LA-UR-19-28760
Approved for public release; distribution is unlimited.

Title:	Radiological Survey of Pajarito Site (Technical Area 18) for the Manhattan Project Historical Park
Author(s):	Whicker, Jeffrey Jay
Intended for:	Report
Issued:	2019-08-29

Radiological Survey of Pajarito Site (Technical Area 18) for the Manhattan Project Historical Park

Jeffrey J. Whicker, EPC-ES

Introduction

The Manhattan Project National Historical Park (Park) was established on November 10, 2015. Through a collaborative partnership between the National Park Service (NPS) and the U.S. Department of Energy (DOE), it is managed to preserve, interpret, and facilitate access to key historic resources associated with the Park. The Manhattan Project was a top-secret national mobilization of scientist, engineers, technicians, and military personnel responsible for producing a deployable atomic weapon during World War II (NPS and DOI 2017). After a strategic planning workshop for the Park in August 2016, participants there published the vision statement for the Park, "Manhattan Project National Historical Park inspires people to explore, debate, and reflect upon difficult events associated with the United States' role in World War II that led to world-changing innovation in science, engineering, and technology" (NPS and DOI 2017). The Park subsumes three different city-states: Los Alamos, New Mexico; Hanford, Washington; and Oak Ridge, Tennessee. Several of these historical buildings and sites reside within the boundaries of Los Alamos National Laboratory (LANL). Research in atomic weapon development in Los Alamos involved working with radiological and chemical materials at levels that could be hazardous. To ensure the safety of the public visiting the Park, the potential hazards were assessed. This report summarizes the survey results for radionuclide measurements made inside the Slotin Building, Pond Cabin, Battleship Bunker, and soils neighboring these structures. The information and data provided herein show that potential radiation dose to the public are negligible and within public dose limits per Department of Energy (DOE) Order 458.1, "*Radiation Protection of the Public and the Environment*", (DOE 2013).

Pajarito Site and a brief history of its buildings

The Pajarito Site (TA-18) is within the Park boundaries and is nested within the boundaries of LANL. An aerial view of the Pararito Site and associated buildings is shown in Figure 1. Past and more recent soil sampling and interior surface sampling were used to evaluate the potential for residual radionuclides. This information combined was used to make decisions regarding public access to Pajarito Site and its associated buildings. From these results, the public could be permitted access to the Slotin Building, Pond Cabin, Battleship Bunker, and surrounding soils.

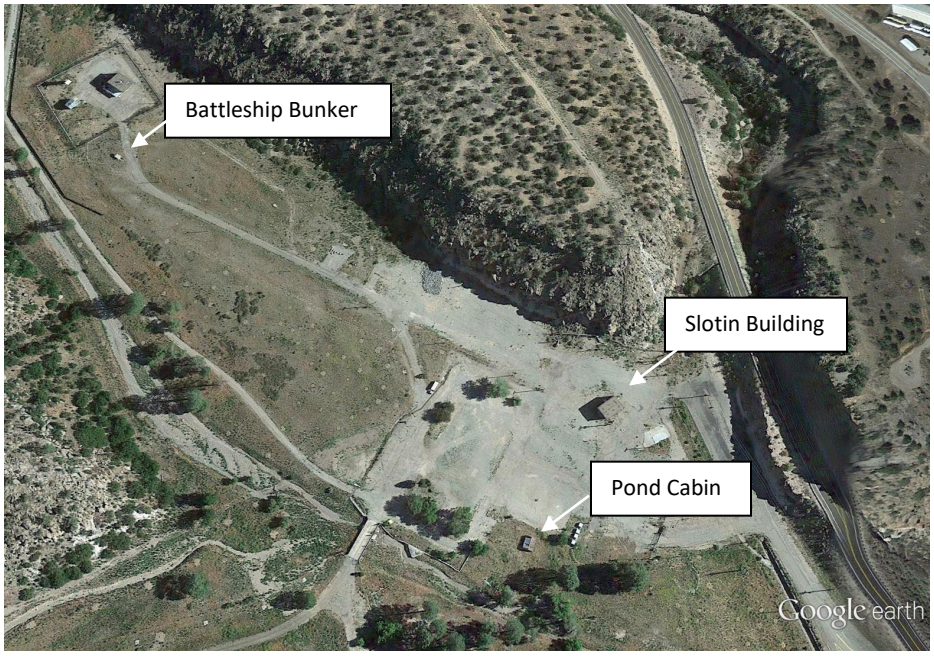

Figure 1. Aerial view of the Pajarito Site (TA-18) (Google Earth).

Pond Cabin (TA-18-29). A settler, Ashley Pond, built the Pond Cabin in 1914 (Figure 2), and used it as a private hunting ranch. Later, this building was appropriated to the federal government, and Los Alamos scientists used it as an office supporting plutonium criticality research (NPS and DOI 2017). No known radiological activities took place in the building. However, some outdoor explosive testing with uranium isotopes took place near its vicinity. Previous soil and sediment sampling outside the cabin's location and within TA-18 floodplain showed low levels of U-234/235 (results from database in Intellus 2015).

Figure 2. The Pond Cabin looking west.

Battleship Bunker (TA-18-2). The bunker (Figure 3) was built in 1944. Its design was a cast-in-place concrete bunker. It was known as the "battleship bunker building" because the west end of the building is shaped like a bow of a ship, was shielded from blast debris with a steel plate (NPS and DOI 2017). No known radiological activities took place within the building. However, outdoor explosive testing with uranium radioisotopes took place near its vicinity. Low levels of U-234/235/238 were found in local soil and sediment (results from database in Intellus 2015).

Figure 3. The Battleship Bunker's access door is shown above and the front steel plate is on the opposite side of the access door.

