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Our ref: HEM-17-70
Date: November 29, 2017

Subject: Westinghouse Hematite Decommissioning Project - Request for NRC Review of Final Status Survey Final Report Volume 3, Chapter 5, Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14, Revision 1 (License No. SNM-00033, Docket No. 070-00036)

The purpose of this letter is to provide for the U.S. Nuclear Regulatory Commission (NRC) review of Final Status Survey Final Report (FSSFR) Volume 3, Chapter 5, Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14, Revision 1.

The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to the application of the WRS Test when applied to the Three Stratum approach. Westinghouse and the NRC discussed the path forward and resolution of the NRC comments. As such, Revision 3 to FSSFR Volume 3 Chapter 1 implemented the resolution of the comments {ML17046A005}. Revision 1 of FSSFR Volume 3, Chapter 3 implements Revision 3 to FSSFR Volume 3, Chapter 1 within the release record.

Attachment 1 contains FSSFR Volume 3, Chapter 5, Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14, Revision 1. Attachment 2 contains a track change version for ease of review. Attachment 3 contains a revision matrix for ease of review.

Please contact me at 314-810-3353, should you have questions or need additional information.

Sincerely,

Kenneth E. Pallagi
Licensing Manager,
Hematite Decommissioning Project

NMSS20

Attachment: 1) Final Status Survey Final Report Volume 3, Chapter 5, Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14, Revision 1 (HDP-RPT-FSS-207 Revision 1)

2) Final Status Survey Final Report Volume 3, Chapter 5, Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14, Revision 1 (HDP-RPT-FSS-207 Revision 1) Track Change Version

3) Revision Matrix for FSSFR Volume 3, Chapter 5, Revision 1

cc: V. J. Kelmeckis, Westinghouse
S. S. Koenick, NRC/DUWP/MDB
J. A. Smith, NRC/DUWP/MDB

Attachment 1

Final Status Survey Final Report Volume 3, Chapter 5, Revision 1

Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14, Revision 1

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

Westinghouse

Final Status Survey Report

Hematite Decommissioning Project

Final Status Survey Final Report Volume 3, Chapter 5

TITLE: **Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14 (LSA 10-13 and LSA 10-14)**

REVISION: **1**

EFFECTIVE DATE: NOV 29 2017

Approvals:

Author: _____ 11-29-2017
Kenneth E. Pallagi — Date

Owner/Manager: _____ 11/29/17
W. Clark Evers — Date

REVISION LOG	
Revision No. Effect. Date	**Revision**
0 11/16/2016	Revision 0 is the initial issuance of the Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14.
1 See Cover Page	The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to the application of the WRS Test when applied to the Three Stratum approach. Westinghouse and the NRC discussed the path forward and resolution of the NRC comments. Revision 3 to FSSFR Volume 3 Chapter 1 implemented the resolution of the comments. Revision 1 of this Survey Area Release Record implements Revision 3 to FSSFR Volume 3 Chapter 1 within this report. Additionally, minor formatting and editorial changes have been made to align this survey area release record with subsequent survey area release records submitted to the NRC.

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LIST OF ACRONYMS AND SYMBOLS

ALARA	As Low As Reasonably Achievable
bgs	below ground surface
CFR	Code of Federal Regulations
cm	centimeter(s)
cpm	count(s) per minute
CSM	Conceptual Site Model
DCGL	Derived Concentration Guideline Level
$DCGL_W$	DCGL for average concentrations over a survey unit, used with statistical tests. ("W" suffix denotes "Wilcoxon")
DGPS	Digital Global Positioning System
DP	Hematite Decommissioning Plan
DQO	Data Quality Observation
EMC	Elevated Measurement Comparison
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
FSS	Final Status Survey
FSSFR	Final Status Survey Final Report
gcpm	gross count(s) per minute
GIS	Graphical Information Software
GPS	Global Positioning System
GWS	Gamma Walkover Survey
HDP	Hematite Decommissioning Project
HP	Health Physics
HRCR	Hematite Radiological Characterization Report
I & C	Isolation and Control
IAL	Investigation Action Level
LSA	Land Survey Area
m	meter(s)
m^2	square meter(s)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Concentration Limit
MDC	Minimum Detectable Concentration
mrem	milliroentgen equivalent man
NAD	North American Datum
NaI	Sodium Iodide
ncpm	net count(s) per minute
NCS	Nuclear Criticality Safety
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocurie(s) per gram
QC	Quality Control
Ra	Radium
RASS	Remedial Action Support Survey
RSO	Radiation Safety Officer
SOF	Sum of Fractions

SU	Survey Unit
Tc	Technetium
Th	Thorium
U	Uranium
WRS	Wilcoxon Rank Sum

EXECUTIVE SUMMARY

This Survey Area Release Record (SARR) presents the results of the final status radiological surveys of the Hematite Decommissioning Project (HDP) Land Survey Area (LSA) 10, Survey Unit (SU) 13 (LSA 10-13) and SU 14 (LSA 10-14). As provided in Final Status Survey Final Report (FSSFR), Volume 1, Chapter 1, Section 7.0 {ML15257A307}, the final report summary, FSSFR Volume 7, *Final Status Survey Final Report*, will be submitted at the conclusion of the post-remediation groundwater monitoring period. FSSFR Volume 7 will be submitted to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 Code of Federal Regulations (CFR) 20 Subpart E, "Criteria for License Termination."

Both LSA 10-13 and LSA 10-14 were designated as Class 1 SUs as presented in Table 14-16 of the HDP Decommissioning Plan (DP) {ML092330123}. The Class 1 designation for both SUs remained in effect throughout remediation and Final Status Survey (FSS). For both SUs, evaluation of analytical results against the Derived Concentration Guideline Levels (DCGL) for the Uniform Stratum Conceptual Site Model (CSM) was the selected approach. The objective of the FSS for both SUs was to obtain and document measurement results, analytical data, and other supporting information in order to demonstrate that after completion of remediation the residual radioactivity levels in the LSA 10-13 and LSA 10-14 SUs are below the applicable Uniform Stratum DCGLs and therefore the land area of these SUs meet the criteria for unrestricted release.

The Uniform Stratum CSM assumes residual radioactivity is uniformly distributed over the entire depth profile of the SU from ground surface to 6.7 meter (m) below ground surface (bgs). As described in FSSFR Volume 3, Chapter 1, 6.2.1, *Systematic Soil Sampling*, systematic soil samples were obtained at depths dependent upon the systematic soil sample location.

This SARR was prepared as described in FSSFR Volume 3, Chapter 1, Section 7.0, *Survey Area Release Record Organization*, as implemented by FSS procedure HDP-PR-FSS-722.

1.0 REPORT BACKGROUND

As a result of the U. S. Nuclear Regulatory Commission (NRC) feedback regarding the submittal of the FSSFR, Westinghouse and the NRC agreed that Westinghouse would develop an outline presenting the format and content of FSS documents required for NRC review. Westinghouse provided the outline to the NRC for discussion during the August 19, 2015, publicly noticed teleconference and the format was agreed upon {ML15238B032}.

FSSFR Volume 3, Chapter 1, Revision 3, *Land Survey Areas (LSA) Overview* provides the information common to land survey areas. This report, FSSFR Volume 3, Chapter 5, builds upon the general information provided in FSSFR Volume 3, Chapter 1, Revision 3.

2.0 HDP SITE, LSA AND SURVEY UNIT DESCRIPTIONS

2.1 HDP Site Description

A general description of the HDP site is given in FSSFR Volume 1, Chapter 1.

2.2 LSA Configuration

The DP Chapter 14 and DP Figure 14-14 provided the conceptual approach for the configuration of LSAs and the survey units within a LSA. Figure 2-1 indicates the LSA configurations for the HDP site.

The DP stated that it was expected that the conceptual boundaries of the SUs would be altered based on the actual configuration and condition of the SU at the time of survey design. As expected, it was necessary to modify the boundary of LSA 10 to facilitate the remediation process. The expansion of LSA 10 was due in part to benching and sloping requirements for excavations and also to ensure adequate remediation of specific areas as indicated by the results of visual inspection and radiological survey. As a result of the expansion of LSA 10, the individual SUs within LSA 10 were also modified. All SUs within LSA 10 were initially classified as Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 1 survey areas in DP Chapter 14. Therefore, for FSS, all SUs within LSA 10 remained classified as MARSSIM Class 1 survey areas, thereby ensuring compliance with the DP.

LSA 10 encompasses the entire "Documented Burial Pit Area" footprint within the Central Tract. LSA 10 consists of SUs LSA 10-01 through LSA 10-14.

2.3 LSA 10-13 and LSA 10-14 Survey Unit Description and Configuration

LSA 10-13 and LSA 10-14 are located within the southern half of LSA 10, the Burial Pit Area. Figure 2-2 indicates the location of LSA 10-13 and LSA 10-14 within LSA 10. Figure 2-3 presents the Final Configuration of the HDP Land Survey Areas and SUs which indicate the location of the boundaries of LSA 10-13 and LSA 10-14.

After the removal of buried materials and the completion of radiological remediation, in the final configuration, LSA 10-13 and LSA 10-14 consisted primarily of the excavated area in the SU which consisted of native soil. There were no structures, piping, groundwater monitoring wells, or spent limestone remaining within the SUs.

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 10-13 presents 1,895 square meters (m^2) in planar (2-dimensional) extent, within an interior surface area of 2,101 m^2 (3-dimensional).

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 10-14 presents 1,756 m^2 in planar (2-dimensional) extent, within an interior surface area of 2,029 m^2 (3-dimensional).

Figure 2-1
HDP Land Survey Areas

Figure 2-2
Final Configuration of Land Survey Area 10 and Survey Units

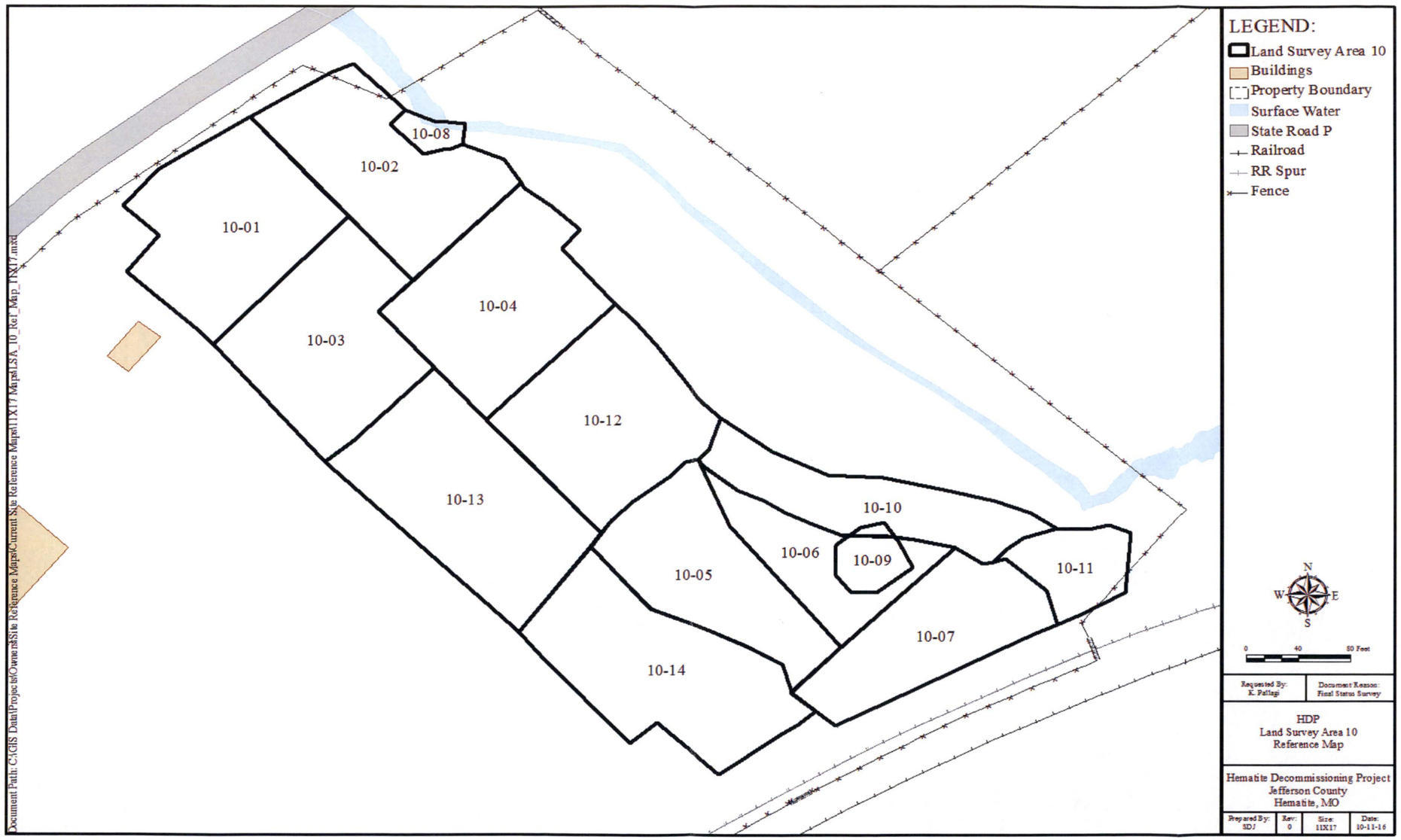
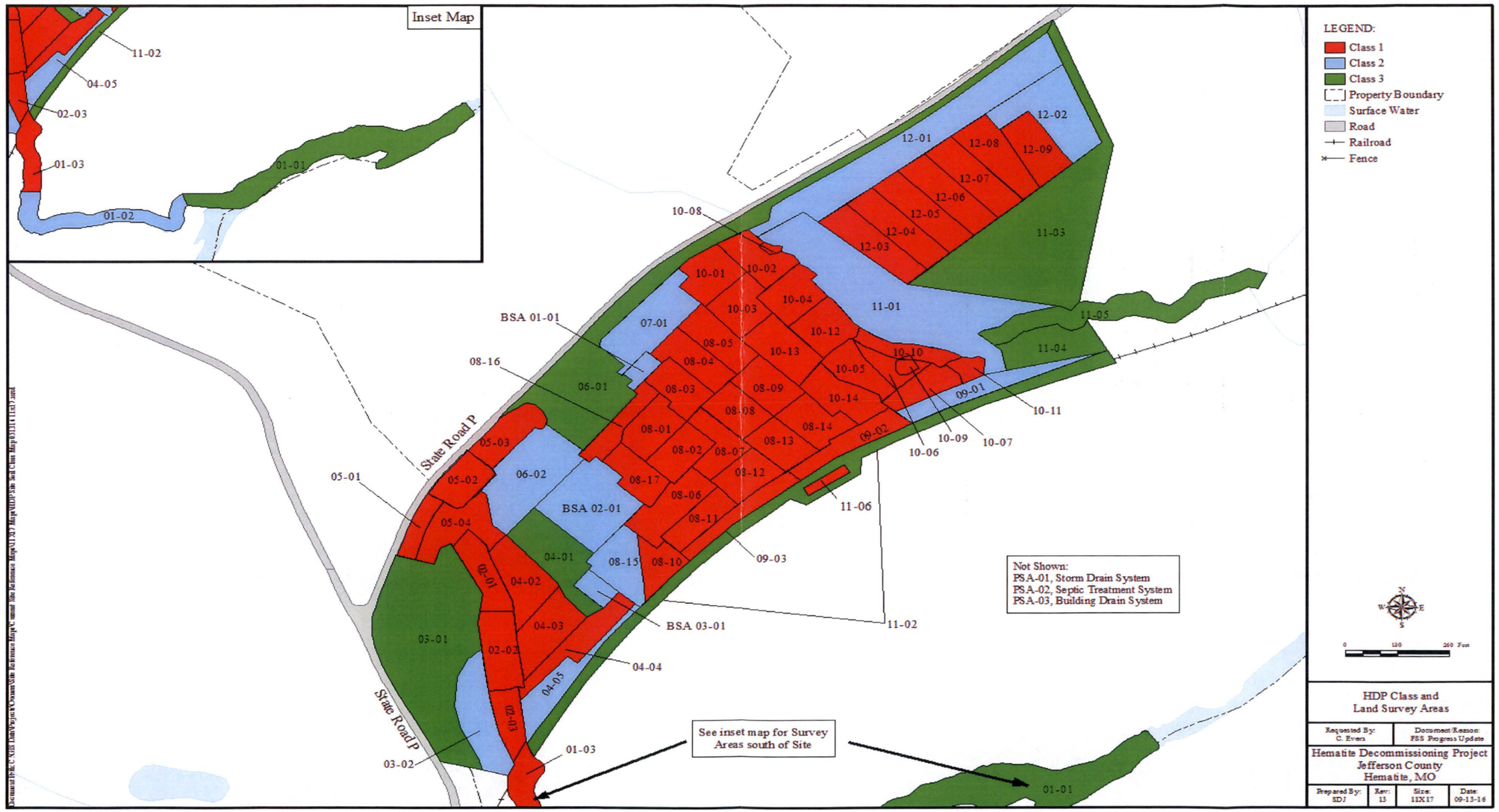


Figure 2-3
Final Configuration of Land Survey Areas and Survey Units



3.0 HISTORY OF OPERATIONS

A discussion of site historical operations prior to the decommissioning phase of the HDP is presented in the FSSFR Volume 1, Chapter 1, Section 3.0, *Site Historical Operations*.

A detailed discussion of the historical background information related to the documented burial pits in the Burial Pit Area is presented in the FSSFR Volume 3, Chapter 1, Section 2.1, *Documented Burial Pits*.

A detailed discussion of the historical background information related to undocumented burials within the HDP site proper is presented in the FSSFR Volume 3, Chapter 1, Section 2.2, *Undocumented Burials*.

3.1 Radioactive Materials in LSA 10-13 and LSA 10-14

Radioactive materials within LSA 10-13 and LSA 10-14 resulted from placement of radioactive contaminated materials below grade and above grade. During the remediation (see Figure 3-1) of LSA 10-13 and LSA 10-14 various types of waste materials were encountered, including drums, bags of trash, fuel pellets, construction debris, small quantities of spent limestone, and contaminated soils.

Remedial actions within the Burial Pit Area revealed that although the underlying burial pits were nearly contiguous, individual burial pits were readily identifiable based on changes in soil color, soil hardness, visibly obvious items of non-native debris, and elevated gamma readings as measured by field instrumentation (see Figure 3-2). Figure 3-11 shows that all intervening soils between individual pits were removed during the remedial excavation regardless of radioactivity concentration.

Figure 3-1
Early Stage of Remedial Excavation in South Burial Pit Area (2012)

Figure 3-2
Burial Pit Becoming Clearly Visible after Overburden Removal (LSA 10-14)

3.2 Reuse Soil Disposition and Characterization

Prior to remediation and removal of contaminated soil and other waste materials within LSA 10-13 and LSA 10-14, overburden soils which exhibited characteristics suitable for potential reuse as onsite backfill material were removed, segregated, and subjected to reuse soil criteria requirements.

A detailed discussion of reuse soils, including general description, segregation, surveys, sorting technology, and technical requirements may be found in the FSSFR Volume 2, Chapter 1.

3.3 Remediation and Remedial Action Support Surveys (RASS) Phase of LSA 10-13 and LSA 10-14

The sections below provide a discussion of the various elements of remediation and the RASS phase of LSA 10-13 and LSA 10-14 necessary to prepare the SUs for FSS.

3.3.1 Remedial Actions

Remedial actions began in LSA 10-13 and LSA 10-14 in April, 2012, and continued through March, 2015. Types of waste materials encountered during the remediation were detailed in Section 3.1.

There were several indicators inherent in the remediation process of LSA 10-13 and LSA 10-14 in which a portion of the Burial Pit Area was located that provided assurance that all wastes were removed prior to the initiation of FSS. As discussed in FSSFR Volume 3, Chapter 1, there was ample historical evidence to confidently delineate the spatial boundary of the Burial Pit Area. As the overburden soil was removed it was easy to visually identify the location of a burial pit based on a change in soil color. Even the undocumented burials were easily identified by a change in soil color even though their size and shape was not as well defined as the documented burial pits (see Figure 3-3). Additionally, the equipment operators conducting the excavation could distinguish when they were digging in a burial pit based on the difference in the hardness of the soil. Workers could even detect the difference in the soil hardness when walking over burial pits, which tended to be soft and spongy. Adding to the visual and soil hardness cues, the burial pits were also radiologically identifiable based on gamma walkover surveys (GWS) once the contaminated layers were reached (see Figure 3-4). In summary, both documented and undocumented burials were easy to distinguish once excavation activities commenced.

Figure 3-3
Example of Burial Pit Soil Discoloration

Figure 3-4
Example of Unearthed Trash and Debris in the Burial Pit Area

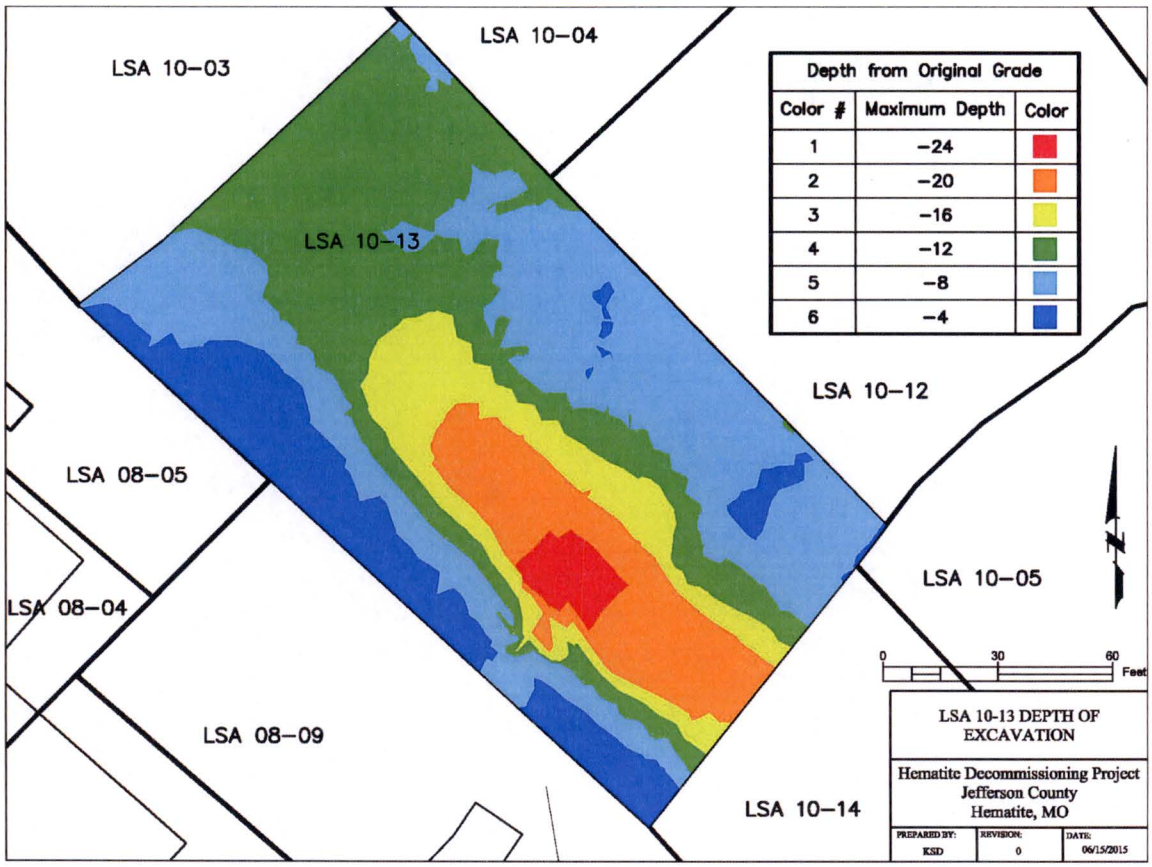
As excavation and remediation of the Burial Pit Area progressed, it became apparent that most of the buried debris was located in the north and south ends of the Burial Pit Area, and typically in closely aligned pits, while the central area had minimal debris and contamination. Since sloping and benching practices were employed, and due to the close nature of the pits, a larger than expected quantity of soil was removed. This resulted in a larger single excavation area as opposed to individual standalone pits.

As excavation progressed for the removal of contaminated wastes and debris in the Burial Pit Area, five activities came into play that determined the extent of remediation in a given survey unit. These were: 1) in process Remedial Action Support Surveys (RASS), 2) conducting core bores to support moving out of nuclear criticality safety controls, 3) performing a final RASS, 4) sampling for VOC remediation, and 5) conducting FSS. These will be discussed in later sections.

The HDP Technical Report HDP-RPT-FSS-303 *Summary Report for Burial Pit Area Remediation* (Appendix H) contains additional specific information related to the remediation of the Burial Pit Area.

The maximum depth of remedial excavation necessary in portions of LSA 10-13 to ensure all areas identified during site characterization and remedial action survey efforts were adequately remediated relative to the original grade was 24 feet. The estimated volume of excavated waste materials from LSA 10-13 was 6,817 cubic yards. Figure 3-5 provides the depth of excavations for LSA 10-13.

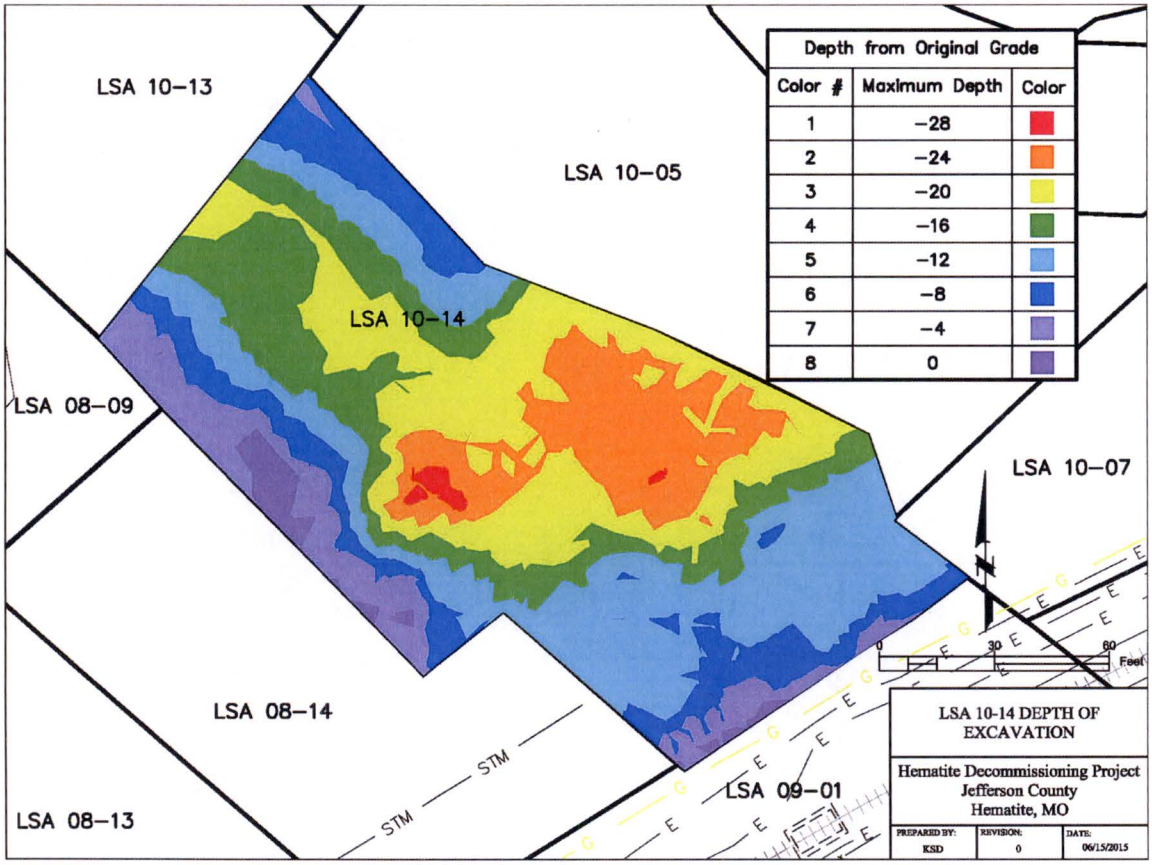
Figure 3-5
LSA 10-13 Depth of Excavation Map (Depths in Feet)*



*Depth of Excavation Map presented in colored bands of feet. Maximum depth is 24 feet.

The maximum depth of remedial excavation necessary in portions of LSA 10-14 to ensure all areas identified during site characterization and remedial action survey efforts were adequately remediated relative to the original grade was 28 feet. The estimated volume of excavated waste materials from LSA 10-14 was 8,754 cubic yards. Figure 3-6 provides the depth of excavations for LSA 10-14.

Figure 3-6
LSA 10-14 Depth of Excavation Map (Depths in Feet)*



*Depth of Excavation Map presented in colored bands of feet. Maximum depth is 28 feet.

3.3.2 In Process Remedial Action Support Surveys

During excavation and remediation of the Burial Pit Area, remedial action support surveys were conducted in accordance with procedure HDP-PR-HP-601, *Remedial Action Support Surveys*. The radiological information obtained from the surveys served the purpose of categorizing the soil/debris into one of four categories; 1) Soil/debris potentially exceeding the Nuclear Criticality Safety Exempt Material Limit, 2) Soil/debris potentially containing radioactivity concentrations above the Reuse Material Screening Level (RML), 3) Soil expected to contain radioactivity concentrations that were less than the RML but requiring removal in order to access additional soil/debris having radioactivity concentrations above the RML, and 4) Soil expected to contain radioactivity concentrations that are less than the RML and not requiring removal.

3.3.3 Nuclear Criticality Safety (NCS) Borings

In addition to the visual inspection and radiological measurements conducted to determine when removal of buried waste was complete and NCS controls could be removed during remediation of LSA 10-13 and LSA 10-14, a series of borings were performed within the NCS Controlled areas of the SUs.

As directed by NSA-TR-09-15, *Nuclear Criticality Safety Assessment of Buried Waste Exhumation and Contaminated Soil Remediation at the Hematite Site* (Reference 12.3), borings were performed for the purpose of downgrading from NCS controls and included an inspection of the core bore soil to confirm that no burial pit debris was present below the excavation surface. The NSA-TR-09-15 Administrative CSC 23 required that these borings (see Figure 3-7 and Figure 3-8) would be performed to 3 feet (ft) below the deepest identified buried waste item in an excavation or 7 ft bgs (representative of 4 ft of overburden soil and an additional 3 ft into the soil that could have potential burial pit waste). In addition to performing a boring below the deepest identified waste item in an excavation, a grid with maximum spacing of 20 ft between boreholes was conducted within the entire documented burial pit area. The grid spacing chosen was based upon the nominal size of a documented burial pit. The spacing was chosen to provide a high probability that material from an unidentified burial pit would be intercepted.

The survey measurements from all of the spoils material and boreholes for LSA 10-13 and LSA 10-14, along with the results of the visual inspection, were then reviewed by the NCS Specialist and the area released from NCS controls. The visual inspection of the cores provided evidence that no materials indicative of burial pit waste were encountered below the excavation surface within LSA 10-13 and LSA 10-14. Once the area was released from NCS controls, excavation continued as necessary for additional remediation of radiological and/or VOC contamination.

No materials indicative of burial pit waste were encountered below the excavation surface within LSA 10-13 and LSA 10-14.

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Figure 3-7
NCS Core Bore Locations in LSA 10-13

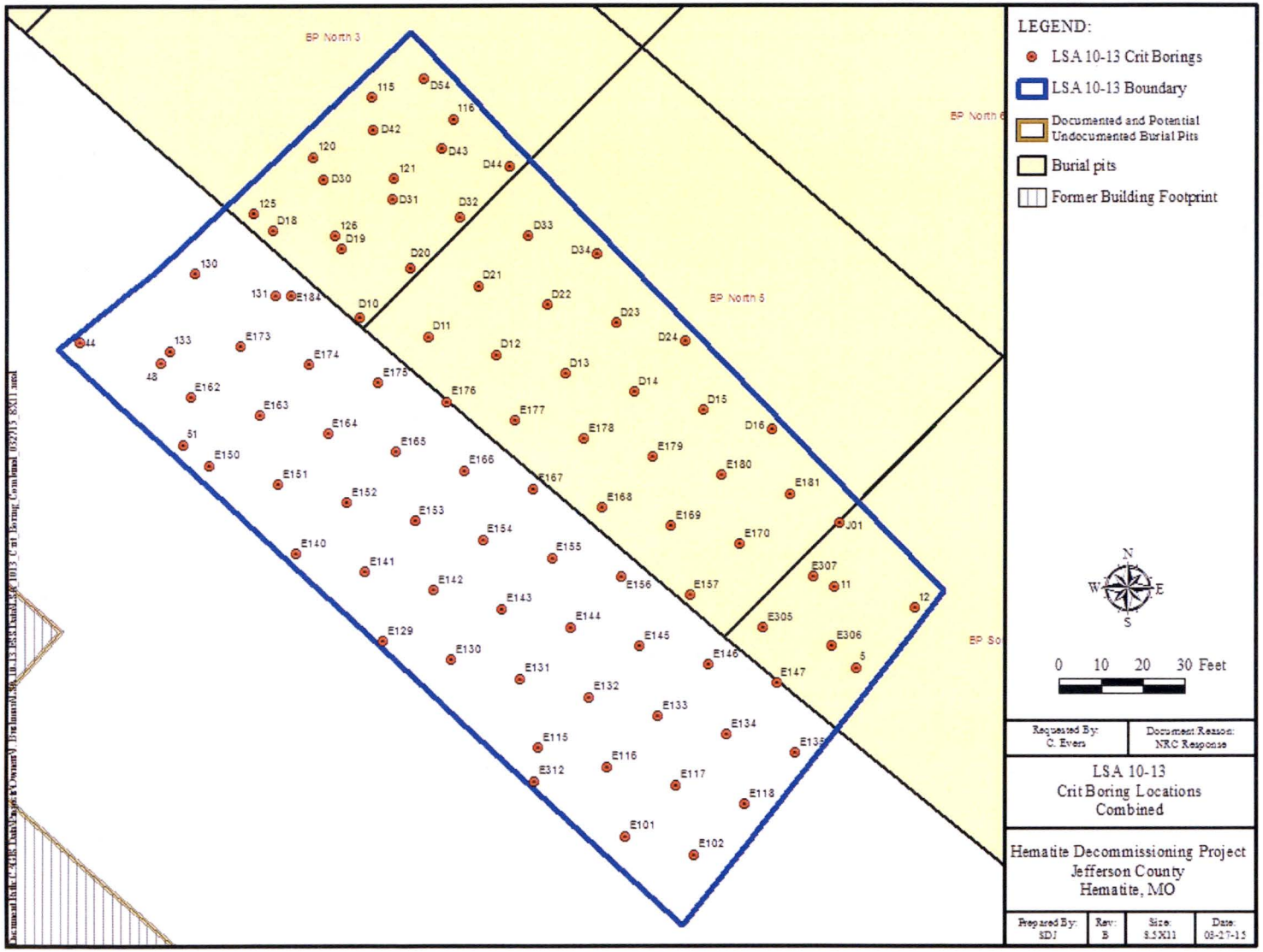
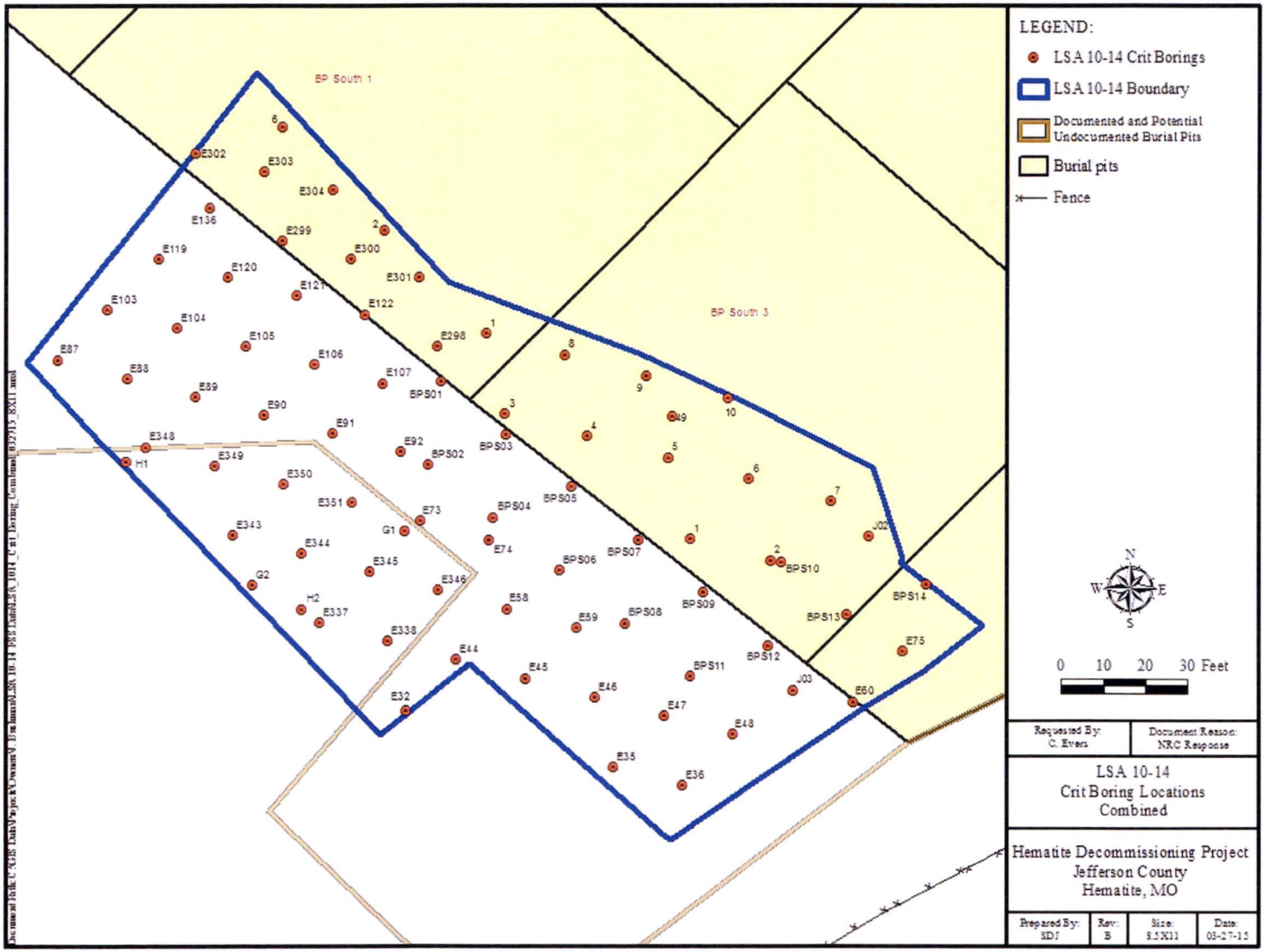


Figure 3-8
NCS Core Bore Locations in LSA 10-14



3.3.4 Groundwater Monitoring Wells

A detailed discussion of history, purpose, use, issues, and results of the groundwater monitoring wells at HDP is presented in the FSSFR Volume 6, Chapter 1.

During the history of site operations and remediation no groundwater monitoring wells were located within the boundary limits of LSA 10-13 and LSA 10-14.

3.3.5 Subterranean Piping

Preliminary remediation planning activities indicated that no subterranean process piping should be encountered in LSA 10-13 and LSA 10-14. During remediation of LSA 10-13 and LSA 10-14 no subterranean process piping was encountered.

As no buried piping remains under the footprint of LSA 10-13 and LSA 10-14 there is no dose contribution from this pathway.

3.3.6 Characterization Core Bores

Radiological characterization surveys for the HDP were conducted in several phases by multiple contractors over several years prior to the issuance of the DP. A total of thirty eight (38) core borings to depths as deep as 35 feet bgs were performed for characterization within both LSA 10-13 and LSA 10-14 prior to remediation.

Within LSA 10-13, one sample (SO-BP4F) of the fifteen characterization boring locations within the SU exceeded a SOF of 1 as compared to the Uniform Stratum criteria at a depth of 8 ft bgs. This was removed during remediation with excavation occurring to a depth of at least 12 ft bgs at this location. Figure 3-9 indicates the radiological characterization boring locations within LSA 10-13

Within LSA 10-14, of the twenty three (23) characterization boring locations within the SU ten (10) samples (five in the Surface Stratum and five in the Root Stratum) exceeded a SOF of 1 as compared to the Uniform Stratum criteria from the surface to depths of up to 5 ft bgs (Root Stratum). Within LSA 10-14 the Surface Stratum was entirely removed. The five (5) Root Stratum samples (SS-HS-001, LB36R, LB3637RC5, LB37R, and LB39R) exceeded a SOF of 1 at depths up to 5 ft bgs, with all 5 of these locations being excavated to depths greater than 8 ft bgs. Figure 3-10 indicates the radiological characterization boring locations within LSA 10-14.

