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Our ref: HEM-16-75
Date: November 14, 2016

Subject: Westinghouse Hematite Decommissioning Project - Request for NRC Review of Final Status Survey Final Report Volume 3, Chapter 4, Survey Area Release Record for Land Survey Area 10, Survey Unit 12 (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 the FSS overview document Final Status Survey Final Report Volume 3, Chapter 4, Survey Area Release Record for Land Survey Area 10, Survey Unit 12.

Attachment 1 contains Final Status Survey Final Report Volume 3, Chapter 4, with a CD containing Appendices.

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

Sincerely,

Kenneth E. Pallagi
Licensing Manager,
Hematite Decommissioning Project

Attachment: 1) Final Status Survey Final Report Volume 3, Chapter 4, Survey Area Release Record for Land Survey Area 10, Survey Unit 12 (HDP-RPT-FSS-206)

cc: J. W. Smetanka, Westinghouse
M. R. Meyer, NRC/DUWP/MDB
J. A. Smith, NRC/DUWP/MDB

NMSS20

Attachment 1

Final Status Survey Final Report Volume 3, Chapter 4

Survey Area Release Record for Land Survey Area 10, Survey Unit 12

with CD containing Appendices

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 4

TITLE: **Survey Area Release Record for Land Survey Area 10, Survey Unit 12 (LSA 10-12)**

REVISION: **0**

EFFECTIVE DATE: NOV 1 4 2016

Approvals:

Author: Kenneth E. Pallagi — 11-14-2016 Date

Owner/Manager: W. Clark Evers — 11/14/16 Date

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LIST OF ACRONYMS AND SYMBOLS

ALARA	As Low As Reasonably Achievable
bgs	below ground surface
bkg	background
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
GIS	Graphical Information Software
GPS	Global Positioning System
GWS	Gamma Walkover Survey
HDP	Hematite Decommissioning Project
HP	Health Physics
HRCR	Hematite Radiological Characterization Report
I & C	Isolation and Control
IAL	Investigation Action Level
LSA	Land Survey Area
m	meter(s)
m^2	square meter(s)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MCL	Maximum Concentration Limit
MDC	Minimum Detectable Concentration
mrem	milliroentgen equivalent man
NAD	North American Datum

NaI	Sodium Iodide
ncpm	net count(s) per minute
NCS	Nuclear Criticality Safety
NRC	U.S. Nuclear Regulatory Commission
pCi/g	picocurie(s) per gram
QC	Quality Control
Ra	Radium
RAI	Request for Additional Information
RASS	Remedial Action Support Survey
RML	Reuse Material Screening Level
RSO	Radiation Safety Officer
SARR	Survey Area Release Record
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) 12 (LSA 10-12). As provided in Final Status Survey Final Report (FSSFR), Volume 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 10-12 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). For the LSA 10-12 SU, evaluation of analytical results against the Derived Concentration Guideline Levels (DCGL) for the "Three Layer" Conceptual Site Model (CSM) was the selected approach. The objective of the FSS for the SU was to obtain and document measurement results, analytical data, and other supporting information in order to demonstrate that after completion of remediation the residual radioactivity levels in the LSA 10-12 SU are below the applicable "Three Layer" Stratum DCGLs and therefore the land area of this SU meets the criteria for unrestricted release.

The three strata include the surface layer, root stratum, and deep stratum. Each stratum has a different set of DCGLs based on the relative risk determined through exposure pathway modeling of the Resident Farmer Scenario as described in FSSFR Volume 3, Chapter 1, Section 3.1, *Release Criteria*. The Three-Layer approach is being used for the evaluation of FSS sample results collected within LSA 10-12 due to results from subsurface samples associated with a hybrid monitoring well boring investigation. Specifically, two elevated Tc-99 results above the Uniform Stratum DCGL, but below the Excavation Stratum DCGL were found in boring samples associated with hybrid monitoring well BP-17 which is located within LSA 10-12. The estimated depth of the elevated Tc-99 result from BP-17 is between 16 ft and 20 ft below the current ground surface which had been partially excavated, and from BP-17E is between 28 to 30 feet (ft) below the ground surface which had not been excavated at the time of sampling.

Accordingly, the FSS Plan for LSA 10-12 was prepared under the approval by the Radiation Safety Officer (RSO) to use the Three-Layer approach. Therefore, all systematic samples within LSA 10-12 were sampled according to the Three-Layer protocol.

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

LSA 10 encompasses the entire "Documented Burial Pit Area" footprint within the Central Tract. LSA 10 consists of SUs LSA 10-1 through LSA 10-14 (Figure 2-2).

2.3 LSA 10-12 Survey Unit Description and Configuration

LSA 10-12 is located within the central section of LSA 10, the Burial Pit Area. Figure 2-2 indicates the location of LSA 10-12 within LSA 10. Figure 2-3 presents the Final Configuration of the HDP Land Survey Areas and SUs which indicate the location of the boundaries of LSA 10-12.

After the removal of buried materials and the completion of radiological remediation, in the final configuration LSA 10-12 consisted primarily of an excavated area in the SU. The excavation depths were not as extensive as in the LSA 10-01, LSA 10-02, LSA 10-03 and LSA 10-04 which were remediated concurrently with LSA 10-12. The final configuration of the SU consisted of native soil. There were no structures, piping, groundwater monitoring wells, or spent limestone remaining within the SU.

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 10-12 presents 1,578 square meters (m^2) in planar (2-dimensional) extent, within an interior surface area of 1,926 m^2 (3-dimensional).

Figure 2-1
HDP Land Survey Areas

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

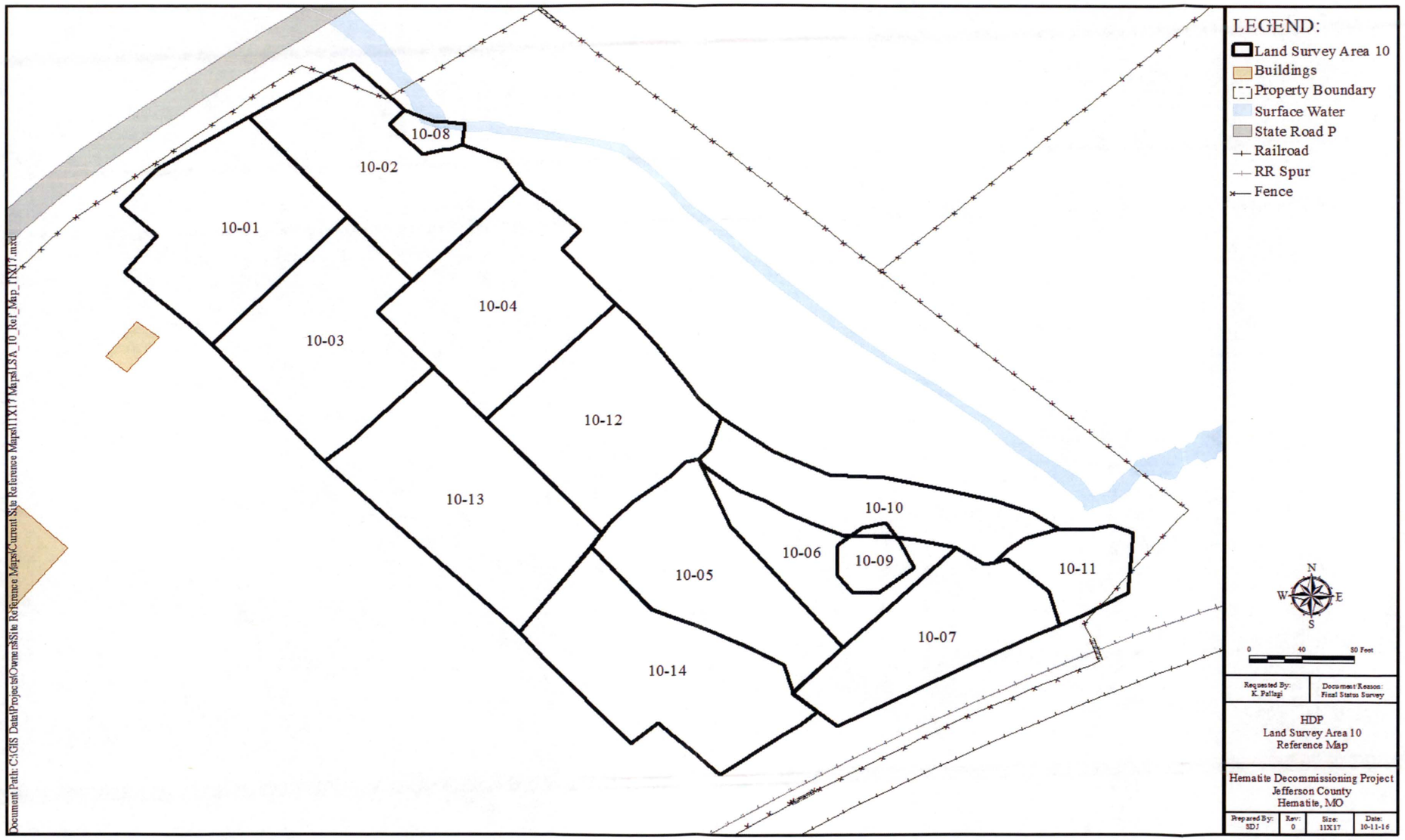
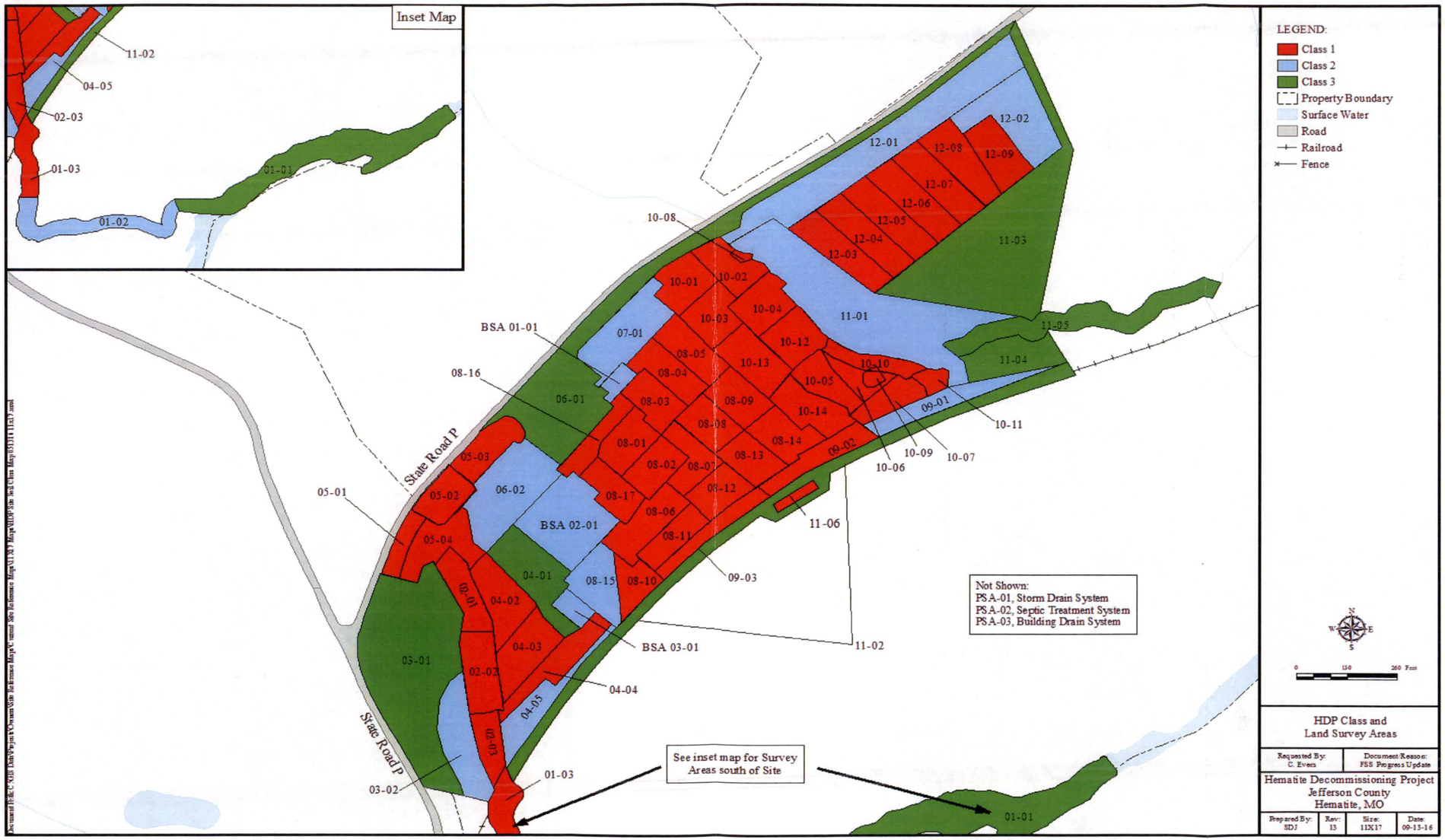


