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

11-AMCP-0249

SEP 29 2011

Mr. D. A. Faulk, Program Manager
Office of Environmental Cleanup
Hanford Project Office
U.S. Environmental Protection Agency
309 Bradley Boulevard, Suite 115
Richland, Washington 99352

Dear Mr. Faulk:

WASTE SITE RECLASSIFICATION FORM (CONTROL NUMBER 2011-077), AND RESPONSE ACTION REPORT FOR THE 200-MG-1 OPERABLE UNIT WASTE SITE 600-228, DOE/RL-2011-90, REVISION 0

This letter transmits signed copies of the Waste Site Reclassification Form (Control Number 2011-077), and the approved Response Action Report for the 200-MG-1 Operable Unit Waste Site 600-228, DOE/RL-2011-90, Revision 0.

If you have any questions, please contact me, or your staff may contact, Al Farabee, of my staff, on (509) 376-8089.

Sincerely,

Jonathan A. Dowell, Assistant Manager
for the Central Plateau

AMCP:PGE

Attachments

cc: See Page 2

cc w/attachs:
G. Bohnee, NPT
L. Buck, Wanapum
L. C. Buelow, EPA
S. Harris, CTUIR
J. A. Hedges, Ecology
R. Jim, YN
S. L. Leckband, HAB
N. M. Menard, Ecology
K. Niles, ODOE
D. Rowland, YN (4) plus 2 CDs
Administrative Record
Environmental Portal

cc w/o attachs:
D. G. Black, CHPRC
R. L. Cathel, CHPRC
R. E. Piippo, MSA
J. G. Vance, MSA
C. B. Walker, CHPRC

WASTE SITE RECLASSIFICATION FORM

Date Submitted: _____	Operable Unit(s): 200-MG-1	Control Number: 2011-077
Originator: N. Chandran	Waste Site Code: 600-228	
Phone: 373-4716	Type of Reclassification Action: Closed Out ☐ Interim Closed Out ☒ No Action ☐ RCRA Postclosure ☐ Rejected ☐ Consolidated ☐	

This form documents agreement among parties listed authorizing classification of the subject unit as Closed Out, Interim Closed Out, No Action, RCRA Postclosure, Rejected, or Consolidated. This form also authorizes backfill of the waste management unit, if appropriate, for Closed Out and Interim Closed out units. Final removal from the NPL of No Action and Closed Out waste management units will occur at a future date.

Description of current waste site condition:
(Summarize status of investigation/remediation of the waste sites.)

The 600-228 waste site, also known as the H-40 Gun Site Dumping Area, is located southeast of the 200 East Area and served as a debris dumping area for an anti-aircraft artillery site. The 600-228 waste site consists of four discrete dumping areas separated by unaffected land. The selected alternative authorized by DOE/RL-2009-86, *Action Memorandum for Non-Time-Critical Removal Action for 37 Waste Sites in the 200-MG-1 Operable Unit* (Action Memorandum) was confirmatory sampling/no further action (CS/NFA). Initial sampling indicated contaminants of potential concern (COPCs) in excess of the established removal action levels (RALs) for the waste site, resulting in the implementation of removal, treatment, and disposal (RTD) activities, in accordance with DOE/RL-2009-53, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit* (RAWP). Following RTD, verification sampling was performed in accordance with DOE/RL-2009-60, *Sampling and Analysis Plan for Selected 200-MG-1 Operable Unit Waste Sites*, which demonstrated the 600-228 waste site had achieved compliance with the RALs and corresponding removal action objectives (RAOs).

The results show that residual soil concentrations of COPCs less than or equal to the RALs supports a reclassification of this site to interim closed out. The current site conditions achieve the RALs and the corresponding RAOs established in the RAWP. The results of waste site sampling are used to make reclassification decisions for the 600-228 waste site in accordance with the TPA-MP-14 (DOE-RL 2007) process. Finalization of a backfill concurrence form provided to the agency(ies) constitutes concurrence that the waste site has achieved the established RAOs and thus backfill and/or contouring may occur at the 600-228 waste site with minimal risk. A Backfill Concurrence Form has been approved by the regulatory agency(ies), and backfill at the 600-228 waste site has been completed.

Basis for reclassification:
(For interim closeout, reference supporting documentation, as listed in Table 3.)

The current site conditions meet RALs and the corresponding RAOs specified in the Action Memorandum. The results show that the residual soil concentrations support reasonably anticipated future land uses recognized in DOE/RL-2008-44, *Engineering Evaluation/Cost Analysis for the 200-MG-1 Operable Unit Waste Sites*, and the Action Memorandum. The results also demonstrate that residual concentrations of COPCs in soil support unrestricted future use of shallow zone soil (i.e., surface to 4.6 m [15 ft] below ground surface) and that COPC concentrations remaining in the soil are protective of groundwater and the Columbia River. There is no deep zone for the 600-228 waste site therefore no institutional controls are required. The basis for reclassification to interim closed out is described in detail in DOE/RL-2011-90, *Response Action Report for 200-MG-1 Operable Unit Waste Site 600-228*, U.S. Department of Energy, Richland Operation Office, Richland, Washington.

Waste Site Controls:
Engineered Controls: Yes ☐ No ☒ Institutional Controls: Yes ☐ No ☒ O&M requirements: Yes ☐ No ☒
If any of the Waste Site Controls are checked Yes specify control requirements including reference to the Record of Decision, TSD Closure Letter, or other relevant documents.

D. A. Farabee	[signature]	9/15/11
DOE Federal Project Director (printed)	Signature	Date
D.R. Einan for L Buelow	[signature]	9/21/11
EPA Project Manager (printed)	Signature	Date

DOE/RL-2011-90
Revision 0

Response Action Report for 200-MG-1 Operable Unit Waste Site 600-228

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

U.S. DEPARTMENT OF ENERGY

Richland Operations Office

P.O. Box 550
Richland, Washington 99352

Approved for Public Release;
Further Dissemination Unlimited

DOE/RL-2011-90
Revision 0

Response Action Report for 200-MG-1 Operable Unit Waste Site 600-228

Date Published
September 2011

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

U.S. DEPARTMENT OF ENERGY

Richland Operations Office

P.O. Box 550
Richland, Washington 99352

J. D. Aardal 09/29/2011
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.

Printed in the United States of America

Approval Page

Title: *Response Action Report for 200-MG-1 Operable Unit Waste Site 600-228*

O. A. Farabee
U.S. Department of Energy, Richland Operations Office

Signature

9/29/11
Date

Executive Summary

This response action report documents the successful completion of the removal action conducted at the 600-228 waste site, also known as the H-40 Gun Site Dumping Area. The alternative proposed in DOE/RL-2008-44, *Engineering Evaluation/Cost Analysis for the 200-MG-1 Operable Unit Waste Sites* (EE/CA)[1] and selected in DOE/RL-2009-86, *Action Memorandum for Non-Time-Critical Removal Action for 37 Waste Sites in 200-MG-1 Operable Unit*[2] (Action Memorandum) was confirmatory sampling/no further action (CS/NFA).

The 600-228 waste site was investigated from February 2010 to July 2011 through field observations and sampling to determine the nature and extent of contaminants of potential concern (COPCs) present in the waste site soils as part of the selected removal action alternative of CS/NFA prescribed in the Action Memorandum. This investigation was performed in accordance with DOE/RL-2009-60, *Sampling and Analysis Plan for Selected 200-MG-1 Operable Unit Waste Sites*[3] and DOE/RL-2009-53, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit*[4] (RAWP). Through the investigation summarized in this report, it was found that analytical results from confirmatory sampling demonstrated that soil conditions at the waste site did not meet removal action levels (RALs). Therefore, in accordance with the methodology prescribed in the Action Memorandum, the alternative was changed to removal, treatment, and disposal (RTD). Verification sampling conducted after RTD activities confirmed that the waste site achieved compliance with RALs and, therefore, met the established removal action objectives without further removal action.

The results show that the residual soil concentrations of COPCs support reasonably anticipated future land use described in the EE/CA (DOE/RL-2008-44) and Action

---

[1] DOE/RL-2008-44, 2009, *Engineering Evaluation/Cost Analysis for the 200-MG-1 Operable Unit Waste Sites*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0096350.

[2] DOE/RL-2009-86, 2009, *Action Memorandum for Non Time Critical Removal Action for 37 Waste Sites in 200-MG-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0084449

[3] DOE/RL-2009-60, 2011, *Sampling and Analysis Plan for Selected 200-MG-1 Operable Unit Waste Sites*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/pdw/fsd/AR/FSD0001/FSD0064/0084054/11-AMCP-0080 - Letter [1102030315] - 1.pdf.

[4] DOE/RL-2009-53, 2010, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=1010180132.

Memorandum (DOE/RL-2009-86). These results also support reclassification to "interim closed out" status in accordance with the process described in RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)."[5] No institutional controls are required because there is no deep vadose zone contamination associated with the 600-228 waste site.

This waste site and the data obtained from the subject sampling evolutions will be included in the risk assessment and the remedial investigation/feasibility study for final remedial decisions for the Outer Area.

[5] RL-TPA-90-0001, 2007, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)," Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/hanford/files/TPA-MP14.pdf.

Contents

1 Introduction 1-1

1.1 Site Description 1-1

1.1.1 Hanford General Site Information 1-2

1.1.2 200-MG-1 Operable Unit 1-2

1.2 Regulatory and Enforcement History 1-2

1.3 Environmental Setting 1-6

2 Waste Site Background 2-1

2.1 Waste Site 600-228 2-1

2.2 Description of the Selected Alternative 2-2

2.2.1 Removal Action Objectives 2-3

2.2.2 Exposure and Land-Use Assumptions 2-6

2.2.3 Design Summary 2-6

2.3 Decision Document Amendments, Significant Differences, or Waivers 2-6

3 Response Activity Summary 3-1

3.1 Summary of Activities 3-1

3.1.1 Waste Site 600-228 Confirmatory Sampling 3-2

3.1.2 Waste Site 600-228 Excavation 3-3

3.1.3 Waste Site 600-228 Verification Sampling 3-3

3.1.4 Backfill and Revegetation 3-4

3.1.5 Statement of Protectiveness 3-5

4 Chronology of Events 4-1

5 Performance Standards and Construction Quality Control 5-1

5.1 Attainment of Performance Standards 5-1

5.1.1 Performance Standard Documentation 5-2

5.1.2 Response Action Objectives Verification 5-2

5.1.3 Contaminant Identification 5-2

5.2 Construction Quality Assurance/Quality Control 5-5

5.3 Clean-up Verification QA/QC 5-5

5.4 Regulatory Oversight 5-7

6 Final Inspection and Certifications 6-1

7 Operations and Maintenance Activities 7-1

7.1 Remedy Related Operations and Maintenance or Monitoring 7-1

7.2 Institutional Controls 7-1

7.3 Five-Year Reviews 7-1

8 Summary of Project Costs 8-1

9 Waste Site Reclassification 9-1

10 Observations and Lessons Learned 10-1

11 Contact Information 11-1

12 References 12-1

Appendix

A Sampling Results for the 600-228 Waste Site ..... A-i

Figures

Figure 1-1. Location of the Hanford Site in Washington State 1-4
Figure 1-2. 200-MG-1 Operable Unit and the 600-228 Waste Site 1-5
Figure 2-1. Waste Site 600-228 Boundary and Operational Areas 2-1
Figure 3-1. Initial Sampling Locations at the 600-228 Waste Site 3-2
Figure 3-2. Verification Sampling Locations at Waste Site 600-228 3-4

Tables

Table 2-1. Nonradiological Removal Action Levels 2-3
Table 3-1. Concentrations of Contaminants of Potential Concern Exceeding Removal Action Levels 3-3
Table 4-1. Response Action Chronology 4-1
Table 5-1. Summary of Attainment of Cleanup Objectives 5-1
Table 5-2. Comparison of Sample Results Against Removal Action Levels for Nonradiological Contaminants of Potential Concern 5-3
Table 8-1. Cost Summary 8-1
Table A-1a. Analytical Results for Initial Surface Sampling for Nonradiological Contaminants A-2
Table A-1b. Analytical Results for Initial Depth Sampling for Nonradiological Contaminants A-5
Table A-2. Analytical Results for In Process Sampling for Nonradiological Contaminants A-8
Table A-3. Analytical Results for Verification Sampling for Nonradiological Contaminants of Potential Concern A-10

Terms

bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
COPC	contaminant of potential concern
CS/NFA	confirmatory sampling/no further action
DOE	U.S. Department of Energy
DQA	data quality assessment
Ecology	Washington State Department of Ecology
EE/CA	*Engineering Evaluation/Cost Analysis for the 200-MG-1 Operable Unit Waste Sites*
EPA	U.S. Environmental Protection Agency
FS	focused sample
HEIS	Hanford Environmental Information System
NA	not analyzed
N/A	not analyzed
NPL	National Priorities List
O&M	operations and maintenance
OU	operable unit
PCB	polychlorinated biphenyl
QA	quality assurance
QC	quality control
RAL	removal action level
RAO	removal action objective
RAWP	*Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit*
RCRA	*Resource Conservation and Recovery Act of 1976*
RDL	required detection limit
RI/FS	remedial investigation/feasibility study
ROD	record of decision

RTD	removal, treatment, and disposal
SAP	*Sampling and Analysis Plan for Selected 200-MG-1 Operable Unit Waste Sites*
SARA	*Superfund Amendments and Reauthorization Act of 1986*
TPH	total petroleum hydrocarbon
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
VSP	Visual Sample Plan
WIDS	Waste Information Data System
ZPC	zone of potential contamination

1 Introduction

This report documents the successful completion of a non-time-critical removal action conducted at the 600-228 waste site. The removal action alternative of confirmatory sampling/no further action (CS/NFA) was selected for this waste site, as proposed in DOE/RL-2008-44, *Engineering Evaluation/Cost Analysis for the 200-MG-1 Operable Unit Waste Sites* (EE/CA) and authorized by DOE/RL-2009-86, *Action Memorandum for Non-Time-Critical Removal Action for 37 Waste Sites in 200-MG-1 Operable Unit* (Action Memorandum). Sampling results from the initial sampling evolution demonstrated that the waste site did not achieve compliance with the removal action levels (RALs). Using the methodology prescribed in the Action Memorandum, based on the analytical results, the alternative was changed to removal, treatment, and disposal (RTD). This report provides the basis for the successful completion of the RTD action performed at the 600-228 waste site. This documentation has been prepared based on U.S. Environmental Protection Agency (EPA) guidance provided in EPA/540/R-98/016, *Close Out Procedures For National Priorities List Sites*.

This report provides a summary of the actions taken and resulting data to support a determination that, through performance of the RTD alternative, conditions remaining at the 600-228 have achieved the established RALs and has met the removal action objectives (RAOs) provided in the Action Memorandum. The documentation process is consistent with the U.S. Department of Energy (DOE) *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) Remedial Action Site Closure Guidance.