Figure 3-9
Site Characterization Borings within LSA 10-13

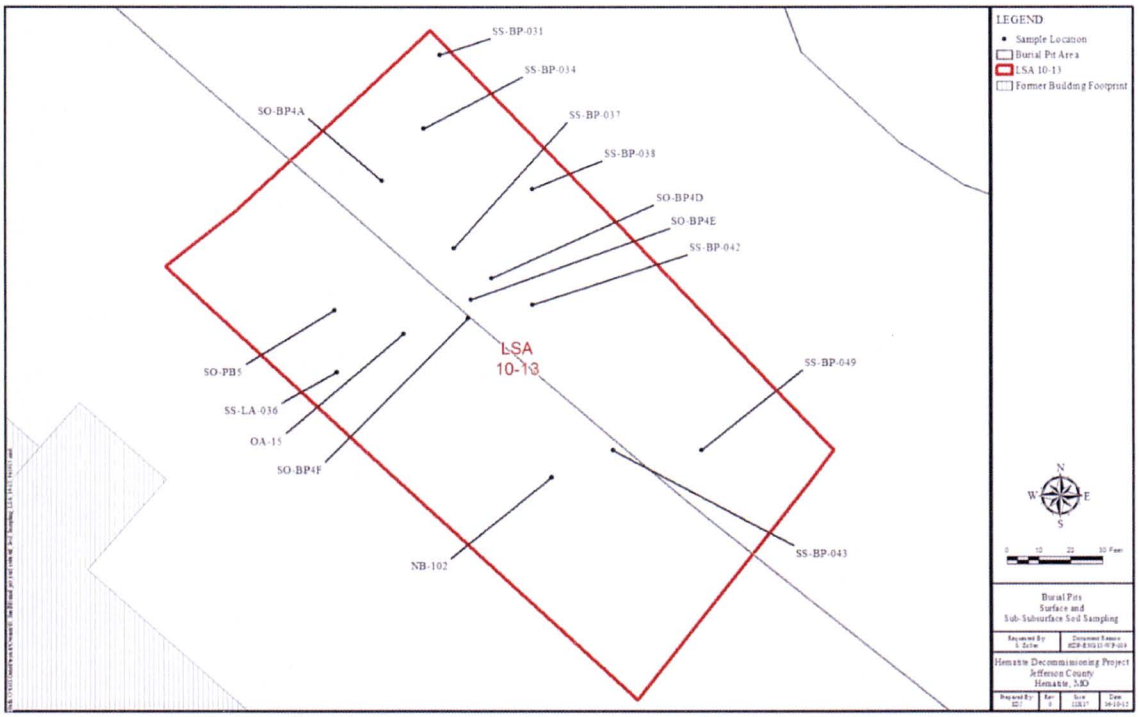
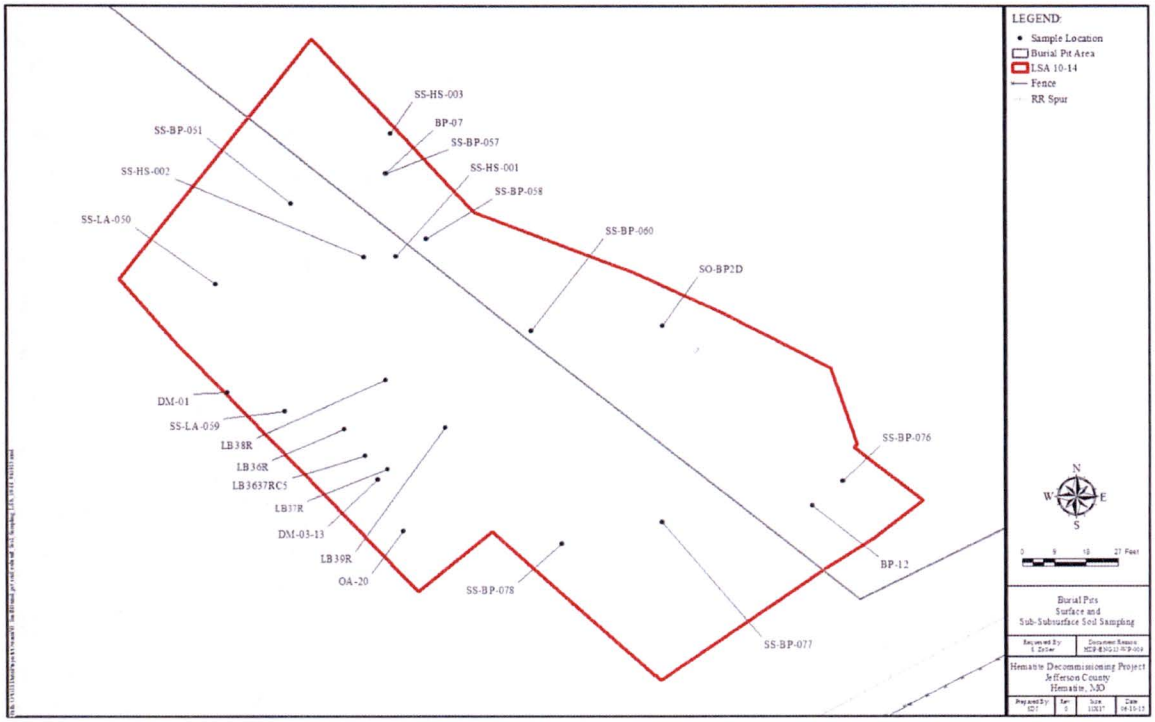


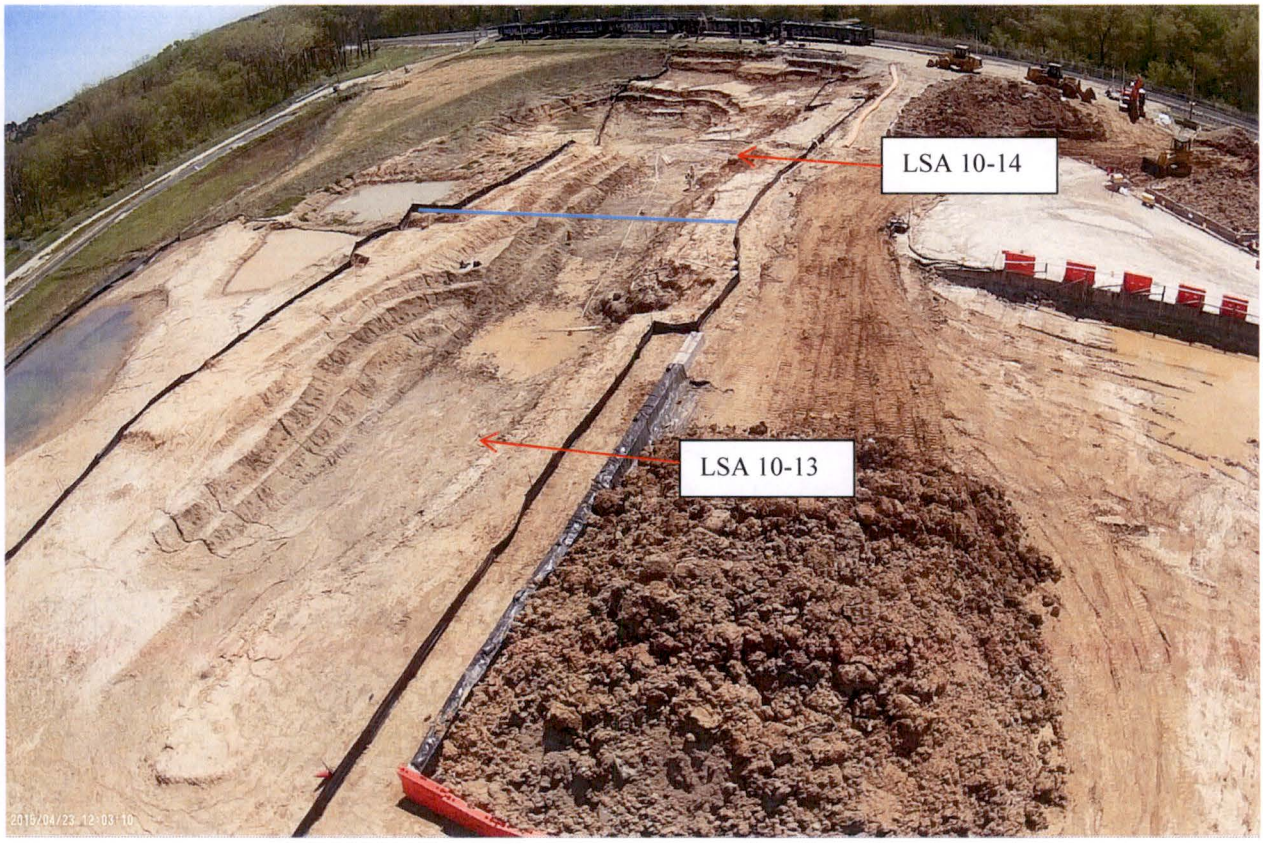
Figure 3-10
Site Characterization Borings within LSA 10-14



3.3.7 Remedial Action Support Survey for FSS Design

The RASS was conducted 1) to guide remediation activities, 2) to determine when an area or survey unit had been adequately prepared for FSS, and 3) to provide updated estimates of the parameters to be used for planning the FSS. Upon completion of remediation within the survey unit and prior to implementation of FSS activities, a final RASS was performed to validate the status of the SU prior to implementing Isolation and Control (I & C) postings. The I & C posting for both LSA 10-13 and LSA 10-14 was completed on March 11, 2015. Figure 3-11 is a photograph which shows LSA 10-13 and LSA 10-14 ready for the final RASS.

Figure 3-11
LSA 10-13 and LSA 10-14 Prepared for RASS FSS Design



The RASS included a GWS, systematic surface sample collection based on an eight (8) -point triangular grid, and biased surface sampling. The Final RASS systematic sample results used to develop the FSS sampling grid are summarized in Table 3-1 below:

Table 3-1
Summary of Final RASS Results for LSA 10-13 and LSA 10-14

LSA	Ra-226 (net)		Tc-99		Th-232 (net)		U-234		U-235		U-238	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
10-13	0.01	0.04	0.21	0.65	0.19	0.28	3.96	14.40	0.22	0.80	1.06	2.50
10-14	0.03	0.23	1.89	11.10	0.17	0.31	2.54	6.17	0.11	0.21	2.89	16.03
DCGL[3]	1.9		25.1		2.0		195.4		51.6		168.8	

Notes:
1. All units are in picocuries per gram (pCi/g)
2. Results reflect net concentrations after subtraction of background (Ra-226 bkg = 0.9 pCi/g; Th-232 bkg = 1.0 pCi/g).
3. Uniform Stratum DCGLs (From Table 4-1)

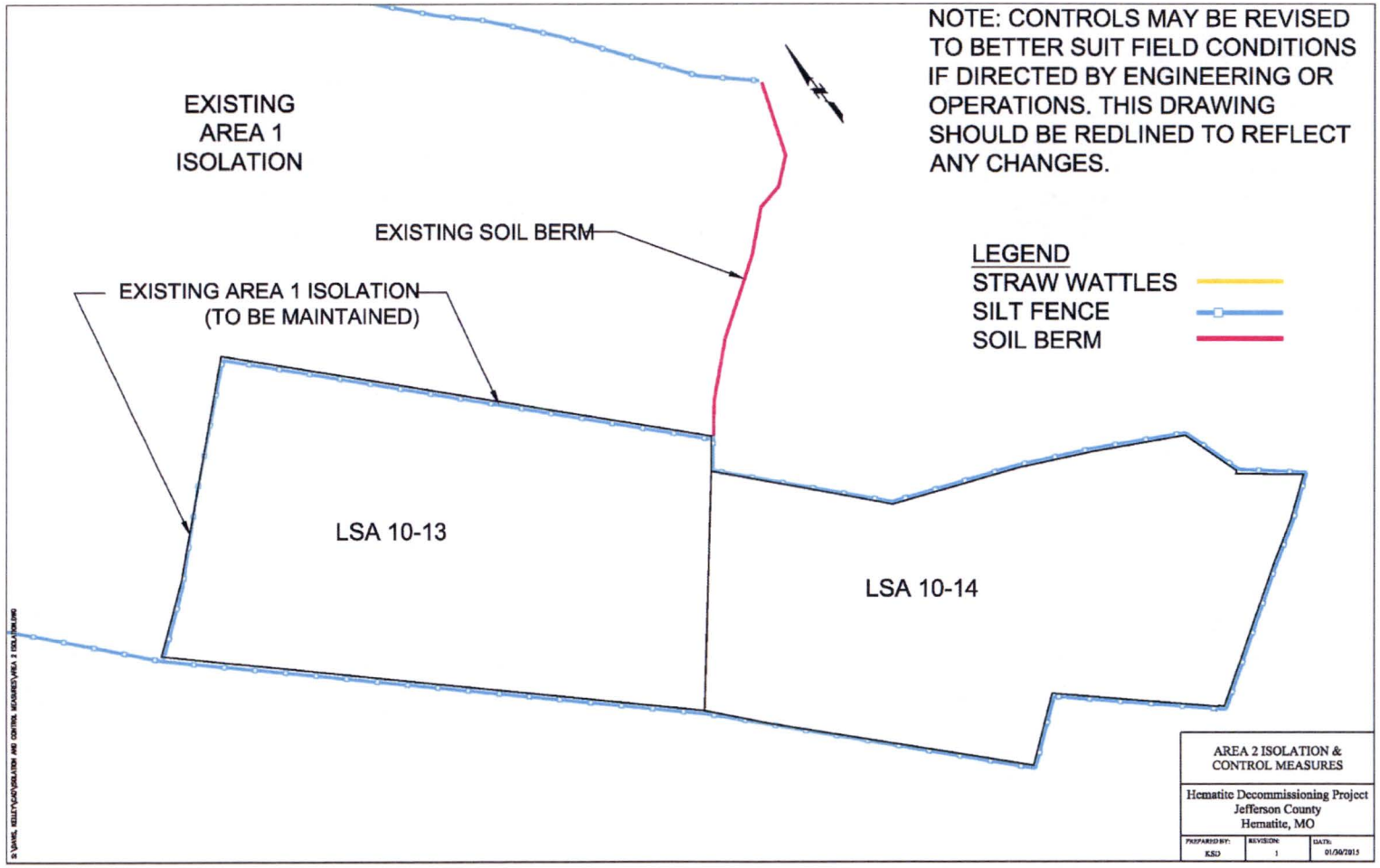
All Final RASS systematic sample and biased sample results were less than the appropriate $DCGL_W$ (Uniform Stratum) and the Final RASS data set was considered sufficient to support FSS design.

3.3.8 Isolation and Control

As directed by HDP-PR-HP-602, *Data Package Development and Isolation and Control Measures to Support Final Status Survey,* on March 11, 2015,, LSA 10-13 and LSA 10-14 were isolated and controlled in accordance with Work Package HDP-WP-ENG-803, *Isolation and Control Measures,* (See Figure 3-12) Isolation and control measures included silt fence, straw wattle, and soil berms between these SUs and the adjacent remediation area to ensure that cross-contamination of these LSAs undergoing FSS did not occur.

The administrative control of distinctive green and white rope with multiple postings labeled "Contact Health Physics Prior to Entry" was installed around the entire perimeter of the SUs prior to FSS field activities to prevent inadvertent entry by site personnel. LSA 10-13 and LSA 10-14 are located within the fenced security perimeter of the HDP which therefore prevents access by the general public.

Figure 3-12
Isolation and Control of Area Containing LSA 10-13 and LSA 10-14



3.3.9 Surveillance Following FSS

Following the completion of a FSS, the DP requires continued surveillance to minimize the potential to re-contaminate a survey unit (e.g., surface water transport of potentially contaminated sediment or a soil pile that was not present during FSS). The surveillance includes the routine visual inspection of the integrity of the I & C measures implemented for LSA 10-13 and LSA 10-14. If a survey unit is suspected of having been re-contaminated then an investigation survey will be performed to reconfirm the FSS survey validity.

3.3.10 Backfill of Survey Units

Although not a function of remediation, but as described in the DP Section 8.8 and FSFFR Volume 2 Chapter 1, the SUs will be backfilled using backfill obtained from on-site material determined to be suitable for reuse (e.g., excavated soil overburden), and/or backfill material from an off-site location.

FSSFR Volume 3, Chapter 1, Section 2.13, *Backfill Operations*, describes the methodologies for placement of backfill soil into an excavation and evaluations of dose impacts. FSSFR Volume 3, Chapter 1, Section 3.1.2 describes how the dose from on-site reuse soil will be added into the SU total dose evaluation.

The entire volume of Reuse Stockpile 3 (FSSFR Volume 2, Chapter 3 {ML16285A370}) material was used as backfill and placed within the Deep Stratum of LSA 10-13. As provided in FSSFR Volume 2, Chapter 3, Reuse Stockpile 3 has been calculated to contribute 3.5 mrem/year (milliroentgen equivalent man/year) to the total dose of a SU when evaluated against the Uniform Stratum release criteria (a SOF of 0.14 rounded up from 0.138). Therefore 3.5 mrem/year will be assigned to the Deep Stratum and added to the total dose calculation for SU LSA 10-13.

The entire volume of Combined Reuse Stockpile 1-2 (FSSFR Volume 2, Chapter 2 {16285A369}) material was used as backfill and placed within the Deep Stratum of LSA 10-14. As provided in FSSFR Volume 2, Chapter 2, Combined Reuse Stockpile 1-2 has been calculated to contribute 2.5 mrem/year to the total dose of a SU when evaluated against the Uniform Stratum release criteria (a SOF of 0.10 rounded up from 0.098). Therefore 2.5 mrem/year will be assigned to the Deep Stratum and added to the total dose calculation for survey unit LSA 10-14.

3.3.11 Groundwater Monitoring

In response to NRC RAI Chapter 3-4, during the review and approval process for the DP, Westinghouse documented in letter HEM-11-96 {ML111880290} the revised text of DP Section 14.5.1 to be as follows:

> "*Post-remediation monitoring wells will be sampled quarterly after the completion of remediation until license termination. The data collected will be used to confirm that the sum of the annual dose from groundwater for all the radionuclides does not exceed the EPA Maximum Contaminant Level (MCL) of 4 millirem/year. Separately, the sum of the dose from all residual sources remaining after remediation, including soil and groundwater*

pathways, will be confirmed to result in an annual dose that does not exceed 25 millirem/year."

As stated in the Executive Summary section, the exposure results of this report will be combined with the dose attributed to groundwater to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 CFR 20 Subpart E, "Criteria for License Termination." As such, for the purpose of this report, groundwater will be assigned a conservative SOF of 0.16 which equates to 4 mrem/year until such time that the post-remediation groundwater sampling has been completed and reported as part of FSSFR Volume 6, Chapter 7, *Post-remediation Groundwater Monitoring Summary*. The final dose for LSA 10-13 and LSA 10-14 will be reported in FSSFR Volume 7, reflecting the updated results of the post-remediation groundwater monitoring.

4.0 LSA RELEASE CRITERIA

As the release criteria for all LSA SUs is common, FSSFR Volume 3, Chapter 1, Section 3.0, *Release Criteria*, provides a detailed discussion on the release criteria that is applicable to LSA 10-13 and LSA 10-14. Table 4-1 provides the applicable DCGLs.

Table 4-1
Adjusted Soil $DCGL_w$'s by CSM[a]

Radionuclide	Three Layer Approach $DCGL_w$ Values (pCi/g)[b]			Uniform Stratum (pCi/g)
	Surface Stratum	Root Stratum	Excavation Scenario	
Radium-226+C[d]	5.0	2.1	5.4	**1.9**
Technetium-99	151.0	30.1	74.0	**25.1**
Thorium-232+C[d]	4.7	2.0	5.2	**2.0**
Uranium-234	508.5	235.6	872.4	**195.4**
Uranium-235+D[c]	102.3	64.1	208.1	**51.6**
Uranium-238+D[c]	297.6	183.3	551.1	**168.8**

[a] Table as presented in FSSFR Volume 3, Chapter 1.
[b] The reported DCGLw's are the activities for the parent radionuclide 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.

5.0 FINAL STATUS SURVEY DESIGN LSA 10-13

This section of the report describes the method for determining the number of samples required for the FSS of LSA 10-13 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_W$, scan survey coverage, and Investigation Action Levels (IAL). The radiological instrumentation used in the FSS of LSA 10-13 and the detection sensitivities are also discussed.

5.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 10-13 were driven by the type (Open Land) and Class (Class 1) of the survey unit and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 5, *Final Status Survey Plan Development*, January 2015.

5.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design.*

5.1.2 $DCGL_W$

During the FSS design process a review was performed of the historic characterization data for LSA 10-13. The review identified one (1) area that was previously found to exceed a Uniform SOF of 1.0 (discussed in Section 3.3.6). Next the remediation history of LSA 10-13 was reviewed to confirm that the area was adequately addressed. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform Stratum $DCGL_W$. Therefore the Uniform Stratum $DCGL_W$ was selected for use in demonstrating compliance with the release criteria.

5.1.3 GWS Coverage

As a Class 1 SU, LSA 10-13 was required to undergo a 100% GWS.

5.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 10-13 was the Ludlum 44-10 2" x 2" sodium iodide (NaI) detectors, coupled to a Ludlum 2221 scaler-ratemeter.

5.1.5 Scan Minimum Detectable Concentration (MDC)

As background levels were approximately 13,000 counts per minute (cpm) within LSA 10-13, the scan minimal detection concentration (MDC) calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{7383\ pCi/g}\right)+\left(\frac{f_{U-235}}{4.9 pCi/g}\right)+\left(\frac{f_{U-238}}{62.8 pCi/g}\right)\right)}$$

Equation 5-1

In order to calculate the Scan MDC for total uranium using the above equation, an average enrichment for the SU must be known which in turn will provide relative isotopic fractions for U-234, U-235, and U-238 as given in Appendix G of HDP-PR-FSS-701, Revision 4, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 10-13, the average enrichment for the SU was 2.8%.

Standard Scan MDCs for Radium-226 and Thorium-232 using a 2" x 2" NaI detector are found in Table 6.4 of NUREG-1507 and are shown in Table 5-1. Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 10-13 are shown below:

Table 5-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 10-13

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 10-13	40.4	25.7	1.19	2.8	0.85	3.0

*$DCGL_W$ includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. $DCGL_W$ values are based on the Uniform Stratum release criteria.

The values in Table 5-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS.

5.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site*". The IAL used during the GWS of LSA 10-13 was established at 4,000 net counts per minute (ncpm).

5.1.7 LSA 10-13 FSS Design Summary

The FSS Plan for LSA 10-13 can be found in Appendix C. Table 5-2 presents an overall FSS design and implementation summary for LSA 10-13.

Table 5-2
FSS Design Summary for LSA 10-13

Gamma Walkover Survey (GWS):		
Scan Coverage	100% exposed excavation floors, benches, pits, and sidewalls	
Scan MDC	40.4 pCi/g total Uranium (based on a 13,000 cpm background); 0.85 pCi/g Th-232; 1.19 pCi/g Ra-226*	
Investigation Action Level (IAL)	4,000 net cpm* *	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments
0 – 15 cm (Surface)	0	These samples were collected on a systematic grid.
15 cm – 1.5 m (Root)	4	
> 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 FSS Supervisor.		
Sidewall Sampling Locations:		
Supplemental Sidewall Sampling: In accordance with *HEM-15-MEMO-039*, two (2) discretionary sidewall samples will be collected based on the following definition of "sidewall": 1) sidewalls must be vertical or near vertical and at least 12" in height, and 2) constitute an aggregate surface area which exceeds 5% of the total surface area of the SU, e.g., 100 m^2 of sidewall area in a 2,000 m^2 SU.		
Instrumentation		
Ludlum 2221 with 44-10 (2" x 2" 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)*", Westinghouse, April 2015.		
**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.		

6.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 10-13

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

6.1 Gamma Walkover Survey

6.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 10-13 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS (Digital Global Positioning System) and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

6.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the survey unit was 1 GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, North American Datum (NAD) 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the HP Technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

HP Technicians performing GWS in LSA 10-13 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 13,000 gross counts per minute (gcpm). Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 18,000 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Sidewalls, hard to reach areas, and non-typical areas were surveyed manually to the maximum extent practical in order to assess the potential for an area of elevated residual activity over 100% of the exposed excavation surface.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics (HP) Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

6.2 Soil Sampling

6.2.1 Systematic Soil Sampling Summary

Table 6-1 provides a summary of systematic sampling by stratum for LSA 10-13.

Table 6-1
Systematic Sampling Summary by Stratum for LSA 10-13

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
10-13	1,895	0	4	8	1

6.2.2 Systematic Sampling LSA 10-13

Within LSA 10-13, there were no systematic locations in which portions of the surface stratum [0 – 15 centimeters (cm)] remained in the SU after remediation. Portions of the root stratum (15 cm – 150 cm) remained at four (4) of the eight systematic locations. At this location the remaining root stratum interval was collected using a hand auger and composited. Excavation stratum samples were collected at all eight locations using either hand trowels, or hand augers where necessary, for six-inch grab samples below the existing excavation surface.

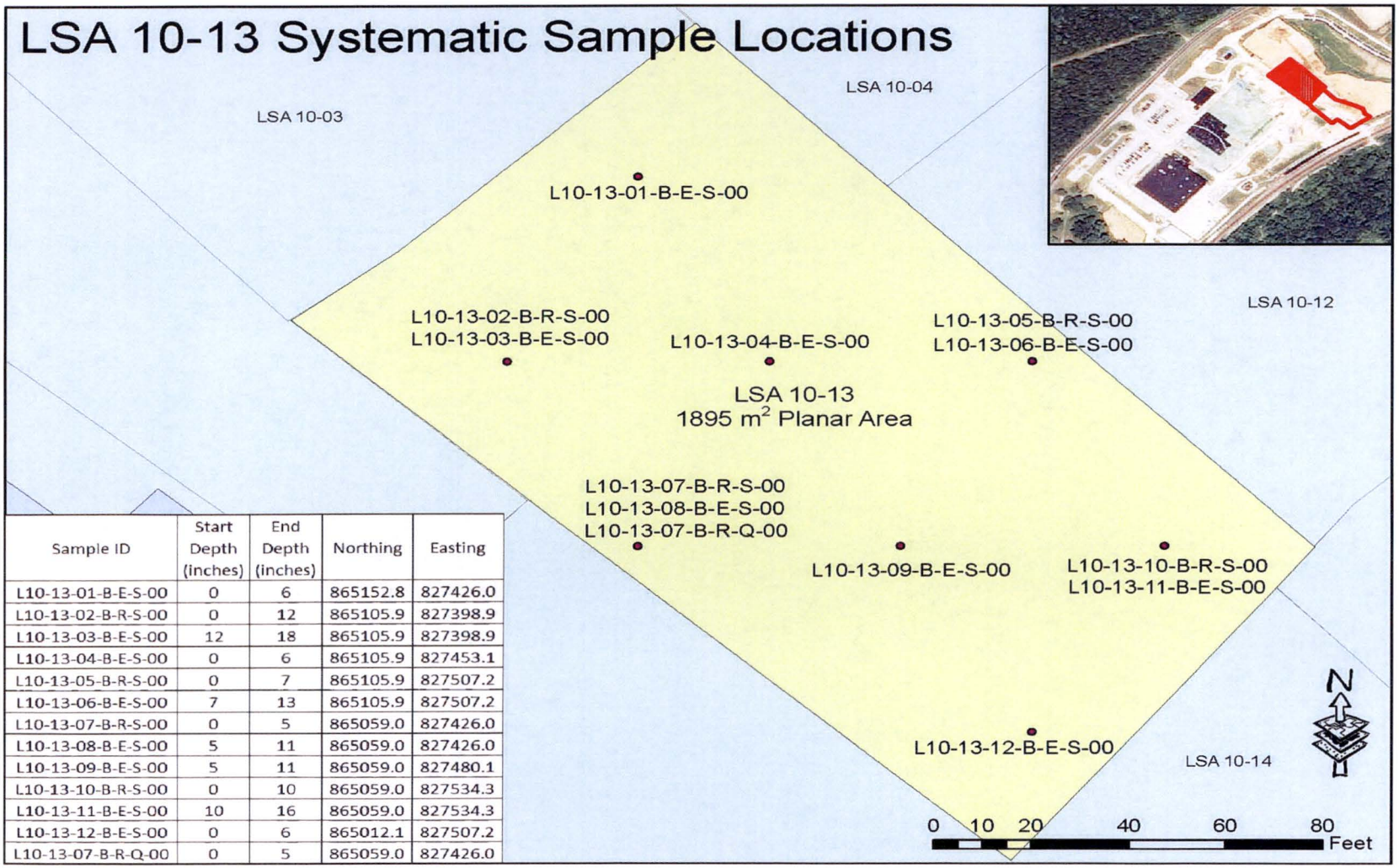
Given a planar area of 1,590 m^2 for LSA 10-13 and an eight - point systematic triangular grid, the point-to-point distance within each row was 15.1 m with spacing of 13.1 m between each of the parallel grid rows within the SU.

While there were eight (8) systematic locations on the LSA 10-13 sampling grid, a total of thirteen (13) samples were collected at these locations, including:

- Zero (0) samples collected within the remaining surface stratum
- Four (4) samples collected within the remaining root stratum
- Eight (8) samples collected within the excavation, or "deep" stratum
- One (1) Quality Control (QC) field replicate

Figure 6-1 presents the map of the eight systematic sample locations which were sampled within LSA 10-13. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 6-1
LSA 10-13 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L10-13-01-B-E-S-00	0	6	865152.8	827426.0
L10-13-02-B-R-S-00	0	12	865105.9	827398.9
L10-13-03-B-E-S-00	12	18	865105.9	827398.9
L10-13-04-B-E-S-00	0	6	865105.9	827453.1
L10-13-05-B-R-S-00	0	7	865105.9	827507.2
L10-13-06-B-E-S-00	7	13	865105.9	827507.2
L10-13-07-B-R-S-00	0	5	865059.0	827426.0
L10-13-08-B-E-S-00	5	11	865059.0	827426.0
L10-13-09-B-E-S-00	5	11	865059.0	827480.1
L10-13-10-B-R-S-00	0	10	865059.0	827534.3
L10-13-11-B-E-S-00	10	16	865059.0	827534.3
L10-13-12-B-E-S-00	0	6	865012.1	827507.2
L10-13-07-B-R-Q-00	0	5	865059.0	827426.0

Table 6-2 below presents a tabular listing of all FSS samples collected within LSA 10-13 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 6-2
FSS Sample Locations and Coordinates for LSA 10-13

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
	Westinghouse Non-Proprietary Class 3	Revision: 5	Appendix P-4, Page 1 of 1

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area:	LSA 10	**Description:**	Burial Pits Open Land Area
Survey Unit:	13	**Description:**	Northern Survey Unit in "Area 2"
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
L10-13-01-B-E-S-00	Uniform	S	426.4	426.0	865152.8	827426.0	Excavation 6-inch grab
L10-13-02-B-R-S-00	Uniform	S	431.2	429.7	865105.9	827398.9	Root 12-inch composite
L10-13-03-B-E-S-00	Uniform	S	429.7	429.2	865105.9	827398.9	Excavation 6-inch grab
L10-13-04-B-E-S-00	Uniform	S	421.5	421.1	865105.9	827453.1	Excavation 6-inch grab
L10-13-05-B-R-S-00	Uniform	S	429.1	428.0	865105.9	827507.2	Root 7-inch composite
L10-13-06-B-E-S-00	Uniform	S	428.0	427.5	865105.9	827507.2	Excavation 6-inch grab
L10-13-07-B-R-S-00	Uniform	S	431.5	430.6	865059.0	827426.0	Root 5-inch composite
L10-13-08-B-E-S-00	Uniform	S	430.6	430.1	865059.0	827426.0	Excavation 6-inch grab
L10-13-09-B-E-S-00	Uniform	S	415.3	414.8	865059.0	827480.1	Excavation 6-inch grab
L10-13-10-B-R-S-00	Uniform	S	429.7	428.4	865059.0	827534.3	Root 10-inch composite
L10-13-11-B-E-S-00	Uniform	S	428.4	427.9	865059.0	827534.3	Excavation 6-inch grab
L10-13-12-B-E-S-00	Uniform	S	419.1	418.6	865012.1	827507.2	Excavation 6-inch grab
L10-13-07-B-R-Q-00	Uniform	Q	431.5	430.6	865059.0	827426.0	Excavation 6-inch grab
L10-13-13-B-R-B-00	Uniform	B	435.0	431.5	865063.0	827417.0	Biased 6-inch Grab
L10-13-14-B-E-B-00	Uniform	B	419.1	418.6	865069.6	827494.4	Sidewall 6-inch grab
L10-13-15-B-E-B-00	Uniform	B	421.6	421.1	865060.7	827453.1	Sidewall 6-inch grab

Green shaded samples are the samples at each sample location, for use in WRS test.

*Elevations are in feet above mean sea level.

** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

6.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 10-13 one (1) biased sample location was selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. This biased location represented the maximum GWS measurement encountered within the SU. Also, this single biased location was the only point which exceeded both the IAL based on the local background readings and a Z-score of 3. Therefore, no additional biased locations were selected for sampling. Westinghouse conservatively decided to perform additional remediation at this location after the sample was collected; the initial GWS reading at L10-13-13 was the SU maximum of approximately 21,800 gcpm. After the manual remediation, the GWS reading at this location was reduced to approximately 14,000 gcpm. This issue is also discussed in Section 9.1– FSS Plan Deviations. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

6.4 Judgmental/Sidewall Sampling for Tc-99

In accordance with the guidance specified in Volume 3, Chapter 1, Section 6.2.3, it was determined that sidewall sampling was necessary. The number of sidewall samples collected from each SU is determined by comparing the sidewall surface area to the two dimensional systematic surface area (e.g., 8 systematic samples were collected over 2,000 m^2, then collect 1 sample per 250 m^2 of sidewall). Two samples were collected in the sidewall of LSA 10-13. These samples were collected from locations selected by the HP Technician at random, and were not based on gamma survey readings (not biased). The results are presented in Section 7.2.5.

6.5 Quality Control Soil Sampling

One QC field duplicate sample point was randomly selected and collected at systematic location L10-13-06 for LSA 10-13.

7.0 FINAL STATUS SURVEY RESULTS LSA 10-13

7.1 Gamma Walkover Survey

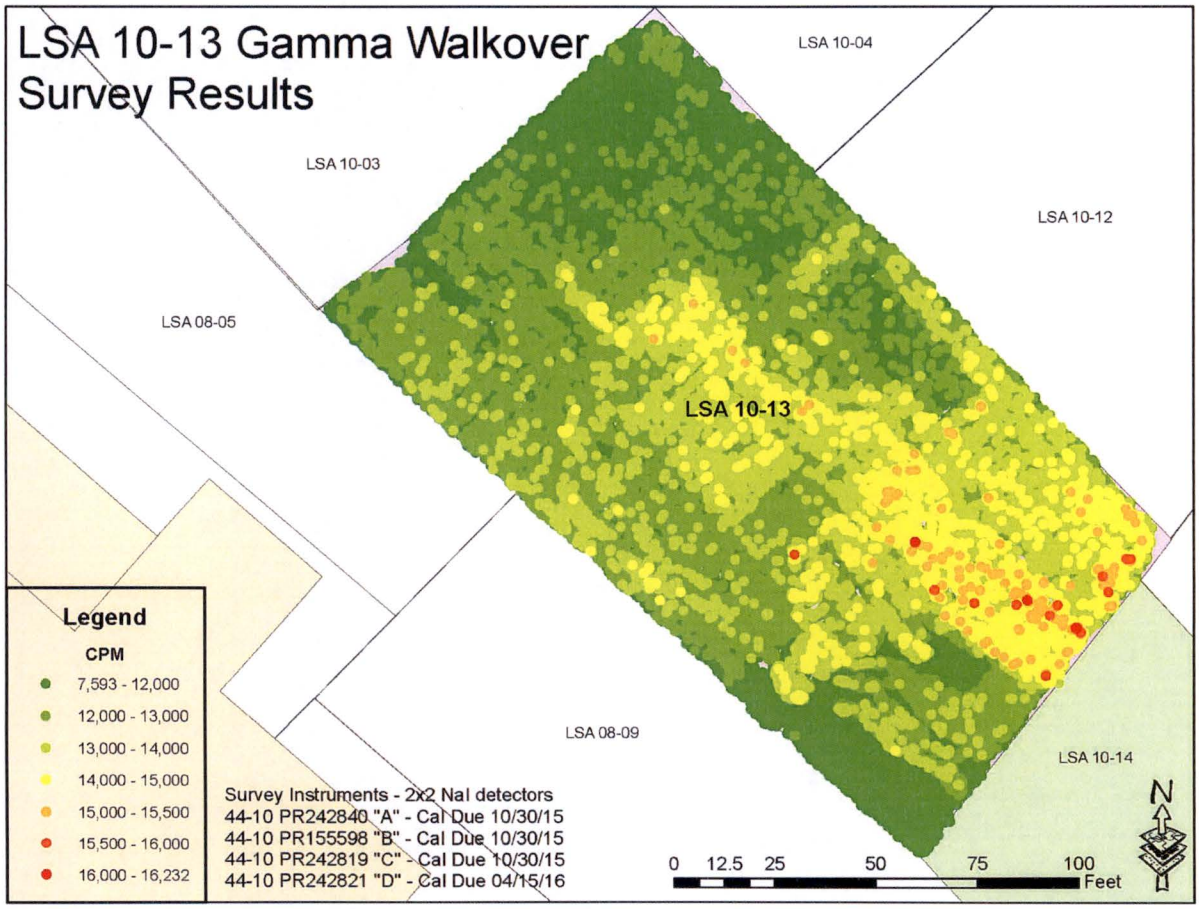
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

GWS measurements were collected in LSA 10-13 between March 31, 2015, and April 29, 2015.

7.1.1 GWS Results for LSA 10-13

For LSA 10-13, GWS count rates ranged between 7,593 gcpm and 16,323 gcpm, with a mean count rate of 11,985 gcpm. The median count rate was 12,035 gcpm and the standard deviation was 1,149 cpm. Figure 7-1 below presents a map of the complete GWS data set.

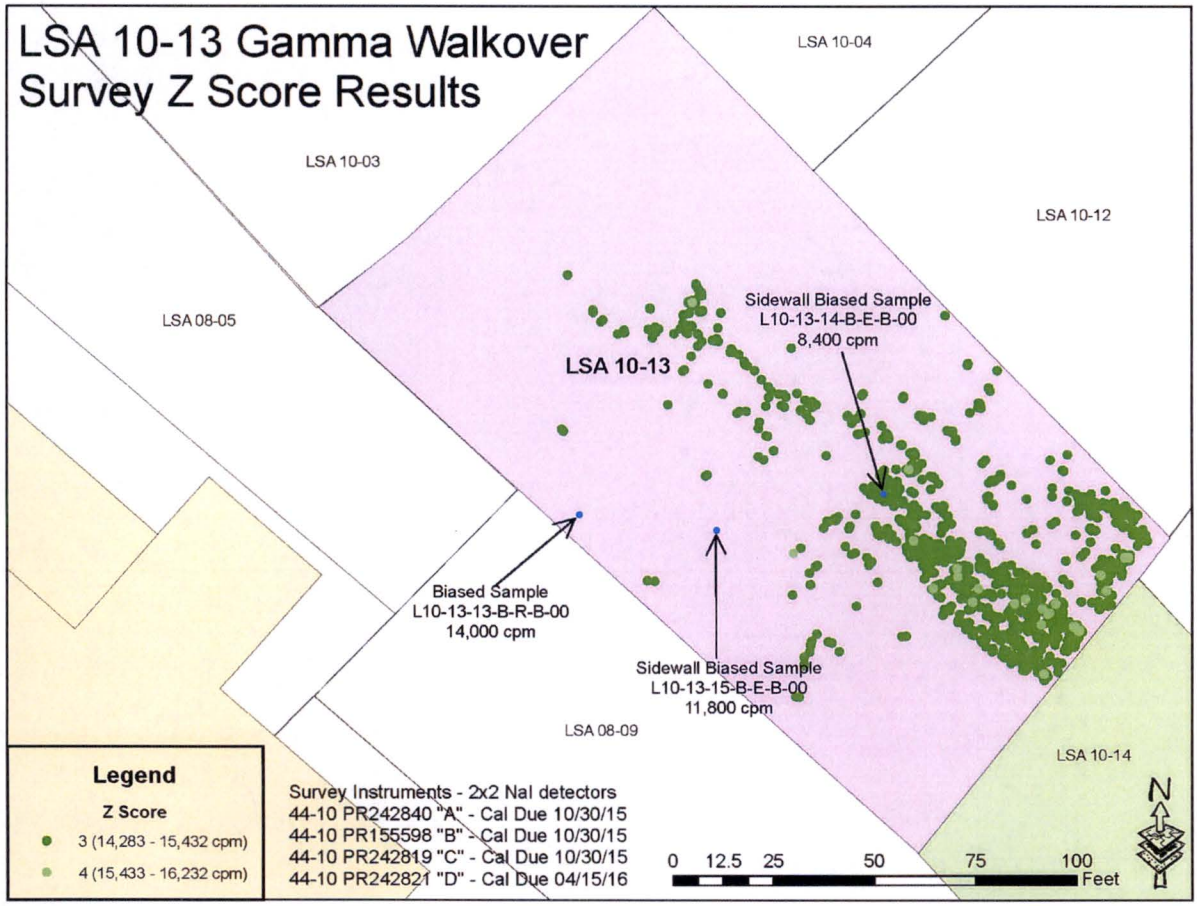
Figure 7-1
Colorimetric GWS Plot for LSA 10-13



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). One location, L10-13-13, was selected for biased sample collection. This biased location represented the maximum GWS measurement encountered within the SU. Also, this single biased location was the only point which exceeded both the IAL based on the local background readings and a Z-score of 3. Therefore, no additional biased locations were selected for sampling. Westinghouse conservatively decided to perform additional remediation at this location after the sample was collected; the initial GWS reading at L10-13-13 was the SU maximum of approximately 21,800 gcpm. After the manual remediation, the GWS reading at this location was reduced to approximately 14,000 gcpm. This issue is discussed further in Section 9.1 – FSS Plan Deviations.

Figure 7-2 below presents a map of the +3 Z-score GWS measurements within LSA 10-13, including the selected biased sampling location (ID: L10-13-13-B-R-B-00). For completeness, the locations of the two supplemental sidewall samples (collected from locations selected by the HP Technician at random) are also shown in Figure 7-2.

Figure 7-2
Colorimetric GWS Plot for LSA 10-13 (Measurements > Z-score of 3)



A total of 85,284 individual GWS measurements were collected in LSA 10-13. Using a conservative side-to-side movement distance of 1 foot, and given the internal SU surface area of LSA 10-13 of approximately 23,000 square feet, the average estimated surveyor speed during GWS of LSA 10-13 was approximately 0.3 ft/sec.

Since all GWS data collected in LSA 10-13 was datalogged and post-processed in Graphical Information Software (GIS), the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015. Using these parameters, a Scan MDC of approximately 46.7 pCi/g is determined. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 10-13, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. The equation used to derive the revised Total Uranium Scan MDC (with a conservative estimate of 4% enrichment) from Section 1.1.5 of HDP-TBD-FSS-002 (Revision 3, August 2015) is as follows:

$$\text{Scan MDC}_{Total\ Uranium} = \quad 1 \Big/ \left(\left(\frac{0.7928}{4172}\right) + \left(\frac{0.0438}{2.65}\right) + \left(\frac{0.1634}{34.9}\right) \right) = 46.7 \frac{pCi}{g}$$

Equation 7-1

HDP-TBD-FSS-002 also modeled Radium-226 and Thorium-232 Scan MDCs to reflect the technical implementation requirements of FSS at the HDP. Using the same parameters as discussed above for total Uranium, the retrospectively estimated Scan MDCs for Radium-226 and Thorium-232 are 1.21 pCi/g and 0.87 pCi/g, respectively using a two inch (2") air gap. A two inch (2") air gap is utilized as a conservative measure considering NUREG-1507 states that the position relates to the average height of the detector. The HP Technicians are instructed to survey as close as possible to the ground surface, (nominally 1", but not to exceed 3" distance from the surface). As such, the use of a two inch air gap is conservative.

7.1.2 GWS Coverage Results LSA 10-13

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, certain small areas of the LSA 10-13 interior could not be accessed for GWS due to especially tall interior pit sidewalls. These areas appear as greyish-pink blanks in the Figure 7-1 above.

The post survey processing of the GPS data indicated that the GWS was 99.39% of the SU (see Table 7-1). As the evaluation indicates that the GPS coverage exceeded 95%, and the readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of the apparent GPS coverage gaps were investigated and found to be satisfactory, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 7-1
GWS Gap Analysis LSA 10-13

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 10-13	729,830	4,484	0.61%	99.39%	1

7.2 Soil Sample Results LSA 10-13

Appendix A presents the analytical results and associated statistics for all FSS samples collected within LSA 10-13.

