CONFIRMATORY SURVEY OF BUILDINGS 7, 8, 9 AND 10A BLOOMFIELD LAMP PLANT WESTINGHOUSE ELECTRIC CORPORATION BLOOMFIELD, NEW JERSEY

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Prepared for the
U. S. Nuclear Regulatory Commission
Region I Office

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

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FINAL REPORT

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BLOOMFIELD, NEW JERSEY

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Bloomfield, New Jersey - August 17, 1993

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ABBREVIATIONS

cm^2	square centimeter
cpm	counts per minute
dpm/100 cm^2	disintegrations per minute/100 square centimeters
ft	foot
GM	Geiger-Mueller
kg	kilogram
km	kilometer
m	meter
m^2	square meter
mi	mile
NaI	Sodium Iodide
pCi/g	picocurie per gram
PIC	Pressurized Ionization Chamber
μR/h	microroentgen per hour
ZnS	Zinc Sulfide

ACRONYMS

ASME	American Society of Mechanical Engineers
EPA	Environmental Protection Agency
EML	Environmental Measurement Laboratory
ESSAP	Environmental Survey and Site Assessment Program
MDA	Minimum Detectable Activity
NIST	National Institute for Standards Technology
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
RMC	Radiation Management Corporation
SEG	Scientific Ecology Group, Inc.
WEC	Westinghouse Electric Corporation

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INTRODUCTION AND SITE HISTORY

The Bloomfield Lamp Plant, owned and operated by Westinghouse Electric Corporation (WEC), is located in Bloomfield, New Jersey, approximately 12 km (7.5 mi) north of the Newark International Airport (Figure 1). This facility was devoted primarily to the development and manufacture of electric lamps; however, radioactive materials were utilized in various processes during the plant operation. In the 1940's, uranium was used in production related to the Manhattan Engineer District. Use of natural uranium was terminated in the early 1950's. Natural thorium was used in the study of emission mixtures and in the production of thoriated tungsten wire. WEC operated this facility until 1982 under Nuclear Regulatory Commission (NRC) License No. SMB-1527 (Docket 40-08976).

In 1986, WEC initiated a project to remediate and decommission the Bloomfield Plant. In 1986, Radiation Management Corporation (RMC) (currently Canberra Nuclear Services Division/RMC) performed a radiological characterization survey of the facility. Remediation activities were initiated in 1989 by Scientific Ecology Group, Inc. (SEG), a subsidiary of WEC. The Bloomfield Plant is comprised of eleven principal buildings with multiple floor levels and several smaller structures (Figure 2). The remediation of Buildings 1 through 6, and associated properties, located on the west side of Arlington Avenue, was completed in 1990. At the request of the Nuclear Regulatory Commission's (NRC's) Region I Office, the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Institute for Science and Education (ORISE) conducted a radiological survey of this portion of the facility in March 1991.[1]

The remediation of Buildings 7, 8, 9, and 10A was completed in 1992. These Buildings contain approximately 30,000 m^2 of floor space, and included the principal areas of radioactive material use at the Bloomfield Plant. The Nuclear Regulatory Commission, Region I Office, requested that the Environmental Survey and Site Assessment Program (ESSAP) of ORISE perform an

independent confirmatory survey of Buildings 7, 8, 9, 10A, and associated properties, located on the east side of Arlington Avenue. This report summarizes the procedures and results of that survey.

SITE DESCRIPTION

Building 7 is a five story concrete and steel structure, used primarily as a laboratory and office building. The major uranium processing operations were performed in this building—primarily in the basement. Activity levels at several locations in this basement exceed the guidelines for unrestricted release of the facility. WEC has prepared a risk analysis for this area, requesting exemption from the guidelines.

Building 8 is a four story concrete and steel structure which was devoted to processing and manufacturing activities. The building is characterized by large, open areas which were optimal for filament manufacturing equipment and material. Use of radioactive materials, primarily thorium, was limited to a few isolated locations within this building.

