APPENDIX P-3

FSS PLAN

Survey Area: LSA 12 **Description:** Laydown Area, Plant Soils SEA
Survey Unit: 09 **Description:** Class 1 Laydown Land Area in "Area 13"

Overview: The Survey Unit (SU) identified as LSA 12-09 has been prepared for Final Status Survey (FSS) by the Hematite Decommissioning Project (HDP). This appendix provides an overview of the proposed FSS implementation as well as general and specific instructions for the technicians responsible for performing the FSS.

- **Data Quality Objectives**

1. Personnel performing FSS duties meet the qualifications listed in HDP-PR-HP-102, *Health Physics Technician Training* and have received training and instruction commensurate with their duties. The RSO has approved all FSS personnel to perform work associated with their individual roles and responsibilities. Training records are documented in accordance with HDP-PR-GM-020, *Training Material Development and Documentation of Training*.
2. All HDP FSS procedures ("700 series") have been reviewed, revised, and validated in order to ensure performance of actual FSS work activities reflect the requirements detailed in the individual FSS Procedures and the HDP Decommissioning Plan.
3. All FSS instrumentation has undergone a receipt inspection by HDP QA personnel, is within current calibration, and is determined to be functioning within acceptable ranges based on initial set-up and daily source checks in accordance with HDP-PR-HP-411, *Radiological Instrumentation*. Prior to field use, HP technicians will confirm that environmental conditions (e.g. operating temperature range, no standing water) are acceptable for use of FSS instrumentation.

- **Location**

LSA 12-09 is designated **Class 1** and is located in the Laydown Area which includes the areas LSA 12-01 through 12-08. This SU is located within the Plant Soils Surrogate Evaluation Area (SEA); therefore the Plant SEA DCGLs were used only for Scan MDC calculations where the inferred Tc-99 DCGL for U-235 is 2.5 pCi/g. The surrogate DCGL for U-235 was used for the calculation of Scan MDC only. Laboratory analysis for Tc-99 will be performed on all final status survey samples and as such, the adjusted U-235 DCGL values will not be used to demonstrate compliance with the final status survey dose criteria. The two-dimensional areal extent of LSA 12-09 is 1,747 m^2 upon which the systematic sampling grid is based. The interior surface area (three-dimensional) of Survey Unit LSA 12-09 is also 1,747 m^2.

HDP Satellite Site View: Area 13 in Red Outline
LSA 12-09 in Red Crosshatching

- **Background**

To date, no remedial actions have been performed in LSA 12-09. The land of LSA 12-09 has been used as a transportation route to and storage area for potentially contaminated soils. No waste materials were excavated from LSA 12-09 during the remedial action although some of the potentially contaminated soils contained a small amount of material that was removed as waste. LSA 12-09 was subject to final Remedial Action Support Surveys (RASS) during April 2016 and to Isolation and Control (I & C) posting finalization in May 2016. RASS included 100% gamma walkover survey (GWS), and systematic (16-point grid) sampling.

The current LSA 12-09 land area was not subject to NCS controls and no NCS borings were performed.

No hybrid monitoring wells were located within LSA 12-09 and no soil sampling of LSA 12-09 was performed as a part of the remedial investigation.

Criteria

All FSS analytical results for samples collected within LSA 12-09 will be evaluated against the Uniform Stratum DCGLs. FSS sampling is implemented using the Three-Layer CSM, however analytical results will be conservatively evaluated using the Uniform Stratum DCGLs. Three-Layer CSM DCGLs may be utilized for FSS data evaluation if necessary.

Radionuclide	Three - Layer $DCGL_w$ Values (pCi/g)[b]			Uniform Stratum (pCi/g)
	Surface Stratum	Root Stratum	Excavation Stratum	
Radium-226+C[d]	N/A	N/A	N/A	**195.4**
Technetium-99	N/A	N/A	N/A	**51.6**
Thorium-232+C[d]	N/A	N/A	N/A	**168.8**
Uranium-234	N/A	N/A	N/A	**25.1**
Uranium-235+D[c]	N/A	N/A	N/A	**2.0**
Uranium-238+D[c]	N/A	N/A	N/A	**1.9**

[a] Table adapted from HDP FSS Procedure HDP-PR-FSS-701 *Final Status Survey Plan Development*, Revision 9, October 2015.
[b] The reported $DCGL_w$s are the activities for the parent radionuclide as specified and were calculated to account for the dose contribution from insignificant radionuclides.
[c] +D indicates the $DCGL_w$ includes short-lived (half-life $\leq$ 6 mo.) decay products.
[d] +C indicates the $DCGL_w$ includes all radionuclides in the associated decay chain.

- **Implementation**

As a Class 1 SU, LSA 12-09 will undergo a 100% gamma walkover survey (GWS) using an uncollimated 2" x 2" sodium iodide (NaI) detector. Remaining interior sidewalls (if applicable) will be scanned by holding the probe as closely as possible to the sidewall moving the probe up and down the sidewall face while advancing.

Based on a statistical evaluation of the RASS dataset, a minimum sample size of eight (8) FSS locations was required. A total of eight (8) surface stratum grab samples, eight (8) root stratum composite samples, and eight (8) excavation stratum grab samples will be collected. Any systematic locations falling on hard packed road areas will require offsetting prior to sampling. If an offset of greater than six feet is required, see the RSO for further direction.

Consideration of residual Tc-99 "hot spots": Previous characterization data collected prior to remediation indicated no samples exceeding the Uniform Stratum DCGL for Tc-99 in LSA 12-09. The maximum final RASS result for Tc-99 in the SU was 2.42 pCi/g. Since this concentration is well below the Tc-99 Uniform DCGL, there is little potential for areas of residual Tc-99 activity exceeding the DCGL, and the eight (8)-point systematic sampling pattern is appropriate.