7.2.1 Surface Soil Sample Results LSA 10-13

There were no samples collected within the surface stratum (0 – 15 cm) of LSA 10-13. There were a total of sixteen (16) soil samples collected within the topmost soil layer of the excavation surface including twelve (12) systematic samples, three (3) biased samples (including two from sidewalls), and one (1) QC field duplicate sample. The maximum SOF result for the "topmost"

samples was 0.45 corresponding to the biased sample L10-13-13-B-R-B-00. The maximum systematic sample SOF result was 0.40 at L10-13-07-B-R-S-00.

7.2.2 Subsurface Soil Sample Results LSA 10-13

There were four systematic locations within LSA 10-13 where root stratum composite sampling was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the four root stratum composite sampling locations, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected. These four excavation stratum samples where there was overlying root stratum remaining were considered "subsurface" samples and therefore did not factor into the WRS test evaluation. The maximum SOF result of the subsurface samples collected in LSA 10-13 was 0.14. This sample (L10-13-08) was the excavation stratum sample collected directly underneath the root stratum sample L10-13-07.

7.2.3 WRS Test Evaluation LSA 10-13

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was required for LSA 10-13 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was greater than one using the Uniform Stratum criteria. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 12 systematically collected samples in LSA 10-13 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic W_R, (911) was greater than the critical value (783) for the test. As such, the null hypothesis that the SU average concentration is greater than the $DCGL_W$ was rejected. The WRS evaluation is also included in Appendix A.

7.2.4 Graphical Data Review LSA 10-13

Table 7-2 below presents summary results for the all systematically collected samples (includes surface (none collected in this SU), root, and excavation stratum samples, but not biased or QC samples) collected within LSA 10-13, and the associated SOF when compared to the Uniform Stratum $DCGL_w$s. The arithmetic average concentration resulted in a SOF of 0.19.

Table 7-2
LSA 10-13 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.15	0.21	0.15	3.16	0.17	1.14	**0.19**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.00 (<BKG)	1.49	0.08	0.81	0.08
Maximum	0.49	0.62	0.35	6.54	0.36	1.66	0.40

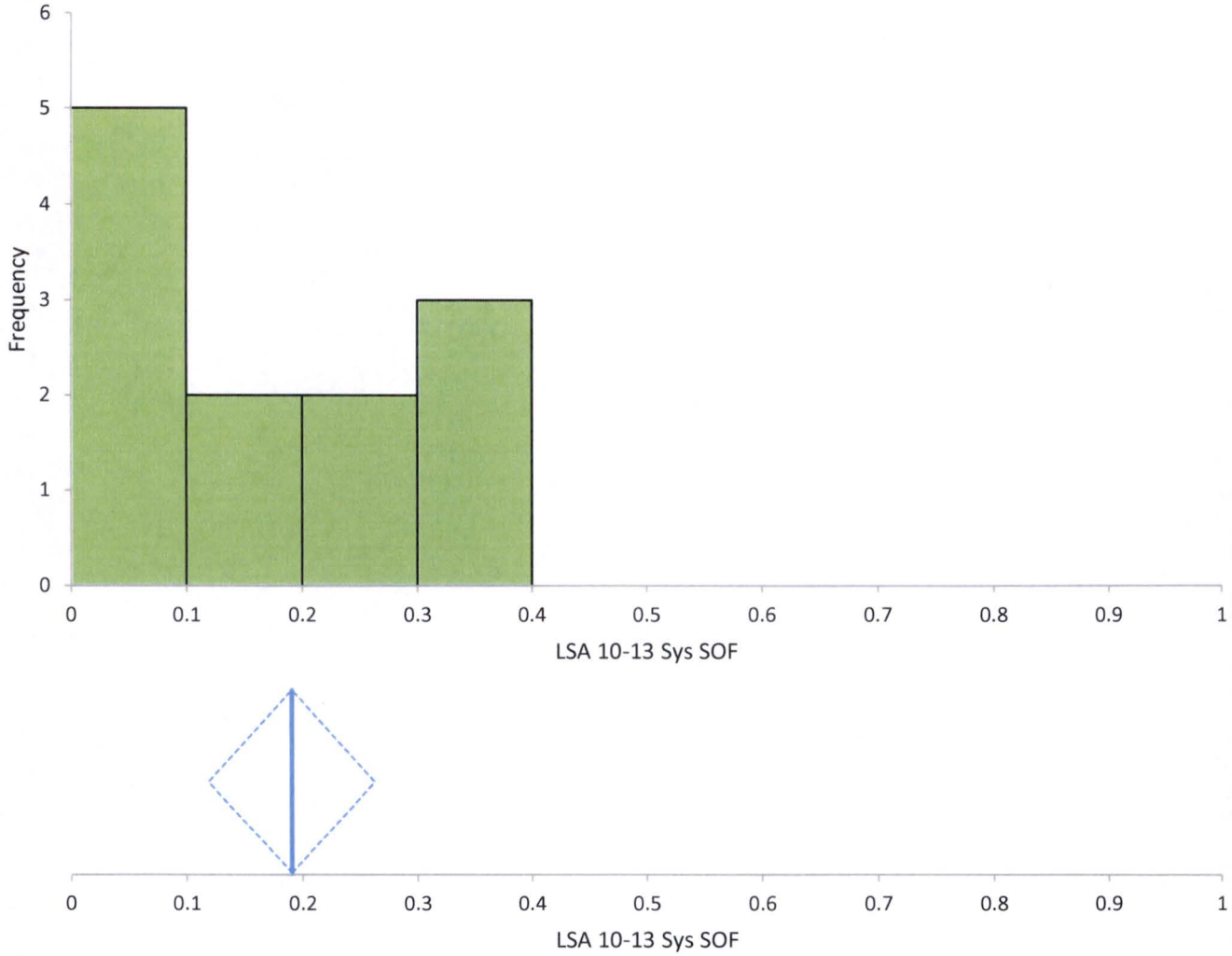
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide concentrations.
3. U-234 values are inferred from the U-235/U-238 ratio.

Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 7-3 presents the overall statistical metrics for the SOF parameter for the 9 systematically collected samples from LSA 10-13. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 10-13. The middle graph presents the mean SOF (0.19 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.12 to 0.26. The 96.1% confidence interval based on the median (0.15) of the sample results is 0.09 to 0.31. The bottom two charts present the various statistical metrics of the LSA 10-13 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 7-3 exhibits no unusual symmetry or bimodality concerns for the LSA 10-13 data associated with the systematically collected measurement locations.

Figure 7-3
Graphic Statistical Summary for LSA 10-13 (SOF parameter)



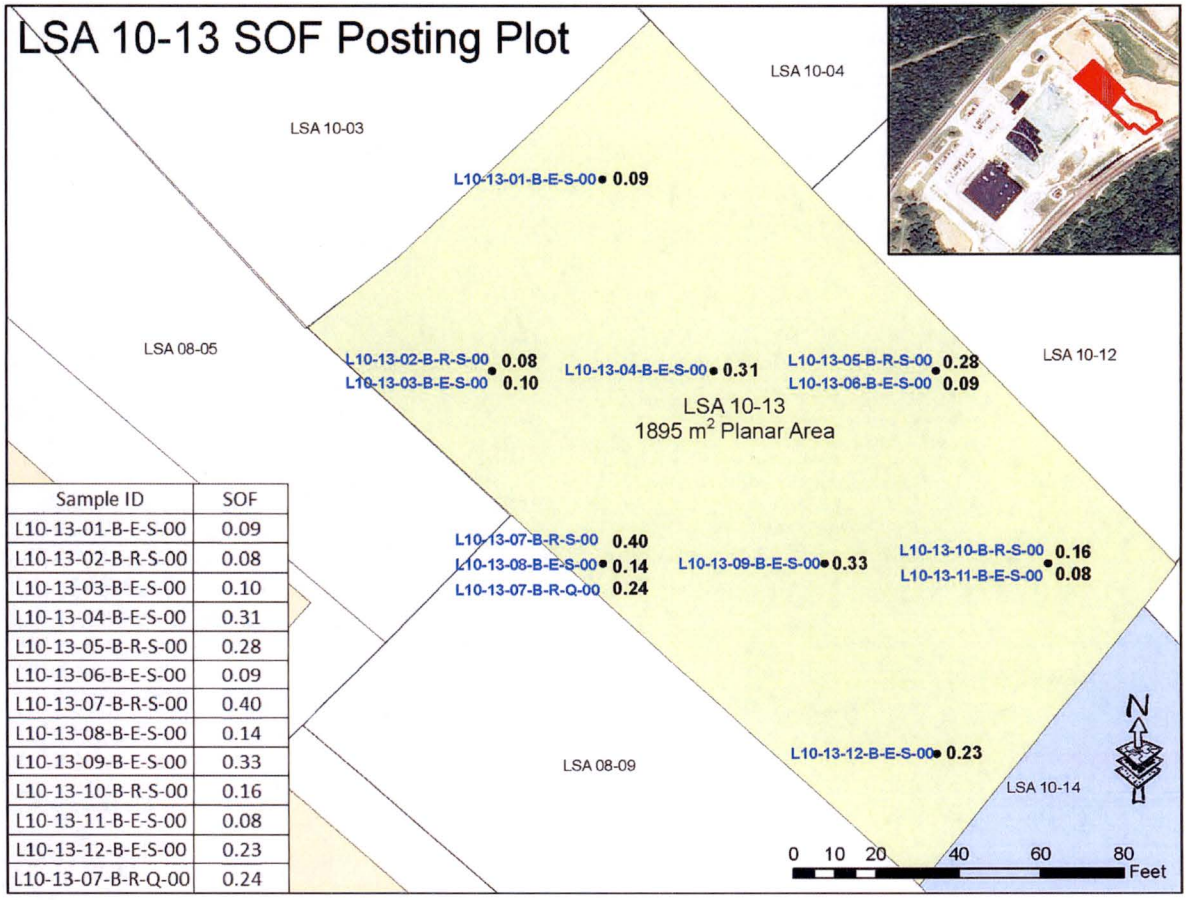
N	12

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-13 Sys SOF	0.19	0.12	to 0.26	0.033	0.11	0.01	0.6	-1.15

	Minimum	1st quartile	Median	96.14% CI		3rd quartile	Maximum	IQR
LSA 10-13 Sys SOF	0.1	0.09	0.15	0.09	to 0.31	0.30	0.4	0.21

A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 10-13 is presented below in Figure 7-4. Figure 7-4 shows no unusual patterns in the data.

Figure 7-4
Posting Plot for LSA 10-13 Systematic Measurement Locations



Sample ID	SOF
L10-13-01-B-E-S-00	0.09
L10-13-02-B-R-S-00	0.08
L10-13-03-B-E-S-00	0.10
L10-13-04-B-E-S-00	0.31
L10-13-05-B-R-S-00	0.28
L10-13-06-B-E-S-00	0.09
L10-13-07-B-R-S-00	0.40
L10-13-08-B-E-S-00	0.14
L10-13-09-B-E-S-00	0.33
L10-13-10-B-R-S-00	0.16
L10-13-11-B-E-S-00	0.08
L10-13-12-B-E-S-00	0.23
L10-13-07-B-R-Q-00	0.24

Appendix A to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 7-2, Figure 7-3, and Figure 7-4 above. A summary of the analytical data is presented in Table 7-3 below. Appendix E to this report presents the TestAmerica Analytical Laboratory soil sample reports.

Table 7-3
Final Status Survey Analytical Data: LSA 10-13

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																										Enr.	SOF
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF
L10-13-01-B-E-S-00	6.83	S	1.120	0.161	0.068	NA	0.050	0.050	0.241	0.241	0.055	0.198	NA	0.890	0.176	0.143	NA	-0.110	0.000	6.536	NA	NA	NA	0.360	0.162	0.225	NA	1.660	0.578	0.849	NA	3.3	0.09
L10-13-02-B-R-S-00	3.45	S	1.090	0.150	0.060	NA	0.020	0.020	0.266	0.266	0.142	0.201	NA	1.090	0.168	0.098	NA	0.090	0.090	1.493	NA	NA	NA	0.078	0.125	0.224	U	0.908	0.292	0.815	NA	1.4	0.08
L10-13-03-B-E-S-00	4.92	S	1.130	0.153	0.060	NA	0.060	0.060	0.245	0.245	0.081	0.213	NA	1.060	0.187	0.115	NA	0.060	0.060	3.624	NA	NA	NA	0.200	0.146	0.212	U	0.814	0.344	1.060	U	3.7	0.10
L10-13-04-B-E-S-00	12.36	S	1.560	0.214	0.087	NA	0.490	0.490	0.104	0.104	0.096	0.203	U	1.050	0.179	0.098	NA	0.050	0.050	2.537	NA	NA	NA	0.138	0.149	0.266	U	0.952	0.336	0.957	U	2.3	0.31
L10-13-05-B-R-S-00	3.82	S	1.280	0.174	0.071	NA	0.210	0.210	0.071	0.071	0.078	0.194	U	1.270	0.208	0.139	NA	0.270	0.270	3.622	NA	NA	NA	0.197	0.184	0.260	U	1.330	0.558	0.855	NA	2.3	0.28
L10-13-06-B-E-S-00	4.92	S	1.030	0.144	0.062	NA	-0.040	0.000	0.021	0.021	0.020	0.204	U	1.120	0.157	0.099	NA	0.120	0.120	3.615	NA	NA	NA	0.198	0.120	0.163	NA	1.110	0.492	0.760	NA	2.7	0.09
L10-13-07-B-R-S-00	4.00	S	1.420	0.209	0.095	NA	0.350	0.350	0.358	0.358	0.080	0.202	NA	1.350	0.225	0.190	NA	0.350	0.350	2.524	NA	NA	NA	0.134	0.160	0.287	U	1.310	0.656	1.020	NA	1.6	0.40
L10-13-08-B-E-S-00	4.92	S	1.200	0.160	0.058	NA	0.130	0.130	0.622	0.622	0.103	0.207	NA	1.060	0.158	0.112	NA	0.060	0.060	2.352	NA	NA	NA	0.126	0.125	0.228	U	1.090	0.491	0.759	NA	1.8	0.14
L10-13-09-B-E-S-00	18.90	S	1.340	0.188	0.077	NA	0.270	0.270	0.401	0.401	0.111	0.244	NA	1.280	0.189	0.107	NA	0.280	0.280	3.553	NA	NA	NA	0.194	0.149	0.213	U	1.210	0.549	0.845	NA	2.5	0.33
L10-13-10-B-R-S-00	3.61	S	1.160	0.160	0.068	NA	0.090	0.090	-0.012	0.000	0.042	0.198	U	1.190	0.167	0.142	NA	0.190	0.190	1.582	NA	NA	NA	0.080	0.140	0.258	U	1.290	0.513	0.780	NA	1.0	0.16
L10-13-11-B-E-S-00	4.92	S	0.990	0.142	0.065	NA	-0.080	0.000	0.090	0.090	0.056	0.211	U	1.090	0.167	0.092	NA	0.090	0.090	4.477	NA	NA	NA	0.247	0.157	0.199	NA	1.040	0.293	0.770	NA	3.6	0.08
L10-13-12-B-E-S-00	15.45	S	1.200	0.166	0.090	NA	0.130	0.130	0.108	0.108	0.060	0.250	U	1.280	0.183	0.137	NA	0.280	0.280	2.016	NA	NA	NA	0.108	0.135	0.247	U	0.937	0.305	0.835	NA	1.8	0.23
L10-13-13-B-R-B-00	3.46	B	1.040	0.144	0.086	NA	-0.030	0.000	2.830	2.830	0.337	0.215	NA	1.380	0.209	0.077	NA	0.380	0.380	19.741	NA	NA	NA	1.090	0.208	0.240	NA	3.430	0.770	1.020	NA	4.8	0.45
L10-13-14-B-E-B-00	14.55	B	1.450	0.280	0.101	NA	0.380	0.380	0.528	0.528	0.171	0.280	NA	1.170	0.325	0.237	NA	0.170	0.170	33.264	NA	NA	NA	1.790	0.539	0.595	NA	2.570	1.920	3.130	U	9.8	0.53
L10-13-15-B-E-B-00	13.28	B	1.650	0.297	0.164	NA	0.580	0.580	0.055	0.055	0.076	0.260	U	1.370	0.314	0.156	NA	0.370	0.370	1.553	NA	NA	NA	0.084	0.303	0.604	U	0.695	1.610	2.700	U	1.9	0.51
L10-13-07-B-R-Q-00	4.00	Q	1.310	0.172	0.063	NA	0.240	0.240	0.340	0.340	0.058	0.212	NA	1.150	0.166	0.114	NA	0.150	0.150	2.336	NA	NA	NA	0.124	0.125	0.231	U	1.260	0.527	0.807	NA	1.6	0.24
Systematic Minimum			0.000						0.000					0.000						1.493				0.078				0.814				2.3	0.08
Systematic Maximum			0.490						0.622					0.350						6.536				0.360				1.660				Average Enrichment (%)	0.40
Systematic Mean			0.150						0.211					0.153						3.161				0.172				1.138					0.19
Systematic Median			0.110						0.175					0.105						3.045				0.166				1.100					0.15
Systematic Standard Deviation			0.153						0.183					0.115						1.412				0.080				0.236					0.11
			With ingrowth, use Ra226 bkg = 1.07											Th232 bkg = 1.0																			

NOTES:

Gross results in units of pCi/g

* Background with ingrowth (1.07 pCi/g) subtracted from gross result

**Background (1.0 pCi/g) subtracted from gross result

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

7.2.5 Biased Soil Sample Result LSA 10-13

The highest biased sample collected from LSA 10-13 had a Uniform SOF result of 0.53, this sample was collected from a sidewall and was not identified by GWS.

7.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 10-13

Two samples were collected from the sidewalls of LSA 10-13. Table 7-4 provides the data summary for the samples.

Table 7-4
LSA 10-13 Sidewall Sample Data Summary and Calculated SOF Values

Sample ID	Ra-226 DCGL = 1.9 BKG = 0.9 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
L10-13-14-B-E-B-00	1.450	0.528	1.170	33.264	1.790	2.570	0.53
L10-13-15-B-E-B-00	1.650	0.055	1.370	1.553	0.084	0.695	0.51

7.2.7 Quality Control Soil Sample Result LSA 10-13

One QC field duplicate sample point was randomly selected for LSA 10-13 which was collected at systematic locations L10-13 -07.

For the 15 samples (i.e., 12 systematic + 1 biased + 2 sidewall) collected within LSA 10-13, one field duplicate sample was collected. This frequency equates to 6.7%, (i.e. 1/15). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 7-5 below).

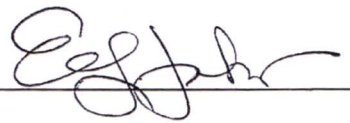
Figure 7-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 10-13

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control		
	Westinghouse Non-Proprietary Class 3	Revision: 1	Page 1 of 1

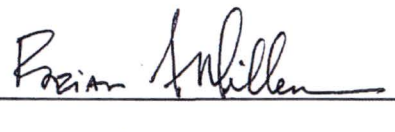
FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.:	LSA 10-13				Survey Unit Description:		Burial Pits Open Land Area Northern Survey Unit in "Area 2"					
Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (pCi/g) Activity (x_i)	Sample (pCi/g) MDC	Field Duplicate Sample (pCi/g) Activity (x_i)	Field Duplicate Sample (pCi/g) MDC	Average Activity ($\bar{X}$) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic[2]	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	Ra-226	1.42	0.0945	1.31	0.0627	1.365	1.9	0.11	0.269	0.403	N
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	Tc-99	0.358	0.202	0.34	0.212	0.349	25.1	0.018	3.552	5.321	N
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	Th-232	1.35	0.19	1.15	0.114	1.250	2.0	0.200	0.283	0.424	N
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	U-234[1]	2.524	NA	2.336	NA	2.430	195.4	0.188	27.649	41.425	N
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	U-235	0.134	0.287	0.124	0.231	0.129	51.6	NA	7.301	10.939	NA
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	U-238	1.31	1.02	1.26	0.807	1.285	168.8	0.050	23.885	35.786	N

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: 

Date: 6/8/2015

Reviewed by: 

Date: 6/8/2015

Quality Record

7.3 Tc-99 Hot Spot Assessment LSA 10-13

As LSA 10-13 and LSA 10-14 are immediately adjacent to each other, the evaluation of potential Tc-99 hotspots in the area was performed for both SUs simultaneously. During site characterization studies a total of 77 samples were collected and analyzed for Tc-99 in LSA 10-13 and LSA 10-14. Within LSA 10-13, the maximum sample identified was 10.5 pCi/g – well below the 25.1 pCi/g limit for the Uniform Stratum DCGL. The maximum sample identified in LSA 10-14 was 52.6 pCi/g, with an overall mean and median concentration of 6.19 pCi/g and 0.43 pCi/g respectively. Within LSA 10-14, a total of four characterization sample results exceeded the Uniform Stratum DCGL of 25.1 pCi/g for Tc-99. No samples exceeded the Tc-99 DCGL during RASS and FSS.

An area factor of 2.1 would be required to account for any potential hot spots of 52.6 pCi/g. Using the Uniform Area Factor table from the DP and interpolation, 475 m^2 is the area per sample station required to equate to an area factor of 2.1. In both LSA 10-13 and LSA 10-14 the area represented by each systematic location was less than 250 m^2 and is adequate to account for any potential hot spots within the SUs.

8.0 ALARA EVALUATION LSA 10-13

All samples collected within LSA 10-13 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 10-13 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.19 for LSA 10-13. The average SOF equates to residual activity contributions from the survey unit area of 4.75 mrem/year for LSA 10-13. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, Chapter 6 {ML17142A356}, Chapter 7 {ML17250A376} and Chapter 8 {ML17240A168} indicate that the groundwater dose contribution is a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/year based upon the U.S. Environmental Protection Agency (EPA) MCLs will be added to the total estimated dose for LSA 10-13. The Reuse Stockpile 3 soil dose contribution will also be accounted for by adding in an additional 3.5 mrem/year. Adding all of the dose contributions together, the total estimated dose for LSA 10-13 is 12.25 mrem/year.

Since the estimated Total Effective Dose Equivalent is below the regulatory release criterion of 25 mrem/year, the conclusion of the As Low As Reasonably Achievable (ALARA) evaluation is that the remediation of LSA 10-13 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing further remediation of LSA 10-13.

9.0 FSS PLAN DEVIATIONS LSA 10-13

9.1 Remedial Actions during FSS

Within LSA 10-13, one location, L10-13-13, was selected for biased sample collection. This biased location represented the maximum GWS measurement encountered within the survey unit. Also, this single biased location was the only point which exceeded both the IAL based on the local background readings and a Z-score of 3.

The initial GWS measurement taken at L10-13-13, which was obtained on April 2, 2015, was the SU maximum GWS measurement of approximately 21,800 gcpm. As the GWS measurement of the location was sufficiently above the 4,000 ncpm IAL, and it was determined that the location would likely exceed the Decision Rule of a SOF greater than 1.0, given the small and isolated location of the elevated area, as provided by the FSS program guidance, the location was manually remediated.

Using hand shovels a very small amount of soil was removed in an area approximately 3 feet wide by approximately 1 foot deep. The soil was placed into bags for transfer out of the SU, and delivered to the Waste Handling Area for disposal. After the manual remediation, the GWS reading at this location was reduced to approximately 14,000 gcpm. The SOF result of the biased sample collected at this location, L10-13-13-B-R-B-00, was 0.45 (with ingrowth).

9.2 Adjustments to Scan MDC Calculations

As previously stated in Section 5.1.5, adjustments were made to the Scan MDC calculations for instrumentation used for the GWS in LSA 10-13. The Scan MDCs presented in the FSS Plan shown in Table 5-1 assumed a surveyor efficiency of 0.5 and did not reflect the information derived from the development of HDP-TBD-FSS-002 which used Microshield modeling of parameters consistent with procedural requirements of GWS implementation at HDP. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 10-13, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. Since all GWS data collected in LSA 10-13 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015.

Based on the data presented in HDP-TBD-FSS-002 and using a surveyor efficiency of 0.75 and a conservative enrichment basis of 4%, revised Scan MDCs were developed and are presented in Table 9-1 below:

Table 9-1

Revised Scan MDCs for 2" x 2" NaI detector: LSA 10-13

	Scan MDC (Total U)	**DCGLw (Total U)**	**Scan MDC (Ra-226)**	**DCGLw (Ra-226)**	**Scan MDC (Th-232)**	**DCGLw (Th-232)**
LSA 10-13	46.7	25.7	1.37	1.9	0.99	2.0

10.0 DATA QUALITY ASSESSMENT

The Data Quality Objective (DQO) process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

10.1 Data Quality Assessment for LSA 10-13

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 10-13 (see Figure 10-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 10-13 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is necessary when the difference between the maximum SU data set measurement SOF and the minimum background area measurement SOF is greater than one. For LSA 10-13, 1 individual gross SOF result(s) in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was required for LSA 10-13. Since the test statistic, WR (911) exceeded the critical value (783), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS evaluation worksheet is presented in Appendix A.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, and the result was a 0.45 Uniform SOF.

- The maximum SOF result for all surface samples within LSA 10-13 was 0.53. The SOF result for the single subsurface samples within LSA 10-13 was 0.14. The average SOF result for all systematically collected samples within LSA 10-13 was 0.19, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.26.
- No FSS sample result in LSA 10-13 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an elevated measurement comparisons (EMC) or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic samples actually collected within LSA 10-13. The successful result of the retrospective power evaluation presented in Table 10-1 for LSA 10-13 indicates that the minimum number of samples required (8) for the WRS Test were equal to the number of sampling locations actually collected within LSA 10-13. The methodology used for the retrospective sampling frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight topmost excavation surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for LSA 10-13 was completed prior to the commencement of backfill operations.

Table 10-1
Retrospective Sample Size Verification for LSA 10-13

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.11
$DCGL_{SOF}$	1
LBGR (Mean)	0.19
Shift	0.81
Relative Shift (Δ/σ)	7.16
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

Δ/σ	P_r
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

MARSSIM Table 5.2, α = 0.05, β = 0.10

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)	
0.005	2.576	
0.01	2.326	
0.015	2.241	
0.025	1.960	
0.05	1.645	α
0.10	1.282	β
0.15	1.036	
0.2	0.842	
0.25	0.674	
0.30	0.524	

Figure 10-1
Data Evaluation Checklists prepared for LSA 10-13 (page 1 of 2)

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: 13 **Description:** Northern Survey Unit in "Area 2"

1.	Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☒	No ☐	
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☒	No ☐	
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☒	No ☐	
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	

If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.

Comments: NA

Figure 10-1
Data Evaluation Checklists prepared for LSA 10-13 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
	Westinghouse Non-Proprietary Class 3	Revision: 7	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: No. 13 **Description:** Northern Survey Unit in "Area 2"

Discrepancy: NA

Corrective Actions Taken: NA

11. Have the corrective actions resolved the discrepancy with the data? Yes ☐ No ☐ NA ☒
    a. If "No", then forward this form to the RSO.
12. The following questions will be answered by the RSO.
    a. If the answer to question 13 was "No", then is the affected data still valid? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit.

	(Print Name)	(Signature)	(Date)
Prepared by (HP Staff):	ELLEN C. YATES		11/19/15
Approved by (RSO):	W. VAN ECKS		11/19/15

Quality Record LSA 10-13

11.0 SURVEILLANCE FOLLOWING FSS

FSS GWS activities in LSA 10-13 were completed on April 29, 2015. There were no events after the completion of FSS that would have the potential to cause contamination above the DCGLs in the SU.

12.0 CONCLUSION LSA 10-13

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 10-13 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 12-1
LSA 10-13 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.19	N/A	0.16	N/A	0.14	**0.49**
DOSE	4.75 mrem/year	N/A	4.0 mrem/year	N/A	3.5 mrem/year	**12.25 mrem/year**

13.0 FINAL STATUS SURVEY DESIGN LSA 10-14

This section describes the method for determining the number of samples required for the FSS of LSA 10-14 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_W$, scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 10-14 and their detection sensitivities are also discussed.

13.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 10-14 were driven by the type (Open Land) and Class (Class 1) of the survey unit and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 5, *Final Status Survey Plan Development*, January 2015.

13.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design.*

13.1.2 $DCGL_W$

During the FSS design process a review was performed of the historic characterization data for LSA 10-14. The review identified several areas that were previously found to exceed a Uniform SOF of 1.0 (discussed in Section 3.3.6). Next the remediation history was reviewed to confirm that these areas were adequately addressed, and the RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform Stratum $DCGL_W$. Therefore the Uniform Stratum $DCGL_W$ was selected for use in demonstrating compliance with the release criteria.

13.1.3 GWS Coverage

As a Class 1 SU, LSA 10-14 was required to undergo a 100% GWS.

13.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 10-14 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

13.1.5 Scan Minimum Detectable Concentration

As background levels were approximately 13,000 cpm within LSA 10-14, the Scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{7383\ pCi/g}\right)+\left(\frac{f_{U-235}}{4.9 pCi/g}\right)+\left(\frac{f_{U-238}}{62.8 pCi/g}\right)\right)}$$

Equation 13-1

In order to calculate the Scan MDC for total uranium using the above equation, an average enrichment for the SU must be known which in turn will provide relative isotopic fractions for U-234, U-235, and U-238 as given in Appendix G of HDP-PR-FSS-701, Revision 4, *Final Status*

Survey Plan Development. Based on the systematically collected RASS samples in LSA 10-14, the average enrichment for the SU was 1.5%.

Standard Scan MDCs for Radium-226 and Thorium-232 using a 2" x 2" NaI detector are found in Table 6.4 of NUREG-1507 and are shown in Table 12-1. Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 10-14 are shown below:

Table 13-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 10-14

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 10-14	40.4	31.2	1.19	2.8	0.85	3.0

*$DCGL_W$ includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. $DCGL_W$ values are based on the Uniform Stratum release criteria.

The values in Table 13-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS.

13.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site*". The IAL used during the GWS of LSA 10-14 was established at 4,000 ncpm.

13.1.7 LSA 10-14 FSS Design Summary

The FSS Plan for LSA 10-14 can be found in Appendix C. Table 13-2 presents an overall FSS design and implementation summary for LSA 10-14.

Table 13-2
FSS Design Summary for LSA 10-14

Gamma Walkover Survey (GWS):		
Scan Coverage	100% exposed excavation floors, benches, pits, and sidewalls	
Scan MDC	40.4 pCi/g total Uranium (based on a 13,000 cpm background); 0.85 pCi/g Th-232; 1.19 pCi/g Ra-226*	
Investigation Action Level (IAL)	4,000 net cpm* *	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments
0 – 15 cm (Surface)	0	These samples were collected on a systematic grid.
15 cm – 1.5 m (Root)	1	
> 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 FSS Supervisor.		
Sidewall Sampling Locations:		
Supplemental Sidewall Sampling: In accordance with *HEM-15-MEMO-039*, two (2) discretionary sidewall samples will be collected based on the following definition of "sidewall": 1) sidewalls must be vertical or near vertical and at least 12" in height, and 2) constitute an aggregate surface area which exceeds 5% of the total surface area of the SU, e.g., 100 m^2 of sidewall area in a 2,000 m^2 SU.		
Instrumentation		
Ludlum 2221 with 44-10 (2" x 2" 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)*", Westinghouse, April 2015.		
**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum $DCGL_W$ 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.		

14.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 10-14

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

14.1 Gamma Walkover Survey

14.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 10-14 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

14.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the SU was one (1) GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

HP Technicians performing GWS in LSA 10-14 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 13,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 18,000 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Sidewalls, hard to reach areas, and non-typical areas were surveyed manually to the maximum extent practical in order to assess the potential for an area of elevated residual activity over 100% of the exposed excavation surface.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics Technician performing the survey to determine if possible

areas of elevated residual activity remained within the survey unit that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

14.2 Soil Sampling

14.2.1 Systematic Soil Sampling Summary

Table 14-1 provides a summary of systematic sampling by stratum for LSA 10-14.

Table 14-1
Systematic Sampling Summary by Stratum for LSA 10-14

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
10-14	1,756	0	1	8	1

14.2.2 Systematic Sampling LSA 10-14

Within LSA 10-14, there were no systematic locations in which portions of the surface stratum [0 – 15 centimeters (cm)] remained in the SU after remediation. Portions of the root stratum (15 cm – 150 cm) remained at one (1) of the eight systematic locations. At these locations the remaining root stratum interval was collected using a hand auger and composited. Excavation stratum samples were collected at all eight locations using either hand trowels for six-inch grabs below the existing excavation surface or hand augers where necessary.

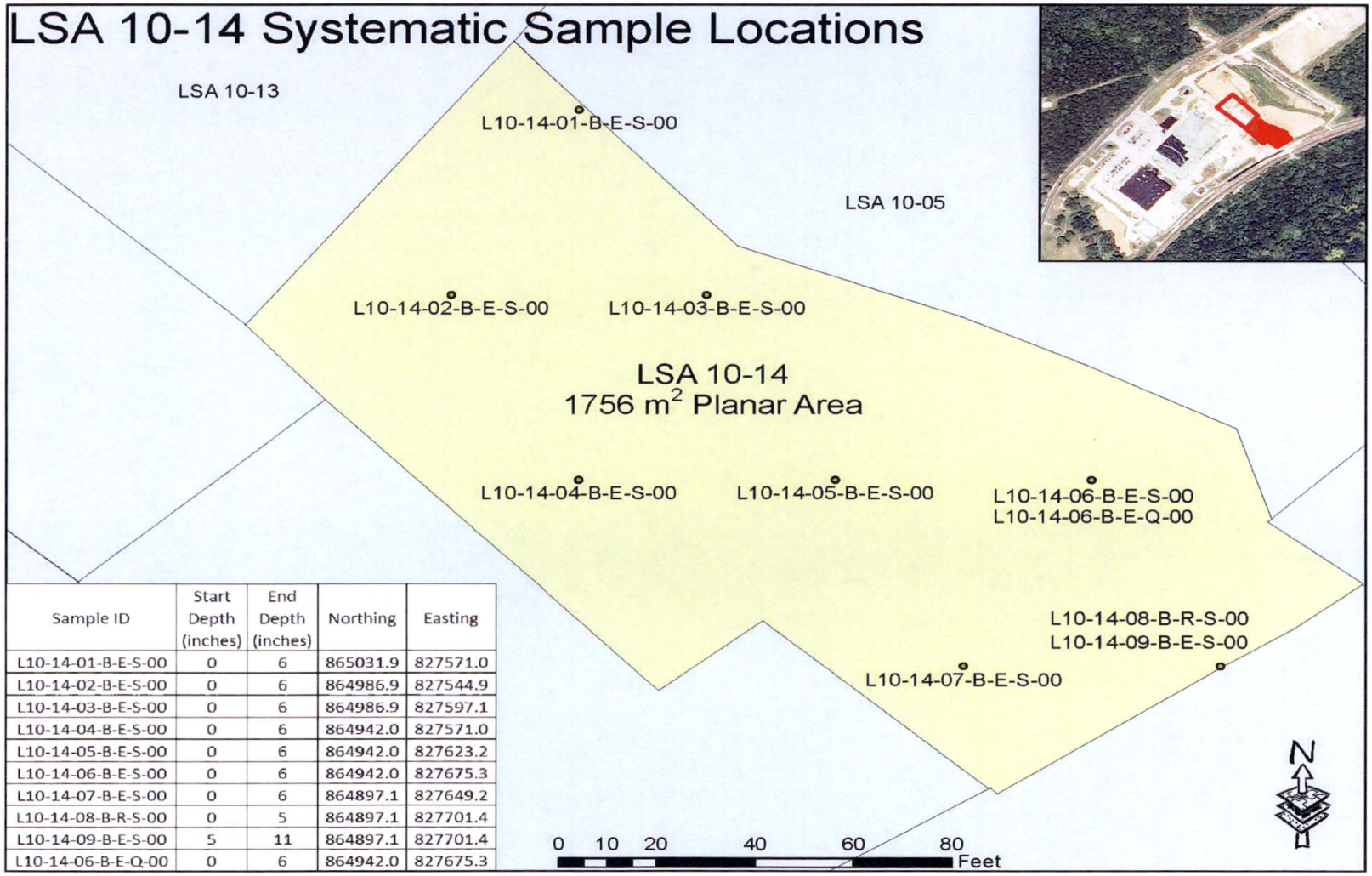
Given a planar area of 1,756 m^2 for LSA 10-14 and an eight - point systematic triangular grid, the point-to-point distance within each row was 15.9 m with spacing of 13.7 m between each of the parallel grid rows within the SU.

While there were eight systematic locations on the LSA 10-14 sampling grid, a total of ten (10) samples were collected at these locations, including:

- Zero (0) samples collected within the remaining surface stratum
- One (1) sample collected within the remaining root stratum
- Eight (8) samples collected within the excavation, or "deep", stratum
- One (1) QC field replicate

Figure 14-1 presents the map of the nine systematic sample locations which were sampled within LSA 10-14. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 14-1
LSA 10-14 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L10-14-01-B-E-S-00	0	6	865031.9	827571.0
L10-14-02-B-E-S-00	0	6	864986.9	827544.9
L10-14-03-B-E-S-00	0	6	864986.9	827597.1
L10-14-04-B-E-S-00	0	6	864942.0	827571.0
L10-14-05-B-E-S-00	0	6	864942.0	827623.2
L10-14-06-B-E-S-00	0	6	864942.0	827675.3
L10-14-07-B-E-S-00	0	6	864897.1	827649.2
L10-14-08-B-R-S-00	0	5	864897.1	827701.4
L10-14-09-B-E-S-00	5	11	864897.1	827701.4
L10-14-06-B-E-Q-00	0	6	864942.0	827675.3

Table 14-2 below presents a tabular listing of all FSS samples collected within LSA 10-14 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 14-2
FSS Sample Locations and Coordinates for LSA 10-14

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
	Westinghouse Non-Proprietary Class 3	Revision: 5	Appendix P-4, Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: 14 **Description:** Southern Survey Unit in "Area 2"
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
L10-14-01-B-E-S-00	Uniform	S	428.3	427.8	865031.9	827571.0	Excavation 6-inch grab
L10-14-02-B-E-S-00	Uniform	S	420.6	420.2	864986.9	827544.9	Excavation 6-inch grab
L10-14-03-B-E-S-00	Uniform	S	423.5	423.0	864986.9	827597.1	Excavation 6-inch grab
L10-14-04-B-E-S-00	Uniform	S	426.1	425.6	864942.0	827571.0	Excavation 6-inch grab
L10-14-05-B-E-S-00	Uniform	S	415.7	415.2	864942.0	827623.2	Excavation 6-inch grab
L10-14-06-B-E-S-00	Uniform	S	416.9	416.4	864942.0	827675.3	Excavation 6-inch grab
L10-14-07-B-E-S-00	Uniform	S	423.9	423.4	864897.1	827649.2	Excavation 6-inch grab
L10-14-08-B-R-S-00	Uniform	S	429.9	429.0	864897.1	827701.4	Root 4.6-inch composite
L10-14-09-B-E-S-00	Uniform	S	429.0	428.5	864897.1	827701.4	Excavation 6-inch grab
L10-14-06-B-E-Q-00	Uniform	Q	416.9	416.4	864942.0	827675.3	Excavation 6-inch grab
L10-14-10-B-E-B-00	Uniform	B	434.6	423.4	864909.0	827633.0	Biased 6-inch grab
L10-14-11-B-E-B-00	Uniform	B	434.7	417.3	864936.0	827593.0	Biased 6-inch grab
L10-14-12-B-E-B-00	Uniform	B	434.0	419.7	864979.0	827594.0	Biased 6-inch grab
L10-14-13-B-E-B-00	Uniform	B	432.9	432.4	864982.7	827605.3	Sidewall 6-inch grab
L10-14-14-B-E-B-00	Uniform	B	433.5	433.0	864926.1	827642.9	Sidewall 6-inch grab

Green shaded samples are the samples at each sample location, for use in WRS test.

*Elevations are in feet above mean sea level.
** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]
Surface: Floor = F; Wall = W; Ceiling = C; Roof = R
CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used
Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

14.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 10-14 several sample locations were selected within the SU based on the evaluation of the GWS survey data. Biased location L10-14-10-B-E-B-00 represents the maximum GWS measurement encountered within in LSA 10-14 and has a Uniform SOF value of 0.30.

14.4 Judgmental/Sidewall Sampling for Tc-99

In accordance with the guidance specified in Volume 3, Chapter 1, Section 6.2.3, it was determined that sidewall sampling was necessary. The number of sidewall samples collected for the SU was determined by comparing the sidewall surface area to the two dimensional systematic surface area (e.g., 8 systematic samples were collected over 2,000 m^2, then collect 1 sample per 250 m^2 of sidewall). Two samples were collected in the sidewall of LSA 10-14. These samples were collected from locations selected by the HP Technician at random, and were not based on gamma survey readings (not biased).

14.5 Quality Control Soil Sampling

One QC field duplicate sample point was randomly selected and collected at systematic location L10-14-06 for LSA 10-14.

15.0 FINAL STATUS SURVEY RESULTS LSA 10-14

15.1 Gamma Walkover Survey

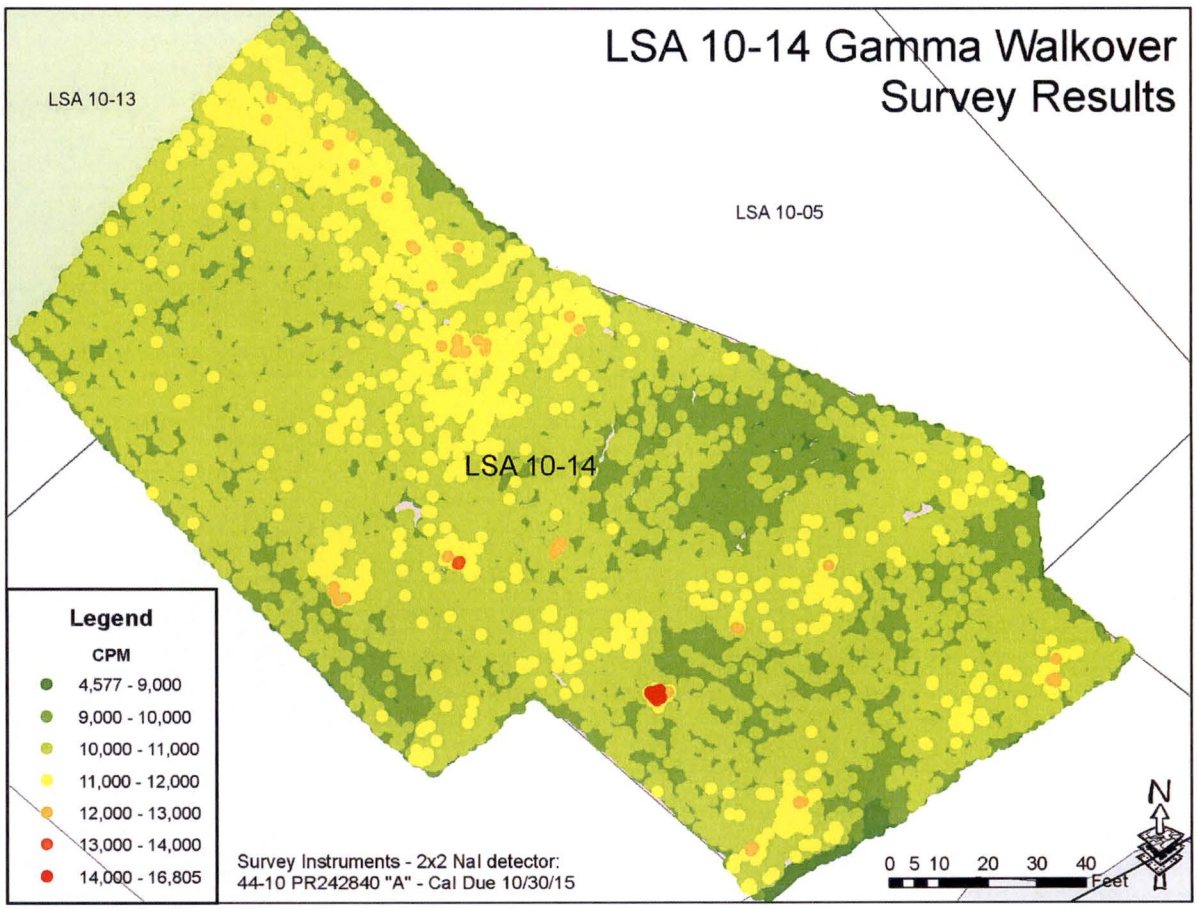
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top"(e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

GWS measurements were collected in LSA 10-14 between March 31, 2015, and April 29, 2015.

