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Revision 1

Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Remedial Process Optimization Wells

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

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Approval Page

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Signature 8-19-09 Date

Lead Regulatory Agency:

☐ U.S. Environmental Protection Agency

☒ Washington State Department of Ecology

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U.S. Environmental Protection Agency, Region 10

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Executive Summary

This sampling and analysis plan (SAP) addresses the installation of new groundwater extraction and injection wells in the 100-HR-3 Groundwater Operable Unit (OU) at the Hanford Site. These wells will facilitate remedial process optimization (RPO) through expansion of the 100-HR-3 Groundwater OU pump-and-treat system currently in place to remediate groundwater contaminated with hexavalent chromium. The hexavalent chromium plume resulted from leaks of sodium-dichromate solutions from unlined basins during reactor operations at the 100-D and 100-H Areas, and from leaks and spills of concentrated sodium-dichromate stock solutions at those areas. The current pump-and-treat system was required by the 100-HR-3 Groundwater OU interim record of decision.[1]

The pump-and-treat system is being operated to meet the remedial action objective of protecting the nearby Columbia River from the hexavalent chromium plume and also to meet the Hanford Site goal of protecting the Columbia River by 2012. The new RPO wells will be installed in the 100-D and 100-H Areas to expand the size and efficiency of the pump-and-treat system in order to address new Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement)[2] target milestones. This SAP also includes sampling and analysis activities to be conducted during installation of RPO boreholes to support the remedial investigation/feasibility study process for the 100-D/H decision unit.

This SAP addresses the location, drilling, sampling, installation, and development of 37 new RPO groundwater wells planned to be installed to meet remedial action objectives. These wells will be installed in the 100-D and 100-H Areas during fiscal years 2009 and 2010 and will consist of 24 new extraction wells and 13 new injection wells. The well locations are based on hydraulic modeling.[3] Installation of additional RPO wells at a later date is expected to be required to provide for continuing groundwater remediation to support the longer-term goal of plume remediation by the year 2020. As the results from initial RPO well installations are evaluated, the number

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1 ROD/R10-96/134, 1996, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units,* Hanford *Site, Benton County, Richland, Washington*, U.S. Environmental Protection Agency, Washington, D.C.

2 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.

3 SGW-40044, 2008, *100-DX Preconceptual Design and Cost Evaluation Technical Memorandum*, Decisional Draft A, CH2M Hill Plateau Remediation Company, Richland, Washington.

and locations of the later RPO wells will be established. Later RPO wells will be added following the change request process (outlined in the Tri-Party Agreement) as well locations are approved for use.

A systematic planning process was used to identify the primary RPO project soil and groundwater data needs. Soil lithological and aquifer property information will be required to optimize the design and operation of the new RPO wells. Groundwater contaminant data are necessary to confirm well use and further characterize the hexavalent chromium plume, which will be accomplished by confirming ambient chromium concentrations and developing a baseline chromium concentration within the aquifer. The lithological and aquifer property data needs will be met during borehole installation by using well drillers' logbooks documenting the full-depth geologic lithology, by collecting geologic samples of aquifer soil for physical properties testing, and by collecting split-spoon samples of upper Ringold Upper Mud Unit soil for laboratory permeability testing and hexavalent chromium analysis. Other geologic soil samples will be collected during borehole installation and will be archived for possible future analysis if data needs are identified. Groundwater data needs will be met by collecting one groundwater sample from each new RPO well after completion of well development to analyze for a list of analytes,[4] including hexavalent chromium, anions, metals, tritium, technetium-99, and strontium-90.

4 DOE/RL-96-90, 1997, *Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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Terms

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CS/LS	chemical separation/liquid scintillation
DOE	U.S. Department of Energy
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
GEA	gamma energy analysis
GFPC	gas flow proportional counting
GS	gamma scan
HEIS	Hanford Environmental Information System
IAMP	interim action monitoring plan
IC	ion chromatography
ICP	inductively coupled plasma
ICP/MS	inductively coupled plasma/mass spectroscopy
MS	mass spectrometry
N/A	not applicable
OU	operable unit
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCT	radiological control technician
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
RPD	relative percent difference

RPO	remedial process optimization
RUM	Ringold Upper Mud (Unit)
S&GRP	Soil & Groundwater Remediation Project
SAP	sampling and analysis plan
TBD	to be determined
TD	total depth
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WAC	*Washington Administrative Code*

1 Introduction

This sampling and analysis plan (SAP) has been prepared for the installation of new remedial process optimization (RPO) groundwater extraction and injection wells in the 100-D and 100-H Areas to optimize and expand the current 100-HR-3 Groundwater Operable Unit (OU) pump-and-treat system. This SAP will be used to collect soil data during borehole installation in order to facilitate RPO well design and maximize well efficiency. Groundwater data will be collected after well development to confirm well use, to confirm ambient chromium concentrations, and to develop a baseline chromium concentration within the aquifer. This SAP also includes the collection of data to support the 100-D/H Area remedial investigation (RI)/feasibility study (FS) process and refine the conceptual site model. In this SAP, these samples are referred to as "RI samples."

The 100-D and 100-H Areas are within the geographic boundary of the 100-HR-3 OU, which underlies the top, northwest bend of the Columbia River in the 100 Areas of the Hanford Site (Figure 1-1). The 100-HR-3 OU contains the 100-D and 100-H Area hexavalent chromium plumes, which represent the systematic planning process decision unit for this SAP. The RPO pump-and-treat system wells installed under this SAP are a portion of the 100-HR-3 OU interim remedial action for treatment of the 100-D and 100-H Area hexavalent chromium plumes.

The combined RPO and RI activities are detailed in Chapter 3 and include the following.

- Install 37 boreholes in the 100-D and 100-H Areas through the unconfined aquifer to develop into RPO groundwater extraction and injection wells.
- During RPO borehole installation, proceed as follows:
  - Collect geologic samples from each RPO borehole for archiving.
  - Collect one RI deep vadose zone soil sample at selected RPO boreholes for analysis and testing of RI chemical and radiological analytes and physical properties.
  - Collect two RPO geologic samples of aquifer materials at each borehole to test the physical properties and facilitate well construction efficiency and optimization.
  - Collect two RI split-spoon samples of aquifer soils at selected RPO boreholes for analysis and testing of RI chemical and radiological analytes and physical properties.
  - Collect one RPO split-spoon sample of Ringold Upper Mud (RUM) Unit soils at the aquifer/RUM interface of each borehole for chromium analysis and permeameter testing to provide additional information on the materials delineating the bottom of the unconfined aquifer.
  - Collect one RI split-spoon sample of RUM unit soil at total borehole depth (1.5 m [5 ft] into the RUM) from selected RPO well locations for analysis and testing of RI chemical and radiological analytes and physical properties.
- Develop boreholes into RPO extraction and injection wells.
- Collect one groundwater sample from each developed RPO well for analysis of RPO analytes to confirm well use, to confirm ambient chromium concentrations, and to develop a baseline chromium concentration within the aquifer.

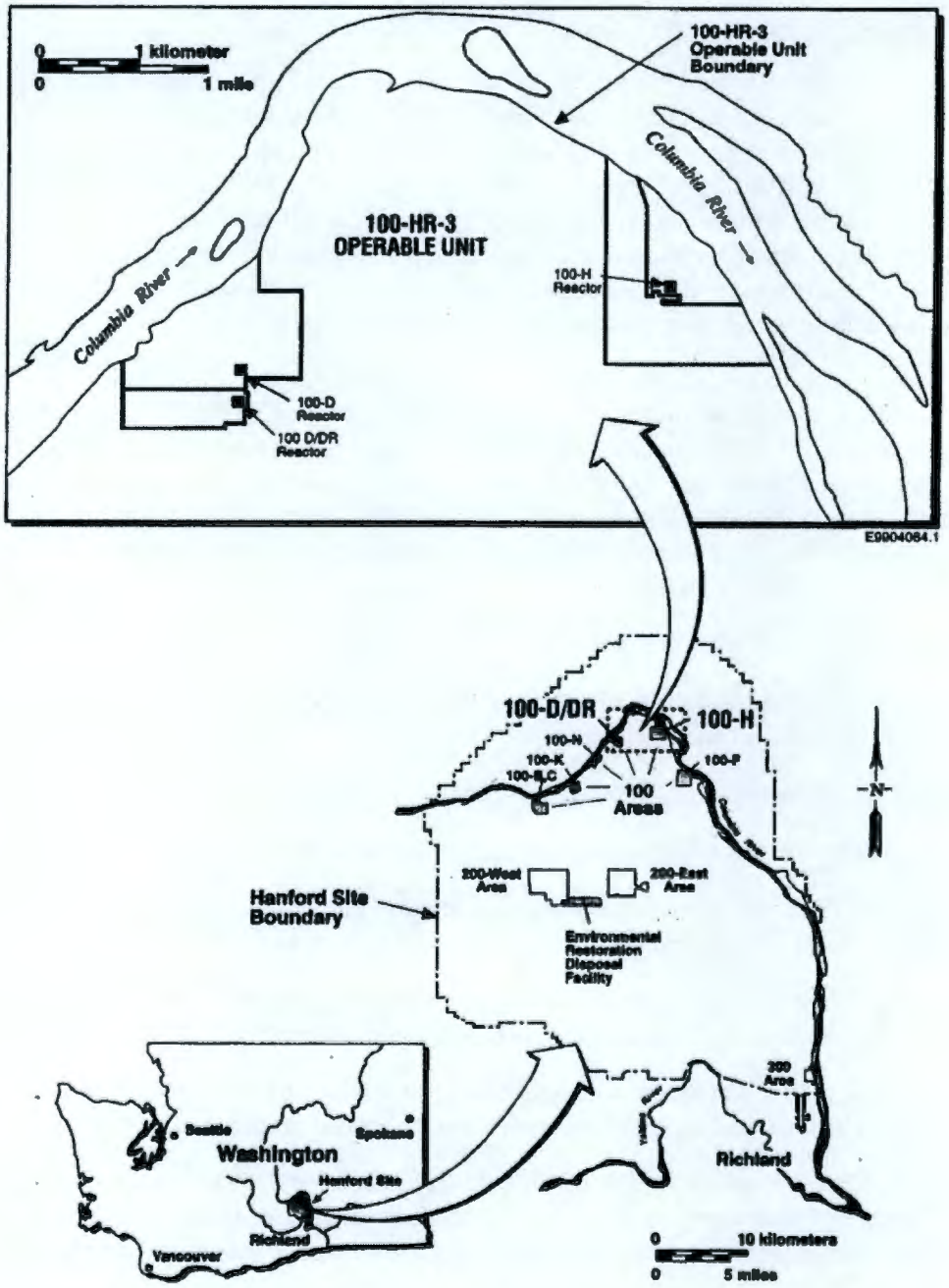

Figure 1-1. Hanford Site and Location of 100-HR-3 Groundwater Operable Unit

The RPO groundwater extraction and injection wells are listed in Table 1-1. The locations of the RPO extraction and injection wells to be installed under this SAP are shown in Figures 1-2 and 1-3. The RPO wells will include 37 new groundwater wells, including 12 wells in the 100-D Area (8 extraction and 4 injection) and 25 wells in the 100-H Area (16 extraction and 9 injection). New well locations and the construction were selected based on modeling documented in Appendix A of the *100-HR-3 Remedial Process Optimization Modeling Technical Memorandum* (SGW-40044).

To meet the RI data needs for the 100-D/H decision unit, samples will be collected from the five RPO well locations identified in Table 1-1.

Table 1-1. New Remedial Process Optimization Groundwater Injection and Extraction Wells

RPO Wells						
100-D Area			100-H Area			
Temp Name	Borehole Number	Well Name	Temp Name	Borehole Number	Well Name	Total Wells
Extraction Wells						
DW-1	C7083	199-D4-95	HW-51	C7098	199-H1-38	
DW-2	C7084	199-D4-96[a]	HW-7	C7099	199-H1-37	
DW-3	C7085	199-D4-97	HW-31	C7100	199-H1-32	
DW-4	C7086	199-D4-98	HW-63	C7102	199-H1-36[a]	
DW-6	C7091	199-D8-89[a]	HW-42	C7104	199-H1-40	
DW-7	C7092	199-D8-90	HW-5	C7105	199-H1-33	
DW-11	C7087	199-D4-99	HW-6	C7106	199-H1-35[a]	
DW-81	C7093	199-D8-91	HW-4	C7107	199-H1-42	
			HW-41	C7108	199-H1-34	24 extraction
			HW-61	C7109	199-H1-39	
			N/A	C7477[b]	199-H1-45	
			N/A	C7478[b]	199-H1-25	
			N/A	C7480[b]	199-H1-27	
			N/A	C7483[b]	199-H4-70	
			N/A	C7485[b]	199-H4-69	
			N/A	C7492[b]	199-H1-43	
Injection Wells						
DWI-2	C7089	199-D2-10	N/A	C7110[b]	199-H3-25	
DWI-4	C7090	199-D2-12	N/A	C7111[b]	199-H1-21	
N/A	C7095	199-D8-93	N/A	C7113[b]	199-H1-20	
N/A	C7096	199-D8-94	N/A	C7114[b]	199-H3-27	
			N/A	C7115[b]	199-H3-26	13 injection
			N/A	C7484[b]	199-H4-73	
			N/A	C7487[b]	199-H4-71	
			N/A	C7488[b]	199-H4-72	
			N/A	C7489[b]	199-H6-2	
					Total RPO project wells:	**37**

a. RPO well sampled to meet 100-D/H decision unit remedial investigation data needs.

b. RPO well added per Revision 1.

N/A = not applicable

RPO = remedial process optimization

1.1 Data Needs

This section identifies the RPO and RI data needs driving the collection of soil and groundwater samples from the RPO well locations.

