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Title: Addendum to Sampling and Analysis Plan (SAP) for Assessment of LANL-Derived Residual Radionuclides in Soils within Tract A-16-d for Land Conveyance and Transfer for Sewage Treatment Facility Area

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Addendum to

Sampling and Analysis Plan (SAP) for Assessment of LANL-Derived Residual Radionuclides in Soils within Tract A-16-d for Land Conveyance and Transfer

for Sewage Treatment Facility Area

February 2016

1.0 Background

This addendum to the Sampling and Analysis Plan (SAP) for Tract A-16-d includes the area around the former sanitary waste treatment facility (STF) which was not sampled with the rest of the Tract (see Figure 1 of the SAP). The STF area is approximately 10,000 m^2 (2.5 acres). The full area of Tract A-16-d with the STF area included is approximately 380,000 m^2 (93 acres).

1.1 Site Location

The STF area and former LANL structures are indicated in Figure 3 of the SAP. Three buildings, a drying bed with concrete stem walls, and two concrete sumps were removed from the property in late 2015/early 2016. Five potential release sites associated with the STF were identified in the area, as described in Section 1.4 of the original SAP.

1.2 Radiological Release of Footprint Reduction Materials

Radiological characterization of the structural material of the decommissioned STF was conducted to satisfy the requirements of DOE Order 458.1 for release of personal property (i.e. building materials such as concrete and metal) to the public. The following two reports presented the results of characterization:

- MARSAME Release Report for TA-21 Buildings 227 (superstructure), 229, and 387 (November 2015)
- MARSAME Release Report for TA-21 Building 227 below-grade tanks and sumps (January 2016)

DOE concurrence was documented in emails referencing each release report (Rex Borders, DOE/NNSA NA-553, November 10, 2015 and January 26, 2016).

2.0 Data Quality Objectives for Sampling

The objective of sampling, fundamental statistical basis, and decision inputs for Tract A-16-d are provided in the original SAP. This Addendum adds the following decision area:

- STF Area – Class 2 Construction

The additional decision area is treated as Class 2 (due to elevated historical measurements in the outfall described in Section 3.1 below), and a construction scenario is used for consistency with the rest of the DP mesa top. Soil screening action levels (SALs) for construction users are more conservative than commercial/industrial SALs and include potential exposures due to future development of the property. If land use requirements change in the future, sampling could be targeted to the specific area of the proposed activity.

2.1 Quality Assurance

Measurement quality objectives, including sample collection and analysis procedures, are described in the original SAP. Statistical evaluation of the survey results will include data from the original three decision units in Tract A-16-d (DP Canyon, Mesa Top, and LA Canyon) as well as the STF area decision unit. For consistency with the stated approach in the original SAP, soil concentrations will be evaluated using Table B-1 of "Derivation and Use of Radionuclide Screening Action Levels, Revision 3" (LA-UR-014-29225, EP2014-0547).

3.0 Results of the Analysis for Sampling Number and Locations

Preliminary results were input into Visual Sample Plan to define sampling at 12 locations in the STF area decision unit. Additionally, a review of preliminary data and historical information indicate a potential for elevated radionuclide concentrations in the outfall, justifying biased samples at 4 additional locations.

3.1 Preliminary Results

The preliminary data included soil samples collected primarily in 2007 (2 measurements of Cs-137 were recorded in 2009) at various depths. Surface samples at two locations in the outfall area north of the sumps indicated elevated readings of Pu-239 above the levels anticipated for the mesa top: 84 pCi/g in one surface sample from location 21-27576 and 20 pCi/g in two surface samples from location 21-27579 (see Figure A1). The Am-241 results for these same locations were similarly elevated, with maximum values of 58.1 pCi/g and 8.41 pCi/g for 21-27576 and 21-27579, respectively. These results compare to construction worker SALs of 72 pCi/g for Pu-239 and 85 pCi/g for Am-241.

Historical information on the STF indicates that water containing process radionuclides may have traveled through the sanitary waste water system during early DP Mesa operations. In the outfall, seepage from leaks in the sewage line could have contributed to elevated soil concentrations of Pu-239 and Am-241.