15.1.1 GWS Results for LSA 10-14

For LSA 10-14, GWS count rates ranged between 4,577 gcpm and 16,805 gcpm, with a mean count rate of 9,711 gcpm. The median count rate was 9,703 gcpm with a standard deviation of 667 cpm. Figure 15-1 below presents a map of the complete GWS data set.

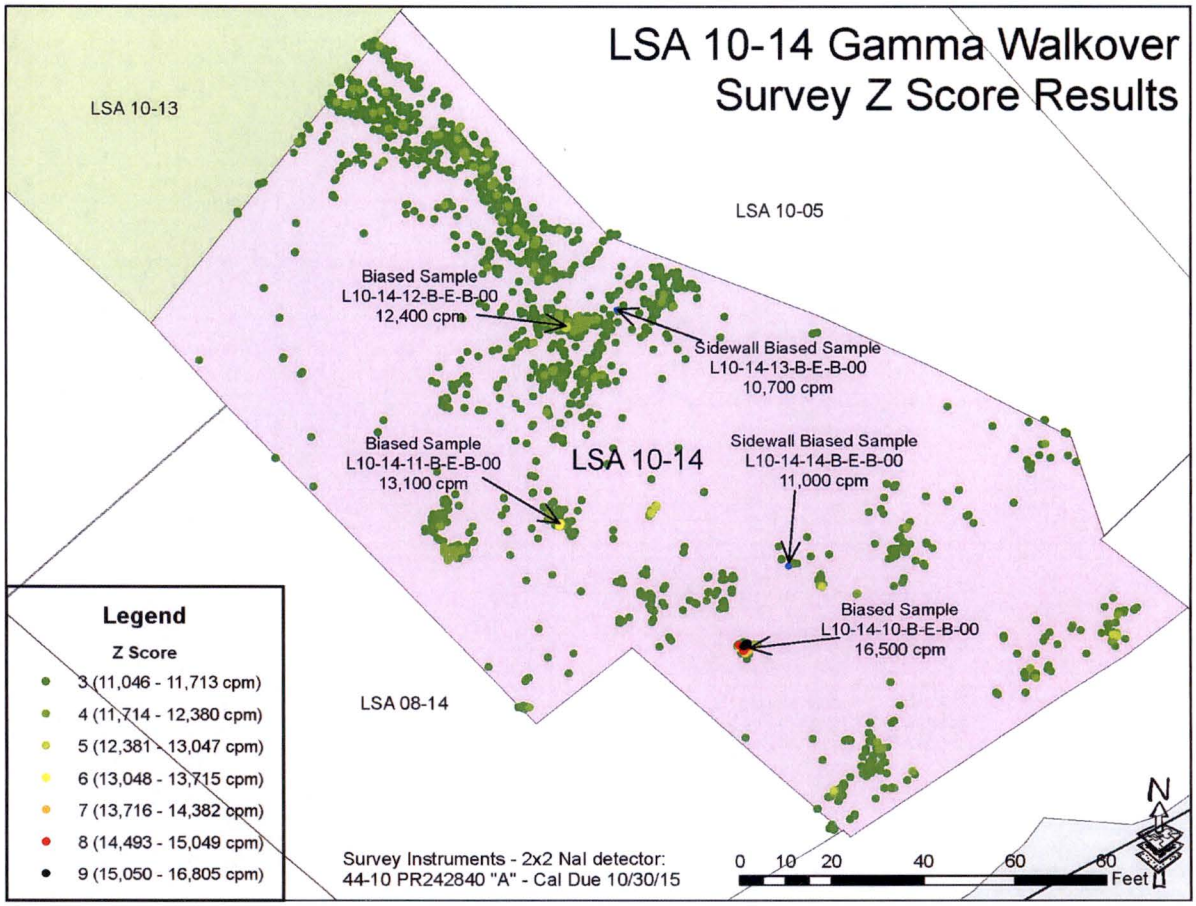
Figure 15-1
Colorimetric GWS Plot for LSA 10-14



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded both the IAL (> 4000 ncpm) and three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Three locations (L10-14-10, L10-14-11, and L10-14-12) were selected for biased sample collection. The sample collected at location L10-14-10 represented the maximum GWS measurement (16,500 gcpm) within the SU.

Figure 15-2 presents a map of the +3 Z-score GWS measurements within LSA 10-14, including the three selected biased sampling locations. For completeness, the locations of the two supplemental sidewall samples (collected from locations selected by the HP Technician at random) are also shown in Figure 15-2 below.

Figure 15-2
Colorimetric GWS Plot for LSA 10-14 (Measurements > Z-score of 3)



A total of 79,112 GWS measurements were collected in LSA 10-14. Using a conservative side-to-side movement distance of 1 foot, and given the internal SU surface areas of LSA 10-14 of approximately 22,000 square feet, the average estimated surveyor speed during GWS of LSA 10-14 was approximately 0.3 ft/sec. Since this retrospectively estimated scanning speed was less than the 1.0 ft/second FSS Plan requirement and the fact that the NaI probe was maintained as close as possible to the surface, actual Scan MDCs based on real field conditions could have been slightly less than the 40.4 pCi/g total Uranium Scan MDC estimate determined during the FSS planning phase for this SU.

Since all GWS data collected in LSA 10-14 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015. Using these parameters, a new Scan MDC of approximately 46.7 pCi/g is determined. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 10-14, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. The equation used to derive the revised Total Uranium Scan MDC (with a conservative

estimate of 4% enrichment) from Section 1.1.5 of HDP-TBD-FSS-002 (Revision 3, August 2015) is as follows:

$$\text{Scan MDC}_{Total\ Uranium} = \quad 1 \Big/ \left(\left(\frac{0.7928}{4172}\right) + \left(\frac{0.0438}{2.65}\right) + \left(\frac{0.1634}{34.9}\right)\right) = 46.7 \frac{pCi}{g}$$

Equation 15-1

HDP-TBD-FSS-002 also modeled Radium-226 and Thorium-232 Scan MDCs to reflect the technical implementation requirements of FSS at the HDP. Using the same parameters as discussed above for total Uranium, the retrospectively estimated Scan MDCs for Radium-226 and Thorium-232 are 1.21 pCi/g and 0.87 pCi/g, respectively using a two inch air gap. A two inch (2") air gap is utilized as a conservative measure considering NUREG-1507 states that the position relates to the average height of the detector. The HP Technicians are instructed to survey as close as possible to the ground surface, (nominally 1", but not to exceed 3" distance from the surface). As such, the use of a two inch air gap is conservative.

15.1.2 GWS Coverage Results LSA 10-14

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, very small areas of the LSA 10-14 interior were not accessed by GPS due to overly steep side slopes or especially tall interior pit sidewalls. These areas appear as small grey/pink blanks or "slivers" in the Figure 15-1 above.

The post survey processing of the GPS data indicated that the GWS was 99.91% of the SU (see Table 15-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 15-1
GWS Gap Analysis LSA 10-14

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 10-14	531,710	473	0.09%	99.91%	1

15.2 Soil Sample Results LSA 10-14

Appendix B presents the analytical results and associated statistics for all FSS samples collected within LSA 10-14.

15.2.1 Surface Soil Sample Results LSA 10-14

There were zero (0) samples collected within the surface stratum (0 – 15 cm) of LSA 10-14. However, there were a total of fifteen (15) soil samples collected within the topmost soil layer of the excavation surface including nine systematic samples, five biased samples (including two from sidewalls), and one QC field duplicate sample. The maximum SOF result for "topmost" samples in LSA 10-14 was 0.30 corresponding to the biased sample L10-14-10-B-E-B-00. The maximum systematic sample SOF result was 0.21 at L10-14-02-B-E-S-00.

15.2.2 Subsurface Soil Sample Results LSA 10-14

There was one systematic location within LSA 10-14 where root stratum composite sampling was performed. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At this sole root stratum composite sampling location, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was collected. This excavation stratum samples where there was overlying root stratum remaining was considered a "subsurface" sample and therefore did not factor into the WRS test evaluation. The maximum SOF result of the subsurface sample collected in LSA 10-14 was 0.08. This sample (L10-14-09) was the excavation stratum sample collected directly underneath the root stratum sample L10-14-08.

15.2.3 WRS Test Evaluation LSA 10-14

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 10-14 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS Test was still performed for LSA 10-14. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 9 systematically collected samples in LSA 10-14 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic W_R, (816) was greater than the critical value (725) for the test. As such, the null hypothesis that the SU average concentration is greater than the $DCGL_W$ was rejected. The WRS evaluation is also included in Appendix B.

15.2.4 Graphical Data Review LSA 10-14

Table 15-2 below presents summary results for the all systematically collected samples (includes surface, root, and excavation stratum samples, but not biased or QC samples) collected within LSA 10-14, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.13.

Table 15-2
LSA 10-14 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.04	0.09	0.17	2.13	0.11	1.13	**0.13**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.04	0.37	0.01	0.81	0.05
Maximum	0.16	0.24	0.32	4.38	0.24	1.57	0.21

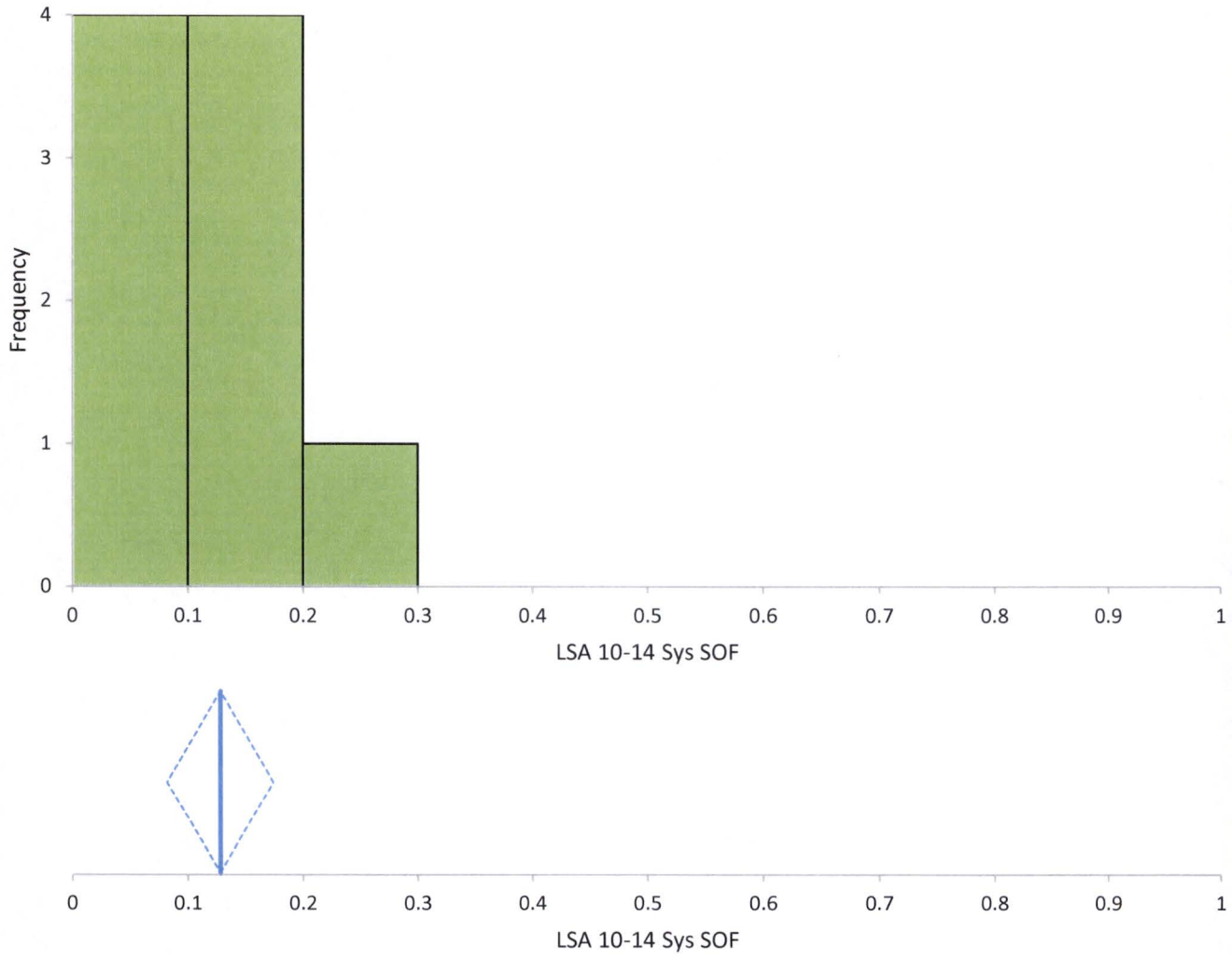
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide concentrations.
3. U-234 values are inferred from the U-235/U-238 ratio.

Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the SU frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 15-3 presents the overall statistical metrics for the SOF parameter for the 10 systematically collected samples from LSA 10-14. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 10-14. The middle graph presents the mean SOF (0.13 rounded up) as indicated by the blue vertical line of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.08 to 0.17. The 96.09% confidence interval based on the median (0.10) of the sample results is 0.08 to 0.20. The bottom two charts present the various statistical metrics of the LSA 10-14 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 15-3 exhibits no unusual symmetry or bimodality concerns for the LSA 10-14 data associated with the systematically collected measurement locations.

Figure 15-3
Graphic Statistical Summary for LSA 10-14 (SOF parameter)



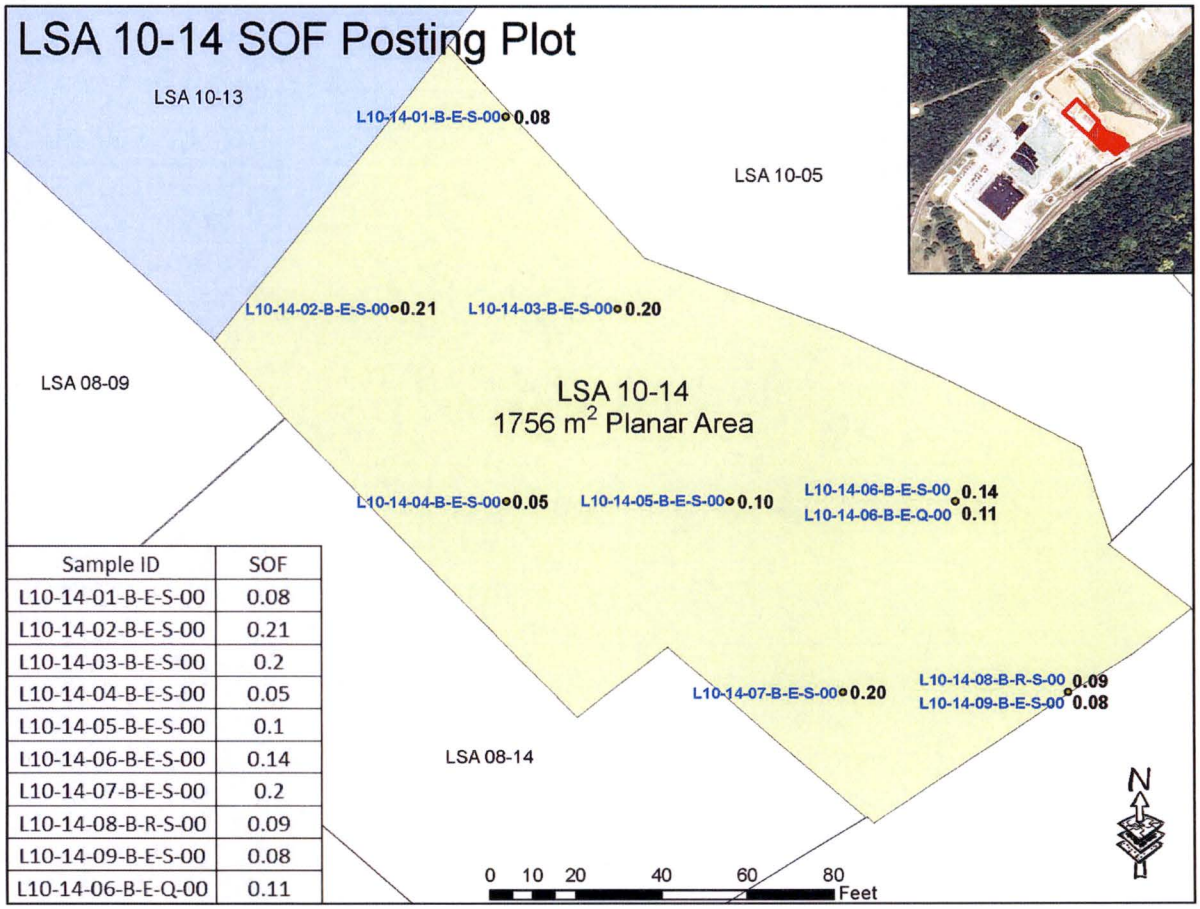
N	9

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-14 Sys SOF	0.13	0.08	to 0.17	0.020	0.06	0.00	0.3	-1.70

	Minimum	1st quartile	Median	96.09% CI		3rd quartile	Maximum	IQR
LSA 10-14 Sys SOF	0.05	0.08	0.10	0.08	to 0.20	0.20	0.2	0.12

A posting plot is simply a map of the survey unit with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 10-14 is presented below in Figure 15-4. Figure 15-4 shows no unusual patterns in the data.

Figure 15-4
Posting Plot for LSA 10-14 Systematic Measurement Locations



Sample ID	SOF
L10-14-01-B-E-S-00	0.08
L10-14-02-B-E-S-00	0.21
L10-14-03-B-E-S-00	0.2
L10-14-04-B-E-S-00	0.05
L10-14-05-B-E-S-00	0.1
L10-14-06-B-E-S-00	0.14
L10-14-07-B-E-S-00	0.2
L10-14-08-B-R-S-00	0.09
L10-14-09-B-E-S-00	0.08
L10-14-06-B-E-Q-00	0.11

Appendix B to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 15-2, Figure 15-3, and Figure 15-4 above. A summary of the analytical data is presented in Table 15-3 below. Appendix F to this report presents the Test America Analytical Laboratory soil sample reports.

Table 15-3
Final Status Survey Analytical Data: LSA 10-14

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																										Enr.	SOF_N
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF_N
L10-14-01-B-E-S-00	5.07	S	0.841	0.135	0.074	NA	-0.229	0.000	-0.022	0.000	0.058	0.227	U	1.130	0.192	0.087	NA	0.130	0.130	2.064	NA	NA	NA	0.111	0.150	0.228	U	0.924	0.293	0.774	NA	1.9	0.08
L10-14-02-B-E-S-00	13.74	S	1.230	0.175	0.072	NA	0.160	0.160	0.241	0.241	0.086	0.260	U	1.190	0.198	0.127	NA	0.190	0.190	1.644	NA	NA	NA	0.084	0.163	0.272	U	1.230	0.568	0.878	NA	1.1	0.21
L10-14-03-B-E-S-00	10.28	S	1.170	0.154	0.084	NA	0.100	0.100	0.084	0.084	0.047	0.222	U	1.270	0.176	0.115	NA	0.270	0.270	0.373	NA	NA	NA	0.014	0.061	0.254	U	0.975	0.289	0.790	NA	0.3	0.20
L10-14-04-B-E-S-00	8.72	S	0.865	0.134	0.069	NA	-0.205	0.000	0.205	0.205	0.026	0.216	U	1.040	0.166	0.106	NA	0.040	0.040	2.095	NA	NA	NA	0.109	0.128	0.248	U	1.350	0.534	0.803	NA	1.3	0.05
L10-14-05-B-E-S-00	18.49	S	0.889	0.162	0.099	NA	-0.181	0.000	0.198	0.198	0.039	0.204	U	1.150	0.212	0.157	NA	0.150	0.150	2.582	NA	NA	NA	0.141	0.187	0.289	U	0.891	0.349	0.954	U	2.5	0.10
L10-14-06-B-E-S-00	16.71	S	1.080	0.157	0.076	NA	0.010	0.010	-0.016	0.000	0.054	0.244	U	1.230	0.182	0.132	NA	0.230	0.230	1.960	NA	NA	NA	0.102	0.153	0.253	U	1.220	0.512	0.783	NA	1.3	0.14
L10-14-07-B-E-S-00	10.61	S	1.020	0.147	0.073	NA	-0.050	0.000	0.105	0.105	0.075	0.226	U	1.320	0.192	0.095	NA	0.320	0.320	4.378	NA	NA	NA	0.241	0.120	0.191	NA	1.160	0.309	0.799	NA	3.2	0.20
L10-14-08-B-R-S-00	4.04	S	1.160	0.184	0.094	NA	0.090	0.090	-0.035	0.000	0.012	0.197	U	1.050	0.170	0.141	NA	0.050	0.050	1.872	NA	NA	NA	0.101	0.156	0.254	U	0.809	0.307	0.841	U	2.0	0.09
L10-14-09-B-E-S-00	4.92	S	1.020	0.168	0.093	NA	-0.050	0.000	-0.010	0.000	0.041	0.203	U	1.120	0.221	0.134	NA	0.120	0.120	2.176	NA	NA	NA	0.111	0.157	0.302	U	1.570	0.925	1.080	NA	1.1	0.08
L10-14-06-B-E-Q-00	16.71	Q	1.100	0.151	0.067	NA	0.030	0.030	-0.033	0.000	0.072	0.243	U	1.150	0.183	0.107	NA	0.150	0.150	2.747	NA	NA	NA	0.150	0.143	0.251	U	0.937	0.306	0.868	NA	2.5	0.11
L10-14-10-B-E-B-00	11.19	B	1.250	0.172	0.073	NA	0.180	0.180	0.011	0.011	0.041	0.243	U	1.050	0.165	0.086	NA	0.050	0.050	28.580	NA	NA	NA	1.470	0.285	0.290	NA	1.200	0.521	0.801	NA	16.0	0.30
L10-14-11-B-E-B-00	17.36	B	1.020	0.167	0.091	NA	-0.050	0.000	1.430	1.430	0.374	0.262	NA	1.090	0.190	0.133	NA	0.090	0.090	1.816	NA	NA	NA	0.097	0.155	0.286	U	0.843	0.359	1.220	U	1.8	0.12
L10-14-12-B-E-B-00	14.25	B	1.390	0.177	0.058	NA	0.320	0.320	0.148	0.148	0.042	0.245	U	1.160	0.171	0.126	NA	0.160	0.160	1.520	NA	NA	NA	0.080	0.133	0.228	U	0.892	0.514	0.819	NA	1.4	0.27
L10-14-13-B-E-B-00	15.91	B	1.250	0.274	0.190	NA	0.180	0.180	0.286	0.286	0.051	0.240	NA	1.260	0.341	0.153	NA	0.260	0.260	3.130	NA	NA	NA	0.172	0.353	0.595	U	0.886	0.809	2.670	U	3.0	0.26
L10-14-14-B-E-B-00	13.62	B	1.640	0.311	0.192	NA	0.570	0.570	0.281	0.281	0.093	0.240	NA	1.530	0.347	0.285	NA	0.530	0.530	1.080	NA	NA	NA	0.048	0.113	0.874	U	1.640	1.910	3.220	U	0.5	0.59
Systematic Minimum			0.000						0.000					0.040						0.373				0.014				0.809				1.6	0.05
Systematic Maximum			0.160						0.241					0.320						4.378				0.241				1.570				Average Enrichment (%)	0.21
Systematic Mean			0.040						0.093					0.167						2.127				0.113				1.125					0.13
Systematic Median			0.000						0.084					0.150						2.064				0.109				1.160					0.10
Systematic Standard Deviation			0.061						0.100					0.095						1.042				0.059				0.247					0.06
			With ingrowth, use Ra226 bkg = 1.07											Th232 bkg = 1.0																				

NOTES:

Gross results in units of pCi/g

* Background with ingrowth (1.07 pCi/g) subtracted from gross result

**Background (1.0 pCi/g) subtracted from gross result

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

15.2.5 Biased Soil Sample Result LSA 10-14

Three (3) biased samples were collected from LSA 10-14. The sample collected at location L10-14-10 represented the maximum GWS measurement (16,500 gcpm) within the SU, and had a result of 0.30 Uniform SOF.

15.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 10-14

Two samples were collected from the sidewalls of LSA 10-14. Table 15-4 provides the data summary for the samples.

Table 15-4
LSA 10-14 Sidewall Sample Data Summary and Calculated SOF Values

Sample ID	Ra-226 DCGL = 1.9 BKG = 0.9 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
L10-14-13-B-E-B-00	1.250	0.286	1.260	3.130	0.172	0.886	0.26
L10-14-14-B-E-B-00	1.640	0.281	1.530	1.080	0.048	1.640	0.59

15.2.7 Quality Control Soil Sample Result LSA 10-14

One QC field duplicate sample point was randomly selected for LSA 10-14 which was collected at systematic locations L10-14-06.

For the 14 samples (i.e., 9 systematic + 3 biased + 2 sidewall) collected within LSA 10-14, one field duplicate sample was collected. This frequency equates to 7.1%, (i.e. 1/14). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 15-5 below).

Figure 15-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 10-14

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control		
	Westinghouse Non-Proprietary Class 3	Revision: 1	Page 1 of 1

FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.:	LSA 10-04				Survey Unit Description:		East Central Survey Unit (North Burial Pits)					
			Sample (pCi/g)		Field Duplicate Sample (pCi/g)							
Sample ID	Field Duplicate Sample ID	Radionuclide	Activity (x_i)	MDC	Activity (x_i)	MDC	Average Activity ($\bar{X}$) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic[2]	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	Ra-226	0.997	0.0676	0.931	0.0669	0.964	1.9	0.066	0.269	0.403	N
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	Tc-99	1.72	0.228	1.35	0.23	1.535	25.1	0.37	3.552	5.321	N
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	Th-232	0.864	0.107	0.830	0.0651	0.847	2.0	0.034	0.283	0.424	N
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	U-234[1]	2.837	NA	2.979	NA	2.908	195.4	0.142	27.649	41.425	N
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	U-235	0.152	0.233	0.162	0.193	0.157	51.6	NA	7.301	10.939	NA
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	U-238	1.34	0.753	1.11	0.807	1.225	168.8	0.23	23.885	35.786	N

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: [signature] Date: 4/13/15

Reviewed by: [signature] Date: 4/13/15

Quality Record

15.3 Tc-99 Hot Spot Assessment LSA 10-14

As LSA 10-13 and LSA 10-14 are immediately adjacent to each other, the evaluation of potential Tc-99 hotspots in the area was performed for both LSA's simultaneously. During site characterization studies a total of 77 samples were collected and analyzed for Tc-99 in LSA-10-13 and LSA-10-14. Within LSA 10-13, the maximum sample identified was 10.5 pCi/g – well below the 25.1 pCi/g limit for the Uniform Stratum DCGL. The maximum sample identified in LSA 10-14 was 52.6 pCi/g, with an overall mean and median concentration of 6.19 pCi/g and 0.43 pCi/g respectively. Within LSA 10-14, a total of four characterization sample results exceeded the Uniform Stratum DCGL of 25.1 pCi/g for Tc-99. No samples exceeded the Tc-99 DCGL during RASS and FSS.

An area factor of 2.1 would be required to account for any potential hot spots of 52.6 pCi/g. Using the Uniform area factor table from the DP and interpolation, 475 m^2 is the area per sample station required to equate to an area factor of 2.1. In both LSA-10-13 and LSA-10-14 the area represented by each systematic location was less than 250 m^2 and is adequate to account for any potential hot spots within the survey units.

16.0 ALARA EVALUATION LSA 10-14

All samples collected within LSA 10-14 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 10-14 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.13 for LSA 10-14. The average SOF equates to residual activity contributions from the SU area of 3.25 mrem/year for LSA 10-14. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, Chapter 6 {ML17142A356}, Chapter 7 {ML17250A376} and Chapter 8 {ML17240A168} indicate that the groundwater dose contribution is a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/year based upon the EPA MCLs will be added to the total estimated dose for LSA 10-14. The Combined Reuse Stockpile 1-2 soil dose contribution will also be accounted for by adding in an additional 2.5 mrem/year. Adding all of the dose contributions together, the total estimated dose for LSA 10-14 is 9.75 mrem/year.

Since the estimated TEDE is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the remediation of LSA 10-14 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing further remediation of LSA 10-14.

17.0 FSS PLAN DEVIATIONS LSA 10-14

17.1 Remedial Actions during FSS

There were no remedial actions after FSS in LSA 10-14.

17.2 Adjustments to Scan MDC Calculations

As previously stated in Section 12.1.5, adjustments were made to the Scan MDC calculations for instrumentation used for the GWS in LSA 10-14. The Scan MDCs presented in the FSS Plan

shown in Table 12-1 assumed a surveyor efficiency of 0.5 and did not reflect the information derived from the development of HDP-TBD-FSS-002 which used Microshield modeling of parameters consistent with procedural requirements of GWS implementation at HDP. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 10-14, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. Since all GWS data collected in LSA 10-14 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015.

Based on the data presented in HDP-TBD-FSS-002 and using a surveyor efficiency of 0.75 and a conservative enrichment basis of 4%, revised Scan MDCs were developed and are presented in Table 17-1 below:

Table 17-1

Revised Scan MDCs for 2" x 2" NaI detector: LSA 10-14

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw (Ra-226)	Scan MDC (Th-232)	DCGLw (Th-232)
LSA 10-14	46.7	31.2	1.37	1.9	0.99	2.0

18.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

18.1 Data Quality Assessment for LSA 10-14

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 10-14 (see Figure 18-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.

- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 10-14 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 10-14, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 10-14, however the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (816) exceeded the critical value (725), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS evaluation worksheet is presented in Appendix B.
- The maximum systematic SOF result for all surface samples within LSA 10-14 was 0.21. The SOF result for the single subsurface sample within LSA 10-14 was 0.08. The average SOF result for all systematically collected samples within LSA 10-14 was 0.13, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.17.
- No FSS sample result in LSA 10-14 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an elevated measurement comparisons (EMC) or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic samples actually collected within LSA 10-14. The successful result of the retrospective power evaluation presented in Table 18-1 for LSA 10-14 indicates that the minimum number of samples required (8) for the WRS Test was less than the number of sampling locations actually collected within LSA 10-14. The methodology used for the retrospective sampling frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight topmost excavation surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the

HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.

- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for LSA 10-14 was completed prior to the commencement of backfill operations.

Table 18-1
Retrospective Sample Size Verification for LSA 10-14

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.06
$DCGL_{SOF}$	1
LBGR (Mean)	0.13
Shift	0.87
Relative Shift (Δ/σ)	14.58
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

Δ/σ	P_r
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

MARSSIM Table 5.2, α = 0.05, β = 0.10

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

α
β

Figure 18-1
Data Evaluation Checklists prepared for LSA 10-14 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
	Westinghouse Non-Proprietary Class 3	Revision: 7	Appendix G-1, Page 1 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: 14 **Description:** Southern Survey Unit in "Area 2"

1.	Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☒	No ☐	
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☒	No ☐	
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☒	No ☐	
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	

If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.

Comments: NA

Quality Record LSA 10-14

Figure 18-1
Data Evaluation Checklists prepared for LSA 10-14 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
	Westinghouse Non-Proprietary Class 3	Revision: 7	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: No. 14 **Description:** Northern Survey Unit in "Area 2"

Discrepancy: NA

Corrective Actions Taken: NA

11. Have the corrective actions resolved the discrepancy with the data? Yes ☐ No ☐ NA ☒
    a. If "No", then forward this form to the RSO.
12. The following questions will be answered by the RSO.
    a. If the answer to question 13 was "No", then is the affected data still valid? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit.

	(Print Name)	(Signature)	(Date)
Prepared by (HP Staff):	Ellen C Weeks		11/19/15
Approved by (RSO):	W Clark Cowes		11/19/15

Quality Record LSA 10-14

19.0 SURVEILLANCE FOLLOWING FSS

FSS GWS activities in LSA 10-14 were completed on April 29, 2015. There were no events after the completion of FSS that would have the potential to cause contamination above the DCGLs in the SU.

20.0 CONCLUSION LSA 10-14

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 10-14 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 20-1
LSA 10-14 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.13	N/A	0.16	N/A	0.10	**0.39**
DOSE	3.25 mrem/year	N/A	4.0 mrem/year	N/A	2.5 mrem/year	**9.75 mrem/year**

21.0 REFERENCES

21.1 DO-08-004, Hematite Decommissioning Plan {ML092330123}.

21.2 DO-08-003, Radiological Characterization Report, July 2009 {ML092870496}

21.3 NSA-TR-09-15, Nuclear Criticality Safety Assessment of Buried Waste Exhumation and Contaminated Soil Remediation at the Hematite Site

21.4 Westinghouse letter HEM-11-96, dated July 5, 2011, *Final Supplemental Response to NRC Request for Additional Information on the Hematite Decommissioning Plan and Related Revision to a Pending License Amendment Request* {ML111880290}

21.5 Westinghouse Internal Memorandum HEM-15-MEMO-021, *Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site* (FSSFR Volume 3, Chapter 1, Appendix D)

21.6 Westinghouse letter HEM-11-56, dated May 5, 2011, *Evaluation of Technetium-99 Under the Process Buildings* {ML111260624}

22.0 APPENDICES (To Be Provided On Separate Data Disc)

APPENDIX A: Analytical Data Evaluation Spreadsheets for LSA 10-13

APPENDIX B: Analytical Data Evaluation Spreadsheets for LSA 10-14

APPENDIX C: FSS Plan Development for LSA 10-13

APPENDIX D: FSS Plan Development for LSA 10-14

APPENDIX E: TestAmerica Laboratory Analytical Data Reports for LSA 10-13

APPENDIX F: TestAmerica Laboratory Analytical Data Reports for LSA 10-14

APPENDIX G: Completed Field Logs (Appendix P-6 from HDP-PR-FSS-701)

APPENDIX H: HDP-RPT-FSS-303, Summary Report for Burial Pit Area Remediation

Attachment 2

Final Status Survey Final Report Volume 3, Chapter 5, Revision 1

Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14, Revision 1 Track Change Version

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

Westinghouse

Final Status Survey Report

Hematite Decommissioning Project

Final Status Survey Final Report Volume 3, Chapter 5

TITLE: **Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14 (LSA 10-13 and LSA 10-14)**

REVISION: **1**

EFFECTIVE DATE: NOV 2 9 2017

TRACK CHANGE VERSION

Approvals:

Author: Kenneth E. Pallagi — 11-29-2017 Date

Owner/Manager: W. Clark Evers — 11/29/17 Date

REVISION LOG	
Revision No. Effect. Date	**Revision**
0 11/16/2016	Revision 0 is the initial issuance of the Survey Area Release Record for Land Survey Area 10, Survey Units 13 and 14.
1 See Cover Page	The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to the application of the WRS Test when applied to the Three Stratum approach. Westinghouse and the NRC discussed the path forward and resolution of the NRC comments. Revision 3 to FSSFR Volume 3 Chapter 1 implemented the resolution of the comments. Revision 1 of this Survey Area Release Record implements Revision 3 to FSSFR Volume 3 Chapter 1 within this report. Additionally, minor formatting and editorial changes have been made to align this survey area release record with subsequent survey area release records submitted to the NRC.

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LIST OF ACRONYMS AND SYMBOLS

ALARA	As Low As Reasonably Achievable
bgs	below ground surface
CFR	Code of Federal Regulations
cm	centimeter(s)
cpm	count(s) per minute
CSM	Conceptual Site Model
DCGL	Derived Concentration Guideline Level
$DCGL_W$	DCGL for average concentrations over a survey unit, used with statistical tests. ("W" suffix denotes "Wilcoxon")
DGPS	Digital Global Positioning System
DP	Hematite Decommissioning Plan
DQO	Data Quality Observation
EMC	Elevated Measurement Comparison
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
FSS	Final Status Survey
FSSFR	Final Status Survey Final Report
gcpm	gross count(s) per minute
GIS	Graphical Information Software
GPS	Global Positioning System
GWS	Gamma Walkover Survey
HDP	Hematite Decommissioning Project
HP	Health Physics
HRCR	Hematite Radiological Characterization Report
I & C	Isolation and Control
IAL	Investigation Action Level
LSA	Land Survey Area
m	meter(s)
m^2	square meter(s)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Concentration Limit
MDC	Minimum Detectable Concentration
mrem	milliroentgen equivalent man
NAD	North American Datum
NaI	Sodium Iodide
ncpm	net count(s) per minute
NCS	Nuclear Criticality Safety
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocurie(s) per gram
QC	Quality Control
Ra	Radium
RASS	Remedial Action Support Survey
RSO	Radiation Safety Officer
SOF	Sum of Fractions

SU	Survey Unit
Tc	Technetium
Th	Thorium
U	Uranium
WRS	Wilcoxon Rank Sum

EXECUTIVE SUMMARY

This Survey Area Release Record (SARR) presents the results of the final status radiological surveys of the Hematite Decommissioning Project (HDP) Land Survey Area (LSA) 10, Survey Unit (SU) 13 (LSA 10-13) and SU 14 (LSA 10-14). As provided in Final Status Survey Final Report (FSSFR), Volume 1, Chapter 1, Section 7.0 {ML15257A307}, the final report summary, FSSFR Volume 7, *Final Status Survey Final Report*, will be submitted at the conclusion of the post-remediation groundwater monitoring period. FSSFR Volume 7 will be submitted to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 Code of Federal Regulations (CFR) 20 Subpart E, "Criteria for License Termination."

Both LSA 10-13 and LSA 10-14 were designated as Class 1 SUs as presented in Table 14-16 of the HDP Decommissioning Plan (DP) {ML092330123}. The Class 1 designation for both SUs remained in effect throughout remediation and Final Status Survey (FSS). For both SUs, evaluation of analytical results against the Derived Concentration Guideline Levels (DCGL) for the Uniform Stratum Conceptual Site Model (CSM) was the selected approach. The objective of the FSS for both SUs was to obtain and document measurement results, analytical data, and other supporting information in order to demonstrate that after completion of remediation the residual radioactivity levels in the LSA 10-13 and LSA 10-14 SUs are below the applicable Uniform Stratum DCGLs and therefore the land area of these SUs meet the criteria for unrestricted release.

The Uniform Stratum CSM assumes residual radioactivity is uniformly distributed over the entire depth profile of the SU from ground surface to 6.7 meter (m) below ground surface (bgs). As described in FSSFR Volume 3, Chapter 1, 6.2.1, *Systematic Soil Sampling*, systematic soil samples were obtained at depths dependent upon the systematic soil sample location.

This SARR was prepared as described in FSSFR Volume 3, Chapter 1, Section 7.0, *Survey Area Release Record Organization*, as implemented by FSS procedure HDP-PR-FSS-722.

1.0 REPORT BACKGROUND

As a result of the U. S. Nuclear Regulatory Commission (NRC) feedback regarding the submittal of the FSSFR, Westinghouse and the NRC agreed that Westinghouse would develop an outline presenting the format and content of FSS documents required for NRC review. Westinghouse provided the outline to the NRC for discussion during the August 19, 2015, publicly noticed teleconference and the format was agreed upon {ML15238B032}.

FSSFR Volume 3, Chapter 1, Revision 3, *Land Survey Areas (LSA) Overview* provides the information common to land survey areas. This report, FSSFR Volume 3, Chapter 5, builds upon the general information provided in FSSFR Volume 3, Chapter 1, Revision 3.

2.0 HDP SITE, LSA AND SURVEY UNIT DESCRIPTIONS

2.1 HDP Site Description

A general description of the HDP site is given in FSSFR Volume 1, Chapter 1.

2.2 LSA Configuration

The DP Chapter 14 and DP Figure 14-14 provided the conceptual approach for the configuration of LSAs and the survey units within a LSA. Figure 2-1 indicates the LSA configurations for the HDP site.

The DP stated that it was expected that the conceptual boundaries of the SUs would be altered based on the actual configuration and condition of the SU at the time of survey design. As expected, it was necessary to modify the boundary of LSA 10 to facilitate the remediation process. The expansion of LSA 10 was due in part to benching and sloping requirements for excavations and also to ensure adequate remediation of specific areas as indicated by the results of visual inspection and radiological survey. As a result of the expansion of LSA 10, the individual SUs within LSA 10 were also modified. All SUs within LSA 10 were initially classified as Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 1 survey areas in DP Chapter 14. Therefore, for FSS, all SUs within LSA 10 remained classified as MARSSIM Class 1 survey areas, thereby ensuring compliance with the DP.

LSA 10 encompasses the entire "Documented Burial Pit Area" footprint within the Central Tract. LSA 10 consists of SUs LSA 10-01 through LSA 10-14.

2.3 LSA 10-13 and LSA 10-14 Survey Unit Description and Configuration

LSA 10-13 and LSA 10-14 are located within the southern half of LSA 10, the Burial Pit Area. Figure 2-2 indicates the location of LSA 10-13 and LSA 10-14 within LSA 10. Figure 2-3 presents the Final Configuration of the HDP Land Survey Areas and SUs which indicate the location of the boundaries of LSA 10-13 and LSA 10-14.

After the removal of buried materials and the completion of radiological remediation, in the final configuration, LSA 10-13 and LSA 10-14 consisted primarily of the excavated area in the SU which consisted of native soil. There were no structures, piping, groundwater monitoring wells, or spent limestone remaining within the SUs.

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 10-13 presents 1,895 square meters (m^2) in planar (2-dimensional) extent, within an interior surface area of 2,101 m^2 (3-dimensional).

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 10-14 presents 1,756 m^2 in planar (2-dimensional) extent, within an interior surface area of 2,029 m^2 (3-dimensional).

