U.S. Department of Energy
Hanford Site

June 1, 2020

20-TF-0027

Ms. Alexandra K. Smith, Program Manager
Nuclear Waste Program
Washington State
Department of Ecology
3100 Port of Benton Blvd.
Richland, Washington 99354

Dear Ms. Smith:

THE U.S. DEPARTMENT OF ENERGY, OFFICE OF RIVER PROTECTION TRANSMITTAL OF RPP-PLAN-63698, FIELD SAMPLING AND ANALYSIS PLAN FOR SOIL SAMPLES IN SUPPORT OF INTERIM MEASURES AT 241-U TANK FARM, REV. 0

The purpose of this letter is to transmit the *Field Sampling and Analysis Plan for Soil Samples In Support of Interim Measures at 241-U Tank Farm,* RPP-PLAN-63698, Rev. 0 (FSAP) for the Washington State Department of Ecology (Ecology) review. The FSAP was developed to specify the field characterization requirements for soil sampling and to provide direction to sampling and laboratory personnel. The development of this FSAP was identified in Ecology et al. 1989, *Hanford Federal Facility Agreement and Consent Order* milestone, M-045-56, meeting notes on July 11, 2019. Ecology was involved with the development of the FSAP and also provided input on the direct push locations.

Field status information will be provided to Ecology and sample depth meetings will be scheduled to ensure Ecology's input is considered in the selection of sample depths.

If you have any questions, please contact me, or your staff may contact Becky Blackwell, Closure Project Manager, Tank Farm Programs Division, Office of River Protection, on (509) 376-0058.

Sincerely,

Robert G. Hastings

Digitally signed by Robert G. Hastings
Date: 2020.06.01 12:45:14 -07'00'

Robert G. Hastings, Assistant Manager
Tank Farms Project
Office of River Protection

TF:RIB

Attachment:
RPP-PLAN-63698

cc: See page 2

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Attachment
20-TF-0027

Field Sampling and Analysis Plan for Soil Samples In Support of Interim Measures at 241-U Tank Farm, Rev. 0
RPP-PLAN-63698

(95 Pages Including Cover Sheet)

DOCUMENT RELEASE AND CHANGE FORM

Prepared For the U.S. Department of Energy, Assistant Secretary for Environmental Management
By Washington River Protection Solutions, LLC., PO Box 850, Richland, WA 99352
Contractor For U.S. Department of Energy, Office of River Protection, under Contract DE-AC27-08RV14800

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DATE:
May 18,2020
HANFORD RELEASE

1. **Doc No:** RPP-PLAN-63698 **Rev.** 00

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Field Sampling and Analysis Plan for Soil Samples in Support of Interim Measures at 241-U Tank Farm

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Originator	Tabor, Cindy L	*Tabor, Cindy L*	04/27/2020
Other Approver	Lungu, Cris C	*Lungu, Cris C*	04/15/2020
Other Approver	McKinney, Steve G	*McKinney, Steve G*	05/05/2020
Other Approver	Schramm, Geoff D	*Schramm, Geoff D*	04/27/2020
Other Approver	Snyder, Susan	*Snyder, Susan*	05/07/2020
Responsible Manager	Rutland, Paul L	*Rutland, Paul L*	05/11/2020

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Catron, Chris E	TFP FIELD CREW OPS
Childress, Ryan D	CLOSURE & INTERIM MEASURES
Cooke, Gary A	PROCESS CHEMISTRY
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Franzen, Ricky L	CONSTRUCTION SERVICES
Gardner, Martin G	CLOSURE & INTERIM MEASURES
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Schramm, Geoff D	QA PROGRAMS & ASSESSMENTS
Snyder, Susan	PROJECT MANAGEMENT
Tabor, Cindy L	CLOSURE & INTERIM MEASURES

INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

Part I: Background Information

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Publish to OSTI? ☐ Yes ☑ No

Information Category:
☐ Abstract ☐ Journal Article ☐ Summary
☐ Internet ☐ Visual Aid ☐ Software
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Document Number: RPP-PLAN-63698 Revision 0 Date: March 2020

Author: Tabor, Cindy L

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Document Release Criteria in TFC-ENG-DESIGN-C-25 completed? (Attach checklist)	☐	☑	
If product contains pictures, safety review completed?	☑	☐	Roberts, Sheryl K Approved - IDMS data file att.

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Responsible Manager	WRPS	03/16/2020	Rutland, Paul L Approved - IDMS data file att.
Other:			

Part V: IRM Clearance Services Review

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Document Contains Information Restricted by DOE Operational Security Guidelines?	☐	☒	Reviewer Signature: Print Name/Signature/Date
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INFORMATION CLEARANCE REVIEW AND RELEASE APPROVAL

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WRPS Office of Chief Counsel	☒	☐	Peter, Amber D Approved - IDMS data file att.
DOE – ORP Public Affairs/Communications	☒	☐	Levardi, Yvonne M / Tyree, Geoff T Approved - IDMS data file att.
Other: ORP SME	☒	☐	Blackwell, Becky Approved - IDMS data file att.
Other: ORP OCC	☒	☐	Zelen, Benjamin J Approved - IDMS data file att.

Comments Required for WRPS-Indicate Purpose of Document:

This field sampling and analysis plan defines the sampling and analysis requirements for vadose zone soil sampling in 241-U Tank Farm.

APPROVED
By Sarah Harrison at 10:55 am, Apr 13, 2020

Approved for Public Release; Further Dissemination Unlimited

Information Release Station

Was/Is Information Product Approved for Release? ☒ Yes ☐ No

If Yes, what is the Level of Releaser? ☑ Public/Unrestricted ☐ Other (Specify) _____

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RPP-PLAN-63698
Revision 0

FIELD SAMPLING AND ANALYSIS PLAN FOR SOIL SAMPLES IN SUPPORT OF INTERIM MEASURES AT 241-U TANK FARM

Prepared by

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Date Published
March 2020

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

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ACRONYMS

ASTM	American Society for Testing and Materials
bgs	below ground surface
CAS	Chemical Abstracts Service
CCU	Cold Creek unit
CCUc	Cold Creek unit calcic
CCUz	Cold Creek unit silt
CFR	*Code of Federal Regulations*
CRBG	Columbia River Basalt Group
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/CAP-AP	DOE Consolidated Audit-Accreditation Program
DOE-ORP	U.S. Department of Energy Office of River Protection
DQA	data quality assessment
DQO	data quality objective
Ecology	Washington State Department of Ecology
EDDPro	Electronic Data Deliverable Processor
ERT	electrical resistivity tomography
FSAP	field sampling and analysis plan
FWS	Field Work Supervisor
GC/ECD	gas chromatography/electron capture detector
GC/MS	gas chromatography/mass spectrometry
GW	groundwater

H1	Hanford formation 1
H2	Hanford formation 2
HASQARD	Hanford Analytical Services Quality Assurance Requirements Document
HEIS	Hanford Environmental Information System
HFFACO	Hanford Federal Facility Agreement and Consent Order
ICP/AES	inductively coupled plasma/atomic emission spectrometry
ICP/MS	inductively coupled plasma/mass spectrometry
LCS	laboratory control sample
NA	not applicable
QA	quality assurance
QC	quality control
QSM	Quality Systems Manual
RPD	relative percent difference
Rtf	Ringold Formation member of Taylor Flat
Rwie	Ringold Formation, member of the Wooded Island - unit E
SMO	Sample Management Office
TSD	Treatment, Storage, and/or Disposal
U Farm	241-U Tank Farm
UPR	unplanned release
WRPS	Washington River Protection Solutions, LLC

1.0 INTRODUCTION

This field sampling and analysis plan (FSAP) defines the sampling and analysis requirements for vadose zone soil sampling in 241-U Tank Farm (U Farm).

The following components are included in this FSAP:

- Introduction (Section 1.0)
- Project Organization (Section 2.0)
- Sampling Requirements (Section 3.0)
- Sample Analysis Requirements (Section 4.0)
- Quality Assurance and Quality Control Requirements (Section 5.0)
- Data Management (Section 6.0)
- Change Control (Section 7.0)
- Documents and Records (Section 8.0)
- Management of Waste (Section 9.0)
- Health and Safety Plan (Section 10.0)
- References (Section 11.0).

Appendix A provides the characterization deviation form, which is further discussed in Section 7.0. Appendix B provides information on unplanned releases (UPRs) in or near U Farm.

1.1 PURPOSE AND SCOPE

The purpose of this FSAP is to specify the requirements for field characterization (i.e., sampling and geophysical logging), laboratory analysis, and data reporting for soil samples that will be collected in U Farm. The work performed under this FSAP is expected to provide data to support recommendations in RPP-35485, *Field Investigation for Waste Management Area U* and RPP-RPT-50097, *Hanford 241-U Farm Leak Inventory Assessment Report*.

Additionally, this investigation is being performed to collect samples while still feasible since an interim surface barrier is to be placed over U Farm by the end of October 2023, per the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1989) (HFFACO) Milestone M-045-92. Work to be performed under this FSAP was also recommended in Ecology et al. 1989, HFFACO Milestone M-045-56 meeting notes on July 11, 2019 [DOE-ORP and Ecology 2019, *Meeting Notes: Annual Meeting Between the U.S. Department of Energy, Office of River Protection (DOE-ORP) and the State of Washington, Department of Ecology (Ecology) to Discuss Interim Measures Completed in Fiscal Year 2019 and Planned for Fiscal Year 2020*]. Opportunistic sampling at U Farm will be conducted in accordance with various quality assurance (QA)/quality control (QC) requirements in RPP-RPT-60227, *Data Quality Objectives for Vadose Zone Characterization at Waste Management Area A-AX* (the Data Quality Objectives [DQO] Report) to support *Resource Conservation and Recovery Act of 1976* requirements and characterization efforts.

The scope of this FSAP consists of collecting vadose zone soil samples from direct push locations and performing geophysical logging in U Farm. Five direct push locations have been selected to assist in this investigation (refer to Figure 1-1). Further information on these pushes and the rationale for their location is provided in Sections 1.2 and 3.0 (Background Information and Sampling Requirements, respectively).

Information regarding treatment, management, and disposal of the radioactive source, byproduct material, and/or special nuclear components of mixed waste (as defined by the *Atomic Energy Act of 1954*, as amended) is not provided in this FSAP for the purpose of regulating the radiation hazards of such components under the authority of this FSAP or the *Hazardous Waste Management Act* (RCW 70.105, "Hazardous Waste Management"), but is provided for informational purposes only.

1.2 BACKGROUND INFORMATION

Previous direct push characterization work at U Farm was performed in 2007. Specific tanks targeted during this characterization campaign included Tanks 241-U-104 (U-104), 241-U-105 (U-105), 241-U-110 (U-110), 241-U-112 (U-112), and 241-U-201 (U-201). Figure 1-1 shows the previous direct push sample locations. The analytical information is summarized in PNNL-17163, *Characterization of Direct Push Vadose Zone Sediments from the 241-U Single-Shell Tank Farm* and RPP-35485.

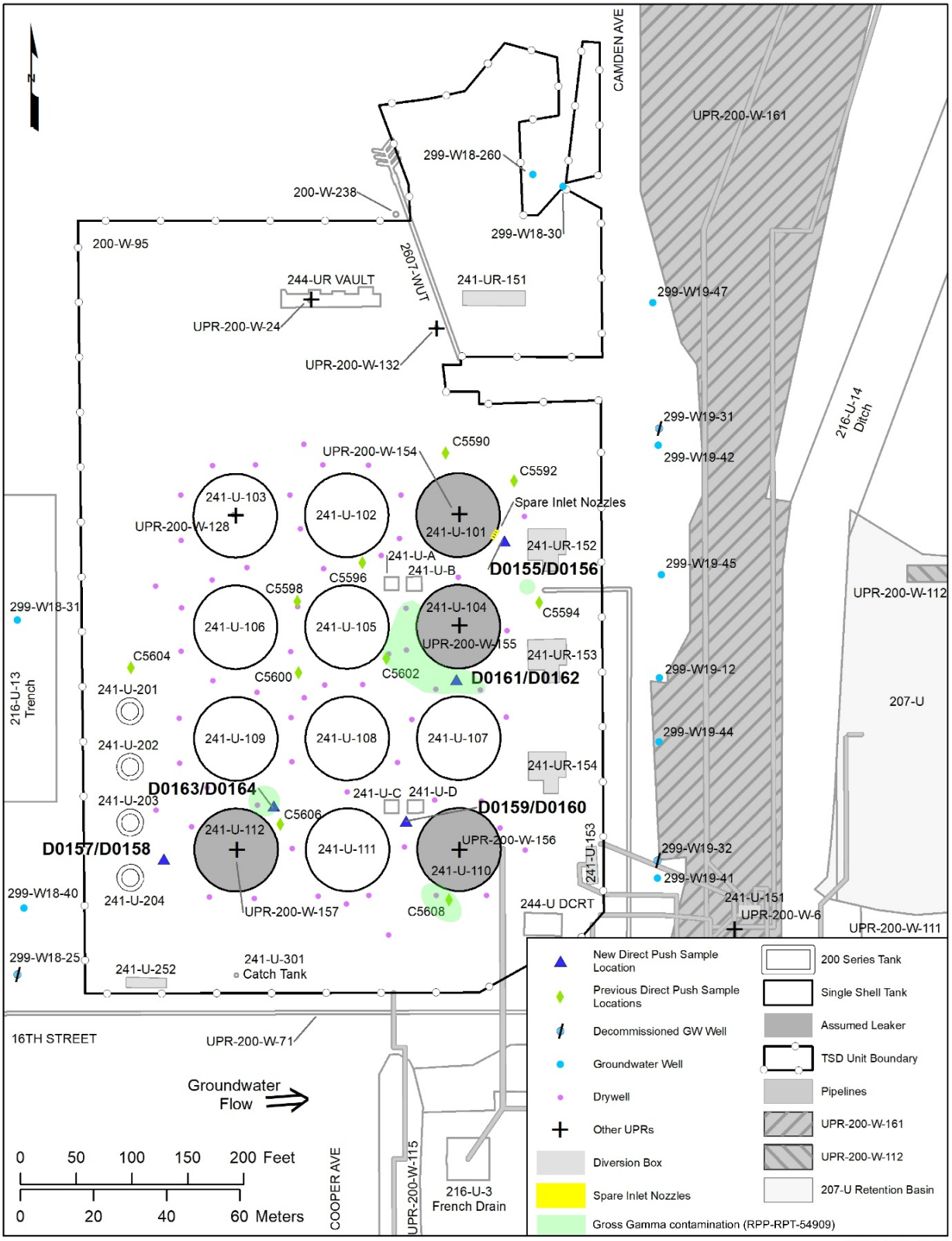
RPP-35485 and RPP-RPT-50097 are the two documents that identify the need for additional field investigations. RPP-35485 makes recommendations for additional investigations, as follows.

- At Tank U-104, deep soil sampling should be conducted to determine the extent of mobile contaminants (e.g., ^{99}Tc and nitrate).

- At Tank 241-U-101 (U-101), deep soil sampling should be conducted to determine the presence and extent of ^{99}Tc and nitrate in the southeast quadrant.

- At Tanks U-110 and U-112, deep soil sampling should be conducted because previous direct pushes at these locations only went to 100 and 51 feet below ground surface (ft bgs). Deeper sampling will help determine the extent of ^{99}Tc and nitrate vertical migration.

Figure 1-1. Vadose Zone Soil Sampling in 241-U Tank Farm.



GW = groundwater TSD = Treatment, Storage, and/or Disposal UPR = unplanned release

RPP-RPT-50097 indicates several tanks in U Farm potentially have leaked and that there have been various UPRs in the farm. Table 1-1 provides information on the potential tank leaks in U Farm. RPP-RPT-50097 recommends that additional vadose zone characterization near Tank U-101 be performed to further assess whether Tank U-101 leaked. In particular, a location near the spare inlet nozzles should be pushed to investigate a potential overflow. Currently, the Tank U-101 leak volume estimate is considered highly uncertain with a range of zero to the reported 30,000 gal. RPP-RPT-50097 also recommends additional drywells and/or direct push locations near the U Farm 200-series tanks since there are no drywells in this area. There were no recommendations for sampling at UPRs; however, information on them is provided in Appendix B for informational purposes.

