Westinghouse Electric Company LLC
Hematite Decommissioning Project
3300 State Road P
Festus, MO 63028
USA

ATTN: Document Control Desk
Director, Office of Federal and State Materials and Environmental Management Programs
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Direct tel: 314-810-3353
E-mail: pallagke@westinghouse.com
Our ref: HEM-17-47
Date: August 2, 2017

Subject: Westinghouse Hematite Decommissioning Project - Request for NRC Review of Final Status Survey Final Report Volume 3, Chapter 17, Survey Area Release Record for Land Survey Area 06, Survey Units 01 and 02, and Land Survey Area 07, Survey Unit 01, and Volume 4, Chapter 11, Survey Release Record for Building Survey Area 04, Survey Unit 03, 04, 06 and 14 (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 Final Status Survey document Final Status Survey Final Report Volume 3, Chapter 17, Survey Area Release Record for Land Survey Area 06, Survey Units 01 and 02, and Land Survey Area 07, Survey Unit 01 (LSA 06-01, LSA 06-02 and LSA 07-01) and Volume 4, Chapter 11, Survey Release Record for Building Survey Area 04, Survey Unit 03, 04, 06 and 14 (BSA 04-03, BSA 04-04, BSA 04-06 and BSA 04-14).

Attachment 1 contains Final Status Survey Final Report Volume 3, Chapter 17, with a CD containing Appendices.

Attachment 2 contains Final Status Survey Final Report Volume 4, Chapter 11, 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

NMSS20

Attachment: 1) Final Status Survey Final Report Volume 3, Chapter 17, Survey Area Release Record for Land Survey Area 06, Survey Units 01 and 02, and Land Survey Area 07, Survey Unit 01 (LSA 06-01, LSA 06-02 and LSA 07-01), with a CD containing Appendices (HDP-RPT-FSS-219)

2) Final Status Survey Final Report Volume 4, Chapter 11, Survey Release Record for Building Survey Area 04, Survey Unit 03, 04, 06 and 14 (BSA 04-03, BSA 04-04, BSA 04-06 and BSA 04-14), with a CD containing Appendices (HDP-RPT-FSS-310)

cc: J. W. Smetanka, Westinghouse
S. S. Koenick, NRC/DUWP/MDB
J. A. Smith, NRC/DUWP/MDB

Attachment 1

Final Status Survey Final Report Volume 3, Chapter 17

Survey Area Release Record for Land Survey Area 06, Survey Units 01 and 02, and Land Survey Area 07, Survey Unit 01
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 17

TITLE: **Survey Area Release Record for Land Survey Area 06, Survey Units 01 and 02, and Land Survey Area 07, Survey Unit 01 (LSA 06-01, LSA 06-02 and LSA 07-01)**

REVISION: **0**

EFFECTIVE DATE: AUG 0 2 2017

Approvals:

Author: Kenneth E. Pallagi — 08-02-2017 Date

Owner/Manager: W. Clark Evers — 8/2/17 Date

HDP-RPT-FSS-219

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ALARA	As Low As Reasonably Achievable
bgs	below ground surface
CFR	Code of Federal Regulations
cm	centimeter(s)
cpm	count(s) per minute
CSM	Conceptual Site Model
DCGL	Derived Concentration Guideline Level
$DCGL_W$	DCGL for average concentrations over a survey unit, used with statistical tests. ("W" suffix denotes "Wilcoxon")
DGPS	Digital Global Positioning System
DP	Hematite Decommissioning Plan
DQO	Data Quality Observation
EMC	Elevated Measurement Comparison
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
FSS	Final Status Survey
FSSFR	Final Status Survey Final Report
gcpm	gross count(s) per minute
GIS	Graphical Information Software
GPS	Global Positioning System
GWS	Gamma Walkover Survey
HDP	Hematite Decommissioning Project
HP	Health Physics
HRCR	Hematite Radiological Characterization Report
HSA	Historical Site Assessment
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
RSO	Radiation Safety Officer

SDS	Storm Drain System
SOF	Sum of Fractions
SU	Survey Unit
Tc	Technetium
TEDE	Total Effective Dose Equivalent
Th	Thorium
U	Uranium
WRS	Wilcoxon Rank Sum

EXECUTIVE SUMMARY

This Survey Area Release Record (SARR) presents the results of the final status radiological surveys of the Hematite Decommissioning Project (HDP) Land Survey Area (LSA) 06, Survey Unit (SU) 01 (LSA 06-01), SU 02 (LSA 06-02) and LSA 07 SU 01 (LSA 07-01). 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."

The land areas that comprises LSA 06-01, LSA 06-02 and LSA 07-01 were initially designated as a Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 3 SUs. Subsequently LSA 06-02 and LSA 07-01 were designated as Class 2 SUs.

For SU LSA 06-01, LSA 06-02 and LSA 07-01 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 Final Status Survey (FSS) for the SUs was to obtain and document measurement results, analytical data, and other supporting information in order to demonstrate that the residual radioactivity levels in LSA 06-01, LSA 06-02 and LSA 07-01 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 FSS documents required for NRC review. Westinghouse provided the outline to the NRC for discussion during the August 19, 2015, publicly noticed teleconference and the format was agreed upon {ML15238B032}.

FSSFR Volume 3, Chapter 1, Revision 3, *Land Survey Areas (LSA) Overview* provides the information common to land survey areas. This report, FSSFR Volume 3, Chapter 17, builds upon the general information provided in FSSFR Volume 3, Chapter 1, Revision 3.

2.0 HDP SITE, LSA AND SURVEY UNIT DESCRIPTIONS

2.1 HDP Site Description

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

2.2 LSA 06 and LSA 07 Configuration

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

LSA 06 encompasses the parking lot area for the site and the land area between State Road P and the site security fence. LSA 06 consists of SUs LSA 06-01 and LSA 06-02 (See Figure 2-3). LSA 07 encompasses the truck scale area. LSA 07 consists of a single SU LSA 07-01.

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 SUs within LSA 06 and LSA 07 to facilitate site remediation activities and the FSS process. A portion of the land area that comprises LSA 06 and all of LSA 07 was elevated in MARSSIM classification. No classification of any land area of LSA 06 was lowered, thus ensuring compliance with the DP.

2.2.1 LSA 06 Configuration Change

A small area of LSA 06 was transferred to LSA 02 and LSA 05 to ensure compliance with the DP in regards to FSS classification due to the progress of remediation work and radiological status in the Site Pond and Site Spring Area. Transferring the land areas to LSA 02 and LSA 05 resulted in those land areas being upgraded to MARSSIM Class 1. Thereby, ensuring compliance with the DP for the specific land area that was transferred.

Also a small portion of LSA 06 adjacent to Building 110 was transferred to LSA 07 to accommodate remediation and FSS of a portion of the site Storm Drain System (SDS). This transfer of land area to LSA 07 resulted in the land area transferred being upgraded to Class 2. Thereby, ensuring compliance with the DP for the specific land area that was transferred.

Figure 2-4 provides a depiction of the final configuration of land survey areas and survey units.

2.2.2 LSA 07 Configuration Change

A small portion of LSA 07 adjacent to Building 110 was transferred to SU LSA 08-04 to accommodate remediation and FSS of SU LSA 08-04. This transfer of land area to LSA 08-04 resulted in the land area transferred being upgraded to Class 1 thereby, ensuring compliance with the DP for the specific land area that was transferred.

Also a small portion of LSA 06-01 was transferred to LSA 07 to accommodate remediation and FSS of a portion of the site Storm Drain System. This transfer of land area to LSA 07-01 resulted in the land area transferred being upgraded to Class 2 thereby, ensuring compliance with the DP for the specific land area that was transferred.

2.2.3 LSA 06-02 Establishment and Classification Change

In the Hematite Radiological Characterization Report, LSA 06-01 was initially designed to encompass the entire parking lot area of the site was and designated as a Class 3 area. During remediation operations the asphalt surface of LSA 06-02 was used to stage trucks loaded with LLW for off-site disposal from LSA 05 (the Barns Area). Also to accomplish removal of the Storm Drain System (SDS), from operation for the purpose of clean-out and FSS of the SDS, a "swale" was constructed to channel surface storm water flow through LSA 06-02 into the Site Pond (LSA 02). To support these activities LSA 06-01 was divided into 2 SUs. As such, LSA 06-02, the area in which remediation support activities occurred was established and designated a Class 2 survey area.

2.2.4 LSA 07-01 Classification Change

LSA 07-01 was originally designated as MARSSIM Class 3 based upon the history of the land area. Based upon use of LSA 07 during site remediation it was recognized that there would be the potential to encounter elevated sample activity within the SU. Considering that there was no history of any sample exceeding the $DCGL_W$ in the area, LSA 07-01 was upgraded and designated a Class 2 survey area.

2.3 LSA 06-01 Survey Unit Description and Configuration

The LSA 06-01 SU is comprised of the land area that contains the main site parking lot and land area between the site security fence and State Road P. The land area that contains the parking lot consists mainly of asphalt designated as a structure survey area (BSA 04-03), small areas of gravel and SDS piping (PSA 01-01, PSA 01-02 and PSA 01-03). The land area between the site security fence and State Road P consists of a mix of soil with vegetation and gravel.

In its final configuration as prepared for FSS, LSA 06-01 presents 8,808 square meters (m^2) in planar (2-dimensional) extent.

2.4 LSA 06-02 Survey Unit Description and Configuration

The LSA 06-02 SU is comprised of the land area that contains the west section of the main site parking lot and is designated as a structure survey area (BSA 04-04). The land area also contains the SDS swale which is comprised of gravel, and also contains small areas of low lying vegetation (grass).

In its final configuration as prepared for FSS, LSA 06-02 presents 3,957 m^2 in planar (2-dimensional) extent.

2.5 LSA 07-01 Survey Unit Description and Configuration

The LSA 07-01 SU is comprised of the land area that contains the northern section of the main site adjacent to Building 110. The land area is also comprised of gravel roadways, the truck scale (BSA 04-14), Building 115 (BSA 04-06), and a small area of low lying vegetation (grass).

In its final configuration as prepared for FSS, LSA 07-01 presents 2,946 m^2 in planar (2-dimensional) extent.

Figure 2-1
Initial Configuration of Land Survey Areas and Survey Units as provided in DP (Figure 14-14)

Figure 2-2
HDP Land Survey Areas

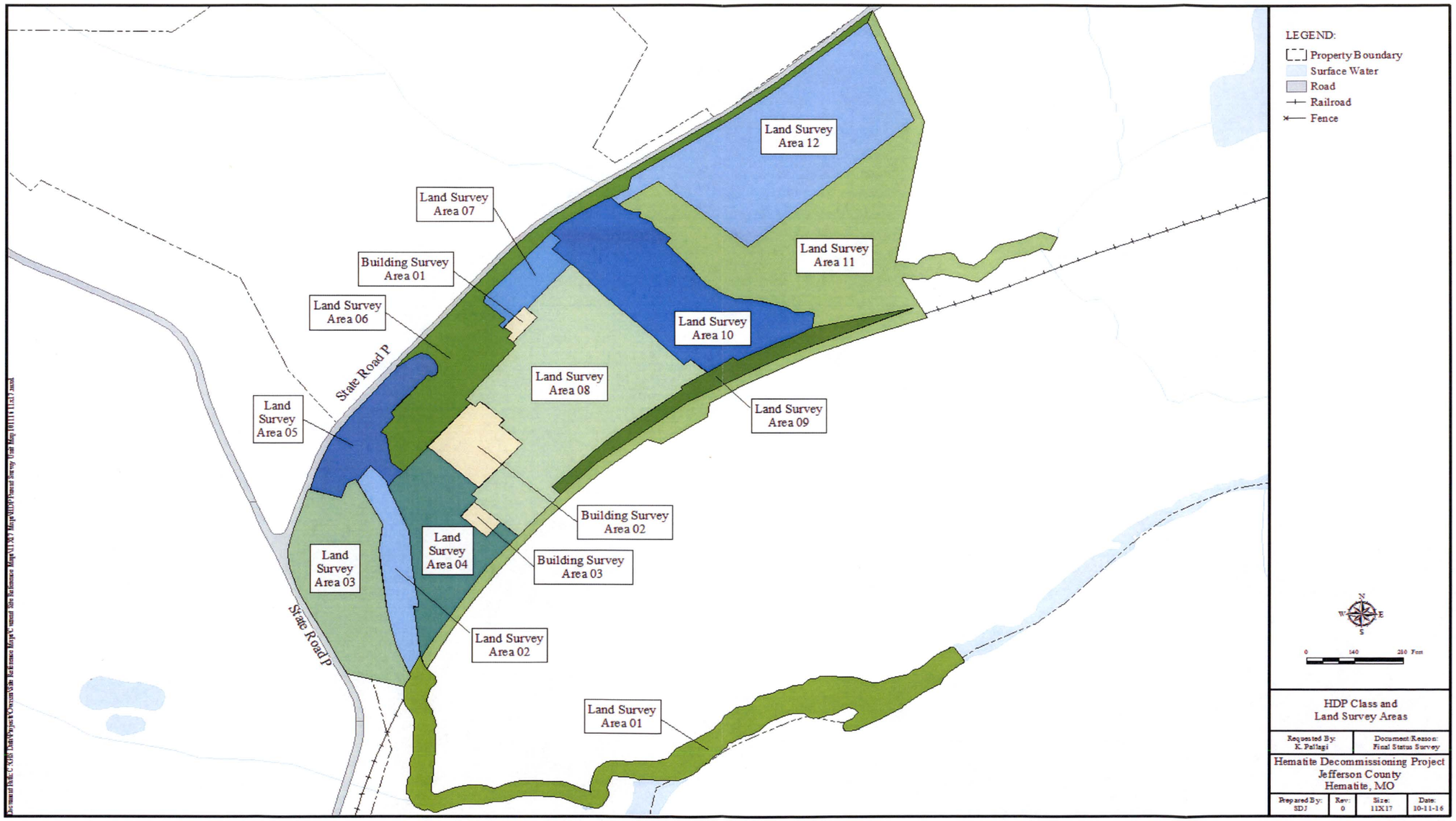


Figure 2-3
Final Configuration of Land Survey Area 06 and Survey Units, and Land Survey Area 07

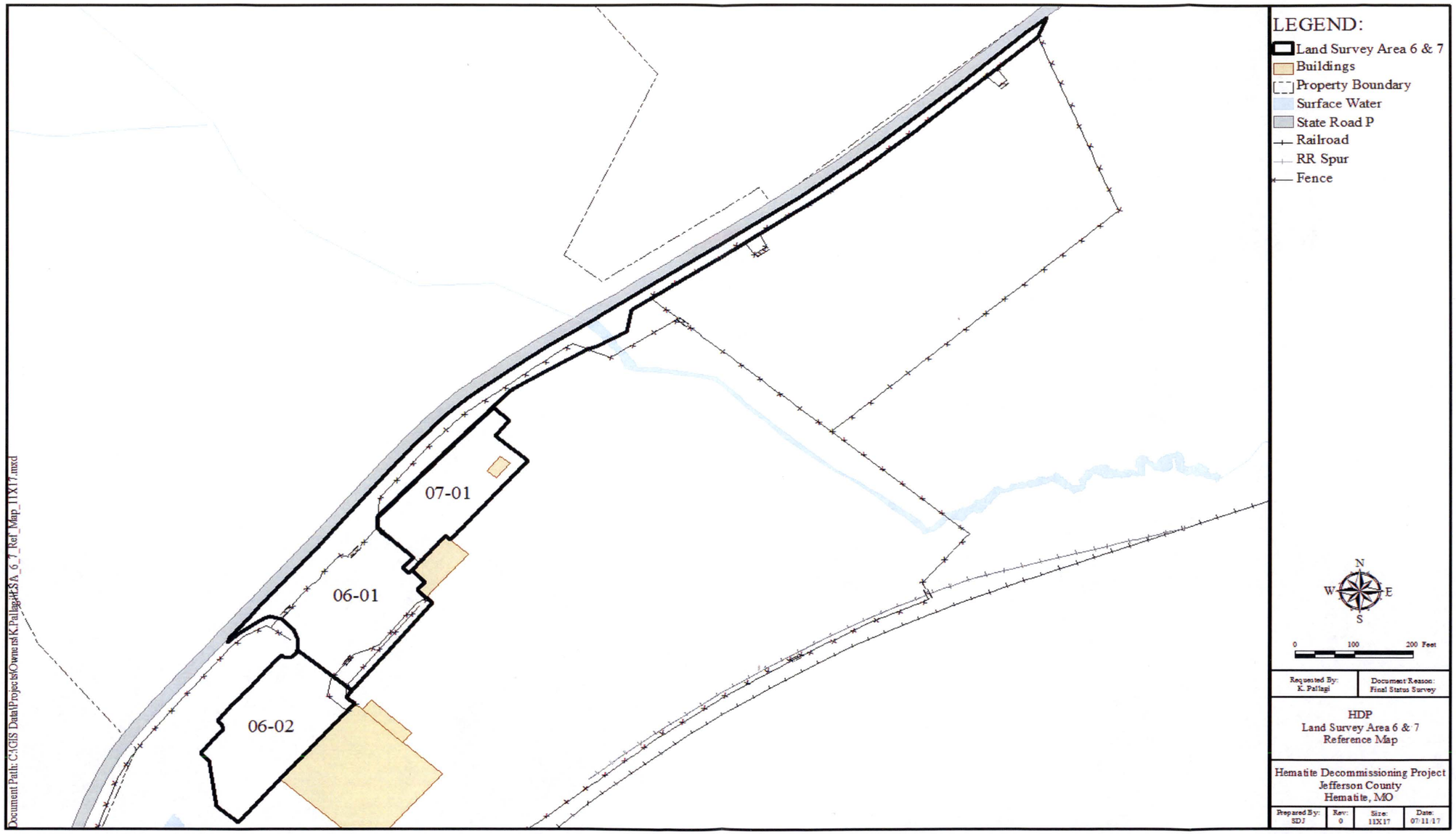
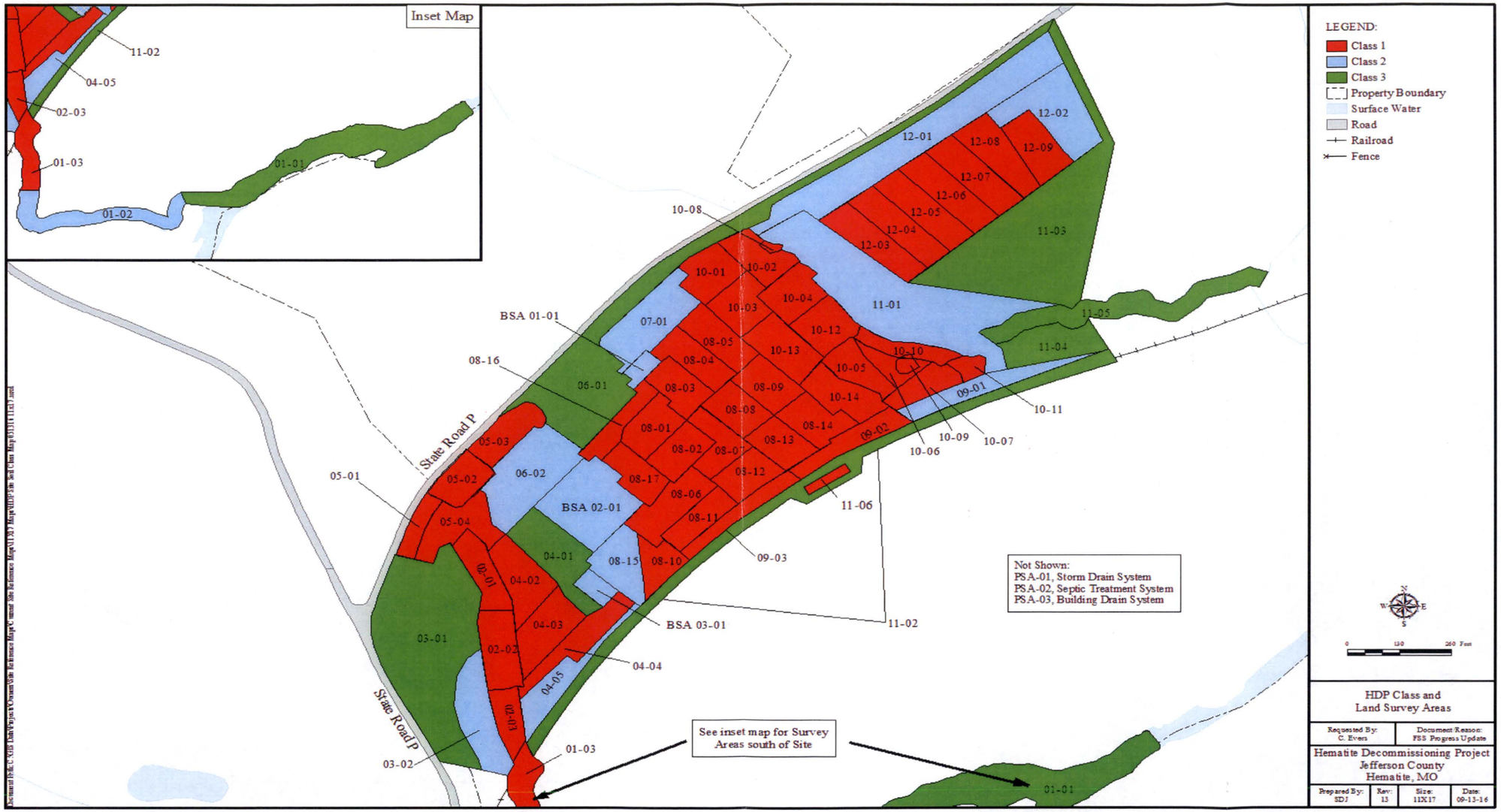


Figure 2-4
Final Configuration of Land Survey Areas and Survey Units



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*.

3.1 History of Use LSA 06-01 - Parking Lot

Aerial photographs as provided in the Historical Site Assessment indicate that the parking lot in LSA 06-01 was present, along with the first site buildings in 1957. This area served as the main parking lot during both site operations and site remediation (see Figure 3-1).

Figure 3-1
Parking Lot in LSA 06-01

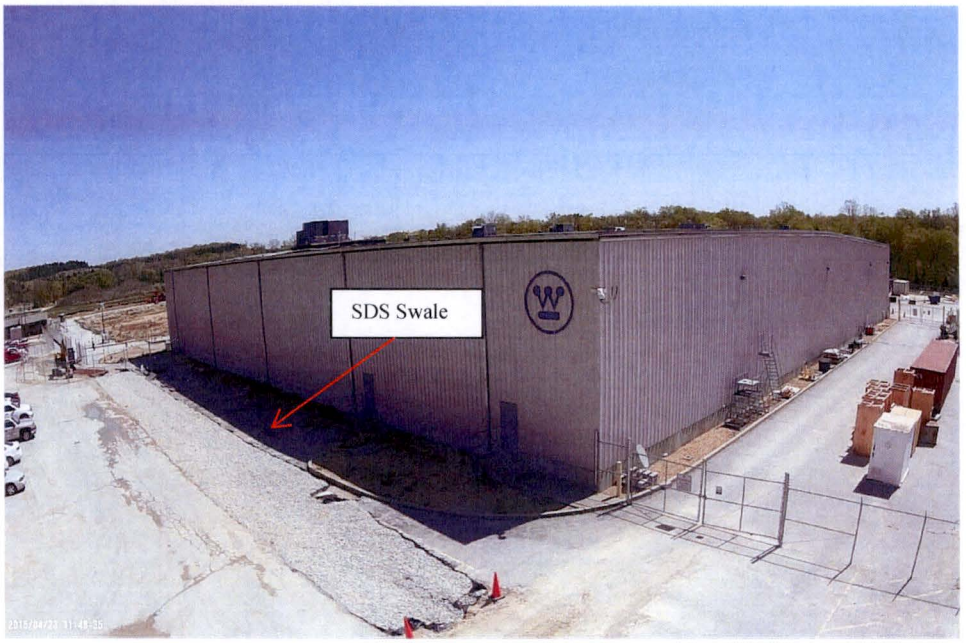
3.2 History of Use LSA 06-02 – Parking Lot

Aerial photographs as provided in the Historical Site Assessment indicate that the paved asphalt areas (parking lot) in LSA 06-02 was installed coincidental to the construction of Building 230 (circa 1992) and served as additional parking space for site employee vehicles (see Figure 3-2). The parking lot also served as a temporary staging area for incoming and outgoing equipment during site remediation activities. During the barns demolition and area remediation the area adjacent to LSA 05 (Barns Area) in LSA 06-02 was used to stage trucks that were loaded with LLW for off-site disposal.

During site remediation, to support clean-out and FSS of the SDS system the SDS Swale was installed to channel storm water to the Site Pond (see Figure 3-3).

