VERIFICATION SURVEY FOR THE LAND AREA FORMERLY SUPPORTING THE HOT LABORATORY (4020) SANTA SUSANA FIELD LABORATORY THE BOEING COMPANY VENTURA COUNTY, CALIFORNIA

J. R. MORTON

Prepared for the
Office of Site Closure
U.S. Department of Energy

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Environmental Survey and Site Assessment Program

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FINAL REPORT

DECEMBER 2000

This report is based on work performed under a contract number DE-AC05-00OR22750 with the U.S. Department of Energy.

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THE BOEING COMPANY
VENTURA COUNTY, CALIFORNIA

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ACKNOWLEDGMENTS

The author would like to acknowledge the significant contributions of the following staff members:

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ABBREVIATIONS AND ACRONYMS

µrem/h	microrem per hour
µR/h	microroentgens per hour
AEC	Atomic Energy Commission
ASME	American Society of Mechanical Engineers
BKG	background
D&D	decontamination and decommissioning
$DCGL_w$	derived concentration guideline level
DOE	U.S. Department of Energy
EM	Environmental Restoration and Waste Management
EML	Environmental Measurements Laboratory
EPA	U.S. Environmental Protection Agency
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
ft	foot
ha	hectare
ITP	Intercomparison Test Program
kg	kilogram
km	kilometer
m	meter
MAPEP	Mixed Analyte Performance Evaluation Program
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual
MeV	million electron volts
M&O	Management and Operation
MDC	minimum detectable concentration
NaI	sodium iodide
NIST	National Institute of Standards and Technology
NRC	U.S. Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
pCi/l	picocuries per liter
pCi/g	picocuries per gram
RIHL	Rockwell International Hot Laboratory
SRE	Sodium Reactor Experiment
SSFL	Santa Susana Field Laboratory

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INTRODUCTION AND SITE HISTORY

Rocketdyne Propulsion and Power of the Boeing Company (Rocketdyne), formerly Rockwell International Rocketdyne Division, operates the Santa Susana Field Laboratory (SSFL). The Energy Technology Engineering Center (ETEC) is that portion of the SSFL, operated for the Department of Energy (DOE), which performs testing of equipment, materials, and components for nuclear and energy related programs. Contract work for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA), predecessor agencies to the DOE, began in the early 1950's. Specific programs conducted for AEC/ERDA/DOE involved the engineering, development, testing, and manufacturing operations of nuclear reactor systems and components. Other SSFL activities have also been conducted for the National Aeronautics and Space Administration, the Department of Defense, and other government related or affiliated organizations and agencies. Some activities have been licensed by the U.S. Nuclear Regulatory Commission (NRC) and by the Radiologic Health Branch of the State of California Department of Health Services.

Numerous buildings and land areas became radiologically contaminated as a result of the various operations which included ten reactors, seven criticality test facilities, fuel fabrication, reactor and fuel disassembly, laboratory work, and on-site storage of nuclear material. Potential radioactive contaminants identified at the site are uranium (predominantly in enriched isotopic abundances), plutonium, Am-241, fission products (primarily Cs-137 and Sr-90), activation products (tritium [H-3], Co-60, Eu-152, Eu-154, and Ni-63). Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater, primarily as a result of rocket engine testing. Decontamination and decommissioning (D&D) of contaminated facilities began in the late 1960's, but were accelerated in the 1990's, and continues as the remaining DOE program operations at ETEC are being terminated. As part of this D&D program, Rocketdyne performed decommissioning and

final status surveys of a number of facilities that supported the various nuclear-related ETEC operations during the latter part of the 1950's and continuing through to the present. Environmental management of DOE contaminated properties continues under the termination clause of the existing Management and Operation (M&O) contract.

Most recently, D&D activities have been completed for Building 4020, the Rockwell International Hot Laboratory (RIHL). The RIHL was designed and constructed to provide hot cells and auxiliary support for the examination of irradiated nuclear fuels and reactor components operating under NRC Special Nuclear Material License SNM-21. The examinations were conducted with Sodium Reactor Experiment (SRE) fuel assemblies, fuel elements, fuel test capsules, and reactors from throughout the country. Three intact reactor cores were disassembled and examined, in addition to the irradiated fuel rods from various reactors which were declad at the RIHL from 1974 to 1988. The demolition of the RIHL was recently completed in accordance with a decommissioning plan prepared in 1990 (Rockwell 1990). The RIHL was a one-story structure consisting of four rectangular hot cells adjoined by four decontamination rooms, and various other rooms. Areas of modest contamination, due to spills and container leakage, were detected on the exterior of the RIHL at the loading dock and holdup yard to the west side of the building and on a concrete pad on the north end of the building. Also on the north end of the building were two underground fission gas tanks. However, these tanks were never used.

DOE's Office of Site Closure—previously the Office of Environmental Restoration, Northwestern Area Programs—is responsible for oversight of a number of remedial actions that have been, or will be conducted at the SSFL. It is the policy of DOE to perform independent (third party) verification of remedial action activities. The purpose of these independent verifications is to confirm that remedial actions have been effective in meeting established and site-specific guidelines and that the documentation accurately and adequately describes the radiological conditions at the site. The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) was designated by the DOE as the organization responsible for this task at SSFL, and was requested to verify the current radiological status of the former RIHL site.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California, approximately 47 kilometers (km [29 miles]) northwest of downtown Los Angeles (Figure 1). The site is comprised of approximately 1,090 hectares (ha[2,700 acres]) and is divided into four administrative areas (Areas I through IV) and a Buffer Zone. DOE operations were conducted in Rockwell International-owned facilities located within the 117 ha Area IV (Figure 2). The ETEC portion of Area IV consists of government-owned buildings that occupy 36 ha.

The RIHL site is located to the south of G Street, in the southern portion of Area IV, and is approximately 0.2 hectares (ha [0.5 acres]) in size (Figure 3).

OBJECTIVES

The objectives of the verification survey were to validate that procedures and methods utilized by the remediation contractor were adequate. In addition, independent verification provides assurance that the post-remediation data are sufficient, accurate, and demonstrates that remedial actions were accomplished in accordance with appropriate standards and guidelines, and that authorized limits were met.

DOCUMENT REVIEW

Final status survey reports were reviewed for general thoroughness, accuracy, and consistency between documents (Boeing 1999). Rocketdyne's Phase I and II final status survey procedures and methods were reviewed in-process for adequacy and appropriateness at the time of the verification survey. The final status procedures applicable to Phase III were reviewed prior to its implementation (Boeing 1999). Data were evaluated to assure that areas exceeding guidelines were identified and had undergone remediation. Final survey results were compared with guidelines to ensure that the data had been interpreted correctly.

