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-18-2
Date: January 9, 2018

Subject: Westinghouse Hematite Decommissioning Project - Request for NRC Review of Final Status Survey Final Report Volume 3, Chapter 16, Survey Area Release Record for Land Survey Area 05, Survey Units 01, 02, 03 and 04, Revision 1 (License No. SNM-00033, Docket No. 070-00036)

The purpose of this letter is to provide for the U.S. Nuclear Regulatory Commission (NRC) review of Final Status Survey Final Report (FSSFR) Volume 3, Chapter 16, Survey Area Release Record for Land Survey Area 05, Survey Units 01, 02, 03 and 04, Revision 1, (LSA 05-01, LSA 05-02, LSA 05-03 and LSA 05-04).

The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to the data provided for LSA 05-01. Of note was incorrect data saved to a spreadsheet during assessment of the data. Subsequently the inadvertently saved data was submitted with the survey area release record for LSA 05-01. Westinghouse and the NRC discussed the path forward and resolution of the NRC comments. As such, Revision 1 to FSSFR Volume 3 Chapter 16 is implemented to remove the inadvertently saved data and to correct the text of the survey area release record for LSA 05-01.

Attachment 1 contains FSSFR Volume 3, Chapter 16, Survey Area Release Record for Land Survey Area 05, Survey Units 01, 02, 03 and 04, Revision 1 with a CD containing Appendices to the report. Attachment 2 contains a revision matrix for FSSFR Volume 3, Chapter 16, Revision 1 indicating the revisions. Attachment 3 contains those pages of FSSFR Volume 3, Chapter 16, Revision 1 in track change format indicating the revision to the text.

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

Sincerely,

Kenneth E. Pallagi
Licensing Manager,

NM5520

Hematite Decommissioning Project

Attachment: 1) Final Status Survey Final Report Volume 3, Chapter 16, Survey Area Release Record for Land Survey Area 05, Survey Units 01, 02, 03 and 04, Revision 1 (HDP-RPT-FSS-218 Revision 1) with CD containing Appendices

2) Revision Matrix for FSSFR Volume 3, Chapter 16, Revision 1

3) Revised Pages of FSSFR Volume 3, Chapter 16, Revision 1 in Track Change

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

Attachment 1

Final Status Survey Final Report Volume 3, Chapter 16, Revision 1

Survey Area Release Record for Land Survey Area 05, Survey Units 01, 02, 03 and 04, Revision 1 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 16

TITLE: **Survey Area Release Record for Land Survey Area 05, Survey Units 01, 02, 03, and 04 (LSA 05-01 through LSA 05-04)**

REVISION: **1**

EFFECTIVE DATE: JAN 0 9 2018

Approvals:

Author: Kenneth E. Pallagi — 01-09-2018 Date

Owner/Manager: W. Clark Evers — 1/9/18 Date

REVISION LOG	
Revision No. Effect. Date	**Revision**
0 03/29/2017	Revision 0 is the initial issuance of the Survey Area Release Record for Land Survey Area 05, Survey Units 01, 02, 03, and 04.
1 See Cover Page	The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to clarification and additional information on the methodology utilized in performance of the Elevated Measurement Comparison for survey unit LSA 05-01. This revision addresses the feedback from the NRC. Additionally this revision includes minor editorial changes to align this survey area release record with subsequent survey area release records submitted to the NRC.

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LIST OF ACRONYMS AND SYMBOLS

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

Tc	Technetium
Th	Thorium
U	Uranium
WRS	Wilcoxon Rank Sum
yr	year

EXECUTIVE SUMMARY

This Survey Area Release Record (SARR) presents the results of the final status radiological surveys of the Hematite Decommissioning Project (HDP) Land Survey Area (LSA) 05, Survey Unit (SU) 01 (LSA 05-01), SU 02 (LSA 05-02), SU 03 (LSA 05-03) and SU 03 (LSA 05-04). 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."

All of the land area that comprises SUs LSA 05-01 through LSA 05-04 was designated as Class 1 as presented in Table 14-16 of the HDP Decommissioning Plan (DP) {ML092330123}. The Class 1 designation for all SUs that comprise the land area remained in effect throughout remediation and Final Status Survey (FSS). For SUs LSA 05-01 through LSA 05-04, evaluation of analytical results against the Derived Concentration Guideline Levels (DCGL) for the Uniform Stratum Conceptual Site Model (CSM) was the selected approach. The objective of the FSS for the SUs was to obtain and document measurement results, analytical data, and other supporting information in order to demonstrate that after completion of remediation the residual radioactivity levels in the LSA 05-01, LSA 05-02, LSA 05-03 and LSA 05-04 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 16, builds upon the general information provided in FSSFR Volume 3, Chapter 1, Revision 3.

2.0 HDP SITE, LSA AND SURVEY UNIT DESCRIPTIONS

2.1 HDP Site Description

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

2.2 LSA Configuration

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

The DP stated that it was expected that the conceptual boundaries of the SUs would be altered based on the actual configuration and condition of the SU at the time of survey design. As expected, it was necessary to modify the boundary of LSA 05 to facilitate the remediation process. The expansion of LSA 05 was due in part to ensure adequate remediation of specific areas as indicated by the results of visual inspection and radiological survey. As a result of the expansion of LSA 05 and the necessity to subdivide the LSA to support unique remediation issues, the individual SUs within LSA 05 were also modified. All SUs within LSA 05 were initially classified as Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Class 1 survey areas in DP Chapter 14. Therefore, for FSS, all SUs within LSA 05 remained classified as MARSSIM Class 1 survey areas, thereby ensuring compliance with the DP.

LSA 05 encompasses the entire Barns Area footprint. LSA 05 consists of SUs LSA 05-01 through LSA 05-04.

2.3 LSA Survey Unit Description and Configuration

Upon completion of remediation, in its final configuration as prepared for FSS, the two dimensional surface area of each SU is listed below:

Table 2-1
LSA 05 Class 1 SU Surface Area Summary

LSA 05-01	LSA 05-02	LSA 05-03	LSA 05-04
1,781 m^2	1,399 m^2	1,563 m^2	2,027 m^2

2.3.1 LSA 05-01 Survey Unit Description and Configuration

LSA 05-01 is located adjacent to State Road P along the westerly boundary of the site within the west half of LSA 05, the Barns Area. Figure 2-3 indicates the location of the SU within LSA 05. Figure 2-4 presents the Final Configuration of the HDP Land Survey Areas and SUs which indicate the location of the boundaries of the SU's.

The conceptual SU boundary for LSA 05-01 as originally provided in DP Figure 14-14 was identified as predominantly encompassing the Site Spring Area from State Road P southerly to the head of the Site Pond. The area also encompassed the Red Room Roof Burial Area and the Cistern Burn Pit Area.

During remediation in the Site Spring Area the site encountered significant water management issues with controlling flow of the site spring. Also encountered during the remediation of the Site Spring Area was the fact that there was evidence of radiological contamination encroachment into the supporting road base structure (embankment) of State Road P.

These issue halted remediation progress to allow for further investigation and re-planning of remediation in the LSA 05 area. To accommodate the re-planned effort LSA 05 was reconfigured into four SUs to allow the site staff to address the specific issues within each new SU. As such, the Site Spring Area and Cistern Burn Area are part of the newly established LSA 05-04 SU and the Red Room Roof Burial Area is part of reconfigured LSA 05-02.

In its final configuration LSA 05-01 encompasses the State Road P supporting road base structure (embankment).

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 05-01 presents 797 square meters (m^2) in planar (2-dimensional) extent, with an estimated interior surface area of 997 m^2 (3-dimensional).

2.3.2 LSA 05-02 Survey Unit Description and Configuration

LSA 05-02 is located in the central area of LSA 05. The conceptual SU boundaries for LSA 05-02, as originally provided in DP Figure 14-14, was identified as predominantly encompassing the area in which the Tile Barn and Wood Barn were located.

As described in section 2.3.1 the re-planning and SU reconfiguring effort to address issues in the Site Spring Area resulted in the reconfiguration of LSA 05-02. In its final configuration LSA 05-02 encompasses the area in which the Tile Barn and Red Room Roof Burial Area were located. After demolition and disposal of the Tile Barn, the entirety of SU LSA 05-02 underwent excavation for the purpose of soil remediation. As such, the area when prepared for FSS was native soil and the structures as discussed in Section 3.3.2 and section 27.0.

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 05-02 presents 1,399 m^2 in planar (2-dimensional) extent, with an estimated interior surface area of 1,586 m^2 (3-dimensional).

2.3.3 LSA 05-03 Survey Unit Description and Configuration

LSA 05-03 is located within the northeast half of LSA 05. A SU designated as LSA 05-03 was not initially identified in the DP. The land area designated as LSA 05-03 was originally designated as LSA 05-02.

As described in section 2.3.1 the re-planning and SU reconfiguring effort to address issues in the Site Spring Area resulted in the reconfiguration of LSA 05-02 by subdividing it into SUs LSA 05-02 and LSA 05-03. In its final configuration LSA 05-03 encompasses the area in which the Wood Barn was located. The majority of the SU LSA 05-03 area underwent excavation for the purpose of soil remediation. As such, the area when prepared for FSS was native soil.

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 05-03 presents 1,563 m^2 in planar (2-dimensional) extent, with an estimated interior surface area of 1,719 m^2 (3-dimensional).

2.3.4 LSA 05-04 Survey Unit Description and Configuration

LSA 05-04 is located within the southern half of LSA 05. A SU designated as LSA 05-04 was not initially identified in the DP. The land area designated as LSA 05-04 was originally designated as a portion of LSA 05-01, LSA 02-01 and LSA 06-02.

As described in section 2.3.1 the re-planning and SU reconfiguring effort to address issues in the Site Spring Area resulted in the establishment of LSA 05-04. In its final configuration LSA 05-04 encompasses the area in which the Site Spring is located, the area where the Cistern Burn Pit was located, and the area where portions of the headwaters of the Site Pond is located. The majority of the SU LSA 05-04 area underwent excavation for the purpose of soil remediation. As such, the area when prepared for FSS was primarily native soil.

Upon completion of remediation, in its final excavated configuration as prepared for FSS, LSA 05-04 presents 2,027 m^2 in planar (2-dimensional) extent, with an estimated interior surface area of 2,189 m^2 (3-dimensional).

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

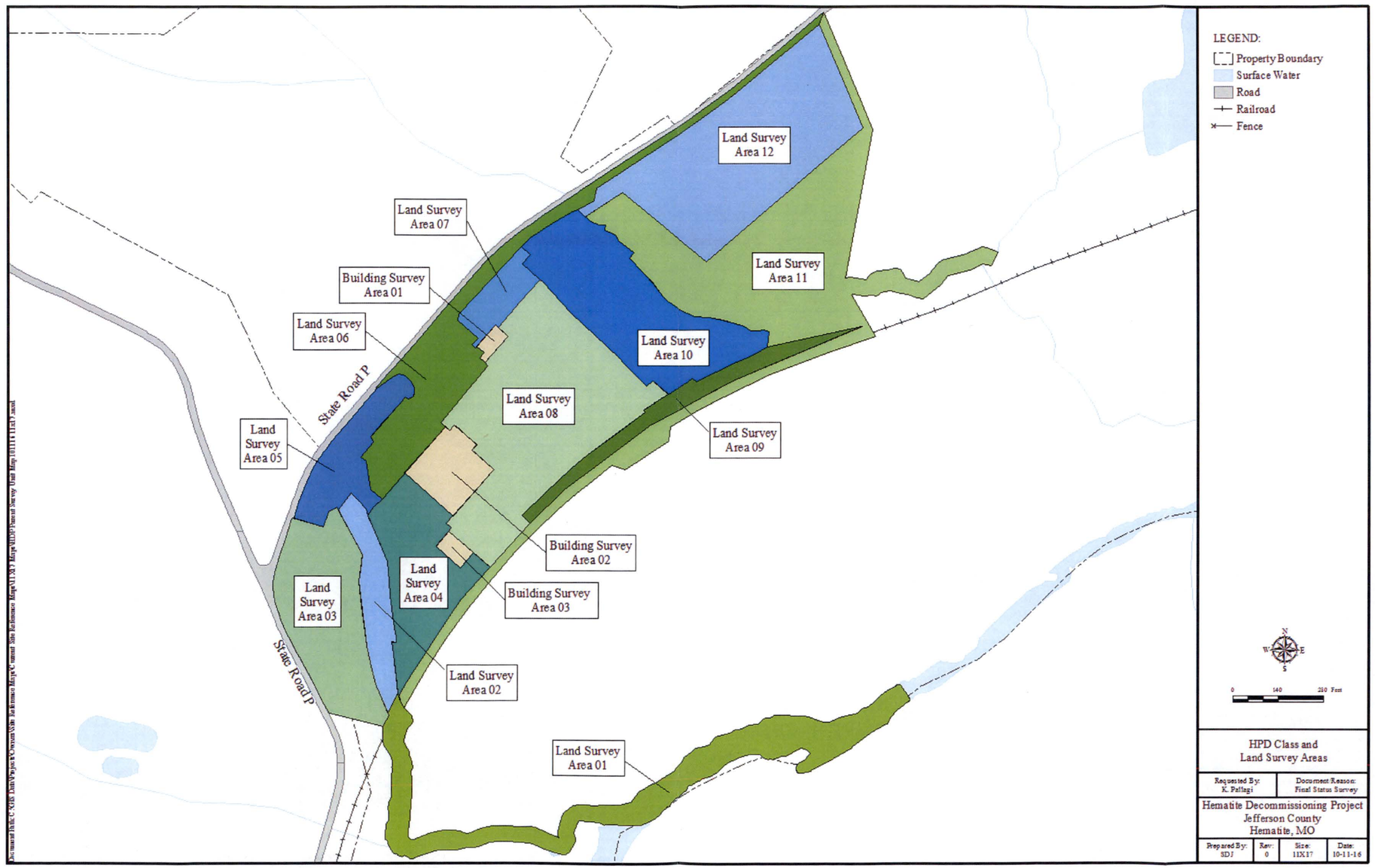


Figure 2-3
Final Configuration of Land Survey Area 05 and Survey Units

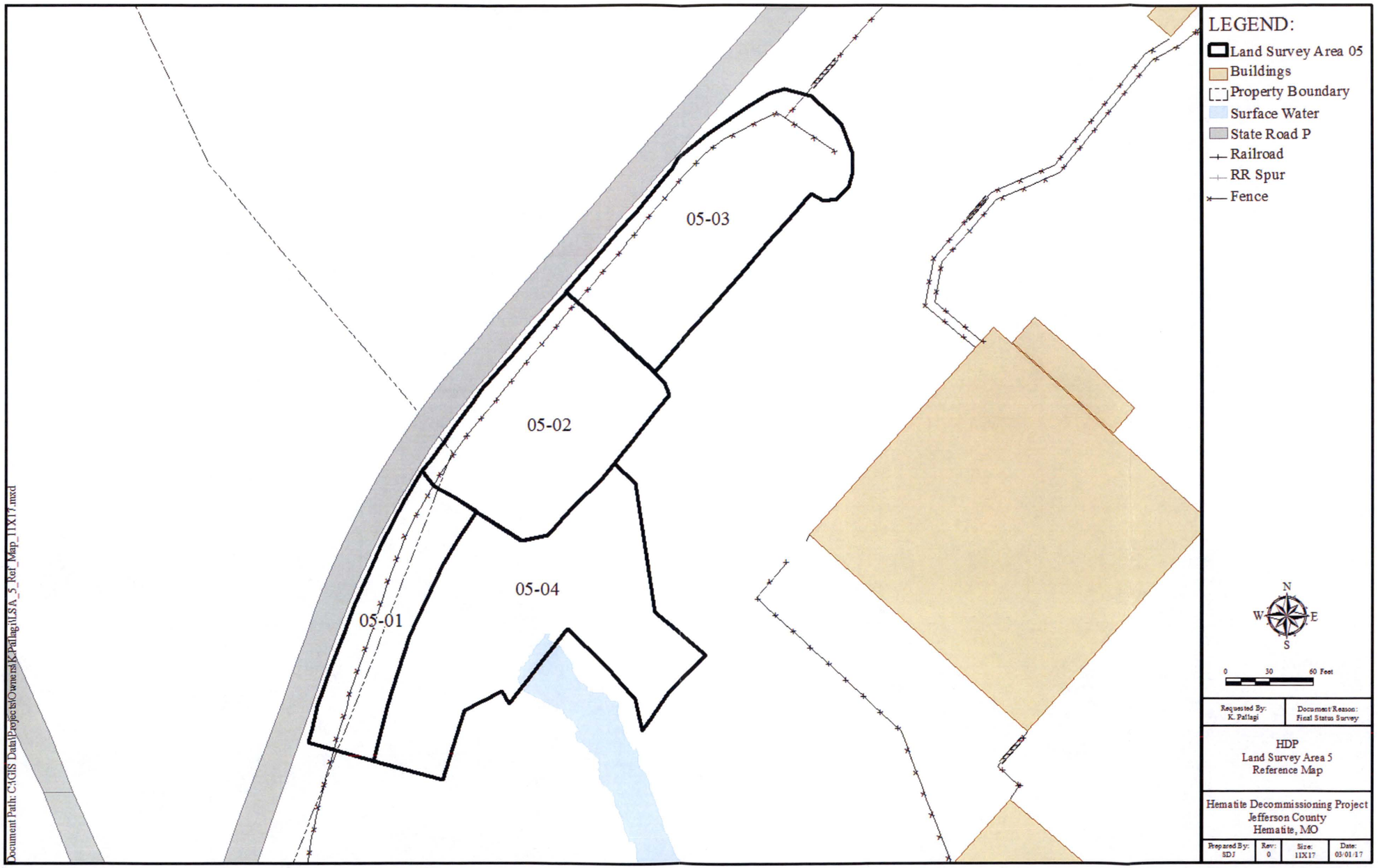
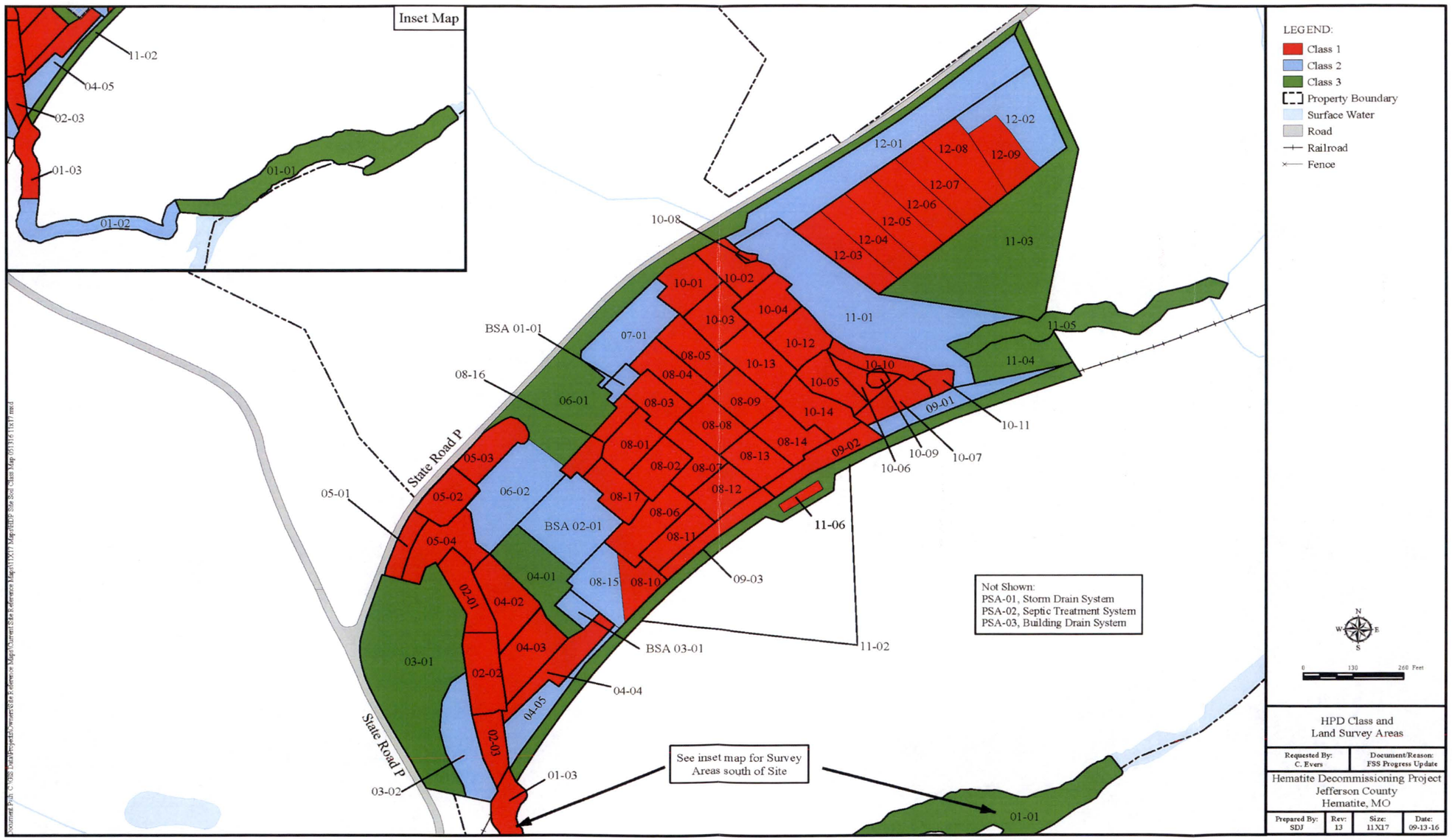


Figure 2-4
Final Configuration of Land Survey Areas and Survey Units



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 Radioactive Materials in the LSA 05

The radioactive material within LSA 05 consist of the radionuclides of concern as provided in the DP Section 14.1.1 and reiterated in FSSFR Volume 1, Chapter 1, Section 5.1.

3.1.1 Radioactive Materials in LSA 05-01

Radioactive materials within LSA 05-01 resulted from placement of radioactive contaminated spent limestone as fill material near the Site Spring. The placement of the spent limestone by previous owners of the facility was an intentional action after receiving authorization from the NRC.

The following excerpt from the HDP Historical Site Assessment describes the origin of the use of spent limestone at the site as fill material:

> *"In 1967, five chemical scrubber columns were installed in Building 260 (Oxide Building) for removal of hydrogen fluoride from the off-gas associated with the conversion of UF6 to UO2. These dry scrubber columns used limestone rock chips as the off-gas scrubber media which became contaminated with trace amounts of Uranium, other volatile contaminants and Tc-99. The limestone was replaced periodically and the "spent" limestone was placed outside Building 260, and subsequently used as fill in other on-site areas as shown in Figure 5-1.*
>
> *In 1989 and 1990, CE requested and was granted permission from the NRC to allow spent limestone, meeting the release criteria of 30 pCi/g, to be used for backfill during the construction of Building 253. Use of this material as backfill was allowed with the understanding that remediation of the fill area may be required during decommissioning* (Reference 37.7 and Reference 37.8). *An employee interview confirmed that the spent limestone was used as backfill under the floor slab of Building 253* (Reference 37-9).
>
> *The presence of Tc-99 was originally discovered in the spent limestone. The facility received UF6 stock from spent nuclear fuel that had been recycled and used as feed in the Uranium enrichment (gaseous diffusion) process. Use of this UF6 enriched from recycled fuel, resulted in the potential for trace amounts of both transuranic radionuclides (elements with an atomic number greater than the atomic number of Uranium) and Tc-99* (Reference 37-10).
>
> *The Hematite Site license contains specific conditions which address monitoring of Tc-99 and historic on-site burial of waste limestone from off-gas scrubbers* (Reference 37-11 and Reference 37-12). *In a September 29, 1997 letter to CE, the NRC stated that at the time of plant decommissioning, the licensee will be required to fully characterize the extent of Tc-99 contamination in soil and groundwater, and remediate if the levels are above established release criteria* (Reference 37-13)."

Location of known placement of the spent limestone was communicated in the DP Figure 2-5, Hematite Historical Remediation Areas of Concern.

3.1.2 Radioactive Materials in LSA 05-02

Radioactive materials within SU LSA 05-02 resulted from placement of radioactive contaminated building materials from the Red Room Roof Burial Area of the former Process Building. The placement of the building materials by previous owners of the facility is presumed to be an intentional action. During the remediation of the SU, the expected identification of the building material and its elevation in reference to surrounding topography indicate that this was a placement of the building material as fill material on a sloped area rather than a burial as was conducted in the Burial Pit Area.

During remediation of SU LSA 05-04 pieces of roofing material were identified in LSA 05-04 and are presumed to have originated from LSA 05-02 Red Room Roof Burial Area, or was inadvertently dispersed on the surface of LSA 05-04 when the material from the Red Room Roof was originally placed and then was subsequently cover by fill material and vegetation.

Subsequent to the completion of remediation efforts in the area and the commencement of FSS in the SU the NRC contracted Oak Ridge Associated Universities (ORAU) to perform confirmatory surveys in what was at that time the land area designated as LSA 05-02. During the ORAU confirmatory survey a fuel pellet fragment and area of soil contamination was identified in the SU. It has been determined that radioactive materials within LSA 05-02 also resulted from the storage of radioactive contaminated equipment in the Tile and Wood Barn during the time period they were utilized by previous owners as storage buildings. The identification of the fuel pellet fragment is documented in NRC Inspection Report 07000036/2013002 {ML13241A252}.

3.1.3 Radioactive Materials in LSA 05-03

Radioactive materials within LSA 05-02 also resulted from the storage of radioactive contaminated equipment in the Tile and Wood Barn during the time period they were utilized by previous owners as storage buildings. Of note is that the Wood Barn was constructed utilizing the existing ground surface as the floor of the barn.

3.1.4 Radioactive Materials in LSA 05-04

As discussed in section 3.1.1 radioactive materials in LSA 05-04 resulted from placement of radioactive contaminated spent limestone as fill material in the Site Spring Area and placement of radioactive contaminated building materials from the Red Room Roof Area of the former Process Buildings.

3.2 Reuse Soil Disposition and Characterization

Prior to remediation and removal of contaminated soil and other waste materials within LSA 05-01, LSA 05-02, LSA 05-03 and LSA 05-04, overburden soils which exhibited characteristics suitable for potential reuse as onsite backfill material were removed, segregated, and subjected to reuse soil criteria requirements.

Between December 10, 2012, and January 15, 2013, during Barns Area remediation, two piles of soil had been generated within the area that were not initially designated as potential reuse soil. One pile consisted of solely of soil and the second pile consisted of soil and a minor amount of

debris. After inspection of the piles the Radiation Safety Officer (RSO) designated the soil as potential reuse soil and directed that HDP-PR-FSS-710 (Revision 4) Approach 1, Utilizing the Box Counter, was the approach used to process the reuse soil.

During an on-site inspection by the NRC, an inspector noted the two piles of soil staged in the Barns Area and questioned site personnel to determine from where it had been exhumed and how it was to be dispositioned in the future. The soil piles had been designated as reuse material and were awaiting transport to the reuse area. Since this area was designated as a non-nuclear criticality safety (NCS) area, in-situ surveys were not required before each lens of soil was exhumed from the area for waste disposal. However, in-situ surveys were required for each lens of soil that was planned to be used as reuse on site. The inspectors discussed with the licensee what surveys had been performed for the soils in the pile designated for reuse and found that in-situ surveys had not been performed for each lens of soil that was exhumed into the reuse pile. This resulted in a Severity Level IV Non-cited Violation for failure to conduct activities in accordance with requirements {ML13155A023}. After development and implementation of the necessary corrective actions, the soil in question was subsequently removed from the Barns Area and processed as reuse soil as Reuse Stockpile 2 and placed in the West Laydown Area.

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

3.3 Remediation and Remedial Action Support Surveys (RASS) Phase

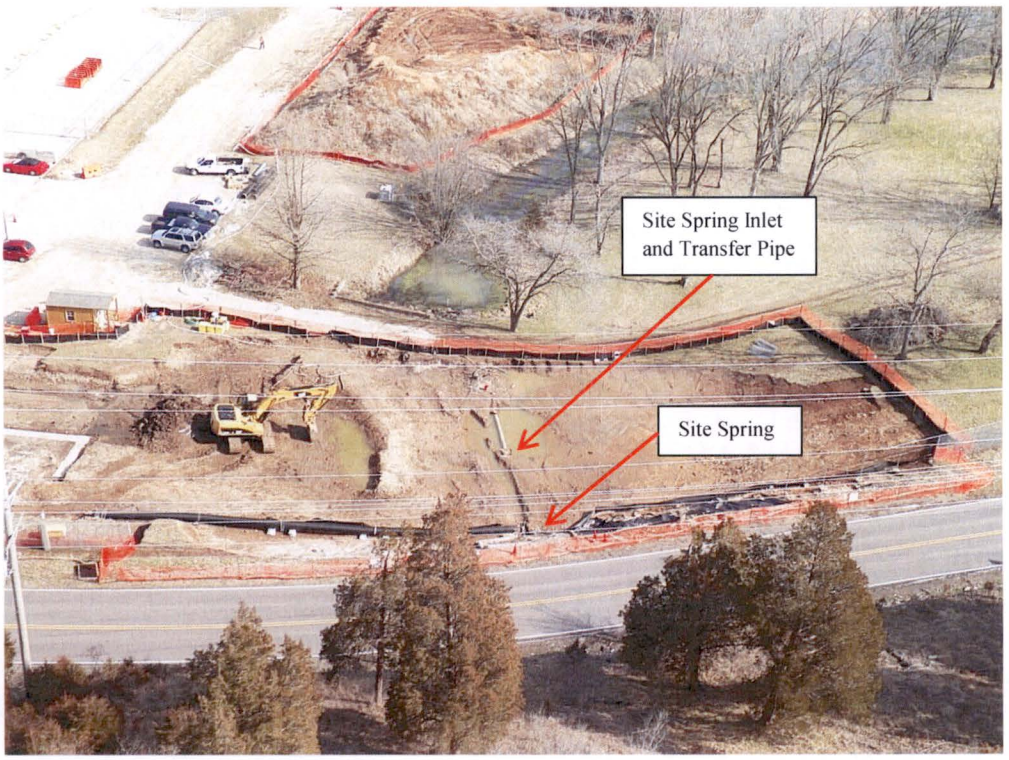
The sections below provide a discussion of the various elements of remediation and the RASS phase of LSA 05-01, LSA 05-02, LSA 05-03 and LSA 05-04 necessary to prepare the SUs for FSS.

3.3.1 Remedial Actions LSA 05-01

Remedial actions began in LSA 05, the Barns Area, in December 2012, which at that time consisted of SUs LSA 05-01 and LSA 05-02. Within a short period of time site personnel had established that the amount of spent limestone in LSA 05-01 to be excavated from the area would significantly exceed the planned estimated volume.

By March of 2013 sufficient spent limestone and soil had been removed to expose the inlet and transfer piping that channeled water from the Site Spring to the Site Pond (Figure 3-1). It was at this juncture that it was identified that spent limestone had been used as a base to support the pipe. This necessitated halting remediation and re-planning the remediation of the area.

Figure 3-1
Exposure of Pipe from Site Spring to Site Pond



The remediation contractor developed a plan in which a new spring inlet and transfer pipe would immediately replace the existing spring inlet and transfer pipe after its removal along with the removal of the underlying spent limestone. The plan was implemented and work commenced to remove the spring inlet and transfer pipe along with the supporting spent limestone and the new piping installed (Figure 3-2). To accomplish this work, as much of it was underwater, the RSO provided a verbal directive to change the survey methodology to address the issue of survey of soil that was underwater. The directive included additional soil samples and that the soil removed from portions of the SU that were underwater would be placed on dry ground and a GWS performed on the soil

Figure 3-2
New Section of Spring Inlet and Transfer Pipe Being Installed

During NRC routine inspection activities, the NRC Inspectors with assistance from ORAU personnel, reviewed the FSS plan and associated instructions for SU LSA-05-01 to determine if the plan was in accordance with MARSSIM guidance and the DP, and the work was being performed in the field as required by the FSS instructions. The NRC Inspectors observed the work to install a section of piping. The inspectors noted that this area was underwater and questioned how final status surveys were being performed under the current FSS instructions because it required a 100% GWS be performed over the entire surface of the SU. The RSO provided that additional samples were being taken in the area that was underwater and soils that were being excavated from underwater were being surveyed after placement on dry ground (Figure 3-3).

The NRC Inspector questioned the HP Staff to determine if the FSS instructions had been revised to incorporate these changes before these surveys had begun and it was determined that these changes were only verbally given to personnel in the field. Site procedures require that if the survey instructions cannot be followed as written, all changes shall be documented, not verbally changed in the field. As a result, the NRC Inspectors identified a Severity Level IV Violation of the use of Procedure HDP-PR-FSS-711 Revision 2 for failure to follow procedure to document changes to the FSS instructions before implementation. As a corrective action the FSS plan for LSA 05-01 was revised to incorporate the verbal directive of the RSO.

Figure 3-3
Example of GWS of Soil Removed from Underwater Location in LSA 05-01

During the remediation of spent limestone from LSA 05-01 a concrete slab was encountered (a remnant of the previous dairy farm operations) and removed to ensure that remediation and radiological survey could be conducted in the area in which the slab resided. The excavation of the concrete slab removed a significant barrier to the hydraulic pressure of the Site Spring which in turn allowed the Site Spring to immediately fill the area with spring water to the point that the elevation of the Site Spring outlet equalized with the level of the Site Pond (see Figure 3-4).

Figure 3-4
Site Spring Area Filled with Water after Removal of Concrete Slab

The remediation of LSA 05-01 was again halted to allow for development of a plan to manage the Site Spring water.

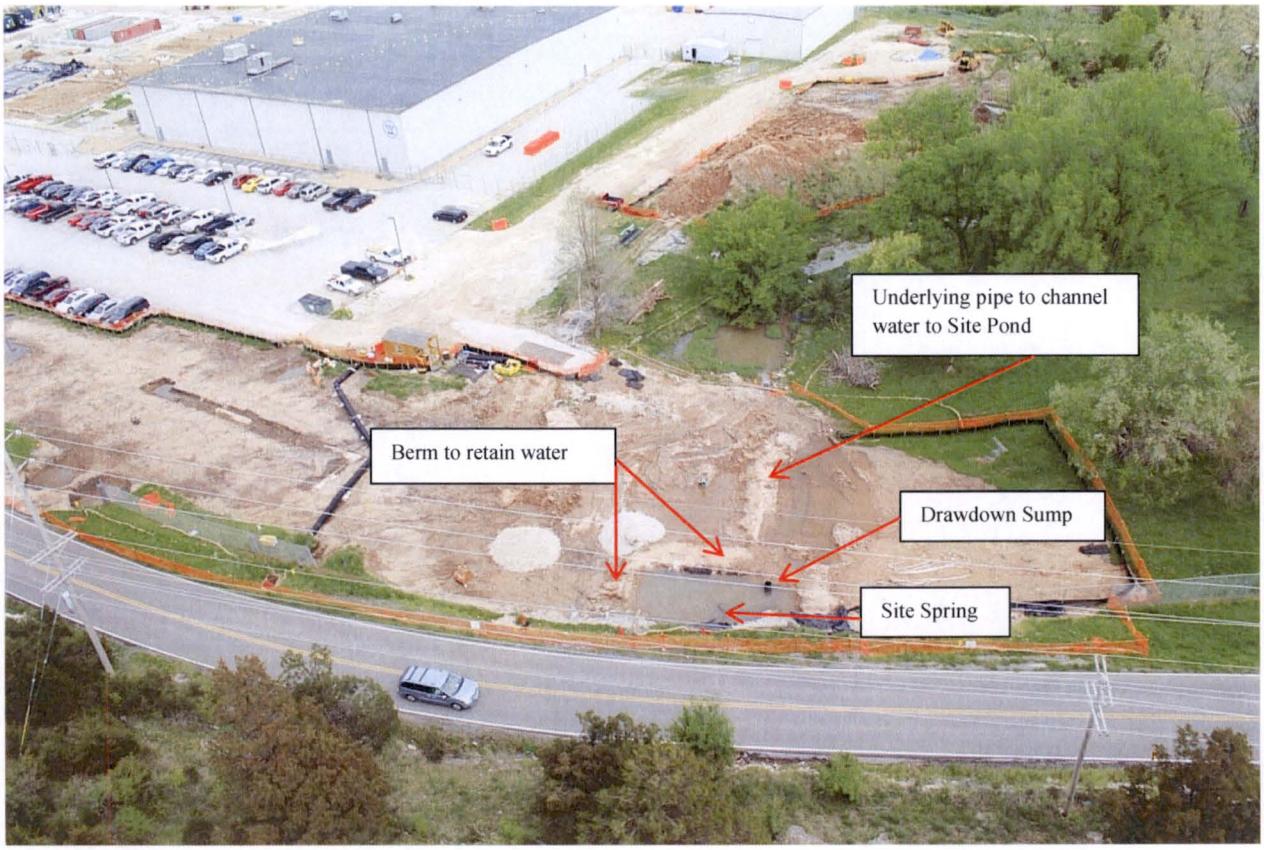
At this juncture the site remediation contractor and site staff revisited the remediation progress in LSA 05 and thereafter modified the approach to the following:

1) Subdivide LSA 05 into three SUs to support the path forward.
2) Implement water control management actions in the southeast half of LSA 05-01 to allow interim backfill of the area. This will localize control of spring water by installation of a drawdown sump and allow remediation equipment back into the area to continue remediation of the sloped area of LSA 05-01.
3) Continue remediation LSA 05-01 lower area by removal of inlet and transfer pipe and underlying spent limestone fill material.
4) Remediate LSA 05-01 (the sloped area) to preclude future sloughing and transfer of soil into the lower elevations of LSA 05-01.
5) Coordinate with the Missouri Department of Transportation (MoDOT) and the NRC to conduct remediation of LSA 05-01 (the sloped area).
6) Perform final remediation of LSA 05-01 (future LSA 05-04) during the seasonal low flow condition of the Site Spring.
7) Conduct soil remediation in LSA 05-03.

8) Address the discovery of an underlying concrete foundation to the Tile Barn foundation that was not removed.

During April to early August 2013 the site implemented the above actions which supported recommencement of remediation of LSA 05-01 (See Figure 3-5).

Figure 3-5
Water Control Management in Place in LSA 05-04



The predominate action, as driven by MoDOT requirements were to 1) implement State Road P traffic control, 2) remediate (remove supporting road base structure (embankment)) only to the engineered specification as provided by MoDOT engineers, 3) immediately perform FSS, and 4) backfill to restore the State Road P road base structure as soon as possible. To accomplish this evolution site personnel coordinated with NRC Region III so that the NRC and ORAU would be on-site to conduct concurrent confirmatory surveys and sampling with the site staff conducting FSS.

Remediation then commenced on the sloped section to remove the spent limestone in LSA 05-01 to the extent allowed by MoDOT (see Figure 3-6 and Figure 3-7).

Figure 3-6
Remediation of Spent Limestone in LSA 05-01

Figure 3-7
Remediation Activities in LSA 05-01

During excavation into the embankment of State Road P additional concrete structures were encountered embedded within the embankment in the area in which MoDOT restricted excavation (Figure 3-8). As the concrete was restricted from being excavated the FSS Plan was revised to include radiological survey of the concrete.

Figure 3-8
Concrete Structure Embedded in State Road P Embankment Prepared for FSS

Immediately upon completion of remediation of LSA 05-01 site personnel conducted FSS.

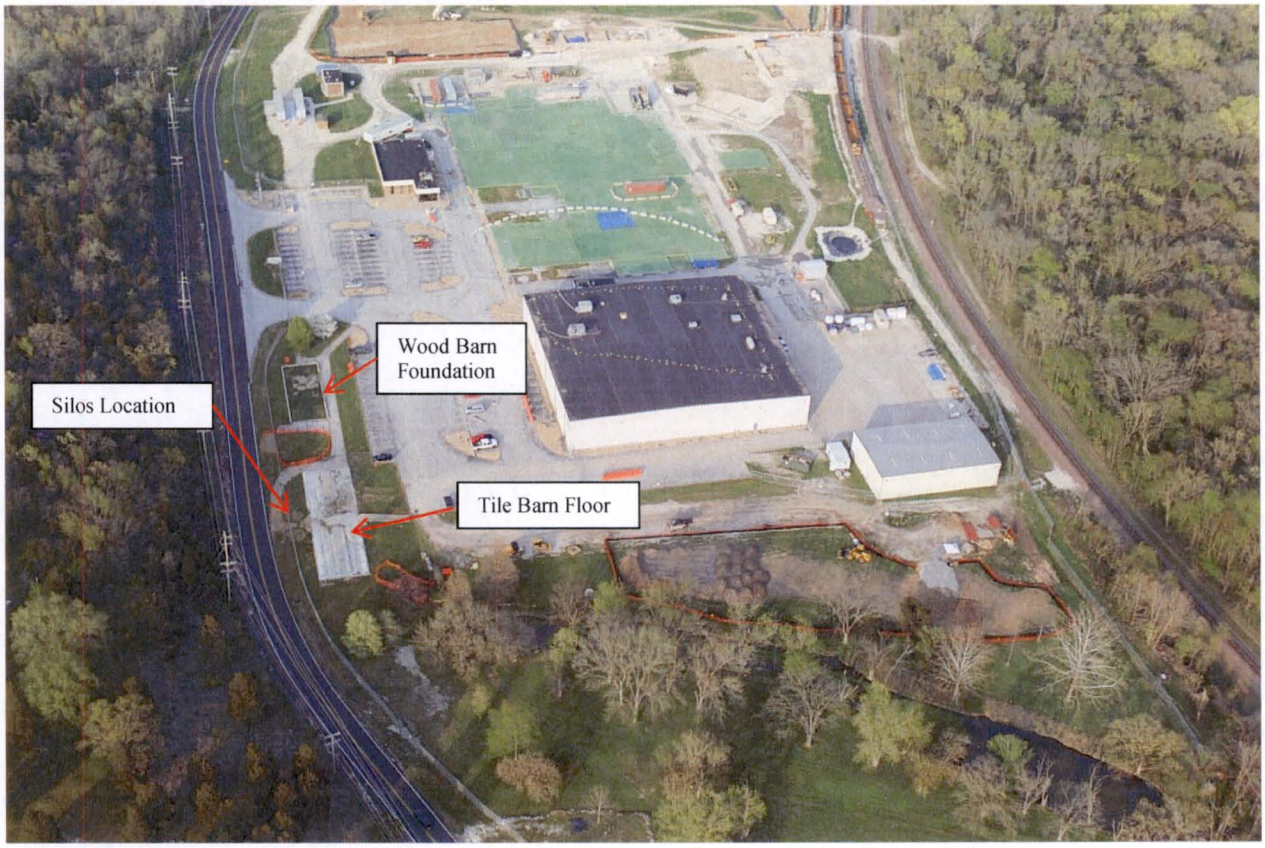
From August 27 through August 29 the NRC and ORAU conducted confirmatory survey and sampling {ML13336A408 and ML14084A566}. Upon completion of all FSS activities the State Road P road base structure was then backfilled and restore to MoDOT specifications (See Figure 3-9).

Figure 3-9
LSA 05-01 Restoration Complete

3.3.2 Remedial Actions LSA 05-02

Prior to soil remediation in the Barns Area, the Tile Barn and the connected silos, and the Wood Barn were demolished. Figure 3-10 is a photograph of the Barns Area with the barns and silos removed.

Figure 3-10
Barns Area after Demolition of Barns and Prior to Remediation



Remedial actions began in LSA 05, the Barns Area, in December 2012, which at that time LSA 05 consisted of SUs LSA 05-01 and LSA 05-02. Initial activities included removal of the Tile Barn concrete floor and foundation, the Wood Barn foundation and the asphalt walkways.

After removal of the concrete and asphalt in the area soil remediation commenced. The soil contained significant amounts of building debris such as clay tile fragments, wood, metal pieces such as hinges and electrical wiring, and also what appeared to be material impacted by fire. As excavation continued an underlying foundation was identified where the Tile Barn foundation had recently been removed (See Figure 3-11).

Figure 3-11
Underlying Foundation Being Unearthed in Tile Barn Area

The discovery of the underlying foundation combined with the significant amount of building debris in the soil provided sufficient evidence to conclude that a fire to a structure (presumably a barn) in that location had occurred. Remnants of the fire remained dispersed in the soil, and subsequently during the construction of the Tile Barn scraps and pieces of construction material were also dispersed onto the soil surface at the time, rather than being picked up and disposed by the builders. At a later date when the Tile Barn construction had been completed, top soil was brought into the area to landscape the area around the Tile Barn, thus covering the debris.

As radiological survey indicated that soil remediation was nearing completion in LSA 05-02 the RSO determined that to perform FSS in the area the foundation would remain in place and the FSS Plan would be revised to incorporate survey of the foundation. As such the remediation contractor was directed to make the surface of the foundation accessible for survey and sampling. This was accomplished by power-washing the surface of the foundation and removal of soil. Figure 3-12 is a photograph that shows LSA 05-02 prepared for FSS, which includes the concrete foundation structure prepared for FSS.

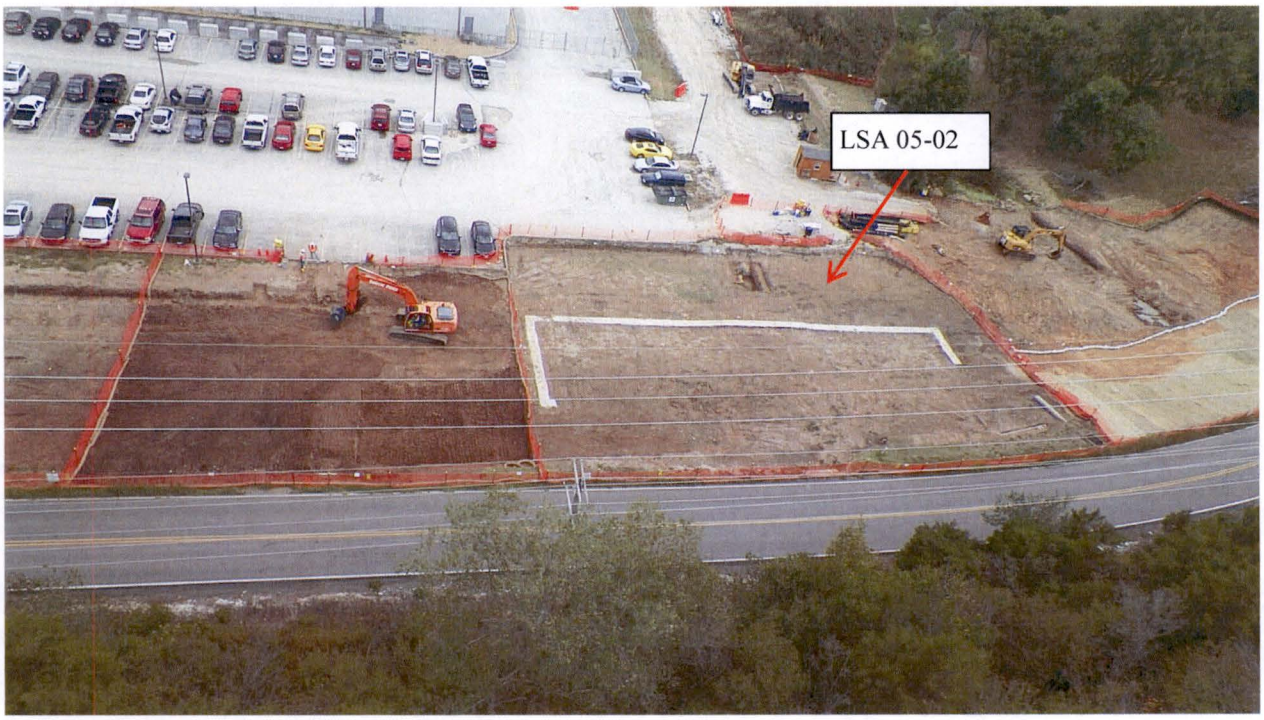
Prior to June 3, 2013, the HP staff had completed GWS of LSA 05-02. The results of the GWS indicated the need to perform biased soil sampling. Concurrent to the preparation of biased sampling in LSA 05-02, between June 3 and June 6, 2013, ORAU also performed GWS of LSA 05-02. The results of the ORAU GWS also indicated that biased sampling would be appropriate.

To provide data for the purpose of comparison, HDP and ORAU/NRC chose to perform split soil samples in the biased locations. During the performance of the split sampling it was evident that for one of the samples the portion of the split sample assigned to HDP had an elevated radiological measurement as compared to the split sample portion assigned to the NRC. Further investigation of the HDP split sample portion identified a fuel pellet fragment. The event was captured within the Westinghouse corrective action system. The event description is also captured in NRC Inspection Report 07000036/2013002 {ML13241A252}. As documented in NRC Inspection Report 07000036/2013003 {ML13336A408} a regulatory compliance issue of minor safety significance was identified for failure to perform an adequate survey to identify both a fuel pellet fragment and localized area of contamination during performance of the FSS.

A corrective action implemented as a result of the event was to perform an evaluation and testing of the GWS process and subsequent data analysis. As a result of the test and evaluation it was determined that the GWS process directed the technicians to hold the detector 3 inches from the ground surface. These measurements indicated that the detectability of a single pellet is highly degraded beyond a depth of 3 inches. This methodology was set up to be consistent with the MCNP calculations used to establish criticality safety limits for site excavation. For the purpose of FSS a more appropriate methodology was determined to have the detector held at a distance of no more than 1 inch from the ground surface with an emphasis on holding the detector as close as practical to the ground surface.

With the information gained from the test and evaluation it was determined to terminate the FSS that was in process. The FSS plan for LSA 05-02 was subsequently revised to include the distance requirement for GWS utilizing the methodology derived from the test and evaluation LSA 05-02 as stated in the revised survey instructions. The change to the FSS survey methodology of a GWS performed no more than 1 inch from the surface was implemented through revision to all future survey instruction documents. LSA 05-02 was resurveyed and remediated based upon the survey results.

Figure 3-12
LSA 05-02 Prepared for Final Status Survey



3.3.3 Remedial Actions LSA 05-03

Remedial actions began in LSA 05-03 (which at that time was designated as LSA 05-02), the Wood Barn Area of the Barns Area, in December 2012.

Remediation in LSA 05-03 consisted of soil remediation. Once soil remediation was completed FSS activities commenced in the SU. Subsequent to the commencement of FSS activities chemical analysis of soil samples indicated the need to perform further remediation for chemical contamination. FSS was subsequently restarted after successful chemical contamination remediation.

3.3.4 Remedial Actions LSA 05-04

Section 3.3.1 provides a description of remediation activities within LSA 05-04 when the SU was designated LSA 05-01. As previously discussed the remediation effort in LSA 05-01 required the establishment of LSA 05-04 which in addition to including a portion of former LSA 05-01 SU now encompassed the land area that is the headwater area of the Site Pond. Therefore, subsequent to the remediation activities as discussed in Section 3.3.1 further remediation of LSA 05-04 was paused. For logistic and work activity reason the remediation of LSA 05-04 was then scheduled to coincide with the remediation of the Site Pond Area. This would allow access to LSA 05-04 after Site Spring and Site Pond water was diverted and removed from the area. Thus allowing access of the heavy equipment required to perform the remediation. Upon remediation of the radioactive and chemical contamination the SU was prepared for FSS.