Figure 3-2
Parking Lot in LSA 06-02

Figure 3-3
SDS Swale located in LSA 06-02



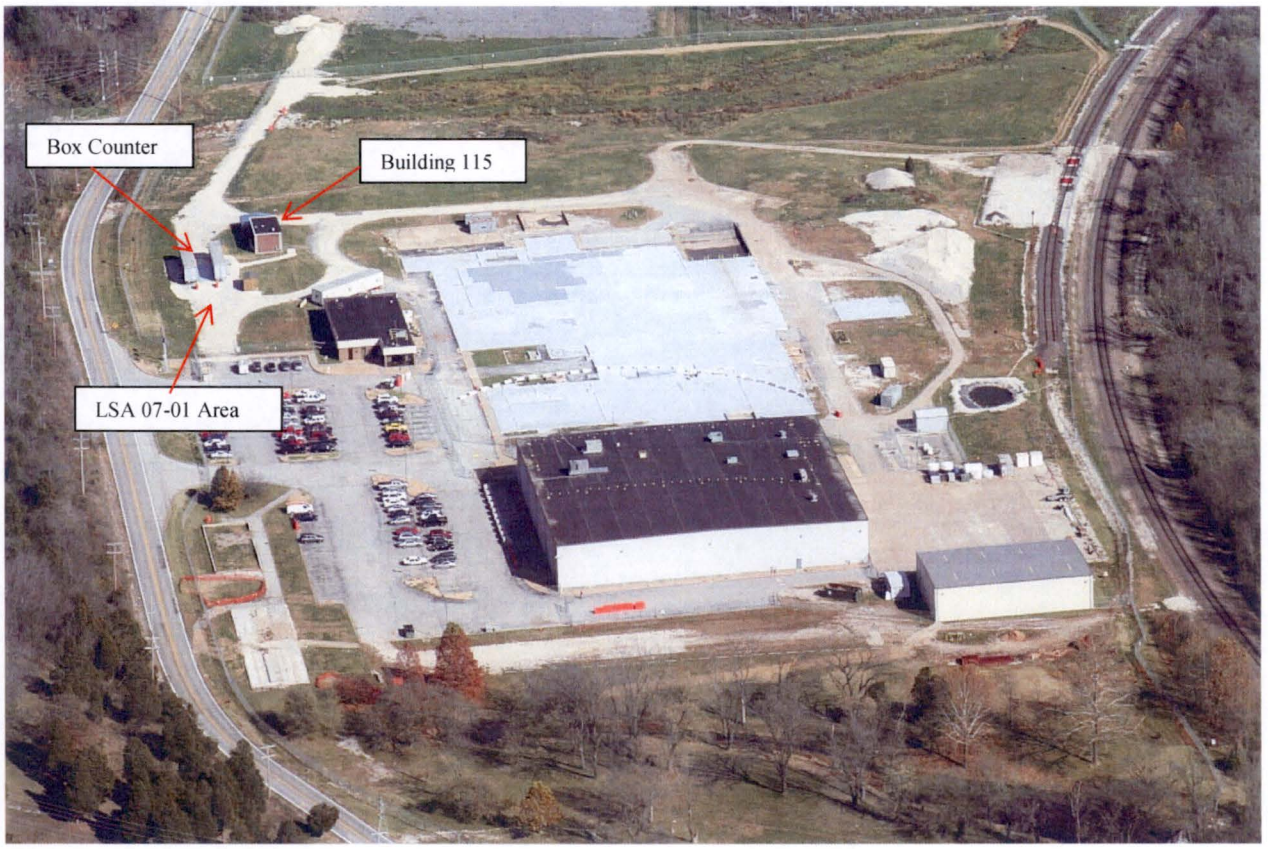
3.3 History of Use LSA 07-01

Aerial photographs as provided in the Historical Site Assessment indicate that the land area that is LSA 07-01 remained predominantly undisturbed and unused as it was located outside of the fence that surrounded site operations. Figure 3-4 is a photograph of the LSA 07-01 in the undisturbed condition.

Figure 3-4
LSA 07-01 Circa 2006

In preparation for site remediation operations the site security fence was expanded to include the LSA 07-01 land area. Thereafter LSA 07-01 was used for site remediation vehicular traffic and box counter operations. Also, Building 115 (the Material Assay Area/Waste Evaluation Area), is located within the boundary of LSA 07-01. Figure 3-5 is a photograph of the LSA 07-01 at the time of preparations for site remediation.

Figure 3-5
LSA 07-01 Circa 2011



3.4 Radioactive Materials in LSA 06-01, LSA 06-02 and LSA 07-01

The majority of the land area that comprises LSA 06-01 and LSA 06-02 was used during the operational history of the site as the main parking lot for employee vehicles and as such had no history of radioactive materials present within the boundaries of the SUs.

The LSA 07 land area remained relatively unused during site operations. The LSA 07 land area served as a traffic way for vehicle traffic during remediation operations and also contained the box counting truck assay unit operations and Building 115 (material assay operations). Based upon the radiological controls in place during remediation operations for site vehicles and operations in Building 115 there was no history of radioactive materials being dumped or spilled in LSA 07-01.

The radioactive material in LSA 06-01, LSA 06-02 and LSA 07-01 consisted of those Radionuclides of Concern described in FSSFR Volume 1, Chapter 1.

3.5 Reuse Soil Disposition and Characterization

As LSA 06 and LSA 07 were originally designated as Class 3 areas in the DP, they were not designated as locations for generation of reuse soil. As such no reuse soil was generated from LSA 06-01, LSA 06-02 or LSA 07-01.

3.6 Remediation and Remedial Action Support Surveys (RASS) Phase of LSA 06-01, LSA 06-02, and LSA 07-01

Based upon the results of the Final RASS and FSS field activities performed in LSA 06 and LSA 07 no remediation was required to be performed in LSA 06-01, LSA 06-02 and LSA 07-01.

3.6.1 Preparation of LSA 06-02 for FSS

To prepare LSA 06-02 for FSS the parking lot section of asphalt adjacent to LSA 05 was removed to provide access to the underlying soil surface. The determination to remove the asphalt was based upon the identification of a fuel pellet fragment in adjacent LSA 05. The removal of the asphalt in LSA 06-02 would provide the ability to perform radiological surveys of the soil to verify the Class 2 designation of the SU and preclude leaving an unknown fuel pellet fragment under the overlying asphalt. The results of the radiological survey verified the Class 2 designation of LSA 06-02.

3.6.2 Preparation of LSA 07-01 for FSS

To accomplish isolation of a portion of the SDS for FSS it was necessary to prepare FSS of LSA 07-01 in two separate iterations. The section of the SDS piping designated as STM-1 resides adjacent to Building 110 and was the recipient of surface storm water and storm water from the Building 110 roof drains. To support FSS of the SDS it was determined that once STM-1 was isolated it would remain isolated as downstream sections of the SDS piping would be removed. As such it was necessary to transfer a small section of LSA 06-02 into LSA 07-01 and then to perform FSS in LSA 07-01 on the area adjacent to Building 110.

Once FSS of the SDS piping was complete FSS was completed on the small section of LSA 07-01 adjacent to Building 110. Once FSS of the small section of LSA 07-01 was successfully completed the surface water inlet and Building 110 roof drain inlets were covered with off-site backfill to isolate the SDS piping and components. The small area of LSA 07-01 was then contoured with off-site backfill to divert all potential future storm water away from the underground SDS piping and Building 110. Isolation and control measures were implemented for the small area of LSA 07-01 until such time the remainder of LSA 07-01 was completed.

Subsequently when the site remediation activities in the box counter, the Material Assay Area/Waste Evaluation Area and vehicular traffic ceased, the area was cleared and FSS performed on the remainder of LSA 07-01.

3.6.3 Nuclear Criticality Safety (NCS) Borings

NCS Borings were not required within LSA 06-01, LSA 06-02 and LSA 07-01 as the land area of these SUs was never subject to burials or potential burials. Therefore, NCS controls were not required.

3.6.4 Groundwater Monitoring Wells

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

During the history of the site, eight groundwater monitoring wells were installed within the SU boundary of LSA 06-01, LSA 06-02 and LSA 07-01.

3.6.4.1 Abandoned Wells

Important to the planning and execution of remediation of the soils under the former Process Buildings was the information provided in Westinghouse letter HEM-11-56 to the NRC which contained the "Evaluation of Technetium-99 Under the Process Building" report. The relevant requirements of HEM-11-56 for remediation of contaminated areas in regards to groundwater monitoring wells is provided below.

> *"The following actions shall be taken to investigate the potential for a preferential pathway of Tc-99 and uranium along a monitoring well screen that crosses both the Silty Clay Aquitard HSU and the Sand/Gravel HSU (hybrid well), and to determine whether contaminated soil exists in proximity to a hybrid monitoring well:*
>
> - *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.*
> - *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. The borings shall extend down to refusal, which indicates bedrock. Composite samples will be collected as follows:*
>
> - *From each 5 foot increment of depth to the top of the screened/filtered interval;*
> - *From the increment that is equivalent to the top half of the screened/filtered interval; and*
> - *From the increment that is equivalent to the bottom half of the screened/filtered interval.*

Should a sample result from the investigation sampling described in this subsection exceed the applicable DCGL, then remediation of the subsurface soil represented by the sample is required. If remediation was by overboring, then sampling borings as described in the preceding paragraph may be used to demonstrate compliance. If remediation was by excavation, a final status survey (FSS) per Chapter 14 will be completed."

The two following groundwater monitoring wells were installed and subsequently abandoned within the land area of LSA 06-01:

NB-56

Hybrid monitoring well NB-56 (total depth 35 ft) was installed on June 24, 2004, and abandoned in August 2006 in accordance with the MDNR requirements. A variance for abandonment of this well was approved by MDNR (Variance No. 3268) that allowed for the removal of the upper 3 feet of casing and tremie filling the well with grout from the bottom to top. Abandonment of monitoring well NB-56 included tremie grouting the well from the bottom to top and the removal of the upper 5 feet of PVC riser pipe.

A review of the radiological water sample data from NB-56 indicates that there were no historic exceedances of uranium above the uranium background threshold value of 8.6 pCi/l. The Tc-99 result was less than the MDC+Error for the water sample collected from this well. The Tc-99 result was 2.93 pCi/l, well below the EPA drinking water standard of 900 pCi/l.

Hybrid well NB-56 was abandoned prior to the establishment of the requirements of HEM-11-56, as such, there was not a documented radiological survey of the soil cuttings as well as no composite samples of the soil cuttings.

NB-57B

Monitoring well NB-57B (total depth 24 ft) was installed on June 25, 2004, and abandoned in August 2006 in accordance with the MDNR requirements. A variance for abandonment of this well was approved by MDNR (Variance No. 3268) that allowed for the removal of the upper 3 feet of casing and tremie filling the well with grout from the bottom to top. Abandonment of monitoring well NB-57B included tremie grouting the well from the bottom to top and the removal of the upper 5 feet of PVC riser pipe. This monitoring well was constructed with a screen isolated in the silty clay overburden zone and therefore does not meet the definition of a hybrid well.

A review of the radiological water sample data from NB-57B indicates there were no historic exceedances of uranium above the uranium background threshold value of 8.6 pCi/l and no Tc-99 results exceeding the MDC+Error. The maximum Tc-99 result was 4.48 pCi/l, well below the EPA drinking water standard of 900 pCi/l.

The three following groundwater monitoring wells were installed and subsequently abandoned within the land area of LSA 07-01:

NB-48

Monitoring well NB-48 (total depth 36.8 ft) was installed on June 21, 2004, and abandoned in August 2006 in accordance with the MDNR requirements. A variance for abandonment of this well was approved by MDNR (Variance No. 3268) that allowed for the removal of the upper 3 feet of casing and tremie filling the well with grout from the bottom to top. Abandonment of monitoring well NB-48 included tremie grouting the well from the bottom to top and the removal of the upper 5 feet of PVC riser pipe. This monitoring well was constructed with a screen isolated in the silty clay overburden zone and therefore does not meet the definition of a hybrid well.

Historical records indicate that NB-48 was installed with a group of well installations to support the Remedial Investigation for chemical contamination. Historical records provide limited sample results as it appears the staff at the time opted to not utilize the well for radiological monitoring.

WS-22

Monitoring well WS-22 (total depth 15.5 ft) was installed on September 24, 1998, and abandoned on October 22, 2010 in accordance with the MDNR requirements. Abandonment of monitoring well WS-22 included overdrilling with 8 inch diameter augers to remove well materials and tremie grouting the hole from the bottom to top. Monitoring well WS-22 was installed with a screen isolated in the silty clay overburden zone and therefore does not meet the definition of a hybrid well.

A review of the radiological water sample data from WS-22 indicates that there were no historic exceedances of uranium above the uranium background threshold value of 8.6 pCi/l. The Tc-99 result was less than the MDC+Error for the water sample collected from this well. The Tc-99 result was 20 pCi/l, well below the EPA drinking water standard of 900 pCi/l.

WS-23

Hybrid monitoring well WS-23 (total depth 38.5 ft) was installed on September 24, 1998, and abandoned on October 22, 2010 in accordance with the MDNR requirements. Abandonment of monitoring well WS-23 included overdrilling with 8 inch diameter augers to remove well materials and tremie grouting the hole from the bottom to top.

A review of the radiological water sample data from WS-23 indicates that there were no historic exceedances of uranium above the uranium background threshold value of 8.6 pCi/l. The Tc-99 results were less than the MDC+Error for the water samples collected from this well. The highest Tc-99 result was 8.09 pCi/l, well below the EPA drinking water standard of 900 pCi/l.

Hybrid well WS-23 was abandoned prior to the establishment of the requirements of HEM-11-56, as such, there was not a documented radiological survey of the soil cuttings as well as no composite samples of the soil cuttings.

3.6.4.2 LSA 06-01

NB-57A

Hybrid monitoring well NB-57A (total depth 35 ft) was installed on June 25, 2004. This existing monitoring well is located on the western side of LSA 06-01 and is used for monitoring of volatile organics in groundwater.

A review of the radiological water sample data from NB-57A indicates that there were no historic exceedances of uranium above the uranium background threshold value of 8.6 pCi/l. The Tc-99 results were less than the MDC+Error for the water samples collected from this well. The highest Tc-99 result was 2.89 pCi/l, well below the EPA drinking water standard of 900 pCi/l.

3.6.4.3 LSA 06-02

The following groundwater monitoring well was installed within the land area of LSA 06-02:

NB-54

Hybrid monitoring well NB-54 (total depth 32 ft) was installed on June 24, 2004. This existing monitoring well is located on the southern side of LSA 06-02 and is used for monitoring of volatile organics in groundwater.

A review of the radiological water sample data from NB-54 indicates that there were no historic exceedances of uranium above the uranium background threshold value of 8.6 pCi/l. The Tc-99 results were less than the MDC+Error for the water samples collected from this well. The highest Tc-99 result was 5.23 pCi/l, well below the EPA drinking water standard of 900 pCi/l.

3.6.4.4 LSA 07-01

The following groundwater monitoring well was installed within the land area of LSA 07-01:

NB-50

Hybrid monitoring well NB-50 (total depth 38.4 ft) was installed on June 22, 2004. This existing monitoring well is located on the western side of LSA 07-01.

A review of the radiological water sample data from NB-50 indicates that there were no historic exceedances of uranium above the uranium background threshold value of 8.6 pCi/l. The Tc-99 results were less than the MDC+Error for the water samples collected from this well. The highest Tc-99 result was 5.32 pCi/l, well below the EPA drinking water standard of 900 pCi/l.

3.6.4.5 Post-remediation Groundwater Monitoring Well

There are no post-remediation groundwater monitoring wells in LSA 06-01, LSA 06-02 and LSA 07-01.

3.6.5 Subterranean Piping

Subterranean piping exists in LSA 06-01, LSA 06-02 and LSA 07-01. STM-1 (PSA 01-01) resides in LSA 06-01 and LSA 07-01. As such, the dose contribution from this pathway will be added to the total dose summation of LSA 06-01 and LSA 07-01.

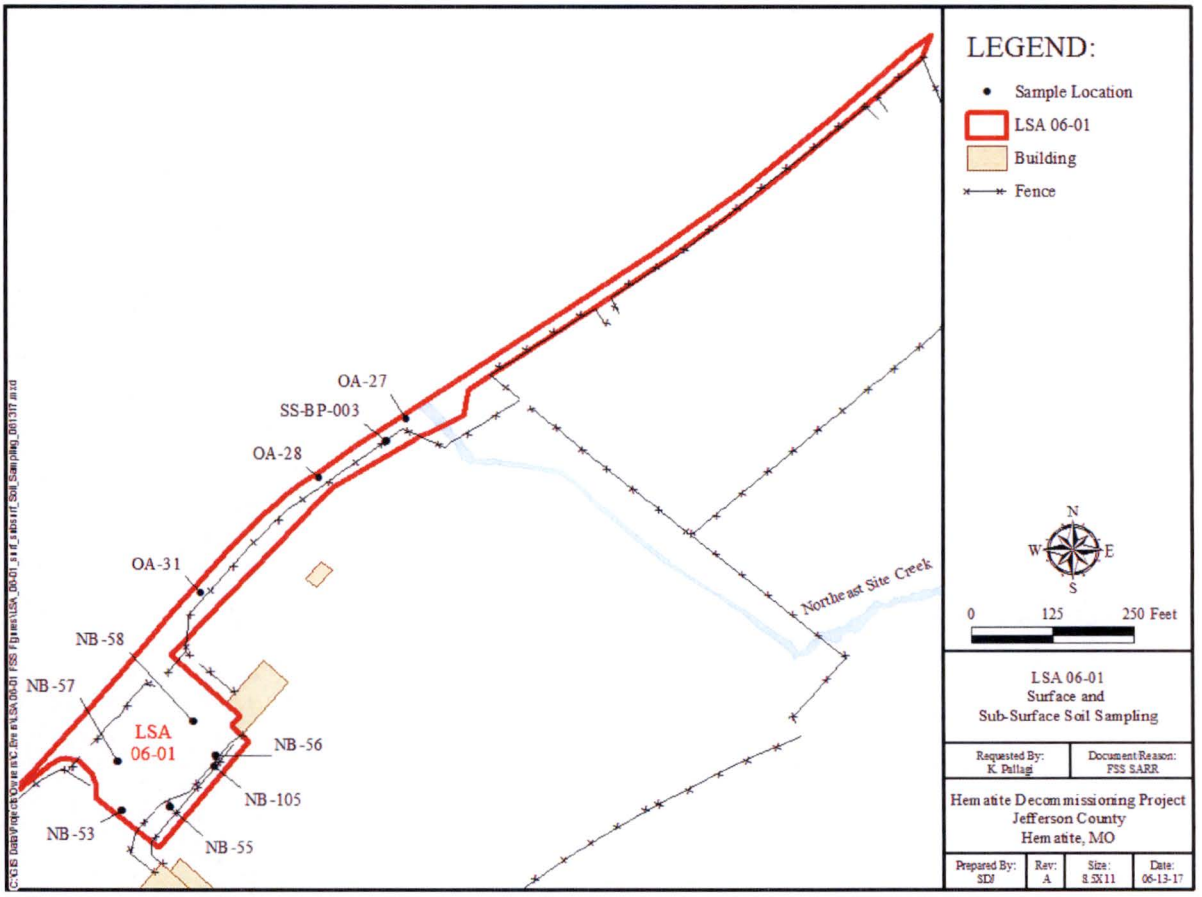
STM-3 (PSA 01-03), STM-4 (PSA 01-04), STM-5 (PSA 01-05), STM-6 (PSA 01-06), STM-7 (PSA 01-07) and STM-8 (PSA 01-08) reside in LSA 06-02. As such, the dose contribution from these pathways will be added to the total dose summation of LSA 06-02.

3.6.6 Characterization History

Radiological characterization surveys for the HDP were conducted in several phases by multiple contractors over several years prior to the approval of the DP. During the various characterization campaigns a total of twenty-eight (28) core borings to depths as deep as 15 feet bgs were performed for within LSA 06 and LSA 07.

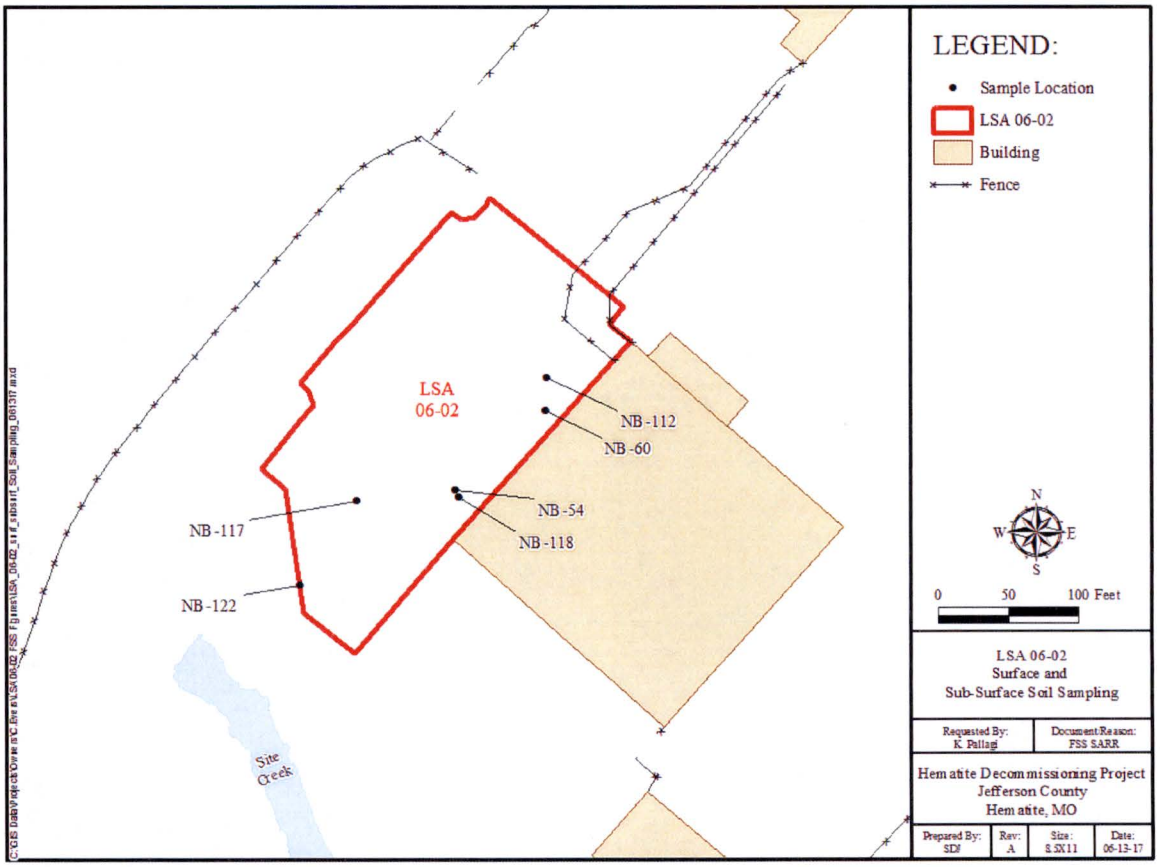
Within LSA 06-01, none of the ten characterization samples exceeded the Uniform $DCGL_W$. Figure 3-6 indicates the radiological characterization boring locations within LSA 06-01.

Figure 3-6
Site Characterization Borings within LSA 06-01



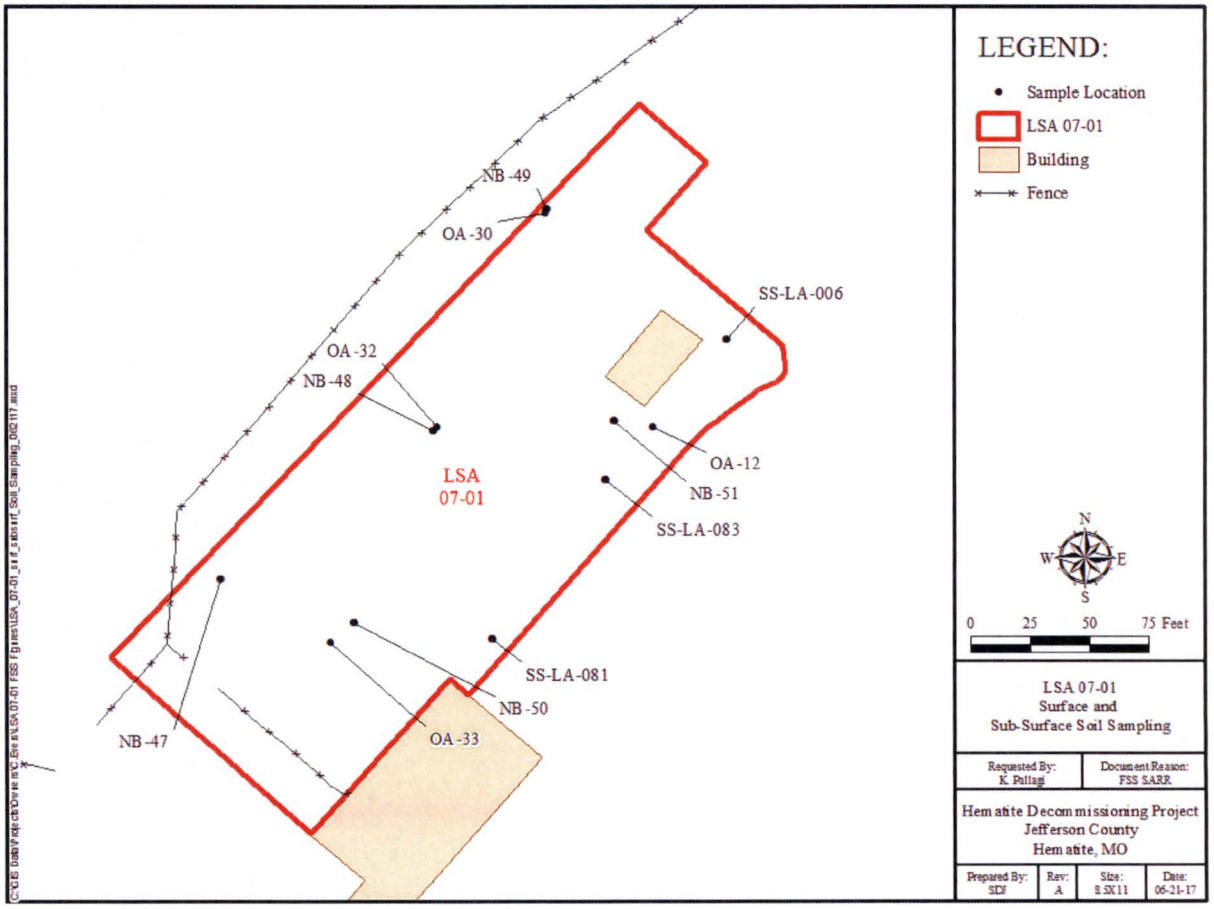
Within LSA 06-02, none of the six characterization samples exceeded the Uniform $DCGL_W$. Figure 3-7 indicates the radiological characterization boring locations within LSA 06-02.

