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Our ref: HEM-17-66
Date: November 2, 2017

Subject: Westinghouse Hematite Decommissioning Project - Request for NRC Review of Final Status Survey Final Report Volume 3, Chapter 7, Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01, 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 7, Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01, 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 7 implements Revision 3 to FSSFR Volume 3, Chapter 1 within the release record.

Attachment 1 contains FSSFR Volume 3, Chapter 7, Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01, 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 7, Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01, Revision 1 (HDP-RPT-FSS-209 Revision 1)

2) Final Status Survey Final Report Volume 3, Chapter 7, Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01, Revision 1 (HDP-RPT-FSS-209 Revision 1) Track Change Version
3) Revision Matrix for FSSFR Volume 3, Chapter 7, 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 7, Revision 1

Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01, 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 7

TITLE: **Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01 (LSA 10-11 and LSA 11-01)**

REVISION: **1**

EFFECTIVE DATE: NOV 0 2 2017

Approvals:

Author: Kenneth E. Pallagi — 11-02-2017 Date

Owner/Manager: W. Clark Evers — 11/2/17 Date

REVISION LOG	
Revision No. Effect. Date	**Revision**
0 12/07/2016	Revision 0 is the initial issuance of the Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01.
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. Updates to the survey area release records in regards to correcting minor editorial errors, spelling errors and nomenclature to make the survey area release records consistent with subsequent survey area release records which were developed after the submittal of FSSFR Volume 3, Chapter 7, Revision 0

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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 Objective
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
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
yr	year

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) 11 (LSA 10-11) and LSA 11, SU 01 (LSA 11-01). 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."

LSA 10-11 was designated as a Class 1 SU as presented in Table 14-16 of the HDP Decommissioning Plan (DP) {ML092330123}. The Class 1 designation for the SU remained in effect throughout remediation and Final Status Survey (FSS). LSA 11-01 was originally designated as a Class 3 SU as presented in Table 14-16 of the HDP Decommissioning Plan (DP) {ML092330123}, but was reclassified to a Class 2 SU based on the potential impact from a flash flood event that occurred early in the Burial Pit remediation process, and the potential impact of flooding events that occurred during remediation of the Burial Pit Area.

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 the residual radioactivity levels in the LSA 10-11 and LSA 11-01 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 Final Status Survey (FFS) 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 2, *Land Survey Areas (LSA) Overview* provides the information common to land survey areas. This report, FSSFR Volume 3, Chapter 7, builds upon the general information provided in FSSFR Volume 3, Chapter 1, Revision 2.

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 10 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. Figure 2-2 indicates the final configuration of LSA 10.

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.

2.2.1 LSA 10-11 Survey Unit Description and Configuration

LSA 10-11 is located in the south eastern tip of LSA 10, the Burial Pit Area and, is adjacent to the Northeast Site Creek area (LSA 11) to its north and northeast. Figure 2-2 indicates the location of LSA 10-11 within LSA 10.

LSA 10-11 is a SU in the group of LSA 10 SUs (LSA 10-05, LSA 10-06, LSA 10-07, LSA 10-09, LSA 10-10 and LSA 10-14) in which the conceptual boundaries were changed. The site staff and Radiation Safety Officer (RSO) at the time of remediation in the south Burial Pit Area chose to depart from the conceptual SU boundary configuration. The configuration of these SU boundaries was derived from physical delineations in the area as a result of remediation activities with the south Burial Pit Area. It is noteworthy that although the boundaries of the SUs changed and new SUs were designated, the boundary of LSA 10 did not change and all SUs within LSA 10 remained classified as MARSSIM Class 1.

The land area of SU LSA 10-11 is positioned within LSA 10 such that the majority of the SU is the lower sloped area that adjoins the Northeast Site Creek. As such, during the history of site operations it was not considered to be a location in which burials would be undertaken. As documented and verified during remediation, burials occurred at higher elevations in the Burial Pit Area where sufficient overburden was available.

While LSA 10-11 was designated as a Class 1 area, there was very little radiological remediation required to ready the area for FSS. A portion of the LSA was covered by a gravel roadway. For

FSS the gravel road was removed in order to provide unencumbered access to the underlying native soil. After completion of site operations in the area, in the final configuration, LSA 10-11 consisted primarily of the excavated area in the SU which consisted of native soil. There were no structures, piping, or spent limestone remaining within the SU. The site security fence transits through the eastern edge of the SU. Groundwater monitoring well WS-31 was present in the LSA and remained undisturbed throughout the remediation process. Additionally ground water monitoring well BR-15-JC was installed after remediation and backfill operations were completed. These wells will remain in place and are monitored as part of the post-remediation groundwater monitoring that will be reported in FSSFR Volume 6 chapters.

The SU is 459 square meters (m^2) in planar (2-dimensional) extent, within an interior surface area of 550 m^2 (3-dimensional).

2.3 LSA 11 Configuration

LSA 11 has been reconfigured (expanded) from the initial conceptual boundary. Figure 2-3 depicts the initial configuration of LSA 11 as provided in DP Figure 14-14. This depiction indicates that the initial conceptual boundary for LSA 11 was a single large Class 3 SU designated LSA 11-01.

2.3.1 LSA 11 Configuration Change – RAI Response

The first configuration change of LSA 11 which impacted the boundary configuration of LSA 11-01 resulted from resolution to a NRC review comment of the Westinghouse response to RAI-HDPC-14-Q5. Westinghouse letter HEM-11-96 Attachment 10, RAI No. 14-4e indicates that "*From the 5/19/11 conference call, it was understood that the underlying concern for RAI 14-4 is related to the amount and type of uranium data within a portion of the area designated as non-impacted, To resolve this concern, HDP will expand the size of the impacted area. The boundary of the existing survey unit LSA-11-01 will be modified as illustrated in Attachment 2, and the size increased from 14,885 m^2 to 24,715 m^2.*"

The expansion of LSA 11 as the result of resolution of a RAI did not decrease the MARSSIM classification of the LSA. Figure 2-4 is the revised figure provided in HEM-11-96 indicating the expanded SU LSA 11-01.

2.3.2 LSA 11 Configuration Change – Flash Flood

The second configuration change of LSA 11 which impacted the boundary of LSA 11-01 resulted as a consequence of a flash flood event that occurred in April 2013. NRC Region III Inspectors were onsite conducting inspection activities at the time of the flash flood. NRC Inspection Report 07000036/2013002 provides a detailed description of the event in which the NRC conclusion was as follows "*The inspectors determined the licensee took appropriate actions to minimize the impact of the flood waters leaving the site and took adequate actions to determine if licensed radioactive materials were being released from the site. The NRC performed confirmatory sampling of soils on- and off-site that resulted in one slightly elevated result onsite that was being evaluated by the licensee.*"

During the flooding event site staff monitored the elevation of the flood water to ascertain which portions of LSA 11 and the previously non-impacted land areas adjoining LSA 11-01 were

affected by the flooding. Based upon the results of the monitoring of the flood water elevation in LSA 11, which at that time consisted of the single SU designated LSA 11-01, SU LSA 11-01 was expanded to include the land area impacted by the flood water. The expansion of LSA 11 resulted in the designation of new SUs LSA 11-01, LSA 11-02, LSA 11-03, LSA 11-04 and LSA 11-05. Figure 2-5 depicts the resulting expanded LSA 11 and the LSA 11 SUs.

The expansion of LSA 11 did not result in a decreased MARSSIM classification of any of the impacted land area.

2.3.3 LSA 11 Reclassification

LSA 11-01 was initially classified as a MARSSIM Class 3 survey area. As discussed in Section 2.3.1 above the expansion of LSA 11 resulted in previously designated non-impacted land being designated as a MARSSIM Class 3 survey area.

2.3.3.1 LSA 11 Reclassification – Flash Flood

As discussed in Section 2.3.2 above, as a consequence of the flash flood event the new LSA 11-02, LSA 11-03, LSA 11-04 and LSA 11-05 were established. The radiological data generated during the flash flood event was reviewed and compared to the SU classifications provided in DP Chapter 14 Section 14.4.2.4, *Initial Classification of Survey Units*. The appropriate classification remained MARSSIM Class 3, for the land area previously approved in the DP as MARSSIM Class 3. The additional land area was reclassified from non-impacted to MARSSIM Class 3. As the westerly boundary of LSA 11-01 was adjacent to LSA 10 (Burial Pit Area), during the flash flood event flood water from LSA 11-01 (Northeast Site Creek) entered LSA 10. As a result of the flood water being in both LSA 10 and LSA 11 and having a shared boundary, LSA 11-01 was reclassified as MARSSIM Class 2 as SU LSA 11-01 now had a potential for radioactive contamination, but was not expected to exceed the $DCGL_w$.

2.3.3.2 Reclassification – Portion of LSA 11-03

During the FSS Remedial Action Support Survey (RASS) for the purpose of FSS Design of SU LSA 11-03, a soil sample analysis result of greater than 0.5 but less than 1.0 Uniform SOF was identified. As this sample result was greater than a SOF of 0.5 (the limit for a Class 3 SU), a new boundary for LSA 11-03 and LSA 11-01 was established. A portion of LSA 11-03 was transferred to LSA 11-01 to allow the reclassification of the affected portion of LSA 11-03 to MARSSIM Class 2 from MARSSIM Class 3. Figure 2-6 contains the reconfigured and reclassified portions of LSA 11-01 and LSA 11-03.

2.3.4 LSA 11-01 Survey Unit Description and Configuration

LSA 11-01 is located east of and adjacent to the entire length of the LSA 10, the Burial Pit Area. The events that contributed to the final boundary configuration of LSA 11-01 have been previously described in this section.

The predominant land feature of LSA 11-01 prior to remediation was the Northeast Site Creek. The remaining land feature of LSA 11-01 is woodlands. While no radiological remediation was necessary in LSA 11-01, excavations were performed to support decommissioning of the site. Prior to the initiation of remediation activities the Northeast Site Creek Diversion was installed

and placed into operation. The Northeast Site Creek Diversion included the installation of storm water culverts at the inlet and outlet to the Controlled Access Area. The areas where the diversion and the storm water culverts were installed were subject to Remedial Action Support Surveys (RASS) prior to installation with no areas of contamination identified. Also installed and placed into operation was a Detention Pond. A haul road along the perimeter of the site security fence that allowed access to the Burial Pit Area from the east side of the site was also installed.

FSS operations in LSA 11-01 began after the completion of FSS in the adjacent former Burial Pit Area, and after the Detention Pond was no longer in service, thus minimizing the potential for cross contamination and ensuring that the FSS was performed on the final surface of LSA 11-01.

Groundwater monitoring wells GW-BB and NB-80 were present in LSA 11-01 prior to commencement of remediation of the site and remained undisturbed throughout the remediation process. These wells remain in place and are monitored as part of the post-remediation groundwater monitoring.

The SU is 9,885 m^2 in planar extent.

Figure 2-1
HDP Land Survey Areas

Figure 2-2
Final Configuration of Land Survey Area 10

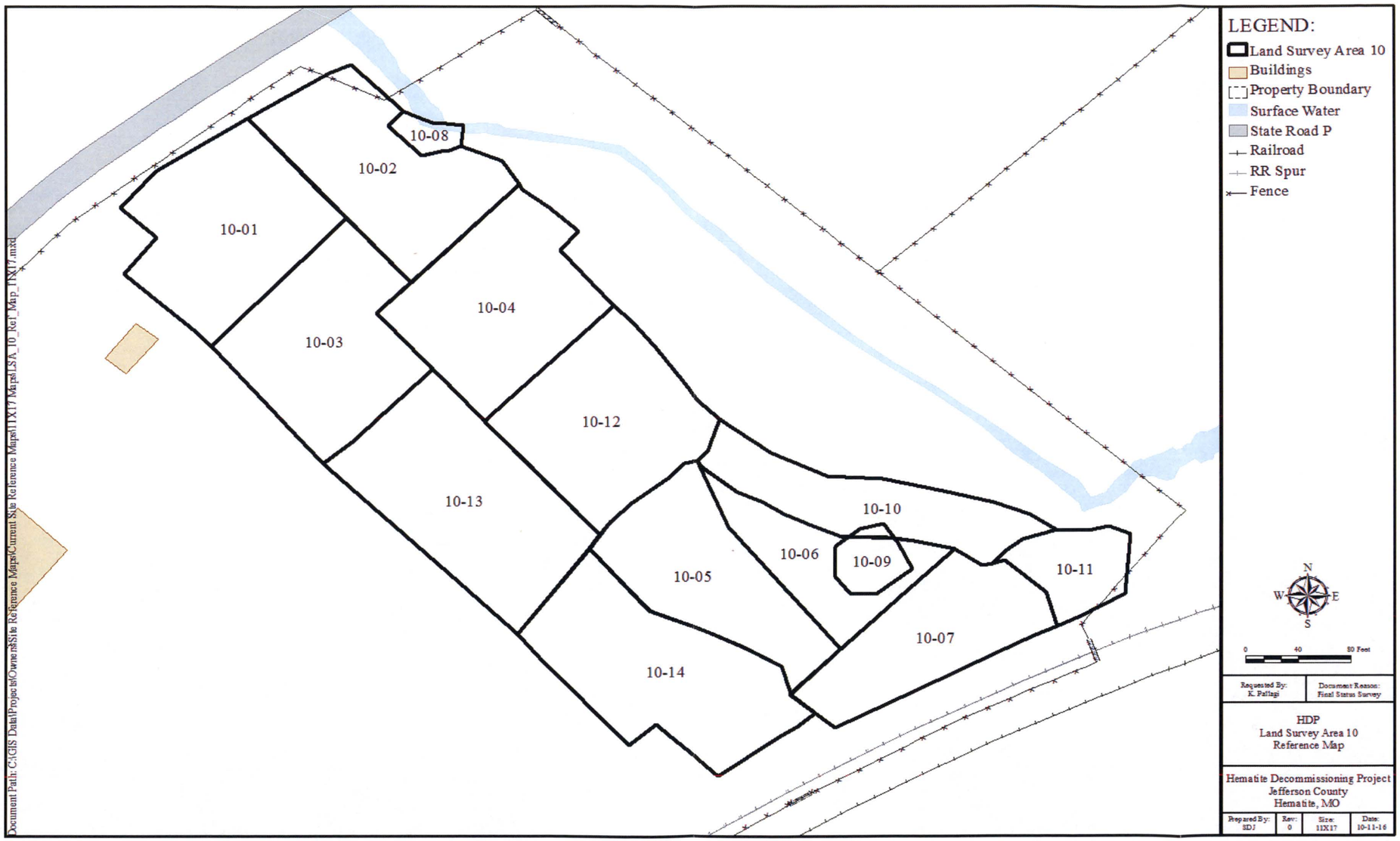


Figure 2-3
Initial Configuration of LSAs as Provided in DP (Figure 14-14)

Figure 2-4
Revised DP Figure Provided in HEM-11-96

Figure 2-5
Configuration of Land Survey Areas and Survey Units after Flash Flood Event

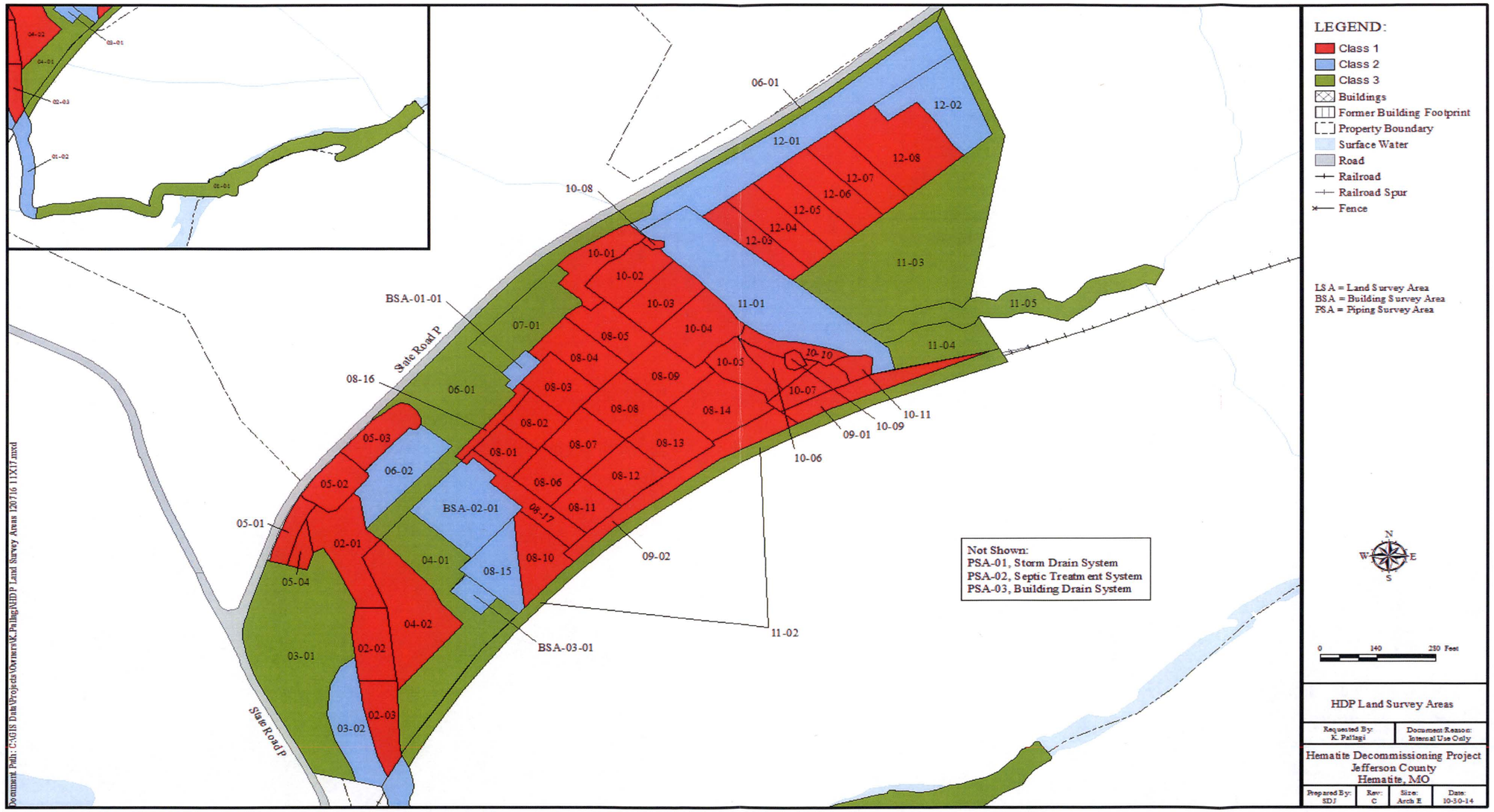
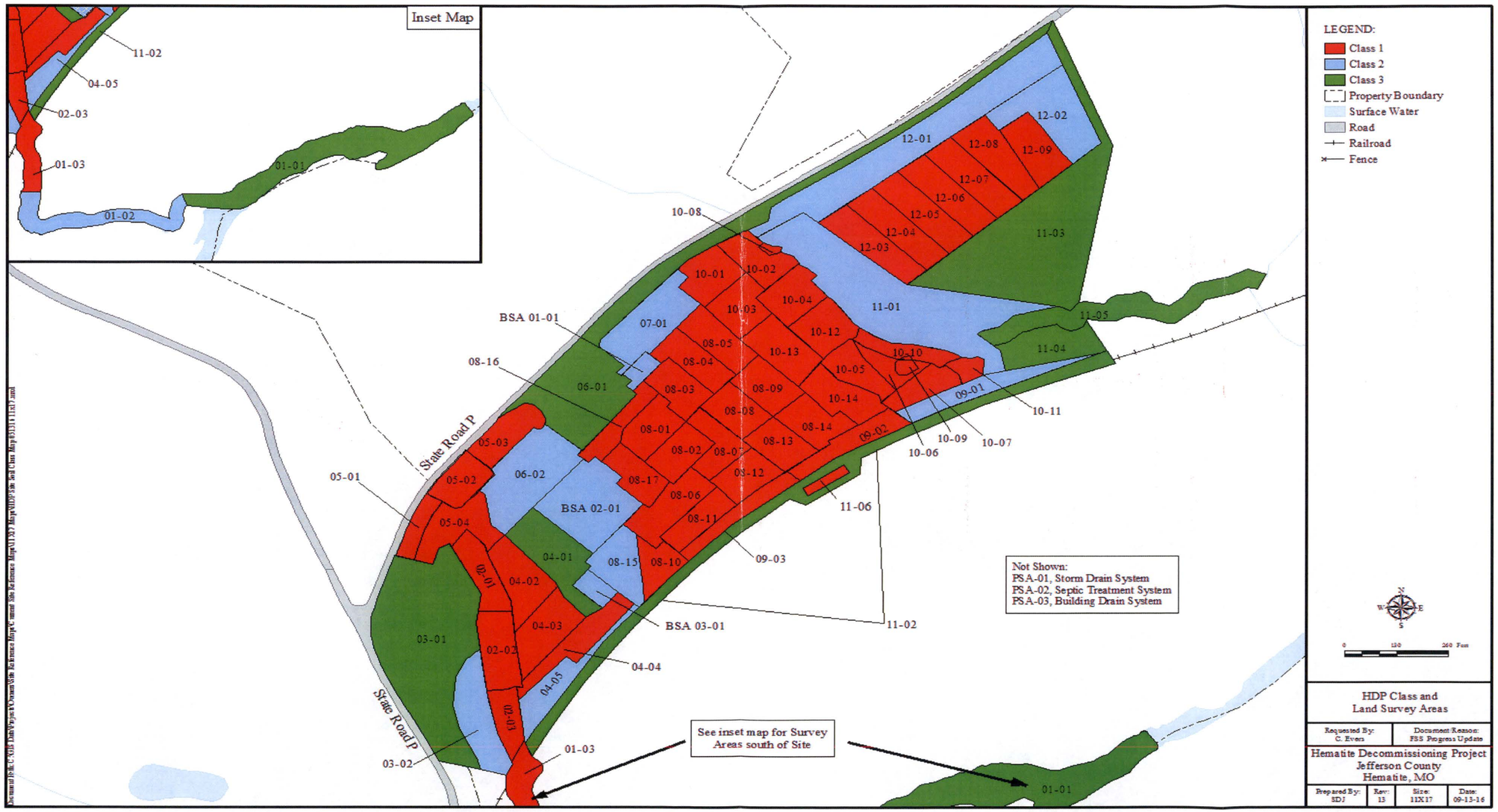


Figure 2-6
Final Configuration of Land Survey Areas and Survey Units



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*.

No Documented Burial Pits or Undocumented Burials were encountered in LSA 10-11 or LSA 11-01.

3.1 Radioactive Materials in LSA 10-11 and LSA 11-01

Due to the location and configuration of LSA 10-11 and LSA 11-01 relative to historical and site remediation activities, as expected, there were no Documented Burial Pits, Undocumented Burials, trash, debris, or spent limestone encountered in LSA 10-11 or LSA 11-01.

3.2 Reuse Soil Disposition and Characterization

No reuse soil was collected from LSA 10-11 or LSA 11-01.

3.3 Remediation and Remedial Action Support Surveys (RASS) Phase of LSA 10-11 and LSA 11-01

Site radiological characterization and site history provided no expectation of discovery of Documented Burial Pits, Undocumented Burials, trash, debris, or spent limestone in LSA 10-11 and LSA 11-01. The remedial and RASS activities in LSA 10-11 were driven by remediation activities in the adjacent Burial Pit Area SUs. No remedial excavation was required for FSS preparation in LSA 11-01.

3.3.1 Remedial Actions

3.3.1.1 Remedial Actions LSA 10-11

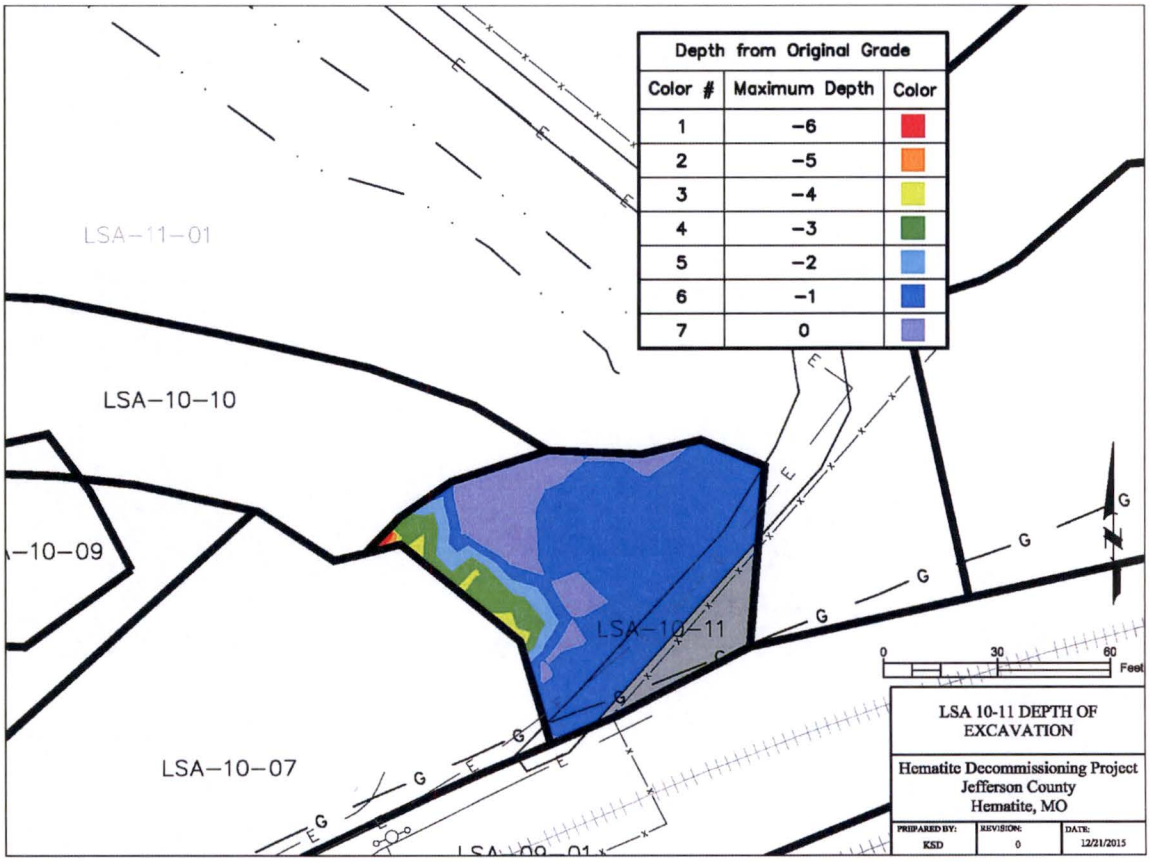
Remedial actions occurred in LSA 10-11 in March, 2015.

As excavation progressed for the removal of contaminated wastes and debris in the adjacent Burial Pit Area SUs, five activities came into play that determined the extent of remediation necessary in LSA 10-11. These were: 1) in process Remedial Action Support Surveys (RASS), 2) conducting core bores to support that nuclear criticality safety controls were not required in LSA 10-11, 3) performing a final RASS, 4) sampling for VOC remediation, and 5) conducting FSS. These will be discussed in later sections.

The average depth of remedial excavation in LSA 10-11 relative to the original grade was 1.33 ft bgs to remove vegetation (grass) and near surface overburden soil to allow visual inspection and radiological measurements to ensure all areas identified during site characterization were adequately remediated (see Figure 3-1). Portions of this SU were excavated to a depth beyond 1.33 feet bgs (up to approximately 6 ft bgs) which was primarily due to benching activities in adjacent SU excavations. It was not necessary to remove vegetation or near surface overburden

in the SU area which was outside of the site security fence. The estimated *in situ* volume of excavated waste materials from LSA 10-11 was 240 cubic yards.

Figure 3-1
LSA 10-11 Depth of Excavation Map (Depths in Feet)*



*Depth of Excavation Map presented in colored bands of feet. Maximum depth is 6 feet.

3.3.1.2 Remedial Actions LSA 11-01

No remedial actions were necessary for LSA 11-01.

3.3.2 In Process Remedial Action Support Surveys

LSA 11-01 was classified as a MARSSIM Class 2 SU with no remediation necessary. As such, in process RASS was not required in LSA 11-01.

During excavation and remediation of the adjacent Burial Pit Area SUs that affected the small area of LSA 10-11, RASS was conducted in accordance with procedure HDP-PR-HP-601, *Remedial Action Support Surveys*. For LSA 10-11 the radiological information obtained from the surveys served the purpose of determining areas of soil with residual contamination that were removed for waste disposal. It is noteworthy that the minimal amount of soil (a small portion of the 240 cubic yards) removed from LSA 10-11 would likely have successfully passed FSS if it

remained in place within the SU. Removal of this soil followed the application of the ALARA (As Low As Reasonably Achievable) philosophy.

3.3.3 Nuclear Criticality Safety (NCS) Borings

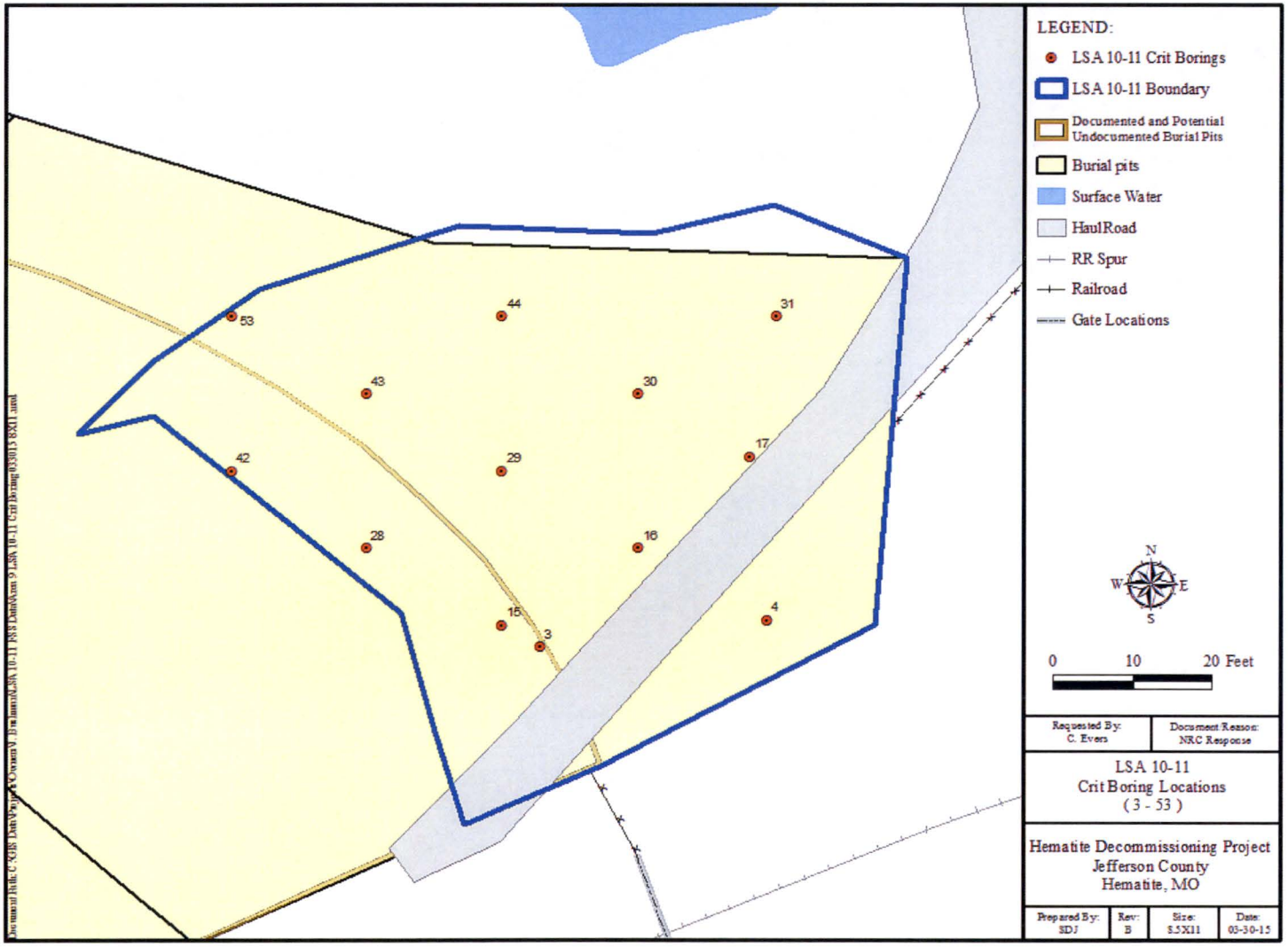
During remediation activities in LSA 10-11, in addition to the visual inspection and radiological measurements to determine when remediation was complete, and also after radiological measurements indicated that NCS controls could be removed from the small portion of the SU under NCS controls, a series of borings were performed within the entire SU.

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 excavated surface. The NSA-TR-09-15 Administrative CSC 23 required that these borings (see Figure 3-2) would be performed to 3 feet (ft) below the deepest identified buried waste item in an excavation (of which there was none) or 7 ft below ground surface (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 (of which there was none), a grid with maximum spacing of 20 ft between boreholes was conducted within the SU. 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 10-11, along with the results of the visual inspection, were then reviewed by the NCS Specialist and the SU was released from NCS controls. The visual inspection of the cores provided evidence that no materials indicative of burial pit waste were encountered below the excavated surface within LSA 10-11.

As LSA 11-01 was never placed under NCS controls, and was never suspected to contain buried materials, NCS core borings were not required to be performed within LSA 11-01.

Figure 3-2
NCS Core Bore Locations in LSA 10-11



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.

Three groundwater monitoring wells (all hybrid design) were installed within the boundary limits of LSA 10-11 and LSA 11-01. Hybrid groundwater monitoring well NB-80 is currently in service and is located within LSA 11-01. Hybrid groundwater monitoring wells NB-61 and WS-29 were located on the westerly boundary of LSA 10-11. Well NB-61 was abandoned prior to 2011, and well WS-29 was abandoned in February 2012 in accordance with State of Missouri requirements.

Hybrid monitoring wells feature wells screens in both the upper silty-clay soil layer and the lower sand/gravel layer. They are of particular concern within SUs due to their design in which the well screen could potentially facilitate the transport of contaminated material from the overburden layer to the Deep stratum and sand/gravel aquifer. As such, HDP has a license commitment associated with the DP to perform soil sampling in the vicinity of hybrid monitoring wells, as described in Section 7.0 of Attachment 1 to Westinghouse letter HEM-11-56 (Reference 6.6) which states:

"When hybrid wells are abandoned they will be over drilled using hollow stem augers of sufficient outside diameter to remove approximately two inches of surrounding soil, the well riser, well screen, and screened filter pack. The auger will continue until reaching refusal, which indicates bedrock. The soil cuttings that are removed during the boring process will be surveyed for indications of elevated radioactivity as a qualitative measure and sampled for laboratory analysis. Within each 5 foot interval, sample(s) of soil indicating elevated concentrations will be collected for laboratory analysis. In the event that an elevated count is not observed, one composite sample of the cuttings collected within each 5 foot interval will be collected for laboratory analysis."

Site records indicate that WS-29 was abandoned and sampled in February 2012, in accordance with the requirements as specified above. The maximum SOF result from the six (6) cuttings samples collected from WS-29 during abandonment was 0.23 of the Uniform $DCGL_w$. As NB-61 was abandoned prior to 2011, no abandonment cuttings samples were collected.

Section 7.0 of Attachment 1 to HEM-11-56 also states:

"When completing remediation actions in the area of a hybrid well screen that extends beyond the depth of soil excavation, any water sample taken over the history of that well will be assessed for results that exceed the MDC+Error for Tc-99 or exceed the Background Threshold Value for total uranium. For such an exceedance, four borings will be made in close proximity (e.g., approximately equidistant within a 2-4 foot radius) to each monitoring well that is not excavated to the bottom of the well."

A review of the radiological water sample data from NB-61 and WS-29 prior to abandonment indicated that there was no historic exceedance of uranium above the uranium background threshold value of 8.6 pCi/l and no Tc-99 results that exceeded the MDC+Error for any water

samples collected from these wells. Therefore, it was not necessary to perform supplemental investigation borings proximal to NB-61 or WS-29.

Appendix I presents the analytical water data for existing hybrid groundwater monitoring well NB-80 and abandoned groundwater monitoring wells NB-61 and WS-29, in addition to the well abandonment soil sample results for groundwater monitoring well WS-29.

3.3.5 Subterranean Piping

Preliminary remediation planning activities indicated that no subterranean process piping should be encountered in LSA 10-11 and LSA 11-01. During the remediation of LSA 10-11 no subterranean process piping was encountered.

As no buried piping existed or remains under the footprint of either LSA 10-11 or LSA 11-01 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 eleven (11) boring locations with depths up to 28 feet bgs were sampled for characterization within LSA 10-11 and LSA 11-01 prior to remediation.

None of the samples collected from the four (4) characterization borings in LSA 10-11 exceeded a SOF of 1 as compared to the Uniform Stratum criteria. Although LSA 10-11 was designated a MARSSIM Class 1 SU, the fact that no characterization samples exceeded cleanup criteria in LSA 10-11 is not unexpected as most of the LSA 10-11 SU land area is located outside the historic Burial Pit Area footprint. Figure 3-3 indicates the radiological characterization boring locations within LSA 10-11.

As would be expected for a MARSSIM Class 2 SU, no sample collected from the seven (7) characterization borings in LSA 11-01 exceeded a SOF of 1 as compared to the Uniform Stratum criteria. Figure 3-4 indicates the radiological characterization boring locations within LSA 11-01.