Building 9 is a single story steel frame structure which was heavily involved with the use of thorium in emission mixtures and in the production of lamps containing thoriated filaments. The building was a manufacturing facility, containing furnaces, presses, and plating equipment, and had a concrete floor, wood and asphalt roof, and concrete block walls. As a result of both radiological and mercury remediation, all equipment, most utilities, portions of interior walls and flooring, and subsurface drains and soils have been removed. The structure on the east side of Building 9 is referred to as Building 10A (Figure 2). It shares a common wall with Building 9. The primary storage site for thorium was located in the north section of this building.

OBJECTIVES

The objectives of the confirmatory process were to provide independent document reviews and radiological data, for use by the NRC in evaluating the adequacy and accuracy of the licensee's radiological status report, relative to established guidelines.

DOCUMENT REVIEW

As part of the confirmatory activities ESSAP reviewed the licensee's radiological survey data.[2] Analytical procedures and methods utilized by the licensee were reviewed for adequacy and appropriateness. The data were reviewed for accuracy, completeness, and compliance with guidelines.

PROCEDURES

During the period May 10-14, 1993, ESSAP performed a confirmatory survey of Buildings 7, 8, 9, and 10A. The survey was conducted in accordance with a survey plan which was submitted to and approved by the NRC Region I Office.[3]

REFERENCE GRID

The licensee established an alphabetical reference grid system in Building 9 and the basement of Building 7; other areas were ungridded. All ESSAP measurement and sampling locations were referenced to grids, to prominent building features, and/or recorded on appropriate drawings.

SURFACE SCANS

Surface scans for alpha, beta, and gamma activity were performed using large area gas proportional and NaI detectors, coupled to ratemeters and ratemeter-scalers with audible indicators. Approximately 20-50% of the accessible floor surface in Buildings 7 and 8, and 50% of the accessible floor surface in Buildings 9 and 10A were scanned. The areas scanned included both the remediated and unremediated areas. Particular attention was given to cracks and joints in the floor where material may have accumulated.

Surface scans for gamma activity were performed on 50% of the roof surface in Building 7. The accessible areas of the pipe chase in Building 7 and the freight elevators in Buildings 7 and

8 were also scanned for alpha and beta activity using ZnS scintillation and thin-window GM detectors, coupled to ratemeter-scalers.

The indoor excavated areas in Buildings 7 and 9 as well as the outdoor areas surrounding each building were scanned for gamma activity. Locations of elevated direct radiation were marked for further investigation.

SURFACE ACTIVITY MEASUREMENTS

Direct measurements to determine total alpha and total beta surface activity were performed in 327 randomly selected locations throughout the surveyed areas and at locations of elevated direct radiation identified by surfaces scans. These measurements were primarily performed using gas proportional detectors, coupled to ratemeter-scalers. A smear sample for determining removable activity was obtained from each direct measurement location. Measurement and sampling locations for total and removable activity are illustrated in Figures 3 - 8 and 10 - 18.

EXPOSURE RATE MEASUREMENT

Background exposure rate measurements, performed during the previous ESSAP survey at this facility, were used for comparison.[1]

Exposure rate measurements were performed at 1 m above surface at 65 interior and 10 exterior locations, using a pressurized ionization chamber (PIC). Measurement locations are illustrated in Figures 21 - 35.

SOIL SAMPLING

The analysis results of background soil samples, collected during the previous ESSAP survey at this facility, were used for comparison.[1] Twenty-seven soil samples were collected in this survey: two samples were collected from excavations in the first floor of Building 7; four samples were collected from excavations in the basement of Building 7; eleven samples were

collected from excavations in Building 9; and ten samples were collected from outdoor areas surrounding the buildings. The sampling locations are illustrated in Figures 9, 19, and 20.

MISCELLANEOUS SAMPLING

In Building 9, a sample of the expansion joint was collected from an area of the floor with elevated direct radiation. The sampling location is illustrated in Figure 19.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and survey data were returned to the ESSAP Oak Ridge laboratory for analyses and interpretation. Smears were analyzed for gross alpha and gross beta activity. Direct measurement and smear data were converted to units of disintegrations per minute per 100 cm^2 (dpm/100 cm^2), and exposure rate measurements were reported in microroentegens per hour (μR/h). Soil and concrete samples were analyzed by gamma spectrometry. Spectra were reviewed for U-235, U-238, Th-232, Th-228, and any other identifiable photopeaks. Soil and concrete sample results were reported in units of picocuries per gram (pCi/g). Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. Results were compared to NRC guidelines which are provided in Appendix C.

