1229356
[0081545H]

RPP-PLAN-57332, Rev. 0

# Field Sampling and Analysis Plan for Soil Samples at Waste Management Area A-AX

Author Name:
A. W. Radloff, C. L. Tabor, R. D. Childress
Washington River Protection Solutions, LLC
Richland, WA 99352
U.S. Department of Energy Contract DE-AC27-08RV14800

RECEIVED
APR 16 2015
EDMC

| | | | |
|---|---|---|---|
| EDT/ECN: | DRCF | UC: | |
| Cost Center: | | Charge Code: | |
| B&R Code: | | Total Pages: | 55 |

Key Words: 241-A Tank Farm, 241-AX Tank Farm, A Farm, AX Farm, Waste Management Area, WMA A-AX, Field Sampling and Analysis Plan, Sampling and Analysis Plan, inductively coupled plasma, mass spectroscopy, laboratory control sample, surface geophysical exploration, single-shell tank.

Abstract: This plan documents the sampling and analysis activities that will be conducted as part of the characterization efforts at 241-A and 241-AX Tank Farms. The overall objective of this effort is characterization of vadose zone soil in 241-A and 241-AX Tank Farms by pushing borings for geophysical logging, soil sampling, and deep electrode placement for electrical resistivity imaging (surface geophysical exploration).

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

APPROVED
By Janis D. Aardal at 2:10 pm, Nov 20, 2014

Release Approval Date

DATE:
Nov 20, 2014
HANFORD RELEASE

Release Stamp

**Approved For Public Release**

S-2-4
WMA- A-AX



50

**RPP-PLAN-57332**
**Revision 0**

# Field Sampling and Analysis Plan for Soil Samples at Waste Management Area A-AX

**A. W. Radloff**
**C. L. Tabor**
**R. D. Childress**
Washington River Protection Solutions, LLC

Date Published
**November 2014**

washington river protection solutions

Prepared for the U.S. Department of Energy
Office of River Protection

Contract No. DE-AC27-08RV14800

This page intentionally left blank.

## TABLE OF CONTENTS


1.0 PURPOSE AND SCOPE ..... 1-1

2.0 FACILITY DESCRIPTION ..... 2-1

3.0 SAMPLING REQUIREMENTS ..... 3-1

3.1 SOIL SAMPLING TECHNIQUE, STRATEGY, AND DESIGN ..... 3-1
3.1.1 Sampling Technique ..... 3-1
3.1.2 Sampling Strategy and Design ..... 3-1
3.2 SAMPLE COLLECTION, HANDLING, AND SHIPPING ..... 3-2
3.3 SAMPLE IDENTIFICATION ..... 3-3
3.4 SAMPLE CUSTODY ..... 3-8

4.0 SAMPLE ANALYSIS REQUIREMENTS ..... 4-1

4.1 DIRECTION FOR SAMPLE HANDLING AND PREPARATION ..... 4-7
4.2 INSUFFICIENT RECOVERY OF SAMPLE MATERIAL ..... 4-8

5.0 QUALITY ASSURANCE AND QUALITY CONTROL ..... 5-1

5.1 QUALITY CONTROL REQUIREMENTS FOR FIELD SAMPLING ..... 5-2
5.1.1 Equipment Rinsate Blank Samples ..... 5-2
5.1.2 Field Blank Samples ..... 5-2
5.1.3 Prevention of Cross-Contamination ..... 5-3
5.2 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS FOR LABORATORY ANALYSIS ..... 5-3
5.2.1 Laboratory Quality Control ..... 5-4
5.2.2 Instrument/Equipment Testing, Inspection, and Maintenance ..... 5-4

6.0 DATA REPORTING ..... 6-1

6.1 "QUICK TURN" REPORTING ..... 6-1
6.2 FORMAT VI REPORTING ..... 6-1
6.3 DATA VERIFICATION AND ASSESSMENT ..... 6-2
6.4 DATA DELIVERABLES ..... 6-2

7.0 CHANGE CONTROL ..... 7-1

8.0 DOCUMENTS AND RECORDS ..... 8-1

9.0 PROJECT ORGANIZATION ..... 9-1

10.0 REFERENCES ..... 10-1

## LIST OF FIGURES

Figure 1-1. 241-A Tank Farm Seven Direct Push Locations ..... 1-3

Figure 1-2. 241-AX Tank Farm Four Direct Push Locations. ..... 1-5

Figure 2-1. Waste Management Area A-AX, Surrounding Facilities, and Direct Push Logging Locations ..... 2-3

## LIST OF TABLES

Table 3-1. Soil Sampling Requirements for Waste Management Area A-AX. ..... 3-4

Table 3-2. Field Quality Control Requirements for Waste Management Area A-AX. ..... 3-6

Table 4-1. Analytical Requirements for Waste Management Area A-AX. ..... 4-2

Table 5-1. Data Quality Definitions ..... 5-3

Table 9-1. Key Personnel ..... 9-2

# LIST OF TERMS

**Acronyms/Abbreviations**

| | |
|---|---|
| ATL | Advanced Technologies and Laboratories International, Inc. |
| bgs | below ground surface |
| CFR | *Code of Federal Regulations* |
| CHPRC | CH2M HILL Plateau Remediation Company |
| DOE | U.S. Department of Energy |
| DOECAP | U.S. Department of Energy Consolidated Audit Program |
| Ecology | Washington State Department of Ecology |
| EPA | U.S. Environmental Protection Agency |
| FEAD | Format for Electronic Analytical Data |
| FSAP | Field Sampling and Analysis Plan |
| HASQARD | *Hanford Analytical Services Quality Assurance Requirements Documents* |
| HEIS | Hanford Environmental Information System |
| ICP/AES | inductively coupled plasma/atomic emission spectroscopy |
| ICP/MS | inductively coupled plasma/mass spectroscopy |
| LCS | laboratory control sample |
| NA | not applicable |
| PUREX | Plutonium Uranium Extraction (Plant) |
| QA | quality assurance |
| QC | quality control |
| QSAS | *Quality Systems for Analytical Services* |
| RCRA | *Resource Conservation and Recovery Act of 1976* |
| RL | U.S. Department of Energy, Richland Operations Office |

| | |
|---|---|
| RPD | relative percent difference |
| WAC | *Washington Administrative Code* |
| WMA | Waste Management Area |
| WRPS | Washington River Protection Solutions LLC |

**Units**

| | |
|---|---|
| °C | degrees Celsius |
| °F | degrees Fahrenheit |
| cm | centimeter |
| ft | feet |
| g | gram |
| gal | gallon |
| in. | inch |
| L | liter |
| m | meter |
| mg/kg | milligram per kilogram |
| mL | milliliter |
| oz | ounce |
| pCi/g | picocuries per gram |

# 1.0 PURPOSE AND SCOPE

Eleven sites will be investigated in Waste Management Area (WMA) A-AX. These 11 sites were selected to optimize installation of depth electrodes for electrical resistivity imaging. Opportunistic vadose zone soil samples will be collected from these sites and submitted for laboratory-based chemical and radiochemical analyses. These analytical results, among other data sources, are intended to be used at a later date to develop data quality objectives for WMA A-AX. This Field Sampling and Analysis Plan (FSAP) has been prepared to direct the collection of information to support this objective.

The characterization sequence in WMA A-AX involves placement of 10 vertical boring sites and one angle boring site for geophysical logging, soil sampling, and deep electrode placement. Seven sites, six vertical and one angle, will be used to integrate the soils in 241-A Tank Farm (A Farm). Four vertical sites will be used in 241-AX Tank Farm (AX Farm). Two borings will be pushed at each site, the first for logging and placement of deep electrodes and the second for collecting soil samples. This logging and sampling work will be followed by geophysical exploration involving surface and deep electrodes. A multidiscipline team consisting of Washington River Protection Solutions, LLC (WRPS) personnel, Energy*Solutions* Federal Services, Inc., Northwest Operation and other lower-tier subcontractors, as necessary, will implement direct push field activities.

Direct push locations were selected to avoid contact and pushing through existing infrastructure (whether on the surface or in the subsurface; e.g., tanks, pipes, diversion boxes) while meeting plan objectives. Twelve sites were originally planned; however, one site in AX Farm could not be established without encroaching upon existing infrastructure. Therefore, 11 total sites will be investigated, as described above. Figures 1-1 and 1-2 show these locations for A Farm and AX Farm, respectively. Soil samples will be collected from a boring within approximately 0.6 meter (m) (2 feet [ft]) of the geophysical logging boring.

This FSAP provides the direction and requirements for the field sampling, laboratory analysis, and data reporting for soil sampling of the 11 direct push locations within WMA A-AX. Information is provided in the following sections:

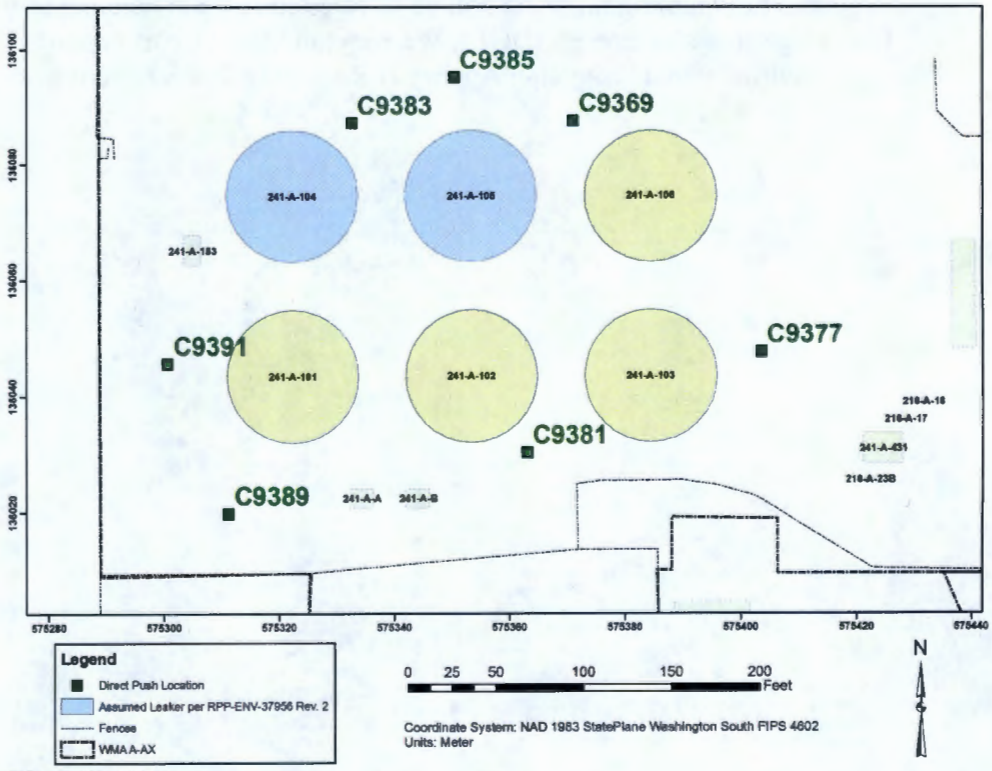
- Facility description (Section 2.0)
- Sampling requirements (Section 3.0)
- Laboratory analysis requirements (Section 4.0)
- Quality assurance (QA) and quality control (QC) (Section 5.0)
- Data reporting (Section 6.0)
- Change control (Section 7.0)
- Documents and records (Section 8.0)
- Project organization (Section 9.0)
- References (Section 10.0).

