APPENDIX H-A

FS-1 DANGEROUS WASTE MANAGEMENT UNIT CLOSURE PLAN

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H-A1 INTRODUCTION

This appendix discusses closure activities for the Low-Level Burial Ground (LLBG) Trenches 31-34-94 Operating Unit Group (OUG) (hereinafter LLBG Trenches 31-34-94) FS-1 Outdoor Container Storage Area dangerous waste management unit (DWMU) (hereinafter FS-1). This DWMU is located along the south side of Trench 34. The U.S. Department of Energy (DOE) has agreed through a Consent Agreement and Final Order with the U.S. Environmental Protection Agency (EPA) to close this DWMU. The closure will be performed in accordance with the schedule provided in Section H-A4. This closure plan complies with WAC 173-303-610(2) through WAC 173-303-610(6), "Dangerous Waste Regulations," "Closure and Post-Closure," and represents the baseline for closure and the enforceable compliance requirements for conducting closure. Amendments to this closure plan will be submitted as a permit modification in accordance with WAC 173-303-610(3)(b).

H-A1.1 Unit Description

FS-1 (Figures H-A-1 and H-A-2) was originally designated as a waste storage area in November 2004 for the temporary storage of non-mixed low-level waste (LLW) containers from the 300 Area prior to their disposal into LLBG Trench 34. The temporary storage of LLW was completed in July 2005. From July 2005 to November 2007, no dangerous, mixed, or *Toxic Substances Control Act of 1976* (TSCA) polychlorinated biphenyl (PCB) LLW was stored in FS-1. From November 2007 through September 2008, FS-1 was used for the storage of LLW, mixed low-level waste (MLLW), and TSCA-PCB LLW containers prior to disposal into LLBG Trenches 31 and 34. A radiological survey, performed on FS-1 in March 2012, confirmed no radiological contamination above the expected background levels.

FS-1 is a gravel-covered, rectangular area approximately 14 m (15 yd) wide by 69 m (75 yd) long equaling a total storage area of 966 m^2 (1,125 yd^2). The perimeter of the storage area is defined by metal T-posts, with the corner posts holding signage designating the area as FS-1. There are no structures or equipment located at the storage area.

FS-1 does not currently store dangerous, mixed, or TSCA-PCB waste. Future dangerous waste container storage and treatment of dangerous, mixed, or TSCA-PCB waste are not authorized within the FS-1 and will not be requested after *Resource Conservation and Recovery Act of 1976* (RCRA) closure is complete.

H-A1.1.1 Maximum Waste Inventory

The maximum inventory of MLLW and TSCA-PCB LLW waste stored on FS-1 over its lifetime included four MLLW containers with an approximate total volume of 12 m^3 (16 yd^3) and seven TSCA-PCB LLW waste containers with an approximate total volume of 1.5 m^3 (1.9 yd^3). MLLW and TSCA-PCB LLW waste storage occurred from November 2007 through September 2008. The MLLW stored at FS-1 was either treated to meet land disposal restriction (LDR) requirements prior to being stored in this area, or the waste met the LDR requirements at the time of generation. Details on the waste containers are presented in Section H-A3.3 of this closure plan.

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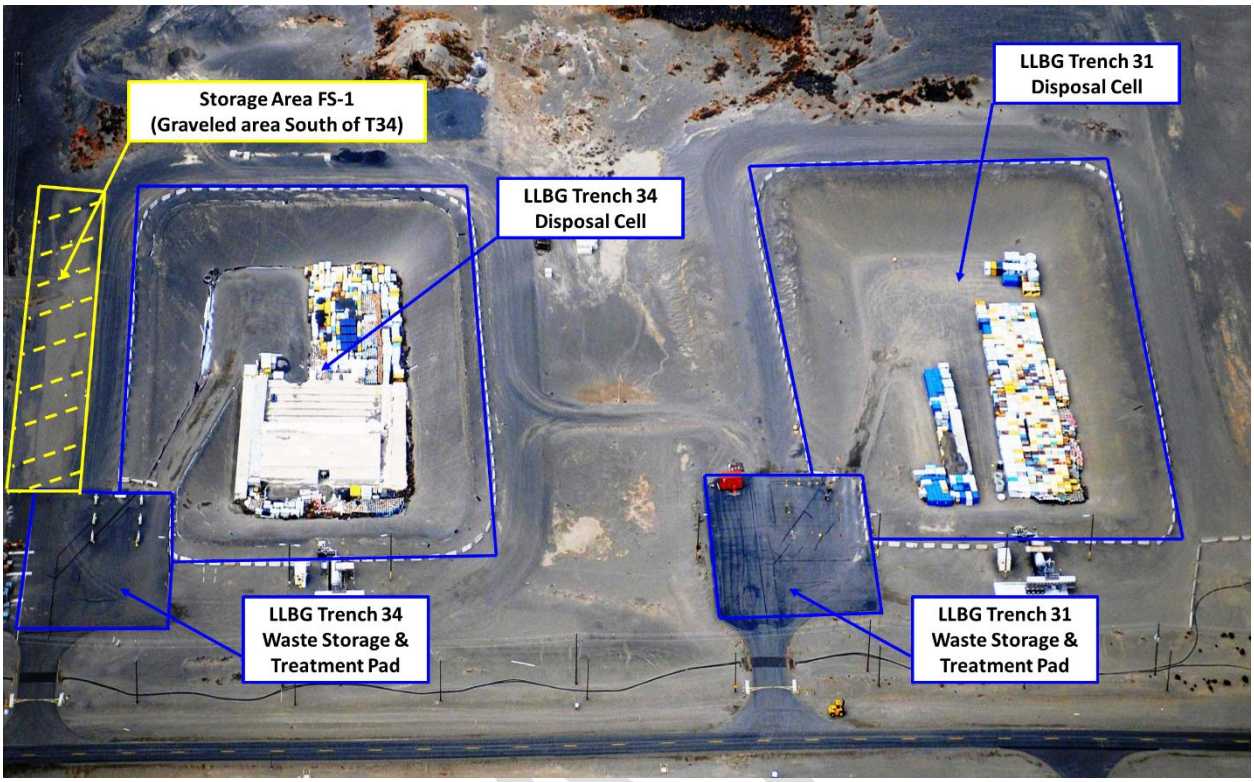

Figure H-A-1. FS-1 and LLBG Trenches 31 and 34 (November 2011)

Figure H-A-2. FS-1 Outdoor Container Storage Area (February 2013)

H-A2 CLOSURE PERFORMANCE STANDARD

Closure performance standards for FS-1 will be based on WAC 173-303-610(2), which requires closure of the facility in a manner that accomplishes the following objectives:

- Minimizes the need for further maintenance
- Controls, minimizes, or eliminates to the extent necessary to protect human health and the environment, post-closure escape of dangerous waste, dangerous constituents, leachate, contaminated runoff, or dangerous waste decomposition products to the ground, surface water, groundwater, or the atmosphere
- Returns the land to the appearance and use of surrounding land areas, to the degree possible, given the nature of the previous dangerous waste activity

These performance standards are addressed in Sections H-A2.1 and H-A3.8 of this closure plan.

H-A2.1 Clean-Closure Levels

FS-1 will be clean closed. The gravel/soil will be sampled and must meet clean-closure levels. In accordance with WAC 173-303-610(2)(b)(i), clean-closure levels for the gravel/soil are the numeric cleanup levels calculated using unrestricted use exposure assumptions according to WAC 173-340, "Model Toxics Control Act—Cleanup," hereinafter called MTCA, cleanup regulations (WAC 173-340-700, "Overview of Cleanup Standards," through WAC 173-340-760, "Sediment Cleanup Standards," excluding WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties"). These numeric cleanup levels have been calculated according to the requirements of WAC 173-303-610(2)(b)(i) as of the effective date of the permit modification. These cleanup levels consider carcinogens, noncarcinogens, groundwater protection, and ecological indicator values.

A null hypothesis is generally assumed true until evidence indicates otherwise. The null hypothesis, as defined in WAC 173-340-200, "Definitions," for FS-1 is that gravel/soil is assumed to be above unrestricted use cleanup levels, commonly called MTCA (WAC 173-340) Method B cleanup levels. Therefore, the site is presumed to be contaminated. Rejection of the null hypothesis means sampling and analysis results of the site indicated that gravel/soil contains contamination below the MTCA (WAC 173-340) Method B cleanup levels. Sampling and analysis will be used to determine whether the null hypothesis can be rejected, thereby confirming that gravel/soil meets closure performance standards (MTCA [WAC 173-340] Method B).

Should sampling and analysis provide a basis that the null hypothesis can be accepted, such an event will be considered an unexpected event during closure, and the gravel/soil would then be identified as contaminated environmental media and managed in accordance with Section H-A3.7.

H-A3 CLOSURE ACTIVITIES

As a storage unit, the clean-closure determination for FS-1 is partially based on review of the operational history, operating records, and waste management records, and a visual inspection of the area to verify that waste-related staining is not present. Based on these reviews, FS-1 is a candidate for clean closure under RCRA, and confirmation sampling will be performed. Sampling and analysis activities were developed utilizing the results of the records review and visual inspection (EPA/240/R-02/005, *Guidance on Choosing a Sampling Design for Environmental Data Collection* [EPA QA/G-5S], and Ecology Publication 94-111, *Guidance for Clean Closure of Dangerous Waste Units and Facilities*) and will be conducted via a sampling and analysis plan (SAP) (Section H-A3.9.1). The objective of the sampling described in this document is to determine if the MTCA (WAC 173-340) Method B closure performance standards for soil were met, demonstrating clean closure of FS-1.

The following closure activities are required to achieve and verify clean closure for gravel/soil:

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- Remove all dangerous, mixed, and TSCA-PCB LLW waste inventory (completed; see Section H-A3.2).
- Review waste container storage, operating, and inspection records (completed; see Section H-A3.3).
- Perform a visual inspection of gravel and visible surface soil (completed; see Section H-A3.3).
- Perform gravel/soil sampling and analysis to confirm that clean-closure standards are met.
- If detected during initial sampling efforts, remove any contaminated environmental media present.
- Resample, as necessary, to confirm that MTCA (WAC 173-340) Method B clean-closure levels have been met.
- Transmit closure certification to the Washington State Department of Ecology (Ecology).

H-A3.1 Health and Safety Requirements

Closure will be performed in a manner to ensure the safety of personnel and the surrounding environment. Qualified personnel will perform any necessary closure activities in compliance with established safety and environmental procedures. Personnel will be equipped with appropriate personal protective equipment. Qualified personnel will be trained in applicable safety and environmental procedures and have appropriate training and experience in sampling activities. Field operations will be performed in accordance with applicable health and safety requirements.