Supplemental Sidewall Sampling: The need for supplemental sidewall sampling will be evaluated based on the requirements of HDP-PR-FSS-701 (Revision 8, Step 8.2.8.k-l.) Sidewalls are defined as vertical or near vertical (> 45° angle) surfaces inside the SU limits which are at least 12" in height.

Since the difference between the 2D planar and 3D surface area (0 m^2) is less than the area bounded by each systematic sample (218.4 m^2), a minimum of one (1) supplemental sidewall sample will be collected as a conservative measure if such a sidewall exists. This sample location will be judgmentally selected at a point on an internal sidewall and will be collected as a six (6) –inch vertical grab.

Biased samples may be collected after a statistical review (e.g. greater than 3σ above mean) of the entire GWS dataset based upon the professional judgment of the RSO or Radiological Engineering.

A minimum of one QC duplicate per SU (or 5% of the total number of samples) will be collected. Since the total number of samples is not expected to exceed 40, two QC duplicate samples will be collected within LSA 12-09.

FSS IMPLEMENTATION SUMMARY TABLE

Gamma Walkover Survey (GWS):		
Scan Coverage	100% exposed soil and rock	
Scan MDC	40.9 pCi/g total Uranium (based on a 10,000 cpm background); 0.87 pCi/g Th-232; 1.21 pCi/g Ra-226*	
Investigation Action Level (IAL)	4,000 net cpm **	
Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	8	These samples will be taken on a random-start systematic grid.
15 cm – 1.5 m (Root)	8	
> 1.5m (Excavation)	8	
Biased Survey/Sampling Locations:		
Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the RSO or Radiological Engineering.		
Sidewall Sampling Locations:		
A minimum of one (1) discretionary sidewall sample will be collected based on the following definition of "sidewall": sidewall candidates for sampling must be vertical or near vertical (> 45° angle) and at least 12" in height.		
Instrumentation:		
Ludlum 2221 with 44-10 (2x2 NaI) detector; with collimation for investigations	Used for GWS and to obtain static count rates at biased measurement locations.	
*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).* The Scan MDC for total Uranium reflects a conservative assumption of 4% enrichment. The actual RASS enrichment (2.96%) would result in Scan MDC values slightly less than those calculated for FSS planning purposes.		
**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum DCGLw derived from the technical bases presented in HEM-MEMO-15-021 and HDP-TBD-FSS-003 "*Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*", Westinghouse, March 2015.		

General Instructions:

1. Summarize daily work activities on the log sheets provided in Appendix P-6. Provide a description of site conditions (including the condition of isolation controls), samples collected and the status of gamma walkover surveys for every shift that involves work in this survey unit. Document the surveyor name and instrumentation used for each GWS event (i.e., data file) in Appendix P-6 for reporting traceability. In the event that a situation arises where the survey instructions cannot be followed as written, stop work and contact the RSO for resolution. All changes to the survey instructions shall be approved by the RSO before continuing work and be documented in the FSS Field Log.
2. In accordance with HDP-PR-FSS-701, *Final Status Survey Plan Development (Sec. 8.4.2),* documentation of activities performed, equipment used, and potential safety hazards that may be encountered during the performance of characterization activities (along with associated controls) will be documented using the FSS Daily Task Briefing log sheet.
3. Verify that isolation controls established in accordance with HDP-PR-HP-602 are in place prior to the start of FSS. Ensure isolation controls include, as necessary, the use of "wattles", a berm, or trenching to minimize the potential for contaminated soils and water from surrounding areas to cross the boundary of this unit.
4. Perform daily pre and post QC source checks in accordance with HDP-PR-HP-416.
5. A gamma walkover survey (GWS) will be performed using a 2"x2" NaI (Tl) detector. Move the survey probe in a serpentine pattern approximately 6-inches off-set from centerline to the body (e.g., "shoulder-to-shoulder") with the probe as close to the surface as possible; maintaining the detector as close as possible to the surface (nominally 1", but not to exceed 3-in. distance from the surface). The meter will be moved at a speed of approximately 0.3 meter (or 1.0 feet) per second or less. The gamma walkover survey will cover the percentage of the exposed surface areas within the area of interest as indicated in the table above. Notify the RSO of any areas, conditions or constraints where surveying (or subsequent sampling) may not be possible. Document the conditions and any resolutions in the FSS Field Log.
6. A GPS system and data logger should be interfaced with the meter. The downloaded information will then be used to prepare maps illustrating relative count rates and to perform statistical analysis of the data. If a GPS data logging system is not available, contact the RSO to determine specific instructions for performing and documenting gamma walkover surveys.
7. LSA 12-09 is a Class 1 Survey Unit. Each sample location will be selected systematically and have associated GPS coordinates specified. In the case of inaccessible sampling locations, additional sample coordinates may be generated with the RSO's approval in order to identify an acceptable sampling location. Any adjustments to sampling locations will be documented in the FSS Field Log, new sample location coordinates will be recorded, and the RSO will be notified.
8. A map of the survey unit showing predetermined sample locations with associated GPS coordinates will be generated. A copy of the sample map and survey locations will be attached to the survey instruction.
9. At each systematic soil sampling location, a composite soil sample will be collected from each location and depth as determined after the completion of excavation (and will be provided in Appendix P-4). The systematic sample locations will include eight (8) samples collected at a depth of 0 cm – 15 cm (surface), eight (8) samples collected at a depth of 15 cm – 1.5 m (root), and eight (8) samples collected at a depth of 1.5 m to 1.65 m (excavation).
10. Biased soil sampling locations may be determined at the discretion of the HP Technician during the performance of the GWS. Biased soil sampling locations may also be determined at the discretion of the RSO based on statistical analysis of the survey/sampling data or process/historical knowledge of the area. Biased soil samples will be collected in a manner similar to systematic soil sampling locations. Radiological Engineer and/or the HP

Technician will log the reason for collection of biased samples in the Field Log sheet and record the location of biased samples on Appendix P-4 of this survey instruction.