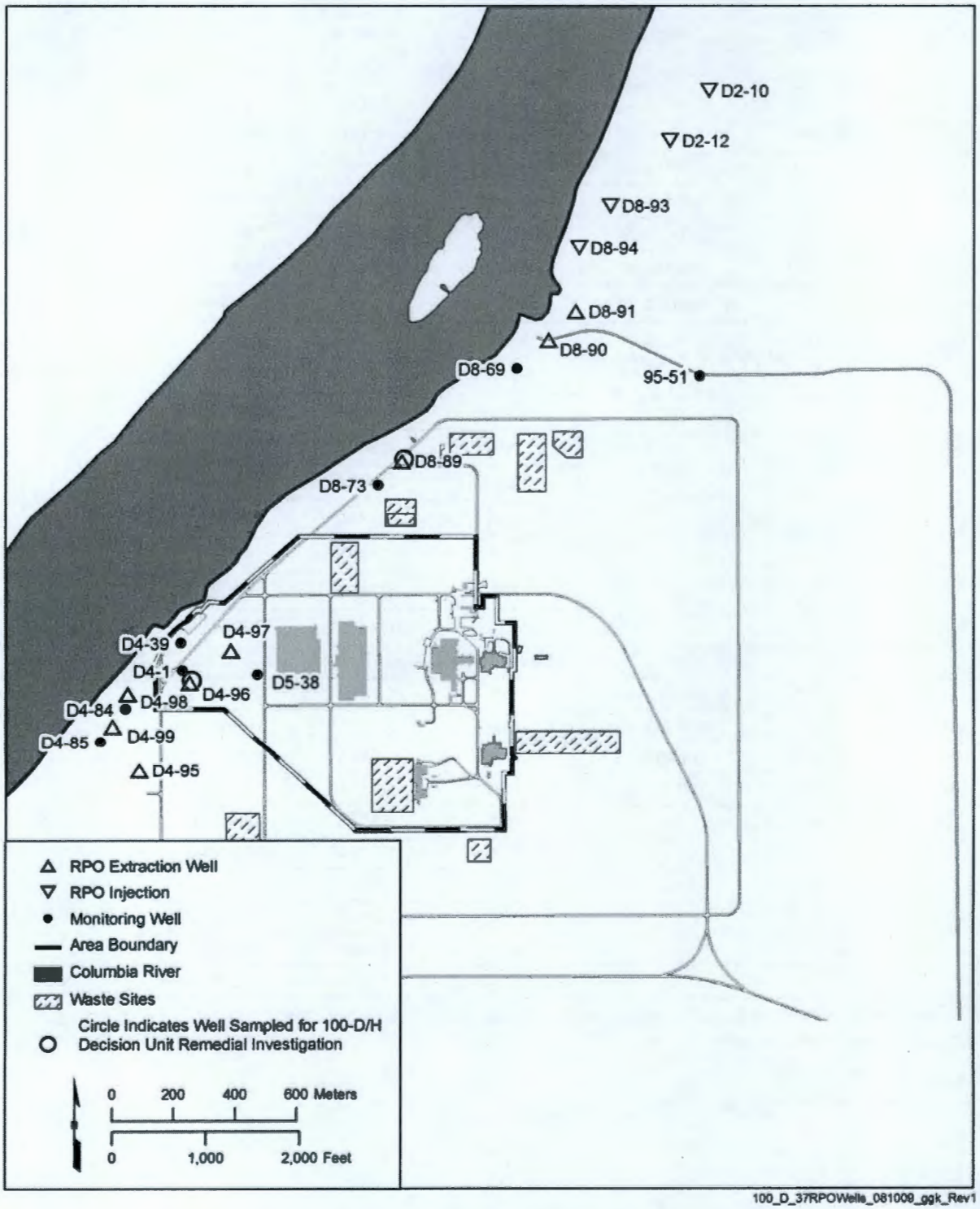

Figure 1-2. Location of 100-D Area Remedial Process Optimization Wells

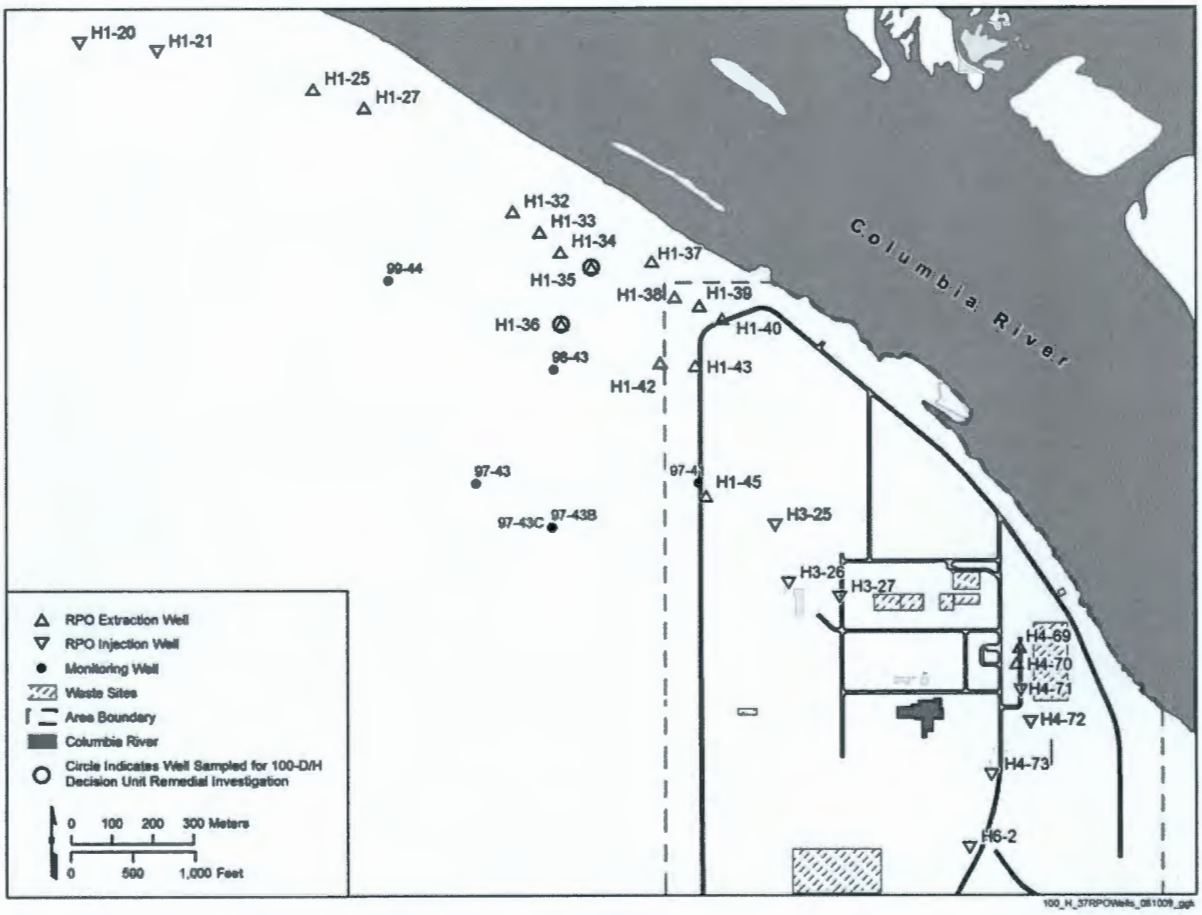

Figure 1-3. Location of 100-H Area Remedial Process Optimization Wells

1.1.1 Remedial Process Optimization Well Data Needs

A systematic planning process was used to identify data needs for the RPO well installation and sampling project. The project team members attended a planning meeting on November 25, 2008, to finalize the project data needs. The planning process identified the type, quantity, and quality of data that will be appropriate for the intended use and to support the sample design presented in this SAP.

Aquifer soils and split-spoon samples of soils from the top of the RUM will be collected during borehole installation. Geologic samples of aquifer soils will provide data on soil physical properties, typically on short turnaround time, to optimize well design and maximize RPO groundwater extraction and injection well efficiency. Split-spoon samples of RUM soils will be collected for laboratory permeameter testing and hexavalent chromium analysis (Table 1-2) to provide additional information on materials delineating the bottom of the unconfined aquifer. Groundwater data will be collected after well development to analyze a subset of 100-HR-3 OU groundwater monitoring analytes (identified in Table 1-3) to confirm RPO well use, to confirm ambient chromium concentrations, and to develop a baseline chromium concentration within the aquifer.

Geologic soil samples will also be collected during borehole installation to total borehole depth but will not be analyzed under this SAP. Instead, these samples will be archived for future analysis if data needs are identified.

The analytes and tests for RI soil samples are listed in Table 1-4.

Table 1-2. List of Remedial Process Optimization Soil Sample Analytes and Tests

Geologic Aquifer Soil Sample Test
Grain-size distribution (sieve analysis)
Ringold Upper Mud Unit Split-Spoon Soil Sample Testing and Analysis
Permeameter test
Chromium (hexavalent)

Table 1-3. List of Remedial Process Optimization Project Groundwater Sampling Analytes

Field Measurements	
pH	Temperature
Specific conductance	Turbidity

Radionuclides	Nonradionuclides	
Strontium-90	Antimony	Magnesium
Technetium-99	Barium	Manganese
Tritium	Beryllium	Potassium
Total alpha	Cadmium	Nickel
Total beta	Chloride	Nitrate
Total gamma	Chromium (hexavalent)	Nitrite
	Chromium (total)	Sodium
	Calcium	Silver
	Copper	Strontium
	Cobalt	Sulfate
	Fluoride	Vanadium
	Iron	Zinc

Table 1-4. Remedial Investigation Vadose Zone, Aquifer Soil, and Ringold Upper Mud Unit Soil Sampling Analytes and Physical Property Tests

Radionuclides	Nonradionuclides*		Physical Properties
Barium-133	Antimony	Manganese	Grain size (sieve analysis)
Cesium-137	Arsenic	Molybdenum	Porosity
Cobalt-60	Barium	Nickel	Sediment moisture content
Europium-152	Beryllium	Selenium	Saturated hydraulic conductivity
Europium-154	Boron	Silver	Bulk density
Europium-155	Cadmium	Thallium	
Strontium-90	Chromium (hexavalent)	Vanadium	
	Chromium (total)	Zinc	
	Copper		
	Lead		
	Lithium		

* Includes geochemical analyses for distribution coefficient and batch leach testing (detailed in Table 2-3 in Chapter 2).

1.1.2 Remedial Investigation Data Needs

In addition to sampling activities to support the design of the pump-and-treat system, this SAP includes the collection of additional data to support the ongoing RI/FS process for the 100-D/H decision unit. The data will be used to support the conceptual site model and will be included in the RI report that will be generated following completion of activities conducted under the RI/FS work plan. To avoid duplication of effort, the RI sampling performed in conjunction with RPO sampling activities will provide data for evaluations of the fate and transport parameters also described in the RI/FS work plan (DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan, Addendum 1*). The RPO wells from which RI data will be collected are identified in Table 1-1, and the RI data needs are identified in Table 1-4. The RPO locations were selected to provide increased special distribution for data collection, particularly within the RUM. The RI analytes selected provide contaminant-specific data that support possible future fate and transport modeling and evaluations.

1.2 Soil and Groundwater Analytes

As directed in this SAP, the RPO project soil samples will be collected and analyzed during borehole installation, and groundwater samples will be collected after completion of RPO well development. The analytical performance requirements for analytes, including the analytical method and required detection limits, are provided in Chapter 2 of this SAP.

Two RPO geologic samples of aquifer soil and one RPO split-spoon sample of upper RUM soils will be collected during borehole installation for testing and analysis (Table 1-2). The two aquifer soil samples will be tested for the physical property of grain-size distribution (sieve analysis) to optimize RPO well design by providing information to help define sand pack and screen size. Analysis of the single RUM split-spoon sample collected from each well location will include permeameter testing and hexavalent chromium analysis. Table 1-2 identifies the RPO soil sample analytes and parameters.

One groundwater sample will be collected from each RPO well after development. The list of groundwater analytes was derived during planning discussions as a subset of the 100-HR-3 OU groundwater monitoring program analytes (DOE/RL-96-90, *Interim Action Monitoring Plan for the 100-HR-3 and 100-KR-4 Operable Units*). The RPO groundwater analytes are presented in Table 1-3. All analytical results reported by the laboratory from method analysis will be reported in the Hanford Environmental Information System (HEIS) database.

1.3 Project Schedule

The activities for RPO borehole installation and soil sampling, as well as for groundwater well development and groundwater sampling, are planned to occur in fiscal year 2009 and 2010 and will be scheduled by the drilling lead. Additional RPO wells could be installed as needed at a later date following the change request process in the Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) as the well locations are approved for use.

2 Quality Assurance Project Plan

This quality assurance project plan (QAPjP) complies with the following requirements:

- U.S. Department of Energy (DOE) O 414.1C, *Quality Assurance*
- 10 *Code of Federal Regulations* (CFR) 830, Subpart A, "Quality Assurance Requirements"
- *EPA Requirements for Quality Assurance Project Plans*, EPA QA/R-5 (EPA/240/B-01/003)
- Performing contractor's applicable quality assurance (QA) program.

Sample process design is not addressed in the QAPjP but is instead addressed in Section 3.2 of this SAP.

This chapter describes the applicable quality requirements and controls. Sections 6.5 and 7.8 of the Tri-Party Agreement require that DOE conduct QA/quality control (QC) and sampling and analysis activities in accordance with EPA/240/B-01/003; therefore, this QAPjP is organized based on the QA elements specified in EPA/240/B-01/003. The QAPjP is divided into four sections that correspond to checklist sections and describe the quality requirements and controls applicable to this investigation.

2.1 Project Management and Organization

The following subsections address project management to ensure that the project has a defined goal, the participants understand the goal and the approach to be used, and the planned outputs are appropriately documented. The project organization is shown in Figure 2-1. The managing contractor will be responsible for collecting, packaging, and shipping samples to the appropriate laboratory.

