

Sampling and Analysis Plan for the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units Remedial Investigation/Feasibility Study

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

100-FR-1 100-IU-2
100-FR-2 100-IU-6
100-FR-3

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Jasen Scott 4-22-2010
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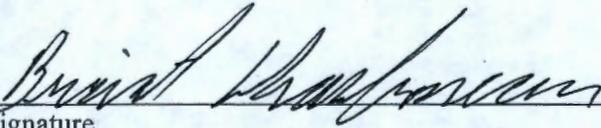
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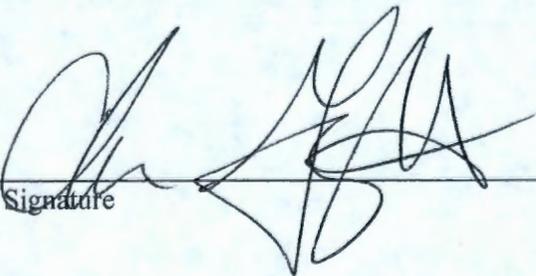
Title: *Sampling and Analysis Plan for the 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units Remedial Investigation/Feasibility Study*

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Terms

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CFR	<i>Code of Federal Regulations</i>
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DOH	Washington State Department of Health
DQA	data quality assessment
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
EQL	estimated quantitation limit
FS	feasibility study
HASQARD	<i>Hanford Analytical Services Quality Assurance Requirements Documents</i>
HEIS	Hanford Environmental Information System database
PCB	polychlorinated biphenyl
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
SAP	sampling and analysis plan
Tri-Party Agreement	<i>Hanford Federal Facility Agreement and Consent Order</i>
VOC	volatile organic compound
WAC	<i>Washington Administrative Code</i>

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1 Introduction

This sampling and analysis plan (SAP) supports the remedial investigation (RI)/feasibility study (FS) process for 100-F/IU-2/IU-6. The 100-F/IU-2/IU-6 areas are located on the Hanford Site in southeastern Washington State and are associated with four source operable units: 100-FR-1, 100-FR-2, 100-IU-2, and 100-IU-6. The 100-FR-3 Groundwater Operable Unit underlies the four source operable units and portions of other groundwater operable units. This SAP describes the sampling and analysis to be performed associated with environmental investigation borings (boreholes) and groundwater monitoring wells. Figure 1-1 shows the location of the planned and existing boreholes and groundwater monitoring wells within 100-F. Figure 1-2 shows the location of the groundwater monitoring wells within 100-IU-2/IU-6. Chapter 2 of DOE/RL-2008-46-ADD4, *Integrated 100 Area Remedial Investigation/ Feasibility Study Work Plan, Addendum 4: 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units* (Addendum 4), describes the site background and environmental setting of 100-F/IU-2/IU-6. Table 1-1 presents the intersection of data needs discussed in Addendum 4 and sampling and analysis activities.

Table 1-1. Plan Activities and Data Needs

Planned Activity	100-F/IU-2/IU-6 Areas		Data Needs No. ^a
	Quantity	Location	
New boreholes (vadose zone) ^b	3	<ul style="list-style-type: none"> • 116-F-14 Retention Basin • 118-F-1 Burial Ground • 118-F-8 Reactor Fuel Storage Basin 	2, 3
New wells to characterize deep vadose zone, unconfined aquifer, and Ringold Upper Mud	3	<ul style="list-style-type: none"> • Well #1 • Well #2 • Well #3 	4, 6, 7
Sample spatial and temporal uncertainty groundwater monitoring wells	55 existing locations		8

Notes:

This SAP is in addition to other planned activities at 100-F/IU-2/IU-6.

- a. Data needs are listed in Table 4-6 of DOE/RL-2008-46-ADD4, *Integrated 100 Area Remedial Investigation/ Feasibility Study Work Plan, Addendum 4: 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*.
- b. Boreholes and groundwater monitoring wells will be logged with a neutron moisture tool and the high-resolution, spectral gamma ray logging system. Geologic samples also will be logged.

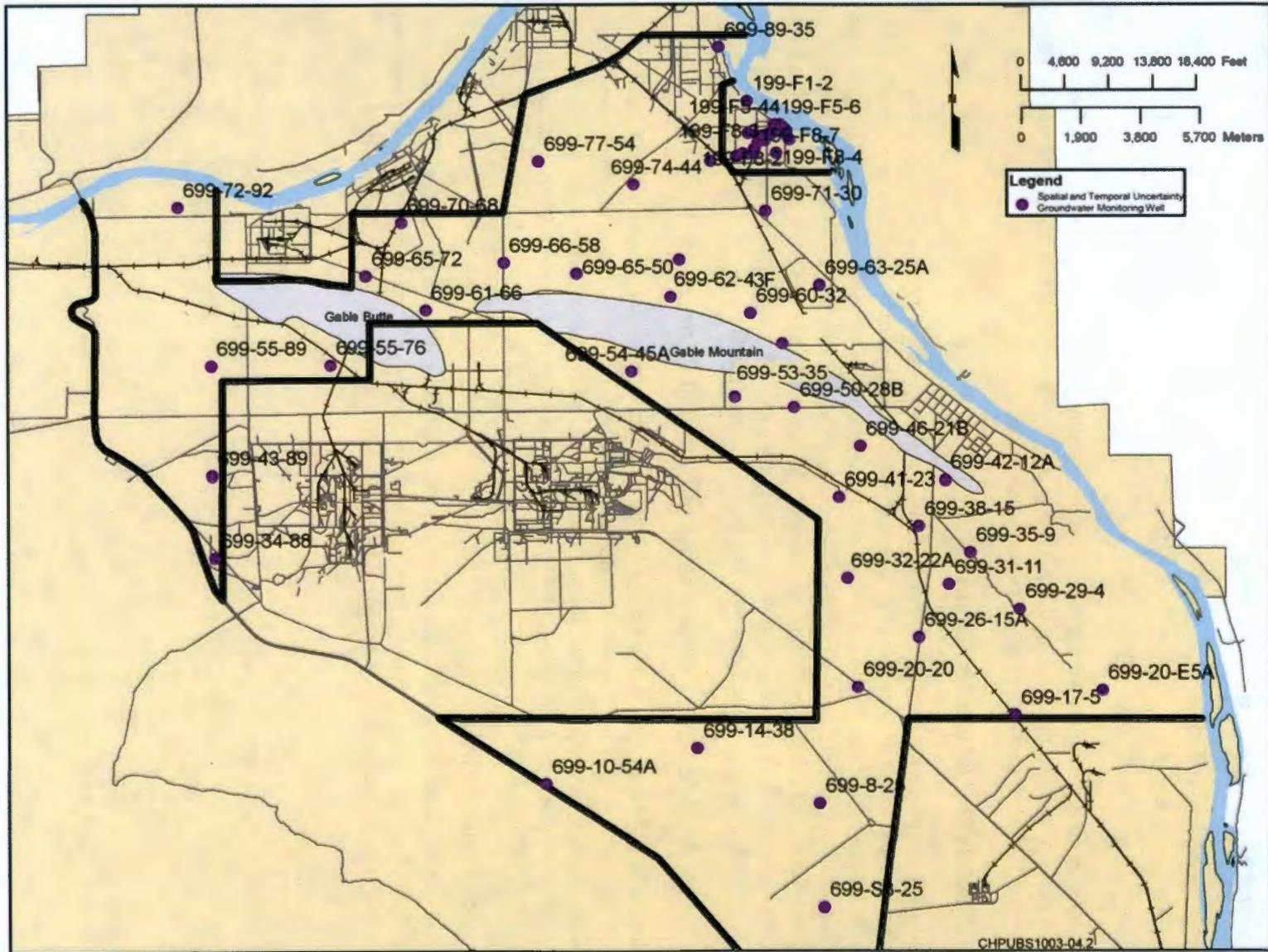


Figure 1-2. 100-IU-2/IU-6 Area Spatial and Temporal Uncertainty Monitoring Well Locations

1.1 Vadose Zone Characterization

This SAP describes activities planned to characterize the vadose zone at three waste sites and three new groundwater monitoring well locations within the 100-F Area. The following waste sites will be characterized by drilling a borehole to groundwater within the waste site boundary:

- 116-F-14 Retention Basin
- 118-F-1 Burial Ground
- 118-F-8 Reactor Fuel Storage Basin

Deep vadose zone soil samples will be collected during drilling of groundwater wells installed as part of the work performed under the scope of this SAP. Samples will be collected and analyzed to evaluate the nature and extent of contamination at the subject waste sites.

1.2 Groundwater Characterization

Groundwater samples will be collected and analyzed from new and existing groundwater monitoring wells to define the extent of contamination and to support evaluation of contaminant transport. Groundwater sampling from completed groundwater monitoring wells will be performed in accordance with field sampling, sample handling, and documentation requirements in DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD), volumes 1 through 4. Where possible, new well locations and well construction have been selected to satisfy multiple project data needs, such as delineating vadose zone and groundwater contamination.

1.3 Target Analytes and Contaminants of Potential Concern

Sample results will be reported in the Hanford Environmental Information System (HEIS) database. The tables in Appendix A have been provided to define the analytes that will be reported when using a method-based analysis approach. In addition, tentatively identified compounds will be reported for SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*, Method 8260.

1.3.1 Soil Target Analytes

Table 1-2 presents the soil/aquifer sediment master list of target analytes. Appendix D of Addendum 4 (DOE/RL-2008-46-ADD4) presents the approach used for development of the master list and waste site-specific target analyte lists. Waste site-specific constituents for analysis are based on the master list.

Table 1-2. Master Soil/Aquifer Sediment Target Analytes

Radionuclides	Nonradionuclides		
Americium-241	1,1-Dichloroethene	Beryllium	Heptachlor Epoxide
Barium-133	2-Butanone	beta-BHC	Hexavalent Chromium
Carbon-14	2-Hexanone	Bis(2-ethylhexyl) phthalate	Indeno(1,2,3-cd)pyrene
Cesium-137	2-Methylnaphthalene	Boron	Lead
Cobalt-60	4,4'-DDD	Butylbenzyl phthalate	Manganese
Europium-152	4,4'-DDE	Cadmium	Mercury
Europium-154	4,4'-DDT	Carbazole	Methoxychlor
Europium-155	4-Methyl-2-pentanone	Carbon Tetrachloride	Methylene chloride
Nickel-63	Acenaphthene	Chlorobenzene	Molybdenum
Plutonium-238	Acetone	Chloroform	Naphthalene
Plutonium-239/240	Aldrin	Chromium (total)	Nickel
Silver-108m	alpha-BHC	Chrysene	Nitrate (as N)
Strontium-90	alpha Chlordane	Cobalt	Petroleum Hydrocarbons
Technetium-99	Anthracene	Copper	Phenanthrene
Tritium	Antimony	Dalapon	Phenol
Uranium-233/234	Aroclor-1016 (PCB)	Dibenz(a,h)anthracene	Pyrene
Uranium-235	Aroclor-1221 (PCB)	Dibenzofuran	Selenium
Uranium-238	Aroclor-1232 (PCB)	Diethyl phthalate	Silver
	Aroclor-1242 (PCB)	Dimethyl phthalate	Styrene
	Aroclor-1248 (PCB)	Di-n-butyl phthalate	Tetrachloroethene
	Aroclor-1254 (PCB)	Endosulfan I	Thallium
	Aroclor-1260 (PCB)	Endosulfan sulfate	Toluene
	Arsenic	Endrin aldehyde	Toxaphene
	Barium	Endrin ketone	Trichloroethene
	Benzo(a)anthracene	Ethylbenzene	Vanadium
	Benzo(a)pyrene	Fluoranthene	Vinyl Chloride
	Benzo(b)fluoranthene	Fluorene	Xylene (total)
	Benzo(g,h,i)perylene	Fluoride	Zinc
	Benzo(k)fluoranthene	gamma Chlordane	

Notes:

PCB = polychlorinated biphenyl

4,4'-DDD = Dichlorodiphenyldichloroethane

4,4'-DDE = Dichlorodiphenyldichloroethylene

4,4'-DDT = Dichlorodiphenyltrichloroethane

BHC = Benzenehexachloride

1.3.2 Groundwater COPCs

Table 1-3 presents the 100-F groundwater contaminants of potential concern (COPCs). Table 1-4 presents the 100-IU-2/IU-6 groundwater COPCs. Chapter 4 of DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan* (work plan), and Appendix D of Addendum 4 (DOE/RL-2008-46-Add4) present the approach used for development of the COPCs.

Table 1-3. 100-F Groundwater Contaminants of Potential Concern

Radionuclides	Nonradionuclides		
Americium-241	1,1-Dichloroethene	Copper	Selenium
Carbon-14	Antimony	Fluoride	Styrene
Cesium-137	Arsenic	Hexavalent Chromium	Sulfate
Cobalt-60	Beryllium	Lead	Tetrachloroethene
Europium-154	Cadmium	Manganese	Thallium
Iodine-129	Carbon Tetrachloride	Mercury	Trichloroethene
Plutonium-238	Chloroform	Nickel	Vinyl Chloride
Plutonium-239/240	Chromium	Nitrate (as N)	Zinc
Strontium-90	Cobalt		
Technetium-99			
Thorium-230			
Tritium			

Table 1-4. 100-IU-2/IU-6 Groundwater Contaminants of Potential Concern

Radionuclides	Nonradionuclides	
Americium-241	1,1-Dichloroethene	Lead
Carbon-14	Antimony	Manganese
Cesium-137	Arsenic	Mercury
Cobalt-60	Benzene	Nickel
Europium-152	Cadmium	Nitrate
Europium-154	Carbon Tetrachloride	Tetrachloroethene
Europium-155	Chloroform	Thallium
Iodine-129	Cobalt	Total petroleum hydrocarbons –diesel range
Strontium-90	Copper	Trichloroethene
Radium-228	Fluoride	Vinyl Chloride
Technetium-99	Hexavalent Chromium	Zinc
Tritium		

1.4 Data Needs

A systematic planning process was used to identify 100-F/IU-2/IU-6 problem statements and data gaps. Chapter 4 of Addendum 4 (DOE/RL-2008-46-ADD4) discussed the identified data needs resulting from the systematic planning process.

1.5 Sampling Design

The type of sampling design is judgmental sampling (e.g., based on prior knowledge, professional judgment, and expertise). The locations of waste sites and groundwater monitoring wells were defined to address the uncertainties and data needs identified during systematic planning. Figures 1-1 and 1-2 show the locations of the planned boreholes and planned and existing groundwater monitoring wells described in this SAP. Tables 2-2 through 2-8 present the analytical methods selected to meet the estimated quantitation limits (EQLs) and the analytical performance requirements. The EQLs will meet the data needs requirements.

1.6 Project Schedule

The 100-F/IU-2/IU-6 Area RI field efforts will occur from approximately April 2010 to May 2011. The drilling lead will prepare the relative borehole and groundwater well schedule for new installations. Samples for three spatial and temporal groundwater monitoring rounds, or events, will be collected for a total of three samples per well. For 100-F, these sample events will be associated with the high, low, and transitional river stages because the wells within the network are near the Columbia River and water levels are influenced by river stage. However, the 100-IU-2/IU-6 network of wells is located primarily inland and is not directly influenced by river stage; therefore, the sample events for 100-IU-2/IU-6 are evenly spaced within the RI/FS sampling interval. A few wells are sampled in alternative months to allow for co-sampling with other projects. Each round of sampling in the spatial and temporal uncertainty groundwater monitoring well network will be completed within 30 consecutive calendar days to minimize statistical variability. The RI report will document the results provided by sampling and analysis in this plan.

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2 Quality Assurance Project Plan

This Quality Assurance Project Plan (QAPjP) establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. This QAPjP complies with the requirements of the following:

- DOE/RL-96-68, HASQARD
- DOE O 414.1C, *Quality Assurance*
- 10 *Code of Federal Regulations* (CFR) 830, "Nuclear Safety Management," Subpart A, "Quality Assurance Requirements"
- EPA/240/B-01/003, EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5

Sections 6.5 and 7.8 of the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al., 1989b), require that quality assurance (QA)/quality control (QC) and sampling and analysis activities specify the QA requirements for treatment, storage, and disposal units, as well as past-practice processes. Therefore, this QAPjP follows the QA elements of EPA/240/B-01/003. The QAPjP demonstrates conformance to Part B requirements of ANSI/ASQC E4-2004, *Quality Systems for Environmental Data and Technology Programs: Requirements with Guidance for Use*.

In addition to the requirements cited above, EPA-505-B-04-900A, *Intergovernmental Data Quality Task Force Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs Part 1: UFP-QAPP Manual* (UFP-QAPP Manual) also was used as a resource for identifying QAPjP elements. The UFP-QAPP Manual (EPA-505-B-04-900A) is not imposed through the Tri-Party Agreement (Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*). However, the UFP-QAPP Manual is a valuable resource and provides a comprehensive treatment of quality elements that should be addressed in any SAP. The UFP-QAPP Manual also was designed to be compatible with QA/R-5 (EPA/240/B-01/003), which forms the basis for this QAPjP.

The QAPjP is divided into the following four sections, which describe the quality requirements and controls applicable to this investigation.

Section 2.1 Project Management – This section addresses project management, including the project history and objectives, roles, and responsibilities of the participants. These elements ensure the project has defined goals, participants understand the goals and the approaches to be used, and planning outputs are documented.

Section 2.2 Data Generation and Acquisition – This section addresses aspects of project design and implementation. Implementing these elements ensures appropriate methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are employed and are properly documented.

Section 2.3 Assessment and Oversight – This section addresses the activities for assessing the effectiveness of implementing the project and associated QA/QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

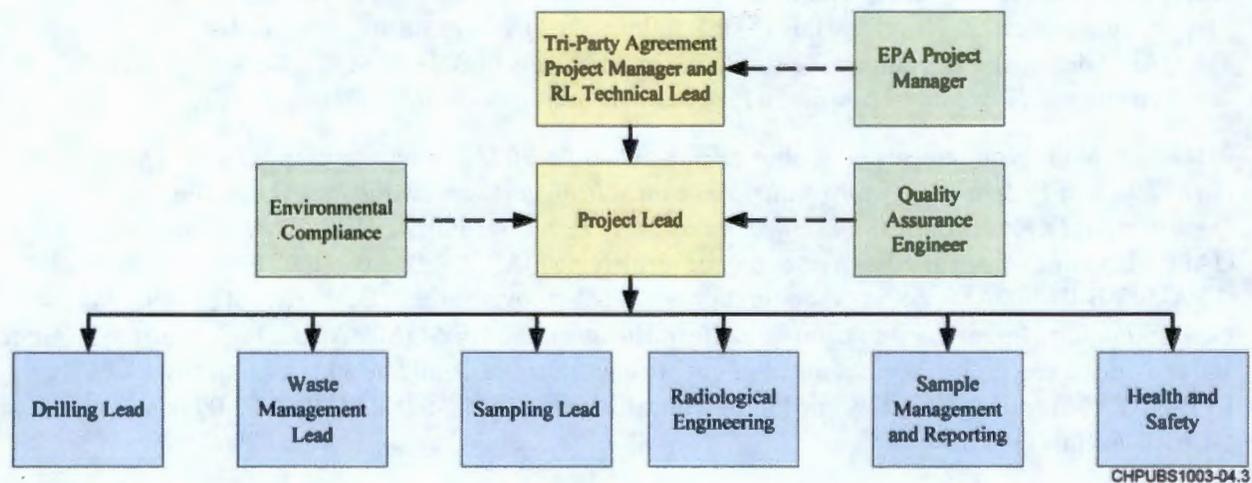
Section 2.4 Data Validation and Usability – This section addresses the QA activities occurring after the data collection or generation phase of the project is completed. Implementing these elements ensures data conform to the specified criteria, thus achieving the project objectives.

