidence, which could affect evaluation of remedial alternatives.

The DQOs and decisions associated with this study are delineated in Appendix A. The following decision statements (DS) were identified during the DQO process.

- DS No. 1 — Determine if the vertical and lateral extent of near-surface contamination can be determined such that excavation parameters (e.g., volume of material, dimensions and coordinates of excavated surface) can be accurately predicted. If so, use the site characterization data to support the design and resource needs for evaluating removal, treatment, and disposal as a remedial alternative for contaminated trench and crib soils. Otherwise, excavate without precise site-characterization data concerning vertical and lateral extent of contamination.
- DS No. 2 — Determine if site characterization data can be correlated to inventory data to predict the dose received by personnel during removal, treatment, and disposal operations

during the treatability test. If so, use inventory data to calculate predicted dose for removal, treatment, and disposal of all shallow contamination at the BC Cribs and Trenches Area. Otherwise, collect additional characterization data or modify models to show adequate correlation between characterization data, inventory data, and dose received during treatability test operations to calculate predicted dose for removal, treatment, and disposal of all shallow contamination at the BC Cribs and Trenches Area.

- DS No. 3 — Determine if a remnant crib-structure subsidence is possible and design appropriate measures to mitigate the effects of subsidence in the final remedial action taken at the BC Cribs. Otherwise, include no design controls for an eventual subsidence event in the final remedial action at the BC Cribs.

- DS No. 4 — Determine if contaminants in the soil removed from the excavations during the treatability test at the BC Cribs and Trenches Area meet the ERDF waste-acceptance criteria and, if so, ship the soils to ERDF. Otherwise, perform additional treatment and/or determine alternative disposal options for the soil wastes generated during the treatability test.

As stated in Section 1.2, the treatability test will be completed in four phases. The test objectives associated with each phase are summarized in Tables 3-1, 3-2, 3-3, and 3-4.

Table 3-1. Test Activities, Objectives, and Criteria Used to Demonstrate Completion of Treatability Test Phase 1.

Activity		Objective		Criteria
1	Perform direct-push technology/spectral gamma logging/soil sampling in boreholes	1a	Define the nature and extent of Cs-137 and Sr-90 contamination in the 216-B-26 Trench	If necessary, revise conceptual site model for the Cs-137 and Sr-90 nature and extent
		1b	Calculate Cs-137 and Sr-90 inventories and compare with soil-inventory model* values	Update Cs-137 and Sr-90 inventories
		1c	Recalculate worker dose estimate	Use revised source term

*RPP-26744, *Hanford Soil Inventory Model Rev. 1*.

Table 3-2. Test Activities, Objectives, and Criteria Used to Demonstrate Completion of Treatability Test Phase 2. (2 Pages)

Activity		Objective		Criteria
1	Excavate one-third of the 216-B-26 Trench	1a	Collect sufficient data to ensure the capability to down-blend highly contaminated soil associated with high dose rates	Demonstrate the capability to down-blend soil to meet ERDF waste-acceptance criteria using minimal ERDF containers and having none that exceed the ERDF waste-acceptance criteria for radiation protection after loading
		1b	Collect sufficient data to compare worker dose with predicted dose	Collect worker dose data for excavation activities for all personnel associated with the process (e.g., excavator operator, associated radiation control technician, water sprayer, spotter, ERDF transport vehicle driver)
		1c	Collect sufficient data to update excavation cost estimates	Collect data that define the time to perform the following operations: - Remove overburden and fill ERDF container - Down-blend highly contaminated soil associated with high dose rates and transfer to ERDF container

Table 3-2. Test Activities, Objectives, and Criteria Used to Demonstrate Completion of Treatability Test Phase 2. (2 Pages)

Activity		Objective		Criteria
				- Remove/stage another ERDF container - Evaluate all other factors that impact costs associated with excavation of the trenches.

ERDF = Environmental Restoration Disposal Facility.

Table 3-3. Test Activities, Objectives, and Criteria Used to Demonstrate Completion of Treatability Test Phase 3.

Activity		Objective		Criteria
1	Perform direct-push technology/spectral gamma logging/soil sampling in boreholes	1a	Define nature and extent of Cs-137 and Sr-90 contamination in the 216-B-14 Crib	If necessary, revise conceptual site model for the Cs-137 and Sr-90 nature and extent
		1b	Calculate Cs-137 and Sr-90 inventories and compare with soil-inventory model* values	Calculate Cs-137 and Sr-90 inventories based on measurement data
		1c	Recalculate worker dose estimate	Use the revised source term determined through characterization
2	Excavate to expose crib structure	2a	Demonstrate subsidence potential by determining the status of the remnant crib structure	Use the condition of the exposed crib structure to qualitatively evaluate the potential for subsidence at other cribs
3	Excavate near-surface contamination	3a	Demonstrate capability to down-blend highly contaminated soil that is associated with high dose rates with overburden including large-diameter gravel	Demonstrate capability to down-blend soil/gravel to meet ERDF waste-acceptance criteria using minimal ERDF containers and having none exceed the ERDF waste-acceptance criteria for radiation protection after loading
		3b	Demonstrate ability to excavate contaminated crib "gravel"	Determine contamination level of crib gravel
		3c	Collect sufficient data to update excavation cost estimates	Collect data that define the time to perform following operations: - Remove overburden and fill ERDF container - Down-blend high dose soil/gravel and transfer to ERDF container - Remove/stage another ERDF container - Evaluate all other factors that impact costs associated with excavation of trenches.

*RPP-26744, *Hanford Soil Inventory Model, Rev. 1.*
ERDF = Environmental Restoration Disposal Facility.

Table 3-4. Test Activities, Objectives, and Criteria Used to Demonstrate Completion of Treatability Test Phase 4.

Activity		Objective		Criteria
1	Perform direct-push technology/spectral gamma logging/soil sampling in boreholes	1a	Define the nature and extent of transuranic (plutonium and americium) contamination in the 216-B-53A Trench	Prepare conceptual site model for the nature and extent of transuranic contamination in the 216-B-53A Trench
		1b	Calculate the inventory of Pu-239 and compare with soil-inventory model* values	Calculate transuranic inventory based on measurement data
		1c	Refine/update conceptual site model	Prepare conceptual site model for near-surface contamination
2	Excavate near-surface contamination if measurement data indicate that the potential exists for soil meeting the definition of transuranic waste	2a	Demonstrate the capability to safely excavate soil that has high levels of transuranic contamination	Perform excavation while meeting all applicable health and safety requirements

* RPP-26744, *Hanford Soil Inventory Model Rev. 1.*

4.0 EXPERIMENTAL DESIGN AND PROCEDURES

Before this test plan was developed, a DQO process was used to define the test objectives and data-collection requirements. This DQO process is summarized in the DQO summary report (Appendix A). After the DQO summary report was completed, a SAP was developed. Sampling and analysis activities for characterization of the 216-B-26 Trench during Phase 1 of the treatability test are provided in DOE/RL-2007-14. The sampling and analysis activities for the remaining phases of the treatability test are included in Appendix B. These documents define the data needs associated with the experimental design and procedures that will be used in the field to meet the objectives of this treatability test. Additional details concerning the experimental design and procedures are provided in this chapter.

Chapter 1.0 of this test plan describes the activities planned for this treatability test. The design of the treatability test allows for work to be completed in phases. If data collected from one or more phases of the test are deemed adequate to provide sufficient data and information to complete the evaluation of the partial removal, treatment, and disposal remedial-action alternative, subsequent phases of the test may be deemed unnecessary. The decision of whether and when to eliminate phases will be determined by mutual agreement between the U.S. Department of Energy, Richland Operations Office, and the EPA. The experimental design described in this chapter includes criteria that will guide determining if and when subsequent phases of the test will be initiated. However, the experimental design also allows for activities common to multiple phases to be conducted simultaneously. For example, the characterization activities associated with Phase 3 and Phase 4 of the test may be completed before the excavation associated with Phase 2 is initiated. The schedule for the various activities is provided in Chapter 13.0 of this test plan.

4.1 TREATABILITY TEST PHASE 1: 216-B-26 TRENCH CHARACTERIZATION

Phase 1 of the test involves characterization of the 216-B-26 Trench using boreholes. Data will be collected to characterize the Cs-137 concentration as a function of depth, using gamma logging instruments. To provide some confirmation of the Cs-137 measurements made by the gamma logging instrument and to characterize Sr-90 concentration at various depths across the trench, soil samples will be collected from selected boreholes.

The 216-B-26 Trench is approximately 152.4 m long by 3 m wide (500 by 10 ft) at the base. It is known that the length of the trench was divided into thirds by berms. Therefore, it is possible that different amounts of waste were received in each one-third of the trench. Because of this, a mean inventory of Cs-137 will be estimated using the mean concentration (and assumed volume of contaminated soil) determined for each one-third of the trench. The exact location of the berms is not known, but aerial photographs taken during construction of the trenches shows them to divide the trenches into approximately equal thirds (Figure A-2 in Appendix A).

The sampling design for characterizing the trench involves two parts: A series of boreholes through the bottom of the trench, to provide data on the contaminant distribution underneath the trench, and a series of *adaptive-cluster* or *step-out* boreholes to determine the lateral extent of contamination.

4.1.1 Trench Sampling

As specified in the DQO and DOE/RL-2007-14, eight boreholes will be installed through the bottom of each one-third of the trench. Also as stated in the DQO, systematic random sampling was chosen to ensure that a large portion of the trench floor would not go unrepresented by the samples collected. Additionally, to ensure that any variability associated with lateral distance from the centerline of the trench bottom is adequately characterized by the sample, a random component is added to the sampling design.

All trench sampling boreholes will be installed to a depth of 7.6 m (25 ft) using a direct-push technique to minimize the management of contaminated soils at the surface that result from other types of drilling operations. A gamma logging instrument equipped with multiple detectors will be inserted in the casing of each borehole, and measurements will be made at 0.15 m (0.5-ft) intervals.

In addition to the gamma logging measurements, soil samples will be collected from three depths in at least eight of the boreholes, ensuring that the entire range of Cs-137 concentration is represented. The soil samples will be sent for laboratory analysis for gamma-emitting radionuclides and total strontium.

The specific location of the eight boreholes in each of the three trench areas (east, west, and center) was determined using a two-step process involving the determination of (1) a longitudinal coordinate, and (2) a lateral coordinate. The longitudinal coordinate represents the distance along the centerline of the trench, and the lateral coordinate represents the offset toward the north or south berm from the centerline. Details are provided in DOE/RL-2007-14.

4.1.2 Establishing Lateral Extent

When the data from the all boreholes installed through the bottom of the trench have been reduced and reported, a series of *adaptive-cluster* or *step-out* boreholes will be advanced. Gamma logging measurements will be collected in each of the adaptive-cluster boreholes. No soil samples will be collected from these additional boreholes. The DQO summary report prepared for the treatability test (Appendix A) describes the basis for action limits associated with determining the lateral extent of contamination in the cribs and trenches. For the 216-B-26 Trench, the applicable action limit is 750 pCi/g Cs-137 within the first 4.6 m (15 ft) below ground surface (bgs). Details are provided in DOE/RL-2007-14.

4.2 TREATABILITY TEST PHASE 2: 216-B-26 TRENCH EXCAVATION

Phase 2 of the treatability test involves excavation in the 216-B-26 Trench to treat, partially remove, and dispose of near-surface contaminated soil. The excavation will not begin until the characterization activities described for Phase 1 are completed and the data obtained during that phase have been evaluated. The data from Phase 1 will be reviewed to refine the estimate of the total inventory of Cs-137 in the entire trench. The data from Phase 1 also will be used to update the calculation used to predict the dose to workers during treatability test Phase 2 operations. The updated calculations of expected worker dose are necessary to finalize the equipment requirements and excavation plans to address ALARA principles before Phase 2 is initiated.

The excavation of the trench will be accomplished in accordance with engineering designs prepared specifically for this treatability test and provided to EPA. Detailed work packages will be prepared after the data from Phase 1 of the test have been reviewed; however, the conceptual design of the excavation activity is described in this plan.

Excavation will be initiated by establishing a bench level from which to accomplish the removal of highly contaminated near-surface soil that is associated with high dose rates. It is anticipated that the bench will be established by removing the first 1.2 or 1.5 m (4 or 5 ft) of soil over a region, which will allow removal of the high dose soil layer identified during the trench characterization activities in Phase 1. The length, width, and depth of the initial bench excavation will depend on the vertical and lateral extent of contamination estimated based on the characterization data. The depth of the bench level depends on the vertical extent of contamination. The excavator must be capable of excavating to approximately 4.6 m (15 ft), because that is the depth to which direct exposure to future receptors is anticipated. The length and width of the bench excavation will allow an adequate angle of repose such that all of the layer of interest will be removed. The excavator will operate from the bench surface as removal of the high dose soil is accomplished.

The excavator will be mixing less-contaminated soil with the highest contaminated soil as the highest dose layer is removed. This will result in some down-blending of the soil with each bucket of excavated soil that is removed. It is anticipated that remote dosimetry will be used on the excavator bucket and/or reach arm to allow estimates of dose associated with each bucket of soil to be obtained before the bucket is lifted toward an ERDF container.

Excavation will begin with the one-third section of the trench having the highest contamination. Selection will be based on evaluation of Phase 1 data. EPA and the U.S. Department of Energy, Richland Operations Office have agreed to begin excavation with a portion of the western third of the trench and proceed into the center section. This will initiate excavation in a section with lower contamination levels where the excavation and handling processes will be tested and revised, if necessary. Experience and lessons learned will be carried into the center section, which has higher contamination levels, to refine the down-blending process. During excavation, detailed notes and observations will be made that will become the basis for documenting the various techniques that are used during excavation. During all operations, dose information will be collected using personal monitoring dosimetry, including supplemental dosimetry to establish doses for various activities.

After excavation has been completed in one-third of the trench, the excavation notes and dosimetry data will be evaluated with respect to the completion criteria in Table 3-2. The results of this evaluation will be discussed with the U.S. Department of Energy, Richland Operations Office and the EPA. The decision makers will determine if sufficient information has been collected to support decision making concerning remediation of near-surface contaminated soil in the trenches using partial removal, treatment, and disposal. If the decision makers determine that excavation of additional sections of the 216-B-26 Trench would add benefit in determining the feasibility of partial removal, treatment, and disposal at the trenches, Phase 2 will proceed to another one-third section of the trench until sufficient data are collected.

Because it is unlikely that all data evaluation for the data colleted during excavation of the first third of the 216-B-26 Trench will be complete at the time that the field work is completed, the test is planned to move to the excavation process associated with Phase 3 (the 216-B-14 Crib) of the test to make efficient use of the field team. If, after the trench excavation data are evaluated, the decision makers believe it is necessary to excavate more of the 216-B-26 Trench, the field team will return to that trench to continue excavation. The following types of data, information, and criteria will be reviewed in determining the benefit of continuing excavation:

- Data indicating that the efficiencies associated with the excavation and down-blending process still are not well developed, such that additional excavation is needed to test different techniques

- Data concerning cost per unit volume or trench length and whether cost estimates could be improved significantly by continuing the excavation activities

- Data concerning worker radiological dose, whether dose estimates could be improved significantly by continuing the excavation activities.

4.3 TREATABILITY TEST PHASE 3: 216-B-14 CRIB CHARACTERIZATION AND EXCAVATION

Phase 3 of the treatability test involves characterization and excavation in the 216-B-14 Crib. The excavation in this crib will remove, treat, and dispose of high dose near-surface soil and evaluate the potential for subsidence in the cribs caused by collapse of the liquid-dispersion structure. Excavation will not begin until completion of characterization activities for the crib.

Characterization of the subsurface soil associated with the 216-B-14 Crib will provide Cs-137 concentration data as a function of depth using a gamma logging instrument equipped with multiple detectors. The boreholes will be installed to a depth of 7.6 m (25 ft) using a direct-push technique. The gamma logging measurements will be made at 0.15 m (0.5-ft) intervals. To provide confirmation of the Cs-137 measurements made by the gamma logging instrument, and to characterize Sr-90 concentration as a function of depth, soil samples will be collected from three depths from boreholes installed as close as possible to the gamma logging boreholes. The depths from which soil samples will be collected will be determined after reviewing the gamma logging data. The project manager will review the data and determine the three depths for soil sample collection. The sampling depths for each borehole will be randomly varied to provide a measure of the continuous nature of Sr-90 concentrations at these depths. The soil samples will be sent for laboratory analysis for gamma-emitting radionuclides and total radioactive strontium.

As specified in the DQO and SAP, eight boreholes will be installed using a random-sampling design throughout the crib.

When the data collected from all boreholes installed in the crib have been reduced and reported, at least one borehole location close to the edge of the crib will be used as a benchmark for a set of adaptive-cluster sampling boreholes, to evaluate lateral contamination spread. As for the primary boreholes, details are provided in the DQO (Appendix A) and the SAP (Appendix B). Only gamma logging measurements will be collected in each of the adaptive-cluster boreholes. No soil samples will be collected from the adaptive-cluster boreholes.

The data from Phase 3 will be reviewed to determine if an acceptable estimate of the total inventory of Cs-137 in the entire crib is available. The data also will be used to update the calculation used to predict the worker dose that will be received during treatability test Phase 3 operations. The updated calculations of expected worker dose are necessary to finalize excavation plans to address ALARA principles before Phase 3 excavation is initiated.

After characterization data have been reviewed, the decision makers will evaluate three criteria to determine whether excavation of the 216-B-14 Crib will be of benefit in evaluating the alternative of partial removal, treatment, and disposal:

- The trench excavation associated with Phase 2 of the test and whether the experience gained there is considered sufficiently characteristic of excavation in a crib
- The results of subsurface 216-B-14 Crib characterization and whether it provides a good estimate of the nature and extent of contamination
- The value of assessing the potential for crib subsidence by exposing one of the existing structures.

If the decision makers conclude that excavation of a crib would not benefit the evaluation of the partial removal, treatment, and disposal remedial-action alternative for the BC Cribs and Trenches Area, then Phase 3 will be completed after the characterization activities have been performed using direct-push boreholes. If excavation is not performed, the test will move to Phase 4. If excavation of the crib is performed, Phase 3 will continue as described in the remainder of this chapter.

The excavation of the crib will be accomplished in accordance with engineering designs prepared specifically for this treatability test. Detailed work packages will be prepared after the characterization data for the crib have been reviewed, but the conceptual design of the excavation activity is described in this plan.

Excavation will be initiated by establishing a bench level from which to accomplish the removal of high dose near-surface soil. It is anticipated that the bench will be established by removing the first 1.2 or 1.5 m (4 or 5 ft) over a region, which will allow removal of the high dose soil layer identified during the characterization activities. The length, width, and depth of the initial bench excavation will depend on the vertical and lateral extent of contamination estimated, based on the characterization data. The depth of the bench level depends on the vertical extent of contamination. The excavator must be capable of excavating to approximately 4.6 m (15 ft), because that is the depth to which direct exposure to future receptors is anticipated. The length and width of the bench excavation will allow an adequate angle of repose, such that all of the layer of interest will be removed. The excavator will operate from the bench surface as removal of the high dose soil is accomplished. The excavator will be mixing less-contaminated soil with the highest contaminated soil as the highest contaminated layer is removed. This will result in some down-blending of the soil with each bucket of excavated soil that is removed. It is anticipated that remote dosimetry will be used on the excavator bucket and/or reach arm to allow estimates of dose associated with each bucket of soil to be obtained the bucket is lifted toward an ERDF container.

Excavation will include efforts to characterize the potential for the present crib structures to fail, allowing subsidence to occur at the surface. During all operations, dose information will be collected using personal monitoring dosimetry, including supplemental dosimetry to collect activity-specific dose information.

As excavation of the crib proceeds, notes and dosimetry data will be evaluated with respect to the completion criteria in Table 3-2. The results of this evaluation will be discussed with the U.S. Department of Energy, Richland Operations Office and the EPA. The decision makers will determine if sufficient information has been collected to support decision making concerning remediation of near-surface contaminated soil using partial removal, treatment, and disposal. If, during excavation, the decision makers determine that excavation at the 216-B-14 Crib no longer is benefiting this decision process, Phase 3 will be complete and activities will move to Phase 4 of the test. The following types of data, information, and criteria will be reviewed in determining the benefit of continuing excavation:

- Data indicating that the efficiencies associated with the excavation and down-blending process still are not well developed, such that additional excavation is needed to test different techniques

- Data concerning worker radiological dose, whether dose estimates could be significantly improved by continuing the excavation activities

- Data concerning cost per unit volume and whether cost estimates could be significantly improved by continuing the excavation activities

- Data concerning the possibility of crib subsidence are adequately obtained, and additional excavation cannot aid further in this evaluation.

4.4 TREATABILITY TEST PHASE 4: 216-B-53A TRENCH CHARACTERIZATION AND EXCAVATION

Phase 4 of the treatability test involves characterization and excavation in the 216-B-53A Trench. The excavation in this trench will excavate and dispose of near-surface plutonium-contaminated soil. The excavation will not begin until characterization activities have been completed for the trench. Details of the preexcavation characterization are provided in the SAP (Appendix B).

The DQO summary report (Appendix A) describes the basis for action limits associated with determining the lateral extent of contamination in the cribs and trenches. For the 216-B-53A Trench, the applicable action limit is 430 pCi/g of Pu-239 within the first 4.6 m (15 ft) bgs. Details for ensuring that the action limit can be met are provided in the SAP (Appendix B).

To provide some confirmation of the Pu-239 concentrations determined by the SGL instrument, to provide a means for determining Pu-239 concentrations that are less than detection levels using SGL instrumentation, and to provide data concerning the ration of Am-241 to Pu-239/240 in the trench, soil samples will be collected from each of the boreholes. The soil samples will be sent for laboratory analysis for the primary transuranic isotopes of concern (i.e., plutonium isotopes and Am-241). Details are provided in the SAP (Appendix B).

Because the trench was bisected by a berm in the center, it is possible that different amounts of waste were received in each half of the trench. Because of this, a mean inventory of Pu-239 will be estimated for each half of the trench.

When the data from all boreholes installed to characterize the bottom of the trench have been reduced and reported, a set of adaptive-cluster sampling boreholes will be installed to evaluate the extent of lateral contamination spread. Details for locating these boreholes and for data collection are provided in the SAP (Appendix B). Only passive-neutron measurements will be collected in each of the adaptive-cluster boreholes. No soil samples will be collected from the adaptive-cluster boreholes. Additional adaptive-cluster sampling holes will be installed to define the influence of the berm. Details are provided in the SAP (Appendix B).

The characterization data will be reviewed to update the total inventory Pu-239 estimate in the entire trench and to address ALARA principles before Phase 4 excavation is initiated. After the characterization data have been reviewed, two criteria will be evaluated by the decision makers to determine whether excavation of the 216-B-53A Trench will be of benefit in evaluating the alternative of partial removal, treatment, and disposal:

- The results of subsurface characterization and whether it indicates the presence of transuranic contamination that may result in standard waste boxes being assayed with soil concentrations greater than 100 nCi/g

- The trench excavation associated with Phase 2 of the test and whether the experience gained there is considered sufficiently characteristic of an excavation conducted in the 216-B-53A Trench.

As established during the DQO process, all phases of the test include the option to cease (or not begin) characterization and/or excavation activities when the data collected in one or more complete (or partially completed) phases are sufficient to allow decision makers to assess the feasibility of partial removal, treatment, and disposal for the BC Cribs and Trenches Area waste sites. Therefore, if the decision makers conclude that excavation of the 216-B-53A Trench would not benefit evaluation of the partial removal, treatment, and disposal remedial-action alternative for the BC Cribs and Trenches Area waste sites, then Phase 4 will be completed after the described characterization activities. If it is decided that the excavation of the 216-B-53A Trench will benefit the evaluation, Phase 4 will continue with the excavation activities as described in the remainder of this chapter.

Excavation of the 216-B-53A Trench will be accomplished in accordance with engineering designs prepared specifically for this treatability test. Detailed work packages will be prepared after the characterization data for the crib have been reviewed; however, the conceptual design of the excavation activity is described in this plan.

Excavation will be initiated by establishing a bench level from which to accomplish the removal of high dose near-surface soil. It is anticipated that the bench will be established by removing the first 1.2 or 1.5 m (4 or 5 ft) over a region, which will allow removal of the high dose soil layer identified during the characterization activities. The length, width, and depth of the initial bench excavation will depend on the vertical and lateral extent of contamination estimated, based on the characterization data. The depth of the bench level depends on the vertical extent of contamination. The excavator must be capable of excavating to approximately 4.6 m (15 ft), because that is the depth to which direct exposure to future receptors is anticipated. The excavator will operate from the bench surface as removal of the high dose soil is accomplished.

During excavation, detailed notes and observations will be made concerning the methods used to excavate the trench and dispose of the contaminated soil. These notes will become the basis for documenting the various techniques that are used during excavation. When methods are changed, the dates and times of the changes will be noted. Contaminated soil will be placed in waste boxes for transport to ERDF, provided ERDF waste-acceptance criteria are satisfied. If characterization data indicate the presence of soil contamination that may result in filled standard waste boxes being assayed with soil concentrations exceeding 100 nCi/g, standard waste boxes will be filled with soil from regions of the trench exhibiting excessive contamination. Down blending will not be performed to reduce contaminant concentration to less than 100 nCi/g. If and when such a determination is made, then each waste container will be evaluated against HNF-EP-0063, *Hanford Site Solid Waste Acceptance Criteria,* for disposal at either the Waste Isolation Pilot Plant or ERDF. If soil exceeds the ERDF waste acceptance criteria, alternate packaging/disposal will be developed in accordance with ultimate Waste Isolation Pilot Plant disposal. During all operations, dose information will be collected using personal monitoring dosimetry. Supplemental personal dosimetry will be used to measure the doses associated with specific activities.

If, during excavation, the decision makers determine that excavation at the 216-B-53A Trench no longer is benefiting the determination of the feasibility of partial removal, treatment, and disposal of the soil in the cribs in the BC Cribs and Trenches Area, the treatability test will be complete.

5.0 EQUIPMENT AND MATERIALS

The equipment and materials required for the data collection activities associated with this treatability test are defined in the SAP. Equipment lists also will be provided in radiological work permits and other work package documents that will be developed before field activities are initiated.

The specific excavation equipment used may require alteration as the radioactively contaminated soil is processed. For example, if the dose encountered by excavator-operator personnel is deemed excessive, work may be stopped to add shielding to the excavator. Alternatively, a new excavator with a longer reach may be used to increase the operator's distance from the soil. Working with radioactive materials requires flexibility in the specification of equipment, to maintain adherence to ALARA principles. Therefore, providing a prescriptive list of the configuration of the excavation and soil-handling equipment is not prudent. However, it is known that the following equipment will be needed at a minimum:

- Excavator with a boom (stick) length of 9.1 m (30 ft), or greater and the ability to accommodate both a 0.76 m^3 and a 2.3 m^3 (1 yd^3 and 3 yd^3) bucket; the reach should be 7.6 m (25 ft) minimum
- ERDF waste cans
- ERDF waste can transporter
- Front-end loader
- Water truck
- Water-spraying equipment
- Soil fixative
- Dump trucks to bring in soil to back-fill the excavation to grade.

This page intentionally left blank.

6.0 SAMPLING AND ANALYSIS

The specific sampling and analysis requirements for characterization of the 216-B-26 Trench during Phase 1 of the treatability test are provided in DOE/RL-2007-14. The sampling and analysis requirements for the remaining phases of the treatability test are found in Appendix B.

This page intentionally left blank.

7.0 DATA MANAGEMENT

Data resulting from this treatability test will be managed and stored by Fluor Hanford Environmental Information Systems, in accordance with approved procedures. At the direction of the task lead, all analytical data packages will be subject to final technical review by qualified personnel before the packages are submitted to regulatory agencies or package information is included in reports. Electronic data access, when appropriate, will be via a database (e.g., *Hanford Environmental Information System* or a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989).

This page intentionally left blank.

8.0 DATA ANALYSIS AND INTERPRETATION

Data analysis and interpretation will be conducted using data sets that have been collected and validated in accordance with the requirements specified in the SAP. The analysis of data collected using statistical sampling designs will be evaluated using data quality assessment (DQA) practices consistent with the EPA methods published in EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide*, EPA QA/G-9R, and EPA/240/B-06/003, *Data Quality Assessment: Statistical Tools for Practitioner*, EPA QA/G-9S. Data collected using nonstatistical sampling designs will be evaluated for their usability in making the decisions associated with these data.

The DQA process is used to determine whether the data meet their intended use and to judge how well a sampling design performs. Steps of the DQA process include the following:

- Review of the project's objectives and sampling design
- Preliminary data review and plotting
- Selection of a statistical method
- Verifying the assumptions of the statistical method
- Statistical hypothesis testing to draw conclusions relative to the null and alternative hypotheses (if a hypothesis test is stated in the DQO).

When statistical sampling designs are used, and hypothesis tests are required to assess the data against the stated DQOs, the outcome of the DQA process is a statement that the statistical hypothesis testing suggests that the null hypothesis is accurate, that the null hypothesis has been rejected, or that not enough data exist to make a determinative conclusion based on the hypothesis test used. In the latter case, either additional data must be collected to support the statistical hypothesis testing or the data user must make a decision with higher uncertainty than the desired levels expressed in the DQO. When statistical sampling designs are used to meet DQOs where no hypothesis test is specified, the outcome of the DQA process is a statement concerning the effectiveness of the sampling design in addressing the data needs specified in the DQO.

At the outset of the DQA phase of the test, the data will be verified and validated to ensure that the sampling and analysis protocols specified in the SAP were followed and that the measurement systems were performed in accordance with the SAP. The DQA chemists and statisticians recognize that data that are flagged during the data verification and validation process are not necessarily invalid. Flagged data are reviewed during the DQA process to determine whether the validation flags affect the intended use of the data. If a complete DQA activity is deemed appropriate for the data generated during the characterization associated with the treatability test being conducted at the BC Cribs and Trenches Area waste sites, the usability of any flagged data will be addressed in the DQA report.

The data that will be generated during this treatability test have several uses. The analysis and interpretation that will be conducted for each data use is summarized in the following sections in this test plan.

8.1 VERTICAL AND LATERAL EXTENT OF CONTAMINATION

The purpose of the adaptive-cluster sampling design is to delineate the edges of the vertical and lateral extent of contamination associated with the trenches and crib selected for this study. The data that will provide these estimates will be generated using SGL instruments inserted in borehole casing in the holes discussed in Chapter 4.0. The data from the gamma logging measurements will be evaluated to define the nature and extent of contamination associated with each trench and crib individually. The estimates of extent of contamination will be used by project management to plan the size of the excavations that must be made to adequately remove, treat, and dispose of near-surface contaminated soil. The vertical and lateral extent of contamination also will be used to calculate the total volume of soil within which the inventory of Cs-137 associated with the 216-B-26 Trench and 216-B-14 Crib and the Pu-239 associated with the 216-B-53A Trench is contained. No statistical testing of the vertical and lateral extent will be required, because the adaptive-cluster sampling design used to determine lateral extent is not statistically based.

8.2 ESTIMATED RADIONUCLIDE INVENTORY

The systematic random-sampling design is being used to provide an estimate of the mean concentration of Cs-137 in soils associated with the 216-B-26 Trench and the 216-B-14 Crib and of Pu-239 in the 216-B-53A Trench. The gamma logging and, for the 216-B-53A Trench, passive neutron logging data will be compared to laboratory data from soil samples. If an adequate correlation between the two measurement methods is shown, then the logging data will be used to calculate a mean concentration throughout the volume of waste that was determined during the evaluation of the extent of contamination. The logging data will be used rather than laboratory data because significantly more logging measurements will be taken, allowing a much better estimate of the mean. For an estimate of the Sr-90 inventory in the 216-B-26 Trench and the 216-B-14 Crib, only laboratory measurements will be used because no Sr-90 data will be available using gamma logging. However, if a reliable ratio between Cs-137 and Sr-90 is obtained, then the gamma logging data may be used in conjunction with the laboratory results to estimate the Sr-90 concentration and inventory. After data collection, the data will be analyzed to determine whether the decisions associated with the DQO can be made within the specified criteria. This analysis will be conducted in accordance with the EPA guidance in EPA/240/B-06/003. After the data are reviewed, graphed, and assessed for distribution, a two-sample t-test (statistical test) will be applied. The two-sample t-test will be used to evaluate the correlation between the soil inventory model prediction (RPP-26744) and the inventory calculated using the measurements made in the boreholes and/or on samples collected from the boreholes. If the two sample t-test determines that the two inventories are not in agreement, then the results obtained from field sampling and the estimates obtained from the soil-inventory model will be further investigated. Specifically, the assumptions concerning the conceptual site model, the volume of contaminated soil associated with the applicable waste site, and potential contributors of significant variation in the soil-inventory model will be reviewed. The conclusion of the data analysis and recommendations for data use will be documented in a DQA report or in a future treatability test report.

8.3 COST

To support the applicability of partial removal, treatment, and disposal as a preferred remedial action alternative for the BC Cribs and Trenches Area waste sites, an updated cost estimate must be developed. Treatability test data concerning items such as rates of soil removal, cost of equipment, numbers of personnel, numbers of shipments to ERDF, will feed the final cost estimate for this remedial-action alternative. As the excavation phase of the test proceeds, the costs associated with different phases of the test will be captured. As changes to cost-affecting processes are made, the impacts to total project costs will be analyzed. The cost estimate for performing partial removal, treatment, and disposal at all of the BC Cribs and Trenches Area waste sites will use assumptions based on the lessons learned in this treatability test. The lessons learned will be documented in the treatability test report that will be prepared to summarize the findings of this study.

8.4 DOSE ESTIMATES

One of the objectives of this treatability test is to correlate predicted external dose information (obtained by modeling worker exposure using preexcavation site-characterization data) to actual dose received during conduct of the treatability test. Characterization data collected during Phases 1, 3, and 4 of the test will be used to calculate a predicted dose to remediation workers during the remediation activities. The calculated dose will be compared to personal dose measurements made during the excavation activities. The method for estimating dose is documented in Appendix F of the FFS (DOE/RL-2004-66). This method calculates a predicted dose for each position held by treatability test personnel (e.g., excavator operator, ERDF health physics technician). The personal-dose measurement data obtained during the treatability test will be compared to the dose predicted using waste site-specific characterization data to determine any scaling of the estimates that may be appropriate in estimating total dose if all BC Cribs and Trenches were addressed using the partial removal, treatment, and disposal remedial-action alternative. This comparison and the conclusions concerning personal dose associated with the partial removal, treatment, and disposal remedial-action alternative at the BC Cribs and Trenches Area waste sites will be provided in the treatability test report prepared to document the results of this study.

8.5 EXCAVATION TECHNIQUES

Waste destined for the ERDF must meet the ERDF waste-acceptance criteria. It is anticipated that a significant amount of soil encountered during excavation activities will exceed the radiological safety criteria in ERDF waste-acceptance criteria related to total dose from waste containers. This will require treating the highly contaminated soils associated with high dose rates by in situ down-blending these soils with less-contaminated soils from the BC Cribs and Trenches Area (either overburden or trench side-wall soils) before the soil is loaded in the ERDF waste boxes. This down-blending also will be required to protect treatability test personnel conducting activities in the BC Cribs and Trenches Area. Therefore, data that will lead to successful and efficient treatment decisions concerning the excavation techniques will be collected during the excavation phase of the test. These data will be in the form of detailed notes made by excavation personnel. Information on the ease (or difficulty) in making down-blending (treatment) and waste-acceptance determinations during the excavation and treatment phase of the test will provide additional data to support the application of partial removal, treatment, and disposal as a preferred remedial-action alternative for the BC Cribs and Trenches Area waste sites.

9.0 HEALTH AND SAFETY

The health and safety requirements for this treatability test are contained in the health and safety plan. As excavation activities are conducted, air monitoring will be conducted in accordance with the radiological air monitoring plan prepared for this study. Both the health and safety plan and air monitoring plan will be issued separately before field work is initiated.

This page intentionally left blank.

10.0 WASTE MANAGEMENT

The waste management requirements for this treatability test are contained in the waste control plan (SGW-34277, *Waste Control Plan for the BC Cribs and Trenches Area in the 200-BC-1 OU*). This plan will be issued separately before field work is initiated.

This page intentionally left blank.

11.0 COMMUNITY RELATIONS

A key goal of public involvement is to obtain stakeholder perspectives on issues affecting the Tri-Party Agreement and to facilitate broad-based participation in the Hanford Site decision-making process. The Tri-Parties, which include the U.S. Department of Energy's, Richland Operations Office and Office of River Protection, the EPA, and the Washington State Department of Ecology, believe that public involvement is essential to the success of Hanford Site cleanup.

11.1 PURPOSE

The purpose of this chapter is to provide an overview of the public involvement opportunities for this treatability test. It identifies the opportunities to inform and involve stakeholders and the public.

11.1.1 Definition of Stakeholders and General Public

Stakeholders are described as individuals who see themselves affected by and/or have an interest in issues. They commit time and energy to participate in decisions. Hanford Site stakeholders include local governments, local and regional businesses, the Hanford Site workforce, local and regional environmental interests, and local and regional public health organizations.

The general public comprises those individuals who are aware of, but may choose not to be involved in, decisions. It is the responsibility of the agencies to provide the public with meaningful information on upcoming decisions so they can choose whether to become involved in Hanford Site decisions.

11.1.2 Availability of the Treatability Test Plan

This treatability test plan is being made available by the Tri-Parties by including it in the Administrative Record. No public comment period is required for this test plan; therefore, no formal public review and comment period is scheduled. Tribal nations, stakeholders, and the general public are encouraged to use this document and other documents produced during this study as resources for considering the Tri-Parties' decisions concerning the BC Cribs and Trenches Area waste sites. Preferred alternatives for these waste sites will be selected only after the public comment period has ended for the FFS, which is being supported by this treatability test, and the comments on the FFS have been received, reviewed, and considered.

11.2 PUBLIC COMMENTS

All public comment periods on Tri-Party Agreement documents are announced in regional newspapers. As described above, public comments on this treatability test plan will be received during the formal public review period for the FFS.

12.0 REPORTS

Reports to management on data quality issues will be made if and when these issues are identified. These issues will be reported to the project manager by laboratory or field sampling and analysis personnel. Subsequently, standard reporting protocols (e.g., project status reports) will be used to communicate these issues to management. Because no performance or system assessments are planned as part of this treatability test, the project manager will not be providing audit or assessment reports to management unless an unanticipated request is made to conduct such an assessment.

At the end of the project, a DQA report will be prepared to evaluate whether the type, quality, and quantity of data that were collected met the intent of the DQO prepared for this treatability test (Appendix A). After completion of the DQA report, a treatability test report summarizing the results of the test will be included as an appendix in a revision to the FFS (DOE/RL-2004-66).

This page intentionally left blank.

13.0 SCHEDULE

The project key activities and dates are listed in Table 13-1.

Table 13-1. Project Schedule.

Activity	Planned Completion Date
Complete Phase 1 (216-B-26 Trench characterization by direct-push technology) of the treatability test plan	March 30, 2008 [c]
Complete Phase 2a (excavation of initial 1/3 of 216-B-26 Trench) of the treatability test plan	July 31, 2008 [c]
Complete Phase 3 (excavation of 216-B-14 Crib) of the treatability test plan	August 31, 2009 [c]
Complete Phase 4 (excavation of 216-B-53A Trench) of the treatability test plan	November 30, 2009 [c]
Submit revised focused feasibility study [a] and proposed plan [b] for the BC Cribs and Trenches Area waste sites, including the results of the treatability test	April 30, 2010 [d]

[a] DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*
[b] DOE/RL-2004-69, *Proposed Plan for the BC Cribs and Trenches Area Waste Sites.*
[c] Project target milestone
[d] Ecology, EPA, and DOE, 1989, *Approved Tri-Party Agreement Modifications for Central Plateau Waste Site and Groundwater Remediation.*

The treatability test activity does not have a regulated milestone date associated with it. However, the FFS (DOE/RL-2004-66) and proposed plan (DOE/RL-2004-69, *Proposed Plan for the BC Cribs and Trenches Area Waste Sites*) for the BC Cribs and Trenches Area waste sites are driven by Tri-Party Agreement Milestone M-015-51. The results of this treatability test are required for completion of the FFS and proposed plan. The Tri-Party Agreement establishes major milestones for completing the waste-site investigation and decision-making processes by December 31, 2011, and completing waste-site remediation by September 30, 2024 (Milestones M-15-00C and M-16-00, respectively) for non-tank farm OUs in the 200 Areas. In 2002, the U.S. Department of Energy, Richland Operations Office, the EPA, and the Washington State Department of Ecology renegotiated the 200 Areas waste-site cleanup milestones under the Tri-Party Agreement. The results of these negotiations are documented in Tri-Party Agreement change forms M-13-02-01, M-15-02-01, M-16-02-01, and M-20-02-01. These milestones relate to the final decisions for 200 Areas waste sites but none set a schedule for, or require the completion of, a treatability test at the BC Cribs and Trenches Area.