RPP-RPT-50097 also provides information on surface radioactivity results. There were also no recommendations regarding sampling of these areas. Figure 1-2 shows surface radioactivity survey results for U Farm and identifies locations of surface hot spots. Typically, the highest gamma activity levels were observed near tanks.

Another report of interest is RPP-RPT-54909, *Hanford Single-Shell Tanks Leak Location and Cause: Summary Report*. This report identifies the locations of the possible tank leaks. For U Farm, locations of leaks and causes are provided for Tanks U-104, U-110, and U-112. Figure 1-1 of this report shows the possible leak locations for these three tanks (i.e., gross gamma contamination). Information on Tank U-101 is not included in RPP-RPT-54909 because it is recommended to be further assessed as per RPP-RPT-50097.

1.3 GEOLOGIC SETTING

U Farm is located on a sequence of sediments that overlie bedrock of the Columbia River Basalt Group (CRBG). Stratigraphic units beneath U Farm (from oldest to youngest) include: Miocene-age CRBG; late Miocene- to Pliocene-age fluvial gravel, sand, and silt of the Ringold Formation; Pliocene- to Pleistocene-age gravel, sand, and silt, including calcic paleosol of the Cold Creek unit (CCU); Pleistocene-age flood gravels and sand of the Hanford formation; and recent Holocene sediments.

The overall vadose zone thickness beneath U Farm is approximately 225 ft (RPP-35485). General characteristics of each sedimentary unit that comprise the vadose zone beneath U Farm, from oldest to youngest, include the following.

- Ringold Formation member of Wooded Island, unit E* (Rwie) – is the uppermost sequence of the Ringold Formation beneath U Farm and consists of slightly silty coarse- to medium-grained sandy gravel with intercalated gravelly sand. Rwie is approximately 295 ft thick and contains the upper portion of the unconfined aquifer (PNNL-13612, *Groundwater Quality Assessment Plan for Single-Shell Tank Waste Management Area U*).

*Indicates this formation occurs below and above the water table.

Table 1-1. Summary of Tank Waste Loss Events.

Tank	Description	Tank Leak/Release Estimate*
241-U-101 (U-101)	Tank U-101 was suspected of leaking based on liquid level decreases in 1960. Neither gamma activity nor low resistivity was found near Tank U-101 and tank surveillance data appear to be inconsistent and unreliable. Lacking additional information, the Tank U-101 leak volume estimate is considered highly uncertain, with a range of zero to the reported 30,000 gal.	0 to 30,000 gal Recommend tank integrity assessment per TFC-ENG-CHEM-D-42. ^{137}Cs = 0 to 7,400 Ci
241-U-104 (U-104)	Tank U-104 was first suspected of leaking based on a reported bulge near the center of the tank and a liquid level decrease in 1956. A leak test was performed between 1957 and 1961, confirming the suspected leak. It was concluded that Tank U-104 leaked during the leak test and likely leaked as early as 1953 during sluicing. The leak volume is highly uncertain because of the tank bulge and uncertainty in liquid level measurements. Based on drywell data, as much as 46,000 lbs (7 Ci) of ^{238}U may have been released from the tank.	≤109,000 gal ^{238}U = 7 Ci
241-U-110 (U-110)	Tank U-110 was first suspected of leaking based on a liquid level decrease and simultaneous drywell gamma activity increase in 1975. It was concluded that Tank U-110 leaked during 1975, and that the composition of the leak should be based on the 1975 sample.	5,000 to 25,000 gal ^{137}Cs = 126 Ci
241-U-112 (U-112)	Tank U-112 was classified as "questionable integrity" based on a 3-inch liquid level decrease between February 1969 and March 1970 and increased gamma activity in drywell 60-12-01. The tank was reclassified as an assumed leaker in 1980.	8,500 to 57,000 gal ^{137}Cs = 24,000 Ci
Other U Farm Single-Shell Tanks	Some single-shell tanks show activity in nearby drywells that has previously been attributed to operational spills, overflows or line leaks but no evidence of a liner failure was found for any of these tanks and no basis was found for an inventory estimate for releases from these tanks.	Not applicable

*Except as noted, ^{137}Cs inventories are decayed to January 1, 2001.

References:
HNF-EP-0182, *Waste Tank Summary Report for Month Ending October 31, 2019, Rev. 382.*
TFC-ENG-CHEM-D-42, "Intrusion Notification and Tank Leak Assessment Process."
RPP-RPT-61279, *Single-Shell Tank Farm Leak Inventory Assessments Summary*.

Modified from: RPP-RPT-50097, *Hanford 241-U Farm Leak Inventory Assessment Report*.

Figure 1-2. 241-U Tank Farm Radioactive Surface Survey Map.

Source: RPP-RPT-50097, *Hanford 241-U Farm Leak Inventory Assessment Report*.

Note: The 241-U Farm surface survey map is a sketch showing results of weekly radioactivity survey reports.

- Ringold Formation member of Taylor Flat (Rtf) – consists of a sequence of fluvial sands and overbank deposits. In the 200 West Area, erosional remnants of the Rft consist of fine-grained fluvial sand and overbank facies with localized stringers of calcium carbonate (CP-60925, *Model Package Report: Central Plateau Vadose Zone Geoframework Version 1.0*).

- Cold Creek unit (CCUc) – is a caliche-rich zone about 3 to 6 ft thick that developed on the paleo-surface of the Ringold Formation (PNNL-15955, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*). It is a calcium carbonate-rich layer with locally-derived basalt detritus, silt-rich deposits, and reworked Ringold Formation material. The calcium carbonate zones are probably discontinuous and occur as layers, nodules, and clast coatings. The subunit dips slightly to the southwest.

- Cold Creek unit (CCUz) – is a silt-rich, sandy soil about 9 to 15 ft thick that is relatively uniform and shows little depositional structure. The fine-grained nature of this unit has significant influence on the vertical movement of moisture in the vadose zone. The subunit dips slightly to the southwest. Perched water above the CCUz has been found to the east beneath the 216-U-14 Ditch and 216-U-1 and 216-U-2 Cribs in the past (PNNL-15955).

- Hanford formation 2 (H2) – consists primarily of a sand layer that averages about 79 ft thick across U Farm (PNNL-15955). It thins to the east and northeast. Repetitive sequences of very thin, flat-lying lamina of silt and sand have been observed in intact core samples and may provide a sedimentary structure that influences moisture movement in the vadose zone.

- Hanford formation 1 (H1) – the upper gravelly sequence consists of pebble to boulder gravel and fine- to coarse-grained sand. The unit thickness varies between 8 and 22 ft bgs.

- Backfill – consists of poorly- to moderately-sorted cobbles, pebbles, and coarse to medium sand derived from the H1 subunit.

Normally, groundwater flows from west to east below U Farm (Figure 1-1). Based on groundwater data, discharges of 500 million gal of waste to the 216-U-14 Ditch began in 1991 causing the groundwater to flow from the east to west and to the north from 1991 through 1996. It also resulted in perched water zones above the CCU. Although drywells show high concentrations of uranium in the vadose zone due to Tank U-104 and Tank U-110 leaks, uranium has not been detected in the groundwater beneath U Farm. A low permeability layer, the CCUz apparently sorbed and slowed uranium migration compared to uranium migration in 241-BX Tank Farm in the 200 East Area which has reached groundwater (RPP-RPT-50097).

High moisture content (greater than 15% by volume) occurs at the interface between the bottom of the tank farm excavation and the undisturbed vadose zone (approximately 50 to 55 ft bgs). High moisture content is also present at a deeper depth interval (approximately 80 ft bgs),

particularly around Tank U-105 (RPP-35485). Perched water zones have also been observed in nearby groundwater monitoring wells east of the 216-U-14 Ditch at approximately 80 to 100 ft bgs. The top of the perched water zone was measured over time and fluctuated between 30 and 100 ft bgs in response to variable discharge. The perched water zone was not determined at U Farm but was presumed to extend to the top of the CCU about 120 to 130 ft bgs (RPP-35485).

Direct push technology will be used to characterize the vadose zone at U Farm and has limited depth capability in coarse-grained or cemented matrices. The approximate depth to the CCUc is 135 ft bgs in the southern area of U Farm and 130 ft bgs in the northern area of U Farm. Characterization will continue until the CCUc (~130 to ~135 ft bgs), or refusal, whichever is encountered first.

1.4 CONCEPTUAL SITE MODEL

A conceptual site model for U Farm was developed during the RCRA Facility Investigation and includes information from the last sampling event in the farm. The conceptual site model is documented in DOE/ORP-2008-01, *RCRA Facility Investigation Report for Hanford Single-Shell Tank Waste Management Areas*.

The stratigraphy of an area represents the framework through which tank fluids and contaminants will move through the vadose zone soils. At U Farm, Tank U-104 released the largest volume of tank liquids. The tank contained bismuth phosphate metal waste at the time of release, similar to that released at Tank 241-BX-102 during the overfill event in 1951. The metal waste contains molar quantities of sodium and a mixture of carbonate, nitrite, nitrate, sulfate, phosphate, and very high concentrations of dissolved uranium compared to other waste streams. Inventory rankings of all single-shell tank releases (PNNL-17154, *Geochemical Characterization Data Package for the Vadose Zone in the Single-Shell Tank Waste Management Areas at the Hanford Site*) indicate that Tank U-104 ranks second in release of carbonate (15,631 lbs), phosphate (2,778 lbs), and uranium (395 lbs); third in release of sulfate (4,938 lbs); and fifth in release of ^{90}Sr (467 Ci) and ^{241}Am (0.83 Ci). Tank U-112 also is in the top ten single-shell tanks for release of these same constituents.

A number of contaminants (e.g., ^{99}Tc, nitrate, and chromium) historically have been seen in groundwater in the region near U Farm. However, the specific source for some of these contaminants is difficult to determine because of the many possible waste sources in the region, (i.e., collection pond 216-U-10 [U Pond], cribs, trenches, ditches, and the tank facilities themselves). Currently, two contaminants, ^{99}Tc and nitrate, are seen in groundwater in the region near U Farm at concentrations that exceed their regulatory limits.

Near U Farm, substantial volumes of intentional wastewater discharges occurred from 1944 to 1995. The very large volume of wastewater produced by various operations associated with reprocessing necessitated these actions, and a wastewater discharge system was built for this purpose. The major components of the discharge system were two long north-to-south trending drainage ditch systems, Z ditches and the 216-U-14 Ditch, whose effluents were discharged into

U Pond. The Z ditches were dedicated to the waste removal from Z Plant operations facilities. The Z ditches consisted of several ditches built and used sequentially between 1944 and 1993. The 216-Z-D1 Ditch was the first to receive effluent and operated from 1944 to 1959, followed by 216-Z-11 Ditch from 1959 to 1971, then 216-Z-19 Ditch from 1971 to 1981, and finally, 216-Z-20 Crib from 1981 to 1992.

The 216-U-14 Ditch was dedicated to the waste removal from U Plant and the Uranium Trioxide Facility (also called 224-U/UA or UO_3 Plant) operations and various other facilities (e.g., the 2723-W Mask Cleaning Station, the 283 Wastewater Treatment Plant, the 284-W Power and the 2724-W Laundry Facility). Initially, wastes were dominantly cooling water from U and UO_3 Plants during uranium recovery operations between 1952 and 1957. The maximum U Pond discharge period between 1952 and 1958 was largely due to the wastewater generated by these operations. Wastes included process cooling water, steam condensate, vacuum pump sealant, chemical sewer waste, and storm runoff.

The effects of these discharges on water table elevations beneath U Pond were recorded at nearby groundwater monitoring wells. With the high discharges in the 1950s, groundwater levels around U Pond rose over 45 ft rapidly and remained elevated into the 1980s. Subsurface monitoring data in the vicinity of U Farm are essentially nonexistent through the 1950s; limited monitoring data are available at other nearby facilities. For example, the first monitoring well close to U Farm was monitoring well 299-W19-1, about 100 ft from the southeast corner of the boundary. Nitrate and water elevation measurements were first recorded in late 1957, and gross beta measurements were recorded in 1959. However, quality control for chemistry measurements is poorly known from that time period. Also, groundwater sampling for chemical analyses ceased in the early 1960s and was not resumed on a routine basis until the early 1990s. For these reasons, the effects on local vadose zone infiltration, water table changes, perturbations to groundwater movement, and subsurface contamination from the approximate 2.1 billion gal discharged to the ditch system and into U Pond prior to 1960 must be inferred.

After 1985, waste discharges to the surface were limited to intentional liquid discharges to the 216-Z-20 Crib and the 216-U-14 Ditch. The 216-Z-20 Crib received Z Plant operations wastewater tluough 1992 at an annual rate between 2.4 and 9.2 million gal. These wastes were not transferred to U Pond and presumably entered the subsurface directly under the crib. The 216-U-14 Ditch continued to receive wastewater from the 242-S Evaporator and the UO_3 Plant through 1993 at an annual rate of 1.1 to 2.1 million gal, except in 1991 when it received about 500 million gal. The effect of this very large release was to temporarily reverse the normal west-to-east groundwater flow gradient. This east-to-west movement took place between 1993 and 1996. A significant perched water zone above the CCU below the 216-U-14 Ditch increased and diminished in volume with the changing discharge into the 216-U-14 Ditch. It is likely that lateral migration in the vadose zone underneath U Farm was also occurring.

Since easterly flow of groundwater was re-established in 1996, nitrate concentrations have increased to the south, and ^{99}Tc concentrations have increased to the north. These distinct trends indicate that there are multiple sources. Sporadic increases of sulfate, chromium, and chloride have also been measured in these wells. These increases may be partially attributable to tank waste leaks. Given the continued increases in nitrate and ^{99}Tc concentrations in groundwater

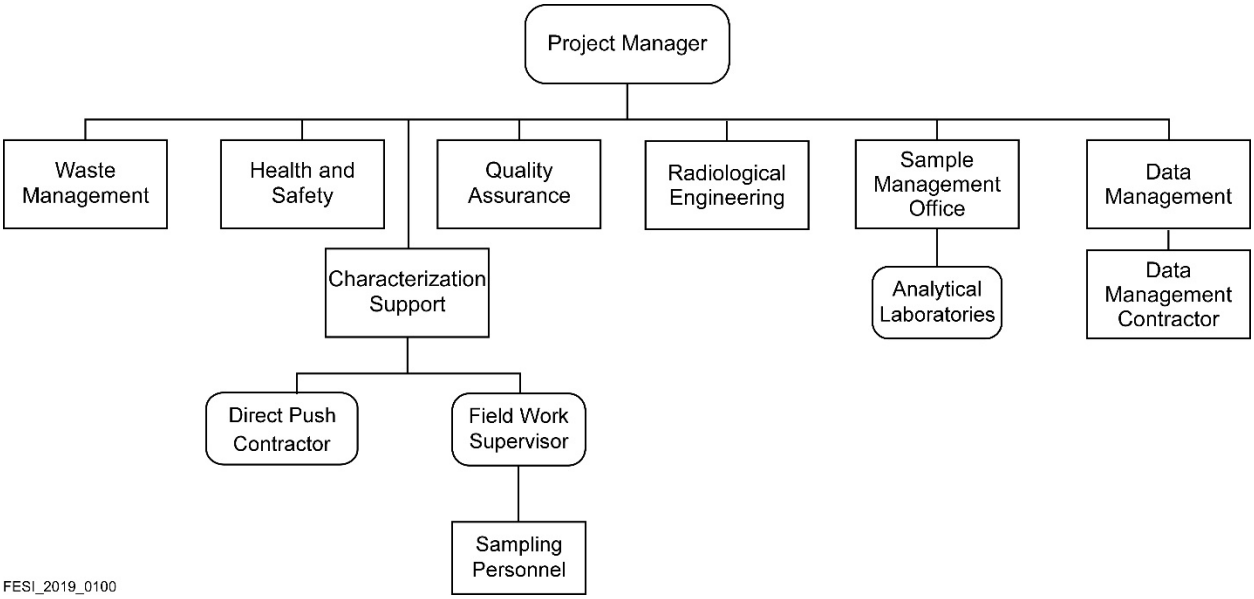
around U Farm and measurements of high-moisture content in the vadose zone, active migration of the mobile tank waste contaminants into the aquifer have occurred due to the influence of decades of wastewater discharges into nearby large ditch systems and from other water sources.