NOTE: If trash, waste, or other non-native materials are observed during sample collection, stop sampling activities and notify HP Supervision (or Radiological Engineering) before collecting samples at any sample location in the unit.

11. Supplemental Sidewall Sampling: A minimum of one discretionary sidewall sample will be collected based on the following definition of "sidewall": sidewall candidates for sampling must be vertical or near vertical (> 45° angle) and at least 12" in height. Sidewall samples will be collected in a vertical orientation as six-inch grabs and are not to be biased toward elevated count rate measurement locations.
12. All samples collected as part of this survey will be analyzed at an off-site laboratory by gamma spectroscopy for radium, thorium, and uranium, and ICP-MS for Tc-99.

Specific Instructions:

NOTE: Unless otherwise indicated, the performance of these specific instructions is the responsibility of the HP Technician.

Before Beginning Work

1. **Rad. Engineer/HP Technician:** Verify, each shift, that isolation controls, established in accordance with HDP-PR-HP-602, are in place prior to the start of FSS using the Daily Task Briefing log sheet.
2. **Rad. Engineering/HP Technician:** Prior to gamma walkover survey in the area to be surveyed, walk the area looking specifically for any debris material (e.g. asphalt, plastic, concrete, etc.) that may indicate further remediation efforts are necessary.
3. **Rad. Engineer/HP Technician:** Perform a daily task-specific briefing; documenting the attendants, planned work activities, anticipated hazards, and controls on the FSS Daily Task Briefing log sheet.

   NOTE: If soil sampling to a depth greater than one foot is required, ensure HDP Safety & Health is aware of the activity, an Excavation Permit (Form HDP-PR-EHS-021-1) has been performed for the work area, and underground utilities have been identified and marked.

   Gamma Walkover Surveys (GWS)

1. Establish a general area background, in accordance with HDP-PR-FSS-711. Use this background level in conjunction with the Investigation Action Level (IAL) of 4,000 net counts per minute as a field guide to pause and, if necessary, flag locations for possible biased sampling (see following Steps 2 and 3 below for details).
2. Perform a gamma walkover of the survey unit holding the probe as close to the surface as possible (nominally 1", but not to exceed 3"), in accordance with HDP-PR-FSS-711.
   a. Look and/or listen for elevated count rates and then pause to determine locations that exhibit anomalous readings (e.g., count rates that exceed the IAL for this unit).
   b. Mark the location(s) exhibiting anomalous readings to facilitate possible future investigations (for example, use a flag, stake, or other marking resistant to anticipated environmental conditions).
3. At each location where anomalous readings occur, perform a more detailed point survey of the area. Pause and place the survey probe as close as possible to the surface to define and record the total count rate associated with the area of interest on the Field Log.

   NOTE: If field conditions limit the ability to perform contact readings, collect readings as close as practical. Contact the RSO (or Radiological Engineering) regarding the issue for each

location. The FSS Technician, RSO, and/or Radiological Engineer will log the issue (and resolution) for each location in the FSS Field Log and on applicable HDP survey forms.

4. **GPS (and associated data logger) is the preferred method for performing GWS.**

   When a GPS and data logger is used, down load and provide the survey data to a GIS Specialist.

   a. **GIS Specialist**: Provide colorimetric maps indicating survey coverage and measurements exceeding the IAL and send the survey data to Radiological Engineering.

   b. **Radiological Engineer**: Provide statistical analysis to determine population characteristics of the survey data set and identify any areas requiring additional surveys or sampling. Contact FSS Technician to mark additional locations requiring survey or sampling.

   If a GPS and data logger cannot be used to perform GWS in any portion of this survey unit, the FSS Technician will contact the RSO or Radiological Engineering to determine compensatory survey methods. The compensatory methods will be logged in the FSS Survey Log.

   Download the survey data at the end of each shift. To minimize data loss, periodically save the GWS data set to an external backup or network drive.

Soil Sampling

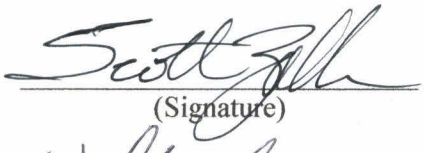
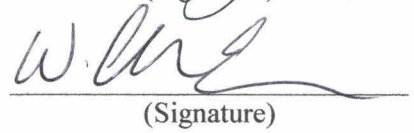
1. Collect soil samples in accordance with HDP-PR-FSS-711 at locations identified in Appendix P-4. Note that additional biased sampling locations may also be listed as determined by the GWS or as determined by the RSO.
2. Collect a minimum of one duplicate sample for every 20 samples. A minimum of one duplicate sample is required for each survey unit.
3. Collect and homogenize the entire volume from the specified depth interval prior to containerizing the sample. When collecting the composite samples, vegetation and native debris/rocks with a diameter greater than 1 inch should be discarded.

   NOTE: If a discrete source of radiation (e.g., a fuel pellet) is discovered during the performance of sampling activities, contact the RSO. Pause any additional characterization work in the immediate area and use a plastic bag to contain the material. Label the plastic bag per HDP-PR-HP-201, Section 8.2 "Labeling Radioactive Material" and transfer the material from the survey unit for controlled storage in the Building 230 Sample Cage via physical turnover to the shift Sample Custodian.
4. Monitor the count rates observed at all exposed surfaces within close proximity (e.g., 2 meter diameter) of each biased sampling location, as practical. Note any accessibility issues and discuss compensatory measures with supervision.

   a. Inform Radiological Engineering of the results obtained from monitoring the locations of biased sampling to receive instructions for further investigation or the need for additional excavation.
5. Collect bias samples from the surface to a depth of 6 inches.
6. Collect a minimum of one (1) supplemental sidewall sample as a 6-inch vertical grab sample, from a judgmentally selected location(s). Sidewall samples are not to be selected based on elevated count rate measurements.
7. Monitor the count rates within the depression created by the collection of biased soil samples.
8. Obtain and record the count rate on contact with features other than soil within the excavation. (e.g., native rock). Record the nature and extent of features other than soil found within the excavation in the FSS Survey Log and

contact the RSO to determine additional characterization methods, if necessary.