This page intentionally left blank.

14.0 MANAGEMENT AND STAFFING

This treatability test will be managed by the U.S. Department of Energy, Richland Operations Office. The test will be conducted by Fluor Hanford Soil and Groundwater Remediation Project personnel. Staffing will include personnel from Fluor Hanford, other Hanford Site contractors, and subcontractors as specified by the Fluor Hanford project manager. The Fluor Hanford project manager will ensure that the personnel selected are qualified to perform all activities in accordance with the requirements specified in this test plan. Specific staffing plans are specified in work planning documents or subcontracts prepared on a task-specific basis.

This page intentionally left blank.

15.0 REFERENCES

40 CFR 61, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61.

40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," Title 40, *Code of Federal Regulations*, Part 61.

40 CFR 61.93, "National Emission Standards for Hazardous Air Pollutants," Title 40, *Code of Federal Regulations*, Part 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," Section 93, "Emission Monitoring and Test Procedures," as amended.

Clean Air Act, 1955, 42 USC 7401, et seq.

Clean Air Act of 1990, 42 USC 7401, et seq., Pub. L. 101-549.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

DE-AC06-96RL13200, 1996, *Contract Between the U.S. Department of Energy, Richland Operations Office, and Fluor Hanford, Inc.*, U.S. Department of Energy, Richland Operations Office, Richland, Washington, as amended.

DOE/RL-91-50, 2000, *Environmental Monitoring Plan United States Department of Energy Richland Operations Office*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-66, 2005, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-69, 2005, *Proposed Plan for the BC Cribs and Trenches Area Waste Sites*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2007-14, 2007, *Sampling and Analysis Plan for Phase 1 of the BC Cribs and Trenches Area Waste Sites Excavation-Based Treatability Test*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, as amended.

Ecology, EPA, and DOE, 2007, *Approved Tri-Party Agreement Modifications for Central Plateau Waste Site and Groundwater Remediation*, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Richland Washington, February 27, REISSUED.

EPA/240/B-06/002, 2006, *Data Quality Assessment: A Reviewers Guide*, EPA QA/G-9R, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

EPA/240/B-06/003, 2006, *Data Quality Assessment: Statistical Tools for Practitioners*, EPA QA/G-9S, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

EPA/540/R-92/071a, 1992, *Guide for Conducting Treatability Studies under CERCLA, Final*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

Hanford Environmental Information System, Hanford Site database.

RCW 70.94, "Public Health and Safety," "Washington Clean Air Act," Title 70, Chapter 94, *Revised Code of Washington*, as amended, Washington State, Olympia, Washington.

RPP-26744, 2005, *Hanford Soil Inventory Model, Rev. 1*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

SGW-34277, 2007, *Waste Control Plan for the BC Cribs and Trenches Area in the 200-BC-1 OU*, Rev. 0, Fluor Hanford, Inc., Richland, Washington.

WAC 173-400, "General Regulations for Air Pollution Sources," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-400-040, "General Regulations for Air Pollution Sources," "General Standards for Maximum Emissions," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-460, "Controls for New Sources of Toxic Air Pollutants," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 246-247, "Department of Health," "Radiation Protection – Air Emissions," *Washington Administrative Code*, as amended, Washington State Department of Health, Olympia, Washington.

WAC 246-247-040, "Department of Health," "Radiation Protection – Air Emissions," "General Standards," *Washington Administrative Code*, as amended, Washington State Department of Health, Olympia, Washington.

APPENDIX A

DATA QUALITY OBJECTIVES SUMMARY REPORT FOR THE EXCAVATION-BASED TREATABILITY TEST AT THE BC CRIBS AND TRENCHES AREA WASTE SITES

This page intentionally left blank.

CONTENTS

FIGURES

TABLES

TERMS

AA	alternative action
AEA	alpha-energy analysis
ALARA	as low as reasonably achievable
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COC	contaminant of concern
D&D	Deactivation and Decommissioning
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
DS	decision statement
EIS	Environmental Information System
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FH	Fluor Hanford
GEA	gamma-energy analysis
GeLi	germanium lithium
GPC	gas-proportional counting
HPGe	high-purity germanium
K_d	distribution coefficient
LDR	land-disposal restriction
N/A	not applicable
NaI	sodium iodide
PQL	practical quantitation limit
PRTR	Plutonium Recycle Test Reactor
PSQ	principal study question
RL	Richland Operations Office
SGW	Soil and Groundwater
SIM	soil-inventory model (RPP-26744, *Hanford Soil Inventory Model, Rev. 1*)
TBD	to be determined
TBP	tributyl phosphate
Tri-Parties	DOE, EPA, and Washington State Department of Ecology
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989)
UPR	unplanned release
URP	Uranium Recovery Process

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If you know	*Multiply by*	*To get*	*If you know*	*Multiply by*	*To get*
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.0929	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces (avoir)
pounds	0.454	kilograms	kilograms	2.205	pounds (avoir)
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
tablespoons	15	milliliters	liters	2.113	pints
ounces (U.S., liquid)	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts (U.S., liquid)	0.946	liters	cubic meters	1.308	cubic yards
gallons (U.S., liquid)	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Centigrade	Centigrade	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

This page intentionally left blank.

APPENDIX A

DATA QUALITY OBJECTIVES SUMMARY REPORT FOR THE EXCAVATION-BASED TREATABILITY TEST AT THE BC CRIBS AND TRENCHES AREA WASTE SITES

A1.0 STEP 1 – STATE THE PROBLEM

The purpose of data quality objective (DQO) Step 1 is to state the problem clearly and concisely and to ensure that the focus of the study is unambiguous.

A1.1 INTRODUCTION

This DQO process has been performed to support a treatability test being conducted to support remedy selection at the BC Cribs and Trenches Area waste sites. Specifically, the partial removal, treatment, and disposal portion of the remedial-action alternative of partial removal, treatment, and disposal with capping will be tested. This DQO summary report documents decisions that will be made based on data collected during treatability test activities at two trenches and one crib selected for this test. The data collected will be used to provide additional characterization information for the trenches and crib selected for the test. Data collected before the remedial action is tested will be used to calculate a predicted dose to remediation workers during the remediation activities. The calculated dose will be compared to actual dose measurements made during the accomplishment of the treatability test. Other data collected during conduct of the treatability test will be used to determine (1) if treatability test wastes meet the Environmental Restoration Disposal Facility (ERDF) waste-acceptance criteria, (2) if the crib structures are likely to result in subsidence if left in place, and (3) the costs for removing, treating, and disposing of contaminated soil in the BC Cribs and Trenches Area waste sites.

Characteristics of the waste sites and descriptions of the waste disposed of to them are described in Section 1.1 of the treatability test plan.

A1.2 PROJECT SCOPE

The scope of this project is to support remedy selection for the BC Cribs and Trenches Area waste sites. To ensure that feasibility-study decisions concerning remedy selection are valid, a treatability test will be conducted to demonstrate the remedial alternative of partial removal, treatment, and disposal of contaminated soil from the BC Cribs and Trenches Area waste sites. The treatability test will be conducted in four phases:

- In Phase 1, data will be collected concerning the nature and extent of contamination in one trench. The trench selected will be from those that received scavenged waste from the uranium recovery process (URP) and the ferrocyanide processes at the 221/224-U Plant. The data collected will be used to estimate the amount of material requiring removal (i.e., define the lateral and vertical extent of the excavations) and to calculate a predicted dose to remediation workers in Phase 2 of the treatability test.

- Phase 2 of the treatability test will involve excavation in one of the 152 m (500-ft) trenches that received scavenged waste to test the process of partial removal, treatment, and disposal of the contaminated soil contained in that trench. Phase 2 of the test will begin with excavation of one-third of the total length of the trench. Data collected will support waste characterization (i.e., assessment of excavated soil relative to the ERDF waste-acceptance criteria and dose measurements to validate dose estimates calculated using the data collected during Phase 1. The process of soil treatment (down-blending) to meet the ERDF waste-acceptance criteria will be refined during this phase of the test. Phase 2 of the treatability test will include the option to cease excavation activities in the trench if the data collected from excavation of one-third of the trench are sufficient to allow decision makers to assess the feasibility of partial removal, treatment, and disposal for trenches in the BC Cribs and Trenches Area.

- Phase 3 of the treatability test will involve characterization, similar to that conducted in Phase 1, followed by excavation to partially remove, treat, and dispose of near-surface contamination from one of the cribs. Data will be collected for the same purposes as those described in Phase 2. Additional data collected during Phase 3 of the test will assess the potential for subsidence in the cribs.

- Phase 4 of the test will involve characterization followed by excavation, treatment, and disposal of contaminated soil in the 216-B-53A Trench. The 216-B-53A Trench was selected because of the significant plutonium inventory received in that trench. Data collected in Phase 4 also will support waste characterization and will validate dose measurements with predicted dose.

All phases of the test include the option to cease (or not begin) characterization and/or excavation activities when the data collected in one or more complete (or partially completed) phases are sufficient to allow decision makers to assess the feasibility of partial removal, treatment, and disposal for the BC Cribs and Trenches Area waste sites. The data collection design described in this DQO will be used to develop a sampling and analysis plan (Appendix B). This DQO summary report provides the basis and documentation for developing the sampling design used to collect data in support of the treatability test plan.

A1.3 PROJECT OBJECTIVE

The objective of this DQO process is to develop the basis for the activities and requirements to characterize the field conditions and the materials removed from the BC Cribs and Trenches Area waste sites as part of this treatability test. The process also will refine bases for worker dose and cost estimates for partial removal of all near-surface contamination at the BC Cribs and Trenches Area waste sites. The data collected will support the remedy selection process that will be documented in a revision to DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*, and ultimately in the record of decision issued by the U.S. Environmental Protection Agency (EPA).

A1.4 PROJECT ASSUMPTIONS

Project assumptions for the investigation are as follows.

- This DQO process follows EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4.
- This treatability test will investigate only partial removal, treatment, and disposal of near-surface highly contaminated soil and will not attempt to demonstrate removal, treatment, and disposal of all soil contamination associated with the waste sites within the BC Cribs and Trenches Area that are chosen for this test.
- Proceeding from the completion of one phase of the treatability test to the next phase is assumed to be authorized by mutual agreement between the EPA and the U.S. Department of Energy (DOE), Richland Operations Office (RL). It is assumed that this agreement is obtained by approval of the DQO, the sampling and analysis instruction, and the treatability test plan. This assumption is required to allow characterization- and excavation-related equipment to proceed from one phase to the next with no delay.
- If data collected from one or more phases of the test are deemed adequate to meet the objective of providing sufficient data and information to complete the evaluation of the partial removal, treatment, and disposal remedial-action alternative, subsequent phases of the test may be deemed unnecessary. The decision of whether and when to eliminate phases will be determined by mutual agreement between RL and the EPA.
- Because this activity is being conducted under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), the EPA will be the lead regulatory agency for the activity. The Washington State Department of Ecology may be provided a courtesy review of the planning documents, results, and recommendations resulting from the data collected during the test, but the EPA holds all final decision-making authority.

A1.5 PROJECT ISSUES

Project issues can include global issues (which transcend the specific DQO project) and project technical issues (which are unique to the project). Both global and project technical issues have the potential to affect the sampling design or the DQO for the project.

A1.5.1 Global Issues

Global Issue No. 1: The treatability test provides data to support technical issues and cost estimates associated with the removal, treatment, and disposal portion of the remedial-action alternative of partial removal, treatment, and disposal with capping described DOE/RL-2004-66. This remedy, if selected, would address the possibility for inadvertent intruder dose by eliminating the source term. If no remediation is performed, excessive near-term intruder dose is predicted (DOE/RL-2004-66). If effective institutional controls can be assured for a few hundred years, the remedial-action alternative of partial removal, treatment, and disposal with capping becomes less effective, because costs for remediation are spent to contain a dose threat that will be naturally attenuated to acceptable dose levels. The period through which DOE is assumed to have institutional control of the BC Cribs and Trenches Area waste sites is not resolved and remains a global issue that transcends this treatability test.

Resolution: The Washington State Department of Ecology, the EPA, and DOE (Tri-Parties) will continue to discuss the period through which DOE can be assumed to retain institutional control of the BC Cribs and Trenches Area waste sites as the treatability test activities are completed. The final preferred alternative for these waste sites will be documented in the record of decision for the 200-BC-1 Operable Unit.

A1.5.2 Project Technical Issues

Project technical issues are technical issues that pertain exclusively to the project. The following project technical issues have been identified for this test.

Project Technical Issue No. 1: Waste destined for ERDF must meet the ERDF waste-acceptance criteria. It is anticipated that a significant amount of soil encountered during excavation activities will exceed the radiological safety criteria in the ERDF waste-acceptance criteria related to total dose from waste containers. This will require treating the highly contaminated soils associated with high dose rates by down-blending these soils with less-contaminated soils before the soil is loaded in the ERDF waste boxes. This down-blending also will be required to protect treatability test personnel conducting activities in the BC Cribs and Trenches Area. A remote-handling capability to blend clean soil with contaminated soil has been demonstrated in previous excavations of trenches at the Hanford Site. However, the blending process demonstrated at other project locations involved lower levels of radioactivity and required less volume of clean soil than the levels of radioactivity expected in soil from the BC Cribs and Trenches Area. Therefore, the project schedule may be impacted if a successful and efficient means for making these treatment decisions cannot be developed as the excavation phase of the test proceeds.

Resolution: Information on the ease (or difficulty) in making down-blending (treatment) and waste-acceptance determinations during the excavation and treatment phase of the test will provide additional data to support the applicability of partial removal, treatment, and disposal as a preferred remedial-action alternative for the BC Cribs and Trenches Area waste sites.

Project Technical Issue No. 2: Potentially, radiation fields encountered during execution of the treatability test will be at levels such that the amounts of protection available to meet as low as reasonably achievable (ALARA) standards for worker dose are impractical.

Resolution: If radiation levels are such that the available equipment and project design cannot mitigate the dose received by treatability test personnel, work will stop and the costs and schedule associated with redesigning the systems required to complete the test will be discussed with the decision makers.

A1.6 DATA QUALITY OBJECTIVES TEAM MEMBERS AND KEY DECISION MAKERS

To formulate the DQOs required to meet the test objectives, a team of appropriate technical personnel was assembled and met in a workshop. Table A-1 identifies the DQO workshop team members. The DQO briefings also were held with the key decision-makers listed in Table A-2.

Table A-1. Data Quality Objectives Workshop and Development Team Members.

Name	Organization	Area of Expertise (Role)
Cliff Watkins	Navarro Research & Engineering, Inc.	DQO facilitator/workbook coauthor, analytical chemistry, statistics
Berta Oates	Navarro Research & Engineering, Inc.	Chemist, data quality assessor, document coauthor
Steve Young	S. Young & Associates	Community relations, CERCLA, document coauthor
Jill Lundell	Portage Environmental, Inc.	Statistics
Terry McKibbin	RadChem Professional Services, LLC	Radiochemistry, radionuclide measurements
Mark Benecke	Fluor Hanford SGW	BC Cribs and Trenches Project Task Lead
Fred Ruck	Fluor Hanford Environmental Programs	Environmental Compliance
Larry Fitch	Fluor Hanford SGW	Remedial Investigation Project Manager
Steven Landsman	Fluor Hanford RadCon Engineering	Radiological Engineering
Jim Hoover	Fluor Hanford D&D	Risk Assessment
Richard Stephenson	Fluor Hanford D&D	Excavation Engineering
Ed Dodd	Fluor Hanford Safety Basis Development	Nuclear Safety
Steve Trent	Fluor Hanford EIS	Analytical Chemistry, Data Management

Personnel listed may delegate their role to others who can adequately represent the stated area of expertise.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*.
D&D = Deactivation and Decommissioning.
DQO = data quality objective.
EIS = Environmental Information Systems.
SGW = Soil and Groundwater Remediation.

Table A-2. Data Quality Objectives Key Decision-Makers.

Name	Organization	Area of Expertise (Role)
Bryan Foley	RL	RL Project Manager
Rod Lobos	EPA Region 10	EPA Project Manager
Tom Post	EPA Region 10	EPA Scientist

EPA = U.S. Environmental Protection Agency.
RL = U.S. Department of Energy, Richland Operations Office.

A1.7 BACKGROUND INFORMATION

The Hanford Site, established in 1943, was originally designed, built, and operated to produce plutonium for nuclear weapons by using production reactors and chemical reprocessing plants.

Operations in the 200 East and 200 West Areas primarily were related to separation of special nuclear materials from spent nuclear fuel (i.e., fuel that has been withdrawn from a nuclear reactor after irradiation). These separations processes were conducted in the B Plant and T Plant. Uranium recovery from the liquid wastes generated at T Plant and B Plant was conducted at the U Plant in the 200 West Area. The liquid-waste streams generated by the chemical separations processes implemented at B Plant, T Plant, and U Plant operations were the primary contaminant sources for the BC Cribs and Trenches Area waste sites. The BC Cribs and Trenches Area waste sites are identified in Figure 1-2.

Both B Plant and T Plant consist of several buildings, including the 221-B Building and 221-T Building (known as "canyon buildings" because of their shape and appearance) and the 224-B Building and 224-T Building (known as concentration facilities because of the operational procedures performed there). The B Plant and T Plant received and processed irradiated fuel rods from the 100 Area reactors. In the B Plant, plutonium was separated from irradiated fuel rods using a bismuth-phosphate process. Recovery of cesium, strontium and other rare earth metals also was performed, using an acid-side oxalate-precipitation process. The bismuth-phosphate process also was used at the T Plant to separate plutonium from irradiated fuel rods. The plutonium separation and purification operations ceased at B Plant in 1952 and at T Plant in 1956.

The bismuth-phosphate separation process generated a waste stream composed of dissolved cladding, metal waste, and first- and second-cycle waste. From 1952 to 1958, operations in the U Plant included a tributyl phosphate (TBP) process to recover uranium from the bismuth-phosphate process wastes. The URP served two purposes: (1) to recover unprocessed uranium to be irradiated and processed into plutonium and (2) to reduce the volume of waste generated at B Plant and T Plant. Waste generated from the URP and disposed of in BC Cribs and Trenches Area waste sites included TBP waste or column waste, solvent-recovery waste, acid-recovery waste, off-gas condensates, and uranium trioxide or powdered waste streams (DOE/RL-2004-66).

From 1954 to 1958, a secondary operation was added to the URP in the U Plant to "scavenge" or precipitate the long-lived fission product out of solutions before the waste was discharged. Chemicals used to scavenge fission products included potassium and sodium derivatives of the metal/ferrocyanide complex ion. Iron, nickel, and cobalt were widely used to assist precipitation. Calcium nitrate and/or strontium nitrate often were added to enhance the precipitation of the radioactive Sr-90. Phosphate ions were added to aid the soil retention of Sr-90. Liquid wastes generated at B Plant, T Plant, and U Plant were routed to underground storage tanks through a series of collection and transfer tanks, diversion boxes, vaults, and piping. The heavier constituents were allowed to settle out from solution and form sludge in a settling process known as "cascading" (DOE/RL-2004-66). The remaining liquid supernatants (no longer containing the long-lived fission products) were then discharged to the soil column in BC Cribs and Trenches Area waste sites 216-B-14 to 216-B-19 Cribs, 216-B-20 to 216-B-34 Trenches, and the 216-B-52 Trench (HW-19140, *Uranium Recovery Technical Manual*; DOE/RL-91-52, *U Plant Source Aggregate Area Management Study Report*; *Waste Information Data System* database; WHC-SD-WM-ER-133, *An Assessment of the Inventories of the Ferrocyanide Watchlist Tanks*; GE, 1958, *Record of Scavenged TBP Waste (Logbook)*, as referenced in DOE/RL-2004-66).

From 1955 to 1957, in-tank scavenging operations were conducted to process the TBP waste that had been returned to the tank farms. This in-tank TBP waste was generated in the U Plant before the implementation of the scavenging operation. The TBP waste was transferred from the tanks to vaults, where it was scavenged and sent back to the original tank farms. The same chemicals were used in the in-tank scavenging that were used in the U Plant process. Often, scavenging was performed in batches from tanks when the liquid effluents did not meet cribbing or trenching limits. The cribs and trenches that received in-tank or in-tank-farm scavenged and/or rescavenged TBP waste include BC Cribs and Trenches Area waste sites 216-B-17 and 216-B-19 Cribs, 216-B-20 to 216-B-23 Trenches, 216-B-28 Trench, 216-B-30 to 216-B-34 Trenches, and 216-B-52 Trench (ARH-947, *200 Areas Disposal Sites for Radioactive Liquid Wastes*, as referenced in DOE/RL-2004-66). The last of the liquid effluents was discharged in 1958 (HW-31442, *Recovery of Cesium-137 from Uranium Recovery Process Wastes*; HW-33591, *Summary of Liquid Radioactive Wastes Discharged to the Ground – 200 Areas (July 1952 through June 1954)*; HW-38562, *Radioactive Contaminants in Liquid Wastes Discharged to Ground at Separation Facilities Through June 1955*; HW-42612, *Cobalt-60 in Groundwater and Separation Waste Streams*, as referenced in DOE/RL-2004-66).

In addition to the waste generated from the 200 Areas plant operations, 300 Area chemical laboratory waste also was disposed of in BC Cribs and Trenches Area waste sites. From 1962 to 1967, liquid laboratory waste from the 300 Area was sent to the 340 Waste Neutralization Facility via the process sewer. Waste above the release limits for the 300 Area Process Ponds was sent by tanker truck to the 216-B-58, 216-B-53B, and 216-B-54 Trenches for disposal. Laboratory process waste was characterized as slightly acidic to alkaline radioactive waste (mainly cesium and strontium) with a low salt and organic content.

The 216-B-53A Trench, also located in the BC Cribs and Trenches Area, was active during October and November 1965. The 216-B-53A Trench received waste from a liquid release at the Plutonium Recycle Test Reactor in the 300 Area. The waste was transported to the trench in tanker trucks. The waste contained an estimated 50 to 100 g of plutonium, which possibly could result in soil contaminated with transuranic constituents at levels of concern (100 nCi/g) (DOE/RL-2004-66).

Two other waste sites within the BC Cribs and Trenches Area include the 200-E-14 Siphon Tank and the 200-E-114 Pipeline. The siphon tank held liquid waste before it was discharged to the cribs, and the pipeline delivered liquid waste to the siphon tank.

Summary information specific to each of the BC Cribs and Trenches Area waste sites is provided in Table A-3. Table A-4 provides a summary of reference and data sources for the BC Cribs and Trenches Area waste sites. Photographs taken during construction of the BC Cribs and Trenches are shown in Figures A-1 and A-2, respectively.

Table A-3. Summary of Information for the BC Cribs and Trenches Area Waste Sites. (5 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Volume/Contaminants Released	Depth	Waste Site Dimensions	General Description
200-E-14	200-E-14, 216-BC-201 Siphon Tank	South of Route 4S and 18 m (60 ft) north of the center between 216-B-14 and 216-B-15 Cribs	1956 to 1957	In-tank farm and scavenged $BiPO_4$ waste from UPR in 221-U	N/A; tank believed to be essentially empty	NA	8.2 m x 3.9 m (27 ft x 13 ft)	The 216-B-14 to 216-B-19 Cribs and 216-B-201 Siphon Tank were all stabilized together with 0.6 m (2 ft) of topsoil in 1981. Concrete AC 540 markers indicate the location. Tank is concrete and discharged waste to BC Cribs (216-B-14 to 216-B-19). Tank received waste via four underground pipelines: 2805-E-1, -2, -3, -4.
200-E-114	200-E-114 Pipeline	Located in 200 East Area, the pipeline extends from the BY and C Tank Farms to the BC Cribs and Trenches Area	1952 to 1954	Scavenged TBP Waste Stream: BY and C Tank Farms: The pipeline transported scavenged bismuth phosphate solvent extraction waste from the URP process waste in the 221-U Building	In 1997, contamination measuring 2,500 to 5,000 d/min beta/gamma was observed in a 6.1 x 30.5 m (20 x 100 ft) area straddling the pipeline northeast of the B Tank Farm near the point where it turns south. In 2001, another radiological survey found contamination measuring up to 19,000 d/min beta/gamma within a 15.2 m (50 ft) diameter area straddling the pipeline near its junction to the 216-B-51 French Drain	2.1 to 3.0 m (7 to 10 ft)	Approximately 4,600 m (15,100 ft) long with a diameter of 6 cm (2.4 in.)	Contaminant types are expected to be very similar to 216-B-26 Trench. The vertical extent of contamination is expected to be considerably less, because evidence suggests that only minor pipeline leakage has occurred, and that leakage was outside of the BC Cribs and Trenches Area.
216-B-14	216-B-14 Crib 216-BC-1 Crib	South of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area	1956 to 1956	Scavenged $BiPO_4$ waste from UPR in 221-U	8,710,000 L 304 Ci Cs-137; 595 Ci Sr-90; 115 g Pu; 269 kg U	4 m (13 ft)	24 m x 24 m[a] (80 ft x 80 ft)	The 216-B-14 to 216-B-19 Cribs and 216-BC-201 Siphon Tank were all stabilized together with 0.6 m (2 ft) of topsoil in 1981. Concrete AC 540 markers indicate the location. Tank discharged waste to BC Cribs (216-B-14 to 216-B-19). Cribs are constructed of wood, cinder block, and steel on a bed of 7.6 cm (3-in.) gravel. Waste was routed to BC Cribs from B, BX, and BY Tank Farms via drain B-51.
216-B-15	216-B-15 Crib 216-BC-2 Crib		1956 to 1957		6,320,000 L 222 Ci Cs-137; 168 Ci Sr-90; 81.5 g Pu; 196 kg U			
216-B-16	216-B-16 Crib 216-BC-3 Crib		1956 to 1956		5,600,000 L 197 Ci Cs-137; 145 Ci Sr-90; 74 g Pu; 173 kg U			
216-B-17	216-B-17 Crib 216-BC-4 Crib	South of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area (cont)	1956 to 1956	In-tank farm scavenged (1st cycle) and scavenged $BiPO_4$ waste from UPR in 221-U	3,410,000 L 120 Ci Cs-137; 82.9 Ci Sr-90; 45.1 g Pu; 104 kg U	4 m (13 ft) (cont)	24 m x 24 m[a] (80 ft x 80 ft) (cont)	The 216-B-14 to 216-B-19 Cribs and 216-BC-201 Siphon Tank were all stabilized together with 0.6 m (2 ft) of topsoil in 1981. Concrete AC 540 markers indicate the location. Tank discharged waste to BC

Table A-3. Summary of Information for the BC Cribs and Trenches Area Waste Sites. (5 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Volume/Contaminants Released	Depth	Waste Site Dimensions	General Description
216-B-18	216-B-18 Crib 216-BC-5 Crib			Scavenged $BiPO_4$ waste from UPR in 221-U	8,520,000 L 299 Ci Cs-137; 227 Ci Sr-90; 113 g Pu; 264 kg U			Cribs (216-B-14 to 216-B-19). Cribs are constructed of wood, cinder block, and steel on a bed of 7.6 cm (3-in.) gravel. Waste was routed to BC Cribs from B, BX, and BY Tank Farms via drain B-51. (cont)
216-B-19	216-B-19 Crib 216-BC-6 Crib		1957 to 1957	In-tank farm scavenged (1[st] cycle) and scavenged $BiPO_4$ waste from UPR in 221-U	6,400,000 L 223 Ci Cs-137; 159 Ci Sr-90; 86.6 g Pu; 194 kg U			
216-B-20	216-B-20 Trench 216-BC-7 Trench		1956 to 1956	Scavenged $BiPO_4$ waste from UPR in 221-U	4,680,000 L 549 Ci Cs-137; 307 Ci Sr-90; 63.6 g Pu; 148 kg U	3 m (10 ft)	153 m x 3 m[b] (500 ft x 10 ft)	The unlined BC Trenches (216-B-20 to 216-B-34) were each backfilled upon reaching capacity. The BC Trenches were stabilized together in 1969 with sand and gravel; in 1981 and1982 with clean soil. Concrete AC 540 markers outline the group of trenches. URP/scavenged liquid extraction waste was routed to trenches from B, BX, and BY Tank Farms via drain B-51. Surface contamination spread through rabbits and vegetation has resulted in ongoing stabilization activities.
216-B-21	216-B-21 Trench 216-BC-8 Trench	West side of the 216-B-20 Trench, south of the 200 East Area (across Route 4S) in the BC Crib Area			4,670,000 L 164 Ci Cs-137; 123 Ci Sr-90; 61.7 g Pu; 144 kg U			See general description for 216-B-20. Groundwater well 299-E13-83 monitors site.
216-B-22	216-B-22 Trench 216-BC-9 Trench	West side of the 216-B-21 Trench, south of the 200 East Area (across Route 4S)			4,740,000 L 166 Ci Cs-137; 122 Ci Sr-90; 62.6 g Pu; 146 kg U			See general description for 216-B-20. Groundwater well 299-E13-9 monitors site.
216-B-23	216-B-23 Trench 216-BC-10 Trench	South of the 200 East Area (across Route 4S)			4,520,000 L 159 Ci Cs-137; 116 Ci Sr-90; 59.7 g Pu; 139 kg U	5.4 m (18 ft); 2.4 m (8 ft) is overburden		See general description for 216-B-20.
216-B-24	216-B-24 Trench 216-BC-11 Trench	Directly south of the 216-B-23 Trench, south of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area	1956 to 1956 (cont)	Scavenged $BiPO_4$ waste from UPR in 221-U (cont)	4,700,000 L 171 Ci Cs-137; 130 Ci Sr-90; 64.3 g Pu; 151 kg U	5.4 m (18 ft); 2.4 m (8 ft) is overburden (cont)	153 m x 3 m[b] (500 ft x 10 ft) (cont)	See general description for 216-B-20. Groundwater well 299-E13-11 monitors site.
216-B-25	216-B-25 Trench 216-BC-12 Trench				3,760,000 L 172 Ci Cs-137; 131 Ci Sr-90; 64.9 g Pu; 152 kg U	6.2 m (20 ft); 3 m (10 ft) is overburden		See general description for 216-B-20.

Table A-3. Summary of Information for the BC Cribs and Trenches Area Waste Sites. (5 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Volume/Contaminants Released	Depth	Waste Site Dimensions	General Description
216-B-26	216-B-26 Trench 216-BC-13 Trench	Directly south of the 216-B-25 Trench, south of the 200 East Area (across Route 4S)	1956 to 1957		5,880,000 L 585 Ci Cs-137; 487 Ci Sr-90; 64.1 g Pu; 159 kg U	5.5 m (18 ft); 2.4 m (8 ft) is overburden		See general description for 216-B-20. Groundwater well 299-E13-12 monitors site.
216-B-27	216-B-27 Trench 216-BC-14 Trench		1957		4,420,000 L 155 Ci Cs-137; 118 Ci Sr-90; 58.4 g Pu; 137 kg U			See general description for 216-B-20.
216-B-28	216-B-28 Trench 216-BC-15 Trench				5,050,000 L 177 Ci Cs-137; 130 Ci Sr-90; 66.7 g Pu; 156 kg U	3 m (10 ft)		See general description for 216-B-20. Groundwater wells 299-E13-13 and 299-E13-19 monitor site.
216-B-29	216-B-29 Trench 216-BC-16 Trench	South of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area			4,840,000 L 170 Ci Cs-137; 249 Ci Sr-90; 63.8 g Pu; 150 kg U			See general description for 216-B-20. Groundwater well 299-E13-14 monitors site.
216-B-30	216-B-30 Trench 216-BC-17 Trench	Directly south of the 216-B-29 Trench; south of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area			4,780,000 L 168 Ci Cs-137; 119 Ci Sr-90; 63.2 g Pu; 146 kg U			See general description for 216-B-20.
216-B-31	216-B-31 Trench 216-BC-18 Trench				4,740,000 L 170 Ci Cs-137; 121 Ci Sr-90; 64.1 g Pu; 148 kg U			See general description for 216-B-20. Groundwater wells 299-E13-15 and 299-E13-16 monitor site.
216-B-32	216-B-32 Trench 216-BC-19 Trench				4,770,000 L 167 Ci Cs-137; 151 Ci Sr-90; 62.8 g Pu; 145 kg U			See general description for 216-B-20.
216-B-33	216-B-33 Trench 216-BC-20 Trench	Directly south of the 216-B-32 Trench; south of the 200 East Area (across Route 4S) in the BC Crib Area			4,740,000 L 167 Ci Cs-137; 170 Ci Sr-90; 62.8 g Pu; 145 kg U			
216-B-34	216-B-34 Trench 216-BC-21 Trench	Directly south of the 216-B-33 Trench; south of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area	1957	Scavenged $BiPO_4$ waste from UPR in 221-U (cont)	4,870,000 L 171 Ci Cs-137; 165 Ci Sr-90; 64.4 g Pu; 148 kg U	3 m (10 ft)	153 m x 3 m[b] (500 ft x 10 ft) (cont)	See general description for 216-B-20.

Table A-3. Summary of Information for the BC Cribs and Trenches Area Waste Sites. (5 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Volume/Contaminants Released	Depth	Waste Site Dimensions	General Description
216-B-52	216-B-52 Trench	Immediately north of the 216-B-23 Trench; south of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area	1957 to 1958		5,530,000 L 300 Ci Cs-137; 387 Ci Sr-90; 113 g Pu; 260 kg U		177 m x 3 m[b] (580 ft x 10 ft)	This unlined BC Trench was backfilled upon reaching capacity. BC Trenches were stabilized together in 1969 with sand and gravel in 1981 and in 1982 with clean soil. Concrete AC 540 markers outline the group of Trenches. URP/scavenged liquid extraction waste was routed to trenches from the BY Tank Farm via drain B-51. Surface contamination from rabbits and vegetation has resulted in ongoing stabilization activities.
216-B-53A	216-B-53A Trench	Immediately north of the 216-B-53B Trench, south of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area	1965	PRTR Process Tube Failure Cleanup Waste Stream: Trench received liquid waste associated with the PRTR upset (process-tube failure). Secondary cooling water became contaminated with plutonium and mixed fission products. Of all of the specific retention trenches in the BC Cribs and Trenches Area, only this trench has the potential to have concentrations of transuranic constituents above 100 nCi/g.	550,000 L 10.5 Ci Cs-137; 8.9 Ci Sr-90; 50.8 g Pu; 30.7 kg U		18.3 m (60 ft) x 3.0 m (10 ft)	Divided into two sections by an earthen dam at the center that was 1.5 m (5 ft) high and 0.1 m (0.3 ft) wide at its top. The depth to the top of contamination is 3 m (10 ft).
216-B-53B	216-B-53B Trench	Immediately north of the 216-B-54 Trench, south of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area	1962-1963	300 Area laboratory waste	~20,000 L 6.1 Ci Cs-137; 5.2 Ci Sr-90; 14.6 g Pu; 8.3 kg U		46 m (150 ft) x 3.0 m (10 ft)	
216-B-54	216-B-54 Trench	Immediately north of the 216-B-58 Trench, south of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area	1963-1965	300 Area laboratory wastes	1, 000,000 L 6.1 Ci Cs-137; 5.2 Ci Sr-90; 17.2 g Pu; 13.4 kg U	3.0 m (10 ft)	60 m (200 ft) x 3.0 m (10 ft)	Divided into two sections by an earthen dam at the center that was 1.5 m (5 ft) high and 0.1 m (0.3 ft) wide at its top. The depth to the top of contamination is 2 m (7 ft).

Table A-3. Summary of Information for the BC Cribs and Trenches Area Waste Sites. (5 Pages)

Site Code	Site Name	Location	Dates of Operation	Source Facility	Volume/Contaminants Released	Depth	Waste Site Dimensions	General Description
216-B-58	216-B-58 Trench	Immediately north of the 216-B-52 Trench, south of the 200 East Area (across Route 4S) in the BC Cribs and Trenches Area	1965-1967	300 Area Laboratory Waste. Liquid wastes from the 300 Area laboratory facilities	417,000 L 4.9 Ci Cs-137; 4.1 Ci Sr-90; 12.8 g Pu; 8.8 kg U			Divided into eight 8 m (25-ft) sections by earthen dams that were 1.5 m (5 ft) high and 0.1 m (0.3 ft) wide at their top. A corrugated 1.22 m (4-ft) diameter perforated pipe runs the length of the trench except for the western 8 m (25-ft) section. The depth to the top of contamination is 3.6 m (12 ft). Located in the BC Cribs and Trenches Area and within the assembly of 216-B-53A through 216-B-58 Trenches.

[a] Surface of waste site.
[b] Bottom of waste site.

Sources: DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan.*
RPP-26744, *Hanford Soil Inventory Model, Rev. 1.*
DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*

PRTR = Plutonium Recycle Test Reactor.
TBP = tributyl phosphate.
UPR = unplanned release.
URP = Uranium Recovery Process.

Table A-4. Existing Documents and Data Sources for the BC Cribs and Trenches Area. (2 Pages)

Reference	Summary
RPP-26744, *Hanford Soil Inventory Model, Rev. 1*	Describes a probabilistic approach to estimating the inventory of contaminants released to soil during the Hanford Site production mission.
DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan — Environmental Restoration Program*	Identifies the representative waste sites for the operable units, provides the inventory values for Cs-137 and Sr-90 for the 216-B-26 Trench.
DOE/RL-96-81, *Waste Site Grouping for 200 Areas Soil Investigations*	Identifies the representative waste sites for the operable units, provides the inventory values for Cs-137 and Sr-90 for the 216-B-26 Trench.
DOE/RL-2003-44, *BC Cribs and Trenches 200-TW-1 Operable Unit Borehole Sampling and Analysis Plan*	Provides sampling requirements for the one borehole (C4191) drilled in the 216-B-26 Trench.
BHI-01356, *Remedial Investigation Data Quality Objectives Summary Report for the 200-TW-1 Scavenged Waste Group and 200-TW-2 Tank Waste Group Operable Units*	Identifies the representative waste sites for the operable units.
DOE/RL-2000-38, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*	Identifies the representative waste sites for the operable units. Includes discussion regarding meteorology, topography, and hydrogeologic frameworks for the BC Cribs and Trenches Area 200-TW-1 Operable Unit waste sites.
DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit)*	Provides characterization data for one of the representative waste sites (216-B-46 Crib), includes discussion regarding meteorology, topography, and hydrogeologic frameworks for the BC Cribs and Trenches Area 200-TW-1 Operable Unit waste sites.
DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*	Provides estimates of contaminants at the 216-B-58 Trench. Two boreholes were drilled in the 216-B-58 Trench to support this study and the acceleration of remedial actions at the BC Cribs and Trenches Area. Includes characterization data for two new 200-TW-1 Operable Unit waste sites located in the BC Cribs and Trenches Area (216-B-26 and 216-B-58 Trenches). Appendix F of this document discusses the estimate of radiation dose to workers that likely would be incurred if the radioactive material were to be excavated, transported, and buried in an engineered burial ground.
DOE/RL-2004-69, *Proposed Plan for the BC Cribs and Trenches Area Waste Sites*	Develops and evaluates alternatives for remediation of the 28 waste sites in the BC Cribs and Trenches Area.
DOE/RL-2001-66, *Chemical Laboratory Waste Group Operable Units RI/FS Work Plan, Includes: 200-LW-1 and 200-LW-2 Operable Units*	Provides estimates of contaminants at the 216-B-58 Trench.
DOE/RL-92-19, *200 East Groundwater Aggregate Area Management Study Report*	Includes discussion regarding meteorology, topography, and hydrogeologic frameworks for the BC Cribs and Trenches Area 200-TW-1 Operable Unit waste sites.
PNNL-13788, *Hanford Site Groundwater Monitoring for Fiscal Year 2001*	Includes discussion regarding meteorology, topography, and hydrogeologic frameworks for the BC Cribs and Trenches Area 200-TW-1 Operable Unit waste sites.
PNNL-13910, *Hanford Site Environmental Report for Calendar Year 2001*	Includes discussion regarding meteorology, topography, and hydrogeologic frameworks for the BC Cribs and Trenches Area 200-TW-1 Operable Unit waste sites.
PNNL-6415, *Hanford Site National Environmental Policy Act (NEPA) Characterization*	Includes discussion regarding meteorology, topography, and hydrogeologic frameworks for the BC Cribs and Trenches Area 200-TW-1 Operable Unit waste sites.
DOE/RW-0164, *Consultation Draft: Site Characterization Plan, Reference Repository Location, Hanford Site, Washington*	Contains geology information relevant to the 200 Areas.

Table A-4. Existing Documents and Data Sources for the BC Cribs and Trenches Area. (2 Pages)

Reference	Summary
DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the Central Pasco Basin*	Contains geology information relevant to the 200 Areas.
HNF-5507, *Subsurface Conditions Description for the B-BX-BY Waste Management Area*	Contains geology information relevant to the 200 Areas.
DOE/RL-2001-54, *Central Plateau Ecological Evaluation*	Provides natural resource information.
BHI-01496, *Groundwater/Vadose Zone Integration Project Hanford Soil Inventory Model*	Provides the Tc-99 contamination value listed for the 216-B-26 Trench.
DOE/RL-91-52, *U Plant Source Aggregate Area Management Study Report*	Provides operational information.