Figure 2-1
HDP Land Survey Areas

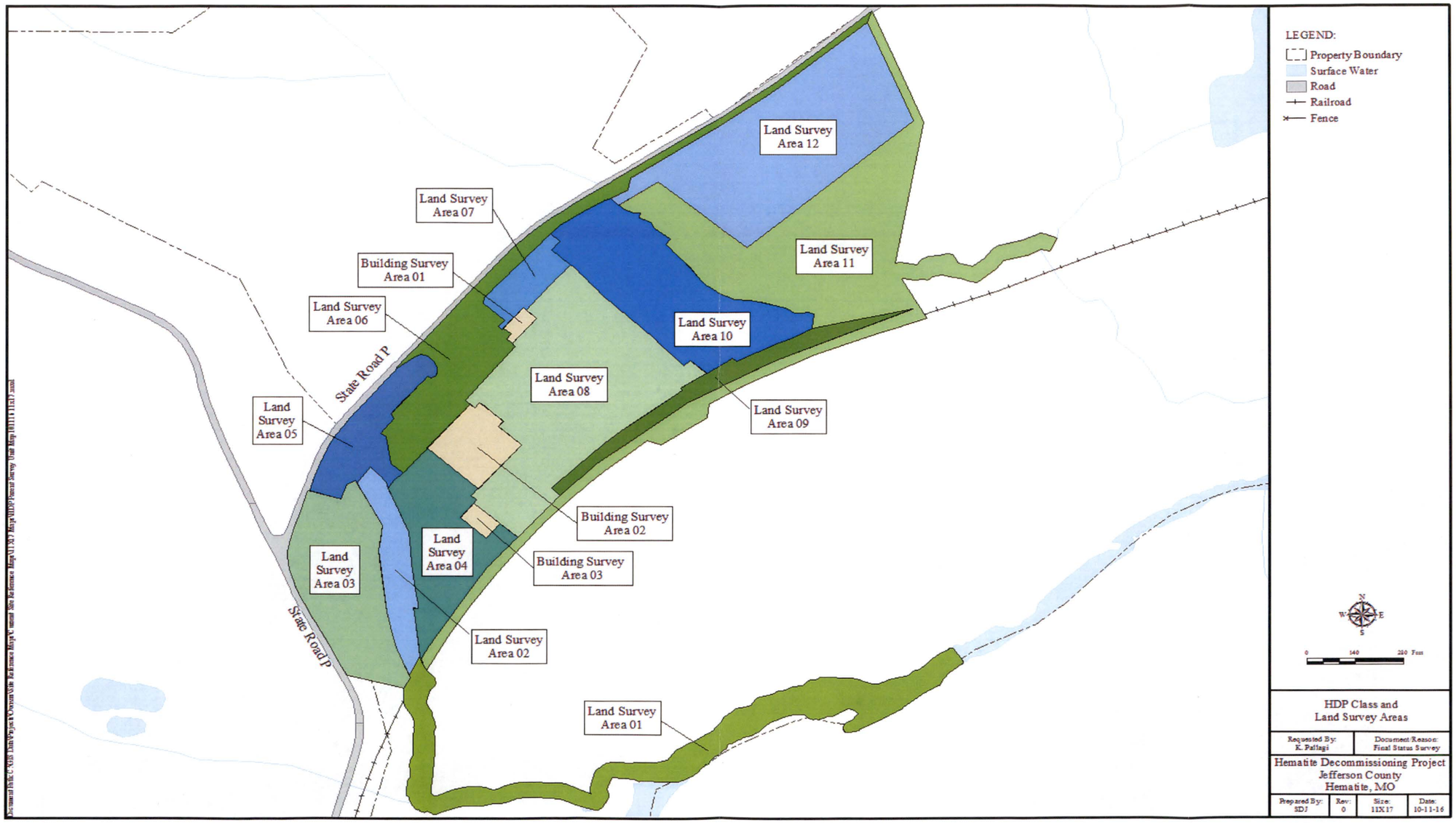


Figure 2-2
Final Configuration of Land Survey Area 10 and Survey Units

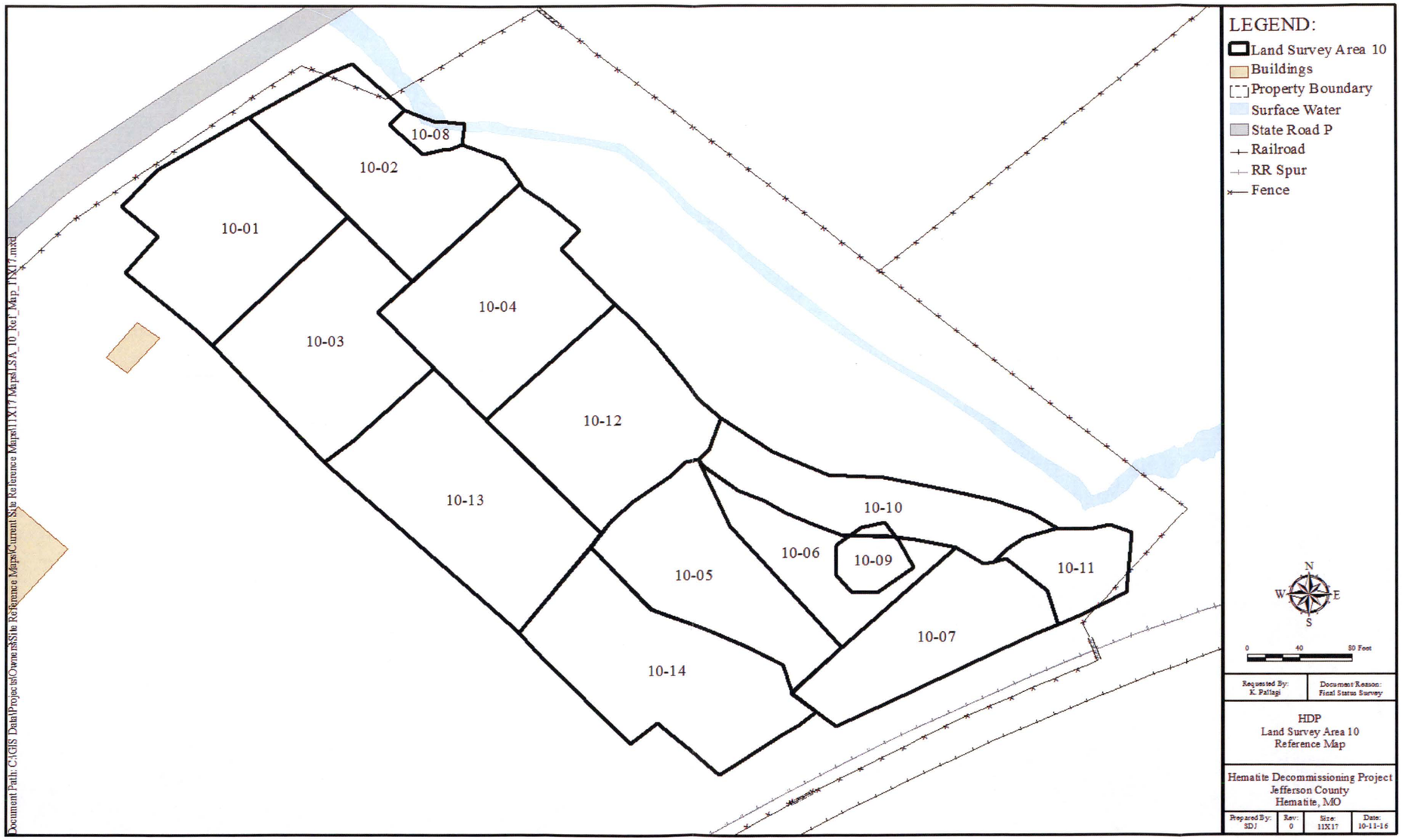
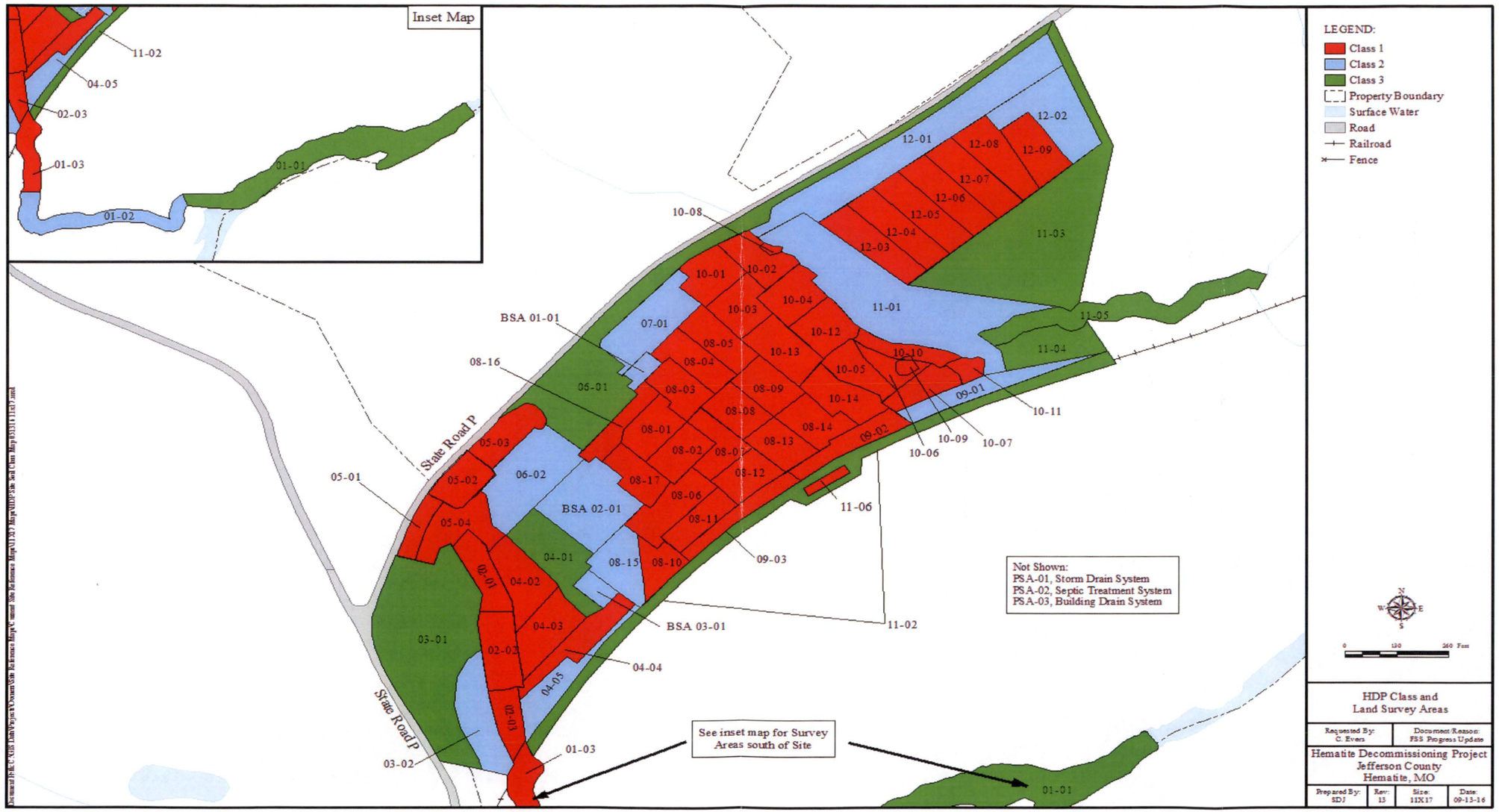


Figure 2-3
Final Configuration of Land Survey Areas and Survey Units



3.0 HISTORY OF OPERATIONS

A discussion of site historical operations prior to the decommissioning phase of the HDP is presented in the FSSFR Volume 1, Chapter 1, Section 3.0, *Site Historical Operations*.

A detailed discussion of the historical background information related to the documented burial pits in the Burial Pit Area is presented in the FSSFR Volume 3, Chapter 1, Section 2.1, *Documented Burial Pits*.

A detailed discussion of the historical background information related to undocumented burials within the HDP site proper is presented in the FSSFR Volume 3, Chapter 1, Section 2.2, *Undocumented Burials*.

3.1 Radioactive Materials in LSA 10-13 and LSA 10-14

Radioactive materials within LSA 10-13 and LSA 10-14 resulted from placement of radioactive contaminated materials below grade and above grade. During the remediation (see Figure 3-1) of LSA 10-13 and LSA 10-14 various types of waste materials were encountered, including drums, bags of trash, fuel pellets, construction debris, small quantities of spent limestone, and contaminated soils.

Remedial actions within the Burial Pit Area revealed that although the underlying burial pits were nearly contiguous, individual burial pits were readily identifiable based on changes in soil color, soil hardness, visibly obvious items of non-native debris, and elevated gamma readings as measured by field instrumentation (see Figure 3-2). Figure 3-11 shows that all intervening soils between individual pits were removed during the remedial excavation regardless of radioactivity concentration.

Figure 3-1
Early Stage of Remedial Excavation in South Burial Pit Area (2012)

Figure 3-2
Burial Pit Becoming Clearly Visible after Overburden Removal (LSA 10-14)

3.2 Reuse Soil Disposition and Characterization

Prior to remediation and removal of contaminated soil and other waste materials within LSA 10-13 and LSA 10-14, overburden soils which exhibited characteristics suitable for potential reuse as onsite backfill material were removed, segregated, and subjected to reuse soil criteria requirements.

A detailed discussion of reuse soils, including general description, segregation, surveys, sorting technology, and technical requirements may be found in the FSSFR Volume 2, Chapter 1.

3.3 Remediation and Remedial Action Support Surveys (RASS) Phase of LSA 10-13 and LSA 10-14

The sections below provide a discussion of the various elements of remediation and the RASS phase of LSA 10-13 and LSA 10-14 necessary to prepare the SUs for FSS.

3.3.1 Remedial Actions

Remedial actions began in LSA 10-13 and LSA 10-14 in April, 2012, and continued through March, 2015. Types of waste materials encountered during the remediation were detailed in Section 3.1.

There were several indicators inherent in the remediation process of LSA 10-13 and LSA 10-14 in which a portion of the Burial Pit Area was located that provided assurance that all wastes were removed prior to the initiation of FSS. As discussed in FSSFR Volume 3, Chapter 1, there was ample historical evidence to confidently delineate the spatial boundary of the Burial Pit Area. As the overburden soil was removed it was easy to visually identify the location of a burial pit based on a change in soil color. Even the undocumented burials were easily identified by a change in soil color even though their size and shape was not as well defined as the documented burial pits (see Figure 3-3). Additionally, the equipment operators conducting the excavation could distinguish when they were digging in a burial pit based on the difference in the hardness of the soil. Workers could even detect the difference in the soil hardness when walking over burial pits, which tended to be soft and spongy. Adding to the visual and soil hardness cues, the burial pits were also radiologically identifiable based on gamma walkover surveys (GWS) once the contaminated layers were reached (see Figure 3-4). In summary, both documented and undocumented burials were easy to distinguish once excavation activities commenced.

Figure 3-3
Example of Burial Pit Soil Discoloration

Figure 3-4
Example of Unearthed Trash and Debris in the Burial Pit Area

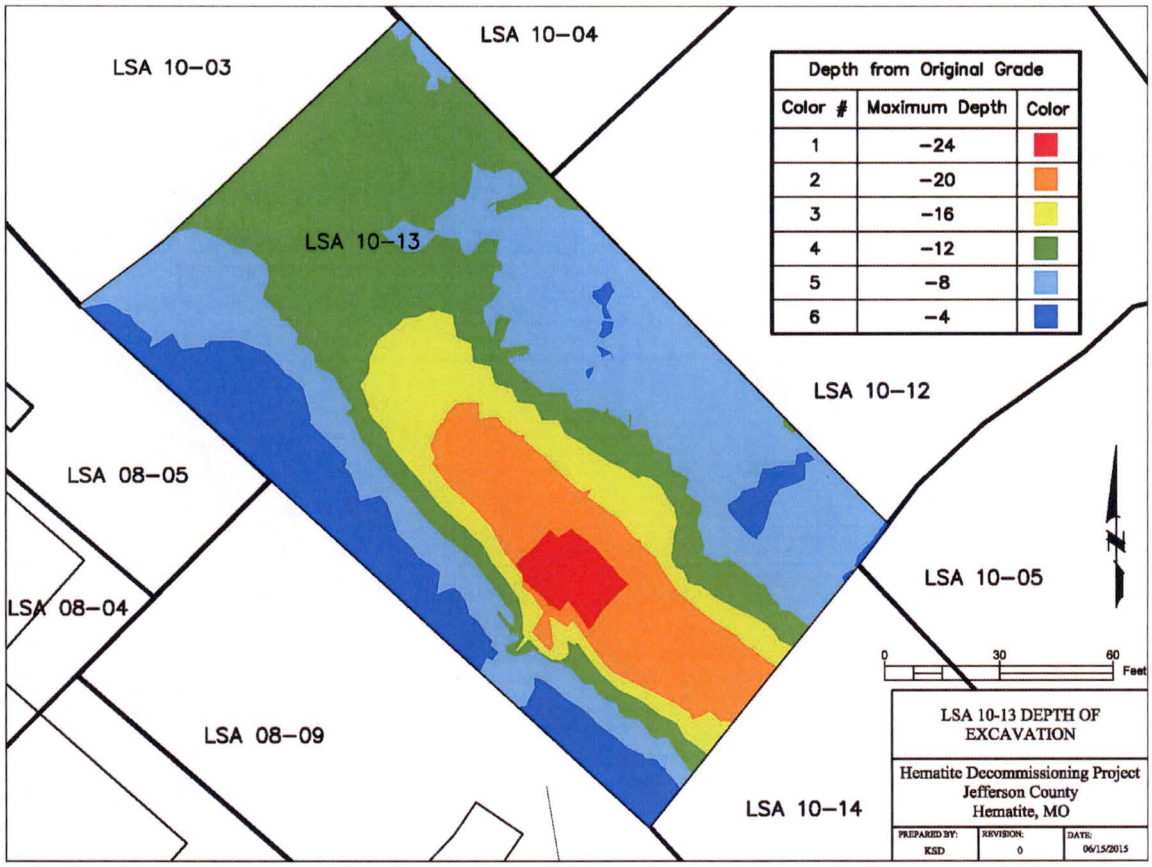
As excavation and remediation of the Burial Pit Area progressed, it became apparent that most of the buried debris was located in the north and south ends of the Burial Pit Area, and typically in closely aligned pits, while the central area had minimal debris and contamination. Since sloping and benching practices were employed, and due to the close nature of the pits, a larger than expected quantity of soil was removed. This resulted in a larger single excavation area as opposed to individual standalone pits.

As excavation progressed for the removal of contaminated wastes and debris in the Burial Pit Area, five activities came into play that determined the extent of remediation in a given survey unit. These were: 1) in process Remedial Action Support Surveys (RASS), 2) conducting core bores to support moving out of nuclear criticality safety controls, 3) performing a final RASS, 4) sampling for VOC remediation, and 5) conducting FSS. These will be discussed in later sections.

The HDP Technical Report HDP-RPT-FSS-303 *Summary Report for Burial Pit Area Remediation* (Appendix H) contains additional specific information related to the remediation of the Burial Pit Area.

The maximum depth of remedial excavation necessary in portions of LSA 10-13 to ensure all areas identified during site characterization and remedial action survey efforts were adequately remediated relative to the original grade was 24 feet. The estimated volume of excavated waste materials from LSA 10-13 was 6,817 cubic yards. Figure 3-5 provides the depth of excavations for LSA 10-13.

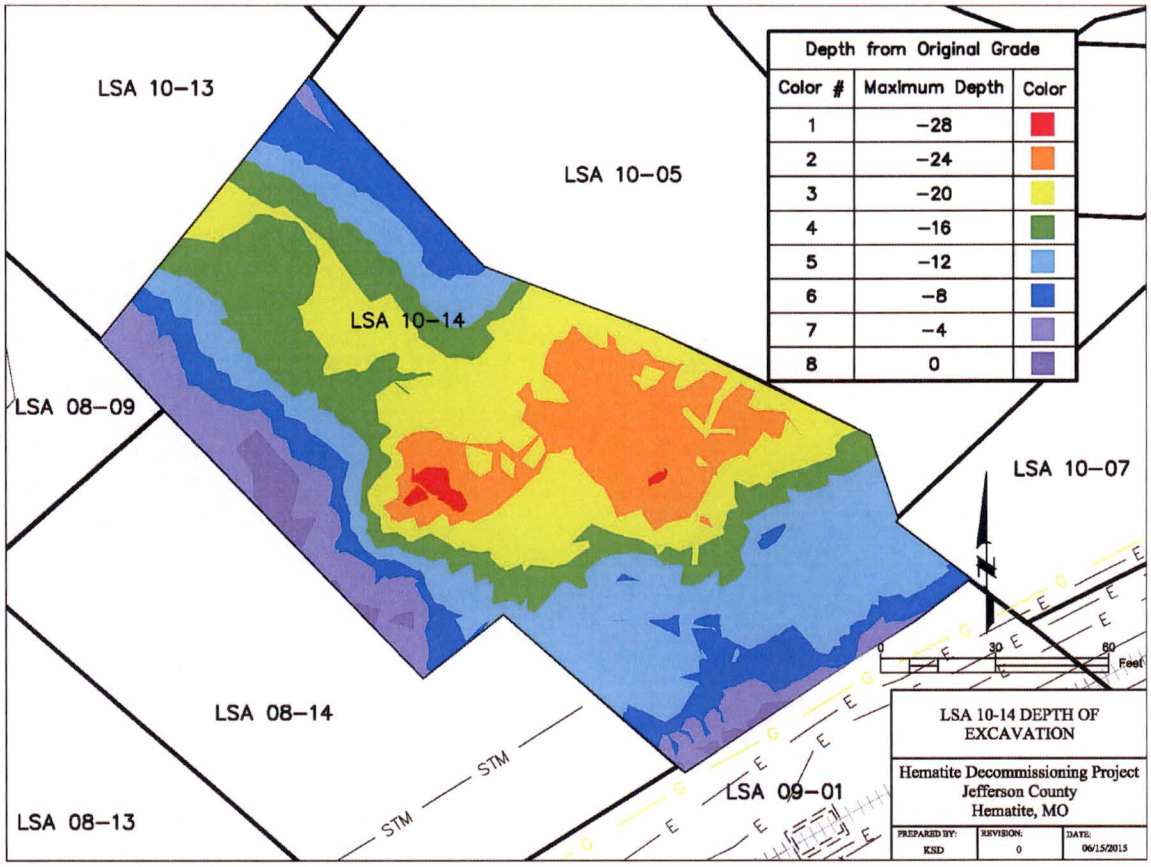
Figure 3-5
LSA 10-13 Depth of Excavation Map (Depths in Feet)*



*Depth of Excavation Map presented in colored bands of feet. Maximum depth is 24 feet.

The maximum depth of remedial excavation necessary in portions of LSA 10-14 to ensure all areas identified during site characterization and remedial action survey efforts were adequately remediated relative to the original grade was 28 feet. The estimated volume of excavated waste materials from LSA 10-14 was 8,754 cubic yards. Figure 3-6 provides the depth of excavations for LSA 10-14.

Figure 3-6
LSA 10-14 Depth of Excavation Map (Depths in Feet)*



*Depth of Excavation Map presented in colored bands of feet. Maximum depth is 28 feet.

3.3.2 In Process Remedial Action Support Surveys

During excavation and remediation of the Burial Pit Area, remedial action support surveys were conducted in accordance with procedure HDP-PR-HP-601, *Remedial Action Support Surveys*. The radiological information obtained from the surveys served the purpose of categorizing the soil/debris into one of four categories; 1) Soil/debris potentially exceeding the Nuclear Criticality Safety Exempt Material Limit, 2) Soil/debris potentially containing radioactivity concentrations above the Reuse Material Screening Level (RML), 3) Soil expected to contain radioactivity concentrations that were less than the RML but requiring removal in order to access additional soil/debris having radioactivity concentrations above the RML, and 4) Soil expected to contain radioactivity concentrations that are less than the RML and not requiring removal.

3.3.3 Nuclear Criticality Safety (NCS) Borings

In addition to the visual inspection and radiological measurements conducted to determine when removal of buried waste was complete and NCS controls could be removed during remediation of LSA 10-13 and LSA 10-14, a series of borings were performed within the NCS Controlled areas of the SUs.

As directed by NSA-TR-09-15, *Nuclear Criticality Safety Assessment of Buried Waste Exhumation and Contaminated Soil Remediation at the Hematite Site* (Reference 12.3), borings were performed for the purpose of downgrading from NCS controls and included an inspection of the core bore soil to confirm that no burial pit debris was present below the excavation surface. The NSA-TR-09-15 Administrative CSC 23 required that these borings (see Figure 3-7 and Figure 3-8) would be performed to 3 feet (ft) below the deepest identified buried waste item in an excavation or 7 ft bgs (representative of 4 ft of overburden soil and an additional 3 ft into the soil that could have potential burial pit waste). In addition to performing a boring below the deepest identified waste item in an excavation, a grid with maximum spacing of 20 ft between boreholes was conducted within the entire documented burial pit area. The grid spacing chosen was based upon the nominal size of a documented burial pit. The spacing was chosen to provide a high probability that material from an unidentified burial pit would be intercepted.

The survey measurements from all of the spoils material and boreholes for LSA 10-13 and LSA 10-14, along with the results of the visual inspection, were then reviewed by the NCS Specialist and the area released from NCS controls. The visual inspection of the cores provided evidence that no materials indicative of burial pit waste were encountered below the excavation surface within LSA 10-13 and LSA 10-14. Once the area was released from NCS controls, excavation continued as necessary for additional remediation of radiological and/or VOC contamination.

No materials indicative of burial pit waste were encountered below the excavation surface within LSA 10-13 and LSA 10-14.

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Figure 3-7
NCS Core Bore Locations in LSA 10-13

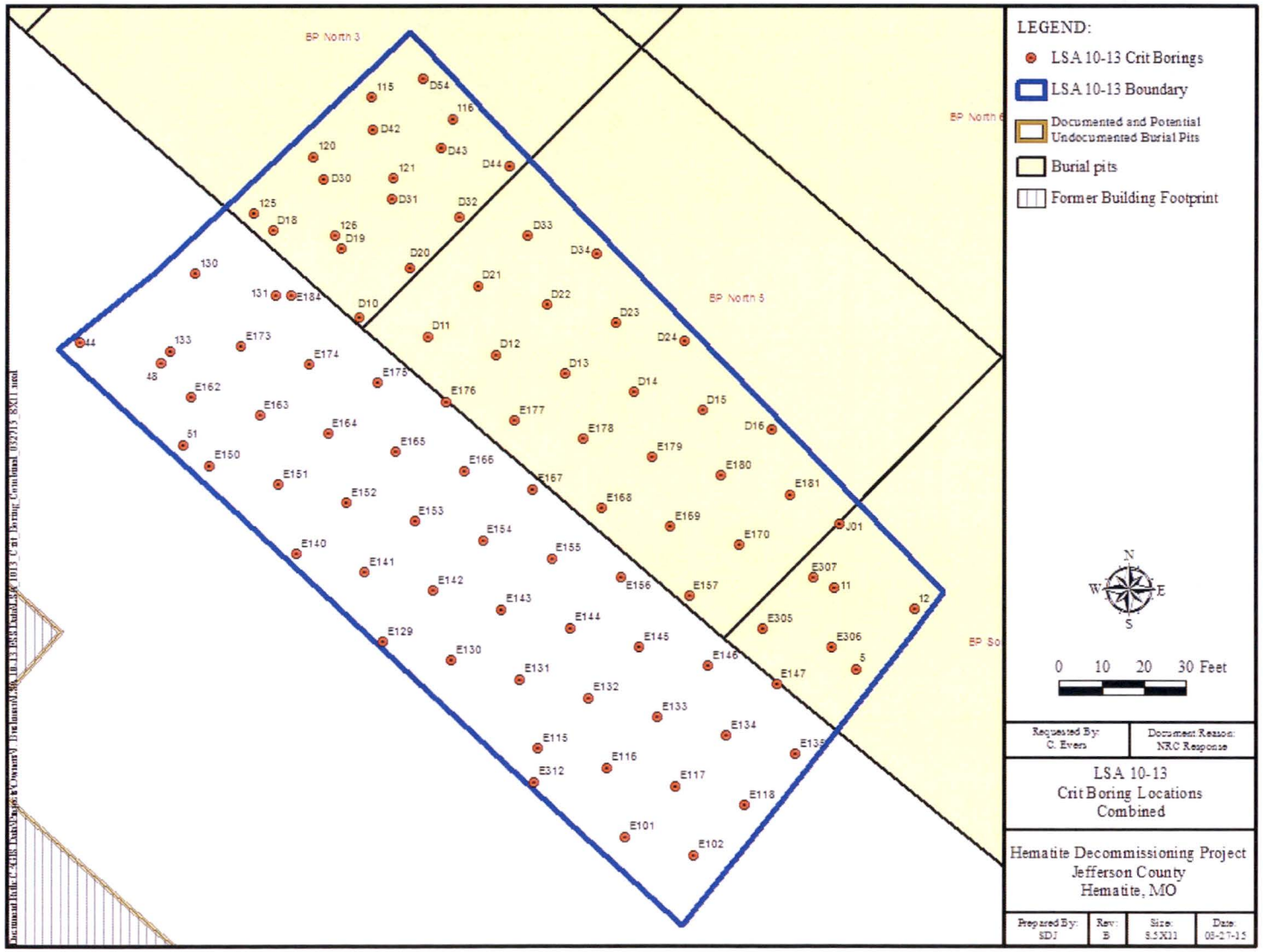
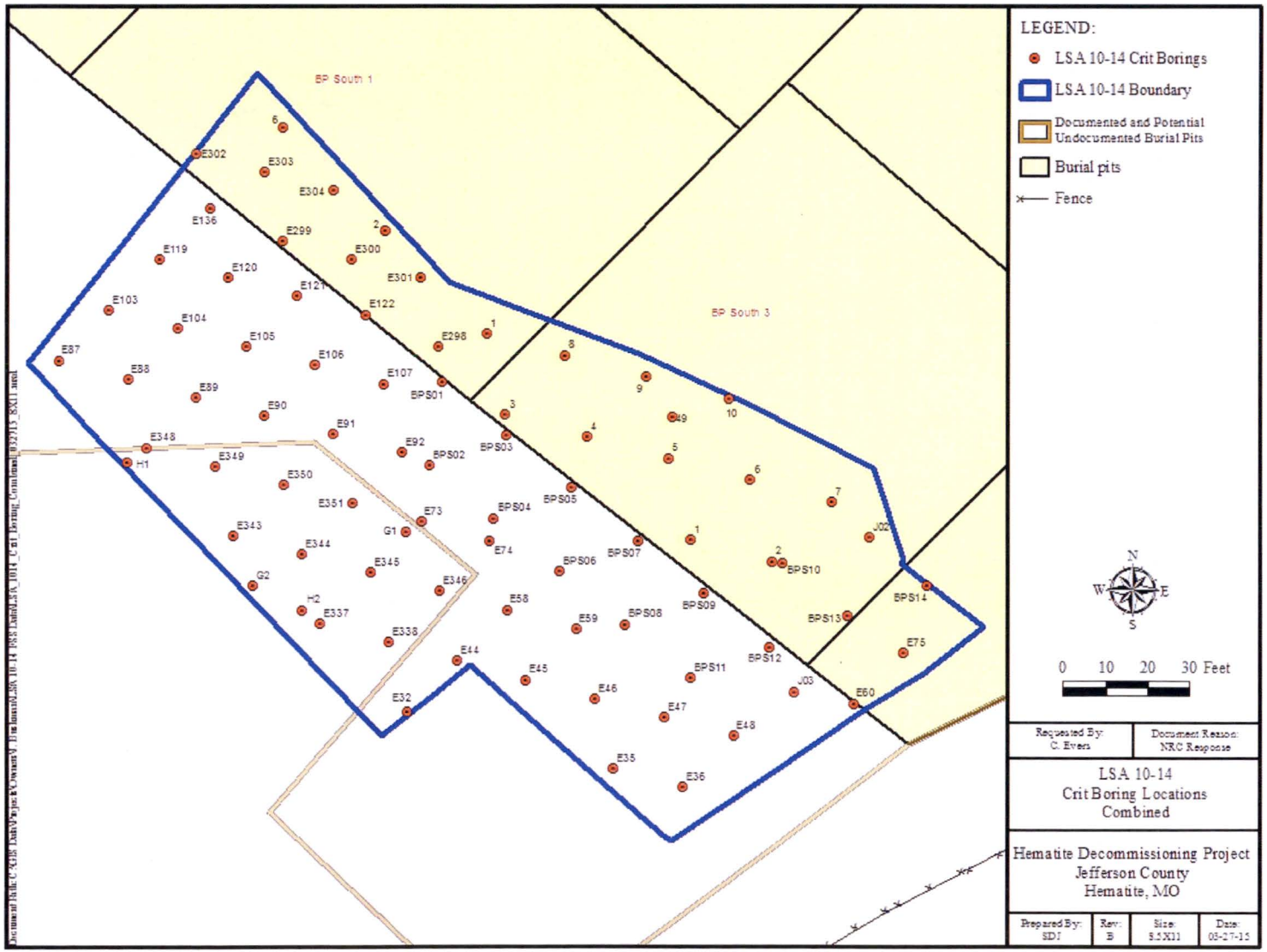


Figure 3-8
NCS Core Bore Locations in LSA 10-14



3.3.4 Groundwater Monitoring Wells

A detailed discussion of history, purpose, use, issues, and results of the groundwater monitoring wells at HDP is presented in the FSSFR Volume 6, Chapter 1.

During the history of site operations and remediation no groundwater monitoring wells were located within the boundary limits of LSA 10-13 and LSA 10-14.

3.3.5 Subterranean Piping

Preliminary remediation planning activities indicated that no subterranean process piping should be encountered in LSA 10-13 and LSA 10-14. During remediation of LSA 10-13 and LSA 10-14 no subterranean process piping was encountered.

As no buried piping remains under the footprint of LSA 10-13 and LSA 10-14 there is no dose contribution from this pathway.

3.3.6 Characterization Core Bores

Radiological characterization surveys for the HDP were conducted in several phases by multiple contractors over several years prior to the issuance of the DP. A total of thirty eight (38) core borings to depths as deep as 35 feet bgs were performed for characterization within both LSA 10-13 and LSA 10-14 prior to remediation.

Within LSA 10-13, one sample (SO-BP4F) of the fifteen characterization boring locations within the SU exceeded a SOF of 1 as compared to the Uniform Stratum criteria at a depth of 8 ft bgs. This was removed during remediation with excavation occurring to a depth of at least 12 ft bgs at this location. Figure 3-9 indicates the radiological characterization boring locations within LSA 10-13

Within LSA 10-14, of the twenty three (23) characterization boring locations within the SU ten (10) samples (five in the Surface Stratum and five in the Root Stratum) exceeded a SOF of 1 as compared to the Uniform Stratum criteria from the surface to depths of up to 5 ft bgs (Root Stratum). Within LSA 10-14 the Surface Stratum was entirely removed. The five (5) Root Stratum samples (SS-HS-001, LB36R, LB3637RC5, LB37R, and LB39R) exceeded a SOF of 1 at depths up to 5 ft bgs, with all 5 of these locations being excavated to depths greater than 8 ft bgs. Figure 3-10 indicates the radiological characterization boring locations within LSA 10-14.

Figure 3-9
Site Characterization Borings within LSA 10-13

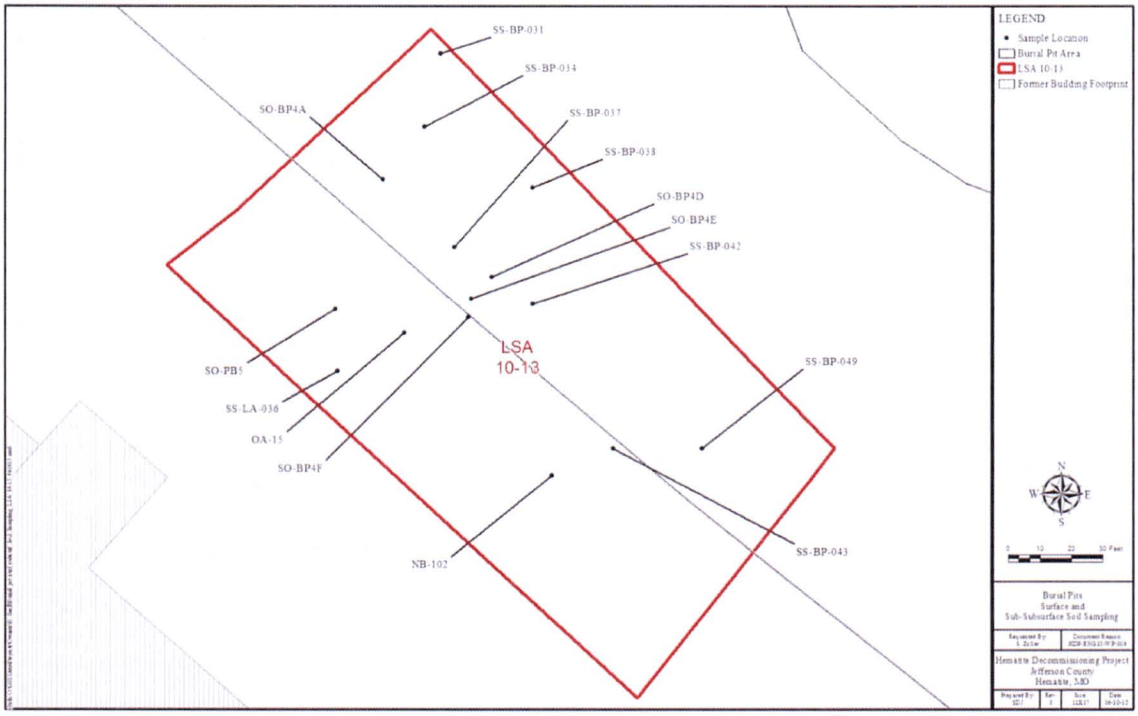
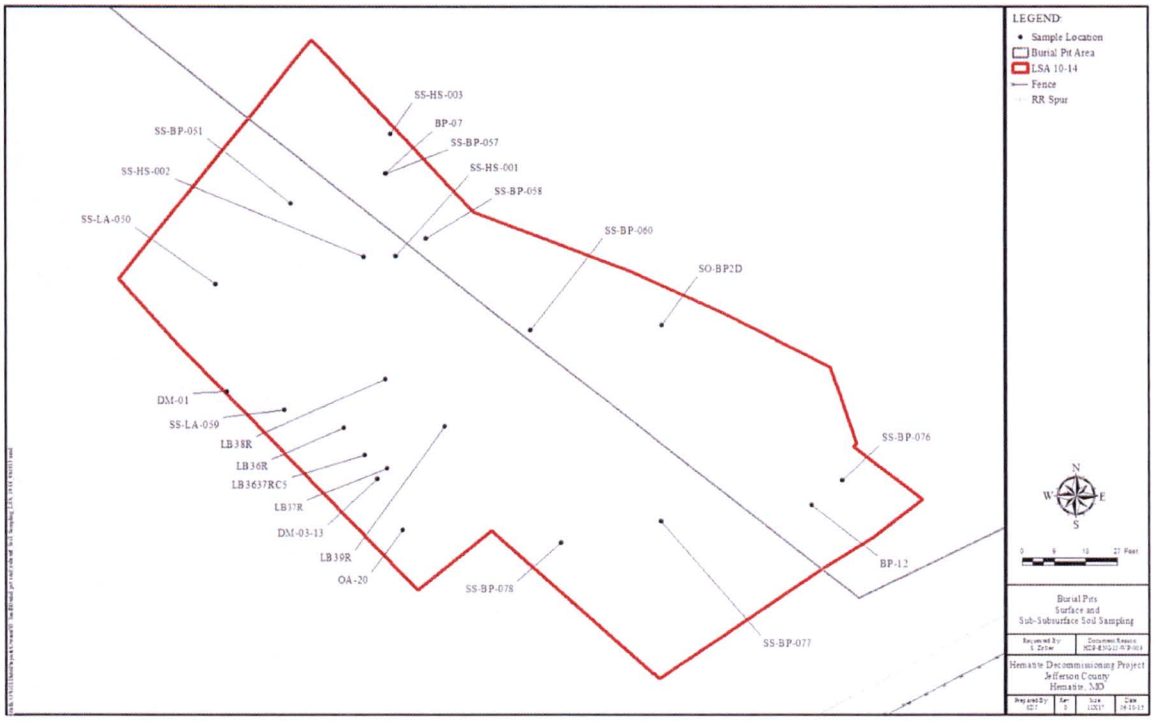


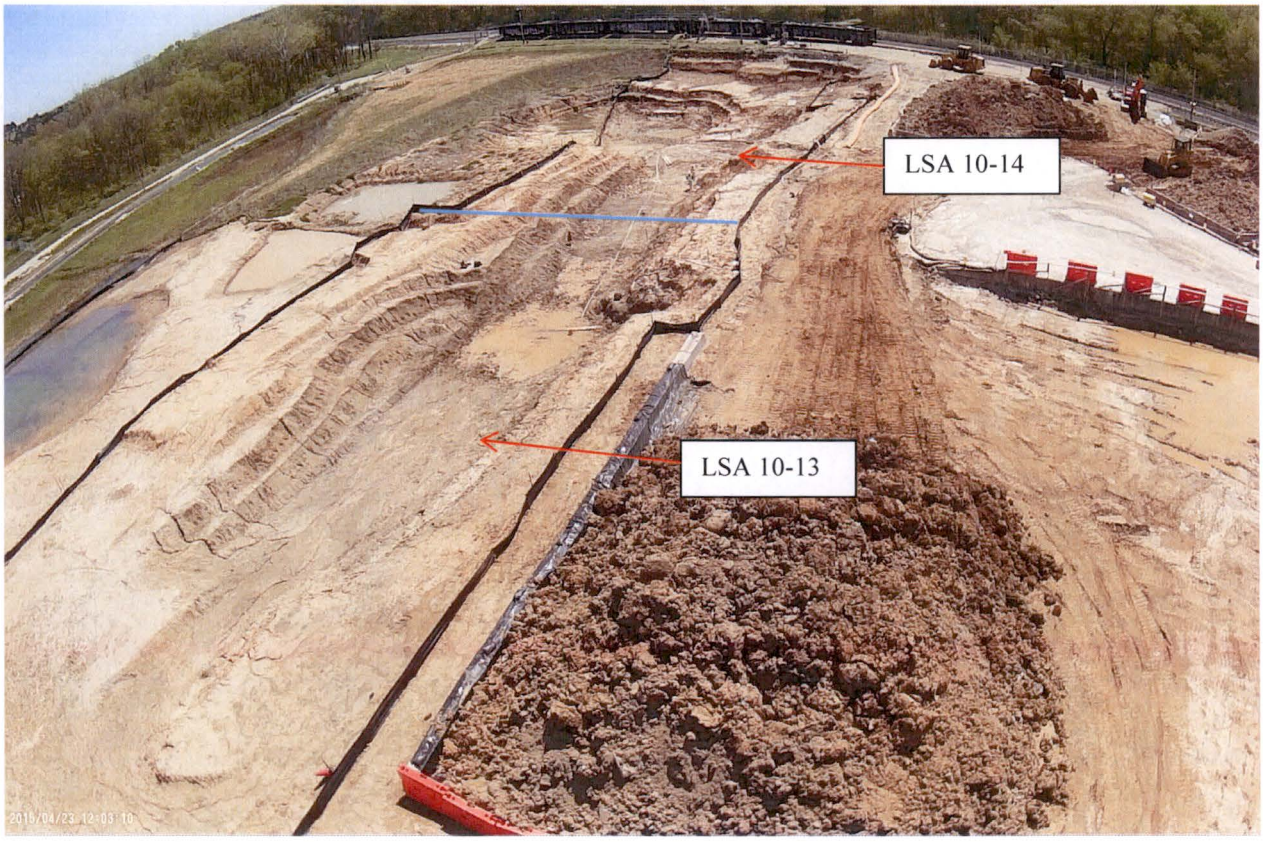
Figure 3-10
Site Characterization Borings within LSA 10-14



3.3.7 Remedial Action Support Survey for FSS Design

The RASS was conducted 1) to guide remediation activities, 2) to determine when an area or survey unit had been adequately prepared for FSS, and 3) to provide updated estimates of the parameters to be used for planning the FSS. Upon completion of remediation within the survey unit and prior to implementation of FSS activities, a final RASS was performed to validate the status of the SU prior to implementing Isolation and Control (I & C) postings. The I & C posting for both LSA 10-13 and LSA 10-14 was completed on March 11, 2015. Figure 3-11 is a photograph which shows LSA 10-13 and LSA 10-14 ready for the final RASS.

