0088781

DOE/RL-2009-45
Revision 0

300 Area Remedial Investigation/Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2 and 300-FF-5 Operable Units

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

Attached to: 0088780 & 0088782

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Approval Page

Title: 300 Area Remedial Investigation/Feasibility Study Sampling and Analysis Plan for the 300-FF-1, 300-FF-2 and 300-FF-5 Operable Units

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U.S. Environmental Protection Agency

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Terms

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
CFR	*Code of Federal Regulations*
COPC	contaminant of potential concern
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
FS	feasibility study
HASQARD	*Hanford Analytical Services Quality Assurance Requirements Documents*
HEIS	Hanford Environmental Information System
PCB	polychlorinated biphenyl
PNNL	Pacific Northwest National Laboratory
PVC	polyvinyl chloride
QA	quality assurance
QAPjP	quality assurance project plan
QC	quality control
RCBRA	River Corridor Baseline Risk Assessment
RI	remedial investigation
RL	U.S. Department of Energy, Richland Operations Office
SAP	sampling and analysis plan
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
VOC	volatile organic compound
WAC	*Washington Administrative Code*

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1 Introduction

This sampling and analysis plan (SAP) is part of the remedial investigation (RI)/feasibility study (FS) work plan for the 300 Area. This SAP is a Tri-Party Agreement (Ecology et al., 1989a, *Hanford Federal Facility Agreement and Consent Order*) primary document. The 300 Area is located on the Hanford Site in southeastern Washington State and is associated with two source operable units: 300-FF-1 and 300-FF-2. The 300-FF-5 Groundwater Operable Unit underlies the two source 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 in the 300 Area within scope of this SAP. Figure 1-2 shows the spatial and temporal uncertainty groundwater monitoring well network within the scope of this SAP including both the 300 Area and 600 Area subregions. Table 1-1 presents the intersection between data needs discussed in DOE/RL-2009-30, *300 Area Remedial Investigation/Feasibility Study Work Plan for the 300-FF-1, 300-FF-2, and 300-FF-5 Operable Units* (work plan), and sampling and analysis activities. Chapter 2 of the work plan describes the site background and environmental setting of the 300 Area.

1.1 Vadose Zone Characterization

This SAP describes activities planned to characterize the vadose zone within the 300 Area. Groundwater wells installed as part of the work performed under the scope of this SAP also will have vadose zone soil samples collected during drilling. Samples will be collected and analyzed to evaluate the nature and extent of contamination. The following areas will be characterized:

- 316-2, North Process Pond
- 316-1, South Process Pond
- 316-5, 300 Area Process Trenches
- Perimeter Area
- Near River Area
- 618-10 Burial Ground
- 618-11 Burial Ground
- 316-4 Crib

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 wells will be performed in accordance with the field sampling, sample handling, and documentation activities requirements in DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD), Volumes 1 through 4. Where possible, new well locations and construction have been selected to satisfy multiple project data needs, such as delineating vadose zone and groundwater contamination.

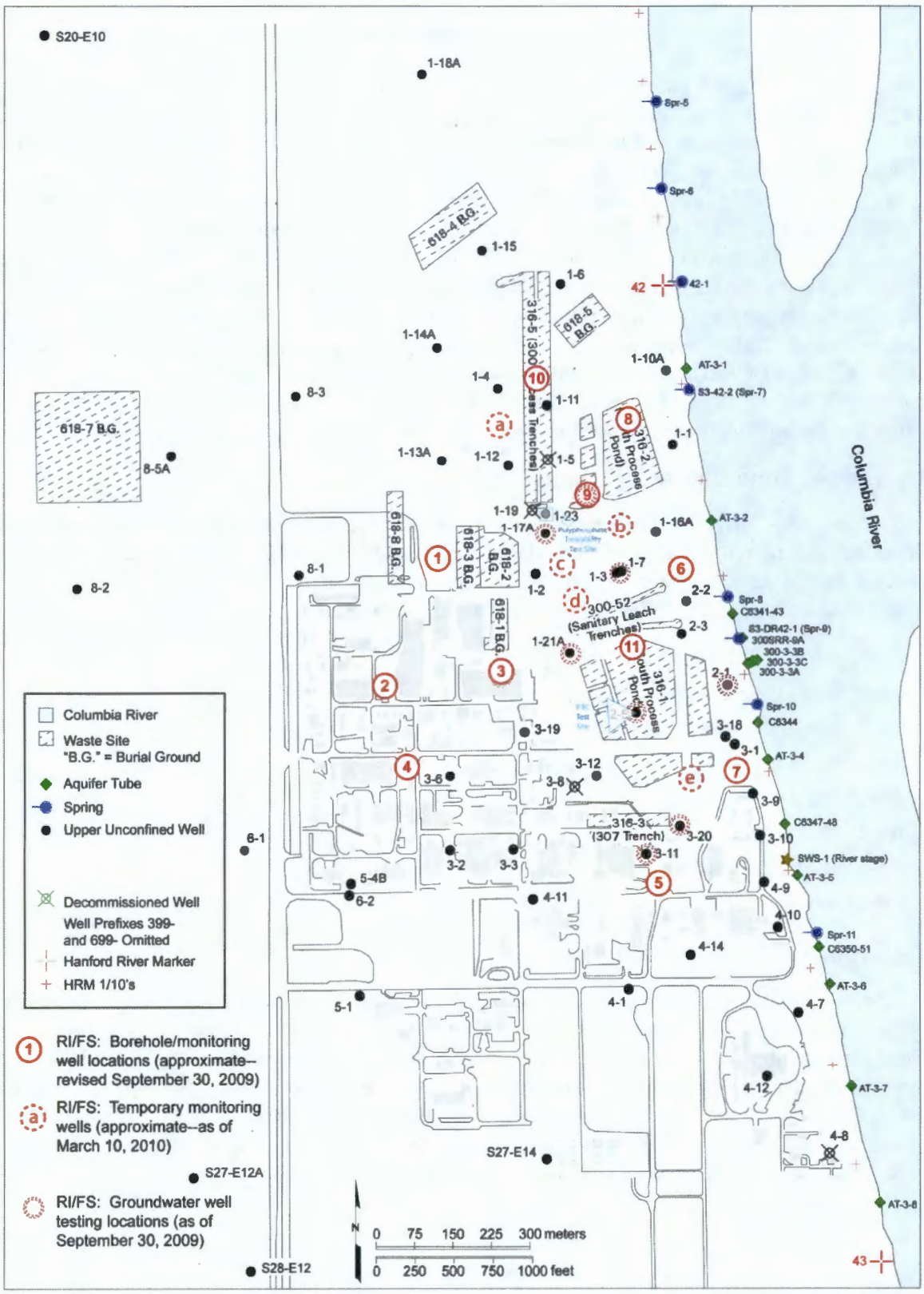

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Figure 1-1. 300 Area Planned and Existing Sampling Locations

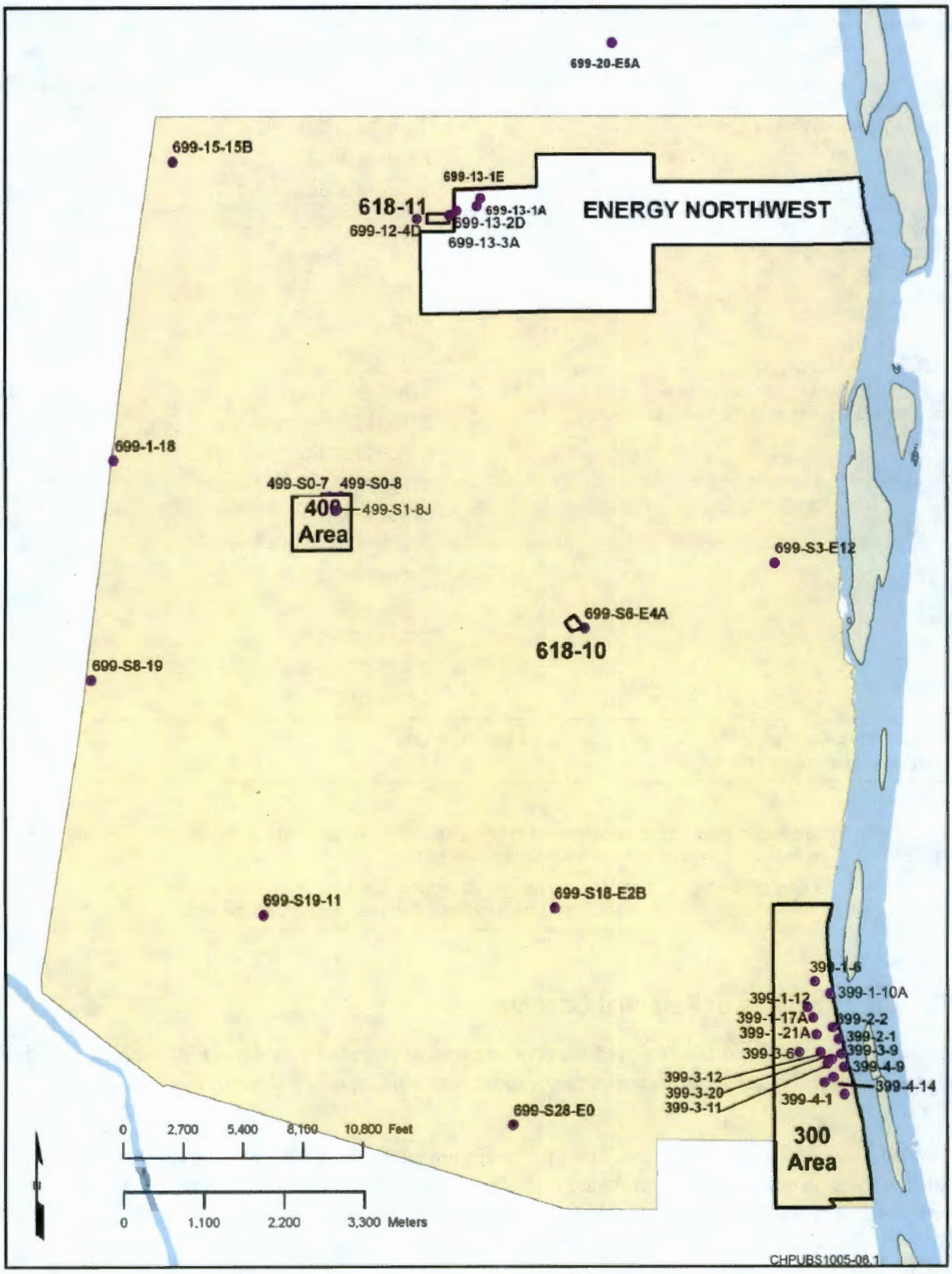


Figure 1-2. 300 Area Spatial and Temporal Uncertainty Monitoring Well Locations

Table 1-1. Plan Activities and Data Needs

Planned Activity	300 Area		Data Needs No.
	Quantity	Location	
New boreholes (vadose zone)*	3	Borehole 300-DU-VZ-1 Borehole 300-DU-VZ-2 Borehole 300-DU-VZ-3	32
New temporary wells to characterize vadose zone and unconfined aquifer*	5	RIFS-a RIFS-b RIFS-c RIFS-d RIFS-e	2, 7, 8, 14, 17
New wells to characterize vadose zone, unconfined aquifer, and the Ringold lower member*	11	C7657 (399-1-58) C7658 (399-6-3) C7659 (399-1-59) C7661 (399-6-4) C7662 (399-4-15) C7656 (399-1-57) C7663 (399-3-33) C7653 (399-1-54) C7654 (399-1-55) C7655 (399-1-56) C7660 (399-2-32)	2, 3, 4, 7, 8,10, 11, 13, 14, 17, 20, 26
Sample spatial and temporal uncertainty groundwater monitoring wells	33 existing locations		33

Notes:

This SAP is in addition to field activities described in DOE/RL-2008-27, Sampling and Analysis Plan for 618-10 and 618-11 Nonintrusive Sampling, and other planned activities.

* Boreholes and new 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.

1.3 Contaminants of Potential Concern

Samples will be collected and analyzed for contaminants of potential concern (COPCs) as described in this SAP. The following sections present the vadose zone soil, aquifer sediment, and groundwater COPC lists.

Sample results will be reported in the Hanford Environmental Information System (HEIS) database. The tables in the appendix 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*, Methods 8260 and 8270.

1.3.1 Soil and Aquifer Sediment

Table 1-2 presents the vadose zone soil COPCs. These lists may change depending on the results of verification sampling performed following remediation of the waste sites.

Only a subset of 300 Area vadose zone soil COPCs is identified for analysis during SAP implementation, based on relevant location- and process-specific data and information. Sample collection in the 400 Area subregion, although part of the 300 Area, is not required under the scope of this SAP. The subset of 300 Area-specific vadose zone soil COPCs to be analyzed is presented in Tables 2-2 and 2-3. In addition, batch leach testing of samples will also be performed in accordance with Tables 2-4 and 3-2.

Table 1-2. 300 Area Vadose Zone Soil COPCs

Radionuclides	Nonradionuclides	
Americium-241	1,1,1-Trichlorethane	Hexachlorobutadiene
Carbon-14	1,2-Dichloroethene (total)	Hexachloroethane
Cesium-137	Antimony	Hexavalent Chromium
Cobalt-60	Aroclor-1016 (PCB)	Lead
Europium-152	Aroclor-1221 (PCB)	Lithium
Europium-154	Aroclor-1232 (PCB)	Manganese
Europium-155	Aroclor-1242 (PCB)	Mercury
Iodine-129	Aroclor-1248 (PCB)	Methyl ethyl ketone
Nickel-63	Aroclor-1254 (PCB)	Methyl isobutyl ketone (hexone)
Plutonium-238	Aroclor-1260 (PCB)	Nickel
Plutonium-239/240	Arsenic	Nitrobenzene
Plutonium-241	Asbestos	Normal paraffin hydrocarbon (kerosene)
Strontium-90	Barium	Phenanthrene
Technetium-99	Benzene	Selenium
Tritium	Benzo(a)pyrene	Silver
Uranium-233/234	Beryllium	Sodium (metal)
Uranium-235	Bis(2-ethylhexyl)phthalate	Strontium
Uranium-238	Bismuth	Tetrachloroethene
	Butylbenzylphthalate	Thallium
	Cadmium	Tin
	Carbon tetrachloride	Toluene
	Chloroform	Total petroleum hydrocarbons
	Chromium (total)	Tributyl phosphate
	Chrysene	Trichloroethene
	cis-1,2-Dichloroethylene	Uranium (total)
	Copper	Vanadium
	Cyanide	Vinyl chloride
	Ethyl acetate	Xylene
	Ethylene glycol	Zinc

Note:

PCB = polychlorinated biphenyl

The samples collected as part of the work performed under the scope of this SAP will be analyzed for additional analytes, as presented in Tables 2-2 through 2-3, to fulfill specific data needs as identified in the work plan.

Table 1-3 presents the aquifer sediment COPCs. The aquifer sediment samples will be analyzed for COPCs and additional analytes as presented in Table 2-5. In addition, batch leach testing of samples will also be performed in accordance with Tables 2-4 and 3-2.