2.1 Project Management

The following sections address the basic aspects of project management, ensure the project has defined goals, the project team understands the goals and the approaches used, and the planned outputs are appropriately documented. Project management roles and responsibilities discussed in this section apply to the major activities covered under the SAP.

2.1.1 Project and Task Organization

The Plateau Remediation Contractor and River Corridor Closure Contractor, or its approved subcontractor, are responsible for planning, coordinating, collecting, preparing, packaging, and shipping samples to the laboratory as defined in their respective contracts. The following sections describe the project organization, concerning sampling and characterization, also shown in Figure 2-1. The project lead maintains a list of individuals or organizations as points of contact for each functional element in the figure. For each functional primary contractor role, a corresponding oversight role exists within the U.S. Department of Energy (DOE).



Notes:

- EPA = U.S. Environmental Protection Agency
 RL = U.S. Department of Energy, Richland Operations Office
 Tri-Party Agreement = Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*

Figure 2-1. Project Organization

EPA Project Manager. The U.S. Environmental Protection Agency (EPA) has assigned project managers responsible for overseeing cleanup projects and activities. The EPA has approval authority as the lead regulatory agency for the work being performed under this SAP. The EPA will work with the U.S. Department of Energy, Richland Operations Office (RL) to resolve concerns over the work as described in this SAP in accordance with the Tri-Party Agreement (Ecology et al, 1989a).

Tri-Party Agreement Project Manager and RL Technical Lead. The Tri-Party Agreement Project Manager is responsible for authorizing RI/FS activities for the 100 Area. The Tri-Party Agreement Project Manager is also responsible for obtaining lead regulatory approval of the work plan and SAP that authorize the RI/FS activities under the Tri-Party Agreement (Ecology et al., 1989a). The RL technical lead is responsible for overseeing the contractor in performing the work scope, working with the contractor and the regulatory agencies to identify and work through issues, and providing technical input to the Tri-Party Agreement Project Manager.

Environmental Compliance. The environmental compliance officer provides technical oversight, direction, and acceptance of project and subcontracted environmental work and develops appropriate mitigation measures with a goal of minimizing adverse environmental impacts. The environmental compliance officer also reviews plans, procedures, and technical documents to ensure that environmental requirements have been addressed; identifies environmental issues affecting operations and develops cost-effective solutions; and responds to environmental and regulatory issues or concerns raised by RL and/or the regulatory agencies. The environmental compliance officer also may oversee project implementation for compliance with applicable internal and external environmental requirements.

Project Lead. The project lead is responsible for managing sampling documents and requirements, field activities, and subcontracted tasks and for ensuring the project file is properly maintained. The project lead ensures that the sampling design requirements are converted into field instructions (e.g., work packages) providing specific direction for field activities. The project lead works closely with QA, Health and Safety, the drilling lead, and the sampling lead to integrate these and the other lead disciplines in planning and implementing the work scope. The project lead maintains a list of individuals or organizations filling each of the functional elements of the project organization (Figure 2-1). In addition, the project lead is responsible for version control of the SAP to ensure personnel are working to the most current job requirements. The project lead also coordinates with RL and the primary contractor management on sampling activities. The project lead supports RL in coordinating sampling activities with the regulators.

Quality Assurance Engineer. The QA point of contact is matrixed to the project lead and is responsible for QA issues on the project. Responsibilities include overseeing implementation of the project QA requirements; reviewing project documents, including data needs summary reports, the field sampling plan, and the QAPJP; and participating in QA assessments on sample collection and analysis activities, as appropriate. The QA point of contact must be independent of the unit generating the data.

Drilling Lead. The drilling lead has overall responsibility for planning, coordinating, and executing drilling activities. Specific responsibilities include coordinating with the geological and drilling contractors. The drilling lead also communicates with the project lead designee to identify field constraints or emergent conditions affecting sampling design or execution, and directs the procurement and installation of materials and equipment needed to support fieldwork.

Waste Management Lead (Waste Coordinator). The waste management lead communicates policies and procedures and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost effective manner. In addition, Waste Management is responsible for identifying waste management sampling and characterization requirements to ensure regulatory compliance, interpreting the characterization data to generate waste designations and profiles, and preparing and maintaining other documents that confirm compliance with waste acceptance criteria.

Sampling Lead. The sampling lead has overall responsibility for planning, coordinating, and executing sampling activities. Specific responsibilities include converting the sampling design requirements into field task instructions providing specific direction for field activities, as well as directing training, mock-ups, and practice sessions with field personnel to ensure the sampling design is understood and can be performed as specified. The sampling lead also communicates with the project lead designee to identify field constraints or emergent conditions affecting sampling design and execution, directs the procurement and installation of materials and equipment needed to support fieldwork, and prepares data packages based on instructions from the project lead designee and information contained in this SAP. The shipping lead reports to the sampling lead for shipment authorization. No sample material will be transported on or off the Hanford Site without permission from an authorized shipper or designee.

Radiological Engineering. The Radiological Engineering lead is responsible for the radiological/health physics support within 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, the Radiological Engineering lead identifies radiological hazards and implements appropriate controls to maintain worker exposures ALARA (e.g., requiring personal protective equipment). The Radiological Engineering lead also interfaces with the project Health and Safety contact, and plans and directs radiological control technician support for activities.

Sample Management and Reporting. Sample Management and Reporting coordinates laboratory analytical work, ensuring the laboratories conform to Hanford Site internal laboratory QA requirements, or their equivalent, as approved by DOE, EPA, and the Washington State Department of Ecology (Ecology). Sample Management and Reporting receives analytical data from the laboratories, performs data entry into HEIS, and arranges for data validation. Sample Management and Reporting is responsible for informing the project lead of any issues reported by the analytical laboratory. Sample Management and Reporting develops and oversees the implementation of the letter of instruction to the analytical laboratories, oversees data validation, and works with the project lead to prepare a characterization report on the sampling and analysis results.

Sample Management and Reporting is also responsible for performing the data needs process, or equivalent. Additional related responsibilities include development of the SAP, including documenting the data needs and the sampling design, preparing associated presentations, resolving technical issues, and preparing revisions to the SAP. Samples collected in the field for shipping and analysis, as well as the resulting data, will be managed in accordance with applicable procedures and work plans.

Laboratories. The laboratories analyze samples in accordance with established procedures, provide necessary sample reports, and explain results in support of data validation. The laboratories must meet site-specific QA requirements and must have an approved QA plan in place.

Health and Safety. Health and Safety is responsible for coordinating industrial safety and health support for the project through health and safety plans, job hazard analyses, and other pertinent safety documents required by federal regulation or by internal primary contractor work requirements. In addition, Health and Safety assists project personnel in complying with applicable health and safety standards and requirements. Health and Safety coordinates with Radiological Engineering to determine personal protective clothing requirements.

2.1.2 Problem Definition and Background

This SAP describes the sampling and analysis to be performed associated with boreholes and groundwater monitoring wells for 100-F/IU-2/IU-6. The specific problems to be solved, background information, and general information are provided in the work plan and Addendum 4 (DOE/RL-2008-46 and DOE/RL-2008-46-ADD4, respectively). Media to be sampled include water, aquifer sediment, and soil. Figures 1-1 and 1-2 show the location of the planned and existing boreholes and groundwater monitoring wells within the scope of this SAP. Regulatory drivers and reference to agreement documents for the activities are provided in the work plan.

2.1.3 Project and Task Description

Chapter 3 presents the field sampling plan. Tables 1-2 through 1-4 present the target analytes and COPCs. Section 1.6 provides guidance on the implementation schedule.

2.1.4 Quality Objectives and Criteria

The QA objective of this plan is to develop implementation guidance for providing data of known and appropriate quality. Data quality indicators describe data quality by evaluation against identified data needs and the work activities identified in this SAP. The applicable QC guidelines, EQLs, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. The principal data quality indicators are precision, bias or accuracy, representativeness, comparability, completeness, and sensitivity. These data quality indicators are defined for the purposes of this document in Table 2-1. The data quality indicators will be evaluated during the data quality assessment (DQA) process (Section 2.4.3).

Tables 2-2 through 2-6 present analytical performance requirements for soil/aquifer sediment samples by location, based on site-specific target analyte lists derived from the master target analyte list in Table 1-2. Tables 2-7 and 2-8 present the analytical performance requirements for water samples, based on the COPCs in Tables 1-3 and 1-4. Laboratory operations and analytical services shall be in compliance with Volume 4 of HASQARD (DOE/RL-96-68) and specific criteria identified in Tables 2-2 through 2-8 below. The criteria in Tables 2-2 through 2-8 take precedence over similar criteria in HASQARD. In consultation with the laboratory, the project lead, and/or others as appropriate, Sample Management and Reporting can approve changes to analytical methods as long as the method is based upon a nationally recognized (e.g., EPA, American Society for Testing and Materials [ASTM]) method, the new method achieves project data quality objectives (DQOs) as well or better than the replaced method, and the new method is required due to the nature of the sample (e.g., high radioactivity).

2.1.5 Special Training and Certification

A graded approach is used to ensure workers receive a level of training commensurate with responsibilities and complies with applicable DOE orders and government regulations. The sampling lead and drilling lead, in coordination with line management, will ensure that field personnel meet special training requirements.

Typical training requirements or qualifications have been instituted by the primary contractor management team to meet training requirements imposed by the contract, regulations, DOE orders, DOE contractor requirements documents, American National Standards Institute/American Society of Mechanical Engineers, and *Washington Administrative Code* (WAC). For example, the environmental, safety and health training program provides workers with the knowledge and skills necessary to execute assigned duties safely. 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 general employee radiation training
- Hanford general employee training
- Radiological worker training

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project Specific Information*	Corrective Action Examples
Precision	<p>The measure of agreement among repeated measurements of the same property under identical or substantially similar conditions; calculated either as the range or as the standard deviation.</p> <p>May also be expressed as a percentage of the mean of the measurements, such as relative range, relative percent difference, or relative standard deviation (coefficient of variation).</p>	<p>Use the same analytical instrument to make repeated analyses on the same sample.</p> <p>Use the same method to make repeated measurements of the same sample within a single laboratory or have two or more laboratories analyze identical samples with the same method.</p> <p>Split a sample in the field and submit both for sample handling, preservation and storage, and analytical measurements.</p> <p>Collect, process, and analyze co-located samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.</p>	<p>Field precision: At randomly selected locations, duplicate samples will be collected at 1 per 20 samples per media.</p> <p>Laboratory precision: Analysis of laboratory duplicate or matrix spike duplicate samples.</p>	<p>If duplicate data do not meet objective:</p> <ul style="list-style-type: none"> • Evaluate apparent cause (e.g., sample heterogeneity) • Request reanalysis or re-measurement • Qualify the data before use
Accuracy	<p>A measure of the overall agreement of a measurement to a known value; includes a combination of random error (precision) and systematic error (bias) components of sampling and analytical operations.</p>	<p>Analyze a reference material or reanalyze a sample to which a material of known concentration or amount of pollutant has been added (a spiked sample); usually expressed either as percent recovery or as a percent bias.</p>	<p>Laboratory accuracy determination based on matrix spikes and matrix spike duplicate results.</p>	<p>If recovery does not meet objective:</p> <ul style="list-style-type: none"> • Qualify the data before use • Request reanalysis or re-measurement

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project Specific Information*	Corrective Action Examples
Representativeness	A qualitative term expressing "the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition." (ANSI/ASQC S2-1995)	Evaluate whether measurements are made and physical samples are collected in such a manner that the resulting data appropriately reflect the environment or condition being measured or studied.	Samples will be collected as described in the sampling design. Judgment sampling ensures areas most likely to be contaminated, based on current information, will be evaluated.	<p>If results are not representative of the system sampled:</p> <ul style="list-style-type: none"> • Identify the reason result is not representative • Reject the data, or, if data are otherwise usable, qualify the data for limited use and define the portion of the system the data represent • Redefine sampling and measurement requirements and protocols • Resample and reanalyze
Comparability	A qualitative term expressing the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made.	Compare sample collection and handling methods, sample preparation and analytical procedures, holding times, stability issues, and QA protocols.	<p>Sampling personnel will use the same sampling protocols.</p> <p>Samples will be submitted to the same laboratories when possible (based on laboratory contracts) for analysis by the same methods, thus data results will be comparable.</p>	<p>If data are not comparable to other data sets:</p> <ul style="list-style-type: none"> • Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Qualify the data as appropriate • Resample and/or reanalyze if needed • Revise sampling/analysis protocols to ensure future comparability

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project Specific Information*	Corrective Action Examples
Completeness	A measure of the amount of valid data needed to be obtained from a measurement system.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's data needs.	The percent complete will be determined during data validation.	<p>If data set does not meet completeness objective:</p> <ul style="list-style-type: none"> • Identify appropriate changes to data collection and/or analysis methods • Identify quantifiable bias, if applicable • Qualify the data as appropriate • Resample and/or reanalyze, if needed • Revise sampling/analysis protocols to ensure future comparability
Sensitivity	The capability of a method or instrument to discriminate among measurement responses representing different levels of the variable of interest.	Determine the minimum concentration or attribute to be measured by a method (method detection limit), by an instrument (instrument detection limit), or by a laboratory (quantitation limit). The practical quantitation limit is the lowest level that can be routinely quantified and reported by a laboratory.	Ensure that sensitivity, as measured by detection limits, is appropriate for the action levels.	<p>If sensitivity does not meet objective:</p> <ul style="list-style-type: none"> • Request reanalysis or re-measurement • Qualify/reject the data before use

Notes:

* Field sampling requirements are noted. Laboratories will follow requirements for use and interpretation of laboratory control samples.

ANSI/ASQC S2-1995, *Introduction to Attribute Sampling*

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-F-14

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements^c								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	^d
—	Gross alpha	100 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	^d
—	Gross beta	5,000 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	^d
Performance Requirements for Laboratory Measurements (Radiological)								
10045-97-3	Cesium-137 ^e	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^f	70-130 ^f
10198-40-0	Cobalt-60 ^e	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^g	NV ^g			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^g	NV ^g			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^g	NV ^g			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^g	NV ^g	LSC – Carbon-14	≤30 ^f	70-130 ^f
13981-37-8	Nickel-63 ^e	30 pCi/g	4,026 pCi/g	83 pCi/g	16 pCi/g	LSC – Nickel-63	≤30 ^f	70-130 ^f
14133-76-7	Technetium-99 ^e	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^f	70-130 ^f
10028-17-8	Tritium ^e	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^f	70-130 ^f
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^g	NV ^g	Isotopic – Plutonium	≤30 ^f	70-130 ^f
10098-97-2	Strontium-90 ^{e,h}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^f	70-130 ^f

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-F-14

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	12,000 mg/kg	24,000 mg/kg	EPA 300.0 (anions by IC)	≤30 ⁱ	70-130 ⁱ
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
7440-36-0	Antimony	6 mg/kg ^j	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ⁱ	70-130 ⁱ
7440-38-2	Arsenic ^k	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^l	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	Molybdenum	2 mg/kg	400 mg/kg	32.3 mg/kg	NV			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ^j	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-28-0	Thallium	5 mg/kg ^j	5.60 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-F-14

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
18540-29-9	Hexavalent Chromium ^m	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30 ^l	70-130 ^l
78-93-3	2-Butanone	0.01 mg/kg	48,000 mg/kg	19.6 mg/kg	NV	EPA 8260 (volatile organics)	≤30 ⁿ	70-130 ⁿ
67-64-1	Acetone	0.02 mg/kg	72,000 mg/kg	28.9 mg/kg	NV			
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-09-2	Methylene chloride	0.005 mg/kg	133 mg/kg	0.0218 mg/kg	0.0409 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^o	11.2 mg/kg	0.00323 mg/kg	0.0355 mg/kg			
1330-20-7	Xylenes (total)	0.01 mg/kg	16,000 mg/kg	14.6 mg/kg	183 mg/kg	EPA 8081 (pesticides)	≤30 ⁿ	70-130 ⁿ
1024-57-3	Heptachlor epoxide	0.00165 mg/kg	0.11 mg/kg	0.008 mg/kg	0.002 mg/kg			
Performance Requirements for Physical Properties								
—	Grain-size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-F-14

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

- Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- 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 200.8, see EPA-600/R-94-111, *Methods for Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods (e.g., EPA 6010), see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Soil will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field screened for gross gamma activity.
- Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.
- Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed 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.