Figure 3-3
Site Characterization Borings within LSA 10-11

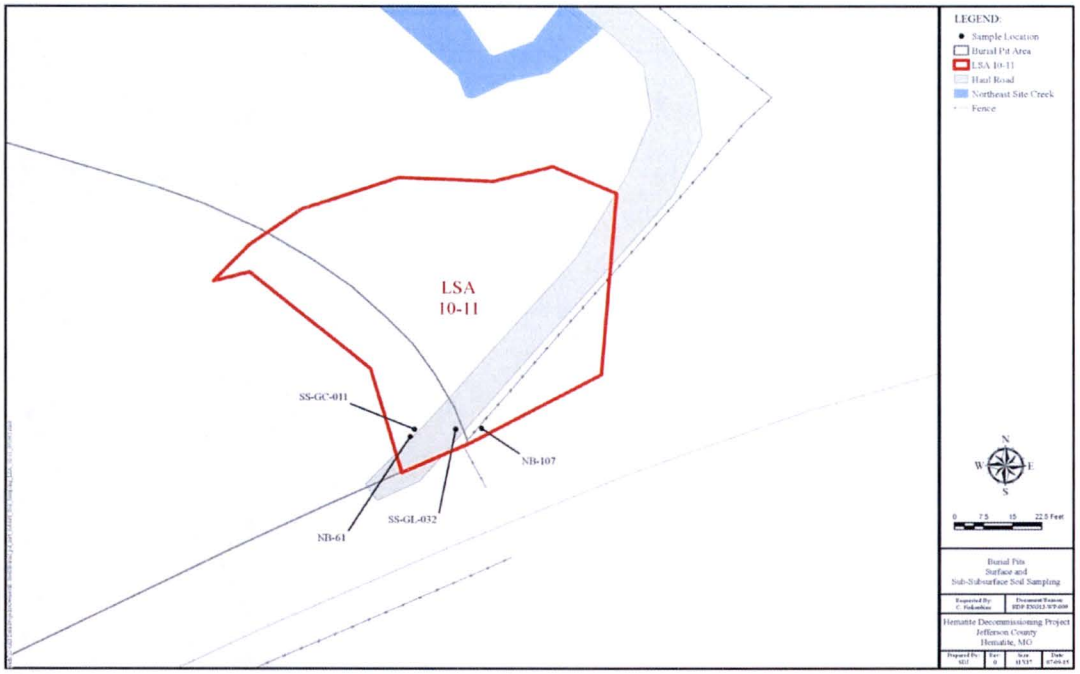
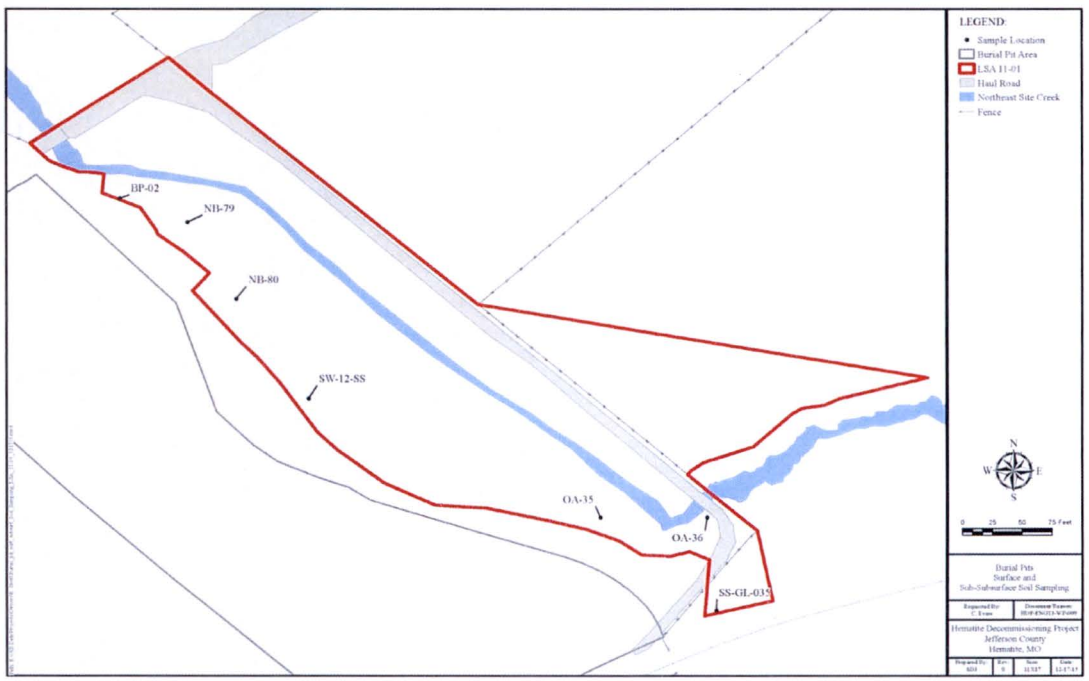


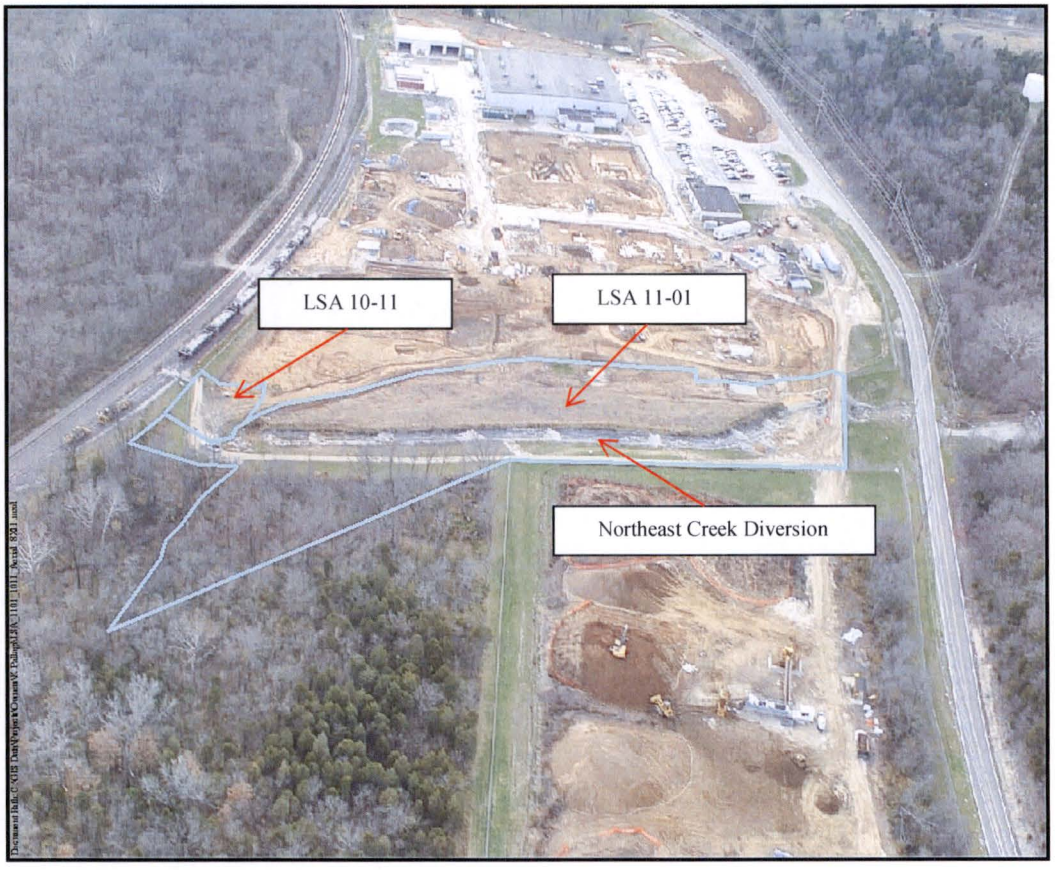
Figure 3-4
Site Characterization Borings within LSA 11-01



3.3.7 Remedial Action Support Survey for FSS Design

The RASS was conducted to guide remediation activities, determine when an area or SU had been adequately prepared for FSS, and provide updated estimates of the parameters to be used for planning the FSS. Upon completion of activities within the SU and prior to implementation of FSS activities, a final RASS was performed prior to the finalization of Isolation and Control (I & C) postings. The I & C postings were completed for both LSA 10-11 and LSA 11-01 on March 30, 2015. Figure 3-5 is a photograph which demonstrates the condition that LSA 10-11 and LSA 11-01 were in when ready for the final RASS. As previously discussed, minimal soil disturbance occurred in LSA 10-11 due to remediation activities in the adjacent Burial Pit Area and no remediation was required to be performed in LSA 11-01.

Figure 3-5
LSA 10-11 and LSA 11-01



The RASS included a GWS, systematic surface sample collection based on an eight (8) -point triangular grid, and biased surface sampling.

For LSA 10-11, twelve sample results (eight systematic, four biased) collected during the final RASS at the time just prior to implementation of isolation and controls were reviewed to validate compliance to the Uniform Stratum DCGLs.

For LSA 11-01, thirteen sample results (eight systematic, five biased) collected during the final RASS at the time just prior to implementation of isolation and controls were reviewed to validate the Class 2 classification and compliance to the Uniform Stratum DCGLs.

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 10-11 and LSA 11-01

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
10-11	0.02	0.10	0.23	0.39	0.08	0.29	2.72	4.79	0.15	0.26	1.17	1.35
11-01	0.02	0.12	0.43	1.13	0.01	0.08	3.09	4.56	0.17	0.25	0.95	1.58
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* (Reference 6.8), on March 30, 2015, LSA 10-11 was isolated and controlled in accordance with Work Package HDP-WP-ENG-803, *Isolation and Control Measures*, (see Figure 3-6) Isolation and control for the south boundary of LSA 11 was established as part of the isolation and control implementation for the Burial Pit Area (see Figure 3-7). Isolation and control measures include silt fence, straw wattle and soil berms between the Class 1 SUs (LSA 10-01 thru LSA 10-11) and adjacent remediation areas to ensure that cross-contamination of the LSA(s) undergoing FSS does 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 LSA 10-11 prior to FSS field activities to prevent inadvertent entry by personnel as is required for Class 1 areas. As a Class 2 area LSA 11-01 was not encompassed with green and white rope, but was administratively controlled by the use of multiple postings labeled "Contact Health Physics Prior to Entry" installed around the perimeter of the SU to prevent inadvertent entry by personnel. LSA 10-11 and LSA 11-01 are partially enclosed within the fenced security perimeter of the HDP Controlled Access Area to prevent access by the general public. An approximately 1800 m^2 section of LSA 11-01 extends eastward into the wooded area outside the site perimeter fence. Approximately 50 m^2 of LSA 10-11 is situated outside the site perimeter fence.

Figure 3-6
Isolation and Control of Area Containing LSA 10-11

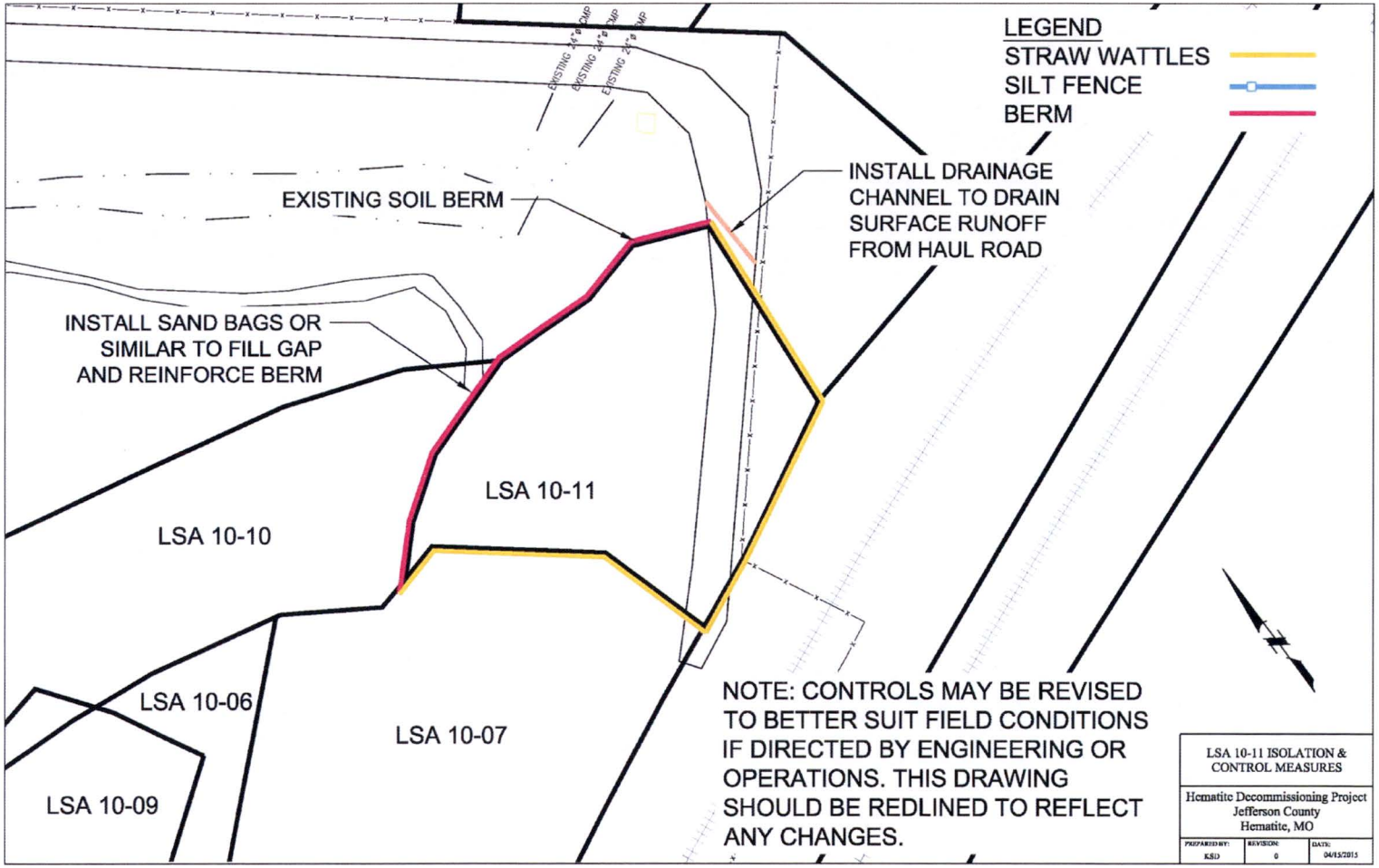
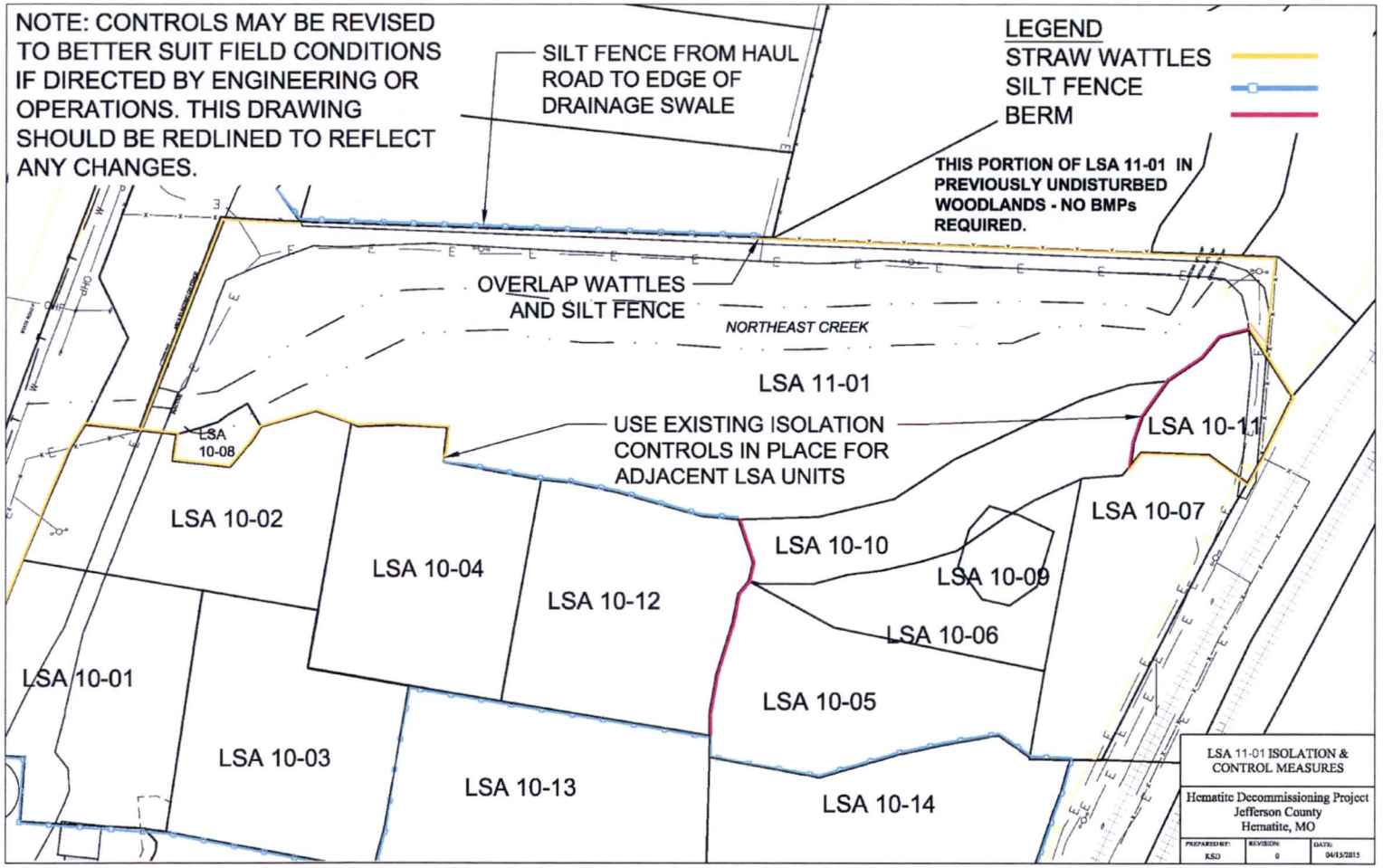


Figure 3-7
Isolation and Control of Area Containing LSA 11-01



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 10-11 and LSA 11-01. 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 start of backfill activities LSA 10-11 and LSA 11-01 have not evidenced 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, LSA 10-11 was backfilled with off-site "borrow" soil from the Horine Road site in Festus, MO. Further details on off-site "borrow" soil can be found in FSSFR Volume 2, Chapter 8 {ML16285A375}. As only off-site backfill material was used in LSA 10-11, no dose will be added to LSA 10-01 for backfill material.

Although LSA 11-01 did not require remedial excavation, a small amount of backfill material was added along the westerly banks of Northeast Site Creek to ensure that the final grade provided positive drainage within the area. Combined Reuse Stockpile 5-6 {ML16285A372} was used for this purpose and as such, 7.75 mrem/year will be added to the total dose calculation for LSA 11-01 to account for the placement of the reuse soil.

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 (milliroentgen equivalent man/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 10-11 and LSA 11-01 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* {ML16027A303}, provides a detailed discussion on the release criteria that is applicable to LSA 10-11 and LSA 11-01. 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 ≤ 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 10-11

This section of the report describes the method for determining the number of samples required for the FSS of LSA 10-11 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 10-11 and the detection sensitivities are also discussed.

5.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 10-11 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 6, *Final Status Survey Plan Development*, March 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 10-11. The review identified no areas were previously found to exceed a Uniform Stratum SOF of 1.0 (discussed in Section 3.3.6). Next the remediation history was reviewed to confirm that the area was 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.

5.1.3 GWS Coverage

As a Class 1 SU, LSA 10-11 was required to undergo a 100% GWS.

5.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 10-11 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 10,000 counts per minute (cpm) within LSA 10-11, 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:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3169\,pCi/g}\right)+\left(\frac{f_{U-235}}{2.0pCi/g}\right)+\left(\frac{f_{U-238}}{26.5pCi/g}\right)\right)}$$

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 6, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 10-11, the average enrichment for the SU was 1.9%.

HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)* documents the calculated MDC_{scan} of 0.75 pCi/g for Th-232 and 1.04 pCi/g for Ra-226 when using a 2"x 2" NaI detector with a 10,000 cpm background.

Table 5-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 10-11

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 10-11	35.5	87.7	1.04	2.8	0.75	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. DCGLw 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 10-11 was established at 4,000 net counts per minute (ncpm).

5.1.7 LSA 10-11 FSS Design Summary

The FSS Plan for LSA 10-11 can be found in Appendix C. Table 5-2 presents an overall FSS design and implementation summary for LSA 10-11.

Table 5-2
FSS Design Summary for LSA 10-11

Gamma Walkover Survey (GWS):		
Scan Coverage	100% accessible excavation floors and walls	
Scan MDC	35.5 pCi/g total Uranium (based on a 10,000 cpm background); 0.75 pCi/g Th-232; 1.04 pCi/g Ra-226*	
Investigation Action Level (IAL)	4,000 net cpm **	
Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	1	These samples will be taken on a systematic grid.
15 cm – 1.5 m (Root)	8	
> 1.5m (Excavation)	8	
Biased Survey/Sampling Locations:		
Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the FSS Supervisor.		
Instrumentation		
Ludlum 2221 with 44-10 (2x2 NaI) detector; with collimation for investigations	Used for GWS and to obtain static count rates at biased measurement locations.	
*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).*		
**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum $DCGL_W$ derived from the technical basis presented in HEM-MEMO-15-021.		

6.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 10-11

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 10-11 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, 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.

FSS technicians performing GWS in LSA 10-11 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), FSS 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, FSS 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 8,000 and 9,000 gross counts per minute (gcpm). Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 12,000 to 13,000 gcpm, FSS 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 10-11.

Table 6-1
Systematic Sampling Summary by Stratum for LSA 10-11

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
10-11	459	1	8	8	1

6.2.2 Systematic Sampling LSA 10-11

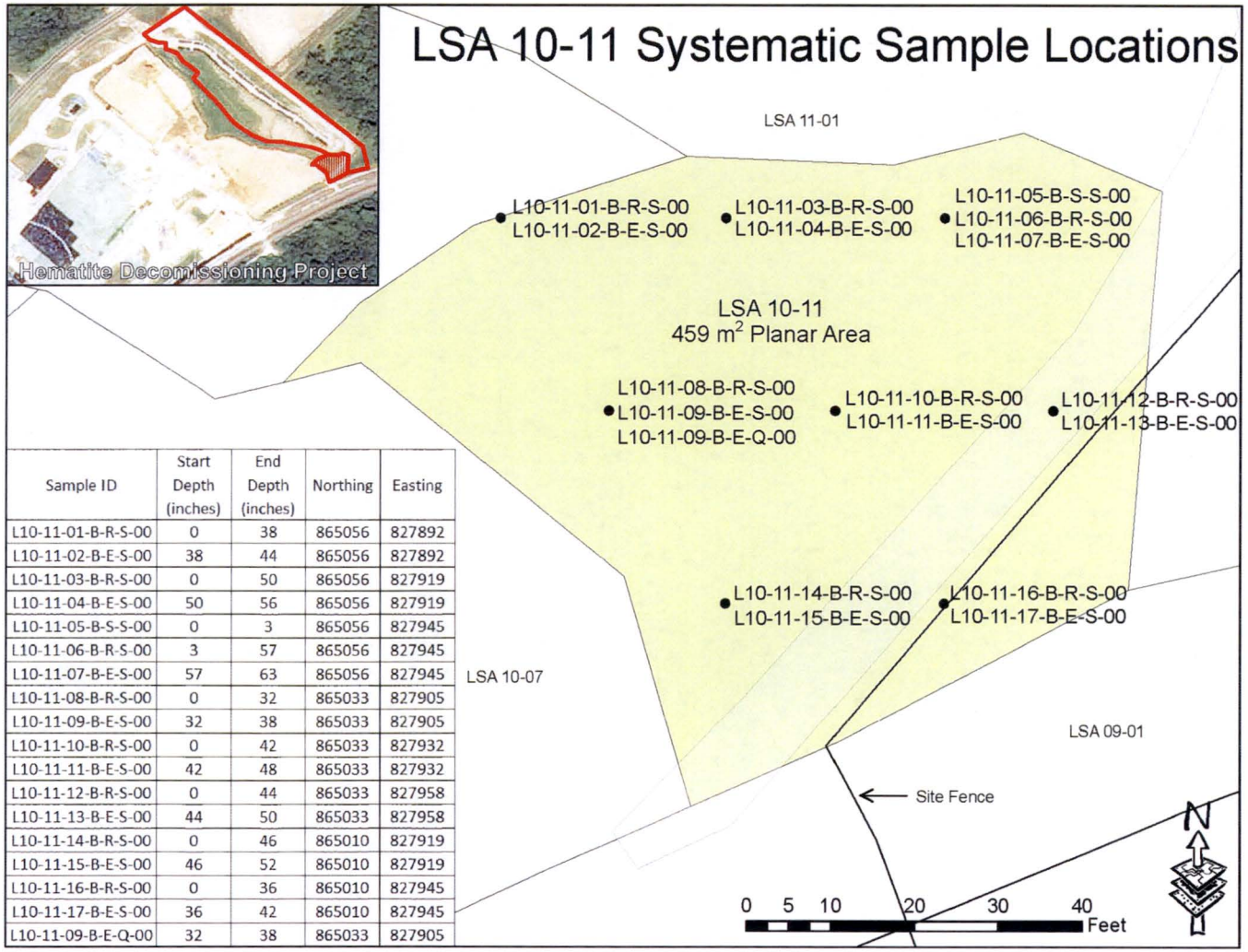
Within LSA 10-11, there was one systematic locations in which portions of the surface stratum [0 – 15 centimeters (cm)] remained in the SU after remediation. Portions of the root stratum (15 cm – 150 cm) remained at all eight (8) of the eight systematic locations. At this location the remaining root 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 459 m^2 for LSA 10-11 and an eight - point systematic triangular grid, the point-to-point distance within each row was 8.1 m with spacing of 7 m between each of the parallel grid rows within the SU.

While there were eight systematic locations on the LSA 10-11 sampling grid, a total of thirteen (13) samples were collected at these locations, including:

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

Figure 6-1 presents the map of the eight systematic sample locations which were sampled within LSA 10-11. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 6-1
LSA 10-11 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L10-11-01-B-R-S-00	0	38	865056	827892
L10-11-02-B-E-S-00	38	44	865056	827892
L10-11-03-B-R-S-00	0	50	865056	827919
L10-11-04-B-E-S-00	50	56	865056	827919
L10-11-05-B-S-S-00	0	3	865056	827945
L10-11-06-B-R-S-00	3	57	865056	827945
L10-11-07-B-E-S-00	57	63	865056	827945
L10-11-08-B-R-S-00	0	32	865033	827905
L10-11-09-B-E-S-00	32	38	865033	827905
L10-11-10-B-R-S-00	0	42	865033	827932
L10-11-11-B-E-S-00	42	48	865033	827932
L10-11-12-B-R-S-00	0	44	865033	827958
L10-11-13-B-E-S-00	44	50	865033	827958
L10-11-14-B-R-S-00	0	46	865010	827919
L10-11-15-B-E-S-00	46	52	865010	827919
L10-11-16-B-R-S-00	0	36	865010	827945
L10-11-17-B-E-S-00	36	42	865010	827945
L10-11-09-B-E-Q-00	32	38	865033	827905

Table 6-2 below presents a tabular listing of all FSS samples collected within LSA 10-11 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 6-2
FSS Sample Locations and Coordinates for LSA 10-11

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

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

Survey Unit: 11 **Description:** South Eastern Survey Unit in "Area 9"

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
L10-11-01-B-R-S-00	Uniform	S	423.6	420.5	865056.0	827892.0	Root 38-inch composite
L10-11-02-B-E-S-00	Uniform	S	420.5	420.0	865056.0	827892.0	Excavation 6-inch grab
L10-11-03-B-R-S-00	Uniform	S	423.7	419.6	865056.0	827918.6	Root 50-inch composite
L10-11-04-B-E-S-00	Uniform	S	419.6	419.1	865056.0	827918.6	Excavation 6-inch grab
L10-11-05-B-S-S-00	Uniform	S	423.4	423.1	865056.0	827945.1	Surface 6-inch grab
L10-11-06-B-R-S-00	Uniform	S	423.1	418.6	865056.0	827945.1	Root 53-inch composite
L10-11-07-B-E-S-00	Uniform	S	418.6	418.1	865056.0	827945.1	Excavation 6-inch grab
L10-11-08-B-R-S-00	Uniform	S	424.9	422.2	865033.0	827905.3	Root 32-inch composite
L10-11-09-B-E-S-00	Uniform	S	422.2	421.7	865033.0	827905.3	Excavation 6-inch grab
L10-11-10-B-R-S-00	Uniform	S	424.8	421.3	865033.0	827931.9	Root 42-inch composite
L10-11-11-B-E-S-00	Uniform	S	421.3	420.8	865033.0	827931.9	Excavation 6-inch grab
L10-11-12-B-R-S-00	Uniform	S	424.3	420.6	865033.0	827958.4	Root 44-inch composite
L10-11-13-B-E-S-00	Uniform	S	420.6	420.2	865033.0	827958.4	Excavation 6-inch grab
L10-11-14-B-R-S-00	Uniform	S	427.7	423.9	865010.1	827918.6	Root 46-inch composite
L10-11-15-B-E-S-00	Uniform	S	423.9	423.4	865010.1	827918.6	Excavation 6-inch grab
L10-11-16-B-R-S-00	Uniform	S	426.4	423.4	865010.1	827945.1	Root 36-inch composite
L10-11-17-B-E-S-00	Uniform	S	423.4	422.9	865010.1	827945.1	Excavation 6-inch grab
L10-11-18-B-R-B-00	Uniform	B	428.9	426.9	865011.0	827913.0	Biased 6-inch grab
L10-11-19-B-R-B-00	Uniform	B	427.0	425.2	865029.0	827919.0	Sidewall 6-inch grab
L10-11-09-B-E-Q-00	Uniform	Q	422.2	421.7	865033.0	827905.3	Excavation 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 10-11 one (1) biased sample locations 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 survey unit of 10,205 gcpm. Biased sample L10-11-18-B-R-B-00 was collected at this location.

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 FSSFR 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).

For LSA 10-11, the difference between the planar (459 m^2) and three-dimensional surface area (550 m^2) was 91 m^2. Using the assumption that the 91 m^2 differential is entirely attributable to interior sidewalls and given the area bounded by each systematic sample in LSA 10-11 was 57.4 m^2 (459 m^2/ 8), the number of required supplemental sidewall samples was calculated was two (2), (i.e., 91 / 57.4 $\approx$ 1.59). However, only one sidewall sample was collected as it was visually apparent that the actual sidewall area within the SU was significantly smaller then the assumed sidewall area, with the majority of the surface area featuring sloping terrain less than 45° towards the former Northeast Site Creek location in LSA 11-01. The LSA 10-11 sidewall sample result (L10-11-19-B-R-B-00) is discussed in Section 7.2.6. The sample was collected from a location selected by the HP Technician at random, and was not based on gamma survey readings (not biased).

6.5 Quality Control Soil Sampling

One QC field duplicate sample point was randomly selected and collected at systematic location L10-11-09 for LSA 10-11.

7.0 FINAL STATUS SURVEY RESULTS LSA 10-11

7.1 Gamma Walkover Survey

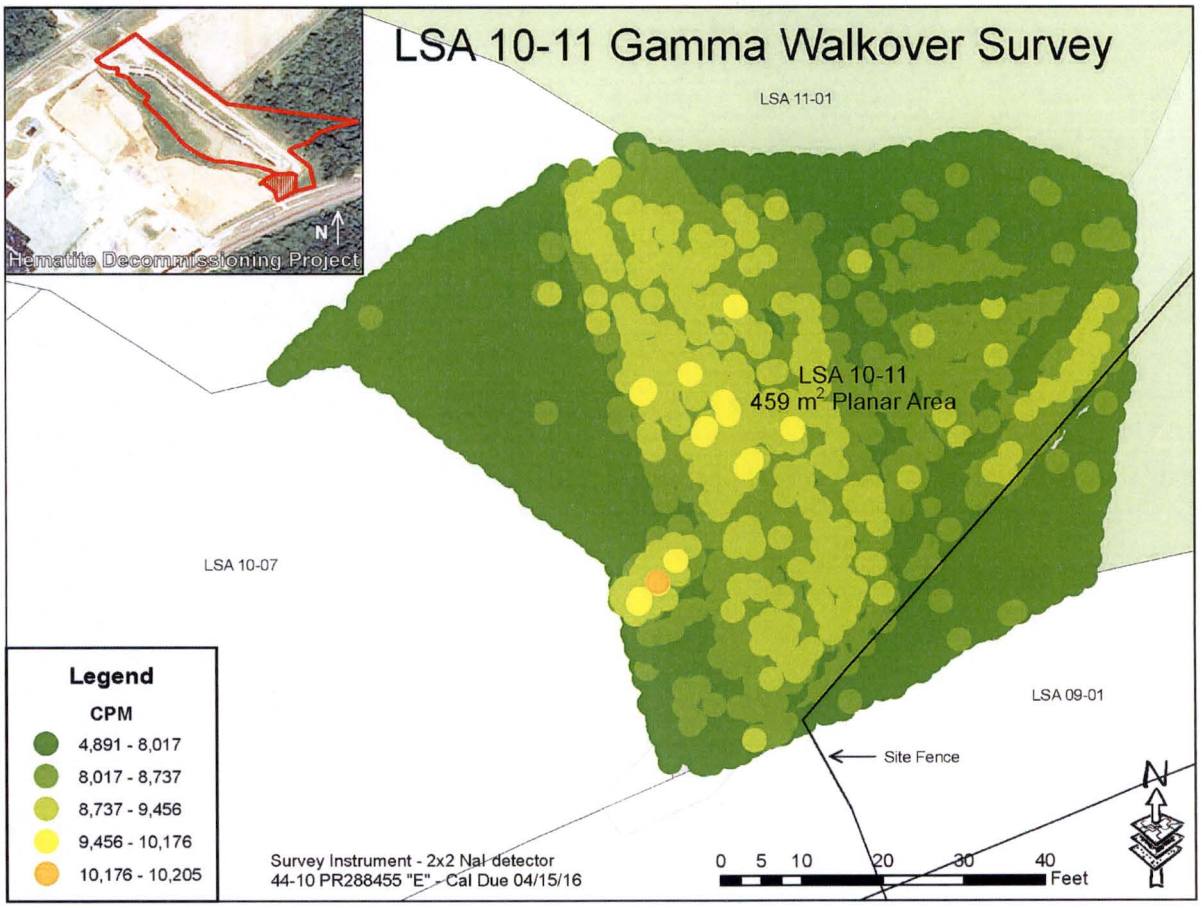
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are 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 10-11 on April 21, 2015.

7.1.1 GWS Results for LSA 10-11

For LSA 10-11, GWS count rates ranged between 4,891 gcpm and 10,205 gcpm, with a mean count rate of 7,297 gcpm. The median count rate was 7,290 gcpm and the standard deviation was 720 cpm. Figure 7-1 below presents a map of the complete GWS data set.

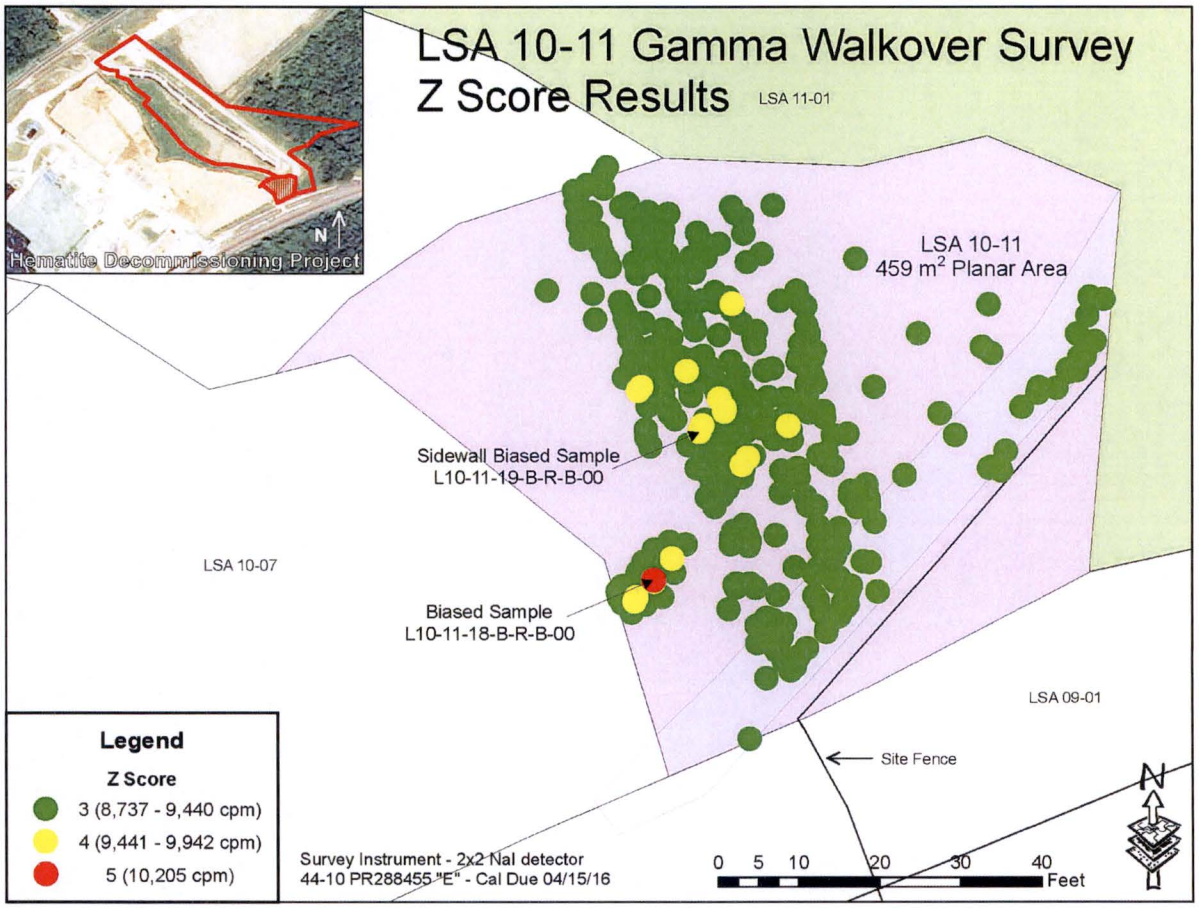
Figure 7-1
Colorimetric GWS Plot for LSA 10-11



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, L10-11-18, was selected for biased sample collection. This biased location represented the maximum GWS measurement encountered within the survey unit, 10,205 gcpm. The gamma measurement at this biased location did not exceed the IAL (~12,000 gcpm) based on the local background readings, but did exceed a Z-score of three (3). No additional biased locations were selected for sampling.

Figure 7-2 below presents a map of the +3 Z-score GWS measurements within LSA 10-11, including the selected biased sampling location (ID: L10-11-18-B-R-B-00). For completeness, the location of the one supplemental sidewall samples (not driven by elevated GWS measurements) is also shown in Figure 7-2.

Figure 7-2
Colorimetric GWS Plot for LSA 10-11 (Measurements > Z-score of 3)



A total of 16,922 individual GWS measurements were collected in LSA 10-11.

Since all GWS data collected in LSA 10-11 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 scan MDC of approximately 40.9 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 10-11, 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:

Scan $MDC_{Total\ Uranium} = 1 / \left(\left(\frac{0.7928}{3659} \right) + \left(\frac{0.0438}{2.32} \right) + \left(\frac{0.1634}{30.6} \right) \right) = 40.9 \frac{pCi}{g}$

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 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 FSS 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 10-11

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. 100% of accessible areas underwent GWS, very small areas along the site fence that were surveyed were not able to be accurately recorded by the GPS handset due to limitations in the GPS technology. 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 99.92% 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 10-11

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 10-11	692,503	588	0.08	99.92	1

7.2 Soil Sample Results LSA 10-11

Appendix A presents the analytical results and associated statistics for all FSS surface samples collected within LSA 10-11.

