ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION

March 13, 1996

Mr. Don Williams
U.S. Department of Energy
EM-421
Cloverleaf Building
Washington, DC 20585-0002

SUBJECT: FINAL REPORT - VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038; SANTA SUSANA FIELD LABORATORY, ROCKWELL INTERNATIONAL, VENTURA COUNTY, CALIFORNIA

Dear Mr. Williams:

Enclosed are two copies of the subject report. Comments on the draft report that were provided in your December 28, 1995 memorandum have been incorporated into the final report. The report describes the procedures and results of the radiological surveys that the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE) performed during the period of September 11 through 14, 1995.

Please contact me at (423) 576-5073 or W. L. (Jack) Beck at (423) 576-5031 if we may provide you with any additional information.

Sincerely,

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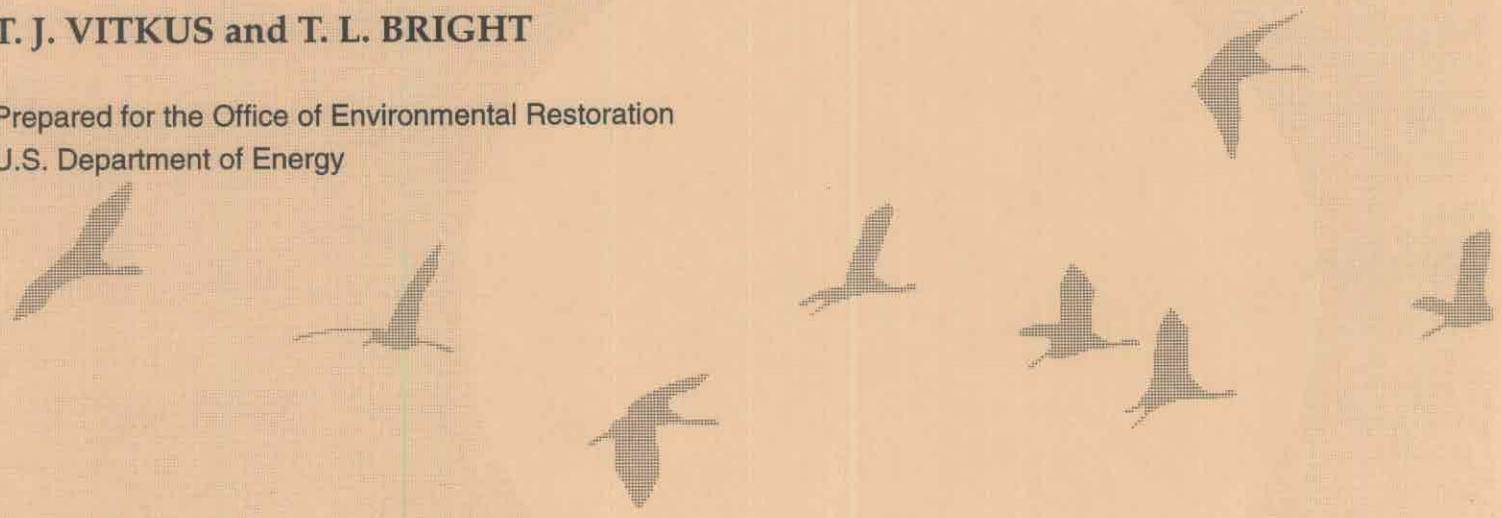
VERIFICATION SURVEY OF THE INTERIM STORAGE FACILITY; BUILDINGS T030, T641, AND T013; AN AREA NORTHWEST OF BUILDINGS T019, T013, T012, AND T059; AND A STORAGE YARD WEST OF BUILDINGS T626 AND T038 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

T. J. VITKUS and T. L. BRIGHT

Prepared for the Office of Environmental Restoration
U.S. Department of Energy



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

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U.S. Department of Energy

FINAL REPORT

FEBRUARY 1996

This report is based on work performed under contract number DE-AC05-76OR00033 with the U.S. Department of Energy.

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ABBREVIATIONS AND ACRONYM

AEC	Atomic Energy Commission
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DOE	Department of Energy
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EM	Environmental Restoration and Management
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
ESSAP	Environmental Survey and Site Assessment Program
ETEC	Energy Technology Engineering Center
GM	Geiger Mueller
ha	hectare
ISF	Interim Storage Facility
km	kilometer
m	meter
m^2	square meter
M&O	Management and Operation
NaI	Sodium Iodide
NIST	National Institute of Standards and Technology
NW Area	Northwest Area
ORISE	Oak Ridge Institute for Science and Education
pCi/g	picocuries per gram
PIC	pressurized ionization chamber
SSFL	Santa Susana Field Laboratory
SNAP	Systems for Nuclear and Auxiliary Power
SRE	Sodium Reactor Experiment
μR/h	microroentgens per hour
ZnS	Zinc Sulfide

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SANTA SUSANA FIELD LABORATORY
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INTRODUCTION AND SITE HISTORY

Rockwell International's 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 Nuclear Regulatory Commission and by the State of California Radiological Health Branch of the 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 (in natural and 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, Ni-63, Pm-147, Ta-182). Chemical contaminants, mainly chlorinated organic solvents, have also been identified in groundwater, primarily as a result of rocket engine testing.

Decontamination and decommissioning of contaminated facilities began in the late 1960's and continues as the remaining DOE program operations at ETEC have been terminated, effective September 30, 1995. As part of this program, Rockwell/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 the 1980's. Environmental Management of DOE contaminated properties continues under the termination clause of the existing M&O contract. Surplus sodium facilities have been included in the current EM (Environmental Restoration and Waste Management) Program for stabilization and eventual cleanup.

The Interim Storage Facility (ISF), also referred to as DOE Facility 654, was constructed in 1958 to support the Sodium Reactor Experiment (SRE). The ISF was used to store dummy and spent fuel elements, shipping and storage casks, hot waste generated at the SRE, and items from the Organic Moderated Reactor Experiment and Systems for Nuclear and Auxiliary Power (SNAP). The ISF consisted of a concrete pad with a trench containing eight 51-centimeter diameter galvanized steel cells extending 7.6 meters into the rock strata. While the ISF was in use, a number of the items stored there deteriorated and released low-level contamination to adjacent asphalt surfaces and soil areas. Decommissioning of the ISF began in 1984 and involved removal of contaminated surfaces, soil, and the storage cells. The area was then backfilled and returned to a natural state (Rockwell 1985).

Building T030 was used from 1960 through 1964 to house a Van deGraaf accelerator facility for the performance of activation experiments. In 1965, the facility was converted for use as an office building although the accelerator remained on-site in an unused condition until at least 1966. Sometime after 1966 the facility was surveyed, and tritium contamination was identified on the accelerator. The accelerator was removed and the facility released for other uses. An asphalt area south of Building T030 was fenced and used for the storage of palletized items. It has not been verified, but items stored there may have included drums containing mixed fission products (Rockwell 1988a).

Building T641 was constructed in 1964 to serve as a shipping and receiving facility for SSFL. All radioactive and nuclear material shipments were only handled on the outdoor dock of the building. Documentation indicates that all shipments were fully packaged and never opened while on the dock. There have been no documented leaks at this facility (Rockwell 1988a).

Building T013 was constructed in 1961 for the assembly and checkout of non-nuclear SNAP reactor components. In 1970, the facility was redesignated as the ETEC Thermal Transient Facility and used for thermal testing and seismic test equipment. Rockwell/Rocketdyne classified this building as non-nuclear related.

The storage area northwest of T059, T019, T013, and T012 consists of a paved area between the buildings and the SNAP facility fence line. The property then drops sharply off to the SSFL property line. The paved portion of this Northwest Area (NW Area) was used for equipment staging and gas tanks. Site documentation identified this area as non-nuclear.

The final area was a storage yard west of Building T626 and T038 that was used for storing equipment and salvageable components. In 1978, drums containing sand contaminated with Co-60 were stored there. Rockwell/Rocketdyne performed final status surveys of each of these areas in the latter part of the 1980's and did not identify residual contamination (Rockwell 1988b).

DOE's 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 conducted within Office of Environmental Restoration programs. The purpose of these independent verifications is to confirm that remedial actions have been effective in meeting established and supplemental 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

as the organization responsible for this task at SSFL and was requested by the DOE to perform verification surveys of these buildings and areas. This report describes the results of the verification surveys.

SITE DESCRIPTION

The SSFL is located in the Simi Hills of southeastern Ventura County, California, approximately 47 kilometers (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 are conducted in Rockwell International-owned and DOE-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 ISF was located in the north-central portion of Area IV. The ISF was paved with a concrete berm containing the eight storage cells. The pavement, berms, and storage cells were removed during the decommissioning and the area was backfilled and graded. Total area of the ISF is not provided in the project documentation, but is estimated to be approximately 150 m^2 based on survey maps. Figures 2 and 3 show the location and plot plan of the ISF.

Building T030 is located north of G Street on 10th Street which is north of G Street in the eastern portion of Area IV (Figure 2). The building is constructed with steel framing, siding, and roofs and consists of an east office section and a west section where the particle accelerator was located. Total floor area of the building is 215 m^2; the west section occupies 125 m^2 of the total. There is an exterior concrete wall at the northern end of the west section that provided shielding for the accelerator beam. Building T641 is located immediately to the south of T030. Total building area is 713 m^2. The loading dock area where radioactive materials were received is located on the east end of the building and occupies approximately 200 m^2. The floor plans of Buildings T030 and T641 are shown on Figures 4 and 5.

Building T013 is located on B Street and is constructed of steel framing and siding (Figure 2). The north half of the building contains office and storage areas while the south half contains the seismic test equipment. Total floor area is approximately 780 m^2. Figure 6 shows the floor plan.