Figure 3-11
LSA 10-13 and LSA 10-14 Prepared for RASS FSS Design



The RASS included a GWS, systematic surface sample collection based on an eight (8) -point triangular grid, and biased surface sampling. The Final RASS systematic sample results used to develop the FSS sampling grid are summarized in Table 3-1 below:

Table 3-1
Summary of Final RASS Results for LSA 10-13 and LSA 10-14

LSA	Ra-226 (net)		Tc-99		Th-232 (net)		U-234		U-235		U-238	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max
10-13	0.01	0.04	0.21	0.65	0.19	0.28	3.96	14.40	0.22	0.80	1.06	2.50
10-14	0.03	0.23	1.89	11.10	0.17	0.31	2.54	6.17	0.11	0.21	2.89	16.03
DCGL[3]	1.9		25.1		2.0		195.4		51.6		168.8	

Notes:
1. All units are in picocuries per gram (pCi/g)
2. Results reflect net concentrations after subtraction of background (Ra-226 bkg = 0.9 pCi/g; Th-232 bkg = 1.0 pCi/g).
3. Uniform Stratum DCGLs (From Table 4-1)

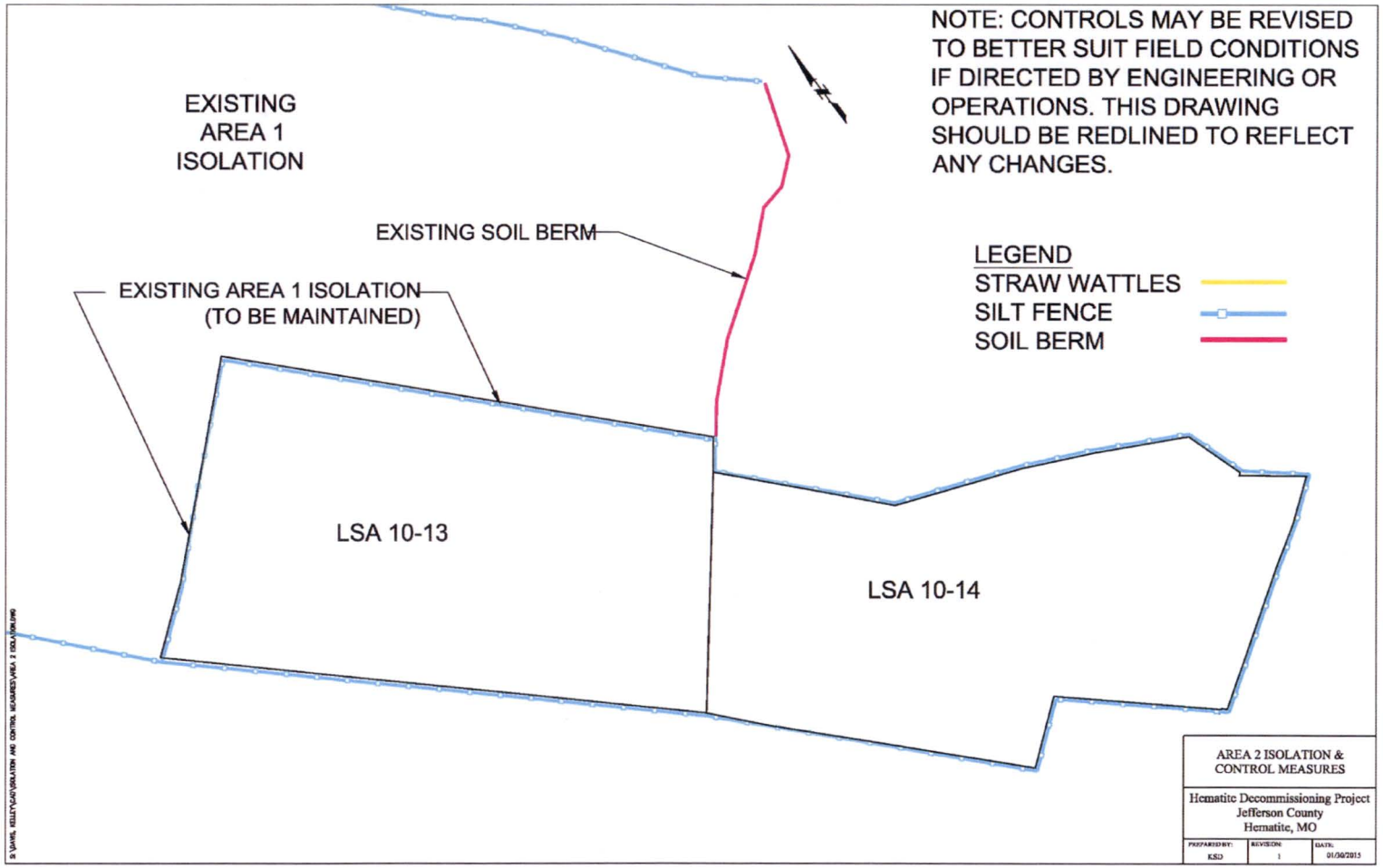
All Final RASS systematic sample and biased sample results were less than the appropriate $DCGL_W$ (Uniform Stratum) and the Final RASS data set was considered sufficient to support FSS design.

3.3.8 Isolation and Control

As directed by HDP-PR-HP-602, *Data Package Development and Isolation and Control Measures to Support Final Status Survey,* on March 11, 2015,, LSA 10-13 and LSA 10-14 were isolated and controlled in accordance with Work Package HDP-WP-ENG-803, *Isolation and Control Measures,* (See Figure 3-12) Isolation and control measures included silt fence, straw wattle, and soil berms between these SUs and the adjacent remediation area to ensure that cross-contamination of these LSAs undergoing FSS did not occur.

The administrative control of distinctive green and white rope with multiple postings labeled "Contact Health Physics Prior to Entry" was installed around the entire perimeter of the SUs prior to FSS field activities to prevent inadvertent entry by site personnel. LSA 10-13 and LSA 10-14 are located within the fenced security perimeter of the HDP which therefore prevents access by the general public.

Figure 3-12
Isolation and Control of Area Containing LSA 10-13 and LSA 10-14



3.3.9 Surveillance Following FSS

Following the completion of a FSS, the DP requires continued surveillance to minimize the potential to re-contaminate a survey unit (e.g., surface water transport of potentially contaminated sediment or a soil pile that was not present during FSS). The surveillance includes the routine visual inspection of the integrity of the I & C measures implemented for LSA 10-13 and LSA 10-14. If a survey unit is suspected of having been re-contaminated then an investigation survey will be performed to reconfirm the FSS survey validity.
~~During the timeframe since the completion of FSS field activities to the date of the start of backfill, LSA 10-13 and LSA 10-14 did not evidence an event that would cause them to be suspect and thus require investigation.~~

3.3.10 Backfill of Survey Units

Although not a function of remediation, but as described in the DP Section 8.8 and FSFFR Volume 2 Chapter 1, the SUs will be backfilled using backfill obtained from on-site material determined to be suitable for reuse (e.g., excavated soil overburden), and/or backfill material from an off-site location.

FSSFR Volume 3, Chapter 1, Section 2.13, *Backfill Operations*, describes the methodologies for placement of backfill soil into an excavation and evaluations of dose impacts. FSSFR Volume 3, Chapter 1, Section 3.1.2 describes how the dose from on-site reuse soil will be added into the SU total dose evaluation.

The entire volume of Reuse Stockpile 3 (FSSFR Volume 2, Chapter 3 {ML16285A370}) material was used as backfill and placed within the Deep Stratum of LSA 10-13. As provided in FSSFR Volume 2, Chapter 3, Reuse Stockpile 3 has been calculated to contribute 3.5 mrem/year (milliroentgen equivalent man/year) to the total dose of a SU when evaluated against the Uniform Stratum release criteria (a SOF of 0.14 rounded up from 0.138). Therefore 3.5 mrem/year will be assigned to the Deep Stratum and added to the total dose calculation for SU LSA 10-13.

The entire volume of Combined Reuse Stockpile 1-2 (FSSFR Volume 2, Chapter 2 {16285A369}) material was used as backfill and placed within the Deep Stratum of LSA 10-14. As provided in FSSFR Volume 2, Chapter 2, Combined Reuse Stockpile 1-2 has been calculated to contribute 2.5 mrem/year to the total dose of a SU when evaluated against the Uniform Stratum release criteria (a SOF of 0.10 rounded up from 0.098). Therefore 2.5 mrem/year will be assigned to the Deep Stratum and added to the total dose calculation for survey unit LSA 10-14.

3.3.11 Groundwater Monitoring

In response to NRC RAI Chapter 3-4, during the review and approval process for the DP, Westinghouse documented in letter HEM-11-96 {ML111880290} the revised text of DP Section 14.5.1 to be as follows:

> "*Post-remediation monitoring wells will be sampled quarterly after the completion of remediation until license termination. The data collected will be used to confirm that the sum of the annual dose from groundwater for all the radionuclides does not exceed the EPA*

Maximum Contaminant Level (MCL) of 4 millirem/year. Separately, the sum of the dose from all residual sources remaining after remediation, including soil and groundwater pathways, will be confirmed to result in an annual dose that does not exceed 25 millirem/year."

As stated in the Executive Summary section, the exposure results of this report will be combined with the dose attributed to groundwater to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 CFR 20 Subpart E, "Criteria for License Termination." As such, for the purpose of this report, groundwater will be assigned a conservative SOF of 0.16 which equates to 4 mrem/year until such time that the post-remediation groundwater sampling has been completed and reported as part of FSSFR Volume 6, Chapter 7, *Post-remediation Groundwater Monitoring Summary*. The final dose for LSA 10-13 and LSA 10-14 will be reported in FSSFR Volume 7, reflecting the updated results of the post-remediation groundwater monitoring.

4.0 LSA RELEASE CRITERIA

As the release criteria for all LSA SUs is common, FSSFR Volume 3, Chapter 1, Section 3.0, *Release Criteria*, provides a detailed discussion on the release criteria that is applicable to LSA 10-13 and LSA 10-14. Table 4-1 provides the applicable DCGLs.

Table 4-1
Adjusted Soil $DCGL_w$'s by CSM[a]

Radionuclide	Three Layer Approach $DCGL_w$ Values (pCi/g)[b]			Uniform Stratum (pCi/g)
	Surface Stratum	Root Stratum	Excavation Scenario	
Radium-226+C[d]	5.0	2.1	5.4	**1.9**
Technetium-99	151.0	30.1	74.0	**25.1**
Thorium-232+C[d]	4.7	2.0	5.2	**2.0**
Uranium-234	508.5	235.6	872.4	**195.4**
Uranium-235+D[c]	102.3	64.1	208.1	**51.6**
Uranium-238+D[c]	297.6	183.3	551.1	**168.8**

[a] Table as presented in FSSFR Volume 3, Chapter 1.
[b] The reported DCGLw's are the activities for the parent radionuclide 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.

5.0 FINAL STATUS SURVEY DESIGN LSA 10-13

This section of the report describes the method for determining the number of samples required for the FSS of LSA 10-13 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_W$, scan survey coverage, and Investigation Action Levels (IAL). The radiological instrumentation used in the FSS of LSA 10-13 and the detection sensitivities are also discussed.

5.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 10-13 were driven by the type (Open Land) and Class (Class 1) of the survey unit and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 5, *Final Status Survey Plan Development*, January 2015.

5.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design.*

5.1.2 $DCGL_W$

During the FSS design process a review was performed of the historic characterization data for LSA 10-13. The review identified one (1) area that was previously found to exceed a Uniform SOF of 1.0 (discussed in Section 3.3.6). Next the remediation history of LSA 10-13 was reviewed to confirm that the area was adequately addressed. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform Stratum $DCGL_W$. Therefore the Uniform Stratum $DCGL_W$ was selected for use in demonstrating compliance with the release criteria.

5.1.3 GWS Coverage

As a Class 1 SU, LSA 10-13 was required to undergo a 100% GWS.

5.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 10-13 was the Ludlum 44-10 2" x 2" sodium iodide (NaI) detectors, coupled to a Ludlum 2221 scaler-ratemeter.

5.1.5 Scan Minimum Detectable Concentration (MDC)

As background levels were approximately 13,000 counts per minute (cpm) within LSA 10-13, the scan minimal detection concentration (MDC) calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{7383\ pCi/g}\right)+\left(\frac{f_{U-235}}{4.9 pCi/g}\right)+\left(\frac{f_{U-238}}{62.8 pCi/g}\right)\right)}$$

Equation 5-1

In order to calculate the Scan MDC for total uranium using the above equation, an average enrichment for the SU must be known which in turn will provide relative isotopic fractions for U-234, U-235, and U-238 as given in Appendix G of HDP-PR-FSS-701, Revision 4, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 10-13, the average enrichment for the SU was 2.8%.

Standard Scan MDCs for Radium-226 and Thorium-232 using a 2" x 2" NaI detector are found in Table 6.4 of NUREG-1507 and are shown in Table 5-1. Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 10-13 are shown below:

Table 5-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 10-13

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 10-13	40.4	25.7	1.19	2.8	0.85	3.0

*$DCGL_W$ includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. $DCGL_W$ values are based on the Uniform Stratum release criteria.

The values in Table 5-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS.

5.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site*". The IAL used during the GWS of LSA 10-13 was established at 4,000 net counts per minute (ncpm).

5.1.7 LSA 10-13 FSS Design Summary

The FSS Plan for LSA 10-13 can be found in Appendix C. Table 5-2 presents an overall FSS design and implementation summary for LSA 10-13.

Table 5-2
FSS Design Summary for LSA 10-13

Gamma Walkover Survey (GWS):		
Scan Coverage	100% exposed excavation floors, benches, pits, and sidewalls	
Scan MDC	40.4 pCi/g total Uranium (based on a 13,000 cpm background); 0.85 pCi/g Th-232; 1.19 pCi/g Ra-226*	
Investigation Action Level (IAL)	4,000 net cpm* *	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments
0 – 15 cm (Surface)	0	These samples were collected on a systematic grid.
15 cm – 1.5 m (Root)	4	
> 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 FSS Supervisor.		
Sidewall Sampling Locations:		
Supplemental Sidewall Sampling: In accordance with *HEM-15-MEMO-039*, two (2) discretionary sidewall samples will be collected based on the following definition of "sidewall": 1) sidewalls must be vertical or near vertical and at least 12" in height, and 2) constitute an aggregate surface area which exceeds 5% of the total surface area of the SU, e.g., 100 m^2 of sidewall area in a 2,000 m^2 SU.		
Instrumentation		
Ludlum 2221 with 44-10 (2" x 2" 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)*", Westinghouse, April 2015.		
**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.		

6.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 10-13

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.

6.1 Gamma Walkover Survey

6.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 10-13 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS (Digital Global Positioning System) and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

6.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the survey unit was 1 GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, North American Datum (NAD) 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the HP Technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

HP Technicians performing GWS in LSA 10-13 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 13,000 gross counts per minute (gcpm). Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 18,000 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Sidewalls, hard to reach areas, and non-typical areas were surveyed manually to the maximum extent practical in order to assess the potential for an area of elevated residual activity over 100% of the exposed excavation surface.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics (HP) Technician performing the survey to determine if possible areas of elevated residual activity remained within the SU that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

6.2 Soil Sampling

6.2.1 Systematic Soil Sampling Summary

Table 6-1 provides a summary of systematic sampling by stratum for LSA 10-13.

Table 6-1
Systematic Sampling Summary by Stratum for LSA 10-13

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
10-13	1,895	0	4	8	1

6.2.2 Systematic Sampling LSA 10-13

Within LSA 10-13, there were no systematic locations in which portions of the surface stratum [0 – 15 centimeters (cm)] remained in the SU after remediation. Portions of the root stratum (15 cm – 150 cm) remained at four (4) of the eight systematic locations. At this location the remaining root stratum interval was collected using a hand auger and composited. Excavation stratum samples were collected at all eight locations using either hand trowels, or hand augers where necessary, for six-inch grab samples below the existing excavation surface.

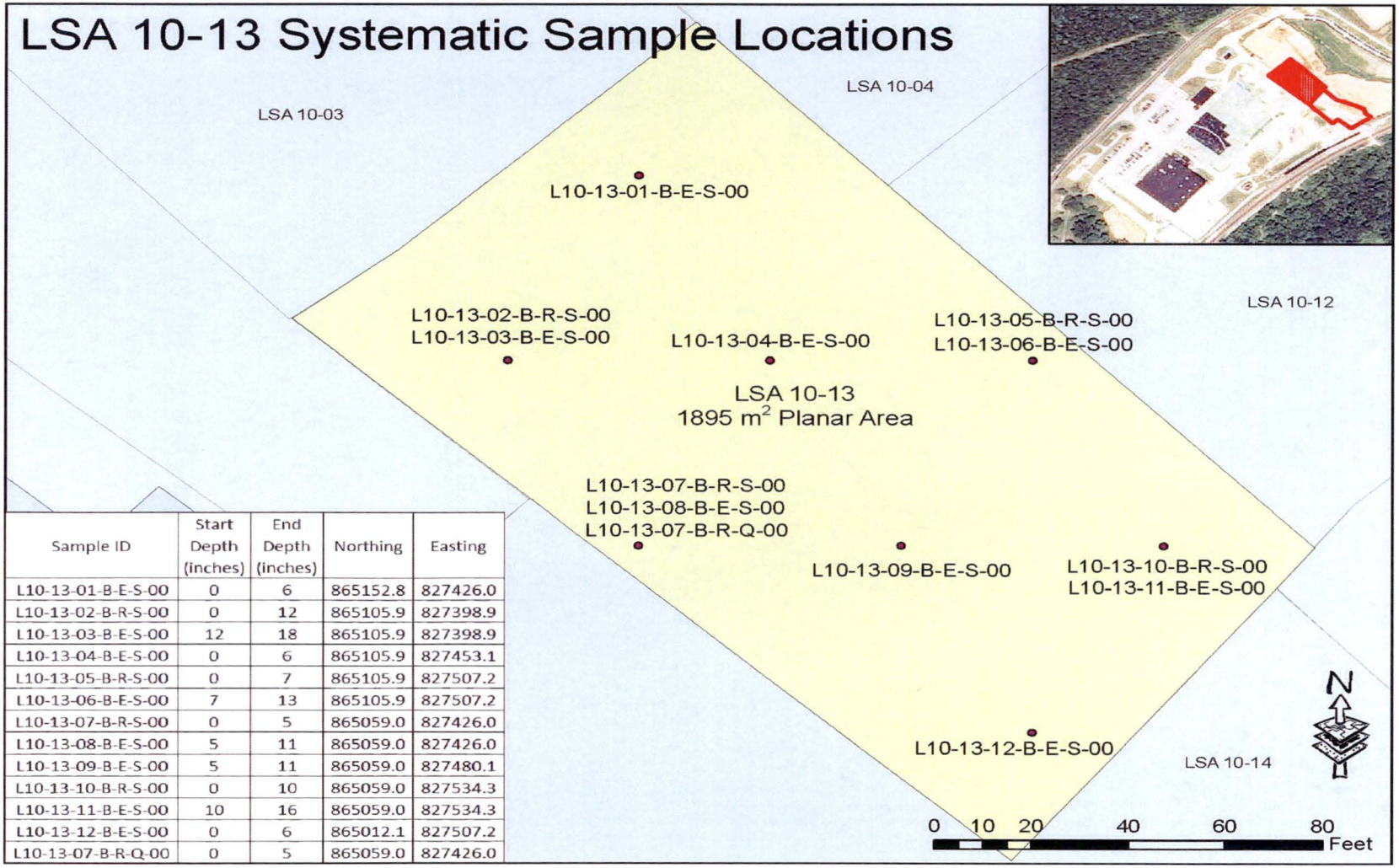
Given a planar area of 1,590 m^2 for LSA 10-13 and an eight - point systematic triangular grid, the point-to-point distance within each row was 15.1 m with spacing of 13.1 m between each of the parallel grid rows within the SU.

While there were eight (8) systematic locations on the LSA 10-13 sampling grid, a total of thirteen (13) samples were collected at these locations, including:

- Zero (0) samples collected within the remaining surface stratum
- Four (4) samples collected within the remaining root stratum
- Eight (8) samples collected within the excavation, or "deep" stratum
- One (1) Quality Control (QC) field replicate

Figure 6-1 presents the map of the eight systematic sample locations which were sampled within LSA 10-13. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 6-1
LSA 10-13 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L10-13-01-B-E-S-00	0	6	865152.8	827426.0
L10-13-02-B-R-S-00	0	12	865105.9	827398.9
L10-13-03-B-E-S-00	12	18	865105.9	827398.9
L10-13-04-B-E-S-00	0	6	865105.9	827453.1
L10-13-05-B-R-S-00	0	7	865105.9	827507.2
L10-13-06-B-E-S-00	7	13	865105.9	827507.2
L10-13-07-B-R-S-00	0	5	865059.0	827426.0
L10-13-08-B-E-S-00	5	11	865059.0	827426.0
L10-13-09-B-E-S-00	5	11	865059.0	827480.1
L10-13-10-B-R-S-00	0	10	865059.0	827534.3
L10-13-11-B-E-S-00	10	16	865059.0	827534.3
L10-13-12-B-E-S-00	0	6	865012.1	827507.2
L10-13-07-B-R-Q-00	0	5	865059.0	827426.0

Table~~Figure~~ 6-2 below presents a tabular listing of all FSS samples collected within LSA 10-13 with associated IDs, sample types, collection intervals, coordinates, and notes.

~~Figure~~ Table 6-2

FSS Sample Locations and Coordinates for LSA 10-13

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
	Westinghouse Non-Proprietary Class 3	Revision: 5	Appendix P-4, Page 1 of 1

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area

Survey Unit: 13 **Description:** Northern Survey Unit in "Area 2"

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
L10-13-01-B-E-S-00	Uniform	S	426.4	426.0	865152.8	827426.0	Excavation 6-inch grab
L10-13-02-B-R-S-00	Uniform	S	431.2	429.7	865105.9	827398.9	Root 12-inch composite
L10-13-03-B-E-S-00	Uniform	S	429.7	429.2	865105.9	827398.9	Excavation 6-inch grab
L10-13-04-B-E-S-00	Uniform	S	421.5	421.1	865105.9	827453.1	Excavation 6-inch grab
L10-13-05-B-R-S-00	Uniform	S	429.1	428.0	865105.9	827507.2	Root 7-inch composite
L10-13-06-B-E-S-00	Uniform	S	428.0	427.5	865105.9	827507.2	Excavation 6-inch grab
L10-13-07-B-R-S-00	Uniform	S	431.5	430.6	865059.0	827426.0	Root 5-inch composite
L10-13-08-B-E-S-00	Uniform	S	430.6	430.1	865059.0	827426.0	Excavation 6-inch grab
L10-13-09-B-E-S-00	Uniform	S	415.3	414.8	865059.0	827480.1	Excavation 6-inch grab
L10-13-10-B-R-S-00	Uniform	S	429.7	428.4	865059.0	827534.3	Root 10-inch composite
L10-13-11-B-E-S-00	Uniform	S	428.4	427.9	865059.0	827534.3	Excavation 6-inch grab
L10-13-12-B-E-S-00	Uniform	S	419.1	418.6	865012.1	827507.2	Excavation 6-inch grab
L10-13-07-B-R-Q-00	Uniform	Q	431.5	430.6	865059.0	827426.0	Excavation 6-inch grab
L10-13-13-B-R-B-00	Uniform	B	435.0	431.5	865063.0	827417.0	Biased 6-inch Grab
L10-13-14-B-E-B-00	Uniform	B	419.1	418.6	865069.6	827494.4	Sidewall 6-inch grab
L10-13-15-B-E-B-00	Uniform	B	421.6	421.1	865060.7	827453.1	Sidewall 6-inch grab

Green shaded samples are the ~~topmost~~ samples at each sample location, for use in WRS test.

*Elevations are in feet above mean sea level.

** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

Quality Record

6.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 10-13 one (1) biased sample location was selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. This biased location represented the maximum GWS measurement encountered within the SU. Also, this single biased location was the only point which exceeded both the IAL based on the local background readings and a Z-score of 3. Therefore, no additional biased locations were selected for sampling. Westinghouse conservatively decided to perform additional remediation at this location after the sample was collected; the initial GWS reading at L10-13-13 was the SU maximum of approximately 21,800 gcpm. After the manual remediation, the GWS reading at this location was reduced to approximately 14,000 gcpm. This issue is also discussed in Section 9.1– FSS Plan Deviations. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

6.4 Judgmental/Sidewall Sampling for Tc-99

In accordance with the guidance specified in Volume 3, Chapter 1, Section 6.2.3, it was determined that sidewall sampling was necessary. The number of sidewall samples collected from each SU is determined by comparing the sidewall surface area to the two dimensional systematic surface area (e.g., 8 systematic samples were collected over 2,000 m^2, then collect 1 sample per 250 m^2 of sidewall). Two samples were collected in the sidewall of LSA 10-13. These samples were collected from locations selected by the HP Technician at random, and were not based on gamma survey readings (not biased). The results are presented in Section 7.2.5.

6.5 Quality Control Soil Sampling

One QC field duplicate sample point was randomly selected and collected at systematic location L10-13-06 for LSA 10-13.

7.0 FINAL STATUS SURVEY RESULTS LSA 10-13

7.1 Gamma Walkover Survey

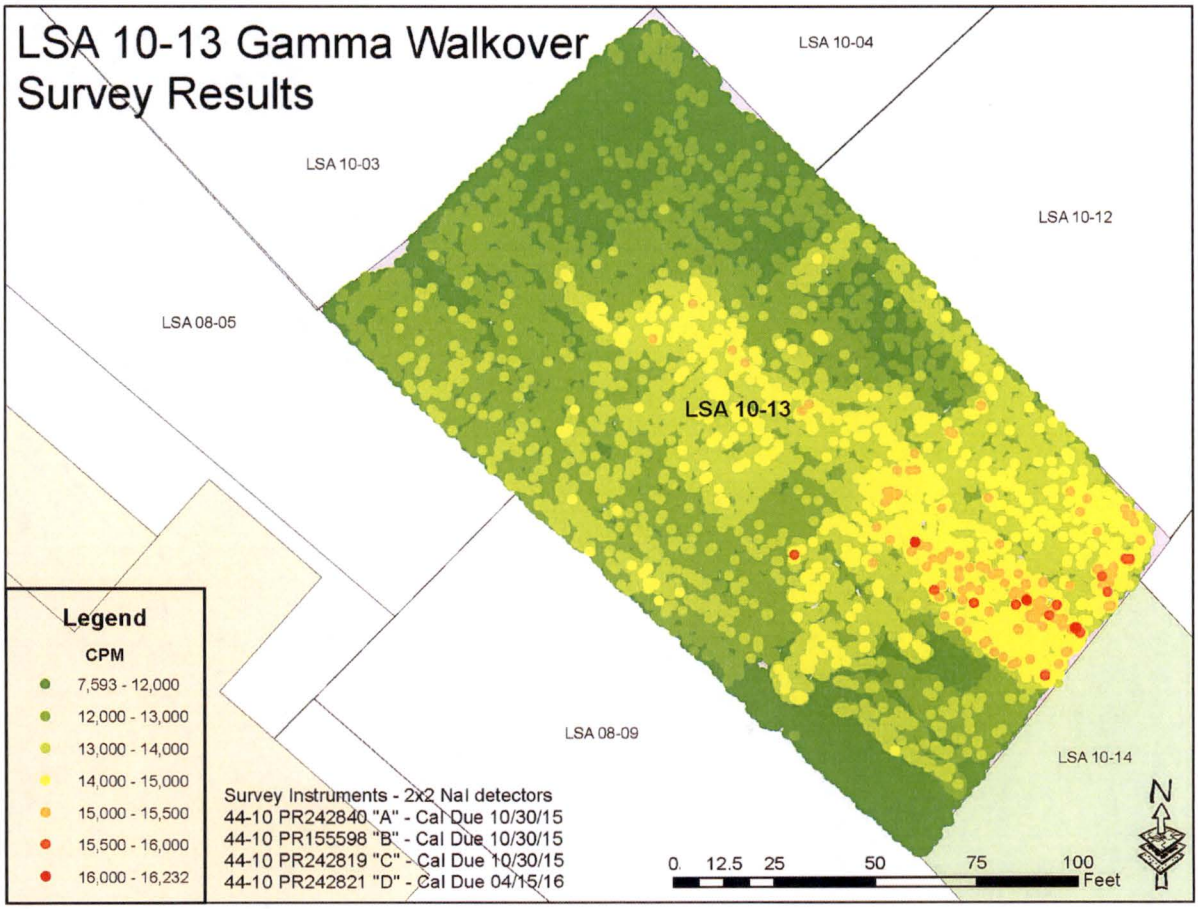
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

GWS measurements were collected in LSA 10-13 between March 31, 2015, and April 29, 2015.

7.1.1 GWS Results for LSA 10-13

For LSA 10-13, GWS count rates ranged between 7,593 gcpm and 16,323 gcpm, with a mean count rate of 11,985 gcpm. The median count rate was 12,035 gcpm and the standard deviation was 1,149 cpm. Figure 7-1 below presents a map of the complete GWS data set.

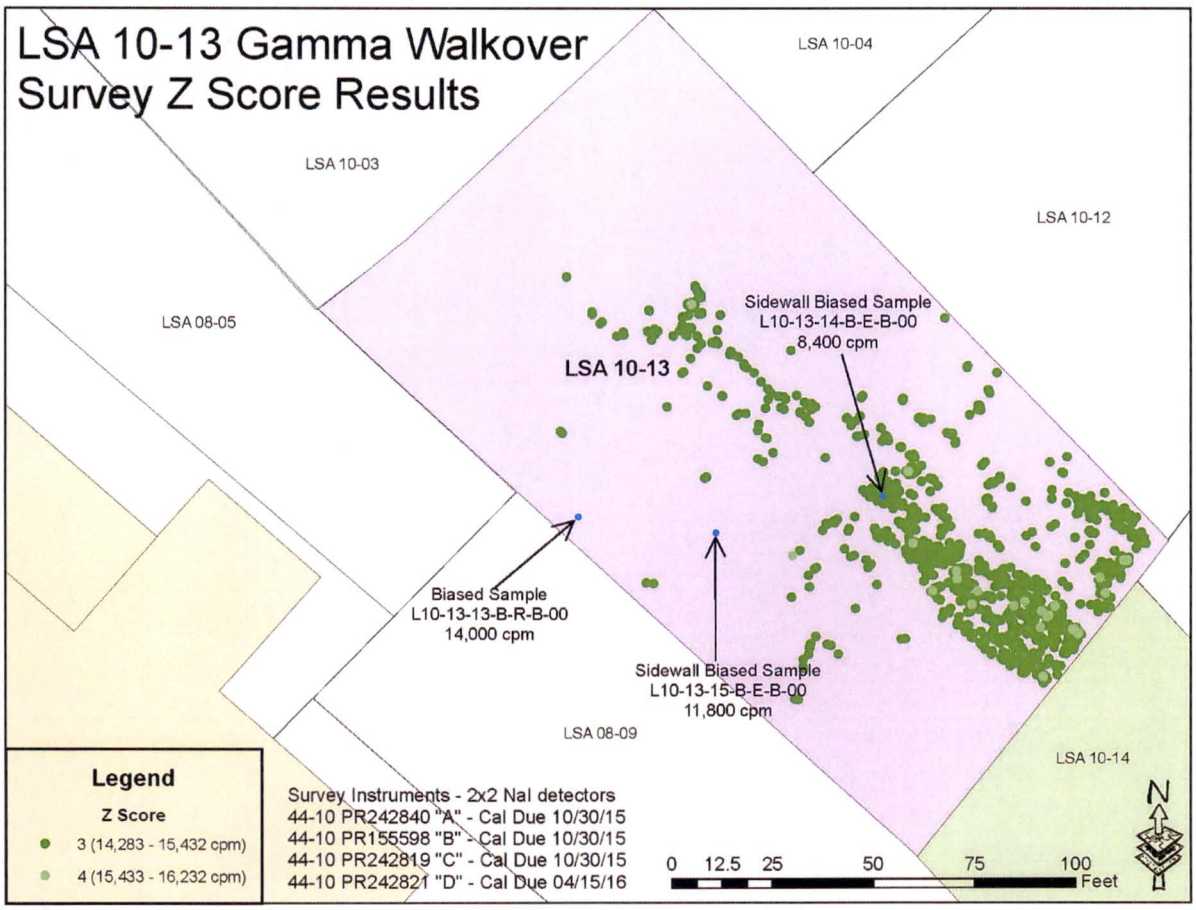
Figure 7-1
Colorimetric GWS Plot for LSA 10-13



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). One location, L10-13-13, was selected for biased sample collection. This biased location represented the maximum GWS measurement encountered within the SU. Also, this single biased location was the only point which exceeded both the IAL based on the local background readings and a Z-score of 3. Therefore, no additional biased locations were selected for sampling. Westinghouse conservatively decided to perform additional remediation at this location after the sample was collected; the initial GWS reading at L10-13-13 was the SU maximum of approximately 21,800 gcpm. After the manual remediation, the GWS reading at this location was reduced to approximately 14,000 gcpm. This issue is discussed further in Section 9.1 – FSS Plan Deviations.

Figure 7-2 below presents a map of the +3 Z-score GWS measurements within LSA 10-13, including the selected biased sampling location (ID: L10-13-13-B-R-B-00). For completeness, the locations of the two supplemental sidewall samples (collected from locations selected by the HP Technician at random) are also shown in Figure 7-2.

Figure 7-2
Colorimetric GWS Plot for LSA 10-13 (Measurements > Z-score of 3)



A total of 85,284 individual GWS measurements were collected in LSA 10-13. Using a conservative side-to-side movement distance of 1 foot, and given the internal SU surface area of LSA 10-13 of approximately 23,000 square feet, the average estimated surveyor speed during GWS of LSA 10-13 was approximately 0.3 ft/sec.

Since all GWS data collected in LSA 10-13 was datalogged and post-processed in Graphical Information Software (GIS), the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015. Using these parameters, a Scan MDC of approximately 46.7 pCi/g is determined. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 10-13, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. The equation used to derive the revised Total Uranium Scan MDC (with a conservative estimate of 4% enrichment) from Section 1.1.5 of HDP-TBD-FSS-002 (Revision 3, August 2015) is as follows:

$$\text{Scan MDC}_{Total\ Uranium} = \quad 1 \Big/ \left(\left(\frac{0.7928}{4172}\right) + \left(\frac{0.0438}{2.65}\right) + \left(\frac{0.1634}{34.9}\right)\right) = 46.7\,\frac{pCi}{g}$$

Equation 7-1

HDP-TBD-FSS-002 also modeled Radium-226 and Thorium-232 Scan MDCs to reflect the technical implementation requirements of FSS at the HDP. Using the same parameters as discussed above for total Uranium, the retrospectively estimated Scan MDCs for Radium-226 and Thorium-232 are 1.21 pCi/g and 0.87 pCi/g, respectively using a two inch (2") air gap. A two inch (2") air gap is utilized as a conservative measure considering NUREG-1507 states that the position relates to the average height of the detector. The HP Technicians are instructed to survey as close as possible to the ground surface, (nominally 1", but not to exceed 3" distance from the surface). As such, the use of a two inch air gap is conservative.

7.1.2 GWS Coverage Results LSA 10-13

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, certain small areas of the LSA 10-13 interior could not be accessed for GWS due to especially tall interior pit sidewalls. These areas appear as greyish-pink blanks in the Figure 7-1 above.

The post survey processing of the GPS data indicated that the GWS was 99.39% of the SU (see Table 7-1). As the evaluation indicates that the GPS coverage exceeded 95%, and the readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of the apparent GPS coverage gaps were investigated and found to be satisfactory, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 7-1
GWS Gap Analysis LSA 10-13

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 10-13	729,830	4,484	0.61%	99.39%	1

7.2 Soil Sample Results LSA 10-13

Appendix A presents the analytical results and associated statistics for all FSS samples collected within LSA 10-13.

7.2.1 Surface Soil Sample Results LSA 10-13

There were no samples collected within the surface stratum (0 – 15 cm) of LSA 10-13. There were a total of sixteen (16) soil samples collected within the topmost soil layer of the excavation surface including twelve (12) systematic samples, three (3) biased samples (including two from sidewalls), and one (1) QC field duplicate sample. ~~Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was performed~~

~~for LSA 10-13 since the difference between the maximum survey unit data set gross SOF and the minimum background area adjusted SOF was greater than one (1). The WRS evaluation is included in Appendix A. Biased and QC sample results are not utilized in the WRS test. The eight systematic samples collected in the "topmost" excavation surface layer were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The survey unit passed the WRS test since the ranked sum of the reference area ranks, or test statistic W_R, (783) was greater than the critical value (705) for the test. As such, the null hypothesis that the survey unit average concentration is greater than the $DCGL_W$ was rejected.~~
The maximum SOF result for the "topmost" samples was 0.45 corresponding to the biased sample L10-13-13-B-R-B-00. The maximum systematic sample SOF result was 0.40 at L10-13-07-B-R-S-00.
~~Appendix A presents the analytical results and associated statistics for all FSS surface samples collected within LSA 10-13.~~

7.2.2 Subsurface Soil Sample Results LSA 10-13

There were four systematic locations within LSA 10-13 where root stratum composite sampling was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the four root stratum composite sampling locations, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected. These four excavation stratum samples where there was overlying root stratum remaining were considered "subsurface" samples and therefore did not factor into the WRS test evaluation. The maximum SOF result of the subsurface samples collected in LSA 10-13 was 0.14. This sample (L10-13-08) was the excavation stratum sample collected directly underneath the root stratum sample L10-13-07.

~~These subsurface samples are presented in Appendix A.~~

7.2.3 WRS Test Evaluation LSA 10-13

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was required for LSA 10-13 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was greater than one using the Uniform Stratum criteria. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 12 systematically collected samples in LSA 10-13 were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic W_R, (911) was greater than the critical value (783) for the test. As such, the null hypothesis that the SU average concentration is greater than the $DCGL_W$ was rejected. The WRS evaluation is also included in Appendix A.

7.2.4 Graphical Data Review LSA 10-13

Table 7-2 below presents summary results for the all systematically collected samples (includes surface (none collected in this SU), root, and excavation stratum samples, but not biased or QC samples) collected within LSA 10-13, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.19.

Table 7-2
LSA 10-13 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.15	0.21	0.15	3.16	0.17	1.14	**0.19**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.00 (<BKG)	1.49	0.08	0.81	0.08
Maximum	0.49	0.62	0.35	6.54	0.36	1.66	0.40

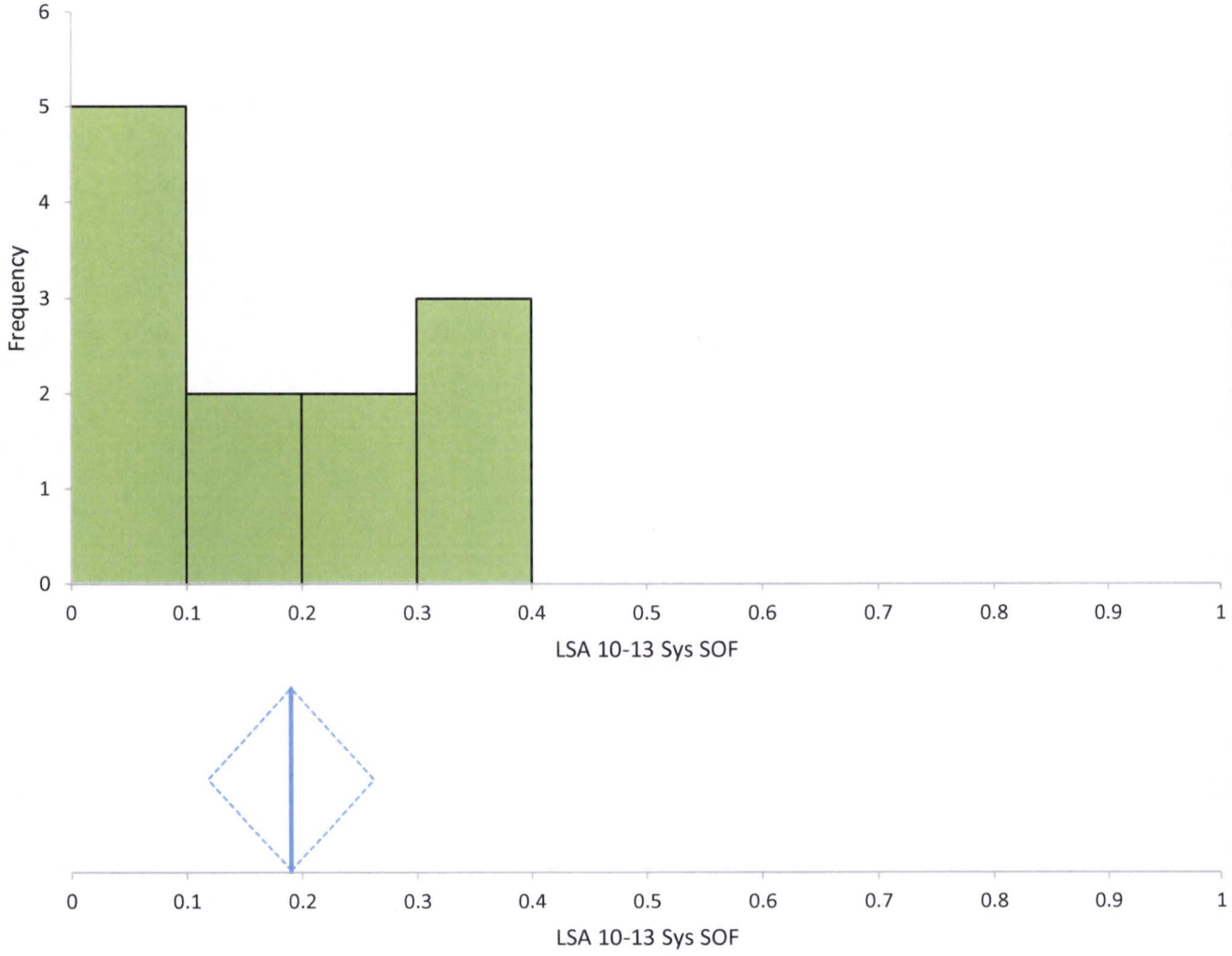
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide concentrations.
3. U-234 values are inferred from the U-235/U-238 ratio.

Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 7-3 presents the overall statistical metrics for the SOF parameter for the 9 systematically collected samples from LSA 10-13. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 10-13. The middle graph presents the mean SOF (0.19 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.12 to 0.26. The 96.1% confidence interval based on the median (0.15) of the sample results is 0.09 to 0.31. The bottom two charts present the various statistical metrics of the LSA 10-13 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 7-3 exhibits no unusual symmetry or bimodality concerns for the LSA 10-13 data associated with the systematically collected measurement locations.

Figure 7-3
Graphic Statistical Summary for LSA 10-13 (SOF parameter)



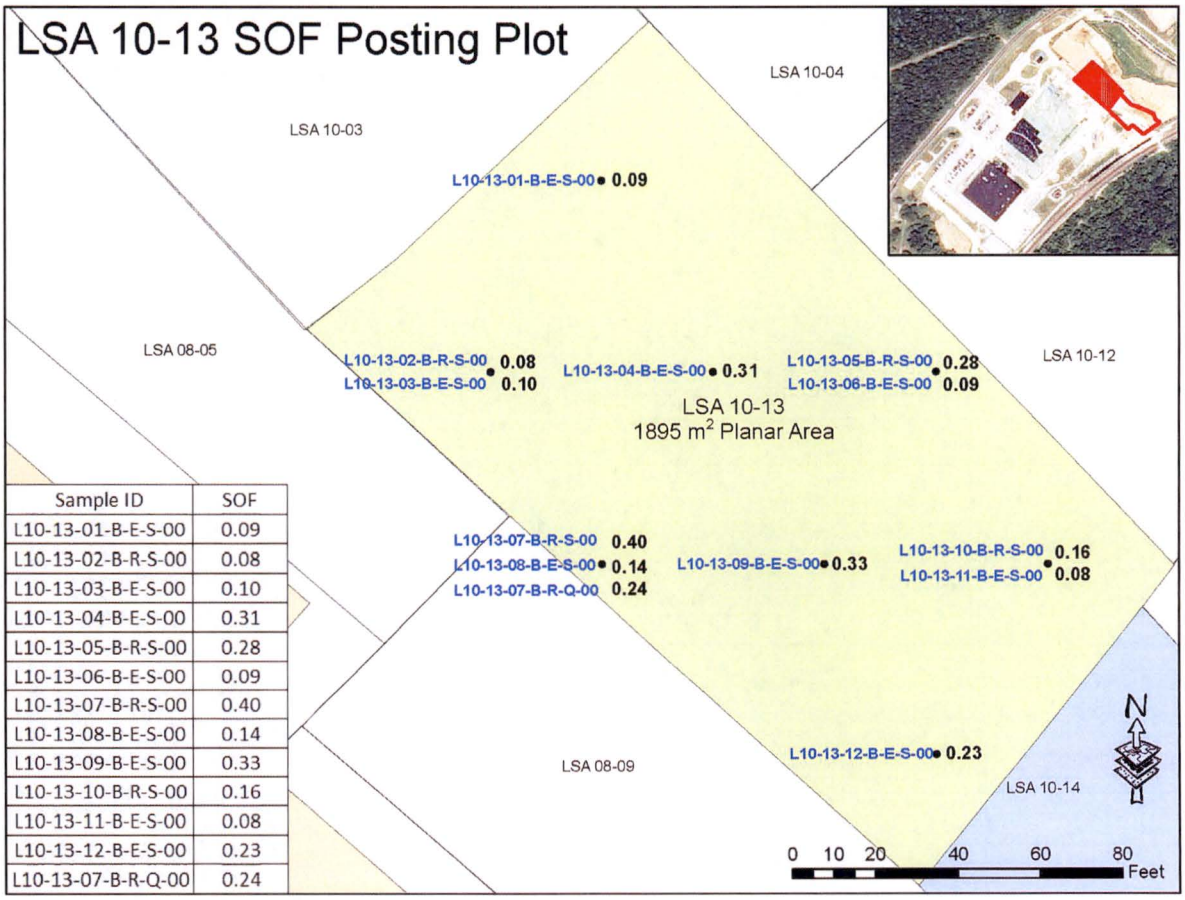
N	12

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-13 Sys SOF	0.19	0.12	to 0.26	0.033	0.11	0.01	0.6	-1.15

	Minimum	1st quartile	Median	96.14% CI		3rd quartile	Maximum	IQR
LSA 10-13 Sys SOF	0.1	0.09	0.15	0.09	to 0.31	0.30	0.4	0.21

A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 10-13 is presented below in Figure 7-4. Figure 7-4 shows no unusual patterns in the data.

Figure 7-4
Posting Plot for LSA 10-13 Systematic Measurement Locations



Sample ID	SOF
L10-13-01-B-E-S-00	0.09
L10-13-02-B-R-S-00	0.08
L10-13-03-B-E-S-00	0.10
L10-13-04-B-E-S-00	0.31
L10-13-05-B-R-S-00	0.28
L10-13-06-B-E-S-00	0.09
L10-13-07-B-R-S-00	0.40
L10-13-08-B-E-S-00	0.14
L10-13-09-B-E-S-00	0.33
L10-13-10-B-R-S-00	0.16
L10-13-11-B-E-S-00	0.08
L10-13-12-B-E-S-00	0.23
L10-13-07-B-R-Q-00	0.24

Appendix A to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 7-2, Figure 7-3, and Figure 7-4 above. A summary of the analytical data is presented in Table 7-3 below. Appendix E to this report presents the TestAmerica Analytical Laboratory soil sample reports.

Table 7-3
Final Status Survey Analytical Data: LSA 10-13

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																										Enr.	SOF
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF
L10-13-01-B-E-S-00	6.83	S	1.120	0.161	0.068	NA	0.050	0.050	0.241	0.241	0.055	0.198	NA	0.890	0.176	0.143	NA	-0.110	0.000	6.536	NA	NA	NA	0.360	0.162	0.225	NA	1.660	0.578	0.849	NA	3.3	0.09
L10-13-02-B-R-S-00	3.45	S	1.090	0.150	0.060	NA	0.020	0.020	0.266	0.266	0.142	0.201	NA	1.090	0.168	0.098	NA	0.090	0.090	1.493	NA	NA	NA	0.078	0.125	0.224	U	0.908	0.292	0.815	NA	1.4	0.08
L10-13-03-B-E-S-00	4.92	S	1.130	0.153	0.060	NA	0.060	0.060	0.245	0.245	0.081	0.213	NA	1.060	0.187	0.115	NA	0.060	0.060	3.624	NA	NA	NA	0.200	0.146	0.212	U	0.814	0.344	1.060	U	3.7	0.10
L10-13-04-B-E-S-00	12.36	S	1.560	0.214	0.087	NA	0.490	0.490	0.104	0.104	0.096	0.203	U	1.050	0.179	0.098	NA	0.050	0.050	2.537	NA	NA	NA	0.138	0.149	0.266	U	0.952	0.336	0.957	U	2.3	0.31
L10-13-05-B-R-S-00	3.82	S	1.280	0.174	0.071	NA	0.210	0.210	0.071	0.071	0.078	0.194	U	1.270	0.208	0.139	NA	0.270	0.270	3.622	NA	NA	NA	0.197	0.184	0.260	U	1.330	0.558	0.855	NA	2.3	0.28
L10-13-06-B-E-S-00	4.92	S	1.030	0.144	0.062	NA	-0.040	0.000	0.021	0.021	0.020	0.204	U	1.120	0.157	0.099	NA	0.120	0.120	3.615	NA	NA	NA	0.198	0.120	0.163	NA	1.110	0.492	0.760	NA	2.7	0.09
L10-13-07-B-R-S-00	4.00	S	1.420	0.209	0.095	NA	0.350	0.350	0.358	0.358	0.080	0.202	NA	1.350	0.225	0.190	NA	0.350	0.350	2.524	NA	NA	NA	0.134	0.160	0.287	U	1.310	0.656	1.020	NA	1.6	0.40
L10-13-08-B-E-S-00	4.92	S	1.200	0.160	0.058	NA	0.130	0.130	0.622	0.622	0.103	0.207	NA	1.060	0.158	0.112	NA	0.060	0.060	2.352	NA	NA	NA	0.126	0.125	0.228	U	1.090	0.491	0.759	NA	1.8	0.14
L10-13-09-B-E-S-00	18.90	S	1.340	0.188	0.077	NA	0.270	0.270	0.401	0.401	0.111	0.244	NA	1.280	0.189	0.107	NA	0.280	0.280	3.553	NA	NA	NA	0.194	0.149	0.213	U	1.210	0.549	0.845	NA	2.5	0.33
L10-13-10-B-R-S-00	3.61	S	1.160	0.160	0.068	NA	0.090	0.090	-0.012	0.000	0.042	0.198	U	1.190	0.167	0.142	NA	0.190	0.190	1.582	NA	NA	NA	0.080	0.140	0.258	U	1.290	0.513	0.780	NA	1.0	0.16
L10-13-11-B-E-S-00	4.92	S	0.990	0.142	0.065	NA	-0.080	0.000	0.090	0.090	0.056	0.211	U	1.090	0.167	0.092	NA	0.090	0.090	4.477	NA	NA	NA	0.247	0.157	0.199	NA	1.040	0.293	0.770	NA	3.6	0.08
L10-13-12-B-E-S-00	15.45	S	1.200	0.166	0.090	NA	0.130	0.130	0.108	0.108	0.060	0.250	U	1.280	0.183	0.137	NA	0.280	0.280	2.016	NA	NA	NA	0.108	0.135	0.247	U	0.937	0.305	0.835	NA	1.8	0.23
L10-13-13-B-R-B-00	3.46	B	1.040	0.144	0.086	NA	-0.030	0.000	2.830	2.830	0.337	0.215	NA	1.380	0.209	0.077	NA	0.380	0.380	19.741	NA	NA	NA	1.090	0.208	0.240	NA	3.430	0.770	1.020	NA	4.8	0.45
L10-13-14-B-E-B-00	14.55	B	1.450	0.280	0.101	NA	0.380	0.380	0.528	0.528	0.171	0.280	NA	1.170	0.325	0.237	NA	0.170	0.170	33.264	NA	NA	NA	1.790	0.539	0.595	NA	2.570	1.920	3.130	U	9.8	0.53
L10-13-15-B-E-B-00	13.28	B	1.650	0.297	0.164	NA	0.580	0.580	0.055	0.055	0.076	0.260	U	1.370	0.314	0.156	NA	0.370	0.370	1.553	NA	NA	NA	0.084	0.303	0.604	U	0.695	1.610	2.700	U	1.9	0.51
L10-13-07-B-R-Q-00	4.00	Q	1.310	0.172	0.063	NA	0.240	0.240	0.340	0.340	0.058	0.212	NA	1.150	0.166	0.114	NA	0.150	0.150	2.336	NA	NA	NA	0.124	0.125	0.231	U	1.260	0.527	0.807	NA	1.6	0.24
Systematic Minimum			0.000						0.000					0.000						1.493				0.078				0.814				**2.3**	0.08
Systematic Maximum			0.490						0.622					0.350						6.536				0.360				1.660				Average Enrichment (%)	0.40
Systematic Mean			0.150						0.211					0.153						3.161				0.172				1.138					0.19
Systematic Median			0.110						0.175					0.105						3.045				0.166				1.100					0.15
Systematic Standard Deviation			0.153						0.183					0.115						1.412				0.080				0.236					0.11
			With ingrowth, use Ra226 bkg = 1.07											Th232 bkg = 1.0																			

NOTES:

Gross results in units of pCi/g

* Background with ingrowth (1.07 pCi/g) subtracted from gross result

**Background (1.0 pCi/g) subtracted from gross result

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

7.2.5 Biased Soil Sample Result LSA 10-13

The highest biased sample collected from LSA 10-13 had a Uniform SOF result of 0.53, this sample was collected from a sidewall and was not identified by GWS.

7.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 10-13

Two samples were collected from the sidewalls of LSA 10-13. Table 7-4 provides the data summary for the samples.

Table 7-4
LSA 10-13 Sidewall Sample Data Summary and Calculated SOF Values

Sample ID	Ra-226 DCGL = 1.9 BKG = 0.9 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
L10-13-14-B-E-B-00	1.450	0.528	1.170	33.264	1.790	2.570	0.53
L10-13-15-B-E-B-00	1.650	0.055	1.370	1.553	0.084	0.695	0.51

7.2.7 Quality Control Soil Sample Result LSA 10-13

One QC field duplicate sample point was randomly selected for LSA 10-13 which was collected at systematic locations L10-13 -07.

For the 15 samples (i.e., 12 systematic + 1 biased + 2 sidewall) collected within LSA 10-13, one field duplicate sample was collected. This frequency equates to 6.7%, (i.e. 1/15). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 7-5 below).

Figure 7-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 10-13

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FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.:	LSA 10-13				Survey Unit Description:		Burial Pits Open Land Area Northern Survey Unit in "Area 2"					
			Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity ($\bar{X}$)	Nuclide DCGL				Statistic Exceeds Limit?
Sample ID	Field Duplicate Sample ID	Radionuclide	Activity (x_i)	MDC	Activity (x_i)	MDC	(pCi/g)	(pCi/g)	Statistic[2]	Warning Limit	Control Limit	(Y/N)
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	Ra-226	1.42	0.0945	1.31	0.0627	1.365	1.9	0.11	0.269	0.403	N
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	Tc-99	0.358	0.202	0.34	0.212	0.349	25.1	0.018	3.552	5.321	N
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	Th-232	1.35	0.19	1.15	0.114	1.250	2.0	0.200	0.283	0.424	N
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	U-234[1]	2.524	NA	2.336	NA	2.430	195.4	0.188	27.649	41.425	N
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	U-235	0.134	0.287	0.124	0.231	0.129	51.6	NA	7.301	10.939	NA
L10-13-07-B-R-S-00	L10-13-07-B-R-Q-00	U-238	1.31	1.02	1.26	0.807	1.285	168.8	0.050	23.885	35.786	N

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: [signature] Reviewed by: [signature]

Date: 6/8/2015 Date: 6/8/2015

Quality Record

7.3 Tc-99 Hot Spot Assessment LSA 10-13

As LSA 10-13 and LSA 10-14 are immediately adjacent to each other, the evaluation of potential Tc-99 hotspots in the area was performed for both SUs simultaneously. During site characterization studies a total of 77 samples were collected and analyzed for Tc-99 in LSA 10-13 and LSA 10-14. Within LSA 10-13, the maximum sample identified was 10.5 pCi/g – well below the 25.1 pCi/g limit for the Uniform Stratum DCGL. The maximum sample identified in LSA 10-14 was 52.6 pCi/g, with an overall mean and median concentration of 6.19 pCi/g and 0.43 pCi/g respectively. Within LSA 10-14, a total of four characterization sample results exceeded the Uniform Stratum DCGL of 25.1 pCi/g for Tc-99. No samples exceeded the Tc-99 DCGL during RASS and FSS.

An area factor of 2.1 would be required to account for any potential hot spots of 52.6 pCi/g. Using the Uniform Area Factor table from the DP and interpolation, 475 m^2 is the area per sample station required to equate to an area factor of 2.1. In both LSA 10-13 and LSA 10-14 the area represented by each systematic location was less than 250 m^2 and is adequate to account for any potential hot spots within the SUs.

8.0 ALARA EVALUATION LSA 10-13

All samples collected within LSA 10-13 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 10-13 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.19 for LSA 10-13. The average SOF equates to residual activity contributions from the survey unit area of 4.75 mrem/year for LSA 10-13. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, Chapter 6 {ML17142A356}, Chapter 7 {ML17250A376} and Chapter 8 {ML17240A168} indicate that the groundwater dose contribution is a fraction of the MCLs.~~Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, indicate that the groundwater dose contribution will be a fraction of the MCLs.~~ Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/year based upon the U.S. Environmental Protection Agency (EPA) MCLs will be added to the total estimated dose for LSA 10-13. The Reuse Stockpile 3 soil dose contribution will also be accounted for by adding in an additional 3.5 mrem/year. Adding all of the dose contributions together, the total estimated dose for LSA 10-13 is 12.25 mrem/year.

Since the estimated Total Effective Dose Equivalent is below the regulatory release criterion of 25 mrem/year, the conclusion of the As Low As Reasonably Achievable (ALARA) evaluation is that the remediation of LSA 10-13 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing further remediation of LSA 10-13.

9.0 FSS PLAN DEVIATIONS LSA 10-13

9.1 Remedial Actions during FSS

Within LSA 10-13, one location, L10-13-13, was selected for biased sample collection. This biased location represented the maximum GWS measurement encountered within the survey

unit. Also, this single biased location was the only point which exceeded both the IAL based on the local background readings and a Z-score of 3.

The initial GWS measurement taken at L10-13-13, which was obtained on April 2, 2015, was the SU maximum GWS measurement of approximately 21,800 gcpm. As the GWS measurement of the location was sufficiently above the 4,000 ncpm IAL, and it was determined that the location would likely exceed the Decision Rule of a SOF greater than 1.0, given the small and isolated location of the elevated area, as provided by the FSS program guidance, the location was manually remediated.

Using hand shovels a very small amount of soil was removed in an area approximately 3 feet wide by approximately 1 foot deep. The soil was placed into bags for transfer out of the SU, and delivered to the Waste Handling Area for disposal. After the manual remediation, the GWS reading at this location was reduced to approximately 14,000 gcpm. The SOF result of the biased sample collected at this location, L10-13-13-B-R-B-00, was 0.45 (with ingrowth).

9.2 Adjustments to Scan MDC Calculations

As previously stated in Section 5.1.5, adjustments were made to the Scan MDC calculations for instrumentation used for the GWS in LSA 10-13. The Scan MDCs presented in the FSS Plan shown in Table 5-1 assumed a surveyor efficiency of 0.5 and did not reflect the information derived from the development of HDP-TBD-FSS-002 which used Microshield modeling of parameters consistent with procedural requirements of GWS implementation at HDP. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 10-13, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. Since all GWS data collected in LSA 10-13 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015.

Based on the data presented in HDP-TBD-FSS-002 and using a surveyor efficiency of 0.75 and a conservative enrichment basis of 4%, revised Scan MDCs were developed and are presented in Table 9-1 below:

Table 9-1

Revised Scan MDCs for 2" x 2" NaI detector: LSA 10-13

	Scan MDC (Total U)	**DCGLw (Total U)**	**Scan MDC (Ra-226)**	**DCGLw (Ra-226)**	**Scan MDC (Th-232)**	**DCGLw (Th-232)**
LSA 10-13	46.7	25.7	1.37	1.9	0.99	2.0

10.0 DATA QUALITY ASSESSMENT

The Data Quality Objective (DQO) process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

10.1 Data Quality Assessment for LSA 10-13

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 10-13 (see Figure 10-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 10-13 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is necessary when the difference between the maximum SU data set measurement SOF and the minimum background area measurement SOF is greater than one. For LSA 10-13, 1 individual gross SOF result(s) in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was required for LSA 10-13. Since the test statistic, WR (911) exceeded the critical value (783), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS evaluation worksheet is presented in Appendix A.
- ~~Eight systematic samples were collected at the excavation surface layer. For LSA 10-13, one individual gross SOF results in the FSS data set exceeded the $DCGL_W$ (SOF of 1.0) by more than the adjusted SOF of the minimum background~~

~~reference area result using the Uniform Stratum criteria. Therefore, the WRS test was required for LSA 10-13. Since the test statistic, WR (783) exceeded the critical value (705), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix A.~~

- A biased soil sample was collected from the location of the highest gamma count rate within the SU, and the result was a 0.45 Uniform SOF.
- The maximum SOF result for all surface samples within LSA 10-13 was 0.53. The SOF result for the single subsurface samples within LSA 10-13 was 0.14. The average SOF result for all systematically collected samples within LSA 10-13 was 0.19, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.26.
- No FSS sample result in LSA 10-13 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an elevated measurement comparisons (EMC) or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic samples actually collected within LSA 10-13. The successful result of the retrospective power evaluation presented in Table 10-1 for LSA 10-13 indicates that the minimum number of samples required (8) for the WRS Test were equal to the number of sampling locations actually collected within LSA 10-13. The methodology used for the retrospective sampling frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight topmost excavation surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for LSA 10-13 was completed prior to the commencement of backfill operations.

Table 10-1
Retrospective Sample Size Verification for LSA 10-13

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.11
$DCGL_{SOF}$	1
LBGR (Mean)	0.19
Shift	0.81
Relative Shift (Δ/σ)	7.16
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

Δ/σ	P_r
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

MARSSIM Table 5.2, α = 0.05, β = 0.10

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

α
β

Figure 10-1
Data Evaluation Checklists prepared for LSA 10-13 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
	Westinghouse Non-Proprietary Class 3	Revision: 7	Appendix G-1, Page 1 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: 13 **Description:** Northern Survey Unit in "Area 2"

1.	Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☒	No ☐	
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☒	No ☐	
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☒	No ☐	
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	

If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.

Comments: NA

Quality Record LSA 10-13

Figure 10-1
Data Evaluation Checklists prepared for LSA 10-13 (page 2 of 2)

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: No. 13 **Description:** Northern Survey Unit in "Area 2"

Discrepancy: NA

Corrective Actions Taken: NA

11. Have the corrective actions resolved the discrepancy with the data? Yes ☐ No ☐ NA ☒
    a. If "No", then forward this form to the RSO.
12. The following questions will be answered by the RSO.
    a. If the answer to question 13 was "No", then is the affected data still valid? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit.

	(Print Name)	(Signature)	(Date)
Prepared by (HP Staff):	ELLEN C. YAKUB		11/19/15
Approved by (RSO):	W. MARK ENGLE		11/19/15

Quality Record LSA 10-13

11.0 SURVEILLANCE FOLLOWING FSS

FSS GWS activities in LSA 10-13 were completed on April 29, 2015. There were no events after the completion of FSS that would have the potential to cause contamination above the DCGLs in the SU.

12.0 CONCLUSION LSA 10-13

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 10-13 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 12-1
LSA 10-13 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.19	N/A	0.16	N/A	0.14	**0.49**
DOSE	4.75 mrem/year	N/A	4.0 mrem/year	N/A	3.5 mrem/year	**12.25 mrem/year**

13.0 FINAL STATUS SURVEY DESIGN LSA 10-14

This section describes the method for determining the number of samples required for the FSS of LSA 10-14 as well as summarizing the applicable requirements of the FSS Plan. These include the $DCGL_W$, scan survey coverage, and IAL. The radiological instrumentation used in the FSS of LSA 10-14 and their detection sensitivities are also discussed.

13.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 10-14 were driven by the type (Open Land) and Class (Class 1) of the survey unit and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 5, *Final Status Survey Plan Development*, January 2015.

13.1.1 Surrogate Evaluation Areas

A discussion of Surrogate Evaluation Areas is given in the FSSFR Volume 3, Chapter 1, Section 5.0, *Final Status Survey Design*.

13.1.2 $DCGL_W$

During the FSS design process a review was performed of the historic characterization data for LSA 10-14. The review identified several areas that were previously found to exceed a Uniform SOF of 1.0 (discussed in Section 3.3.6). Next the remediation history was reviewed to confirm that these areas were adequately addressed, and the RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform Stratum $DCGL_W$. Therefore the Uniform Stratum $DCGL_W$ was selected for use in demonstrating compliance with the release criteria.

13.1.3 GWS Coverage

As a Class 1 SU, LSA 10-14 was required to undergo a 100% GWS.

13.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 10-14 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

13.1.5 Scan Minimum Detectable Concentration

As background levels were approximately 13,000 cpm within LSA 10-14, the Scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{7383\ pCi/g}\right)+\left(\frac{f_{U-235}}{4.9 pCi/g}\right)+\left(\frac{f_{U-238}}{62.8 pCi/g}\right)\right)}$$

Equation 13-1

In order to calculate the Scan MDC for total uranium using the above equation, an average enrichment for the SU must be known which in turn will provide relative isotopic fractions for U-234, U-235, and U-238 as given in Appendix G of HDP-PR-FSS-701, Revision 4, *Final Status*

Survey Plan Development. Based on the systematically collected RASS samples in LSA 10-14, the average enrichment for the SU was 1.5%.

Standard Scan MDCs for Radium-226 and Thorium-232 using a 2" x 2" NaI detector are found in Table 6.4 of NUREG-1507 and are shown in Table 12-1. Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 10-14 are shown below:

Table 13-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 10-14

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 10-14	40.4	31.2	1.19	2.8	0.85	3.0

*$DCGL_W$ includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. $DCGL_W$ values are based on the Uniform Stratum release criteria.

The values in Table 13-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS.

13.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site*". The IAL used during the GWS of LSA 10-14 was established at 4,000 ncpm.

13.1.7 LSA 10-14 FSS Design Summary

The FSS Plan for LSA 10-14 can be found in Appendix C. Table 13-2 presents an overall FSS design and implementation summary for LSA 10-14.

Table 13-2
FSS Design Summary for LSA 10-14

Gamma Walkover Survey (GWS):		
Scan Coverage	100% exposed excavation floors, benches, pits, and sidewalls	
Scan MDC	40.4 pCi/g total Uranium (based on a 13,000 cpm background); 0.85 pCi/g Th-232; 1.19 pCi/g Ra-226*	
Investigation Action Level (IAL)	4,000 net cpm* *	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments
0 – 15 cm (Surface)	0	These samples were collected on a systematic grid.
15 cm – 1.5 m (Root)	1	
> 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 FSS Supervisor.		
Sidewall Sampling Locations:		
Supplemental Sidewall Sampling: In accordance with *HEM-15-MEMO-039*, two (2) discretionary sidewall samples will be collected based on the following definition of "sidewall": 1) sidewalls must be vertical or near vertical and at least 12" in height, and 2) constitute an aggregate surface area which exceeds 5% of the total surface area of the SU, e.g., 100 m^2 of sidewall area in a 2,000 m^2 SU.		
Instrumentation		
Ludlum 2221 with 44-10 (2" x 2" 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)*", Westinghouse, April 2015.		
**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum $DCGL_W$ 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.		

14.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 10-14

FSS was performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment.*

14.1 Gamma Walkover Survey

14.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 10-14 was a 2" x 2" NaI detector in combination with a Ludlum 2221 rate meter. Each NaI instrumentation set was interfaced with a Trimble DGPS and handheld data logger.

Prior to the first field use of the GWS instrumentation, initial set-ups were performed. Also, daily pre- and post-use source checks were performed for each day that GWS was performed within the SU. Initial set-ups, daily source checks, and control charting were performed according to the requirements of HDP-PR-HP-416, *Operation of the Ludlum 2221 for Final Status Survey*.

14.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewalls collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in the SU was one (1) GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

The GWS requirements involved moving the NaI detector in a side-to-side fashion no faster than 1 foot per second while holding the probe as close as possible to the excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

HP Technicians performing GWS in LSA 10-14 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 13,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 18,000 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

Sidewalls, hard to reach areas, and non-typical areas were surveyed manually to the maximum extent practical in order to assess the potential for an area of elevated residual activity over 100% of the exposed excavation surface.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the Health Physics Technician performing the survey to determine if possible

areas of elevated residual activity remained within the survey unit that required biased sample investigation. Areas that were flagged by the HP Technician were considered, as well as a statistical evaluation of the GWS data set. The statistical evaluation determined the mean count rate and standard deviation associated with the GWS and then could be used to identify any areas that exceeded 3 standard deviations above the mean. The number of biased samples to be collected and the locations are based on flagged locations exceeding the IAL, the statistical evaluation of the GWS data set, and the professional judgment of Radiological Engineering.

14.2 Soil Sampling

14.2.1 Systematic Soil Sampling Summary

Table 14-1 provides a summary of systematic sampling by stratum for LSA 10-14.

Table 14-1
Systematic Sampling Summary by Stratum for LSA 10-14

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
10-14	1,756	0	1	8	1

14.2.2 Systematic Sampling LSA 10-14

Within LSA 10-14, there were no systematic locations in which portions of the surface stratum [0 – 15 centimeters (cm)] remained in the SU after remediation. Portions of the root stratum (15 cm – 150 cm) remained at one (1) of the eight systematic locations. At these locations the remaining root stratum interval was collected using a hand auger and composited. Excavation stratum samples were collected at all eight locations using either hand trowels for six-inch grabs below the existing excavation surface or hand augers where necessary.

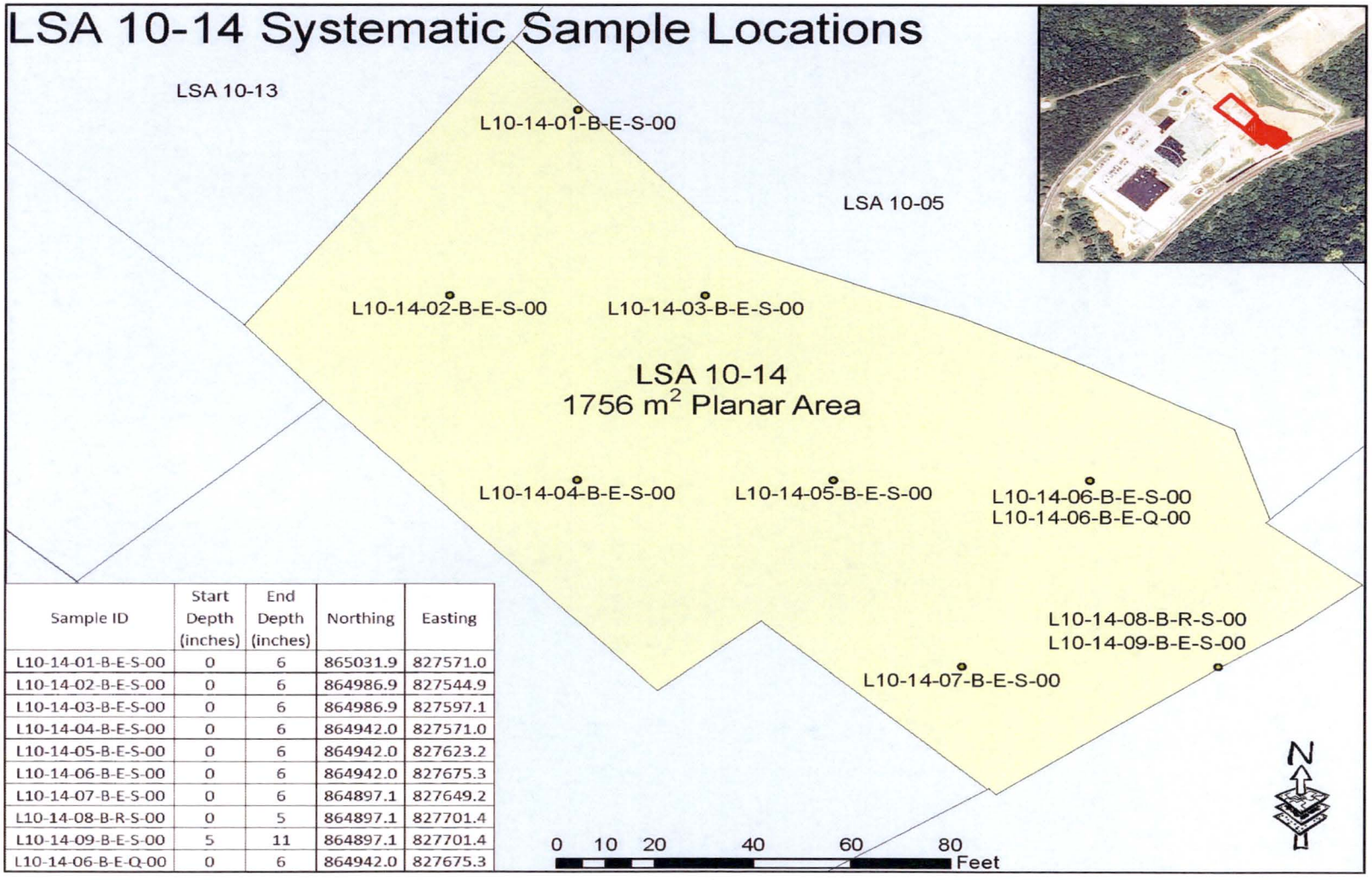
Given a planar area of 1,756 m^2 for LSA 10-14 and an eight - point systematic triangular grid, the point-to-point distance within each row was 15.9 m with spacing of 13.7 m between each of the parallel grid rows within the SU.

While there were eight systematic locations on the LSA 10-14 sampling grid, a total of ten (10) samples were collected at these locations, including:

- Zero (0) samples collected within the remaining surface stratum
- One (1) sample collected within the remaining root stratum
- Eight (8) samples collected within the excavation, or "deep", stratum
- One (1) QC field replicate

Figure 14-1 presents the map of the nine systematic sample locations which were sampled within LSA 10-14. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 14-1
LSA 10-14 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L10-14-01-B-E-S-00	0	6	865031.9	827571.0
L10-14-02-B-E-S-00	0	6	864986.9	827544.9
L10-14-03-B-E-S-00	0	6	864986.9	827597.1
L10-14-04-B-E-S-00	0	6	864942.0	827571.0
L10-14-05-B-E-S-00	0	6	864942.0	827623.2
L10-14-06-B-E-S-00	0	6	864942.0	827675.3
L10-14-07-B-E-S-00	0	6	864897.1	827649.2
L10-14-08-B-R-S-00	0	5	864897.1	827701.4
L10-14-09-B-E-S-00	5	11	864897.1	827701.4
L10-14-06-B-E-Q-00	0	6	864942.0	827675.3

~~Figure~~ Table 14-2 below presents a tabular listing of all FSS samples collected within LSA 10-14 with associated IDs, sample types, collection intervals, coordinates, and notes.

~~Figure~~ Table 14-2

FSS Sample Locations and Coordinates for LSA 10-14

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area

Survey Unit: 14 **Description:** Southern Survey Unit in "Area 2"

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
L10-14-01-B-E-S-00	Uniform	S	428.3	427.8	865031.9	827571.0	Excavation 6-inch grab
L10-14-02-B-E-S-00	Uniform	S	420.6	420.2	864986.9	827544.9	Excavation 6-inch grab
L10-14-03-B-E-S-00	Uniform	S	423.5	423.0	864986.9	827597.1	Excavation 6-inch grab
L10-14-04-B-E-S-00	Uniform	S	426.1	425.6	864942.0	827571.0	Excavation 6-inch grab
L10-14-05-B-E-S-00	Uniform	S	415.7	415.2	864942.0	827623.2	Excavation 6-inch grab
L10-14-06-B-E-S-00	Uniform	S	416.9	416.4	864942.0	827675.3	Excavation 6-inch grab
L10-14-07-B-E-S-00	Uniform	S	423.9	423.4	864897.1	827649.2	Excavation 6-inch grab
L10-14-08-B-R-S-00	Uniform	S	429.9	429.0	864897.1	827701.4	Root 4.6-inch composite
L10-14-09-B-E-S-00	Uniform	S	429.0	428.5	864897.1	827701.4	Excavation 6-inch grab
L10-14-06-B-E-Q-00	Uniform	Q	416.9	416.4	864942.0	827675.3	Excavation 6-inch grab
L10-14-10-B-E-B-00	Uniform	B	434.6	423.4	864909.0	827633.0	Biased 6-inch grab
L10-14-11-B-E-B-00	Uniform	B	434.7	417.3	864936.0	827593.0	Biased 6-inch grab
L10-14-12-B-E-B-00	Uniform	B	434.0	419.7	864979.0	827594.0	Biased 6-inch grab
L10-14-13-B-E-B-00	Uniform	B	432.9	432.4	864982.7	827605.3	Sidewall 6-inch grab
L10-14-14-B-E-B-00	Uniform	B	433.5	433.0	864926.1	827642.9	Sidewall 6-inch grab

Green shaded samples are the ~~topmost~~ samples at each sample location, for use in WRS test.

*Elevations are in feet above mean sea level.

** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]

Surface: Floor = F; Wall = W; Ceiling = C; Roof = R

CSM: Three-Layer (Surface-Root-Excavation) or Uniform DCGLs used

Type: Systematic = S, Biased = B; QC =Q; Investigation = I

14.3 Biased Soil Sampling

As discussed in FSSFR Volume 3, Chapter 1, Section 6.1.3, there are three key methods for identifying areas for biased soil sampling, the IAL, the Z-score of the FSS GWS, and the professional judgment of the HP Staff. For LSA 10-14 several sample locations were selected within the SU based on the evaluation of the GWS survey data. Biased location L10-14-10-B-E-B-00 represents the maximum GWS measurement encountered within in LSA 10-14 and has a Uniform SOF value of 0.30.

14.4 Judgmental/Sidewall Sampling for Tc-99

In accordance with the guidance specified in Volume 3, Chapter 1, Section 6.2.3, it was determined that sidewall sampling was necessary. The number of sidewall samples collected for the SU was determined by comparing the sidewall surface area to the two dimensional systematic surface area (e.g., 8 systematic samples were collected over 2,000 m^2, then collect 1 sample per 250 m^2 of sidewall). Two samples were collected in the sidewall of LSA 10-14. These samples were collected from locations selected by the HP Technician at random, and were not based on gamma survey readings (not biased).

14.5 Quality Control Soil Sampling

One QC field duplicate sample point was randomly selected and collected at systematic location L10-14-06 for LSA 10-14.

15.0 FINAL STATUS SURVEY RESULTS LSA 10-14

15.1 Gamma Walkover Survey

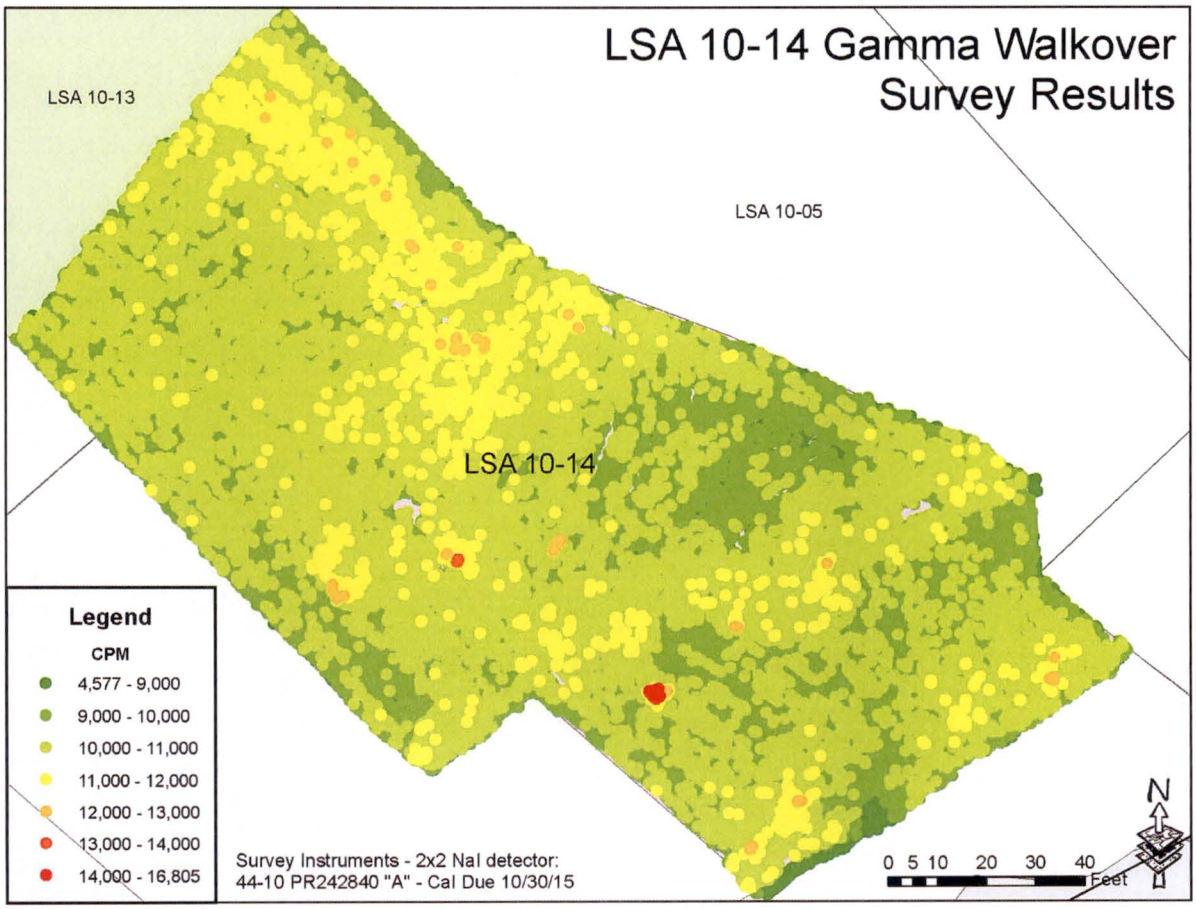
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are plotted "on top"(e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

GWS measurements were collected in LSA 10-14 between March 31, 2015, and April 29, 2015.

15.1.1 GWS Results for LSA 10-14

For LSA 10-14, GWS count rates ranged between 4,577 gcpm and 16,805 gcpm, with a mean count rate of 9,711 gcpm. The median count rate was 9,703 gcpm with a standard deviation of 667 cpm. Figure 15-1 below presents a map of the complete GWS data set.