7.2.1 Surface Soil Sample Results LSA 10-11

There was one sample collected within the surface stratum (0 – 15 cm) of LSA 10-11. There were a total of ten (10) soil samples collected within the topmost soil layer of the excavation surface including eight systematic samples (one surface and seven root composite samples) and two biased samples. The maximum SOF result for the "topmost" samples was 0.34 corresponding to sample L10-11-14-B-R-S-00, with the biased samples (L10-11-18-B-R-B-00 and L10-11-19-B-R-B-00) resulting in a 0.18 and 0.17 SOF, respectively.

7.2.2 Subsurface Soil Sample Results LSA 10-11

There was one systematic location within LSA 10-11 where root stratum composite sampling below a 6-inch (0.15 m) surface sample was performed. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At all eight root stratum composite sampling location, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected. The eight excavation stratum samples where there was overlying root stratum remaining, the root sample below a systematic surface sample, as well as the QC field duplicate sample, were all considered "subsurface" samples and therefore did not factor into the WRS test evaluation. The maximum SOF result of the subsurface samples collected in LSA 10-11 was 0.36. This sample (L10-11-07) was the excavation stratum sample collected directly underneath the root stratum sample L10-11-06 and surface sample L10-11-05.

7.2.3 WRS Test Evaluation LSA 10-11

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 10-11 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 10-11. 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 17 systematically collected samples in LSA 10-11 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, (1072) was greater than the critical value (879) 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 10-11

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 10-11, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.15.

Table 7-2
LSA 10-11 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	0.11	0.11	0.15	1.71	0.09	1.03	**0.15**
Minimum	0.00 (<BKG)	0.05	0.00 (<BKG)	0.10	0.00	0.61	0.01
Maximum	0.45	0.47	0.33	2.99	0.16	1.41	0.36

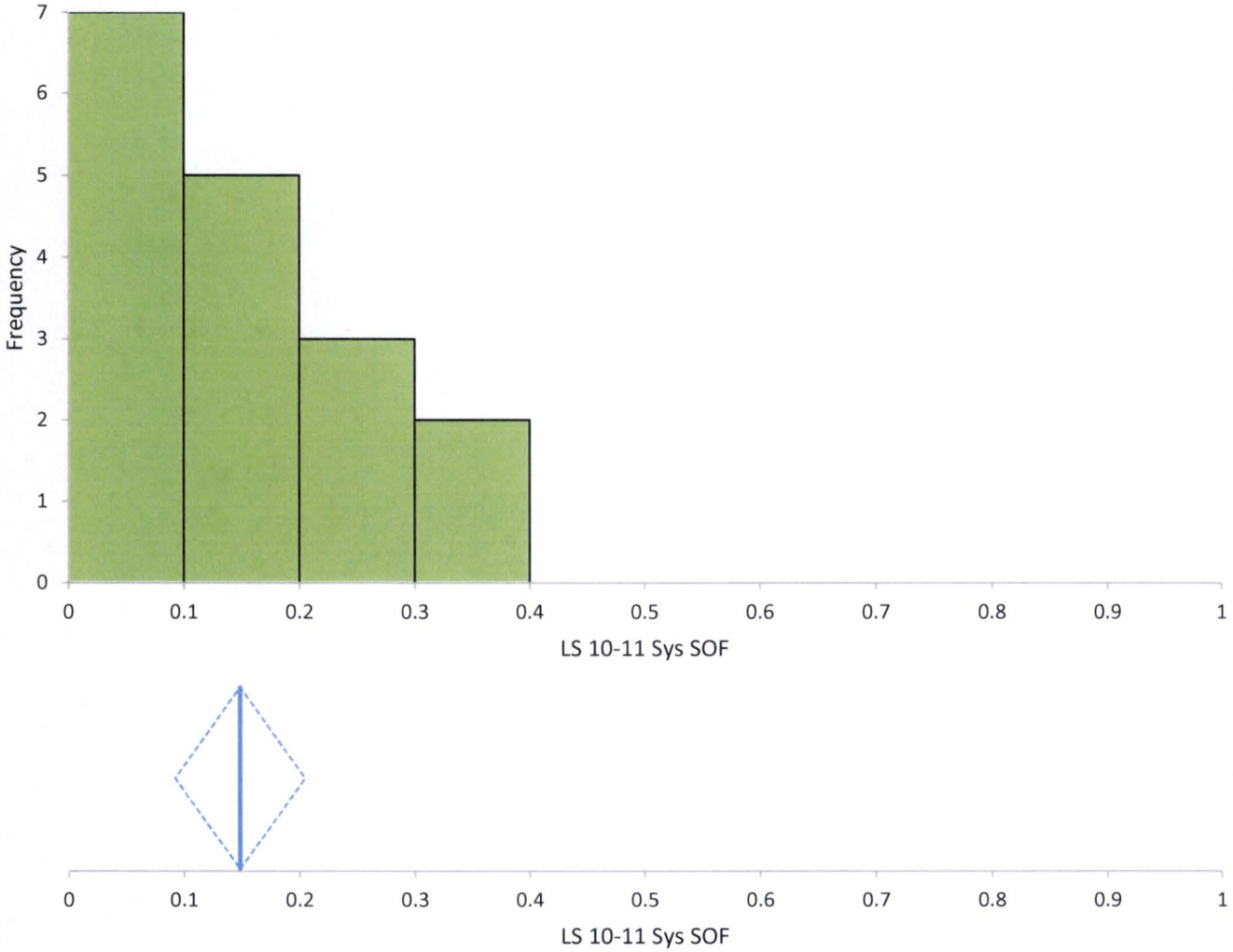
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide 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 10-11. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 10-11. The middle graph presents the mean SOF (0.15 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 0.09 to 0.20. The 95.1% confidence interval based on the median (0.12) of the sample results is 0.08 to 0.22. The bottom two charts present the various statistical metrics of the LSA 10-11 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 10-11 data associated with the systematically collected measurement locations.

Figure 7-3
Graphic Statistical Summary for LSA 10-11 (SOF parameter)



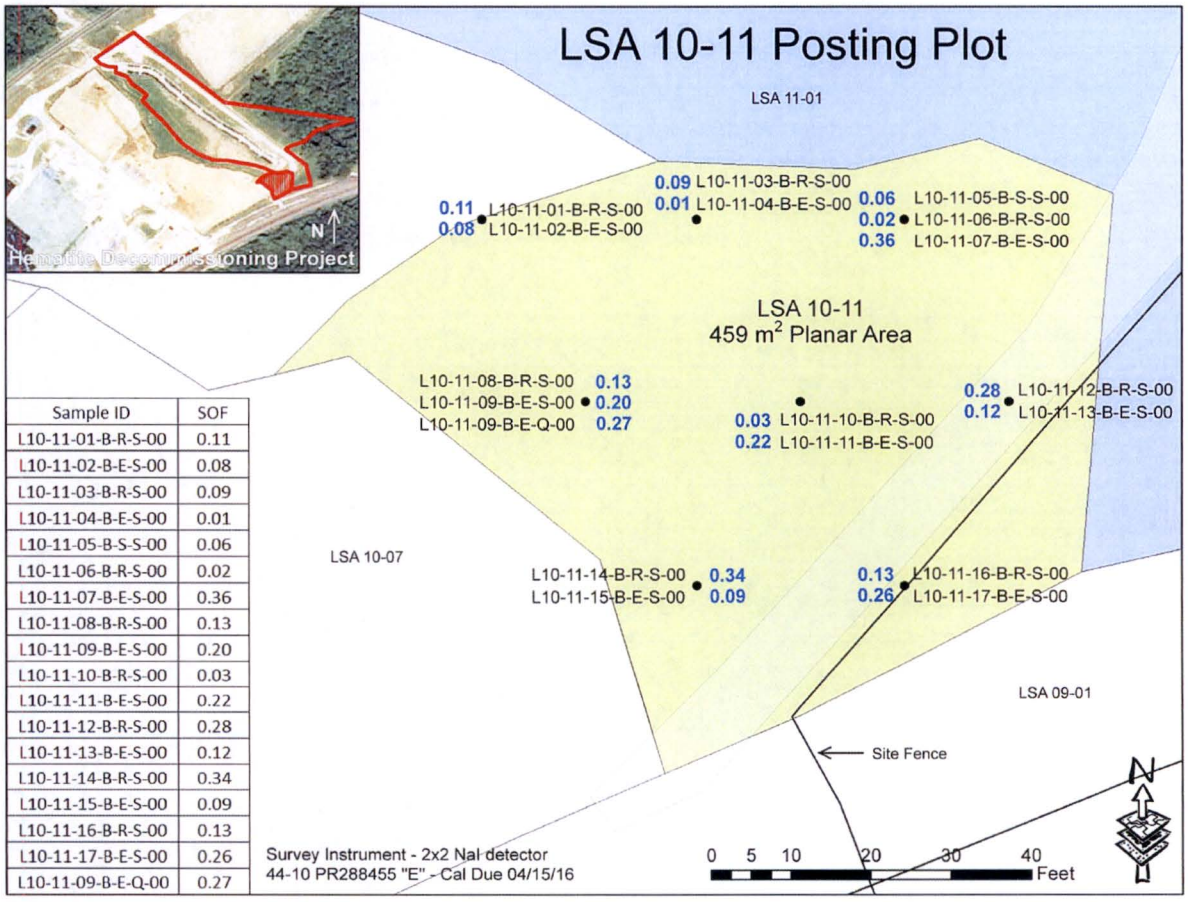
	N
	17

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LS 10-11 Sys SOF	0.15	0.09	to 0.20	0.027	0.11	0.01	0.7	-0.59

	Minimum	1st quartile	Median	95.1% CI		3rd quartile	Maximum	IQR
LS 10-11 Sys SOF	0.01	0.07	0.12	0.08	to 0.22	0.23	0.36	0.16

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 10-11 is presented below in Figure 7-4. Figure 7-4 shows no unusual patterns in the data.

Figure 7-4
Posting Plot for LSA 10-11 Systematic Measurement Locations



Sample ID	SOF
L10-11-01-B-R-S-00	0.11
L10-11-02-B-E-S-00	0.08
L10-11-03-B-R-S-00	0.09
L10-11-04-B-E-S-00	0.01
L10-11-05-B-S-S-00	0.06
L10-11-06-B-R-S-00	0.02
L10-11-07-B-E-S-00	0.36
L10-11-08-B-R-S-00	0.13
L10-11-09-B-E-S-00	0.20
L10-11-10-B-R-S-00	0.03
L10-11-11-B-E-S-00	0.22
L10-11-12-B-R-S-00	0.28
L10-11-13-B-E-S-00	0.12
L10-11-14-B-R-S-00	0.34
L10-11-15-B-E-S-00	0.09
L10-11-16-B-R-S-00	0.13
L10-11-17-B-E-S-00	0.26
L10-11-09-B-E-Q-00	0.27

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 Test America Analytical Laboratory soil sample reports.

Table 7-3
Final Status Survey Analytical Data: LSA 10-11

Sample ID	Sample 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
L10-11-01-B-R-S-00	1.79	S	1.080	0.154	0.068	NA	0.010	0.010	0.146	0.146	0.028	0.236	U	1.180	0.162	0.091	NA	0.180	0.180	0.980	NA	NA	NA	0.049	0.123	0.223	U	0.915	0.317	0.791	NA	0.9	0.11
L10-11-02-B-E-S-00	4.92	S	1.120	0.183	0.085	NA	0.050	0.050	0.137	0.137	0.033	0.231	U	1.050	0.189	0.148	NA	0.050	0.050	2.220	NA	NA	NA	0.121	0.155	0.303	U	0.794	0.347	0.984	U	2.4	0.08
L10-11-03-B-R-S-00	0.77	S	1.110	0.157	0.074	NA	0.040	0.040	0.146	0.146	0.050	0.242	U	1.090	0.159	0.107	NA	0.090	0.090	2.117	NA	NA	NA	0.111	0.128	0.233	U	1.280	0.625	0.773	NA	1.4	0.09
L10-11-04-B-E-S-00	4.92	S	0.896	0.123	0.047	NA	-0.174	0.000	0.045	0.045	0.044	0.242	U	0.866	0.137	0.092	NA	-0.134	0.000	1.280	NA	NA	NA	0.069	0.117	0.197	U	0.608	0.237	0.671	U	1.8	0.01
L10-11-05-B-S-S-00	0.21	S	1.030	0.175	0.090	NA	-0.040	0.000	0.468	0.468	0.067	0.239	NA	1.060	0.192	0.183	NA	0.060	0.060	1.240	NA	NA	NA	0.065	0.163	0.293	U	0.722	0.360	0.921	U	1.4	0.06
L10-11-06-B-R-S-00	0.49	S	1.040	0.142	0.073	NA	-0.030	0.000	0.061	0.061	0.041	0.241	U	0.945	0.144	0.085	NA	-0.055	0.000	1.408	NA	NA	NA	0.071	0.099	0.204	U	1.200	0.514	0.790	NA	1.0	0.02
L10-11-07-B-E-S-00	4.92	S	1.520	0.192	0.057	NA	0.450	0.450	0.100	0.100	0.037	0.239	U	1.200	0.175	0.112	NA	0.200	0.200	1.800	NA	NA	NA	0.094	0.158	0.262	U	1.100	0.548	0.860	NA	1.4	0.36
L10-11-08-B-R-S-00	2.27	S	1.030	0.146	0.063	NA	-0.040	0.000	0.124	0.124	0.109	0.251	U	1.190	0.171	0.089	NA	0.190	0.190	2.986	NA	NA	NA	0.160	0.133	0.178	U	1.380	0.545	0.727	NA	1.8	0.13
L10-11-09-B-E-S-00	4.92	S	1.150	0.169	0.059	NA	0.080	0.080	0.087	0.087	0.058	0.243	U	1.270	0.205	0.159	NA	0.270	0.270	1.686	NA	NA	NA	0.089	0.153	0.263	U	0.916	0.375	0.993	U	1.5	0.20
L10-11-10-B-R-S-00	1.44	S	1.100	0.147	0.056	NA	0.030	0.030	0.052	0.052	0.013	0.241	U	0.922	0.158	0.100	NA	-0.078	0.000	1.317	NA	NA	NA	0.067	0.135	0.217	U	1.010	0.492	0.769	NA	1.1	0.03
L10-11-11-B-E-S-00	4.92	S	1.360	0.203	0.085	NA	0.290	0.290	0.094	0.094	0.019	0.245	U	1.080	0.195	0.158	NA	0.080	0.080	2.528	NA	NA	NA	0.138	0.173	0.291	U	0.838	0.360	1.020	U	2.5	0.22
L10-11-12-B-R-S-00	1.24	S	1.290	0.181	0.085	NA	0.220	0.220	0.046	0.046	0.065	0.256	U	1.290	0.190	0.106	NA	0.290	0.290	1.839	NA	NA	NA	0.096	0.153	0.254	U	1.190	0.563	0.879	NA	1.3	0.28
L10-11-13-B-E-S-00	4.92	S	1.110	0.148	0.055	NA	0.040	0.040	0.065	0.065	0.010	0.248	U	1.150	0.174	0.096	NA	0.150	0.150	2.422	NA	NA	NA	0.127	0.097	0.148	U	1.410	0.505	0.753	NA	1.4	0.12
L10-11-14-B-R-S-00	1.08	S	1.370	0.180	0.069	NA	0.300	0.300	0.083	0.083	0.061	0.249	U	1.330	0.210	0.135	NA	0.330	0.330	1.592	NA	NA	NA	0.080	0.162	0.260	U	1.270	0.571	0.887	NA	1.0	0.34
L10-11-15-B-E-S-00	4.92	S	1.110	0.152	0.057	NA	0.040	0.040	0.074	0.074	0.083	0.246	U	1.080	0.161	0.109	NA	0.080	0.080	2.510	NA	NA	NA	0.135	0.126	0.180	U	1.110	0.613	0.828	NA	1.9	0.09
L10-11-16-B-R-S-00	1.89	S	1.080	0.170	0.112	NA	0.010	0.010	0.112	0.112	0.062	0.252	U	1.230	0.216	0.180	NA	0.230	0.230	0.104	NA	NA	NA	0.002	0.040	0.319	U	0.891	0.344	0.952	U	0.1	0.13
L10-11-17-B-E-S-00	4.92	S	1.290	0.170	0.065	NA	0.220	0.220	0.092	0.092	0.053	0.243	U	1.260	0.194	0.130	NA	0.260	0.260	1.048	NA	NA	NA	0.053	0.125	0.252	U	0.888	0.320	0.894	U	1.0	0.26
L10-11-18-B-R-B-00	2.08	B	1.130	0.156	0.065	NA	0.060	0.060	0.129	0.129	0.055	0.263	U	1.250	0.215	0.112	NA	0.250	0.250	1.269	NA	NA	NA	0.062	0.142	0.227	U	1.250	0.515	0.788	NA	0.8	0.18
L10-11-19-B-R-B-00	1.82	B	1.230	0.180	0.069	NA	0.160	0.160	0.155	0.155	0.093	0.268	U	1.100	0.200	0.173	NA	0.100	0.100	3.634	NA	NA	NA	0.199	0.147	0.178	NA	1.140	0.602	0.945	NA	2.7	0.17
L10-11-09-B-E-Q-00	4.92	Q	1.300	0.173	0.072	NA	0.230	0.230	0.078	0.078	0.042	0.251	U	1.250	0.186	0.112	NA	0.250	0.250	1.964	NA	NA	NA	0.103	0.148	0.251	U	1.170	0.529	0.823	NA	1.4	0.27
Systematic Minimum			0.000						0.045					0.000						0.104				0.002				0.608				**1.4**	0.01
Systematic Maximum			0.450						0.468					0.330						2.986				0.160				1.410				Average Enrichment (%)	0.36
Systematic Mean			0.105						0.114					0.145						1.710				0.090				1.031					0.15
Systematic Median			0.040						0.092					0.150						1.686				0.089				1.010					0.12
Systematic Standard Deviation			0.137						0.097					0.109						0.712				0.039				0.235					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 10-11

The biased sample collected from LSA 10-11 had a Uniform SOF result of 0.18, this sample was collected from the location of the highest identified GWS measurement.

7.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 10-11

One sample was collected from the sidewalls of LSA 10-11. Table 7-4 provides the data summary for the samples.

Table 7-4
LSA 10-11 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)
L10-11-19-B-R-B-00	0.16	0.16	0.10	3.63	0.20	1.14	0.17

7.2.7 Quality Control Soil Sample Result LSA 10-11

One QC field duplicate sample point was randomly selected for LSA 10-11 which was collected at systematic locations L10-11-09.

For the 19 samples (i.e., 17 systematic + 1 biased + 1 sidewall) collected within LSA 10-11, one field duplicate sample was collected. This frequency equates to 5.26 %, (i.e. 1/19). 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 10-11

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

Survey Unit No.:	LSA 10-11				Survey Unit Description:		Burial Pits Open Land Area South Eastern Survey Unit in "Area 9"					
			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)
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	Ra-226	1.15	0.0587	1.3	0.0722	1.225	1.9	0.15	0.269	0.403	N
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	Tc-99	0.0871	0.243	0.0782	0.251	0.083	25.1	NA	3.552	5.321	NA
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	Th-232	1.27	0.159	1.25	0.112	1.260	2.0	0.020	0.283	0.424	N
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	U-234[1]	1.686	NA	1.964	NA	1.825	195.4	0.278	27.649	41.425	N
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	U-235	0.089	0.263	0.103	0.251	0.096	51.6	NA	7.301	10.939	NA
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	U-238	0.916	0.993	1.17	0.823	1.043	168.8	NA	23.885	35.786	NA

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: Brian Antill

Date: 12/15/15 Date: 12/15/15

Quality Record

7.3 Tc-99 Hot Spot Assessment LSA 10-11

Within LSA 10-11 a total of 37 samples were collected and analyzed for Tc-99 during the site characterization, RASS, and FSS sample collection efforts. Within LSA 10-11, the maximum characterization sample Tc-99 concentration was 0.46 pCi/g – which is consistent with the maximum Tc-99 sample result collected during FSS of 0.47 pCi/g, and is well below the Tc-99 Uniform Stratum $DCGL_w$ of 25.1 pCi/g.

8.0 ALARA EVALUATION LSA 10-11

All samples collected within LSA 10-11 were evaluated against the Uniform Stratum $DCGL_w$. For LSA 10-11 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.15 for LSA 10-11. The average SOF equates to residual activity contributions from the survey unit area of 3.75 mrem/year for LSA 10-11. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 {ML16287A528}, 3 and 4, 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 10-11. As only offsite borrow soil was used as backfill, no dose will be added to LSA 10-11 for backfill soil. Adding all of the dose contributions together, the total estimated dose for LSA 10-11 is 7.75 mrem/year.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the remediation of LSA 10-11 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 10-11.

9.0 FSS PLAN DEVIATIONS LSA 10-11

9.1 Remedial Actions During FSS

There were no remedial actions after FSS in LSA 10-11.

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 10-11. Subsequent to field FSS activities within the SU, the calculation of Scan MDCs varied in approach based on the guidance given in Technical Basis Document (HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys,* Westinghouse April, 2015), as well as later discussions between HDP and the NRC via teleconference (August 2015) on the technical assumptions and inputs related to Scan MDC estimates. The Scan MDCs presented in the FSS Plan shown in Table 5-1 assumed a surveyor efficiency of 1.0 (the surveyor efficiency prescribed by the DP when data logging is utilized). The current version of HDP-TBD-FSS-002 uses a surveyor efficiency of 0.75 (the surveyor efficiency agreed upon between HDP and the NRC via teleconference). Although the revised Scan MDC for Total U increased to 40.9 pCi/g, it remained less than the $DCGL_w$ for the SU. The Scan MDCs for Ra-226 and Th-232 increased slightly to 1.21 pCi/g and 0.87 pCi/g, respectively. Using a 10,000 cpm background and a

conservative 4% enrichment for the SU, 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 10-11

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw (Ra-226)	Scan MDC (Th-232)	DCGLw (Th-232)
LSA 10-11	40.9	87.7	1.21	1.9	0.87	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 10-11

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 10-11 (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 10-11 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 10-11, 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 10-11, however the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1072) exceeded the critical value (879), 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 10-11 was 0.34. The maximum SOF result for all subsurface samples within LSA 10-11 was 0.36. The average SOF result for all systematically collected samples within LSA 10-11 was 0.15, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.20.
- No FSS sample result in LSA 10-11 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 of systematic samples actually collected within LSA 10-11. The successful result of the retrospective power evaluation presented in Table 10-1 for LSA 10-11 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 10-11. 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 10-11 was completed prior to the commencement of backfill operations. A confirmatory GWS was performed within the 72 hours prior to backfill operations, the results of the confirmatory GWS were compared to the original FSS results, no readings in the confirmatory GWS were identified to exceed 3 standard deviations above the mean of the

original FSS survey results, This survey was performed in accordance with the requirements of HDP-WP-ENG-802.

Table 10-1
Retrospective Sample Size Verification for LSA 10-11

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)	0.15
Shift	0.85
Relative Shift (Δ/σ)	7.79
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 10-11 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	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: 11 **Description:** South Eastern Survey Unit in "Area 9"

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

Figure 10-1
Data Evaluation Checklists prepared for LSA 10-11 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
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APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: 11 **Description:** South Eastern Survey Unit in "Area 9"

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 11 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): Ellen C. Jakub (Print Name) _____ (Signature) 12/16/15 (Date)

Approved by (RSO): W. Clark Evers (Print Name) _____ (Signature) 12/16/15 (Date)

Quality Record

11.0 SURVEILLANCE FOLLOWING FSS

FSS GWS activities in LSA 10-11 were completed on April 21, 2015. A GWS survey was performed on December 10, 2015, to verify no radiological status change in the SU prior to the start of backfill operations in the SU on the same day. 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 10-11

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 10-11 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 10-11 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.15	N/A	0.16	N/A	N/A	**0.31**
DOSE	4.75 mrem/year	N/A	4.0 mrem/year	N/A	N/A	**7.75 mrem/year**

13.0 FINAL STATUS SURVEY DESIGN LSA 11-01

This section describes the method for determining the number of samples required for the FSS of LSA 11-01 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 11-01 and their detection sensitivities are also discussed.

13.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 11-01 were driven by the type (Open Land) and Class (Class 2) of the survey unit and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 6, *Final Status Survey Plan Development*, March 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 11-01. The review indicated that there were no areas that were previously found to exceed a Uniform SOF of 1.0 (discussed in Section 3.3.6). As a Class 2 area, there is no expectation of the potential to exceed a DCGL, and no radiological remediation is required. 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 2 SU, LSA 11-01 was required to undergo a minimum of 50% GWS of the ground surface.

13.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 11-01 was the Ludlum 44-10 2" x 2" sodium iodide (NaI) detectors, coupled to a Ludlum 2221 scaler-ratemeter.

13.1.5 Scan Minimum Detectable Concentration

As background levels were approximately 10,000 cpm within LSA 11-01, 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:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3169\,pCi/g}\right)+\left(\frac{f_{U-235}}{2.0pCi/g}\right)+\left(\frac{f_{U-238}}{26.5pCi/g}\right)\right)}$$

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 6, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 11-01, the average enrichment for the SU was 2.9%.

HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)* documents the calculated MDC_{scan} of 0.75 pCi/g for Th-232 and 1.04 pCi/g for Ra-226 when using a 2"x 2" NaI detector with a 10,000 cpm background.

Table 13-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 11-01

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 11-01	34.8	46.9	1.04	2.8	0.75	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. DCGLw 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 11-01 was established at 4,000 net counts per minute (ncpm).

13.1.7 LSA 11-01 FSS Design Summary

The FSS Plan for LSA 11-01 can be found in Appendix C. Table 13-2 presents an overall FSS design and implementation summary for LSA 11-01.

Table 13-2
FSS Design Summary for LSA 11-01

Gamma Walkover Survey (GWS):		
Scan Coverage	Minimum 50% of ground surface	
Scan MDC	34.8 pCi/g total Uranium (based on a 10,000 cpm background); 0.75 pCi/g Th-232; 1.04 pCi/g Ra-226*	
Investigation Action Level (IAL)	1,677 net cpm**	
Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	5	These samples will be collected on a systematic grid. ***Excavation stratum samples beneath surface stratum samples will be archived and analyzed only if the associated root stratum result exceeds a SOF of 0.5.
15 cm – 1.5 m (Root)	8	
> 1.5 m (Excavation)	8***	
Biased Survey/Sampling Locations:		
Collect a minimum of one biased sample at the maximum GWS measurement within the Survey Unit. Additional 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.		
Instrumentation		
Ludlum 2221 with 44-10 (2x2 NaI) detector; with collimation for investigations	Used for GWS and to obtain static count rates at biased measurement locations.	
*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).*		
**IAL is the net count per minute (ncpm) equivalent to an activity concentration less than the Uniform Stratum $DCGL_w$ (the appropriate criterion for Class 2 and Class 3 LSAs) based on 3% enriched uranium and using the Infer Tc-99 DCGL for U-235; 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 11-01

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 11-01 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 across the SU 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.

FSS technicians performing GWS in LSA 11-01 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), FSS 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, FSS 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 8,000 and 9,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 12,000 to 13,000 gcpm, FSS 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.

On September 30, 2015, as documented in Inspection Report 07000036/2015003, the NRC observed a FSS Technician performing GWS over a sloped portion of the SU. Non-compliance of FSS procedures was noted in that the height of the detector was not adjusted for changing elevation of the slope and as such was at times more than maximum allowable three (3) inches above the ground surface. In a NRC letter dated November 27, 2015, this occurrence was addressed as a Notice of Violation (ML15334A404). As an immediate corrective action, all sloped areas within LSA 11-01 underwent a new GWS on October 1, 2015 by a different FSS Technician with a different survey instrument under supervision by the RSO. A significant fraction of the "slope GWS redo area" included portions of the SU which had not previously undergone GWS (Note: The FSS Plan requirement for LSA 11-01 was a minimum of 50% scan coverage). The measurement data comparison of the original GWS and the new GWS were consistent. For both GWS performed, no elevated measurements were observed on sloped surfaces which would have triggered biased sampling.

After the GWS survey was complete, the GWS was reviewed to confirm that the minimum GWS requirement of 50% of the SU surface was met.

Next, 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 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.

14.2 Soil Sampling

14.2.1 Systematic Soil Sampling Summary

Table 14-1 provides a summary of systematic sampling by stratum for LSA 11-01.

Table 14-1
Systematic Sampling Summary by Stratum for LSA 11-01

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
11-01	9,885	5	8	3	2

14.2.2 Systematic Sampling LSA 11-01

As expected there was no radiological remediation required in LSA 11-01, although there was a small amount of excavation in portions of the SU to support the construction of the Northeast Site Creek Diversion, and the Detention Pond. Also, for the purpose of site restoration final grade, in areas of the SU adjacent to the former Burial Pit Area, in order to obtain positive drainage the final grade engineering design called for additional soil to be placed. This resulted in portions of the SU final grade to be at a higher elevation than the original grade.

As described in the DP Chapter 14, systematic sampling is based on the final grade, meaning that sampling of each stratum of soil will be performed as it will remain in the final SU configuration. Due to elevation differentials between the original grade and final grade, and following the systematic sampling protocol provided in the DP, there were 3 systematic sample locations in which the surface stratum was not present.

Within LSA 11-01, there were five (5) systematic locations in which portions of the surface stratum [0 – 15 centimeters (cm)] remained and were sampled. Portions of the root stratum (15 cm – 150 cm) remained at all eight (8) systematic locations. At these locations, the remaining root stratum interval was collected using a hand auger and composited. Excavation stratum samples were collected at seven locations using either hand trowels, or hand augers where necessary, for six-inch grab samples below the existing excavation surface. However, four of these seven samples were collected and archived; Excavation samples that fall below Surface and Root zone samples are only required to be analyzed if the overlying Root zone sample

exceeds a 0.5 SOF. As no Root zone sample exceeded a 0.5 SOF, these archived samples were not analyzed.

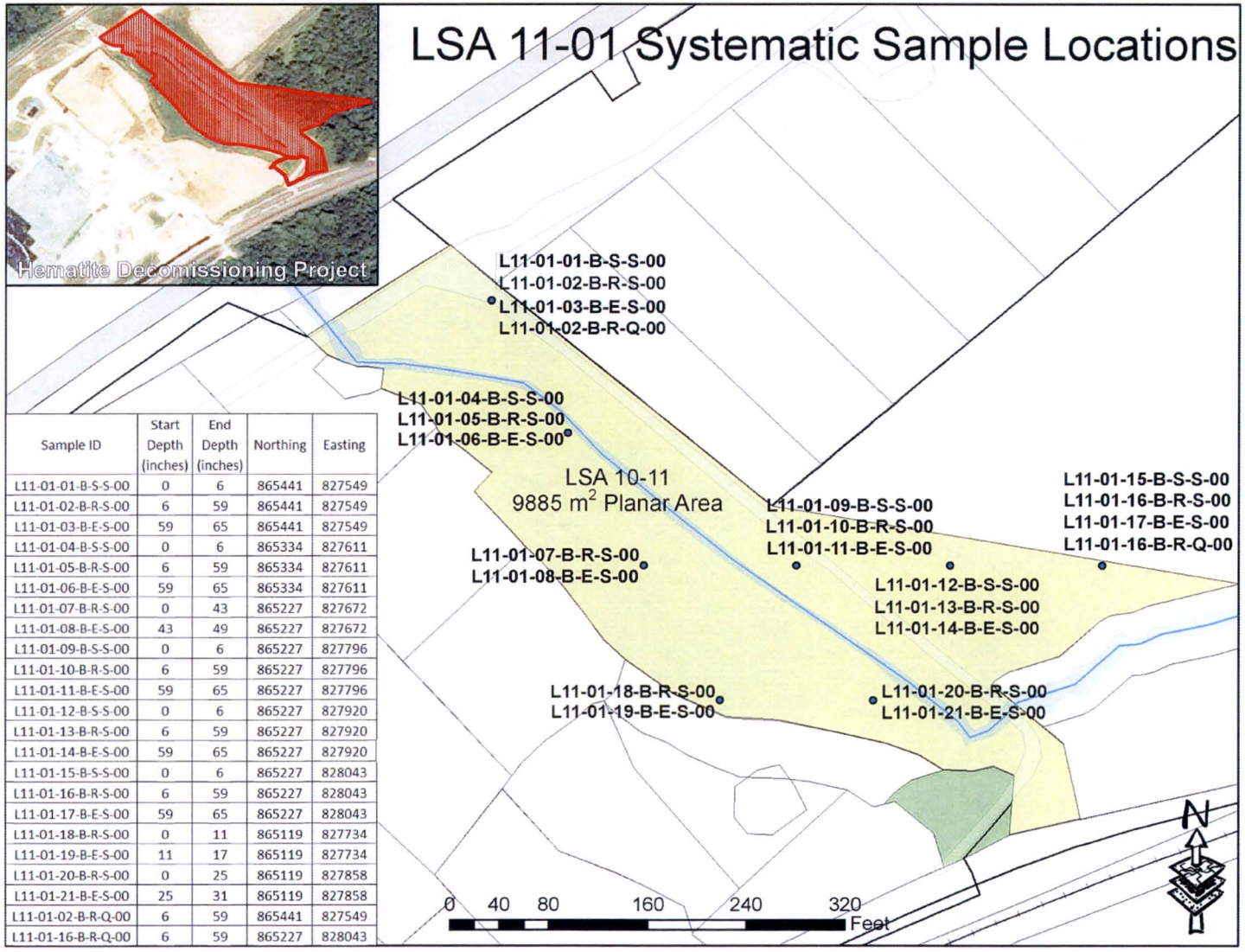
Given a planar area of 9,885 m^2 for LSA 11-01 and an eight - point systematic triangular grid, the point-to-point distance within each row was 37.7 m with spacing of 32.7 m between each of the parallel grid rows within the SU.

While there were eight systematic locations on the LSA 11-01 sampling grid, a total of twenty-three (22) samples were collected at these locations, including:

- Five (5) samples collected within the remaining surface stratum
- Eight (8) samples collected within the remaining root stratum
- Seven (7) samples collected within the excavation, or "deep", stratum (3 Excavation samples were analyzed and reported, 4 were collected for archive and not analyzed)
- Two (2) QC field replicates

Figure 14-1 presents the map of the eight systematic sample locations which were sampled within LSA 11-01. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 14-1
LSA 11-01 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L11-01-01-B-S-S-00	0	6	865441	827549
L11-01-02-B-R-S-00	6	59	865441	827549
L11-01-03-B-E-S-00	59	65	865441	827549
L11-01-04-B-S-S-00	0	6	865334	827611
L11-01-05-B-R-S-00	6	59	865334	827611
L11-01-06-B-E-S-00	59	65	865334	827611
L11-01-07-B-R-S-00	0	43	865227	827672
L11-01-08-B-E-S-00	43	49	865227	827672
L11-01-09-B-S-S-00	0	6	865227	827796
L11-01-10-B-R-S-00	6	59	865227	827796
L11-01-11-B-E-S-00	59	65	865227	827796
L11-01-12-B-S-S-00	0	6	865227	827920
L11-01-13-B-R-S-00	6	59	865227	827920
L11-01-14-B-E-S-00	59	65	865227	827920
L11-01-15-B-S-S-00	0	6	865227	828043
L11-01-16-B-R-S-00	6	59	865227	828043
L11-01-17-B-E-S-00	59	65	865227	828043
L11-01-18-B-R-S-00	0	11	865119	827734
L11-01-19-B-E-S-00	11	17	865119	827734
L11-01-20-B-R-S-00	0	25	865119	827858
L11-01-21-B-E-S-00	25	31	865119	827858
L11-01-02-B-R-Q-00	6	59	865441	827549
L11-01-16-B-R-Q-00	6	59	865227	828043

Table 14-2 below presents a tabular listing of all FSS samples collected within LSA 11-01 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 14-2
FSS Sample Locations and Coordinates for LSA 11-01

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
	~~Westinghouse Proprietary Class 3~~ Non-Proprietary	Revision: 6	Appendix P-4, Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 11 **Description:** Plant Open Land Area

Survey Unit: 01 **Description:** Northeast Site Creek in "Area 9"

Survey Type: FSS **Classification:** Class 2

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L11-01-01-B-S-S-00	Uniform	S	427.0	426.5	865441.0	827549.0	Surface 6-inch grab
L11-01-02-B-R-S-00	Uniform	S	426.5	422.0	865441.0	827549.0	Root 4.4-ft composite
L11-01-04-B-S-S-00	Uniform	S	423.9	423.4	865334.0	827611.0	Surface 6-inch grab
L11-01-05-B-R-S-00	Uniform	S	423.4	419.0	865334.0	827611.0	Root 4.4-ft composite
L11-01-07-B-R-S-00	Uniform	S	424.1	420.5	865227.0	827672.0	Root 3.6-ft composite
L11-01-08-B-E-S-00	Uniform	S	420.5	420.0	865227.0	827672.0	Excavation 6-inch grab
L11-01-09-B-S-S-00	Uniform	S	422.7	422.2	865227.0	827796.0	Surface 6-inch grab
L11-01-10-B-R-S-00	Uniform	S	422.2	417.7	865227.0	827796.0	Root 4.4-ft composite
L11-01-12-B-S-S-00	Uniform	S	422.2	421.7	865227.0	827920.0	Surface 6-inch grab
L11-01-13-B-R-S-00	Uniform	S	421.7	417.3	865227.0	827920.0	Root 4.4-ft composite
L11-01-15-B-S-S-00	Uniform	S	420.9	420.4	865227.0	828043.0	Surface 6-inch grab
L11-01-16-B-R-S-00	Uniform	S	420.4	415.9	865227.0	828043.0	Root 4.4-ft composite
L11-01-18-B-R-S-00	Uniform	S	422.8	421.9	865119.0	827734.0	Root 0.9-ft composite
L11-01-19-B-E-S-00	Uniform	S	421.9	421.4	865119.0	827734.0	Excavation 6-inch grab
L11-01-20-B-R-S-00	Uniform	S	421.4	419.4	865119.0	827858.0	Root 2-ft composite
L11-01-21-B-E-S-00	Uniform	S	419.4	418.9	865119.0	827858.0	Excavation 6-inch grab
L11-01-02-B-R-Q-00	Uniform	Q	426.5	422.0	865441.0	827549.0	Root 4.4-ft composite
L11-01-16-B-R-Q-00	Uniform	Q	420.4	415.9	865227.0	828043.0	Root 4.4-ft composite
L11-01-22-B-S-B-00	Uniform	B	423.0	422.5	865291.0	827544.0	Surface 6-inch grab
L11-01-23-B-S-B-00	Uniform	B	424.0	423.5	865247.0	827842.0	Surface 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

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 11-01 two sample locations were selected within the SU based on the evaluation of the GWS survey data. Biased location L11-01-23-B-S-B-00 represents the maximum GWS measurement encountered within in LSA 11-01 and has a Uniform SOF value of 0.07.

14.4 Judgmental/Sidewall Sampling for Tc-99

As a Class 2 SU, sidewall sampling was not necessary in LSA 11-01.

14.5 Quality Control Soil Sampling

Two QC field duplicate sample points were randomly selected and collected at systematic location L11-01-02, and L11-01-16 for LSA 11-01.