Table 1-3. 300 Area Subregion Aquifer Sediment COPCs

Radionuclides	Nonradionuclides	
Strontium-90	1,2-Dichloroethene (total)	Mercury
Tritium	Antimony	Nickel
Uranium-233/234	Arsenic	Nitrate (as Nitrogen)
Uranium-235	Cadmium	Nitrite (as Nitrogen)
Uranium-238	Carbon tetrachloride	Selenium
	Chloroform	Silver
	Chromium	Sulfate
	cis-1,2-Dichloroethene	Tetrachloroethene
	Cobalt	Thallium
	Copper	Trichloroethene
	Cyanide	Uranium
	Fluoride	Vinyl Chloride
	Lead	Zinc
	Manganese	

1.3.2 Groundwater

Tables 1-4 and 1-5 present the groundwater COPCs for the 300 and 600 Area subregions, respectively. Chapter 4 of the work plan presents the approach used for development of the COPCs.

Table 1-4. 300 Area Subregion Groundwater COPCs

Radionuclides	Nonradionuclides	
Strontium-90	1,2-Dichloroethene (total)	Mercury
Tritium	Antimony	Nickel
Uranium-233/234	Arsenic	Nitrate (as Nitrogen)
Uranium-235	Cadmium	Nitrite (as Nitrogen)
Uranium-238	Carbon tetrachloride	Selenium
	Chloroform	Silver
	Chromium	Sulfate
	cis-1,2-Dichloroethene	Tetrachloroethene
	Cobalt	Thallium
	Copper	Trichloroethene
	Cyanide	Uranium
	Fluoride	Vinyl Chloride
	Lead	Zinc
	Manganese	

Table 1-5. 600 Area Subregion Groundwater COPCs

Radionuclides	Nonradionuclides	
Iodine-129	Antimony	Nitrate (as Nitrogen)
Strontium-90	Arsenic	Nitrite (as Nitrogen)
Tritium	Cadmium	Sulfate
	Carbon tetrachloride	Tetrachloroethene
	Chromium	Tributyl phosphate
	Copper	Trichloroethene
	Fluoride	Uranium
	Lead	Vinyl Chloride
	Manganese	Zinc
	Nickel	

1.4 Data Needs

Chapter 1 of the work plan (DOE\RL-2009-30) describes the systematic planning process used to identify the 300 Area data gaps. The problem statement definition was covered in the systematic planning process. The work plan provides the systematic planning process and resultant data needs outcomes for the 300 Area.

1.5 Sampling Design

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

1.6 Project Schedule

The 300 Area RI field efforts are scheduled to occur between April 2010 and March 2011. The borehole and groundwater well installation schedule will be prepared by the drilling lead. Samples for a spatial and temporal uncertainty groundwater sample round, or event, will be collected from each a seasonal "high" water level, a seasonal "low" water level, and a "mid-point" water level, for a total of three samples per well. Each round of groundwater monitoring in the network of spatial and temporal groundwater monitoring wells for the 300 Area will be completed within the shortest interval of time that logistics permit, to minimize statistical variability in water levels. The RI Report will document the results provided by sampling and analysis in this plan.

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. The work performed under this QAPjP is conducted in accordance with:

- DOE/RL-96-68 (HASQARD)
- DOE O 414.1C, *Quality Assurance*
- 10 CFR 830, 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 QA/R-5 (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, the following reference also was used as a resource for identification of QAPjP elements:

- 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).

The UFP-QAPP Manual (EPA-505-B-04-900A) is not imposed through the Tri-Party Agreement. 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 the implementation of the project and associated QA/QC activities. The purpose of assessment is to ensure that the QAPjP is implemented as prescribed.

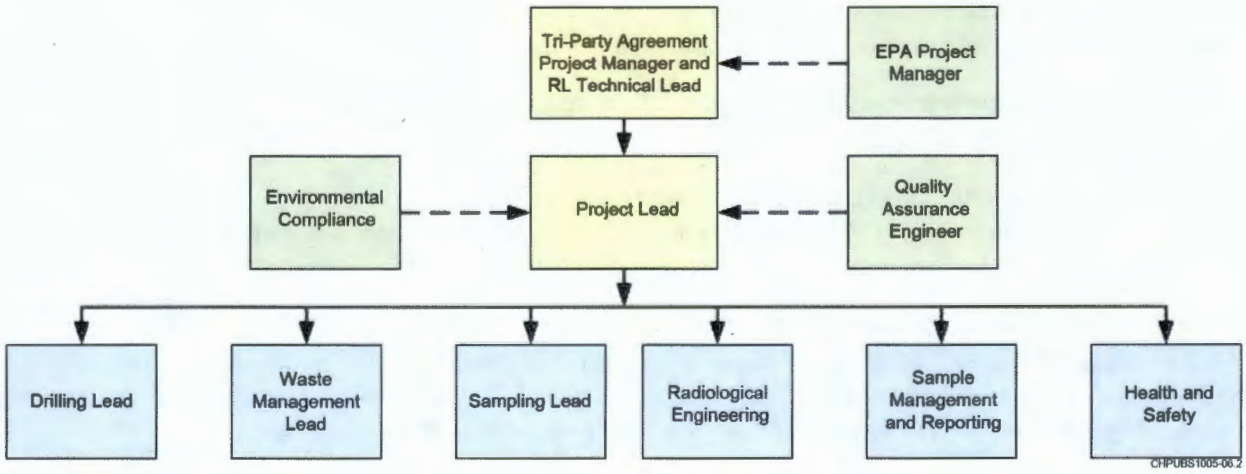
Section 2.4 Data Validation and Usability – This section addresses the QA activities occurring after the data collection or generation phase of the project is completed. Implementing these elements ensures that data conform to the specified criteria, thus achieving the project objectives.

2.1 Project Management

The following sections address the basic aspects of project management, ensuring 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 this SAP.

2.1.1 Project and Task Organization

The Plateau Remediation Contractor and River Corridor 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, regarding sampling and characterization, also shown graphically 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).



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 the 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 300 Area. The Tri-Party Agreement Project Manager also is 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/regulatory issues or concerns raised by RL and/or 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 that 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 and/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/or 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, the 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. In addition, 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.

The Sample Management and Reporting organization also is responsible for performing the data needs process, or equivalent. Additional related responsibilities include developing 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/Background

This SAP describes the sampling and analysis to be performed associated with boreholes and groundwater monitoring wells. The work plan provides the specific problems to be solved, background information, and general information. Media to be sampled include groundwater, 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. The regulatory drivers and references to agreement documents for the activity are provided in the work plan.

2.1.3 Project/Task Description

Chapter 3 presents the field sampling plan. Tables 1-2 through 1-5 present the COPCs for vadose zone soil, aquifer sediment, and groundwater. 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, quantitative target limits, and levels of effort for assessing data quality are dictated by the intended use of the data and the nature of the analytical method. 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 and 2-3 present analytical performance requirements for vadose zone soil samples based on site-specific lists derived from the COPC list in Table 1-2. Table 2-5 presents analytical performance requirements for aquifer sediment samples for the COPCs listed in Table 1-3. Table 2-4 presents batch leach requirements for vadose zone soil and aquifer sediment samples. Tables 2-6 through 2-8 present analytical performance requirements for water samples based on the COPCs listed in Tables 1-4 and 1-5. The appendix tables provide the full list of analytes reported for each multi-constituent analytical method in this SAP. Laboratory operations and analytical services will be in compliance with Volume 4 of HASQARD and specific criteria identified in Tables 2-2 through 2-8. The criteria listed 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 as or better than the replaced method, and the new method is required due to the nature of the sample (e.g., high radioactivity).

The preliminary cleanup goals listed in Tables 2-2 and 2-3 are associated with different depths below ground surface. For vadose zone soils or debris in the top 4.5 m (15 ft) below ground surface (bgs), cleanup will be achieved when contaminant concentrations are demonstrated to be less than or equal to the direct contact cleanup levels within the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* risk range of 10^{-4} to 10^{-6} (operationally equivalent to a dose of 15 mrem/yr), and contaminant concentrations meet cleanup levels that provide protection to groundwater and the Columbia River. For vadose zone soil or debris below 4.5 m (15 ft) bgs, direct exposure/direct contact are not applicable; however, cleanup levels protective of groundwater and the Columbia River must be met.

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

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, 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 any field work.

Table 2-1. Data Quality Indicators

Data Quality Indicator	Definition	Example Determination Methodologies	Project-Specific Information*	Corrective-Action Examples
Precision	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. 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).	Use the same analytical instrument to make repeated analyses on the same sample. 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. Split a sample in the field and submit both for sample handling, preservation and storage, and analytical measurements. Collect, process, and analyze co-located samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	Field precision: At randomly selected locations, duplicate samples will be collected 1 per 20 samples per media. Laboratory precision: Analysis of laboratory duplicate or matrix spike duplicate samples. One duplicate sample will be analyzed per sample set (i.e., group of samples collected from a media and analyzed using the same laboratory method), exclusive of batch leach testing and physical properties analyses, and as applicable to the method.	If duplicate data do not meet objective: • Evaluate apparent cause (e.g., sample heterogeneity) • Request reanalysis or re-measurement • Qualify the data before use
Accuracy	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.	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.	Laboratory accuracy determination based on matrix spike and matrix spike duplicate results.	If recovery does not meet objective: • Qualify the data before use • Request reanalysis or re-measurement
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 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.	If results are not representative of the system sampled: • Identify the reason the 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.	Sampling personnel will use the same sampling protocols. 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.	If data are not comparable to other data sets: • 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
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.	If data set does not meet completeness objective: • 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.	If sensitivity does not meet objective: • Request reanalysis or re-measurement • Qualify/reject the data before use

Notes:

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

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

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Table 2-2. Analytical Performance Requirements for Soil from Monitoring Wells

CAS	Analyte	QL	Preliminary Cleanup Goals[a]				Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Direct Exposure (residential)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
10198-40-0	Cobalt-60[c,d]	0.05 pCi/g	5.2 pCi/g	1.4 pCi/g	NV[e]	NV[e]	Gamma energy analysis	≤30[f]	70-130[f]
10045-97-3	Cesium-137[c,d]	0.1 pCi/g	25 pCi/g	6.2 pCi/g	NV[e]	NV[e]			
—	Plutonium-239/240[g]	1 pCi/g	245 pCi/g	35.1 pCi/g	NV[e]	NV[e]	Isotopic – Plutonium	≤30[f]	70-130[f]
14133-76-7	Technetium-99[c,g]	0.25 pCi/g	410,000 pCi/g	34.7 pCi/g	239 pCi/g	33.2 pCi/g	LSC – Technetium-99	≤30[f]	70-130[f]
10028-17-8	Tritium	10 pCi/g	1,980 pCi/g	711 pCi/g	5,360 pCi/g	746 pCi/g	LSC – Tritium	≤30[f]	70-130[f]
—	Uranium-233/234	1 pCi/g	167 pCi/g	27.2 pCi/g	127.4 pCi/g	17.9 pCi/g	Isotopic – Uranium	≤30[f]	70-130[f]
15117-96-1	Uranium-235	0.5 pCi/g	16 pCi/g	2.7 pCi/g	13.2 pCi/g	1.8 pCi/g			
—	Uranium-238	1 pCi/g	167 pCi/g	26.2 pCi/g	127.4 pCi/g	17.3 pCi/g			
Performance Requirements for Laboratory Measurements (nonradiological)									
7440-36-0	Antimony[c,d]	6 mg/kg[h]	1,400 mg/kg	32 mg/kg	5 mg/kg	5 mg/kg	EPA 6010 or 6020	≤30[i]	70-130[i]
7440-38-2	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	Barium	2 mg/kg	4,900 mg/kg	1,600 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	Beryllium[g]	0.5 mg/kg	104 mg/kg	10.4 mg/kg	1.51 mg/kg	1.51 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg	139 mg/kg	13.9 mg/kg	0.81 mg/kg	0.81 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	5,250,000 mg/kg	120,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-50-8	Copper	1 mg/kg	130,000 mg/kg	2,960 mg/kg	59.2 mg/kg	22.0 mg/kg			
7439-92-1	Lead	5 mg/kg	1,000 mg/kg	353 mg/kg	10.2 mg/kg	10.2 mg/kg			
7439-96-5	Manganese	5 mg/kg	165,000 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	70,000 mg/kg	1,600 mg/kg	19.1 mg/kg	27.4 mg/kg			
7782-49-2	Selenium[d,g]	10 mg/kg[h]	17,500 mg/kg	400 mg/kg	5 mg/kg	1 mg/kg			
7440-22-2	Silver[c,g]	1 mg/kg[h]	17,500 mg/kg	400 mg/kg	8 mg/kg	0.73 mg/kg			
7440-24-6	Strontium	1 mg/kg	2,100,000 mg/kg	48,000 mg/kg	960 mg/kg	NV			
7440-28-0	Thallium[j]	5 mg/kg[h]	245 mg/kg	NV	1.59 mg/kg	4.46 mg/kg			
7440-31-5	Tin[d]	10 mg/kg	2,100,000 mg/kg	48,000 mg/kg	960 mg/kg	NV			
7440-62-2	Vanadium	2.5 mg/kg	24,500 mg/kg	560 mg/kg	85.1 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	1,050,000 mg/kg	24,000 mg/kg	480 mg/kg	67.8 mg/kg			
7439-97-6	Mercury[d]	0.2 mg/kg	1,050 mg/kg	24 mg/kg	0.33 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	≤30[i]	70-130[i]
7440-61-1	Uranium (total)	1 mg/kg	505 mg/kg	81 mg/kg	53 mg/kg	106 mg/kg	UKPA or via Isotopic	≤30[i]	70-130[i]