The Permittees have instituted training or qualification programs to meet training requirements imposed by regulations, DOE orders, and national standards such as those published by the American National Standards Institute/American Society of Mechanical Engineers. For example, the environmental, safety, and health training program provides workers with the knowledge and skills necessary to execute assigned duties safely. The Hanford Facility RCRA Permit, Attachment 5, describes specific requirements for the Hanford Facility Personnel Training program. The Permittees will comply with the training matrix shown in Table H-A-1, which provides training requirements for Hanford Facility personnel associated with FS-1.

Project-specific safety training addressed explicitly to the project and the day's activity will include the following:

- Training will provide the knowledge and skills needed for sampling personnel to perform work safely and in accordance with quality assurance (QA) requirements.
- Samplers are required to be qualified in the type of sampling being performed in the field.

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Table H-A-1. Training Matrix for FS-1 DWMU

	Training Category[a]				
Permit Attachment 5 Training Category	General Hanford Facility Training	Contingency Plan Training	Emergency Coordinator Training	Operations Training	
SWOC Closure Unit DWTP Implementing Plan	Orientation Program	Emergency Response (Contingency Plan)	Emergency Coordinator Training	General Waste Management and Closure Support	Container Management
Job Title/Position					
NCO	X	X		X[a]	X[b]
Operations Supervisor	X	X	X	X[b]	
ECO	X			X[b]	
Waste Service Provider	X			X[b]	X[b]
Sampler	X			X[b]	

a. Refer to the LLBG Trenches 31-34-94 DWTP for a complete description of coursework in each training category.

b. Training received is commensurate with the duties performed. Individuals in this category who do not perform these duties are not required to receive this training.

DWMU = dangerous waste management unit
DWTP = dangerous waste training plan
ECO = environmental compliance officer
LLBG = low-level burial ground
NCO = nuclear chemical operator
SWOC = Solid Waste Operations Complex

Pre-job briefings will be performed to evaluate activities and associated hazards by considering the following factors:

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

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Training records are maintained for each employee in an electronic training record database. The Permittees' training organization maintains the training records system.

H-A3.2 Removal of Wastes and Waste Residues

No MLLW or TSCA-PCB LLW waste is currently stored at FS-1. MLLW was removed in September 2008, and TSCA-PCB LLW was removed in January 2008. FS-1 will no longer be used for dangerous, mixed, or TSCA-PCB waste storage. FS-1 will be maintained in accordance with WAC 173-303-610 in a manner that demonstrates that all steps have been taken and will continue to be taken to prevent threats to human health and the environment from the unclosed but not operating DWMU, including compliance with all applicable permit requirements. Inspection requirements during the closure period are identified in Section H-A3.5.

Dangerous waste or waste residues are not anticipated at this unit. There are no containers or structures in FS-1 where waste or waste residues could be present. Any unanticipated waste or waste residues would be in the form of contaminated gravel/soil and will be managed as contaminated environmental media in accordance with Section H-A3.7.

H-A3.3 FS-1 Outdoor Storage Area Operating Records Review and Visual Inspection

To support the development of this closure plan and the included SAP, a review of the FS-1 RCRA operating records was completed (Table H-A-2). The records review included the following RCRA operating record documents: facility daily operating logbooks (including any spill information), waste management records, and weekly dangerous waste inspection checklists. The RCRA operating record documents that were reviewed focused on the time frame during active MLLW or TSCA-PCB LLW storage. The records review included the time period of November 2007 through September 2008. The records review, completed on July 31, 2013, indicated no documented releases of MLLW or TSCA-PCB LLW waste to FS-1.

Table H-A-2. RCRA Facility Operating Records Review Summary

Document Title	Document Type	Facility	Start Date	End Date	Items of Concern Noted
FS-1 Daily Operating Logbook Review	Logbook	FS-1	07/10/2007	04/16/2009	No
Checklist 2 – LLBG Weekly RCRA Inspections for Trenches 31 and 34 in 218-W-5 (Trench 34)	Weekly Inspection	FS-1	01/01/2007	09/23/2008	Yes*

* The container noted as an item of concern was not a dangerous waste container. No evidence of leaking was noted (see Attachment H-A.a for details.

LLBG = low-level burial ground

RCRA = *Resource Conservation and Recovery Act of 1976*

Waste management records for MLLW and TSCA-PCB LLW containers stored in FS-1 were reviewed to determine the target analytes to be included in the closure plan SAP (Section H-A3.9.1). The waste management records review indicated that all target analytes in MLLW and TSCA-PCB LLW previously stored in FS-1 were LDR compliant (either treated to meet LDR requirements or below LDR-regulated levels at the time of generation) prior to storage in FS-1 (Table H-A-3).

A visual inspection was completed on July 31, 2013, no waste-related staining was identified during the visual inspection.

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Based on the operating record review, waste management records, and visual inspection, only confirmation sampling and analysis will be performed.

Supporting documentation for the RCRA operating records review and visual inspection are documented in Attachment H-A.a and include the FS-1 Daily Operating Log Book Review sheet, LLBG Trench 34/FS-1 Weekly Dangerous Waste Inspection Checklist Review, LLBG 218-W-5, FS-1 Outdoor Container Storage Area visual inspection sheet, and any additional supporting information.

Table H-A-3. Waste Container Data

Container ID	Facility ID	Storage Unit	Waste Package Type	Package Volume (m^3)	Waste Type	Moved-In Date	Moved-Out Date	Assigned Waste Code	LDR Status
MW07700211	LLBG 218W5	FS-1	DOT metal box	2.72	MLLW	11/29/2007	11/29/2007	D005, D006, D007, D008, D009, D011, D035, F001, F002, F003	Treated to meet LDR standards
MW07700604	LLBG 218W5	FS-1	DOT metal box	2.72	MLLW	11/29/2007	11/29/2007	D007, D008, D009, D035, F002, F003, F005	Treated to meet LDR standards
MW077006551	LLBG 218W5	FS-1	DOT metal box	6.38	MLLW	11/29/2007	11/29/2007	D007, D008, D009, D011, D026, D035, D037, F001, F002, F003, F004, F005, P029, P030, P098, P106, P120, U002, U031, U108, U123, U133, U154, U159, U162, U210, U239	Treated to meet LDR standards
0020830	LLBG 218W5	FS-1	DOT 55 gal drum	0.21	MLLW	12/10/2007	09/10/2008	WT02	LDR compliant at the point of generation
0015656	LLBG 218W5	FS-1	DOT 55 gal drum	0.21	TSCA-LLW	12/10/2007	01/14/2008	N/A	N/A
0015684	LLBG 218W5	FS-1	DOT 55 gal drum	0.21	TSCA-LLW	12/10/2007	01/14/2008	N/A	N/A
0015687	LLBG 218W5	FS-1	DOT 55 gal drum	0.21	TSCA-LLW	12/10/2007	01/14/2008	N/A	N/A
0015717	LLBG 218W5	FS-1	DOT 55 gal drum	0.21	TSCA-LLW	12/10/2007	01/14/2008	N/A	N/A
0015760	LLBG 218W5	FS-1	DOT 55 gal drum	0.21	TSCA-LLW	12/10/2007	01/14/2008	N/A	N/A
0017284	LLBG 218W5	FS-1	DOT 55 gal drum	0.21	TSCA-LLW	12/10/2007	01/14/2008	N/A	N/A

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Table H-A-3. Waste Container Data

Container ID	Facility ID	Storage Unit	Waste Package Type	Package Volume (m^3)	Waste Type	Moved-In Date	Moved-Out Date	Assigned Waste Code	LDR Status
PNL-00-139	LLBG 218W5	FS-1	DOT 55 gal drum	0.21	TSCA-LLW	12/10/2007	01/14/2008	N/A	N/A

DOT = U.S. Department of Transportation
ID = identification
LDR = land disposal restriction
LLBG = low-level burial ground
LLW = low-level waste
MLLW = mixed low-level waste
N/A = not applicable
TSCA = *Toxic Substances Control Act of 1976*

H-A3.4 Unit Components, Parts, and Ancillary Equipment

FS-1 does not have any unit components, parts, or ancillary equipment.

H-A3.5 Inspection of Units before Decontamination

Decontamination activities are not anticipated for FS-1; however, to prevent threats to human health and the environment during the closure period, FS-1 will be inspected in accordance with WAC 173-303-320(2), "General Inspection." Inspections of FS-1 will be performed annually, until the clean-closure certification is approved by Ecology, and will verify the following:

- Posted warning signs at each entrance to the LLBG Trenches 31-34-94 are present, legible, and visible at 7.6 m (25 ft).
- No evidence of unusual conditions exists at the closing DWMU site.

H-A3.6 Decontamination

Decontamination activities are not anticipated for FS-1.

H-A3.7 Identifying and Managing Contaminated Environmental Media

The records review and visual inspection outlined in Section H-A3.3 did not identify any documented releases of MLLW or TSCA-PCB LLW or the presence of potentially contaminated environmental media. Contaminated environmental media removal is not anticipated.

If contaminated environmental media (gravel/soil) is identified as a result of clean-closure verification sampling activities (i.e., samples indicate contamination above clean-closure standards), the nature and extent of contamination will be evaluated. Contaminated gravel/soil will be removed using equipment capable of removing the quantity of material required to complete removal and clean close the DWMU. Following removal of contaminated gravel/soil, additional confirmatory sampling efforts will be conducted for FS-1 in accordance with the approved closure plan SAP (see Section H-A3.9.1) to demonstrate clean-closure levels.

If contaminated gravel/soil removal is required from the DWMU, it will be managed as a newly generated waste stream in accordance with WAC 173-303-610(5). Contaminated gravel/soil generated during the closure period must be properly disposed. The contaminated gravel/soil will be a newly generated waste and must be handled in accordance with all applicable requirements of WAC 173-303-170,

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"Requirements for Generators of Dangerous Waste," through 173-303-230, "Special Conditions." The contaminated gravel/soil will be containerized, labeled, sampled for waste characterization, designated as a dangerous or nondangerous waste, stored, and transported offsite where it will be treated (if necessary) to meet LDRs in 40 CFR 268, "Land Disposal Restrictions," incorporated into WAC 173-303-140(2)(a), "Land Disposal Restrictions," by reference, then ultimately disposed of in an appropriate waste disposal facility.

H-A3.8 Confirming Clean Closure

FS-1 will be clean closed. A review of applicable RCRA operating record documents was completed to determine the release history of the area. Records review included facility daily operating logbooks (including any spill information) and weekly dangerous waste inspection checklists as outlined in Section H-A3.3. In addition to the records review, a visual inspection of the area was performed to identify any dangerous waste-related staining of the gravel or visible surface soil.

All MLLW and TSCA-PCB LLW waste has been previously removed, and there have been no documented spills or releases of MLLW and TSCA-PCB LLW. Post-closure escape of MLLW, TSCA-PCB LLW, and any associated constituents, leachate, contaminated run-off, and dangerous waste decomposition products to the ground, surface water, groundwater, or air is not anticipated.