Buildings T626 and T038 are located west of 20th Street in Area IV (Figure 2). The storage area where the contaminated sands were stored is located to the western side of these buildings (Figure 7). The entire area is paved with asphalt. The area northwest of Buildings T059, T019, T013, and T012 (the NW Area) is paved with asphalt for approximately 30 meters north of the buildings, where the asphalt ends and the area drops-off to the property line (Figures 2, 8, and 9). This portion of the NW Area is covered with brush with interspersed boulders and sandstone outcroppings.

OBJECTIVE

The objective of the verification surveys was to validate that cleanup procedures and survey methods utilized by Rockwell/Rocketdyne were adequate. Perfomance of independent document reviews and evaluation of measurement and sampling data provides assurance that the post-remediation data is sufficient, accurate, and demonstrates that remedial actions were accomplished in accordance with appropriate standards and guidelines, and that authorized limits were met.

DOCUMENT REVIEW

ESSAP has reviewed Rockwell/Rocketdyne's supporting documentation concerning each building or outdoor areas final status survey procedures and results (Rockwell 1985, 1988a, and1988b).

PROCEDURES

ESSAP personnel conducted independent measurement and sampling activities at the SSFL facility during the period September 11 through 14, 1995. Survey activities were performed in

accordance with a site-specific survey plan (ORISE 1995), using procedures and instruments described in the ESSAP Survey Procedures and Quality Assurance Manuals and summarized in Appendices A and B.

For this survey, ESSAP classified buildings or outdoor areas that did not have a history of radiological use or storage as unaffected (referred to as "non-nuclear use" in Rockwell/Rocketdyne documentation). Buildings and outdoor areas with a history of radiological use, or where radioactive materials were known to or suspected of having been stored, were classified as affected areas. Survey coverage was determined based on whether an area was designated as unaffected or affected in accordance with the following procedures.

SURVEY PROCEDURES: UNAFFECTED AREAS

The following survey procedures applied to Building T013 and the NW Area.

Reference System

Measurement and sampling locations were referenced to prominent building or site features, and recorded on representative area drawings.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed in Building T013 and the paved portions of the NW Area. Only gamma scans were performed in the soil portions of the NW Area. Scan area coverage was approximately 10 to 50 percent of the floors and lower walls (up to 2 meters) of Building T013 and the paved and soil areas of the NW Area. Scans were performed using gas proportional, ZnS, GM, and/or NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators.

Surface Activity Measurements

Direct measurements for total alpha and total beta activity were performed at 31 randomly selected locations within Building T013 and at 25 locations on the paved portion of the NW Area. Direct measurements were made using gas proportional, ZnS, and/or GM detectors coupled to ratemeter-scalers. A smear sample for the determination of removable gross alpha and gross beta activity was collected from each of the Building T013 direct measurement locations. Figures 6 and 8 show measurement and sampling locations in unaffected areas.

Exposure Rate Measurements

ESSAP performed exterior background exposure rate measurements at six locations within 0.5 to 10 km of the site (Figure 10) and used Rockwell's previously determined building interior background exposure rate measurements for data comparisons. Exposure rate measurements were performed at four locations in Building T013 and a total of seven locations within the NW Area. Exposure rate measurements were performed at 1 meter above the surface using a pressurized ionization chamber (PIC). Figures 6, 7, and 8 show measurement locations.

Soil Sampling

Background soil samples were collected from the six background exposure measurement locations (Figure 10). Surface (0 to 15 cm) soil samples were collected from five locations in the NW area (Figure 9).

SURVEY PROCEDURES: AFFECTED AREAS

The following survey procedures were applicable to Building T030, the Building T641 loading dock, the ISF, and the storage yard west of Buildings T626 and T038.

Reference System

Measurement and sampling locations were referenced to prominent building or site features, and recorded on representative area drawings.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed over 50 to 100 percent of the accessible floors and lower walls (up to 2 m) within Building T030, the Building T641 loading dock, and the paved portions of the storage yard. Accessible overhead surfaces where material may have settled or accumulated were also scanned. Gamma scans only were performed in the ISF and the soil area that is located west of the storage yard. The ISF was excavated to a depth of 7.5 to 9 meters when the storage cells were removed and then backfilled to grade. As a result of back-filling, the original soil was inaccessible; therefore, scans of the ISF were concentrated in the peripheral areas where contamination may have migrated. Scans were performed using gas proportional, ZnS, GM, and/or NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators.

Surface Activity Measurements

Single-point direct measurements for total alpha and total beta activity were performed on floors, walls, equipment, and on pavement in the designated areas. A total of 19, 50, and 25 measurements were performed in Building T030, the Storage Yard west of Buildings T626 and T038, and the Building T641 loading dock, respectively. Direct measurements were performed using gas proportional, ZnS, and/or GM detectors coupled to ratemeter-scalers. A smear sample for the determination of removable gross alpha and gross beta activity was collected from each direct measurement location. In the western portion of Building T030, a second smear was collected from each direct measurement location for determination of removable tritium activity levels. Measurement and sampling locations for total and removable activity are shown in Figures 4, 5, and 7.

Exposure Rate Measurements

Exterior background exposure rate measurements were made at six locations within 0.5 to 10 km of the site (Figure 10). Exposure rate measurements were performed at 17 locations in the affected areas. Figures 3, 4, 5, and 7 indicate measurement locations. Exposure rate measurements were performed at 1 meter above the surface using a PIC.

Soil Sampling

Individual soil samples were collected from four locations in the ISF area. One composite surface (0-15 cm) soil sample was collected from the T626 storage area over a 100 m^2 area. Figures 3 and 7 indicate sampling locations.

Miscellaneous Sampling

Because available field instrumentation cannot detect tritium surface activity at the guideline levels, a limited number of miscellaneous samples were collected in order to provide a quantitative indication of total tritium surface activity. Paint samples were collected from five randomly selected 100 cm^2 area on the walls of the western portion of Building T030, where the accelerator was formerly located. Sampling locations are shown in Figure 4.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ORISE's ESSAP laboratory in Oak Ridge, Tennessee for analysis and interpretation. Soil samples were analyzed by solid state gamma spectrometry. Spectra were reviewed for U-238, U-235, Th-232, Cs-137, Co-60 and any other identifiable photopeaks, particularly additional activation and fission products. Gamma spectrometry data were reported in picocuries per gram (pCi/g). Smears were analyzed for gross alpha and gross beta activity using a low background proportional counter, and for tritium by liquid scintillation. Miscellaneous samples were analyzed for tritium by liquid scintillation counting. Smear results,

miscellaneous sample results, and direct measurement data were converted to units of disintegrations per minute per 100 square centimeters (dpm/100 cm^2). Exposure rates are reported in microroentgens per hour (μR/h).

FINDINGS AND RESULTS

DOCUMENT REVIEW

Based on the review of the project documents, it is ESSAP's opinion that the documentation was inadequate to satisfactorily demonstrate that each building or area meet the DOE guidelines for release to unrestricted use. Overall, the documentation for each building or area does not provide a clear description of the sequence of events necessary for demonstrating that the subject areas meet the requirements for release to unrestricted use. That is, the specification of contaminants present, selection of the appropriate guidelines, development of a sampling and analysis plan that provides adequate data for guideline interpretation, and presentation of the data in a manner that can be directly compared with the guidelines. The types of deficiencies noted in the reports included the following: all potential contaminants were not identified, final surveys were not designed to identify residual contamination of all suspected radionuclides, residual surface activity data was either absent or not reported in units of dpm/100 cm^2, radionuclide-specific sample analyses were not performed (i.e., gross beta analysis of soil samples was performed and the data used for demonstrating compliance), and appropriate guidelines were not always cited or unapproved site-specific guidelines were used. Comments on the documentation were provided to the DOE (ORISE 1996).

UNAFFECTED AREAS

The results of the verification surveys for unaffected buildings and areas are discussed below.

Surface Scans

Surface scans did not identify any areas of elevated alpha, beta, or gamma direct radiation.

Surface Activity Levels

Surface activity levels are summarized in Table 1. Total surface activity levels in Building T013 were less than 55 dpm/100 cm^2 for alpha and less than 1,400 dpm/100 cm^2 for beta. For the paved portion of the NW Area, surface activity levels were less than 100 dpm/100 cm^2 and less than 1,400 dpm/100 cm^2 for alpha and beta, respectively. Removable activity levels were less than 12 dpm/100 cm^2 for gross alpha and less than 16 dpm/100 cm^2 for gross beta.

Exposure Rates

Exposure rate measurement data is provided in Tables 3 and 4. Background exterior exposure rates ranged from 12 to 16 μR/h and averaged 14 μR/h. Exposure rates in the NW Area ranged from 14 to 16 μR/h. Exposure rates inside of Building T013 ranged from 8 to 11 μR/h.

Radionuclide Concentration In Soil

Radionuclide concentrations in soil samples are summarized in Table 5. Background concentration ranges were as follows: Cs-137, less than 0.1 to 0.2 pCi/g; Ra-226, less than 0.2 to 1.2 pCi/g; Th-228, 0.6 to 1.4 pCi/g; Th-232, 0.6 to 1.7 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 2.2 to 2.5 pCi/g. Radionuclide concentrations in samples collected from the NW Area were: Cs-137, less than 0.1 to 0.5 pCi/g; Ra-226, 0.8 to 1.0 pCi/g; Th-228, 1.2 to 1.5 pCi/g; Th-232, 1.5 to 1.7 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 1.5 to 1.9 pCi/g.

AFFECTED AREAS

The survey results for Buildings T030, T641 loading dock, the storage yard west of T626 and T038, and the ISF are discussed below.

Surface Scans

Surface scans for alpha, beta and gamma activity did not identify any locations of elevated direct radiation indicative of residual contamination.