Slotin Building (TA-18-1). The Slotin Building (Figure 4) was constructed in 1946 at the end of the Manhattan Project (NPS and DOI 2017). It was used for criticality research. Louis Slotin, a scientist, was conducting such research when a criticality accident occurred, killing him a few days later (NPS and DOI 2017). There were radiological operations within the building, however criticality experiments were later moved to other buildings. The integrated neutron flux from the limited number of criticality experiments in the Slotin accident was not sufficient to create long-lived activation radionuclides such as Eu-152 or Co-60.

Figure 4. The Slotin Building's main access door is to the left and the larger doors with the extending crane boom is to the right.

Methods

Public tours in the future could include access to the inside of the buildings and areas immediately outside the structures. Therefore, measurement results for residual radionuclides on building surfaces and in neighboring soil and sediment were evaluated against regulatory requirements for public safety.

Building Interior Sampling

Given the little historical data available on surface contamination inside the buildings, a LANL survey plan, "*Survey Plan for Visitor Access into the Slotin Building, Pond Cabin, and Battleship Bunker Rev. 0, 09/20/2016*" was developed to measure for surface contamination inside the three buildings (Attachment 1). While public access to the Slotin Building is most likely to be restricted for now, access to the interior of all the buildings in TA-18 may be granted in the future. Therefore, all building interior surfaces were surveyed for residual radioactivity and the results documented herein. The protocols used for this survey are detailed in the LANL procedure, "*Surveying for Fixed and Removable Contamination*," (LANL 2017). Scans for gamma exposure rates within the interior surfaces of the buildings were performed to measure for areas of elevated gamma fields, and nothing above background levels were noted. Measurement results were compared to surface contamination limits provided in LANL Policy P121 "*Radiation Protection*" (LANL 2019), as show in Table 1.

Table 1. DOE preapproved authorized limits for surface radioactivity (DOE 2013).

Surface Contamination Values from EPC-ES-FSD-004 Section 1021 Table 10-2.		
U-natural, U-235, U-238, and associated decay products (Removable)	1,000	dpm/100 cm^2
U-natural, U-235, U-238, and associated decay products (Total)	5,000	dpm/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129 (Removable)	20	dpm/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129 (Total)	100	dpm/100 cm^2
Th-natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133 (Removable)	200	dpm/100 cm^2
Th-natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133 (Total)	1,000	dpm/100 cm^2
β/γ emitters (Removable)	1,000	dpm/100 cm^2
β/γ emitters (Total)	5,000	dpm/100 cm^2
Tritium and Special Tritium Compounds	10,000	dpm/100 cm^2

Field Soil and Sediment Sampling in TA-18

Soil sample results from past investigations

Soil and sediment were previously sampled in the TA-18 area, and the data is publically available through the Intellus database (Intellus 2015). Historical records suggest that outdoor explosive testing with uranium took place adjacent to CASA 1 (just west of Battleship Bunker), and above background levels of U-234/235/238 were found in the local soil and sediment within this general area (Figure 5).

Figure 5. The shaded blue area represents the approximate boundaries of the Manhattan Project Historical Park (cite photo).

There were no soil measurements at locations next to the three buildings in TA-18. Because the public is expected to congregate around the buildings during tours, additional soil samples around the buildings.

Current protocols used for soil sampling

LANL's Sampling and Analysis Plan (SAP) (Attachment 2) was developed for sampling soils along the perimeter of the buildings, where construction activities and public tours are scheduled (Figure 6). The soil sampling results are then evaluated by a third party to ensure any residual radionuclides are below screening levels for construction and public visitation purposes.

Figure 6. Map showing the locations of the soil sampling done along the perimeter of the buildings (Google Earth).

Soil sampling was executed following the LANL procedure titled, "Soil and vegetation sampling at facility sites" (LANL 2019). Quality assurance for these measurements was implemented and executed through the LANL procedure, "*Implementation of the soil, foodstuffs, and biota program*" (LANL 2019). After collection, the soil samples were transferred to an independent analytical laboratory and analyzed. The radiochemical protocols followed Environmental Measurements Laboratory (EML), "*Procedures manual of the Environmental Measurements Laboratory*" Report HASL-300 (EML 1997) and Environmental Protection Agency (EPA), "Method 901.1-Gamma Emitting Radionuclides in Drinking Water" EPA 600/4/80/032 (EPA 1980).

Results

Field Soil and Sediment Sampling in TA-18

Soil sample results from past investigations

Previous results of samples of soil (outside the floodplain) and sediment (within the floodplain) from TA-18 show elevated U-234 (Table 2). Elevated U-234 in these samples is consistent with the use of enriched uranium (U-235) in explosive testing within TA-18 (Table 2). Though elevated in U-234, the maximum concentration in soil (76 pCi/g) was approximately 145 times less than the 25 mrem Screening Action Level (SAL) for recreational use (11,000 pCi/g) and 13

times lower than the construction worker SAL (1000 pCi/g) (LANL 2016). Thus, dose assessments based on the maximum soil concentrations showed that the potential dose to the public were significantly below the public dose limit threshold and are considered As Low As Reasonably Achievable (ALARA). Note that some of the soil samples were collected at depths beyond what would be accessible to the public, but perhaps could be accessed during construction activities.

Table 2. Results (pCi/g) from general site soil sampling done within boundaries of the TA-18 Manhattan Project Historical Park. Details are provided in Attachment 2.

