LA-UR-14-22571

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Title:	Sampling and Analysis Plan (SAP) for Assessment of LANL-Derived Residual Radionuclides in soils within Tract A-5-2 for Land Transfer Decisions
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Intended for:	Internal report Report Environmental Programs
Issued:	2014-04-16

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Sampling and Analysis Plan (SAP) for Assessment of LANL-Derived Residual Radionuclides in Soils within Tract A-5-2 for Land Transfer Decisions

April 2014

1.0 Background for A-5-2

1.1 Site Location

The A-5-2 Tract is located just west of the eastern boundary of DP Mesa, Technical Area-21 (TA-21) and south of Highway 502 (Figure 1). This A-5-2 Tract is a revision of the original tract and now stops approximately at the northern boundary of the DP Canyon floodplain an extends from the A-10 tract downstream. The tract consists of the DP Canyon portion of the "Airport Tract" (DOE 1999). This tract contains undeveloped hillslope and canyon bottom accessed from DP Road. Vegetation includes ponderosa and piñon-juniper woodlands with open shrub, grasslands, and wildflower areas; A-5-2 is considered potentially sensitive wildlife habitat. DP Canyon has an ephemeral stream and receives runoff from surrounding mesas and areas.

The legal property boundary description of this tract is provided by the U.S. Army Corps of Engineers' *Land Survey Plat, Los Alamos National Laboratory, Tract A-10, Being a Part of Tract AA and Parcel 2, Eastern Area No. 2, County of Los Alamos, State of New Mexico,* recorded by the Los Alamos County Clerk on March 18, 2003 (NEED FINAL BOUNDRY DESCRIPTION).

1.2 General History

Historical maps from the pre-LANL era (1924), aerial photographs (1935), and historical accounts of life in the area show little development prior to LANL occupancy (pre World War II). Detroit businessman Ashley Pond started the "Los Alamos Ranch School" in 1917. The school began with a few ranch buildings from the Harold H. Brook homestead.

Laboratory operations began on nearby DP Mesa, just south of Tract A-5-2, in the late 1940s. Plutonium processing operations were conducted on DP Mesa in Tract A-16 in the technical area TA-21. Additionally, waste disposal operations were conducted at what is now designated Material Disposal Area B (MDA B) on the mesa-top in the western portion of Tract A-16. Tract A-5-2 has remained vacant throughout.

There are no Potential Release Sites (PRSs) located on the A-5-2 tract, but there are several PRSs that are associated with the historical Laboratory operations on adjacent lands.

1.3 Current Use

Tract A-5-2 is unoccupied, vacant land. No structures or facilities associated with LANL's federal, state, or local permits (such as air monitoring stations, radiation monitoring stations, or wastewater discharge outfalls) are located within the tract. The tract was never actively used by the Laboratory, no Laboratory operations were conducted within the tract boundaries, and no Laboratory structures were situated within the tract.

1.4 Summary of Historical Evaluation of LANL Impact

There are records of radioactive materials being spilled into the canyon bottom (Cs-137 and Sr-90 and Am-241) and air fall from historical operations at TA-21, southeast of this tract, and stack emissions from TA-1 may have resulted in surface deposition of radionuclides, particularly plutonium.

Tract A-5-2 does not meet the CERCLA 120(h) "uncontaminated" definition, even though DOE/NNSA and LANL believe all remedial actions necessary to address the known contamination on this tract, and allow its unrestricted transfer, have been completed according to the requirements of PL 105-119. Because the tract is not "uncontaminated," CERCLA Section 120(h)(4) is not applicable.

1.4.1 Adjacent Properties with Known or Suspected Releases

SWMU 21-029 and Consolidated Unit 21-021-99 are located immediately west of the A-5-2 tract. The remainder of the DP Canyon PRS, AOC C-00-021 is located directly west (upgradient) of the A-5-2 tract. See Appendix C in Swanton et al. (2006) for the history of use, site investigation and remediation activities, and current regulatory status of the PRSs in this tract.