FINDINGS AND RESULTS

DOCUMENT REVIEW

ESSAP reviewed the licensee's radiological survey data and comments were provided to the NRC.[4] Several areas were identified which required additional information. At the request of NRC, Region I, the licensee performed additional surveys of the facility and provided the results to the NRC.[5]

SURFACE SCANS

Surface scans identified several locations of elevated beta activity in Buildings 7, 8, 9, and 10A. These locations were marked for further investigation. The gamma scans of excavations in Buildings 9 and 7 also identified several areas of elevated activity; soil samples were collected at these locations. The gamma scan of the outdoor area surrounding the buildings identified one location on the south side of Building 9 with elevated activity. The gamma activity increased at this location as the soil was removed. Two soil samples were collected at this location.

SURFACE ACTIVITY LEVELS

Results of total and removable surface activity measurements are summarized in Tables 1-4. In Building 7, total surface activity levels ranged from <41 to 11,000 dpm/100 cm^2 for alpha and <560 to 92,000 dpm/100 cm^2 for beta (Tables 1, 4). In Building 8, total surface activity levels ranged from <41 to 3300 dpm/100 cm^2 for alpha and <560 to 50,000 dpm/100 cm^2 for beta (Table 2). In Buildings 9 and 10A, total surface activity levels ranged from 67 to 69,000 dpm/100 cm^2 for alpha and 700 to 830,000 dpm/100 cm^2 for beta (Table 3). In most areas, locations of elevated activity were confined to relatively small (<0.5 m^2) areas. However, in Building 10A, an approximately 20 m^2 area in the north section of the building had elevated alpha and beta activity.

The removable activity levels in Buildings 7,8,9, and 10A ranged from <12 to 130 dpm/100 cm^2 for alpha and <20 to 88 dpm/100 cm^2 for beta.

EXPOSURE RATES

The background exposure rates for building interiors, previously measured at this site, ranged from 7 - 9 μR/h and averaged 8 μR/h.[1] Exposure rate measurements at 65 interior locations ranged from 6 to 18 μR/h (Table 5). The 18 μR/h measurement was taken in the north section of Building 10A.

The background exposure rates for outdoor locations, previously measured at this site, ranged from 8 to 11 μR/h and averaged 9 μR/h.[1] Exposure rate measurements at 10 exterior locations ranged from 7 to 14 μR/h (Table 6).

RADIONUCLIDE CONCENTRATIONS IN SOIL AND MISCELLANEOUS SAMPLES

Radionuclide concentrations in soil samples taken from building excavations are presented in Table 7. In Room 104 of Building 7, the concentrations of total thorium ranged from 7 to 61 pCi/g and concentrations of total uranium ranged from 8 to 12 pCi/g. In the basement of Building 7, the concentrations of total thorium ranged from 1 to 4 pCi/g and concentrations of total uranium ranged from 21 to 209 pCi/g. In Building 9 excavations, the concentrations of total thorium ranged from 2 to 1030 pCi/g and concentrations of total uranium ranged from 3 to 83 pCi/g.

Radionuclide concentrations in soil samples taken from outdoor areas surrounding the buildings are presented in Table 8. The concentrations of total thorium in these samples ranged from 1 to 31 pCi/g and concentrations of total uranium ranged from 2 to 82 pCi/g. The location on the south side of Building 9 was identified by surface gamma scans. As soil was removed from this area, the gamma activity increased. The values listed in Table 8 for this location represent the concentrations of radionuclides in the 0-15 cm and the 15-30 cm layer of soil; they do not represent the amount of activity which appears to be located at a greater depth in that location.

The concentration of Th-232 in the expansion joint filling material collected from Building 9 was 520 pCi/g. The concentration of U-235 in this sample was <4.9 pCi/g. The concentration of U-238 could not be measured accurately for this sample by gamma spectrometry because of large interference by the photons from the thorium series radionuclides.