3.3.5 In Process Remedial Action Support Surveys

During excavation and remediation of LSA 05, the Barns Area, remedial action support surveys were conducted in accordance with procedure HDP-PR-HP-601, *Remedial Action Support Surveys*. The radiological information obtained from the surveys served the purpose of categorizing the soil/debris into one of three categories; 1) Soil/debris potentially containing radioactivity concentrations above the Reuse Material Screening Level (RML), 2) Soil expected to contain radioactivity concentrations that were less than the RML but requiring removal in order to access additional soil/debris having radioactivity concentrations above the RML, and 3) Soil expected to contain radioactivity concentrations that are less than the RML and not requiring removal.

3.3.6 Nuclear Criticality Safety (NCS) Borings

NCS Borings were not required within LSA 05 as the area was never subject to NCS controls.

3.3.7 Groundwater Monitoring Wells

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

During the history of site operations and remediation no groundwater monitoring wells were located within the boundary limits of LSA 05-01 and LSA 05-03.

One monitoring well was located in LSA-05-02. Monitoring well RR-05 was installed in LSA-05-02 on June 2, 2004 to assess potential groundwater impact in the Red Room Roof Burial Area in conjunction with the Remedial Investigation activities. This monitoring well was constructed to a total depth of 26 ft below ground surface and its screen was isolated to the silty clay zone. Monitoring well RR-05 was abandoned on August 15, 2006. 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 RR-05 included tremie grouting the well from the bottom to top and the removal of the upper 17.6 feet of PVC riser pipe.

Three monitoring wells were/are located in LSA-05-04. Hybrid well CB-02 (total depth 31.5 ft) was installed on June 2, 2004. This well was installed to assess potential groundwater impact in the Cistern Burn Pit area in conjunction with the Remedial Investigation activities. Well CB-02 was abandoned on August 15, 2006. 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 CB-02 included tremie grouting the well from the bottom to top and the removal of the upper 29.5 feet of PVC riser pipe.

Monitoring well GW-AA (total depth 29.9 ft) was installed on September 10, 2009 and its screen was isolated in the sand/gravel hydrostratigraphic unit. This monitoring well was abandoned on November 6, 2013. The well was overdrilled with 8 inch Outside Diameter Hollow Stem Augers to remove the existing well materials including PVC screen, PVC riser, sand filter pack and grout. The well overdrilling was advanced to the top of bedrock. Following the removal of the

well materials, the borehole was tremie grouted from the bottom to top in accordance with MDNR regulations (10 CSR 23-4.080).

Post-remediation monitoring well GW-HH was installed on June 6, 2016. This well is installed to a depth of 29.5 ft and is screened in the sand/gravel hydrostatigraphic unit. Monitoring well GW-HH was installed to collect groundwater samples during the post-remediation phase of decommissioning. The results of this monitoring well are presented in FSSFR Volume 6.

3.3.8 Subterranean Piping

Preliminary remediation planning activities indicated that Site Spring inlet and transfer piping should be encountered in LSA 05-01 and LSA 05-04, and that a portion of an abandoned public water line would be encountered in LSA 05-02 and LSA 05-03. As LSA 05 is not within the area of the former Process Buildings and site warehouse no process piping would be present or encountered within LSA 05.

As described in Section 3.3.1, the Site Spring inlet and transfer pipe was replaced with a new pipe. As such, there is no dose associated with this piping in LSA 05-01.

The abandoned public water piping line encountered in LSA 05-02 and LSA 05-03 was removed and disposed of. As such, there is no dose associated with piping in LSA 05-02 and LSA 05-03.

A portion of piping SU STM-6 remains in LSA 05-04, therefore 0.5 mrem/yr will be added to the LSA 05-04 total dose summation to account for the remaining subterranean piping dose contribution.

3.3.9 Characterization Core Bores

Radiological characterization surveys for the HDP were conducted in several phases by multiple contractors over several years prior to the issuance of the DP. A total of twenty-seven (27) core borings to depths as deep as 35 feet bgs were performed for characterization within LSA 05-01, LSA 05-02, LSA 05-03, and LSA 05-04 prior to remediation.

Within LSA 05-01, one of the four characterization boring locations within the SU exceeded a SOF of 1 as compared to the Uniform Stratum criteria (sample NB-124) up to a maximum depth of 4.55 ft bgs. Remediation progress was reviewed to ensure that the soil in the area of the sample was adequately removed during remediation with the excavation of soil occurring to average depths of 7 to 10 feet bgs at this location.

Within LSA 05-02, two of the seven characterization boring locations within the SU exceeded a SOF of 1 as compared to the Uniform Stratum criteria (samples SO-RR6 and RR-01) up to a maximum depth of 1 ft bgs. Remediation progress was reviewed to ensure that the soil in the area of the samples was adequately removed during remediation with excavation of soil occurring to average depths of 4 to 5 feet bgs at these locations.

Within LSA 05-03, one of the five characterization boring locations within the SU exceeded a SOF of 1 as compared to the Uniform Stratum criteria (sample OA-04) up to a maximum depth of 1 ft bgs. Remediation progress was reviewed to ensure that the soil in the area of the soil

sample was adequately removed during remediation with excavation of soil occurring to average depths of 4 to 5 feet bgs at this location.

Within LSA 05-04, one of the eleven characterization boring locations within the SU exceeded a SOF of 1 as compared to the Uniform Stratum criteria (sample SW-01) up to a maximum depth of 1 ft bgs. Remediation progress was reviewed to ensure that the soil in the area of the soil sample was adequately removed during remediation with excavation of soil occurring to average depths of 8 to 10 feet bgs at this location.

Figures 3-13 through Figure 3-16 provide the location of the characterization samples taken in each SU.

Figure 3-13
Site Characterization Borings within LSA 05-01

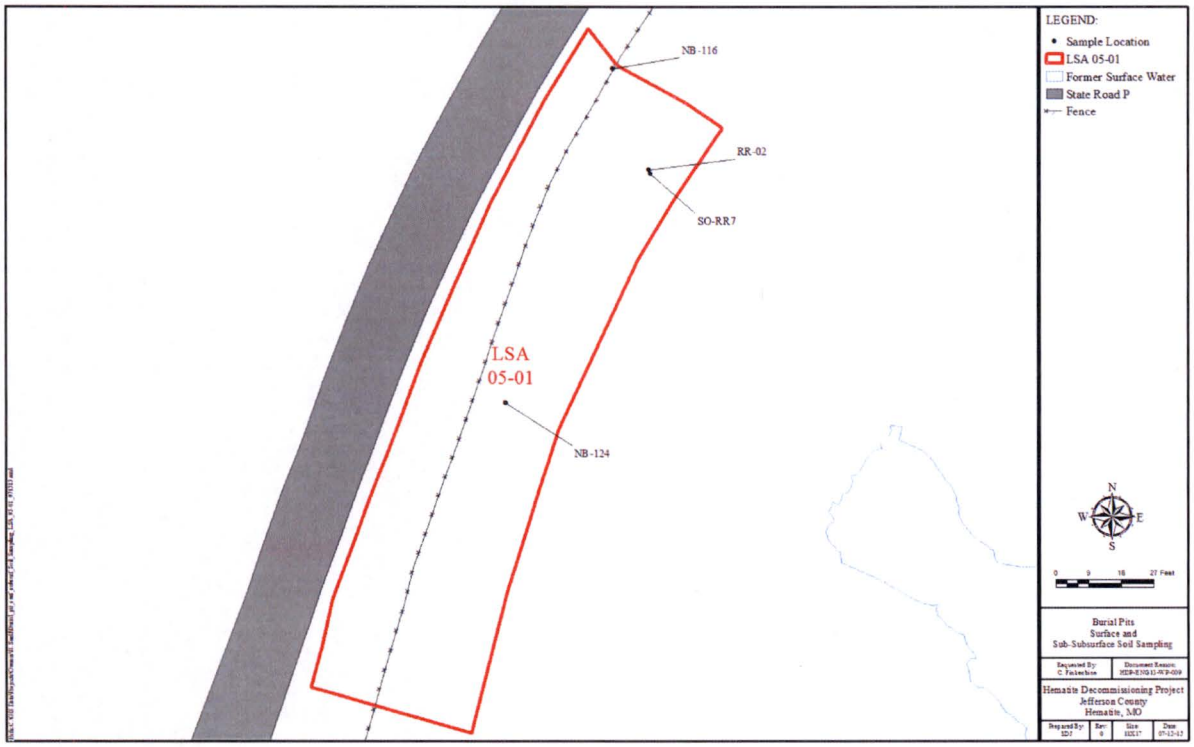


Figure 3-14
Site Characterization Borings within LSA 05-02

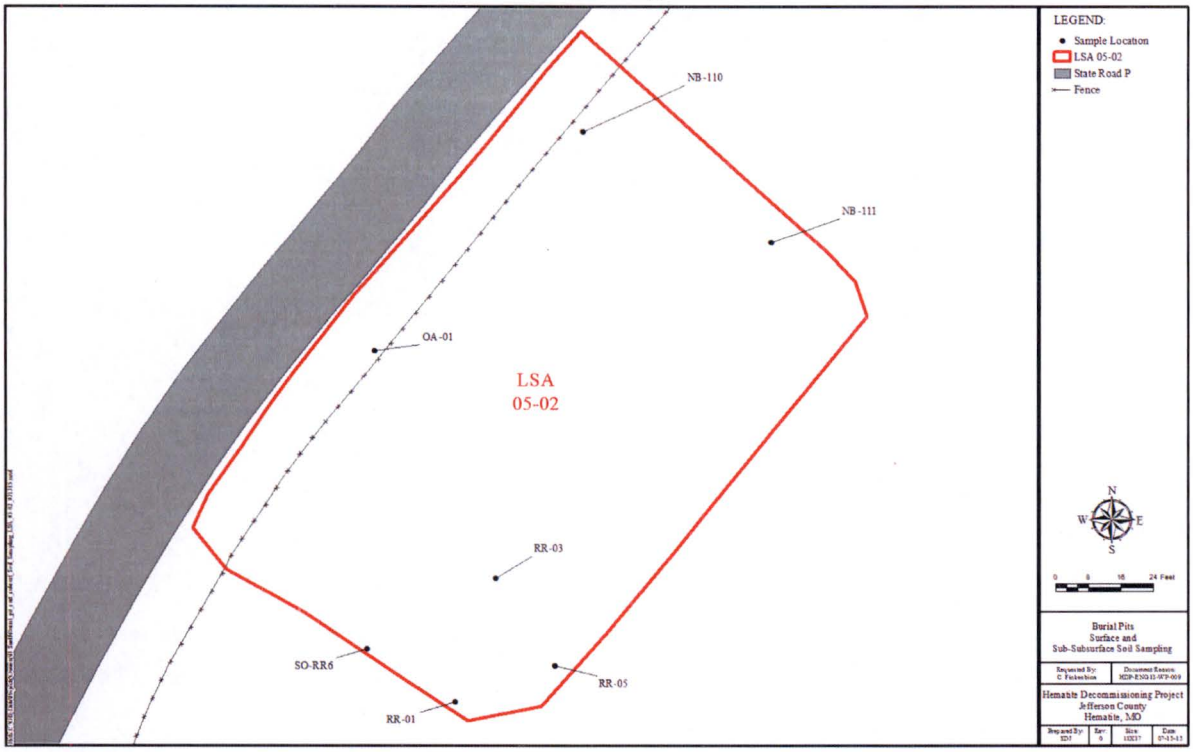


Figure 3-15
Site Characterization Borings within LSA 05-03

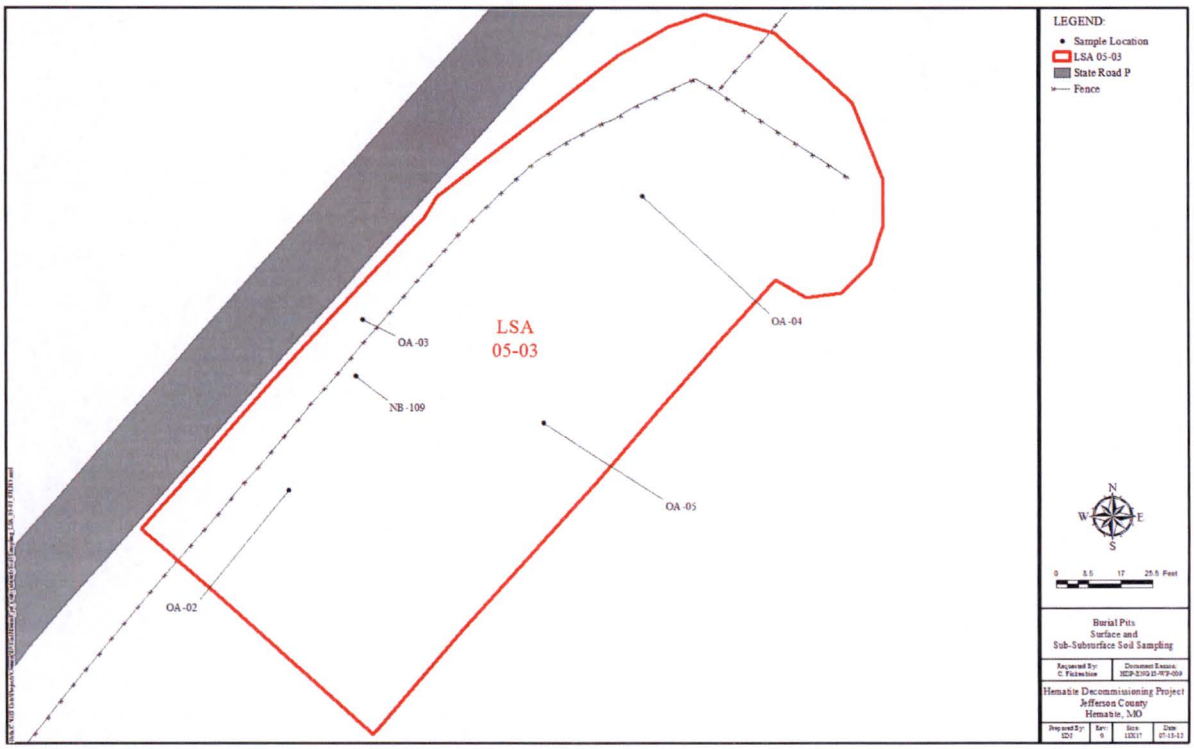
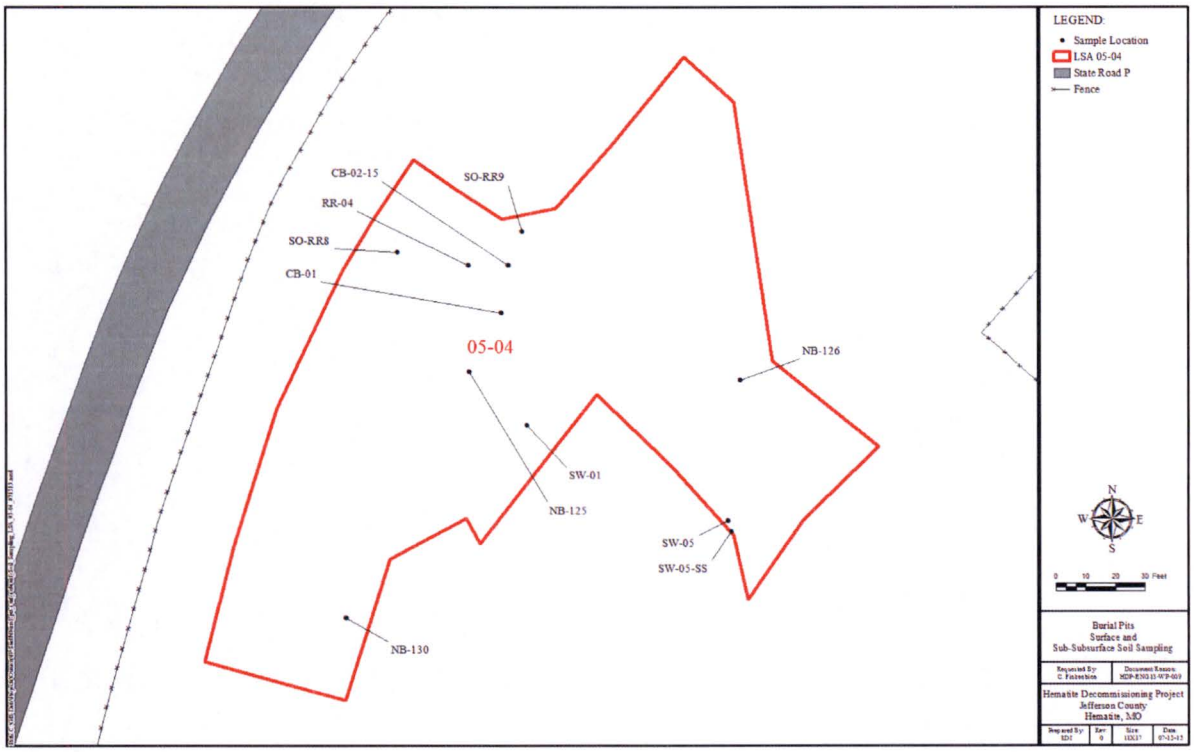


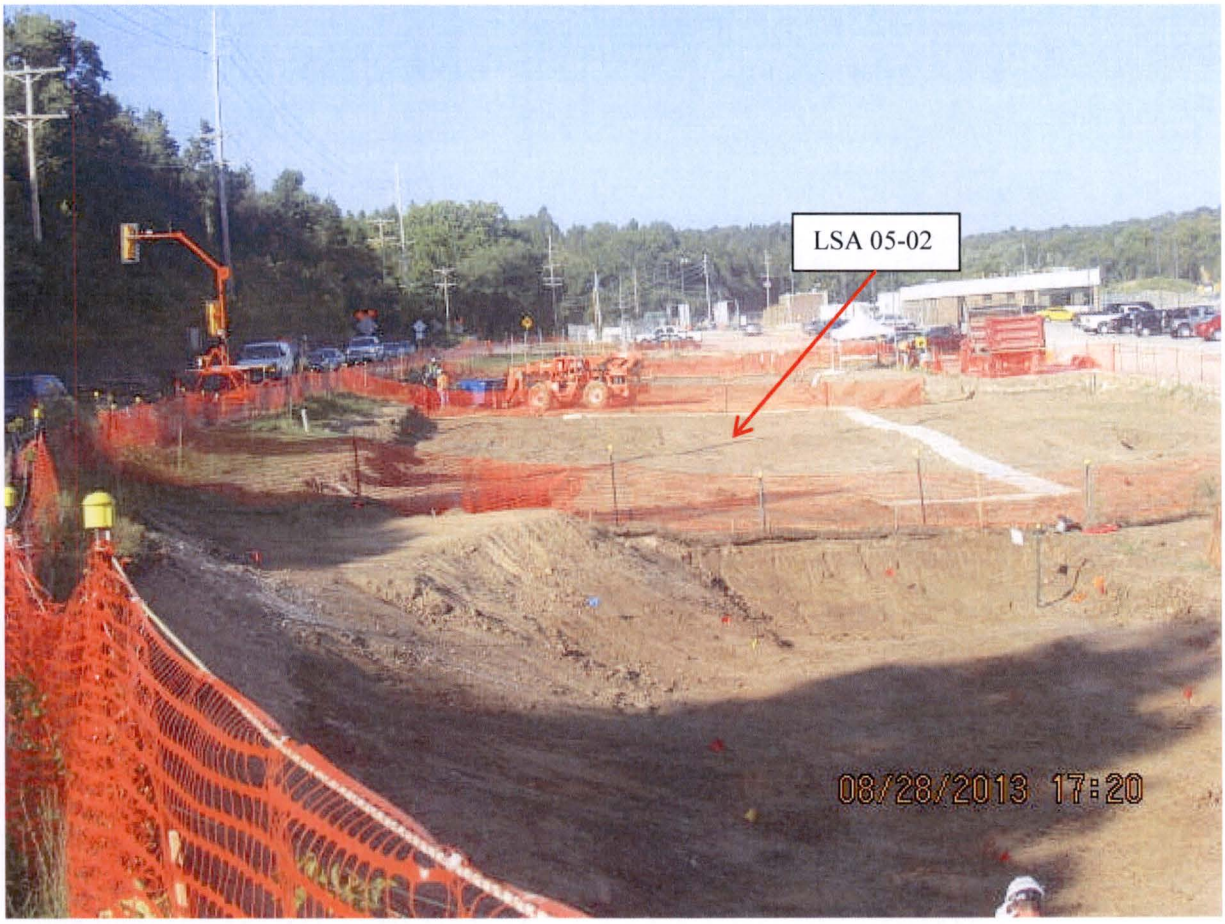
Figure 3-16
Site Characterization Borings within LSA 05-04



3.3.10 Remedial Action Support Survey for FSS Design

The RASS was conducted 1) to guide remediation activities, 2) to determine when an area or SU had been adequately prepared for FSS, and 3) to provide updated estimates of the parameters to be used for planning the FSS. Upon completion of remediation within the SU and prior to implementation of FSS activities, a final RASS was performed to validate the status of the SU prior to implementing Isolation and Control (I & C) postings. The I & C posting for LSA 05-01, LSA 05-02, LSA 05-03, and LSA 05-04 were completed on various dates ranging from August, 2013 to November, 2015. Figure 3-17 is a photograph provided as an example, which shows LSA 05-02 ready for final RASS to support FSS Design.

Figure 3-17
LSA 05-02 Isolation and Control for FSS Design



The RASS of each SU included a GWS, systematic surface sample collection based on a random start triangular grid (ranging from 8 to 19 samples per SU), and biased surface sampling. For LSA 05-01 a mixture of on-site soil data, and previously collected characterization data was used. For LSA 05-02 and LSA 05-03, soil samples were analyzed onsite by gamma spectroscopy, no Tc-99 sampling was performed during the RASS of these SUs. Instead, historic Tc-99 data was reviewed to determine the potential for residual Tc-99 contamination in LSA 05-01 and LSA 05-02. For LSA 05-04 all RASS soil samples were analyzed at the offsite laboratory. 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 05-01 Through LSA 05-04

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
05-01	0.18	0.52	4.65	9.96	NEG	0.28	4.63	11.9	0.16	0.64	0.22	2.47
05-02	0.36	0.71	-	-	0.16	0.33	14.0	36.7	0.52	1.39	2.13	12.5
05-03	0.41	0.72	-	-	0.13	0.35	10.2	29.0	0.45	1.60	1.72	9.56
05-04	NEG	NEG	1.75	9.37	0.03	0.18	4.68	14.3	0.26	0.79	1.40	3.53
DCGL[3]	1.9		25.1		2.0		195.4		51.6		168.8	

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

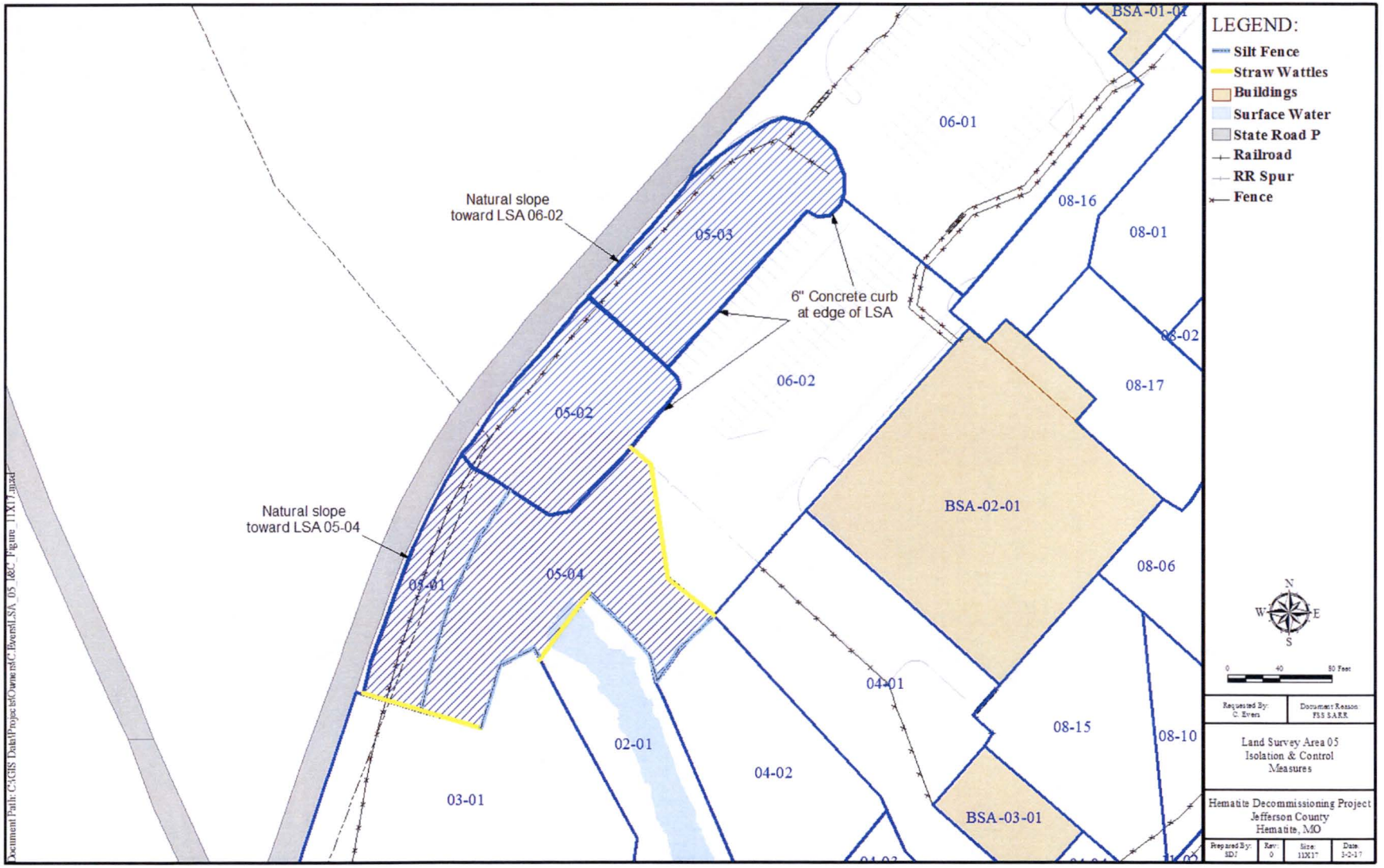
All Final RASS systematic sample and biased sample results were less than the appropriate $DCGL_w$ (Uniform Stratum) and the Final RASS data set was considered sufficient to support FSS design.

3.3.11 Isolation and Control

As directed by HDP-PR-HP-602, *Data Package Development and Isolation and Control Measures to Support Final Status Survey,* LSA 05-01, LSA 05-02, LSA 05-03, and LSA 05-04 were isolated and controlled in accordance with Work Package HDP-WP-ENG-803, *Isolation and Control Measures,* (See Figure 3-18). Isolation and control measures included silt fence, straw wattle, and soil berms between these SUs and the adjacent remediation area to ensure that cross-contamination of these LSAs undergoing FSS did not occur.

The administrative control of distinctive green and white rope with multiple postings labeled "Contact Health Physics Prior to Entry" was installed around the entire perimeter of the SUs prior to FSS field activities to prevent inadvertent entry by site personnel. LSA 05-01, LSA 05-02, LSA 05-03 and LSA 05-04 are located within the fenced security perimeter of the HDP which therefore inhibits access by the general public.

Figure 3-18
Isolation and Control of Area Containing LSA 05-01 through LSA 05-04



3.3.12 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). The surveillance includes the routine visual inspection of the integrity of the I & C measures implemented for LSA 05-01, LSA 05-02, LSA 05-03, and LSA 05-04. If a SU is suspected of having been re-contaminated then an investigation survey will be performed to reconfirm the FSS survey validity.

LSA 05 as a consequence of its location on the site and the sequence of remediation activities within the LSA provided no risk of re-contamination of any SU within LSA 05. LSA 05-01, LSA 05-02 and LSA 05-03 are bounded on the northwest boundaries of the SUs by State Road P a public road which does not contain radioactive material (see Figure 3-18). Therefore there is not a possibility of contamination from up-gradient land areas (State Road P).

LSA 06-01 and LSA 06-02 are below the grade of LSA 05-02 and LSA 05-03 (see Figure 3-25) and are Class 3 and Class 2 SU respectively. Therefore, there is not a possibility of recontamination LSA 05-02 or LSA 05-03 from LSA 06-01 and LSA 06-02.

LSA 05-04 is down-gradient of LSA 05-01 and LSA 05-02. The remediation and FSS of LSA 05-04 was completed after the completion of FSS in LSA 05-01 and LSA 05-02. Therefore, there is not a possibility of recontamination LSA 05-04 from LSA 05-01 and LSA 06-02. LSA 03-01 is adjacent to the western boundary of LSA 05-04 and is a Class 3 SU. As such it does not present the possibility of recontamination of LSA 05-04. LSA 02-01 is down-gradient of LSA 05-04 and therefore does not present a possibility of recontamination of LSA 05-04.

3.3.13 Backfill of Survey Units

Although not a function of remediation, but as described in the DP Section 8.8, LSA 05-01, LSA 05-02 and LSA 05-03 were backfilled with "off-site borrow" soil from the Horine Road (sub-surface backfill) and Huskey Road (topsoil) sites. Further details on off-site "borrow" soil can be found in FSSFR Volume 2, Chapter 8.

As a result of the identification of a fuel pellet fragment identified in LSA 05-02 (as described in detail in section 17.1) it was identified that there was a possibility that fuel pellet fragments may exist in previously processed reuse soil. As such, the RSO and the remediation contractor established a process assumed to provide efficient operations while ensuring adequate survey to identify a fuel pellet fragment. A layer of reuse soil would be placed within LSA 05-02 and surveyed to identify a fuel pellet fragment.

An approximate 6 inch layer (estimated 275 cubic yards) of Reuse Stockpile 2 was placed in LSA 05-02 and the requisite GWS was performed. At the completion of the first layer of reuse soil transport, spreading and GWS in LSA 05-02 the soil was found to be acceptable. A review of the process was determined by the remediation contractor to be inefficient. The process was abandoned with the single layer of Reuse Stockpile 2 remaining in LSA 05-02. The dose impact associated with Reuse Stockpile 2 is assigned to LSA 05-02. LSA 05-02 was subsequently backfilled with off-site borrow material.

As a consequence of the inefficiency of surveying each layer of reuse soil being place in a SU process the remediation contractor and site staff pursued and established the use of the ISO-Pacific S3 Soil Sorting System to process reuse soil for the presence of fuel pellet fragments. This process proved to be more efficient. See FSSFR Volume 2, Chapter 1 for a detailed discussion of the ISO-Pacific S3 Soil Sorting System

During backfill operations 238 cubic yards of Reuse Stockpile 8b was placed in LSA 05-04. The dose impact associated with Reuse Stockpile 8b is assigned to LSA 05-04.

3.3.14 Groundwater Monitoring

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

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

As stated in the Executive Summary section, the exposure results of this report will be combined with the dose attributed to groundwater to demonstrate that the site has met the requirements for unrestricted release consistent with the requirements of the Title 10 CFR 20 Subpart E, "Criteria for License Termination." As such, for the purpose of this report, groundwater will be assigned a conservative SOF of 0.16 which equates to 4 mrem/yr (milliroentgen equivalent man/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 05-01, LSA 05-02, LSA 05-03 and LSA 05-04 will be reported in FSSFR Volume 7 reflecting the updated results of the post-remediation groundwater monitoring.

4.0 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 05-01, LSA 05-02, LSA 05-03 and LSA 05-04. Table 4-1 provides the applicable DCGLs.

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

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

[a] Table as presented in FSSFR Volume 3, Chapter 1.
[b] The reported DCGLw's are the activities for the parent radionuclide and were calculated to account for the dose contribution from insignificant radionuclides.
[c] +D indicates the $DCGL_w$ includes short-lived (half-life ≤ 6 mo.) decay products.
[d] +C indicates the $DCGL_w$ includes all radionuclides in the associated decay chain.

As the release criteria for all BSA SUs is common, FSSFR Volume 4, Chapter 1, Section 3.0, *Release Criteria*, provides a detailed discussion on the release criteria that is applicable to BSA 05-01 and BSA 05-02. Table 4-2 provides the applicable DCGLs.

Table 4-2
Building and Structural Surfaces Gross Radioactivity $DCGL_w$ for Small Office

Radionuclide	$DCGL_w$ (dpm/100 cm^2)	Radioactivity Fractions Based on Characterization Data [a]
U-234	20,000	8.27E-01
U-235 + D	19,000	3.72E-02
U-238 + D	21,000	1.27E-01
Tc-99	13,000,000	2.83E-03
Th-232 + C	1,200	3.21E-03
Np-237 + D	2,700	5.57E-05
Pu-239/240	3,500	2.03E-06
Am-241	3,400	2.68E-03
Totals:		**1.0**
Gross Activity $DCGL_w$ (dpm/100 cm^2) [b] :		**18,925**

[a] Values are taken from Table 4-1 of DP Chapter 4.
[b] Calculated using Equation 4-4 of MARSSIM and rounded down (truncated) to two significant figures.

5.0 FINAL STATUS SURVEY DESIGN LSA 05-01

This section of the report describes the method for determining the number of samples required for the FSS of LSA 05-01 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 05-01 and the detection sensitivities are also discussed.

5.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 05-01 were driven by the type (Open Land) and Class (Class 1) of the SU and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 2, *Final Status Survey Plan Development*, February 2013.

5.1.1 Surrogate Evaluation Areas

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

5.1.2 $DCGL_w$

During the FSS design process a review was performed of the historic characterization data for LSA 05-01. The review identified one area that was previously found to exceed a Uniform SOF of 1.0 (discussed in Section 3.3.9). Next the remediation history was reviewed to confirm that the area was adequately addressed, and the RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform $DCGL_w$. Therefore the Uniform $DCGL_w$ was selected for use in demonstrating compliance with the release criteria.

5.1.3 GWS Coverage

As a Class 1 SU, LSA 05-01 was required to undergo a 100% GWS.

5.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 05-01 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)

As background levels were approximately 10,000 counts per minute (cpm) within LSA 05-01, the scan minimal detection concentration (MDC) calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

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

Equation 5-1

In order to calculate the Scan MDC for total uranium using the above equation, an average enrichment for the SU must be known which in turn will provide relative isotopic fractions for U-234, U-235, and U-238 as given in Appendix G of HDP-PR-FSS-701, Revision 2, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 05-01, the average enrichment for the SU was 2.73%.

Standard Scan MDCs for Radium-226 and Thorium-232 using a 2" x 2" NaI detector are found in Table 6.4 of NUREG-1507 and are shown in Table 5-1. Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 05-01 are shown below:

Table 5-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 05-01

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 05-01	74.7	25.9	2.8	2.8	1.8	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 Plans prepared for the SU prior to FSS. See Section 9.2 for a discussion of the changes made to Scan MDC calculations after FSS was originally performed based on commitments made to the NRC.

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 FSS in LSA 05-01 was performed prior to the development of HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 Areas at the Westinghouse Hematite Site*" which established a standard Scan IAL for all Class 1 SU's at the Hematite Site. The IAL used during the GWS of LSA 05-01 was established at 1,352 net counts per minute (ncpm) which was a calculated value equivalent to the expected scan rate for a potential hot spot representing the $DCGL_w$ for Total Uranium of 74.7 pCi/g (using a U-235 enrichment of 2.73%). Given that this Scan IAL is conservative compared to the value of 4,000 ncpm prescribed by the revised HDP FSS program, and that all FSS data is post processed and evaluated as described in FSSFR Volume 3, Chapter 1, Section 6.1.3, the Scan IAL for LSA 05-01 of 1.352 is considered acceptable.

5.1.7 LSA 05-01 FSS Design Summary

The FSS Plans for LSA 05-01 can be found in Appendix G. Table 5-2 presents an overall FSS design and implementation summary for LSA 05-01.

Table 5-2
FSS Design Summary for LSA 05-01

Gamma Walkover Survey (GWS):		
Scan Coverage	100% Accessible Excavation Floor and Wall Surfaces	
Scan MDC	74.7 pCi/g total Uranium (unsaturated soil) 97.6 pCi/g total Uranium (saturated soil)	
Investigation Action Level (IAL)	1,352 net cpm* *After GWS is performed, the data will be examined to confirm areas exceeding the calculated IAL and statistical analysis will determine significance.	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments: Water intrusion has caused less than five percent (<5%) of the floor surfaces adjacent to the toe of the slope (within the footprint of Spring Pipe Section #2) to be underwater and not accessible for scan survey. See the "Specific Instructions" section for compensatory measures that will be used to characterize areas not immediately accessible for scan surveys.
0 – 15 cm (Surface)	4	
15 cm – 1.5 m (Root)	15	
> 1.5m (Excavation)	12	
Biased Survey/Sampling Locations:		
Biased samples may be collected during Gamma Walkover Surveys (at the discretion of the HP Technician), after statistical analysis of the survey data, or at the direction of Radiological Engineering. <u>Inaccessible (Underwater) Sample Locations:</u> Samples will be collected at three stations located within areas that will be underwater. Two samples will be collected from each location (for a total of 6 samples). See Appendix P-4 for detail regarding the depth and location of these samples. <u>Limestone Slope Area:</u> **NOTE:** The purpose of the following biased samples on the slope are to determine the extent of limestone that extends beyond a 1:1 slope, therefore the following samples may be taken prior to isolation and control or any time prior to backfill. Both vertical and horizontal cores will be used to collect samples from the sloped area containing limestone. - **VERTICAL SAMPLES:** Samples will be collected by coring vertically down into the sloped limestone area from 9 stations located on the sloped surface leading up to State Road P. Two samples will be collected from each station for a total of 18 samples. - **HORIZONTAL SAMPLES:** Samples will be collected by coring horizontally into the sloped limestone area from 5 stations located on the sloped surface near State Road P. Two samples will be collected from each station for a total of 10 coring locations. The first sample will be collected to determine the extent of limestone remaining on the hillside. The second sample will collect the remaining 6-inches of soil past the depth of remaining limestone. If no limestone is present, sample the first 6-inches of soil; then sample the next 6-inches of soil. See details from the instructions and the maps provided in subsequent sections of this survey instruction.		
Instrumentation		
Ludlum 2221 with 44-10 (2" x 2" NaI) detector	Used for GWS and to obtain static count rates at biased measurement locations.	

6.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 05-01

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 05-01 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 on the excavation floor and slope 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 excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

Health Physics (HP) Technicians performing GWS in LSA 05-01 used the 1,352 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 for both manual and GPS datalogged GWS.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 12,000 gross counts per minute (gcpm). Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 11,352 to 13,352 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.

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

After the GWS survey was complete, the GPS/GWS data was reviewed by Radiological Engineering and the 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 05-01.

Table 6-1
Systematic Sampling Summary by Stratum for LSA 05-01

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
05-01	1,781	0	6	21	3

6.2.2 Systematic Sampling LSA 05-01

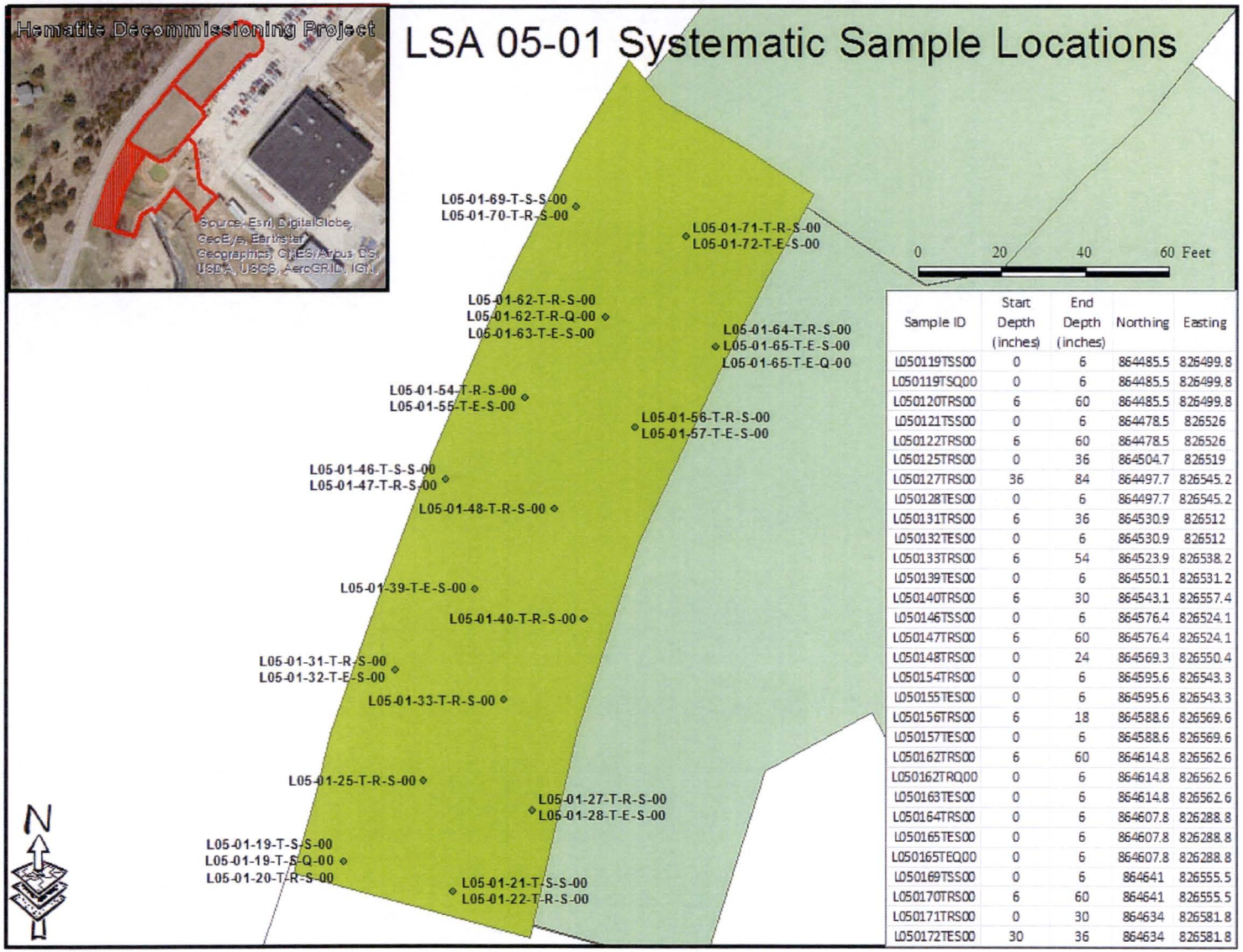
Within LSA 05-01 in its final configuration, there were no systematic locations in which portions of the surface stratum [0 – 15 centimeters (cm)] remained in the SU after remediation. There were six systematic locations in which portions of the root stratum (15 cm – 150 cm) remained in the SU after remediation. Twenty one (21) excavation stratum samples were collected using hand trowels for six-inch grabs, or hand augers as necessary below the existing excavation surface. Given a planar area of 1,781 m^2 for LSA 05-01 and a 16 - point systematic triangular grid, the point-to-point distance within each row was 11.3 m.

While there were sixteen systematic locations on the LSA 05-01 sampling grid, a total of thirty (30) samples were collected at these locations, including:

- Zero (0) samples collected within the remaining surface stratum
- Six (6) samples collected within the remaining root stratum
- Twenty-one (21) samples collected within the excavation, or "deep" stratum
- Three (3) Quality Control (QC) field replicate

Figure 6-1 presents the map of the systematic sample locations which were sampled within LSA 05-01. 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 05-01 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L050119TSS00	0	6	864485.5	826499.8
L050119TSQ00	0	6	864485.5	826499.8
L050120TRS00	6	60	864485.5	826499.8
L050121TSS00	0	6	864478.5	826526
L050122TRS00	6	60	864478.5	826526
L050125TRS00	0	36	864504.7	826519
L050127TRS00	36	84	864497.7	826545.2
L050128TES00	0	6	864497.7	826545.2
L050131TRS00	6	36	864530.9	826512
L050132TES00	0	6	864530.9	826512
L050133TRS00	6	54	864523.9	826538.2
L050139TES00	0	6	864550.1	826531.2
L050140TRS00	6	30	864543.1	826557.4
L050146TSS00	0	6	864576.4	826524.1
L050147TRS00	6	60	864576.4	826524.1
L050148TRS00	0	24	864569.3	826550.4
L050154TRS00	0	6	864595.6	826543.3
L050155TES00	0	6	864595.6	826543.3
L050156TRS00	6	18	864588.6	826569.6
L050157TES00	0	6	864588.6	826569.6
L050162TRS00	6	60	864614.8	826562.6
L050162TRQ00	0	6	864614.8	826562.6
L050163TES00	0	6	864614.8	826562.6
L050164TRS00	0	6	864607.8	826288.8
L050165TES00	0	6	864607.8	826288.8
L050165TEQ00	0	6	864607.8	826288.8
L050169TSS00	0	6	864641	826555.5
L050170TRS00	6	60	864641	826555.5
L050171TRS00	0	30	864634	826581.8
L050172TES00	30	36	864634	826581.8

Table 6-2 below presents a tabular listing of all FSS samples collected within LSA 05-01 with associated IDs, sample types, collection intervals, coordinates, and notes as presented in the FSS Plan (Appendix G).

Table 6-2
FSS Sample Locations and Coordinates for LSA 05-01

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 05 **Description:** Barns and Cistern Open Land Area

Survey Unit: 01 **Description:** Red Room Roof / Limestone Fill / Cistern Burn Pit

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L050119TSS00	Uniform	S	439.8	439.3	864486	826500	Surface 6-in grab
L050120TRS00	Uniform	S	439.3	434.8	864486	826500	Root Zone Composite
L050121TSS00	Uniform	S	435.0	434.5	864479	826526	Surface 6-in grab
L050122TRS00	Uniform	S	434.5	430.0	864479	826526	Root Zone Composite
L050125TRS00	Uniform	S	432.2	429.2	864505	826519	Root Zone Composite
L050127TRS00	Uniform	S	429.4	425.4	864498	826545	Root Zone Composite
L050128TES00	Uniform	S	425.4	424.9	864498	826545	Excavation 6-in Grab
L050131TRS00	Uniform	S	439.0	436.5	864531	826512	Root Zone Composite
L050132TES00	Uniform	S	436.5	436.0	864531	826512	Excavation 6-in Grab
L050133TRS00	Uniform	S	427.7	423.7	864524	826538	Root Zone Composite
L050139TES00	Uniform	S	427.7	427.2	864550	826531	Excavation 6-in Grab
L050140TRS00	Uniform	S	426.6	424.6	864543	826557	Root Zone Composite
L050146TSS00	Uniform	S	441.7	441.2	864576	826524	Surface 6-in grab
L050147TRS00	Uniform	S	441.2	436.7	864576	826524	Root Zone Composite
L050148TRS00	Uniform	S	427.0	425.0	864569	826550	Root Zone Composite
L050154TRS00	Uniform	S	429.1	428.6	864596	826543	Root Zone Composite
L050155TES00	Uniform	S	428.6	428.1	864596	826543	Excavation 6-in Grab
L050156TRS00	Uniform	S	426.4	425.4	864589	826570	Root Zone Composite
L050157TES00	Uniform	S	425.4	424.9	864589	826570	Excavation 6-in Grab
L050162TRS00	Uniform	S	428.1	423.6	864615	826563	Root Zone Composite
L050163TES00	Uniform	S	427.6	427.1	864615	826563	Excavation 6-in Grab
L050164TRS00	Uniform	S	426.6	426.1	864608	826289	Root Zone Composite
L050165TES00	Uniform	S	426.1	425.6	864608	826289	Excavation 6-in Grab
L050169TSS00	Uniform	S	441.5	441.0	864641	826556	Surface 6-in grab
L050170TRS00	Uniform	S	441.0	436.5	864641	826556	Root Zone Composite
L050171TRS00	Uniform	S	428.6	426.1	864634	826582	Root Zone Composite

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L050172TES00	Uniform	S	426.1	425.6	864634	826582	Excavation 6-in Grab
L050119TSQ00	Uniform	Q	439.8	439.3	864486	826500	QA Duplicate Sample
L050162TRQ00	Uniform	Q	428.1	427.6	864615	826563	QA Duplicate Sample
L050165TEQ00	Uniform	Q	426.6	426.1	864608	826289	QA Duplicate Sample
L050176TUB00	Uniform	B	427.8	427.3	864558	826554	Biased 6-in Grab
L050177TUB00	Uniform	B	427.3	426.8	864558	826554	Biased 6-in Grab
L050186TUB00	Uniform	B	427.5	427.0	864572	826559	Biased 6-in Grab
L050187TUB00	Uniform	B	427.0	426.5	864572	826559	Biased 6-in Grab
L050188TUB00	Uniform	B	427.3	426.8	864557	826548	Biased 6-in Grab
L050189TUB00	Uniform	B	426.8	426.3	864557	826548	Biased 6-in Grab
L050190TUB00	Uniform	B	426.9	426.4	864581	826553	Biased 6-in Grab
L050191TUB00	Uniform	B	426.4	425.9	864581	826553	Biased 6-in Grab
L050192TUB00	Uniform	B	427.1	426.6	864569	826551	Biased 6-in Grab
L050193TUB00	Uniform	B	426.6	426.1	864569	826551	Biased 6-in Grab
L050194TUB00	Uniform	B	427.4	426.9	864557	826546	Biased 6-in Grab
L050195TUB00	Uniform	B	426.9	426.4	864557	826546	Biased 6-in Grab
L050196TUB00	Uniform	B	427.6	427.1	864566	826548	Biased 6-in Grab
L050197TUB00	Uniform	B	427.1	426.6	864566	826548	Biased 6-in Grab
L050198TUB00	Uniform	B	427.4	426.9	864596	826553	Biased 6-in Grab
L050199TUB00	Uniform	B	429.3	429.3	864607	826549	Biased 6-in Horizontal Grab
L0501100TUB0	Uniform	B	433.2	433.2	864610	826545	Biased 6-in Horizontal Grab
L0501101TUB0	Uniform	B	428.8	428.8	864615	826558	Biased 6-in Horizontal Grab
L0501102TUB0	Uniform	B	434.4	434.4	864620	826550	Biased 6-in Horizontal Grab
L0501103TUB0	Uniform	B	426.8	426.8	864584	826538	Biased 6-in Horizontal Grab
L0501104TUB0	Uniform	B	426.6	426.1	864548	826537	Biased 6-in Grab
L0501105TUB0	Uniform	B	431.9	431.4	864555	826527	Biased 6-in Grab
L0501106TUB0	Uniform	B	436.9	436.4	864504	826511	Biased 6-in Grab
L0501107TUB0	Uniform	B	436.5	436.0	864553	826521	Biased 6-in 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] (Open Land Area)

CSM: Three-Layer (Surface-Root-Deep) or Uniform

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 05-01 a significant number of biased locations

were selected within the SU, 24 samples in total. These biased samples were based on the evaluation of the GWS survey, or based on the judgment of the Radiological Engineering department.