Statutory authority for the action taken is in accordance with CERCLA (as amended by the *Superfund Amendments and Reauthorization Act of 1986* [SARA]), Executive Order 12580, *Superfund Implementation* (1987), the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989), also known as the Tri-Party Agreement, and 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan."

In March 2011, the non-time-critical removal action for the 600-228 waste site was completed in accordance with DOE/RL-2009-53, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit* (RAWP). This report provides the following information relative to the completion of the subject removal action:

- Background, historical information, regulatory enforcement history, and environmental setting pertinent to this removal action.
- Descriptions of the selected alternative, RAOs, and exposure and land use assumptions provided in the related regulatory documents.
- A summary of the completed actions, the resulting data collected in support of completion of that removal action, a comparison of that data against objectives, and demonstration that RAOs have been met.

1.1 Site Description

General information on the Hanford Site and the 200-MG-1 Operable Unit (OU) provides a background of the 600-228 waste site and the development of the removal action for the 600-228 waste site and is described in the subsections that follow.

1.1.1 Hanford General Site Information

The Hanford Site, which is part of the DOE nuclear weapons complex, occupies approximately 1,517 km^2 (586 mi^2) along the Columbia River in Benton County, northwest of the City of Richland in the Lower Columbia Basin in southeastern Washington State (Figure 1-1). From the early 1940s to approximately 1989, the Hanford Site mission included building the world's first large-scale plutonium production facility and, until the 1980s, the site was used to produce plutonium for nuclear weapons. Other activities included nuclear research, development, and nuclear materials production. These activities created a wide variety of chemical and radioactive wastes that were released into the environment. The Hanford Site mission is now focused on the cleanup of those wastes and ultimate closure of the Hanford Site.

1.1.2 200-MG-1 Operable Unit

The Washington State Department of Ecology (Ecology), DOE, and EPA created the 200-MG-1 OU through the Tri-Party Agreement Milestone M-015-06-02 and Tri-Party Agreement Change Request C-06-02 (Ecology et al., 1989). The 200-MG-1 OU is made up of waste sites in the 200 East and 200 West Areas, and the 600 Area of the Hanford Site. The 600 Area encompasses those areas south of the Columbia River that are not part of another designated area (i.e., 300 Area, 200 East Area, and 100-K) and are not specifically identified (Figure 1-1). The 200-MG-1 OU waste sites consist of French drains, trenches, cribs, ditches, and retention basins with shallow contamination (generally less than 4.6 m [15 ft] deep), and where chemical and radioactive contaminants were released during material transfers (i.e., unplanned release sites). Additionally, some 200-MG-1 OU sites were produced by airborne dissemination of radioactive particles, or biodegradation and dispersion of plant or animal matter. For those sites containing radionuclides, the radionuclide inventory for this conceptual model group does not include transuranic isotopes greater than or equal to 100 nCi/g.

All of the waste sites contained in the 200-MG-1 OU are located within the Central Plateau, as described in the EE/CA (DOE/RL-2008-44) and Action Memorandum (DOE/RL-2009-86). The 600-228 waste site, also known as the H-40 Gun Site Dumping Area, is located southeast of the 200 East Area (Figure 1-2).

1.2 Regulatory and Enforcement History

CERCLA was enacted to enable the federal government to conduct cleanup of hazardous substances released into the environment. In 1986, CERCLA was amended by SARA, which included Section 120 (42 USC 9620, "Federal Facilities"), developed specifically for federal facility cleanup. Presidential Executive Order 12580, *Superfund Implementation*, delegated to DOE the primary authority to conduct removal and remedial actions under authority of CERCLA Section 104, "Response Authorities." In 1987, the federal government determined that waste that included a mixture of radioactive and hazardous chemical components was subject to regulation under the *Resource Conservation and Recovery Act of 1976* (RCRA) and its Washington State counterpart. In 1989, DOE, EPA, and Ecology signed the Tri-Party Agreement (Ecology et al., 1989). The Tri-Party Agreement implemented DOE's exercise of CERCLA remedial action authority under EPA oversight, in accordance with CERCLA Section 120, and also included an Ecology Consent Order containing a schedule for bringing all current Hanford Site hazardous waste operations into compliance with RCRA under the new mixed waste requirements. DOE's authority to conduct removal actions under CERCLA Section 104 is independent of the Tri-Party Agreement, but is exercised cooperatively with the respective oversight authorities of EPA and Ecology.

As discussed in Chapter 1, statutory authority for this removal action is taken in accordance with CERCLA. Further governing requirements for compliance with CERCLA and the RCRA activities at Hanford are in accordance with the Tri-Party Agreement (Ecology et al., 1989). The Hanford Site was proposed for inclusion in 53 FR 23988, "National Priorities List for Uncontrolled Hazardous Waste Sites

– Update 7," hereafter referred to as the National Priorities List (NPL), and was placed on the NPL on November 3, 1989 (54 FR 41015, "National Priorities List for Uncontrolled Hazardous Waste Sites – Final Rule 10/04/89") by the EPA. The EPA placed the four aggregate areas (i.e., the 100, 200, 300, and 1100 Areas) on the NPL. The 200 Area NPL site consists of the 200 West and 200 East Areas, which contain waste management facilities and inactive irradiated-fuel reprocessing facilities. The site also includes the 200 North Area, formerly used for interim storage and staging of irradiated fuel, and the waste sites assigned to the 200-MG-1 OU.

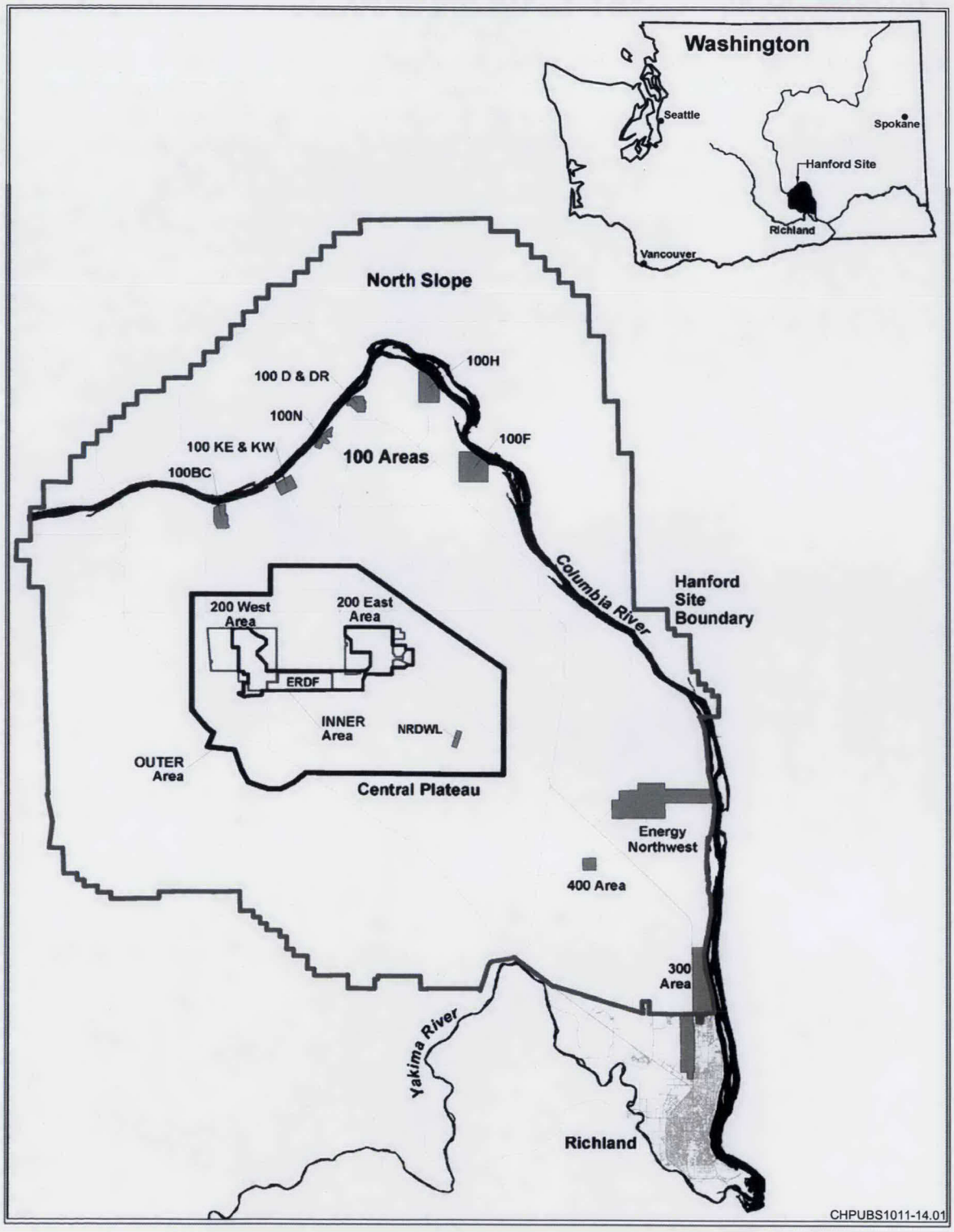

Figure 1-1. Location of the Hanford Site in Washington State

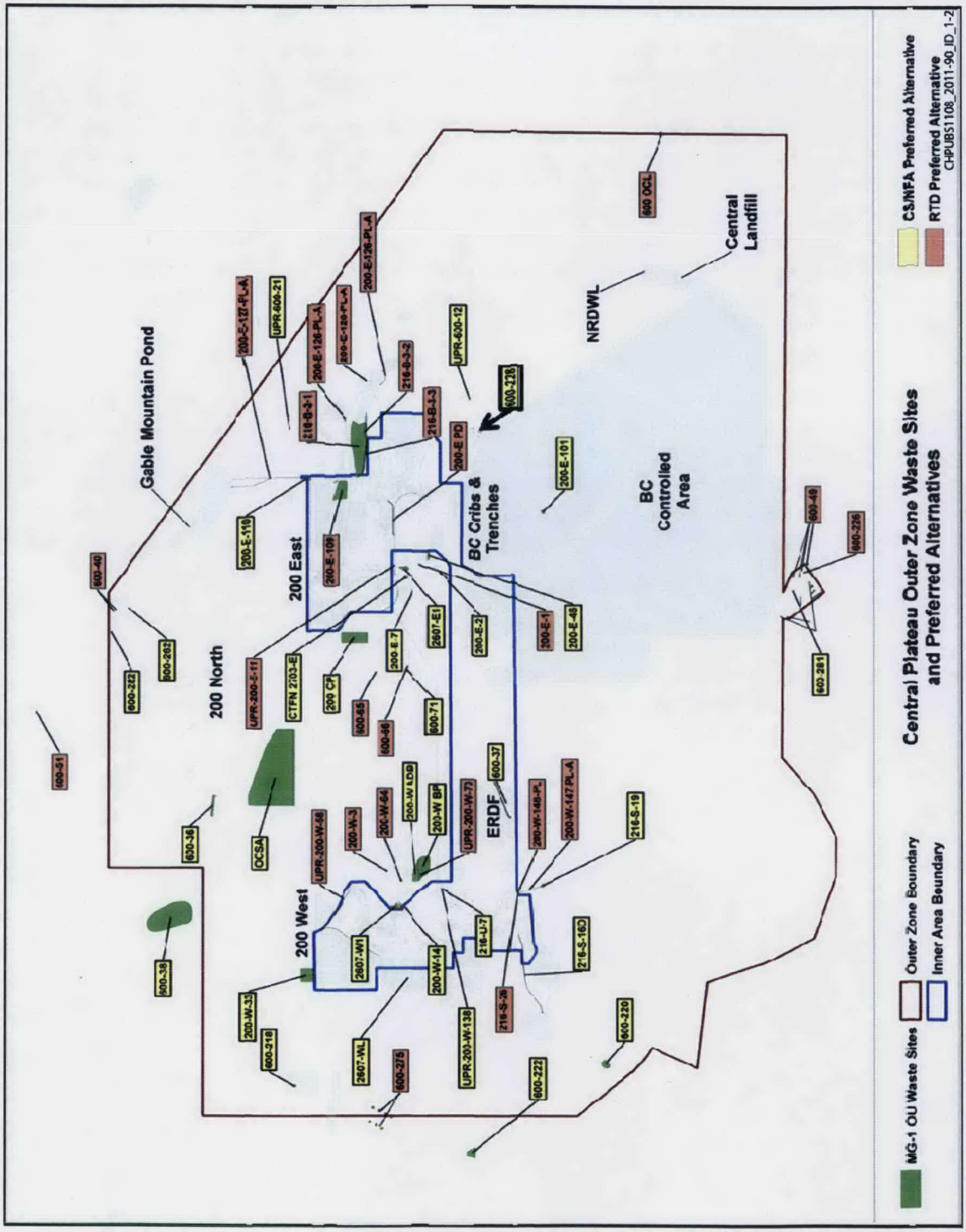

Figure 1-2. 200-MG-1 Operable Unit and the 600-228 Waste Site

1.3 Environmental Setting

The Hanford Site is located within the semiarid Pasco Basin in the northern portion of the Columbia Plateau. Normal annual precipitation is 17.7 cm (7 in.). According to PNL-10285, *Estimated Recharge Rates at the Hanford Site*, 2.6 to 17.3 mm (0.1 to 0.7 in.) per year of recharge is estimated in the 100 Area. Bedrock beneath the site is basalt of the Columbia River Basalt Group.

The Ringold Formation and the Hanford formation cover the basalt throughout the Central Plateau. Poorly consolidated, river-deposited, well-drained sands, gravels, cobbles, and boulders dominate these units. The Ringold Formation is an interstratified sequence of unconsolidated clay, silt, sand, and gravel-to-cobble sediment deposited by the ancestral Columbia River. The Hanford formation consists of uncemented gravels, sands, and silts deposited by Pleistocene cataclysmic floodwaters. Groundwater from the Hanford Site discharges to the Columbia River, the dominant surface water body of the Hanford Site. The direction of groundwater flow beneath the Central Plateau is toward the east-northeast. The uses of the Columbia River include the production of hydroelectric power, irrigation, drinking water, recreation, and natural resources.

The average depth from ground surface to groundwater beneath the 200 Area ranges from 50 m (164 ft) to greater than 100 m (328 ft). Additional details on the geology and hydrogeology underlying the 200 Area and the 200-MG-1 OU are not provided in the base response action documents because the 200-MG-1 OU was created for shallow zone (less than 4.6 m [15 ft] in depth) waste sites, which are assumed not to be a threat to groundwater quality. This assumption is based on historical and process knowledge regarding volumes of liquids discharged, lack of mobility of contaminants, and shallow depths of the discharge(s).