9. Submit samples for analysis to TestAmerica following sample chain of custody requirements contained in HDP-PR-QA-006.

Prepared by:	Matthew E. Cushman (Print Name)	 (Signature)	5/4/16 (Date)
Peer Reviewed by:	Scott G. Zoller (Print Name)	 (Signature)	05/04/16 (Date)
Approved by (RSO):	W. Clark Evers (Print Name)	 (Signature)	5/4/16 (Date)

APPENDIX P-1
FINAL STATUS SURVEY SAMPLING PLAN DEVELOPMENT CHECKLIST FOR SOIL SURVEY UNITS

Survey Area: LSA 12 **Description:** Laydown Area, Plant Soils SEA

Survey Unit: 09 **Description:** Class 1 Laydown Land Area in "Area 13"

1. Verify Survey Unit Isolation & Control

Survey Unit properly isolated and/or controlled (indicated by outlining the area with green rope and posting the appropriate signage) as required by HDP-PR-HP-602, *Data Package Development and Isolation and Control Measures to Support Final Status Survey*? Yes☒ No☐

(If "No", discontinue survey design until area turnover requirements have been met.)

2. Evaluate Final Remedial Action Support Survey (RASS) Data

a. Number of RASS Samples = 16 for full analysis, including Tc-99.

b. Record analytical results and summary statistics for each RASS sample.

	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)	Tc-99 (pCi/g)	Th-232 (pCi/g)	Ra-226 (pCi/g)
Minimum	1.825	0.094	1.050	0.108	0.000	0
Maximum	9.952	0.549	2.300	2.420	0.210	0
Mean	5.239	0.287	1.482	0.527	0.034	0
Median	4.634	0.256	1.405	0.418	0.000	0
Standard Deviation	2.421	0.135	0.426	0.537	0.033	0
# of Samples	16	16	16	16	16	16

c. Are all RASS results less, or equal to the appropriate $DCGL_W$ from Appendix A of HDP-PR-FSS-701? Yes☒ No☐

d. If "No", have remaining locations of elevated concentration been evaluated? N/A☒ Yes☐ No☐
(If "No", discontinue survey design until investigation is complete.)

e. Have elevated areas identified by gamma walkover surveys been investigated? N/A☒ Yes☐ No☐
(If "No", then terminate survey design and perform additional investigation and repeat the planning process.)

f. Are the Initial Characterization and RASS data sufficient to support FSS Design? Yes☒ No☐
(If "No", terminate survey design, perform additional characterization or remediation and repeat the planning process.)

3. Define the Survey Unit Classification

Write a short description of the survey unit based on historical use and remedial activities:

The LSA 12-09 survey unit (SU) is classified as MARSSIM Class 1. LSA 12-09 is located in the laydown area of the HDP site. The planar area of this SU is 1,747 m^2. This SU along with LSA 12-01 through 12-08 are collectively referred to as "Area 13" for the purposes of remediation planning and work sequencing.

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FINAL STATUS SURVEY SAMPLING PLAN DEVELOPMENT CHECKLIST FOR SOIL SURVEY UNITS

Classification: 2 Survey Unit Area (m^2): 1,747

a. Has the Classification changed from the Initial Classification as indicated in DP Ch. 14 Table 14-16 and Figures 14-14 through 14-17? Yes☐ No☒
(If "Yes", then include a copy of Appendix P-5, *Survey Unit Classification Change Form.*)

b. Is the Survey Unit area less than the maximum size for the Classification? Yes☒ No☐
(If "No", then terminate survey design and evaluate dividing the survey unit into multiple survey units.)

4. Define the Surrogate Evaluation Area (SEA)

Select the appropriate SEA as input to calculating scan sensitivity and variability in the RASS SOF.
Plant Soils SEA ☒ Tc-99 SEA ☐ Burial Pit SEA ☐

5. Define Final Survey Unit Conditions

☒ No Excavations, Paved/Partially Paved or Excavated but not Backfilled

☐ Excavated and to be Backfilled

☐ Excavated and Backfilled

Note: If a portion of a Survey Unit is paved, then Surface Soil Stratum begins at the bottom of the paved surface and extends 15 cm from that point below grade. The lower depth of the Root Stratum remains at 1.5 m below grade. The pavement is then treated as a separate structural Survey Unit within the Survey Area.

6. Define the Type of FSS Samples and Measurements

Select the appropriate types of samples and measurements for FSS of this Survey Unit that corresponds to the final condition and survey classification of the Survey Unit.

Not Excavated, Paved/Partially Paved or Excavated but not Backfilled:	Excavated and to be Backfilled:
☒ Surface Soil (<15cm) Samples.	☐ Surface Soil Samples taken from any remaining surface soil Stratum and Root Stratum Soil Samples taken at the same locations as Surface Samples, composited over the entire root stratum.
☒ Root Stratum Soil Samples composited from 15cm to 1.5m.	☐ Root Stratum Soil Samples composited from exposed grade to 1.5m and Deep Stratum Soil Samples taken at the same locations as Root Samples of the top 15cm of the Deep Stratum.
☒ Deep Stratum Soil Samples of the top 15 cm of the Deep Stratum.	☐ Deep Stratum Soil Samples of the top 15 cm of the exposed Deep Stratum.

