U.S. Department of Energy

West Valley Demonstration Project

Phase 1 Final Status Survey Plan for the West Valley Demonstration Project

Revision 1

May 2011

Prepared by

Argonne National Laboratory

Environmental Science Division

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West Valley Demonstration Project

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Prepared for the
U.S. Department of Energy
West Valley Demonstration Project
West Valley, New York

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ACRONYMS, ABBREVIATIONS, UNITS OF MEASURE, AND SYMBOLS

Am	americium
C	carbon
CG	cleanup goal
cm	centimeter(s)
Cm	curium
Cs	cesium
CSAP	characterization sampling and analysis plan
CSM	conceptual site model
DCGL	(radionuclide-specific) derived concentration guideline level
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQCR	daily quality control report
DQI	data quality indicator
DQO	data quality objective
emc (subscript)	radionuclide-specific activity concentration that must be met over area smaller than individual survey unit
FIDLER	field instrument for detection of low-energy radiation
FSS	final status survey
FSSP	final status survey plan
FSSR	final status survey report
ft	foot (feet)
g	gram(s)
GWS	gamma walkover survey
I	iodine
IDW	investigation-derived waste
LBGR	lower bound of the gray region
m	meter(s)
m^2	square meter(s)
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MDC	minimum detectable concentration
mrem	millirem
NaI	sodium iodide
NCR	nonconformance report
NIST	National Institute of Standards and Technology
Np	neptunium
NRC	U.S. Nuclear Regulatory Commission
pCi	picocurie(s)

Phase 1 DP	*Phase 1 Decommissioning Plan for the West Valley Demonstration Project* (Revision 2, December 2009)
PPE	personal protective equipment
Pu	plutonium
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
Ra	radium
RCRA	Resource Conservation and Recovery Act
ROI	radionuclide of interest
RQC	radiological quality control
SOR	sum of ratios
Sr	strontium
Tc	technetium
Th	thorium
U	uranium
W (subscript)	radionuclide-specific activity concentrations that must be met, on average, for each individual survey unit
WMA	waste management area
WRS	Wilcoxon Rank Sum
WVDP	West Valley Demonstration Project
yd^3	cubic yard(s)
yr	year(s)

RECORD OF SIGNIFICANT REVISIONS

Date	Section	Revision	Reason
10/31/2010	Throughout document	Removed references to composite sampling and revised the text to include only discrete samples	Per DOE request
10/31/2010	Throughout document	Redefined surface soil sampling intervals as 0–15 cm and 15–100 cm	To improve understanding of vertical distribution of contamination
10/31/2010	Throughout document	Calculated 0–1 m surface soil activity concentrations by using 0- to 15-cm and 15- to 100-cm soil sample results rather than by measuring them directly	To improve understanding of vertical distribution of contamination
10/31/2010	Throughout document	Removed references to Class 3 units	No Class 3 units are expected as part of the Phase 1 FSS process
10/31/2010	Section 2.2, first sentence	Modified sentence to clarify the basis for DCGL derivation	Per New York State Energy Research and Development Authority (NYSERDA) comment
10/31/2010	Tables 1, 2, and 3	Added footnote to indicate that Sr-90 and Cs-137 CG values will be decay-corrected when applied for FSS purposes	Per NYSERDA comment
10//31/2010	Section 7.2	Added requirements for removing radionuclides from the FSS list for specific areas	Per NYSERDA and NRC comments
10/31/2010	Section 4.3 and 4.4	Added text to clarify the use of CSAP GWS and biased sampling results for FSS purposes	Per NYSERDA comment
10/31/2010	Section 5.3	Added paragraph to address concerns about the possibility of contamination in the top 1 m of soil whose presence is masked from GWS by a thin layer of clean cover	Per NYSERDA comment
10/31/2010	Section 5.3	Added paragraph added to discuss how detector responses will be normalized	Per NYSERDA comment
10/31/2010	Section 5.5.1	Added paragraph to discuss FSS RQC applicability to CSAP data intended for FSS use	Per NYSERDA comment
10/31/2010	Table 1	Corrected streambed DCGLemc values to match Phase 1 DP Revision 2 values	Per NRC comment

Date	Section	Revision	Reason
10/31/2010	Throughout document	Replaced references to “near surface” soils by text specifying the soil horizon referenced	Per NRC comment
10/31/2010	Section 7.2	Added text specifying that 10% of FSS samples from a given area will be selected at random and submitted for analysis of all 18 radionuclides	Per NRC comment
03/11/2011	Various Locations	Added text clarifying that the DCGLw SOR requirement will be adjusted to reflect radionuclides that are dropped from FSS consideration because of minimal contributions to the overall dose present at the site	Per NRC comment
05/20/2011	Sections 2.3 and 7.2	Text added clarifying that additional radionuclides may be added to the FSS process for specific areas if the CSAP data collection activities identify one or more of the 12 potential radionuclides of interest as being present above background levels and of concern.	Per NYSERDA comment

EXECUTIVE SUMMARY

This plan provides the technical basis and associated protocols to support Phase 1 final status survey (FSS) data collection and interpretation as part of the West Valley Demonstration Project Phase 1 Decommissioning Plan process. This plan is consistent with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM).

The Phase 1 Decommissioning Plan provides the relevant derived concentration guideline levels (DCGLs) for the Phase 1 radionuclides of interest. This plan includes protocols that will be applied to the deep excavations planned for Waste Management Area (WMA) 1 and WMA 2, for surface soils outside the WMA 1 and WMA 2 excavations that do not have contamination impacts at depths greater than one meter, and for areas that are used for Phase 1 contaminated soil lay-down purposes. All excavated and lay-down areas will be classified as MARSSIM Class 1 areas. Surface soils that have not been excavated, are not expected to exceed DCGLs, and do not have contamination impacts at depths greater than one meter will be divided into either Class 1 or Class 2 areas depending on the expected potential for surface soil contamination in those areas.

The plan uses gamma scans combined with biased soil samples to address $DCGL_{emc}$ concerns. The plan uses systematic soil sampling combined with area factors to address $DCGL_w$ and $DCGL_{emc}$ concerns. The Sign test will be used to statistically evaluate $DCGL_w$ compliance. If the results from the characterization sampling and analysis plan (CSAP) data collection indicate that background may be a significant issue for Sign test implementation, the Wilcoxon rank sum (WRS) test will be used instead to demonstrate $DCGL_w$ compliance. A reference area will be selected on the basis of CSAP data results if the WRS test becomes a necessity.

The WMA 1 excavation footprint includes approximately 476 foundation pilings that will be trimmed and left in place. Piling-specific systematic and biased sampling will be conducted to address concerns that these pilings may have served as preferential flow pathways into the underlying Lavery till.

Phase 1 FSS data collection results will be summarized, presented, and interpreted in one or more FSS reports.

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1.0 INTRODUCTION AND PURPOSE

The *Phase 1 Decommissioning Plan for the West Valley Demonstration Project,* Revision 2 (Phase 1 DP; see DOE 2009) describes the Phase 1 decommissioning activities proposed for the West Valley Demonstration Project (WVDP) premises. These activities will at least partially address residual radionuclide contamination concerns in environmental media (soils, sediments, and groundwater). The Phase 1 DP includes unrestricted release derived concentration guideline levels (DCGLs) for the identified radionuclides of interest (ROIs) pertinent to the environmental media to be addressed by Phase 1 activities.

This final status survey plan (FSSP) describes the decision-making process and data requirements necessary for Phase 1 final status survey (FSS) purposes. The contents of this plan supplement and expand upon contents of the Phase 1 DP Section 9 and Appendix G. The information contained in this plan is consistent with the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NUREG-1575 and DOE/EH-412/0020/0403; see DOE 2000 and NRC 2000) and NUREG-1757 (NRC 2006). All field activities conducted as part of FSSP activities will be conducted consistent with the Health and Safety Plan described by the Phase 1 DP.

The objective of the Phase 1 decommissioning activities is to remove certain facilities and remediate specific portions of the WVDP premises to criteria for unrestricted release consistent with the license termination rule in the *Code of Federal Regulations* at 10 CFR 20.1402 in a manner that will not limit future Phase 2 decommissioning options. The Phase 1 DP activities are intended to reduce short- and long-term health and safety risks in a manner that will ultimately support the Phase 2 decommissioning activities required to complete decontamination and decommissioning of the project premises.

As part of Phase 1 decommissioning activities, data will be collected to demonstrate that upon completion of the Waste Management Area (WMA) 1 and 2 excavations, the excavation floors meet the appropriate DCGL requirements. In addition, the U.S. Department of Energy (DOE) may also choose to collect data to demonstrate that surface soils for other portions of the WVDP project premises also meet the Phase 1 DCGL requirements (DP Revision 2, Table 5-14) for those areas where contamination is not present at depths greater than one meter (1 m). Examples of these areas include the following: (1) soils exposed by hardstand, pad, or foundation removal that are believed to be below DCGL requirements; (2) soils with surface contamination above DCGL goals that DOE chooses to remediate; or (3) other soils where there is no evidence of contamination above DCGL requirements. The Phase 1 DP includes DCGL requirements for stream sediments. Stream sediments are not expected to be included in Phase 1 FSS activities. If addressing stream sediments becomes advantageous, this plan will be revised as appropriate.

2.0 FINAL STATUS SURVEY DESIGN BASIS

As required by the Phase 1 DP, the Phase 1 FSSP is consistent with MARSSIM (NUREG-1575, Revision 1, August 2000). There are aspects of the WVDP premises (e.g., buried subsurface soil contamination) that are beyond MARSSIM's scope. In those instances, the proposed closure protocols will be consistent with the intent of MARSSIM.

2.1 WVDP Premises and Proposed Phase I Activities

The WVDP premises consist of approximately 167 acres. The major features of the premises include existing facilities and associated above ground and buried infrastructure, disposal areas, active and inactive waste lagoons, roads, hardstands and paved parking lots, a railway spur, streams that drain the area, and open land. The project premises were used for commercial spent-fuel reprocessing in the 1960s and early 1970s. Reprocessing activities resulted in environmental releases of radionuclides to surrounding soils, surface water, and groundwater.

To address known historical releases and other areas of interest, the Phase 1 DP activities include the following planned environmental remediation activities: (1) a deep (30- to 45-foot [ft]), extensive (3-acre) excavation of contaminated soils adjacent to and beneath the Main Plant Process Building (i.e., WMA 1); (2) a deep (up to 14 ft), extensive (4-acre) excavation of contaminated soils adjacent to and beneath facilities and lagoons associated with the Low-Level Waste Treatment Facility (i.e., WMA 2); and (3) excavation of contaminated and uncontaminated soils down to approximately 2 ft below grade that are associated with selective building and infrastructure removal in WMA 1, WMA 2, WMA 3, WMA 5, WMA 6, WMA 7, WMA 9, and WMA 10. In addition to these planned excavations, DOE may also choose to remove additional surface contaminated soils and/or sediments as part of Phase 1 decommissioning work. Upon completion of the Phase 1 DP activities, any residual contamination within the WVDP premises that results in a dose exceedance concern will be addressed by Phase 2 decommissioning activities.

Figure 1 provides a map of the project premises identifying the footprints of the WMAs. Figure 2 is an oblique aerial photograph of the project premises from the west to the east showing the existing buildings and the layout of the proposed WMA 1 and WMA 2 excavations.