PROCEDURES

On the dates of October 1, 1997, September 28, 1998, and October 28, 1999, ESSAP performed verification surveys of the land area that formerly supported the RIHL. The surveys were performed during three phases in accordance with a plan dated September 25, 1997, submitted to and approved by the DOE (ORISE 1997a) and the ORISE/ESSAP Survey Procedures and Quality Assurance Manuals (ORISE 1995a and b, 1996a, and 1997b). Appendices A and B provide additional information on equipment and procedures. Although the RIHL site had not been completely remediated at the times of the Phase I and II ESSAP surveys in 1997 and 1998, Rocketdyne requested that verification surveys be performed on the building footprint and septic trench, which would allow the areas to be backfilled prior to the approaching rainy season. The DOE approved of this request and the survey was completed in three phases. For the Phase III 1999 survey, Rocketdyne had adapted the final status survey methodologies contained in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) (NRC 1997). Surveyed areas were catagorized as Class 1, 2, or 3 based on the history of radioactive materials use. Class 1 areas were those that had been contaminated above the derived concentration guideline level ($DCGL_W$) prior to remediation operations. Class 2 survey units included those areas where slight contamination may have existed, but at levels less than the $DCGL_W$. Class 3 survey units included areas where no contamination existed during the building's history. This report summarizes the procedures and results of the three verification surveys.

REFERENCE SYSTEM

Measurement and sampling locations for the Phase I and II surveys of the RIHL were referenced to a 10 m × 10 m grid system established by ORISE (Figures 4 and 5). Phase III sample locations were referenced to Rocketdyne's 200 ft × 200 ft grid system (Figure 6).

SURFACE SCANS

Surface scans for gamma activity were performed over 100 percent of the RIHL using NaI scintillation detectors coupled to ratemeters with audible indicators.

EXPOSURE RATE MEASUREMENTS

Exposure rate measurements were performed at one meter above the surface at 26 locations using a microrem meter (Figures 4 through 6). Background exposure rates were performed during a previous site survey (ORISE 1996b).

SOIL SAMPLING

Surface (0-15 cm) soil samples were collected from a total of 42 locations within the RIHL land area (Figures 4 through 6). Background soil samples collected during a previous site survey were used for comparison purposes (ORISE 1996b).

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Sample analyses were performed in accordance with the ORISE/ESSAP Laboratory Procedures Manual (ORISE 1996c, 1998, and 1999a). Soil samples were analyzed by gamma spectroscopy. The radionuclides of interest were uranium and mixed fission and activation products; however, gamma spectra were reviewed for other identifiable photopeaks. Composite samples from the Phase I survey were analyzed by wet chemistry for strontium and isotopic plutonium. All radionuclide concentrations in soils were reported in units of picocuries per gram (pCi/g). Exposure rates were reported in units of microroentgens per hour (μR/h). The data generated were compared with Rocketdyne's documentation and the DOE guidelines established for release for unrestricted use.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP's review of Rocketdyne's project documentation indicated that most procedures and methods used by Rocketdyne were adequate and that data were appropriate for demonstrating compliance with the release criteria. Comments identified were concerned with the implementation of MARSSIM final status survey guidance and were provided to the DOE (ORISE 1999b). Rocketdyne provided comment resolutions in a letter correspondence and the final status report (Boeing 2000a and b).

SURFACE SCANS

Surface scans for gamma activity did not identify any locations of direct radiation in excess of ambient background levels.

EXPOSURE RATES

Exposure rates are summarized in Table 1. Background exterior exposure rates for SSFL averaged 14 μR/h, while RIHL exposure rates, including background, ranged from 10 to 18 μR/h.

RADIONUCLIDE CONCENTRATIONS IN SOIL

Concentrations of radionuclides in soil samples collected from the RIHL are provided in Tables 1 and 2. The radionuclide concentrations were less than the minimum detectable concentrations (MDC) for Am-241, Co-57, Co-58, Co-60, Cr-51, Eu-152, Fe-59, Mn-54, Sb-124, U-235, Sr-90, Pu-238, Pu-239, and Zn-65 and ranged from less than 0.1 to 0.4 pCi/g for Cs-137, less than 0.4 to 1.2 pCi/g for Ra-226, less than 0.9 to 1.8 pCi/g for Th-232, and less than 2.3 pCi/g for U-238.

COMPARISON OF RESULTS WITH GUIDELINES

The primary contaminants of concern for this site are uranium and mixed fission and activation products. The applicable site-specific guidelines are provided in Table 3 and have been approved by both the DOE and State of California (DOE 1996 and State of California 1996). Individual soil samples were within these guidelines.

The DOE's exposure rate guideline is 20 μR/h above background (DOE 1990), although Rocketdyne/Boeing has elected to use a more restrictive guideline of 5 μR/h above background. All exposure rates were below this guideline.

SUMMARY

During three phases, the Environmental Survey and Site Assessment Program performed verification surveys of the land area formerly supporting the Rockwell International Hot Laboratory at the Santa Susana Field laboratory. Verification activities included document reviews, independent surface scans, exposure rate measurements, and soil sampling.

The independent verification survey results for residual radionuclide concentrations in soil and exposure rates were less than the guideline levels. The verification survey findings, therefore, support Rocketdyne's final status survey conclusion, that the radiological conditions of the former Rockwell International Hot Laboratory site satisfy the DOE guidelines for release without radiological restrictions.

