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CONFIRMATORY AND RADIOLOGICAL SURVEYS OF THE NUCLEAR LAKE SITE PAWLING, NEW YORK

[DOCKET NO. 070-00903]

T. J. VITKUS

Prepared for the
Division of Low-Level Waste Management and Decommissioning
U.S. Nuclear Regulatory Commission

ORISE
OAK RIDGE INSTITUTE FOR SCIENCE AND EDUCATION
Environmental Survey and Site Assessment Program
Energy/Environment Systems Division

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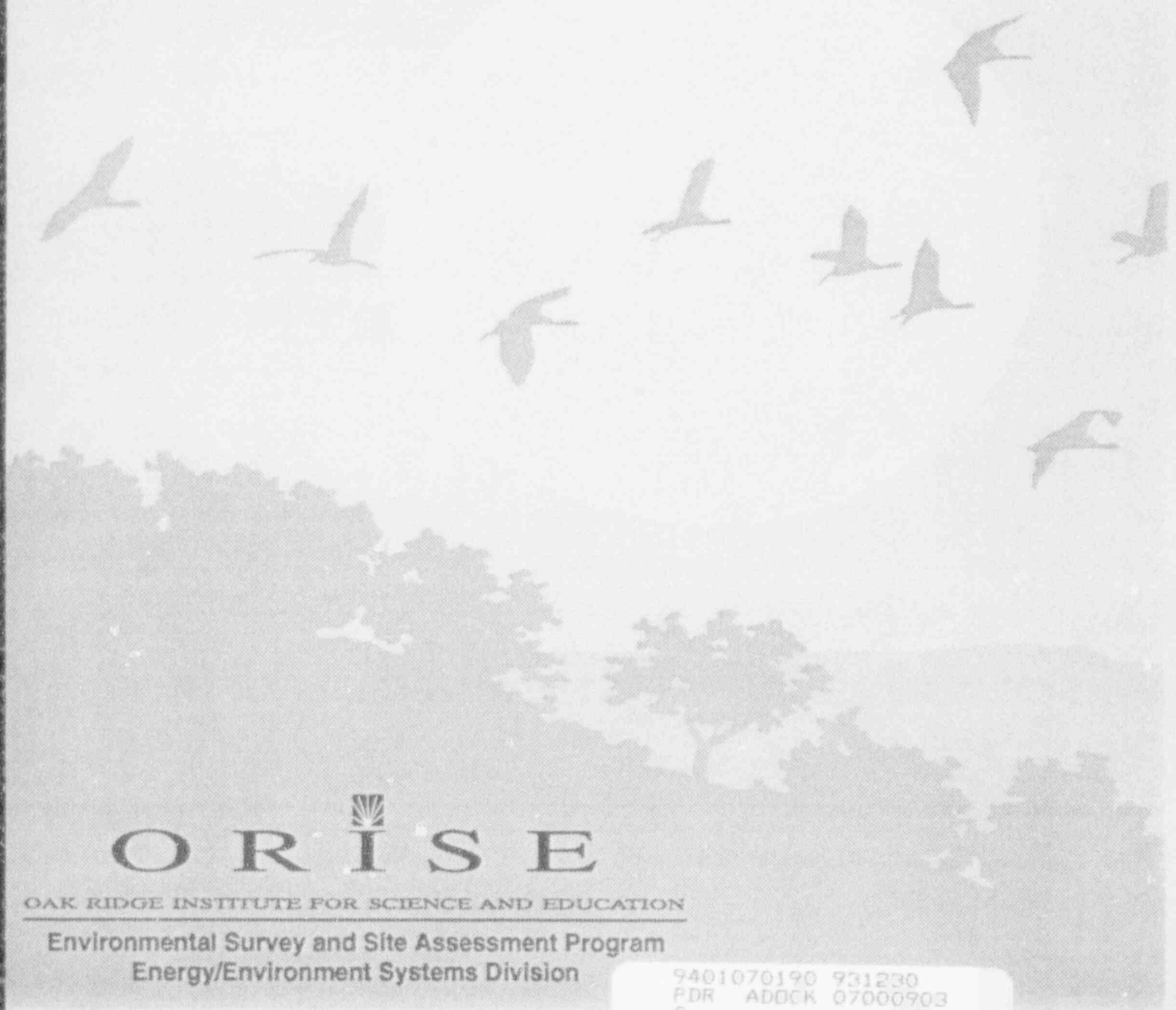

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CONFIRMATORY AND RADIOLOGICAL SURVEYS
OF THE
NUCLEAR LAKE SITE
PAWLING, NEW YORK

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ABBREVIATIONS AND ACRONYMS

ac	acre
ANST	Appalachian National Scenic Trail
ASME	American Society of Mechanical Engineers
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
EML	Environmental Measurements Laboratory
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
f^2	square feet
ha	hectare
GM	Geiger-Mueller
km	kilometer
m	meter
m^2	square meter
MDA	minimum detectable activity
mi	mile
NaI	sodium iodide
NES	Nuclear Energy Services
NIST	National Institute of Standards and Technology
NPS	National Park Service
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
PIC	pressurized ionization chamber
QA	quality assurance

CONFIRMATORY AND RADIOLOGICAL SURVEYS OF THE NUCLEAR LAKE SITE PAWLING, NEW YORK

INTRODUCTION AND SITE HISTORY

Nuclear fuels processing and research began in 1958 at a site near Pawling, New York, known as Nuclear Lake. Initial operations were performed by Nuclear Development Corporation; subsequently, the site was owned and operated by United Nuclear Corporation and Gulf United Corporation. Uranium oxide fuels of various U-235 enrichments were fabricated and tested at the site. Fuels utilizing thorium and plutonium were also fabricated and tested. The testing facilities at the site included several small experimental reactors. In 1972, activities at the site were discontinued and the site was decontaminated and surveyed. A report, indicating that the facilities satisfied the criteria for decommissioning, was prepared by ATCOR.[1] The U.S. Nuclear Regulatory Commission (NRC) license for the site was then terminated in 1975. The property was acquired in 1979 by the National Park Service (NPS) for the purpose of relocation of the Appalachian National Scenic Trail (ANST).

The NPS contracted Nuclear Energy Services (NES) to conduct additional surveys of portions of the property. Results of that survey, presented in a July 1984 report, identified a small area of residual contamination in the former Waste Disposal Building.[2] No other evidence of contamination in excess of the limits for unrestricted use was noted.

However, studies and reviews by the Nuclear Lake Management Committee, a local citizens group, raised concerns regarding possible residual contamination in building drains, septic tank and drain field systems, sediment in Nuclear Lake, and building interior paint.[3] The possibility that containers of radioactive or other hazardous wastes had been discarded into Nuclear Lake was also indicated by the Management Committee.[3] As a result of these concerns, the NPS requested that the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education (ORISE), then known as the Radiological Site Assessment Program of Oak Ridge Associated Universities, conduct investigations and

radiological surveys of the site that would address these concerns. A survey was conducted during September 1986 and the results provided in a July 1988 report.[4]

The survey identified alpha and/or beta surface activity levels in four buildings which exceeded the NRC surface contamination guidelines. In addition, several soil samples contained elevated levels of plutonium and Cs-137. Electromagnetrometry and ground penetrating radar studies, which were conducted concurrently with the 1986 survey, identified a number of anomalies in Nuclear Lake. Radiation Technical Services performed an underwater investigation of these anomalies, during November 1992. The investigation was unable to substantiate that any of the anomalies were associated with metal drums as originally suspected.[5]

The site has remained in caretaker status pending decontamination and demolition of site buildings and excavation of contaminated soils. Chevron USA, Inc., under a consent agreement with the NRC, contracted NES to characterize and perform remediation of contaminated building surfaces and soils at the Nuclear Lake Site. Structural decontamination was limited to the Plutonium Facility, Multiple Failure Building, and the Waste Disposal Building. Remediation of site soils was performed within the vicinities of the Plutonium Facility, Waste Disposal Building, and Shield Mock-Up Building. NES then performed final status surveys of the remediated buildings and soil areas.

At the request of the NRC's Division of Low-Level Waste Management, ESSAP performed a confirmatory survey of the remediated portions of the Nuclear Lake Site. In addition, ESSAP performed radiological surveys of those unaffected buildings and open land areas where previous surveys had not identified contamination. This report describes the procedures and results of these surveys.

SITE DESCRIPTION

The Nuclear Lake Site is located off of Old State Route 55 between the towns of Pawling and Beekman in the eastern portion of New York State (Figure 1). The 460 ha (1136 ac) site is heavily wooded with the exception of the 20 ha lake; clearings in the vicinity of the recently

reconstructed dam, which impounds the lake at its southern end; the central portion of the site, where eight of the nine original site buildings are located; and near the entrance to the site, where the ninth building is located (Figure 2).

The site history indicates that of the nine buildings, only four may have been potentially used for the processing or storage of radioactive materials. These buildings are the 700 m^2 (7500 ft^2), Plutonium Facility, the Waste Disposal Building (39 m^2), the Shield Mock-Up Building (60 m^2), and the Critical Facility (510 m^2) (Figures 3 through 6). The 1986 radiological survey identified residual contamination above the NRC guidelines in the eastern portion of the Plutonium Facility, a small area in the Multiple Failure Building (45 m^2) and Waste Disposal Building (54 m^2), and one measurement location, remediated at the time of the survey, in the Critical Facility. The other buildings located on the site include the Engineering Building (410 m^2), the Lodge (66 m^2), and a house currently occupied by the site caretaker that was previously known as the Remote Assembly Building (106 m^2) (Figures 7 through 10).

OBJECTIVES

The objectives of the confirmatory process were to validate the results of the NES final surveys by providing independent document reviews and radiological data for use by the NRC in evaluating the adequacy and accuracy of the NES radiological status report for the buildings and surrounding soil areas. The radiological survey was performed to supplement previous survey results and gather additional data, to confirm that no contamination in excess of the unrestricted use limits exists on the remainder of the property.

DOCUMENT REVIEW

ESSAP reviewed the NES work plan for soil remediation, the decommissioning plan for the Plutonium Facility and Multiple Failure Building, final release survey plan, and final survey report and supporting documentation concerning site characterization and remediation activities.[6-9] Information was evaluated for accuracy, completeness, and compliance with guidelines.

PROCEDURES

A survey team from ESSAP visited the Nuclear Lake Site from September 20 through 28, 1993, and performed visual inspections, measurements, and sampling. The surveys were in accordance with a plan dated September 17, 1993, submitted to and approved by the NRC Headquarters Division of Low-Level Waste Management and Decommissioning.[10] The surveys performed for the various portions of the site were objective dependent. Confirmatory survey procedures were implemented for remediated site buildings and outdoor soil areas and radiological survey procedures, designed to meet draft NUREG/CR-5849 requirements, were used for the remaining unaffected buildings and outdoor areas. Confirmatory and radiological survey procedures are described below. Additional information regarding instrumentation and procedures may be found in Appendices A and B.

CONFIRMATORY SURVEY PROCEDURES: INTERIOR

The following procedures were used for interior surveys of the Plutonium Facility, the Waste Disposal Building, and the Multiple Failure Building.

Reference Grid

ESSAP used the 1 m x 1 m survey grid system, established by NES, for referencing measurement and sampling locations. This grid system had been installed on the floor and lower walls (up to 2 m) of the rooms within each building. The upper walls and ceilings in rooms 3 and 5 of the Plutonium Facility were also gridded.

Measurements and samples collected from ungridded surfaces were referenced to the floor and/or lower wall grid or to prominent building features.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed over 100% of floor and lower wall surfaces and 5 to 10% of the upper wall and ceiling surfaces of the Waste Disposal Building, the eastern portion of the Plutonium Facility (Rooms 2-5, 14, and 15), and the Multiple Failure Building. Scans of non-remediated portions of the Plutonium Facility (Rooms 1, 6-13, 16-18) covered 50% of floor and lower wall surfaces. The floors of Rooms 12 and 13, both restrooms, could not be scanned due to standing water. Scans were performed using gas proportional, GM, and/or NaI detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Locations of elevated direct radiation, detected by scans, were marked for further investigation.

Surface Activity Measurements

Three hundred and sixteen direct measurements for total and removable alpha and beta activity levels were performed in the Plutonium Facility, 20 were performed in the Waste Disposal Building, and 17 in the Multiple Failure Building. Most direct measurement locations were selected randomly; however, 21 sets of measurements (17 in the Plutonium Facility, 3 in the Waste Disposal Building, and 1 in the Multiple Failure Building) were performed in areas based on the surface scan results. The measurements were made in floor and lower wall grid blocks and at a frequency of 1 measurement for every 20 m^2 of upper wall and ceiling surfaces (scans identified elevated direct radiation at 11 of the 124 upper wall and ceiling measurement locations). Figures 11 through 21 show measurement locations. Locations with alpha or beta surface activity levels, which exceeded the NRC average surface activity guideline, were investigated to determine the size of the contaminated area, a direct measurement made within each contaminated region, and 4 to 6 additional grid block measurements performed to determine the average surface activity levels in the contiguous 1 m^2 area. A weighted 1 m^2 average was then determined in accordance with NUREG/CR-5849. At representative locations where NES

performed additional remediation, ESSAP performed pre- and post-remediation measurements. Direct measurements were made using gas proportional detectors coupled to ratemeter-scalers.

A smear sample for determining removable gross alpha and gross beta activity levels was collected from each direct measurement location or, when more than one measurements was performed in a grid block, from the direct measurement location with the highest total activity.

Exposure Rate Measurements

Exposure rate measurements were performed within each room of the Plutonium Facility and in the center of the Multiple Failure Building and the Waste Disposal Building (Figures 19 through 22). Exposure rates were measured at 1 m above the floor using a pressurized ionization chamber (PIC).

Subfloor Soil Sampling

Soil samples were collected from 25, 2, and 1 subfloor locations within the Plutonium Facility, Waste Disposal Building, and the Multiple Failure Building, respectively (Figures 19 through 22). Soil sample locations were placed adjacent to expansion joints or floor cracks, when present.

CONFIRMATORY SURVEY: EXTERIOR

The following procedures were applicable to the perimeter affected soil areas associated with the Plutonium Facility, the Waste Disposal Building, and the Shield Mock-Up Building.

Reference System

ESSAP used prominent building features to reference measurement and sampling locations.

Surface Scans

Surface scans for gamma activity were conducted over the exterior grounds of the affected buildings extending out to a distance of 10 m. Surface scans were performed using NaI detectors coupled to ratemeters with audible indicators. Locations of elevated direct radiation detected by scans were marked for further investigation.

Soil Sampling

Soil samples were collected from 21 locations within excavated areas, or adjacent to the excavations, that were associated with the Plutonium Facility, Waste Disposal Building, and the Shield Mock-Up Building (Figures 23 and 30).

Exposure Rate Measurements

Exposure rate measurements were made at 16 of the soil sampling locations. Measurements were made at 1 m above the surface using a PIC (Figures 23 and 30).

RADIOLOGICAL SURVEY PROCEDURES: INTERIOR

The procedures described below are applicable to the interior of the following unaffected buildings: Engineering Building, Shield Mock-Up, Critical Facility, the Lodge, and the Remote Assembly Building.

Reference System

ESSAP used prominent building features to reference measurement and sampling locations.

Surface Scans

Surface scans for alpha, beta, and gamma activity were performed over a minimum of 10% of the accessible floors and lower walls (up to 2 m) of each building with the exception of the Lodge. Because of the extent of debris on the floors and the wet surfaces, only gamma and minimal beta scans could be performed in the Lodge. Scans were performed using gas proportional, GM, and/or NaI detectors coupled to ratemeters or ratemeter-scalers with audible indicators.

Surface Activity Measurements

Direct measurements for total alpha and/or beta surface activity were performed at a minimum of 30 locations within each building (Figures 24 through 28). Direct measurements were performed using gas proportional and/or GM detectors coupled to ratemeter-scalers. Smear samples for determining removable activity levels were collected from each direct measurement location. Only beta direct measurements were performed in the Lodge, due to the extensive debris and wet surfaces.

Exposure Rate Measurements

Exposure rate measurements were made in each building (Figures 24 through 28). NUREG/CR-5849 recommends that an exposure rate measurement be performed at each direct measurement location; however, the small size of most of the site buildings did not necessitate this measurement frequency. Therefore, one measurement was made per building or room, whichever was applicable. Measurements were made at 1 m above the surface using a PIC.

Subfloor Soil Sampling

Subfloor soil samples were collected from 2 locations within each building (Figures 24 through 28).

RADIOLOGICAL SURVEY PROCEDURES: EXTERIOR

The following procedures were used for unaffected portions of the site associated with buildings, roads, walkways, and the dam area.

Reference System

The unaffected outdoor areas were subdivided into 4 survey units (Figure 29). ESSAP then established a grid system consisting of 50 m x 50 m grid blocks to reference measurement and sampling locations within survey unit areas located north of the dam. Prominent site features or structures were used for reference measurement and sampling locations which were south of the dam area.

Surface Scans

Surface scans for gamma activity were conducted over approximately 100% of the cleared portions of the site, which included those areas associated with the buildings, roads, walkways, clearings, and the remnants of the emergency generator building, sodium tent, and shield blocks. Additional scans were performed over approximately 10% of the remaining portions of each survey unit. Scans were performed using NaI detectors coupled to ratemeters with audible indicators. Locations of elevated direct radiation detected by scans were marked for further investigation.

Soil Sampling

Surface (0 to 15 cm or less in depth) soil samples were collected from 127 locations within the 4 survey units. Subsurface samples could not be collected due to the proximity of bedrock to the surface, where, at many locations, refusal was reached at 5 cm in depth. The surface soil samples collected from each survey unit also incorporated the land areas located outside of the buildings' perimeter. Soil sample locations were systematically selected throughout the site or were located at suspect locations that were identified during surface scans. Sample locations

were typically clustered around each building and spaced further apart, within the heavily forested portions of each survey unit (Figures 30 through 35).

Exposure Rate Measurements

Exposure rates were measured at 1 m above the surface at 33 soil sampling locations using a PIC (Figures 30, 31, 32, and 35). For all remaining soil sampling locations, a gamma radiation measurement was performed at contact and at 1 m above the surface using a NaI detector coupled to a ratemeter, and compared with the ambient background level.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and data were returned to ESSAP's Oak Ridge, Tennessee facility for analysis and interpretation. Smears were analyzed for gross alpha and gross beta activity with a low background proportional counter. Soil samples were individually analyzed by gamma spectrometry. The spectra were reviewed for uranium, thorium, americium, cesium and any other identifiable photopeaks. Nine composite samples were also analyzed for isotopic plutonium by alpha spectrometry. Subfloor samples from Rooms 2, 3, and 4 and samples from the exterior of the Plutonium Facility and samples where Am-241 levels exceeded the gamma spectrometry minimum detectable activity levels were selected for the alpha spectrometry analysis.

The background was subtracted from the smear analytical results and direct measurement data and the results were converted to units of dpm/100 cm^2. Exposure rates were reported in μR/h and included background. Soil results were reported in pCi/g. The data were compared to the final survey results provided by NES and the NRC generic and site specific guidelines.[9,11] The background exposure rates and radionuclide concentrations in soil previously collected were also used for data comparison.[4]

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP's review of the characterization, decontamination and decommissioning, and the final survey with addendum reports identified several deficiencies in the documents. These deficiencies, which included concerns regarding the affected outdoor area characterization methods, were provided to the NRC in several correspondences.[12-14]

CONFIRMATORY SURVEY: INTERIOR

Provided below are the results of the confirmatory surveys of the Plutonium Facility, Waste Disposal Building, and the Multiple Failure Building.

Surface Scans

Surface scans of the interior of the Plutonium Facility identified elevated direct alpha radiation levels on the floor, walls, and ceiling of Rooms 3, 4, and 5 on north wall of Room 1, and on the floor of Rooms 14 and 15. Elevated beta radiation levels were also detected on the floors of Rooms 3 and 15. Alpha, beta, and gamma scans of the remaining rooms in the Plutonium Facility did not identify any locations of elevated direct radiation.

Surface scans in the Waste Disposal Building identified three locations of elevated direct beta radiation on the upper level floor. All other alpha, beta, and gamma scans of the floors and walls did not identify any locations of elevated direct radiation.

Surface scans of the Multiple Failure Building identified one location of elevated direct beta radiation levels on the floor immediately north of the contaminated area that had been previously remediated. In addition, a small trough that was formed by the wall sheet metal immediately adjacent to the remediated area was also determined to have elevated beta radiation. There were no other areas of elevated direct radiation detected on floor and wall surfaces.

Each specific location and/or general areas of contamination were brought to the attention of the NES site representative. ESSAP characterized the small areas of elevated alpha and beta direct radiation which surface scans identified in Rooms 1, 3, 5, 14, and 15 of the Plutonium Facility and in the Waste Disposal and Multiple Failure Buildings. The distributed areas of alpha contamination which ESSAP identified in the rooms 3, 4, and 5 of the Plutonium Facility were re-surveyed and recharacterized by NES. NES personnel then remediated the areas and performed post-remedial action surveys as necessary. ESSAP personnel then performed additional surface scans and direct measurements to confirm that remedial actions had been effective in reducing contamination to acceptable levels.

Surface Activity Levels

Surface activity levels for representative locations of elevated direct radiation identified in the affected buildings are summarized in Table 1. Prior to additional remediation, the surface activity ranges for locations of elevated direct remediation for the Plutonium Facility were: 11 to 2,300 dpm/100 cm^2 for total alpha activity, with 20 to 310 dpm/100 cm^2 being the range of alpha activity in 1 m^2 areas; for locations with elevated beta activity, the total activity range was -420 to 100,000 dpm/100 cm^2 with a 1 m^2 average activity range of -5 to 47,000 dpm/100 cm^2. For the three locations in the Waste Disposal building total beta activity levels ranged from 420 to 260,000 dpm/100 cm^2 and the 1 m^2 average activity levels ranged from 2,000 to 7,800 dpm/100 cm^2. In the Multiple Failure Building, elevated beta activity was 50,000 dpm/100 cm^2 and the 1 m^2 average was 9,800 dpm/100 cm^2.

Removable activity levels ranged from -1 to 25 dpm/100 cm^2, for alpha, and from -3 to 10 dpm/100 cm^2, for beta.

Final confirmatory survey surface activity levels are provided in Table 2. For the affected portions of the Plutonium Facility (Rooms 2-5, 14, and 15), total activity levels ranged from -5 to 200 dpm/100 cm^2, for alpha, and from -1,800 to 2,500 dpm/100 cm^2 for beta. The 1 m^2 averages were determined for direct measurement locations with total surface activity in excess

of 100 dpm/100 cm^2 for alpha and 5,000 dpm/100 cm^2 for beta. These 1 m^2 averages ranged from 0 to 93 dpm/100 cm^2 and -110 to 1,300 dpm/100 cm^2 for alpha and beta, respectively.

Total activity levels in the unaffected rooms of the Plutonium Facility (Rooms 1, 6-13, and 16-18) were -7 to 180 dpm/100 cm^2 for alpha and -590 to 2,600 dpm/100 cm^2 for beta. The 1 m^2 average ranges were 14 dpm/100 cm^2 and 370 dpm/100 cm^2 for alpha and beta, respectively.

Removable activity levels for the Plutonium Facility ranged from -4 to 12 dpm/100 cm^2 for gross alpha and -5 to 21 dpm/100 cm^2 for gross beta.

Total surface activity levels in the Waste Disposal Building ranged from -2 to 27 dpm/100 cm^2 and -660 to 950 dpm/100 cm^2 for alpha and beta, respectively. The 1 m^2 averages were 9 dpm/100 cm^2 for alpha and 1,400 to 1,700 dpm/100 cm^2, for beta. Removable activity levels were -1 to 4 dpm/100 cm^2 and -4 to 8 dpm/100 cm^2 for gross alpha and gross beta, respectively.

The activity levels in the Multiple Failure Building were -7 to 27 dpm/100 cm^2 for alpha and -500 to 1,300 dpm/100 cm^2 for beta. The 1 m^2 average was 14 dpm/100 cm^2 for alpha and 770 dpm/100 cm^2 for beta. Removable activity levels were -1 to 4 dpm/100 cm^2 for gross alpha and -5 to 5 dpm/100 cm^2 for gross beta.

Exposure Rates

Exposure rates for the affected buildings are summarized in Table 3. The exposure rates, including background, in the Plutonium Facility ranged from 9 to 12 μR/h and averaged 10 μR/h. Exposure rates in the Waste Disposal Building and Multiple Failure Building were 10 μR/h and 8 μR/h, respectively.

Radionuclide Concentrations in Subfloor Soils

Table 4 provides a summary of the radionuclide concentrations in subfloor soils within the affected buildings. The samples collected from beneath the Plutonium Facility, Waste Disposal

Building, and Multiple Failure Building contained the following concentration ranges: Cs-137, less than 0.1 to 0.7 pCi/g; Am-241, less than 0.1 pCi/g; Th-232, 0.3 to 1.0 pCi/g; U-235, less than 0.1 to 0.1 pCi/g; U-238, less than 1.1 to 1.1 pCi/g. Plutonium concentrations in composite samples are summarized in Table 5 and subfloor samples were less than 0.09 to 0.12 pCi/g for Pu-238 and less than 0.07 pCi/g for Pu-239/240. Due to the low levels of plutonium and americium present in samples as indicated here and elsewhere in this report (most sample concentration levels were below the minimum detectable activity level) ESSAP was unable to confirm the plutonium to Am-241 ratio of 7:1.

CONFIRMATORY SURVEY: EXTERIOR

The confirmatory survey results for the affected soil areas are discussed below.

Surface Scans

The gamma surface scans did not identify any locations of elevated direct radiation.

Radionuclide Concentrations in Soil

The radionuclide concentrations in soil samples collected from the affected soil areas are summarized in Table 6. Concentration ranges were less than 0.1 to 5.5 pCi/g for Cs-137, less than 0.2 pCi/g for Am-241, 0.4 to 1.1 pCi/g for Th-232, less than 0.1 to 0.1 for U-235, and 0.2 to 1.6 pCi/g for U-238. Plutonium concentrations in composite samples summarized in Table 5, were less than 0.24 pCi/g for Pu-238 and less than 0.24 pCi/g for Pu-239/240.

Exposure Rates

Exposure rates for the affected outdoor soil areas are provided in Table 6. Exposure rates, including background, ranged from 8 to 12 μR/h.

RADIOLOGICAL SURVEY: INTERIOR

The results of the interior surveys of the Engineering Building, the Critical Facility Building, the Shield Mock-Up Building, the Remote Assembly Building, and the Lodge are provided below.

Surface Scans

Alpha, beta, and gamma surface scans of the interiors of each building did not identify any locations of elevated direct radiation.

Surface Activity Levels

Surface activity levels for each building are summarized in Table 7. The total activity levels within the Critical Facility were -7 to 37 dpm/100 cm^2 for alpha and -290 to 1,100 dpm/100 cm^2 for beta; removable activity levels were -1 to 4 dpm/100 cm^2 and -7 to 8 dpm/100 cm^2 for gross alpha and gross beta, respectively. For the Engineering Building, total activity levels were -2 to 23 dpm/100 cm^2 for alpha and -320 to 850 dpm/100 cm^2 for beta. Removable activity levels were -1 to 6 dpm/100 cm^2 for gross alpha and -5 to 16 dpm/100 cm^2 for gross beta. The Remote Assembly Building total activity levels were -620 to 54 dpm/100 cm^2 for alpha and -620 to 730 dpm/100 cm^2 for beta; removable activity levels were -1 to 4 dpm/100 cm^2 for gross alpha and -7 to 6 dpm/100 cm^2 for gross beta. The total alpha activity levels in the Shield Mock-Up Building were -2 to 39 dpm/100 cm^2 and beta activity levels were -580 to 820 dpm/100 cm^2; removable activity levels were less than -1 to 10 dpm/100 cm^2 for gross alpha and less than -7 to 14 dpm/100 cm^2 for gross beta. The beta activity levels within the Lodge were -650 to 1,200 dpm/100 cm^2 and removable activity levels were -1 to 6 dpm/100 cm^2 for gross alpha and -7 to 8 dpm/100 cm^2 for gross beta.