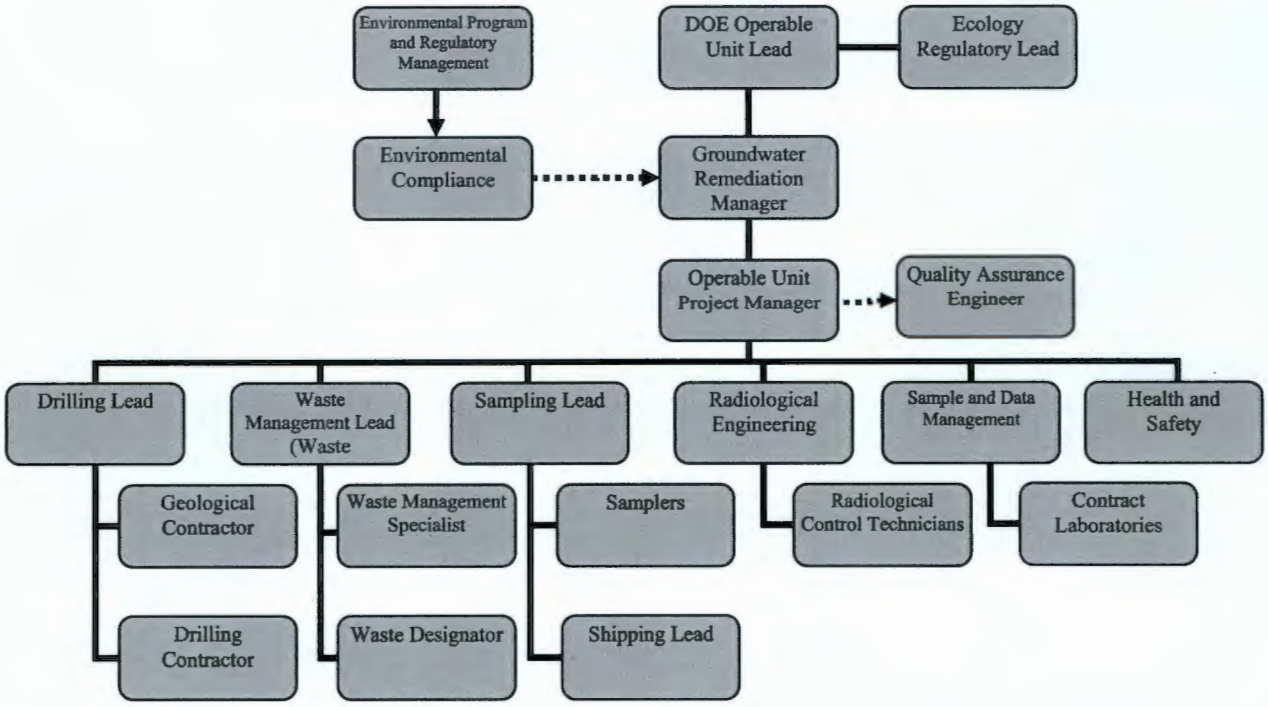

Figure 2-1. Project Organization

2.1.1 Management Responsibilities

Management responsibilities and inter-relationships are described in the following subsections.

2.1.1.1 Environmental Compliance

The environmental compliance officers work under the Environmental Program and Regulatory Management group. The environmental compliance officers provide oversight in dealing with environmental management assessments and compliance assessments, define potential environmental impacts, and identify corrective actions (if needed) for Hanford Site activities.

The Groundwater remediation manager provides oversight for activities and coordinates with the U.S. Department of Energy, Richland Operations Office (RL); the U.S. Environmental Protection Agency (EPA); and contractor management. In addition, support is provided to the OU project manager to ensure that work is performed safely and cost effectively.

2.1.1.2 Regulatory Project Manager

The Washington State Department of Ecology (Ecology) project manager is responsible for regulatory oversight of cleanup project and activities. Ecology, as lead regulatory agency for the RPO project, has approval authority as for the work being performed under this SAP. Ecology will work with RL to resolve concerns regarding the work as described in this SAP in accordance with the Tri-Party Agreement.

2.1.1.3 Tri-Party Agreement Project Manager and RL Technical Lead

RL is responsible for the Hanford cleanup. The RL project manager is responsible for authorizing the contractor to perform Hanford Site activities in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA); the *Resource Conservation and Recovery Act of 1976*; the *Atomic Energy Act of 1954*; and the Tri-Party Agreement. RL is also responsible for obtaining lead regulatory agency approval of the SAP, which authorizes the field sampling activities. The RL technical lead is responsible for providing day-to-day oversight of the contractor's workscope performance, for working with the contractor and the regulatory agencies to identify and work through issues, and for providing technical input to the RL Federal project director.

2.1.1.4 Operable Unit Project Manager

The project manager (or designee) for the 100-D and 100-H Areas is responsible for direct management of sampling documents and requirements, field activities, and subcontracted tasks. The project manager ensures that the field team lead and others responsible for implementing this SAP and QAPjP are provided with current copies of this document and revisions thereto. For each sampling event, the project manager establishes the analytes, directs the field team lead (i.e., sample coordinator), and works closely with the QA and the Health and Safety organizations to integrate these and other lead disciplines in planning and implementing the workscope. The project manager coordinates with and reports to RL and contractor management regarding sampling activities.

2.1.1.5 Quality Assurance Engineer

The QA engineer is matrixed to the OU project manager and is responsible for QA on the project. Responsibilities include overseeing implementation of project QA requirements, closing corrective actions, reviewing project documents (including SAPs and the QAPjP), and participating in QA assessments.

2.1.1.6 Waste Management Lead (Waste Coordinator)

The waste management lead communicates policies and procedures for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner to ensure project compliance. Other

responsibilities include receiving data from the field team lead to initiate waste designations and meet the requirements of other documents (e.g., the waste management plan) to ensure project compliance with waste acceptance criteria and disposal practices.

2.1.1.7 Field Team Lead

The field team lead has overall responsibility for planning, coordinating, and executing field activities. Specific responsibilities include converting the sampling design requirements into field task instructions to provide specific direction for field activities, as well as directing training, mock-ups, and practice sessions with field personnel to ensure that the sampling design is understood and can be performed as specified. The field team lead also communicates with the OU project manager to identify field constraints or emergent conditions affecting sampling design/execution, to direct the procurement and installation of materials and equipment to support fieldwork, and to prepare data packages based on instructions from the OU project manager (or designee) and information contained in this SAP. The shipping lead reports to the field team lead for shipment authorization. No sample material will be transported on or off the Hanford Site without permission from the Soil & Groundwater Remediation Project (S&GRP) authorized shipper (or designee).

2.1.1.8 Radiological Engineering

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

2.1.1.9 Sample and Data Management

The Sample and Data Management organization is responsible for managing the analyses and resulting analytical data for samples collected for this SAP. Sample and Data Management selects laboratories to perform the required analyses and ensures that the laboratories conform to Hanford internal laboratory QA requirements (or equivalent), as approved by RL, EPA, and Ecology. After the selected laboratories complete the analyses, Sample and Data Management receives the analytical data from the selected laboratories, performs data entry into the HEIS database, and arranges for data interpretation. After analytical data interpretation is completed, Sample and Data Management provides the analytical data to the waste management lead (i.e., waste coordinator). Sample and Data Management also interfaces with the field team lead (i.e., sample coordinator) regarding sampling information (e.g., sampling activities, sample and associated data tracking, and distributing analytical data).

2.1.1.10 Health and Safety

The Health and Safety organization's responsibilities include coordinating industrial safety and health support within the project as carried out through health and safety plans, job hazard analyses, and other pertinent safety documents required by Federal regulations or by internal contractor work requirements. In addition, the organization assists project personnel in complying with applicable health and safety standards and requirements. Personal protective equipment requirements are coordinated with Radiological Engineering.

2.1.2 Problem Definition/Background

New RPO wells will be installed in the 100-D and 100-H Areas to expand the size and efficiency of the pump-and-treat system installed in accordance with the 100-HR-3 OU interim ROD

(EPA/ROD/R10-96/134, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units, Hanford Site, Benton County, Richland, Washington*) to protect the nearby Columbia River from the hexavalent chromium plume. The new RPO wells are required for pump-and-treat system expansion in order to address new Tri-Party Agreement target milestones. Soil property data and aquifer property information will be required to optimize the design and operations of the new RPO wells to maximize remedial action efficiency. Groundwater data will help to confirm well use, confirm ambient chromium concentrations, and develop a baseline chromium concentration within the aquifer.

The problem definition and background for the RI sampling are presented in DOE/RL-2008-46, Addendum 1, Appendix E.

2.1.3 Project/Task Description

This SAP governs the installation and sampling of 37 new RPO groundwater extraction and injection wells. The RPO boreholes listed in Table 1-1 will be installed through the aquifer and approximately 1.5 m (5 ft) into the RUM at locations shown in Figures 1-2 and 1-3 for development into RPO extraction or injection wells. Figures 1-2 and 1-3 also identify the boreholes from which samples will be collected to meet RI data needs. Borehole installation to this depth will allow for construction of the well pump sump below the base of the aquifer, which will allow for maximum drawdown during well operations.

During borehole installation, RPO and RI data will be collected from selected RPO well locations as part of RPO sampling and analysis activities. Geologic samples will be taken at 1.5-m (5-ft) intervals and at major lithologic changes at each borehole to total borehole depth, beginning at 1.5 m (5 ft) below ground surface (bgs). These geologic samples will not be analyzed under this SAP but will instead be archived in case future data needs are identified. One RI sample of vadose zone soil will be taken 0.6 m (2 ft) above the water table at selected RPO well locations for analysis of RI analytes shown in Table 1-4. Two RPO geologic samples of aquifer soils with a short turnaround time will be collected at each borehole to test the physical property of grain-size distribution. To meet the RI data needs, two samples of aquifer soils (one from the upper half and one from the lower half of the aquifer) will also be collected from selected RPO boreholes (Table 1-1) for analysis of Table 1-4 RI analytes.

One RPO split-spoon sample of soil of the top of the RUM will be collected for laboratory permeameter testing and analysis for hexavalent chromium (Table 1-2) to help delineate the bottom of the unconfined aquifer. One RI split-spoon sample of RUM soil will be collected from selected RPO boreholes for analysis of Table 1-4 RI analytes.

One groundwater sample will be collected upon completion of well development. Groundwater samples will be analyzed for the constituents identified in Table 1-3, which are derived from the list of 100-HR-3 groundwater monitoring program analytes.

Section 1.3 provides the schedule for implementing SAP activities, and Chapter 3 summarizes the work to be performed. Figures 1-2 and 1-3 provide maps of the geographic locations for field tasks. Additional sampling may occur based on the observation of geologists during geological logging of borehole materials.

2.1.4 Quality Objectives and Criteria for Measurement Data

The QA objective of this SAP is to develop implementation guidance providing data of known and appropriate quality. Data quality for this SAP may be assessed by five criteria: representativeness, accuracy, comparability, completeness, and precision. The applicable QC guidelines, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the

nature of the analytical methods. The applicable QC guidelines and level of effort are addressed in the following subsections.

The analytical methods, detection limits, and the precision and accuracy requirements for each analysis to be performed are summarized in Tables 2-3 and 2-4 (provided later in this chapter). Procedures from the contractor (or its approved subcontractor) will be used for sampling.

2.1.4.1 Representativeness

Representativeness is a measure of how closely analytical results reflect the actual concentration and distribution of the constituents in the matrix sampled. Sampling plan design, sampling techniques, and sample-handling protocols (e.g., storage, preservation, and transportation) are discussed in subsequent sections of this SAP. The required documentation will establish the protocols to be followed and will ensure appropriate sample identification and integrity.

2.1.4.2 Accuracy

Accuracy is an assessment of the closeness of the measured value to the true value. Radionuclide measurements requiring chemical separations use this technique to measure method performance. For radionuclide measurements analyzed by gamma spectroscopy, laboratories typically compare results of blind-audit samples against known standards to establish accuracy. The validity of calibrations is evaluated by comparing results from the measurement of a standard to known values and/or by generation of in-house statistical limits based on three standard deviations (±3 standard deviations). Tables 2-3 and 2-4 list the laboratory accuracy parameters for this SAP.

2.1.4.3 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Data comparability will be maintained by using standard procedures, uniform methods, and consistent units.

2.1.4.4 Completeness

The RPO project analytes and parameters are shown in Tables 2-3 and 2-4, which also identify laboratory performance parameters. For the test for grain-size distribution (sieve analysis), because the primary parameter is grain-size distribution, the sampling will be considered incomplete if grain-size distribution is not included. For groundwater sampling, total and hexavalent chromium are the primary analytes for technical evaluation, and the analytical data set for the groundwater sampling will be considered incomplete if these are not included. If one or more of the other analytical parameters listed in Tables 2-3 or/and 2-4 are not reported, the OU project manager (or designee) will determine whether the data set is complete for this SAP.

The determination of analytes for waste characterization will be made in accordance with a separate data quality objectives (DQO) process, which is outside the scope of this SAP. Consequently, completeness of the analytical data set for this purpose is not a consideration for this SAP.

2.1.4.5 Precision

Precision is a measure of the data spread when more than one measurement exists of the same sample. Precision can be expressed as the relative percent difference (RPD) for duplicate measurements, or relative standard deviation for triplicates. Analytical precision for laboratory analyses is included in Tables 2-3 and 2-4.

2.1.5 Special Training Requirements and Certification

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

- Occupational Safety and Health Administration 40-Hour Hazardous Waste Worker Training and Supervised 24-Hour Hazardous Waste Site Experience
- 8-Hour Hazardous Waste Worker Refresher Training (as required)
- Hanford Site General Employee Radiation Training
- Radiological Worker Training.

A graded approach is used to ensure that workers receive a level of training commensurate with their responsibilities in compliance with applicable DOE orders and government regulations. Specialized employee training includes pre-job briefings, on-the-job training, emergency preparedness, plan-of-the-day instructions, and facility/work site orientations.

2.1.6 Documentation and Records

Field sampling and laboratory analytical documentation will be in accordance with contractor procedures and standard industry practices. Work products resulting from sampling and analysis may be included as documents and records, including the following:

- Forms required by *Washington Administrative Code* (WAC) 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the master drilling contract
- Borehole summary reports
- Laboratory data packages
- Verification and validation report.