FIGURES

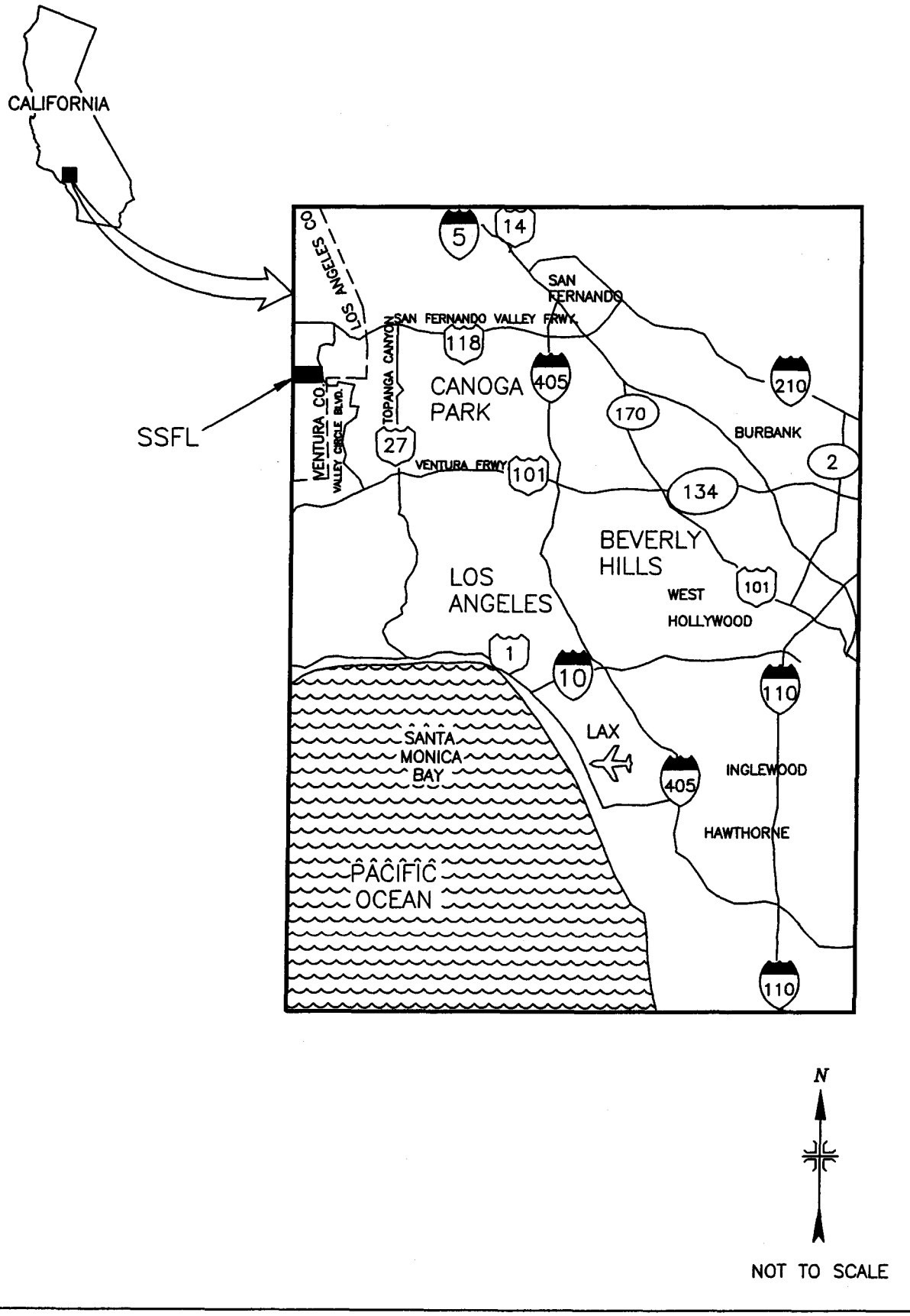


FIGURE 1: Los Angeles, California Area – Location of the Santa Susana Field Laboratory Site

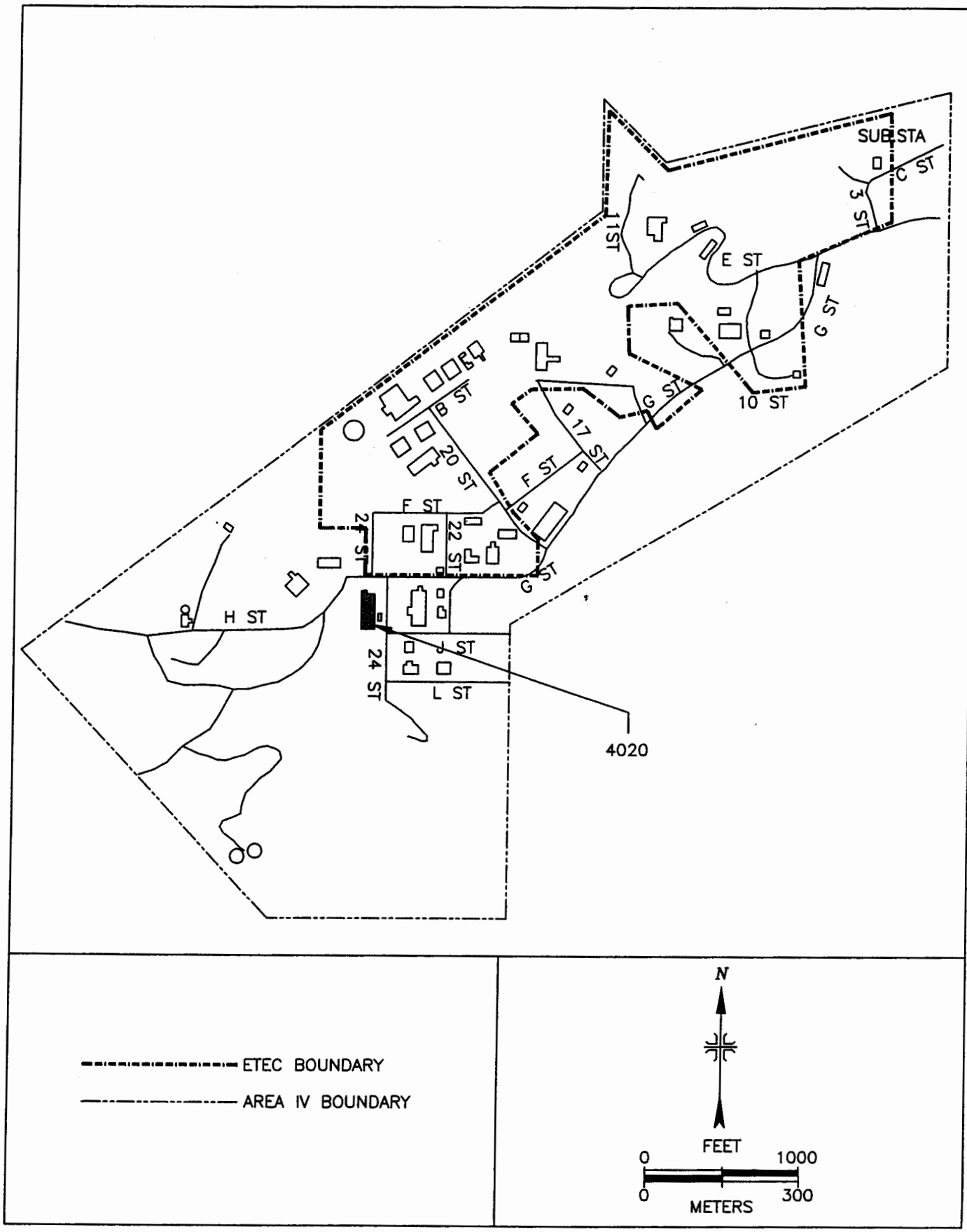


FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of the Former Hot Laboratory (4020)