FS-1 is adjacent to the LLBG Trench 34 DWMU. Sampling of FS-1 will be conducted to confirm that soil unrestricted use cleanup standards (MTCA [WAC 173-340] Method B) have been achieved. If sample results indicated contamination above clean-closure levels, contaminated gravel/soil will be removed and managed in accordance with Section H-A3.7. Once analytical results confirm clean-closure levels of target analytes, a determination will be made to leave the gravel surface of FS-1 in place.

H-A3.9 Sampling and Analysis and Constituents to be Analyzed

The SAP summarizes the sampling design used and associated assumptions based on the knowledge of FS-1. The sampling design includes input parameters used to determine the number and location of samples.

H-A3.9.1 Sampling and Analysis Plan

Sampling and analysis of FS-1 gravel and soil will be conducted to confirm that clean-closure levels have been achieved. All sampling and analysis will be performed in accordance with the sampling and quality standards established in this closure SAP. The closure SAP details sampling and analysis procedures in accordance with SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B*; the ASTM International, formerly the American Society for Testing and Materials (ASTM), *Annual Book of ASTM Standards*; and applicable EPA guidance. Sampling and analysis activities will meet applicable requirements of SW-846, ASTM standards, EPA-approved methods, and DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD), at the time of closure. This SAP was also developed using Ecology Publication 94-111, Section 7.0, "Sampling and Analysis for Clean Closure," and EPA/240/R-02/005.

H-A3.9.2 Target Analytes

Waste management records for MLLW and TSCA-PCB LLW containers previously stored at FS-1 were reviewed. The waste management records identified the federal and state waste codes required for disposal of MLLW and TSCA-PCB LLW. The identified waste codes were the basis for the list of target analytes for analysis in this SAP. Table H-A-4 details the waste codes listed for the FS-1 waste containers and the target analyte associated with each waste code.

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Table H-A-4. Target Analyte List

Target Analyte (Waste Code)	CAS Number	Target Analyte (Waste Code)	CAS Number
Barium (D005)	7440-39-3	Ethyl Ether (F003)	60-29-7
Cadmium (D006)	7440-43-9	Methanol (F003) (U154)	67-56-1
Chromium (Hexavalent) (D007)	18540-29-9	Methyl Isobutyl Ketone (F003)	108-10-1
Lead (D008)	7439-92-1	Xylene (F003) (U239)	1330-20-7
Mercury (D009)	7439-97-6	*o*-Cresol (F004)	95-48-7
Silver (D011)	7440-22-4	Benzene, nitro (F004)	98-95-3
Cresol (D026)	N/A	Benzene (F005)	71-43-1
Methyl Ethyl Ketone (D035) (F005) (U159)	78-93-3	Pyridine (F005)	110-86-1
Pentachlorophenol (D037)	87-86-5	2-Nitropropane (F005)	79-46-9
Carbon Tetrachloride (F001) (F002)	56-23-5	Carbon Disulfide (F005)	75-15-0
Trichloroethylene (F001) (F002)	79-01-6	Isobutanol (F005)	78-83-1
1,1,1-Trichloroethane (F001) (F002)	71-55-6	2-Ethoxyethanol (F005)	110-80-5
Methylene Chloride (F001) (F002)	75-09-2	Toluene (F005)	108-88-3
Tetrachloroethylene (F001) (F002) (U210)	127-18-4	1-Butanol (I) (U031)	71-36-3
Chlorinated Fluorocarbons (F001) (F002)	N/A	1,4-Diethyleneoxide (U108)	123-91-1
Chlorobenzene (F002)	108-90-7	Formic Acid (U123)	64-18-6
Ortho-dichlorobenzene (F002)	95-50-1	Hydrazine (R,T) (U133)[a]	302-01-2
1,1,2-Trichloroethane (F002)	79-00-5	Methyl Methacrylate (I,T) (U162)	80-62-6
1,1,2-Trichloro-1,2,2-trifluoroethane (F002)	73-13-1	Copper Cyanide (P029)[b]	544-92-3
Acetone (F003) (U002)	67-64-1	Cyanides (P030)	N/A
N-butyl alcohol (F003)	71-36-3	Potassium Cyanide (P098)[b]	151-50-8
Cyclohexanone (F003)	108-94-1	Sodium Cyanide (P106)[b]	143-33-9
Ethyl Acetate (F003)	141-78-6	Vanadium Oxide (P120)	1314-62-1
Ethyl Benzene (F003)	100-41-4	PCBs (Aroclors)	N/A

a. Due to the reactive and volatile nature of hydrazine, quantitation is difficult, and its presence in soil samples from waste stored in 2008 is unlikely; therefore, samples will not be analyzed for hydrazine.

b. Analyzed as total cyanide.

CAS = Chemical Abstracts Service

N/A = not applicable

PCB = polychlorinated biphenyl

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H-A3.9.3 FS-1 SAP Schedule

Confirmation closure sampling and analysis will be performed in accordance with the closure plan schedule in Section H-A4.

H-A3.9.4 FS-1 Project Management

The Permittees are responsible for planning, coordinating, sampling, preparing, packaging, and shipping samples to the laboratory.

H-A3.9.5 Sampling Design

The primary purpose of sampling the FS-1 DWMU is to determine if analytical data values exceed the MTCA (WAC 173-340) Method B clean closure performance standards.

This SAP utilized Ecology Publication 94-111, Section 7.0, "Sampling and Analysis for Clean Closure," to determine the type of sampling design that will be utilized to demonstrate clean closure. When designing the sampling plan, both focused and area wide (grid) sampling methods were considered. Ecology Publication 94-111, Section 7.2.1, identifies that area wide sampling is appropriate when the spatial distribution of contamination at or from the closure unit is uncertain. Ecology Publication 94-111, Section 7.3, "Sampling to Determine or Confirm Clean Closure," identifies the area wide sampling approach as generally appropriate for sampling to determine or confirm that clean closure levels are achieved. Focused sampling, as identified in Section 7.2.2 of Ecology Publication 94-111, is selective sampling of areas where contamination is expected or releases have been documented. Based on the records review and visual inspection performed for FS-1 (Section H-A3.3), there is no known contamination within the sampling area and no documented releases; therefore, the area wide sampling approach was determined to be appropriate for FS-1 with no additional focused sampling.

The quantity and location of area wide samples were determined utilizing the Visual Sampling Plan (VSP) software. VSP is a tool used throughout Washington State and nationally that statistically determines the quantity of samples required to accept or reject the null hypothesis based on input parameters specific to the FS-1 DWMU.

Both parametric and nonparametric equations rely on assumptions about the data population. Typically, however, nonparametric equations require fewer assumptions and allow for more uncertainty about the distribution of data. Alternatively, if parametric assumptions are valid, the required number of samples is usually less than if a nonparametric equation was used. For FS-1, data assumptions were largely based on information obtained from a grouping of similar waste sites with the same type of constituents. Parameters from the 200-MG-1 waste sites were approved by Ecology in the SAP (DOE/RL-2009-60, *Sampling and Analysis Plan for Selected 200-MG-1 Operable Unit Waste Sites*), evaluated, deemed appropriate, and utilized for the input parameters for FS-1. VSP parameter inputs and the basis for those inputs are detailed in Table H-A-5.

The decision rule for demonstrating compliance with the MTCA (WAC 173-340) Method B clean closure level has three parts:

- The 95 percent upper confidence limit on the true data mean must be less than the MTCA (WAC 173-340) Method B clean closure level.
- No sample concentration can be more than twice the cleanup level.
- Less than 10 percent of the samples can exceed the cleanup level.

Using a nonparametric test and the input parameters identified in Table H-A-5, VSP calculated that a minimum of 20 samples is required to reject the null hypotheses with 95 percent confidence and ensure that FS-1 would not be mistakenly released as clean. For the purpose of utilizing VSP software, the null hypothesis is to compare a site mean to a fixed threshold. Data will be evaluated to ensure that less than

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10 percent of the values exceed MTCA (WAC 173-340) Method B clean closure performance standards and that no values are more than twice the cleanup level.

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Table H-A-5. Visual Sampling Plan Parameter Inputs

Parameter	Value	Basis
Primary Objective of the Sampling Design	Compare a site mean or median to a fixed threshold	Reject the null hypothesis.
Type of Sampling Design	Nonparametric	Data are not assumed to be normally distributed.
Working Null Hypothesis	The mean value at the site exceeds the threshold (WAC 173-340 "Model Toxics Control Act—Cleanup," Method B closure performance standards)	The null hypothesis assumes that the site is dirty requiring the sampling and analysis to demonstrate through statistical analysis that the site is clean.
Area Wide Grid Sampling Pattern	Triangular	A triangular pattern provided an even distribution of sample locations over the FS-1 dangerous waste management unit.
Standard Deviation (S)	0.45	This is the assumed standard deviation value relative to a unit action level for the sampling area. The value of 0.45 is conservative, based on consideration of past verification sampling. MARSSIM suggests 0.30 as a starting point; however, 0.45 has been selected to be more conservative. (Number of samples calculated increases with higher standard deviation values relative to a unit action level.)
Delta (Δ)	0.40	This is the width of the gray region. It is a user-defined value relative to a unit action level. The value of 0.40 balances unnecessary remediation cost with sampling cost.
Alpha (α)	5%	This is the acceptable error of deciding a dirty site is clean when the true mean is equal to the action level. It is a maximum error rate since dirty sites with a true mean above the action level will be easier to detect. A value of 5% was chosen as a practical balance between health risks and sampling cost.
Beta (β)	20%	This is the acceptable error of deciding a clean site is dirty when the true mean is at the lower bound of the gray region. A value of 20% was chosen during the data quality objectives process as a practical balance between unnecessary remediation cost and sampling cost.
MARSSIM sampling overage	20%	MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of *n*.

Source: EPA 402-R-97-016, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*.

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Sample locations were determined using the area wide grid with a random start sampling method run in the VSP software. Statistical analysis of systematically collected data is valid if a random start to the grid is used. FS-1 dimensions were entered into VSP to determine the locations of samples. The triangular grid sampling layout was determined to have an even distribution over the entire FS-1 sampling area providing the most representative data set including coverage of the middle portion of the sampling area. The 20 samples will be taken from the node locations indicated by the VSP software (Attachment B) and will be assigned sample location identifications and sample numbers using the Hanford Environmental Information System (HEIS). The southeast corner of the FS-1 DWMU is considered the (0,0) point of the sampling location map in Appendix B.

The first node location was chosen at random by the VSP software, and the subsequent 19 sample locations were assigned by the VSP software using a triangular grid sampling layout. Supporting documentation and the sampling grid map automatically generated by the VSP software are documented in Attachment B. Grid sampling is further defined in the following paragraph.