Additionally, water-extractable nitrate concentrations 5 to 10 times above background levels were measured in soil samples collected around Tanks U-101, U-104, and U-105 at depths between 78 and 92 ft bgs and to a lesser extent about 50 ft bgs (RPP-35485). In some of these samples, elevated water-extractable sulfate and chloride were observed, but a consistent correlation with elevated nitrate was not observed. Four soil samples collected between 82 and 97 ft bgs contained water-extractable chloride 2 to 3 times above background. The variability in anomalously leachable chemical constituents in the samples and lack of other tank waste characteristics (e.g., remnant elevated pH and the presence of ^{99}Tc) may suggest multiple non-tank sources. Plausible sources of contamination at U Farm include various wastewaters discharged into nearby ditches (e.g., the 216-U-14 Ditches to the east of U Farm) that migrated laterally underneath U Farm in addition to tank waste leak sources (RPP-35485).

2.0 PROJECT ORGANIZATION

The project organization information for this FSAP is presented in the following sections and in Figure 2-1.

Figure 2-1. Project Organization.



2.1 PROJECT MANAGER

The Project Manager (or designee) is responsible for the project-related activities including coordinating with the U.S. Department of Energy (DOE), regulators, and contractors in support of field activities to ensure that work is performed safely and cost effectively. The Project Manager (or designee) coordinates the preparation and updates to the FSAPs as required. In addition, the Project Manager (or designee) is also responsible for managing sampling documents and requirements, field activities, and subcontracted tasks, and for ensuring that the project file is properly maintained.

2.2 WASTE MANAGEMENT

The Waste Management organization is responsible for identifying waste management sampling/characterization requirements to ensure regulatory compliance. Waste Management communicates policies and practices and ensures project compliance for storage, transportation, disposal, and waste tracking in a safe and cost-effective manner.

2.3 HEALTH AND SAFETY

The Health and Safety organization is responsible for coordinating industrial health and safety support within the project as per required health and safety plan, job hazard analyses, and other pertinent safety documents; providing assistance to ensure compliance with applicable health and safety standards/requirements; and coordinating with Radiological Engineering to determine personal protective clothing requirements.

2.4 QUALITY ASSURANCE

The QA point of contact provides independent oversight. The QA point of contact performs assessments and surveillances and reviews documentation generated through implementation of field, data management, and/or laboratory activities, as needed.

2.5 RADIOLOGICAL ENGINEERING

The Radiological Engineering organization is responsible for conducting As Low As Reasonably Achievable reviews, exposure and release modeling, and radiological control optimization; identifying that appropriate controls are implemented to maintain worker safety; interfacing with Health and Safety; and planning and directing radiological control technicians that support field activities.

2.6 SAMPLE MANAGEMENT OFFICE

The Sample Management Office (SMO) coordinates laboratory analytical work to ensure that laboratories conform to the requirements of this plan, and verifies that laboratories are qualified for performing Hanford Site analytical work. SMO also coordinates with Data Management and the associated contractor if issues arise with performing analyses.

The analytical laboratories analyze samples in accordance with established procedures and the requirements of this plan, and provide necessary laboratory data reports containing analytical and QC results. Laboratories provide explanations of results to support data review and in response to resolution of analytical issues, and coordinate with the SMO and the Data Management Lead.

2.7 DATA MANAGEMENT

The Data Management organization and the associated contractor are responsible for generating field sampling documents, labels, and instructions for field sampling personnel, and for developing the sample authorization form, which provides information and instruction to the analytical laboratories. Data Management and the associated contractor ensure that field sampling documents are revised to reflect approved changes and coordinate with the SMO on project requirements.

Data Management and the associated contractor receive analytical data from the laboratories, ensure that it is appropriately reviewed, and perform data entry into the Hanford Environmental Information System (HEIS) database. Data Management and the associated contractor are also responsible for resolving sample documentation deficiencies or issues associated with field activities, laboratories, or other entities. The Data Management Lead is responsible for informing the Project Manager of any issues reported by the analytical laboratories.

2.8 CHARACTERIZATION SUPPORT

Characterization Support personnel convey field requirements and schedule information to various supporting organizations including the Direct Push Contractor and the Field Work Supervisor (FWS). The direct push contractor will work under the supervision of Characterization Support personnel. The Characterization Support personnel will also act as the Sampling Lead and coordinate with nuclear chemical operators (sampling personnel), as necessary.

The FWS directs the sampling personnel, who collect samples in accordance with this FSAP, corresponding standard methods, work packages, and procedures. The FWS ensures that deviations from field sampling documents or issues encountered in the field are documented appropriately (e.g., in the field logbook). The FWS ensures that sampling personnel are appropriately trained and available. Sampling personnel collect samples in accordance with sampling documentation; complete field logbooks, chain-of-custody forms, and any necessary shipping paperwork; and deliver samples to the analytical laboratory.

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3.0 SAMPLING REQUIREMENTS

This section provides direction for the field activities associated with soil sampling at five vertical locations in U Farm (Figure 1-1). Each of these five locations are comprised of two pushes, the first for geophysical logging and the second for collecting soil samples. Electrical resistivity tomography (ERT) electrodes will be placed at each location in the logging push. All field sampling activities shall be conducted in accordance with this FSAP and the appropriate procedures and work packages to ensure that data is of known and appropriate quality. Soil sampling services for this work will be performed by sampling personnel (e.g., nuclear chemical operators). The sampling personnel shall follow sampling protocols and procedures.

3.1 SOIL SAMPLING TECHNIQUE, STRATEGY, AND DESIGN

The following subsections provide additional information on the soil sampling technique, strategy, and design.

3.1.1 Sampling Technique

Sampling at U Farm will be conducted using a hydraulic hammer direct push rig technology and dual-string sampling system, which consists of inner and outer strings that are deployed by small-diameter push rods. When the targeted sampling depth is achieved, the rods are pulled back and the removable tip is removed from the inner rods. A sampler is attached to the inner string and 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 by use of a proprietary method, and the entire assembly is advanced through the targeted sample interval.

The sampler body holds three stainless steel liners. The liners are 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 selected laboratory for analysis. The “dummy” tip is reattached to the inner string and returned to bottom and placed in the casing shoe, and the entire assembly is advanced to the next designated 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 push is decommissioned using an approach pre-approved by Washington State Department of Ecology (Ecology).

3.1.2 Sampling Strategy

Direct push locations, a summary of sampling rationale, and targeted depths are included in Table 3-1. The sampling strategy at each direct push site is summarized as follows.

- A minimum of two pushes will be completed at each location. The initial push is logged for gross gamma, spectral logging, neutron moisture, and temperature (i.e., geophysical logging). The second push is for soil sampling.

- Per the Characterization Support Lead, ERT electrodes will be placed at each location in either the logging or sampling push. Electrical resistivity tomography electrodes are installed for subsurface geophysical exploration and the push is decommissioned using an approach pre-approved by Ecology.

- The depth of each location's first push (logging push) is provided in Table 3-1. A depth of 135 ft bgs is planned; however, the CCU may limit the push depth. Each push will go to the CCUc (~130 to ~135 ft bgs), or refusal, whichever is encountered first.

- It is anticipated that up to six sample depth intervals will be selected for each direct push location. The interval for sampling individual horizons will be selected by reviewing the geophysical logs of the first direct push; information pertinent to the site, geologic summary of the area, operational history, historical characterization data at that site; and available "quick turn" (e.g., ^{99}Tc and nitrate) data. Note that "quick turn" data may become available from some of the pushes identified in this plan as the work progresses. The sampling horizons will be selected in meetings with Washington River Protection Solutions (WRPS), the DOE Office of River Protection (DOE-ORP), and Ecology. The number of samples intervals may be adjusted with DOE-ORP and Ecology concurrence.

3.1.3 Sampling Design

A non-probabilistic (or judgmental) sampling strategy, based on existing knowledge, was used to determine locations for this investigation (refer to Table 3-1). Physical interferences (i.e., buried infrastructure and topographic constraints) were also considered during the direct push location selection process.

Field activities include the following:

- Soil sampling at ground surface (i.e., first 1 ft)

- Soil sampling using a vertical push with direct push technology

- Geophysical logging (gross gamma, spectral logging, neutron moisture, temperature, and gyroscope).

Table 3-1. Sample Location Strategy for 241-U Tank Farm. (2 sheets)

Direct Push Identification #[a]	Approximate Location	Input Factors Associated with Location Reason for Sampling	Target Depth (below ground surface)
D0155/D0156	Southeast quadrant of Tank 241-U-101 (U-101), adjacent to the spare inlet nozzles	• Additional characterization of the shallow vadose zone near Tank U-101[b] • Further assess whether Tank U-101 leaked[b] • Near spare inlet nozzles to investigate a potential overflow[b] • Characterize deep vadose zone contamination near Tank U-101[b,c] • Corresponds to higher radioactive surface area[d] **Assess potential migration of contaminants from Tank U-101 to better estimate magnitude of release and pathway of contamination. Integrate vadose zone and groundwater characterization to determine relationship of surrounding contaminant sources.**	135 ft
D0157/D0158	West of Tank 241-U-112 (U-112), east of the 200-series tanks 241-U-203 and 241-U-204	• Supplement drywell network near the 200-series tanks[b] • Characterize deep vadose zone contamination near Tank U-112[c] **Support future 241-U Tank Farm corrective actions and closure activities. Assess potential migration of contaminants from Tank U-112 and surrounding area to determine magnitude and pathway of contamination. Integrate vadose zone and groundwater characterization to determine relationship of surrounding contaminant sources.**	135 ft
D0159/D0160	Northwest of Tank 241-U-110 (U-110), between Tanks U-110 and 241-U-111	• Characterize deep vadose zone contamination near Tank U-110[c] • Characterize higher radioactive surface area[d] **Assess potential migration of contaminants from Tank U-110 and surrounding area to determine magnitude and pathway of contamination. Integrate vadose zone and groundwater characterization to determine relationship of surrounding contaminant sources.**	135 ft

Table 3-1. Sample Location Strategy for 241-U Tank Farm. (2 sheets)

Direct Push Identification #[a]	Approximate Location	Input Factors Associated with Location Reason for Sampling	Target Depth (below ground surface)
D0161/D0162	South of Tank 241-U-104 (U-104), between Tanks U-104 and 241-U-107	• Characterize deep vadose zone contamination near Tank U-104[c] • Corresponds to possible leak location[e] **Assess potential migration of contaminants from Tank U-104 and surrounding area to determine magnitude and pathway of contamination. Integrate vadose zone and groundwater characterization to determine relationship of surrounding contaminant sources.**	135 ft
D0163/D0164	Northeast of Tank 241-U-112 (U-112)	• Characterize deep vadose zone contamination near Tank U-112[c] • Supplement information collected at C5606 with additional analytical data • Characterize higher radioactive surface area[d] • Correponds to possible leak location[e] **Support future 241-U Tank Farm corrective actions and closure activities. Assess potential migration of contaminants from Tank U-112 and surrounding area to determine magnitude and pathway of contamination. Integrate vadose zone and groundwater characterization to determine relationship of surrounding contaminant sources.**	135 ft

[a] The identification numbers ending with an odd number (i.e., D0159) are for geophysical logging direct pushes. The identification numbers ending in an even number (i.e., D0156) are for soil sample collection direct pushes.

[b] Specific reason for sampling identified in RPP-RPT-50097, *Hanford 241-U Farm Leak Inventory Assessment Report.*

[c] Specific reason for sampling identified in RPP-35485, *Field Investigation for Waste Management Area U.*

[d] Refer to Figure 1-2 for higher radioactive surface areas.

[e] Possible leak locations are identified in RPP-RPT-54909, *Hanford Single-Shell Tanks Leak Causes, Locations, and Rates: Summary Report* (refer to Figure 1-1 gross gamma contamination).

As identified, direct push locations, a summary of sampling rationale, and targeted depths are included in Table 3-1, and Figure 1-1 shows the locations of the five planned direct push locations. Figures 3-1 through 3-5 provide vertical profile depictions of the five proposed pushes. These preliminary site locations may change based on surface and subsurface interferences. Further modifications may be required after field walkdowns are conducted, during work package development, and/or if an obstruction occurs during pushing. Changes in direct push locations will require notification and approval of the Project Manager or designee. If a push meets refusal prior to achieving total depth, the Direct Push Contractor will temporarily suspend work and will contact Characterization Support personnel. The Characterization Support personnel will determine the appropriate path forward. Changes to the FSAP will be documented as noted in Section 7.0.

3.2 SOIL SAMPLE COLLECTION, HANDLING, AND SHIPPING

Vadose zone soil analysis methods and holding times for radiological and nonradiological analytes are shown in Table 3-2. Table 3-2 also identifies those constituents that the laboratory will analyze as "quick turn" and those physical properties that are to be measured. Sample preservation and containers are also discussed in Table 3-2 (i.e., table footnotes). For this investigation, there are five sampling pushes, each having up to six soil sampling intervals.

Field QC samples shall be collected to evaluate the potential for cross-contamination and laboratory performance. This FSAP requires the collection of field duplicates, equipment rinsate blanks, and field blanks. Sample preservation, containers, and holding times for the field duplicates, equipment rinsates and field blanks are shown in Table 3-3. Based on the QC requirements for field sampling (Section 5.1), field duplicates, equipment rinsates, and field blank samples will be collected for every 20 samples (i.e., frequency of 5%). Therefore, two field duplicates, two equipment rinsate blanks, and two field blanks will be collected for this investigation.

The following subsections provide additional sample collection information:

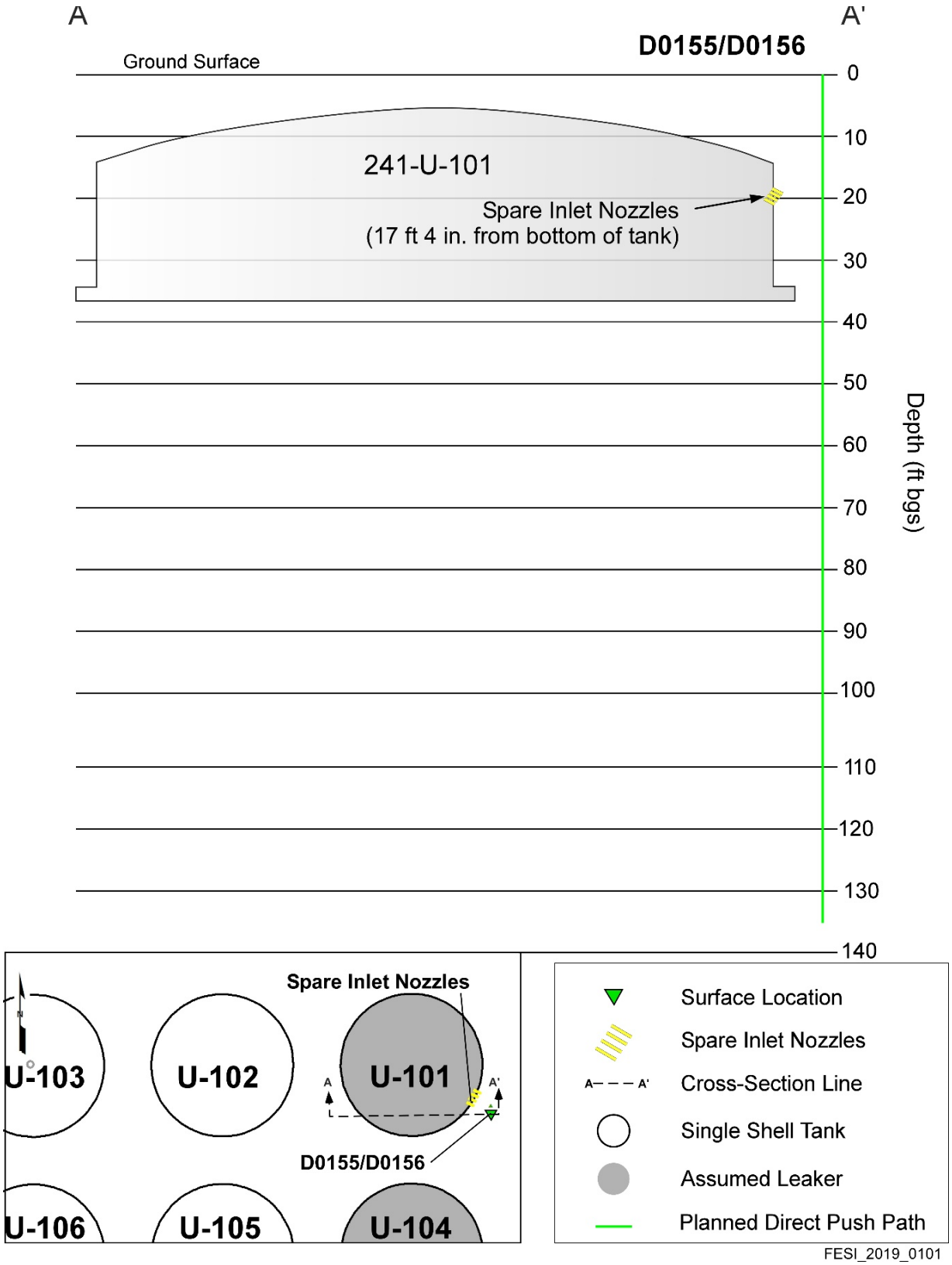
- Surface sample collection (Section 3.2.1)
- Subsurface sample collection for direct push locations (Section 3.2.2).