Figure 2-3
Final Configuration of Land Survey Areas and Survey Units



3.0 HISTORY OF OPERATIONS

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

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

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

3.1 Radioactive Materials in LSA 10-12

Radioactive materials within LSA 10-12 resulted from placement of radioactive contaminated materials below grade and above grade. As with the remediation of LSAs 10-01, 10-02, 10-03, and 10-04, during the remediation of LSA 10-12 (see Figure 3-1 and Figure 3-2), various types of waste materials were encountered, including drums, bags of trash, fuel pellets, construction debris, quantities of spent limestone, and contaminated soils.

Remedial actions within the Burial Pit Area revealed that although the underlying burial pits were nearly contiguous, individual burial pits were readily identifiable based on changes in soil color, soil hardness, visibly obvious items of non-native debris, and elevated gamma readings as measured by field instrumentation. Figure 3-8 shows that all intervening soils between individual pits were removed during the remedial excavation regardless of radioactivity concentration.

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

Figure 3-2
Removal of Trash and Debris in LSA 10-12 (2013)

3.2 Reuse Soil Disposition and Characterization

Prior to remediation and removal of contaminated soil and other waste materials within LSA 10-12, overburden soils which exhibited characteristics suitable for potential reuse as onsite backfill material were removed, segregated, and subjected to reuse soil criteria requirements.

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

3.3 Remediation and Remedial Action Support Surveys (RASS) Phase of LSA 10-12

The sections below provide a discussion of the various elements of remediation and the RASS phase of LSA 10-12 necessary to prepare the SU for FSS.

3.3.1 Remedial Actions

Remedial actions began in LSA 10-12 in April 2012, and continued through December 2014. Types of waste materials encountered during the remediation are detailed in Section 3.1.

There were several indicators inherent in the remediation process of LSA 10-12 in which a portion of the Burial Pit Area was located that provided assurance that all wastes were removed prior to the initiation of FSS. As discussed in FSSFR Volume 3, Chapter 1, there was ample historical evidence to confidently delineate the spatial boundary of the Burial Pit Area. As the overburden soil was removed it was easy to visually identify the location of a burial pit based on a change in soil color. Even the undocumented burials were easily identified by a change in soil

color even though their size and shape was not as well defined as the documented burial pits (see Figure 3-3). Additionally, the equipment operators conducting the excavation could distinguish when they were digging in a burial pit based on the difference in the hardness of the soil. Workers could even detect the difference in the soil hardness when walking over burial pits, which tended to be soft and spongy. Adding to the visual and soil hardness cues, the burial pits were also radiologically identifiable based on gamma walkover surveys (GWS) once the contaminated layers were reached (Figure 3-4). In summary, both documented and undocumented burials were easy to distinguish once excavation activities commenced.

Figure 3-3
Example of Burial Pit Soil Discoloration

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

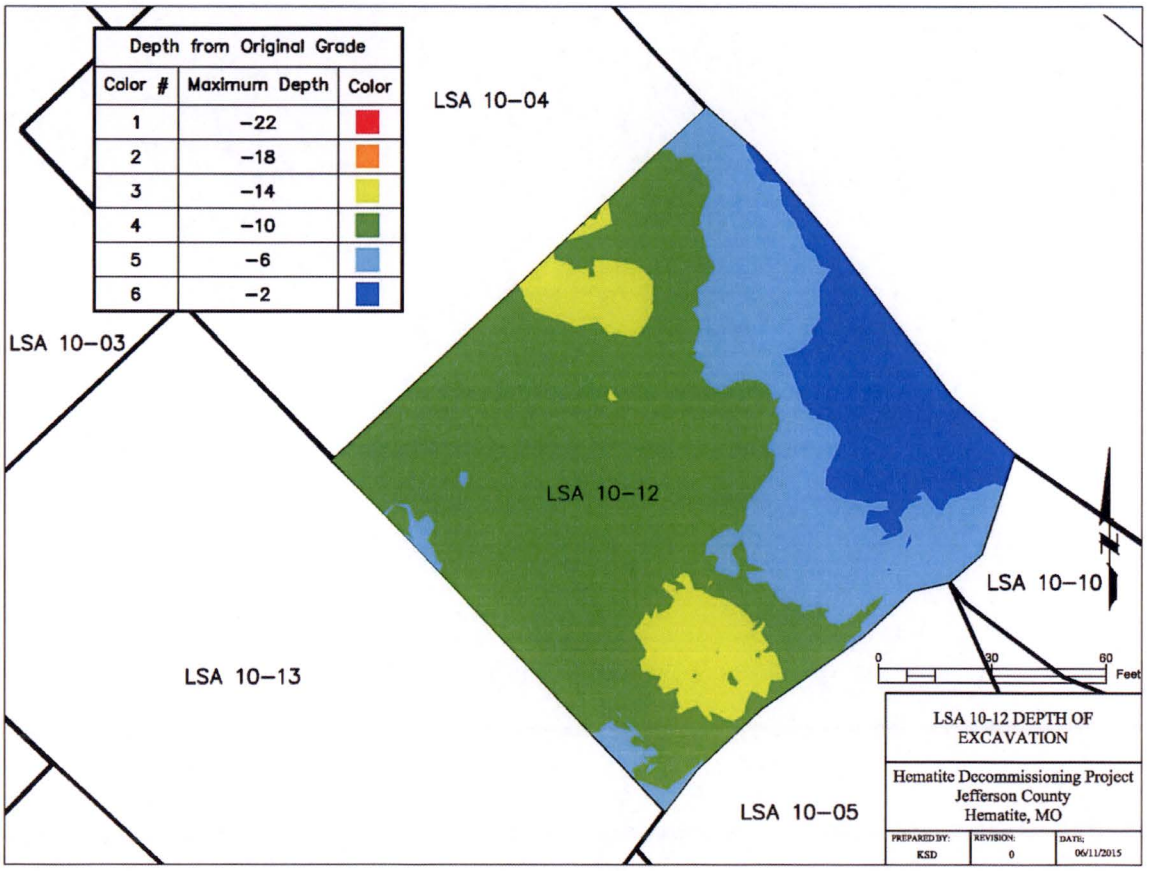
As excavation and remediation of the Burial Pit Area progressed, it became apparent that most of the buried debris was located in the north and south ends of the Burial Pit Area, and typically in closely aligned pits, while the central area had minimal debris and contamination. Since sloping and benching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

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

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

The maximum depth of remedial excavation necessary in portions of LSA 10-12 to ensure all areas identified during site characterization and remedial action survey efforts were adequately remediated relative to the original grade was 14 ft. The estimated volume of excavated waste materials from LSA 10-12 was 3,991 cubic yards. Figure 3-5 provides the depth of excavations for LSA 10-12. The areas of the LSA 10-12 indicated in Figure 3-5 in the blue and light blue shaded areas indicate the excavation from the original downward sloped terrain surface to the lower elevation of the Northeast Site Creek. The final elevation of the excavation floor was relatively the same across the SU.

Figure 3-5
LSA 10-12 Depth of Excavation Map (Depths in Feet)*



*Depth of Excavation Map presented in colored bands of feet. Maximum depth is 14ft.

3.3.2 In Process Remedial Action Support Surveys

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

3.3.3 Nuclear Criticality Safety (NCS) Borings

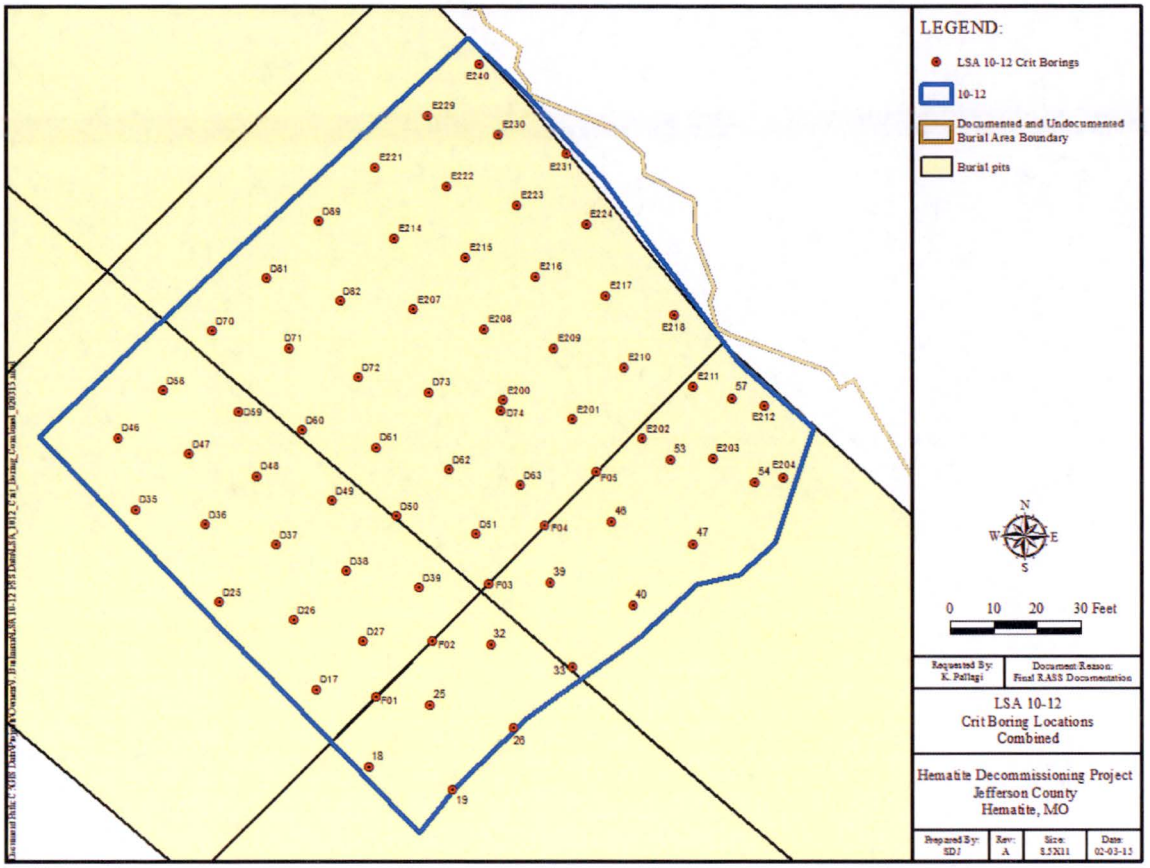
In addition to the visual inspection and radiological measurements conducted to determine when removal of buried waste was complete and NCS controls could be removed during remediation of LSA 10-12, a series of borings were performed within the NCS Controlled areas of the SU.