Both hardcopy and electronic versions of the record deliverables will be provided. Data files shall be in an ASCII-compatible format. The OU project manager is responsible for ensuring that project personnel are working to the current version of this SAP.

2.2 Data Generation and Acquisition

The following subsections present the requirements for sampling methods, sample handling and custody, analytical methods, and field and laboratory QC. The requirements for instrument calibration and maintenance, supply inspections, and data management are also addressed. The sampling design is presented in Chapter 3 of this SAP.

The field team lead is responsible for ensuring that all field procedures are followed completely and that field sampling personnel are adequately trained to perform sampling activities under this SAP. The field team lead must document all deviations from procedures or other problems pertaining to sample collection, chain of custody, sample analytes, sample transport, or noncompliant monitoring. As appropriate, such deviations or problems will be documented in the file logbook or in nonconformance report forms in accordance with internal corrective action procedures. The field team lead is responsible for communicating field corrective action requirements and for ensuring that immediate corrective actions are applied to field activities.

2.2.1 Sample Preservation, Containers, and Holding Times

Suggested sample container, preservation, and holding-time requirements are specified in Table 2-1 for soil samples and in Table 2-2 for groundwater samples. These requirements are in accordance with the requirements of the specific analytical method prepared for specific sample events. The final container type and volumes will be provided on the sampling authorization form and the chain-of-custody form. This SAP defines a "sample" as a filled sample bottle for starting the clock for holding-time restrictions.

Table 2-1. Soil Sample Preservation, Containers, and Holding Time Requirements

Method Name	Number of Bottles	Bottle Type	Volume (g)	Preservation Required	Holding Time
ASTM D422-63 (sieve analysis)	1	G/P	250	None	6 months
ASTM D4525-08 (air permeability test)	1	G/P	1,000	None	N/A
EPA 7196 (hexavalent chromium)	1	G/P	50	Cool ~4°C	24 hours
EPA 6010 (ICP metal)	1	G/P	15	Cool~4°C	6 months
ASTM D2216 (sediment moisture content)	1	Moisture-resistant container	200	None	None
ASTM D5084 (saturated hydraulic conductivity – silt or mud)	1	P	1,000	None	None
ASTM D2434 (saturated hydraulic conductivity – sand or sandy gravel)	1	P	1,000	None	None
ASTM D2937 (bulk density)	1	G/P	1,000	None	None
GEA (radionuclides)	1	G/P	750	None	None
Gas flow proportional counting (radionuclides)	1	G/P	5	None	None
Batch leach contacting test[a]	1	G	100 g/120 mL	Cool ~4°C	28 days[b]

a. This test to be performed by Pacific Northwest National Laboratory.

b. The 28 days from field to extraction.

ASTM D433-63, *Standard Test Methods for Particle-Size Analysis of Soils*

ASTM D4525-08, *Standard Test Method for Permeability of Rocks by Flowing Air*

ASTM = American Society for Testing and Materials

EPA = U.S. Environmental Protection Agency

G = glass

GEA = gamma energy analysis

ICP = inductively coupled plasma

N/A = not applicable

P = plastic

Table 2-2. Sample Container, Preservation, and Holding Time Guidelines for Groundwater Samples by Analytical Method

Method Name	Number of Bottles	Bottle Type	Volume (mL)	Preservation Requirement	Holding Time
Sr-90 CS/LS	1	G/P	1,000	HNO_3 to pH <2	6 months
Tc-99 CS/LS	2	G/P	1,000	HNO_3 to pH <2	6 months
Tritium 906.0	1	G	250	None	6 months
EPA 6010 – ICP	1	G/P	250	HNO_3 to pH <2	6 months
ICP/MS 200.8	1	G/P	500	HNO_3 to pH <2	6 months
EPA 7196	1	G/P	250	Cool 4°C	30 days
IC anions 300.0	1	P	120	Cool 4°C	28 days/ 48 hours
EPA 9310	1	G/P	500	None	6 months
Gamma spectroscopy	1	G/P	500	None	6 months

For EPA Method 200.8, see EPA/600/R-94/111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1.*
For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes.*
For EPA Method 906.0, see EPA/600/4-80/032, *Prescribed Procedures for Measurement of Radioactivity in Drinking Water.*
For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, 3rd Edition; Final Update IV-B.

CS/LS = chemical separation/liquid scintillation
EPA = U.S. Environmental Protection Agency
G = glass
IC = ion chromatography
ICP = inductively coupled plasma
MS = mass spectroscopy
P = plastic

2.2.2 Sampling Methods Requirements

The procedures to be implemented in the field should be in accordance with those presented in Section 3.3 of this SAP.

2.2.3 Sampling Identification

A sample and data tracking database will be used to track the samples from the point of collection through the laboratory analysis process. The HEIS database is the repository for laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project, and the numbers are to be carried through the laboratory data-tracking system.

2.2.4 Sample Handling, Shipping, and Custody Requirements

The processes followed for sample handling, shipping, and custody requirements will be in accordance with those presented in Section 3.3 of this SAP.

2.2.5 Laboratory Sample Custody

Sample custody during laboratory analysis will be addressed in the applicable laboratory's standard operating procedures. Laboratory custody procedures will ensure that sample integrity and identification are maintained throughout the analytical process.

2.2.6 Analytical Methods Requirements

Analytical parameters and methods are presented in Table 2-3 for soil samples and Table 2-4 for groundwater samples. Laboratory analysis should be conducted within allowable sample holding times for each analyte tested. Analyses for metals should be performed on unfiltered groundwater samples. This flag will be carried through sample and data tracking. The batch leach method in Table 2-3 for analysis of EPA metals in RI soil samples will be performed by Pacific Northwest National Laboratory in accordance with their internal laboratory procedures to obtain data for use in calculating distribution coefficient.

Table 2-3. Testing and Analytical Performance Requirements for Remedial Process Optimization and Remedial Investigation Soil Samples

Class	Parameter/ Analyte[a]	Analytical Method[b]	Required Detection Limit[c]	Precision Requirement (%)	Accuracy Requirement (%)
RPO: Testing of Geologic Aquifer Soil Samples					
PHY	Grain-size (sieve analysis)	ASTM D422-63	N/A[d]	N/A[d]	N/A[d]
PRO: RUM Geologic Spit-Spoon Soil Samples					
PHY	Air permeability test	ASTM D4525-08	N/A[d]	N/A[d]	N/A[d]
MET	Chromium (hexavalent)	EPA 7196	0.5	±30	70-130
RI: Vadose, Aquifer, and RUM Split-Spoon Soil Samples					
RI: Nonradiological					
MET	Antimony	EPA 6010 (ICP metals)	0.6 mg/kg[e]	±30[f]	70-130[f]
MET	Arsenic	Trace EPA 6010 (ICP metals) or ICP/MS (6020 or 200.8)	1.0 mg/kg	±30[f]	70-130[f]
MET	Barium	EPA 6010 (ICP metals)	0.2 mg/kg	±30[f]	70-130[f]
MET	Beryllium	EPA 6010 (ICP metals)	0.5 mg/kg	±30[f]	70-130[f]
MET	Boron	EPA 6010 (ICP metals)	2 mg/kg	±30[f]	70-130[f]
MET	Cadmium	EPA 6010 (ICP metals)	0.5 mg/kg	±30[f]	70-130[f]
MET	Chromium (hexavalent)	EPA 7196	0.5 mg/kg	±30[f]	70-130[f]
MET	Chromium (total)	EPA 6010 (ICP metals)	1 mg/kg	±30[f]	70-130[f]
MET	Copper	EPA 6010 (ICP metals)	1 mg/kg	±30[f]	70-130[f]
MET	Lead	EPA 6010 (ICP metals)	5 mg/kg	±30[f]	70-130[f]
MET	Lithium	EPA 6010 (ICP metals)	2.5 mg/kg	±30[f]	70-130[f]

Table 2-3. Testing and Analytical Performance Requirements for Remedial Process Optimization and Remedial Investigation Soil Samples

Class	Parameter/ Analyte[a]	Analytical Method[b]	Required Detection Limit[c]	Precision Requirement (%)	Accuracy Requirement (%)
MET	Manganese	EPA 6010 (ICP metals)	5 mg/kg	±30[f]	70-130[f]
MET	Molybdenum	EPA 6010 (ICP metals)	2 mg/kg	±30[f]	70-130[f]
MET	Nickel	EPA 6010 (ICP metals)	4 mg/kg	±30[f]	70-130[f]
MET	Selenium	EPA 6010 (ICP metals)	1 mg/kg[e]	±30[f]	70-130[f]
MET	Silver	EPA 6010 (ICP metals)	0.2 mg/kg[e]	±30[f]	70-130[f]
MET	Thallium	EPA 6010 (ICP metals)	5 mg/kg	±30[f]	70-130[f]
MET	Vanadium	EPA 6010 (ICP metals)	2.5 mg/kg	±30[f]	70-130[f]
MET	Zinc	EPA 6010 (ICP metals)	10 mg/kg	±30[f]	70-130[f]
MET	Arsenic	Batch leach followed by EPA 6010 (ICP metals)	50 µg/L	±30[f]	70-130[f]
MET	Barium	Batch leach followed by EPA 6010 (ICP metals)	50 µg/L	±30[f]	70-130[f]
MET	Cadmium	Batch leach followed by EPA 6010 (ICP metals)	50 µg/L	±30[f]	70-130[f]
MET	Chromium (hexavalent)	Batch leach followed by EPA 7196	100 µg/L	±30[f]	70-130[f]
MET	Chromium (total)	Batch leach followed by EPA 6010 (ICP metals)	100 µg/L	±30[f]	70-130[f]
MET	Lead	Batch leach followed by EPA 6010 (ICP metals)	50 µg/L	±30[f]	70-130[f]
MET	Selenium	Batch leach followed by EPA 6010 (ICP metals)	100 µg/L	±30[f]	70-130[f]
MET	Silver	Batch leach followed by EPA 6010 (ICP metals)	100 µg/L	±30[f]	70-130[f]
		RI: Physical Properties			
PHY	Porosity	Calculation	N/A[d]	N/A[d]	N/A[d]
PHY	Sediment moisture content	ASTM D2216	N/A[d]	N/A[d]	N/A[d]
PHY	Saturated hydraulic conductivity	ASTM D5084 – for soil with low hydraulic conductivity (silt or mud) ' ASTM D2434 – for soil with high hydraulic conductivity (sand or sandy gravel)	N/A[d]	N/A[d]	N/A[d]
PHY	Bulk density	ASTM D2937	N/A[d]	N/A[d]	N/A[d]

Table 2-3. Testing and Analytical Performance Requirements for Remedial Process Optimization and Remedial Investigation Soil Samples

Class	Parameter/ Analyte[a]	Analytical Method[b]	Required Detection Limit[c]	Precision Requirement (%)	Accuracy Requirement (%)
		RI: Radiological			
RAD	Barium-133	GEA	1 pCi/g	±30[g]	70-130[g]
RAD	Cesium-137	GEA	0.1 pCi/g	±30[g]	70-130[g]
RAD	Cobalt-60	GEA	0.05 pCi/g	±30[g]	70-130[g]
RAD	Europium-152	GEA	0.1 pCi/g	±30[g]	70-130[g]
RAD	Europium-154	GEA	0.1 pCi/g	±30[g]	70-130[g]
RAD	Europium-155	GEA	0.1 pCi/g	±30[g]	70-130[g]
RAD	Strontium-90	GFPC	1 pCi/g	±30[g]	70-130[g]

a. The RPO and RI soil analyte lists are from Section 1.2.

b. Analytical method selection is based on available methods for laboratories currently contracted to the Hanford Site. Equivalent methods may be substituted in future sampling and analysis instructions or other documents. For the four-digit EPA method, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, 3rd Edition; Final Update IV-B.

c. Units are in "pCi/g" for radionuclides and for nonradionuclides "mg/kg" or "µg/L" for batch leach. For RPO samples, the specified detection limits or minimum detectable concentrations are based on current Hanford laboratory contracts. The required detection limit and the precision and accuracy requirements for RI samples are those anticipated to meet data needs for the RI/FS process.

d. Physical property samples have no specific quality control.

e. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory may also substitute graphite furnace or ICP mass spectrometry methods if required detection limits are met.

f. The accuracy criteria specified are for calculated percent recoveries for associated analytical batch matrix spike samples. Additional accuracy evaluation based on statistical control limits for analytical batch laboratory control samples also is performed. The precision criteria shown are for batch laboratory replicate matrix spike or replicate sample relative percent differences.

g. The accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criteria shown are for batch laboratory replicate sample relative percent differences.