3.2.1 Surface Sample Collection

Prior to ground surface sampling, sampling tools shall be vendor-certified cleaned or cleaned in accordance with procedures compliant with SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods* protocol. The cleaned samplers shall be kept in the wrapping until they are used for sampling.

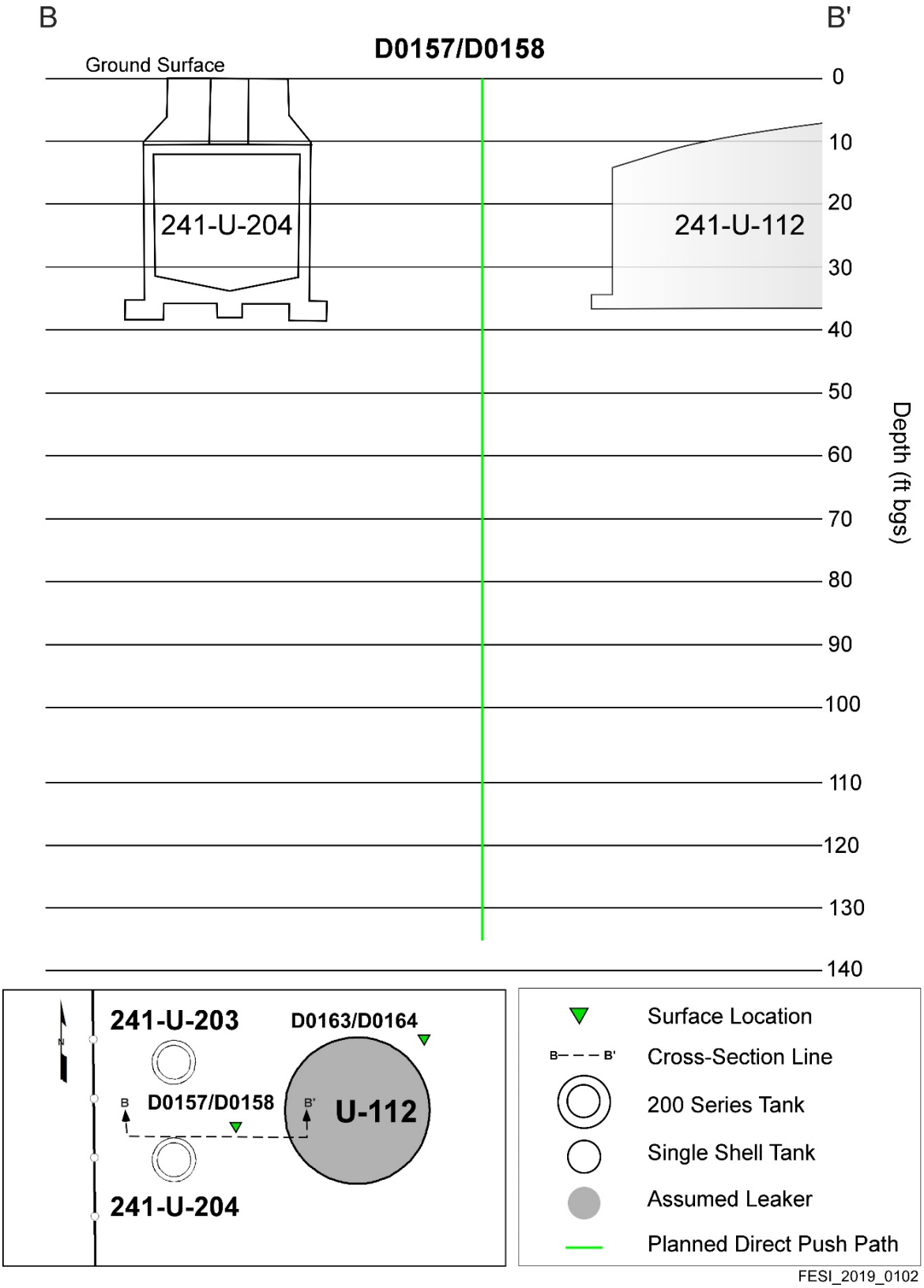
Surface soil samples will be collected at the locations where direct push samples are planned. Soil in the top 1 ft will be collected using spatula, scoop, or miniature core samplers and placed in two 500-mL (16-oz) glass jars.

Figure 3-1. Vertical Depiction of D0155/D0156.



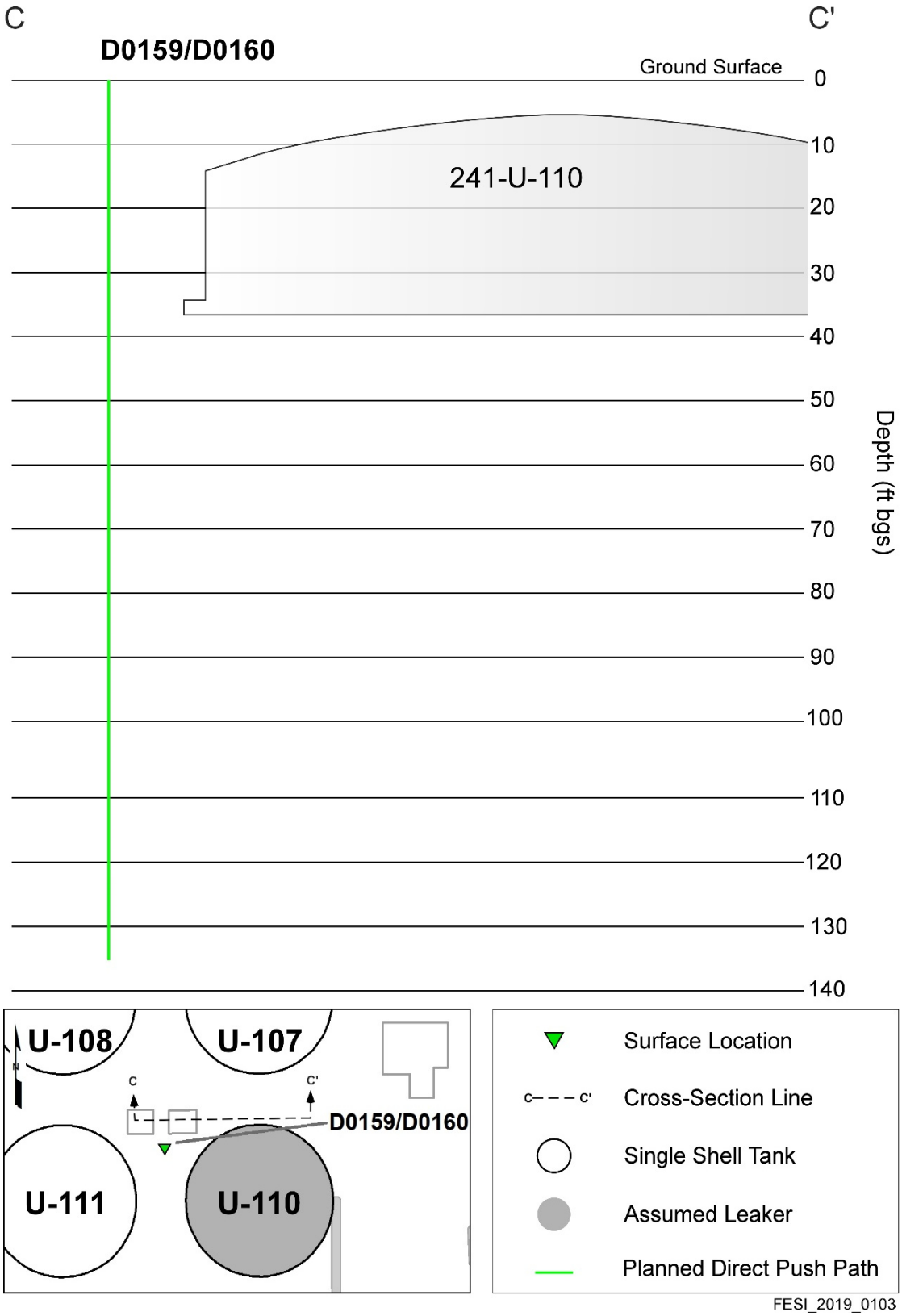
ft bgs = feet below ground surface

Figure 3-2. Vertical Depiction of D0157/D0158.



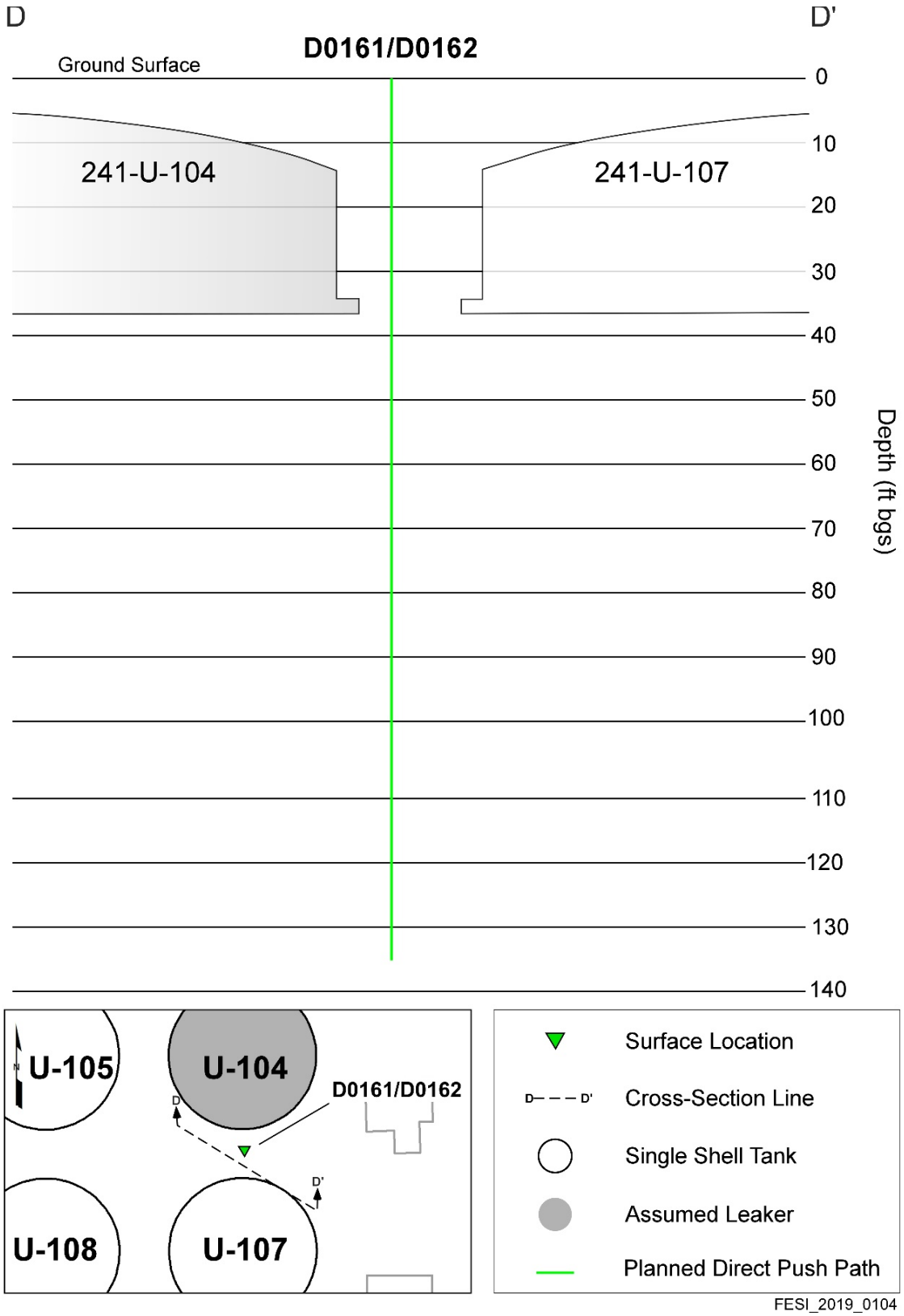
ft bgs = feet below ground surface

Figure 3-3. Vertical Depiction of D0159/D0160.



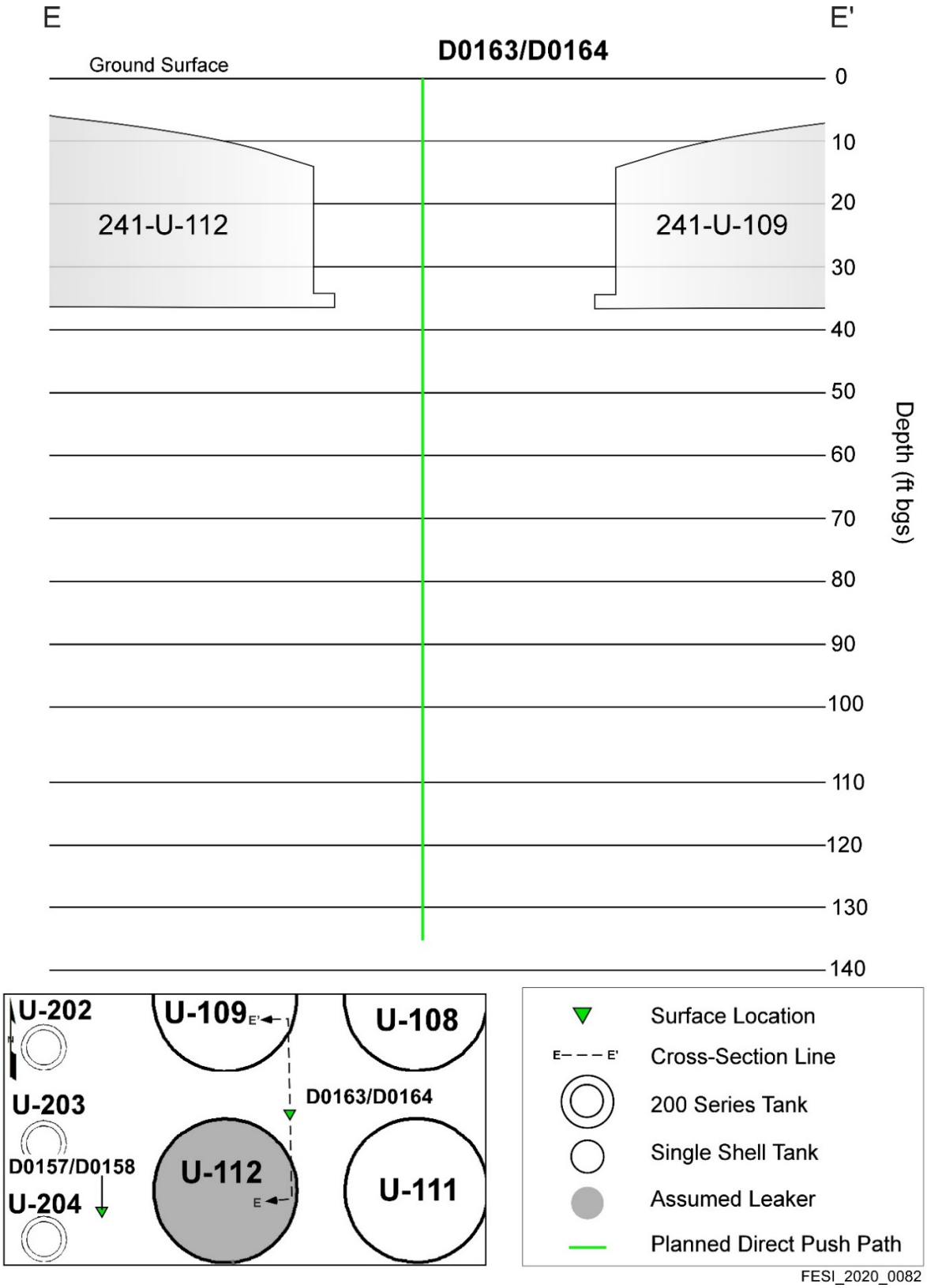
ft bgs = feet below ground surface

Figure 3-4. Vertical Depiction of D0161/D0162.