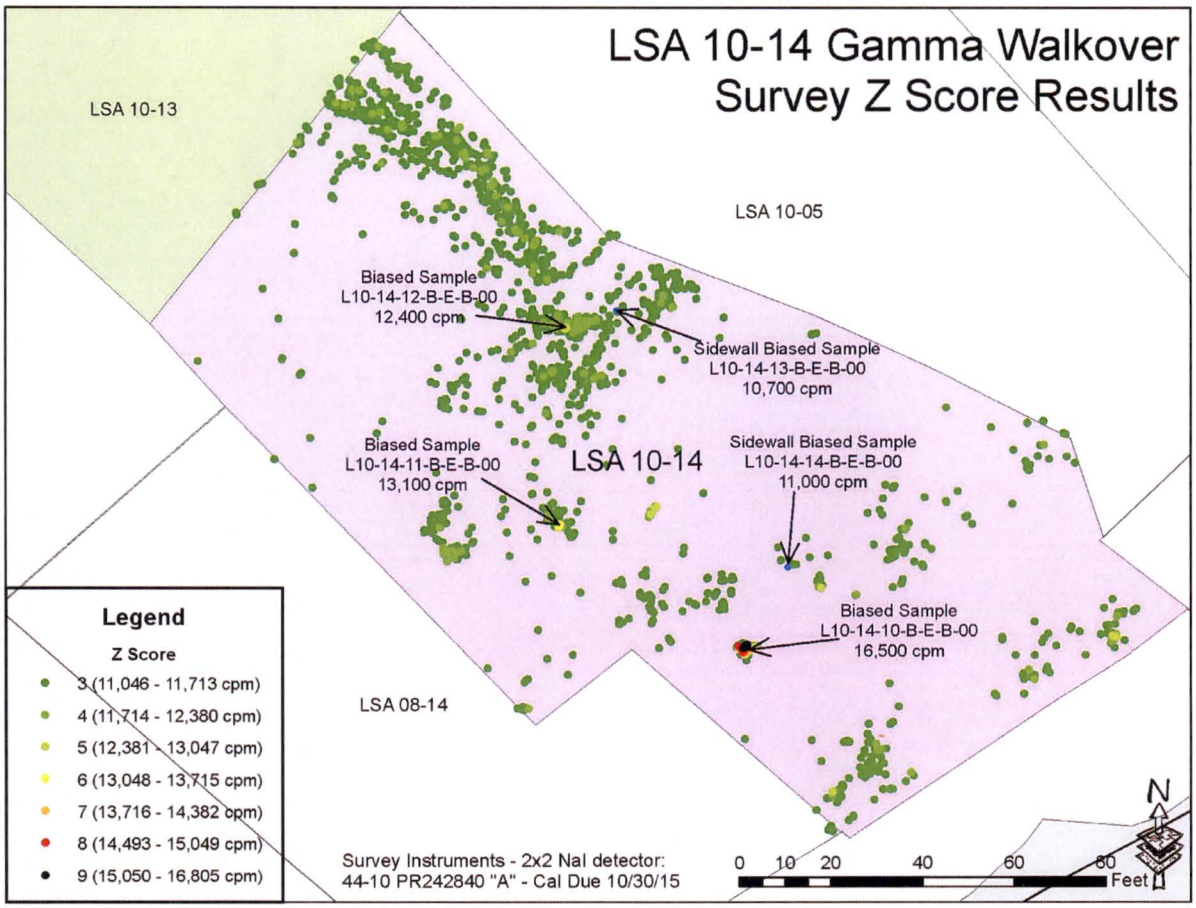
Figure 15-1
Colorimetric GWS Plot for LSA 10-14



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded both the IAL (> 4000 ncpm) and three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Three locations (L10-14-10, L10-14-11, and L10-14-12) were selected for biased sample collection. The sample collected at location L10-14-10 represented the maximum GWS measurement (16,500 gcpm) within the SU.

Figure 15-2 presents a map of the +3 Z-score GWS measurements within LSA 10-14, including the three selected biased sampling locations. For completeness, the locations of the two supplemental sidewall samples (collected from locations selected by the HP Technician at random) are also shown in Figure 15-2 below.

Figure 15-2
Colorimetric GWS Plot for LSA 10-14 (Measurements > Z-score of 3)



A total of 79,112 GWS measurements were collected in LSA 10-14. Using a conservative side-to-side movement distance of 1 foot, and given the internal SU surface areas of LSA 10-14 of approximately 22,000 square feet, the average estimated surveyor speed during GWS of LSA 10-14 was approximately 0.3 ft/sec. Since this retrospectively estimated scanning speed was less than the 1.0 ft/second FSS Plan requirement and the fact that the NaI probe was maintained as close as possible to the surface, actual Scan MDCs based on real field conditions could have been slightly less than the 40.4 pCi/g total Uranium Scan MDC estimate determined during the FSS planning phase for this SU.

Since all GWS data collected in LSA 10-14 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015. Using these parameters, a new Scan MDC of approximately 46.7 pCi/g is determined. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 10-14, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. The equation used to derive the revised Total Uranium Scan MDC (with a conservative

estimate of 4% enrichment) from Section 1.1.5 of HDP-TBD-FSS-002 (Revision 3, August 2015) is as follows:

$$\text{Scan MDC}_{Total\ Uranium} = \quad 1 \Big/ \left(\left(\frac{0.7928}{4172}\right) + \left(\frac{0.0438}{2.65}\right) + \left(\frac{0.1634}{34.9}\right)\right) = 46.7 \frac{pCi}{g}$$

Equation 15-1

HDP-TBD-FSS-002 also modeled Radium-226 and Thorium-232 Scan MDCs to reflect the technical implementation requirements of FSS at the HDP. Using the same parameters as discussed above for total Uranium, the retrospectively estimated Scan MDCs for Radium-226 and Thorium-232 are 1.21 pCi/g and 0.87 pCi/g, respectively using a two inch air gap. A two inch (2") air gap is utilized as a conservative measure considering NUREG-1507 states that the position relates to the average height of the detector. The HP Technicians are instructed to survey as close as possible to the ground surface, (nominally 1", but not to exceed 3" distance from the surface). As such, the use of a two inch air gap is conservative.

15.1.2 GWS Coverage Results LSA 10-14

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, very small areas of the LSA 10-14 interior were not accessed by GPS due to overly steep side slopes or especially tall interior pit sidewalls. These areas appear as small grey/pink blanks or "slivers" in the Figure 15-1 above.

The post survey processing of the GPS data indicated that the GWS was 99.91% of the SU (see Table 15-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 15-1
GWS Gap Analysis LSA 10-14

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 10-14	531,710	473	0.09%	99.91%	1

15.2 Soil Sample Results LSA 10-14

Appendix B presents the analytical results and associated statistics for all FSS samples collected within LSA 10-14.

15.2.1 Surface Soil Sample Results LSA 10-14

There were zero (0) samples collected within the surface stratum (0 – 15 cm) of LSA 10-14. However, there were a total of fifteen (15) soil samples collected within the topmost soil layer of the excavation surface including nine systematic samples, five biased samples (including two from sidewalls), and one QC field duplicate sample. ~~Per Step 7.8.3 of HDP-PR-FSS-721, *Final Status Survey Data Evaluation*, the WRS statistical test was not necessary for LSA 10-14, since the difference between the maximum survey unit gross SOF and the minimum background area adjusted SOF was less than one. However, for illustrative purposes, the WRS evaluation was performed for LSA 10-14 and is included in Appendix B. QC and biased sample results are not utilized in the WRS test. The eight systematic samples collected in the "topmost" excavation surface layer were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The survey unit automatically passed the WRS test since the ranked sum of the Reference Area Ranks – i.e., the test statistic W_r (784) was greater than the critical value (705) for the test. As such, the null hypothesis that the survey unit average concentration is greater than the $DCGL_W$ was rejected.~~ The maximum SOF result for "topmost" samples in LSA 10-14 was 0.30 corresponding to the biased sample L10-14-10-B-E-B-00. The maximum systematic sample SOF result was 0.21 at L10-14-02-B-E-S-00.

~~Appendix B presents the analytical results and associated statistics for all FSS surface samples collected within LSA 10-14.~~

15.2.2 Subsurface Soil Sample Results LSA 10-14

There was one systematic location within LSA 10-14 where root stratum composite sampling was performed. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At this sole root stratum composite sampling location, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was collected. This excavation stratum samples where there was overlying root stratum remaining was considered a "subsurface" sample and therefore did not factor into the WRS test evaluation. The maximum SOF result of the subsurface sample collected in LSA 10-14 was 0.08. This sample (L10-14-09) was the excavation stratum sample collected directly underneath the root stratum sample L10-14-08.

~~The results of the three subsurface samples collected in LSA 10-14 are presented in Appendix B.~~

15.2.3 WRS Test Evaluation LSA 10-14

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was not required for LSA 10-14 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was less than one using the Uniform Stratum criteria. However, for illustrative purposes, the WRS Test was still performed for LSA 10-14. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 9 systematically collected samples in LSA 10-14 were ranked against the adjusted activity

concentrations of the 32 samples collected within the Background Reference Area. The SU passed the WRS Test since the ranked sum of the reference area ranks, or test statistic W_R, (816) was greater than the critical value (725) for the test. As such, the null hypothesis that the SU average concentration is greater than the $DCGL_W$ was rejected. The WRS evaluation is also included in Appendix B.

15.2.4 Graphical Data Review LSA 10-14

Table 15-2 below presents summary results for the all systematically collected samples (includes surface, root, and excavation stratum samples, but not biased or QC samples) collected within LSA 10-14, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.13.

Table 15-2
LSA 10-14 FSS Sample Data Summary and Calculated SOF Values (Systematic)

Statistic	Ra-226 DCGL = 1.9 BKG = 1.07 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
Average	0.04	0.09	0.17	2.13	0.11	1.13	**0.13**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.04	0.37	0.01	0.81	0.05
Maximum	0.16	0.24	0.32	4.38	0.24	1.57	0.21

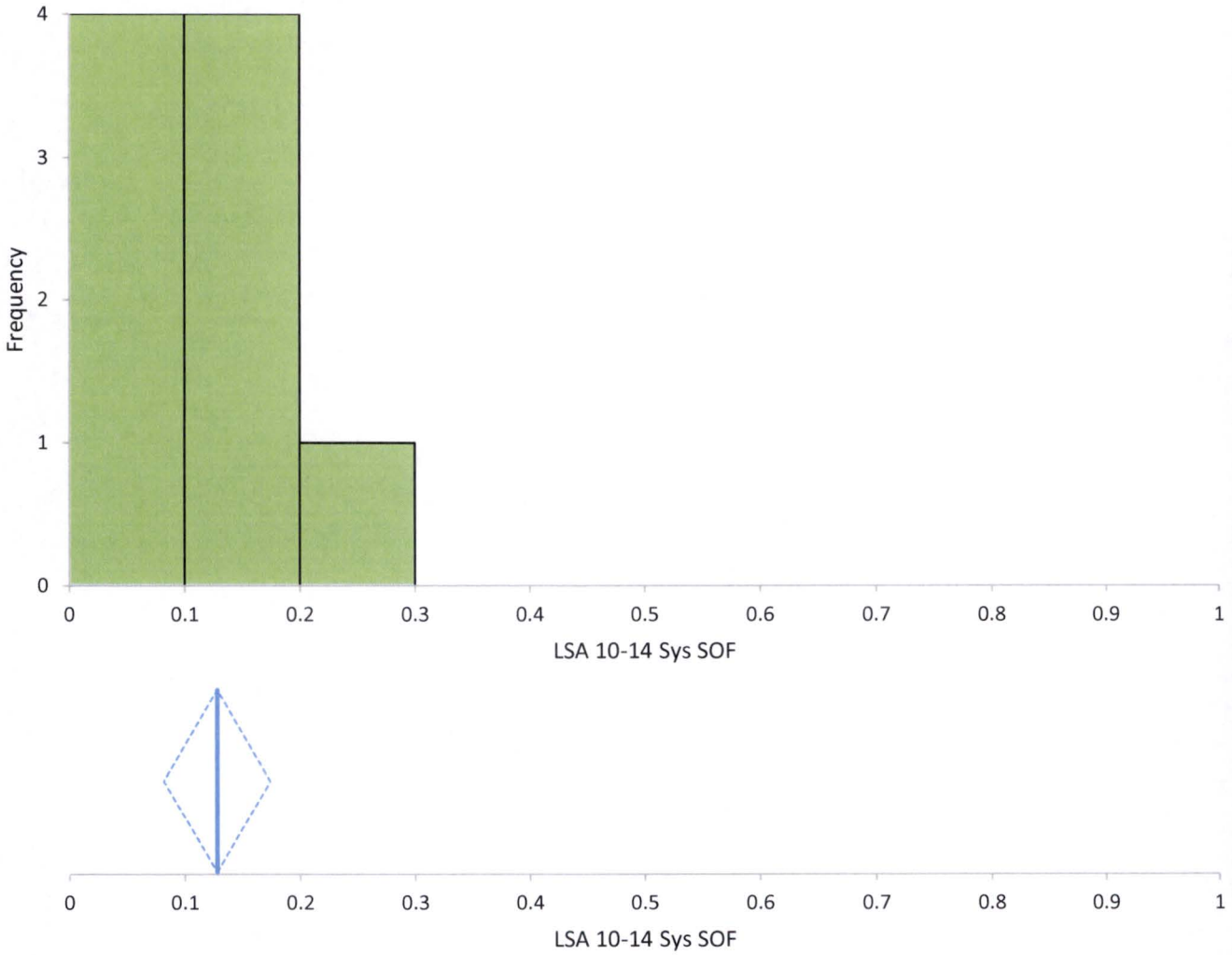
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide concentrations.
3. U-234 values are inferred from the U-235/U-238 ratio.

Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the survey unit. The presence of two peaks in the SU frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 15-3 presents the overall statistical metrics for the SOF parameter for the 10 systematically collected samples from LSA 10-14. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 10-14. The middle graph presents the mean SOF (0.13 rounded up) as indicated by the blue vertical line of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.08 to 0.17. The 96.09% confidence interval based on the median (0.10) of the sample results is 0.08 to 0.20. The bottom two charts present the various statistical metrics of the LSA 10-14 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 15-3 exhibits no unusual symmetry or bimodality concerns for the LSA 10-14 data associated with the systematically collected measurement locations.

Figure 15-3
Graphic Statistical Summary for LSA 10-14 (SOF parameter)



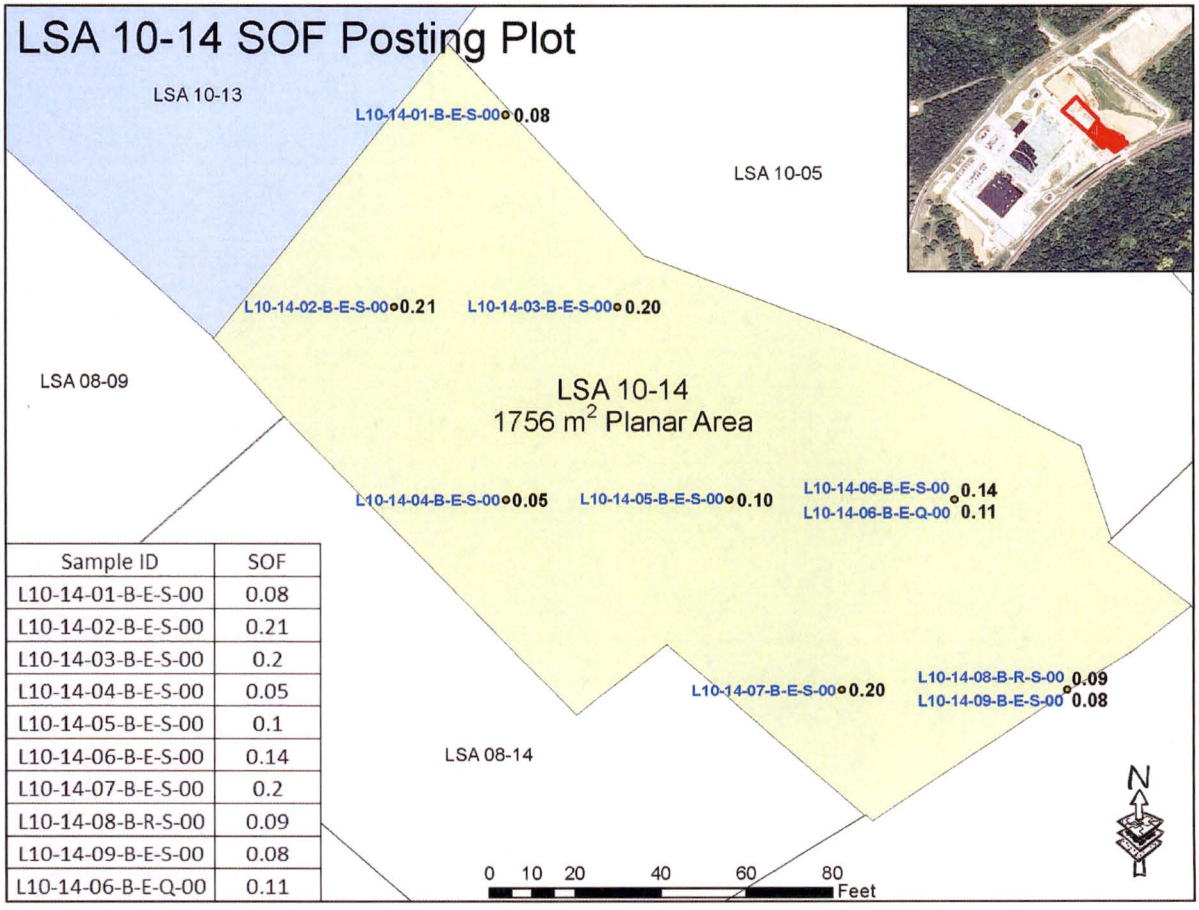
N	9

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-14 Sys SOF	0.13	0.08	to 0.17	0.020	0.06	0.00	0.3	-1.70

	Minimum	1st quartile	Median	96.09% CI		3rd quartile	Maximum	IQR
LSA 10-14 Sys SOF	0.05	0.08	0.10	0.08	to 0.20	0.20	0.2	0.12

A posting plot is simply a map of the survey unit with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 10-14 is presented below in Figure 15-4. Figure 15-4 shows no unusual patterns in the data.

Figure 15-4
Posting Plot for LSA 10-14 Systematic Measurement Locations



Sample ID	SOF
L10-14-01-B-E-S-00	0.08
L10-14-02-B-E-S-00	0.21
L10-14-03-B-E-S-00	0.2
L10-14-04-B-E-S-00	0.05
L10-14-05-B-E-S-00	0.1
L10-14-06-B-E-S-00	0.14
L10-14-07-B-E-S-00	0.2
L10-14-08-B-R-S-00	0.09
L10-14-09-B-E-S-00	0.08
L10-14-06-B-E-Q-00	0.11

Appendix B to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 15-2, Figure 15-3, and Figure 15-4 above. A summary of the analytical data is presented in Table 15-3 below. Appendix F to this report presents the Test America Analytical Laboratory soil sample reports.

Table 15-3
Final Status Survey Analytical Data: LSA 10-14

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																												Enr.	SOF_N
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF_N
L10-14-01-B-E-S-00	5.07	S	0.841	0.135	0.074	NA	-0.229	0.000	-0.022	0.000	0.058	0.227	U	1.130	0.192	0.087	NA	0.130	0.130	2.064	NA	NA	NA	0.111	0.150	0.228	U	0.924	0.293	0.774	NA	1.9	0.08
L10-14-02-B-E-S-00	13.74	S	1.230	0.175	0.072	NA	0.160	0.160	0.241	0.241	0.086	0.260	U	1.190	0.198	0.127	NA	0.190	0.190	1.644	NA	NA	NA	0.084	0.163	0.272	U	1.230	0.568	0.878	NA	1.1	0.21
L10-14-03-B-E-S-00	10.28	S	1.170	0.154	0.084	NA	0.100	0.100	0.084	0.084	0.047	0.222	U	1.270	0.176	0.115	NA	0.270	0.270	0.373	NA	NA	NA	0.014	0.061	0.254	U	0.975	0.289	0.790	NA	0.3	0.20
L10-14-04-B-E-S-00	8.72	S	0.865	0.134	0.069	NA	-0.205	0.000	0.205	0.205	0.026	0.216	U	1.040	0.166	0.106	NA	0.040	0.040	2.095	NA	NA	NA	0.109	0.128	0.248	U	1.350	0.534	0.803	NA	1.3	0.05
L10-14-05-B-E-S-00	18.49	S	0.889	0.162	0.099	NA	-0.181	0.000	0.198	0.198	0.039	0.204	U	1.150	0.212	0.157	NA	0.150	0.150	2.582	NA	NA	NA	0.141	0.187	0.289	U	0.891	0.349	0.954	U	2.5	0.10
L10-14-06-B-E-S-00	16.71	S	1.080	0.157	0.076	NA	0.010	0.010	-0.016	0.000	0.054	0.244	U	1.230	0.182	0.132	NA	0.230	0.230	1.960	NA	NA	NA	0.102	0.153	0.253	U	1.220	0.512	0.783	NA	1.3	0.14
L10-14-07-B-E-S-00	10.61	S	1.020	0.147	0.073	NA	-0.050	0.000	0.105	0.105	0.075	0.226	U	1.320	0.192	0.095	NA	0.320	0.320	4.378	NA	NA	NA	0.241	0.120	0.191	NA	1.160	0.309	0.799	NA	3.2	0.20
L10-14-08-B-R-S-00	4.04	S	1.160	0.184	0.094	NA	0.090	0.090	-0.035	0.000	0.012	0.197	U	1.050	0.170	0.141	NA	0.050	0.050	1.872	NA	NA	NA	0.101	0.156	0.254	U	0.809	0.307	0.841	U	2.0	0.09
L10-14-09-B-E-S-00	4.92	S	1.020	0.168	0.093	NA	-0.050	0.000	-0.010	0.000	0.041	0.203	U	1.120	0.221	0.134	NA	0.120	0.120	2.176	NA	NA	NA	0.111	0.157	0.302	U	1.570	0.925	1.080	NA	1.1	0.08
L10-14-06-B-E-Q-00	16.71	Q	1.100	0.151	0.067	NA	0.030	0.030	-0.033	0.000	0.072	0.243	U	1.150	0.183	0.107	NA	0.150	0.150	2.747	NA	NA	NA	0.150	0.143	0.251	U	0.937	0.306	0.868	NA	2.5	0.11
L10-14-10-B-E-B-00	11.19	B	1.250	0.172	0.073	NA	0.180	0.180	0.011	0.011	0.041	0.243	U	1.050	0.165	0.086	NA	0.050	0.050	28.580	NA	NA	NA	1.470	0.285	0.290	NA	1.200	0.521	0.801	NA	16.0	0.30
L10-14-11-B-E-B-00	17.36	B	1.020	0.167	0.091	NA	-0.050	0.000	1.430	1.430	0.374	0.262	NA	1.090	0.190	0.133	NA	0.090	0.090	1.816	NA	NA	NA	0.097	0.155	0.286	U	0.843	0.359	1.220	U	1.8	0.12
L10-14-12-B-E-B-00	14.25	B	1.390	0.177	0.058	NA	0.320	0.320	0.148	0.148	0.042	0.245	U	1.160	0.171	0.126	NA	0.160	0.160	1.520	NA	NA	NA	0.080	0.133	0.228	U	0.892	0.514	0.819	NA	1.4	0.27
L10-14-13-B-E-B-00	15.91	B	1.250	0.274	0.190	NA	0.180	0.180	0.286	0.286	0.051	0.240	NA	1.260	0.341	0.153	NA	0.260	0.260	3.130	NA	NA	NA	0.172	0.353	0.595	U	0.886	0.809	2.670	U	3.0	0.26
L10-14-14-B-E-B-00	13.62	B	1.640	0.311	0.192	NA	0.570	0.570	0.281	0.281	0.093	0.240	NA	1.530	0.347	0.285	NA	0.530	0.530	1.080	NA	NA	NA	0.048	0.113	0.874	U	1.640	1.910	3.220	U	0.5	0.59
Systematic Minimum			0.000						0.000					0.040						0.373				0.014				0.809				1.6	0.05
Systematic Maximum			0.160						0.241					0.320						4.378				0.241				1.570				Average Enrichment (%)	0.21
Systematic Mean			0.040						0.093					0.167						2.127				0.113				1.125					0.13
Systematic Median			0.000						0.084					0.150						2.064				0.109				1.160					0.10
Systematic Standard Deviation			0.061						0.100					0.095						1.042				0.059				0.247					0.06
			With ingrowth, use Ra226 bkg = 1.07											Th232 bkg = 1.0																				

NOTES:

Gross results in units of pCi/g

* Background with ingrowth (1.07 pCi/g) subtracted from gross result

**Background (1.0 pCi/g) subtracted from gross result

U Qualifier: Result is less than the sample detection limit.

All uncertainty values are reported at the 2-sigma confidence level.

15.2.5 Biased Soil Sample Result LSA 10-14

Three (3) biased samples were collected from LSA 10-14. The sample collected at location L10-14-10 represented the maximum GWS measurement (16,500 gcpm) within the SU, and had a result of 0.30 Uniform SOF.

15.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 10-14

Two samples were collected from the sidewalls of LSA 10-14. Table 15-4 provides the data summary for the samples.

Table 15-4
LSA 10-14 Sidewall Sample Data Summary and Calculated SOF Values

Sample ID	Ra-226 DCGL = 1.9 BKG = 0.9 (pCi/g)	Tc-99 DCGL = 25.1 (pCi/g)	Th-232 DCGL = 2.0 BKG = 1.0 (pCi/g)	U-234 DCGL=195.4 (pCi/g)	U-235 DCGL=51.6 (pCi/g)	U-238 DCGL=168.8 (pCi/g)	Sample SOF (Uniform DCGL)
L10-14-13-B-E-B-00	1.250	0.286	1.260	3.130	0.172	0.886	0.26
L10-14-14-B-E-B-00	1.640	0.281	1.530	1.080	0.048	1.640	0.59

15.2.7 Quality Control Soil Sample Result LSA 10-14

One QC field duplicate sample point was randomly selected for LSA 10-14 which was collected at systematic locations L10-14-06.

For the 14 samples (i.e., 9 systematic + 3 biased + 2 sidewall) collected within LSA 10-14, one field duplicate sample was collected. This frequency equates to 7.1%, (i.e. 1/14). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample results that all comparison criteria were less than the calculated warning limits (see Figure 15-5 below).

Figure 15-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 10-14

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control		
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FORM HDP-PR-FSS-703-1
FIELD DUPLICATE SAMPLE ASSESSMENT

Survey Unit No.:	LSA 10-04				Survey Unit Description:		East Central Survey Unit (North Burial Pits)					
			Sample (pCi/g)		Field Duplicate Sample (pCi/g)							
Sample ID	Field Duplicate Sample ID	Radionuclide	Activity (x_i)	MDC	Activity (x_i)	MDC	Average Activity ($\bar{X}$) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic[2]	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	Ra-226	0.997	0.0676	0.931	0.0669	0.964	1.9	0.066	0.269	0.403	N
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	Tc-99	1.72	0.228	1.35	0.23	1.535	25.1	0.37	3.552	5.321	N
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	Th-232	0.864	0.107	0.830	0.0651	0.847	2.0	0.034	0.283	0.424	N
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	U-234[1]	2.837	NA	2.979	NA	2.908	195.4	0.142	27.649	41.425	N
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	U-235	0.152	0.233	0.162	0.193	0.157	51.6	NA	7.301	10.939	NA
L10-04-08-B-E-S-00	L10-04-08-B-E-Q-00	U-238	1.34	0.753	1.11	0.807	1.225	168.8	0.23	23.885	35.786	N

Comments:
1. U-234 is inferred, no MDC available.
2. Duplicate assessment is not necessary if the result of either sample is < MDC.

Performed by: [signature] Date: 4/13/15

Reviewed by: [signature] Date: 4/13/15

Quality Record

15.3 Tc-99 Hot Spot Assessment LSA 10-14

As LSA 10-13 and LSA 10-14 are immediately adjacent to each other, the evaluation of potential Tc-99 hotspots in the area was performed for both LSA's simultaneously. During site characterization studies a total of 77 samples were collected and analyzed for Tc-99 in LSA-10-13 and LSA-10-14. Within LSA 10-13, the maximum sample identified was 10.5 pCi/g – well below the 25.1 pCi/g limit for the Uniform Stratum DCGL. The maximum sample identified in LSA 10-14 was 52.6 pCi/g, with an overall mean and median concentration of 6.19 pCi/g and 0.43 pCi/g respectively. Within LSA 10-14, a total of four characterization sample results exceeded the Uniform Stratum DCGL of 25.1 pCi/g for Tc-99. No samples exceeded the Tc-99 DCGL during RASS and FSS.

An area factor of 2.1 would be required to account for any potential hot spots of 52.6 pCi/g. Using the Uniform area factor table from the DP and interpolation, 475 m^2 is the area per sample station required to equate to an area factor of 2.1. In both LSA-10-13 and LSA-10-14 the area represented by each systematic location was less than 250 m^2 and is adequate to account for any potential hot spots within the survey units.

16.0 ALARA EVALUATION LSA 10-14

All samples collected within LSA 10-14 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 10-14 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.13 for LSA 10-14. The average SOF equates to residual activity contributions from the SU area of 3.25 mrem/year for LSA 10-14. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, Chapter 6 {ML17142A356}, Chapter 7 {ML17250A376} and Chapter 8 {ML17240A168} indicate that the groundwater dose contribution is a fraction of the MCLs.~~Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3, indicate that the groundwater dose contribution will be a fraction of the MCLs.~~ Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/year based upon the EPA MCLs will be added to the total estimated dose for LSA 10-14. The Combined Reuse Stockpile 1-2 soil dose contribution will also be accounted for by adding in an additional 2.5 mrem/year. Adding all of the dose contributions together, the total estimated dose for LSA 10-14 is 9.75 mrem/year.

Since the estimated TEDE is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the remediation of LSA 10-14 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing further remediation of LSA 10-14.

17.0 FSS PLAN DEVIATIONS LSA 10-14

17.1 Remedial Actions during FSS

There were no remedial actions after FSS in LSA 10-14.

17.2 Adjustments to Scan MDC Calculations

As previously stated in Section 12.1.5, adjustments were made to the Scan MDC calculations for instrumentation used for the GWS in LSA 10-14. The Scan MDCs presented in the FSS Plan shown in Table 12-1 assumed a surveyor efficiency of 0.5 and did not reflect the information derived from the development of HDP-TBD-FSS-002 which used Microshield modeling of parameters consistent with procedural requirements of GWS implementation at HDP. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 10-14, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. Since all GWS data collected in LSA 10-14 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015.

Based on the data presented in HDP-TBD-FSS-002 and using a surveyor efficiency of 0.75 and a conservative enrichment basis of 4%, revised Scan MDCs were developed and are presented in Table 17-1 below:

Table 17-1

Revised Scan MDCs for 2" x 2" NaI detector: LSA 10-14

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw (Ra-226)	Scan MDC (Th-232)	DCGLw (Th-232)
LSA 10-14	46.7	31.2	1.37	1.9	0.99	2.0

18.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process are presented in Volume 3, Chapter 1, Section 4.0 of the FSSFR and correspond to the DQO steps described in Chapter 14, Section 4.2.1 of the DP. The HDP DQO process reflects the recommendations given in MARSSIM, Chapter 2, Figure 2-2.

18.1 Data Quality Assessment for LSA 10-14

The Data Quality Assessment of the survey methodology, sampling and sample analysis results, and the Quality Control sampling and analysis results to ascertain the validity of the conclusion for LSA 10-14 (see Figure 18-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed

using a NIST traceable source. The instruments used were successfully source checked prior to and after use.

- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control*.
- LSA 10-14 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.
- The WRS Test is not necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 10-14, no individual gross SOF result in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was not required for LSA 10-14, however the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (816) exceeded the critical value (725), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS evaluation worksheet is presented in Appendix B.
- ~~For LSA 10-14, the WRS statistical test was not necessary since the difference between the maximum survey unit gross SOF and the minimum background area adjusted SOF was less than one. However the WRS Test was still performed for illustrative purposes and the worksheet is presented in Appendix B.~~
- The maximum systematic SOF result for all surface samples within LSA 10-14 was 0.21. The SOF result for the single subsurface sample within LSA 10-14 was 0.08. The average SOF result for all systematically collected samples within LSA 10-14 was 0.13, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.17.
- No FSS sample result in LSA 10-14 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an elevated measurement comparisons (EMC) or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic samples actually collected within LSA 10-14. The successful result of the retrospective power evaluation presented in Table 18-1 for LSA 10-14 indicates that the minimum number of samples required (8) for the WRS Test was less than the number of sampling locations actually collected

within LSA 10-14. The methodology used for the retrospective sampling frequency evaluation is similar to the prospective sample size determination performed during FSS Plan Development except that actual FSS sample results and statistics are used in the sample size verification. Specifically, the mean and standard deviation of the eight topmost excavation surface samples (i.e., the WRS Test sample data set) are used to derive the relative shift for each LSA. Given the HDP Type I and Type II errors of 0.05 and 0.10, respectively, the calculated relative shift is then correlated to a minimum sample size number as provided in Table 5-1 of MARSSIM.

- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for LSA 10-14 was completed prior to the commencement of backfill operations.

Table 18-1
Retrospective Sample Size Verification for LSA 10-14

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.06
$DCGL_{SOF}$	1
LBGR (Mean)	0.13
Shift	0.87
Relative Shift (Δ/σ)	14.58
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	8
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

Δ/σ	P_r
0.1	0.528182
0.2	0.556223
0.3	0.583985
0.4	0.611335
0.5	0.638143
0.6	0.664290
0.7	0.689665
0.8	0.714167
0.9	0.737710
1.0	0.760217
1.1	0.781627
1.2	0.801892
1.3	0.820978
1.4	0.838864
1.5	0.855541
1.6	0.871014
1.7	0.885299
1.8	0.898420
1.9	0.910413
2.0	0.921319
2.25	0.944167
2.5	0.961428
2.75	0.974067
3.0	0.983039
3.5	0.993329
4.0	0.997658
4.01	1.000000

MARSSIM Table 5.2, α = 0.05, β = 0.10

α (or β)	$Z_{1-\alpha}$ (or $Z_{1-\beta}$)
0.005	2.576
0.01	2.326
0.015	2.241
0.025	1.960
0.05	1.645
0.10	1.282
0.15	1.036
0.2	0.842
0.25	0.674
0.30	0.524

α

β

Figure 18-1
Data Evaluation Checklists prepared for LSA 10-14 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
	Westinghouse Non-Proprietary Class 3	Revision: 7	Appendix G-1, Page 1 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: 14 **Description:** Southern Survey Unit in "Area 2"

1.	Have all measurements and/or analysis results that will be subjected to data analysis for FSS been individually reviewed and validated in accordance with Section 8.1 of this procedure?	Yes ☒	No ☐	
2.	Have all systematic measurements and/or samples been taken or acquired at the locations specified in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
3.	Have all scans surveys been performed of the areas specified as required in the FSSP and the FSS Sample Instructions?	Yes ☒	No ☐	
4.	Have all biased measurements and/or samples been taken or acquired at the locations specified in the FSSP & the FSS Sample Instructions?	Yes ☒	No ☐	NA ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☒	No ☐	
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐	
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐	
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐	
9.	Do the samples match those identified on the chain of custody?	Yes ☒	No ☐	
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control?	Yes ☒	No ☐	
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	

If "No" was the response to any of the questions above, then document the discrepancy as well as any corrective actions that were taken to resolve the discrepancy.

Comments: NA

Quality Record LSA 10-14

Figure 18-1
Data Evaluation Checklists prepared for LSA 10-14 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
	Westinghouse Non-Proprietary Class 3	Revision: 7	Appendix G-1, Page 2 of 2

APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: No. LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: No. 14 **Description:** Northern Survey Unit in "Area 2"

Discrepancy: NA

Corrective Actions Taken: NA

11. Have the corrective actions resolved the discrepancy with the data? Yes ☐ No ☐ NA ☒
    a. If "No", then forward this form to the RSO.
12. The following questions will be answered by the RSO.
    a. If the answer to question 13 was "No", then is the affected data still valid? Yes ☐ No ☐ NA ☒
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ NA ☒
    c. If "No", then direct the acquisition of additional measurements or samples as necessary to demonstrate compliance for the survey unit.

Prepared by (HP Staff): Eliseo C. Ybarra (Print Name) _____ (Signature) 11/19/15 (Date)
Approved by (RSO): W. Clark Cross (Print Name) _____ (Signature) 11/19/15 (Date)

Quality Record LSA 10-14

19.0 SURVEILLANCE FOLLOWING FSS

FSS GWS activities in LSA 10-14 were completed on April 29, 2015. There were no events after the completion of FSS that would have the potential to cause contamination above the DCGLs in the SU.

20.0 CONCLUSION LSA 10-14

An adequate quantity and quality of radiological surveys and samples, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with all sources within SU LSA 10-14 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 20-1
LSA 10-14 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.13	N/A	0.16	N/A	0.10	**0.39**
DOSE	3.25 mrem/year	N/A	4.0 mrem/year	N/A	2.5 mrem/year	**9.75 mrem/year**

21.0 REFERENCES

21.1 DO-08-004, Hematite Decommissioning Plan {ML092330123}.

21.2 DO-08-003, Radiological Characterization Report, July 2009 {ML092870496}

21.3 NSA-TR-09-15, Nuclear Criticality Safety Assessment of Buried Waste Exhumation and Contaminated Soil Remediation at the Hematite Site

21.4 Westinghouse letter HEM-11-96, dated July 5, 2011, *Final Supplemental Response to NRC Request for Additional Information on the Hematite Decommissioning Plan and Related Revision to a Pending License Amendment Request* {ML111880290}

21.5 Westinghouse Internal Memorandum HEM-15-MEMO-021, *Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site* (FSSFR Volume 3, Chapter 1, Appendix D)

21.6 Westinghouse letter HEM-11-56, dated May 5, 2011, *Evaluation of Technetium-99 Under the Process Buildings* {ML111260624}

22.0 APPENDICES (To Be Provided On Separate Data Disc)

APPENDIX A: Analytical Data Evaluation Spreadsheets for LSA 10-13

APPENDIX B: Analytical Data Evaluation Spreadsheets for LSA 10-14

APPENDIX C: FSS Plan Development for LSA 10-13

APPENDIX D: FSS Plan Development for LSA 10-14

APPENDIX E: TestAmerica Laboratory Analytical Data Reports for LSA 10-13

APPENDIX F: TestAmerica Laboratory Analytical Data Reports for LSA 10-14

APPENDIX G: Completed Field Logs (Appendix P-6 from HDP-PR-FSS-701)

APPENDIX H: HDP-RPT-FSS-303, Summary Report for Burial Pit Area Remediation

Attachment 3

Revision Matrix for FSSFR Volume 3, Chapter 5, Revision 1

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

REVISION MATRIX FOR FSSFR VOLUME 3, CHAPTER 3, REVISION 1
Survey Area Release Record for Land Survey Area 10,
Survey Units 13 and 14
(LSA 10-13 and LSA 10-14)

The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to the application of the WRS Test when applied to the Three Stratum approach. Westinghouse and the NRC discussed the path forward and resolution of the NRC comments. At that time Westinghouse agreed to revise the appropriate survey area release records. This revision to FSSFR Volume 3, Chapter 5, implements the "WRS Test" revision.
This revision also provides an opportunity to update the reports in regards to correcting minor editorial error, spelling errors and nomenclature to make them consistent with subsequent survey area release records which were submitted after the submittal of FSSFR Volume 3, Chapter 5, Revision 0. There has been no change or revision to the data that supports the conclusion of the survey area release records.

SECTION	REVISION	REASON
3.3.9	Transferred indicated text to Section 11.0 and Section 19.0.	
6.2.2 Table 6-2	Changed title from "Figure" to "Table".	A NRC comment from a weekly teleconference was that "The figure appeared to be more like a table." in regards to the information provided. Westinghouse agreed and implemented the change in all succeeding reports. This revision provides the opportunity to make the change in this report.
6.2.2 Table 6-2	Deleted "topmost".	WRS Test Revision.
7.2	Added sentence: "Appendix A presents the analytical results and associated statistics for all FSS samples collected within LSA 10-13."	WRS Test Revision.
7.2.1	Transferred indicated text and revised into Section 7.2.3.	WRS Test Revision.
7.2.2	Transferred indicated text to Section 7.2.	WRS Test Revision.
7.2.3	Added text to describe the WRS Test for LSA 10-03.	WRS Test Revision.
8.0	Updated FSSFR Volume 6 Chapter information.	Updated to reflect Volume 6 Chapters submitted to date.

REVISION MATRIX FOR FSSFR VOLUME 3, CHAPTER 3, REVISION 1
Survey Area Release Record for Land Survey Area 10,
Survey Units 13 and 14
(LSA 10-13 and LSA 10-14)

SECTION	REVISION	REASON
10.1	Revised bullet discussing WRS Test.	WRS Test Revision.
11.0	Inserted new section titled "Surveillance Following FSS".	As documented through NRC Inspection Reports and correspondence from Westinghouse to the NRC a weather related event which occurred on August 30, 2015, of which a violation was issued (ML15334A404), evolved to a technical position in which Westinghouse has been required to demonstrate by evaluation that no radioactive material has unknowingly been left in a remediated area and subsequently covered with backfill soil. From that point, future survey area release records contain the "Surveillance Following FSS" section to provide the relevant information to the survey unit. This revision provides the opportunity to add the relevant information to the report. Detailed information for all survey units has been provided to the NRC in Westinghouse letter HEM-17-30 (K. Pallagi) to NRC (NRC Region III and NRC Document Control Desk), dated April 27, 2017, "Response to NRC Region III email dated February 2, 2017 Final Status Survey Proposed Comments/Questions on LSA Template from and "Plausibility Matrix of Contaminated Items in an Excavation Prior to Backfill" dated February 3, 2017"
14.2.2 Table 14-2	Changed title from "Figure" to "Table".	A NRC comment from a weekly teleconference was that "The figure appeared to be more like a table." in regards to the information provided. Westinghouse agreed and implemented the change in all succeeding reports. This revision provides the opportunity to make the change in this report.
14.2.2 Table 14-2	Deleted "topmost".	WRS Test Revision.
15.2	Added sentence: "Appendix B presents the analytical	WRS Test Revision.

REVISION MATRIX FOR FSSFR VOLUME 3, CHAPTER 3, REVISION 1
Survey Area Release Record for Land Survey Area 10,
Survey Units 13 and 14
(LSA 10-13 and LSA 10-14)

SECTION	REVISION	REASON
	results and associated statistics for all FSS samples collected within LSA 10-14."	
15.2.1	Transferred indicated text and revised into Section 15.2.3.	WRS Test Revision.
15.2.2	Transferred indicated text to Section 15.2.	WRS Test Revision.
15.2.3	Added text to describe the WRS Test for LSA 10-04.	WRS Test Revision.
16.0	Updated FSSFR Volume 6 Chapter information.	Updated to reflect Volume 6 Chapters submitted to date.
18.1	Revised bullet discussing WRS Test.	WRS Test Revision.
19.0	Inserted new section titled "Surveillance Following FSS".	As documented through NRC Inspection Reports and correspondence from Westinghouse to the NRC a weather related event which occurred on August 30, 2015, of which a violation was issued (ML15334A404), evolved to a technical position in which Westinghouse has been required to demonstrate by evaluation that no radioactive material has unknowingly been left in a remediated area and subsequently covered with backfill soil. From that point, future survey area release records contain the "Surveillance Following FSS" section to provide the relevant information to the survey unit. This revision provides the opportunity to add the relevant information to the report.
Appendix A	WRS Test performed as agreed based upon NRC feedback.	WRS Test Revision.
Appendix B	WRS Test performed as agreed based upon NRC feedback.	WRS Test Revision.