Due to the proximity of LSA 05-01 to the public roadway State Highway P, and due to the MoDOT restrictions on excavation near the active roadway, a significant number of biased samples were collected within the right of way of the roadway, some collected horizontally into the slope of the roadway. These samples are intended to represent the soil that must be left in place so that the structural integrity of the roadway is not impacted.

It is important to note that during systematic sampling of LSA 05-01, an area of elevated Tc-99 activity was identified exceeding the $DCGL_w$. Additional biased samples were collected in this area, and two of these biased samples also exceeded the $DCGL_w$. An Elevated Measurement Comparison (EMC) investigation was performed on this area, and the successful results of the EMC are presented in the following Section 6.3.1.

6.3.1 EMC Investigation

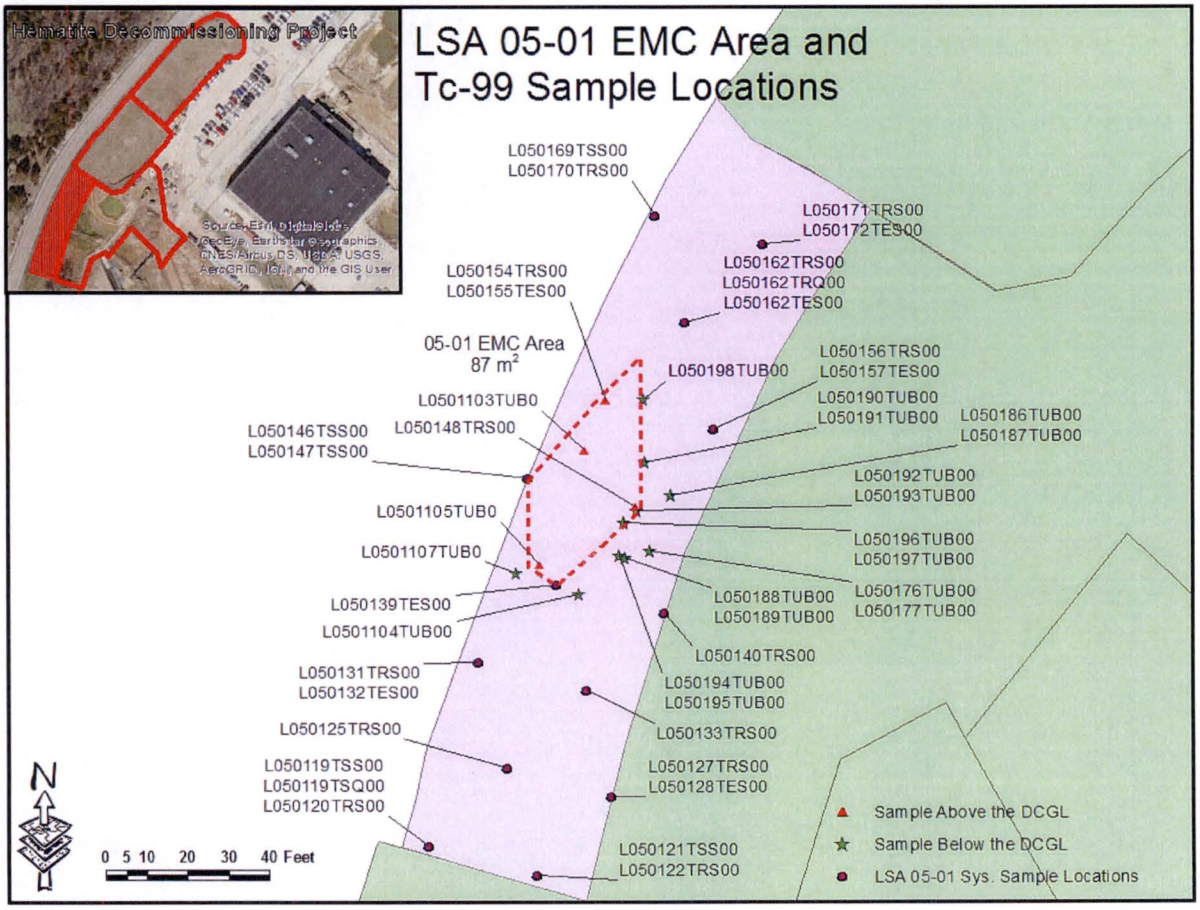
Since several systematic and biased samples from one area of LSA 05-01 exceeded a SOF of 1, an EMC Investigation was performed for the SU as required by Procedure HDP-PR-FSS-721 *Final Status Survey Data Evaluation*. As the elevated sample activity was due to Tc-99, GWS survey data was not used in determining the size or shape of the area. The size of the associated elevated area surrounding this biased location was determined by using the nearest "clean" systematic and biased locations, as well as professional judgment to define a polygonal area of 87 m^2 as calculated by GIS software. This 87 m^2 polygon was placed around the elevated biased sample locations to define the area where the elevated sample activity remains within the SU. To the East, South, and West of the EMC area, there were a significant number of "clean" samples, creating a clear boundary. However to the North of the EMC area, there was less available sample data which required the Health Physics Staff to rely on professional judgment. Since LSA 05-01 borders a public roadway (State Road P), and excavation into the "right of way" of the roadway was limited by the Missouri DOT, less excavation (and thus less sampling) was performed in this area. Three elevated samples were identified to remain in the Northern portion of the EMC area. While there is less available "clean" sample data creating a clear boundary to the North, the area in question is still relatively small. There is less than 15 feet in linear distance from each of the elevated samples, to the nearest "clean" sample. Given these factors, the Health Physics Staff placed the Northern EMC boundary so that the three elevated sample points were completely enclosed within the 87 m^2 polygon, and that the all systematic samples collected above the Northern most boundary of the EMC area were significantly less than the DCGLs.

Furthermore, the Health Physics Staff considered given the radiological conditions of the EMC area what the maximum size of the EMC are could be without exceeding a SF of 1.0 for the SU. Evaluations determined that the area of the EMC would have to exceed 500 m^2 in order for the EMC evaluation to be unsuccessful. Knowing that the allowable maximum area is significantly larger than the actual estimated area provides an additional layer of confidence, but the purpose of the EMC Investigation is to determine the actual radiological conditions that remain in the area, not the allowable maximum, therefore the 87 m^2 polygon is considered appropriate.

Following the steps presented in Section 8.6.7 of HDP-PR-FSS-721, the $DCGL_{EMC}$s for all nuclides were calculated based on the nuclide-specific area factors corresponding to 87 m^2. Then the difference between the average activity for each nuclide in the elevated area, and the average activity of the corresponding nuclide in the general SU area was divided by the nuclide-specific $DCGL_{EMC}$ to determine an activity fraction for each nuclide in the elevated area. These six activity fractions were added together for a total SOF of 0.11 for the EMC area. This SOF is equivalent to a dose of 2.75 mrem/year. Additional information on the EMC calculation can be found in Appendix A.

Figure 6-2 depicts the location of the EMC area in LSA 05-01 as bounded by the dashed lines.

Figure 6-2
EMC Investigation Area within LSA 05-01



6.4 Judgmental/Sidewall Sampling for Tc-99

During the recommencement of FSS activities in early 2015, during a NRC Region III inspection, the NRC Inspector questioned the site staff in regards to the FSS program requirements for excavation side wall sampling. The NRC Inspector was specifically interested in sampling for Tc-99. The site staff reiterated the requirements as provided in the HDP DP Chapter 14.4.4.1.6.2, *Subsurface Soil*, and provided an explanation of how the requirements were implemented within the FSS program and procedures. This topic was conveyed to NRC

Headquarters and subsequently Westinghouse was provided with three options for addressing the issue. After discussions held on Publicly Noticed Teleconference Call {ML1520A324}, Westinghouse and the NRC agreed on a path forward.

> *"NRC staff concluded that the method described in HEM-15-MEMO-039 was acceptable, with the exception that the NRC staff had concerns with the first bullet (i.e., samples would only be taken if the systematic or biased samples from the survey unit exceeded 10% of the applicable DCGLw). Westinghouse committed to revising the memo to delete this bullet and to revise its procedure to include this information. NRC staff also noted that it would also be clearer if a definition of "vertical or near vertical" were included in these documents."*
>
> *"Westinghouse stated that this process would be used in the future and had been used in the past. Westinghouse noted, however, that there are some survey units that have already been backfilled for which this process was not followed. These survey units had shallower excavations and had low Tc-99. Westinghouse will provide justification for the characterization of Tc-99 in the FSSRs for these survey units. NRC staff stated that it will evaluate the information available for those survey units when those FSS reports are submitted to determine if they have been characterized adequately."*

See FSSFR Volume 3, Chapter 1, Section 5.2, *Tc-99 Side Wall Sampling* for further discussion.

The FSS field activities for LSA 05-01 predated the agreed upon path forward. At the time of FSS of LSA 05-01, site FSS procedures implemented the requirements for sampling side walls for Tc-99 as provided in DP Chapter 14.4.4.1.6.2, *Subsurface Soil.*

SU LSA 05-01 is unique in that remediation of the sloped area was limited by requirements of MoDOT to ensure safety of the State Road P support structure. An excavation requirement of a 1 to 1 slope had to be maintained at all times, meaning that the entire surface area of LSA 05-01 was on a 45 degree slope. There were no vertical surfaces, and no slopes greater than 45 degrees were allowed for the structural safety of the roadway. Therefore, neither the sidewall sampling requirements of the FSS program nor the sidewall sampling requirements of HEM-15-MEMO-039 are applicable. However, in order to adequately characterize the soil that was not allowed to be excavated (in the right of way of the highway) horizontal sampling was performed using hand augers to assess the soil that remained in place. While these soil samples were not collected for the purposes of sidewall sampling, they can objectively be called sidewall samples. The 5 samples collected in this manner are identified as "Biased 6-in Horizontal Grab" in Table 6-2.

6.5 Quality Control Soil Sampling

Three QC field duplicate sample points were randomly selected and collected at systematic locations L10-05-19, L05-01-62, and L05-01-65 for LSA 05-01.

7.0 FINAL STATUS SURVEY RESULTS LSA 05-01

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 when GPS data logging was used. Manual surveys of the slopped areas of the SU were documented and reviewed by the Radiological Engineering staff. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same

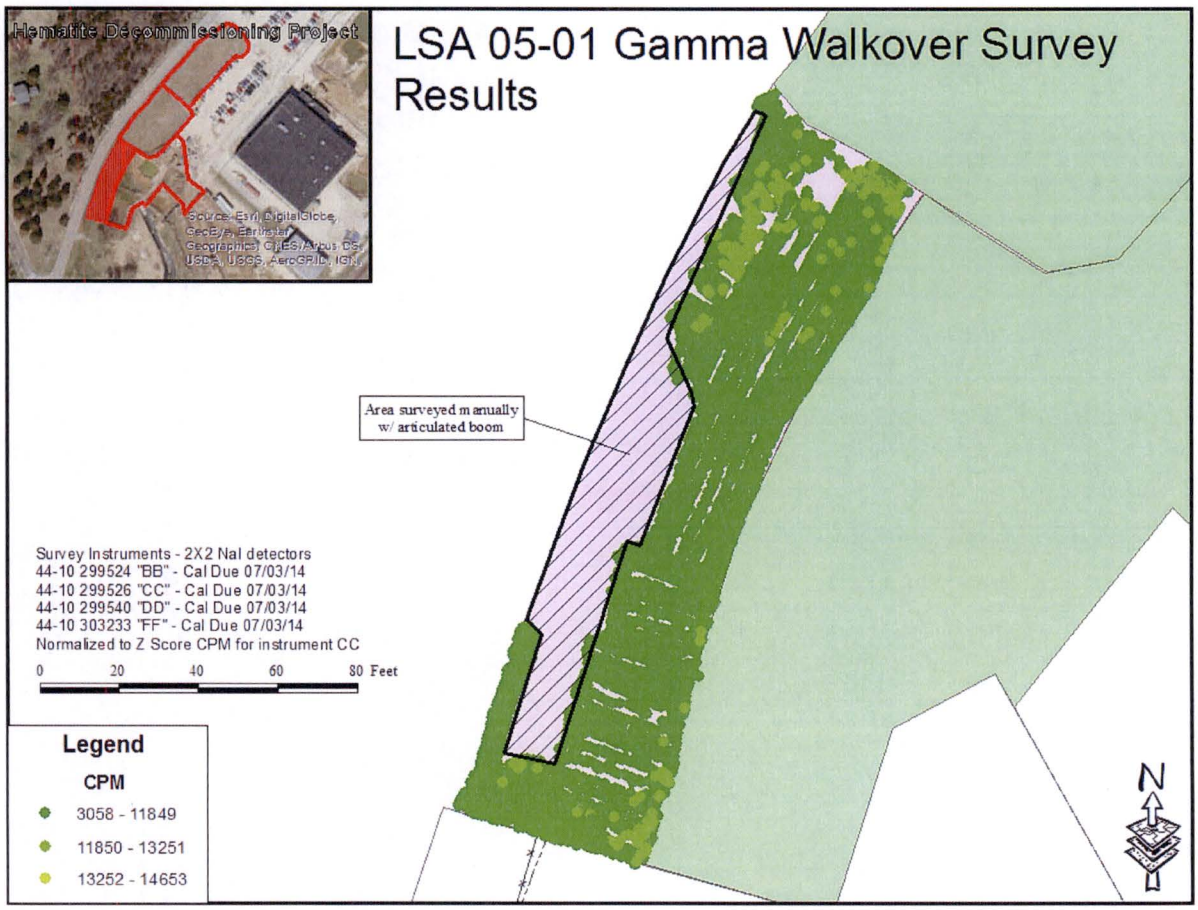
GPS location during the walkover, the most elevated radiological measurements are plotted "on top" (e.g. if any sidewalls featured more elevated readings than the floor directly below, the sidewall radiological measurements would overlie the lower floor readings).

GWS measurements were collected in LSA 05-01 from August 19, 2013, to August 30, 2013.

7.1.1 GWS Results for LSA 05-01

For the datalogged survey data collected in LSA 05-01, GWS count rates ranged between 3,058 gcpm and 13,349 gcpm, with a mean count rate of 8972 gcpm. The median count rate was 9392 gcpm and the standard deviation was 2227 cpm. Figure 7-1 below presents a map of the complete GWS data set.

Figure 7-1
Colorimetric GWS Plot for LSA 05-01



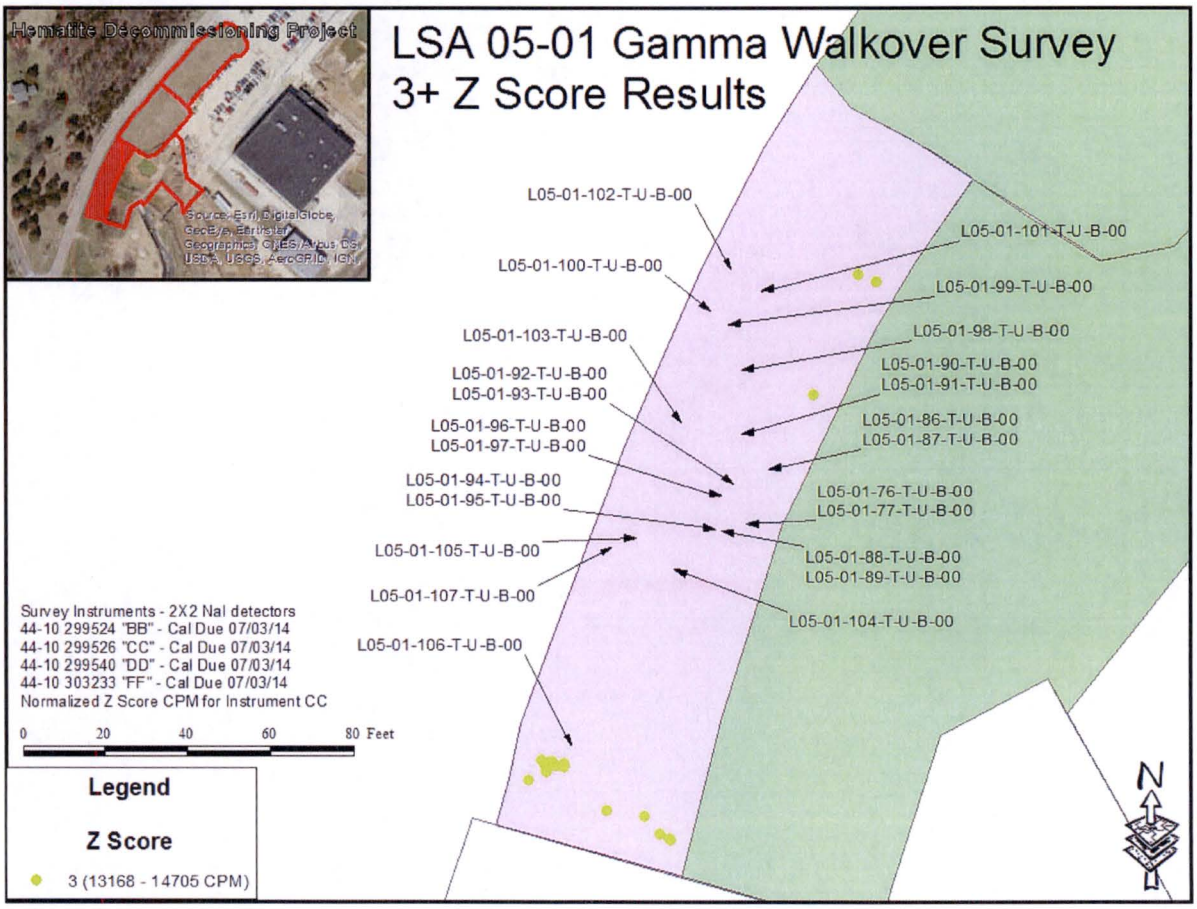
Due to the presence of the large slope of the road bank, a large area of LSA 05-01 was not able to be surveyed using the preferred method of GWS using GPS data logging. This area (as indicated on Figure 7-1 above) was surveyed manually by HP Technicians. The results of the manual surveys were reviewed and it was determined that the portion of the slope manually surveyed did not present any elevated readings. The GWS readings for the surrounding areas

that were surveyed by GWS using GPS datalogging were equivalent to the results of the manual slope survey.

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"). Several locations were selected for biased sample collection based on the evaluation of the GWS data, and the judgment of Radiological Engineering.

Figure 7-2 below presents a map of the +3 Z-score GWS measurements within LSA 05-01, including the selected biased sampling locations.

Figure 7-2
Colorimetric GWS Plot for LSA 05-01 (Measurements > Z-score of 3)



Since the majority of the GWS data collected in LSA 05-01 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015. While manual surveys were also performed within LSA 05-01, the data collected from the manual surveys is considered to be equivalent to the data collected using GPS datalogging from the surrounding areas. Using these parameters, and a 10,000 gcpm general area background, a Scan MDC of approximately 40.9 pCi/g is determined. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*,

prepared after the completion of field FSS activities in LSA 05-01, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. The equation used to derive the revised Total Uranium Scan MDC (with a conservative estimate of 4% enrichment) from Section 1.1.5 of HDP-TBD-FSS-002 (Revision 3, August 2015) is as follows:

$$\text{Scan MDC}_{Total\ Uranium} = \quad 1 \Big/ \left(\left(\frac{0.7928}{3659}\right) + \left(\frac{0.0438}{2.32}\right) + \left(\frac{0.1634}{30.6}\right)\right) = 46.7 \frac{pCi}{g}$$

Equation 7-1

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

7.1.2 GWS Coverage Results LSA 05-01

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. Although 100% of accessible areas underwent GWS, certain portions of the LSA 05-01 interior could not be accessed by GPS datalogging due to especially tall interior excavation sidewalls. These areas appear as greyish-pink blanks in the Figure 7-1 above.

The post survey processing of the GPS data and manual survey records indicated that the GWS covered 89.95% of the SU (see Table 7-1). While this level of coverage is slightly less than the prescribed minimum of 95% coverage, it is clear in viewing the GWS figure above that there minimal elevated gamma measurements existed none of which approached the IAL. Given the extremely low uniform gamma activity across the SU, the lack of any elevated measurements identified during the GWS, and the very high number of systematic and biased samples collected within the SU, the GWS for LSA 05-01 is considered sufficient for the purpose of this FSS.

Table 7-1
GWS Gap Analysis LSA 05-01

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 05-01	139,981	14,064	10.05	89.95	1

7.2 Soil Sample Results LSA 05-01

Appendix A presents the analytical results and associated statistics for all FSS samples collected within LSA 05-01.

7.2.1 Surface Soil Sample Results LSA 05-01

There were no samples collected within the surface stratum (0 – 15 cm). However there were a total of twenty-two (22) systematic soil samples collected within the topmost soil layer of the exposed excavation surface, seventeen (17) biased samples, and two QC field duplicate samples. The maximum SOF result for the "topmost" samples was 2.73 corresponding to the systematic sample LSA 05-01-54-T-R-S-00. An EMC evaluation was performed of this area and the successful results are presented in Section 6.3

7.2.2 Subsurface Soil Sample Results LSA 05-01

There were a total of eleven (11) systematic soil samples collected beneath the topmost soil layer of the exposed excavation surface (considered sub-surface), seven (7) biased samples, and one QC field duplicate samples. The maximum SOF result for the "topmost" samples was 2.73 corresponding to the systematic sample LSA 05-01-54-T-R-S-00.

7.2.3 WRS Test Evaluation for LSA 05-01

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the WRS statistical test was required for LSA 05-01 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 27 systematically collected samples in LSA 05-01 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, (1296) was greater than the critical value (1069) for the test. As such, the null hypothesis that the SU average concentration is greater than the $DCGL_W$ was rejected. The WRS evaluation is also included in Appendix A.

7.2.4 Graphical Data Review LSA 05-01

Table 7-2 below presents summary results for the all 24 systematically collected samples (but not the EMC area, biased or QC samples) collected within LSA 05-01, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.13.

Table 7-2
LSA 05-01 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	0.044	1.453	0.068	2.151	0.114	1.050	**0.13**
Minimum	0.00 (NEG)	0.01	0.00 (NEG)	0.242	0.010	0.330	0.01
Maximum	0.400	11.50	0.290	7.255	0.400	1.710	0.49

Table 7-2 Notes:

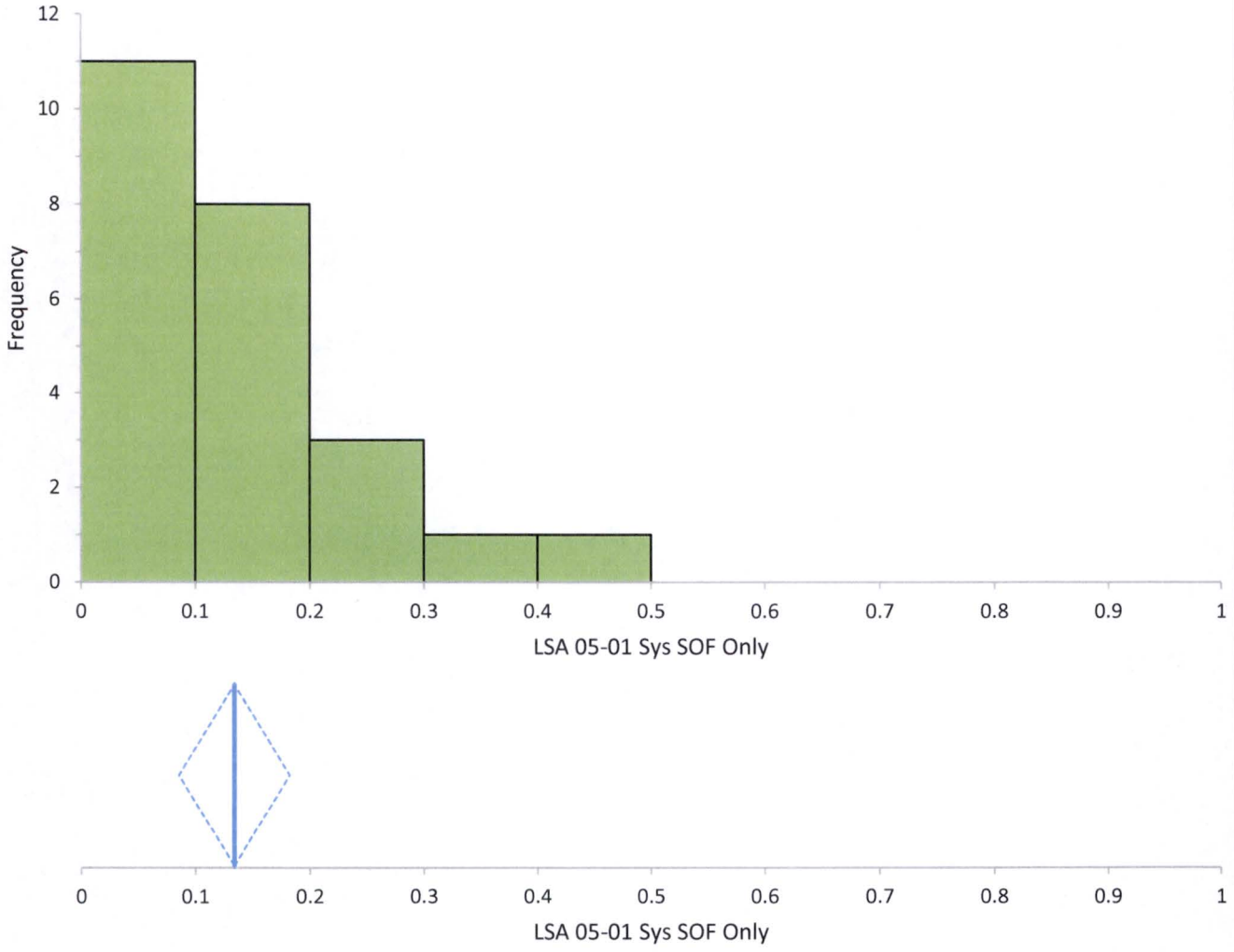
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide 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 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 8 systematically collected samples from LSA 05-01. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 05-01. The middle graph presents the mean SOF (0.13 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.09 to 0.18. The 97.73% confidence interval based on the median (0.12) of the sample results is 0.07 to 0.18. The bottom two charts present the various statistical metrics of the LSA 05-01 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 05-01 data associated with the systematically collected measurement locations.

Figure 7-3
Graphic Statistical Summary for LSA 05-01 (SOF parameter)



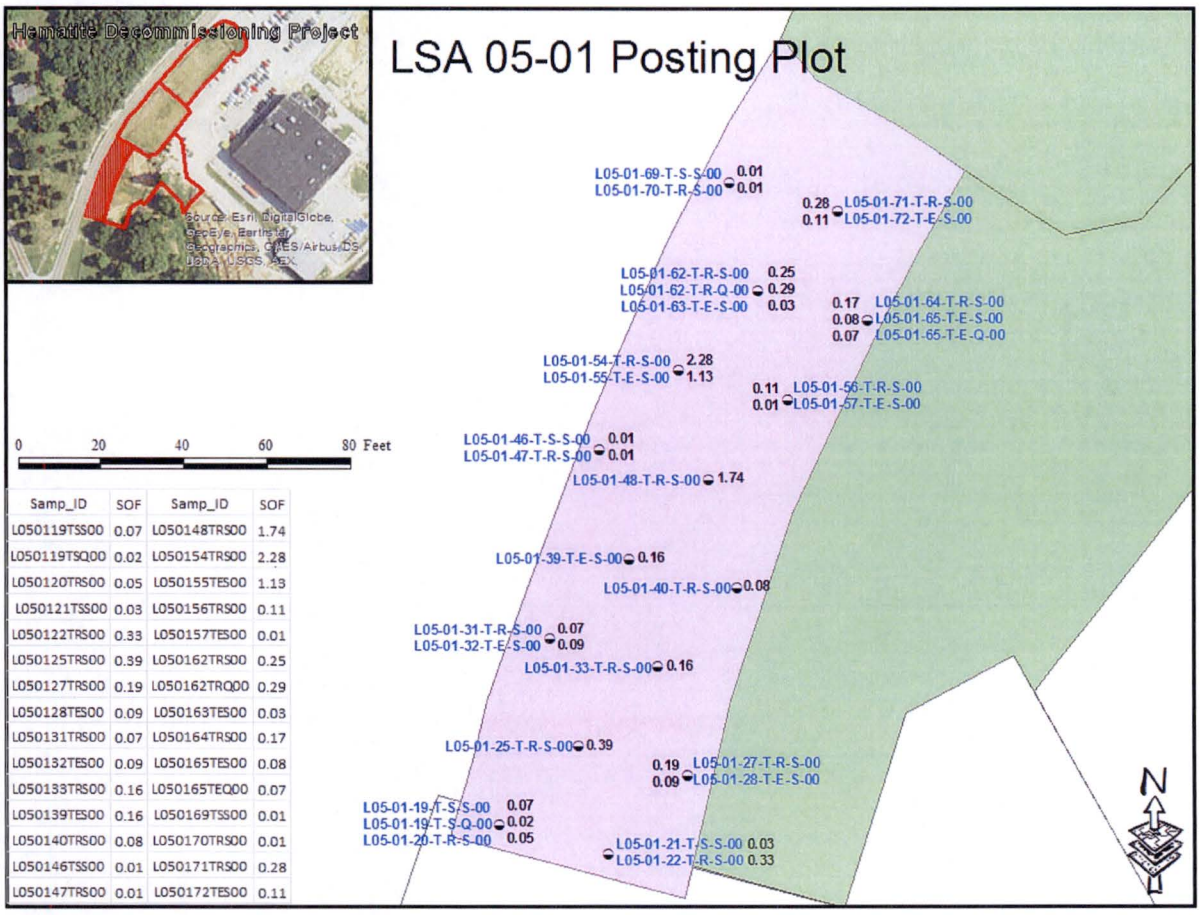
N	24

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 05-01 Sys SOF Only	0.13	0.09	to 0.18	0.023	0.11	0.01	1.6	3.20

	Minimum	1st quartile	Median	97.73% CI		3rd quartile	Maximum	IQR
LSA 05-01 Sys SOF Only	0.01	0.05	0.12	0.07	to 0.18	0.18	0.5	0.13

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 05-01 is presented below in Figure 7-4. Figure 7-4 shows no unusual patterns in the data.

Figure 7-4
Posting Plot for LSA 05-01 Systematic Measurement Locations



Samp_ID	SOF	Samp_ID	SOF
L050119TSS00	0.07	L050148TRS00	1.74
L050119TSQ00	0.02	L050154TRS00	2.28
L050120TRS00	0.05	L050155TES00	1.13
L050121TSS00	0.03	L050156TRS00	0.11
L050122TRS00	0.33	L050157TES00	0.01
L050125TRS00	0.39	L050162TRS00	0.25
L050127TRS00	0.19	L050162TRQ00	0.29
L050128TES00	0.09	L050163TES00	0.03
L050131TRS00	0.07	L050164TRS00	0.17
L050132TES00	0.09	L050165TES00	0.08
L050133TRS00	0.16	L050165TEQ00	0.07
L050139TES00	0.16	L050169TSS00	0.01
L050140TRS00	0.08	L050170TRS00	0.01
L050146TSS00	0.01	L050171TRS00	0.28
L050147TRS00	0.01	L050172TES00	0.11

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

Table 7-3
Final Status Survey Analytical Data: LSA 05-01

Sample ID	Sample Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																										Enr.	SOF_N
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF_N
L050119TSS00	11.13	S	0.97	0.140	0.070	N/A	-0.100	0.000	0.42	0.420	0.110	0.210	N/A	0.89	0.200	0.130	N/A	-0.110	0.000	7.255	NA	NA	NA	0.4	0.200	0.210	N/A	1.09	0.380	0.940	N/A	5.4	0.07
L050120TRS00	15.13	S	0.94	0.130	0.060	N/A	-0.130	0.000	0.3	0.300	0.100	0.200	N/A	0.91	0.140	0.100	N/A	-0.090	0.000	2.224	NA	NA	NA	0.12	0.140	0.230	U	0.93	0.330	0.830	N/A	2.0	0.03
L050121TSS00	3.92	S	0.83	0.140	0.080	N/A	-0.240	0.000	3.11	3.110	0.470	0.210	N/A	0.83	0.150	0.090	N/A	-0.170	0.000	1.137	NA	NA	NA	0.05	0.100	0.240	U	1.61	0.610	0.760	N/A	0.5	0.14
L050122TRS00	7.92	S	1.23	0.180	0.080	N/A	0.160	0.160	0.4	0.400	0.070	0.230	N/A	1.28	0.240	0.160	N/A	0.280	0.280	1.264	NA	NA	NA	0.06	0.160	0.330	U	1.5	0.770	1.000	N/A	0.7	0.26
L050125TRS00	9.96	S	1.47	0.240	0.100	N/A	0.400	0.400	2.97	2.970	0.470	0.280	N/A	0.5	0.190	0.270	N/A	-0.500	0.000	2.188	NA	NA	NA	0.12	0.280	0.460	U	0.66	0.550	1.920	U	2.8	0.35
L050127TRS00	4.23	S	1.07	0.150	0.070	N/A	0.000	0.000	0.38	0.380	0.040	0.220	N/A	1.13	0.170	0.110	N/A	0.130	0.130	2.062	NA	NA	NA	0.11	0.110	0.190	U	1.03	0.330	0.770	N/A	1.7	0.10
L050128TES00	0.73	S	1.04	0.160	0.090	N/A	-0.030	0.000	0.28	0.280	0.040	0.220	N/A	1.29	0.190	0.120	N/A	0.290	0.290	2.498	NA	NA	NA	0.13	0.120	0.190	U	1.55	0.750	0.950	N/A	1.3	0.18
L050131TRS00	13.12	S	0.66	0.110	0.060	N/A	-0.410	0.000	1.52	1.520	0.190	0.200	N/A	0.43	0.090	0.060	N/A	-0.570	0.000	2.548	NA	NA	NA	0.14	0.100	0.130	N/A	0.72	0.220	0.520	N/A	3.0	0.08
L050132TES00	11.12	S	1.18	0.190	0.090	N/A	0.110	0.110	2.5	2.500	0.260	0.190	N/A	0.74	0.140	0.080	N/A	-0.260	0.000	2.691	NA	NA	NA	0.14	0.190	0.330	U	1.71	0.500	1.300	N/A	1.3	0.18
L050133TRS00	7.42	S	1	0.140	0.050	N/A	-0.070	0.000	2.94	2.940	0.330	0.200	N/A	0.8	0.140	0.090	N/A	-0.200	0.000	1.884	NA	NA	NA	0.1	0.120	0.200	U	0.99	0.550	0.720	N/A	1.6	0.13
L050139TES00	7.76	S	0.72	0.120	0.050	N/A	-0.350	0.000	11.5	11.500	1.720	0.190	N/A	0.37	0.110	0.120	N/A	-0.630	0.000	4.404	NA	NA	NA	0.24	0.110	0.150	N/A	1.52	0.360	0.680	N/A	2.4	0.49
L050140TRS00	2.27	S	0.64	0.100	0.060	N/A	-0.430	0.000	1.86	1.860	0.220	0.200	N/A	0.43	0.090	0.050	N/A	-0.570	0.000	1.054	NA	NA	NA	0.05	0.110	0.180	U	1.13	0.520	0.620	N/A	0.7	0.09
L050146TSS00	11.79	S	0.57	0.080	0.040	N/A	-0.500	0.000	0.11	0.110	0.070	0.190	N/A	0.19	0.050	0.060	N/A	-0.810	0.000	1.635	NA	NA	NA	0.09	0.060	0.100	U	0.43	0.170	0.450	U	3.2	0.02
L050147TRS00	15.79	S	0.44	0.070	0.040	N/A	-0.630	0.000	0.09	0.090	0.060	0.200	N/A	0.19	0.050	0.040	N/A	-0.810	0.000	0.242	NA	NA	NA	0.01	0.070	0.120	U	0.42	0.150	0.390	N/A	0.4	0.01
L050148TRS00	6.16	S*	0.68	0.100	0.040	N/A	-0.390	0.000	51.4	51.400	5.190	0.220	N/A	0.14	0.050	0.070	N/A	-0.860	0.000	4.124	NA	NA	NA	0.22	0.090	0.130	N/A	1.99	0.610	0.610	N/A	1.7	2.08
L050154TRS00	9.38	S*	0.86	0.120	0.040	N/A	-0.210	0.000	67.5	67.500	6.710	0.360	N/A	0.11	0.050	0.080	N/A	-0.890	0.000	5.459	NA	NA	NA	0.3	0.100	0.130	N/A	1.52	0.290	0.500	N/A	3.0	2.73
L050155TES00	9.38	S*	0.86	0.120	0.040	N/A	-0.210	0.000	82.5	82.500	8.670	0.200	N/A	0.15	0.050	0.030	N/A	-0.850	0.000	6.338	NA	NA	NA	0.35	0.130	0.140	N/A	1.32	0.320	0.580	N/A	4.0	3.33
L050156TRS00	2.71	S	0.48	0.080	0.040	N/A	-0.590	0.000	2.75	2.750	0.270	0.180	N/A	0.36	0.070	0.050	N/A	-0.640	0.000	1.867	NA	NA	NA	0.1	0.080	0.110	U	0.85	0.420	0.530	N/A	1.8	0.13
L050157TES00	2.21	S	0.6	0.090	0.050	N/A	-0.470	0.000	0.66	0.660	0.210	0.200	N/A	0.49	0.090	0.090	N/A	-0.510	0.000	0.961	NA	NA	NA	0.05	0.100	0.160	U	0.62	0.210	0.540	N/A	1.3	0.04
L050162TRS00	10.83	S	0.97	0.160	0.090	N/A	-0.100	0.000	1.5	1.500	0.260	0.220	N/A	1.13	0.180	0.070	N/A	0.130	0.130	2.780	NA	NA	NA	0.15	0.120	0.180	U	1.19	0.400	0.980	N/A	2.0	0.15
L050163TES00	6.83	S	0.83	0.130	0.070	N/A	-0.240	0.000	0.44	0.440	0.090	0.220	N/A	1.11	0.180	0.110	N/A	0.110	0.110	1.645	NA	NA	NA	0.08	0.150	0.250	U	1.62	0.720	0.860	N/A	0.8	0.09
L050164TRS00	12.88	S	0.98	0.150	0.070	N/A	-0.090	0.000	0.5	0.500	0.060	0.240	N/A	1.17	0.210	0.100	N/A	0.170	0.170	3.273	NA	NA	NA	0.18	0.120	0.180	U	0.89	0.620	0.850	N/A	3.1	0.13
L050165TES00	12.88	S	1.09	0.150	0.050	N/A	0.020	0.020	0.16	0.160	0.080	0.220	N/A	1.15	0.210	0.110	N/A	0.150	0.150	0.909	NA	NA	NA	0.04	0.090	0.240	U	1.37	0.720	0.920	N/A	0.5	0.11
L050169TSS00	12.03	S	0.38	0.080	0.040	N/A	-0.690	0.000	0.13	0.130	0.030	0.200	N/A	0.24	0.090	0.090	N/A	-0.760	0.000	1.272	NA	NA	NA	0.07	0.090	0.150	U	0.33	0.220	0.640	U	3.2	0.01
L050170TRS00	16.03	S	0.29	0.050	0.030	N/A	-0.780	0.000	0.01	0.010	0.060	0.190	N/A	0.27	0.060	0.020	N/A	-0.730	0.000	0.919	NA	NA	NA	0.05	0.060	0.110	U	0.34	0.140	0.440	U	2.3	0.01
L050171TRS00	7.10	S	1.16	0.17	0.08	N/A	0.090	0.090	0.15	0.150	0.060	0.230	N/A	1.26	0.210	0.120	N/A	0.260	0.260	2.072	NA	NA	NA	0.11	0.140	0.160	U	1.09	0.790	1.000	N/A	1.6	0.20
L050172TES00	5.10	S	1.34	0.22	0.1	N/A	0.270	0.270	0.2	0.200	0.030	0.220	N/A	1.11	0.200	0.170	N/A	0.110	0.110	2.842	NA	NA	NA	0.15	0.180	0.300	U	1.6	0.870	1.110	N/A	1.5	0.23
L050119TSQ00	11.13	Q	0.87	0.130	0.060	N/A	-0.200	0.000	0.3	0.300	0.050	0.200	N/A	1	0.160	0.100	N/A	0.000	0.000	4.045	NA	NA	NA	0.22	0.150	0.190	N/A	1.51	0.680	0.830	N/A	2.3	0.05
L050162TRQ00	6.83	Q	1.13	0.160	0.070	N/A	0.060	0.060	1.75	1.750	0.170	0.220	N/A	1.19	0.200	0.110	N/A	0.190	0.190	2.965	NA	NA	NA	0.16	0.160	0.260	U	1.22	0.750	0.940	N/A	2.0	0.22
L050165TEQ00	12.88	Q	1.08	0.180	0.100	N/A	0.010	0.010	0.2	0.200	0.070	0.230	N/A	1.11	0.200	0.140	N/A	0.110	0.110	0.266	NA	NA	NA	0.01	0.200	0.340	U	0.7	0.360	0.960	U	0.3	0.07
L050176TUB00	2.66	B	1.19	0.174	0.0769	N/A	0.120	0.120	0.568	0.568	0.177	0.245	N/A	1.16	0.18	0.0863	N/A	0.160	0.160	2.393	NA	NA	NA	0.127	0.147	0.248	U	1.28	0.619	0.817	N/A	1.6	0.19
L050177TUB00	2.66	B	1.24	0.199	0.103	N/A	0.170	0.170	1.51	1.510	0.196	0.251	N/A	1.16	0.219	0.17	N/A	0.160	0.160	2.193	NA	NA	NA	0.121	0.213	0.331	U	0.51	0.506	1.34	U	3.6	0.25
L050186TUB00	2.86	B	0.798	0.12	0.055	N/A	-0.272	0.000	1.08	1.080	0.164	0.236	N/A	0.677	0.116	0.0958	N/A	-0.323	0.000	2.220	NA	NA	NA	0.121	0.119	0.204	U	0.778	0.306	0.788	U	2.4	0.06
L050187TUB00	2.86	B	0.78	0.118	0.0699	N/A	-0.290	0.000	1.57	1.570	0.193	0.245	N/A	0.805	0.13	0.101	N/A	-0.195	0.000	4.158	NA	NA	NA	0.227	0.132	0.173	N/A	1.38	0.663	0.799	N/A	2.5	0.10
L050188TUB00	4.48	B	1.14	0.217	0.143	N/A	0.070	0.070	0.839	0.839	0.214	0.252	N/A	1.34	0.247	0.162	N/A	0.340	0.340	1.498	NA	NA	NA	0.0711	0.214	0.445	U	1.82	1.43	1.84	U	0.7	0.26
L050189TUB00	4.48	B	0.741	0.128	0.0771	N/A	-0.329	0.000	0.334	0.334	0.118	0.223	N/A	0.844	0.149	0.116	N/A	-0.156	0.000	1.495	NA	NA	NA	0.0753	0.161	0.268	U	1.19	0.707	0.893	N/A	1.0	0.03
L050190TUB00	5.34	B	0.963	0.147	0.0725	N/A	-0.107	0.000	0.234	0.234	0.0869	0.244	U	0.874	0.157	0.109	N/A	-0.126	0.000	1.301	NA	NA	NA	0.0664	0.14	0.244	U	0.986	0.575	0.76	N/A	1.1	0.02

Sample ID	Sample Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																										Enr.	SOF_N
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF_N
L050191TUB00	5.34	B	0.949	0.143	0.0596	N/A	-0.121	0.000	1.54	1.540	0.165	0.242	N/A	0.785	0.14	0.11	N/A	-0.215	0.000	2.513	NA	NA	NA	0.136	0.137	0.184	U	0.988	0.316	0.767	N/A	2.1	0.08
L050192TUB00	15.65	B	0.782	0.138	0.0723	N/A	-0.288	0.000	16.5	16.500	1.77	0.254	N/A	0.249	0.1	0.0785	N/A	-0.751	0.000	6.293	NA	NA	NA	0.347	0.151	0.167	N/A	1.5	0.48	0.859	N/A	3.5	0.71
L050193TUB00	15.65	B	0.939	0.142	0.0712	N/A	-0.131	0.000	4.32	4.320	0.573	0.249	N/A	0.672	0.117	0.0951	N/A	-0.328	0.000	5.270	NA	NA	NA	0.291	0.113	0.153	N/A	1.12	0.347	0.833	N/A	3.9	0.21
L050194TUB00	4.09	B	0.982	0.147	0.0711	N/A	-0.088	0.000	1.12	1.120	0.193	0.276	N/A	0.872	0.152	0.104	N/A	-0.128	0.000	1.297	NA	NA	NA	0.0708	0.136	0.216	U	0.447	0.613	1.02	U	2.5	0.06
L050195TUB00	4.09	B	0.787	0.131	0.0625	N/A	-0.283	0.000	1.77	1.770	0.224	0.265	N/A	0.678	0.13	0.114	N/A	-0.322	0.000	1.609	NA	NA	NA	0.0837	0.147	0.231	U	1.03	0.615	0.793	N/A	1.3	0.09
L050196TUB00	4.91	B	0.765	0.119	0.0564	N/A	-0.305	0.000	0.299	0.299	0.0765	0.228	N/A	0.573	0.104	0.0942	N/A	-0.427	0.000	1.268	NA	NA	NA	0.0688	0.101	0.156	U	0.487	0.259	0.834	U	2.2	0.02
L050197TUB00	4.91	B	0.877	0.134	0.0671	N/A	-0.193	0.000	0.195	0.195	0.0206	0.26	U	0.656	0.126	0.0803	N/A	-0.344	0.000	1.250	NA	NA	NA	0.0608	0.153	0.249	U	1.22	0.673	0.812	N/A	0.8	0.02
L050198TUB00	7.13	B	1.17	0.170	0.070	N/A	0.100	0.100	3.71	3.710	0.470	0.230	N/A	0.93	0.170	0.100	N/A	-0.070	0.000	0.484	NA	NA	NA	0.02	0.160	0.280	U	0.83	0.350	0.930	U	0.4	0.21
L050199TUB00	8.19	B	1.02	0.230	0.190	N/A	-0.050	0.000	1.78	1.780	0.300	0.210	N/A	1.11	0.270	0.330	N/A	0.110	0.110	4.413	NA	NA	NA	0.24	0.270	0.440	U	1.65	1.270	1.630	N/A	2.3	0.16
L0501100TUB0	10.01	B	0.47	0.090	0.060	N/A	-0.600	0.000	0.22	0.220	0.060	0.200	N/A	0.25	0.080	0.130	N/A	-0.750	0.000	1.687	NA	NA	NA	0.09	0.090	0.170	U	0.82	0.290	0.640	N/A	1.7	0.02
L0501101TUB0	7.57	B	1.36	0.260	0.150	N/A	0.290	0.290	1.39	1.390	0.230	0.210	N/A	1.19	0.220	0.130	N/A	0.190	0.190	6.486	NA	NA	NA	0.35	0.290	0.520	U	2.79	1.810	2.140	N/A	2.0	0.36
L0501102TUB0	10.07	B	0.39	0.090	0.060	N/A	-0.680	0.000	0.05	0.050	0.030	0.200	U	0.23	0.090	0.110	N/A	-0.770	0.000	1.993	NA	NA	NA	0.11	0.110	0.190	U	0.44	0.240	0.750	U	3.8	0.02
L0501103TUB0	8.79	B	0.88	0.210	0.170	N/A	-0.190	0.000	46.8	46.800	4.770	0.200	N/A	0.58	0.200	0.120	N/A	-0.420	0.000	16.322	NA	NA	NA	0.9	0.390	0.420	N/A	3.95	2.050	2.450	N/A	3.5	1.99
L0501104TUB0	8.65	B	0.66	0.100	0.040	N/A	-0.410	0.000	16.9	16.900	1.730	0.200	N/A	0.22	0.060	0.090	N/A	-0.780	0.000	2.743	NA	NA	NA	0.15	0.080	0.110	N/A	0.9	0.260	0.510	N/A	2.6	0.70
L0501105TUB0	9.19	B	1.15	0.170	0.060	N/A	0.080	0.080	58.4	58.400	6.490	0.310	N/A	0.73	0.150	0.160	N/A	-0.270	0.000	4.792	NA	NA	NA	0.26	0.170	0.290	U	1.86	0.900	1.050	N/A	2.2	2.41
L0501106TUB0	9.39	B	1.08	0.160	0.080	N/A	0.010	0.010	1.49	1.490	0.210	0.200	N/A	0.95	0.180	0.100	N/A	-0.050	0.000	2.715	NA	NA	NA	0.14	0.140	0.230	U	1.84	0.710	0.870	N/A	1.2	0.09
L0501107TUB0	10.52	B	0.66	0.110	0.040	N/A	-0.410	0.000	0.68	0.680	0.130	0.190	N/A	0.14	0.050	0.090	N/A	-0.860	0.000	2.175	NA	NA	NA	0.12	0.080	0.110	N/A	0.49	0.210	0.550	U	3.7	0.04
Systematic Minimum			0.000						0.010					0.000						0.242				0.010				0.330				2.0	0.01
Systematic Maximum			0.400						11.500					0.290						7.255				0.400				1.710				Average Enrichment (%)	0.49
Systematic Mean			0.044						1.453					0.068						2.151				0.114				1.050					0.13
Systematic Median			0.000						0.430					0.000						1.973				0.105				1.060					0.12
Systematic Standard Deviation			0.101						2.397					0.100						1.421				0.080				0.443					0.11
			With ingrowth, use Ra226 bkg =					1.07						Th232 bkg =			1.0																	

NOTES:

Gross results in units of pCi/g.

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

**Background, 1.0 pCi/g subtracted from gross result.

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

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

7.2.5 Biased Soil Sample Result LSA 05-01

Due to the presence of elevated biased soil sampling results, an EMC investigation was performed. It is important to note that outside of this EMC area, the highest biased soil sample result was a 0.71 Uniform SOF result.

7.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 05-01

SU LSA 05-01 is unique in that remediation of the sloped area was limited by requirements of MoDOT to ensure safety of the State Road P support structure. Spent limestone contaminated with Tc-99 was intentionally left in place to comply with MoDOT requirements. Therefore, neither the sidewall sampling requirements of the FSS program nor the sidewall sampling requirements of HEM-15-MEMO-039 were applicable.

7.2.7 Quality Control Soil Sample Result LSA 05-01

Three QC field duplicate sample points were randomly selected for LSA 05-01 which were collected at systematic locations L05-01-19, L05-01-62, and L05-01-65.