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 excavation surface. The NSA-TR-09-15 Administrative CSC 23 required that these borings (see Figure 3-6) would be performed to 3 ft below the deepest identified buried waste item in an excavation or 7 ft below ground surface (bgs) (representative of 4 ft of overburden soil and an additional 3 ft into the soil that could have potential burial pit waste). In addition to performing a boring below the deepest identified waste item in an excavation, a grid with maximum spacing of 20 ft between boreholes was conducted within the entire documented burial pit area. The grid spacing chosen was based upon the nominal size of a documented burial pit. The spacing was chosen to provide a high probability that material from an unidentified burial pit would be intercepted.

The survey measurements from the spoils material and boreholes for LSA 10-12, along with the results of the visual inspection, were then reviewed by the NCS Specialist and the area released from NCS controls. The visual inspection of the cores provided evidence that no materials indicative of burial pit waste were encountered below the excavation surface within LSA 10-12. Once the area was released from NCS controls, excavation continued, as necessary, for additional remediation of radiological and/or VOC contamination.

No materials indicative of burial pit waste were encountered below the excavation surface within LSA 10-12.

Figure 3-6
NCS Core Bore Locations in LSA 10-12



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.

One hybrid groundwater monitoring well, BP-17 and one drawdown well BP-040, were located within LSA 10-12 and both have since been abandoned in accordance with State of Missouri requirements.

It has been determined that the installation of hybrid monitoring wells could have created a potential pathway for shallow contamination to migrate into deeper strata around the well as hybrid wells contain a screen extending from the silty/clay layer and into the underlying sand/gravel layer. As such the NRC License SNM-33 for HDP has a License Condition that states *"Except as specifically provided otherwise in this license, the licensee shall conduct its program in accordance with statements, representations, and procedures contained in the documents, including any enclosures listed below."* Westinghouse letter HEM-11-56 which is listed in the License Condition states in regards to hybrid wells:

"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."

> Note: Due to equipment availability there was a minor deviation from the Request for Additional Information (RAI) response as provided above. The sampling interval was actually performed in four (4) foot rather than five (5) foot intervals, as a consequence of the drill rig configuration. An evaluation was performed and documented which concluded that 4-foot interval sampling met the intent of and was of equivalent quality in the data derived during the sampling.

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."

Site records indicate that BP-17 was abandoned and sampled in January of 2012, in accordance with the requirements as specified above. For hybrid well BP-17 a review of the January 2012 sample data indicated exceedances of the Tc-99 MDC+Error. Therefore, as provided in HEM-11-56, four (4) borings were completed around the well. Three (3) of the thirty four (34) soil sample results from these four (4) proximal borings exceeded the Uniform DCGL, with a maximum result of 2.39 Uniform SOF which was collected from location BP-17-E at a depth interval of 28-30 ft bgs. Therefore, additional supplemental investigation borings were performed proximal to BP-17 toward the Northeast Site Creek. Only one (1) of the additional 53 investigation samples was found to exceed the Uniform DCGL with a SOF or 1.41 at location BP-17-5, at a depth interval of 21.6 – 25.6 ft bgs. In total four (4) results exceeding the Uniform Stratum DCGL but below the Excavation Stratum DCGL were found in boring samples associated with hybrid monitoring well BP-17. Two of the elevated boring locations were removed during remediation. The two residual intervals of elevated activity are located at BP-17-5 between 21.6 ft and 25.6 ft below original grade, and at BP-17E between 28 to 30 ft bgs. Although the analytical sample results from these location intervals exceed the Uniform Stratum SOF of 1, they do not exceed a SOF value of 1 as compared to the Excavation Stratum DCGLs.

The maximum SOF result of the soil samples collected from BP-17 during abandonment was 0.31 of the Excavation Stratum $DCGL_W$.

> Note: Due to significant safety considerations there was a minor field deviation from the RAI response provided in HEM-11-56. The hybrid well investigation was performed prior to completing the remedial excavation in order to allow the drill rig to safely access and maneuver to the required sampling locations. Safe drill rig operation and access to all sampling locations would not have been feasible over the expected final as-left excavation surface. The re-sequencing of the investigation within the remediation process did

not impact the results of the investigation as the buried waste that overlay the vicinity of the abandoned well had been removed for disposal (source term had been removed).

Appendix F presents the analytical soil and water results for Hybrid Well BP-17.

BP-040 was a well that was installed on May 23, 2008, for the purpose of determining groundwater drawdown and recharge rates that could be expected in the shallow soils to be excavated in the Burial Pit Area during remediation. This 4" diameter well was installed to a depth of 30' bgs. A 20' screen was installed in the silty clay material from 10' to 30' bgs. This well was abandoned in accordance with MDNR Well Construction Rules on January 25, 2012. During the abandonment of non-hybrid well BP-040, the maximum SOF result was 0.53 of the Excavation Stratum DCGL. The sample interval was at a depth of 10' ft bgs and was removed during remediation of the SU.

3.3.5 Subterranean Piping

Preliminary remediation planning activities indicated that no subterranean process piping should be encountered in LSA 10-12. During remediation of LSA 10-12 no subterranean process piping was encountered.

As no buried piping remains under the footprint of LSA 10-12 there is no dose contribution from this pathway.

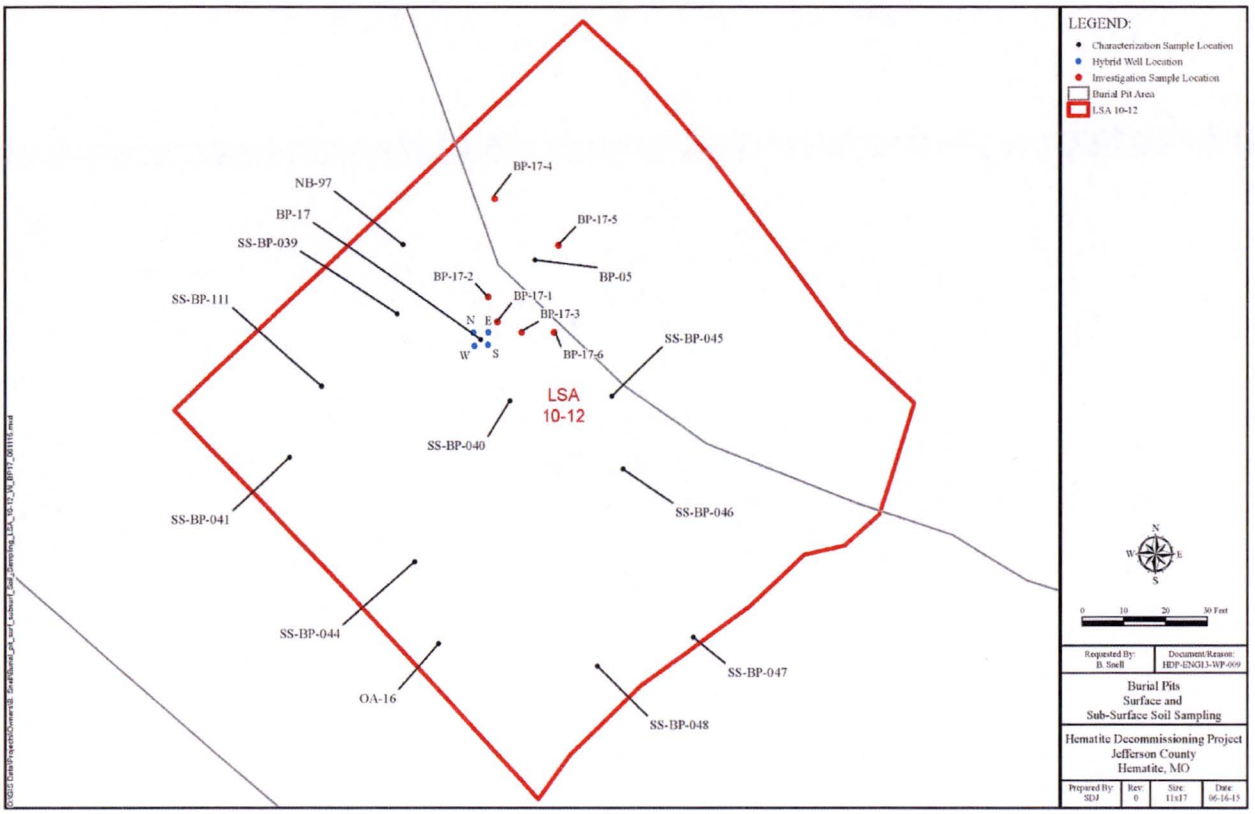
3.3.6 Characterization Core Bores

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 thirteen (13) core borings to depths as deep as 31' bgs were performed for characterization within LSA 10-12 prior to remediation.

No sample collected during the characterization effort exceeded an SOF of 1 as compared to the Uniform Stratum DCGLs; accordingly no characterization sample collected within LSA 10-12 exceeded an SOF of 1 as compared to the Three-Layer DCGLs.

Figure 3-7 depicts the characterization boring locations within LSA 10-12.

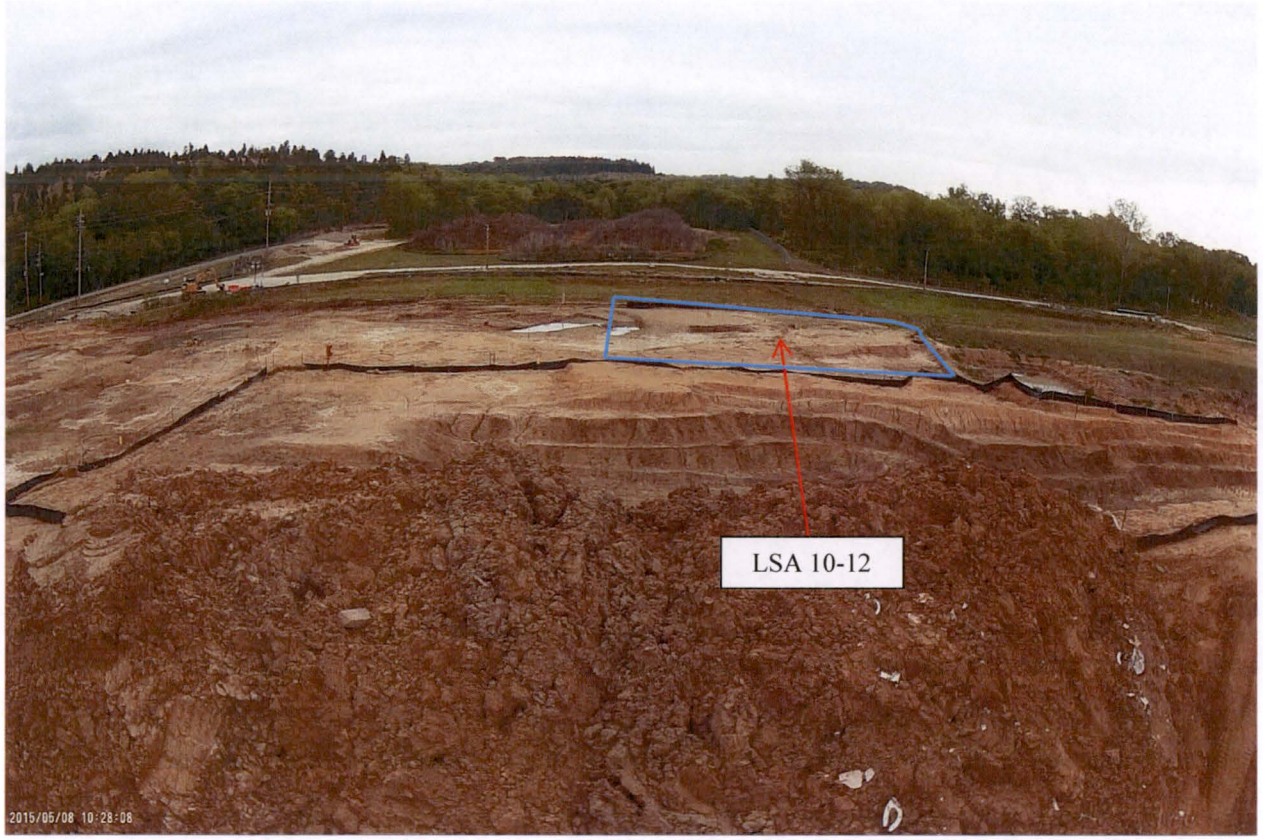
Figure 3-7
Site Characterization Borings within LSA 10-12



3.3.7 Remedial Action Support Survey for FSS Design

The RASS was conducted 1) to guide remediation activities, 2) to determine when an area or survey unit had been adequately prepared for FSS, and 3) to provide updated estimates of the parameters to be used for planning the FSS. Upon completion of remediation within the SU and prior to implementation of FSS activities, a final RASS was performed to validate the status of the SU prior to implementing Isolation and Control (I & C) postings. The I & C posting for LSA 10-12 was completed on December 12, 2014. Figure 3-8 is a photograph which shows LSA 10-12 ready for the final RASS prior to final storm water removal.