Table 2-2. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 116-F-14

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
g.	Generic RESRAD modeling reported in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i> , predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.							
h.	Strontium will be assessed as total radioactive strontium.							
i.	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.							
j.	To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.							
k.	The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i> .							
l.	Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.							
m.	A task is included in DOE/RL-2008-46 to re-evaluate hexavalent chromium cleanup levels.							
n.	Accuracy criteria shown are 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 performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.							
o.	Calculated preliminary cleanup goal values are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels and will be periodically reviewed to establish if lower detection limit capabilities have become available.							
CAS	=	Chemical Abstracts Service	N/A	=	not applicable			
Cr(VI)	=	hexavalent chromium	NV	=	no value			
dpm	=	disintegrations per minute	MS	=	mass spectroscopy			
IC	=	ion chromatography	RESRAD	=	RESidual RADioactivity (dose model)			
ICP	=	inductively coupled plasma	TBD	=	to be determined			
LSC	=	liquid scintillation counter						

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-1

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements^c								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	^d
—	Gross alpha	100 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	^d
—	Gross beta	5,000 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	^d
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^e	NV ^e	Americium-241/Curium-244	≤30 ^f	70-130 ^f
14391-65-2	Silver-108m	0.2 pCi/g	2.38 pCi/g	NV ^e	NV ^e	Gamma energy analysis	≤30 ^f	70-130 ^f
10045-97-3	Cesium-137 ^g	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g			
10198-40-0	Cobalt-60 ^g	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^e	NV ^e			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^e	NV ^e			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^e	NV ^e	LSC – Carbon-14	≤30 ^f	70-130 ^f
13981-37-8	Nickel-63 ^g	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^f	70-130 ^f
14133-76-7	Technetium-99 ^g	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^f	70-130 ^f
10028-17-8	Tritium ^g	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^f	70-130 ^f

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-1

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^e	NV ^e	Isotopic – Plutonium	≤30 ^f	70-130 ^f
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^e	NV ^e			
10098-97-2	Strontium-90 ^{g,h}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^f	70-130 ^f
—	Uranium-238	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^f	70-130 ^f
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	12,000 mg/kg	24,000 mg/kg	EPA 300.0 (anions by IC)	≤30 ^f	70-130 ^f
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
7440-38-2	Arsenic ⁱ	10 mg/kg	TBD	TBD	TBD	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^f	70-130 ^f
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-42-8	Boron	2 mg/kg	16,000 mg/kg	210 mg/kg	NV			
7440-43-9	Cadmium	0.5 mg/kg ^k	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			
7439-96-5	Manganese ^l	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7439-98-7	Molybdenum	2 mg/kg	400 mg/kg	32.3 mg/kg	NV			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-1

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent Chromium ^m	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30 ⁱ	70-130 ⁱ
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	≤30 ⁱ	70-130 ⁱ
67-64-1	Acetone	0.02 mg/kg	72,000 mg/kg	28.9 mg/kg	NV	EPA 8260 (volatile organics)	≤30 ⁿ	70-130 ⁿ
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-09-2	Methylene chloride	0.005 mg/kg	133 mg/kg	0.0218 mg/kg	0.0409 mg/kg			
Performance Requirements for Physical Properties								
—	Grain-size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-1

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

- a. Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- b. 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 200.8, see EPA-600/R-94-111, *Methods for Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods (e.g., EPA 6010), see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- c. Soil will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field screened for gross gamma activity.
- d. Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.
- f. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed 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.
- g. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, Revision 6.
- h. Strontium will be assessed as total radioactive strontium.
- i. 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.
- j. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan*.

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-1

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
<p>k. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.</p> <p>l. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.</p> <p>m. A task is included in DOE/RL-2008-46 to re-evaluate hexavalent chromium cleanup levels.</p> <p>n. Accuracy criteria shown are 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 performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.</p>								
CAS	=	Chemical Abstracts Service	N/A	=	not applicable			
Cr(VI)	=	hexavalent chromium	NV	=	no value			
dpm	=	disintegrations per minute	MS	=	mass spectroscopy			
IC	=	ion chromatography	RESRAD	=	RESidual RADioactivity (dose model)			
ICP	=	inductively coupled plasma	TBD	=	to be determined			
LSC	=	liquid scintillation counter						

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-8

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements^c								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	^d
—	Gross alpha	100 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	^d
—	Gross beta	5,000 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	^d
Performance Requirements for Laboratory Measurements (Radiological)								
14596-10-2	Americium-241	1 pCi/g	31.1 pCi/g	NV ^e	NV ^e	Americium-241/ Curium-244	≤30 ^f	70-130 ^f
13981-41-4	Barium-133	0.2 pCi/g	11.8 pCi/g	NV ^e	NV ^e	Gamma energy analysis	≤30 ^f	70-130 ^f
10045-97-3	Cesium-137 ^g	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g			
10198-40-0	Cobalt-60 ^g	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^e	NV ^e			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^e	NV ^e			
14391-16-3	Europium-155	0.1 pCi/g	125 pCi/g	NV ^e	NV ^e			
14762-75-5	Carbon-14	2 pCi/g	5.16 pCi/g	NV ^e	NV ^e	LSC – Carbon-14	≤30 ^f	70-130 ^f
13981-37-8	Nickel-63 ^g	30 pCi/g	4,026 pCi/g	83 pCi/g	166 pCi/g	LSC – Nickel-63	≤30 ^f	70-130 ^f
14133-76-7	Technetium-99 ^g	0.25 pCi/g	5.7 pCi/g	0.46 pCi/g	0.92 pCi/g	LSC – Technetium-99	≤30 ^f	70-130 ^f
10028-17-8	Tritium ^g	10 pCi/g	510 pCi/g	12.6 pCi/g	25.2 pCi/g	LSC – Tritium	≤30 ^f	70-130 ^f

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-8

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
13981-16-3	Plutonium-238	1 pCi/g	37.4 pCi/g	NV ^e	NV ^e	Isotopic – Plutonium	≤30 ^f	70-130 ^f
—	Plutonium-239/240	1 pCi/g	33.9 pCi/g	NV ^e	NV ^e			
10098-97-2	Strontium-90 ^{g,h}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^f	70-130 ^f
—	Uranium-233/234	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g	Isotopic – Uranium	≤30 ^f	70-130 ^f
15117-96-1	Uranium-235	0.5 pCi/g ⁱ	0.61 pCi/g	0.185 pCi/g	0.185 pCi/g			
—	Uranium-238	1 pCi/g	1.1 pCi/g	1.1 pCi/g	1.1 pCi/g			
Performance Requirements for Laboratory Measurements (Nonradiological)								
16984-48-8	Fluoride	5 mg/kg	4,800 mg/kg	12,000 mg/kg	24,000 mg/kg	EPA 300.0 (anions by IC)	≤30 ^j	70-130 ^j
14797-55-8	Nitrate (as N)	2.5 mg/kg	128,000 mg/kg	40 mg/kg	80 mg/kg			
7440-36-0	Antimony	6 mg/kg ^k	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^j	70-130 ^j
7440-38-2	Arsenic ^l	10 mg/kg	TBD	TBD	TBD			
7440-39-3	Barium	2 mg/kg	16,000 mg/kg	1,650 mg/kg	3,300 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ^k	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-48-4	Cobalt	2 mg/kg	24 mg/kg	15.7 mg/kg	NV			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-8

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
7439-96-5	Manganese ^m	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ^k	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ^k	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ^k	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent Chromium ⁿ	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30 ^j	70-130 ^l
7439-97-6	Mercury	0.2 mg/kg	24 mg/kg	2.09 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	≤30 ^j	70-130 ^l
12674-11-2	Aroclor-1016 (PCB)	0.017 mg/kg ⁱ	0.5 mg/kg	0.0942 mg/kg	0.000447 mg/kg	EPA 8082 (PCB by GC)	≤30 ^o	70-130 ^o
11104-28-2	Aroclor-1221 (PCB)	0.017 mg/kg ⁱ	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
11141-16-5	Aroclor-1232 (PCB)	0.017 mg/kg ⁱ	0.5 mg/kg	0.00920 mg/kg	0.0000437 mg/kg			
53469-21-9	Aroclor-1242 (PCB)	0.017 mg/kg ⁱ	0.5 mg/kg	0.0394 mg/kg	0.000187 mg/kg			
12672-29-6	Aroclor-1248 (PCB)	0.017 mg/kg ⁱ	0.5 mg/kg	0.0386 mg/kg	0.000183 mg/kg			
11097-69-1	Aroclor-1254 (PCB)	0.017 mg/kg ⁱ	0.5 mg/kg	0.0664 mg/kg	0.000315 mg/kg			

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-8

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
11096-82-5	Aroclor-1260 (PCB)	0.017 mg/kg ^j	0.5 mg/kg	0.721 mg/kg	0.00342 mg/kg			
67-64-1	Acetone	0.02 mg/kg	72,000 mg/kg	28.9 mg/kg	NV	EPA 8260 (volatile organics)	≤30 ^o	70-130 ^o
67-66-3	Chloroform	0.005 mg/kg	164 mg/kg	0.038 mg/kg	0.0607 mg/kg			
75-09-2	Methylene chloride	0.005 mg/kg	133 mg/kg	0.0218 mg/kg	0.0409 mg/kg			
108-88-3	Toluene	0.005 mg/kg	NV	4.65 mg/kg	99 mg/kg			
79-01-6	Trichloroethene	0.005 mg/kg ^j	11.2 mg/kg	0.003 mg/kg	0.0355 mg/kg			
1024-57-3	Heptachlor epoxide	0.00165 mg/kg	0.11 mg/kg	0.008 mg/kg	0.002 mg/kg	EPA 8081 (pesticides)	≤30 ^o	70-130 ^o
7440-61-1	Uranium (total) ^p	1 mg/kg	240 mg/kg	3.21 mg/kg	3.21 mg/kg	UKPA or via isotopic	≤30 ^j	70-130 ^j
Performance Requirements for Physical Properties								
—	Grain-size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-8

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud). ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

- a. Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup," 2007.
- b. 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 200.8, see EPA-600/R-94-111, *Methods for Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods (e.g., EPA 6010), see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- c. Soil will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field screened for gross gamma activity.
- d. Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- e. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.
- f. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed 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.

Table 2-4. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from 118-F-8

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
<p>g. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, <i>Remedial Design Report/Remedial Action Work Plan for the 100 Area</i>, Revision 6.</p> <p>h. Strontium will be assessed as total radioactive strontium.</p> <p>i. Calculated preliminary cleanup goal values are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels and will be periodically reviewed to establish if lower detection limit capabilities have become available.</p> <p>j. 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.</p> <p>k. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.</p> <p>l. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, <i>Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan</i>.</p> <p>m. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.</p> <p>n. A task is included in DOE/RL-2008-46 to re-evaluate hexavalent chromium cleanup levels.</p> <p>o. Accuracy criteria shown are 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 performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.</p> <p>p. The uranium groundwater and river protection preliminary clean goal values are not risk-based. The values are based on Hanford Site background.</p>								
CAS	=	Chemical Abstracts Service	N/A	=	not applicable			
Cr(VI)	=	hexavalent chromium	NV	=	no value			
dpm	=	disintegrations per minute	PCB	=	polychlorinated biphenyl			
GC	=	gas chromatography	MS	=	mass spectroscopy			
IC	=	ion chromatography	RESRAD	=	RESidual RADioactivity (dose model)			
ICP	=	inductively coupled plasma	TBD	=	to be determined			
LSC	=	liquid scintillation counter	UKPA	=	total uranium by kinetic phosphorescence analysis			

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements^c								
—	Gross gamma	10 pCi/g	N/A	N/A	N/A	Portable sodium iodide detector	≤50	^d
—	Gross alpha	100 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	^d
—	Gross beta	5,000 dpm/ 100 cm ²	N/A	N/A	N/A	Portable contamination detector	≤50	^d
Performance Requirements for Laboratory Measurements (Radiological)								
10045-97-3	Cesium-137 ^e	0.1 pCi/g	6.2 pCi/g	1,465 pCi/g	2,930 pCi/g	Gamma energy analysis	≤30 ^f	70-130 ^f
10198-40-0	Cobalt-60 ^e	0.05 pCi/g	1.4 pCi/g	13,900 pCi/g	27,800 pCi/g			
14683-23-9	Europium-152	0.1 pCi/g	3.3 pCi/g	NV ^g	NV ^g			
15585-10-1	Europium-154	0.1 pCi/g	3.0 pCi/g	NV ^g	NV ^g			
10098-97-2	Strontium-90 ^{e,h}	1 pCi/g	4.5 pCi/g	27.6 pCi/g	55.2 pCi/g	Strontium-90	≤30 ^f	70-130 ^f
Performance Requirements for Laboratory Measurements (Nonradiological)								
7440-36-0	Antimony	6.0 mg/kg ⁱ	32 mg/kg	5.4 mg/kg	25.3 mg/kg	EPA 6010 or 200.8 (ICP or ICP/MS metals)	≤30 ^j	70-130 ^j
7440-38-2	Arsenic ^k	10 mg/kg	TBD	TBD	TBD			
7440-41-7	Beryllium	0.5 mg/kg	160 mg/kg	63.2 mg/kg	126 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg ⁱ	80 mg/kg	0.69 mg/kg	0.25 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	120,000 mg/kg	2,000 mg/kg	2,600 mg/kg			
7440-50-8	Copper	1 mg/kg	3,200 mg/kg	284 mg/kg	1,150 mg/kg			
7439-92-1	Lead	5 mg/kg	250 mg/kg	3,000 mg/kg	840 mg/kg			

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
7439-96-5	Manganese ^l	5 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	1,600 mg/kg	130 mg/kg	357 mg/kg			
7782-49-2	Selenium	10 mg/kg ^l	400 mg/kg	5.2 mg/kg	1.04 mg/kg			
7440-22-4	Silver	1 mg/kg ^l	400 mg/kg	13.6 mg/kg	0.884 mg/kg			
7440-28-0	Thallium	5 mg/kg ^l	5.6 mg/kg	1.59 mg/kg	4.46 mg/kg			
7440-62-2	Vanadium	2.5 mg/kg	560 mg/kg	2,240 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	24,000 mg/kg	5,970 mg/kg	226 mg/kg			
18540-29-9	Hexavalent Chromium ^m	0.5 mg/kg	TBD	TBD	TBD	EPA 7196 (Cr(VI))	≤30 ^l	70-130 ^l
Performance Requirements for Physical Properties								
—	Grain-size (sieve) analysis	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Porosity	N/A	N/A	N/A	N/A	Calculation	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	ASTM D2216	N/A	N/A
—	Saturated hydraulic conductivity	N/A	N/A	N/A	N/A	ASTM D5084-03 for soil with low hydraulic conductivity (silt or a mud) ASTM D2434-68 for soil with high hydraulic conductivity (sand or sandy gravel)	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			

Notes:

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

- a. Unless otherwise noted, Preliminary Cleanup Goals are established in WAC 173-340, "Model Toxics Control Act – Cleanup."
- b. Equivalent methods may be substituted. For EPA Method 200.8, see EPA-600/R-94-111, *Methods for Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods (e.g., EPA 6010), see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- c. Soil will be logged with a neutron moisture tool and the high resolution, spectral gamma ray logging system. Geologic samples will also be logged. Vadose zone soil samples will be field screened for gross alpha, gross beta, and gross gamma activities. Aquifer sediment samples will be field screened for gross gamma activity.
- d. Field measurements have no specific QC requirement for accuracy except to perform checks to verify manufacturer's expected performance.
- e. The groundwater protection and river protection preliminary cleanup goal values were established in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area, Revision 6*.
- f. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for gamma energy analysis, additional accuracy criteria include analysis-specific evaluations performed 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.
- g. Generic RESRAD modeling reported in DOE/RL-96-17, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*, predicts the contaminant will not reach groundwater within 1,000 years; however, site-specific modeling will be performed, as necessary, to determine whether preliminary cleanup goals have been met.
- h. Strontium will be assessed as total radioactive strontium.
- i. To meet or approach calculated cleanup goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if estimated quantitation limits are met.
- j. 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.
- k. The preliminary cleanup goal value for arsenic will be re-evaluated as described in DOE/RL-2008-46, *Integrated 100 Area Remedial Investigation/Feasibility Study Work Plan*.

Table 2-5. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Groundwater Wells

CAS Number	Analyte	EQL	Preliminary Cleanup Goals ^a			Analytical Method ^b	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
l. Manganese groundwater and river protection preliminary cleanup goal values are not risk-based. The values are based on Hanford Site background values.								
m. A task is included in DOE/RL-2008-46 to re-evaluate hexavalent chromium cleanup levels.								
CAS	=	Chemical Abstracts Service	N/A	=	not applicable			
Cr(VI)	=	hexavalent chromium	NV	=	no value			
dpm	=	disintegrations per minute	MS	=	mass spectroscopy			
IC	=	ion chromatography	RESRAD	=	RESidual RADioactivity (dose model)			
ICP	=	inductively coupled plasma	TBD	=	to be determined			
LSC	=	liquid scintillation counter						

Table 2-6. Analytical Performance Requirements for Batch Leach Testing

CAS Number	Analyte	EQL	Preliminary Cleanup Goals			Analytical Method ^a	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (Radiological)								
10098-97-2	Strontium-90 ^b	1 pCi/L	N/A	N/A	N/A	Batch leach followed by strontium-90	≤30 ^c	70-130 ^c
Performance Requirements for Laboratory Measurements (Nonradiological)								
7440-38-2	Arsenic	50 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 6010 (ICP metals)	≤30 ^c	70-130 ^c
7440-39-3	Barium	50 µg/L	N/A	N/A	N/A			
7440-43-9	Cadmium	50 µg/L	N/A	N/A	N/A			
7440-47-3	Chromium	100 µg/L	N/A	N/A	N/A			
7439-92-1	Lead	50 µg/L	N/A	N/A	N/A			
7440-22-4	Silver	100 µg/L	N/A	N/A	N/A			
7782-49-2	Selenium	100 µg/L	N/A	N/A	N/A			
18540-29-9	Hexavalent Chromium	100 µg/L	N/A	N/A	N/A	Batch leach followed by EPA 7196	≤30 ^c	70-130 ^c
—	Distribution coefficient for EPA 6010/ 6020/7196/ 7470/200.8 metals	N/A	N/A	N/A	N/A	Desorption distribution coefficient using 1:1 water extract and acid leach	N/A	N/A

Notes:

- Equivalent methods may be substituted. For the four-digit EPA methods (e.g., EPA 6010), see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.
- Strontium-90 batch leach testing will be performed on samples containing more than 4.5 pCi/g Strontium-90.
- 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.