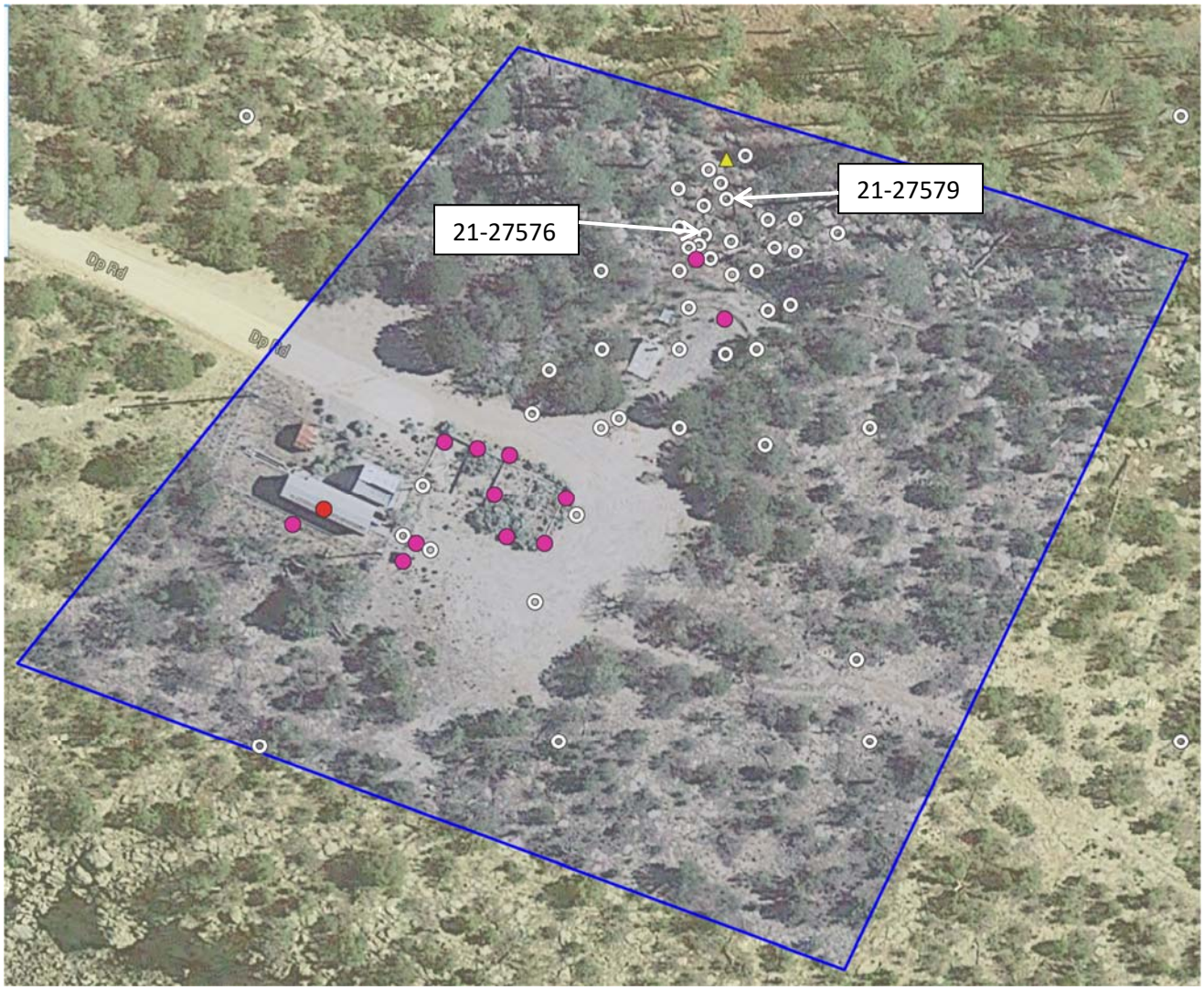


Figure A1. Preliminary sample locations from Intellus 2015 used to generate the tables below and define input parameters for this sampling plan addendum. Locations 21-27576 and 21-27579 had elevated results for Pu-239 and Am-241. ***Note***: STF area boundary is approximate.

Pu-239 [pCi/g]	
Mean	1.78
Standard Error	1.13
Median	0.02
Standard Deviation	9.96
Minimum	-0.01
Maximum	83.50
Count	77
Confidence Level(95.0%)	2.26
UCL Estimate	4.04

Cs-137 [pCi/g]	
Mean	0.10
Standard Error	0.02
Median	0.03
Standard Deviation	0.16
Minimum	0.04
Maximum	0.79
Count	78
Confidence Level(95.0%)	0.04
UCL Estimate	0.13

Am-241 [pCi/g]	
Mean	0.83
Standard Error	0.40
Median	0.03
Standard Deviation	5.27
Minimum	-0.27
Maximum	58.10
Count	174
Confidence Level(95.0%)	0.79
UCL Estimate	1.62

Sr-90 [pCi/g]	
Mean	0.01
Standard Error	0.01
Median	0.00
Standard Deviation	0.12
Minimum	0.49
Maximum	0.39
Count	75
Confidence Level(95.0%)	0.03
UCL Estimate	0.02

3.2 Sample Locations

Sampling in the STF area decision unit will include 12 samples on a triangular grid pattern (Class 2), and 4 biased samples in the former STF outfall. The approximate sample locations are indicated in Figure A2.