Full citations for the references are provided in Chapter A8.0.

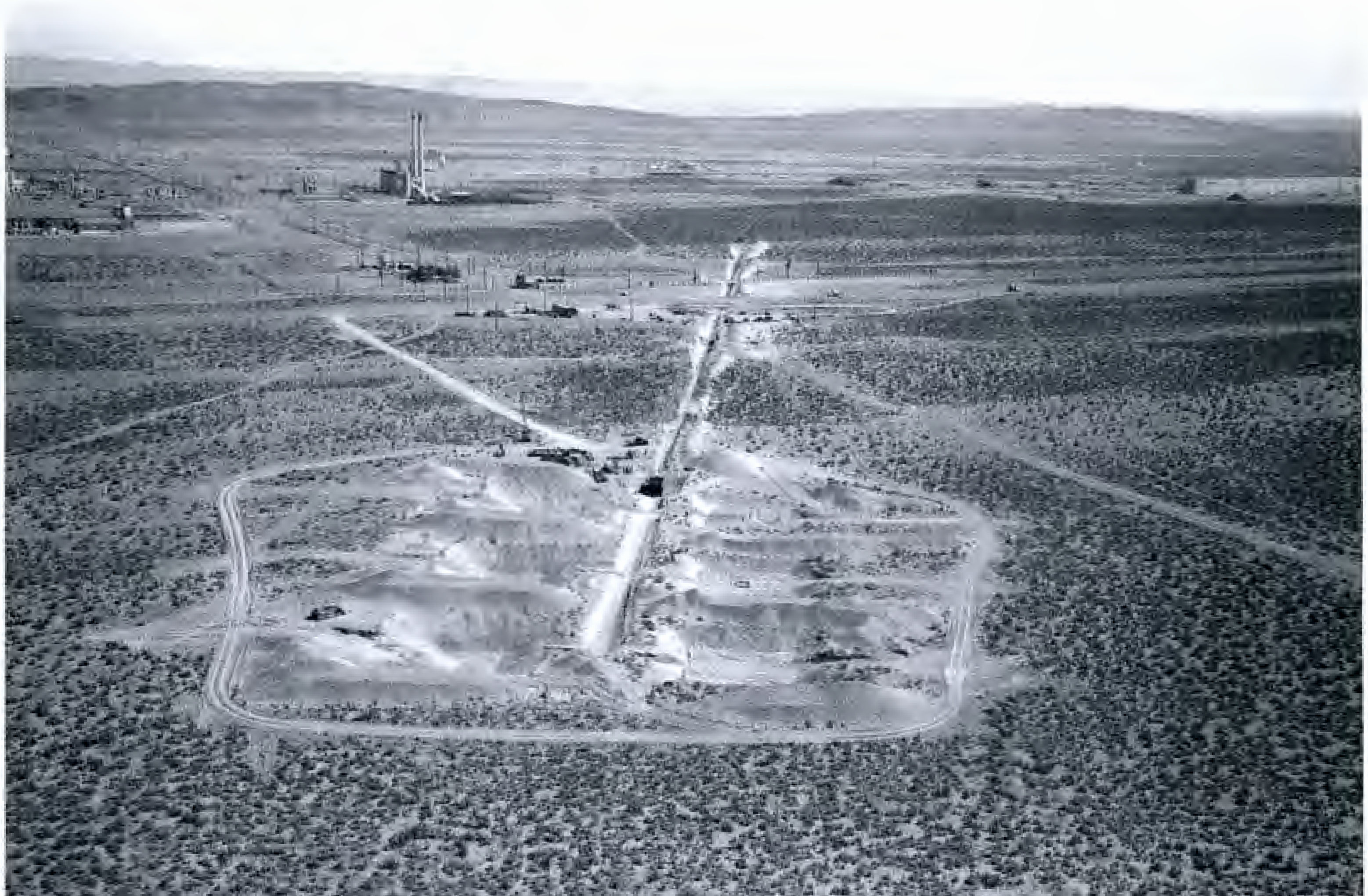
A1.7.1 Characterized Waste Sites and Representative Waste Sites

The remedial investigation of the BC Cribs and Trenches Area is represented by three waste sites: the 216-B-26 and 216-B-58 Trenches and the 216-B-46 Crib. Designation of a representative waste site takes into account multiple factors, including the construction type and size of the waste site, the estimated contaminant inventory, the effluent volume received, and the geology to describe the expected contaminant distribution. Because the 216-B-20 through 216-B-25 Trenches, 216-B-27 through 216-B-34 Trenches, and the 216-B-52 Trench are collocated with the 216-B-26 Trench and received similar waste volume and contaminant load, the contaminant distributions are expected to be similar. Therefore, these waste sites are considered analogous to the 216-B-26 Trench. Likewise, the 216-B-53A, 216-B-53B, and 216-B-54 trenches are considered analogous to the 216-B-58 Trench. Cribs 216-B-14 through 216-B-19 are analogous to the 216-B-46 Crib, because they received the same type of waste and have similar construction and geology. Characterization has been conducted of each of these representative waste sites.

A1.7.1.1 216-B-26 Trench

To locate the region of the trench with the highest contamination, six shallow (12.2-m [40-ft] deep) holes spaced evenly along the length of the 216-B-26 Trench were installed. Data were collected (i.e., logged) on residual gamma radiation. Some portions of the trench appeared to be heavily contaminated, while other portions were only slightly contaminated. One of the shallow boreholes showed no contamination, suggesting that it intersected a berm that divided the trench. Two others exhibited Cs-137 concentrations in excess of 1 million pCi/g. Another two boreholes exhibited maximum Cs-137 concentrations ranging from 20,000 to 60,000 pCi/g, and one borehole indicated approximately 400,000 pCi/g of Cs-137.

Figure A-1. Construction of BC Cribs, June 1955.



Source: DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*.

Figure A-2. Construction of BC Trenches in 1956.

Source: DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*.

A single borehole was drilled to groundwater at the place of highest contamination, based on the gamma-radiation logging of the evenly spaced shallow holes, and periodic soil samples were collected. The borehole also was logged to assess residual gamma-emitting radionuclides and moisture concentrations.

High concentrations of Cs-137 and Sr-90 are present near the surface, approximately 3.7 to 4.6 m (12 to 15 ft) deep. Their spatial distribution may be uneven, based on the shallow borehole characterization described above. These contaminants are relatively immobile and confined to near-surface soil.

Elevated concentrations of Tc-99 and nitrate were found in fine-grained soil layers at 30.5 to 39.6 m (100 to 130 ft) deep. Essentially no contamination was observed below 46 m (150 ft). Figure A-3 depicts the contaminant distribution and summarizes characterization data.

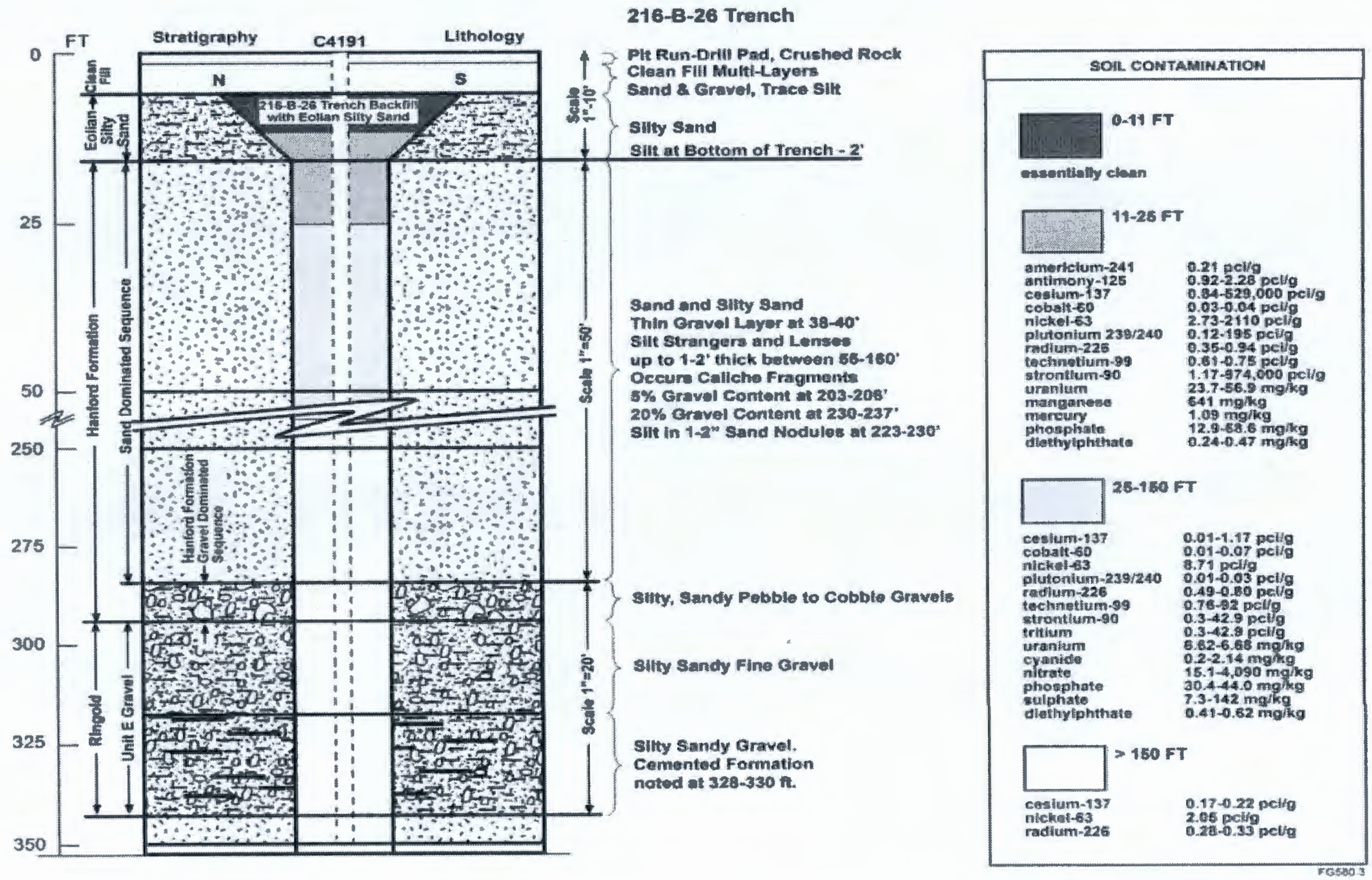
A1.7.1.2 216-B-58 Trench

To locate the region of the 216-B-58 Trench with the highest contamination, eight shallow (10.7 m [35 ft] deep) holes were installed, spaced evenly along the length of the trench. Data were collected on residual gamma radiation. The data indicate that some portions of the trench received more waste than others.

One borehole located at the place of highest contamination was drilled to a depth of 30.5 m (100 ft). Another borehole located at the west end of the trench was drilled to the same depth. Periodic soil samples were collected. These boreholes also were logged to assess residual gamma-emitting radionuclides and moisture concentrations.

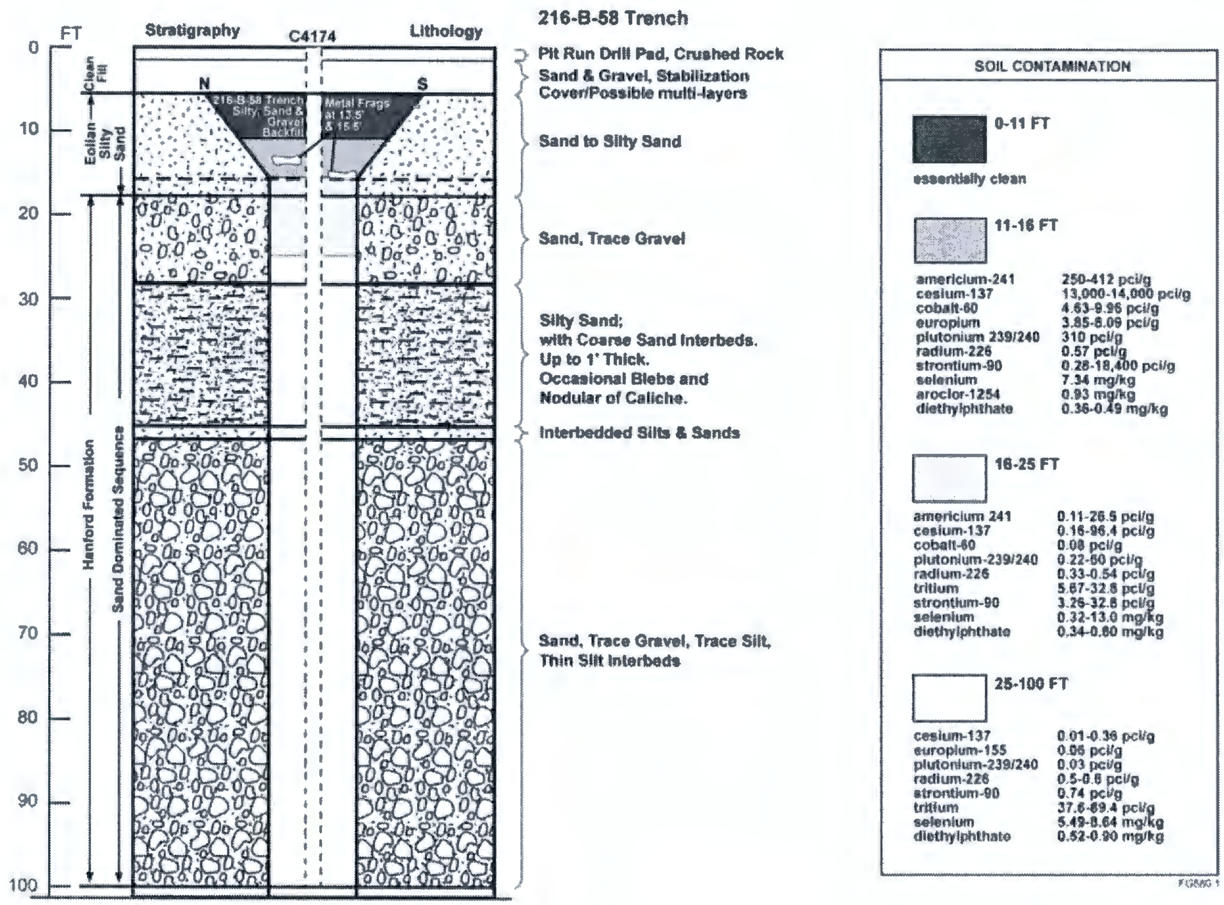
Cesium-137 and Sr-90 concentrations in the 216-B-58 Trench were low compared to those in the 216-B-26 Trench. These contaminants were confined to a depth corresponding to near the bottom of the trench (DOE/RL-2004-69) (see Figures A-4 and A-5).

Figure A-3. 216-B-26 Trench Contaminant Distribution Model of Contaminants of Concern.



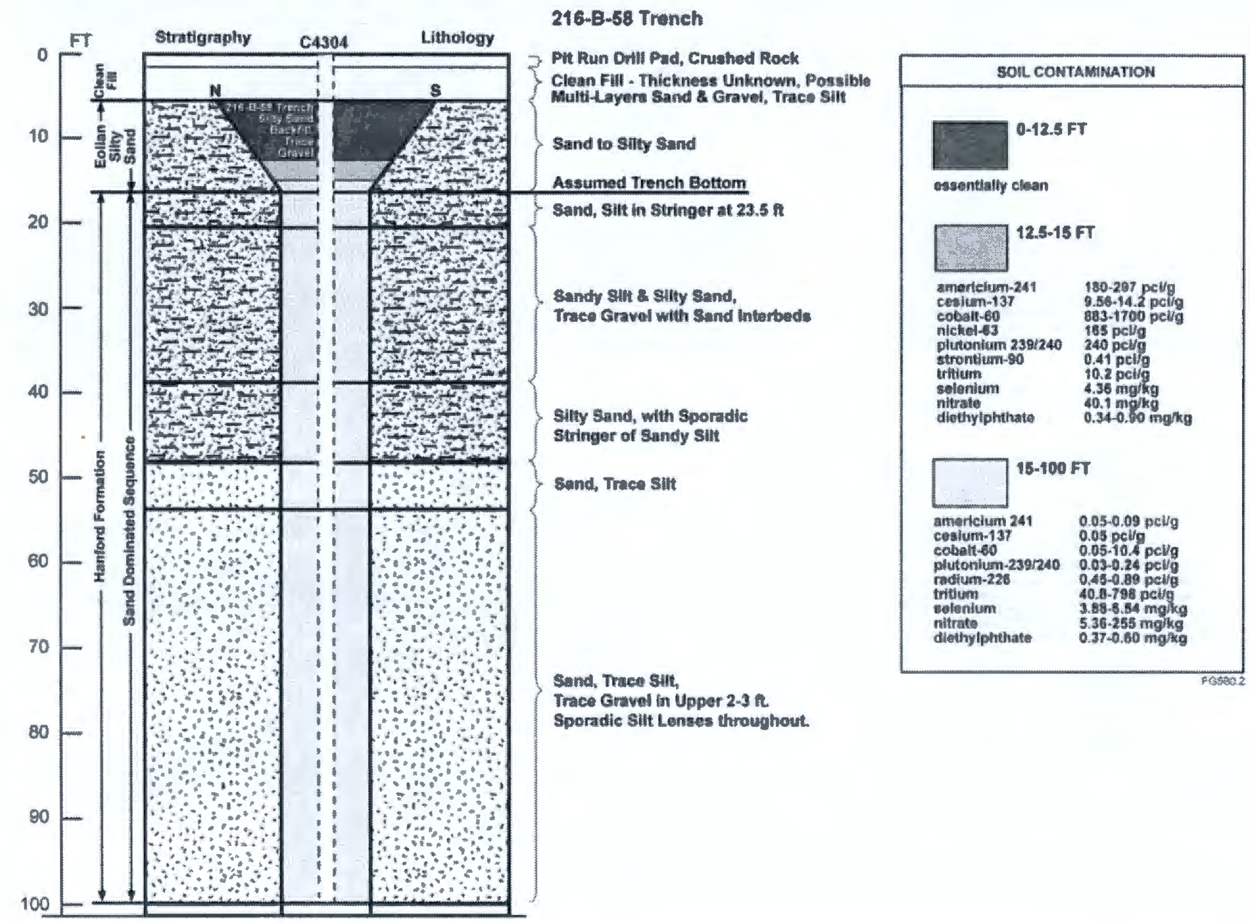
Source: DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*

Figure A-4. 216-B-58 Trench Contaminant Distribution Model of Contaminants of Concern (Middle of Trench).



Source: DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*

Figure A-5. 216-B-58 Trench Contaminant Distribution Model of Contaminants of Concern (West End of Trench).



Source: DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*

A1.7.1.3 216-B-46 Crib

The 216-B-46 Crib was characterized during the investigation of the 200-TW-1 Operable Unit. Three shallow, 9.1 to 10.7 m (30 to 35 ft) deep holes spaced approximately 6.1 m (20 ft) apart in a triangular array were installed through the crib. Soil samples were collected from each borehole. Each borehole also was logged to assess residual gamma-emitting radionuclide and moisture concentrations.

A deep borehole was drilled through the nearby 216-B-49 Crib, which received approximately the same volume and level of contamination as was received by the 216-B-46 Crib. This borehole was used to evaluate the groundwater risks associated with the 216-B-46 Crib. Soil samples were collected. The borehole also was logged geophysically to assess residual gamma-emitting radionuclide and moisture concentrations.

As shown in Figure A-6, Cs-137 and Sr-90 are the predominant contaminants in the shallow zone associated with the bottom of the crib. Technetium-99 and nitrate are present in elevated concentrations from 15.2 m (50 ft) to near the groundwater.

A1.8 CONTAMINANTS OF CONCERN

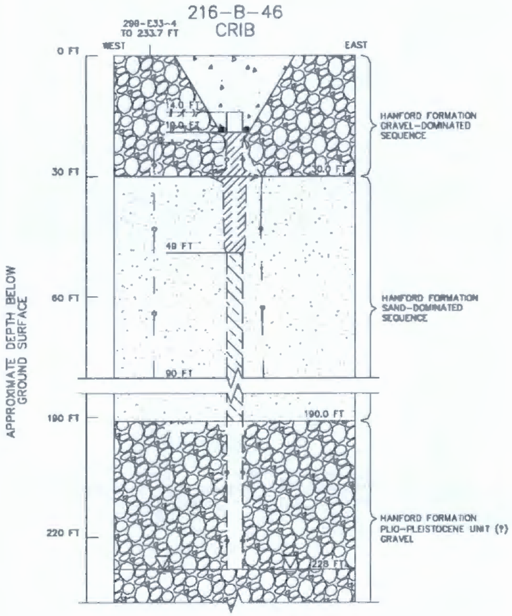
Through the DQO process, a systematic methodology is used for identifying the contaminants of concern (COC) for each project. The BC Cribs and Trenches Area waste sites received scavenged waste from the following facilities:

- The URP and the ferrocyanide processes at the 221/224-U Plant
- 300 Area laboratory facilities
- 340 Waste Neutralization Facility
- Plutonium Recycle Test Reactor.

Before excavation activities are begun, boreholes will be installed in as many as two trenches and one crib using direct-push technology. Data will be collected to characterize the nature and extent of contamination in the trenches.

Figure A-6. 216-B-46 Crib Contaminant Distribution Model of Contaminants of Concern.

2W:060602A



SOIL CONTAMINATION

0-18 FT
NITRATE 60.3-135 mg/kg
PHOSPHATE 1.3-3.0 mg/kg
STRONTIUM-90 0.6-2.9 pCi/g
SULFATE 268-477 mg/kg
RADIUM-226 < 1.0 pCi/g

18-49 FT
ANTIMONY-125 22.7-50.4 pCi/g
CESIUM-137 50.1-364,000 pCi/g
COBALT-60 0.685 pCi/g
CYANIDE 3.2-7.1 mg/kg
PHOSPHATE 14-42 mg/kg
NITRATE 316-4840 mg/kg
NITRITE 2.8-12.2 mg/kg
PLUTONIUM-238 0.115-6.94 pCi/g
PLUTONIUM-239 < 1.0 pCi/g
PLUTONIUM-239/240 3.53-227 pCi/g
RADIUM-226 0.872-2.44 pCi/g
SODIUM 1590-4390 mg/kg
STRONTIUM-90 2.6-353000 pCi/g
SULFATE 264-1080 mg/kg
TECHNETIUM-99 90-120 pCi/g
TRITIUM 21-53 pCi/g
TOTAL URANIUM 4.1-35.3 mg/kg

49-190 FT
COBALT-60 1.24-4.03 pCi/g
CYANIDE 1.5 mg/kg
NITRATE 2220-5470 mg/kg
RADIUM-226 < 1.01 pCi/g
SODIUM 1370-2410 mg/kg
STRONTIUM-90 < 1.0 pCi/g
SULFATE 362-822 mg/kg
TECHNETIUM-99 65-160 pCi/g
TOTAL URANIUM 2.4 mg/kg

>190 FT
BISMUTH 31.3 mg/kg
COBALT-90 1.45-1.65 pCi/g
CYANIDE 1.2 mg/kg
NITRATE 3760-3710 mg/kg
SODIUM 2750 mg/kg
SULFATE 722 mg/kg
TECHNETIUM-99 100-140 pCi/g

RLS DATA
CESIUM-137

? UNCERTAINTY

U.S DEPARTMENT OF ENERGY DOE FIELD OFFICE, RICHLAND HANFORD ENVIRONMENTAL RESTORATION PROGRAM	216-B-46 CRIB CONTAMINANT DISTRIBUTION MODEL

Source: DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*

The COCs for the measurements obtained before excavation and partial removal, treatment, and disposal of contaminated soil were begun are listed in Table A-5.

Table A-5. Contaminants of Concern for Measurements Made Before Excavation.

Radionuclides
Field analyses using a borehole gamma logging instrument for a target list consisting of only Cs-137 (gamma-energy analysis) in the 216-B-26 Trench and the 216-B-14 Crib and only Pu-239 in the 216-B-53A Trench
Laboratory analyses and isotopic analyses for the radionuclides isotopic americium (alpha-energy analysis),* isotopic plutonium (alpha-energy analysis),* total radioactive strontium (gas-proportional counting), and Cs-137 (gamma-energy analysis)

*These radionuclides are of interest in determining the nature and extent of contamination only in the 216-B-53A Trench.

As excavation activities begin, it will be necessary to characterize the waste generated before the soil is shipped to the ERDF. Existing site-characterization data indicate that the most highly contaminated soil in the BC Cribs and Trenches Area will meet the ERDF waste-acceptance criteria requirements for total curies per cubic meter. However, the ERDF supplemental waste-acceptance criteria (BHI-DIS-2-28-05, 0000X-DC-W0001, *Supplemental Waste Acceptance Criteria for Bulk Shipments to the Environmental Restoration Disposal Facility*) requirement that the waste have a radiation level of less than 80 mR/h gamma when measured at 30 cm (1 ft) from the surface of the container would not be met by some of the soils before treatment. Therefore, it will be necessary to down-blend (mix) the highly contaminated soil with less-contaminated soil. As the soil is treated by down-blending, field-screening instruments will characterize it to ensure that the ERDF supplemental waste-acceptance criteria requirements are met. The COCs that will be characterized in the soil to demonstrate compliance with the ERDF waste-acceptance criteria and supplemental waste-acceptance criteria before the soil is shipped will be established via a separate DQO process before field activities are initiated.

A1.9 CONCEPTUAL CONTAMINANT DISTRIBUTION MODEL

Table A-6 provides the relevant physical setting and background information for the BC Cribs and Trenches Area waste sites.

Table A-6. Conceptual Contaminant Distribution Model Discussion for the BC Cribs and Trenches Area Waste Sites.

Physical Setting
The BC Cribs and Trenches Area waste sites are located south of the 200 East Area. The ground surface elevation is approximately 230 m (755 ft) above mean sea level and slopes to the northeast. The thickness of the vadose zone underlying the BC Cribs and Trenches Area waste sites is approximately 105 m (345 ft) (DOE/RL-2004-66). The vadose zone is within the Hanford formation and Ringold Formation in this part of the 200 East Area (DOE/RL-2004-66). The unconfined aquifer is contained within the sand and gravel of the Hanford formation, which directly overlies the basalt (PNNL-13080). Areas of basalt project above the water table north of the 200 East Area (DOE/RL-2001-66). The thickness of the unconfined aquifer beneath the BC Cribs and Trenches Area waste sites is not well defined (PNNL-13080).
The regional flow of groundwater in the unconfined aquifer is from west of the Hanford Site toward the Columbia River. However, the local direction and rate of flow have been influenced by the discharge of wastewater to the soil column between 1944 and 1995 as a result of Hanford Site operations. Groundwater flows primarily from west to east under the BC Cribs and Trenches Area waste sites, influenced by the basalt high north and east of the waste sites and the presence of the B Pond groundwater mound (PNNL-13080). The gradient of the water table has never been calculated from wells located in the BC Cribs and Trenches Area. The flow rate has been estimated at 0.002 to 0.0075 m/d for the groundwater beneath the nearby Integrated Disposal Facility (PNNL-15670).
Nature and Extent of Contamination
Because the cribs and trenches received uncontained liquids, contaminants were released directly to the environment in the BC Cribs and Trenches Area waste sites. Contaminants have been detected from depths of 2.7 m (9 ft) to as deep as 40 m (130 ft). The majority of contaminants and the highest concentrations detected in samples collected from the 216-B-26 Trench were found from 3.4 to 5.2 m (11 to 17 ft) below ground surface. The maximum concentrations of many of the contaminants were associated with what is presumed to be the bottom of the original trench excavation at a depth of about 3.4 m (11 ft) below ground surface. As contaminants were released, they were held by the native soil column at varying degrees of effectiveness, depending on the contaminant distribution coefficient (K_d) of the constituent. While some constituents with high K_d values (e.g., Cs-137) appear to be held within the first meter of native soil below the original trench surface, constituents with low K_d values (e.g., Tc-99 and nitrate) have been detected between 30 and 40 m (100 and 130 ft). Penetration of contaminants with high K_d values is anticipated to be localized and irregular, based on limited characterization of near-surface soil at the 216-B-26 Trench. Based on geophysical characterization (high-resolution resistivity), the more mobile contaminants are believed to have merged beneath the individual waste sites. Surface contamination is possible at shallow depths below and at the top of stabilizing soil covers, where plants, animals, and insects have brought the material to the surface. Contamination of the trench backfill may be encountered as a result of this bio intrusion.
Long-lived mobile radionuclides (uranium, Tc-99) have not been detected above drinking water standards in groundwater monitoring wells at the BC Cribs and Trenches Area waste sites, suggesting that contaminant migration through the vadose zone has not reached groundwater.

DOE/RL-2001-66, *Chemical Laboratory Waste Group Operable Units RI/FS Work Plan, Includes: 200-LW-1 and 200-LW-2 Operable Units.*

DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*

PNNL-13080, *Hanford Site Groundwater Monitoring: Setting, Sources and Methods.*

PNNL-15670, *Hanford Site Groundwater Monitoring for Fiscal Year 2005.*

K_d = distribution coefficient.

A1.10 CONCISE STATEMENT OF THE PROBLEM

Table A-7 combines relevant background information into a concise statement of the problem to be resolved.

Table A-7. Concise Statement of the Problem.

Problem Statement:
To support remedy selection at the BC Cribs and Trenches Area waste sites, the feasibility of the remedial-action alternative of partial removal, treatment, and disposal of near-surface contaminated soil must be assessed. Additional site-characterization data are required to better estimate the nature and extent of contamination, to provide better estimates of the contamination and associated radiological risks that will be encountered during excavation activities, and to predict dose that likely will be received by workers if this remedial-action alternative is chosen. Data are required to correlate actual dose received by partial removal, treatment, and disposal personnel to the predicted values. Data are required to assess the potential for subsidence to occur at any of the crib waste sites. Data are required to dispose of contaminated soil wastes that result from conducting this treatability test at the Environmental Restoration Disposal Facility. Cost data are required to improve the basis for estimating the cost for applying this remedial-action alternative to all of the BC Cribs and Trenches Area waste sites.

This page intentionally left blank.

A2.0 STEP 2 – IDENTIFY THE DECISION

DQO Step 2 defines all of the principal study questions (PSQ) that need to be resolved to address the problems identified in DQO Step 1 and the alternative actions (AA) that would result from resolving the PSQs. The PSQs and AAs then are combined into decision statements (DS) that express a choice among AAs. Table A-8 presents the task-specific PSQs and AAs and the resulting DSs. This table also provides a qualitative assessment of the severity of the consequences of selecting an incorrect AA. This assessment takes into consideration human health and the environment (flora and fauna) and political, economic, and legal ramifications. The consequences are expressed as low, moderate, or severe. Severe-consequence decisions generally indicate that statistically based sampling designs should be considered to ensure that acceptable decision error is specified, controlled, and tested through data quality assessment.

Table A-8. Summary of Data Quality Objective Step 2 Information. (3 Pages)

PSQ-AA	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
PSQ No. 1 – Can the vertical and lateral extent of near-surface contamination in the BC Cribs and Trenches Area be identified before excavation activities are initiated?			
1-1	Characterization results in accurate identification of the vertical and lateral extent of near-surface contamination in the trench and/or crib. The dimensions of the excavation and amount of material to be processed for disposal will be well defined as excavation begins.	Erroneously determining that the vertical and/or lateral extent of contamination is known when it is not would lead to project delays, increased waste volumes sent to ERDF, and greater potential for exposure to additional dose as the excavation proceeds farther vertically and/or laterally than planned.	Low
1-2	Characterization results in indeterminate identification of the vertical and lateral extent of contamination in the trench and/or crib, and less-confident decisions are made regarding the dimensions of the excavation and amount of material to be processed for disposal as the excavation phase of the test begins.	Erroneously determining that the vertical and/or lateral extent of contamination cannot be determined using direct-push technology boreholes and gamma logging instruments would lead to project delays and higher costs as more holes are installed or other instrumentation is used to determine the vertical and/or lateral extent of contamination. Erroneously concluding that the chosen characterization techniques cannot determine the extent of lateral contamination spread also might result in unnecessary measurements in the field during excavation, which could result in additional personnel exposure, leaving contaminated soil in place that should be removed, or removing soil that is not contaminated, which would unnecessarily occupy ERDF cell space.	Low
DS No. 1 – Determine if the vertical and lateral extent of near-surface contamination can be determined such that excavation parameters (e.g., volume of material, radiation protection requirements, dimensions and coordinates of excavated surface) can be accurately predicted. If so, use the site-characterization data to support the design and resource needs for evaluating partial removal, treatment, and disposal as a remedial alternative for contaminated trench and crib soils. Otherwise, excavate without precise site-characterization data concerning the vertical and lateral extent of contamination.			

Table A-8. Summary of Data Quality Objective Step 2 Information. (3 Pages)

PSQ-AA	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
PSQ No. 2 – Can site-characterization and inventory data be used to predict the exposures to radioactivity encountered by excavation and waste-handling personnel if partial removal, treatment, and disposal is selected for remediation of the BC Cribs and Trenches Area?			
2-1	Site-characterization data correlated to inventory data allows adequate prediction of the activity encountered during excavation such that this correlation can be used to accurately predict the dose received by personnel during partial removal, treatment, and disposal operations for all of the BC Cribs and Trenches. The technique of correlating the inventory received at other BC Cribs and Trenches to the dose that would be received by partial removal, treatment, and disposal personnel is used to determine total dose that would be received if this remedial-action alternative is selected for all BC Cribs and Trenches.	Erroneously concluding that site-characterization data can be correlated to waste-site inventories, allowing use of inventory data only in assessment of total dose that would be received by partial removal, treatment, and disposal personnel when this correlation is not accurate, could lead to higher than calculated dose to personnel if this remedial-action alternative is chosen.	Moderate
2-2	Site characterization data correlated to inventory data does not adequately characterize the activity to be encountered during excavation such that this correlation inaccurately predicts the dose received by personnel during partial removal, treatment, and disposal operations for all the BC Cribs and Trenches. The technique of correlating the inventory received at other BC Cribs and Trenches to the dose that would be received by partial removal, treatment, and disposal personnel cannot be used to determine total dose that would be received if this remedial-action alternative is selected for all BC Cribs and Trenches.	Erroneously concluding that site characterization data cannot be correlated to waste-site inventory data to predict total dose to be received if the partial removal, treatment, and disposal remedial alternative when this correlation can be made would lead to project delays while additional site-characterization or modeling are undertaken to obtain data to adequately predict dose.	Low
DS No. 2 – Determine if site-characterization data can be correlated to inventory data to predict the dose received by personnel during partial removal, treatment, and disposal operations during the treatability test. If so, use inventory data to calculate predicted dose for all near-surface contamination at the BC Cribs and Trenches Area. Otherwise, collect additional characterization data or modify models to show adequate correlation between characterization data, inventory data, and dose received during treatability test operations to calculate predicted dose for partial removal, treatment, and disposal of all near-surface contamination at the BC Cribs and Trenches Area.			
PSQ No. 3 – Could a subsidence event occur at one or more of the BC Cribs?			
3-1	Data indicate that a subsidence event could occur at a BC Crib. Cap design and construction include steps to mitigate the impacts of this event.	Erroneous conclusion that a subsidence event could occur when it cannot would result in delays in completion of capping the cribs as steps to mitigate the possibility of subsidence are erroneously taken (e.g., injection of grout, enhanced cap design).	Low
3-2	Data indicate that a subsidence event cannot occur at a BC Crib. No design and/or construction features are included to address the possibility of subsidence.	Erroneous conclusion that a subsidence event cannot occur when it is possible would lead to inadequate cap design to address the possibility of subsidence.	Moderate[a]
DS No. 3 – Determine if a remnant crib structure subsidence is possible and design appropriate measures to mitigate the effects of subsidence in the final remedial action taken at the BC Cribs. Otherwise, include no design controls for an eventual subsidence event in the final remedial action at the BC Cribs.			

Table A-8. Summary of Data Quality Objective Step 2 Information. (3 Pages)

PSQ-AA	Alternative Action	Consequences of Erroneous Actions	Severity of Consequences
PSQ No. 4 – Do the soil wastes removed from the BC Cribs and Trenches meet the ERDF waste-acceptance criteria for disposal?			
4-1	Contaminants in the soil removed from the excavations meet the ERDF waste-acceptance criteria and are shipped to ERDF.	Erroneous conclusion that the soils removed from the treatability test excavations meet the ERDF waste-acceptance criteria when they do not would result in waste being received at ERDF that would not be consistent with the ERDF record of decision, explanation of significant difference, or record of decision amendment. Receipt of waste of this type would exceed the operational and safety assumptions for ERDF. The result would be unacceptable risk to human health and the environment by exposure of ERDF personnel to the waste and by disposal in a facility not designed to receive these wastes.	High[b]
4-2	Contaminants in the soil removed from the excavations do not meet the ERDF waste-acceptance criteria and require treatment before shipment to ERDF or require alternative waste disposal.	Erroneous conclusion that soils do not meet the ERDF waste-acceptance criteria when they do would result in additional treatment of the soil when none is necessary. Schedule impacts are possible, because soils are treated when this treatment is not required.	Low
DS No. 4 – Determine if contaminants in the soil removed from the excavations during the treatability test at the BC Cribs and Trenches Area meet the ERDF waste-acceptance criteria and, if so, ship the soils to ERDF. Otherwise, perform additional treatment and/or determine alternative disposal options for the soil wastes generated during the treatability test.			

[a] Severity of consequences is considered moderate, because erroneously concluding that a subsidence event cannot occur when it could may lead to inadequate environmental protection being developed as part of a cap design.

[b] Severity of consequences is considered high, because this decision error likely would result in adverse impacts to human health and/or the environment.

AA = alternative action.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
COC = contaminant of concern.
DS = decision statement.
ERDF = Environmental Restoration Disposal facility.
PSQ = principal study question.

This page intentionally left blank.

A3.0 STEP 3 – IDENTIFY THE INPUTS TO THE DECISION

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

A3.1 BASIS FOR SETTING THE PRELIMINARY ACTION LEVEL

The preliminary action level is the threshold value that provides the criterion for choosing between AAs. Table A-9 identifies the basis (i.e., regulatory threshold or risk based) for establishing the preliminary action level for each COC. Although this activity is a CERCLA treatability test, some of the action levels developed are not based on the criteria typically used in CERCLA investigations. Typical action levels developed in CERCLA investigations are based on risk to human health and the environment. Some action levels for this test are related to risk-based levels, but others are based on the health and safety of workers exposed to the Waste during removal, treatment, and disposal operations.