COMPARISON OF RESULTS WITH GUIDELINES

The NRC guidelines for surface contamination and residual concentrations of radionuclides in soil, established for license termination or release of a facility for unrestricted use, are presented

in Appendix C.[6,7] The primary contaminants of concern for this site are processed uranium (i.e. uranium separated from its long-lived daughter products) and natural thorium. The applicable NRC guidelines for surface activity levels are:

for thorium:

1,000 dpm/100 cm^2, total, averaged over a 1 m^2 area
3,000 dpm/100 cm^2, total, maximum in a 100 cm^2 area
200 dpm/100 cm^2, removable activity

for uranium:

5,000 α dpm/100 cm^2, total, averaged over a 1 m^2 area
15,000 α dpm/100 cm^2, total, maximum in a 100 cm^2 area
1,000 α dpm/100 cm^2, removable activity

The thorium guidelines apply to both alpha and beta activity, measured independently. The uranium guidelines specify alpha activity. However, natural uranium emits both alpha and beta radiations in approximately equal proportions; therefore, beta activity levels may be considered representative of uranium surface activity. Because rough, dirty, or damp surfaces may selectively attenuate alpha radiation, beta activity was also measured and used for comparison to the guidelines.

The licensee has provided a list to the NRC which identifies the contaminant in various areas of the facility.[5] Because both thorium and uranium were identified in locations not on the original listing, the identity of contaminants in many areas may need to be re-examined. For example, in Building 9 where thorium is listed as the only isotope of concern, significant amounts of uranium (up to 84 pCi/g) were identified by the ESSAP survey. Furthermore, in Building 7, adjacent rooms are listed as having thorium or uranium as the contaminant of concern. The possibility of cross contamination in those areas has not been addressed. In all buildings, the ESSAP survey identified several locations with total surface beta activity well in

excess of the 15,000 dpm/100 cm^2 criterion. There were also several locations with surface beta activity exceeding the 3,000 dpm/100 cm^2 criterion in areas where thorium is the contaminant of concern.

The removable activity levels in all locations were within guidelines.

The exposure rate guideline is 5 μR/h above background.[8] With the exception of two interior locations, all exposure rate measurements were within this limit. The exceptions were in Building 8, second floor, Room 8 (8 μR/h above background) and in the north section of Building 10A (10 μR/h above background).

The applicable soil concentration guidelines for processed uranium (natural isotopic abundances) and natural thorium are 35 pCi/g and 10 pCi/g, respectively. The radionuclide concentrations at several locations in Buildings 7 and 9 exceed the NRC guidelines for thorium, uranium, or both. These locations are in the excavated area in Room 104 of Building 7, in the Basement of Building 7, and in areas throughout Building 9. In addition, the radionuclide concentrations at several locations outside the buildings exceed the NRC guidelines for thorium or uranium. These areas were located at the northeast corner of Building 7, on the outside of Building 7 freight elevator, and in the area north of manhole near Building 8. In addition, subsurface contamination was identified on the south side of Building 9.

SUMMARY

At the request of the NRC, Region I Office, ESSAP performed a confirmatory survey of Buildings 7, 8, 9, and 10A of the Westinghouse Bloomfield Lamp Plant, during the period of May 10-14, 1993. Survey activities included alpha, beta, and gamma floor scans, measurements of total and removable surface activity, exposure rate measurements, and soil and miscellaneous sampling. The results of the survey demonstrate that radiological contamination in excess of guideline values exists in several areas of the facility.

The surface activity levels in the basement, second, third, and fourth floor, and the freight elevator door track in Building 7, and in the basement, third and fourth floor of Building 8, Building 9, and the north section of Building 10A exceed the surface contamination guidelines for uranium. In addition there are several locations in the facility that exceed thorium surface contamination guidelines; these include the first and second floor of Building 8 and cracks in the pavement in front of Building 9, north loading dock. At many locations in Building 7, it is not clear whether the more conservative thorium guidelines should be applied. If so, the surface activity at several additional locations in that building exceed the 3,000 dpm/100 cm^2 criterion. The soil concentrations at a number of locations exceed the applicable guidelines for thorium, uranium, or both.