15.0 FINAL STATUS SURVEY RESULTS LSA 11-01

15.1 Gamma Walkover Survey

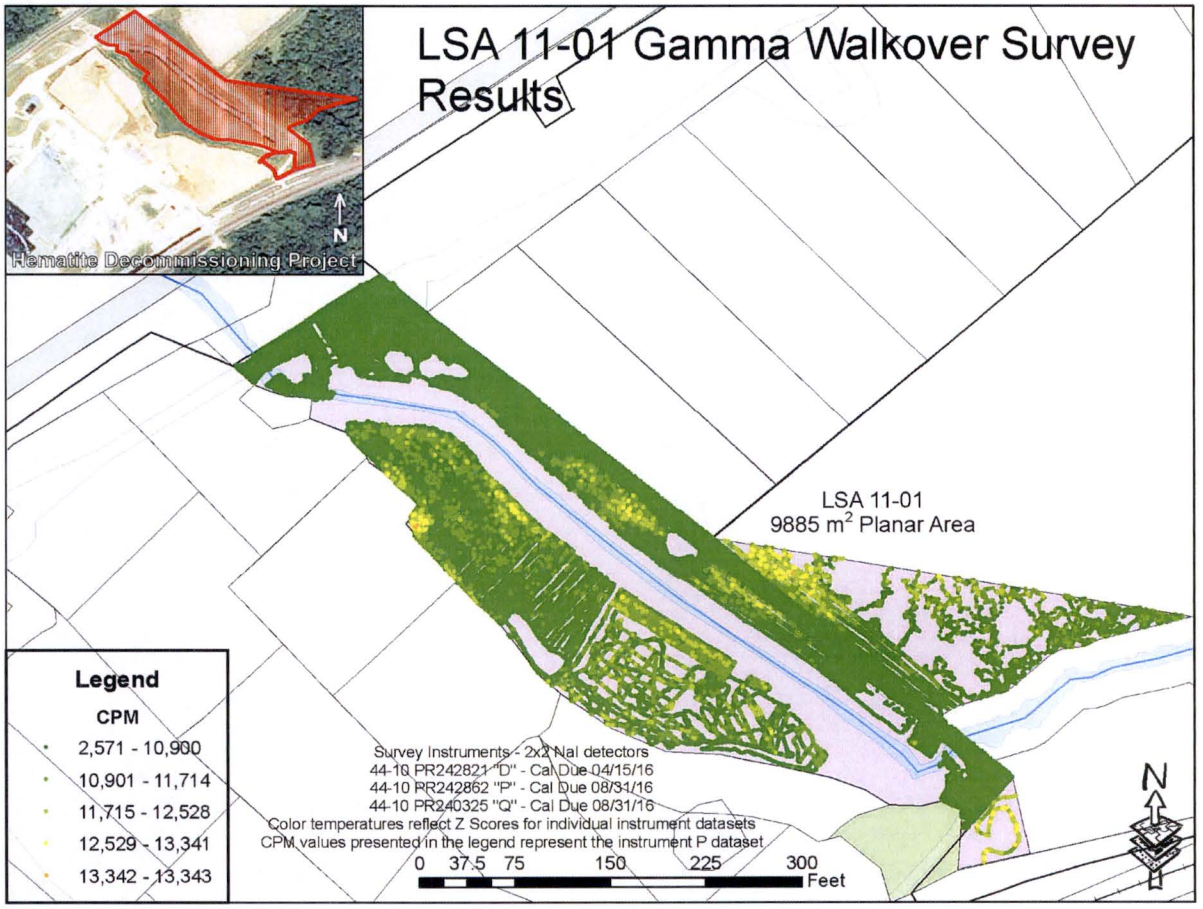
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are 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 in LSA 11-01 were collected between September 17, 2015 and October 1, 2015.

15.1.1 GWS Results for LSA 11-01

For LSA 11-01, GWS count rates ranged between 4,891 gcpm and 10,205 gcpm, with a mean count rate of 7,297 gcpm. The median count rate was 7,290 gcpm and the standard deviation was 720 cpm. Figure 15-1 below presents a map of the complete GWS data set.

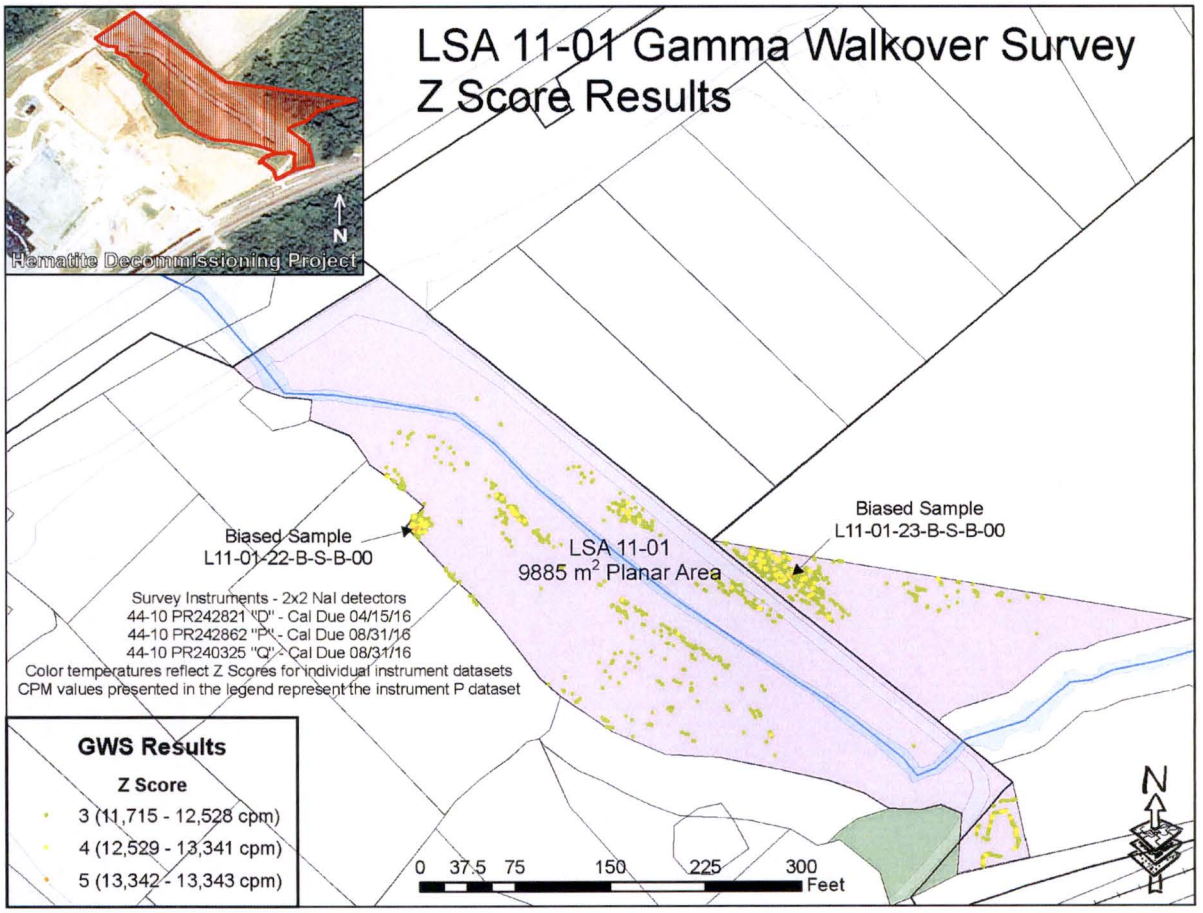
Figure 15-1
Colorimetric GWS Plot for LSA 11-01



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded both the IAL (> 1,677 ncpm) and three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Two locations (L11-01-22 and L11-01-23) were selected for biased sample collection. The sample collected at location L11-01-23 represented the maximum GWS measurement (13,343 gcpm) within the SU.

Figure 15-2 below presents a map of the +3 Z-score GWS measurements within LSA 11-01, including the two selected biased sampling locations.

Figure 15-2
Colorimetric GWS Plot for LSA 11-01 (Measurements > Z-score of 3)



A total of 114,530 GWS measurements were collected in LSA 11-01 covering 62.3% of the 9,885 m^2 area, meeting the FSS Plan requirement of 50% minimum scan coverage.

Since all GWS data collected in LSA 11-01 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 40.9 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 11-01, 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:

$$\text{Scan MDC}_{Total\ Uranium} = \quad 1 \Big/ \left(\left(\frac{0.7928}{3659}\right) + \left(\frac{0.0438}{2.32}\right) + \left(\frac{0.1634}{30.6}\right) \right) = 40.9 \frac{pCi}{g}$$

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 FSS 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 11-01

As stated above, 62.3% of the LSA was subjected to GWS which exceeds the minimum FSS Plan requirement of 50% coverage for a Class 2 SU.

15.2 Soil Sample Results LSA 11-01

Appendix B presents the analytical results and associated statistics for all FSS surface samples collected within LSA 11-01.

15.2.1 Surface Soil Sample Results LSA 11-01

There were five (5) samples collected within the surface stratum (0 – 15 cm) of LSA 11-01. However, there were a total of ten (10) soil samples collected within the topmost soil layer of the SU surface including eight systematic samples (five surface and three root composite samples) and two biased samples. The maximum SOF result for "topmost" samples in LSA 11-01 was 0.72 corresponding to the biased sample L11-01-22-B-S-B-00. The maximum systematic sample SOF result was 0.14 at L11-01-09-B-S-S-00.

15.2.2 Subsurface Soil Sample Results LSA 11-01

There were five systematic locations within LSA 11-01 where root stratum composite sampling below a 6-inch (0.15 m) surface sample was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. There were three systematic locations within LSA 11-01 where excavation stratum sampling below a root stratum sample was necessary. These root stratum and excavation stratum samples were 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 11-01 was 0.08. This sample (L11-01-09) was the excavation stratum sample collected directly underneath the root stratum sample L11-01-08.

15.2.3 WRS Test Evaluation LSA 11-01

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 11-01 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 11-01. 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 16 systematically collected samples in LSA 11-01 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,

(1040) was greater than the critical value (860) 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 11-01

Table 15-1 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 11-01, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.03.

Table 15-1
LSA 11-01 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	0.01	0.24	0.01	1.40	0.07	0.73	**0.03**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.00 (<BKG)	0.44	0.02	0.27	0.01
Maximum	0.13	0.67	0.14	3.24	0.17	1.56	0.14

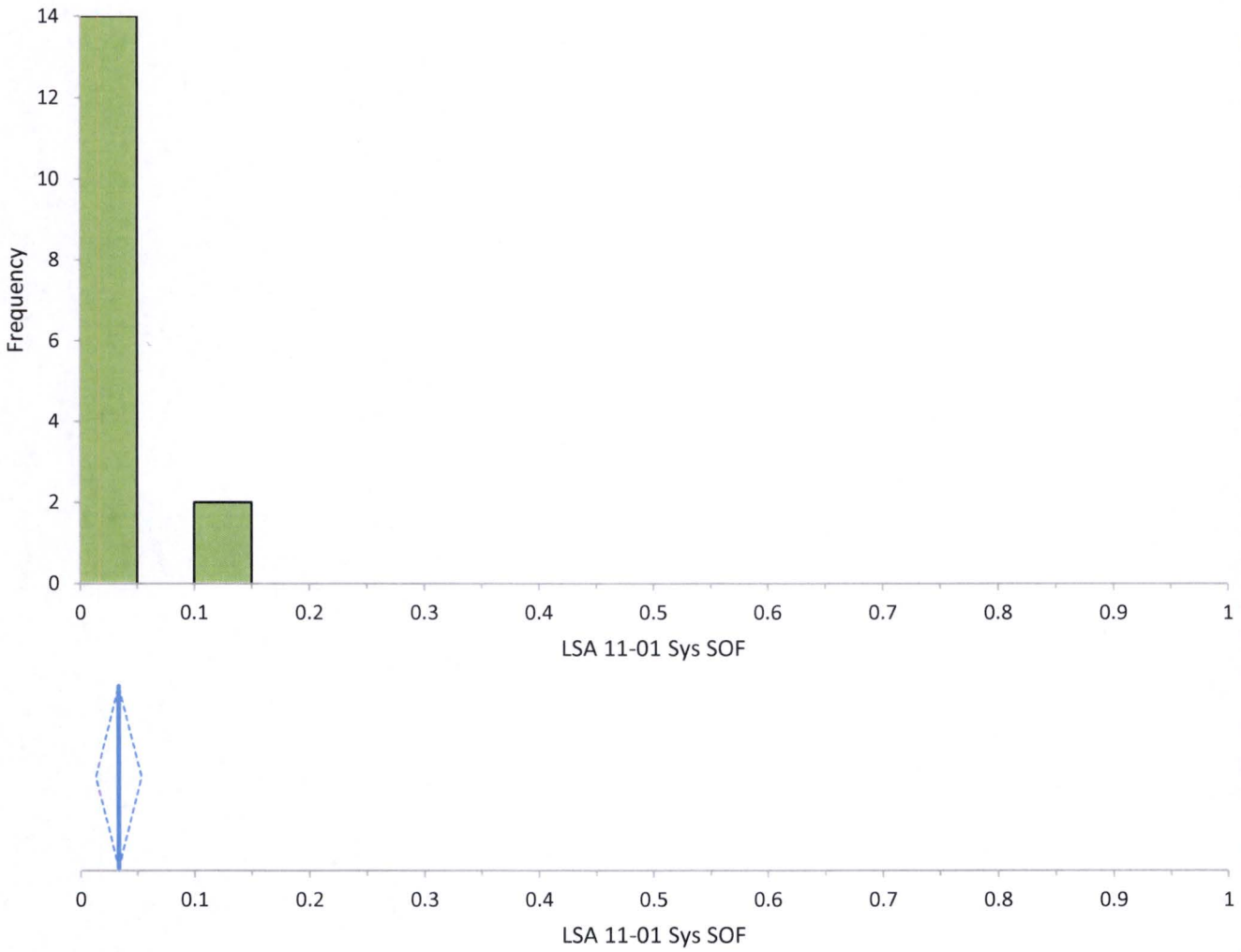
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide 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 15-3 presents the overall statistical metrics for the SOF parameter for the 10 systematically collected samples from LSA 11-01. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 11-01. The middle graph presents the mean SOF (0.03) 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 0.01 to 0.05. The 97.87% confidence interval based on the median (0.02) of the sample results is 0.01 to 0.04. The bottom two charts present the various statistical metrics of the LSA 11-01 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 11-01 data associated with the systematically collected measurement locations.

Figure 15-3
Graphic Statistical Summary for LSA 11-01 (SOF parameter)



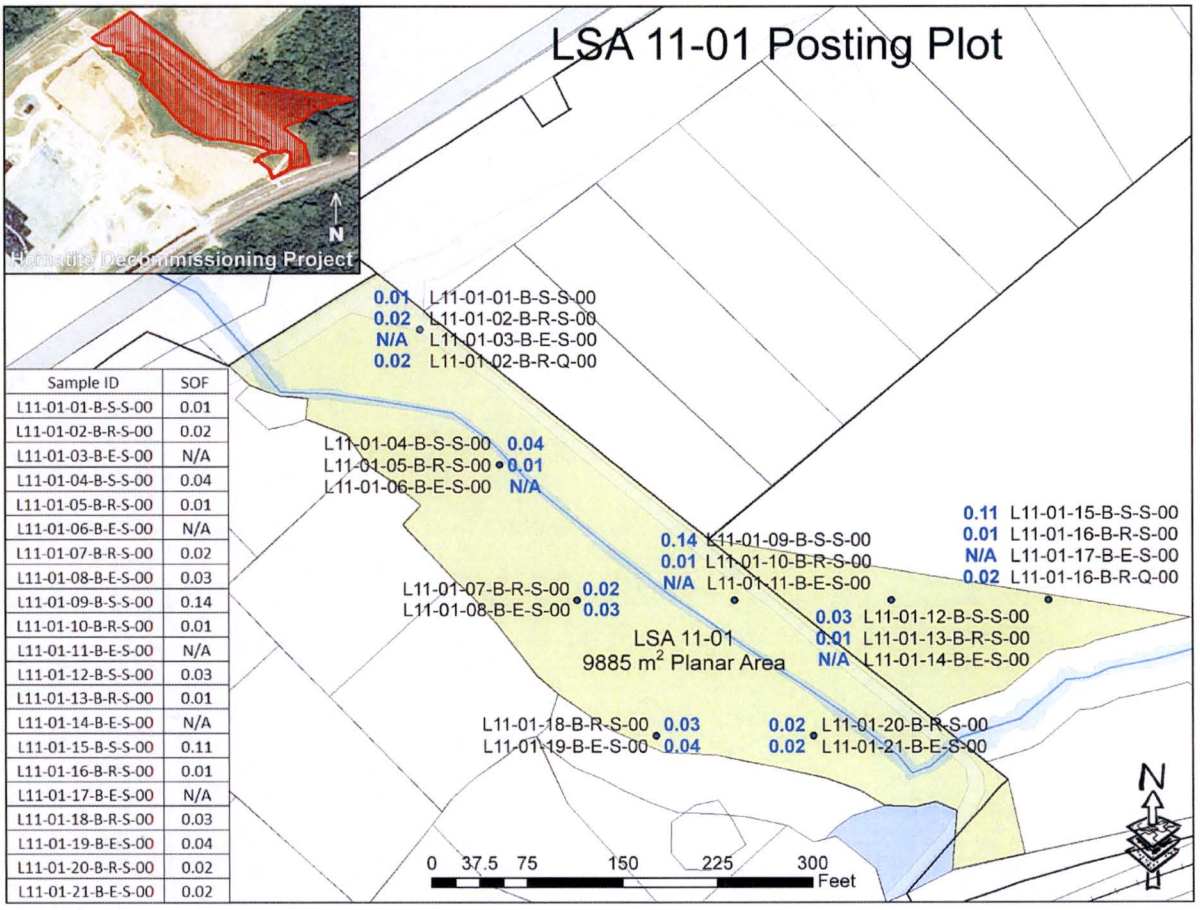
	N	16

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 11-01 Sys SOF	0.03	0.01	to 0.05	0.009	0.04	0.00	2.3	5.04

	Minimum	1st quartile	Median	97.87% CI		3rd quartile	Maximum	IQR
LSA 11-01 Sys SOF	0.01	0.01	0.02	0.01	to 0.04	0.03	0.1	0.02

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 11-01 is presented below in Figure 15-4. Figure 15-4 shows no unusual patterns in the data.

Figure 15-4
Posting Plot for LSA 11-01 Systematic Measurement Locations



Sample ID	SOF
L11-01-01-B-S-S-00	0.01
L11-01-02-B-R-S-00	0.02
L11-01-03-B-E-S-00	N/A
L11-01-04-B-S-S-00	0.04
L11-01-05-B-R-S-00	0.01
L11-01-06-B-E-S-00	N/A
L11-01-07-B-R-S-00	0.02
L11-01-08-B-E-S-00	0.03
L11-01-09-B-S-S-00	0.14
L11-01-10-B-R-S-00	0.01
L11-01-11-B-E-S-00	N/A
L11-01-12-B-S-S-00	0.03
L11-01-13-B-R-S-00	0.01
L11-01-14-B-E-S-00	N/A
L11-01-15-B-S-S-00	0.11
L11-01-16-B-R-S-00	0.01
L11-01-17-B-E-S-00	N/A
L11-01-18-B-R-S-00	0.03
L11-01-19-B-E-S-00	0.04
L11-01-20-B-R-S-00	0.02
L11-01-21-B-E-S-00	0.02

Appendix B to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 15-1, Figure 15-3, and Figure 15-4 above. A summary of the analytical data is presented in Table 15-2 below. Appendix F to this report presents the Test America Analytical Laboratory soil sample reports.

Table 15-2
Final Status Survey Analytical Data: LSA 11-01

Sample ID	Sample 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
L11-01-01-B-S-S-00	0.00	S	0.483	0.080	0.043	NA	-0.587	0.000	0.055	0.055	0.051	0.223	U	0.172	0.066	0.082	NA	-0.828	0.000	0.442	NA	NA	NA	0.023	0.061	0.129	U	0.273	0.133	0.398	U	1.3	0.01
L11-01-02-B-R-S-00	0.50	S	0.937	0.126	0.051	NA	-0.133	0.000	0.055	0.055	0.073	0.241	U	0.799	0.116	0.089	NA	-0.201	0.000	1.701	NA	NA	NA	0.090	0.107	0.176	U	0.904	0.374	0.570	NA	1.6	0.02
L11-01-04-B-S-S-00	0.00	S	0.921	0.129	0.058	NA	-0.149	0.000	0.425	0.425	0.075	0.240	NA	0.799	0.132	0.087	NA	-0.201	0.000	2.427	NA	NA	NA	0.134	0.119	0.193	U	0.516	0.231	0.696	U	3.9	0.04
L11-01-05-B-R-S-00	0.50	S	0.940	0.132	0.056	NA	-0.130	0.000	0.112	0.112	0.023	0.231	U	0.792	0.132	0.072	NA	-0.208	0.000	1.115	NA	NA	NA	0.061	0.104	0.169	U	0.384	0.223	0.696	U	2.5	0.01
L11-01-07-B-R-S-00	0.50	S	0.821	0.112	0.045	NA	-0.249	0.000	0.309	0.309	0.129	0.243	NA	0.709	0.120	0.077	NA	-0.291	0.000	0.639	NA	NA	NA	0.033	0.109	0.191	U	0.485	0.211	0.609	U	1.1	0.02
L11-01-08-B-E-S-00	5.00	S	0.761	0.104	0.043	NA	-0.309	0.000	0.666	0.666	0.101	0.249	NA	0.716	0.113	0.062	NA	-0.284	0.000	0.653	NA	NA	NA	0.032	0.061	0.116	U	0.594	0.356	0.570	NA	0.9	0.03
L11-01-09-B-S-S-00	0.00	S	1.150	0.151	0.050	NA	0.080	0.080	0.274	0.274	0.091	0.236	NA	1.140	0.168	0.118	NA	0.140	0.140	2.538	NA	NA	NA	0.139	0.145	0.228	U	0.797	0.297	0.805	U	2.7	0.14
L11-01-10-B-R-S-00	0.50	S	0.900	0.130	0.056	NA	-0.170	0.000	0.010	0.010	0.113	0.238	U	0.781	0.121	0.066	NA	-0.219	0.000	1.571	NA	NA	NA	0.086	0.101	0.187	U	0.515	0.234	0.671	U	2.6	0.01
L11-01-12-B-S-S-00	0.00	S	0.981	0.140	0.063	NA	-0.089	0.000	0.247	0.247	0.179	0.247	NA	0.813	0.128	0.106	NA	-0.187	0.000	1.837	NA	NA	NA	0.099	0.128	0.219	U	0.757	0.266	0.728	NA	2.1	0.03
L11-01-13-B-R-S-00	0.50	S	0.893	0.119	0.047	NA	-0.177	0.000	-0.009	0.000	0.093	0.225	U	0.797	0.130	0.065	NA	-0.203	0.000	0.727	NA	NA	NA	0.032	0.064	0.182	U	1.110	0.575	0.668	NA	0.5	0.01
L11-01-15-B-S-S-00	0.00	S	1.200	0.168	0.060	NA	0.130	0.130	0.206	0.206	0.095	0.235	U	0.983	0.168	0.084	NA	-0.017	0.000	3.243	NA	NA	NA	0.173	0.136	0.184	U	1.560	0.650	0.802	NA	1.7	0.11
L11-01-16-B-R-S-00	0.50	S	0.822	0.116	0.055	NA	-0.248	0.000	-0.024	0.000	0.074	0.228	U	0.730	0.134	0.087	NA	-0.270	0.000	0.520	NA	NA	NA	0.022	0.061	0.172	U	0.889	0.361	0.548	NA	0.4	0.01
L11-01-18-B-R-S-00	0.50	S	0.902	0.124	0.050	NA	-0.168	0.000	0.415	0.415	0.044	0.222	NA	0.689	0.112	0.080	NA	-0.311	0.000	1.536	NA	NA	NA	0.083	0.076	0.124	U	0.609	0.224	0.650	U	2.1	0.03
L11-01-19-B-E-S-00	5.00	S	0.833	0.134	0.064	NA	-0.237	0.000	0.669	0.669	0.074	0.226	NA	0.743	0.128	0.111	NA	-0.257	0.000	1.577	NA	NA	NA	0.084	0.129	0.214	U	0.798	0.423	0.663	NA	1.7	0.04
L11-01-20-B-R-S-00	0.50	S	1.060	0.147	0.066	NA	-0.010	0.000	0.313	0.313	0.089	0.234	NA	0.854	0.153	0.102	NA	-0.146	0.000	0.507	NA	NA	NA	0.022	0.120	0.203	U	0.814	0.436	0.685	NA	0.5	0.02
L11-01-21-B-E-S-00	5.00	S	0.832	0.116	0.050	NA	-0.238	0.000	0.068	0.068	0.059	0.233	U	0.773	0.114	0.096	NA	-0.227	0.000	1.396	NA	NA	NA	0.075	0.081	0.135	U	0.643	0.214	0.574	NA	1.8	0.02
L11-01-02-B-R-Q-00	0.50	Q	0.804	0.111	0.048	NA	-0.266	0.000	0.139	0.139	0.081	0.230	U	0.665	0.105	0.057	NA	-0.335	0.000	1.498	NA	NA	NA	0.080	0.098	0.178	U	0.783	0.373	0.581	NA	1.6	0.02
L11-01-16-B-R-Q-00	0.50	Q	0.847	0.118	0.054	NA	-0.223	0.000	-0.015	0.000	0.042	0.231	U	0.792	0.119	0.073	NA	-0.208	0.000	1.801	NA	NA	NA	0.097	0.112	0.145	U	0.769	0.409	0.644	NA	2.0	0.02
L11-01-22-B-S-B-00	0.00	B	1.580	0.203	0.071	NA	0.510	0.510	8.500	8.500	0.970	0.230	NA	0.910	0.157	0.108	NA	-0.090	0.000	14.918	NA	NA	NA	0.824	0.224	0.242	NA	2.720	0.656	0.882	NA	4.5	0.72
L11-01-23-B-S-B-00	0.00	B	1.040	0.143	0.060	NA	-0.030	0.000	0.402	0.402	0.162	0.238	NA	1.060	0.157	0.106	NA	0.060	0.060	2.632	NA	NA	NA	0.138	0.127	0.219	U	1.520	0.604	0.765	NA	1.4	0.07
Systematic Minimum			0.000						0.000					0.000						0.442				0.022				0.273				1.8	0.01
Systematic Maximum			0.130						0.669					0.140						3.243				0.173				1.560				Average Enrichment (%)	0.14
Systematic Mean			0.013						0.239					0.009						1.402				0.074				0.728					0.03
Systematic Median			0.000						0.227					0.000						1.466				0.079				0.700					0.02
Systematic Standard Deviation			0.037						0.220					0.035						0.827				0.046				0.308					0.04
			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 11-01

Two (2) biased samples were collected from LSA 11-01. The sample collected at location L11-01-23 represented the maximum GWS measurement (13,343 gcpm) within the SU, and had a result of 0.07 Uniform SOF. The sample collected at location L11-01-23 represented the highest Uniform SOF result of 0.72 primarily due to trace amounts of Tc-99 identified in the sample. As Tc-99 is not a gamma emitter, this would not have been identified by gamma scanning, and given the proximity of the sample location to areas where spent limestone was remediated, the slightly elevated result is not altogether unexpected.

15.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 11-01

As a Class 2 LSA, sidewall sampling was not required in LSA 11-01.

15.2.7 Quality Control Soil Sample Result LSA 11-01

Two QC field duplicate sample point was randomly selected for LSA 11-01 which were collected at systematic locations L11-01-02 and L11-01-16.

For the 18 "regular" (i.e., 16 systematic + 2 biased) samples collected within LSA 11-01, two field duplicate samples were collected. This frequency equates to 11.1%, (i.e. 2/18). The results were documented on form HDP-PR-FSS-703-1 (see Figure 15-5 below). Form HDP-PR-FSS-703-1 documents that the duplicate sample result compares well with its partner's results – all comparison criteria less than the calculated warning limits.

Figure 15-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 11-01

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

Survey Unit No.: LSA 11-01 | Survey Unit Description: Plant Soils Open Land Area east of Burial Pits in "Area 9"

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)
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	Ra-226	0.937	0.0507	0.804	0.048	0.8705	1.9	0.133	0.269	0.403	N
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	Tc-99	0.0546	0.241	0.139	0.23	0.0968	25.1	NA	3.552	5.321	NA
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	Th-232	0.716	0.089	0.665	0.057	0.691	2.0	0.051	0.283	0.424	N
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	U-234[1]	1.701	NA	1.498	NA	1.599	195.4	0.203	27.649	41.425	N
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	U-235	0.0903	0.176	0.0795	0.178	0.085	51.6	NA	7.301	10.939	NA
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	U-238	0.904	0.57	0.783	0.581	0.8435	168.8	0.121	23.885	35.786	N
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	Ra-226	0.822	0.0545	0.847	0.0543	0.8345	1.9	0.025	0.269	0.403	N
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	Tc-99	-0.0235	0.228	-0.0146	0.231	-0.01905	25.1	NA	3.552	5.321	NA
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	Th-232	0.73	0.0866	0.792	0.0729	0.761	2.0	0.062	0.283	0.424	N
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	U-234[1]	0.520	NA	1.801	NA	1.161	195.4	1.281	27.649	41.425	N
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	U-235	0.0215	0.172	0.0972	0.145	0.059	51.6	NA	7.301	10.939	NA
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	U-238	0.889	0.548	0.769	0.644	0.829	168.8	0.12	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: 12/15/15

Reviewed by: [signature] Date: 12/15/15

Quality Record

15.3 Tc-99 Hot Spot Assessment LSA 11-01

LSA 11-01 is a Class 2 SU and therefore no characterization, RASS, or FSS samples exceeded the Tc-99 Uniform DCGL as such a potential Tc-99 hot spot assessment is not required.

16.0 ALARA EVALUATION LSA 11-01

All samples collected within LSA 11-01 were evaluated against the Uniform Stratum $DCGL_w$. For LSA 11-01 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.03 for LSA 11-01. The average SOF equates to residual activity contributions from the survey unit area of 0.75 mrem/year for LSA 11-01. Groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2, 3 and 4, 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 11-01. The Stockpile 5-6 reuse soil dose contribution will also be accounted for by adding in an additional 7.75 mrem/year. Adding all of the dose contributions together, the total estimated dose for LSA 11-01 is 12.5 mrem/year.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the assessment of LSA 11-01 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 attempting to further reduce the residual activity of LSA 11-01.

17.0 FSS PLAN DEVIATIONS LSA 11-01

The systematic sample location which included sample IDs L11-01-01, L11-01-02, and L11-01-03 which fell upon the packed gravel haul road was relocated approximately 45' to the southwest. Even at this relocated sample location, auger refusal was encountered in the Root Stratum at 3.0 ft bgs. As a result, no excavation stratum sample (L11-01-03) was collected at this location. While the FSS plan called for excavation samples to be collected and archived, no Root Stratum sample exceeded a Uniform SOF of 0.5, therefore analysis of this sample, or any Excavation Stratum sample was unnecessary.

Chain of custody prepared for FSS samples collected in LSA 11-01 reflected sample IDs which incorrectly indicated samples being located within the Burial Pit SEA. LSA 11-01 is actually located within the Plant Soil SEA. FSS Plan calculations were performed using the correct SEA, and no data evaluation calculations involving SOFs or dose assignments were impacted. Note that SEA's are used for FSS planning purposes only, and all FSS samples are analyzed for Tc-99, the chain of custody error was merely a typographical error.

The initial DP Class 3 classification of LSA 11-01 was upgraded to Class 2 because of the flash flood event that occurred early in the Burial Pit Area remediation process. The size of LSA 11-01 was increased by approximately 1800 m^2 in April 2015 due to a surface soil RASS sample (see section 2.3.3.2) in Class 3 SU LSA 11-03 which exceeded a SOF of 0.5. The area that was removed from LSA 11-03 was subsequently included in the adjacent Class 2 LSA 11-01. This

change condition occurred prior to the preparation of the FSS Plan for LSA 11-01 and is presented here as supplemental background information, but is not considered a deviation.

17.1 Remedial Actions During FSS

There were no remedial actions after FSS in LSA 11-01.

17.2 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 11-01. Subsequent to field FSS activities within the SU, the calculation of Scan MDCs varied in approach based on the guidance given in Technical Basis Document (HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys,* Westinghouse April, 2015), as well as later discussions between HDP and the NRC via teleconference (August 2015) on the technical assumptions and inputs related to Scan MDC estimates. The Scan MDCs presented in the FSS Plan shown in Table 5-1 assumed a surveyor efficiency of 1.0 (the surveyor efficiency prescribed by the DP when data logging is utilized). The current version of HDP-TBD-FSS-002 uses a surveyor efficiency of 0.75 (the surveyor efficiency agreed upon between HDP and the NRC via teleconference). Although the revised Scan MDC for Total U increased to 40.9 pCi/g, it remained less than the $DCGL_w$ for the SU. The Scan MDCs for Ra-226 and Th-232 increased slightly to 1.21 pCi/g and 0.87 pCi/g, respectively. Using a 10,000 cpm background and a conservative 4% enrichment for the SU, 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 11-01

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw (Ra-226)	Scan MDC (Th-232)	DCGLw (Th-232)
LSA 11-01	40.9	46.9	1.21	1.9	0.87	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 11-01

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 11-01(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 11-01 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 11-01, 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 11-01, however the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), 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 SOF result for all surface samples within LSA 11-01 was 0.72. The maximum SOF result for all subsurface samples within LSA 11-01 was 0.04. The average SOF result for all systematically collected samples within LSA 11-01 was 0.03, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.05.
- No FSS sample result in LSA 11-01 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an 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 of systematic samples actually collected within LSA 11-01. The successful result of the retrospective power evaluation presented in Table 18-1 for LSA 11-01 indicates that the minimum number of samples required (8) for the WRS Test was equal to the number of sampling locations actually collected within LSA 11-01. 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 11-01 was completed prior to the commencement of backfill operations. A confirmatory GWS was performed within the 72 hours prior to backfill operations, the results of the confirmatory GWS were compared to the original FSS results, no readings in the confirmatory GWS were identified to exceed 3 standard deviations above the mean of the original FSS survey results, This survey was performed in accordance with the requirements of HDP-WP-ENG-802

Table 18-1
Retrospective Sample Size Verification for LSA 11-01

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.04
$DCGL_{SOF}$	1
LBGR (Mean)	0.03
Shift	0.97
Relative Shift (Δ/σ)	25.77
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 11-01 (page 1 of 2)

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

Survey Area: LSA 11 **Description:** Land Survey Area 11, Plant Soils Area
Survey Unit: 01 **Description:** Northeast Site Creek Survey Unit in "Area 9"

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 ☐ NA ☐
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 ☐ NA ☐
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: *Deviations Footnotes: See "Discrepancy" on Page 2 of this document.

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Figure 18-1
Data Evaluation Checklists prepared for LSA 11-01 (page 2 of 2)

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

Survey Area: LSA 11 **Description:** Land Survey Area 11, Plant Soils Area

Survey Unit: 01 **Description:** Northeast Site Creek Survey Unit in "Area 9"

Discrepancy: **Item 2**: The sample location for sample IDs L11-01-01, L11-01-02, and L11-01-03 was relocated ~ 45' southwest due to haul road gravel. Sample ID L11-01-02 did not achieve the target depth (59" bgs) due to refusal at 36". Therefore, the Root Stratum sample is "short", i.e. only 30" collected from the 53" Root interval, and the sample ID L11-01-03 Excavation Stratum sample was not taken.

Item 9: All sample IDs include "B" code indicating Burial Pit SEA. The Survey Unit is actually in the Plant Soils SEA. This mis-labeling does not affect any results or calculations. The FSS Plan calculations were prepared using the correct SEA.

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 11 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): Ellen C. Jakub (Print Name) [signature] (Signature) 12/17/15 (Date)

Approved by (RSO): W. Clark Evers (Print Name) [signature] (Signature) 12/17/15 (Date)

Quality Record

19.0 SURVEILLANCE FOLLOWING FSS

FSS GWS activities in LSA 11-01 were completed on October 1, 2015. A GWS survey was performed on December 7, 2015, to verify no radiological status change in the SU prior to the start of backfill operations in the SU on the same day. 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 11-01

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 11-01 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 11-01 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.03	N/A	0.16	N/A	0.31	**0.5**
DOSE	0.75 mrem/year	N/A	4.0 mrem/year	N/A	7.75 mrem/year	**12.5 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 10-11

APPENDIX B: Analytical Data Evaluation Spreadsheets for LSA 11-01

APPENDIX C: FSS Plan Development for LSA 10-11

APPENDIX D: FSS Plan Development for LSA 11-01

APPENDIX E: TestAmerica Laboratory Analytical Data Reports for LSA 10-11

APPENDIX F: TestAmerica Laboratory Analytical Data Reports for LSA 11-01

APPENDIX G: Completed Field Logs (Form P-6)

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

APPENDIX I: Hybrid Well Analytical Data

Attachment 2

Final Status Survey Final Report Volume 3, Chapter 7, Revision 1

Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01, 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 7

TITLE: **Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01 (LSA 10-11 and LSA 11-01)**

REVISION: **1**

EFFECTIVE DATE: NOV 0 2 2017

TRACK CHANGE VERSION

Approvals:

Author: Kenneth E. Pallagi — 11-02-2017 Date

Owner/Manager: W. Clark Evers — 11/2/17 Date

REVISION LOG	
Revision No. Effect. Date	**Revision**
0 12/07/2016	Revision 0 is the initial issuance of the Survey Area Release Record for Land Survey Area 10, Survey Unit 11, and Land Survey Area 11, Survey Unit 01.
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. Updates to the survey area release records in regards to correcting minor editorial errors, spelling errors and nomenclature to make the survey area release records consistent with subsequent survey area release records which were developed after the submittal of FSSFR Volume 3, Chapter 7, Revision 0

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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 Objective
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
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
yr	year

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) 11 (LSA 10-11) and LSA 11, SU 01 (LSA 11-01). 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."

LSA 10-11 was designated as a Class 1 SU as presented in Table 14-16 of the HDP Decommissioning Plan (DP) {ML092330123}. The Class 1 designation for the SU remained in effect throughout remediation and Final Status Survey (FSS). LSA 11-01 was originally designated as a Class 3 SU as presented in Table 14-16 of the HDP Decommissioning Plan (DP) {ML092330123}, but was reclassified to a Class 2 SU based on the potential impact from a flash flood event that occurred early in the Burial Pit remediation process, and the potential impact of flooding events that occurred during remediation of the Burial Pit Area.

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 the residual radioactivity levels in the LSA 10-11 and LSA 11-01 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 Final Status Survey (FFS) 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 2, *Land Survey Areas (LSA) Overview* provides the information common to land survey areas. This report, FSSFR Volume 3, Chapter 7, builds upon the general information provided in FSSFR Volume 3, Chapter 1, Revision 2.

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 10 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. Figure 2-2 indicates the final configuration of LSA 10.

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.