SWMU 21-011(k) is an outfall that discharged into the south side of DP Canyon resulting in primarily Cs-137, Sr-90 and Am-241 soil contamination. This contamination is mainly confined to SWMU-21-011(k) and in downstream sediments within the floodplain. Both the DP Canyon floodplain and SWMU 21-029 are adjacent to A-5-2 along the southern boundary (Figure 2), and the radionuclide concentrations of these soils are lower than limits for recreational use (LANL 2004).

1.5 Preliminary Results from Surveys for Residual Contamination

Preliminary data was taken from soil surface samples collected in Tract A-5-2. Figure 2 shows the sample locations used in this analysis, and Table 1 provides the measured soil concentrations for the primary radionuclides of interest. The summary statistics in Table 1 show that the soil concentrations are at nominal background levels except for Pu-238 and Pu-239. Comparisons of soil concentrations show that all radionuclide concentrations are several orders of magnitude below the recreational use and the construction worker SALs (Table 1).

1.6 Conclusions regarding the classification of Tract A-5-2 relative to potential for residual radioactive contamination

There are properties adjacent or near to Tract A-5-2 that are either contaminated or have emitted radionuclides historically, and the preliminary data suggest LANL impact. Thus, residual contamination may exist on A-5-2 that was deposited from activities conducted by neighboring LANL operations from the late 1940s through the 2000s. However, the soil concentrations of radionuclides in soil from the preliminary set of measurements suggest that general levels are likely to be substantially below all SALs for recreational use and near background levels. Thus, DOE/NNSA believes no additional remedial activities are needed on the A-5-2 tract. Based on this assessment, the A-5-2 tract qualifies as a Class 3 area under MARSSIM (i.e., potentially impacted with concentrations of residual radioactive material in soils elevated, but likely to be below thresholds for the intended land uses and close to background levels (MARSSIM 2000). The Class 3 designation is modified further by the projected recreational land use. Regarding the recreational use designation, the exposure scenario would be for use of the entire tract for periodic recreation (hiking, biking, etc.) and the decision area would be the entire tract. If future use designation changes in these areas, to industrial use, for example, sampling plans for specifically identified areas of construction could be considered.

2.0 Data Quality Objectives for Sampling and Analysis Plan

The sampling and analysis plans (SAPs) for Tract A-5-2 follows the LANL (2012b) procedure EDA-QP-238, "Dose assessment data quality objectives for land transfers into the public domain."

2.1 Objective of the SAP

The objective of this sampling and analysis plan is to confirm, within the stated statistical confidence limits, that the mean levels of potential radioactive residual contamination in soils in the tract A-5-2 is documented, in appropriate units, and is below the 15 mrem yr^{-1} for public recreational use. The Screening Action Levels (SALs), as derived in LANL (2012) for a recreational scenario are provided in Table 1. **This and other SALs are used by LANL as preapproved Authorization Limits (ALs), as required in DOE Order 458.1 (section 2.k.(6)(f)2 in the contractors Requirements Document), and are identified as ALs in the rest of this SAP with regards to statistical decisions.**

2.2 Decision identification

The principle study question is: Does the residual radioactive contamination exceed ALs for the recreational exposure scenario in the area within A-5-2? The decision alternatives are:

- If results from the soil radioactive contamination measurements are at or above the AL (collectively), the site is not a candidate for land transfer.
- If results from the soil radioactive contamination measurements are below the AL (collectively), the site is a candidate for land transfer.

2.3 Inputs into the Decision

The assumed near-term future land use and exposure pathway assumes recreational use. ALs used for all the radionuclides analyzed for and the respective SALs are provided in Table 1 and the derivation of the SALs is provided in LANL (2012). The 15 mrem yr^{-1} SALs used in this analysis were calculated using RESRAD (RESRAD 2001) and documented in LANL (2012).