ASTM	=	Americal Society for Testing and Materials	MET	=	metal
EPA	=	U.S. Environmental Protection Agency	N/A	=	not applicable
FS	=	feasibiilty study	PHY	=	physical property
GEA	=	gamma energy analysis	RAD	=	radiological property
GFPC	=	gas flow proportional counting	RI	=	remedial investigation
IC	=	ion chromatography	RPO	=	remedial process optimization
ICP	=	inductively coupled plasma	RUM	=	Ringold Upper Mud (Unit)

Table 2-4. Analytical Performance Requirements for Remedial Process Optimization Groundwater Samples

Class	Analyte[a]	Analytical Method[b]	Detection Limit[c]	Precision Requirement (%)	Accuracy Requirement (%)
		Field Measurements			
NA	pH measurement	Probe	0.5 pH unit	[g]	[g]
NA	Specific conductance	Probe	1 µS/cm	[g]	[g]
NA	Temperature	Probe	--	[g]	[g]
NA	Turbidity	Probe	--	[g]	[g]
		Nonradionuclides			
MET	Antimony	Trace - ICP (6010) or ICP/MS (6020 or 200.8)	6.0	80-120[d]	±20[d]
MET	Barium	EPA 6010 – ICP	20	70-130[d]	±30[d]
MET	Beryllium	Trace - ICP (6010) or ICP/MS (6020 or 200.8)	2.0	80-120[d]	±20[d]
MET	Cadmium	Trace - ICP (6010) or ICP/MS (6020 or 200.8)	2.0	80-120[d]	±20[d]
Anion	Chloride	EPA IC 300.0	200	70-130[d]	±30[d]
MET	Chromium (total)	EPA 6010 – ICP	10	80-120[d]	±20[d]
MET	Chromium (hexavalent)	EPA 7196	10	80-120[d]	±20[d]
MET	Calcium	EPA 6010 – ICP	1,000	70-130[d]	±30[d]
MET	Copper	EPA 6010 – ICP	10	80-120[d]	±20[d]
MET	Cobalt	EPA 6010 – ICP	20	70-130[d]	±30[d]
Anion	Fluoride	EPA IC 300.0	500	70-130[d]	±30[d]
MET	Iron	EPA 6010 – ICP	50	70-130[d]	±30[d]
MET	Magnesium	EPA 6010 – ICP	750	70-130[d]	±30[d]
MET	Manganese	EPA 6010 – ICP	5.0	80-120[d]	±20[d]
MET	Potassium	EPA 6010 – ICP	4,000	70-130[d]	±30[d]
MET	Nickel	EPA 6010 – ICP	40	80-120[d]	±20[d]
Anion	Nitrate	EPA IC 300.0	250	80-120[d]	±20[d]
Anion	Nitrite	EPA IC 300.0	250	80-120[d]	±20[d]
MET	Sodium	EPA 6010 – ICP	500	70-130[d]	±30[d]
MET	Silver	EPA 6010 – ICP	10	80-120[d]	±20[d]
MET	Strontium	EPA 6010 – ICP	10	70-130[d]	±30[d]

Table 2-4. Analytical Performance Requirements for Remedial Process Optimization Groundwater Samples

Class	Analyte[a]	Analytical Method[b]	Detection Limit[c]	Precision Requirement (%)	Accuracy Requirement (%)
Anion	Sulfate	EPA IC 300.0	500	80-120 [d]	±20 [d]
MET	Vanadium	EPA 6010 – ICP	25	80-120 [d]	±20 [d]
MET	Zinc	EPA 6010 – ICP	10	80-120 [d]	±20 [d]
		Radionuclides			
RAD	Strontium-90	Sr-90 905.0 GFPC	2.0	80-120 [e]	±20 [e]
RAD	Technetium-99	Tc-99 CS/LS	15	80-120 [e]	±20 [e]
RAD	Tritium	Tritium 906.0	400	80-120 [e]	±20 [e]
RAD	Gross alpha/beta	EPA 9310	3	80-120 [e]	±20 [e]
RAD	Gross gamma	Gamma_GS	[f]	80-120 [e]	±20 [e]

a. The groundwater analytes list is from Table 1-3.

b. Analytical method selection is based on available methods by laboratories currently contracted to the Hanford Site. However, equivalent methods may be substituted.
For EPA Method 300.0, see EPA/600/4-79/020, *Methods for Chemical Analysis of Water and Wastes*.
For EPA Method 906.0, see EPA/600/4-80/032, *Prescribed Procedures for Measurement of Radioactivity in Drinking Water*.
For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, 3rd Edition, Final Update IV-B.

c. Units are in "pCi/L" for radionuclides or "µg/L" for nonradionuclides. The specified detection limit or minimum detectable concentrations are based on current Hanford laboratory contracts.

d. The accuracy criterion shown is the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control, if more stringent. Additional accuracy criteria include analyte-specific evaluations preformed for matrix spike, and surrogate recoveries as appropriate to the method. The precision criterion shown is for batch laboratory replicate matrix spike analysis relative percent differences.

e. For radionuclides, the accuracy criterion shown is for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations preformed for matrix spike, tracer, and/or carrier recoveries as appropriate to the method. The precision criterion shown is for batch laboratory replicate sample relative percent differences.

f. Multiple isotope method; detection limit dependent on isotope.

g. Field measurements have no specific quality control except to perform the manufacturer's required performance checks.

CS/LS = chemical separation/liquid scintillation
EPA = U.S. Environmental Protection Agency
GFPC = gas flow proportional counting
GS = gamma scan
IC = ion chromatography
ICP = inductively coupled plasma
MET = metal parameter
RAD = radiological parameter

2.2.7 Quality Control Requirements

Samples for QC are not required for project soil samples that are tested solely for physical properties. Trip, equipment, and transfer blank QC samples address sample contamination that does not pertain to physical property analyses. Duplicate QC samples pertain to variability of analysis that is not expected

to be significant due to the large size of physical property samples. Driller logbooks that identify soil properties can be used to establish physical property analysis variability. In addition, because the parameters will be used to aid in engineering determinations and not to meet regulatory levels, the parameter information has no regulatory basis from which to derive a minimum detection limit. No QC samples are required for the archived samples.

Field QC samples will be collected during soil and groundwater sampling to evaluate the potential for cross-contamination and laboratory performance to ensure that reliable data are obtained. Particular care will be exercised to avoid the following common ways in which cross-contamination or background contamination may compromise samples:

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample bottles by setting the equipment/sample bottle on or near potential contamination sources (e.g., uncovered ground)
- Handling bottles or equipment with dirty hands or gloves
- Improperly decontaminating equipment before sampling or between sampling events.

Table 2-5 identifies the field QC samples for soil and groundwater sampling. For groundwater samples, one duplicate and one trip blank will be collected from one RPO well in the 100-D Area and one well in the 100-H Area. This number of QC samples is conservatively established based on site procedures that call for approximately one set of QC samples per 20 sampling well trips, with each RPO well representing one sampling well trip.

Laboratory QC sample requirements will be specified in the applicable laboratory's statement of work.

Table 2-5. Field Quality Control Requirements

Sample Type	Frequency	Purpose
Field replicate	Minimum of 1 sample in 20	To check the precision of the laboratory analyses
Equipment rinsates or blanks	Minimum of 1 sample in 20	To check the effectiveness of the decontamination process

2.2.7.1 Field Replicates

Field replicates will be collected at a frequency of one in 20 samples, and at least one per well. Field replicates are used to evaluate laboratory consistency and the precision of field sampling methods.

2.2.7.2 Equipment Rinsates or Blanks

Equipment blanks are collected from reusable sampling devices on a 1-in-20 basis, and at least one per well. The field team leader may request that additional equipment blanks be taken. Equipment blanks will consist of silica sand or analyte-free water poured over the decontaminated sampling equipment and placed in containers, as identified on the project sampling authorization form. Equipment blanks are not needed for disposable sampling equipment.

2.2.8 Measurement Equipment

Each user of the measuring equipment is responsible to ensure that the equipment is functioning as expected, properly handled, and is calibrated before expiration in accordance with procedures governing control of the measuring equipment. Onsite environmental instrument testing, inspection, calibration, and maintenance shall be recorded in a bound logbook (see Section 3.4.3). Field screening instruments will be used, maintained, and calibrated in accordance with the manufacturer's specifications and other approved procedures.

2.2.8.1 Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Onsite environmental instruments shall be tested, inspected, and maintained. Measurement equipment must be inspected before use. Tags will be attached to field screening and onsite analytical instruments, noting the date when the instrument was last calibrated and the calibration expiration date. Maintenance requirements (e.g., parts lists and documentation of routine maintenance) will be included in the individual laboratory's and onsite organization's QA plan and/or operating procedures. Measurement and testing equipment used in the field or in the laboratory directly affecting the quality of analytical data will be subject to preventive maintenance measures to ensure that measurement system downtime is minimized.

2.2.8.2 Instrument Calibration

Laboratories and onsite measurement organizations must maintain and calibrate equipment. Calibration of laboratory instruments will be performed in a manner consistent with SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, or with auditable DOE Hanford Site and contractual requirements. Calibration of radiological field instruments will be performed by RCTs. The data will be reported as accepted, rejected, or qualified.

Calibration is conducted with certified equipment and/or standards with a known valid relationship to nationally recognized performance standards. If no such standards exist, the basis for calibration shall be documented.

2.2.9 Inspection of Consumable Supplies

Consumables, supplies, and reagents will be reviewed in accordance with the current requirements of SW-846 and will be appropriate for use. Potential contamination is monitored by QC samples and laboratory blanks. The lot number from the manufacturer-certified, pre-cleaned sample containers shall be recorded in the sampler's logbook.

2.2.10 Nondirect Measurement

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

2.2.11 Data Management

Data resulting from the implementation of the SAP will be stored in the HEIS database. Reports and supporting analytical data packages will be subject to final technical review by qualified reviewers before submittal to the regulatory agencies or inclusion in reports or technical memoranda. Electronic data access, when appropriate, shall be through computerized database (e.g., HEIS). Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the Tri-Party Agreement.

2.2.12 Laboratory Quality Control

Laboratory duplicates will be analyzed for the waste designation samples. Laboratory method blanks and laboratory control samples/blank spikes are defined in Chapter 1 of SW-846 and will be run as specified in Chapter 1 of SW-846.

2.2.13 Field Documentation

Field documentation shall be maintained in the form of chain-of-custody/sample analysis request forms and logbook entries.

2.3 Assessment/Oversight

Routine evaluation of data quality described for this project will be documented and filed with the data in the project file. The OU project manager (or designee) and/or the field team lead will monitor field activities for this SAP. The OU project manager retains overall responsibility for sampling but may delegate specific responsibilities to the field team lead or other appropriate contractor staff.

The Sample and Data Management organization will select a laboratory to perform the soil and groundwater analyses for this SAP. The Sample and Data Management organization will assess and verify that analytical data are reported by the laboratory and will then enter the verified data into the HEIS database.

2.3.1 Assessments and Response Action

Random surveillance and assessments may be conducted to verify compliance with the requirements outlined in this SAP, project work packages, the QAPjP, procedures, and regulatory requirements. Deficiencies identified by these assessments will be reported. The project's QA organization coordinates corrective actions/deficiencies in accordance with the contractor's QA program. When appropriate, corrective actions will be taken by the OU project manager (or designee).

2.3.2 Reports to Management

Management will be made aware of deficiencies identified by self-assessments, corrective actions from environmental compliance officers, and findings from QA assessments and surveillances.

2.4 Data Review, Verification, Validation, and Usability Requirements

Samples taken for standard turnaround time during drilling will be received from the laboratory, loaded into a database (e.g., HEIS), and verified (Section 2.4.1). A total of 5% of the data will be validated (Section 2.4.3), and then data assessment will be performed (Section 2.4.4). At the direction of the OU project manager (or designee), analytical data packages will be subject to final technical review by qualified personnel before submittal to the regulatory agencies or inclusion in reports. Electronic data access, when appropriate, will be via a database (e.g., HEIS). Where electronic data are not available, hardcopies will be provided in accordance with Section 9.6 of the Tri-Party Agreement.

2.4.1 Data Verification and Usability Methods

Data review and verification are performed by the laboratory to confirm that sampling and chain-of-custody documentation are complete. This review shall include linking sample numbers to specific sampling locations, reviewing sample collection dates and also sample preparation and analysis dates to assess whether holding times have been met, and reviewing QC data to determine whether analyses have met the data quality requirements specified in this SAP.

2.4.2 Resolution of Analytical System Errors

Errors reported by the laboratories are reported to the Sample and Data Management organization's project coordinator, who initiates a sample disposition record in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution with the OU project manager. In addition, the contractor QA engineer receives quarterly reports providing summaries and statistics of the analytical errors.

2.4.3 Data Validation

Validation activities will be based on EPA functional guidelines in *Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses* (Bleyler 1988a) and *Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses* (Bleyler 1988b). Data validation may be performed by the analytical laboratory, by the Sample and Data Management organization, and/or by a party independent of both the data collector and the data user. A total of 5% of the results will undergo Level C validation, as defined by the validation guidelines.

The RPDs between the pair of field duplicates/replicates will be calculated to determine whether the precision requirements of the project (RPD $\leq$30%) were met for the analytes. The RPDs will be calculated only when the results for the duplicate and the corresponding primary sample were more than five times the required detection limit or reporting limit. When at least one result was a detect and one or both results are less than five times the detection limit, the results are compared by difference using the reporting value for nondetects. A difference of up to two times the detection limit is considered satisfactory for samples. Where both results were nondetects, a RPD is not calculated.

2.4.4 Data Assessment

The data quality assessment process compares completed field activities to those in corresponding documents and provides an evaluation of the resulting data. The purpose of the data assessment is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project DQOs. The assessment will be consistent with the data quality assessment process in *Data Quality Assessment: A Reviewer's Guide* (EPA/240/B-06/002), and *Data Quality Assessment: Statistical Tools for Practitioners* (EPA/240/B-06/003).

Method blanks and any field/equipment blanks will be compared to the data to assess contamination. The comparison will evaluate whether any analyte present in the trip/equipment or laboratory blank exceeds the regulatory limits (i.e., universal treatment standards and toxicity characteristics).

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3 Field Sampling Plan

This field sampling plan identifies activities for installation of new RPO groundwater extraction and injection wells, soil sampling during borehole installation, and groundwater sampling after RPO well development. During RPO borehole installation, soil data will be collected at boreholes identified in Table 1-1 to meet 100-D/H decision unit RI data needs.

As discussed later in Section 3.5, waste characterization sampling for purposes of project waste designation will occur outside the scope of this SAP in accordance with the *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units* (DOE/RL-97-01).

3.1 Sampling Objectives

The RPO project soil and groundwater sampling objectives were identified by the project team during the sample planning process (described in Chapter 1 and documented in SGW-40044). This SAP provides for soil and groundwater sampling to meet the defined sampling objectives. The primary objective of the RPO sampling is to provide soil data to optimize the design of the new RPO wells being installed to expand and optimize the current 100-HR-3 OU pump-and-treat system for remediation of groundwater contaminated with hexavalent chromium.

The RI soil data collected from RPO samples will provide data and additional information for physical and hydrogeologic parameters to support possible future fate and transport evaluations, particularly beneath the unconfined aquifer. The RPO wells selected to support the RI/FS process were chosen because they provide increased spatial density and representation of the data. The RI parameters selected were those that support future fate and transport evaluations.