Area Wide (Grid) Sampling. In grid sampling, samples are collected at regularly spaced intervals over space or time. An initial location or time is chosen at random, and the remaining sampling locations are defined so that locations are at regular intervals over an area (grid). Grid sampling is used to search for hot spots and infer means, percentiles, or other parameters. It is useful for estimating spatial patterns or trends over time. This design provides a practical method for designating sample locations and ensures uniform coverage of a site, unit, or process.

H-A3.9.6 Sampling Methods and Handling

Grab sample matrix will consist of gravel and soil collected in precleaned sample containers taken at a depth of 0 to 15.24 cm (0 to 6 in.) below ground surface. For the purpose of this SAP, ground surface is defined as the exposed surface layer once loose gravel has been moved aside. Over time, precipitation would have caused any potential contamination from waste storage to migrate down from the loose surface gravel into the surface soil and compacted gravel below. Subsurface sampling was evaluated; however, based on results of the records review, free liquid waste was not stored in the FS-1 DWMU, no releases of dangerous waste were identified, and subsurface sampling was not deemed necessary.

To gather the most representative sample, loose surface gravel will be moved aside to expose the surface soil and compacted gravel. Once the compacted gravel and soil are sampled, the sampled media will be screened to remove material larger than approximately 2 mm (0.08 in.) in diameter. Removal of material larger than approximately 2 mm (0.08 in.) in diameter will allow for a larger surface area to volume ratio and be more likely to identify any potential contamination in the sample. Grab samples will be collected into containers at the chosen node sample locations. To ensure sample and data usability, sampling will be performed in accordance with established sampling practices, procedures, and requirements pertaining to sample collection, collection equipment, and sample handling.

Sample container, preservation, and holding time requirements are specified in Table H-A-6 for gravel/soil samples. These requirements are in accordance with the analytical method specified. The final container type and volumes will be identified on the sampling authorization form and the chain-of-custody form.

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Table H-A-6. Sample Preservation, Container, and Holding Time for Soil Samples

Method	Analysis/Analytes	Preservation Requirement	Holding Time	Bottle Type	Minimum Sample Size
EPA 6010	Metals	Cool ~4°C	6 months	G/P	20 g
EPA 7196	Chromium (Hexavalent)	Cool ~4°C	24 hours	G/P	20 g
EPA 7471	Mercury by Cold Vapor Atomic Absorption	None	28 days	G/P	15 g
EPA 8082	Polychlorinated Biphenyl	None	1 year	Amber Glass	250 g
EPA 8260	Volatile Organic Analytes	Cool ~4°C	14 days	G	5 × 40 g
EPA 8270	Semivolatile Organic Compounds	Cool ~4°C	14/40 days	Amber Glass	250 g
EPA 300.0*	Anions	Cool ~4°C	48 hours/28 days	G/P	120 g
EPA 9012	Cyanide	None	14 days	G/P	120 g
EPA 9056A*	Anions	None	48 hours/28 days	G/P	250 g
EPA 9010/9012/ 9013/9014	Cyanide	None	14 days	G/P	15 g
EPA 200.8	Metals by Inductively Coupled Plasma-Mass Spectrometry	None	6 months	G/P	10 g

* Method 300.0 is for analysis of aqueous solutions, and method 9056A is for analysis of sample extractions from a solid (e.g., soils).

Note: For EPA Method 300.0, see EPA-600/4-79-020, *Methods for Chemical Analysis of Water and Wastes.* For four-digit EPA methods, see SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, Third Edition; Final Update IV-B.*

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

EPA = U.S. Environmental Protection Agency

G/P = glass/plastic

To prevent potential contamination of samples, care will be taken to use decontaminated equipment for each sampling activity.

Level I EPA precleaned sample containers will be used for samples collected for chemical analysis. Container sizes may vary depending on laboratory specific volumes/requirements for meeting analytical detection limits.

The sample location, depth, and corresponding HEIS numbers will be documented in the sampler's field logbook. A custody seal (e.g., evidence tape) will be affixed to each sample container and/or sample collection package in such a way as to indicate potential tampering.

Each sample container will be labeled with the following information on firmly affixed, water resistant labels:

- Sampling Authorization Form and form number
- HEIS number
- Sample collection date and time
- Sampler identification

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- Analysis required
- Preservation method (if applicable)

Sample records must include the following information:

- Analysis required
- Sample location
- Matrix (e.g., water or soil)

Sample custody will be maintained in accordance with existing Hanford Site protocols to ensure maintenance of sample integrity throughout the analytical process. Chain-of-custody protocols will be followed throughout sample collection, transfer, analysis, and disposal to ensure that sample integrity is maintained.

All waste (including unexpected waste) generated by sampling activities will be containerized, labeled, characterized, designated as a dangerous or nondangerous waste, stored, and transported offsite where it will be treated (if necessary) to meet LDRs in 40 CFR 268 incorporated into WAC 173-303-140(2)(a) by reference, then ultimately disposed of in an approved waste disposal facility.

H-A3.9.7 Analytical Methods

All analyses and testing will be performed consistent with this closure plan, laboratory analytical procedures, and HASQARD (DOE/RL-96-68). The approved laboratory must achieve the lowest practical quantitation limits (PQLs) consistent with the selected analytical method to confirm clean closure levels. If a target analyte is detected at or above the clean closure level but less than the PQL of the analytical method, Ecology will be notified and alternatives will be discussed to demonstrate clean closure levels.

Analytical methods and performance requirements associated with the target analytes are outlined in Table H-A-7.

H-A3.9.8 Quality Control

Quality control (QC) procedures must be followed in the field and laboratory to ensure that reliable data are obtained. Field QC samples will be collected to evaluate the potential for cross-contamination and provide information pertinent to field sampling variability. Field QC will include collection of the following samples:

- Full trip blank
- Field transfer blank
- Equipment rinsate blank
- Field duplicate
- Field split samples

Laboratory QC samples estimate the precision and bias of the analytical data. Field and laboratory QC samples are summarized in Table H-A-8.

A data quality assessment will be performed utilizing the guidance in EPA/240/B-06/084, *Data Quality Assessment: A Reviewer's Guide*, and implementing the specific requirements in Sections H-A3.9.8 through H-A3.9.10.

Data verification, data validation, and data quality assessment will include both the primary samples and quality control samples.

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Table H-A-7. Soil Analytical Performance Requirements

CAS Number	Analyte	Analytical Method	Closure Performance Standard[a,b] (mg/kg)		Practical Quantitation Limit[e] (mg/kg)	Accuracy Req't (% Recovery)[c]	Precision Req't (Relative Percent Difference)[c]
			Carcinogen	Noncarcinogen			
7440-39-3	Barium	SW-846 Method 6010	N/A	16,000	2.0	±30	≤30
7440-43-9	Cadmium	SW-846 Method 6010	N/A	80	0.5	±30	≤30
18540-29-9	Chromium (Hexavalent)	SW-846 Method 7196	N/A	240	1.0	±30	≤30
7439-92-1	Lead	SW-846 Method 6010	N/A	250(method A)	5.0	±30	≤30
7439-97-6	Mercury	SW-846 Method 7471 or 200.8	N/A	2(method A)	0.2	±30	≤30
7440-22-4	Silver	SW-846 Method 6010	N/A	400	1.0	±30	≤30
71-43-2	Benzene	SW-846 Method 8260	18.2	320	0.005	±30	≤30
56-23-5	Carbon Tetrachloride	SW-846 Method 8260	14.3	320	0.005	±30	≤30
108-39-4	*m*-cresol	SW-846 Method 8270	N/A	4,000	0.66	±30	≤30
95-48-7	*o*-cresol	SW-846 Method 8270	N/A	4,000	0.33	±30	≤30
106-44-5	*p*-cresol	SW-846 Method 8270	N/A	8,000	0.33	±30	≤30
78-93-3	Methyl Ethyl Ketone (2- Butanone)	SW-846 Method 8260	N/A	48,000	0.01	±30	≤30
98-95-3	Benzene, Nitro	SW-846 Method 8270	N/A	160	0.33	±30	≤30
87-86-5	Pentachlorophenol	SW-846 Method 8260	2.5	400	0.33	±30	≤30
110-86-1	Pyridine	SW-846 Method 8260	N/A	80	0.005	±30	≤30
79-01-6	Trichloroethylene	SW-846 Method 8260	12	40	0.005	±30	≤30
71-55-6	1,1,1-Trichloroethane	SW-846 Method 8260	N/A	160,000	0.005	±30	≤30

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Table H-A-7. Soil Analytical Performance Requirements

CAS Number	Analyte	Analytical Method	Closure Performance Standard[a,b] (mg/kg)		Practical Quantitation Limit[e] (mg/kg)	Accuracy Req't (% Recovery)[c]	Precision Req't (Relative Percent Difference)[c]
			Carcinogen	Noncarcinogen			
76-13-1	Chlorinated fluorocarbons (1,1,2-Trichloro-1,2,2-trifluoroethane)	SW-846 Method 8260	N/A	2,400,000	0.01	±30	≤30
75-09-2	Methylene Chloride	SW-846 Method 8260	500	480	0.005	±30	≤30
127-18-4	Tetrachloroethylene	SW-846 Method 8260	476	480	0.005	±30	≤30
108-90-7	Chlorobenzene	SW-846 Method 8260	N/A	1,600	0.005	±30	≤30
95-50-1	Ortho-dichlorobenzene	SW-846 Method 8270	N/A	7,200	0.33	±30	≤30
79-00-5	1,1,2-trichloroethane	SW-846 Method 8260	17.5	320	0.005	±30	≤30
67-64-1	Acetone	SW-846 Method 8260	N/A	72,000	0.02	±30	≤30
71-36-3	N-butyl alcohol (I-Butanol)	SW-846 Method 8260	N/A	8,000	0.1	±30	≤30
108-94-1	Cyclohexanone	SW-846 Method 8270	N/A	400,000	200	±30	≤30
141-78-6	Ethyl Acetate	SW-846 Method 8015	N/A	72,000	5.0	±30	≤30
100-41-4	Ethyl Benzene	SW-846 Method 8260	N/A	8,000	0.005	±30	≤30
60-29-7	Ethyl Ether	SW-846 Method 8260	N/A	16,000	0.005	±30	≤30
67-56-1	Methanol	SW-846 Method 8260	N/A	160,000	1.0	±30	≤30
108-10-1	Methyl Isobutyl Ketone (4-Methyl-2-Pentanone)	SW-846 Method 8260	N/A	6,400	0.01	±30	≤30
108-38-3	*m*-Xylene	SW-846 Method 8260	N/A	16,000	0.005	±30	≤30
95-47-6	*o*-Xylene	SW-846 Method 8260	N/A	16,000	0.005	±30	≤30
106-42-3	*p*-Xylene	SW-846 Method 8260	N/A	16,000	0.005	±30	≤30
79-46-9	2-Nitropropane	SW-846 Method 8260	0.105	N/A	1	±30	≤30
75-15-0	Carbon Disulfide	SW-846 Method 8260	N/A	8,000	0.005	±30	≤30
78-83-1	Isobutanol	SW-846 Method 8260	N/A	24,000	0.5	±30	≤30
110-80-5	2-Ethoxyethanol	SW-846 Method 8270	N/A	7,200	200	±30	≤30
108-88-3	Toluene	SW-846 Method 8260	N/A	6,400	0.005	±30	≤30