Figure 3-7
Site Characterization Borings within LSA 06-02



Within LSA 07-01, none of the twelve characterization samples exceeded the Uniform $DCGL_W$. Figure 3-8 indicates the radiological characterization boring locations within LSA 07-01.

Figure 3-8
Site Characterization Borings within LSA 07-01



3.6.7 Remedial Action Support Survey for FSS Design

RASS was conducted within LSA 06-01, LSA 06-02 and LSA 07-01, 1) to determine when a SU had been adequately prepared for FSS, and 2) to provide updated estimates of the parameters to be used for planning the FSS. Upon the completion of remediation of 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 postings.

The RASS included a GWS, systematic surface sample collection based on an eight (8) point triangular grid, and biased surface sampling. The Final RASS results were used to develop the FSS Plan for each SU. 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 06-01, LSA 06-02 and LSA 07-01

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
06-01	0.003	0.023	0.166	0.428	0.010	0.080	3.166	9.219	0.170	0.507	1.123	1.950
06-02	0.001	0.008	0.062	0.218	0.079	0.270	1.901	3.287	0.102	0.180	0.800	1.060
07-01	<BKG	<BKG	0.429	0.711	<BKG	<BKG	3.283	6.048	0.180	0.334	0.713	1.110
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 $DCGL_W$, therefore the Final RASS data set was considered sufficient to support FSS design.

3.6.8 Isolation and Control LSA 06-01 and LSA 06-02

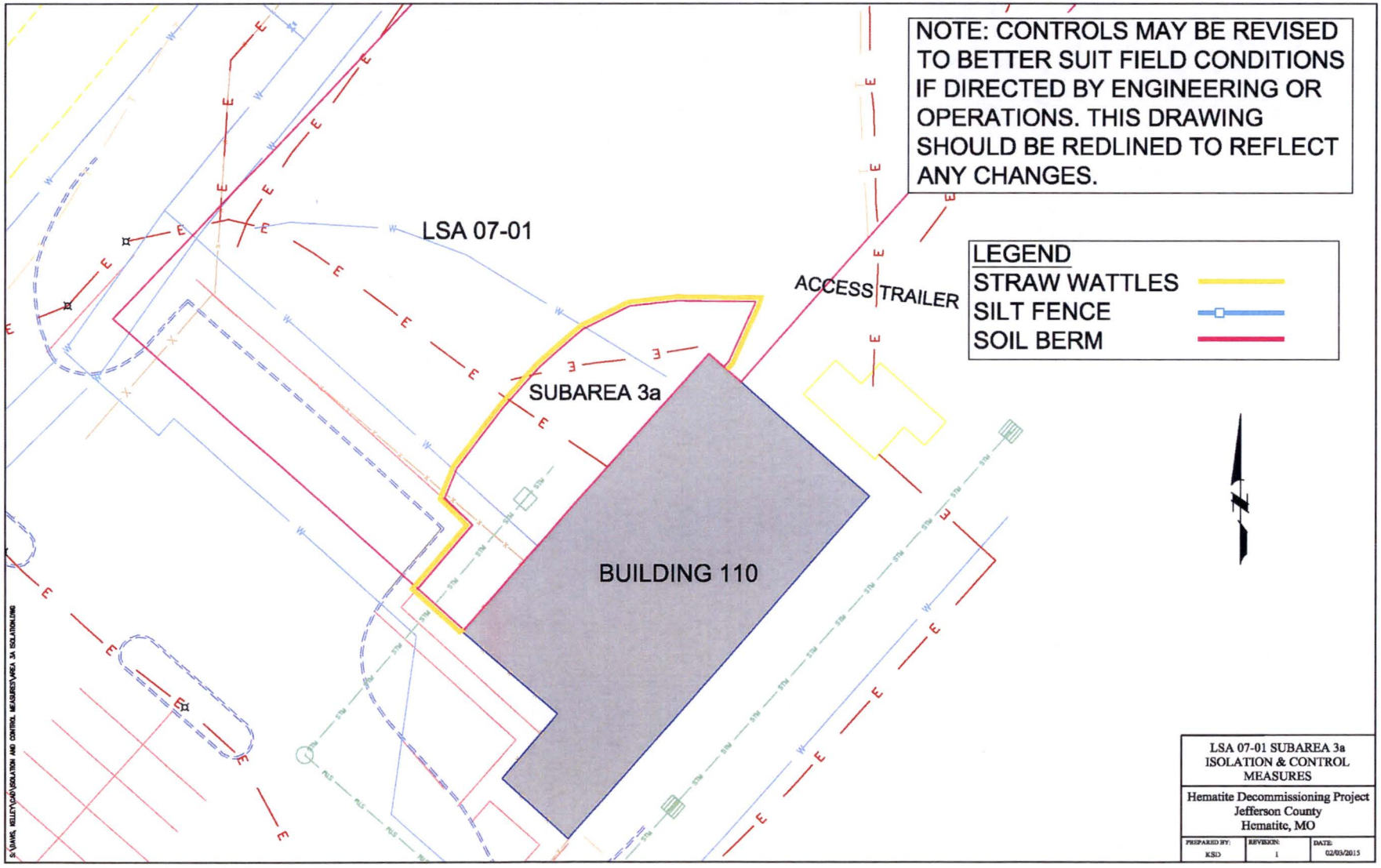
As directed by HDP-PR-HP-602, *Data Package Development and Isolation and Control Measures to Support Final Status Survey,* in July of 2015, the SUs in LSA 06 were isolated and controlled in accordance with Work Package HDP-WP-ENG-803, *Isolation and Control Measures.* Limited isolation and control measures were required for LSA 06-01 and LSA 06-02 as they were Class 2 and Class 3 SUs, and as the adjacent LSA 02 (Site Pond) area and LSA 05 (Barns) area were already subjected to isolation and control measures. Isolation and Control measures remained in place for LSA 05 after backfill, and for LSA 02 after the flow of water had been restored to the Site Pond. The administrative control of multiple postings labeled "Contact Health Physics Prior to Entry" were installed around the entire perimeter of the SUs prior to FSS field activities to prevent inadvertent entry by site personnel.

The LSA 06 SUs are isolated from the remainder of the property by the Site Pond and are bounded by the fence that runs along public roadway State Road P preventing inadvertent entry by the public.

3.6.9 Isolation and Control LSA 07-01

As discussed in Section 3.6.2, FSS for LSA 07-01 was completed in two iterations. To maintain the small area of LSA 07-01 that was surveyed in the first iteration of FSS, isolation and control measures were implemented as directed by HDP-PR-HP-602, *Data Package Development and Isolation and Control Measures to Support Final Status Survey.* The isolation and control measures included the use of soil berms, straw waddles, and green and white rope with signs stating "Contact Health Physics Prior to Entry" were installed around the perimeter of the area. (See Figure 3-9 Below)

Figure 3-9
Isolation and Control Instruction Diagram for LSA 07-01



3.7 Surveillance Following FSS

Following the completion of a FSS, the DP requires continued surveillance to minimize the potential to re-contaminate a SU (e.g., surface water transport of potentially contaminated sediment or a soil pile that was not present during FSS).

During the timeframe since the completion of FSS field activities to the date of completion of all physical work at HDP and project demobilization, LSA 06-01, LSA 06-02 and LSA 07-01 did not evidence an event that would cause them to be suspect and thus require investigation.

3.8 Backfill of Survey Units

As there were no remediation excavation activities in LSA 06 and LSA 07. Therefore, there were no backfill activities required to fill excavations. As discussed in section 3.6.2 a small amount of off-site backfill was used in LSA 07-01 to isolate the SDS and contour the area adjacent to Building 110 for the purpose of stormwater runoff.

3.9 Groundwater Monitoring

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

> "*Post-remediation monitoring wells will be sampled quarterly after the completion of remediation until license termination. The data collected will be used to confirm that the sum of the annual dose from groundwater for all the radionuclides does not exceed the EPA Maximum Contaminant Level (MCL) of 4 millirem/year. Separately, the sum of the dose from all residual sources remaining after remediation, including soil and groundwater pathways, will be confirmed to result in an annual dose that does not exceed 25 millirem/year.*"

As stated in the Executive Summary section, the exposure results of this report will be combined with the dose attributed to groundwater to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 CFR 20 Subpart E, "Criteria for License Termination." As such, for the purpose of this report, groundwater will be assigned a conservative SOF of 0.16 which equates to 4 mrem/year until such time that the post-remediation groundwater sampling has been completed and reported as part of FSSFR Volume 6, Chapter 7, *Post-remediation Groundwater Monitoring Summary*. The final dose for LSA 06-01, LSA 06-02 and LSA 07-01 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*, provides a detailed discussion on the release criteria that is applicable to LSA 06-01, LSA 06-02 and LSA 07-01. 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 06-01

This section of the report describes the method for determining the number of samples required for the FSS of LSA 06-01 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 06-01 and the detection sensitivities are also discussed.

5.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 06-01 were driven by the type (Open Land) and Class (Class 3) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 8, *Final Status Survey Plan Development*, August 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 RASS data for LSA 06-01. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the SU 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 3 SU, LSA 06-01 was required to undergo a minimum of a 1-10% GWS.

5.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 06-01 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)

Scan MDCs for LSA 06-01 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD-FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. As background levels were approximately 8,000 counts per minute (cpm) within LSA 06-01, 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:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3273\ pCi/g}\right)+\left(\frac{f_{U-235}}{2.08 pCi/g}\right)+\left(\frac{f_{U-238}}{27.4\ pCi/g}\right)\right)}$$

Equation 5-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the systematically collected RASS samples in LSA 06-01, the average enrichment for the SU was 2.4%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 06-01 are shown below:

Table 5-1
Scan MDCs for 2" x 2" NaI detector, 8,000 cpm background: LSA 06-01

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 06-01	36.6	48.3	1.08	2.8	0.77	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 SU LSA 06-01 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-TBD-FSS-003, *Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*. The IAL used during the GWS of LSA 06-01 was established at 1,624 ncpm, which is the equivalent of an activity concentration that is less than the Uniform Stratum $DCGL_W$.

5.1.7 LSA 06-01 FSS Design Summary

The FSS Plan for LSA 06-01 can be found in Appendix D. Table 5-2 presents an overall FSS design and implementation summary for LSA 06-01.

Table 5-2
FSS Design Summary for LSA 06-01

Gamma Walkover Survey (GWS):		
Scan Coverage	Minimum 10% of LSA 06-01 total area	
Scan MDC	36.6 pCi/g total Uranium; 0.77 pCi/g Th-232; 1.08 pCi/g Ra-226 (based on an 8,000 cpm background)*	
Investigation Action Level (IAL)	1,624 net cpm **	
Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	8	These samples will be taken on a systematic grid. ***Excavation stratum samples will be collected and archived, but will be analyzed *only* in the event the overlying root stratum sample exceeds a SOF of 0.5
15 cm – 1.5 m (Root)	8	
> 1.5m (Excavation)	8***	
Biased Survey/Sampling Locations:		
Collect a minimum of one biased sample at the maximum GWS measurement within the SU. Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the FSS Supervisor.		
Sidewall Sampling Locations:		
Supplemental Sidewall Sampling: Not applicable; SU is a Class 3 (no excavation) area.		
Instrumentation:		
Ludlum 2221 with 44-10 (2x2 NaI) detector.	Used for GWS and to obtain static count rates at biased measurement locations.	

*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).* The Scan MDC for total Uranium reflects a conservative assumption of 4% enrichment. The actual RASS enrichment (2.4%) would result in Scan MDC values slightly less than those calculated for FSS planning purposes.

**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum $DCGL_W$ 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 LSA 06-01

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 06-01 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 (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 were 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 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 surface (nominally 1", but not to exceed 3"). At the same time, the Health Physics (HP) Technician was required to slowly advance, causing the detector to trace out a serpentine path over the surface.

HP Technicians performing GWS in LSA 06-01 used the 1,624 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to the 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 10,000 gross counts per minute (gcpm). Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 9,624 to 11,624 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the 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 06-01.

Table 6-1
Systematic Sampling Summary by Stratum for LSA 06-01

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
06-01	8,808	8	8	0	2

6.2.2 Systematic Sampling LSA 06-01

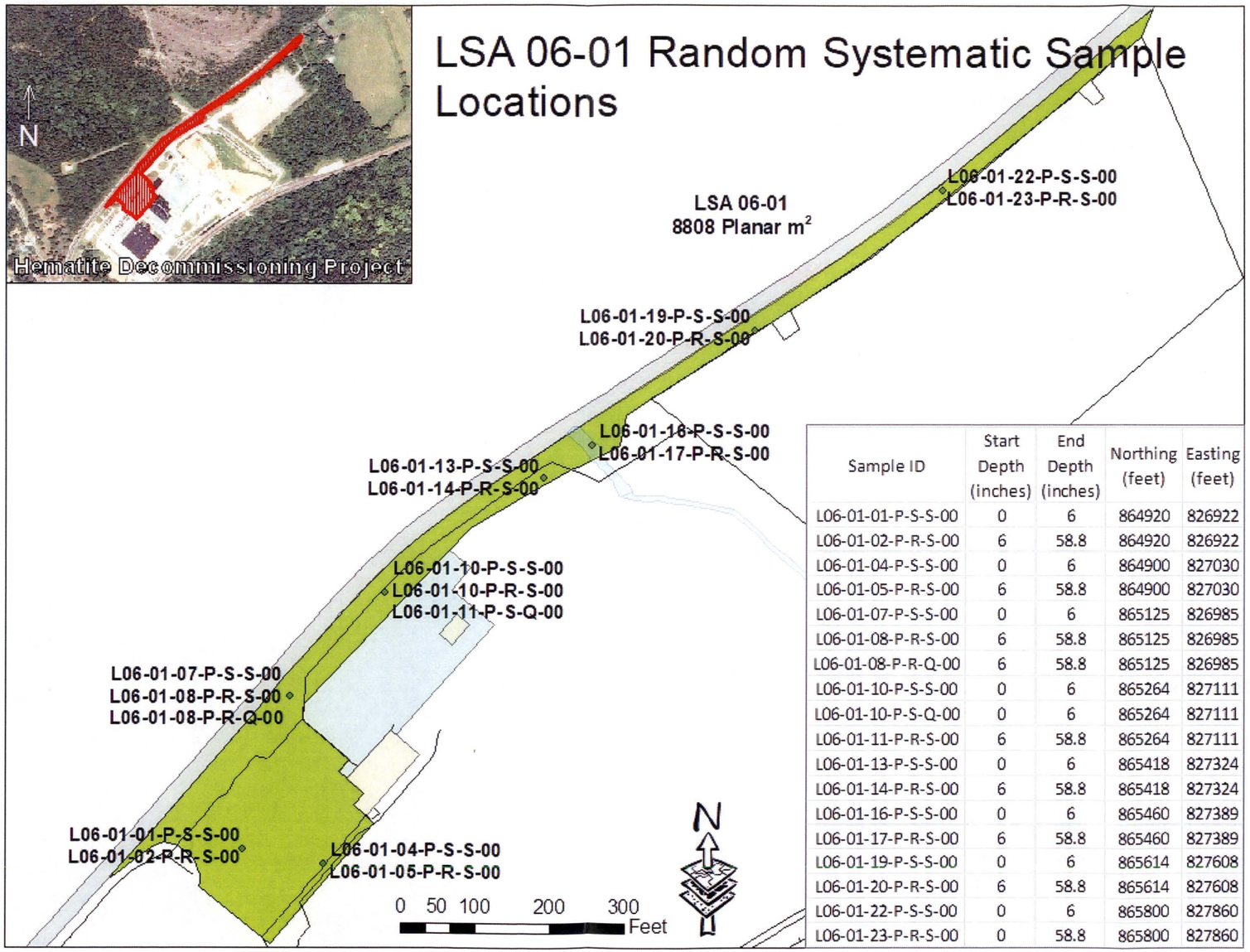
Within LSA 06-01, there were 8 random systematic locations in which the surface stratum [0 – 15 centimeters (cm)] was sampled in the SU. The underlying root stratum was also sampled at all 8 locations. Excavation stratum samples were collected at all 8 locations, although they were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF. Where necessary overlying asphalt was removed to access the soil.

While there were eight (8) random systematic locations on the LSA 06-01 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) Quality Control (QC) field replicate

Figure 6-1 presents the map of the eight random systematic sample locations, and three sediment sample locations, which were sampled within LSA 06-01. 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 06-01 Random Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing (feet)	Easting (feet)
L06-01-01-P-S-S-00	0	6	864920	826922
L06-01-02-P-R-S-00	6	58.8	864920	826922
L06-01-04-P-S-S-00	0	6	864900	827030
L06-01-05-P-R-S-00	6	58.8	864900	827030
L06-01-07-P-S-S-00	0	6	865125	826985
L06-01-08-P-R-S-00	6	58.8	865125	826985
L06-01-08-P-R-Q-00	6	58.8	865125	826985
L06-01-10-P-S-S-00	0	6	865264	827111
L06-01-10-P-S-Q-00	0	6	865264	827111
L06-01-11-P-R-S-00	6	58.8	865264	827111
L06-01-13-P-S-S-00	0	6	865418	827324
L06-01-14-P-R-S-00	6	58.8	865418	827324
L06-01-16-P-S-S-00	0	6	865460	827389
L06-01-17-P-R-S-00	6	58.8	865460	827389
L06-01-19-P-S-S-00	0	6	865614	827608
L06-01-20-P-R-S-00	6	58.8	865614	827608
L06-01-22-P-S-S-00	0	6	865800	827860
L06-01-23-P-R-S-00	0	58.8	865800	827860

Table 6-2 below presents a tabular listing of all FSS samples collected within LSA 06-01 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 6-2
FSS Sample Locations and Coordinates for LSA 06-01

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4, Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 06 **Description:** Plant Soils SEA Open Land Area
Survey Unit: 01 **Description:** Eastern Parking Lot Survey Unit in "Area 10"
Survey Type: FSS **Classification:** Class 3

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L06-01-01-P-S-S-00	Uniform	S	436.449	436.0	864920.0	826922.0	Surface 6-inch grab
L06-01-02-P-R-S-00	Uniform	S	435.959	431.5	864920.0	826922.0	Root 4.4-ft composite
L06-01-04-P-S-S-00	Uniform	S	434.053	433.6	864900.0	827030.0	Surface 6-inch grab
L06-01-05-P-R-S-00	Uniform	S	433.563	429.1	864900.0	827030.0	Root 4.4-ft composite
L06-01-07-P-S-S-00	Uniform	S	440.124	439.6	865125.0	826985.0	Surface 6-inch grab
L06-01-08-P-R-S-00	Uniform	S	439.634	435.2	865125.0	826985.0	Root 4.4-ft composite
L06-01-10-P-S-S-00	Uniform	S	441.971	441.5	865264.0	827111.0	Surface 6-inch grab
L06-01-11-P-R-S-00	Uniform	S	441.481	437.1	865264.0	827111.0	Root 4.4-ft composite
L06-01-13-P-S-S-00	Uniform	S	435.143	434.7	865418.0	827324.0	Surface 6-inch grab
L06-01-14-P-R-S-00	Uniform	S	434.7	430.2	865418.0	827324.0	Root 4.4-ft composite
L06-01-16-P-S-S-00	Uniform	S	429.3	428.8	865460.0	827389.0	Surface 6-inch grab
L06-01-17-P-R-S-00	Uniform	S	428.8	424.3	865460.0	827389.0	Root 4.4-ft composite
L06-01-19-P-S-S-00	Uniform	S	436.3	435.8	865614.0	827608.0	Surface 6-inch grab
L06-01-20-P-R-S-00	Uniform	S	435.8	431.4	865614.0	827608.0	Root 4.4-ft composite
L06-01-22-P-S-S-00	Uniform	S	436.6	436.2	865800.0	827860.0	Surface 6-inch grab
L06-01-23-P-R-S-00	Uniform	S	436.2	431.7	865800.0	827860.0	Root 4.4-ft composite
L06-01-08-P-R-Q-00	Uniform	Q	439.6	435.2	865125.0	826985.0	Root 4.4-ft composite
L06-01-10-P-S-Q-00	Uniform	Q	442.0	441.5	865264.0	827111.0	Surface 6-inch grab
L06-01-25-P-R-B-00	Uniform	B	430.2	429.7	864867.9	827011.8	Sidewall Sample

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 06-01 no biased sampling was determined to be necessary based on the evaluation if the GWS data.

6.4 Judgmental/Sidewall Sampling for Tc-99

Although no excavation was performed in LSA 06-01, excavation was performed in the adjacent LSA 08-16 in order to support the removal of former process building drain lines. As this excavation exposed a sidewall of LSA 06-01, one sidewall sample was collected from this location.

6.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic locations L06-01-08 and L06-01-10 for LSA 06-01.

7.0 FINAL STATUS SURVEY RESULTS LSA 06-01

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.

GWS measurements were collected in LSA 06-01 from April 28, 2016 to May 18, 2016.

7.1.1 GWS Results for LSA 06-01

For LSA 06-01, GWS count rates ranged between 2,571 gcpm and 12,426 gcpm, with a mean count rate of 7,103 gcpm. The median count rate was 7,134 gcpm and the standard deviation was 1,557 cpm. Figure 7-1 below presents a map of the complete GWS data set.

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"). Based on the evaluation of the GWS data, no biased sampling was determined to be necessary.

Figure 7-2 below presents a map of the +3 Z-score GWS measurements within LSA 06-01, including the selected biased sampling location.

All GWS data collected in LSA 06-01 was datalogged and post-processed in Graphical Information Software (GIS).

Figure 7-1
Colorimetric GWS Plot for LSA 06-01

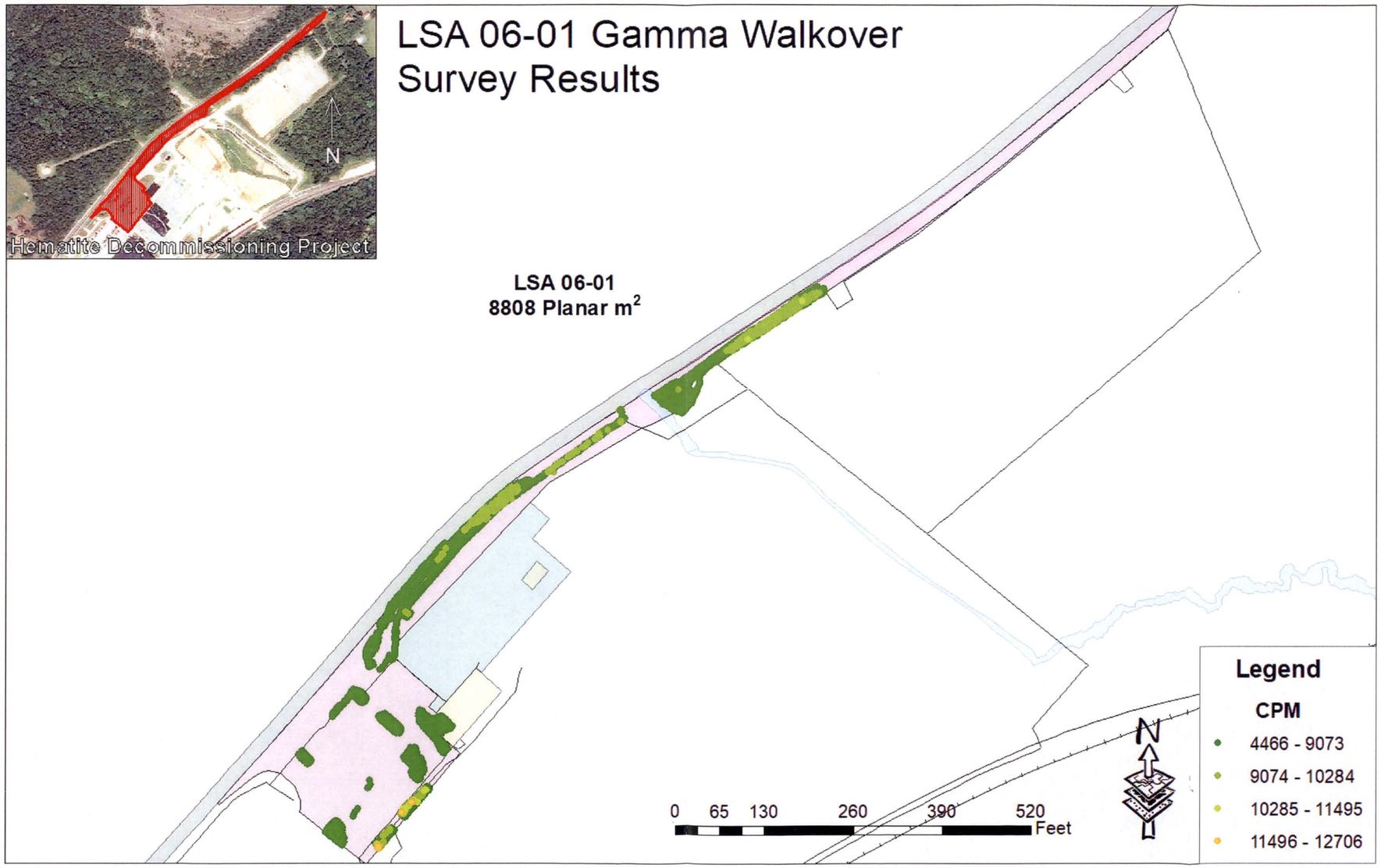
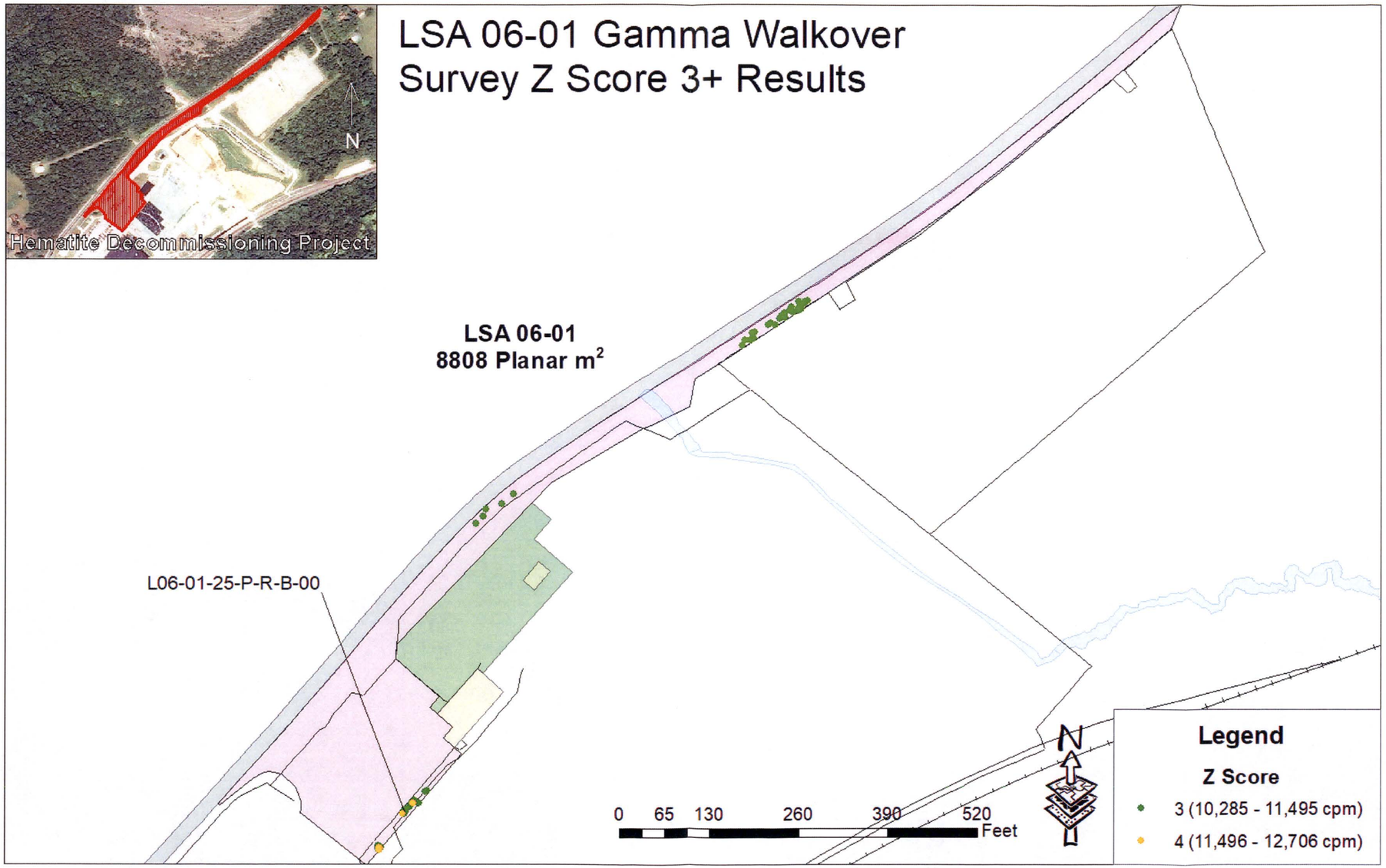


Figure 7-2
Colorimetric GWS Plot for LSA 06-01 (Measurements > Z-score of 3)



7.1.2 GWS Coverage Results LSA 06-01

As a Class 3 SU LSA 06-01 was required to undergo a minimum of a 10% GWS as specified by the FSS Plan. The GWS coverage for FSS was 15.8% of the SU surface.