Geologic samples will be collected at 1.5-m (5-ft) intervals and major lithologic changes to total borehole depth during installation of each borehole and will be archived to address possible future data needs. To support RI data needs, one split-spoon sample will be collected of vadose zone soil approximately 0.6 m (2 ft) above the water table at boreholes identified in Table 1-1 for analysis and testing of the RI analytes listed in Table 1-4. Data collected from 0.6 m (2 ft) above water table represents the periodically rewetted zone, which may be an area where contamination migrates. Shallower samples were not proposed because RPO wells are not located near known contaminant sources. The RPO project geologic samples will be collected from aquifer soils during borehole installation for testing of soil physical properties used to facilitate RPO well design. To support RI data needs, two split-spoon samples will be collected of aquifer materials at RPO boreholes (at boreholes identified in Table 1-1) for analysis and testing of Table 1-4 RI analytes to provide RI data on aquifer sediments/soils. The RPO project split-spoon samples will be collected on top of the RUM soils for laboratory permeameter testing and hexavalent chromium analysis to provide additional information on materials delineating the bottom of the unconfined aquifer. To support RI data needs, one split-spoon sample of RUM soil will be collected at total borehole depth (approximately 1.5 m [5 ft] into the RUM) at boreholes identified in Table 1-1 for analysis and testing of Table 1-4 RI analytes to provide data and information on soil beneath the unconfined aquifer, within the aquitard.

Groundwater samples from each RPO well site after well development to obtain groundwater contaminant information will help confirm RPO well use, to confirm ambient chromium concentrations, and to develop a baseline chromium concentration within the aquifer.

3.2 Sampling Design

To meet project sampling objectives, the sampling design identifies the sampling locations, sample intervals, sample processes, target analytes and parameters, and analytical methods. The key features of RPO soil and groundwater sampling design and the sampling rationale are summarized in Table 3-1.

Table 3-1. Key Features of Remedial Process Optimization Project Sampling Design

Analytical Methodology	Key Features of Design	Sampling Design Rationale
RPO Geologic Samples for Archiving		
Geological sampling	Specific location/area of concern: The boreholes requiring geologic sampling are located as shown in Figures 1-2 and 1-3. The soils of concern for geologic sampling range from 1.5 m (5 ft) bgs to total borehole depth. Investigation method: Geologic samples will be taken beginning at a depth of 1.5 m (5 ft) bgs and continuing at 1.5-m (5-ft) intervals and at major lithologic changes to total borehole depth. Analytes: These samples will be archived for possible future analysis, and target analytes would be determined based on data needs identified at that time.	Geologic samples will be archived in case future data needs are identified.
RI Only – Split-Spoon Deep Vadose Zone Samples		
Split-spoon sampling	Specific location/area of concern: The borehole soil of concern to the RI are the deep vadose zone soils just above the unconfined aquifer at the wells identified for RI sampling in Table 1-1. Investigation method: Deep vadose zone soil will be investigated by collection of one split-spoon sample 0.6 m (2 ft) above the water table at the wells identified for RI sampling in Table 1-1. Analytes: The vadose zone soil sample will undergo laboratory analysis and testing for the RI analytes and physical properties shown in Table 1-4.	This sampling will support RI data needs for the periodically re-wetted zone as an area where contamination migrates.
RPO Geologic Aquifer Soil Samples		
Geological sampling	Specific location/area of concern: The soils of the unconfined aquifer are of interest to this investigation. Investigation method: Aquifer soil will be investigated by collection of one geologic sample from soil of the upper half of the aquifer and one sample from soil of the lower half of the aquifer. Analytes: The aquifer soil samples will be tested for the physical property of grain-size distribution (sieve analysis) (Table 1-2).	Soil physical property data are necessary to facilitate RPO well design to maximize well efficiency.
RI Only – Aquifer Material Split-Spoon Samples		
Split-spoon sampling	Specific location/area of concern: These samples will be collected from soils of the unconfined aquifer. Investigation method: Aquifer soil will be investigated by collection of two samples at each RPO well identified for RI sampling in Table 1-1. One split-spoon sample will be collected from the soil of the upper half of the aquifer and one split-spoon sample from the soil of the lower half of the aquifer. Analytes: The aquifer soil samples will undergo laboratory analysis and testing for RI analytes and physical properties identified in Table 1-4.	This sampling will support RI data needs for data on aquifer sediments/soils.

Table 3-1. Key Features of Remedial Process Optimization Project Sampling Design

Analytical Methodology	Key Features of Design	Sampling Design Rationale
RPO Split-Spoon Top of the RUM Soil Samples		
Split-spoon sampling	Specific location/area of concern: RUM Unit soil, at the RUM/aquifer interface is of concern for this sampling. Investigation method: The RUM soil will be investigated by collecting one split-spoon sample of RUM soil near the RUM and aquifer interface. Analytes: The RUM soil samples will undergo laboratory permeameter testing and analysis for hexavalent chromium (Table 1-2).	RUM soil samples will provide additional information on materials that delineate the bottom of the unconfined aquifer.
RI Only – Split-Spoon RUM Soil Sample		
Split-spoon sampling	Specific location/area of concern: Soils at total borehole depth (approximately 1.5 m [5 ft] into the RUM) are of interest to this sampling. Investigation method: The RUM soil will be investigated by collection of one split-spoon sample at total borehole depth (1.5 m [5 ft] into the RUM) from each RPO well identified for RI sampling in Table 1-1. Analytes: The aquifer soil samples will undergo analysis and testing for RI analytes and physical properties identified in Table 1-4.	This sampling will support RI data needs for data and information on soil beneath the unconfined aquifer, within the aquitard.
Groundwater Sampling		
Groundwater sampling	Specific location/area of concern: The groundwater at each new RPO well location is of concern. Investigation method: One groundwater sample will be collected from each well location upon completion of well development. Analytes: The list of groundwater analytes includes metals, radionuclides, and physical properties identified on Table 1-3.	Confirm RPO well use and the ambient chromium concentrations that will be used to develop a baseline chromium concentration within the aquifer.

bgs = below ground surface
RI = remedial investigation
RPO = remedial process optimization
RUM = Ringold Upper Mud (Unit)

3.2.1 Borehole Drilling

Boreholes for the new RPO groundwater wells will be drilled through the upper unconfined aquifer of the 100-D and 100-H Areas to a depth at least 1.5 m (5 ft) into the RUM most likely using an air-circulation technique, except in the vicinity of the ISRM barrier, although the final drilling method will be determined by the drilling lead and drilling contractor. Well locations are shown in Figures 1-2 and 1-3. Given the variability of depth to groundwater in the 100-D and 100-H Areas, the aquifer thickness, and the 1.5-m (5-ft) penetration into the RUM, total borehole depths at the 100-D Area could vary from approximately 14 to 30 m (46 to 98 ft) and at the 100-H Area from approximately 14 to 16 m (46 to 52 ft) in depth.

3.2.2 Remedial Process Optimization Well Installation and Development

Well drilling will be performed in accordance with the requirements of WAC 173-160. If the completion differs from the WAC 173-160 requirements, then variances will be obtained from Ecology.

The wells will be constructed generally (as shown in Figure 3-1) using 15.2-cm (6-in.)-diameter (or larger) casing. The method of drilling most likely will be an air-circulation technique; however, the final drilling method will be determined by the drilling lead and drilling contractor. Air rotary drilling will not be used in the vicinity of the ISRM barrier (near wells 199-D4-95, 199-D4-96, 199-D4-97, 199-D4-98, and 199-D4-99) due to the need to maintain reducing conditions. The wells will be constructed with Schedule 10, Type 304 or 316, stainless-steel, V-slot, continuous wire-wrap screen, on top of a 0.9-m (3-ft)-long, stainless-steel sump with end cap. A Schedule 10 stainless-steel riser will be used to extend the permanent well into the vadose zone, with Schedule 10 stainless-steel casing through the vadose zone to ground surface. Colorado silica sand (unless otherwise determined by the drilling contract) will be used for the sand pack; sodium bentonite pellets and/or natural sodium bentonite chunks, crumbles, or powdered bentonite will be used for bentonite sealing material; and Type I/II Portland cement will be used for cement grout.

For these wells, depending on aquifer thickness, at least a 6.1-m (20-ft) screen is planned to be installed, with the top of the screen above the aquifer high-water mark. The screen slot size and length will be finalized prior to well development based on grain-size (sieve analysis) data obtained from aquifer soil sampling, aquifer thickness, and fluctuation in river stage.

Surface construction consisting of protective casing, protective guard posts, and cement pad must be in place before job completion. The protective casing shall be a minimum of 5.1 cm (2 in.) larger in diameter than the permanent casing. Protective casing shall rise approximately 0.9 m (3 ft) above the ground surface. Permanent casing shall rise to approximately 0.3 m (1 ft) below the top of the protective casing. Protective casing shall have a lockable well cap extending approximately 38 cm (15 in.) above the top of the protective casing.

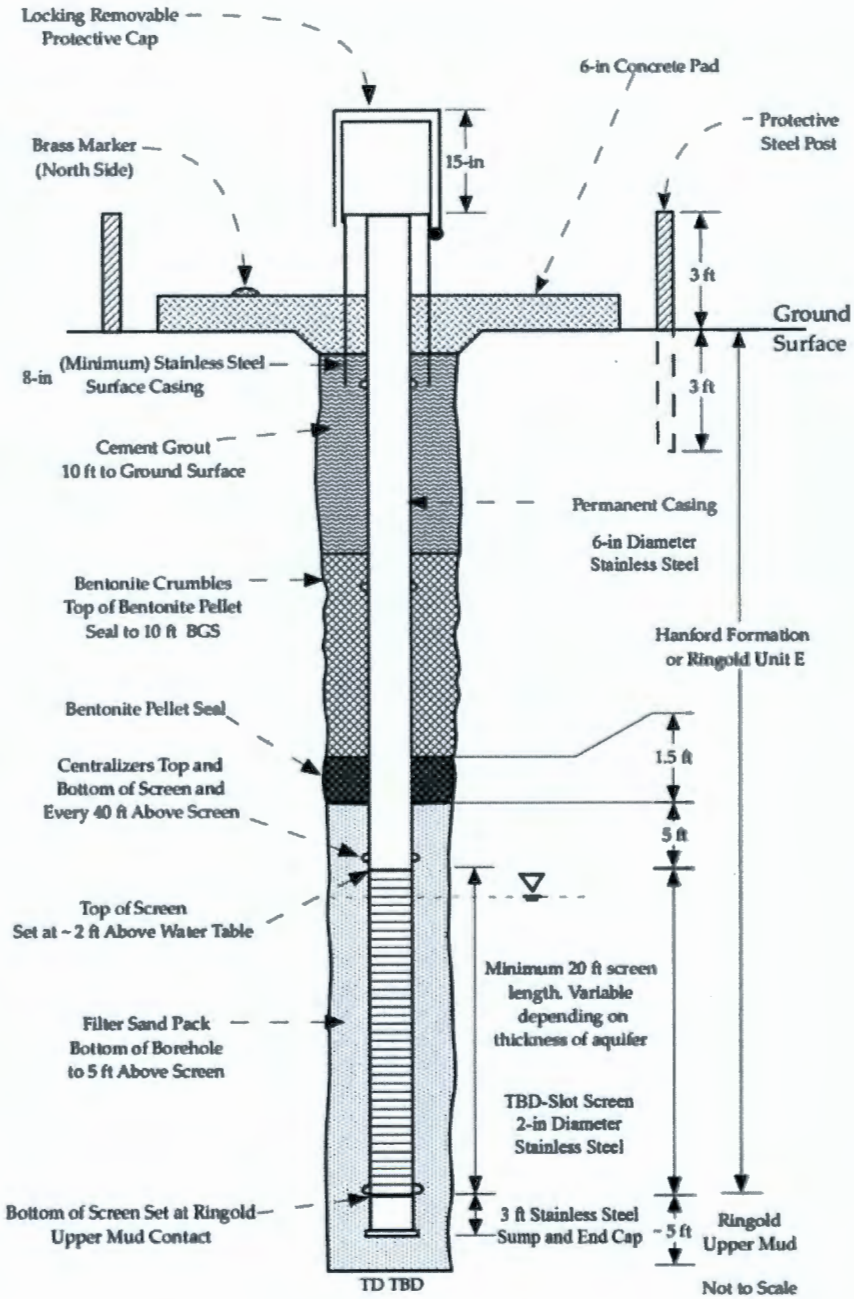
3.3 Sampling Locations and Frequencies

Boreholes will be drilled through the unconfined aquifer and at least 1.5 m (5 ft) into the RUM. Figures 1-2 and 1-3 show the approximate RPO well installation locations. The actual well locations could vary based on a field walkdown of current site conditions in order to avoid Hanford Site National Historic Monument restrictions, roads, and other obstructions.

3.3.1 Soil Sample Locations and Frequencies

During borehole installation, RPO and RI soil samples will be collected. Sample locations and frequency are summarized in Table 3-2.