Data to be used in the analysis include preliminary surface soil concentration measurements (see Figure 2 for locations and Table 1 for the data used).

The unity rule will be applied because there are multiple radionuclides in the analysis. The formula used in for the unity rule is:

$$\frac{C_1}{AL_1} + \frac{C_2}{AL_2} + \frac{C_3}{AL_3} \ldots \ldots \frac{C_n}{AL_n} \leq \mathbf{1} \qquad \text{(eqn. 1)}$$

where $C_{1\text{-}n}$ and $AL_{1\text{-}n}$ are the upper-bound estimates of the mean concentrations for radionuclides (e.g., upper 95% values) and Authorized Levels 1 through n, respectively.

2.4 Study Boundaries

The study is limited to Tract A-5-2, as identified in Figure 1. As concluded from historical information and previous sediment sampling, the list of radionuclides in the analysis include Am-241, Cs-137, Co-60, H-3, Pu-238, Pu-239, Sr-90, U-234, U-235, and U-238. Individual doses are evaluated out to 1000 years.

2.5 Decision Rule

The decision rule is based on the null hypothesis that the mean residual contamination levels in soil and/or sediment in Tract A-5-2 combined over all radionuclides is above the AL and likely to result in an all-pathway radiation dose to the critical receptor above 15 mrem yr^{-1}. The alternative hypothesis is that the mean residual contamination levels in soil and/or sediment in Tract A-5-2 combined over all radionuclides is below the AL and not likely to result in an all-pathway radiation dose to the critical receptor above 15 mrem yr^{-1}.

2.6 Limits on Decision Errors

The acceptable statistical errors for this analysis are that Type I error (i.e., conclude contamination levels at site are < AL when in fact it is > AL) has a probability of $p < 0.05$; and the Type II error is (i.e., conclude soil contamination level is > AL when in fact it is < AL) has a probability of $p < 0.1$. Normality of the distribution for the preliminary data is not assumed.

2.7 Optimization of Design Process

The survey design is optimized by analyzing historical information data. Specifically, there is no evidence of radiological operations within Tract A-5-2, but the preliminary data suggest there is evidence of impact from surrounding LANL operations though the soil concentrations are expected to be substantially lower than the SALs. Thus, the entire tract will be treated as a Class 3 area optimizing the number of required sample locations based on recreational land use. If land use requirements change in the future, sampling could be targeted to the specific area of the proposed activity, depending on the specifics of the activity.

2.8 Statistically-Based Evaluation for Number of Samples Required using MARSSIM

Google Earth was used to download a map of the Tract A-5-2 area, which was then incorporated into Visual Sampling Plan (VSP) software (Matzke et al. 2010). The approximate boundary of the tract was then delineated as a sampling area (Figure 3). The MARSSIM application within VSP was then used to determine the statistically-based sampling plan. The preliminary sampling data in Table 1 was used to determine the standard deviations needed for calculating the needed number of samples for each of the identified radionuclides. All sampling locations were randomly determined.

2.9 Instrumentation and Measurement Quality Objectives

The main objectives are to determine appropriate analysis techniques for each radionuclide and ensure Measurement Quality Objectives are satisfied. One should be confident that the measurement results are valid and appropriate for the decisions being made.

2.9.1 Measurement Quality Objectives:

- Detection Capability: Minimum Detection Concentration (MDC) should be below the MARSSIM defined Lower Bound of the Gray Region (LBGR).
- The degree of measurement uncertainty (combined precision and bias) should be reported and the level should be reasonable relative to the needed accuracy of the decision and accounted for in the statistical analysis.
- Range of the instrument and measurement technique should be appropriate for the concentrations expected.
- The instrument and measurement technique should be specific for the radionuclide(s) being measured. Specificity is the ability of the measurement method to measure the radionuclide of concern in the presence of interferences.
- For field instruments, the instrument should be rugged enough to consistently provide reliable measurements. However, in this case, all samples will be analyzed in the laboratory.