7.2 Soil Sample Results LSA 06-01

Appendix A presents the analytical results and associated statistics for all FSS surface samples collected within LSA 06-01.

7.2.1 Surface Soil Sample Results LSA 06-01

There were eight random systematic samples collected within the surface stratum (0 – 15 cm) of LSA 06-01. Additionally one QC was collected in the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 0.10.

7.2.2 Subsurface Soil Sample Results LSA 06-01

There were eight systematic locations within LSA 06-01 where root stratum composite sampling was necessary. Additionally there was one QC sample collected from the root stratum. The root stratum zone is between 0.15 and 1.50 m below the surface. At all of the eight root stratum composite sampling locations, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 06-01 was 0.21.

7.2.3 WRS Evaluation LSA 06-01

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 06-01 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. For illustrative purposes the WRS Test evaluation was still performed for LSA 06-01. 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 06-01 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 Test Evaluation is also included in Appendix A.

7.2.4 Graphical Data Review LSA 06-01

Table 7-1 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 06-01, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.06.

Table 7-1
LSA 06-01 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	0.024	0.169	0.049	1.419	-0.011	0.932	**0.06**
Minimum	0.00 (<BKG)	0.017	0.00 (<BKG)	0.253	-0.147	0.253	0.01
Maximum	0.150	0.456	0.230	3.361	0.185	1.320	0.21

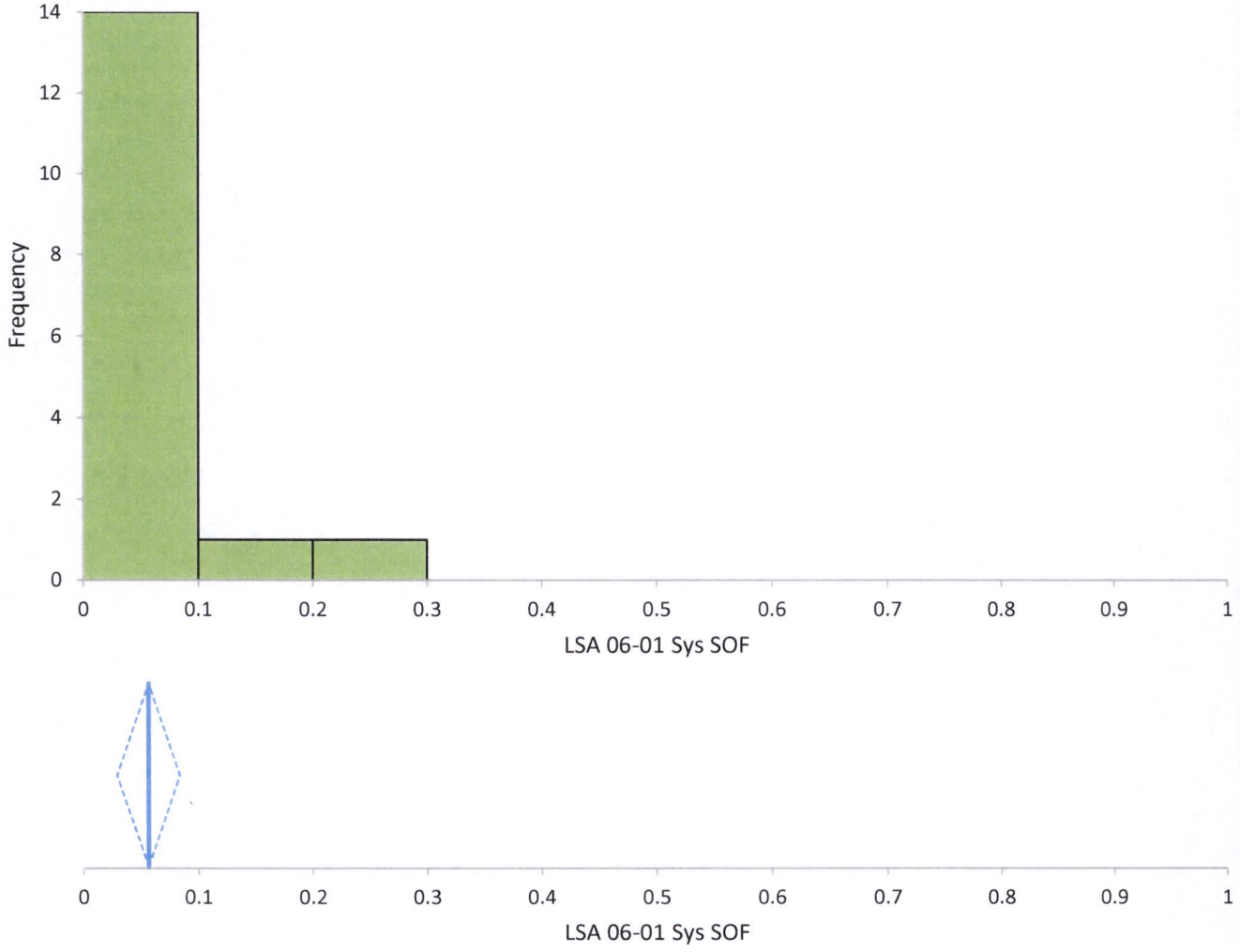
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide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

Section 8.2.2.2 of MARSSIM recommends a graphical review of FSS analytical data, to include at a minimum, a posting plot and a histogram. A frequency plot, or histogram, is a useful tool for examining the general shape of a data distribution. This plot is a bar chart of the number of data points within a certain range of values. The frequency plot will reveal any obvious departures from symmetry, such as skewness or bimodality (two peaks), in the data distribution for the SU. The presence of two peaks in the SU 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 16 systematically collected samples from LSA 06-01. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 06-01. The middle graph presents the mean SOF (0.06 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 0.03 to 0.08. The 97.87% confidence interval based on the median (0.04) of the sample results is 0.02 to 0.08. The bottom two charts present the various statistical metrics of the LSA 06-01 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 06-01 data associated with the systematically collected measurement locations.

Figure 7-3
Graphic Statistical Summary for LSA 06-01 (SOF parameter)



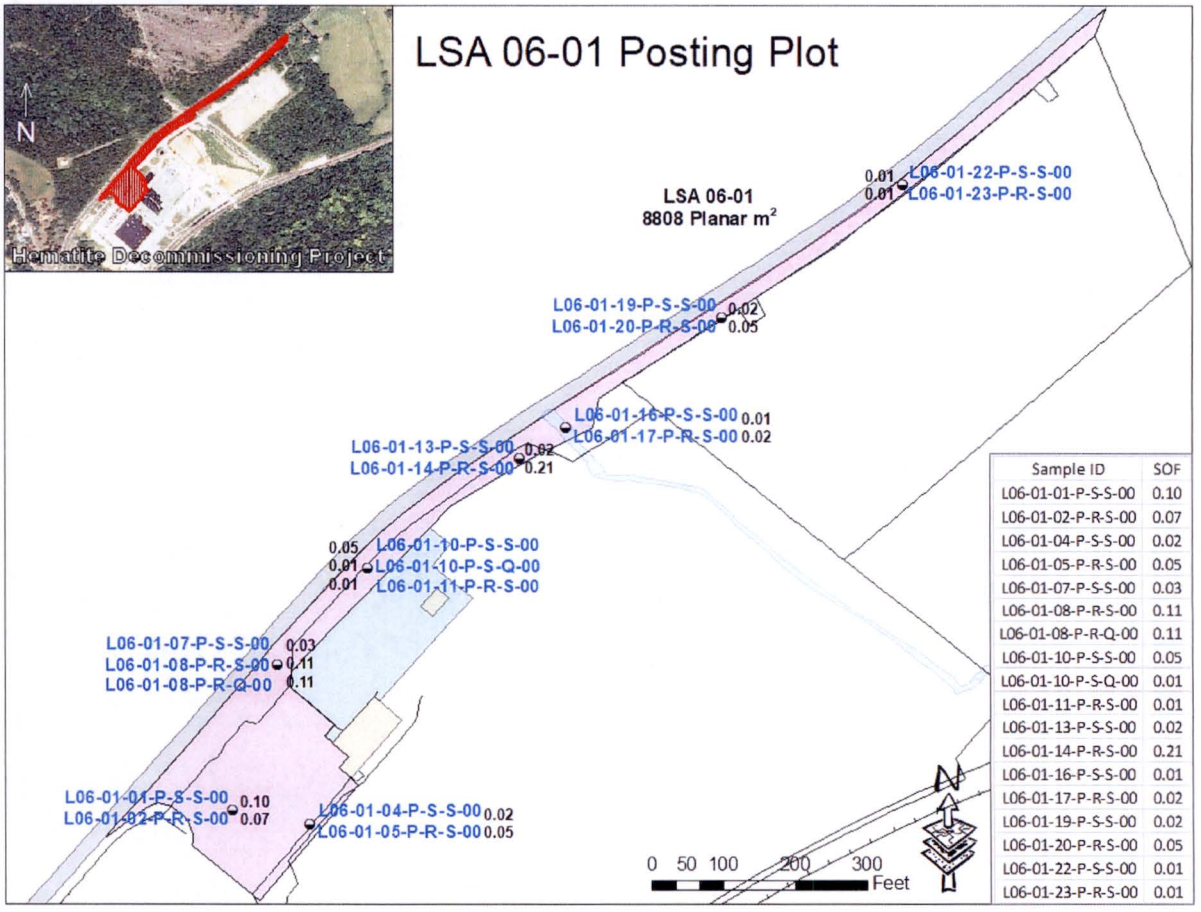
N	16

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 06-01 Sys SOF	0.06	0.03	to 0.08	0.013	0.05	0.00	2.1	5.24

	Minimum	1st quartile	Median	97.87% CI		3rd quartile	Maximum	IQR
LSA 06-01 Sys SOF	0.0	0.02	0.04	0.02	to 0.08	0.07	0.2	0.05

A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 06-01 is presented below in Figure 7-4. Figure 7-4 shows no unusual patterns in the data.

Figure 7-4
Posting Plot for LSA 06-01 Systematic Measurement Locations



Appendix A to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 7-1, Figure 7-3, and Figure 7-4 above. A summary of the analytical data is presented in Table 7-2 below. Appendix G to this report presents the TestAmerica Analytical Laboratory soil sample reports.

Table 7-2
Final Status Survey Analytical Data: LSA 06-01

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
L06-01-01-P-S-S-00	0.00	S	1.160	0.175	0.080	N/A	0.090	0.090	0.040	0.040	0.008	0.222	U	1.100	0.185	0.074	N/A	0.100	0.100	0.253	NA	NA	NA	-0.147	0.166	0.687	U	0.253	0.952	1.590	U	0.7	0.10
L06-01-02-P-R-S-00	0.50	S	1.080	0.148	0.060	N/A	0.010	0.010	0.017	0.017	0.050	0.238	U	1.130	0.186	0.100	N/A	0.130	0.130	1.060	NA	NA	NA	-0.126	0.128	0.534	U	1.060	0.541	0.839	N/A	0.7	0.08
L06-01-04-P-S-S-00	0.00	S	1.010	0.141	0.059	N/A	-0.060	0.000	0.355	0.355	0.090	0.234	N/A	0.982	0.148	0.091	N/A	-0.018	0.000	3.361	NA	NA	NA	0.185	0.119	0.154	N/A	0.890	0.286	0.752	N/A	3.2	0.04
L06-01-05-P-R-S-00	0.50	S	1.110	0.159	0.074	N/A	0.040	0.040	0.021	0.021	0.054	0.234	U	1.060	0.183	0.119	N/A	0.060	0.060	0.770	NA	NA	NA	-0.126	0.191	0.658	U	0.770	0.311	0.868	U	0.7	0.06
L06-01-07-P-S-S-00	0.00	S	0.779	0.134	0.070	N/A	-0.291	0.000	0.409	0.409	0.139	0.259	N/A	0.761	0.138	0.094	N/A	-0.239	0.000	2.468	NA	NA	NA	0.131	0.259	0.510	U	1.320	0.581	0.874	N/A	1.6	0.04
L06-01-08-P-R-S-00	0.50	S	1.140	0.160	0.072	N/A	0.070	0.070	0.067	0.067	0.048	0.241	U	1.120	0.176	0.091	N/A	0.120	0.120	1.170	NA	NA	NA	-0.016	0.121	0.417	U	1.170	0.574	0.738	N/A	0.7	0.11
L06-01-10-P-S-S-00	0.00	S	0.916	0.149	0.077	N/A	-0.154	0.000	0.127	0.127	0.056	0.227	U	1.090	0.199	0.165	N/A	0.090	0.090	0.867	NA	NA	NA	-0.125	0.111	0.651	U	0.867	0.338	0.938	U	0.7	0.06
L06-01-11-P-R-S-00	0.50	S	1.060	0.146	0.063	N/A	-0.010	0.000	0.088	0.088	0.055	0.220	U	0.966	0.154	0.122	N/A	-0.034	0.000	2.624	NA	NA	NA	0.142	0.146	0.182	U	1.070	0.494	0.753	N/A	2.1	0.03
L06-01-13-P-S-S-00	0.00	S	0.882	0.140	0.074	N/A	-0.188	0.000	0.347	0.347	0.113	0.238	N/A	0.787	0.153	0.097	N/A	-0.213	0.000	3.297	NA	NA	NA	0.182	0.126	0.188	U	0.719	0.307	0.705	N/A	3.8	0.04
L06-01-14-P-R-S-00	0.50	S	1.220	0.169	0.075	N/A	0.150	0.150	0.072	0.072	0.013	0.239	U	1.230	0.184	0.133	N/A	0.230	0.230	1.320	NA	NA	NA	0.064	0.147	0.593	U	1.300	0.570	0.868	N/A	0.8	0.21
L06-01-16-P-S-S-00	0.00	S	0.614	0.103	0.044	N/A	-0.456	0.000	0.273	0.273	0.106	0.248	N/A	0.386	0.087	0.071	N/A	-0.614	0.000	0.566	NA	NA	NA	0.029	0.038	0.408	U	0.435	0.217	0.623	U	1.1	0.02
L06-01-17-P-R-S-00	0.50	S	0.634	0.093	0.040	N/A	-0.436	0.000	0.456	0.456	0.174	0.224	N/A	0.391	0.076	0.054	N/A	-0.609	0.000	0.593	NA	NA	NA	0.000	0.077	0.328	U	0.593	0.333	0.518	N/A	0.7	0.02
L06-01-19-P-S-S-00	0.00	S	0.878	0.141	0.070	N/A	-0.192	0.000	0.336	0.336	0.064	0.234	N/A	0.786	0.160	0.130	N/A	-0.214	0.000	1.250	NA	NA	NA	-0.137	0.190	0.643	U	1.250	0.547	0.823	N/A	0.7	0.02
L06-01-20-P-R-S-00	0.50	S	1.100	0.147	0.067	N/A	0.030	0.030	0.017	0.017	0.040	0.240	U	1.050	0.185	0.108	N/A	0.050	0.050	1.310	NA	NA	NA	-0.127	0.120	0.548	U	1.310	0.533	0.802	N/A	0.7	0.05
L06-01-22-P-S-S-00	0.00	S	0.874	0.126	0.059	N/A	-0.196	0.000	0.048	0.048	0.044	0.264	U	0.882	0.133	0.111	N/A	-0.118	0.000	0.537	NA	NA	NA	0.025	0.085	0.434	U	0.652	0.257	0.703	U	0.6	0.01
L06-01-23-P-R-S-00	0.50	S	0.898	0.145	0.072	N/A	-0.172	0.000	0.029	0.029	0.044	0.239	U	0.784	0.144	0.126	N/A	-0.216	0.000	1.250	NA	NA	NA	-0.124	0.175	0.555	U	1.250	0.517	0.770	N/A	0.7	0.01
L06-01-08-P-R-Q-00	0.50	Q	1.040	0.167	0.082	N/A	-0.030	0.000	0.145	0.145	0.057	0.229	U	1.180	0.194	0.117	N/A	0.180	0.180	3.096	NA	NA	NA	0.168	0.132	0.186	U	1.170	0.557	0.848	N/A	2.2	0.12
L06-01-10-P-S-Q-00	0.00	Q	1.050	0.142	0.050	N/A	-0.020	0.000	0.105	0.105	0.057	0.251	U	0.936	0.145	0.104	N/A	-0.064	0.000	1.100	NA	NA	NA	0.000	0.110	0.476	U	1.100	0.462	0.696	N/A	0.7	0.02
L06-01-25-P-R-B-00	0.00	B	0.893	0.140	0.067	N/A	-0.177	0.000	-0.014	0.000	0.037	0.236	U	1.010	0.186	0.101	N/A	0.010	0.010	0.223	NA	NA	NA	0.009	0.015	0.589	U	0.444	0.284	1.440	U	0.4	0.01
Systematic Minimum			0.000						0.017					0.000						0.253				-0.147				0.253				1.2	0.01
Systematic Maximum			0.150						0.456					0.230						3.361				0.185				1.320				Average Enrichment (%)	0.21
Systematic Mean			0.024						0.169					0.049						1.419				-0.011				0.932					0.06
Systematic Median			0.000						0.080					0.000						1.210				-0.008				0.975					0.04
Systematic Standard Deviation			0.044						0.162					0.068						0.979				0.123				0.337					0.05
			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 06-01

Based on the evaluation of the GWS data, no biased sampling was determined to be necessary.

7.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 06-01

Even though no excavation was performed in LSA 06-01, excavation in the adjacent LSA 08-16 exposed a sidewall of LSA 06-01, therefore one sidewall sample was collected, and the results are presented below.

Table 7-3
LSA 06-01 Sidewall Sample Data Summary and Calculated SOF Values

Sample ID	Ra-226 DCGL = 5.4 BKG = 0.9 (pCi/g)	Tc-99 DCGL = 74.0 (pCi/g)	Th-232 DCGL = 5.2 BKG = 1.0 (pCi/g)	U-234 DCGL=872.4 (pCi/g)	U-235 DCGL=208.1 (pCi/g)	U-238 DCGL=551.1 (pCi/g)	Sample SOF (Uniform DCGL)
L06-01-25-P-R-B-00	0.893	-0.014	1.010	0.223	0.009	0.444	0.01

7.2.7 Quality Control Soil Sample Result LSA 06-01

Two QC field duplicate sample points were randomly selected for LSA 06-01 which were collected at random systematic locations L06-01-08 and L06-01-10.

For the 17 samples (i.e., 16 systematic + 1 biased) collected within LSA 06-01, two field duplicate samples were collected. This frequency equates to 11.8%, (i.e. 2/17). 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 06-01 (1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control	Revision: 2	Page 1 of 1

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

Survey Unit No.: LSA 06-01 — Survey Unit Description: Eastern Parking Lot Survey Unit in "Area 10"

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)
L06-01-08-P-R-S-00	L06-01-08-P-R-Q-00	Ra-226	1.14	0.072	1.04	0.0817	1.090	1.9	0.1	0.269	0.403	N
L06-01-08-P-R-S-00	L06-01-08-P-R-Q-00	Tc-99	0.0674	0.241	0.145	0.229	0.106	25.1	NA	3.552	5.321	NA
L06-01-08-P-R-S-00	L06-01-08-P-R-Q-00	Th-232	1.12	0.0912	1.18	0.117	1.150	2.0	0.060	0.283	0.424	N
L06-01-08-P-R-S-00	L06-01-08-P-R-Q-00	U-234[1]	1.170	N/A	3.096	N/A	2.133	195.4	1.926	27.649	41.425	N
L06-01-08-P-R-S-00	L06-01-08-P-R-Q-00	U-235	-0.0155	0.417	0.168	0.186	0.076	51.6	NA	7.301	10.939	NA
L06-01-08-P-R-S-00	L06-01-08-P-R-Q-00	U-238	1.17	0.738	1.17	0.848	1.170	168.8	0.000	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: Thomas Yardy — Reviewed by: Clark Evers

Date: 7-18-17 — Date: 7/19/17

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Figure 7-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 06-01 (2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control		
		Revision: 2	Page 1 of 1

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

Survey Unit No.:	LSA 06-01				Survey Unit Description:		Eastern Parking Lot Survey Unit in "Area 10"					
			Sample (pCi/g)		Field Duplicate Sample (pCi/g)		Average Activity ($\bar{X}$)	Nuclide DCGL		Warning	Control	Statistic Exceeds Limit?
Sample ID	Field Duplicate Sample ID	Radionuclide	Activity (x_i)	MDC	Activity (x_i)	MDC	(pCi/g)	(pCi/g)	Statistic[2]	Limit	Limit	(Y/N)
L06-01-10-P-S-S-00	L06-01-10-P-S-Q-00	Ra-226	0.916	0.0772	1.05	0.0503	0.983	1.9	0.134	0.269	0.403	N
L06-01-10-P-S-S-00	L06-01-10-P-S-Q-00	Tc-99	0.127	0.227	0.105	0.251	0.116	25.1	NA	3.552	5.321	NA
L06-01-10-P-S-S-00	L06-01-10-P-S-Q-00	Th-232	1.09	0.165	0.936	0.104	1.013	2.0	0.154	0.283	0.424	N
L06-01-10-P-S-S-00	L06-01-10-P-S-Q-00	U-234[1]	0.867	N/A	1.100	N/A	0.984	195.4	0.233	27.649	41.425	N
L06-01-10-P-S-S-00	L06-01-10-P-S-Q-00	U-235	-0.125	0.651	0	0.476	-0.063	51.6	NA	7.301	10.939	NA
L06-01-10-P-S-S-00	L06-01-10-P-S-Q-00	U-238	0.867	0.938	1.1	0.696	0.984	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: Thomas Yardy 

Date: 7-15-17

Reviewed by: Clark Evers

Date: 7/19/17

Quality Record

7.3 Tc-99 Hot Spot Assessment LSA 06-01

As a Class 3 SU, there is no history of any sample from the SU exceeding the Tc-99 $DCGL_W$, or a SOF of 1.0. The highest Tc-99 sample result collected from both Final RASS and FSS was 0.45 pCi/g. There is no indication of a potential Tc-99 hot spot exceeding the $DCGL_W$ of 25.1 pCi/g, and therefore a Tc-99 hot spot assessment is not required.