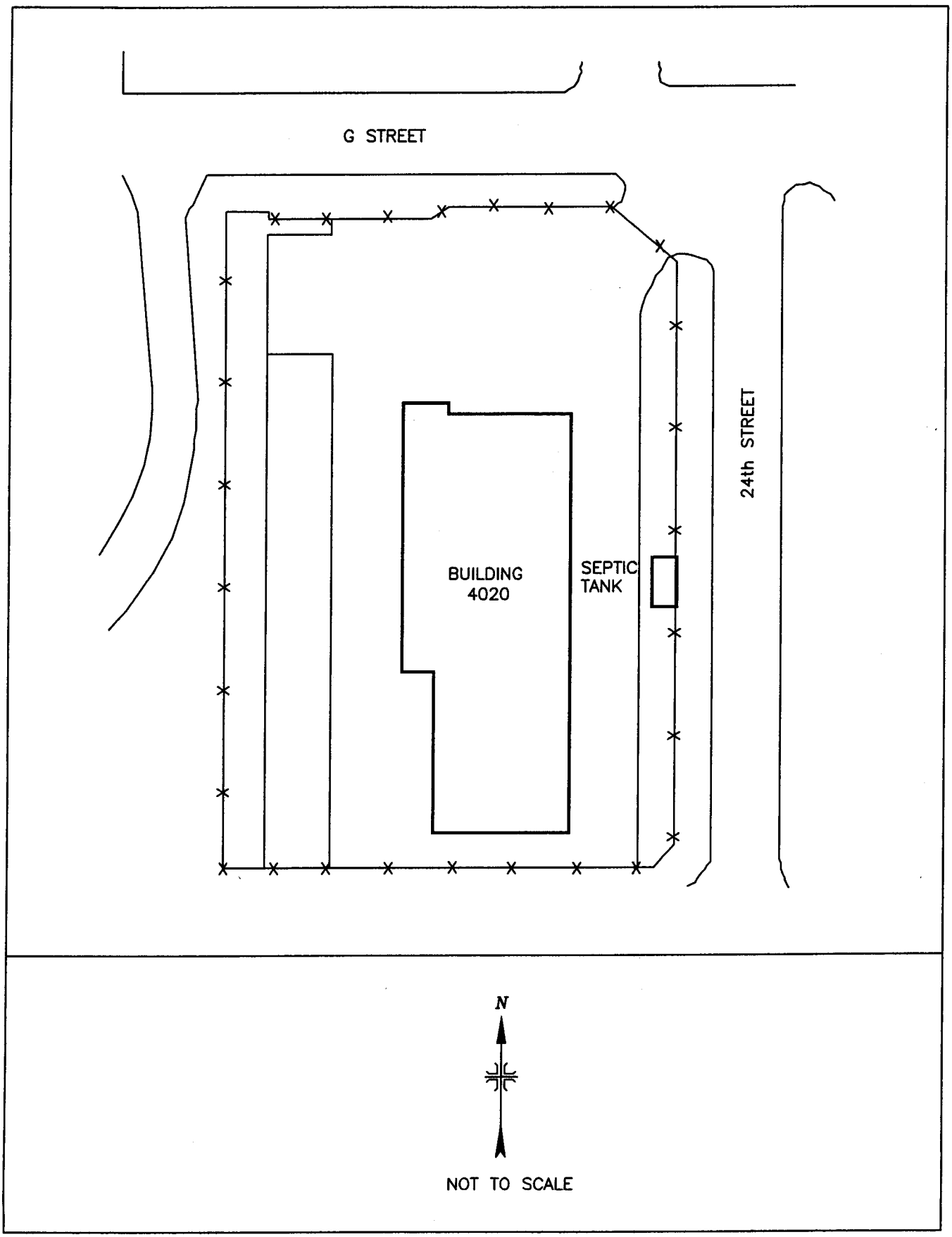
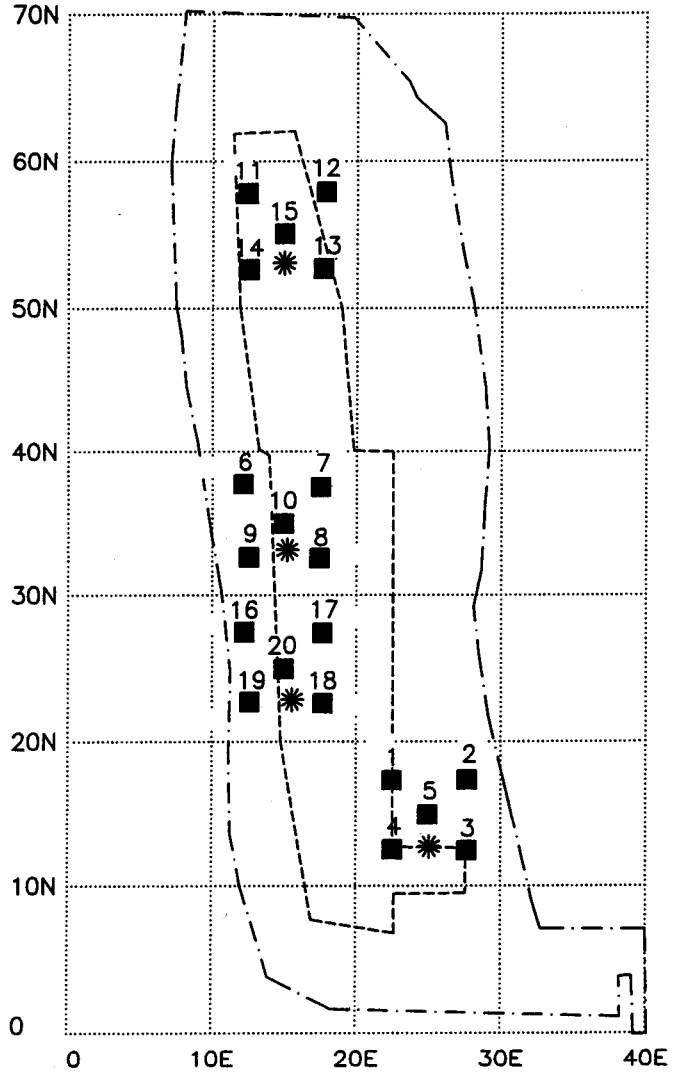