CAS = Chemical Abstracts Service

N/A = not applicable

ICP = inductively coupled plasma

Table 2-7. Analytical Performance Requirements for 100-F Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
—	Oxidation reduction potential	REDOX PROBE	N/A	^c	^c	N/A	N/A
—	pH measurement	PROBE	0.5 pH unit	^c	^c	N/A	N/A
—	Specific conductance	PROBE	1 μ S/cm	^c	^c	N/A	N/A
—	Temperature	PROBE	—	^c	^c	N/A	N/A
—	Dissolved oxygen	PROBE	—	^c	^c	N/A	N/A
—	Turbidity	PROBE	0.1 NTU	^c	^c	N/A	N/A
Performance Requirements for Laboratory Measurements (Radiological)							
12587-46-1	Gross alpha	GPC	3 pCi/L	$\leq 30^d$	70-130 ^d	15 pCi/L	Federal MCL
12587-47-2	Gross beta	GPC	4 pCi/L	$\leq 30^d$	70-130 ^d	N/A	4 mrem/year Federal MCL
10098-97-2	Strontium-90 ^e	Strontium-90	2 pCi/L	$\leq 30^d$	70-130 ^d	8 pCi/L	40 CFR 141.66
10045-97-3	Cesium-137	GEA	15 pCi/L	$\leq 30^d$	70-130 ^d	200 pCi/L	Federal MCL
10198-40-0	Cobalt-60	GEA	25 pCi/L	$\leq 30^d$	70-130 ^d	100 pCi/L	Federal MCL
15585-10-1	Europium-154	GEA	50 pCi/L	$\leq 30^d$	70-130 ^d	60 pCi/L	40 CFR 141.66
15046-84-1	Iodine-129	Iodine-129 – Low Level	1 pCi/L	$\leq 30^d$	70-130 ^d	1 pCi/L	40 CFR 141.66
13981-16-3	Plutonium-238	Isotopic – Plutonium	1 pCi/L	$\leq 30^d$	70-130 ^d	15 pCi/L	40 CFR 141.66
—	Plutonium-239/240	Isotopic – Plutonium	1 pCi/L	$\leq 30^d$	70-130 ^d	15 pCi/L	40 CFR 141.66
14269-63-7	Thorium-230	Isotopic – Thorium	1 pCi/L	$\leq 30^d$	70-130 ^d	15 pCi/L	40 CFR 141.66
14596-10-2	Americium-241	Americium-241/Curium-244	1 pCi/L	$\leq 30^d$	70-130 ^d	15 pCi/L	40 CFR 141.66

Table 2-7. Analytical Performance Requirements for 100-F Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
14762-75-5	Carbon-14	LSC - Carbon-14	200 pCi/L	≤30 ^d	70-130 ^d	2,000 pCi/L	40 CFR 141.66
14133-76-7	Technetium-99	LSC - Technetium-99	15 pCi/L	≤30 ^d	70-130 ^d	900 pCi/L	40 CFR 141.66
10028-17-8	Tritium	LSC - Tritium	400 pCi/L	≤30 ^d	70-130 ^d	20,000 pCi/L	40 CFR 141.66
Performance Requirements for Laboratory Measurements (Nonradiological)							
7440-36-0	Antimony	Trace - ICP (6010) or ICP/MS (6020 or 200.8)	5 µg/L	≤20 ^f	80-120 ^f	5.6 µg/L	Human Health for the Consumption of Water + Organism
7440-38-2	Arsenic	Trace - ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L ^{gh}	≤20 ^f	80-120 ^f	0.018 µg/L	Human Health for the Consumption of Water + Organism
7440-41-7	Beryllium	Trace - ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L	≤20 ^f	80-120 ^f	4.0 µg/L	40 CFR 141.62
7440-43-9	Cadmium	Trace - ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L ^g	≤20 ^f	80-120 ^f	0.25 µg/L	Freshwater CCC
7440-47-3	Chromium	EPA 6010 (ICP metals)	10 µg/L	≤20 ^f	80-120 ^f	74 µg/L	Freshwater CCC
7440-48-4	Cobalt	Trace - ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	≤20 ^f	80-120 ^f	4.8 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
7440-50-8	Copper	Trace - ICP (6010) or ICP/MS (6020 or 200.8)	8 µg/L	≤20 ^f	80-120 ^f	9 µg/L	Freshwater CCC
18540-29-9	Hexavalent Chromium	EPA 7196 (Cr(VI))	10 µg/L	≤20 ^f	80-120 ^f	10 µg/L	WAC 173-201A

Table 2-7. Analytical Performance Requirements for 100-F Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
7439-92-1	Lead	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L	≤20 ^f	80-120 ^f	2.1 µg/L	WAC 173-201A
7439-96-5	Manganese	EPA 6010 (ICP metals)	5 µg/L	≤20 ^f	80-120 ^f	50 µg/L	40 CFR 143.3
7439-97-6	Mercury	EPA 7470 or 200.8	0.5 µg/L ^g	≤20 ^f	80-120 ^f	0.05 µg/L	WAC 173-201A
7440-02-0	Nickel	EPA 6010 (ICP metals)	40 µg/L	≤20 ^f	80-120 ^f	52 µg/L	Freshwater CCC
7782-49-2	Selenium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	≤20 ^f	80-120 ^f	5 µg/L	Freshwater CCC
7440-28-0	Thallium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L ^g	≤20 ^f	80-120 ^f	0.24 µg/L	Human Health for the Consumption of Water + Organism
7440-66-6	Zinc	EPA 6010 (ICP metals)	10 µg/L	≤20 ^f	80-120 ^f	91 µg/L	WAC 173-201A
75-35-4	1,1-Dichloroethene	EPA 8260 (volatile organics)	2 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.073 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
56-23-5	Carbon Tetrachloride	EPA 8260 (volatile organics)	1 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.23 µg/L	Human Health for the Consumption of Water + Organism
67-66-3	Chloroform	EPA 8260 (volatile organics)	5 µg/L	≤20 ⁱ	80-120 ⁱ	5.7 µg/L	Human Health for the Consumption of Water + Organism
100-42-5	Styrene	EPA 8260 (volatile organics)	5 µg/L ^h	≤20 ⁱ	80-120 ⁱ	1.46 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
127-18-4	Tetrachloroethene	EPA 8260 (volatile organics)	5 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.081 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)

Table 2-7. Analytical Performance Requirements for 100-F Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
79-01-6	Trichloroethene	EPA 8260 (volatile organics)	1 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.49 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-01-4	Vinyl Chloride	EPA 8260 (volatile organics)	5 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.025 µg/L	Human Health for the Consumption of Water + Organism
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	≤20 ^f	80-120 ^f	960 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
14797-55-8	Nitrate (as N)	EPA 300.0 (anions by IC)	250 µg/L	≤20 ^f	80-120 ^f	10,000 µg/L	40 CFR 141.62
14808-79-8	Sulfate	EPA 300.0 (anions by IC)	500 µg/L	≤20 ^f	80-120 ^f	250,000 µg/L	40 CFR 143.3

Notes:

40 CFR 141.62, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels for Inorganic Contaminants."

40 CFR 141.66, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels for Radionuclides."

40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington."

WAC 173-340-720(4), "Model Toxics Control Act-Cleanup," "Groundwater Standards," "Method B Cleanup Levels for Potable Ground Water."

- 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 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods (e.g., EPA 6010), see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. Tentatively identified compounds will be reported for Method SW-846 8260.
- EQL typically equal to 5 to 10 times the MDL (SW-846). MDLs are listed in DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, Table C-30. When the action level is less than the MDL, the action level defaults to the MDL.
- Field measurements have no specific QC requirement except to perform checks to verify manufacturer's expected performance.
- Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations performed 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.
- Strontium will be assessed as total radioactive strontium.

Table 2-7. Analytical Performance Requirements for 100-F Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
<p>f. 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 is also performed. The precision criteria shown is for batch laboratory replicate matrix spike or replicate sample relative percent differences.</p> <p>g. To meet or approach calculated action levels, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods, if EQLs are met.</p> <p>h. Action levels are less than established analytical methodology capabilities. The analytical detection limits will be used for working levels, and will be periodically reviewed to establish if lower detection limit capabilities have become available.</p> <p>i. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.</p>							
CAS	=	Chemical Abstracts Service	ICP	=	inductively coupled plasma		
CCC	=	criterion continuous concentration	LSC	=	liquid scintillation counter		
CFR	=	<i>Code of Federal Regulations</i>	MCL	=	maximum contaminant level		
Cr(VI)	=	hexavalent chromium	MDL	=	method detection limit		
GEA	=	gamma energy analysis	MS	=	mass spectrometry		
GPC	=	gross particle counting	N/A	=	not applicable		
IC	=	ion chromatography	NTU	=	nephelometric turbidity unit		

Table 2-8. Analytical Performance Requirements for 100-IU-2/IU-6 Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
—	Oxidation reduction potential	REDOX PROBE	N/A	^c	^c	N/A	N/A
—	pH measurement	PROBE	0.5 pH unit	^c	^c	N/A	N/A
—	Specific conductance	PROBE	1 μ S/cm	^c	^c	N/A	N/A
—	Temperature	PROBE	—	^c	^c	N/A	N/A
—	Dissolved oxygen	PROBE	—	^c	^c	N/A	N/A
—	Turbidity	PROBE	0.1 NTU	^c	^c	N/A	N/A
Performance Requirements for Laboratory Measurements (Radiological)							
12587-46-1	Gross alpha	GPC	3 pCi/L	$\leq 30^d$	70-130 ^e	15 pCi/L	Federal MCL
12587-47-2	Gross beta	GPC	4 pCi/L	$\leq 30^d$	70-130 ^d	N/A	4 mrem/year Federal MCL
15046-84-1	Iodine-129	Iodine-129 – Low Level	1 pCi/L	$\leq 30^d$	70-130 ^d	1 pCi/L	40 CFR 141.66
10098-97-2	Strontium-90 ^e	Strontium-90	2 pCi/L	$\leq 30^d$	70-130 ^d	8 pCi/L	40 CFR 141.66
10045-97-3	Cesium-137	GEA	15 pCi/L	$\leq 30^d$	70-130 ^d	200 pCi/L	Federal MCL
10198-40-0	Cobalt-60	GEA	25 pCi/L	$\leq 30^d$	70-130 ^d	100 pCi/L	Federal MCL
14683-23-9	Europium-152	GEA	50 pCi/L	$\leq 30^d$	70-130 ^d	200 pCi/L	40 CFR 141.66
15585-10-1	Europium-154	GEA	50 pCi/L	$\leq 30^d$	70-130 ^d	60 pCi/L	40 CFR 141.66
14391-16-3	Europium-155	GEA	50 pCi/L	$\leq 30^d$	70-130 ^d	600 pCi/L	40 CFR 141.66
15262-20-1	Radium-228	GEA	3 pCi/L	$\leq 30^d$	70-130 ^d	900 pCi/L	40 CFR 141.66
14596-10-2	Americium-241	Americium-241/Curium-244	1 pCi/L	$\leq 30^d$	70-130 ^d	15 pCi/L	40 CFR 141.66

Table 2-8. Analytical Performance Requirements for 100-IU-2/IU-6 Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
14762-75-5	Carbon-14	LSC – Carbon-14	200 pCi/L	≤30 ^d	70-130 ^d	2,000 pCi/L	40 CFR 141.66
14133-76-7	Technetium-99	LSC –Technetium-99	15 pCi/L	≤30 ^d	70-130 ^d	900 pCi/L	40 CFR 141.66
10028-17-8	Tritium	LSC - Tritium	400 pCi/L	≤30 ^d	70-130 ^d	20,000 pCi/L	40 CFR 141.66
Performance Requirements for Laboratory Measurements (Nonradiological)							
7440-36-0	Antimony	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	5 µg/L	≤20 ^f	80-120 ^f	5.6 µg/L	Human Health for the Consumption of Water + Organism
7440-38-2	Arsenic	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L ^{gh}	≤20 ^f	80-120 ^f	0.018 µg/L	Human Health for the Consumption of Water + Organism
7440-43-9	Cadmium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L ^g	≤20 ^f	80-120 ^f	0.25 µg/L	Freshwater CCC
7440-48-4	Cobalt	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	≤20 ^f	80-120 ^f	4.8 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
7440-50-8	Copper	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	8 µg/L	≤20 ^f	80-120 ^f	9 µg/L	Freshwater CCC
18540-29-9	Hexavalent Chromium	EPA 7196 (Cr(VI))	10 µg/L	≤20 ^f	80-120 ^f	10 µg/L	WAC 173-201A
7439-92-1	Lead	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L	≤20 ^f	80-120 ^f	2.1 µg/L	WAC 173-201A
7439-96-5	Manganese	EPA 6010 (ICP metals)	5 µg/L	≤20 ^f	80-120 ^f	50 µg/L	40 CFR 143.3
7439-97-6	Mercury	EPA 7470 or 200.8	0.5 µg/L ^g	≤20 ^f	80-120 ^f	0.05 µg/L	WAC 173-201A

Table 2-8. Analytical Performance Requirements for 100-IU-2/IU-6 Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
7440-02-0	Nickel	EPA 6010 (ICP metals)	40 µg/L	≤20 ^f	80-120 ^f	52 µg/L	Freshwater CCC
7440-28-0	Thallium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L ^g	≤20 ^f	80-120 ^f	0.24 µg/L	Human Health for the Consumption of Water + Organism
7440-66-6	Zinc	EPA 6010 (ICP metals)	10 µg/L	≤20 ^f	80-120 ^f	91 µg/L	WAC 173-201A
75-35-4	1,1-Dichloroethene	EPA 8260 (volatile organics)	2 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.073 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
71-43-2	Benzene	EPA 8260 (volatile organics)	1.5 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.795 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
56-23-5	Carbon Tetrachloride	EPA 8260 (volatile organics)	1 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.23 µg/L	Human Health for the Consumption of Water + Organism
67-66-3	Chloroform	EPA 8260 (volatile organics)	5 µg/L	≤20 ⁱ	80-120 ⁱ	5.7 µg/L	Human Health for the Consumption of Water + Organism
127-18-4	Tetrachloroethene	EPA 8260 (volatile organics)	5 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.081 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
79-01-6	Trichloroethene	EPA 8260 (volatile organics)	1 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.49 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)
75-01-4	Vinyl Chloride	EPA 8260 (volatile organics)	5 µg/L ^h	≤20 ⁱ	80-120 ⁱ	0.025 µg/L	Human Health for the Consumption of Water + Organism
68334-30-5	TPH-diesel range	WTPH-D	500 µg/L	≤20 ⁱ	80-120 ⁱ	500 µg/L	WAC 173-340-720(3)
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	≤20 ^f	80-120 ^f	960 µg/L	WAC 173-340-720(4)(b)(iii)(A) and (B)

Table 2-8. Analytical Performance Requirements for 100-IU-2/IU-6 Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
14797-55-8	Nitrate (as N)	EPA 300.0 (anions by IC)	250 µg/L	≤20 ^f	80-120 ^f	10,000 µg/L	40 CFR 141.62

Notes:

40 CFR 141.62, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels for Inorganic Contaminants."

40 CFR 141.66, "National Primary Drinking Water Regulations," "Maximum Contaminant Levels for Radionuclides."

40 CFR 143.3, "National Secondary Drinking Water Regulations," "Secondary Maximum Contaminant Levels."

WAC 173-201A, "Water Quality Standards for Surface Waters of the State of Washington."

WAC 173-340-720(3), "Model Toxics Control Act—Cleanup," "Ground Water Cleanup Standards," "Method A Cleanup Levels for Potable Ground Water."

WAC 173-340-720(4), "Model Toxics Control Act—Cleanup," "Groundwater Standards," "Method B Cleanup Levels for Potable Ground Water."

- a. 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 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*. For the four-digit EPA methods (e.g., EPA 6010), see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*. Tentatively identified compounds will be reported for SW-846, Method 8260.
- b. EQL typically equal to 5 to 10 times the MDL (SW-846). MDLs are listed in DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*, Table C-30. When the action level is less than the MDL, the action level defaults to the MDL.
- c. Field measurements have no specific QC requirement except to perform checks to verify manufacturer's expected performance.
- d. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Except for GEA, additional accuracy criteria include analysis-specific evaluations performed 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.
- e. Strontium will be assessed as total radioactive strontium.
- f. 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 is also performed. The precision criteria shown is for batch laboratory replicate matrix spike or replicate sample relative percent differences.
- g. To meet or approach calculated action levels, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods, if EQLs are met.
- h. Action levels are less established analytical methodology capabilities. The analytical detection limits will be used for working levels and will be periodically reviewed to establish if lower detection limit capabilities have become available.
- i. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries. Laboratories must meet statistically based control limits, if more stringent. Additional accuracy criteria include analyte-specific evaluations performed for matrix spike and surrogate recoveries, as appropriate to the method. The precision criteria shown are for batch laboratory replicate matrix spike analysis relative percent differences. Tentatively identified compounds will be reported for SW-846 Method 8260.

Table 2-8. Analytical Performance Requirements for 100-IU-2/IU-6 Area Water Samples

CAS Number	Analyte	Analytical Method ^a	EQL ^b	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
CAS	= Chemical Abstracts Service	ICP	= inductively coupled plasma				
CCC	= criterion continuous concentration	LSC	= liquid scintillation counter				
CFR	= <i>Code of Federal Regulations</i>	MCL	= maximum contaminant level				
Cr(VI)	= hexavalent chromium	MDL	= method detection limit				
GEA	= gamma energy analysis	MS	= mass spectrometry				
GPC	= gross particle counting	N/A	= not applicable				
IC	= ion chromatography	NTU	= nephelometric turbidity unit				

Project specific safety training, geared specifically to the project and the day's activity, will be provided. Project specific training includes the following:

- Training requirements or qualifications needed by sampling personnel will be in accordance with QA requirements.
- Samplers are required to have training and/or experience in the type of sampling being performed in the field (soil/aquifer sediment sampling and water sampling).
- The Radiation Protection Program establishes qualification requirements for radiological control technicians. The radiological control technicians assigned to these activities will be qualified through the prescribed training program and will undergo ongoing training and qualification activities.

In addition, pre-job briefings will be performed to evaluate an activity and its hazards by considering many factors, including the following:

- Objective of the activities
- Individual tasks to be performed
- Hazards associated with the planned tasks
- Controls applied to mitigate the hazards
- Environment in which the job will be performed
- Facility where the job will be performed
- Equipment and material required
- Safety procedures applicable to the job
- Training requirements for individuals assigned to perform the work
- Level of management control
- Proximity of emergency contacts

Training records are maintained for each individual in an electronic training record database. The contractor training organization maintains the training records system. Line management will be used to confirm an individual employee's training is appropriate and up-to-date before performing fieldwork.

2.1.6 Documents and Records

The project lead is responsible for ensuring the current version of the SAP is being used and for providing updates to field personnel. Version control is maintained through the administrative document control process. Before implementation, DOE and the lead regulatory agency will review and approve changes to the sampling plan affecting the data needs. Information pertinent to sampling and analysis will be recorded in field checklists and bound logbooks in accordance with existing sample collection protocols in accordance with HASQARD (DOE/RL-96-68).

The sampling lead or drilling lead is responsible for ensuring the field instructions are maintained up-to-date and aligned with revisions or other approved changes to the SAP. The sampling lead or drilling lead will ensure that deviations from the SAP or problems encountered in the field are documented appropriately (e.g., in the field logbook, on nonconformance report forms) in accordance with internal corrective action procedures.

The project lead, drilling lead, sampling lead, or designee will be responsible for communicating field corrective action requirements and for ensuring immediate corrective actions are applied to field activities. Table 2-9 presents the change control for this project.