The nearest natural surface water body to the 600-228 waste site is the Columbia River, located approximately 11 km (4.2 mi) northeast. The potential for natural groundwater recharge within the 200 Area is limited to precipitation infiltration. Estimates of recharge from precipitation at the Hanford Site range from 0 to 10 cm (0 to 4 in.) per year.

2 Waste Site Background

This chapter provides a description of the 600-228 waste site and information on process and background, describes the selected alternative, and delineates the RAOs and cleanup standards applicable to this removal action as prescribed in the Action Memorandum (DOE/RL-2009-86).

2.1 Waste Site 600-228

The 600-228 waste site, also known as the H-40 Gun Site Dumping Area, is located southeast of the 200 East Area and served as a debris dumping area for an anti-aircraft artillery site. The 600-228 waste site consists of four discrete dumping areas separated by unaffected land as shown in Figure 2-1.

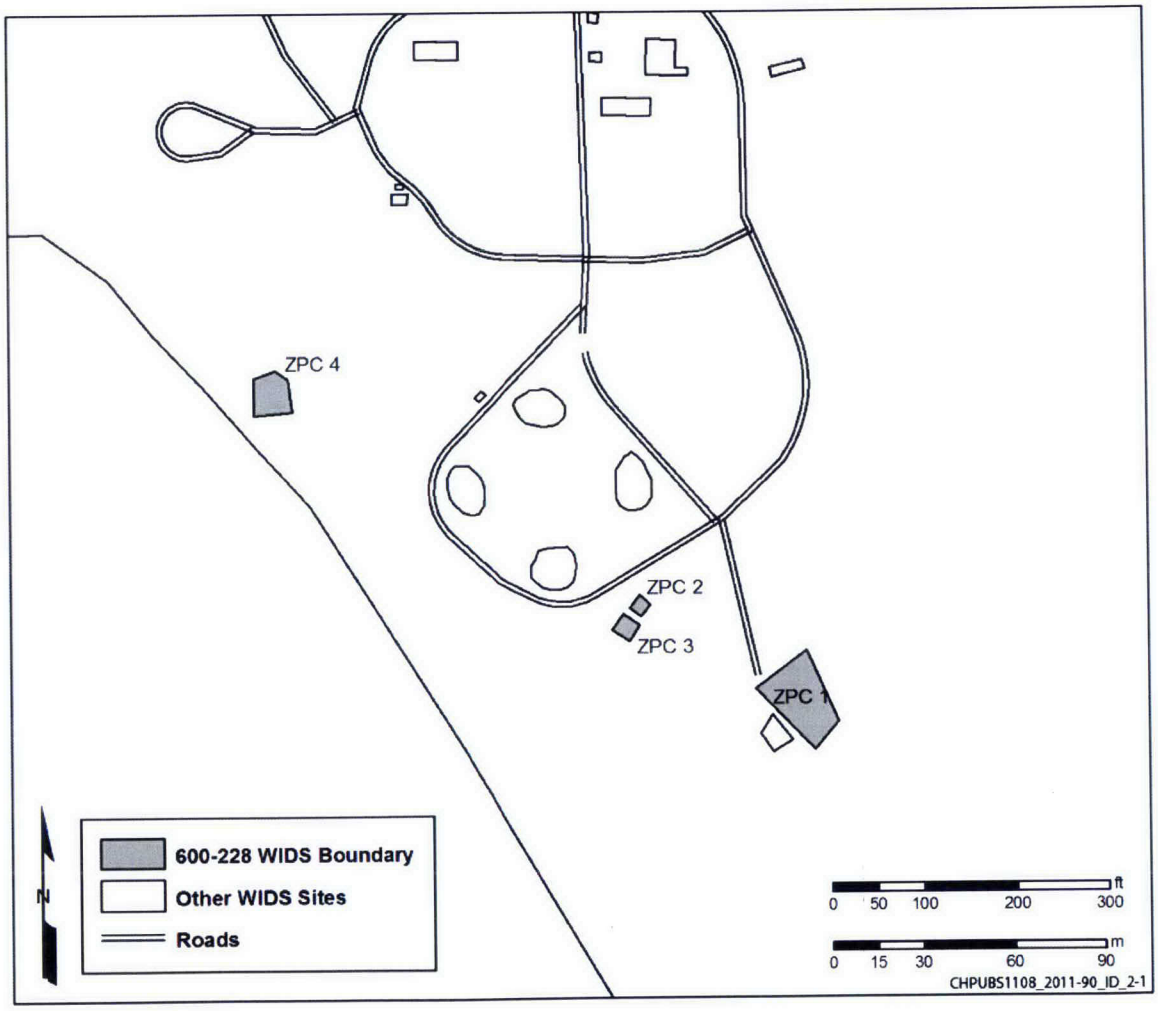

Figure 2-1. Waste Site 600-228 Boundary and Operational Areas

Several anti-aircraft artillery sites were constructed on the Hanford site during the period of nuclear materials production. The artillery sites were well-appointed encampments, typically covering about 20 acres (8 ha) with various permanent structures. Historical descriptions of the debris in the dumping areas include mostly metal objects (barbed wire, fence posts, etc.), glass, construction/demolition debris, and wood debris.

The release mechanism for this waste site is miscellaneous dumping or abandonment of debris. The current form of all the waste materials in the 600-228 is solid. Due to the presence of empty paint cans and material that appears to be dried paint, the site is listed as having had a potential for liquid release. No chemical and radiological processes involving sustained release of materials is associated with this waste site; therefore, any liquid release would be characterized as low volume, discrete, dumping activities.

2.2 Description of the Selected Alternative

As stated in the EE/CA (DOE/RL-2008-44) and Action Memorandum (DOE/RL-2009-86), the selected alternative for the subject waste site was CS/NFA. This alternative was selected because, due to historical activity and process knowledge, contaminants of potential concern (COPCs) were not expected to exceed the RALs. Initial sampling and analysis did not confirm that concentrations of COPCs in soil were less than or equal to the RALs without the need for further action. As a result, in accordance with the Action Memorandum (DOE/RL-2009-86), the alternative was changed to RTD. Activities involved in the RTD action set forth in the RAWP (DOE/RL-2009-53) and DOE/RL-2009-60, *Sampling and Analysis Plan for Selected 200-MG-1 Operable Unit Waste Sites* (SAP) include soil excavation and verification sampling to demonstrate that concentrations of COPCs in soil are less than or equal to established RALs, and that no additional removal action is required. The general removal action sampling design criteria are provided in this section followed by a summary of waste site history, specific sampling design and methodology, and analytical results for the 600-228 waste site.

Following is the activity summary relevant to the 600-228 waste site considered during the development of the sample design:

- Direct visual inspection of the site surface was performed, using available site information as a guide for visual cues such as staining, discoloration, absence of vegetation, presence of debris and other anomalies.
- Radiological field screening performed at the surface of the waste site to provide an indication of the presence of radiological COPCs.
- A combination of focused and random sampling was performed per the methodology prescribed in the SAP (DOE/RL-2009-60). The use of focused and random samples based on process knowledge and visual indicators was considered appropriate for the initial sampling evolution. Random sampling in the impacted areas was considered appropriate for the verification sampling evolution.

Based on these key design features, soil samples were collected from the 600-228 waste site and analyzed for COPC concentrations. Evaluation of the initial sampling analytical results demonstrated that, for specific areas, concentrations of COPCs exceeded the RALs, resulting in the implementation of the RTD alternative. Under this alternative, soils were removed from the impacted areas, and a verification sampling evolution was conducted, the results of which confirmed that remaining in-situ soils were less than or equal to RALs for COPCs applicable to each impacted area. Table 5-2 provides the maximum concentrations for each COPC from the verification sampling analytical data. Table A-1 and Table A-2 provide detailed summaries of all analytical data results for sampling conducted at the 600-228 waste site (Appendix A).

Personnel with current training and qualifications performed field radiological surveying of the samples and sampling locations during the sampling evolutions. Survey methods and practices were performed in accordance with established contractor methods and protocols. Of the radiological surveys performed for the 600-228 waste site, no radiological dose readings were greater than the measured background and no radiological contamination was found.

2.2.1 Removal Action Objectives

The removal action alternatives for the 200-MG-1 OU waste sites were evaluated based on their overall ability to protect human health and the environment and their effectiveness in maintaining both short-term and long-term protection. The selected alternative must meet the following RAOs established in the Action Memorandum (DOE/RL-2009-86):

- **RAO 1**–Prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with non-radiological constituents to 4.6 m (15 ft) below ground surface (bgs) at concentrations above the appropriate RALs.
- **RAO 2**–Prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with radiological constituents to 4.6 m (15 ft) bgs at concentrations above the appropriate RALs.
- **RAO 3**–Control the sources of groundwater contamination to minimize impacts to groundwater resources, protect the Columbia River from adverse impacts, and reduce the degree of groundwater cleanup that may be required under future action.
- **RAO 4**–Prevent adverse impacts to cultural resources and threatened or endangered species, and minimize wildlife habitat disruption.

The RALs for the waste sites identified in the Action Memorandum (DOE/RL-2009-86) are based on the RAOs noted above. These RALs are based on attainment of acceptable levels of human health, ecological risk, and protection of groundwater but are not lower than background levels or detection limits for waste sites. Attainment of RALs is intended to meet the first three RAOs and is expected to satisfy the remedial action objectives established in the final record of decision (ROD). The fourth RAO is met through cultural and ecological reviews performed before starting removal action activities. The RALs applicable to the 600-228 waste site are listed in Table 2-1. The attainment of RALs and RAOs is provided in Chapter 5 of this report.

Table 2-1. Nonradiological Removal Action Levels

Contaminant of Concern	Background Concentration[a] (mg/kg)	Direct Exposure[b] (mg/kg)	Groundwater Protection[c] (mg/kg)	Required Detection Limit (mg/kg)	Removal Action Levels (mg/kg)	Ecological Risk Screening Values (mg/kg)
Antimony	5	32	5.4	0.6	5.4	5
Arsenic	6.5	6.5[d]	6.5[d]	1.0	6.5[d]	7
Barium	132	16,000	1,650	2	1,650	102
Beryllium	1.51	160	63.2	0.5	63.2	10
Boron	N/A	16,000	210	2	210	0.5
Cadmium	0.81	80	0.81[d]	0.5	0.81[d]	4
Chromium Total	18.5	120,000	2,000	1	2,000	42
Chromium (VI)	N/A	240	—[e]	0.5	—[e]	N/A
Cobalt	15.7	24	15.7[d]	2	15.7[d]	20
Copper	22.0	3,200	284	1	284	50

Table 2-1. Nonradiological Removal Action Levels

Contaminant of Concern	Background Concentration[a] (mg/kg)	Direct Exposure[b] (mg/kg)	Groundwater Protection[c] (mg/kg)	Required Detection Limit (mg/kg)	Removal Action Levels (mg/kg)	Ecological Risk Screening Values (mg/kg)
Lead	10.2	250	3,000	5.0	250	50
Lithium	33.5	160	192	2.5	160	35
Manganese	512	3,760	512[d]	5	512[d]	1,100
Mercury	0.33	24	2.09	0.2	2.09	0.1
Nickel	19.1	1,600	130	4	130	30
Selenium	0.78	400	5.2	1	5.2	0.3
Silver	0.73	400	13.6	0.2	13.6	2
Strontium	N/A	48,000	2,920	1	2,920	N/A
Thallium	N/A	5.6	1.59	1	1.59	1
Tin	N/A	48,000	48,000	10	48,000	50
Uranium (soluble salts)	3.21	240	3.21[d]	1	3.21[d]	5
Vanadium	85.1	560	2,240	2.5	560	2
Zinc	67.8	24,000	5,970	1	5,970	86
PCB Aroclor 1016	N/A	0.5	0.094	0.017	0.094	0.65
PCB Aroclor 1221	N/A	0.5	0.017[d]	0.017	0.017[d]	0.65
PCB Aroclor 1232	N/A	0.5	0.017[d]	0.017	0.017[d]	0.65
PCB Aroclor 1242	N/A	0.5	0.039	0.017	0.039	0.65
PCB Aroclor 1248	N/A	0.5	0.039	0.017	0.039	0.65
PCB Aroclor 1254	N/A	0.5	0.066	0.017	0.066	0.65
PCB Aroclor 1260	N/A	0.5	0.72	0.017	0.5	0.65
Acenaphthene	N/A	4,800	98	0.33	98	20
Acenaphthylene	N/A	4,800	98	0.33	98	N/A
Anthracene	N/A	24,000	2,270	0.33	2,270	N/A
Benzo[*a*]anthracene	N/A	1.37	0.86	0.33	0.86	N/A
Benzo[*a*]pyrene	N/A	0.137	0.233[f]	0.33	0.33[d]	12
Benzo[*b*]fluoranthene	N/A	1.37	2.95	0.33	1.37	N/A
Benzo[*g,h,i*]perylene	N/A	2,400	25,700	0.33	2,400	N/A
Benzo[*k*]fluoranthene	N/A	1.37	2.95[f]	0.33	1.37	N/A
Chrysene	N/A	13.7	9.56	0.33	9.56	N/A
Dibenz[*a,h*]anthracene	N/A	1.37	4.29	0.33	1.37	N/A
Fluoranthene	N/A	3,200	631	0.33	631	N/A
Fluorene	N/A	3,200	101	0.33	101	30

Table 2-1. Nonradiological Removal Action Levels

Contaminant of Concern	Background Concentration[a] (mg/kg)	Direct Exposure[b] (mg/kg)	Groundwater Protection[c] (mg/kg)	Required Detection Limit (mg/kg)	Removal Action Levels (mg/kg)	Ecological Risk Screening Values (mg/kg)
Indeno[*1,2,3-cd*]pyrene	N/A	1.37	8.33	0.33	1.37	N/A
Naphthalene	N/A	1,600	4.46	0.33	4.46	N/A
Phenanthrene	N/A	24,000	1,140	0.33	1,140	N/A
Pyrene	N/A	2,400	655	0.33	655	N/A
Carbon tetrachloride[g]	N/A	7.69	0.0031	0.005	0.005	N/A
Xylene[h]	N/A	16,000	14.6	0.01	14.6	N/A
Nitrate (as nitrogen)	11.8	128,000	40	0.75	40	N/A
TPH-Diesel	N/A	2,000	2,000	5	2,000	200
TPH-Kerosene	N/A	2,000	2,000	5	2,000	200
Fluoride[i]	N/A	4,800	16	5	16	N/A
Asbestos	N/A	N/A [j]	N/A [j]	N/A [j]	1 % [j]	N/A

a. If Hanford Site-specific background data are not available, values are then taken from Ecology Publication No. 94-115, *Natural Background Soil Metals Concentrations in Washington State*. Hanford Site background values are available from nonradiological background data in DOE/RL-92-24, *Hanford Site Soil Background: Part 1, Soil Background for Nonradioactive Analytes*, Table D9-2.