For the 51 "regular" samples (i.e., 27 systematic + 24 biased) collected within LSA 05-01, three field duplicate samples were collected. This frequency equates to 5.9%, (i.e. 3/51). 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 05-01 (1 of 3)

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 05-01				Survey Unit Description:		Red Room Roof / Limestone Fill / Cistern Burn Pit					
			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)
L050119TSS00	L050119TSQ00	Ra-226	0.970	0.07	0.870	0.060	0.92	1.9	0.1	0.269	0.403	N
L050119TSS00	L050119TSQ00	Tc-99	0.42	0.21	0.3	0.05	0.36	25.1	0.12	3.552	5.321	N
L050119TSS00	L050119TSQ00	Th-232	0.89	0.13	1.000	0.100	0.945	2.0	0.110	0.283	0.424	N
L050119TSS00	L050119TSQ00	U-234[1]	7.255	NA	4.045	NA	5.650	195.4	3.210	27.649	41.425	N
L050119TSS00	L050119TSQ00	U-235	0.4	0.21	0.22	0.21	0.310	51.6	0.18	7.301	10.939	N
L050119TSS00	L050119TSQ00	U-238	1.09	0.94	1.09	0.94	1.09	168.8	0	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: 3-13-17

Reviewed by: Clark Evers

Date: 3/16/17

Quality Record

Figure 7-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 05-01 (2 of 3)

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 05-01 — Survey Unit Description: Red Room Roof / Limestone Fill / Cistern Burn Pit

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						
L050165TES00	L050165TEQ00	Ra-226	1.090	0.05	1.080	0.100	1.085	1.9	0.01	0.269	0.403	N
L050165TES00	L050165TEQ00	Tc-99	0.16	0.22	0.2	0.23	0.18	25.1	NA	3.552	5.321	NA
L050165TES00	L050165TEQ00	Th-232	1.15	0.11	1.110	0.140	1.130	2.0	0.040	0.283	0.424	N
L050165TES00	L050165TEQ00	U-234[1]	0.909	NA	0.266	NA	0.588	195.4	0.643	27.649	41.425	N
L050165TES00	L050165TEQ00	U-235	0.04	0.24	0.01	0.34	0.025	51.6	NA	7.301	10.939	NA
L050165TES00	L050165TEQ00	U-238	1.37	0.92	0.7	0.96	1.035	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 — Reviewed by: Clark Evers

Date: 3-13-17 — Date: 3/16/17

Quality Record

Figure 7-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 05-01 (3 of 3)

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 05-01 — Survey Unit Description: Red Room Roof / Limestone Fill / Cistern Burn Pit

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)
L050162TRS00	L050162TRQ00	Ra-226	0.970	0.09	1.130	0.070	1.05	1.9	0.16	0.269	0.403	N
L050162TRS00	L050162TRQ00	Tc-99	1.5	0.22	1.75	0.17	1.625	25.1	0.25	3.552	5.321	N
L050162TRS00	L050162TRQ00	Th-232	1.13	0.07	1.190	0.110	1.160	2.0	0.060	0.283	0.424	N
L050162TRS00	L050162TRQ00	U-234[1]	2.780	NA	2.965	NA	2.873	195.4	0.185	27.649	41.425	N
L050162TRS00	L050162TRQ00	U-235	0.15	0.18	0.16	0.16	0.155	51.6	NA	7.301	10.939	NA
L050162TRS00	L050162TRQ00	U-238	1.19	0.98	1.22	1.22	1.205	168.8	0.03	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: 3-13-17 — Date: 3/16/17

Quality Record

7.3 Tc-99 Hot Spot Assessment LSA 05-01

The highest observed Tc-99 sample result collected from LSA 05-01 was 101 pCi/g (a characterization sample). As this sample result exceeds the Uniform $DCGL_W$ (and an EMC investigation was performed in the SU), a Tc-99 hot spot assessment has been performed below.

The surface area covered by the SU is 1,781 m^2, and there were 16 systematic locations collected within the SU, resulting in 1 sample per 111.3 m^2. Using the table provided in Appendix E of HDP-PR-FSS-721 (Table 14-12 in Chapter 14 of the DP), and interpolating the area of 111.3 m^2 provides an Area Factor (AF) of 9.2 for Tc-99. The hypothetical $DCGL_{EMC}$ is then determined by multiplying the $DCGL_W$ by the AF, which results in a maximum $DCGL_{EMC}$ value of 230.9 pCi/g for Tc-99. Furthermore, using the hypothetical sample maximum sample result of 101 pCi/g, an AF of 4.0 would be required for the area to successfully pass an EMC investigation. An AF on 4.0 would require a minimum sample density of 1 sample per every 255 m^2 of the SU.

As the maximum observed value of 101 pCi/g is significantly less than the maximum allowable value (or 230.9 pCi/g of Tc-99), and that the actual sample density collected of 1 sample per 111.3 m^2 is much greater than the minimum sample density requirements (of 1 sample per 255 m^2), the Tc-99 hot spot assessment is considered successful since the evaluation determines that there is little chance of an unidentified Tc-99 "hotspot" within the SU based on this criteria.

8.0 ALARA EVALUATION LSA 05-01

In the case of LSA 05-01, one sample exceeded a SOF of 1 which triggered an EMC investigation. The outcome of the EMC investigation was successful in that compliance with the unity rule (<1) was achieved. The total dose contribution from the bounded EMC area in LSA 05-01 was 2.75 mrem/yr - equivalent to a SOF of 0.11. The EMC evaluation is discussed in greater detail in Section 6.3.1.

For LSA 05-01 the average SOF results based on all systematically collected samples was 0.13. The remaining structure designated as BSA 05-01 (see Section 13.0) was evaluated to be 1% of the $DCGL_{SO}$, and therefore will contribute 0.25 mrem/year to the SU. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3, indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, assuming a maximum groundwater contribution of 4.0 mrem/yr based upon the U.S. Environmental Protection Agency (EPA) MCLs will be added to the total estimated doses for LSA 05-01. The sum of the average systematically collected samples (0.13), the EMC (0.11), the structure dose (0.01) and the maximum groundwater contribution (0.16) total to a 0.42 Uniform SOF value for the SU, equivalent to 10.5 mrem/yr.

Since the estimated Total Effective Dose Equivalent is below the regulatory release criterion of 25 mrem/yr, the conclusion of the As Low As Reasonably Achievable (ALARA) evaluation is that the remediation of LSA 05-01 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing further remediation of LSA 05-01.

9.0 FSS PLAN DEVIATIONS LSA 05-01

9.1 Remedial Actions during FSS

Remedial actions in LSA 05-01 are discussed in detail in Section 3.3.1. The data presented in this report is the summary of all data collected after all remediation efforts were complete, and represent the "as left" condition of the SU.

9.2 Adjustments to Scan MDC Calculations

As previously stated in Section 5.1.5, adjustments were made to the Scan MDC calculations for instrumentation used for the GWS in LSA 05-01. The Scan MDCs presented in the FSS Plans shown in Table 5-1 assumed a surveyor efficiency of 0.5 and did not reflect the information derived from the development of HDP-TBD-FSS-002 which used Microshield modeling of parameters consistent with procedural requirements of GWS implementation at HDP. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 05-01, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. Since the majority of the GWS data collected in LSA 05-01 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015.

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

Table 9-1

Revised Scan MDCs for 2" x 2" NaI detector: LSA 05-01

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw (Ra-226)	Scan MDC (Th-232)	DCGLw (Th-232)
LSA 05-01	40.9	25.9	1.21	1.9	0.87	2.0

10.0 DATA QUALITY ASSESSMENT

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

10.1 Data Quality Assessment for LSA 05-01

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 05-01 (see Figure 10-1) provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDC less than the appropriate investigation level, and were verified to be operable prior to and after use in accordance with HDP-PR-HP-416 (*Operation of the Ludlum 2221 for Final Status Survey*).
- The calibration of all instruments that were used to measure or analyze data was current at the time of use and the calibrations of the instruments were performed using a NIST traceable source. The instruments used were successfully source checked prior to and after use.
- The systematic samples that were collected (on a random-start triangular grid) and the gamma scan surveys that were conducted were performed in accordance with procedure HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*.
- All samples sent for analysis at the approved offsite laboratory (TestAmerica) were tracked on a chain of custody form in accordance with HDP-PR-QA-006, *Chain of Custody*.
- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control* (See section 7.2.6).
- During the review of documentation for LSA 05-01 it is recognized that the FSS Plan for LSA 05-01 specified that surface, root, and excavation samples would be collected across the systematic grid, however the stratum of FSS sampling is based on the projected final grade of the SU after all backfill operations have been completed. The FSS Plan for LSA 05-01 used the original grade of the SU to determine sample depth. During data validation utilizing the final grade for assessment of the samples it has been determined that no FSS soil samples were collected from the surface stratum, 6 of the 27 FSS soil samples were actually collected from the root stratum, and 21 of 27 FSS soil samples were actually collected from the excavation stratum, and in some cases, multiple samples were collected from the same stratum at the same location. To avoid confusion the COC for the laboratory analysis the sample IDs were not changed to reflect the change in stratum in which the sample was taken. During the validation and

assessment process the actual depths of the soil samples in relation to final grade are used for the purposes of determining where each FSS sample was collected within the SU.

- LSA 05-01 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 greater than one. For LSA 05-01, three 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 05-01. Since the test statistic, WR (1296) exceeded the critical value (1069), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS Test worksheet is presented in Appendix A.
- The average SOF result for all systematically collected samples within LSA 05-01 was 0.13, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.18.
- An EMC evaluation was performed on the small area identified to exceed the DCGLw. The successful results of the EMC are presented in Section 6.3.1, and the EMC dose has been included in the final evaluation of the LSA 05-01 residual activity.
- 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 05-01. The result of the retrospective power evaluation presented in Table 10-1 for LSA 05-01 indicates that the number of systematic locations actually collected (12) exceeds the minimum number of sampling locations necessary (8). 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.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for LSA 05-01 was completed prior to the commencement of backfill operations.

Table 10-1
Retrospective Sample Size Verification for LSA 05-01

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.11
$DCGL_{SOF}$	1
LBGR (Mean)	0.13
Shift	0.87
Relative Shift (Δ/σ)	7.55
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	12
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 05-01 (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 05 **Description:** Barns and Cistern Open Land Area
Survey Unit: 01 **Description:** Red Room Roof/Limestone Fill/Cistern Burn Pit

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 05-01 (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 05 **Description:** Barns and Cistern Open Land Area
Survey Unit: No. 01 **Description:** Red Room Roof/Limestone Fill/Cistern Burn Pit

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)	3-13-17 (Date)
Approved by (RSO):	Clark Evers (Print Name)	(Signature)	3/16/17 (Date)

Quality Record

11.0 SURVEILLANCE FOLLOWING FSS

As required by MDOT, the slope of State Road P was backfilled as soon as possible after the completion of FSS activities and confirmatory survey and sampling by ORAU and NRC Region III. State Road P is upland and adjacent to LSA 05-01. As such, there is no possibility of recontamination of LSA 05-01 from another upland or adjacent SU.

12.0 FINAL STATUS SURVEY IMPLEMENTATION OF BSA 05-01

As previous discussed in Section 3.3.1 the work plan for LSA 05-01 to meet MoDOT requirements was to remediate as much of the State Road P slope as allowed by MoDOT and immediately follow that activity by soil sampling and survey. During the remediation of the slope of State Road P a concrete structure embedded in the embankment of State Road P was identified within the SU that was not originally known to exist (See Figure 3-8). The concrete structure is believed to be the foundation of a former well/spring house that was present on the site before the property was purchased for licensed operations. Based upon MoDOT requirements to maintain the structural integrity of the road base the concrete structure could not be removed. As a result of the discovery of the concrete structure the FSS Plan for LSA 05-01 was revised by the HP Staff to include the necessary direction for survey and assessment of the structure.

The following sections provide the FSS survey data and information regarding the concrete structure that was required to remain within LSA 05-01 and an assessment of the validity of the data. The concrete structure is designated as SU BSA 05-01. FSS of BSA 05-01 was performed in accordance with procedure HDP-PR-HP-311, *Radiological Surveys*, and in compliance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems, and Components*.

12.1 Scan Survey

12.1.1 Instrumentation

The chosen instrumentation was a Ludlum Model 43-89 detector, paired with a Ludlum Model 2360 data logging meter.

12.1.2 Scan Survey Performance

A 100% scan survey was performed of all exposed surfaces of the structure.

12.1.3 Systematic Measurements

The structure was scanned in approximate 1 square meter sections, with a systematic measurement collected from each separate section. Fifty-six (56) individual systematic measurements were collected across the structure comprising BSA 05-01. Table 12-1 provides the listing of measurement locations as specified in the FSS Plan (Appendix G).

Table 12-1
FSS Measurement Locations for BSA 05-01

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: BSA 05 **Description:** Class 1 Structure inside LSA 05-02

Survey Unit: 02 **Description:** Former Tile Barn Foundation

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start * Elevation	End * Elevation	Location ID	Remarks / Notes
B05-01-01-S-O-S-00	O	S	NA	NA	Foundation location #1	Spring House Foundation
B05-01-02-S-O-S-00	O	S	NA	NA	Foundation location #2	Spring House Foundation
B05-01-03-S-O-S-00	O	S	NA	NA	Foundation location #3	Spring House Foundation
B05-01-04-S-O-S-00	O	S	NA	NA	Foundation location #4	Spring House Foundation
B05-01-05-S-O-S-00	O	S	NA	NA	Foundation location #5	Spring House Foundation
B05-01-06-S-O-S-00	O	S	NA	NA	Foundation location #6	Spring House Foundation
B05-01-07-S-O-S-00	O	S	NA	NA	Foundation location #7	Spring House Foundation
B05-01-08-S-O-S-00	O	S	NA	NA	Foundation location #8	Spring House Foundation
B05-01-09-S-O-S-00	O	S	NA	NA	Foundation location #9	Spring House Foundation
B05-01-10-S-O-S-00	O	S	NA	NA	Foundation location #10	Spring House Foundation
B05-01-11-S-O-S-00	O	S	NA	NA	Foundation location #11	Spring House Foundation
B05-01-12-S-O-S-00	O	S	NA	NA	Foundation location #12	Spring House Foundation
B05-01-13-S-O-S-00	O	S	NA	NA	Foundation location #13	Spring House Foundation
B05-01-14-S-O-S-00	O	S	NA	NA	Foundation location #14	Spring House Foundation
B05-01-15-S-O-S-00	O	S	NA	NA	Foundation location #15	Spring House Foundation
B05-01-16-S-O-S-00	O	S	NA	NA	Foundation location #16	Spring House Foundation
B05-01-17-S-O-S-00	O	S	NA	NA	Foundation location #17	Spring House Foundation
B05-01-18-S-O-S-00	O	S	NA	NA	Foundation location #18	Spring House Foundation
B05-01-19-S-O-S-00	O	S	NA	NA	Foundation location #19	Spring House Foundation
B05-01-20-S-O-S-00	O	S	NA	NA	Foundation location #20	Spring House Foundation
B05-01-21-S-O-S-00	O	S	NA	NA	Foundation location #21	Spring House Foundation
B05-01-22-S-O-S-00	O	S	NA	NA	Foundation location #22	Spring House Foundation
B05-01-23-S-O-S-00	O	S	NA	NA	Foundation location #23	Spring House Foundation
B05-01-24-S-O-S-00	O	S	NA	NA	Foundation location #24	Spring House Foundation
B05-01-25-S-O-S-00	O	S	NA	NA	Foundation location #25	Spring House Foundation
B05-01-26-S-O-S-00	O	S	NA	NA	Foundation location #26	Spring House Foundation
B05-01-27-S-O-S-00	O	S	NA	NA	Foundation location #27	Spring House Foundation
B05-01-28-S-O-S-00	O	S	NA	NA	Foundation location #28	Spring House Foundation
B05-01-29-S-O-S-00	O	S	NA	NA	Foundation location #29	Spring House Foundation

Measurement or Sample ID	Surface Or CSM	Type	Start * Elevation	End * Elevation	Location ID	Remarks / Notes
B05-01-30-S-O-S-00	O	S	NA	NA	Foundation location #30	Spring House Foundation
B05-01-31-S-O-S-00	O	S	NA	NA	Foundation location #31	Spring House Foundation
B05-01-32-S-O-S-00	O	S	NA	NA	Foundation location #32	Spring House Foundation
B05-01-33-S-O-S-00	O	S	NA	NA	Foundation location #33	Spring House Foundation
B05-01-34-S-O-S-00	O	S	NA	NA	Foundation location #34	Spring House Foundation
B05-01-35-S-O-S-00	O	S	NA	NA	Foundation location #35	Spring House Foundation
B05-01-36-S-O-S-00	O	S	NA	NA	Foundation location #36	Spring House Foundation
B05-01-37-S-O-S-00	O	S	NA	NA	Foundation location #37	Spring House Foundation
B05-01-38-S-O-S-00	O	S	NA	NA	Foundation location #38	Spring House Foundation
B05-01-39-S-O-S-00	O	S	NA	NA	Foundation location #39	Spring House Foundation
B05-01-40-S-O-S-00	O	S	NA	NA	Foundation location #40	Spring House Foundation
B05-01-41-S-O-S-00	O	S	NA	NA	Foundation location #41	Spring House Foundation
B05-01-42-S-O-S-00	O	S	NA	NA	Foundation location #42	Spring House Foundation
B05-01-43-S-O-S-00	O	S	NA	NA	Foundation location #43	Spring House Foundation
B05-01-44-S-O-S-00	O	S	NA	NA	Foundation location #44	Spring House Foundation
B05-01-45-S-O-S-00	O	S	NA	NA	Foundation location #45	Spring House Foundation
B05-01-46-S-O-S-00	O	S	NA	NA	Foundation location #46	Spring House Foundation
B05-01-47-S-O-S-00	O	S	NA	NA	Foundation location #47	Spring House Foundation
B05-01-48-S-O-S-00	O	S	NA	NA	Foundation location #48	Spring House Foundation
B05-01-49-S-O-S-00	O	S	NA	NA	Foundation location #49	Spring House Foundation
B05-01-50-S-O-S-00	O	S	NA	NA	Foundation location #50	Spring House Foundation
B05-01-51-S-O-S-00	O	S	NA	NA	Foundation location #51	Spring House Foundation
B05-01-52-S-O-S-00	O	S	NA	NA	Foundation location #52	Spring House Foundation
B05-01-53-S-O-S-00	O	S	NA	NA	Foundation location #53	Spring House Foundation
B05-01-54-S-O-S-00	O	S	NA	NA	Foundation location #54	Spring House Foundation
B05-01-55-S-O-S-00	O	S	NA	NA	Foundation location #55	Spring House Foundation
B05-01-56-S-O-S-00	O	S	NA	NA	Foundation location #56	Spring House Foundation
B05-01-57-S-O-B-00	O	S	NA	NA	Biased location measurements #1	Biased loc. Section 42
B05-01-58-S-O-B-00	O	S	NA	NA	Biased location post sample measurement	Biased loc. Section 42

*X and Y coordinates originate from lower left or southwest corner of structural surface. Each structural surface has it's own origin (0,0) point.

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

CSM: Three-Layer (Surface-Root-Deep) or Uniform

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

Quality Record

No location exceeded the $DCGL_{SO}$. The highest observed systematic measurement was recorded at location P05-01-42-S-O-S-00 with a TSC result of 1,243 dpm/100 cm^2 (7% of the $DCGL_{so}$). The complete FSS results are provided in Appendix P.

12.2 Biased Measurement

Two biased measurements were collected from BSA 05-01. The first biased measurement B05-01-57-S-O-B-00 was collected upon identifying an area that was elevated above the Scan IAL specified in the FSS Instructions. Although not required by the FSS Plan, the HP Staff collected a composite concrete sample at location for internal informational purposes. The second biased measurement B05-01-58-S-O-B-00 was taken at the same location after the composite concrete sample was collected. The measurement results are provided in Table 13-1

12.3 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergo a complete replicate survey by a different technician from that which was used in the original FSS of that particular SSC SU. While BSA 05-01 was not originally evaluated as a Structural SU, it can now be evaluated along with all other remaining structural SUs, and as such, no QC measurements were required for BSA 05-01.

13.0 FINAL STATUS SURVEY RESULTS BSA 05-01

The average fraction of the $DCGL_{SO}$ for BSA 05-01 is 1% of the $DCGL_{SO}$. The analytical data sheets used to evaluate the BSA 05-01 FSS data are provided in Appendix B. A summary table of the FSS results is presented below in Table 13-1.

Table 13-1
FSS Data Summary for BSA 05-01

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm^2 (α+β)	Corrected Net dpm/100cm^2	Fraction of DCGL
B05-01-01-S-O-S-00	Foundation location #1	8/29/2013	alpha + beta TSC	256	247	9	82	82	0%
B05-01-02-S-O-S-00	Foundation location #2	8/29/2013	alpha + beta TSC	226	247	-21	-192	0	0%
B05-01-03-S-O-S-00	Foundation location #3	8/29/2013	alpha + beta TSC	257	247	10	91	91	0%
B05-01-04-S-O-S-00	Foundation location #4	8/29/2013	alpha + beta TSC	269	247	22	201	201	1%
B05-01-05-S-O-S-00	Foundation location #5	8/29/2013	alpha + beta TSC	274	247	27	247	247	1%
B05-01-06-S-O-S-00	Foundation location #6	8/29/2013	alpha + beta TSC	301	247	54	494	494	3%
B05-01-07-S-O-S-00	Foundation location #7	8/29/2013	alpha + beta TSC	299	247	52	475	475	3%
B05-01-08-S-O-S-00	Foundation location #8	8/29/2013	alpha + beta TSC	259	247	12	110	110	1%
B05-01-09-S-O-S-00	Foundation location #9	8/29/2013	alpha + beta TSC	275	247	28	256	256	1%
B05-01-10-S-O-S-00	Foundation location #10	8/29/2013	alpha + beta TSC	313	247	66	603	603	3%
B05-01-11-S-O-S-00	Foundation location #11	8/29/2013	alpha + beta TSC	273	247	26	238	238	1%
B05-01-12-S-O-S-00	Foundation location #12	8/29/2013	alpha + beta TSC	240	247	-7	-64	0	0%
B05-01-13-S-O-S-00	Foundation location #13	8/29/2013	alpha + beta TSC	274	247	27	247	247	1%
B05-01-14-S-O-S-00	Foundation location #14	8/29/2013	alpha + beta TSC	291	247	44	402	402	2%
B05-01-15-S-O-S-00	Foundation location #15	8/29/2013	alpha + beta TSC	319	247	72	658	658	3%
B05-01-16-S-O-S-00	Foundation location #16	8/29/2013	alpha + beta TSC	301	247	54	494	494	3%
B05-01-17-S-O-S-00	Foundation location #17	8/29/2013	alpha + beta TSC	259	247	12	110	110	1%
B05-01-18-S-O-S-00	Foundation location #18	8/29/2013	alpha + beta TSC	276	247	29	265	265	1%
B05-01-19-S-O-S-00	Foundation location #19	8/29/2013	alpha + beta TSC	278	247	31	283	283	1%
B05-01-20-S-O-S-00	Foundation location #20	8/29/2013	alpha + beta TSC	312	247	65	594	594	3%
B05-01-21-S-O-S-00	Foundation location #21	8/29/2013	alpha + beta TSC	269	247	22	201	201	1%
B05-01-22-S-O-S-00	Foundation location #22	8/29/2013	alpha + beta TSC	279	247	32	293	293	2%
B05-01-23-S-O-S-00	Foundation location #23	8/29/2013	alpha + beta TSC	271	247	24	219	219	1%
B05-01-24-S-O-S-00	Foundation location #24	8/29/2013	alpha + beta TSC	344	247	97	887	887	5%
B05-01-25-S-O-S-00	Foundation location #25	8/29/2013	alpha + beta TSC	300	247	53	485	485	3%
B05-01-26-S-O-S-00	Foundation location #26	8/29/2013	alpha + beta TSC	266	247	19	174	174	1%
B05-01-27-S-O-S-00	Foundation location #27	8/29/2013	alpha + beta TSC	246	247	-1	-9	0	0%
B05-01-28-S-O-S-00	Foundation location #28	8/29/2013	alpha + beta TSC	246	247	-1	-9	0	0%
B05-01-29-S-O-S-00	Foundation location #29	8/29/2013	alpha + beta TSC	294	247	47	430	430	2%
B05-01-30-S-O-S-00	Foundation location #30	8/29/2013	alpha + beta TSC	234	247	-13	-119	0	0%
B05-01-31-S-O-S-00	Foundation location #31	8/29/2013	alpha + beta TSC	228	247	-19	-174	0	0%
B05-01-32-S-O-S-00	Foundation location #32	8/29/2013	alpha + beta TSC	252	247	5	46	46	0%

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm^2 (α+β)	Corrected Net dpm/100cm^2	Fraction of DCGL
B05-01-33-S-O-S-00	Foundation location #33	8/29/2013	alpha + beta TSC	250	247	3	27	27	0%
B05-01-34-S-O-S-00	Foundation location #34	8/29/2013	alpha + beta TSC	236	247	-11	-101	0	0%
B05-01-35-S-O-S-00	Foundation location #35	8/29/2013	alpha + beta TSC	266	247	19	174	174	1%
B05-01-36-S-O-S-00	Foundation location #36	8/29/2013	alpha + beta TSC	258	247	11	101	101	1%
B05-01-37-S-O-S-00	Foundation location #37	8/29/2013	alpha + beta TSC	230	247	-17	-155	0	0%
B05-01-38-S-O-S-00	Foundation location #38	8/29/2013	alpha + beta TSC	253	247	6	55	55	0%
B05-01-39-S-O-S-00	Foundation location #39	8/29/2013	alpha + beta TSC	266	247	19	174	174	1%
B05-01-40-S-O-S-00	Foundation location #40	8/29/2013	alpha + beta TSC	243	247	-4	-37	0	0%
B05-01-41-S-O-S-00	Foundation location #41	8/29/2013	alpha + beta TSC	263	247	16	146	146	1%
B05-01-42-S-O-S-00	Foundation location #42	8/29/2013	alpha + beta TSC	383	247	136	1243	1243	7%
B05-01-43-S-O-S-00	Foundation location #43	8/29/2013	alpha + beta TSC	290	247	43	393	393	2%
B05-01-44-S-O-S-00	Foundation location #44	8/29/2013	alpha + beta TSC	296	247	49	448	448	2%
B05-01-45-S-O-S-00	Foundation location #45	8/29/2013	alpha + beta TSC	283	247	36	329	329	2%
B05-01-46-S-O-S-00	Foundation location #46	8/29/2013	alpha + beta TSC	309	247	62	567	567	3%
B05-01-47-S-O-S-00	Foundation location #47	8/29/2013	alpha + beta TSC	271	247	24	219	219	1%
B05-01-48-S-O-S-00	Foundation location #48	8/29/2013	alpha + beta TSC	261	247	14	128	128	1%
B05-01-49-S-O-S-00	Foundation location #49	8/29/2013	alpha + beta TSC	267	247	20	183	183	1%
B05-01-50-S-O-S-00	Foundation location #50	8/29/2013	alpha + beta TSC	271	247	24	219	219	1%
B05-01-51-S-O-S-00	Foundation location #51	8/29/2013	alpha + beta TSC	266	247	19	174	174	1%
B05-01-52-S-O-S-00	Foundation location #52	8/29/2013	alpha + beta TSC	262	247	15	137	137	1%
B05-01-53-S-O-S-00	Foundation location #53	8/29/2013	alpha + beta TSC	300	247	53	485	485	3%
B05-01-54-S-O-S-00	Foundation location #54	8/29/2013	alpha + beta TSC	309	247	62	567	567	3%
B05-01-55-S-O-S-00	Foundation location #55	8/29/2013	alpha + beta TSC	294	247	47	430	430	2%
B05-01-56-S-O-S-00	Foundation location #56	8/29/2013	alpha + beta TSC	302	247	55	503	503	3%
B05-01-57-S-O-B-00	Biased location measurements #1	8/29/2013	alpha + beta TSC	495	247	248	2267	2267	12%
B05-01-58-S-O-B-00	Biased location post sample measurement	8/29/2013	alpha + beta TSC	278	247	31	283	283	1%
							Min	0	**1%**
							Max	2267	
							Mean	308	**$DCGL_{SO}$**
							Median	219	**0.25**
							Stdev	357.0	
									mrem/year

*NOTE: Differences from documented survey results are due to rounding in Excel

14.0 ALARA EVALUATION BSA 05-01

All measurements collected within BSA 05-01 were evaluated against the $DCGL_{SO}$. For BSA 05-01 no measurement result exceeded the $DCGL_{SO}$. The fraction of the $DCGL_{SO}$, based on all systematically collected samples, was 1% for BSA 05-01. The average of all measurements equates to residual activity contributions from the SU area of 0.25 mrem/yr for BSA 05-01. As the estimated Total Effective Dose Equivalent for LSA 05-01 including the dose contribution of BSA 05-01 is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the evaluation of BSA 05-01 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 05-01.

15.0 FSS PLAN DEVIATIONS BSA 05-01

There were no deviations from the FSS Plan as written.

15.1 Remedial Actions During FSS

As the measurement results of the FSS indicated the results were below the $DCGL_{SO}$ no remedial actions during FSS were necessary.

16.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 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.

16.1 Data Quality Assessment for BSA 05-01

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 05-01 provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDA less than the appropriate investigation level, and were verified to be operable prior to and after use in compliance with HDP-PR-HP-415 (*Operation of the Ludlum 2360 for Final Status Survey*), and HDP-PR-HP-411 (*Radiological Instrumentation*).
- 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 TSC systematic measurements that were collected and the scan surveys that were conducted were performed in compliance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems and Components*.
- Quality Control sample results were not required for BSA 05-01.

- BSA 05-01 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation.*
- Fifty-six (56) systematic measurements were collected in BSA 05-01. None of the 56 samples exceeded the $DCGL_{SO}$ with the highest systematic result of 7% of the $DCGL_{SO}$. As such performance of the Sign Test is not required. Although the Sign Test was performed for illustrative purposes and is provided in Table 16-1. The Sign Test was successful as the total number of systematic measurements (56), far exceeded the minimum requirement of samples.
- During the review of FSS documentation for BSA 05-01 it was identified that a composite concrete sample L05-01-108-T-U-B-00 was collected from the biased measurement location B05-01-57-S-O-B-00, and a follow up biased measurement B05-01-58-S-O-B-00 (see figure table 12-2) was recorded at that location after the composite concrete sample was taken. The composite concrete sample was not a requirement of the FSS Plan. It is noted that the concrete sample was assigned a sample ID from LSA 05-01. Assigning a sample ID is consistent with procedural requirements for sampling. As the sample was and is not a requirement of the FSS plan, therefore it is presumed that the sample was taken for informational purposes by the HP Staff. As an informational sample the information from the concrete sample is not intended to be used and has not been used to demonstrate the compliance of BSA 05-01 release criteria ($DCGL_{SO}$) as it would not be consistent with the FSS Program.
- The maximum observed result in BSA 05-01 was 12% of the $DCGL_{SO}$ at biased location B05-01-57. The average residual radioactivity concentration fraction based on the systematically collected measurements was 1% of the $DCGL_{SO}$, equating to a residual dose contribution of 0.25 mrem/yr.
- During the review of FSS documentation for BSA 05-01 it was identified that when the surveys were performed the FSS plan specified that surface surveys of the structure should be performed in accordance with HDP-PR-HP-311, *Radiological Surveys* instead of HDP-PR-FSS-712, *FSS of Structures Systems and Components (SSCs).* The HDP FSS program directs that for Total Surface Contamination measurements are to be collected and reported with alpha and beta measurements combined. HDP-PR-HP-311, *Radiological Surveys* provides that the alpha and beta measurements are recorded separately. The survey methodology used for the FSS of BSA 05-01 was in accordance with HDP-PR-FSS-712 in every aspect other than the way the TSC measurements were recorded. As a function of the data assessment process the RSO reviewed the surveys and has made the determination that the data still meets the FSS DQOs, and is therefore acceptable for use in evaluation of BSA 05-01. For the purposes of FSS reporting, these separate alpha and beta measurements were combined and compared to the $DCGL_{SO}$.
- No FSS measurement result in BSA 05-01 exceeded the $DCGL_{SO}$, therefore hot spot averaging was not required.

Table 16-1
Sign Test for BSA 05-01

Sign Test							MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+	
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W_s)	Difference ($1-W_s$)	Corrected Difference		N	Alpha = 0.05
B05-01-01-S-O-S-00	Foundation location #1	82	0.004	0.996	0.996	$\alpha = 0.05$	4	4
B05-01-02-S-O-S-00	Foundation location #2	0	0.000	1.000	1.000		5	4
B05-01-03-S-O-S-00	Foundation location #3	91	0.005	0.995	0.995		6	5
B05-01-04-S-O-S-00	Foundation location #4	201	0.011	0.989	0.989		7	6
B05-01-05-S-O-S-00	Foundation location #5	247	0.013	0.987	0.987		8	6
B05-01-06-S-O-S-00	Foundation location #6	494	0.026	0.974	0.974		9	7
B05-01-07-S-O-S-00	Foundation location #7	475	0.025	0.975	0.975		10	8
B05-01-08-S-O-S-00	Foundation location #8	110	0.006	0.994	0.994		11	8
B05-01-09-S-O-S-00	Foundation location #9	256	0.014	0.986	0.986		12	9
B05-01-10-S-O-S-00	Foundation location #10	603	0.032	0.968	0.968		13	9
B05-01-11-S-O-S-00	Foundation location #11	238	0.013	0.987	0.987		14	10
B05-01-12-S-O-S-00	Foundation location #12	0	0.000	1.000	1.000		15	11
B05-01-13-S-O-S-00	Foundation location #13	247	0.013	0.987	0.987		16	11
B05-01-14-S-O-S-00	Foundation location #14	402	0.021	0.979	0.979		17	12
B05-01-15-S-O-S-00	Foundation location #15	658	0.035	0.965	0.965		18	12
B05-01-16-S-O-S-00	Foundation location #16	494	0.026	0.974	0.974		19	13
B05-01-17-S-O-S-00	Foundation location #17	110	0.006	0.994	0.994		20	14
B05-01-18-S-O-S-00	Foundation location #18	265	0.014	0.986	0.986		21	14
B05-01-19-S-O-S-00	Foundation location #19	283	0.015	0.985	0.985		22	15
B05-01-20-S-O-S-00	Foundation location #20	594	0.031	0.969	0.969		23	15
B05-01-21-S-O-S-00	Foundation location #21	201	0.011	0.989	0.989		24	16
B05-01-22-S-O-S-00	Foundation location #22	293	0.015	0.985	0.985		25	17
B05-01-23-S-O-S-00	Foundation location #23	219	0.012	0.988	0.988		26	17
B05-01-24-S-O-S-00	Foundation location #24	887	0.047	0.953	0.953		27	18
B05-01-25-S-O-S-00	Foundation location #25	485	0.026	0.974	0.974		28	18
B05-01-26-S-O-S-00	Foundation location #26	174	0.009	0.991	0.991		29	19
B05-01-27-S-O-S-00	Foundation location #27	0	0.000	1.000	1.000		30	19
B05-01-28-S-O-S-00	Foundation location #28	0	0.000	1.000	1.000		31	20
B05-01-29-S-O-S-00	Foundation location #29	430	0.023	0.977	0.977		32	21
B05-01-30-S-O-S-00	Foundation location #30	0	0.000	1.000	1.000		33	21
B05-01-31-S-O-S-00	Foundation location #31	0	0.000	1.000	1.000		34	22
B05-01-32-S-O-S-00	Foundation location #32	46	0.002	0.998	0.998		35	22
B05-01-33-S-O-S-00	Foundation location #33	27	0.001	0.999	0.999		36	23
B05-01-34-S-O-S-00	Foundation location #34	0	0.000	1.000	1.000		37	23
B05-01-35-S-O-S-00	Foundation location #35	174	0.009	0.991	0.991		38	24
B05-01-36-S-O-S-00	Foundation location #36	101	0.005	0.995	0.995		39	25
B05-01-37-S-O-S-00	Foundation location #37	0	0.000	1.000	1.000		40	25
B05-01-38-S-O-S-00	Foundation location #38	55	0.003	0.997	0.997		41	26
B05-01-39-S-O-S-00	Foundation location #39	174	0.009	0.991	0.991		42	26
B05-01-40-S-O-S-00	Foundation location #40	0	0.000	1.000	1.000		43	27
B05-01-41-S-O-S-00	Foundation location #41	146	0.008	0.992	0.992		44	27
B05-01-42-S-O-S-00	Foundation location #42	1243	0.066	0.934	0.934		45	28
B05-01-43-S-O-S-00	Foundation location #43	393	0.021	0.979	0.979		46	29
B05-01-44-S-O-S-00	Foundation location #44	448	0.024	0.976	0.976		47	29
B05-01-45-S-O-S-00	Foundation location #45	329	0.017	0.983	0.983		48	30
B05-01-46-S-O-S-00	Foundation location #46	567	0.030	0.970	0.970		49	30
B05-01-47-S-O-S-00	Foundation location #47	219	0.012	0.988	0.988		50	31
B05-01-48-S-O-S-00	Foundation location #48	128	0.007	0.993	0.993			
B05-01-49-S-O-S-00	Foundation location #49	183	0.010	0.990	0.990			

B05-01-50-S-O-S-00	Foundation location #50	219	0.012	0.988	0.988
B05-01-51-S-O-S-00	Foundation location #51	174	0.009	0.991	0.991
B05-01-52-S-O-S-00	Foundation location #52	137	0.007	0.993	0.993
B05-01-53-S-O-S-00	Foundation location #53	485	0.026	0.974	0.974
B05-01-54-S-O-S-00	Foundation location #54	567	0.030	0.970	0.970
B05-01-55-S-O-S-00	Foundation location #55	430	0.023	0.977	0.977
B05-01-56-S-O-S-00	Foundation location #56	503	0.027	0.973	0.973
				Number of Positive Differences (S+)	56
				Sign Test Critical Value (MARSSIM Table I-3)	**34**

For N greater than 50 use:

$$\frac{N}{2} + \frac{z}{2}\sqrt{N}$$

Where z = 1.645 (for α = 0.05)

TEST: **PASS**

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

17.0 CONCLUSION BSA 05-01

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structures designated as BSA 05-01 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

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Table 17-1
BSA 05-01 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**1%**
Dose	**0.25 mrem/year**

18.0 DOSE CONTRIBUTION OF BSA 05-01 TO THE LSA SURVEY UNIT

The 0.25 mrem/year dose contribution determined for the structure designated as BSA 05-01 will be added to the total dose determination for SU LSA 05-01.

19.0 CONCLUSION LSA 05-01

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 05-01 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

Table 19-1
LSA 05-01 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	STRUCTURES	REUSE SOIL	**TOTAL**
SOF	0.13	0.11	0.16	0.01	N/A	**0.41**
DOSE	3.25 mrem/year	2.75 mrem/year	4.0 mrem/year	0.25 mrem/year	N/A	**10.25 mrem/year**

20.0 FINAL STATUS SURVEY DESIGN LSA 05-02

This section describes the method for determining the number of samples required for the FSS of LSA 05-02 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 05-02 and their detection sensitivities are also discussed.

20.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 05-02 were driven by the type (Open Land) and Class (Class 1) of the survey unit and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 2, *Final Status Survey Plan Development*, February 2013.

20.1.1 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.*

20.1.2 $DCGL_w$

During the FSS design process a review was performed of the historic characterization data for LSA 05-02. Next the remediation history was reviewed, and the RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform $DCGL_w$. Therefore the Uniform $DCGL_w$ was selected for use in demonstrating compliance with the release criteria.

20.1.3 GWS Coverage

As a Class 1 SU, LSA 05-02 was required to undergo a 100% GWS.

20.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 05-02 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

20.1.5 Scan Minimum Detectable Concentration

As background levels were approximately 10,000 cpm within LSA 05-02, 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:

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

Equation 20-1

In order to calculate the Scan MDC for total uranium using the above equation, an average enrichment for the SU must be known which in turn will provide relative isotopic fractions for U-234, U-235, and U-238 as given in Appendix G of HDP-PR-FSS-701, Revision 4, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 05-02,

the average enrichment for the SU was 75.88%. Note that this is a conservatively high estimate of enrichment. Since all of the RASS soil samples for LSA 05-02 were analyzed on-site, the low activity samples were not able to identify U-238 above sample MDC and reported as zero. For this reason the enrichment of 75.88% was used for Scan MDC calculation. The actual enrichment from all FSS samples was 2.2% when the samples were analyzed at the offsite laboratory.

Standard Scan MDCs for Radium-226 and Thorium-232 using a 2" x 2" NaI detector are found in Table 6.4 of NUREG-1507 and are shown in Table 20-1. Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 05-02 are shown below:

Table 20-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 05-02

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 05-02	126.1	54.3	2.8	2.9	1.8	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 20-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS.

20.1.6 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 FSS in LSA 05-02 was performed prior to the development of HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site*" which established a standard Scan IAL for all Class 1 SU's at the Hematite Site. The IAL used during the GWS of LSA 05-02 was established at 1,762 ncpm which was a calculated value equivalent to the expected scan rate for a potential hot spot representing the $DCGL_{EMC}$ for Total Uranium of 164 pCi/g (using a U-235 enrichment of 75.88%). Given that this Scan IAL is conservative compared to the value of 4,000 ncpm prescribed by the revised HDP FSS program, and that all FSS data is post processed and evaluated as described in FSSFR Volume 3, Chapter 1, Section 6.1.3, the Scan IAL for LSA 05-02of 1,762 is considered acceptable.

20.1.7 LSA 05-02 FSS Design Summary

The FSS Plan for LSA 05-02 can be found in Appendix H. Table 20-2 presents an overall FSS design and implementation summary for LSA 05-02.

Table 20-2
FSS Design Summary for LSA 05-02

Gamma Walkover Survey (GWS):		
Scan Coverage	100% accessible excavation floors and walls	
Scan MDC	126 pCi/g total Uranium (1,352 ncpm)	
Investigation Action Level (IAL)	1,762 net cpm* *After th GWS is performed, the data collected will be examined to confirm areas exceeding the calculated IAL and statistical analysis will be performed to determine significance.	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments
0 – 15 cm (Surface)	0	None
15 cm – 1.5 m (Root)	7	
> 1.5m (Excavation)	12	
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 Radiological Engineering.		
Instrumentation		
Ludlum 2221 with 44-10 (2" x 2" NaI) detector	Used for GWS and to obtain static count rates at biased measurement locations.	

21.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 05-02

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

21.1 Gamma Walkover Survey

21.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 05-02 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*.

21.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewall collected with the NaI detector(s) were connected to a Trimble DGPS and with a hand-held data logger. The logging frequency in

the SU was one (1) GWS measurement per second. Each gross gamma measurement is correlated to a set of coordinates based on the Missouri East State Plane, NAD 1983.

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

HP Technicians performing GWS in LSA 05-02 used the 1,762 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 12,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 11,762 to 13,762gcpm, 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.

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

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

21.2 Soil Sampling

21.2.1 Systematic Soil Sampling Summary

Table 21-1 provides a summary of systematic sampling by stratum for LSA 05-02.

Table 21-1
Systematic Sampling Summary by Stratum for LSA 05-02

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
05-02	1,399	0	18	1	1

21.2.2 Systematic Sampling LSA 05-02

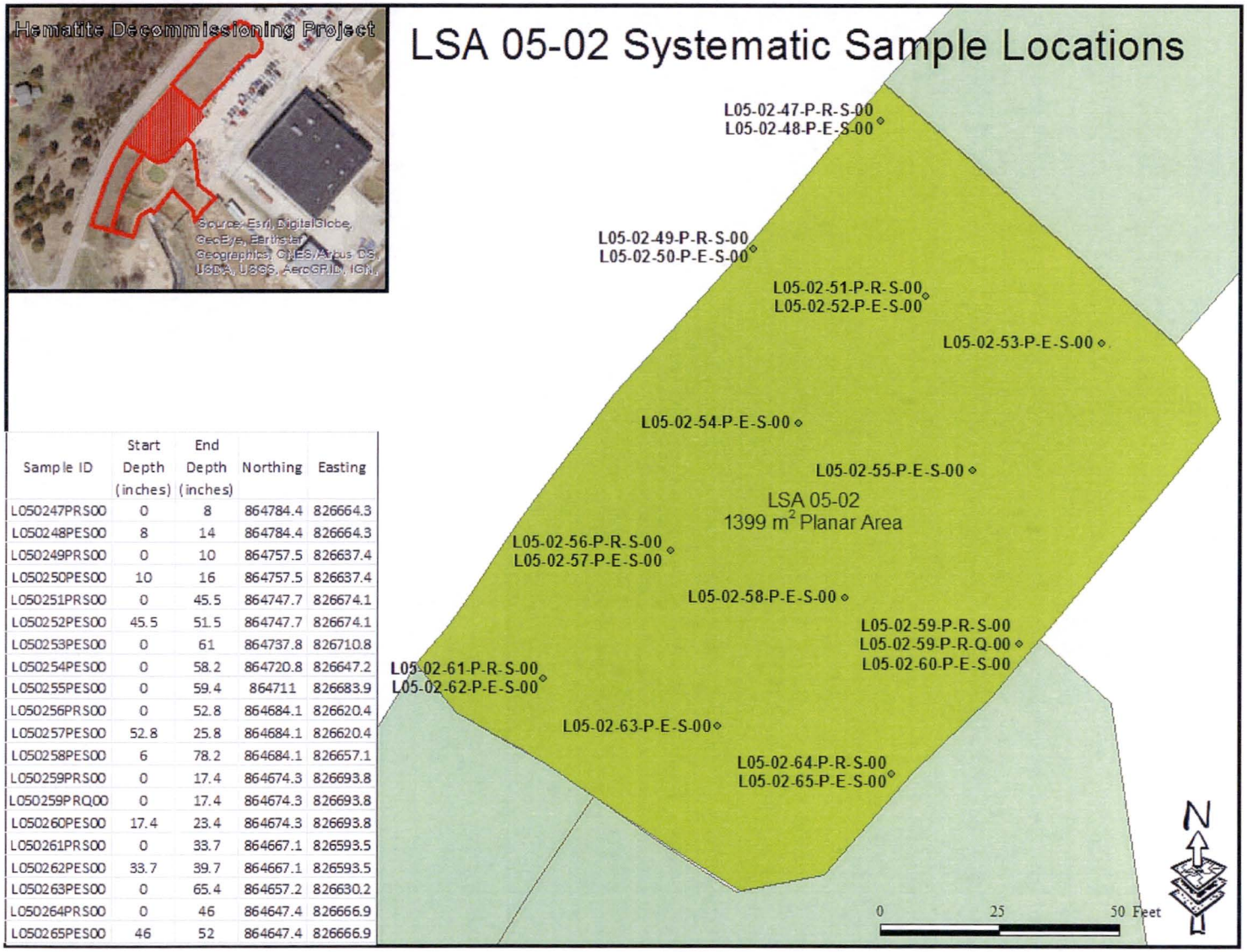
In its final configuration, LSA 05-02, there were no systematic locations in which portions of the surface stratum (0 – 15 cm) remained in the SU after remediation. Portions of the root stratum (15 cm – 150 cm) remained at all twelve systematic locations, however eighteen systematic samples were collected from the root stratum in total. At these locations the remaining root stratum interval was collected using a hand auger and composited. An excavation stratum sample was collected at one location. Given a planar area of 1,399 m^2 for LSA 05-02 and a twelve - point systematic triangular grid, the point-to-point distance within each row was 12.1 m.

While there were twelve systematic locations on the LSA 05-02 sampling grid, a total of twenty (20) samples were collected at these locations, including:

- Zero (0) samples collected within the remaining surface stratum
- Eighteen (18) samples collected within the remaining root stratum
- One (1) sample collected within the excavation, or "deep" stratum
- One (1) QC field replicate

Figure 21-1 presents the map of the twelve systematic sample locations which were sampled within LSA 05-02. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 21-1
LSA 05-02 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing	Easting
L050247PRS00	0	8	864784.4	826664.3
L050248PES00	8	14	864784.4	826664.3
L050249PRS00	0	10	864757.5	826637.4
L050250PES00	10	16	864757.5	826637.4
L050251PRS00	0	45.5	864747.7	826674.1
L050252PES00	45.5	51.5	864747.7	826674.1
L050253PES00	0	61	864737.8	826710.8
L050254PES00	0	58.2	864720.8	826647.2
L050255PES00	0	59.4	864711	826683.9
L050256PRS00	0	52.8	864684.1	826620.4
L050257PES00	52.8	25.8	864684.1	826620.4
L050258PES00	6	78.2	864684.1	826657.1
L050259PRS00	0	17.4	864674.3	826693.8
L050259PRQ00	0	17.4	864674.3	826693.8
L050260PES00	17.4	23.4	864674.3	826693.8
L050261PRS00	0	33.7	864667.1	826593.5
L050262PES00	33.7	39.7	864667.1	826593.5
L050263PES00	0	65.4	864657.2	826630.2
L050264PRS00	0	46	864647.4	826666.9
L050265PES00	46	52	864647.4	826666.9

Table 21-2 below presents a tabular listing of all FSS samples collected within LSA 05-02 with associated IDs, sample types, collection intervals, coordinates, and notes as presented in the FSS plan (Appendix H).

Table 21-2
FSS Sample Locations and Coordinates for LSA 05-02

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 05 **Description:** Barns and Cistern Open Land Area

Survey Unit: 02 **Description:** Tile Barn Area

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L050247PRS00	Uniform	S	437.35	436.7	864784.4	826664.3	Root Zone Composite
L050248PES00	Uniform	S	436.7	436.2	864784.4	826664.3	Excavation 6-in grab
L050249PRS00	Uniform	S	437.56	436.7	864757.5	826637.4	Root Zone Composite
L050250PES00	Uniform	S	436.7	436.2	864757.5	826637.4	Excavation 6-in grab
L050251PRS00	Uniform	S	436.66	432.9	864747.7	826674.1	Root Zone Composite
L050252PES00	Uniform	S	432.9	432.4	864747.7	826674.1	Excavation 6-in grab
L050253PES00	Uniform	S	435.8	430.7	864737.8	826710.8	Excavation 6-in grab
L050254PES00	Uniform	S	436.71	431.9	864720.8	826647.2	Excavation 6-in grab
L050255PES00	Uniform	S	436.08	431.1	864693.9	826620.4	Excavation 6-in grab
L050256PRS00	Uniform	S	436.23	431.8	864684.1	826620.4	Root Zone Composite
L050257PES00	Uniform	S	431.8	431.3	864684.1	826620.4	Excavation 6-in grab
L050258PES00	Uniform	S	437.4	431.4	864684.1	826657.1	Excavation 6-in grab
L050259PRS00	Uniform	S	432.6	431.2	864674.3	826693.8	Root Zone Composite
L050260PES00	Uniform	S	431.2	430.7	864674.3	826693.8	Excavation 6-in grab
L050261PRS00	Uniform	S	436.5	433.7	864667.1	826593.5	Root Zone Composite
L050262PES00	Uniform	S	433.7	433.2	864667.1	826593.5	Excavation 6-in grab
L050263PES00	Uniform	S	436.4	431.0	864657.2	826630.2	Excavation 6-in grab
L050264PRS00	Uniform	S	432.3	428.5	864647.4	826666.9	Root Zone Composite
L050265PES00	Uniform	S	428.5	428.0	864647.4	826666.9	Excavation 6-in grab
L050259PRQ00	Uniform	Q	432.6	431.2	864674.3	826693.8	Root Zone Composite
L050266PUB00	Uniform	B	434.5	434.0	864671.6	826587.6	Biased 6-in grab
L050267PUB00	Uniform	B	434.7	434.2	864678.0	826591.5	Biased 6-in grab
L050268PUB00	Uniform	B	435.6	435.1	864686.1	826593.9	Biased 6-in grab
L050269PUB00	Uniform	B	424.7	424.2	864673.0	826687.5	Biased 6-in 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

21.3 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 05-02 several sample locations were selected within the SU based on the evaluation of the GWS survey data, and the professional judgment of the HP Staff. Biased location L05-02-69-P-U-B-00 represents the maximum GWS measurement encountered within in LSA 05-02 and has a Uniform SOF value of 0.16.