There were four alpha measurement locations in unaffected buildings which were in excess of 25% (25 dpm/100 cm^2) of the alpha guideline, one each in the Critical Facility and Shield Mock-Up Building and two in the Remote Assembly Building. One location within the Remote

Assembly Building was attributed to the rock and masonry construction material of the fireplace and the second location, also a result of natural background radioactivity, was on a rock outcropping found in the basement of the structure. For the locations in the other buildings, there were no indications, based on additional measurements from the localized areas (1 m^2) and surface scans, that there was contamination present. There were no beta measurements which exceeded 25% (1,250 dpm/100 cm^2) of the beta guidelines.

Exposure Rates

Area background exposure rates ranged from 9 to 11 μR/h and averaged 10 μR/h.[4] Exposure rates, including background, for each unaffected building are summarized in Table 8 and were as follows: Critical Facility, a range of 11 to 12 μR/h and averaged 12 μR/h; Engineering Building, a range of 9 to 10 μR/h and averaged 9 μR/h; Remote Assembly Building, a range of 7 to 11 μR/h and averaged 9 μR/h; Shield Mock-Up Building the exposure rate was 10 μR/h; and for the Lodge exposure rates ranged from 9 to 10 μR/h and averaged 10 μR/h.

Radionuclide Concentrations in Subfloor Soils

Radionuclide concentrations in subfloor soil samples are provided in Table 9. Concentration ranges for all the subfloor samples were less than 0.1 to 0.2 pCi/g of Cs-137; less than 0.1 to 0.1 pCi/g of Am-241, 0.1 to 0.7 pCi/g of Th-232, 0.1 to 0.2 to U-235, and 0.2 to 0.8 pCi/g of U-238.

RADIOLOGICAL SURVEY: EXTERIOR

The results of the radiological survey of unaffected outdoor survey units 1 though 4 are provided below.

Surface Scans

Surface scans for gamma radiation of the exterior unaffected survey units identified one area of elevated direct radiation south of the Lodge (Figure 31). The anomaly, which was approximately 2 m × 2 m in size, was centered at grid coordinate 168 N, 29 E. A 30 cm deep borehole, at which point bedrock was encountered, was excavated at the anomaly center and scanned for gamma activity. Gamma levels were 4 times background at the surface and decreased to 2.5 times background at 30 cm, indicating the elevated activity was present primarily in the upper layers of soil. All other gamma scans were within ambient background levels.

Exposure Rates

Exposure rate measurements are summarized in Table 10. Exposure rates, including background, for the unaffected outdoor area ranged from 8 to 12 μR/h and averaged 9 μR/h.

Radionuclide Concentrations in Soil

Background concentrations ranges for each radionuclide of concern are as follows: Cs-137 0.1 to 1.6 pCi/g; Pu-238, less than 0.2 to 0.10 pCi/g; Pu-239/240 0.10 to 0.21 pCi/g; Th-232, 0.2 to 1.3 pCi/g; U-235, less than 0.3 pCi/g; U-238, less than 1.7 pCi/g.[4] Radionuclide concentrations in soil for each of the survey units are summarized in Table 10. Concentration ranges for each survey unit were as follows: Survey Unit 1, less than 0.1 to 5.9 pCi/g Cs-137; less than 0.3 pCi/g Am-241; 0.2 to 1.4 pCi/g Th-232; less than 0.1 to 0.3 pCi/g U-235; 0.1 to 2.5 pCi/g U-238. Survey Unit 2, less than 0.1 to 6.1 pCi/g Cs-137; less than 0.4 pCi/g Am-241; less than 0.5 to 1.4 pCi/g Th-232; less than 0.3 to 0.4 pCi/g U-235; 0.2 to 3.7 pCi/g U-238. Survey Unit 3, less than 0.1 to 3.0 pCi/g Cs-137; less than 0.3 to 0.5 pCi/g Am-241; less than 0.4 to 1.1 pCi/g Th-232; less than 0.2 to 0.3 pCi/g U-235; less than 1.7 to 4.3 pCi/g U-238. Survey Unit 4 ranges were 0.1 to 3.6 pCi/g Cs-137; less than 0.2 pCi/g Am-241; 0.3 to 1.3 pCi/g Th-232; less than 0.1 to 0.2 pCi/g U-235; and less than 2.7 to 2.9 pCi/g U-238.

Plutonium concentrations in composite samples, summarized in Table 5; were less than 0.07 pCi/g for Pu-238 and 0.05 to 1.2 pCi/g for Pu-239/240.

The maximum Cs-137 concentration of 6.1 pCi/g coincided with the location of elevated gamma radiation identified in Survey Unit 2. The average Cs-137 concentration in the four samples collected from the contiguous 100 m^2 area was 1.3 pCi/g.

DISCUSSION

ESSAP initiated instrumentation cross-comparison at the time of the confirmatory survey. These cross-comparisons were initiated because of the significant areas of residual alpha contamination being identified while performing surface scans and investigative direct measurements in Rooms 3, 4, and 5 of the Plutonium Facility. A review of NES alpha instrumentation calibration records, a comparison of ESSAP and NES instrument responses to a known activity plutonium calibration source, and subsequent conversions from counts per minute to dpm/100 cm^2, indicated that the efficiency factor provided to NES for their ZnS detectors was in error. The efficiency provided (39%) appeared to be a 2π rather than the appropriate 4π efficiency, which is typically 15 to 20%. As a result, NES underestimated residual alpha activity, where present, by 50 to 60% during the initial termination survey.

After consultation with the NRC, ESSAP discontinued the confirmatory survey for Rooms 3, 4, and 5, where the most wide spread residual contamination had been identified, and NES then performed the additional characterization surveys, remediation, and post-remedial surveys in these areas. For these surveys, NES obtained large area detectors which were better suited for conducting surface scans and identifying gross contamination at the plutonium guideline levels. In addition, NES acquired recalibrated instrumentation to be used for quantitative surface activity measurements during characterization and post-remedial action surveys. The results of these surveys were provided in the October 1993 addendum to the NES final project report.[9] At the completion of the secondary remedial actions and NES surveys, ESSAP concluded the confirmatory survey of these areas.

COMPARISON OF RESULTS WITH GUIDELINES

The confirmatory survey results were compared with both the data provided by NES and the generic and site-specific NRC guidelines for release to unrestricted use. The radiological data for the building and unaffected outdoor soil areas, were also compared with the guidelines.

The applicable surface contamination guidelines, presented in Appendix C, are those for plutonium and Cs-137.

The plutonium guidelines are:

Total
100 dpm/100 cm^2, average in a 1 m^2 area
300 dpm/100 cm^2, maximum in a 100 cm^2 area

Removable
20 dpm/100 cm^2

The Cs-137 guidelines are those for the beta-gamma emitters which are:

Total
5,000 dpm/100 cm^2, average in a 1 m^2 area
15,000 dpm/100 cm^2, maximum in a 100 cm^2 area

Removable
1,000 dpm/100 cm^2

Exposure rates were compared with the 5 μR/h above background guideline, currently being used by the NRC.[15]

Soil concentration levels of Cs-137 were compared with the 15 pCi/g site-specific guideline. The site-specific guideline for total plutonium is 7.5 pCi/g. Americium-241 concentrations, together with the results of plutonium analyses were used to determine the plutonium concentrations relative to the guideline. An Am-241 to plutonium ratio of 1:7 developed by NES and approved by the NRC, was used to estimate total plutonium levels in samples that were

not analyzed for plutonium.[9] Other radionuclide concentrations were compared to background concentrations.

All surface activity levels were below the NRC's residual surface contamination guidelines. ESSAP's surface activity data for both the affected and unaffected buildings were tested in accordance with Draft NUREG/CR-5849; the results of which are provided in Tables 11 and 12. The tests support that, with the exception of Room 5 in the Plutonium Building, the surface activity levels within each building satisfy the guidelines at the 95% confidence level.

All exposure rates at 1 m were within the 5 μR/h above background guideline. Soil concentration levels for all areas were below the guidelines and/or comparable to background.

SUMMARY

ESSAP performed confirmatory and radiological surveys of the Nuclear Lake Site in Pawling, New York during the period September 20 through 28, 1993. Confirmatory activities included document reviews, surface scans, direct measurements, exposure rate measurements, and soil sampling.

The confirmatory survey identified residual surface contamination inside each of the three affected buildings. Contaminated areas were remediated and resurveyed by NES and post-remedial action surveys by ESSAP confirmed that surface contamination had been reduced to acceptable levels. The radiological survey did not identify any locations of residual contamination in excess of NRC guideline levels. One room in the Plutonium Facility (Room 5) did not satisfy the plutonium total activity guidelines at the 95% confidence level.

The final confirmatory survey results support those of NES and together with radiological survey results indicate the site structures and soil areas satisfy the guidelines for release to unrestricted use.

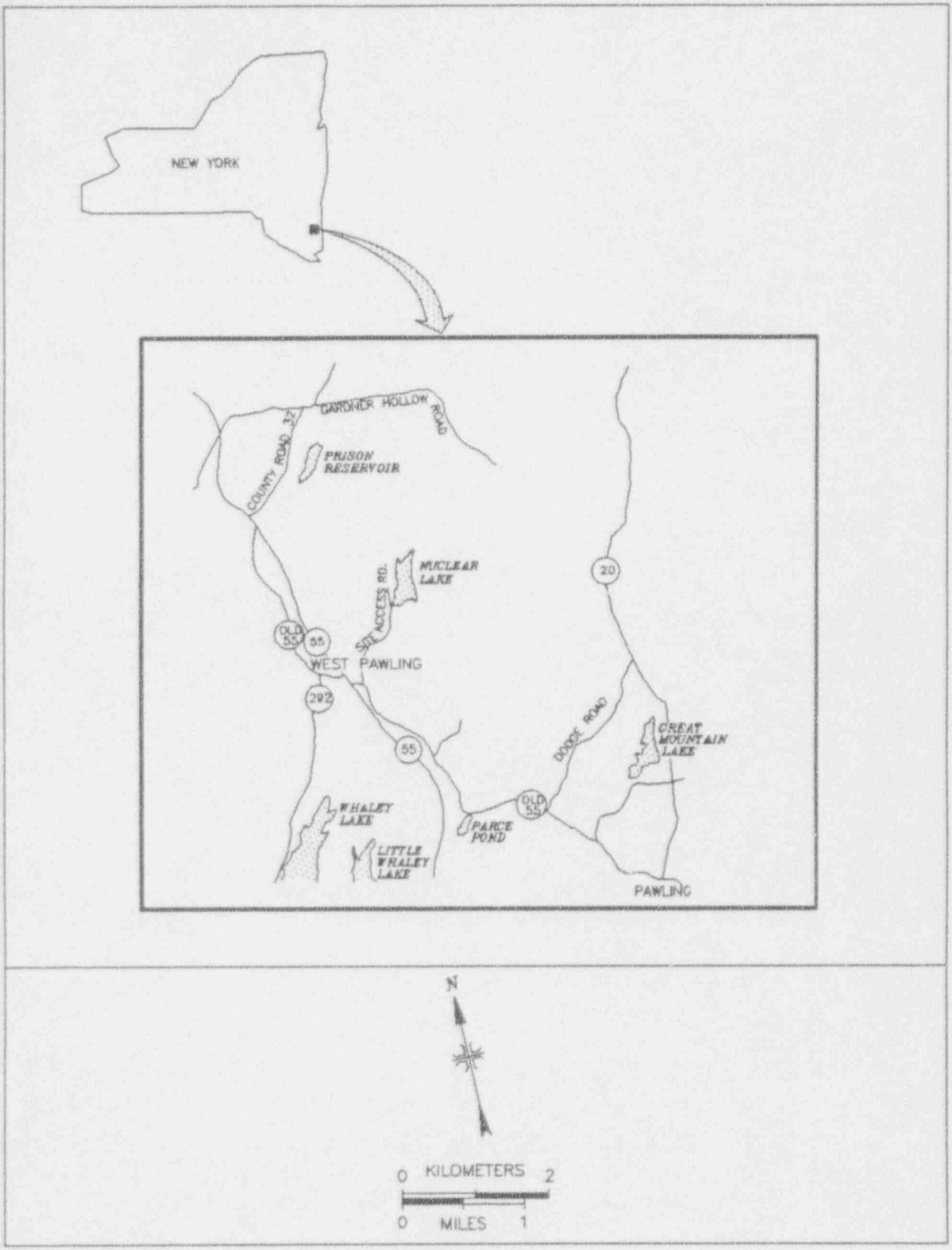


FIGURE 1: Map of the Pawling, New York Area
Showing the Location of the Nuclear Lake Site

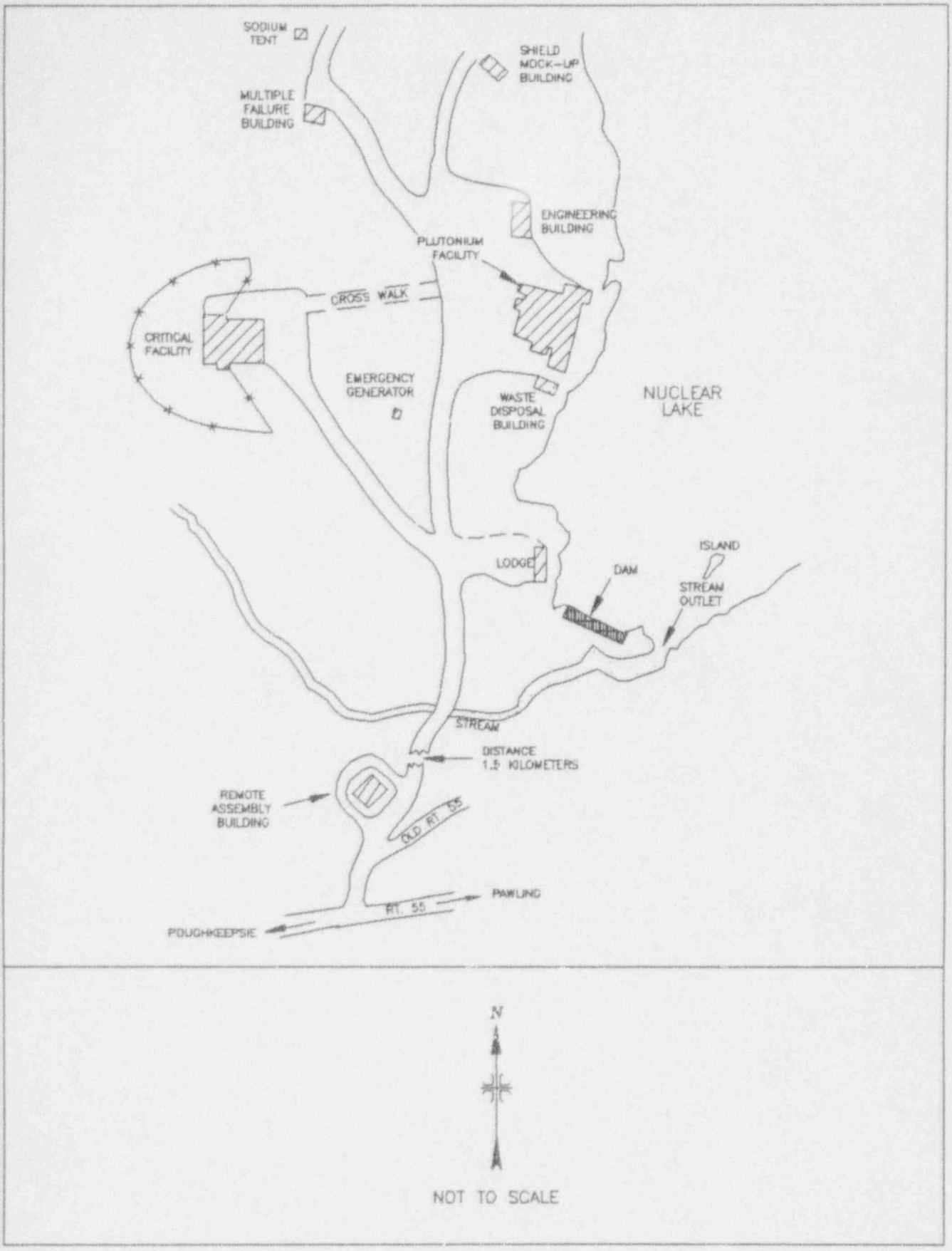


FIGURE 2: Plot Plan of the Nuclear Lake Site

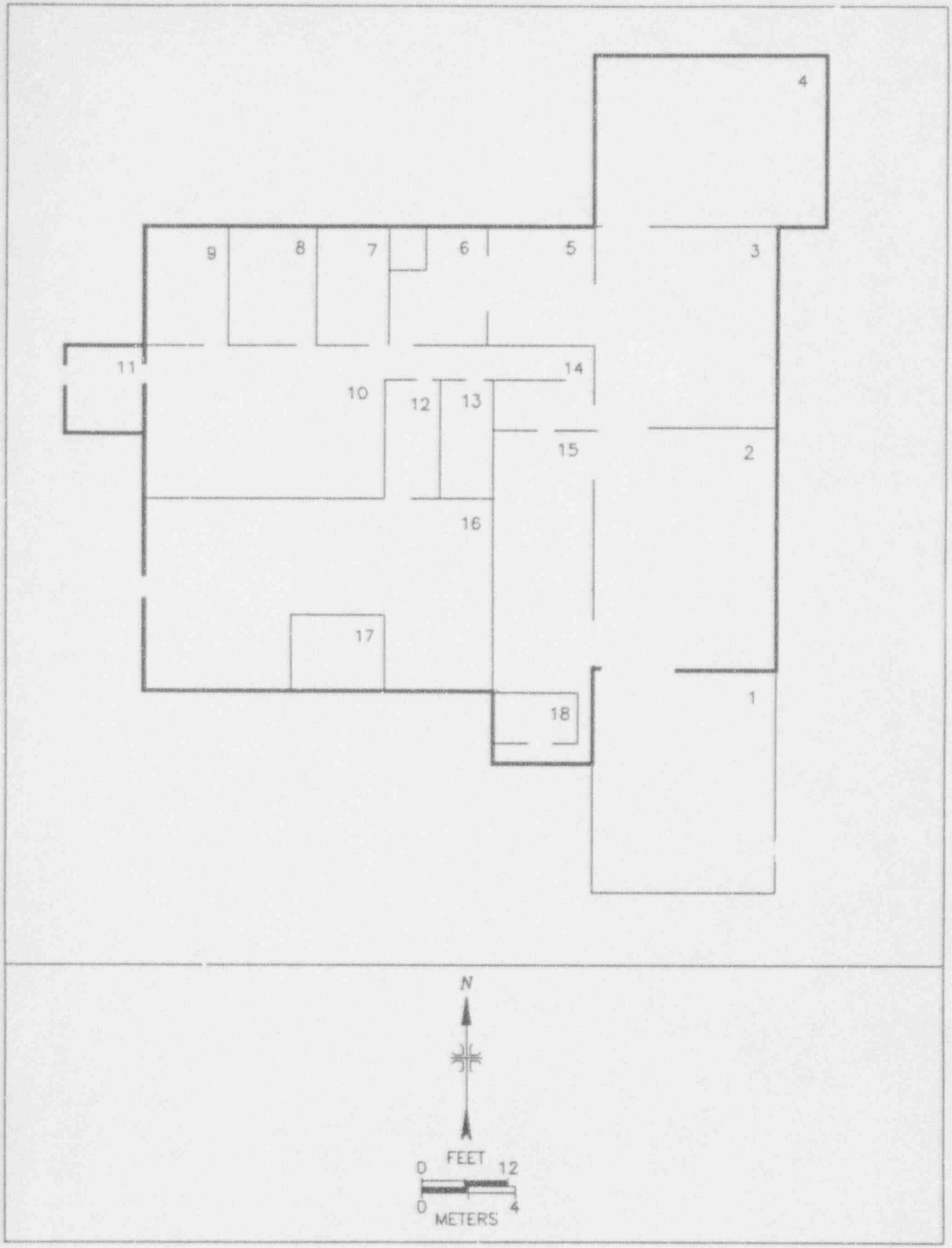
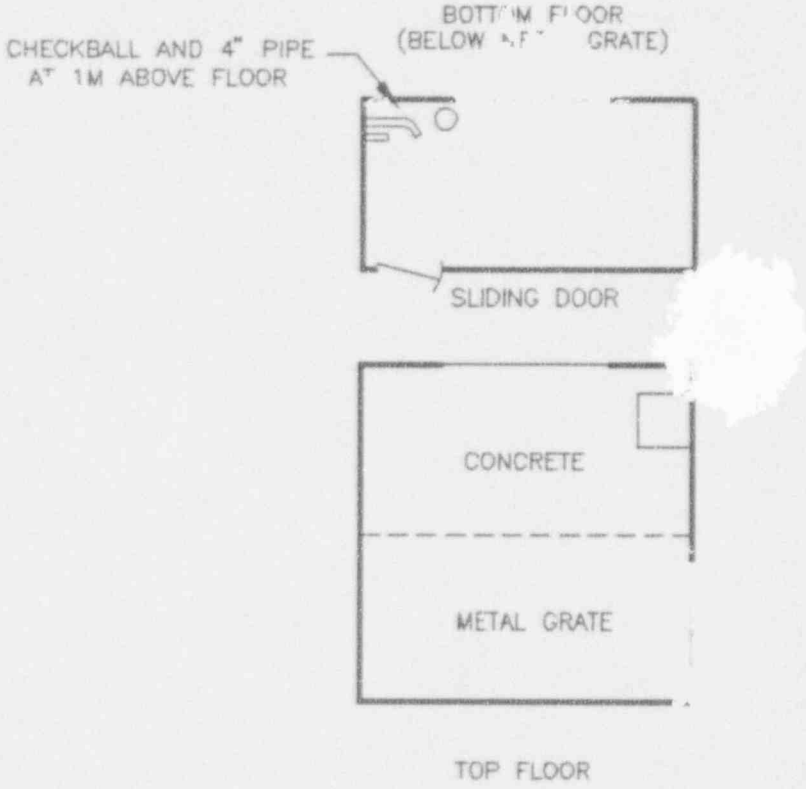