2.2.1 LSA 10-11 Survey Unit Description and Configuration

LSA 10-11 is located in the south eastern tip of LSA 10, the Burial Pit Area and, is adjacent to the Northeast Site Creek area (LSA 11) to its north and northeast. Figure 2-2 indicates the location of LSA 10-11 within LSA 10.

LSA 10-11 is a SU in the group of LSA 10 SUs (LSA 10-05, LSA 10-06, LSA 10-07, LSA 10-09, LSA 10-10 and LSA 10-14) in which the conceptual boundaries were changed. The site staff and Radiation Safety Officer (RSO) at the time of remediation in the south Burial Pit Area chose to depart from the conceptual SU boundary configuration. The configuration of these SU boundaries was derived from physical delineations in the area as a result of remediation activities with the south Burial Pit Area. It is noteworthy that although the boundaries of the SUs changed and new SUs were designated, the boundary of LSA 10 did not change and all SUs within LSA 10 remained classified as MARSSIM Class 1.

The land area of SU LSA 10-11 is positioned within LSA 10 such that the majority of the SU is the lower sloped area that adjoins the Northeast Site Creek. As such, during the history of site operations it was not considered to be a location in which burials would be undertaken. As documented and verified during remediation, burials occurred at higher elevations in the Burial Pit Area where sufficient overburden was available.

While LSA 10-11 was designated as a Class 1 area, there was very little radiological remediation required to ready the area for FSS. A portion of the LSA was covered by a gravel roadway. For

FSS the gravel road was removed in order to provide unencumbered access to the underlying native soil. After completion of site operations in the area, in the final configuration, LSA 10-11 consisted primarily of the excavated area in the SU which consisted of native soil. There were no structures, piping, or spent limestone remaining within the SU. The site security fence transits through the eastern edge of the SU. Groundwater monitoring well WS-31 was present in the LSA and remained undisturbed throughout the remediation process. Additionally ground water monitoring well BR-15-JC was installed after remediation and backfill operations were completed. These wells will remain in place and are monitored as part of the post-remediation groundwater monitoring that will be reported in FSSFR Volume 6 chapters.

The SU is 459 square meters (m^2) in planar (2-dimensional) extent, within an interior surface area of 550 m^2 (3-dimensional).

2.3 LSA 11 Configuration

LSA 11 has been reconfigured (expanded) from the initial conceptual boundary. Figure 2-3 depicts the initial configuration of LSA 11 as provided in DP Figure 14-14. This depiction indicates that the initial conceptual boundary for LSA 11 was a single large Class 3 SU designated LSA 11-01.

2.3.1 LSA 11 Configuration Change – RAI Response

The first configuration change of LSA 11 which impacted the boundary configuration of LSA 11-01 resulted from resolution to a NRC review comment of the Westinghouse response to RAI-HDPC-14-Q5. Westinghouse letter HEM-11-96 Attachment 10, RAI No. 14-4e indicates that "*From the 5/19/11 conference call, it was understood that the underlying concern for RAI 14-4 is related to the amount and type of uranium data within a portion of the area designated as non-impacted, To resolve this concern, HDP will expand the size of the impacted area. The boundary of the existing survey unit LSA-11-01 will be modified as illustrated in Attachment 2, and the size increased from 14,885 m^2 to 24,715 m^2.*"

The expansion of LSA 11 as the result of resolution of a RAI did not decrease the MARSSIM classification of the LSA. Figure 2-4 is the revised figure provided in HEM-11-96 indicating the expanded SU LSA 11-01.

2.3.2 LSA 11 Configuration Change – Flash Flood

The second configuration change of LSA 11 which impacted the boundary of LSA 11-01 resulted as a consequence of a flash flood event that occurred in April 2013. NRC Region III Inspectors were onsite conducting inspection activities at the time of the flash flood. NRC Inspection Report 07000036/2013002 provides a detailed description of the event in which the NRC conclusion was as follows "*The inspectors determined the licensee took appropriate actions to minimize the impact of the flood waters leaving the site and took adequate actions to determine if licensed radioactive materials were being released from the site. The NRC performed confirmatory sampling of soils on- and off-site that resulted in one slightly elevated result onsite that was being evaluated by the licensee.*"

During the flooding event site staff monitored the elevation of the flood water to ascertain which portions of LSA 11 and the previously non-impacted land areas adjoining LSA 11-01 were

affected by the flooding. Based upon the results of the monitoring of the flood water elevation in LSA 11, which at that time consisted of the single SU designated LSA 11-01, SU LSA 11-01 was expanded to include the land area impacted by the flood water. The expansion of LSA 11 resulted in the designation of new SUs LSA 11-01, LSA 11-02, LSA 11-03, LSA 11-04 and LSA 11-05. Figure 2-5 depicts the resulting expanded LSA 11 and the LSA 11 SUs.

The expansion of LSA 11 did not result in a decreased MARSSIM classification of any of the impacted land area.

2.3.3 LSA 11 Reclassification

LSA 11-01 was initially classified as a MARSSIM Class 3 survey area. As discussed in Section 2.3.1 above the expansion of LSA 11 resulted in previously designated non-impacted land being designated as a MARSSIM Class 3 survey area.

2.3.3.1 LSA 11 Reclassification – Flash Flood

As discussed in Section 2.3.2 above, as a consequence of the flash flood event the new LSA 11-02, LSA 11-03, LSA 11-04 and LSA 11-05 were established. The radiological data generated during the flash flood event was reviewed and compared to the SU classifications provided in DP Chapter 14 Section 14.4.2.4, *Initial Classification of Survey Units*. The appropriate classification remained MARSSIM Class 3, for the land area previously approved in the DP as MARSSIM Class 3. The additional land area was reclassified from non-impacted to MARSSIM Class 3. As the westerly boundary of LSA 11-01 was adjacent to LSA 10 (Burial Pit Area), during the flash flood event flood water from LSA 11-01 (Northeast Site Creek) entered LSA 10. As a result of the flood water being in both LSA 10 and LSA 11 and having a shared boundary, LSA 11-01 was reclassified as MARSSIM Class 2 as SU LSA 11-01 now had a potential for radioactive contamination, but was not expected to exceed the $DCGL_w$.

2.3.3.2 Reclassification – Portion of LSA 11-03

During the FSS Remedial Action Support Survey (RASS) for the purpose of FSS Design of SU LSA 11-03, a soil sample analysis result of greater than 0.5 but less than 1.0 Uniform SOF was identified. As this sample result was greater than a SOF of 0.5 (the limit for a Class 3 SU), a new boundary for LSA 11-03 and LSA 11-01 was established. A portion of LSA 11-03 was transferred to LSA 11-01 to allow the reclassification of the affected portion of LSA 11-03 to MARSSIM Class 2 from MARSSIM Class 3. Figure 2-6 contains the reconfigured and reclassified portions of LSA 11-01 and LSA 11-03.

2.3.4 LSA 11-01 Survey Unit Description and Configuration

LSA 11-01 is located east of and adjacent to the entire length of the LSA 10, the Burial Pit Area. The events that contributed to the final boundary configuration of LSA 11-01 have been previously described in this section.

The predominant land feature of LSA 11-01 prior to remediation was the Northeast Site Creek. The remaining land feature of LSA 11-01 is woodlands. While no radiological remediation was necessary in LSA 11-01, excavations were performed to support decommissioning of the site. Prior to the initiation of remediation activities the Northeast Site Creek Diversion was installed

and placed into operation. The Northeast Site Creek Diversion included the installation of storm water culverts at the inlet and outlet to the Controlled Access Area. The areas where the diversion and the storm water culverts were installed were subject to Remedial Action Support Surveys (RASS) prior to installation with no areas of contamination identified. Also installed and placed into operation was a Detention Pond. A haul road along the perimeter of the site security fence that allowed access to the Burial Pit Area from the east side of the site was also installed.

FSS operations in LSA 11-01 began after the completion of FSS in the adjacent former Burial Pit Area, and after the Detention Pond was no longer in service, thus minimizing the potential for cross contamination and ensuring that the FSS was performed on the final surface of LSA 11-01.

Groundwater monitoring wells GW-BB and NB-80 were present in LSA 11-01 prior to commencement of remediation of the site and remained undisturbed throughout the remediation process. These wells remain in place and are monitored as part of the post-remediation groundwater monitoring.

The SU is 9,885 m^2 in planar extent.

Figure 2-1
HDP Land Survey Areas

Figure 2-2
Final Configuration of Land Survey Area 10

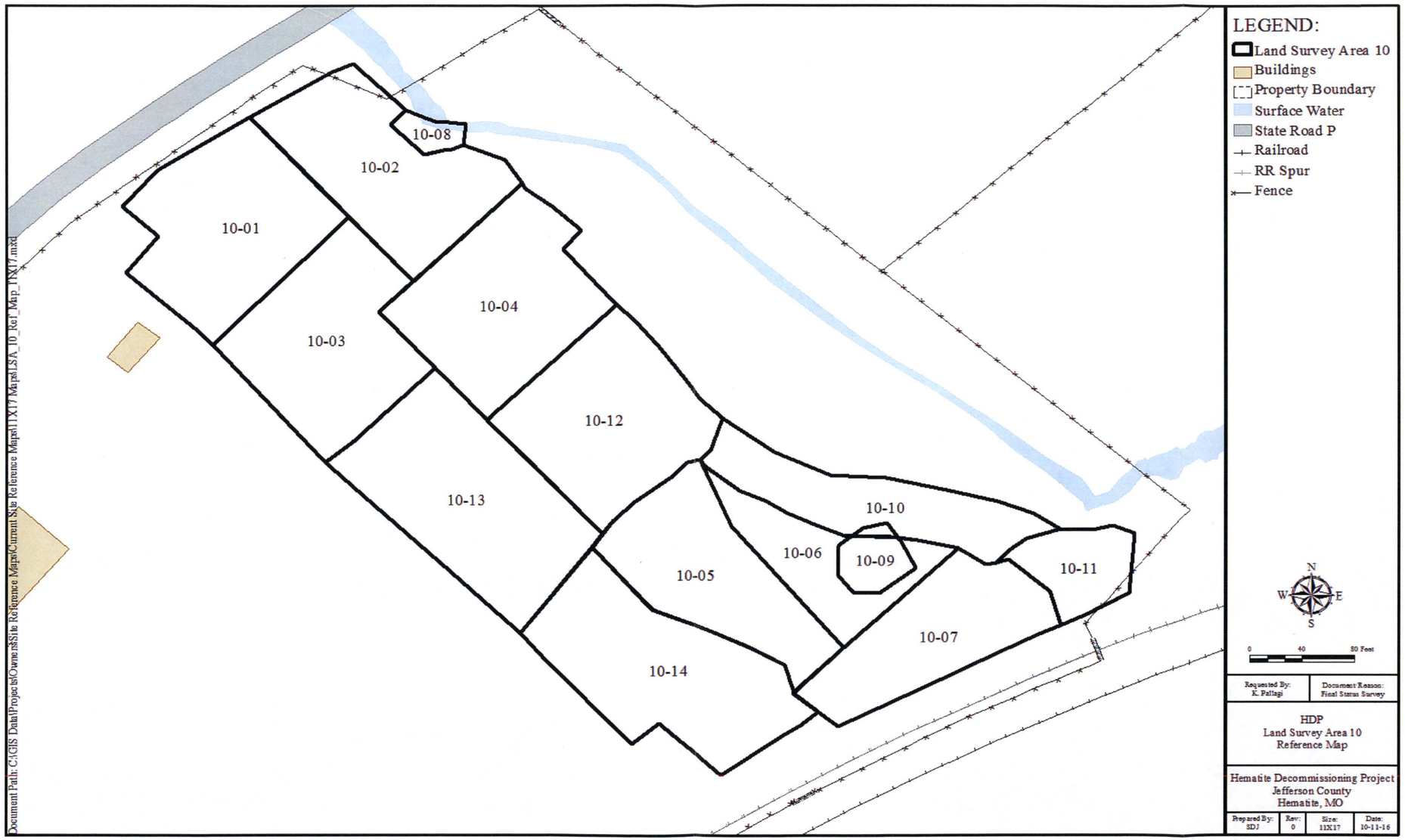


Figure 2-3
Initial Configuration of LSAs as Provided in DP (Figure 14-14)

Figure 2-4
Revised DP Figure Provided in HEM-11-96

Figure 2-5
Configuration of Land Survey Areas and Survey Units after Flash Flood Event

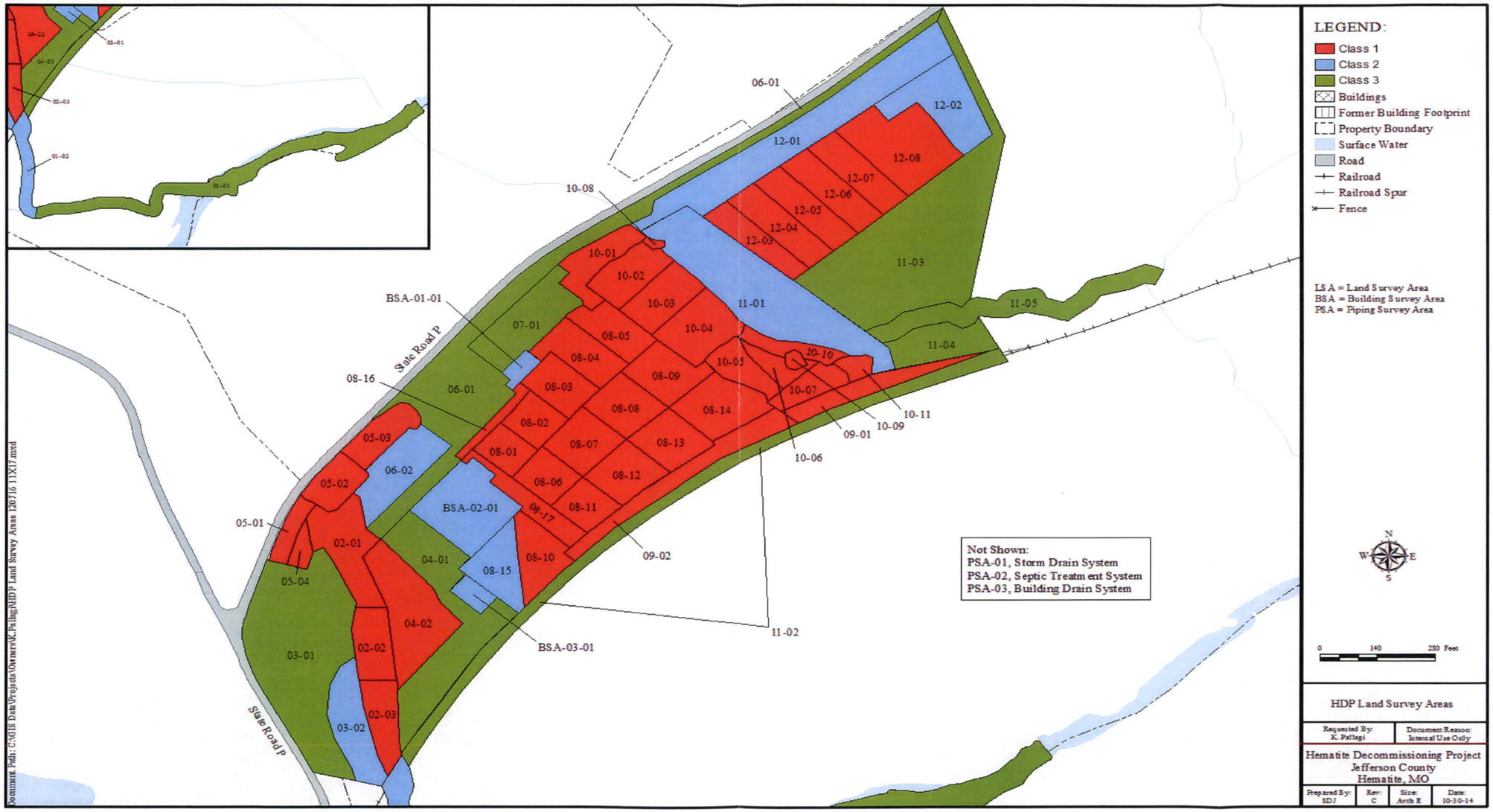
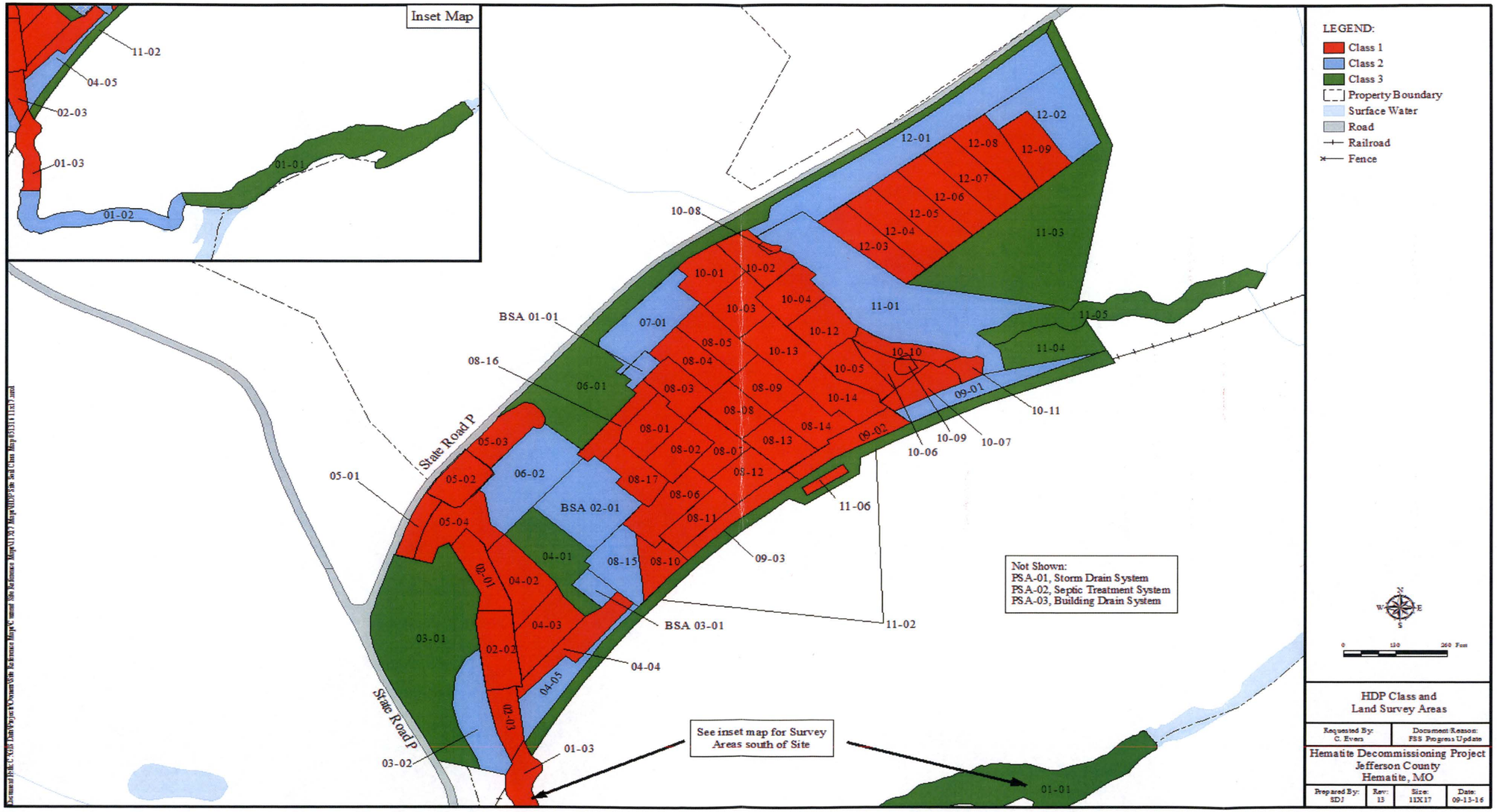


Figure 2-6
Final Configuration of Land Survey Areas and Survey Units



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*.

No Documented Burial Pits or Undocumented Burials were encountered in LSA 10-11 or LSA 11-01.

3.1 Radioactive Materials in LSA 10-11 and LSA 11-01

Due to the location and configuration of LSA 10-11 and LSA 11-01 relative to historical and site remediation activities, as expected, there were no Documented Burial Pits, Undocumented Burials, trash, debris, or spent limestone encountered in LSA 10-11 or LSA 11-01.

3.2 Reuse Soil Disposition and Characterization

No reuse soil was collected from LSA 10-11 or LSA 11-01.

3.3 Remediation and Remedial Action Support Surveys (RASS) Phase of LSA 10-11 and LSA 11-01

Site radiological characterization and site history provided no expectation of discovery of Documented Burial Pits, Undocumented Burials, trash, debris, or spent limestone in LSA 10-11 and LSA 11-01. The remedial and RASS activities in LSA 10-11 were driven by remediation activities in the adjacent Burial Pit Area SUs. No remedial excavation was required for FSS preparation in LSA 11-01.

3.3.1 Remedial Actions

3.3.1.1 Remedial Actions LSA 10-11

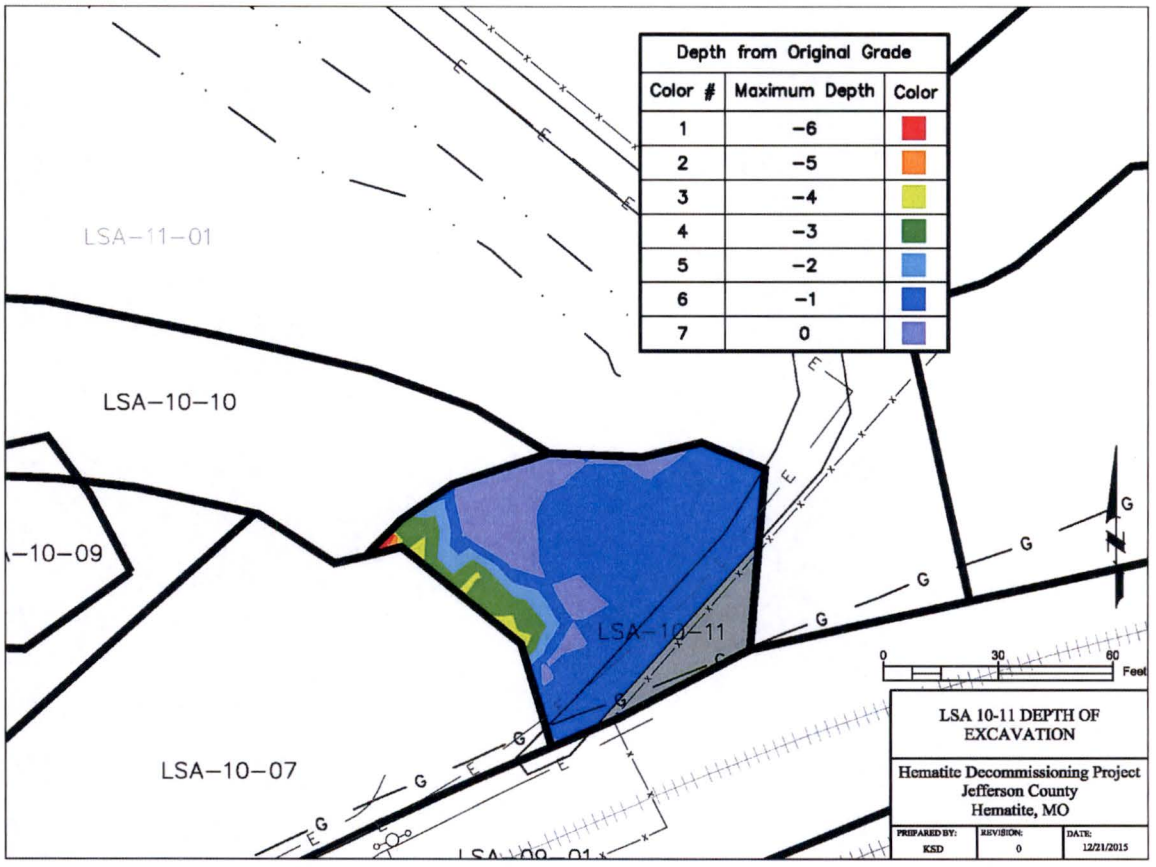
Remedial actions occurred in LSA 10-11 in March, 2015.

As excavation progressed for the removal of contaminated wastes and debris in the adjacent Burial Pit Area SUs, five activities came into play that determined the extent of remediation necessary in LSA 10-11. These were: 1) in process Remedial Action Support Surveys (RASS), 2) conducting core bores to support that nuclear criticality safety controls were not required in LSA 10-11, 3) performing a final RASS, 4) sampling for VOC remediation, and 5) conducting FSS. These will be discussed in later sections.

The average depth of remedial excavation in LSA 10-11 relative to the original grade was 1.33 ft bgs to remove vegetation (grass) and near surface overburden soil to allow visual inspection and radiological measurements to ensure all areas identified during site characterization were adequately remediated (see Figure 3-1). Portions of this SU were excavated to a depth beyond 1.33 feet bgs (up to approximately 6 ft bgs) which was primarily due to benching activities in adjacent SU excavations. It was not necessary to remove vegetation or near surface overburden

in the SU area which was outside of the site security fence. The estimated *in situ* volume of excavated waste materials from LSA 10-11 was 240 cubic yards.

Figure 3-1
LSA 10-11 Depth of Excavation Map (Depths in Feet)*



*Depth of Excavation Map presented in colored bands of feet. Maximum depth is 6 feet.

3.3.1.2 Remedial Actions LSA 11-01

No remedial actions were necessary for LSA 11-01.

3.3.2 In Process Remedial Action Support Surveys

LSA 11-01 was classified as a MARSSIM Class 2 SU with no remediation necessary. As such, in process RASS was not required in LSA 11-01.

During excavation and remediation of the adjacent Burial Pit Area SUs that affected the small area of LSA 10-11, RASS was conducted in accordance with procedure HDP-PR-HP-601, *Remedial Action Support Surveys*. For LSA 10-11 the radiological information obtained from the surveys served the purpose of determining areas of soil with residual contamination that were removed for waste disposal. It is noteworthy that the minimal amount of soil (a small portion of the 240 cubic yards) removed from LSA 10-11 would likely have successfully passed FSS if it

remained in place within the SU. Removal of this soil followed the application of the ALARA (As Low As Reasonably Achievable) philosophy.

3.3.3 Nuclear Criticality Safety (NCS) Borings

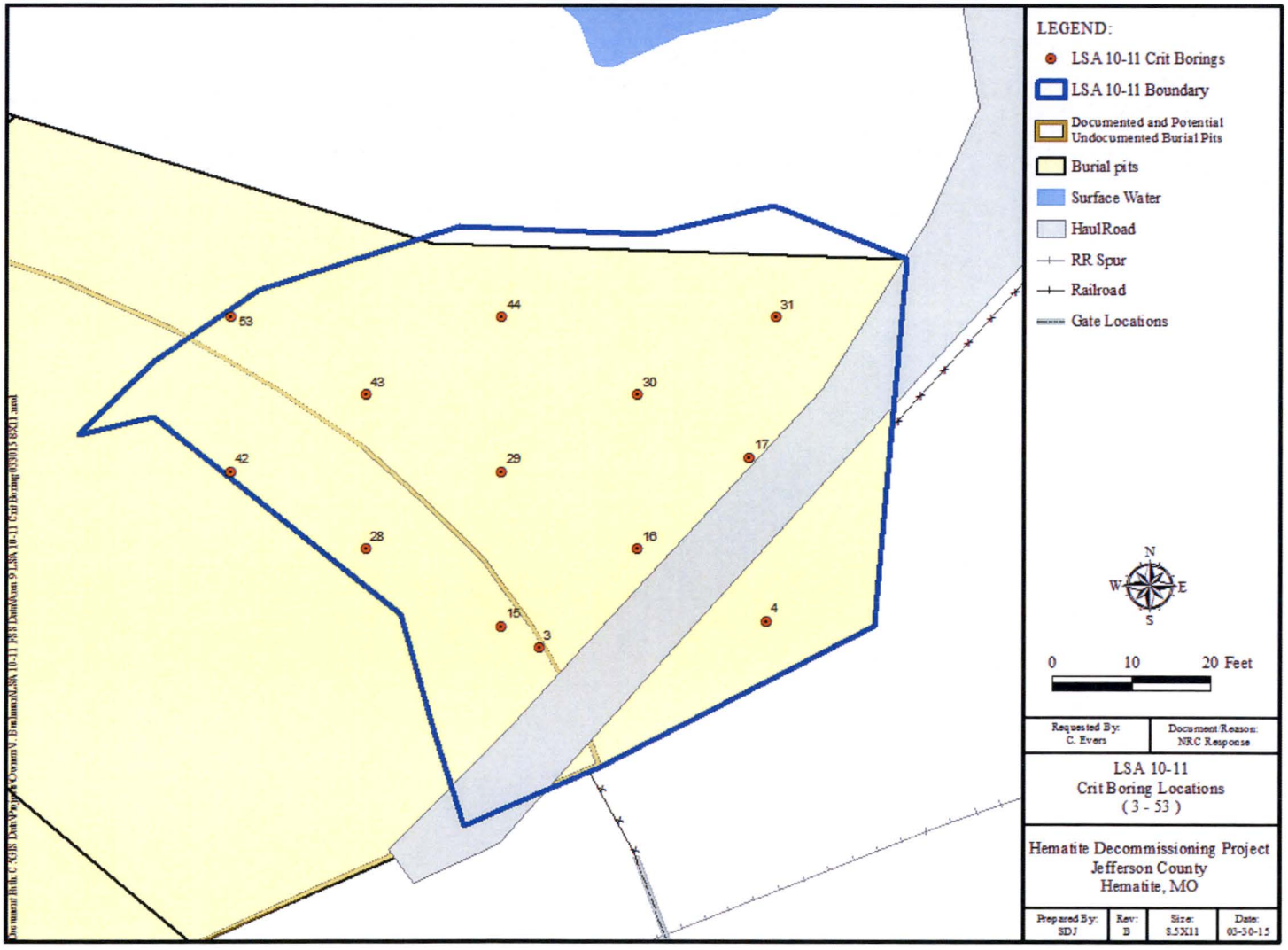
During remediation activities in LSA 10-11, in addition to the visual inspection and radiological measurements to determine when remediation was complete, and also after radiological measurements indicated that NCS controls could be removed from the small portion of the SU under NCS controls, a series of borings were performed within the entire SU.

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 excavated surface. The NSA-TR-09-15 Administrative CSC 23 required that these borings (see Figure 3-2) would be performed to 3 feet (ft) below the deepest identified buried waste item in an excavation (of which there was none) or 7 ft below ground surface (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 (of which there was none), a grid with maximum spacing of 20 ft between boreholes was conducted within the SU. 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 10-11, along with the results of the visual inspection, were then reviewed by the NCS Specialist and the SU was released from NCS controls. The visual inspection of the cores provided evidence that no materials indicative of burial pit waste were encountered below the excavated surface within LSA 10-11.

As LSA 11-01 was never placed under NCS controls, and was never suspected to contain buried materials, NCS core borings were not required to be performed within LSA 11-01.

Figure 3-2
NCS Core Bore Locations in LSA 10-11



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.

Three groundwater monitoring wells (all hybrid design) were installed within the boundary limits of LSA 10-11 and LSA 11-01. Hybrid groundwater monitoring well NB-80 is currently in service and is located within LSA 11-01. Hybrid groundwater monitoring wells NB-61 and WS-29 were located on the westerly boundary of LSA 10-11. Well NB-61 was abandoned prior to 2011, and well WS-29 was abandoned in February 2012 in accordance with State of Missouri requirements.

Hybrid monitoring wells feature wells screens in both the upper silty-clay soil layer and the lower sand/gravel layer. They are of particular concern within SUs due to their design in which the well screen could potentially facilitate the transport of contaminated material from the overburden layer to the Deep stratum and sand/gravel aquifer. As such, HDP has a license commitment associated with the DP to perform soil sampling in the vicinity of hybrid monitoring wells, as described in Section 7.0 of Attachment 1 to Westinghouse letter HEM-11-56 (Reference 6.6) which states:

"When hybrid wells are abandoned they will be over drilled using hollow stem augers of sufficient outside diameter to remove approximately two inches of surrounding soil, the well riser, well screen, and screened filter pack. The auger will continue until reaching refusal, which indicates bedrock. The soil cuttings that are removed during the boring process will be surveyed for indications of elevated radioactivity as a qualitative measure and sampled for laboratory analysis. Within each 5 foot interval, sample(s) of soil indicating elevated concentrations will be collected for laboratory analysis. In the event that an elevated count is not observed, one composite sample of the cuttings collected within each 5 foot interval will be collected for laboratory analysis."

Site records indicate that WS-29 was abandoned and sampled in February 2012, in accordance with the requirements as specified above. The maximum SOF result from the six (6) cuttings samples collected from WS-29 during abandonment was 0.23 of the Uniform $DCGL_w$. As NB-61 was abandoned prior to 2011, no abandonment cuttings samples were collected.

Section 7.0 of Attachment 1 to HEM-11-56 also states:

"When completing remediation actions in the area of a hybrid well screen that extends beyond the depth of soil excavation, any water sample taken over the history of that well will be assessed for results that exceed the MDC+Error for Tc-99 or exceed the Background Threshold Value for total uranium. For such an exceedance, four borings will be made in close proximity (e.g., approximately equidistant within a 2-4 foot radius) to each monitoring well that is not excavated to the bottom of the well."

A review of the radiological water sample data from NB-61 and WS-29 prior to abandonment indicated that there was no historic exceedance of uranium above the uranium background threshold value of 8.6 pCi/l and no Tc-99 results that exceeded the MDC+Error for any water

samples collected from these wells. Therefore, it was not necessary to perform supplemental investigation borings proximal to NB-61 or WS-29.

Appendix I presents the analytical water data for existing hybrid groundwater monitoring well NB-80 and abandoned groundwater monitoring wells NB-61 and WS-29, in addition to the well abandonment soil sample results for groundwater monitoring well WS-29.

3.3.5 Subterranean Piping

Preliminary remediation planning activities indicated that no subterranean process piping should be encountered in LSA 10-11 and LSA 11-01. During the remediation of LSA 10-11 no subterranean process piping was encountered.

As no buried piping existed or remains under the footprint of either LSA 10-11 or LSA 11-01 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 eleven (11) boring locations with depths up to 28 feet bgs were sampled for characterization within LSA 10-11 and LSA 11-01 prior to remediation.

None of the samples collected from the four (4) characterization borings in LSA 10-11 exceeded a SOF of 1 as compared to the Uniform Stratum criteria. Although LSA 10-11 was designated a MARSSIM Class 1 SU, the fact that no characterization samples exceeded cleanup criteria in LSA 10-11 is not unexpected as most of the LSA 10-11 SU land area is located outside the historic Burial Pit Area footprint. Figure 3-3 indicates the radiological characterization boring locations within LSA 10-11.

As would be expected for a MARSSIM Class 2 SU, no sample collected from the seven (7) characterization borings in LSA 11-01 exceeded a SOF of 1 as compared to the Uniform Stratum criteria. Figure 3-4 indicates the radiological characterization boring locations within LSA 11-01.