b. Direct-contact values were calculated based on WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards;" using method B methodology and assumptions.

c. The groundwater protection values were obtained using equations provided in WAC 173-340-747(4), "Deriving Soil Concentrations for Ground Water Protection," with the physical parameters obtained from http://www.ecy.wa.gov/.

d. Where cleanup levels are less than background or RDLs, cleanup levels default to background or RDLs in accordance with WAC 173-340-700(6)(d), "Overview of Cleanup Standards," and WAC 173-340-707(2), "Analytical Considerations," respectively.

e. Based on process knowledge, chromium (VI) is not expected to be present at 200-MG-1 OU waste sites. The following values are given to help guide cleanup:

- 0.2 mg/kg - calculated value using Kd=0, based on PNNL-13895 *Hanford Contamination Distribution Coefficient Database and Users Guide* and WAC 173-340-747, "Deriving Soil Concentrations for Groundwater Protection," equation 747-1.
- 2.1 mg/kg - based on DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area.*
- 18.4 mg/kg - based on Ecology, 2007, *Cleanup Levels & Risk Calculations (CLARC)* database.

f. The soil concentration for protection of groundwater values for benzo[*a*]pyrene and benzo[*k*]fluoranthene were incorrectly reported in DOE/RL-2009-48, *Action Memorandum for Non-Time-Critical Removal Action for 11 Waste Sites in 200-MG-1 Operable Unit*, and have been corrected.

g. Carbon tetrachloride is applicable to waste sites authorized by Action Memorandum DOE/RL-2009-48 (11 sites).

h. Xylene is applicable only to the 200-W-3, 216-S-19, and 216-S-26.

i. Fluoride is added as a contaminant of potential concern for select sites, such as 216-S-19 and 216-S-26, based on process history.

j. The Removal Action Level for asbestos in soil is 1% by weight (measured using Polarized Light Microscopy). EPA has used this value for determining if response actions for asbestos should be undertaken (*Clarifying Cleanup Goals and Identification of New Assessment Tools for Evaluating Asbestos at Superfund Cleanups*, OSWER 9345.4-05 [EPA 2004]). Further evaluation of removal actions for asbestos will be conducted as needed on a site-specific basis in the Outer Area RI/FS.

N/A = not available

RDL = required detection limit

TPH = total petroleum hydrocarbon

Ecological screening values, which are based on WAC 173-340-900, ("Model Toxics Control Act—Cleanup," "Tables," Table 749-3), are used for screening purposes only and are not considered cleanup levels for this CERCLA removal action (described more fully in Chapter 5 of the Action Memorandum [DOE/RL-2009-86]). If analytical results exceed the ecological screening values, the results will be further evaluated during the final ecological risk assessment in accordance with the remedial investigation/feasibility study (RI/FS) for the Central Plateau in order to make the final cleanup decisions.

2.2.2 Exposure and Land-Use Assumptions

The 600-228 waste site is located within the Central Plateau, as discussed in more detail in the EE/CA and Action Memorandum (DOE/RL-2008-44 and DOE/RL-2009-86, respectively) for the 200-MG-1 OU. Land use for the Central Plateau is designated for reasonably anticipated future uses recognized in the EE/CA and Action Memorandum (DOE/RL-2008-44 and DOE/RL-2009-86, respectively); for the purposes of this interim action, RAOs were selected that would support unrestricted land use.

2.2.3 Design Summary

The CS/NFA action alternative was the selected alternative for the 600-228 waste site. Sampling and analysis indicated that contaminant concentrations in the waste site soils were greater than the RALs. Based on those analytical results, and per the methodology prescribed in the Action Memorandum (DOE/RL-2009-86), the alternative progressed to RTD. Following removal of the impacted soil, verification sampling was conducted to confirm that remaining in-situ soil was less than or equal to the RALs. The sampling objectives for the 600-228 waste site included visual inspection and collection of discrete soil samples from the waste site as described in Section 3.1 of this report. Key features of the site-specific sampling design for the 600-228 waste site included the following:

- Direct visual inspection of the site surface was performed, using available site information as a guide for visual cues such as staining, discoloration, absence of vegetation, presence of debris and other anomalies.
- Radiological field screening was performed at the surface of the waste site to provide an indication of the presence of radiological COPCs.
- A combination of focused and random sampling performed per the methodology prescribed in the SAP (DOE/RL-2009-60). The use of focused and random samples based on process knowledge and visual indicators was considered appropriate for the initial sampling evolution. Random sampling in the impacted areas was considered appropriate for the verification sampling evolution.

2.3 Decision Document Amendments, Significant Differences, or Waivers

No amendments to the EE/CA (DOE/RL-2008-44) or Action Memorandum (DOE/RL-2009-86), or technical impracticability waivers, were associated with this removal action. A Tri-Party Agreement change (TPA-CN-350, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-86 Action Memorandum for Non-Time-Critical Removal Action for 37 Waste Sites in the 200-MG-1 Operable Unit, Rev. 0*) has been approved for the Action Memorandum to add sites to the scope of the removal action; however, the change had no effect on the previously authorized action or on cleanup levels for this waste site.

3 Response Activity Summary

As stated in the EE/CA (DOE/RL-2008-44) and Action Memorandum (DOE/RL-2009-86), the selected alternative for the 600-228 waste site was CS/NFA. The results of the confirmatory sampling indicated COPC concentrations greater than the RALs in two of the sampled areas (further details are provided in the following text). Per the provisions of the Action Memorandum, the removal action activities progressed to implementation of the RTD alternative for those areas and for debris removal at the waste site. Upon completion of RTD activities, verification sampling was conducted to demonstrate that contaminant concentrations in soil at the 600-228 waste site were less than or equal to the RALs, thus demonstrating that the RAOs were met.

3.1 Summary of Activities

The removal action at the 600-228 waste site was conducted from February 2010 through July 2011 and included the collection of focused and random samples from locations within the waste site, as specified in Section 2.2, and per the methodologies prescribed in the SAP (DOE/RL-2009-60). Key activities pertinent to the removal action at the 600-228 waste site are listed as follows:

- Collection of judgmental and random soil samples during initial sampling (Figure 3-1) based on historical and process knowledge of the waste site as a dumping area, and visual indicators.
- Excavation of soil, under the RTD alternative, in zones of potential contamination (ZPCs) 1 and 4. Debris observed at ZPCs 2 and 3 was also removed.
- Collection of random samples from ZPC 1 and ZPC 4 for verification purposes; laboratory analysis of soil samples for COPCs; and evaluation of analytical results to demonstrate achievement of RALs.

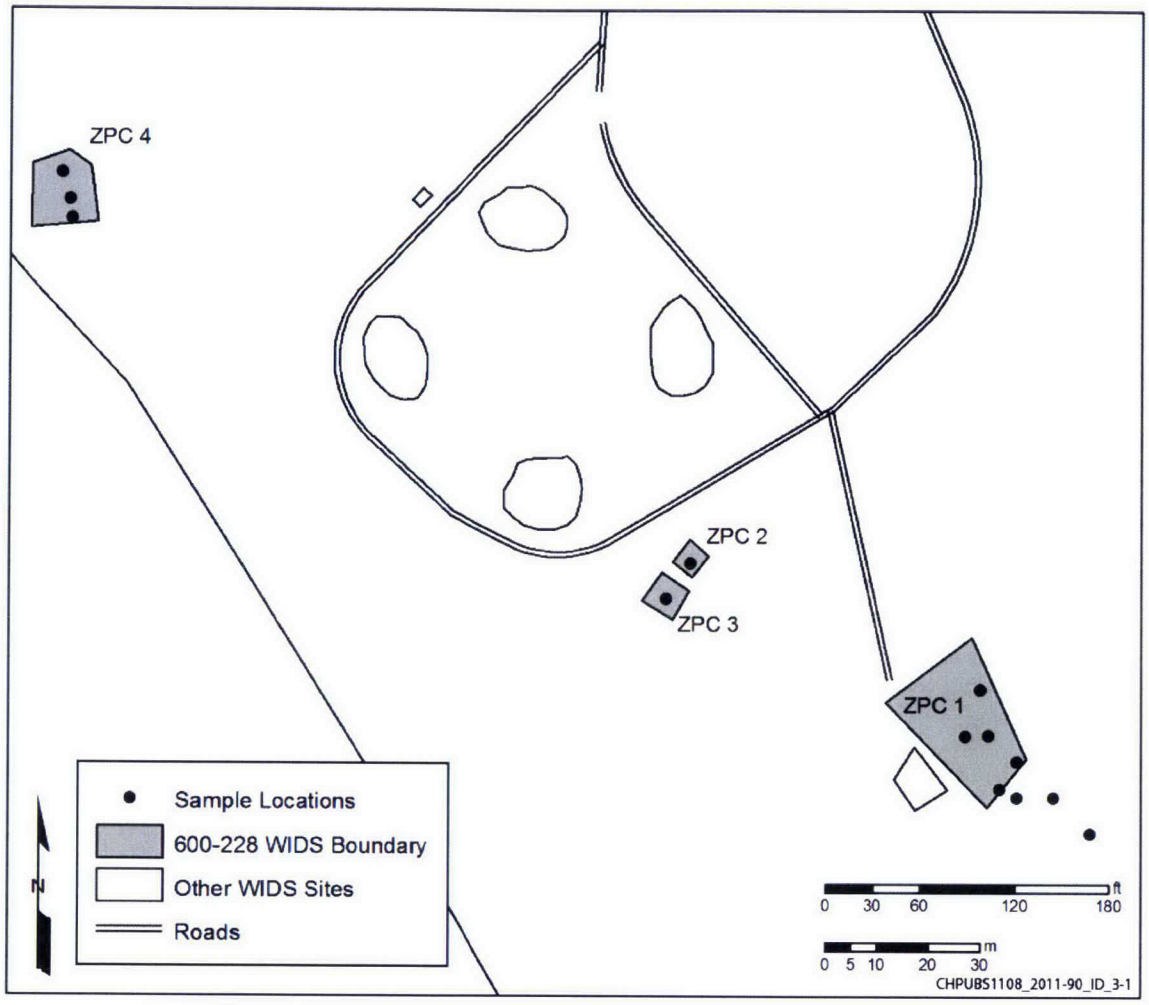

Figure 3-1. Initial Sampling Locations at the 600-228 Waste Site

3.1.1 Waste Site 600-228 Confirmatory Sampling

A site evaluation was performed in February 2010 prior to performance of the initial sampling evolution. This evaluation served to support job planning as well as completion of the visual inspection component of the sampling activities described in the SAP (DOE/RL-2009-60). During the site evaluation it was noted that 600-228 contained miscellaneous trash and debris scattered throughout the site in four debris dumping locations. Observed debris included material such as transite siding, rusty nails, broken glass, metal piping and gauges. Using the rationale provided in the SAP, and based on observations made during site evaluation, four ZPCs were identified for initial sampling at the debris dumping locations, as shown in Figure 3-1. The outer dimensions of each ZPC were established to encompass the lateral extent of the visual cues, such as the presence of debris, burned areas, areas of defoliation, and/or soil staining.

For radiological field screening at the 600-228 waste site, surveys were performed in accordance with established contractor methods and protocols by personnel with current training and qualifications. No radiological postings were present at the waste site. Radiological surveys performed during sampling activities indicated no radiological readings greater than the measured background, and no radiological contamination was found. The site was confirmed to be a nonradiological site, and the radiological COPCs were eliminated from the list of analytes to be included for laboratory analysis.

Initial surface soil sampling was conducted in June 2010, and initial depth samples were collected between September and November 2010 at the four ZPCs established during site evaluation. Focused samples were collected from ZPC 1, ZPC 2, and ZPC 3 based on visual indicators, process knowledge, and ground-penetrating radar surveying conducted during site evaluation. Samples were collected from ZPC 1 and ZPC 4 utilizing Visual Sample Plan™ (VSP) software to place samples randomly within the ZPC. Samples were analyzed for the full suite of COPCs (metals, polynuclear aromatic hydrocarbons, volatile organic analytes, anions, and total petroleum hydrocarbons) in accordance with the SAP (DOE/RL-2009-60).

Initial samples collected from ZPC 1 and ZPC 4 indicated concentrations of antimony and lead were greater than the RALs. Analytical results of samples collected from ZPC 2 and ZPC 3 did not indicate any contaminant concentrations greater than RALs. A summary of analytical results exceeding the RALs is provided in Table 3-1.

Table 3-1. Concentrations of Contaminants of Potential Concern Exceeding Removal Action Levels

		Initial Sampling		
Contaminant of Potential Concern	**Removal Action Level (mg/kg)**	**ZPC 1 FS 1 Surface[a] (mg/kg)**	**ZPC 1-4 0.6 to 1.2 m (2 to 4 ft) bgs (mg/kg)**	**ZPC 4-3 Surface[a] (mg/kg)**
Antimony	5.4	**10.6[b]**	**7.93[b]**	0.49
Lead	250	**453[b]**	9.49	**941[b]**

a. Surface is 0 to 0.3 m (0 to 1 ft) below ground surface.

b. Bold values represent concentrations of contaminants of potential concern in excess of the removal action levels as a result of initial sampling.

FS = focused sample

3.1.2 Waste Site 600-228 Excavation

Samples collected from ZPCs 1 and 4 contained antimony and lead concentrations greater than RALs, thus initiating RTD in those areas. Removal of impacted soils at the 600-228 waste site was completed in July 2011. The lateral area of excavation in each area of impact was driven by visual indicators such as stained soil, devegetation, or the presence of debris. The area comprising ZPC 1 was excavated, utilizing in process sampling to further refine the vertical extent of excavation, to depths ranging from approximately 0.91 m (3 ft) below original ground surface in the southeast corner to approximately 2.4 m (8 ft) in the northwest corner. The area comprising ZPC 4 was excavated to a depth of approximately 0.61 m (2 ft) below original ground surface. Areas of scattered debris observed at ZPCs 2 and 3 were also removed during RTD activities at the 600-228 waste site.

3.1.3 Waste Site 600-228 Verification Sampling

Analytical results from initial sampling indicated concentrations of antimony and lead were greater than the RALs at ZPC 1 and ZPC 4. These locations became areas of excavation during implementation of the RTD alternative. The lateral and vertical extent of excavation in each area was identified utilizing visual indicators and in process sampling collected during RTD activities. Upon completion of RTD activities, a

™Visual Sample Plan (VSP) statistical software was developed by Pacific Northwest National Laboratory and Oak Ridge National Laboratory with support from the U.S. Department of Energy's National Analytical Management Program and the U.S. Environmental Protection Agency Quality Division

verification sampling design was developed for ZPC 1 and ZPC 4 utilizing VSP software to place samples randomly within each affected area, in accordance with the methodology provided in Section 3.2.5.2 of the SAP (DOE/RL-2009-60). Samples were collected as described in the following subsections, and shown in Figure 3-2.