During borehole installation, geologic samples will be collected for archiving beginning at 1.5 m (5 ft) bgs and continuing at 1.5-m (5-ft) intervals and at major lithologic changes to total borehole depth. Figures 3-2 and 3-3 are generalized borehole schematics that identify RPO and RI soil sampling intervals at the 100-D Area boreholes. Figures 3-4 and 3-5 are generalized borehole schematics that identify RPO and RI soil sampling intervals at the 100-H Area boreholes. Figures 3-2 through 3-5 also generally locate the major 100-D and 100-H Area lithological contacts to help ensure that these contacts are geologically logged.



bgs = below ground surface

TBD = to be determined

TD = total depth

Figure 3-1. General Well Construction Diagram for Dual-Function Extraction and Injection Wells

Table 3-2. Summary of 100-HR-3 Operable Unit Remedial Process Optimization and 100-D/H Decision Unit Remedial Investigation Analytical Sample Collection Requirements

	Sample Collection Methodology		Sample Location Information							Analytical Requirements and Parameters	
				Sample Depths/ Intervals		No. of Samples Collected		No. of Field Quality Control Samples			
RPO Well No.	Soil	Ground-water	Borehole/ Sample Location	Soil	Ground-water	Soil Split Spoon[a]	Ground-water	Soil	Ground-water	Soil	Ground-water
199-D4-95	Split spoon	Pump	Figures 1-2 and 1-3	Figure 3-2	Total borehole depth [b]	1[c]	1[e]	8[f]	6[g]	h	Chromium (hexavalent), anions, metals, tritium, Tc-99, Sr-90, gross alpha and beta, and gross gamma[j]
199-D4-96[b]				Figures 3-2/3-3		5[d]	1[e]			i	
199-D4-97				Figure 3-2		1[c]	1[e]			h	
199-D4-98				Figure 3-2		1[c]	1[e]			h	
199-D4-99				Figure 3-2		1[c]	1[e]			h	
199-D2-10[b]				Figures 3-2		5[d]	1[e]			i	
199-D2-12				Figure 3-2		1[c]	1[e]			h	
199-D8-89[b]				Figures 3-2/3-3		5[d]	1[e]			i	
199-D8-90				Figure 3-2		1[c]	1[e]			h	
199-D8-91				Figure 3-2		1[c]	1[e]			h	
199-D8-93				Figure 3-2		1[c]	1[e]			h	
199-D8-94				Figure 3-2		1[c]	1[e]			h	
199-H1-32				Figure 3-4		1[c]	1[e]			h	
199-H1-33				Figure 3-4		1[c]	1[e]			h	
199-H1-34				Figure 3-4		1[c]	1[e]			h	
199-H1-35[b]				Figures 3-4/3-5		5[d]	1[e]			i	
199-H1-37				Figure 3-4		1[c]	1[e]			h	

Table 3-2. Summary of 100-HR-3 Operable Unit Remedial Process Optimization and 100-D/H Decision Unit Remedial Investigation Analytical Sample Collection Requirements

	Sample Collection Methodology		Sample Location Information							Analytical Requirements and Parameters	
				Sample Depths/ Intervals		No. of Samples Collected		No. of Field Quality Control Samples			
RPO Well No.	Soil	Ground-water	Borehole/ Sample Location	Soil	Ground-water	Soil Split Spoon[a]	Ground-water	Soil	Ground-water	Soil	Ground-water
199-H1-38				Figure 3-4		1[c]	1[e]			h	
199-H1-36[bb]				Figures 3-4/3-5		5[d]	1[e]			i	
199-H1-39				Figure 3-4		1[c]	1[e]			h	
199-H1-40				Figure 3-4		1[c]	1[e]			h	
199-H1-42				Figure 3-4		1[c]	1[e]			h	
199-H1-45				Figure 3-4		1[c]	1[e]			h	
199-H1-25				Figure 3-4		1[c]	1[e]			h	
199-H1-27				Figure 3-4		1[c]	1[e]			h	
199-H4-70				Figure 3-4		1[c]	1[e]			h	
199-H4-69				Figure 3-4		1[c]	1[e]			h	
199-H1-43				Figure 3-4		1[c]	1[e]			h	
199-H3-25				Figure 3-4		1[c]	1[e]			h	
199-H1-21				Figure 3-4		1[c]	1[e]			h	
199-H1-20				Figure 3-4		1[c]	1[e]			h	
199-H3-27				Figure 3-4		1[c]	1[e]			h	
199-H3-26				Figure 3-4		1[c]	1[e]			h	
199-H4-73				Figure 3-4		1[c]	1[e]			h	

Table 3-2. Summary of 100-HR-3 Operable Unit Remedial Process Optimization and 100-D/H Decision Unit Remedial Investigation Analytical Sample Collection Requirements

RPO Well No.	Sample Collection Methodology		Sample Location Information							Analytical Requirements and Parameters	
				Sample Depths/ Intervals		No. of Samples Collected		No. of Field Quality Control Samples			
	Soil	Ground-water	Borehole/ Sample Location	Soil	Ground-water	Soil Split Spoon[a]	Ground-water	Soil	Ground-water	Soil	Ground-water
199-H4-71				Figure 3-4		1[c]	1[e]			h	
199-H4-72				Figure 3-4		1[c]	1[e]			h	
199-H6-2				Figure 3-4		1[c]	1[e]			h	
Soil samples	Soil split-spoon samples			57							
	QC soil samples			8							
				Total soil samples		***65***					
Groundwater samples	Total groundwater samples collected			37							
	Total groundwater QC samples			6							
				Total groundwater samples		***43***					
				Total number of analytical samples		***109***					

a. All RPO and RI soil samples are expected to be collected as split-spoon samples.

b. 100-D/H decision unit RI samples will be collected from this RPO well as indicated in Table 1-1. The RI wells are shaded gray for clarity.

c. One RPO sample will be collected of RUM soil at the aquifer/RUM unit interface of every borehole for laboratory analysis. This table does not contain RPO geologic samples that will be archived or geologic aquifer soil samples that will be field tested.

d. One RPO RUM soil sample (footnote d) and four RI soil samples (one deep vadose zone, two aquifer soil, and one deeper RUM soil sample) will be collected for laboratory analysis.

e. One groundwater sample will be collected from each developed RPO well.

f. One set of soil QC samples (comprised of one duplicate and one equipment blank) will be collected during RUM soil sampling from two RPO wells in the 100-D Area and from two RPO wells in the 100-H Area for a total of eight QC soil samples.

Table 3-2. Summary of 100-HR-3 Operable Unit Remedial Process Optimization and 100-D/H Decision Unit Remedial Investigation Analytical Sample Collection Requirements

	Sample Collection Methodology		Sample Location Information							Analytical Requirements and Parameters	
				Sample Depths/ Intervals		No. of Samples Collected		No. of Field Quality Control Samples			
RPO Well No.	Soil	Ground-water	Borehole/ Sample Location	Soil	Ground-water	Soil Split Spoon[a]	Ground-water	Soil	Ground-water	Soil	Ground-water

g. One set of groundwater QC samples (comprised of one duplicate and one equipment blank) will be collected after well development from one RPO well in the 100-D Area and two wells in the 100-H Area for a total of six groundwater QC samples.

h. RPO RUM soil sample analyzed for air permeability and hexavalent chromium (Table 2-3).

i. The RI samples will undergo analysis for RI analytes identified in Table 2-4.

j. The complete list of groundwater analytes and analytical requirements is identified in Table 2-4.

k. Not included are additional field directed samples collected at the direction of the field team lead in consultation with the site geologist, as described in Section 2.1.2.

QC = quality control

RI = remedial investigation

RPO = remedial process optimization

RUM = Ringold Upper Mud (Unit)

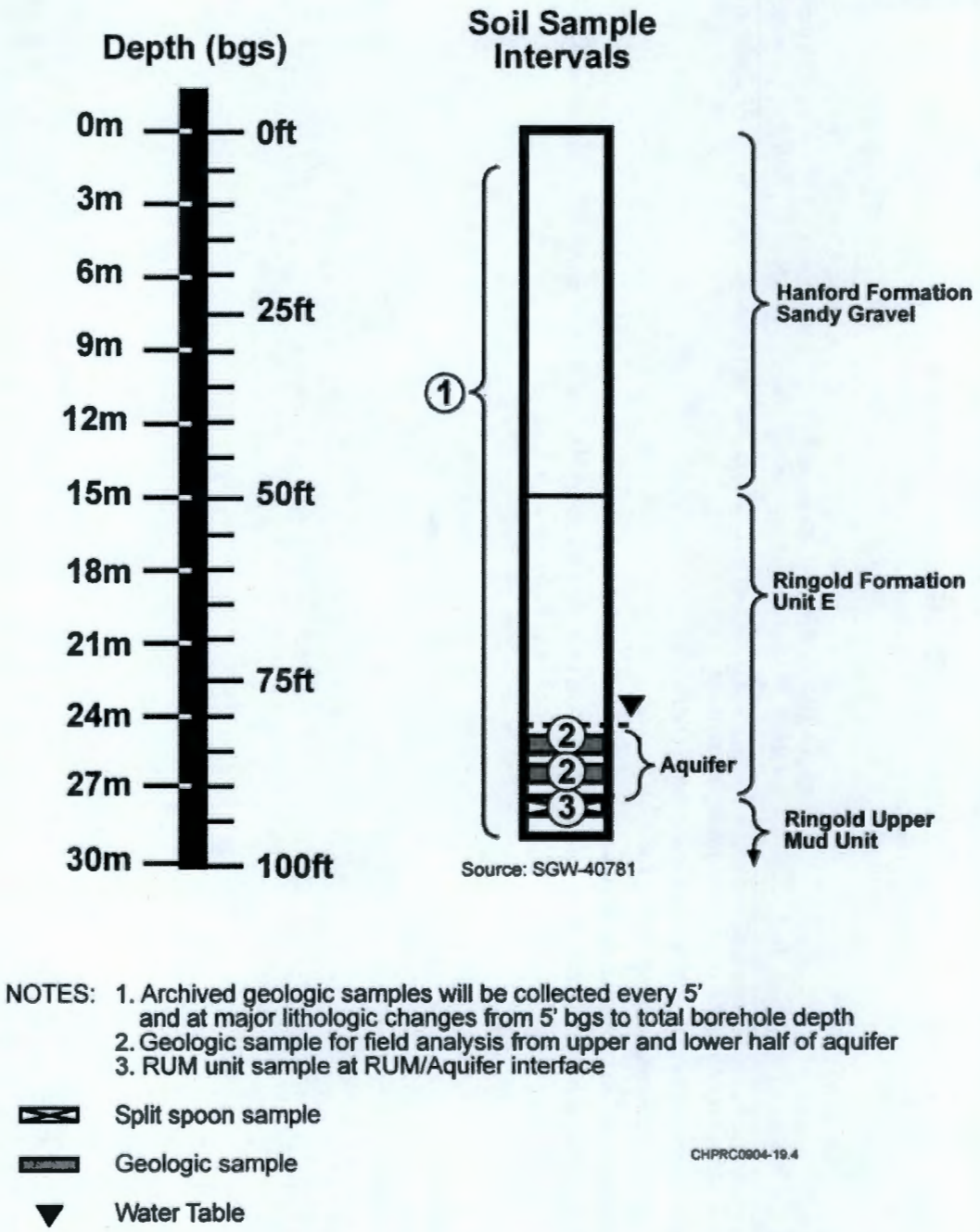
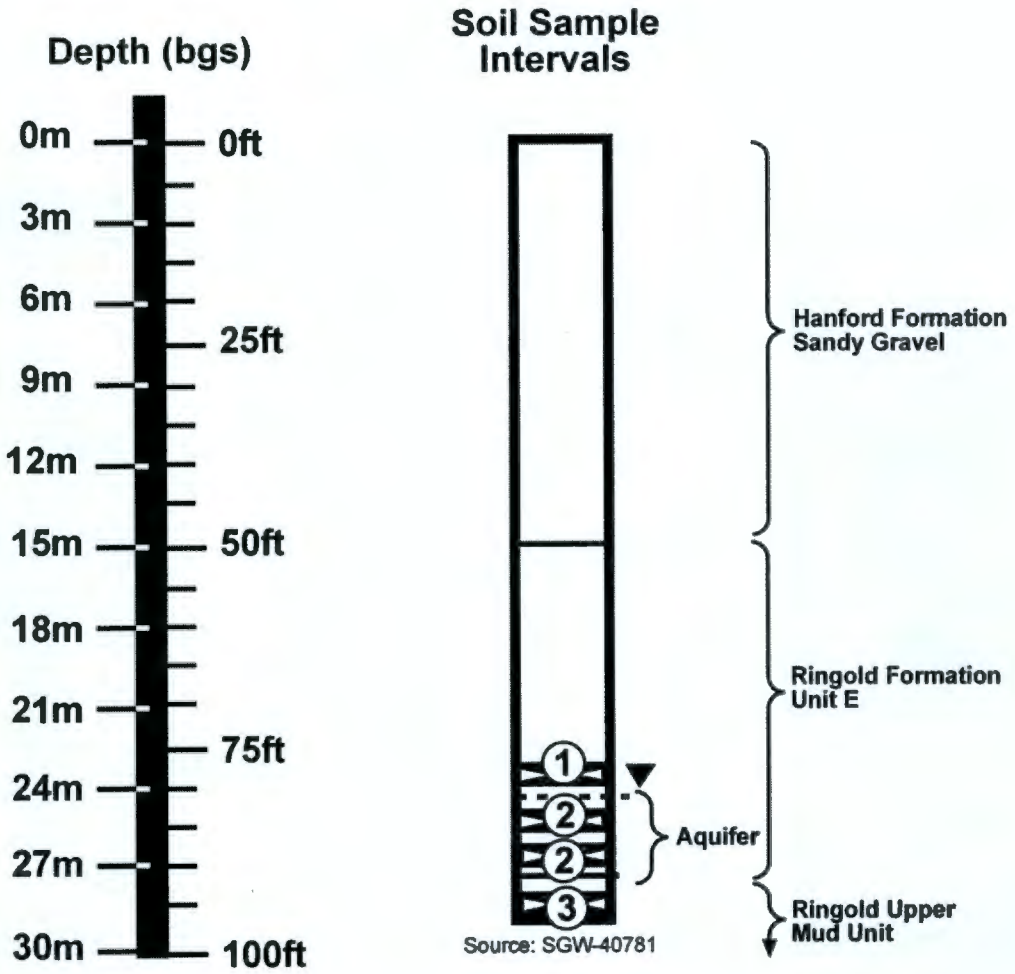