Figure 3-3
Site Characterization Borings within LSA 10-11

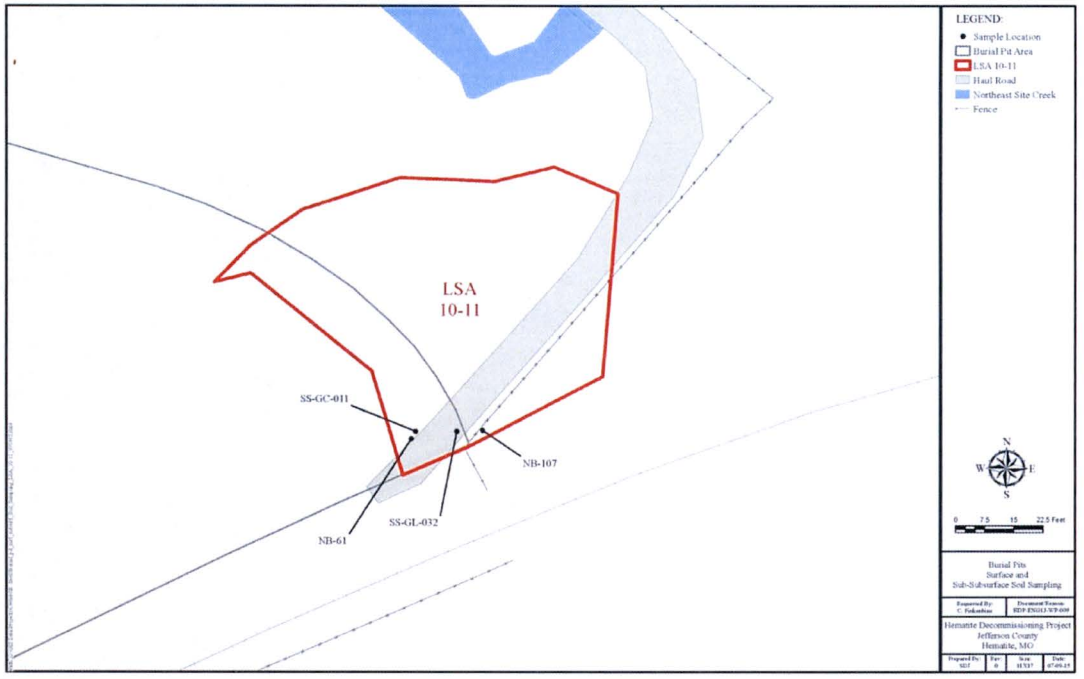
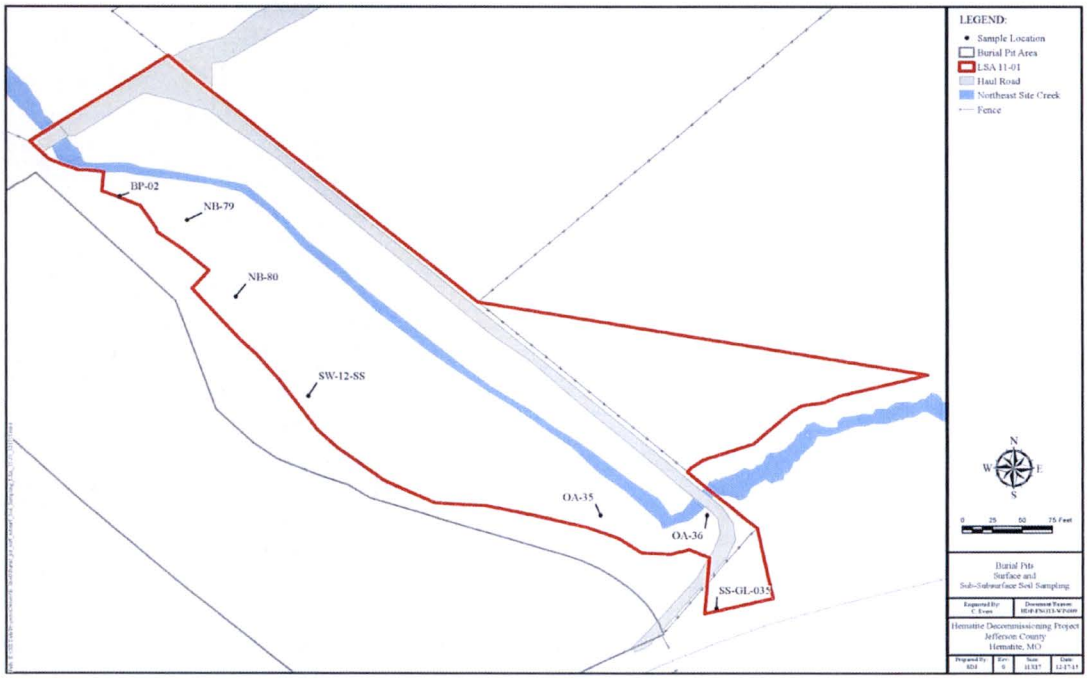


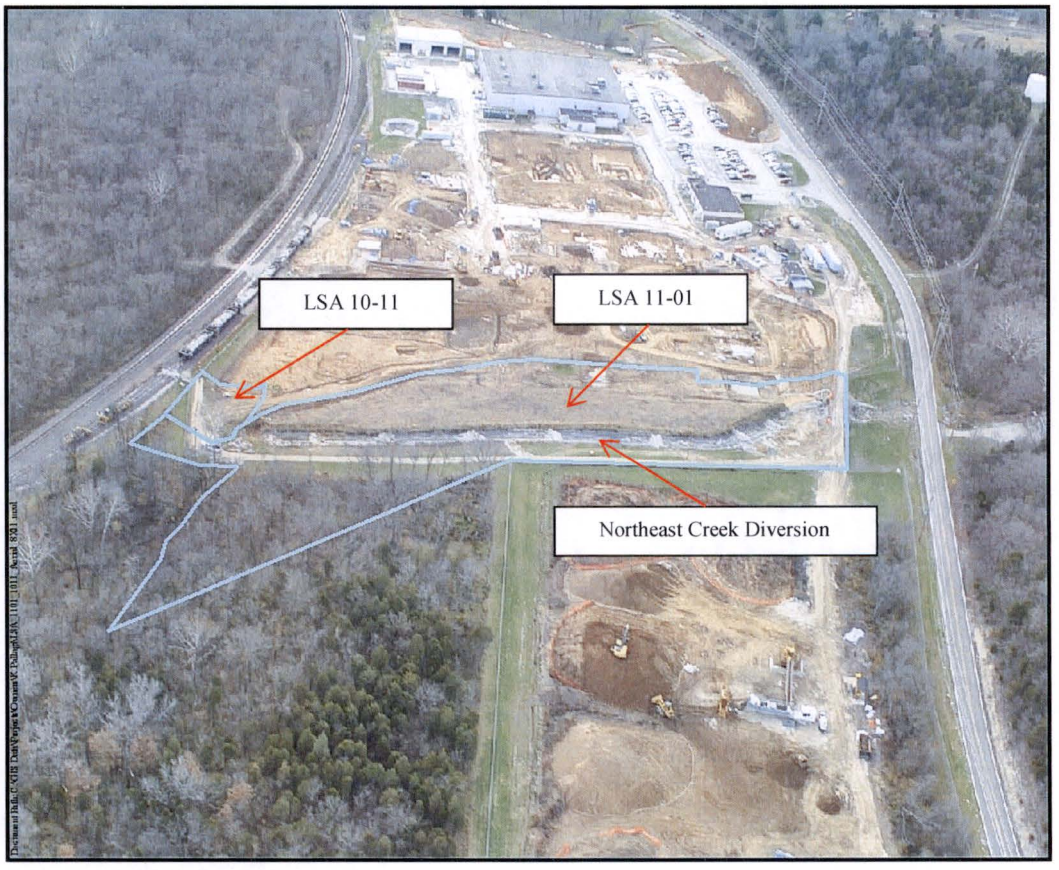
Figure 3-4
Site Characterization Borings within LSA 11-01



3.3.7 Remedial Action Support Survey for FSS Design

The RASS was conducted to guide remediation activities, determine when an area or SU had been adequately prepared for FSS, and provide updated estimates of the parameters to be used for planning the FSS. Upon completion of activities within the SU and prior to implementation of FSS activities, a final RASS was performed prior to the finalization of Isolation and Control (I & C) postings. The I & C postings were completed for both LSA 10-11 and LSA 11-01 on March 30, 2015. Figure 3-5 is a photograph which demonstrates the condition that LSA 10-11 and LSA 11-01 were in when ready for the final RASS. As previously discussed, minimal soil disturbance occurred in LSA 10-11 due to remediation activities in the adjacent Burial Pit Area and no remediation was required to be performed in LSA 11-01.

Figure 3-5
LSA 10-11 and LSA 11-01



The RASS included a GWS, systematic surface sample collection based on an eight (8) -point triangular grid, and biased surface sampling.

For LSA 10-11, twelve sample results (eight systematic, four biased) collected during the final RASS at the time just prior to implementation of isolation and controls were reviewed to validate compliance to the Uniform Stratum DCGLs.

For LSA 11-01, thirteen sample results (eight systematic, five biased) collected during the final RASS at the time just prior to implementation of isolation and controls were reviewed to validate the Class 2 classification and compliance to the Uniform Stratum DCGLs.

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 10-11 and LSA 11-01

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
10-11	0.02	0.10	0.23	0.39	0.08	0.29	2.72	4.79	0.15	0.26	1.17	1.35
11-01	0.02	0.12	0.43	1.13	0.01	0.08	3.09	4.56	0.17	0.25	0.95	1.58
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* (Reference 6.8), on March 30, 2015, LSA 10-11 was isolated and controlled in accordance with Work Package HDP-WP-ENG-803, *Isolation and Control Measures*, (see Figure 3-6) Isolation and control for the south boundary of LSA 11 was established as part of the isolation and control implementation for the Burial Pit Area (see Figure 3-7). Isolation and control measures include silt fence, straw wattle and soil berms between the Class 1 SUs (LSA 10-01 thru LSA 10-11) and adjacent remediation areas to ensure that cross-contamination of the LSA(s) undergoing FSS does 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 LSA 10-11 prior to FSS field activities to prevent inadvertent entry by personnel as is required for Class 1 areas. As a Class 2 area LSA 11-01 was not encompassed with green and white rope, but was administratively controlled by the use of multiple postings labeled "Contact Health Physics Prior to Entry" installed around the perimeter of the SU to prevent inadvertent entry by personnel. LSA 10-11 and LSA 11-01 are partially enclosed within the fenced security perimeter of the HDP Controlled Access Area to prevent access by the general public. An approximately 1800 m^2 section of LSA 11-01 extends eastward into the wooded area outside the site perimeter fence. Approximately 50 m^2 of LSA 10-11 is situated outside the site perimeter fence.

Figure 3-6
Isolation and Control of Area Containing LSA 10-11

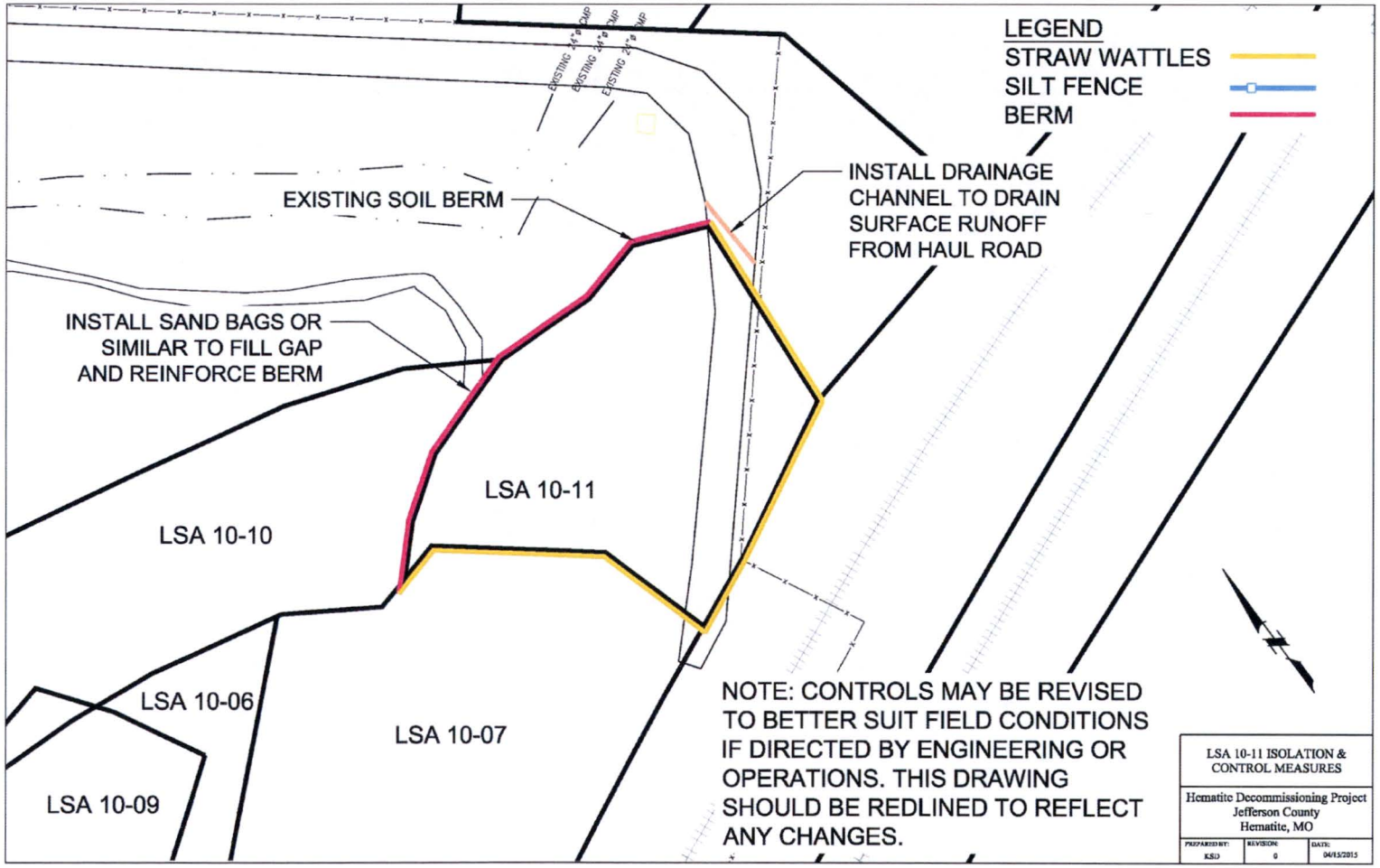
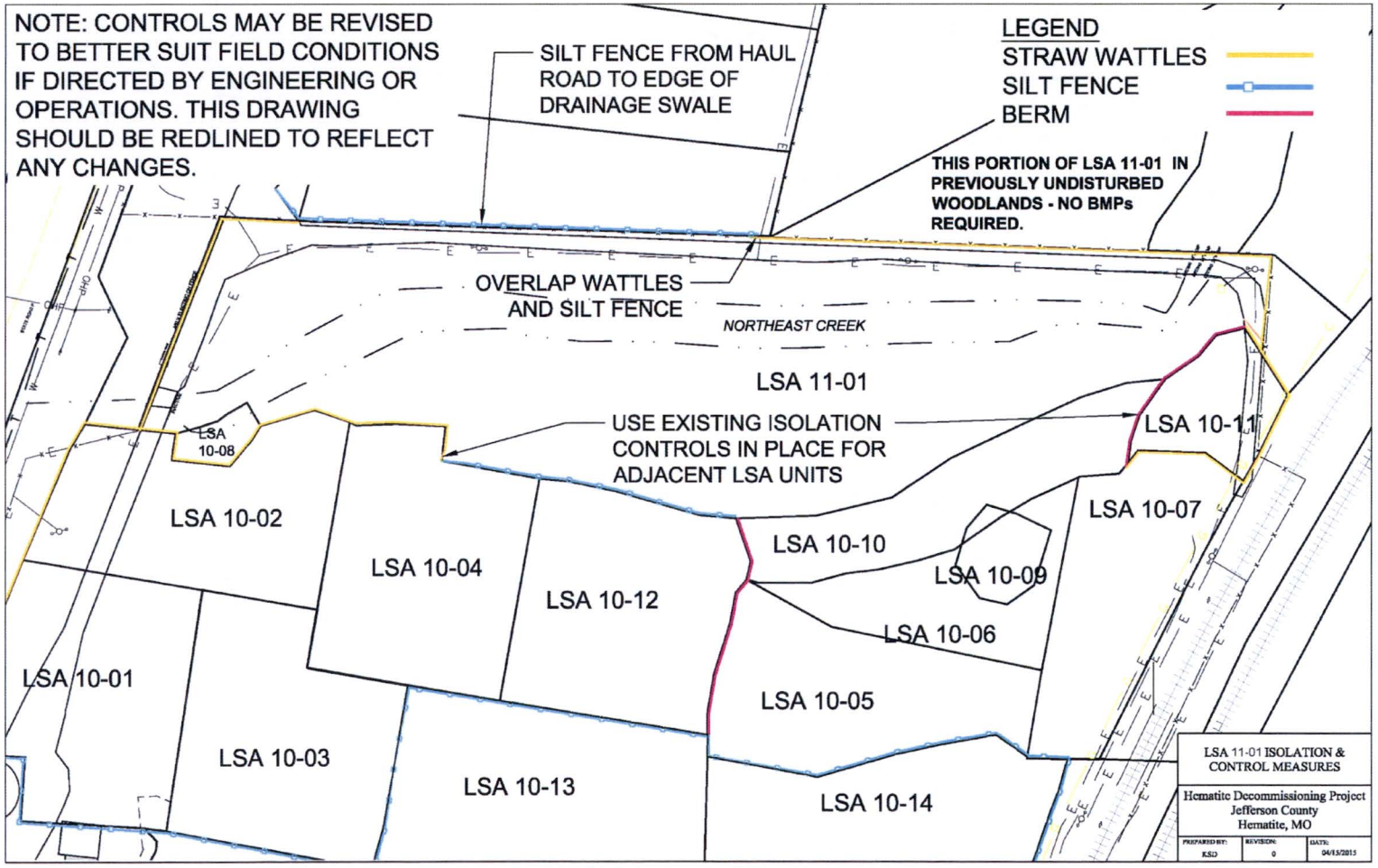


Figure 3-7
Isolation and Control of Area Containing LSA 11-01



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 10-11 and LSA 11-01. 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 start of backfill activities LSA 10-11 and LSA 11-01 have not evidenced 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, LSA 10-11 was backfilled with off-site "borrow" soil from the Horine Road site in Festus, MO. Further details on off-site "borrow" soil can be found in FSSFR Volume 2, Chapter 8 {ML16285A375}. As only off-site backfill material was used in LSA 10-11, no dose will be added to LSA 10-01 for backfill material.

Although LSA 11-01 did not require remedial excavation, a small amount of backfill material was added along the westerly banks of Northeast Site Creek to ensure that the final grade provided positive drainage within the area. Combined Reuse Stockpile 5-6 {ML16285A372} was used for this purpose and as such, 7.75 mrem/year will be added to the total dose calculation for LSA 11-01 to account for the placement of the reuse soil.

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 (milliroentgen equivalent man/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 10-11 and LSA 11-01 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* {ML16027A303}, provides a detailed discussion on the release criteria that is applicable to LSA 10-11 and LSA 11-01. 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 10-11

This section of the report describes the method for determining the number of samples required for the FSS of LSA 10-11 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 10-11 and the detection sensitivities are also discussed.

5.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 10-11 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 6, *Final Status Survey Plan Development*, March 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 10-11. The review identified no areas were previously found to exceed a Uniform Stratum SOF of 1.0 (discussed in Section 3.3.6). Next the remediation history was reviewed to confirm that the area was 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.

5.1.3 GWS Coverage

As a Class 1 SU, LSA 10-11 was required to undergo a 100% GWS.

5.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 10-11 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 10,000 counts per minute (cpm) within LSA 10-11, 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:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3169\ pCi/g}\right)+\left(\frac{f_{U-235}}{2.0 pCi/g}\right)+\left(\frac{f_{U-238}}{26.5 pCi/g}\right)\right)}$$

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 6, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 10-11, the average enrichment for the SU was 1.9%.

HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)* documents the calculated MDC_{scan} of 0.75 pCi/g for Th-232 and 1.04 pCi/g for Ra-226 when using a 2"x 2" NaI detector with a 10,000 cpm background.

Table 5-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 10-11

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 10-11	35.5	87.7	1.04	2.8	0.75	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. DCGLw 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 10-11 was established at 4,000 net counts per minute (ncpm).

5.1.7 LSA 10-11 FSS Design Summary

The FSS Plan for LSA 10-11 can be found in Appendix C. Table 5-2 presents an overall FSS design and implementation summary for LSA 10-11.

Table 5-2
FSS Design Summary for LSA 10-11

Gamma Walkover Survey (GWS):		
Scan Coverage	100% accessible excavation floors and walls	
Scan MDC	35.5 pCi/g total Uranium (based on a 10,000 cpm background); 0.75 pCi/g Th-232; 1.04 pCi/g Ra-226*	
Investigation Action Level (IAL)	4,000 net cpm **	
Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	1	These samples will be taken on a systematic grid.
15 cm – 1.5 m (Root)	8	
> 1.5m (Excavation)	8	
Biased Survey/Sampling Locations:		
Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the FSS Supervisor.		
Instrumentation		
Ludlum 2221 with 44-10 (2x2 NaI) detector; with collimation for investigations	Used for GWS and to obtain static count rates at biased measurement locations.	
*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).*		
**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum $DCGL_W$ derived from the technical basis presented in HEM-MEMO-15-021.		

6.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 10-11

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 10-11 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, 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.

FSS technicians performing GWS in LSA 10-11 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), FSS 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, FSS 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 8,000 and 9,000 gross counts per minute (gcpm). Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 12,000 to 13,000 gcpm, FSS 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 10-11.

Table 6-1
Systematic Sampling Summary by Stratum for LSA 10-11

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
10-11	459	1	8	8	1

6.2.2 Systematic Sampling LSA 10-11

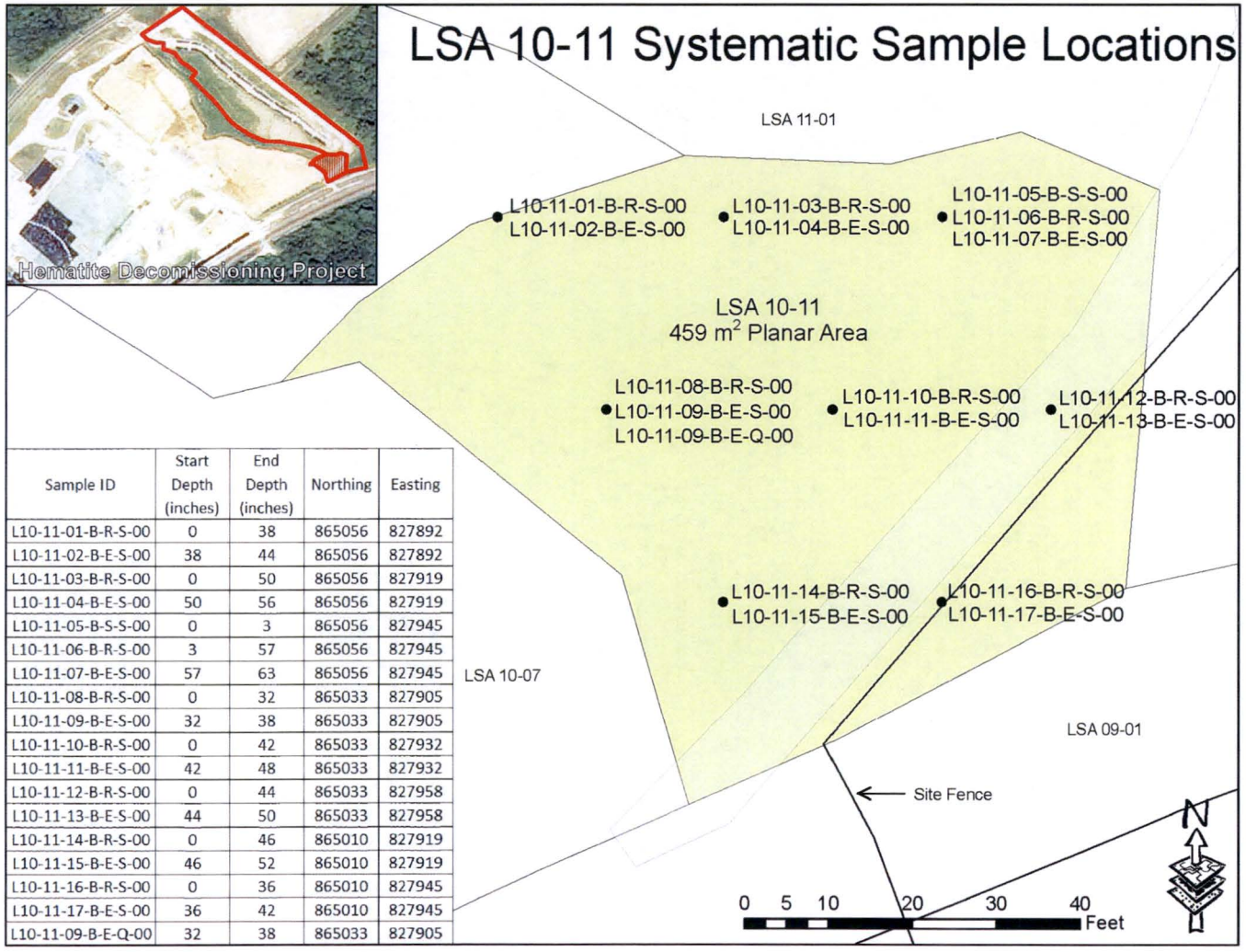
Within LSA 10-11, there was one systematic locations in which portions of the surface stratum [0 – 15 centimeters (cm)] remained in the SU after remediation. Portions of the root stratum (15 cm – 150 cm) remained at all eight (8) of the eight systematic locations. At this location the remaining root 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 459 m^2 for LSA 10-11 and an eight - point systematic triangular grid, the point-to-point distance within each row was 8.1 m with spacing of 7 m between each of the parallel grid rows within the SU.

While there were eight systematic locations on the LSA 10-11 sampling grid, a total of thirteen (13) samples were collected at these locations, including:

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

Figure 6-1 presents the map of the eight systematic sample locations which were sampled within LSA 10-11. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 6-1
LSA 10-11 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L10-11-01-B-R-S-00	0	38	865056	827892
L10-11-02-B-E-S-00	38	44	865056	827892
L10-11-03-B-R-S-00	0	50	865056	827919
L10-11-04-B-E-S-00	50	56	865056	827919
L10-11-05-B-S-S-00	0	3	865056	827945
L10-11-06-B-R-S-00	3	57	865056	827945
L10-11-07-B-E-S-00	57	63	865056	827945
L10-11-08-B-R-S-00	0	32	865033	827905
L10-11-09-B-E-S-00	32	38	865033	827905
L10-11-10-B-R-S-00	0	42	865033	827932
L10-11-11-B-E-S-00	42	48	865033	827932
L10-11-12-B-R-S-00	0	44	865033	827958
L10-11-13-B-E-S-00	44	50	865033	827958
L10-11-14-B-R-S-00	0	46	865010	827919
L10-11-15-B-E-S-00	46	52	865010	827919
L10-11-16-B-R-S-00	0	36	865010	827945
L10-11-17-B-E-S-00	36	42	865010	827945
L10-11-09-B-E-Q-00	32	38	865033	827905

~~Figure~~ Table 6-2 below presents a tabular listing of all FSS samples collected within LSA 10-11 with associated IDs, sample types, collection intervals, coordinates, and notes.

~~Figure~~ Table 6-2

FSS Sample Locations and Coordinates for LSA 10-11

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

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

Survey Unit: 11 **Description:** South Eastern Survey Unit in "Area 9"

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
L10-11-01-B-R-S-00	Uniform	S	423.6	420.5	865056.0	827892.0	Root 38-inch composite
L10-11-02-B-E-S-00	Uniform	S	420.5	420.0	865056.0	827892.0	Excavation 6-inch grab
L10-11-03-B-R-S-00	Uniform	S	423.7	419.6	865056.0	827918.6	Root 50-inch composite
L10-11-04-B-E-S-00	Uniform	S	419.6	419.1	865056.0	827918.6	Excavation 6-inch grab
L10-11-05-B-S-S-00	Uniform	S	423.4	423.1	865056.0	827945.1	Surface 6-inch grab
L10-11-06-B-R-S-00	Uniform	S	423.1	418.6	865056.0	827945.1	Root 53-inch composite
L10-11-07-B-E-S-00	Uniform	S	418.6	418.1	865056.0	827945.1	Excavation 6-inch grab
L10-11-08-B-R-S-00	Uniform	S	424.9	422.2	865033.0	827905.3	Root 32-inch composite
L10-11-09-B-E-S-00	Uniform	S	422.2	421.7	865033.0	827905.3	Excavation 6-inch grab
L10-11-10-B-R-S-00	Uniform	S	424.8	421.3	865033.0	827931.9	Root 42-inch composite
L10-11-11-B-E-S-00	Uniform	S	421.3	420.8	865033.0	827931.9	Excavation 6-inch grab
L10-11-12-B-R-S-00	Uniform	S	424.3	420.6	865033.0	827958.4	Root 44-inch composite
L10-11-13-B-E-S-00	Uniform	S	420.6	420.2	865033.0	827958.4	Excavation 6-inch grab
L10-11-14-B-R-S-00	Uniform	S	427.7	423.9	865010.1	827918.6	Root 46-inch composite
L10-11-15-B-E-S-00	Uniform	S	423.9	423.4	865010.1	827918.6	Excavation 6-inch grab
L10-11-16-B-R-S-00	Uniform	S	426.4	423.4	865010.1	827945.1	Root 36-inch composite
L10-11-17-B-E-S-00	Uniform	S	423.4	422.9	865010.1	827945.1	Excavation 6-inch grab
L10-11-18-B-R-B-00	Uniform	B	428.9	426.9	865011.0	827913.0	Biased 6-inch grab
L10-11-19-B-R-B-00	Uniform	B	427.0	425.2	865029.0	827919.0	Sidewall 6-inch grab
L10-11-09-B-E-Q-00	Uniform	Q	422.2	421.7	865033.0	827905.3	Excavation 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 10-11 one (1) biased sample locations 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 survey unit of 10,205 gcpm. Biased sample L10-11-18-B-R-B-00 was collected at this location.

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 FSSFR 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).

For LSA 10-11, the difference between the planar (459 m^2) and three-dimensional surface area (550 m^2) was 91 m^2. Using the assumption that the 91 m^2 differential is entirely attributable to interior sidewalls and given the area bounded by each systematic sample in LSA 10-11 was 57.4 m^2 (459 m^2/ 8), the number of required supplemental sidewall samples was calculated was two (2), (i.e., 91 / 57.4 $\approx$ 1.59). However, only one sidewall sample was collected as it was visually apparent that the actual sidewall area within the SU was significantly smaller then the assumed sidewall area, with the majority of the surface area featuring sloping terrain less than 45° towards the former Northeast Site Creek location in LSA 11-01. The LSA 10-11 sidewall sample result (L10-11-19-B-R-B-00) is discussed in Section 7.2.6. The sample was collected from a location selected by the HP Technician at random, and was not based on gamma survey readings (not biased).

6.5 Quality Control Soil Sampling

One QC field duplicate sample point was randomly selected and collected at systematic location L10-11-09 for LSA 10-11.

7.0 FINAL STATUS SURVEY RESULTS LSA 10-11

7.1 Gamma Walkover Survey

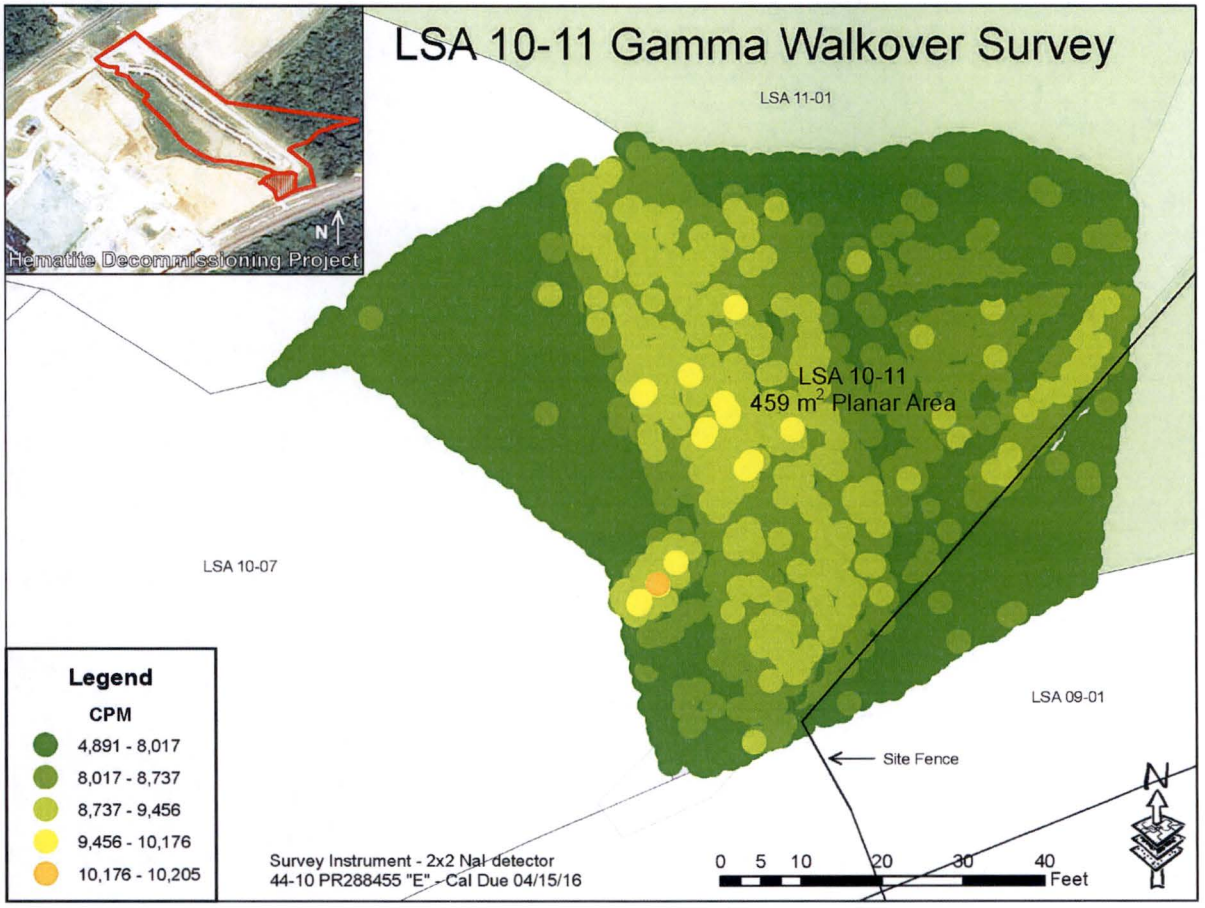
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are 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 10-11 on April 21, 2015.

7.1.1 GWS Results for LSA 10-11

For LSA 10-11, GWS count rates ranged between 4,891 gcpm and 10,205 gcpm, with a mean count rate of 7,297 gcpm. The median count rate was 7,290 gcpm and the standard deviation was 720 cpm. Figure 7-1 below presents a map of the complete GWS data set.

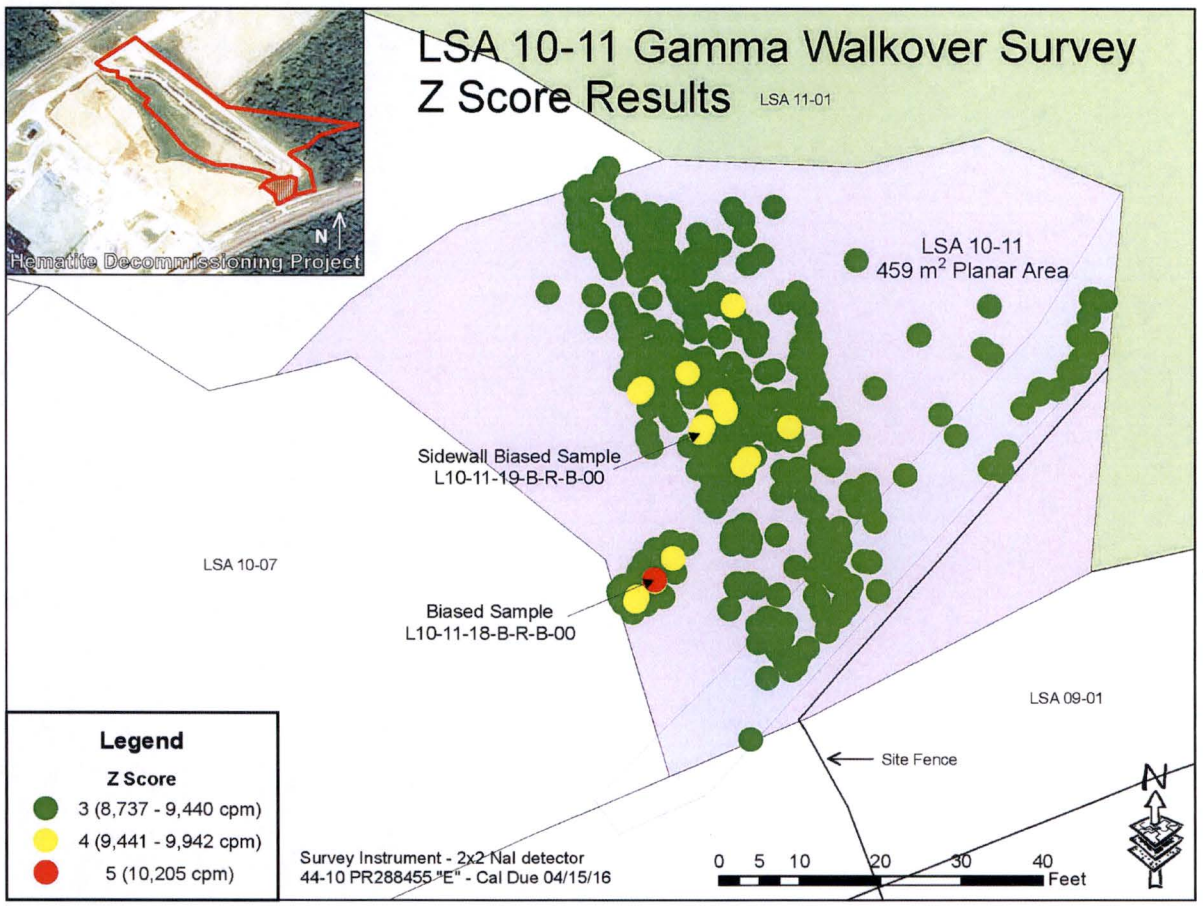
Figure 7-1
Colorimetric GWS Plot for LSA 10-11



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, L10-11-18, was selected for biased sample collection. This biased location represented the maximum GWS measurement encountered within the survey unit, 10,205 gcpm. The gamma measurement at this biased location did not exceed the IAL (~12,000 gcpm) based on the local background readings, but did exceed a Z-score of three (3). No additional biased locations were selected for sampling.

Figure 7-2 below presents a map of the +3 Z-score GWS measurements within LSA 10-11, including the selected biased sampling location (ID: L10-11-18-B-R-B-00). For completeness, the location of the one supplemental sidewall samples (not driven by elevated GWS measurements) is also shown in Figure 7-2.

Figure 7-2
Colorimetric GWS Plot for LSA 10-11 (Measurements > Z-score of 3)



A total of 16,922 individual GWS measurements were collected in LSA 10-11.

Since all GWS data collected in LSA 10-11 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 scan MDC of approximately 40.9 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 10-11, 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:

$$\text{Scan MDC}_{Total\ Uranium} = \quad 1 \Big/ \left(\left(\frac{0.7928}{3659}\right) + \left(\frac{0.0438}{2.32}\right) + \left(\frac{0.1634}{30.6}\right)\right) = 40.9 \frac{pCi}{g}$$

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 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 FSS 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 10-11

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. 100% of accessible areas underwent GWS, very small areas along the site fence that were surveyed were not able to be accurately recorded by the GPS handset due to limitations in the GPS technology. 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 99.92% 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 10-11

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 10-11	692,503	588	0.08	99.92	1

7.2 Soil Sample Results LSA 10-11

Appendix A presents the analytical results and associated statistics for all FSS surface samples collected within LSA 10-11.

7.2.1 Surface Soil Sample Results LSA 10-11

There was one sample collected within the surface stratum (0 – 15 cm) of LSA 10-11. There were a total of ten (10) soil samples collected within the topmost soil layer of the excavation surface including eight systematic samples (one surface and seven root composite samples) and two biased samples. ~~Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the WRS statistical test was not necessary for LSA 10-11, since the difference between the maximum survey unit data set gross SOF and the minimum background area adjusted SOF was less than one. However, for illustrative purposes, the WRS evaluation was performed for LSA~~

~~10-11 and is included in Appendix A. QC and biased sample results are not utilized in the WRS test. The eight systematic samples collected in the "topmost" SU 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, W_r (784), was greater than the critical value, CV (705), for the test. As such, the null hypothesis that the SU average concentration is greater than the $DCGL_W$ was rejected.~~ The maximum SOF result for the "topmost" samples was 0.34 corresponding to sample L10-11-14-B-R-S-00, with the biased samples (L10-11-18-B-R-B-00 and L10-11-19-B-R-B-00) resulting in a 0.18 and 0.17 SOF, respectively.

~~Appendix A presents the analytical results and associated statistics for all FSS surface samples collected within LSA 10-11.~~

7.2.2 Subsurface Soil Sample Results LSA 10-11

There was one systematic location within LSA 10-11 where root stratum composite sampling below a 6-inch (0.15 m) surface sample was performed. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At all eight root stratum composite sampling location, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected. The eight excavation stratum samples where there was overlying root stratum remaining, the root sample below a systematic surface sample, as well as the QC field duplicate sample, were all considered "subsurface" samples and therefore did not factor into the WRS test evaluation. The maximum SOF result of the subsurface samples collected in LSA 10-11 was 0.36. This sample (L10-11-07) was the excavation stratum sample collected directly underneath the root stratum sample L10-11-06 and surface sample L10-11-05.

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

7.2.3 WRS Test Evaluation LSA 10-11

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 10-11 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 10-11. 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 17 systematically collected samples in LSA 10-11 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, (1072) was greater than the critical value (879) 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 10-11

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 10-11, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.15.