Surface Activity Levels

Surface activity levels are summarized in Table 1. Surface activity levels for Building T030 were less than 55 dpm/100 cm^2 for total alpha and less than 1,400 dpm/100 cm^2 for total beta. Of the five miscellaneous samples collected from Building T030, four were less than the minimum detectable activities of the tritium procedure which ranged from 132 to 209 dpm/100 cm^2 (Table 2). One sample, location #2 on Figure 4, had a total tritium activity level of 6,600 dpm/100 cm^2. Activity levels for the Building T641 loading dock were less than 100 dpm/100 cm^2 for alpha and less than 1,400 dpm/100 cm^2 for beta. Total surface activity for the storage yard west of Building T626 and T038 was less than 55 dpm/100 cm^2 for alpha and ranged from less than 1,000 to 1,800 dpm/100 cm^2 for beta. Removable activity levels were less than 12 dpm/100 cm^2 for gross alpha and less than 16 dpm/100 cm^2 for gross beta. Removable tritium activity in Building T030 was less than 221 dpm/100 cm^2.

Exposure Rates

Exposure rates are summarized in Tables 3 and 4. Exposure rates ranged from 10 to 12 μR/h for the interior of Building T030 and the loading dock of Building T641. Rockwell determined that the average interior background exposure rate was approximately 8 μR/h. Exterior exposure rates for the ISF, ranged from 10 to 15 μR/h. Exterior background exposure rates ranged from 12 to 16 μR/h, and averaged 14 μR/h.

Radionuclide Concentrations in Soil

Radionuclide concentrations in soil samples are summarized in Table 5. Background concentration ranges were as follows: Cs-137, less than 0.1 to 0.2 pCi/g; Th-232, 0.6 to

1.7 pCi/g; Th-228, 0.6 to 1.4 pCi/g; Ra-226, less than 0.2 to 1.2 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 2.2 to 2.5 pCi/g. Radionuclide concentrations in samples collected from the ISF and the area adjacent to the storage yard west of Buildings T626 and T038 were: Cs-137, less than 0.1 to 0.4 pCi/g; Th-232, 1.5 to 1.7 pCi/g; Th-228, 1.2 to 1.6 pCi/g; Ra-226, 0.7 to 1.2 pCi/g; U-235, less than 0.1 pCi/g; and U-238, less than 2.0 pCi/g.

COMPARISON OF RESULTS WITH GUIDELINES

Surface activity levels in each area were compared to the appropriate residual radioactive material guidelines specified in DOE Order 5400.5 for uranium and mixed fission and activation products (DOE 1990). These guidelines are summarized in Appendix C. The applicable guidelines for uranium are as follows:

Total Activity

5,000 α dpm/100 cm^2, average in a 1 m^2 area

15,000 α dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1000 α dpm/100 cm^2

and the guidelines for beta-gamma emitters are:

Total Activity

5,000 β-γ dpm/100 cm^2, average in a 1 m^2 area

15,000 β-γ dpm/100 cm^2, maximum in a 100 cm^2 area

Removable Activity

1,000 β-γ dpm/100 cm^2

and the guidelines for tritium are (DOE 1995):

Removable Activity

10,000 dpm/100 cm^2

Although fixed tritium contamination was identified in Building T030, the guideline only addresses removable contamination. Removable tritium activity levels were within the guideline. All other total and removable activity levels were also within the respective guidelines.

The DOE's exposure rate guideline is 20 μR/h above background, although Rockwell/Rocketdyne has elected to use a more restrictive guideline of 5 μR/h above background. Exposure rates at 1 meter above the surface were within these guidelines.

Other than the DOE's generic residual soil concentration guidelines for thorium and radium of 5 pCi/g in the first 15 cm of soil and 15 pCi/g in 15 cm thick layers of subsurface soil, guidelines for other radionuclides are developed on a site-specific basis. Currently, there are no approved site-wide guidelines at SSFL for the radionuclides of concern. As a result, radionuclide concentrations in soils were compared to the background concentration levels. There were no radionuclides identified in excess of background levels.

SUMMARY

The Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education conducted verification activities for Buildings T013, T030, the loading dock of Building T641, the NW Area, the ISF, and the storage area west of Buildings T626 and T038 at the Santa Susana Field Laboratory in Ventura County, California. Verification activities included document reviews and during the period September 9 through 12, 1995 ESSAP personnel visited the site and performed independent surface scans, surface activity measurements, exposure rate measurements, miscellaneous material sampling, and soil sampling.

ESSAP's review identified a number of deficiencies in the final status documentation that was prepared for each building or area. Deficiencies noted included inadequate final status survey methods, no discussion of specific contaminants, inconsistent specification of all applicable guidelines and presentation of data that may be compared to the guidelines, absence of quantitative laboratory data, and inconsistent presentation of adequate figures documenting remediated areas and measurement and sampling locations.

ESSAP's verification survey results showed that surface activity levels, exposure rates, and/or radionuclide concentration levels in soil in the surveyed areas of Building T013, Building T030, the loading dock of Building T641, the NW Area, the Storage Yard West of Buildings T626 and T038, and the ISF were less than the current DOE guidelines for release to unrestricted use, or in the case of radionuclide concentrations in soils, comparable to background concentration levels.

Because of documentation deficiencies, ESSAP is unable to verify the radiological status of all areas. It is ESSAP's recommendation that final status documentation be revised and additional surveys performed as necessary to address those deficiencies that were identified and provided to DOE (ORISE 1996).

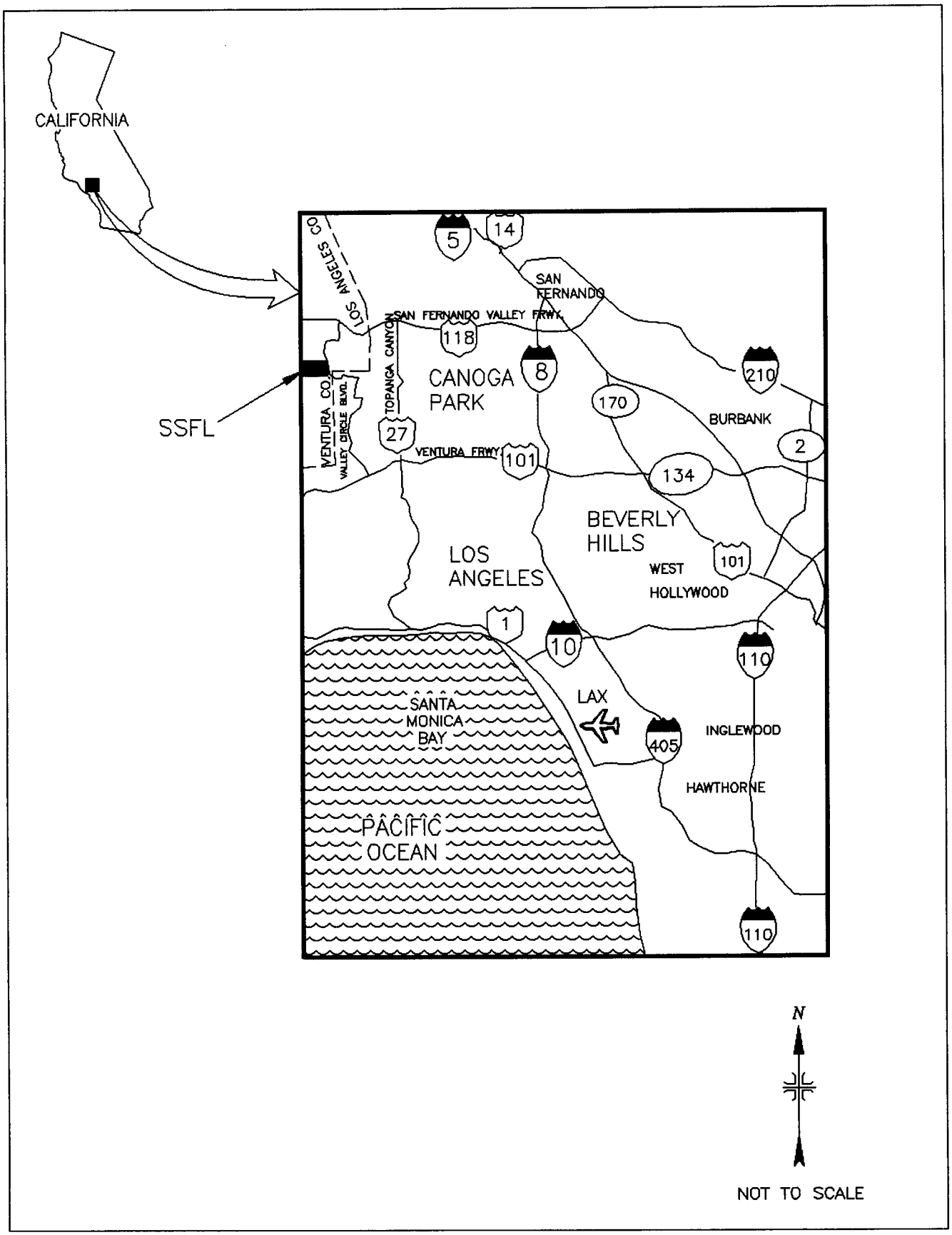

FIGURE 1: Los Angeles, California Area – Location of Santa Susana Field Laboratory Site