The QA plan objectives are met through implementation of all sections of this FSAP.

It is anticipated that direct push depths will reach up to 62 m (205 ft) below ground surface (bgs). Soil samples will be collected at an average of three depths from each sample boring. It is anticipated that approximately 36 soil samples will be collected. Samples will be analyzed for constituents identified in RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*, excluding the organic analyses, and RPP-RPT-38152, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/Corrective Measures Study* [as amended by approval letter 11-NWP-053, "Re: Organic Analyses Optimization for Waste Management Area (WMA) C"]. See Sections 3.0 and 4.0 for more detailed constituent information.

Geophysical logging data along with any available quick turnaround analysis results ("quick turn") for two mobile contaminants ($^{99}$Tc and nitrate) will be used to aid in determining sample depths. The sampling horizons will be selected in an open meeting to which WRPS staff, U.S. Department of Energy (DOE), Washington State Department of Ecology (Ecology), U.S. Environmental Protection Agency (EPA), and other Site contractors shall be invited.

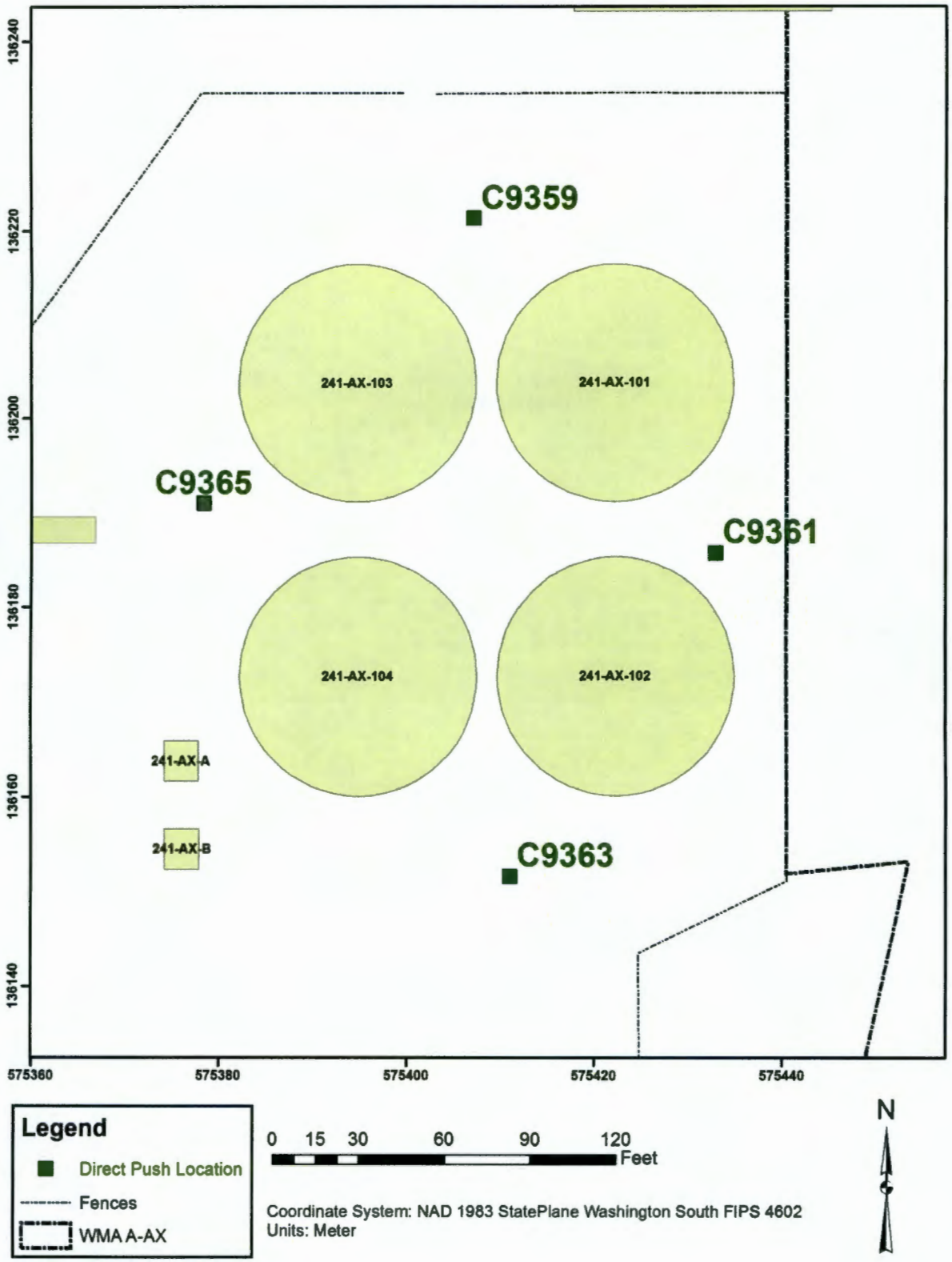
**Figure 1-1. 241-A Tank Farm Seven Direct Push Locations.**




WMA = Waste Management Area

Reference: RPP-ENV-37956, *Hanford 241-A and 241-AX Tank Farms Leak Inventory Assessment Report.*

**Figure 1-2. 241-AX Tank Farm Four Direct Push Locations.**




WMA = Waste Management Area

This page intentionally left blank.

## 2.0 FACILITY DESCRIPTION

Waste Management Area A-AX encompasses two tank farms (A and AX) that contain a total of 10 single-shell tanks, Tanks 241-A-101 through 241-A-106 in A Farm and Tanks 241-AX-101 through 241-AX-104 in AX Farm. The A Farm was constructed from 1954 to 1955, and AX Farm was constructed in 1963 and 1964. Each tank consists of a carbon steel liner inside a concrete tank. Each liner is 23 m (75 ft) in diameter and 9.1 m (30 ft) deep with an approximate capacity of 3.8 million Liters (1 million gal). The steel bottoms intersect the sidewalls orthogonally, rather than the dished bottoms of earlier designed tank farms. The concrete thicknesses are 0.15 m (0.5 ft) (A Farm tanks) or 0.46 m (1.5 ft) (AX Farm tanks) on the tank bottom, 0.38 m (1.25 ft) to 0.6 m (2 ft) on the side walls, and 0.38 m (1.25 ft) for the tank dome. The concrete tank dome thickness increases to approximately 1.1 m (3.5 ft) (A Farm tanks) or approximately 1.5 m (5 ft) (AX Farm tanks) along the side walls. The tanks were connected by overflow lines but did not cascade. Tanks in WMA A-AX included a grid of drain slots beneath the shell liner bottom and a leak detection well that could collect potential leakage. Both tank farms received the majority of their waste from the Plutonium Uranium Extraction (PUREX) facility.

The A Farm tanks were designed for the storage of boiling waste generated from irradiated fuel reprocessing at the 202-A PUREX Plant. The tanks have airlift circulators for cooling the boiling wastes, an underground vessel ventilation header to remove condensate and volatiles, and laterals 0.3 m (10 ft) beneath the tank for leak detection. Each tank was originally equipped with 2.7- to 3.4-m (9- to 11-ft) risers and a 50-centimeter (cm)-diameter (20-inch [in.]) vapor exhaust pipeline that penetrated the tank dome and four airlift circulators that were operated to suspend solids, mix the tank contents, and dissipate heat.

The A Farm tanks were originally designed to contain liquid and solid waste at a maximum temperature of 140°C (280°F) (RPP-10435, *Single-Shell Tank System Integrity Assessment Report*). After installation of airlift circulators, the operating temperature limit was revised to a maximum of 150°C (300°F) at the tank bottom (RPP-10435). Wastes at higher temperatures could cause buckling of the steel liner and/or structural damage to the concrete shell.

The AX Farm tanks were originally equipped with 54 risers that penetrated the tank domes and 22 airlift circulators that were operated to suspend solids, mix the tank contents, and dissipate heat. The tanks were originally designed to contain liquid and solid wastes at a maximum temperature of 180°C (350°F). Wastes at higher temperatures should cause buckling of the steel liner and/or damage to the concrete shell.

The A Farm and AX Farm tanks were vented to an underground vessel ventilation header that connected to the two tank farms and later to the 241-AY Tank Farm. The purpose of this ventilation header was to remove off-gas and water vapor from these tanks, which were often operated with the wastes at boiling conditions. The A Farm and AX Farm tanks were isolated from this ventilation header in the early 1980s.

Based on RPP-ENV-37956, *Hanford 241-A and 241-AX Tank Farms Leak Inventory Assessment Report*, Tanks 241-A-104 and 241-A-105 are assumed to have leaked in A Farm. It appears the

Tank 241-A-104 liner leaked at or near the tank footing and below the 79-cm (31-in.) waste level. It is estimated approximately 7,600 L (2,000 gal) PUREX sludge supernate leaked from Tank 241-A-104. Available information, including video observation of a bulge and ripped liner, indicate Tank 241-A-105 likely leaked from around the tank perimeter at the tank base. It is estimated that 7,600 to 150,000 L (2,000 to 40,000 gal) of waste may have leaked from Tank 241-A-105. The waste type believed to have leaked from Tank 241-A-105 was a combination of PUREX supernatant waste and B Plant ion exchange waste.

Based on information presented in RPP-ENV-37956, there are no tanks known or presumed to have leaked in AX Farm.