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FINAL STATUS SURVEY SAMPLING PLAN DEVELOPMENT CHECKLIST FOR SOIL SURVEY UNITS

Note: If the SOF of the Root Stratum sample exceeds 0.5, a composite sample is collect from 1.5 meters to an appropriate depth (Deep Stratum).

Excavated and Backfilled

☐ Core through backfill layer to the lowest point where remediation occurred and composite a sample from a coring that extends one meter deeper than the lowest point where remediation occurred.

7. Define Derived Concentration Guideline Levels (DCGL)

Select the appropriate DCGL for each Radionuclide of Concern (ROC) based on the corresponding SEA and the Uniform Conceptual Site Model (CSM).

- If Tc-99 was measured during the characterization/RASS survey, then the "Measure Tc-99" DCGLs will be used from Appendix A of HDP-PR-FSS-701.
- If Tc-99 was not measured in the characterization/RASS survey, then the modified U-235 DCGL ("Infer Tc-99") will be used from Appendix A HDP-PR-FSS-701.

	Surface Stratum (pCi/g)	Root Stratum (pCi/g)	Deep Stratum [1] (pCi/g)	Uniform (pCi/g)
U-234	N/A	N/A	N/A	195.4
U-235	N/A	N/A	N/A	51.6
U-238	N/A	N/A	N/A	168.8
Tc-99	N/A	N/A	N/A	25.1
Th-232 + C	N/A	N/A	N/A	2.0
Ra-226 + C	N/A	N/A	N/A	1.9

1. The Deep Stratum DCGLs correspond to the Excavation Scenario DCGL from Appendix A of HDP-PR-FSS-701.

8. Determine the Number of Samples in the Statistical Survey Population

Note: The statistical survey population is routinely derived based on the Uniform DCGL.

- Alternatively, if the Survey Unit excavation extends into multiple CSMs (e.g. surface, root & deep), then the DCGL(s) from the most limiting strata can be used with the equations below; OR
- If the excavation significantly extends into the Deep Stratum, then the alternate approach presented in Step 8.2.5 of HDP-PR-FSS-701 may be used for determining the mean SOF and weighted standard deviation that accounts for the reduced dose from the deeper surface, i.e., by weighting the Root Stratum and Excavation $DCGL_W$ values.
- The values used in determining the following (SOF_{mean} and σ_{SOF}) can be found in the tables from Section 2b and Section 7.

a. Determine a mean SOF for the characterization/RASS survey data set using the equation from Step 8.2.5a of HDP-PR-FSS-701.

Lower Bound of the Grey Region (LBGR) = $SOF_{Mean} = 0.07$

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b. Determine the weighted standard deviation in the SOF for the characterization/RASS survey data set using the equation from Step 8.2.5b of HDP-PR-FSS-701.

Note: For the determination of SOF_{Mean} and σ_{SOF} , include the concentration for Tc-99 if it was measured. If Tc-99 was not measured, include the modified U-235 DCGL and omit Tc-99 concentration term.

		✓ Larger of the two used in worksheet survey design
Survey Unit σ_{SOF} =	0.03	☐
Background σ_{SOF}=	0.14	☒

c. Define the Decision Errors.

Type I Error = 0.05 Type II Error = 0.10

Note: The Type II Error is set at 0.10 initially but it may be adjusted with RSO concurrence.

d. Determine the Relative Shift using the equation in Step 8.2.5d of HDP-PR-FSS-701.

Relative Shift = 6.57* * Spreadsheet value may differ from hand-calculated results due to rounding.

e. Is the Relative Shift between 1 and 3? Yes☐ No☒

- If "Yes", then continue to Step 8f.
- If "No", then adjust the LBGR as necessary to achieve a relative shift between 1 and 3. In order to accomplish this, the LBGR may be set as low as the MDC for the analytical technique.

Adjusted LBGR = 0.58

Adjusted Relative Shift = 3.0

f. Determine the Number of Samples (N/2) required corresponding to the Type I error, Type II Error and the Relative Shift from Appendix F or calculate using equation 5-1 from MARSSIM.

No. of Samples (N/2) = 8

9. Determine the Scan MDC for Total Uranium

- When U-235 is reported as negative or zero and U-238 is reported as positive, set the sample enrichment to 0.72% (natural uranium).
- When U-235 is reported as positive and U-238 is reported as negative or zero, set the sample enrichment to 100% (highly enriched).
- When both U-235 and U-238 data are reported as positive, determine the U-238/U-235 ratio for each sample and use Appendix G of HDP-PR-FSS-701, to determine the uranium enrichment that corresponds to the mean U-238:U-235 ratio.

a. Record the average Uranium enrichment for the survey unit using the enrichment determined for each individual sample.

Average Enrichment (%) =2.96

APPENDIX P-1
FINAL STATUS SURVEY SAMPLING PLAN DEVELOPMENT CHECKLIST FOR SOIL SURVEY UNITS

Note: The Activity Fractions (f) for each radionuclide corresponding to the mean enrichment used in the following calculations is obtained from Appendix G of HDP-PR-FSS-701.

If the Uniform DCGL is not used, and the excavation extends into multiple CSMs (e.g. surface, root & deep), then the most conservative DCGLs should be used in the following calculation.

b. Determine a $DCGL_W$ for Total Uranium using the equation from Step 8.2.6b of HDP-PR-FSS-701.

$DCGL_{WTotU}$ for Total Uranium = 46.6 pCi/g

c. Identify the Radiological Instrument that will be used for scanning.