Figure 3-8
LSA 10-12 Prepared for RASS FSS Design



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

Table 3-1
Summary of Final RASS Results for LSA 10-12

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
10-12	0.05	0.27	3.86	13.40	0.11	0.35	2.68	5.82	0.14	0.32	1.22	1.87
DCGL Root Stratum	2.1		30.1		2.0		235.6		64.1		183.3	
DCGL Excavation Stratum	5.4		74.0		5.2		872.4		208.1		551.1	

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).

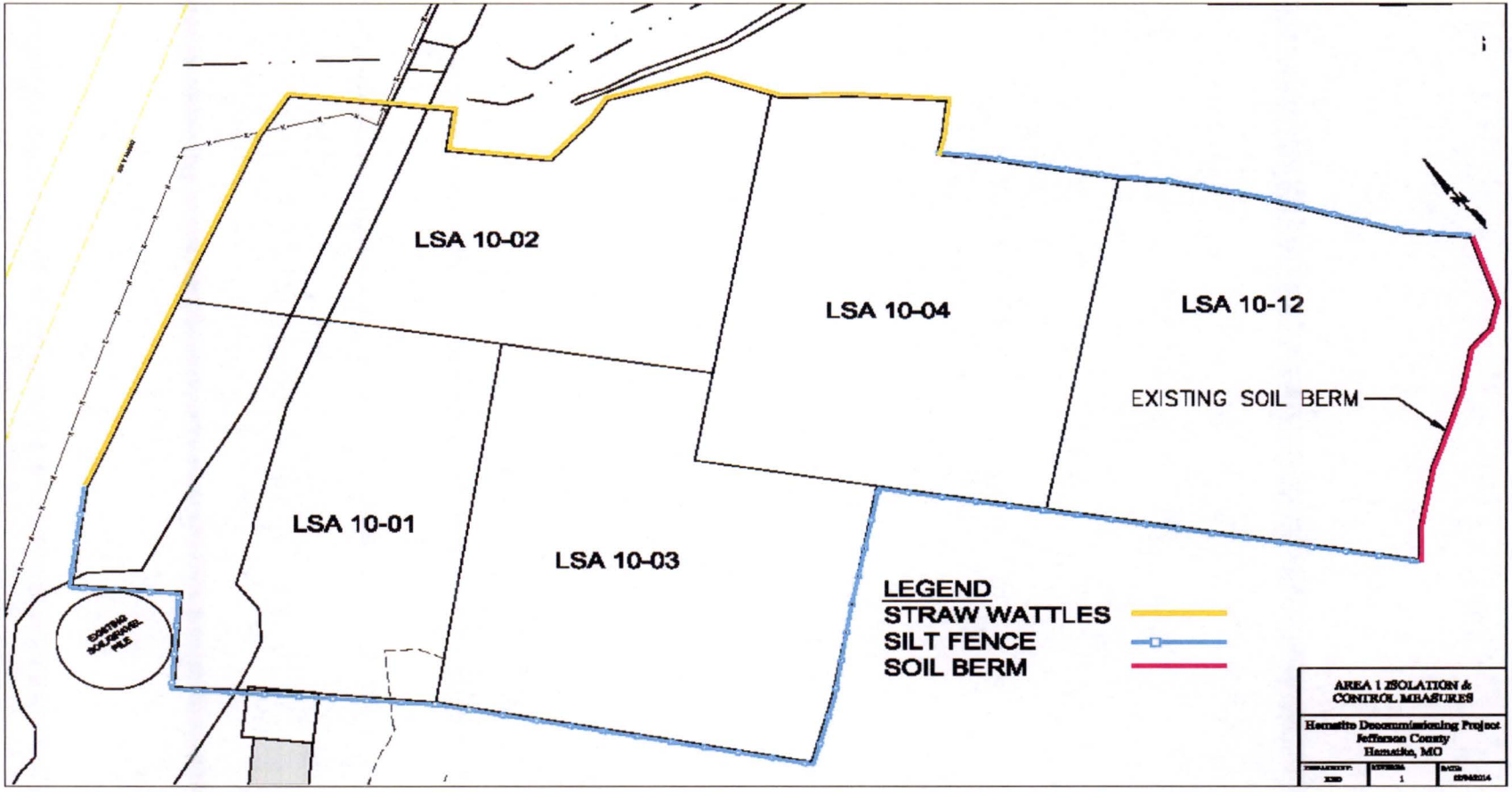
All Final RASS systematic sample and biased sample results were less than the appropriate $DCGL_W$ (Three Stratum) and the Final RASS data set was considered sufficient to support FSS design.

3.3.8 Isolation and Control

As directed by HDP-PR-HP-602, *Data Package Development and Isolation and Control Measures to Support Final Status Survey,* on December 12, 2014, LSA 10-01, LSA 10-02, LSA 10-03, LSA 10-04, and LSA 10-12 were isolated and controlled in accordance with Work Package HDP-WP-ENG-803, *Isolation and Control Measures,* (See Figure 3-9) Isolation and control measures included silt fencing, straw wattles, and soil berms between these SUs and the adjacent remediation area to ensure that cross-contamination of these LSAs undergoing FSS did not occur.

The administrative control of distinctive green and white rope with multiple postings labeled "Contact Health Physics Prior to Entry" was installed around the entire perimeter of the SUs prior to FSS field activities to prevent inadvertent entry by site personnel. LSA 10-12 is located within the fenced security perimeter of the HDP which therefore prevents access by the general public.

Figure 3-9
Isolation and Control of Area Containing LSA 10-12



3.3.9 Surveillance Following FSS

Following the completion of the 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 included the routine visual inspection of the integrity of the I & C measures implemented for LSA 10-12. If a survey unit was suspected of having been re-contaminated then an investigation survey will be performed to reconfirm the FSS survey validity. This requirement remained in place until FSS of the adjacent survey units had been completed and backfill of the area was performed, which occurred in August, 2015.

No instances occurred prior to the completion of backfill activities in LSA 10-12, and therefore there is no reason to suspect the validity of the FSS that has been performed.

3.3.10 Backfill of Survey Units

Although not a function of remediation, but as described in the DP Section 8.8, LSA 10-12 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. As only off-site backfill material was used, no dose will be added to LSA 10-12 for backfill material.

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/yr (milliroentgen equivalent man per 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 10-12 will be reported in FSSFR Volume 7 reflecting the updated results of the post-remediation groundwater monitoring.

4.0 LSA RELEASE CRITERIA

As the release criteria for all LSA SUs is common, FSSFR Volume 3, Chapter 1, Section 3.0, *Release Criteria*, provides a detailed discussion on the release criteria that is applicable to LSA 10-12. Table 4-1 provides the applicable $DCGL_W$s.

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

This section describes the method for determining the number of samples required for the FSS of LSA 10-12 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 10-12 and their detection sensitivities are also discussed.

5.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 10-12 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 4, *Final Status Survey Plan Development*, January 2015.

5.1.1 Surrogate Evaluation Areas

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

5.1.2 $DCGL_W$

The Three-Layer CSM is being used for the evaluation of FSS sample results collected within LSA 10-12 due to results from subsurface samples associated with a hybrid monitoring well boring investigation. Specifically, two elevated Tc-99 result above the Uniform Stratum DCGL but below the Excavation Stratum DCGL were found in boring samples associated with hybrid monitoring well BP-17 which is located within LSA 10-12. The estimated depth of the elevated Tc-99 result from BP-17 is between 16 ft and 20 ft below the current ground surface which has been partially excavated, and from BP-l7E is between 28 to 30 ft below the ground surface which had not been excavated at the time of sampling.

5.1.3 GWS Coverage

As a Class 1 SU, LSA 10-12 was required to undergo a 100% GWS.

5.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 10-12 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 10-12, the scan minimal detection concentration (MDC) calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

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

Equation 5-1

In order to calculate the Scan MDC for total uranium using the above equation, an average enrichment for the SU must be known which in turn will provide relative isotopic fractions for U-234, U-235, and U-238 as given in Appendix G of HDP-PR-FSS-701, Revision 4, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 10-12, the average enrichment for the SU was 1.9%.

Standard scan MDCs for Radium-226 and Thorium-232 using a 2" x 2" NaI detector are found in Table 6.4 of NUREG-1507 and are shown in Table 5-1. Prospectively calculated scan MDCs for 2" x 2" NaI detectors that were used in LSA 10-12are shown below:

Table 5-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 10-12

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	$DCGL_{EMC}$* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 10-12	82.6	104.0	2.8	5.04	1.8	3.0

* $DCGL_{EMC}$ and DCGLw includes background concentrations of 0.9 pCi/g for Ra-226 (no ingrowth) and 1.0 pCi/g for Th-232. Ra-226 $DCGL_{EMC}$ values are based on the Root Stratum Release criteria and the AF_{Ra-226} of 2.4. Th-232 DCGLw values are based on the Root Stratum release criteria.

The values in Table 5-1 reflect those presented in the FSS Plans 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 10-12 was established at 4,000 net counts per minute (ncpm).

5.1.7 LSA 10-12 FSS Design Summary

The FSS Plan for LSA 10-12 can be found in Appendix B. Table 5-2 presents an overall FSS design and implementation summary for LSA 10-12.

Table 5-2
FSS Design Summary for LSA 10-12

Gamma Walkover Survey (GWS):		
Scan Coverage	100% accessible excavation floors, benches, pits, and sidewalls	
Scan MDC	82.6 pCi/g total Uranium (based on a 10,000 cpm background)	
Investigation Action Level (IAL)	4,000 net cpm*	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments
0 – 15 cm (Surface)	0	These samples were collected on a systematic grid.
15 cm – 1.5 m (Root)	3	
> 1.5m (Excavation)	9	
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 (2" x 2" NaI) detector; with collimation for investigations.	Used for GWS and to obtain static count rates at biased measurement locations.	
*IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum $DCGL_W$ derived from the technical bases presented in HEM-MEMO-15-021 and HDP-TBD-FSS-003 "*Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*", Westinghouse, March 2015.		

6.0 FINAL STATUS SURVEY IMPLEMENTATION

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

6.1 Gamma Walkover Surveys

6.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 10-12 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 10-12 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 10,000 and 11,000 gross counts per minute (gcpm). Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 15,000 gross counts per minute (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 Technician performing the survey to determine if possible areas of elevated residual activity remained within the survey unit that required biased sample investigation. During the review areas that were flagged by the Health Physics (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 10-12.