Figure A2. Map of sampling locations in the STF decision area for tract A-16-d. Grid locations are indicated with pink dots. Biased locations are indicated for STF-13 and STF-14 in the dash-outlined outfall area. Two additional biased locations should be field-located within the dash-outlined area. ***Note***: Map locations and boundaries are approximate.

3.2.1 Grid Locations

Grid location coordinates are provided in the following table. Locations were selected using a quasi-random number generator for x and y coordinates. VSP outputs are provided in Section 4.0.

Note: due to potential image distortion in VSP, some of the coordinates listed in the table may not accurately reflect the point shown in the image. Additionally, some of the locations may not be readily accessible. Samples may be field located or moved based on accessibility; accurate GPS locations should be recorded with the sample data.

Tract A-16-d STF Area Class 2 Construction (Systematic Triangular Grid Sampling – UTM Coordinates)		
	X Coordinate (m)	Y Coordinate (m)
STF-1	385532.7234	3970791.9149
STF-2	385563.5326	3970791.9149
STF-3	385594.3417	3970791.9149
STF-4	385548.1280	3970818.5964
STF-5	385578.9371	3970818.5964
STF-6	385609.7463	3970818.5964
STF-7	385563.5326	3970845.2779
STF-8	385594.3417	3970845.2779
STF-9	385625.1509	3970845.2779
STF-10	385578.9371	3970871.9594
STF-11	385609.7463	3970871.9594
STF-12	385640.5555	3970871.9594

3.2.2 Biased Locations

In addition to the 12 grid locations provided by VSP, biased sampling is proposed to better inform radiological release decisions based on the current state of the Tract. An additional 4 soil samples will be collected in the outfall as follows:

- STF-13: 1 sample at Location 21-27576 (*-106.26731, 35.87525*)
- STF-14: 1 sample at Location 21-27579 (*-106.26728, 35.87529*)
- STF-15&16: 2 samples at locations chosen by the sampling team to represent high-risk areas in the outfall (e.g. where the discharged water may have flowed or leaked from pipes)

4.0 VSP Output for A-16-d STF Area (Grid locations)

STF Area

Systematic sampling locations for comparing a median with a fixed threshold (nonparametric - MARSSIM)

Summary

This report summarizes the sampling design used, associated statistical assumptions, as well as general guidelines for conducting post-sampling data analysis. Sampling plan components presented here include how many sampling locations to choose and where within the sampling area to collect those samples. The type of medium to sample (i.e., soil, groundwater, etc.) and how to analyze the samples (in-situ, fixed laboratory, etc.) are addressed in other sections of the sampling plan.

The following table summarizes the sampling design developed. A figure that shows sampling locations in the field and a table that lists sampling location coordinates are also provided below.

SUMMARY OF SAMPLING DESIGN	
Primary Objective of Design	Compare a site mean or median to a fixed threshold
Type of Sampling Design	Nonparametric
Sample Placement (Location) in the Field	Systematic with a random start location
Working (Null) Hypothesis	The median(mean) value at the site exceeds the threshold
Formula for calculating number of sampling locations	Sign Test - MARSSIM version
Calculated total number of samples	11
Number of samples on map [a]	12

[a] This number may differ from the calculated number because of 1) grid edge effects, 2) adding judgment samples, or 3) selecting or unselecting sample areas.

Primary Sampling Objective

The primary purpose of sampling at this site is to compare a site median or mean value with a fixed threshold. The working hypothesis (or 'null' hypothesis) is that the median(mean) value at the site is equal to or exceeds the threshold. The alternative hypothesis is that the median(mean) value is less than the threshold. VSP calculates the number of samples required to reject the null hypothesis in favor of the alternative one, given a selected sampling approach and inputs to the associated equation.

Selected Sampling Approach

A nonparametric systematic sampling approach with a random start was used to determine the number of samples and to specify sampling locations. A nonparametric formula was chosen because the conceptual model and historical information (e.g., historical data from this site or a very similar site) indicate that typical parametric assumptions may not be true.

Both parametric and non-parametric equations rely on assumptions about the population. Typically, however, non-parametric equations require fewer assumptions and allow for more uncertainty about the statistical distribution of values at the site. The trade-off is that if the parametric assumptions are valid, the required number of samples is usually less than if a non-parametric equation was used.