☒ 2"x 2" NaI Detector ☐ FIDLER NaI Detector ☐ Other_____

d. Determine the Scan MDC for the selected instrument using the equation in Step 8.2.6d of HDP-PR-FSS-701 or the calculations presented in the Open Land Area Gamma Scan MDCs section in Chapter 14 of the DP.

MDC_{scan} for Total Uranium = 40.9 pCi/g

10. Determine the Scan MDC for Th-232 and Ra-226

a. Select the appropriate $DCGL_W$ for Th-232 and Ra-226 corresponding to the soil strata that will be exposed at the time of FSS and the SEA where the survey unit is located.

Th-232 $DCGL_W$ = 2.0 pCi/g Ra-226 $DCGL_W$ = 1.9 pCi/g

Note: If the Uniform DCGL is not used, and the excavation extends into multiple CSMs (e.g. surface, root & deep), then the most conservative DCGL for the strata should be used. With RSO concurrence, the alternate approach as presented in DP Ch. 14, Section 14.4.3.1.10 may be used in lieu of using the most conservative.

b. Determine the Scan MDC for the selected instrument

Note: HDP-TBD-FSS-002 documents the calculated MDC_{scan} of 0.82 pCi/g for Th-232 and 1.14 pCi/g for Ra-226 when using a 2"x 2" NaI detector with a background of 9,000 cpm. If a different background is indicated, see Appendix C of HDP-TBD-FSS-002 for the appropriate MDC_{scan}.

Note: If the selected instrument is not a 2"x 2" NaI detector, then the MDC_{scan} can be determined in accordance with the Open Land Area Gamma Scan MDCs section in DP Ch. 14.

MDC_{scan} for Th-232 = 0.87 pCi/g MDC_{scan} for Ra-226 = 1.21 pCi/g

Note: If a value is not applicable, mark as N/A.

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FINAL STATUS SURVEY SAMPLING PLAN DEVELOPMENT CHECKLIST FOR SOIL SURVEY UNITS

11. Adjust the Statistical Sample Population Size (N/2) for Scan MDC

a. Is the Scan MDC for the selected instrument less than the $DCGL_W$ that was determined for Total Uranium? (compare values from Step 9b and 9d) Yes☒ No☐

Class 2 and 3 survey units - If "Yes", then proceed to Step 12, if "No", then contact the RSO for direction as to changing parameters for scanning such as scanning speed, detector distance, different instrumentation, etc.

Class 1 survey units, proceed to the next step.

b. Divide the total area of the survey unit by the Number of Samples (N/2) determined in Step 8f to determine the area bounded by the statistical sample population.

Area Bounded by the Statistical Sample Population (A_{SU}) = 218.4 m^2

URANIUM

c. Was the Scan MDC for the selected instrument less than the $DCGL_W$ that was determined for Total Uranium in Step 11.a? NA☐ Yes☒ No☐

(If "Yes", then proceed to Step 12, if "No", then proceed to the next step).

d. Using the Area Factors in Appendix H of HDP-PR-FSS-701 and using the equation from Step 8.2.8d of HDP-PR-FSS-701, determine a Total Uranium AF for each listed area using the Activity Fractions (*f*) for each radionuclide that corresponds to the mean enrichment from Appendix G of HDP-PR-FSS-701.

Area (m^2)	153,375	10,000	3,000	1,000	300	100	30	10	3	1
AF_{TotalU}	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Note: The AFs for the Uniform Stratum will generally be used. The RSO may approve use of AFs from the Surface, Root or Deep CSMs, or the Excavation Scenario.

e. Find the Area Factor (AF_{TotalU}) determined in the previous step that corresponds to the area bounded by the statistical sample population (A_{SU}).

AF_{TotU} for the Bounded Area (A_{SU}) = NA

f. Multiply the $DCGL_W$ determined for Total Uranium by the Area Factor (AF_{TotU}) to derive a $DCGL_{EMC}$ for Total Uranium.

$DCGL_{EMC}$ for Total Uranium = NA pCi/g

g. Is the MDC_{scan} for the selected instrument less than the $DCGL_{EMC}$ that was determined for Total Uranium? NA☒ Yes☐ No☐

(If "Yes", then proceed to Step 11k, if "No", then proceed to the next step.)

APPENDIX P-1
FINAL STATUS SURVEY SAMPLING PLAN DEVELOPMENT CHECKLIST FOR SOIL SURVEY UNITS

h. Determine a new AF (AF_{EMC}) corresponding to the MDC_{scan} for the selected instrument by dividing the MDC_{scan} by the $DCGL_W$.

AF_{EMC} for U_{total} = NA

i. Find the Area (A') that corresponds to the Area Factor (AF_{EMC}).
A' for U_{total} = NA

j. Determine an Adjusted Number of Samples (N_{EMC}) for the statistical sample population size that corresponds to the bounded A_{EMC} using the equation from Step 8.2.7j of HDP-PR-FSS-701.

N_{EMC} corresponding to A' for U_{total} = NA

TECHNETIUM (Tc-99)

k. Determine if the maximum reasonable result for Tc-99 from previous Characterization or RASS remaining within the area is greater than the $DCGL_W$ for the appropriate CSM and SEA?

N/A☒ Yes☐ No☐

(If "No", then proceed to Step 12, if "Yes", then proceed to the next step.)

l. Determine the area per sample station needed to account for potential Tc-99 hotspots by dividing the highest Tc-99 result obtained by the Tc-99 $DCGL_W$ for the appropriate CSM and compare that value to the Area Factor Tables in Appendix H.

A' for potential Tc-99 hotspots = NA

m. Determine the number of samples needed by dividing the A_{SU} by the A' for potential Tc-99 hotspots determined in Step 11l.