FIGURE 3: Plutonium Facility – Floor Plan



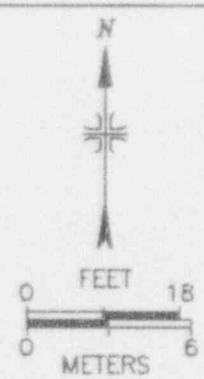


FIGURE 4: Waste Disposal Building – Floor Plan

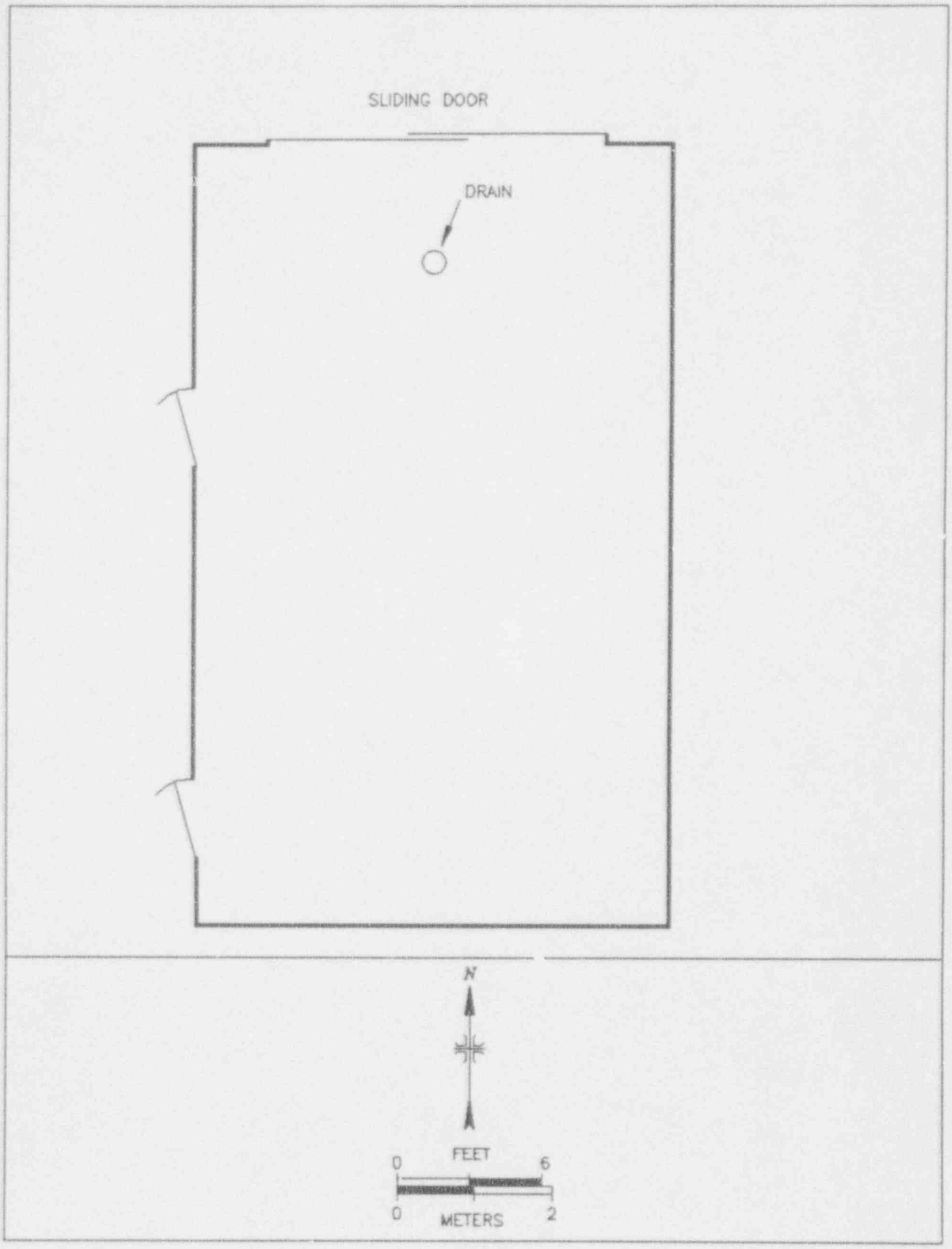


FIGURE 5: Shield Mock-Up Building - Floor Plan

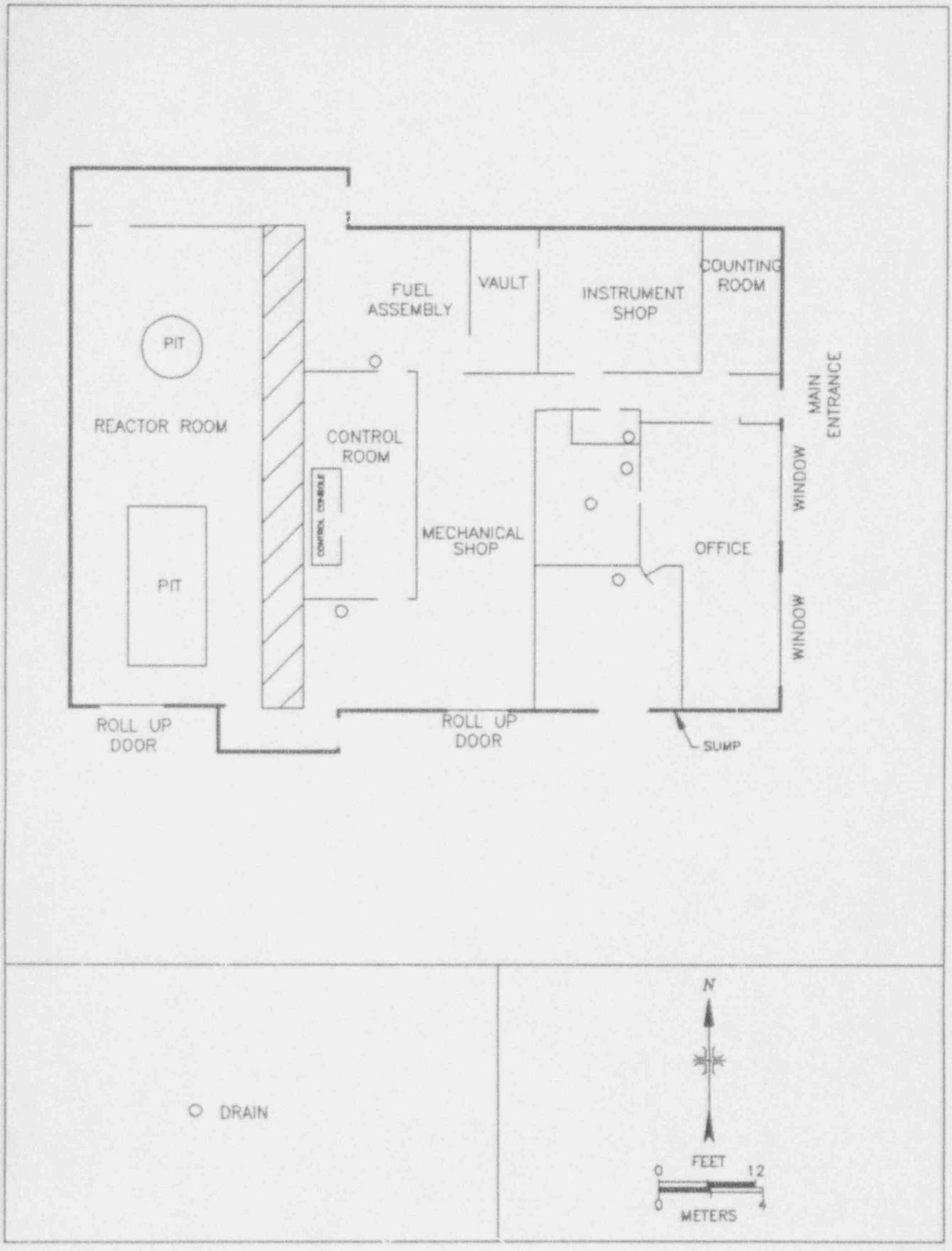


FIGURE 6: Critical Facility – Floor Plan

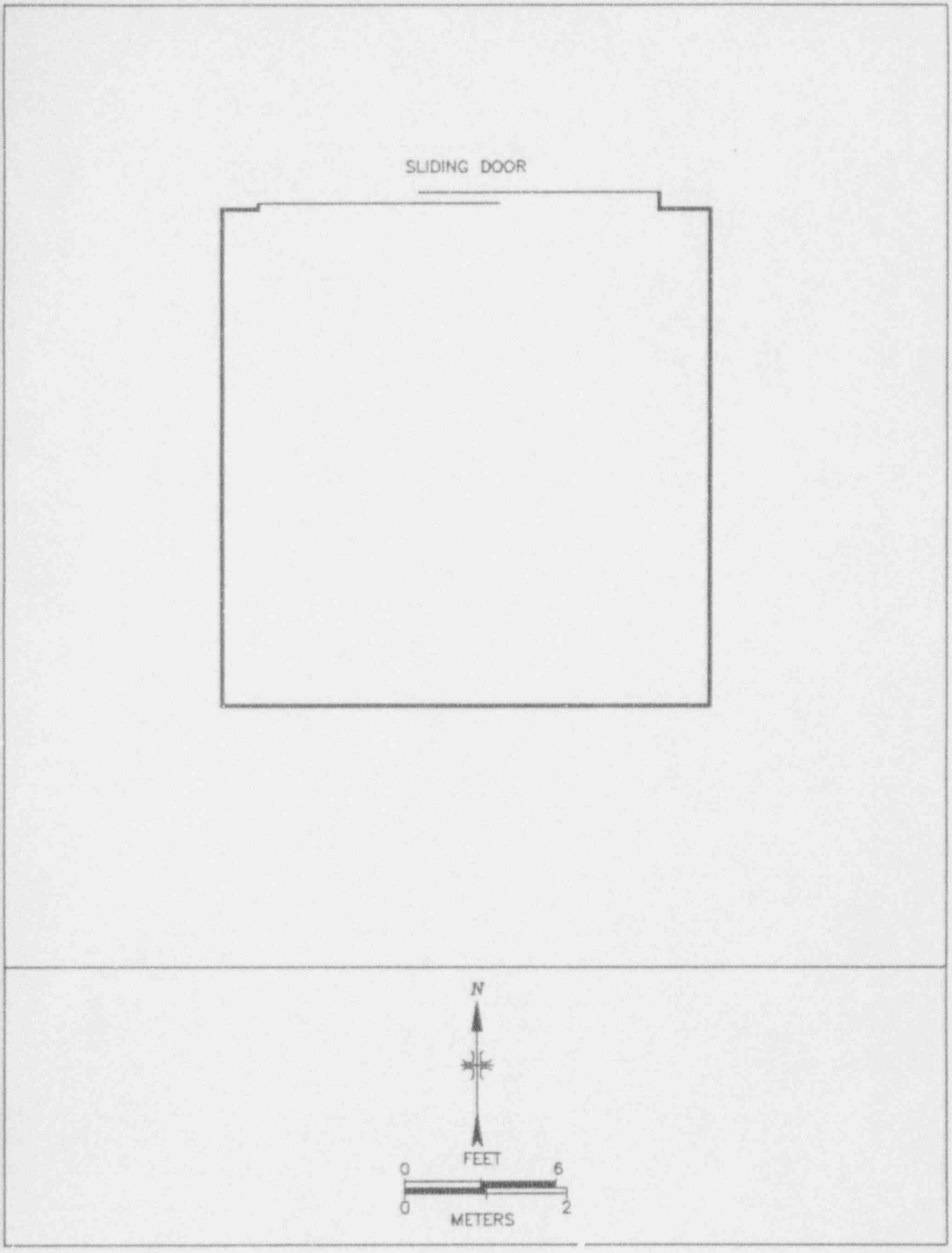


FIGURE 27: Multiple Failure Building – Floor Plan

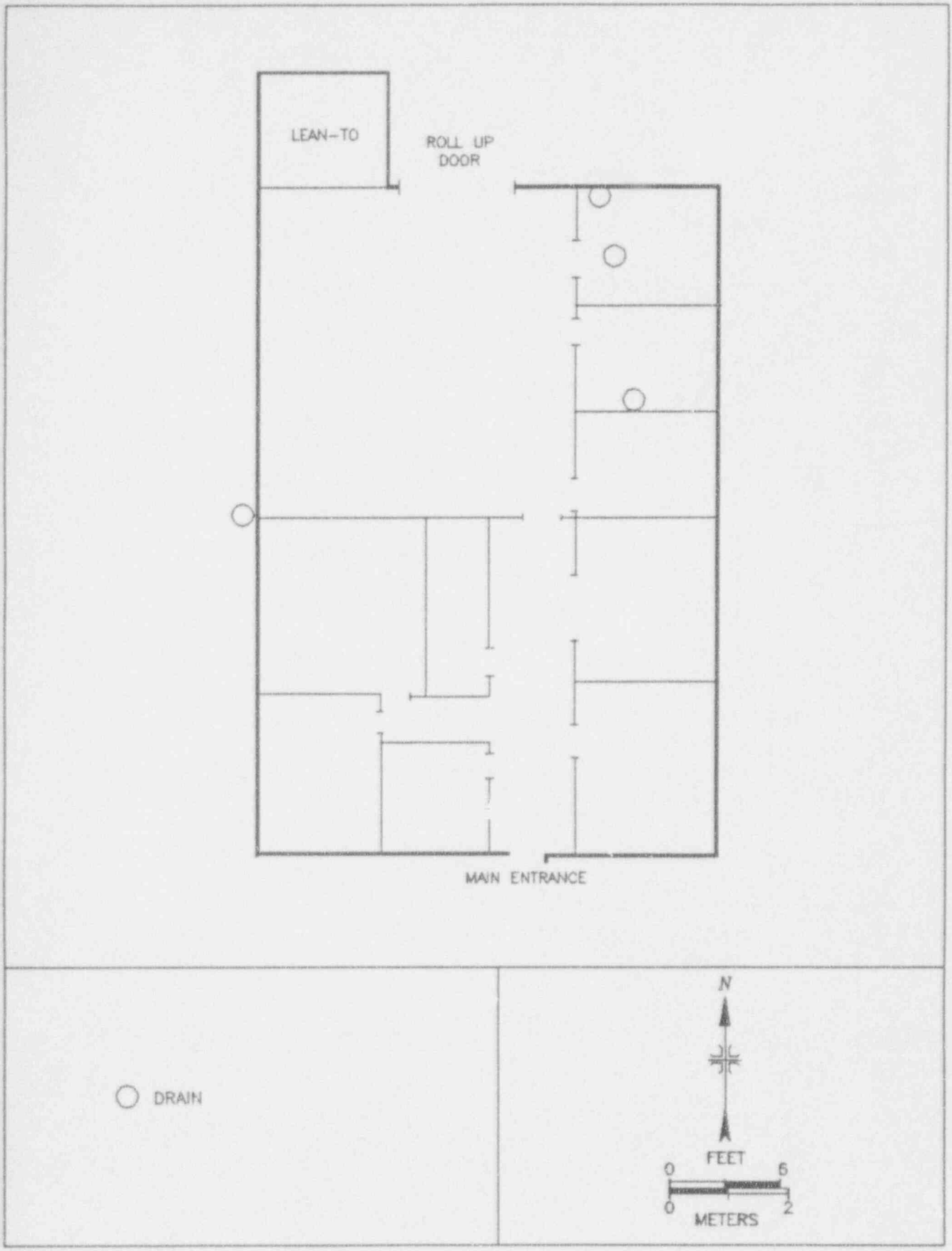


FIGURE 8: Engineering Building – Floor Plan

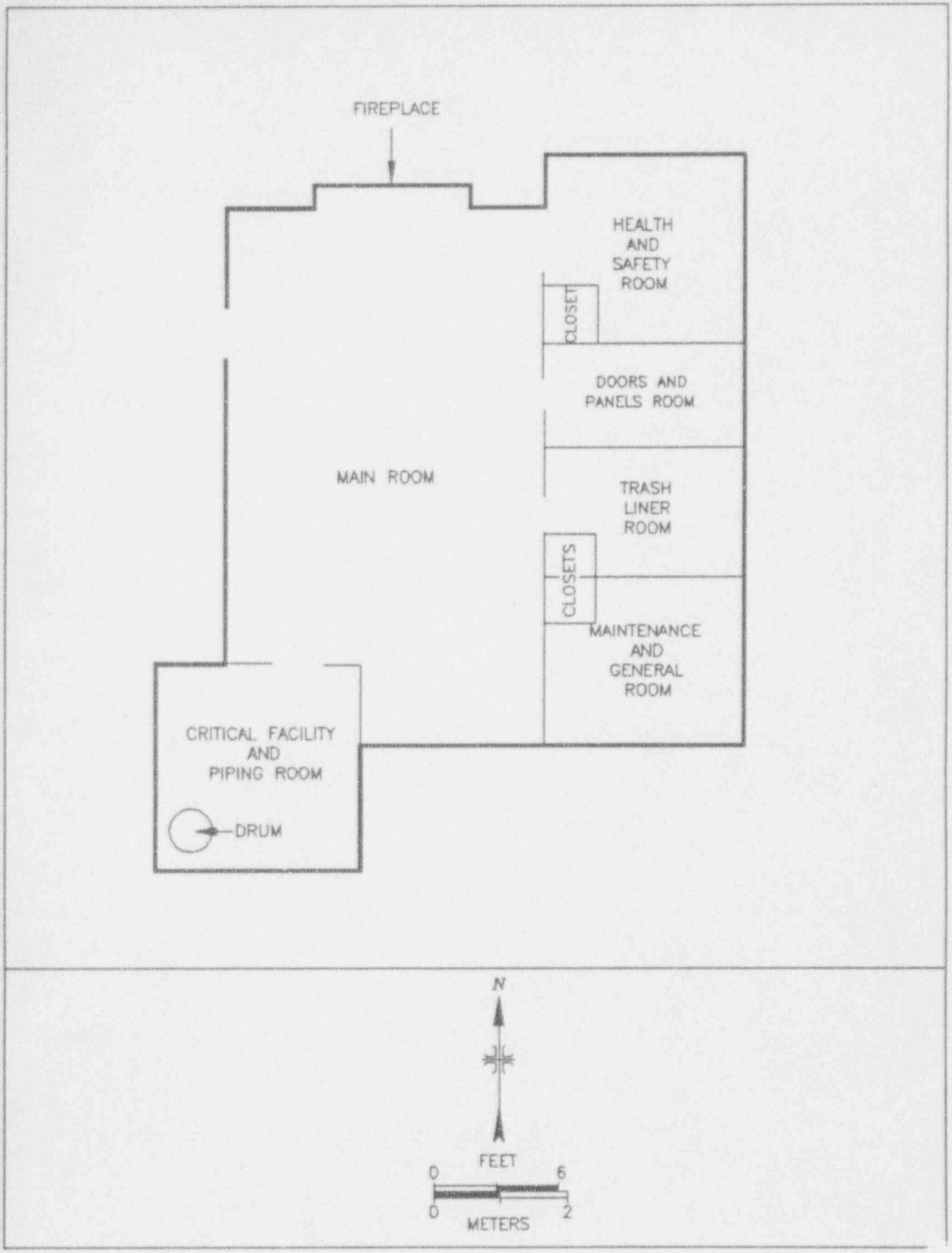


FIGURE 9: Lodge – Floor Plan

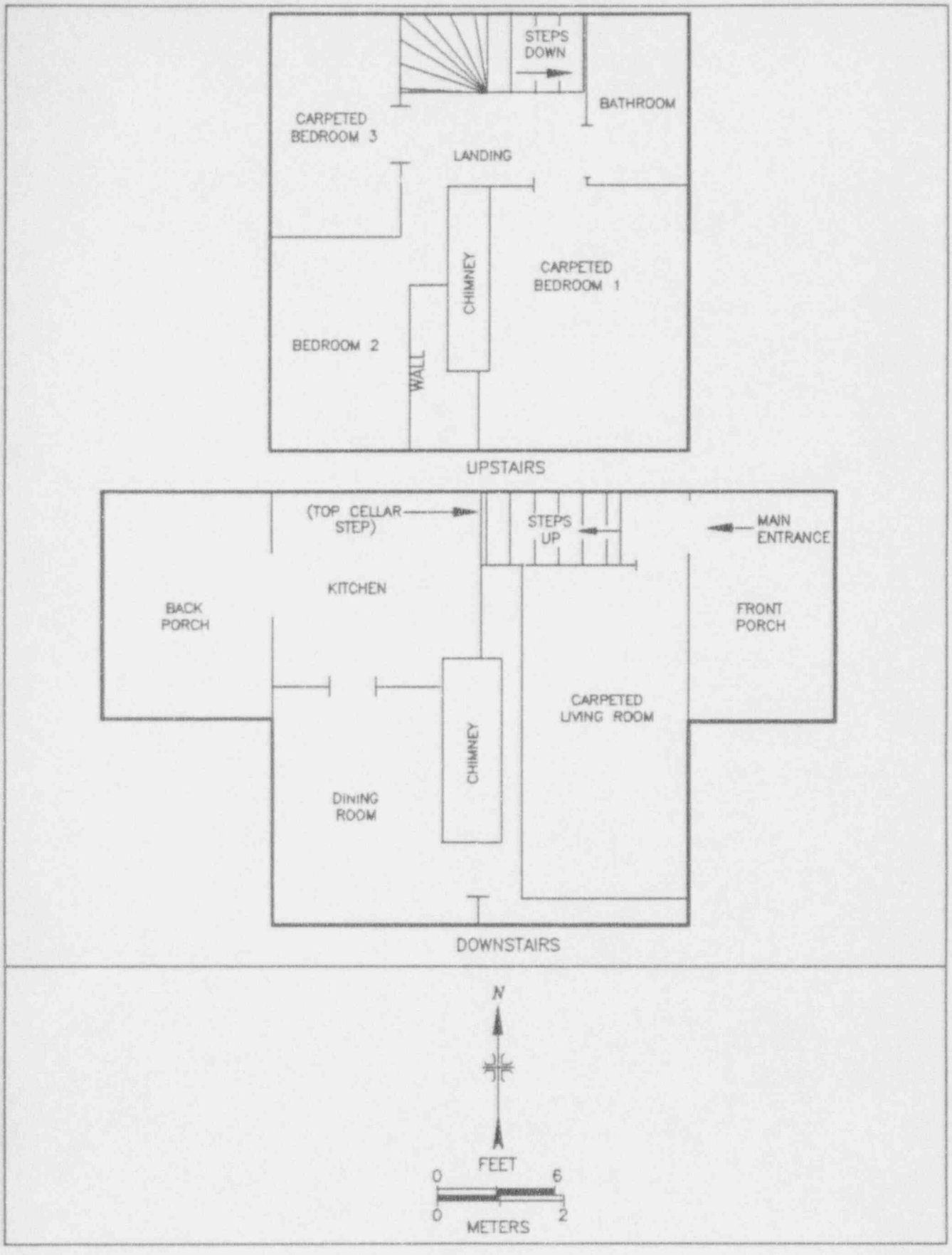


FIGURE 10: Remote Assembly Building - Floor Plan

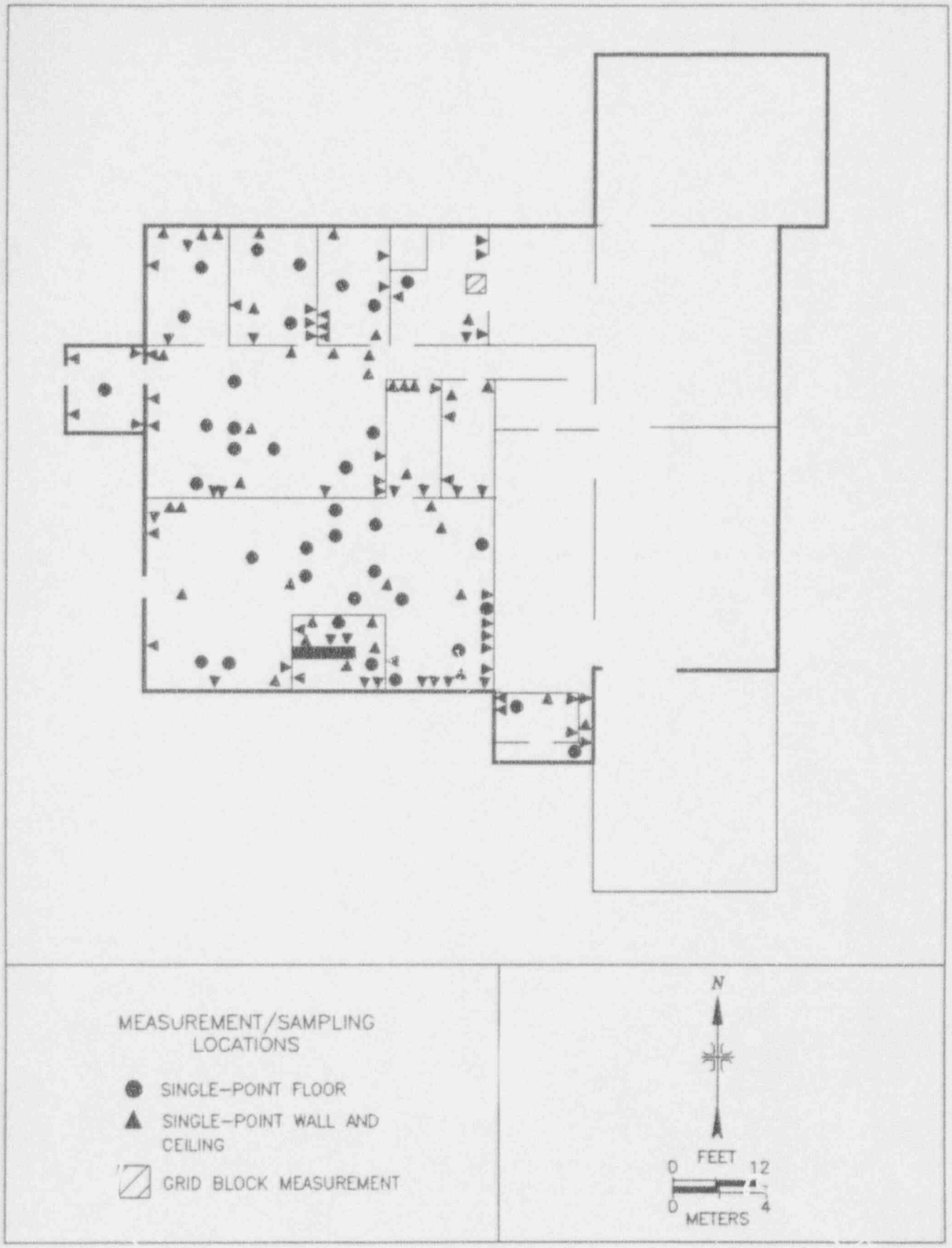


FIGURE 11: Plutonium Facility, Unaffected Areas – Measurement and Sampling Locations