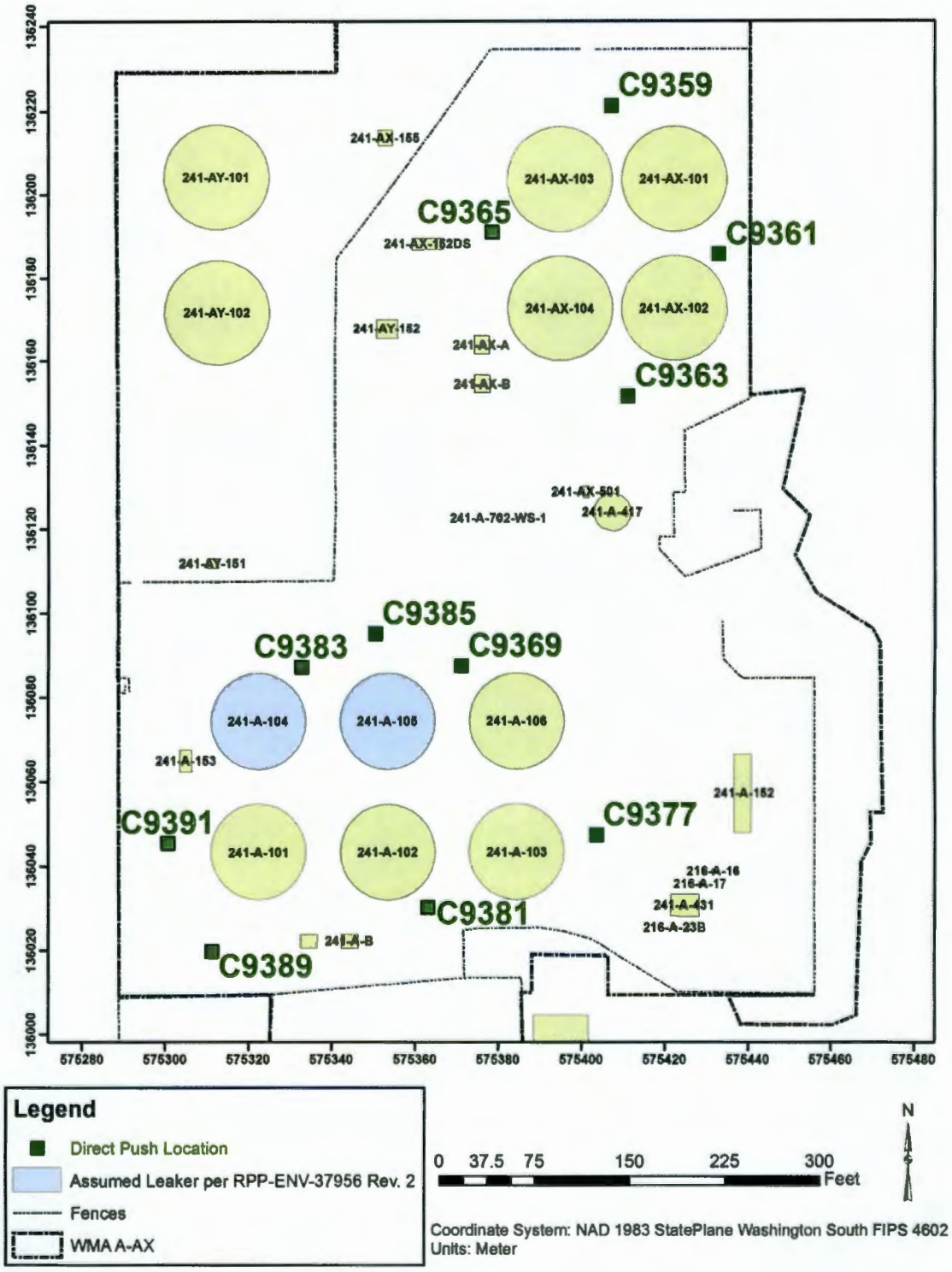
The A and AX Tank Farms were constructed in excavations into the near-surface sediments that overlie the Columbia River Basalt Group. The Columbia River Basalt forms the basement bedrock. From oldest to youngest, these deposits include the following:

- Columbia River Basalt Group
- Undifferentiated Plio-Pleistocene silt and gravels
- Hanford Formation – lower gravelly sequence (H3 subunit)
- Hanford Formation – lower fine sand and silt sequence (H2 subunit)
- Hanford Formation – middle coarse sand and gravel sequence, upper fine sand and top gravelly sand sequence (H1 sub-unit)
- Recent deposits and/or backfill.

The thickness of the vadose zone is approximately 90 m (295 ft) in WMA A-AX. The unconfined aquifer lies mostly within the undifferentiated Plio-Pleistocene silt and gravels.

Figure 2-1 shows the layout of WMA A-AX.

**Figure 2-1. Waste Management Area A-AX, Surrounding Facilities, and Direct Push Logging Locations.**




WMA = Waste Management Area

Reference: RPP-ENV-37956, *Hanford 241-A and 241-AX Tank Farms Leak Inventory Assessment Report.*

This page intentionally left blank.

# 3.0 SAMPLING REQUIREMENTS

All field sampling activities shall be conducted in accordance with this FSAP and the appropriate procedures and work packages. Soil sampling services for this work will be contracted through the CH2M HILL Plateau Remediation Company (CHPRC) or performed by WRPS sampling personnel (e.g., nuclear chemical operators). The soil sampling personnel shall follow CHPRC or WRPS sampling protocols and procedures, which cover items such as cleaning of sampling devices, chain-of-custody, etc.

## 3.1 SOIL SAMPLING TECHNIQUE, STRATEGY, AND DESIGN

This section provides details about sampling techniques, strategy, and design.

### 3.1.1 Sampling Technique

Sampling at WMA A-AX will be conducted with hydraulic hammer direct push rig technology using the dual-string sampling system, which consists of inner and outer strings that are deployed by small-diameter push rods. When the target sampling depth is reached, the rods are pulled back and the tip is removed from the inner rods. A sampler is attached to the inner string, returned to the bottom of the outer casing/push tubing, and positioned against the inner receiver face of the drive shoe. The inner and outer tubing strings are "locked" together using a proprietary method and the entire assembly is advanced approximately 10% deeper than the targeted sample interval to secure the material in the sampler.

The sampler body holds three stainless steel liners. After sample collection, the liners will be removed from the sampler body and surveyed. Trained sample handling technicians document recovery, sample condition, and volume recovery percent. They then package and transport the sample under chain-of-custody control to the laboratory for analysis. The "dummy" tip is reattached to the inner string, returned to bottom and placed in the casing shoe, and the entire assembly is advanced to the next sample depth. This process is repeated until all sample depths are achieved or the tubing meets refusal.

Upon completion of the final sample extraction, or upon meeting refusal, the dummy tip or sampler is removed, and the borehole is decommissioned per requirements of *Washington Administrative Code* 173-160, "Minimum Standards for Construction and Maintenance of Wells."

### 3.1.2 Sampling Strategy and Design

The probe locations will be pushed to depths of approximately 62 m (205 ft) bgs or refusal, and soil samples will be collected at an average of three depths from each location. Three depths were chosen to assist in defining the extent of the vertical boundaries of contamination in

WMA A-AX. Note that if additional sampling is warranted, more samples (i.e., more than three per location) may be collected. Sampling strategy at each site is summarized as follows:

- A minimum of two direct push borings will be completed at each location. The initial boring will be logged for both gross gamma and neutron moisture (i.e., geophysical logging). Following logging, deep electrodes will be installed for possible future surface geophysical exploration, and the hole will be decommissioned per *Washington Administrative Code* 173-160. The second push will be for soil sampling.

- The depth of the first boring will be approximately 62 m (205 ft) bgs or refusal (whichever comes first).

- Deep electrodes will be placed in the borings at the direction of the Field Lead.

- The depth for sampling individual horizons will be selected by reviewing the gamma and moisture logs of the first boring and the following information: any leak loss inventory information pertinent to the site, geologic summary of the area, operational history, historical characterization data at that site, and available "quick turn" ($^{99}$Tc and nitrate) data. Note that $^{99}$Tc and nitrate "quick turn" data may become available from some of the borings identified in this plan as the work progresses. As the data becomes available, it may be used to help select sample depths for later boring locations. The sampling horizons will be selected in an open meeting to which Tank Operations Contractor staff, DOE, Ecology, EPA, and other Site contractors shall be invited.

Note: Depths are subject to constraints in the field and may be modified, if necessary.

## 3.2 SAMPLE COLLECTION, HANDLING, AND SHIPPING

As previously indicated, the dual-string sampler used to collect soil samples holds three stainless steel liners and a shoe to collect sample material during the direct push. After sample collection, the liners are removed from the sampler body and surveyed. The material in the shoe shall be placed in a 500-milliliter (mL) (16-ounce [oz]) glass jar. Stainless steel liner A is the liner closest to the shoe. The next or middle liner is liner B and the topmost stainless steel liner is liner C. Each liner shall be marked to indicate its bottom (labeled B) and top (labeled T) to signify the position of the sample prior to shipping and transport.

Trained sampling personnel will document recovery, sample condition, and volume recovery percent. They will then package and transport the sample under chain-of-custody control to the laboratory for analysis. Sampling personnel will place the shoe material in a 500-mL (16-oz) glass bottle and cap the liners (see Section 3.3). Sample material will be extruded, documented, composited, and aliquoted and prepared by the laboratory in accordance with direction for sample handling and preparation provided in Section 4.1.

Analytical methods and holding times for chemical and radiochemical analytes are shown in Table 3-1. Soil sample preservation and container requirements are discussed in the footnotes to

Table 3-1. Field QC samples, specifically equipment rinsate blank and field blank samples, will be collected to evaluate for potential cross-contamination and laboratory performance. Sample preservation, containers, and holding times for these field QC samples are shown in Table 3-2.

Samples shall be maintained and shipped at or below 6°C (43°F) as specified in Tables 3-1 and 3-2. To meet applicable holding time requirements, the samples shall be shipped to the laboratory as soon as possible. However, it is recognized that some samples may have elevated levels of radioactivity. These samples may need to be stored and transported in shielded shipping containers that might not allow the samples to be maintained at or below 6°C (43°F). Samples not meeting temperature or holding time requirements will be identified as they occur, brought to the immediate attention of the Primary Laboratory Contact, and discussed in the laboratory data report. The impact on subsequent use or interpretation of these data will be evaluated by the WRPS personnel.

Radiological control technician(s) will measure the dose rates of each sample container (i.e., jar and liners). The radiological control technician(s) also will measure radiological activity on the outside of the sample container (through the container) and will document the highest contact radiological reading in millirem per hour. This information, along with other data, will be used to select proper packaging, marking, labeling, and shipping paperwork in accordance with U.S. Department of Transportation regulations [Title 49, *Code of Federal Regulations*, "Transportation" (49 CFR)], and to verify that the sample can be received by the analytical laboratory in accordance with the laboratory's acceptance criteria.