Figure 3-2. Intervals for 100-D Area Remedial Process Optimization Soil Samples



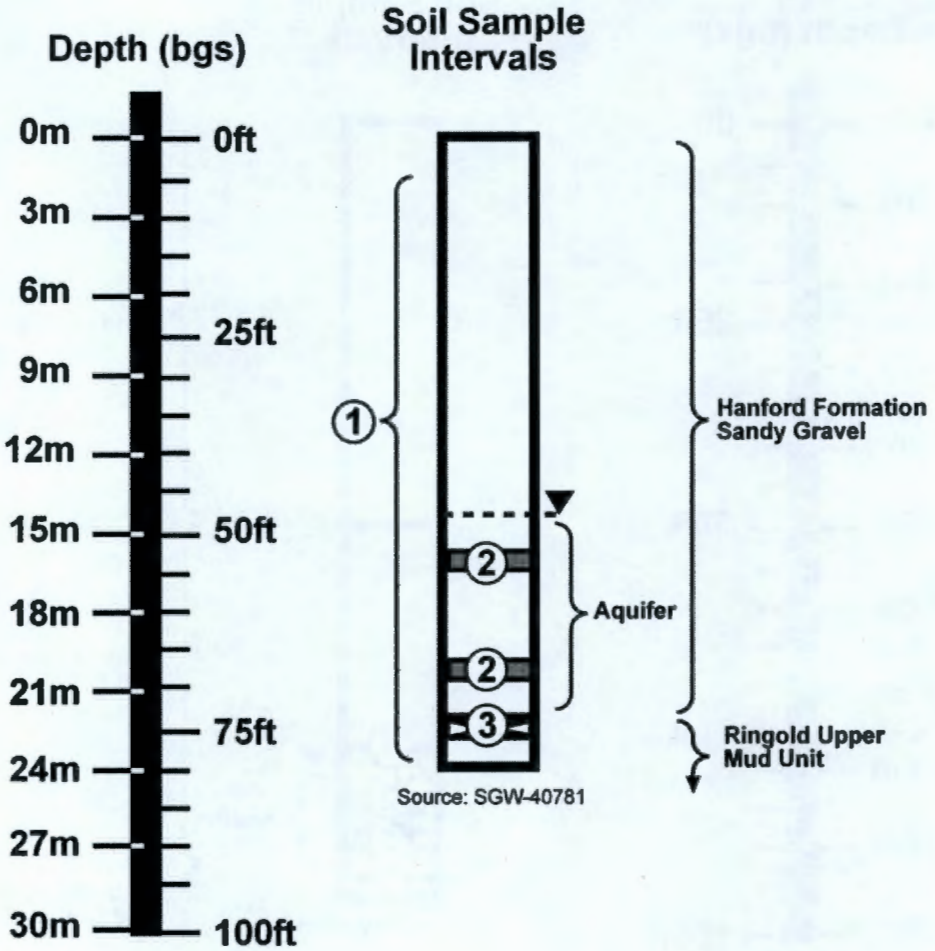
NOTES:
1. One split-spoon sample at 2' above water table
2. One RI Sample from upper and lower half of aquifer
3. RUM sample at total borehole depth
4. All RPO Project samples also will be collected at RI sampling wells

Split spoon sample

Water Table

CHPRC0904-19.2

Figure 3-3. Intervals for 100-D Area Remedial Investigation Soil Samples



NOTES: 1. Archived geologic samples will be collected every 5' and at major lithologic changes from 5' bgs to total borehole depth
2. Geologic sample for field analysis from upper and lower half of aquifer
3. RUM unit sample at RUM/Aquifer interface

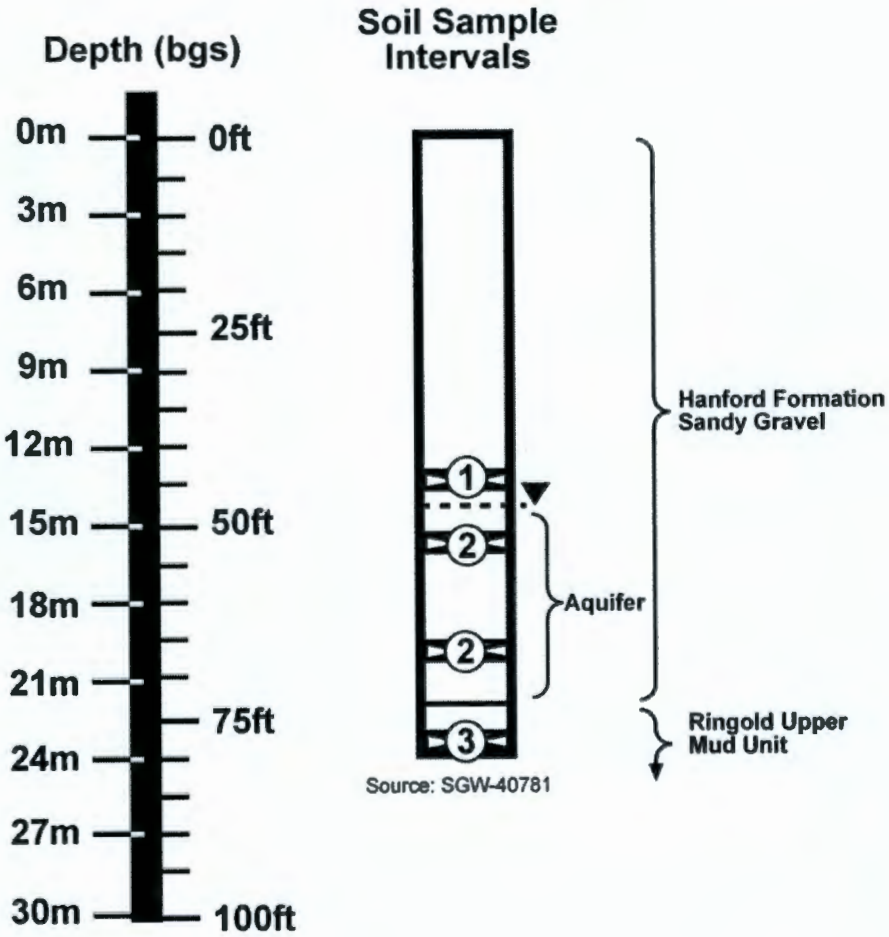
Split spoon sample

Geologic sample

Water Table

CHPRC0904-19.3

Figure 3-4. Intervals for 100-H Area Remedial Process Optimization Soil Samples



NOTES: 1. One split-spoon sample at 2' above water table
2. One RI Sample from upper and lower half of aquifer
3. RUM sample at total borehole depth
4. All RPO Project samples also will be collected at RI sampling wells

Split spoon sample

Water Table

CHPRC0904-19.1

Figure 3-5. Intervals for 100-H Area Remedial Investigation Soil Samples

The number of geologic samples collected for archiving will vary depending on actual borehole depth. Given the variable depths to the RUM (plus an additional 1.5 m [5 ft] into the RUM for the well sump), geologic samples could be collected to depth ranges of approximately 14 to 30 m (46 to 98 ft) bgs in the 100-D Area and 14 to 16 m (46 to 52 ft) in the 100-H Area. This would provide for collection of from 9 to 19 archived geologic samples at each 100-D Area borehole and from 9 to 11 geologic samples at each 100-H Area borehole. These geologic samples do not provide well design information and, thus, will not be analyzed under this SAP but will be archived for possible future analysis in case data needs are identified later. Because these samples will not be analyzed under this SAP, they are not shown in Table 3-2.

One RI split-spoon sample will be collected from deep vadose zone soils 0.6 m (2 ft) above the water table at the RPO wells identified for RI sampling in Table 1-1. These soil samples will undergo analysis for the RI analytes identified in Table 2-3.

Two RPO geologic samples of aquifer soils will be collected during borehole installation for physical property of grain-size distribution (sieve analysis) testing to provide location-specific soil property data. One sample will be collected from soil of the upper half of the aquifer and one sample will be collected from soil of the lower half of the aquifer. These samples are anticipated to be obtained as split-spoon samples (Table 3-2). However, if the drilling method allows recovery of an intact grab sample, the field team lead may allow this alternative.

Two RI split-spoon samples of aquifer soil will be collected at RPO well locations identified for RI sampling in Table 1-1. One sample will be collected from soil of the upper half of the aquifer and one sample will be taken from soil of the lower half of the aquifer. These samples will undergo analysis for the RI analytes identified in Table 2-3.

One RPO split-spoon sample will be collected from the each well location from RUM soil near the RUM/aquifer interface. This sample will undergo laboratory permeameter testing and will be analyzed for hexavalent chromium as shown in Table 2-3.

One RI sample will be collected from RUM soil at total borehole depth (approximately 1.5 m [5 ft] into the RUM) at each RPO borehole identified for RI sampling in Table 1-1. These samples will undergo analysis for RI analytes as identified on Table 2-3.

3.3.2 Groundwater Sample Locations and Frequencies

One groundwater sample will be collected from the unconfined aquifer at each RPO well location after well development for analysis as shown in Table 2-4. Groundwater contaminant data will help confirm RPO well type and placement, will confirm ambient chromium concentrations, and will help develop a baseline chromium concentration within the aquifer. Groundwater samples to be collected are summarized in Table 3-2.

After each new well is properly developed, slug testing and pump testing that are outside the scope of this SAP will be performed to characterize hydraulic conductivity. A separate test plan will be generated to document well testing activities following well development and the analysis of well development data to ensure proper test design.

The groundwater sample will be collected through RPO well screens and brought to the surface. Before sample capture, the well will be purged by operating the pump for a period of time sufficient to provide stabilized field readings and to process at least three casing volumes.

3.4 Field-Specific Collection Requirements

3.4.1 Sample Location and Depth

The sample number, well identification number, and depth shall be documented. Each sample bottle and chain-of-custody form must be identified by sample number and sampling authorization form number.

3.4.2 Sample Identification

A sample tracking database will be used to track the samples through the collection and laboratory analysis process. The HEIS database is the repository for the laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project. The radiological and physical properties of each sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook. Each sample container will be labeled with the following information, using a waterproof marker on firmly affixed, water-resistant labels:

- Sampling authorization form number
- HEIS number
- Sample collection date and time
- Analysis required
- Preservation method (if applicable).

3.4.3 Field Sample Logbook

Information pertinent to sampling and analysis will be recorded in field checklists and logbooks in accordance with existing sample collection protocols. The sampling team will be responsible for recording relevant sampling information. Entries made in the logbook will be dated and signed by the individual making the entry. Program requirements for managing the generation, identification, transfer, protection, storage, retention, retrieval, and disposition of records will be followed.

3.4.4 Sample Custody

Sample custody will be maintained in accordance with existing Hanford Site protocols. The custody of samples will be maintained from the time that samples are collected until ultimate disposal of the samples, as appropriate. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to the laboratory. Sample shipping procedures will be followed throughout sample shipment. Each chain-of-custody form will include the sample identification number, associated well identification number, and remediation system designation. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form.

Chain-of-custody procedures will be followed throughout sample collection, storage, transfer, analysis, and disposal to ensure that sample integrity is maintained. Each time the responsibility for the custody of the sample changes, the new and previous custodians will sign the record and note the date and time. A custody seal (i.e., evidence tape) will be affixed to the lid of each sample jar. The container seal will be inscribed with the sampler's initials and the date. Sample custody during laboratory analysis will be addressed in the applicable laboratory's standard operating procedures.

3.4.5 Sample Shipping

Samples will be transported after authorization from the S&GRP-authorized shipper. If the wells have a medium or high risk of encountering radiological material, radiological surveys will be required. If radiological materials are not anticipated, RCT surveys may not be required if the RCT field readings show no activity above background. As applicable, the RCT will measure the contamination levels on the outside of each sample jar and the dose rates on each sample jar. As applicable, the RCT will also measure the radiological activity on the outside of the sample container (through the container) and will document the highest contact radiological reading in millirem per hour (mrem/hr). This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation regulations (49 CFR, "Transportation") and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria. The sampler will send copies of the shipping documentation to Sample and Data Management within 48 hours of shipment.

As a general guideline, samples with activities <0.5 mrem/hr can be shipped to an appropriate offsite laboratory (e.g., DOE contract laboratory, or a laboratory with a U.S. Nuclear Regulatory Commission or state license for specific radionuclides). Samples with activities between 0.5 and 10 mrem/hr can be shipped to an offsite laboratory, although samples with dose rates within this range will be evaluated on a case-by-case basis by Sample and Data Management. Samples with activities >10 mrem/hr will be sent to an onsite laboratory, as arranged by the Sample and Data Management organization.

3.5 Management of Waste

Waste generated by sampling activities under this SAP (e.g., personal protective clothing and equipment) will be managed in accordance with the waste management plan (DOE/RL-97-01). Remediation wastes generated by sampling activities covered under this SAP (e.g., personal protective clothing and equipment) are subject to CERCLA requirements. These wastes will be characterized as outlined in a site-specific DQO summary report and will be managed in accordance with DOE/RL-97-01. Proximal data and/or a document covering similar location/materials may be used in lieu of a site-specific DQO summary report, with the concurrence of the regulators associated with the final waste disposal facility. An exception to this requirement may be approved by the regulators associated with the final disposal facility if sufficient proximal data exist, or if another document of this type covering similar locations and/or materials is deemed appropriate for the location(s).

Unused samples and associated laboratory waste for the analysis will be dispositioned in accordance with the laboratory contract and agreements for return of waste to the project site. Pursuant to 40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Control Plan," "Procedures for Planning and Implementing Off-Site Response Actions," approval of the DOE remedial project manager as the lead agency (40 CFR 300.5) is required before returning unused samples or waste from offsite laboratories (as applicable).

Sampling, analysis, and disposition of soil cuttings, personal protective equipment, and small-volume miscellaneous solid waste will be performed in accordance with a site or OU-specific DQO summary report. An exception to this requirement may be approved by the regulators associated with the final disposal facility if sufficient proximal data exist, or if another document of this type covering similar locations and/or materials is deemed appropriate for the location(s).

4 Health and Safety

Field operations will be performed in accordance with health and safety requirements and appropriate S&GRP requirements. Work control documents will be prepared to further control site operations. Safety documentation will include an activity hazard analysis and, as applicable, radiological work permits. The sampling procedures and associated activities will implement ALARA practices to minimize the radiation exposure to the sampling team, consistent with the requirements defined in 10 CFR 835, "Occupational Radiation Protection."

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