ft bgs = feet below ground surface

Figure 3-5. Vertical Depiction of D0163/D0164.



ft bgs = feet below ground surface

Table 3-2. Soil Sampling Requirements for 241-U Tank Farm[a]. (3 sheets)

Analysis Type	Primary Method[b]	Constituent/Physical Properties	Holding Time
"Quick Turn"[c]	ICP/MS (water extraction)	Technetium-99	6 months
	9056 Ion chromatography	Nitrate[d]	48 hours
	9045	pH	24 hours (or as soon as possible) after receipt by laboratory
	9050	Specific Conductance	28 days
Standard	6010 ICP/AES	Aluminum, Barium, Beryllium, Bismuth, Boron, Calcium, Cerium, Chromium, Copper, Iron, Lanthanum, Lead, Lithium, Magnesium, Manganese, Molybdenum, Neodymium, Phosphorous, Potassium, Rhodium, Silicon, Sodium, Strontium, Sulfur, Tantalum, Thorium, Tin, Tungsten, Zinc, Zirconium	6 months
	6020 ICP/MS	Antimony, Arsenic, Cadmium, Cobalt, Nickel, Selenium, Silver, Thallium, Uranium, Vanadium	6 months
	Calculation	Uranium[e]	6 months
	7471 Cold vapor atomic absorption	Mercury	28 days
	7196 Colorimetric	Hexavalent Chromium	30 days
	9056 Ion chromatography	Bromide, Chloride, Fluoride, Nitrate[c], Nitrite[c], Phosphate, Sulfate, Acetate, Formate, Glycolate, Oxalate	28 days/48 hours[f]
	Ion chromatography EPA 300.7	Ammonium	7 days/28 days[g]
	9014 Spectrophotometric	Cyanide	14 days
	9060	Total Organic Carbon	28 days

Table 3-2. Soil Sampling Requirements for 241-U Tank Farm[a]. (3 sheets)

Analysis Type	Primary Method[b]	Constituent/Physical Properties	Holding Time
Standard	8081 GC/ECD	4,4′-DDD, 4,4′-DDE, 4,4′-DDT, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, Chlordane, Dieldrin, Endrin, Heptachlor, Heptachlor epoxide, Hexachlorobenzene	14 days/40 days[h]
	8082 GC/ECD	Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260	None
	8270 GC/MS	bis(2-Ethylhexl)phthalate, Tributyl phosphate	14 days/40 days[h]
	Gamma energy analysis	Antimony-125, Cesium-137, Cobalt-60, Europium-152, Europium-154, Europium-155, Radium-226	6 months
	Low energy gamma counting	Iodine-129	6 months
	ICP/MS (acid extraction)	Neptunium-237, Technetium-99, Tin-126, Thorium-232, Uranium-233, Uranium-234, Uranium-235, Uranium-236, Uranium-238	6 months
	Liquid scintillation	Carbon-14, Nickel-63, Plutonium-241, Selenium-79, Tritium	6 months
	Alpha energy analysis	Americium-241, Curium-242, Curium-243/244, Plutonium-238, Plutonium-239/240	6 months
	Beta gas proportional counting	Strontium-90	6 months
	Gravimetric[i]	Percent solids	None
	Gravimetric[i]	Percent water	None
	Gravimetric[j]	Bulk (sediment) density	None
	ASTM D7928 ASTM D6913	Particle size distribution[k]	None

Note: The most current version/revision of methods and/or test plans are preferred.

[a] Sampling personnel will place the shoe material in a 500 mL (16 oz) glass jar. The samples will be cooled to ≤6°C (≤43°F).

[b] Equivalent methods may be used by the laboratory with prior approval by the Data Management Lead.

Table 3-2. Soil Sampling Requirements for 241-U Tank Farm[a]. (3 sheets)

Analysis Type	Primary Method[b]	Constituent/Physical Properties	Holding Time

[c] "Quick turn" analyses will be prepared using a 1:1 water digest method. Around 50 g of soil sample is leached using a ratio of one part water to one part soil. The amount of water added to the soil sample is adjusted based on the percent moisture of the soil to maintain the 1:1 ratio of water to soil. The resultant slurries are placed on a shaker table for around an hour, transferred to a centrifuge tube, centrifuged at 4,000 rpm for 30 minutes and filtered. The filtrates are transferred to a sample bottle and analyzed for nitrate by ion chromatography and technetium-99 by ICP/MS. A separate unfiltered aliquot of the digest is analyzed for conductivity and pH.

[d] Analysis for nitrate (CAS number 14797-55-8) and nitrite (CAS number 14797-65-0) will be performed by the laboratory. Nitrogen in nitrate and nitrogen in nitrite will be determined from nitrate and nitrite results.

[e] Total uranium result will be calculated using isotopic uranium analysis results. The holding time listed is applicable to the analysis of samples for isotopic uranium.

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

[g] Holding time is 7 days from collection to extraction/distillation and 28 days from distillation to analysis of preserved distillate.

[h] Holding time is 14 days from collection to extraction and 40 days from extraction to analysis.

[i] Performed using ASTM D2216 with minor modification of the target temperature to 105°C (221°F) and a 1% criteria for final mass difference (Method A).

[j] Bulk (sediment) density will be determined as described in LAB-PLN-18-00004. Bulk density cannot be determined using ASTM D2937 due to the compaction that occurs using the direct push sampling technique. The reported results using LAB-PLN-18-00004 will not be a true bulk density, but rather, a sediment density measurement.

[k] Particle size distribution will be performed by the laboratory, if sample volume is sufficient.

ASTM = American Society for Testing and Materials
CAS = Chemical Abstracts Service
GC/ECD = gas chromatography/electron capture detector
GC/MS = gas chromatography/mass spectrometry
ICP/AES = inductively coupled plasma/atomic emission spectrometry
ICP/MS = inductively coupled plasma/mass spectrometry

References:

ASTM D2216, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*
ASTM D2937, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method*.
ASTM D6913, *Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis*.
ASTM D7928, *Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis*.
EPA 600/S4-86/024, *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."
LAB-PLN-18-00004, *Test Plan for Sample Breakdown and Analysis of Sediment Samples Obtained as Part of the Vadose Zone Project*.
SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*.

Table 3-3. Field Quality Control Requirements for Field Blanks and Equipment Rinsate Blanks for 241-U Tank Farm (Deionized Water Samples). (2 sheets)

Primary Method[a]	Constituent	Container	Preservative	Holding Time
6010 Inductively coupled plasma/atomic emission spectrometry	Aluminum, Barium, Beryllium, Bismuth, Boron, Calcium, Cerium, Chromium, Copper, Iron, Lanthanum, Lead, Lithium, Magnesium, Manganese, Molybdenum, Neodymium, Phosphorous, Potassium, Rhodium, Silicon, Sodium, Strontium, Sulfur, Tantalum, Thorium, Tin, Tungsten, Zinc, Zirconium	Glass/plastic 500 mL	HNO_3 to pH<2	6 months (28 days for Mercury)
6020 Inductively coupled plasma/mass spectrometry	Antimony, Arsenic, Cadmium, Cobalt, Nickel, Selenium, Silver, Thallium, Uranium, Vanadium			
Calculation	Uranium[b]			
Inductively coupled plasma/ mass spectrometry	Neptunium-237, Technetium-99, Tin-126, Thorium-232, Uranium-233, Uranium-234, Uranium-235, Uranium-236, Uranium-238			
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	28 days
9056 Ion chromatography	Bromide, Chloride, Fluoride, Nitrate[c], Nitrite[c], Phosphate, Sulfate, Acetate, Formate, Glycolate, Oxalate	Glass/plastic 500 mL	Cool to ≤6°C	28 days/ 48 hours[d]
7196 Colorimetric	Hexavalent Chromium	Glass/plastic 500 mL	Cool to ≤6°C	24 hours
9014 Spectrophotometric	Cyanide	Glass/plastic 60 mL	NaOH to pH≥12/ Cool to ≤6°C	14 days
9060	Total Organic Carbon	Amber glass 500 mL	H_2SO_4 to pH<2/ Cool to ≤6°C	28 days
8081 GC/ECD	4,4′-DDD, 4,4′-DDE, 4,4′-DDT, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, Chlordane, Dieldrin, Endrin, Heptachlor, Heptachlor epoxide, Hexachlorobenzene	Amber glass 2×1,000 mL	Cool to ≤6°C	7 days/ 40 days[e]
8082 GC/ECD	Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260	Amber glass 2×1,000 mL	Cool to ≤6°C	1 year

Table 3-3. Field Quality Control Requirements for Field Blanks and Equipment Rinsate Blanks for 241-U Tank Farm (Deionized Water Samples). (2 sheets)

Primary Method[a]	Constituent	Container	Preservative	Holding Time
8270 GC/MS	bis(2-Ethylhexl)phthalate, Tributyl phosphate	Amber glass 2×1,000 mL	Cool to ≤6°C	7 days/ 40 days[e]
Gamma energy analysis	Antimony-125, Cesium-137, Cobalt-60, Europium-152, Europium-154, Europium-155, Radium-226	Glass/plastic 2×1,000 mL	HNO_3 to pH<2	6 months
Alpha energy analysis	Americium-241, Curium-242, Curium-243/244, Plutonium-238, Plutonium-239/240			
Liquid scintillation	Nickel-63, Plutonium-241, Selenium-79			
Beta gas proportional counting	Strontium-90			
Liquid scintillation	Carbon-14, Tritium	Glass/plastic 1,000 mL	None	6 months
Low energy gamma counting	Iodine-129			

Note: The most current version/revision of methods and/or test plans are preferred.

[a] Equivalent methods may be used by the laboratory with prior approval by the Data Management Lead.

[b] Total uranium result will be calculated using isotopic uranium analysis results.

[c] Analysis for nitrate (CAS number 14797-55-8) and nitrite (CAS number 14797-65-0) will be performed by the laboratory. Nitrogen in nitrate and nitrogen in nitrite will be determined from nitrate and nitrite results.

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

[e] Holding time is 14 days from collection to extraction and 40 days from extraction to analysis.

CAS = Chemical Abstracts Service GC/ECD = gas chromatography/electron capture detector GC/MS = gas chromatography/mass spectrometry

References:

EPA 600/S4-86/024, *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."

SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*.

The gravel surface in tank farms may prevent collection of a sample because larger soil particles (i.e., gravel/rocks greater than 0.25 in. in diameter), typically cannot be used for analysis. Therefore, larger soil particles should not be included in the sample. Preferably, soil particles less than 2 mm (0.08 in.) in diameter (i.e., fine material), should be collected. As sample material is collected, samplers may remove rock and stones to maximize the amount of soil captured for analysis. Additionally, sample material may be sieved, as needed.

If a sample cannot be collected because there is not enough fine material for analysis (full 500 mL [16 oz] glass jars), then Characterization Support personnel will be contacted by the FWS for directions. If a sample is not collected, then pictures of the sampling site will be taken to show the gravelly nature of the land surface. Additionally, the reason a sample could not be collected will be documented in direct push completion reports and noted in the logbook.

3.2.2 Subsurface Sample Collection

As indicated, vadose zone soil sampling will be conducted using hydraulic hammer direct push rig technology with dual-string sampling system consisting of inner and outer strings deployed by small-diameter push rods. When the target sampling depth is reached, the rods are pulled back and the “dummy” 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. The entire assembly is advanced approximately 10% deeper than the targeted sample interval in order to secure the material in the sampler.

The dual-string sampler used to collect soil samples holds three stainless-steel liners and a shoe to collect samples during the direct push. The liners are removed from the sampler body and surveyed. The material in the shoe shall be collected in a 500-mL 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. Sampling personnel will cap the liners and label the samples in accordance with Section 3.3. Trained sampling personnel document recovery, sample condition, and estimated volume recovery percent. They then package and transport the sample under chain-of-custody control to the laboratory for analysis.

After sample collection, the “dummy” tip is reattached to the inner string, placed in the casing shoe, and the entire assembly is advanced to the next sample depth. This process is repeated until all samples are collected or the tubing meets refusal. If an insufficient amount of soil is recovered (approximately less than 75% of expected volume), Characterization Support personnel will be contacted to determine if back-to-back samples will be collected to achieve the necessary sample volume for the laboratory analyses.

All samples shall be stored and shipped at a temperature of ≤ 6°C (43°F). To meet applicable holding time requirements, the samples shall be shipped to the laboratory as soon as possible, typically the same day as collected. 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 ≤ 6°C (43°F). Sample shipments not meeting temperature or holding time requirements will be identified as they occur, brought to the immediate attention of the Data Management Lead, and discussed in the laboratory data report. The impact on subsequent use or interpretation of these data will be evaluated by the Project Manager.

Radiological control technician(s) will measure the dose rates of each sample container (i.e., glass 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* [CFR], "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 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 will be placed in a 500-mL (16-oz) glass jar and the three liners will each 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 location identification 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., "quick turn" analyses).

Additionally, coordinate and elevation information for each sample location will be stored in HEIS. Vertical survey data are recorded using NAVD88, *North American Vertical Datum of 1988* and the horizontal coordinates are recorded using the Washington State Plane (South Zone) NAD83, *North American Datum of 1983*, with the 1991 adjustment for horizontal coordinates. The coordinates and elevations (e.g., ground surface, sample depths) will be in metric units.

3.4 SAMPLE CUSTODY

Sampling personnel 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 location identification 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

This section provides direction to the laboratory for sample preparation and analytical requirements for samples collected from the surface and subsurface. The analytical methods are identified in Table 4-1.

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)/physical properties
- Required detection limit
- Primary and alternative method of analysis
- QC acceptance requirements for the primary methods
- Holding times.

"Quick turn" constituents for soil samples are bolded in Table 4-1 and include ^{99}Tc, nitrate, pH, and specific conductance. Results for "quick turn" constituents will be reported for each sample, provided sufficient sample material is obtained to perform all analyses.

Changes to the approved laboratory analytical procedures or methods may be required to accommodate analysis of samples that are contaminated with Hanford Site tank waste and/or to reduce radiological exposure to the analysts. Documentation will be provided in the laboratory data report to reaffirm that these changes will not affect the quality of the data or its intended use. 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.

Additional regulatory QA or DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Documents* (HASQARD) requirements for documenting procedure modifications shall also be followed. Note that prior to deviating from the methods identified in Table 4-1, the Data Management Lead must be contacted.

4.1 DIRECTIONS FOR SAMPLE PREPARATION AND ANALYSIS

Samples delivered to 222-S Laboratory are normally received from the field at door 13 of the Multicurie Section. Samples transported in coolers will be stored under refrigeration until they are processed. Upon receipt, the sample custodian will verify the identification number on each sample container and ensure that 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 Data Management Lead.