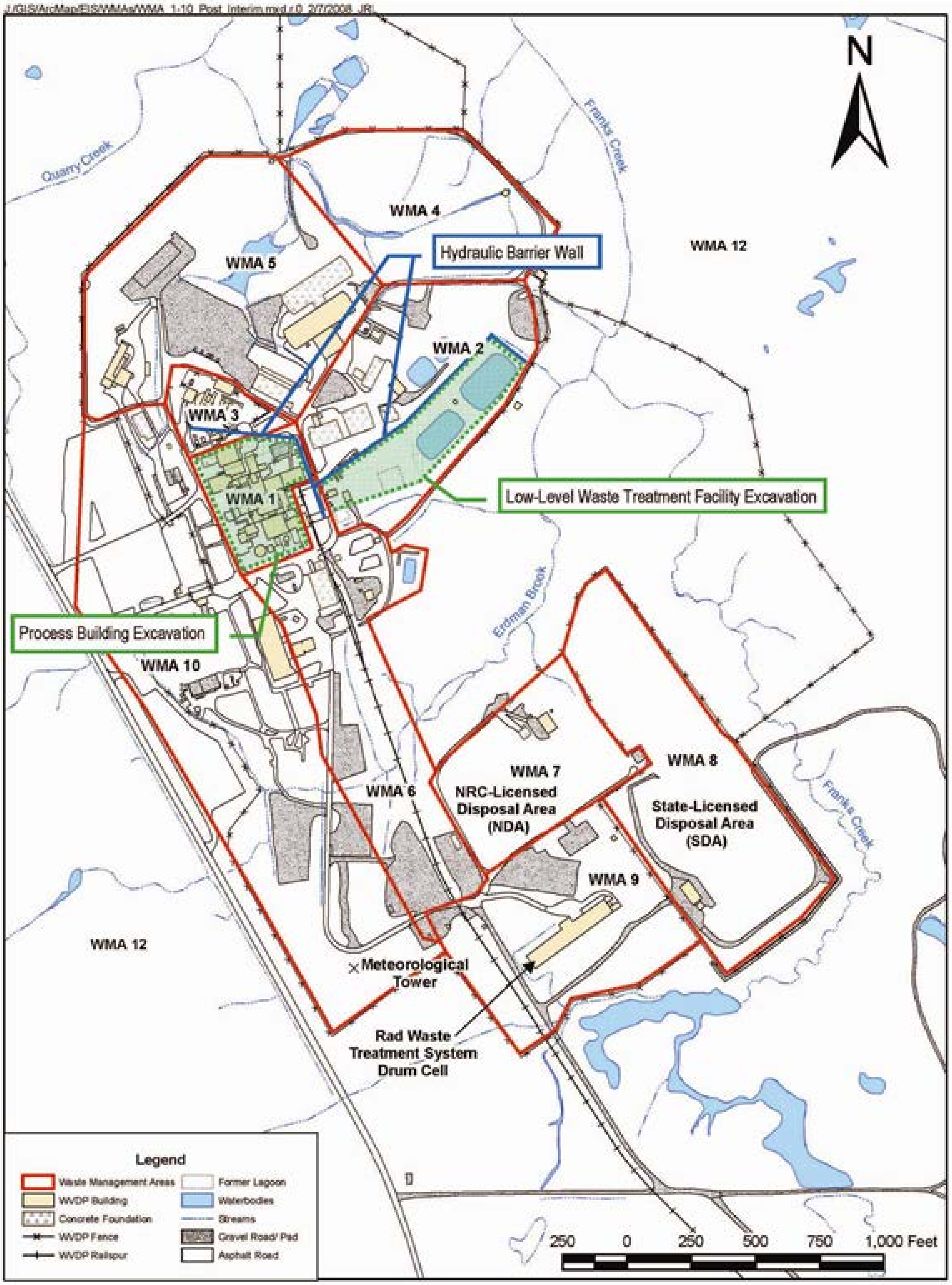

Figure 1 WVDP Waste Management Areas

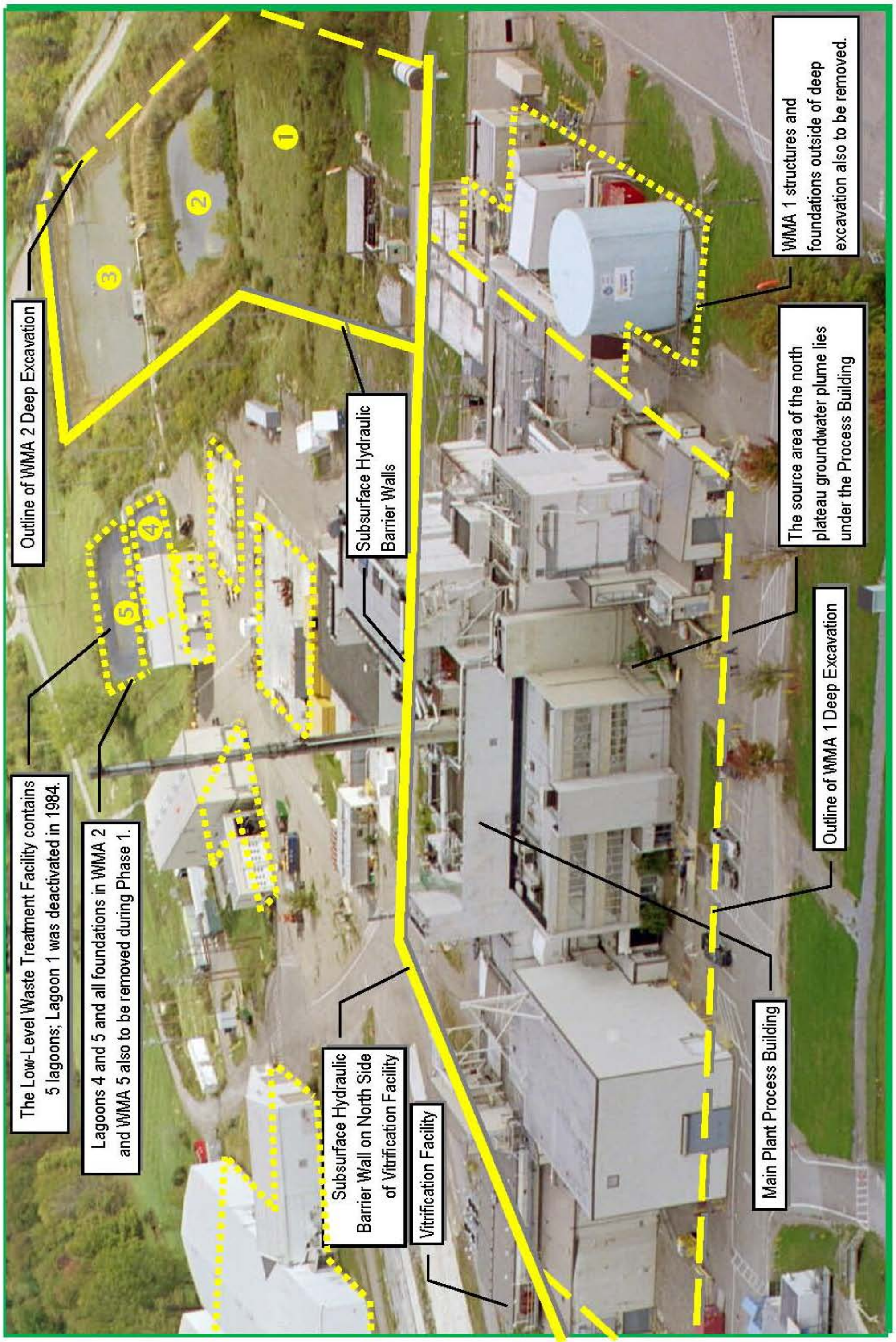

Figure 2 Oblique Aerial Photograph of WMA 1 and WMA 2

2.2 Derived Concentration Guideline Level Requirements

The Phase 1 DP identified 18 ROIs for the project premises, and DCGL values for each of the ROIs were developed to meet the unrestricted release criteria of 25 millirem per year (mrem/yr) in 10 CFR 20.1402. The DCGL requirements included a $DCGL_w$ value to be applied as an area-averaged goal to FSS units and $DCGL_{emc}$ values applicable to areas of 100 square meters (m^2) and 1 m^2. The Phase 1 DP also provides area factors that can be used to calculate additional $DCGL_{emc}$ requirements for areas smaller than FSS units. In addition, the Phase 1 DP distinguishes between DCGL values for surface soils (defined as soils to a depth of 1 m), subsurface soils (defined as soils at a depth greater than one meter that would be temporarily exposed by proposed Phase 1 excavation activities in WMA 1 and WMA 2), and streambed sediments.

These DCGL values were further refined to reflect cumulative dose concerns, resulting in a final set of DCGL values listed in Table 5-14 of the Phase 1 DP. Table 5-14 refers to these as cleanup goals (CGs). The CGs are more conservative than the DCGL requirements since they account for the possibility of cumulative dose. To be consistent with the Phase 1 DP terminology, from this point forward, the term "cleanup goals" or CGs will be used to refer to the requirements that must be met. Specifically, the term CG_w refers to radionuclide-specific activity concentrations that must be met, on average, for each individual survey unit, and the term CG_{emc} refers to radionuclide-specific activity concentrations that must be met over areas smaller than individual survey units. Table 5-14 of the Phase 1 DP is reproduced as Table 1 in the FSSP.

2.3 Key Assumptions

The FSSP includes several key assumptions discussed below.

- *Consultation with U.S. Nuclear Regulatory Commission (NRC) on the Phase 1 DP.* DOE consulted with NRC on the Phase 1 DP and made changes in Revision 2 to address NRC's related requests for information. This FSSP is based on the DCGLs and CGs as defined in Revision 2 to the Phase 1 DP. Any changes in these DCGL/GC values or definitions may require revisions to this FSSP.

Table 1 Phase 1 Cleanup Goals (picocuries per gram [pCi/g]) (Source: WVDP Phase 1 Decommissioning Plan, Revision 2, Table 5-14)

Nuclide	Surface Soil		Subsurface Soil		Streambed Sediment	
	CG_w[1]	CG_{emc}[2]	CG_w	CG_{emc}	CG_w	CG_{emc}
Am-241	2.6E+01	3.9E+03	2.8E+03	1.2E+04	1.0E+03	2.1E+04
C-14	1.5E+01	1.6E+06	4.5E+02	8.0E+04	1.8E+02	5.9E+05
Cm-243	3.1E+01	7.5E+02	5.0E+02	4.0E+03	3.1E+02	2.8E+03
Cm-244	5.8E+01	1.2E+04	9.9E+03	4.5E+04	3.8E+03	3.6E+05
Cs-137[3]	1.4E+01	3.0E+02	1.4E+02	1.7E+03	1.0E+02	9.4E+02
I-129	2.9E-01	6.0E+02	3.4E+00	3.4E+02	7.9E+01	2.0E+04
Np-237	2.3E-01	7.5E+01	4.5E-01	4.3E+01	3.2E+01	1.1E+03
Pu-238	3.6E+01	7.6E+03	5.9E+03	2.8E+04	1.2E+03	1.7E+05
Pu-239	2.3E+01	6.9E+03	1.4E+03	2.6E+04	1.2E+03	1.7E+05
Pu-240	2.4E+01	6.9E+03	1.5E+03	2.6E+04	1.2E+03	1.7E+05
Pu-241	1.0E+03	1.3E+05	1.1E+05	6.8E+05	3.4E+04	7.5E+05
Sr-90[3]	3.7E+00	7.9E+03	1.3E+02	7.3E+03	4.7E+02	7.1E+04
Tc-99	1.9E+01	2.6E+04	2.7E+02	1.5E+04	6.6E+04	4.2E+06
U-232	1.4E+00	5.9E+01	3.3E+01	4.2E+02	2.2E+01	2.1E+02
U-233	7.5E+00	8.0E+03	8.6E+01	9.4E+03	2.2E+03	4.4E+04
U-234	7.6E+00	1.6E+04	9.0E+01	9.4E+03	2.2E+03	2.1E+05
U-235	3.1E+00	6.1E+02	9.5E+01	3.3E+03	2.3E+02	2.0E+03
U-238	8.9E+00	2.9E+03	9.5E+01	9.9E+03	8.2E+02	8.2E+03

Notes:
(1) CG_w refers to activity concentrations that must be achieved, on average, over areas the size of FSS units.
(2) CG_{emc} refers to activity concentrations that must be achieved, on average, over 1-m^2 areas.
(3) CG requirements provided in this table for Cs-137 and Sr-90 assume one half-life of decay will occur before the possible release of the site in 2041. As part of the FSS process, these values will be decay-corrected reflecting the date of the data collection to ensure that the desired dose standard is achieved.

- *CG Definitions*. The Phase 1 DP provides CG definitions for the 18 ROIs. In the case of surface soil CGs, the assumed vertical interval is 1 m in depth. The planned Phase 1 soil and stream sediment characterization work within the project premises described in the characterization sample and analysis plan (CSAP) may identify project premise characteristics that are inconsistent with the conceptual site model (CSM) used for CG derivation (e.g., surface contamination restricted to the top few centimeters of the soil surface, subsurface contamination covered by several centimeters of clean overburden soil, or contaminated soils extending to a depth greater than 1 m). To address this potential issue: (1) surface soil CG standards and the FSS process will only be applied outside the WMA 1 and WMA 2 excavations when contamination impacts are less than 1 m in depth; (2) surface soil CG standards will be applied to the top 15 cm of soil and to the top 1-m soil interval as part of the FSS process; and (3) the presence of thin, highly elevated zones overlain by clean surface soils will be evaluated by the CSAP data collection. In the last instance, if contaminated layers that result in potential dose concerns are encountered within the top 1 m of soil by CSAP data collection that would not have been identified by the proposed FSS data collection, then the FSS process will be modified to meet the specific needs of those areas.

- *Lower Bound of the Gray Region (LBGR).* MARSSIM's LBGR is defined as the bottom of a range of values where the consequences of making a decision error are relatively minor. In practice, it corresponds to the average residual activity concentration that will be present when FSS data collection activities begin. For areas that do not require remediation, the LBGR is the existing average level of contamination present. For areas requiring remediation, the LBGR is the cleanup level targeted by the remediation program. By definition, the LBGR represents activity concentrations that are below the required CG standards. In combination with the Type II error rate and expected sample variability, the LBGR is an important determinant of the number of systematic samples required to demonstrate compliance with the CG_w.
- *Data Gaps*. There are key data gaps that will be addressed as part of the pre-design characterization work called for by the Phase 1 DP and described in the CSAP. One example of these is the presence and spatial prevalence of the 18 ROIs identified in the Phase 1 DP. A second example is the presence and importance of radionuclides other than the 18 identified by the Phase 1 DP. While the prospect is unlikely, this FSSP may need to be revised if conditions encountered during CSAP characterization work are determined to be significantly different from the Phase 1 DP assumptions and CSM.
- *Chemical Contamination*. Chemical contamination may exist for portions of the project premises. Chemical contamination concerns will be addressed in compliance with the Resource Conservation and Recovery Act (RCRA), and are not directly within the scope of the Phase 1 FSSP. Soil sampling to fulfill RCRA closure requirements for facilities closed during Phase 1 decommissioning will be identified in the appropriate RCRA closure plans for these waste management areas.
- *Scope of Phase 1 FSSP Data Collection*. As part of Phase 1 decommissioning activities, data will be collected to demonstrate that the floors and walls of the WMA 1 and 2 excavations meet the appropriate CG requirements. In addition, the DOE may also choose to collect data to demonstrate that surface soils for other portions of the WVDP premises also meet the Phase 1 CG requirements for those situations where contamination is not present at depths greater than 1 m in depth. Examples of these areas include (1) soils exposed by hardstand, pad, or foundation removal that are believed to be below CG requirements; (2) soils with surface contamination

above CG goals that DOE chooses to remediate; and/or (3) other soils where there is no evidence of contamination above CG requirements.

- *Sign Test Applicability*. Because all 18 ROIs identified in the Phase 1 DP are either not naturally occurring or have CG_w requirements that are an order of magnitude or more above background levels, the Sign test is considered appropriate for demonstrating compliance with wide-area CG (CG_w) requirements. In the event that CG values are lowered, it may be necessary to establish a background reference area and use the Wilcoxon rank sum (WRS) instead of the Sign test to demonstrate compliance with the CG_w requirements. To address that possibility, this plan includes a reference area that can be used for background sampling, as necessary.
- *CG_{emc} Applicability*. The CG_{emc}, as derived by the Phase 1 DP is radionuclide-specific and applies to 100-m^2 and 1-m^2 areas. Gross gamma surveys will be used for demonstrating compliance with the CG_{emc} criteria where appropriate. In addition, appropriate CG_{emc} values will be calculated that correspond to the area represented by systematic samples collected to demonstrate CG_w compliance by using area factors provided by the Phase 1 DP (see Tables 9.1 and 9.2 in the Phase 1 DP). The latter is intended to address the ROIs that are not detectable by gamma scans and that may exist in isolation for specific portions of the project premises (e.g., the floor of the WMA 1 excavation where strontium-90 [Sr-90] may be the principal radionuclide of interest).
- *ROI List*. The Phase I DP identified 18 ROIs for the project premises. Because historical processes and contaminant release scenarios vary from location to location across the project premises, not all 18 ROIs may be pertinent to specific areas. The assumption is that CSAP data collection may be used to determine which of the 18 ROIs are pertinent to specific areas within the project premises. If the CSAP data results indicate that only a subset of the ROI are pertinent for specific areas, then the FSS sample analyses for those individual areas may be limited to the smaller set of relevant ROI. In this instance, the CG_w SOR requirement will be reduced to reflect the average dose contribution of the dropped radionuclides if one or more of those radionuclides existed at measurable levels. In addition to the 18 radionuclides identified by the Phase 1 DP, an additional 12 radionuclides have been identified that potentially are of interest. One of the goals of the CSAP data collection effort is to determine whether any of these 12 radionuclides should be added to the list of 18. In the event that one or more of the 12 radionuclides of potential interest are confirmed to be present at levels above background and are a concern for a specific area of the site, those radionuclides will be included in the FSS process for that area.
- *Use of Sum of Ratio (SOR) Calculations*. Because of the multiple ROI, all FSS determinations will be based on sample SOR calculations. The SOR calculation for any particular sample will be based on the subset of radionuclides pertinent to the FSS unit that was the source of the sample.

In general, the SOR CG_w requirement is unity; however if radionuclides are observed at measurable levels but are dropped from the FSSP process for a specific area because of their inconsequential contribution to dose, the SOR requirement will be reduced to reflect the average dose contribution of the dropped radionuclides. Sections 7.2 and 7.3 of the FSSP along with Section 6.1 of the CSAP provide additional detail on what is considered an inconsequential dose

- *Subsurface Soil Contamination*. The Phase 1 FSS process is not applicable to areas outside the WMA 1 and 2 excavations where subsurface soil contamination greater than 1 m in depth exists.
- *Null Hypothesis and Acceptable Error Rates*. For the Sign test, the null hypothesis will be that FSS units are contaminated above CG_w levels based on sample SOR values. In this context, the acceptable Type I error rate (i.e., rejecting the null hypothesis when it should have been accepted) will be 0.05. The Type II error rate (i.e., accepting the null hypothesis when it should have been rejected) will be set based on an engineering cost analysis that weighs the potential for false contaminated conclusions with the costs of FSS data collection. The Type I error rate establishes the minimum number of systematic samples required for Sign test implementation. In the case of an error rate of 0.05, the minimum number is five samples per survey unit; FSS units, however, will likely require more systematic samples than this minimum number to meet Type II error rate needs.
- The minimum number of systematic samples per survey unit is determined by the desired Type I and II error rates, the degree of heterogeneity expected within survey units, the confidence desired to identify elevated areas, and the expected average residual activity concentration and the statistical test to be used. The determination makes use of standard MARSSIM concepts, equations, and tables. For Class 1 units, a minimum of one sample per 100 m^2 will be collected.
- *Surrogate Methods*. It is unlikely that a surrogate ROI can be found that would be applicable across the WVDP premises. CSAP data collection is expected to confirm that this is the case. If Phase 1 CSAP data collection indicates surrogates would be useful in the FSS process, then the Phase 1 FSSP would be revised to reflect the use of surrogates and would include appropriate quality assurance requirements.
- *Analytical Methods*. The Phase 1 DP ROI list includes 18 radionuclides with, in some cases, relatively low CG_w requirements. The 18 radionuclides span a range of required analytical techniques, including gamma spectroscopy, alpha spectroscopy, liquid scintillation, and gas proportional counting. Later sections in this plan specify the analytical performance requirements for each radionuclide. In some cases (e.g., gamma spectroscopy and liquid scintillation), a field-based laboratory may prove advantageous, particularly for those radionuclides that will likely be the primary decision drivers (e.g., cesium-137 [Cs-137] and Sr-90). Whether data from field-

deployable techniques can be used for FSS compliance demonstration will depend on whether FSS data quality standards can be achieved and documented. There may be cases where a particular field-deployable technique may not have sufficient data quality for FSS purposes, but where the technique still serves an important and useful role, either as a screening tool for identifying an elevated area of concern or as part of pre-FSS/remedial action support survey collection to determine that an area is ready for FSS data collection.