Radionuclide	Plutonium-239/240	Tritium	Uranium-234	Uranium-235/236	Uranium-238
	0.007	0.05	75.8	0.037	1.31
	0.007	0.01	10.57	0.225	1.55
	-0.009	0.02	1.72	0.112	1.136
	0.0	0.03	13.12	0.165	1.176
	0.002		21.1	0.286	2.04
	0.545		0.817	0.836	0.736
	0.432		7.1	0.195	5.28
	0.021		0.783	0.019	0.641
	0.0059		0.47	0.048	0.524
	0.0022		0.479	0.028	0.447
	0.004		4.32	0.034	4.21
	0.0		3.32	1.152	2.53
	-0.001		0.666	0.217	0.653
	0.0042		1.91	0.073	0.907
	0.0102		3.08	0.043	2.59
	0.0077		1.54	0.037	1.5
	0.004		0.729	0.029	0.587
	0.0087		0.936	0.046	0.843
	-0.001		0.663	0.0105	0.618

Radionuclide	Plutonium-239/240	Tritium	Uranium-234	Uranium-235/236	Uranium-238
			0.565	0.084	0.48
				0.028	
				0.042	
				0.043	
Mean	0.06	0.03	7.48	0.16	1.49
Standard Deviation	0.15	0.02	16.95	0.28	1.30
Median	0.00	0.03	1.63	0.05	1.02
Maximum	0.55	0.05	75.80	1.15	5.28
Background	0.06	0.08	2.59	0.2	2.29
Recreational use SAL	2900	8.2 E6	11,000	1300	4800

Assessment for construction and public access

On-site restoration work is proposed for the Slotin Building, Battleship Bunker, and the Pond Cabin. Once this construction is complete, public tours will commence providing access to the buildings and sites. Soils have been sampled along the perimeter of these buildings and the results are provided in Table 3. These results are generally consistent with background, though U-234 and U-238 concentrations appear to be above background around the TA-18 floodplain of the canyon, again consistent with explosive testing with uranium, especially closer to Battleship Bunker. Though elevated, the concentrations around the bunker are well within the construction and recreational SALs (i.e., < two orders of magnitude). We conclude that the restoration work and recreation activities on and around these buildings and sites may proceed without restriction and are considered ALARA (i.e., potential doses < 3mrem/yr). The results in Table 3 also suggest potential for higher concentration in the western portions of the Manhattan Project Historical Park because the highest four concentrations in Table 3 were sampled around Battleship Bunker. As needed, future sampling of soil will be conducted in the specific locations where construction activities are planned (i.e., for parking lots, walking paths, or small structures such as bathrooms) and could account for possible spatial trends.

Table 3. Sample results from radionuclides in soils around Slotin Building, Battleship Bunker and Pond Cabin with comparisons to construction worker SALs. Units are pCi/g.

Radionuclide	Am-241	Cs-134	Cs-137	Co-60	Pu-238	Pu-239/240	Tritium	U-234	U-235/236	U-238
	0.01	0.19	0.33	0.02	0.01	0.02	0.02	12.10	0.65	12.90
	0.01	0.14	0.29	0.01	0.01	0.02	0.02	9.02	0.49	9.10
	0.01	0.14	0.25	0.01	0.01	0.02	0.01	5.57	0.34	5.68
	0.00	0.10	0.17	0.01	0.01	0.02	0.01	3.62	0.22	3.73
	0.00	0.08	0.17	0.00	0.01	0.01	0.00	1.36	0.14	1.18
	0.00	0.08	0.16	0.00	0.01	0.01	0.00	1.08	0.08	1.12
	0.00	0.08	0.13	0.00	0.00	0.01	0.00	0.96	0.08	1.01
	0.00	0.06	0.12	-0.01	0.00	0.01	0.00	0.96	0.07	0.95
	0.00	0.04	0.12	-0.01	0.00	0.01	0.00	0.92	0.07	0.92
	-0.05	0.04	0.11	-0.01	0.00	0.01	0.00	0.92	0.07	0.89
	-0.07	0.03	0.10	-0.01	0.00	0.00	0.00	0.90	0.07	0.79
	-0.12	0.02	0.04	-0.03	0.00	0.00	0.00	0.65	0.07	0.77
Mean	-0.02	0.08	0.17	0.00	0.00	0.01	0.01	3.17	0.20	3.25
Standard Dev.	0.04	0.05	0.08	0.01	0.00	0.01	0.01	3.80	0.20	4.00
Median	0.00	0.08	0.15	0.00	0.01	0.01	0.00	1.02	0.08	1.07
Maximum	0.01	0.19	0.33	0.02	0.01	0.02	0.02	12.10	0.65	12.90
Background (95% UTL)	0.013	NA	1.65	NA	0.023	0.054	0.1	2.59	0.2	2.29
Construction SAL	140	13	31	6.8	130	120	62000	770	100	410
Recreation SAL	3200	150	370	81	3200	2900	8200000	11,000	1300	4800

Building Interior Sampling

All surface radioactivity levels in the Slotin Building, Pond Cabin and Battleship Bunker were below surface contamination limits for unrestricted access (Table 1). These results are consistent with historical knowledge confirming these building were not used for radiological work. We found the sampled locations were sufficiently representative of accessible areas and the measurements met the quality objectives. Thus, we conclude that the public can have unrestricted access in the building for visitation purposes. Maintenance activities, beyond general inspections, should be coordinated with radiation protection staff, as needed.

Conclusions

Environmental Protection Compliance-Environmental Stewardship (EPC-ES) has evaluated radiological process history and all measurement data and found: (1) soil and interior surface sampling meet the data quality objectives contained in MARSSIM (2000) and MARSAME (2009), as reflected in LANL procedures (LANL 2015a, 2015b), (2) that the interiors of the Slotin Building, Pond Cabin and Battleship Bunker were within surface contamination limits for unrestricted access, and (3) the soils around the Slotin Building, Pond Cabin and Battleship Bunker are below Screening Action Levels for both construction work and recreational use (LANL 2016). Therefore, public access inside the Slotin Building and to the outside areas surrounding the Slotin Building, Pond Cabin and Battleship Bunker area are not restricted. This finding is consistent with the requirements of DOE Order 458.1 "*Radiation Protection of the Public and the Environment*" (DOE 2013) and LANL procedure "*Environmental Radiation Protection*" (LANL 2018).