21.4 Judgmental/Sidewall Sampling for Tc-99

The procedural requirements for sidewall sampling are discussed in detail in Section 6.4.

The FSS field activities for LSA 05-02 predated the agreed upon path forward. At the time of FSS of LSA 05-02, site FSS procedures implemented the requirements for soil sampling (including any potential sidewalls) as provided in DP Chapter 14.4.4.1.6.2, *Subsurface Soil.* As such, there were no specific provisions made to assess or collect sidewall samples in LSA 05-02.

Nevertheless, the issue of Tc-99 in a sidewall does not present itself in LSA 05-02 as the sidewall is limited to that area of the SU adjacent to State Road P. State Road P is up-gradient of LSA 05-02 and therefore does not present a pathway for the migration of Tc-99 (See Figure 21-2). Additionally there is no historical sample data or FSS data that indicates that Tc-99 could be present in concentrations that would exceed the DCGL.

Figure 21-2
Location of Sidewall in LSA 05-02

21.5 Quality Control Soil Sampling

One QC field duplicate sample point was randomly selected and collected at systematic location L05-02-59 for LSA 05-02.

22.0 FINAL STATUS SURVEY RESULTS LSA 05-02

22.1 Gamma Walkover Survey

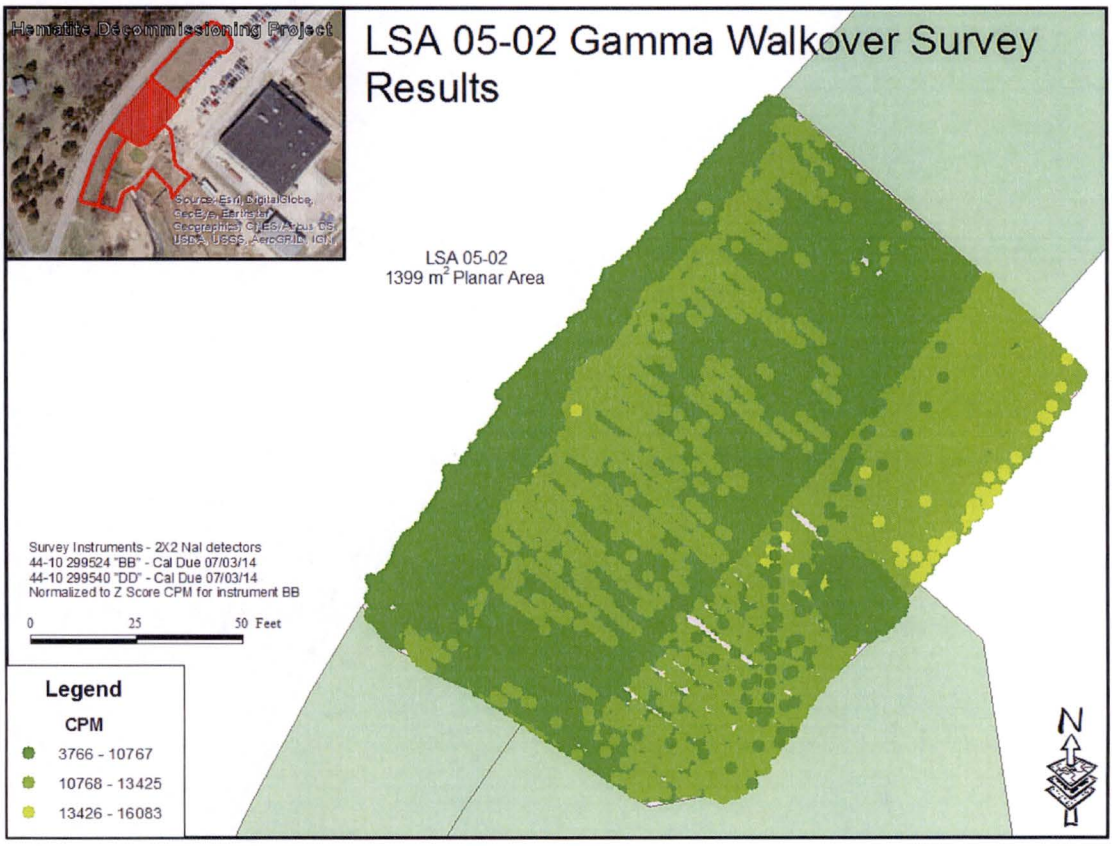
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are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

GWS measurements were collected in LSA 05-02 between July 27, 2013, and August 19, 2013.

22.1.1 GWS Results for LSA 05-02

For LSA 05-02, GWS count rates ranged between 3,766 gcpm and 15,542 gcpm, with a mean count rate of 9,175 gcpm. The median count rate was 9,747 gcpm with a standard deviation of 1,996 cpm. Figure 22-1 below presents a map of the complete GWS data set.

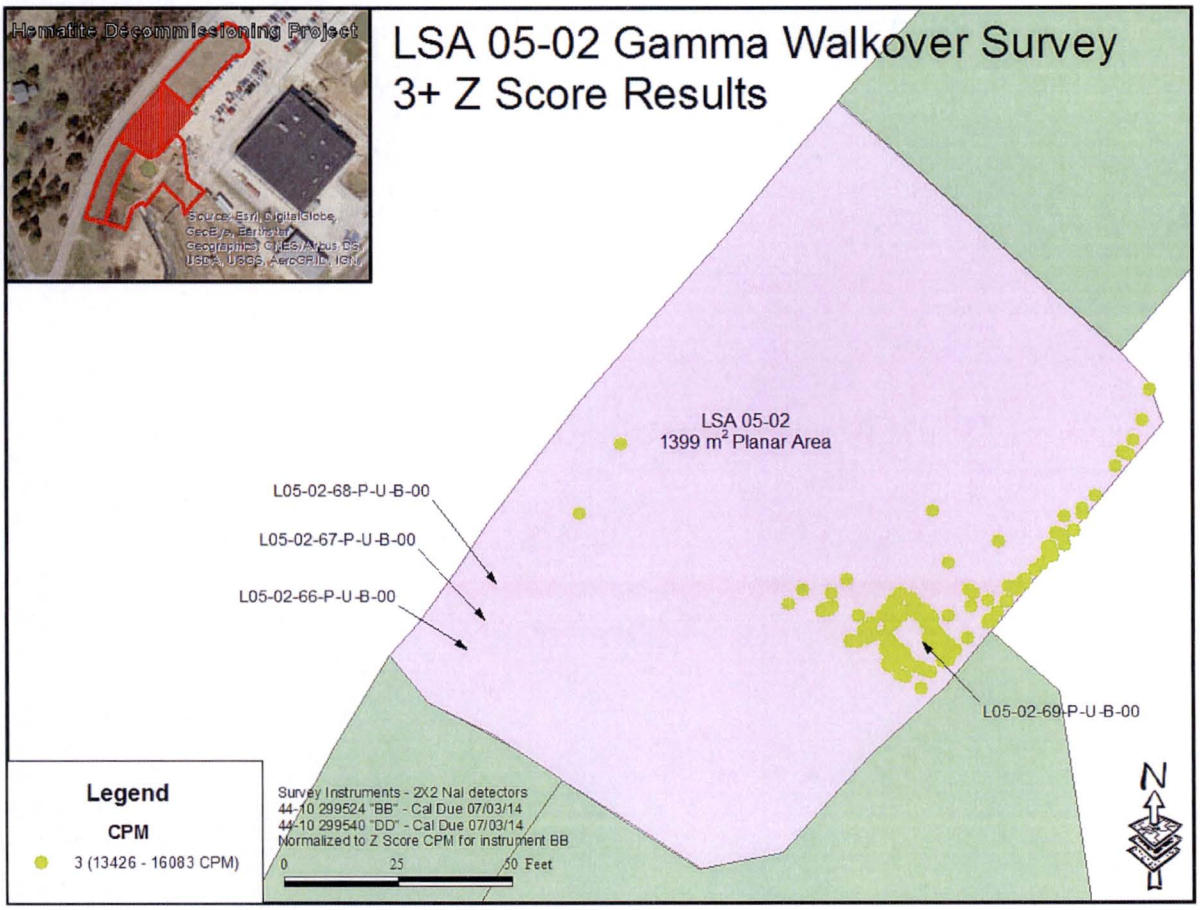
Figure 22-1
Colorimetric GWS Plot for LSA 05-02



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"). Four locations (L05-02-66, L05-02-67, L05-02-68, and L05-02-69) were selected for biased sample collection. The sample collected at location L05-02-69 represented the maximum GWS measurement within the SU and had a Uniform SOF result of 0.16.

Figure 22-2 presents a map of the +3 Z-score GWS measurements within LSA 05-02, including the four selected biased sampling locations.

Figure 22-2
Colorimetric GWS Plot for LSA 05-02 (Measurements > Z-score of 3)



Since all GWS data collected in LSA 05-02 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015. Using these parameters, a new Scan MDC of approximately 40.9 pCi/g is determined. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 05-02, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in

NUREG-1507. The equation used to derive the revised Total Uranium Scan MDC (with a conservative estimate of 4% enrichment) from Section 1.1.5 of HDP-TBD-FSS-002 (Revision 3, August 2015) is as follows:

$$\text{Scan MDC}_{Total\ Uranium} = \quad 1 \Big/ \left(\left(\frac{0.7928}{3659}\right) + \left(\frac{0.0438}{2.32}\right) + \left(\frac{0.1634}{30.6}\right)\right) = 44.9\,\frac{pCi}{g}$$

Equation 22-1

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

22.1.2 GWS Coverage Results LSA 05-02

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. Although 100% of accessible areas underwent GWS, very small areas of the LSA 05-02 interior were not accessed by GPS due primarily to limitations of the GPS technology. These areas appear as small pink blanks or "slivers" in the Figure 22-1 above.

The post survey processing of the GPS data indicated that the GWS was 98.51% of the SU (see Table 22-1). As the evaluation indicates that the GPS coverage is greater than 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 22-1
GWS Gap Analysis LSA 05-02

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 05-02	288,685	4,291	1.49	98.51	1

22.2 Soil Sample Results LSA 05-02

Appendix B presents the analytical results and associated statistics for all FSS samples collected within LSA 05-02.

22.2.1 Surface Soil Sample Results LSA 05-02

There were zero (0) samples collected within the surface stratum (0 – 15 cm) of LSA 05-02. There were a total of seventeen (17) soil samples collected within the topmost soil layer of the excavation surface including twelve systematic samples, four biased samples, and one QC field

duplicate sample. The maximum SOF result for "topmost" samples in LSA 05-02 was 0.61 corresponding to the systematic sample L05-02-64-P-R-S-00.

22.2.2 Subsurface Soil Sample Results LSA 05-02

Although only one systematic sample was actually collected from the excavation stratum, there were seven systematic locations within LSA 05-02 where subsurface sampling was performed. The maximum SOF result of the subsurface samples collected in LSA 05-02 was 0.47 corresponding to the systematic sample L05-02-65-P-R-S-00. This sample (L05-02-65) was the subsurface sample collected directly underneath the root stratum sample L05-02-64.

22.2.3 WRS Test Evaluation for LSA 05-02

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the Wilcoxon Rank Sum (WRS) statistical test was required for LSA 05-02 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 19 systematically collected samples in LSA 05-02 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, (1131) was greater than the critical value (917) 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.

22.2.4 Graphical Data Review LSA 05-02

Table 22-2 below presents summary results for the all systematically collected samples (includes surface, root, and excavation stratum samples, but not biased or QC samples) collected within LSA 05-02, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.34.

Table 22-2
LSA 05-02 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	0.261	0.091	0.331	3.546	0.191	1.427	**0.34**
Minimum	0.080	0.031	0.140	1.959	0.101	0.831	0.19
Maximum	0.480	0.217	0.850	6.478	0.356	1.910	0.61

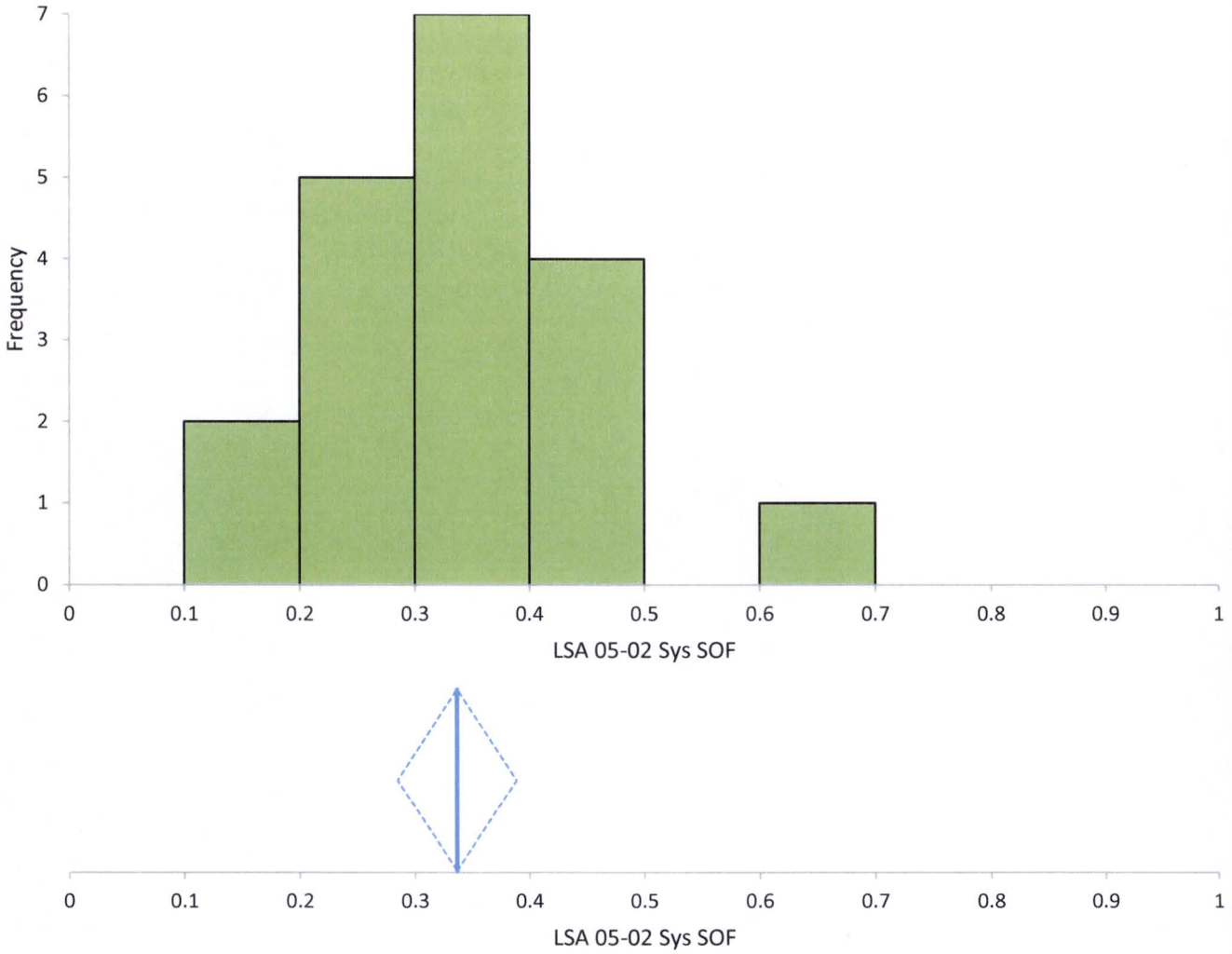
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide 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 22-3 presents the overall statistical metrics for the SOF parameter for the 19 systematically collected samples from LSA 05-02. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 05-02. The middle graph presents the mean SOF (0.34) 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 0.28 to 0.39. The 98.09% confidence interval based on the median (0.32) of the sample results is 0.25 to 0.42. The bottom two charts present the various statistical metrics of the LSA 05-02 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 22-3 exhibits no unusual symmetry or bimodality concerns for the LSA 05-02 data associated with the systematically collected measurement locations.

Figure 22-3
Graphic Statistical Summary for LSA 05-02 (SOF parameter)



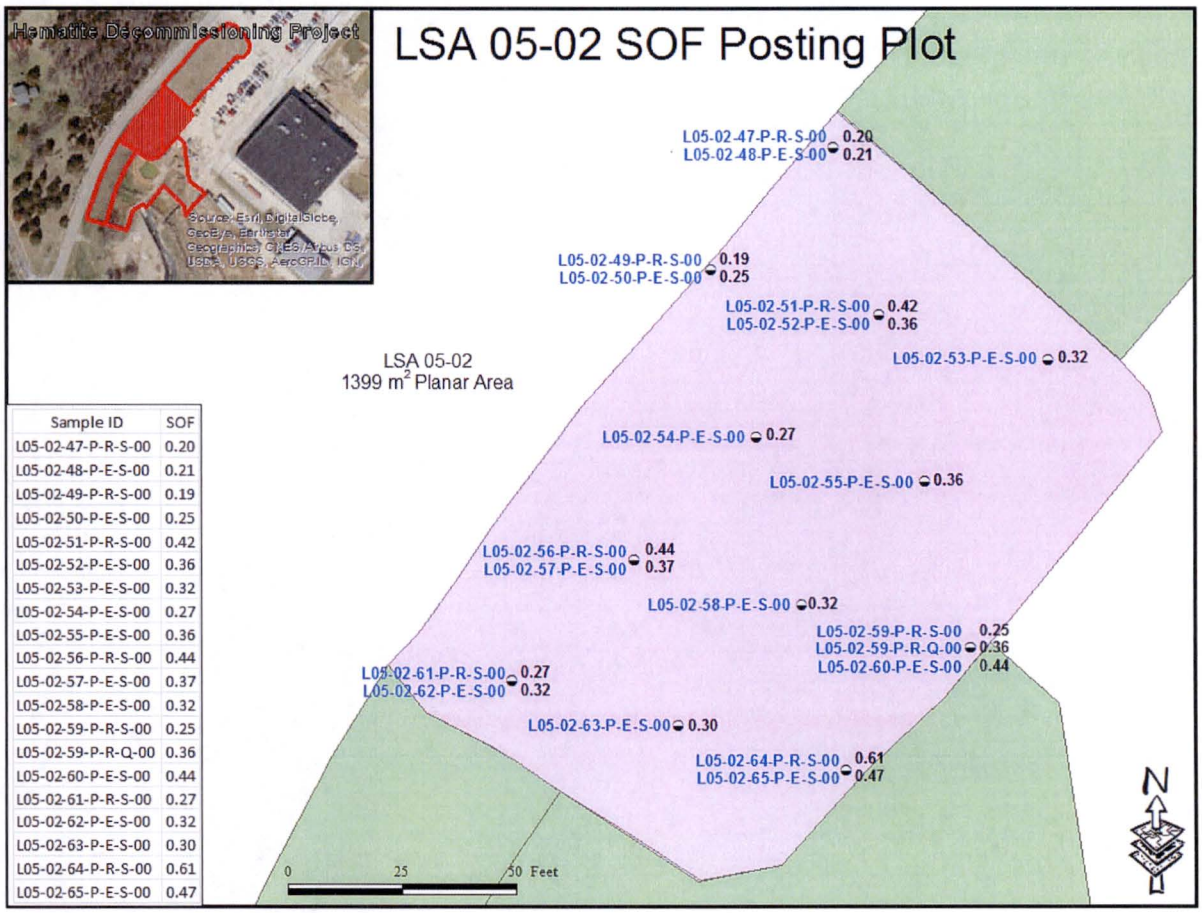
	N
	19

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 05-02 Sys SOF	0.34	0.28	to 0.39	0.025	0.11	0.01	0.9	0.93

	Minimum	1st quartile	Median	98.08% CI		3rd quartile	Maximum	IQR
LSA 05-02 Sys SOF	0.2	0.25	0.32	0.25	to 0.42	0.42	0.6	0.16

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 05-02 is presented below in Figure 22-4. Figure 22-4 shows no unusual patterns in the data.

Figure 22-4
Posting Plot for LSA 05-02 Systematic Measurement Locations



Sample ID	SOF
L05-02-47-P-R-S-00	0.20
L05-02-48-P-E-S-00	0.21
L05-02-49-P-R-S-00	0.19
L05-02-50-P-E-S-00	0.25
L05-02-51-P-R-S-00	0.42
L05-02-52-P-E-S-00	0.36
L05-02-53-P-E-S-00	0.32
L05-02-54-P-E-S-00	0.27
L05-02-55-P-E-S-00	0.36
L05-02-56-P-R-S-00	0.44
L05-02-57-P-E-S-00	0.37
L05-02-58-P-E-S-00	0.32
L05-02-59-P-R-S-00	0.25
L05-02-59-P-R-Q-00	0.36
L05-02-60-P-E-S-00	0.44
L05-02-61-P-R-S-00	0.27
L05-02-62-P-E-S-00	0.32
L05-02-63-P-E-S-00	0.30
L05-02-64-P-R-S-00	0.61
L05-02-65-P-E-S-00	0.47

Appendix C to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 22-2, Figure 22-3, and Figure 22-4 above. A summary of the analytical data is presented in Table 22-3 below. Appendix L to this report presents the Test America Analytical Laboratory soil sample reports.

Table 22-3
Final Status Survey Analytical Data: LSA 05-02

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
L050247PRS00	1.34	S	1.150	0.167	0.083	NA	0.080	0.080	0.171	0.171	0.111	0.220	U	1.200	0.199	0.141	NA	0.200	0.200	6.478	NA	NA	NA	0.36	0.191	0.227	NA	1.79	0.793	0.974	NA	3.0	0.20
L050248PES00	1.80	S	1.230	0.172	0.081	NA	0.160	0.160	0.085	0.085	0.042	0.222	U	1.200	0.203	0.131	NA	0.200	0.200	2.681	NA	NA	NA	0.14	0.171	0.293	U	1.36	0.743	1.100	NA	1.7	0.21
L050249PRS00	1.61	S	1.240	0.176	0.069	NA	0.170	0.170	0.098	0.098	0.119	0.226	U	1.140	0.174	0.132	NA	0.140	0.140	3.328	NA	NA	NA	0.18	0.174	0.255	U	1.48	0.662	0.868	NA	1.9	0.19
L050250PES00	2.10	S	1.200	0.196	0.101	NA	0.130	0.130	0.056	0.056	0.058	0.226	U	1.320	0.240	0.155	NA	0.320	0.320	2.118	NA	NA	NA	0.11	0.208	0.322	U	1.05	0.407	1.040	NA	1.7	0.25
L050251PRS00	3.15	S	1.490	0.207	0.103	NA	0.420	0.420	0.054	0.054	0.076	0.228	U	1.340	0.212	0.132	NA	0.340	0.340	4.182	NA	NA	NA	0.23	0.154	0.286	U	0.831	0.356	0.973	U	4.2	0.42
L050252PES00	3.70	S	1.470	0.204	0.097	NA	0.400	0.400	0.072	0.072	0.056	0.229	U	1.250	0.206	0.173	NA	0.250	0.250	2.221	NA	NA	NA	0.12	0.193	0.315	U	1.03	0.400	1.240	U	1.8	0.36
L050253PES00	2.88	S	1.190	0.252	0.215	NA	0.120	0.120	0.050	0.050	0.010	0.228	U	1.440	0.333	0.268	NA	0.440	0.440	4.539	NA	NA	NA	0.25	0.289	0.574	U	1.16	0.654	2.700	U	3.3	0.32
L050254PES00	4.43	S	1.240	0.185	0.111	NA	0.170	0.170	0.035	0.035	0.053	0.227	U	1.310	0.229	0.154	NA	0.310	0.310	2.918	NA	NA	NA	0.15	0.186	0.340	U	1.7	0.971	1.190	NA	1.4	0.27
L050255PES00	2.69	S	1.350	0.189	0.095	NA	0.280	0.280	0.044	0.044	0.010	0.223	U	1.380	0.226	0.165	NA	0.380	0.380	2.210	NA	NA	NA	0.12	0.192	0.320	U	1.4	0.823	1.010	NA	1.3	0.36
L050256PRS00	4.73	S	1.500	0.218	0.112	NA	0.430	0.430	0.031	0.031	0.041	0.226	U	1.380	0.204	0.160	NA	0.380	0.380	2.893	NA	NA	NA	0.16	0.174	0.297	U	1.39	0.820	1.060	NA	1.8	0.44
L050257PES00	5.20	S	1.410	0.215	0.105	NA	0.340	0.340	0.117	0.117	0.067	0.238	U	1.310	0.225	0.166	NA	0.310	0.310	4.029	NA	NA	NA	0.22	0.221	0.365	U	1.35	0.821	1.260	NA	2.5	0.37
L050258PES00	2.73	S	1.330	0.185	0.083	NA	0.260	0.260	0.087	0.087	0.114	0.234	U	1.320	0.193	0.152	NA	0.320	0.320	2.230	NA	NA	NA	0.12	0.170	0.288	U	1.49	0.784	1.000	NA	1.2	0.32
L050259PRS00	0.87	S	1.290	0.263	0.200	NA	0.220	0.220	0.096	0.096	0.031	0.245	U	1.170	0.317	0.298	NA	0.170	0.170	4.730	NA	NA	NA	0.26	0.267	0.657	U	1.91	1.380	2.280	U	2.1	0.25
L050260PES00	1.40	S	1.550	0.219	0.113	NA	0.480	0.480	0.033	0.033	0.030	0.235	U	1.330	0.240	0.150	NA	0.330	0.330	1.959	NA	NA	NA	0.10	0.168	0.327	U	1.32	0.743	0.957	NA	1.2	0.44
L050261PRS00	3.17	S	1.300	0.181	0.097	NA	0.230	0.230	0.050	0.050	0.017	0.236	U	1.230	0.226	0.133	NA	0.230	0.230	3.799	NA	NA	NA	0.21	0.210	0.300	U	1.6	0.967	1.160	NA	2.0	0.27
L050262PES00	3.70	S	1.260	0.177	0.084	NA	0.190	0.190	0.127	0.127	0.072	0.238	U	1.370	0.199	0.123	NA	0.370	0.370	3.579	NA	NA	NA	0.19	0.175	0.257	U	1.88	0.790	0.943	NA	1.6	0.32
L050263PES00	3.13	S	1.320	0.204	0.090	NA	0.250	0.250	0.132	0.132	0.041	0.237	U	1.280	0.227	0.202	NA	0.280	0.280	2.783	NA	NA	NA	0.15	0.181	0.315	U	1.05	0.394	1.020	NA	2.2	0.30
L050264PRS00	3.57	S	1.340	0.272	0.195	NA	0.270	0.270	0.173	0.173	0.125	0.235	U	1.850	0.379	0.244	NA	0.850	0.850	5.173	NA	NA	NA	0.28	0.476	0.809	U	1.48	1.870	3.030	U	2.9	0.61
L050265PES00	4.10	S	1.430	0.225	0.127	NA	0.360	0.360	0.217	0.217	0.085	0.240	U	1.460	0.259	0.214	NA	0.460	0.460	5.513	NA	NA	NA	0.30	0.215	0.384	U	1.85	0.995	1.210	NA	2.5	0.47
L050259PRQ00	0.87	Q	1.460	0.294	0.159	NA	0.390	0.390	0.112	0.112	0.104	0.229	U	1.220	0.270	0.312	NA	0.220	0.220	4.231	NA	NA	NA	0.23	0.339	0.506	U	1.72	1.690	3.080	U	2.1	0.36
L050266PUB00	-	B	1.150	0.166	0.082	NA	0.080	0.080	0.051	0.051	0.061	0.219	U	1.010	0.194	0.125	NA	0.010	0.010	1.277	NA	NA	NA	0.06	0.150	0.276	U	1.49	0.735	0.905	NA	0.7	0.07
L050267PUB00	-	B	1.450	0.192	0.080	NA	0.380	0.380	0.032	0.032	0.012	0.226	U	1.130	0.206	0.163	NA	0.130	0.130	3.017	NA	NA	NA	0.16	0.159	0.292	U	1.99	0.854	0.999	NA	1.3	0.30
L050268PUB00	-	B	0.619	0.100	0.045	NA	-0.451	0.000	0.231	0.231	0.050	0.194	NA	0.358	0.076	0.109	NA	-0.642	0.000	3.621	NA	NA	NA	0.20	0.117	0.194	NA	0.745	0.535	0.668	NA	4.1	0.04
L050269PUB00	-	B	1.110	0.185	0.096	NA	0.040	0.040	0.032	0.032	0.066	0.289	U	1.210	0.206	0.139	NA	0.210	0.210	3.935	NA	NA	NA	0.22	0.168	0.277	U	0.954	0.448	1.160	U	3.5	0.16
Systematic Minimum			0.080						0.031					0.140						1.959				0.101				0.831				2.2	0.19
Systematic Maximum			0.480						0.217					0.850						6.478				0.356				1.910				Average Enrichment (%)	0.61
Systematic Mean			0.261						0.091					0.331						3.546				0.191				1.427					0.34
Systematic Median			0.250						0.085					0.320						3.328				0.179				1.400					0.32
Systematic Standard Deviation			0.116						0.053					0.153						1.296				0.073				0.312					0.11
			With ingrowth, use Ra226 bkg = 1.07											Th232 bkg = 1.0																				

NOTES:
Gross results in units of pCi/g.
* Background with ingrowth (1.07 pCi/g) subtracted from gross result.
**Background (1.0 pCi/g) subtracted from gross result.
U Qualifier: Result is less than the sample detection limit.
All uncertainty values are reported at the 2-sigma confidence level.

22.2.5 Biased Soil Sample Result LSA 05-02

Four (4) biased samples were collected from LSA 05-02. The sample collected at location L05-02-69 represented the maximum GWS measurement (15,542 gcpm) within the SU, and had a result of 0.16 Uniform SOF.

22.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 05-02

Utilizing FSS procedural guidance, based upon the NRC approval of the content of the DP, at the time of FSS the FSS Plan did not require sidewall samples to be taken in LSA 05-02. See Section 21.4.

22.2.7 Quality Control Soil Sample Result LSA 05-02

One QC field duplicate sample point was randomly selected for LSA 05-02 which was collected at systematic location L05-02-59.

For the 23 "regular" samples (i.e., 19 systematic + 4 biased) collected within LSA 05-02, one field duplicate sample was collected. This frequency equates to 4.3%, (i.e. 1/23). Form HDP-PR-FSS-703-1 documents that the duplicate sample result comparison with the partner's sample result that all comparison criteria were less than the calculated Warning Limits (see Figure 22-5 below). While the QC sample frequency is less than 5% considering all samples, it is above 5% considering only the systematically collected samples in LSA 05-02, and the overall project QC sample frequency remains above 5%, therefore no additional actions are needed.

Figure 22-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 05-02

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 05-02 — Survey Unit Description: Tile Barn Area

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)
L050259PRS00	L050259PRQ00	Ra-226	1.29	0.2	1.46	0.159	1.375	1.9	0.17	0.269	0.403	N
L050259PRS00	L050259PRQ00	Tc-99	0.096	0.245	0.112	0.229	0.104	25.1	NA	3.552	5.321	NA
L050259PRS00	L050259PRQ00	Th-232	1.17	0.298	1.22	0.312	1.195	2.0	0.050	0.283	0.424	N
L050259PRS00	L050259PRQ00	U-234[1]	4.730	N/A	4.231	N/A	4.481	195.4	0.499	27.649	41.425	N
L050259PRS00	L050259PRQ00	U-235	0.26	0.657	0.23	0.506	0.243	51.6	NA	7.301	10.939	NA
L050259PRS00	L050259PRQ00	U-238	1.91	2.28	1.72	3.08	1.815	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: 3-13-17

Reviewed by: Clark Evers

Date: 3/16/17

Quality Record

22.3 Tc-99 Hot Spot Assessment LSA 05-02

During site characterization studies a total of 7 samples were collected and analyzed for Tc-99 in LSA 05-02. None of the 7 characterization samples exceeded the Tc-99 DCGLw, with the highest recorded Tc-99 result of 14.5 pCi/g. No samples exceeded the Tc-99 DCGL during FSS. Within LSA 05-02, the maximum sample Tc-99 identified during FSS was 0.22 pCi/g which is well below Tc-99 Uniform Stratum DCGL of 25.1 pCi/g.

23.0 ALARA EVALUATION LSA 05-02

All samples collected within LSA 05-02 were evaluated against the Uniform Stratum $DCGL_W$. For LSA 05-02 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.34 for LSA 05-02. The average SOF equates to residual activity contributions from the SU area of 8.5 mrem/yr for LSA 05-02. The groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2 through 5 indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/yr based upon the EPA MCLs will be added to the total estimated dose for LSA 05-02. One layer of Reuse Stockpile 2 was placed into LSA 05-02 (see Section 3.3.13), and as such the dose contribution of 2.5 mrem/yr will be added to account for the placement of reuse soil. LSA 05-02 contained the original structure, designated BA 05-02, of a barn foundation (see Section 27.0), for which 0.75 mrem/yr will be added to account for the structure dose. Summing the dose contributions from all sources, the total estimated dose for LSA 05-02 is 15.75 mrem/yr.

As the estimated Total Effective Dose Equivalent is below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the remediation of LSA 05-02 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing further remediation of LSA 05-02.

24.0 FSS PLAN DEVIATIONS LSA 05-02

24.1 Remedial Actions during FSS

While not considered a "deviation" from the FSS plans as written, it is noted in the DQO checklist that a field instrument used for the purpose of scanning the BSA 05-02 foundation did not successfully pass post-QC checks at the end of shift. This survey data was discarded, and the surveys were repeated the following day with an instrument that did successfully pass both pre and post-QC checks.

24.2 Adjustments to Scan MDC Calculations

As previously stated in Section 20.1.5, adjustments were made to the Scan MDC calculations for instrumentation used for the GWS in LSA 05-02. The Scan MDCs presented in the FSS Plans shown in Table 20-1 assumed a surveyor efficiency of 0.5 and did not reflect the information derived from the development of HDP-TBD-FSS-002 which used Microshield modeling of parameters consistent with procedural requirements of GWS implementation at HDP. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of

field FSS activities in LSA 05-02, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. Since all GWS data collected in LSA 05-02 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015.

Based on the data presented in HDP-TBD-FSS-002 and using a surveyor efficiency of 0.75 and a conservative enrichment basis of 4%, revised Scan MDCs were developed and are presented in Table 24-1 below:

Table 24-1

Revised Scan MDCs for 2" x 2" NaI detector: LSA 05-02

	Scan MDC (Total U)	**DCGLw (Total U)**	**Scan MDC (Ra-226)**	**DCGLw (Ra-226)**	**Scan MDC (Th-232)**	**DCGLw (Th-232)**
LSA 05-02	40.9	54.3	1.21	1.9	0.87	2.0

25.0 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.

25.1 Data Quality Assessment for LSA 05-02

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 05-02 (see Figure 25-1) 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*.
- During the review of documentation for LSA 05-02 it is recognized that the FSS Plan for LSA 05-02 specified that root, and excavation samples would be collected across the systematic grid, however the stratum of FSS sampling is based on the projected final grade of the SU after all backfill operations have been completed. The FSS Plan for LSA 05-02 used the original grade of the SU to determine sample depth. During data validation utilizing the final grade for assessment of the samples it has been determined that no FSS soil samples were collected from the surface stratum, 18 of the 19 FSS soil samples were actually collected from the root stratum, and 1 of 19 FSS soil samples were actually collected from the excavation stratum, and in some cases, multiple samples were collected from the same stratum at the same location. To avoid confusion the COC for the laboratory analysis the sample IDs were not changed to reflect the change in stratum in which the sample was taken. During the validation and assessment process the actual depths of the soil samples in relation to final grade are used for the purposes of determining where each FSS sample was collected within the SU.
- LSA 05-02 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 necessary when the difference between the maximum survey unit data set measurement SOF and the minimum background area measurement SOF is greater than one. For LSA 05-02, 5 individual gross SOF result(s) in the FSS data set exceeded the SOF of the minimum background reference area measurement by more than one using the Uniform Stratum criteria. Therefore, the WRS Test was required for LSA 05-02. Since the test statistic, WR (1131) exceeded the critical value (917), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS evaluation worksheet is presented in Appendix C.
- The maximum systematic SOF result for all surface samples within LSA 05-02 was 0.61. The maximum systematic SOF result for all subsurface samples within LSA 05-02 was 0.47. The average SOF result for all systematically collected samples within LSA 05-02 was 0.34, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.39.
- No FSS sample result in LSA 05-02 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 (12) of systematic sample locations actually collected within LSA 05-02. The successful result of the retrospective power evaluation presented in Table 25-1 for LSA 05-02 indicates that the minimum number of sample locations required (8) for the WRS Test was less than the number of sampling locations actually collected (12) within LSA 05-02. 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.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for LSA 05-02 was completed prior to the commencement of backfill operations.

Table 25-1
Retrospective Sample Size Verification for LSA 05-02

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.11
$DCGL_{SOF}$	1
LBGR (Mean)	0.34
Shift	0.66
Relative Shift (Δ/σ)	6.16
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	12
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

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

MARSSIM Table 5.2, $\alpha = 0.05$, $\beta = 0.10$

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

α
β

Figure 25-1
Data Evaluation Checklists prepared for LSA 05-02 (page 1 of 2)

Revision: 2 Page G-1 of 2

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

Survey Area: 05 **Description:** Barns/ Cistern Area
Survey Unit: 02 **Description:** Entire Unit

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 step 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 ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☑ No ☐
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☑ No ☐
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☑ No ☐
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☑ No ☐ see comments below
9.	Do the samples match those identified on the chain of custody?	Yes ☑ No ☐
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control (Reference 5.11)	Yes ☑ No ☐

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

Comments;

per Item #8 above: On 08/13/13 17:45 the L-2360 Meter "I" failed Beta post check 3 consecutive times. All survey data for that day was deemed null and void. Surveys were repeated on 08/14/13 and instruments passed pre- and post-check successfully. R.N.

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Figure 25-1
Data Evaluation Checklists prepared for LSA 05-02 (page 2 of 2)

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

Survey Area: No. 05 **Description:** Barns / Cistern Area
Survey Unit: No. 02 **Description:** Entire Unit

Discrepancy; None.

R.N.

Corrective Actions Taken;

R.N.

11. Have the corrective actions resolved the discrepancy with the data? Yes ☐ No ☐ N/A R.N.
    a. If "No", then forward this form to the RSO.
12. The following questions will be answered by the RSO.
    a. If the answer to question 13 was "No", then is the affected data still valid? Yes ☐ No ☐ N/A R.N.
    b. If "No", then are the existing valid measurements or samples sufficient to demonstrate compliance for the survey unit? Yes ☐ No ☐ N/A R.N.
    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):	Rock Nevenn (Print Name)	(Signature)	9/23/13 (Date)
Approved by (RSO):	Joseph Guido (Print Name)	(Signature)	2-21-14 (Date)

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26.0 SURVEILLANCE FOLLOWING FSS

FSS of SU LSA 05-02 was completed on November 18, 2013 as well as FSS of adjacent SUs LSA 05-01 (January 19, 2014), and LSA 05-03 (November 25, 2013). Given the location of LSA 05-02 on the northern most boundary of the site, and that the elevation of LSA 05-02 places it above all other remaining un-remediated LSAs, this precludes the possibility of cross contamination. As such, the radiological status of all of the SUs adjacent to LSA 05-02 did not present a possibility of recontamination of LSA 05-02 as a consequence of a storm event. Figure 26-1 is a photograph of SU LSA 05-02 being backfilled.

Figure 26-1
LSA 05-02 Backfill Operations

27.0 FINAL STATUS SURVEY IMPLEMENTATION OF BSA 05-02

During the development of the FSS Plan for the land area that comprises LSA 05-02 the developers of the FSS Plan did not provide consideration to the structures that resided in the SU. At the time FSS was being performed, in accordance with HDP-PR-FSS-711, *Final Status Surveys and Sampling of Soil and Sediment*, it was recognized that there existed an inability to perform the FSS in accordance with the FSS Plan due to the presence of structures within the SU. As required by HDP-PR-FSS-711 FSS was halted and HP Supervision was informed. The FSS Plan was subsequently revised and approved to address FSS of the structures within LSA 05-02.

The structures within LSA 05-02 were collectively designated as BSA 05-02. The structures consisted of the former barn foundation (for additional detail see Section 3.3.2), a small section of the ramp to the former Tile Barn and a storm drain basin with a small section of metal storm drain piping that is integral to the storm drain basin. Although the storm drain basin and piping are considered one structure the survey data is documented separately as the storm drain basin and the metal pipe.

The storm drain basin serves to tie together a MoDOT storm drain from a higher elevation across and under State Road P to storm drain piping that directs storm water during acute rainfall from the public right of way to the Site Pond. The storm drain basin is in the public right of way and remained in service and therefore could not be removed. As the storm drain basin remained dry except for an acute rain event it was easily surveyed in a dry condition.

This section provides the FSS survey data that was originally collected of the remaining structures now identified as BSA 05-02, and an assessment of the validity of the data. FSS of BSA 05-02 was performed in accordance with procedure HDP-PR-HP-311, *Radiological Surveys*, and in compliance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems, and Components*.

27.1 Scan Survey

27.1.1 Instrumentation

The chosen instrumentation was a Ludlum Model 43-89 detector, paired with a Ludlum Model 2360 data logging meter.

27.1.2 Scan Survey Performance

A 100% scan survey was performed of all exposed surfaces of the structures.

27.1.3 Systematic Measurements

Each remaining structure was scanned in 1 square meter sections, with a systematic measurement collected from each separate section. Forty-eight (48) individual systematic measurements were collected across all remaining structures comprising BSA 05-02. Table 27-1 provides a listing of the measurement locations as specified in the FSS plan (Appendix H).

Table 27-1
FSS Measurement Locations for BSA 05-02

APPENDIX P-4

FSS SAMPLE & MEASUREMENT LOCATIONS & COORDINATES

Survey Area: BSA 05 **Description:** Class 1 Structure inside LSA 05-02

Survey Unit: 02 **Description:** Former Tile Barn Foundation

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start * Elevation	End * Elevation	Location ID	Remarks / Notes
B05-02-01-S-O-S-00	O	S	NA	NA	Footer Section 1	Former Barn Footer
B05-02-02-S-O-S-00	O	S	NA	NA	Footer Section 2	Former Barn Footer
B05-02-03-S-O-S-00	O	S	NA	NA	Footer Section 3	Former Barn Footer
B05-02-04-S-O-S-00	O	S	NA	NA	Footer Section 4	Former Barn Footer
B05-02-05-S-O-S-00	O	S	NA	NA	Footer Section 5	Former Barn Footer
B05-02-06-S-O-S-00	O	S	NA	NA	Footer Section 6	Former Barn Footer
B05-02-07-S-O-S-00	O	S	NA	NA	Footer Section 7	Former Barn Footer
B05-02-08-S-O-S-00	O	S	NA	NA	Footer Section 8	Former Barn Footer
B05-02-09-S-O-S-00	O	S	NA	NA	Footer Section 9	Former Barn Footer
B05-02-10-S-O-S-00	O	S	NA	NA	Footer Section 10	Former Barn Footer
B05-02-11-S-O-S-00	O	S	NA	NA	Footer Section 11	Former Barn Footer
B05-02-12-S-O-S-00	O	S	NA	NA	Footer Section 12	Former Barn Footer
B05-02-13-S-O-S-00	O	S	NA	NA	Footer Section 13	Former Barn Footer
B05-02-14-S-O-S-00	O	S	NA	NA	Footer Section 14	Former Barn Footer
B05-02-15-S-O-S-00	O	S	NA	NA	Footer Section 15	Former Barn Footer
B05-02-16-S-O-S-00	O	S	NA	NA	Footer Section 16	Former Barn Footer
B05-02-17-S-O-S-00	O	S	NA	NA	Footer Section 17	Former Barn Footer
B05-02-18-S-O-S-00	O	S	NA	NA	Footer Section 18	Former Barn Footer
B05-02-19-S-O-S-00	O	S	NA	NA	Footer Section 19	Former Barn Footer
B05-02-20-S-O-S-00	O	S	NA	NA	Footer Section 20	Former Barn Footer
B05-02-21-S-O-S-00	O	S	NA	NA	Footer Section 21	Former Barn Footer
B05-02-22-S-O-S-00	O	S	NA	NA	Footer Section 22	Former Barn Footer
B05-02-23-S-O-S-00	O	S	NA	NA	Footer Section 23	Former Barn Footer
B05-02-24-S-O-S-00	O	S	NA	NA	Footer Section 24	Former Barn Footer
B05-02-25-S-O-S-00	O	S	NA	NA	Footer Section 25	Former Barn Footer
B05-02-26-S-O-S-00	O	S	NA	NA	Footer Section 26	Former Barn Footer
B05-02-27-S-O-S-00	O	S	NA	NA	Footer Section 27	Former Barn Footer
B05-02-28-S-O-S-00	O	S	NA	NA	Footer Section 28	Former Barn Footer
B05-02-29-S-O-S-00	O	S	NA	NA	Footer Section 29	Former Barn Footer
B05-02-30-S-O-S-00	O	S	NA	NA	Footer Section 30	Former Barn Footer
B05-02-31-S-O-S-00	O	S	NA	NA	Ramp Footer Section 1	Former Ramp Footer
B05-02-32-S-O-S-00	O	S	NA	NA	Ramp Footer Section 2	Former Ramp Footer
B05-02-33-S-O-S-00	O	S	NA	NA	Ramp Footer Section 3	Former Ramp Footer
B05-02-34-S-O-S-00	O	S	NA	NA	Ramp Footer Section 4	Former Ramp Footer
B05-02-35-S-O-S-00	O	S	NA	NA	Ramp Footer Section 5	Former Ramp Footer
B05-02-36-S-O-S-00	O	S	NA	NA	Ramp Footer Section 6	Former Ramp Footer
B05-02-37-S-O-S-00	O	S	NA	NA	Ramp Footer Section 7	Former Ramp Footer
B05-02-38-S-O-S-00	O	S	NA	NA	Drain Basin Section 1	Remaining Drain Basin
B05-02-39-S-O-S-00	O	S	NA	NA	Drain Basin Section 2	Remaining Drain Basin

Measurement or Sample ID	Surface or CSM	Type	Start * Elevation	End * Elevation	Location ID	Remarks / Notes
B05-02-40-S-O-S-00	O	S	NA	NA	Drain Basin Section 3	Remaining Drain Basin
B05-02-41-S-O-S-00	O	S	NA	NA	Drain Basin Section 4	Remaining Drain Basin
B05-02-42-S-O-S-00	O	S	NA	NA	Drain Basin Section 5	Remaining Drain Basin
B05-02-43-S-O-S-00	O	S	NA	NA	Small Junction Box	Remaining Drain Basin
B05-02-44-S-O-S-00	O	S	NA	NA	Metal Storm Drain Pipe Ext 1	Remaining Drain Basin
B05-02-45-S-O-S-00	O	S	NA	NA	Metal Storm Drain Pipe Ext 2	Remaining Drain Basin
B05-02-46-S-O-S-00	O	S	NA	NA	Metal Storm Drain Pipe Ext 3	Remaining Drain Basin
B05-02-47-S-O-S-00	O	S	NA	NA	Metal Storm Drain Pipe Ext 4	Remaining Drain Basin
B05-02-48-S-O-S-00	O	S	NA	NA	Metal Storm Drain Pipe Int.	Remaining Drain Basin

*X and Y coordinates originate from lower left or southwest corner of structural surface. Each structural surface has it's own origin (0,0) point.

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

CSM: Three-Layer (Surface-Root-Deep) or Uniform

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

Quality Record

No location exceeded the $DCGL_{SO}$. The highest observed systematic measurement was recorded at location P05-02-08-S-O-S-00 with a TSC result of 1,280 dpm/100 cm^2 (7% of the $DCGL_{so}$). The complete FSS results are provided in Appendix Q.

27.2 Biased Measurement

No biased locations were selected based on elevated scan survey readings, and no static readings exceeded the investigation level, therefore no biased measurements were necessary for BSA 05-02.

27.3 Quality Control Measurements

The QC requirement found in HDP-PR-FSS-703, *Final Status Survey Quality Control* states that at least 5% of the total number of structural SUs undergo a complete replicate survey by a different technician from that which was used in the original FSS of that particular SSC SU. While BSA 05-02 was not originally evaluated as a Structural SU, it can now be evaluated along with all other remaining structural SUs, and as such, no QC measurements were required for BSA 05-02.

28.0 FINAL STATUS SURVEY RESULTS BSA 05-02

During the course of FSS of BSA 05-02, no scan measurement exceeded the Scan IAL of specified in the original FSS plans, and no removable measurement exceeded 10% of the minimum TSC measurements (all removable measurements were <MDA). The average fraction of the $DCGL_{SO}$ for BSA 05-02 is 3% of the $DCGL_{SO}$. The analytical data sheets used to evaluate the BSA 05-02 FSS data are provided in Appendix D. A summary table of the FSS results is presented below in Table 28-1.