The results of ESSAP confirmatory measurements do not support the licensee's conclusion that the facility satisfies NRC's guidelines for release to unrestricted use.

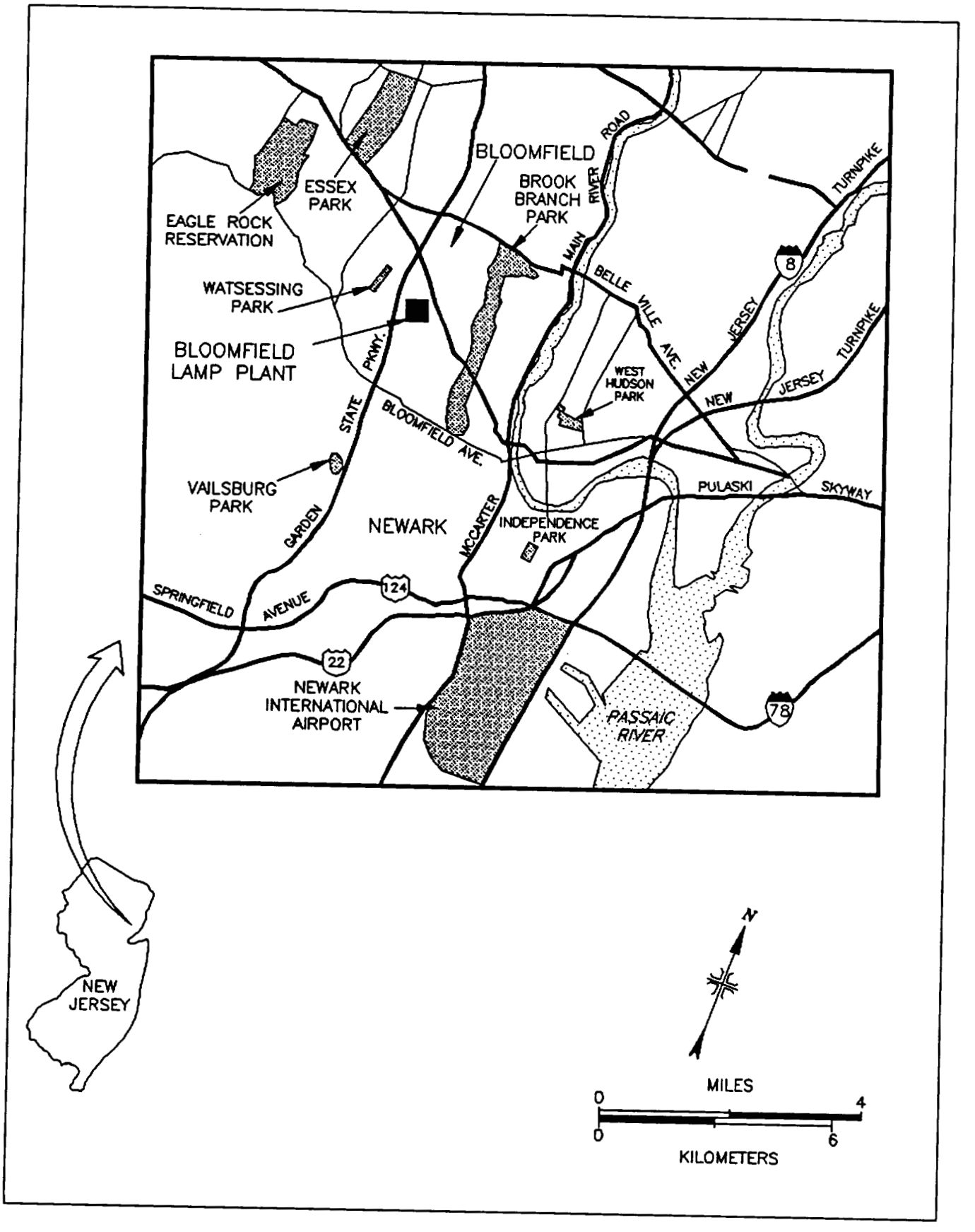

FIGURE 1: Location of Westinghouse Electric Corporation's Bloomfield Lamp Plant, Bloomfield, New Jersey