References

Department of Energy (DOE), 2013. Radiation protection of the public and the environment. DOE Order 458.1. https://www.directives.doe.gov/directives-documents/400-series/0458-1-border-admc3/@@images/file.

Environment Monitoring Laboratory (EML), 1997. The procedure manual of the environmental measurements laboratory. Report HASL-300: Radionuclide specific procedures for radionuclides of AM-241, PU-239 and U-238, Volume I, 28th ed. New York, NY. https://www.wipp.energy.gov/NAMP/EMLLegacy/ProcMan/Start.htm.

Environmental Protection Agency (EPA), "Method 901.1-Gamma Emitting Radionuclides in Drinking Water" EPA 600/4/80/032; 1980.

Intellus 2015. Web address for database access: https://www.intellusnm.com/

Los Alamos National Laboratory (LANL), 2015a. Data quality objectives for measurement of radioactivity in or on items for transfer into the public domain. LANL Technical Procedure EPC-ES-TPP-001. http://int.lanl.gov/training/v-courses/29488/29488.pdf

Los Alamos National Laboratory (LANL), 2019. Dose assessment data quality objectives for land transfers into the public domain. LANL Technical Procedure ENV-ES-TP-238, R2. http://int.lanl.gov/training/adesh/15602/15602.pdf

Los Alamos National Laboratory (LANL), 2016. Derivation of authorized limits for land transfer at Los Alamos National Laboratory. LANL Report LA-UR-16-27038. https://permalink.lanl.gov/object/tr?what=info:lanl-repo/lareport/LA-UR-16-27038

Los Alamos National Laboratory (LANL), 2017. Surveying for fixed and removable contamination. LANL Technical Procedure RP-SOP-037, Revision 3. http://int.lanl.gov/org/ddops/aldeshqss/radiation-protection/_assets/docs/procedures/work-processes/RP-SOP-037.pdf

Los Alamos National Laboratory (LANL), 2019. Soil and vegetation sampling at facility sites. LANL Technical Procedure ENV-ES-TP-006. http://int.lanl.gov/training/adesh/31047/31047.pdf

Los Alamos National Laboratory (LANL), 2017 Environmental radiation protection. Functional Series Document EPC-ES-FSD-004. http://int.lanl.gov/training/adesh/39373/39373.pdf

Los Alamos National Laboratory (LANL), 2019. Implementation of the soil, foodstuffs, and biota program. LANL Quality Assurance Project Plan: EPC-ES-QAPP-001. http://int.lanl.gov/training/adesh/45148/45148.pdf

Los Alamos National Laboratory (LANL), 2019. Radiation protection Rev. 6. LANL Policy P121. http://int.lanl.gov/policy/documents/P121.pdf

Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), 2000. NUREG-1575 Rev. 1, EPA 402-R-97-016 Rev.1, DOE/EH-0624, Rev.1. https://www.epa.gov/sites/production/files/2017-09/documents/marssim_manual_rev1.pdf

Multi-Agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME), 2009. NUREG-1575, Supp.-1, EPA 402-R-09-001, DOE/HS-0004. https://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1575/supplement1/sr1575s1.pdf

National Park Service (NPS) and U.S. Department of the Interior (DOI), 2017. Foundation document Manhattan Project National Historical Park. https://www.nps.gov/mapr/upload/MAPR_FD_PRINT.pdf

U.S. Environmental Protection Agency (EPA), 1980. EPA 901.1: Gamma emitting radionuclides in drinking water. Prescribed Procedure for Measurement of Radioactivity in Drinking Water, EPA/600/4/80/032. https://www.epa.gov/esam/epa-method-9011-gamma-emitting-radionuclides-drinking-water

Attachment 1

Survey Plan for Visitor Access into the Slotin Building, Pond Cabin, and Battleship Bunker

Rev. 0, 09/20/2016

Summary

The goal of the Manhattan Project Historical Park is to provide public access to buildings and sites of national historical importance. The Park comprises of three different city-states, which include Los Alamos, New Mexico, Hanford, Washington, and Oakridge, Tennessee. At the Los Alamos location, atomic bombs were designed and built during World War II. Today these building and sites are located within Los Alamos National Laboratory (LANL) boundaries. During this historic time, the locations of these buildings and sites were top-secret. Some of the research that took place there included working with radiological and chemical materials at levels that could be hazardous. To ensure the Park is safe for public access, potential hazards were assessed. . At present, only visitor access to the Slotin building is requested. However, this survey plan also includes the possibility of public access inside the Pond Cabin and Battleship Bunker in the future.

1. Purpose and Scope of the MARSAME Final Release Survey

1.1. Based on radiological history, process knowledge, and past survey measurements, the Slotin Building, Pond Cabin and Battleship Bunker are considered radiologically non-impacted under DOE Order 458.1, "*Radiation Protection of the Public and the Environment"*. Despite the non-impacted classification, given historical uncertainties, and out of an abundance of caution, LANL will perform a confirmation survey prior to allowing general access for visitors into the buildings and sites. The MARSAME data analysis approach will be used to evaluate the measurement results.