Table 28-1
FSS Data Summary for BSA 05-02

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm^2 (α+β)	Corrected Net dpm/100cm^2	Fraction of DCGL
B05-02-01-S-O-S-00	Footer Section 1	8/14/2013	alpha + beta TSC	338	253	85	850	850	4%
B05-02-02-S-O-S-00	Footer Section 2	8/14/2013	alpha + beta TSC	328	253	75	750	750	4%
B05-02-03-S-O-S-00	Footer Section 3	8/14/2013	alpha + beta TSC	318	253	65	650	650	3%
B05-02-04-S-O-S-00	Footer Section 4	8/14/2013	alpha + beta TSC	380	253	127	1270	1270	7%
B05-02-05-S-O-S-00	Footer Section 5	8/14/2013	alpha + beta TSC	332	253	79	790	790	4%
B05-02-06-S-O-S-00	Footer Section 6	8/14/2013	alpha + beta TSC	358	253	105	1050	1050	6%
B05-02-07-S-O-S-00	Footer Section 7	8/14/2013	alpha + beta TSC	329	253	76	760	760	4%
B05-02-08-S-O-S-00	Footer Section 8	8/14/2013	alpha + beta TSC	381	253	128	1280	1280	7%
B05-02-09-S-O-S-00	Footer Section 9	8/14/2013	alpha + beta TSC	350	253	97	970	970	5%
B05-02-10-S-O-S-00	Footer Section 10	8/14/2013	alpha + beta TSC	364	253	111	1110	1110	6%
B05-02-11-S-O-S-00	Footer Section 11	8/14/2013	alpha + beta TSC	355	253	102	1020	1020	5%
B05-02-12-S-O-S-00	Footer Section 12	8/14/2013	alpha + beta TSC	352	253	99	990	990	5%
B05-02-13-S-O-S-00	Footer Section 13	8/14/2013	alpha + beta TSC	347	253	94	940	940	5%
B05-02-14-S-O-S-00	Footer Section 14	8/14/2013	alpha + beta TSC	355	253	102	1020	1020	5%
B05-02-15-S-O-S-00	Footer Section 15	8/14/2013	alpha + beta TSC	372	253	119	1190	1190	6%
B05-02-16-S-O-S-00	Footer Section 16	8/14/2013	alpha + beta TSC	241	250	-9	-82	0	0%
B05-02-17-S-O-S-00	Footer Section 17	8/14/2013	alpha + beta TSC	230	250	-20	-183	0	0%
B05-02-18-S-O-S-00	Footer Section 18	8/14/2013	alpha + beta TSC	256	250	6	55	55	0%
B05-02-19-S-O-S-00	Footer Section 19	8/14/2013	alpha + beta TSC	266	250	16	146	146	1%
B05-02-20-S-O-S-00	Footer Section 20	8/14/2013	alpha + beta TSC	259	250	9	82	82	0%
B05-02-21-S-O-S-00	Footer Section 21	8/14/2013	alpha + beta TSC	264	250	14	128	128	1%
B05-02-22-S-O-S-00	Footer Section 22	8/14/2013	alpha + beta TSC	271	250	21	192	192	1%
B05-02-23-S-O-S-00	Footer Section 23	8/14/2013	alpha + beta TSC	268	250	18	165	165	1%
B05-02-24-S-O-S-00	Footer Section 24	8/14/2013	alpha + beta TSC	293	250	43	393	393	2%
B05-02-25-S-O-S-00	Footer Section 25	8/14/2013	alpha + beta TSC	233	250	-17	-155	0	0%
B05-02-26-S-O-S-00	Footer Section 26	8/14/2013	alpha + beta TSC	252	250	2	18	18	0%
B05-02-27-S-O-S-00	Footer Section 27	8/14/2013	alpha + beta TSC	233	250	-17	-155	0	0%

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm^2 (α+β)	Corrected Net dpm/100cm^2	Fraction of DCGL
B05-02-28-S-O-S-00	Footer Section 28	8/14/2013	alpha + beta TSC	281	250	31	283	283	1%
B05-02-29-S-O-S-00	Footer Section 29	8/14/2013	alpha + beta TSC	271	250	21	192	192	1%
B05-02-30-S-O-S-00	Footer Section 30	8/14/2013	alpha + beta TSC	272	250	22	201	201	1%
B05-02-31-S-O-S-00	Ramp Footer Section 1	8/14/2013	alpha + beta TSC	468	354	114	1140	1140	6%
B05-02-32-S-O-S-00	Ramp Footer Section 2	8/14/2013	alpha + beta TSC	430	354	76	760	760	4%
B05-02-33-S-O-S-00	Ramp Footer Section 3	8/14/2013	alpha + beta TSC	352	354	-2	-20	0	0%
B05-02-34-S-O-S-00	Ramp Footer Section 4	8/14/2013	alpha + beta TSC	370	354	16	160	160	1%
B05-02-35-S-O-S-00	Ramp Footer Section 5	8/14/2013	alpha + beta TSC	386	354	32	320	320	2%
B05-02-36-S-O-S-00	Ramp Footer Section 6	8/14/2013	alpha + beta TSC	391	354	37	370	370	2%
B05-02-37-S-O-S-00	Ramp Footer Section 7	8/14/2013	alpha + beta TSC	445	354	91	910	910	5%
B05-02-38-S-O-S-00	Drain Basin Section 1	8/14/2013	alpha + beta TSC	387	354	33	330	330	2%
B05-02-39-S-O-S-00	Drain Basin Section 2	8/14/2013	alpha + beta TSC	390	354	36	360	360	2%
B05-02-40-S-O-S-00	Drain Basin Section 3	8/14/2013	alpha + beta TSC	350	354	-4	-40	0	0%
B05-02-41-S-O-S-00	Drain Basin Section 4	8/14/2013	alpha + beta TSC	372	354	18	180	180	1%
B05-02-42-S-O-S-00	Drain Basin Section 5	8/14/2013	alpha + beta TSC	354	354	0	0	0	0%
B05-02-43-S-O-S-00	Small Junction Box	8/14/2013	alpha + beta TSC	359	379	-20	-200	0	0%
B05-02-44-S-O-S-00	Metal Storm Drain Pipe Ext 1	8/14/2013	alpha + beta TSC	403	354	49	490	490	3%
B05-02-45-S-O-S-00	Metal Storm Drain Pipe Ext 2	8/14/2013	alpha + beta TSC	400	354	46	460	460	2%
B05-02-46-S-O-S-00	Metal Storm Drain Pipe Ext 3	8/14/2013	alpha + beta TSC	424	354	70	700	700	4%
B05-02-47-S-O-S-00	Metal Storm Drain Pipe Ext 4	8/14/2013	alpha + beta TSC	384	354	30	300	300	2%
B05-02-48-S-O-S-00	Metal Storm Drain Pipe Int.	8/14/2013	alpha + beta TSC	400	354	46	460	460	2%
							Min	0	**3%**
							Max	1280	
							Mean	488	**$DCGL_{SO}$**
							Median	365	**0.75**
							Stdev	419.3	
									mrem/year

*NOTE: Differences from documented survey results are due to rounding in Excel

29.0 ALARA EVALUATION BSA 05-02

All measurements collected within BSA 05-02 were evaluated against the $DCGL_{SO}$. For BSA 05-02 no measurement result exceeded the $DCGL_{SO}$. The fraction of the $DCGL_{SO}$, based on all systematically collected samples, was 3% for BSA 05-02. The average of all systematic measurements equates to residual activity contributions from the SU area of 0.75 mrem/yr for BSA 05-02. As the estimated Total Effective Dose Equivalent for LSA 05-02 including the dose contribution of BSA 05-02 is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the FSS of BSA 05-02 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing remediation of BSA 05-02.

30.0 FSS PLAN DEVIATIONS BSA 05-02

30.1 Remedial Actions During FSS

As the measurement results of the FSS indicated the results were below the $DCGL_{SO}$ no remedial actions during FSS were necessary.

31.0 DATA QUALITY ASSESSMENT

The DQO process is thoroughly integrated within the DP and Hematite FSS procedures. The steps of the DQO process specific to FSS of structures are presented in HDP-PO-FSS-700 Section 9.0 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.

31.1 Data Quality Assessment for BSA 05-02

The Data Quality Assessment of the survey methodology, measurement and analysis results to ascertain the validity of the conclusion for BSA 05-02 provides the following:

- The field and laboratory instruments utilized were capable of detecting activity at an MDA less than the appropriate investigation level, and were verified to be operable prior to and after use in compliance with HDP-PR-HP-415 (*Operation of the Ludlum 2360 for Final Status Survey*), and HDP-PR-HP-411 (*Radiological Instrumentation*).
- 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 TSC systematic measurements that were collected and the scan surveys that were conducted were performed in compliance with procedure HDP-PR-FSS-712, *Final Status Surveys of Structures, Systems and Components*.
- Quality Control sample results were not required for BSA 05-02.
- BSA 05-02 survey and sample results were independently reviewed and validated in accordance with HDP-PR-FSS-721 *Final Status Survey Data Validation*.

- Forty-eight (48) systematic measurements were collected in BSA 05-02. None of the 48 samples exceeded the $DCGL_{SO}$ with the highest systematic result of 7% of the $DCGL_{SO}$. As such performance of the Sign Test is not required, but was still performed for illustrative purposes and is provided in Table 31-1. The Sign Test was successful as the total number of systematic measurements (48), far exceeded the minimum requirement of samples.
- The maximum observed result in BSA 05-02 was 7% of the $DCGL_{SO}$. The average residual radioactivity concentration fraction based on the systematically collected measurements was 3% of the $DCGL_{SO}$, equating to a residual dose contribution of 0.75 mrem/yr.
- During the review of FSS documentation for BSA 05-02 it was identified that when the surveys were performed the FSS plan specified that surface surveys of the structure should be performed in accordance with HDP-PR-HP-311, *Radiological Surveys* instead of HDP-PR-FSS-712, *FSS of Structures Systems and Components (SSCs)*. The HDP FSS program directs that for Total Surface Contamination measurements are to be collected and reported with alpha and beta measurements combined. HDP-PR-HP-311, *Radiological Surveys* provides that the alpha and beta measurements are recorded separately. The survey methodology used for the FSS of BSA 05-02 was in accordance with HDP-PR-FSS-712 in every aspect other than the way the TSC measurements were recorded. As a function of the data assessment process the Radiation Safety Officer reviewed the surveys and has made the determination that the data still meets the FSS DQOs, and is therefore acceptable for use in evaluation of BSA 05-02. For the purposes of FSS reporting, these separate alpha and beta measurements were combined and compared to the $DCGL_{SO}$.
- No FSS measurement result in BSA 05-02 exceeded the $DCGL_{SO}$, therefore hot spot averaging was not required.

Table 31-1
Sign Test for BSA 05-02

Sign Test							MARSSIM Table I-3 Critical Values for the Sign Test Statistic S+	
SAMPLE ID	SAMPLE ID	Gross TSC	Gross TSC / Adj. Gross DCGL (W_s)	Difference (1-W_s)	Corrected Difference	α = 0.05	N	Alpha = 0.05
B05-02-01-S-O-S-00	Footer Section 1	850	0.045	0.955	0.955		4	4
B05-02-02-S-O-S-00	Footer Section 2	750	0.040	0.960	0.960		5	4
B05-02-03-S-O-S-00	Footer Section 3	650	0.034	0.966	0.966		6	5
B05-02-04-S-O-S-00	Footer Section 4	1270	0.067	0.933	0.933		7	6
B05-02-05-S-O-S-00	Footer Section 5	790	0.042	0.958	0.958		8	6
B05-02-06-S-O-S-00	Footer Section 6	1050	0.055	0.945	0.945		9	7
B05-02-07-S-O-S-00	Footer Section 7	760	0.040	0.960	0.960		10	8
B05-02-08-S-O-S-00	Footer Section 8	1280	0.068	0.932	0.932		11	8
B05-02-09-S-O-S-00	Footer Section 9	970	0.051	0.949	0.949		12	9
B05-02-10-S-O-S-00	Footer Section 10	1110	0.059	0.941	0.941		13	9
B05-02-11-S-O-S-00	Footer Section 11	1020	0.054	0.946	0.946		14	10
B05-02-12-S-O-S-00	Footer Section 12	990	0.052	0.948	0.948		15	11
B05-02-13-S-O-S-00	Footer Section 13	940	0.050	0.950	0.950		16	11
B05-02-14-S-O-S-00	Footer Section 14	1020	0.054	0.946	0.946		17	12
B05-02-15-S-O-S-00	Footer Section 15	1190	0.063	0.937	0.937		18	12
B05-02-16-S-O-S-00	Footer Section 16	0	0.000	1.000	1.000		19	13
B05-02-17-S-O-S-00	Footer Section 17	0	0.000	1.000	1.000		20	14
B05-02-18-S-O-S-00	Footer Section 18	55	0.003	0.997	0.997		21	14
B05-02-19-S-O-S-00	Footer Section 19	146	0.008	0.992	0.992		22	15
B05-02-20-S-O-S-00	Footer Section 20	82	0.004	0.996	0.996		23	15
B05-02-21-S-O-S-00	Footer Section 21	128	0.007	0.993	0.993		24	16
B05-02-22-S-O-S-00	Footer Section 22	192	0.010	0.990	0.990		25	17
B05-02-23-S-O-S-00	Footer Section 23	165	0.009	0.991	0.991		26	17
B05-02-24-S-O-S-00	Footer Section 24	393	0.021	0.979	0.979		27	18
B05-02-25-S-O-S-00	Footer Section 25	0	0.000	1.000	1.000		28	18
B05-02-26-S-O-S-00	Footer Section 26	18	0.001	0.999	0.999		29	19
B05-02-27-S-O-S-00	Footer Section 27	0	0.000	1.000	1.000		30	19
B05-02-28-S-O-S-00	Footer Section 28	283	0.015	0.985	0.985		31	20
B05-02-29-S-O-S-00	Footer Section 29	192	0.010	0.990	0.990		32	21
B05-02-30-S-O-S-00	Footer Section 30	201	0.011	0.989	0.989		33	21
B05-02-31-S-O-S-00	Ramp Footer Section 1	1140	0.060	0.940	0.940		34	22
B05-02-32-S-O-S-00	Ramp Footer Section 2	760	0.040	0.960	0.960		35	22
B05-02-33-S-O-S-00	Ramp Footer Section 3	0	0.000	1.000	1.000		36	23
B05-02-34-S-O-S-00	Ramp Footer Section 4	160	0.008	0.992	0.992		37	23
B05-02-35-S-O-S-00	Ramp Footer Section 5	320	0.017	0.983	0.983		38	24
B05-02-36-S-O-S-00	Ramp Footer Section 6	370	0.020	0.980	0.980		39	25
B05-02-37-S-O-S-00	Ramp Footer Section 7	910	0.048	0.952	0.952		40	25
B05-02-38-S-O-S-00	Drain Basin Section 1	330	0.017	0.983	0.983		41	26
B05-02-39-S-O-S-00	Drain Basin Section 2	360	0.019	0.981	0.981		42	26
B05-02-40-S-O-S-00	Drain Basin Section 3	0	0.000	1.000	1.000		43	27
B05-02-41-S-O-S-00	Drain Basin Section 4	180	0.010	0.990	0.990		44	27
B05-02-42-S-O-S-00	Drain Basin Section 5	0	0.000	1.000	1.000		45	28
B05-02-43-S-O-S-00	Small Junction Box	0	0.000	1.000	1.000		46	29
B05-02-44-S-O-S-00	Metal Storm Drain Pipe Ext 1	490	0.026	0.974	0.974		47	29
B05-02-45-S-O-S-00	Metal Storm Drain Pipe Ext 2	460	0.024	0.976	0.976		48	30
B05-02-46-S-O-S-00	Metal Storm Drain Pipe Ext 3	700	0.037	0.963	0.963		49	30
B05-02-47-S-O-S-00	Metal Storm Drain Pipe Ext 4	300	0.016	0.984	0.984		50	31
B05-02-48-S-O-S-00	Metal Storm Drain Pipe Int.	460	0.024	0.976	0.976			
					Number of Positive Differences (S+)			
					Sign Test Critical Value (MARSSIM Table I-3)			

TEST: PASS

If every measurement in the systematic sample population is <= the DCGL, a statistical test is not required.

32.0 CONCLUSION BSA 05-02

An adequate quantity and quality of radiological surveys and measurements, as well as the corresponding laboratory analysis has been performed, evaluated and documented to demonstrate that the dose associated with the structures designated as BSA 05-02 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

Table 32-1
BSA 05-02 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**3%**
Dose	**0.75 mrem/year**

33.0 DOSE CONTRIBUTION OF BSA 05-02 TO THE LSA SURVEY UNIT

The 0.75 mrem/year dose contribution determined for the structures designated as BSA 05-02 will be added to the total dose determination for SU LSA 05-02.

34.0 CONCLUSION LSA 05-02

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 05-02 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

Table 34-1
LSA 05-02 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	STRUCTURE DOSE	REUSE SOIL	**TOTAL**
SOF	0.34	N/A	0.16	0.03	0.1	**0.63**
DOSE	8.5 mrem/year	N/A	4.0 mrem/year	0.75 mrem/year	2.5 mrem/year	**15.75 mrem/year**

35.0 FINAL STATUS SURVEY DESIGN LSA 05-03

This section of the report describes the method for determining the number of samples required for the FSS of LSA 05-03 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 05-03 and the detection sensitivities are also discussed.

35.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 05-03 were driven by the type (Open Land) and Class (Class 1) of the survey unit and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 2, *Final Status Survey Plan Development*, February 2013.

35.1.1 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.*

35.1.2 $DCGL_w$

During the FSS design process a review was performed of the historic characterization data for LSA 05-03. The review identified several areas were previously found to exceed a Uniform SOF of 1.0 (discussed in Section 3.3.8). Next the remediation history was reviewed to confirm that the area was adequately addressed, and the RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform $DCGL_w$. Therefore the Uniform $DCGL_w$ was selected for use in demonstrating compliance with the release criteria.

35.1.3 GWS Coverage

As a Class 1 SU, LSA 05-03 was required to undergo a 100% GWS.

35.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 05-03 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

35.1.5 Scan Minimum Detectable Concentration

As background levels were approximately 10,000 cpm within LSA 05-03, the scan MDC calculation for total uranium given in HDP-PR-FSS-701, *Final Status Survey Plan Development*, Step 8.2.6.d, was applied:

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

Equation 35-1

In order to calculate the Scan MDC for total uranium using the above equation, an average enrichment for the SU must be known which in turn will provide relative isotopic fractions for U-234, U-235, and U-238 as given in Appendix G of HDP-PR-FSS-701, Revision 4, *Final Status Survey Plan Development*. Based on the systematically collected RASS samples in LSA 05-03, the average enrichment for the SU was 68%. Note that this is a conservatively high estimate of enrichment. Since all of the RASS soil samples for LSA 05-03 were analyzed on-site, the low activity samples were not able to identify U-238 above sample MDC and reported as zero. For this reason the enrichment of 68% was used for Scan MDC calculation. The actual enrichment from all FSS samples was 1.5% when the samples were analyzed at the offsite laboratory.

Standard Scan MDCs for Radium-226 and Thorium-232 using a 2" x 2" NaI detector are found in Table 6.4 of NUREG-1507 and are shown in Table 35-1. Prospectively calculated Scan MDCs for 2" x 2" NaI detectors that were used in LSA 05-03 are shown below:

Table 35-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 05-03

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 05-03	121.1	52.8	2.8	2.9	1.8	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 35-1 reflect those presented in the FSS Plan prepared for the SU prior to FSS.

35.1.6 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 FSS in LSA 05-03 was performed prior to the development of HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site*" which established a standard Scan IAL for all Class 1 SU's at the Hematite Site. The IAL used during the GWS of LSA 05-03 was established at 1,698 ncpm which was a calculated value equivalent to the expected scan rate for a potential hot spot representing the $DCGL_{EMC}$ for Total Uranium of 152 pCi/g (using a U-235 enrichment of 68%). Given that this Scan IAL is conservative compared to the value of 4,000 ncpm prescribed by the revised HDP FSS program, and that all FSS data is post processed and evaluated as described in FSSFR Volume 3, Chapter 1, Section 6.1.3, the Scan IAL for LSA 05-03 of 1,698 is considered acceptable.

35.1.7 LSA 05-03 FSS Design Summary

The FSS Plan for LSA 05-03 can be found in Appendix I. Table 35-2 presents an overall FSS design and implementation summary for LSA 05-03.

Table 35-2
FSS Design Summary for LSA 05-03

Gamma Walkover Survey (GWS):		
Scan Coverage	100% exposed excavation floors and walls	
Scan MDC	121.1 pCi/g total Uranium (1,352 ncpm)	
Investigation Action Level (IAL)	1,698 net cpm* *After GWS is performed, the data collected will be examined to confirm areas exceeding the calculated IAL and statistical analysis will be performed to determine significance.	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments
0 – 15 cm (Surface)	0	These samples were collected on a systematic grid.
15 cm – 1.5 m (Root)	11	
> 1.5m (Excavation)	11	
Biased Survey/Sampling Locations:		
Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the FSS Supervisor.		
Instrumentation		
Ludlum 2221 with 44-10 (2" x 2" NaI) detector	Used for GWS and to obtain static count rates at biased measurement locations.	

36.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 05-03

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

36.1 Gamma Walkover Survey

36.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 05-03 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*.

36.1.2 GWS Performance

All GWS measurements on the excavation floor and sidewall 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 excavation surface (nominally 1", but not to exceed 3"). At the same time, the technician was required to slowly advance, causing the detector to trace out a serpentine path over the excavation surface.

HP Technicians performing GWS in LSA 05-03 used the 1,698 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 12,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 11,698 to 13,698 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

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

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

36.2 Soil Sampling

36.2.1 Systematic Soil Sampling Summary

Table 36-1 provides a summary of systematic sampling by stratum for LSA 05-03.

Table 36-1
Systematic Sampling Summary by Stratum for LSA 05-03

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
05-03	1,563	1	21	0	1

36.2.2 Systematic Sampling LSA 05-03

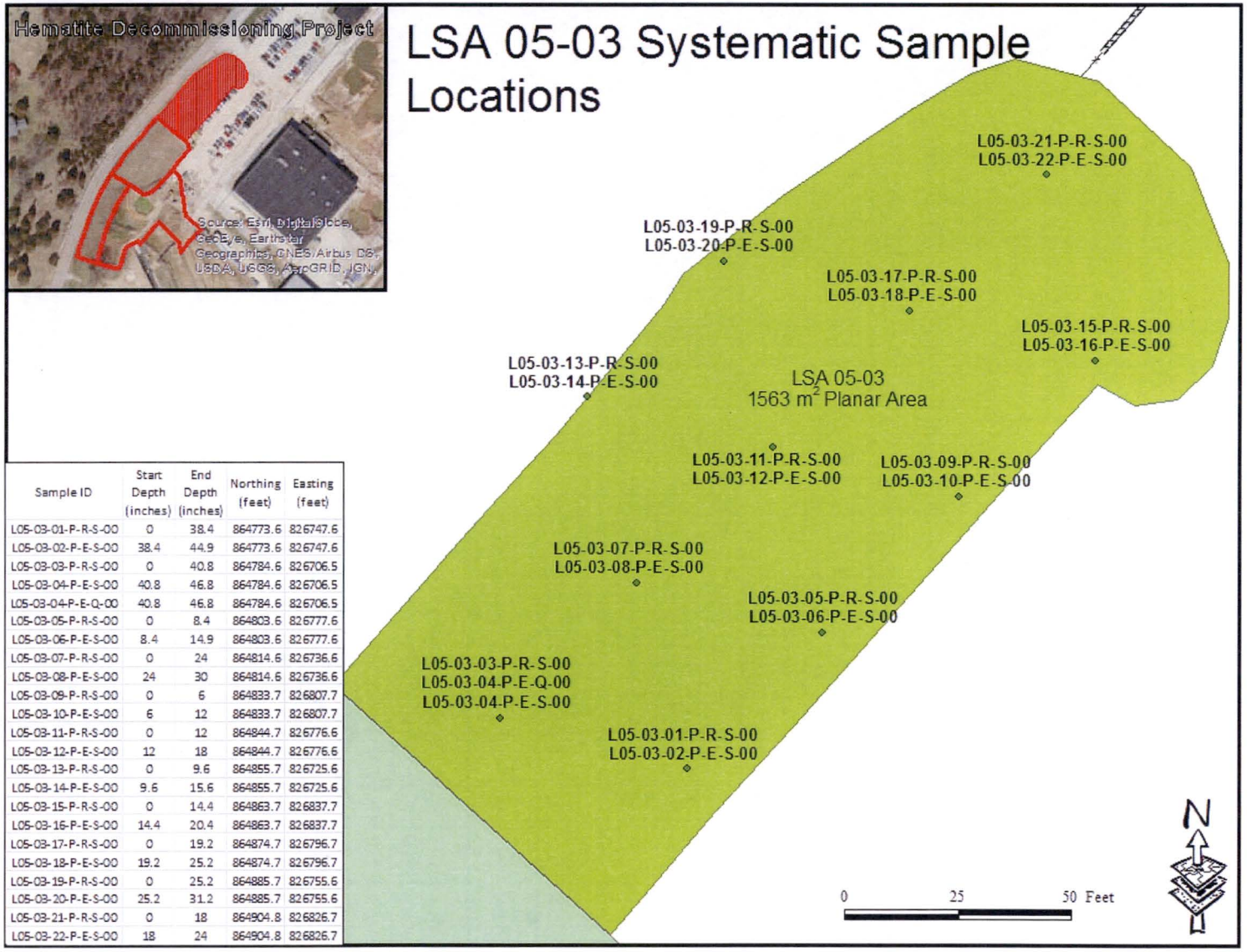
Within LSA 05-03, there was one systematic location in which portions of the surface stratum (0 – 15 cm) remained in the SU after remediation. At this location the underlying root stratum interval was collected using a hand auger and composited. Portions of the root stratum (15 cm – 150 cm) remained at all of the remaining systematic locations, however 21 systematic root stratum samples were collected in total. Given a planar area of 1,563 m^2 for LSA 05-03 and an eleven - point systematic triangular grid, the point-to-point distance within each row was 12.8 m.

While there were eleven systematic locations on the LSA 05-03 sampling grid, a total of twenty-three (23) samples were collected at these locations, including:

- One (1) samples collected within the remaining surface stratum
- Twenty-one (21) samples collected within the remaining root stratum
- Zero (0) samples collected within the excavation, or "deep" stratum
- One (1) Quality Control field replicate

Figure 36-1 presents the map of the eleven systematic sample locations which were sampled within LSA 05-03. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 36-1
LSA 05-03 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing (feet)	Easting (feet)
L05-03-01-P-R-S-00	0	38.4	864773.6	826747.6
L05-03-02-P-E-S-00	38.4	44.9	864773.6	826747.6
L05-03-03-P-R-S-00	0	40.8	864784.6	826706.5
L05-03-04-P-E-S-00	40.8	46.8	864784.6	826706.5
L05-03-04-P-E-Q-00	40.8	46.8	864784.6	826706.5
L05-03-05-P-R-S-00	0	8.4	864803.6	826777.6
L05-03-06-P-E-S-00	8.4	14.9	864803.6	826777.6
L05-03-07-P-R-S-00	0	24	864814.6	826736.6
L05-03-08-P-E-S-00	24	30	864814.6	826736.6
L05-03-09-P-R-S-00	0	6	864833.7	826807.7
L05-03-10-P-E-S-00	6	12	864833.7	826807.7
L05-03-11-P-R-S-00	0	12	864844.7	826776.6
L05-03-12-P-E-S-00	12	18	864844.7	826776.6
L05-03-13-P-R-S-00	0	9.6	864855.7	826725.6
L05-03-14-P-E-S-00	9.6	15.6	864855.7	826725.6
L05-03-15-P-R-S-00	0	14.4	864863.7	826837.7
L05-03-16-P-E-S-00	14.4	20.4	864863.7	826837.7
L05-03-17-P-R-S-00	0	19.2	864874.7	826796.7
L05-03-18-P-E-S-00	19.2	25.2	864874.7	826796.7
L05-03-19-P-R-S-00	0	25.2	864885.7	826755.6
L05-03-20-P-E-S-00	25.2	31.2	864885.7	826755.6
L05-03-21-P-R-S-00	0	18	864904.8	826826.7
L05-03-22-P-E-S-00	18	24	864904.8	826826.7

Table 36-2 below presents a tabular listing of all FSS samples collected within LSA 05-03 with associated IDs, sample types, collection intervals, coordinates, and notes as presented in the FSS Plan (Appendix I).

Table 36-2
FSS Sample Locations and Coordinates for LSA 05-03

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 05 **Description:** Barns and Cistern Open Land Area
Survey Unit: 03 **Description:** Red Barn Area
Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L050301PRS00	Uniform	S	434.9	431.7	864773.6	826747.6	Root Zone Composite
L050302PES00	Uniform	S	431.7	431.2	864773.6	826747.6	Excavation 6-in Grab
L050303PRS00	Uniform	S	435.9	432.5	864784.6	826706.5	Root Zone Composite
L050304PES00	Uniform	S	432.5	432.0	864784.6	826706.5	Excavation 6-in Grab
L050305PRS00	Uniform	S	434.6	433.9	864803.6	826777.6	Root Zone Composite
L050306PES00	Uniform	S	433.9	433.4	864803.6	826777.6	Excavation 6-in Grab
L050307PRS00	Uniform	S	435.7	433.7	864814.6	826736.6	Root Zone Composite
L050308PES00	Uniform	S	433.7	433.2	864814.6	826736.6	Excavation 6-in Grab
L050309PRS00	Uniform	S	434.7	434.2	864833.7	826807.7	Root Zone Composite
L050310PES00	Uniform	S	434.2	433.7	864833.7	826807.7	Excavation 6-in Grab
L050311PRS00	Uniform	S	435.6	434.6	864844.7	826776.6	Root Zone Composite
L050312PES00	Uniform	S	434.6	434.1	864844.7	826776.6	Excavation 6-in Grab
L050313PRS00	Uniform	S	438.1	437.3	864855.7	826725.6	Root Zone Composite
L050314PES00	Uniform	S	437.3	436.8	864855.7	826725.6	Excavation 6-in Grab
L050315PRS00	Uniform	S	435.1	433.9	864863.7	826837.7	Root Zone Composite
L050316PES00	Uniform	S	433.9	433.4	864863.7	826837.7	Excavation 6-in Grab
L050317PRS00	Uniform	S	435.5	433.9	864874.7	826796.7	Root Zone Composite
L050318PES00	Uniform	S	433.9	433.4	864874.7	826796.7	Excavation 6-in Grab
L050319PRS00	Uniform	S	439.1	437.0	864885.7	826755.6	Root Zone Composite
L050320PES00	Uniform	S	437.0	436.5	864885.7	826755.6	Excavation 6-in Grab
L050321PRS00	Uniform	S	436.6	435.1	864904.8	826826.7	Root Zone Composite
L050322PES00	Uniform	S	435.1	434.6	864904.8	826826.7	Excavation 6-in Grab
L050304PEQ00	Uniform	Q	432.5	432.0	864784.6	826706.5	QA Duplicate Sample
L050323PUB00	Uniform	B	434.6	434.1	864823.3	826718.4	Biased 6-in Grab
L050324PUB00	Uniform	B	434.8	434.3	864891.7	826783.8	Biased 6-in Grab
L050325PUB00	Uniform	B	434.7	434.2	864907.2	826827.6	Biased 6-in Grab
L050343PUB00	Uniform	B	432.8	432.3	864811.5	826707.6	Biased 6-in Grab
L050344PUB00	Uniform	B	431.2	430.7	864780.1	826739.2	Biased 6-in Grab
L050345PUB00	Uniform	B	435.8	435.3	864825.9	826699.6	Biased 6-in Grab
L050346PUB00	Uniform	B	432.8	432.3	864811.5	826707.6	Biased 6-in Grab
L050347PUB00	Uniform	B	431.2	430.7	864780.1	826739.2	Biased 6-in Grab
L050348PUB00	Uniform	B	435.8	435.3	864825.9	826699.6	Biased 6-in Grab
L050349PUB00	Uniform	B	430.1	429.6	864765.2	826730.7	Biased 6-in Grab
L050350PUB00	Uniform	B	431.9	431.4	864783.4	826701.3	Biased 6-in Grab
L050351PUB00	Uniform	B	432.9	432.4	864809.5	826704.5	Biased 6-in 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

36.3 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 05-03 twelve (12) biased sample locations 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.

36.4 Judgmental/Sidewall Sampling for Tc-99

The procedural requirements for sidewall sampling are discussed in detail in Section 6.4.

The FSS field activities for LSA 05-03 predated the agreed upon path forward. At the time of FSS of LSA 05-03, site FSS procedures implemented the requirements for soil sampling (including any potential sidewalls) as provided in DP Chapter 14.4.4.1.6.2, *Subsurface Soil.* As such, there were no specific provisions made to assess or collect sidewall samples in LSA 05-03.

Nevertheless, the issue of Tc-99 in a sidewall does not present itself as the sidewall in LSA 05-03 was limited to that area of the SU adjacent to State Road P. State Road P is up-gradient of LSA 05-03 and therefore does not present a pathway for the migration of Tc-99. Additionally there is no historical sample data or FSS data that indicates that Tc-99 could be present in concentrations that would exceed the DCGL.

36.5 Quality Control Soil Sampling

One QC field duplicate sample point was randomly selected and collected at systematic location L05-03-04 for LSA 05-03.

37.0 FINAL STATUS SURVEY RESULTS LSA 05-03

37.1 Gamma Walkover Survey

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

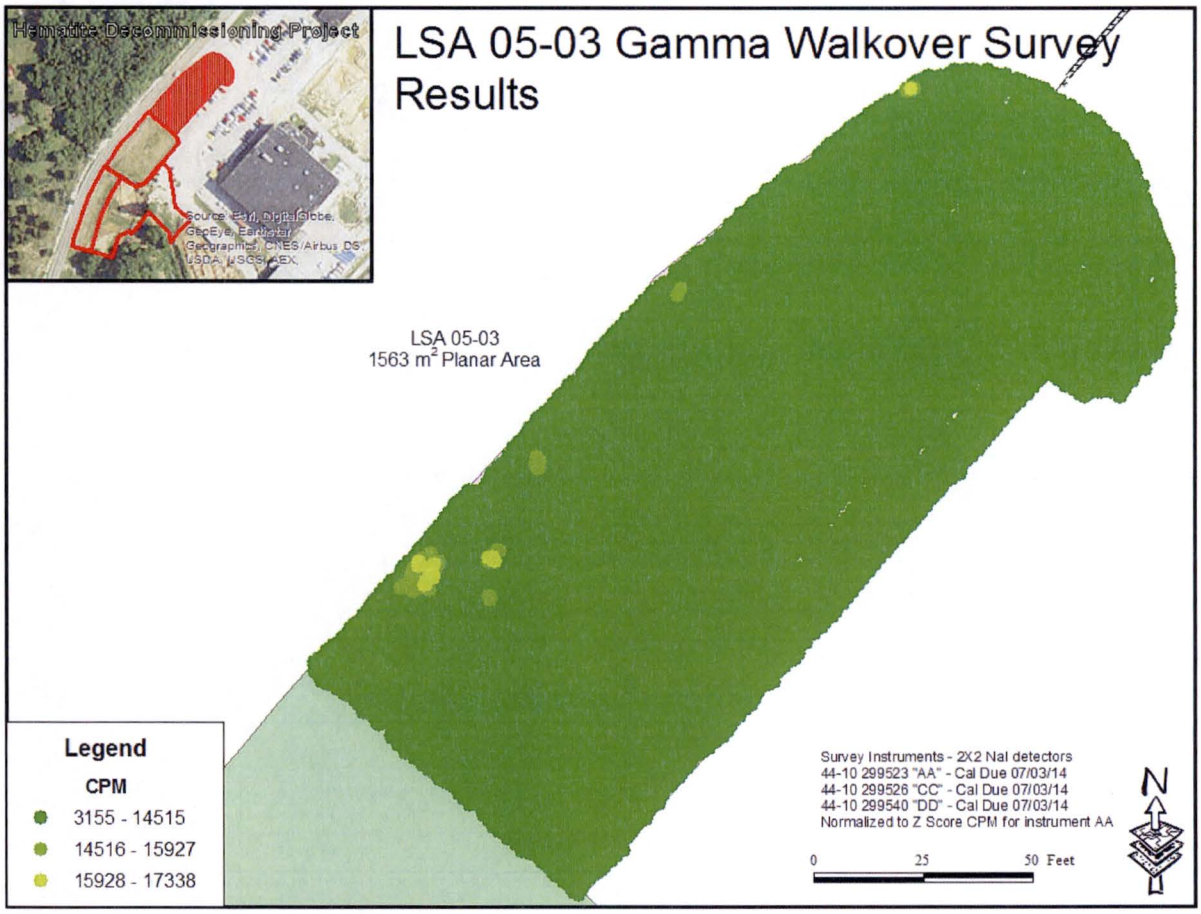
GWS measurements were collected in LSA 05-03 from August 21, 2013, to October 11, 2013.

37.1.1 GWS Results for LSA 05-03

For datalogged GWS data in LSA 05-03, GWS count rates ranged between 3,155 gcpm and 17,338 gcpm, with a mean count rate of 9,919 gcpm. The median count rate was 10,280 gcpm

and the standard deviation was 2,122 cpm. Figure 37-1 below presents a map of the complete GWS data set.

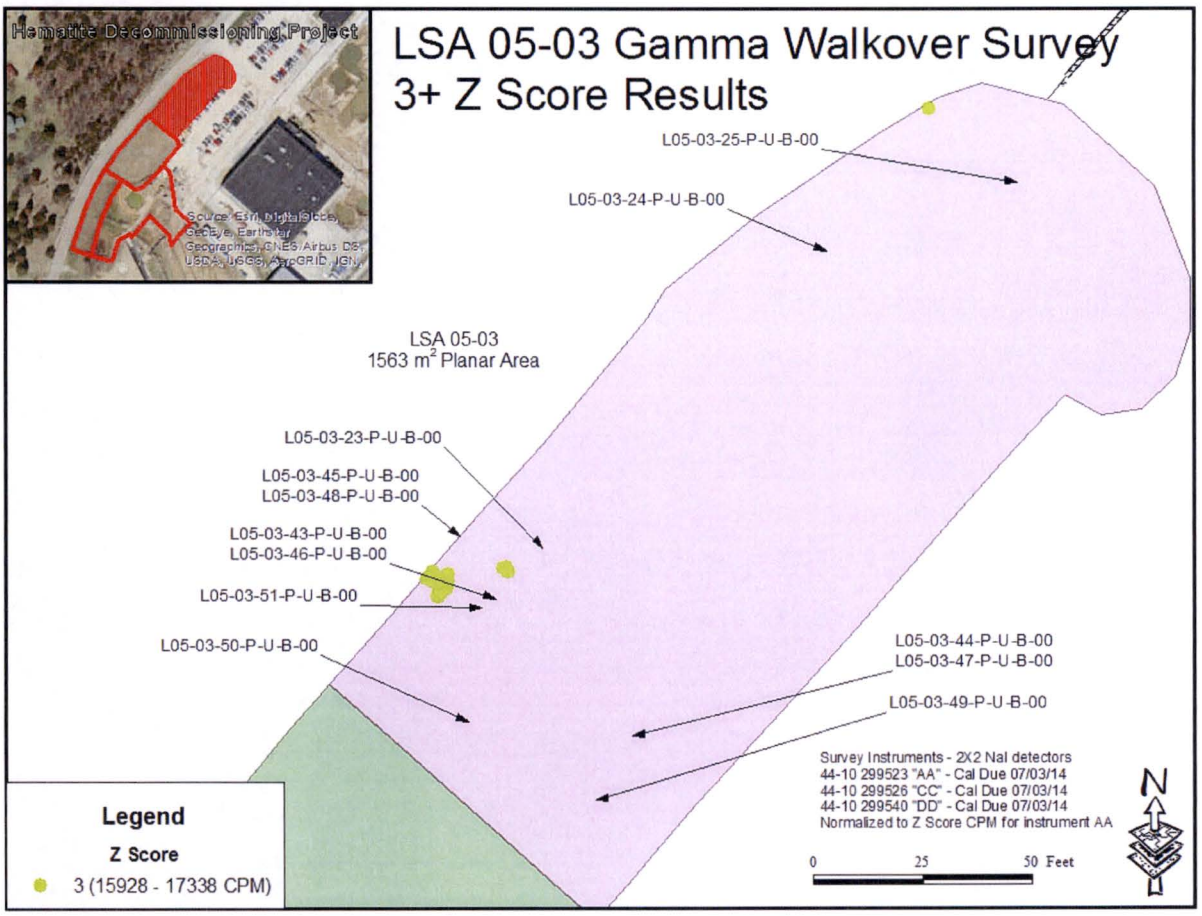
Figure 37-1
Colorimetric GWS Plot for LSA 05-03



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"). Several locations were selected for biased sampling prior to the completion of GWS in the field based on HP Technician professional judgment.

Figure 37-2 below presents a map of the +3 Z-score GWS measurements within LSA 05-03, including the selected biased sampling locations.

Figure 37-2
Colorimetric GWS Plot for LSA 05-03 (Measurements > Z-score of 3)



Since the majority of GWS data collected in LSA 05-03 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015. Using these parameters, and a general area FSS background of 10,000 gcpm, a Scan MDC of approximately 40.9 pCi/g is determined. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 05-03, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. The equation used to derive the revised Total Uranium Scan MDC (with a conservative estimate of 4% enrichment) from Section 1.1.5 of HDP-TBD-FSS-002 (Revision 3, August 2015) is as follows:

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

Equation 37-1

HDP-TBD-FSS-002 also modeled Radium-226 and Thorium-232 Scan MDCs to reflect the technical implementation requirements of FSS at the HDP. Using the same parameters as

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

37.1.2 GWS Coverage Results LSA 05-03

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS, certain portions of the LSA 05-03 were not covered. These areas appear as greyish-pink blanks in the Figure 37-1 above.

The post survey processing of the GPS data indicated that the datalogged GWS covered 98.9% of the SU (see Table 37-1). As the evaluation indicates that the GWS coverage exceeds 95%, and the readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of the apparent GPS coverage gaps were investigated and found to be satisfactory, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 37-1
GWS Gap Analysis LSA 05-03

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 05-03	319,700	8405	1.1	98.9	1

37.2 Soil Sample Results LSA 05-03

Appendix E presents the analytical results and associated statistics for all FSS samples collected within LSA 05-03.

37.2.1 Surface Soil Sample Results LSA 05-03

There was one sample collected within the surface stratum (0 – 15 cm) of LSA 05-03. However, there were a total of twenty-three (23) soil samples collected within the topmost soil layer of the excavation surface including eleven systematic samples, and twelve biased samples. The maximum SOF result for the "topmost" samples was 0.21 corresponding to the systematic sample L05-03-01.

37.2.2 Subsurface Soil Sample Results LSA 05-03

There were eleven systematic locations within LSA 05-03 where subsurface sampling was performed, including eleven systematic locations and one QC sample. The maximum SOF result of the subsurface samples collected in LSA 05-03 was 0.34 collected at location L05-03-04.

37.2.3 WRS Test Evaluation

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the WRS statistical test was not required for LSA 05-03 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 05-03. 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 22 systematically collected samples in LSA 05-03 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, (1232) was greater than the critical value (974) 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 E.

37.2.4 Graphical Data Review LSA 05-03

Table 37-2 below presents summary results for the all systematically collected samples (includes surface (none collected in this SU), root, and excavation stratum samples, but not biased or QC samples) collected within LSA 05-03, and the associated SOF when compared to the Uniform Stratum $DCGL_W$s. The arithmetic average concentration resulted in a SOF of 0.12.

Table 37-2
LSA 05-03 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	0.068	0.008	0.124	2.428	0.128	1.333	**0.12**
Minimum	0.00 (<BKG)	0.00 (NEG)	0.00 (<BKG)	0.634	0.028	0.812	0.01
Maximum	0.370	0.139	0.370	7.242	0.398	2.350	0.34

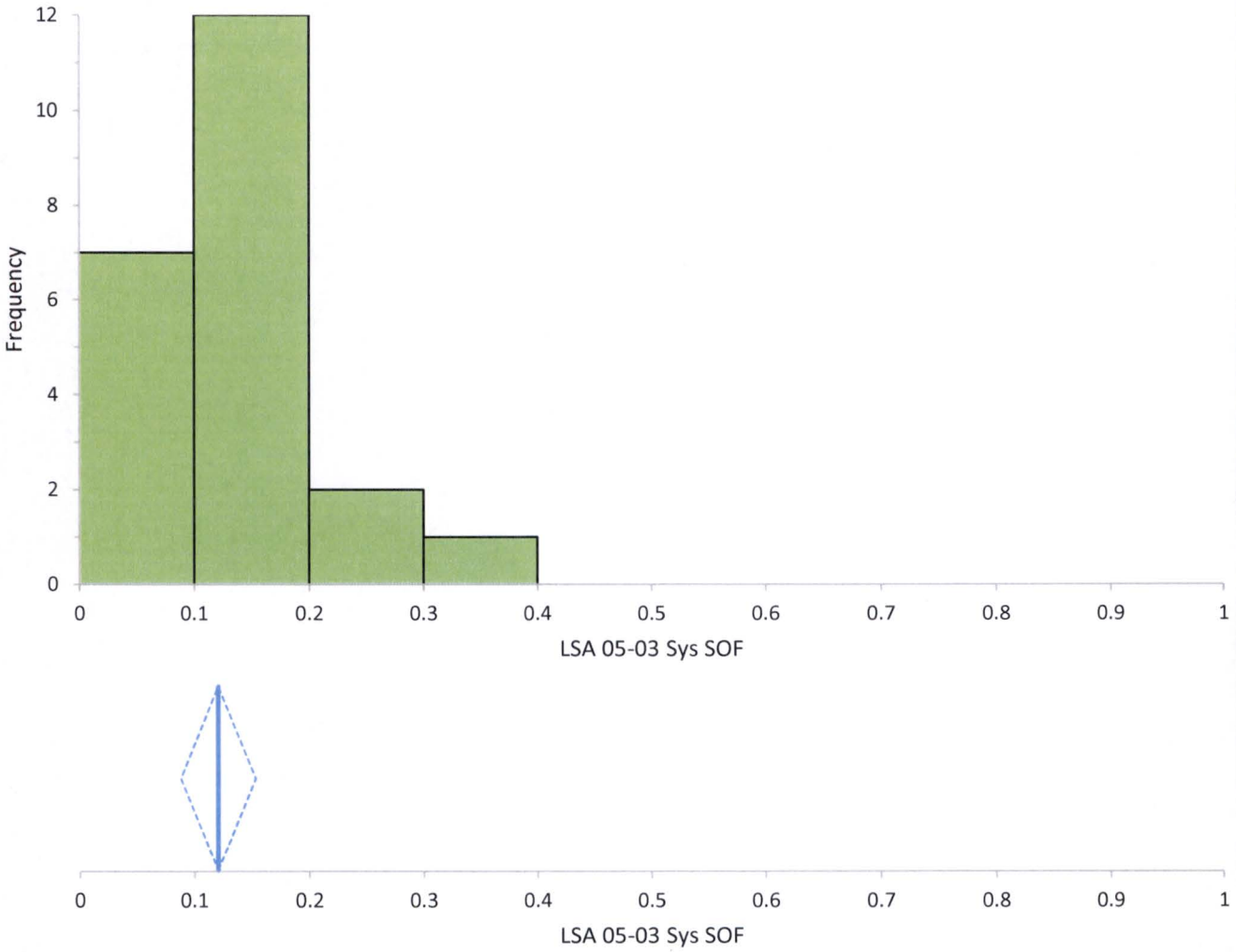
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide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

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

Figure 37-3 presents the overall statistical metrics for the SOF parameter for the 22 systematically collected samples from LSA 05-03. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 05-03. The middle graph presents the mean SOF (0.12 as indicated by the blue vertical line) of the sample population and the 95% confidence interval of the mean SOF represented by the blue diamond which is 0.09 to 0.15. The 98.31% confidence interval based on the median (0.11) of the sample results is 0.08 to 0.15. The bottom two charts present the various statistical metrics of the LSA 05-03 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 37-3 exhibits no unusual symmetry or bimodality concerns for the LSA 05-03 data associated with the systematically collected measurement locations.

Figure 37-3
Graphic Statistical Summary for LSA 05-03 (SOF parameter)



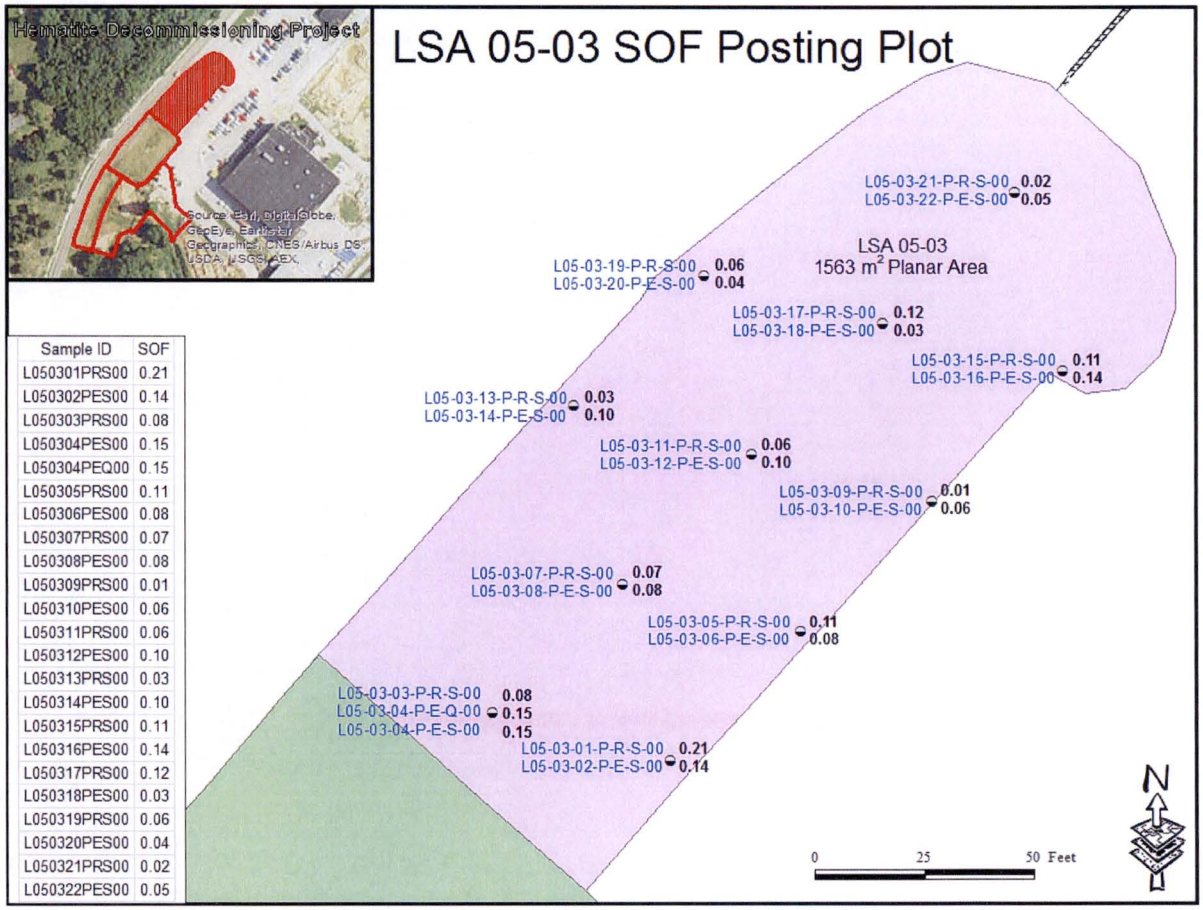
N	22

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 05-03 Sys SOF	0.12	0.09	to 0.15	0.016	0.07	0.01	1.3	2.87

	Minimum	1st quartile	Median	98.31% CI		3rd quartile	Maximum	IQR
LSA 05-03 Sys SOF	0.01	0.08	0.11	0.08	to 0.15	0.15	0.3	0.07

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 sample locations. This potentially reveals heterogeneities in the data – especially possible patches of elevated residual radioactivity. The posting plot for LSA 05-03 is presented below in Figure 37-4. Figure 37-4 shows no unusual patterns in the data.

Figure 37-4
Posting Plot for LSA 05-03 Systematic Measurement Locations



Sample ID	SOF
L050301PRS00	0.21
L050302PES00	0.14
L050303PRS00	0.08
L050304PES00	0.15
L050304PEQ00	0.15
L050305PRS00	0.11
L050306PES00	0.08
L050307PRS00	0.07
L050308PES00	0.08
L050309PRS00	0.01
L050310PES00	0.06
L050311PRS00	0.06
L050312PES00	0.10
L050313PRS00	0.03
L050314PES00	0.10
L050315PRS00	0.11
L050316PES00	0.14
L050317PRS00	0.12
L050318PES00	0.03
L050319PRS00	0.06
L050320PES00	0.04
L050321PRS00	0.02
L050322PES00	0.05

Appendix E to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 37-2, Figure 37-3, and Figure 37-4 above. A summary of the analytical data is presented in Table 37-3 below. Appendix M to this report presents the Test America Analytical Laboratory soil sample reports.