- *Use of CSAP Data for FSS Purposes*. The CSAP has been developed so that data generated by the CSAP, when appropriate, meet the data quality objectives (DQOs) specified by this FSSP. The intent is that data associated with the CSAP, if collected consistent with FSSP protocols and data quality standards, can potentially be used for FSS purposes if contamination levels requiring remediation are not identified.

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3.0 DATA QUALITY OBJECTIVES

The DQOs for the WVDP Phase 1 FSS process are provided below to establish a systematic procedure for defining the criteria that must be met by the data collection design. The DQO process includes a description of when to collect samples, where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect. The DQO process has the following seven steps, listed below (EPA 2006):

1. State the problem.
2. Identify the goals of the study.
3. Identify information inputs.
4. Define the boundaries of the study.
5. Develop the analytic approach.
6. Specify performance or acceptance criteria.
7. Develop the plan for obtaining data.

The DQO process is described in the following sections as it applies to WVDP Phase 1 FSS data collection.

3.1 State the Problem

This FSSP will be used to determine whether radionuclide activity concentrations in surface and subsurface soils at the WVDP premises for selected areas comply with CGs as described by the Phase 1 DP and shown in Table 1. The CGs for the WVDP premises are derived from dose goals; they were developed to limit the annual dose to less than 25 mrem/yr. The CG_w refers to a wide area average requirement that must be met for areas the size of an FSS unit. The CG_{emc} refers to an elevated measurement comparison requirement that addresses more localized elevated areas that may exceed the CG_w at specific locations but not when averaged over a survey unit. The CGs were developed so that post-remediation residual activity concentrations are consistent with the dose goals derived for the project premises. As discussed in the Phase 1 DP, CGs were derived for surface soils (defined as the upper 1 m) and for deep subsurface soils that will be exposed by the WMA 1 and WMA 2 excavations. While the Phase 1 DP also includes derived stream sediment CGs, there will be no FSS data collection in Franks Creek or Erdman Brook as part of the Phase 1 activities.

Compliance with the CGs will be demonstrated by using guidance found in MARSSIM (DOE 2000). Specifically, compliance will be demonstrated by performing gamma surface scans and collecting systematic (i.e., samples associated with a grid) and biased (i.e., samples targeting specific areas of concern) soil samples consistent with MARSSIM guidance.

3.2 Identify the Goals of the Study

The goal of the Phase 1 FSSP and associated FSS data collection is to establish that, for selected areas of the WVDP premises, Phase 1 DP CGs (Table 1) have been met.

3.3 Identify Information Inputs

The following information will be gathered and used as the basis for FSS decision-making:

- Historical information pertaining to area-specific land use and contamination releases (historical aerial photography analysis, anecdotal information, etc.).
- Results from planned CSAP field work, which will include gamma walkover data, intrusive subsurface soil sampling data, and surface soil sampling data.
- Results from remedial action support survey collection for those areas where excavation takes place as part of Phase 1 decommissioning activities. Remedial action support survey collection will include gamma walkover surveys (GWSs) and soil sampling results.
- FSS data collection, which will include gamma surveys of exposed surfaces and biased soil sampling that target locations of particular contamination concern as well as systematic surface soil sampling.

Historical, CSAP, and remedial action support survey collection will be used primarily to confirm the appropriate FSS unit classification designation for specific areas of interest. FSS data collection will be used to address FSS decision-making. CSAP data (e.g., remedial action support survey collection) may be used for FSS decision-making if the CSAP data are collected in a manner consistent with FSS protocols and data quality requirements.

3.4 Define the Boundaries of the Study

Phase 1 FSSP activities will address selected portions of the WVDP premises. These will include the excavation floors and soils sloping up to the walls of the WMA 1 and WMA 2 excavations. They may include surface soils outside of the WMA 1 and WMA 2 excavations exposed by Phase 1 removal activities (e.g., hardstand or foundation removals) and other surface soils that likely meet Phase 1 DP CG requirements. Outside of the WMA 1 and WMA 2 excavations, the Phase 1 FSSP activities will address surface soils areas at DOE discretion. Alternatively, DOE may postpone FSS data collection for these surface areas until Phase 2 decommissioning activities.

The Phase 1 FSSP is **not** applicable to any areas outside the WMA 1 and WMA 2 excavations where there is evidence of contamination impacts above background conditions at depths exceeding 1 m. The exception to this rule are areas to be used for contaminated soil lay-down during Phase 1 activities; after removal of those soils, the lay-down areas will undergo Phase 1 FSS data collection to document their contamination status regardless of whether subsurface soil contamination is known to be present.

The exact footprint of Phase 1 FSSP activities will primarily depend on the results of CSAP data collection, Phase 1 soil excavations, and DOE's planning processes. Definitive Phase 1 FSS unit footprints will be established prior to the initiation of Phase 1 FSS data collection. All areas within the Phase 1 FSSP footprint will be associated with an FSS unit.

FSS data collection within FSS units applies to exposed soils to a depth of 1 m.

3.5 Develop the Analytical Approach

The analytical methods to be employed for soil analyses, along with required detection limits, are described in detail in Section 6. Where advantageous, an on-site laboratory may be used for some radionuclides during the FSS process if the data quality standards achieve those prescribed by Section 6. An on-site laboratory may prove particularly useful for Cs-137 and Sr-90, since these two radionuclides are expected to be of primary concern from a FSS perspective. These are the two radionuclides that have been consistently identified in historical soil sample analyses. The assumption that these are the two radionculides of primary concern will be tested by CSAP data collection.

An appropriate gross gamma detector or detectors will be used to perform surveys of exposed surfaces to evaluate the presence and spatial distribution of ROIs as part of the FSS process. Several of the ROIs are either not detectable by gamma surveys or are marginally detectable (i.e., detectable but at activity concentrations higher than CG requirements). To address lower-energy, marginally detectable radionuclides such as the various plutonium isotopes and americium-241 (^{241}Am), at a minimum, a field instrument for detecting low-energy radiation (FIDLER) or equivalent detector will be deployed. Expected minimum detectable activity concentrations for gamma scans are presented in greater detail in Section 6.

3.6 Specify Performance or Acceptance Criteria

Section 7 describes the decision-making process for FSS units in detail. Individual FSS units must comply with two distinct CG requirements, the CG_w and the CG_{emc}. In the case of the CG_w, an individual FSS unit will be considered in compliance if:

- The average SOR result for systematic soil samples obtained from the FSS unit is less than one (assuming the Sign test is to be used for statistical purposes), or the difference between the average SOR for the reference area and the average SOR for the FSS unit is less than one (assuming the WRS test is to be used for statistical purposes). In the case of areas where radionuclides were measurable based on CSAP results but dropped from the FSS process because of inconsequential contributions to dose, the SOR requirement will be reduced to reflect the average dose contributions of the dropped radionuclides.
- The systematic soil sample results from the FSS unit satisfy the appropriate statistical test at the appropriate confidence level. The Sign test will be used as the statistical test unless the CG requirements are modified such that a WRS test is required. The null hypothesis is that the unit is contaminated. The required Type I error rate is 0.05.

In the case of the CG_{emc}, an individual FSS unit will be considered in compliance if:

- GWS results do not indicate any anomalous areas that have not been addressed by biased sampling.
- Individual biased sample results are less than the CG_{emc}.
- Individual systematic sample results are less than the CG_{emc} as calculated by using area factors, with the area factor reflecting the area represented by each systematic sample. Area factors to be used in this adjustement are provided in Section 4.

3.7 Develop the Plan for Obtaining Data

Detailed plans for obtaining the required data are presented in Section 4 (general data collection activities) and Section 5 (field activities).

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4.0 DATA COLLECTION PLAN

This section describes the general FSS data collection activities that will take place to satisfy the DQO described in the previous section. Section 5 provides details about field implementation of this plan.

4.1 Classification of Survey Units

Before FSS data collection can take place, the area of interest must be divided into MARSSIM FSS units. MARSSIM defines three types of FSS units. Class 1 units include areas that required remediation and areas where historical data indicate CG exceedances likely existed prior to remediation. Class 1 units can range up to 2,000 m^2 in size. Class 2 units include areas that are impacted but are not expected to require remediation (i.e., no historical evidence that contamination would exceed CG activity concentrations). Class 2 units can range up to 10,000 m^2 in size. Class 3 units include areas where there is no historical evidence of significant impacts. There is no size limit to Class 3 areas.

Phase 1 FSS unit layout will occur after CSAP data collection (for those areas that will not require remediation) or after remediation is complete (for those areas where soil/foundation removal activities will take place). Phase 1 FSS units will include Class 1 units and may include Class 2, depending upon the results of CSAP data collection. No Class 3 units are anticipated as part of the Phase 1 FSS process.

Individual FSS units will define areas that are believed to be relatively homogenous in their physical characteristics and in their assumed contamination status.

Outside of the WMA 1 and WMA 2 excavations, only those areas likely to satisfy Phase 1 FSS requirements and where there is no evidence of soil contamination deeper than 1 m in depth will be candidates for Phase 1 FSS unit designation and subsequent FSS data collection. The exception to this rule are areas to be used for contaminated soil lay-down during Phase 1 activities; after removal of those soils, the lay-down areas will undergo Phase 1 FSS data collection to document their contamination status regardless of whether subsurface soil contamination is present.

4.2 Derived Concentration Guideline Levels

Table 1 provides CG_w and CG_{emc} standards for surface and subsurface soils. For the purposes of this plan, these CG values are the equivalent of MARSSIM DCGL values. The CG_{emc} values listed in Table 1 are applicable to 1-m^2 areas. In addition to these explicit standards, the Phase 1 DP also provides area factors for determining CG_{emc} equivalents for systematic or biased FSS samples representative of areas larger than 1 m^2. These area factors are provided in Tables 9.1 and 9.2 of the Phase 1 DP and are reproduced as Tables 2 and 3 in this plan. In the event that a FSS sample area does not correspond to a particular area presented in these tables, the area factor to be used would be a linear interpolation based on the data contained in these tables. The following subsections discuss the applicability of the CG standards.

4.2.1 Subsurface Soils

The subsurface soil CG standards are only applicable to the excavation floors and sides of the WMA 1 and WMA 2 excavations from the excavation bottom to a point 1 m below the ground surface. They will be applied to a 1-m-deep soil interval.

4.2.2 Surface Soils

The surface soil CG standards are only applicable when there is no evidence of contamination impacts extending beyond 1 m in depth. Although they were derived by assuming a 1-m deep contamination interval, they will be applied to both a 1-m-deep soil interval and to a 15-centimeter (cm)-deep soil interval. The latter addresses the possibility of a thin but highly elevated surface soil contamination layer that potentially poses a direct exposure concern but that would be diluted if only 1-m-deep soil samples were collected.

The objective of sampling two different depth intervals is to address the possibility of isolated contamination being present in the top few centimeters of soil that would result in a direct exposure dose concern that might not be identified in samples collected from a 1-m depth. The fundamental issue is that the primary exposure pathway for the different radionuclides of interest differs, but a 1-m surface soil depth interval was used across radionuclides for CG derivation. This use is appropriate for radionuclides where plant uptake and groundwater are the primary dose drivers, but not as appropriate for radionuclides where direct exposure is the principal concern.

Table 2 Area Factors for Surface Soils (Source: WVDP Phase 1 Decommissioning Plan, Revision 2, Table 9-1)

Nuclide	CG_w 10,000 m^2 (pCi/g)	Area Factors (CG_{emc}/CG_w)	
		100 m^2	1 m^2
Am-241	2.6E+01	1.5E+01	1.5E+02
C-14	1.5E+01	2.8E+02	1.1E+05
Cm-243	3.1E+01	3.0E+00	2.4E+01
Cm-244	5.8E+01	1.8E+01	2.1E+02
Cs-137(1)	1.4E+01	2.8E+00	2.2E+01
I-129	2.9E-01	3.8E+01	2.1E+03
Np-237	2.3E-01	6.0E+00	3.2E+02
Pu-238	3.6E+01	1.7E+01	2.1E+02
Pu-239	2.3E+01	2.5E+01	3.0E+02
Pu-240	2.4E+01	2.4E+01	2.9E+02
Pu-241	1.0E+03	1.3E+01	1.3E+02
Sr-90[1]	3.7E+00	2.6E+01	2.1E+03
Tc-99	1.9E+01	2.2E+01	1.4E+03
U-232	1.4E+00	5.4E+00	4.4E+01
U-233	7.5E+00	3.7E+01	1.1E+03
U-234	7.6E+00	4.1E+01	2.1E+03
U-235	3.1E+00	2.6E+01	1.9E+02
U-238	8.9E+00	2.9E+01	3.3E+02

(1) CG requirements provided in this table for Cs-137 and Sr-90 assume one half-life of decay will occur before the possible release of the site in 2041. As part of the FSS process, these values will be decay-corrected reflecting the date of the data collection to ensure that the desired dose standard is achieved.

Table 3 Area Factors for Subsurface Soils (Source: WVDP Phase 1 Decommissioning Plan, Revision 2, Table 9-2)

Nuclide	CG_W 2,000 m^2 (pCi/g)	Area Factors (CG_{emc}/CG_w)	
		92 m^2	1 m^2
Am-241	2.8E+03	1.1E+00	4.3E+00
C-14	4.5E+02	1.2E+01	1.8E+02
Cm-243	5.0E+02	3.2E+00	8.0E+00
Cm-244	9.9E+03	1.5E+00	4.5E+00
Cs-137(1)	1.4E+02	9.3E+00	1.2E+01
I-129	3.4E+00	4.7E+00	9.9E+01
Np-237	4.5E-01	4.2E+00	9.6E+01
Pu-238	5.9E+03	1.0E+00	4.8E+00
Pu-239	1.4E+03	1.6E+00	1.9E+01
Pu-240	1.5E+03	1.5E+00	1.7E+01
Pu-241	1.1E+05	2.3E+00	6.2E+00
Sr-90[1]	1.3E+02	2.6E+00	5.6E+01
Tc-99	2.7E+02	8.1E+00	5.7E+01
U-232	3.3E+01	2.1E+00	1.3E+01
U-233	8.6E+01	3.6E+00	1.1E+02
U-234	9.0E+01	3.6E+00	1.0E+02
U-235	9.5E+01	3.5E+00	3.5E+01
U-238	9.5E+01	3.6E+00	1.0E+02

(1) CG requirements provided in this table for Cs-137 and Sr-90 assume one half-life of decay will occur before the possible release of the site in 2041. As part of the FSS process, these values will be decay- corrected reflecting the date of the data collection to ensure that the desired dose standard is achieved.

In practice, for any surface soil sampling location, the two depth intervals to be sampled are the 0- to 15-cm interval and the 15- to 100-cm depth interval. The activity concentration over the complete 0- to 1-m interval will be calculated by using the results from these two intervals as a weighted average, where the weight corresponds to the interval mass. The reason for this approach is to provide information on the vertical location of contamination if it is encountered in the 0- to 1-m depth interval.

4.3 Role of Gamma Surveys

GWS data will be collected from all exposed soil surfaces as part of the FSS data collection process. GWS will be conducted with at least one detector suitable for detecting low-energy gamma-emitting radionuclides (e.g., a FIDLER). Field experience with the combined use of FIDLER and 2×2/3×3 sodium iodide (NaI) detectors at several other sites where both low-energy (e.g., uranium, plutonium, and americium) and high-energy (e.g., radium-226 [Ra-226], Ra-228, and thorium-232 [Th-232]) gamma-emitting radionuclides exist is that the FIDLER matches 2×2 NaI performance for higher-energy radionuclides and significantly exceeds performance for lower-energy radionuclides. The former is true because the FIDLER, while less sensitive to higher-energy gamma rays, is more sensitive to Compton scatter, and in a soil setting with radionuclide contamination extending into soil profiles, the contribution of Compton scatter to the overall gross activity observed is significant. The FIDLER also provides significant advantages when geometry is a potential issue (e.g., shine from excavation walls or buildings), since it is less sensitive to gamma ray sources that are not directly below the detector face. That experience is expected to be confirmed on the WVDP project premises by CSAP data collection activities. A FIDLER and a 2×2 NaI detector will be used for CSAP purposes for at least a portion of the project premises where Cs-137 is the principal concern. On the basis on these CSAP results, if a FIDLER cannot achieve sufficiently low detection limits for Cs-137 given its CG requirements, but a 2×2 NaI detector can, a 2×2 NaI detector or similar detector will be used for CSAP and FSS data collection in conjunction with a FIDLER.