1.2. Per MARSSIM Section 2.4, there are six principal steps in the MARSSIM Radiation Survey and Site Investigation Process:

- Site Identification
- Historical Site Assessment (HSA)
- Scoping Survey
- Characterization Survey
- Remedial Action Support Survey
- Final Status Survey

1.3. The MARSSIM HSA information for these structures is contained is Section 2 below. Informal radiological surveys for surface contamination have been conducted and no removable or fixed contamination was detected. The purpose of

this survey is to systematically measure and formally document the results from these measurements as part of the Final Status Survey.

1.4. Notes and Assumptions:

1.4.1. This plan was prepared in accordance with LANL EPC-ES-FSD-004, "*Environmental Radiation Protection"*, and developed using required data quality objectives.

1.4.2. The nominal release criteria for these materials are from Table 10-2 of EPC-ES-FSD-004 for surface radioactivity (see Section 4 of this plan).

2. Historical Site Assessment Information

2.1. The Slotin Building was constructed in 1946 and was used for criticality research. Therefore, radiological operations took place in this building early in LANL history, though criticality experiments were later moved to other buildings. Recent radiological surveys measured no elevated surface contamination, and the building is not posted for radiological purposes.

2.2. The Pond Cabin was built in 1914 as part of a private hunting ranch. This building was later used by scientists as office space to support plutonium research. No known radiological activities took place in the building. No public access inside this building is planned at this time, due to the age and fragility of the building.

2.3. Battleship Bunker was built in 1944 and supported implosion research. No known radiological activities took place within the building. Outdoor soil samples suggest that explosive testing with enriched and possibly depleted uranium took place in its vicinity, but measured levels on the outside of the building are below Screening Action Levels for residential land use. Radionuclides of interest are U-234, U-235, and U-238. No public access inside this building is planned, because the space inside the building is small and could not support crowds.

3. Survey Units and Data Analysis

3.1. This plan is designed to provide sufficient information for public access to these buildings for tours. If surveyors encounter contamination or unexplained increases in standard deviation or measured concentrations during the survey, further mitigation, sampling, and data analysis may be required.

4. Nominal Release Criteria

Table 1. DOE preapproved authorized limits for surface radioactivity

Surface contamination values from EPC-ES-FSD-004 Section 1021 Table 10--2		
U-natural, U-235, U-238 and associated decay products (Removable)	1,000	dpm/100cm^2
U-natural, U-235, U-238 and associated decay products (Total)	5,000	dpm/100cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227,I-125, I-129 (Removable)	20	dpm/100cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129 (Total)	100	dpm/100cm^2
Th-natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133 (Removable)	200	dpm/100cm^2
Th-natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133 (Total)	1,000	dpm/100cm^2
β/γ emitters (Removable)	1,000	dpm/100cm^2
β/γ emitters (Total)	5,000	dpm/100cm^2
Tritium and Special Tritium Compounds	10,000	dpm/100cm^2

5. General Survey Instructions

5.1 Verify characterization activities are on the applicable Plan-of-the-Day, as appropriate.

5.2 Perform a Pre-Evaluation Brief and/or Job Task Brief in accordance with P300.

5.3 Verify personnel have appropriate training for the work they will be performing.

5.4 Comply with applicable Radiological Work Permit (RWP) requirements, if RWP is required.

5.5 Follow applicable Integrated Work Documents [IWD(s)], as necessary.

6. Survey-Specific Instructions

6.1 For the purpose of this survey, room 100 will be considered a survey unit and the smaller rooms 101 and 102 are combined into another decision unit because of the lower potential for contamination in these rooms. The floor and four walls in each room, up to 10 feet from the floor, will be surveyed. A total of about 12 sampling locations will be identified using a semi-grid sampling approach for survey unit. For example, Figure 1 shows a floor plan of the Slotin Building. At least 12 sets of measurements will be made in room 100 and another 12 in rooms 101 and 102 combined. The two rooms, North and South, in the Pond Cabin will be treated and individual decision units with about 12 sample locations each. Battleship Bunker will be treated as an individual sampling unit. Table 1 provides a summary of this sampling plan. Based on process knowledge, sampling and data analysis for volumetric radioactivity is not required.

6.2 Follow P121, RP-1-DP-37 "*Surveying for Fixed and Removable Contamination*", and other applicable characterization and sampling procedures. Document all survey results on the appropriate survey form(s). All direct and removable measurement results are to be reported as dpm/100cm^2. Do not use no detectable activity or "NDA."

6.3 Collect and record direct measurement instrument background readings periodically during surveys (approximately five background measurements per survey unit). Identify and document background measurements on the survey form with the survey unit number, "-BKG," and sequential background number (e.g. 1-BKG1, 1-BKG2, etc.). Collect background measurements on direct reading probes by pointing the probe into the air.

6.4 Required Surveys include:

6.4.1 Surface scan surveys using a SHP380AB (α / β) detector, listening for increased count rate areas. Scan percentage should be < 10% for all surfaces.

6.4.2 60 second scalar direct surveys using an SHP380AB (α / β).

6.4.3 NUCON smears (counted for α and β/γ) should be collected for each item counted as described in Section 6.4.2 above.

6.5 QA survey measurements are required for MARSAME Final Status Surveys. Duplicate measurements should be made at approximately 10 percent of the

surveyed locations. Since this is a lower-lower confirmation survey, QA measurements are not required.

6.6 On the survey forms, denote surface material (e.g., bare concrete, painted concrete, metal, rusted metal, wall board, wood, linoleum, etc.).

6.7 Smear survey results are to be reported in the form consistent with the results from the Health Physics Analytical Laboratory (HPAL). HPAL should be requested to report results as dpm/100cm^2 (not NDA). In consultation with HPAL, isotopic analysis can be performed on smears with high gross alpha/beta results if the radioisotope (or mixture) is unknown. Save all smears for possible future HPAL analysis.