## 3.3 SAMPLE IDENTIFICATION

The Hanford Environmental Information System (HEIS) database will be the electronic repository for the laboratory analytical results. The HEIS sample numbers will be issued to the sampling organization for this project in accordance with onsite organizational procedures. Each sample will be identified and labeled with a unique HEIS sample number. The sample location, depth, and corresponding HEIS numbers will be documented in the sampling personnel's field logbook. The shoe material placed in a 500-mL (16-oz) glass jar and the three liners will each have a unique HEIS number. The composite sample will also have a unique HEIS number. Each sample container will be labeled with the following information using a waterproof marker on firmly affixed water-resistant labels:

- Sample identification number
- Sample collection date and time
- Name or initials of person collecting the sample
- Preservation method (if applicable)
- Sample location (direct push hole number and depth of collection).

Due to limited space on sample labels, it is not possible to list all analytes; however, the laboratory is provided all necessary information to complete analysis. This information is provided in Section 4.0, which identifies the full list of analytes, appropriate analysis methods, and additional analysis information (e.g., detection limits).

**Table 3-1. Soil Sampling Requirements for Waste Management Area A-AX[a]. (2 sheets)**

| Analysis Type | Primary Analysis[b] | Constituent | Holding Time |
|---|---|---|---|
| "Quick Turn" | ICP/MS (water extraction) | Technetium-99 | 6 months |
| | 9056 Ion chromatography | Nitrate | 48 hours |
| | 9045 | pH | 24 hours (or as soon as possible) after receipt by laboratory |
| | 9050 | Conductivity | 28 days |
| Standard | 6010 ICP/AES | Aluminum, Barium, Beryllium, Calcium, Chromium, Copper, Iron, Lead, Lithium, Manganese, Magnesium, Molybdenum, Phosphorous, Potassium, Sodium, Strontium, Zinc, Boron, Bismuth, Cerium, Europium, Lanthanum, Neodymium, Niobium, Palladium, Praseodymium, Rubidium, Rhodium, Ruthenium, Samarium, Silicon, Tin, Sulfur, Tantalum, Tellurium, Thorium, Titanium, Tungsten, Yttrium, Zirconium | 6 months |
| | 6020 ICP/MS | Antimony, Arsenic, Cadmium, Cobalt, Nickel, Selenium, Silver, Thallium, Vanadium | 6 months |
| | Calculation | Uranium[c] | 6 months |
| | 7471 Cold vapor atomic absorption | Mercury | 28 days |
| | 9056 Ion chromatography | Fluoride, Nitrite, Nitrate, Chloride, Sulfate, Acetate, Formate, Glycolate, Oxalate, Bromide, Phosphate | 28 days/48 hours[d] |
| | Ion chromatography EPA 300.7 | Ammonium | 7 days to distillation/28 days for preserved distillate |
| | 9014 Spectrophotometric | Cyanide, Ferrocyanide[e] | 14 days |
| | Gamma energy analysis | Cesium-137, Cobalt-60, Antimony-125, Europium-152, Europium-154, Europium-155, , Potassium-40, Thorium-234 | 6 months |
| | Low energy gamma counting | Iodine-129 | 6 months |

**Table 3-1. Soil Sampling Requirements for Waste Management Area A-AX[a]. (2 sheets)**

| Analysis Type | Primary Analysis[b] | Constituent | Holding Time |
|---|---|---|---|
| | ICP/MS (acid extraction) | Plutonium-242, Techenetium-99, Tin-126, Uranium-233, Uranium-234, Uranium-235, Uranium-236, Uranium-238, Neptunium-237, Thorium-230, Thorium-232 | 6 months |
| | Liquid scintillation | Carbon-14, Tritium, Nickel-63, Selenium-79, Plutonium-241 | 6 months |
| Standard | Alpha energy analysis | Plutonium-238, Plutonium-239/240, Americium-241, Curium-242, Curium-243/244, Thorium-228 | 6 months |
| | Beta proportional counting | Strontium-90 | 6 months |
| | Gravimetric (ASTM D2216) | Percent solids | None |
| | Gravimetric (ASTM D2216) | Percent water | None |
| | Gravimetric[f] | Soil density | None |

[a] Sampling personnel will place the shoe material in a 500-mL glass bottle. The samples will be cooled to ≤6°C (38°F). Available material from the shoe and liners (A, B, and C) are composited by the laboratory and the composited material is used in the "quick turn" and standard analyses.

[b] Equivalent methods may be used by the laboratory with prior approval by Primary Laboratory Contact and Project Manager.

[c] Uranium result will be calculated using isotopic uranium analysis results.

[d] 48-hour hold time is for nitrate, nitrite, and phosphate.

[e] Cyanide result will be used as a conservative estimate for ferrocyanide.

[f] Soil density will be determined as described in Interoffice memorandum WRPS-0900155 Rev 2, "Test Plan for Sample Breakdown and Analysis of Sediment Samples Obtained as Part of the Vadose Zone Project."

EPA = U.S. Environmental Protection Agency
ICP/AES = inductively coupled plasma/atomic emission spectroscopy
ICP/MS = inductively coupled plasma/mass spectroscopy

References:

EPA 600/4-86/024, 1986, *Development of Standard Methods for the Collection and Analysis of Precipitation*, "Method 300.7, Dissolved Sodium, Ammonium, Potassium, Magnesium, and Calcium in Wet Deposition by Chemically Suppressed Ion Chromatography," U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Office of Research and Development, Cincinnati, Ohio.

SW-846, 1986, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, Third Edition as amended, U.S. Environmental Protection Agency, Washington, D.C.

ASTM D2216, 2010, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*, ASTM International, West Conshohocken, Pennsylvania.

**Table 3-2. Field Quality Control Requirements for Waste Management Area A-AX[a]. (2 sheets)**

| Primary Analysis Method[b] | Constituent | Container | Preservative | Holding Time |
|---|---|---|---|---|
| 6010 Inductively coupled plasma/atomic emission spectroscopy | Aluminum, Barium, Beryllium, Calcium, Chromium, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Phosphorous, Potassium, Sodium, Strontium, Zinc, Boron, Bismuth, Cerium, Europium, Lanthanum, Neodymium, Niobium, Palladium, Praseodymium, Rubidium, Rhodium, Ruthenium, Samarium, Silicon, Tin, Sulfur, Tantalum, Tellurium, Thorium, Titanium, Tungsten, Yttrium, Zirconium | Glass/plastic 500 mL | $HNO_3$ to pH<2 | 6 months (28 days for Mercury) |
| 6020 Inductively coupled plasma/mass spectroscopy | Antimony, Arsenic, Cadmium, Cobalt, Nickel, Selenium, Silver, Thallium, Vanadium | | | |
| Calculation | Uranium[c] | | | |
| Inductively coupled plasma/ mass spectroscopy | Plutonium-242, Technetium-99, Tin-126, Uranium-233, Uranium-234, Uranium-235, Uranium-236, Uranium-238, Neptunium-237, Thorium-230, Thorium-232 | | | |
| 7470 Cold vapor atomic absorption | Mercury | | | |
| Ion chromatography EPA 300.7 | Ammonium | Glass/plastic 250 mL | $H_2SO_4$ to pH<2/ Cool to 6°C | 7 days |
| 9056 Ion chromatography | Fluoride, Nitrite, Nitrate, Chloride, Sulfate, Acetate, Formate, Glycolate, Oxalate, Bromide, Phosphate | Glass/plastic 500 mL | Cool to 6°C | 28 days/ 48 hours[d] |
| 9014 Spectrophotometric | Cyanide, Ferrocyanide[e] | Glass/plastic 60 mL | NaOH to pH≥12/ Cool to 6°C | 14 days |
| Gamma energy analysis | Cesium-137, Cobalt-60, Antimony-125, Europium-152, Europium-154, Europium-155, Potassium-40, Thorium-234 | Glass/plastic 2×1,000 mL | $HNO_3$ to pH<2 | 6 months |
| Alpha energy analysis | Plutonium-238, Plutonium-239/240, Americium-241, Curium-242, Curium-243/244, Thorium-228 | | | |
| Liquid scintillation | Nickel-63, Selenium-79, Plutonium-241 | | | |
| Beta proportional counting | Strontium-90 | | | |

**Table 3-2. Field Quality Control Requirements for Waste Management Area A-AX[a]. (2 sheets)**

| Primary Analysis Method[b] | Constituent | Container | Preservative | Holding Time |
|---|---|---|---|---|
| Liquid scintillation | Carbon-14, Tritium | Glass/plastic 1,000 mL | None | 6 months |
| Low energy gamma counting | Iodine-129 | | | |

[a] Percent moisture, percent solids, conductivity, and pH will not be measured/analyzed on field quality control samples.

[b] Equivalent methods may be used by the laboratory with prior approval by the Primary Laboratory Contact and Project Manager.

[c] Uranium result will be calculated using isotopic uranium analysis results.

[d] 48-hour hold time is for nitrate, nitrite, and phosphate.

[e] Cyanide result will be used as a conservative estimate for ferrocyanide.

References:

EPA 600/4-86/024, 1986, *Development of Standard Methods for the Collection and Analysis of Precipitation*, "Method 300.7, Dissolved Sodium, Ammonium, Potassium, Magnesium, and Calcium in Wet Deposition by Chemically Suppressed Ion Chromatography," U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Office of Research and Development, Cincinnati, Ohio.

SW-846, 1986, *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods*, Third Edition as amended, U.S. Environmental Protection Agency, Washington, D.C.

Additionally, coordinate and elevation information for each sample location will be stored in HEIS. The coordinates will be in state plane North American Datum 83/91 and elevations (e.g., ground surface, sample depths) will be in metric units.

## 3.4 SAMPLE CUSTODY

The sampling team shall initiate a chain-of-custody form for each sample. The chain-of-custody form shall accompany each sample. At a minimum, the following sampling information shall be included on the chain-of-custody form:

- Project name
- Signature of the collector
- Date and time of collection
- Sample type (e.g., soil)
- Sample preservation information
- Requested analysis or provide a reference for sample analysis
- Signatures of persons involved in the chain of possession
- Date and time relinquished to the laboratory
- Unique HEIS sample identification number assigned to the sample
- Sample location (direct push hole number and depth of collection)
- A notation of pertinent sampling information including unusual characteristics or sampling problems
- A brief description of the sample matrix, such as color or consistency, if possible.