Table 2-2. Analytical Performance Requirements for Soil from Monitoring Wells

CAS	Analyte	QL	Preliminary Cleanup Goals[a]				Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Direct Exposure (residential)	Groundwater Protection	River Protection			
141-78-6	Ethyl acetate[j]	5 mg/kg	3,150,000 mg/kg	NV	29.8 mg/kg	NV	EPA 8015 or 8260 (nonhalogenated volatile organics)	≤30[k]	70-130[k]
12674-11-2	Aroclor-1016 (PCB)[c,d]	0.017 mg/kg	65.6 mg/kg	0.5 mg/kg	0.017 mg/kg	0.017 mg/kg	EPA 8082 (PCB by GC)	≤30[k]	70-130[k]
11104-28-2	Aroclor-1221 (PCB)[c,d]	0.017 mg/kg	65.6 mg/kg	0.5 mg/kg	0.017 mg/kg	0.017 mg/kg			
11141-16-5	Aroclor-1232 (PCB)[c,d]	0.017 mg/kg	65.6 mg/kg	0.5 mg/kg	0.017 mg/kg	0.017 mg/kg			
53469-21-9	Aroclor-1242 (PCB)[c,d]	0.017 mg/kg	65.6 mg/kg	0.5 mg/kg	0.017 mg/kg	0.017 mg/kg			
12672-29-6	Aroclor-1248 (PCB)[c,d]	0.017 mg/kg	65.6 mg/kg	0.5 mg/kg	0.017 mg/kg	0.017 mg/kg			
11097-69-1	Aroclor-1254 (PCB)[c,d]	0.017 mg/kg	65.6 mg/kg	0.5 mg/kg	0.017 mg/kg	0.017 mg/kg			
11096-82-5	Aroclor-1260 (PCB)[c,d]	0.017 mg/kg	65.6 mg/kg	0.5 mg/kg	0.017 mg/kg	0.017 mg/kg			
71-55-6	1,1,1-Trichloroethane[g,j]	0.005 mg/kg	7,000,000 mg/kg	NV	1.58 mg/kg	3.17 mg/kg	EPA 8260 (volatile organics)	≤30[k]	70-130[k]
540-59-0	1,2-Dichloroethene (total)[d,j]	0.005 mg/kg	31,500 mg/kg	NV	0.360 mg/kg	0.700 mg/kg			
71-43-2	Benzene[c,d,j]	0.005 mg/kg[l]	2,390 mg/kg	NV	0.004 mg/kg	0.014 mg/kg			
56-23-5	Carbon Tetrachloride[d,g]	0.005 mg/kg[l]	1,010 mg/kg	7.69 mg/kg	0.0337 mg/kg	0.05 mg/kg			
156-59-2	cis-1,2-Dichloroethene[j]	0.005 mg/kg	35,000 mg/kg	NV	0.350 mg/kg	NV			
127-18-4	Tetrachloroethene[j]	0.005 mg/kg	35,000 mg/kg	NV	0.008 mg/kg	0.008 mg/kg			
108-88-3	Toluene[d,g]	0.005 mg/kg	28,000 mg/kg	6,400 mg/kg	64 mg/kg	1,360 mg/kg			
79-01-6	Trichloroethene[j]	0.005 mg/kg[l]	1,470 mg/kg	NV	0.003 mg/kg	0.090 mg/kg			
1330-20-7	Xylene (total)	0.01 mg/kg	700,000 mg/kg	16,000 mg/kg	160 mg/kg	NV			
117-81-7	bis(2-Ethylhexyl) phthalate[d]	0.33 mg/kg	9,380 mg/kg	71.4 mg/kg	0.6 mg/kg	0.36 mg/kg	EPA 8270 (semivolatiles)	≤30[k]	70-130[k]
50-32-8	Benzo(a)pyrene[c]	0.015 mg/kg	18 mg/kg	0.137 mg/kg	0.015 mg/kg	0.015 mg/kg	EPA 8310 (polynuclear aromatic hydrocarbons)	≤30[k]	70-130[k]
218-01-9	Chrysene[c]	0.1 mg/kg	1,800 mg/kg	13.7 mg/kg	0.12 mg/kg	0.1 mg/kg			
Performance Requirements for Target Analytes									
16887-00-6	Chloride	2 mg/kg	N/A	N/A	N/A	N/A	EPA 300.0 (anions by IC)	≤30[i]	70-130[i]
16984-48-8	Fluoride	5 mg/kg	N/A	N/A	N/A	N/A			
147-97-55-8	Nitrate (as Nitrogen)	2.5 mg/kg	N/A	N/A	N/A	N/A			
147-97-65-0	Nitrite (as Nitrogen)	2.5 mg/kg	N/A	N/A	N/A	N/A			
—	Total carbon	200 mg/kg	N/A	N/A	N/A	N/A	Carbon dioxide coulometer	N/A	N/A
—	Inorganic carbon	200 mg/kg	N/A	N/A	N/A	N/A	Carbon dioxide coulometer	N/A	N/A
—	Calcium carbonate equivalent	N/A	N/A	N/A	N/A	N/A	Calculation	N/A	N/A

Table 2-2. Analytical Performance Requirements for Soil from Monitoring Wells

CAS	Analyte	QL	Preliminary Cleanup Goals[a]				Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (industrial)	Direct Exposure (residential)	Groundwater Protection	River Protection			
Performance Requirements for Physical Properties									
—	Grain-size (sieve) analysis	N/A	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Bulk density	N/A	N/A	N/A	N/A	N/A	ASTM D2937-04	N/A	N/A

Notes:

Unless otherwise noted, the COPCs listed are applicable to all new monitoring wells. Field parameters, target analytes, and physical properties listed will be measured at each monitoring well.

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

a. Unless otherwise noted, Preliminary Cleanup Goals are established in DOE/RL-2001-47, *Remedial Design Report/Remedial Action Work Plan for the 300 Area*. These numbers will be revised per the ARAR analysis in the RI/FS report.

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

c. Considered a COPC for Near River (C7656 and C7663) groundwater wells.

d. Considered a COPC for North Process Pond (C7653 and C7654), Process Trenches (C7655), South Process Pond (C7660), and temporary (RIFS-a through RIFS-e) groundwater wells.

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.

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

g. Considered a COPC for Perimeter (C7657, C7658, C7659, C7661, and C7662) groundwater wells.

h. 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 QLs are met.

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

j. Preliminary cleanup goal values from WCH-332, *300 Area Contaminant of Potential Concern List Development for Soil.*

k. The 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 preformed 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 Methods 8260 and 8270.

l. Calculated cleanup goals are below 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.

$CaCO_3$	= calcium carbonate	N/A	= not applicable
CAS	= Chemical Abstracts Service	NV	= no value
IC	= ion chromatography	QL	= quantitation limit
ICP	= inductively coupled plasma	RESRAD	= RESidual RADioactivity (dose model)
MS	= mass spectrometry	UKPA	= total uranium by kinetic phosphorescence analysis

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Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Boreholes 300-DU-VZ-1, 300-DU-VZ-2, and 300-DU-VZ-3

CAS	Analyte	QL	Preliminary Cleanup Goals[a]				Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (residential)	Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Field Measurements									
	Gross gamma	10 pCi/g	N/A	N/A	N/A	N/A	Portable sodium iodide detector	≤50	[c]
—	Gross alpha	100 dpm/100 cm^2	N/A	N/A	N/A	N/A	Portable contamination detector	≤50	[c]
—	Gross beta	5,000 dpm/100 cm^2	N/A	N/A	N/A	N/A	Portable contamination detector	≤50	[c]
Performance Requirements for Laboratory Measurements (radiological)									
10045-97-3	Cesium-137[d]	0.1 pCi/g	25 pCi/g	6.2 pCi/g	NV[e]	NV[e]	Gamma energy analysis	≤30[f]	70-130[f]
10198-40-0	Cobalt-60[d]	0.05 pCi/g	5.2 pCi/g	1.4 pCi/g	NV[e]	NV[e]			
15046-84-1	Iodine-129[d]	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	2 pCi/g	Low energy – gamma energy analysis	≤30[f]	70-130[f]
14762-75-5	Carbon-14	2 pCi/g	82 pCi/g	8.7 pCi/g	NV[e]	NV[e]	LSC – Carbon-14	≤30[f]	70-130[f]
13981-37-8	Nickel-63	30 pCi/g	3,370,000 pCi/g	4,026 pCi/g	NV[e]	NV[e]	LSC – Nickel-63	≤30[f]	70-130[f]
14133-76-7	Technetium-99	0.25 pCi/g	410,000 pCi/g	34.7 pCi/g	239 pCi/g	33.2 pCi/g	LSC – Technetium-99	≤30[f]	70-130[f]
10028-17-8	Tritium	10 pCi/g	1,980 pCi/g	711 pCi/g	5,360 pCi/g	746 pCi/g	LSC – Tritium	≤30[f]	70-130[f]
Performance Requirements for Laboratory Measurements (nonradiological)									
7440-36-0	Antimony[d]	6 mg/kg[g]	1,400 mg/kg	32 mg/kg	5 mg/kg	5 mg/kg	EPA 6010 or 6020	≤30[h]	70-130[h]
7440-38-2	Arsenic	8 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg	20 mg/kg			
7440-39-3	Barium	10 mg/kg	4,900 mg/kg	1,600 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	Beryllium[d]	0.5 mg/kg	104 mg/kg	10.4 mg/kg	1.51 mg/kg	1.51 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	5,250,000 mg/kg	120,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-50-8	Copper	1 mg/kg	130,000 mg/kg	2,960 mg/kg	59.2 mg/kg	22.0 mg/kg			
7439-96-5	Manganese	5 mg/kg	165,000 mg/kg	3,760 mg/kg	512 mg/kg	512 mg/kg			
7440-02-0	Nickel	4 mg/kg	70,000 mg/kg	1,600 mg/kg	19.1 mg/kg	27.4 mg/kg			
7782-49-2	Selenium	10 mg/kg[g]	17,500 mg/kg	400 mg/kg	5 mg/kg	1 mg/kg			
7440-22-4	Silver	1 mg/kg[g]	17,500 mg/kg	400 mg/kg	8 mg/kg	0.73 mg/kg			
7440-24-6	Strontium	1 mg/kg	2,100,000 mg/kg	48,000 mg/kg	960 mg/kg	NV			
7440-62-2	Vanadium	2.5 mg/kg	24,500 mg/kg	560 mg/kg	85.1 mg/kg	NV			
7440-66-6	Zinc	1 mg/kg	1,050,000 mg/kg	24,000 mg/kg	480 mg/kg	67.8 mg/kg			
7439-97-6	Mercury	0.2 mg/kg	1,050 mg/kg	24 mg/kg	0.33 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	≤30[h]	70-130[h]
126-73-8	Tributyl phosphate[d]	3.3 mg/kg	24,300 mg/kg	18.5 mg/kg	3.3 mg/kg	NV	EPA 8270 (semivolatiles)	≤30[i]	70-130[i]
98-95-3	Nitrobenzene[d]	0.33 mg/kg	7,000 mg/kg	160 mg/kg	1.6 mg/kg	3.4 mg/kg			

Table 2-3. Analytical Performance Requirements for Soil/Aquifer Sediment Samples from Boreholes 300-DU-VZ-1, 300-DU-VZ-2, and 300-DU-VZ-3

CAS	Analyte	QL	Preliminary Cleanup Goals[a]				Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (residential)	Direct Exposure (industrial)	Groundwater Protection	River Protection			
71-43-2	Benzene[f,j]	0.005 mg/kg[k]	2,390 mg/kg	NV	0.004 mg/kg	0.014 mg/kg	EPA 8260 (volatile organics)	≤30[i]	70-130[i]
67-66-3	Chloroform[d,j]	0.005 mg/kg[k]	21,500 mg/kg	NV	0.038 mg/kg	0.0607 mg/kg			
79-01-6	Trichloroethene[d,j]	0.005 mg/kg[k]	1,470 mg/kg	NV	0.003 mg/kg	0.090 mg/kg			
7440-61-1	Uranium (total)	1 mg/kg	505 mg/kg	81 mg/kg	53 mg/kg	106 mg/kg	UKPA or via isotopic	≤30[h]	70-130[h]
			Performance Requirements for Target Analytes						
16887-00-6	Chloride	2 mg/kg	N/A	N/A	N/A	N/A	EPA 300.0 (anions by IC)	≤30[h]	70-130[h]
16984-48-8	Fluoride	5 mg/kg	N/A	N/A	N/A	N/A			
14797-55-8	Nitrate (as Nitrogen)	2.5 mg/kg	N/A	N/A	N/A	N/A			
14797-65-0	Nitrite (as Nitrogen)	2.5 mg/kg	N/A	N/A	N/A	N/A			

Notes:

Unless otherwise noted, the COPCs listed are applicable to all boreholes. Field parameters and target analytes listed will be measured at each borehole.

a. Unless otherwise noted, Preliminary Cleanup Goals are established in DOE/RL-2001-47, *Remedial Design Report/Remedial Action Work Plan for the 300 Area*. These numbers will be revised per the ARAR analysis in the RI/FS report.

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

c. Field measurements have no specific accuracy quality control requirement except to perform checks to verify manufacturer's expected performance.

d. Considered a COPC for boreholes 300-DU-VZ-1 and 300-DU-VZ-3.

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.

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

g. 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 QLs are met.

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

i. The 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 preformed 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 Methods 8260 and 8270.

j. Preliminary cleanup goal values from WCH-332, *300 Area Contaminant of Potential Concern List Development for Soil*.

k. Calculated cleanup goals are below 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
dpm = disintegrations per minute
IC = ion chromatography
ICP = inductively coupled plasma
MS = mass spectrometry
N/A = not applicable
NV = no value
QL = quantitation limit
RESRAD = RESidual RADioactivity (dose model)
UKPA = total uranium by kinetic phosphorescence analysis

Table 2-4. Analytical Performance Requirements for Batch Leach Testing

CAS	Analyte	QL	Analytical Method	Precision Requirement (%)	Accuracy Requirement (%)
Performance Requirements for Laboratory Measurements (radiological)					
13966-29-5	Uranium-234[a]	1 pCi/L	Water leachate from sediment ICP/MS, PNNL-AGG-415 (or equivalent)	≤10[b]	90-110[b]
15117-96-1	Uranium-235[a]	1 pCi/L			
—	Uranium-238[a]	1 pCi/L			
13966-29-5	Uranium-234[a]	1 pCi/L	Water leachate from sediment Isotopic – Uranium	≤20[b]	80-120[b]
15117-96-1	Uranium-235[a]	1 pCi/L			
—	Uranium-238[a]	1 pCi/L			
Performance Requirements for Laboratory Measurements (nonradiological)					
7440-38-2	Arsenic	1 µg/L	Water leachate from sediment ICP/MS, PNNL-AGG-415 (or equivalent)	≤10[c]	90-110[c]
7440-43-9	Cadmium	1 µg/L			
7440-47-3	Chromium	1 µg/L			
7440-50-8	Copper	1 µg/L			
7439-92-1	Lead	1 µg/L			
7439-98-7	Molybdenum	1 µg/L			
7782-49-2	Selenium	1 µg/L			
7440-22-4	Silver	1 µg/L			
7440-61-1	Uranium	1 µg/L			
7440-38-2	Arsenic	50 µg/L	Water leachate from sediment EPA 6010[d]	≤20[c]	80-120[c]
7440-43-9	Cadmium	50 µg/L			
7440-47-3	Chromium	100 µg/L			
7440-50-8	Copper	50 µg/L			
7439-92-1	Lead	50 µg/L			
7439-98-7	Molybdenum	50 µg/L			
7782-49-2	Selenium	100 µg/L			
7440-22-4	Silver	100 µg/L			
7440-61-1	Uranium	5 µg/L	Water leachate from sediment UKPA or via Isotopic	≤20[c]	80-120[c]

Notes:

PNNL-AGG-415, *Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.*

a. Uranium batch leach testing will be performed for samples associated with installation of new monitoring wells only.