Table 4-1. Analytical and Quality Control Requirements for 241-U Tank Farm Soil Samples. (8 sheets)

Constituent/Physical Properties	Required Detection Limit[a]	Primary Method[b, c] (prep)	Alternative Method[b] (prep)	QC Acceptance Requirements[d,e]			Holding Times
				LCS %Recovery	Spike %Recovery	RPD	
Aluminum	2.75	6010 ICP/AES (acid)	6020 ICP/MS (acid)	80-120%	75-125%	≤30%	6 months
Barium	10.2						
Beryllium	0.5						
Calcium	6.25						
Chromium	0.15						
Copper	1						
Iron	5						
Lead	5						
Lithium	0.9						
Magnesium	26.3						
Manganese	0.55						
Molybdenum	0.47[e]						
Phosphorus	9.8						
Potassium	157						
Silicon	5.05						
Sodium	22.4						
Strontium	0.55						
Sulfur	11.4						
Tantalum	25.5						
Thorium	4.85						
Tin	6						

Table 4-1. Analytical and Quality Control Requirements for 241-U Tank Farm Soil Samples. (8 sheets)

Constituent/Physical Properties	Required Detection Limit[a]	Primary Method[b, c] (prep)	Alternative Method[b] (prep)	QC Acceptance Requirements[d,e]			Holding Times
				LCS %Recovery	Spike %Recovery	RPD	
Tungsten	42.9	6010 ICP/AES (acid)	NA	80-120%	75-125%	≤30%	6 months
Zinc	1						
Zirconium	1.2						
Bismuth	25.8						
Boron	6						
Cerium	10.5						
Lanthanum	2.75						
Neodymium	5.05						
Rhodium	25.8						
Antimony	0.13[f]	6020 ICP/MS (acid)	6010 ICP/AES (acid)	80-120%	75-125%	≤30%	6 months
Arsenic	0.2						
Cadmium	2.02E-2						
Cobalt	2						
Nickel	3						
Selenium	0.02						
Silver	6.00E-04						
Thallium	4.00E-04						
Vanadium	6.00E-03						
Uranium	0.5						
Uranium[g]	0.5	Calculated from Isotopic Uranium Results	NA	80-120%	75-125%	≤30%	6 months

Table 4-1. Analytical and Quality Control Requirements for 241-U Tank Farm Soil Samples. (8 sheets)

Constituent/Physical Properties	Required Detection Limit[a]	Primary Method[b, c] (prep)	Alternative Method[b] (prep)	QC Acceptance Requirements[d,e]			Holding Times
				LCS %Recovery	Spike %Recovery	RPD	
Mercury	0.01[f]	7471 Cold vapor atomic absorption (acid)	6020 ICP/MS (acid)	80-120%	75-125%	≤30%	28 days
Hexavalent Chromium	0.09	7196 Colorimetric (water)	NA	80-120%	75-125%	≤30%	30 days
Ammonium	0.5	Ion Chromatography EPA 300.7 (distillation)	NA	80-120%	75-125%	≤30%	7 days/28 days[h]
pH	—	9045	NA	± 0.1 pH units	NA	NA	24 hours (or as soon as possible) after receipt by laboratory
Bromide	1	Ion Chromatography 9056 (water)	NA	80-120%	75-125%	≤30%	28 days
Chloride	0.3						28 days
Fluoride	2.81[f]						28 days
Nitrate[i]	2.5						48 hours
Nitrite[i]	2.5						48 hours
Phosphate	0.785[f]						48 hours
Sulfate	2.7						28 days
Acetate	4.5						28 days
Formate	10.0						28 days
Glycolate	3.8						28 days
Oxalate	2						28 days

Table 4-1. Analytical and Quality Control Requirements for 241-U Tank Farm Soil Samples. (8 sheets)

Constituent/Physical Properties	Required Detection Limit[a]	Primary Method[b, c] (prep)	Alternative Method[b] (prep)	QC Acceptance Requirements[d,e]			Holding Times
				LCS %Recovery	Spike %Recovery	RPD	
Cyanide	0.5	9014 Spectrophotometric (distillation)	9012 Colorimetric	80-120%	75-125%	≤30%	14 days
Total Organic Carbon	20	9060	NA	85-115%	70-130%	≤30%	28 days
4,4′-DDD	0.025[j]	8081 GC/ECD (acid)	8270 GC/MS	70-130%	70-130%	≤30%	14 days/ 40 days[k]
4,4′-DDE	0.025[j]						
4,4′-DDT	0.025[j]						
Aldrin	0.01						
alpha-BHC[l]	NA						
beta-BHC[l]	NA						
gamma-BHC[l]	0.6						
Chlordane	0.1						
Dieldrin	0.007						
Endrin	0.02						
Heptachlor	0.04						
Heptachlor epoxide	0.04						
Hexachlorobenzene	1.70						
Aroclor-1016	0.02	8082 GC/ECD (acid)	NA	70-130%	70-130%	≤30%	None
Aroclor-1221	0.02						
Aroclor-1232	0.02						
Aroclor-1242	0.02						

Table 4-1. Analytical and Quality Control Requirements for 241-U Tank Farm Soil Samples. (8 sheets)

Constituent/Physical Properties	Required Detection Limit[a]	Primary Method[b, c] (prep)	Alternative Method[b] (prep)	QC Acceptance Requirements[d,e]			Holding Times
				LCS %Recovery	Spike %Recovery	RPD	
Aroclor-1248	0.02	8082 GC/ECD (acid)	NA	70-130%	70-130%	≤30%	None
Aroclor-1254	0.02						
Aroclor-1260	0.02						
bis(2-Ethylhexyl)phthalate	2.95	8270 GC/MS (acid)	NA	70-130%	70-130%	≤30%	14 days/ 40 days[k]
Tributyl phosphate	3.3						
Antimony-125 – ^{125}Sb	0.3	Gamma energy analysis (direct)	NA	80-120%	N/A	≤30%	6 months
Cesium-137 – ^{137}Cs	0.1						
Cobalt-60 – ^{60}Co	0.01[f]						
Radium-226 – ^{226}Ra	0.2[f]			NA	75-125%		
Europium-152 – ^{152}Eu	0.1[f]				NA		
Europium-154 – ^{154}Eu	0.03[e,f]						
Europium-155 – ^{155}Eu	0.05[e,f]						
Iodine-129 – ^{129}I	2	Low energy gamma counting (fusion)	ICP/MS (acid)	80-120%	NA	≤30%	6 months
Technetium-99^{m}– ^{99}Tc	1	ICP/MS (water)	NA	80-120%	75-125%	≤30%	6 months
Technetium-99^{m}– ^{99}Tc	1	ICP/MS (acid)	Liquid scintillation (acid)	80-120%	75-125%	≤30%	6 months
Tin-126[n]– ^{126}Sn	400		NA				
Uranium-233 – ^{233}U	0.174			NA	NA		
Uranium-234 – ^{234}U	3.75E-02						

Table 4-1. Analytical and Quality Control Requirements for 241-U Tank Farm Soil Samples. (8 sheets)

Constituent/Physical Properties	Required Detection Limit[a]	Primary Method[b, c] (prep)	Alternative Method[b] (prep)	QC Acceptance Requirements[d,e]			Holding Times
				LCS %Recovery	Spike %Recovery	RPD	
Uranium-235 – ^{235}U	4.32E-05	ICP/MS (acid)	NA	80-120%	75-125%	≤30%	6 months
Uranium-236 – ^{236}U	5.18E-04			NA	NA		
Uranium-238 – ^{238}U	4.37E-04			80-120%	75-125%		
Thorium-232 – ^{232}Th	4.40E-05						
Neptunium-237 – ^{237}Np	3.80E-02		Alpha energy analysis (acid)				
Tritium – ^{3}H	30	Liquid scintillation (water[o])	NA	80-120%	75-125%	≤30%	6 months
Carbon-14 – ^{14}C	1	Liquid scintillation (acid)	NA	80-120%	75-125%	≤30%	6 months
Nickel-63 – ^{63}Ni	30			80-120%	NA	≤30%	
Selenium-79 – ^{79}Se	10			NA	NA	≤30%	
Plutonium-241 – ^{241}Pu	1.65E+04		Calculation (from ^{238}Pu and $^{239/240}Pu$)	80-120%	75-125%	≤30%	
Plutonium-238 – ^{238}Pu	1	Alpha energy analysis (acid)	ICP/MS (acid)	NA	NA	≤30%	6 months
Plutonium-239/240 – $^{239/240}Pu$	0.03[f]			80-120%			
Americium-241 – ^{241}Am	1						
Curium-242 – ^{242}Cm	1			NA		NA	
Curium-243/244 – $^{243/244}Cm$	1						
Strontium-90 – ^{90}Sr	0.18[f]	Beta gas proportional counting (acid)	NA	80-120%	75-125%	≤30%	6 months
Percent water	—	Gravimetric[p]	NA	NA	NA	≤30%	None
Percent solids	—					NA	

Table 4-1. Analytical and Quality Control Requirements for 241-U Tank Farm Soil Samples. (8 sheets)

Constituent/Physical Properties	Required Detection Limit[a]	Primary Method[b, c] (prep)	Alternative Method[b] (prep)	QC Acceptance Requirements[d,e]			Holding Times
				LCS %Recovery	Spike %Recovery	RPD	
Specific Conductance	—	9050	NA	NA	NA	NA	28 days
Bulk (sediment) density[q]	—	Gravimetric[q]	NA	NA	NA	≤30%	None
Particle size distribution[r]	—	ASTM D7928 ASTM D6913	NA	NA	NA	NA	None

Note 1: All standard analyses are performed on composite samples. The laboratory data report will be provided by the laboratory in Format VI. "Quick turn" analyses (excluding pH and specific conductance) will be provided via e-mail to the Data Management Lead and will also be available in the laboratory data report for loading into Hanford Environmental Information System (HEIS).
Note 2: The most current version/revision of methods and/or test plans are preferred.
Note 3: **Bold** constituents are "quick turn" constituents. These constituents are also analyzed as part of the standard analyses. Technetium-99 (^{99}Tc) is listed twice in the table because the preparation method is different for "quick turn" and standard analysis. "Quick turn" analyses will be prepared using a 1:1 water digest method. Around 50 g of soil sample is leached using a ratio of one part water to one part soil. The amount of water added to the soil sample is adjusted based on the percent moisture of the soil to maintain the 1:1 ratio of water to soil. The resultant slurries are placed on a shaker table for around an hour, transferred to a centrifuge tube, centrifuged at 4,000 rpm for 30 minutes and filtered. The filtrates are transferred to a sample bottle and analyzed for nitrate by ion chromatography and ^{99}Tc by ICP/MS. A separate unfiltered aliquot of the digest is analyzed for conductivity and pH.
Note 4: Detection limits may be lower than achievable. The laboratory shall report results to the lowest achievable detection limit while maintaining quality standards. Detection limits that were not achieved will be documented in the laboratory data report (e.g., narrative).

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

[b] Equivalent methods may be used by the laboratory with prior approval by the Data Management Lead.

[c] Sampling personnel will place the shoe material in a 500 mL (16 oz) glass jar. The samples will be cooled to ≤6°C (≤43°F). Directions for sample preparation are provided in Section 4.1.

[d] Laboratory quality acceptance requirements are based on RPP-23403, RPP-RPT-38152, and WHL-MP-1011.

[e] QC failures will be brought to the immediate attention of Sample Management Office and the Data Management Lead and will be discussed in the laboratory data report narrative. The associated result(s) will be qualified appropriately in the laboratory data report.

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

[g] Total uranium result will also be calculated using isotopic uranium analysis results. The QC Acceptance Requirements and holding time listed are applicable to the analysis of samples for isotopic uranium.

[h] Holding time is 7 days from collection to extraction/distillation and 28 days from distillation to analysis of preserved distillate.

[i] Analysis for nitrate (CAS number 14797-55-8) and nitrite (CAS number 14797-65-0) will be performed by the laboratory. Nitrogen in nitrate and nitrogen in nitrite will be determined from nitrate and nitrite results.

Table 4-1. Analytical and Quality Control Requirements for 241-U Tank Farm Soil Samples. (8 sheets)

Constituent/Physical Properties	Required Detection Limit[a]	Primary Method[b, c] (prep)	Alternative Method[b] (prep)	QC Acceptance Requirements[d,e]			Holding Times
				LCS %Recovery	Spike %Recovery	RPD	

[j] In support of the ecological risk assessment, the detection limit identified in the Data Quality Objectives Report (RPP-RPT-60227) has been lowered.

[k] Holding time is 14 days from collection to extraction and 40 days from extraction to analysis.

[l] CAS number 319-84-6 is for alpha-Hexachlorocyclohexane and alpha-BHC. CAS number 319-85-7 is for beta-Hexachlorocyclohexane and beta-BHC (also known as beta-1,2,3,4,5,6-Hexachlorocyclohexane [beta-BHC] in HEIS). CAS number 58-89-9 is for gamma-Hexachlorocyclohexane (Lindane) and gamma-BHC.

[m] The laboratory shall differentiate between water extraction and acid extraction ^{99}Tc results in both hard copy and electronic (HEIS) reporting. For HEIS upload, the extraction (WE [water] or AE [acid]) will be appended to the method name.

[n] The acceptance requirements listed are those for Tin-117 (^{117}Sn), which is used as a surrogate to estimate precision and accuracy of the method for ^{126}Sn.

[o] RPP-RPT-60227 erroneously identified acid as the sample preparation method.

[p] Performed using ASTM D2216 with minor modification of the target temperature to 105°C (221°F) and a 1% criteria for final mass difference (Method A).

[q] Bulk (sediment) density will be determined as described in LAB-PLN-18-00004. Bulk density cannot be determined using ASTM D2937 due to the compaction that occurs using the direct push sampling technique. The reported results using LAB-PLN-18-00004 will not be a true bulk density, but rather, a sediment density measurement.

[r] Particle size distribution will be performed by the laboratory, if sample volume is sufficient.

CAS = Chemical Abstracts Service
GC/ECD = gas chromatography/electron capture detector
GC/MS = gas chromatography/mass spectrometry
ICP/AES = inductively coupled plasma/atomic emission spectrometry
ICP/MS = inductively coupled plasma/mass spectrometry
LCS = laboratory control sample
NA = not applicable
QC = quality control
RPD = relative percent difference

References:

ASTM D2216, *Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.*
ASTM D2937, *Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.*
ASTM D6913, *Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis*.
ASTM D7928, *Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis*.
EPA 600/S4-86/024, *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."
LAB-PLN-18-00004, *Test Plan for Sample Breakdown and Analysis of Sediment Samples Obtained as Part of the Vadose Zone Project*.
RPP-23403, *Single-Shell Tank Component Closure Data Quality Objectives*.
RPP-RPT-38152, *Data Quality Objectives Report Phase 2 Characterization for Waste Management Area C RCRA Field Investigation/Corrective Measures Study*.
RPP-RPT-60227, *Data Quality Objectives for Vadose Zone Characterization at Waste Management Area A-AX.*
SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*.
WHL-MP-1011, *Quality Assurance Project Plan for 222-S Laboratory.*

For surface and subsurface sample liner, a licensed geologist with Hanford Site experience will photograph, examine, and describe the material from each glass jar and liner. A geologist without a license and/or Hanford Site experience may perform this work under the supervision of a licensed geologist with Hanford Site experience. Visual inspection and manual manipulations are performed to provide a geologic description of each sample. These descriptions shall provide estimates of the percentage of sand, fine sand, very fine sand, coarse to fine silt, and mud content per ASTM D2488, *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*. The soil descriptions are recorded and used to classify the soil texture on a modified Folk/Wentworth diagram. Note that additional HEIS sample numbers will be assigned to the composite and "quick turn" samples, as needed.

Particle size distribution will be performed per LAB-PLN-18-00004, *Test Plan for Sample Breakdown and Analysis of Sediment Samples Obtained as Part of the Vadose Zone Project* only if there is enough sample material. Sections 4.1.1 and 4.1.2 describe surface and subsurface sample analysis, respectively.

4.1.1 Surface Sample Analysis

Surface samples will be photographed, geologically described, and subsampled per LAB-PLN-18-00004. Percent water and percent solids will also be determined per LAB-PLN-18-00004. Bulk (sediment) density will not be calculated on surface samples. Subsampled material will be used to perform the "quick turn" and standard analysis identified in Table 4-1.

Direction regarding insufficient sample material is provided in Section 4.2. Reporting of laboratory results is described in Section 6.0.