Table 2-9. Change Control for the 100-F/IU-2/IU-6 Project

Type of Change	Action	Documentation
By drilling lead or sampling lead: <ul style="list-style-type: none"> Increasing sampling frequency based on field screening results or visual observations. 	No SAP revision necessary	Field logbooks or operational records
By project management: <ul style="list-style-type: none"> Change in target analytes or COPCs Adding/removing wells Significant increases or decreases in sampling frequency 	Revise SAP (can be accomplished with a Tri-Party Agreement Change Notice); obtain regulatory approval; distribute plan	Revised plan or approved Tri-Party Agreement Change Notice

Logbooks are required for field activities. The logbook must be identified with a unique project name and number. Individuals responsible for logbooks will be listed. Only authorized persons may make entries in logbooks. Logbooks will be signed by the sampling lead, drilling lead, cognizant scientist/engineer or other responsible individual. Logbooks will be permanently bound, waterproof, and ruled with sequentially numbered pages. Pages will not be removed from logbooks for any reason.

Logbook entries will be made in indelible ink. Corrections will be made by marking the erroneous data through with a single line, entering the correct data, and initialing and dating the changes.

The project lead is responsible for ensuring a project file is properly maintained. The project file will contain the records or references to their storage locations. The project file will include the following, as appropriate:

- Field logbooks or operational records
- Data forms
- Global Positioning System data
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective action reports
- Interim progress reports
- Final reports
- Forms required by WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," and the master drilling contract
- Laboratory data packages
- RI report
- Verification and validation reports

The laboratory is responsible for maintaining, and having available upon request, the following:

- Analytical logbooks

- Raw data and QC sample records
- Standard reference material and/or proficiency test sample data
- Instrument calibration information

Records may be stored in either electronic or hard copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure accuracy and availability of stored records. Records required by the Tri-Party Agreement will be managed in accordance with the requirements of the Agreement.

2.2 Data Generation and Acquisition

The following sections address data generation and acquisition to ensure the project methods for sampling, measurement and analysis, data collection or generation, data handling, and QC activities are appropriate and documented.

2.2.1 Sampling Process Design (Experimental Design)

The sampling design is judgmental sampling. In judgmental sampling, sampling unit selection (e.g., the number, location, and/or timing of sample collection) is based on knowledge of the feature or condition under investigation and on professional judgment. Judgmental sampling is distinguished from probability based sampling in that inferences are based on professional judgment, not statistical scientific theory. Therefore, conclusions about the target population are limited and depend entirely on the validity and accuracy of professional judgment. Probabilistic statements about parameters cannot be made. Section 3.5 provides the types, number, and location of samples.

2.2.2 Sampling Methods

Section 3.6 describes the sampling methods. The specific information includes the following:

- Field sampling methods
- Corrective actions for sampling activities (the task lead will be responsible for corrective action)
- Decontamination of sampling equipment
- Radiological field data

2.2.3 Sample Handling and Custody

A sampling and data tracking database is used to track the samples from the point of collection through the laboratory analysis process. Samplers should note any anomalies (e.g., sample appears unusual, sample is sludge) with the samples to prevent batching across similar matrices. If anomalies are found, the samplers should write "DO NOT BATCH" on the chain-of-custody form and inform Sample Management and Reporting.

Laboratory analytical results are entered and maintained in HEIS. The HEIS sample numbers are issued to the sampling organization for the project. Each chemical, radiological, and physical properties sample is identified and labeled with a unique HEIS sample number.

Section 3.7 provides the following specific sample handling information:

- Container packaging
- Container labeling
- Sample custody requirements
- Sample transportation

Sample custody during laboratory analysis is addressed in the applicable laboratory standard operating procedures. Laboratory custody procedures will ensure the sample integrity and identification are maintained throughout the analytical process. Storage of samples at the laboratory will be consistent with laboratory instructions prepared by Sample Management and Reporting.

2.2.4 Analytical Methods

Tables 2-2 through 2-8 provide information on analytical methods. These analytical methods are controlled in accordance with the laboratory's QA plan and the requirements of this QAPjP. The primary contractor or vadose zone contractor, as applicable, participates in overseeing offsite analytical laboratories to qualify them for performing Hanford Site analytical work.

If the laboratory uses a nonstandard or unapproved method, then the laboratory must provide method validation data to confirm the method is adequate for the intended use of the data. This includes information such as determination of detection limits, quantitation limits, typical recoveries, and analytical precision and bias. In consultation with the laboratory, the project lead, and/or others as appropriate, Sample Management and Reporting can approve changes to analytical methods as long as the method is based upon a nationally recognized (e.g., EPA, ASTM) method, the new method achieves project DQOs as well as or better than the replaced method, and the new method is required due to the nature of the sample (e.g., high radioactivity).

Laboratories providing analytical services in support of this SAP will have in place a corrective action program addressing analytical system failures and documenting the effectiveness of corrective actions. Issues affecting analytical results are to be resolved by Sample Management and Reporting in coordination with the project lead.

Batch leach tests will be performed on soil and aquifer sediment samples. Standardized batch leach tests are done using a leach procedure based on ASTM D3987-06, *Standard Test Method for Shake Extraction of Solid Waste with Water*. The procedure recommends using soil screened through 3/8-inch mesh. Demineralized water, pH adjusted according to EPA's West Coast recommendation, will be used as the leaching liquid. Selected soil samples will be leached at soil to water weight ratios of 1 to 1, 1 to 2.5, and 1 to 5 with one test in each series duplicated. Soil/water mixtures are placed in clean watertight sample containers (extraction vessels) and rotated end over end through the vessel centerline at a rate of approximately 30 rotations per minute for 18 hours. Following 18 hours of mixing, the soil/water slurry is filtered through a 0.45- μ m filter. The leachate will be analyzed for pH, conductivity, and metals or other contaminants of interest. Metals analysis will be done using Method 6010, 6020, or 200.8 for inductively coupled plasma metals, as applicable. Analytical results are compared between different soil to water ratios and duplicate tests to evaluate repeatability and attainment of equilibrium conditions. Details of the test will be discussed with the laboratory personnel before analysis.

Distribution coefficient values will be established to support modeling needs. Distribution coefficient calculations will be performed using the analytical results from bulk soils analysis and leach testing of soils collected from the same location. The distribution coefficient is calculated as the ratio of contaminant sorbed to soil to the contaminant in solution by the following equation:

$$K_d = \frac{(C_s \times M_s) - (C_L \times V_L)}{M_s} \times \frac{1}{C_L}$$

where:

C_S = Contaminant concentration in bulk soil matrix prior to leaching ($\mu\text{g/g}$)

M_S = Dry mass of soil used for leaching (g)

C_L = Contaminant concentration in leachate ($\mu\text{g/L}$)

V_L = Liquid volume used for leaching (L)

Contamination present in pore water within the bulk soil matrix is not analyzed or accounted for separately, as the associated contaminant mass is included within the bulk leachate. Distribution coefficient values are calculated separately for each contaminant and each dilution ratio. The series of calculated values is then qualitatively evaluated to determine if the variation within results is reasonable and explainable.

A minimum of 10 independent samples (e.g., from different locations) will be analyzed by this method.

Grain size (sieve) analysis may be performed as a field procedure or in the laboratory based on ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*. Field grain size analysis may be used to select well screens for groundwater wells.

2.2.5 Quality Control

QC procedures must be followed in the field and laboratory to ensure reliable data are obtained. Field personnel will collect QC samples to evaluate the potential for cross-contamination and to provide information pertinent to field variability. Field QC for sampling will require the collection of field duplicate, trip or field transfer blank, equipment rinsate blank, and field split samples. Laboratory QC samples estimate the precision and bias of the analytical data. Table 2-10 summarizes field and laboratory QC samples.

Table 2-10. Project Quality Control Checks

QC Sample Type	Purpose	Frequency
Field Quality Control		
Full trip blank	Assess contamination from containers or transportation	One per 20 samples, <i>per media sampled</i> .
Field transfer blank	Assess contamination from sampling site	One per day when volatile organic compounds are sampled for groundwater monitoring activities. A minimum of one field transfer blank will be collected at each borehole, <i>per media sampled</i> , where the samples will undergo volatile organic analysis.
Equipment rinsate blank	Verify adequacy of sampling equipment decontamination	As needed. ^a If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank is not required. Otherwise, 1 per 20 samples, <i>per media sampled</i> .

Table 2-10. Project Quality Control Checks

QC Sample Type	Purpose	Frequency
Field duplicates	Estimate precision, including sampling and analytical variability	One per 20 samples maximum for groundwater monitoring activities. A minimum of one field duplicate sample will be collected at each borehole, <i>per media sampled</i> .
Field split	Estimate precision, including sampling, analytical, and inter-laboratory variability	At a minimum, one per analytical method, <i>per media sampled</i> , for analyses performed where detection limit and precision and accuracy criteria have been defined in the Performance Requirements Tables.
Laboratory Quality Control ^b		
Method blank	Assess response of an entire laboratory analytical system	One per batch, ^b 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i> .
Matrix spike	Identify analytical (preparation and analysis) bias; possible matrix affect on the analytical method used	When required by the method guidance, one per batch, ^b 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i> .
Matrix duplicate or matrix spike duplicate	Estimate analytical bias and precision	When required by the method guidance, one per batch, ^b 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i> .
Laboratory control samples	Assess method accuracy	One per batch, ^b 20 samples maximum, or as identified by the method guidance, <i>per media sampled</i> .
Surrogates	Estimate recovery/yield	When required by the method guidance, as identified by the method guidance.

Notes:

- a When a new type of non-dedicated equipment is used, an equipment rinsate blank will be collected every time sampling occurs until it can be shown that less frequent collection of equipment rinsate blanks is adequate to monitor the decontamination procedure for the non-dedicated equipment.
- b Batching across projects is allowed for similar matrices (e.g., Hanford Site groundwater).

2.2.5.1 Field QC Samples

The field QC sample types are discussed within this section.

Full trip blanks are samples prepared by the sampling team before traveling to the sampling site. The preserved bottle set is identical to the set collected in the field, but is filled with reagent water or silica sand, as appropriate to the primary sample media. The bottles are sealed and transported, unopened, to the field in the same storage container used for samples collected the same day. Full trip blanks are typically analyzed for the same constituents as the samples from the associated sampling event. However, the analytical list for full trip blanks on soil may be limited to volatile organic compounds (VOCs), semivolatiles organics, and total petroleum hydrocarbons. Full trip blanks are not required on aquifer sediments being analyzed for metals, strontium-90, and hexavalent chromium.

Field transfer blanks are preserved VOCs sample vials filled at the sample collection site with reagent water or silica sand, as appropriate to the primary sample media, that has been transported to the field. The samples are prepared during sampling activities to evaluate potential contamination caused by field conditions. After collection, field transfer blank sample vials are sealed and placed in the same storage container with the samples from the associated sampling event. Field transfer blank samples are analyzed for VOCs only.

The field transfer blank sample will consist of reagent water or silica sand, as appropriate to the primary sample media, added to clean sample containers at the location where the VOC sample was collected. The field transfer blank sample will be batched with samples for which VOC analysis is requested.

Equipment rinsate blanks are collected for reused sampling devices to assess the adequacy of the decontamination process. Equipment rinsate blank samples will consist of silica sand or reagent water poured over the decontaminated sampling equipment and placed in containers, as identified on the project sampling authorization form. If disposable (e.g., single-use) equipment is used, equipment rinsate blank samples will not be required.

For the field blank samples (e.g., full trip blank, field transfer blank, equipment rinsate blank), results greater than two times the method detection limit are identified as suspected contamination. However, for common laboratory contaminants such as acetone, methylene chloride, 2-butanone, toluene, and phthalate esters, the limit is five times the method detection limit. For radiological data, blank results are flagged if they are greater than two times the total minimum detectable activity.

Field duplicate samples are used to evaluate sample consistency and the precision of field sampling methods. Field duplicates are independent samples collected as close as possible to the same point in space and time. They are two separate samples collected from the same source, stored in separate containers, and analyzed independently.

The duplicate should be collected generally from an area expected to have some contamination, so valid comparisons between the samples can be made (e.g., at least some of the constituents will be above the detection limit). When sampling is performed from a split spoon, VOC samples and VOC duplicate samples are collected directly from the sampler. The remaining soil/aquifer sediment is then composited in a stainless steel mixing bowl. The soil/aquifer sediment sample and duplicate sample are collected from this composited material.

Evaluation of the results can provide an indication of intra-laboratory variability. Only those field duplicate sample pairs with at least one result greater than five times the method detection limit or minimum detectable activities are evaluated. Large relative percent differences can be an indication of laboratory performance problems and should be investigated.

A **field split** is a representative sample from a sampling event sent to a third-party laboratory (i.e., reference laboratory). Only those results greater than five times the method detection limit or minimum detectable activity at both laboratories are evaluated. Evaluation of the results can provide an indication of inter-laboratory variability. Large relative percent differences can be an indication of laboratory performance problems and should be investigated.

2.2.5.2 Laboratory QC Samples

The laboratory QC samples (e.g., method blank, laboratory control sample/blank spike, and matrix spike) are defined for three-digit EPA methods (EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*, and EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*) and four-digit EPA methods (SW-846). The laboratory QC samples will be run at the frequency specified in the respective reference. QC checks outside of control limits will be reflected in the data validation process and during the DQA described in Section 2.4.

2.2.5.3 QC Requirements

If only disposable equipment is used or equipment is dedicated to a particular well, then an equipment rinsate blank sample is not required. If no VOC samples are collected, then a field transfer blank sample is not required. Field transfer blank samples are not required when simply transferring samples to the field gas chromatograph for analysis.

Only those field duplicate sample result pairs with at least one result greater than five times the appropriate detection limit or minimum detectable activity are evaluated. Field duplicate sample results must agree within 20 percent for water (35 percent for soil/aquifer sediment), as measured by the relative percent difference, to be acceptable. Unacceptable field duplicate results also flagged with a "Q" qualifier in the HEIS database. Large relative percent differences can be an indication of potential laboratory performance problems and should be investigated.

Only those field sample result pairs with both results greater than five times the appropriate detection limit or minimum detectable activity are evaluated. Field split sample results must agree within 20 percent for water (35 percent for soil/aquifer sediment) as measured by the relative percent difference to be acceptable. Unacceptable field split results are qualified and flagged in the HEIS database, as appropriate. Large relative percent differences can be an indication of inter-laboratory variability and potential laboratory performance problems and should be investigated.

For chemical analyses, the acceptance criteria for laboratory duplicate, laboratory control, matrix spike, and matrix spike duplicate samples are stated in Tables 2-2 through 2-8.

Holding time is the elapsed time period between sample collection and analysis, or sample collection to extraction and sample extraction to analysis, as applicable to the method. Exceeding required holding times could result in changes in constituent concentrations due to volatilization, decomposition, or other chemical alterations. Required holding times depend on the analytical method, as specified for three- and four-digit EPA methods (EPA-600/4-79-020; EPA-600/R-94-111; SW-846). Data associated with exceeded holding times are flagged and qualified in HEIS, as appropriate.

Additional QC measures include laboratory audits and participation in nationally based performance evaluation studies. The laboratories participate in national studies such as the EPA-sanctioned water pollution and water supply performance evaluation studies. The Soil and Groundwater Remediation Project periodically audits the analytical laboratories to identify and solve quality problems or to prevent such problems. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies are presented in the annual groundwater monitoring report (e.g., DOE/RL-2008-66, *Hanford Site Groundwater Monitoring for Fiscal Year 2008*). Failure of QC will be determined and evaluated during data validation and the DQA process. Data will be qualified as appropriate.

2.2.6 Instrument and Equipment Testing, Inspection, and Maintenance

Equipment used for collection, measurement, and testing should meet the applicable standards (e.g., ASTM) or have been evaluated as acceptable and valid in accordance with the procedures, requirements, and specifications. The sampling lead or equivalent will ensure that the data generated from instructions using a software system are backed up and/or downloaded regularly. Software configuration will be acceptance tested before use in the field.

Measurement and testing equipment used in the field or in the laboratory that directly affects the quality of analytical data will be subject to preventive maintenance measures to ensure minimization of measurement system downtime. Laboratories and onsite measurement organizations must maintain and calibrate their equipment. Maintenance requirements (such as documentation of routine maintenance) will be included in the individual laboratory and the onsite organization QA plan or operating procedures, as appropriate. Maintenance of laboratory instruments will be performed in a manner consistent with three- and four-digit EPA methods (EPA-600/4-79-020; EPA-600/R-94-111; SW-846), or with auditable Hanford Site and contractual requirements. Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

2.2.7 Instrument and Equipment Calibration and Frequency

Section 3.4 provides specific field equipment calibration information. Analytical laboratory instruments and measuring equipment are calibrated in accordance with the laboratory's QA plan.

2.2.8 Inspection and Acceptance of Supplies and Consumables

Supplies and consumables used in support of sampling and analysis activities will be procured in accordance with internal work requirements and processes described in the contractor acquisition system. Responsibilities and interfaces necessary to ensure items are procured or acquired for the contractor to meet the specific technical and quality requirements must be in place. The procurement system ensures purchased items comply with applicable procurement specifications. Supplies and consumables are checked and accepted by users before use. Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratories' QA plans.

2.2.9 Non-Direct Measurements

Non-direct measurements include data obtained from sources such as computer databases, programs, literature files, and historical databases. Non-direct measurements will not be evaluated as part of the activities under the scope of this SAP.

2.2.10 Data Management

Sample Management and Reporting, in coordination with the project lead, is responsible for ensuring analytical data are appropriately reviewed, managed, and stored in accordance with the applicable programmatic requirements governing data management procedures. Electronic data access, when appropriate, will be through a database (e.g., HEIS). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the Tri-Party Agreement Action Plan (Ecology et al., 1989b).

Laboratory errors are reported to Sample Management and Reporting routinely. For reported laboratory errors, a sample issue resolution form will be initiated in accordance with contractor procedures. This process is used to document analytical errors and to establish resolution with the project lead. The sample issue resolution forms become a permanent part of the analytical data package for future reference and for records management.

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

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

When this SAP is implemented, approved work control packages and procedures will be used to document field activities, including radiological and nonradiological measurements. Field activities will be recorded in the field logbook. Examples of the types of documentation for field radiological data include the following:

- Instructions regarding the minimum requirements for documenting radiological controls information in accordance with 10 CFR 835, "Occupational Radiation Protection."
- Instructions for managing the identification, creation, review, approval, storage, transfer, and retrieval of primary contractor radiological records.
- Minimum standards and practices necessary for preparing, performing, and retaining radiological related records.
- Indoctrination of personnel on the development and implementation of sample plans.
- Requirements associated with preparing and transporting regulated material.
- Daily reports of radiological surveys and measurements collected during field investigation activities. Data will be cross-referenced between laboratory analytical data and radiation measurements to facilitate interpreting the investigation results.