FIGURE 3: Hot Laboratory (4020) – Plot Plan



MEASUREMENT/SAMPLING LOCATIONS

■ # SURFACE SOIL

✱ EXPOSURE RATE

BUILDING FOOTPRINT

EXCAVATED AREA

N

FEET 0 30

METERS 0 10

FIGURE 4: Former Hot Laboratory (4020), Building Footprint – Phase I Measurement and Sampling Locations

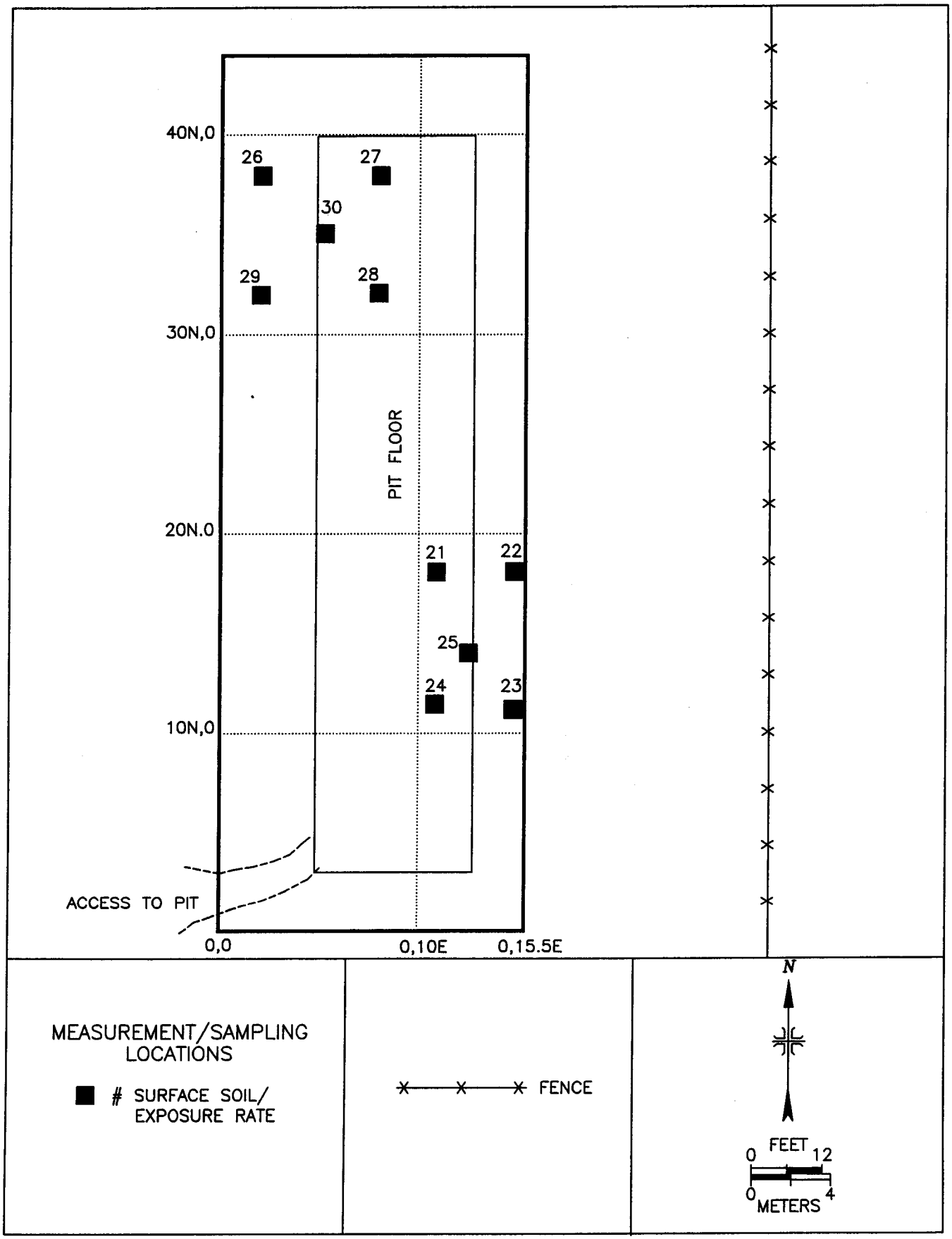


FIGURE 5: Former Hot Laboratory (4020), Septic Trench – Phase II Measurement and Sampling Locations