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

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

d. For EPA method 6010, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

CAS = Chemical Abstracts Service
ICP = inductively coupled plasma
QL = quantitation limit
MS = mass spectrometry
UKPA = total uranium by kinetic phosphorescence analysis

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Table 2-5. Analytical Performance Requirements for Aquifer Sediment Samples

CAS	Analyte	QL	Preliminary Cleanup Goals[a]				Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (residential)	Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Laboratory Measurements (radiological)									
—	Uranium-233/234	1 pCi/g	167 pCi/g	27.2 pCi/g	127.4 pCi/g	17.9 pCi/g	Isotopic – Uranium	≤30[f]	70-130[f]
15117-96-1	Uranium-235	0.5 pCi/g	16 pCi/g	2.7 pCi/g	13.2 pCi/g	1.8 pCi/g			
—	Uranium-238	1 pCi/g	167 pCi/g	26.2 pCi/g	127.4 pCi/g	17.3 pCi/g			
7440-38-2	Arsenic	10 mg/kg	58 mg/kg	20 mg/kg	20 mg/kg	20 mg/kg	EPA 6010 or 6020	≤30[c]	70-130[c]
7440-39-3	Barium	2 mg/kg	4,900 mg/kg	1,600 mg/kg	200 mg/kg	400 mg/kg			
7440-41-7	Beryllium	0.5 mg/kg	104 mg/kg	10.4 mg/kg	1.51 mg/kg	1.51 mg/kg			
7440-43-9	Cadmium	0.5 mg/kg	139 mg/kg	13.9 mg/kg	0.81 mg/kg	0.81 mg/kg			
7440-47-3	Chromium (total)	1 mg/kg	5,250,000 mg/kg	120,000 mg/kg	18.5 mg/kg	18.5 mg/kg			
7440-50-8	Copper	1 mg/kg	130,000 mg/kg	2,960 mg/kg	59.2 mg/kg	22.0 mg/kg			
7439-92-1	Lead	5 mg/kg	1,000 mg/kg	353 mg/kg	10.2 mg/kg	10.2 mg/kg			
7439-96-5	Manganese	5 mg/kg	165,000 mg/kg	3,760mg/kg	512 mg/kg	512 mg/kg			
7440-22-2	Silver	1 mg/kg[d]	17,500 mg/kg	400 mg/kg	8 mg/kg	0.73 mg/kg			
7440-66-6	Zinc	1 mg/kg	1,050,000 mg/kg	48,000 mg/kg	480 mg/kg	67.8 mg/kg			
7439-97-6	Mercury	0.2 mg/kg	1,050 mg/kg	24 mg/kg	0.33 mg/kg	0.33 mg/kg	EPA 7471 (mercury cold vapor)	≤30[c]	70-130[c]
7440-61-1	Uranium (total)	1 mg/kg	505 mg/kg	81 mg/kg	53 mg/kg	106 mg/kg	UKPA or via Isotopic	≤30[c]	70-130[c]
16887-00-6	Chloride	2 mg/kg	NV	NV	25,000 mg/kg	N/A	EPA 300.0 (anions by IC)	≤30[c]	70-130[c]
16984-48-8	Fluoride	5 mg/kg	210,000 mg/kg	4,800 mg/kg	96 mg/kg	400 mg/kg			
147-97-55-8	Nitrate (as Nitrogen)	2.5 mg/kg	5,600,000 mg/kg	8,000 mg/kg	1,000 mg/kg	2,000 mg/kg			
147-97-65-0	Nitrite (as Nitrogen)	2.5 mg/kg	350,000 mg/kg	8,000 mg/kg	100 mg/kg	200 mg/kg			
56-23-5	Carbon tetrachloride	0.005 mg/kg	1,010 mg/kg	7.69 mg/kg	0.0337 mg/kg	0.05 mg/kg	EPA 8260 (volatile organics)	≤30[e]	70-130[e]
156-59-2	cis-1,2-dichloroethene[f]	0.005 mg/kg	35,000 mg/kg	NV	0.350 mg/kg	NV			
127-18-4	Tetrachloroethene[f]	0.005 mg/kg	35,000 mg/kg	NV	0.008 mg/kg	0.008 mg/kg			
79-01-6	Trichloroethene[f]	0.005 mg/kg[g]	1,470 mg/kg	NV	0.003 mg/kg	0.090 mg/kg			
75-01-4	Vinyl chloride[f]	0.005 mg/kg[g]	87.5 mg/kg	NV	0.00018 mg/kg	0.0252 mg/kg			
—	Total carbon	200 mg/kg	N/A	N/A	N/A	N/A	Carbon dioxide coulometer	N/A	N/A
—	Inorganic carbon	200 mg/kg	N/A	N/A	N/A	N/A	Carbon dioxide coulometer	N/A	N/A
—	Calcium carbonate equivalent	N/A	N/A	N/A	N/A	N/A	Calculation	N/A	N/A

Table 2-5. Analytical Performance Requirements for Aquifer Sediment Samples

CAS	Analyte	QL	Preliminary Cleanup Goals[a]				Analytical Method[b]	Precision Requirement (%)	Accuracy Requirement (%)
			Direct Exposure (residential)	Direct Exposure (industrial)	Groundwater Protection	River Protection			
Performance Requirements for Physical Properties									
—	Grain-size (sieve) analysis	N/A	N/A	N/A	N/A	N/A	Field procedure or ASTM D422-63	N/A	N/A
—	Sediment moisture content	N/A	N/A	N/A	N/A	N/A	ASTM D2216-05	N/A	N/A
—	Bulk density	N/A	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 D2937-04, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.

a. Unless otherwise noted, Preliminary Cleanup Goals are established in DOE/RL-2001-47, *Remedial Design Report/Remedial Action Work Plan for the 300 Area*.

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

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

d. 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 QLs are met.

e. The 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 preformed 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 Methods 8260 and 8270.

f. Preliminary cleanup goal values from WCH-332, 300 Area Contaminant of Potential Concern List Development for Soil.

g. Calculated cleanup goals are below 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.

$CaCO_3$	=	calcium carbonate	N/A	=	not applicable
CAS	=	Chemical Abstracts Service	NV	=	no value
IC	=	ion chromatography	QL	=	quantitation limit
ICP	=	inductively coupled plasma	RESRAD	=	RESidual RADioactivity (dose model)
MS	=	mass spectrometry	UKPA	=	total uranium by kinetic phosphorescence analysis

Table 2-6. Analytical Performance Requirements for Groundwater Water Samples from New Wells

CAS	Analyte	Analytical Method[a]	QL	Precision Requirement (%)	Accuracy Requirement (%)
		Performance Requirements for Field Measurements			
—	Oxidation reduction potential	REDOX PROBE	N/A	[b]	[b]
—	pH measurement	PROBE	0.5 pH unit	[b]	[b]
—	Specific conductance	PROBE	1 µS/cm	[b]	[b]
—	Temperature	PROBE	—	[b]	[b]
—	Dissolved oxygen	PROBE	—	[b]	[b]
—	Turbidity	PROBE	0.1 NTU	[b]	[b]
—	Water level in the well at time of sampling	Tape	N/A	N/A	N/A
		Performance Requirements for Laboratory Measurements (nonradiological)			
7440-38-2	Arsenic	EPA 6010 or 6020	4 µg/L[c]	≤20[d]	80-120[d]
7440-39-3	Barium	EPA 6010 or 6020	20 µg/L	≤20[d]	80-120[d]
7440-41-7	Beryllium	EPA 6010 or 6020	2 µg/L[c]	≤20[d]	80-120[d]
7440-43-9	Cadmium	EPA 6010 or 6020	2 µg/L[c]	≤20[d]	80-120[d]
7440-47-3	Chromium	EPA 6010 or 6020	10 µg/L	≤20[d]	80-120[d]
7440-50-8	Copper	EPA 6010 or 6020	8 µg/L	≤20[d]	80-120[d]
7439-89-6	Iron	EPA 6010 or 6020	50 µg/L	≤20[d]	80-120[d]
7439-92-1	Lead	EPA 6010 or 6020	2 µg/L[c]	≤20[d]	80-120[d]
7439-95-4	Magnesium	EPA 6010 or 6020	750 µg/L	≤20[d]	80-120[d]
7439-96-5	Manganese	EPA 6010 or 6020	5 µg/L	≤20[d]	80-120[d]
7439-97-6	Mercury	EPA 7470 or 200.8 (Mercury)	0.5 µg/L	≤20[d]	80-120[d]
7440-09-7	Potassium	EPA 6010 or 6020	4,000 µg/L	≤20[d]	80-120[d]
7440-22-4	Silver	EPA 6010 or 6020	10 µg/L	≤20[d]	80-120[d]
7440-66-6	Zinc	EPA 6010 or 6020	10 µg/L	≤20[d]	80-120[d]
7440-61-1	Uranium	Total uranium (chemical)	1 µg/L	≤20[d]	80-120[d]
56-23-5	Carbon tetrachloride	EPA 8260 (volatile organics)	2 µg/L	≤20[e]	80-120[e]
156-59-2	cis-1,2-Dichloroethene	EPA 8260 (volatile organics)	5 µg/L	≤20[e]	80-120[e]
127-18-4	Tetrachloroethene	EPA 8260 (volatile organics)	5 µg/L	≤20[e]	80-120[e]
79-01-6	Trichloroethene	EPA 8260 (volatile organics)	2 µg/L	≤20[e]	80-120[e]
75-01-4	Vinyl Chloride	EPA 8260 (volatile organics)	5 µg/L	≤20[e]	80-120[e]
16887-00-6	Chloride	EPA 300.0 (anions by IC)	200 µg/L	≤20[d]	80-120[d]
24959-67-9	Bromide	EPA 300.0 (anions by IC)	250 µg/L	≤20[d]	80-120[d]

Table 2-6. Analytical Performance Requirements for Groundwater Water Samples from New Wells

CAS	Analyte	Analytical Method[a]	QL	Precision Requirement (%)	Accuracy Requirement (%)
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	≤20[d]	80-120[d]
14797-55-8	Nitrate (as Nitrogen)	EPA 300.0 (anions by IC)	250 µg/L	≤20[d]	80-120[d]
14797-65-0	Nitrite (as Nitrogen)	EPA 300.0 (anions by IC)	250 µg/L	≤20[d]	80-120[d]
14265-44-2	Phosphate	EPA 300.0 (anions by IC)	500 µg/L	≤20[d]	80-120[d]
14808-79-8	Sulfate	EPA 300.0 (anions by IC)	500 µg/L	≤20[d]	80-120[d]
—	Alkalinity	f	f	f	f
—	Microbiological activity	g	g	g	g

Notes:

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 the four-digit EPA methods, 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 8260.

b. Field measurements have no specific QC requirement except to perform checks to verify manufacturer's expected performance.

c. To meet QL goals, laboratories must use axial-based ("trace") ICP analytical methods. The laboratory also may substitute graphite furnace or ICP/MS methods if QLs are met.

d. Accuracy criteria specified are for calculated recent 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 are for batch laboratory replicated matrix spike or replicate sample relative percent difference.

e. 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 indentified compounds will be reported for SW-846 Methods 8260 and 8270.

f. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

g. The purpose of determining microbial activity will be to identify the microbes in the aquifer responsible for degradation of trichloroethene or tetrachloroethene to dichloroethene. Details of the tests, including QL, precision and accuracy, will be discussed with the laboratory personnel before analysis.

CAS = Chemical Abstracts Service
QL = quantitation limit
IC = ion chromatography
N/A = not applicable
REDOX = Reduction Oxidation (Plant or process)
NTU = nephelometric turbidity unit

Table 2-7. Analytical Performance Requirements for 300 Area Subregion Spatial and Temporal Uncertainty Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	QL	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
—	Oxidation reduction potential	REDOX PROBE	N/A	[b]	[b]	N/A	N/A
—	pH measurement	PROBE	0.5 pH unit	[b]	[b]	N/A	N/A
—	Specific conductance	PROBE	1 µS/cm	[b]	[b]	N/A	N/A
—	Temperature	PROBE	—	[b]	[b]	N/A	N/A
—	Dissolved oxygen	PROBE	—	[b]	[b]	N/A	N/A
—	Turbidity	PROBE	0.1 NTU	[b]	[b]	N/A	N/A
Performance Requirements for Laboratory Measurements (radiological)							
10098-97-2	Strontium-90	Strontium-90	2 pCi/L	≤30[c]	70-130[c]	8 pCi/L	40 CFR 141.66
10028-17-8	Tritium	LSC – Tritium	400 pCi/L	≤30[c]	70-130[c]	20,000 pCi/L	40 CFR 141.66
—	Uranium-233/234	Isotopic – Uranium	1 pCi/L	≤30[d]	70-130[d]	15 pCi/L	Federal MCL
15117-96-1	Uranium-235	Isotopic – Uranium	1 pCi/L	≤30[d]	70-130[d]	15 pCi/L	Federal MCL
7440-61-1	Uranium-238	Isotopic – Uranium	1 pCi/L	≤30[d]	70-130[d]	15 pCi/L	Federal MCL
Performance Requirements for Laboratory Measurements (nonradiological)							
7440-36-0	Antimony	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	5 µg/L	≤20[d]	80-120[d]	5.60 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[e,f]	≤20[d]	80-120[d]	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[e,f]	≤20[d]	80-120[d]	0.25 µg/L	Freshwater CCC
7440-47-3	Chromium	EPA 6010 (ICP metals)	10 µg/L	≤20[d]	80-120[d]	74 µg/L	Freshwater CCC
7440-48-4	Cobalt	EPA 6010 (ICP metals)	4 µg/L	≤20[d]	80-120[d]	4.8 µg/L	WAC 173-340-720(4)
7440-50-8	Copper	Trace – ICP (6010)	8 µg/L	≤20[d]	80-120[d]	9 µg/L	Freshwater CCC
7439-92-1	Lead	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L[e]	≤20[d]	80-120[d]	2.5 µg/L	Freshwater CCC
7439-96-5	Manganese	EPA 6010 (ICP metals)	5 µg/L	≤20[d]	80-120[d]	50 µg/L	40 CFR 143.3
7439-97-6	Mercury	EPA 7470 or 200.8 (Mercury)	0.5 µg/L[e]	≤20[d]	80-120[d]	0.05 µg/L	WAC 173-201A
7440-02-0	Nickel	EPA 6010 (ICP metals)	40 µg/L	≤20[d]	80-120[d]	52 µg/L	Freshwater CCC
7782-49-2	Selenium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	4 µg/L	≤20[d]	80-120[d]	5 µg/L	Freshwater CCC
7440-22-4	Silver	EPA 6010 (ICP metals)	10 µg/L[e]	≤20[d]	80-120[d]	5 µg/L	WAC 173-201A
7440-28-0	Thallium	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L[e,f]	≤20[d]	80-120[d]	0.24 µg/L	Human Health for the Consumption of Water + Organism
7440-61-1	Uranium	Total uranium (chemical)	1 µg/L	≤20[d]	80-120[d]	30 µg/L	40 CFR 141.66
7440-66-6	Zinc	EPA 6010 (ICP metals)	10 µg/L	≤20[d]	80-120[d]	120 µg/L	Freshwater CCC
540-59-0	1,2-Dichloroethene (total)	EPA 8260 (volatile organics)	10 µg/L	≤20[g]	80-120[g]	72 µg/L	WAC 173-340-720(4)

Table 2-7. Analytical Performance Requirements for 300 Area Subregion Spatial and Temporal Uncertainty Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	QL	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
56-23-5	Carbon tetrachloride	EPA 8260 (volatile organics)	2 µg/L[f]	≤20[g]	80-120[g]	0.23 µg/L	Human Health for the Consumption of Water + Organism
67-66-3	Chloroform	EPA 8260 (volatile organics)	5 µg/L	≤20[g]	80-120[g]	5.7 µg/L	Human Health for the Consumption of Water + Organism
156-59-2	cis-1,2-Dichloroethene	EPA 8260 (volatile organics)	5 µg/L	≤20[g]	80-120[g]	70 µg/L	40 CFR 141.66
127-18-4	Tetrachloroethene	EPA 8260 (volatile organics)	5 µg/L[f]	≤20[g]	80-120[g]	0.081 µg/L	WAC 173-340-720(4)
79-01-6	Trichloroethene	EPA 8260 (volatile organics)	2 µg/L[f]	≤20[g]	80-120[g]	0.49 µg/L	WAC 173-340-720(4)
75-01-4	Vinyl chloride	EPA 8260 (volatile organics)	5 µg/L[f]	≤20[g]	80-120[g]	0.029 µg/L	Human Health for the Consumption of Water + Organism
57-12-5	Cyanide	EPA 9010 or 9012 (total cyanide)	5 µg/L	≤20[g]	80-120[g]	5.2 µg/L	Freshwater CCC
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	≤20[d]	80-120[d]	960 µg/L	WAC 173-340-720(4)
14797-55-8	Nitrate (as Nitrogen)	EPA 300.0 (anions by IC)	250 µg/L	≤20[d]	80-120[d]	10,000 µg/L	40 CFR 141.66
14797-65-0	Nitrite (as Nitrogen)	EPA 300.0 (anions by IC)	250 µg/L	≤20[d]	80-120[d]	1,000 µg/L	40 CFR 141.66
14808-79-8	Sulfate	EPA 300.0 (anions by IC)	500 µg/L	≤20[d]	80-120[d]	250,000 µg/L	40 CFR 143.3
—	Alkalinity	[h]	[h]	[h]	[h]		