6.8 Collect and maintain all characterization paperwork. Number each page of the survey unit packages using the format "XX of XX". Survey unit packages should include survey forms, maps, HPAL smear results, and HPAL isotopic analysis (if required). Provide all completed paperwork to Jeff Whicker.

Figure 1. Floor plan for Slotin Building.

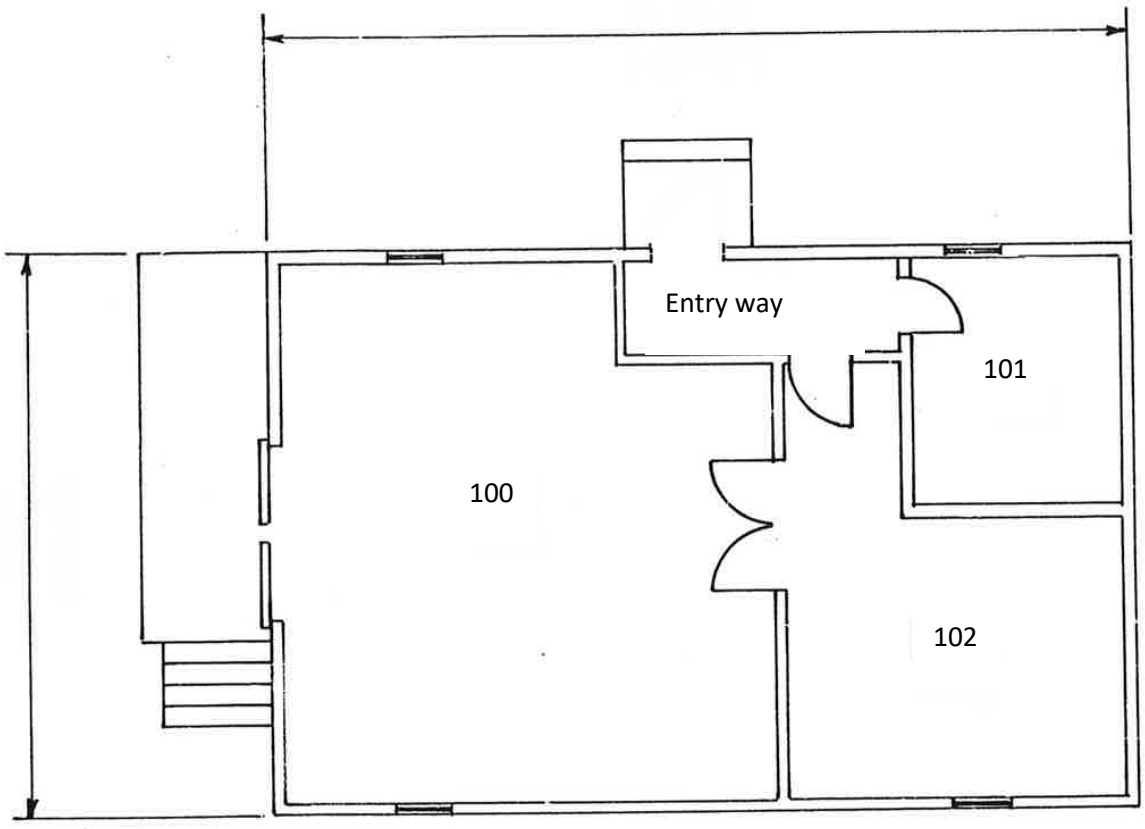

Table 1. Sampling plan for buildings in Pajarito Site (TA-18) for the Manhattan Project National Park.

Slotin Building (SB): Final Status Survey Units and Survey Requirements

Survey Unit #	Description	Directs & Smears	Scanning	Other	Justification
18-1-100	Building interior floor and walls	~12 semi-grid samples	< 10% surface area	~ 3 bias sample locations (direct and smear)	Process knowledge and previous characterization surveys suggest small potential for contamination.
18-1-101,102	Building interior floor and walls	~12 semi-grid samples	< 10% surface area	~ 3 bias sample locations (direct and smear)	Process knowledge and previous characterization surveys suggest small potential for contamination.

Pond Cabin (PC): Final Status Survey Units and Survey Requirements

Survey Unit #	Description	Directs & Smears	Scanning	Other	Justification
PC-South room	Building interior	~12 grid samples	< 10% surface area	~ 3 bias sample locations (direct and smear)	Process knowledge and previous characterization surveys suggest little potential for contamination.
PC-North room	Building interior	~12 grid samples	< 10% surface area	~ 3 bias sample locations (direct and smear)	Process knowledge and previous characterization surveys suggest little potential for contamination.

Battleship Bunker (BB): Final Status Survey Units and Survey Requirements

Survey Unit #	Description	Directs & Smears	Scanning	Other	Justification
BB	Building interior	~12 grid samples	< 10% surface area	~ 6 bias sample locations (direct and smear)	Process knowledge and previous characterization surveys suggest little potential for contamination.

Attachment 2

Sampling and Analysis Plan of Soil for Preservation, Site Improvement, and Public Access: Pond Cabin, Slotin Building, and Battleship Bunker at Technical Area 18 (Pajarito Site) for the Manhattan Project National Historical Park

May 2016

1.0 Background

1.1 Scope

This Sampling and Analysis Plan (SAP) supports the Manhattan Project National Historical Park (MPNHP) with limited soil samples around buildings at Technical Area (TA)-18: 18-0001 (Slotin Building), 18-0002 (Battleship Bunker), and 18-0029 (Pond Cabin). The soil samples described in this plan are intended to support preservation activities and site improvement projects around these buildings. Soil samples will be analyzed for radiological and chemical constituents to ensure safe public access and working conditions, as appropriate.