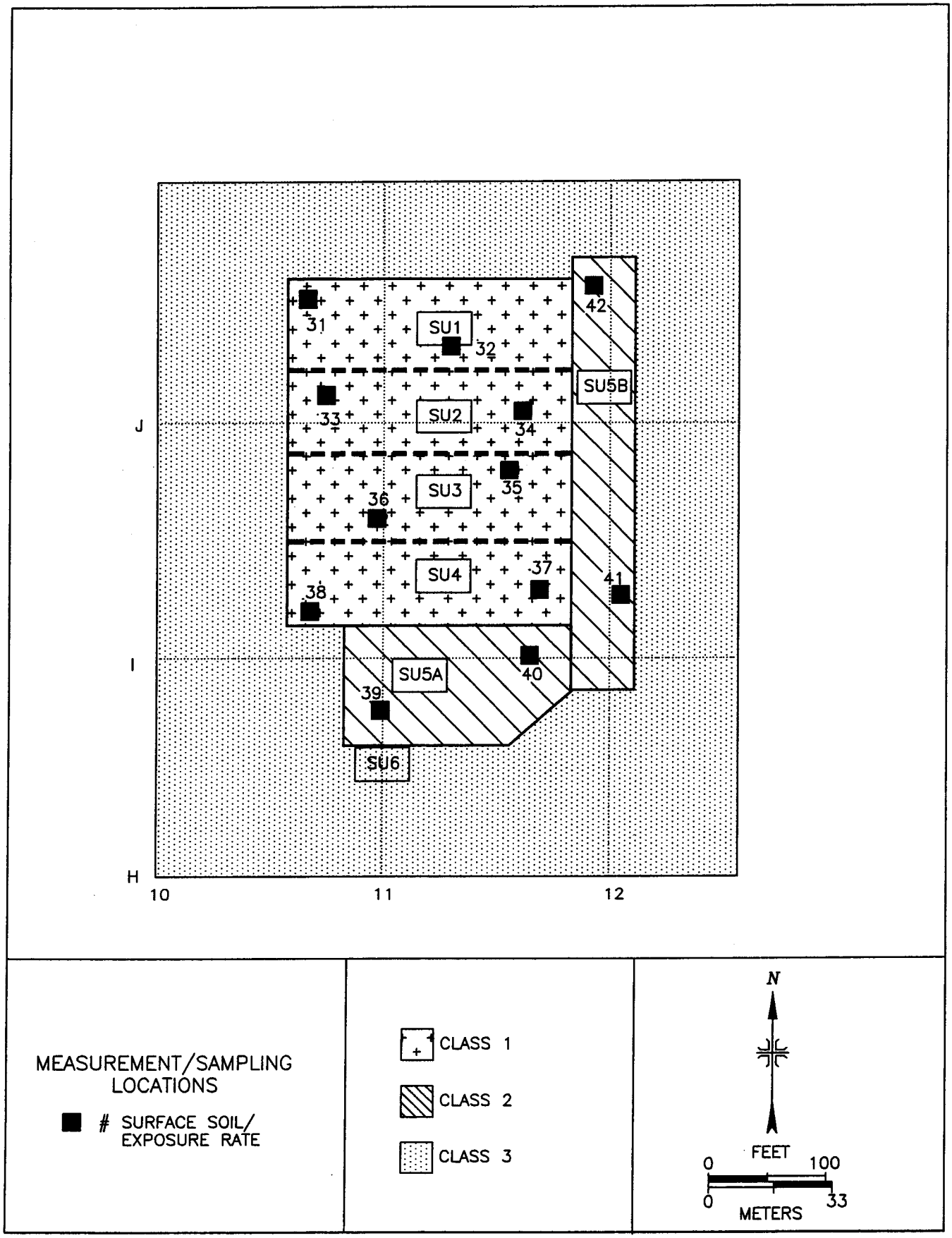


FIGURE 6: Former Hot Laboratory (4020) – Phase III
Measurement and Sampling Locations

TABLES

TABLE 1

RADIONUCLIDE CONCENTRATIONS IN SOIL
FOR THE
FORMER HOT LABORATORY (4020)
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Sample Location[a]	Exposure Rate at 1 m (μR/h)	Radionuclide Concentration (pCi/g)														
		Am-241	Co-57	Co-58	Co-60	Cr-51	Cs-137	Eu-152	Fe-59	Mn-54	Ra-226	Sb-124	Th-232	U-235	U-238	Zn-65
Phase I, Building Footprint																
1	--	<0.2	<0.1	<0.1	<0.1	<0.8	0.4 ± 0.1[b]	<0.3	<0.2	<0.1	0.7 ± 0.2[b]	<0.1	1.5 ± 0.5	<0.6	<2.2	<0.3
2	--	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.2	<0.1	<0.1	0.7 ± 0.2	<0.1	1.3 ± 0.5	<0.3	1.6 ± 1.4	<0.2
3	--	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.2	<0.1	<0.1	0.7 ± 0.2	<0.1	1.4 ± 0.4	<0.4	0.9 ± 1.2	<0.2
4	--	<0.1	<0.1	<0.1	<0.1	<0.4	0.1 ± 0.1	<0.1	<0.1	<0.1	0.6 ± 0.1	<0.1	1.2 ± 0.3	<0.3	0.9 ± 0.9	<0.1
5	17	<0.2	<0.1	<0.1	<0.2	<0.8	<0.1	<0.2	<0.2	<0.1	0.7 ± 0.2	<0.1	<0.9	<0.5	<2.3	<0.2
6	--	<0.2	<0.1	<0.1	<0.1	<0.5	<0.1	<0.2	<0.2	<0.1	0.8 ± 0.2	<0.1	1.5 ± 0.4	<0.4	<1.5	<0.2
7	--	<0.2	<0.1	<0.1	<0.1	<0.5	0.3 ± 0.1	<0.2	<0.2	<0.1	0.6 ± 0.2	<0.1	1.5 ± 0.4	<0.3	0.8 ± 1.3	<0.2
8	--	<0.1	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	0.7 ± 0.1	<0.1	1.6 ± 0.3	<0.3	<1.2	<0.1
9	--	<0.2	<0.1	<0.1	<0.1	<0.7	<0.1	<0.3	<0.3	<0.1	<0.4	<0.1	1.4 ± 0.5	<0.5	<2.0	<0.2
10	17	<0.1	<0.1	<0.1	<0.1	<0.5	0.1 ± 0.1	<0.2	<0.2	<0.1	0.8 ± 0.2	<0.1	1.3 ± 0.4	<0.3	1.5 ± 1.2	<0.2
11	--	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.2	<0.2	<0.1	0.7 ± 0.2	<0.1	1.4 ± 0.3	<0.3	1.1 ± 1.0	<0.2
12	--	<0.1	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	0.7 ± 0.1	<0.1	<0.5	<0.3	<1.1	<0.1
13	--	<0.2	<0.1	<0.1	<0.2	<0.7	<0.1	<0.2	<0.2	<0.1	0.7 ± 0.2	<0.1	1.6 ± 0.4	<0.5	0.9 ± 1.1	<0.3
14	--	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.2	<0.1	<0.1	0.8 ± 0.2	<0.1	1.6 ± 0.4	<0.4	<1.7	<0.2