Any pertinent sampling information (recovery, unusual characteristics, or sampling problems) shall be recorded in the sampling logbook. Each sample will be shipped to 222-S Laboratory (or alternate laboratory, if necessary) in an approved shipping container in accordance with approved procedures. Each sample will be sealed with a sample seal to demonstrate that the samples have reached the laboratory without alteration.

## 4.0 SAMPLE ANALYSIS REQUIREMENTS

Samples are normally received from the field at door 13 of the 222-S Laboratory Multicurie Section. Samples transported in coolers will be stored under refrigeration until they are processed. On receipt, the sample custodian will verify the identification number on each sample container and ensure it matches the sample seal on the sample container and the chain-of-custody form. Laboratory sample identification numbers will be affixed to each container that is retained past initial receipt. Residual sample material remaining after analysis will be maintained in refrigerated storage until directed otherwise by the Primary Laboratory Contact.

After the samples are received at the laboratory, the samples will be prepared and analyzed in accordance with this FSAP. Table 4-1 identifies the following information:

- Constituent (analyte)
- Required detection limit and/or target detection limit
- Primary and alternate analytical method, including preparation information
- Quality control acceptance requirements for the primary methods.

"Quick turn" constituents for soil samples are bolded in Table 4-1. Results for quick turn, primary, and secondary constituents will be reported for each sample, provided sufficient sample material is obtained to perform all analyses.

Section 4.1 provides sample handling, preparation, and analytical requirements. Direction for addressing insufficient sample recovery is provided in Section 4.2. The laboratory shall use the least possible dilution to obtain the lowest detection limits for all requested analytes.

**Table 4-1. Analytical Requirements for Waste Management Area A-AX. (5 sheets)**

| Constituent | Required Detection Limit [a, b] | Analytical Method[c] (prep) | Alternate Method[c] (prep) | QC Acceptance Requirements[d, e] | | |
|---|---|---|---|---|---|---|
| | | | | LCS % Recovery | Spike % Recovery | % RPD |
| Aluminum – Al | 2.75 | 6010 ICP/AES (acid) | 6020 ICP/MS (acid) | 80-120% | 75-125% | ≤30% |
| Barium – Ba | 10.2 | | | | | |
| Beryllium – Be | 0.5 | | | | | |
| Calcium[f] – Ca | 6.25 | | | | | |
| Chromium – Cr | 0.15 | | | | | |
| Copper – Cu | 1 | | | | | |
| Iron – Fe | 5 | | | | | |
| Lead – Pb | 5 | | | | | |
| Lithium[f] – Li | 0.9 | | | | | |
| Manganese – Mn | 0.55 | | | | | |
| Magnesium[f] – Mg | 26.3 | | | | | |
| Molybdenum[f] – Mo | 0.470[g] | | | | | |
| Phosphorus[f] – P | 9.8 | | | | | |
| Potassium[f] – K | 157 | | | | | |
| Sodium[f] – Na | 22.4 | | | | | |
| Strontium – Sr | 0.55 | | | | | |
| Zinc – Zn | 1 | | | | | |
| *Boron – B* | 6 | | NA | | | |
| *Bismuth – Bi* | 25.8 | | | | | |
| *Cerium – Ce* | 10.5 | | | | | |
| *Europium – Eu* | 5.55 | | | | | |
| *Lanthanum – La* | 2.75 | | | | | |
| *Neodymium – Nd* | 5.05 | | | | | |
| *Niobium – Nb* | 5.0 | | | | | |
| *Palladium – Pd* | 75.8 | | | | | |
| *Praseodymium – Pr* | 26.1 | | | | | |
| *Rubidium – Rb* | 254 | | | | | |
| *Rhodium – Rh* | 25.8 | | | | | |

**Table 4-1. Analytical Requirements for Waste Management Area A-AX. (5 sheets)**

| Constituent | Required Detection Limit [a, b] | Analytical Method[c] (prep) | Alternate Method[c] (prep) | QC Acceptance Requirements[d, e] | | |
|---|---|---|---|---|---|---|
| | | | | LCS % Recovery | Spike % Recovery | % RPD |
| *Ruthenium – Ru* | 26.7 | 6010 ICP/AES (acid) | NA | 80-120% | 75-125% | ≤30% |
| *Samarium – Sm* | 5.35 | | 6020 ICP/MS (acid) | | | |
| *Silicon – Si* | 5.05 | | | | | |
| *Tin – Sn* | 6 | | | | | |
| *Sulfur – S* | 11.4 | | | | | |
| *Tantalum – Ta* | 25.5 | | | | | |
| *Tellurium – Te* | 25.6 | | | | | |
| *Thorium – Th* | 4.85 | | | | | |
| *Titanium – Ti* | 0.65 | | | | | |
| *Tungsten – W* | 42.9 | | | | | |
| *Yttrium – Y* | 0.6 | | | | | |
| *Zirconium – Zr* | 1.2 | | | | | |
| Antimony – Sb | 0.130[g] | 6020 ICP/MS (acid) | 6010 ICP/AES (acid) | 80-120% | 75-125% | ≤30% |
| Arsenic – As | 0.2 | | | | | |
| Cadmium – Cd | 2.02E-02 | | | | | |
| Cobalt – Co | 2 | | | | | |
| Nickel – Ni | 3 | | | | | |
| Selenium[h] – Se | 0.02 | | | | | |
| Silver[h] – Ag | 6.00E-04 | | | | | |
| Thallium[h] – Tl | 4.00E-04 | | | | | |
| Uranium[i] – U | 0.5 | | | | | |
| Vanadium – V | 6.00E-03 | | | | | |
| Mercury – Hg | 0.01 | 7471 Cold vapor atomic absorption (acid) | 6020 ICP/MS (acid) | 80-120% | 75-125% | ≤30% |
| Ammonium – $NH_4^+$ | 0.5 | Ion Chromatography EPA 300.7 (distillation) | NA | 80-120% | 75-125% | ≤30% |
| **pH** | - | 9045 | NA | ± 0.1 pH units | NA | NA |

**Table 4-1. Analytical Requirements for Waste Management Area A-AX. (5 sheets)**

| Constituent | Required Detection Limit [a, b] | Analytical Method[c] (prep) | Alternate Method[c] (prep) | QC Acceptance Requirements[d, e] | | |
|---|---|---|---|---|---|---|
| | | | | LCS % Recovery | Spike % Recovery | % RPD |
| Fluoride – $F^-$ | 2.81[g] | Ion Chromatography 9056 (water) | NA | 80-120% | 75-125% | ≤30% |
| Nitrite – $NO_2^-$ | 2.5 | | | | | |
| **Nitrate – $NO_3^-$** | 2.5 | | | | | |
| Chloride – $Cl^-$ | 0.3 | | | | | |
| Sulfate – $SO_4^{-2}$ | 2.7 | | | | | |
| Acetate – $C_2H_3O_2^-$ | 4.5 | | | | | |
| Formate – $CHO_2^-$ | 10.0 | | | | | |
| Glycolate – $C_2H_3O_3^-$ | 3.8 | | | | | |
| Oxalate – $C_2O_4^{-2}$ | 2 | | | | | |
| *Bromide – Br* | 1 | | | | | |
| *Phosphate – $PO_4^{-3}$* | 0.785[g] | | | | | |
| Cyanide[j] – $CN^-$ | 0.5 | 9014 Spectrophotometric (distillation) | 9012 Colorimetric | 80-120% | 75-125% | ≤30% |
| Cesium-137 – $^{137}Cs$ | 0.1 | Gamma energy analysis (direct) | NA | 80-120% | N/A | ≤30% |
| Cobalt-60[h] – $^{60}Co$ | 0.01[g] | | | | | |
| Antimony-125 – $^{125}Sb$ | 0.3 | | | | | |
| Europium-152 – $^{152}Eu$ | 0.1 | | | NA | NA | ≤30% |
| Europium-154[h] – $^{154}Eu$ | 0.03[g] | | | | | |
| Europium-155[h] – $^{155}Eu$ | 0.05[g] | | | | | |
| Potassium-40 – $^{40}K$ | 10 | | | | | |
| Thorium-234 – $^{234}Th$ | - | | | | | |
| Iodine-129 – $^{129}I$ | 2 | Low energy gamma counting (fusion) | NA | 80-120% | NA | ≤30% |
| **Technetium-99[k] – $^{99}Tc$** | 1 | ICP/MS (water) | Liquid scintillation (water) | 80-120% | 75-125% | ≤30% |
| Technetium-99[k] – $^{99}Tc$ | 1 | ICP/MS (acid) | Liquid scintillation (acid) | 80-120% | 75-125% | ≤30% |
| Tin-126 – $^{126}Sn$ | 400 | | NA | 80-120% | 75-125% | ≤30% |

**Table 4-1. Analytical Requirements for Waste Management Area A-AX. (5 sheets)**

| Constituent | Required Detection Limit [a, b] | Analytical Method[c] (prep) | Alternate Method[c] (prep) | QC Acceptance Requirements[d, e] | | |
|---|---|---|---|---|---|---|
| | | | | LCS % Recovery | Spike % Recovery | % RPD |
| Uranium-233[h] – $^{233}U$ | 0.174 | ICP/MS (acid) | NA | NA | NA | ≤30% |
| Uranium-234 – $^{234}U$ | 3.75E-02 | | | NA | NA | ≤30% |
| Uranium-235 – $^{235}U$ | 4.32E-05 | | | 80-120% | 75-125% | ≤30% |
| Uranium-236 – $^{236}U$ | 5.18E-04 | | | NA | NA | ≤30% |
| Uranium-238 – $^{238}U$ | 4.37E-04 | | | 80-120% | 75-125% | ≤30% |
| Neptunium-237 – $^{237}Np$ | 3.80E-02 | | Alpha energy analysis (acid) | 80-120% | 75-125% | ≤30% |
| Thorium-230 – $^{230}Th$ | 0.288 | | NA | NA | NA | ≤30% |
| Thorium-232 – $^{232}Th$ | 4.40E-05 | | | 80-120% | 75-125% | ≤30% |
| Plutonium-242 – $^{242}Pu$ | - | | | NA | NA | NA |
| Carbon-14 – $^{14}C$ | 1 | Liquid scintillation (water) | NA | 80-120% | 75-125% | ≤30% |
| Tritium – $^{3}H$ | 30 | | | | | |
| Nickel-63 – $^{63}Ni$ | 30 | Liquid scintillation (acid) | NA | 80-120% | NA | ≤30% |
| Selenium-79 – $^{79}Se$ | 10 | | | Not performed | NA | ≤30% |
| Plutonium-241 – $^{241}Pu$ | 1.65E+04 | | Calculation (from $Pu^{238}$ and $Pu^{239/240}$) | NA | NA | NA |
| Plutonium-238 – $^{238}Pu$ | 1 | Alpha energy analysis (acid) | ICP/MS (acid) | NA | NA | ≤30% |
| Plutonium-239/240[h] – $^{239/240}Pu$ | 0.03[g] | | | 80-120% | NA | ≤30% |
| Americium-241 – $^{241}Am$ | 1 | | | | | |
| Curium-242 – $^{242}Cm$ | 1 | | | NA | NA | NA |
| Curium-243/244 – $^{243/244}Cm$ | 1 | | | | | |
| Thorium-228 – $^{228Th}$ | 1 | | | | | |
| Strontium-90[h] – $^{90}Sr$ | 0.18[g] | Beta proportional counting (acid) | NA | 80-120% | NA | ≤30% |
| Percent water | - | Gravimetric | NA | 80-120% | NA | ≤30% |