4.1.2 Subsurface Sample Analysis

Subsurface samples are photographed, geologically described, and subsampled per LAB-PLN-18-00004. Percent water, percent solid, and bulk (sediment) density will also be determined per LAB-PLN-18-00004. Bulk (sediment) density is performed on the contents of only full liners or intact cores. A visual inspection will be performed to determine which liner contains the highest moisture content. The contents of this liner or intact core liner will be used for the "quick turn" analysis. Percent water and percent solids will be determined for the contents of this liner. The remaining material from this liner, the other liners, and the shoe will be composited, and percent water and percent solids will also be determined from the composited material. Subsampled composited material will be used to perform the analyses identified in Table 4-1.

Direction regarding insufficient sample material is provided in Section 4.2. Reporting of laboratory results is described in Section 6.0.

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 and/or SMO shall notify the Data Management Lead within one working day to identify the path forward. The typical prioritization of analyses is listed in Table 4-2; however, changes may be made based on specific data needs. The Data Management Lead will identify the analysis priority based on available sample material and discussion with project personnel (e.g., Project Manager). Changes to this prioritization will be documented in the laboratory data report. Additionally, if there is not sufficient sample available to perform laboratory QC analyses, the laboratory will make note of the condition in the laboratory data report narrative, and the associated data results will have laboratory qualifiers added as appropriate. Any analyses prescribed by this FSAP, but not performed, shall be identified in the laboratory data report and through the characterization deviation form (refer to Section 7.0 and Appendix A).

Table 4-2. Analytical Priorities for 241-U Tank Farm Soil Samples. (2 sheets)

Priority	Analysis Type	Primary Method	Constituent/Physical Properties
1	"Quick Turn"	ICP/MS (water extraction)	Technetium-99
		9056 Ion chromatography	Nitrate
		9050	Specific Conductance
2		9045	pH
3	Standard	Gravimetric	Percent solids
		Gravimetric	Percent water
4		Gravimetric	Bulk (sediment) density
5		Gamma energy analysis	Antimony-125, Cesium-137, Cobalt-60, Europium-152, Europium-154, Europium-155, Radium-226
6		ICP/MS (acid extraction)	Technetium-99
7		6010 ICP/AES and 6020 ICP/MS	Aluminum, Barium, Beryllium, Bismuth, Boron, Calcium, Cerium, Chromium, Copper, Iron, Lanthanum, Lead, Lithium, Magnesium, Manganese, Molybdenum, Neodymium, Phosphorous, Potassium, Rhodium, Silicon, Sodium, Strontium, Sulfur, Tantalum, Thorium, Tin, Tungsten, Zinc, Zirconium Arsenic, Cadmium, Cobalt, Nickel, Selenium, Silver, Thallium, Uranium, Vanadium Neptunium-237, Thorium-232, Uranium-233, Uranium-234, Uranium-235, Uranium-236, Uranium-238
8		Low energy gamma counting	Iodine-129
9		Liquid scintillation	Selenium-79
10		ICP/MS (acid extraction)	Antimony, Tin-126
11		Beta gas proportional counting	Strontium-90
12		Liquid scintillation	Nickel-63
13		Liquid scintillation	Tritium

Table 4-2. Analytical Priorities for 241-U Tank Farm Soil Samples. (2 sheets)

Priority	Analysis Type	Primary Method	Constituent/Physical Properties
14	Standard	Liquid scintillation	Carbon-14
15		Liquid scintillation	Plutonium-241
16		Alpha energy analysis	Americium-241, Curium-242, Curium-243/244, Plutonium-238, Plutonium-239/240
17		7471 Cold vapor atomic absorption	Mercury
18		7196 Colorimetric	Hexavalent Chromium
19		9056 Ion chromatography	Bromide, Chloride, Fluoride, Nitrate, Nitrite, Phosphate, Sulfate, Acetate, Formate, Glycolate, Oxalate
20		Ion chromatography EPA 300.7	Ammonium
21		9060	Total Organic Carbon
22		8270 GC/MS	bis(2-Ethylhexl)phthalate, Tributyl phosphate
23		8081 GC/ECD	4,4′-DDD, 4,4′-DDE, 4,4′-DDT, Aldrin, alpha-BHC, beta-BHC, gamma-BHC, Chlordane, Dieldrin, Endrin, Heptachlor, Heptachlor epoxide, Hexachlorobenzene
24		8082 GC/ECD	Aroclor-1016, Aroclor-1221, Aroclor-1232, Aroclor-1242, Aroclor-1248, Aroclor-1254, Aroclor-1260
25		9014 Spectrophotometric	Cyanide
26		ASTM D7928 ASTM D6913	Particle size distribution

ASTM = American Society for Testing and Materials
GC/ECD = gas chromatography/electron capture detector
GC/MS = gas chromatography/mass spectrometry
ICP/AES = inductively coupled plasma/atomic emission spectrometry
ICP/MS = inductively coupled plasma/mass spectrometry

References:
ASTM D6913, *Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis*.
ASTM D7928, *Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis*.
EPA 600/S4-86/024, *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."
SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*.

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5.0 QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

Quality assurance plan objectives are met through implementation of all sections of this FSAP. This FSAP establishes the quality requirements for environmental data collection, including planning, implementation, and assessment of sampling, field measurements, and laboratory analysis. This FSAP has been developed to comply with the elements found in:

- DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD)
- DOE O 414.1D, *Quality Assurance*
- EPA/240/B-01/003, *EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5*.

This FSAP is also compliant with the HFFACO Action Plan, Section 6.5, Quality Assurance.

The HASQARD establishes the quality requirements for environmental data collection, including sampling and analysis, in support of the single-shell tank *Resource Conservation and Recovery Act of 1976* Corrective Action Program. The HASQARD applies to field and laboratory activities and identifies the QC requirements for environmental data collection, including sampling, field measurements, and laboratory analysis.

Hanford Site onsite laboratories performing analyses in support of this FSAP will have approved and implemented QA plans. The laboratories are evaluated under the DOE Consolidated Audit-Accreditation Program (DOE/CAP-AP) or its successor programs to U.S. Department of Defense (DoD)/DOE Quality Systems Manual (QSM) requirements [*Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (DoD/DOE 2019)]. HASQARD requirements, beyond those within the DoD/DOE QSM, are also evaluated under the DOE/CAP-AP. A commercial laboratory off the Hanford Site is subject to WRPS audit and QA Program approval.

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.

All sampling and analysis activities will be performed using approved methods, procedures, work packages, and plans. The methods, procedures, work packages, and plans are written to meet regulatory, operational, and/or laboratory QA plan requirements.

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 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 sample collection. Field QC samples shall be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability. Field QC samples will include the collection of field duplicates, equipment rinsate blanks, and field blanks. Sampling personnel will prepare field QC samples.

5.1.1 Field Duplicates

Field duplicates are independent samples collected as close as possible to the same time and same location, and intended to be identical. Field duplicates are used to determine precision for both sampling and laboratory requirements. It is not possible to collect field duplicates for direct push. For this reason, field duplicates will not be required for subsurface samples; however, field duplicates will be collected for surface soil samples (i.e., first 1 ft).

The duplicate samples shall be shipped to the laboratory in the same manner as the primary samples. Per HASQARD, field duplicates are normally collected at a frequency of 5 to 10% of the samples collected per matrix (e.g., soil). For this project, field duplicates for surface samples will be collected at a frequency of 50%.

5.1.2 Field Blanks

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. HASQARD does not identify a frequency for collection of field blanks but does suggest a frequency of not less

than 5%. For this project, field blank samples will be collected for every 20 samples (i.e., frequency of 5%).

5.1.3 Equipment Rinsate Blanks

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. Per HASQARD, equipment rinsate blanks shall be collected in the field and at the rate specified by the project. For this project, equipment rinsate blanks will be collected for every 20 samples (i.e., frequency of 5%).

5.1.4 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 to prevent any portion of the collected sample from coming in contact with the sampling personnel's gloves.
- Improperly decontaminating equipment before sampling or between sampling events.

5.2 REQUIRED QUALITY CONTROL FOR ANALYSIS

The QA objective of this plan is to develop implementation guidance that will provide data of known and appropriate quality and that are suitable for the intended use. Data quality is assessed, in part, by evaluation of precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity. These terms (i.e., data quality indicators) are defined in Table 5-1.

Laboratories performing analyses in support of this FSAP shall have approved and implemented QA plans. These QA plans shall meet HASQARD minimum requirements.

Table 5-1. Data Quality Indicators. (3 sheets)

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Precision (field duplicates, laboratory sample duplicates, and matrix spike duplicates)	Precision measures the agreement among a set of replicate measurements. Field precision is assessed through the collection and analysis of field duplicates. Analytical precision is estimated by duplicate/replicate analyses, usually on laboratory control samples, spiked samples, and/or field samples.	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. Acquire replicate field samples for information on sample acquisition, handling, shipping, storage, preparation, and analytical processes and measurements.	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 (laboratory control samples, matrix spikes, and surrogates)	Accuracy is the closeness of a measured result to an accepted reference value. Accuracy is usually measured as a percent recovery. QC analyses used to measure accuracy include standard recoveries, laboratory control samples, spiked samples, and surrogates.	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).	If recovery does not meet objective: Qualify the data before use Request reanalysis or re-measurement.
Representativeness (field duplicates)	Sample representativeness expresses 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. It is dependent on the proper design of the sampling program and will be satisfied by ensuring that the approved plans were followed during sampling and analysis.	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.	If results are not representative of the system sampled: Identify the reason for results not being representative Flag for further review Review data for usability If data are usable, qualify the data for limited use and define the portion of the system that the data represent

Table 5-1. Data Quality Indicators. (3 sheets)

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Representativeness (field duplicates) (continued)			If data are not usable, flag as appropriate Redefine sampling and measurement requirements and protocols Resample and reanalyze, as appropriate.
Comparability (field duplicates, laboratory control samples, matrix spikes, and matrix spike duplicates)	Comparability expresses the degree of confidence with which one data set can be compared to another. It is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the approved plans are followed and that proper sampling and analysis techniques are applied.	Use identical or similar sample collection and handling methods, sample preparation and analytical methods, holding times, and QA protocols.	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 (no QC element; addressed in data quality assessment)	Completeness is a measure of the amount of valid data collected compared to the amount planned. Field completeness is a measure of the number of samples collected versus the number of samples planned. Laboratory completeness is a measure of the number of valid measurements compared to the total number of measurements planned.	Compare the number of valid measurements completed (samples collected or samples analyzed) with those established by the project's quality criteria (data quality objectives or performance/ acceptance criteria).	If data set does not meet the completeness objective: Identify appropriate changes to data collection and/or analysis methods Identify quantifiable bias, if applicable Resample and/or reanalyze if needed Revise sampling/analysis protocols to ensure future completeness.

Table 5-1. Data Quality Indicators. (3 sheets)

Data Quality Indicator (QC Element)[a]	Definition	Determination Methodologies	Corrective Actions
Bias (equipment blanks, field blanks, laboratory control samples, matrix spikes, and method blanks)	Bias is the systematic or persistent distortion of a measurement process that causes error in one direction (e.g., the sample measurement is consistently lower than the sample's true value). Bias can be introduced during sampling, analysis, and data evaluation. Analytical bias refers to deviation in one direction (i.e., high, low, or unknown) of the measured value from a known spiked amount.	Sampling bias may be revealed by analysis of replicate samples. Analytical bias may be assessed by comparing a measured value in a sample of known concentration to an accepted reference value or by determining the recovery of a known amount of contaminant spiked into a sample (matrix spike).	For sampling bias: Properly select and use sampling tools. Institute correct sampling and subsampling practices to limit preferential selection or loss of sample media. Use sample handling practices, including proper sample preservation, that limit the loss or gain of constituents to the sample media. Analytical data that are known to be affected by either sampling or analytical bias are flagged to indicate possible bias. Laboratories that are known to generate biased data for a specific analyte are asked to correct their methods to remove the bias as best as practicable. Otherwise, samples are sent to other laboratories for analysis.
Sensitivity (method detection limit, practical quantitation limit, and relative percent difference)	Sensitivity is an instrument's or method's minimum concentration that can be reliably measured (i.e., instrument detection limit or limit of quantitation).	Determine the minimum concentration or attribute to be measured by an instrument (instrument detection limit) or by a laboratory (limit of quantitation). The lower limit of quantitation[b] is the lowest level that can be routinely quantified and reported by a laboratory.	If detection limits do not meet objective: Request reanalysis or re-measurement using methods or analytical conditions that will meet required detection or limit of quantitation Qualify/reject the data before use.

QA = quality assurance QC = quality control

Source: SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*, as amended.

[a] QC acceptance requirements are provided in Table 4-1.

[b] For purposes of this sampling plan, the lower limit of quantitation is interchangeable with the practical quantitation limit.

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 are goals for demonstrating reliable method performance. The laboratory will use its internal QA system for addressing any QC failures. QC failures will be brought to the immediate attention of the SMO and the Data Management Lead. Additionally, if the QC failures are systematic and cannot be resolved by the internal protocols, the SMO and the Data Management Lead shall be consulted to determine the proper action. The laboratory should suggest a course of action at that time. Data not meeting the QC requirements shall be properly noted, and the associated QC failures shall be discussed in the narrative of the laboratory data report.

5.2.1 Laboratory Quality Control

Laboratory QC samples estimate precision and accuracy of the analytical data. The laboratory method blanks, duplicates, laboratory control sample/blank spike, and matrix spikes are defined 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 (refer to Section 4.2). If insufficient sample is available for completion of laboratory QC analyses, the laboratory will make note of the condition in the data package (i.e., laboratory data report) 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, which 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). Analytical laboratory instruments are calibrated in accordance with the laboratory's QA plan and applicable Hanford Site requirements.

Supplies and consumables used in support of sampling and analysis activities are procured in accordance with internal work requirements. Supplies and consumables are checked and accepted by users prior to use. Supplies and consumables procured by the analytical laboratories are procured, checked, and used in accordance with the laboratory's QA plan.

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6.0 DATA MANAGEMENT

This section describes the reporting requirements for the U Farm soil sample results. Section 6.1 identifies "quick turn" reporting requirements, and Section 6.2 identifies how all the analyses will be reported. "Quick turn" constituents are bolded in Table 4-1. Analytical results will be reported in Format VI data packages (i.e., laboratory data reports).

It is anticipated that the 222-S Laboratory will perform all of the analyses. If necessary, the laboratory and/or SMO 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 QA personnel and Data Management Lead prior to commencement of laboratory analysis.

6.1 "QUICK TURN" REPORTING

The "quick turn" analyses will be reported as preliminary results on an expedited time frame (within 7 days of the last sample received for a batch; however, upon request, they will be reported within a shorter period of time, as negotiated with the laboratory and/or SMO prior to sample delivery). The "quick turn" results will be transmitted via e-mail to the Data Management Lead. They will also be reported in the laboratory data report, and the information will be loaded into HEIS by the laboratory via Electronic Data Deliverable Processor (EDDPro).

6.2 FORMAT VI REPORTING AND DATA DELIVERABLES

Analysis performed by laboratories will be provided in Format VI laboratory data reports. A Format VI Report with QA verification includes the following:

- Narrative – contains a description of sample receipt and 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 e-mail correspondence and/or characterization deviation forms (refer to Section 7.0 and Appendix A) that document issues that arose during sampling and analysis, and subsequent decisions that affected initial work instructions.

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

The laboratory data report will also include tentatively identified compounds found in the semi-volatile organic analyses. The tentatively identified compounds shall not be reported in HEIS unless directed by the Data Management Lead. A discussion of the tentatively identified compound evaluation process shall be provided in the narrative. A Format VI laboratory data report is subject to internal laboratory QA verification and review, including peer review prior to release.

The laboratory data report will be provided to the Data Management Lead. The laboratory shall issue the report within 180 calendar days following receipt of the last samples. Preliminary results for "quick turn" data shall be available within 7 days, unless an expedited turnaround time is requested. Preliminary results for the remaining data shall be within 60 days following receipt of the last sample, unless the Data Management Lead is informed of QC failures that require re-extraction and/or reanalysis (e.g., within two times holding times). As indicated in Section 5.2, laboratory changes will be communicated to the Data Management Lead and documented in the laboratory data report(s) narrative. Sample raw data will be provided, upon request, to the Data Management Lead. Additionally, documentation of deviations to the FSAP analysis requirements shall be appended to the final laboratory data report (e.g., change in specified methods, characterization deviation form [refer to Section 7.0 and Appendix A]). The Project Manager will identify personnel to be included on the distribution list for the final laboratory data report.