N corresponding to A' for potential Tc-99 hotspots = NA

12. Determine the Grid Spacing

a. Larger of N/2 from Step 8f, the maximum value of N_{EMC} from Step 11j, or N corresponding to A' for potential Tc-99 hotspots from Step 11m.
N/2, N_{EMC}[max], or N corresponding to the potential Tc-99 hotspot = 8

b. Is the Survey Unit a Class 3 Survey Unit? Yes☐ No☒
(If "Yes", then continue to Step 13, if "No", then proceed to the next step).

c. Determine Grid Spacing (L) using the equation from Step 8.2.9 of HDP-PR-FSS-701.

Grid Spacing (L) for Survey Unit = 15.8 m

13. Generate a Survey Map

a. Assign a unique identification number to each sample in the statistical sample population using the guidance and direction provided in Appendix M of HDP-PR-FSS-701.

APPENDIX P-1
FINAL STATUS SURVEY SAMPLING PLAN DEVELOPMENT CHECKLIST FOR SOIL SURVEY UNITS

b. Generate a graphic representation of the Survey Unit with dimensions and boundaries corresponding to the established reference coordinate system in accordance with Step 8.2.10 of HDP-PR-FSS-701.

c. Using the reference coordinate system, ascertain coordinates for each sample location.

d. Designate sample locations, and location coordinates on Appendix P-4, *FSS Sample & Measurement Locations & Coordinates* and attach a copy of that form to the FSSP.

e. Attach a copy of the developed Survey Map with sample locations to the FSSP.

14. QC, Biased & Discretionary Samples

a. Randomly choose 5% of the statistical sample population as QC samples in accordance with HDP-PR-FSS-703, *Final Status Survey Quality Control*.

b. Designate QC sample locations, and location coordinates on attached Appendix P-4, *FSS Sample & Measurement Locations & Coordinates*.

c. Designate if any biased samples will be taken at the discretion of the HP Staff designing the survey and the basis for taking them. Necessary biased samples will be explained on Appendix P-3, *FSS Sampling Plan.*

d. Using the reference coordinate system, determine coordinates for each biased sample location.

e. Designate biased sample locations, and location coordinates on attached Appendix P-4, *FSS Sample & Measurement Locations & Coordinates*.

f. Include discretionary sidewall samples as applicable using guidance in Step 8.2.11. Are discretionary sidewall samples required? N/A☐ Yes☒ No☐

(If "No", then proceed to Step 15, if "Yes", then proceed to the next step.)

g. Determine the number of samples to be collected based on the sidewall surface area compared to the two dimensional systematic surface area.

Number of discretionary sidewall samples = **1** (maximum); may be reduced with RSO approval if the actual sidewall surface area is significantly less than the CAD-calculated theoretical maximum.

h. Any discretionary sidewall samples will be taken at randomly chosen location(s) of the sidewall(s) (i.e., not based on radiological scans) selected at the discretion of the Health Physics Technician performing soil sampling. Necessary sidewall samples will be explained on Appendix P-3, *FSS Sampling Plan.*

APPENDIX P-1
FINAL STATUS SURVEY SAMPLING PLAN DEVELOPMENT CHECKLIST FOR SOIL SURVEY UNITS

15. Scan Coverage

a. The Survey Unit is: ☒ Class 1 ☐ Class 2 ☐ Class 3

b. Based on the Survey Unit Classification, the scan coverage in this Survey Unit is;
☒ 100% Scan Coverage of exposed soil ☐ _____% Scan Coverage of exposed soil

c. Designate any specific scan locations, as determined necessary, on Appendix P-3, *FSS Sampling Plan.*

16. Investigation Levels

a. The Survey Unit is: ☐ Class 3

1) Scan Investigation Levels are set at: NA cpm

2) Sample Investigation Levels are set at 50% of the $DCGL_W$ when expressed as the SOF.

b. The Survey Unit is: ☐ Class 2

1) Scan Investigation Levels are set at: 1,624 cpm

2) Sample Investigation Levels are set at the $DCGL_W$ when expressed as the SOF.

c. The Survey Unit is: ☒ Class 1

1) Scan Investigation Levels are set at: 4,000 net cpm

2) Sample Investigation Levels are set at the $DCGL_W$ when expressed as the SOF.

17. Attachments

Attach a copy of completed forms as appropriate:

☒ Appendix P-3, *FSS Survey Sampling Plan,*
☒ Appendix P-4, *FSS Sample & Measurement Locations & Coordinates*
☐ Appendix P-5, *FSS Unit Classification Change Form*
☐ Appendix P-6, *FSS Field Log*
☒ Survey Unit Figure
☐ Other:

18. FSSP Development Checklist Approval

Prepared by:	Matthew E Cushman (Print Name)	(Signature)	5/14/16 (Date)
Peer Reviewed by:	Scott G. Zoller (Print Name)	(Signature)	05/04/16 (Date)
Approved by (RSO):	W. Clark Evers (Print Name)	(Signature)	5/14/16 (Date)