Table 37-3
Final Status Survey Analytical Data: LSA 05-03

Sample ID	Sample Start Depth (ft)	Type (Systematic, Bias, QC)	TestAmerica Analytical Results																										Enr.	SOF_N
			Ra-226						Tc-99					Th-232						Inferred U-234				U-235				U-238					
			Result	Uncertainty	MDC	Qualifier	Net Result*	Corrected Result	Result	Corrected Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Net Result**	Corrected Result	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Result	Uncertainty	MDC	Qualifier	Enrichment (%)	SOF_N
L050301PRS00	2.20	S	1.060	0.173	0.096	NA	-0.010	0.000	-0.040	0.000	0.024	0.240	U	1.370	0.216	0.184	NA	0.370	0.370	2.595	NA	NA	NA	0.14	0.190	1.240	U	1.11	0.483	1.240	U	2.0	0.21
L050302PES00	2.70	S	1.240	0.179	0.082	NA	0.170	0.170	-0.048	0.000	0.021	0.240	U	1.240	0.204	0.109	NA	0.240	0.240	2.615	NA	NA	NA	0.14	0.154	1.050	U	1.5	0.891	1.050	NA	1.5	0.23
L050303PRS00	3.88	S	1.110	0.160	0.078	NA	0.040	0.040	-0.064	0.000	0.072	0.231	U	1.140	0.180	0.143	NA	0.140	0.140	1.087	NA	NA	NA	0.05	0.156	0.995	U	0.926	0.390	0.995	U	0.9	0.10
L050304PES00	4.38	S	1.440	0.213	0.096	NA	0.370	0.370	-0.062	0.000	0.090	0.260	U	1.180	0.223	0.180	NA	0.180	0.180	7.242	NA	NA	NA	0.40	0.233	1.110	U	2.02	0.922	1.110	NA	3.0	0.34
L050305PRS00	0.65	S	1.060	0.152	0.074	NA	-0.010	0.000	-0.036	0.000	0.064	0.240	U	1.170	0.197	0.133	NA	0.170	0.170	3.187	NA	NA	NA	0.17	0.146	0.903	U	1.62	0.734	0.903	NA	1.7	0.11
L050306PES00	1.15	S	1.060	0.156	0.075	NA	-0.010	0.000	0.139	0.139	0.068	0.242	U	1.120	0.160	0.101	NA	0.120	0.120	0.836	NA	NA	NA	0.04	0.071	0.883	U	1.29	0.675	0.883	NA	0.5	0.08
L050307PRS00	2.74	S	1.200	0.183	0.081	NA	0.130	0.130	0.034	0.034	0.074	0.256	U	1.080	0.190	0.156	NA	0.080	0.080	3.453	NA	NA	NA	0.19	0.158	1.100	U	1.57	0.938	1.100	NA	1.8	0.14
L050308PES00	3.24	S	1.140	0.161	0.064	NA	0.070	0.070	-0.044	0.000	0.081	0.243	U	1.120	0.208	0.126	NA	0.120	0.120	2.056	NA	NA	NA	0.11	0.142	0.853	U	1.32	0.640	0.853	NA	1.3	0.12
L050309PRS00	0.29	S	0.969	0.141	0.067	NA	-0.101	0.000	-0.050	0.000	0.060	0.236	U	0.991	0.195	0.122	NA	-0.009	0.000	0.835	NA	NA	NA	0.03	0.123	0.818	U	1.44	0.637	0.818	NA	0.4	0.01
L050310PES00	0.79	S	1.120	0.184	0.096	NA	0.050	0.050	-0.063	0.000	0.073	0.235	U	1.080	0.188	0.130	NA	0.080	0.080	1.885	NA	NA	NA	0.10	0.169	1.200	U	0.869	0.391	1.200	U	1.8	0.08
L050311PRS00	1.78	S	1.150	0.169	0.089	NA	0.080	0.080	-0.069	0.000	0.040	0.258	U	1.080	0.195	0.131	NA	0.080	0.080	2.945	NA	NA	NA	0.16	0.157	0.914	U	0.812	0.368	0.914	U	3.1	0.11
L050312PES00	2.28	S	1.100	0.153	0.078	NA	0.030	0.030	-0.082	0.000	0.032	0.249	U	1.150	0.184	0.115	NA	0.150	0.150	2.856	NA	NA	NA	0.15	0.149	0.920	U	1.35	0.736	0.920	NA	1.8	0.12
L050313PRS00	1.62	S	1.160	0.162	0.067	NA	0.090	0.090	-0.042	0.000	0.052	0.239	U	1.000	0.194	0.102	NA	0.000	0.000	3.095	NA	NA	NA	0.17	0.163	0.859	U	1.33	0.657	0.859	NA	2.0	0.07
L050314PES00	2.12	S	1.100	0.174	0.075	NA	0.030	0.030	-0.071	0.000	0.088	0.250	U	1.140	0.220	0.191	NA	0.140	0.140	3.718	NA	NA	NA	0.20	0.153	1.020	U	1.25	0.790	1.020	NA	2.5	0.12
L050315PRS00	0.58	S	1.040	0.149	0.063	NA	-0.030	0.000	-0.050	0.000	0.048	0.259	U	1.170	0.173	0.107	NA	0.170	0.170	2.364	NA	NA	NA	0.12	0.159	0.960	U	1.47	0.804	0.960	NA	1.3	0.11
L050316PES00	1.08	S	1.130	0.159	0.076	NA	0.060	0.060	-0.025	0.000	0.070	0.231	U	1.270	0.209	0.120	NA	0.270	0.270	0.634	NA	NA	NA	0.03	0.133	1.010	U	0.894	0.396	1.010	U	0.5	0.18
L050317PRS00	2.54	S	1.140	0.163	0.080	NA	0.070	0.070	-0.057	0.000	0.022	0.244	U	1.210	0.178	0.093	NA	0.210	0.210	0.922	NA	NA	NA	0.05	0.103	0.977	U	0.867	0.392	0.977	U	0.9	0.15
L050318PES00	3.04	S	1.030	0.148	0.061	NA	-0.040	0.000	-0.049	0.000	0.019	0.241	U	1.020	0.163	0.091	NA	0.020	0.020	2.078	NA	NA	NA	0.11	0.141	0.919	U	1.58	0.762	0.919	NA	1.1	0.03
L050319PRS00	1.59	S	1.170	0.168	0.079	NA	0.100	0.100	-0.056	0.000	0.083	0.224	U	1.100	0.175	0.138	NA	0.100	0.100	0.880	NA	NA	NA	0.04	0.140	0.961	U	0.86	0.380	0.961	U	0.8	0.11
L050320PES00	2.09	S	1.270	0.279	0.194	NA	0.200	0.200	-0.058	0.000	0.069	0.231	U	0.795	0.266	0.276	NA	-0.205	0.000	4.780	NA	NA	NA	0.26	0.299	2.240	U	2.35	1.760	2.240	NA	1.7	0.15
L050321PRS00	1.47	S	1.040	0.164	0.081	NA	-0.030	0.000	0.003	0.003	0.087	0.238	U	1.010	0.173	0.156	NA	0.010	0.010	1.528	NA	NA	NA	0.07	0.086	1.030	U	1.54	0.830	1.030	NA	0.8	0.02
L050322PES00	1.97	S	1.080	0.168	0.073	NA	0.010	0.010	0.001	0.001	0.068	0.236	U	1.070	0.180	0.051	NA	0.070	0.070	1.815	NA	NA	NA	0.09	0.170	1.110	U	1.36	0.900	1.110	NA	1.1	0.06
L050304PEQ00	4.38	Q	1.260	0.179	0.083	NA	0.190	0.190	-0.088	0.000	0.012	0.245	U	1.270	0.205	0.127	NA	0.270	0.270	1.737	NA	NA	NA	0.09	0.174	0.813	U	0.956	0.328	0.813	NA	1.5	0.25
L050323PUB00	3.32	B	1.060	0.161	0.085	NA	-0.010	0.000	0.004	0.004	0.020	0.231	U	1.200	0.188	0.116	NA	0.200	0.200	3.973	NA	NA	NA	0.22	0.146	0.886	U	1.56	0.688	0.886	NA	2.1	0.13
L050324PUB00	2.79	B	1.080	0.158	0.075	NA	0.010	0.010	-0.033	0.000	0.045	0.232	U	1.230	0.188	0.039	NA	0.230	0.230	1.214	NA	NA	NA	0.06	0.107	1.110	U	1.29	0.926	1.110	NA	0.7	0.14
L050325PUB00	2.05	B	1.120	0.165	0.087	NA	0.050	0.050	-0.036	0.000	0.034	0.249	U	1.190	0.193	0.125	NA	0.190	0.190	2.303	NA	NA	NA	0.12	0.169	0.958	U	1.89	0.820	0.958	NA	1.0	0.15
L050343PUB00	5.12	B	1.230	0.181	0.086	NA	0.160	0.160	-0.041	0.000	0.028	0.230	U	0.987	0.165	0.175	NA	-0.013	0.000	2.097	NA	NA	NA	0.10	0.160	0.948	U	2.02	0.794	0.948	NA	0.8	0.11
L050344PUB00	3.92	B	1.070	0.174	0.101	NA	0.000	0.000	-0.042	0.000	0.072	0.238	U	1.160	0.205	0.124	NA	0.160	0.160	2.283	NA	NA	NA	0.12	0.177	0.986	U	1.78	0.827	0.986	NA	1.0	0.10
L050345PUB00	3.10	B	1.240	0.166	0.060	NA	0.170	0.170	-0.043	0.000	0.061	0.253	U	0.882	0.140	0.144	NA	-0.118	0.000	5.971	NA	NA	NA	0.33	0.144	0.838	U	2.01	0.461	0.838	NA	2.5	0.14
L050346PUB00	5.12	B	1.170	0.170	0.085	NA	0.100	0.100	-0.039	0.000	0.092	0.235	U	0.939	0.174	0.139	NA	-0.061	0.000	2.422	NA	NA	NA	0.12	0.130	0.925	U	1.97	0.786	0.925	NA	1.0	0.08
L050347PUB00	3.92	B	1.240	0.173	0.070	NA	0.170	0.170	-0.029	0.000	0.061	0.233	U	1.100	0.186	0.116	NA	0.100	0.100	3.468	NA	NA	NA	0.19	0.137	0.862	U	0.888	0.343	0.862	NA	3.3	0.17
L050348PUB00	3.10	B	1.070	0.171	0.094	NA	0.000	0.000	0.005	0.005	0.047	0.232	U	1.110	0.189	0.100	NA	0.110	0.110	5.203	NA	NA	NA	0.28	0.153	1.040	U	1.88	0.887	1.040	NA	2.3	0.10
L050349PUB00	4.04	B	1.120	0.156	0.068	NA	0.050	0.050	-0.008	0.000	0.017	0.224	U	0.903	0.164	0.094	NA	-0.097	0.000	3.243	NA	NA	NA	0.18	0.152	0.808	U	1.37	0.612	0.808	NA	2.0	0.05
L050350PUB00	5.11	B	1.280	0.175	0.073	NA	0.210	0.210	-0.048	0.000	0.019	0.231	U	1.160	0.183	0.095	NA	0.160	0.160	2.288	NA	NA	NA	0.12	0.158	0.928	U	1.54	0.753	0.928	NA	1.2	0.21
L050351PUB00	5.02	B	1.170	0.160	0.068	NA	0.100	0.100	-0.042	0.000	0.021	0.212	U	1.180	0.191	0.106	NA	0.180	0.180	2.899	NA	NA	NA	0.15	0.163	0.976	U	1.79	0.850	0.976	NA	1.4	0.17
Systematic Minimum			0.000						0.000					0.000						0.634				0.028				0.812				**1.5**	0.01
Systematic Maximum			0.370						0.139					0.370						7.242				0.398				2.350				Average Enrichment (%)	0.34
Systematic Mean			0.068						0.008					0.124						2.428				0.128				1.333					0.12
Systematic Median			0.045						0.000					0.120						2.221				0.115				1.340					0.11
Systematic Standard Deviation			0.088						0.030					0.095						1.535				0.086				0.387					0.07
			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.

37.2.5 Biased Soil Sample Result LSA 05-03

Twelve (12) biased samples were collected from LSA 05-03. The sample collected at location L05-03-23 represented the maximum GWS measurement (17,338 gcpm) within the SU, and had a result of 0.25 Uniform SOF.

37.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 05-03

The FSS plan design as implemented by FSS procedures at the time of FSS determined that sidewall sampling was not necessary in LSA 05-03.

37.2.7 Quality Control Soil Sample Result LSA 05-03

One QC field duplicate sample point was randomly selected for LSA 05-03 which was collected at systematic locations L05-03-04.

For the 34 "regular" samples (i.e., 22 systematic + 12 biased) collected within LSA 05-03, one field duplicate sample was collected. This frequency equates to 2.9%, (i.e. 1/34). While this QC sample frequency is less than the desired 5% sample rate, the overall project QC sample frequency remains above 5%. 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 37-5 below).

Figure 37-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 05-03

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

Survey Unit No.: LSA 05-03 — Survey Unit Description: Red Barn Area

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						
L050304PES00	L050304PEQ00	Ra-226	1.44	0.0964	1.26	0.0828	1.35	1.9	0.18	0.269	0.403	N
L050304PES00	L050304PEQ00	Tc-99	-0.0618	0.26	-0.0875	0.245	-0.07465	25.1	NA	3.552	5.321	NA
L050304PES00	L050304PEQ00	Th-232	1.18	0.18	1.27	0.127	1.225	2.0	0.090	0.283	0.424	N
L050304PES00	L050304PEQ00	U-234[1]	7.242	NA	1.737	NA	4.490	195.4	5.505	27.649	41.425	N
L050304PES00	L050304PEQ00	U-235	0.40	1.11	0.09	0.813	0.245	51.6	NA	7.301	10.939	NA
L050304PES00	L050304PEQ00	U-238	2.02	1.11	0.956	0.813	1.488	168.8	1.064	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: 3-16-17 — Date: 3/16/17

Quality Record

37.3 Tc-99 Hot Spot Assessment LSA 05-03

During site characterization studies a total of 5 samples were collected and analyzed for Tc-99 in LSA 05-03. One of these 5 samples exceeded a Uniform SOF result of 1.0 prior to remediation. However the sample was not elevated due to Tc-99. No samples exceeded the Tc-99 DCGL during FSS. Within LSA 05-03, the maximum sample identified was 0.14 pCi/g – well below the 25.1 pCi/g limit for the Uniform DCGL.

38.0 ALARA EVALUATION LSA 05-03

For LSA 05-03, no sample result exceeded a Uniform SOF of 1.0, and the average SOF results based on all systematically collected samples was 0.12. The groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2 through 5 indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, an assumed maximum groundwater contribution of 4.0 mrem/yr based upon the EPA MCLs will be added to LSA 05-03. The sum of the average systematically collected samples (0.12), and the maximum groundwater contribution (0.16) total to a 0.28 Uniform SOF value for the SU, equivalent to 7.0 mrem/year.

Since the estimated Total Effective Dose Equivalent is below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the remediation of LSA 05-03 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing further remediation of LSA 05-03.

39.0 FSS PLAN DEVIATIONS LSA 05-03

39.1 Remedial Actions during FSS

There was no remedial action in LSA 05-03 after FSS had begun.

39.2 Adjustments to Scan MDC Calculations

As previously stated in Section 35.1.5, adjustments were made to the Scan MDC calculations for instrumentation used for the GWS in LSA 05-03. The Scan MDCs presented in the FSS Plans shown in Table 35-1 assumed a surveyor efficiency of 0.5 and did not reflect the information derived from the development of HDP-TBD-FSS-002 which used Microshield modeling of parameters consistent with procedural requirements of GWS implementation at HDP. The technical basis document, HDP-TBD-FSS-002 *Evaluation and Documentation of the Scanning Minimum Detectable Concentrations for Final Status Surveys*, prepared after the completion of field FSS activities in LSA 05-03, presents the modeling assumptions and evaluation of Scan MDCs for FSS reflecting actual technical implementation of the GWS, rather than using default parameters such as presented in NUREG-1507. Since all GWS data collected in LSA 05-03 was datalogged and post-processed in GIS software, the surveyor efficiency can effectively be set to 0.75 as agreed upon with NRC during a Public Teleconference Meeting held on August 12, 2015.

Based on the data presented in HDP-TBD-FSS-002 and using a surveyor efficiency of 0.75 and a conservative enrichment basis of 4%, revised Scan MDCs were developed and are presented in Table 39-1 below:

Table 39-1

Revised Scan MDCs for 2" x 2" NaI detector: LSA 05-03

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw (Ra-226)	Scan MDC (Th-232)	DCGLw (Th-232)
LSA 05-03	40.9	52.8	1.21	1.9	0.87	2.0

40.0 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.

40.1 Data Quality Assessment for LSA 05-03

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 05-03 (see Figure 40-1) 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*.
- During the review of documentation for LSA 05-03 it is recognized that the FSS Plan for LSA 05-03 specified that root, and excavation samples would be collected across the systematic grid, however the stratum of FSS sampling is based on the projected final grade of the SU after all backfill operations have been completed. The FSS Plan for LSA 05-03 used the original grade of the SU to determine sample depth. During data validation utilizing the final grade for assessment of the samples it has been determined that 21 of the 22 FSS soil samples were actually collected from the root stratum, and in some cases, multiple

samples were collected from the root stratum at the same location. To avoid confusion the COC for the laboratory analysis the sample IDs were not changed to reflect the change in stratum in which the sample was taken. During the validation and assessment process the actual depths of the soil samples in relation to final grade are used for the purposes of determining where each FSS sample was collected within the SU.

- Quality Control sample results were verified to meet the acceptance criteria as specified in HDP-PR-FSS-703, *Final Status Survey Quality Control.*
- LSA 05-03 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 05-03, 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 05-03, however the WRS Test was still performed for illustrative purposes. Since the test statistic, WR (1232) exceeded the critical value (974), the FSS data set passed the WRS Test and the null hypothesis was rejected. The WRS evaluation worksheet is presented in Appendix E.
- No FSS sample result in LSA 05-03 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an EMC or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- The maximum SOF result for all surface samples within LSA 05-03 was 0.21. The maximum SOF result for all surface subsamples within LSA 05-03 was 0.34. The average SOF result for all systematically collected samples within LSA 05-03 was 0.12, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.15.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (11) of systematic sample locations actually collected within LSA 05-03. The successful result of the retrospective power evaluation presented in Table 40-1 for LSA 05-03 indicates that the minimum number of sample locations required (8) for the WRS Test was less than the number of sampling locations actually collected within LSA 05-03. 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.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for LSA 05-03 was completed prior to the commencement of backfill operations.

Table 40-1
Retrospective Sample Size Verification for LSA 05-03

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.07
$DCGL_{SOF}$	1
LBGR (Mean)	0.12
Shift	0.88
Relative Shift (Δ/σ)	11.97
MARSSIM Table 5.1 (P_r)	1.000000
N	12
N + 20%	14.4
N/2	8
FSS N/2	11
Verification Check	**SUFFICIENT MEASUREMENTS**
"N/2" Corresponds to the number of survey unit measurement locations required for the WRS Test	

MARSSIM Table 5.1

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

MARSSIM Table 5.2, $\alpha = 0.05$, $\beta = 0.10$

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

Figure 40-1
Data Evaluation Checklists prepared for LSA 05-03 (page 1 of 2)

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

Survey Area: 05 **Description:** Barns and Cistern Open Land Area
Survey Unit: 03 **Description:** Wood (Red) Barn Area

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 step 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 ☐
5.	Have duplicate and/or split samples or measurements been taken or acquired at each location designated as a QC sample?	Yes ☒	No ☐
6.	Were the instruments used to measure or analyze the survey data capable of detecting the ROCs or gross activity at a MDC less than the appropriate investigation level?	Yes ☒	No ☐
7.	Was the calibration of all instruments that were used to measure or analyze data, current at the time of use and were those calibrations performed using a NIST traceable source?	Yes ☒	No ☐
8.	Were the instruments successfully response-checked before use and, where required, after use on the day the data was measured?	Yes ☒	No ☐
9.	Do the samples match those identified on the chain of custody?	Yes ☒	No ☐
10.	Do the QC Sample Results meet the acceptance criteria as specified in HDP-PR-FSS-703, Final Status Survey Quality Control (Reference 5.11)	Yes ☒	No ☐

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

Figure 40-1
Data Evaluation Checklists prepared for LSA 05-03 (page 2 of 2)

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

Survey Area: No. 05 **Description:** Barn and Cistern Open Land Area
Survey Unit: No. 03 **Description:** Wood (Red) Barn Area

Discrepancy; None

Corrective Actions Taken; None

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

	(Print Name)	(Signature)	(Date)
Prepared by (HP Staff):	Scott Jenkins		02/20/14
Approved by (RSO):	Joseph Grimes		2-21-14

41.0 SURVIELLENCE FOLLOWING FSS

FSS of SU LSA 05-03 was completed on November 25, 2013 as well as FSS of adjacent SUs LSA 05-01 (January 19, 2014), and LSA 05-02 (November 18, 2013). Given the location of LSA 05-03 on the northern most boundary of the site, and that the elevation of LSA 05-03 places it above all other remaining un-remediated LSAs, this precludes the possibility of cross contamination. As such, the radiological status of all of the SUs adjacent to LSA 05-03 did not present a possibility of recontamination of LSA 05-03 as a consequence of a storm event.

42.0 CONCLUSION LSA 05-03

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 05-03 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

Table 42-1
LSA 05-03 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.12	N/A	0.16	N/A	N/A	**0.28**
DOSE	3.0 mrem/year	N/A	4.0 mrem/year	N/A	N/A	**7.0 mrem/year**

43.0 FINAL STATUS SURVEY DESIGN LSA 05-04

This section describes the method for determining the number of samples required for the FSS of LSA 05-04 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 05-04 and their detection sensitivities are also discussed.

43.1 FSS Plan Design Requirements

FSS Plan requirements for LSA 05-04 were driven by the type (Open Land) and Class (Class 1) of the survey unit and developed in accordance with HDP procedure, HDP-PR-FSS-701, Revision 9, *Final Status Survey Plan Development*, October 2015.

43.1.1 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.*

43.1.2 $DCGL_w$

During the FSS design process a review was performed of the historic characterization data for LSA 05-03. The review identified one area was previously found to exceed a Uniform SOF of 1.0 (discussed in Section 3.3.8). Next the remediation history was reviewed to confirm that the area was adequately addressed, and the RASS data was used as confirmation that no known areas of residual radioactivity remained within the survey areas that exceeded the Uniform $DCGL_w$. Therefore the Uniform $DCGL_w$ was selected for use in demonstrating compliance with the release criteria.

43.1.3 GWS Coverage

As a Class 1 SU, LSA 05-04 was required to undergo a 100% GWS.

43.1.4 Instrumentation

Radiological instrumentation selected for performance of GWS within LSA 05-04 was the Ludlum 44-10 2" x 2" NaI detectors, coupled to a Ludlum 2221 scaler-ratemeter.

43.1.5 Scan Minimum Detectable Concentration

Scan MDCs for LSA 05-04 were calculated in accordance with HDP-PR-FSS-701, Revision 9, *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 10,000 cpm within LSA 05-04, 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:

$$\text{Scan MDC}_{\text{(total uranium)}} = \frac{1}{\left(\left(\frac{f_{U-234}}{3659\ pCi/g}\right)+\left(\frac{f_{U-235}}{2.32\ pCi/g}\right)+\left(\frac{f_{U-238}}{30.6\ pCi/g}\right)\right)}$$

Equation 43-1

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 05-04, the average enrichment for the SU was 2.54%. 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 05-04 are shown below:

Table 43-1
Scan MDCs for 2" x 2" NaI detector, 10,000 cpm background: LSA 05-04

	Scan MDC (Total U)	DCGLw (Total U)	Scan MDC (Ra-226)	DCGLw* (Ra-226)	Scan MDC (Th-232)	DCGLw* (Th-232)
LSA 05-04	40.9	26.4	1.21	2.8	0.87	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 43-1 reflect those presented in the FSS Plans prepared for the SU prior to FSS.

43.1.6 Investigation Action Level

FSSFR Volume 3, Chapter 1, Section 6.1.3, *Investigation Action Level (IAL)*, provides a discussion in regards to the IAL. The basis of the IAL is detailed in HDP memorandum, HEM-15-MEMO-021 "*Evaluation of the Scan IAL for Class 1 areas at the Westinghouse Hematite Site*". The IAL used during the GWS of LSA 05-04 was established at 4,000 ncpm.

43.1.7 LSA 05-04 FSS Design Summary

The FSS Plan for LSA 05-04 can be found in Appendix J. Table 43-2 presents an overall FSS design and implementation summary for LSA 05-04.

Table 43-2
FSS Design Summary for LSA 05-04

Gamma Walkover Survey (GWS):		
Scan Coverage	100% exposed excavation floors and walls	
Scan MDC	40.9 pCi/g total Uranium (based on a 10,000 cpm background); 0.87 pCi/g Th-232; 1.21 pCi/g Ra-226*	
Investigation Action Level (IAL)	4,000 net cpm**	
Systematic Sampling Locations:		
Depth	Number of Samples	Comments
0 – 15 cm (Surface)	7	These samples were collected on a systematic grid.
15 cm – 1.5 m (Root)	7	
> 1.5m (Excavation)	8	
Biased Survey/Sampling Locations:		
Biased samples may be collected during GWS at the discretion of the HP Technician, after statistical analysis of the survey data, or at the direction of the FSS Supervisor.		
Sidewall Sampling Locations:		
One (1) discretionary sidewall sample will be collected based on the following definition of "sidewall"; sidewall candidates for sampling must be vertical or near vertical (> 45° angle) and at least 12" in height.		
Instrumentation:		
Ludlum 2221 with 44-10 (2" x 2" 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 of (2.5%0 would result in a Scan MDC slightly less than those calculated for FSS planning purposes.		
**IAL is the net count per minute (ncpm) equivalent of an activity concentration less than the Uniform Stratum DCGLw derived from the technical bases presented in HEM-MEMO-15-021 and HDP-TBD-FSS-003 "*Modeling and Calculation of Investigative Action Levels for Final Status Soil Survey Units*", Westinghouse, March 2015.		

44.0 FINAL STATUS SURVEY IMPLEMENTATION LSA 05-04

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

44.1 Gamma Walkover Survey

44.1.1 Instrumentation

The selected instrumentation to perform the GWS in LSA 05-04 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*.

44.1.2 GWS Performance

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

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

HP Technicians performing GWS in LSA 05-04 used the 4,000 ncpm IAL as a field guide to know when to slow or pause the GWS for more deliberate investigation. If during the GWS, audible count rates noticeably increase above the general area average (i.e., > minimum detectable count rate), HP Technicians were required to pause momentarily and observe count rates. If sustained count rates approached the IAL, further focused investigation was conducted within the locally elevated area.

To use the IAL effectively, HP Technicians first determined the local background count rate before starting the GWS. Although the ambient gamma level may vary across the SU due to excavation geometry and relative distance from contaminated materials in nearby remedial excavations, the average background rate (measured at waist level) within the LSA ranged between 10,000 and 12,000 gcpm. Therefore, at locations where the 2" x 2" NaI detector measurements exceeded 14,000 to 16,000 gcpm, HP Technicians slowed or paused the GWS for more careful investigation of the small areas of elevated activity before deciding if "flagging" a point for potential biased sampling was warranted.

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.

44.2 Soil Sampling

44.2.1 Systematic Soil Sampling Summary

Table 44-1 provides a summary of systematic sampling by stratum for LSA 05-04.

Table 44-1
Systematic Sampling Summary by Stratum for LSA 05-04

LSA	SU Area, planar (m^2)	Systematic			QC
		Surface	Root	Deep (Excavation)	
05-04	2,027	5	9	2	2

44.2.2 Systematic Sampling LSA 05-04

Within LSA 05-04, there were five locations in which portions of the surface stratum (0 – 15 cm) remained in the SU after remediation. Portions of the root stratum (15 cm – 150 cm) also remained at seven systematic locations, but nine root stratum samples were collected in total. At these locations the remaining root stratum interval was collected using a hand auger and composited. One systematic location was collected at a location where only the excavation stratum remained, and one additional excavation stratum sample was errantly sent to the lab for analysis although it was not required, for all other locations the 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.

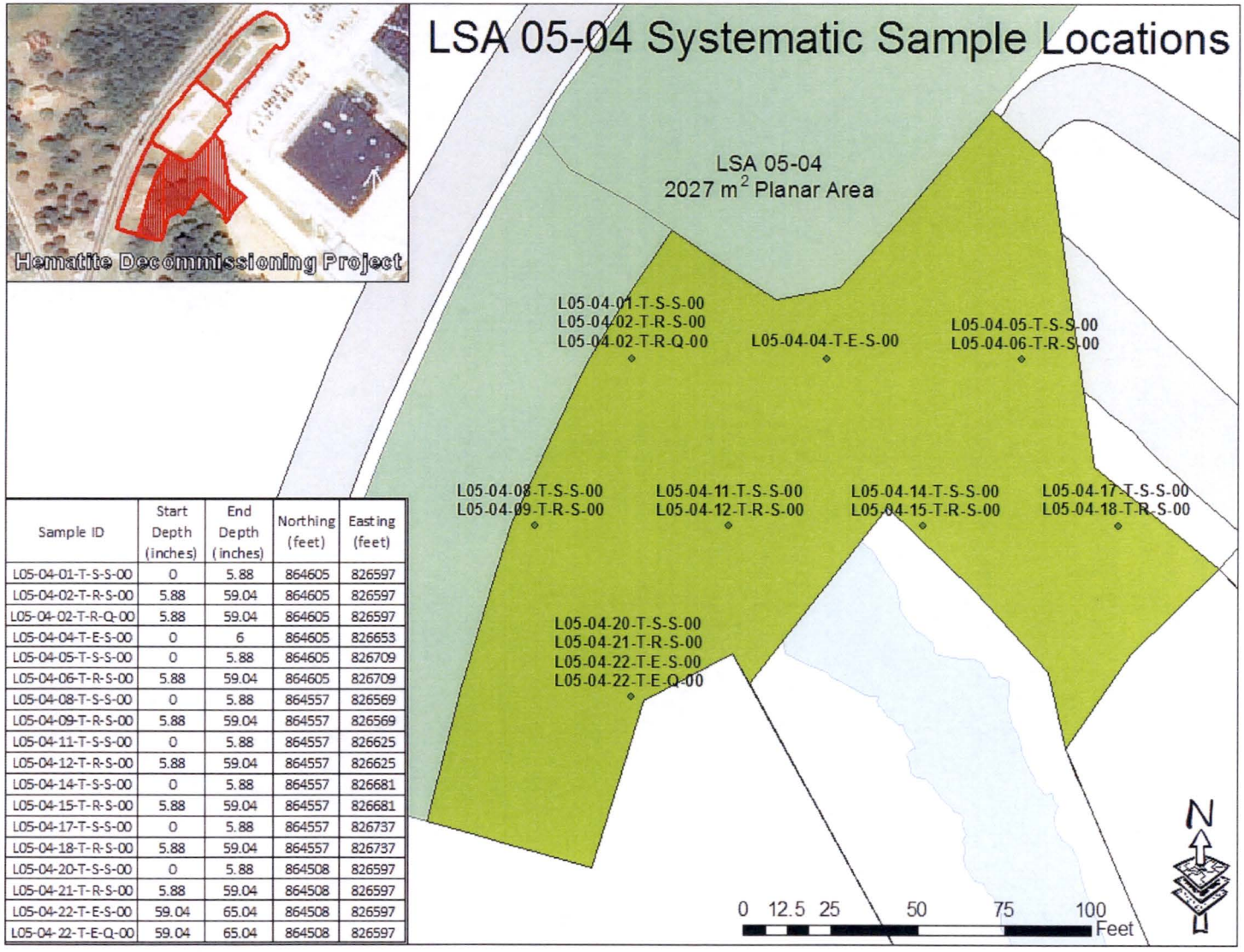
Given a planar area of 2,027 m^2 for LSA 05-04 and a ten - point systematic triangular grid, the point-to-point distance within each row was 14.5 m.

While there were eight systematic locations on the LSA 05-04 sampling grid, a total of eighteen (18) samples were collected at these locations, including:

- Five (5) samples collected within the remaining surface stratum
- Nine (9) sample collected within the remaining root stratum
- Two (2) samples collected within the excavation, or "deep" stratum
- Two (2) QC field replicate

Figure 44-1 presents the map of the eight systematic sample locations which were sampled within LSA 05-04. The inset table notes the location coordinates (Missouri East, NAD 1983) and collection intervals for each systematic location.

Figure 44-1
LSA 05-04 Systematic Soil Sample Locations



Sample ID	Start Depth (inches)	End Depth (inches)	Northing (feet)	Easting (feet)
L05-04-01-T-S-S-00	0	5.88	864605	826597
L05-04-02-T-R-S-00	5.88	59.04	864605	826597
L05-04-02-T-R-Q-00	5.88	59.04	864605	826597
L05-04-04-T-E-S-00	0	6	864605	826653
L05-04-05-T-S-S-00	0	5.88	864605	826709
L05-04-06-T-R-S-00	5.88	59.04	864605	826709
L05-04-08-T-S-S-00	0	5.88	864557	826569
L05-04-09-T-R-S-00	5.88	59.04	864557	826569
L05-04-11-T-S-S-00	0	5.88	864557	826625
L05-04-12-T-R-S-00	5.88	59.04	864557	826625
L05-04-14-T-S-S-00	0	5.88	864557	826681
L05-04-15-T-R-S-00	5.88	59.04	864557	826681
L05-04-17-T-S-S-00	0	5.88	864557	826737
L05-04-18-T-R-S-00	5.88	59.04	864557	826737
L05-04-20-T-S-S-00	0	5.88	864508	826597
L05-04-21-T-R-S-00	5.88	59.04	864508	826597
L05-04-22-T-E-S-00	59.04	65.04	864508	826597
L05-04-22-T-E-Q-00	59.04	65.04	864508	826597

Table 44-2 below presents a tabular listing of all FSS samples collected within LSA 05-04 with associated IDs, sample types, collection intervals, coordinates, and notes as presented in the FSS Plan (Appendix J).

Table 44-2
FSS Sample Locations and Coordinates for LSA 05-04

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 05 **Description:** Technetium-99 Soils Open Land Area

Survey Unit: 04 **Description:** Survey Unit in "Barns Area - Area 16"

Survey Type: FSS **Classification:** Class 1

Measurement or Sample ID	Surface or CSM	Type	Start Elevation*	End Elevation*	Northing** (Y Axis)	Easting** (X Axis)	Remarks / Notes
L05-04-01-T-S-S-00	Uniform	S	425.95	425.5	864605.0	826597.0	Surface 6-inch grab
L05-04-02-T-R-S-00	Uniform	S	425.46	421.0	864605.0	826597.0	Root 4.4-ft composite
L05-04-04-T-E-S-00	Uniform	S	422.973	422.5	864605.0	826653.0	Excavation 6-inch grab
L05-04-05-T-S-S-00	Uniform	S	429.846	429.4	864605.0	826709.0	Surface 6-inch grab
L05-04-06-T-R-S-00	Uniform	S	429.356	424.9	864605.0	826709.0	Root 4.4-ft composite
L05-04-08-T-S-S-00	Uniform	S	426.104	425.6	864557.0	826569.0	Surface 6-inch grab
L05-04-09-T-R-S-00	Uniform	S	425.614	421.2	864557.0	826569.0	Root 4.4-ft composite
L05-04-11-T-S-S-00	Uniform	S	425.355	424.9	864557.0	826625.0	Surface 6-inch grab
L05-04-12-T-R-S-00	Uniform	S	424.865	420.4	864557.0	826625.0	Root 4.4-ft composite
L05-04-14-T-S-S-00	Uniform	S	424.2	423.7	864557.0	826681.0	Surface 6-inch grab
L05-04-15-T-R-S-00	Uniform	S	423.7	419.3	864557.0	826681.0	Root 4.4-ft composite
L05-04-17-T-S-S-00	Uniform	S	430.0	429.5	864557.0	826737.0	Surface 6-inch grab
L05-04-18-T-R-S-00	Uniform	S	429.5	425.1	864557.0	826737.0	Root 4.4-ft composite
L05-04-20-T-S-S-00	Uniform	S	428.0	427.5	864508.0	826597.0	Surface 6-inch grab
L05-04-21-T-R-S-00	Uniform	S	427.5	423.1	864508.0	826597.0	Root 4.4-ft composite
L05-04-22-T-E-S-00	Uniform	S	423.1	422.6	864508.0	826597.0	Excavation 6-inch grab
L05-04-02-T-R-Q-00	Uniform	Q	425.5	421.0	864605.0	826597.0	QA Duplicate Sample
L05-04-22-T-E-Q-00	Uniform	Q	423.1	422.6	864508.0	826597.0	QA Duplicate Sample
L05-04-23-T-R-B-00	Uniform	B	426.6	426.6	864590.0	826700.0	Sidewall 6-in Grab
L05-04-24-T-S-B-00	Uniform	B	422.6	422.1	864617.0	826638.0	Biased 6-in Grab
L05-04-25-T-S-B-00	Uniform	B	426.3	425.8	864625.0	826642.0	Biased 6-in Grab
L05-04-26-T-S-B-00	Uniform	B	422.2	421.7	864592.0	826704.0	Biased 6-in 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

44.3 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 05-04 several sample locations were selected within the SU based on the evaluation of the GWS survey data, HP Technician professional judgment. While there were two very small and isolated areas in LSA 05-04 that exceeded the 3 sigma Z-score criteria, these areas represented holes that were excavated deeper than the surrounding areas and are believed to be elevated due to poor counting geometry conditions. Biased location L05-04-25-T-S-B-00 represents the maximum measurement encountered within in LSA 05-04 and has a Uniform SOF value of 0.23.

44.4 Judgmental/Sidewall Sampling for Tc-99

In accordance with the guidance specified in Volume 3, Chapter 1, Section 6.2.3, it was determined that sidewall sampling was necessary. The number of sidewall samples collected from each SU is determined by comparing the sidewall surface area to the two dimensional systematic surface area (e.g., 8 systematic samples were collected over 2,000 m^2, then collect 1 sample per 250 m^2 of sidewall). One sample was collected from a sidewall of LSA 05-04. This sample was collected from a location selected by the HP Technician at random, and was not based on gamma survey readings (not biased).

44.5 Quality Control Soil Sampling

Two QC field duplicate sample points were randomly selected and collected at systematic locations L05-04-02 and L05-04-22 for LSA 05-04.

45.0 FINAL STATUS SURVEY RESULTS LSA 05-04

45.1 Gamma Walkover Survey

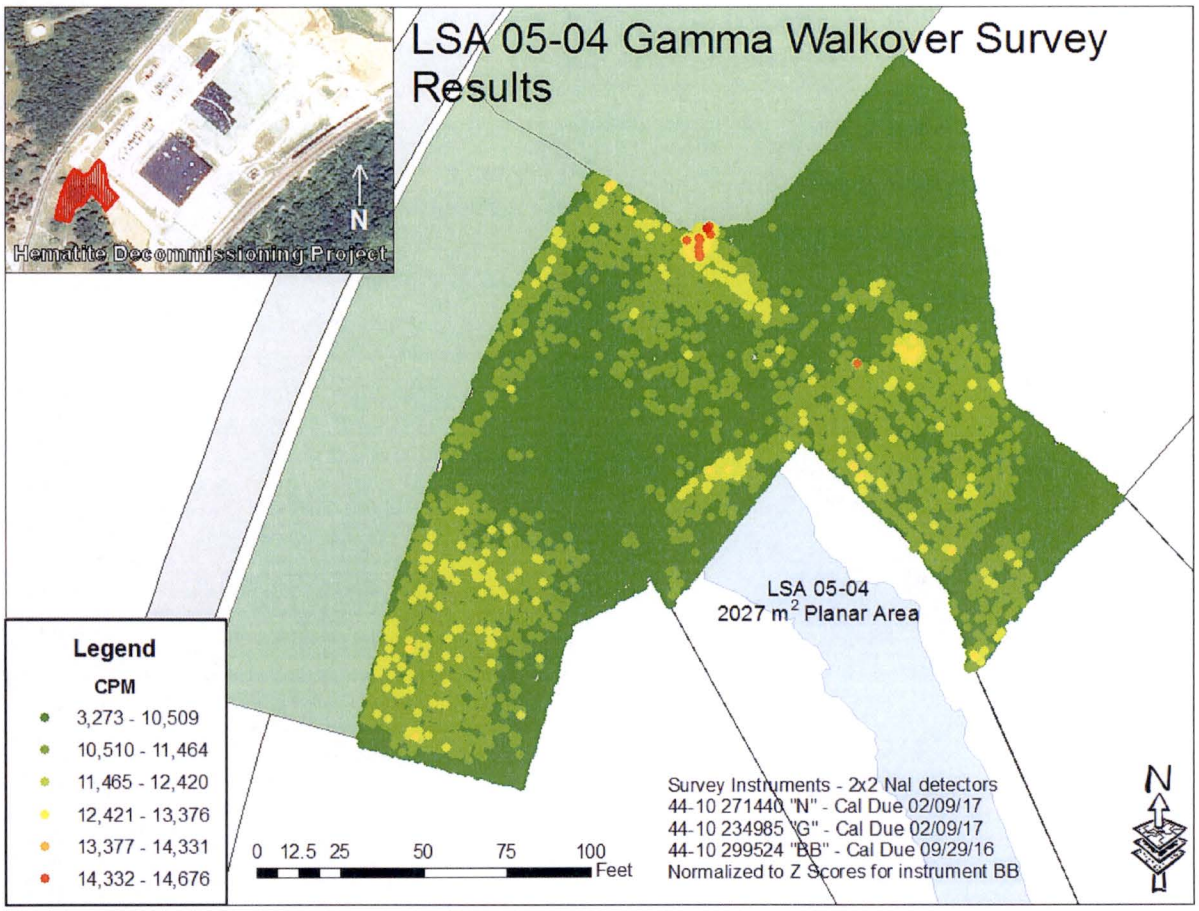
Post-processed GPS coordinate data is accurate to within ± 0.1 m for the handheld GPS models used during the GWS. The GWS maps are plotted and presented in a 2-D format. When multiple data points are collected at the same GPS location during the walkover, the most elevated radiological measurements are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

GWS measurements were collected in LSA 05-04 on April 1, 2016 and April 2, 2016.

45.1.1 GWS Results for LSA 05-04

For LSA 05-04, GWS count rates ranged between 3,273 gcpm and 14,676 gcpm, with a mean count rate of 9,001 gcpm. The median count rate was 9,531 gcpm with a standard deviation of 1,808 cpm. Figure 45-1 below presents a map of the complete GWS data set.

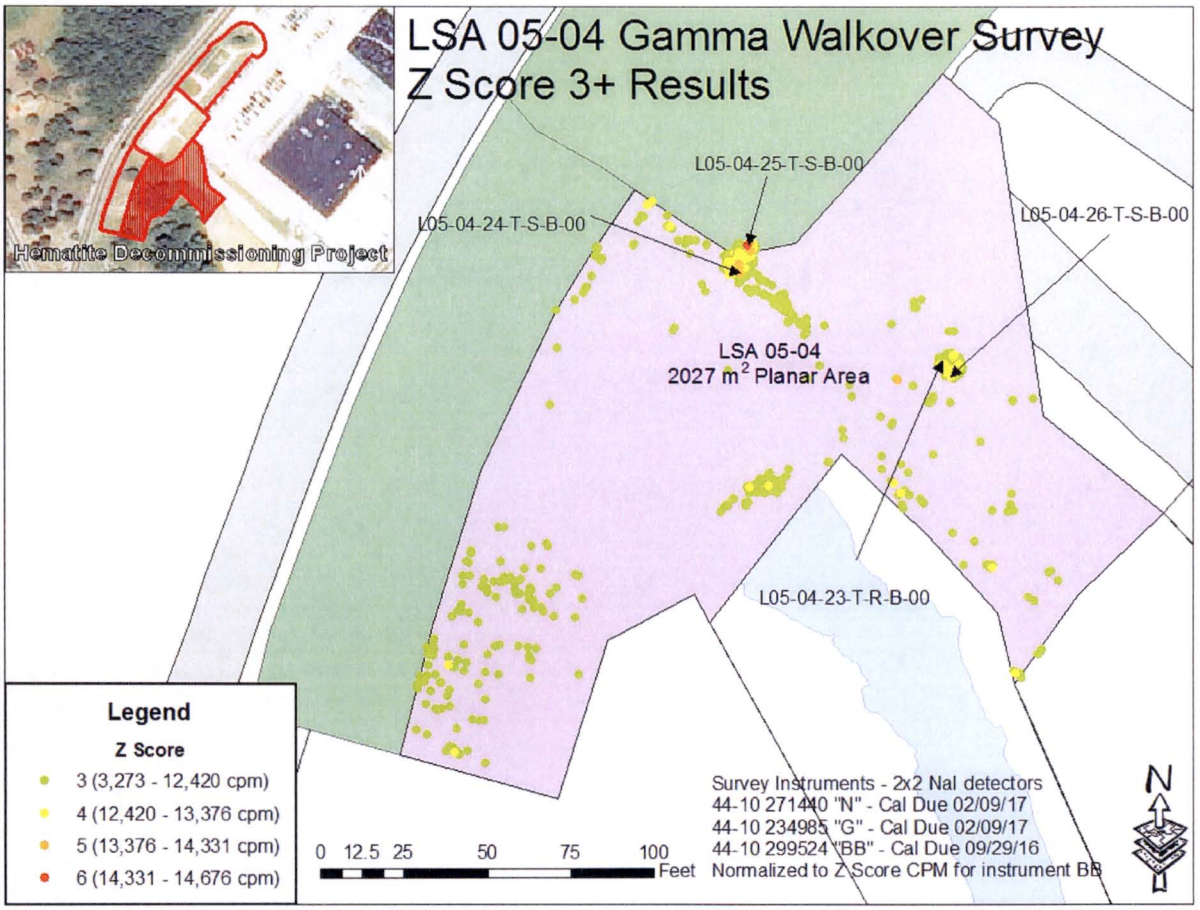
Figure 45-1
Colorimetric GWS Plot for LSA 05-04



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"). While there were two very small and isolated areas in LSA 05-04 that exceeded the 3 sigma Z-score criteria, these areas represented holes that were excavated deeper than the surrounding areas and are determined to be elevated due to poor counting geometry conditions.

Figure 45-2 presents a map of the +3 Z-score GWS measurements within LSA 05-04, including the four total selected biased sampling locations.

Figure 45-2
Colorimetric GWS Plot for LSA 05-04 (Measurements > Z-score of 3)



All GWS data collected in LSA 05-04 was datalogged and post-processed in GIS.

45.1.2 GWS Coverage Results LSA 05-04

FSSFR Volume 3, Chapter 1, Section 6.1.4, *Exposed Surfaces versus Accessible Surfaces*, provides a discussion and the criteria for evaluating the GWS coverage of a SU during FSS. Although 100% of accessible areas underwent GWS

The post survey processing of the GPS data indicated that the GWS was 99.94% of the SU (see Table 45-1). As the evaluation indicates that the GPS coverage exceeded 95% with no readings approaching or exceeding the IAL of 4,000 net cpm in the vicinity of any apparent GPS coverage gaps, the GWS coverage for the SU has been evaluated to meet the intent of the "100% GWS coverage" requirement.

Table 45-1
GWS Gap Analysis LSA 05-04

	Total SU Pixels	GWS Gap Pixels	Gap Percentage	GWS Coverage	MARSSIM Class
LSA 05-04	312,396	177	0.06	99.94	1

45.2 Soil Sample Results LSA 05-04

Appendix F presents the analytical results and associated statistics for all FSS samples collected within LSA 05-04.

45.2.1 Surface Soil Sample Results LSA 05-04

There were five (5) samples collected within the surface stratum (0 – 15 cm) of LSA 05-04. However, there were a total of twelve (12) soil samples collected within the topmost soil layer of the excavation surface including eight systematic samples, three biased samples, and one sidewall sample. The maximum SOF result for "topmost" samples in LSA 05-04 was 0.245 corresponding to sample L05-04-11-T-S-S-00.

45.2.2 Subsurface Soil Sample Results LSA 05-04

There were ten systematic locations within LSA 05-04 where subsurface sampling was performed including eight systematic samples, and two QC samples. The maximum SOF result of the subsurface samples collected in LSA 05-04 was sample L05-04-15-T-R-S-00 with a Uniform SOF result of 0.13.

45.2.3 WRS Evaluation

Per Step 7.8.3 of HDP-PR-FSS-721 *Final Status Survey Data Evaluation*, the WRS Test was not required for LSA 05-04 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 evaluation was still performed for LSA 05-04. 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 05-04 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 F.

45.2.4 Graphical Data Review LSA 05-04

Table 45-2 below presents summary results for the all systematically collected samples (includes root, and excavation stratum samples, but not biased or QC samples) collected within LSA 05-04, 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 45-2
LSA 05-04 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	0.033	1.207	0.031	3.793	0.197	1.012	**0.11**
Minimum	0.00 (<BKG)	0.030	0.00 (<BKG)	0.955	-0.099	0.668	0.02
Maximum	0.200	9.620	0.140	9.314	0.513	1.630	0.45

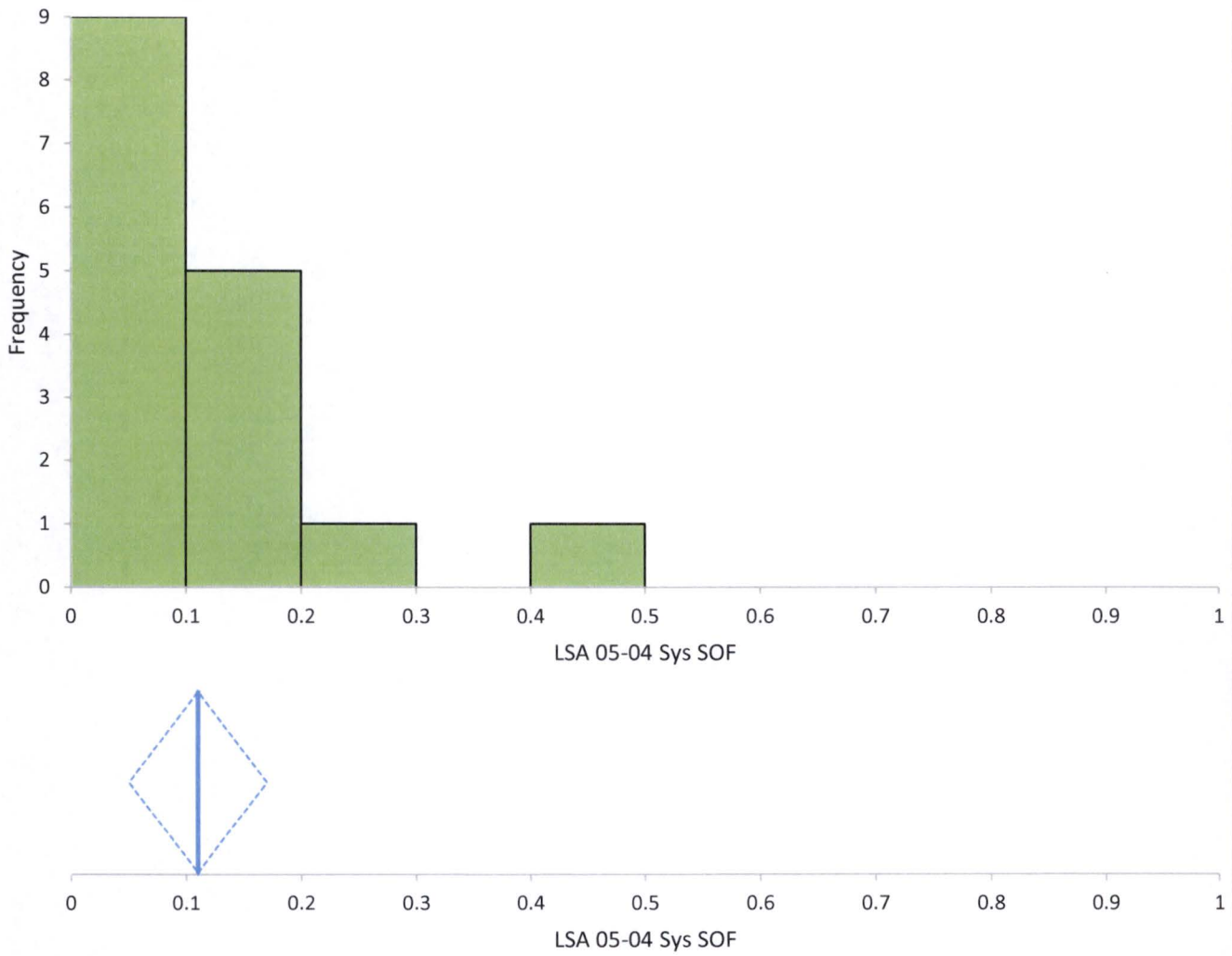
Notes:
1. Ra-226 and Th-232 background activities subtracted prior to calculating SOF value. Ra-226 background without ingrowth = 0.9 pCi/g; Ra-226 background with ingrowth = 1.07 pCi/g. Negative SOF components are set to zero in SOF calculation.
2. Average SOF for data set calculated using average radionuclide 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 45-3 presents the overall statistical metrics for the SOF parameter for the 16 systematically collected samples from LSA 05-04. The top graph is a histogram and line plot of the SOF for the systematic data population for LSA 05-04. 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 0.05 to 0.17. The 97.87% confidence interval based on the median (0.05) of the sample results is 0.04 to 0.16. The bottom two charts present the various statistical metrics of the LSA 05-04 SOF data set, including the mean, median, standard deviation, minimum, maximum, confidence intervals, etc.