2.9.2 Procedures used to meet these measurement quality objectives:

1) Collection of valid soil sample appropriate for the dose assessment,
    a. Sampling of soil will be done using LANL (2012a) procedure SOP-5132 “Collection of soil and vegetation samples for the environmental surveillance program.” These are surface soil samples appropriate for the deposition pathway and the exposure scenario (i.e., top 5 cm). Subsurface soil samples are not required as depositions would be to surfaces with little migration to deeper soil expected.
    b. Additional quality assurance for the collection of the samples is provided through LANL (2008) procedure QAPP-0001 “Quality and assurance project plan for the soils, foodstuffs, and non foodstuff biota monitoring project.”
2) Soil sample analysis using appropriate EPA approved analytical procedures for each radionuclide. The following will be used by the independent laboratory:
    a. Environmental Measurements Laboratory (EML). **The procedures manual of the Environmental Measurements Laboratory**. Report HASL-300; 1997. Radionuclide specific procedures for the radionuclides of Am-241, Pu-239 and U-238 are provided in EML (EML 1997).
    b. Environmental Protection Agency (EPA). **Method 901.1 - Gamma Emitting Radionuclides in Drinking Water***: Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, EPA 600/4-80-032, prepared by EPA’s Environmental Monitoring and Support Laboratory, August 1980 (EPA 1980). Available from NTIS, document no. PB 80-224744.

c. Environmental Protection Agency (EPA). **Method 905.0 - Radioactive Strontium in Drinking Water***: Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, EPA 600/4-80-032, prepared by EPA's Environmental Monitoring and Support Laboratory, August 1980 (EPA 1980). Available from U.S. Department of Commerce, National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, document no. PB 80-224744.
d. Environmental Protection Agency (EPA). **Method 906.0 - Tritium in Drinking Water***: Prescribed Procedures for Measurement of Radioactivity in Drinking Water*, EPA 600/4-80-032, prepared by EPA's Environmental Monitoring and Support Laboratory, August 1980 (EPA 1980). Available from U.S. Department of Commerce, National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161, document no. PB 80-224744.

After the measurements are completed, the laboratory results in units equivalent to the ALs will be evaluated with respect to the MQOs, as stated above.

2.10 Statistical Evaluation of the Survey Results

All the applicable data that has passed the MQO evaluation will be used to determine the upper-bound estimate of the mean for soil concentrations (generally, the 95% value) for each radionuclide. The EPA software ProUCL (EPA 2010) will be used to determine this value. The statistical decision as to whether the residual soil contamination levels (i.e., the 95% UCLs) are below the authorized limits will be evaluated using the following criteria. All analyses and results will be documented.

Decision Criteria:

1) When evaluating individual sample results, if all samples are ≤ the recreational AL, then no further action is required and the site passes the criteria for recreational occupation. No further actions are needed.

2) If all individual samples or the UCL are > the recreational AL, then the site is not a candidate for release and site remediation is needed, followed by resampling before it can be released.

3) If the UCL is below the AL but some individual measurements are above the AL, then statistical analysis is needed. Generally, non-parametric statistical approaches are used to evaluate the null hypothesis. If contamination is present in background, the Wilcoxon Rank Sum test is suggested, and if contamination is not present in background or very low relative to the AL, use the Sign Test. For Tract A-5-2, the Sign Test will be used with a $p < 0.05$ decision threshold for significance. See MARSSIM chapter 8 for details and examples.