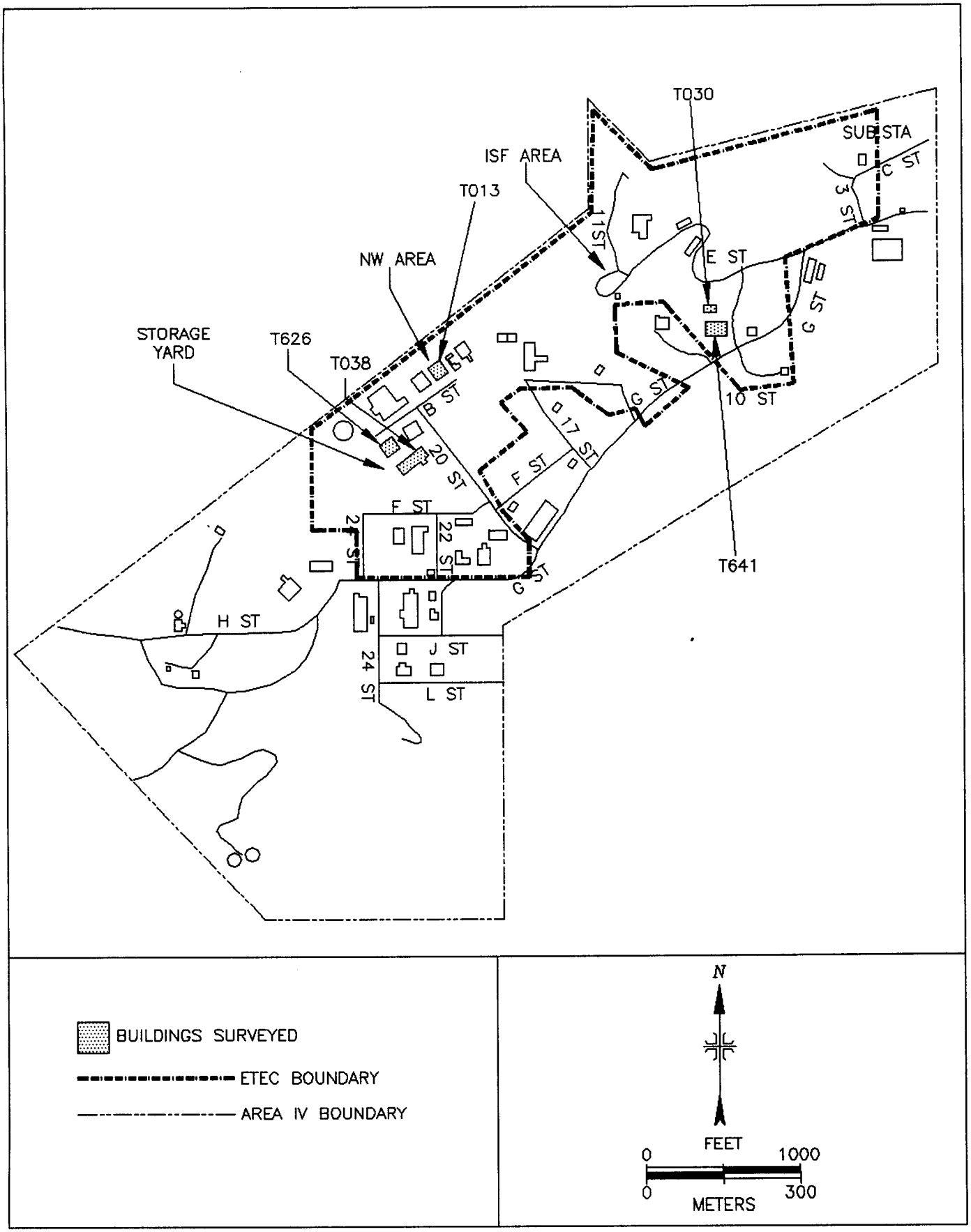

FIGURE 2: Santa Susana Field Laboratory Area IV, Plot Plan – Location of Surveyed Areas

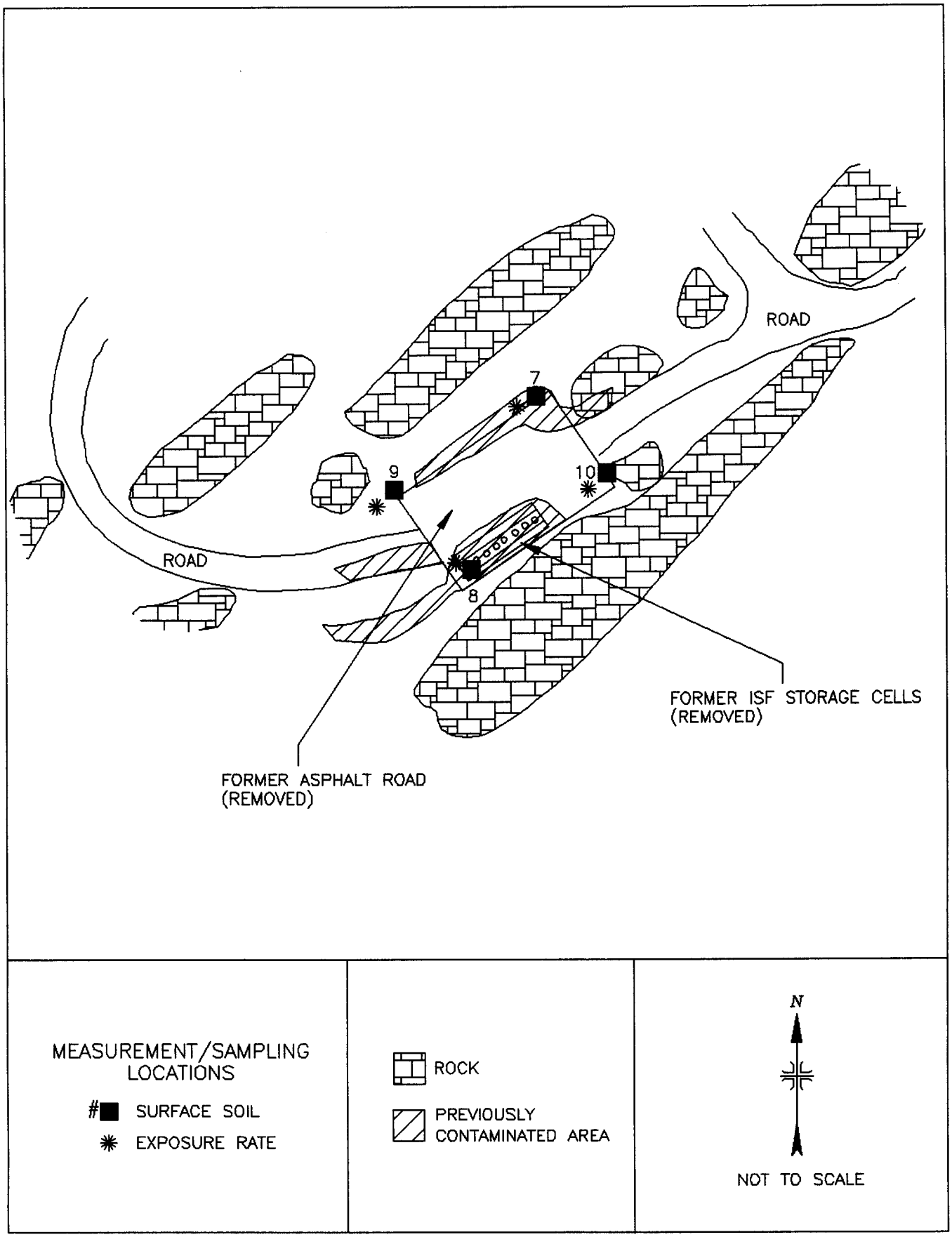

FIGURE 3: Interim Storage Facility – Plot Plan and Measurement and Sampling Locations