GWS data will be electronically logged and matched with coordinate information. GWS will be conducted so that complete coverage is obtained for exposed soil surfaces within a FSS unit. Section 5 provides greater detail about FSS GWS requirements.

GWS data collection will be initiated as part of the CSAP data collection effort. CSAP GWS data collection will be performed consistent with FSS requirements so that the CSAP GWS data may be used for FSS purposes where appropriate (i.e., there was nothing undertaken in an area between CSAP GWS data collection and FSS activities that might have invalidated CSAP GWS results). CSAP GWS data collection may indicate field data collection realities/GWS performance that require the FSS protocols in this plan to be revisited. Potential examples include, but are not limited to, performance in streambeds and wetlands and performance where contamination is overlain by a thin layer of clean soil or other backfill material.

As part of the FSS process, GWSs serve three primary roles. They (1) establish that an area is ready for FSS soil sampling (i.e., no significant evidence of elevated gross activity that may indicate CG exceedances), (2) identify surface soil gross activity anomalies that might be indicative of CG_{emc} exceedances within FSS units, and (3) identify spatial trends in gross activity within or across FSS survey units that would assist in interpreting systematic soil sampling results if there are CG_w exceedances in systematic sampling results. Because of detection sensitivity limitations for some of the ROIs, the GWS may not be able to completely satisfy all three goals for all ROIs.

A surface soil background reference area (Section 4.7) will be established prior to the onset of FSS data collection. This background reference area will be surveyed to determine background responses of the instruments to be used for FSS GWS data collection. Gamma walkover data from the background reference area will be used to develop gross activity field investigation levels that indicate when a gamma walkover reading collected during the FSS process is not consistent with background conditions. This background area will also be used as a reference area for the WRS test if that statistical test is required to demonstrate CG_w compliance.

4.4 Role of Biased Samples

Biased samples will be collected to target specific locations where there is concern about potential CG_{emc} exceedances within FSS units. Biased sampling locations may be selected on the basis of a variety of factors, such as an elevated GWS result (either collected as part of CSAP activities or FSS activities), visual evidence of contamination, the presence of physical infrastructure that still exists within the FSS unit footprint, etc. Section 5 contains details about soil sampling protocols.

Biased samples collected in response to CSAP GWS results as part of the CSAP data collection effort will have been collected consistent with FSS requirements so that the data obtained can be used for FSS purposes, when appropriate.

For FSS units associated with the excavation floors and sloped soil surfaces of the WMA 1 and WMA 2 excavations, biased samples will represent a 1-m-deep soil interval, consistent with the subsurface CG derivation for this area. For FSS units associated with surface soils outside the WMA 1 and WMA 2 excavations for each location requiring biased sampling, two samples will be collected, one representing the 0- to 15-cm soil interval, and one representing the 15- to 100-cm soil interval.

Biased sampling will also be a key component of soil sampling along remaining foundation pilings locations in the WMA 1 and WMA 2 excavations to address the concern that those foundation pilings may have presented preferential contamination migration pathways deeper into the subsurface. The details of this are described in Section 5.

The analytical results from biased samples will be compared to the appropriate CG_{emc} standards. Section 6 contains details about analytical requirements. Typically, this standard will be the CG_{w} multiplied by the appropriate area factor contained in Tables 2 and 3 to reflect the area that the biased sample was intended to represent.

4.5 Role of Systematic Samples

FSS systematic samples will be used to evaluate compliance with CG_{w} requirements and to confirm that CG_{emc} exceedances are not an issue for the areas each systematic sample represents. Section 4.6 calculates the generic number of systematic sampling locations required for survey units; these numbers may be revised if area-specific conditions turn out to be significantly different than the assumptions used for the sample number calculations. Section 5 contains details about soil sampling protocols.

For FSS units associated with the floors of the WMA 1 and WMA 2 excavations, systematic samples will represent a 1-m-deep soil interval, consistent with the subsurface CG derivation for this area. For FSS units associated with surface soils outside the WMA 1 and WMA 2 excavations for each location requiring a systematic sample, two samples will be collected, one representing the 0- to 15-cm soil interval, and one representing the 15- to 100-cm deep soil interval.

Systematic sample analytical results will be compared first to CG_{emc} requirements, using the CG_{w} multiplied by the appropriate area factor contained in Tables 2 and 3. Section 6 contains details about analytical requirements. If there are no CG_{emc} exceedances, systematic sample analytical results will be used to evaluate CG_{w} compliance. Details of this analysis are contained in Section 7.

4.6 Sample Number Calculations

Because all CG_w requirements are either associated with radionuclides that are not naturally occurring or are an order of magnitude greater than background activity concentrations, the Sign test will be used to evaluate CG_w compliance. The following sample number derivation is based on the assumption that the Sign test will be used; if the CG_w values change significantly from those that are contained in the Phase 1 DP (Revision 2), (and, in particular, if they are closer to background conditions for naturally occurring radionuclides), the WRS test may be required. In that event, the following sample number calculations will be revisited. Also, the sample number calculations presented below are based on certain assumptions about the condition of exposed soils at the start of the FSS data collection process. If the conditions at the project premises that are encountered differ significantly from these assumptions, the appropriate number of systematic samples will need to be revisited.

The null hypothesis for the Sign test is that the FSS unit is not in compliance with the CG_w requirement. The required Type I error probability is 0.05 (i.e., deciding to continue to remediate when the FSS unit actually has met the CG_w requirements). On the basis of these assumptions, the minimum number of systematic sampling locations and associated analytical results is five (Table I.3, Appendix I, MARSSIM, 2000).

Depending on the FSS unit contamination conditions, use of five sampling locations is not likely to result in an acceptable Type II error probability (i.e., the probability of incorrectly determining a FSS unit does not meet CG_w requirements), nor does it address the potential issue of sample loss/sample set incompleteness. Table 5.5 of MARSSIM provides sample number estimates for different combinations of relative shift, Type I error rates, and Type II error rates. The sample numbers contained in Table 5.5 include 20% more than absolutely required to account for the possibility of incomplete sample sets.

The Type I error rate for the Phase 1 FSS process has been set to 0.05. The Type II error rate is an engineering decision that is a function of costs and DOE’s risk tolerance. In the case of the WMA 1 and 2 excavations, for example, DOE would likely require much lower Type II error rates, since the schedule and budget implications of a FSS unit failure are much greater in that instance than for surface soils elsewhere on the project premises. The relative shift is a function of the LBGR, the CG_w, and the variability one would expect to see in systematic sampling results. In the case of the WVDP Phase 1 FSS activities, the LBGR is the average SOR score that one would expect to see in a set of FSS systematic samples collected from a FSS unit.

If an LBGR SOR of 0.25, a CG_w SOR of 1.0, and an expected SOR standard deviation of 0.25 are assumed, the relative shift would be 3. From using Table 5.5, depending on the Type II error rate specified, sample numbers range between 8 and 20. Visual Sample Plan confirms these values (width of gray region = 0.75, action level = 1, and standard deviation = 0.25).

As a point of comparison, there are limited data currently available for subsurface soil samples collected from the Lavery till interface. Table C-4 of the Phase 1 DP provides the activity concentrations observed for these samples within the WMA 1 and WMA 2 excavation footprints. The radionuclide with values closest to subsurface CG requirements was Sr-90. In the case of WMA 1, there were 13 soil cores with observed results that ranged from less than 1 up to 450 pCi/g, with 11 of the 13 having activity concentrations less than 20 pCi/g and an average of approximately 43 pCi/g. In the case of WMA 2, there were seven soil cores with observed results that ranged from less than 1 up to 180 pCi/g and an average of approximately 30 pCi/g. These values are likely higher than what will be encountered because the majority of the samples were collected in 1993 with decay having taken place, because these samples typically straddled the till interface and so included portions of the more heavily contaminated soils above the till, and because the proposed excavations will progress some depth into the till (with the assumption that activity concentrations will decrease with depth into the till). The CG_w and CG_{emc} for Sr-90 (Phase 1 DP Table 5-14) are 130 pCi/g and 7,300 pCi/g, respectively. On the basis of the observed standard deviations, these would correspond to relative shifts of 0.7 for WMA 1 and 1.5 for WMA 2.

Pre-excavation CSAP data results will provide more definitive information about the actual LBGR and variability that can be expected in surface soils outside the WMA 1 and WMA 2 excavations. In addition, there will be a significant number of CSAP soil cores taken from within the WMA 1 and WMA 2 excavation footprints that will extend into the Lavery till and that will provide additional information on the contamination status of the top of the Lavery till. Likewise, CSAP remedial action support survey collection during the WMA 1 and WMA 2 excavations will also provide useful information about the contamination status of the excavation floors at the completion of those excavations. FSS systematic sample numbers will be established on the basis of those data sets and may vary from area to area to reflect the realities of the residual contamination levels in area.

The following provides an example of the calculation to be used to determine the appropriate Type II error rate and corresponding systematic sample requirements. The numbers provided are for illustration purposes only. Assume excavation, transportation, and disposal costs are \$1,000/cubic yard (yd^3) of soil in situ. Assume that the cost of collecting and analyzing one systematic FSS soil sample is $600. Assume that WMA 1 excavation yields an exposed excavated surface with residual contaminant concentrations equivalent to a relative shift of 1.0. MARSSIM Table 5.5 provides sample number requirements for the Sign test; for a Type 1 error rate of 0.05 and a relative shift of 1.0, sample numbers range from 15 for a Type II error rate of 0.25 and up to 41 for a Type II error rate of 0.01. Assume that if a Type II error occurs, one-fourth of the offending FSS unit would require excavation to a depth of 0.5 m, representing an in situ volume of 327 yd^3 at a cost of $327,000. The number of systematic samples should be selected to balance this potential cost; in other words, the cost of systematically sampling the unit should be equal to the expected cost associated with a Type II error.

The expected cost of a Type II error is the probability of an error occurring multiplied by the cost that would be incurred. In the case of a relative shift of 1.0 and the costs as described, the appropriate number of samples associated with a Type II error rate of 0.025 would be approximately 30 per survey unit. This analysis neglects the cost of maintaining an open excavation while awaiting FSS sampling results; this cost would be negligible for surface soils, but will likely be significant for the WMA 1 and WMA 2 excavations. The net effect would be to increase systematic sampling requirements per survey unit for the WMA 1 and 2 excavations, as compared to surface soil excavations elsewhere on the project premises.

This analysis is driven, in part, by the relative shift. Higher relative shifts result in lower FSS systematic sampling requirements. In the case of the WMA 1 and 2 excavations, a higher relative shift can be achieved by excavating or scraping additional till material to lower the final average residual activity concentrations remaining in the exposed excavated soil surface. In the example provided above, a relative shift of 2.0 would reduce the number of required samples to approximately 18 per survey unit. This reduction in FSS sample numbers would be at the expense of additional till excavation prior to FSS data collection.

CSAP remedial action support survey data will provide information regarding the contamination status of excavated surfaces (e.g., average activity concentration and the degree of variability in sample results likely present). DOE will use this information along with cost data to determine the appropriate Type II error rate and associated systematic sampling numbers. For Class 1 units, a minimum of one sample per 100 m^2 will be collected, which would correspond to 20 samples for a Class 1 unit that is 2,000 m^2 in size.

4.7 Reference Area

A 2,000-m^2 reference area will be identified and finalized prior to the initiation of FSS data collection activities. Final selection of the reference area will be based on CSAP data collection results. The reference area will be chosen such that there is no measurable evidence of impacts from historical Nuclear Fuel Services (NFS) or WVDP activities in order to distinguish site radioactivity from natural background.

The reference area will potentially serve multiple purposes. It will be used to generate background data sets for gross gamma activity detectors deployed in support of FSS data collection. These data sets, in turn, will be used to derive detector-specific field investigation levels that can be used to identify FSS results inconsistent with background conditions. As a contingency, it may also be used to generate surface soil samples to be used as part of a WRS test evaluation during FSS data analysis if that statistical test turns out to be necessary. However, at this time, the Sign test is expected to be adequate for the Phase 1 FSS closure process. In the event that a WRS test becomes necessary, soil sample collection from the reference area will be consistent with the sampling protocols proposed for the Phase 1 FSS units. Because the subsurface CG_w values are more than an order of magnitude above background, the WRS test will not be necessary for the WMA 1 and 2 excavation footprints; hence, a reference area is not required for these areas. Background detector responses for subsurface soils will be developed when excavations expose subsurface soils at depths that appear to be unimpacted.

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5.0 FIELD ACTIVITIES

The Phase 1 FSS field activities follow the same general approach for every FSS unit and include the following: (1) initially collecting FSS GWS data; (2) verifying that the GWS data do not identify gross activity levels that would be of potential concern from a FSS perspective; (3) performing biased sampling as necessary with evaluation of biased samples by on-site laboratory analysis or quick-turnaround off-site laboratory analysis (gamma spectroscopy and Sr-90 liquid scintillation) to determine if elevated area concerns (i.e., CG_{emc}) exist that require additional remediation; and (4) systematic sampling with off-site laboratory analyses to support CG_w evaluations. An on-site laboratory may be used for systematic sampling analyses if that laboratory can produce data of a quality equivalent to those obtained by off-site laboratory analyses.

Besides these general activities, in the case of WMA 1, excavation footprint sampling targeting soils adjacent to remaining pilings will take place. A detailed description of field activities, organized by survey unit type, is provided in the subsections below.

5.1 Class 1 Soil Survey Units

All areas undergoing excavation to remove contamination that have historical data indicating CG exceedances or where historical information indicates there is a chance of encountering contamination above CG levels will be classified as Class 1 FSS areas and divided, as appropriate, into Class 1 FSS units. Consistent with MARSSIM, these units will not exceed 2,000 m^2 in size.

5.1.1 WMA 1 Excavation Footprint

Figure 3 shows conceptual cross sections of the planned WMA 1 excavation. Cross section A-A’ provides a west-to-east profile view of the proposed excavation. Cross section B-B’ provides a north-to-south profile view of the proposed excavation. The eastern portion of the excavation – the floor of the excavation – will extend to the slurry wall. In the northern, southern, and western portion of the excavation, the excavation will be sloped at an expected 45 degree angle up to land surface.