2.3 Assessment and Oversight

The elements included in assessment and oversight address the activities for assessing the effectiveness of project implementation and associated QA/QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

2.3.1 Assessments and Response Actions

Contractor management, regulatory compliance, quality, and/or health and safety organizations may conduct random surveillance and assessments to verify compliance with the requirements outlined in this SAP, project work packages, procedures, and regulatory requirements. Section 2.4 discusses the only planned assessment, a DQA, for the activities identified in this SAP. The results of the DQA will be provided to the project lead.

If circumstances arise in the field dictating the need for additional assessment activities, then additional assessments will be performed. Deficiencies identified by these assessments will be reported in

accordance with existing programmatic requirements. The project's line management chain coordinates the corrective actions and/or deficiencies in accordance with the contractor QA program, the corrective action management program, and associated procedures that implement these programs.

Oversight activities in the analytical laboratories, including corrective action management, are conducted in accordance with the laboratories' QA plans. The contractor oversees offsite analytical laboratories and qualifies the laboratories for performing Hanford Site analytical work.

2.3.2 Reports to Management

Reports to management on data quality issues will be made if these issues are identified. Issues reported by the laboratories are communicated to Sample Management and Reporting, which initiates a sample issue resolution form in accordance with contractor procedures. This process is used to document analytical or sample issues and to establish resolution with the project lead. At the end of the project, a DQA report will be prepared to determine if the type, quality, and quantity of collected data met the quality objectives described in this SAP.

2.4 Data Validation and Usability

The elements under data validation and usability address the QA activities occurring after the data collection phase of the project is completed. Implementation of these elements determines whether the data conform to the specified criteria, thus satisfying the project objectives.

2.4.1 Data Review, Verification, and Validation

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

Data validation will be performed to ensure that the data quality goals established during the planning phase have been achieved. Data validation will be in accordance with internal procedures. The criteria for data validation are based on a graded approach. The primary contractor has defined five levels of validation, Level A through Level E. Level A is the lowest level and is the same as verification. Level E is a 100 percent review of data (e.g., calibration data; calculations of representative samples from the dataset). Validation will be performed to contractor Level C, which is a review of the QC data. Level C validation specifically requires verification of deliverables; requested versus reported analyses; and qualification of the results based on analytical holding times, method blank results, matrix spike/matrix spike duplicate results, surrogate spike recoveries, and duplicate sample results. Level C validation will be performed on at least 5 percent of the data by matrix and analyte group. Analyte group refers to categories such as radionuclides, VOCs, semivolatiles, polychlorinated biphenyls (PCBs), metals, and anions. The goal is to cover the various analyte groups and matrices during the validation.

Relative to analytical data in sample media, physical data and/or field screening results are of lesser importance in making inferences of risk. Field QA/QC data will be reviewed to ensure that physical property data and/or field screening results are usable.

2.4.2 Verification and Validation Methods

Validation activities will be based on EPA functional guidelines. Data validation may be performed by Sample Management and Reporting and/or by a party independent of both the data collector and the data user. Data validation qualifiers must be compatible with the HEIS database.

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

2.4.3 Reconciliation with User Requirements

The DQA process compares completed field sampling activities to those proposed in corresponding sampling documents and provides an evaluation of the resulting data. The purpose of the data evaluation is to determine if quantitative data are of the correct type and are of adequate quality and quantity to meet the project data needs. The results of the DQA will be used in interpreting the data and determining if the objectives of this activity have been met. The DQA will be in accordance with EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide*, and EPA/240/B-06/003, *Data Quality Assessment: Statistical Methods for Practitioners*.

2.4.4 Corrective Actions

The responses to data quality defects identified through the DQA process will vary and may be data- or measurement-specific. Table 2-1 identified some pre-identified corrective actions.

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3 Field Sampling Plan

The following sections provide additional details regarding field-specific sample and data collection requirements.

3.1 Site Background and Objectives

Site background information is contained in Addendum 4. The target analytes and COPCs are presented in Tables 1-2 through 1-4. Section 1.6 of this SAP provides guidance on the implementation of the schedule. The objective of a field-sampling plan is to clearly identify project sampling and analysis activities. The field-sampling plan uses the sampling design identified during the systematic planning process and presents the design to identify sampling locations, the total number of samples to be collected, and analyses to be performed.

3.2 Documentation of Field Activities

Logbooks or data forms are required for field activities. Section 2.1.6 provides logbook requirements. Data forms may be used to collect field information. However, the data forms must be referenced in the logbooks and must follow the same requirements as those for logbooks presented below. The following is a summary of information to be recorded in logbooks:

- Purpose of activity
- Day, date, time, weather conditions
- Names, titles, organizations of personnel present
- Deviations from the QAPjP or procedures
- All site activities, including field tests
- Materials quality documentation (e.g., certifications)
- Details of samples collected (primary, splits, duplicates, blanks)
- Location and types of samples
- Chain-of-custody details and variances relating to chain-of-custody
- Field measurements
- Field calibrations, surveys, and equipment identification numbers as applicable
- Equipment decontaminated, number of decontaminations, and variations to decontamination procedures
- Equipment failures or breakdowns and descriptions of any corrective actions
- Telephone calls relating to field activities

3.3 Sampling Design

As Section 2.2.1 presents, the sampling design is judgmental sampling.

3.4 Calibration of Field Equipment

The sampling lead is responsible for ensuring that field equipment is calibrated appropriately. Onsite environmental instruments are calibrated in accordance with manufacturer operating instructions, internal work requirements and processes, and/or work packages that provide direction for equipment calibration or verification of accuracy by analytical methods. The results from instrument calibration activities are recorded in logbooks and/or work packages. Hard copy or electronic versions are acceptable.

Calibrations must be performed as follows:

- Before initial use of a field analytical measurement system
- At the frequency recommended by the manufacturer or procedure, or as required by regulations
- Upon failure to meet specified QC criteria

Field instrumentation, calibration, and QA checks will be performed in accordance with the following:

- As specified in its program documentation, Pacific Northwest National Laboratory calibrates radiological field instruments on the Hanford Site.
- Daily calibration checks will be performed and documented for each instrument used to characterize areas under investigation. These checks will be made on standard materials sufficiently like the matrix under consideration for direct comparison of data. Analysis times will be sufficient to establish detection efficiency and resolution.

3.5 Sample Location and Frequency

The purpose of this section is to identify the sampling locations and frequencies and define the sampling and analysis requirements for samples and measurements to be collected. Figures 1-1 and 1-2 show the approximate location of planned and existing boreholes and groundwater monitoring wells described in this SAP. The actual locations will be determined based on a field walkdown of current site conditions to avoid Hanford Site National Historic restrictions, roads, and other obstructions.

3.5.1 Vadose Zone Characterization

Samples will be collected from boreholes and planned groundwater monitoring wells to support characterization of the vadose zone and groundwater as outlined in Table 1-1. The vadose zone will be characterized by performing intrusive investigations at three waste sites: 116-F-14 Retention Basin, 118-F-1 Burial Ground, and 118-F-8 Reactor Fuel Storage Basin. Intrusive investigations consist mainly of collecting and analyzing samples from planned boreholes in areas of known or suspected contamination. Samples will be collected during installation of each groundwater well for vadose zone characterization. These activities are planned to characterize the nature and vertical extent of contamination in the vadose zone beneath waste sites, characterize the physical properties of soil/aquifer sediments, locate potential sources, and verify contaminant distribution coefficients to support modeling and an assessment of risk. The data from these activities will be used to verify the adequacy of interim remedial actions and refine the preliminary conceptual site model of 100-F/IU-2/IU-6.

The scope of vadose zone characterization efforts includes field screening, collecting and analyzing soil samples from the vadose zone, collecting and analyzing aquifer sediment samples, performing groundwater sampling and analysis, and performing geophysical logging. The general intent of the borehole sampling design is to begin sample collection at the maximum depth of remedial action or bottom of the waste site and sample at 1.5 m (5-ft) intervals. The sampling frequency will be continuous within 3.1 m (10 ft) of the vadose zone-groundwater interface. Vadose zone samples will be collected

according to the sampling scheme shown in Table 3-1. The sampling scheme for each borehole includes collecting soil samples periodically throughout the vadose zone, collecting one sample of aquifer sediments at 1.5 m (5 ft) into the water table, and collecting one filtered groundwater sample. The sampling scheme for deep vadose zone samples at groundwater wells includes collecting soil samples periodically above the water table and collecting samples of aquifer sediments in the water table. Additional samples may be collected based on field observations.

For those soil/aquifer sediment intervals for which a batch leach test has been requested, strontium-90 batch leach test will be performed for samples containing more than 4.5 pCi/g strontium-90.

Physical property samples will be collected to provide site-specific values to support modeling efforts. The physical property samples will be collected from lithologies representing major facies in the vadose zone. The physical property samples will be collected in conjunction with split-spoon sample intervals, where possible.

3.5.1.1 Field Screening

Radiological field screening data, visual observation of lithologies, visual observation of contamination, or site geologist professional judgment may be used to adjust sampling points presented in Table 3-1, to assist in determining sample shipping requirements, and to support worker health and safety monitoring. Section 3.6.3 describes radiological field screening methods.

3.5.1.2 Geophysical Logging

The planned boreholes and groundwater monitoring wells will be geophysically logged with the high-resolution, spectral gamma-ray logging system to determine the vertical distribution and concentration of gamma-emitting radionuclides. Soil moisture will be determined using a neutron logging tool. The groundwater monitoring wells and boreholes will be logged before the casing is telescoped and before the borehole is decommissioned. The starting point for logging will be recorded; this is usually at the ground surface or the top of the casing. Boreholes will be decommissioned with RL and EPA approval, in accordance with WAC 173-160, after geophysical logging and all sampling are completed.

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth ^b	Analyte/Property List	Sample Interval Depth ^b	Analyte List
<p>116-F-14 Retention Basin</p> <p>One borehole to groundwater.</p> <p>Justification: Maximum residual contaminations for hexavalent chromium in the soil column are above remedial action goals for protection of the Columbia River.</p>	<p>15-17.5, 20-22.5, 25-27.5, 30-32.5, 35-37.5, 37.5-40, 40-42.5, 42.5-45, 45-47.5 ft bgs (50-52.5 ft bgs aquifer sediment sample^c) by split spoon (10 samples)</p> <hr/> <p>Major formation and lithology changes by split spoon (2 samples)</p>	<p>Target analytes, field screening parameters in accordance with Table 2-2 and batch leach test in accordance with Table 2-6</p> <p>Sediment sample will be analyzed for metals, hexavalent chromium, and strontium-90 in accordance with Table 2-2</p> <hr/> <p>Physical properties in accordance with Table 2-2</p>	<p>50-52.5 ft bgs aquifer water sample^c (1 filtered groundwater sample)</p>	<p>Metals, hexavalent chromium, and strontium-90 in accordance with Table 2-7</p>
<p>118-F-1 Burial Ground</p> <p>One borehole to groundwater.</p> <p>Justification: This site is being characterized because it is suspected of being the source of a hexavalent chromium and tritium groundwater plume.</p>	<p>17.5-20, 20-22.5, 25-27.5, 30-32.5, 32.5-35, 35-37.5, 37.5-40 ft bgs (45-47.5 ft bgs aquifer sediment sample^c) by split spoon (8 samples)</p> <hr/> <p>Major formation and lithology changes by split spoon (2 samples)</p>	<p>Target analytes, field screening parameters in accordance with Table 2-3 and batch leach test in accordance with Table 2-6</p> <p>Sediment sample will be analyzed for metals, hexavalent chromium, and strontium-90 in accordance with Table 2-3</p> <hr/> <p>Physical properties in accordance with Table 2-3</p>	<p>45-47.5 ft bgs aquifer water sample^c (1 filtered groundwater sample)</p>	<p>Metals, hexavalent chromium, and strontium-90 in accordance with Table 2-7</p>

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth ^b	Analyte/Property List	Sample Interval Depth ^b	Analyte List
<p>118-F-8 Reactor Fuel Storage Basin One borehole to groundwater. Justification: Residual contamination may extend beyond the depth of remedial Action. Additionally, this borehole is being drilled to satisfy external requirements to evaluate the nature and extent of contamination beneath the reactor structure. Data are not available to assess impact to groundwater.</p>	<p>20-22.5, 25-27.5, 30-32.5, 35-37.5, 37.5-40, 40-42.5, 42.5-45, 45-47.5 ft bgs (50-52.5 ft bgs aquifer sediment sample^c) by split spoon (9 samples)</p>	<p>Target analytes, field screening parameters in accordance with Table 2-4 and batch leach test in accordance with Table 2-6 Sediment sample will be analyzed for metals, hexavalent chromium, and strontium-90 in accordance with Table 2-4</p>	<p>50-52.5 ft bgs aquifer water sample^c (1 filtered groundwater sample)</p>	<p>Metals, hexavalent chromium, and strontium-90 in accordance with Table 2-7</p>
	<p>Major formation and lithology changes by split spoon (2 samples)</p>	<p>Physical properties in accordance with Table 2-4</p>		
<p>Well No. 1 Install borehole in 100-F reaching a total depth approximately 5 ft into the Ringold Upper Mud Unit and screened in the unconfined aquifer. The screen will be installed at the water table and centered within the area of highest hexavalent chromium contamination.^d Justification: Proposed to define the extent of hexavalent chromium in groundwater.</p>	<p>During drilling, grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings^e</p>	<p>Geologic archive samples</p>	<p>During drilling, samples to be collected at 5-ft intervals throughout unconfined aquifer (5 samples)^e</p>	<p>Field screening parameters and Table 1-3 constituents in accordance with Table 2-7</p>
	<p>During drilling, samples to be collected 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, and at the bottom of the unconfined aquifer and 5 ft into the Ringold Upper Mud Unit within a non-water-bearing unit by split spoon (8 samples)^e</p>	<p>Target analytes, field screening parameters, and physical properties in accordance with Table 2-5 and batch leach test in accordance with Table 2-6</p>		
	<p>Major formation and lithology changes by split spoon (2 samples)</p>	<p>Physical properties in accordance with Table 2-5</p>		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth ^b	Analyte/Property List	Sample Interval Depth ^b	Analyte List
<p>Well No. 2</p> <p>Install borehole in 100-F reaching a total depth approximately 5 ft within the Ringold Upper Mud Unit and screened in the unconfined aquifer. The screen will be installed at the water table and centered within the area of highest strontium-90 contamination.^d</p> <p>Justification: Proposed to define the extent of strontium-90 in groundwater.</p>	<p>During drilling, grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings^e</p>	<p>Geologic archive samples</p>	<p>During drilling, samples to be collected at 5-ft intervals throughout unconfined aquifer (5 samples)^c</p>	<p>Field screening parameters and Table 1-3 constituents in accordance with Table 2-7</p>
	<p>During drilling, samples to be collected 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, and at the bottom of the unconfined aquifer and 5 ft into the Ringold Upper Mud Unit within a non-water-bearing unit by split spoon (8 samples)^c</p>	<p>Target analytes, field screening parameters, and physical properties in accordance with Table 2-5 and batch leach test in accordance with Table 2-6</p>		
	<p>Major formation and lithology changes by split spoon (2 samples)</p>	<p>Physical properties in accordance with Table 2-5</p>		

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth ^b	Analyte/Property List	Sample Interval Depth ^b	Analyte List
<p>Well No. 3</p> <p>Install borehole in the 100-F Area, reaching a total depth approximately 50 ft within the Ringold Upper Mud Unit and screened in the first water bearing unit of the Ringold Upper Mud Unit in 100-F. The screen will be positioned within the first water-bearing unit of the Ringold Upper Mud Unit based on ability to produce water.^d</p> <p>Justification: Proposed to collect geochemical and hydrogeologic data to evaluate near-shore area groundwater contaminant fate and transport.</p>	<p>During drilling, grab samples will be collected every 5 ft or where lithology changes occur in one pint jar and a chip tray from the drill cuttings^e</p>	<p>Geologic archive samples</p>	<p>During drilling, samples to be collected at 5-ft intervals throughout unconfined aquifer and one sample to be collected during drilling from a water-bearing interval of the Ringold Upper Mud Unit if sufficient water is available (<u>6 samples</u>)^e</p>	<p>Field screening parameters and Table 1-3 constituents in accordance with Table 2-7</p>
	<p>During drilling, samples to be collected 15, 10, 5, and 2 ft above water table, at the water table, 5 ft below the water table, at the bottom of the unconfined aquifer and from the top, middle, and bottom of the non-water-bearing units of the Ringold Upper Mud Unit by split spoon (<u>10 samples</u>)^e</p>	<p>Target analytes, field screening parameters, and physical properties in accordance with Table 2-5 and batch leach test in accordance with Table 2-6</p>		
	<p>Major formation and lithology changes by split spoon (<u>2 samples</u>)</p>	<p>Physical properties in accordance with Table 2-5</p>		
<p>Sample 19 spatial and temporal uncertainty groundwater monitoring wells in 100-F (Table 3-2); three rounds</p>	<p>None</p>	<p>None</p>	<p>Three sampling rounds to support RI. (<u>19 wells x approximately 3 rounds = 57 samples</u>)</p>	<p>Field screening parameters and Table 1-3 constituents in accordance with Table 2-7</p>

Table 3-1. Sample/Measurement Locations and Depth

Sampling Location	Soil/Aquifer Sediment Sample/Measurement ^a		Water Sample/Measurement	
	Sample Interval Depth ^b	Analyte/Property List	Sample Interval Depth ^b	Analyte List
Sample 36 spatial and temporal uncertainty groundwater monitoring wells in 100-IU-2/IU-6 (Table 3-3); three rounds	None	None	Three sampling rounds to support RI. (36 wells × approximately 3 rounds = 108 samples)	Field screening parameters and Table 1-4 constituents in accordance with Table 2-8
Estimated number of samples ^b	<u>Soil/aquifer sediment chemical</u> : 53 <u>Physical property</u> : 38 <u>Geologic archive samples</u> : Variable		<u>Water samples collected during drilling</u> : 19 <u>Spatial and temporal uncertainty groundwater samples</u> : 165 (3 rounds total)	
Estimated minimum number of field quality control samples ^b	<u>Soil/aquifer sediment chemical</u> : 10 (3 equipment rinsate blank, 3 field blank, 3 duplicate, 1 split) <u>Physical property</u> : 0 <u>Geologic archive samples</u> : 0		<u>Water samples collected during drilling</u> : 4 (1 equipment rinsate blank, 1 field blank, 1 duplicate, 1 split) <u>Spatial and temporal uncertainty groundwater samples</u> : 28 (9 equipment rinsate blank, 9 field blank, 9 duplicate, 1 split)	
Estimated total number of samples ^b	<u>Soil/aquifer sediment chemical</u> : 63 <u>Physical property</u> : 38 <u>Geologic archive samples</u> : Variable		<u>Water samples collected during drilling</u> : 23 <u>Spatial and temporal uncertainty groundwater samples</u> : 193	

Notes:

- Upon visual observation of contamination, a depth discrete sample will be collected for applicable analysis. For example, if evidence of hexavalent chromium contamination is observed at any interval other than those stated for sampling, a depth discrete sample would be collected for hexavalent chromium analysis.
- Numbers of samples listed are estimated. Actual number of samples collected may differ based on conditions encountered during field activities.
- Aquifer sediment sample will be collected from the unconfined aquifer. Filtered groundwater sample to be collected at approximately 5 feet into unconfined aquifer.
- Final well design, including screen placement and length, will be determined by concurrence of the field geologist, drilling lead, and operable unit lead based on field conditions.
- Archive samples may be omitted at the discretion of the field geologist due to radiological field data.

bgs = below ground surface

3.5.2 Groundwater Characterization

Groundwater characterization, including well activities, identification of wells to be sampled, well depth and screen placement, and well drilling and completion procedures, is discussed in this section.