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Table H-A-7. Soil Analytical Performance Requirements

CAS Number	Analyte	Analytical Method	Closure Performance Standard[a,b] (mg/kg)		Practical Quantitation Limit[e] (mg/kg)	Accuracy Req't (% Recovery)[c]	Precision Req't (Relative Percent Difference)[c]
			Carcinogen	Noncarcinogen			
123-91-1	1,4-Diethyleneoxide (1,4-Dioxane)	SW-846 Method 8260	10	2,400	0.5	±30	≤30
64-18-6	Formic Acid (U123)	Modified 9056A or Modified 300.0	N/A	72,000	NA	±20	≤35
302-01-2	Hydrazine (U133)[d]	SW-846 Method 8260	0.333	N/A	NA	±30	≤30
80-62-6	Methyl Methacrylate (I,T) (U162)	SW-846 Method 8260	N/A	112,000	0.010	±30	≤30
57-12-5	Cyanide	SW-846 Method 9010/9012/9013/ 9014	N/A	48	0.5	±30	≤30
7440-62-2	Vanadium	SW-846 Method 6010/200.8	N/A	720	NA	±30	≤30
1336-36-3	Polychlorinated Biphenyl	SW-846 Method 8082	0.5	1.6	0.16	±30	≤30

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

a. Closure performance standards are the numeric cleanup levels calculated using unrestricted use exposure assumptions according to WAC 173-340, "Model Toxics Control Act—Cleanup," regulations (WAC 173-340-740, "Unrestricted Land Use Soil Cleanup Standards." These numeric cleanup levels will be calculated according to WAC 173-340 Method B (unrestricted use standards) and Method A where noted. Where both carcinogen and a noncarcinogen performance standards are available, the lowest value will be used.

b. The quantity of waste that was managed in this area was too small to represent a threat to groundwater, and therefore no groundwater cleanup standards were addressed.

c. Accuracy criteria for associated batch matrix spike percent recoveries. Evaluation based on statistical control of laboratory control samples is also performed. Precision criteria for batch laboratory replicate matrix spike analyses or replicate sample analyses.

d. Due to the reactive and volatile nature of hydrazine, quantitation is difficult and its presence in soil samples from waste stored in 2008 is unlikely; therefore, samples will not be analyzed for hydrazine.

e. For these analytical performance requirements, the required detection limit and practical quantitation limit are identical.

N/A = not applicable
NA = not available

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Table H-A-8. Project Quality Control Sampling Summary

Quality Control Sample Type	Frequency	Characteristics Evaluated
Field Quality Control		
Full Trip Blanks	One per 20 samples per media sampled.	Contamination from containers or transportation
Equipment Rinsate Blanks	As needed. If only disposable equipment is used, then an equipment blank is not required. Otherwise, one per 20 samples per media[a].	Adequacy of sampling equipment decontamination and contamination from nondedicated equipment
Field Duplicates	One per batch[h], 20 samples maximum of each media sampled (soil samples[b]).	Precision, including sampling and analytical variability
Field Split Samples	As needed. When needed, the minimum is one per analytical method, per media sampled, for analyses performed where detection limit and precision and accuracy criteria have been defined in the Performance Requirements tables.	Precision, including sampling, analytical, and interlaboratory
Laboratory Quality Control[h]		
Method Blanks	1 per batch[h]	Laboratory contamination
Lab Duplicates	[c]	Laboratory reproducibility and precision
Matrix Spikes	[c]	Matrix effect/laboratory accuracy
Matrix Spike Duplicates	[c]	Laboratory reproducibility, accuracy, and precision
Surrogates	[c]	Recovery/yield
Tracers	[c]	Recovery/yield
Laboratory Control Samples	1 per batch[h]	Evaluate laboratory accuracy
Performance Evaluation Programs[d]	Annual	Evaluate laboratory accuracy
Double-Blind Standards	Quarterly[e]	Evaluate laboratory accuracy
Audit/Assessment	Annually[f] or every 3 years[g]	Evaluate overall laboratory performance and operations

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Table H-A-8. Project Quality Control Sampling Summary

Quality Control Sample Type	Frequency	Characteristics Evaluated

a. Whenever a new type of nondedicated equipment is used, an equipment blank shall be collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination procedure for the non-dedicated equipment.

b. Soil grab samples are exempted from duplicate sampling.

c. As defined in the laboratory contract or quality assurance plan and/or analysis procedures.

d. Nationally recognized program, such as DOE Mixed Analyte Performance Evaluation Program or Environmental Resource Associates.

e. Soil matrix double-blind standards are submitted by request of Analytical Services.

f. DOE Quality Systems for Analytical Services requires annual audit of commercial laboratories.

g. DOE/RL-96-68, *Hanford Analytical Services Quality Assurance Requirements Document* (HASQARD), does not define a frequency for assessment of onsite laboratories. Three year evaluated supplier list requirement is typically applied.

h. Batching across projects is allowing for similar matrices.

DOE = U.S. Department of Energy

H-A3.9.9 Data Verification

Analytical results will be received from the laboratory, loaded into a database (e.g., HEIS), and verified. Verification activities include, but are not limited to, the following:

- Amount of data requested matches the amount of data received (number of samples for requested methods of analytes)
- Procedures/methods are used.
- Documentation/deliverables are complete.
- Hard copy and electronic versions of the data are identical.
- Data seem reasonable based on analytical methodologies.

H-A3.9.10 Data Validation

Data validation is performed by a third party. The laboratory supplies contract laboratory program equivalent analytical data packages intended to support data validation by the third party. The laboratory submits data packages that are supported by QC test results and raw data.

Controls are in place to preserve the data sent to the validators and allow only additions to be made, not changes to the raw data.

The format and requirements for data validation activities are based upon the most current version of USEPA-540-R-08-01, *National Functional Guidelines for Superfund Organic Methods Data Review* (OSWER 9240.1-48), and USEPA-540-R-10-011, *National Functional Guidelines for Inorganic Superfund Data Review* (OSWER 9240.1-51). As defined by the validation guidelines, 5 percent of the results will undergo Level C validation.

H-A3.9.11 Verification of VSP Input Parameters

Analytical data will be entered back into the VSP software. If all analytical data for a particular analyte are nondetect, verification of VSP input parameters is not required for that analyte. The VSP software uses the analytical data to determine if the user input parameters were estimated appropriately.
Once analytical data are entered into the VSP software, VSP will calculate the true standard deviation and if the null hypothesis can be rejected. If the calculated standard deviation is smaller than the estimated user input standard deviation, no additional sampling will be required. If the calculated standard deviation

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is larger than the estimated standard deviation, additional sampling may be required. Verification of the null hypothesis through VSP will determine if the mean value of the site analytical data supports rejection of the null hypothesis (Section H-A2.1).

H-A3.9.12 Documents and Records

The Project Manager is responsible for ensuring that the current version of the SAP is being used and providing any updates to field personnel. Version control is maintained by the administrative document control process. Changes to the SAP affecting the data needs will be submitted as a permit modification in accordance with WAC 173-303-610(3)(b) to DOE and the lead regulatory agency.

Logbooks are required for field activities. A logbook must be identified with a unique project name and number. The individual(s) responsible for logbooks will be identified in the front of the logbook, and 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 data with a single line, entering the correct data, and initialing and dating the changes.

The project manager is responsible for ensuring that a project file is properly maintained. The project file will contain the records or references to their storage locations. The following items will be included in the project file, as appropriate:

- Field logbooks or operational records
- Data forms
- Global positioning system data
- Chain-of-custody forms
- Sample receipt records
- Inspection or assessment reports and corrective action reports
- Interim progress reports
- Final reports
- Laboratory data packages
- Verification and validation reports

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

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

Records may be stored in either electronic or hard copy format. Documentation and records, regardless of medium or format, are controlled in accordance with internal work requirements and processes to ensure the accuracy and retrievability of stored records. Records required by the Tri-Party Agreement (Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*) will be managed in accordance with the requirements therein.

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H-A3.9.13 Sampling and Analysis Requirements to Address Removal of Contaminated Gravel/soil

In the event that sample results based on the MTCA Method B (WAC 173-340) three part test (Section H-A3.9.5) indicate contamination above clean closure levels, the contaminated gravel/soil will be removed in accordance with Section H-A3.7. Following removal of contaminated gravel/soil, additional samples will be taken at the same grid location as identified in Attachment B. Additional focused sampling may be added in areas where contamination is identified. Additional focused samples will be documented, as required in Section H-A3.9.12, and provided with the closure certification upon request by Ecology. These samples will be analyzed in accordance with the methods specified in Table H-A-7, with accompanying QC samples as discussed in Section H-A3.9.8.

H-A3.9.14 Revisions to the Sampling and Analysis Plan and Constituents to Be Analyzed

If changes to the SAP are necessary due to unexpected events during closure that will affect sampling, a revision to this SAP will be submitted no later than 30 days after the unexpected event as a permit modification as required in WAC 173-303-610(3)(b)(iii) and WAC 173-303-830, "Permit Changes."

H-A3.10 Role of the Independent Qualified Registered Professional Engineer

An independent, qualified, registered professional engineer (IQRPE) will be retained to provide certification of the closure, as required by WAC 173-303-610(6). The IQRPE will be responsible for observing field activities and reviewing documents associated with closure of FS-1. At a minimum, the following field activities would be completed:

- Review LLBG FS-1 visual inspection.
- Review sampling procedures and results.
- Observe and/or review sampling activities.
- Observe and/or review contaminated environmental debris removal (as applicable).
- Verify that locations of samples are as specified in the SAP.

The IQRPE will record his or her observations and reviews in a written report that will be retained in the operating record. The resulting report will be used to develop the clean closure certification, which will then be provided to Ecology.

H-A3.11 Closure Certification

In accordance with WAC 173-303-610(6), within 60 days of completion of closure of FS-1, a certification that the DWMU has been closed in accordance with the specifications in this closure plan will be submitted to Ecology by registered mail. The certification will be signed by the owner or operator and by an IQRPE.