Table 7-2
LSA 10-11 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	0.11	0.11	0.15	1.71	0.09	1.03	**0.15**
Minimum	0.00 (<BKG)	0.05	0.00 (<BKG)	0.10	0.00	0.61	0.01
Maximum	0.45	0.47	0.33	2.99	0.16	1.41	0.36

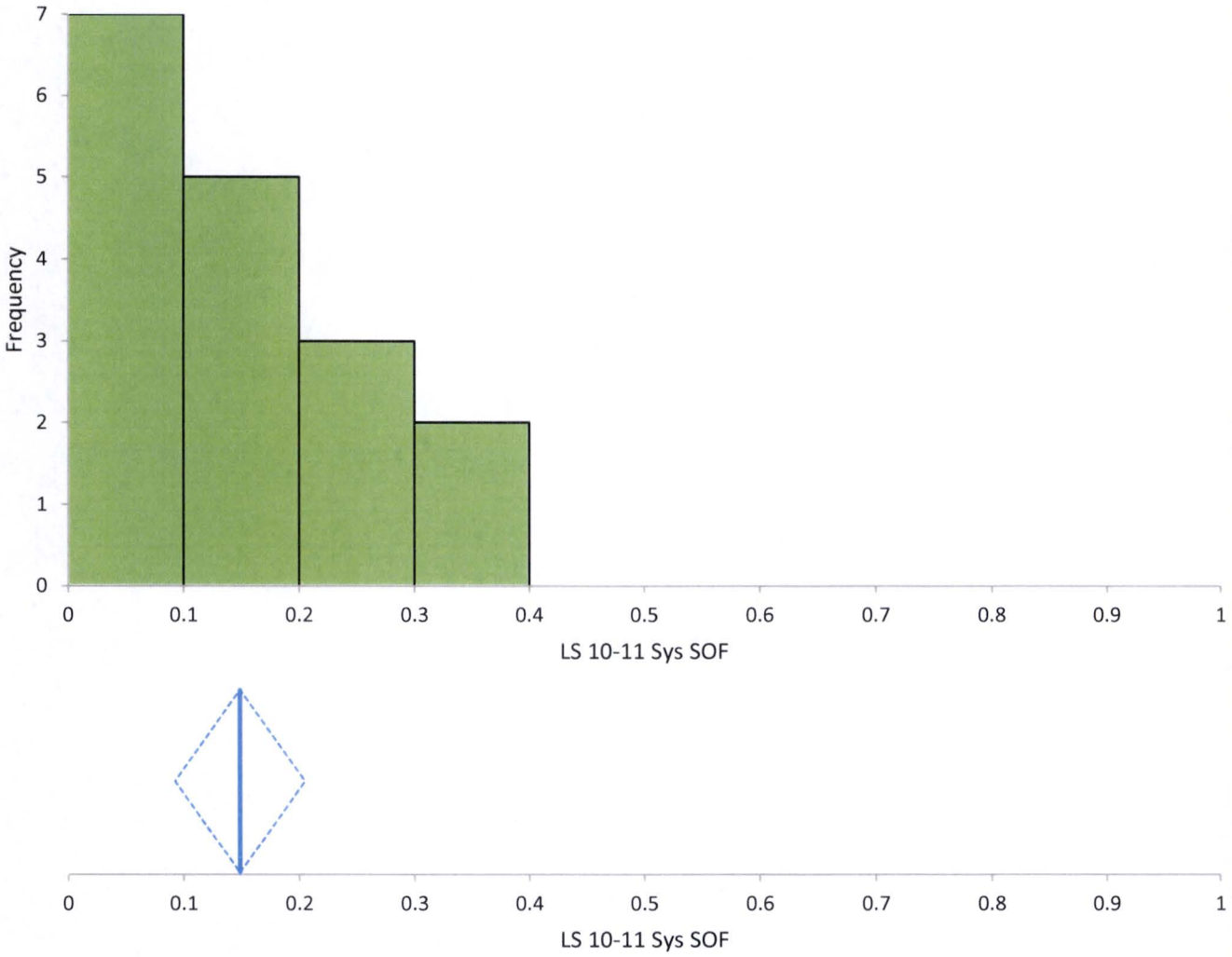
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide 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 10-11. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 10-11. The middle graph presents the mean SOF (0.15 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 0.09 to 0.20. The 95.1% confidence interval based on the median (0.12) of the sample results is 0.08 to 0.22. The bottom two charts present the various statistical metrics of the LSA 10-11 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 10-11 data associated with the systematically collected measurement locations.

Figure 7-3
Graphic Statistical Summary for LSA 10-11 (SOF parameter)



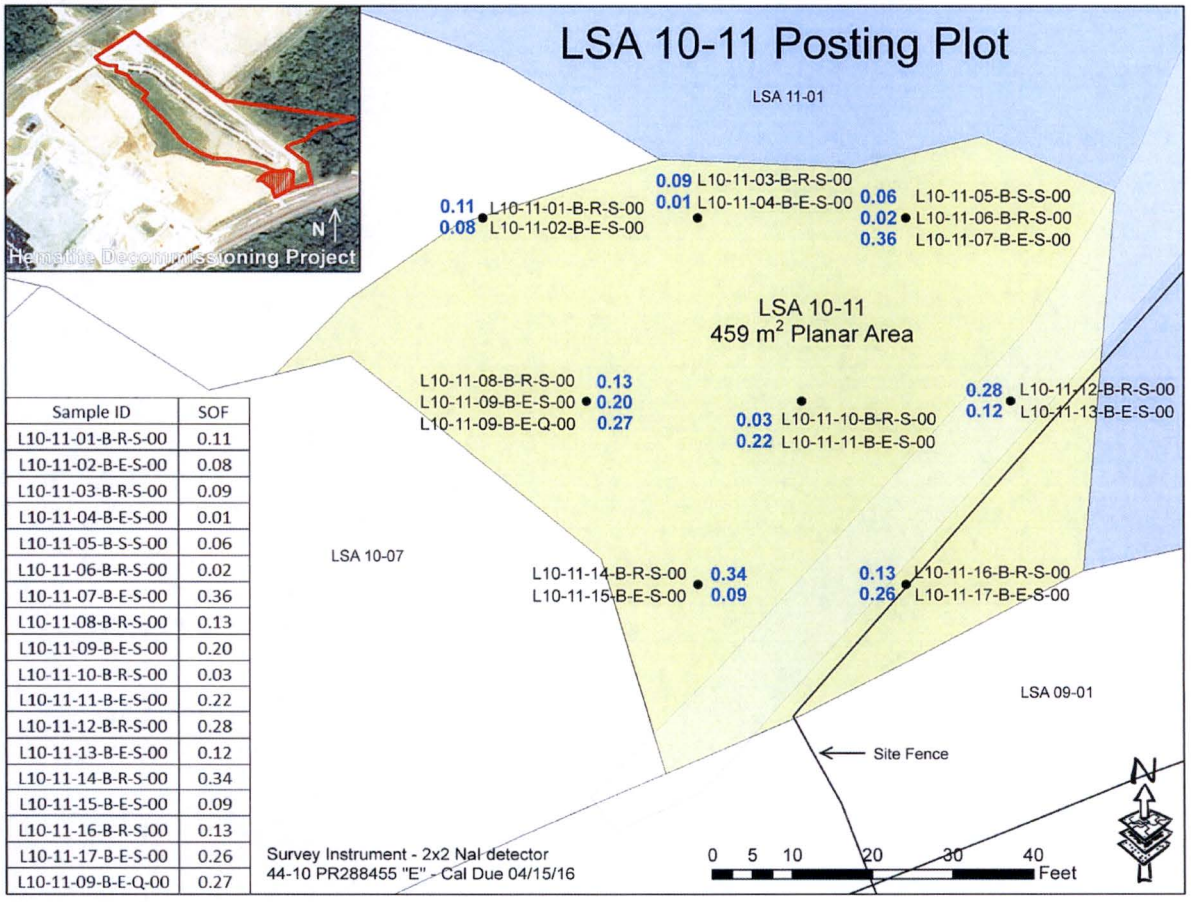
N	17

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LS 10-11 Sys SOF	0.15	0.09	to 0.20	0.027	0.11	0.01	0.7	-0.59

	Minimum	1st quartile	Median	95.1% CI		3rd quartile	Maximum	IQR
LS 10-11 Sys SOF	0.01	0.07	0.12	0.08	to 0.22	0.23	0.36	0.16

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 10-11 is presented below in Figure 7-4. Figure 7-4 shows no unusual patterns in the data.

Figure 7-4
Posting Plot for LSA 10-11 Systematic Measurement Locations



Sample ID	SOF
L10-11-01-B-R-S-00	0.11
L10-11-02-B-E-S-00	0.08
L10-11-03-B-R-S-00	0.09
L10-11-04-B-E-S-00	0.01
L10-11-05-B-S-S-00	0.06
L10-11-06-B-R-S-00	0.02
L10-11-07-B-E-S-00	0.36
L10-11-08-B-R-S-00	0.13
L10-11-09-B-E-S-00	0.20
L10-11-10-B-R-S-00	0.03
L10-11-11-B-E-S-00	0.22
L10-11-12-B-R-S-00	0.28
L10-11-13-B-E-S-00	0.12
L10-11-14-B-R-S-00	0.34
L10-11-15-B-E-S-00	0.09
L10-11-16-B-R-S-00	0.13
L10-11-17-B-E-S-00	0.26
L10-11-09-B-E-Q-00	0.27

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 Test America Analytical Laboratory soil sample reports.

Table 7-3
Final Status Survey Analytical Data: LSA 10-11

Sample ID	Sample 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
L10-11-01-B-R-S-00	1.79	S	1.080	0.154	0.068	NA	0.010	0.010	0.146	0.146	0.028	0.236	U	1.180	0.162	0.091	NA	0.180	0.180	0.980	NA	NA	NA	0.049	0.123	0.223	U	0.915	0.317	0.791	NA	0.9	0.11
L10-11-02-B-E-S-00	4.92	S	1.120	0.183	0.085	NA	0.050	0.050	0.137	0.137	0.033	0.231	U	1.050	0.189	0.148	NA	0.050	0.050	2.220	NA	NA	NA	0.121	0.155	0.303	U	0.794	0.347	0.984	U	2.4	0.08
L10-11-03-B-R-S-00	0.77	S	1.110	0.157	0.074	NA	0.040	0.040	0.146	0.146	0.050	0.242	U	1.090	0.159	0.107	NA	0.090	0.090	2.117	NA	NA	NA	0.111	0.128	0.233	U	1.280	0.625	0.773	NA	1.4	0.09
L10-11-04-B-E-S-00	4.92	S	0.896	0.123	0.047	NA	-0.174	0.000	0.045	0.045	0.044	0.242	U	0.866	0.137	0.092	NA	-0.134	0.000	1.280	NA	NA	NA	0.069	0.117	0.197	U	0.608	0.237	0.671	U	1.8	0.01
L10-11-05-B-S-S-00	0.21	S	1.030	0.175	0.090	NA	-0.040	0.000	0.468	0.468	0.067	0.239	NA	1.060	0.192	0.183	NA	0.060	0.060	1.240	NA	NA	NA	0.065	0.163	0.293	U	0.722	0.360	0.921	U	1.4	0.06
L10-11-06-B-R-S-00	0.49	S	1.040	0.142	0.073	NA	-0.030	0.000	0.061	0.061	0.041	0.241	U	0.945	0.144	0.085	NA	-0.055	0.000	1.408	NA	NA	NA	0.071	0.099	0.204	U	1.200	0.514	0.790	NA	1.0	0.02
L10-11-07-B-E-S-00	4.92	S	1.520	0.192	0.057	NA	0.450	0.450	0.100	0.100	0.037	0.239	U	1.200	0.175	0.112	NA	0.200	0.200	1.800	NA	NA	NA	0.094	0.158	0.262	U	1.100	0.548	0.860	NA	1.4	0.36
L10-11-08-B-R-S-00	2.27	S	1.030	0.146	0.063	NA	-0.040	0.000	0.124	0.124	0.109	0.251	U	1.190	0.171	0.089	NA	0.190	0.190	2.986	NA	NA	NA	0.160	0.133	0.178	U	1.380	0.545	0.727	NA	1.8	0.13
L10-11-09-B-E-S-00	4.92	S	1.150	0.169	0.059	NA	0.080	0.080	0.087	0.087	0.058	0.243	U	1.270	0.205	0.159	NA	0.270	0.270	1.686	NA	NA	NA	0.089	0.153	0.263	U	0.916	0.375	0.993	U	1.5	0.20
L10-11-10-B-R-S-00	1.44	S	1.100	0.147	0.056	NA	0.030	0.030	0.052	0.052	0.013	0.241	U	0.922	0.158	0.100	NA	-0.078	0.000	1.317	NA	NA	NA	0.067	0.135	0.217	U	1.010	0.492	0.769	NA	1.1	0.03
L10-11-11-B-E-S-00	4.92	S	1.360	0.203	0.085	NA	0.290	0.290	0.094	0.094	0.019	0.245	U	1.080	0.195	0.158	NA	0.080	0.080	2.528	NA	NA	NA	0.138	0.173	0.291	U	0.838	0.360	1.020	U	2.5	0.22
L10-11-12-B-R-S-00	1.24	S	1.290	0.181	0.085	NA	0.220	0.220	0.046	0.046	0.065	0.256	U	1.290	0.190	0.106	NA	0.290	0.290	1.839	NA	NA	NA	0.096	0.153	0.254	U	1.190	0.563	0.879	NA	1.3	0.28
L10-11-13-B-E-S-00	4.92	S	1.110	0.148	0.055	NA	0.040	0.040	0.065	0.065	0.010	0.248	U	1.150	0.174	0.096	NA	0.150	0.150	2.422	NA	NA	NA	0.127	0.097	0.148	U	1.410	0.505	0.753	NA	1.4	0.12
L10-11-14-B-R-S-00	1.08	S	1.370	0.180	0.069	NA	0.300	0.300	0.083	0.083	0.061	0.249	U	1.330	0.210	0.135	NA	0.330	0.330	1.592	NA	NA	NA	0.080	0.162	0.260	U	1.270	0.571	0.887	NA	1.0	0.34
L10-11-15-B-E-S-00	4.92	S	1.110	0.152	0.057	NA	0.040	0.040	0.074	0.074	0.083	0.246	U	1.080	0.161	0.109	NA	0.080	0.080	2.510	NA	NA	NA	0.135	0.126	0.180	U	1.110	0.613	0.828	NA	1.9	0.09
L10-11-16-B-R-S-00	1.89	S	1.080	0.170	0.112	NA	0.010	0.010	0.112	0.112	0.062	0.252	U	1.230	0.216	0.180	NA	0.230	0.230	0.104	NA	NA	NA	0.002	0.040	0.319	U	0.891	0.344	0.952	U	0.1	0.13
L10-11-17-B-E-S-00	4.92	S	1.290	0.170	0.065	NA	0.220	0.220	0.092	0.092	0.053	0.243	U	1.260	0.194	0.130	NA	0.260	0.260	1.048	NA	NA	NA	0.053	0.125	0.252	U	0.888	0.320	0.894	U	1.0	0.26
L10-11-18-B-R-B-00	2.08	B	1.130	0.156	0.065	NA	0.060	0.060	0.129	0.129	0.055	0.263	U	1.250	0.215	0.112	NA	0.250	0.250	1.269	NA	NA	NA	0.062	0.142	0.227	U	1.250	0.515	0.788	NA	0.8	0.18
L10-11-19-B-R-B-00	1.82	B	1.230	0.180	0.069	NA	0.160	0.160	0.155	0.155	0.093	0.268	U	1.100	0.200	0.173	NA	0.100	0.100	3.634	NA	NA	NA	0.199	0.147	0.178	NA	1.140	0.602	0.945	NA	2.7	0.17
L10-11-09-B-E-Q-00	4.92	Q	1.300	0.173	0.072	NA	0.230	0.230	0.078	0.078	0.042	0.251	U	1.250	0.186	0.112	NA	0.250	0.250	1.964	NA	NA	NA	0.103	0.148	0.251	U	1.170	0.529	0.823	NA	1.4	0.27
Systematic Minimum			0.000						0.045					0.000						0.104				0.002				0.608				**1.4**	0.01
Systematic Maximum			0.450						0.468					0.330						2.986				0.160				1.410				Average Enrichment (%)	0.36
Systematic Mean			0.105						0.114					0.145						1.710				0.090				1.031					0.15
Systematic Median			0.040						0.092					0.150						1.686				0.089				1.010					0.12
Systematic Standard Deviation			0.137						0.097					0.109						0.712				0.039				0.235					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 10-11

The biased sample collected from LSA 10-11 had a Uniform SOF result of 0.18, this sample was collected from the location of the highest identified GWS measurement.

7.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 10-11

One sample was collected from the sidewalls of LSA 10-11. Table 7-4 provides the data summary for the samples.

Table 7-4
LSA 10-11 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)
L10-11-19-B-R-B-00	0.16	0.16	0.10	3.63	0.20	1.14	0.17

7.2.7 Quality Control Soil Sample Result LSA 10-11

One QC field duplicate sample point was randomly selected for LSA 10-11 which was collected at systematic locations L10-11-09.

For the 19 samples (i.e., 17 systematic + 1 biased + 1 sidewall) collected within LSA 10-11, one field duplicate sample was collected. This frequency equates to 5.26 %, (i.e. 1/19). 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 10-11

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

Survey Unit No.: LSA 10-11 | Survey Unit Description: Burial Pits Open Land Area South Eastern Survey Unit in "Area 9"

Sample ID	Field Duplicate Sample ID	Radionuclide	Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity ($\bar{X}$) (pCi/g)	Nuclide DCGL (pCi/g)	Statistic[2]	Warning Limit	Control Limit	Statistic Exceeds Limit? (Y/N)
			Activity (x_i)	MDC	Activity (x_i)	MDC						
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	Ra-226	1.15	0.0587	1.3	0.0722	1.225	1.9	0.15	0.269	0.403	N
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	Tc-99	0.0871	0.243	0.0782	0.251	0.083	25.1	NA	3.552	5.321	NA
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	Th-232	1.27	0.159	1.25	0.112	1.260	2.0	0.020	0.283	0.424	N
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	U-234[1]	1.686	NA	1.964	NA	1.825	195.4	0.278	27.649	41.425	N
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	U-235	0.089	0.263	0.103	0.251	0.096	51.6	NA	7.301	10.939	NA
L10-11-09-B-E-S-00	L10-11-09-B-E-Q-00	U-238	0.916	0.993	1.17	0.823	1.043	168.8	NA	23.885	35.786	NA

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: 12/15/15

Reviewed by: Brian Antill Date: 12/15/15

Quality Record

7.3 Tc-99 Hot Spot Assessment LSA 10-11

Within LSA 10-11 a total of 37 samples were collected and analyzed for Tc-99 during the site characterization, RASS, and FSS sample collection efforts. Within LSA 10-11, the maximum characterization sample Tc-99 concentration was 0.46 pCi/g – which is consistent with the maximum Tc-99 sample result collected during FSS of 0.47 pCi/g, and is well below the Tc-99 Uniform Stratum $DCGL_w$ of 25.1 pCi/g.

8.0 ALARA EVALUATION LSA 10-11

All samples collected within LSA 10-11 were evaluated against the Uniform Stratum $DCGL_w$. For LSA 10-11 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.15 for LSA 10-11. The average SOF equates to residual activity contributions from the survey unit area of 3.75 mrem/year for LSA 10-11. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 {ML16287A528}, 3 and 4, 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 10-11. As only offsite borrow soil was used as backfill, no dose will be added to LSA 10-11 for backfill soil. Adding all of the dose contributions together, the total estimated dose for LSA 10-11 is 7.75 mrem/year.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the remediation of LSA 10-11 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 10-11.

9.0 FSS PLAN DEVIATIONS LSA 10-11

9.1 Remedial Actions During FSS

There were no remedial actions after FSS in LSA 10-11.

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 10-11. Subsequent to field FSS activities within the SU, the calculation of Scan MDCs varied in approach based on the guidance given in Technical Basis Document (HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys,* Westinghouse April, 2015), as well as later discussions between HDP and the NRC via teleconference (August 2015) on the technical assumptions and inputs related to Scan MDC estimates. The Scan MDCs presented in the FSS Plan shown in Table 5-1 assumed a surveyor efficiency of 1.0 (the surveyor efficiency prescribed by the DP when data logging is utilized). The current version of HDP-TBD-FSS-002 uses a surveyor efficiency of 0.75 (the surveyor efficiency agreed upon between HDP and the NRC via teleconference). Although the revised Scan MDC for Total U increased to 40.9 pCi/g, it remained less than the $DCGL_w$ for the SU. The Scan MDCs for Ra-226 and Th-232 increased slightly to 1.21 pCi/g and 0.87 pCi/g, respectively. Using a 10,000 cpm background and a

conservative 4% enrichment for the SU, 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 10-11

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw (Ra-226)	Scan MDC (Th-232)	DCGLw (Th-232)
LSA 10-11	40.9	87.7	1.21	1.9	0.87	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 10-11

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 10-11 (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 10-11 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 10-11, 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 10-11, however the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1072) exceeded the critical value (879), 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. No individual SOF result in the FSS data set exceeded the $DCGL_w$ (SOF of 1.0) by more than the SOF of the minimum background reference area result using the Uniform Stratum criteria. Therefore, the WRS test was not required for LSA 10-11. The WRS Test worksheet is presented for illustrative purposes 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 10-11 was 0.34. The maximum SOF result for all subsurface samples within LSA 10-11 was 0.36. The average SOF result for all systematically collected samples within LSA 10-11 was 0.15, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.20.

- No FSS sample result in LSA 10-11 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 of systematic samples actually collected within LSA 10-11. The successful result of the retrospective power evaluation presented in Table 10-1 for LSA 10-11 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 10-11. 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 10-11 was completed prior to the commencement of backfill operations. A confirmatory GWS was performed within the 72 hours prior to backfill operations, the results of the confirmatory GWS were compared to the original FSS results, no readings in the confirmatory GWS were identified to exceed 3 standard deviations above the mean of the original FSS survey results, This survey was performed in accordance with the requirements of HDP-WP-ENG-802.

Table 10-1
Retrospective Sample Size Verification for LSA 10-11

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)	0.15
Shift	0.85
Relative Shift (Δ/σ)	7.79
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, $\alpha = 0.05$, $\beta = 0.10$

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 10-11 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
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APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: 11 **Description:** South Eastern Survey Unit in "Area 9"

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

Figure 10-1
Data Evaluation Checklists prepared for LSA 10-11 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
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APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: 11 **Description:** South Eastern Survey Unit in "Area 9"

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 11 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): Ellen C. Jakub (Print Name) _____ (Signature) 12/16/15 (Date)

Approved by (RSO): W. Clark Evers (Print Name) _____ (Signature) 12/16/15 (Date)

Quality Record

11.0 SURVEILLANCE FOLLOWING FSS

FSS GWS activities in LSA 10-11 were completed on April 21, 2015. A GWS survey was performed on December 10, 2015, to verify no radiological status change in the SU prior to the start of backfill operations in the SU on the same day. 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 10-11

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 10-11 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 10-11 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.15	N/A	0.16	N/A	N/A	**0.31**
DOSE	4.75 mrem/year	N/A	4.0 mrem/year	N/A	N/A	**7.75 mrem/year**

13.0 FINAL STATUS SURVEY DESIGN LSA 11-01

This section describes the method for determining the number of samples required for the FSS of LSA 11-01 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 11-01 and their detection sensitivities are also discussed.

13.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 11-01 were driven by the type (Open Land) and Class (Class 2) of the survey unit and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 6, *Final Status Survey Plan Development*, March 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 11-01. The review indicated that there were no areas that were previously found to exceed a Uniform SOF of 1.0 (discussed in Section 3.3.6). As a Class 2 area, there is no expectation of the potential to exceed a DCGL, and no radiological remediation is required. 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 2 SU, LSA 11-01 was required to undergo a minimum of 50% GWS of the ground surface.

13.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 11-01 was the Ludlum 44-10 2" x 2" sodium iodide (NaI) detectors, coupled to a Ludlum 2221 scaler-ratemeter.

13.1.5 Scan Minimum Detectable Concentration

As background levels were approximately 10,000 cpm within LSA 11-01, 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:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3169\ pCi/g}\right)+\left(\frac{f_{U-235}}{2.0 pCi/g}\right)+\left(\frac{f_{U-238}}{26.5 pCi/g}\right)\right)}$$

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 6, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 11-01, the average enrichment for the SU was 2.9%.

HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)* documents the calculated MDC_{scan} of 0.75 pCi/g for Th-232 and 1.04 pCi/g for Ra-226 when using a 2"x 2" NaI detector with a 10,000 cpm background.

Table 13-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 11-01

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 11-01	34.8	46.9	1.04	2.8	0.75	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. DCGLw 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 11-01 was established at 4,000 net counts per minute (ncpm).

13.1.7 LSA 11-01 FSS Design Summary

The FSS Plan for LSA 11-01 can be found in Appendix C. Table 13-2 presents an overall FSS design and implementation summary for LSA 11-01.

Table 13-2
FSS Design Summary for LSA 11-01

Gamma Walkover Survey (GWS):		
Scan Coverage	Minimum 50% of ground surface	
Scan MDC	34.8 pCi/g total Uranium (based on a 10,000 cpm background); 0.75 pCi/g Th-232; 1.04 pCi/g Ra-226*	
Investigation Action Level (IAL)	1,677 net cpm**	
Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	5	These samples will be collected on a systematic grid. ***Excavation stratum samples beneath surface stratum samples will be archived and analyzed only if the associated root stratum result exceeds a SOF of 0.5.
15 cm – 1.5 m (Root)	8	
> 1.5 m (Excavation)	8***	
Biased Survey/Sampling Locations:		
Collect a minimum of one biased sample at the maximum GWS measurement within the Survey Unit. Additional 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.		
Instrumentation		
Ludlum 2221 with 44-10 (2x2 NaI) detector; with collimation for investigations	Used for GWS and to obtain static count rates at biased measurement locations.	
*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).*		
**IAL is the net count per minute (ncpm) equivalent to an activity concentration less than the Uniform Stratum $DCGL_w$ (the appropriate criterion for Class 2 and Class 3 LSAs) based on 3% enriched uranium and using the Infer Tc-99 DCGL for U-235; 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 11-01

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 11-01 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 across the SU 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.

FSS technicians performing GWS in LSA 11-01 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), FSS 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, FSS 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 8,000 and 9,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 12,000 to 13,000 gcpm, FSS 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.

On September 30, 2015, as documented in Inspection Report 07000036/2015003, the NRC observed a FSS Technician performing GWS over a sloped portion of the SU. Non-compliance of FSS procedures was noted in that the height of the detector was not adjusted for changing elevation of the slope and as such was at times more than maximum allowable three (3) inches above the ground surface. In a NRC letter dated November 27, 2015, this occurrence was addressed as a Notice of Violation (ML15334A404). As an immediate corrective action, all sloped areas within LSA 11-01 underwent a new GWS on October 1, 2015 by a different FSS Technician with a different survey instrument under supervision by the RSO. A significant fraction of the "slope GWS redo area" included portions of the SU which had not previously undergone GWS (Note: The FSS Plan requirement for LSA 11-01 was a minimum of 50% scan coverage). The measurement data comparison of the original GWS and the new GWS were consistent. For both GWS performed, no elevated measurements were observed on sloped surfaces which would have triggered biased sampling.

After the GWS survey was complete, the GWS was reviewed to confirm that the minimum GWS requirement of 50% of the SU surface was met.

Next, 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 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.

14.2 Soil Sampling

14.2.1 Systematic Soil Sampling Summary

Table 14-1 provides a summary of systematic sampling by stratum for LSA 11-01.

Table 14-1
Systematic Sampling Summary by Stratum for LSA 11-01

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
11-01	9,885	5	8	3	2

14.2.2 Systematic Sampling LSA 11-01

As expected there was no radiological remediation required in LSA 11-01, although there was a small amount of excavation in portions of the SU to support the construction of the Northeast Site Creek Diversion, and the Detention Pond. Also, for the purpose of site restoration final grade, in areas of the SU adjacent to the former Burial Pit Area, in order to obtain positive drainage the final grade engineering design called for additional soil to be placed. This resulted in portions of the SU final grade to be at a higher elevation than the original grade.

As described in the DP Chapter 14, systematic sampling is based on the final grade, meaning that sampling of each stratum of soil will be performed as it will remain in the final SU configuration. Due to elevation differentials between the original grade and final grade, and following the systematic sampling protocol provided in the DP, there were 3 systematic sample locations in which the surface stratum was not present.

Within LSA 11-01, there were five (5) systematic locations in which portions of the surface stratum [0 – 15 centimeters (cm)] remained and were sampled. Portions of the root stratum (15 cm – 150 cm) remained at all eight (8) systematic locations. At these locations, the remaining root stratum interval was collected using a hand auger and composited. Excavation stratum samples were collected at seven locations using either hand trowels, or hand augers where necessary, for six-inch grab samples below the existing excavation surface. However, four of these seven samples were collected and archived; Excavation samples that fall below Surface and Root zone samples are only required to be analyzed if the overlying Root zone sample

exceeds a 0.5 SOF. As no Root zone sample exceeded a 0.5 SOF, these archived samples were not analyzed.

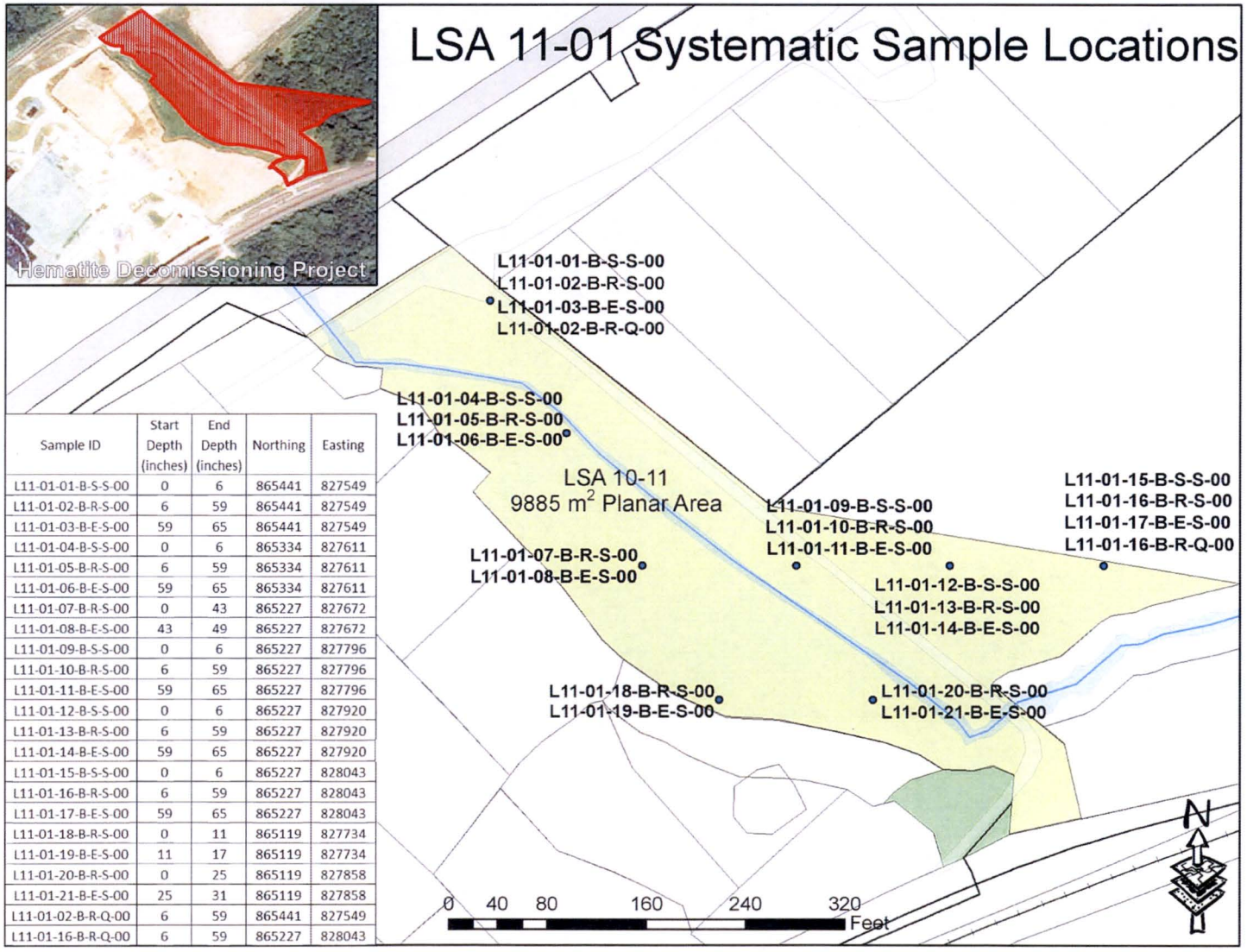
Given a planar area of 9,885 m^2 for LSA 11-01 and an eight - point systematic triangular grid, the point-to-point distance within each row was 37.7 m with spacing of 32.7 m between each of the parallel grid rows within the SU.

While there were eight systematic locations on the LSA 11-01 sampling grid, a total of twenty-three (22) samples were collected at these locations, including:

- Five (5) samples collected within the remaining surface stratum
- Eight (8) samples collected within the remaining root stratum
- Seven (7) samples collected within the excavation, or "deep", stratum (3 Excavation samples were analyzed and reported, 4 were collected for archive and not analyzed)
- Two (2) QC field replicates

Figure 14-1 presents the map of the eight systematic sample locations which were sampled within LSA 11-01. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 14-1
LSA 11-01 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L11-01-01-B-S-S-00	0	6	865441	827549
L11-01-02-B-R-S-00	6	59	865441	827549
L11-01-03-B-E-S-00	59	65	865441	827549
L11-01-04-B-S-S-00	0	6	865334	827611
L11-01-05-B-R-S-00	6	59	865334	827611
L11-01-06-B-E-S-00	59	65	865334	827611
L11-01-07-B-R-S-00	0	43	865227	827672
L11-01-08-B-E-S-00	43	49	865227	827672
L11-01-09-B-S-S-00	0	6	865227	827796
L11-01-10-B-R-S-00	6	59	865227	827796
L11-01-11-B-E-S-00	59	65	865227	827796
L11-01-12-B-S-S-00	0	6	865227	827920
L11-01-13-B-R-S-00	6	59	865227	827920
L11-01-14-B-E-S-00	59	65	865227	827920
L11-01-15-B-S-S-00	0	6	865227	828043
L11-01-16-B-R-S-00	6	59	865227	828043
L11-01-17-B-E-S-00	59	65	865227	828043
L11-01-18-B-R-S-00	0	11	865119	827734
L11-01-19-B-E-S-00	11	17	865119	827734
L11-01-20-B-R-S-00	0	25	865119	827858
L11-01-21-B-E-S-00	25	31	865119	827858
L11-01-02-B-R-Q-00	6	59	865441	827549
L11-01-16-B-R-Q-00	6	59	865227	828043

~~Figure~~ Table 14-2 below presents a tabular listing of all FSS samples collected within LSA 11-01 with associated IDs, sample types, collection intervals, coordinates, and notes.

~~Figure~~ Table 14-2

FSS Sample Locations and Coordinates for LSA 11-01

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
	Westinghouse Proprietary Class 3	Revision: 6	Appendix P-4, Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 11 **Description:** Plant Open Land Area

Survey Unit: 01 **Description:** Northeast Site Creek in "Area 9"

Survey Type: FSS **Classification:** Class 2

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L11-01-01-B-S-S-00	Uniform	S	427.0	426.5	865441.0	827549.0	Surface 6-inch grab
L11-01-02-B-R-S-00	Uniform	S	426.5	422.0	865441.0	827549.0	Root 4.4-ft composite
L11-01-04-B-S-S-00	Uniform	S	423.9	423.4	865334.0	827611.0	Surface 6-inch grab
L11-01-05-B-R-S-00	Uniform	S	423.4	419.0	865334.0	827611.0	Root 4.4-ft composite
L11-01-07-B-R-S-00	Uniform	S	424.1	420.5	865227.0	827672.0	Root 3.6-ft composite
L11-01-08-B-E-S-00	Uniform	S	420.5	420.0	865227.0	827672.0	Excavation 6-inch grab
L11-01-09-B-S-S-00	Uniform	S	422.7	422.2	865227.0	827796.0	Surface 6-inch grab
L11-01-10-B-R-S-00	Uniform	S	422.2	417.7	865227.0	827796.0	Root 4.4-ft composite
L11-01-12-B-S-S-00	Uniform	S	422.2	421.7	865227.0	827920.0	Surface 6-inch grab
L11-01-13-B-R-S-00	Uniform	S	421.7	417.3	865227.0	827920.0	Root 4.4-ft composite
L11-01-15-B-S-S-00	Uniform	S	420.9	420.4	865227.0	828043.0	Surface 6-inch grab
L11-01-16-B-R-S-00	Uniform	S	420.4	415.9	865227.0	828043.0	Root 4.4-ft composite
L11-01-18-B-R-S-00	Uniform	S	422.8	421.9	865119.0	827734.0	Root 0.9-ft composite
L11-01-19-B-E-S-00	Uniform	S	421.9	421.4	865119.0	827734.0	Excavation 6-inch grab
L11-01-20-B-R-S-00	Uniform	S	421.4	419.4	865119.0	827858.0	Root 2-ft composite
L11-01-21-B-E-S-00	Uniform	S	419.4	418.9	865119.0	827858.0	Excavation 6-inch grab
L11-01-02-B-R-Q-00	Uniform	Q	426.5	422.0	865441.0	827549.0	Root 4.4-ft composite
L11-01-16-B-R-Q-00	Uniform	Q	420.4	415.9	865227.0	828043.0	Root 4.4-ft composite
L11-01-22-B-S-B-00	Uniform	B	423.0	422.5	865291.0	827544.0	Surface 6-inch grab
L11-01-23-B-S-B-00	Uniform	B	424.0	423.5	865247.0	827842.0	Surface 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 11-01 two sample locations were selected within the SU based on the evaluation of the GWS survey data. Biased location L11-01-23-B-S-B-00 represents the maximum GWS measurement encountered within in LSA 11-01 and has a Uniform SOF value of 0.07.

14.4 Judgmental/Sidewall Sampling for Tc-99

As a Class 2 SU, sidewall sampling was not necessary in LSA 11-01.

14.5 Quality Control Soil Sampling

Two QC field duplicate sample points were randomly selected and collected at systematic location L11-01-02, and L11-01-16 for LSA 11-01.