Table A-9. Basis for Setting Preliminary Action Level. (3 Pages)

<table>
<tr><th>DS</th><th>COC</th><th>Basis for Setting Preliminary Action Level</th><th>Preliminary Action Levels</th></tr>
<tr><td>1</td><td>Gamma-emitting radionuclides (primarily Cs-137), Sr-90, and Pu 239/240</td><td>The preliminary action level is the activity that defines the extent to which soil partial removal must occur to reduce the residual contamination associated with trench and/or crib soils to below risk-based concentrations. The industrial-use scenario includes assessment of chronic exposure to soils to a depth of 15 ft below ground surface. A chronic dose exposure of 15 mrem/yr equates to approximately a 10^{-4} excess lifetime cancer risk (DOE/RL-2004-66). The predominant COCs affecting human health per this scenario are Cs-137 and Pu-239/240. Direct exposure to soil contaminated with Cs-137 with an activity of 23 pCi/g corresponds to a chronic dose of 15 mrem/yr. For Sr-90, the corresponding concentration is 2410 pCi/g. For Pu-239/240, 15 mrem/yr corresponds to 425 pCi/g. Various times of evaluation are shown for Cs-137, Sr-90, and Pu-239/240.</td><td>Basis: Human health - direct exposure (industrial-use scenario)
<table>
<tr><th>Time before exposure</th><th>Cs-137 (pCi/g)</th><th>Sr-90 (pCi/g)</th><th>Pu-239/240 (pCi/g)</th></tr>
<tr><td>150 yr</td><td>750</td><td>90,000</td><td>432</td></tr>
<tr><td>250 yr</td><td>7,300</td><td>990,000</td><td>436</td></tr>
<tr><td>500 yr</td><td>2.3 E+06</td><td>4.1 E+08</td><td>448</td></tr>
</table>
</td></tr>
</table>

Table A-9. Basis for Setting Preliminary Action Level. (3 Pages)

<table>
<tr><th>DS</th><th>COC</th><th>Basis for Setting Preliminary Action Level</th><th>Preliminary Action Levels</th></tr>
<tr><td>1</td><td>Gamma-emitting radionuclides (primarily Cs-137), Sr-90 and Pu 239/240 (cont)</td><td>The predominant contaminant of concern for chronic exposure to an intruder is Sr-90, because an intruder is assumed to be exposed primarily via an ingestion pathway for Sr-90 by intrusion into the waste sites. The maximum acceptable chronic dose from Sr-90 is 100 mrem/yr. Using the resident-with-pasture scenario (HNF-SD-WM-TI-707), an average activity of approximately 1.1 E+08 pCi/g of Sr-90 (within a 2-ft-thick region) corresponds to a 100 mrem/yr dose. This Sr-90 concentration is bounded by that associated with the industrial worker scenario.</td><td>Basis: Inadvertent intruder - resident with garden
<table>
<tr><th>Time before exposure</th><th>Cs-137 (pCi/g)</th><th>Sr-90 (pCi/g)</th><th>Pu-239/240 (pCi/g)</th></tr>
<tr><td>150 yr</td><td>2.2 E+07</td><td>5.1 E+06</td><td>6.5 E+05</td></tr>
<tr><td>250 yr</td><td>2.2 E+08</td><td>5.0 E+07</td><td>6.5 E+05</td></tr>
</table>
Basis: Inadvertent intruder - resident with pasture
<table>
<tr><th>Time before exposure</th><th>Cs-137 (pCi/g)</th><th>Sr-90 (pCi/g)</th><th>Pu-239/240 (pCi/g)</th></tr>
<tr><td>150 yr</td><td>3.4 E+08</td><td>1.1 E+08</td><td>2.3 E+07</td></tr>
<tr><td>250 yr</td><td>3.4 E+09</td><td>1.4 E+09</td><td>2.4 E+07</td></tr>
</table></td></tr>
<tr><td>2</td><td>Gamma-emitting radionuclides (primarily Cs-137)</td><td>Concentration-based action levels are not applicable to this decision statement, because no concentration will be measured above or below which one decision will be made (i.e., there is no regulatory threshold value associated with this decision). Rather, inventory data and site-characterization data will be correlated, and a determination of the adequacy of that correlation will be made. Actual personnel dose measurements made during the treatability test will be compared to predictions made using inventory data from the soil-inventory model (SIM). If the SIM and the inventory calculated using site-characterization data are acceptably equivalent, then the SIM data will be deemed acceptable in estimating dose that would be received by personnel if partial removal, treatment, and disposal were chosen as the remedial action at all of the BC Cribs and Trenches Area waste sites. The dose measurements made during the treatability test can be used as a scaling factor for the dose predictions (if they are significantly different) when the SIM data are accepted as accurate.</td><td>N/A</td></tr>
<tr><td>3</td><td>Visual observation or remote sensing data</td><td>Subsidence of crib structures could have an adverse impact on cap performance if the cap is not appropriately designed.</td><td>Visual indications (e.g., observation of exhumed crib structure showing significant voids) or remote-sensing data indicating the presence of voids in the crib chosen for the test.</td></tr>
</table>

Table A-9. Basis for Setting Preliminary Action Level. (3 Pages)

DS	COC	Basis for Setting Preliminary Action Level	Preliminary Action Levels
4	Chemicals and radionuclides	Action levels based on BHI-00139, and BHI-DIS-2-28-05, 0000X-DC-W0001, 80 mR/h gamma when measured 30 cm (1 ft from the waste container.	Chemical action levels are concentration-based limits required to meet land disposal restriction standards in accordance with 40 CFR 268 and WAC 173-303-140. Radionuclide action levels are provided in BHI-00139, Table 2, and BHI-DIS-2-28-05, 0000X-DC-W0001, Section 1.3.

40 CFR 268, "Land Disposal Restrictions."
BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria.*
BHI-DIS-2-28, 0000X-DC-W0001, *Supplemental Waste Acceptance Criteria for Bulk Shipments to the Environmental Restoration Disposal Facility.*
DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*
HNF-SD-WM-TI-707, *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment.*
RPP-26744, *Hanford Soil Inventory Model, Rev. 1.*
WAC 173-303-140, "Dangerous Waste Regulations," "Land Disposal Restrictions."

bgs = below ground surface
COC = contaminant of concern
DS = decision statement.
SIM = soil-inventory model (RPP-26744).

A3.2 INFORMATION REQUIRED TO RESOLVE DECISION STATEMENTS

Table A-10 lists the data required to resolve each DS identified in Table A-9 and identifies whether the data already exist. For the existing data, the references for the data have been provided with a qualitative assessment of whether the data are of sufficient quality to resolve the corresponding DS.

Table A-10. Required Information and References. (2 Pages)

DS	Required Information Category	Do Data Exist? Y/N	Ref	Available Data: Of Sufficient Quality and Quantity to Support Decision-Making? (Y/N)	Available Data: Required to Support Decision-Making? (Y/N)
1	Concentration of Cs-137 and Sr-90 and depth and lateral dispersion from the centerline of trenches and center points of cribs.	Y	1, 2	N	Y
1a	Concentration of Pu-239/240 and depth and lateral dispersion from the centerline of the 216-B-53A Trench.	N	--	N	Y
2	Total inventory of gamma-emitting radionuclides to which removal, treatment, and disposal workers will be exposed during excavation activities.	Y	1, 2	N	Y
3	Evidence of a subsidence event occurring at a crib in the BC Cribs and Trenches Area	Y	3	N	Y
3a	Visual observations of exposed crib structure or remote sensing data	N	--	N	Y
4	Chemical and radiological constituent concentrations in the soil waste to be sent to ERDF.	Y	1	Y	N
4a	Gamma activity at 1 ft from the surface of ERDF waste containers before they are shipped.	N	--	N	Y

Table A-10. Required Information and References. (2 Pages)

DS	Required Information Category	Do Data Exist? Y/N	Ref	Available Data	
				Of Sufficient Quality and Quantity to Support Decision-Making? (Y/N)	Required to Support Decision-Making? (Y/N)

Ref. 1. DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*
Ref. 2. RPP-26744, *Hanford Soil Inventory Model, Rev. 1.*
Ref. 3. ARH-3046, *Engineering Evaluation of Waste Disposal Cribs - 200 Area.*
DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.

Data Gap Analysis

The near-surface (to a depth of 12 m [40 ft]) soils beneath the 216-B-26 Trench have been characterized preliminarily using spectral-gamma logging (SGL) for Cs-137. The SGL data came from six shallow boreholes that were installed at roughly equidistant intervals along the centerline of the trench. Also, one deep borehole (C4191) was drilled to groundwater, and one soil sample was collected at a depth interval corresponding to high Cs-137 concentrations (4.0 to 4.7 m [13 to 15.5 ft] below ground surface) and analyzed for plutonium isotopes, Sr-90, and gamma-emitting radionuclides. These data were used to establish a ratio of Cs-137 to Sr-90 of 1:1.8. Data from RPP-26744, *Hanford Soil Inventory Model, Rev. 1*, indicate that the ratio of Cs-137 to Sr-90 in the waste streams disposed to the trenches should be closer to 1:1. Because the half-lives of Cs-137 and Sr-90 are very close, radioactive decay cannot account for the difference in the ratio. It is possible that Sr-90 is migrating vertically through the soil at a different rate than the Cs-137, and data concerning the concentration of Sr-90 as a function of depth are required in making excavation decisions. It also is possible that the inventory estimate for this waste site is in error. Regardless, a means of estimating total Sr-90 activity present, as a function of Cs-137 activity, in the soil is desirable. This is because Sr-90 activity is not easily measured in the field, while the activity of Cs-137 is easily measured. Real-time decisions concerning the amount of Sr-90 at risk during excavation activities only can be made using Cs-137 measurements.

As stated, the six shallow wells from which SGL data have been collected were installed along the centerline of the 216-B-26 Trench. No data concerning the lateral extent of contamination are available. To provide for a complete excavation design and estimation of treatability test waste that will be generated, these data are required.

Because a subsidence event occurred at one of the BC cribs in 1974 (ARH-3046, *Engineering Evaluation of Waste Disposal Cribs - 200 Areas*), the possibility for other crib subsidence events to occur requires evaluation. Data concerning the presence of void space at depth or the structural integrity of the cribs are not available and are required.

Based on soil-characterization data collected from the soils taken from Borehole C4191 through the 216-B-26 Trench, the chemical and radionuclide concentrations of the measured species were compared to the ERDF waste-acceptance criteria. No chemical species exceed the land-disposal restriction (LDR) standards or the secondary standards listed in the ERDF waste-acceptance criteria. Process knowledge also supports that none of the LDR or secondary ERDF chemical constituents for which no characterization data exist should be present in the BC Cribs or Trenches. Using the sum of the fractions method described in the ERDF waste-acceptance criteria, the total radionuclide content of the untreated soil would meet the ERDF waste-acceptance criteria. However, because of the concentration of Cs-137 in the most contaminated soils, the ERDF waste container would have a gamma reading greater than 80 mR/h when measured at 30 cm (1 ft) from the waste container. Therefore, soil blending will be required before wastes are shipped to ERDF. The only waste-characterization data required to demonstrate compliance with the ERDF waste-acceptance criteria before soil wastes generated during the treatability test are shipped will be surface dose readings from the ERDF waste containers.

No boreholes have been installed through the 216-B-53A Trench to determine the nature and extent of contamination. Of the four trenches formerly in the 200-LW-1 Operable Unit, this trench is of the most interest, because it is the only trench that received waste from the Plutonium Recycle Test Reactor upset. Because inventory data suggest that a significant amount of plutonium may be present in this trench, site-characterization data for this trench is a significant data gap.

A3.3 COMPUTATIONAL, SURVEY, AND ANALYTICAL DATA

Table A-11 identifies the DSs where data either do not exist or are of insufficient quality to resolve the DSs. For these DSs, Table A-12 presents computational and/or surveying and sampling methods that could be used to obtain the required data, identifies each survey and/or analytical method that may be used to provide the information needed to resolve each DS, and provides the possible limitations associated with each of these methods.

Table A-11. Information Required to Resolve the Decision Statements. (2 Pages)

DS	Remedial Investigation Variable	Required Data	Computational Methods	Survey/Analytical Methods
1	Concentration (activity) of Cs-137 and Sr-90 and depth and lateral dispersion from the centerline of the trenches and cribs.	Concentrations of Cs-137 and Sr-90 at multiple depths within boreholes at multiple locations to determine vertical and lateral extent of contamination in near-surface soil.	N/A	Sodium iodide detector spectral-gamma logging (gamma-energy analysis), gas-proportional counting.
1a	Concentration (activity) of Pu-239/240 and depth and lateral dispersion from the centerline the 216-B-53A Trench.	Concentrations of Pu-239/240 at multiple depths within boreholes at multiple locations to determine vertical and lateral extent of contamination in near-surface soil.	N/A	High-purity germanium detector spectral-gamma logging (gamma-energy analysis), passive-neutron detector
2	Concentrations of radionuclides that contribute to total dose received by removal, treatment, and disposal personnel.	Measurement data for radionuclides in the soil that will be encountered during partial removal, treatment, and disposal activities. Computational data to determine dose that would be received by personnel during partial removal, treatment, and disposal activities at BC Cribs and Trenches that are not the subject of this treatability test. Measurement data of actual dose received by personnel working on the treatability test.	N/A	Gamma-energy analysis, gas-proportional counting, alpha-energy analysis, liquid-scintillation counting Personal dose monitors (e.g., lapel monitors)
3	Integrity of BC Cribs.	Visual observations made during excavation of cribs or remote sensing data to support presence or absence of voids in the remnant crib structures.	N/A	Visual observations or remote sensing data.

Table A-11. Information Required to Resolve the Decision Statements. (2 Pages)

DS	Remedial Investigation Variable	Required Data	Computational Methods	Survey/Analytical Methods
4	Historical records of crib and trench contents, existing soil characterization data.	Historical records data.	N/A	N/A
4a	Gamma radiation level at 30 cm (1 ft) from the surface of the ERDF waste container	Measurement of gamma-radiation field at 30 cm (1 ft) from waste container surface.	N/A	Dose rate (gamma field)

ERDF = Environmental Restoration Disposal Facility.

Table A-12. Potentially Appropriate Survey and/or Analytical Methods. (2 Pages)

Medium	Remediation Variable	Potentially Appropriate Survey/Analytical Method	Features/Possible Limitations
Field Analysis Samples			
Soil in, below, and around cribs and trenches	Concentration (activity) of Cs-137 and depth and lateral dispersion from the centerline of the trenches and cribs	Gamma logging Radiological survey instruments to measure dose	Radioactivity contributed by Cs-137 can be determined as a function of 15.2 cm (6-in.) depth intervals.
ERDF waste containers	Gamma radiation level at 30 cm (1 ft) from the surface of the ERDF waste container	Radiological survey instruments	Hand-held alpha and beta/gamma radiological survey instruments that detect the total beta/gamma and alpha fields. These surveys will not determine the specific radionuclides detected.
Personnel exposure	Radioactive constituents	Dose-rate monitoring, contamination-control surveys personnel dosimetry, constant air sampling, and lapel sampling	Radiological control technicians will perform dose-rate monitoring and contamination control surveys. All personnel will wear combination thermoluminescent dosimeters. Low-volume air sampling will be required. All personnel performing hands-on work will wear a lapel sampler for derived air concentration/hour tracking.
Laboratory Analysis Samples			
Soil in, below, and around cribs and trenches	Concentration (activity) of Cs-137, Sr-90, and Pu-239/240 and depth and lateral dispersion from the centerline of the trenches and cribs	Direct soil sampling by sample spoons, auger, split-spoon sampler, cone penetrometer testing, or other sample collection method for laboratory analysis	Laboratory analysis is required for most beta- and alpha-emitting radionuclides for which quantitative data are required. Highly radiologically contaminated samples require use of onsite laboratories, with associated impacts (e.g., high cost, reduced analyte lists, matrix effects, degraded detection limits, long turnaround times). Lower contamination levels allow use of offsite laboratories, thus avoiding these limitations.

Table A-12. Potentially Appropriate Survey and/or Analytical Methods. (2 Pages)

Medium	Remediation Variable	Potentially Appropriate Survey/Analytical Method	Features/Possible Limitations
	Concentrations of radionuclides that contribute to total dose received by removal, treatment, and disposal personnel.	Direct soil sampling by sample spoons, auger, split-spoon sampler, cone penetrometer testing, or other sample collection method for laboratory analysis	Laboratory analysis is required for most beta- and alpha-emitting radionuclides for which quantitative data are required. Highly radiologically contaminated samples may require use of onsite laboratories, with associated impacts (e.g., high cost, reduced analyte lists, matrix effects, degraded detection limits, long turnaround times). A lower contamination level allows use of offsite laboratories and avoids these limitations.
	Concentrations of contaminants of concern in soil	Cone penetrometer wire-line sampler	Cone penetrometer-based wire-line tools enable sampling without retrieval of the cone penetrometer rods. The soil sampler provides 2.5 cm (1-in.) diameter soil samples that can be sealed and shipped for analysis.

ERDF = Environmental Restoration Disposal Facility.

A3.4 ANALYTICAL PERFORMANCE REQUIREMENTS

Tables A-13 and A-14 define the analytical performance requirements for the radionuclide analyses that will be performed in the field and in the laboratory to produce data with the quality required to resolve each DS. These performance requirements include the PQL and the precision and accuracy requirements for each COC where applicable and/or available.

The analytical techniques, quality objectives, and performance requirements identified in Table A-13 pertain to field measurements from the boreholes installed to characterize the vertical and lateral extent of contamination and the personnel monitoring conducted during treatability test activities. Analytical techniques, quality objectives, and performance requirements identified in Table A-14 pertain to data generated from the laboratory analyses conducted on soil samples collected during the treatability test. The use of specific analytical techniques depends mainly on the medium being sampled. The performance requirements then are assessed against the potentially applicable techniques listed in Tables A-13 and A-14 and any practical constraints for data collection to select the methods required for characterizing the nature and extent of contamination in the BC Cribs and Trenches Area waste sites and the radiological conditions encountered by personnel performing treatability test activities in the BC Cribs and Trenches.

Table A-13. Analytical Performance Requirements for Radiological Field Measurements.

Contaminant of Concern	Chemical Abstracts Service	Preliminary Action Level		Name/Analytical Technology	Target Required Quantitation Limits	Precision Soil (%)	Accuracy Soil (%)
		15 mrem/yr [a] (pCi/g)	ERDF Waste-Acceptance Criteria [b]		Soil-Other Conc.		
Pu-239	N/A	430 [a]	N/A	HPGe - SGL	13,000 pCi/g [c]	±20	80-120
Cs-137	N/A	750 [a]	N/A	NaI - SGL	300 pCi/g	±20	80-120
Exposure/dose rate (beta/gamma emission)	N/A	N/A	80 mR/h	RO-20/RO-03 [d] Portable ionization chamber (microrem)	0.5 mrem/h 10 μrem/h	N/A	80-120
Gamma-emitting radionuclides	N/A	N/A	80 mR/h	Portable NaI detector	6.2 pCi/g	±20	80-120
Gamma-emitting radionuclides	N/A	N/A	N/A	GeLi detector	N/A	N/A	N/A

[a] The preliminary action levels for radionuclides using the 15 mrem/yr = nonrad worker industrial exposure scenario; 2,000 h/yr onsite, 60 percent indoors, 40 percent outdoors are based on the need to determine the vertical and lateral extent of contamination. The action levels have been decay corrected based on the assumption that institutional controls will be in place for 150 years.

[b] Environmental Restoration Disposal Facility Waste Acceptance Criteria.

[c] The quantitation limit for Pu-239 using spectral-gamma logging is too high to assess the action limit specified. The spectral-gamma data will be useful for showing areas of relative high Pu-239 concentration and whether areas of soil are contaminated at transuranic waste concentrations (>100 nCi/g). Passive-neutron analysis will be performed in conjunction with the spectral-gamma logging determination, to provide a semiquantitative method for determining the lateral spread of Pu-239 contamination at levels below the detection limit for the spectral-gamma logging. Soil samples collected for laboratory analysis will be used to assess the action level.

[d] RO-20 and RO-03 are trademarks of Eberline Instruments, a subsidiary of Thermo Electron Corporation, Waltham Massachusetts.

ERDF = Environmental Restoration Disposal Facility.
GeLi = germanium lithium.
HPGe = high-purity germanium (spectral gamma logger).
N/A = not applicable.
NaI = sodium iodide.
SGL = spectral gamma (borehole) logging.

Table A-14. Analytical Performance Requirements for Radiological Laboratory Measurements.

Contaminant of Concern	Chemical Abstracts Service	Preliminary Action Level [a]		Name/ Analytical Technology	Target Required Quantitation Limits		Precision Soil (%)	Accuracy Soil (%)
		15 mrem/yr (pCi/g)	Groundwater Protection (pCi/g or mg/kg)		Soil Low Activity [c] (pCi/g)	Soil High Activity [d] (pCi/g)		
Americium-241	14596-10-2	335	N/A	Americium isotopic - AEA	1	4,000	±35	65-135
Cesium-137	10045-97-3	23.4	N/A	GEA	0.1	2,000	±35	65-135
Cobalt-60 [e]	10198-40-0	4.90	N/A	GEA	0.05	2,000	±35	65-135
Europium-152 [e]	14683-23-9	11.4	N/A	GEA	0.1	2,000	±35	70-130
Europium-154 [e]	15585-10-1	10.3	N/A	GEA	0.1	2,000	±35	70-130
Europium-155 [e]	14391-16-3	426	N/A	GEA	0.1	2,000	±35	70-130
Plutonium-238 [f]	13981-16-3	470	N/A	Plutonium isotopic - AEA	1	1,300	±35	65-135
Plutonium-239/240	Pu-239/240	425	N/A	Plutonium isotopic - AEA	1	1,300	±35	65-135
Strontium-90	Rad-Sr	2,410	N/A	Total radioactive strontium – GPC	1	800	±35	65-135

[a] The preliminary action levels for radionuclides are based on 15 mrem/yr = nonrad worker industrial exposure scenario; 2,000 h/yr onsite, 60 percent indoors, 40 percent outdoors and are used to determine appropriate analytical requirements.

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

[c] Low activity implies a level of radioactivity such that the radioanalytical methods can be performed as designed. The quantitation limits are the state of the art for a soil sample matrix using the given technology.

[d] High activity implies a level of radioactivity such that the radioanalytical methods cannot be performed as designed. Some method deviation (e.g., use of a smaller aliquot of soil) must be taken to ensure the health and safety of sampling and/or laboratory personnel. The quantitation limits listed are estimated and are provided as an illustration of the variability in the possible quantitation limits that result from high radioactivity in the soil samples collected.

[e] No action levels are associated with these analytes. However, because they are gamma-emitting radionuclides, they will be detected and reported during analyses conducted by gamma-energy analysis.

[f] No action level is associated with Pu-238. However, it will be reported during analyses conducted for plutonium isotopes by alpha-energy analysis

CERCLA = Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 USC 9601 et seq.

AEA = alpha-energy analysis.
GEA = gamma-energy analysis.
GPC = gas-proportional counting.
N/A = not applicable.

This page intentionally left blank.

A4.0 STEP 4 – DEFINE THE BOUNDARIES OF THE STUDY

A4.1 OBJECTIVE

In Step 4, the DQO team identifies the spatial, temporal, and practical constraints on the sampling design and considers the consequences. This ensures that the sampling design results in data being collected accurately to reflect the true condition of the site and/or populations being studied.

A4.2 STUDY BOUNDARIES

The BC Cribs and Trenches Area waste sites include 16 trenches that received scavenged waste. The DQO team considered which of these trenches would be most conducive to providing data that would meet the objectives of the test. Because the 216-B-26 Trench initially has been characterized and received one of the largest inventories of Cs-137 and Sr-90, this trench was selected for Phase 1 and Phase 2 of the test.

Of the BC Cribs, the 216-B-14 and 216-B-18 Cribs received the highest inventories of Cs-137 and Sr-90. Because a documented subsidence event occurred at the 216-B-18 Crib, it may not be possible to observe voids or other features (e.g., crib-structure continuity) by characterizing and/or excavating this crib. Therefore, the 216-B-14 Crib is believed to provide the best site for meeting the objectives of the treatability test for Phase 3.

Of the trenches in the former 200-LW-1 Operable Unit, the 216-B-53A Trench is the only trench in the BC Cribs and Trenches Area waste sites to receive waste from the Plutonium Recycle Test Reactor upset. This trench is of interest for the possible amount of plutonium and other transuranic isotopes that may be contained in the trench soils. Initial characterization data are available for one of the other three trenches formerly in the 200-LW-1 Operable Unit (the 216-B-58 Trench). These other three trenches received similar waste streams, and it is believed that the existing site-characterization data for the 216-B-58 Trench will allow assessment of the partial removal, treatment, and disposal option for these three trenches. For these reasons, the 216-B-53A Trench was chosen for Phase 4 of the test.

Table A-15 defines the population of interest to clarify what the samples are intended to represent. The table also lists the characteristics that define the population of interest.

Table A-16 defines the spatial boundaries of the decision and the domain or geographic area (or volume) within which all decisions must apply (in some cases, this may be defined by the operable unit). The domain is a region distinctly marked by some physical features (e.g., volume, length, width, boundary).

Table A-15. Characteristics that Define the Population of Interest.

DS	Population of Interest	Characteristics
1	The earth materials containing measurable contamination within, around, and beneath the trenches and cribs at the BC Cribs and Trenches Area waste sites that could be subject to partial removal, treatment, and disposal	Concentrations of radionuclides of concern (Cs-137, Sr-90 and/or Pu-239/240*), their depth and lateral dispersion from the centerline of trenches and the center of a crib structure
2	The earth materials containing measurable contamination within, around, and beneath the trenches and cribs at the BC Cribs and Trenches Area waste sites that could be subject to partial removal, treatment, and disposal	Total inventory of radionuclides of concern (Cs-137, Sr-90 and/or Pu-239/240*) contained within the soil volume that will be subject to partial removal, treatment, and disposal
3	The crib structures exposed or characterized using remote sensing or some other method during Phase 3 of the treatability test	Condition of the crib structures
4	The waste in containers loaded for shipment to the Environmental Restoration Disposal Facility	Radiation level at 30 cm (1 ft) from the surface of the Environmental Restoration Disposal Facility container

*The radionuclides Pu-239/240 are of primary interest in the 216-B-53A Trench only.
DS = decision statement.

Table A-16. Geographic Boundaries of the Investigation.

DS	Geographic Boundaries of the Investigation
1, 2	The geographic boundaries are the volume of soil contaminated at a level that requires the soil to be removed, treated, and disposed of at the Environmental Restoration Disposal Facility. The process of partial removal, treatment, and disposal will be demonstrated at the 216-B-26 Trench, 216-B-14 Crib, and 216-B-53A Trench. The exact geographic boundaries will be delineated by the centerline of the trench (or center point of a crib) out to the lateral extent of contamination identified in Phase 1 of the test (or the initial characterization portions of Phase 3 and/or Phase 4) excluding the berms within a trench and to a maximum depth of 4.6 m (15 ft) bgs.
3	The geographic boundaries are the extent of the crib structure or remnant crib structure in the 216-B-14 Crib.
4	The geographic boundaries are the individual Environmental Restoration Disposal Facility waste containers out to a distance of 30 cm (1 ft) from the surface of these containers.

bgs = below ground surface.
DS = decision statement.

In this part of DQO Step 4, the populations of interest may be divided into strata that have unique characteristics. The ultimate goal is to define the decision units important to the sampling design. The DQO team must evaluate process knowledge, historical data, and plant configurations to establish the logic that supports alignment of the populations into strata and decision units.

The strata of interest for the BC Cribs and Trenches Area waste sites treatability test are shown in Table A-17. Delineating the strata allows the development of spatial decision units.

The temporal boundaries of the investigation are defined in Table A-18.

Table A-17. Strata with Homogeneous Characteristics.

DS	Population of Interest	Strata	Homogeneous Characteristic Logic
1, 2	The earth materials containing measurable contamination within, around, and beneath the trenches and cribs at the BC Cribs and Trenches Area waste sites that could be subject to partial removal, treatment, and disposal	Contaminated soil associated with each 1/3 section of the 216-B-26 Trench	Initial characterization data from the 216-B-26 Trench indicate that the berms that divide the trench in approximate 1/3 segments may have influenced the amount of waste received in each segment. Therefore, estimates of the mean concentration of COCs in each 1/3 of the trench are required because the initial execution of the treatability test will involve excavation of only 1/3 of the trench. Also, the difference in the amount of waste received and waste delivery mechanics (i.e., trench versus crib) make it possible that the vertical and lateral extent of contamination may be much different for a trench than for a crib that received similar waste streams.
		Contaminated soil associated with the 216-B-14 Crib	
		Contaminated soil associated with the 216-B-53A Trench	The waste stream received at the 216-B-53A Trench was much different than the scavenged waste stream received at the 216-B-26 Trench and the 216-B-14 Crib.
3	The crib structures exposed or characterized using remote sensing or some other method during Phase 3 of the treatability test	The crib structure or remnants of the crib structure in the 216-B-14 Crib	The crib structure is a unique feature of each crib.
4	The waste in containers loaded for shipment to ERDF	The radiation field at 30 cm (1 ft) from the surface of the ERDF container	Radiation fields surrounding the ERDF container will be the limiting criteria for whether removed soil can be accepted at ERDF.

COC = contaminant of concern.
ERDF = Environmental Restoration Disposal Facility.

Table A-18. Temporal Boundaries of the Investigation.

DS	Timeframe	When to Collect Data
1	Supportive of meeting Tri-Party Agreement Milestone M-015-51*	Before initiation of the partial removal, treatment, and disposal phases of the treatability test
2		Before initiation and during execution of the partial removal, treatment, and disposal phases of the treatability test
3		Using remote-sensing techniques or installing through a crib structure before initiation of the partial removal, treatment, and disposal phases of the treatability test in a crib Using visual observations during execution of the partial removal, treatment, and disposal phases of the treatability test in the crib
4		After loading waste into an ERDF waste container and before loading the container on a vehicle for final shipment to ERDF

*Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*, as amended (Tri-Party Agreement).
DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.

A4.3 SCALE OF DECISION MAKING

Table A-19 defines the scale of decision-making for each DS. The scale of decision-making is defined as the smallest, most appropriate subsets of the population (subpopulation) for which decisions will be made based on the spatial or temporal boundaries of the area under investigation.

Table A-19. Scale of Decision-Making. (2 Pages)

DS	Population of Interest	Geographic Boundary	Temporal Boundary		Decision Units
			Timeframe	When to Collect Data	
1	The earth materials containing measurable contamination within, around, and beneath the trenches and cribs at the BC Cribs and Trenches Area waste sites that could be subject to partial removal, treatment, and disposal	Delineated by the centerline of the trench (or center point of a crib) out to the lateral extent of contamination identified in Phase 1 of the test (or the initial characterization portions of Phases 3 and/or 4) and to a maximum depth of 4.6 m (15 ft) below ground surface	TBD	Before initiation of the partial removal, treatment, and disposal phases of the treatability test	Soil to be removed from the 216-B-26 Trench, the 216-B-14 Crib, and the 216-B-53A Trench are separate decision units to which this decision will be applied.
2	The earth materials containing measurable contamination within, around, and beneath the trenches and cribs at the BC Cribs and Trenches Area waste sites that could be subject to partial removal, treatment, and disposal	Delineated by the centerline of the trench (or center point of a crib) out to the lateral extent of contamination identified in Phase 1 of the test (or the initial characterization portions of Phases 3 and/or 4) and to a maximum depth of 4.6 m (15 ft) below ground surface	TBD	Before initiation and during execution of the partial removal, treatment, and disposal phases of the treatability test	Soil to be removed from the 216-B-26 Trench, the 216-B-14 Crib, and the 216-B-53A Trench are separate strata that will be compared to inventory data and model predictions to provide data for making remedial-action decisions for the BC Cribs and Trenches Area waste sites.

Table A-19. Scale of Decision-Making. (2 Pages)

DS	Population of Interest	Geographic Boundary	Temporal Boundary		Decision Units
			Timeframe	When to Collect Data	
3	The crib structures exposed or characterized using remote sensing or some other method during Phase 3 of the treatability test	The extent of the crib structure or remnant crib structure in the 216-B-14 Crib	TBD	Using remote sensing techniques or installing through a crib structure before initiation of the partial removal, treatment, and disposal phases of the treatability test in a crib. Using visual observations during execution of the partial removal, treatment, and disposal phases of the treatability test in the crib.	The crib structure at the 216-B-14 Crib will be used to make decisions regarding the potential for subsidence associated with all the crib structures at the BC Cribs and Trenches Area.
4	The waste in containers loaded for shipment to ERDF	The individual ERDF waste containers out to a distance of 30 cm (1 ft) from the surface of these containers	TBD	After loading an ERDF waste container with waste and before loading the container on a vehicle for final shipment to ERDF	Each waste container will be measured, and the decision will be applied to each individual waste container.

DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.
TBD = to be determined.

A4.4 PRACTICAL CONSTRAINTS

The following practical constraints could affect data collection. These constraints are physical barriers, difficult sample matrices, health and safety concerns, and any other condition that will need to be considered in the design and scheduling of the sampling program.

- Extreme weather conditions could limit or shut down field operations.
- Soil samples collected may contain significant gamma fields such that some desirable sampling techniques (e.g., compositing) will not be possible because of health and safety concerns.
- Conducting excavation in accordance with ALARA principles could interfere with visually examining the crib structures before excavation equipment could cause damage or collapse of the structures.
- Collection of photographic data during visual examination of the cribs may not be possible because of ALARA concerns.

This page intentionally left blank.

A5.0 STEP 5 – DEVELOP A DECISION RULE

DQO Step 5 initially defines the population parameter of interest (e.g., maximum concentration, mean concentration). The parameter of interest is an absolute value of the population that is estimated using the measurement data obtained. This step of the DQO process also is used to specify the statistic that will be used to estimate the parameter of interest (e.g., 95 percent upper confidence level of the sample distribution). In cases where statistics are used, the chosen statistic is compared against the action level. The population parameter of interest specifies the characteristic or attribute that a decision-maker would like to know about the population. The preliminary action level for each COC also is identified in DQO Step 5. Using the population parameter of interest and the action level, a decision rule (DR) is developed for each DS in the form of an "IF…THEN…" statement that incorporates the statistic that will be used to estimate the parameter of interest, the scale of decision-making, the preliminary action level, and the AAs that would result from the decision resolution. The scale of decision-making and the AAs were identified in DQO Step 4 and Step 2, respectively.

In this treatability test, the measurements will be used to perform the following:

- Identify relatively high values (i.e., the vertical and lateral extent of contamination)
- Estimate the mean concentration of COCs for each stratum of interest and validate inventory records for waste added to each stratum
- Estimate the mean concentration of COCs for each stratum of interest and calculate predicted dose received to partial removal, treatment, and disposal personnel during treatability test activities
- Estimate the dose received by personnel performing partial removal, treatment, and disposal activities for comparison to the dose predicted
- Ensure that loaded waste containers meet the ERDF supplemental waste-acceptance criteria (BHI-DIS-2-28-05, 0000X-DC-W0001) before they are shipped to ERDF.

In measurements being conducted to determine relative high concentrations, no parameter of interest has been identified. Rather, comparisons between individual measurements will determine areas of interest to the test.

When comparing the inventory data to measurements made, the mean concentration of contaminants will be estimated and applied to the total volume of soil believed to be contaminated. Using the mean and volume, a total inventory can be estimated through calculation. The calculated inventory will be compared to the records (i.e., the soil-inventory model [SIM] estimates) to determine the validity of records relevant to the strata for which measurements are obtained. Therefore, this test will be using a statistic determined through measurements (i.e., the sample mean) to estimate the total curies of a given COC present in a given stratum and comparing that value to the inventory that the SIM uses as the amount disposed to a given trench and/or crib. The concept of action level is not relevant to this determination of equivalency. Rather, comparison of the inventory for a radionuclide COC (as calculated based on measurements) with a SIM inventory value will be determined by use of a two-sample statistical test of means. It is appropriate to use a test on means to compare total inventories, because a total inventory is essentially a mean multiplied by a constant.

For dose measurements conducted as the soil is being excavated, treated, and loaded for disposal, the parameter of interest is the total dose to which an individual is exposed during full-scale waste removal, treatment, and disposal operations. The total dose is measured by the individual by wearing a personal dosimetry device that constantly measures dose taken as operations continue. No statistic is used to estimate the parameter of interest. Rather, the highest measured value is used to conservatively estimate the parameter. For each position held by treatability test personnel (e.g., excavator operator, ERDF health physics technician), a method for calculating predicted dose has been devised (DOE/RL-2004-66, Appendix F). Also, supplemental dosimetry will be used by personnel to collect activity-specific dose data. The dose data obtained during the treatability test will be compared to the dose predicted to determine any scaling of the estimates that may be appropriate in estimating total dose if all BC Cribs and Trenches were addressed using the partial removal, treatment, and disposal remedial-action alternative.

For radiation measurements made at 30 cm (1 ft) from the surface of a loaded ERDF waste container, the action level is 80 mR/h. No statistic is used to estimate the population parameter associated with these measurements, because every waste container will be measured. This is a census sample, because every member of the population of interest is measured, and no uncertainty (other than that inherent in the measurement equipment) is associated with the data obtained. Because measurement equipment can be in error, a conservative action level can be chosen to compensate for any unquantifiable bias introduced by the measurement process.

A5.1 INPUTS NEEDED TO DEVELOP DECISION RULES

Tables A-20, A-21 and A-22 present the information needed to formulate the DRs in Section 5.2. This information includes the DSs and AAs identified in DQO Step 2, the scale of decision-making identified in DQO Step 4, the population parameters of interest, and the preliminary action levels for each COC.

A5.2 DECISION RULES

The output of the previous parts of DQO Step 5 and the other previous DQO steps are combined into "IF...THEN..." DRs that incorporate the parameter of interest, the scale of decision-making, the action level, and the actions that would result from resolving the decision. The DRs are listed in Table A-22.

Table A-20. Decision Statements.

DS	Decision Statement
1	Determine if the vertical and lateral extent of near-surface contamination can be determined such that excavation parameters (e.g., volume of material, radiation protection requirements, dimensions and coordinates of excavated surface) can be accurately predicted. If so, use the site-characterization data to support the design and resource needs for evaluating partial removal, treatment, and disposal as a remedial alternative for contaminated trench and crib soils. Otherwise, excavate without precise site-characterization data concerning the vertical and lateral extent of contamination.
2	Determine if site-characterization data can be correlated to inventory data to predict the dose received by personnel during partial removal, treatment, and disposal operations during the treatability test. If so, use inventory data to calculate predicted dose for all near-surface contamination at the BC Cribs and Trenches Area. Otherwise, collect additional characterization data or modify models to show adequate correlation between characterization data, inventory data, and dose received during treatability test operations to calculate predicted dose for partial removal, treatment, and disposal of all near-surface contamination at the BC Cribs and Trenches Area.
3	Determine if a remnant crib structure subsidence is possible and design appropriate measures to mitigate the effects of subsidence in the final remedial action taken at the BC Cribs. Otherwise, include no design controls for an eventual subsidence event in the final remedial action at the BC Cribs.
4	Determine if contaminants in the soil removed from the excavations during the treatability test at the BC Cribs and Trenches Area meet the ERDF waste-acceptance criteria and, if so, ship the soils to ERDF. Otherwise, perform additional treatment and/or determine alternative disposal options for the soil wastes generated during the treatability test.

DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.

Table A-21. Inputs Needed to Develop Decision Rules. (2 Pages)

DS	COCs	Parameter of Interest	Scale of Decision-Making	Action Levels
1	Gamma-emitting radionuclides (primarily Cs-137), Sr-90, and Pu-239/240	The concentration of COCs; their depth and lateral dispersion from the trench and/or crib structures in the BC Cribs and Trenches Area	Data concerning the vertical and lateral extent of contamination measured during the treatability test will be used in developing estimates concerning the amount of contaminated material associated with all of the BC Cribs and Trenches Area waste sites	~750 pCi/g of Cs-137 ~430 pCi/g of Pu-239/240 90,000 pCi/g of Sr-90
2	Gamma-emitting radionuclides (primarily Cs-137)	Total inventory of gamma-emitting radionuclides in the trench and/or crib being excavated	Decisions concerning the accuracy of inventory data and the ability to relate the inventory of radionuclides in a trench to dose received will be used in developing estimates concerning dose received by personnel if partial removal, treatment, and disposal is chosen for all of the BC Cribs and Trenches Area waste sites	No numeric action level other than a specified level of agreement between the inventory of COCs based on measurements and those provided in historical records as used by the soil-inventory model (RPP-26744)
		Dose received by individuals working on partial removal, treatment, and disposal activities during execution of the treatability test		N/A

Table A-21. Inputs Needed to Develop Decision Rules. (2 Pages)

DS	COCs	Parameter of Interest	Scale of Decision-Making	Action Levels
3	No COCs. Visible or inferred integrity of the crib structures	Integrity of the crib structures as determined by visual examination or as inferred using remote-sensing techniques	Crib structures exposed in the selected crib for use in the treatability test will be used to estimate the likelihood of a subsidence event occurring at any of the BC Cribs	Visual evidence or remote-sensing data indicating voids that might collapse and lead to a subsidence event
4	Gamma radiation filed at 30 cm (1 ft) from the surface of a waste container	Detected radiation	Decisions concerning waste containers packaged for shipment to ERDF are made individually for each container.	80 mR/h at 30 cm (1 ft) from the surface of the ERDF waste container

RPP-26744, *Hanford Soil Inventory Model, Rev. 1.*
COC = contaminant of concern.
DS = decision statement.
ERDF = Environmental Restoration Disposal Facility.
N/A = not applicable.

Table A-22. Decision Rules.

DR	Decision Rule
1	*If* the field measurements for gamma-emitting radionuclides indicate the presence of Cs-137 at a concentration greater than 750 pCi/g in the first 4.6 m (15 ft) below ground surface, or laboratory measurements for Sr-90 indicate a concentration greater than 90,000 pCi/g in the 216-B-26 Trench and/or the 216-B-14 Crib, *then* additional characterization data will be obtained to further establish the nature and extent of contamination. Otherwise, excavation parameters (e.g., volume of material, dimensions and coordinates of excavated surface) will be determined without precise site-characterization data concerning vertical and lateral extent of contamination.
1a	*If* the field or laboratory measurements for Pu-239/240 indicate the presence of these isotopes at a level greater than 430 pCi/g in the first 4.6 m (15 ft) below ground surface in the 216-B-53A Trench, *then* additional characterization data will be obtained to further establish the nature and extent of contamination. Otherwise, excavation parameters (e.g., volume of material, dimensions and coordinates of excavated surface) will be determined without precise site-characterization data concerning vertical and lateral extent of contamination.
2	*If* the true mean concentration for applicable radionuclide constituents agrees with the concentration predicted by using the inventory inputs for the soil-inventory model (RPP-26744) (as represented by the inventory value being within the 95 percent confidence interval around the sample mean), *then* the soil-inventory model will be considered valid for use in determining the inventory present in all of the BC Cribs and Trenches Area waste sites. Otherwise, additional characterization data will be collected or models will be modified to show adequate correlation between characterization data and inventory data.
2a	*If* the dose received by personnel involved in the treatability test operations agrees with the predicted dose using the method described in DOE/RL-2004-66, Appendix F, *then* the method described in DOE/RL-2004-66, Appendix F, will be used to predict the dose received if partial removal, treatment, and disposal is chosen for all of the BC Cribs and Trenches Area waste sites. Otherwise, a scaling factor will be applied to dose predictions, based on actual dose received during this treatability test.
3	*If* visual examination or remote-sensing data indicate that voids are present in the crib structures such that subsidence is possible, *then* appropriate measures will be taken during the design phase to mitigate the effects of subsidence in the final remedial action taken at the BC Cribs. Otherwise, no design controls for an eventual subsidence event will be included in the final remedial action at the BC Cribs.
4	*If* the gamma radiation field at 30 cm (1 ft) from the surface of an individual ERDF waste container exceeds 80 mR/h (as represented by any surface dose reading >72 mR/h at 30 cm [1 ft] from the surface of the container), *then* the container will be emptied and the soil will be further treated before being repackaged for disposal. Otherwise, the container will be shipped to ERDF.

DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites.*
RPP-26744, *Hanford Soil Inventory Model, Rev. 1.*
DR = decision rule. ERDF = Environmental Restoration Disposal Facility.

A6.0 STEP 6 – SPECIFY TOLERABLE LIMITS ON DECISION ERRORS

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

A focused sampling approach will be used to identify the nature and extent of contamination, whether the predicted dose matches the dose received during treatability test operations, whether voids are present in the crib structures such that subsidence is possible, and whether a waste box loaded for shipment to ERDF meets the ERDF supplemental waste-acceptance criteria (BHI-DIS-2-28-05, 0000X-DC-W0001) (DRs #1, #1a, #2a, #3, and #4). A statistical sampling design was not used to make those five decisions. However, a statistical sampling design is appropriate and required for determining if the true mean concentration for applicable radionuclide constituents agrees with the concentration predicted by using the inventory inputs for the SIM (DR #2).

Decisions concerning nature and extent of contamination (DRs #1 and #1a) include determining the vertical and lateral extent of contamination. The extent of contamination for the purposes of this data collection has been defined as soil contaminated with Cs-137 at greater than 750 pCi/g, Sr-90 at greater than 90,000 pCi/g, and/or Pu-239/240 at greater than 430 pCi/g within the first 4.6 m (15 ft) bgs. Samples will be collected to determine if this level of contamination is present. If the concentration of the COCs is less than the action level, the extent of contamination can be bounded by the regions from which those samples were collected. If levels of contamination detected in a single measurement are greater than the action levels, the extent of contamination has not been totally resolved by that sample. Another use for the data collected in defining nature and extent will be to determine if a correlation can be established between Cs-137 and Sr-90 activity as a function of depth.

The decision concerning dose predicted compared to dose received (DR #2a) will be made using data collected from radiation-control sampling. For radiation-control sampling and monitoring, the field radiation-controls health-physics personnel will collect samples using personal monitors, air monitoring instrumentation, radiation detection instrumentation, and any other instruments required to test for the specified contaminants of concern. Using these techniques, sample collection is continuous, and the sample represents something close to a census of the population of interest. Using a census sampling approach eliminates the need to design a statistically based sampling design, because the entire available population is being included in the measurements. Therefore, a detailed statistical discussion of the radiological-controls sampling conducted during the treatability test will not be developed further.

The entire crib structure for the 216-B-14 Crib either will be surveyed using geophysical tools or will be visually examined during excavation to determine if voids present in the crib structure could lead to future subsidence events in the BC Cribs (DR #3). If visual examination is used in making this decision, the uncertainty associated with the decision of determining whether a subsidence event could occur is considered to be relatively low. This is because the 216-B-14 Crib will be examined, and the integrity of the structure and/or voids observed will be assumed to be representative of the other cribs in the BC Cribs and Trenches Area. If remote-sensing data are used, the uncertainty in making the decision will be dependent on the uncertainty associated with the measurement system used. The entire crib structure will be observed or measured in making the decision, regardless of the technique used to measure the characteristics. This is a form of census sampling, and no discussion of decision error associated with sampling design is required.

For decisions concerning waste shipments to ERDF (DR #4), another form of census sampling will be used. Every member of the population of interest (i.e., every box loaded for shipment to ERDF) will be measured for total radiation at a distance of 30 cm (1 ft) from the surface of the container to ensure that the dose is less that 80 mR/h. Because measurement system error can occur, a value of 90 percent of the allowed dose will be used as a cutoff. That is, as long as the dose measured is less than 72 mR/h at 30 cm (1 ft) from the surface of the ERDF container, the container will be assumed to have a dose of less than 80 mR/h at 30 cm (1 ft) from the container. Although not quantifiable, use of this conservative decision criterion is considered an acceptable method to reduce the decision error associated with this decision.

As stated, a statistical sampling design is appropriate and required for estimating if the true mean concentration for applicable radionuclide constituents agrees with the concentration predicted by using the inventory inputs for the SIM (RPP-26744) (DR #2). This decision will be based on measurement data; however, the data provide only an estimate of the true state of the soil waste to be excavated. Therefore, decisions could be based on data that may not accurately reflect the true state of the soil in the 216-B-26 Trench, 216-B-53A Trench, and/or the 216-B-14 Crib. If the data are not a true representation of the characteristics of the soil to be excavated, the decision-maker could make a decision error. The decision-maker must define tolerable limits on the probability of making a decision error.

The probability of a decision error can be controlled by adopting a scientific approach. Using this approach, the data are used to select between the presumed condition of the soil in the trenches and the alternative condition. One of these conditions is assumed to be the baseline condition and is referred to as the *null hypothesis* (H_0). The alternative condition is referred to as the *alternative hypothesis* (H_a). The null hypothesis is presumed to be true in the absence of strong evidence to the contrary. This feature provides a way for the decision-makers to guard against making the decision error with the most undesirable consequences.

A decision error occurs when the decision-maker rejects the null hypothesis when it is true (a *false positive decision error)* or fails to reject the null hypothesis when it is false (a *false negative decision error*). For example, a decision-maker presumes that a certain waste is hazardous (i.e., the null hypothesis is "the waste is hazardous"). However, if the data on that waste cause the decision-maker to conclude that the waste is not hazardous when it really is hazardous, then the decision-maker would make a false positive decision error. Statisticians usually refer to this as a Type I error. The size of this error is called alpha (α), the level of significance, or the size of the critical region.

A false negative decision error occurs when the decision-maker fails to reject the null hypothesis when it is false. In the waste example given above, the false negative decision would be to use the data to conclude that the waste is hazardous, when in fact it is not. Statisticians usually refer to false negative decision errors as Type II errors. The measure of the size of this error is called beta (β), and the measure is also known as the complement of the power of a hypothesis test.

The possibility of decision error cannot be eliminated. However, the error can be minimized by controlling the total study error. Methods for controlling total study error include (1) collecting a large number of samples (to control sampling design error), (2) analyzing individual samples several times, or (3) analyzing individual samples using more precise analytical methods (to control measurement error). The chosen method for reducing decision errors depends on where the largest components of total study error exist in the data set and the ease in reducing error in those data components. The amount of effort expended on controlling decision error is directly proportional to the consequences of making an error. It is important for decision-makers to determine the acceptable error rates before they develop the sampling scheme, to ensure that project goals are adequately met.

DR #2 addresses a decision based on the values being equal rather than one based on exceeding an action limit. Because uncertainty is associated with both the SIM data (RPP-26744) and the inventory calculated based on measurements made during the treatability test, the decision makers must be willing to accept the inventory predicted by the SIM, as long as there is some degree of agreement between the SIM and the inventory calculated using the sample data obtained during the treatability test. For statistical-hypothesis testing, the sample mean is being compared to a prescribed value (i.e., the SIM inventory). Therefore, only one option is possible for the null hypothesis. The null *must* be that there is no difference between the SIM inventory and the inventory calculated using the true mean concentrations of radionuclides of concern (as represented by the sample mean). Because the hypothesis to be tested is two-sided, the null hypothesis has to be that there is no difference, and the alternative must be that there is a difference between the two methods of determining the total inventory. This decision is dictated by the mathematics and theory of the hypothesis test. Therefore, the null hypothesis for DR #2 becomes: the SIM estimates are equal to the actual inventory in the trench (or crib) (as calculated using the true mean concentrations and volume of soil in the trench). Therefore, the data collected must authoritatively show that the inventories used in the SIM inputs and true inventory present in the trench (or crib) are not equal when the statistical hypothesis is tested.

One type of decision error for determining that the SIM input predictions and the true inventory present in the trench (or crib) are equivalent is to conclude that the SIM accurately predicts the true inventory (or mean concentration of constituents) in the trench (or crib) when in fact it does not. The second type of decision error for validation that the SIM input predictions and the true inventory present in the trench (or crib) are equivalent is to conclude that the SIM is not accurately predicting the true inventory (or mean concentrations of constituents) in the trench (or crib) when, in fact, the inventory inputs are producing accurate predictions. The consequences of each decision error must be considered. Deciding that the SIM calculation is producing accurate estimates of the contents of the trench (or crib) when in fact it is not would result in erroneously using a model or process inventory calculation that will incorrectly characterize the possible dose to be received by personnel if the partial removal, treatment, and disposal option is chosen for the remaining BC Cribs and Trenches. Concluding that the SIM is not estimating the inventory in the trenches correctly when, in fact, it is will result in unnecessary, costly, and time-intensive measures being taken to characterize and/or remediate the trenches if the partial removal, treatment, and disposal option is chosen for the remaining BC Cribs and Trenches.

DR #2 addresses whether estimates produced by the SIM are equal to the actual inventory (as calculated from the true mean concentration) of the constituents in the total volume of soil in the trench (or crib). In this situation, the SIM estimates are considered inadequate if less than the actual inventory in the trench or crib or if greater than the actual inventories. Only equality between the actual inventory disposed to the trenches and cribs and the SIM predictions will allow a conclusion that the inventory calculation is producing estimates that coincide with the true nature of the soil in the trenches and cribs. In a situation where the equality between two values is the primary question, statistical theory of hypothesis tests dictates that the null hypothesis must be that the estimates obtained from the SIM are equal to the actual inventory in the trenches and cribs. Conversely, the alternative hypothesis must be that the estimates produced by the SIM are not equal to the actual inventory in the trenches and cribs.

One performance-acceptance criterion for determining that the modeled or calculated concentration and observed sample mean are adequately in agreement is to perform the two-sample *t*-test. (A description of the two-sample *t*-test can be found in EPA/240/B-06/003, *Data Quality Assessment: Statistical Tools for Practitioners*, EPA QA/G-9S). If a statistical comparison of the SIM estimates with the actual mean concentrations of the target radionuclides indicates that the two methods for calculating inventory produce the same result, then the SIM prediction is accepted as equivalent to the measured value. Because the data will be used for calculating dose received by personnel performing partial removal, treatment, and disposal activities for other cribs and trenches (a calculation that in itself includes adding a measure of conservatism), very large deviations between measured and predicted values should be acceptable. However, if a larger possibility of committing a false positive decision error (α) is chosen as acceptable for determining that the SIM and observed inventory (as calculated using the sample mean and trench volume) are acceptably close, there is also less chance of determining that the SIM value is accurate when it is, in fact, inaccurate. The DQO team discussed the possible error rates that would be acceptable for determining that the measured trench inventory and SIM inventory are adequately close. Based on an analysis of the expected variability of the soil measurements, the team determined that $\alpha = 0.05$ (or 5 percent) should be used for determining if the SIM estimates and the actual measured inventory are equivalent. That is, there will be a 5 percent chance of determining that the values are not acceptably close when in fact they are.

Another method commonly used for determining the degree of agreement between two quantities is the percent difference. Although the percent difference is not statistical in nature, it provides valuable information regarding the agreement between the SIM values and the measured inventory. The percent difference is calculated using the following equation.

$$\%D = \frac{\bar{x}_A}{MC_A} \times 100,$$

where

%D	=	percent difference
$\bar{x}_A$	=	inventory calculated using the sample mean of the measurements made for constituent A
MC_A	=	inventory derived from the SIM for constituent A.

This page intentionally left blank.

A7.0 STEP 7 – OPTIMIZE THE DESIGN

A7.1 PURPOSE

DQO Step 7 identifies the most resource-effective design for generating data to support decisions, while maintaining the desired degree of precision and accuracy. When determining an optimal design, the following activities should be performed.

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

A7.2 DESIGN OPTIMIZATION

Table A-23 identifies information related to determining the data-collection design.

Table A-23. Determine Data-Collection Design. (2 Pages)

DR	Statistical	Nonstatistical	Rationale
1	Adaptive-cluster sampling design.	N/A	The need to determine lateral extent will be met using a form of biased sampling aimed at identifying the maximum lateral extent of contamination. The vertical extent of contamination also will be determined in the sampling design selected for addressing DR #2. Therefore, a separate sampling design to resolve vertical extent is not required.
1a	Adaptive-cluster sampling design.	N/A.	The need to determine lateral extent will be met using a form of biased sampling aimed at identifying the maximum lateral extent of contamination. The vertical extent of contamination also will be determined in the sampling design selected for addressing DR #2. Therefore, a separate sampling design to resolve vertical extent is not required.
2	Systematic random statistical-sampling design to determine mean concentration of the contaminant of concern.	N/A	Determining the mean concentration in a given volume of soil (determined by understanding the vertical and lateral extent of contamination) and knowing the density of the soil allow calculation of the total inventory of the contaminant of concern present in a trench. This measured inventory then can be compared to inventory predicted by the soil-inventory model and a determination of the soil-inventory model's accuracy can be made.

Table A-23. Determine Data-Collection Design. (2 Pages)

DR	Statistical	Nonstatistical	Rationale
2a	N/A	Census sampling design.	The dose predicted by models that use radionuclide inventories as inputs, and the dose received as measured by constant personal monitors (a form of census sampling), can be compared to determine how dose predictions for partial removal, treatment, and disposal of all near-surface soil at the BC Cribs and Trenches Area should be adjusted.
3	N/A	Biased sampling design.	Use visual observations of one exposed crib structure or remote sensing of one subsurface crib structure to make decisions on the possibility of a crib subsidence event, and use the data obtained during the selection and design of the final remedial-action alternative for the BC Cribs.
4	N/A	Census sampling design.	The data-collection design involves measurements of each member of the population of interest (i.e., each waste box before it is shipped to ERDF). This is required to meet the ERDF supplemental waste-acceptance criteria requirements (BHI-DIS-2-28-05, 0000X-DC-W0001, *Supplemental Waste Acceptance Criteria for Bulk Shipments to the Environmental Restoration Disposal Facility*).

DR = decision rule.
ERDF = Environmental Restoration Disposal Facility
N/A = not applicable.

Before these design options were specified, others were evaluated based on cost and the ability to meet the DQO constraints. The results of the trade-off analyses led to the selection of a design that most efficiently meets all of the DQO constraints without requiring the modification of any outputs from DQO Step 1 through Step 6 and the subsequent selection of a design that meets the new constraints.

The following key features of the selected design are then documented:

- Descriptions of sample locations, strata, inaccessible areas, and maps (if beneficial)
- Directions for selecting sample locations, if the selection is not necessary or appropriate at this time
- Order in which samples should be collected (if important)
- Stopping rules (if applicable)
- Special sample-collection methods
- Special analytical methods.

A7.3 IMPLEMENTATION DESIGN

The design to be implemented during the treatability test involves conducting characterization activities before excavation (i.e., soil removal, treatment, and disposal activities) and conducting characterization during excavation. The preexcavation phase will consist of characterization of the subsurface soil and perhaps the crib structures using a nonintrusive technique. The characterization conducted during excavation will consist of visual examination of crib structures, dose measurements of personnel involved in excavation operations, and radiation measurements of waste containers loaded for shipment to the ERDF.

Changes to the sampling design may be required because of unexpected field conditions, new information, health and safety concerns, or other unforeseen conditions. Minor changes that have no adverse effect on the technical adequacy of the job (i.e., on the DQOs) or schedule can be made in the field with approval of the project manager or assigned task lead and will be documented in the daily field logbook and/or field-summary reports. Changes that affect DQOs will require concurrence by RL and the lead regulatory agency and can be documented through unit managers' meetings. Alternatively, if substantial changes are required, the treatability test plan can be revised with RL and regulator approval.

A7.3.1 Near-Surface Soil Characterization

Three primary data needs associated with characterizing the near-surface soil contamination have been identified. First, the vertical and lateral extent of contamination needs to be defined to determine the depth and width of excavations to be made during partial removal, treatment, and disposal operations. Second, an estimate of the total inventory needs to be obtained for the radionuclides of interest (Cs-137 and Sr-90 in the 216-B-26 Trench and Pu-239/240 in the 216-B-53A Trench) that will be encountered during partial removal, treatment, and disposal activities. Finally, the correlation between Sr-90 concentrations and Cs-137 concentrations with depth in the 216-B-26 Trench needs to be established to ensure that operations can account for the amount of Sr-90 at risk as partial removal, treatment, and disposal activities proceed.

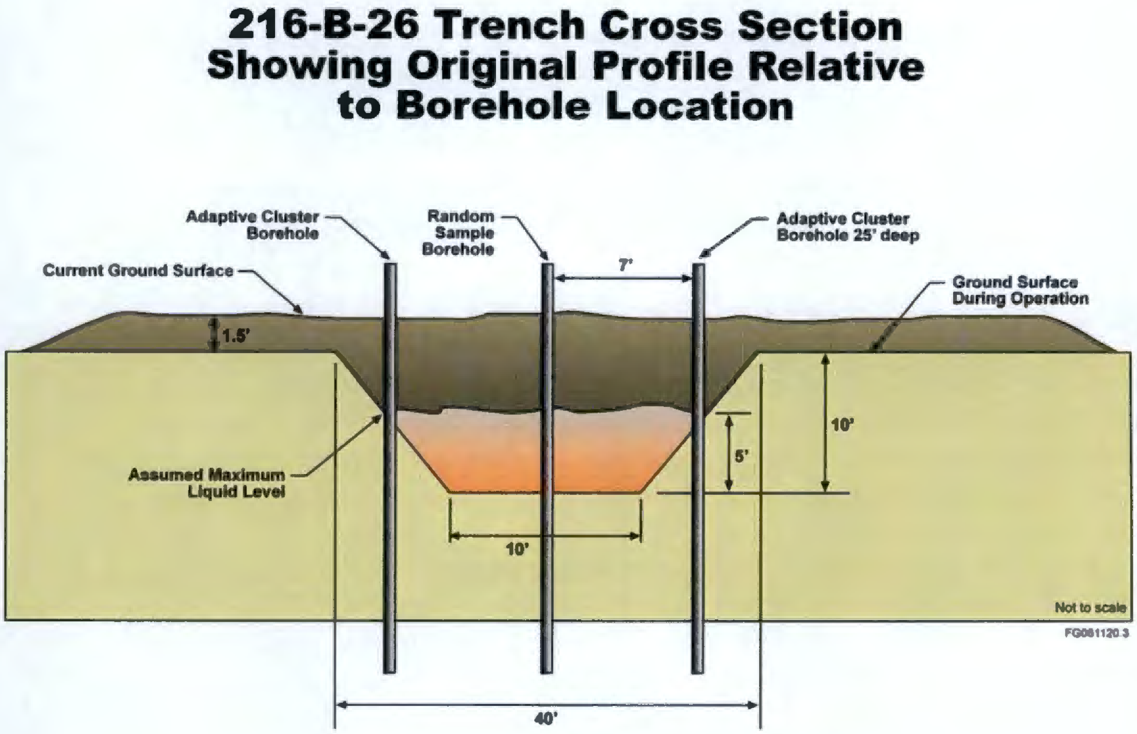
A7.3.1.1 Vertical and Lateral Extent of Contamination

Figure A-7 shows the cross section of the 216-B-26 Trench. The vertical extent of contamination will be determined by installing all boreholes to 7.6 m (25 ft) below ground surface. Historical data obtained from boreholes installed down the length of the 216-B-26 Trench show that Cs-137 contamination is less than 750 pCi/g at 6.1 to 6.7 m (20 to 22 ft) below ground surface in most holes. The data from boreholes where Cs-137 was detected at more than 750 pCi/g at depths at or below 7.6 m (25 ft) indicate that downhole cross contamination may have been occurring from the significant activity higher in the borehole. Also, because the action level associated with the industrial-use scenario is only applicable to soils up to a depth of 4.6 m (15 ft) below ground surface, the DQO team determined that 7.6 m (25 ft) would be the total depth required for the boreholes to determine the vertical extent of contamination.

The lateral extent of contamination will be determined using adaptive-cluster sampling. Adaptive-cluster sampling involves the selection of an initial probability-based sample. Additional sampling units then are selected for observation when a characteristic of interest is present in an initial unit or when the initial unit has a specific value meeting some specified condition (e.g., when a critical threshold is exceeded). Adaptive-cluster sampling designs have two key elements: (1) choosing an initial sample of units and (2) choosing a rule or condition for determining adjacent units to be added to the sample (EPA/240/R-02/005, *Guidance on*

Choosing a Sampling Design for Environmental Data Collection, EPA QA/G-5S). The initial, probability-based sample of units will be the boreholes installed to answer the question concerning inventory, as discussed in the next section.

Figure A-7. Cross-Section of the 216-B-26 Trench at the BC Cribs and Trenches Area, Showing Presumed Liquid Level When Filled and Borehole Locations.

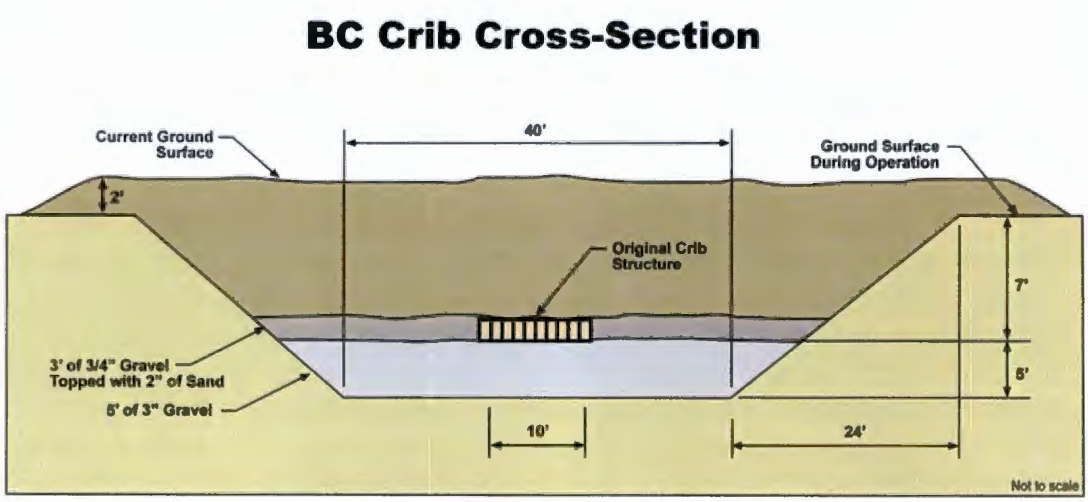


For the trenches, the rule or condition that will be used to determine where adjacent units are to be added to the sample will be concentrations measured in at least one borehole from each section of the trench (i.e., each one third of the 216-B-26 Trench or each half of the 216-B-53A Trench). At least one of the boreholes from each section that shows the highest total Cs-137 inventory (for the 216-B-26 Trench) or Pu-239/240 (for the 216-B-53A Trench) will be selected. At points approximately 2.1 m (7.0 ft) due north and due south of the selected boreholes, two additional boreholes will be installed to 7.6 m (25 ft) below ground surface. If Cs-137 is detected at more than 750 pCi/g within the first 4.6 m (15 ft) below ground surface in the 216-B-26 Trench (or Pu-239/240 is detected at more than 430 pCi/g within the first 4.6 m (15 ft) below ground surface in the 216-B-53A Trench) in any of the additional holes, another borehole will be installed approximately 60 cm (2 ft) further (i.e., further north or further south) from the centerline of the trench away from the borehole where the condition was met. This will continue until a borehole is installed that shows no Cs-137 concentrations greater than 750 pCi/g within the first 4.6 m (15 ft) below ground surface at the 216-B-26 Trench or Pu-239/240 concentrations greater than 430 pCi/g within the first 4.6 m (15 ft) below ground surface at the 216-B-53A Trench. When the condition of no Cs-137 or Pu-239/240 concentrations exceeding the specified action levels is met, no additional boreholes will be installed in the direction of the borehole meeting that condition. If the condition of a concentration greater than 750 pCi/g within the first 4.6 m (15 ft) below ground surface at the 216-B-26 Trench or Pu-239/240 greater than 430 pCi/g within the first 4.6 m (15 ft) below ground surface at the 216-B-53A Trench is not met in any of the first adaptive-cluster sampling boreholes installed approximately 2.1 m (7.0 ft) from the centerline of the trench, additional boreholes will be installed closer to the centerline of the trench until the concentration condition is approached. The project manager will determine if concentrations slightly above the action level adequately delineate the lateral extent of contamination or if additional boreholes should be installed.

For the 216-B-14 Crib, the lateral extent of contamination will be determined by selecting at least one of the initial probability-based borehole locations close to the edge of the crib that show the highest inventory of Cs-137 and installing an additional borehole approximately 1.8 m (6 ft) outside the edge of the original crib bottom. If Cs-137 is detected in that borehole at concentrations greater than 750 pCi/g within the first 4.6 m (15 ft) bgs, another borehole will be installed approximately 60 cm (2 ft) farther outside the crib at the same location. When the condition is met of no Cs-137 measurements exceeding the action level, no additional boreholes will be installed in the direction of the borehole meeting that condition. If Cs-137 is not detected in the adaptive cluster sampling borehole at concentrations more than 750 pCi/g within the first 4.6 m (15 ft) below ground surface, additional boreholes will be installed closer to the original borehole to determine the lateral extent of contamination in the crib subsurface.

Figure A-8 shows a cross-section of a crib. Because the bottom of the crib was wider than the trench, and gravel was placed in the cribs to enhance downward movement of the liquid, it is assumed that the liquid level would not have been high along the crib walls. Therefore, a 1.8 m (6-ft) distance should intersect the lateral extent of contamination present outside the crib excavation.

Figure A-8. Cross-Section of a Typical Crib at the BC Cribs, Showing Presumed Liquid Level When Filled, and Borehole Locations.



To calculate an estimate of the total inventory of radionuclides in the 216-B-26 Trench and 216-B-53A Trench, an estimate of the volume of contaminated soil is required. The location of the berms is not precisely known. Therefore, the boreholes closest to the berm exclusion area also will be used as benchmark holes for adaptive-cluster sampling to determine the lateral extent of contamination near the berms. Additional adaptive-cluster sampling holes will be installed along the centerline of the trench approximately 1.2 m (4 ft) away from the first borehole installed in the random sample of eight boreholes installed along the centerline of the trench (i.e., the closest borehole to the berm) in each end section of the trench. These boreholes will be installed in the direction toward the berm until a borehole is installed that shows no Cs-137 concentrations greater than 750 pCi/g within the first 4.6 m (15 ft) below ground surface at the 216-B-26 Trench or Pu-239/240 concentrations greater than 430 pCi/g within the first 4.6 m (15 ft) below ground surface at the 216-B-53A Trench. If the condition of a concentration more than 750 pCi/g within the first 4.6 m (15 ft) below ground surface at the 216-B-26 Trench or Pu-239/240 more than 430 pCi/g within the first 4.6 m (15 ft) below ground surface at the 216-B-53A Trench is not met in any of the first adaptive-cluster sampling boreholes installed closest to the berm along the centerline of the trench toward the berm, the location of the berm will be considered to be adequately known and no additional boreholes will be installed.

A7.3.1.2 Determining the Estimated Radionuclide Inventory

To estimate the inventory of radionuclides (and the variability of the concentrations) that will be encountered during partial removal, treatment, and disposal demonstrations at the BC Cribs and Trenches Area waste sites, measurements of the COCs will be made. These measurements will be used to estimate the mean concentration present in the trenches and/or crib that are the subject of this treatability test. The mean concentration, the volume of soil to which it applies, and the density of the soil can be used to calculate the estimated total inventory present. To aid in performing an estimate of the dose that will be encountered during partial removal, treatment, and disposal operations, an understanding of the variability of radionuclide concentrations in the near-surface soils is required. To estimate a mean with known confidence, a statistical sampling design is required. Typically, some form of random sampling is chosen for these designs.

Commonly accepted mathematical expressions are used to solve the design problems for a random-sampling approach. A mathematical expression is used to test the statistical hypothesis and define the formula for determining the number of samples required with the chosen design alternative.

In 1992, the EPA determined that when confidence intervals are used, 8 to 10 observations are recommended. This value (8 to 10) comes from the fact that for normal data, an adequate approximation of the standard deviation is not possible with fewer samples. One formula for computing the number of samples required for a random-sampling approach is shown in the equation below. This formula is appropriate for estimating the numbers of samples needed to determine if the predictions made using the SIM of total inventory present in the trenches and/or crib are sufficiently representative of the true state of the soil in these waste sites.

$$n = (Z_{1-(\alpha/2)}\eta \,/\, d_r)^2$$

where

- n = number of samples required
- Z_p = the Z number (from statistical tables) for the p^{th} percentile of the standard normal distribution. The p^{th} percentile is determined as one half the acceptable α error subtracted from 1.0
- α = the acceptable percentage, expressed as a decimal (e.g., 5% = 0.05), for getting a set of data for which the relative error exceeds the maximum tolerable value
- η = coefficient of variation (CV) or σ/μ
- d_r = relative error or the absolute value of the difference of the sample mean and population mean, which is then divided by the population mean
- σ = population standard deviation
- μ = population mean.

Because the maximum variability of the constituents (and properties) in the soil can be estimated based on previous measurements made for Cs-137 in measurements made from boreholes, an assumed variability (and calculation for coefficient of variation [CV]) can be chosen. This is done by looking at previous analytical data and assuming that the sample standard deviation (s) is an adequate estimate of the population standard deviation (σ) and that the sample mean ($\bar{x}$) is an adequate estimate of the population mean (μ). Using data presented in DOE/RL-2004-66, Appendix F, two estimates of the CV were calculated. The specific data used were the SGL data collected at 3.7 and 4.0 m (12 and 13 ft) below ground surface. The estimated CV using the data collected at 3.7 m (12 ft) is 1.02 and, using the data collected at 4.0 m (13 ft) is 0.75. Therefore, a CV of 1.0 can be estimated using these historical data, and the assumption is made that it is acceptable to have a 5 percent chance (i.e., $\alpha = 0.05$) of getting a set of data for which the relative error exceeds 70 percent. Hence $d_r = 0.70$ and $Z_{1-0.05/2} = 1.96$ and $\eta = 1.0$. Following is an example of how the number of samples is derived, using these variables.

$$n = \left[\frac{1.96(1.0)}{0.7}\right]^2 = 7.84\,.$$

Using this equation, it can be shown that eight samples of each strata of interest would suffice in meeting the project DQOs for estimating mean soil concentrations in the BC Cribs and Trenches Area waste sites. Eight samples is a minimum value for the number of samples.

Random sampling will be accomplished using a systematic random-sampling design in the 216-B-26 Trench and 216-B-53A Trench (Figures A-9 and A-10) and an aerial random-sampling design in the 216-B-14 Crib (Figure A-11). Systematic random sampling was chosen over simple random sampling for the trenches to ensure that no large portion of the trench floor went underrepresented in the sample. To ensure that the sampling design represents a possibility of collecting measurements at locations associated with lateral dispersion of contaminants, the measurements and samples will be collected from boreholes that are installed at one node along lines that are drawn perpendicular to the centerline of the trench. The perpendicular lines will be drawn at systematic intervals along the centerline of the trench (Figures A-9 and A-10).

Figure A-9. Random and Adaptive-Cluster Sampling Designs for the 216-B-26 Trench.

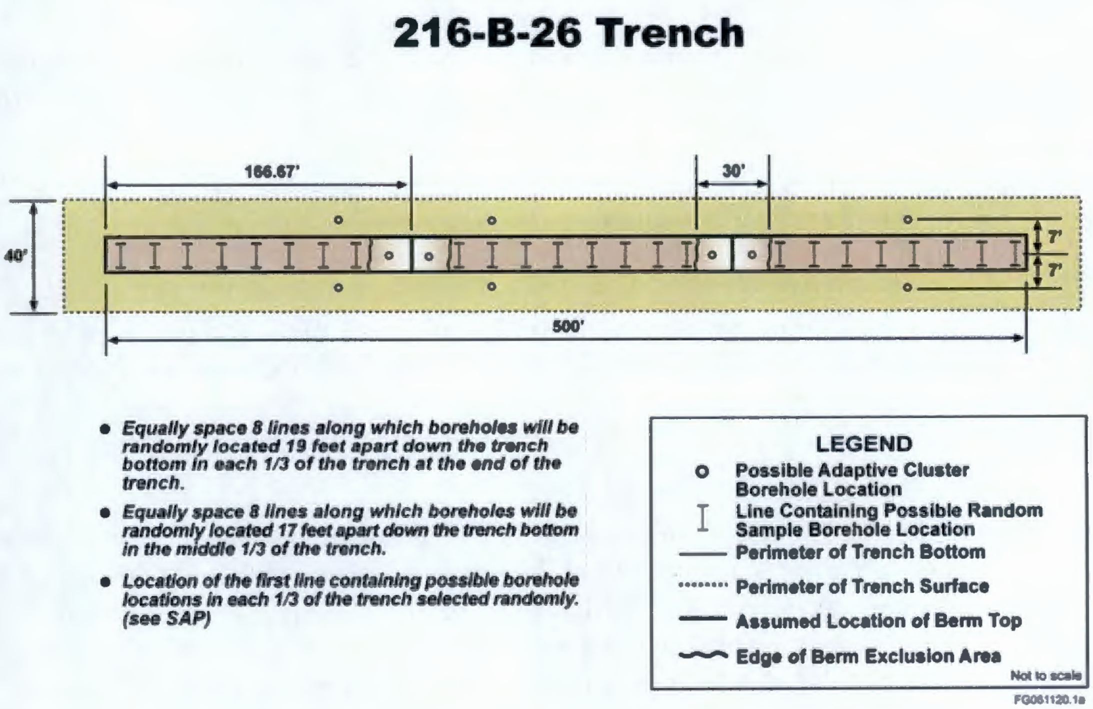


Figure A-10. Random and Adaptive-Cluster Sampling Designs for the 216-B-53A Trench.

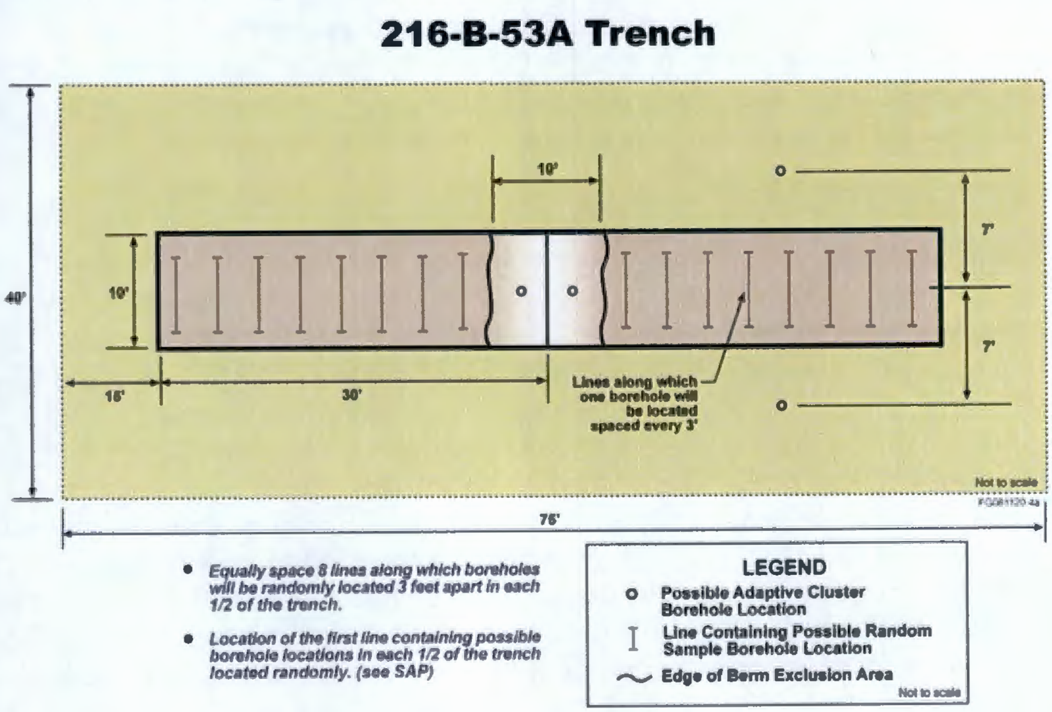
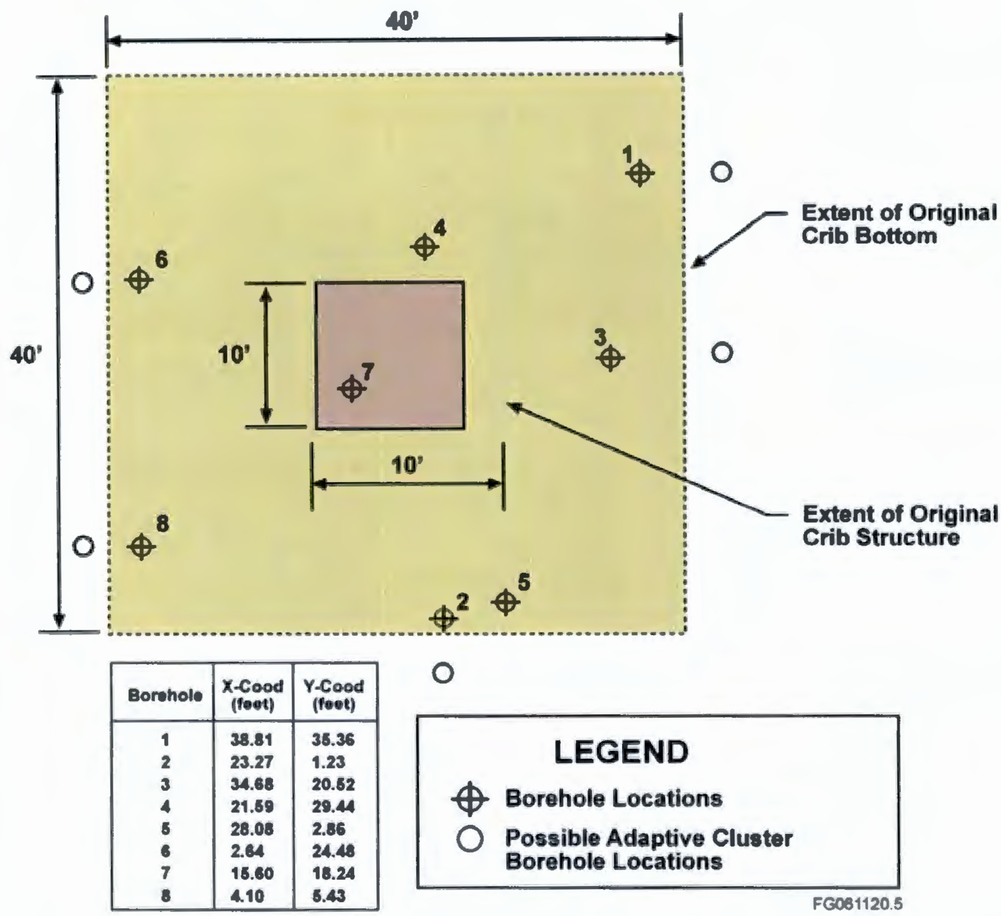


Figure A-11. Random and Adaptive-Cluster Sampling Designs for the 216-B-14 Crib.

216-B-14 Crib



Borehole	X-Cood (feet)	Y-Cood (feet)
1	38.81	35.36
2	23.27	1.23
3	34.68	20.52
4	21.59	29.44
5	28.08	2.86
6	2.64	24.48
7	15.60	18.24
8	4.10	5.43

To ensure randomness for the systematic element of the sampling, the location of the first line along which possible borehole locations will be randomly selected also must also be selected randomly, and the remaining lines will be drawn equal distances from the first line. The details of the selection of each borehole location will be documented in the sampling and analysis plan. The aerial sampling design for the 216-B-14 Crib was developed using *Visual Sample Plan* software, Version 4.6D.