8.0 ALARA EVALUATION LSA 06-01

All samples collected within LSA 06-01 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 06-01 no FSS sample result exceeded a SOF of 1.0. The average SOF result, based on all random systematically collected samples, was 0.06 for LSA 06-01. The average SOF equates to residual activity contributions from the SU area of 1.5 mrem/year for LSA 06-01. Groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, and Chapter 6 {ML17142A356} 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 06-01. Additionally, 0.25 mrem/year will be added to LSA 06-01 to account for the dose contribution from the presence of the parking lot structure (BSA 04-03), and 0.4 mrem/year will be added to LSA 06-01 to account for the remaining SDS piping (PSA 01-01, PSA 01-02 and PSA 01-03). Summing these dose contributions together, the total estimated dose for LSA 06-01 is 6.15 mrem/year.

Since the estimated Total Effective Dose Equivalent (TEDE) is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of LSA 06-01 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 06-01.

9.0 FSS PLAN DEVIATIONS LSA 06-01

9.1 Remedial Actions during FSS

There was no remedial action after FSS in LSA 06-01.

9.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 06-01 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 8,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 7,103 cpm. Therefore the calculated Scan MDCs are appropriate.

10.0 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.

10.1 Data Quality Assessment for LSA 06-01

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 06-01 (see Figure 10-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at a 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 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 06-01 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 SU data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 06-01, 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 06-01. 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 Test worksheet is presented in Appendix A.

- The maximum SOF result for all surface samples within LSA 06-01 was 0.10. The maximum SOF result for all subsurface samples within LSA 06-01 was 0.21. The average SOF result for all systematically collected samples within LSA 06-01 was 0.06, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.08.
- No FSS sample result in LSA 06-01 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an elevated measurement comparison (EMC) or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic sample locations actually collected within LSA 06-01. The successful result of the retrospective power evaluation presented in Table 10-1 for LSA 06-01 indicates that the minimum number of sample locations required (8) for the WRS Test were equal to the number of sampling locations actually collected within LSA 06-01. 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 LSA 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 was performed periodically, and confirmed that there were no instances of potential cross contamination from weather events until the FSS of all remaining areas at HDP were completed.

Table 10-1
Retrospective Sample Size Verification for LSA 06-01

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.05
$DCGL_{SOF}$	1
LBGR (Mean)	0.06
Shift	0.94
Relative Shift (Δ/σ)	18.41
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 06-01 (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 06 **Description:** Plant Soils SEA Open Land Area
Survey Unit: 01 **Description:** Eastern Parking Lot Survey Unit in "Area 10"

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 ☐	NA ☐
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	NA ☐

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: N/A

Quality Record

Figure 10-1
Data Evaluation Checklists prepared for LSA 06-01 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

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

Survey Area: No. LSA 06 **Description:** Plant Soils SEA Open Land Area
Survey Unit: No. 01 **Description:** Eastern Parking Lot Survey Unit in "Area 10"

Discrepancy: None

Corrective Actions Taken: None

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):	Thomas Yardy (Print Name)	(Signature)	7-18-17 (Date)
Approved by (RSO):	Clark Evers (Print Name)	(Signature)	7/19/17 (Date)

Quality Record

11.0 SURVEILLANCE FOLLOWING FSS

FSS activities in LSA 06-01 were completed in May 2016. 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 06-01

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 06-01 of 6.15 mrem/year does not exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mem/year.

Table 12-1
LSA 06-01 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	REMAINING STRUCTURE	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.06	0.01	0.16	0.015	N/A	**0.245**
DOSE	2.25 mrem/year	0.25 mrem/year	4.0 mrem/year	0.4 mrem/year	N/A	**6.15 mrem/year**

13.0 FINAL STATUS SURVEY DESIGN LSA 06-02

This section of the report describes the method for determining the number of samples required for the FSS of LSA 06-02 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 06-02 and their detection sensitivities are also discussed.

13.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 06-02 were driven by the type (Open Land) and Class (Class 2) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 8, *Final Status Survey Plan Development*, August 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 RASS data for LSA 06-02. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the SU that exceeded the Uniform Stratum $DCGL_W$. Therefore the Uniform Stratum $DCGL_W$ was selected for use in demonstrating compliance with the release criteria.

13.1.3 GWS Coverage

As a Class 2 SU, LSA 06-02 was required to undergo a minimum of a 10% GWS.

13.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 06-02 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

13.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 06-02 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).* As background levels were approximately 8,000 cpm within LSA 06-02, 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:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3273\ pCi/g}\right)+\left(\frac{f_{U-235}}{2.08\ pCi/g}\right)+\left(\frac{f_{U-238}}{27.4\ pCi/g}\right)\right)}$$

Equation 13-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the systematically collected RASS samples in LSA 06-02, the average enrichment for the SU was 2.3%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 06-02 are shown below:

Table 13-1
Scan MDCs for 2" x 2" NaI detector, 8,000 cpm background: LSA 06-02

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 06-02	36.6	49.2	1.08	2.8	0.77	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-TBD-FSS-003, *Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*. The IAL used during the GWS of LSA 06-02 was established at 1,624 ncpm, which is the equivalent of an activity concentration that is less than the Uniform Stratum $DCGL_W$.

13.1.7 LSA 06-02 FSS Design Summary

The FSS Plan for LSA 06-02 can be found in Appendix E. Table 13-2 presents an overall FSS design and implementation summary for LSA 06-02.

Table 13-2
FSS Design Summary for LSA 06-02

Gamma Walkover Survey (GWS):	
Scan Coverage	Minimum 50% of LSA 06-02 total area
Scan MDC	36.6 pCi/g total Uranium; 0.77 pCi/g Th-232; 1.08 pCi/g Ra-226 (based on an 8,000 cpm background)*
Investigation Action Level (IAL)	1,624 net cpm **

Systematic Sampling Locations:		
Depth	Number of Sample	Comments
0 – 15 cm (Surface)	8	These samples will be taken on a systematic grid. ***Excavation stratum samples will be collected and archived, but will be analyzed *only* in the event the overlying root stratum sample exceeds a SOF of 0.5
15 cm – 1.5 m (Root)	8	
> 1.5m (Excavation)	8***	

Biased Survey/Sampling Locations:

Collect a minimum of one biased sample at the maximum GWS measurement within the SU. Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the FSS Supervisor.

Sidewall Sampling Locations:

Supplemental Sidewall Sampling: Not applicable; SU is a Class 2 (no excavation) area.

Instrumentation:	
Ludlum 2221 with 44-10 (2x2 NaI) detector.	Used for GWS and to obtain static count rates at biased measurement locations.

*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).* The Scan MDC for total Uranium reflects a conservative assumption of 4% enrichment. The actual RASS enrichment (2.3%) would result in Scan MDC values slightly less than those calculated for FSS planning purposes.

**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum $DCGL_W$ derived from the technical bases presented in HEM-MEMO-15-021 and HDP-TBD-FSS-003 "*Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*", Westinghouse, March 2015.

14.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 06-02

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 06-02 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 were 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 surface (nominally 1", but not to exceed 3"). At the same time, the HP Technician was required to slowly advance, causing the detector to trace out a serpentine path over the surface.

HP Technicians performing GWS in LSA 06-02 used the 1,624 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to geometry and relative distance from potentially contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 6,000 and 8,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 7,624 to 9,624 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the 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.

14.2 Soil Sampling

14.2.1 Systematic Soil Sampling Summary

Table 14-1 provides a summary of systematic sampling by stratum for LSA 06-02.

Table 14-1
Systematic Sampling Summary by Stratum for LSA 06-02

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
06-02	3,957	8	8	0	2

14.2.2 Systematic Sampling LSA 06-02

Within LSA 06-02, there were 8 systematic locations in which the surface stratum (0 – 15 cm) was sampled in the SU. The underlying root stratum was also sampled at all 8 locations. Excavation stratum samples were collected and archived, but were not required to be analyzed since no root stratum sample exceeded a 0.5 Uniform SOF. Where necessary overlying asphalt was removed to access the soil.

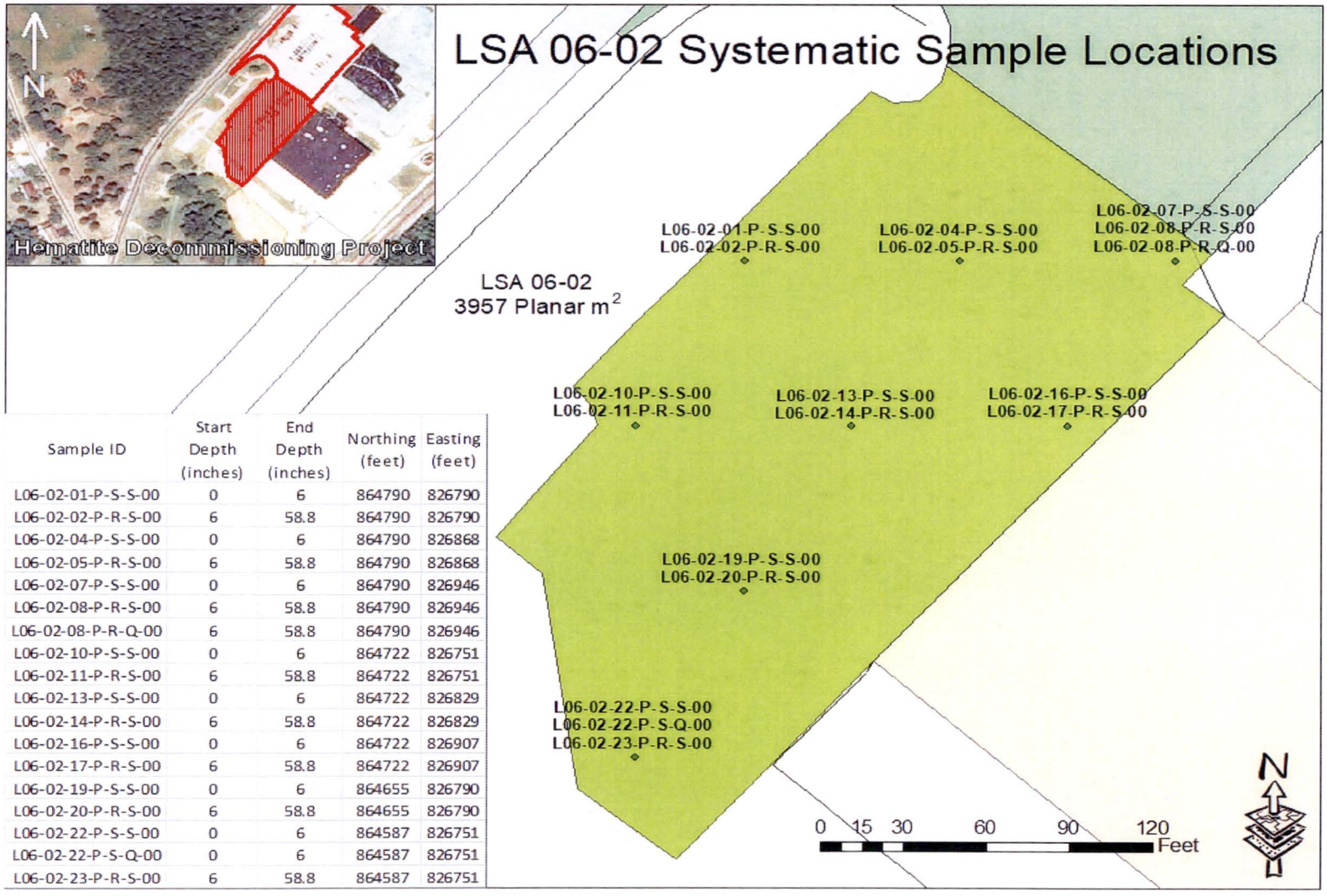
Given a planar area of 3,957 m^2 for LSA 06-02 and an eight - point systematic triangular grid, the point-to-point distance within each row was 23.8 m within the SU.

While there were eight (8) systematic locations on the LSA 06-02 sampling grid, a total of eighteen (18) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Eight (8) samples collected and analyzed within the root stratum
- Zero (0) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 14-1 presents the map of the eight systematic sample locations which were sampled within LSA 06-02. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 14-1
LSA 06-02 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing (feet)	Easting (feet)
L06-02-01-P-S-S-00	0	6	864790	826790
L06-02-02-P-R-S-00	6	58.8	864790	826790
L06-02-04-P-S-S-00	0	6	864790	826868
L06-02-05-P-R-S-00	6	58.8	864790	826868
L06-02-07-P-S-S-00	0	6	864790	826946
L06-02-08-P-R-S-00	6	58.8	864790	826946
L06-02-08-P-R-Q-00	6	58.8	864790	826946
L06-02-10-P-S-S-00	0	6	864722	826751
L06-02-11-P-R-S-00	6	58.8	864722	826751
L06-02-13-P-S-S-00	0	6	864722	826829
L06-02-14-P-R-S-00	6	58.8	864722	826829
L06-02-16-P-S-S-00	0	6	864722	826907
L06-02-17-P-R-S-00	6	58.8	864722	826907
L06-02-19-P-S-S-00	0	6	864655	826790
L06-02-20-P-R-S-00	6	58.8	864655	826790
L06-02-22-P-S-S-00	0	6	864587	826751
L06-02-22-P-S-Q-00	0	6	864587	826751
L06-02-23-P-R-S-00	6	58.8	864587	826751

Table 14-2 below presents a tabular listing of all FSS samples collected within LSA 06-02 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 14-2
FSS Sample Locations and Coordinates for LSA 06-02

Hematite Decommissioning Project | Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development | Revision: 10 | Appendix P-4, Page 1 of 1

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 06 **Description:** Plant Soils SEA Open Land Area

Survey Unit: 02 **Description:** West Parking Lot Survey Unit in "Area 10"

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
L06-02-01-P-S-S-00	Uniform	S	436.4	436.0	864789.8	826790.0	Surface 6-inch grab
L06-02-02-P-R-S-00	Uniform	S	436.0	431.5	864789.8	826790.0	Root 4.4-ft composite
L06-02-04-P-S-S-00	Uniform	S	434.1	433.6	864789.8	826868.1	Surface 6-inch grab
L06-02-05-P-R-S-00	Uniform	S	433.6	429.1	864789.8	826868.1	Root 4.4-ft composite
L06-02-07-P-S-S-00	Uniform	S	440.1	439.6	864789.8	826946.2	Surface 6-inch grab
L06-02-08-P-R-S-00	Uniform	S	439.6	435.2	864789.8	826946.2	Root 4.4-ft composite
L06-02-10-P-S-S-00	Uniform	S	442.0	441.5	864722.2	826751.0	Surface 6-inch grab
L06-02-11-P-R-S-00	Uniform	S	441.5	437.1	864722.2	826751.0	Root 4.4-ft composite
L06-02-13-P-S-S-00	Uniform	S	435.1	434.7	864722.2	826829.1	Surface 6-inch grab
L06-02-14-P-R-S-00	Uniform	S	434.7	430.2	864722.2	826829.1	Root 4.4-ft composite
L06-02-16-P-S-S-00	Uniform	S	429.3	428.8	864722.2	826907.2	Surface 6-inch grab
L06-02-17-P-R-S-00	Uniform	S	428.8	424.3	864722.2	826907.2	Root 4.4-ft composite
L06-02-19-P-S-S-00	Uniform	S	436.3	435.8	864654.6	826790.0	Surface 6-inch grab
L06-02-20-P-R-S-00	Uniform	S	435.8	431.4	864654.6	826790.0	Root 4.4-ft composite
L06-02-22-P-S-S-00	Uniform	S	436.6	436.2	864587.0	826751.0	Surface 6-inch grab
L06-02-23-P-R-S-00	Uniform	S	436.2	431.7	864587.0	826751.0	Root 4.4-ft composite
L06-02-08-P-R-Q-00	Uniform	Q	439.6	435.2	864789.8	826946.2	Root 4.4-ft composite
L06-02-22-P-S-Q-00	Uniform	Q	442.0	441.5	864587.0	826751.0	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 06-02 based on the evaluation of the GWS data, no biased sampling was determined to be necessary.

14.4 Judgmental/Sidewall Sampling for Tc-99

As a Class 2 SU no remediation was expected to be or was conducted in LSA 06-02. As such, sidewall samples were not required to be collected in LSA 06-02. Therefore, no sidewall samples were collected within the SU.

14.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic location L06-02-08 and L06-02-22 for LSA 06-02.

15.0 FINAL STATUS SURVEY RESULTS LSA 06-02

15.1 Gamma Walkover Survey

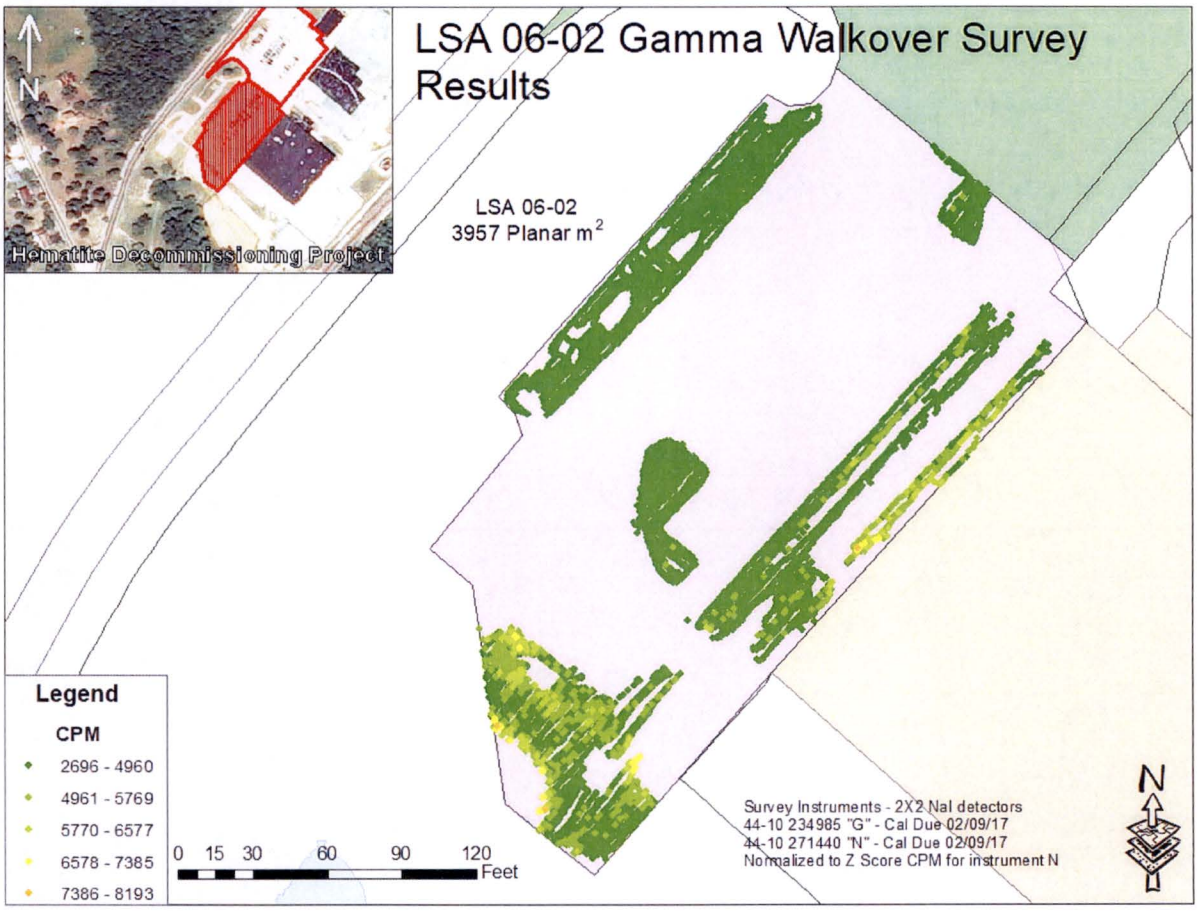
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are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

GWS measurements were collected in LSA 06-02 between May 18, 2016, and June 17, 2016.

15.1.1 GWS Results for LSA 06-02

For LSA 06-02, GWS count rates ranged between 2,308 gcpm and 7,807 gcpm, with a mean count rate of 4,149 gcpm. The median count rate was 4,030 gcpm with a standard deviation of 797 cpm. Figure 15-1 below presents a map of the complete GWS data set.

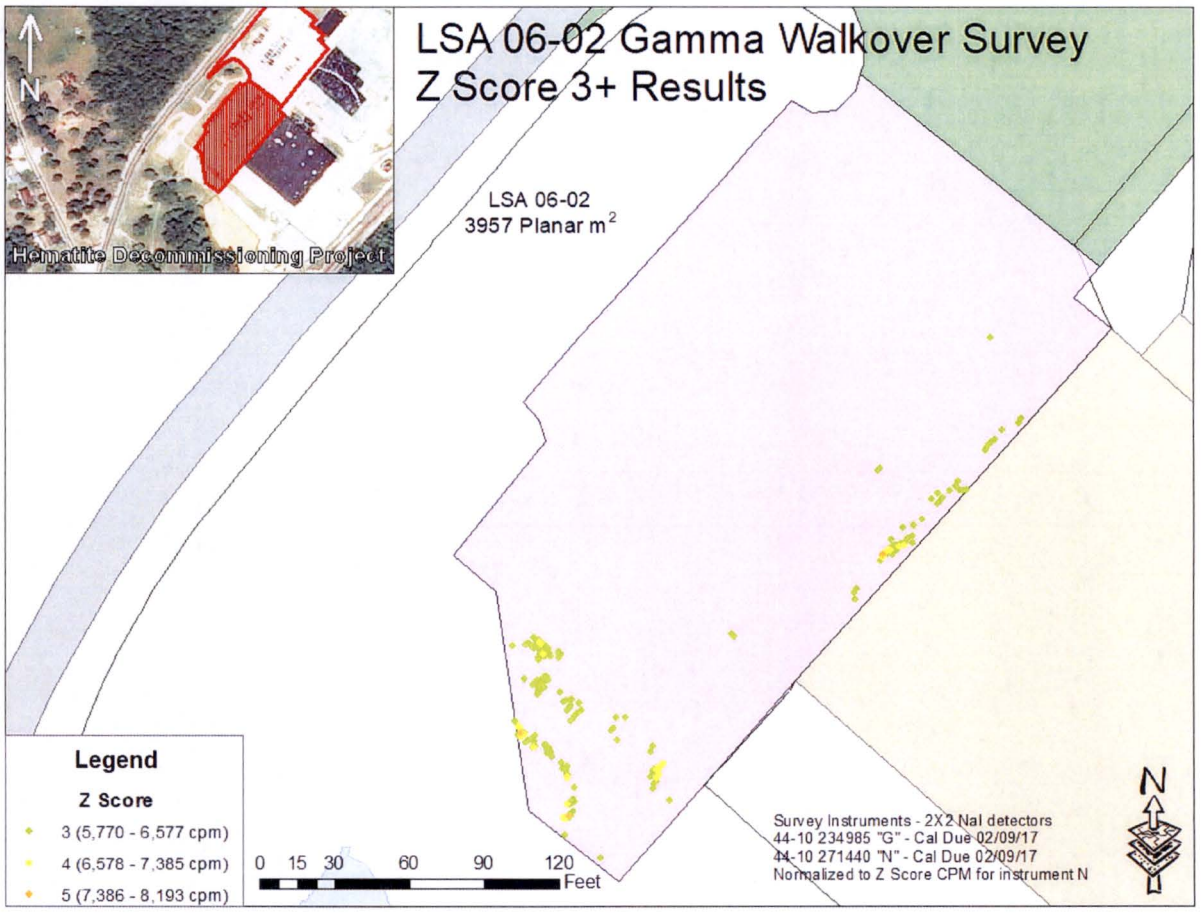
Figure 15-1
Colorimetric GWS Plot for LSA 06-02



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded both the IAL (> 4000 ncpm) and three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Based on the evaluation of the GWS data, no biased sampling was determined to be necessary.

Figure 15-2 presents a map of the +3 Z-score GWS measurements within LSA 06-02.

Figure 15-2
Colorimetric GWS Plot for LSA 06-02 (Measurements > Z-score of 3)



All GWS data collected in LSA 06-02 was datalogged and post-processed in GIS software.

15.1.2 GWS Coverage Results LSA 06-02

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.

As a Class 2 SU LSA 06-02 was required to undergo a minimum of a 10% GWS. The actual GWS coverage was 23.9% of the SU surface.

15.2 Soil Sample Results LSA 06-02

Appendix B presents the analytical results and associated statistics for all FSS samples collected within LSA 06-02.

15.2.1 Surface Soil Sample Results LSA 06-02

There were eight systematic samples collected within the surface stratum (0 – 15 cm) of LSA 06-02. Additionally there was one QC sample collected in the topmost layer of soil. The maximum Uniform SOF result for the surface samples was 0.20.

15.2.2 Subsurface Soil Sample Results LSA 06-02

There were eight systematic locations within LSA 06-02 where root stratum composite sampling was necessary. Additionally there was one QC sample collected in the root stratum. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At each of the eight root stratum composite sampling locations, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. The maximum SOF result of the subsurface samples collected in LSA 06-02 was 0.18.

15.2.3 WRS Evaluation LSA 06-02

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the WRS statistical test was not required for LSA 06-02 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 06-02. 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 06-02 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 06-02

Table 15-1 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 06-02, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.08.