15.0 FINAL STATUS SURVEY RESULTS LSA 11-01

15.1 Gamma Walkover Survey

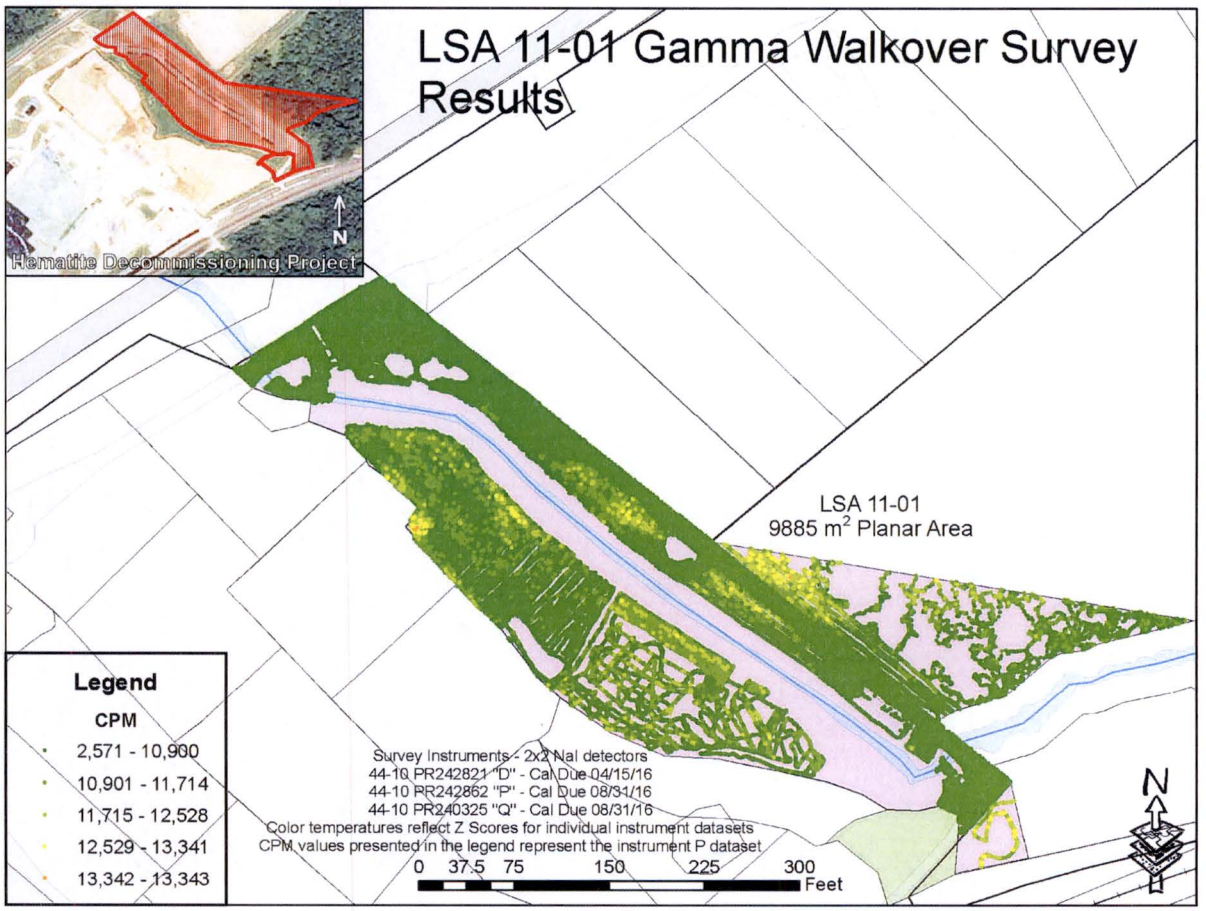
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are 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 in LSA 11-01 were collected between September 17, 2015 and October 1, 2015.

15.1.1 GWS Results for LSA 11-01

For LSA 11-01, GWS count rates ranged between 4,891 gcpm and 10,205 gcpm, with a mean count rate of 7,297 gcpm. The median count rate was 7,290 gcpm and the standard deviation was 720 cpm. Figure 15-1 below presents a map of the complete GWS data set.

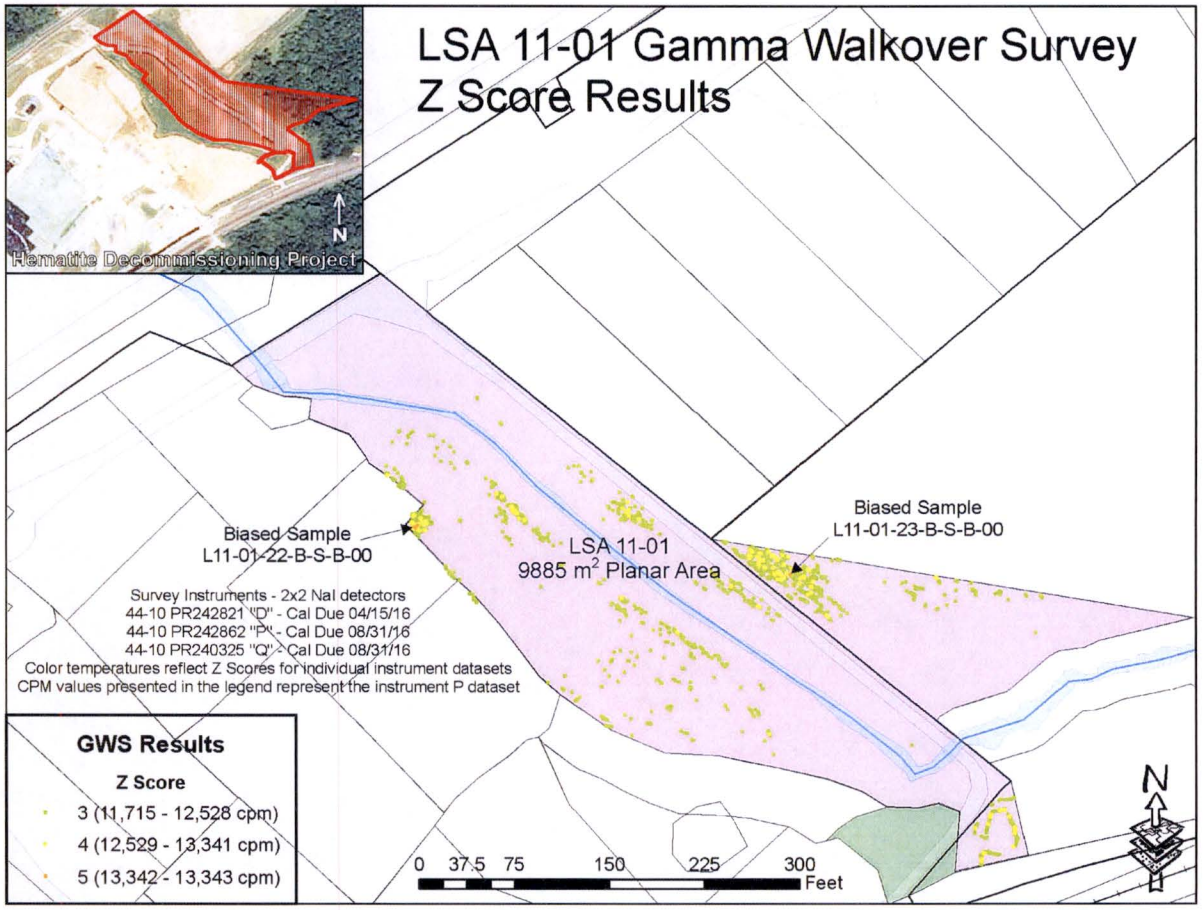
Figure 15-1
Colorimetric GWS Plot for LSA 11-01



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded both the IAL (> 1,677 ncpm) and three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Two locations (L11-01-22 and L11-01-23) were selected for biased sample collection. The sample collected at location L11-01-23 represented the maximum GWS measurement (13,343 gcpm) within the SU.

Figure 15-2 below presents a map of the +3 Z-score GWS measurements within LSA 11-01, including the two selected biased sampling locations.

Figure 15-2
Colorimetric GWS Plot for LSA 11-01 (Measurements > Z-score of 3)



A total of 114,530 GWS measurements were collected in LSA 11-01 covering 62.3% of the 9,885 m^2 area, meeting the FSS Plan requirement of 50% minimum scan coverage.

Since all GWS data collected in LSA 11-01 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 40.9 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 11-01, 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:

$$\text{Scan MDC}_{Total\ Uranium} = \quad 1 \Big/ \left(\left(\frac{0.7928}{3659}\right) + \left(\frac{0.0438}{2.32}\right) + \left(\frac{0.1634}{30.6}\right) \right) = 40.9 \frac{pCi}{g}$$

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 FSS 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 11-01

As stated above, 62.3% of the LSA was subjected to GWS which exceeds the minimum FSS Plan requirement of 50% coverage for a Class 2 SU.

15.2 Soil Sample Results LSA 11-01

Appendix B presents the analytical results and associated statistics for all FSS surface samples collected within LSA 11-01.

15.2.1 Surface Soil Sample Results LSA 11-01

There were five (5) samples collected within the surface stratum (0 – 15 cm) of LSA 11-01. However, there were a total of ten (10) soil samples collected within the topmost soil layer of the SU surface including eight systematic samples (five surface and three root composite samples) and two biased samples. ~~Per Step 7.8.3 of HDP-PR-FSS-721, *Final Status Survey Data Evaluation*, the WRS statistical test was not necessary for LSA 11-01, since the difference between the maximum survey unit data set gross SOF and the minimum background area adjusted SOF was less than one. However, for illustrative purposes, the WRS evaluation was performed for LSA 11-01 and is included in Appendix B. Biased and QC sample results are not utilized in the WRS test. The eight systematic samples collected in the "topmost" SU 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, W_r (784), was greater than the critical value, CV (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 11-01 was 0.72 corresponding to the biased sample L11-01-22-B-S-B-00. The maximum systematic sample SOF result was 0.14 at L11-01-09-B-S-S-00.

~~Appendix B presents the analytical results and associated statistics for all FSS surface samples collected within LSA 11-01.~~

15.2.2 Subsurface Soil Sample Results LSA 11-01

There were five systematic locations within LSA 11-01 where root stratum composite sampling below a 6-inch (0.15 m) surface sample was necessary. The root stratum zone is between 0.15 and 1.50 m below final grade surface. There were three systematic locations within LSA 11-01 where excavation stratum sampling below a root stratum sample was necessary. These root stratum and excavation stratum samples were 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 11-01 was 0.08. This sample (L11-01-09) was the excavation stratum sample collected directly underneath the root stratum sample L11-01-08.

~~The results of the three subsurface samples collected in LSA 11-01 are presented in Appendix B.~~

15.2.3 WRS Test Evaluation LSA 11-01

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 11-01 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 11-01. 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 16 systematically collected samples in LSA 11-01 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, (1040) was greater than the critical value (860) 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 11-01

Table 15-1 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 11-01, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.03.

Table 15-1
LSA 11-01 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	0.01	0.24	0.01	1.40	0.07	0.73	**0.03**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.00 (<BKG)	0.44	0.02	0.27	0.01
Maximum	0.13	0.67	0.14	3.24	0.17	1.56	0.14

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.

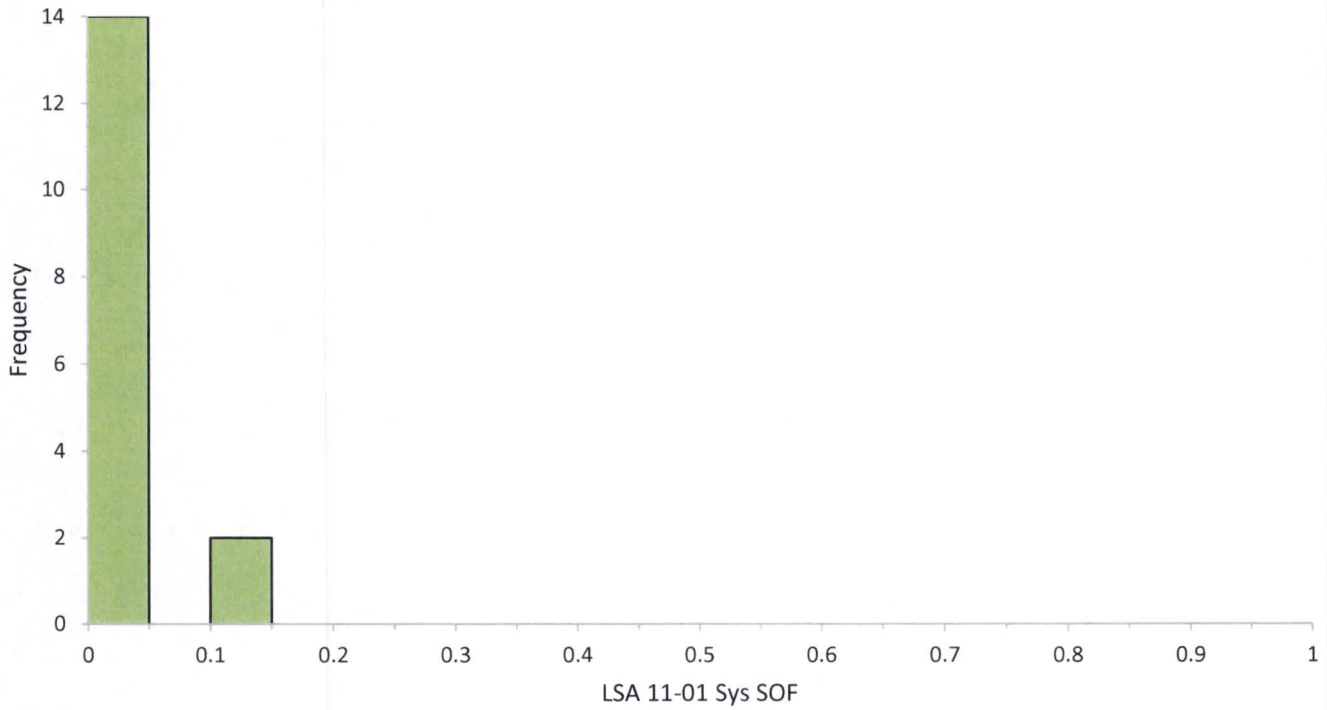
Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within 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

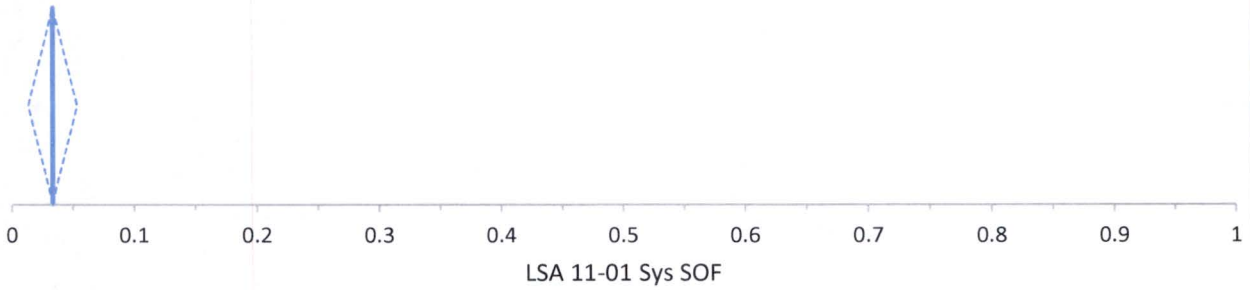
for the survey unit. The presence of two peaks in the survey unit frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 15-3 presents the overall statistical metrics for the SOF parameter for the 10 systematically collected samples from LSA 11-01. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 11-01. The middle graph presents the mean SOF (0.03) 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 0.01 to 0.05. The 97.87% confidence interval based on the median (0.02) of the sample results is 0.01 to 0.04. The bottom two charts present the various statistical metrics of the LSA 11-01 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 11-01 data associated with the systematically collected measurement locations.

Figure 15-3
Graphic Statistical Summary for LSA 11-01 (SOF parameter)





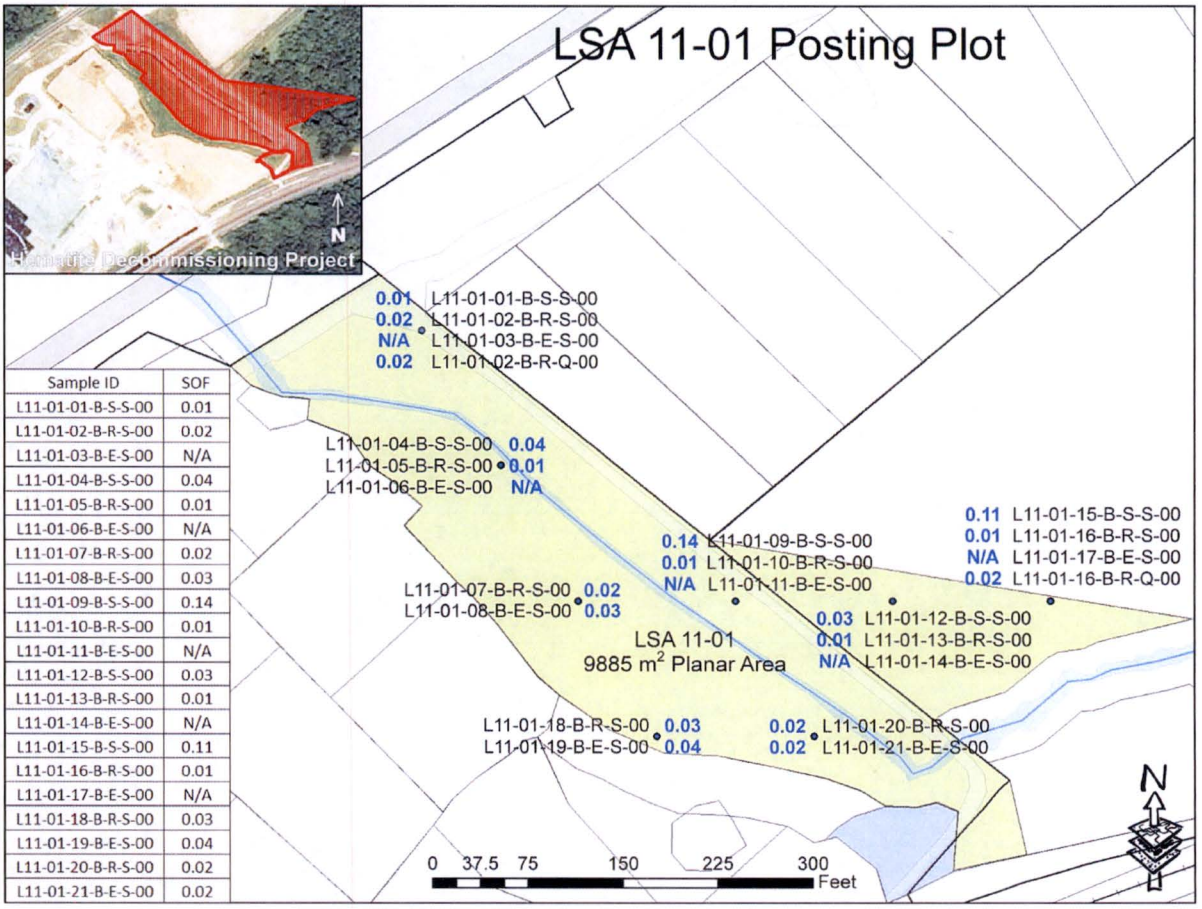
N	16

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 11-01 Sys SOF	0.03	0.01	to 0.05	0.009	0.04	0.00	2.3	5.04

	Minimum	1st quartile	Median	97.87% CI		3rd quartile	Maximum	IQR
LSA 11-01 Sys SOF	0.01	0.01	0.02	0.01	to 0.04	0.03	0.1	0.02

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 11-01 is presented below in Figure 15-4. Figure 15-4 shows no unusual patterns in the data.

Figure 15-4
Posting Plot for LSA 11-01 Systematic Measurement Locations



Sample ID	SOF
L11-01-01-B-S-S-00	0.01
L11-01-02-B-R-S-00	0.02
L11-01-03-B-E-S-00	N/A
L11-01-04-B-S-S-00	0.04
L11-01-05-B-R-S-00	0.01
L11-01-06-B-E-S-00	N/A
L11-01-07-B-R-S-00	0.02
L11-01-08-B-E-S-00	0.03
L11-01-09-B-S-S-00	0.14
L11-01-10-B-R-S-00	0.01
L11-01-11-B-E-S-00	N/A
L11-01-12-B-S-S-00	0.03
L11-01-13-B-R-S-00	0.01
L11-01-14-B-E-S-00	N/A
L11-01-15-B-S-S-00	0.11
L11-01-16-B-R-S-00	0.01
L11-01-17-B-E-S-00	N/A
L11-01-18-B-R-S-00	0.03
L11-01-19-B-E-S-00	0.04
L11-01-20-B-R-S-00	0.02
L11-01-21-B-E-S-00	0.02

Appendix B to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 15-1, Figure 15-3, and Figure 15-4 above. A summary of the analytical data is presented in Table 15-2 below. Appendix F to this report presents the Test America Analytical Laboratory soil sample reports.

Table 15-2
Final Status Survey Analytical Data: LSA 11-01

Sample ID	Sample 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
L11-01-01-B-S-S-00	0.00	S	0.483	0.080	0.043	NA	-0.587	0.000	0.055	0.055	0.051	0.223	U	0.172	0.066	0.082	NA	-0.828	0.000	0.442	NA	NA	NA	0.023	0.061	0.129	U	0.273	0.133	0.398	U	1.3	0.01
L11-01-02-B-R-S-00	0.50	S	0.937	0.126	0.051	NA	-0.133	0.000	0.055	0.055	0.073	0.241	U	0.799	0.116	0.089	NA	-0.201	0.000	1.701	NA	NA	NA	0.090	0.107	0.176	U	0.904	0.374	0.570	NA	1.6	0.02
L11-01-04-B-S-S-00	0.00	S	0.921	0.129	0.058	NA	-0.149	0.000	0.425	0.425	0.075	0.240	NA	0.799	0.132	0.087	NA	-0.201	0.000	2.427	NA	NA	NA	0.134	0.119	0.193	U	0.516	0.231	0.696	U	3.9	0.04
L11-01-05-B-R-S-00	0.50	S	0.940	0.132	0.056	NA	-0.130	0.000	0.112	0.112	0.023	0.231	U	0.792	0.132	0.072	NA	-0.208	0.000	1.115	NA	NA	NA	0.061	0.104	0.169	U	0.384	0.223	0.696	U	2.5	0.01
L11-01-07-B-R-S-00	0.50	S	0.821	0.112	0.045	NA	-0.249	0.000	0.309	0.309	0.129	0.243	NA	0.709	0.120	0.077	NA	-0.291	0.000	0.639	NA	NA	NA	0.033	0.109	0.191	U	0.485	0.211	0.609	U	1.1	0.02
L11-01-08-B-E-S-00	5.00	S	0.761	0.104	0.043	NA	-0.309	0.000	0.666	0.666	0.101	0.249	NA	0.716	0.113	0.062	NA	-0.284	0.000	0.653	NA	NA	NA	0.032	0.061	0.116	U	0.594	0.356	0.570	NA	0.9	0.03
L11-01-09-B-S-S-00	0.00	S	1.150	0.151	0.050	NA	0.080	0.080	0.274	0.274	0.091	0.236	NA	1.140	0.168	0.118	NA	0.140	0.140	2.538	NA	NA	NA	0.139	0.145	0.228	U	0.797	0.297	0.805	U	2.7	0.14
L11-01-10-B-R-S-00	0.50	S	0.900	0.130	0.056	NA	-0.170	0.000	0.010	0.010	0.113	0.238	U	0.781	0.121	0.066	NA	-0.219	0.000	1.571	NA	NA	NA	0.086	0.101	0.187	U	0.515	0.234	0.671	U	2.6	0.01
L11-01-12-B-S-S-00	0.00	S	0.981	0.140	0.063	NA	-0.089	0.000	0.247	0.247	0.179	0.247	NA	0.813	0.128	0.106	NA	-0.187	0.000	1.837	NA	NA	NA	0.099	0.128	0.219	U	0.757	0.266	0.728	NA	2.1	0.03
L11-01-13-B-R-S-00	0.50	S	0.893	0.119	0.047	NA	-0.177	0.000	-0.009	0.000	0.093	0.225	U	0.797	0.130	0.065	NA	-0.203	0.000	0.727	NA	NA	NA	0.032	0.064	0.182	U	1.110	0.575	0.668	NA	0.5	0.01
L11-01-15-B-S-S-00	0.00	S	1.200	0.168	0.060	NA	0.130	0.130	0.206	0.206	0.095	0.235	U	0.983	0.168	0.084	NA	-0.017	0.000	3.243	NA	NA	NA	0.173	0.136	0.184	U	1.560	0.650	0.802	NA	1.7	0.11
L11-01-16-B-R-S-00	0.50	S	0.822	0.116	0.055	NA	-0.248	0.000	-0.024	0.000	0.074	0.228	U	0.730	0.134	0.087	NA	-0.270	0.000	0.520	NA	NA	NA	0.022	0.061	0.172	U	0.889	0.361	0.548	NA	0.4	0.01
L11-01-18-B-R-S-00	0.50	S	0.902	0.124	0.050	NA	-0.168	0.000	0.415	0.415	0.044	0.222	NA	0.689	0.112	0.080	NA	-0.311	0.000	1.536	NA	NA	NA	0.083	0.076	0.124	U	0.609	0.224	0.650	U	2.1	0.03
L11-01-19-B-E-S-00	5.00	S	0.833	0.134	0.064	NA	-0.237	0.000	0.669	0.669	0.074	0.226	NA	0.743	0.128	0.111	NA	-0.257	0.000	1.577	NA	NA	NA	0.084	0.129	0.214	U	0.798	0.423	0.663	NA	1.7	0.04
L11-01-20-B-R-S-00	0.50	S	1.060	0.147	0.066	NA	-0.010	0.000	0.313	0.313	0.089	0.234	NA	0.854	0.153	0.102	NA	-0.146	0.000	0.507	NA	NA	NA	0.022	0.120	0.203	U	0.814	0.436	0.685	NA	0.5	0.02
L11-01-21-B-E-S-00	5.00	S	0.832	0.116	0.050	NA	-0.238	0.000	0.068	0.068	0.059	0.233	U	0.773	0.114	0.096	NA	-0.227	0.000	1.396	NA	NA	NA	0.075	0.081	0.135	U	0.643	0.214	0.574	NA	1.8	0.02
L11-01-02-B-R-Q-00	0.50	Q	0.804	0.111	0.048	NA	-0.266	0.000	0.139	0.139	0.081	0.230	U	0.665	0.105	0.057	NA	-0.335	0.000	1.498	NA	NA	NA	0.080	0.098	0.178	U	0.783	0.373	0.581	NA	1.6	0.02
L11-01-16-B-R-Q-00	0.50	Q	0.847	0.118	0.054	NA	-0.223	0.000	-0.015	0.000	0.042	0.231	U	0.792	0.119	0.073	NA	-0.208	0.000	1.801	NA	NA	NA	0.097	0.112	0.145	U	0.769	0.409	0.644	NA	2.0	0.02
L11-01-22-B-S-B-00	0.00	B	1.580	0.203	0.071	NA	0.510	0.510	8.500	8.500	0.970	0.230	NA	0.910	0.157	0.108	NA	-0.090	0.000	14.918	NA	NA	NA	0.824	0.224	0.242	NA	2.720	0.656	0.882	NA	4.5	0.72
L11-01-23-B-S-B-00	0.00	B	1.040	0.143	0.060	NA	-0.030	0.000	0.402	0.402	0.162	0.238	NA	1.060	0.157	0.106	NA	0.060	0.060	2.632	NA	NA	NA	0.138	0.127	0.219	U	1.520	0.604	0.765	NA	1.4	0.07
Systematic Minimum			0.000						0.000					0.000						0.442				0.022				0.273				**1.8**	0.01
Systematic Maximum			0.130						0.669					0.140						3.243				0.173				1.560				Average Enrichment (%)	0.14
Systematic Mean			0.013						0.239					0.009						1.402				0.074				0.728					0.03
Systematic Median			0.000						0.227					0.000						1.466				0.079				0.700					0.02
Systematic Standard Deviation			0.037						0.220					0.035						0.827				0.046				0.308					0.04
			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 11-01

Two (2) biased samples were collected from LSA 11-01. The sample collected at location L11-01-23 represented the maximum GWS measurement (13,343 gcpm) within the SU, and had a result of 0.07 Uniform SOF. The sample collected at location L11-01-23 represented the highest Uniform SOF result of 0.72 primarily due to trace amounts of Tc-99 identified in the sample. As Tc-99 is not a gamma emitter, this would not have been identified by gamma scanning, and given the proximity of the sample location to areas where spent limestone was remediated, the slightly elevated result is not altogether unexpected.

15.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 11-01

As a Class 2 LSA, sidewall sampling was not required in LSA 11-01.

15.2.7 Quality Control Soil Sample Result LSA 11-01

Two QC field duplicate sample point was randomly selected for LSA 11-01 which were collected at systematic locations L11-01-02 and L11-01-16.

For the 18 "regular" (i.e., 16 systematic + 2 biased) samples collected within LSA 11-01, two field duplicate samples were collected. This frequency equates to 11.1%, (i.e. 2/18). The results were documented on form HDP-PR-FSS-703-1 (see Figure 15-5 below). Form HDP-PR-FSS-703-1 documents that the duplicate sample result compares well with its partner's results – all comparison criteria less than the calculated warning limits.

Figure 15-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 11-01

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

Survey Unit No.: LSA 11-01 | Survey Unit Description: Plant Soils Open Land Area east of Burial Pits in "Area 9"

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)
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	Ra-226	0.937	0.0507	0.804	0.048	0.8705	1.9	0.133	0.269	0.403	N
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	Tc-99	0.0546	0.241	0.139	0.23	0.0968	25.1	NA	3.552	5.321	NA
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	Th-232	0.716	0.089	0.665	0.057	0.691	2.0	0.051	0.283	0.424	N
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	U-234[1]	1.701	NA	1.498	NA	1.599	195.4	0.203	27.649	41.425	N
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	U-235	0.0903	0.176	0.0795	0.178	0.085	51.6	NA	7.301	10.939	NA
L11-01-02-B-R-S-00	L11-01-02-B-R-Q-00	U-238	0.904	0.57	0.783	0.581	0.8435	168.8	0.121	23.885	35.786	N
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	Ra-226	0.822	0.0545	0.847	0.0543	0.8345	1.9	0.025	0.269	0.403	N
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	Tc-99	-0.0235	0.228	-0.0146	0.231	-0.01905	25.1	NA	3.552	5.321	NA
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	Th-232	0.73	0.0866	0.792	0.0729	0.761	2.0	0.062	0.283	0.424	N
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	U-234[1]	0.520	NA	1.801	NA	1.161	195.4	1.281	27.649	41.425	N
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	U-235	0.0215	0.172	0.0972	0.145	0.059	51.6	NA	7.301	10.939	NA
L11-01-16-B-R-S-00	L11-01-16-B-R-Q-00	U-238	0.889	0.548	0.769	0.644	0.829	168.8	0.12	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: 12/15/15

Reviewed by: [signature] Date: 12/15/15

Quality Record

15.3 Tc-99 Hot Spot Assessment LSA 11-01

LSA 11-01 is a Class 2 SU and therefore no characterization, RASS, or FSS samples exceeded the Tc-99 Uniform DCGL as such a potential Tc-99 hot spot assessment is not required.

16.0 ALARA EVALUATION LSA 11-01

All samples collected within LSA 11-01 were evaluated against the Uniform Stratum $DCGL_w$. For LSA 11-01 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.03 for LSA 11-01. The average SOF equates to residual activity contributions from the survey unit area of 0.75 mrem/year for LSA 11-01. Groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2, 3 and 4, 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 11-01. The Stockpile 5-6 reuse soil dose contribution will also be accounted for by adding in an additional 7.75 mrem/year. Adding all of the dose contributions together, the total estimated dose for LSA 11-01 is 12.5 mrem/year.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the assessment of LSA 11-01 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 attempting to further reduce the residual activity of LSA 11-01.

17.0 FSS PLAN DEVIATIONS LSA 11-01

The systematic sample location which included sample IDs L11-01-01, L11-01-02, and L11-01-03 which fell upon the packed gravel haul road was relocated approximately 45' to the southwest. Even at this relocated sample location, auger refusal was encountered in the Root Stratum at 3.0 ft bgs. As a result, no excavation stratum sample (L11-01-03) was collected at this location. While the FSS plan called for excavation samples to be collected and archived, no Root Stratum sample exceeded a Uniform SOF of 0.5, therefore analysis of this sample, or any Excavation Stratum sample was unnecessary.

Chain of custody prepared for FSS samples collected in LSA 11-01 reflected sample IDs which incorrectly indicated samples being located within the Burial Pit SEA. LSA 11-01 is actually located within the Plant Soil SEA. FSS Plan calculations were performed using the correct SEA, and no data evaluation calculations involving SOFs or dose assignments were impacted. Note that SEA's are used for FSS planning purposes only, and all FSS samples are analyzed for Tc-99, the chain of custody error was merely a typographical error.

The initial DP Class 3 classification of LSA 11-01 was upgraded to Class 2 because of the flash flood event that occurred early in the Burial Pit Area remediation process. The size of LSA 11-01 was increased by approximately 1800 m^2 in April 2015 due to a surface soil RASS sample (see section 2.3.3.2) in Class 3 SU LSA 11-03 which exceeded a SOF of 0.5. The area that was removed from LSA 11-03 was subsequently included in the adjacent Class 2 LSA 11-01. This

change condition occurred prior to the preparation of the FSS Plan for LSA 11-01 and is presented here as supplemental background information, but is not considered a deviation.

17.1 Remedial Actions During FSS

There were no remedial actions after FSS in LSA 11-01.

17.2 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 11-01. Subsequent to field FSS activities within the SU, the calculation of Scan MDCs varied in approach based on the guidance given in Technical Basis Document (HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys,* Westinghouse April, 2015), as well as later discussions between HDP and the NRC via teleconference (August 2015) on the technical assumptions and inputs related to Scan MDC estimates. The Scan MDCs presented in the FSS Plan shown in Table 5-1 assumed a surveyor efficiency of 1.0 (the surveyor efficiency prescribed by the DP when data logging is utilized). The current version of HDP-TBD-FSS-002 uses a surveyor efficiency of 0.75 (the surveyor efficiency agreed upon between HDP and the NRC via teleconference). Although the revised Scan MDC for Total U increased to 40.9 pCi/g, it remained less than the $DCGL_w$ for the SU. The Scan MDCs for Ra-226 and Th-232 increased slightly to 1.21 pCi/g and 0.87 pCi/g, respectively. Using a 10,000 cpm background and a conservative 4% enrichment for the SU, 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 11-01

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw (Ra-226)	Scan MDC (Th-232)	DCGLw (Th-232)
LSA 11-01	40.9	46.9	1.21	1.9	0.87	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 11-01

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 11-01(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 11-01 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 11-01, 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 11-01, however the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1040) exceeded the critical value (860), 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 11-01, the WRS statistical test was not necessary since the difference between the maximum SU 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 SOF result for all surface samples within LSA 11-01 was 0.72. The maximum SOF result for all subsurface samples within LSA 11-01 was 0.04. The average SOF result for all systematically collected samples within LSA 11-01 was 0.03, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.05.

- No FSS sample result in LSA 11-01 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an 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 of systematic samples actually collected within LSA 11-01. The successful result of the retrospective power evaluation presented in Table 18-1 for LSA 11-01 indicates that the minimum number of samples required (8) for the WRS Test was equal to the number of sampling locations actually collected within LSA 11-01. 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 11-01 was completed prior to the commencement of backfill operations. A confirmatory GWS was performed within the 72 hours prior to backfill operations, the results of the confirmatory GWS were compared to the original FSS results, no readings in the confirmatory GWS were identified to exceed 3 standard deviations above the mean of the original FSS survey results, This survey was performed in accordance with the requirements of HDP-WP-ENG-802

Table 18-1
Retrospective Sample Size Verification for LSA 11-01

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.04
$DCGL_{SOF}$	1
LBGR (Mean)	0.03
Shift	0.97
Relative Shift (Δ/σ)	25.77
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 18-1
Data Evaluation Checklists prepared for LSA 11-01 (page 1 of 2)

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

Survey Area: LSA 11 **Description:** Land Survey Area 11, Plant Soils Area
Survey Unit: 01 **Description:** Northeast Site Creek Survey Unit in "Area 9"

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 ☐	NA ☐
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 ☐	NA ☐
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: *Deviations Footnotes: See "Discrepancy" on Page 2 of this document.

Quality Record

Figure 18-1
Data Evaluation Checklists prepared for LSA 11-01 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
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APPENDIX G-1
FINAL STATUS SURVEY DATA QUALITY OBJECTIVES REVIEW CHECKLIST

Survey Area: LSA 11 **Description:** Land Survey Area 11, Plant Soils Area

Survey Unit: 01 **Description:** Northeast Site Creek Survey Unit in "Area 9"

Discrepancy: **Item 2**: The sample location for sample IDs L11-01-01, L11-01-02, and L11-01-03 was relocated ~ 45' southwest due to haul road gravel. Sample ID L11-01-02 did not achieve the target depth (59" bgs) due to refusal at 36". Therefore, the Root Stratum sample is "short", i.e. only 30" collected from the 53" Root interval, and the sample ID L11-01-03 Excavation Stratum sample was not taken.

Item 9: All sample IDs include "B" code indicating Burial Pit SEA. The Survey Unit is actually in the Plant Soils SEA. This mis-labeling does not affect any results or calculations. The FSS Plan calculations were prepared using the correct SEA.

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 11 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): Ellen C. Jakub (Print Name) [signature] (Signature) 12/17/15 (Date)

Approved by (RSO): W. Clark Evers (Print Name) [signature] (Signature) 12/17/15 (Date)

Quality Record

19.0 SURVEILLANCE FOLLOWING FSS

FSS GWS activities in LSA 11-01 were completed on October 1, 2015. A GWS survey was performed on December 7, 2015, to verify no radiological status change in the SU prior to the start of backfill operations in the SU on the same day. 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 11-01

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 11-01 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 11-01 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.03	N/A	0.16	N/A	0.31	**0.5**
DOSE	0.75 mrem/year	N/A	4.0 mrem/year	N/A	7.75 mrem/year	**12.5 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 10-11

APPENDIX B: Analytical Data Evaluation Spreadsheets for LSA 11-01

APPENDIX C: FSS Plan Development for LSA 10-11

APPENDIX D: FSS Plan Development for LSA 11-01

APPENDIX E: TestAmerica Laboratory Analytical Data Reports for LSA 10-11

APPENDIX F: TestAmerica Laboratory Analytical Data Reports for LSA 11-01

APPENDIX G: Completed Field Logs (Form P-6)

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

APPENDIX I: Hybrid Well Analytical Data

Attachment 3

Revision Matrix for FSSFR Volume 3, Chapter 7, Revision 1

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

REVISION MATRIX FOR FSSFR VOLUME 3, CHAPTER 7, REVISION 1
Survey Area Release Record for Land Survey Area 10, Survey Unit 11,
and Land Survey Area 11, Survey Unit 01
(LSA 10-11 and LSA 11-01)

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 7, 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 7, 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
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.
7.2	Added sentence: "Appendix A presents the analytical results and associated statistics for all FSS surface samples collected within LSA 10-11."	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 10-11.	WRS Test Revision.
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

SECTION	REVISION	REASON
		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.
15.2	Added sentence: "Appendix B presents the analytical results and associated statistics for all FSS surface samples collected within LSA 11-01."	WRS Test Revision.
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 11-01.	WRS Test Revision.

REVISION MATRIX FOR FSSFR VOLUME 3, CHAPTER 7, REVISION 1
Survey Area Release Record for Land Survey Area 10, Survey Unit 11,
and Land Survey Area 11, Survey Unit 01
(LSA 10-11 and LSA 11-01)

SECTION	REVISION	REASON
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.