4) Alternatively, one could confirm that the ratio of the upper-confidence level (UCL) of the average concentration divided by the AL and the sum of hot spot activity ratios do not exceed 1, as show in Equation 3.

$$\frac{\overline{C}_{UCL}}{C_{AL}} + \sum_{i=1}^{n} \frac{C_{i,C>AL}}{C_{AL} * AF} \leq 1 \qquad \text{(eqn. 2)}$$

Here $\overline{C}_{UCL}$ is the 95% upper bound estimate of the concentration mean, C_{AL} is the recreational AL (15 mrem yr^{-1}), $C_{i,c>AL}$ is the sample concentration for a single sample above the AL (i.e., has elevated measured concentrations), and *AF* is the Area Factor [ratio of effective dose calculated for area of contamination normalized to effective dose calculated for 10,000 m^2 (RESRAD default)]. If value in eqn. 2 is > 1, the site is a candidate for further characterization of the nature and extent of the contamination, remediation of the site, follow up confirmatory sampling, and reanalysis against the decision criteria in this section. Area Factors are dependent on the exposure scenario and should be calculated individually.

5) If there are multiple radionuclides (*i*) being evaluated in a sampling unit, the sum of the ratios should be less than or equal to 1, as shown in eqn. 1.

6) The dose assessment based on the soil measurements will include the sum of doses from all radionuclides, and this sum will be compared to the 3 mrem/yr threshold for follow up ALARA analysis.

3.0 Results of the Analysis for Sampling Number and Locations

The specific details of the analysis using MARSSIM and the results are provided in Attachment 1 of this report. Results showed that 11 randomly-sited samples were needed within Tract A-5-2. The approximate locations are drawn on Figure 3. Locations were randomly selected using a quasi-random number generator for x and y coordinates (Matzke et al. 2010). The specific statistical parameter values, analysis, results, and approximate coordinates for the randomly selected sampling locations are provided in the summary report (Attachment1).

4.0 REFERENCES

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4.1 HISTORICAL RECORDS AND OTHER PERTINENT DOCUMENTS

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Table 1. Summary of preliminary data and comparisons to background and relevant SALs. Measurements are in units of pCi/g.

Radionuclide	Mean (1std)	Background	Recreational SAL	Construction Worker SAL
Am-241	0.077 (0.079)	0.013	280	34
Cs-137	0.351 (0.172)	1.65	210	18
Co-60	-0.003 (0.004)		46	4.1
Tritium	-0.907 (0.928)	0.08	5.3E6	3.2E5
Pu-238	0.009 (0.011)	0.023	330	40
Pu-239	0.500 (0.407)	0.054	300	36
Sr-90	0.194 (0.161)	1.31	5600	800
U-234	0.936 (0.242)	2.59	3200	220
U-235	0.033 (0.013)	0.2	520	43
U-238	0.988 (0.207)	2.29	2100	160

Figure 1. Map of the A-5-2 Tract.