Notes:

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), "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, 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 8260.

b. Field measurements have no specific accuracy quality control requirement except to perform checks to verify manufacturer's expected performance.

c. Accuracy criteria shown are for associated batch laboratory control sample percent recoveries. Additional accuracy criteria include analysis–specific evaluations performed for matrix spike, tracer, and/or carrier recoveries, as appropriate to the method. Precision criteria shown are for batch laboratory replicate matrix spike analyses or replicate sample analyses.

d. 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 preformed. The precision criteria shown are for batch laboratory replicated matrix spike or replicate sample relative percent difference.

e. 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 estimated quantitation limits are met.

f. Calculated cleanup goals are below 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.

g. The accuracy criteria shown are the minimum for associated catch 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 laboratory replicate matrix spike analysis relative differences. Tentatively identified compounds will be reported for SG-846 methods 8260 and 8270.

h. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

CAS = Chemical Abstracts Service
CCC = criterion continuous concentration
IC = ion chromatography
ICP = inductively coupled plasma
LSC = liquid scintillation counter
MCL = maximum contaminant level
MS = mass spectrometry
N/A = not applicable
NTU = nephelometric turbidity unit
QL = quantitation limit
REDOX = Reduction Oxidation (Plant or process)

Table 2-8. Analytical Performance Requirements for 600 Area Subregion Spatial and Temporal Uncertainty Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	QL	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
Performance Requirements for Field Measurements							
—	Oxidation reduction potential	REDOX PROBE	N/A	[b]	[b]	N/A	N/A
—	pH measurement	PROBE	0.5 pH unit	[b]	[b]	N/A	N/A
—	Specific conductance	PROBE	1 µS/cm	[b]	[b]	N/A	N/A
—	Temperature	PROBE	—	[b]	[b]	N/A	N/A
—	Dissolved oxygen	PROBE	—	[b]	[b]	N/A	N/A
—	Turbidity	PROBE	0.1 NTU	[b]	[b]	N/A	N/A
Performance Requirements for Laboratory Measurements (radiological)							
15046-84-1	Iodine-129	Iodine-129 – low level	1 pCi/L[c]	≤30[d]	70-130[d]	1 pCi/L	40 CFR 141.66
10098-97-2	Strontium-90	Strontium-90	2 pCi/L	≤30[d]	70-130[d]	8 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[e]	80-120[e]	5.60 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[c,f]	≤20[e]	80-120[e]	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[c,f]	≤20[e]	80-120[e]	0.25 µg/L	Freshwater CCC
7440-47-3	Chromium	EPA 6010 (ICP metals)	10 µg/L	≤20[e]	80-120[e]	74 µg/L	Freshwater CCC
7440-50-8	Copper	Trace – ICP (6010)	8 µg/L	≤20[e]	80-120[e]	9 µg/L	Freshwater CCC
7439-92-1	Lead	Trace – ICP (6010) or ICP/MS (6020 or 200.8)	2 µg/L[f]	≤20[e]	80-120[e]	2.5 µg/L	Freshwater CCC
7439-96-5	Manganese	EPA 6010 (ICP metals)	5 µg/L	≤20[e]	80-120[e]	50 µg/L	40 CFR 143.3
7440-02-0	Nickel	EPA 6010 (ICP metals)	40 µg/L	≤20[e]	80-120[e]	52 µg/L	Freshwater CCC
7440-61-1	Uranium	Total uranium (chemical)	1 µg/L	≤20[e]	80-120[e]	30 µg/L	40 CFR 141.66
7440-66-6	Zinc	EPA 6010 (ICP metals)	10 µg/L	≤20[e]	80-120[e]	120 µg/L	Freshwater CCC
56-23-5	Carbon Tetrachloride	EPA 8260 (volatile organics)	2 µg/L[c]	≤20[g]	80-120[g]	0.23 µg/L	Human Health for the Consumption of Water + Organism
127-18-4	Tetrachloroethene	EPA 8260 (volatile organics)	5 µg/L[c]	≤20[g]	80-120[g]	0.081 µg/L	WAC 173-340-720(4)
79-01-6	Trichloroethene	EPA 8260 (volatile organics)	2 µg/L[c]	≤20[g]	80-120[g]	0.49 µg/L	WAC 173-340-720(4)
75-01-4	Vinyl Chloride	EPA 8260 (volatile organics)	5 µg/L[c]	≤20[g]	80-120[g]	0.029 µg/L	Human Health for the Consumption of Water + Organism
126-73-8	Tributyl Phosphate	EPA 8270 (semivolatile organics)	100 µg/L[c]	≤20[g]	80-120[g]	16.2 µg/L	WAC 173-340-720(4)
16984-48-8	Fluoride	EPA 300.0 (anions by IC)	500 µg/L	≤20[e]	80-120[e]	960 µg/L	WAC 173-340-720(4)

Table 2-8. Analytical Performance Requirements for 600 Area Subregion Spatial and Temporal Uncertainty Monitoring Well Water Samples

CAS	Analyte	Analytical Method[a]	QL	Precision Requirement (%)	Accuracy Requirement (%)	Action Level	Action Level Basis
14797-55-8	Nitrate (as Nitrogen)	EPA 300.0 (anions by IC)	250 µg/L	≤20[e]	80-120[e]	10,000 µg/L	40 CFR 141.66
14797-65-0	Nitrite (as Nitrogen)	EPA 300.0 (anions by IC)	250 µg/L	≤20[e]	80-120[e]	1,000 µg/L	40 CFR 141.66
14808-79-8	Sulfate	EPA 300.0 (anions by IC)	500 µg/L	≤20[e]	80-120[e]	250,000 µg/L	40 CFR 143.3
—	Alkalinity	[h]	[h]	[h]	[h]		

Notes:

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 173-340-720(4), "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, 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 Methods 8260 and 8270.

b. Field measurements have no specific QC requirement except to perform checks to verify manufacturer's expected performance.

c. Calculated cleanup goals are below 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.

d. Accuracy criteria specified are for associated analytical batch laboratory control sample percent recoveries. 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 analyses.

e. Accuracy criteria specified are for calculated recent 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 are for batch laboratory replicated matrix spike or replicate sample relative percent difference.

f. 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 estimated quantitation limits are met.

g. Accuracy criteria shown are the minimum for associated batch laboratory control sample percent recoveries 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 indentified compounds will be reported for SW-846 methods 8260 and 8270.

h. Rounds, 2006, "Alkalinity and Acid Neutralizing Capacity (Version 3.0)."

CAS = Chemical Abstracts Service
CCC = criterion continuous concentration
IC = ion chromatography
ICP = inductively coupled plasma
LSC = liquid scintillation counter
MCL = maximum contaminant level
MS = mass spectrometry
N/A = not applicable
QL = quantitation limit
REDOX = Reduction Oxidation (Plant or process)
NTU = nephelometric turbidity unit

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 that affect 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.

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 made by marking the erroneous data through with a single line, entering the correct data, and initialing and dating the changes.

Table 2-9. Change Control for the 300 Area Project

Type of Change	Action	Documentation
By drilling lead or sampling lead: • Increasing sampling frequency based on field screening results or visual observations	No SAP revision necessary	Field logbooks or operational records
By project management: • Change in COPCs • Adding/removing wells • Significant increases or decreases in sampling frequency	Revise SAP plan (can be accomplished with Tri-Party Agreement Change Notice); obtain regulatory approval; distribute plan	Revised plan or approved Tri-Party Agreement Change Notice

The project lead is responsible for ensuring the 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, the 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 are not possible. 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:

- Sample 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 that 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 the 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.

For the analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future performed by Pacific Northwest National Laboratory (PNNL), details of the tests will be discussed with the laboratory personnel before analysis.

The purpose of determining microbial activity will be to identify the microbes in the aquifer responsible for degradation of trichloroethylene or tetrachloroethene to dichloroethene. Details of the tests will be discussed with the laboratory personnel before analysis.

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-in. 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 water tight sample containers (extraction vessels) and rotated end over end through the vessel centerline at a rate of about 30 rotations per minute for 18 hours. Following 18 hours of mixing, the soil/water slurry is filtered using a 0.45-µm 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: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 (µg/g)

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

C_L = Contaminant concentration in leachate (µg/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. Additional QC samples may be collected if conditions arise.

Table 2-10. Project QC Checks

QC Sample Type	Purpose	Frequency
	Field QC	
Full trip blank	Assess contamination from containers or transportation	One per 20 samples for samples that will undergo volatile organic analysis, per media sampled.
Field transfer blank	Assess contamination from sampling site	One per day when volatile organics are sampled, for groundwater monitoring activities. A minimum of one field transfer blank will be collected at each borehole, *per media sampled*, 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, *per media sampled.*
Field duplicates	Estimate precision, including sampling and analytical variability	One per batch,[b] 20 samples maximum, for groundwater monitoring activities. A minimum of one field duplicate will be collected at each borehole, *per media sampled.*
Field split	Estimate precision, including sampling, analytical, and inter-laboratory variability	At a minimum, one per analytical method, per media, for analyses performed where detection limit and precision and accuracy criteria have been defined in the performance requirements tables in Chapter 2.
	Laboratory QC[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, *per media sampled.*
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, *per media sampled.*
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, *per media sampled.*
Laboratory control samples	Assess method accuracy	One per batch,[b] 20 samples maximum, or as identified by the method guidance, *per media sampled.*
Surrogates	Estimate recovery/yield	When required by the method guidance, one as identified by the method guidance.

Table 2-10. Project QC Checks

QC Sample Type	Purpose	Frequency

Notes:

a. Whenever a new type of non-dedicated equipment is used, an equipment rinsate blank will be collected every time sampling occurs at a location 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 it 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 for soil may be limited to volatile organic analytes. Full trip blanks are not required for aquifer sediment samples to be analyzed for metals.

Field transfer blanks are preserved volatile organic analysis sample containers 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 containers are sealed and placed in the same storage container with the samples from the associated sampling event. Field transfer blank samples are analyzed for volatile organic compounds (VOCs) only.

The field transfer blank 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 will be batched with samples for which volatile organic analysis is being 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, and 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 greater than 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 taken from the same source, stored in separate containers, and analyzed independently.

The duplicate samples will be collected generally from an area expected to have some contamination, so valid comparisons between the sample results 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 activity are evaluated. Large relative percent differences can be an indication of laboratory performance problems and should be investigated.

Field split samples are representative samples from a sampling event sent to a third-party laboratory (reference laboratory). Evaluation of the results can provide an indication of inter-laboratory variability. Only those field split sample pairs with results greater than five times the method detection limit or minimum detectable activity at both laboratories are evaluated. Large relative percent differences can be an indication of laboratory performance problems and should be investigated. One field split will be collected for each analytical method, except for PNNL-specific tests, per media sampled.

2.2.5.2 Laboratory QC Samples

The laboratory QC samples (e.g., method blanks, laboratory control sample/blank spike, 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), and will be run at the frequency specified in the respective reference. Laboratory QC sample results 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 is not required. If no VOC samples are collected, then a field transfer blank is not required. Field transfer blanks are not required when simply transferring samples to the field gas chromatograph for analysis.

Only those field duplicates 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 samples (35 percent for soil/aquifer sediment samples), as measured by the relative percent difference, to be acceptable. Unacceptable field duplicate results are flagged and qualified in the database, as appropriate.

Only those field split 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 samples (35 percent for soil/aquifer sediment samples), as measured by the relative percent difference between results, 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 duplicates, matrix spikes, matrix spike duplicates, and laboratory control 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 on a regular basis. 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 are items procured and/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 work within 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 via a database (e.g., HEIS, a project-specific database). Where electronic data are not available, hard copies will be provided in accordance with Section 9.6 of the *Hanford Federal Facility Agreement and Consent Order 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. In the event 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 conduct of 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 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, quality, and/or Health and Safety organizations may conduct random surveillance and assessment 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 assessment activities would 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.

Data validation will occur on at least 5 percent of the data by matrix and analyte group (e.g., VOCs in groundwater for 1 of 20 laboratory sample delivery groups). When outliers or questionable results are identified, the data associated with these outlines and questionable data will be validated and additional data validation will be performed. This data validation will consist of selecting up to an additional 5 percent of the data for the analytical method for which statistical outliers and/or questionable data were found during the initial round of data validation (e.g., a second of the 20 sample delivery groups for groundwater VOCs will be validated). 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 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. Some pre-identified corrective actions are identified in Table 2-1.

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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 the work plan. Tables 1-2 through 1-5 present the COPCs for vadose zone soil, aquifer sediments, and groundwater. Section 1.6 of this SAP provides guidance for implementation schedule. The objective of the 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 any decontamination procedures
- Equipment failures or breakdowns and descriptions of 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 the 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:

- A as specified in its program documentation, calibration of radiological field instruments on the Hanford Site is performed by PNNL.
- 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. Figure 1-1 shows the approximate location of boreholes and new groundwater monitoring wells described in this SAP. The actual locations of boreholes and new groundwater monitoring wells will be determined based on a field walkdown of current site conditions to avoid Hanford Site National Historic restrictions, roads, and other obstructions. Figure 1-2 shows the approximate locations of the existing groundwater monitoring wells in the spatial and temporal uncertainty monitoring well network described in this SAP. There are no planned sampling activities in the 400 Area subregion.

The locations of boreholes for the 618-10 and 618-11 Burial Grounds, and the 316-4 Crib (locations 300-DU-VZ-1 through 300-DU-VZ-3) will be based on results of the radiological surveys performed during remediation of the waste sites and verification sampling results following remediation. Emphasis for locating the boreholes will be placed on points of high residual contamination at the bottom of the excavations and locations of deep vadose zone contamination approaching the water table.

Table 3-1 presents estimates for the minimum and maximum thicknesses for saturated Hanford formation sediment during the course of a seasonal cycle at the approximate locations for the 16 proposed wells in the 300 Area.

3.5.1 Vadose Zone Characterization

Samples will be collected from planned boreholes and new groundwater monitoring wells to support characterization of the vadose zone and groundwater as outlined in Table 1-1.