3.1.3.1 ZPC 1

Analytical results from initial sampling at ZPC 1 indicated antimony and lead concentrations that were greater than RALs. As a result, the COPC list targeted during verification sampling was metals analysis only. The area of impact identified at ZPC 1 was approximately 461 m^2 (4,962 ft^2); therefore, 11 verification grab samples were collected from this area.

3.1.3.2 ZPC 4

Analytical results from initial sampling at ZPC 4 indicated lead concentrations that were greater than RALs. As a result, the COPC list targeted during verification sampling at ZPC 4 was metals analysis only. The area of impact identified at ZPC 4 was approximately 65 m^2 (700 ft^2); therefore, two verification samples were collected from this area.

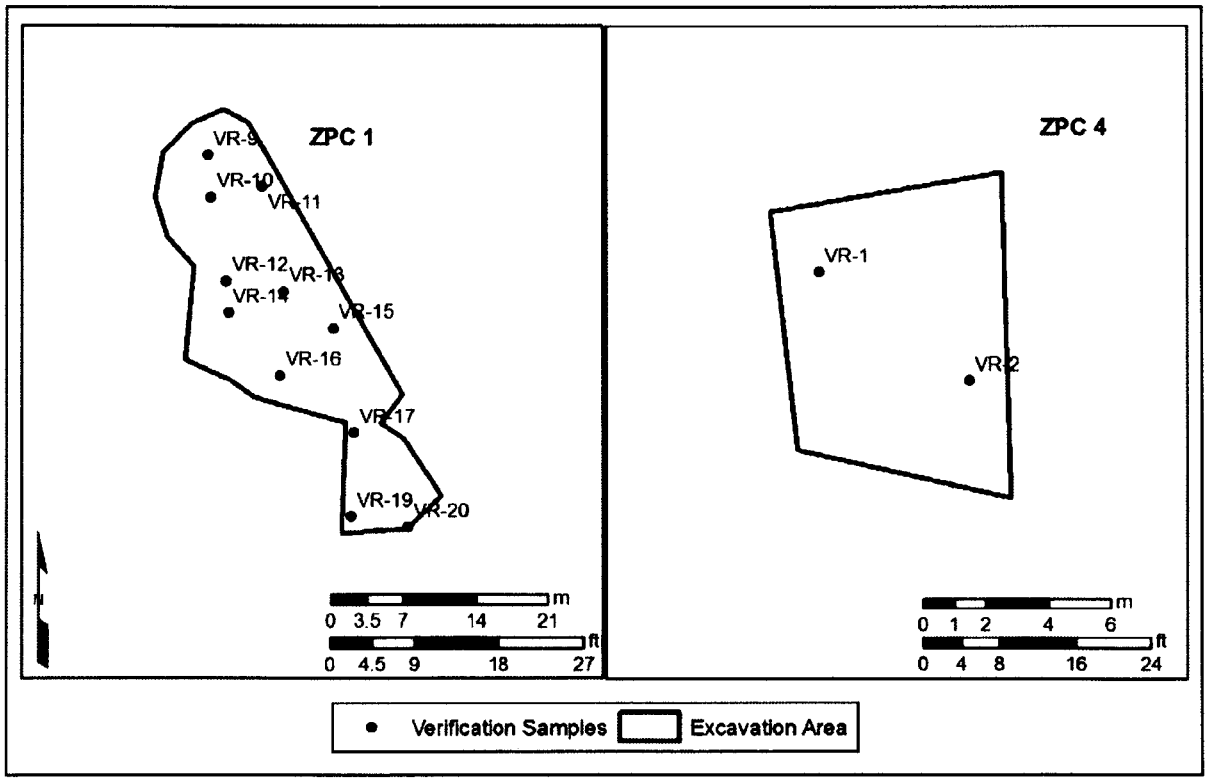

Figure 3-2. Verification Sampling Locations at Waste Site 600-228

3.1.4 Backfill and Revegetation

As described in Sections 2.1 and 5.5.1 of the RAWP, backfill and/or contouring may take place at the 600-228 waste site upon concurrence by the signing parties that the RAOs have been attained. Finalization of a backfill concurrence form provided to the agency(ies) provided concurrence that the waste site had achieved the established RAOs; therefore, backfill and/or contouring proceeded at the

600-228 waste site. The backfill concurrence form was approved by the regulatory agency(ies) on August 22, 2011. Backfill of the 600-228 waste site was completed on September 8, 2011.

In accordance with the ecological compliance review conducted for the 600-228 waste site, this area does not meet the requirements of a Level III or Level IV designation as described in DOE/RL-96-32, *Hanford Site Biological Resources Management Plan*; therefore, revegetation at the 600-228 waste site is not required. DOE may elect to revegetate the 600-228 waste site at a future date for aesthetic purposes.

3.1.5 Statement of Protectiveness

In accordance with the SAP (DOE/RL-2009-60), the soil at the 600-228 waste site has been sampled, analyzed, and evaluated. The results obtained through the implementation of the RTD alternative demonstrate that contaminant concentrations in the soil at the 600-228 waste site are less than RALs (discussed in further detail in Chapter 5). These results also indicate that residual concentrations will support reasonably anticipated future land use recognized in the EE/CA (DOE/RL-2008-44) and Action Memorandum (DOE/RL-2009-86), and demonstrate that residual concentrations of COPCs in soil throughout the site are unlikely to affect groundwater or the Columbia River. As summarized in Chapter 5, a review of the sampling results showed that the removal action at the 600-228 waste site has demonstrated achievement of the RAOs established in the Action Memorandum and identified in the RAWP (DOE/RL-2009-53).

4 Chronology of Events

Table 4-1 presents a chronology of major events associated with sampling the subject waste site. The chronology includes approval of the regulatory documents that form the basis of the removal action and key fieldwork activities associated with the removal action.

Table 4-1. Response Action Chronology

Date	Event
June 5, 2009	DOE/RL-2008-44, *Engineering Evaluation/Cost Analysis for the 200-MG-1 Operable Unit Waste Sites*, approved
February 17, 2010	Site evaluation of the 600-228 waste site completed
April 15, 2010	DOE/RL-2009-86, Revision 0, *Action Memorandum for Non-Time-Critical Removal Action for 37 Waste Sites in 200-MG-1* Operable Unit, approved
April 21, 2010	Draft of DOE/RL-2009-53, Revision 1, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit*, completed and routed for approval
May 20, 2010	Draft of DOE/RL-2009-60, Revision 1, *Sampling and Analysis Plan for Selected 200-MG-1 Operable Unit Waste Sites,* completed and routed for approval
June 22, 2010	Initial surface sampling of the 600-228 waste site commenced
July 20, 2010	Laboratory analytical data evaluation completed
October 7, 2010	DOE/RL-2009-53, Revision 1, approved
November 11, 2010	Initial depth sampling of the 600-228 waste site completed
November 23, 2010	Laboratory analytical data evaluation completed
January 10, 2011	DOE/RL-2009-60, Revision 1, approved
May 10, 2011	RTD of the 600-228 waste site commenced
June 8, 2011	In process sampling of the 600-228 waste site conducted
June 22, 2011	Laboratory analytical data evaluation completed
July 15, 2011	RTD of the 600-228 waste site completed
August 2, 2011	Verification sampling of the 600-228 waste site completed
August 17, 2011	Laboratory analytical data evaluation completed
August 22, 2011	Backfill Concurrence Form approved
September 8, 2011	Backfill of the 600-228 waste site completed

5 Performance Standards and Construction Quality Control

This section addresses the process for demonstrating achievement of performance standards, which include attaining RALs and RAOs and maintaining the required quality control (QC) during removal activities.

5.1 Attainment of Performance Standards

Initial, in process, and verification sampling and analysis confirm that the 600-228 waste site meets the RAOs identified in the Action Memorandum (DOE/RL-2009-86), and residual levels of COPCs remaining in the soil are less than or equal to the RALs. As shown in Table 5-1, RAOs 1 and 2 are achieved by preventing unacceptable risk to human health and the environment through direct exposure to soils and debris by reducing the soil concentration of COPCs to less than or equal to the RALs. RAO 3 is achieved by preventing migration and/or leaching of radiological and nonradiological contamination to groundwater by reducing the soil concentration of COPCs to less than or equal to the RALs. RAO 4 is met through cultural and ecological evaluation, performed in May 2010 and January 2010, respectively, and by the implementation of considerations and recommendations during work activities. Demonstration that the soil concentration of COPCs is less than or equal to RALs (Table 5-2) meets RAOs 1, 2, and 3.

Table 5-1. Summary of Attainment of Cleanup Objectives

Removal Action Objective	Compliance Methods	Removal Action Objective Attained?
RAO 1: Prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with nonradiological constituents to 4.6 m (15 ft) bgs at concentrations above the appropriate RALs.	Achieved through verification soil sampling, performed upon completion of RTD activities, which demonstrated that all individual COPC concentrations are less than the RALs.	Yes
RAO 2: Prevent unacceptable risk to human health and ecological receptors from exposure to soils and/or debris contaminated with radiological constituents to 4.6 m (15 ft) bgs at concentrations above the appropriate RALs.	Achieved through the radiological survey of soils within the ZPCs, conducted during site evaluation and sampling evolutions, which resulted in no measured dose rates greater than background for the waste site and no detectable radiological contamination. This demonstrates that COPC concentrations are below the RALs as a result.	Yes
RAO 3: Control the sources of groundwater contamination to minimize impacts to groundwater resources, protect the Columbia River from adverse impacts, and reduce the degree of groundwater cleanup that may be required under future actions.	Achieved through verification soil sampling, performed upon completion of RTD activities, which demonstrated that concentrations of COPCs in soil were less than established RALs.	Yes
RAO 4: Prevent adverse impacts to cultural resources and threatened or endangered species, and minimize wildlife habitat disruption.	Achieved through cultural and ecological evaluation and the implementation of considerations during removal activities to minimize wildlife habitat and cultural artifact disruption.	Yes

Per the methodology prescribed in the RAWP (DOE/RL-2009-53) and SAP (DOE/RL-2009-60), initial sampling of the 600-228 waste site consisted of visual inspection, radiological survey, and soil sampling performed starting in February 2010. Resulting data from the sampling evolution indicating concentrations of COPCs greater than the RALs initiated the removal of debris and impacted soils, performed in May through July 2011, followed by verification sampling performed in August 2011. The analytical results, provided in Table 5-2, and Tables A-1 through Table A-3 (Appendix A), demonstrate that there are no chemical COPC concentrations greater than the RALs remaining in soil at the 600-228 waste site, thus meeting RAOs 1 and 3. Radiological survey performed during removal action activities demonstrated no radiological dose rates greater than background and no contamination found, thus meeting RAO 2.

This waste site and the data obtained from the subject sampling evolutions will be included in the RI/FS for final remedial action of the Outer Area.

5.1.1 Performance Standard Documentation

This response action report addresses the individual 600-228 waste site and not an OU; therefore, this section is not applicable.

5.1.2 Response Action Objectives Verification

RAO performance standard attainment involves comparisons of soil analytical data to RALs. The RALs, identified in the Action Memorandum (DOE/RL-2009-86) and RAWP (DOE/RL-2009-53), are directly compared to the maximum results from the verification sampling analytical data (Table 5-2). Appendix A provides a full set of analytical results from all samples collected.

5.1.3 Contaminant Identification

Table 5-2 provides a direct comparison of verification sample analytical results for each nonradiological COPC, as determined from process knowledge and historical information, against the established RALs for the 600-228 waste site.

Table 5-2. Comparison of Sample Results Against Removal Action Levels for Nonradiological Contaminants of Potential Concern

Contaminant of Potential Concern	Background Concentration[a] (mg/kg)	Removal Action Levels (mg/kg)	Maximum Concentration in Soil (mg/kg)	Does the Maximum Exceed Removal Action Levels?
Metals				
Antimony	5	5.4	0.49	No
Arsenic	6.5	6.5[b]	6.19	No
Barium	132	1,650	212	No
Beryllium	1.51	63.2	0.433	No
Boron	N/A	210	47.6	No
Cadmium	0.81	0.81[b]	0.21	No
Chromium (Total)	18.5	2,000	12.6	No
Chromium (VI)	N/A	--[c]	0.1	No
Cobalt	15.7	15.7[b]	9.21	No
Copper	22.0	284	27.5	No
Lead	10.2	250	6.54	No
Lithium	33.5	160	14.5	No
Manganese	512	512[b]	418	No
Mercury	0.33	2.09	U	No
Nickel	19.1	130	12.1	No
Selenium	0.78	5.2	2.25	No
Silver	0.73	13.6	0.25	No
Strontium	N/A	2920	211	No
Thallium	0.1	1.59	0.125	No
Tim	N/A	48,000	3.35	No
Uranium (soluble salts)	3.21	3.21[b]	1.29	No
Vanadium	85.1	560	64.8	No
Zinc	67.8	5,970	201	No
Polychlorinated Biphenyls				
Aroclor-1016	N/A	0.094	U	No
Aroclor-1221	N/A	0.017	U	No
Aroclor-1232	N/A	0.017	U	No

Table 5-2. Comparison of Sample Results Against Removal Action Levels for Nonradiological Contaminants of Potential Concern

Contaminant of Potential Concern	Background Concentration[a] (mg/kg)	Removal Action Levels (mg/kg)	Maximum Concentration in Soil (mg/kg)	Does the Maximum Exceed Removal Action Levels?
Aroclor-1242	N/A	0.039	U	No
Aroclor-1248	N/A	0.039	U	No
Aroclor-1254	N/A	0.066	U	No
Aroclor-1260	N/A	0.5	U	No
Anions				
Nitrate (as Nitrogen)	11.8	40	2.42	No
Polynuclear Aromatic Hydrocarbons				
Acenaphthene	N/A	98	U	No
Acenaphthylene	N/A	98	U	No
Anthracene	N/A	2,270	U	No
Benzo[*a*]anthracene	N/A	0.86	U	No
Benzo[*a*]pyrene	N/A	0.33[b]	U	No
Benzo[*b*]fluoranthene	N/A	1.37	U	No
Benzo[*g,h,i*]perylene	N/A	2,400	U	No
Benzo[*k*]fluoranthene	N/A	1.37	U	No
Chrysene	N/A	9.56	U	No
Dibenz[*a,h*]anthracene	N/A	1.37	0.35	No
Fluoranthene	N/A	631	0.16	No
Fluorene	N/A	101	0.16	No
Indeno[*1,2,3-cd*]pyrene	N/A	1.37	0.35	No
Naphthalene	N/A	4.46	U	No
Phenanthrene	N/A	1,140	U	No
Pyrene	N/A	655	U	No
Total Petroleum Hydrocarbons				
TPH – Diesel	N/A	2000	35	No
TPH – Kerosene	N/A	2000	U	No

a. If Hanford Site-specific background data are not available, values are then taken from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*. Hanford Site background values are available from nonradiological background data in DOE/RL-92-24, *Hanford Site Soil Background: Part 1, Soil Background for Nonradioactive Analytes*, Table D9-2.