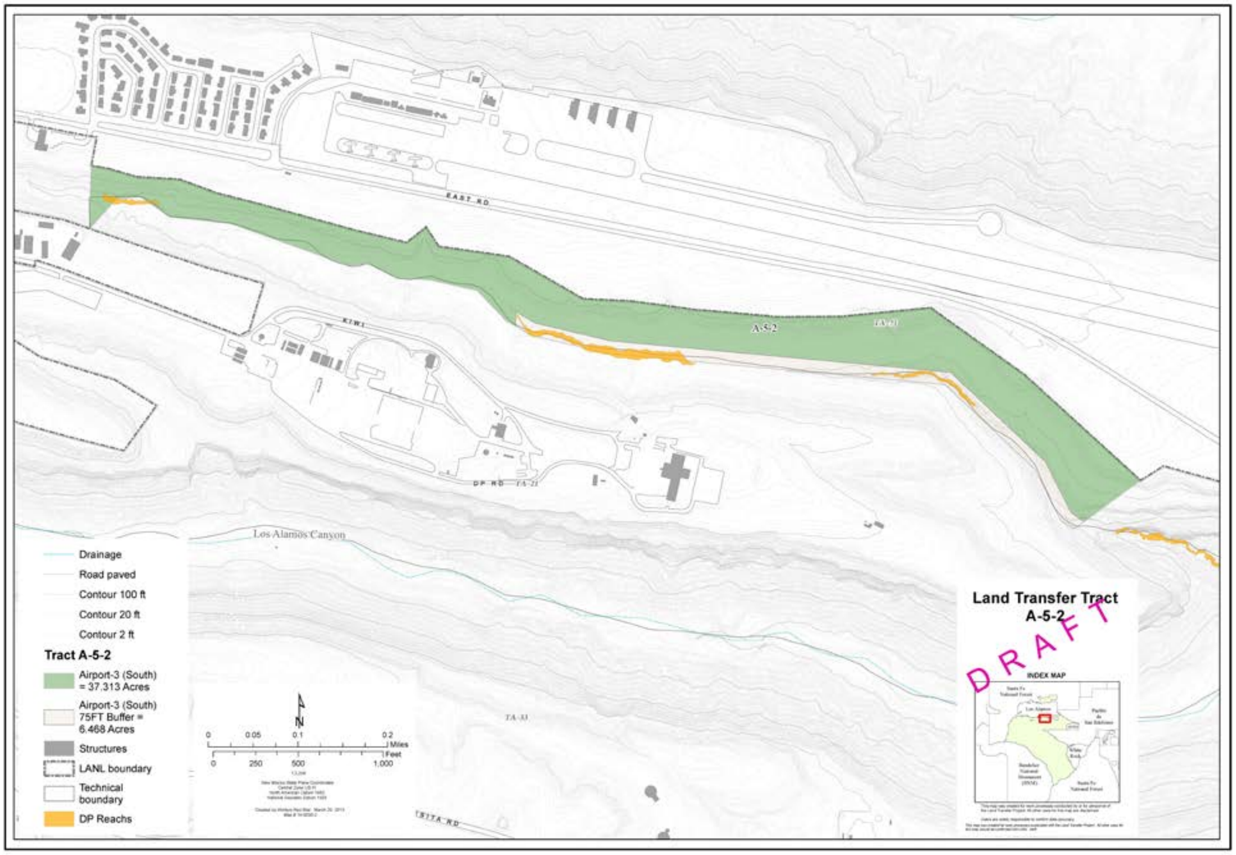


Figure 2. Map of previous sampling locations in DP Canyon. Data from sample locations 21-99, 21-100, 21-101, 21-102, 21-108, 21-109, 21-112, 21-113, and 21-114 (the north side of the canyon) were used in the preliminary assessment for development of the final SAP.