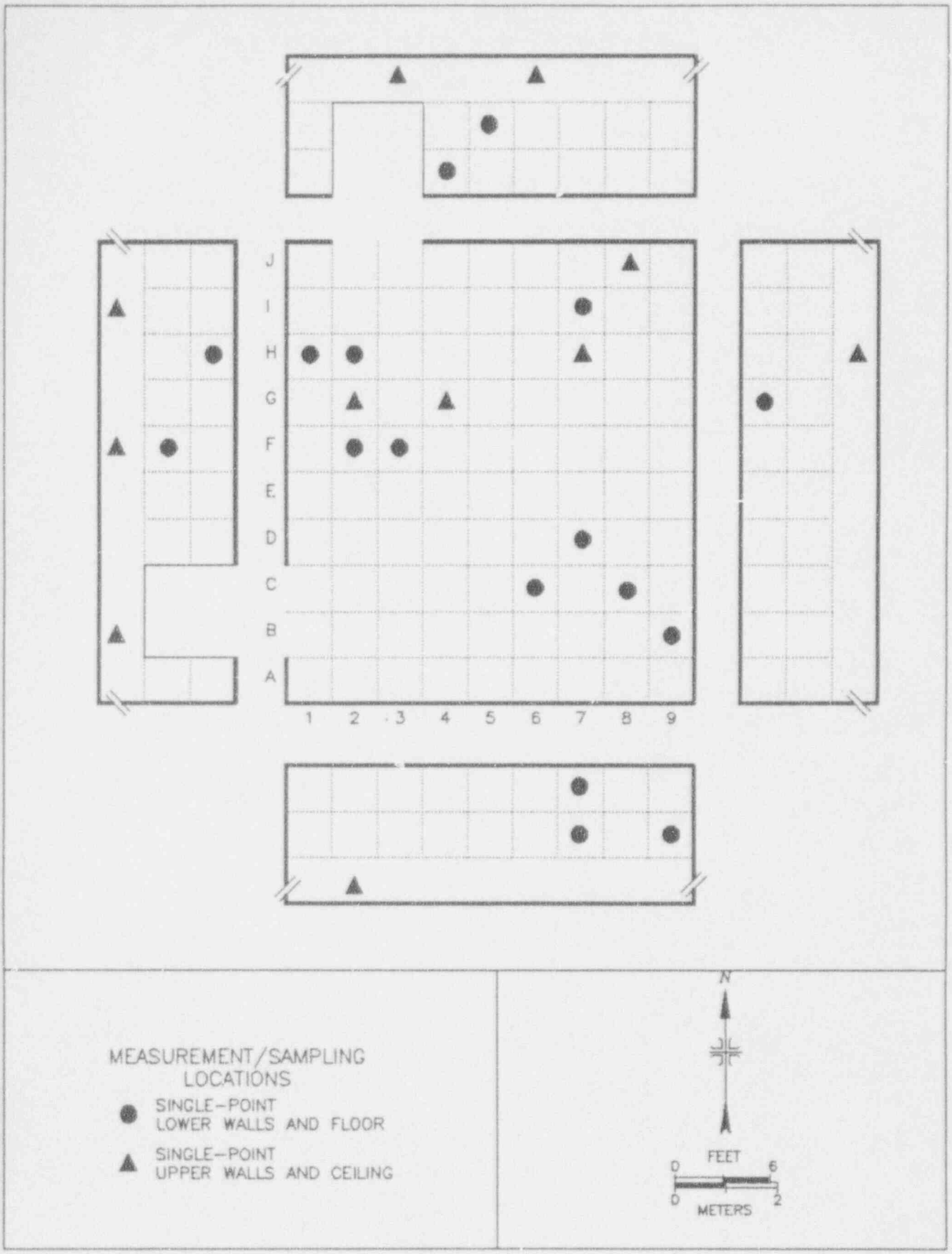


FIGURE 12: Plutonium Facility, Room 1 – Measurement and Sampling Locations

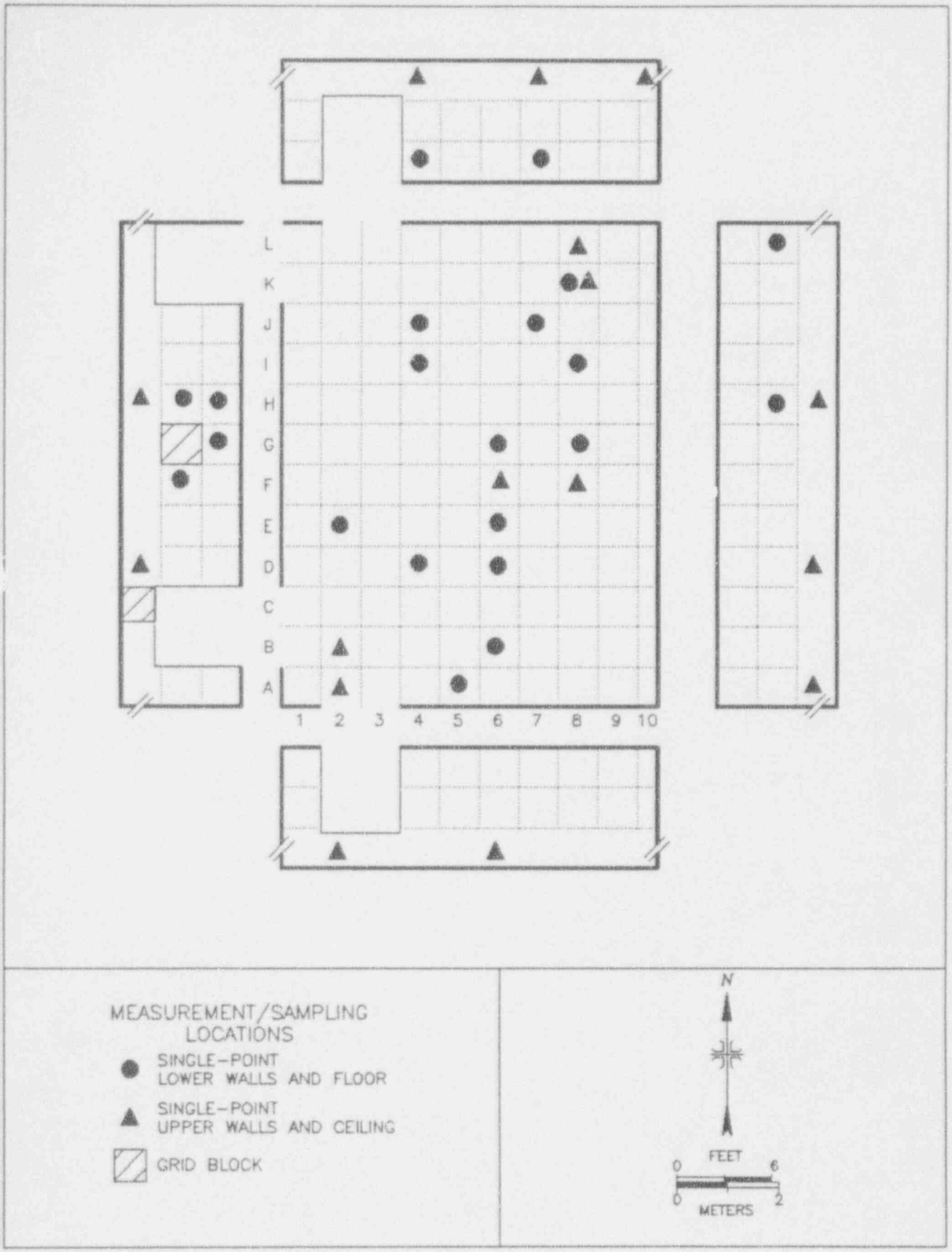


FIGURE 13: Plutonium Facility, Room 2 – Measurement and Sampling Locations

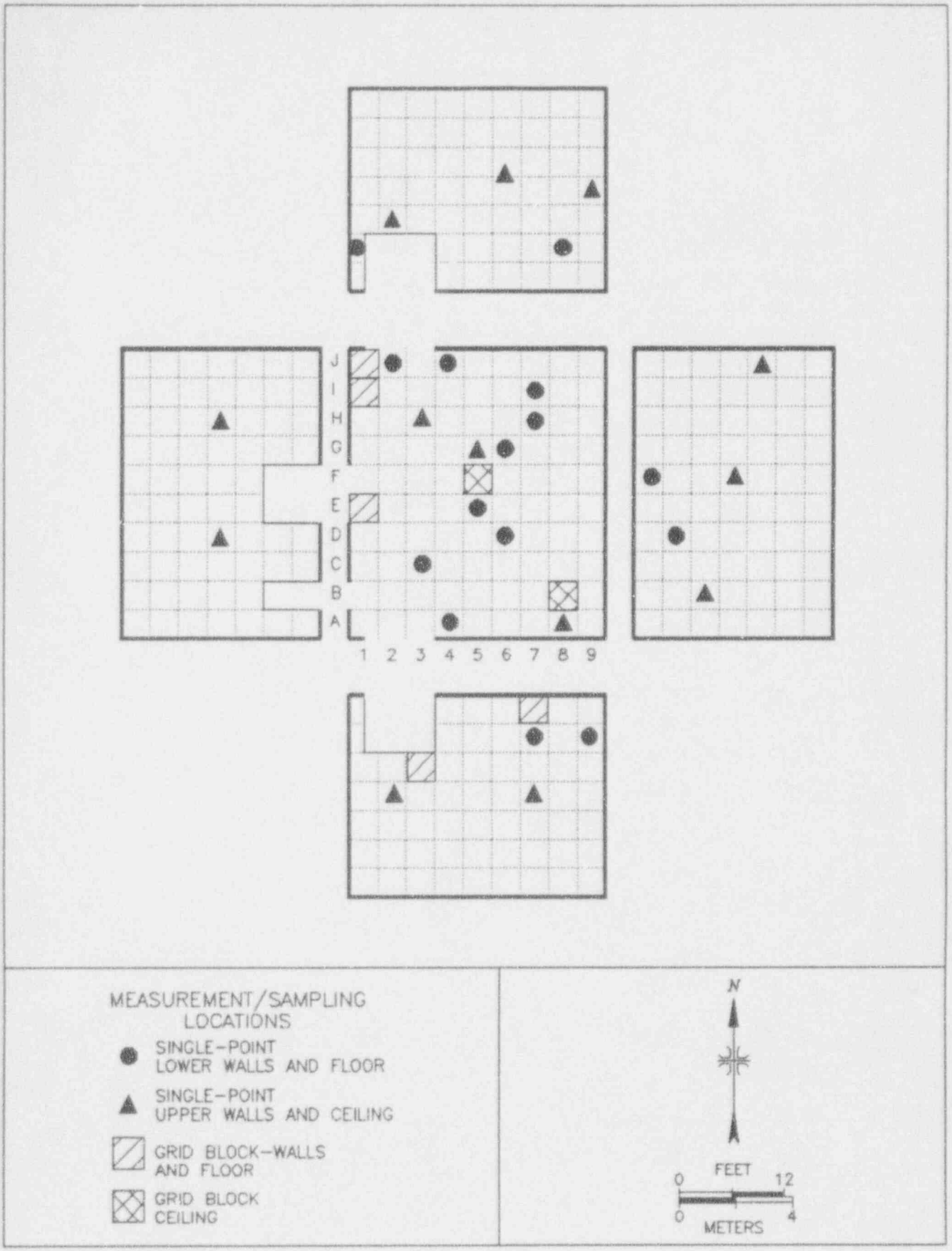


FIGURE 14: Plutonium Facility, Room 3 – Measurement and Sampling Locations

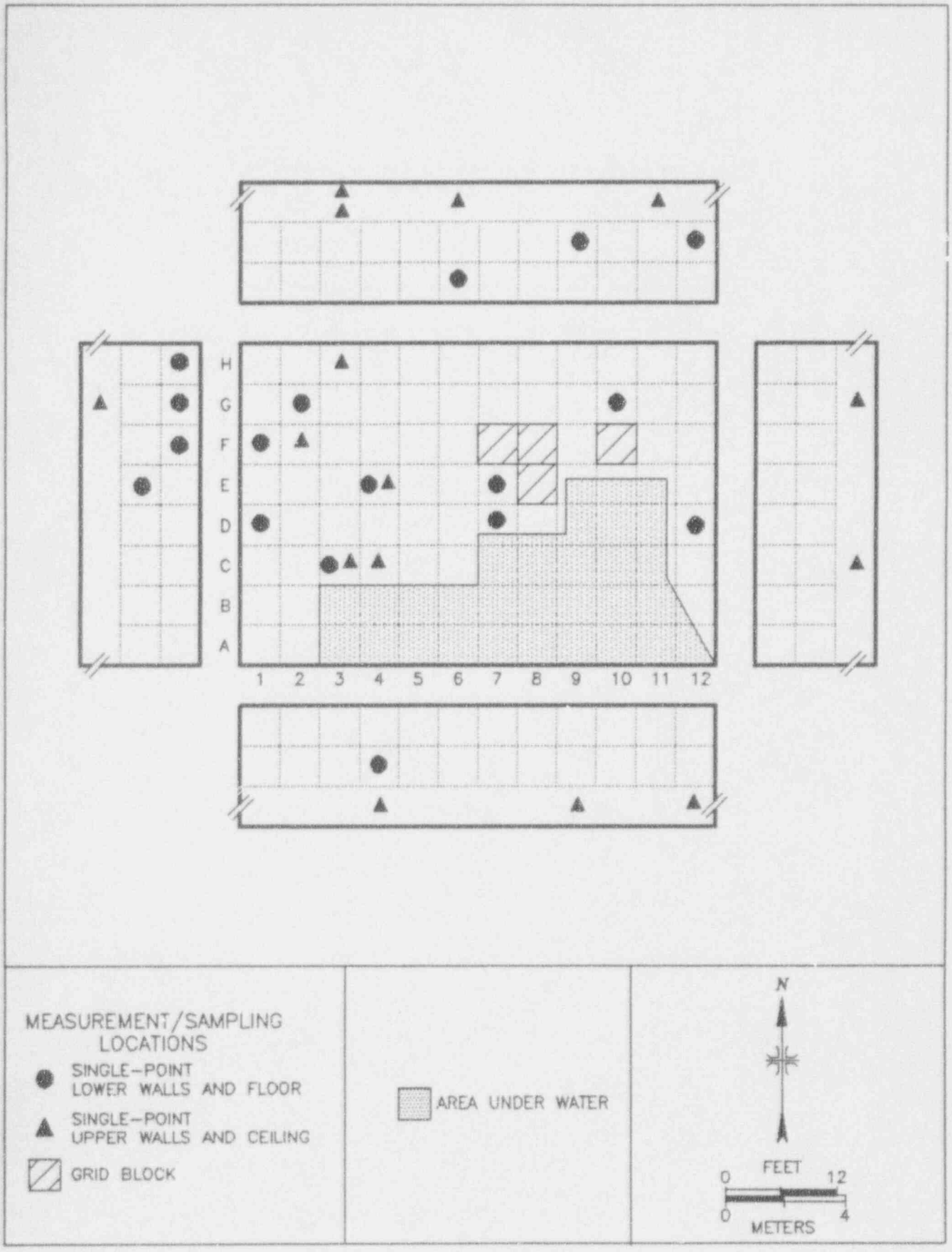


FIGURE 15: Plutonium Facility, Room 4 – Measurement and Sampling Locations

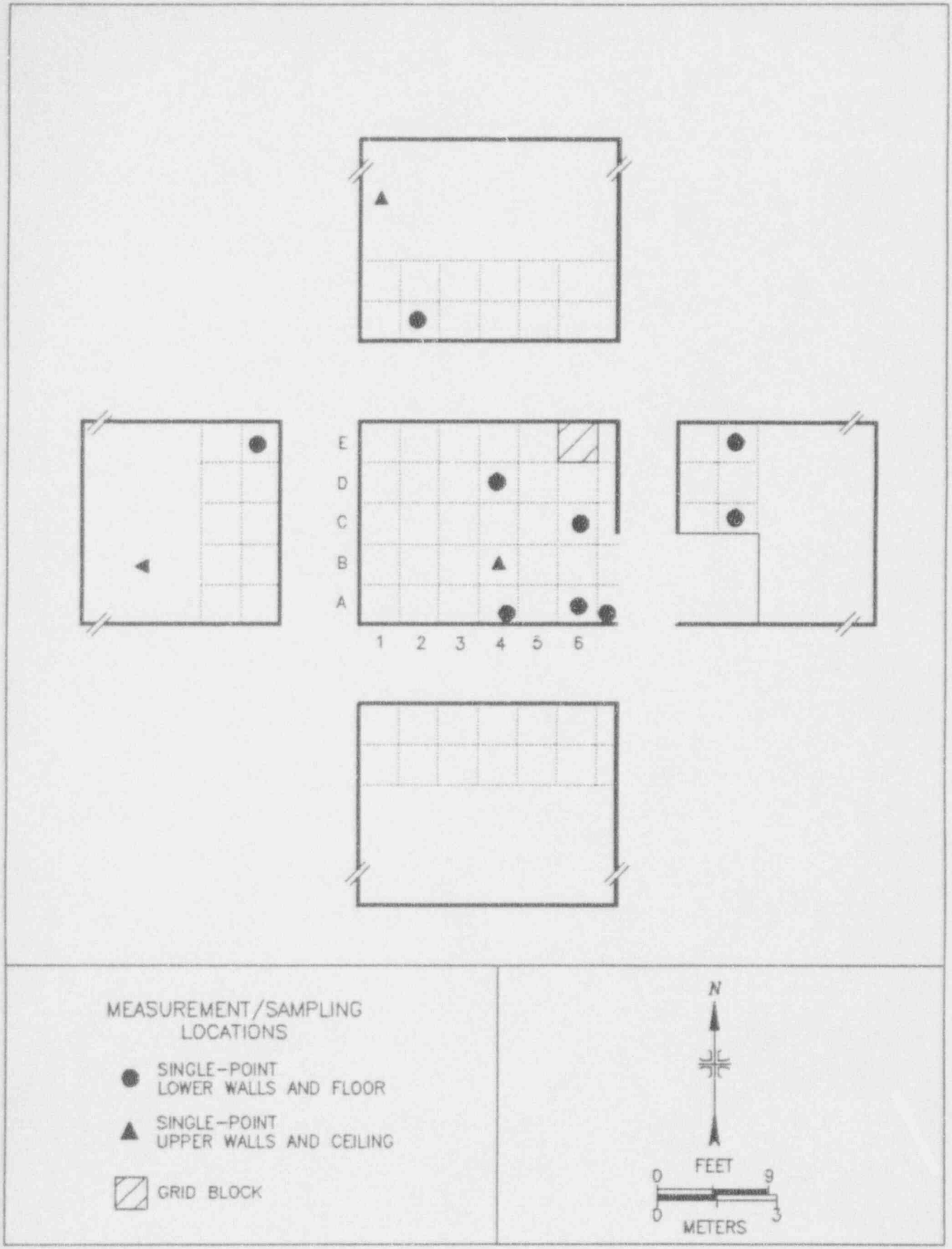


FIGURE 16: Plutonium Facility, Room 5 – Measurement and Sampling Locations

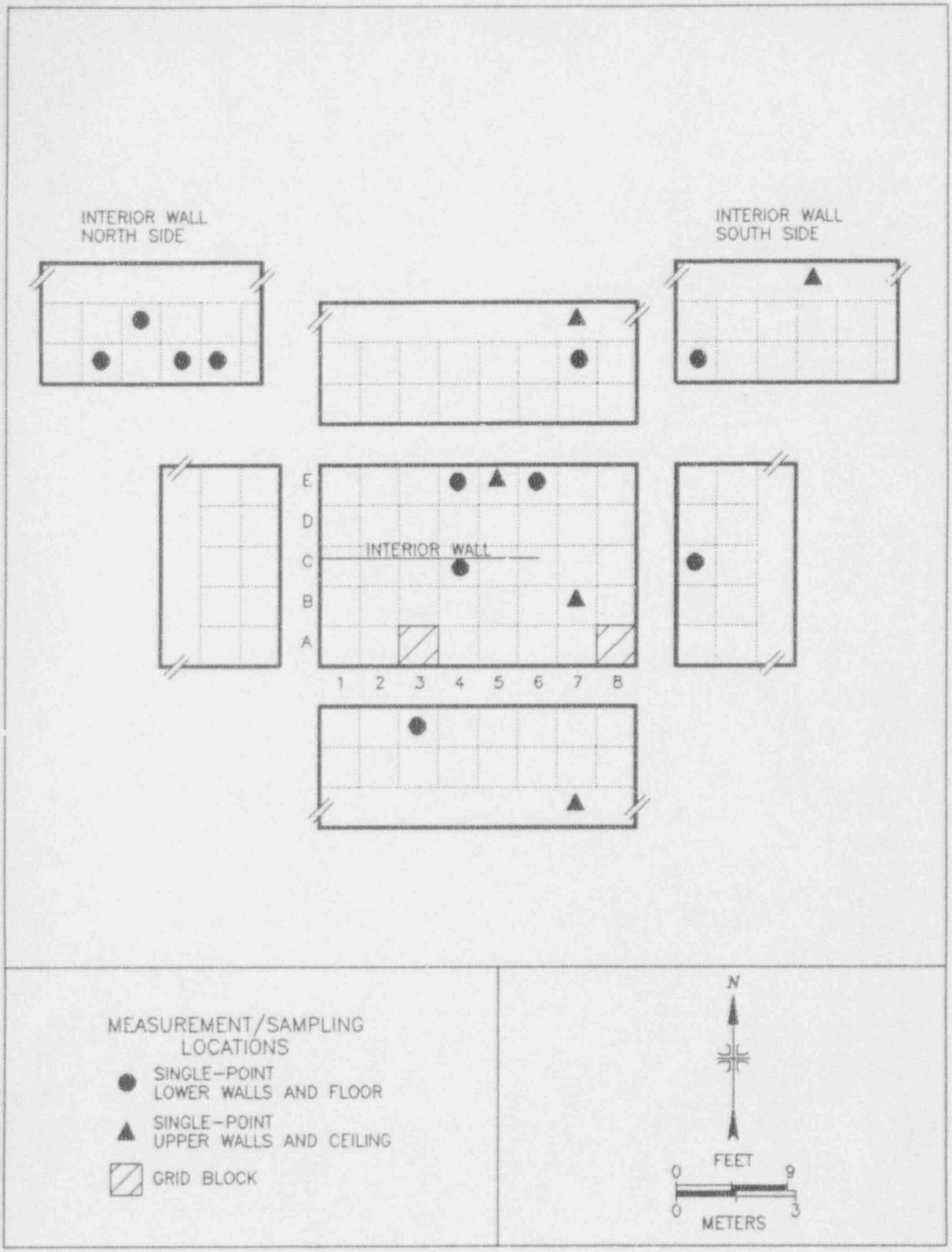


FIGURE 17: Plutonium Facility, Room 14 - Measurement and Sampling Locations

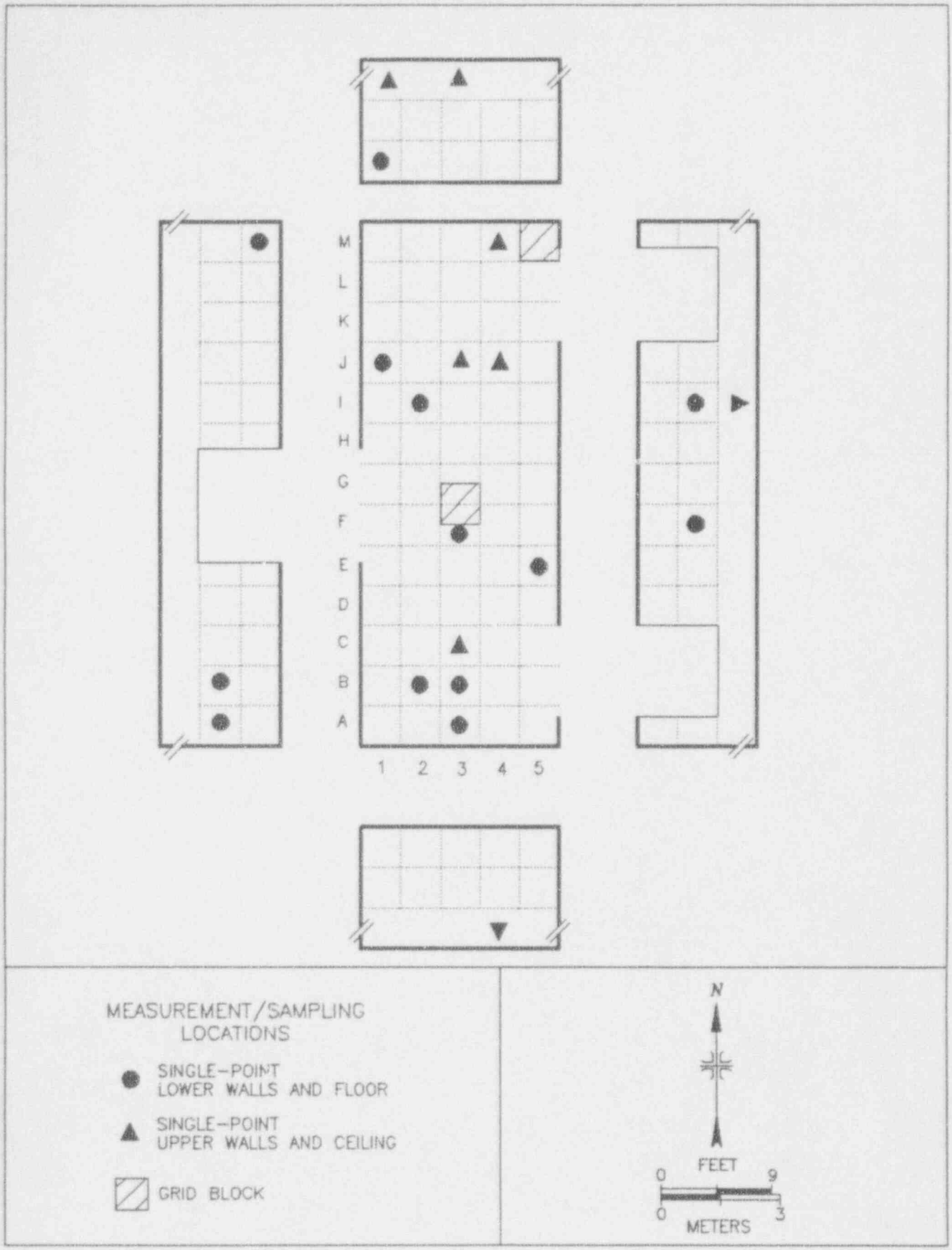


FIGURE 18: Plutonium Facility, Room 15 – Measurement and Sampling Locations

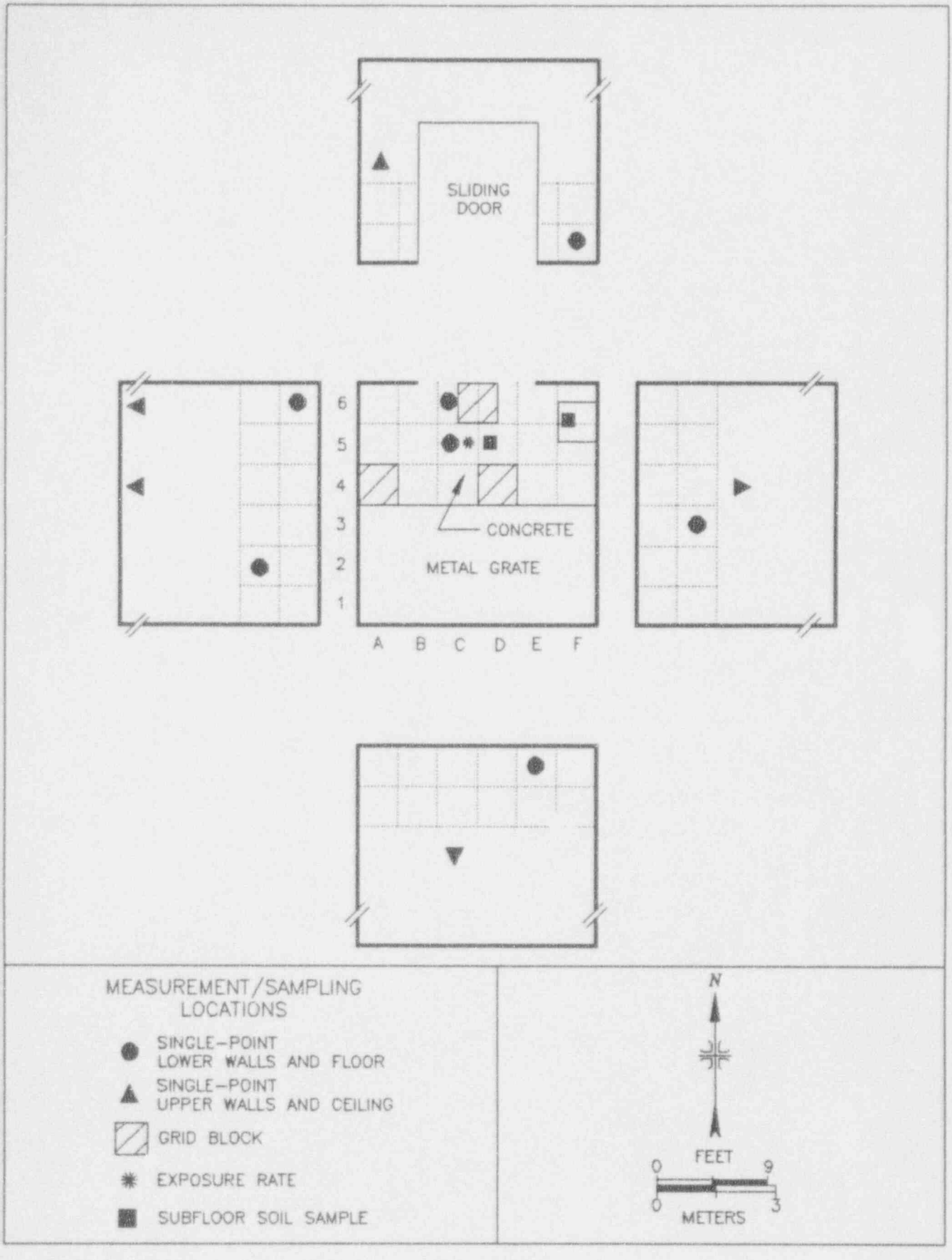


FIGURE 19: Waste Disposal Building, Upper Level – Measurement and Sampling Locations

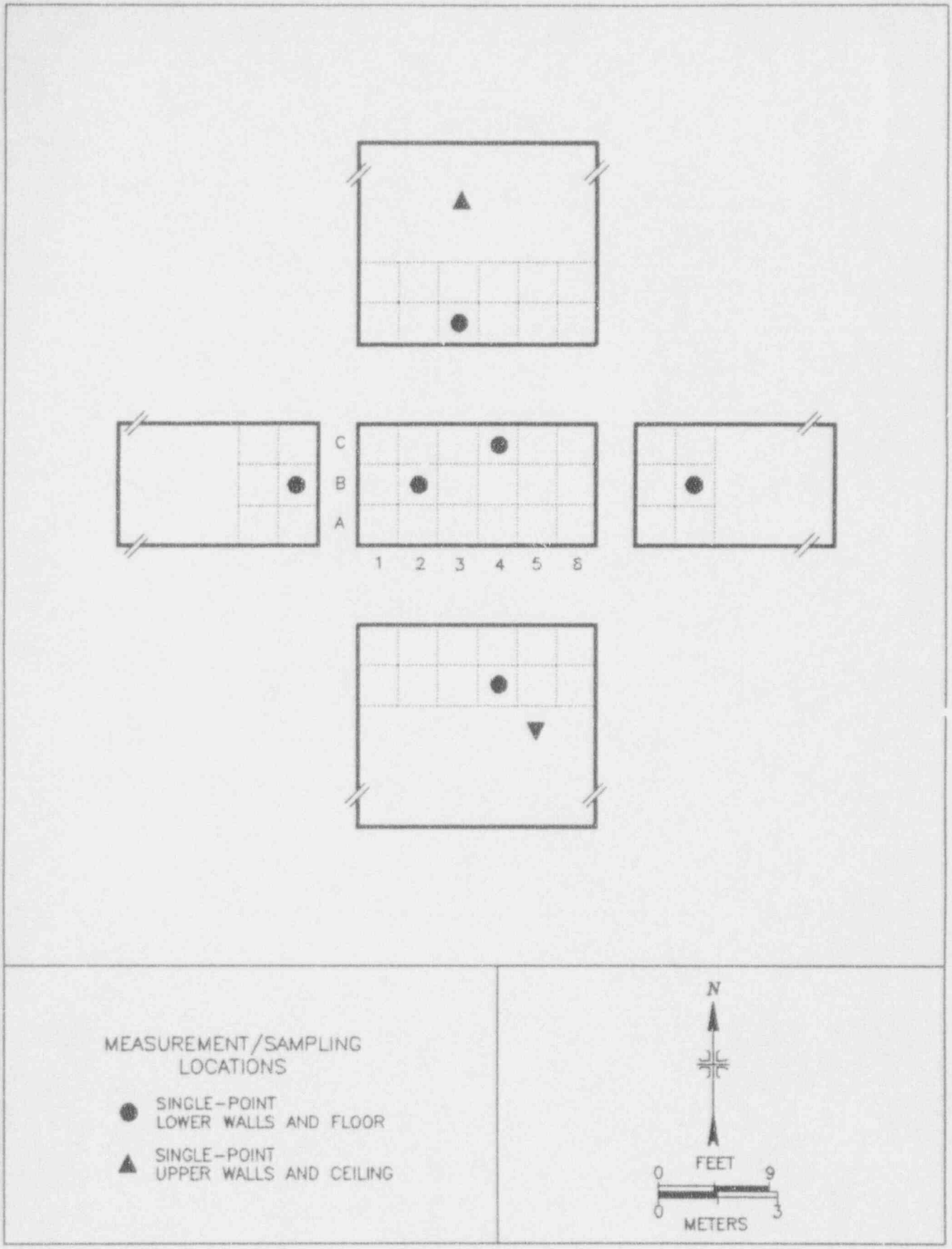


FIGURE 20: Waste Disposal Building, Lower Level – Measurement and Sampling Locations