Figure 4 shows a conceptual layout of Class 1 survey units for the footprint of the WMA 1 excavation. Actual Class 1 survey unit boundaries will be defined when excavation is complete and the excavation

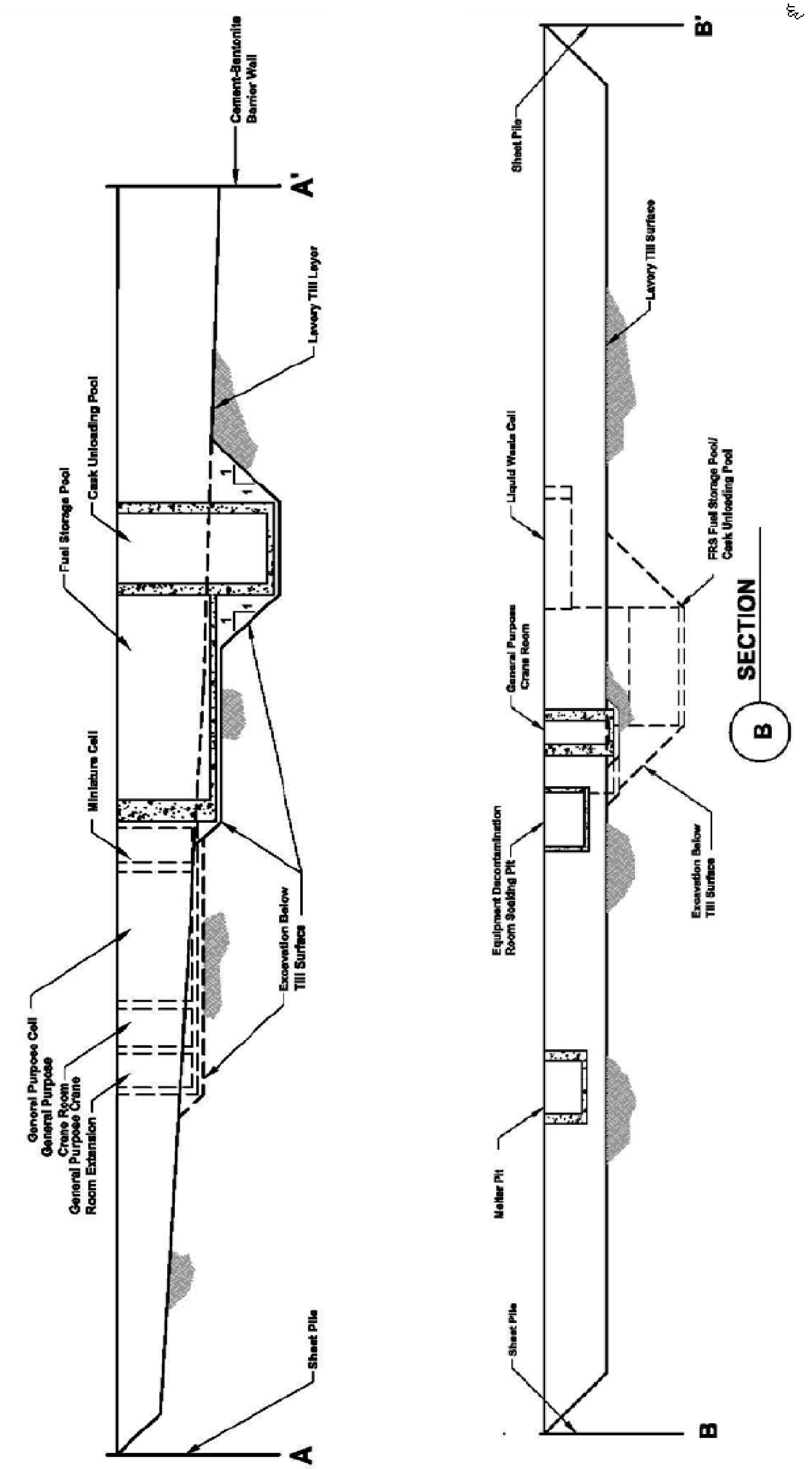

Figure 3 Conceptual Cross Sections of WMA 1 Excavation

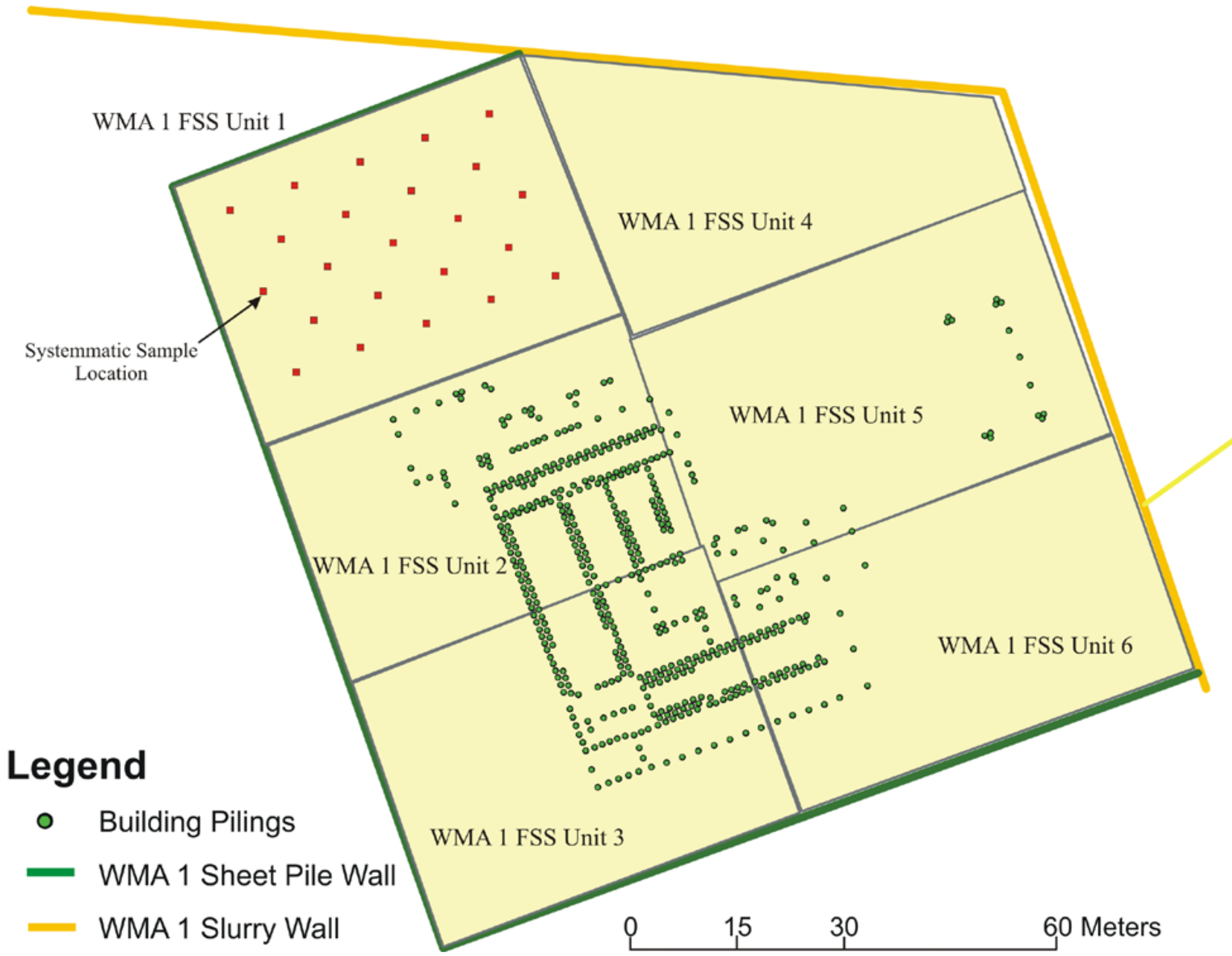

Figure 4 Conceptual Layout of WMA 1 FSS Class 1 Units

footprint is finalized. WMA 1 Class 1 units will not exceed 2,000 m^2 in size. Biased and systematic FSS soil sampling will target a 1-m depth interval, consistent with the subsurface CG derivation. More details regarding soil sampling protocols can be found in following sections. Along the northern, western, and southern portions of the excavation, the Class 1 units will include the sloped surfaces up to 1 m below land surface.

The eastern and northeastern wall of the WMA 1 excavation is expected to be nearly vertical since the excavation floor is expected to extend to the slurry wall and there may even be some removal of contaminated material from the wall itself. The slurry wall face will be its own FSS unit. Its exposed face is expected to be about 150-m long by about 10-m high, for an area of 1,500 m^2. Physical samples obtained from the wall for FSS purposes will be retrieved perpendicular to the exposed wall face. It is possible that contamination may be entrained in the wall by the wall placement process (this would be particularly true for deep portions of the wall); in the event that the slurry wall fails to meet subsurface CG standards, the FSS data collected will serve to document the contamination status of the wall for Phase 2 purposes.

The top 1 m of the northern, western, and southern portions of the sloped surfaces and the top 1 m of the slurry wall will not be included in formal WMA 1 FSS units but will be scanned and potentially sampled as part of CSAP remedial support activities. If surface soils adjacent to the WMA 1 excavation in these areas appear to meet surface soil CG requirements and there is no evidence of subsurface contamination based on CSAP data collection, DOE may choose to implement Phase 1 FSS protocols for those surface soils, in which case the scans of the top 1 m of sloped surface will be included as part of the FSS data sets. If not, then scans of the top 1 m of sloped surface will simply document the contamination status of these soils for Phase 2 decision-making.

The initial FSS field activity for the WMA 1 FSS units will be the collection of FSS GWS data. These data will be reviewed for any evidence of gross gamma activities inconsistent with background conditions. Inconsistency is defined as gross activity results that are unlikely to be associated with background conditions as observed in excavated areas where there is no evidence of contamination impacts.

In the event that either visual evidence (staining, etc.) or gamma walkover data indicate the potential for contamination impacts, biased samples will be collected that target the locations/areas of concern. Biased samples will either be submitted for gamma spectroscopy/Sr-90 analyses at an on-site laboratory or sent off site for the same analyses with quick turnaround. If these analyses indicate contamination levels exceeding CG_{emc} requirements, remediation will take place prior to additional FSS data collection. If additional remediation is necessary, the areas of concern will be excavated, the exposed surface will be re-scanned, and biased sampling will occur to demonstrate that the location meets CG_{emc} requirements before FSS data collection continues. If neither the gamma spectroscopy nor Sr-90 analyses indicate CG_{emc} exceedances, the remaining sample mass will be analyzed for the ROI for the WMA 1 FSS units, as described in Section 6.

Within the WMA 1 FSS units there are expected to be some 476 foundation pilings extending deeper into and, in some cases, through the Lavery till. Figure 4 shows the locations of the foundation pilings based on historical engineering drawings. There are concerns that these pilings may have provided vertical preferential flow pathways for contaminated groundwater into the Lavery till, resulting in soil contamination at levels of potential concern within the till. This issue will be addressed both by remedial action support survey collection described in the CSAP and by data collection as part of the FSS process for FSS units that include foundation pilings.

If foundation pilings did serve as preferential pathways for contamination entry into the Lavery till, the following conditions would be expected to be true:

- Contamination would have occurred between the piling and surrounding soil.
- Contamination that penetrated into the till would have left evidence at the till/overburden interface (i.e., soil contamination at that interface).
- The possibility for till contamination to occur would have been greatest where groundwater contamination was the greatest – beneath the original release point and immediately downgradient within the boundaries of the North Plateau Groundwater Plume.

On the basis of these assumptions, the FSS process for demonstrating that there are no significant till contamination concerns associated with pilings has the following components:

- Excavation work and associated remedial action support survey collection will identify the exact locations of pilings and will determine where contaminated soil at levels of concern existed immediately above the Lavery till.
- Pilings will be broken into two groups: pilings that are within the greater-than-CG footprint of contaminated soils immediately above the Lavery till and pilings that are not. FSS data collection will target those pilings that are within the greater-than-CG footprint.
- In this set of pilings, there will be a combination of biased and systematic data collection:

    - Ten piling locations per survey unit will be selected for biased sampling to determine if there are CG_{emc} exceedances. This selection will target those pilings most likely to exhibit till contamination, if it existed. The selection will be based on a combination of factors, including proximity to the original release event, level of soil contamination as identified by remedial support sampling immediately above the till, visual evidence of “spaces” between till material and pilings that might have provided preferential flow pathways, etc.

- The justification for selecting 10 pilings is that if they all turn out to have contamination that is less than CG_{emc} requirements, there is less than a 5% probability that more than 25% of the piles are contaminated at CG_{emc} levels.
- A minimum of eight of the pilings per survey unit would be selected for each FSS unit at random for CG_w sampling. In the event that this random selection process identifies a piling already selected for biased sampling, the sample collected from that piling will be used for both CG_{emc} and CG_w compliance demonstration purposes.
- The justification for selecting eight pilings is that this number combined with a Sign test will give a 95% confidence level that less than half of the pilings and associated till soils have contamination that is more than the CG_w, the same level of certainty required for the exposed till itself.

For those pilings selected for sampling (either biased or systematic), the sampling will focus on obtaining a discrete soil sample from immediately along the piling at a depth of 1 m below the excavation surface. These samples will either be submitted for gamma spectroscopy/Sr-90analyses at an on-site laboratory or sent off site for the same analyses with quick turnaround. If any sample indicates contamination levels exceeding CG_{emc} requirements, remediation will take place at the affected piling(s) prior to additional FSS data collection. If additional remediation is necessary, biased sampling of the remediated area will occur, and the sample location must demonstrate meeting CG_{emc} requirements before FSS data collection continues. If neither the gamma spectroscopy nor Sr-90 analyses indicate CG_{emc} exceedances, the remaining sample mass will be analyzed for the ROI for the WMA 1 FSS units, as described in Section 6.

For each FSS unit that includes pilings within the greater-than-CG overburden footprint, the systematic sample results from pilings will be evaluated by using the Sign test. If the pilings satisfy the Sign test and there are no biased piling samples with CG_{emc} exceedances, till contamination associated with pilings will not be considered an issue for that FSS unit. If fewer than eight systematic piling samples are available, rather than using the Sign test, all systematic piling samples will be compared to the CG_w requirement. If none are above, then till contamination associated with pilings will not be considered an issue for that FSS unit.

Systematic soil sampling will also take place for exposed soils. As described in Section 4.6, the number of required systematic locations will be determined on the basis of the remedial action support survey data collected as excavation proceeds. The number of systematic locations will not be fewer than one per 100 m^2. Systematic soil samples will be placed on a random start triangular grid. Systematic soil samples will be representative of a depth of 0 to 1 m. There will be no 0- to 15-cm samples required since direct exposure is not a concern for the WMA 1 excavated surface. Figure 4 illustrates the placement of 23 systematic sample locations for one of the WMA 1 FSS units. Each systematic soil sample will be submitted for off-site analysis of all ROI in the WMA 1 excavation, as described in Section 6. If remedial action support survey collection indicates that Sr-90 above CG_w requirements is a significant concern for the final excavated surface, DOE may choose to perform an on-site analysis for Sr-90 to identify potential problems requiring additional soil excavation prior to off-site laboratory analyses.

The decision logic applied to biased and systematic soil sampling results, as well as to discrete samples collected along pilings, is described in Section 7.

5.1.2 WMA 2 Excavation Footprint

Figure 5 shows a conceptual layout of Class 1 survey units for the footprint of the WMA 2 excavation. Actual Class 1 survey unit boundaries will be defined when excavation is complete and the excavation footprint is finalized. Biased and systematic FSS soil sampling will target a 1-m depth interval, consistent with the subsurface CG derivation. More details regarding soil sampling protocols can be found in the following sections. Along all edges where sloped surfaces exist, Class 1 units will include the sloped surfaces up to 1 m below land surface.

The eastern, western, and northern wall of the WMA 2 excavation is expected to be nearly vertical, since the excavation floor is expected to extend to the slurry wall and there may even be some removal of contaminated material from the wall itself. The slurry wall face will be its own FSS unit. Its exposed face is expected to be about 380-m long by about 5-m high, for an area of 1,900 m^2. Physical samples obtained from the wall for FSS purposes will be retrieved perpendicular to the exposed wall face. It is possible that contamination may be entrained in the wall by the wall placement process; in the event that the slurry wall fails to meet subsurface CG standards, the FSS data collected will serve to document the contamination status of the wall for Phase 2 purposes.