Table 6-1
Systematic Sampling Summary by Stratum for LSA 10-12

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep	
10-12	1,578	0	3	9	1

6.2.1.1 Systematic Sampling LSA 10-12

Within LSA 10-12, there were portions of the surface stratum [0 – 15 centimeters (cm)] remaining in the SU after remediation. Portions of the root stratum (15 cm – 150 cm) remained at three (3) of the eight systematic locations. At these locations the remaining root stratum interval sample was collected using a hand auger and composited. Excavation stratum samples were collected at all nine locations using either hand trowels, or hand augers where necessary, for six-inch grab samples below the existing excavation surface.

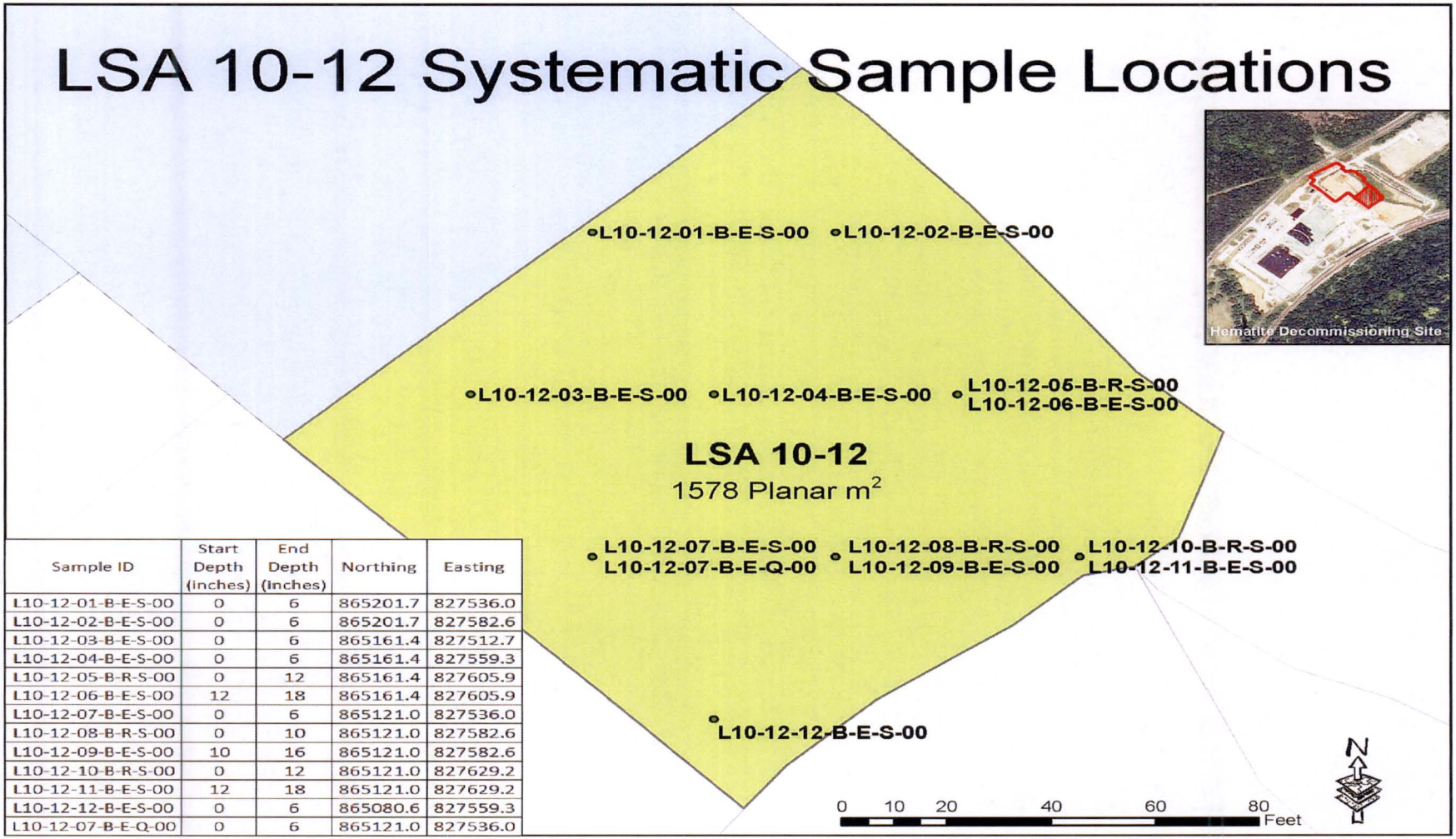
Given a planar area of 1,578 m^2 for LSA 10-12 and a nine - point systematic triangular grid, the point-to-point distance within each row was 14.2 m with spacing of 12.3 m between each of the parallel grid rows within the SU.

While there were nine systematic locations on the LSA 10-12 sampling grid, a total of 13 samples were collected at these locations, including:

- Zero (0) samples collected within the remaining surface stratum,
- Three (3) samples collected within the remaining root stratum,
- Nine (9) samples collected within the excavation, or "deep", stratum, and
- One (1) QC field replicate.

Figure 6-1 presents the map of the nine systematic sample locations which were sampled within LSA 10-12. The inset table notes the location coordinates (Missouri East, North American Datum (NAD) 1983) and collection intervals for each systematic location.

Figure 6-1
LSA 10-12 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L10-12-01-B-E-S-00	0	6	865201.7	827536.0
L10-12-02-B-E-S-00	0	6	865201.7	827582.6
L10-12-03-B-E-S-00	0	6	865161.4	827512.7
L10-12-04-B-E-S-00	0	6	865161.4	827559.3
L10-12-05-B-R-S-00	0	12	865161.4	827605.9
L10-12-06-B-E-S-00	12	18	865161.4	827605.9
L10-12-07-B-E-S-00	0	6	865121.0	827536.0
L10-12-08-B-R-S-00	0	10	865121.0	827582.6
L10-12-09-B-E-S-00	10	16	865121.0	827582.6
L10-12-10-B-R-S-00	0	12	865121.0	827629.2
L10-12-11-B-E-S-00	12	18	865121.0	827629.2
L10-12-12-B-E-S-00	0	6	865080.6	827559.3
L10-12-07-B-E-Q-00	0	6	865121.0	827536.0

Figure 6-2 below presents a tabular listing of all FSS samples collected within LSA 10-12 with associated IDs, sample types, collection intervals, coordinates, and notes.

Figure 6-2
FSS Sample Locations and Coordinates for LSA 10-12

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

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area:	LSA 10	**Description:**	Burial Pits Open Land Area
Survey Unit:	12	**Description:**	Southeast Survey Unit (North Burial Pit)
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
L10-12-01-B-E-S-00	Three-Layer	S	422.0	421.6	865201.7	827536.0	Excavation 6-inch grab
L10-12-02-B-E-S-00	Three-Layer	S	422.4	421.9	865201.7	827582.6	Excavation 6-inch grab
L10-12-03-B-E-S-00	Three-Layer	S	424.9	424.4	865161.4	827512.7	Excavation 6-inch grab
L10-12-04-B-E-S-00	Three-Layer	S	423.1	422.6	865161.4	827559.3	Excavation 6-inch grab
L10-12-05-B-R-S-00	Three-Layer	S	425.0	424.0	865161.4	827605.9	Root 12-inch composite
L10-12-06-B-E-S-00	Three-Layer	S	424.0	423.5	865161.4	827605.9	Excavation 6-inch grab
L10-12-07-B-E-S-00	Three-Layer	S	426.4	425.9	865121.0	827536.0	Excavation 6-inch grab
L10-12-08-B-R-S-00	Three-Layer	S	426.4	425.6	865121.0	827582.6	Root 10-inch composite
L10-12-09-B-E-S-00	Three-Layer	S	425.6	425.1	865121.0	827582.6	Excavation 6-inch grab
L10-12-10-B-R-S-00	Three-Layer	S	425.4	424.4	865121.0	827629.2	Root 12-inch composite
L10-12-11-B-E-S-00	Three-Layer	S	424.4	423.9	865121.0	827629.2	Excavation 6-inch grab
L10-12-12-B-E-S-00	Three-Layer	S	426.8	426.3	865080.6	827559.3	Excavation 6-inch grab
L10-12-07-B-E-Q-00	Three-Layer	Q	426.4	425.9	865121.0	827536.0	Excavation 6-inch grab
L10-12-13-B-E-B-00	Three-Layer	B	427.4	426.9	865065.4	827560.4	Excavation 6-inch grab
L10-12-14-B-E-B-00	Three-Layer	B	426.4	425.9	865094.0	827531.8	Excavation 6-inch grab
L10-12-15-B-E-B-00	Three-Layer	B	424.1	423.6	865117.4	827586.0	Excavation 6-inch grab
L10-12-16-B-E-B-00	Three-Layer	B	422.5	422.0	865165.2	827580.8	Excavation 6-inch grab

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

*Elevations are in feet above mean sea level.
** Missouri - East State Plane Coordinates [North American Datum (NAD) 1983]
Surface: Floor = F; Wall = W; Ceiling = C; Roof = R
CSM: Three-Layer (Surface-Root-Excavation) or Uniform Stratum 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 10-12 two biased sample locations were selected within the LSA based on the evaluation of the GWS survey data. Biased location L10-12-13-B-E-B-00 represented the maximum GWS measurement encountered within the survey unit and had an Excavation SOF value of 0.14. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

6.4 Judgmental/Sidewall Sampling for Tc-99

In accordance with the guidance specified in Volume 3, Chapter 1, Section 6.2.3, it was determined that sidewall sampling was necessary. The number of sidewall samples collected from each LSA is determined by comparing the sidewall surface area to the two dimensional systematic surface area (e.g., 9 systematic samples were collected over 2,000 m^2, then collect 1 sample per 222 m^2 of sidewall). Two samples were collected in the sidewall of LSA 10-12. These samples were collected from locations selected by the Health Physics Technician at random, and were not based on gamma survey readings (not biased). The results are presented in Section 7.2.5.

6.5 Quality Control Soil Sampling

One QC field duplicate sample point was randomly selected and collected at systematic location L10-12-07 for LSA 10-12.