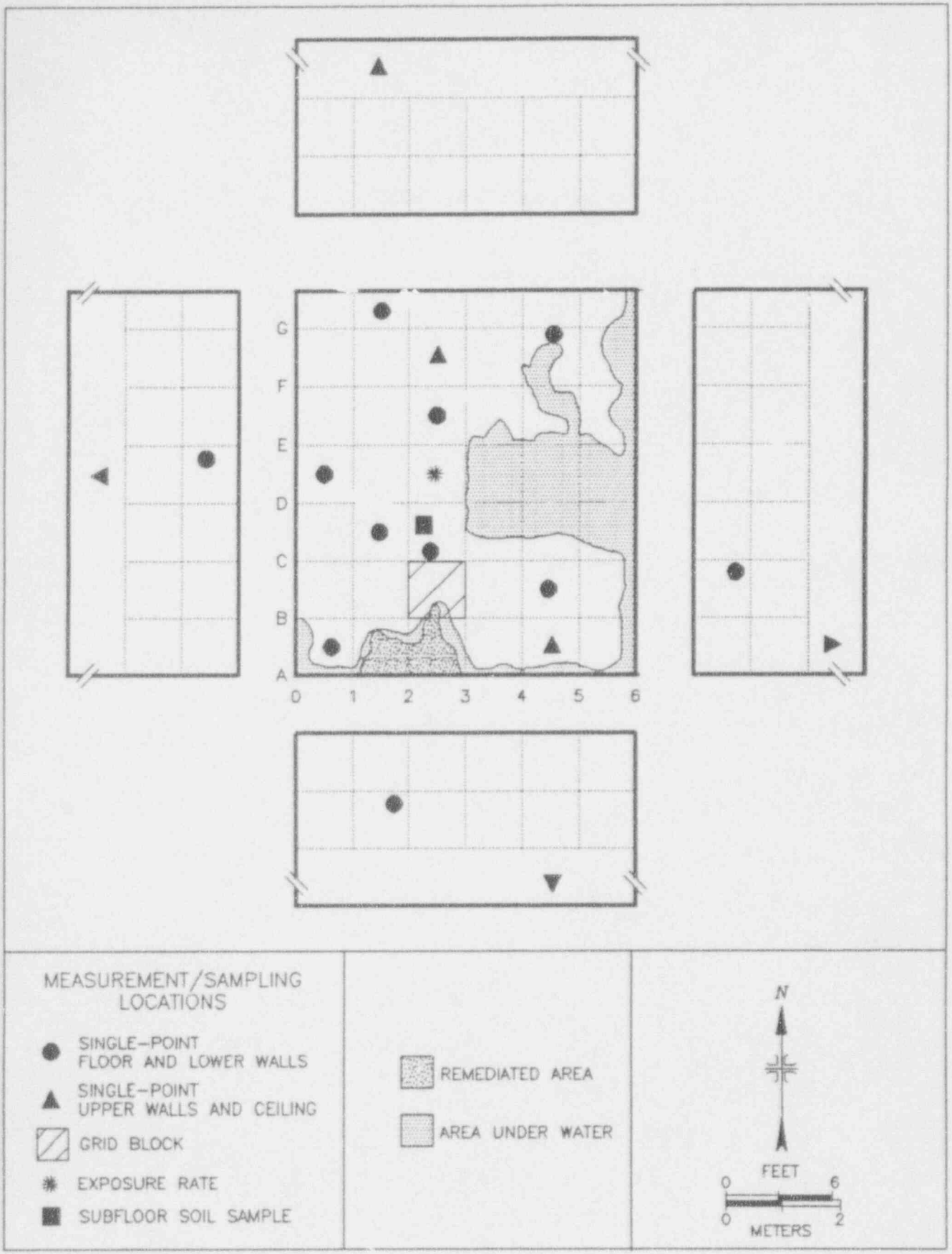


FIGURE 21: Multiple Failure Building – Measurement and Sampling Locations

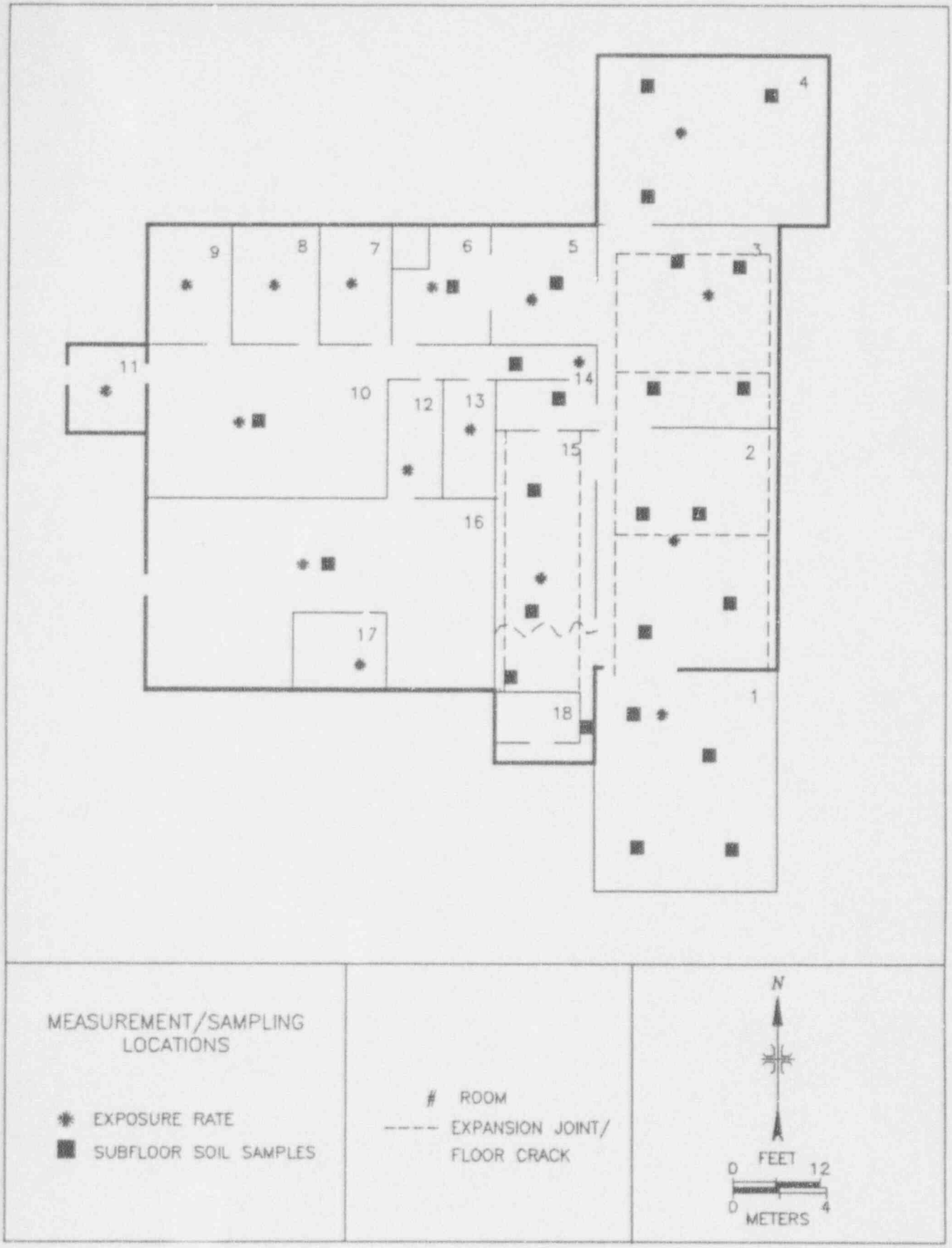


FIGURE 22: Plutonium Facility – Exposure Rate Measurement and Subfloor Sampling Locations