## Table 4-1. Analytical Requirements for Waste Management Area A-AX. (5 sheets)

| Constituent | Required Detection Limit [a, b] | Analytical Method[c] (prep) | Alternate Method[c] (prep) | QC Acceptance Requirements[d, e] | | |
|---|---|---|---|---|---|---|
| | | | | LCS % Recovery | Spike % Recovery | % RPD |
| Percent solids | - | Gravimetric | NA | NA | NA | NA |
| **Conductivity** | - | 9050 | NA | NA | NA | NA |
| Soil Density | - | Gravimetric | NA | NA | NA | ≤30% |

Note: All analyses are performed on composite samples. Data packages will be provided by the laboratory in Format VI. "Quick turn" analyses (excluding pH and conductivity) will be provided via e-mail to the Characterization Lead but will also be available in the data package for loading into Hanford Environmental Information System.
**Bold** constituents are "quick turn" constituents.
*Italicized* constituents are considered secondary constituents per RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives.*

[a] Detection limits for non-radiological constituents are in mg/kg and detection limits for radiological constituents are in pCi/g.

[b] Unless otherwise noted, detection limit is the more conservative of those listed in RPP-23403, *Single-Shell Tank Component Closure Data Quality Control Objectives* and RPP-RPT-38152, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/Corrective Measures Study.*

[c] Equivalent methods may be used by the laboratory with prior approval by the Primary Laboratory Contact and Project Manager.

[d] Laboratory quality acceptance requirements are based on RPP-23403, RPP-RPT-38152, and ATL-MP-1011, *ATL Quality Assurance Project Plan for 222-S Laboratory.* The laboratory quality control samples will be analyzed at a frequency of no less than 1 of 20 samples (1 per batch) with the following exceptions:

- Duplicates are not required for Hg analysis.
- Matrix spikes are not applicable for percent water, percent solids, constituents analyzed per gamma energy analysis, pH, conductivity, Sr-90, Am-241, isotopic curium and plutonium, Ni-63, and Se-79.
- Matrix spike duplicates are not required for all analyses except Hg analysis.
- Blanks are NA for percent water, percent solids, and pH.
- Laboratory control samples are not applicable for percent water, percent solids analyses, Sn-126, Th-230, U-234, U-236, isotopic Cm, and Se-79.
- The LCS for gamma energy analysis contains only Cs-137 and Co-60.

[e] QC failures will be brought to the immediate attention of the Primary Laboratory Contact, discussed in the report narrative, and associated result(s) qualified appropriately in the data package. Note that if there are QC failures associated with secondary analytes, reanalysis will not be required.

[f] Calcium, lithium, molybdenum, magnesium, sodium, phosphorous, and potassium were moved from secondary to primary constituents in RPP-23403 at the request of Washington State Department of Ecology to help evaluate whether tank fluids have passed through the sediments.

[g] Detection limit listed is Hanford background value. The laboratory shall attempt to achieve a detection limit less than Hanford background.

[h] Detection limit may be less than can be reported by current analytical methodology. The laboratory shall report results to the lowest achievable detection limit while maintaining quality standards.

[i] Uranium result will be calculated using isotopic uranium analysis results.

[j] Cyanide results will be used as a conservative estimate for ferrocyanide concentration.

[k] The laboratory shall differentiate between water extraction and acid extraction Tc-99 results in both hard copy and electronic (HEIS) reporting. For HEIS upload, the extraction (WE or AE) will be appended to the METHOD_NAME.

EPA = U.S. Environmental Protection Agency
ICP/AES = inductively coupled plasma/atomic emission spectroscopy
ICP/MS = inductively coupled plasma/mass spectroscopy
LCS = laboratory control sample
NA = not applicable
QC = quality control
RPD = relative percent difference

## 4.1 DIRECTION FOR SAMPLE HANDLING AND PREPARATION

The following steps shall be performed on each sample, as soon as the sample from the last interval for each boring has been received (batching to be done per boring).

A. Remove sample material from each liner (Liners A, B, and C) and the shoe, then place each in a separate plastic tray. Sample material from the liners may be removed by inserting a push rod in one end of the core tube and forcing the material out of the other end onto a flat smooth surface. If the material is packed into the core tube too tightly to be extruded in this fashion, use a hydraulic extruder, scoop, or spatula to dislodge the material from the tube. Document the samples photographically, immediately after extrusion. The photographs shall be recorded and transmitted in the same format. A licensed geologist with Hanford experience will describe the samples. Visual inspection and simple manual manipulations shall be performed to provide a geologic description of each sample. These descriptions shall include estimates of the percentage of sand, fine sand, very fine sand, coarse to fine silt and mud content. The sediment descriptions will be recorded and used to classify the sediment texture on a modified Folk/Wentworth diagram. Note that soil density shall be measured for each full liner.

B. Composite the material from Liners A, B and C and the shoe and homogenize.

C. Subsample a representative portion (10 to 15 g) of the composited material and place into a pre-weighed jar on a calibrated balance as soon as possible after extrusion and compositing. Place the jar with sample in an oven set to 105°C overnight. Cool the sample and weigh; calculate the percent moisture content by weight. Return the sample to the oven for at least 2 hours of additional heating. Reweigh the sample after cooling and calculate the cumulative weight loss. Repeat this process with additional weighing until a constant weight is achieved (less than 0.01 g change on successive weighing). The cumulative weight loss on drying is used to calculate the moisture content by weight and the percent dry solids by weight.

D. Subsample a sufficient amount of the composited material to perform the required "quick turn" analysis specified in Table 4-1 and contact with an equal portion of deionized water. Initially, assume the amount of moisture in the sample material is 5%, to calculate the amount of water needed to make up a 1:1 ratio of water to dry solids. The assumed leach factors will be mathematically corrected prior to reporting results, once the percent moisture results are complete.

E. Perform analysis for nitrate, conductivity, and $^{99}$Tc on the 1:1 water digest. The nitrate and $^{99}$Tc results are to be reported to the Primary Laboratory Contact within an expedited time frame (within one week of sample receipt at 222-S Laboratory). If requested by the Primary Laboratory Contact, the data will be provided within 48 hours. Standard laboratory QC requirements are applied to these analyses (i.e., laboratory blank, laboratory control sample, and duplicate). Conductivity (method 9050) and pH (method 9045) are also quick turn constituents; however, the pH and conductivity results

will only be reported with the quick turn analyses if requested by the Primary Laboratory Contact. The pH conductivity results will be reported in the standard data package.

F. Subsample sufficient amount of the composited material to perform all remaining analyses identified in Table 4-1. Direction regarding insufficient sample material is provided in Section 4.2.

The analytical methods are identified in Table 4-1. It will be necessary for the laboratory to contact the Primary Laboratory Contact to deviate from the methods identified in Table 4-1. It is understood that the laboratory analytical procedures may have changes to the approved methods to accommodate analysis of samples that are contaminated with Hanford tank waste and/or to reduce radiological exposure to the analysts. It is also understood that those changes and their effect on method performance will be and have been documented to demonstrate that these procedures provide satisfactory performance for the intended use of the data. The documentation of changes (e.g., substitutions, deviations, or modifications) to the methods shall be in writing, maintained at the laboratory, and available for inspection on request by authorized representatives of regulatory authorities and WRPS. Additional regulatory QA or DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document, Volumes 1 to 4* (HASQARD) requirements for documenting procedure modifications should also be followed.

## 4.2 INSUFFICIENT RECOVERY OF SAMPLE MATERIAL

If the quantity of sample material is insufficient to perform the analyses required in this FSAP, the laboratory shall notify the Primary Laboratory Contact within 1 working day. The Primary Laboratory Contact will identify the analysis priority based on available sample material and discussion with project personnel (e.g., Project Manager). Any analyses prescribed by this FSAP, but not performed, shall be identified in the data report and through the change notice process described in Section 7.0, Change Control.

# 5.0 QUALITY ASSURANCE AND QUALITY CONTROL

DOE/RL-96-68 identifies the quality requirements for environmental data collection, including sampling, field measurements, and laboratory analysis, and complies with the requirements of:

a) DOE O 414.1C, *Quality Assurance*

b) Title 10, *Code of Federal Regulations*, Part 830, "Nuclear Safety Management," Subpart A—Quality Assurance Requirements, § 830.120, "Scope" (10 CFR 830.120)

c) EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans EPA QA/R-5.*

Hanford onsite laboratories performing analyses in support of this FSAP will have approved and implemented QA plans. As required by TFC-PLN-02, "Quality Assurance Program Description," these QA plans will meet the minimum requirements of DOE/RL-96-68 as the baseline for laboratory quality systems. If subcontracting any portion of the analytical requirements to a commercial laboratory off the Hanford Site, the subcontractor's implementing QA program shall comply with *Quality Systems for Analytical Services* (QSAS), or be scheduled for DOE Consolidated Audit Program (DOECAP) certification. A commercial laboratory off the Hanford Site is subject to WRPS audit and QA Program approval.

All sampling and analysis activities will be performed using approved methods, procedures, and work packages that are written in accordance with approved operational and laboratory QA plans, which are consistent with the requirements of this FSAP. Sampling and analysis activities shall be performed by qualified personnel using properly maintained and calibrated equipment.

Sampling and laboratory personnel shall complete the necessary training and must receive appropriate certification to perform assigned tasks in support of the characterization project. The environmental safety and health training program provides workers with the knowledge and skills necessary to safely execute assigned duties. Field personnel typically will have completed, at a minimum, 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)
- Radiological worker training.