7.0 FINAL STATUS SURVEY RESULTS

7.1 Gamma Walkover Survey

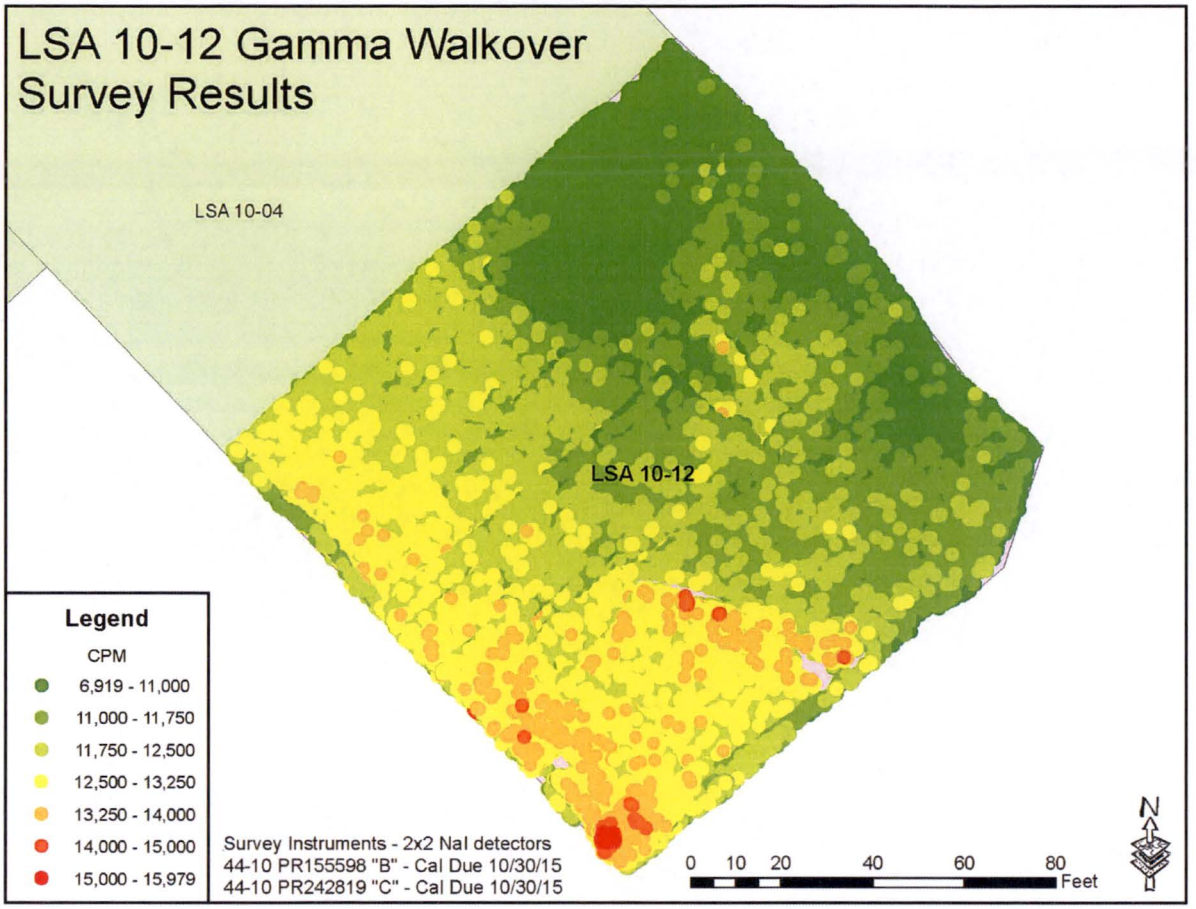
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are 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 10-12 between January 29, 2015, and February 11, 2015.

7.1.1 GWS Results for LSA 10-12

For LSA 10-12, GWS count rates ranged between 6,919 gcpm and 15,979 gcpm, with a mean count rate of 11,229 gcpm. The median count rate was 11,356 gcpm and the standard deviation was 1,117 cpm. Figure 7-1 below presents a map of the complete GWS data set.

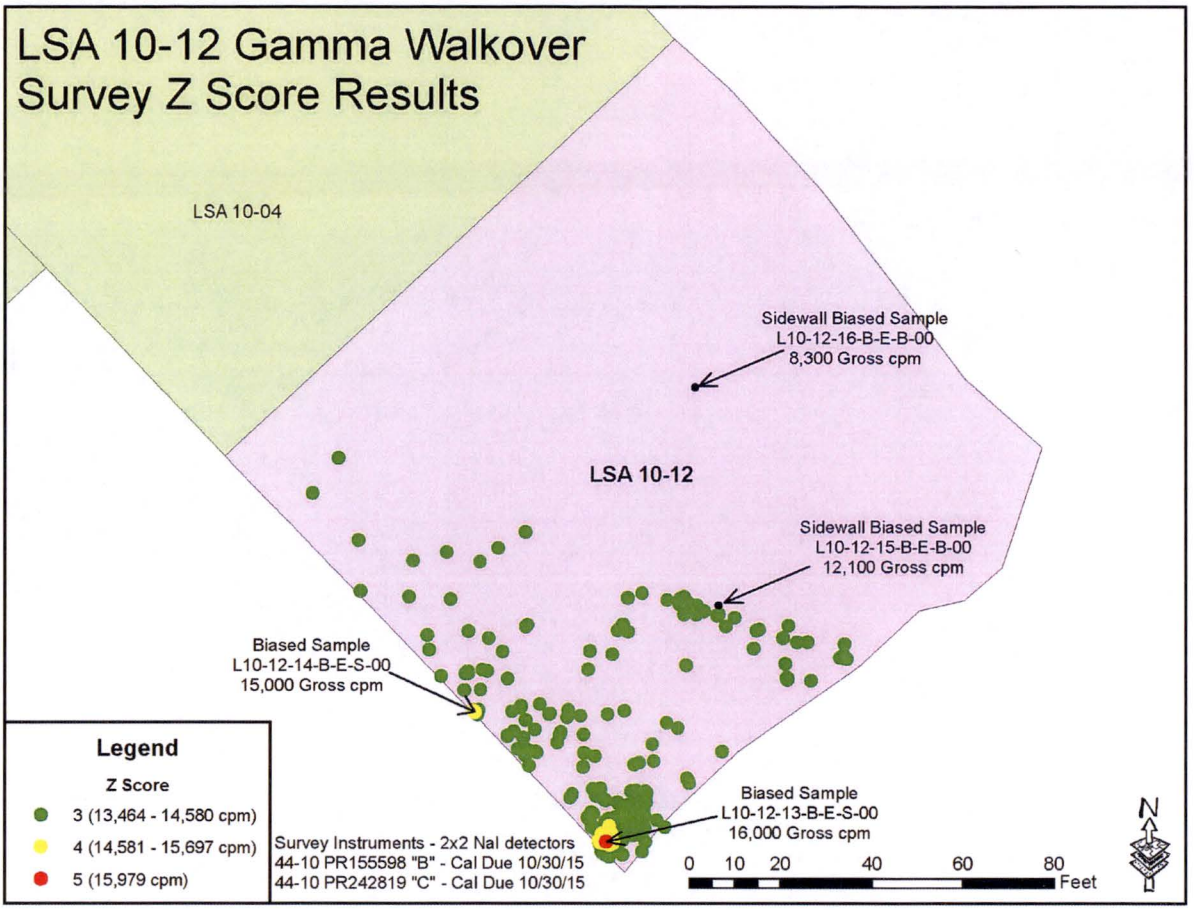
Figure 7-1
Colorimetric GWS Plot for LSA 10-12



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"). Two locations, L10-12-13 and L10-12-14, were selected for biased sample collections. Location L10-12-13 represented the maximum GWS measurement encountered within the survey unit.

Figure 7-2 below presents a map of the +3 Z-score GWS measurements within LSA 10-12, including the selected biased sampling locations (ID: L10-12-13-B-E-S-00, L10-12-14-B-E-S-00).

Figure 7-2
Colorimetric GWS Plot for LSA 10-12 (Measurements > Z-score of 3)



A total of 53,181 individual GWS measurements were collected in LSA 10-12. Using a conservative side-to-side movement distance of 1 ft, and given the internal SU surface area of LSA 10-12 of approximately 21,000 square ft, the average estimated surveyor speed during GWS of LSA 10-01 was approximately 0.4 ft/sec. Since this retrospectively estimated scanning speed was less than the 1.0 ft/second FSS Plan requirement and the fact that the NaI probe was maintained as close as possible to the surface, actual scan MDCs based on real field conditions would have been considerably less than the 82.6 pCi/g total Uranium Scan MDC estimate determined during the FSS planning phase for this SU. It should also be noted that the 82.6 pCi/g Scan MDC prospectively estimated for LSA 10-12 assumed a surveyor efficiency of 0.5.

Since all GWS data collected in LSA 10-12 was datalogged and post-processed in Graphical Information Software (GIS), the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015. Using these parameters, a more realistic 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 10-12, 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:

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

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 air gap. A two inch 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.

7.1.1.1 GWS Coverage Results LSA 10-12

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, very small areas of the LSA 10-12 interior were not accessed by GPS due to limitations of 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 99.49% of the SU (see Table 7-1). As the evaluation indicates that the GPS coverage exceeded 95% and biased samples were collected in several areas where count rates were observed approaching the IAL (biased samples were also in the vicinity of apparent GPS coverage gaps), 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 10-12

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 10-12	488,980	2,500	0.51	99.49	1

7.2 Soil Sample Results LSA 10-12

7.2.1 Surface Soil Sample Results LSA 10-12

There were no samples collected within the surface stratum (0 – 15 cm) of LSA 10-12. However, there were a total of twelve (12) soil samples collected within the topmost soil layer of the excavation surface including nine systematic samples, two biased samples, and one QC field duplicate sample. Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was performed for LSA 10-12 since the difference between the maximum survey unit data set gross SOF and the minimum background area adjusted SOF was greater than one. The WRS evaluation is included in Appendix A. QC and biased sample results are not utilized in the WRS test. The nine systematic samples collected in the "topmost" excavation surface layer were ranked against the adjusted activity concentrations of the 32 samples collected within the Background Reference Area. The survey unit passed the WRS test since the ranked sum of the reference area ranks was greater than the critical value for the test. As such, the null hypothesis that the survey unit average concentration is greater than the $DCGL_W$ was rejected. The maximum SOF result for the "topmost" samples was 0.30 corresponding to the root stratum systematic sample L10-12-10-B-R-S-00, with the maximum biased sample (L10-12-13-B-E-B-00) resulting in a 0.14 SOF.

Appendix A presents the analytical results and associated statistics for all FSS surface samples collected within LSA 10-12.

7.2.2 Subsurface Soil Sample Results LSA 10-12

There were three systematic locations within LSA 10-12 where the remaining root stratum interval was composite sampled. At each of these locations, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected. These three excavation stratum samples underlying the root stratum sample locations are considered "subsurface" samples and therefore did not factor into the WRS test evaluation. The maximum SOF result of the subsurface samples collected in LSA 10-12 was 0.19. This sample (L10-12-11) was the excavation stratum sample collected directly underneath the root stratum sample L10-12-10.

These subsurface sample results are also presented in Appendix A.

7.2.3 Graphical Data Review LSA 10-12

Table 7-2 below presents summary results for the all systematically collected samples (includes surface, root, and excavation stratum samples, but not biased or QC samples) collected within LSA 10-12, and the associated SOF when compared to the Three-Layer Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.17, however the Weighted Mean SOF resulted in a value of 0.23 when weighting factors were applied to the remaining portions of the Root and Deep Stratums.

Table 7-2
LSA 10-12 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 (Three-Layer DCGL)
Average	0.24	2.71	0.23	2.54	0.13	1.07	**0.17**
Minimum	0.00 (< bkg)	0.04	0.00 (< bkg)	1.08	0.00	0.67	0.03
Maximum	0.56	19.10	0.47	5.60	0.31	1.46	0.30