From each borehole in the 216-B-26 Trench and 216-B-14 Crib, gamma logging will be performed to provide Cs-137 measurements for each 0.15 m (0.5-ft) interval. From each borehole installed in the 216-B-53A Trench, SGL will be performed to provide Pu-239/240 measurements for each 0.15 m (0.5-ft) interval. From each borehole installed in the 216-B-53A Trench, passive-neutron logging also will be conducted. This will allow an estimate of the mean concentration of the COCs in each 0.15 m (0.5-ft) layer of the soil beneath a trench or crib. In addition, three 0.15 m (0.5-ft) intervals will be selected to collect soil samples. Soil samples collected from boreholes in the 216-B-26 Trench and 216-B-14 Crib will be sent for laboratory analysis for gamma-emitting radionuclides and Sr-90. Soil samples collected from boreholes in the 216-B-53A Trench will be sent for laboratory analysis for gamma-emitting radionuclides and Pu-239/240. The soil-sample analyses will be used to correlate Cs-137 and Pu-239/240 results obtained by SGL and/or passive-neutron logging to those obtained in a laboratory. The laboratory results also will provide Sr-90 and/or Pu-239/240 concentrations that cannot be measured in the field.

A7.3.1.3 Correlating Cesium-137 and Strontium-90 Data

As stated in Section A7.3.1.2, three 0.15 m (0.5-ft) intervals from at least eight boreholes will be selected to collect soil samples. Sampling depths will be randomly selected within the range of significant gamma activity approximately 3.0 to 5.5 m (10.0 to 18 ft). Soil samples collected from boreholes in the 216-B-26 Trench and 216-B-14 Crib will be sent for laboratory analysis for gamma-emitting radionuclides and Sr-90. The Sr-90 results will be used to determine if Cs-137 and Sr-90 are most concentrated in the same intervals or if it appears that Sr-90 is migrating at a different rate than Cs-137.

The data from soil sampling design will be compared with the gamma logging data from the corresponding location via multiple linear regression and correlation analysis.

The correlation (r) will be computed for each of these pairs of variables:

- Cs-137 laboratory measurements vs. gamma logging data
- Sr-90 laboratory measurements vs. depth data.

The correlation indicates the strength of the relationship between the two variables. Two comparisons will be examined; one that compares the Cs-137 laboratory data with the gamma logging results and depth, and one that examines the Sr-90 laboratory data vs. depth data. The primary model that will be examined is a multiple linear regression model. A multiple linear regression equation has the form: $y = b_1x_1 + b_2x_2 + b_3$. The numbers b_1, b_2, and b_3 represent the two relationship and the positioning constants, respectively. Development of the regression model for the desired comparisons will indicate an appropriate relationship between the Cs-137 (or Sr-90) laboratory data with the gamma logging data and depth. If a relationship exists that is non-linear, then a transformation can be performed to appropriately express the proper relationship between the two variables. The gamma logging data and depth will be the independent variables (x-variables) and either Cs-137 or Sr-90 laboratory data will be the dependent variable (y-variable).

It is possible to adequately determine the relationship between gamma logging data and between the Cs-137 and Sr-90 laboratory data with twenty one data points. Harrell (2001) demonstrates that the number of samples needed to adequately fit a regression model is 10 times the number of independent variables. The proposed number of independent variables is 2, which means that 20 samples should be adequate for construction of the model. Because the proposed revision to the sampling plan will produce 24 points for the regression analysis, a satisfactory model should result. However, the data will be analyzed after it is collected to determine if 24 is an adequate number of samples. This will be done by performing a power analysis on the correlation test. If it can be shown that a power value of 0.80 was obtained, then the number of samples will be sufficient. If the power is less than 0.80 then at least 24 additional samples will be collected and combined with the initial 24 samples and the statistical analysis will be repeated. If a power of 0.80 cannot be obtained with the 48 samples, another 24 samples will be collected and the statistical analysis will be redone on all 72 samples.

A7.3.2 Personal Dose Characterization

The breathing air and radiation fields to which workers may be exposed in the work area encountered as partial removal, treatment, and disposal operations are conducted will be monitored in accordance with 10 CFR 835, "Occupational Radiation Protection," and the HNF-5173, *PHMC Radiological Control Manual*. The frequency of sample collection and analysis is defined in those documents. Because personnel will be wearing constant dose monitors, a census sample will be collected for these measurements. No statistical-sampling design considerations need be discussed when census sampling is used.

A7.3.3 Crib Subsidence Characterization

The visual examination of remnant crib structures will take place during the partial removal, treatment, and disposal phase of the treatability test at the 216-B-14 Crib. As the soil overlaying the crib structure is uncovered, field logs and photographic records will be used to document the condition of these structures. Alternatively, a remote-sensing technique such as installing through a crib structure and using a video camera, or some other geophysical technique, may be used to detect voids in the 216-B-14 Crib. Because the entire crib structure will be characterized, this also is census sampling, and no statistical-sampling design need be discussed for this characterization. Decisions concerning the potential for subsidence of the crib structures will be required before final remedial-action selection at the BC Cribs waste sites.

A7.3.4 Environmental Restoration Disposal Facility Waste Containers

The supplemental ERDF waste-acceptance criteria (BHI-DIS-2-28-05, 0000X-DC-W0001) require that all waste containers have radiation fields less than 80 mR/h when measured 30 cm (1 ft) from the container surface. All containers loaded for transport to ERDF will be surveyed, and if radiation fields exceed 72 mR/h at 30 cm (1 ft) from the surface of the container, additional treatment will be undertaken to ensure that the radiation fields are reduced before the containers are shipped. Because all waste containers will be measured, this also is census sampling, and no statistical-sampling design need be discussed for this characterization.

A7.3.5 Excavation and Soil Treatment

Waste destined for the ERDF must meet the ERDF waste-acceptance criteria. It is anticipated that a significant amount of soil encountered during excavation activities will exceed the radiological safety criteria in the ERDF waste-acceptance criteria related to total dose from waste containers. This will require treating the highly contaminated soils associated with high dose rates by in situ down-blending these soils with less-contaminated soils before the soils are loaded in the ERDF waste boxes. This down-blending also will be required to protect treatability test personnel conducting activities in the BC Cribs and Trenches Area. A remote-handling capability to blend clean soil with contaminated soil has been demonstrated in previous excavations of trenches at the Hanford Site. However, the blending process demonstrated at other project locations involved lower levels of radioactivity (and required less volume of clean soil) than the levels of radioactivity expected in soil from the BC Cribs and Trenches Area. Therefore, data will be collected during the excavation phase of the test, concerning the excavation techniques that lead to successful and efficient treatment decisions. These data will be in the form of detailed notes made by excavation personnel. Information on the ease (or difficulty) of making down-blending (treatment) and waste-acceptance determinations during the excavation and treatment phase of the test will provide additional data to support the applicability of partial removal, treatment, and disposal as a preferred remedial-action alternative for the BC Cribs and Trenches Area waste sites.

A7.3.6 Cost

To support the applicability of partial removal, treatment, and disposal as a preferred remedial-action alternative for the BC Cribs and Trenches Area waste sites, an updated cost estimate must be developed. Treatability test data concerning rates of soil removal, cost of equipment, numbers of personnel, numbers of shipments to ERDF, etc., all will feed the final cost estimate for this remedial-action alternative. As the excavation phase of the test proceeds, the costs associated with different phases of the test will be captured. As changes to cost-affecting processes are made (e.g., treatment efficiencies are increased), the impacts to total project costs will be analyzed. The cost estimate for performing partial removal, treatment, and disposal at all of the BC Cribs and Trenches Area waste sites will use assumptions based on the lessons learned in this treatability test.

A7.3.7 Potential Sample Design Limitations

The sampling design is intended to fill all identified data gaps. However, as with any sampling event, some data gaps may exist at the end of the treatability test. As presented, the sampling design allows for reassessment of characterization and selection of appropriate remediation alternatives after considering financial priorities. This approach recognizes that decision-makers will be in a better position to evaluate options for further response after conceptual-model data gaps have been filled.

Other potential limitations of the proposed sampling designs are as follows.

- Unexpected borehole installing-equipment refusal may not allow sample collection and/or measurements at all of the depths specified in the sampling design.
- If the centerline of the bottom of the 216-B-26 Trench and/or 216-B-53A Trench is not precisely locatable using surface surveying techniques, boreholes installed at sampling nodes far from the assumed centerline of the trench and intended to penetrate the bottom

of the trench may penetrate a side slope of the trench and potentially underestimate soil concentrations in the portion of the trench bottom intended for sampling at that borehole.

A7.4 DATA ANALYSIS AND USE

After data collection, the data will be analyzed to determine whether the decisions associated with the DQO can be made within the specified criteria. This analysis will be conducted in accordance with the EPA guidance in EPA/240/B-06/003 (EPA QA/G-9S). After the data are reviewed, graphed, and assessed for distribution, the statistical test will be applied. The two-sample *t*-test will be used to evaluate the correlation between the SIM inventory prediction and the inventory calculated using the measurements made in the boreholes and/or on samples collected from the boreholes. If the two-sample *t*-test determines that the two inventories are not in agreement, then the results obtained from field sampling and the estimates obtained from the SIM will be investigated further. Specifically, the assumptions concerning the conceptual-site model, the volume of contaminated soil associated with the applicable waste site, and potential contributors of significant variation in the SIM will be reviewed. The conclusion of the data analysis and recommendations for data use will be documented in a data quality assessment report for the treatability test.

This page intentionally left blank.

A8.0 REFERENCES

10 CFR 835, "Occupational Radiation Protection," Title 10, *Code of Federal Regulations*, Part 835, as amended.

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

ARH-947, 1972, *200 Areas Disposal Sites for Radioactive Liquid Wastes*, Atlantic Richfield Hanford Company, Richland, Washington.

ARH-3046, 1974, *Engineering Evaluation Waste Disposal Cribs - 200 Area*, Atlantic Richfield Hanford Company, Richland, Washington.

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

BHI-01356, 2000, *Remedial Investigation Data Quality Objectives Summary Report for the 200-TW-1 Scavenged Waste Group and the 200-TW-2 Tank Waste Group Operable Units*, Bechtel Hanford, Inc., Richland, Washington.

BHI-01496, 2001, *Groundwater/Vadose Zone Integration Project Hanford Soil Inventory Model*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

BHI-DIS-2-28-05, 0000X-DC-W0001, 2005, *Supplemental Waste Acceptance Criteria for Bulk Shipments to the Environmental Restoration Disposal Facility*, Rev. 6, Bechtel Hanford Company, Richland, Washington.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

DOE/RL-91-52, 1992, *U Plant Source Aggregate Area Management Study Report*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

DOE/RL-96-81, 1997, *Waste Site Grouping for 200 Areas Soil Investigations*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-98-28, 1999, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2000-38, 2001, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan,* Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-54, 2005, *Central Plateau Ecological Evaluation*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2001-66, 2002, *Chemical Laboratory Waste Group Operable Units RI/FS Work Plan, Includes: 200-LW-1 and 200-LW-2 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2002-39, 2002, *Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the Central Pasco Basin*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2002-42, 2003, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit)*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2003-44, 2003, *BC Cribs and Trenches 200-TW-1 Operable Unit Borehole Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland, Operations Office, Richland, Washington.

DOE/RL-2004-66, 2005, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-69, 2005, *Proposed Plan for the BC Cribs and Trenches Area Waste Sites*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RW-0164, 1988, *Consultation Draft: Site Characterization Plan, Reference Repository Location, Hanford Site, Washington*, Vols. 1-9, U.S. Department of Energy, Washington, D.C.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, as amended.

EPA/240/B-06/001, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

EPA/240/B-06/003, 2006, *Data Quality Assessment: Statistical Tools for Practitioners*, EPA QA/G-9S, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

EPA/240/R-02/005, 2002, *Guidance on Choosing a Sampling Design for Environmental Data Collection*, EPA QA/G-5S, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

GE, 1958, *Record of Scavenged TBP Waste (Logbook)*, General Electric Company, Richland, Washington.

Harrell, F. E., 2001, *Regression Modeling Strategies with Applications to Linear Models, Logistic Regression, and Survival Analysis*. Springer, New York.

HNF-5173, 2006, *PHMC Radiological Control Manual,* Rev. 4, Fluor Hanford, Inc., Richland, Washington.

HNF-5507, 2000, *Subsurface Conditions Description of the B-BX-BY Waste Management Area*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

HNF-SD-WM-TI-707, 2004, *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment,* Rev. 4, CH2M HILL Hanford Group, Inc., Richland, Washington.

HW-19140, 1951, *Uranium Recovery Technical Manual*, General Electric Company, Richland, Washington.

HW-31442, 1954, *Recovery of Cesium-137 from Uranium Recovery Process Wastes*, General Electric Company, Richland, Washington.

HW-33591, 1954, *Summary of Liquid Radioactive Wastes Discharged to the Ground – 200 Areas (July 1952 Through June 1954)*, General Electric Company, Richland, Washington.

HW-38562, 1955, *Radioactive Contaminants in Liquid Wastes Discharged to Ground at Separation Facilities Through June 1955*, General Electric Company, Richland, Washington.

HW-42612, 1956, *Cobalt-60 in Groundwater and Separation Waste Streams*, General Electric Company, Richland, Washington.

PNNL-6415, 2005, *Hanford Site National Environmental Policy Act (NEPA) Characterization,* Rev. 17, Pacific Northwest National Laboratory, Richland, Washington. Available on the Internet at http://www.pnl.gov/ecology/Library/NEPA.html .

PNNL-13080, 2000, *Hanford Site Groundwater Monitoring: Setting, Sources and Methods*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13788, 2002, *Hanford Site Groundwater Monitoring for Fiscal Year 2001*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-13910, 2002, *Hanford Site Environmental Report for Calendar Year 2001*, Pacific Northwest National Laboratory, Richland, Washington.

PNNL-15670, 2006, *Hanford Site Groundwater Monitoring for Fiscal Year 2005*, Pacific Northwest National Laboratory, Richland, Washington.

RPP-26744, 2005, *Hanford Soil Inventory Model, Rev. 1*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Visual Sample Plan software, Version 4.6D, 2006, Battelle Memorial Institute, Columbus, Ohio, November 14.

WAC 173-303-140, "Dangerous Waste Regulations," "Land Disposal Restrictions," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

Waste Information Data System Report, Hanford Site database.

WHC-SD-WM-ER-133, 1991, *An Assessment of the Inventories of the Ferrocyanide Watchlist Tanks*, Westinghouse Hanford Company, Richland, Washington.

APPENDIX B

SAMPLING AND ANALYSIS PLAN FOR THE EXCAVATION-BASED TREATABILITY TEST AT THE BC CRIBS AND TRENCHES AREA WASTE SITES

This page intentionally left blank.

CONTENTS

FIGURES

TABLES

This page intentionally left blank.

TERMS

ALARA	as low as reasonably achievable
bgs	below ground surface
COC	contaminant of concern
DOE	U.S. Department of Energy
DQO	data quality objective
DR	decision rule
EPA	U.S. Environmental Protection Agency
ERDF	Environmental Restoration Disposal Facility
FH	Fluor Hanford
HEIS	*Hanford Environmental Information System* database
HPGe	high-purity germanium
NaI	sodium iodide
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCT	radiological control technician
RL	U.S. Department of Energy, Richland Operations Office
RTD	removal, treatment, and disposal
SAP	sampling and analysis plan
SGL	spectral gamma logging
SIM	Soil Inventory Model
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989)

METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If you know	*Multiply by*	*To get*	*If you know*	*Multiply by*	*To get*
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.0929	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces (avoir)
pounds	0.454	kilograms	kilograms	2.205	pounds (avoir)
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces (U.S., liquid)
tablespoons	15	milliliters	liters	2.113	pints
ounces (U.S., liquid)	29.573	milliliters	liters	1.057	quarts (U.S., liquid)
cups	0.24	liters	liters	0.264	gallons (U.S., liquid)
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts (U.S., liquid)	0.946	liters	cubic meters	1.308	cubic yards
gallons (U.S., liquid)	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Temperature			**Temperature**		
Fahrenheit	(°F-32)*5/9	Centigrade	Centigrade	(°C*9/5)+32	Fahrenheit
Radioactivity			**Radioactivity**		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

APPENDIX B

SAMPLING AND ANALYSIS PLAN FOR THE EXCAVATION-BASED TREATABILITY TEST AT THE BC CRIBS AND TRENCHES AREA WASTE SITES

B1.0 INTRODUCTION

As a part of the excavation-based treatability test plan for the BC Cribs and Trenches area waste sites, this appendix describes the sampling and analysis required to achieve the data quality objectives (DQO) described in Appendix A in support of the remedy selection at these waste sites. This sampling and analysis plan (SAP) addresses the elements of a quality assurance project plan (QAPjP) and field-sampling plan as outlined in EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5. This SAP also will ensure compliance with the quality assurance/quality control QA/QC requirements of the Hanford Site, the U.S. Department of Energy, Richland Operations Office (RL), and the U.S. Environmental Protection Agency (EPA) as referenced in applicable documents throughout this SAP.

The activities described in this SAP involve soil sampling and analysis and gamma logging of boreholes to be installed using direct-push technology in the 216-B-53A Trench and 216-B-14 Crib within the BC Cribs and Trenches Area waste sites. The soil sampling and analysis and gamma logging of boreholes in the 216-B-26 Trench during Phase 1 of the treatability study are addressed in DOE/RL-2007-14, *Sampling and Analysis Plan for Phase 1 of the BC Cribs and Trenches Area Waste Sites Excavation-Based Treatability Test.* Data generated during the treatability test will determine the nature and extent of near-surface contamination, the level of contamination, and predicted dose-associated radiological risks encountered during excavation activities. Other data generated will be used to determine the actual dose received by personnel conducting partial removal, treatment, and disposal (RTD) of soil at the selected waste sites and will ensure that requirements of BHI-00139, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, are met for disposal of contaminated soil wastes. In addition, the condition of one crib will be assessed to determine the potential for structural failure of the crib to result in subsidence on the surface at any of the crib waste sites. The results of the treatability test will support the remedy selection process that will be documented in a revision to DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*, and ultimately in the Record of Decision issued by the EPA.

B1.1 PROJECT SCOPE

The treatability test being conducted at these waste sites will ensure that feasibility study decisions concerning remedy selection are valid. The treatability test consists of the following four phases.

- In Phase 1, data concerning the nature and extent of Cs-137 and Sr-90 contamination in the 216-B-26 Trench will be collected in accordance with DOE/RL-2007-14. Section 4.1 of the main text provides a description of this trench. The data collected during Phase 1 will be used to estimate the amount of material requiring removal (i.e., define the lateral and vertical extent of the excavations) and to calculate a predicted dose that remediation workers will receive in Phase 2 of the treatability test. Data from this phase of the test also will be used to correlate the total inventory of Cs-137 in the trench as determined by measurements and estimates of contaminated volume with the inventory predicted by RPP-26744, *Hanford Soil Inventory Model, Rev. 1* (SIM).

- Phase 2 of the treatability test will involve excavation to test the process of partial RTD of the highly contaminated 216-B-26 Trench near-surface soil that is associated with high dose rates. Phase 2 of the test will begin with excavation of one-third of the total trench length. Data will be collected to ensure that Environmental Restoration Disposal Facility (ERDF) waste-acceptance criteria are met. Personal dose monitoring devices will be used to measure worker dose. The actual dose measurements then will be compared to the estimated dose to workers using the data collected during Phase 1. The process of soil treatment (down-blending) to meet the ERDF waste-acceptance criteria will be refined during this phase of the test. Phase 2 of the treatability test will include the option to cease excavation activities in the trench if the data collected from excavation of a portion of the trench are sufficient to allow decision makers to assess the feasibility of partial RTD for trenches in the BC Cribs and Trenches Area.

- Phase 3 of the treatability test will involve characterization, similar to that conducted in Phase 1, followed by excavation of the highly contaminated near-surface soil and residual structures in the 216-B-14 Crib. Data will be collected for the same purposes as described in Phase 1 and Phase 2. In addition, the potential for subsidence due to failure of the remnant crib structure will be evaluated.

- Phase 4 of the test will involve characterization followed by excavation of the plutonium-contaminated near-surface soil in the 216-B-53A Trench. Data collected in Phase 4 also will support initial site characterization and waste characterization, and will validate dose measurements with predicted dose.

The decision makers will review data as they are collected in each phase of the test. When sufficient data are collected to complete the assessment of the feasibility of the partial RTD remedial alternative, the treatability test may be concluded without completion and/or initiation of one or more of the phases listed.

B1.2 CONTAMINANTS OF CONCERN

Through the DQO process, a systematic methodology is used for identifying the contaminants of concern (COC) for each project. Data will be collected to characterize the nature and extent of contamination in the crib and trenches before excavation activities. Boreholes will be installed in as many as two trenches and one crib using direct-push technology.

Table B-1 lists the COCs for the measurements obtained before excavation and partial RTD of contaminated soil in the BC Cribs and Trenches Area waste sites.

Table B-1. Contaminants of Concern for Measurements Made Before Excavation.

Field Measurements	
Cs-137 in the 216-B-26 Trench	Field analyses using a borehole gamma logging instrument
Cs-137 in the 216-B-14 Crib	Field analyses using a borehole gamma logging instrument
Pu-239 in the 216-B-53A Trench	Field analyses using a borehole spectral gamma logging instrument and borehole passive neutron counter
Laboratory Measurements	
Cs-137 Total radioactive strontium	Laboratory analyses for radionuclides in the 216-B-26 Trench & 216-B-14 Crib
Isotopic americium Isotopic plutonium	Laboratory analyses for radionuclides in the 216-B-53A Trench

As excavation activities begin to test the remedial alternative of partial RTD of contaminated soil, it will be necessary to characterize the waste generated before shipment to ERDF. Existing site characterization data indicate that the most highly contaminated soil in the BC Cribs and Trenches will meet the ERDF waste-acceptance criteria requirements for total curies per cubic meter. However, the ERDF supplemental waste-acceptance criteria (BHI-DIS-2-28-05, 0000X-DC-W0001, *Supplemental Waste Acceptance Criteria for Bulk Shipments to the Environmental Restoration Disposal Facility*) requirement that the waste have a radiation level less than 80 mR/h gamma when measured at 30 cm (1 ft) from the surface of the container would not be met by some of the soils before treatment. Therefore, it will be necessary to down-blend (mix) the highly contaminated soil with less contaminated soil. As the soil is treated by down-blending, it will be characterized by using field-screening instruments to ensure that the ERDF supplemental waste-acceptance criteria requirements are met. The COCs are listed in Table B-2 that demonstrate compliance with the ERDF waste-acceptance criteria and supplemental waste-acceptance criteria.

Table B-2. Contaminants of Concern for Characterization of Contaminated Treatability Test Waste for Shipment to the Environmental Restoration Disposal Facility.

Radionuclides
Field analyses using a beta/gamma detection instrument for dose rates from beta/gamma-emitting radionuclides

B1.3 DATA QUALITY OBJECTIVES

The DQOs were developed in accordance with EPA/240/B-06/001, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, and were used as the basis for requirements in this SAP. This section summarizes the key outputs resulting from the implementation of the multi-step DQO process. Additional details are included in the DQO summary report in Appendix A.

B1.3.1 Statement of the Problem

To support remedy selections, the feasibility of the remedial-action alternative of partial RTD of near-surface contaminated soil must be assessed. Additional site characterization data are required to determine the nature and extent of contamination, provide better estimates of the contamination and associated radiological risks that will be encountered during excavation activities, and predict dose that likely will be received if this remedial-action alternative is chosen. Data are required to correlate actual dose received by partial RTD personnel to the predicted values. Data are required to assess the potential for subsidence to occur at any of the crib waste sites. Data also are required to dispose of contaminated soil wastes that result from conducting this treatability test at ERDF. Cost data are required to improve the basis for estimating the cost for applying this remedial-action alternative to all of the BC Cribs and Trenches Area waste sites.

B1.3.2 Decision Rules

Decision rules (DR) are developed from the combined results of DQO Steps 2, 3, and 4. These results include the principal study questions, decision statements, remedial-action alternatives, data needs, COC action levels, analytical requirements, and scale of the decision(s). DRs generally are structured as "IF…THEN" statements that indicate the action that will be taken when a prescribed condition is met. DRs incorporate the parameters of interest (e.g., COCs), the scale of the decision (e.g., location), the preliminary action level (e.g., COC concentration), and the resulting action(s). The DRs developed for the treatability test are summarized in Table B-3.

Table B-3. Decision Rules. (2 Pages)

DR	Decision Rule
1	*If* the field measurements for gamma-emitting radionuclides indicate the presence of Cs-137 at a concentration greater than 750 pCi/g or laboratory measurements for Sr-90 indicate a concentration greater than 90,000 pCi/g in the 216-B-14 Crib, *then* additional characterization data will be obtained to further establish the nature and extent of contamination. Otherwise, excavation parameters (e.g., volume of material, dimensions, and coordinates of excavated surface) will be determined without precise site characterization data concerning vertical and lateral extent of contamination.
1a	*If* the field or laboratory measurements for Pu-239/240 indicate the presence of these isotopes at a level greater than 430 pCi/g in the 216-B-53A Trench, *then* additional characterization data will be obtained to further establish the nature and extent of contamination. Otherwise, excavation parameters (e.g., volume of material, dimensions, and coordinates of excavated surface) will be determined without precise site characterization data concerning vertical and lateral extent of contamination.
2	*If* the true mean concentration for applicable radionuclide constituents agrees with the concentration predicted by using the inventory inputs for the SIM (as represented by the inventory value being within the 95 percent confidence interval around the sample mean), *then* the SIM will be considered valid for use in determining inventory present in all of the BC Cribs and Trenches Area waste sites. Otherwise, additional characterization data will be collected or models will be modified to show adequate correlation between characterization data and inventory data.

Table B-3. Decision Rules. (2 Pages)

DR	Decision Rule
2a	*If* the dose received by personnel involved in the treatability test operations agrees with that predicted dose using the method described in DOE/RL-2004-66, Appendix F, *then* the method described in DOE/RL-2004-66, Appendix F, will be used to predict the dose received if partial removal, treatment, and disposal is chosen for all of the BC Cribs and Trenches Area waste sites. Otherwise, a scaling factor will be applied to dose predictions based on actual dose received during this treatability test.
3	*If* visual examination or remote sensing data indicate that voids are present in the crib structures such that subsidence is possible, *then* appropriate measures will be taken during the design phase to mitigate the effects of subsidence in the final remedial action taken at the BC Cribs. Otherwise, no design controls for an eventual subsidence event will be included in the final remedial action at the BC Cribs.
4	*If* the gamma radiation field at 30 cm (1 ft) from the surface of an individual ERDF waste container exceeds 80 mR/h (as represented by any surface dose reading greater than 72 mR/h at 30 cm [1 ft] from the surface of the container), *then* the container disposition will be addressed on a case-by-case basis. Otherwise, the container will be shipped to ERDF for normal disposition.

DOE/RL-2004-66, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*.
DR = decision rule.
ERDF = Environmental Restoration Disposal Facility.
SIM = Soil Inventory Model (RPP-26744, *Hanford Soil Inventory Model, Rev. 1*).

B1.3.3 Sample Design Summary

The primary purpose of DQO Step 6 is to determine which DRs, if any, require a statistically based sample design. For those DRs requiring a statistically based sample design, DQO Step 6 defines tolerable limits on the probability of making a decision error. For sampling designs that are non-statistically based (i.e., judgmental), uncertainty is evaluated qualitatively to estimate decision error.

Changes to the sampling design may be required because of unexpected field conditions, new information, health and safety concerns, or other unforeseen conditions. Minor changes that have no adverse effect on the technical adequacy of the job (i.e., on the DQOs) or schedule can be made in the field with approval by the project manager or assigned task lead and will be documented in the daily field logbook and/or field summary reports. Changes that affect DQOs will require concurrence by RL and the lead regulatory agency and can be documented through unit managers' meetings. Alternatively, if substantial changes are required, the treatability test plan can be revised with RL and regulator approval.

Table B-4 summarizes the data collection design for the treatability test.

Table B-4. Data Collection Design.

DR	Statistical	Nonstatistical	Rationale
1	Adaptive-cluster sampling design	N/A	The need to determine lateral extent will be met using a form of biased sampling aimed at identifying the maximum lateral extent of contamination. The vertical extent of contamination also will be determined in the sampling design selected for addressing DR 2. Therefore, a separate sampling design to resolve vertical extent is not required.
1a	Adaptive-cluster sampling design	N/A	The need to determine lateral extent will be met using a form of biased sampling aimed at identifying the maximum lateral extent of contamination. The vertical extent of contamination also will be determined in the sampling design selected for addressing DR 2. Therefore, a separate sampling design to resolve vertical extent is not required.
2	Systematic random statistical sampling design to determine mean concentration of the constituent of concern	N/A	Determining the mean concentration in a given volume of soil (determined by understanding the vertical and lateral extent of contamination) and knowing the density of the soil allow calculation of the total inventory of the contaminant of concern present in a trench. This measured inventory then can be compared to inventory predicted by the SIM and a determination of the SIM's accuracy can be made. In addition, the random-sampling design provides information on the variability of contaminants to support dose estimates based on these measurements.
2a	N/A	Census sampling design	The dose predicted by models that use radionuclide inventories as inputs and the dose received as measured by constant personal monitors (a form of census sampling) can be compared to determine how dose predictions for partial removal, treatment, and disposal of all near-surface soil at the BC Cribs and Trenches Area should be adjusted.
3	N/A	Biased sampling design	Use visual observations of one exposed crib structure or remote sensing of one subsurface crib structure to make decisions on the possibility of a crib subsidence event and use the data obtained during selection and design of the final remedial-action alternative for the BC Cribs.
4	N/A	Census sampling design	The data collection design involves measurements of each member of the population of interest (i.e., each waste box before shipment to ERDF). This is required to meet the ERDF supplemental waste-acceptance criteria requirements (BHI-DIS-2-28-05, 0000X-DC-W0001, *Supplemental Waste Acceptance Criteria for Bulk Shipments to the Environmental Restoration Disposal Facility*).

DR = decision rule.
ERDF = Environmental Restoration Disposal Facility.
N/A = not applicable.
SIM = Soil Inventory Model (RPP-26744, *Hanford Soil Inventory Model, Rev. 1*).

A statistical sampling approach will not be used to determine whether the predicted dose matches the dose received during treatability test operations and whether a waste box loaded for shipment to ERDF meets the ERDF supplemental waste-acceptance criteria (DRs 2a and 4). However, a statistical sampling design is appropriate and required for estimating if the true mean concentration for applicable radionuclide constituents agrees with the concentration predicted by using the inventory inputs for the SIM (DR 2). Adaptive-cluster sampling, which involves the selection of an initial probability-based sample, will be used to determine the lateral extent of contamination. Therefore, while adaptive-cluster sampling is not strictly a statistical sampling method, the method has elements based on a statistical design because the initial, probability-based sample of units will be the boreholes installed to address DR 2.

Decisions concerning nature and extent of contamination (DRs 1 and 1a) include determining the vertical and lateral extent of contamination. Contamination for the purposes of this data collection effort has been defined as soil contaminated with Cs-137 at more than 750 pCi/g, Sr-90 at more than 90,000 pCi/g, and/or Pu-239/240 at more than 430 pCi/g. These values represent maximum concentrations that are protective of human health 150 years from the present under an industrial scenario. It should be noted that this action level only applies to the soil within the first 4.6 m (15 ft) below ground surface (bgs) because that is the point of compliance for human-health exposure. Further discussion is provided in Appendix A. Samples will be collected to determine if this level of contamination is present. For samples collected to determine the lateral extent of contamination, if COCs above the action level are found, additional samples will be taken to determine the lateral extent of contamination. If the concentrations of the COCs in the additional samples are less than the action level, the extent of contamination can be bounded by the regions from which those samples were collected. If levels of contamination detected in a single measurement are greater than the action levels, the extent of contamination has not been totally resolved by that sample. In addition, another use for the data from measurements conducted on soil samples collected from the boreholes installed to estimate the mean concentration of contaminants in the trench (i.e., from all boreholes except the adaptive-cluster sampling boreholes) will be to determine if a correlation between Cs-137 and Sr-90 activity can be established as a function of depth.

The decision concerning dose predicted compared to dose received (DR 2a) will be made using data collected from radiation control sampling. Comparison will be between the predicted dose updated by the revised source term and actual dose incurred. Arbitrarily, good correlation would be agreement within 50 percent. For radiation control sampling and monitoring, the field radiation controls health physics personnel will collect samples using personal monitors, air monitoring instrumentation, radiation detection instrumentation, and any other instruments required to test for the specified COCs. Using these techniques, sample collection is continuous and the sample represents something close to a census of the population of interest. Using a census-sampling approach eliminates the need to design a statistically based sampling design because the entire available population is being included in the measurements. Therefore, a detailed statistical discussion of the radiological controls sampling conducted during the treatability test will not be developed further.

The entire crib structure for the 216-B-14 Crib either will be surveyed using geophysical tools or visually examined during excavation to determine if voids present in the crib structure could lead to future subsidence events in the BC Cribs (DR 3). If visual examination is used in making this decision, the uncertainty associated with the decision of determining whether a subsidence event could occur is considered to be relatively low. This is because the 216-B-14 Crib will be examined and the integrity of the structure and/or voids observed will be assumed representative of the other cribs in the BC Cribs and Trenches Area. If remote sensing data are used, the uncertainty in making the decision will be dependent on the uncertainty associated with the measurement system used. The entire crib structure will be observed or measured in making the decision regardless of the technique used to measure the characteristics. This is a form of census sampling, and no discussion of decision error associated with sampling design is required.

For decisions concerning waste shipments to ERDF (DR 4), another form of census sampling will be used. Every member of the population of interest (i.e., every box loaded for shipment to ERDF) will be measured for total radiation at a distance of 30 cm (1 ft) from the surface of the container to ensure that the dose is less than 80 mR/h. Because measurement system error can occur, an arbitrary value of 90 percent of the allowed dose will be used as a cutoff. That is, as long as the dose measured is less than 72 mR/h at 30 cm (1 ft) from the surface of the ERDF container, the container will be assumed to have a dose of less than 80 mR/h at 30 cm (1 ft) from the container. Although not quantifiable, use of this conservative decision criterion is considered an acceptable method to reduce the decision error associated with this decision.

The vertical extent of contamination will be determined by drilling all boreholes to 7.6 m (25 ft) bgs. Historical data obtained from boreholes installed down the length of the 216-B-26 Trench show that Cs-137 contamination is less than 750 pCi/g at 6.1 to 6.7 m (20 to 22 ft) bgs in most holes. The data from boreholes where Cs-137 was detected at more than 750 pCi/g at depths exceeding 7.6 m (25 ft) bgs indicate that down-hole cross contamination from the significant activity higher in the borehole may have been occurring. In addition, because the action level associated with the industrial-use scenario is only applicable to soils up to a depth of 4.6 m (15 ft) bgs, the DQO team determined that 7.6 m (25 ft) would be a conservative total depth required for the boreholes in determining the vertical extent of contamination.

The lateral extent of contamination will be determined using adaptive-cluster sampling. Adaptive-cluster sampling involves the selection of an initial probability-based sample. Additional sampling units then are selected for observation when a characteristic of interest is present in an initial unit or when the initial unit has a specific value meeting some specified condition (e.g., when a critical threshold is exceeded). Adaptive-cluster sampling designs have two key elements: (1) choosing an initial sample of units and (2) choosing a rule or condition for determining adjacent units to be added to the sample (EPA/240/R-02/005, *Guidance on Choosing a Sampling Design for Environmental Data Collection*, EPA QA/G-5S). The initial, probability-based sample of units will be the boreholes installed to answer the question concerning inventory as discussed in the next section.

For the 216-B-53A Trench, the rule or condition that will be used to determine where adjacent units are to be added to the sample will be the relative concentrations measured in at least one borehole from each half of the 216-B-53A Trench. At least one of the boreholes from each half that shows the highest Pu-239/240 will be selected. At points that are approximately 2.1 m (7.0 ft) due north and due south of the centerline of the trench (i.e., as measured along a line perpendicular to the centerline which runs due east-west), two additional boreholes will be installed to 7.6 m (25 ft) bgs. If Pu-239/240 is detected greater than 430 pCi/g within the first 4.6 m (15 ft) bgs in the 216-B-53A Trench in any of the additional holes, another borehole will be installed approximately 60 cm (2 ft) further (i.e., further north or further south) from the centerline of the trench away from the borehole where the condition was met. This will continue until a borehole is installed that shows no Pu-239/240 concentrations more than 430 pCi/g at the

216-B-53A Trench in the 0 to 4.6 m (0 to 15 ft) bgs interval. When the condition of no Pu-239/240 concentrations exceeding the specified action levels is met, no additional boreholes will be installed further from the centerline of the trench in that direction. If the condition of a Pu-239/240 concentration greater than 430 pCi/g at the 216-B-53A Trench is not met in any of the first adaptive-cluster sampling boreholes installed approximately 2.1 m (7 ft) from the centerline of the trench, additional boreholes may be installed closer to the centerline of the trench along the same line as the first adaptive-cluster borehole. This will continue until Pu-239/240 in the 216-B-53A Trench is seen to approach 430 pCi/g in the 0 to 4.6 m (0 to 15 ft) bgs interval. The project manager will determine how much closer to the benchmark borehole the subsequent adaptive-cluster borehole should be installed when this occurs. The project manager also will determine whether concentrations measured slightly higher than 430 pCi/g within the first 4.6 m (15 ft) bgs are close enough to define the lateral extent of contamination or if additional boreholes are required.

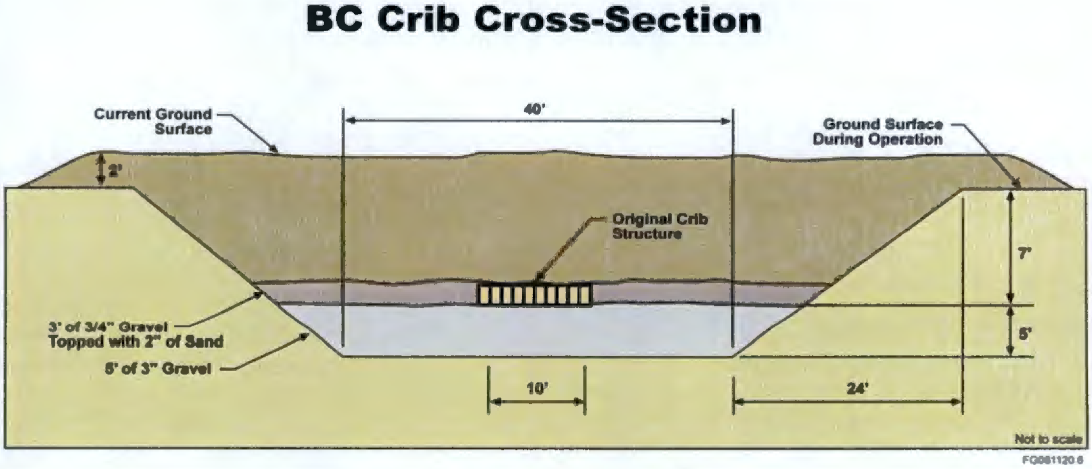
For the 216-B-14 Crib, the lateral extent of contamination will be determined by selecting at least one of the initial probability-based borehole locations close to the edge of the crib that show the highest inventory of Cs-137 and drilling an additional borehole approximately 1.8 m (6 ft) outside the edge of the original crib bottom. If Cs-137 is detected in the first 4.6 m (15 ft) bgs in that borehole at concentrations greater than 750 pCi/g, another borehole will be installed approximately 0.6 m (2 ft) further outside the crib at the same location. When the condition of no Cs-137 measurements exceeding the action level is met, no additional boreholes will be installed in the direction of the borehole meeting that condition. If Cs-137 is not detected in the adaptive-cluster sampling borehole at concentrations more than 750 pCi/g, additional boreholes will be installed closer to the original borehole to determine the lateral extent of contamination in the crib subsurface.

To calculate an estimate of the total inventory of Pu-239/240 in the 216-B-53A Trench, an estimate of the volume of contaminated soil is required. While the location of the ends of the trench is known, the location of the berms is not precisely known. Therefore, the boreholes closest to the berm exclusion area also will be used as benchmark holes for adaptive-cluster sampling. Additional adaptive-cluster sampling holes will be installed along the centerline of the trench approximately 1.2 m (4 ft) away from each borehole closest to the berm in the direction toward the berm. This will continue until the condition of a Pu-239/240 concentration more than 430 pCi/g in the 216-B-53A Trench (in the 0 to 4.6 m [0 to 15 ft] bgs interval) is not met. If the concentration-based, depth-sensitive action level is not met in any of the first adaptive-cluster sampling boreholes installed in the 216-B-53A Trench approximately 1.2 m (4 ft) away from the boreholes closest to the berm along the centerline of the trench toward the berm, additional boreholes will be installed closer to the benchmark boreholes until the activity of Pu-239/240 in the 216-B-53A Trench is seen to approach 430 pCi/g in the 0 to 4.6 m (0 to 15 ft) bgs interval. The project manager will determine how much closer to the benchmark borehole the subsequent adaptive-cluster borehole should be installed when this occurs. The project manager also will determine whether concentrations measured slightly higher than 430 pCi/g (or 430 pCi/g) within the first 4.6 m (15 ft) bgs are close enough to define the lateral extent of contamination or if additional boreholes are required

A similar logic was applied in selecting a 1.8 m (6-ft) distance from the edge of the crib for adaptive-cluster sampling at the 216-B-14 Crib. Figure B-1 shows a cross-section of a crib.