Upon request by Ecology, the following information will be submitted to support the closure certification:

- All field notes and photographs related to closure activities
- A description of any minor deviations from the approved closure plan and justification for these deviations
- Documentation of the removal and final disposition of any unanticipated contaminated environmental media
- All laboratory and/or field data, including sampling procedures, sampling locations, QA/QC samples, and chain-of-custody procedures for all samples and measurements, including samples and measurements taken to determine background conditions and/or determine or confirm clean closure

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- A summary report that identifies and describes the data reviewed by the IQRPE and tabulates the analytical results of samples taken to determine and confirm clean closure
- A description of the DWMU area appearance at completion of closure, including what parts of the former unit, if any, will remain after closure

H-A3.12 Conditions That Will Be Achieved When Closure Is Complete

Upon confirmation of clean closure levels through sampling and analysis, FS-1 will remain in an "as-is" state with the gravel remaining in place. The area surrounding FS-1 is an industrial setting and will continue to be used due to active RCRA-compliant landfill operations in the immediate vicinity; therefore, no removal of gravel is necessary, and the land will not be restored to its pre-operational appearance. The storage area marking will be removed once the closure activities are completed. A permit modification request will be submitted after clean closure has been confirmed to remove FS-1 from the sitewide permit active DWMUs.

H-A4 CLOSURE SCHEDULE AND TIME FRAME

Confirmation sampling and analysis activities will be completed no more than 180 days after approval of the permit modification incorporating this closure plan. Should unexpected circumstances arise and an extension to the 180-day closure activity expiration date be deemed necessary, a Class 1 permit modification request will be submitted to Ecology for approval at least 30 days prior to the 180-day expiration date in accordance with WAC 173-303-610(4)(c) and WAC 173-303-830, Appendix I. The extension request would also demonstrate that all steps to prevent threats to human health and the environment, including compliance with all applicable permit requirements and criteria in WAC 173-303-610(4)(b)(i) or (ii), have been and will be taken. Closure certification will be submitted to Ecology within 60 days following completion of closure activities at FS-1 as outlined in Section H-A3.11 (Table H-A-9 and Figure H-A-3).

H-A5 CLOSURE COSTS

A detailed written estimate outlining updated projections of anticipated closure costs for the Hanford Facility treatment, storage, and disposal units is not required per Permit Condition II.H.

DRAFT

Table H-A-9. FS-1 Closure Activity Description

Primary Activity	Secondary Activity	Expected Duration
Verify sampling of gravel and soil for clean closure levels	Not applicable	180 days
CLOSURE ACTIVITIES COMPLETE		
Transmit closure certification to Washington State Department of Ecology	Not applicable	60 days

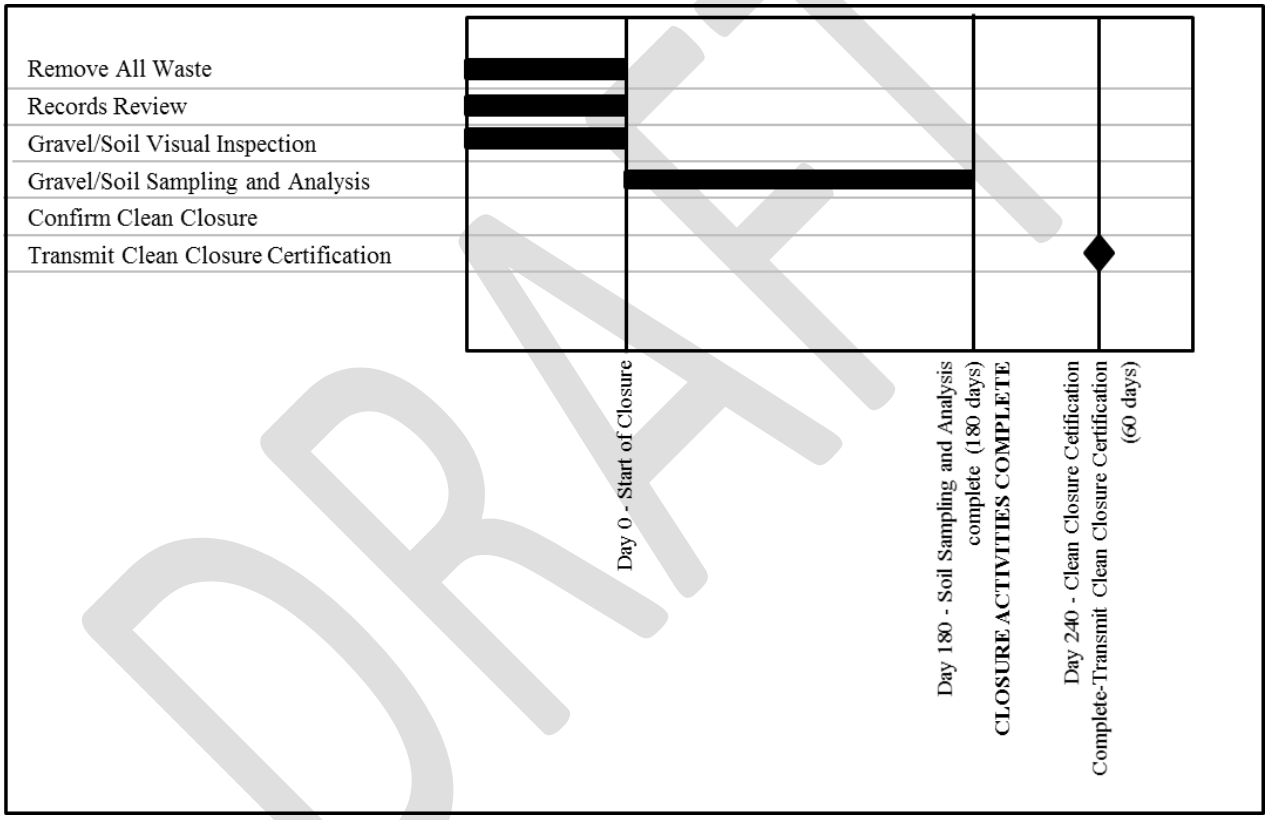

Figure H-A-3. FS-1 Outdoor Container Storage Area Closure Schedule Activities

DRAFT

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ATTACHMENT H-A.a
RECORDS REVIEW AND VISUAL INSPECTION SUPPORTING DOCUMENTATION

DRAFT

LLBG 218-W-5, FS1 Outdoor Container Storage Area

Purpose:

A visual inspection walkdown of the 218-W-5 FS1 outdoor container storage area was performed to determine if there is any evidence of spills and/or leaks from waste packages containing dangerous that were stored at this location during the period of November 2007 through September 2008. The inspection was to identify and document by photographing any waste related staining of the storage area surface (i.e., gravel and soil), and to denote any remaining waste related items.

The inspection was performed on July 31, 2013 by Dean Nester, Waste Disposition Project Manager (CHPRC), and Lana Strickling, Low-Level Burial Grounds Environmental Compliance Officer (CHPRC).

Results:

No staining of any kind was identified on the storage area surface. Only a few small pieces of debris material were observed and photographed:

- Unused drum wicks – approximately 6
- Dried caulking material – approximately 4-6 small pieces
- Piece of wood - ~ 10" x 1"

Housekeeping will be performed on the area prior to closure and the debris material will be removed.

Signature/Date:

Dean Nester: 7/31/2013

Lana Strickling: Lana Strickling 7/31/13

FS-1 Daily Operating Log Book Review

Date of Log Book Review: 7/31/13

Reviewer's Name: Lana Strickling

Daily Operating Log Book Document No: HNF-N-450 85 (Solid Waste Storage & Disposal/Waste Retrieval Project Daily Operating Log Book)

Log Book Timeframe
(Month/Year to Month/Year): 7/10/07 – 2/6/08

Items of Concern Noted (Circle) YES☐ NO☑
If "YES", complete entire checklist.
If "NO", skip to Reviewer's signature and date.

Items of Concern:
Attach copies of log book pages noting concern.

Log Book Page# Referencing Spill:

Dates of Corrective Actions:
Attach copies of log book pages noting corrective actions.

Log Book Page#
Referencing Corrective Action:

Reviewer's Signature and Date: Lana Strickling 7/31/13

Instructions:

Review Daily Operating Log for any references to unplanned spills, releases or discharges associated with dangerous waste containers. Anomalies that would not affect closure of the unit such as missing labels, open containers, or dented containers, do not need to be documented.

If items of concern are noted, check "YES" and complete the entire checklist. If no items of concern are noted, check "NO" and skip to the signature and date field. Note that if no items of concern are noted for the entire year, the "Log Book Time Frame" can be January 1, 20xx to December 31, 20xx.

If unplanned spills, releases or discharges are referenced in the Daily Operating Log, document the item of concern as "spill", "stain", "ruptured container", etc. Also note the date of the corrective action.

Attach copies of the Daily Operating Log page(s) noting the items of concern and corrective actions.

Complete all review fields as applicable.

Sign and date form and deliver to Stephanie Johansen.

FS-1 Daily Operating Log Book Review

Date of Log Book Review: 8/12/13

Reviewer's Name: Joel Williams

Daily Operating Log Book Document No: HNF-N-450-91; HNF-N-450-94

Log Book Timeframe
(Month/Year to Month/Year): 02/07/08 – 8/26/08; 08/27/08 – 04/16/09

Items of Concern Noted (Circle) YES☐ NO☑

If "YES", complete entire checklist.
If "NO", skip to Reviewer's signature and date.

Items of Concern:
Attach copies of log book pages noting concern.

Log Book Page# Referencing Spill:

Dates of Corrective Actions:
Attach copies of log book pages noting corrective actions.

Log Book Page#
Referencing Corrective Action:

Reviewer's Signature and Date: Joel Williams 8-20-2013

Instructions:

Review Daily Operating Log for any references to unplanned spills, releases or discharges associated with dangerous waste containers. Anomalies that would not affect closure of the unit such as missing labels, open containers, or dented containers, do not need to be documented.

If items of concern are noted, check "YES" and complete the entire checklist. If no items of concern are noted, check "NO" and skip to the signature and date field. Note that if no items of concern are noted for the entire year, the "Log Book Time Frame" can be January 1, 20xx to December 31, 20xx.

If unplanned spills, releases or discharges are referenced in the Daily Operating Log, document the item of concern as "spill", "stain", "ruptured container", etc. Also note the date of the corrective action.

Attach copies of the Daily Operating Log page(s) noting the items of concern and corrective actions.

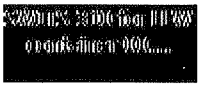
Complete all review fields as applicable.

Sign and date form and deliver to Stephanie Johansen.

Strickling, Lana R

From: Tuott, Lee C
Sent: Thursday, August 01, 2013 8:02 AM
To: Horn, Sarah R; Williams, Joel F Jr; Seaver, Jennie R
Cc: Nester, Dean E; Strickling, Lana R; Dixon, Brian J; Johansen, Stephanie K; Engelmann, Richard H; Cawrse, Allan E; Ruck, Fred A III; Toebe, Wayne E; Swenson, Raymond T; Tarter, Kimberly D; Martin, Paul W - CHPRC
Subject: RE: COMPLETED REVIEW OF TRENCH 34/FS-1 RECORDS

To facilitate "closeout" for this container from a RCRA perspective (and to support future closure evaluation at Trench 31/31), I've attached the SWITS 310 report that identifies the container is a LLW (and not a dangerous waste).