Table 3-1. Estimates for Thickness of Saturated Hanford Formation

Location ID	Site Description	Min. Water Table Elevation, 1992-2009 (m)	Max. Water Table Elevation, 1992-2009 (m)	Hanford/Ringold Contact Elevation (m)	Minimum Saturated Thickness (m)	Maximum Saturated Thickness (m)
C7657 (399-1-58)	Northwest portion of uranium plume	104.676	107.905	96	8.7	11.9
C7658 (399-6-3)	West portion of uranium plume	104.676	107.905	95	9.7	12.9
C7659 (399-1-59)	West-central portion of uranium plume	104.593	107.267	95	9.6	12.3
C7661 (399-6-4)	Southwest portion of uranium plume	104.544	108.294	97	7.5	11.3
C7662 (399-4-15)	Southern portion of uranium plume	104.544	107.622	94	10.5	13.6
C7656 (399-1-57)	Near-river portion of uranium plume, north	104.598	108.295	98	6.6	10.3
C7663 (399-3-33)	Near-river portion of uranium plume, south	104.344	108.227	102	2.3	6.2
C7653 (399-1-54)	North Process Pond, north portion	104.399	108.452	99	5.4	9.5
C7654 (399-1-55)	North Process Pond, south portion	104.399	108.452	100	4.4	8.5
C7655 (399-1-56	300 Area Process Trenches, south portion	104.524	108.505	103	1.5	5.5
C7660 (399-2-32)	South Process Pond, north portion	104.524	107.684	98	6.5	9.7
RIFS-a	West of 316-5 – 300 Process Trenches	104.524	108.505	103	1.5	5.5
RIFS-b	South of 316-2 – North Process Pond	104.593	107.267	95	9.6	12.3
RIFS-c	Between 315-5 – 300 Process Trenches and 300-52 – Sanitary Leach Trenches	104.593	107.267	95	9.6	12.3
RIFS-d	Northwest of 300-52 – Sanitary Leach Trenches	104.593	107.267	95	9.6	12.3
RIFS-e	South of 316-1 – South Process Pond	104.399	108.452	100	4.4	8.5

Notes:

North American Vertical Datum of 1988 (NAVD88).

Reference: PNNL-17034, *Uranium Contamination in the Subsurface Beneath the 300 Area, Hanford Site, Washington.*

ID = identification

The vadose zone and groundwater will be characterized by performing intrusive investigations in eight areas: the North Process Pond, the South Process Pond, the 300 Area Process Trenches, the Perimeter Area, the Near River Area, 618-10 Burial Ground, 618-11 Burial Ground, and 316-4 Crib. Intrusive investigations consist mainly of collecting and analyzing samples from planned boreholes and new groundwater monitoring wells in areas of known or suspected contamination. Each new groundwater well will have vadose zone samples collected for vadose zone characterization. These activities are planned to characterize the nature and extent of contamination in the vadose zone, characterize the physical properties of soil/aquifer sediments, locate potential sources, and support modeling and an assessment of risk. The data from the activities will be used to verify the adequacy of interim remedial actions and refine the preliminary conceptual site model of the 300 Area.

The scope of vadose zone characterization efforts includes field screening, collecting and analyzing soil samples from the vadose zone, collecting and analyzing aquifer sediment, performing groundwater sampling and analysis, and performing geophysical logging. The general intent of the borehole sampling design is to begin sample collection at the highest point of the historically high-water level or bottom of the waste site. The sampling frequency will be continuous from 3.1 m (10 ft) above and below the predicted historically high vadose zone-groundwater interface and at select intervals thereafter. Soil/ aquifer sediment and water samples will be collected according to the sampling scheme shown in Table 3-2. Additional samples may be collected based on observations made in the field.

Soil and aquifer sediment samples will be collected at select locations as listed in Table 3-2. The purpose for collecting trace metals, major cations, and major anions in the vadose zone and periodically rewetted zone in select locations is to increase understanding with respect to the geochemical environment and uranium transport. PNNL-specific tests also will include analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future.

As listed in Table 3-2, sediment samples will be analyzed for various physical properties that are used as input parameters for computer models. The physical property samples will be collected from major formation and lithology changes, approximately in the unsaturated Hanford formation, partially saturated water-table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones. 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 3-2, assist in determining sample shipping requirements, and support worker health and safety monitoring. Section 3.6.3 describes radiological field screening methods.

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
Well C7657 (399-1-58) – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the Perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at northwest perimeter of uranium plume.	38	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 2 samples from within the saturated Hanford formation by **split spoon** (8 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4 (PNNL-AGG-415, or equivalent).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water-table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 26-28.5, 32-34.5, and 35-37.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		
Well C7658 (399-6-3) – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at west perimeter of uranium plume.	48	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 2 samples from within the saturated Hanford formation by **split spoon** (11 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 35-37.5, 41-43.5, and 44-46.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		
Well C7659 (399-1-59) – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at west perimeter of uranium plume, and downgradient of 618-1 and 618-2 Burial Grounds remedial action sites.	41	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.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 2 samples from within the saturated Hanford formation by **split spoon** (9 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 29-31.5, 35-37.5, and 38-40.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-5.		
		Major formation and lithology changes and 29-31.5, 35-37.5, and 41-43.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Geochemical analyses of sediments in accordance with Table 2-5.		
Well C7656 (399-1-57) – Near River To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the Near River Area. Justification. Proposed to evaluate water-table zone and unconfined aquifer in high-concentration portion of uranium plume, within zone of groundwater/river water interaction.	34	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Expedited VOC analysis will be requested for the sample collected from the bottom of the unconfined aquifer. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 2 samples from within the saturated Hanford formation by **split spoon** (7 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 23-25.5, 29-31.5, and 32-34.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
Well C7661 (399-6-4) – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at southwest perimeter of uranium plume.	47	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 2 samples from within the saturated Hanford formation by **split spoon** (9 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 35-37.5, 41-43.5, and 44-46.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		
Well C7662 (399-4-15) – Perimeter To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer at the perimeter of the 300 Area. Justification. Proposed to evaluate vadose zone and unconfined aquifer at south perimeter of uranium plume. This location is south of the uranium plume between the western edge and the river.	44	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 2 samples from within the saturated Hanford formation by **split spoon** (10 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
Well C7663 (399-3-33) – Near River To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the Near River Area. Justification. Proposed to evaluate water-table zone and unconfined aquifer in high-concentration portion of uranium plume, within zone of groundwater/river water interaction.	41	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 2 samples from within the saturated Hanford formation by **split spoon** (9 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 29-31.5, 35-37.5, and 38-40.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		
Well C7653 (399-1-54) – North Process Pond To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the northern portion of the North Process Pond. Justification. Proposed to evaluate vadose zone and unconfined aquifer beneath former liquid-waste-disposal site.	29	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Expedited VOC analysis will be requested for the sample collected from the bottom of the unconfined aquifer. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 47-49.5, 50-52.5 (or bottom of saturated Hanford formation), by **split spoon** (11 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 20-22.5, 23-25.5, and 26-28.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		
Well C7654 (399-1-55) – North Process Pond To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the southern portion of the North Process Pond. Justification. Proposed to evaluate vadose zone and unconfined aquifer beneath former liquid-waste-disposal site.	31	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Expedited VOC analysis will be requested for the sample collected from the bottom of the unconfined aquifer. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5 (or bottom of saturated Hanford formation), by **split spoon** (8 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 20-22.5, 26-28.5, and 29-31.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
Well C7655 (399-1-56) – 300 Area Process Trenches To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the southern end of the 300 Area Process Trenches. Justification. Proposed to evaluate vadose zone and unconfined aquifer beneath former liquid waste disposal site.	32	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5 (or bottom of saturated Hanford formation), by **split spoon** (7 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 20-22.5, 26-28.5, and 29-31.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		
Well C7660 (399-2-32) – South Process Pond To be drilled to the bottom of the aquifer and completed in the upper unconfined aquifer in the 300 Area at the northern end of the South Process Pond. Justification. Proposed to evaluate vadose zone and unconfined aquifer beneath former liquid-waste-disposal site.	29	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, samples to be collected from the top, middle, and bottom of the unconfined aquifer and as necessary at geology changes (in particular supplemental samples from water yielding fine grain units will be targeted) (estimated 5 samples). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		20-22.5, 23-25.5, 26-28.5, 29-31.5, 32-34.5, 35-37.5, 38-40.5, 41-43.5, 44-46.5, 47-49.5 (or bottom of saturated Hanford formation), by **split spoon** (10 samples).	Geologic description of sediments encountered: • Above water table: Laboratory analyses in accordance with Table 2-2. Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent).		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
		Major formation and lithology changes samples by **split spoon** – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (5 samples).	Physical properties in accordance with Table 2-2.		
		Major formation and lithology changes and 20-22.5, 23-25.5, and 26-28.5 (at the water table), **grab** samples – Approximately in the unsaturated Hanford formation, partially saturated water table Hanford formation, Hanford formation permanently saturated, Ringold coarse, and Ringold fine zones (8 samples).	Laboratory analyses in accordance with Table 2-5.		
Temporary Well RIFS-a To be drilled deep enough to collect the identified samples and completed in the upper unconfined aquifer. Justification. Proposed to develop contaminant information along transects away from waste site footprints and determine where uranium may be concentrated in the lower vadose zone near waste sites.	Unknown	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, sample to be collected when saturated conditions are encountered (estimated 1 sample). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		During drilling, samples to be collected 10-7.5, 7-4.5, and 4-1.5 ft above water table, at water table, 2-4.5, 5-7.5, and 8-10.5 ft below top of water table by **split spoon** (7 samples). Geologists will ensure at least 1 sample will be taken in the zone always saturated at lowest water level.	Geologic description of sediments encountered: • Above water table: Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent). Physical properties in accordance with Table 2-5.		
Temporary Well RIFS-b To be drilled deep enough to collect the identified samples and completed in the upper unconfined aquifer. Justification. Proposed to develop contaminant information along transects away from waste site footprints and determine where uranium may be concentrated in the lower vadose zone near waste sites.	Unknown	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, sample to be collected when saturated conditions are encountered (estimated 1 sample). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		During drilling, samples to be collected 10-7.5, 7-4.5, and 4-1.5 ft above water table, at water table, 2-4.5, 5-7.5, and 8-10.5 ft below top of water table by **split spoon** (7 samples). Geologists will ensure at least 1 sample will be taken in the zone always saturated at lowest water level.	Geologic description of sediments encountered: • Above water table: Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent). Physical properties in accordance with Table 2-5.		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
Temporary Well RIFS-c To be drilled deep enough to collect the identified samples and completed in the upper unconfined aquifer. Justification. Proposed to develop contaminant information along transects away from waste site footprints and determine where uranium may be concentrated in the lower vadose zone near waste sites.	Unknown	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, sample to be collected when saturated conditions are encountered (estimated 1 sample). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		During drilling, samples to be collected 10-7.5, 7-4.5, and 4-1.5 ft above water table, at water table, 2-4.5, 5-7.5, and 8-10.5 ft below top of water table by **split spoon** (7 samples). Geologists will ensure at least 1 sample will be taken in the zone always saturated at lowest water level.	Geologic description of sediments encountered: • Above water table: Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent). Physical properties in accordance with Table 2-5.		
Temporary Well RIFS-d To be drilled deep enough to collect the identified samples and completed in the upper unconfined aquifer. Justification. Proposed to develop contaminant information along transects away from waste site footprints and determine where uranium may be concentrated in the lower vadose zone near waste sites.	Unknown	During drilling, grab samples will be collected at the specified intervals where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, sample to be collected when saturated conditions are encountered (estimated 1 sample). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		During drilling, samples to be collected 10-7.5, 7-4.5, and 4-1.5 ft above water table, at water table, 2-4.5, 5-7.5, and 8-10.5 ft below top of water table by **split spoon** (7 samples). Geologists will ensure at least 1 sample will be taken in the zone always saturated at lowest water level.	Geologic description of sediments encountered: • Above water table: Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent). Physical properties in accordance with Table 2-5.		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
Temporary Well RIFS-e To be drilled deep enough to collect the identified samples and completed in the upper unconfined aquifer. Justification. Proposed to develop contaminant information along transects away from waste site footprints and determine where uranium may be concentrated in the lower vadose zone near waste sites.	Unknown	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	During drilling, sample to be collected when saturated conditions are encountered (estimated 1 sample). Samples will be filtered as required.	Laboratory analyses in accordance with Table 2-6. Field parameters at the time of sampling in accordance with Table 2-6.
		During drilling, samples to be collected 10-7.5, 7-4.5, and 4-1.5 ft above water table, at water table, 2-4.5, 5-7.5, and 8-10.5 ft below top of water table by **split spoon** (7 samples). Geologists will ensure at least 1 sample will be taken in the zone always saturated at lowest water level.	Geologic description of sediments encountered: • Above water table: Batch leach analysis designed to reveal exchange rates between solid and dissolved forms of uranium (primary isotopes and metal) under geochemical conditions expected for the 300 Area subsurface within 10 feet of the water table during the foreseeable future (see Section 2.2.4 for procedure). • Below water table: Leach tests in accordance with Table 2-4(PNNL-AGG-415, or equivalent). Physical properties in accordance with Table 2-5.		
Borehole 300-DU-VZ-1 – 618-10 To be drilled to the bottom of the aquifer and decommissioned in the 600 Area at the 618-10 Burial Ground. Justification. Proposed to evaluate the 618-10 Burial Ground.	Unknown	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	None	None
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5, 79-81.5, 82-84.5, 85-87.5, 88-90.5, 91-93.5, 94-96.5, 97-99.5 (or bottom of saturated Hanford formation), by **split spoon** (25 samples).	Laboratory analyses and field parameters in accordance with Table 2-3. Leach tests for sediment samples in accordance with Table 2-4 (EPA 6010, UKPA or isotopic uranium). Physical properties for sediment samples in accordance with Table 2-3.		
Borehole 300-DU-VZ-2 – 618-11 To be drilled to the bottom of the aquifer and decommissioned in the 600 Area at the 618-11 Burial Ground. Justification. Proposed to evaluate the 618-11 Burial Ground.	Unknown	During drilling, grab archive samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	None	None
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5, 79-81.5, 82-84.5, 85-87.5, 88-90.5, 91-93.5, 94-96.5, 97-99.5 (or bottom of saturated Hanford formation), by **split spoon** (25 samples).	Laboratory analyses and field parameters in accordance with Table 2-3. Leach tests for sediment samples in accordance with Table 2-4 (EPA 6010, UKPA or isotopic uranium). Physical properties for sediment samples in accordance with Table 2-3.		
Borehole 300-DU-VZ-3 – 316-4 To be drilled to the bottom of the aquifer and decommissioned in the 600 Area at the 316-4 Crib. Justification. Proposed to evaluate the 316-4 Crib.	Unknown	During drilling, grab samples will be collected at the specified intervals or where lithology changes occur in one-pint jar and a chip tray from the drill cuttings.*	Geologic archive samples.*	None	None
		20-22.5, 30-32.5, 33-35.5, 36-38.5, 39-41.5, 42-44.5, 45-47.5, 48-50.5, 50.5-53, 53-55.5, 55.5-58, 58-60.5, 61-63.5, 64-66.5, 67-69.5, 70-72.5, 73-75.5, 76-78.5, 79-81.5, 82-84.5, 85-87.5, 88-90.5, 91-93.5, 94-96.5, 97-99.5 (or bottom of saturated Hanford formation), by **split spoon** (25 samples).	Laboratory analyses and field parameters in accordance with Table 2-3. Leach tests for sediment samples in accordance with Table 2-4(EPA 6010, UKPA or isotopic uranium). Physical properties for sediment samples in accordance with Table 2-3.		