Because the bottom of the crib was wider than the trench and gravel was placed in the cribs to enhance downward movement of the liquid, it is assumed the liquid level would not have been high along the crib walls. Therefore, a 1.8 m (6-ft) distance should intersect the lateral extent of contamination present outside the crib excavation.

Figure B-1. Cross-Section of Typical 216-B-14 Crib Showing Presumed Liquid Level When Filled, and Borehole Locations.



To estimate the inventory of radionuclides (and the variability of the concentrations) that will be encountered during partial RTD demonstrations at the BC Cribs and Trenches Area waste sites, measurements of the COCs in the 216-B-14 Crib and the 216-B-53A Trench will be used to estimate the mean concentration present. The mean concentration, the volume of soil to which it applies, and the density of the soil can be used to calculate the estimated total inventory present. To aid in performing an estimate of the dose that will be encountered during partial RTD operations, an understanding of the variability of radionuclide concentrations in the near-surface soils also is required. To estimate a mean with known confidence, a statistical sampling design is required. Systematic random sampling was chosen in this situation to ensure that longitudinal variability along the bottom of the trench is adequately determined. This sampling plan allows the data user to determine how concentrations of contaminants vary along the bottom of the trench by ensuring that no large areas of the trench bottom are left unrepresented in the sample.

To ensure that the sampling design represents a possibility to collect measurements at locations associated with lateral dispersion of contaminants, the measurements and samples will be collected from boreholes that are installed at a selected point along lines that are drawn perpendicular to the centerlines of the 216-B-53A Trench. The perpendicular lines will be drawn at systematic intervals along the centerline of the trench (Figure B-2). To ensure randomness for the systematic element of the sampling, the location of the first line along which possible borehole locations will be randomly selected and the remaining lines will be drawn equal distances from the first line. A random number generator was used to select the distance to the first line that is drawn perpendicular to the centerline of the trench and to select where on the perpendicular lines the boreholes will be installed. Random sampling is accomplished by an aerial random-sampling design in the 216-B-14 Crib (Figure B-3). The aerial sampling design for the 216-B-14 Crib was developed using Visual Sample Plan software. The details of the selection of each borehole location are documented in Chapter B3.0.

Figure B-2. Random and Adaptive-Cluster Sampling Designs for the 216-B-53A Trench.

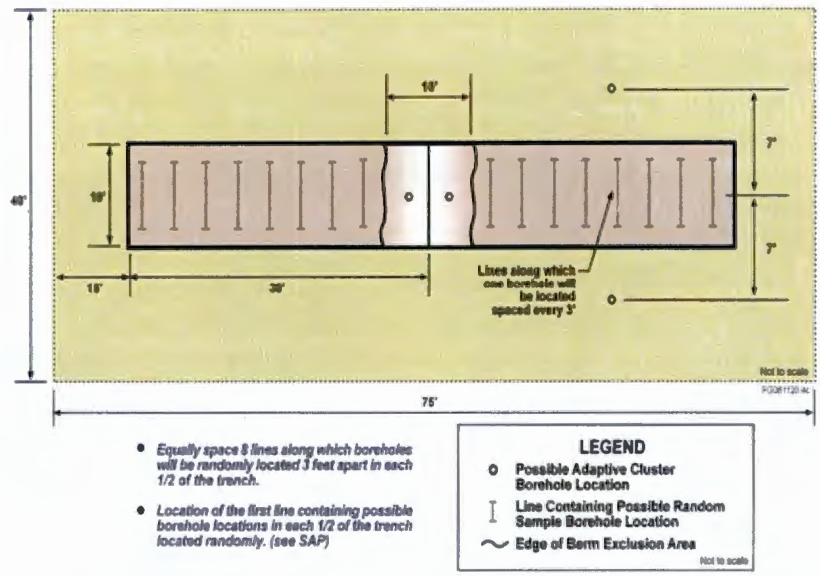
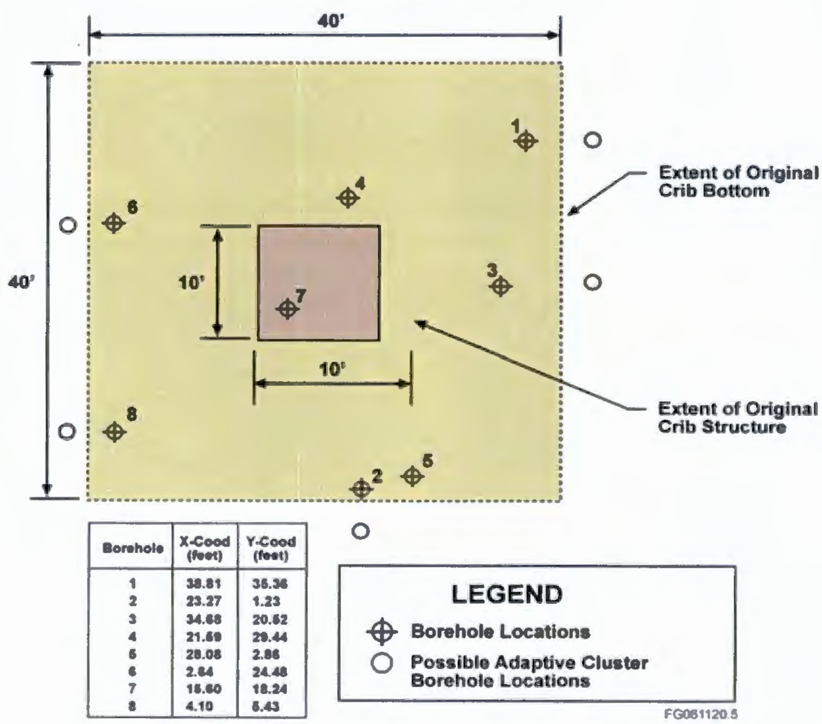


Figure B-3. Random and Adaptive-Cluster Sampling Designs for the 216-B-14 Crib.



Borehole	X-Cood (feet)	Y-Cood (feet)
1	38.81	36.36
2	23.27	1.23
3	34.68	20.62
4	21.69	29.44
5	26.08	2.86
6	2.64	24.48
7	15.60	18.24
8	4.10	5.43

From each borehole in the 216-B-14 Crib, gamma logging will be performed to provide Cs-137 measurements for each 0.15 m (0.5-ft) interval. From each borehole installed along the centerline in the 216-B-53A Trench, SGL will be performed to provide Pu-239/240 measurements for each 0.15 m (0.5-ft) interval. In the boreholes installed along the centerline in the 216-B-53A Trench, passive neutron measurements also will be made for each 0.15 m (0.5-ft) interval. While this technique is not quantitative, the data will be used to field calibrate the passive-neutron measurements. This will be required because the sensitivity of SGL measurements is not sufficient to detect plutonium isotopes at the required action level in the adaptive-cluster sampling boreholes. The SGL measurements for Cs-137 and Pu-239 (where detectable) will allow an estimate of the mean concentration of the COCs in each 0.15 m (0.5-ft) layer of the soil beneath a trench or crib. In addition, soil samples will be collected. Soil samples collected from boreholes in the 216-B-14 Crib will be sent for laboratory analysis for gamma-emitting radionuclides and Sr-90. Soil samples collected from boreholes in the 216-B-53A Trench will be sent for laboratory analysis for gamma-emitting radionuclides, Pu-239/240, and Am-241. The soil-sample analyses will be used to correlate Cs-137 and Pu-239/240 results obtained by SGL to those obtained in a laboratory. The laboratory results also will provide Sr-90 concentrations that cannot be measured in the field.

The implementation of the random and adaptive-cluster sampling design is detailed in Chapter B3.0.

B2.0 QUALITY ASSURANCE PROJECT PLAN

The QAPjP establishes the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis. The QAPjP complies with the requirements of the following:

- DOE O 414.1C, *Quality Assurance*
- 10 CFR 830.120, "Quality Assurance Requirements"
- EPA/240/B-01/003.

The following sections describe the quality requirements and controls applicable to this SAP.

B2.1 PROJECT MANAGEMENT

This section addresses the basic areas of project management and ensures that the project has a defined goal, that the participants understand the goal and approach to its use, and that the planned outputs have been appropriately documented.

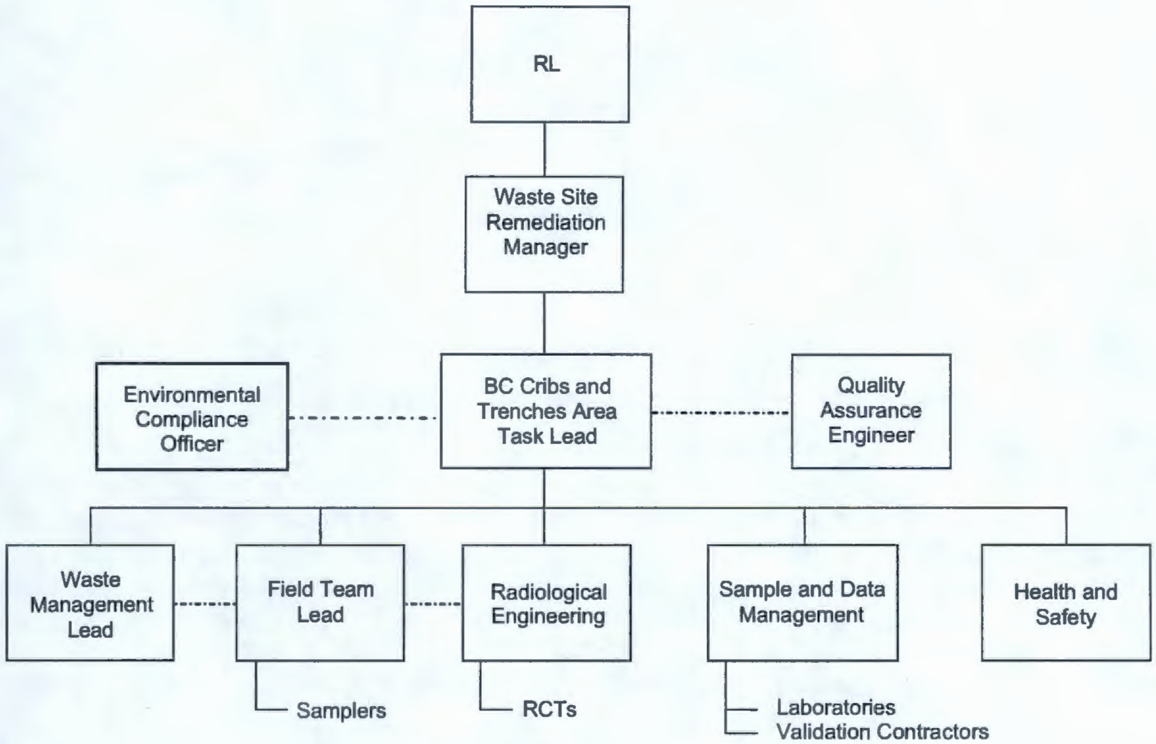
B2.1.1 Project/Task Organization

Fluor Hanford (FH), or its approved subcontractor, is responsible for collecting, packaging, and shipping samples to the laboratory. FH will select a laboratory to perform the analyses. The selected laboratory must conform to Hanford Site laboratory procedures (or equivalent), as approved by RL and the EPA. FH is responsible for managing all interfaces among subcontractors involved in executing the work described in this SAP. The project organization is described in the subsections that follow and is shown in Figure B-4.

Waste Site Remediation Manager. The Waste Site Remediation manager provides oversight for all activities and coordinates with RL, the regulators, and FH management in support of sampling activities. In addition, the Waste Site Remediation manager provides support to the Central Plateau task lead to ensure that work is performed safely and cost effectively. The Waste Site Remediation manager maintains the approved QAPjP.

BC Cribs and Trenches Area Task Lead. The BC Cribs and Trenches Area task lead is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The task lead ensures that the field team lead, samplers, and others responsible for implementation of the SAP and QAPjP are provided with current copies of this document and any revisions thereto. The task lead works closely with the QA and health and safety organizations and the field team lead to integrate these and the other lead disciplines in planning and implementing the scope of work. The task lead coordinates with and reports to RL and FH management on all sampling activities. The task lead supports RL in coordinating sampling activities with the regulators.

Figure B-4. Project Organization.



RCT = radiological control technician.
RL = U.S. Department of Energy, Richland Operations Office.

Environmental Compliance Officer. The Environmental Compliance Officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The Environmental Compliance Officer also reviews plans, procedures, and technical documents to ensure that all environmental requirements have been addressed, identifies environmental issues that affect operations and develops cost-effective solutions, and responds to environmental/regulatory issues or concerns raised by the DOE and/or regulatory staff.

Quality Assurance Engineer. The QA engineer is "matrixed" to the BC Cribs and Trenches Area task lead and is responsible for QA on the project. Responsibilities include oversight of implementation of the project QA requirements; review of project documents including DQO summary reports, SAPs, and the QAPjP; and participation in QA assessments on sample collection and analysis activities, as appropriate.

Waste Management Lead. The Waste Management lead communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner. Other responsibilities include identifying waste management sampling/characterization requirements to ensure regulatory compliance and interpreting the characterization data to generate waste designations, profiles, and other documents that confirm compliance with waste-acceptance criteria.

Field Team Lead. The field team lead has overall responsibility for the planning, coordination, and execution of field characterization activities. Specific responsibilities include converting the sampling design requirements into field task instructions that provide specific direction for field activities. Responsibilities also include directing training, mock-ups, and practice sessions with field personnel to ensure that the sampling design is understood and can be performed as specified. The field team lead communicates with the BC Cribs and Trenches Area task lead to identify field constraints that could affect the sampling design. In addition, the field team lead directs the procurement and installation of materials and equipment needed to support fieldwork.

The field team lead oversees field-sampling activities including sample collection and packaging, provision of certified clean sampling bottles/containers, documentation of sampling activities in controlled logbooks, chain-of-custody documentation, and packaging and transportation of samples to the laboratory or shipping center.

Radiological Engineering. The radiological engineering organization is responsible for the radiological engineering and health physics support for the project. Specific responsibilities include conducting as low as reasonably achievable (ALARA) reviews, exposure and release modeling, and radiological controls optimization for all work planning. In addition, radiological hazards are identified and appropriate controls are implemented to maintain worker exposures to hazards at ALARA levels. Radiological engineering interfaces with the project health and safety representative and plans and directs radiological control technician (RCT) support for all activities.

Sample and Data Management. The Sample and Data Management organization selects the laboratories that perform the analyses. This organization ensures that the laboratories conform to Hanford Site internal laboratory QA requirements (or their equivalent), as approved by RL, the EPA, and the Washington State Department of Ecology. Sample and data management receives the analytical data from the laboratories, performs data entry into the *Hanford Environmental Information System* (HEIS) database, and arranges for data validation.

Health and Safety. The health and safety organization's responsibilities include coordination of industrial safety and health support within the project, as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by Federal regulations or by internal FH work requirements. In addition, assistance is provided to project personnel in complying with applicable health and safety standards and requirements. Personal protective equipment requirements are coordinated with the radiological engineering organization.

B2.1.2 Problem Definition/Background

The problem definition and background information are located in Chapter 1.0 of the treatability test plan. The definition of the problem is reiterated in Section B1.3.1 of this appendix and additional historical, background details are provided in Appendix A.

B2.1.3 Project/Task Description

Sampling and analysis activities in the BC Cribs and Trenches Area waste sites include drilling boreholes for field measurements and collecting soil samples for laboratory analyses. In the

216-B-14 Crib, gamma logging measurements of Cs-137 will be made through the boreholes and soil samples will be collected for laboratory analysis for Cs-137 and Sr-90. In the 216-B-53A Trench, SGL and passive neutron measurements of Cs-137 and Pu-239 will be made through the boreholes and soil samples will be collected for laboratory analysis for isotopic americium and plutonium analyses. The potential for subsidence in the 216-B-14 Crib will be investigated. The radiation field associated with waste containers destined for ERDF will be measured to ensure that waste-acceptance criteria requirements are met. Personal dose-monitoring devices will measure worker dose. The sampling and analysis activities are described in further detail in Chapter B3.0. The data resulting from this SAP ultimately will be reported in a treatability test report and will support the feasibility study.

B2.1.4 Quality Objectives and Criteria

The QA objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality is assessed by accuracy and precision, by evaluation against the identified DQOs, and by evaluation against the work activities identified in this SAP. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method, which are addressed in the following subsections.

Accuracy

Accuracy is an assessment of the closeness of the measured value to the true value. Accuracy of chemical test results may be assessed by spiking samples with known standards and establishing the average recovery. A matrix spike is the addition to a sample of a known amount of a standard compound similar to the compounds being measured. Radionuclide measurements that require chemical separations use this technique to measure method performance. For radionuclide measurements that are analyzed by gamma spectroscopy, laboratories typically compare the results of blind audit samples against known standards to establish accuracy. Validity of calibrations is evaluated by comparing results from the measurement of a standard to known values and/or by generating in-house statistical limits based on three standard deviations (i.e., ±3 SD).

Precision

Precision is a measure of the data spread when more than one measurement has been taken on the same sample. Precision can be expressed as the relative percent difference for duplicate measurements or relative standard deviation for replicate analyses.

Detection Limits

Detection limits are functions of the analytical method used to provide the data and the quantity of the sample available for analyses.

Quality objectives and criteria (including analytical methods, detection limits, and precision and accuracy requirements for each analysis to be performed) are summarized in Table B-5 for field measurements and in Table B-6 for laboratory analyses.

Table B-5. Analytical Performance Requirements for Radiological Field Measurements.

Contaminant of Concern	Chemical Abstracts Service	Preliminary Action Level		Name/Analytical Technology	Target Required Quantitation Limits	Precision Soil (%)	Accuracy Soil (%)
		15 mrem/yr[a] (pCi/g)	ERDF Waste-Acceptance Criteria[b]		Soil-Other Conc.		
Pu-239	N/A	430[a]	N/A	HPGe – SGL	13000 pCi/g[c]	±20	80-120
Cs-137	N/A	750[a]	N/A	NaI – SGL	300 pCi/g	±20	80-120
Exposure/dose rate (beta/gamma emission)	N/A	N/A	80 mR/h	RO-20/RO-03 Portable ionization chamber (microrem)	0.5 mrem/h 10 µrem/h	N/A	80-120
Gamma-emitting radionuclides	N/A	N/A	80 mR/h	Portable NaI detector	6.2 pCi/g	±20	80-120
Gamma-emitting radionuclides	N/A	N/A	N/A	GeLi detector	N/A	N/A	N/A

[a] The preliminary action levels for radionuclides using the 15 mrem/yr = non-rad worker industrial exposure scenario; 2,000 h/yr onsite, 60 percent indoors, 40 percent outdoors are based on the need to determine vertical and lateral extent of contamination. The action levels have been decay corrected based on the assumption that institutional controls will be in place for 150 years.

[b] ERDF waste-acceptance criteria.

[c] HPGe detectors for SGL require a minimum of a 4-in.-diameter borehole. NaI detectors require a minimum of a 2-in.-diameter borehole.

[d] The quantitation limit for Pu-239 using SGL is too high to assess the action limit specified. The spectral gamma data will be useful for showing areas of relative high Pu-239 concentration and whether areas of soil are contaminated at transuranic waste concentrations (>100 nCi/g). Passive neutron analysis will be performed in conjunction with the SGL determinations to provide a semi-quantitative method for determining the lateral extent of Pu-239 contamination at levels below the detection limit for the SGL. Soil samples collected for laboratory analysis will be used to assess the action level.

RO-20 and RO-03 are trademarks of Eberline Instruments, a subsidiary of Thermo Electron Corporation, Waltham Massachusetts.

ERDF = Environmental Restoration Disposal Facility.
GeLi = germanium lithium.
HPGe = high-purity germanium.
N/A = not applicable.
NaI = sodium iodide.
SGL = spectral gamma logging.

Table B-6. Analytical Performance Requirements for Radiological Laboratory Measurements.

Contaminant of Concern	Chemical Abstracts Service	Preliminary Action Level[a]		Name/Analytical Technology	Target Required Quantitation Limits		Precision Soil (%)	Accuracy Soil (%)
		15 mrem/yr (pCi/g)	Groundwater Protection (pCi/g or mg/kg)		Soil – Low Activity[b] (pCi/g)	Soil – High Activity[c] (pCi/g)		
Am-241	14596-10-2	335	N/A	Americium isotopic – AEA	1	4,000	±35	65-135
Cs-137	10045-97-3	23.4	N/A	GEA	0.1	2,000	±35	65-135
Pu-238[e]	13981-16-3	470	N/A	Plutonium isotopic – AEA	1	1,300	±35	65-135
Pu-239/240	Pu-239/240	425	N/A	Plutonium isotopic – AEA	1	1,300	±35	65-135
Sr-90	Rad-Sr	2,410	N/A	Total radioactive strontium – GPC	1	800	±35	65-135

[a] The preliminary action levels for radionuclides are based on 15 mrem/yr = non-rad worker industrial exposure scenario; 2,000 h/yr onsite, 60 percent indoors, 40 percent outdoors and are used to determine appropriate analytical requirements.

[b] Low activity implies a level of radioactivity such that the radioanalytical methods can be performed as designed. The quantitation limits are the typical expected performance using the given technology.

[c] High activity implies a level of radioactivity such that the radioanalytical methods cannot be performed as designed. Some method deviation (e.g., use of a smaller aliquot of soil) must be taken to ensure the health and safety of sampling and/or laboratory personnel. The quantitation limits listed are estimated and provided as an illustration of the variability in the possible quantitation limits that result from high radioactivity in the soil samples collected.

[d] Cs-137 is the only gamma-emitting radionuclide with an action level. However, other detected gamma-emitting radionuclides will be reported during analyses conducted by GEA.

[e] No action level is associated with Pu-238. However, results for this isotope will be reported during analyses conducted for plutonium isotopes by AEA.

AEA = alpha energy analysis.
GEA = gamma energy analysis.
GPC = gas proportional counting.
N/A = not applicable.

B2.1.5 Special Training Certification

The FH team has instituted typical training or certification requirements to meet the training requirements imposed by the FH contract (DE-AC06-96RL13200, *Contract Between the U.S. Department of Energy, Richland Operations Office, and Fluor Hanford, Inc.*), regulations, U.S. Department of Energy (DOE) orders, contractor requirements documents, American National Standards Institute/American Society of Mechanical Engineers standards, the *Washington Administrative Code*, etc. For example: "Training or certification requirements needed by sampling personnel will be in accordance with Hanford Site analytical quality requirements."

The Environmental Health and Safety Training Program provides workers with the knowledge and skills necessary to safely execute assigned duties. Field personnel typically will have completed the following training before starting work:

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training
- 8-Hour Hazardous Waste Worker Refresher Training (as required)
- Radiological Worker Training
- Hanford General Employee Training.

A graded approach is used to ensure that workers receive a level of training that is commensurate with their responsibilities and that complies with applicable DOE orders and government regulations. Specialized employee training includes pre-job briefings, on-the-job training, emergency preparedness, plan-of-the-day activities, and facility/worksite orientations. Field personnel training records will be documented and kept on file by the training organization.

B2.1.6 Documentation and Records

The BC Cribs and Trenches Area task lead ensures that the field team lead, samplers, and others responsible for implementation of this SAP and QAPjP are provided with current copies of this document and any revisions thereto.

Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes that comprise a collection of document control systems and processes that use a graded approach for the preparation, review, approval, distribution, use, revision, storage/retention, retrieval, disposition, and protection of documents and records generated or received in support of FH work.

All information pertinent to field sampling and analysis will be recorded in bound logbooks or appropriate forms or media as directed by procedure. The sampling team will be responsible for recording all relevant sampling information in the logbooks. Entries made in the logbook will be dated and signed by the individual making the entry.

Data collected through sampling will support development and evaluation of remedial alternatives through the feasibility study process. This evaluation will be documented and summarized in the proposed plan. These documents will be prepared in accordance with *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* requirements and guidance and with the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al., 1989). In addition to these formal documents, a contractor-level document will be produced to summarize the field activities and to capture (in a referenceable form) the SGL data collected from the drilling activities. This borehole summary report will be consistent with similar documents prepared for other boreholes.

Primary documents under the Tri-Party Agreement (Ecology et al., 1989) will be submitted to the administrative record. All other documentation will be prepared, approved, and maintained in accordance with RL and contractor requirements for these processes.

B2.2 DATA GENERATION AND ACQUISITION

This section presents the requirements for sampling methods, sample handling and custody, analytical methods, and field and laboratory QC. The requirements for instrument calibration and maintenance, supply inspections, and data management also are discussed.

B2.2.1 Sampling Process Design

The borehole locations will be staked before the field engineer begins drilling. Minor changes in sample locations can be made and documented in the field. More significant changes in sample locations that do not impact the DQOs will require notification and approval of the BC Cribs and Trenches Area task lead. Changes to sample locations that could result in impacts to meeting the DQOs will require RL and lead regulatory concurrence. The field team will note in the daily field sampling logbook any instance when samples cannot be collected because of field conditions, and these events will be discussed in the follow-up borehole summary report. Sample locations may be adjusted based on visual or field-screening methods that may indicate a better sampling location to meet the DQOs (e.g., higher concentrations at a different depth). Additional locations may be sampled based on the judgment of field personnel and the BC Cribs and Trenches Area task lead, based on real-time field conditions. Additional specification regarding sample locations is found in Chapter B3.0 of this appendix.

B2.2.2 Sampling Methods

The borehole sampling associated with this SAP will be performed in accordance with established sampling practices and requirements pertaining to sample collection, collection equipment, and sample handling. These practices include steps to preclude cross contamination of the sample by using disposable pre-cleaned sampling equipment and the cleaning or decontamination of reusable sampling equipment in accordance with internal procedures that are consistent with EPA cleaning protocols. The field team lead and the BC Cribs and Trenches Area task lead are responsible for ensuring that all field procedures are followed completely and that field personnel are trained adequately. The field team lead and the BC Cribs and Trenches

Area task lead must document situations that may impair the usability of the samples and/or data in the field logbook or on nonconformance report forms in accordance with internal corrective action procedures, as appropriate. The field team lead will note any deviations from the standard procedures for sample collection, COCs, sample transport, or monitoring that occurs. The field team lead also will be responsible for coordinating all activities relating to the use of field-monitoring equipment (e.g., dosimeters and industrial hygiene equipment). Field personnel will document in the logbook all pertinent information regarding noncompliant measurements taken during field sampling to facilitate corrective action. Ultimately, the BC Cribs and Trenches Area task lead will be responsible for corrective action when a failure occurs in the sampling or measurement system, for documenting all deviations from procedure, and for ensuring that immediate corrective actions are applied to field activities. Problems with sample collection, custody, or data acquisition that adversely impact the quality of data or impair the ability to acquire data, or failure to follow procedure, shall be documented in accordance with internal corrective action procedures, as appropriate.

B2.2.3 Sample Handling, Shipping, and Custody Requirements

Level I EPA pre-cleaned sample containers will be used for samples collected for radiological analysis. Container sizes may vary depending on laboratory-specific volumes/requirements for meeting analytical detection limits. If, however, the dose rate on the outside of a sample jar or the curie content exceeds levels acceptable by the laboratory, the sampling lead and the BC Cribs and Trenches Area task lead can send smaller volumes to the laboratory after consultation with FH Sample and Data Management to determine acceptable volumes. Table B-7 presents sample preservation, containers, holding times, and sampling method details for chemical and radiological analytes of interest and physical property analyses. Final sample collection requirements will be identified on the Sampling Authorization Form.

Table B-7. Sample Preservation, Container, and Holding Time Guidelines.

Analytes	Matrix	Bottle		Amount (g)*	Preservation	Packing Requirements	Holding Time (Months)
		Number	Type				
Am-241	Soil	1	G/P	10-1000	None	None	6
Cs-137	Soil	1	G/P	100-1500	None	None	6
Pu-238	Soil	1	G/P	10-1000	None	None	6
Pu-239/240	Soil	1	G/P	10-1000	None	None	6
Sr-90	Soil	1	G/P	10-1000	None	None	6

*Optimal volumes, which may be adjusted downward to accommodate the possibility of retrieval of small amount of sample. Minimum sample size will be defined in the chain-of-custody form.

G/P = glass or plastic.

The FH *Sample Data Tracking* database will be used to track the samples from the point of collection through the laboratory analysis process. The HEIS database is the repository for laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project in accordance with onsite organization procedures. Each radiological sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook.

Each sample container will be labeled with the following information using a waterproof marker on firmly affixed, water-resistant labels:

- Sampling Authorization Form
- HEIS number
- Sample collection date/time
- Name of person collecting the sample
- Analysis required
- Preservation method (if applicable).

A custody seal (i.e., evidence tape) will be affixed to the lid of each sample jar in such a way to indicate potential tampering with the sample. The container seal will be inscribed with the sampler's initials and the date.

B2.2.4 Laboratory Sample Custody

Sample custody during laboratory analysis will be addressed in the applicable laboratory standard operating procedures. Laboratory custody procedures will ensure the maintenance of sample integrity and identification throughout the analytical process.

Sample custody will be maintained in accordance with existing Hanford Site protocols. The custody of samples will be maintained from the time that the samples are collected until the ultimate disposal of the samples, as appropriate. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory. Wire or laminated waterproof tape will be used to seal the coolers. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time the responsibility changes for the custody of the sample, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to FH Sample and Data Management within 48 hours of shipping.

The RCT will measure both the contamination levels on the outside of each sample jar and the dose rates on each sample jar. The RCT also will measure the radiological activity on the outside of the sample container (through the container) and will document the highest contact radiological reading in millirem per hour. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation regulations (49 CFR, "Transportation") and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria. The sampler will send copies of the shipping documentation to FH Sample and Data Management within 48 hours of shipping.

B2.2.5 Analytical Methods

Requirements for detection limits, precision, and accuracy are presented in Table B-5 for radiological field measurements and Table B-6 for radiological laboratory measurements. These tables also show the analytical technologies. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this SAP. Offsite laboratories are required to be evaluated and approved for use by FH.

Laboratories providing analytical services in support of this SAP will be responsible for establishing a corrective action program that addresses the following:

- Evaluation of impacts of laboratory QC failures on data quality
- Root cause analysis of QC failures
- Evaluation of recurring conditions that are adverse to quality
- Trend analysis of quality-affecting problems
- Implementation of a quality improvement process
- Control of nonconforming materials that may affect data quality.

Implementation of these corrective action processes will be evaluated as part of periodic laboratory audits by Hanford Site contractors or by the DOE.

The FH Sample and Data Management organization will manage communications with the laboratory. Sample and Data Management will be responsible for communicating the status, issues, corrective actions, and other pertinent laboratory information to the BC Cribs and Trenches Area task lead and the Waste Site Remediation manager. Errors reported by the laboratories are reported to Sample and Data Management, who initiates a Sample Disposition Record. This process is used to document analytical errors and to establish resolution with the project task lead.

B2.2.6 Quality Control Requirements

The QC procedures must be followed in the field and laboratory to ensure that reliable data are obtained. When field sampling is performed, care should be taken to prevent the cross contamination of sampling equipment, sample bottles, and other equipment that could compromise sample integrity.

Field QC samples will be collected to evaluate the potential for cross contamination and laboratory performance. The QC samples and the required frequency for collection are described in this section. The QC samples will be collected as part of the verification and confirmatory sampling activities.

The collection of QC samples for onsite measurements is not applicable to the gamma logging measurements described in this SAP. Field instrumentation will be calibrated and controlled as discussed in Sections B2.2.7 and B2.2.8, as applicable.

The laboratory method blanks, laboratory control sample/blank spike, and matrix spike are defined in Chapter 1 of SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical*

Methods, Third Edition; Final Update III-B, and will be run at the frequency specified in that reference.

Field Duplicates. Field duplicates are independent samples collected as close as possible to the same point in space and time, taken from the same source, stored in separate containers, and analyzed independently. These samples are not to be homogenized together. Field duplicates provide information regarding the variability of the measurement system attributable to the sample collection procedures, the sample matrix, and the precision of the analysis process.

Because previous characterization data show the soil in the 216-B-26 Trench is quite inhomogeneous, anticipated high degree of variability was taken into account in the sampling design. A sufficient number of samples will be collected to establish the variability of the sample. Therefore, no data use is associated with co-located field duplicates, and none of these samples will be collected. For the BC Cribs and Trenches Area waste site treatability test, information to aid in the assessment of laboratory precision will be generated by having the analytical laboratory conduct analyses of two aliquots from a collected soil sample. A minimum of 5 percent of the total collected soil samples will be analyzed in duplicate (i.e., test one sample for every 20 samples).

Equipment Rinsate Blanks. Equipment blanks are typically collected at the same frequency that the duplicate samples are collected, and are used to verify the adequacy of sampling equipment decontamination procedures. Because the action levels associated with this treatability test are relatively high, the impact to decisions is not as great as in trace level analyses. Adequacy of equipment cleaning will be demonstrated by smears and surveys similar to those conducted by RCTs for removal of equipment from contamination zones.

Field Transfer Blanks. Field transfer blanks (i.e., trip blanks) are not required because no sampling for volatile organic analyses is planned.

B2.2.7 Instrument/Equipment Testing, Inspection, and Maintenance

All onsite environmental instruments will be tested, inspected, and maintained in accordance with the manufacturers' operating instructions and in accordance with approved work packages. Results from testing, inspection, and maintenance activities are documented in logbooks and/or work packages.

Analytical laboratory instruments and measuring equipment are tested, inspected, and maintained in accordance with the laboratories' QA plans. Daily response checks for radiological field survey instruments are performed in accordance with approved work packages.

Measurement and testing equipment used in the field or in the laboratory that directly affect the quality of analytical data will be subject to preventive maintenance measures to minimize the downtime of the measurement system. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (e.g., parts lists and documentation of routine maintenance) will be included in the individual laboratories and the onsite organization's QA plans or operating procedures (as appropriate). Calibration of laboratory instruments will be performed in a manner consistent with SW-846 or with auditable DOE Hanford Site-wide and contractual requirements. The calibration of radiological field instruments is discussed in Section B2.2.8.

Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use. Note that contamination is monitored using the QC sample process discussed in Section B2.2.

B2.2.8 Instrument/Equipment Calibration and Frequency

All onsite environmental instruments are calibrated in accordance with the manufacturers' operating instructions, internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from all instrument calibration activities are recorded in logbooks and/or work packages.

Equipment expected to be used include a sodium iodide (NaI) detector gamma logging system (for small-diameter boreholes), high-purity germanium detector (HPGe) SGL system, a passive neutron logging system, and various portable radiation control monitoring equipment. The borehole logging equipment is calibrated (at least) annually on the Hanford Calibration Models located near the weather station. Portable radiation control monitoring equipment is calibrated by the Pacific Northwest National Laboratory.

Analytical laboratory instruments and measuring equipment are calibrated in accordance with laboratories' QA plans. Calibration of radiological field survey instruments on the Hanford Site is performed under contract by Pacific Northwest National Laboratory on an annual basis, as specified in the Laboratory's program documentation.

B2.2.9 Inspection/Acceptance of Supplies and Consumables

Supplies and consumables procured by FH that are used in support of sampling and analysis activities are procured in accordance with internal work requirements and processes that describe the FH acquisition system and the responsibilities and interfaces necessary to ensure that structures, systems, and components, or other items and services procured/acquired for FH, meet the specific technical and quality requirements. The procurement process ensures that purchased items and services comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users before use.

Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratories' QA plans.

B2.2.10 Nondirect Measurements

Nondirect measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. Nondirect measurements will not be evaluated as part of this activity.

B2.2.11 Data Management

Data resulting from the implementation of this SAP will be managed and stored in accordance with applicable programmatic requirements governing data management procedures. At the direction of the BC Cribs and Trenches Area task lead, all analytical data packages shall be subject to final technical review by personnel assigned by the project before the results are submitted to the regulatory agencies or before inclusion in reports. Electronic data access, when appropriate, shall be via a database (e.g., HEIS or a project-specific database). Where electronic data are not available, hard copies shall be provided in accordance with Section 9.6 of the Tri-Party Agreement (Ecology et al., 1989).

Planning for sample collection and analysis shall be in accordance with the programmatic requirements governing fixed-laboratory sample collection activities, as discussed in the sampling teams' procedures. In the event that specific procedures do not exist for a particular work evolution, or if additional guidance to complete certain tasks is needed, a work package will be developed to adequately control the activities, as appropriate. Examples of the sample teams' requirements include activities associated with the following:

- Chain-of-custody/sample analysis requests
- Project and sample identification for sampling services
- Control of certificates of analysis
- Logbooks and checklists
- Sample packaging and shipping.

Approved work control packages and procedures will be used to document radiological measurements when implementing this SAP. Examples of the types of documentation for field radiological data include the following:

- Instructions regarding the minimum requirements for documenting radiological controls information in accordance with 10 CFR 835, "Occupational Radiation Protection"
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of Hanford Site radiological records
- The minimum standards and practices necessary for preparing, performing, and retaining radiological-related records
- Indoctrination of personnel on the development and implementation of survey/sample plans
- The requirements associated with preparing and transporting regulated material.

Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpretation of the investigation results.

Errors reported by the laboratories are reported to the Sample and Data Management project coordinator, who initiates a Sample Disposition Record. This process is used to document analytical errors and to establish resolution with the project task lead.

B2.3 ASSESSMENT AND OVERSIGHT

Assessment and oversight activities evaluate the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

B2.3.1 Assessments and Response Action

The FH QA group may conduct random surveillance and assessments to verify compliance with the requirements outlined in this SAP, project work packages, the project quality management plan, procedures, and regulatory requirements.

Deficiencies identified during these assessments shall be reported in accordance with existing programmatic requirements. The QA group coordinates the reporting of deficiencies in accordance with FH's QA program. When appropriate, corrective actions will be taken by the project engineer and/or task lead.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. Fluor Hanford conducts oversight of offsite analytical laboratories to qualify them for performing Hanford Site analytical work.

No assessments have been specifically planned for this task.

B2.3.2 Reports to Management

Reports to management on data quality issues will be made if and when these issues are identified. These issues will be reported by laboratory personnel to the Sample and Data Management group, which then will communicate the issues to the BC Cribs and Trenches Area task lead and manager. Subsequently, standard reporting protocols (e.g., project status reports) will be used to communicate these issues to management. Because performance or system assessments are not planned as part of this activity, the BC Cribs and Trenches Area task lead will not be providing audit or assessment reports to management for this activity, unless an unanticipated request is made to conduct such an assessment. At the end of the project, a data quality assessment report will be prepared to evaluate whether the type, quality, and quantity of data that were collected meet the intent of the DQOs and SAP.

B2.4 DATA VALIDATION AND USABILITY

Data validation and usability activities occur after the data-collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying project objectives. Data will be accepted, rejected, or qualified.

B2.4.1 Data Review, Verification, and Validation

The criteria for verification include, but are not limited to, review for completeness (all samples were analyzed as requested), use of the correct analytical method/procedure, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Laboratory personnel may perform data verification.

Data validation will be performed to ensure that the data quality goals established during the planning phase have been achieved. As recommended in EPA guidance (Bleyler 1988a, *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*; Bleyler 1988b, *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*), the criteria for data validation are based on a graded approach. The primary contractor has defined five levels of validation, A – E. Level A is the lowest level and is the same as verification. Level E is a 100 percent review of all data (e.g., calibration data, calculations of representative samples from the dataset).

Validation will be performed to contractor Level C. Level C validation is a review of the QC data and specifically requires verification of deliverables and requested versus reported analyses and qualification of the results based on analytical holding times, method blank results, matrix spike/matrix spike duplicate, surrogate recoveries, duplicates, and analytical method blanks. Level C validation will be performed on at least 5 percent of the data by matrix and analyte group. Analyte group refers to categories, such as radionuclides, volatile chemicals, semivolatiles, polychlorinated biphenyls, metals, and anions. The goal is to cover the various analyte groups and matrices during the validation.

Relative to analytical data in sample media, physical data and/or field screening results are of lesser importance in making inferences of risk. Because of the secondary importance of such data, no validation for SGL results will be performed. However, field QA/QC will be reviewed to ensure that the data are useable.

B2.4.2 Verification and Validation Methods

Validation activities will be based on EPA functional guidelines (Bleyler 1988a; Bleyler 1988b). Data validation may be performed by the analytical laboratory, Sample and Data Management, and/or by a party independent of both the data collector and the data user.

When outliers or questionable results are identified, additional data validation will be performed. The additional validation will be performed for up to 5 percent of the statistical outliers and/or questionable data. The additional validation will begin with Level C and may increase to Levels D and E as needed to ensure that the data are usable. Note that Level C validation is a review of the QC data, while Levels D and E include review of calibration data and calculations of representative samples from the dataset. All data validation will be documented in data validation reports. An example of questionable data is the positive detections greater than the practical quantitation limit or reporting limit in soil from a reference site that should not have exhibited contamination. Similarly, results below background would not be expected and could trigger a validation inquiry. The determination of data usability will be conducted and documented in the data quality assessment.