LSA 12-09 Systematic Sample Locations

L12-09-01-P-S-S-00
L12-09-02-P-R-S-00
L12-09-03-P-E-S-00

L12-09-04-P-S-S-00
L12-09-05-P-R-S-00
L12-09-06-P-E-S-00

L12-09-07-P-S-S-00
L12-09-08-P-R-S-00
L12-09-09-P-E-S-00
L12-09-07-P-S-Q-00

L12-09-10-P-S-S-00
L12-09-11-P-R-S-00
L12-09-12-P-E-S-00

LSA 12-09
1747 m^2 Planar Area

L12-09-13-P-S-S-00
L12-09-14-P-R-S-00
L12-09-15-P-E-S-00
L12-09-14-P-R-Q-00

L12-09-16-P-S-S-00
L12-09-17-P-R-S-00
L12-09-18-P-E-S-00

L12-09-19-P-S-S-00
L12-09-20-P-R-S-00
L12-09-21-P-E-S-00

L12-09-22-P-S-S-00
L12-09-23-P-R-S-00
L12-09-24-P-E-S-00

0 12.5 25 50 75 100 Feet

N

Sample ID	Start Depth (inches)	End Depth (inches)	Northing (feet)	Easting (feet)
L12-09-01-P-S-S-00	0	6	865742	828039
L12-09-02-P-R-S-00	6	59	865742	828039
L12-09-03-P-E-S-00	59	65	865742	828039
L12-09-04-P-S-S-00	0	6	865742	828091
L12-09-05-P-R-S-00	6	59	865742	828091
L12-09-06-P-E-S-00	59	65	865742	828091
L12-09-07-P-S-S-00	0	6	865697	828065
L12-09-08-P-R-S-00	6	59	865697	828065
L12-09-09-P-E-S-00	59	65	865697	828065
L12-09-10-P-S-S-00	0	6	865697	828117
L12-09-11-P-R-S-00	6	59	865697	828117
L12-09-12-P-E-S-00	59	65	865697	828117
L12-09-13-P-S-S-00	0	6	865652	828091
L12-09-14-P-R-S-00	6	59	865652	828091
L12-09-15-P-E-S-00	59	65	865652	828091
L12-09-16-P-S-S-00	0	6	865652	828143
L12-09-17-P-R-S-00	6	59	865652	828143
L12-09-18-P-E-S-00	59	65	865652	828143
L12-09-19-P-S-S-00	0	6	865607	828117
L12-09-20-P-R-S-00	6	59	865607	828117
L12-09-21-P-E-S-00	59	65	865607	828117
L12-09-22-P-S-S-00	0	6	865607	828169
L12-09-23-P-R-S-00	6	59	865607	828169
L12-09-24-P-E-S-00	59	65	865607	828169
L12-09-07-P-S-Q-00	0	6	865697	828065
L12-09-14-P-R-Q-00	6	59	865652	828091

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 12 **Description:** Laydown Area, Plant Soils SEA
Survey Unit: 09 **Description:** Class 1 Laydown Land Area in "Area 13"
Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L12-09-01-P-S-S-00	CSM	S	430.2	429.7	865742	828039	Surface 6-inch grab
L12-09-02-P-R-S-00	CSM	S	429.7	425.2	865742	828039	Root 59-inch composite
L12-09-03-P-E-S-00	CSM	S	425.2	424.7	865742	828039	Excavation 6-inch grab
L12-09-04-P-S-S-00	CSM	S	430.7	430.2	865742	828091	Surface 6-inch grab
L12-09-05-P-R-S-00	CSM	S	430.2	425.7	865742	828091	Root 59-inch composite
L12-09-06-P-E-S-00	CSM	S	425.7	425.2	865742	828091	Excavation 6-inch grab
L12-09-07-P-S-S-00	CSM	S	429.9	429.4	865697	828065	Surface 6-inch grab
L12-09-08-P-R-S-00	CSM	S	429.4	425.0	865697	828065	Root 59-inch composite
L12-09-09-P-E-S-00	CSM	S	425.0	424.5	865697	828065	Excavation 6-inch grab
L12-09-10-P-S-S-00	CSM	S	429.8	429.3	865697	828117	Surface 6-inch grab
L12-09-11-P-R-S-00	CSM	S	429.3	424.8	865697	828117	Root 59-inch composite
L12-09-12-P-E-S-00	CSM	S	424.8	424.4	865697	828117	Excavation 6-inch grab
L12-09-13-P-S-S-00	CSM	S	429.8	429.3	865652	828091	Surface 6-inch grab
L12-09-14-P-R-S-00	CSM	S	429.3	424.8	865652	828091	Root 59-inch composite
L12-09-15-P-E-S-00	CSM	S	424.8	424.4	865652	828091	Excavation 6-inch grab
L12-09-16-P-S-S-00	CSM	S	429.6	429.1	865652	828143	Surface 6-inch grab
L12-09-17-P-R-S-00	CSM	S	429.1	424.7	865652	828143	Root 59-inch composite
L12-09-18-P-E-S-00	CSM	S	424.7	424.2	865652	828143	Excavation 6-inch grab
L12-09-19-P-S-S-00	CSM	S	429.6	429.1	865607	828117	Surface 6-inch grab
L12-09-20-P-R-S-00	CSM	S	429.1	424.7	865607	828117	Root 59-inch composite
L12-09-21-P-E-S-00	CSM	S	424.7	424.2	865607	828117	Excavation 6-inch grab
L12-09-22-P-S-S-00	CSM	S	429.5	429.0	865607	828169	Surface 6-inch grab
L12-09-23-P-R-S-00	CSM	S	429.0	424.6	865607	828169	Root 59-inch composite
L12-09-24-P-E-S-00	CSM	S	424.6	424.1	865607	828169	Excavation 6-inch grab
L12-09-07-P-S-Q-00	CSM	S	429.9	429.4	865697	828065	Surface 6-inch grab
L12-09-14-P-R-Q-00	CSM	S	429.3	424.8	865652	828091	Root 59-inch composite
L12-09-XX-P-Y-B-00	Uniform	B	TBD	TBD	TBD	TBD	Bias sample may be taken after evaluation of GWS data (e.g., data > 3σ over the mean of the walkover data).

Samples highlighted in red will be collected and archived; radiological analyses performed only if overlying root sample has a SOF >0.5.

*Elevations are in feet above mean sea level.

** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983] (Open Land Area) OR
Distance in feet from lower left corner of the surface (Structures); each surface has it's own (X,Y) = (0,0); OR
For piping the distance from the beginning of the survey unit.

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R
CSM: Three-Layer (Surface-Root-Deep) or Uniform
Type: Systematic = S, Biased = B; QC =Q; Investigation = I