Locating the sample points over a systematic grid with a random start ensures spatial coverage of the site. Statistical analyses of systematically collected data are valid if a random start to the grid is used. One disadvantage of systematically collected samples is that spatial variability or patterns may not be discovered if the grid spacing is large relative to the spatial patterns.

Number of Total Samples: Calculation Equation and Inputs
The equation used to calculate the number of samples is based on a Sign test (see PNNL 13450 for discussion). For this site, the null hypothesis is rejected in favor of the alternative one if the median(mean) is sufficiently smaller than the threshold. The number of samples to collect is calculated so that if the inputs to the equation are true, the calculated number of samples will cause the null hypothesis to be rejected.

The formula used to calculate the number of samples is:

$$n = \frac{(Z_{1-\alpha} + Z_{1-\beta})^2}{4(SignP - 0.5)^2}$$

where

$$SignP = \Phi\left(\frac{\Delta}{s_{total}}\right)$$

$\Phi(z)$ is the cumulative standard normal distribution on $(-\infty,z)$ (see PNNL-13450 for details),
n is the number of samples,
S_{total} is the estimated standard deviation of the measured values including analytical error,
Δ is the width of the gray region,
α is the acceptable probability of incorrectly concluding the site median(mean) is less than the threshold,
β is the acceptable probability of incorrectly concluding the site median(mean) exceeds the threshold,
$Z_{1-\alpha}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\alpha}$ is $1-\alpha$,
$Z_{1-\beta}$ is the value of the standard normal distribution such that the proportion of the distribution less than $Z_{1-\beta}$ is $1-\beta$.

Note: MARSSIM suggests that the number of samples should be increased by at least 20% to account for missing or unusable data and uncertainty in the calculated value of n. VSP allows a user-supplied percent overage as discussed in MARSSIM (EPA 2000, p. 5-33).

The values of these inputs that result in the calculated number of sampling locations are:

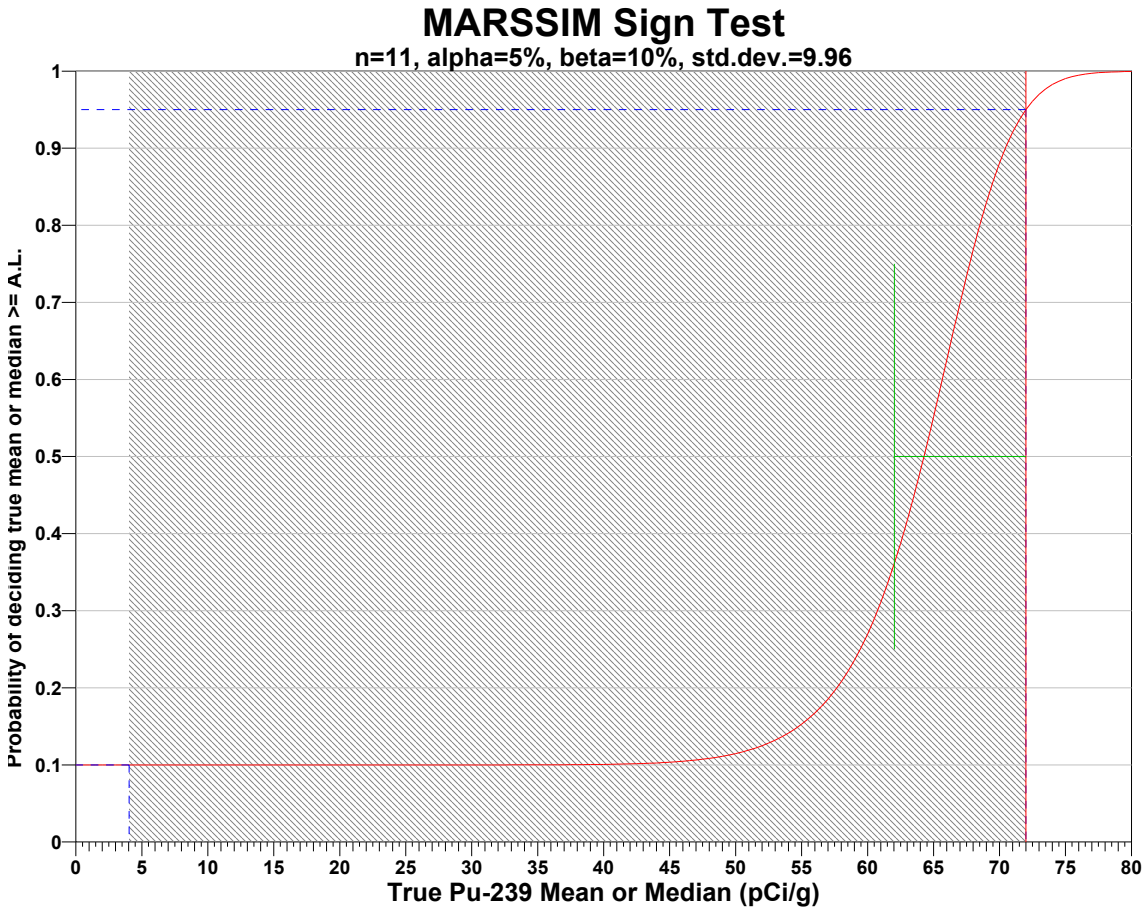
Analyte	n[a]	Parameter					
		S	Δ	α	β	$Z_{1-\alpha}$ [b]	$Z_{1-\beta}$ [c]
Pu-239	11	9.96 pCi/g	67.96 pCi/g	0.05	0.1	1.64485	1.28155
Cs-137	11	0.16 pCi/g	17.87 pCi/g	0.05	0.1	1.64485	1.28155