In addition to the laboratory data report, an electronic version of the analytical results shall be uploaded to HEIS by the laboratory via EDDPro within 14 calendar days of release of the report. The electronic data shall be in the standard electronic format for HEIS.

6.3 DATA REVIEW AND USABILITY

This section addresses the data management and QA activities that occur after data collection. These activities will primarily be subcontracted to CH2M HILL Plateau Remediation Company or current contractor. Implementation of these activities determines whether the data conform to the specified criteria, thus satisfying the project objectives. The Data Management Lead or designee will be responsible for ensuring the completeness of the data report(s), reviewing results against any existing knowledge, and assessing the data to determine if they are adequate for the intended use. A review will also be performed to verify all data were correctly loaded into HEIS.

6.3.1 Data Review and Verification

Data review and verification are performed to confirm that sampling and chain-of-custody documentation are complete. This review includes linking sample numbers to specific sampling locations, and reviewing sample collection dates and sample preparation and analysis dates to assess whether holding times, if any, have been met. Furthermore, review of QC data is used to determine whether analyses have met the data quality requirements specified in this FSAP.

The criteria for verification include, but are not limited to, use of the correct analytical method, transcription errors, correct application of dilution factors, appropriate reporting of dry weight versus wet weight, and correct application of conversion factors. Field QA/QC results will be reviewed to ensure they are usable.

Data reviews will be performed to help determine if observed changes reflect potential data errors, which may result in submitting a request for data review on questionable data. The laboratory may be asked to check calculations or reanalyze the sample. In extreme cases, another sample may be collected. Results of the request for the data review process are used to flag the data appropriately in the HEIS database and/or to add comments.

6.3.2 Reconciliation with User Requirements

The purpose of reconciliation with user requirements 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 data quality assessment (DQA) process is the scientific and statistical evaluation of previously verified and validated data to determine if information obtained from environmental data operations are of the right type, quality, and quantity to support their intended use (usability). The DQA process uses the entirety of the collected data to determine usability for decision making. For judgmental (focused) sampling designs, data quality indicators such as precision, accuracy, representativeness, comparability, completeness, and sensitivity for the specific data sets (individual laboratory data packages) are evaluated in accordance with EPA/240/R-02/004, *Guidance on Environmental Data Verification and Data Validation, EPA QA/G-8*. Data verification is integral to the statistical DQA data evaluation process and the data quality indicator evaluation process. Guidelines from EPA/240/B-06/002, *Data Quality Assessment: A Reviewer's Guide, EPA QA/G-9R* and data assessment requirements and specifications in HASQARD will be followed, as applicable. Results of the DQA/data quality indicator processes will be used by the Project Manager to interpret the data and determine if the DQOs for this FSAP have been met.

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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 designee. These work scope changes will be documented in the sampling work package and/or Format VI laboratory data report(s). Changes will also be summarized in FSAP revisions, if revisions are needed. Justification for the changes to work scope shall be provided in sufficient detail to explain the basis for the change.

Version control is maintained by the administrative document control process. Three types of changes during the accomplishment of sampling and analysis that could affect compliance with the requirements in the FSAP are as follows.

- A **fundamental change** is a change that does not meet the requirements set forth in the FSAP or that incorporates characterization activities not defined in the scope of the FSAP.

- A **significant change** generally involves a significant change to a component of the characterization that does not fundamentally alter the overall test approach.

- A **minor change** will not have a significant impact on the scope, schedule, or cost of the characterization. Minor field changes can be made by the person in charge of the field activity. These minor changes should be documented in the project file (for example, through interoffice memoranda or logbooks). Insignificant changes will not impact the requirements of the FSAP.

The Project Manager will discuss the change with DOE. DOE will then discuss significant changes with Ecology, as needed, including changes described in Sections 9.3 and 12.0 of the HFFACO Action Plan. Appropriate documentation will follow, in accordance with the requirements for the type of change. The Project Manager or designee is responsible for communicating field corrective action requirements and ensuring that immediate corrective actions are applied to field activities.

Characterization Support personnel are responsible for tracking all changes. Characterization Support personnel are also responsible for ensuring that the field instructions are maintained and aligned with any revisions or approved changes to the FSAP; for ensuring that the current version of the FSAP is being used; and for providing any updates to field personnel. Characterization Support personnel and/or the Data Management Lead will also ensure that deviations from the FSAP or problems encountered in the field are documented appropriately (e.g., in the field logbook or characterization deviation form). Appendix A provides a copy of the characterization deviation form.

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8.0 DOCUMENTS AND RECORDS

All information pertinent to field sampling will be recorded in bound logbooks in accordance with existing sample collection protocols. Sampling personnel 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.

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 project information is properly maintained. The following information will be maintained, as appropriate:

- Field logbooks
- Change notices
- Final reports (e.g., direct push completion and logging reports)
- Laboratory data report
- Verification reports.

The laboratory will follow their own procedures with respect to documents and records. Audits will be periodically conducted by WRPS QA to ensure that their practices are following requirements.

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 the accuracy and retrievability of stored records. Records required by the HFFACO will be managed in accordance with the HFFACO requirements.

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9.0 MANAGEMENT OF WASTE

Waste generated by field activities will be managed consistent with the applicable waste management plan. Because this field investigation will principally use direct push technology, no waste to minimal waste will be generated.

Waste will be handled in accordance with the requirements of *Washington Administrative Code* 173-303, "Dangerous Waste Regulations," and as reflected in the site-specific waste management plan. Waste handling practices are based on minimizing the exposure of field personnel to both radiation and chemical pollutants to as low as reasonably achievable, and to comply with regulatory requirements.

If unused samples and associated laboratory waste for analysis are to be dispositioned, the process must adhere with the laboratory contract and agreements. In accordance with Title 40, CFR, Part 300, "National Oil and Hazardous Substances Pollution Contingency Plan" (40 CFR 300), Subpart E—Hazardous Substance Response, §300.440, "Procedures for planning and implementing off-site response actions" (40 CFR 300.440), the Data Management Lead's approval is required before unused samples or waste are returned from offsite laboratories. Additionally, the Data Management Lead's approval is required before disposal of unused sample material at onsite laboratories.

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10.0 HEALTH AND SAFETY PLAN

Field operations will be performed in accordance with health and safety requirements identified in appropriate procedures and plans. Work control documents will be prepared to provide further control of site operations. Safety documentation will include a job hazard analysis and, as applicable, radiological work permits. The sampling procedures and associated activities will implement As Low As Reasonably Achievable practices to minimize the radiation exposure to the sampling and analytical teams, consistent with the requirements defined in Title 10, CFR, Part 835, “Occupational Radiation Protection” (10 CFR 835).

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11.0 REFERENCES

Note: The most current version/revision of methods and/or test plans are preferred.

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APPENDIX A

CHARACTERIZATION DEVIATION FORM

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CHARACTERIZATION DEVIATION FORM

Document: _____ **Change Number:** _____ **ECN to FSAP Required?** Y / N

Requestor: _____ **Date:** _____

Original Requirement:

Samples Impacted:

Proposed Change:

Reason for Change:

Date Change Effective:

Schedule Impact:

Authorization:
Project Manager (Print/Sign): **Date:**

Quality Assurance (Print/Sign): **Date:**

222-S Sample Management Office (Print/Sign): **Date:**

Laboratory Project Coordinator (Print/Sign): **Date:**

Other (Optional, Print/Sign): **Date:**

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APPENDIX B

UNPLANNED RELEASES IN OR NEAR 241-U TANK FARM

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INTRODUCTION

Table B-1 identifies documented known or suspected unplanned releases (UPRs) in U Farm. The date the release was detected, the waste type and the volume of waste that leaked to the soil (if known) are listed in Table B-1. Some, but not all of these releases are designated UPRs in the Waste Information Data System database. The source of this table is RPP-RPT-50097, *Hanford 241-U Farm Leak Inventory Assessment Report.*

Table B-1. Unplanned Releases in or Near 241-U Tank Farm. (4 sheets)

Date	Type of Event / Facility	Event as Described in Reference	Comments
February 1950	Tank 241-U-101 (U-101)	In the 221-T Bismuth Phosphate Plant (T Plant), work was completed on taking the metal waste sludge sample from Tank U-101. The equipment was moved to an alternate riser with a maximum exposure rate of 7.5 rem/hr including 400 mr/hr at 1 ft. Seventeen runs were made at the new location to complete the sample. When frozen ground thawed, permitting slight settling of the cask, sludge slurry leaked in the recess of the cask. One spot of contamination on the frozen ground of 40 Röntgen equivalent physical (rep)/hr including 1.5 r/hr at 2 in. was reported, and the zone was roped off pending decontamination.	Surface contamination within confines of tank farm site 200-W-95. Not specifically identified in the Waste Information Data System (WIDS).
March 1950	Tank U-101	In T Plant, water believed to have come from melted snow running into the pipe encasement filled the 155-TX Catch Tank and ran into the 155-TX Diversion Box. The water was jetted to the 241-TX Tile Field. Cleanup work around Tank U-101 was completed and 96 drums of contaminated dirt were removed and taken to a burial ground. Three sludge samples were obtained from Tank U-101 with a maximum dosage-rate of 30 rep/hr including 1 r/hr at 4 ft.	Tank U-101 contained metal waste from T Plant. Surface contamination within confines of tank farm site 200-W-95. Not specifically identified in WIDS.
May 1950	Tank U-101	Cleanup work in the 241-U Tank Farm (U Farm) area continued with about 400 cans of contaminated dirt removed and taken to a burial ground.	Surface contamination within confines of tank farm site 200-W-95. Not specifically identified in WIDS.
Spring 1950	241-U-151 (U-151) and 241-U-152 Diversion Boxes	Work being done at the diversion boxes resulted in contamination to the ground around the boxes. The maximum dose rate was 20 mrad/ hr on the soil surface. A portion of the contamination was removed and the remainder covered with a foot of clean soil (gravel) and the area roped and posted.	UPR-200-W-6
Spring 1951	Tank 241-U-106 (U-106)	Removal of reinforcing rings from a 36-in. manhole on the tank resulted in the spread of contamination to the excavated area. The contamination was covered with several feet of clean soil. The area is not delimited above ground.	Surface contamination within confines of tank farm site 200-W-95. Not specifically identified in WIDS.
Fall 1951	Tank 241-U-107	Removal of a thermal element from the tank resulted in the spread of contamination to the excavated area. The contamination was covered with several feet of clean soil. The area is not delimited above ground.	Surface contamination within confines of tank farm site 200-W-95. Not specifically identified in WIDS.

Table B-1. Unplanned Releases in or Near 241-U Tank Farm. (4 sheets)

Date	Type of Event / Facility	Event as Described in Reference	Comments
June 1952	Tank U-101	During removal of the 101-UR pump assembly, considerable difficulty was encountered. Local ground contamination up to 2 rep/hr occurred from adverse "breezy" conditions which arose during this pump removal. The ground contamination was immediately detected and removed.	Surface contamination within confines of tank farm site 200-W-95. Not specifically identified in WIDS.
May 1953	244-UR Vault	Widespread contamination occurred in the 244-UR Vault when a violent reaction took place in the blending Tank 002-UR during the addition of caustic metal waste supernate to nitric acid. This reaction was caused by failure to agitate the mixture and resulted in process liquid spurting 30 ft in the air for 30 seconds through a temporarily plugged 4-in. tank riser. Wind velocities up to 20 mph increased the contamination spread. Ground, building and equipment contamination ranged from 35 rep/hr at 6 in. over the standing puddles of liquid around the riser, to 4,000 cpm 400 ft downwind from the vault area. Decontamination is still in progress. This incident was investigated (Class I, Number 65). Estimated release, 6,000 gal MW supernate and 2,800 gal 80% nitric acid.	UPR-200-W-24
May 1953	244-UR Vault	A pressurization in the Tank UR-002, while blending supernate from Tank 241-U-109, resulted in the gross contamination of a wide area. The probable cause of the pressurization was that the blending operation was carried out without the agitator in Tank UR-002 being on.	UPR-200-W-24
February 1955	Overground pipeline from Tank U-101 to Tank 241-U-102 (U-102)	The overground line, which was installed when the cascade line from Tank U-101 to Tank U-102 plugged, was found to be leaking and required the replacement of one section of pipe. Higher priority work delayed this scheduled replacement for 4 days.	Surface contamination within confines of tank farm site 200-W-95. Not specifically identified in WIDS. The plugged line likely contributed to overfilling Tank U-101 between November 1953 and March 1955.
February 1956	Tank 241-U-110	80 ft^2 of ground near Tank UR-110 was contaminated by a leaking process lubricated pump. Dose rates of 500 mR/hr at 12 ft/sec were encountered while covering the ground with paper and plastic to prevent a secondary spread of contamination.	Not specifically identified in WIDS.

Table B-1. Unplanned Releases in or Near 241-U Tank Farm. (4 sheets)

Date	Type of Event / Facility	Event as Described in Reference	Comments
July 1956	241-UR-151 Diversion Box	500 gal of MW feed solution for the tributyl phosphate process overflowed the diversion box. Two pools of liquid were observed near the box with dose rates of 10 rad/hr 3 m from the pools.	UPR-200-W-132
January 8, 1971	241-U-103 Tank Pit	An employee cut through a waste line in the waste pit resulting in contamination of 2 employees from 3,000 to 20,000 cpm. No information in incident report describing effect to the surrounding area.	UPR-200-W-128
April 9, 1975	244-UR to Tank 241-U-107 (U-107) pipeline	Pressure checks of the line from the 244-UR Vault to Tank U-107 indicated a leak which may have been due to the transfer of acidic solution. The line has been taken out of service.	Surface contamination within confines of tank farm site 200-W-95. Not specifically identified in WIDS.
September 27, 1976	Tank 241-U-105 (U-105) Pump Pit	During transfer of waste from Tank U-106, as a result of failure of a closed valve, the line was pressurized and radioactive waste solution was released into the Tank U-105 pump pit when a pump discharge jumper was disconnected.	Personnel received low level contamination, but no indication of release to surrounding soils.
December 21, 1977	U-151 Diversion Box	While preparing to cut line V453 in an excavation near the U-151 Diversion Box, a hole was drilled in the top of the line spraying contamination into the excavation. Fixative was applied to the contamination in the pit and the hole was filled in with clean dirt.	Surface contamination within confines of tank farm site 200-W-95. Not specifically identified in WIDS.
March 22, 1979	Tank U-106	Vapor observed escaping from riser #9.	—
March 2, 1981	244-UR Vault raw water line	Water was discovered bubbling out of the ground approximately 200 yards west of the U Farm vault area. The source was a 4 in. raw water line passing through the cooling coil discharge line from the 244-UR Vault and directed into the drain line for the 216-Z-11 Ditch. The discharge line valves were closed, but apparently leaking an estimated 20 to 40 gal/day. 160 ft of the raw water line was abandoned.	The duration and volume of the raw water line leak is unknown.
May 1983 to 2009	North side of U Farm, east of 2607-WUT	Underground radioactive materials area. Specks of contamination observed in May 1983 from 500 to 200,000 cpm. The area was listed as an underground materials area in 1995 and was covered with gravel. The size and shape of the contaminated area has increased since then.	200-W-91, consolidated into 200-W-95.

Table B-1. Unplanned Releases in or Near 241-U Tank Farm. (4 sheets)

Date	Type of Event / Facility	Event as Described in Reference	Comments
January 12, 1990	Surface contamination east of U Farm	Contamination up to 8,000 cpm discovered during radiation surveys and posted with underground radioactive material signs. A tank farm pipeline is buried in this approximate location. In March 1996 2 to 6 in.of soil was scraped into a pile at the northeast end of the zone. The pile was covered with clean dirt and the scraped area was released.	UPR-200-W-161

MW = $BiPO_4$ Metal Waste WIDS = Waste Information Data System

Modified from: RPP-RPT-50097, *Hanford 241-U Farm Leak Inventory Assessment Report*, Table 5-2.

REFERENCE

RPP-RPT-50097, 2011, *Hanford 241-U Farm Leak Inventory Assessment Report*, Rev. 0, Washington River Protection Solutions, LLC/CH2M HILL Plateau Remediation Company, Richland, Washington.