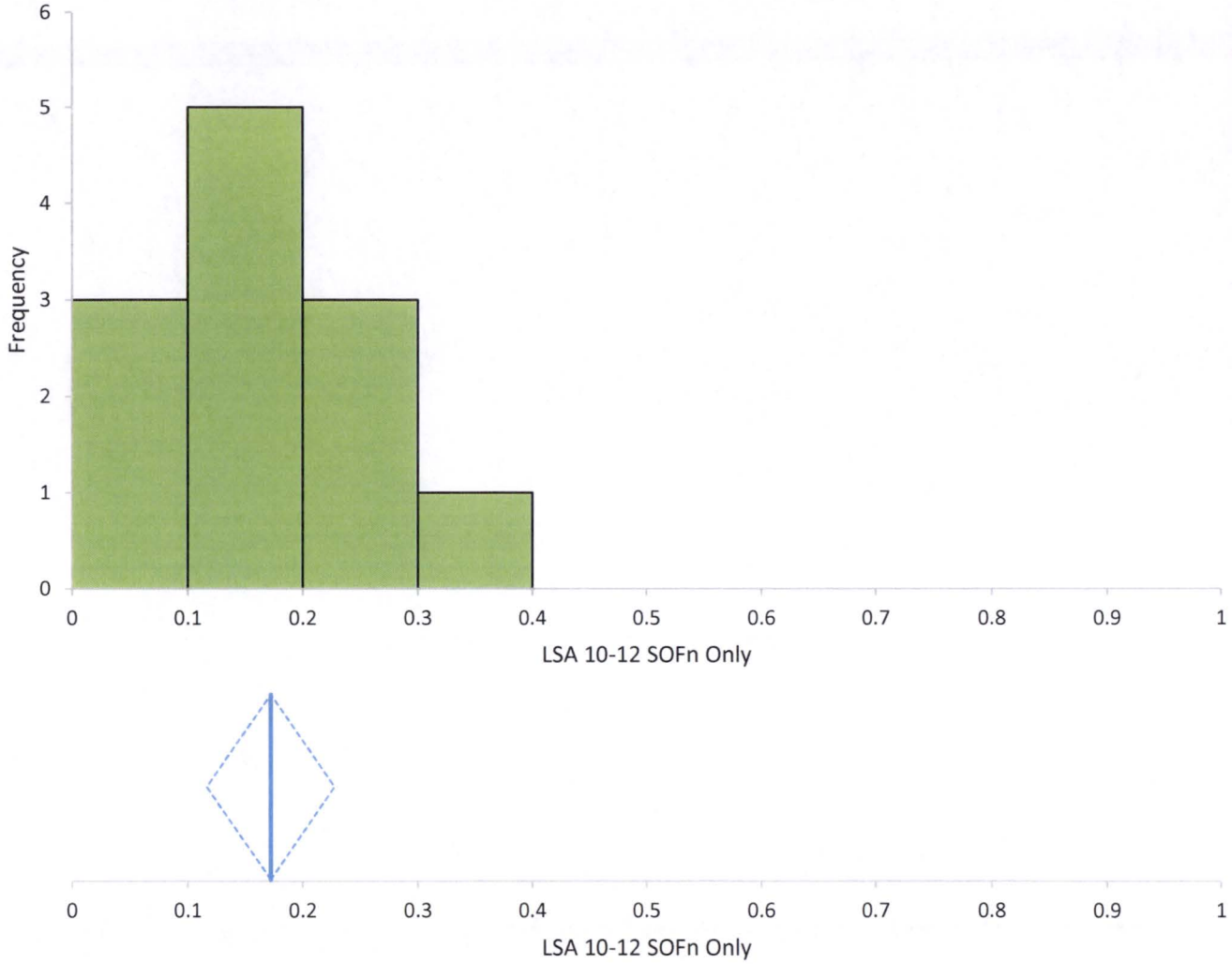
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide 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 10-12. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 10-12. The middle graph presents the mean SOF (0.17 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.12 to 0.23. The 99% confidence interval based on the median (0.16) of the sample results is 0.07 to 0.26. The bottom two charts present the various statistical metrics of the LSA 10-12 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 10-12 data associated with the systematically collected measurement locations.

Figure 7-3
Graphic Statistical Summary for LSA 10-12 (SOF parameter)



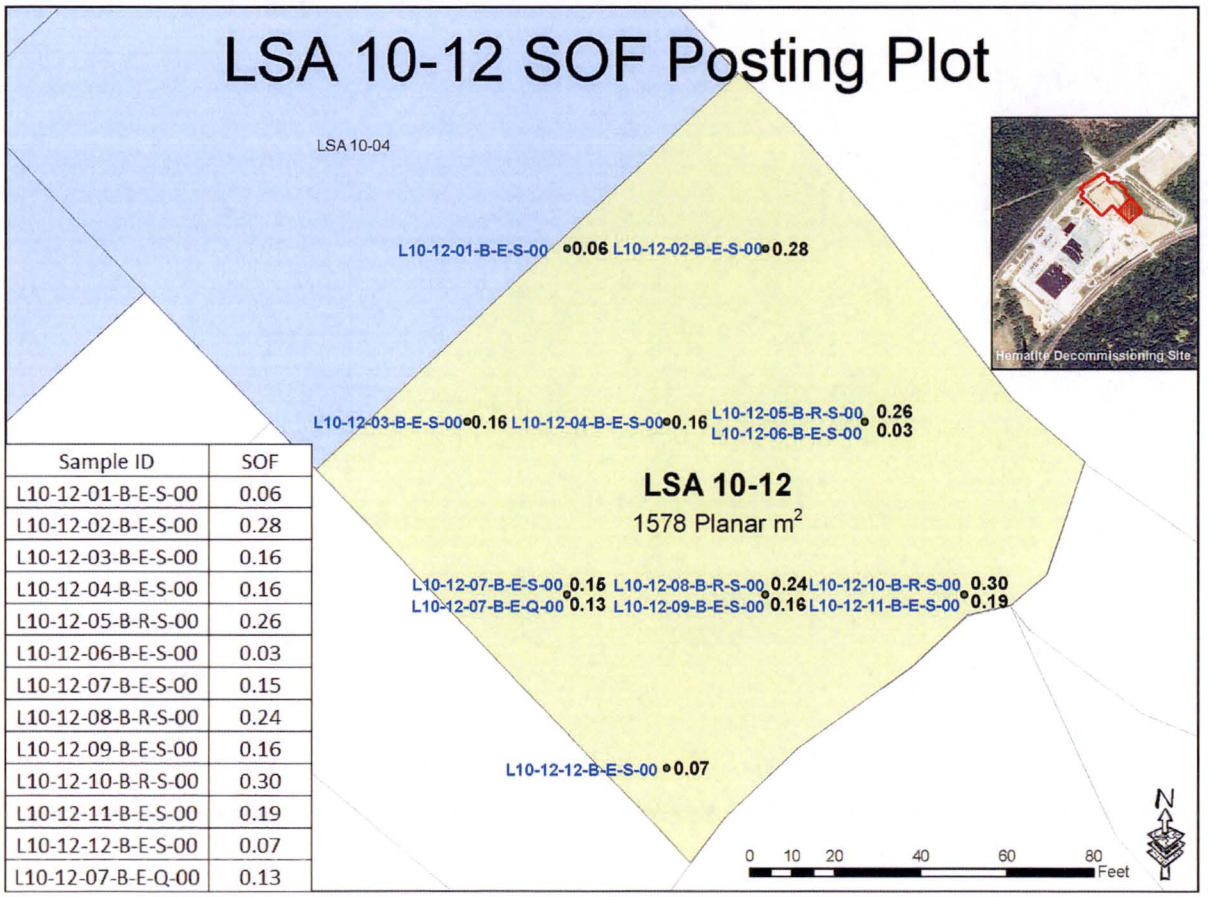
N	12

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 10-12 SOFn Only	0.17	0.12	to 0.23	0.025	0.09	0.01	-0.1	-0.96

	Minimum	1st quartile	Median	96.14% CI		3rd quartile	Maximum	IQR
LSA 10-12 SOFn Only	0.03	0.11	0.16	0.07	to 0.26	0.25	0.3	0.15

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 10-12 is presented below in Figure 7-4. Figure 7-4 shows no unusual patterns in the data.

Figure 7-4
Posting Plot for LSA 10-12 Systematic Measurement Locations



Sample ID	SOF
L10-12-01-B-E-S-00	0.06
L10-12-02-B-E-S-00	0.28
L10-12-03-B-E-S-00	0.16
L10-12-04-B-E-S-00	0.16
L10-12-05-B-R-S-00	0.26
L10-12-06-B-E-S-00	0.03
L10-12-07-B-E-S-00	0.15
L10-12-08-B-R-S-00	0.24
L10-12-09-B-E-S-00	0.16
L10-12-10-B-R-S-00	0.30
L10-12-11-B-E-S-00	0.19
L10-12-12-B-E-S-00	0.07
L10-12-07-B-E-Q-00	0.13

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 10-12

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																										Enr.	SOF	
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238						
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	Root SOF	Excavation SOF
L10-12-01-B-E-S-00	7.60	S	0.949	0.136	0.060	NA	-0.121	0.000	4.200	4.200	0.527	0.231	NA	1.010	0.160	0.112	NA	0.010	0.010	1.079	NA	NA	NA	0.052	0.141	0.251	U	1.130	0.539	0.836	NA	0.7	-	0.06
L10-12-02-B-E-S-00	6.05	S	0.904	0.160	0.094	NA	-0.166	0.000	19.100	19.100	1.840	0.218	NA	1.080	0.198	0.107	NA	0.080	0.080	2.043	NA	NA	NA	0.109	0.166	0.264	U	0.990	0.588	0.932	NA	1.7	-	0.28
L10-12-03-B-E-S-00	6.39	S	1.390	0.192	0.087	NA	0.320	0.320	0.267	0.267	0.160	0.220	NA	1.470	0.224	0.129	NA	0.470	0.470	*1.250*	NA	NA	NA	*0.000*	0.169	0.285	U	*1.250*	0.384	1.060	NA	*0.7*	-	0.16
L10-12-04-B-E-S-00	7.03	S	1.160	0.170	0.079	NA	0.090	0.090	4.420	4.420	0.507	0.221	NA	1.410	0.233	0.095	NA	0.410	0.410	2.725	NA	NA	NA	0.146	0.155	0.269	U	1.290	0.610	0.943	NA	1.8	-	0.16
L10-12-05-B-R-S-00	3.94	S	1.250	0.185	0.077	NA	0.180	0.180	2.420	2.420	0.405	0.225	NA	1.120	0.178	0.139	NA	0.120	0.120	5.595	NA	NA	NA	0.308	0.151	0.197	NA	1.460	0.360	0.903	NA	3.2	0.26	-
L10-12-06-B-E-S-00	4.92	S	1.120	0.172	0.076	NA	0.050	0.050	1.530	1.530	0.324	0.223	NA	0.981	0.183	0.156	NA	-0.019	0.000	1.733	NA	NA	NA	0.093	0.162	0.205	U	0.790	0.429	1.190	U	1.9	-	0.03
L10-12-07-B-E-S-00	5.38	S	1.530	0.204	0.083	NA	0.460	0.460	0.066	0.066	0.078	0.213	U	1.310	0.187	0.110	NA	0.310	0.310	2.138	NA	NA	NA	0.115	0.167	0.275	U	0.956	0.316	0.888	NA	1.9	-	0.15
L10-12-08-B-R-S-00	4.09	S	1.340	0.177	0.060	NA	0.270	0.270	0.041	0.041	0.021	0.263	U	1.170	0.181	0.133	NA	0.170	0.170	3.879	NA	NA	NA	0.214	0.165	0.214	NA	0.898	0.317	0.866	NA	3.6	0.24	-
L10-12-09-B-E-S-00	4.92	S	1.600	0.247	0.115	NA	0.530	0.530	0.117	0.117	0.157	0.248	U	1.300	0.234	0.170	NA	0.300	0.300	1.629	NA	NA	NA	0.088	0.177	0.317	U	0.674	0.366	1.100	U	2.0	-	0.16
L10-12-10-B-R-S-00	3.95	S	1.350	0.221	0.121	NA	0.280	0.280	0.216	0.216	0.053	0.225	U	1.270	0.214	0.079	NA	0.270	0.270	4.171	NA	NA	NA	0.229	0.191	0.221	NA	1.210	0.657	1.030	NA	2.9	0.30	-
L10-12-11-B-E-S-00	4.92	S	1.630	0.208	0.078	NA	0.560	0.560	0.050	0.050	0.096	0.235	U	1.400	0.210	0.112	NA	0.400	0.400	1.791	NA	NA	NA	0.091	0.166	0.274	U	1.280	0.577	0.895	NA	1.1	-	0.19
L10-12-12-B-E-S-00	5.94	S	1.250	0.171	0.070	NA	0.180	0.180	0.127	0.127	0.164	0.223	U	1.170	0.168	0.089	NA	0.170	0.170	2.427	NA	NA	NA	0.132	0.145	0.242	U	0.908	0.306	0.880	NA	2.3	-	0.07
L10-12-07-B-E-Q-00	5.38	Q	1.430	0.214	0.093	NA	0.360	0.360	0.023	0.023	0.078	0.206	U	1.290	0.209	0.200	NA	0.290	0.290	2.025	NA	NA	NA	0.102	0.188	0.313	U	1.580	0.910	1.140	NA	1.0	-	0.13
L10-12-13-B-E-B-00	5.49	B	1.340	0.217	0.107	NA	0.270	0.270	0.375	0.375	0.169	0.261	NA	1.410	0.230	0.154	NA	0.410	0.410	2.454	NA	NA	NA	0.132	0.209	0.329	U	1.090	0.403	1.110	U	1.9	-	0.14
L10-12-14-B-E-B-00	6.36	B	1.330	0.185	0.077	NA	0.260	0.260	0.024	0.024	0.027	0.257	U	1.300	0.188	0.115	NA	0.300	0.300	1.216	NA	NA	NA	0.056	0.160	0.269	U	1.650	0.594	0.883	NA	0.6	-	0.11
L10-12-15-B-E-B-00	6.21	B	1.460	0.192	0.068	NA	0.390	0.390	-0.073	0.000	0.019	0.216	U	1.290	0.191	0.118	NA	0.290	0.290	1.219	NA	NA	NA	0.064	0.141	0.254	U	0.746	0.314	0.993	U	1.4	-	0.13
L10-12-16-B-E-B-00	6.88	B	1.010	0.136	0.050	NA	-0.060	0.000	5.010	5.010	0.584	0.217	NA	0.962	0.163	0.084	NA	-0.038	0.000	1.370	NA	NA	NA	0.073	0.119	0.199	U	0.706	0.266	0.685	NA	1.6	-	0.07
Systematic Minimum			0.000						0.041					0.000						1.079				0.000				0.674				2.0	0.03	
Systematic Maximum			0.560						19.100					0.470						5.595				0.308				1.460				Average Enrichment (%)	0.30	
Systematic Mean (unweighted)			0.243						2.713					0.226						2.539				0.131				1.070					0.17	
Systematic Median			0.225						0.242					0.220						2.091				0.112				1.060					0.16	
Systematic Standard Deviation			0.196						5.411					0.158						1.351				0.084				0.236					0.09	
			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: A normal, non-detected result (result less than MDC).