Table 15-1
LSA 06-02 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	0.166	0.072	0.183	2.107	0.111	1.202	**0.08**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.00 (<BKG)	0.071	0.002	0.751	0.01
Maximum	0.490	0.213	0.420	5.236	0.289	1.960	0.20

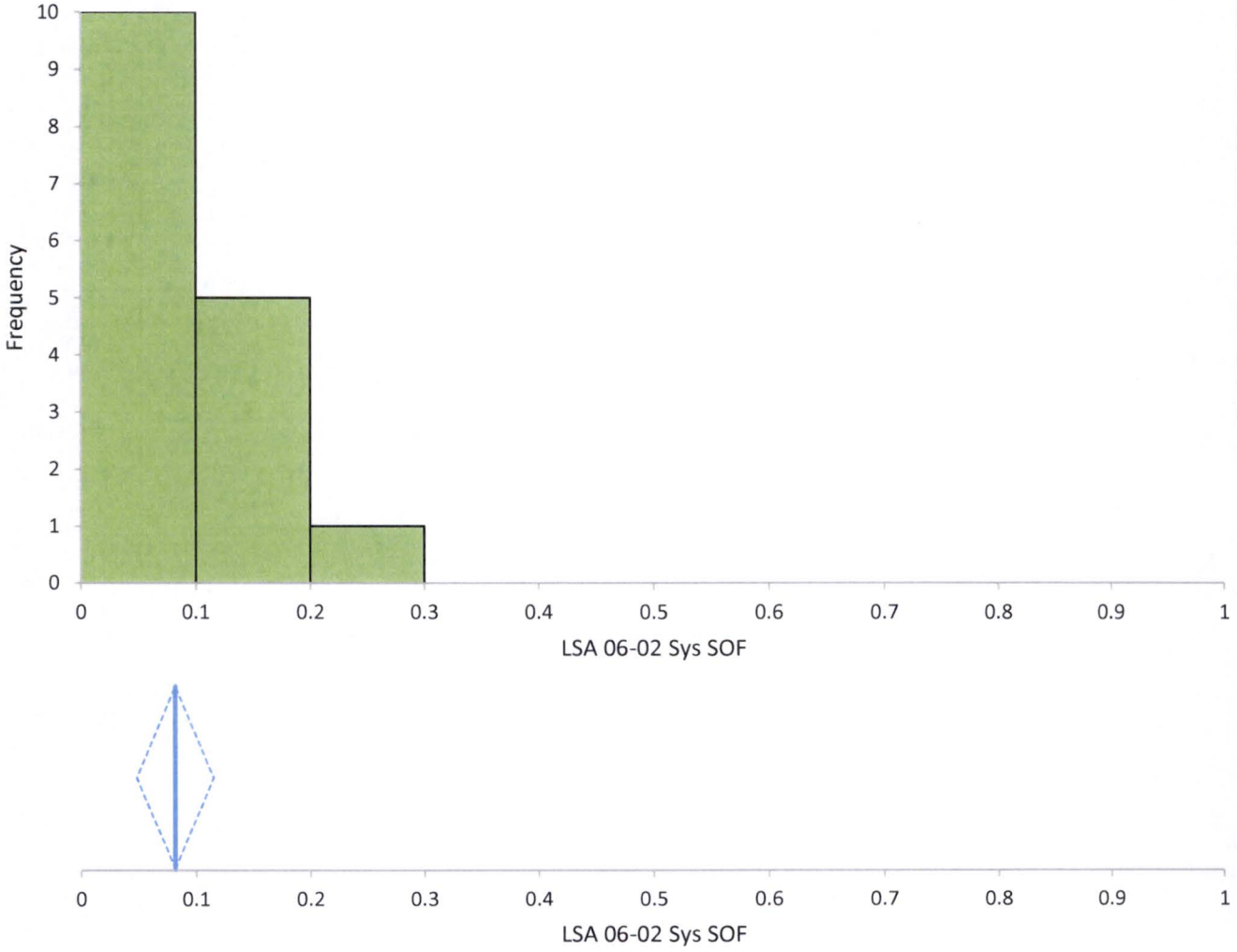
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide 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 SU. The presence of two peaks in the SU frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 15-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 06-02. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 06-02. The middle graph presents the mean SOF (0.08) 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 0.05 to 0.12. The 97.87% confidence interval based on the median (0.05) of the sample results is 0.03 to 0.13. The bottom two charts present the various statistical metrics of the LSA 06-02 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 06-02 data associated with the systematically collected measurement locations.

Figure 15-3
Graphic Statistical Summary for LSA 06-02 (SOF parameter)



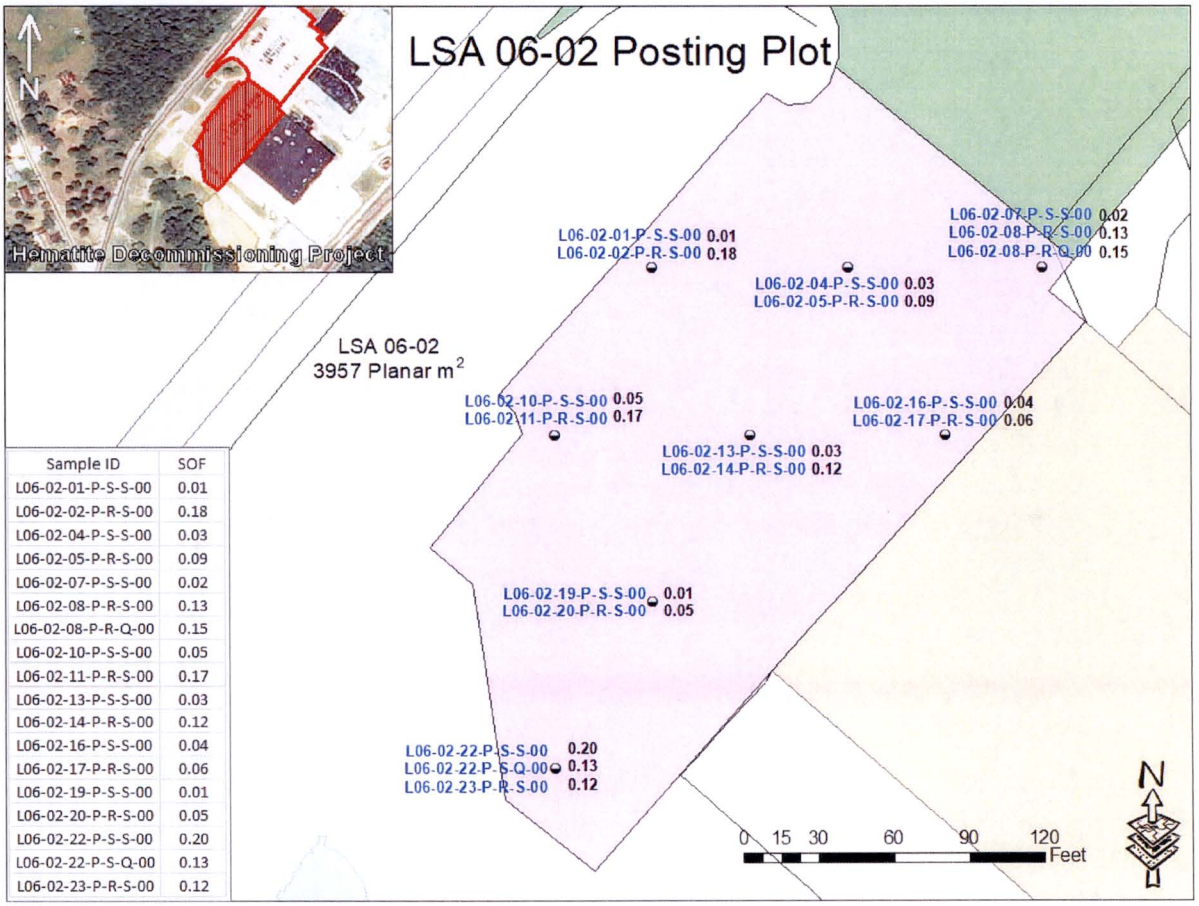
N	16

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 06-02 Sys SOF	0.08	0.05	to 0.12	0.016	0.06	0.00	0.7	-0.88

	Minimum	1st quartile	Median	97.87% CI		3rd quartile	Maximum	IQR
LSA 06-02 Sys SOF	0.01	0.03	0.05	0.03	to 0.13	0.12	0.2	0.10

A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 06-02 is presented below in Figure 15-4. Figure 15-4 shows no unusual patterns in the data.

Figure 15-4
Posting Plot for LSA 06-02 Systematic Measurement Locations



Sample ID	SOF
L06-02-01-P-S-S-00	0.01
L06-02-02-P-R-S-00	0.18
L06-02-04-P-S-S-00	0.03
L06-02-05-P-R-S-00	0.09
L06-02-07-P-S-S-00	0.02
L06-02-08-P-R-S-00	0.13
L06-02-08-P-R-Q-00	0.15
L06-02-10-P-S-S-00	0.05
L06-02-11-P-R-S-00	0.17
L06-02-13-P-S-S-00	0.03
L06-02-14-P-R-S-00	0.12
L06-02-16-P-S-S-00	0.04
L06-02-17-P-R-S-00	0.06
L06-02-19-P-S-S-00	0.01
L06-02-20-P-R-S-00	0.05
L06-02-22-P-S-S-00	0.20
L06-02-22-P-S-Q-00	0.13
L06-02-23-P-R-S-00	0.12

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 H to this report presents the Test America Analytical Laboratory soil sample reports.

Table 15-2
Final Status Survey Analytical Data: LSA 06-02

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
L06-02-01-P-S-S-00	0.00	S	1.04	0.173	0.0971	N/A	-0.030	0.000	-0.0351	0.000	0.049	0.234	U	0.976	0.19	0.159	N/A	-0.024	0.000	1.241	NA	NA	NA	0.0646	0.134	0.633	U	0.81	0.306	0.763	N/A	1.3	0.01
L06-02-02-P-R-S-00	0.50	S	1.19	0.161	0.0822	N/A	0.120	0.120	-0.033	0.000	0.09	0.236	U	1.22	0.183	0.117	N/A	0.220	0.220	1.010	NA	NA	NA	-0.139	0.202	0.602	U	1.01	0.322	0.816	N/A	0.7	0.18
L06-02-04-P-S-S-00	0.00	S	0.91	0.148	0.0759	N/A	-0.160	0.000	-0.0323	0.000	0.04	0.231	U	0.916	0.166	0.117	N/A	-0.084	0.000	3.857	NA	NA	NA	0.213	0.167	0.195	N/A	0.801	0.326	0.855	U	4.0	0.03
L06-02-05-P-R-S-00	0.50	S	1.07	0.161	0.0776	N/A	0.000	0.000	-0.0654	0.000	0.067	0.242	U	1.13	0.191	0.134	N/A	0.130	0.130	3.578	NA	NA	NA	0.195	0.148	0.186	N/A	1.26	0.539	0.808	N/A	2.4	0.09
L06-02-07-P-S-S-00	0.00	S	0.862	0.14	0.0706	N/A	-0.208	0.000	0.0486	0.049	0.09	0.221	U	0.814	0.154	0.0756	N/A	-0.186	0.000	2.823	NA	NA	NA	0.155	0.128	0.151	N/A	0.836	0.299	0.77	N/A	2.9	0.02
L06-02-08-P-R-S-00	0.50	S	1.16	0.164	0.078	N/A	0.090	0.090	-0.0389	0.000	0.089	0.243	U	1.13	0.162	0.129	N/A	0.130	0.130	1.430	NA	NA	NA	-0.015	0.172	0.559	U	1.43	0.57	0.855	N/A	0.7	0.13
L06-02-10-P-S-S-00	0.00	S	0.936	0.127	0.0587	N/A	-0.134	0.000	-0.0093	0.000	0.078	0.233	U	1.04	0.153	0.1	N/A	0.040	0.040	4.040	NA	NA	NA	0.222	0.118	0.178	N/A	1.15	0.518	0.791	N/A	3.0	0.05
L06-02-11-P-R-S-00	0.50	S	1.21	0.166	0.0532	N/A	0.140	0.140	-0.0636	0.000	0.076	0.245	U	1.14	0.186	0.131	N/A	0.140	0.140	2.650	NA	NA	NA	0.143	0.173	0.202	U	1.09	0.533	0.816	N/A	2.0	0.17
L06-02-13-P-S-S-00	0.00	S	0.905	0.141	0.0655	N/A	-0.165	0.000	0.031	0.031	0.082	0.221	U	1.03	0.174	0.122	N/A	0.030	0.030	0.824	NA	NA	NA	0.0393	0.14	0.614	U	0.844	0.307	0.773	N/A	0.7	0.03
L06-02-14-P-R-S-00	0.50	S	0.963	0.135	0.0779	N/A	-0.107	0.000	-0.0682	0.000	0.093	0.235	U	1.22	0.171	0.105	N/A	0.220	0.220	0.970	NA	NA	NA	-0.133	0.193	0.572	U	0.97	0.302	0.752	N/A	0.7	0.12
L06-02-16-P-S-S-00	0.00	S	1.02	0.166	0.0743	N/A	-0.050	0.000	-0.0411	0.000	0.055	0.241	U	1.06	0.188	0.154	N/A	0.060	0.060	0.784	NA	NA	NA	-0.016	0.0234	0.644	U	0.784	0.352	0.92	U	0.7	0.04
L06-02-17-P-R-S-00	0.50	S	0.76	0.11	0.0559	N/A	-0.310	0.000	-0.0664	0.000	0.05	0.246	U	1.06	0.153	0.0708	N/A	0.060	0.060	3.662	NA	NA	NA	0.202	0.117	0.157	N/A	0.855	0.288	0.734	N/A	3.6	0.06
L06-02-19-P-S-S-00	0.00	S	0.897	0.139	0.0696	N/A	-0.173	0.000	-0.0597	0.000	0.042	0.239	U	0.976	0.164	0.127	N/A	-0.024	0.000	1.440	NA	NA	NA	0.0755	0.211	0.357	U	0.832	0.293	0.751	N/A	1.4	0.01
L06-02-20-P-R-S-00	0.50	S	0.94	0.151	0.0691	N/A	-0.130	0.000	-0.0773	0.000	0.067	0.242	U	1.08	0.171	0.085	N/A	0.080	0.080	1.221	NA	NA	NA	0.0654	0.126	0.622	U	0.566	0.283	1.55	U	1.8	0.05
L06-02-22-P-S-S-00	0.00	S	1.25	0.176	0.0774	N/A	0.180	0.180	-0.0515	0.000	0.057	0.234	U	1.19	0.184	0.104	N/A	0.190	0.190	1.340	NA	NA	NA	-0.139	0.194	0.587	U	1.34	0.54	0.805	N/A	0.7	0.20
L06-02-23-P-R-S-00	0.50	S	1.18	0.152	0.0626	N/A	0.110	0.110	-0.0657	0.000	0.071	0.243	U	1.05	0.172	0.119	N/A	0.050	0.050	4.018	NA	NA	NA	0.219	0.121	0.15	N/A	1.4	0.48	0.695	N/A	2.4	0.12
L06-02-08-P-R-Q-00	0.50	Q	1.2	0.188	0.0929	N/A	0.130	0.130	-0.012	0.000	0.089	0.24	U	1.13	0.191	0.142	N/A	0.130	0.130	1.748	NA	NA	NA	0.085	0.289	0.581	U	1.66	0.79	0.985	N/A	0.8	0.15
L06-02-22-P-S-Q-00	0.00	Q	1.03	0.17	0.0843	N/A	-0.040	0.000	-0.0193	0.000	0.084	0.242	U	1.22	0.221	0.0964	N/A	0.220	0.220	2.846	NA	NA	NA	0.154	0.242	0.381	U	1.14	0.419	1.01	N/A	2.1	0.13
Systematic Minimum			0.000						0.000					0.000						0.784				-0.139				0.566				1.8	0.01
Systematic Maximum			0.180						0.049					0.220						4.040				0.222				1.430				Average Enrichment (%)	0.20
Systematic Mean			0.040						0.005					0.084						2.181				0.072				0.999					0.08
Systematic Median			0.000						0.000					0.060						1.435				0.070				0.913					0.05
Systematic Standard Deviation			0.064						0.014					0.078						1.283				0.131				0.254					0.06
			With ingrowth, use Ra226 bkg =				1.07							Th232 bkg =		1.0																	

NOTES:

Gross results in units of pCi/g.

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

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

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

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

15.2.5 Biased Soil Sample Result LSA 06-02

Based on the evaluation of the GWS data set, no biased sampling was determined to be necessary in LSA 06-02.

15.2.6 Quality Control Soil Sample Result LSA 06-02

Two QC field duplicate sample points were randomly selected for LSA 06-02 which were collected at systematic locations L06-02-08 and L06-02-22.

For the 16 systematic samples collected within LSA 06-02, two field duplicate samples were collected. This frequency equates to 12.5%, (i.e. 2/16). 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 15-5 below).

Figure 15-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 06-02 (1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control	Revision: 2	Page 1 of 1

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

Survey Unit No.: LSA 06-02 — Survey Unit Description: West Parking Lot Survey Unit in "Area 10"

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)
L06-02-08-P-R-S-00	L06-02-08-P-R-Q-00	Ra-226	1.16	0.078	1.2	0.0929	1.180	1.9	0.04	0.269	0.403	N
L06-02-08-P-R-S-00	L06-02-08-P-R-Q-00	Tc-99	-0.0389	0.243	-0.012	0.24	-0.025	25.1	NA	3.552	5.321	NA
L06-02-08-P-R-S-00	L06-02-08-P-R-Q-00	Th-232	1.13	0.129	1.13	0.142	1.130	2.0	0.000	0.283	0.424	N
L06-02-08-P-R-S-00	L06-02-08-P-R-Q-00	U-234[1]	1.430	N/A	1.748	N/A	1.589	195.4	0.318	27.649	41.425	N
L06-02-08-P-R-S-00	L06-02-08-P-R-Q-00	U-235	-0.0154	0.559	0.085	0.581	0.035	51.6	NA	7.301	10.939	NA
L06-02-08-P-R-S-00	L06-02-08-P-R-Q-00	U-238	1.43	0.855	1.66	0.985	1.545	168.8	0.230	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: Thomas Yardy — Date: 7-15-17

Reviewed by: Clark Evers — Date: 7/19/17

Quality Record

Figure 15-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 06-02 (2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control		
		Revision: 2	Page 1 of 1

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

Survey Unit No.:	LSA 06-02				Survey Unit Description:		West Parking Lot Survey Unit in "Area 10"					
			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)
L06-02-22-P-S-S-00	L06-02-22-P-S-Q-00	Ra-226	1.25	0.0774	1.03	0.0843	1.140	1.9	0.22	0.269	0.403	N
L06-02-22-P-S-S-00	L06-02-22-P-S-Q-00	Tc-99	-0.0515	0.234	-0.0193	0.242	-0.035	25.1	NA	3.552	5.321	NA
L06-02-22-P-S-S-00	L06-02-22-P-S-Q-00	Th-232	1.19	0.104	1.22	0.0964	1.205	2.0	0.030	0.283	0.424	N
L06-02-22-P-S-S-00	L06-02-22-P-S-Q-00	U-234[1]	1.340	N/A	2.846	N/A	2.093	195.4	1.506	27.649	41.425	N
L06-02-22-P-S-S-00	L06-02-22-P-S-Q-00	U-235	-0.139	0.587	0.154	0.381	0.007	51.6	NA	7.301	10.939	NA
L06-02-22-P-S-S-00	L06-02-22-P-S-Q-00	U-238	1.34	0.805	1.14	1.01	1.240	168.8	0.200	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: Thomas Yardy 

Date: 7-19-17

Reviewed by: Clark Evers

Date: 7/19/17

Quality Record

15.3 Tc-99 Hot Spot Assessment LSA 06-02

As a Class 2 SU, there is no history of any sample from the SU exceeding the Tc-99 $DCGL_W$, or a SOF of 1.0. The highest Tc-99 sample result collected from both Final RASS and FSS was 0.22 pCi/g. There is no indication of a potential Tc-99 hot spot exceeding the $DCGL_W$ of 25.1 pCi/g, and therefore a Tc-99 hot spot assessment is not required.

16.0 ALARA EVALUATION LSA 06-02

All samples collected within LSA 06-02 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 06-02 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.08 for LSA 06-02. The average SOF equates to residual activity contributions from the SU area of 2.0 mrem/year for LSA 06-02. Groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, and Chapter 6 {ML17142A356} 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 06-02. Additionally, 0.75 mrem/year dose will be added to LSA 06-02 to account for dose contribution from the remaining parking lot structure (BSA 04-04), and 0.8 mrem/year will be added to LSA 06-02 for the remaining SDS piping (PSA 01-03, PSA 01-04, PSA 01-05, PSA 01-06, PSA 01-07 and PSA 01-08). Summing these dose contributions together, the total estimated dose for LSA 06-02 is 7.55 mrem/year.

Since the estimated TEDE is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of LSA 06-02 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 06-02.

17.0 FSS PLAN DEVIATIONS LSA 06-02

17.1 Remedial Actions during FSS

There were no remedial actions after FSS in LSA 06-02.

17.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 06-02 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 8,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 4,149 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

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 06-02

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 06-02 (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 06-02 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 06-02, 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 06-02, 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 06-02 was 0.20. The maximum SOF result for all subsurface samples within LSA 06-02 was 0.18.

The average SOF result for all systematically collected samples within LSA 06-02 was 0.08, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.12.

- No FSS sample result in LSA 06-02 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an EMC or supplemental investigations were 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 sample locations actually collected within LSA 06-02. The successful result of the retrospective power evaluation presented in Table 18-1 for LSA 06-02 indicates that the minimum number of sample locations required (8) for the WRS Test was equal to the number of sampling locations actually collected (8) within LSA 06-02. 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 LSA 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 were performed periodically, and confirmed that there were no instances of potential cross contamination from weather events until the FSS of all remaining areas at HDP were completed.

Table 18-1
Retrospective Sample Size Verification for LSA 06-02

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.06
$DCGL_{SOF}$	1
LBGR (Mean)	0.08
Shift	0.92
Relative Shift (Δ/σ)	14.60
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 06-02 (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 06 **Description:** Plant Soils SEA Open Land Area
Survey Unit: 02 **Description:** West Parking Lot Survey Unit in "Area 10"

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 ☐	NA ☐
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	NA ☐

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: N/A

Quality Record

Figure 18-1
Data Evaluation Checklists prepared for LSA 06-02 (page 2 of 2)

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

Survey Area: No. LSA 06 **Description:** Plant Soils SEA Open Land Area
Survey Unit: No. 02 **Description:** West Parking Lot Survey Unit in "Area 10"

Discrepancy: None

Corrective Actions Taken: None

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):	Thomas Yardy (Print Name)	(Signature)	7-18-17 (Date)
Approved by (RSO):	Clark Evers (Print Name)	(Signature)	7/19/17 (Date)

Quality Record

19.0 SURVEILLANCE FOLLOWING FSS

FSS activities in LSA 06-02 were completed in June 2016. 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 06-02

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 06-02 of 7.55 mrem/year does not exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 20-1
LSA 06-02 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	REMAINING STRUCTURE	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.08	0.03	0.16	0.033	N/A	**0.303**
DOSE	2.0 mrem/year	0.75 mrem/year	4.0 mrem/year	0.8 mrem/year	N/A	**7.55 mrem/year**

21.0 FINAL STATUS SURVEY DESIGN LSA 07-01

This section of the report describes the method for determining the number of samples required for the FSS of LSA 07-01 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 07-01 and their detection sensitivities are also discussed.

21.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 07-01 were driven by the type (Open Land) and Class (Class 2) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development*, November 2015.

21.1.1 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.*

21.1.2 $DCGL_W$

During the FSS design process a review was performed of the RASS data for LSA 06-02. The RASS data was used as confirmation that no known areas of residual radioactivity remained within the SU that exceeded the Uniform Stratum $DCGL_W$. Therefore the Uniform Stratum $DCGL_W$ was selected for use in demonstrating compliance with the release criteria.

21.1.3 GWS Coverage

As a Class 2 SU, LSA 07-01 was required to undergo a minimum of a 10% GWS.

21.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 07-01 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

21.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 07-01 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).* As background levels were approximately 9,000 cpm within LSA 07-01, 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:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3471\ pCi/g}\right)+\left(\frac{f_{U-235}}{2.20\ pCi/g}\right)+\left(\frac{f_{U-238}}{29.0\ pCi/g}\right)\right)}$$

Equation 21-1

To determine isotopic Uranium fractions HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* assumes that the average LSA enrichment is 4% or less. Based on the systematically collected RASS samples in LSA 07-01, the average enrichment for the SU was 4.3%. All other Scan MDC parameters agreed upon between Westinghouse and the NRC were applied (e.g. use of a 2 in air gap, scan rate of 1 ft/sec, 0.75 surveyor efficiency), therefore no subsequent changes to the calculated Scan MDCs need to be made.

Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 07-01 are shown below:

Table 21-1
Scan MDCs for 2" x 2" NaI detector, 9,000 cpm background: LSA 07-01

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 07-01	38.8	44.1	1.14	2.8	0.82	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 21-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS.

21.1.6 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-TBD-FSS-003, *Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*. The IAL used during the GWS of LSA 07-01 was established at 1,624 ncpm, which is the equivalent of an activity concentration that is less than the Uniform Stratum $DCGL_W$.

21.1.7 LSA 07-01 FSS Design Summary

The FSS Plan for LSA 07-01 can be found in Appendix F. Table 21-2 presents an overall FSS design and implementation summary for LSA 07-01.

Table 21-2
FSS Design Summary for LSA 07-01

Gamma Walkover Survey (GWS):		
Scan Coverage	10-100% exposed grounds and walls	
Scan MDC	38.8 pCi/g total Uranium (based on a 9,000 cpm background); 0.82 pCi/g Th-232; 1.14 pCi/g Ra-226*	
Investigation Action Level (IAL)	1,624 net cpm**	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments
0 – 15 cm (Surface)	8	These samples will be taken on a random-start systematic grid. Two sample locations were previously collected during FSS of "Area 3a".
15 cm – 1.5 m (Root)	9	
> 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 RSO or Radiological Engineering.		
Sidewall Sampling Locations:		
A minimum of one (1) discretionary sidewall sample (if any sidewall exists) will be collected based on the following definition of "sidewall": sidewall candidates for sampling must be vertical or near vertical (> 45° angle) and at least 12" in height.		
Instrumentation:		
Ludlum 2221 with 44-10 (2x2 NaI) detector; with collimation for investigations.	Used for GWS and to obtain static count rates at biased measurement locations.	
*Values based on information provided in HDP-TBD-FSS-002, "*Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS).* The Scan MDC for total Uranium reflects a conservative assumption of 4% enrichment. The actual RASS enrichment (4.3%) would result in Scan MDC values slightly less than those calculated for FSS planning purposes. However this difference is considered to be insignificant, and therefore the values provided in HDP-TBD-FSS-002 will still be used.		
**IAL is the net count per minute (ncpm) equivalent to the Uniform Stratum DCGLw (the appropriate criterion for Class 2 and Class 3 LSAs) based on 4% enriched uranium and using the Infer Tc-99 DCGL for U-235. Reference: HDP-TBD-FSS-003, Section 2.2, Westinghouse 2015.		