1.2 Site Location

The TA-18 site (Pajarito Site) of the MPNHP is located in Pajarito Canyon west of Pajarito Road (see Figure 1).

1.3 General History

The Manhattan Project was an unprecedented, top-secret government program during World War II with the goal to construct a nuclear bomb before Nazi Germany. The project resulted in science and technology that transformed the role of the United States in the world and ushered in the atomic age. Operating from 1942 to 1946, the Manhattan Project employed close to 130,000 workers at its peak (NPS 2017). The DOE has identified exceptionally significant historic buildings and sites associated with World War II and the Cold War as candidates for long-term retention and management.

The Pond Cabin, constructed in 1914, is listed on the New Mexico State Register of Historic Places and is the only surviving standing log structure at LANL dating to the Homestead period. The cabin was built by Ashley Pond to serve as the office for the Pajarito Club, a commercial ranch located on the Ramón Vigil Grant (NPS and DOI, 2017). During the Manhattan Project, the Pond Cabin was used by Emilio Segrè as an office supporting his group's plutonium chemistry research. Discoveries made by Segrè's team resulted in the discontinuation of the Thin Man plutonium weapon design and led to a major reorganization of the wartime laboratory in order to develop the Fat Man implosion weapon.

TA-18-2 (Battleship Bunker) was constructed in 1944 to support implosion diagnostic tests related to Fat Man design development. Experiments using the magnetic method, carried out at Pajarito Site, detected changes in a magnetic field during a high-explosives shot. TA-18-2 is a robust, cast-in-place concrete bunker (NPS and DOI, 2017). It is known as a battleship building because the west of the building is bow shaped and shielded with a steel plate.

The high-bay addition at TA-18-0001 (Slotin Building) was constructed in 1946, at the end of the Manhattan Project era, and supported criticality research at the wartime laboratory's Pajarito Site. This building addition was the location of the May 21, 1946, criticality accident, which occurred during an experiment known as "tickling the dragon's tail" and led to the death of scientist Louis Slotin (NPS and DOI, 2017). TA-18-1 is known as the Slotin Building today. It is a relatively small, wood-frame building with asbestos-type shingles, and was built according to typical World War II temporary construction standards. After the war, the building supported Cold War research and was later used as a shop.

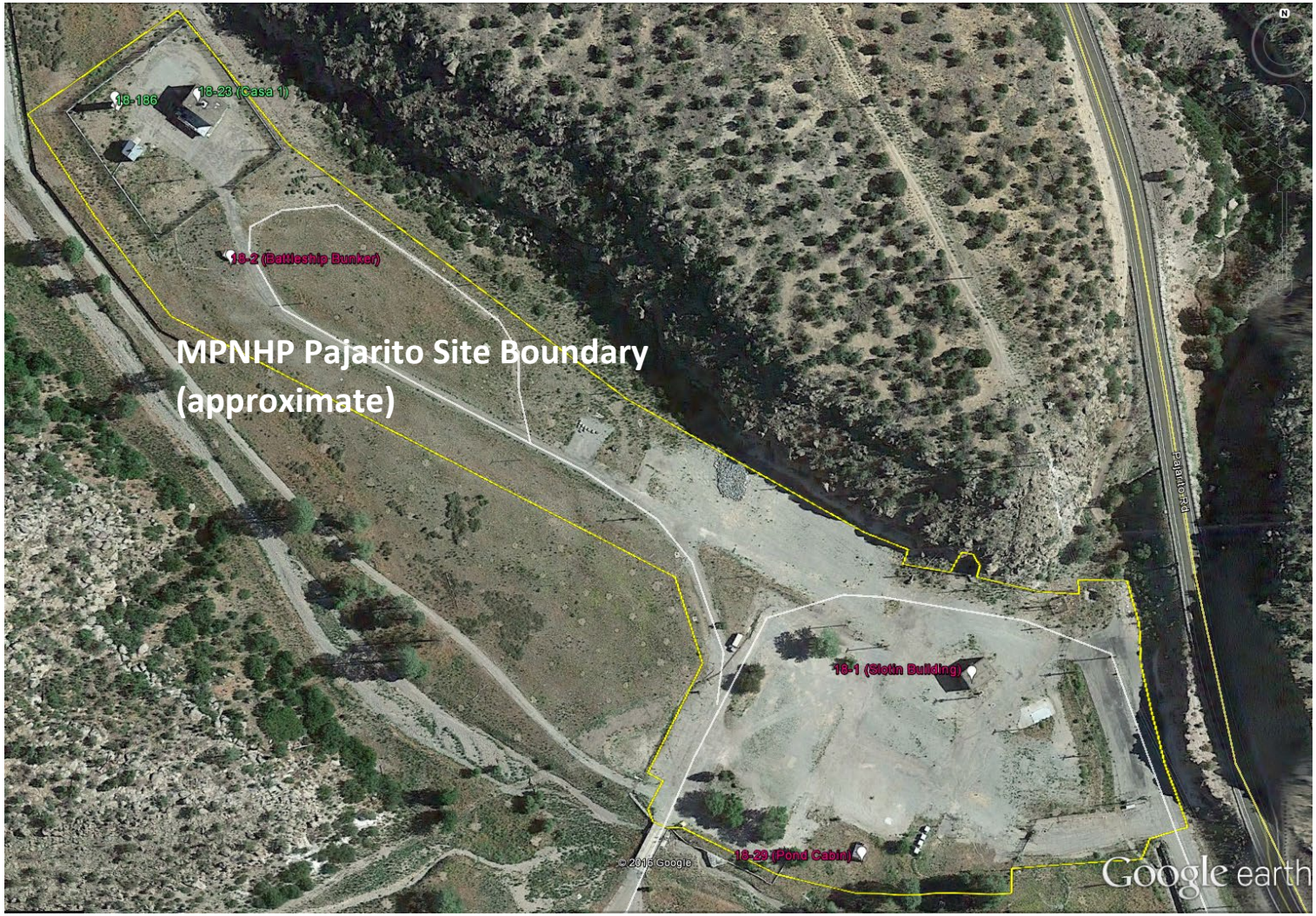

Figure 1. Aerial view of the MPNHP Pajarito Site boundary with Park buildings indicated in pink and Park contributing sites indicated in green. Note: Map locations and boundaries are approximate (Google Earth).