Table 5-2. Comparison of Sample Results Against Removal Action Levels for Nonradiological Contaminants of Potential Concern

Contaminant of Potential Concern	Background Concentration[a] (mg/kg)	Removal Action Levels (mg/kg)	Maximum Concentration in Soil (mg/kg)	Does the Maximum Exceed Removal Action Levels?

b. Where cleanup levels are less than background or RDLs, cleanup levels default to background or RDLs in accordance with WAC 173-340-700(6)(d), "Overview of Cleanup Standards," and WAC 173-340-707(2), "Analytical Considerations," respectively.

c. Based on process knowledge, chromium (VI) is not expected to be present at 200-MG-1 OU waste sites. The following values are given to help guide cleanup:

- 0.2 mg/kg is the calculated value using Kd=0, based on PNNL-13895, Hanford Contamination Distribution Coefficient Database and Users Guide, and WAC 173-340-747, "Deriving Soil Concentrations for Groundwater Protection," equation 747-1.
- 2.1 mg/kg is based on DOE/RL-96-17, Remedial Design Report/Remedial Action Work Plan for the 100 Area.
- 18.4 mg/kg is based on Ecology, 2007, Cleanup Levels and Risk Calculations database.

N/A = not available
RDL = required detection limit
TPH = total petroleum hydrocarbon
U = result is less than laboratory detection limit

5.2 Construction Quality Assurance/Quality Control

No construction-related aspects were implemented as part of the selected remedy for the 600-228 waste site; therefore, this section is not applicable.

5.3 Clean-up Verification QA/QC

A data quality assessment (DQA) review was performed to compare the sampling approach and analytical data with the sampling and data requirements specified by the SAP (DOE/RL-2009-60). This review involves evaluation of the data to determine if they are of the right type, quality, and quantity to support the intended use. The assessment review completes the data life cycle (i.e., planning, implementation, and assessment) that was initiated by the data quality process.

Level C data validation as defined in the contractor's validation procedures, which are based on EPA functional guidelines (for example, Bleyler, 1988a, *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*; Bleyler, 1988b, *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*), was performed for the entire sampling and analysis data package for the samples collected for the 600-228 waste site. 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.

Specific data quality objectives for the site are found in the SAP (DOE/RL-2009-60).

All of the sampling and analysis data generated from the sampling at the 600-228 waste site are tracked through the Hanford Environmental Information System (HEIS). All of the sampling and analysis data for the 600-228 waste site were found to be useable for decision-making purposes as provided in the following summary:

HEIS Identification Numbers: B25FT9, B25FV0, B25FV1, B25FV2, B25FV4, B25FV5, B25FV6, B25FV7, B25FV8, B25FV9, B25FW0, B25FW1, B25FW2, B25H62, B25H63, B25H64, B25H65, B25H66, B25H67, B25H68, B25H69, B25H70, B25H71, B25H72, B25H74, B2F5J7, B2F5J8, B2F5J9, B2F5K0, B2F5K1, B2F5K3, B2F5K6, B2F5K7, B2FPJ0, B2FPJ1, B2FPJ2, B2FPJ3, B2FPJ4, B2FPJ5, B2FPJ6, B2FPJ7, B2FPJ9, B2FPK0, B2FPK1 and B2FPK2.

Blanks: Equipment blanks (B25FY5, B25FY6, B25H82, B25H83, B25H84, B25H85, B25H86, B25H87, B25H88, B29CJ4, B2F5K4 and B2FPK6) were received intact to the laboratory and holding times were acceptable.

Field Duplicates: The duplicate (B25FV3, B25H73, B25H73, B2F5K2 and B2FPJ8) results were acceptable.

Data Completeness: Analytical reports submitted for validation and verified for completeness based on the percentage of data determined to be valid (i.e., not rejected). The completion percentage was 100 percent. The data has been determined to be useable for decision-making purposes. The final results, narrative supporting the sampling analysis activities and findings, and copies of chains of custody were transmitted in letter reports from the laboratory.

Field Screening: 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 physical property data and/or field screening results was performed. However, field quality assurance (QA)/QC was reviewed to ensure that the data are useable. Field instrumentation, calibration, and QA checks were performed in accordance with the following:

- Calibration of radiological field instruments (such as Geiger-Müeller and portable alpha meters) on the Hanford Site is performed under contract by Pacific Northwest National Laboratory, as specified in their program documentation.
- Daily calibration checks are performed and documented for each instrument used in support of waste site sampling and investigation. These checks are made on standard materials that are sufficiently like the matrix under consideration that direct comparison of data can be made. Daily calibration checks of radiological field instruments were performed by trained and qualified radiological control technicians in accordance with established program requirements.

The review and approval of completed field radiation surveys by the radiological controls organization represents the data validation and usability review for handheld field radiological measurements.

The DQA review for the 600-228 waste site found the analytical results to be accurate within the standard errors associated with the methods, including sampling and sample handling. The data are of the correct type, quality, and quantity to support the intended use. Detection limits, precision, accuracy, and sampling data group completeness were assessed to determine if any analytical results should be rejected because of QA/QC deficiencies. All analytical data were found acceptable for decision-making purposes. All of the sampling analytical data are stored in HEIS.

5.4 Regulatory Oversight

This document provides a summary of the removal action taken at the 600-228 waste site; it shows a comparison of the data collected to RALs authorized in approved regulatory documents and provides the basis to reclassify the waste site status (see Section 9). Though this report does not require approval by Ecology or the EPA, concurrence of those agencies is necessary, under CERCLA Section 120 and the Tri-Party Agreement (Ecology et al., 1989), for determinations concerning follow on remedial actions. This report is therefore provided to the agency (or agencies) for review, in accordance with the approval process for waste site reclassification, as supporting documentation. Upon approval of the waste site reclassification, a copy of this report shall be maintained in the Administrative Record. No additional regulatory oversight was required for the sampling of the 600-228 waste site.

6 Final Inspection and Certifications

There were no final inspections or certifications required in the implementation of the selected alternative for the 600-228 waste site; therefore, this section is not applicable.

7 Operations and Maintenance Activities

This chapter discusses the operations and maintenance (O&M) for the 600-228 waste site.

7.1 Remedy Related Operations and Maintenance or Monitoring

There are no O&M activities or monitoring requirements for the 600-228 waste site; therefore, this section is not applicable.

7.2 Institutional Controls

Based on the analyses performed and presented in this report, there are no waste site specific institutional controls required at the 600-228 waste site; therefore, this section is not applicable.

7.3 Five-Year Reviews

Five-year reviews are required by CERCLA for post-ROD remedial actions, but do not apply to the 600-228 waste site. This waste site and the data obtained from the subject sampling evolutions will be included in the risk assessment and RI/FS for final remedial action of the Outer Area.

8 Summary of Project Costs

For the purposes of reporting costs of removal action for the 600-228 waste site, costs are pro rated utilizing an activity/schedule-based methodology (Table 8-1). This method is not considered to be audit quality data. Actual costs for waste site clean-up will continue to be collected for each OU or closure area in accordance with the current cost tracking methodology. These costs will then be included, in accordance with CERCLA requirements, in the response action report for the final remedial action of the OU or closure area.

Table 8-1. Cost Summary

Cost Item	Actual Cost Fiscal Year 2010 ($)	Actual Cost Fiscal Year 2011 ($)	Actual Total Cost ($)
Removal Action Capital (Construction) Costs	0	0	0
Removal Action Operating Costs	162,746.37	63,605.51	226,351.88
Total Removal Action Cost	162,746.37	63,605.51	226,351.88
Projected Yearly Operations and Maintenance Cost	0	0	0

9 Waste Site Reclassification

The waste site reclassification form for the 600-228 waste site is proposed and processed in accordance with the procedures and definitions described in RL-TPA-90-0001, 2007, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS) (TPA-MP-14). Reclassification form 2011-077 for the 600-228 waste site proposes that the status of this waste site be changed to "interim closed out." Per TPA-MP-14, "interim closed out" status indicates that a site meets the cleanup standards specified in the approved 200-MG-1 Action Memorandum (DOE/RL-2009-86) (i.e., the interim response action decision document). This site will be evaluated under the cleanup standards established for the final ROD for this area.

10 Observations and Lessons Learned

There were no observations or lessons learned applicable for inclusion in this report.

11 Contact Information

The DOE Contractor:

R.L. Cathel
Geographic Closure, Environmental, Waste, and Quality Assurance Director
CH2M HILL Plateau Remediation Company
P.O. Box 1600, MSIN R3-60
Richland, WA 99352
Telephone: 509-373-9171

The Project Manager for DOE:

F.M. Roddy
200-MG-1 Operable Unit Project Manager
Department of Energy, Richland Operations Office
P.O. Box 550, MSIN A5-11
Richland, WA 99352
Telephone: 509-372-0945

The Project Manager for the Lead Regulatory Agency:

L. Buelow
Environmental Scientist
U.S. Environmental Protection Agency
Hanford Project Office
309 Bradley Boulevard, Suite 115, MSIN B1-46
Richland, WA 99352
Telephone: 509-376-5466

12 References

40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan," *Code of Federal Regulations*. Available at: http://www.access.gpo.gov/nara/cfr/waisidx_10/40cfr300_10.html.

Appendix B, "National Priorities List," *Code of Federal Regulations*. Available at: http://edocket.access.gpo.gov/cfr_2009/julqtr/40cfr300AppB.htm.

53 FR 23988, "National Priorities List for Uncontrolled Hazardous Waste Sites – Update 7," *Federal Register*, Vol. 53, No. 122, pp. 23988 – 23998, June 24, 1988. Available at: http://www.epa.gov/superfund/sites/npl/p880624.htm#23988.

54 FR 41015, "National Priorities List for Uncontrolled Hazardous Waste Sites – Final Rule 10/04/89," *Federal Register*, Vol. 54, No. 191, pp. 41015 – 41025, October 4, 1989. Available at: http://www.epa.gov/superfund/sites/npl/f891004.htm#41015.

Bleyler, Ruth, 1988a, *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*, Hazardous Site Evaluation Division, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www2.hanford.gov/ARPIR/index.cfm?content=findpage&AKey=D196013784.

Bleyler, Ruth, 1988b, *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses*, Hazardous Site Evaluation Division, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www2.hanford.gov/ARPIR/index.cfm?content=findpage&AKey=D196013785.

C-06-02, 2006, *Federal Facility Agreement and Consent Order Change Control Form: Hanford Federal Facility Agreement and Consent Order, Appendix C, Prioritized Listing of Operable Units*, dated September 14, U.S. Department of Energy, Richland Operations Office, Washington State Department of Ecology, and U. S. Environmental Protection Agency, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=DA04569777.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: http://epw.senate.gov/cercla.pdf.

DOE Office of Health, Safety, and Security 2004, *CERCLA Remedial Action Site Closure Guidance*. Available at: http://homer.ornl.gov/nuclearsafety/env/guidance/cercla/siteclosure.

DOE/EIS-0222-F, 1999, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Washington, D.C. Available at:
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158842.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158843.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158844.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158845.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158846.
http://www5.hanford.gov/arpir/?content=findpage&AKey=D199158847.

DOE/EIS-0222-SA-01, 2008, *Supplement Analysis: Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/SAwith_signed-R1.pdf.

DOE/RL-92-24, 2001, *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analytes*, Rev. 4, 2 vols., U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0096062. http://www2.hanford.gov/arpir/?content=findpage&AKey=0096061.

DOE/RL-96-12, 1996, *Hanford Site Background: Part 2, Soil Background for Radionuclides*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www2.hanford.gov/arpir/?content=findpage&AKey=D1808987.

DOE/RL-96-17, 2009, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0095436.

DOE/RL-96-32, 2001, *Hanford Site Biological Resources Management Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.pnl.gov/ecomon/docs/brmap/BRMaP.pdf.

DOE/RL-2008-44, 2009, *Engineering Evaluation/Cost Analysis for the 200-MG-1 Operable Unit Waste Sites*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0096350.

DOE/RL-2009-48, 2009, *Action Memorandum for Non-Time-Critical Removal Action for 11 Waste Sites in 200-MG-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0096131.

DOE/RL-2009-53, 2010, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/arpir/index.cfm?content=findpage&AKey=0912100290.

DOE/RL-2009-60, 2011, *Sampling and Analysis Plan for Selected 200-MG-1 Operable Unit Waste Sites*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www5.hanford.gov/pdw/fsd/AR/FSD0001/FSD0064/0084054/11-AMCP-0080_-_Letter_[1102030315]_-_1.pdf.

DOE/RL-2009-86,2009, *Action Memorandum for Non Time Critical Removal Action for 37Waste Sites in 200-MG-1 Operable Unit*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Availablc at: http://www2.hanford.gov/arpir/?content=findpage&AKey=0084449

Ecology Publication 94-06, 2003, *Model Toxics Control Act Cleanup Regulation 173-340 WAC*, as revised, Washington State Department of Ecology, Olympia, Washington.

Ecology Publication 94-115, 1994, *Natural Background Soil Metals Concentrations in Washington State*, Toxics Cleanup Program, Washington State Department of Ecology, Olympia, Washington. Available at: http://www.ecy.wa.gov/pubs/94115.pdf.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

EPA 540-R-98-016, 2000, *Close Out Procedures for National Priorities List Sites*, OSWER Directive 9320.2-09A-P, Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/superfund/programs/npl_hrs/closeout/pdf/guidance.pdf.

EPA/540-R-00-007, 2000, *Soil Screening Guidance for Radionuclides: User's Guide*, OSWER 9355.4-16A, Office of Radiation and Indoor Air, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C. Available at: http://www.epa.gov/superfund/health/contaminants/radiation/radssg.htm.

EPA 2004. *Clarifying Cleanup Goals and Identification of New Assessment Tools for Evaluating Asbestos at Superfund Cleanups*. OSWER 9345.4-05. Available at: http://www.epa.gov/region09/toxic/noa/eldorado/pdf/memo722b.pdf.

Ecology, 2007, Cleanup Levels and Risk Calculations (CLARC) database, Washington State Department of Ecology. Available at: https://fortress.wa.gov/ecy/clarc/CLARCHome.aspx.

Executive Order 12580, 1987, *Superfund Implementation*, Ronald W. Reagan, January 23. Available at: http://www.archives.gov/federal-register/codification/executive-order/12580.html.