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
Sample one existing monitoring well in the 300 Area: • 399-1-16B Justification. Proposed to support Data Need 4.	N/A	None	None	Total of 10 samples as pumping proceeds.	For the 1st and 10th samples – only analyze for the following in accordance with Table 2-6: • Uranium (total, unfiltered sample) • Method 6010 or 6020 • Method 7470 or 200.8 • Method 8260 • Method 300.0 • Alkalinity Field parameters at the time of sampling in accordance with Table 2-6. For the 2nd through 9th samples: Only analyze for the following in accordance with Table 2-6: • Method 8260 • Alkalinity Field parameters at the time of sampling in accordance with Table 2-6.
Sample one existing and one new monitoring well in the 300 Area: • 399-1-8 Well C7654 (399-1-55) Justification. Proposed to support Data Need 4.	N/A	None	None	One sample at the beginning of the pump test and one a day following completion of the test for each well (2 samples x 2 wells=4 samples).	Only analyze for the following in accordance with Table 2-6: • Uranium (total, unfiltered sample) • Method 6010 or 6020 • Method 7470 or 200.8 • Method 8260 • Method 300.0 • Alkalinity Field parameters at the time of sampling in accordance with Table 2-6.
Sample 16 spatial/temporal uncertainty monitoring wells (Table 3-3); three rounds in the 300 Area.	N/A	None	None	Multiple sampling rounds to support RI (16 wells × 3 rounds = 48 samples).	Laboratory analyses in accordance with Table 2-7. Field parameters at the time of sampling in accordance with Table 2-7.
Sample 17 spatial/temporal uncertainty monitoring wells (Table 3-3); three rounds in the 600 Area.	N/A	None	None	Multiple sampling rounds to support RI (17 wells × 3 rounds = 51 samples).	Laboratory analyses in accordance with Table 2-8. Field parameters at the time of sampling in accordance with Table 2-8.

Table 3-2. Sample/Measurement Locations and Depth

Sampling Location	Estimated Depth to GW (ft bgs)	Soil/Aquifer Sediment Sample/Measurement		Water Sample/Measurement	
		Sample Interval Depth (ft bgs)	Analyte/Property List	Sample Interval Depth (ft bgs) or Frequency	Analyte/Property List
Summary					
(1) Estimated number of samples:					
Soil/aquifer sediment chemical:		264			
Physical property:		80			
Geologic archive samples:		variable			
Water samples collected during drilling:		60			
Spatial and temporal uncertainty groundwater samples:		99 (3 rounds total)			
Pump test groundwater samples:		14			
(2) Estimated minimum number of field QC samples:					
Soil/aquifer sediment chemical:		43 (14 equipment rinsate blank, 14 field blank, 14 duplicate, 1 split)			
Physical property:		0			
Geologic archive samples:		0			
Water samples collected during drilling:		10 (3 equipment rinsate blank, 3 field blank, 3 duplicate, 1 split)			
Spatial and temporal uncertainty groundwater samples:		16 (5 equipment rinsate blank, 5 field blank, 5 duplicate, 1 split)			
Pump test groundwater samples:		6 (2 equipment rinsate blank, 2 field blank, 2 duplicate)			
(3) Estimated total number of samples [(1) + (2)]:					
Soil/aquifer sediment chemical:		307			
Physical property:		80			
Geologic archive samples:		variable			
Water samples collected during drilling:		70			
Spatial and temporal uncertainty groundwater samples:		115			
Pump test groundwater samples:		20			

Notes:

* Archive samples may be omitted at the discretion of the field geologist due to radiological field data.

bgs = below ground surface

GW = groundwater

UKPA = total uranium by kinetic phosphorescence analysis

3.5.1.2 Geophysical Logging

The planned boreholes and new 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.

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 3-2 summarizes well activities. For each new well screened in the Ringold Formation Upper Mud Unit, slug testing and pump testing will be performed to characterize hydraulic conductivity. Groundwater samples will be collected from the groundwater wells (including temporary wells) installed under the scope of this SAP quarterly for the first year, with a reduction in frequency for subsequent years, if warranted, in accordance with DOE/RL-2002-11, *300-FF-5 Operable Unit Sampling and Analysis Plan.*

Well Depth and Screen Placement

For the 11 new groundwater wells in the unconfined aquifer in the 300 Area, a 4.6 m (15-ft) screen will be installed such that groundwater samples can be taken from the well during all expected groundwater elevation conditions. .An exception to this will be made if VOC contamination is discovered deeper in the unconfined aquifer (i.e., at a depth horizon comparable to that observed at Well 399-1-16B). If that occurs, screen length and placement will be specified based on the contaminated horizons and sediment characteristics encountered, with the intent to be able to sample distinct contaminated horizons. Concurrence of EPA on screen placement will be gained prior to completing the well. This exception has the greatest likelihood of occurrence at locations No. 6, No. 8, and No. 9 (Figure 1-1) (Wells C7656, C7653, and C7654). Screen length at a particular location may be modified to account for local hydrologic conditions. Also, screen slot size will be based on conditions encountered at the site.

For the five temporary groundwater wells, designated RIFS-a, RIFS-b, RIFS-c, RIFS-d and RIFS-e, to be completed in the unconfined aquifer in the 300 Area, a 0.6 m (2-ft) screen will be installed to cover the top of the water table at low seasonal conditions. Screen length may be modified to account for local hydrologic conditions. Also, screen slot size will be based on conditions encountered at the site.

For the three boreholes in the 600 Area subregion, each will be decommissioned with RL and EPA approval, in accordance with WAC 173-160, after sampling and geophysical logging are completed.

Well Drilling and Completion Procedures

Well drilling will be performed in accordance with WAC 173-160. The 11 new wells will be drilled using 25.4 cm (10-in.-) diameter (or larger) casing to total depth. The five temporary wells will be drilled using 20.3 cm (8-in.-) diameter (or larger) casing to total depth. The drilling method(s) will be determined based on discussions between the drilling lead and drilling contractor.

The 11 new wells will be constructed as 15.2 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 stainless steel casing through the vadose zone to ground surface. Colorado silica sand 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.

The five temporary wells will be constructed as 10 cm (4-in.) wells with Schedule 40 polyvinyl chloride (PVC), including sump and end cap, and 20-slot well screen. A Schedule 40 PVC riser will be used to extend the temporary well into and through the vadose zone to ground surface. Colorado silica sand will be used for the sand pack; sodium bentonite pellets and/or natural sodium bentonite chunks, crumbles, or powdered bentonite will be used for sealing material; and Type I/II Portland cement to grout the remaining annular space.

For all 16 wells, 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 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 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 on field conditions.

3.5.2.2 Groundwater Network to Evaluate Spatial and Temporal Uncertainty

Table 3-2 summarizes groundwater monitoring activities to address spatial and temporal uncertainties. Tables 3-3 and 3-4 present the spatial and temporal uncertainty groundwater monitoring wells to be sampled under the scope of this SAP. Three rounds of groundwater samples will be collected for analysis to support the spatial and temporal uncertainty evaluation at the 300 Area for the RI. To capture baseline 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 the "high", "transition," and "low" river stages (June, late July/August, and September/October, respectively). The dates and frequency of sample collection are based on measurements of river elevations to optimize collection of samples representing the temporal changes groundwater conditions. This groundwater sampling schedule captures the maximum effects of changes river elevations on aquifer conditions as well as the transition time between the maximum and minimum conditions.

The samples collected during the three spatial and temporal sampling events will be analyzed for COPCs listed in Tables 1-4 and 1-5 in accordance with performance requirements in Table 2-7 and 2-8, respectively.

Table 3-3. 300 Area Subregion Spatial and Temporal Uncertainty Monitoring Well Network Near-Field Uranium Plume Wells

399-1-10A	399-1-6	399-3-12	399-4-1
399-1-12	399-2-1	399-3-20	399-4-9
399-1-21A	399-2-2	399-3-6	399-4-12
399-1-17A	399-3-11	399-3-9	399-4-14

Table 3-4. 600 Area Subregion Spatial and Temporal Uncertainty Monitoring Well Network Far-Field Wells

99-S0-7	699-13-1A	699-15-15B	699-S28-E0
499-S0-8	699-13-1E	699-20-E5A	699-S3-E12
499-S1-8J	699-13-2D	699-S18-E2B	699-S6-E4A
699-1-18	699-13-3A	699-S19-11	699-S8-19
699-12-4D			

To determine spatial and temporal risk uncertainty for potential human and ecological receptors, the RI process requires that the groundwater be sampled, providing data representative of aquifer conditions. It is required the groundwater be sampled throughout an operable unit 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 temporal risk uncertainties to potential 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 operable units associated with the River Corridor RI/FS investigations. The resulting well network data will be used to evaluate the groundwater risk information presented in DOE/RL-2007-21, the *Risk Assessment Report for the 100 Area and 300 Area Component of the River Corridor Baseline Risk Assessment* (RCBRA), while observations and conclusions regarding the data collected and the RCBRA evaluation will be documented in the RI report (e.g., risk uncertainties associated with temporal and spatial representativeness, verifying RCBRA groundwater risk conclusions, ensuring no contaminants were inadvertently overlooked, and establishing a "present condition" dataset that can be used to measure the progress of future cleanup actions).

Sampling Frequency

To capture baseline aquifer conditions fully, 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 operable units bordering on the Columbia River, the changing aquifer conditions are caused by fluctuating river elevations 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. The date and frequency of sample collection is based on measurements of the river elevation to optimize collection of samples representing these temporal changes in groundwater conditions.

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 upriver 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 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 Hanford Reach.

When water is released upriver, 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 upriver reservoirs, groundwater moves from the aquifer into the river. The river then recharges 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, 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 these temporal effects on contaminant plumes within the aquifer from the low river elevation, groundwater sampling should be conducted prior to late October.

Inland from the river, the rapid river elevation changes form to a pressure pulse that appears to be transmitted along the free surface of the unconfined aquifer. This effect causes groundwater elevation changes in wells not affected by actual movement of aquifer water. For some places, 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.

Groundwater Sampling Dates

Because the goal of the temporal uncertainty groundwater sampling is to determine groundwater conditions when the river has the maximum effect on flow rate and direction, sampling is scheduled for late May to mid-June during the highest peak and from late September to late October during the time of the lowest elevation. From the second week in June to mid-September, the river elevation is in transition, decreasing from the maximum elevation to the lowest elevation. Also from March through April, elevations change from low to the high that occur in the first week of June. Consequently, the best opportunity to capture transitional conditions occurs during the months of March and April or July and August.

Based on the previous discussion, three sampling events are recommended to represent the temporal fluctuations in groundwater conditions at each of operable units located along the river corridor. One sampling event captures the effect on the aquifer when the river stage is highest and the greatest increase in aquifer elevation occurs (May to mid-June). The second sampling interval ranges from mid-September to mid-October when the river is at the lowest elevation for the year. This 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 March through April or July through August. Thus, the groundwater sampling schedules, which support the temporal uncertainty evaluation for the RI/FS at each operable unit along the river, capture the maximum effects of changing river elevations on aquifer conditions as well as the transitional time between the maximum and minimum changing conditions.

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 precleaned, stainless steel mixing bowl or other suitable precleaned 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:

- For 300 Area Subregion: Leach tests on sediment with chemical and radiological analysis of pore water samples, analysis designed to reveal exchange rates between solid and dissolved forms of contaminant uranium under geochemical conditions expected for the 300 Area subsurface during the foreseeable future, and uranium (chemical and isotopic) and COPCs are high priority. Physical property and geochemical analyses of sediments are lower priority.
- For 600 Area Subregion: Leach tests on sediment with chemical and radiological analysis of pore water samples are high priority, followed by chemical and radiological COPC analysis and field screening parameters.

Groundwater samples collected during drilling, before development, will be pumped from selected intervals. If field conditions preclude use of a pump for purging and sampling, the groundwater samples collected during drilling may be bailed from the interval(s). The pump (or bailer) will be operated for a period of time sufficient to provide stabilized field readings, but not necessarily three casing volumes. Borehole water samples will be filtered as required during drilling. If the solid content in the water influences the collection of the samples, then filtering will be performed. No absolute turbidity value is given as to filter or not, it is a judgment in the field by the sampling lead.

For the spatial and temporal uncertainty groundwater monitoring well network, before sample capture, the pump will be operated for a period of time sufficient 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, 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 impacting 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 RL and regulator 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/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), 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 disseminated to personnel performing work in support of this SAP.

- Instructions will be provided 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

Sample handling, including sample packaging, container labeling, sample custody, and sample transportation, is discussed in this section.

3.7.1 Sample Packaging

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 3-5 and 3-6.

Table 3-5. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size[a]
ICP/MS, PNNL-AGG-415	Cool 4 °C	6 months	Stainless steel or Lexan liner	4-in.-diameter by 6-in.-long liners
PNNL specific tests	To be determined	To be determined	To be determined	Variable between 1 L poly container and a 5-gal bucket due to variability in grain size (cobble or larger sediment will need the largest sample)
Isotopic – uranium	None	6 month	G/P	5 g
Isotopic – plutonium	None	6 months	G/P	5 g
Liquid scintillation counter	None	6 months	G	33 g
Gamma energy analysis	None	6 months	G/P	750 g
EPA 6010/6020	Cool ~4 °C	6 months	G/P	15 g
EPA 7471	None	28 days	G/P	15 g
EPA 8015	Cool ~4 °C	14 days	G	50 g
EPA 8082	Cool ~4 °C	14/40 days[b]	aG	50 g
EPA 8260	Cool ~4 °C [c]	14 days	G	50 g
EPA 8270	Cool ~4 °C	14/40 days [b]	aG	50 g
EPA 8310	Cool ~4 °C	14/40 days [b]	aG	120 g
UKPA	None	6 months	G/P	10 g
EPA 300.0	Cool ~4 °C	48 hours/ 28 days[d]	G/P	50 g
Total carbon	None	6 months	Stainless steel or Lexan liner	4-in.-diameter by 6-in.-long liners

Table 3-5. Sample Preservation, Container, and Holding Time for Soil/Aquifer Sediment Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size[a]
Inorganic carbon	None	6 months	Stainless steel or Lexan liner	4-in.-diameter by 6-in.-long liners
Alkalinity	None	None	G	100 mL
ASTM D2216-05	None	None	Moisture-proof container	200 g
ASTM D2937-04	None	None	G/P	1,000 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.

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

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

PNNL-AGG-415, Inductively Coupled Plasma Mass Spectrometric (ICP-MS) Analysis.

Lexan is a registered trademark of Sabin Innovative Plastics, Pittsfield, Massachusetts.

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

a. Based on minimum QC requirements.

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

c. Field preservation EPA 5035A also may be used.

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

aG = amber glass
C = centigrade
g = gram(s)
G = glass
ICP/MS = inductively coupled plasma/mass spectrometry
in. = inch(es)
mL = milliliter
P = plastic
UKPA = total uranium by kinetic phosphorescence analysis

Table 3-6. Sample Preservation, Container, and Holding Time for Water Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size[a]
PNNL specific tests (to include microbial activity)	To be determined	To be determined	To be determined	To be determined
Iodine-129 – low level	None	6 months	G/P	2,000 mL
Strontium 89/90 – Sr-90	HNO_3 to pH <2	6 months	G/P	2,000 mL
Tritium (H-3)	None	6 months	G	60 mL

Table 3-6. Sample Preservation, Container, and Holding Time for Water Samples

Method	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size[a]
Isotopic – Uranium	None	6 months	G/P	2,000 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
Total uranium (chemical)	HNO_3 to pH <2	6 months	G/P	500 mL
EPA 8260	Cool ~4 °C, HCl or H_2SO_4 to pH <2	14 days	aGs	40 mL
EPA 8270	Cool ~4 °C	14/40 days[b]	aG	1,000 mL
EPA 7470 or 200.8	HNO_3 to pH <2	28 days	G	500 mL
EPA 9010 or 9012	NaOH to pH >= 12	14 days	G/P	1,000 mL
Alkalinity	None	None	G	100 mL
EPA 300.0	Cool ~4 °C	48 hours/28 days[c]	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.

a. Based on minimum QC requirements.