Figure 45-3 exhibits no unusual symmetry or bimodality concerns for the LSA 05-04 data associated with the systematically collected measurement locations.

Figure 45-3
Graphic Statistical Summary for LSA 05-04 (SOF parameter)



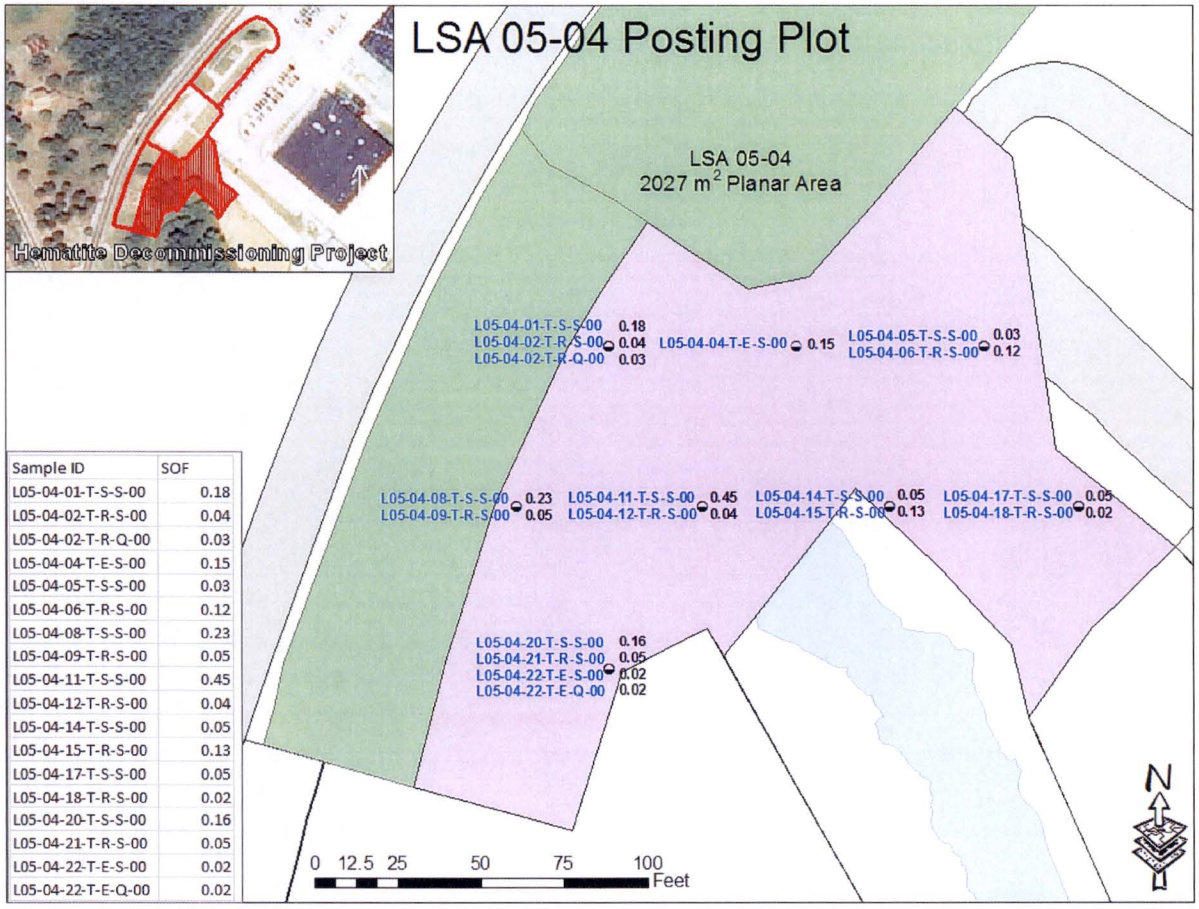
N	16

	Mean	95% CI		Mean SE	SD	Variance	Skewness	Kurtosis
LSA 05-04 Sys SOF	0.11	0.05	to 0.17	0.028	0.11	0.01	2.0	4.81

	Minimum	1st quartile	Median	97.87% CI		3rd quartile	Maximum	IQR
LSA 05-04 Sys SOF	0.02	0.04	0.05	0.04	to 0.16	0.16	0.4	0.12

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 05-04 is presented below in Figure 45-4. Figure 45-4 shows no unusual patterns in the data.

Figure 45-4
Posting Plot for LSA 05-04 Systematic Measurement Locations



Sample ID	SOF
L05-04-01-T-S-S-00	0.18
L05-04-02-T-R-S-00	0.04
L05-04-02-T-R-Q-00	0.03
L05-04-04-T-E-S-00	0.15
L05-04-05-T-S-S-00	0.03
L05-04-06-T-R-S-00	0.12
L05-04-08-T-S-S-00	0.23
L05-04-09-T-R-S-00	0.05
L05-04-11-T-S-S-00	0.45
L05-04-12-T-R-S-00	0.04
L05-04-14-T-S-S-00	0.05
L05-04-15-T-R-S-00	0.13
L05-04-17-T-S-S-00	0.05
L05-04-18-T-R-S-00	0.02
L05-04-20-T-S-S-00	0.16
L05-04-21-T-R-S-00	0.05
L05-04-22-T-E-S-00	0.02
L05-04-22-T-E-Q-00	0.02

Appendix F to this report presents the complete analytical data set (in Microsoft Excel format) used to derive the summary statistics presented in Table 45-2, Figure 45-3, and Figure 45-4 above. A summary of the analytical data is presented in Table 45-3 below. Appendix N to this report presents the Test America Analytical Laboratory soil sample reports.

Table 45-3
Final Status Survey Analytical Data: LSA 05-04

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
L05-04-01-T-S-S-00	0.19	S	1.270	0.171	0.057	N/A	0.200	0.200	0.007	0.007	0.019	0.226	U	1.070	0.160	0.116	N/A	0.070	0.070	5.558	NA	NA	NA	0.307	0.157	0.193		1.050	0.310	0.782	N/A	4.4	0.18
L05-04-02-T-R-S-00	0.50	S	0.909	0.129	0.060	N/A	-0.161	0.000	0.073	0.073	0.042	0.234	U	1.030	0.170	0.092	N/A	0.030	0.030	2.743	NA	NA	NA	0.150	0.124	0.228	U	0.894	0.283	0.775	N/A	2.6	0.04
L05-04-04-T-E-S-00	5.00	S	1.170	0.170	0.076	N/A	0.100	0.100	0.294	0.294	0.079	0.280	N/A	1.140	0.205	0.095	N/A	0.140	0.140	1.690	NA	NA	NA	0.091	0.110	0.232	U	0.745	0.272	0.761	U	1.9	0.15
L05-04-05-T-S-S-00	0.24	S	0.758	0.105	0.035	N/A	-0.312	0.000	0.146	0.146	0.104	0.212	U	0.754	0.117	0.074	N/A	-0.246	0.000	2.716	NA	NA	NA	0.147	0.089	0.156	U	1.090	0.387	0.568	N/A	2.1	0.03
L05-04-06-T-R-S-00	0.50	S	1.210	0.190	0.089	N/A	0.140	0.140	-0.011	0.000	0.045	0.224	U	1.060	0.190	0.153	N/A	0.060	0.060	2.043	NA	NA	NA	0.109	0.113	0.289	U	1.000	0.371	1.210	U	1.7	0.12
L05-04-08-T-S-S-00	0.53	S	0.886	0.140	0.055	N/A	-0.184	0.000	4.200	4.200	0.559	0.229	N/A	0.908	0.165	0.132	N/A	-0.092	0.000	9.314	NA	NA	NA	0.513	0.186	0.236	N/A	1.320	0.347	0.870	N/A	5.7	0.23
L05-04-09-T-R-S-00	1.00	S	1.010	0.146	0.067	N/A	-0.060	0.000	0.772	0.772	0.077	0.228	N/A	0.857	0.151	0.093	N/A	-0.143	0.000	3.223	NA	NA	NA	0.178	0.102	0.159	N/A	0.668	0.267	0.702	U	4.0	0.05
L05-04-11-T-S-S-00	0.46	S	0.570	0.083	0.038	N/A	-0.500	0.000	9.620	9.620	0.980	0.211	N/A	0.525	0.098	0.065	N/A	-0.475	0.000	8.835	NA	NA	NA	0.488	0.115	0.136	N/A	1.630	0.343	0.702	N/A	4.5	0.45
L05-04-12-T-R-S-00	1.00	S	0.877	0.140	0.075	N/A	-0.193	0.000	0.416	0.416	0.071	0.236	N/A	0.913	0.180	0.150	N/A	-0.087	0.000	2.156	NA	NA	NA	0.115	0.140	0.223	U	1.070	0.505	0.779	N/A	1.7	0.04
L05-04-14-T-S-S-00	0.09	S	0.838	0.130	0.069	N/A	-0.232	0.000	0.079	0.079	0.048	0.239	U	1.010	0.146	0.083	N/A	0.010	0.010	5.321	NA	NA	NA	0.293	0.113	0.176	N/A	0.740	0.277	0.773	U	5.8	0.05
L05-04-15-T-R-S-00	0.60	S	1.160	0.174	0.075	N/A	0.090	0.090	0.005	0.005	0.020	0.229	U	1.140	0.201	0.157	N/A	0.140	0.140	1.446	NA	NA	NA	0.076	0.126	0.261	U	0.867	0.319	0.871	U	1.4	0.13
L05-04-17-T-S-S-00	0.49	S	0.320	0.060	0.032	N/A	-0.750	0.000	0.131	0.131	0.019	0.202	U	0.228	0.068	0.040	N/A	-0.772	0.000	6.143	NA	NA	NA	0.339	0.103	0.128	N/A	0.985	0.331	0.470	N/A	5.1	0.05
L05-04-18-T-R-S-00	1.00	S	0.998	0.167	0.088	N/A	-0.072	0.000	0.061	0.061	0.076	0.224	U	0.920	0.215	0.156	N/A	-0.080	0.000	1.320	NA	NA	NA	-0.099	0.226	0.272	U	1.320	0.609	0.939	N/A	0.7	0.02
L05-04-20-T-S-S-00	0.29	S	0.683	0.107	0.056	N/A	-0.387	0.000	3.030	3.030	0.357	0.222	N/A	0.702	0.124	0.075	N/A	-0.298	0.000	5.885	NA	NA	NA	0.325	0.120	0.178	N/A	1.220	0.272	0.637	N/A	4.0	0.16
L05-04-21-T-R-S-00	0.50	S	0.956	0.142	0.067	N/A	-0.114	0.000	0.325	0.325	0.070	0.218	N/A	1.040	0.177	0.118	N/A	0.040	0.040	1.332	NA	NA	NA	0.069	0.120	0.222	U	0.883	0.263	0.672	N/A	1.2	0.05
L05-04-22-T-E-S-00	5.00	S	0.846	0.133	0.073	N/A	-0.224	0.000	0.159	0.159	0.119	0.227	U	0.882	0.143	0.106	N/A	-0.118	0.000	0.955	NA	NA	NA	0.049	0.144	0.243	U	0.705	0.277	0.799	U	1.1	0.02
L05-04-02-T-R-Q-00	0.50	Q	0.909	0.160	0.091	N/A	-0.161	0.000	0.088	0.088	0.036	0.225	U	0.574	0.165	0.181	N/A	-0.426	0.000	2.243	NA	NA	NA	0.113	0.187	0.269	U	1.810	0.907	1.050	N/A	1.0	0.03
L05-04-22-T-E-Q-00	5.00	Q	0.912	0.150	0.083	N/A	-0.158	0.000	0.134	0.134	0.085	0.223	U	0.972	0.187	0.113	N/A	-0.028	0.000	1.338	NA	NA	NA	0.072	0.137	0.229	U	0.619	0.278	0.794	U	1.8	0.02
L05-04-23-T-R-B-00	0.00	B	1.160	0.159	0.071	N/A	0.090	0.090	0.095	0.095	0.075	0.232	U	0.869	0.158	0.130	N/A	-0.131	0.000	3.218	NA	NA	NA	0.177	0.108	0.176	N/A	0.888	0.273	0.716	N/A	3.1	0.08
L05-04-24-T-S-B-00	4.72	B	1.070	0.167	0.074	N/A	0.000	0.000	0.110	0.110	0.107	0.233	U	1.100	0.184	0.095	N/A	0.100	0.100	1.606	NA	NA	NA	0.088	0.167	0.278	U	0.576	0.296	0.837	U	2.4	0.07
L05-04-25-T-S-B-00	4.20	B	1.300	0.172	0.063	N/A	0.230	0.230	0.009	0.009	0.040	0.237	N/A	1.180	0.177	0.116	N/A	0.180	0.180	2.377	NA	NA	NA	0.130	0.148	0.242	U	0.780	0.291	0.801	U	2.6	0.23
L05-04-26-T-S-B-00	5.30	B	1.200	0.180	0.082	N/A	0.130	0.130	0.020	0.020	0.091	0.244	U	1.020	0.229	0.151	N/A	0.020	0.020	2.601	NA	NA	NA	0.142	0.162	0.294	U	0.891	0.338	0.944	U	2.5	0.10
Systematic Minimum			0.000						0.000					0.000						0.955				-0.099				0.668				**2.8**	0.02
Systematic Maximum			0.200						9.620					0.140						9.314				0.513				1.630				Average Enrichment (%)	0.45
Systematic Mean			0.033						1.207					0.031						3.793				0.197				1.012					0.11
Systematic Median			0.000						0.153					0.000						2.730				0.149				0.993					0.05
Systematic Standard Deviation			0.063						2.544					0.049						2.705				0.166				0.263					0.11
			With ingrowth, use Ra226 bkg = 1.07											Th232 bkg = 1.0																			

NOTES:

Gross results in units of pCi/g.
* Background with ingrowth (1.07 pCi/g) subtracted from gross result.
**Background (1.0 pCi/g) subtracted from gross result.
U Qualifier: Result is less than the sample detection limit.
All uncertainty values are reported at the 2-sigma confidence level.

45.2.5 Biased Soil Sample Result LSA 05-04

For LSA 05-04 several sample locations were selected within the SU based on the evaluation of the GWS survey data, HP Technician professional judgment. Biased location L05-04-25-T-S-B-00 represents the maximum measurement encountered within in LSA 05-04 and has a Uniform SOF value of 0.23.

45.2.6 Judgmental/Sidewall Soil Sample for Tc-99 Results LSA 05-04

One sidewall sample was collected from LSA 05-04, from location L05-04-23 –T-R-B-00, with a Uniform SOF result of 0.08.

45.2.7 Quality Control Soil Sample Result LSA 05-04

Two QC field duplicate sample points was randomly selected for LSA 05-04 which were collected at systematic locations L05-04-02 and L05-04-22.

For the 20 "regular" samples (i.e., 16 systematic + 3 biased + 1 sidewall) collected within LSA 05-04, two field duplicate sample were collected. This frequency equates to 10%, (i.e. 2/20). 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 45-5 below).

The statistical assessment of the Laboratory QC sample results indicated that one field duplicate sample (L05-04-02-T-R-Q-00) exceeded the calculated Control Limit for Th-232. 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 Th-232 the calculated statistic (0.456) only slightly exceeded the Control Limit (0.424). Additionally, while the sample results were evaluated against the Uniform DCGL criteria, this sample was actually collected from the excavation stratum. If the excavation stratum DCGL's are substituted for the calculation of the sample statistics then the calculated statistic (0.456) is easily less than both the Warning Limit (0.736) and the Control Limit (1.102). Also, considering the low activity and the errors associated with the sample results, the Th-232 activity of both samples were relatively close. 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 45-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 05-04 (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 05-04 — Survey Unit Description: Survey Unit in "Barns Area - Area 16"

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)
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	Ra-226	0.846	0.073	0.912	0.0834	0.879	1.9	0.066	0.269	0.403	N
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	Tc-99	0.159	0.227	0.134	0.223	0.147	25.1	NA	3.552	5.321	NA
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	Th-232	0.882	0.106	0.972	0.113	0.927	2.0	0.090	0.283	0.424	N
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	U-234[1]	0.955	N/A	1.338	N/A	1.146	195.4	0.384	27.649	41.425	N
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	U-235	0.0487	0.243	0.0717	0.229	0.060	51.6	NA	7.301	10.939	NA
L05-04-22-T-E-S-00	L05-04-22-T-E-Q-00	U-238	0.705	0.799	0.619	0.794	0.662	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 — Reviewed by: Clark Evers

Date: 3-16-17 — Date: 3/16/17

Quality Record

Figure 45-5
Form HDP-PR-FSS-703-1 Field Duplicate Sample Assessment LSA 05-04 (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 05-04				Survey Unit Description:		Survey Unit in "Barns Area - Area 16"					
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)
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	Ra-226	0.909	0.0596	0.909	0.0905	0.909	1.9	0	0.269	0.403	N
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	Tc-99	0.0725	0.234	0.0878	0.0905	0.080	25.1	NA	3.552	5.321	NA
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	Th-232	1.03	0.0922	0.574	0.225	0.802	2.0	0.456	0.283	0.424	Y
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	U-234[1]	2.743	N/A	2.243	N/A	2.493	195.4	0.499	27.649	41.425	N
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	U-235	0.15	0.228	0.113	0.269	0.132	51.6	NA	7.301	10.939	NA
L05-04-02-T-R-S-00	L05-04-02-T-R-Q-00	U-238	0.894	0.775	1.81	1.05	1.352	168.8	0.916	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: 3-16-17

Reviewed by: Clark Evers

Date: 3/16/17

Quality Record

45.3 Tc-99 Hot Spot Assessment LSA 05-04

During site characterization studies a total of 11 samples were collected and analyzed for Tc-99 in LSA 05-04. One of these 1 samples exceeded a Uniform SOF result of 1.0 prior to remediation, with a Tc-99 result of 22.3 pCi/g prior to remediation. No samples exceeded the Tc-99 DCGL during FSS. Within LSA 05-04, the maximum sample identified during FSS was 9.62 pCi/g – well below the 25.1 pCi/g limit for the Uniform DCGL, therefore no Tc-99 hot spot assessment is necessary for LSA 05-04.

46.0 ALARA EVALUATION LSA 05-04

All samples collected within LSA 05-04 were evaluated against the Uniform Stratum $DCGL_w$. For LSA 05-04 no sample result exceeded a SOF of 1.0. The average SOF result, based on all systematically collected samples, was 0.11 for LSA 05-04. The average SOF equates to residual activity contributions from the SU of 2.75 mrem/yr. Reuse Stockpile 8b soil was placed into LSA 05-04 therefore 4.25 mrem/yr will be added to the LSA 05-04 total dose summation to account for the reuse soil dose contribution. A portion of piping SU STM-6 remains in LSA 05-04 therefore 0.5 mrem/yr will be added to the LSA 05-04 total dose summation to account for the remaining subterranean piping dose contribution. The groundwater monitoring well data provided in FSSFR Volume 6, Chapters 2 through 5 indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, a maximum groundwater contribution assumption of 4.0 mrem/yr based upon the EPA MCLs will be added to the total estimated dose for LSA 05-04. Summing all of the dose contributions together, the total estimated dose for LSA 05-04 is 11.5 mrem/yr.

Since the estimated Total Effective Dose Equivalent is well below the regulatory release criterion of 25 mrem/yr, the conclusion of the ALARA evaluation is that the remediation of LSA 05-04 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing further remediation of LSA 05-04.

47.0 FSS PLAN DEVIATIONS LSA 05-04

47.1 Remedial Actions during FSS

There were no remedial actions after FSS in LSA 05-04.

47.2 Adjustments to Scan MDC Calculations

Scan MDCs for LSA 05-04 were calculated in accordance with HDP-PR-FSS-701, Revision 9, *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 10,000 cpm was applied to determine the prospective Scan MDCs, and the actual mean count rate from the FSS survey was 9,001 cpm. Therefore the calculated Scan MDCs are appropriate, and no adjustments need to be made.

48.0 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.

48.1 Data Quality Assessment for LSA 05-04

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 05-04 (see Figure 48-1) 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 (see section 38.2.7).
- The FSS Plan for LSA 05-04 specified that surface, root, and excavation samples would be collected across the systematic grid, based on the projected final grade of the SU after all backfill operations have been completed. Subsequent to the sampling event HDP Engineering adjusted the final grade configuration for site restoration. As such the final backfill elevation in LSA 05-04 was approximately 6 to 8 inches higher than originally planned. The additional amount of backfill added to the contour of the SU resulted in there being 5 systematic samples collected within the SU surface instead of the 7 prescribed by the FSS Plan. To avoid confusion the COC for the laboratory analysis the sample IDs were not changed to reflect the change in stratum in which the sample was taken. During the validation and assessment process the actual depths of the soil samples in relation to final grade are used for the purposes of determining where each FSS sample was collected within the SU.

- LSA 05-04 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 05-04, 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 05-04, 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 F.
- The maximum SOF result for all surface samples within LSA 05-04 was 0.45. The maximum SOF result for all subsurface sample within LSA 05-04 was 0.13. The average SOF result for all systematically collected samples within LSA 05-04 was 0.11, with an upper 95% confidence level (UCL_{mean} 0.95) of 0.17.
- No FSS sample result in LSA 05-04 exceeded a SOF of 1.0 as compared to the Uniform Stratum criteria, therefore an EMC or supplemental investigations was not required. For the same reason, no comparisons to the alternate "Three-Layer" multi-CSM (i.e. Surface, Root and Excavation) DCGLs were necessary.
- A retrospective sampling frequency evaluation was performed to determine if sufficient statistical power exists to reject the null hypothesis based on the total number (8) of systematic sample locations actually collected within LSA 05-04. The successful result of the retrospective power evaluation presented in Table 48-1 for LSA 05-04 indicates that the minimum number of sample locations required (8) for the WRS Test was equal to the number of sampling locations actually collected within LSA 05-04. 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.
- HDP staff ensured that a visual inspection of the SU configuration and of the Isolation & Control measures for LSA 05-04 was completed prior to the commencement of backfill operations. Additionally a pre-backfill confirmatory GWS was performed within the 72 hours prior to backfill of the SU.

Table 48-1
Retrospective Sample Size Verification for LSA 05-04

Uniform DCGL Criteria Evaluation	
N/2 Value Verification	
Isotope(s)	**SOF (Ra/Tc/Th/Iso U)**
St. Dev.	0.11
$DCGL_{SOF}$	1
LBGR (Mean)	0.11
Shift	0.89
Relative Shift (Δ/σ)	7.93
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 48-1
Data Evaluation Checklists prepared for LSA 05-04 (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 05 **Description:** Technetium-99 Soils Open Land Area
Survey Unit: 04 **Description:** Survey Unit in "Barns Area-Area16"

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 QC sample result for Th-232 exceeded the calculated Control Limit, however the results were reviewed by the RSO and the FSS QC results are still considered acceptable. This review is documented in the FSS Report.

Quality Record

Figure 48-1
Data Evaluation Checklists prepared for LSA 10-8 (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 05 **Description:** Technetium-99 Soils Open Land Area
Survey Unit: No. 04 **Description:** Survey Unit in "Barns Area-Area16"

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] (Signature) 3-16-17 (Date)

Approved by (RSO): Clark Evers (Print Name) [signature] (Signature) 3/16/17 (Date)

Quality Record

49.0 SURVEILLENCE FOLLOWING FSS

FSS activities in LSA 05-04 were completed on April 27,2016. Between the completion of FSS and the commencement of backfill operations there were no events that had a potential to re-contaminate LSA 05-04. The assessment that there were no events that had a potential to re-contaminate LSA 05-04 was confirmed by the Pre-backfill GWS that was completed for LSA 05-04 prior to the commencement of backfill operations.

50.0 CONCLUSION LSA 05-04

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 05-04 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

Table 50-1
LSA 05-04 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	BURIED PIPING	REUSE SOIL	**TOTAL**
SOF	0.11	N/A	0.16	0.02	0.17	**0.44**
DOSE	2.75 mrem/year	N/A	4.0 mrem/year	0.5 mrem/year	4.25 mrem/year	**11.5 mrem/year**

51.0 REFERENCES

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

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

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

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

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

51.7 Combustion Engineering, Letter to U.S. Nuclear Regulatory Commission dated April 7, 1989, *Spent Limestone Results*

52.0 APPENDICES (To Be Provided On Separate Data Disc)

APPENDIX A: Analytical Data Evaluation Spreadsheets for LSA 05-01

APPENDIX B: Analytical Data Evaluation Spreadsheets for BSA 05-01

APPENDIX C: Analytical Data Evaluation Spreadsheets for LSA 05-02

APPENDIX D: Analytical Data Evaluation Spreadsheets for BSA 05-02

APPENDIX E: Analytical Data Evaluation Spreadsheets for LSA 05-03

APPENDIX F: Analytical Data Evaluation Spreadsheets for LSA 05-04

APPENDIX G: FSS Plan Development for LSA 05-01

APPENDIX H: FSS Plan Development for LSA 05-02

APPENDIX I: FSS Plan Development for LSA 05-03

APPENDIX J: FSS Plan Development for LSA 05-04

APPENDIX K: TestAmerica Laboratory Analytical Data Reports for LSA 05-01

APPENDIX L: TestAmerica Laboratory Analytical Data Reports for LSA 05-02

APPENDIX M: TestAmerica Laboratory Analytical Data Reports for LSA 05-03

APPENDIX N: TestAmerica Laboratory Analytical Data Reports for LSA 05-04

APPENDIX O: Manual Slope Surveys of LSA 05-01

APPENDIX P: BSA 05-01 Survey Documentation

APPENDIX Q: BSA 05-02 Survey Documentation

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

Attachment 2

Revision Matrix for FSSFR Volume 3, Chapter 16, Revision 1

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

REVISION MATRIX FOR FSSFR VOLUME 3, CHAPTER 16, REVISION 1
Survey Area Release Record for Land Survey Area 05, Survey Units 01, 02, 03 and 04

The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to clarification and additional information on the methodology utilized in performance of the Elevated Measurement Comparison for survey unit LSA 05-01. This revision addresses the feedback from the NRC.
This revision also provides an opportunity to update the reports in regards to correcting minor editorial error, spelling errors and nomenclature to make them consistent with subsequent survey area release records which were submitted after the submittal of FSSFR Volume 3, Chapter 16, Revision 0.

SECTION	REVISION	REASON
4.0 Table 4-2	Changed "$DCGL_W$" to "$DCGL_{SO}$".	Corrected minor editorial error.
6.3.1	Added text.	The NRC provided feedback during recurring weekly publicly noticed teleconferences in regards to clarification and additional information on the methodology utilized in performance of the Elevated Measurement Comparison for survey unit LSA 05-01. The additional text provides clarification and additional information regarding the EMC Investigation.
7.3	Added text.	Additional information supporting revision to section 6.3.1.
8.0	Revised values.	Incorrect values (conservatively high) for the EMC determination were previously reported in the ALARA Evaluation Section. These values were corrected to reflect he actual dose determination for the EMC Evaluation.
Table 13-1 and Table 28-1	Revised "mrem" to mrem/year".	Corrected minor editorial error.
Table 19-1	Revised values.	See Section 8.0 response above. Note: This revision reduces the total survey unit does for LSA 05-01 as reported in FSSFR Volume 7, Chapter 1, Final Status Survey Final Report.

REVISION MATRIX FOR FSSFR VOLUME 3, CHAPTER 16, REVISION 1
Survey Area Release Record for Land Survey Area 05, Survey Units 01, 02, 03 and 04

SECTION	REVISION	REASON
Appendix A	LSA 05-01 spreadsheets	Three minor corrections were made: 1) In the 'Ingrowth Data Eval' tab the weighted Uniform SOF calculation was corrected, the previous reported value of 0.14 SOF (conservative) was corrected to 0.13 SOF, the appropriate value. 2) In the 'Step 8.6 Investigation' tab, an average SU Tc-99 concentration of 0.0 was used (conservative), the NRC provided feedback that this was unnecessary, and the Tc-99 concentration was updated to reflect the actual SU average concentration of 1.453 pCi/g. 3) In the 'AF Interpolation Step 8.6.7b' tab, area factor size was updated to reflect the actual estimated size of 87 m^2, however this correction did not result in a change to the reported EMC value of 0.11 SOF.

Attachment 3

Final Status Survey Final Report Volume 3, Chapter 16, Revision 1

Revised Pages of FSSFR Volume 3, Chapter 16, Revision 1
In Track Change

Westinghouse Electric Company LLC, Hematite Decommissioning Project

Docket No. 070-00036

4.0 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 05-01, LSA 05-02, LSA 05-03 and LSA 05-04. 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.

As the release criteria for all BSA SUs is common, FSSFR Volume 4, Chapter 1, Section 3.0, *Release Criteria*, provides a detailed discussion on the release criteria that is applicable to BSA 05-01 and BSA 05-02. Table 4-2 provides the applicable DCGLs.

Table 4-2
Building and Structural Surfaces Gross Radioactivity $DCGL_w$ for Small Office

Radionuclide	$DCGL_w$ (dpm/100 cm^2)	Radioactivity Fractions Based on Characterization Data [a]
U-234	20,000	8.27E-01
U-235 + D	19,000	3.72E-02
U-238 + D	21,000	1.27E-01
Tc-99	13,000,000	2.83E-03
Th-232 + C	1,200	3.21E-03
Np-237 + D	2,700	5.57E-05
Pu-239/240	3,500	2.03E-06
Am-241	3,400	2.68E-03
Totals:		**1.0**
Gross Activity $DCGL_{SO}$ (dpm/100 cm^2) [b] :		**18,925**

[a] Values are taken from Table 4-1 of DP Chapter 4.
[b] Calculated using Equation 4-4 of MARSSIM and rounded down (truncated) to two significant figures.

were selected within the SU, 24 samples in total. These biased samples were based on the evaluation of the GWS survey, or based on the judgment of the Radiological Engineering department.

Due to the proximity of LSA 05-01 to the public roadway State Highway P, and due to the MoDOT restrictions on excavation near the active roadway, a significant number of biased samples were collected within the right of way of the roadway, some collected horizontally into the slope of the roadway. These samples are intended to represent the soil that must be left in place so that the structural integrity of the roadway is not impacted.

It is important to note that during systematic sampling of LSA 05-01, an area of elevated Tc-99 activity was identified exceeding the $DCGL_w$. Additional biased samples were collected in this area, and two of these biased samples also exceeded the $DCGL_w$. An Elevated Measurement Comparison (EMC) investigation was performed on this area, and the successful results of the EMC are presented in the following Section 6.3.1.

6.3.1 EMC Investigation

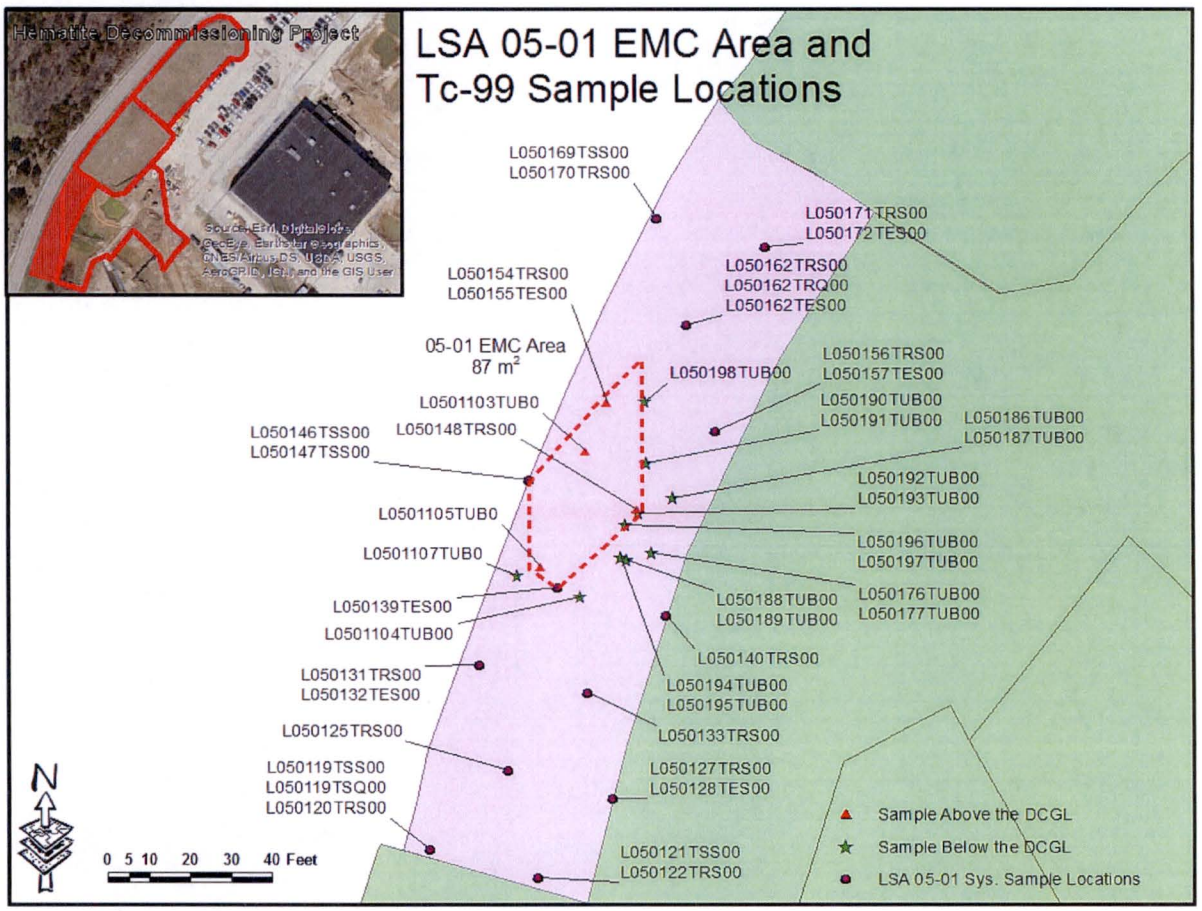
Since several systematic and biased samples from one area of LSA 05-01 exceeded a SOF of 1, an EMC Investigation was performed for the SU as required by Procedure HDP-PR-FSS-721 *Final Status Survey Data Evaluation*. As the elevated sample activity was due to Tc-99, GWS survey data was not used in determining the size or shape of the area. The size of the associated elevated area surrounding this biased location was determined by using the nearest "clean" systematic and biased locations, as well as professional judgment to define a polygonal area of 87 m^2 as calculated by GIS software. ~~As the elevated sample activity was due to Tc-99, GWS survey data was not used in determining the size or shape of the area.~~This 87 m^2 polygon was placed around the elevated biased sample locations to define the area where the elevated sample activity remains within the SU. To the East, South, and West of the EMC area, there were a significant number of "clean" samples, creating a clear boundary. However to the North of the EMC area, there was less available sample data which required the Health Physics Staff to rely on professional judgment. Since LSA 05-01 borders a public roadway (State Road P), and excavation into the "right of way" of the roadway was limited by the Missouri DOT, less excavation (and thus less sampling) was performed in this area. Three elevated samples were identified to remain in the Northern portion of the EMC area. While there is less available "clean" sample data creating a clear boundary to the North, the area in question is still relatively small. There is less than 15 feet in linear distance from each of the elevated samples, to the nearest "clean" sample. Given these factors, the Health Physics Staff placed the Northern EMC boundary so that the three elevated sample points were completely enclosed within the 87 m^2 polygon, and that the all systematic samples collected above the Northern most boundary of the EMC area were significantly less than the DCGLs.

Furthermore, the Health Physics Staff considered given the radiological conditions of the EMC area what the maximum size of the EMC are could be without exceeding a SF of 1.0 for the SU. Evaluations determined that the area of the EMC would have to exceed 500 m^2 in order for the EMC evaluation to be unsuccessful. Knowing that the allowable maximum area is significantly larger than the actual estimated area provides an additional layer of confidence, but the purpose of the EMC Investigation is to determine the actual radiological conditions that remain in the area, not the allowable maximum, therefore the 87 m^2 polygon is considered appropriate.

Following the steps presented in Section 8.6.7 of HDP-PR-FSS-721, the $DCGL_{EMC}$s for all nuclides were calculated based on the nuclide-specific area factors corresponding to 87 m^2. Then the difference between the average activity ~~of~~ for each nuclide in the elevated area, and the average activity of the corresponding nuclide in the general SU area was divided by the nuclide-specific $DCGL_{EMC}$ to determine an activity fraction for each nuclide in the elevated area. These six activity fractions were added together for a total SOF of 0.11 for the EMC area. This SOF is equivalent to a dose of 2.75 mrem/year. Additional information on the EMC calculation can be found in Appendix A.

Figure 6-2 depicts the location of the EMC area in LSA 05-01 as bounded by the dashed lines.

Figure 6-2
EMC Investigation Area within LSA 05-01



6.4 Judgmental/Sidewall Sampling for Tc-99

During the recommencement of FSS activities in early 2015, during a NRC Region III inspection, the NRC Inspector questioned the site staff in regards to the FSS program requirements for excavation side wall sampling. The NRC Inspector was specifically interested in sampling for Tc-99. The site staff reiterated the requirements as provided in the HDP DP Chapter 14.4.4.1.6.2, *Subsurface Soil*, and provided an explanation of how the requirements were

7.3 Tc-99 Hot Spot Assessment LSA 05-01

The highest observed Tc-99 sample result collected from LSA 05-01 was 101 pCi/g (a characterization sample). As this sample result exceeds the Uniform $DCGL_w$ (and an EMC investigation was performed in the SU), a Tc-99 hot spot assessment has been performed below.

The surface area covered by the SU is 1,781 m^2, and there were 16 systematic locations collected within the SU, resulting in 1 sample per 111.3 m^2. Using the table provided in Appendix E of HDP-PR-FSS-721 (Table 14-12 in Chapter 14 of the DP), and interpolating the area of 111.3 m^2 provides an Area Factor (AF) of 9.2 for Tc-99. The hypothetical $DCGL_{EMC}$ is then determined by multiplying the $DCGL_W$ by the AF, which results in a maximum $DCGL_{EMC}$ value of 230.9 pCi/g for Tc-99. Furthermore, using the hypothetical sample maximum sample result of 101 pCi/g, an AF of 4.0 would be required for the area to successfully pass an EMC investigation. An AF on 4.0 would require a minimum sample density of 1 sample per every 255 m^2 of the SU.

As the maximum observed value of 101 pCi/g is significantly less than the maximum allowable value (or 230.9 pCi/g of Tc-99), and that the actual sample density collected of 1 sample per 111.3 m^2 is much greater than the minimum sample density requirements (of 1 sample per 255 m^2), the Tc-99 hot spot assessment is considered successful since the evaluation determines that there is little chance of an unidentified Tc-99 "hotspot" within the SU based on this criteria.

8.0 ALARA EVALUATION LSA 05-01

In the case of LSA 05-01, one sample exceeded a SOF of 1 which triggered an EMC investigation. The outcome of the EMC investigation was successful in that compliance with the unity rule (<1) was achieved. The total dose contribution from the bounded EMC area in LSA 05-01 was ~~8~~2.75 mrem/yr - equivalent to a SOF of 0.~~35~~11. The EMC evaluation is discussed in greater detail in Section 6.3.1.

For LSA 05-01 the average SOF results based on all systematically collected samples was 0.~~14~~13. The remaining structure designated as BSA 05-01 (see Section 13.0) was evaluated to be 1% of the $DCGL_{SO}$, and therefore will contribute 0.25 mrem/year to the SU. Groundwater Monitoring Well data provided in FSSFR Volume 6, Chapters 2 and 3, indicate that the groundwater dose contribution will be a fraction of the MCLs. Nevertheless, assuming a maximum groundwater contribution of 4.0 mrem/yr based upon the U.S. Environmental Protection Agency (EPA) MCLs will be added to the total estimated doses for LSA 05-01. The sum of the average systematically collected samples (0.~~14~~13), the EMC (0.~~35~~11), the structure dose (0.01) and the maximum groundwater contribution (0.16) total to a 0.~~66~~42 Uniform SOF value for the SU, equivalent to ~~16~~10.5 mrem/yr.

Since the estimated Total Effective Dose Equivalent is below the regulatory release criterion of 25 mrem/yr, the conclusion of the As Low As Reasonably Achievable (ALARA) evaluation is that the remediation of LSA 05-01 was successful and that there would be no discernable benefit to the health and safety of the public in discounting the results of FSS and performing further remediation of LSA 05-01.

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm^2 (α+β)	Corrected Net dpm/100cm^2	Fraction of DCGL
B05-01-33-S-O-S-00	Foundation location #33	8/29/2013	alpha + beta TSC	250	247	3	27	27	0%
B05-01-34-S-O-S-00	Foundation location #34	8/29/2013	alpha + beta TSC	236	247	-11	-101	0	0%
B05-01-35-S-O-S-00	Foundation location #35	8/29/2013	alpha + beta TSC	266	247	19	174	174	1%
B05-01-36-S-O-S-00	Foundation location #36	8/29/2013	alpha + beta TSC	258	247	11	101	101	1%
B05-01-37-S-O-S-00	Foundation location #37	8/29/2013	alpha + beta TSC	230	247	-17	-155	0	0%
B05-01-38-S-O-S-00	Foundation location #38	8/29/2013	alpha + beta TSC	253	247	6	55	55	0%
B05-01-39-S-O-S-00	Foundation location #39	8/29/2013	alpha + beta TSC	266	247	19	174	174	1%
B05-01-40-S-O-S-00	Foundation location #40	8/29/2013	alpha + beta TSC	243	247	-4	-37	0	0%
B05-01-41-S-O-S-00	Foundation location #41	8/29/2013	alpha + beta TSC	263	247	16	146	146	1%
B05-01-42-S-O-S-00	Foundation location #42	8/29/2013	alpha + beta TSC	383	247	136	1243	1243	7%
B05-01-43-S-O-S-00	Foundation location #43	8/29/2013	alpha + beta TSC	290	247	43	393	393	2%
B05-01-44-S-O-S-00	Foundation location #44	8/29/2013	alpha + beta TSC	296	247	49	448	448	2%
B05-01-45-S-O-S-00	Foundation location #45	8/29/2013	alpha + beta TSC	283	247	36	329	329	2%
B05-01-46-S-O-S-00	Foundation location #46	8/29/2013	alpha + beta TSC	309	247	62	567	567	3%
B05-01-47-S-O-S-00	Foundation location #47	8/29/2013	alpha + beta TSC	271	247	24	219	219	1%
B05-01-48-S-O-S-00	Foundation location #48	8/29/2013	alpha + beta TSC	261	247	14	128	128	1%
B05-01-49-S-O-S-00	Foundation location #49	8/29/2013	alpha + beta TSC	267	247	20	183	183	1%
B05-01-50-S-O-S-00	Foundation location #50	8/29/2013	alpha + beta TSC	271	247	24	219	219	1%
B05-01-51-S-O-S-00	Foundation location #51	8/29/2013	alpha + beta TSC	266	247	19	174	174	1%
B05-01-52-S-O-S-00	Foundation location #52	8/29/2013	alpha + beta TSC	262	247	15	137	137	1%
B05-01-53-S-O-S-00	Foundation location #53	8/29/2013	alpha + beta TSC	300	247	53	485	485	3%
B05-01-54-S-O-S-00	Foundation location #54	8/29/2013	alpha + beta TSC	309	247	62	567	567	3%
B05-01-55-S-O-S-00	Foundation location #55	8/29/2013	alpha + beta TSC	294	247	47	430	430	2%
B05-01-56-S-O-S-00	Foundation location #56	8/29/2013	alpha + beta TSC	302	247	55	503	503	3%
B05-01-57-S-O-B-00	Biased location measurements #1	8/29/2013	alpha + beta TSC	495	247	248	2267	2267	12%
B05-01-58-S-O-B-00	Biased location post sample measurement	8/29/2013	alpha + beta TSC	278	247	31	283	283	1%
							Min	0	1%
							Max	2267	
							Mean	308	$DCGL_{SO}$
							Median	219	0.25
							Stdev	357.0	
									mrem/year

*NOTE: Differences from documented survey results are due to rounding in Excel

17.0 CONCLUSION BSA 05-01

An adequate quantity and quality of radiological surveys and measurements has been performed, evaluated and documented to demonstrate that the dose associated with the structures designated as BSA 05-01 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

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Table 17-1
BSA 05-01 $DCGL_{SO}$ and Dose Summation

AVE. SU RESIDUAL RADIOACTIVITY	
$DCGL_{SO}$	**1%**
Dose	**0.25 mrem/year**

18.0 DOSE CONTRIBUTION OF BSA 05-01 TO THE LSA SURVEY UNIT

The 0.25 mrem/year dose contribution determined for the structure designated as BSA 05-01 will be added to the total dose determination for SU LSA 05-01.

19.0 CONCLUSION LSA 05-01

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 05-01 does not to exceed the dose criterion for unrestricted release in accordance with 10 CFR 20.1402.

Table 19-1
LSA 05-01 SOF and Dose Summation

	AVE. SU SOIL RADIOACTIVITY	ELEVATED AREA CONTRIBUTION	GROUND WATER	STRUCTURES	REUSE SOIL	**TOTAL**
SOF	0.~~14~~13	0.~~35~~11	0.16	0.01	N/A	**0.~~66~~41**
DOSE	3.25 mrem/year	~~8~~2.75 mrem/year	4.0 mrem/year	0.25 mrem/year	N/A	**~~16~~10.25 mrem/year**

MEASUREMENT ID	MEASUREMENT LOCATION	DATE MEAS	MEASUREMENT	GROSS cpm (α+β)	BKG cpm (a+b)	Net cpm (α + β)	Combined Net dpm/100 cm^2 (α+β)	Corrected Net dpm/100cm^2	Fraction of DCGL
B05-02-28-S-O-S-00	Footer Section 28	8/14/2013	alpha + beta TSC	281	250	31	283	283	1%
B05-02-29-S-O-S-00	Footer Section 29	8/14/2013	alpha + beta TSC	271	250	21	192	192	1%
B05-02-30-S-O-S-00	Footer Section 30	8/14/2013	alpha + beta TSC	272	250	22	201	201	1%
B05-02-31-S-O-S-00	Ramp Footer Section 1	8/14/2013	alpha + beta TSC	468	354	114	1140	1140	6%
B05-02-32-S-O-S-00	Ramp Footer Section 2	8/14/2013	alpha + beta TSC	430	354	76	760	760	4%
B05-02-33-S-O-S-00	Ramp Footer Section 3	8/14/2013	alpha + beta TSC	352	354	-2	-20	0	0%
B05-02-34-S-O-S-00	Ramp Footer Section 4	8/14/2013	alpha + beta TSC	370	354	16	160	160	1%
B05-02-35-S-O-S-00	Ramp Footer Section 5	8/14/2013	alpha + beta TSC	386	354	32	320	320	2%
B05-02-36-S-O-S-00	Ramp Footer Section 6	8/14/2013	alpha + beta TSC	391	354	37	370	370	2%
B05-02-37-S-O-S-00	Ramp Footer Section 7	8/14/2013	alpha + beta TSC	445	354	91	910	910	5%
B05-02-38-S-O-S-00	Drain Basin Section 1	8/14/2013	alpha + beta TSC	387	354	33	330	330	2%
B05-02-39-S-O-S-00	Drain Basin Section 2	8/14/2013	alpha + beta TSC	390	354	36	360	360	2%
B05-02-40-S-O-S-00	Drain Basin Section 3	8/14/2013	alpha + beta TSC	350	354	-4	-40	0	0%
B05-02-41-S-O-S-00	Drain Basin Section 4	8/14/2013	alpha + beta TSC	372	354	18	180	180	1%
B05-02-42-S-O-S-00	Drain Basin Section 5	8/14/2013	alpha + beta TSC	354	354	0	0	0	0%
B05-02-43-S-O-S-00	Small Junction Box	8/14/2013	alpha + beta TSC	359	379	-20	-200	0	0%
B05-02-44-S-O-S-00	Metal Storm Drain Pipe Ext 1	8/14/2013	alpha + beta TSC	403	354	49	490	490	3%
B05-02-45-S-O-S-00	Metal Storm Drain Pipe Ext 2	8/14/2013	alpha + beta TSC	400	354	46	460	460	2%
B05-02-46-S-O-S-00	Metal Storm Drain Pipe Ext 3	8/14/2013	alpha + beta TSC	424	354	70	700	700	4%
B05-02-47-S-O-S-00	Metal Storm Drain Pipe Ext 4	8/14/2013	alpha + beta TSC	384	354	30	300	300	2%
B05-02-48-S-O-S-00	Metal Storm Drain Pipe Int.	8/14/2013	alpha + beta TSC	400	354	46	460	460	2%

Min	0	3%
Max	1280	
Mean	488	DCGL$_{SO}$
Median	365	0.75
Stdev	419.3	mrem/year

*NOTE: Differences from documented survey results are due to rounding in Excel