22.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 07-01

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

22.1 Gamma Walkover Survey

22.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 06-02 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*.

22.1.2 GWS Performance

All GWS measurements were 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 surface (nominally 1", but not to exceed 3"). At the same time, the HP Technician was required to slowly advance, causing the detector to trace out a serpentine path over the surface.

HP Technicians performing GWS in LSA 07-01 used the 1,624 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to geometry and relative distance from potentially 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 9,624 to 10,624 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the 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.

22.2 Soil Sampling

22.2.1 Systematic Soil Sampling Summary

Table 22-1 provides a summary of systematic sampling by stratum for LSA 07-01.

Table 22-1
Systematic Sampling Summary by Stratum for LSA 07-01

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
07-01	2,946	8	9	1	2

22.2.2 Systematic Sampling LSA 07-01

Within LSA 07-01, there were 8 systematic locations in which the surface stratum (0 – 15 cm) was sampled in the SU. The underlying root stratum was sampled at all 9 locations. An Excavation stratum sample was collected at one location.

Given a planar area of 2,946 m^2 for LSA 07-01 and an eight - point systematic triangular grid, the point-to-point distance within each row was 19.4 m within the SU.

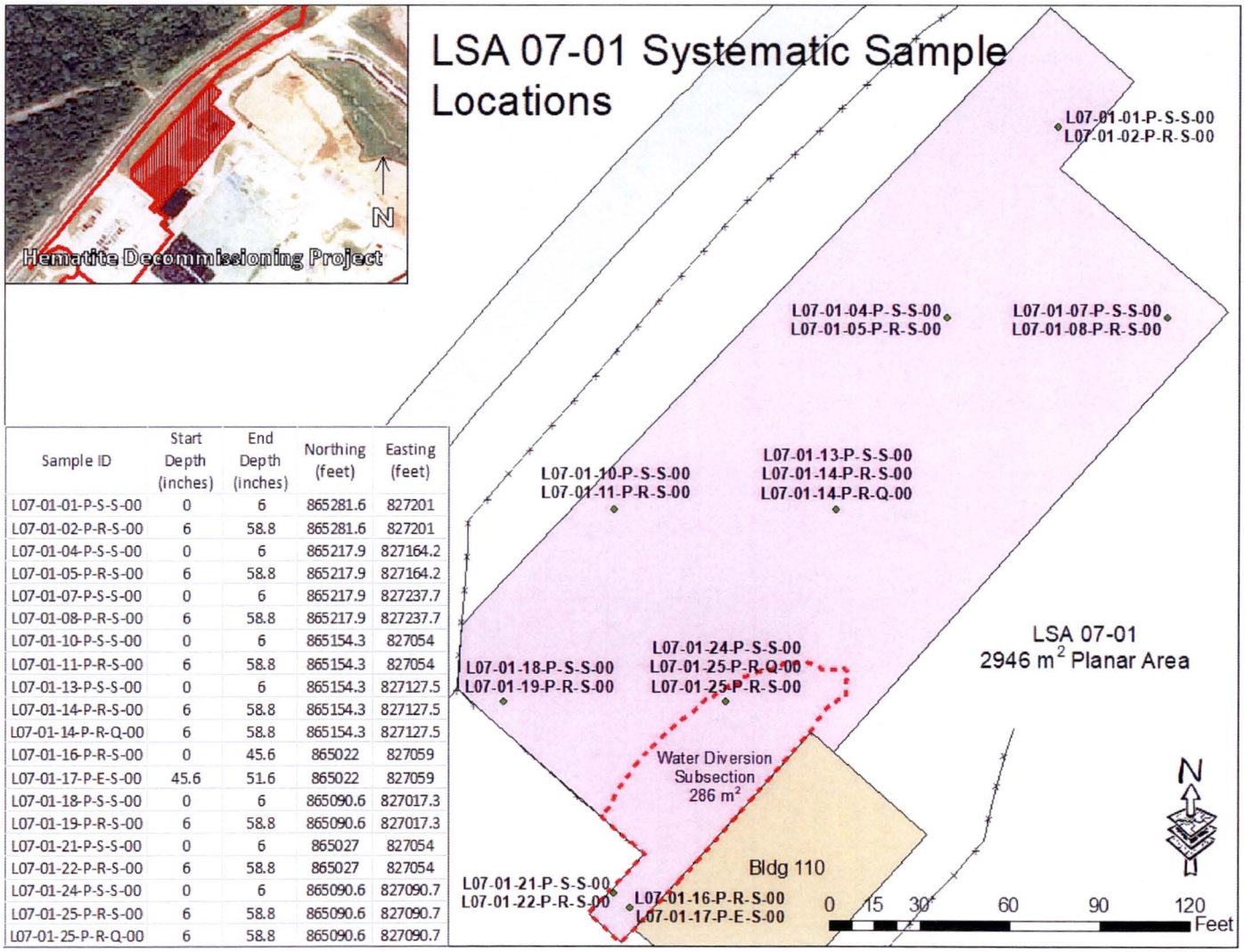
It is important to note that LSA 07-01 was originally designated as a Class 3 SU, and a small portion of the LSA was required to be covered with offsite soil to allow for the isolation of the Storm Water Piping system. A FSS Plan for a Class 3 LSA was prepared, and a "partial" FSS was performed on the area designated to receive offsite soil. Samples L07-01-16 and L07-01-17 were collected as the randomly generated sample points that fell inside the area. However, after the partial FSS was performed, the administrative decision was made to upgrade the LSA to Class 2. The FSS Plans were revised to now include an 8-point systematic sample grid, but the data previously collected for the randomly selected sample location were kept, making 9 systematic locations within the SU.

While there were nine (9) systematic locations on the LSA 07-01 sampling grid, a total of twenty (20) samples were collected and analyzed at these locations, including:

- Eight (8) samples collected and analyzed within the surface stratum
- Nine (9) samples collected and analyzed within the root stratum
- One (1) samples analyzed within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 22-1 presents the map of the nine systematic sample locations which were sampled within LSA 07-01. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 22-1
LSA 07-01 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing (feet)	Easting (feet)
L07-01-01-P-S-S-00	0	6	865281.6	827201
L07-01-02-P-R-S-00	6	58.8	865281.6	827201
L07-01-04-P-S-S-00	0	6	865217.9	827164.2
L07-01-05-P-R-S-00	6	58.8	865217.9	827164.2
L07-01-07-P-S-S-00	0	6	865217.9	827237.7
L07-01-08-P-R-S-00	6	58.8	865217.9	827237.7
L07-01-10-P-S-S-00	0	6	865154.3	827054
L07-01-11-P-R-S-00	6	58.8	865154.3	827054
L07-01-13-P-S-S-00	0	6	865154.3	827127.5
L07-01-14-P-R-S-00	6	58.8	865154.3	827127.5
L07-01-14-P-R-Q-00	6	58.8	865154.3	827127.5
L07-01-16-P-R-S-00	0	45.6	865022	827059
L07-01-17-P-E-S-00	45.6	51.6	865022	827059
L07-01-18-P-S-S-00	0	6	865090.6	827017.3
L07-01-19-P-R-S-00	6	58.8	865090.6	827017.3
L07-01-21-P-S-S-00	0	6	865027	827054
L07-01-22-P-R-S-00	6	58.8	865027	827054
L07-01-24-P-S-S-00	0	6	865090.6	827090.7
L07-01-25-P-R-S-00	6	58.8	865090.6	827090.7
L07-01-25-P-R-Q-00	6	58.8	865090.6	827090.7

Table 22-2 below presents a tabular listing of all FSS samples collected within LSA 07-01 with associated IDs, sample types, collection intervals, coordinates, and notes.

Table 22-2
FSS Sample Locations and Coordinates for LSA 07-01

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-701, Final Status Survey Plan Development		
		Revision: 10	Appendix P-4, Page 1 of 1

APPENDIX P-4
FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: LSA 07 **Description:** Plant Open Land Area

Survey Unit: 01 **Description:** Northwest of Bldg 110

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
L07-01-01-P-S-S-00	Uniform	S	438.21	437.7	865281.6	827201.0	Surface 6-inch grab
L07-01-02-P-R-S-00	Uniform	S	437.72	433.3	865281.6	827201.0	Root 4.4-ft composite
L07-01-04-P-S-S-00	Uniform	S	438.5	438.0	865217.9	827164.2	Surface 6-inch grab
L07-01-05-P-R-S-00	Uniform	S	438.01	433.6	865217.9	827164.2	Root 4.4-ft composite
L07-01-07-P-S-S-00	Uniform	S	437.6	437.1	865217.9	827237.7	Surface 6-inch grab
L07-01-08-P-R-S-00	Uniform	S	437.11	432.7	865217.9	827237.7	Root 4.4-ft composite
L07-01-10-P-S-S-00	Uniform	S	438.3	437.8	865154.3	827054.0	Surface 6-inch grab
L07-01-11-P-R-S-00	Uniform	S	437.81	433.4	865154.3	827054.0	Root 4.4-ft composite
L07-01-13-P-S-S-00	Uniform	S	438	437.5	865154.3	827127.5	Surface 6-inch grab
L07-01-14-P-R-S-00	Uniform	S	437.5	433.1	865154.3	827127.5	Root 4.4-ft composite
L07-01-16-P-R-S-00	Uniform	S	436.5	432.7	865022.0	827059.0	Root 3.8-ft composite
L07-01-17-P-E-S-00	Uniform	S	432.7	432.3	865022.0	827059.0	Excavation 6-inch grab
L07-01-18-P-S-S-00	Uniform	S	438.9	438.4	865090.6	827017.3	Surface 6-inch grab
L07-01-19-P-R-S-00	Uniform	S	438.4	434.0	865090.6	827017.3	Root 4.4-ft composite
L07-01-21-P-S-S-00	Uniform	S	437.3	436.8	865027.0	827054.0	Surface 6-inch grab
L07-01-22-P-R-S-00	Uniform	S	436.8	432.4	865027.0	827054.0	Root 4.4-ft composite
L07-01-24-P-S-S-00	Uniform	S	437.6	437.1	865090.6	827090.7	Surface 6-inch grab
L07-01-25-P-R-S-00	Uniform	S	437.1	432.7	865090.6	827090.7	Root 4.4-ft composite
L07-01-14-P-R-Q-00	Uniform	Q	437.5	433.1	865154.3	827127.5	Root 4.4-ft composite
L07-01-25-P-R-Q-00	Uniform	Q	437.1	432.7	865090.6	827090.7	Root 4.4-ft composite
L07-01-27-P-S-B-00	Uniform	B	437.2	436.7	865026.6	827057.4	Biased 6-inch grab
L07-01-28-P-S-B-00	Uniform	B	438.3	437.8	865120.2	827018.8	Biased 6-inch grab
L07-01-29-P-S-B-00	Uniform	B	437.5	436.9	865088.2	827117.0	Biased 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

22.3 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 07-01 three (3) biased sample location were selected within the SU based on the evaluation of the GWS survey data and HP Technician professional judgment. Biased samples are collected at the prescribed location to a depth of 6 inches below the exposed ground surface.

22.4 Judgmental/Sidewall Sampling for Tc-99

As a Class 2 SU no remediation was expected to be or was conducted in LSA 07-01. As such, sidewall samples were not required to be collected in LSA 07-01. Therefore, no sidewall samples were collected within the SU.

22.5 Quality Control Soil Sampling

Two QC field duplicate sample point were randomly selected and collected at systematic location L07-01-14 and L07-01-25 for LSA 07-01.

23.0 FINAL STATUS SURVEY RESULTS LSA 07-01

23.1 Gamma Walkover Survey

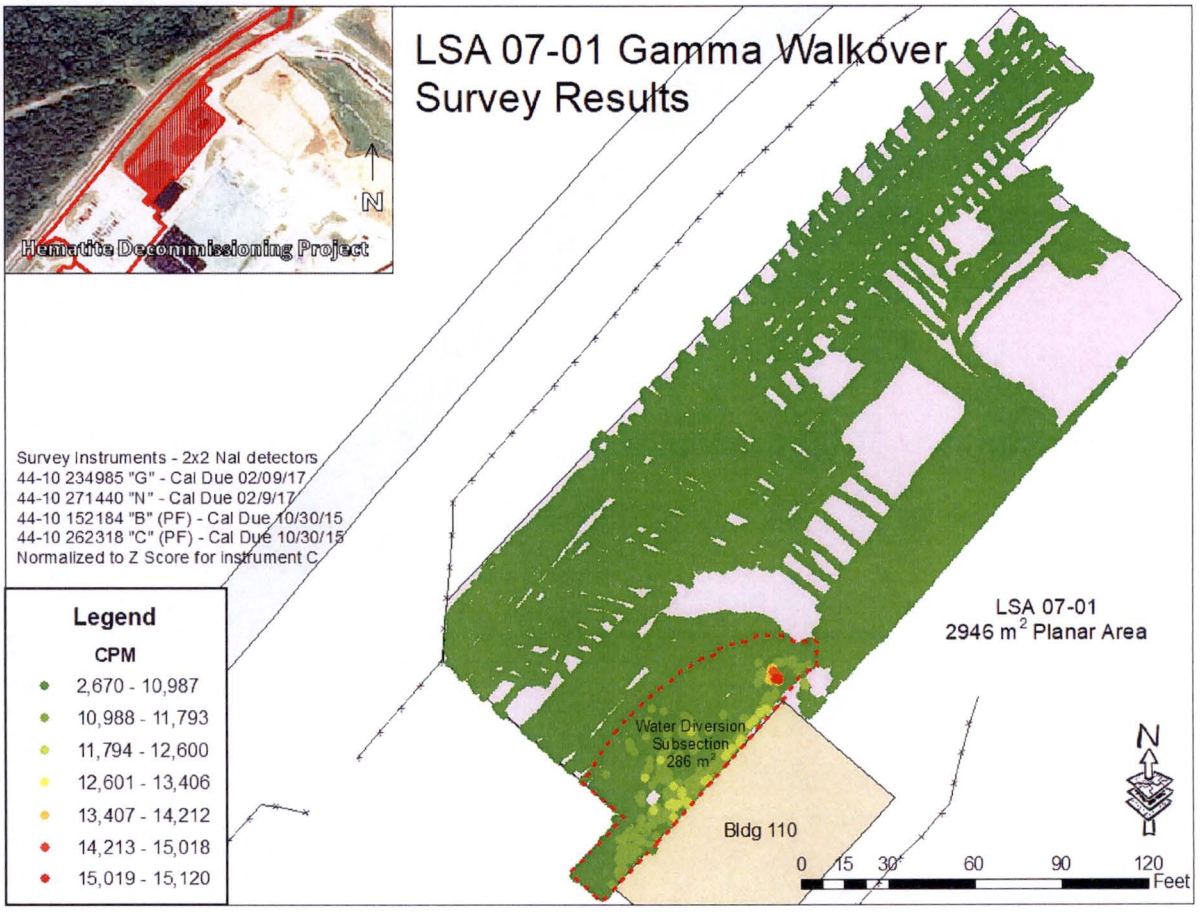
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are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

GWS measurements were originally collected in the small area designated as "LSA 07-01a" on March 9, 2015. GWS measurements were collected in the remainder of LSA 07-01 between April 4, 2016, and April 5, 2016.

23.1.1 GWS Results for LSA 07-01

For LSA 07-01, GWS count rates ranged between 2,670 gcpm and 15,120 gcpm, with a mean count rate of 6,693 gcpm. The median count rate was 5,835 gcpm with a standard deviation of 2,452 cpm. Figure 23-1 below presents a map of the complete GWS data set.

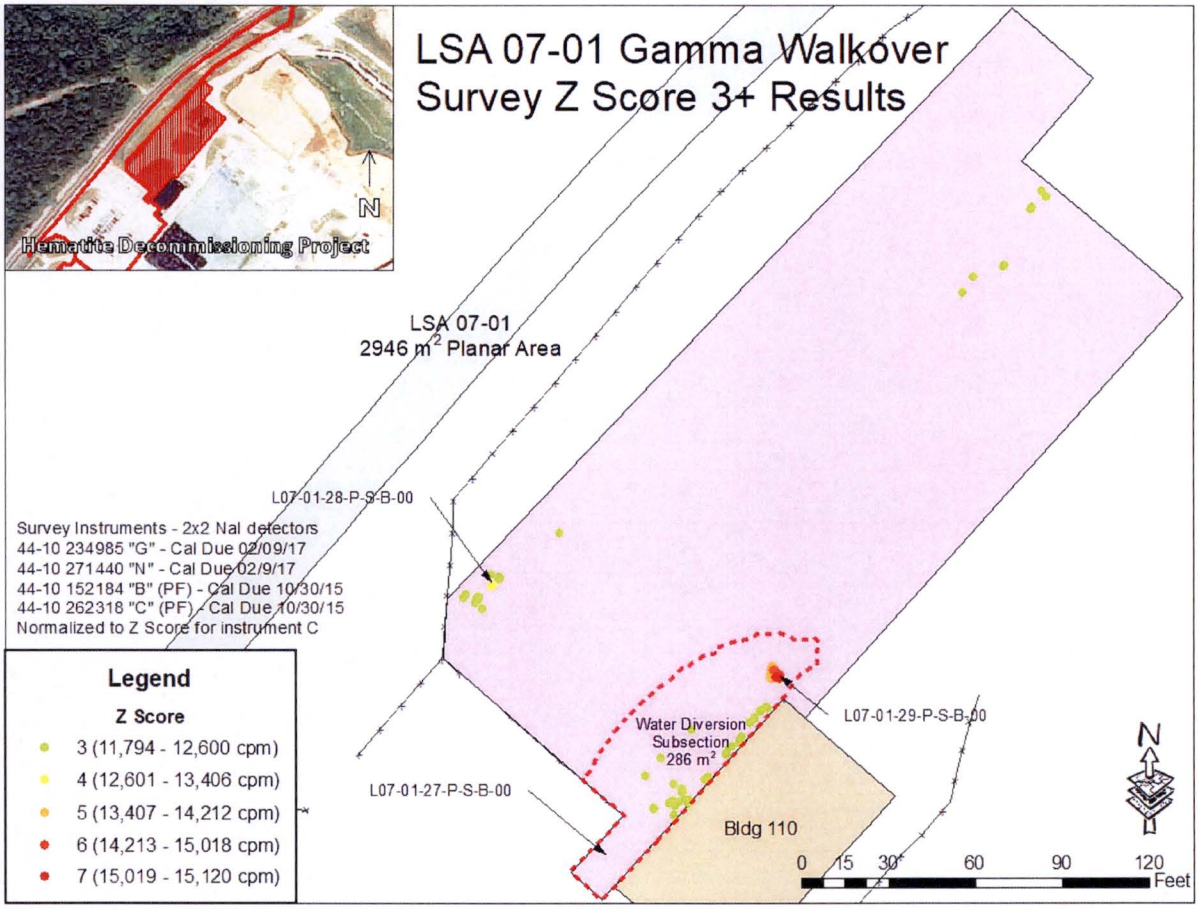
Figure 23-1
Colorimetric GWS Plot for LSA 07-01



An evaluation of the entire GWS data set was performed to evaluate those small areas of elevated activity which exceeded both the IAL (> 4000 ncpm) and three (3) standard deviations above the GWS mean measurement, (i.e., "+3 Z-score"). Three locations were selected for biased sample collection. The sample collected at location L07-01-29 represented the maximum GWS measurement (15,120 gcpm) within the SU.

Figure 23-2 presents a map of the +3 Z-score GWS measurements within LSA 07-01, including the selected biased sampling location.

Figure 23-2
Colorimetric GWS Plot for LSA 07-01 (Measurements > Z-score of 3)



All GWS data collected in LSA 07-01 was datalogged and post-processed in GIS software.

23.1.2 GWS Coverage Results LSA 07-01

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.

As a Class 2 SU LSA 07-01 was required to undergo a minimum of a 10% GWS. The actual GWS coverage was 77.13% of the SU surface.

23.2 Soil Sample Results LSA 07-01

Appendix C presents the analytical results and associated statistics for all FSS samples collected within LSA 07-01.

23.2.1 Surface Soil Sample Results LSA 07-01

There were eight systematic samples collected within the surface stratum (0 – 15 cm) of LSA 07-01. However there were a total of 12 samples collected in the topmost layer of soil (including 9 systematic, and 3 biased samples). The maximum Uniform SOF result for the surface samples was 0.90.

23.2.2 Subsurface Soil Sample Results LSA 07-01

There were nine systematic locations within LSA 07-01 where root stratum composite sampling was necessary. Additionally there were two QC samples collected in the root stratum, and one systematic sample in the excavation stratum. The root stratum zone is between 0.15 and 1.50 m below final grade surface. At seven of the eight root stratum composite sampling locations, the top six inches (1.50 – 1.65 m below final grade surface) of the underlying excavation stratum was also collected and archived, however these excavation samples were not required to be analyzed as no overlying root stratum sample exceeded a 0.5 SOF. One excavation sample was analyzed as prescribed by the FSS Plan. The maximum SOF result of the subsurface samples collected in LSA 07-01 was 0.37.

23.2.3 WRS Evaluation LSA 07-01

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the WRS statistical test was required for LSA 06-02 since the difference between the maximum SU data set gross SOF and the minimum background area SOF was greater than one using the Uniform Stratum criteria. All systematically collected samples regardless of depth are used to perform the WRS Test, however biased and QC sample results are not utilized in the WRS Test. The 18 systematically collected samples in LSA 07-01 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, (1103) was greater than the critical value (898) 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 C.

23.2.4 Graphical Data Review LSA 07-01

Table 23-1 below presents summary results for the all systematically collected samples (includes surface, and root, but not biased or QC samples) collected within LSA 07-01, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.11.

Table 23-1
LSA 07-01 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	0.007	1.829	0.028	2.683	0.144	1.093	**0.11**
Minimum	0.00 (<BKG)	0.003	0.00 (<BKG)	0.507	0.028	0.092	0.01
Maximum	0.090	20.600	0.200	10.709	0.589	2.890	0.90

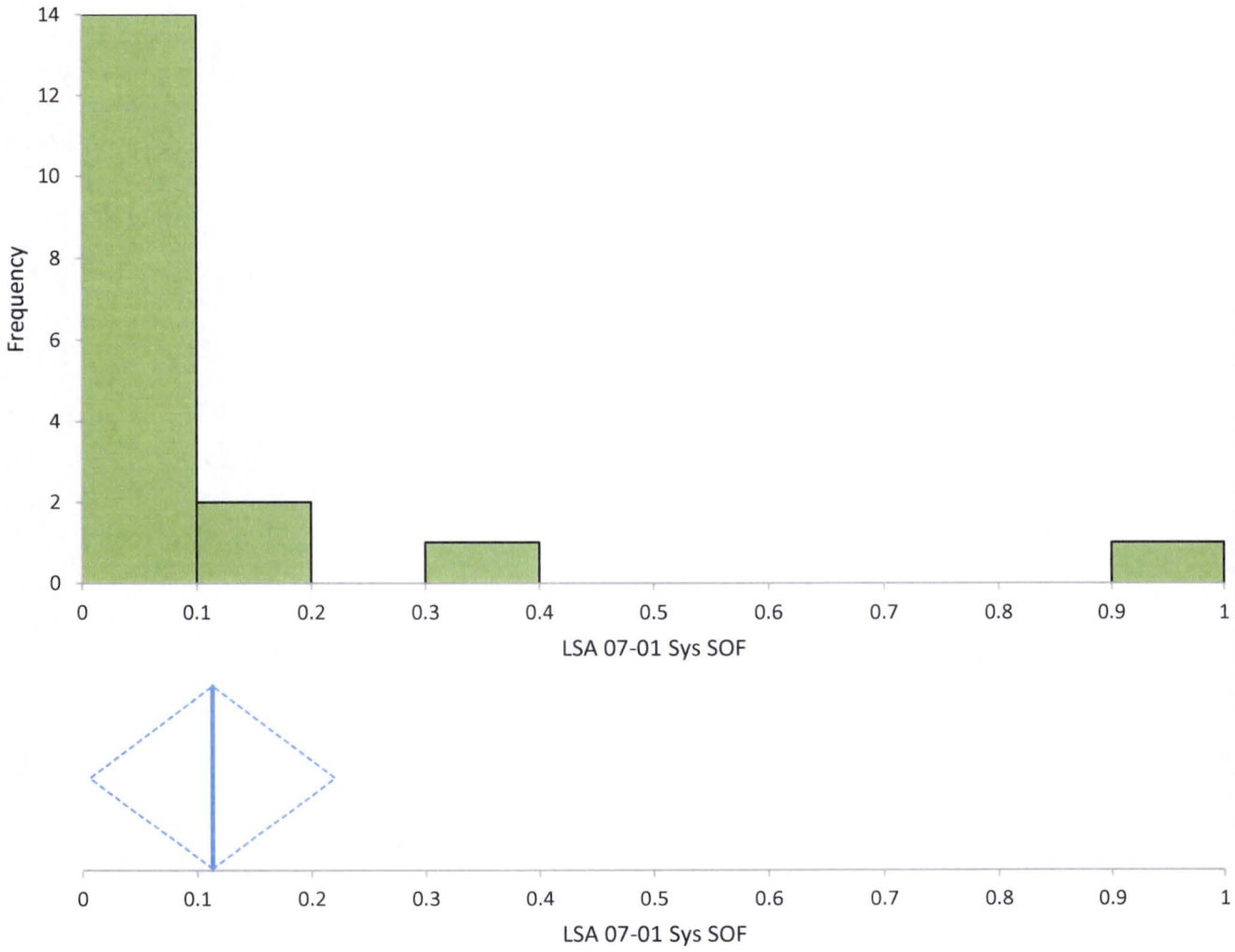
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide 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 SU. The presence of two peaks in the SU frequency plot may indicate the existence of isolated areas of residual radioactivity.