TABLE 1 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL
FOR THE
FORMER HOT LABORATORY (4020)
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Sample Location[a]	Exposure Rate at 1 m (µR/h)	Radionuclide Concentration (pCi/g)														
		Am-241	Co-57	Co-58	Co-60	Cr-51	Cs-137	Eu-152	Fe-59	Mn-54	Ra-226	Sb-124	Th-232	U-235	U-238	Zn-65
15	18	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.2	<0.1	0.7 ± 0.2	<0.1	1.1 ± 0.3	<0.3	<1.2	<0.2
16	--	<0.1	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	0.7 ± 0.1	<0.1	1.8 ± 0.4	<0.3	<1.3	<0.1
17	--	<0.2	<0.1	<0.1	<0.2	<0.8	<0.1	<0.3	<0.2	<0.1	0.7 ± 0.2	<0.1	1.4 ± 0.5	<0.5	<2.3	<0.2
18	--	<0.1	<0.1	<0.1	<0.1	<0.4	0.2 ± 0.1	<0.1	<0.2	<0.1	0.6 ± 0.2	<0.1	1.1 ± 0.3	<0.3	1.1 ± 1.0	<0.1
19	--	<0.2	<0.1	<0.1	<0.1	<0.5	<0.1	<0.2	<0.1	<0.1	0.9 ± 0.2	<0.1	1.4 ± 0.4	<0.4	<1.5	<0.1
20	15	<0.1	<0.1	<0.1	<0.1	<0.4	0.2 ± 0.1	<0.1	<0.1	<0.1	0.6 ± 0.1	<0.1	1.3 ± 0.3	<0.3	0.8 ± 0.8	<0.1
Phase II, Septic Trench																
21	12	<0.1	<0.1	<0.1	<0.1	<0.3	0.1 ± 0.1	<0.1	<0.1	<0.1	1.1 ± 0.1	<0.1	1.5 ± 0.2	<0.2	1.0 ± 0.7	<0.1
22	12	<0.1	<0.1	<0.1	<0.1	<0.2	0.1 ± 0.1	<0.1	<0.1	<0.1	0.8 ± 0.1	<0.1	1.4 ± 0.2	<0.1	1.1 ± 0.5	<0.1
23	10	<0.1	<0.1	<0.1	<0.1	<0.3	0.2 ± 0.1	<0.1	<0.1	<0.1	0.7 ± 0.1	<0.1	1.4 ± 0.2	<0.2	0.7 ± 0.1	<0.1
24	13	<0.1	<0.1	<0.1	<0.1	<0.2	0.1 ± 0.1	<0.1	<0.1	<0.1	0.7 ± 0.1	<0.1	1.4 ± 0.2	<0.1	0.8 ± 0.5	<0.1
25	11	<0.1	<0.1	<0.1	<0.1	<0.3	0.1 ± 0.1	<0.1	<0.1	<0.1	0.8 ± 0.1	<0.1	1.4 ± 0.2	<0.2	1.3 ± 0.6	<0.1
26	11	<0.1	<0.1	<0.1	<0.1	<0.2	0.1 ± 0.1	<0.1	<0.1	<0.1	0.7 ± 0.1	<0.1	1.4 ± 0.2	<0.1	0.9 ± 0.5	<0.1
27	13	<0.1	<0.1	<0.1	<0.1	<0.4	0.2 ± 0.1	<0.1	<0.1	<0.1	0.8 ± 0.1	<0.1	1.3 ± 0.2	<0.2	0.8 ± 0.7	<0.1
28	12	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	0.8 ± 0.1	<0.1	1.4 ± 0.2	<0.2	0.7 ± 0.6	<0.1
29	11	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	0.9 ± 0.1	<0.1	1.4 ± 0.2	<0.2	0.8 ± 0.6	<0.1
30	13	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	0.8 ± 0.1	<0.1	1.4 ± 0.1	<0.2	0.9 ± 0.2	<0.1

TABLE 1 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SOIL
FOR THE
FORMER HOT LABORATORY (4020)
SANTA SUSANA FIELD LABORATORY
VENTURA COUNTY, CALIFORNIA

Sample Location[a]	Exposure Rate at 1 m (μR/h)	Radionuclide Concentration (pCi/g)														
		Am-241	Co-57	Co-58	Co-60	Cr-51	Cs-137	Eu-152	Fe-59	Mn-54	Ra-226	Sb-124	Th-232	U-235	U-238	Zn-65
Phase III																
31	14	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	0.9 ± 0.2	<0.1	<0.5	<0.3	0.7 ± 0.6	<0.2
32	15	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	0.9 ± 0.1	<0.1	<0.3	<0.2	0.8 ± 0.6	<0.1
33	15	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	1.2 ± 0.1	<0.1	<0.3	<0.2	1.3 ± 0.6	<0.1
34	14	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	0.9 ± 0.1	<0.1	<0.3	<0.1	1.2 ± 0.6	<0.1
35	16	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	1.0 ± 0.2	<0.1	<0.5	<0.3	1.6 ± 0.9	<0.1
36	16	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	0.9 ± 0.1	<0.1	<0.4	<0.2	0.3 ± 0.6	<0.1
37	15	<0.1	<0.1	<0.1	<0.1	<0.5	<0.1	<0.1	<0.1	<0.1	1.1 ± 0.3	<0.1	<0.5	<0.3	0.9 ± 0.6	<0.1
38	15	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	1.0 ± 0.1	<0.1	<0.3	<0.1	1.0 ± 0.5	<0.1
39	15	<0.1	<0.1	<0.1	<0.1	<0.3	<0.1	<0.1	<0.1	<0.1	1.0 ± 0.1	<0.1	<0.4	<0.2	1.1 ± 0.8	<0.1
40	13	<0.1	<0.1	<0.1	<0.1	<0.4	<0.1	<0.1	<0.1	<0.1	0.7 ± 0.1	<0.1	<0.5	<0.3	0.5 ± 0.7	<0.1
41	14	<0.1	<0.1	<0.1	<0.1	<0.2	0.1 ± 0.1	<0.1	<0.1	<0.1	0.8 ± 0.1	<0.1	<0.3	<0.2	0.9 ± 0.5	<0.1
42	13	<0.1	<0.1	<0.1	<0.1	<0.3	0.2 ± 0.1	<0.1	<0.1	<0.1	0.8 ± 0.1	<0.1	<0.4	<0.2	0.7 ± 0.7	<0.1

[a] See Figures 4 through 6.

[b] Uncertainties represent the 95% confidence level, based on total propogated uncertainties.