1.4 Proposed Use/Exposure Parameters

This SAP is limited to support sampling in the immediate vicinity of the Pond Cabin, Slotin Building, and Battleship Bunker. Preservation activities and site improvement efforts are projected to occur around these buildings in 2016, with the potential for soil disturbance. Therefore, there is sufficient justification to sample the soil around these buildings as a defense in depth measure to ensure public and worker safety. Radiological data may be compared to soil screening action levels for a recreation use or a construction use scenario. Non-radiological data may be compared to occupational/industrial standards, as appropriate.

1.5 Preliminary Results from Surveys for Residual Contamination

Due to the potential for LANL-derived residual radioactivity in the soil, previous radiological sampling data were obtained from Intellus (2016) for this site. Results were well below the construction use screening action levels for all radionuclides, and in most cases measured values were within expected background ranges. Several samples indicated concentrations of Uranium-234 in excess of background; this finding is consistent with known historical activities using enriched uranium at Pajarito Site.

2.0 Proposed Sampling

2.1 Locations

For coverage of work activities around the Pond Cabin, Slotin Building, and Battleship Bunker, soil samples will be collected around the perimeter of each structure. Samples should be equally spaced along the sides of each building, as follows:

- 2 locations per side on the Pond Cabin
- 3 locations per side on the Slotin Building
- 2 locations per long side / 1 location per short side on the Battleship Bunker (6 total locations)

Samples may be field located as appropriate. For record keeping and database purposes, GPS coordinates should be assigned to the samples based on the midpoint of each building wall.

2.2 Specific Sampling Techniques

To optimize the sampling for the activities described in Section 1, the soil from multiple locations should be composited (combined and homogenized) in a representative manner, as follows:

- Pond Cabin – combine the 2 samples from each side so that 4 samples are sent to the lab
- Slotin Building – combine the 3 samples from each side so that 4 samples are sent to the lab
- Battleship Bunker – combine the 2 samples from each *long* side so that 4 samples are sent to the lab
- Some chemical constituents may not be composited based on the nature of the collection technique. For these samples, 1 location per side of each building will be used.

Twelve (12) unique samples should be sent for laboratory analysis of radiological and some chemical constituents. Four (4) additional samples per building may be required for some specific chemical constituents. These samples will be collected and sent separately at the discretion of the sampling team.

2.3 Constituents of Interest

Soil samples should be analyzed for the following constituents, as appropriate:

- Radiological: Americium-241, Cesium-134, Cesium-137, Hydrogen-3, Plutonium-238, Plutonium-239/240, Uranium-234, Uranium-235, Uranium-238
- Non-Radiological: target analyte list metals, nitrate, cyanide, perchlorate, volatile organic compounds, semi-volatile organic compounds, polychlorinated biphenyls (aroclors), high explosives, asbestos. Only the radiological constituents are reported here.

3.0 Measurement Quality Objectives

To ensure confidence that the measurement results are valid and appropriate for the decisions being made, the following Measurement Quality Objectives should bet met:

- Minimum Detectable Concentration should be below the applicable screening level for each constituent.
- 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.
- Instrument and measurement technique should be specific for the constituent(s) being measured. Specificity is the ability of the measurement method to measure the constituent 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.

4.0 Sampling and Analytical Procedures

Soil samples should be collected in accordance with the following procedures and any applicable project specific safety documentation:

- EPC-ES-TP-006 Rev. 2 (2019). “Soil and vegetation sampling at facility sites”
- EPC-ES-QAPP-001, Rev.2 (2019). “Implementation of the soil, foodstuffs, and biota program .”

Soil sample analysis will use EPA-approved analytical procedures for each constituent.

5.0 References

Department of Energy (DOE), 2013. Radiation protection of the public and the environment, Administrative Change 3. DOE Order 458.1. https://www.directives.doe.gov/directives-documents/400-series/0458-1-border-admc3/@@images/file.

Intellus 2016. Web address for database access: https://www.intellusnm.com/.Los Alamos National Laboratory (LANL), 2014. Derivation and use of radionuclide screening action levels, Rev. 3. Report Number LA-UR-014-29225, EP2014-0547. https://permalink.lanl.gov/object/tr?what=info:lanl-repo/eprr/ESHID-600064-02.

Los Alamos National Laboratory (LANL), 2015. Sampling soil and vegetation at facility sites. Procedure ENV-ES-TP-006.

Los Alamos National Laboratory (LANL), 2019. Implementation of the soil, foodstuffs, and biota program. LANL Quality Assurance Project Plan: EPC-ES-QAPP-001, Rev.2. http://int.lanl.gov/training/adesh/45148/45148.pdf

Los Alamos National Laboratory (LANL) 2019. Soil and vegetation sampling at facility sites. Technical Procedure EPC-ES-TP-005, Rev.2. http://int.lanl.gov/training/adesh/31047/31047.pdf

National Park Service (NPS) and U.S. Department of the Interior (DOI), 2017. Foundation document Manhattan Project National Historical Park. https://www.nps.gov/mapr/upload/MAPR_FD_PRINT.pdf