Lee Tuott
WRAP & IDF Environmental Compliance Officer, CHPRC
509.376.1045 (office); 509.713.0065 (cell)
email: lee_c_tuott@rl.gov

From: Horn, Sarah R
Sent: Thursday, August 01, 2013 7:51 AM
To: Williams, Joel F Jr; Seaver, Jennie R
Cc: Nester, Dean E; Strickling, Lana R; Dixon, Brian J; Johansen, Stephanie K; Engelmann, Richard H; Cawrse, Allan E; Ruck, Fred A III; Toebe, Wayne E; Swenson, Raymond T; Tuott, Lee C; Tarter, Kimberly D; Martin, Paul W - CHPRC
Subject: RE: COMPLETED REVIEW OF TRENCH 34/FS-1 RECORDS

Jennie,
I confirmed the container number on the weekly inspection that Joel provided does not match any of the dangerous waste containers so we should be just fine.

Joel,
Thanks for getting those done so quickly!

Sarah

From: Williams, Joel F Jr
Sent: Thursday, August 01, 2013 7:39 AM
To: Seaver, Jennie R
Cc: Horn, Sarah R; Nester, Dean E; Strickling, Lana R; Dixon, Brian J; Johansen, Stephanie K; Engelmann, Richard H; Cawrse, Allan E; Ruck, Fred A III; Toebe, Wayne E; Swenson, Raymond T; Tuott, Lee C; Tarter, Kimberly D; Martin, Paul W - CHPRC
Subject: COMPLETED REVIEW OF TRENCH 34/FS-1 RECORDS

Jennie

Attached is a pdf copy of my completed and signed off review of LLBG Trench 34/FS-1 weekly inspection records from January 1, 2007 through September 23, 2008. This was the time period provided to me to review.

<< File: JFW Signed Review Records for TR 34 FS-1 7-31-2013.pdf >>
I just have one comment...I found a record during this time period (4-2-2008) that mentions that a container was found to have a pin hole. The record does not mention any leakage and does state that the container was repackaged. I have attached the record and email on this container. I realize that this does not meet the criteria of a leak for closure but I want to send this to you just in case.

<< File: LLBG Wky Insp Sheet 4-2-2008 and Email 7-31-2013.pdf >>
If you have any questions, please call me on 376-4782 or 528-7641.

Thanks for your time and patience.

Joel F. Williams Jr.
CHPRC Regulatory Inspection Lead
Environmental Protection
CH2M Hill PRC

LLBG Trench 34/FS-1 Weekly Dangerous Waste Inspection Checklist Review

Title of Weekly Waste Inspection Form:	SW-040-041 Inspect Low-Level Burial Grounds, Checklist 2 - LLBG Weekly RCRA Inspections for Trenches 31 and 34 in 218-W-5 (Trench 34)
Date of Review:	July 31, 2013
Reviewer's Name:	Joel F. Williams Jr.
Waste Management Unit:	Trench 34/FS-1
Time Frame of Weekly Inspections:	January 1, 2007 through September 23, 2008
Items of Concern Noted (Circle) If "YES", complete entire checklist. If "NO", skip to Reviewer's signature and date.	YES☐ NO☒
Items of Concerns: Attach copies of log book pages noting concern.	
Dates of Corrective Actions: Attach copies of log book pages noting concern.	
Reviewer's Signature and Date:	Joel F Williams 7-31-2013

Instructions:

Review Weekly Waste Inspection checklists for any references to unplanned spills, releases or discharges associated with dangerous waste containers. Anomalies that would not affect closure of the unit such as missing labels, open containers, or dented containers, do not need to be documented.

If items of concern are noted, check "YES" and complete the entire checklist. If no items of concern are noted, check "NO" and skip to the signature and date field. Note that if no items of concern are noted for an extended period of time, the "Time Frame of Weekly Inspections" can be January 1, 20xx to December 31, 20xx or even several years if no items of concern are noted.

If unplanned spills, releases or discharges are referenced on the inspection checklist, document the item of concern as "spill", "stain", "ruptured container", etc. Also note the date of the corrective action.

Attach copies of weekly waste inspection checklists noting the items of concern and corrective actions.

Complete all review fields as applicable.

 JRS 8/5/13

SW-040-041	Inspect Low-Level Burial Grounds	H-0

Checklist 2 - LLBG Weekly RCRA Inspection for Trenches 31 & 34 in 218-W-5

Burial Ground (circle one): 218-W-5 **Trench 31** **Trench 34** 1300 **Time/Date:** 4/2/08

#	Yes	No	N/A	Container Inspection Items
1		✓		Container integrity is not compromised by punctures, dents, penetrating scratches, loose lids, bulging, excessive corrosion or other damage/deterioration (where possible to inspect). **[TSR 5.6.12.e]**
2	✓			Containers are closed , are stored in a manner which will not rupture the containers or cause them to leak , and show no evidence of spillage or leakage, such as moisture on the sides or underneath (where possible to inspect). **[TSR 1.2]**
3	✓			Container marking/labeling is intact, unobscured, legible, and in good condition (where possible to inspect).
4	✓			Areas between and within 33 ft of waste zones are free of transient combustibles such as, paper, rags, trash, scrap wood, etc. **[TSR 5.6.7.b&c]**
5	✓			Aisle space between rows of containers appears to be at least 30 inches.
6	✓			Wind blown vegetation has been removed.
7	✓			Fire break defensible space (within 30 ft of waste containers) is clear of all ground fuels, dead rooted vegetation, and combustible materials. [TSR 5.6.7, Fire Breaks]
8	✓			Fire break defensible space (within 30 ft of waste containers) is clear of live vegetation. **[TSR 5.6.7, Fire Breaks]**
9	✓			Are trench walls and floor intact (not deteriorated, damaged or eroded)?
10	✓			Is asphalt pad intact (not deteriorated, damaged or eroded)?
11	✓			Is trench entrance ramp intact (not deteriorated, damaged or eroded)?
12	✓			Clean interim soil covers bulk waste. ***If answer is NO, Notify team lead.*** For Trench 34 Only
13	✓			Interim soil cover not eroded by wind or water. ***If answer is NO, Notify team lead.*** For Trench 34 Only
14	✓			Subsidence areas or sinkholes in interim soil cover are not observed. ***If answer is NO, Notify team lead.*** For Trench 34 Only

Comments/Observations: ① Found possible puncture on Drum # ~~[illegible]~~ 0001248, SW30-02-308-01. Notify Teamhead and SBTA, put Tape over the pinhole. Drum entered into ACMP. Close out #07-058, weed spray is no longer needed. PJS 4/3/08
See open Item # 07-058, 07-055.
Add as new open item to LLBG RCRA open item list PJS 4/3/08

Operator (print/sign): [signature] B.S. Valerio 4/2/08 **Date/time:** 1520

Team Lead (print/sign): [signature] Brad L. Slettene **Date:** 4/3/08

Williams, Joel F Jr

From: Tarter, Kimberly D
Sent: Wednesday, July 31, 2013 9:05 AM
To: Williams, Joel F Jr
Subject: FW: 08-026

FYI

From: Matarazzo, Laci D
Sent: Wednesday, July 31, 2013 9:05 AM
To: Tarter, Kimberly D
Subject: RE: 08-026

Open Item List

Log #	R/N	C/L/S	Bldg/Item #	Tr #	Initiator	Item #	Inspected	Description/Status	Complete	Closed	Corr Action	H&SI Area
08-026	R	L	218-W-5, T34		BS Valerio		4/3/2008	Found possible puncture on Drum #0001248, SWSD-02-308-01.	X	5/22/2008	Possible puncture on Drum #0001248, SWSD-02-308-01. Notify Team Lead and SBTA, put tape over the pinhole. Drum entered into ACMP. (BS) 04/02/2008. Drum was overpacked and put into ACMP. (BS) 05/22/2008.	

Laci

From: Tarter, Kimberly D
Sent: Wednesday, July 31, 2013 9:01 AM
To: Matarazzo, Laci D
Subject: 08-026
Importance: High

Hi Laci,
The only one I don't have is 08-026. Can you please look for this one?

Thanks,

U310 Container Detail - Package ID: 0001248

Basic Info | TSD Info | TSD Mgmt | Detail | Components | LDR | Billing | Shipping Info

Package ID 0001248

Secondary ID SWSD-02-308-01

Contents Repackaged

Control by TSDO

Regulations

Dangerous? N

CERCLA? N

RAD? LLW

TSCA? N

Loc Facility REPACKAGED

Unit

Inner Package

Accumulation Dt 10/27/2004

Due Date

Full Date

Group ID SWSD

POC ID 0066673 GARY COX

Labpacked? N

Waste Description

LLW CONSISTING OF SOIL, PAPER, PLASTIC, ETC.

Container

Type / Size / UOM DM 55 GALLON

Volume (m3) .2082

DOT Spec 1A2

Source Company FH

Source Facility SWO

Profile Number SWPO-100-0013

Rev 0

Treatability Group

Gross Wgt (kg) 51.7000

Tare Wgt (kg) 21.3000

Packaging Wgt (kg) .4000

Waste Wgt (kg) 30.0000

Comments

LOW LEVEL WASTE. SOIL,PAPER,PLASTIC, ECT..