[a] The final number of samples has been increased by the MARSSIM Overage of 20%.
[b] This value is automatically calculated by VSP based upon the user defined value of α.
[c] This value is automatically calculated by VSP based upon the user defined value of β.

The following figure is a performance goal diagram, described in EPA's QA/G-4 guidance (EPA, 2000). It shows the probability of concluding the sample area is dirty on the vertical axis versus a range of possible true median(mean) values for the site on the horizontal axis. This graph contains all of the inputs to the number of samples equation and pictorially represents the calculation.

The red vertical line is shown at the threshold (action limit) on the horizontal axis. The width of the gray shaded area is equal to Δ; the upper horizontal dashed blue line is positioned at $1-\alpha$ on the vertical axis;

the lower horizontal dashed blue line is positioned at β on the vertical axis. The vertical green line is positioned at one standard deviation below the threshold. The shape of the red curve corresponds to the estimates of variability. The calculated number of samples results in the curve that passes through the lower bound of Δ at β and the upper bound of Δ at 1-α. If any of the inputs change, the number of samples that result in the correct curve changes.



Statistical Assumptions

The assumptions associated with the formulas for computing the number of samples are:

1. the computed sign test statistic is normally distributed,
2. the variance estimate, S^2, is reasonable and representative of the population being sampled,
3. the population values are not spatially or temporally correlated, and
4. the sampling locations will be selected probabilistically.

The first three assumptions will be assessed in a post data collection analysis. The last assumption is valid because the gridded sample locations were selected based on a random start.

Sensitivity Analysis

The sensitivity of the calculation of number of samples was explored by varying the standard deviation, lower bound of gray region (% of action level), beta (%), probability of mistakenly concluding that μ > action level and alpha (%), probability of mistakenly concluding that μ < action level. The following table shows the results of this analysis.

Number of Samples						
	α=5		α=10		α=15	
	s=0.32	s=0.16	s=0.32	s=0.16	s=0.32	s=0.16

LBGR=90	**β=5**	14	14	11	11	10	10
	β=10	11	11	9	9	8	8
	β=15	10	10	8	8	6	6
	β=5	14	14	11	11	10	10
	β=10	11	11	9	9	8	8
	β=15	10	10	8	8	6	6
	β=5	14	14	11	11	10	10
	β=10	11	11	9	9	8	8
	β=15	10	10	8	8	6	6

s = Standard Deviation
LBGR = Lower Bound of Gray Region (% of Action Level)
β = Beta (%), Probability of mistakenly concluding that μ > action level
α = Alpha (%), Probability of mistakenly concluding that μ < action level
AL = Action Level (Threshold)

Recommended Data Analysis Activities

Post data collection activities generally follow those outlined in EPA's Guidance for Data Quality Assessment (EPA, 2000). The data analysts will become familiar with the context of the problem and goals for data collection and assessment. The data will be verified and validated before being subjected to statistical or other analyses. Graphical and analytical tools will be used to verify to the extent possible the assumptions of any statistical analyses that are performed as well as to achieve a general understanding of the data. The data will be assessed to determine whether they are adequate in both quality and quantity to support the primary objective of sampling.

Because the primary objective for sampling for this site is to compare the site median(mean) value with a threshold value, the data will be assessed in this context. Assuming the data are adequate, at least one statistical test will be done to perform a comparison between the data and the threshold of interest. Results of the exploratory and quantitative assessments of the data will be reported, along with conclusions that may be supported by them.