The top 1 m of the sloped surfaces and the slurry wall will not be included in formal WMA 2 FSS units but will be scanned and potentially sampled as part of CSAP remedial support activities. If surface soils adjacent to the WMA 2 excavation in these areas appear to meet surface soil CG requirements and there is

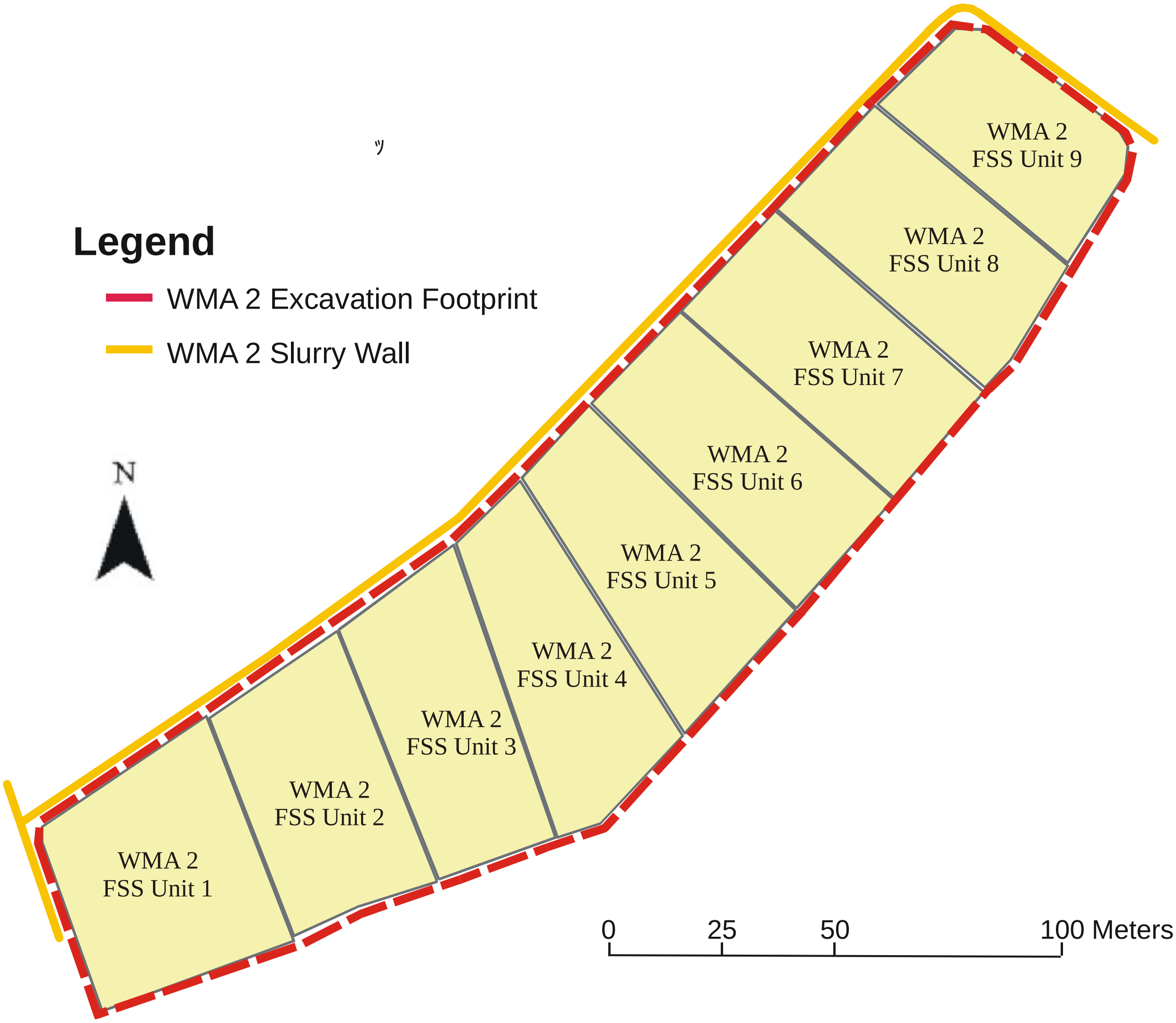

Figure 5 Conceptual Layout of WMA 2 FSS Class 1 Units

no evidence of subsurface contamination based on CSAP data collection, DOE may choose to implement Phase 1 FSS protocols for those surface soils, in which case the scans of the top 1 m of sloped surface will be included in those FSS data sets. If not, then scans of the top 1 m of sloped surface will simply document the contamination status of these soils for Phase 2 decision-making purposes.

The initial FSS field activity for the WMA 2 FSS units will be the collection of FSS GWS data. These data will be reviewed for any evidence of gross gamma activities inconsistent with background conditions. Inconsistency is defined as gross activity results that are unlikely to be associated with background conditions as observed in excavated areas where there is no evidence of contamination impacts.

In the event that either visual evidence or gamma walkover data indicate the potential for contamination impacts, biased samples will be collected that target the locations/areas of concern. Biased samples will either be submitted for gamma spectroscopy/Sr-90 analyses at an on-site laboratory or sent off site for the same analyses with quick turnaround. If these analyses indicate contamination levels exceeding CGemc requirements, remediation will take place prior to additional FSS data collection. If additional remediation is necessary, biased sampling of the remediated area will occur, the affected area will be re-scanned, and the location will be demonstrated to meet CG_{emc} requirements before FSS data collection continues. If neither the gamma spectroscopy nor Sr-90 analyses indicate CG_{emc} exceedances, the remaining sample mass will be analyzed for the ROI for the WMA 2 FSS units, as described in Section 6.

Systematic soil sampling will also take place for exposed soils. As described in Section 4.6, the number of required systematic locations will be determined on the basis of remedial action support survey data collected as excavation proceeds. The number of systematic locations will not be fewer than one per 100 m^2. Systematic locations will be placed on a random start triangular grid. Each systematic soil sample will be submitted for off-site analysis of all ROI in the WMA 2 excavation, as described in Section 6. If remedial action support survey collection indicates that Sr-90 above CG_w requirements is a significant concern for the final excavated surface, DOE may choose to perform an on-site analysis for Sr-90 to identify potential problems requiring additional soil excavation prior to off-site laboratory analyses.

The decision logic applied to biased and systematic soil sampling results is described in Section 7.

5.1.3 Class 1 Surface Soil Survey Units

For Phase 1, Class 1 surface soil FSS units may be identified on the basis of the results of the CSAP and at DOE’s discretion. Candidates for the Phase 1 Class 1 surface soil FSS units are areas where exposed soils are not contaminated above CG requirements and there is no evidence of contamination impacts more than 1 m in depth but there is the possibility that soils exceeding CG requirements exist. Any area that historically required contamination removal or that was excavated as part of Phase 1 activities to address contamination concerns will be considered a Class 1 area.

The layout of Class 1 surface soil FSS units will take place after CSAP data collection and any Phase 1 soil/hardstand/foundation removals that might take place outside of the WMA 1 and WMA 2 excavations. Surface soil Class 1 FSS units will not exceed 2,000 m^2 in size.

The initial FSS field activity for Class 1 surface soil FSS units will be the collection of FSS GWS data, if these data do not already exist as part of CSAP efforts or if additional FSS gamma walkover data are needed to supplement the CSAP data set. Gamma walkover data will be reviewed for any evidence of gross gamma activities that might be indicative of CG exceedances.

In the event that either visual evidence or gamma walkover data indicate the potential for contamination impacts, biased samples will be collected that target the locations/areas of concern. If biased soil samples are collected, two samples will be collected and analyzed for each biased sampling location: one that is representative of the top 15 cm of exposed soils, and one that is representative of the 15- to 100-cm soil depth. These samples will either be submitted for gamma spectroscopy/Sr-90 analyses at an on-site laboratory or sent off site for the same analyses with quick turnaround. If these analyses indicate contamination levels exceeding CG_{emc} requirements, remediation will take place prior to additional FSS data collection. If additional remediation is necessary, the areas of concern will be excavated, the exposed surface will be re-scanned, biased sampling will occur, and the location will be demonstrated to meet CG_{emc} requirements before FSS data collection continues. If neither the gamma spectroscopy nor Sr-90 analyses indicate CG_{emc} exceedances, the remaining sample mass will be analyzed for the balance of the ROI for the Class 1 unit, as described in Section 6.

Systematic soil sampling will also take place. As described earlier, the number of required systematic locations will be determined on the basis of CSAP data available for the area and/or historical information. The number of systematic locations will not be fewer than one per 100 m^2 for Class 1 units. Systematic locations will be placed on a random start triangular grid. Two samples will be collected from each systematic sampling location. One sample will be representative of soils to a depth of 15 cm, and one will be representative of soils to a depth of 15–100 cm. Each systematic soil sample will be submitted for off-site analysis of all ROIs applicable to the area of interest, as described in Section 6.

The decision logic applied to biased and systematic soil sampling results is described in Section 7.

5.1.4 Class 1 Lay-Down Areas

Phase 1 decommissioning activities will result in the removal and staging of contaminated soils. As part of those activities, specific areas will be identified and used for contaminated soil lay-down. For these areas, after soil lay-down activities are completed, the area will undergo Phase 1 FSS data collection consistent with the protocols described in Section 5.1.3. In these cases, if CSAP data collection from these areas did not identify subsurface contamination at depths greater than 1 m and Phase 1 FSS data collection indicates CG standards have been met, these data may be used to demonstrate CG compliance for FSS purposes. If CSAP data collection indicates subsurface contamination at depths greater than 1 m, or FSS data collection indicates residual contamination above Phase 1 CG standards, then the data collected as part of the Phase 1 FSS process will simply be used to document the contamination status of these areas.

5.2 Class 2 Soil Survey Units

For Phase 1, Class 2 surface soil FSS units may be identified on the basis of the results of the CSAP and at DOE's discretion. Candidates for Class 2 surface soil FSS units are areas where there is no evidence of surface soil contamination above CG requirements and there is no evidence of contamination impacts more than 1 m in depth. Any area that historically required contamination removal or that was excavated as part of Phase 1 activities to address contamination concerns cannot be considered a Class 2 area.

The layout of Class 2 surface soil FSS units will take place after CSAP data collection and any Phase 1 soil/hardstand/foundation removals that might take place outside of the WMA 1 and WMA 2 excavations. Surface soil Class 2 FSS units will not exceed 10,000 m^2 in size.

The initial FSS field activity for Class 2 surface soil FSS units will be a review of GWS data, which will have been collected as part of CSAP efforts. Gamma walkover data will be reviewed for any evidence of gross gamma activities that might be indicative of CG exceedances. In the event that either visual evidence or gamma walkover data indicate the potential for contamination impacts, biased samples would have been collected as part of the CSAP effort that targeted the locations/areas of concern. If biased soil samples were collected, two samples would have been collected and analyzed for each biased sampling location: one representative of the top 15 cm of exposed soils, and one representative of a 15- to 100-cm soil depth. These samples will either be submitted for gamma spectroscopy/Sr-90 analyses at an on-site laboratory or sent off site for the same analyses with quick turnaround. If these analyses indicated contamination levels exceeding CG requirements, the area would be addressed as a Class 1 FSS survey unit, not a Class 2 unit.

Assuming GWS data do not exhibit characteristics inconsistent with a Class 2 FSS designation, systematic soil sampling will take place. As described earlier, the number of required systematic locations will be determined on the basis of CSAP data available for the area and/or historical information. The number of systematic locations will not be fewer than eight per FSS unit. Systematic locations will be placed on a random start triangular grid. Two samples will be collected at each systematic sampling location. One sample will be representative of soils to a depth of 15 cm, and one will be representative of soils to a depth of 15–100 cm. Each systematic soil sample will be submitted for off-site analysis of all ROI for the Class 2 area, as described in Section 6.

The decision logic applied to biased and systematic soil sampling results is described in Section 7.

5.3 Gamma Surveying Protocols

GWS will be conducted with at least one detector capable of detecting low-energy gamma-emitting radionuclides such as ^{241}Am (e.g., a FIDLER). GWS will be performed in a manner that provides complete coverage of exposed soil surfaces, with a data density of, on average, at least one measurement per square meter. All FSS GWS will be electronically logged with suitable coordinate recording equipment that provides a minimum precision of +/-1 m accuracy. GWS should be conducted with the detector approximately six inches above the ground. In the event that elevated activities are encountered, stationary readings will be collected for a minimum of 30 seconds over the location of interest. In addition, for each location where a biased soil sample is collected, a static 30-second reading from a height of six inches will be collected above each soil sampling location.

Prior to the use of any particular detector for FSS purposes, that detector will conform to these minimum quality control (QC) standards:

- The reference area will be surveyed with the detector and data will be logged consistent with protocols to be used for FSS data collection purposes. These data will be reviewed and compared with existing data sets from similar detectors (if available) to confirm consistency in general detector behavior (average gross activity concentration recorded and observed variability in detector response).

- QC data will be obtained from a fixed QC point at a height of six inches above exposed soils from a point established for this purpose outside any areas expected to be remediated. These data will be used to construct a control chart that can be used for QC purposes for subsequent deployments of the detector as part of FSS work.

During FSS data collection activities, QC will consist of, at a minimum, the following for each detector in use:

- A stationary reading will be taken from the QC point at the start and end of each day a detector is in use. These QC data will be compared to the control chart to determine that the detector response is consistent with historical responses from that location. If a QC measurement results in a detector response "out of control" at the start of the day, the measurement will be repeated. If the subsequent measurement is still out of control, the reason for the discrepancy will be established before the detector is used. If the out-of-control event occurs at the end of the day and is verified by a subsequent measurement, the reason for the discrepancy will be established before the data collected that day with that detector are considered acceptable for FSS purposes. "Out of control" is defined as a result that is more than two standard deviations above or below the average historical detector response at that control point.
- Electronically logged data will be reviewed for completeness (e.g., evidence of spatial "holes" in collected data), evidence of erratic detector behavior (e.g., sequential readings during a moving survey that show a marked increase or decrease in gross activity not confirmed by spatially adjacent measurements), or evidence of shine (e.g., systematically elevated readings proximal to structures, buildings, soil piles, storage units or excavated soil walls). In the case of incomplete data, data collection will be conducted to fill the gap. In the event of erratic behavior, the cause will be investigated, suspect data will be flagged as such, and additional data collection will be conducted to address affected areas as appropriate.

Given the size of the WVDP premises and the duration of proposed CSAP and FSS data collection efforts, multiple detectors of the same type will likely be used for GWS purposes. It is common for the response for the same type of detector (e.g., FIDLER) to vary somewhat from detector to detector. Before presenting data representing multiple detectors, data will be "normalized" by using the QC information described above. Normalization involves multiplying an individual detector's results by a constant to correct for any systematic over or under-reporting of gross activity as compared to other detectors of the same type.

All FSS gamma walkover data that satisfy QC requirements will be archived electronically in a readily retrievable format along with appropriate meta data (e.g., date collected, detector identification, technician identification, purpose of survey, and any necessary explanatory notes).

There may be portions of the project premises where shine from adjacent buildings or excavation walls interferes with gross gamma activity scans. In such areas, the presence and significance of interfering shine will be evaluated (e.g., through a combination of shielded and unshielded measurements). In areas where shine has an unacceptable impact on gamma scan data quality, mitigating strategies will be used. Examples of mitigating strategies include using a collimated detector or developing shine corrections that can be applied to acquired data sets.

There may be situations where soil contamination that would be of CG concern is overlain by a thin layer of clean cover (e.g., a few inches of clean soil). These situations would potentially prevent a GWS from correctly identifying the presence of contamination. For this reason, biased sampling as part of CSAP and FSS work will focus on GWS results not consistent with background conditions and will include sampling down to a depth of 1 m. Also, as part of the CSAP data collection process, the presence and prevalence of situations where contamination is present within the top 1 m of soil but is covered by a clean soil or other backfill material will be evaluated. If the CSAP identifies this as a significant issue, the FSS GWS and intrusive sampling protocols may be modified to better address this concern.

5.4 Soil Sampling Protocols

Systematic and biased FSS soil sampling, in general, will follow the protocols outlined below. Exceptions may be made for biased soil samples where the nature of the location (adjacent to infrastructure, excavation walls, etc.) requires an adjustment. In those cases, the reason for the deviation and the nature of the deviation must be noted in a preservable manner (e.g., field notebook dedicated to this purpose). Additional details about sampling tools and related field protocols will be described in standard operating procedures to be developed by the contractor responsible for FSS data collection.

Within the WMA 1 and WMA 2 excavation footprints, FSS soil sampling will be conducted in a manner that results in a sample representative of a 1-m depth interval for each required location. The total mass of each sample collected must be sufficient to allow analysis for all 18 ROIs, if necessary. Sampling tools must be thoroughly decontaminated (if reused) between samples.

For all other areas undergoing Phase 1 FSS data collection, FSS soil sampling will be conducted in a manner that yields two samples for each required location. The first sample should be representative of a depth interval of 0–15 cm. The second one should be representative of a of depth interval of 15–100 cm. The total mass of each sample collected must be sufficient to allow analysis for all 18 ROIs, if necessary. Sampling tools must be thoroughly decontaminated (if reused) between samples.

5.5 Quality Assurance Procedures

5.5.1 Contractor Quality Assurance Program

The radiological quality control (RQC) program to be utilized during this investigation consists of three primary phases: preparatory, initial, and follow-up. All RQC functions and reviews will be directed by the RQC representative. Detailed procedures relating to the RQC will be provided in the project quality assurance project plan (QAPP) developed to support the field sampling.

- *Preparatory Phase.* The preparatory phase of the RQC program is documented by the RQC representative and includes meetings to be held with contractor and subcontractor personnel to address issues, including the review of procedures, field decontamination, investigation-derived waste (IDW) management, and sample management.
- *Initial Phase.* The initial phase of the RQC program is conducted by the RQC representative and includes monitoring and audits associated with the initial work performed as part of each definable feature of work. Initial phase topics include field sampling oversight, sample management documentation, and inspection of field logbooks and other field records.
- *Follow-up Phase.* The follow-up phase of the RQC program is conducted by the RQC representative and includes the daily performance of the activities noted in the initial phase until completion of the specific definable feature of work.

In some cases (e.g., GWS data and biased sampling in response to GWS data), data used for the FSS process may have originated as part of CSAP activities. All CSAP data that could potentially be used to support FSS decision-making will conform to FSS data quality requirements as described in this plan.