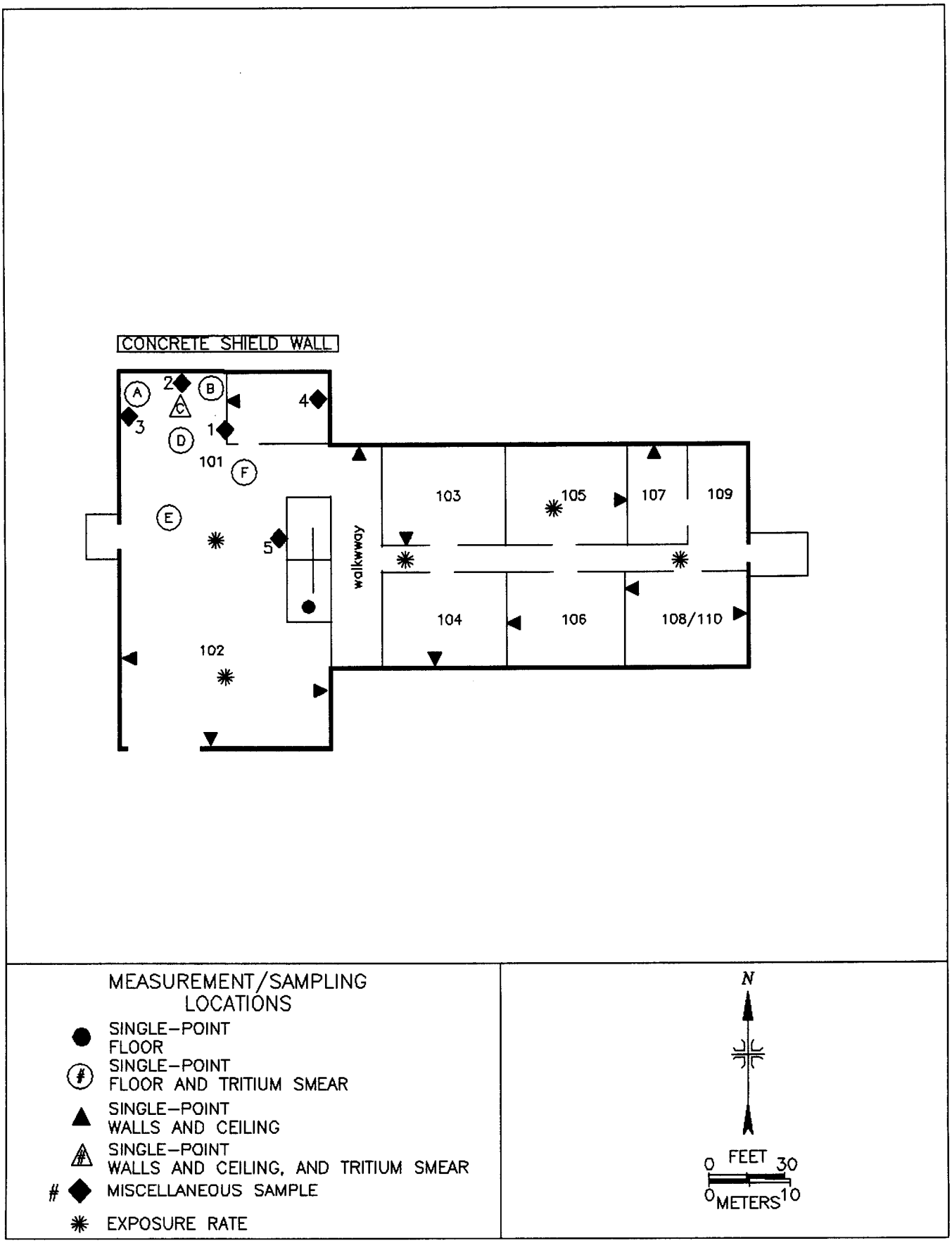

FIGURE 4: Building T030 – Floor Plan and Measurement and Sampling Locations

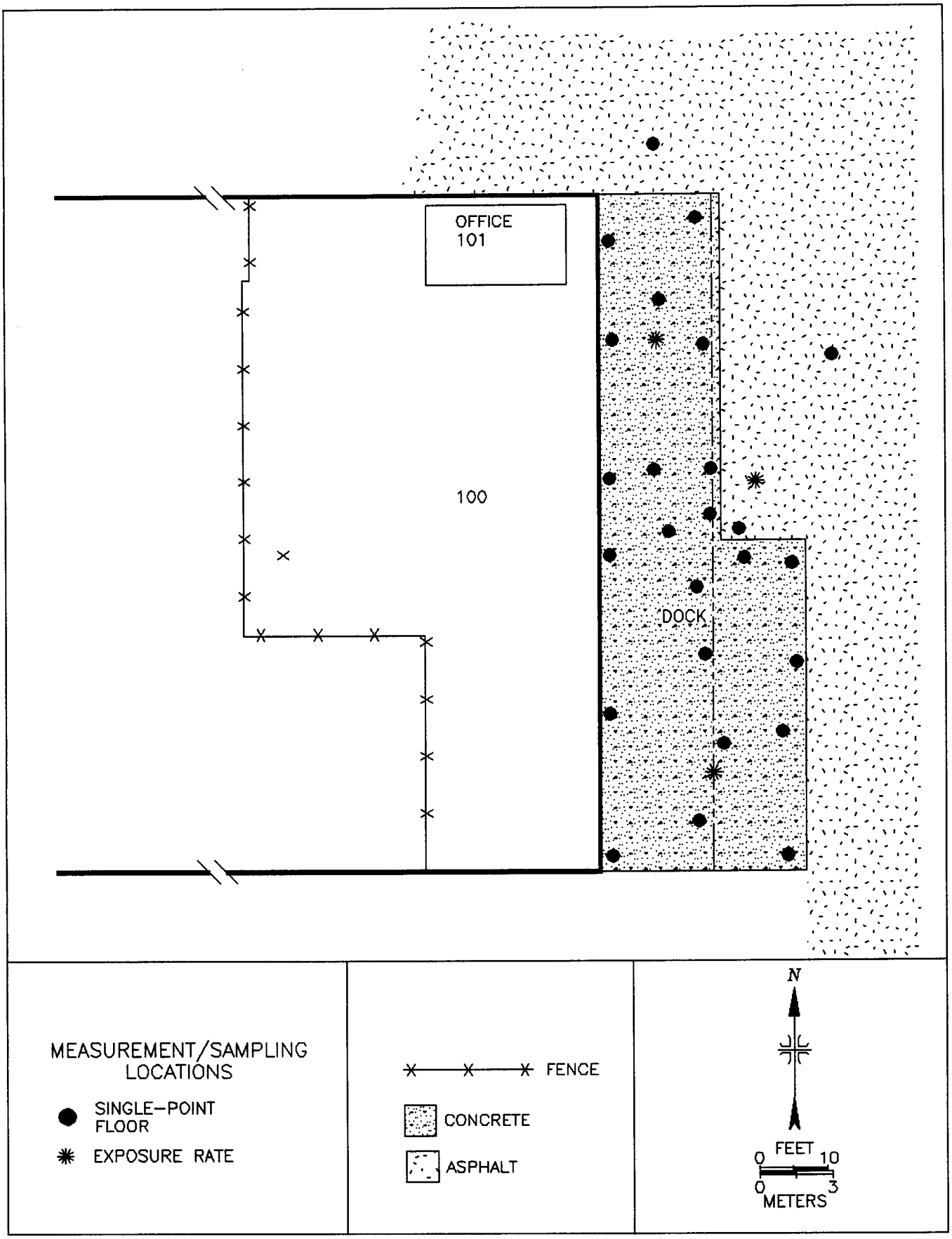

FIGURE 5: Building T641 – Floor Plan and Measurement and Sampling Locations

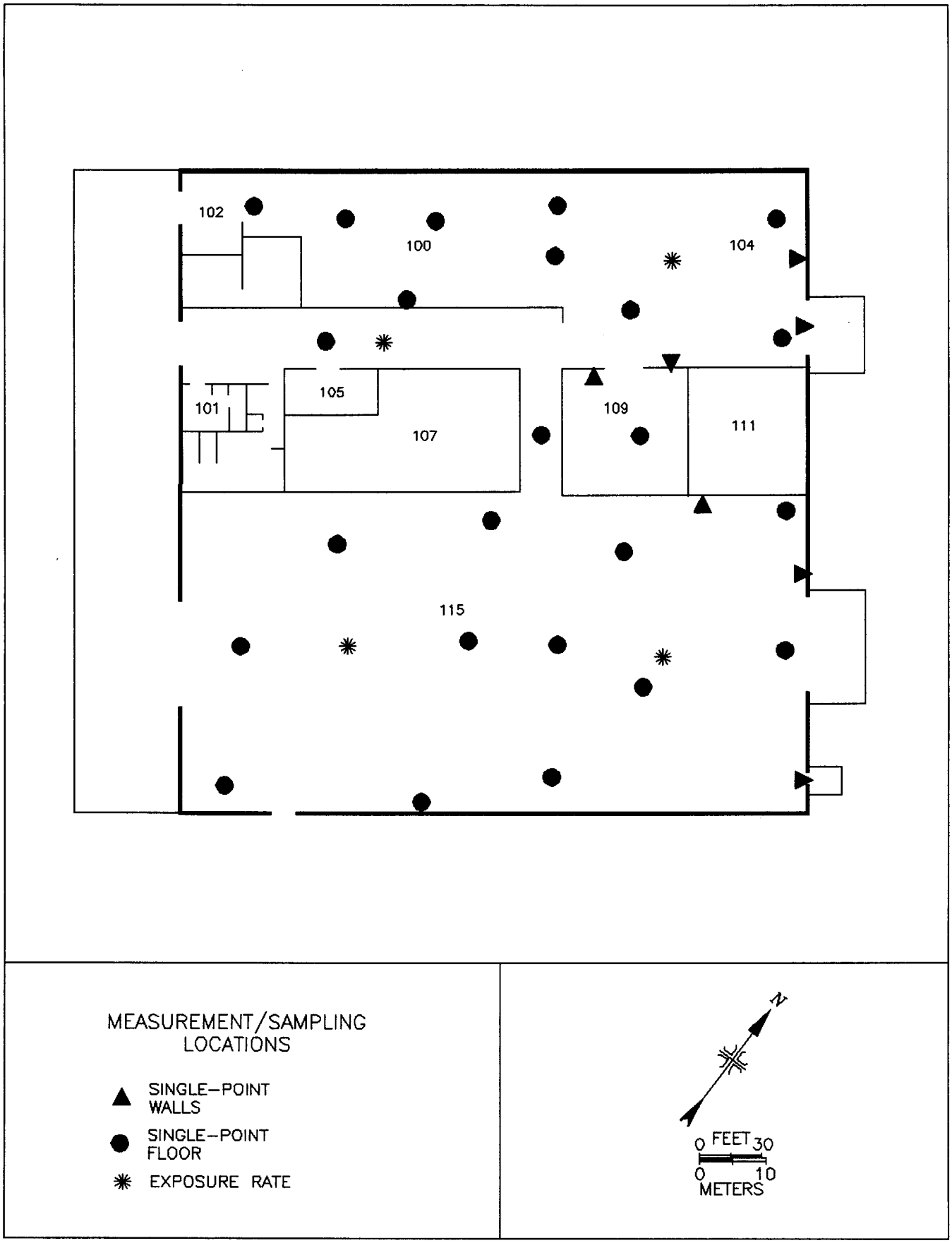

FIGURE 6: Building T013 – Floor Plan and Measurement and Sampling Locations

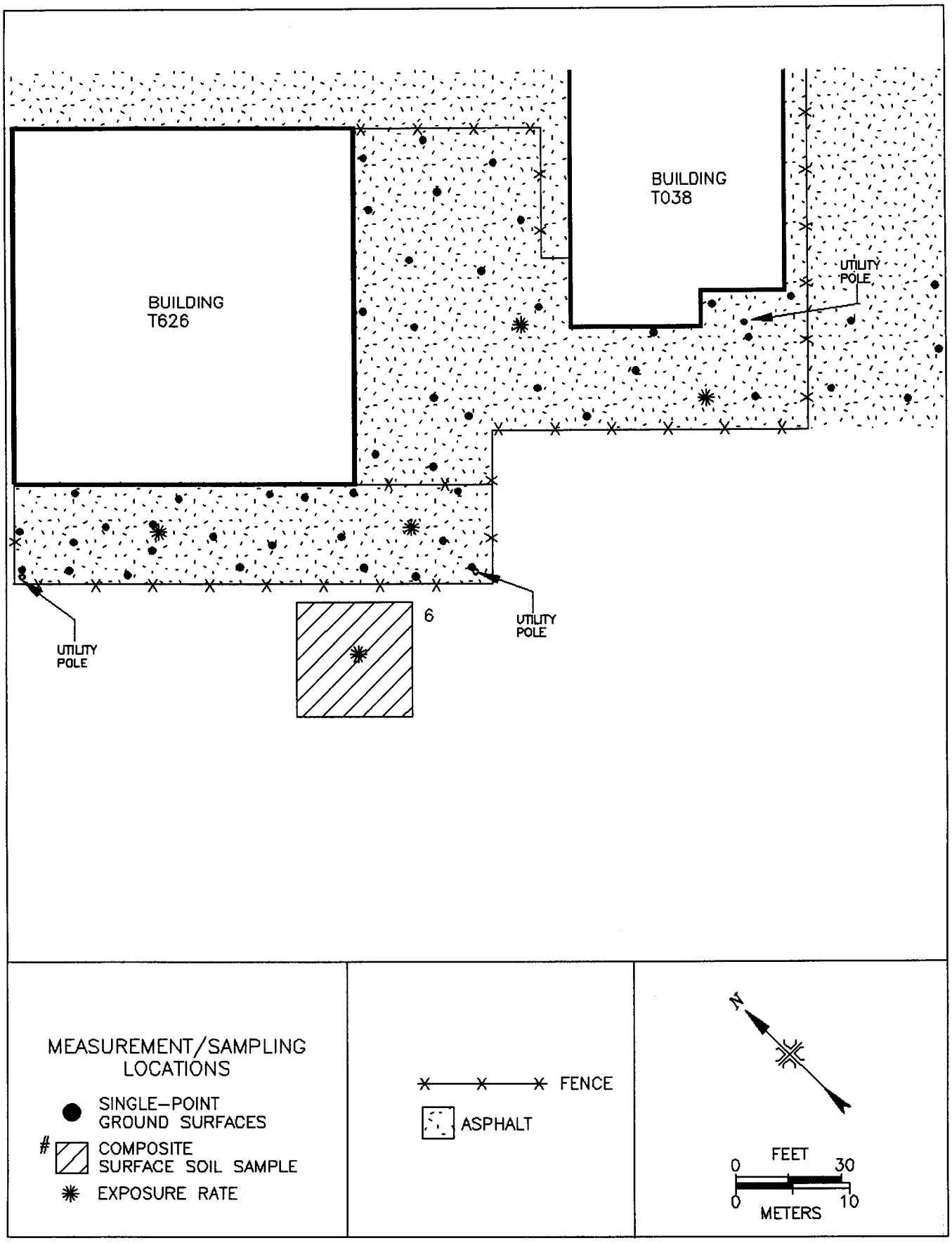