3.5.2.1 New Groundwater Wells

Table 3-1 summarizes groundwater monitoring well activities.

For new wells installed into the Ringold Upper Mud Unit, slug tests and pump testing will be performed to characterize hydraulic conductivity. These tests should be performed after each well is properly developed.

Well Depth and Screen Placement

For the two new groundwater wells in the unconfined aquifer in 100-F, a 6.1 m (20-ft) screen will be installed at the water table and centered within the area of highest hexavalent chromium contamination for Well No. 1 and strontium-90 contamination for Well No. 2. For the one new groundwater well in 100-F to be drilled reaching a total depth approximately 15 m (50 ft) within the Ringold Upper Mud Unit, up to a 6.1 m (20-ft) screen will be installed based on ability to produce water in the first water-bearing Ringold Upper Mud Unit.

Well Drilling and Completion Procedures

Well drilling will be performed in accordance with WAC 173-160. The wells will be constructed using 25 cm (10-in.-) diameter (or larger) casing to the water table, and 15 cm (6-in.-) diameter (or larger) casing to total depth. The drilling method will be determined based on discussions between the drilling lead and drilling contractor.

The wells will be constructed as 15 cm (6-in.) wells with Schedule 10, Type 304 or 316 stainless steel, V-slot continuous wire wrap screen, atop a 1.5 m (5-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 carbon 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.

Surface construction consisting of protective casing, protective guard posts, and cement pad must be in place before job completion. The protective casing will be a minimum of 5.1 cm (2 in.) larger in diameter than the permanent casing. Protective casing will rise approximately 0.9 m (3 ft) above the ground surface. Permanent casing will rise to approximately 0.3 m (1 ft) below the top of the protective casing. Protective casing will have a lockable well cap extending approximately 38.1 cm (15 in.) above the top of the protective casing.

Final well design, including screen placement and length, will be determined by concurrence of the field geologist, drilling lead, and operable unit lead based upon field conditions.

3.5.2.2 Spatial and Temporal Uncertainty Groundwater Monitoring Well Network Development

Table 3-1 summarizes the spatial and temporal uncertainty groundwater monitoring well activities. Tables 3-2 and 3-3 present the spatial and temporal uncertainty groundwater monitoring wells to be sampled. Three spatial and temporal uncertainty groundwater sample rounds, or events, will be performed to support the assessment of risk for the RI.

To capture baseline aquifer conditions fully, it is required that samples represent spatial variations and changes occurring over time. For representing baseline groundwater conditions, samples are required and

will be collected to represent the varying aquifer conditions associated with seasonal “high,” “low,” and “transitional,” water levels. The dates and frequency of sample collection will optimize collection of samples representing these temporal changes in groundwater conditions. The samples collected from wells listed in Tables 3-2 and 3-3 during the three events will be analyzed for the COPCs listed in Tables 1-3 and 1-4, respectively.

Table 3-2. 100-F Area Spatial and Temporal Uncertainty Groundwater Monitoring Well Network

199-F1-2	199-F5-43A	199-F5-48	199-F7-2	199-F8-4
199-F5-1	199-F5-44	199-F5-6	199-F7-3	199-F8-7
199-F5-4	199-F5-45	199-F6-1	199-F8-2	699-77-36
199-F5-42	199-F5-46	199-F7-1	199-F8-3	

Table 3-3. 100-IU-2/IU-6 Area Spatial and Temporal Uncertainty Groundwater Monitoring Well Network

699-10-54A	699-32-22A	699-50-28B	699-63-25A	699-77-54
699-14-38	699-34-88	699-53-35	699-65-50	699-8-25
699-17-5	699-35-9	699-54-45A	699-65-72	699-89-35
699-20-20	699-38-15	699-55-76	699-66-58	699-S3-25
699-20-E5A	699-41-23	699-55-89	699-70-68	
699-26-15A	699-42-12A	699-60-32	699-71-30	
699-29-4	699-43-89	699-61-66	699-72-92	
699-31-11	699-46-21B	699-62-43F	699-74-44	

To determine the risk to human and ecological receptors, the RI process requires the groundwater be sampled to provide data representative of aquifer conditions, both spatially and temporally. Groundwater should be sampled throughout an area without regard to the location of surface facilities or known groundwater plumes. If there are temporal changes in groundwater conditions, samples must be collected to capture these varying stages to properly delineate risk to receptors. The following discussion explains the method used to develop both the number and location of sampling points along with the sampling frequency for the area associated with the River Corridor RI/FS investigations. The resulting networks of wells will be used to collect groundwater samples in support of the assessment of risk as part of the River Corridor RI/FS process.

Sampling Frequency

To capture baseline aquifer conditions, it is required that samples represent not only spatial variations but also changes that occur over time. Near the river, these varying conditions are observed as changes in groundwater flow, both direction and rate, causing temporary movement of contaminants through different portions of the unconfined aquifer. For areas bordering on the Columbia River, the changing aquifer conditions are caused by fluctuating river elevation associated with flood control and hydroelectric production. For representing baseline groundwater conditions, samples are required to represent these varying aquifer conditions associated with high, low and mid-point or transitional river elevations. To optimize collection of samples representing these temporal changes in groundwater conditions, the date and frequency of sample collection for 100-F is based on measurements of the river elevation.

For 100-IU-2/IU-6, which is primarily inland from the river, the river elevation changes do not directly influence groundwater level and thus, the sampling events are evenly spaced with the RI/FS sampling interval.

Proposed timing for the three spatial and temporal uncertainty groundwater monitoring sampling events in relation to river stages is discussed in the "Spatial and Temporal Groundwater Monitoring Sampling Dates" section below.

Effect of River Elevation on Groundwater Conditions

Along the Columbia River, rapid, periodic, or cyclic elevation fluctuations of the river occur in controlled response to flood conditions, hydroelectric production, and salmon spawning programs at a series of dams and reservoirs up river of the Hanford Site. These rapid elevation changes in the river cause periodic influences on flow conditions within the aquifer. For example, there are two times during a calendar year when the river elevation peaks and two times the river elevation is low. The peak with the highest river elevation occurs in early June when water is released from reservoirs that have reached capacity from the melting snow pack in the Cascade Mountains. The lowest river elevation is engineered in late September to early October to encourage salmon spawning in low pockets of the river bottom along the Columbia Reach. Another smaller secondary peak in river elevation occurs late December to January as reservoirs release water held back in the fall to achieve the low fall river elevation. Then the reservoirs are drained, resulting in a secondary low that occurs in March. Reservoir levels are now ready to accept the large volume of melt water from the winter's snow pack.

When sufficient water is released up river, the river elevation rises above the elevation of the local aquifer causing movement of water from the river into the aquifer. At this time, the flow direction in the aquifer is modified from the ambient condition and varies with local conditions along the river. This flow from the river brings cleaner river water into the groundwater causing a temporary reduction in contaminant levels in monitoring wells near the river.

When the river elevation is artificially lowered to a level below the aquifer by holding water back in the up river reservoirs, groundwater moves from the aquifer into the river. The river is then recharging from the aquifer causing a change in the flow direction to roughly perpendicular to the river's edge, once again varying with specific locations along the river. These changes in direction may bring contaminated groundwater through observation wells at certain places and into the river. Thus, locally near the river-groundwater interface, the flow direction and rate change with time. The effect on aquifer conditions is greatest when the river peaks in June and, again, at its lowest level in late September to early October. To capture the effects on contaminant plumes within the aquifer from the low river elevation, spatial and temporal uncertainty sampling should be conducted prior to late October.

Inland from the river, the rapid river elevation changes form a pressure pulse that appears to be transmitted along the free surface of the unconfined aquifer. This effect causes small groundwater elevation changes in wells not affected by actual movement of aquifer water. For some places within known plumes, the elevation increase may allow the groundwater to interact with contaminated soils located just above the water table. The timing of these periodic or cyclic river elevation changes determines the sampling frequency required to represent the temporal variations in groundwater conditions.

Spatial and Temporal Uncertainty Groundwater Monitoring Sampling Dates

100-F. Because the goal is to determine groundwater conditions when the river has the maximum effect on flow rate and direction, spatial and temporal uncertainty groundwater sampling is scheduled for late May to mid-June during the highest peak and from mid-September to late October during the time of the lowest elevation. From mid-June to mid-September, the river elevation is in transition, decreasing from the maximum elevation to the lowest elevation. Also from February through April, elevations are decreasing from a secondary high in January to the secondary low approximately in April. Consequently,

the best opportunity to capture transitional conditions occurs during the months from February to April or from July through August.

Based on the previous discussion, three sampling events are recommended to represent the temporal fluctuations in groundwater conditions at each of areas located along the river corridor. One sampling event captures the effect on the aquifer when the river stage is highest during May and June and the greatest increase in aquifer elevation occurs. The second sampling interval ranges from mid-September to mid-October when the river is at the lowest elevation for the year. This time period is when contamination from the aquifer might be affecting the river. The third sampling point represents the mid-point or transitional aquifer conditions occurring from either February through April or July through August. Thus, the groundwater sampling schedules developed in support of the spatial and temporal uncertainty groundwater investigation for the RI/FS at each area along the river captures the maximum effects of changing river elevations on aquifer conditions along with the transitional time between the maximum and minimum changing conditions.

100-IU-2/IU-6. The 100-IU-2/IU-6 area is located primarily within the 600 Area. Thus the variations in river elevation do not directly affect groundwater conditions for this network of wells. Consequently, the sampling events for the IU-2/IU-6 network are evenly spaced within the allowed RI/FS sampling interval. Although a sampling of a few wells is scheduled to allow for co-sampling with other projects, the entire network should be sampled within 30 consecutive days,

3.6 Sampling Methods

Soil/aquifer sediment sampling will be performed in accordance with approved procedures for soil and aquifer sediment sampling using a 10.2-cm (4-in.) split-spoon sampler. The split-spoon samplers will be equipped with separate stainless steel or polycarbonate liners. Site personnel will not overdrive the sampling device. Samples for VOCs will be packaged first. Next, the remaining soil/aquifer sediment will be transferred to a pre-cleaned, stainless steel mixing bowl or other suitable pre-cleaned container, homogenized, then containerized in accordance with the sampling procedure. If sample volume requirements cannot be met, samples will be collected according to the following priority: strontium-90, hexavalent chromium, metals (including mercury and uranium), batch leach test, tritium, technetium-99, other radionuclides, PCBs, and hydraulic properties.

Groundwater samples collected during drilling, before development, will be pumped from selected intervals. The pump will be operated long enough to provide stabilized field readings, but not necessarily three casing volumes.

For the spatial and temporal groundwater monitoring well network, before sample capture, the pump will be operated long enough to provide stabilized field readings, and at least three casing volumes.

3.6.1 Corrective Actions and Deviations for Sampling Activities

The project lead, sampling lead, drilling lead, or designee, must document deviations from procedures or other problems pertaining to sample collection, chain-of-custody, target analytes, COPCs, sample transport, or noncompliant monitoring. Examples of deviations include samples not collected because of field conditions, changes in sample locations because of physical obstructions, or additions of sample depth(s).

As appropriate, such deviations or problems will be documented in the field logbook or on nonconformance report forms in accordance with internal corrective action procedures. The project lead, sampling lead, drilling lead, or designee will be responsible for communicating field corrective action requirements and for ensuring immediate corrective actions are applied to field activities.

More significant changes in sample locations not affecting the data needs will require notification and approval of the project lead. Changes to sample locations resulting in impacts to meeting the data needs will require concurrence with DOE and regulatory project leads. Changes to the SAP will be documented as noted in Section 2.1.6.

3.6.2 Decontamination of Sampling and Drilling Equipment

Sampling equipment will be decontaminated in accordance with the sampling equipment decontamination procedure. To prevent contamination of the samples, care should be taken to use clean equipment for each sampling activity. Special care should be taken to avoid the following common ways in which cross-contamination or background contamination may compromise the samples.

- Improperly storing or transporting sampling equipment and sample containers
- Contaminating the equipment or sample container by setting the equipment and/or sample container 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. Field decontamination (e.g., field washing and reuse) is not appropriate for sampling equipment.

The drill rig derrick, all downhole equipment, and temporary casing will be field decontaminated (e.g., high pressure and temperature wash), at a minimum, before mobilization and demobilization at each drilling location.

3.6.3 Radiological Field Data

Alpha and beta/gamma data collection in the field will be used as needed to support sampling and analysis efforts. Generally, cuttings from boreholes (excluding slough) will be field screened for evidence of radiological contamination. Screening will be conducted visually and with field instruments. Radiological screening will be performed by the radiological control technician or other qualified personnel. The radiological control technician will record field measurements, noting the depth of the sample and the instrument reading. Measurements will be relayed to the field geologist for inclusion into the field logbook or operational records daily, as applicable.

The following information will be distributed to personnel performing work in support of this SAP.

- Instructions to radiological control technicians on the methods required to measure sample activity and media for gamma, alpha, and/or beta emissions, as appropriate.
- Information regarding the Geiger-Müller, portable alpha meter, dual phosphors beta/gamma, and sodium iodide portable instruments, will include a physical description of the instruments, radiation and energy response characteristics, calibration/maintenance and performance testing descriptions, and the application/operation of the instrument. These instruments are commonly used on the Hanford Site for obtaining measurements of removable surface contamination measurements and direct measurements of the total surface contamination.

- Information on the characteristics associated with the hand-held probes to be used in the performance of direct radiological measurements will include a physical description of the probe, the radiation and energy response characteristics, calibration/maintenance, and performance testing descriptions, and the application/operation of the instrument. The hand-held probe is an alpha detection instrument commonly used on the Hanford Site for obtaining removable surface contamination measurements and direct measurements of the total surface contamination.

3.7 Sample Handling

Sampling handling, including sample containers, container labeling, sample custody, and sample transportation, is discussed in this section.

3.7.1 Sample Containers

Level I EPA pre-cleaned sample containers will be used for soil/aquifer sediment and water samples collected for chemical analysis. Container sizes may vary depending on laboratory specific volumes and requirements for meeting analytical detection limits. Radiological Engineering will measure the contamination levels and dose rates associated with the sample containers. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria. If the dose rate on the outside of a sample container or the curie content exceeds levels acceptable by an offsite laboratory, the sampling lead, in consultation with Sample Management and Reporting, can send smaller volumes to the laboratory. Preliminary container types and volumes are identified in Tables 3-4 and 3-5.

Table 3-4. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size ^a
Gamma energy analysis	None	6 months	G/P	750 g
Liquid scintillation counter	None	6 months	G	33 g
Strontium-90	None	6 months	G/P	5 g
Isotopic – Plutonium	None	6 months	G/P	5 g
Isotopic – Uranium	None	6 months	G/P	5 g
UKPA	None	6 months	G/P	5 g
Americium-241/Curium-244	None	6 months	G/P	5 g
EPA 6010	Cool ~4°C	6 months	G/P	15 g
EPA 7196	Cool ~4°C	30 days	G/P	50 g
EPA 7471	None	28 days	G/P	15 g
EPA 8081	Cool ~4°C	14/40 days	aG	120 g
EPA 8082	Cool ~4°C	14/40 days	aG	50 g
EPA 8260 ^b	Cool ~4°C	14 days	G	50 g
EPA 300.0	Cool ~4°C	48 hours/ 28 days	G/P	50 g
ASTM D422-63	None	None	G/P	1,000 g

Table 3-4. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size ^a
ASTM D2216-05	None	None	Moisture-proof container	200 g
ASTM D2937-04	None	None	G/P	1,000 g
ASTM D2434-68	None	None	P	1,000 g
ASTM D5084-03	None	None	P	1,000 g
Batch leaching test	Cool -4°C	28 days from field to extraction	G	100 g/120 mL
Distribution coefficient	Cool -4°C	—	Moisture-proof container	250 g

Notes:

For the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*.

ASTM D422-63, *Standard Test Method for Particle-Size Analysis of Soils*.

ASTM D2216-05, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*.

ASTM D2434-68, *Standard Test Method for Permeability of Granular Soils (Constant Head)*.

ASTM D2937-04, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.

ASTM D5084-03, *Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter*.

- a. Based on minimum QC requirements.
- b. Field preservation EPA 5035A also may be used.

14/40 days = 14 days to extraction, then 40 days to analysis

48 hours/28 days = 48 hours for nitrate, nitrite, and phosphate; others, 28 days

aG = amber glass

G = glass

P = plastic

UKPA = total uranium by kinetic phosphorescence analysis

Table 3-5. Sample Preservation, Container, and Holding Time for Water Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size*
Iodine-129 – Low Level	None	6 months	G/P	2000 mL
Strontium-90	HNO ₃ to pH <2	6 months	G/P	2000 mL
Liquid scintillation counter – Tritium	None	6 months	G	60 mL
Gas flow proportional counting	HNO ₃ to pH < 2	6 months	G/P	1,000 mL

Table 3-5. Sample Preservation, Container, and Holding Time for Water Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size*
Gamma Energy Analysis	HNO ₃ to pH < 2	6 months	G/P	500 mL
Isotopic – Plutonium	None	6 months	G/P	2,000 mL
Isotopic – Thorium	None	6 months	G/P	2,000 mL
Americium-241/Curium-244	HNO ₃ to pH < 2	6 months	G/P	500 mL
EPA 6020 or 200.8	HNO ₃ to pH <2	6 months	G/P	300 mL
EPA 6010	HNO ₃ to pH <2	6 months	G/P	300 mL
EPA 7196	Cool ~4°C	24 hours	aG	500 mL
EPA 7470 or 200.8	HNO ₃ to pH <2	28 days	G	500 mL
WTPH-D	Cool~4 C (~39°F) HCl to pH < 2	14/40 days	aG	3,000 mL
EPA 8260	Cool ~4°C, HCl or H ₂ SO ₄ to pH <2	14 days	aGs	40 mL
EPA 300.0	Cool ~4°C	48 hours/28 days	P	125 mL

Notes:

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 the four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*.