TABLE 2

STRONTIUM AND PLUTONIUM CONCENTRATIONS IN SOIL FOR THE FORMER HOT LABORATORY (4020) SANTA SUSANA FIELD LABORATORY VENTURA COUNTY, CALIFORNIA

Sample Location[a]	Radionuclide Concentration (pCi/g)		
	Sr-90	Pu-238	Pu-239
1	<0.72	_[b]	--
2	<0.78	--	--
3	<0.73	--	--
4	<0.83	--	--
5	<0.70	--	--
Composite of 1-5		<0.02	<0.02
6	<0.70	--	--
7	<0.75	--	--
8	<0.71	--	--
9	<0.64	--	--
10	<0.67	--	--
Composite of 6-10		<0.03	<0.03
11	<0.67	--	--
12	<0.70	--	--
13	<0.69	--	--
14	<0.62	--	--
15	<0.67	--	--
Composite of 11-15		<0.03	<0.03
16	<0.69	--	--
17	<0.64	--	--
18	<0.69	--	--
19	<0.70	--	--
20	<0.70	--	--
Composite of 16-20		<0.03	<0.02

[a]Refer to Figure 4
[b]Analysis not performed individually

TABLE 3

GENERIC LIMITS FOR SOIL AND WATER (REFERENCE N001SRR140127)[a] SANTA SUSANA FIELD LABORATORY VENTURA COUNTY, CALIFORNIA

Radionuclide	Soil Guidelines (pCi/g)	Water (pCi/l)
Am-241	5.44	1.5
Co-60	1.94	200
Cs-134	3.33	75
Cs-137	9.20	110
Eu-152	4.51	840
Eu-154	4.11	570
Fe-55	629,000	9,000
H-3	31,900	20,000[b]
K-40	27.6	290
Mn-54	6.11	2,000
Na-22	2.31	480
Ni-59	151,000	26,000
Ni-63	55,300	9,500
Pu-238	37.2	1.7
Pu-239	33.9	1.6
Pu-240	33.9	1.6
Pu-241	230	80
Pu-242	35.5	1.6
Ra-226	5[c] and 15[c]	4.1
Sr-90	36.0	8[b]
Th-228	5[c] and 15[c]	6.8

TABLE 3 (Continued)

GENERIC LIMITS FOR SOIL AND WATER (REFERENCE N001SRR140127)[a] SANTA SUSANA FIELD LABORATORY VENTURA COUNTY, CALIFORNIA

Radionuclide	Soil Guidelines (pCi/g)	Water (pCi/l)
Th-232	5[c] and 1[c]	2.0
U-234	30[d]	
U-235	30[d]	total uranium 20[b]
U-238	35[d]	
Gross alpha (not including radon and uranium	---	15[b]
Gross beta	---	50[b]

[a]Reference taken from Rocketdyne/Boeing 96ETEC-DRF-0374, Enclosure A, June 28, 1996
[b]State of California Maximum Contaminant Levels, CCR Title 22
[c]DOE Order 5400.5 limits are proposed (5 pCi/g averaged over first 15 cm of soil depth and 15 pCi/g averaged over 15 cm layers below the top 15 cm).
[d]Generally more conservative NRC limits for uranium isotopes are proposed.

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APPENDIX A

MAJOR INSTRUMENTATION

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The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the author or his employer.

DIRECT RADIATION MEASUREMENT

Instruments

Eberline Pulse Ratemeter
Model PRM-6
(Eberline, Santa Fe, NM)

Detectors

Bicron Micro-Rem Meter
(Bicron Corporation, Newburg, OH)

Victoreen NaI Scintillation Detector
Model 489-55
3.2 cm x 3.8 cm Crystal
(Victoreen, Cleveland, OH)

LABORATORY ANALYTICAL INSTRUMENTATION

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
DEC Alpha Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detector
Model No. GMX-45200-5
(ORTEC)
used in conjunction with:
Lead Shield Model SPG-16-K8
(Nuclear Data)
Multichannel Analyzer
DEC Alpha Workstation
(Canberra, Meriden, CT)

High Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
DEC Alpha Workstation
(Canberra, Meriden, CT)

Alpha Spectrometry System
Tennelec Model 256
(Oxford, Oak Ridge, TN)
Used in conjunction with:
Surface Barrier and Ion Implanted Detectors
(EG&G ORTEC, Oak Ridge, TN and Canberra, Meriden, CT) and
DEC Alpha Workstation
(Canberra, Meriden, CT)

Alpha Spectrometry System
Canberra Model 7401VR
(Canberra, Meriden, CT)
Used in conjunction with:
Ion Implanted Detectors and
Multichannel Analyzer
DEC Alpha Workstation
(Canberra, Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

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SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the detectors slowly over the surface; the distance between the detector and the surface was maintained at a minimum—nominally about 5 to 10 cm. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Gamma - NaI scintillation detector with ratemeter

Exposure Rate Measurements

Measurements of dose equivalent rates (μrem/h) were performed at 1 m above the surface using a Bicron microrem meter. Although the instrument displays data in μrem/h—the conversion to μR/h is essentially unity.

Soil Sampling

Approximately 1 kg of soil was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Gamma Spectroscopy

Samples of soil were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system.

Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. All photopeaks associated with the radionuclides of concern were reviewed for consistency of activity. Energy peaks used for determining the activities of radionuclides of concern were:

Am-241	0.059 MeV
Ra-226	0.351 MeV from Pb-214*
Th-228	0.239 MeV from Pb-212*
Th-230	0.067 MeV
Th-232	0.911 MeV from Ac-228*
U-235	0.143 MeV (or 0.186 MeV)
U-238	0.063 MeV from Th-234* (or 1.001 MeV from Pa-234 m)*
Cs-137	0.662 MeV

*Secular equilibrium assumed.
Spectra were also reviewed for other identifiable photopeaks.

Alpha Spectroscopy

Soil samples were crushed, homogenized, and analyzed for isotopic plutonium. Samples were dissolved by potassium fluoride and pyrosulfate fusion and the elements of interest were precipitated with barium sulfate. Barium sulfate precipitate was redissolved and the specific elements of interest were individually separated by liquid-liquid extraction and re-precipitated with a cerium fluoride carrier. The precipitate was then counted using ion implanted detectors (Canberra), alpha spectrometers (Tennelec and Canberra), and a mulitchannel analyzer (Canberra).

Strontium-90 Analysis

Soil samples were dried, mixed, crushed and then aliquots of the soil were dissolved using a potassium fluoride and pyrosulfate fusion. Strontium was dissolved in dilute hydrochloric acid and precipitated as lead sulfate. Lead and calcium were removed in EDTA. Barium is removed as barium chromate. Strontium carbonate was collected on a filter and counted using a low background Tennelec gas proportional counter. Count rates were corrected for yttrium-90 ingrowth. Chemically

yield was determined gravimetrically.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent total propagated uncertainty at the 95% confidence level. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

Calibration of all field and laboratory instrumentation was based on standards/sources traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry-recognized organization were used.

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, (April 1995 and October 1997)
- Laboratory Procedures Manual, (August 1996, June 1998, and October 1999)
- Quality Assurance Manual, (January 1995 and September 1996)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 414.1A and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EML, ITP, and MAPEP laboratory Quality Assurance Programs.

- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.