FIGURE 7: Building T626 and T038 Storage Yard – Plot Plan and Measurement and Sampling Locations

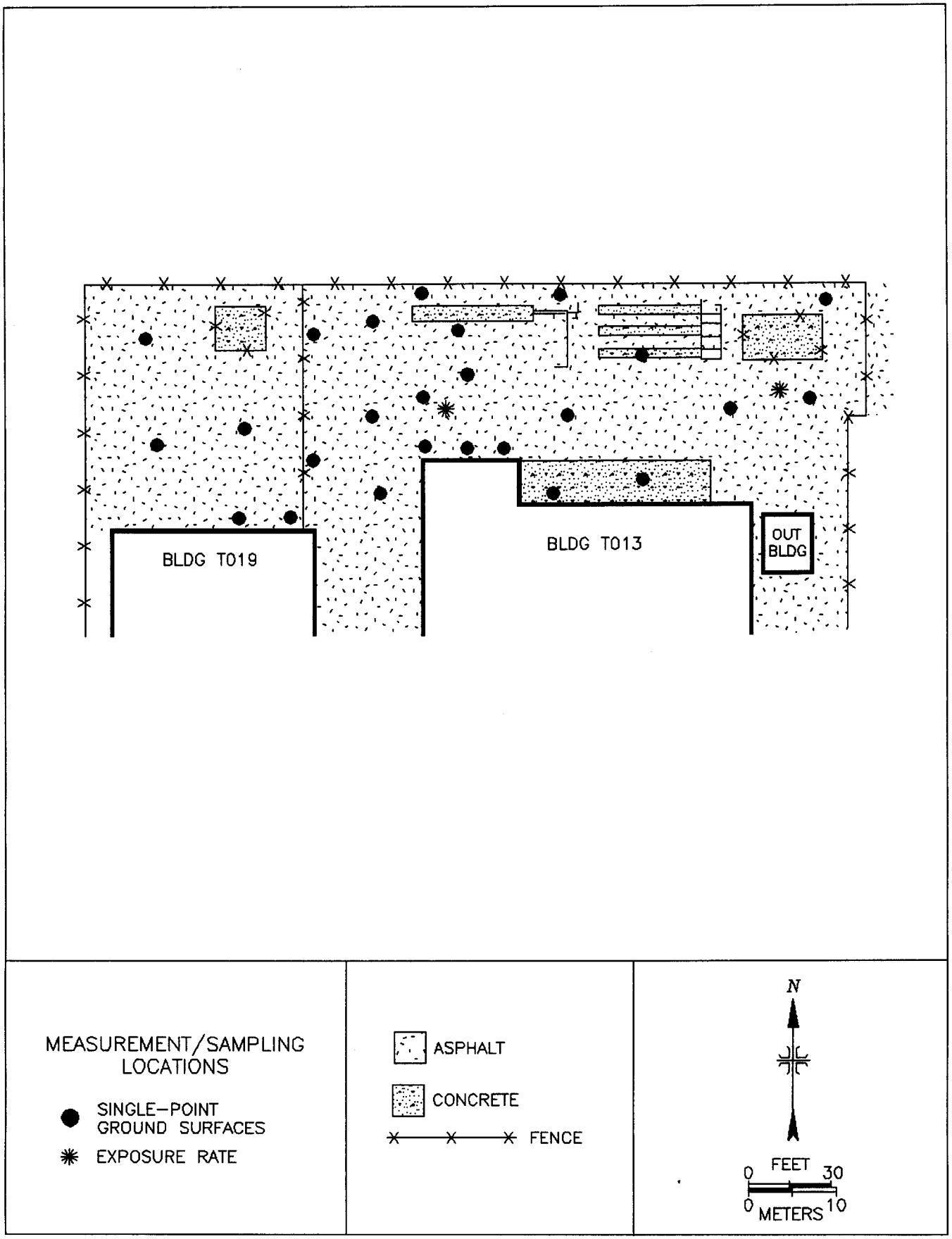

FIGURE 8: Paved Portion of the Northwest Area – Plot Plan and Measurement and Sampling Locations

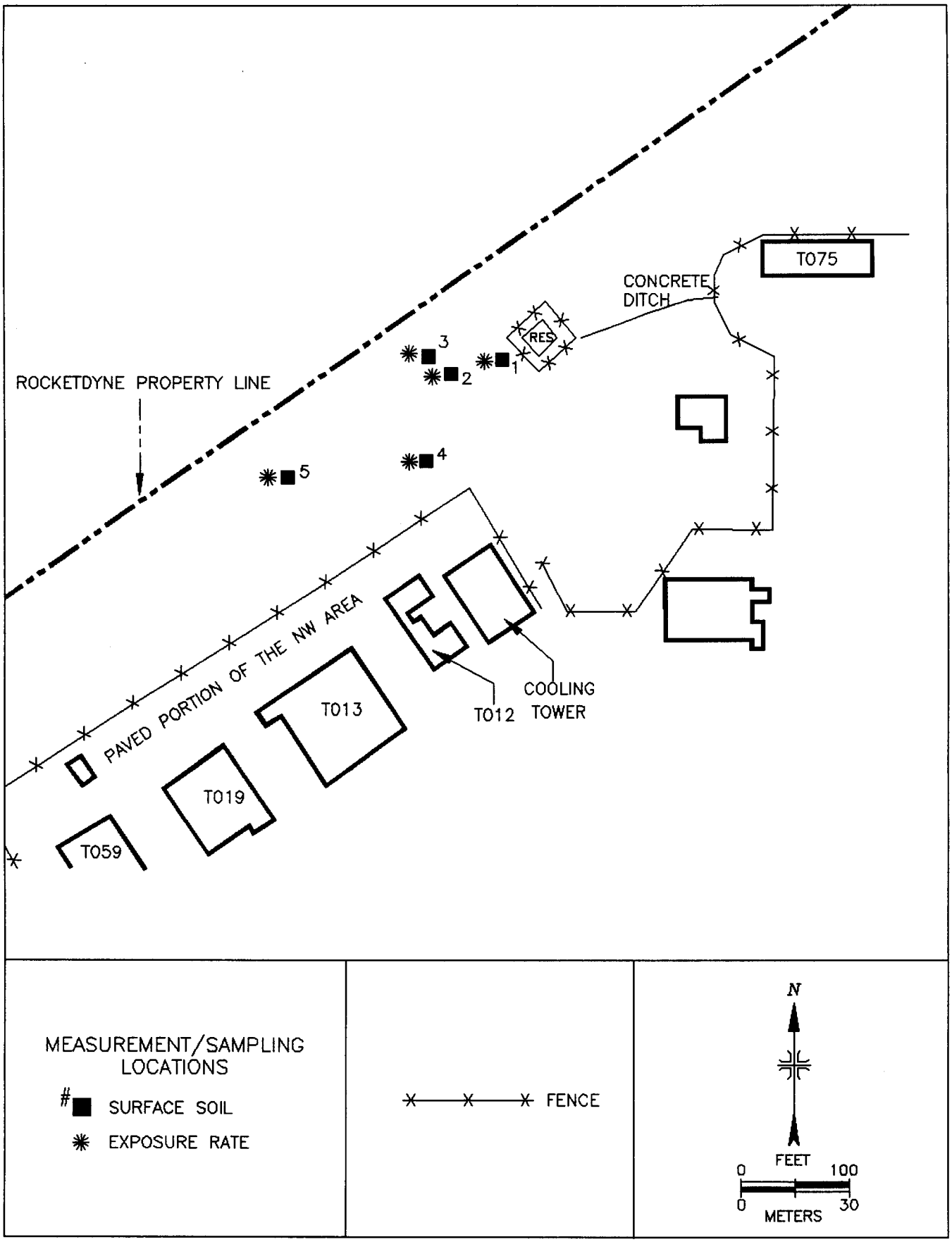

FIGURE 9: Soil Portion of the Northwest Area – Plot Plan and Measurement and Sampling Locations