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

Italicized values assume natural uranium; set negative value of U-235 to zero.

7.2.4 Biased Soil Sample Result LSA 10-12

The highest biased sample collected from LSA 10-12 had an Excavation Stratum SOF result of 0.14, which is consistent with the gamma survey results of 16,000 gcpm (4,771 ncpm).

7.2.5 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 10-12

Two samples were collected from the sidewalls of LSA 10-12. Table 7-4 provides the data summary for the samples.

Table 7-4
LSA 10-12 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)
L10-12-15-B-E-B-00	1.460	< 0.073	1.290	1.219	< 0.064	< 0.746	0.13
L10-12-16-B-E-B-00	1.010	5.010	0.962	1.370	< 0.073	0.706	0.07

7.2.6 Quality Control Soil Sample Result LSA 10-12

One Quality Control (QC) field duplicate sample point was randomly selected for LSA 10-12 which was collected at systematic locations L10-12-07.

For the 16 samples (i.e., 12 systematic + 2 biased + 2 sidewall) collected within LSA 10-12, one field duplicate sample was collected. This frequency equates to 6.25%, (i.e. 1/16). 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 10-12

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

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

Survey Unit No.:	LSA 10-12				Survey Unit Description:		South East Corner Survey Unit (North Burial Pits)					
			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)
L10-12-07-B-E-S-00	L10-12-07-B-E-Q-00	Ra-226	1.530	0.0827	1.430	0.093	1.48	5.4	0.100	0.764	1.145	N
L10-12-07-B-E-S-00	L10-12-07-B-E-Q-00	Tc-99	0.0661	0.213	0.023	0.206	0.0444	74	NA	10.471	15.688	NA
L10-12-07-B-E-S-00	L10-12-07-B-E-Q-00	Th-232	1.310	0.110	1.290	0.200	1.300	5.2	0.020	0.736	1.102	N
L10-12-07-B-E-S-00	L10-12-07-B-E-Q-00	U-234[1]	2.138	NA	2.025	NA	2.082	872.4	0.113	123.445	184.949	N
L10-12-07-B-E-S-00	L10-12-07-B-E-Q-00	U-235	0.115	0.275	0.102	0.313	0.109	208.1	NA	29.446	44.117	NA
L10-12-07-B-E-S-00	L10-12-07-B-E-Q-00	U-238	0.956	0.888	1.580	1.140	1.268	551.1	0.624	77.981	116.833	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: Ellen C. Jakubs

Date: 4/1/15

Reviewed by: Brian Lahlouh

Date: 4/1/15

Quality Record

7.3 Tc-99 Hot Spot Assessment LSA 10-12

During site characterization studies a total of 38 samples were collected and analyzed for Tc-99 in LSA 10-12. The maximum sample identified was 21.3 pCi/g, with an overall mean and median concentration of 2.7 pCi/g and 1.9 pCi/g, respectively. During hybrid well investigation and well abandonment sampling a total of 101 additional samples were collected and analyzed for Tc-99 in LSA-10-12. The maximum sample identified was 59.6 pCi/g, with an overall mean and median concentration of 4.6 and 1.7 pCi/g. There were no sample results that exceeded the Root Stratum DCGL of 30.1 pCi/g (most conservative of the three layers), for Tc-99 during site characterization and 4 samples that exceeded the Tc-99 DCGL during the hybrid well investigation and well abandonment sampling (as discussed in section 3.3.4). No sample results exceeded the Surface Stratum or Excavation Stratum DCGLs.

An area factor of 2.4 would be required to account for any potential hot spots of 59.6 pCi/g. Using the Root Zone area factor table from the DP and interpolation, 510 m^2 is the area per sample station required to equate to an area factor of 1.98. In LSA 10-12 the area represented by each systematic location was approximately 175 m^2 and is adequate to account for any potential hot spots within the survey units.

8.0 ALARA EVALUATION

All FSS samples collected within LSA 10-12 were evaluated against the $DCGL_w$s applicable to the stratum in which they were collected. Since no surface stratum samples were collected, the applicable DCGLs would be the Root Stratum and Excavation Stratum (see Table 5-1). The FSS samples collected within LSA 10-12, including biased samples, were actually less than the Uniform Stratum $DCGL_w$s for each of the six Radionuclides of Concern – which features the lowest (most conservative) set of $DCGL_w$s. It was only due to the presence of two deep (> 20 ft bgs) characterization samples exceeding the Uniform Stratum DCGLw for Tc-99 that LSA 10-12 samples results were evaluated against the Three-Layer CSMs. As such, no individual systematic sample result exceeded a SOF of 1 when compared to the Root and Excavation Stratum DCGLs, with 0.30 being the maximum SOF value for the entire FSS sample data set.

The average unweighted SOF result based on all systematically collected samples was 0.17. As the FSS samples were collected from both the Root and the Excavation strata, the overall SOF value must be weighted to account for the differing numbers of samples from each strata as well as the different set of $DCGL_w$s for each CSM. In accordance with Volume 3, Chapter 1, Section 3.1.2, the weighted SOF result of all systematically collected samples in LSA 10-12 was calculated to be 0.23 (rounded slightly up). This average SOF equates to residual activity contributions from the general survey unit area of 5.7 mrem/year (mrem/yr). The spreadsheets used to perform this weighted SOF calculation are provided in Appendix A.

Assuming a maximum groundwater contribution of 4.0 mrem/yr based on a very conservative assignment of groundwater concentrations in HDP monitoring wells equal to the U.S. Environmental Protection Agency (EPA) maximum concentration limits (MCLs). Offsite borrow material was used as backfill; therefore there is no dose contribution from this pathway. The total estimated dose for LSA 10-12 is 9.7 mrem/yr. Since this estimated Total Effective Dose Equivalent is below the license release criterion of 25 mrem/yr, the conclusion of the As

Low As Reasonably Achievable (ALARA) evaluation is that the remediation of LSA 10-12 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 10-12.

9.0 FSS PLAN DEVIATIONS

9.1 Remedial Actions during FSS

Within LSA 10-12, there were no measurements or sample results during the FSS GWS or soil sampling which triggered a decision to perform additional remediation of small areas of elevated activity, i.e., "hot spots".

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

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

Table 9-1

Revised Scan MDCs for 2" x 2" NaI detector: LSA 10-12

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw (Ra-226)	Scan MDC (Th-232)	DCGLw (Th-232)
LSA 10-12	40.9	104.0	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 10-12

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 10-12 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 10-12 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation.*
- Nine systematic samples were collected at the excavation surface layer. For LSA 10-12, one individual gross SOF results in the FSS data set exceeded the $DCGL_W$ (SOF of 1.0) by more than the adjusted SOF of the minimum background reference area result using the Root Stratum criteria. Therefore, the WRS test was required for LSA 10-12. Since the test statistic, WR (815) exceeded the critical value (725), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix A.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, and the result was a 0.14 Excavation Stratum SOF.

- The maximum SOF result for all Root Stratum samples within LSA 10-12 was 0.30. The SOF result for all Excavation Stratum samples within LSA 10-12 was 0.28. The average SOF result for all systematically collected samples within LSA 10-12 was 0.17, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.23. And the ultimate metric for compliance, the Weighted Mean SOF was 0.23.
- No FSS sample result in LSA 10-12 exceeded a SOF of 1.0 as compared to the "Three Layer" criteria, therefore an elevated measurement comparisons (EMC) or supplemental investigations was not required.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (9) of systematic samples actually collected within LSA 10-12. The successful result of the retrospective power evaluation presented in Table 10-1 for LSA 10-12 indicates that the minimum number of samples required (8) for the WRS Test was less than the number of sampling locations actually collected within LSA 10-12. 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 10-12 was completed prior to the commencement of backfill operations.

Table 10-1
Retrospective Sample Size Verification for LSA 10-12

Stratum DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.09
$DCGL_{SOF}$	1
LBGR (Mean)	0.17
Shift	0.83
Relative Shift (Δ/σ)	9.50
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	9
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

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

MARSSIM Table 5.2, α = 0.05, β = 0.10

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

α
β

Figure 10-1
Data Evaluation Checklists prepared for LSA 10-12 (page 1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
	Westinghouse Non-Proprietary Class 3	Revision: 5	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: 12 **Description:** Southeast SU in "Area 1" (northern Pits)

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:

Quality Record

Figure 10-1
Data Evaluation Checklists prepared for LSA 10-12 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
	Westinghouse Non-Proprietary Class 3	Revision: 5	Appendix G-1, Page 2 of 2

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

Survey Area: No. LSA 10 **Description:** Burial Pits Open Land Area
Survey Unit: No. 12 **Description:** South East Survey Unit (North Burial Pit Area)

Discrepancy: NA

Corrective Actions Taken: NA

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

	(Print Name)	(Signature)	(Date)
Prepared by (HP Staff):	BRIAN A. MILLER	Brian A. Miller	11/13/2015
Approved by (RSO):	W Clark	W Clark	11/16/15

Quality Record LSA 10-12

11.0 CONCLUSION

11.1 LSA 10-12

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 10-12 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

Table 11-1
LSA 10-12 SOF and Dose Summation

	WEIGHTED AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.23	N/A	0.16	N/A	N/A	**0.39**
DOSE	5.7 mrem	N/A	4.0 mrem	N/A	N/A	**9.7 mrem**

12.0 REFERENCES

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

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

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

12.4 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}

12.5 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)

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

13.0 APPENDICES (To Be Provided On Separate Data Disc)

APPENDIX A: Analytical Data Evaluation Spreadsheets for LSA 10-12

APPENDIX B: FSS Plan Development for LSA 10-12

APPENDIX C: TestAmerica Laboratory Analytical Data Reports for LSA 10-12

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

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

APPENDIX F: Hybrid Well BP-17 analytical results