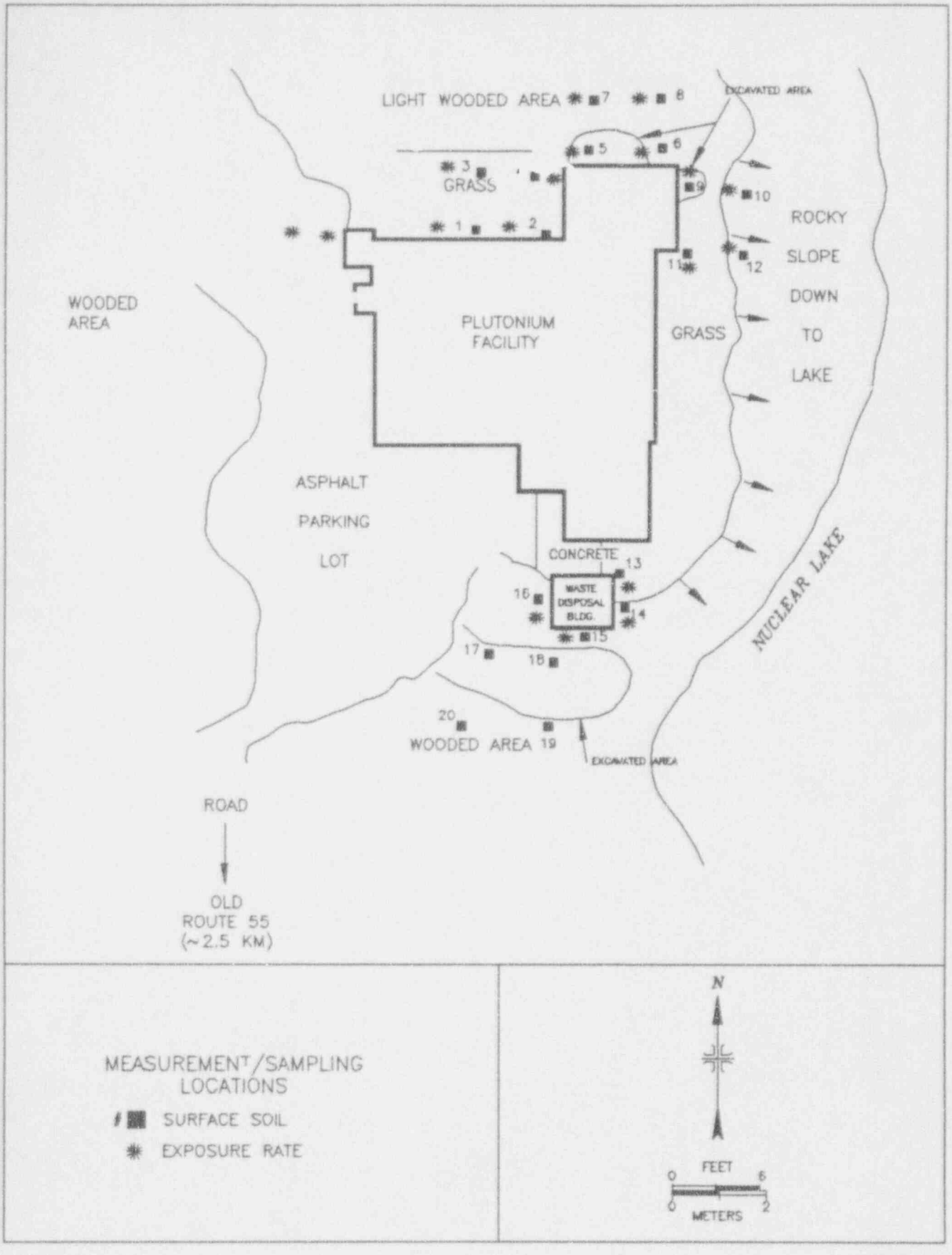


FIGURE 23: Affected Outdoor Soil Areas – Measurement and Sampling Locations

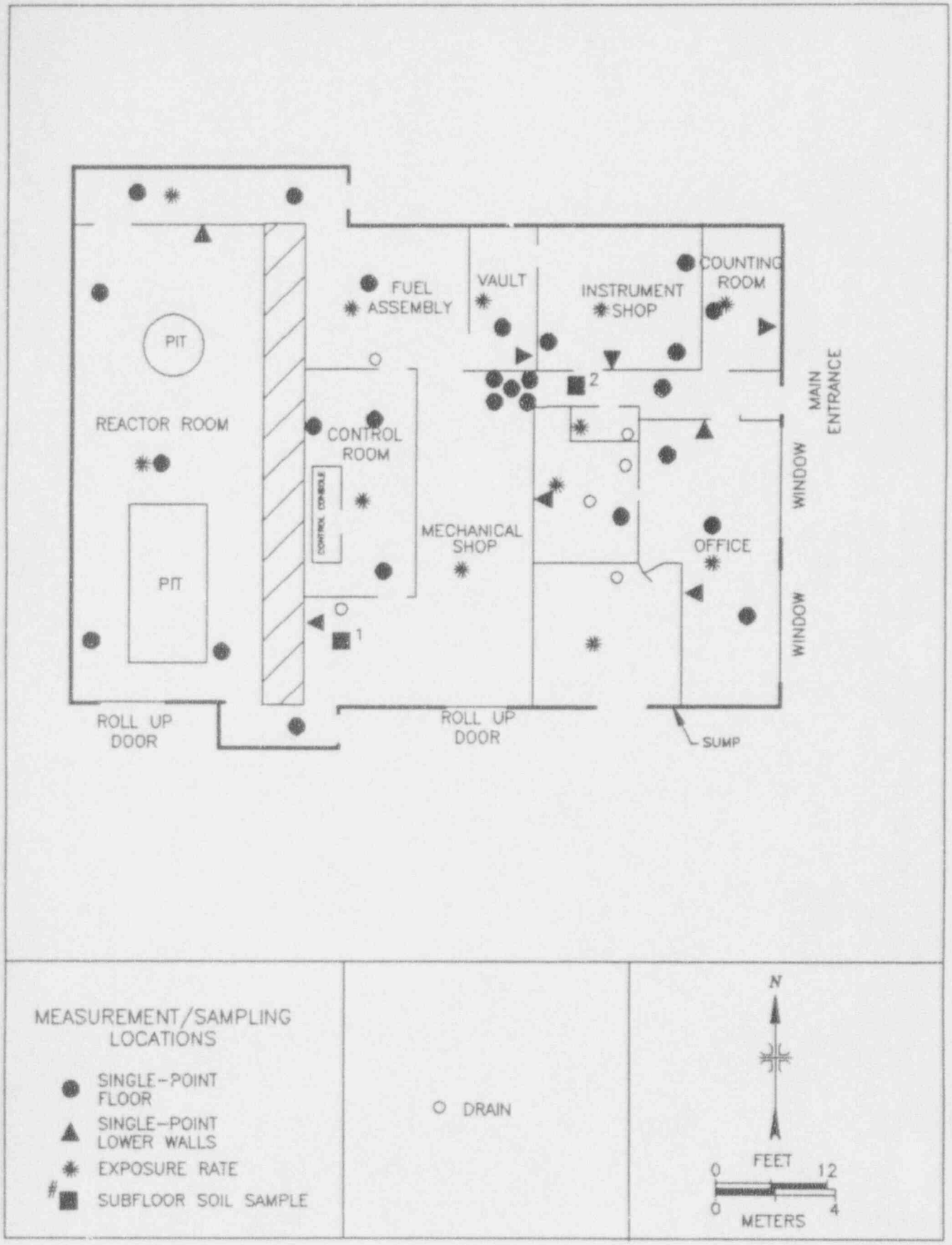


FIGURE 24: Critical Facility Building – Measurement and Sampling Locations

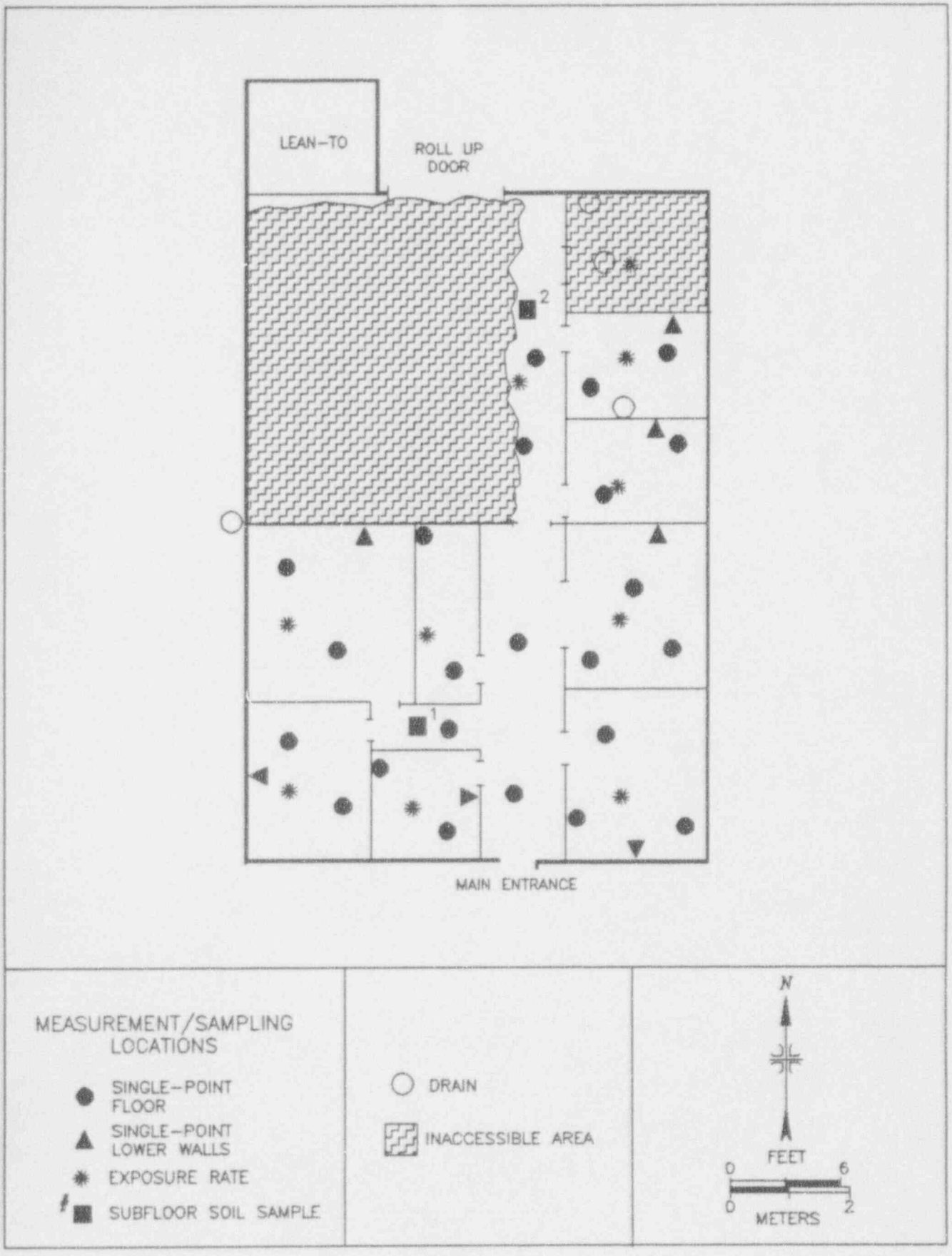


FIGURE 25: Engineering Building – Measurement and Sampling Locations

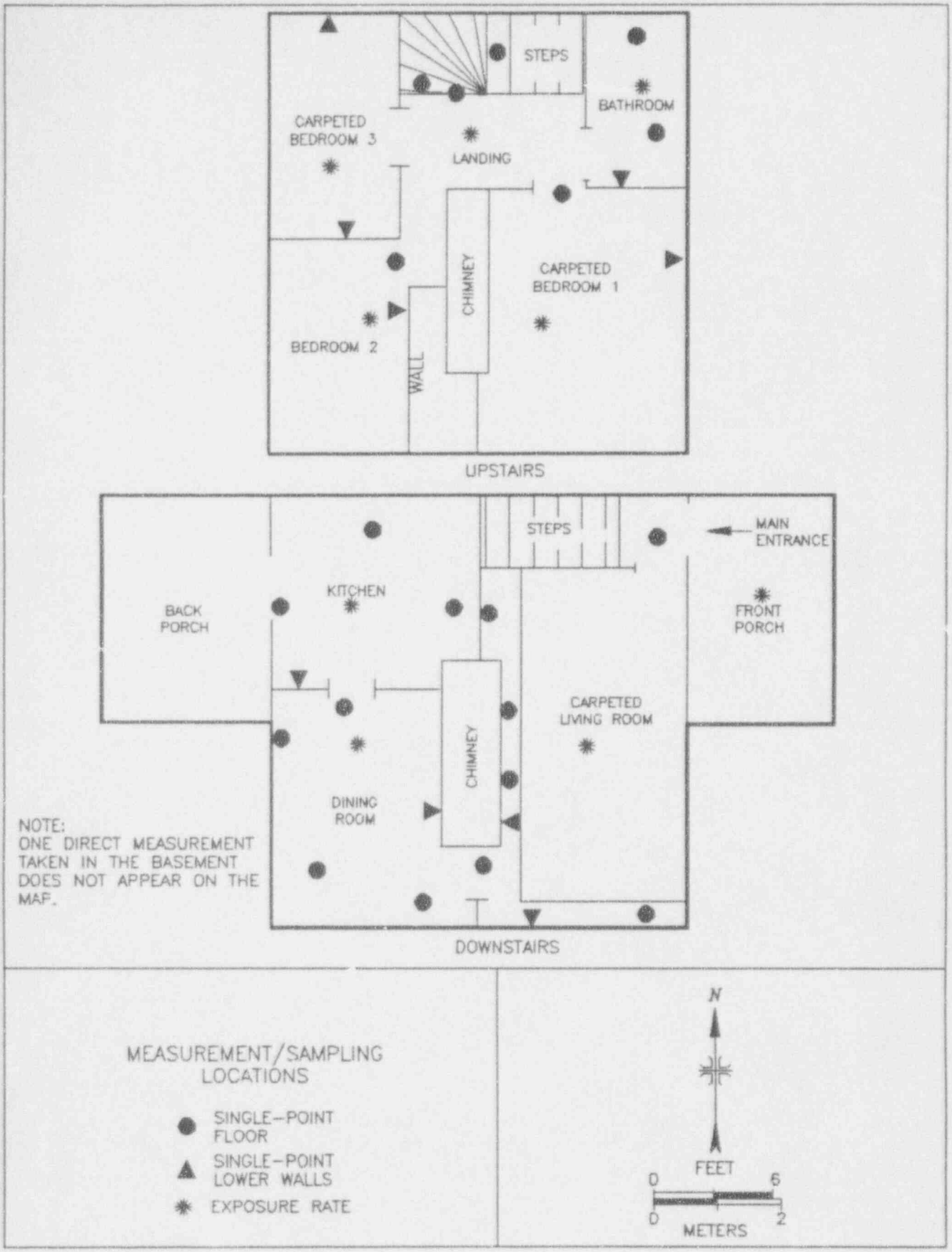


FIGURE 26: Remote Assembly Building – Measurement and Sampling Locations

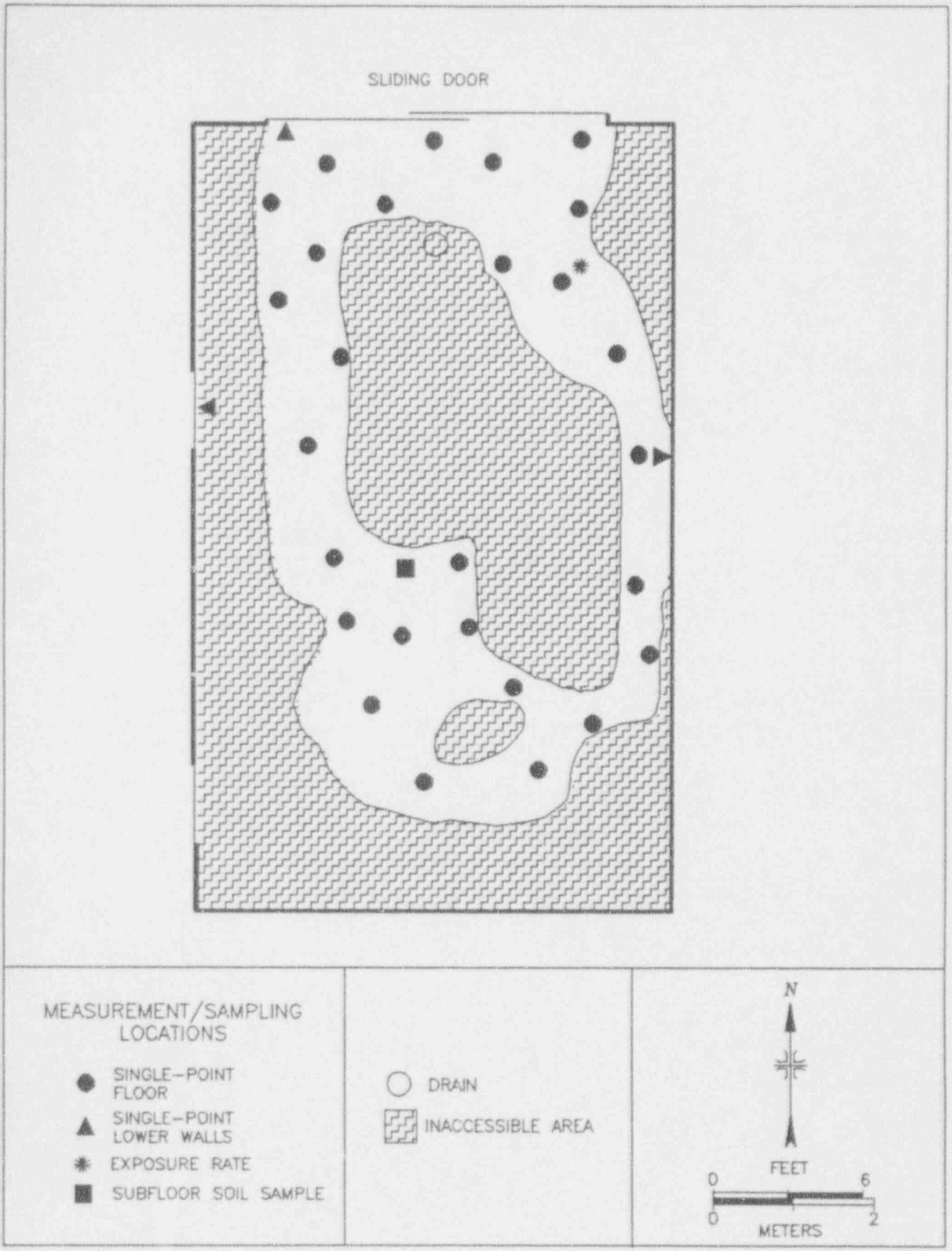


FIGURE 27: Shield Mock-Up Building - Measurement and Sampling Locations

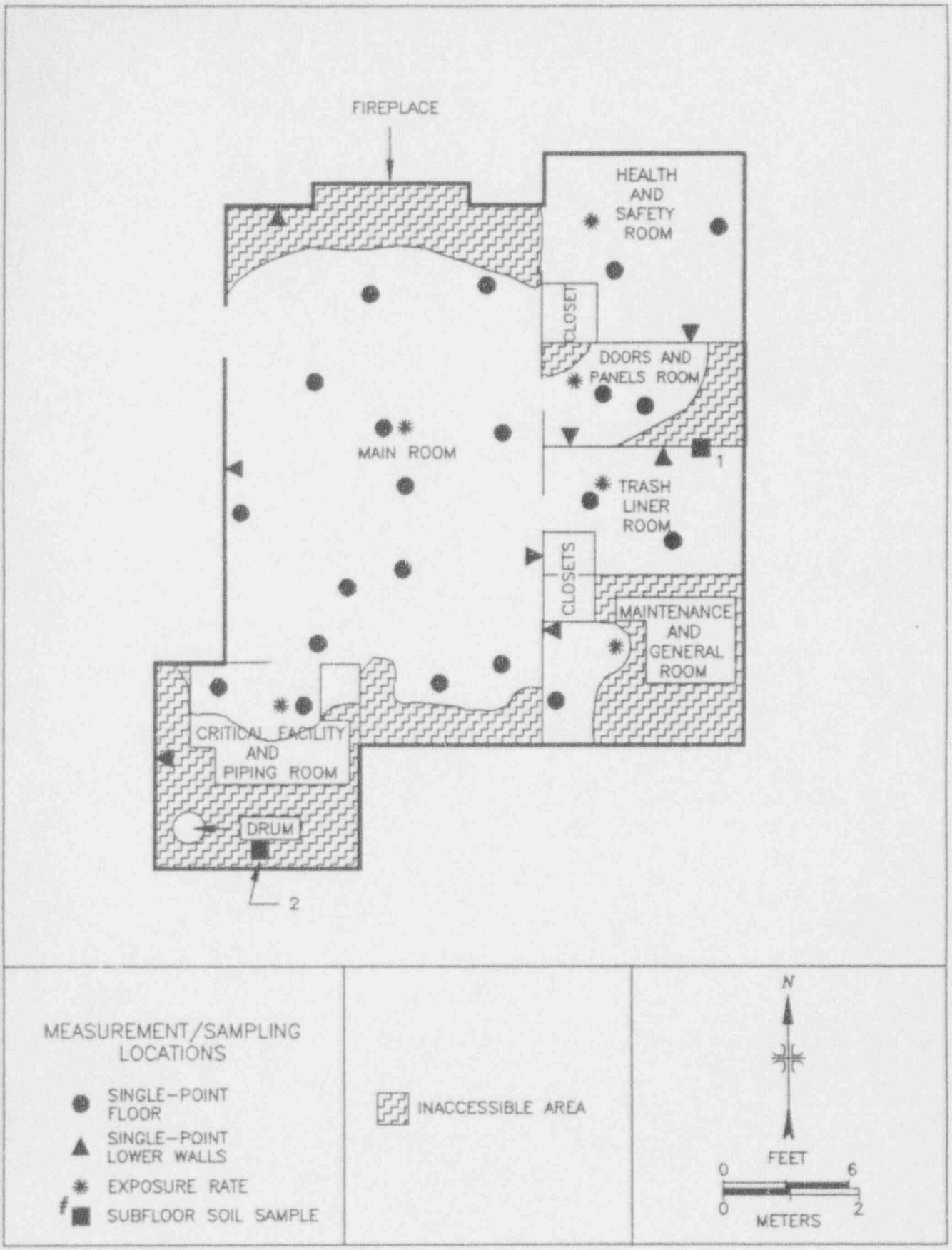
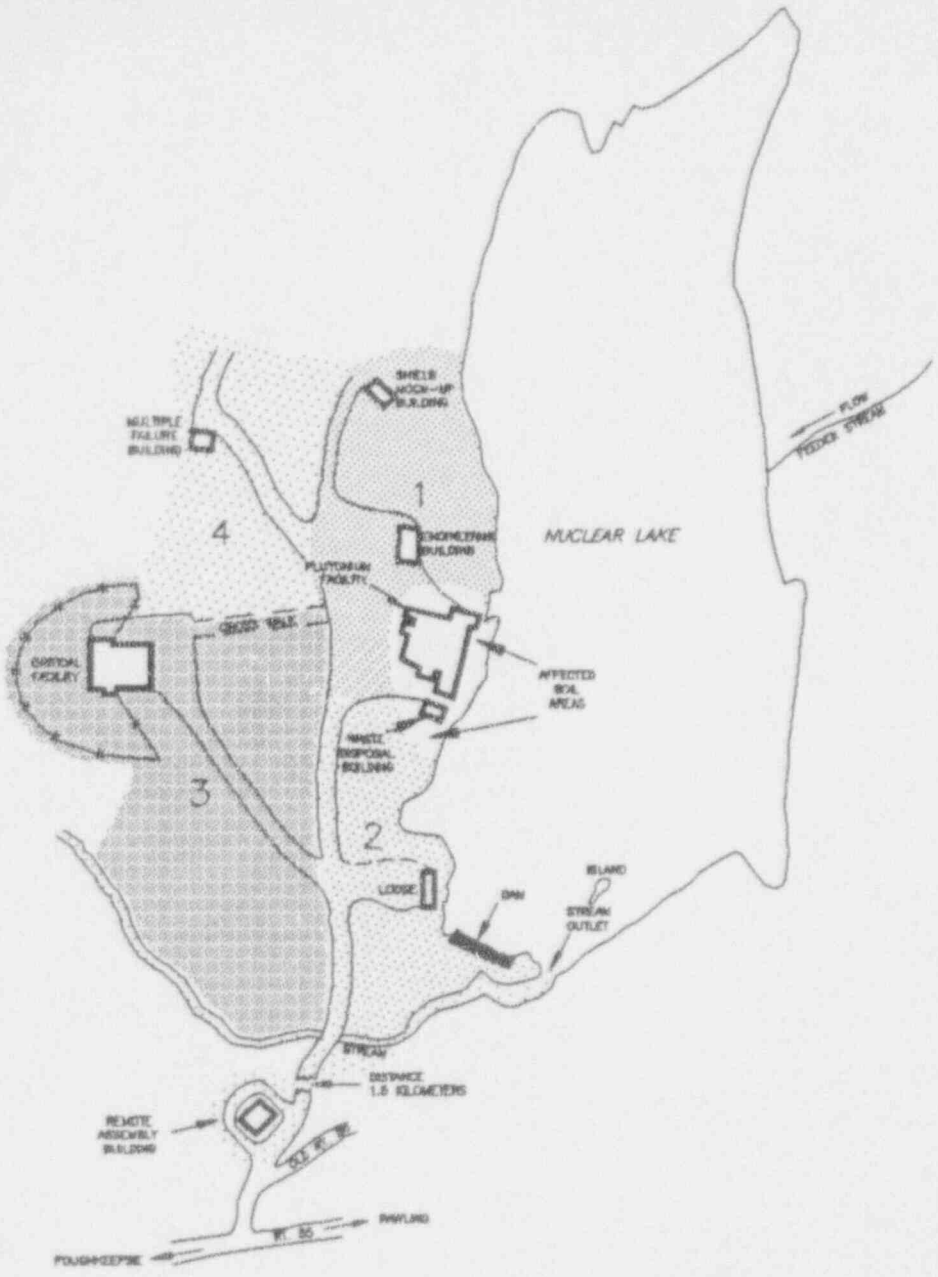


FIGURE 28: Lodge – Measurement and Sampling Locations



SURVEY UNIT

N

NOT TO SCALE

FIGURE 29: Nuclear Lake Site – Unaffected Outdoor Survey Units

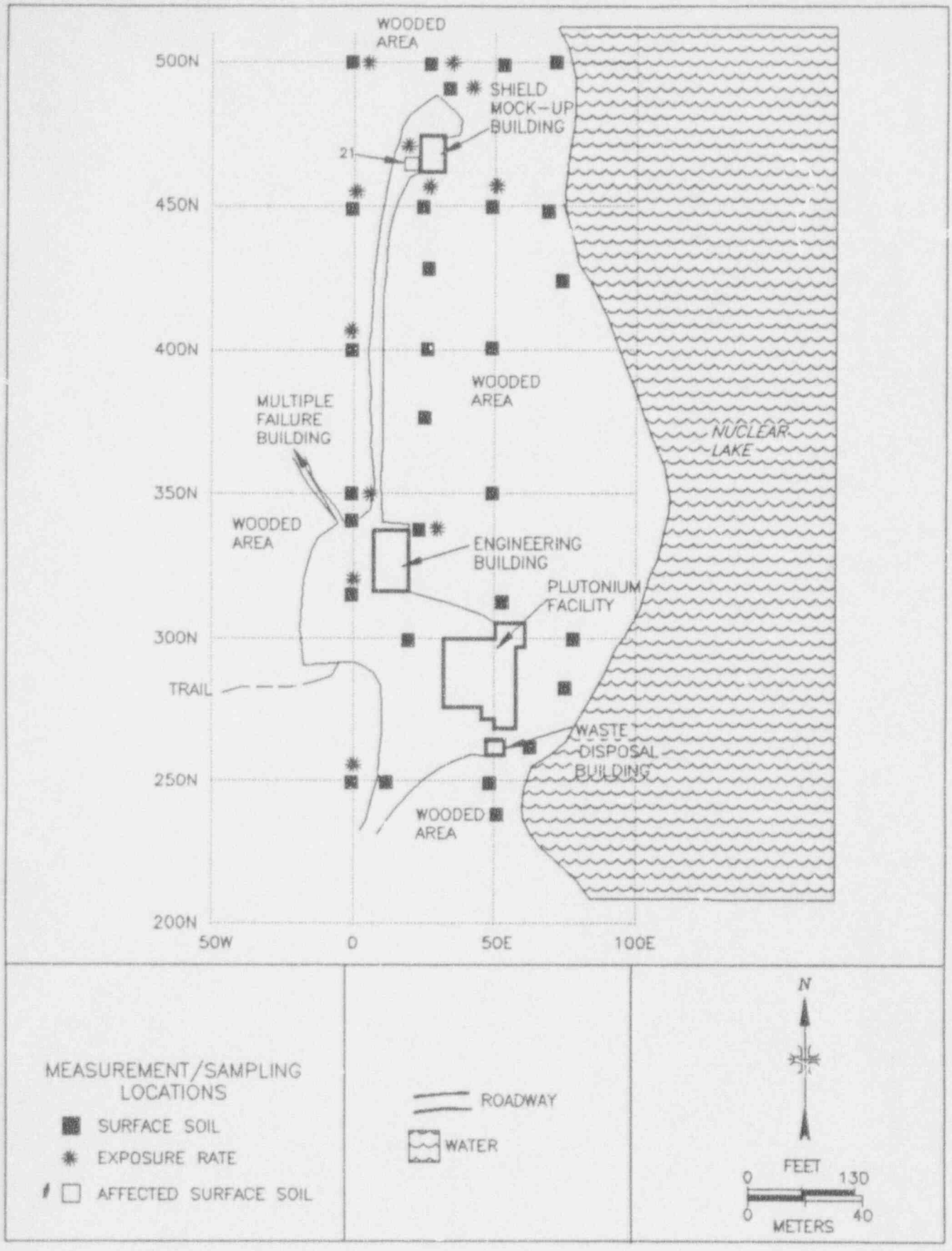


FIGURE 30: Survey Unit 1 – Measurement and Sampling Locations

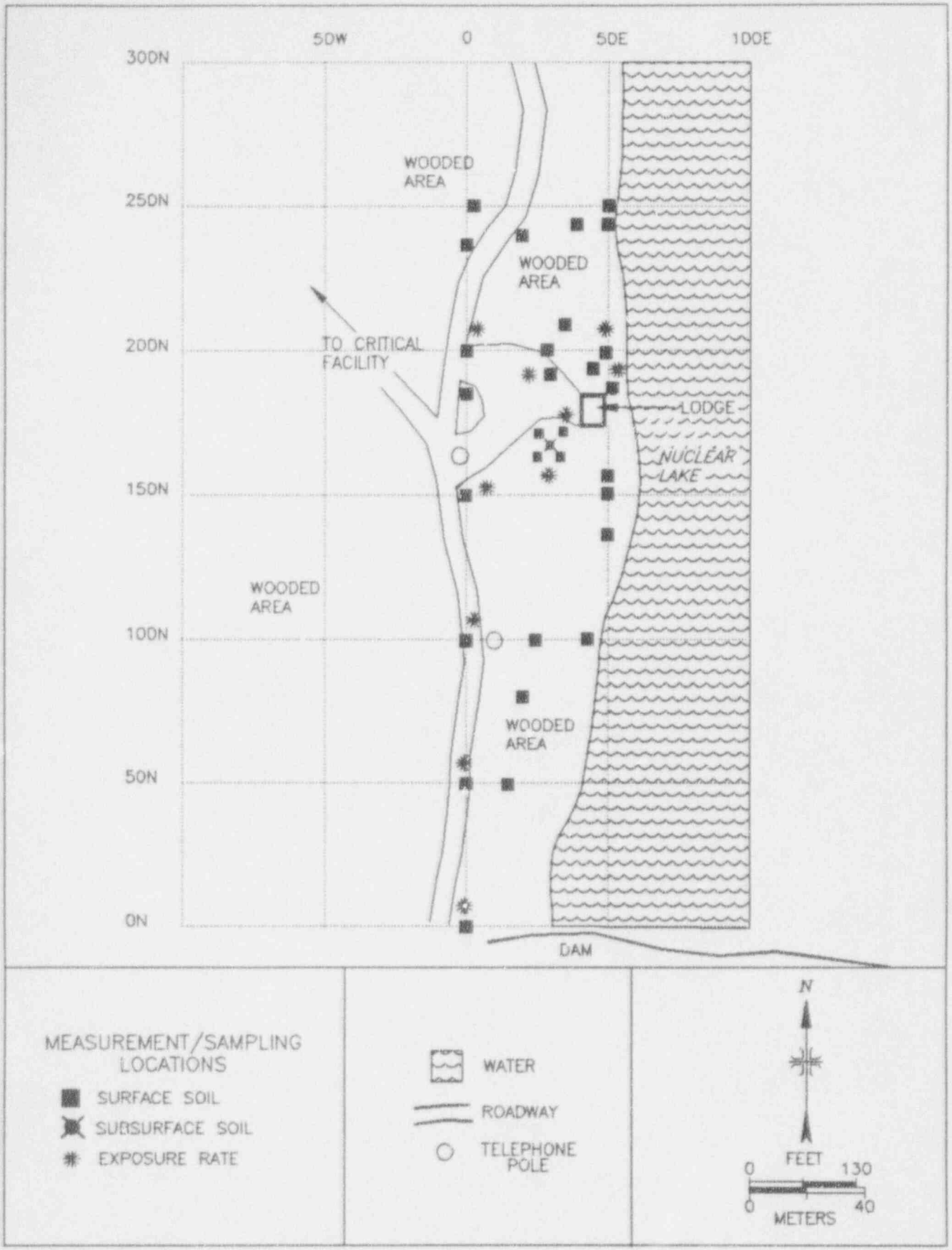


FIGURE 31: Survey Unit 2 (North Portion) – Measurement and Sampling Locations

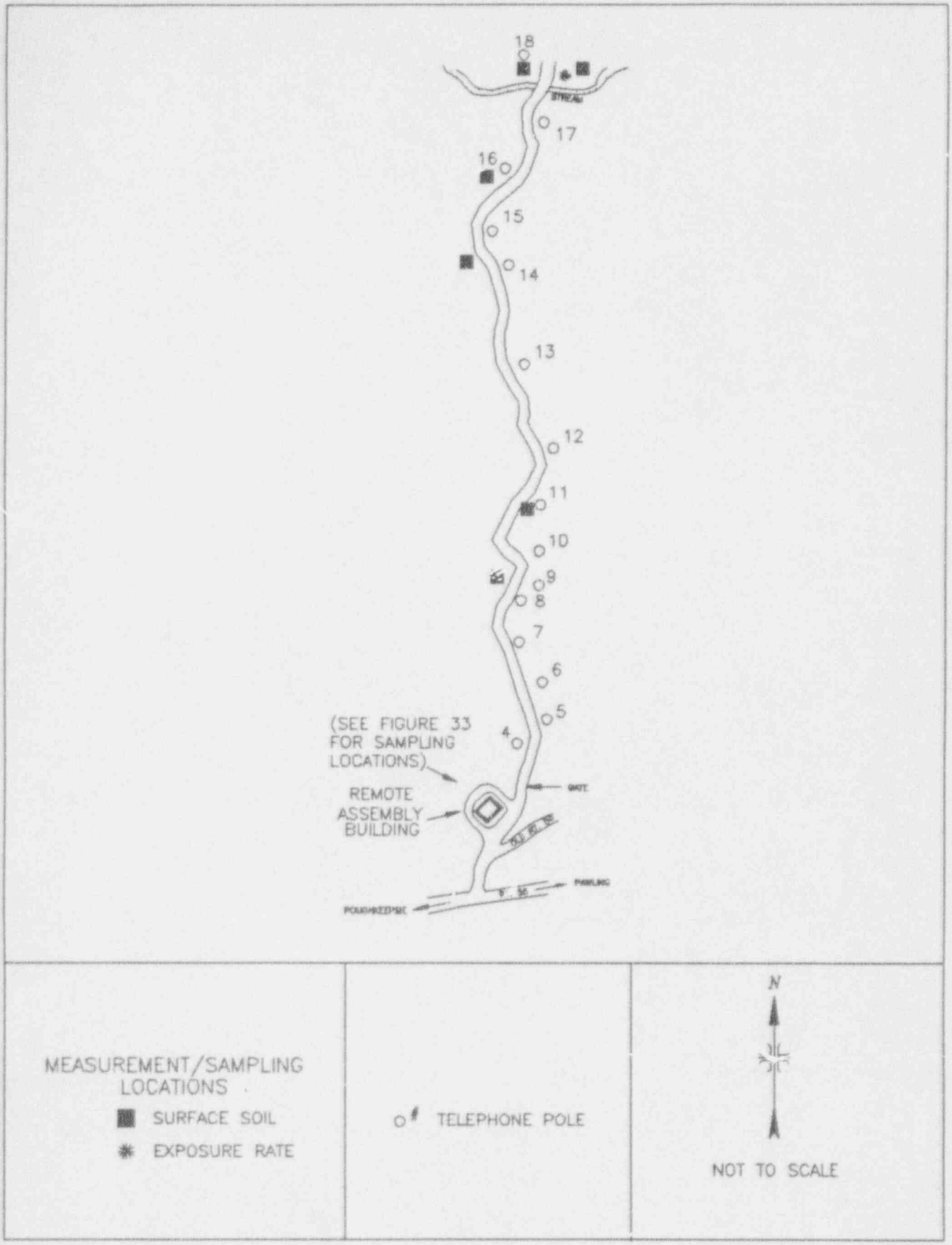


FIGURE 32: Survey Unit 2 (Central Portion, Access Road) – Measurement and Sampling Locations

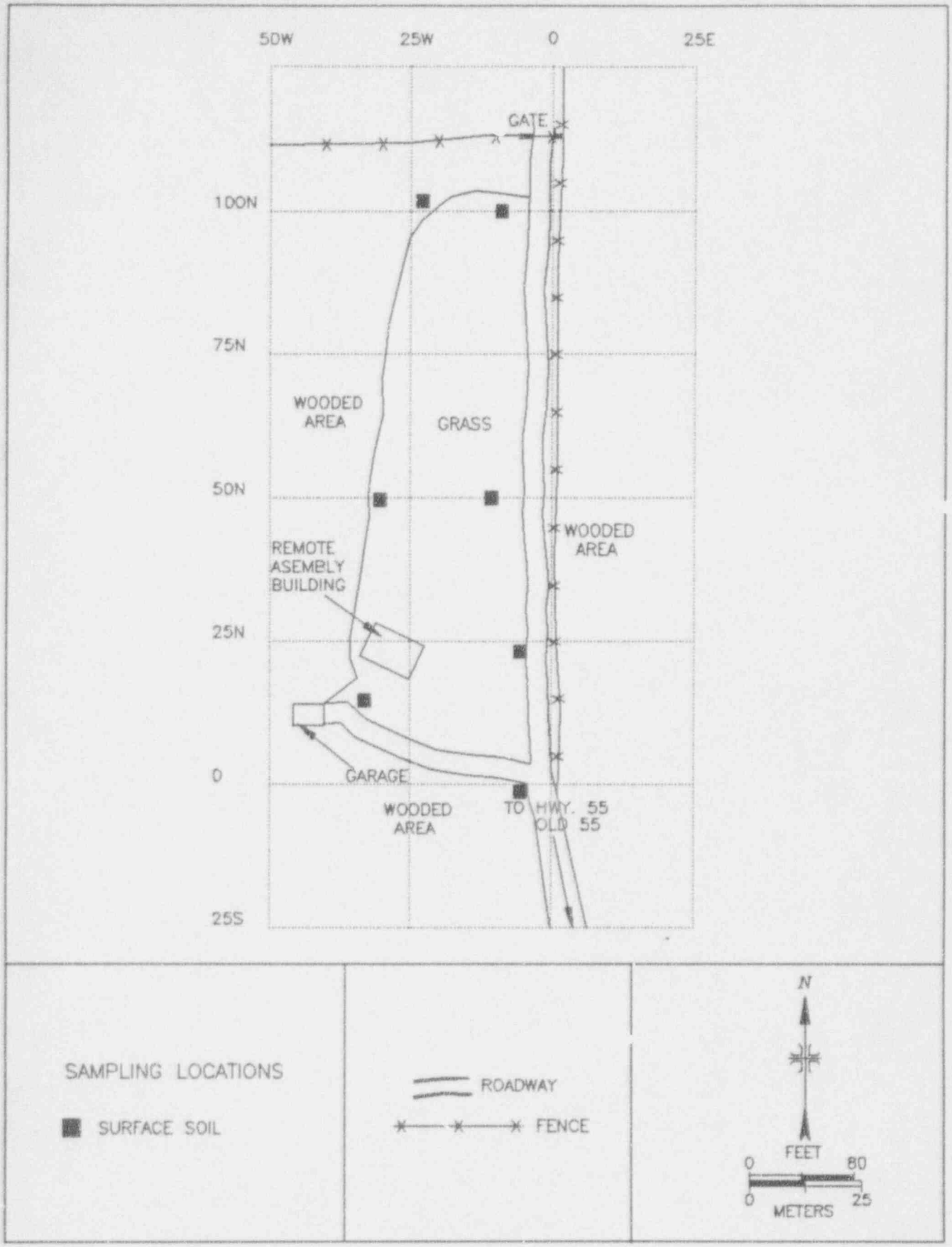


FIGURE 33: Survey Unit 2 (South Portion) – Measurement and Sampling Locations

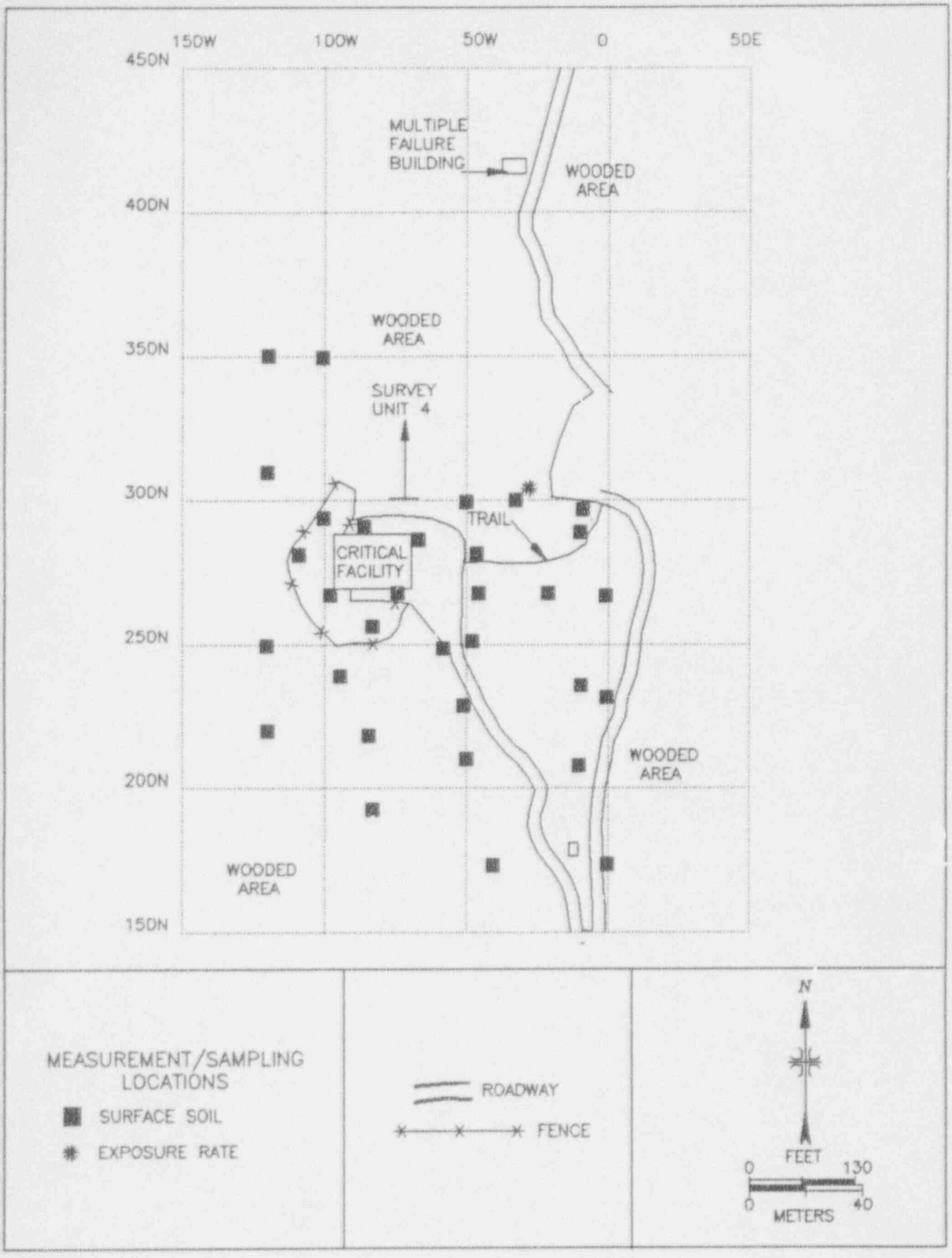


FIGURE 34: Survey Unit 3 and Southwest Survey Unit 4 – Measurement and Sampling Locations