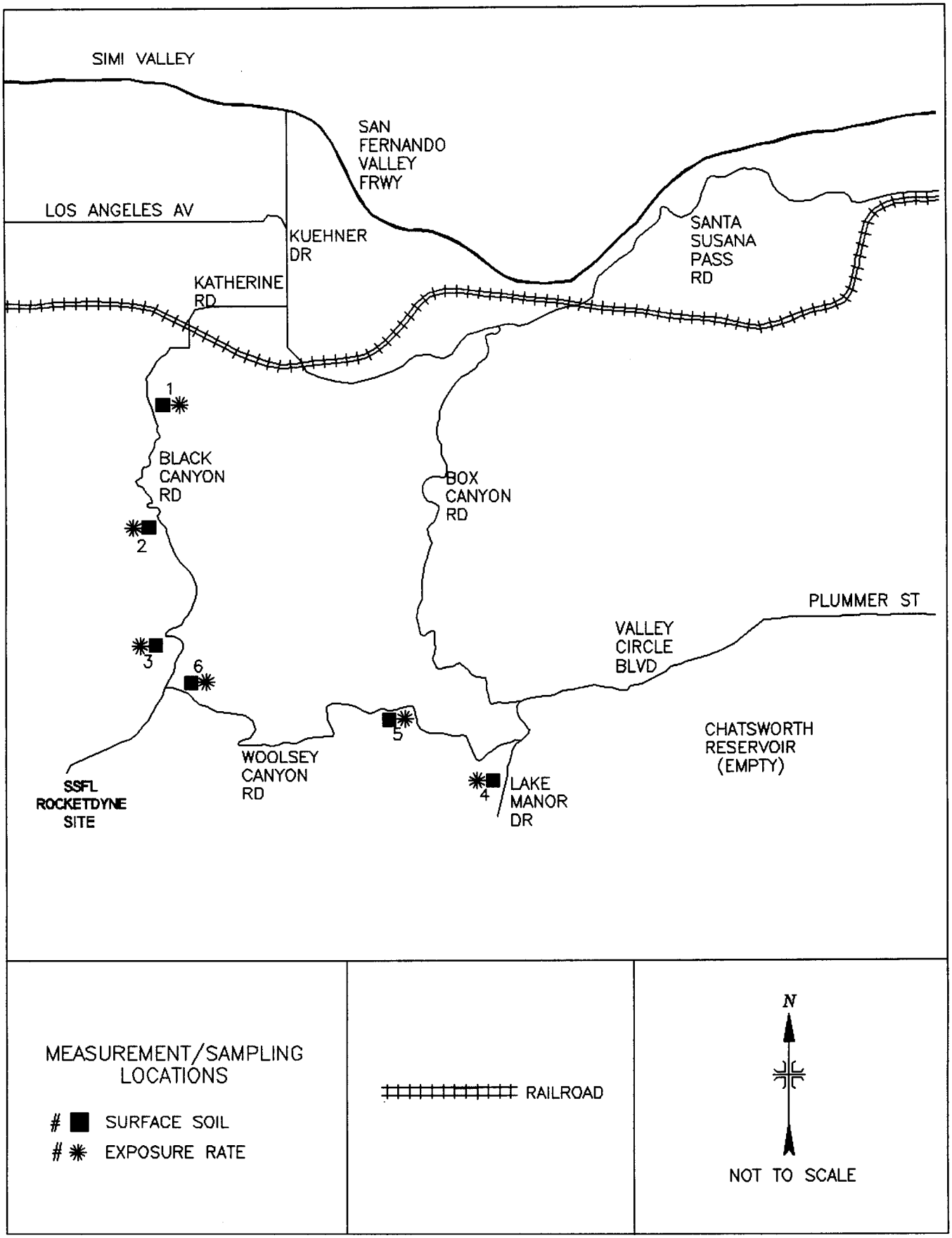

FIGURE 10: Santa Susana Field Laboratory, Ventura County, California – Background Measurement and Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY LEVELS
BUILDINGS T013, T030, T641 LOADING DOCK, NW AREA, AND STORAGE YARD WEST OF T626 AND T038
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Number of Measurement Locations	Total Activity Range (dpm/100 cm^2)		Removable Activity Range (dpm/100 cm^2)	
	Single-Pt.	Alpha[b]	Beta[c]	Alpha[d]	Beta[e]
INTERIOR					
T013					
Floor	24	<55	<1,000 - <1,400	<12	<16
Lower Wall	7	<55	<900	<12	<16
T030					
Floor	6	<55	<1,000	<12	<16
Lower Wall	11	<55	<900 - <1,400	<12	<16
Upper Wall and Ceiling	2	<55	<1,000	<12	<16
EXTERIOR					
Storage Yard West of T626 and T038	50	<55	<1,000 - 1,800	<12	<16
T641 Dock	25	<100	<1,400	<12	<16
NWArea	25	<100	<1,400	<12	<16

[a]Refer to Figures 4, 5, 6, 7, and 8.
[b]Guidelines = 5,000 α dpm/100 cm^2 average in a 1 m^2 area and 15,000 α dpm/100 cm^2 maximum
[c]Guidelines = 5,000 β-γ dpm/100 cm^2 average in a 1 m^2 area and 15,000 β-γ dpm/100 cm^2 maximum
[d]Guideline = 1,000 α dpm/100 cm^2
[e]Guideline = 1,000 β-γ dpm/100 cm^2

TABLE 2

TRITIUM ACTIVITY IN MISCELLANEOUS SAMPLES FOR BUILDING T030 SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Location[a]	Type	Activity (dpm/100 cm^2)
Room 101, East Wall	Paint	<200[b]
Room 101, North Wall	Paint	6,600 ± 220[b]
Room 101, West Wall	Paint	<200[b]
Room 101B, East Wall	Paint	<200[b]
Room 101, W Restroom Wall	Paint	<160[b]
Location A	Smear	<30[c]
Location B	Smear	<33[c]
Location C	Smear	<36[c]
Location D	Smear	<57[c]
Location E	Smear	<44[c]
Location F	Smear	<65[c]
Location G	Smear	<220[c]

[a]Refer to Figure 4.
[b]Total Activity
[c]Removable Activity

TABLE 3

BACKGROUND EXPOSURE RATES FOR THE SANTA SUSANA FIELD LABORATORY ROCKWELL INTERNATIONAL VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rate at 1 m above Surface (μR/h)
#1 Gaston Road	13
#2 Black Canyon Road	16
#3 Black Canyon Road	14
#4 Valley Circle Road	15
#5 Woolsey Canyon Road	12
#6 Woolsey Canyon Road	14

[a]Refer to Figure 10.

TABLE 4

SITE EXPOSURE RATES
FOR
BUILDINGS T013, T030, STORAGE YARD WEST OF T626, T641 DOCK,
PAVED YARD OF NORTHWEST AREA, AND INTERIM STORAGE FACILITY
SANTA SUSANA LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Exposure Rate Ranges at 1 m above Surface (μR/h)
Building T013	8 to 11
Building T030	10 to 11
Storage Yard West of T626 and T038	10 to 13
Building T641 Dock	10 to 12
Soil Portion of the NW Area	14 to 16
Paved Yard of NW Area	12
Interim Storage Facility	15

[a]Refer to Figures 4 through 8.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SOIL
SANTA SUSANA FIELD LABORATORY
ROCKWELL INTERNATIONAL
VENTURA COUNTY, CALIFORNIA

Location[a]	Radionuclide Concentrations pCi/g					
	Cs-137	Ra-226	Th-228	Th-232	U-235	U-238
BACKGROUND						
#1 Gaston Rd.	<0.1	1.2 ± 0.2[b]	1.4 ± 0.1	1.6 ± 0.4	<0.1	2.5 ± 1.6
#2 Black Canyon	0.2 ± 0.1	1.0 ± 0.2	1.4 ± 0.2	1.7 ± 0.3	<0.1	1.4 ± 1.5
#3 Sage Ranch Park	0.2 ± 0.1	1.0 ± 0.2	1.4 ± 0.1	1.3 ± 0.3	<0.1	1.6 ± 1.1
#4 Valley Circle Road	0.2 ± 0.1	1.0 ± 0.2	1.2 ± 0.1	1.1 ± 0.4	<0.1	<2.2
#5 Woolsey Canyon 386S017	<0.1	0.9 ± 0.2	1.1 ± 0.1	1.2 ± 0.3	<0.1	2.1 ± 1.2
#6 Woolsey Canyon 386S018	<0.1	<0.2	0.6 ± 0.1	0.6 ± 0.3	<0.1	<1.0
SSFL AREAS						
NW Area #1	0.5 ± 0.1	1.0 ± 0.2	1.5 ± 0.1	1.6 ± 0.3	<0.1	0.8 ± 1.3
NW Area #2	<0.1	1.0 ± 0.2	1.4 ± 0.1	1.5 ± 0.4	<0.1	1.2 ± 1.4
NW Area #3	<0.1	1.0 ± 0.2	1.3 ± 0.1	1.7 ± 0.4	<0.1	1.9 ± 1.3
NW Area #4	<0.1	0.8 ± 0.2	1.2 ± 0.1	1.5 ± 0.3	<0.1	1.0 ± 0.9
NW Area #5	0.2 ± 0.1	1.0 ± 0.2	1.2 ± 0.1	1.6 ± 0.3	<0.1	<1.5
Storage Yard #6	0.1 ± 0.1	0.7 ± 0.2	1.2 ± 0.1	1.7 ± 0.4	<0.1	<2.0
ISF #7	<0.1	1.2 ± 0.2	1.6 ± 0.1	1.6 ± 0.3	<0.1	1.0 ± 1.5
ISF #8	0.4 ± 0.1	0.8 ± 0.2	1.4 ± 0.2	1.7 ± 0.4	<0.1	1.2 ± 1.3
ISF #9	0.1 ± 0.1	0.8 ± 0.2	1.4 ± 0.1	1.6 ± 0.4	<0.1	1.7 ± 1.4
ISF #10	0.1 ± 0.1	1.0 ± 0.2	1.3 ± 0.2	1.5 ± 0.4	<0.1	<1.5

[a]Refer to Figures 3, 7, 9, and 10.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

REFERENCES

U.S. Department of Energy (DOE). Radiation Protection of the Public and Environment. Washington, DC; DOE order 5400.,5; February 1990.