5.5.2 Daily Quality Control Reports

The FSS contractor will prepare daily quality control reports (DQCRs) that will be signed and dated by the RQC representative. Daily reports then will be submitted to the DOE Project Manager and DOE

Contracting Representative on a weekly basis. Each DQCR will address topics that include a summary of work performed, weather conditions, and departures from the FSSP. Any deviation that may affect the project outcomes or performance objectives will be immediately forwarded to the DOE Project Manager and DOE Contracting Representative.

5.5.3 Corrective Actions

Corrective actions will be initiated if problems related to analytical/equipment errors or noncompliance with approved criteria are identified. Corrective actions will be documented through a formal corrective action program at the time the problem is identified.

Any nonconformance with the established procedures presented in the plan or in the project QAPP will be identified and corrected in accordance with the QAPP. The contractor Project Manager will issue a nonconformance report (NCR) for each nonconforming condition. In addition, corrective actions will be implemented and documented in the appropriate field logbook.

Detailed procedures for corrective actions related to sample collection/field measurements and laboratory analyses will be explained in the QAPP that supports the FSS field activities.

5.6 Sample Chain-of-Custody/Documentation

5.6.1 Field Logbooks

All information pertinent to field activities, including field instrument calibration data, will be recorded in field logbooks. The logbooks will be bound, and the pages will be consecutively numbered. Entries in the logbooks will be made in black waterproof ink and will include, at a minimum, a description of all activities, individuals involved in field activities, dates and times of sampling, weather conditions, any problems encountered, and all field measurements. Lot numbers, manufacturer names, and expiration dates of standards used for field instrument calibration will be recorded in the field logbooks. A summary of each day's activities also will be recorded in the logbooks.

Sufficient information will be recorded in the logbooks to permit reconstruction of all Phase 1 FSS activities conducted. Information recorded on other project documents will not be repeated in the logbooks except in summary form where determined necessary. When not being utilized during field work, all field logbooks will be kept in the possession of the appropriate field personnel or in a secure place. Upon completion of the field activities, all logbooks will become part of the final project evidence file.

Entries recorded in logbooks will include, but not be limited to, the following information:

- Author, date, and times of arrival to and departure from the work site;
- Purpose of the FSS field activity and summary of daily tasks;
- Names and responsibilities of field crew members;
- Sample collection method;
- Number and volume of samples collected;
- Information regarding sampling changes, scheduling modifications, and change orders;
- Details of sampling locations, including a sketch map illustrating the sampling locations;
- Field observations;
- Types of field instruments used and purpose of use, including calibration methods and results;
- Any field measurements made that were not recorded electronically;
- Sample identification number(s); and
- Sample documentation information.

5.6.2 Photographs

Photographs can be an important source of supplemental information for the FSS process. Examples of when photographs are appropriate include when there is a need for visual evidence of potential contamination, evidence of obstructions that require moving sampling locations, documentation of sampling points, and documentation of anomalous conditions that might affect either data quality or data interpretation. Photographs taken during the FSS activities will be noted in the field logbook in accordance with the requirements of the field procedure. If photographs are taken to document sampling points to facilitate relocating the point at a later date, two or more permanent reference points should be included within the photograph. In addition to the information recorded in the field logbook, one or more site photograph reference maps will be prepared as required.

5.6.3 Sample Numbering System

A unique sample numbering scheme will be used to identify each sample designated for laboratory analysis. The purpose of this numbering scheme is to provide a tracking system for the retrieval of analytical and field data on each sample. Sample identification numbers will be used on all sample labels or tags, field data sheets and/or logbooks, chain-of-custody records, and all other applicable documentation used during the project. The sample numbering scheme used for field samples will also be used for duplicate samples so that these types of samples will not be discernible by the laboratory. Other field QC samples, however, will be numbered so that they can be readily identified.

5.6.4 Sample Labels

Labels will be affixed to all sample containers during sampling activities. Information will be recorded on each sample container label at the time of sample collection. The information to be recorded on the labels will be as follows:

- Sample identification number,
- Sample type (e.g., systematic or biased),
- Sampled interval (e.g., 0–15-cm),
- Site name and sampling station number,
- Analysis to be performed,
- Type of chemical preservative present in container,
- Date and time of sample collection, and
- Sampler’s name and initials.

5.6.5 Cooler Receipt Checklist

The condition of shipping coolers and enclosed sample containers will be documented upon receipt at the analytical laboratory. This documentation will be accomplished by using the cooler receipt checklist as described in the project QAPP. A copy of the checklist will either be placed into each shipping cooler along with the completed chain-of-custody form or provided to the laboratory at the start of the project. Another copy of the checklist will be faxed to the contractor’s field manager immediately after it has been completed at the laboratory. The original completed checklist will be transmitted with the final analytical results from the laboratory.

5.6.6 Chain-of-Custody Records

Chain-of-custody procedures implemented for the project will provide documentation of the handling of each sample from the time of collection until completion of laboratory analysis. The chain-of-custody form serves as a legal record of possession of the sample. A sample is considered to be under custody if one or more of the following criteria are met:

- The sample is in the sampler's possession,
- The sample is in the sampler's view after being in possession,
- The sample was in the sampler's possession and then was placed into a locked area to prevent tampering, and
- The sample is in a designated secure area.

Custody will be documented throughout the project field sampling activities by a chain-of-custody form initiated on each day that samples are collected. The chain-of-custody will accompany the samples from the project premises to the laboratory and will be returned to the laboratory coordinator with the final analytical report. All personnel with sample custody responsibilities will be required to sign, date, and note the time on a chain-of-custody form when relinquishing samples from their immediate custody (except in the case where samples are placed into designated secure areas for temporary storage prior to shipment). Bills of lading or air bills will be used as custody documentation during times when the samples are being shipped from the project premises to the laboratory, and they will be retained as part of the permanent sample custody documentation.

Chain-of-custody forms will be used to document the integrity of all samples collected. To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, chain-of-custody forms will be filled out for sample sets as deemed appropriate during the course of fieldwork. An example of the chain-of-custody form to be used for the project will be provided in the project QAPP.

The individual responsible for shipping the samples from the field to the laboratory will be responsible for completing the chain-of-custody form and noting the date and time of shipment. This individual will also inspect the form for completeness and accuracy. After the form has been inspected and determined to be satisfactorily completed, the responsible individual will sign, date, and note the time of transfer on the form. The chain-of-custody form will be put in a sealable plastic bag and placed inside the cooler used for sample transport after the field copy of the form has been detached. The field copy of the form will be appropriately filed and kept at the project premises for the duration of the activities.

In addition to the chain-of-custody form, chain-of-custody seals will also be placed on each cooler used for sample transport. These seals will consist of a tamper-proof adhesive material placed across the lid and body of the coolers. The chain-of-custody seals will be used to ensure that no sample tampering occurs between the time the samples are placed into the coolers and the time the coolers are opened for analysis at the laboratory. Cooler custody seals will be signed and dated by the individual responsible for completing the chain-of-custody form contained within the cooler.

5.6.7 Receipt of Sample Forms

The contracted laboratory will document the receipt of environmental samples by accepting custody of the samples from the approved shipping company. In addition, the contracted laboratory will document the condition of the environmental samples upon receipt.

5.7 Documentation Procedures

The tracking procedure to be utilized for documentation of all samples collected during the project will involve the following series of steps.

- Collect and place samples into laboratory sample containers.
- Complete sample container label information.
- Complete sample documentation information in the field logbook.
- Complete project and sampling information sections of the chain-of-custody form(s).
- Complete the air bill for the cooler to be shipped.
- Perform a completeness and accuracy check of the chain-of-custody form(s).
- Complete the sample relinquishment section of the chain-of-custody form(s) and place the form(s) into cooler.
- Place chain-of-custody seals on the exterior of the cooler.
- Package and ship the cooler to the laboratory.
- Receive cooler at the laboratory, inspect contents, and fax contained chain-of-custody form(s) and cooler receipt form(s), as defined in the project QAPP.
- Transmit original chain-of-custody form(s) with final analytical results from laboratory.

5.8 Corrections to Documentation

All original information and data in field logbooks, on sample labels, on chain-of-custody forms, and on any other project-related documentation will be recorded in black waterproof ink in a completely legible manner. Errors made on any accountable document will be corrected by crossing out the error and entering the correct information or data. Any error discovered on a document will be corrected by the individual responsible for the entry. Erroneous information or data will be corrected in a manner that will not obliterate the original entry, and all corrections will be initialed and dated by the individual responsible for the entry.

5.9 Sample Packaging and Shipping

5.9.1 Sample Packaging

Sample containers will be packaged in thermally insulated rigid-body coolers. Sample packaging and shipping will be conducted in accordance with procedures that will be described in the project QAPP and applicable U.S. Department of Transportation (DOT) specifications. A checklist to be provided in the project QAPP will be used by the individual responsible for packaging environmental samples to verify completeness of sample shipment preparations. In addition, the laboratory will document the condition of the environmental samples upon receipt. This documentation will be accomplished by using the cooler receipt checklist to be provided in the project QAPP.

5.9.2 Additional Requirements for Samples Classified as Radioactive Material

Transportation of radioactive materials is regulated by the DOT under 49 CFR 173.401. Samples generated during project activities will be transported in accordance with procedures that ensure compliance with regulatory requirements. In addition to the packaging and shipping requirements cited in Section 5.6, the following will be performed for radioactive materials:

- The cooler must have the shipper and receiver addresses affixed to it in case the Federal Express air bill is lost during shipping.
- Samples will be screened prior to packing to determine if they meet the definition of a DOT Class 7 (radioactive) material.
- For samples that meet DOT requirements for radioactive materials:
  - The cooler will be surveyed for radiation and to ensure the package meets the requirements for limited quantity as found in 49 CFR 173.421.
  - A notice must be enclosed on the inside of the cooler that includes the name of the consignor and the statement “This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material,

UN2910." The outside of the inner packaging, or if there is no inner packaging, the outside of the package itself must be labeled "Radioactive."

- The following labels will be placed on the cooler:
  - Appropriate hazard class label and
  - If applicable, "Cargo Aircraft Only."
- The air bill for the shipment will be completed and attached to the top of the shipping systematic gamma scan box/cooler, which will then be transferred to the courier for delivery to the laboratory.

5.9.3 Sample Shipping

All environmental samples collected during the project will be shipped no later than 48 to 72 hours after the time of collection. The latter time of 72 hours may be necessary if the samples are collected on a Friday and have to be shipped on a Monday via commercial courier. During the time period between collection and shipment, all samples will be stored in a secure area. All coolers containing environmental samples will be shipped overnight to the laboratory via Federal Express, a similar courier, or a laboratory courier.

5.10 Investigation-Derived Waste

The field activities described in this plan will generate IDW materials. The materials generally consist of soil, sludge, water, and spent personal protective equipment (PPE) resulting from sampling and associated project premise activities. When accumulated, these materials must be managed appropriately to minimize exposure and risks to human health and the environment while adhering to applicable regulatory requirements. IDW will be managed and disposed of consistent with DOE waste management procedures. The objective of this section is to establish specific management practices for the handling and subsequent disposition of these materials.

The IDW includes all materials generated during project performance that cannot be effectively reused, recycled, or decontaminated in the field. It consists of both materials that could potentially pose a risk to human health and the environment (e.g., sampling and decontamination wastes) and materials that have little potential to pose risk to human health and the environment (e.g., sanitary solid wastes). Two types of IDW will be generated during the implementation of field activities: indigenous and non-indigenous. Indigenous IDW expected to be generated during Phase 1 FSS activities includes primarily soils. Nonindigenous IDW expected to be generated includes decontamination fluid/water and miscellaneous trash, including PPE. When accumulated, the media will managed appropriately to minimize exposure and risks to human health and the environment while adhering to applicable regulatory requirements.

5.11 Field Decontamination

Field sampling equipment used during soil sampling will be decontaminated between samples. Equipment to be decontaminated includes stainless steel scoops, bowls, spoons, core barrels, and hand auger barrels. Other equipment used during sampling activities that does not directly contact sample materials (down-hole rods, shovels, etc.) will be cleaned by a pressurized steam cleaner to remove visible soil contamination.

Field decontamination will be conducted in an area near the field equipment staging area
or in an area approved by DOE. Decontamination activities will be conducted so that all solid and liquid wastes generated can be containerized and disposed of as described in Section 5.10.

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6.0 LABORATORY ANALYSES AND GAMMA WALKOVER DATA

6.1 Laboratory Analyses

FSS soil samples may be screened by an on-site laboratory to verify the absence of significant contamination issues (e.g., gamma spectroscopy for Cs-137 and/or liquid scintillation for Sr-90). This screening would allow corrective actions (e.g., additional remediation and re-sampling) to be taken immediately before committing resources to off-site laboratory analyses. Data from an on-site laboratory would not be used to demonstrate CG compliance unless a quality assurance (QA)/QC program is established and demonstrated to produce results equivalent to those of an off-site contract laboratory.

FSS samples will be shipped to an off-site contract laboratory for analysis. Laboratory methods, instruments, and sensitivities will be in accordance with New York State protocols for environmental analysis. Any laboratory used for environmental sample analysis will have appropriate New York State Department of Health Environmental Laboratory Approval Program certification or equivalent. Table 4 indicates the target minimum detectable concentrations (MDCs) for radionuclides in laboratory analyses of soil samples as well as the analytical methods to be used. MDC requirements are set to whichever is lower: (1) approximately 10% of the most restrictive radionuclide-specific CG, (2) 25% of background for naturally occurring radionuclides, or (3) standard laboratory MDCs. All laboratory instrumentation will be calibrated by using National Institute of Standards and Technology (NIST)-traceable standards.

Activity concentrations in soil will be reported in units of picocuries per gram. Other QC activities are incorporated into specific field survey procedures.

6.2 Scan Minimum Detectable Concentrations

Procedures are provided in the MARSSIM for calculating scan MDCs for particular survey instruments. More details on signal detection theory and instrument response are provided in NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*.

Table 4 Radionuclide Target Sensitivity for Laboratory Sample Analysis

Nuclide	Instrument/Method	Target Sensitivity (pCi/g)[1]
Am-241	Alpha and/or gamma spectrometry	1[2]
C-14	Sample oxidizer and liquid scintillation	2[2]
Cm-234/244	Alpha and/or gamma spectrometry	1[2]
Cs-137	Gamma spectrometry	0.1[2]
I-129	Gamma spectrometry	0.03[3]
Np-237	Alpha and/or gamma spec	0.01[3]
Pu-238	Alpha spectrometry	1[2]
Pu-239/240	Alpha spectrometry	1[2]
Pu-241	Liquid scintillation	15[2]
Sr-90	Liquid scintillation	0.4[3]
Tc-99	Gas flow proportional counting	2[3]
U-232	Alpha spectrometry	0.5[3]
U-233/234	Alpha spectrometry	0.2[4]
U-235 (-236)	Alpha spectrometry	0.1[4]
U-238	Alpha spectrometry	0.2[4]

Notes:
(1) Dependent on sample size, counting time, etc.
(2) Standard laboratory MDCs.
(3) About 10% of the most restrictive radionuclide-specific cleanup goal identified in Table 5-14.
(4) 25% of background for naturally occurring radionuclides.

To assist with FSS planning activities, estimated scanning MDCs in soil for the ROIs were obtained by reviewing available information; these values are shown in Table 5. Information is provided for only 14 of the 18 radionuclides, since 4 have no or minimal photon (gamma ray and x-ray) emissions, making them impractical to detect with field scanning instruments. Field survey instruments for soil contamination are generally limited to those that can detect photons given the uneven terrain and conditions encountered in the field. This is in contrast to survey instruments that can be used for buildings, many of which allow for the detection of alpha and beta contamination as well as gamma emissions.

Comparing the estimated MDCs in Table 5 with the CG requirements in Table 1 for all 14 radionuclides potentially detectable by gamma surveys shows that the estimated MDCs are less than the respective CG_{emc}. In some cases (e.g., Am-241, Cm-243, Cm-244, and Cs-137) the MDCs are less than or in the range of the CG_w. The conclusion is that for the majority of the ROIs, gamma scans will provide a high level of confidence that there are no CG_{emc} concerns regarding surface soils. For those ROIs where this is not the case, CG_{emc} compliance will be demonstrated via sampling, as described earlier in the plan.