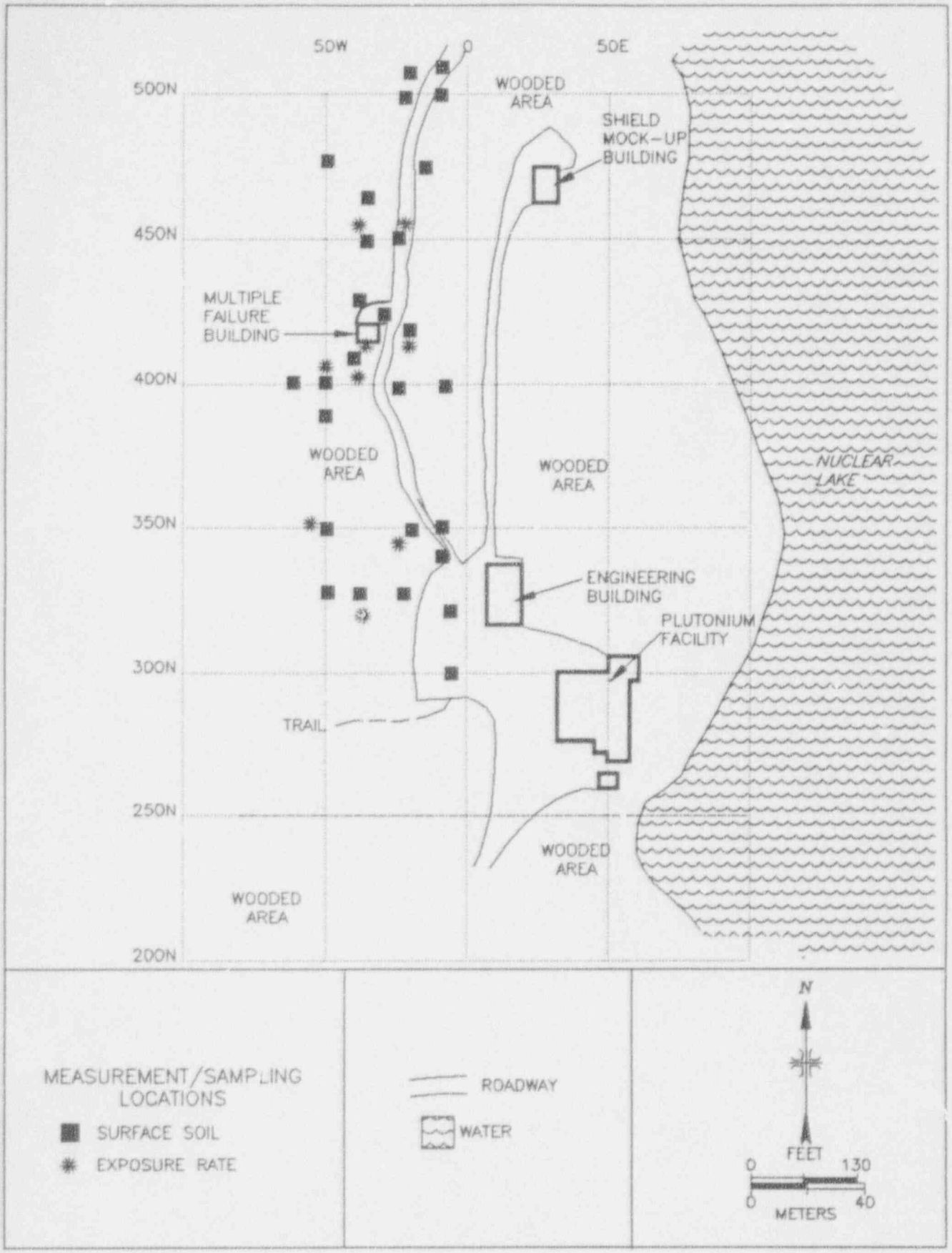


FIGURE 35: Survey Unit 4 – Measurement and Sampling locations

TABLE 1

SUMMARY OF PRE-REMEDIATION SURFACE ACTIVITY MEASUREMENTS
AFFECTED BUILDINGS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm²)				Removable Activity Range (dpm/100 cm²)	
			Single Measurements		Grid Block Average			
	Single-pt.	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Plutonium Facility								
Room 3								
Floor	---	3	11 to 800	710 to 47,000	30 to 280	860 to 47,000	-1 to 6	-3 to 1
Lower Walls	---	1	59 to 230	230 to 650	310	360	-1	0
U. Walls and Ceiling	---	3	20 to 440	-420 to 270	80 to 240	-5 to -95	-1 to 1	-3 to 1
Room 4								
Floor	---	4	40 to 420	270 to 880	75 to 200	500 to 580	-1 to 12	-1 to 5
U. Walls and Ceiling	2	---	33 to 2,300	6 to 4,900	---	---	-1 to 25	2 to 3
Room 5								
Floor	2	1	41 to 420	970 to 1,300	120	1,200	1 to 4	-5 to 0
Room 14								
Floor	---	1	57 to 230	500 to 1,100	120	820	1	4
Room 15								
Floor	---	2	11 to 700	950 to 100,000	20 to 270	1,100 to 21,000	-1 to 4	-4 to 10
Waste Disposal Building								
Floor	---	3	-2 to 260	420 to 260,000	5 to 34	2,000 to 7,800	-1 to 6	-1 to 3
Multiple Failure Building								
Floor	---	1	2 to 14	720 to 50,000	11	9,800	-1	4

[a]Refer to Figures 14 through 16, 17 through 19, 21.

TABLE 2

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
NUCLEAR LAKE SITE—AFFECTED BUILDINGS
PAWLING, NEW YORK

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm^2)				Removable Activity Range (dpm/100 cm^2)	
			Single Measurements		Grid Block Average			
	Single-pt.	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Plutonium Facility								
Room 1								
Floor	9	---[b]	20 to 59	640 to 970	---	---	-1 to 4	-5 to 3
Lower Walls	8	---	-5 to 84	-570 to 360	---	---	-1 to 6	-4 to 1
U. Walls and Ceiling	11	---	-3 to 58	-590 to 490	---	---	-1 to 4	-3 to 4
Room 2								
Floor	12	---	9 to 52	810 to 1,200	---	---	-1 to 4	-3 to 2
Lower Walls	9	1	7 to 200	-520 to 500	72	26	-1 to 1	-4 to 1
U. Walls and Ceiling	17	1	0 to 110	-850 to 380	73	---	-1 to 6	-3 to 8
Room 3								
Floor	9	3	0 to 70	560 to 1,000	16 to 23	650 to 680	-1 to 4	-4 to 8
Lower Walls	6	1	-5 to 25	190 to 350	20	84	-1 to 4	-1 to 1
U. Walls and Ceiling	13	3	-2 to 200	-640 to 730	0 to 80	-100 to 310	-4 to 12	-5 to 8
Room 4								
Floor	9	4	0 to 140	-140 to 400	9 to 41	5 to 400	1 to 6	-1 to 7
Lower Walls	8	---	-2 to 20	-560 to -110	---	---	-1 to 4	-5 to 6
U. Wall and Ceiling	15	---	8 to 60	-1,800 to 6	---	---	-1 to 4	-4 to 8

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
NUCLEAR LAKE SITE--AFFECTED BUILDING
PAWLING, NEW YORK

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm²)				Removable Activity Range (dpm/100 cm²)	
			Single Measurements		Grid Block Average			
	Single-pt.	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Room 5								
Floor	5	1	7 to 70	850 to 1,200	23	480	-1 to 4	-5 to 4
Lower Walls	4	---	5 to 80	120 to 550	---	---	-1 to 4	-4 to 1
U. Walls and Ceiling	3	---	8 to 93	-20 to 260	---	---	-1 to 4	-4 to 1
Room 6								
Floor	1	1	5 to 180	210 to 1,500	14	370	-1 to 4	-3 to 0
Lower Walls	3	---	9 to 36	250 to 410	---	---	-4 to 4	-3 to 5
U. Walls and Ceiling	3	---	-2 to 32	19 to 230	---	---	-1 to 4	-4 to 3
Room 7								
Floor	2	---	16 to 34	880 to 960	---	---	-1 to 1	-1 to 3
Lower Walls	4	---	5 to 36	250 to 570	---	---	-1 to 1	-5 to 1
U. Walls and Ceiling	3	---	2 to 11	24 to 240	---	---	-1 to 1	-1 to 3
Room 8								
Floor	3	---	14 to 27	960 to 1,100	---	---	1 to 4	-1 to 8
Lower walls	4	---	-2 to 16	-240 to 410	---	---	-1 to 1	-3 to 0
U. Walls and Ceiling	3	---	2 to 20	38 to 330	---	---	-1 to 1	-3 to 9

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
NUCLEAR LAKE SITE—AFFECTED BUILDING
PAWLING, NEW YORK

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm²)				Removable Activity Range (dpm/100 cm²)	
			Single Measurements		Grid Block Average			
	Single-pt.	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Room 9								
Floor	2	---	0 to 7	790 to 880	---	---	-1 to 4	-3 to -1
Lower Walls	3	---	-7 to 14	-340 to 230	---	---	-1 to 1	-4 to 0
U. Walls and Ceiling	3	---	-2 to 27	-80 to 130	---	---	-1 to 1	-5 to 1
Room 10								
Floor	8	---	23 to 82	890 to 1,200	---	---	-1 to 6	-5 to 0
Lower Walls	9	---	-2 to 55	-480 to 360	---	---	-1 to 4	-4 to 21
U. Walls and Ceiling	8	---	-2 to 16	-120 to 450	---	---	-1 to 4	-3 to 17
Room 11								
Floor	1	---	14	630	---	---	6	-4
Lower Walls	3	---	0 to 18	-26 to 210	---	---	-1 to 1	-1 to 3
U. Walls and Ceiling	1	---	18	290	---	---	-1	0
Room 12								
Lower Walls	4	---	2 to 18	-210 to 360	---	---	-1	-3 to 3
U. Walls and Ceiling	3	---	5 to 11	340 to 2,300	---	---	-1 to 4	0 to -4

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
NUCLEAR LAKE SITE—AFFECTED BUILDING
PAWLING, NEW YORK

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm²)				Removable Activity Range (dpm/100 cm²)	
			Single Measurements		Grid Block Average			
	Single-pt.	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Room 13								
Floors	4	---	18 to 25	-430 to 2,100	---	---	1	-4 to 3
Lower Walls	3	---	9 to 16	200 to 280	---	---	-1 to 4	-3 to 9
Room 14								
Floor	3	2	0 to 150	450 to 510	50 to 93	-110 to 1,100	-1 to 6	-4 to 1
Lower Walls	8	---	2 to 48	-260 to 570	---	---	-1 to 1	-4 to 1
U. Walls and Ceiling	5	---	0 to 66	-76 to 320	---	---	-1 to 4	-4 to 1
Room 15								
Floor	7	2	-5 to 43	560 to 2,500	9 to 18	780 to 1,300	-1 to 4	-4 to 1
Lower Walls	6	---	5 to 64	18 to 730	---	---	-1 to 1	-3 to 3
U. Walls and Ceiling	8	---	11 to 89	58 to 610	---	---	-1 to 4	-5 to 4
Room 16								
Floor	15	---	18 to 68	640 to 1,200	---	---	-1 to 8	-5 to 7
Lower Walls	13	---	-5 to 50	-230 to 1,000	---	---	-1 to 4	-5 to 6
U. Walls and Ceiling	12	---	-5 to 43	-76 to 310	---	---	-4 to 6	-3 to 6

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
NUCLEAR LAKE SITE—AFFECTED BUILDING
PAWLING, NEW YORK

Location[a]	Number of Measurement Locations		Total Activity Range (dpm/100 cm²)				Removable Activity Range (dpm/100 cm²)	
			Single Measurements		Grid Block Average			
	Single-pt.	Grid Blocks	Alpha	Beta	Alpha	Beta	Alpha	Beta
Room 17								
Floor	2	---	34 to 86	310 to 500	---	---	1	-4 to 1
Lower Walls	6	---	30 to 73	240 to 870	---	---	1 to 1	-5 to 6
U. Walls and Ceiling	5	---	16 to 55	250 to 940	---	---	-1 to 8	-3 to 3
Room 18								
Floor	2	---	41 to 89	-11 to 860	---	---	1	-3 to 1
Lower Walls	5	---	-7 to 20	5 to 2,600	---	---	-1 to 1	-5 to -3
U. Walls and Ceiling	3	---	11 to 64	-10 to 490	---	---	-1 to 1	-5 to 0
Waste Disposal Building								
Floor	4	3	2 to 27	400 to 950	9	1,400 to 1,700	-1 to 1	-3 to -1
Lower Walls	9	---	-2 to 25	-660 to 390	---	---	-1 to 4	-4 to 3
U. Walls and Ceiling	7	---	0 to 9	180 to 350	---	---	-1 to 4	-1 to 8
Multiple Failure Buildings								
Floor	8	1	5 to 27	500 to 1,300	14	770	-1 to 4	-3 to 4
Lower Walls	3	---	-2 to 7	-500 to -460	---	---	-1 to 4	-3 to 0
U. Walls and Ceiling	6	---	-7 to 5	-460 to 120	---	---	-1 to 1	-5 to 5

[a]Refer to Figures 11 through 21.

TABLE 3

EXPOSURE RATES
AFFECTED BUILDINGS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Exposure Rate Range at 1 m (μR/h)[b]	Average
Plutonium Facility	9 to 12	10
Waste Disposal Building	10	10
Multiple Failure Building	8	8

[a]Refer to Figures 19 through 22.
[b]Includes background.

TABLE 4

RADIONUCLIDE CONCENTRATIONS IN SUBFLOOR SOIL
AFFECTED BUILDINGS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Radionuclide Concentration (pCi/g)				
	Cs-137	Am-241	Th-232	U-235	U-238
Plutonium Facility					
Room 1					
B,3	0.2 ± 0.1[b]	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.3 ± 0.4
B,8	0.1 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	1.0 ± 0.9
G,6	0.7 ± 0.1	<0.1	1.0 ± 0.2	0.1 ± 0.1	0.9 ± 0.8
H,1	0.1 ± 0.1	<0.1	0.9 ± 0.3	0.1 ± 0.1	0.9 ± 1.2
Room 2					
C,3[c]	<0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.8 ± 1.0
D,7[c]	<0.1	<0.1	0.8 ± 0.4	0.1 ± 0.1	1.1 ± 1.0
H,4[c]	<0.1	<0.1	1.0 ± 0.3	0.1 ± 0.1	1.0 ± 1.0
H,7[c]	<0.1	<0.1	0.9 ± 0.3	0.1 ± 0.1	0.6 ± 0.7
K,8[c]	<0.1	<0.1	0.9 ± 0.4	0.1 ± 0.1	0.3 ± 0.8
Room 3					
B,3[d]	<0.1	<0.1	0.9 ± 0.2	0.1 ± 0.1	0.8 ± 1.1
B,8[d]	<0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	1.2 ± 0.7
J,4[d]	<0.1	<0.1	<0.4	0.1 ± 0.1	<1.1
J,8[d]	<0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	0.1 ± 0.1
Room 4					
B,4[e]	0.1 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.6 ± 0.7
G,3[e]	0.2 ± 0.1	<0.1	0.5 ± 0.2	0.1 ± 0.1	<1.1
Room 5					
C,5	<0.1	<0.1	0.3 ± 0.2	0.1 ± 0.1	0.3 ± 0.6
Room 6					
C,3	<0.1	<0.1	0.5 ± 0.2	0.1 ± 0.1	0.5 ± 0.8

TABLE 4 (Continued)

RADIONUCLIDE CONCENTRATIONS IN SUBFLOOR SOIL
AFFECTED BUILDINGS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Radionuclide Concentration (pCi/g)				
	Cs-137	Am-241	Th-232	U-235	U-238
Plutonium Facility (Continued)					
Room 10					
D,5	0.1 ± 0.1	<0.1	0.4 ± 0.2	0.1 ± 0.1	0.7 ± 0.9
Room 14					
B,5	<0.1	<0.1	0.5 ± 0.2	0.1 ± 0.1	0.8 ± 0.9
D,5	<0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	0.6 ± 0.8
Room 15					
A,1	0.1 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	0.9 ± 0.6
G,3	<0.1	<0.1	0.5 ± 0.3	0.1 ± 0.1	0.9 ± 0.8
K,3	<0.1	<0.1	0.4 ± 0.2	0.1 ± 0.1	0.5 ± 0.9
Room 16					
G,10	<0.1	<0.1	0.6 ± 0.4	<0.1	0.6 ± 0.9
Room 18					
B,4	<0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.2 ± 1.0
Waste Disposal Building					
D,4	0.1 ± 0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.9 ± 0.6
F,5	0.4 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	1.1 ± 0.9
Multiple Failure Building					
C,3	<0.1	<0.1	0.5 ± 0.2	0.1 ± 0.1	0.8 ± 0.9

[a]Refer to Figures 19 through 22.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c-e]Sample composite groups analyzed by alpha spectrometry for plutonium.

TABLE 5

PLUTONIUM CONCENTRATIONS IN COMPOSITE SOILS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Plutonium Concentration (pCi/g)	
	Pu-239/240	Pu-238
Plutonium Facility Subfloor Room 2	<0.03	<0.12
Plutonium Facility Subfloor Room 3	<0.03	0.12 ± 0.08[b]
Plutonium Facility Subfloor Room 4	<0.07	<0.09
Plutonium Facility Exterior Sample Locations 1-4	<0.03	<0.8
Plutonium Facility Exterior Sample Locations 5-8	<0.07	0.04 ± 0.04
Plutonium Facility Exterior Sample Locations 9-12	<0.24	<0.24
Survey Unit 3 270N,20W; 270N,0	0.38 ± 0.12	<0.02
Survey Unit 3 286N,9W; 283N,46W	1.20 ± 0.21	<0.07
Survey Unit 4 400N,60W; 425N,30W; 465N, 40W	0.05 ± 0.05	0.05 ± 0.04

[a]Refer to Figures 22, 23, and 34.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

TABLE 6

EXPOSURE RATES AND
RADIONUCLIDE CONCENTRATIONS IN SOIL
AFFECTED OUTDOOR SOIL AREAS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Exposure Rate at 1 m (μR/h)	Radionuclide Concentration (pCi/g)				
		Cs-137	Am-241	Th-232	U-235	U-238
Plutonium Facility						
1[c]	12	0.1 ± 0.1[b]	<0.1	0.8 ± 0.6	0.1 ± 0.1	0.8 ± 0.8
2[c]	11	0.4 ± 0.1	<0.1	0.8 ± 0.3	<0.1	0.7 ± 1.0
3[c]	10	<0.1	<0.1	1.0 ± 0.2	0.1 ± 0.1	0.8 ± 1.1
4[c]	10	0.1 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	0.8 ± 0.3
5[d]	10	0.1 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.8 ± 1.0
6[d]	11	0.1 ± 0.1	<0.1	1.1 ± 0.3	0.1 ± 0.1	1.6 ± 1.5
7[d]	9	0.6 ± 0.1	<0.1	1.0 ± 0.3	0.1 ± 0.1	1.3 ± 1.0
8[d]	10	0.2 ± 0.1	0.1 ± 0.1	0.9 ± 0.4	<0.1	1.2 ± 1.1
9[e]	10	0.1 ± 0.1	0.1 ± 0.1	0.6 ± 0.3	0.1 ± 0.1	1.6 ± 1.1
10[e]	11	0.6 ± 0.1	<0.2	1.1 ± 0.5	0.1 ± 0.1	1.0 ± 1.0
11[e]	10	0.2 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	0.5 ± 0.6
12[e]	12	1.1 ± 0.2	<0.2	0.4 ± 0.3	0.1 ± 0.1	0.4 ± 0.9
Waste Disposal Building						
13	10	0.6 ± 0.1	0.1 ± 0.1	0.5 ± 0.2	0.1 ± 0.1	0.9 ± 0.6
14	10	0.3 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.8 ± 0.8
15	11	0.1 ± 0.1	<0.1	0.5 ± 0.3	0.1 ± 0.1	0.5 ± 0.7
16	11	0.1 ± 0.1	<0.1	0.6 ± 0.3	0.1 ± 0.1	1.2 ± 1.2
17	--	0.5 ± 0.1	<0.2	0.9 ± 0.4	0.1 ± 0.1	1.5 ± 1.2
18	--	0.5 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	0.7 ± 0.6
19	--	5.5 ± 0.3	<0.1	0.7 ± 0.3	0.1 ± 0.1	1.6 ± 1.5
20	--	0.4 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	1.0 ± 1.0
Shield Mock-Up Building						
21	8	0.1 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.2 ± 0.6

[a]Refer to Figures 23 and 30.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c-e]Sample composite groups analyzed by alpha spectrometry for plutonium.

TABLE 7

SUMMARY OF SURFACE ACTIVITY LEVELS
UNAFFECTED BUILDINGS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Number of Measurement Locations	Total Activity Range (dpm/100 cm²) Single Measurements		Removable Activity Range (dpm/100 cm²)	
		Alpha	Beta	Alpha[e]	Beta[f]
Critical Facility					
Floor	26	0 to 37[b]	660 to 1,100[c]	-1 to 4	-7 to 8
Lower Walls	8	-7 to 18[b]	-290 to 510[c]	-1 to 4	-3 to 8
Engineering Building					
Floor	23	-2 to 16[b]	420 to 850[c]	-1 to 4	-5 to 3
Lower Walls	7	0 to 23[b]	-320 to 230[c]	-1 to 6	-1 to 16
Remote Assembly Building					
Floor	21	-270 to 54[b]	-270 to 610[c]	-1 to 1	-7 to 6
Lower Walls	9	-620 to 32[b]	-620 to 730[c]	-1 to 4	-4 to 1
Shield Mock-up Building					
Floor	27	0 to 39[b]	420 to 820[c]	-1 to 6	-7 to 14
Lower Walls	3	-2 to 2[b]	-580 to -400[c]	-1 to 10	-4 to 3
Lodge					
Floor	22	NA	-580 to 1,200[d]	-1 to 6	-7 to 8
Lower Walls	8	NA	-650 to -240[d]	-1 to 1	-7 to 6

[a]Refer to Figures 24 through 28.
[b]Minimum detectable activity is 25 dpm/100 cm² for alpha instrumentation.
[c]Minimum detectable activity is 390 dpm/100 cm² for beta instrumentation.
[d]Minimum detectable activity is 990 dpm/100 cm² for beta instrumentation.
[e]Minimum detectable activity is 12 dpm/100 cm².
[f]Minimum detectable activity is 16 dpm/100 cm².

TABLE 8

EXPOSURE RATES
UNAFFECTED BUILDINGS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Exposure Rate Range at 1 m (μR/h)[b]	Average
Critical Facility	11 - 12	12
Engineering Building	9 - 10	9
Remote Assembly Building	7 - 11	9
Shield Mock-Up Building	10	10
Lodge	9 - 10	10

[a]Refer to Figures 24 through 28.
[b]Includes background.

TABLE 9

RADIONUCLIDE CONCENTRATIONS IN SUBFLOOR SOIL
UNAFFECTED BUILDINGS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Radionuclide Concentration (pCi/g)				
	Cs-137	Am-241	Th-232	U-235	U-238
Critical Facility					
#1	<0.1	<0.1	0.7 ± 0.2[b]	0.1 ± 0.1	0.8 ± 0.5
#2	<0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	0.3 ± 0.7
Engineering Building					
#1	<0.1	0.1 ± 0.1	0.5 ± 0.3	0.1 ± 0.1	0.6 ± 0.4
#2	<0.1	<0.1	0.6 ± 0.3	0.1 ± 0.1	0.2 ± 0.5
Shield Mock-Up Building					
#1	<0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	0.7 ± 0.8
Lodge					
#1	<0.1	<0.1	0.1 ± 0.1	0.2 ± 0.1	0.6 ± 1.3
#2	0.2 ± 0.1	<0.1	0.4 ± 0.3	0.1 ± 0.1	0.6 ± 1.1

[a]Refer to Figures 24 through 28.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.