Lindsey, K.A., 1996, *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-Central Washington and North-Central Oregon*, Washington Department of Natural Resources, Washington Division of Geology and Earth Resources, Open File Report 96-8, Olympia, Washington. Available at: http://www/dnr.wa.gov/Publications/ger_ofr96-8_ringold_formation.pdf.

PNL-5506, 1986, *Hanford Site Water Table Changes 1950 through 1980: Data Observations and Evaluation*, Pacific Northwest Laboratory, Richland, Washington.

PNL-10285, 1995, *Estimated Recharge Rates at the Hanford Site*, Pacific Northwest Laboratory, Richland, Washington. Available at: http://www.osti.gov/energycitations/servlets/purl/10122247-XORHkt/webviewable/10122247.pdf.

PNNL-13116, 2000, *Hanford Site Groundwater Monitoring for Fiscal Year 1999*, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=D2736610. http://www5.hanford.gov/arpir/?content=findpage&AKey=D2736978.

PNNL-13895, 2003, *Hanford Contaminant Distribution Coefficient Database and Users Guide*, Rev. 1, Pacific Northwest National Laboratory, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=0911300341.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://epw.senate.gov/rcra.pdf.

RL-TPA-90-0001, 2007, *Tri-Party Agreement Handbook Management Procedures, Guideline Number TPA-MP-14*, "Maintenance of the Waste Information Data System (WIDS)," Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://www.hanford.gov/files.cfm/TPA-MP14.pdf.

Superfund Amendments and Reauthorization Act of 1986, 42 USC 103, et seq. Available at: http://www.epa.gov/superfund/policy/sara.htm.

TPA-CN-350, *Tri-Party Agreement Change Notice Form: DOE/RL-2009-86 Action Memorandum for Non-Time-Critical Removal Action for 37 Waste Sites in the 200-MG-1 Operable Unit, Rev. 0,* dated October 10, U.S. Department of Energy, Richland Operations Office, and Washington State Department of Ecology, Richland, Washington. Available at: http://www5.hanford.gov/arpir/?content=findpage&AKey=1010270164.

WAC 173-340, "Model Toxics Control Act—Cleanup," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-340.

340-700, "Overview of Cleanup Standards."

340-707, "Analytical Considerations."

340-747, "Deriving Soil Concentrations for Groundwater Protection."

340-900, "Tables."

Appendix A

Sampling Results for the 600-228 Waste Site

A1 Sampling Results for the 600-281 Waste Site

This appendix contains laboratory analytical results, provided in Tables A-1 through A-3, from the sampling conducted at the 600-228 waste site. The following information is provided in the table headings: Hanford Environmental Information System identification numbers, field sample identifier, and sample depth. Surface samples are collected from approximately 0 to 0.3 m (0 to 1 ft) below ground surface (bgs), and depths listed are bgs.

Tables A-1a and A-1b provide analytical results for nonradiological contaminants from samples collected during the initial phase of sampling. Analytical results from two areas did not meet the established removal action levels (RALs), therefore requiring removal, treatment, and disposal (RTD).

Table A-2 provides analytical results from in process samples collected during RTD activities. The analytical results from these in process samples were used to further refine the vertical extent of excavation at ZPC 1 during RTD activities.

Tables A-3 includes final verification sampling results for nonradiological contaminants of potential concern (COPCs) from the areas of impact identified during initial sampling. The analytical results presented in these tables demonstrate achievement of the established RALs and corresponding removal action objectives (RAOs) at the 600-228 waste site.

Table A-1a. Analytical Results for Initial Surface Sampling for Nonradiological Contaminants

Contaminant	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B25FT9 ZPC 1-1 Surface	B25FV0 ZPC 1-2 Surface	B25FV1 ZPC 1-3 Surface	B25FV2 ZPC 1-4 Surface	B25FV4 ZPC 1-5 Surface	B25FV5 ZPC 1-6 Surface	B25FV6 ZPC 1 FS 1 Surface	B25FV7 ZPC 1 FS 2 Surface	B25FV8 ZPC 2-1 Surface	B25FV9 ZPC 3-1 Surface	B25FW0 ZPC 4-1 Surface	B25FW1 ZPC 4-2 Surface	B25FW2 ZPC 4-3 Surface
Metals	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Antimony	5.4	0.6	0.33	5	U	U	U	0.36	U	U	10.6	U	U	U	U	U	0.49
Arsenic	6.5[c]	1	0.44	6.5	3.78	3.89	3.02	3.04	2.91	2.62	4.15	4.37	6.19	2.55	2.48	2.84	2.68
Barium	1,650	2	0.22	132	88.9	98.4	82.7	86.6	80.3	76.5	81.6	87.1	107	78.1	83	77	212
Beryllium	63.2	0.5	0.11	1.51	0.32	0.37	0.3	0.29	0.32	0.27	0.3	0.29	0.4	0.23	0.25	0.26	0.25
Boron	210	2	4.5	N/A	29.5	33.8	26.8	28.9	27.4	27.1	26	29	24.9	24.8	24.6	26.1	47.6
Cadmium	0.81[c]	0.5	0.11	0.81	0.15	0.12	U	0.11	U	U	0.21	U	0.12	0.13	U	U	0.16
Chromium (Total)	2000	1	0.54	18.5	10.3	9.65	7.93	8.8	8.45	7.39	8.64	7.76	10.4	7.86	6.58	7.76	8.16
Chromium (VI)	N/A	0.5	0.11	N/A	U	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	U
Cobalt	15.7[c]	2	0.11	15.7	8.38	8.56	7.86	8.06	7.56	6.82	8.39	7.87	8.05	7.92	7.18	8.19	6.62
Copper	284	1	0.11	22	12.6	14.6	13.1	12.1	10.9	10.2	17.3	12	16.2	27.5	10.8	11.5	20.9
Lead	250	5	0.11	10.2	5.58	24.7	5.73	6.02	5.53	5.75	453	6.04	7.4	5.65	5.03	4.79	941
Lithium	160	2.5	0.44	33.5	9.11	9.92	7.53	8.51	7.79	7.32	9	10.4	14.5	7.31	6.73	7.55	10.6
Manganese	512[c]	5	0.11	512	374	381	370	359	366	335	360	362	418	370	327	368	319
Mercury	2.09	0.2	0.054	0.33	U	U	U	U	U	U	U	U	U	U	U	U	U
Nickel	130	4	0.22	19.1	10	10.1	8.95	10.4	9.67	8.04	10.6	8.77	11.3	9.3	8.25	9.34	8.86
Selenium	5.2	1	0.33	0.78	1.21	1.4	1.09	1.22	1.48	1.03	0.85	1.53	1.57	1.14	0.85	1.01	0.85
Silver	13.6	0.2	0.11	0.73	U	U	U	U	U	U	0.25	U	U	U	U	U	U
Strontium	2,920	1	0.11	N/A	28.8	38.3	21.4	27.1	23.7	23.4	23.9	33.5	45.2	22.5	28.4	26.8	211
Thallium	1.59	1	0.11	0.1	U	0.11	U	U	U	U	U	U	0.1	U	U	U	U
Tin	48,000	10	0.11	N/A	0.49	0.49	0.42	0.4	0.38	0.4	0.84	0.38	0.38	0.43	0.35	0.36	0.85
Uranium	3.21[c]	1	0.11	3.21	0.41	0.76	0.34	0.4	0.38	0.37	0.75	0.49	0.44	0.35	0.44	0.34	0.34
Vanadium	560	2.5	0.22	85.1	62.6	64.8	62.8	61.9	57.7	54.6	55.3	59	48.1	62.4	57.6	61.8	52.8
Zinc	5970	1	0.87	67.8	46.5	48.4	43.3	47.8	44.5	42	76.5	43.7	43.5	82.8	38.9	44.2	201
Anions	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Nitrate-N	40	0.75	1.7[d]	11.8	U	U	U	2.41	U	1.85	U	U	U	U	U	U	2.42

Table A-1a. Analytical Results for Initial Surface Sampling for Nonradiological Contaminants

Contaminant	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B25FT9 ZPC 1-1 Surface	B25FV0 ZPC 1-2 Surface	B25FV1 ZPC 1-3 Surface	B25FV2 ZPC 1-4 Surface	B25FV4 ZPC 1-5 Surface	B25FV5 ZPC 1-6 Surface	B25FV6 ZPC 1 FS 1 Surface	B25FV7 ZPC 1 FS 2 Surface	B25FV8 ZPC 2-1 Surface	B25FV9 ZPC 3-1 Surface	B25FW0 ZPC 4-1 Surface	B25FW1 ZPC 4-2 Surface	B25FW2 ZPC 4-3 Surface
Polynuclear Aromatic Hydrocarbons	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**
Acenaphthene	98	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Acenaphthylene	98	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Anthracene	2,270	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*a*]anthracene	0.86	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*a*]pyrene	0.33[c]	0.33	0.24	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*b*]fluoranthene	1.37	0.33	0.21	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*k*]fluoranthene	1.37	0.33	0.22	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*g,h,i*]perylene	2,400	0.33	0.35[d]	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Chrysene	9.56	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Dibenzo[*a,h*]anthracene	1.37	0.33	0.35[d]	N/A	U	0.35	0.34	0.35	0.34	0.35	0.35	0.35	0.34	0.34	0.33	0.34	U
Fluoranthene	631	0.33	0.2	N/A	U	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.16	U
Fluorene	101	0.33	0.2	N/A	U	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.16	U
Indeno[*1,2,3-cd*]pyrene	1.37	0.33	0.35[d]	N/A	U	0.35	0.34	0.35	0.34	0.35	0.35	0.35	0.34	0.34	0.33	0.34	U
Naphthalene	4.46	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Phenanthrene	1,140	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Pyrene	655	0.5	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Polychlorinated Biphenyls	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**
Aroclor 1016	0.094	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1221	0.017[c]	0.017	0.009	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1232	0.017[c]	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1242	0.039	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1248	0.039	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1254	0.066	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1260	0.5	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U

Table A-1a. Analytical Results for Initial Surface Sampling for Nonradiological Contaminants

Contaminant	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B25FT9 ZPC 1-1 Surface	B25FV0 ZPC 1-2 Surface	B25FV1 ZPC 1-3 Surface	B25FV2 ZPC 1-4 Surface	B25FV4 ZPC 1-5 Surface	B25FV5 ZPC 1-6 Surface	B25FV6 ZPC 1 FS 1 Surface	B25FV7 ZPC 1 FS 2 Surface	B25FV8 ZPC 2-1 Surface	B25FV9 ZPC 3-1 Surface	B25FW0 ZPC 4-1 Surface	B25FW1 ZPC 4-2 Surface	B25FW2 ZPC 4-3 Surface
Total Petroleum Hydrocarbons	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**
Diesel	2,000	5	4.3	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U
Kerosene	2,000	5	4.3	N/A	U	U	U	U	U	U	U	U	U	U	U	U	U

a. Removal action levels are from DOE/RL-2009-53, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit* (RAWP).

b. If Hanford Site-specific background data is not available, values are then taken from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*. Hanford Site background values are available in Nonradiological Background data from DOE/RL-92-24, Rev. 1, Table D39-2.

c. Where cleanup levels are less than background or required detection limits, cleanup levels default to background or required detection limits per Ecology (1996), WAC 173-340-700(6)(d), and WAC 173 340 707(2), respectively.

d. Maximum reported laboratory method detection limits were greater than the required detection limit per the RAWP; however, analytical results are below the established removal action levels and meet the corresponding removal action objectives.

N/A = not available

U = result is less than laboratory method detection limit

Table A-1b. Analytical Results for Initial Depth Sampling for Nonradiological Contaminants

Contaminant	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B25H62 ZPC 1-1 0.6 to 1.2 m (2 to 4 ft)	B25H63 ZPC 1-2 0.6 to 1.2 m (2 to 4 ft)	B25H64 ZPC 1-3 0.6 to 1.2 m (2 to 4 ft)	B25H65 ZPC 1-4 0.6 to 1.2 m (2 to 4 ft)	B25H66 ZPC 1-5 0.6 to 1.2 m (2 to 4 ft)	B25H67 ZPC 1-6 0.6 to 1.2 m (2 to 4 ft)	B25H68 ZPC 1-6 2.4 to 3 m (8 to 10 ft.)	B25H69 ZPC 1-6 3.4 to 4 m (11 to 13ft.)	B25H70 ZPC 1 FS1	B25H71 ZPC 1 FS2 0.6 to 1.2 m (2 to 4 ft)	B25H72 ZPC 3-1 0.6 to 1.2 m (2 to 4 ft)	B25H74 ZPC 3-1 1 m (3 ft)
Metals	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**
Antimony	5.4	0.6	0.33	5	U	U	U	7.93	U	U	U	U	U	U	U	U
Arsenic	6.5[c]	1	0.44	6.5	2.31	3.4	4.07	3.23	3.63	3.41	5.01	5.97	4.82	3.73	5.16	5.56
Barium	1,650	2	0.22	132	95.6	102	90.8	101	92.8	90.8	103	113	93.3	114	75	96.6
Beryllium	63.2	0.5	0.11	1.51	0.39	0.296	0.232	0.164	0.338	0.154	0.301	0.191	0.249	0.36	0.189	0.363
Boron	210	2	4.5	N/A	9.8	10.6	U	U	7.17	5.53	6.17	9.24	U	U	34.5	16.9
Cadmium	0.81[c]	0.5	0.11	0.81	U	0.186	0.0932	0.105	U	U	0.111	0.128	0.117	0.0953	U	0.106
Chromium (Total)	2000	1	0.54	18.5	8.86	7.34	10.7	10.9	7.94	6.86	11.3	9.97	12.6	10.6	4.98	8.57
Chromium (VI)	N/A	0.5	0.11	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Cobalt	15.7[c]	2	0.11	15.7	8.22	7.33	8.66	8.11	8.05	7.43	8.17	7.83	8.18	8.66	6.83	8.15
Copper	284	1	0.11	22	16.7	13	13.1	22	11.6	10.5	14.6	14.6	12.2	12.9	11.4	25.5
Lead	250	5	0.11	10.2	4.83	43.5	5.13	9.49	5	5.25	6.57	7.34	9.38	4.89	4.25	7.59
Lithium	160	2.5	0.44	33.5	5.82	6.95	8.79	6.63	8.19	9.08	11.6	13.1	10.7	8.34	6.82	8.05
Manganese	512[c]	5	0.11	512	304	347	377	357	352	326	399	376	367	385	283	372
Mercury	2.09	0.2	0.054	0.33	U	U	U	U	U	U	U	U	U	U	U	U
Nickel	130	4	0.22	19.1	9.55	9.01	10.2	11.2	9.66	9.07	12.1	10.3	10.3	10.2	6.98	9.77
Selenium	5.2	1	0.33	0.78	2.06	0.822	1.58	0.921	1.56	1.46	0.794	1.73	1.28	1.34	1.75	2.25
Silver	13.6	0.2	0.11	0.73	U	U	U	U	U	U	U	U	U	U	U	U
Strontium	2,920	1	0.11	N/A	20.3	38	37.5	22.5	27.8	27	29.9	34.7	37.5	26.9	37.6	47.6
Thallium	1.59	1	0.11	0.1	U	U	U	U	U	V	0.125	0.118	U	U	U	U
Tin	48,000	10	0.11	N/A	0.402	3.35	0.318	2.35	0.354	0.371	0.346	0.374	0.389	0.406	0.269	0.359
Uranium	3.21[c]	1	0.11	3.21	0.396	0.345	0.874	0.39	0.374	0.842	0.741	1.29	0.565	0.74	0.581	0.535
Vanadium	560	2.5	0.22	85.1	23.3	23	58.7	59.8	43.7	28.5	35.9	35.6	54	60	21.5	32.1
Zinc	5970	1	0.87	67.8	31	60.6	45.8	59.8	40.7	34.9	48.2	47.5	43.5	45.7	28.5	41.6
Anions	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**
Nitrate-N	40	0.75	1.7[d]	11.8	U	U	U	U	U	U	U	U	U	U	U	U