In practice, the response of any particular instrument varies by radionuclide; for the WVDP premises, it is likely radionuclides will be commingled. Consequently, the implementation of scans will be based on identifying scan readings that are not consistent with background conditions. Those instances will be followed by biased sampling to resolve what radionuclides are present and at what activity concentrations.

Table 5 Estimated Scanning Minimum Detectable Concentrations (MDCs) of Radionuclides in Soil

Radionuclide	Type of detector	Scan MDC (pCi/g)
Am-241	FIDLER	30
C-14	NA[1]	-
Cm-243	2” by 2” NaI	50
Cm-244	FIDLER	300
Cs-137	2” by 2” NaI	7[2]
I-129	FIDLER	60
Np-237	FIDLER	30
Pu-238	FIDLER	100[3]
Pu-239	FIDLER	200[3]
Pu-240	FIDLER	100
Pu-241	NA[1]	-
Sr-90	NA[1]	-
Tc-99	NA[1]	-
U-232	FIDLER	60
U-233	FIDLER	500
U-234	FIDLER	60
U-235	FIDLER	30
U-238	FIDLER	60

Notes:
(1) NA means not applicable; either there are no photons associated with the radionuclide, or the photon yield is too low to allow for detection by field scanning instruments.
(2) A specific calculation of the scanning minimum detectable count rate for Cs-137 in soil performed in connection with preparation of the Phase 1 Decommissioning Plan yielded a value equivalent to 7 pCi per gram of Cs-137. A comparable value of 6.4 pCi/g is given in Table 6.7 of the MARSSIM when units are given in pCi/g.
(3) While scan MDCs of 10 and 20 pCi/g are reported for Pu-238 and Pu-239, respectively, in Appendix H of MARSSIM, much larger values were reported elsewhere. The values given here are those expected to be reasonably achievable under field conditions.

7.0 DECISION LOGIC

Through the course of the FSS design, implementation, and data collection process there are a number of generic key decision points. These include:

- Identifying appropriate FSS area designation (i.e., Class 1 or Class 2) and layout of individual FSS units;
- Assigning pertinent ROIs;
- Demonstrating there are no CG_{emc} exceedances through a combination of gamma scans, biased soil sampling (as necessary), and systematic soil sampling; and
- Demonstrating compliance with CG_w requirements through the use of systematic samples from FSS units and statistical tests such as the Sign test or WRS test.

Currently CG_w levels are such that the Sign test is appropriate for demonstrating CG_w compliance. However, if CG_w levels are reduced, then the WRS test may be necessary.

7.1 FSS Area Designation

The first FSS decision that must be made is what the appropriate FSS designation is for areas that are candidates for Phase 1 FSS data collection. FSS class designation has already been discussed in previous sections of this FSSP. In summary, any area where (1) excavation has taken place to address contamination concerns for ROI, (2) characterization data (including CSAP-generated data) indicate CG_w exceedances exist, or (3) historical information (e.g., anecdotal evidence of an environmental release) indicates a possibility that contamination may exist above CG_w requirements will be classified as a Class 1 area. Area designation will not take place until after soil remediation is complete for that area (if remediation was necessary).

Areas not meeting the Class 1 area definition but showing some evidence of contamination impacts based on historical information or on characterization data will be classified as Class 2 areas.

It is not expected that there will be Class 3 areas for Phase 1 FSS activities.

After an area has been designated as a Class 1 or Class 2 area, it will be divided into one or more FSS units. Class 1 units may range up to 2,000 m^2 in size. Class 2 units may range up to 10,000 m^2 in size. All areas that are included in the Phase 1 FSS process will be completely encompassed in either Class 1 or Class 2 units (or some combination).

In the event that contamination that requires remediation is encountered in a Class 2 area during the FSS process, the affected area will be reclassified as a Class 1 area and FSS data will be collected consistent with the Class 1 FSS unit protocols after remediation is complete.

7.2 Pertinent Radionuclides of Interest

The ROI list contains 18 radionuclides. Currently there is insufficient information to determine whether all 18 radionuclides are applicable across the entire WVDP premises. One goal of the CSAP data collection effort is to collect the data necessary to make this determination for individual areas that are candidates for the Phase 1 FSS process. The following criteria will be used to determine which radionuclides should be included in the FSS process for specific areas:

- Historical knowledge and inventory records pertinent to a specific area.
- The presence/absence of radionuclides above their CG_w requirements.
- Consistent with NRC guidance in Section 3 of NUREG-1757, Volume 2 (NRC 2006), if, based on CSAP data, a radionuclide contributes no more than 10% to the observed dose, it will be considered insignificant and will not be carried into the FSS process for that area. This determination will be made on the basis of the SOR calculations described in Section 7.3 after adjusting for background. The exception is this: If removing a radionuclide results in reducing a CSAP SOR result to less than unity for one or more samples from an area, the radionuclide will be retained for that area. The SOR requirement will be reduced from unity to reflect the average dose contribution from the dropped ROI.

If all ROIs appear to be either not present or present at levels close to background conditions such that none contribute more than 10% to the observed SOR values after adjusting for background, then, at a minimum, Cs-137 and Sr-90 will be carried into the FSS process, reflecting the fact that there are known environmental impacts at levels of concern for those two radionuclides across the WVDP premises.

Ten percent of FSS samples collected for a specific area will be selected at random and analyzed for all 18 radionuclides.

In addition to the 18 radionuclides identified by the Phase 1 DP, an additional 12 radionuclides have been identified that potentially are of interest. One of the goals of the CSAP data collection effort is to determine whether any of these 12 radionuclides should be added to the list of 18. In the event that one or more of the 12 radionuclides of potential interest are confirmed to be present at levels above background and are a concern for a specific area of the site, those radionuclides will be included in the FSS process for that area.

7.3 Sum of Ratios Calculation

Because there are multiple ROIs, a SOR calculation will be used to address cumulative dose concerns. For any individual sample, the corresponding SOR value is the sum of the observed activity concentration for each pertinent ROI divided by the appropriate CG value. In the case of SOR calculations for CG_w evaluations, the appropriate CG value would be the CG_w for the ROI. In the case of SOR calculations for CG_{emc} evaluations, the appropriate CG value would be the CG_{emc} for the ROI. Individual sample SOR values greater than or equal to one indicate a CG exceedance, except in those instances when the SOR requirement has been reduced to reflect the dose contributions of radionuclides dropped from the FSS process. In those cases the appropriate requirement is the adjusted SOR requirement.

To ensure that dose contributions of all radionuclides removed from consideration are adequately addressed during the FSS process, the average relative CG_w SOR contribution will be determined for radionuclides of interest that are considered insignificant for a particular area using CSAP data. The CG SOR requirement will be reduced by that amount for that area during the FSS evaluation for those radionuclides retained as part of the FSS process. As an example, if Pu-241 and Am-241 were measurable in CSAP results for an area but, on average, contributed only 2% and 3%, respectively, to the overall CG SOR calculation they would be dropped from the FSS analytical list for that area. The CG SOR standard for that area would be reduced from 1.0 to 0.95 in the FSS process to reflect the missing dose contribution of Pu-241 and Am-241.

In the calculation of SOR values, the reported activity concentrations for pertinent ROIs will be used regardless of whether the result has been qualified as a detection or nondetection.

7.4 Confirming Survey Unit Classification

FSS data sets (gamma walkover data and sampling results) will be reviewed to determine if there is evidence of anomalous results inconsistent with the original survey unit classification for the area from which the data were collected. An example of an anomalous result would be a systematic sample result near or above the CG_w value for a Class 2 unit. Anomalous results do not necessarily indicate noncompliance with CG standards but may indicate that the underlying conceptual site model used as a basis for FSS unit classification was incorrect. In these instances, further investigation may take place to ensure that the anomalous result is not indicative of unexpected residual contamination that warrants attention or reclassification of a Class 2 unit.

7.5 Demonstrating CGemc Compliance

The generic process for demonstrating CG_{emc} compliance is the same for Class 1 and Class 2 units. Logged, spatially complete GWS data will be collected for each FSS unit. These data will be compared to a field investigation level derived from the gamma walkover data collected from the reference area. The field investigation level will be selected to allow identification of GWS results inconsistent with background conditions.

Locations flagged as potential anomalies by the gamma walkover data or for any other reason (visual evidence of contamination, historical information, etc.) will be biased sampled. The biased sample will focus on the location of greatest concern. Biased sampling will include both a 15-cm-deep sample and a 15- to 100-cm-deep sample for surface soils but only a 1-m-deep sample from the WMA 1 or WMA 2 excavation surface.

Activity concentration values representative of the depth interval of 0–1 m will be constructed for each surface soil sampling location by using the results from the 0- to 15-cm sample and the 15- to 100-cm sample and a weighted average approach.

If the result is above the $CG_{w,}$, each 0- to 15-cm and 0- to 1-m individual systematic soil sample result will be compared to the appropriate CG_{emc} requirement. In this instance, the appropriate standard is the CG_w adjusted by an area factor selected to match the area originally represented by the systematic sample. If the sample result exceeds this adjusted CG_w, further data may be collected to better define the footprint of the affected area, and remediation will take place before the FSS process continues. Area factors are provided in Tables 2 and 3 of this plan.

7.6 Demonstrating CG_w Compliance

Each survey unit will have systematic samples collected to allow for a CG_w compliance evaluation. Survey units within the WMA 1 and WMA 2 excavation footprints will have one set of systematic samples per survey unit representative of the contamination status of the top 1 m of the excavated soil surface. Survey units outside the WMA 1 and WMA 2 excavation footprints will have two sets of systematic samples per survey unit, one set representative of the top 15 cm of soil surface, and the second set representative of the 15–100 cm of soil surface. The results from these two samples will be used to estimate the activity concentration for the 0–1-m depth interval by using a weighted average approach.

If the Sign test is used (as initially planned), the average SOR value will first be calculated for each set of results (0–15 cm and 0–1 m). If the average is above the CG_w requirement, the survey unit will be considered not in compliance, the reason will be investigated, and appropriate action will be taken. If the average is below the CG_w requirement, then the Sign test will be performed with a Type I error rate set to 0.05 to establish with statistical confidence that, in fact, the unit has met the CG_w requirement. If the unit does not pass the Sign test, the reason why will be investigated, and appropriate action will be taken. If additional remediation is required within a FSS unit, the affected area will be reclassified as a Class 1 area (if not already), and the FSS data collection process will be repeated.

If the WRS test is used, systematic soil samples obtained from a reference area will be compared to each set of systematic FSS results from a unit. If the difference between the average SOR scores for the FSS unit and the background reference area is greater than one, the survey unit will be considered not in compliance, the reason will be investigated, and appropriate action will be taken. If the average SOR scores differ by less than one, then the WRS test will be performed with a Type I error rate set to 0.05 to establish with statistical confidence that, in fact, the unit has met the CG_w requirement. If the unit does not pass the WRS test, the reason why will be investigated, and appropriate action will be taken. If additional remediation is required within a FSS unit, the affected area will be reclassified as a Class 1 area (if not already), and the FSS data collection process will be repeated.

7.7 Class 1 WMA 1 FSS Units

Class 1 WMA 1 FSS units differ from the rest of the project premises in that most will have foundation pilings remaining in the exposed subsurface Lavery till. There are concerns that preferential flow may have taken place along the pilings and that the flow would have resulted in the transport of contaminated groundwater into the till and subsequent till contamination. To address this concern, systematic and biased soil samples, as described in Section 5.1.1, that target specific pilings will be collected.

In the case of biased piling soil samples, the CG_{emc} SOR value will be calculated for each sample collected. If the SOR is equal to or greater than one, the level of contamination will be considered unacceptable, and additional investigation/remediation take place until remaining till soils at that location meet the CG_{emc} requirement.

In the case of systematic piling soil samples, the average CG_w SOR value will be calculated. If it is equal to or greater than one, the level of contamination will be considered unacceptable, and additional investigation/remediation will take place. If it is less than one, the Sign test will be applied to statistically demonstrate compliance. If the number of systematic piling samples is less than the minimum required for the Sign test, then all systematic piling samples must have CG_w SOR values less than one for the unit to pass.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL MEASURES

QA/QC measures are employed throughout the FSS process to ensure that all decisions are made on the basis of data of acceptable quality. As necessary, a QAPP will be prepared to cover all project QA/QC requirements and activities that have not already been addressed by existing QA/QC procedures associated with the Phase 1 decommissioning process, consistent with the Phase 1 DP. Part of the QA/QC process is data validation. Data validation will take place as described in the Phase 1 DP QAPP.

Data quality indicators (DQIs) are quantitative and qualitative measures of the reliability of the selected measurement methods (laboratory and field screening). Such indicators include the accuracy, precision, representativeness, completeness, and comparability of the data. Measurement instruments and methods will be evaluated in terms of these indicators when they are selected. Accuracy addresses the potential for bias in laboratory analytical results and is typically monitored through the use of standards, blanks, and control charts, as appropriate. Precision reflects measurement error; for radio-analytical methods, the required precision is reflected by required method detection limits. Required method detection limits are as specified by this FSSP. Representativeness is guaranteed by appropriate sampling and analytical protocols and is monitored by ensuring that those protocols are, in fact, carried out during field and laboratory work. The data completeness goal for this FSSP is 80%, which reflects the fact that the MARSSIM CG_w sample number calculations build in a 20% safety factor to account for rejected or missing data. Comparability refers to whether data sets generated by FSS work pertain to establishing compliance with CG requirements. All FSS CG-related decisions will be supported by laboratory analytical work providing radionuclide-specific activity concentrations for the ROI.

A QA program will be conducted during surveys that, in accordance with established procedures, will specify and measure the performance of measurement methods through the collection of an appropriate number or frequency of QC samples. Such samples could include field and laboratory blanks, field duplicates, laboratory replicates, and spiked samples. Field measurements will be calibrated on NIST-traceable standards at a frequency prescribed in the QAPP. Twice-daily response checks will be performed for all field instruments before use. Corrective actions will be conducted if performance falls outside expected ranges.

All surveys and sample collection for this FSS will be performed in accordance with established QC requirements. Replicate surveys, sample recounts, instrument performance checks, chain of custody, control of field survey data and databases, and QC investigations provide the highest level of confidence in the data collected to support the survey outcome.

In addition, QA/QC measures will ensure that trained personnel conduct surveys with approved procedures and properly calibrated instruments. Procedures will cover sample documentation, chain of custody, field and laboratory QC measurements, and data management. The FSSP contractor will be required to develop and supply these procedures either as appendices to this plan or as stand-alone standard operating procedures.

In addition, the expectation is that the NRC will provide for an independent verification contractor as described by the Phase 1 DP in Section 9.2.7.

9.0 REPORT OF SURVEY FINDINGS

Consistent with NRC guidance, one or more final status survey reports (FSSRs) describing and documenting the FSS outcomes for the Phase 1 FSS survey units will be prepared. Given the complexity and the timeframe of Phase 1 activities, DOE may choose to bundle FSS results for sets of survey units into individual FSSRs that are prepared as data from those units become available. At the completion of Phase 1 activities, the set of FSSRs (if there are more than one) will demonstrate that Phase 1 requirements have been met for those areas that underwent the Phase 1 FSS process.

Each FSSR will include the following information pertinent to the survey units contained in that FSSR:

- Summary of the applicable CGs;
- Discussion of any changes that were made in the FSS from what was proposed in the FSSP;
- Description of the method by which the number of samples was determined for each survey unit;
- Summary of the values used to determine the number of samples and a justification for these values;
- Survey results for each survey unit, including the following:
  - Number of samples taken for the survey unit;
  - Description of the survey unit, including (1) a map or drawing of the survey unit showing the reference system and random start systematic sample locations for Class 1 and 2 survey units, (2) discussion of remedial actions and unique features, and (3) areas scanned for Class 2 survey units;
  - Measured sample concentrations, in units that are comparable to the CGs;
  - Statistical evaluation of the measured concentrations;
  - Biased and miscellaneous sample data sets reported separately from those samples collected for performing the statistical evaluation;
  - Discussion of anomalous data, including any areas of elevated direct radiation detected during scanning that exceeded the investigation level or any measurement locations in excess of CG_W; and
  - Statement that a given survey unit satisfied the CG_W and the elevated measurement comparison if any sample points exceeded the CG_W;
- Description of any changes in initial survey unit assumptions relative to the extent of residual radioactivity (e.g., material not accounted for during site characterization); and

- Description of how ALARA (as low as reasonably achievable) practices were employed to achieve final activity levels.

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