DOE Memorandum from R. Pelletier to Distribution, "Application of DOE 5400.5 Requirements for Release and Control of Property Containing Residual Radioactive Material", November 17, 1995.

Oak Ridge Institute for Science and Education (ORISE). Verification Survey Plan for the Interim Storage Facility; Buildings T030, T024, T019, T013; An Area Northwest of Buildings T019, T013, T012, and T059; and a Storage Yard West of Buildings T626 and T038; Santa Susana Field Laboratory, Rockwell International, Ventura County, California. Oak Ridge, TN; September 6, 1995.

ORISE. Comments on the Final Status Survey Documentation for the Interim Storage Facility; Building T013, T019, T024, T030, and T641; the Storage Yard West of Building T626 and T038; and the NW Area; Santa Susana Field Laboratory, Ventura County, California. Oak Ridge, TN; January 11, 1996.

Rockwell International. Interim Storage Facility Decommissioning Final Report. Ventura County, CA; March 15, 1985.

Rockwell International. Radiological Survey of Shipping/Receiving and Old Accelerator Area - Buildings T641 and T030. Ventura County, CA; August 19, 1988a.

Rockwell International. Radiological Survey of Buildings T019 and T013; An Area Northwest of T059, T019, T013, and T012; and A Storage Yard West of Buildings T626 and T038. Ventura County, CA; August 26, 1988b.

APPENDIX A

MAJOR INSTRUMENTATION

APPENDIX A

MAJOR INSTRUMENTATION

The display of a specific product is not to be construed as an endorsement of the product or its manufacturer by the authors or their employers.

DIRECT RADIATION MEASUREMENT

Instruments

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

Eberline "Rascal" Ratemeter-Scaler
Model PRS-1
(Eberline, Santa Fe, NM)

Ludlum Floor Monitor
Model 239-1
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Ludlum Ratemeter-Scaler
Model 2221
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Detectors

Eberline GM Detector
Model HP-260
Physical Area, 20 cm^2
(Eberline, Santa Fe, NM)

Eberline ZnS Scintillation Detector
Model AC-3-7
Physical Area, 74 cm^2
(Eberline, Santa Fe, NM)

Ludlum Gas Proportional Detector
Model 43-37
Physical Area, 550 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Ludlum Gas Proportional Detector
Model 43-68
Physical Area, 126 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Reuter-Stokes Pressurized Ion Chamber
Model RSS-112
(Reuter-Stokes, Cleveland, 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
3100 Vax 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
3100 Vax Workstation
(Canberra, Meriden, CT)

Low Background Gas Proportional Counter
Model LB-5100-W
(Oxford, Oak Ridge, TN)

Tri-Carb Liquid Scintillation Analyzer
Model 1900CA
(Packard Instrument Co., Meriden, CT)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum - nominally about 1 cm. A large surface area, gas proportional floor monitor was used to scan the floors and paved portions of the surveyed areas. Other surfaces were scanned using small area (20 cm^2, 74 cm^2 or 126 cm^2) hand-held detectors. 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:

Alpha	-	gas proportional detector with ratemeter-scaler
	-	ZnS scintillation detector with ratemeter-scaler
Beta	-	gas proportional detector with ratemeter-scaler
	-	GM detector with ratemeter-scaler

Surface Activity Measurements

Measurements of total alpha and total beta activity levels were performed using ZnS scintillation and GM detectors with ratemeter-scalers.

Count rates (cpm), which were integrated over 1 minute in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. Because different building materials (poured concrete, concrete block, steel, etc.) can have very different background levels, average background counts were determined for each material encountered in the surveyed area at a location of similar construction and having no known radiological history. The beta activity background count rates for the GM detectors averaged 95 cpm for concrete, 36 cpm for sheet rock, 33 cpm for structural steel, 96 cpm for cinder block, and 92 cpm for asphalt. Alpha background count rates for the ZnS detectors averaged 7 cpm for concrete, 1 cpm for sheet rock, 2 cpm for structural steel, 3 cpm for cinder block, and 2 cpm for asphalt. Net count rates were determined by subtracting the appropriate material background from the gross count rate for each measurement location. Beta efficiency factors ranged from 0.17 to 0.18 for the GM detector calibrated to Tc-99. The beta minimum detectable activities (MDA) for the GM detectors varied by material and ranged from 870 to 1,400 dpm/100cm^2. Alpha efficiency factors ranged from 0.18 to 0.19 for the ZnS detectors calibrated to Pu-239 and MDAs ranged from 50 to 100 dpm/100cm^2. The physical window area for the GM and ZnS detectors were 20 cm^2 and 74 cm^2, respectively.

Removable Activity Measurements

Removable activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear and approximately 100 cm^2 of the surface was wiped. Tritium smears were first moistened with deionized water before the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a pressurized ionization chamber (PIC). The instrument was adjusted to one meter above the surface and allowed to stabilize. The measurement was read directly in μR/h.

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.

Paint Sampling

Paint samples were obtained by chipping the paint from 100 cm^2 of surface area. The sample was then placed in a plastic specimen cup sealed, and labeled in accordance with ESSAP survey procedures.

ANALYTICAL PROCEDURES

Removable Activity

Gross Alpha/Beta

Smears were counted on a low background gas proportional system for gross alpha and gross beta activity.

Liquid Scintillation

Smears were counted in a liquid scintillation counter for low-energy beta activity to determine H-3 activity.

Gamma Spectrometry

Soil samples were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in 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 concerns were:

Co-60	1.173 MeV
Cs-137	0.662 MeV
Eu-152	0.344 MeV
Eu-154	0.723 MeV
Ra-226	0.351 MeV from Pb-214*
Th-228	0.239 MeV from Pb-212*
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)*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

Tritium

Tritium in solid samples was exchanged with water by refluxing and the resulting liquid was distilled to remove other radionuclides and organic materials. The samples were spiked with a standard tritium solution to evaluate quenching and counted in a liquid scintillation counter.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross

sample count levels and the associated background count levels. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable activity (MDA), were based on 2.71 plus 4.65 times the standard deviation of the background count [$2.71 + 4.65\sqrt{BKG}$]. When the activity was determined to be less than the MDA of the measurement procedure, the result was reported as less than MDA. 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 standard/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Calibration of pressurized ionization chambers was performed by the manufacturer.

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, Revision 9 (April 1995)
- Laboratory Procedures Manual, Revision 9 (January 1995)
- Quality Assurance Manful, Revision 7 (January 1995)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C 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 EPA and EML laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

STRUCTURE GUIDELINES

Indoor/Outdoor Structure Surface Contamination

	Allowable Total Residual Surface Contamination (dpm/100 cm^2)[b]		
Radionuclides[a]	**Average[c,d]**	**Maximum[d,e]**	**Removable[f]**
Transuranics, Ra-226, Ra-228, Th-230 Th-228, Pa-231, Ac-227, I-125, I-129 [g]	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000α	15,000α	1,000α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above [h]	5,000β-γ	15,000β-γ	1,000β-γ

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restriction on its use shall not exceed the background level by more than 20 μR/h and will comply with the basic dose limits when an appropriate-use scenario is considered.

SOIL GUIDELINES

Radionuclides	Soil Concentration (pCi/g) Above Background[i,j,k]
Uranium and mixed fission and activation products	Soil guidelines are calculated on a site-specific basis, using the DOE manual developed for this use.

[a] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[b] As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[d] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 1 cm.

[e] The maximum contamination level applies to an area of not more than 100 cm^2.

[f] The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. It is not necessary to use wiping techniques to measure removable contamination levels, if direct scan surveys indicate that total residual surface contamination levels are within the limits for removable contamination.

[g] Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

[h] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90, which has been separated from the other fission products, or mixtures where the Sr-90 has been enriched.

[i]These guidelines take into account ingrowth of radium-226 from thorium-230 or thorium-232 and radium-228 and assume secular equilibrium. If either Th-230 and Ra-226 or Th-232 and Ra-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that (1) the dose for the mixtures will not exceed the basic dose limit, or (2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[j] These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100 m^2 surface area.

[k] If the average concentration in any surface or below-surface area, less than or equal to 25 m^2, exceeds the authorized limit of guideline by a factor of $(100/A)^{1/2}$, where A is the area or the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/8901. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

REFERENCES

"U.S. Department of Energy Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites," Revision 2, March 1987.

"DOE Order 5400.5, Radiation Protection of the Public and the Environment," February 1990.