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

## 5.1 QUALITY CONTROL REQUIREMENTS FOR FIELD SAMPLING

Prior to sampling, sampling equipment shall be cleaned using a procedure that is consistent with SW-846 sampling equipment cleaning protocol. Only new (unused) pre-cleaned, quality assured sample containers shall be used for sampling.

Field QC samples shall be collected to evaluate the potential for cross-contamination and laboratory performance. Soil sampling requires the collection of field duplicate, equipment rinsate blank, field blank, and/or trip blank samples, where appropriate. This FSAP requires equipment rinsate blank and field blank samples. Field duplicate samples (i.e., samples taken at the same location), which are used to evaluate precision of the sampling process, will not be collected as it is not possible to obtain direct pushes exactly at the same location. Trip blanks, which are blank samples that travel with sample containers to the sampling site and return unopened to the laboratory with the samples, measure contamination during sample transport and are only analyzed for volatile organic compounds. Because there are no volatile organic compounds on the constituent list (Tables 3-1, 3-2, and 4-1), no trip blanks will be collected and analyzed for this FSAP.

### 5.1.1 Equipment Rinsate Blank Samples

Sampling personnel from CHPRC or WRPS will prepare the equipment rinsate blank samples. Equipment rinsate blanks are prepared after the sampling equipment is cleaned; they are used to verify the adequacy of sampling equipment decontamination procedures, and shall be collected for each sampling method or type of equipment used. Equipment rinsate blank samples shall consist of deionized water washed over or through decontaminated sampling equipment. Equipment rinsate blank samples are to be collected every 20 samples for the analytes listed in Table 3-2. The total number of samples for the 11 WMA A-AX sampling sites is anticipated to be approximately 36; therefore, it is expected that two equipment rinsate blank samples will be collected.

### 5.1.2 Field Blank Samples

Sampling personnel from CHPRC or WRPS will prepare the field blank samples. Field blank samples are samples prepared in the field at the sample collection site and returned to the laboratory with the samples to be analyzed. They are primarily used to test for contamination from the atmosphere. Field blank samples shall consist of deionized water. Field blank samples are to be collected every 20 samples for the analytes listed in Table 3-2. The total number of samples for the 11 locations in WMA A-AX is anticipated to be approximately 36; therefore, two field blank samples are expected to be collected.

### 5.1.3 Prevention of Cross-Contamination

Special care shall be taken to prevent cross-contamination of samples. Particular care will be exercised 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 bottles by setting them on or near potential contamination sources, such as uncovered ground. Samples shall not be collected or stored in the presence of exhaust fumes.
- Handling bottles or equipment with dirty hands. Sample containers shall be filled with care so as to prevent any portion of the collected sample coming in contact with the sampling personnel's gloves.
- Improperly decontaminating equipment before sampling or between sampling events.

## 5.2 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS FOR LABORATORY ANALYSIS

The QA objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality. Data quality is assessed, in part, by evaluation of representativeness, comparability, accuracy, precision, and completeness. These terms are defined in Table 5-1. 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.

**Table 5-1. Data Quality Definitions.**

| Data Quality Term | Definition |
|---|---|
| Representativeness | Representativeness is the degree to which data accurately and precisely represents a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. |
| Comparability | Comparability is the confidence with which one data set can be compared to another. |
| Accuracy | Accuracy represents the degree to which a measurement agrees with an accepted reference or true value. |
| Precision | Precision represents a measure of the degree of reproducibility of measurements under prescribed similar conditions. |
| Completeness | Completeness is a measure of the amount of usable and/or valid data obtained from a measurement system compared to the total amount of data requested. |

ATL-MP-1011, *ATL Quality Assurance Project Plan for 222-S Laboratory*, specifies the requirements for ensuring the quality of sample analyses performed by Advanced Technologies

and Laboratories International, Inc. (ATL) at the 222-S Laboratory. Analyses performed at 222-S Laboratory by WRPS will be governed by ATS-MP-1032, *222-S Laboratory Quality Assurance Project Plan*. All analyses shall be performed in accordance with these requirements. Laboratories performing analyses in support of this FSAP shall have approved and implemented QA plans. These QA plans shall meet HASQARD minimum requirements as the baseline for laboratory quality systems.

The analytical QC requirements (duplicates, spikes, etc.) are identified in Table 4-1. The laboratory shall also use calibration blanks and calibration check standards appropriate for the analytical instrumentation being used (see HASQARD for definitions of QC samples and standards). The criteria presented in the tables are goals for demonstrating reliable method performance. The laboratory will use its internal QA system for addressing any QC failures. If the QC failures are systematic and cannot be resolved by the internal protocols, the Quality Assurance personnel and Primary Laboratory Contact shall be consulted to determine the proper action. The laboratory should suggest a course of action at that time. All data not meeting the QC requirements shall be properly noted, and the associated QC failures shall be discussed in the narrative of the data report.

### 5.2.1 Laboratory Quality Control

The laboratory method blanks, duplicates, laboratory control sample/blank spike, and matrix spikes are defined in Chapter 1 of SW-846 and will be run at the frequency specified in Chapter 1 of SW-846. In the event that sample material is not sufficient to perform all analyses, analyses will be prioritized and sample material allocated to complete as many analyses as possible in priority order. If insufficient sample is available for completion of laboratory QC analyses, the laboratory will make note of the condition in the data package narrative, and the associated data results will have laboratory qualifiers added as appropriate. If sample volume is insufficient to run all method-required QC, where spike duplicates are required, duplicates do not need to be analyzed, and where duplicates are required, spike duplicates are not required. Minimally, a duplicate and spike (or spike duplicate) is required per laboratory batch.

### 5.2.2 Instrument/Equipment Testing, Inspection, and Maintenance

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 as specified by the manufacturer or other applicable guidelines. Maintenance requirements (such as parts lists and documentation of routine maintenance) will be included in the individual laboratory and the onsite organization QA plan or operating procedures (as appropriate). Calibration of laboratory instruments will be performed in a manner consistent with SW-846 or HASQARD.

Consumables, supplies, and reagents will be reviewed in accordance with SW-846 requirements and will be appropriate for their use.

# 6.0 DATA REPORTING

This section describes the reporting requirements for the WMA A-AX soil sample results. Section 6.1 identifies "quick turn" reporting requirements, and Section 6.2 identifies how all the analyses will be reported. Note that "quick turn" constituents are bolded and secondary constituents are italicized in Table 4-1. Quick turn, primary, and secondary constituents will be reported in Format VI data packages.

It is anticipated that the 222-S Laboratory will perform all of the analyses. If necessary, the laboratory may subcontract certain analyses to another qualified laboratory. The subcontracted laboratory shall meet all QA/QC requirements in this FSAP. The 222-S Laboratory will prepare a statement of work authorizing the subcontracted laboratory to perform the analyses. The statement of work shall be reviewed and approved by the Primary Laboratory Contact, Quality Assurance personnel, and Data Management Lead prior to commencement of laboratory analysis.

## 6.1 "QUICK TURN" REPORTING

The "quick turn" $^{99}$Tc and nitrate analyses will be reported as preliminary results on an expedited time frame (within one week of the last sample received for a batch; however, upon request, will be reported within 48 hours). The results will be transmitted via e-mail to the Primary Laboratory Contact, Characterization Task Lead, and Data Management Lead. They will also be reported in the standard data package and the information will be loaded into HEIS. Results will be reported on an as-received basis with percent solids and percent moisture values associated with each result in HEIS.

## 6.2 FORMAT VI REPORTING

Analysis performed at the 222-S Laboratory will be provided in Format VI data packages. Analysis performed at other laboratories will be provided in a format equivalent to a 222-S Laboratory Format VI report.

Format VI Report with QA Verification includes the following.

- Narrative – contains a description of sample receipt, sample breakdown, and has a section corresponding to each method describing any analytical/QC deviations.

- Results Table (Data Summary Report) – printout containing sample and duplicate results, relative percent difference, standard and spike recoveries, blank results, and data qualifiers (flags).

- Sample section that contains sample breakdown diagrams, chain of custody forms, and geologist's descriptions.

- Section that contains all e-mail correspondence documenting issues that arose during sampling and analysis, and subsequent decisions that affected initial work instructions.

- Laboratory will perform a QA review of the final report. Typical QA reviews require a minimum 10% review.

A Format VI data package is subject to internal laboratory QA verification and review including peer review prior to release.

The final data package will be provided to the Primary Laboratory Contact. The laboratory shall issue the data package within 180 calendar days following receipt of the last samples. Preliminary results shall be available within 7 days for the quick turn data, unless an expedited turnaround time is requested, and within 60 days for the remaining data following receipt of the last sample; however, the Primary Laboratory Contact will be informed of QC failures that may require re-extraction and/or reanalysis within two times holding times. As indicated in Section 5.0, laboratory changes will be communicated to the Primary Laboratory Contact and documented in the laboratory report(s) narrative. Sample raw data will be provided, upon request, to the Primary Laboratory Contact and/or Project Manager.

In addition to this data package, an electronic version of the analytical results shall be uploaded to HEIS within 3 calendar days of release of the data package. The electronic data shall be in the standard electronic format for HEIS [CP-15383, *Common Requirements of the Format for Electronic Analytical Data (FEAD)*].

## 6.3 DATA VERIFICATION AND ASSESSMENT

The data quality verification and assessment 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 is of the correct type and is of adequate quality and quantity to meet the project data quality objectives. Data quality assessment will be performed according to guidelines in EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide, EPA QA/G-9R.*

It should be noted that both the laboratory and Closure and Corrective Measures organizations have data review, verification and/or validation procedures and plans (ATL-312, Section 8.07, *Data Review* and TFC-PLN-134, "Vadose Zone Data Management Plan"). DOE/RL-96-68 (HASQARD) also identifies data assessment requirements and specifications. Data associated with this project will undergo a thorough verification and assessment process as identified in the above plans and procedures.

## 6.4 DATA DELIVERABLES

Available finalized and issued data will be provided in the field completion summary. Additionally, all quick turn data used to support interim action recommendations will be

provided to Ecology at the time of recommendations. When the remaining data is finalized and released, it will be made available electronically to Ecology (e.g., HEIS, data disks).

This page intentionally left blank.

# 7.0 CHANGE CONTROL

Field activity and laboratory work scope changes may be required based on unexpected field conditions, new information, health and safety concerns, or other circumstances. Changes to work scope may result in modifications to this FSAP. Work scope changes that do not result in deviation from the FSAP requirements can be made in the field or laboratory with the approval of the project manager or assigned task lead. These work scope changes will be documented in the sampling work package and/or Format VI laboratory report(s). Justification for the changes to work scope shall be provided in sufficient detail to explain the basis for the change.