Figure 23-3 presents the overall statistical metrics for the SOF parameter for the 18 systematically collected samples from LSA 07-01. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 07-01. The middle graph presents the mean SOF (0.11) 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 0.22. The 96.91% confidence interval based on the median (0.04) of the sample results is 0.02 to 0.10. The bottom two charts present the various statistical metrics of the LSA 07-01 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 23-3 exhibits no unusual symmetry or bimodality concerns for the LSA 07-01 data associated with the systematically collected measurement locations.

Figure 23-3
Graphic Statistical Summary for LSA 07-01 (SOF parameter)



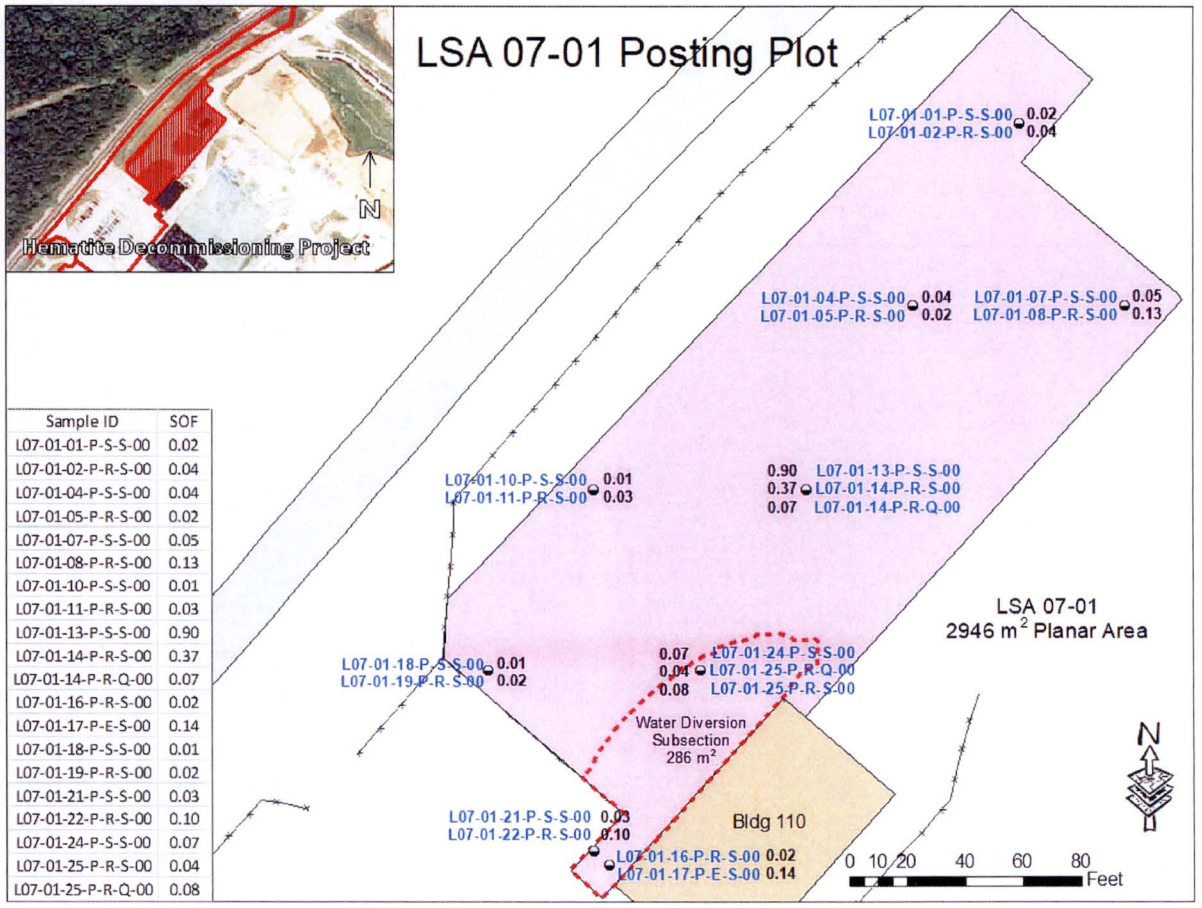
N	18

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 07-01 Sys SOF	0.11	0.01	to 0.22	0.051	0.22	0.05	3.3	11.86

	Minimum	1st quartile	Median	96.91% CI		3rd quartile	Maximum	IQR
LSA 07-01 Sys SOF	0.01	0.02	0.04	0.02	to 0.10	0.10	0.9	0.08

A posting plot is simply a map of the SU with the data values (in this case the SOF values for each systematically collected sample) entered at the measurement locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 07-01 is presented below in Figure 23-4. Figure 23-4 shows no unusual patterns in the data.

Figure 23-4
Posting Plot for LSA 07-01 Systematic Measurement Locations



Sample ID	SOF
L07-01-01-P-S-S-00	0.02
L07-01-02-P-R-S-00	0.04
L07-01-04-P-S-S-00	0.04
L07-01-05-P-R-S-00	0.02
L07-01-07-P-S-S-00	0.05
L07-01-08-P-R-S-00	0.13
L07-01-10-P-S-S-00	0.01
L07-01-11-P-R-S-00	0.03
L07-01-13-P-S-S-00	0.90
L07-01-14-P-R-S-00	0.37
L07-01-14-P-R-Q-00	0.07
L07-01-16-P-R-S-00	0.02
L07-01-17-P-E-S-00	0.14
L07-01-18-P-S-S-00	0.01
L07-01-19-P-R-S-00	0.02
L07-01-21-P-S-S-00	0.03
L07-01-22-P-R-S-00	0.10
L07-01-24-P-S-S-00	0.07
L07-01-25-P-R-S-00	0.04
L07-01-25-P-R-Q-00	0.08

Appendix C to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 23-1, Figure 23-3, and Figure 23-4 above. A summary of the analytical data is presented in Table 23-2 below. Appendix I to this report presents the Test America Analytical Laboratory soil sample reports.

Table 23-2
Final Status Survey Analytical Data: LSA 07-01

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
L07-01-01-P-S-S-00	0.00	S	0.572	0.083	0.036	N/A	-0.498	0.000	0.257	0.257	0.093	0.186	N/A	0.399	0.071	0.054	N/A	-0.601	0.000	1.123	NA	NA	NA	0.060	0.091	0.152	U	0.545	0.265	0.413	N/A	1.7	0.02
L07-01-02-P-R-S-00	0.50	S	0.875	0.128	0.051	N/A	-0.195	0.000	0.397	0.397	0.106	0.215	N/A	1.020	0.169	0.078	N/A	0.020	0.020	1.762	NA	NA	NA	0.092	0.097	0.159	U	1.060	0.469	0.717	N/A	1.4	0.04
L07-01-04-P-S-S-00	0.00	S	0.806	0.124	0.063	N/A	-0.264	0.000	0.261	0.261	0.060	0.214	N/A	0.796	0.132	0.093	N/A	-0.204	0.000	4.512	NA	NA	NA	0.249	0.118	0.159	N/A	1.030	0.567	0.695	N/A	3.7	0.04
L07-01-05-P-R-S-00	0.50	S	0.884	0.119	0.057	N/A	-0.186	0.000	0.103	0.103	0.034	0.219	U	0.928	0.141	0.075	N/A	-0.072	0.000	1.437	NA	NA	NA	0.073	0.104	0.212	U	1.030	0.464	0.717	N/A	1.1	0.02
L07-01-07-P-S-S-00	0.00	S	0.720	0.114	0.052	N/A	-0.350	0.000	0.541	0.541	0.106	0.212	N/A	0.654	0.123	0.104	N/A	-0.346	0.000	3.916	NA	NA	NA	0.215	0.154	0.186	N/A	1.140	0.454	0.676	N/A	2.9	0.05
L07-01-08-P-R-S-00	0.50	S	1.160	0.157	0.063	N/A	0.090	0.090	0.399	0.399	0.107	0.212	N/A	1.100	0.164	0.108	N/A	0.100	0.100	2.343	NA	NA	NA	0.125	0.120	0.172	U	1.170	0.498	0.766	N/A	1.7	0.13
L07-01-10-P-S-S-00	0.00	S	0.111	0.029	0.023	N/A	-0.959	0.000	0.042	0.042	0.022	0.181	U	0.037	0.021	0.043	N/A	-0.963	0.000	0.507	NA	NA	NA	0.028	0.036	0.065	U	0.092	0.087	0.281	U	4.5	0.01
L07-01-11-P-R-S-00	0.50	S	0.840	0.137	0.062	N/A	-0.230	0.000	0.205	0.205	0.109	0.212	U	0.974	0.178	0.157	N/A	-0.026	0.000	1.536	NA	NA	NA	0.075	0.140	0.233	U	1.540	0.776	0.917	N/A	0.8	0.03
L07-01-13-P-S-S-00	0.00	S	0.856	0.121	0.053	N/A	-0.214	0.000	20.600	20.600	2.090	0.196	N/A	0.629	0.101	0.081	N/A	-0.371	0.000	10.709	NA	NA	NA	0.589	0.133	0.162	N/A	2.890	0.558	0.645	N/A	3.1	0.90
L07-01-14-P-R-S-00	0.50	S	0.806	0.119	0.059	N/A	-0.264	0.000	8.410	8.410	0.938	0.211	N/A	0.881	0.141	0.097	N/A	-0.119	0.000	4.809	NA	NA	NA	0.264	0.153	0.172	N/A	1.380	0.488	0.725	N/A	2.9	0.37
L07-01-16-P-R-S-00	1.10	S	0.913	0.125	0.050	N/A	-0.157	0.000	0.003	0.003	0.053	0.213	U	0.811	0.124	0.074	N/A	-0.189	0.000	1.941	NA	NA	NA	0.101	0.106	0.189	U	1.260	0.452	0.674	N/A	1.3	0.02
L07-01-17-P-E-S-00	4.92	S	1.090	0.146	0.086	N/A	0.020	0.020	0.070	0.070	0.029	0.227	U	1.200	0.182	0.119	N/A	0.200	0.200	2.117	NA	NA	NA	0.108	0.137	0.231	U	1.550	0.526	0.779	N/A	1.1	0.14
L07-01-18-P-S-S-00	0.00	S	0.165	0.038	0.029	N/A	-0.905	0.000	0.090	0.090	0.136	0.181	U	0.095	0.041	0.047	N/A	-0.905	0.000	0.835	NA	NA	NA	0.046	0.045	0.054	U	0.150	0.123	0.342	U	4.6	0.01
L07-01-19-P-R-S-00	0.50	S	0.695	0.106	0.053	N/A	-0.375	0.000	0.117	0.117	0.024	0.196	U	0.694	0.105	0.067	N/A	-0.306	0.000	1.351	NA	NA	NA	0.071	0.109	0.183	U	0.744	0.363	0.564	N/A	1.5	0.02
L07-01-21-P-S-S-00	0.00	S	0.892	0.148	0.068	N/A	-0.178	0.000	0.391	0.391	0.084	0.233	N/A	0.894	0.159	0.111	N/A	-0.106	0.000	1.223	NA	NA	NA	0.060	0.133	0.258	U	1.180	0.587	0.910	N/A	0.8	0.03
L07-01-22-P-R-S-00	0.50	S	1.080	0.147	0.062	N/A	0.010	0.010	0.090	0.090	0.076	0.227	U	1.150	0.167	0.124	N/A	0.150	0.150	1.820	NA	NA	NA	0.099	0.143	0.235	U	0.679	0.266	0.811	U	2.3	0.10
L07-01-24-P-S-S-00	0.00	S	0.983	0.143	0.068	N/A	-0.087	0.000	0.568	0.568	0.071	0.220	N/A	1.030	0.158	0.117	N/A	0.030	0.030	4.632	NA	NA	NA	0.254	0.141	0.243	N/A	1.410	0.526	0.787	N/A	2.8	0.07
L07-01-25-P-R-S-00	0.50	S	0.766	0.108	0.046	N/A	-0.304	0.000	0.381	0.381	0.042	0.219	N/A	1.010	0.159	0.065	N/A	0.010	0.010	1.719	NA	NA	NA	0.092	0.121	0.202	U	0.827	0.265	0.686	N/A	1.7	0.04
L07-01-14-P-R-Q-00	0.50	Q	1.050	0.164	0.084	N/A	-0.020	0.000	1.180	1.180	0.127	0.222	N/A	0.981	0.156	0.090	N/A	-0.019	0.000	3.348	NA	NA	NA	0.184	0.114	0.150	N/A	0.946	0.285	0.747	N/A	3.0	0.07
L07-01-25-P-R-Q-00	0.50	Q	0.800	0.129	0.076	N/A	-0.270	0.000	0.352	0.352	0.084	0.216	N/A	1.080	0.155	0.114	N/A	0.080	0.080	3.775	NA	NA	NA	0.207	0.137	0.173	N/A	1.130	0.482	0.740	N/A	2.8	0.08
L07-01-27-P-S-B-00	0.00	B	0.613	0.112	0.072	N/A	-0.457	0.000	0.614	0.614	0.116	0.219	N/A	0.878	0.150	0.136	N/A	-0.122	0.000	4.450	NA	NA	NA	0.242	0.122	0.163	N/A	1.650	0.653	0.778	N/A	2.3	0.06
L07-01-28-P-S-B-00	0.00	B	1.080	0.158	0.071	N/A	0.010	0.010	0.084	0.084	0.051	0.239	U	1.080	0.158	0.127	N/A	0.080	0.080	1.666	NA	NA	NA	0.090	0.122	0.232	U	0.757	0.280	0.768	U	1.9	0.06
L07-01-29-P-S-B-00	0.00	B	0.893	0.139	0.067	N/A	-0.177	0.000	0.102	0.102	0.099	0.232	U	1.110	0.178	0.128	N/A	0.110	0.110	2.343	NA	NA	NA	0.125	0.128	0.240	U	1.150	0.536	0.828	N/A	1.7	0.08
Systematic Minimum			0.000						0.003					0.000						0.507				0.028				0.092				2.2	0.01
Systematic Maximum			0.090						20.600					0.200						10.709				0.589				2.890				Average Enrichment (%)	0.90
Systematic Mean			0.007						1.829					0.028						2.683				0.144				1.093					0.11
Systematic Median			0.000						0.259					0.000						1.791				0.096				1.100					0.04
Systematic Standard Deviation			0.021						5.066					0.059						2.407				0.134				0.615					0.22
			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.

23.2.5 Biased Soil Sample Result LSA 07-01

Three (3) biased sample were collected from LSA 07-01. The sample collected at location L07-01-29 represented the maximum GWS measurement (15,120 gcpm) within the SU, and had a result of 0.08 Uniform SOF.

23.2.6 Quality Control Soil Sample Result LSA 07-01

Two QC field duplicate sample points were randomly selected for LSA 07-01 which were collected at systematic locations L07-01-14 and L07-01-25.

For the 21 samples (i.e., 18 systematic + 3 biased) collected within LSA 07-01, two field duplicate samples were collected. This frequency equates to 9.5%, (i.e. 2/21). 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 with one exception (see Figure 23-5 below).

The statistical assessment of the Laboratory QC sample results indicated that one field duplicate sample (L07-01-14-P-R-Q-00) exceeded the calculated Control Limit for Tc-99. In accordance with procedure HDP-PR-FSS-703, *Final Status Survey Quality Control*, when an exceedance occurs an investigation is performed to determine if corrective actions were necessary. The investigation determined that for Tc-99 the calculated statistic (7.23) exceeded the Control Limit (5.32), however this is the first time a FSS QC sample has exceed the control limit for Tc-99, which is expected to occur at a frequency of approximately 1 in 100 samples. Additionally the overall project FSS QC sample rate remains high (above 5%), and indicates that the offsite laboratory sample results are generally in agreement. Based upon the investigation of the exceedance and the results of previous Quality Assurance audits of the overall performance of the laboratory, no corrective actions were determined to be necessary.

Figure 23-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 07-01 (1 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control	Revision: 2	Page 1 of 1

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

Survey Unit No.: LSA 07-01 — Survey Unit Description: Northwest of Bldg 110

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						
L07-01-14-P-R-S-00	L07-01-14-P-R-Q-00	Ra-226	0.806	0.0589	1.05	0.0839	0.928	1.9	0.244	0.269	0.403	N
L07-01-14-P-R-S-00	L07-01-14-P-R-Q-00	Tc-99	8.41	0.211	1.18	0.222	4.795	25.1	7.23	3.552	5.321	Y
L07-01-14-P-R-S-00	L07-01-14-P-R-Q-00	Th-232	0.881	0.0972	0.981	0.09	0.931	2.0	0.100	0.283	0.424	N
L07-01-14-P-R-S-00	L07-01-14-P-R-Q-00	U-234[1]	4.809	N/A	3.348	N/A	4.079	195.4	1.461	27.649	41.425	N
L07-01-14-P-R-S-00	L07-01-14-P-R-Q-00	U-235	0.264	0.172	0.184	0.15	0.224	51.6	0.08	7.301	10.939	N
L07-01-14-P-R-S-00	L07-01-14-P-R-Q-00	U-238	1.38	0.725	0.946	0.747	1.163	168.8	0.434	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: Thomas Yardy — Reviewed by: Clark Evers

Date: 7-19-17 — Date: 7/19/17

Quality Record

Figure 23-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 07-01 (2 of 2)

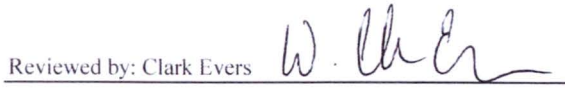
Hematite Decommissioning Project	Procedure: HDP-PR-FSS-703, Final Status Survey Quality Control	Revision: 2	Page 1 of 1

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

Survey Unit No.: LSA 07-01 | Survey Unit Description: Northwest of Bldg 110

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						
L07-01-25-P-R-S-00	L07-01-25-P-R-Q-00	Ra-226	0.766	0.0463	0.8	0.0758	0.783	1.9	0.034	0.269	0.403	N
L07-01-25-P-R-S-00	L07-01-25-P-R-Q-00	Tc-99	0.381	0.219	0.352	0.216	0.367	25.1	0.029	3.552	5.321	N
L07-01-25-P-R-S-00	L07-01-25-P-R-Q-00	Th-232	1.01	0.0647	1.08	0.114	1.045	2.0	0.070	0.283	0.424	N
L07-01-25-P-R-S-00	L07-01-25-P-R-Q-00	U-234[1]	1.719	N/A	3.775	N/A	2.747	195.4	2.056	27.649	41.425	N
L07-01-25-P-R-S-00	L07-01-25-P-R-Q-00	U-235	0.0917	0.202	0.207	0.173	0.149	51.6	NA	7.301	10.939	NA
L07-01-25-P-R-S-00	L07-01-25-P-R-Q-00	U-238	0.827	0.686	1.13	0.74	0.979	168.8	0.303	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: Thomas Yardy  Reviewed by: Clark Evers 

Date: 7-19-17 Date: 7/19/17

Quality Record

23.3 Tc-99 Hot Spot Assessment LSA 07-01

As a Class 2 SU, there is no history of any sample from the SU exceeding the Tc-99 $DCGL_W$, or a SOF of 1.0. The highest Tc-99 sample result collected from both Final RASS and FSS was 20.6 pCi/g. There is no indication of a potential Tc-99 hot spot exceeding the $DCGL_W$ of 25.1 pCi/g, and therefore a Tc-99 hot spot assessment is not required.

24.0 ALARA EVALUATION LSA 07-01

All samples collected within LSA 07-01 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 07-01 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.11 for LSA 07-01. The average SOF equates to residual activity contributions from the SU area of 2.75 mrem/year for LSA 07-01. Groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2 and 3 {ML16287A528}, Chapter 4 {ML16342B552}, Chapter 5 {ML17018A105}, and Chapter 6 {ML17142A356} 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 07-01. Additionally, 1.0 mrem/year dose will be added to LSA 07-01 to account for the dose contribution from the remaining structures (BSA 04-06 and BSA 04-14). PSA 01-01 is also present in LSA 07-01 but does not account for any additional dose (0.0 mrem/year). The use of off-site backfill soil in LSA 07-01 contributes 0.0 mrem/year to the SU. Summing these dose contributions together, the total estimated dose for LSA 07-01 is 7.75 mrem/year.

Since the estimated TEDE is below the regulatory release criterion of 25 mrem/year, the conclusion of the ALARA evaluation is that the FSS of LSA 07-01 was successful and that there would be no discernable benefit to the health and safety of the public in attempting to further reduce the results of FSS by performing remediation of LSA 07-01.

25.0 FSS PLAN DEVIATIONS LSA 07-01

25.1 Remedial Actions during FSS

There were no remedial actions after FSS in LSA 07-01.

25.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 07-01 were calculated in accordance with HDP-PR-FSS-701, Revision 10, *Final Status Survey Plan Development* and HDP-TBD- FSS-002, Revision 3, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*. The assumed LSA background count rate of 9,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 6,693 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

26.0 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.

26.1 Data Quality Assessment for LSA 07-012

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 07-01 (see Figure 26-1) 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* with one exception.
- LSA 07-01 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 necessary when the difference between the maximum SU data set measurement SOF and the minimum background area measurement SOF is less than or equal to one. For LSA 07-01, one 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 required for LSA 07-01. Since the test statistic, WR (1103) exceeded the critical value (898), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix C.
- A biased soil sample was collected from the location of the highest gamma count rate within the SU, with a maximum result of 0.08 Uniform SOF.

- The maximum SOF result for all surface samples within LSA 07-01 was 0.90. The maximum SOF result for all subsurface samples within LSA 07-01 was 0.37. The average SOF result for all systematically collected samples within LSA 07-01 was 0.11, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.22.
- No FSS sample result in LSA 07-01 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an EMC or supplemental investigations were 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 sample locations actually collected within LSA 07-01. The successful result of the retrospective power evaluation presented in Table 26-1 for LSA 07-01 indicates that the minimum number of sample locations required (8) for the WRS Test was equal to the number of sampling locations actually collected (8) within LSA 07-01. 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 LSA 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 were performed periodically, and confirmed that there were no instances of potential cross contamination from weather events until the FSS of all remaining areas at HDP were completed.

Table 26-1
Retrospective Sample Size Verification for LSA 07-01

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.22
$DCGL_{SOF}$	1
LBGR (Mean)	0.11
Shift	0.89
Relative Shift (Δ/σ)	4.12
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	α
0.10	1.282	β
0.15	1.036	
0.2	0.842	
0.25	0.674	
0.30	0.524	

Figure 26-1
Data Evaluation Checklists prepared for LSA 07-01 (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 07 **Description:** Plant Open Land Area
Survey Unit: 01 **Description:** Northwest of Bldg. 110

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 ☐	NA ☐
11.	Are all Laboratory QC parameters within acceptable limits?	Yes ☒	No ☐	NA ☐

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: *One sample (L07-01-14-P-R-Q-00) exceeded the control limit for Tc-99. The RSO has reviewed the sample data and determined that the results are still acceptable, and no further action is necessary. See section 23.2.6 of Volume 3 Chapter 17 for further detail.

Quality Record

Figure 26-1
Data Evaluation Checklists prepared for LSA 07-01 (page 2 of 2)

Hematite Decommissioning Project	Procedure: HDP-PR-FSS-721, Final Status Survey Data Evaluation		
		Revision: 10	Appendix G-1, Page 2 of 2

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

Survey Area: No. LSA 07 **Description:** Plant Open Land Area
Survey Unit: No. 01 **Description:** Northwest of Bldg. 110

Discrepancy: None

Corrective Actions Taken: None

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):	Thomas Yardy (Print Name)	(Signature)	7-19-17 (Date)
Approved by (RSO):	Clark Evers (Print Name)	(Signature)	7/19/17 (Date)

Quality Record

27.0 SURVEILLANCE FOLLOWING FSS

FSS activities in LSA 07-01 were completed in April 2016. There were no events after the completion of FSS that would have the potential to cause contamination above the DCGLs in the SU.

28.0 CONCLUSION LSA 07-01

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 07-01 of 7.75 mrem/year does not exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402 of 25 mrem/year.

Table 28-1
LSA 07-01 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	REMAINING STRUCTURE	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.11	0.04	0.16	0.0	N/A	**0.31**
DOSE	2.75 mrem/year	1.0 mrem/year	4.0 mrem/year	0.0 mrem/year	N/A	**7.75 mrem/year**

29.0 REFERENCES

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

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

29.3 HDP-TBD-FSS-002, *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations (MDC) for Final Status Surveys (FSS)*

29.4 Westinghouse letter HEM-10-80, *Response to request for Additional Information Concerning Hematite Decommissioning Plan: Chapter 14, Characterization Report and Surrogates Report* {ML102140158}

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

29.6 Westinghouse letter HEM-11-56, "Evaluation of Technetium-99 Under the Process Buildings", dated May 5, 2011

30.0 APPENDICES (To Be Provided On Separate Data Disc)

APPENDIX A: Analytical Data Evaluation Spreadsheets for LSA 06-01

APPENDIX B: Analytical Data Evaluation Spreadsheets for LSA 06-02

APPENDIX C: Analytical Data Evaluation Spreadsheets for LSA 07-01

APPENDIX D: FSS Plan Development for LSA 06-01

APPENDIX E: FSS Plan Development for LSA 06-02

APPENDIX F: FSS Plan Development for LSA 07-01

APPENDIX G: TestAmerica Laboratory Analytical Data Reports for LSA 06-01

APPENDIX H: TestAmerica Laboratory Analytical Data Reports for LSA 06-02

APPENDIX I: TestAmerica Laboratory Analytical Data Reports for LSA 07-01

APPENDIX J: Completed Field Logs