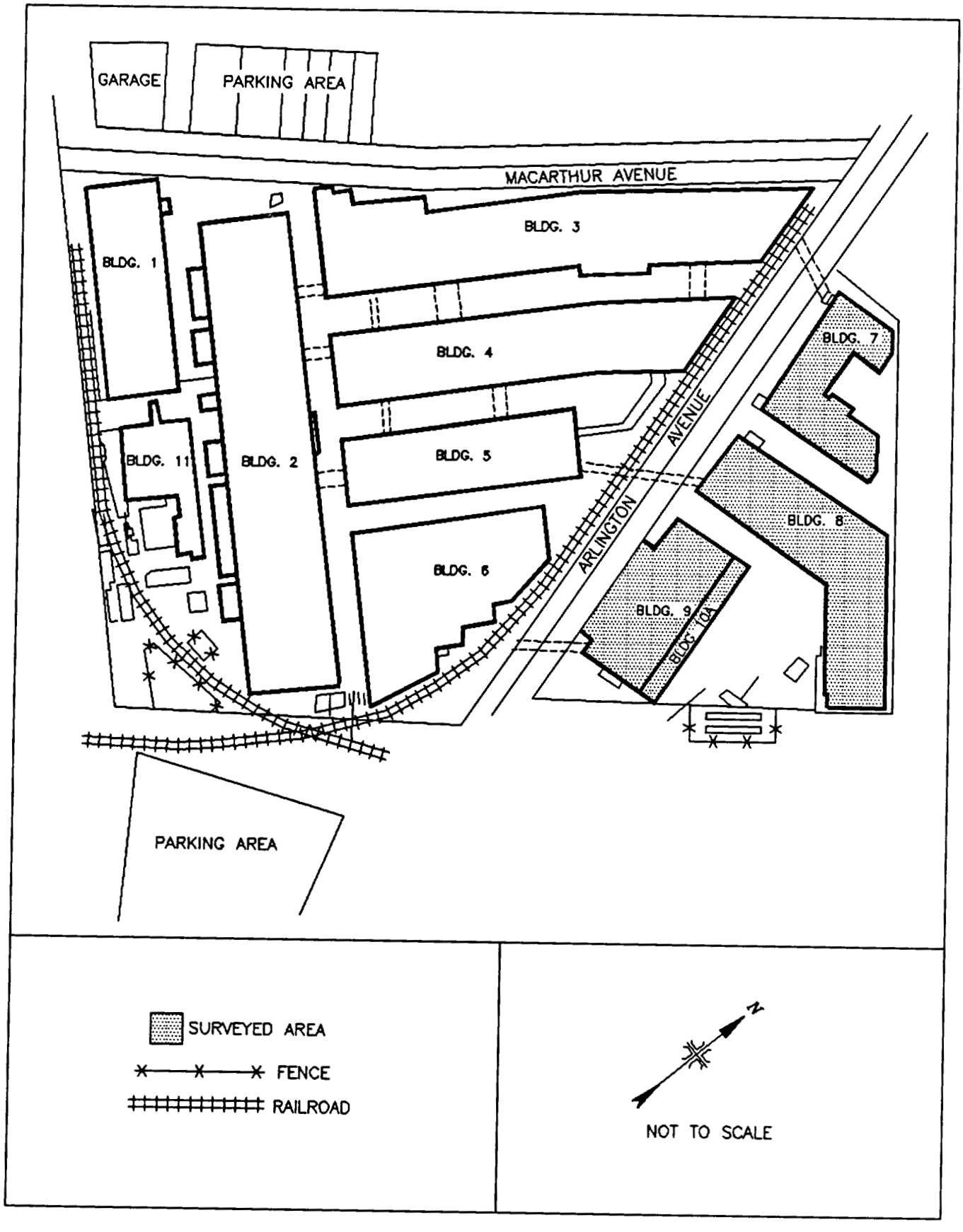

FIGURE 2: Plot Plan of the Westinghouse Electric Corporation's Bloomfield Lamp Plant