R101 - Waste Generation Edits | U201 - Batch Shipment | U330 - Request TSD Approval

ATTACHMENT H-A.b
VISUAL SAMPLING PLAN SUPPORTING DOCUMENTATION

DRAFT

Systematic sampling locations for comparing a median with a fixed threshold (nonparametric - MARSSIM)

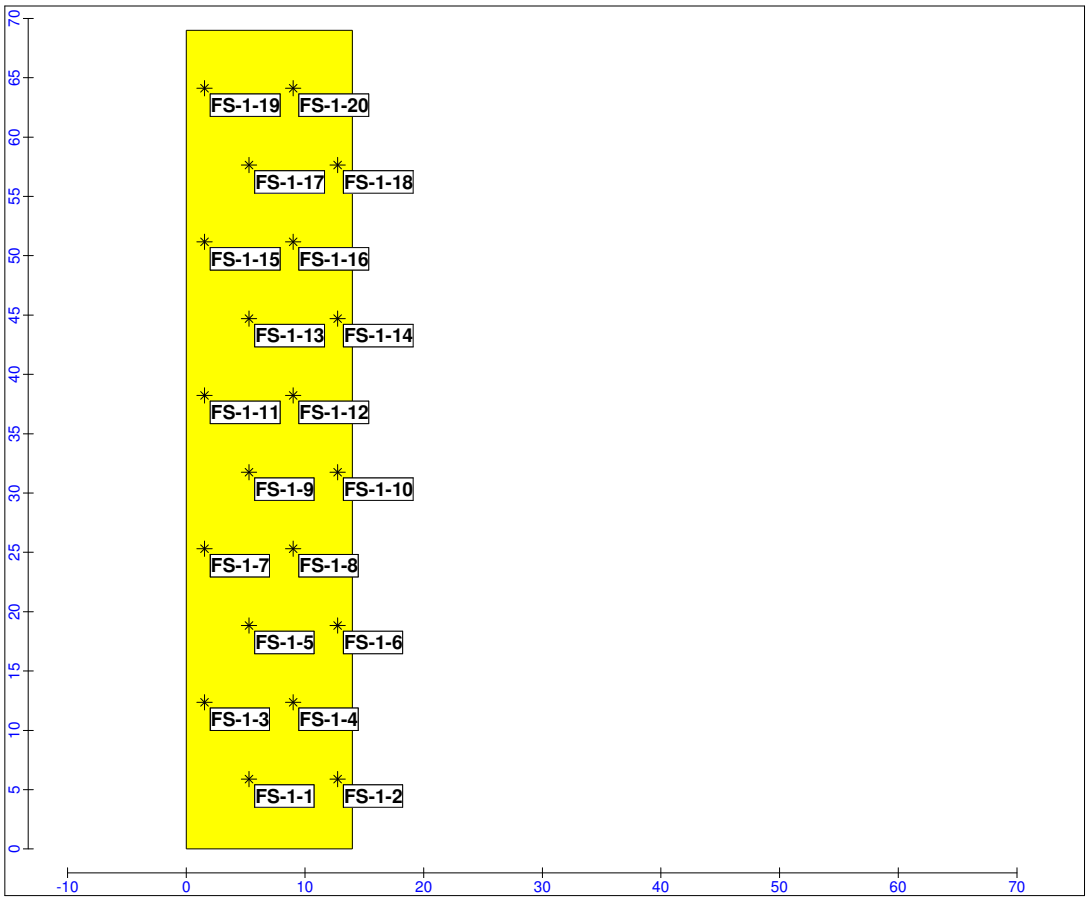
Summary

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) in the Field	Systematic with a random start location
Working (Null) Hypothesis	The median(mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test - MARSSIM version
Calculated total number of samples	20
Number of samples on map [a]	20
Number of selected sample areas [b]	1
Specified sampling area [c]	966.00 m^2
Size of grid / Area of grid cell [d]	7.46807 meters / 48.3 m^2
Grid pattern	Triangular
Total cost of sampling [e]	$0.00

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.
[d] Size of grid / Area of grid cell gives the linear and square dimensions of the grid used to systematically place samples.
[e] Including measurement analyses and fixed overhead costs. See the Cost of Sampling section for an explanation of the costs presented here.



Area: FS-1 Outdoor Container Storage Area					
X Coord	**Y Coord**	**Label**	**Value**	**Type**	**Historical**
5.2719	5.8939	FS-1-1		Systematic	
12.7399	5.8939	FS-1-2		Systematic	
1.5378	12.3615	FS-1-3		Systematic	
9.0059	12.3615	FS-1-4		Systematic	
5.2719	18.8290	FS-1-5		Systematic	
12.7399	18.8290	FS-1-6		Systematic	
1.5378	25.2965	FS-1-7		Systematic	
9.0059	25.2965	FS-1-8		Systematic	
5.2719	31.7641	FS-1-9		Systematic	
12.7399	31.7641	FS-1-10		Systematic	
1.5378	38.2316	FS-1-11		Systematic	
9.0059	38.2316	FS-1-12		Systematic	
5.2719	44.6992	FS-1-13		Systematic	
12.7399	44.6992	FS-1-14		Systematic	
1.5378	51.1667	FS-1-15		Systematic	
9.0059	51.1667	FS-1-16		Systematic	
5.2719	57.6342	FS-1-17		Systematic	

12.7399	57.6342	FS-1-18		Systematic	
1.5378	64.1018	FS-1-19		Systematic	
9.0059	64.1018	FS-1-20		Systematic	

Primary Sampling Objective
The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach
A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

Locating the sample points over a systematic grid with a random start ensures spatial coverage of the site. Statistical analyses of systematically collected data are valid if a random start to the grid is used. One disadvantage of systematically collected samples is that spatial variability or patterns may not be discovered if the grid spacing is large relative to the spatial patterns.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Sign test (see PNNL 13450 for discussion). For this site, the null hypothesis is rejected in favor of the alternative one if the median(mean) is sufficiently smaller than the threshold. The number of samples to collect is calculated so that if the inputs to the equation are true, the calculated number of samples will cause the null hypothesis to be rejected.

The formula used to calculate the number of samples is:

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(SignP - 0.5)^2}$$

where

$$SignP = \Phi\left(\frac{\Delta}{s_{total}}\right)$$

$\Phi(z)$ is the cumulative standard normal distribution on $(-\infty,z)$ (see PNNL-13450 for details),
n is the number of samples,
S_{total} is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold,
β is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n. VSP allows a user-supplied percent overage as discussed in MARSSIM (EPA 2000, p. 5-33).

The values of these inputs that result in the calculated number of sampling locations are:

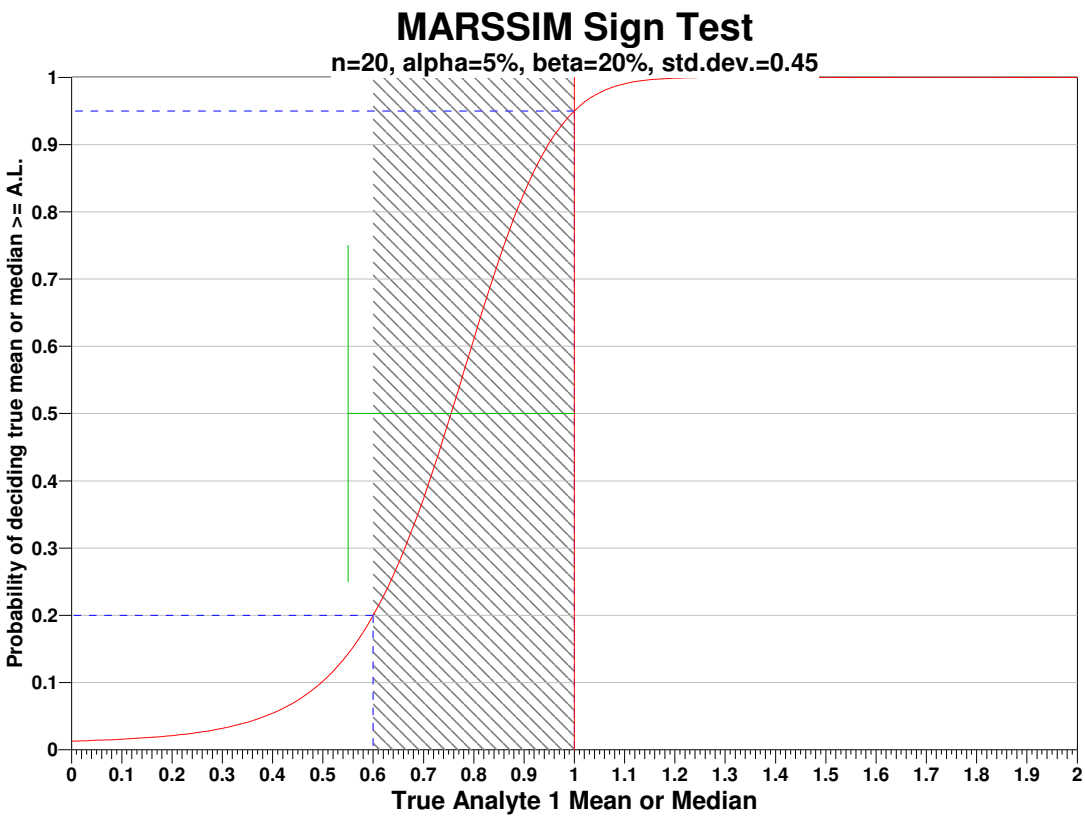
Analyte	n[a]	Parameter

	S	Δ	α	β	$Z_{1-\alpha}$ [b]	$Z_{1-\beta}$ [c]	
Analyte 1	20	0.45	0.4	0.05	0.2	1.64485	0.841621

[a] The final number of samples has been increased by the MARSSIM Overage of 20%.
[b] This value is automatically calculated by VSP based upon the user defined value of α.
[c] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at 1-α on the vertical axis; the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions
The assumptions associated with the formulas for computing the number of samples are:
1. the computed sign test statistic is normally distributed,
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis
The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability

of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples							
AL=1		α=5		α=10		α=15	
		s=0.9	s=0.45	s=0.9	s=0.45	s=0.9	s=0.45
LBGR=90	β=15	1103	280	825	209	659	167
	β=20	948	240	692	176	542	138
	β=25	826	209	587	149	449	114
LBGR=80	β=15	280	75	209	56	167	45
	β=20	240	64	176	47	138	36
	β=25	209	56	149	40	114	30
LBGR=70	β=15	128	36	95	27	77	22
	β=20	110	32	81	23	63	18
	β=25	95	27	69	20	52	15

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Cost of Sampling
The total cost of the completed sampling program depends on several cost inputs, some of which are fixed, and others that are based on the number of samples collected and measured. Based on the numbers of samples determined above, the estimated total cost of sampling and analysis at this site is $0.00, which averages out to a per sample cost of $0.00. The following table summarizes the inputs and resulting cost estimates.

COST INFORMATION			
Cost Details	**Per Analysis**	**Per Sample**	**20 Samples**
Field collection costs		$0.00	$0.00
Analytical costs	$0.00	$0.00	$0.00
Sum of Field & Analytical costs		**$0.00**	**$0.00**
Fixed planning and validation costs			$0.00
Total cost			**$0.00**

Recommended Data Analysis Activities
Post data collection activities generally follow those outlined in EPA's Guidance for Data Quality Assessment (EPA, 2000). The data analysts will become familiar with the context of the problem and goals for data collection and assessment. The data will be verified and validated before being subjected to statistical or other analyses. Graphical and analytical tools will be used to verify to the extent possible the assumptions of any statistical analyses that are performed as well as to achieve a general understanding of the data. The data will be assessed to determine whether they are adequate in both quality and quantity to support the primary objective of sampling.

Because the primary objective for sampling for this site is to compare the site median(mean) value with a threshold value, the data will be assessed in this context. Assuming the data are adequate, at least one statistical test will be done to perform a comparison between the data and the threshold of interest. Results of the exploratory and quantitative assessments of the data will be reported, along with conclusions that may be supported by them.

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