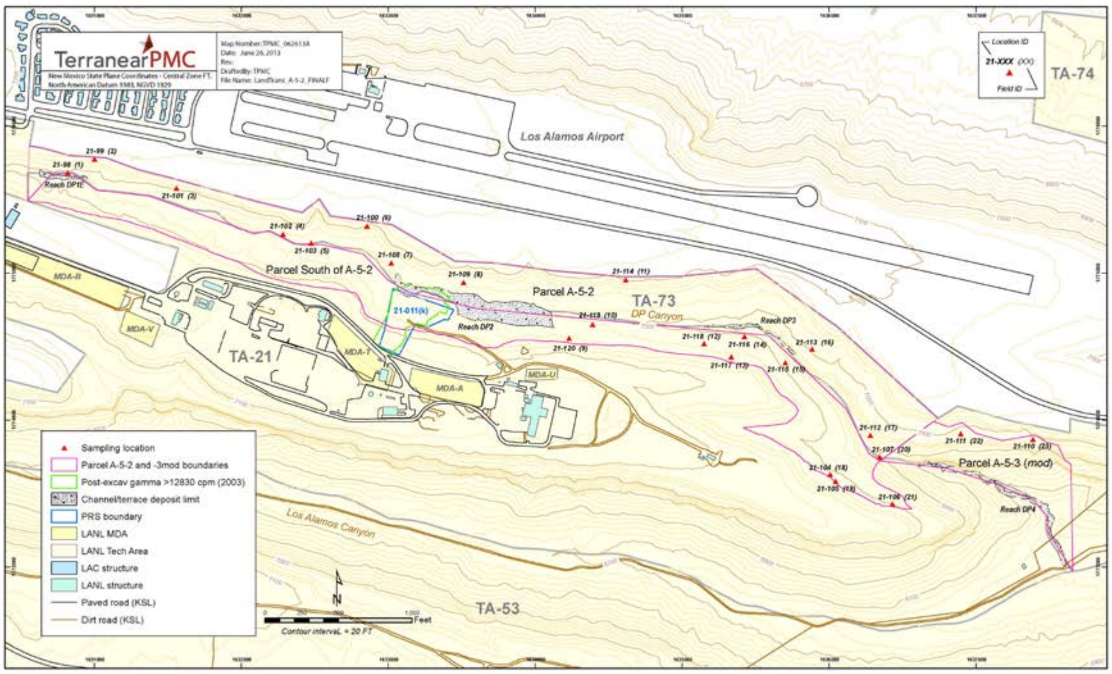
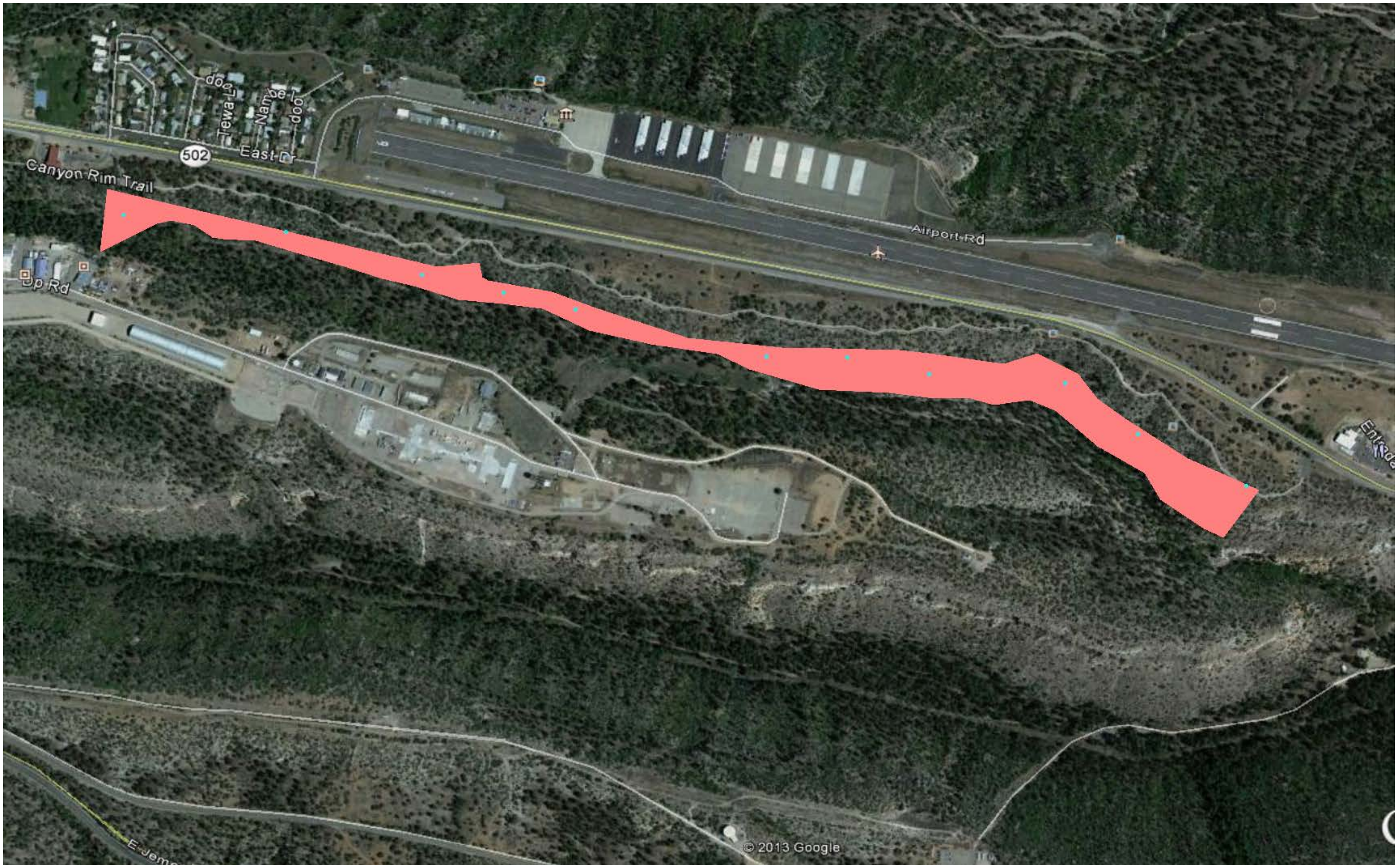