Table A-1b. Analytical Results for Initial Depth Sampling for Nonradiological Contaminants

Contaminant	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B25H62 ZPC 1-1 0.6 to 1.2 m (2 to 4 ft)	B25H63 ZPC 1-2 0.6 to 1.2 m (2 to 4 ft)	B25H64 ZPC 1-3 0.6 to 1.2 m (2 to 4 ft)	B25H65 ZPC 1-4 0.6 to 1.2 m (2 to 4 ft)	B25H66 ZPC 1-5 0.6 to 1.2 m (2 to 4 ft)	B25H67 ZPC 1-6 0.6 to 1.2 m (2 to 4 ft)	B25H68 ZPC 1-6 2.4 to 3 m (8 to 10 ft.)	B25H69 ZPC 1-6 3.4 to 4 m (11 to 13ft.)	B25H70 ZPC 1 FS1	B25H71 ZPC 1 FS2 0.6 to 1.2 m (2 to 4 ft)	B25H72 ZPC 3-1 0.6 to 1.2 m (2 to 4 ft)	B25H74 ZPC 3-1 1 m (3 ft)
Polynuclear Aromatic Hydrocarbons	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Acenaphthene	98	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Acenaphthylene	98	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Anthracene	2,270	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*a*]anthracene	0.86	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*a*]pyrene	0.33[c]	0.33	0.24	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*b*]fluoranthene	1.37	0.33	0.21	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*k*]fluoranthene	1.37	0.33	0.22	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Benzo[*g,h,i*]perylene	2,400	0.33	0.35[d]	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Chrysene	9.56	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Dibenzo[*a,h*]anthracene	1.37	0.33	0.35[d]	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Fluoranthene	631	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Fluorene	101	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Indeno[*1,2,3-cd*]pyrene	1.37	0.33	0.35[d]	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Naphthalene	4.46	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Phenanthrene	1,140	0.33	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Pyrene	655	0.5	0.2	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Polychlorinated Biphenyls	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Aroclor 1016	0.094	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1221	0.017[c]	0.017	0.009	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1232	0.017[c]	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1242	0.039	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1248	0.039	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1254	0.066	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U
Aroclor 1260	0.5	0.017	0.005	N/A	U	U	U	U	U	U	U	U	U	U	U	U

Table A-1b. Analytical Results for Initial Depth Sampling for Nonradiological Contaminants

Contaminant	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B25H62 ZPC 1-1 0.6 to 1.2 m (2 to 4 ft)	B25H63 ZPC 1-2 0.6 to 1.2 m (2 to 4 ft)	B25H64 ZPC 1-3 0.6 to 1.2 m (2 to 4 ft)	B25H65 ZPC 1-4 0.6 to 1.2 m (2 to 4 ft)	B25H66 ZPC 1-5 0.6 to 1.2 m (2 to 4 ft)	B25H67 ZPC 1-6 0.6 to 1.2 m (2 to 4 ft)	B25H68 ZPC 1-6 2.4 to 3 m (8 to 10 ft.)	B25H69 ZPC 1-6 3.4 to 4 m (11 to 13ft.)	B25H70 ZPC 1 FS1	B25H71 ZPC 1 FS2 0.6 to 1.2 m (2 to 4 ft)	B25H72 ZPC 3-1 0.6 to 1.2 m (2 to 4 ft)	B25H74 ZPC 3-1 1 m (3 ft)
Total Petroleum Hydrocarbons	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**
Diesel	2,000	5	4.3	N/A	U	U	U	U	U	U	U	U	U	U	U	35
Kerosene	2,000	5	4.3	N/A	U	U	U	U	U	U	U	U	U	U	U	U

a. Removal action levels are from DOE/RL-2009-53, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit* (RAWP).

b. If Hanford Site-specific background data is not available, values are then taken from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*. Hanford Site background values are available in Nonradiological Background data from DOE/RL-92-24, Rev. 1, Table D39-2.

c. Where cleanup levels are less than background or required detection limits, cleanup levels default to background or required detection limits per Ecology (1996), WAC 173-340-700(6)(d), and WAC 173 340 707(2), respectively.

d. Maximum reported laboratory method detection limits were greater than the required detection limit per the RAWP; however, analytical results are below the established removal action levels and meet the corresponding removal action objectives.

N/A = not available

U = result is less than laboratory method detection limit

Table A-2. Analytical Results for In Process Sampling for Nonradiological Contaminants

Contaminant	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B2F5J7 ZPC-1 VR-3 Surface	B2F5J8 ZPC-1 VR-4 Surface	B2F5J9 ZPC-1 VR-5 Surface	B2F5K0 ZPC-1 VR-6 Surface	B2F5K1 ZPC-1 VR-7 Surface	B2F5K3 ZPC-1 VR-8 Surface
Metals	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Antimony	5.4	0.6	0.31	5	0.333	0.632	0.761	20.6	U	2.65
Arsenic	6.5[c]	1	N/A	6.5	NA	NA	NA	NA	NA	NA
Barium	1,650	2	N/A	132	NA	NA	NA	NA	NA	NA
Beryllium	63.2	0.5	N/A	1.51	NA	NA	NA	NA	NA	NA
Boron	210	2	N/A	N/A	NA	NA	NA	NA	NA	NA
Cadmium	0.81[c]	0.5	N/A	0.81	NA	NA	NA	NA	NA	NA
Chromium (Total)	2000	1	N/A	18.5	NA	NA	NA	NA	NA	NA
Cobalt	15.7[c]	2	N/A	15.7	NA	NA	NA	NA	NA	NA
Copper	284	1	N/A	22	NA	NA	NA	NA	NA	NA
Lead	250	5	0.1	10.2	24	9.68	10.9	18.9	6.32	7.38
Lithium	160	2.5	N/A	33.5	NA	NA	NA	NA	NA	NA
Manganese	512[c]	5	N/A	512	NA	NA	NA	NA	NA	NA
Mercury	2.09	0.2	N/A	0.33	NA	NA	NA	NA	NA	NA
Nickel	130	4	N/A	19.1	NA	NA	NA	NA	NA	NA
Selenium	5.2	1	N/A	0.78	NA	NA	NA	NA	NA	NA
Silver	13.6	0.2	N/A	0.73	NA	NA	NA	NA	NA	NA
Strontium	2,920	1	N/A	N/A	NA	NA	NA	NA	NA	NA
Thallium	1.59	1	N/A	0.1	NA	NA	NA	NA	NA	NA

Table A-2. Analytical Results for In Process Sampling for Nonradiological Contaminants

Contaminant	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B2F5J7 ZPC-1 VR-3 Surface	B2F5J8 ZPC-1 VR-4 Surface	B2F5J9 ZPC-1 VR-5 Surface	B2F5K0 ZPC-1 VR-6 Surface	B2F5K1 ZPC-1 VR-7 Surface	B2F5K3 ZPC-1 VR-8 Surface
Tin	48,000	10	N/A	N/A	NA	NA	NA	NA	NA	NA
Uranium	3.21[c]	1	N/A	3.21	NA	NA	NA	NA	NA	NA
Vanadium	560	2.5	N/A	85.1	NA	NA	NA	NA	NA	NA
Zinc	5970	1	N/A	67.8	NA	NA	NA	NA	NA	NA

a. Removal action levels are from DOE/RL-2009-53, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit* (RAWP).

b. If Hanford Site-specific background data is not available, values are then taken from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*. Hanford Site background values are available in Nonradiological Background data from DOE/RL-92-24, Rev. 1, Table D39-2.

c. Where cleanup levels are less than background or required detection limits, cleanup levels default to background or required detection limits per Ecology (1996), WAC 173-340-700(6)(d), and WAC 173 340 707(2), respectively.

NA = not analyzed

N/A = not available

U = result is less than laboratory method detection limit

Table A-3. Analytical Results for Verification Sampling for Nonradiological Contaminants of Potential Concern

Contaminant of Potential Concern	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B2F5K6 ZPC-4 VR-1 Surface	B2F5K7 ZPC-4 VR-2 Surface	B2FPJ0 VR-9 Surface	B2FPJ1 VR-10 Surface	B2FPJ2 VR-11 Surface	B2FPJ3 VR-12 Surface	B2FPJ4 VR-13 Surface	B2FPJ5 VR-14 Surface	B2FPJ6 VR-15 Surface	B2FPJ7 VR-16 Surface	B2FPJ9 VR-17 Surface	B2FPK1 VR-19 Surface	B2FPK2 VR-20 Surface
Metals	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Antimony	5.4	0.6	0.31	5	NA	NA	0.31	0.29	0.29	0.3	0.3	0.422	0.28	0.31	0.3	0.479	0.331
Arsenic	6.5[c]	1	0.41	6.5	NA	NA	2.93	1.98	1.63	2.62	4.59	5.57	3.42	5.12	4.11	3.25	2.72
Barium	1,650	2	0.21	132	NA	NA	74.4	79.4	56.7	72.6	96	100	101	100	89.3	83	74.2
Beryllium	63.2	0.5	0.1	1.51	NA	NA	0.413	0.328	0.19	0.252	0.347	0.403	0.353	0.433	0.36	0.337	0.325
Boron	210	2	0.52	N/A	NA	NA	2.29	1.93	1.27	0.773	1.3	1.42	2.16	1.24	1.27	1.44	1.21
Cadmium	0.81[c]	0.5	0.1	0.81	NA	NA	0.1	0.127	0.097	0.098	0.1	0.1	0.094	0.1	0.1	0.096	0.095
Chromium (Total)	2000	1	0.52	18.5	NA	NA	6.43	4.83	3	4.32	8.64	11.1	6.9	11.1	8.6	7.06	5.98
Chromium (VI)	N/A	0.5	NA	N/A	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt	15.7[c]	2	0.1	15.7	NA	NA	7.95	8.64	7.56	9.21	8.7	8.52	8.94	8.46	7.83	7.62	7.81
Copper	284	1	0.1	22	NA	NA	12.7	12.5	12.8	14.9	12.6	13.5	11.2	13.4	10.9	10.6	10.8
Lead	250	5	0.1	10.2	5.94	11.6	6.54	5.55	2.6	3.45	6.09	5.93	4.45	6.22	5.03	5.57	4.83
Lithium	160	2.5	0.42	33.5	NA	NA	6.5	5.58	3.77	5.31	7.51	8.53	6.99	8.99	8.56	6.27	5.44
Manganese	512[c]	5	0.1	512	NA	NA	339	361	266	326	376	375	403	384	350	332	329
Mercury	2.09	0.2	NA	0.33	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Nickel	130	4	0.21	19.1	NA	NA	7.82	8.16	5.2	7.11	10.1	11.3	8.63	11.3	9.46	8.9	8.35
Selenium	5.2	1	0.31	0.78	NA	NA	1.24	1.37	1.49	1.48	0.973	1.12	1.12	0.964	0.916	1.11	1.05
Silver	13.6	0.2	0.1	0.73	NA	NA	0.114	0.095	0.097	0.098	0.1	0.1	0.094	0.1	0.1	0.096	0.095
Strontium	2,920	1	0.1	N/A	NA	NA	21.6	20.7	24.5	30.1	44.2	44.4	29	39	32.9	21.8	24.3
Thallium	1.59	1	N/A	0.1	NA	NA	0.123	0.0968	U	U	U		U	0.113	U	U	U
Tin	48,000	10	0.1	N/A	NA	NA	0.859	0.817	0.401	0.52	0.48	0.408	0.362	0.406	0.322	0.386	0.405
Uranium	3.21[c]	1	0.1	3.21	NA	NA	0.544	0.458	0.353	0.385	0.448	0.508	0.36	0.581	0.46	0.349	0.333
Vanadium	560	2.5	0.21	85.1	NA	NA	50.7	63.3	55.2	62	55.6	51.4	57.2	47.7	44.7	51.6	55.1
Zinc	5970	1	0.83	67.8	NA	NA	44.6	44	37.6	46.4	46	45.3	41.8	46.4	40.9	42.3	43.1

Table A-3. Analytical Results for Verification Sampling for Nonradiological Contaminants of Potential Concern

Contaminant of Potential Concern	Removal Action Levels[a]	Required Detection Limit	Maximum Reported Laboratory Method Detection Limit	Background Concentration[b]	B2F5K6 ZPC-4 VR-1 Surface	B2F5K7 ZPC-4 VR-2 Surface	B2FPJ0 VR-9 Surface	B2FPJ1 VR-10 Surface	B2FPJ2 VR-11 Surface	B2FPJ3 VR-12 Surface	B2FPJ4 VR-13 Surface	B2FPJ5 VR-14 Surface	B2FPJ6 VR-15 Surface	B2FPJ7 VR-16 Surface	B2FPJ9 VR-17 Surface	B2FPK1 VR-19 Surface	B2FPK2 VR-20 Surface

a. Removal action levels are from DOE/RL-2009-53, *Removal Action Work Plan for 48 Waste Sites in the 200-MG-1 Operable Unit* (RAWP).

b. If Hanford Site-specific background data is not available, values are then taken from Ecology Publication 94-115, *Natural Background Soil Metals Concentrations in Washington State*. Hanford Site background values are available in Nonradiological Background data from DOE/RL-92-24, Rev. 1, Table D39-2.

c. Where cleanup levels are less than background or required detection limits, cleanup levels default to background or required detection limits per Ecology (1996), WAC 173-340-700(6)(d), and WAC 173 340 707(2), respectively.

NA = not analyzed

N/A = not available

U = result is less than laboratory method detection limit