* Based on minimum QC requirements.

48 hours/28 days = 48 hours for nitrate, nitrite, and phosphate; others, 28 days.

aG = amber glass

aGs = amber glass septum; no headspace

G = glass

P = plastic

TPH-D = Northwest total petroleum hydrocarbon – diesel

3.7.2 Container Labeling

The sample location, depth, and corresponding HEIS number are documented in the sampler's field logbook. A custody seal (e.g., evidence tape) is affixed to each sample container and/or the sample collection package in such a way as to indicate potential tampering. Each sample container will be labeled with the following information on firmly affixed, water resistant labels:

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

In addition to the above information, sample records must include the following:

- Analysis required
- Source of sample
- Matrix
- Field data (e.g., pH, radiological readings)

Except for VOC samples, a custody seal (i.e., evidence tape) will be affixed to the lid of each sample container. The custody seal will be inscribed with the sampler's initials and the date. Custody seals are not applied directly to VOC sample vials because of a potential for affecting analytical results and/or fouling of laboratory equipment. Custody seals and any other required labels or documentation can be fixed to the exterior of a sample container holding the vials in such a manner to detect potential tampering.

3.7.3 Sample Custody Requirements

Sample custody will be maintained in accordance with existing Hanford Site protocols to maintain sample integrity throughout the analytical process. Chain-of-custody procedures will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained. A chain-of-custody record will be initiated in the field at the time of sampling and will accompany each set of samples shipped to any laboratory. Shipping requirements will determine how sample shipping containers are prepared for shipment. The analyses requested for each sample will be indicated on the accompanying chain-of-custody form. Each time the responsibility changes for the custody of the sample, the new and previous custodians will sign the record and note the date and time. The sampler will make a copy of the signed record before sample shipment and will transmit the copy to Sample Management and Reporting within 48 hours of shipping.

The following information is required on a completed chain-of-custody form:

- Project name
- Signature of sampler
- Unique sample number
- Date and time of collection
- Matrix
- Preservatives
- Signatures of individual involved in sample transfer
- Requested analyses or reference thereto

3.7.4 Sample Transportation

Sample transportation will be in compliance with the applicable regulations for packaging, marking, labeling, and shipping hazardous materials, hazardous substances, and hazardous waste mandated by the U.S. Department of Transportation (49 CFR 171, "General Information, Regulations, and Definitions," through Part 177, "Carriage By Public Highway") in association with the International Air Transportation Authority, DOE requirements, and applicable program specific implementing procedures.

3.8 Management of Waste

All waste (including unexpected waste) generated by sampling activities will be managed in accordance with DOE/RL-2004-31, *Waste Control Plan for the 100-FR-3 Operable Unit*. Pursuant to 40 CFR 300.440, "National Oil and Hazardous Substances Pollution Contingency Plan," "Procedures for Planning and Implementing Off-Site Response Actions," approval from the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) lead agency Remedial Project Manager is required before returning unused samples or waste from offsite laboratories.

4 Health and Safety

Field operations will be performed in accordance with health and safety requirements and appropriate Soil and Groundwater Remediation Project requirements. Additionally, 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.

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5 References

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Appendix A

Analyte Lists for Method-Based Analyses

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A1 Analyte Lists for Method-Based Analyses

Tables A-1 through A-8 provide the lists of analytes that will be reported when using a methods-based approach.

A2 References

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Table A-1. U.S. Environmental Protection Agency Method 300.0

CAS No.	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
24959-67-9	Bromide	250	2,500	≤20/≤30	80-120/70-130
16887-00-6	Chloride	200	2,000	≤20/≤30	80-120/70-130
16984-48-8	Fluoride	500	5,000	≤20/≤30	80-120/70-130
14797-55-8	Nitrate	250	2,500	≤20/≤30	80-120/70-130
14797-65-0	Nitrite	250	2,500	≤20/≤30	80-120/70-130
NO3-N	Nitrogen in nitrate	75	750	≤20/≤30	80-120/70-130
NO2-N	Nitrogen in nitrite	75	750	≤20/≤30	80-120/70-130
14265-44-2	Phosphate	500	5,000	≤20/≤30	80-120/70-130
14808-79-8	Sulfate	500	5,000	≤20/≤30	80-120/70-130

Notes:

EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes*.

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-2. U.S. Environmental Protection Agency SW-846 Method 6010

CAS No.	Constituent	Water EQL ($\mu\text{g/L}$)	Soil EQL ($\mu\text{g/kg}$)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
7429-90-5	Aluminum	50	5,000	$\leq 20/\leq 30$	80-120/70-130
7440-36-0	Antimony	60	6,000	$\leq 20/\leq 30$	80-120/70-130
7440-38-2	Arsenic	100	10,000	$\leq 20/\leq 30$	80-120/70-130
7440-39-3	Barium	20	2,000	$\leq 20/\leq 30$	80-120/70-130
7440-41-7	Beryllium	2	500	$\leq 20/\leq 30$	80-120/70-130
7440-69-9	Bismuth	100	10000	$\leq 20/\leq 30$	80-120/70-130
7440-42-8	Boron	20	2,000	$\leq 20/\leq 30$	80-120/70-130
7440-43-9	Cadmium	2	500	$\leq 20/\leq 30$	80-120/70-130
7440-70-2	Calcium	1,000	100,000	$\leq 20/\leq 30$	80-120/70-130
7440-47-3	Chromium	10	1,000	$\leq 20/\leq 30$	80-120/70-130
7440-48-4	Cobalt	4	2,000	$\leq 20/\leq 30$	80-120/70-130
7440-50-8	Copper	8	1,000	$\leq 20/\leq 30$	80-120/70-130
7439-89-6	Iron	50	5,000	$\leq 20/\leq 30$	80-120/70-130
7439-92-1	Lead	50	5,000	$\leq 20/\leq 30$	80-120/70-130
7439-93-2	Lithium	25	2,500	$\leq 20/\leq 30$	80-120/70-130
7439-95-4	Magnesium	750	75,000	$\leq 20/\leq 30$	80-120/70-130
7439-96-5	Manganese	5	5,000	$\leq 20/\leq 30$	80-120/70-130
7439-98-7	Molybdenum	20	2,000	$\leq 20/\leq 30$	80-120/70-130
7440-02-0	Nickel	40	4,000	$\leq 20/\leq 30$	80-120/70-130
7440-09-7	Potassium	4,000	400,000	$\leq 20/\leq 30$	80-120/70-130
7782-49-2	Selenium	100	10,000	$\leq 20/\leq 30$	80-120/70-130
7440-21-3	Silicon	20	2,000	$\leq 20/\leq 30$	80-120/70-130
7440-22-4	Silver	10	1,000	$\leq 20/\leq 30$	80-120/70-130
7440-23-5	Sodium	500	50,000	$\leq 20/\leq 30$	80-120/70-130
7440-24-6	Strontium (elemental)	10	1,000	$\leq 20/\leq 30$	80-120/70-130
7440-28-0	Thallium	50	5,000	$\leq 20/\leq 30$	80-120/70-130
7440-31-5	Tin	100	10,000	$\leq 20/\leq 30$	80-120/70-130
7440-62-2	Vanadium	25	2,500	$\leq 20/\leq 30$	80-120/70-130
7440-66-6	Zinc	10	1,000	$\leq 20/\leq 30$	80-120/70-130

Notes:

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

CAS = Chemical Abstracts Service

 $\mu\text{g/kg}$ = micrograms per kilogram

EQL = estimated quantitation limit

 $\mu\text{g/L}$ = micrograms per liter

Table A-3. U.S. Environmental Protection Agency Method 200.8 or SW-846 Method 6020

CAS No.	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
7440-36-0	Antimony	5	600	≤20/≤30	80-120/70-130
7440-38-2	Arsenic	4	1,000	≤20/≤30	80-120/70-130
7440-39-3	Barium	5	500	≤20/≤30	80-120/70-130
7440-41-7	Beryllium	2	200	≤20/≤30	80-120/70-130
7440-43-9	Cadmium	2	200	≤20/≤30	80-120/70-130
7440-47-3	Chromium	2	200	≤20/≤30	80-120/70-130
7439-92-1	Lead	2	500	≤20/≤30	80-120/70-130
7782-49-2	Selenium	4	1,000	≤20/≤30	80-120/70-130
7440-22-4	Silver	2	200	≤20/≤30	80-120/70-130
7440-28-0	Thallium	2	500	≤20/≤30	80-120/70-130

Notes:

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

For EPA Method 200.8, see EPA-600/R-94-111, *Methods for the Determination of Metals in Environmental Samples, Supplement 1*.

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-4. U.S. Environmental Protection Agency SW-846 Method 8081

CAS No.	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
72-54-8	4,4'-DDD	0.1	3.3	≤20/≤30	80-120/70-130
72-55-9	4,4'-DDE	0.1	3.3	≤20/≤30	80-120/70-130
50-29-3	4,4'-DDT	0.1	3.3	≤20/≤30	80-120/70-130
309-00-2	Aldrin	0.05	1.65	≤20/≤30	80-120/70-130
319-84-6	alpha-BHC	0.05	1.65	≤20/≤30	80-120/70-130
5103-71-9	alpha-Chlordane	0.5	16.5	≤20/≤30	80-120/70-130
319-85-7	beta-BHC	0.05	1.65	≤20/≤30	80-120/70-130
57-74-9	Chlordane	0.5	16.5	≤20/≤30	80-120/70-130
319-86-8	delta-BHC	0.05	1.65	≤20/≤30	80-120/70-130
60-57-1	Dieldrin	0.05	3.3	≤20/≤30	80-120/70-130
959-98-8	Endosulfan I	0.05	1.65	≤20/≤30	80-120/70-130
33213-65-9	Endosulfan II	0.1	3.3	≤20/≤30	80-120/70-130
1031-07-8	Endosulfan sulfate	0.1	3.3	≤20/≤30	80-120/70-130
72-20-8	Endrin	0.1	3.3	≤20/≤30	80-120/70-130
7421-93-4	Endrin aldehyde	0.1	3.3	≤20/≤30	80-120/70-130
53494-70-5	Endrin ketone	0.1	3.3	≤20/≤30	80-120/70-130
58-89-9	gamma-BHC (Lindane)	0.05	1.65	≤20/≤30	80-120/70-130
76-44-8	Heptachlor	0.05	1.65	≤20/≤30	80-120/70-130
1024-57-3	Heptachlor epoxide	0.05	1.65	≤20/≤30	80-120/70-130
72-43-5	Methoxychlor	0.5	16.5	≤20/≤30	80-120/70-130
8001-35-2	Toxaphene	2	165	≤20/≤30	80-120/70-130
5103-74-2	trans-Chlordane	0.5	16.5	≤20/≤30	80-120/70-130

Notes:

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

4,4'-DDD = Dichlorodiphenyldichloroethane

BHC = Benzenehexachloride

4,4'-DDE = Dichlorodiphenyldichloroethylene

CAS = Chemical Abstracts Service

4,4'-DDT = Dichlorodiphenyltrichloroethane

EQL = estimated quantitation limit

Table A-5. U.S. Environmental Protection Agency SW-846 Method 8082

CAS No.	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
12674-11-2	Aroclor-1016	0.5	16.5	≤20/≤30	80-120/70-130
11104-28-2	Aroclor-1221	0.5	16.5	≤20/≤30	80-120/70-130
11141-16-5	Aroclor-1232	0.5	16.5	≤20/≤30	80-120/70-130
53469-21-9	Aroclor-1242	0.5	16.5	≤20/≤30	80-120/70-130
12672-29-6	Aroclor-1248	0.5	16.5	≤20/≤30	80-120/70-130
11097-69-1	Aroclor-1254	0.5	16.5	≤20/≤30	80-120/70-130
11096-82-5	Aroclor-1260	0.5	16.5	≤20/≤30	80-120/70-130
37324-23-5	Aroclor-1262	0.5	16.5	≤20/≤30	80-120/70-130
11100-14-4	Aroclor-1268	0.5	16.5	≤20/≤30	80-120/70-130

Notes:

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-6. U.S. Environmental Protection Agency SW-846 Method 8260

CAS No.	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
71-55-6	1,1,1-Trichloroethane	5	5	≤20/≤30	80-120 / 70-130
79-34-5	1,1,2,2-Tetrachloroethane	5	5	≤20 / ≤30	80-120 / 70-130
79-00-5	1,1,2-Trichloroethane	2	5	≤20 / ≤30	80-120 / 70-130
75-34-3	1,1-Dichloroethane	2	10	≤20 / ≤30	80-120 / 70-130
75-35-4	1,1-Dichloroethene	10	10	≤20 / ≤30	80-120 / 70-130
107-06-2	1,2-Dichloroethane	5	5	≤20 / ≤30	80-120 / 70-130
540-59-0	1,2-Dichloroethene(total)	10	5	≤20 / ≤30	80-120 / 70-130
78-87-5	1,2-Dichloropropane	5	5	≤20 / ≤30	80-120 / 70-130
78-93-3	2-Butanone	10	10	≤20 / ≤30	80-120 / 70-130
591-78-6	2-Hexanone	20	20	≤20 / ≤30	80-120 / 70-130
108-10-1	4-Methyl-2-pentanone	10	10	≤20 / ≤30	80-120 / 70-130
67-64-1	Acetone	20	20	≤20 / ≤30	80-120 / 70-130

Table A-6. U.S. Environmental Protection Agency SW-846 Method 8260

CAS No.	Constituent	Water EQL (µg/L)	Soil EQL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
71-43-2	Benzene	1.5	5	≤20 / ≤30	80-120 / 70-130
75-27-4	Bromodichloromethane	5	5	≤20 / ≤30	80-120 / 70-130
75-25-2	Bromoform	5	5	≤20 / ≤30	80-120 / 70-130
74-83-9	Bromomethane	10	10	≤20 / ≤30	80-120 / 70-130
75-15-0	Carbon disulfide	5	5	≤20/≤30	80-120 / 70-130
56-23-5	Carbon tetrachloride	2	5	≤20 / ≤30	80-120 / 70-130
108-90-7	Chlorobenzene	5	5	≤20 / ≤30	80-120 / 70-130
75-00-3	Chloroethane	10	10	≤20 / ≤30	80-120 / 70-130
67-66-3	Chloroform	5	5	≤20 / ≤30	80-120 / 70-130
74-87-3	Chloromethane	10	10	≤20 / ≤30	80-120 / 70-130
156-59-2	cis-1,2-Dichloroethylene	5	5	≤20 / ≤30	80-120 / 70-130
10061-01-5	cis-1,3-dichloropropene	5	5	≤20 / ≤30	80-120/70-130
124-48-1	Dibromochloromethane	5	5	≤20 / ≤30	80-120 / 70-130
100-41-4	Ethylbenzene	5	5	≤20 / ≤30	80-120 / 70-130
75-09-2	Methylene chloride	5	5	≤20 / ≤30	80-120 / 70-130
100-42-5	Styrene	5	5	≤20 / ≤30	80-120 / 70-130
127-18-4	Tetrachloroethene	5	5	≤20 / ≤30	80-120 / 70-130
108-88-3	Toluene	5	5	≤20 / ≤30	80-120 / 70-130
156-60-5	trans-1,2-Dichloroethylene	5	5	≤20/30	80-120/70-130
10061-02-6	trans-1,3-Dichloropropene	5	5	≤20 / ≤30	80-120 / 70-130
79-01-6	Trichloroethene	1	5	≤20 / ≤30	80-120 / 70-130
75-01-4	Vinyl chloride	5	5	≤20 / ≤30	80-120 / 70-130
1330-20-7	Xylenes (total)	10	10	≤20 / ≤30	80-120 / 70-130

Notes:

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-7. Gamma Spectroscopy, Germanium High-Energy Detectors (Gamma Energy Analysis)

CAS No.	Constituent	Water EQL (pCi/L)	Soil EQL (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
14234-35-6	Antimony-125	50	0.3	≤30	70-130
13966-02-4	Beryllium-7	50	0.3	≤30	70-130
13967-70-9	Cesium-134	15	0.1	≤30%	70-130
10045-97-3	Cesium-137	15	0.1	≤30	70-130
10198-40-0	Cobalt-60	25	0.05	≤30	70-130
14683-23-9	Europium-152	50	0.1	≤30	70-130
15585-10-1	Europium-154	50	0.1	≤30	70-130
14391-16-3	Europium-155	50	0.1	≤30	70-130
13966-00-2	Potassium-40			≤30	70-130
13967-48-1	Ruthenium-106			≤30	70-130

Notes:

Where EQL is not specified, the EQLs attainable by the laboratories for the methods-based constituents using the same analytical conditions as for the contaminants of concern are applicable.

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-8. Isotopic Uranium

CAS No.	Constituent	Water EQL (pCi/L)	Soil EQL (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
13966-29-5	Uranium-234	1	1	≤30	70-130
15117-96-1	Uranium-235	1	0.5	≤30	70-130
U-238	Uranium-238	1	1	≤30	70-130

Notes:

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-9. Plutonium

CAS No.	Constituent	Water EQL (pCi/L)	Soil EQL (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
13981-16-3	Plutonium-238	1	1	≤30	70-130
PU-239/240	Plutonium-239/240	1	1	≤30	70-130

Notes:

CAS = Chemical Abstracts Service

EQL = estimated quantitation limit

Table A-10. Gross Alpha/Beta by Gas Proportional Flow Counting Method 900.0

Chemical Abstracts Service Number	Constituent	Water Estimated Quantitation Limit (pCi/L)	Soil Estimated Quantitation Limit (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
12587-46-1	Gross Alpha Activity	3	NA	≤30	70-130
12587-47-2	Gross Beta Activity	4	NA	≤30	70-130

Notes:

NA = not applicable

Distribution

	<u>MS</u>	<u>Quantity</u>
<u>U.S. Department of Energy, Richland Operations Office</u>		
K.M. Thompson	A6-38	60
DOE Public Reading Room	H2-53	1
 <u>CH2M HILL Plateau Remediation Company</u>		
J.V. Borghese	H3-21	10
 <u>Washington Closure Hanford, LLC</u>		
R.O. Ovink	H4-21	6
 <u>Pacific Northwest National Laboratory</u>		
J.S. Fruchter	K6-96	2
 <u>Administrative Record</u>		
	H6-08	1
 <u>Document Clearance</u>		
	H6-08	1

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