All data validation will be documented in data validation reports, which will be provided to the Sampling Coordinator. The Sampling Coordinator is responsible for distributing the data validation report as necessary.

B2.4.3 Reconciliation with User Requirements

The data will be reviewed to determine whether the DQOs were met with regard to precision, accuracy, and completeness. Conclusions will be drawn whether the data are of sufficient quality and quantity to estimate the amount of material requiring removal (i.e., define the lateral and vertical extent of the excavations), to calculate a predicted dose that remediation workers will receive in Phase 2 of the treatability test, and to correlate the total curie content of Cs-137 in the trench as determined by measurements and estimates of contaminated volume with the total curie content predicted by the SIM (RPP-26744).

This page intentionally left blank.

B3.0 FIELD-SAMPLING PLAN

B3.1 SAMPLING OBJECTIVES

This field-sampling plan is based on the sampling design developed during the DQO process (Appendix A) and describes the pertinent elements of the sampling program. This section identifies sample methods, procedures, locations, and frequencies for the data collection efforts associated with the treatability test.

Field-sampling objectives for this SAP include the following.

- Determine the vertical and lateral extent of near-surface contamination of Cs-137 and Sr-90 in the 216-B-14 Crib.
- Determine the vertical and lateral extent of near-surface contamination of transuranic radionuclides (primarily Pu-239/240) in the 216-B-53A Trench.
- Determine dose received during treatability test operations for RTD of near-surface contamination at the BC Cribs and Trenches Area waste sites.
- Examine and document a remnant crib structure for possible subsidence.
- Measure radiation levels of waste containers filled with soil removed from the excavations during the treatability test at the 216-B-26 Trench, 216-B-53A Trench, and 216-B-14 Crib to ensure that ERDF waste-acceptance criteria requirements are met.

The design of the treatability test allows work to be completed in phases. If data collected from one or more phases of the test are deemed adequate to provide sufficient data and information to complete the evaluation of the partial RTD remedial-action alternative, subsequent phases of the test may be decreased in scope or deemed unnecessary. The decision whether and when to eliminate or abbreviate phases will be determined by mutual agreement between RL and the EPA. The sampling design described in this section includes criteria that will guide determining if and when subsequent phases of the test will be initiated. However, the sampling design also allows for activities common to multiple phases to be conducted simultaneously. For example, the characterization activities associated with Phase 3 and Phase 4 of the test may be completed before initiation or during excavation associated with Phase 2.

B3.2 TREATABILITY TEST PHASE 1: 216-B-26 TRENCH CHARACTERIZATION

Phase 1 of the test involves characterization of the 216-B-26 Trench using boreholes. The sampling and analysis activities for Phase 1 are not included in this appendix but are addressed in a separate SAP (DOE/RL-2007-14).

B3.3 TREATABILITY TEST PHASE 2: 216-B-26 TRENCH EXCAVATION

Excavation in the 216-B-26 Trench to partially remove, treat, and dispose of near-surface contaminated soil will not begin until completion of the characterization activities described in DOE/RL-2007-14 and evaluation of the data obtained during that phase. The data from characterization of the 216-B-26 Trench will be reviewed to update the Cs-137 inventory in the entire trench. The data also will be used to update the calculation used to predict the dose to workers during excavation operations. The updated calculations of expected worker dose are necessary to finalize the equipment requirements and excavation plans to address ALARA principles before initiation of excavation operations.

Initial excavation plans call for excavation of a one-third section of the trench. The specific section to be excavated will be determined after review of characterization data. The section of the trench to be excavated will be determined based on operational, safety, and logistical factors. The decision concerning which section to excavate will be discussed and agreed to between RL and EPA at unit managers' meetings.

If soil staining or some other unexpected feature associated with the waste stream is encountered during excavation of the first third of the 216-B-26 Trench, DOE and EPA will be notified and its characteristics will be documented via photographs, placement with respect to depth and position within the trench, and notes describing soil texture, color, dimensions, extent, etc. That feature will not be sampled. However, the documentation is expected to be sufficient such that if future sampling is desired, a similar feature could be located in another portion of the trench for sampling.

Excavation will focus on the most highly contaminated soil that requires down-blending and adjacent soil not requiring down-blending. The intent of excavation is not to remove all soil contamination exceeding the potential action level, but to collect information to update the worker dose and cost estimates. It is believed that sufficient information can be obtained without "chasing" the contamination until all soil exceeding the Cs-137 and/or Sr-90 action levels is removed. During excavation, detailed notes and observations will be made concerning the methods used to excavate the trench and down-blend contaminated soil. These notes will become the basis for documenting the various techniques that are used during excavation. When methods are changed, the dates and times of the changes will be noted. As contaminated soil is encountered, it will be down-blended with less contaminated soil (if necessary) and placed in waste boxes for transport to ERDF. During all operations, dose information will be collected using personal monitoring dosimetry. Supplemental personal dosimetry will be used to measure the doses associated with specific activities.

After completion of excavation in one-third of the trench, the excavation notes and dosimetry data will be evaluated. The dose received will be compared to the level of contamination encountered and the excavation, treatment, and disposal techniques developed. The results of this evaluation will be discussed with RL and the EPA. The decision makers will determine if enough information has been collected to support decision making concerning remediation of near-surface contaminated soil in the trenches in the BC Cribs and Trenches Area waste sites. If the decision makers determine that excavation of additional sections of the 216-B-26 Trench would add benefit in determining the feasibility of partial RTD at the trenches in these waste sites, Phase 2 will proceed to another one-third section of the trench until sufficient data are collected. When sufficient data have been collected to support decisions concerning the feasibility of this remedial alternative, Phase 2 will be complete.

B3.4 TREATABILITY TEST PHASE 3: 216-B-14 CRIB CHARACTERIZATION AND EXCAVATION

The characterization and excavation in the 216-B-14 Crib will excavate near-surface contaminated soil and evaluate the potential for subsidence in the cribs. Excavation will not begin until completion of characterization activities for the crib.

Characterization of the subsurface soil associated with the 216-B-14 Crib will provide Cs-137 concentration data as a function of depth using gamma logging. The boreholes will be installed to a depth of 7.6 m (25 ft) using a direct-push drilling technique. The gamma logging instrument will be inserted in the casing of each borehole, and measurements will be made at 0.15 m (0.5-ft) intervals. The gamma logging instrument provides a measurement that is reported in units of picocuries per gram. The concentration reported represents the average soil concentration associated with the soils considered to be within the region of influence on the instrument's detector. This region varies as a function of many factors, but the primary factors are soil composition (chemistry), soil density, and the thickness of the drill casing through which the measurements are made. The personnel performing the measurements and gamma logging data reduction and reporting functions have significant experience with making these measurements at Hanford waste sites.

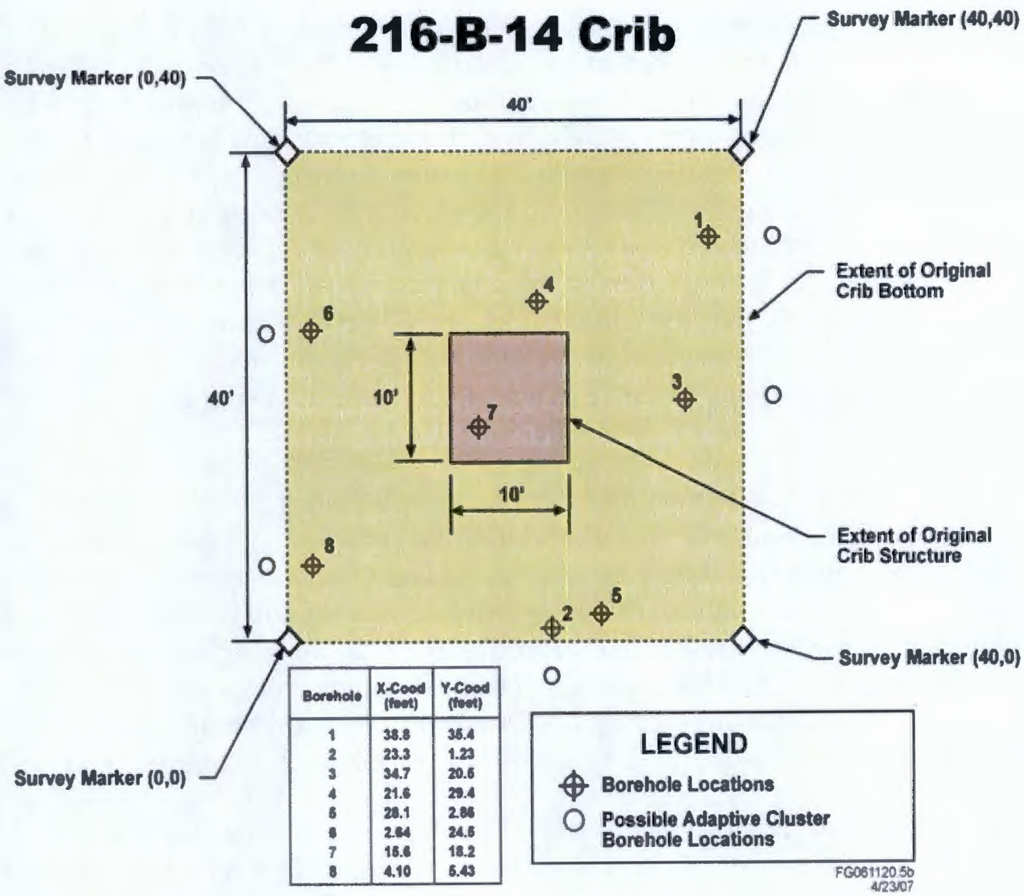
To provide some confirmation of the Cs-137 measurements made by gamma logging, and to provide a means for determining Sr-90 concentration as a function of depth, soil samples will be collected from three depths from boreholes drilled as close as possible to the gamma logging boreholes. The depths from which soil samples will be collected will be determined after reviewing the gamma logging data using the same random sampling strategy employed for Phase 1 soil sampling of the 216-B-26 Trench. Data will provide a measure of Sr-90 concentrations and corroborate the logging measurements. The soil samples will be sent for laboratory analysis for gamma-emitting radionuclides and total radioactive strontium.

Eight boreholes will be installed using a random-sampling design throughout the crib (Figure B-5). This random-sampling design requires that survey benchmarks be established at the ground surface directly above the four corners of the crib. One benchmark will be used as an origin (grid coordinates 0, 0) from which all other sample locations are determined (Figure B-5).

When the data collected from all boreholes installed in the crib have been reduced and reported, at least one borehole location close to the edge of the crib (i.e., borehole 1, 2, 3, 5, 6, or 8) will be used as a benchmark for a set of adaptive-cluster sampling boreholes. The first adaptive-cluster sampling borehole associated with each benchmark borehole selected will be installed at a location approximately 1.8 m (6 ft) directly outside the 12.2 by 12.2 m (40- by 40-ft) crib structure (Figure B-5). If Cs-137 activity is detected in the first 4.6 m (15 ft) bgs by gamma logging at a concentration greater than 750 pCi/g in any adaptive-cluster sampling borehole, another borehole will be installed approximately 0.6 m (2 ft) further from the benchmark borehole. This will continue until an adaptive-cluster sampling borehole is installed where Cs-137 is not detected at more than approximately 750 pCi/g in the first 4.6 m (15 ft) bgs. No soil sampling will be performed in conjunction with the adaptive-cluster holes.

If any of the initial adaptive-cluster sampling boreholes show no Cs-137 activity greater than 750 pCi/g in the first 4.6 m (15 ft) bgs, then adaptive-cluster sampling boreholes will be installed closer to the benchmark borehole along the same line as the first adaptive-cluster borehole until Cs-137 activity is detected at more than 750 pCi/g (±10 percent) in the 0 to 4.6 m (0 to 15 ft) bgs interval. The project manager will determine how much closer to the benchmark borehole the subsequent adaptive-cluster borehole should be installed when this occurs.

Figure B-5. Random and Adaptive-Cluster Sampling Designs for the 216-B-14 Crib.



Borehole	X-Cood (feet)	Y-Cood (feet)
1	38.8	35.4
2	23.3	1.23
3	34.7	20.6
4	21.6	29.4
5	28.1	2.86
6	2.64	24.5
7	15.6	18.2
8	4.10	5.43

The data will be reviewed to update the total Cs-137 inventory in the crib. The data also will be used to update the calculation used to predict the worker dose that will be received during treatability test Phase 3 operations. The updated calculations of expected worker dose are necessary to finalize excavation plans to address ALARA principles before initiation of Phase 3 excavation.

After characterization data have been reviewed, the decision makers will evaluate three criteria to determine whether excavation of the 216-B-14 Crib will be of benefit in evaluating the alternative of partial RTD:

- The trench excavation associated with Phase 2 of the test and whether the experience gained there is considered sufficiently characteristic of excavation in a crib
- The results of subsurface 216-B-14 Crib characterization and whether it provides a good estimate of the nature and extent of contamination
- The value of assessing the potential for crib subsidence by exposing one of the existing structures.

If the decision makers conclude that excavation of a crib would not benefit the evaluation of the partial RTD remedial-action alternative for the BC Cribs and Trenches Area, then Phase 3 will be completed after the characterization activities performed using direct-push boreholes. If excavation is not performed, the test will move to Phase 4.

If excavation of the crib is performed, it will include efforts to characterize the potential for the present crib structures to fail, allowing subsidence to occur at the surface. During excavation, detailed notes and observations and photographic documentation will be collected concerning the condition of the crib structure. Detailed notes will be made concerning the methods used to excavate the crib and down-blend contaminated soil. These notes will become the basis for documenting the various techniques used during excavation. When methods are changed, the dates and times of the changes will be noted. Excavation will focus on the most highly contaminated soil that requires down-blending and adjacent soil not requiring down-blending. The intent of excavation is not to remove all soil contamination exceeding the potential action level, but to collect information to update the worker dose and cost estimates. It is believed that sufficient information can be obtained without "chasing" the contamination until all soil exceeding the Cs-137 and/or Sr-90 action levels is removed. As contaminated soil is encountered, it will be down-blended with less contaminated soil (if necessary) and placed in waste boxes for transport to ERDF. During all operations, dose information will be collected using personal monitoring dosimetry, including supplemental dosimetry to collect activity-specific dose information.

As excavation of the crib proceeds, notes and dosimetry data will be evaluated. The dose received will be compared to the level of contamination encountered and to the excavation, treatment, and disposal techniques developed during Phase 3. The results of this evaluation will be discussed with DOE and the EPA. The decision makers will determine if enough information has been collected to support decision making concerning remediation of near-surface contaminated soil in the cribs in the BC Cribs and Trenches Area waste sites using partial RTD. If, during excavation, the decision makers determine that excavation at the 216-B-14 Crib no longer is benefiting the determination of the feasibility of partial RTD of the cribs in the BC Cribs and Trenches Area, Phase 3 will be complete and activities will move to Phase 4 of the test.

B3.5 TREATABILITY TEST PHASE 4: 216-B-53A TRENCH CHARACTERIZATION AND EXCAVATION

Phase 4 of the treatability test involves characterization and excavation in the 216-B-53A Trench. The excavation will partially remove, treat, and dispose of near-surface plutonium-contaminated soil. The excavation will not begin until characterization activities have been completed for the trench.

Data to characterize the Pu-239 concentration as a function of depth will be collected using the high resolution spectral gamma logging system equipped with a high purity germanium (HPGe) detector to detect and quantify Pu-239 on the basis of characteristic gamma emissions. A passive neutron log also will be used to detect neutron activity originating from alpha,n reactions between transuranic and light elements (such as oxygen or nitrogen) and, to a lesser degree, neutrons originating from spontaneous fission (e.g. Pu-240). Because the HPGe detector requires a larger borehole diameter, the boreholes installed down the centerline of the 216-B-53A Trench will be 10 cm (4 in.) in diameter. The boreholes will be installed using a direct-push drilling technique. Both high resolution spectral gamma logs and passive neutron logs will be run, with stationary measurements at 0.5 ft intervals.

The passive-neutron log detects thermal neutrons resulting from (α, n) reactions caused by alpha particles interacting with various light elements (oxygen, nitrogen or fluorine) with which they may be associated. Because the Pu-239 associated with the 216-B-53A Trench likely is oxidized, the neutron flux resulting from (α, n) reactions may be relatively low. In areas of high gamma activity, it is likely that the passive neutron detector may be subject to interference from gamma rays.

Because the action limit associated with the lateral extent of contamination for the 216-B-53A Trench is 430 pCi/g of Pu-239, and the HPGe SGL will have an instrument detection limit of approximately 13,000 pCi/g (assuming the anticipated low gamma field from various fission products), the data correlating Pu-239 concentration with passive neutron results down the centerline of the trench, and the soil sampling data, will be used to estimate when the 430 pCi/g lateral extent of contamination has been reached in the adaptive-cluster sampling boreholes installed away from the center of the trench. Thus, the extent of lateral Pu-239 spread will be determined using a combination of SGL and passive neutron logging that is correlated to soil sampling data.

Soil samples will be collected from three depths from eight randomly selected boreholes to provide some confirmation of the Pu-239 measurements made by the SGL instrument, provide a means for determining Pu-239 concentrations that are less than detection levels using SGL instrumentation, and to determine an approximate correlation between passive neutron measurements and total transuranic concentration in the soil. The depths from which soil samples will be collected will be determined after reviewing the logging data using the same random strategy employed for Phase 1 sampling of the 216-B-26 Trench. Data will provide a measure of Pu-239, Cs-137 and Sr-90 concentrations at these depths. The soil samples will be sent for laboratory analysis for plutonium isotopes and Am-241.

It is known that the trench was divided in half by a berm in the center of the trench. Therefore, it is possible that different amounts of waste were received in each half of the trench. Because of this, a mean inventory of Pu-239 will be estimated using the mean concentration (and assumed volume of contaminated soil) determined for each half of the trench. The exact location of the berm is not known, but the waste-site description for the trench states that the trench "was divided into two sections by an earthen dam at the center that was 1.5 m (5 ft) high and 0.1 m (0.3 ft) wide at its top" (DOE/RL-2004-66, Draft A).

Eight boreholes will be installed through the bottom of each half of the trench. Also as stated in Appendix A, systematic random sampling was chosen to ensure that a large portion of the trench floor would not go unrepresented by the sample collected. To ensure that any variability associated with lateral distance from the centerline of the trench bottom is adequately characterized by the sample, a random component is added to the sampling design in these directions. The systematic component of the random-sampling design requires that the node line along which the first approximately 10 cm (4-in.) borehole will be located in each half of the trench be selected randomly, and that the subsequent boreholes are randomly located on additional node lines that are equal distances apart (Figure B-6). The node lines will have nine nodes at which a borehole may be installed. The nodes on each node line will be 0.3 m (1 ft) apart, with one node on the centerline and four others on each side of the centerline (Figures B-7 and B-8). The boreholes will be installed at locations defined by specifying the distance from survey markers placed on the surface above the centerline of the trench that the node lines are drawn and installing the borehole at one of the randomly selected nodes.

Figure B-6. Random and Adaptive-Cluster Sampling Designs for the 216-B-53A Trench.

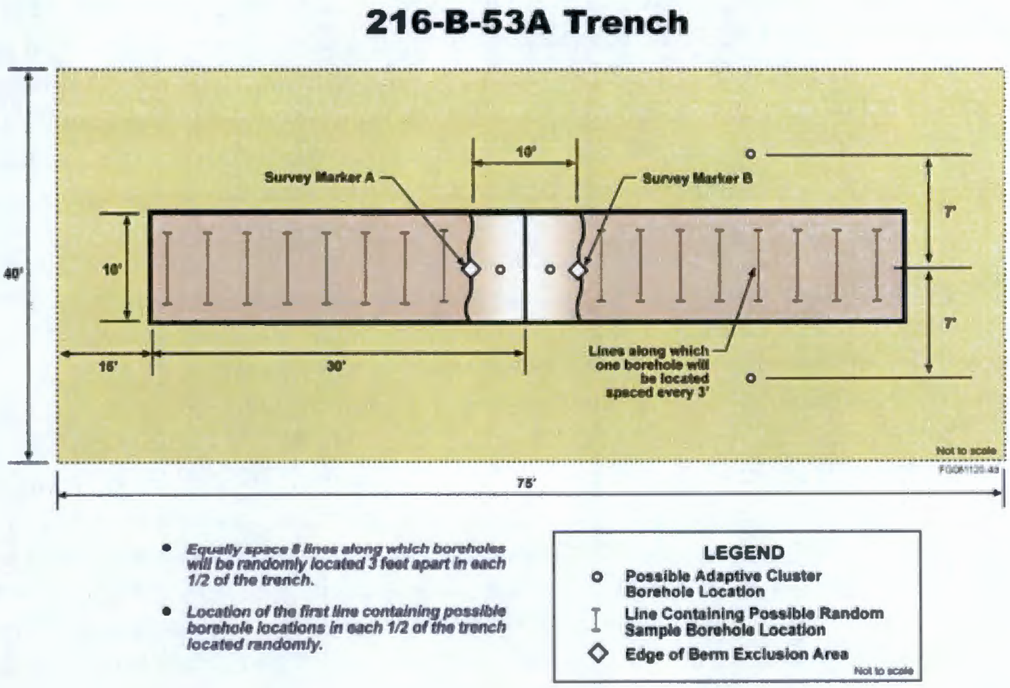


Figure B-7. Western Half of the 216-B-53A Trench Showing the Sample Node Lines and all Possible Locations for Randomly Locating Boreholes Along Those Lines.

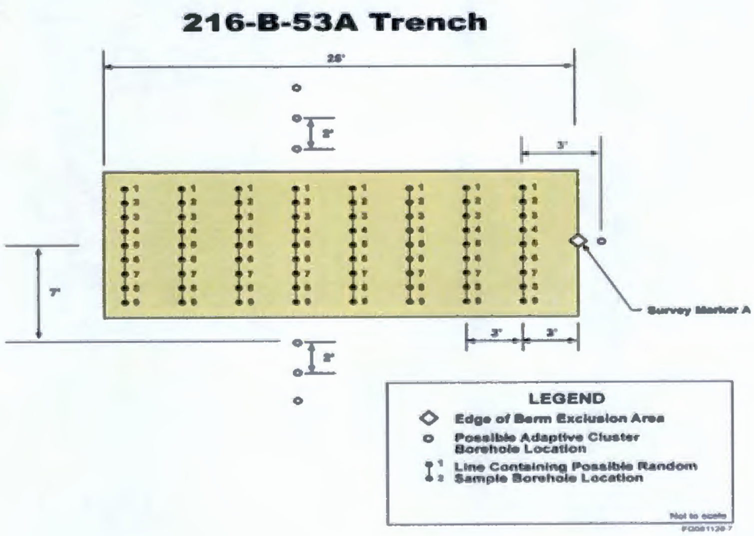
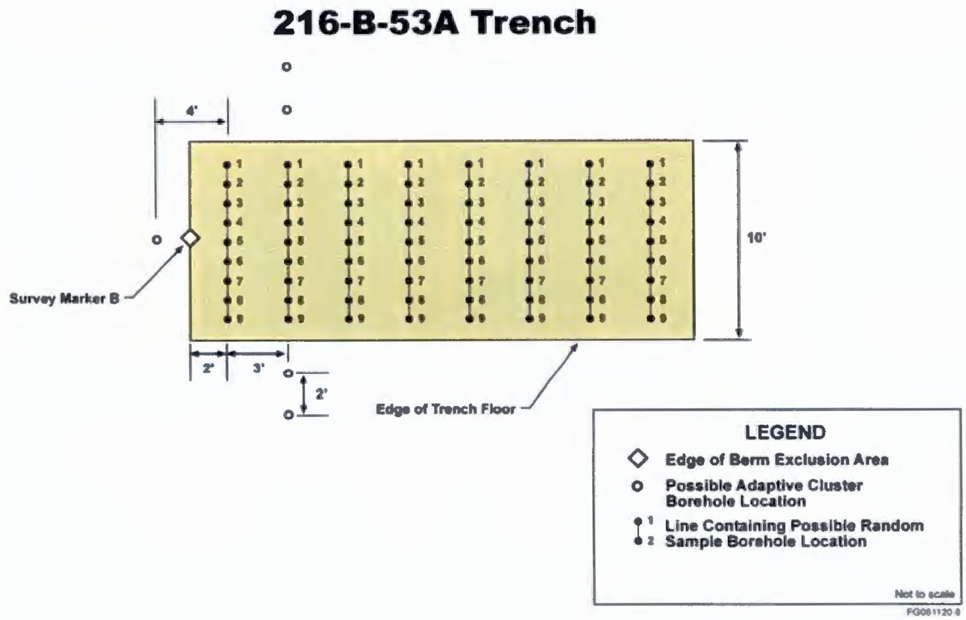


Figure B-8. Eastern Half of the 216-B-53A Trench Showing the Sample Node Lines and all Possible Locations for Randomly Locating Boreholes Along Those Lines.



A survey stake (or alternative suitable markers) marking the centerline of the trench will be placed on each end of the trench and at a distance of 9.1 m (30 ft) from one end. The marker at 9.1 m (30 ft) will be assumed to locate the top of the berm. To eliminate the possibility of intersecting the berm, an exclusion area 3 m (10 ft) wide will be delineated in which no boreholes will be installed. Survey markers (survey Markers A and B) will be placed on the present ground surface at points above the centerline of the trench 1.5 m (5 ft) on either side of the marker that indicates the assumed location of the berm top (Figure B-6). The markers that delineate the exclusion zone (survey Markers A and B) will be used as benchmark locations from which the systematic component of the random-sampling design will originate. A random number generator was used to select the distance to the first node line, which is drawn perpendicular to the centerline of the trench in each half of the trench, and to select the node through which the first approximately 10 cm (4-in.) diameter borehole will be installed. Each subsequent approximately 10 cm (4-in.) borehole will be installed at a randomly selected node that lies on the equally spaced node lines (Figures B-7 and B-8). That is, all of the node lines will be equal distances from the line preceding it. The systematic random-sampling design will start using survey Marker A (Figure B-7) as a benchmark, and node lines perpendicular to the centerline of the trench will be drawn at 0.9, 1.8, 2.7, 3.6, 4.6, 5.5, 6.4, and 7.3 m (3, 6, 9, 12, 15, 18, 21, and 24 ft) away from survey Marker A toward the west end of the trench. The boreholes will be installed at the nodes indicated in Table B-8.

After the SGL and passive-neutron measurements in these boreholes have been completed, measurements will continue using survey Marker B as the origin benchmark. Boreholes will be installed along node lines drawn perpendicular to the centerline of the trench at points 0.6, 1.5, 2.4, 3.4, 4.3, 5.2, 6.1, and 7.0 m (2, 5, 8, 11, 14, 17, 20, and 23 ft) away from Marker B toward the east end of the trench (Figure B-8). The boreholes will be installed at the nodes indicated in Table B-8. Figure B-9 depicts a scale drawing of the trench floor showing the sample node lines and the randomly selected nodes for locating boreholes in the western half of the 216-B-53A Trench. Figure B-10 depicts a scale drawing of the trench floor showing the sample node lines and the randomly selected nodes for locating boreholes in the eastern half of the 216-B-53A Trench.

Table B-8. Borehole Locations in the 216-B-53A Trench.

Borehole Locations in the Western Half of the 216-B-53A Trench			
Distance of Node Line from Survey Marker A (ft)	**Sample Node**	**Distance from Centerline Node 5 (ft)**	**Direction from Centerline Node 5**
3.0	6	1	South
6.0	1	4	North
9.0	9	4	South
12	4	1	North
15	7	2	South
18	7	2	South
21	1	4	North
24	7	2	South
Borehole Locations in the Eastern Half of the 216-B-53A Trench			
Distance of Node Line from Survey Marker B (ft)	**Sample Node**	**Distance From Centerline Node 5 (ft)**	**Direction From Centerline Node 5**
2.0	9	4	South
5.5	8	3	South
8.0	7	2	South
11	2	3	North
14	5	0	N/A
17	7	2	South
20	8	3	South
23	5	0	N/A

N/A = not applicable.

Figure B-9. Sample Node Lines and the Randomly Selected Nodes for Locating Boreholes in the Western Half of the 216-B-53A Trench.

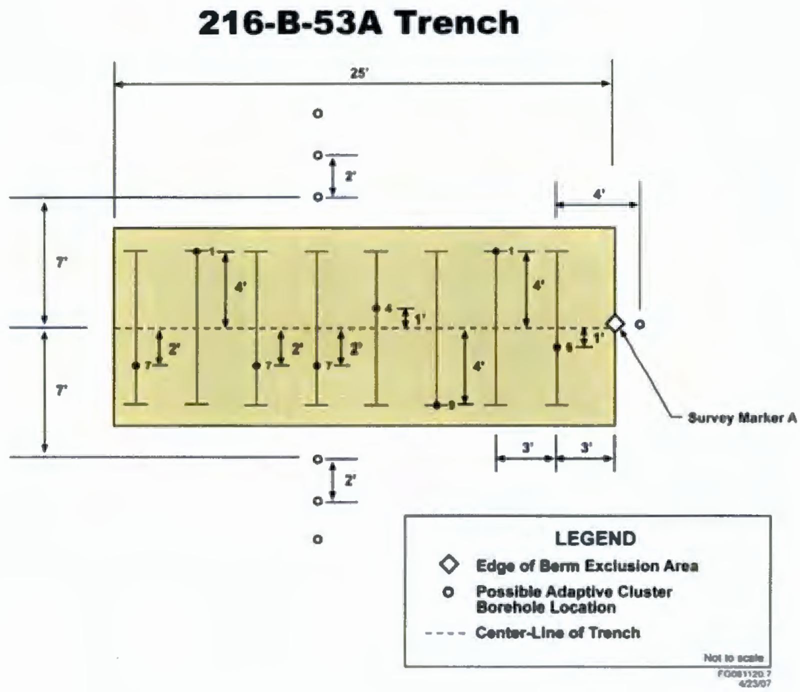
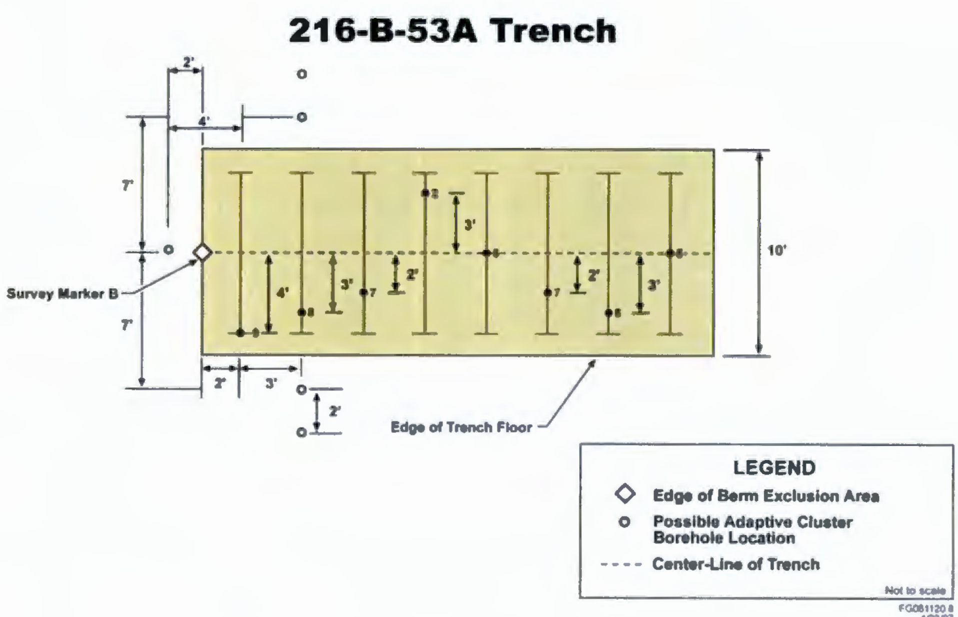


Figure B-10. Sample Node Lines and the Randomly Selected Nodes for Locating Boreholes in the Eastern Half of the 216-B-53A Trench.



After SGL and passive neutron logging data have been reviewed for the 16 boreholes installed, eight borehole locations will be randomly selected for sampling. Soil sampling will utilize a separate hole located approximately 0.40 m (16 in.) toward the axis of the trench from the logging borehole. For the logging borehole located on the trench axis in the eastern half of the trench, the sampling borehole will be located to the north. Three soil samples will be collected from each sampling borehole, with the first sample in each borehole randomly collected from a depth range comprising the initial 0.61-0.91 m (2-3 ft) of significant contamination. The next two samples from each hole will be collected at approximately 0.76 m (2.5 ft) intervals. The interval will be selected to ensure that the depth range of expected samples covers the depth range of significant near-surface contamination.

When the data from the all boreholes installed to characterize the bottom of the trench have been reduced and reported, at least one of the node 5 locations from each half of the trench will be used as a benchmark for a set of adaptive-cluster sampling boreholes. The first two adaptive-cluster sampling boreholes will be installed at locations on extensions of the node line approximately 2.1 m (7 ft) away from the centerline of the trench (i.e., away from node 5) in both directions. Because only passive neutron measurements will be made in the adaptive-cluster boreholes in the 216-B-53A Trench, these boreholes may be installed with an approximately 5 cm (2-in.) diameter.

Appendix A describes the basis for action limits associated with determining the lateral extent of contamination in the cribs and trenches. For the 216-B-53A Trench, the applicable action limit is 430 pCi/g of Pu-239 within the first 4.6 m (15 ft) bgs. If passive neutron activity is detected in any adaptive-cluster sampling borehole at a level that would indicate presence of Pu-239 at more than 430 pCi/g in the 0 to 4.6 m (0 to 15 ft) bgs interval, another approximately 5 cm (2-in.) diameter borehole will be installed along the same line that the first adaptive-cluster borehole was installed, 5 cm (2 ft) further from the benchmark borehole. This will continue until an adaptive-cluster sampling borehole is installed where passive neutron data indicate Pu-239 either is not detected or definitely is less than 430 pCi/g throughout the 0 to 4.6 m (0 to 15 ft) interval bgs.

If any of the initial adaptive-cluster sampling boreholes shows no passive neutron activity, then adaptive-cluster sampling boreholes may be installed closer to the benchmark borehole along the same line as the first adaptive-cluster borehole until passive neutron activity is seen to approach an estimated 430 pCi/g within the first 4.6 m (15 ft) bgs. The project manager will determine how much closer to the benchmark borehole the subsequent adaptive-cluster borehole should be installed when this occurs. The project manager also will determine whether passive neutron activity measured slightly higher than that estimated to indicate Pu-239 approaching 430 pCi/g within the first 4.6 m (15 ft) bgs is close enough to define the lateral extent of contamination or if additional boreholes are required. Only passive neutron measurements will be collected in each of the adaptive-cluster boreholes. No soil samples will be collected from the adaptive-cluster boreholes. The survey locations for all boreholes installed will be concatenated with analytical results using the sample numbering and detailed field logbook procedures specified in Section B2.2.

To calculate an estimate of the total inventory of transuranic isotopes in the trench, an estimate of the volume of contaminated soil is required. The location of the berms is not precisely known. Therefore, node 5 on the line perpendicular to the centerline of the trench that is closest to the berm exclusion area also will be used as a benchmark for adaptive-cluster sampling. Additional adaptive-cluster sampling holes will be installed along the centerline of the trench 1.2 m (4 ft) away from node 5 on the first perpendicular line used to define borehole locations (i.e., the node 5 that is closest to the berm) in each end section of the trench. These boreholes will be installed in the direction toward the berm until the condition of a passive neutron measurement estimating a concentration greater than 430 pCi/g Pu-239 in the 0 to 4.6 m (0 to 15 ft) bgs level is not met.

The data from Phase 4 will be reviewed to update the total inventory Pu-239 estimate in the entire trench. The data also will be used to update the calculation used to predict the dose to workers during treatability test operations. The updated calculations of expected worker dose will be used to finalize the equipment requirements and excavation plans to address ALARA principles before Phase 4 excavation is initiated.

After the characterization data have been reviewed, two criteria will be evaluated by the decision makers to determine whether excavation of the 216-B-53A Trench will be of benefit in evaluating the alternative of partial RTD:

- The results of subsurface characterization and whether it indicates the presence of transuranic contamination at concentrations greater than 100 nCi/g

- The trench excavation associated with Phase 2 of the test and whether the experience gained there is considered sufficiently characteristic of an excavation conducted in the 216-B-53A Trench.

If the decision makers conclude that excavation of the 216-B-53A Trench would not benefit evaluation of the partial RTD remedial-action alternative for the BC Cribs and Trenches Area waste sites, then Phase 4 will be completed after the described characterization activities.

If excavation of the 216-B-53A Trench is performed, detailed notes and observations concerning the methods used to excavate the trench and dispose of the contaminated soil will be made. These notes will become the basis for documenting the various techniques that are used during excavation. When methods are changed, the dates and times of the changes will be noted. Contaminated soil will be placed in waste boxes for transport to ERDF, provided ERDF waste-acceptance criteria are satisfied. If soil exceeds the waste-acceptance criteria, alternate packaging/disposal will be developed, including supplemental dosimetry to collect activity-specific dose data. During all operations, dose information will be collected using personnel monitoring dosimetry.

As excavation of the 216-B-53A Trench proceeds, notes and dosimetry data will be evaluated. The dose received will be compared to the level of contamination encountered and to the excavation, treatment, and disposal techniques developed during Phase 4. The results of this evaluation will be discussed with RL and the EPA. The decision makers will determine if enough information has been collected to support decision making concerning remediation of near-surface contaminated soil in the cribs in the BC Cribs and Trenches Area waste sites using partial RTD. If, during excavation, the decision makers determine that excavation at the 216-B-53A Trench is no longer benefiting the determination of the feasibility of partial RTD of the cribs in the BC Cribs and Trenches Area, the treatability test will be complete.

B4.0 REFERENCES

10 CFR 830.120, "Quality Assurance Requirements," Title 10, *Code of Federal Regulations*, Part 830.120, as amended.

10 CFR 835, "Occupational Radiation Protection," Title 10, *Code of Federal Regulations*, Part 835, as amended.

49 CFR, "Transportation," Title 49, *Code of Federal Regulations*, as amended.

BHI-00139, 2002, *Environmental Restoration Disposal Facility Waste Acceptance Criteria*, Rev. 4, Bechtel Hanford, Inc., Richland, Washington.

BHI-DIS-2-28-05, 0000X-DC-W0001, 2005, *Supplemental Waste Acceptance Criteria for Bulk Shipments to the Environmental Restoration Disposal Facility*, Rev. 6, Bechtel Hanford, Inc., Richland, Washington.

Bleyler, R., 1988a, *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*, Hazardous Site Evaluation Division, U.S. Environmental Protection Agency, Washington, D.C.

Bleyler, R., 1988b, *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*, Hazardous Site Evaluation Division, U.S. Environmental Protection Agency, Washington, D.C.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

DE-AC06-96RL13200, 1996, *Contract Between the U.S. Department of Energy, Richland Operations Office, and Fluor Hanford, Inc.*, U.S. Department of Energy, Richland Operations Office, Richland, Washington, as amended.

DOE O 414.1C, *Quality Assurance*, as amended, U.S. Department of Energy, Washington, D.C.

DOE/RL-2004-66, 2005, *Focused Feasibility Study for the BC Cribs and Trenches Area Waste Sites*, Draft A, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2007-14, 2007, *Sampling and Analysis Plan for Phase 1 of the BC Cribs and Trenches Area Waste Sites Excavation-Based Treatability Test*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington, as amended.

EPA/240/B-01/003, 2001, *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5, Quality Assurance Division, U.S. Environmental Protection Agency, Washington, D.C.

EPA/240/B-06/001, 2006, *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

EPA/240/R-02/005, 2002, *Guidance on Choosing a Sampling Design for Environmental Data Collection*, EPA QA/G-5S, Office of Environmental Information, U.S. Environmental Protection Agency, Washington, D.C.

Hanford Environmental Information System, Hanford Site database.

RPP-26744, 2005, *Hanford Soil Inventory Model, Rev. 1*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

Sample Data Tracking database, Hanford Site database.

SW-846, 2005, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update III-B*, as amended, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available on the Internet at www.epa.gov/SW-846/main.htm .

DISTRIBUTION

Onsite

3	U.S. Department of Energy Richland Operations Office	
	DOE Public Reading Room	H2-53
	B. L. Foley (2)	A6-38
1	Pacific Northwest National Laboratory	
	Hanford Technical Library	P8-55
6	Fluor Hanford, Inc.	
	M. W. Benecke	E6-44
	G. B. Chronister	R3-60
	L. R. Fitch	E6-44
	B. H. Ford	E6-44
	W. R. Thackaberry	E6-35
	R. W. Oldham	E6-35
2	Lockheed Martin Enterprise Solutions & Services	
	Administrative Record	H6-08
	Document Clearance	H6-08

This page intentionally left blank.