TABLE 10

EXPOSURE RATES AND
RADIONUCLIDE CONCENTRATIONS IN SOIL
UNAFFECTED OUTDOOR AREAS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Exposure Rate at 1 m (μR/h)[b]	Radionuclide Concentration (pCi/g)				
		Cs-137	Am-241	Th-232	U-235	U-238
Survey Unit 1						
260N, 60E	--[c]	1.5 ± 0.2[d]	<0.2	0.6 ± 0.3	0.2 ± 0.1	0.7 ± 0.8
280N, 70E	--	0.5 ± 0.1	<0.2	1.0 ± 0.4	0.1 ± 0.1	2.0 ± 1.8
300N, 20E	--	0.2 ± 0.1	<0.1	0.9 ± 0.2	0.1 ± 0.1	0.1 ± 0.8
300N, 80E	--	0.9 ± 0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	1.1 ± 0.7
310N, 50E	--	2.4 ± 0.3	<0.3	0.2 ± 0.4	0.2 ± 0.1	2.5 ± 1.9
314N, 0	10	<0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	1.2 ± 0.9
332N, 18E	9	0.4 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	1.0 ± 0.8
342N, 0	--	0.4 ± 0.1	<0.1	0.8 ± 0.2	0.1 ± 0.1	0.4 ± 0.9
350N, 0	9	0.3 ± 0.1	<0.1	1.0 ± 0.3	0.1 ± 0.1	0.6 ± 1.2
350N, 50E	--	1.4 ± 0.2	<0.2	0.5 ± 0.4	0.1 ± 0.1	1.4 ± 2.5
375N, 25E	--	1.0 ± 0.2	<0.2	1.2 ± 0.5	0.1 ± 0.1	1.5 ± 0.8
400N, 0	10	0.9 ± 0.2	<0.2	1.0 ± 0.4	0.1 ± 0.1	1.5 ± 1.0
400N, 25E	--	0.5 ± 0.1	<0.2	0.8 ± 0.4	<0.1	1.1 ± 0.7
400N, 50E	--	0.8 ± 0.1	<0.1	1.4 ± 0.4	0.1 ± 0.1	1.9 ± 1.5
425N, 25E	--	0.9 ± 0.2	0.1 ± 0.1	0.9 ± 0.3	0.1 ± 0.1	0.5 ± 0.9
425N, 70E	--	1.5 ± 0.2	<0.3	0.5 ± 0.6	0.2 ± 0.1	1.8 ± 1.6
450N, 0	9	1.3 ± 0.2	<0.2	1.3 ± 0.5	0.2 ± 0.1	0.8 ± 1.9
450N, 25E	8	0.1 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	0.2 ± 0.6
450N, 50E	8	0.4 ± 0.1	<0.2	0.8 ± 0.4	0.1 ± 0.1	0.9 ± 0.7
450N, 65E	--	1.1 ± 0.2	<0.2	0.7 ± 0.6	0.1 ± 0.1	0.5 ± 1.5
480N, 40E	8	1.1 ± 0.2	<0.1	0.6 ± 0.3	0.1 ± 0.1	0.7 ± 1.2
500N, 0	8	5.9 ± 0.8	0.2 ± 0.2	0.9 ± 0.6	0.1 ± 0.2	1.1 ± 2.0
500N, 25E	9	0.7 ± 0.2	<0.2	0.9 ± 0.3	0.1 ± 0.1	1.4 ± 1.7
500N, 50E	--	2.0 ± 0.2	<0.2	0.9 ± 0.3	0.1 ± 0.1	2.3 ± 1.8
500N, 65E	--	3.3 ± 0.5	<0.3	0.9 ± 0.5	0.3 ± 0.1	1.4 ± 2.5

TABLE 10 (Continued)

EXPOSURE RATES AND
RADIONUCLIDE CONCENTRATIONS IN SOIL
UNAFFECTED OUTDOOR AREAS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Exposure Rate at 1 m (μR/h)[b]	Radionuclide Concentration (pCi/g)				
		Cs-137	Am-241	Th-232	U-235	U-238
Survey Unit 2						
0, 0	12	0.1 ± 0.1	<0.2	0.8 ± 0.3	0.1 ± 0.1	0.4 ± 0.9
50N, 0	10	0.2 ± 0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.6 ± 0.4
50N, 20E	--	0.4 ± 0.1	<0.1	0.9 ± 0.3	0.2 ± 0.1	1.4 ± 1.1
80N, 20E	--	1.0 ± 0.2	<0.3	0.5 ± 0.3	0.1 ± 0.1	1.1 ± 1.7
100N, 0	11	0.2 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	0.7 ± 0.8
100N, 25E	--	1.7 ± 0.2	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.9 ± 1.1
100N, 45E	--	0.4 ± 0.1	<0.2	1.0 ± 0.3	0.2 ± 0.1	0.9 ± 1.0
140N, 50E	--	2.0 ± 0.3	<0.4	0.6 ± 0.4	0.2 ± 0.1	3.7 ± 2.6
150N, 0	11	0.9 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	1.0 ± 0.6
150N, 50E	--	1.1 ± 0.2	<0.2	1.0 ± 0.4	0.2 ± 0.1	1.2 ± 1.4
155N, 50E	--	1.0 ± 0.1	<0.1	0.9 ± 0.3	0.1 ± 0.1	0.6 ± 1.6
163N, 24E	--	0.7 ± 0.1	<0.1	0.5 ± 0.4	0.1 ± 0.1	0.8 ± 1.0
163N, 34E	--	3.6 ± 0.4	<0.2	0.6 ± 0.5	<0.2	0.6 ± 2.1
168N, 29E	12	3.4 ± 0.7	<0.3	<0.5	<0.3	1.1 ± 1.1
168N, 29E (15-30 cm)	--	6.1 ± 0.3	<0.1	0.8 ± 0.2	0.1 ± 0.1	0.8 ± 0.2
173N, 24E	12	0.3 ± 0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.6 ± 0.7
173N, 34E	9	0.5 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.6 ± 1.3
188N, 50E	9	0.1 ± 0.1	<0.2	1.3 ± 0.4	0.1 ± 0.4	0.6 ± 1.1
194N, 0	--	0.3 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.5 ± 0.8
195N, 30E	--	0.1 ± 0.1	<0.1	0.6 ± 0.3	0.1 ± 0.1	0.8 ± 0.6
195N, 45E	9	0.4 ± 0.1	<0.1	0.8 ± 0.2	0.1 ± 0.1	1.0 ± 0.8
200N, 0	10	<0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.4 ± 0.6
200N, 30E	--	0.1 ± 0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.6 ± 0.8
200N, 50E	9	1.1 ± 0.1	<0.2	0.7 ± 0.3	<0.1	0.9 ± 1.1

TABLE 10 (Continued)

EXPOSURE RATES AND
RADIONUCLIDE CONCENTRATIONS IN SOIL
UNAFFECTED OUTDOOR AREAS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Exposure Rate at 1 m (μR/h)[b]	Radionuclide Concentration (pCi/g)				
		Cs-137	Am-241	Th-232	U-235	U-238
Survey Unit 2 (Continued)						
210N, 35E	--	1.2 ± 0.1	<0.1	0.6 ± 0.4	0.1 ± 0.2	1.5 ± 0.8
240N, 20E	--	0.2 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	0.2 ± 0.7
240N, 40E	--	2.4 ± 0.3	<0.2	0.3 ± 0.4	0.1 ± 0.1	2.1 ± 1.8
240N, 50E	--	5.7 ± 0.5	<0.3	1.1 ± 0.6	0.3 ± 0.1	1.8 ± 1.2
240N, 0	11	0.8 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	0.5 ± 0.6
250N, 5E	--	0.2 ± 0.1	<0.1	0.8 ± 0.2	0.1 ± 0.1	0.7 ± 0.6
250N, 50E	--	2.2 ± 0.5	<0.4	1.0 ± 1.2	0.4 ± 0.3	1.9 ± 5.7
Access Rd. Pole #18	12	0.3 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.6 ± 0.7
Access Rd. Stream Culvert	--	0.5 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	0.8 ± 0.8
Access Rd. Pole #16	--	1.6 ± 0.3	<0.2	0.8 ± 0.5	0.2 ± 0.1	2.7 ± 1.5
Access Rd. Pole #14	--	0.3 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.6 ± 0.7
Access Rd. Pole #11	--	1.2 ± 0.2	<0.2	1.4 ± 0.6	0.1 ± 0.1	1.0 ± 1.6
Access Rd. Pole #9	--	0.2 ± 0.1	<0.1	0.5 ± 0.2	0.1 ± 0.1	0.4 ± 0.7
0,5W[c]	--	0.4 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.6 ± 0.8
14N, 34W[c]	--	0.3 ± 0.1	<0.1	1.0 ± 0.4	0.1 ± 0.1	1.1 ± 1.5
23N, 7W[c]	--	0.6 ± 0.1	<0.1	0.9 ± 0.3	0.1 ± 0.1	1.1 ± 1.0
50N, 10W[c]	--	0.9 ± 0.1	<0.2	0.7 ± 0.3	0.1 ± 0.1	0.3 ± 0.9
50N, 31W[c]	--	0.2 ± 0.1	<0.1	0.8 ± 0.2	0.1 ± 0.1	0.8 ± 1.1
100N, 9W[c]	--	0.4 ± 0.1	<0.2	0.9 ± 0.5	0.2 ± 0.1	1.9 ± 1.1
100N, 24W[c]	--	0.4 ± 0.1	<0.1	1.3 ± 0.4	0.2 ± 0.1	1.6 ± 1.2

TABLE 10 (Continued)

EXPOSURE RATES AND
RADIONUCLIDE CONCENTRATIONS IN SOIL
UNAFFECTED OUTDOOR AREAS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Exposure Rate at 1 m (μR/h)[b]	Radionuclide Concentration (pCi/g)				
		Cs-137	Am-241	Th-232	U-235	U-238
Survey Unit 3						
173N, 0	--	0.2 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	0.2 ± 0.7
173N, 40W	--	1.2 ± 0.2	<0.2	0.7 ± 0.4	0.2 ± 0.1	0.1 ± 1.3
193N, 82W	--	2.5 ± 0.3	<0.1	0.3 ± 0.3	0.1 ± 0.1	1.4 ± 1.2
205N, 6W	--	0.4 ± 0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.2 ± 0.7
210N, 50W	--	3.0 ± 0.2	<0.2	1.0 ± 0.4	0.1 ± 0.1	0.1 ± 1.2
220N, 82W	--	1.4 ± 0.2	<0.2	0.4 ± 0.3	0.1 ± 0.1	1.3 ± 0.8
220N, 120W	--	2.5 ± 0.4	<0.4	0.5 ± 0.6	0.1 ± 0.2	1.8 ± 4.2
230N, 0	--	0.1 ± 0.1	<0.1	0.6 ± 0.3	0.1 ± 0.1	0.9 ± 0.6
230, 50W	--	1.7 ± 0.2	<0.3	0.8 ± 0.4	0.1 ± 0.1	2.8 ± 1.8
233N, 7W	--	1.7 ± 0.2	<0.3	1.1 ± 0.5	0.3 ± 0.1	4.3 ± 3.3
240N, 94W	--	0.8 ± 0.2	0.1 ± 0.1	<0.4	<0.2	<1.7
249N, 58W	--	2.6 ± 0.3	0.1 ± 0.1	0.5 ± 0.3	0.1 ± 0.1	0.6 ± 1.1
250N, 50W	--	0.5 ± 0.1	<0.1	0.2 ± 0.3	0.1 ± 0.1	0.7 ± 0.8
250N, 120W	--	1.4 ± 0.2	<0.1	0.7 ± 0.4	0.1 ± 0.9	1.2 ± 1.1
256N, 83W	--	0.4 ± 0.1	<0.1	0.6 ± 0.3	0.1 ± 0.1	1.1 ± 1.2
268N, 98W	--	0.7 ± 0.1	<0.1	0.8 ± 0.3	<0.1	0.2 ± 0.9
269N, 77W	--	0.2 ± 0.1	<0.1	0.9 ± 0.3	0.1 ± 0.1	0.5 ± 0.9
270N, 0[f]	--	2.5 ± 0.2	0.5 ± 0.1	0.2 ± 0.3	0.1 ± 0.1	0.7 ± 1.0
270N, 20W[f]	--	0.9 ± 0.2	0.1 ± 0.1	0.8 ± 0.4	0.1 ± 0.1	1.3 ± 0.8
270N, 43W	--	0.5 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	2.0 ± 1.0
282N, 110W	--	1.0 ± 0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	1.5 ± 1.2
283N, 46W[g]	--	1.8 ± 0.2	0.3 ± 0.2	1.0 ± 0.4	0.3 ± 0.1	1.0 ± 1.1
286N, 9W[g]	--	1.6 ± 0.2	0.4 ± 0.2	0.7 ± 0.3	0.1 ± 0.1	0.5 ± 1.1
286N, 68W	--	0.2 ± 0.1	<0.1	1.1 ± 0.3	0.1 ± 0.1	1.1 ± 1.1

TABLE 10 (Continued)

EXPOSURE RATES AND
RADIONUCLIDE CONCENTRATIONS IN SOIL
UNAFFECTED OUTDOOR AREAS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Exposure Rate at 1 m (μR/h)[b]	Radionuclide Concentration (pCi/g)				
		Cs-137	Am-241	Th-232	U-235	U-238
Survey Unit 3 (Continued)						
290N, 10W	--	<0.1	0.1 ± 0.1	0.6 ± 0.3	0.1 ± 0.1	1.3 ± 0.6
292N, 88W	--	0.1 ± 0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.7 ± 0.6
295N, 101W	--	1.0 ± 0.2	<0.3	0.9 ± 0.3	0.1 ± 0.1	1.4 ± 1.3
300N, 25W	--	0.1 ± 0.1	<0.1	0.6 ± 0.3	0.1 ± 0.1	0.3 ± 0.5
300N, 50W	--	2.1 ± 0.2	<0.2	0.9 ± 0.5	0.1 ± 0.1	1.8 ± 1.9
310N, 120W	--	0.5 ± 0.1	<0.2	0.5 ± 0.3	0.1 ± 0.1	0.7 ± 0.7
Survey Unit 4						
300N, 10W	10	0.1 ± 0.1	<0.1	0.7 ± 0.2	0.1 ± 0.1	0.4 ± 0.8
325N, 10W	--	0.2 ± 0.1	<0.2	0.9 ± 0.3	0.1 ± 0.1	0.9 ± 0.8
325N, 25W	--	1.1 ± 0.2	<0.1	1.0 ± 0.3	0.1 ± 0.1	0.6 ± 1.1
325N, 40W	--	2.4 ± 0.3	<0.2	0.8 ± 0.5	0.2 ± 0.1	2.3 ± 2.2
325N, 50W	9	3.6 ± 0.4	<0.2	0.3 ± 0.3	0.2 ± 0.1	0.4 ± 1.3
340N, 5W	--	0.1 ± 0.1	<0.1	0.5 ± 0.2	0.1 ± 0.1	0.6 ± 0.9
350N, 10W	--	0.3 ± 0.1	<0.1	0.6 ± 0.3	0.1 ± 0.1	0.9 ± 0.9
350N, 25W	9	1.8 ± 0.3	<0.2	1.1 ± 0.6	0.2 ± 0.1	<2.7
350N, 50W	9	1.3 ± 0.2	<0.2	0.9 ± 0.3	0.1 ± 0.8	1.1 ± 0.7
350N, 100W	--	1.7 ± 0.3	<0.2	1.1 ± 0.5	0.1 ± 0.1	1.5 ± 1.6
350N, 125W	--	1.0 ± 0.2	<0.2	1.3 ± 0.5	0.1 ± 0.1	2.3 ± 1.8
390N, 50W	--	0.8 ± 0.1	<0.1	0.8 ± 0.3	0.2 ± 0.1	2.1 ± 1.5
400N, 10W	--	0.5 ± 0.2	<0.2	0.3 ± 0.3	0.1 ± 0.1	0.9 ± 0.8
400N, 30W	--	0.3 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	0.2 ± 0.7
400N, 50W	9	0.5 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	1.5 ± 1.1
400N, 60W[h]	--	1.0 ± 0.2	0.1 ± 0.1	1.0 ± 0.4	0.2 ± 0.1	..0 ± 1.2
406N, 35W	9	0.1 ± 0.1	<0.1	0.7 ± 0.3	0.1 ± 0.1	0.8 ± 0.6

TABLE 10 (Continued)

EXPOSURE RATES AND
RADIONUCLIDE CONCENTRATIONS IN SOIL
UNAFFECTED OUTDOOR AREAS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Location[a]	Exposure Rate at 1 m (μR/h)[b]	Radionuclide Concentration (pCi/g)				
		Cs-137	Am-241	Th-232	U-235	U-238
Survey Unit 4 (Continued)						
410N, 25W	9	0.1 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	0.7 ± 0.7
420N, 35W	9	0.2 ± 0.1	<0.1	0.8 ± 0.3	0.1 ± 0.1	0.9 ± 0.9
425N, 30W[h]	9	0.2 ± 0.1	0.1 ± 0.1	0.6 ± 0.3	0.1 ± 0.1	0.9 ± 0.7
450N, 25W	9	0.6 ± 0.1	<0.1	0.6 ± 0.2	0.1 ± 0.1	1.2 ± 0.8
450N, 35W	9	0.6 ± 0.1	<0.2	0.7 ± 0.5	0.1 ± 0.1	1.2 ± 1.1
465N, 40W[h]	--	1.4 ± 0.2	0.1 ± 0.1	0.8 ± 0.5	<0.1	2.3 ± 1.3
475N, 10W	--	0.8 ± 0.1	<0.1	0.4 ± 0.3	0.1 ± 0.1	0.8 ± 0.5
475N, 50W	--	0.8 ± 0.1	<0.2	1.0 ± 0.4	0.1 ± 0.1	1.4 ± 1.4
500N, 10W	--	0.3 ± 0.1	<0.1	1.3 ± 0.4	0.1 ± 0.1	1.2 ± 1.2
500N, 20W	--	1.0 ± 0.2	0.1 ± 0.1	0.6 ± 0.4	0.1 ± 0.1	2.9 ± 1.9
510N, 10W	--	1.5 ± 0.2	<0.2	0.5 ± 0.5	0.1 ± 0.1	1.1 ± 1.0
510N, 20W	--	0.3 ± 0.1	<0.1	1.0 ± 0.2	0.1 ± 0.1	0.4 ± 0.6

[a]Refer to Figures 30 through 35.
[b]Includes background.
[c]--No measurement made.
[d]Uncertainties represent the 95% confidence level, based only on counting statistics.
[e]Remote Assembly Building grid coordinates.
[f-h]Sample composite groups analyzed by alpha spectrometry for plutonium.

TABLE 11

GUIDELINE COMPARISON OF SURFACE ACTIVITY LEVELS
AFFECTED BUILDINGS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Building	Survey Unit Area (m^2)	Averaged Total Activity (dpm/100 cm^2)								Guidelines/ Conditions Satisfied
		Alpha[a]				Beta[b]				
		Number of Meas.	Mean	Std. Deviation	μ_m	Number of Meas.	Mean	Std. Deviation	μ_m	
Plutonium Building										
Affected Area										
Room 1	90	28	25	24	33	28	120	540	290	Yes/Yes
Room 2	114	48	41	42	51	43	290	530	420	Yes/Yes
Room 3	90	71	46	74	56	71	200	490	290	Yes/Yes
Room 4	96	52	36	49	47	52	43	420	140	Yes/Yes
Room 5	32	24	77	100	110	24	760	400	900	Yes/No
Room 14	40	22	29	36	42	22	430	390	570	Yes/Yes
Room 15	65	32	21	19	27	32	790	550	960	Yes/Yes
Unaffected Area										
Rooms 6-13, 16-18	360	146	24	25	27	146	440	490	510	Yes/Yes
Waste Disposal Bldg.	54	41	20	52	33	41	650	1000	910	Yes/Yes
Multiple Failure Bldg.	45	21	8	9	12	21	250	590	470	Yes/Yes

[a]Alpha surface contamination guidelines:
100 dpm/100 cm^2, average in a 1 m^2 area
300 dpm/100 cm^2, maximum in a 100 cm^2

[b]Beta-gamma surface contamination guidelines:
5,000 dpm/100 cm^2, average in a 1 m^2 area
15,000 dpm/100 cm^2, maximum in a 100 cm^2 area

[c]Calculated value for statistically testing site data in accordance with Draft NUREG/CR-5849.

TABLE 12

GUIDELINE COMPARISON OF SURFACE ACTIVITY LEVELS
UNAFFECTED BUILDINGS
NUCLEAR LAKE SITE
PAWLING, NEW YORK

Building	Survey Unit Area (m^2)	Averaged Total Activity (dpm/100 cm^2)								Guidelines/ Conditions Satisfied
		Alpha[a]				Beta[b]				
		Number of Meas.	Mean	Std. Deviation	μ_α	Number of Meas.	Mean	Std. Deviation	μ_α	
Critical Facility	510 m^2	34	14	8	16	34	660	290	750	Yes/Yes
Engineering Bldg.	410 m^2	30	6	6	8	30	500	280	590	Yes/Yes
Remote Assembly Bldg.	106 m^2	30	5	12	9	30	-26	300	67	Yes/Yes
Shield Mock-Up Bldg.	60 m^2	30	11	9	14	30	490	350	600	Yes/Yes
Lodge	66 m^2	0	NA	NA	NA	30	-160	340	-61	Yes/Yes

[a]Alpha surface contamination guidelines:
100 dpm/100 cm^2, average in a 1 m^2 area
300 dpm/100 cm^2, maximum in a 100 cm^2

[b]Beta-gamma surface contamination guidelines:
5,000 dpm/100 cm^2, average in a 1 m^2 area
15,000 dpm/100 cm^2, maximum in a 100 cm^2 area

[c]Calculated value for statistically testing site data in accordance with Draft NUREG/CR-5849.

REFERENCES

1. ATCOR, Inc., "Final Survey Results After Decontamination, Gulf United Nuclear Fuels Corporation Plutonium Facility, Pawling, New York", January 1974.

2. Nuclear Energy Services, "UNC Facility Survey and Radiological Analysis", July 1984.

3. Letter from C. W. Gillert, Acting Chairperson, Nuclear Lake Management Committee to D. A. Richie, United States Department of Interior, July 1985.

4. Oak Ridge Associated Universities, "Radiological Survey of the Nuclear Lake Site, Pawling, New York", July 1988.

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6. Nuclear Energy Services, "Work Plan for the Soil Remediation of the National Park Service Property Located Near Pawling, New York for the Chevron USA, Incorporated", November 1992.

7. Nuclear Energy Services, "Decommissioning Plan for the Plutonium Facility and Multiple Failure Building of the National Park Service Property Located Near Pawling, New York for Chevron USA, Incorporated", February 1993.

8. Nuclear Energy Services, "Final Release Survey Plan of the National Park Service Property Located Near Pawling, New York for Chevron USA, Incorporated", May 1993.

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10. Letter from T. J. Vitkus, ORISE to M. Nalluswami, U.S. Nuclear Regulatory Commission, "Revised Confirmatory and Radiological Survey Plan for the Nuclear Lake Site, Pawling, New York," September 17, 1993.

11. U.S. Nuclear Regulatory Commission, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use of Termination of License for Byproduct, Service, or special Nuclear Material", August 1987.

12. Letter from T. J. Vitkus, ORISE to M. Nalluswami, U.S. Nuclear Regulatory Commission, "Comments on the Work Plan for Soil Remediation of the National Park Service Property, Located Near Pawling, New York for the Chevron USA, Incorporated", December 9, 1992.

REFERENCES (Continued)

13. Letter from M. R. Landis, ORISE to M. Nalluswami, U.S. Nuclear Regulatory Commission, "Comments of the Decommissioning Plan for the Plutonium Facility and Multiple Failure Building of the National Park Service Property Located Near Pawling, New York for Chevron USA, Incorporated", March 18, 1993.

14. Letter from M. R. Landis, ORISE to M. Nalluswami, U.S. Nuclear Regulatory Commission, " Comments on Final Release Survey Plan, National Park Service Property, Pawling, New York", March 30, 1993.

15. U.S. Nuclear Regulatory Commission, "Guidance and Discussion of Requirement for an Application to Terminate a Non-power Reactor Facility Operating License," Revision 1, September 1984.

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
Effective Area, 15.5 cm^2
(Eberline, Santa Fe, NM)

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

Ludlum Gas Proportional Detector
Model 43-68
Effective Area, 100 cm^2
(Ludlum Measurements, Inc.,
Sweetwater, TX)

Reuter-Stokes Pressurized Ion Chamber
Model RSS-111
(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

Alpha Spectrometry System
(Canberra, Meriden, CT)
Used in conjunction with:
Multichannel Analyzer
3100 Vax Workstations
(Canberra, Meriden, CT)
(Canberra, Meriden, CT)

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-5110
(Tennelec, Oak Ridge, TN)

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 of the surveyed areas. Other surfaces were scanned using small area (15.5 cm^2 or 100 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
Beta	-	gas proportional detector with ratemeter-scaler
	-	pancake GM detector with ratemeter-scaler
Gamma	-	NaI detector with ratemeter

Surface Activity Measurements

Measurements of total alpha and total beta activity levels were primarily performed using gas proportional and/or GM detectors with portable ratemeter-scalers.

Count rates which were integrated over a 1 or 2 minute period 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 sample count time and active area of the detector. The alpha activity background countrates for the gas proportional detectors averaged approximately 1 cpm for each detector. Alpha efficiency factors ranged from 0.20 to 0.22 for the gas proportional detectors. The beta activity

background count rates for the proportional detectors and the GM detectors averaged 290 and 44 cpm, respectively. Beta efficiency factors ranged from 0.19 to 0.21 for the gas proportional detectors and 0.15 to 0.16 for the GM detectors. The effective window for the gas proportional, and GM detectors were 100 cm^2, and 15.5 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. 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).

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

Removable Activity

Smears were counted on a low background gas proportional system for gross alpha and gross beta 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 and ranged from 130 to 1100 g of material. 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. Energy peaks used for determination of radionuclides of concern were:

Am-241	0.059 MeV
Th-232	0.911 MeV from Ac-228*
U-235	0.186 MeV
U-238	0.063 MeV from Th-234* (or 0.093 MeV)

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

Alpha Spectrometry

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 surface barrier and ion implanted detectors (ORTEC), alpha spectrometers (Canberra), and a multichannel analyzer (Nuclear Data).

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represents 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. When the net sample count was less than 2.71 + 4.66 times the statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the measurement procedure. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in sample, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

CALIBRATION AND QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following documents:

- Survey Procedures Manual Revision 7.1 (September 1993)
- Laboratory Procedures Manual Revision 8 (August 1993)
- Quality Assurance Manual Revision 6 (July 1993)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C for Quality Assurance and contain measures to assess processes during their performance.

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. Calibration of pressurized ionization chambers was performed by the manufacturer.

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

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE OR SPECIAL NUCLEAR MATERIAL

GUIDELINES FOR DECONTAMINATION OF FACILITIES AND EQUIPMENT PRIOR TO RELEASE FOR UNRESTRICTED USE OR TERMINATION OF LICENSES FOR BYPRODUCT, SOURCE, OR SPECIAL NUCLEAR MATERIAL

U.S. Nuclear Regulatory Commission
Division of Fuel Cycle & Material Safety
Washington, D.C. 20555

August 1987

The instructions in this guide, in conjunction with Table 1, specify the radionuclides and radiation exposure rate limits which should be used in decontamination and survey of surfaces or premises and equipment prior to abandonment or release for unrestricted use. The limits in Table 1 do not apply to premises, equipment, or scrap containing induced radioactivity for which the radiological considerations pertinent to their use may be different. The release of such facilities or items from regulatory control is considered on a case-by-case basis.

1. The licensee shall make a reasonable effort to eliminate residual contamination.

2. Radioactivity on equipment or surfaces shall not be covered by paint, plating, or other covering material unless contamination levels, as determined by a survey and documented, are below the limits specified in Table 1 prior to the application of the covering. A reasonable effort must be made to minimize the contamination prior to use of any covering.

3. The radioactivity on the interior surfaces of pipes, drain lines, or ductwork shall be determined by making measurements at all traps, and other appropriate access points, provided that contamination at these locations is likely to be representative of contamination on the interior of the pipes, drain lines, or ductwork. Surfaces or premises, equipment, or scrap which are likely to be contaminated, but are such size, construction, or location as to make the surface inaccessible for purposes of measurement, shall be presumed to be contaminated in excess of the limits.

4. Upon request, the Commission may authorize a licensee to relinquish possession or control of premises, equipment, or scrap having surfaces contaminated with materials in excess of the limits specified. This may include, but would not be limited to special circumstances such as razing of buildings, transfer from premises to another organization continuing work with radioactive materials, or conversion of facilities to a long-term storage or standby status. Such requests must:

   a. Provide detailed, specific information describing the premises, equipment or scrap, radioactive contaminants, and the nature, extent, and degree of residual surface contamination.

   b. Provide a detailed health and safety analysis which reflects that the residual amounts of materials on surface areas, together with other considerations such as prospective use of the premises, equipment, or scrap, are unlikely to result in an unreasonable risk to the health and safety of the public.

5. Prior to release of premises for unrestricted use, the licensee shall make a comprehensive radiation survey which establishes that contamination is within the limits specified in Table 1. A copy of the survey report shall be filed with the Division of Fuel Cycle, Medical, Academic, and Commercial Use Safety, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, and also the Administrator of the NRC Regional Office having jurisdiction. The report should be filed at least 30 days prior to the planned date of abandonment. The survey report shall:

   a. Identify the premises.

   b. Show that reasonable effort has been made to eliminate residual contamination.

   c. Describe the scope of the survey and general procedures followed.

   d. State the findings of the survey in units specified in the instruction.

   Following review of the report, the NRC will consider visiting the facilities to confirm the survey.

TABLE 1
ACCEPTABLE SURFACE CONTAMINATION LEVELS

Nuclides[a]	Average[b,c,f]	Maximum[b,d,f]	Removable[b,e,f]
U-nat, U-235, U-238, and associated decay products	5,000 dpm α/100 cm^2	15,000 dpm α/100 cm^2	1,000 dpm α/100 cm^2
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-125, I-129	100 dpm/100 cm^2	300 dpm/100 cm^2	20 dpm/100 cm^2
Th-nat, Th-232, Sr-90, Ra-223, Ra-224, U-232, I-126, I-131, I-133	1,000 dpm/100 cm^2	3,000 dpm/100 cm^2	200 dpm/100 cm^2
Beta-gamma emitters (nuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above.	5,000 dpm $\beta\gamma$/100 cm^2	15,000 dpm $\beta\gamma$/100 cm^2	1,000 dpm $\beta\gamma$/100 cm^2

[a]Where surface contamination by both alpha- and beta-gamma-emitting nuclides exists, the limits established for alpha- and beta-gamma-emitting nuclides 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 observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[c]Measurements of average contaminant should not be averaged over more than 1 square meter. For objects of less surface area, the average should be derived for each such object.

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

[e]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels should be reduced proportionally and the entire surface should be wiped.

[f]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 milligrams per square centimeter of total absorber.