Figure 3. Map of sampling locations in A-5-2 Tract.



ATTACHMENT 1

Random 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	Simple random sampling
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]	11
Number of selected sample areas [b]	1
Specified sampling area [c]	109680.30 m^2

[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.
[b] The number of selected sample areas is the number of colored areas on the map of the site. These sample areas contain the locations where samples are collected.
[c] The sampling area is the total surface area of the selected colored sample areas on the map of the site.

Area: Area 5					
X Coord	Y Coord	Label	Value	Type	Historical
384467.3033	3971428.6450			Random	
384964.1757	3971295.9403			Random	
384839.9576	3971325.4302			Random	
384187.8126	3971458.1349			Random	
385429.9935	3971214.8430			Random	
385926.8659	3971082.1382			Random	
385802.6478	3971170.6081			Random	
386113.1930	3970994.0325			Random	
385290.2482	3971215.2070			Random	
384700.2122	3971355.2842			Random	
385569.7389	3971185.7171			Random	

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 random sampling approach 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 randomly provides data that are separated by many distances, whereas systematic samples are all equidistant apart. Therefore, random sampling provides more information about the spatial structure of the potential contamination than systematic sampling does. As with systematic sampling, random sampling also provides information regarding the mean value, but there is the possibility that areas of the site will not be represented with the same frequency as if uniform grid sampling were performed.

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]
Cs-137	11	0.172 pCi/g	209 pCi/g	0.05	0.1	1.64485	1.28155
Am-241	11	0.079 pCi/g	889 pCi/g	0.05	0.1	1.64485	1.28155
Co-60	11	0.004 pCi/g	45 pCi/g	0.05	0.1	1.64485	1.28155
Pu-238	11	0.011 pCi/g	849 pCi/g	0.05	0.1	1.64485	1.28155
Pu-239	11	0.011 pCi/g	769 pCi/g	0.05	0.1	1.64485	1.28155
Sr-90	11	0.161 pCi/g	3199 pCi/g	0.05	0.1	1.64485	1.28155
U-234	11	0.242 pCi/g	2299 pCi/g	0.05	0.1	1.64485	1.28155
U-235	11	0.013 pCi/g	569 pCi/g	0.05	0.1	1.64485	1.28155
U-238	11	0.207 pCi/g	1699 pCi/g	0.05	0.1	1.64485	1.28155
H-3	11	0.928 pCi/g	129999 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.

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 randomly.

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

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							
AL=3200		α=5		α=10		α=15	
		s=0.322	s=0.161	s=0.322	s=0.161	s=0.322	s=0.161
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
LBGR=80	β=5	14	14	11	11	10	10
	β=10	11	11	9	9	8	8
	β=15	10	10	8	8	6	6
LBGR=70	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.

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