This page intentionally left blank.

## 8.0 DOCUMENTS AND RECORDS

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

Logbooks are required for field activities. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook. Only authorized persons may make entries in logbooks. Logbooks will be signed by the field manager, supervisor, 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. Entries will be made in indelible ink. Corrections will be made by marking through the erroneous entry with a single line, entering the correct information, and initialing and dating the changes.

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

- Field logbooks or operational records
- Data forms
- Chain-of-custody forms
- Sample receipt records.

The laboratory will follow their own procedures with respect to documents and records. Audits will be periodically conducted by WRPS QA to ensure their practices are following requirements. All WRPS records are put into the Integrated Document Management System, the Hanford Site record repository.

This page intentionally left blank.

# 9.0 PROJECT ORGANIZATION

This section addresses the basic areas of project management, and it ensures that the project has a defined goal, that the participants understand the goal and approach to be used, and that the planned outputs have been appropriately documented. The project organization is described in Table 9-1. Project management and QA may conduct random surveillance and assessments to verify compliance with the requirements outlined in this FSAP, project work packages, procedures, and regulatory requirements. Deficiencies identified by these assessments shall be reported in accordance with existing programmatic requirements. Corrective actions will be implemented as required by WRPS policy and procedures. Management will be made aware of deficiencies identified by assessments and surveillances and subsequent corrective actions.

**Table 9-1. Key Personnel. (3 sheets)**

| Title | Responsibility | Primary Contact | Alternate Contact |
|---|---|---|---|
| Project Manager | • Coordinates the preparation of data quality objectives, data requirements plans, work plans, Sampling and Analysis Plans, and Field Sampling and Analysis Plans, as required.<br>• Coordinates with U.S. Department of Energy and Washington State Department of Ecology. | Cindy Tabor | Susan Eberlein |
| Characterization Task Lead | • Prepares Sampling and Analysis Plans and/or Field Sampling and Analysis Plans and documents required change notices, as necessary.<br>• Coordinates with Field Team Lead to identify reporting schedule requirements.<br>• Coordinates with team members to ensure that project requirements are understood.<br>• Determines where quality control samples will be collected to meet plan requirements.<br>• Reviews paperwork to ensure plan requirements are achieved.<br>• Plans, coordinates, and oversees field sampling activities including sample collection, packaging, provision of certified clean sampling bottles/containers, documentation of sampling activities in controlled logbooks, chain-of-custody form, and packaging and transporting of samples to laboratory or shipping center.<br>• Reviews field paperwork to ensure that it has been completed correctly.<br>• Directs training, mock-ups, and practice sessions to ensure that the sampling design is understood.<br>• Identifies resources needed for sampling; develops and revises sampling procedures and training material; and performs training, as necessary.<br>• Ensures equipment and materials (e.g., bottles) associated with sampling are available and ensures that equipment receives preventative maintenance as required. | Anna Radloff | Cindy Tabor |
| Field Team Lead | • Develops information to be included in work packages.<br>• Provides direction to Field Work Supervisor regarding field scope, schedule, and priorities.<br>• Provides direction regarding drilling activities to field personnel including subcontractors.<br>• Prepares work package information for all field activities.<br>• Plans, coordinates, and oversees field drilling activities.<br>• Coordinates with necessary organizations to ensure field drilling activities are conducted safely and correctly.<br>• Communicates with the Characterization Task Lead, Primary Laboratory Contact, and Data Management Lead to identify field constraints that could affect sampling design or that would necessitate a change notice.<br>• Leads the effort of determining sample depth for each boring.<br>• Ensures field activities are documented in direct push completion reports. | Harold Sydnor | Jacob Throolin |

**Table 9-1. Key Personnel. (3 sheets)**

| Title | Responsibility | Primary Contact | Alternate Contact |
|---|---|---|---|
| Field Work Supervisor | • Acts as the key field interface for daily field activities.<br>• Conducts daily briefings and goes over the daily plan.<br>• Ensures work activities are performed in a safe and productive manner and in accordance with all applicable administrative and technical procedures.<br>• Ensures that work does not commence until all personnel involved with the field work understand their roles and responsibilities.<br>• Applies the work planning process, including conducting pre-job briefings and post-job reviews.<br>• Oversees personnel performing low/medium risk, self-directed tasks with supervision only on an as-needed basis.<br>• Identifies, recognizes, mitigates, and controls hazards. | Rick Franzen, Sr. | Chuck Peoples, Manager |
| Primary Laboratory Contact and Data Management Lead | • Acts as the primary laboratory interface.<br>• Selects laboratory to perform the analyses and requests assessments/surveillances of the laboratories.<br>• Works with the laboratory to resolve data quality issues and to ensure plan requirements are achieved.<br>• Assists with resolving Data Validation issues and performs technical review of third party Data Validation results.<br>• Assists in laboratory surveillances.<br>• Ensures Sample Data Tracking system is set up to meet sampling and analysis objectives and ensures paperwork is generated for sampling events.<br>• Oversees all Sample Data Tracking efforts in order to prioritize data management efforts and to ensure that project requirements are achieved.<br>• Ensures the data verification process is completed and that data is reviewed against existing knowledge and data quality assessment guidelines.<br>• Ensures that data is loaded into Hanford Environmental Information System correctly. | Anna Radloff | Cindy Tabor |
| Quality Assurance | • Provides oversight to ensure data integrity.<br>• Performs assessments and surveillance, as necessary.<br>• Reviews documentation generated through implementation of Sampling and Analysis Plans and/or Field Sampling and Analysis Plans.<br>• Performs Quality Assurance review of third party Data Validation results.<br>• Reviews changes to data documents and forms.<br>• Reviews issues identified during data processes for corrective actions.<br>• Identifies Quality Assurance hold points or best management practices, as needed. | Matthew Romano | Glen Clark |

**Table 9-1. Key Personnel. (3 sheets)**

| Title | Responsibility | Primary Contact | Alternate Contact |
|---|---|---|---|
| Radiological Engineering Contact | • Conducts As Low As Reasonably Achievable reviews, exposure and release modeling, and radiological control optimization.<br>• Identifies that appropriate controls are implemented to maintain worker safety.<br>• Interfaces with health and safety contact.<br>• Plans and directs radiological control technicians that support field activities. | Field Team Lead contacts:<br>Daren Christensen<br>Phone: 373-3748 | |
| Health and Safety Contact | • Coordinates industrial health and safety support within the project as per required health and safety plan, job hazard analyses, and other pertinent safety documents.<br>• Provides assistance to ensure compliance with applicable health and safety standards/requirements.<br>• Coordinates with radiological engineering to determine personal protective clothing requirements. | Field Team Lead contacts:<br>Mike Powers<br>Phone: 376-5597 | |
| Waste Management Contact | • Communicates policies and procedures to ensure project compliance with storage, transportation, disposal, and waste tracking requirements. | Field Team Lead contacts:<br>Keith Smith<br>Phone: 372-1322 | |

## 10.0 REFERENCES

10 CFR 830, "Nuclear Safety Management," Subpart A—Quality Assurance Requirements, § 830.120, "Scope," *Code of Federal Regulations*, as amended.

11-NWP-053, 2011, "Re: Organic Analyses Optimization for Waste Management Area (WMA) C" (letter from J. J. Lyon to R. W. Lober, U.S. Department of Energy, Office of River Protection, June 1), State of Washington Department of Ecology, Richland, Washington.

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

ASTM D2216, 2010, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass*, ASTM International, West Conshohocken, Pennsylvania.

ATL-312, Section 8.07, 2012, *Data Review*, Rev. 0, Advanced Technologies and Laboratories International, Inc., Richland, Washington.

ATL-MP-1011, 2014, *ATL Quality Assurance Project Plan for 222-S Laboratory*, Rev. 12-3, Advanced Technologies and Laboratories International, Inc., Richland, Washington.

ATS-MP-1032, 2014, *222-S Laboratory Quality Assurance Project Plan*, Rev. D-4, Washington River Protection Solutions, LLC, Richland, Washington.

CP-15383, 2007, *Common Requirements of the Format for Electronic Analytical Data (FEAD)*, Rev. 8, Fluor Hanford, Inc., Richland, Washington.

DOE O 414.1C, 2005, *Quality Assurance*, U.S. Department of Energy, Washington, D.C.

DOE QSAS, 2013, *Quality Systems for Analytical Services*, Rev. 3.0, U.S. Department of Energy, Oak Ridge Office, Oak Ridge, Tennessee.

DOE/RL-96-68, 2014, *Hanford Analytical Services Quality Assurance Requirements Documents, Volumes 1 to 4*, Rev. 4, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

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

EPA 600/4-86/024, 1986, *Development of Standard Methods for the Collection and Analysis of Precipitation*, "Method 300.7, Dissolved Sodium, Ammonium, Potassium, Magnesium, and Calcium in Wet Deposition by Chemically Suppressed Ion Chromatography," U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Office of Research and Development, Cincinnati, Ohio.

*Resource Conservation and Recovery Act of 1976*, 42 USC 6901, et seq.

RPP-10435, 2002, *Single-Shell Tank System Integrity Assessment Report*, Rev. 0, CH2M HILL Hanford Group, Inc., Richland, Washington.

RPP-23403, 2013, *Single-Shell Tank Component Closure Data Quality Objectives*, Rev. 5, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-ENV-37956, 2014, *Hanford 241-A and 241-AX Tank Farms Leak Inventory Assessment Report*, Rev. 2, Washington River Protection Solutions, LLC, Richland, Washington.

RPP-RPT-38152, 2008, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/Corrective Measures Study*, Rev. 0, Cenibark International, Inc., Richland, Washington.

SW-846, 1986, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Third Edition as amended, U.S. Environmental Protection Agency, Washington, D.C.

TFC-PLN-02, Rev. H, "Quality Assurance Program Description," Washington River Protection Solutions, LLC, Richland, Washington.

TFC-PLN-134, Rev. A, "Vadose Zone Data Management Plan," Washington River Protection Solutions, LLC, Richland, Washington.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, as amended.

WRPS-0900155 Rev 2, "Test Plan for Sample Breakdown and Analysis of Sediment Samples Obtained as Part of the Vadose Zone Project" (interoffice memorandum from G. A. Cooke to H. L. Anastos, September 1), Washington River Protection Solutions, LLC, Richland, Washington.