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

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

aG	= amber glass	HCl	= hydrochloric acid
aGs	= amber glass septum; no headspace	HNO_3	= nitric acid
C	= centigrade	mL	= milliliter
G	= glass	NaOH	= sodium hydroxide
H_2SO_4	= sulfuric acid	P	= plastic

3.7.2 Container Labeling

The sample location, depth, and corresponding HEIS numbers 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 (pH, radiological readings)

Except for volatile organic analysis samples, a custody seal 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 volatile organic analysis sample vials because of a potential for affecting analytical results and/or fouling of laboratory equipment. Custody seals and any other required labels/ documentation can be fixed to the exterior of a sample container holding vials in such a manner to detect potential tampering.

3.7.3 Sample Custody

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 171-177, Chapter 1, "Research and Special Programs Administration, Department of Transportation," Part 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-2000-56, *Waste Management Plan for the 300-FF-5 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 lead agency Remedial Project Manager is required before returning unused samples or waste from offsite laboratories.

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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-11 provide the lists of analytes that will be reported when using a methods-based approach.

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

CAS No.	Constituent	Water QL (µg/L)	Soil QL (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:

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.*

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

CAS = Chemical Abstracts Service

QL = quantitation limit

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

CAS No.	Constituent	Water QL (µg/L)	Soil QL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
7429-90-5	Aluminum	50	5,000	≤20/≤30	80-120/70-130
7440-36-0	Antimony	60	6,000	≤20/≤30	80-120/70-130
7440-38-2	Arsenic	100	10,000	≤20/≤30	80-120/70-130
7440-39-3	Barium	20	2,000	≤20/≤30	80-120/70-130
7440-41-7	Beryllium	2	500	≤20/≤30	80-120/70-130
7440-69-9	Bismuth	100	10,000	≤20/≤30	80-120/70-130
7440-42-8	Boron	20	2,000	≤20/≤30	80-120/70-130
7440-43-9	Cadmium	2	500	≤20/≤30	80-120/70-130
7440-70-2	Calcium	1,000	100,000	≤20/≤30	80-120/70-130
7440-47-3	Chromium	10	1,000	≤20/≤30	80-120/70-130
7440-48-4	Cobalt	4	2,000	≤20/≤30	80-120/70-130
7440-50-8	Copper	8	1,000	≤20/≤30	80-120/70-130
7439-89-6	Iron	50	5,000	≤20/≤30	80-120/70-130
7439-92-1	Lead	50	5,000	≤20/≤30	80-120/70-130
7439-93-2	Lithium	25	2,500	≤20/≤30	80-120/70-130
7439-95-4	Magnesium	750	75,000	≤20/≤30	80-120/70-130
7439-96-5	Manganese	5	5,000	≤20/≤30	80-120/70-130
7439-98-7	Molybdenum	20	2,000	≤20/≤30	80-120/70-130
7440-02-0	Nickel	40	4,000	≤20/≤30	80-120/70-130
7723-14-0	Phosphorus	100	50,000	≤20/≤30	80-120/70-130
7440-09-7	Potassium	4,000	400,000	≤20/≤30	80-120/70-130
7782-49-2	Selenium	100	10,000	≤20/≤30	80-120/70-130
7440-21-3	Silicon	20	2,000	≤20/≤30	80-120/70-130
7440-22-4	Silver	10	1,000	≤20/≤30	80-120/70-130
7440-23-5	Sodium	500	50,000	≤20/≤30	80-120/70-130
7440-24-6	Strontium (elemental)	10	1,000	≤20/≤30	80-120/70-130
7440-28-0	Thallium	50	5,000	≤20/≤30	80-120/70-130
7440-31-5	Tin	100	10,000	≤20/≤30	80-120/70-130
7440-62-2	Vanadium	25	2,500	≤20/≤30	80-120/70-130
7440-66-6	Zinc	10	1,000	≤20/≤30	80-120/70-130

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

CAS No.	Constituent	Water QL (µg/L)	Soil QL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)

Notes:

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

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

CAS = Chemical Abstracts Service

QL = quantitation limit

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

CAS No.	Constituent	Water QL (µg/L)	Soil QL (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.

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

CAS = Chemical Abstracts Service

QL = quantitation limit

Table A-4. U.S. Environmental Protection Agency SW-846 Method 8015

CAS No.	Constituent	Water QL (µg/L)	Soil QL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
107-21-1	Ethylene glycol	5,000	5,000	≤20/≤30	80-120/70-130
141-78-6	Ethyl acetate	5,000	5,000	≤20/≤30	80-120/70-130
60-29-7	Diethyl ether	5,000	5,000	≤20/≤30	80-120/70-130
64-17-5	Ethanol	5,000	5,000	≤20/≤30	80-120/70-130
71-36-3	1-Butanol	5,000	5,000	≤20/≤30	80-120/70-130

Notes:

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

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

CAS = Chemical Abstracts Service

QL = quantitation limit

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

CAS No.	Constituent	Water QL (µg/L)	Soil QL (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.*

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

CAS = Chemical Abstracts Service

QL = quantitation limit

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

CAS No.	Constituent	Water QL (µg/L)	Soil QL (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	10	≤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
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

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

CAS No.	Constituent	Water QL (µg/L)	Soil QL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
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	2	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.*

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

CAS = Chemical Abstracts Service

QL = quantitation limit

Table A-7. U.S. Environmental Protection Agency SW-846 Method 8270

CAS No.	Constituent	Water QL (µg/L)	Soil QL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
120-82-1	1,2,4-Trichlorobenzene	10	330	≤20/≤30	80-120/70-130
95-50-1	1,2-Dichlorobenzene	10	330	≤20/≤30	80-120/70-130
541-73-1	1,3-Dichlorobenzene	10	330	≤20/≤30	80-120/70-130
106-46-7	1,4-Dichlorobenzene	5	330	≤20/≤30	80-120/70-130
95-95-4	2,4,5-Trichlorophenol	10	330	≤20/≤30	80-120/70-130
88-06-2	2,4,6-Trichlorophenol	10	330	≤20/≤30	80-120/70-130
120-83-2	2,4-Dichlorophenol	10	330	≤20/≤30	80-120/70-130
105-67-9	2,4-Dimethylphenol	10	330	≤20/≤30	80-120/70-130
51-28-5	2,4-Dinitrophenol	25	825	≤20/≤30	80-120/70-130
121-14-2	2,4-Dinitrotoluene	10	330	≤20/≤30	80-120/70-130
606-20-2	2,6-Dinitrotoluene	10	330	≤20/≤30	80-120/70-130
91-58-7	2-Chloronaphthalene	10	330	≤20/≤30	80-120/70-130
95-57-8	2-Chlorophenol	10	330	≤20/≤30	80-120/70-130
91-57-6	2-Methylnaphthalene	10	330	≤20/≤30	80-120/70-130

Table A-7. U.S. Environmental Protection Agency SW-846 Method 8270

CAS No.	Constituent	Water QL (µg/L)	Soil QL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
95-48-7	2-Methylphenol (cresol, o-)	10	330	≤20/≤30	80-120/70-130
88-74-4	2-Nitroaniline	10	330	≤20/≤30	80-120/70-130
88-75-5	2-Nitrophenol	20	660	≤20/≤30	80-120/70-130
91-94-1	3,3'-Dichlorobenzidine	10	330	≤20/≤30	80-120/70-130
65794-96-9	3+4 Methylphenol (cresol, m+p)*	10	330	≤20/≤30	80-120/70-130
99-09-2	3-Nitroaniline	10	330	≤20/≤30	80-120/70-130
534-52-1	4,6-Dinitro-2-methylphenol	10	330	≤20/≤30	80-120/70-130
101-55-3	4-Bromophenylphenyl ether	10	330	≤20/≤30	80-120/70-130
59-50-7	4-Chloro-3-methylphenol	10	330	≤20/≤30	80-120/70-130
106-47-8	4-Chloroaniline	10	330	≤20/≤30	80-120/70-130
7005-72-3	4-Chlorophenylphenyl ether	10	330	≤20/≤30	80-120/70-130
100-01-6	4-Nitroaniline	10	330	≤20/≤30	80-120/70-130
100-02-7	4-Nitrophenol	20	660	≤20/≤30	80-120/70-130
83-32-9	Acenaphthene	10	330	≤20/≤30	80-120/70-130
208-96-8	Acenaphthylene	10	330	≤20/≤30	80-120/70-130
120-12-7	Anthracene	10	330	≤20/≤30	80-120/70-130
56-55-3	Benzo(a)anthracene	10	330	≤20/≤30	80-120/70-130
50-32-8	Benzo(a)pyrene	10	330	≤20/≤30	80-120/70-130
205-99-2	Benzo(b)fluoranthene	10	330	≤20/≤30	80-120/70-130
191-24-2	Benzo(ghi)perylene	10	330	≤20/≤30	80-120/70-130
207-08-9	Benzo(k)fluoranthene	10	330	≤20/≤30	80-120/70-130
108-60-1	Bis(2-chloro-1-methylethyl)ether	10	330	≤20/≤30	80-120/70-130
111-91-1	Bis(2-Chloroethoxy)methane	10	330	≤20/≤30	80-120/70-130
111-44-4	Bis(2-chloroethyl) ether	10	330	≤20/≤30	80-120/70-130
117-81-7	Bis(2-ethylhexyl) phthalate	10	330	≤20/≤30	80-120/70-130
85-68-7	Butylbenzylphthalate	10	330	≤20/≤30	80-120/70-130
86-74-8	Carbazole	10	330	≤20/≤30	80-120/70-130
218-01-9	Chrysene	10	330	≤20/≤30	80-120/70-130
53-70-3	Dibenz[a,h]anthracene	10	330	≤20/≤30	80-120/70-130
132-64-9	Dibenzofuran	10	330	≤20/≤30	80-120/70-130

Table A-7. U.S. Environmental Protection Agency SW-846 Method 8270

CAS No.	Constituent	Water QL (µg/L)	Soil QL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
84-66-2	Diethylphthalate	10	330	≤20/≤30	80-120/70-130
131-11-3	Dimethyl phthalate	10	330	≤20/≤30	80-120/70-130
84-74-2	Di-n-butylphthalate	10	330	≤20/≤30	80-120/70-130
117-84-0	Di-n-octylphthalate	10	330	≤20/≤30	80-120/70-130
206-44-0	Fluoranthene	10	330	≤20/≤30	80-120/70-130
86-73-7	Fluorene	10	330	≤20/≤30	80-120/70-130
118-74-1	Hexachlorobenzene	10	330	≤20/≤30	80-120/70-130
87-68-3	Hexachlorobutadiene	10	330	≤20/≤30	80-120/70-130
77-47-4	Hexachlorocyclopentadiene	10	330	≤20/≤30	80-120/70-130
67-72-1	Hexachloroethane	10	330	≤20/≤30	80-120/70-130
193-39-5	Indeno(1,2,3-cd)pyrene	10	330	≤20/≤30	80-120/70-130
78-59-1	Isophorone	10	330	≤20/≤30	80-120/70-130
91-20-3	Naphthalene	10	330	≤20/≤30	80-120/70-130
98-95-3	Nitrobenzene	10	330	≤20/≤30	80-120/70-130
621-64-7	n-Nitrosodi-n-dipropylamine	10	330	≤20/≤30	80-120/70-130
86-30-6	n-Nitrosodiphenylamine	10	330	≤20/≤30	80-120/70-130
87-86-5	Pentachlorophenol	10	330	≤20/≤30	80-120/70-130
85-01-8	Phenanthrene	10	330	≤20/≤30	80-120/70-130
108-95-2	Phenol	10	330	≤20/≤30	80-120/70-130
129-00-0	Pyrene	10	330	≤20/≤30	80-120/70-130

Notes:

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

* May report as 3-Methylphenol (cresol, p-) and 4-Methylpheonl (cresol, m-) or a 3+4 Methylphenol (cresol, m+p) total.

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

CAS = Chemical Abstracts Service

QL = quantitation limit

Table A-8. U.S. Environmental Protection Agency SW-846 Method 8310

CAS No.	Constituent	Water QL (µg/L)	Soil QL (µg/kg)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
83-32-9	Acenaphthene	20	100	≤20/≤30	80-120/70-130
208-96-8	Acenaphthylene	25	100	≤20/≤30	80-120/70-130
120-12-7	Anthracene	10	50	≤20/≤30	80-120/70-130
56-55-3	Benzo(a)anthracene	0.3	15	≤20/≤30	80-120/70-130
50-32-8	Benzo(a)pyrene	0.5	15	≤20/≤30	80-120/70-130
205-99-2	Benzo(b)fluoranthene	0.5	15	≤20/≤30	80-120/70-130
191-24-2	Benzo(ghi)perylene	1	30	≤20/≤30	80-120/70-130
207-08-9	Benzo(k)fluoranthene	0.5	15	≤20/≤30	80-120/70-130
218-01-9	Chrysene	5	50	≤20/≤30	80-120/70-130
53-70-3	Dibenz[a,h]anthracene	1	30	≤20/≤30	80-120/70-130
206-44-0	Fluoranthene	5	50	≤20/≤30	80-120/70-130
86-73-7	Fluorene	3	30	≤20/≤30	80-120/70-130
193-39-5	Indeno(1,2,3-cd)pyrene	1	30	≤20/≤30	80-120/70-130
91-20-3	Naphthalene	20	100	≤20/≤30	80-120/70-130
85-01-8	Phenanthrene	10	50	≤20/≤30	80-120/70-130
129-00-0	Pyrene	5	50	≤20/≤30	80-120/70-130

Notes:

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

µg/kg = micrograms per kilogram

µg/L = micrograms per liter

CAS = Chemical Abstracts Service

QL = quantitation limit

Table A-9. Gamma Spectroscopy, Germanium High-Energy Detectors (Gamma Energy Analysis)

CAS No.	Constituent	Water QL (pCi/L)	Soil QL (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

Table A-9. Gamma Spectroscopy, Germanium High-Energy Detectors (Gamma Energy Analysis)

CAS No.	Constituent	Water QL (pCi/L)	Soil QL (pCi/g)	Precision Requirement Water/Soil (%)	Accuracy Requirement Water/Soil (%)
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 QL is not specified, the QLs 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

QL = quantitation limit

pCi/g = picocuries per gram

pCi/L = picocuries per liter

Table A-10. Isotopic Uranium

CAS No.	Constituent	Water QL (pCi/L)	Soil QL (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

QL = quantitation limit

pCi/g = picocuries per gram

pCi/L = picocuries per liter

Table A-11. Plutonium

CAS No.	Constituent	Water QL (pCi/L)	Soil QL (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

QL = quantitation limit

pCi/g = picocuries per gram

pCi/L = picocuries per liter

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