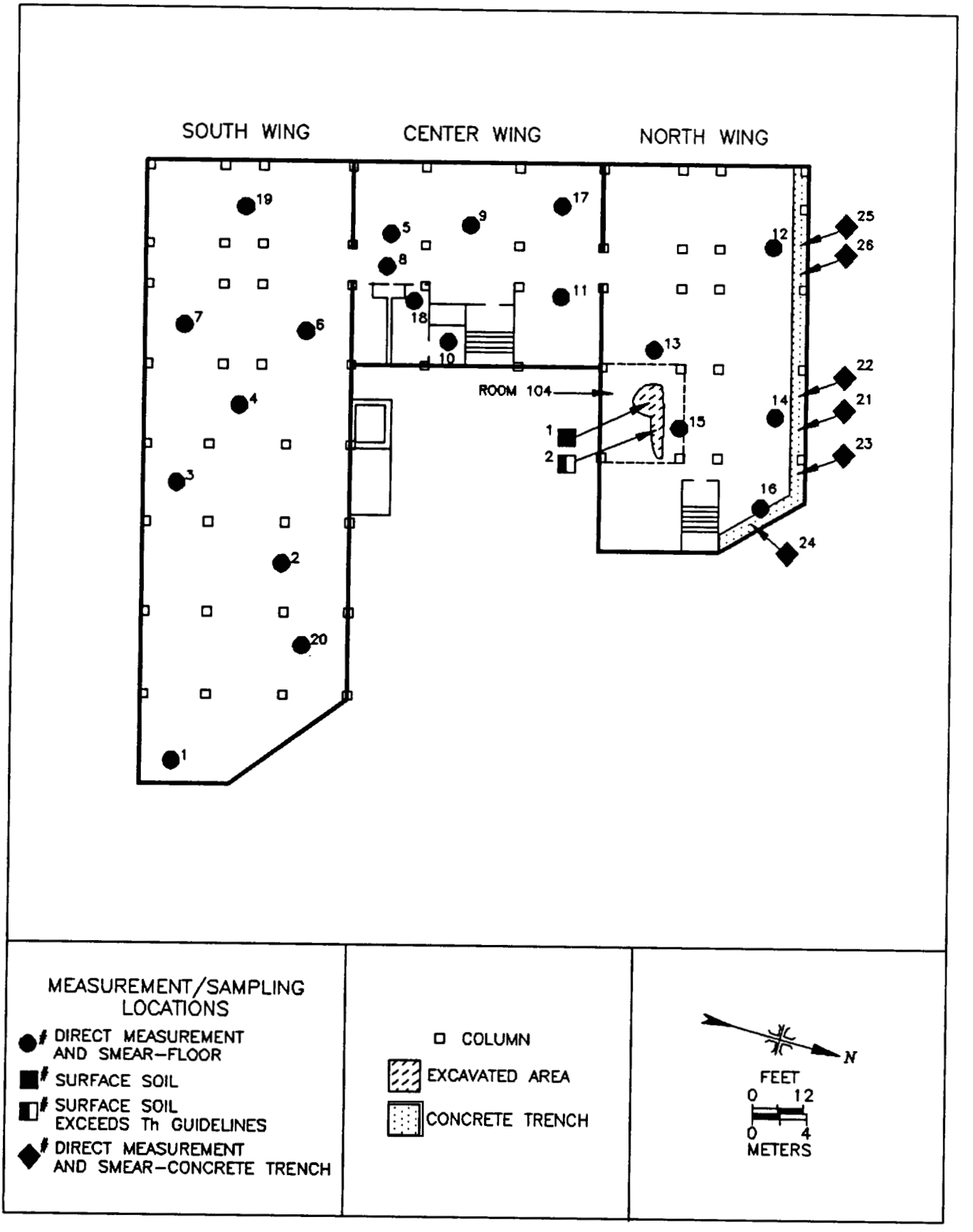

FIGURE 3: Building 7, First Floor – Measurement and Sampling Locations

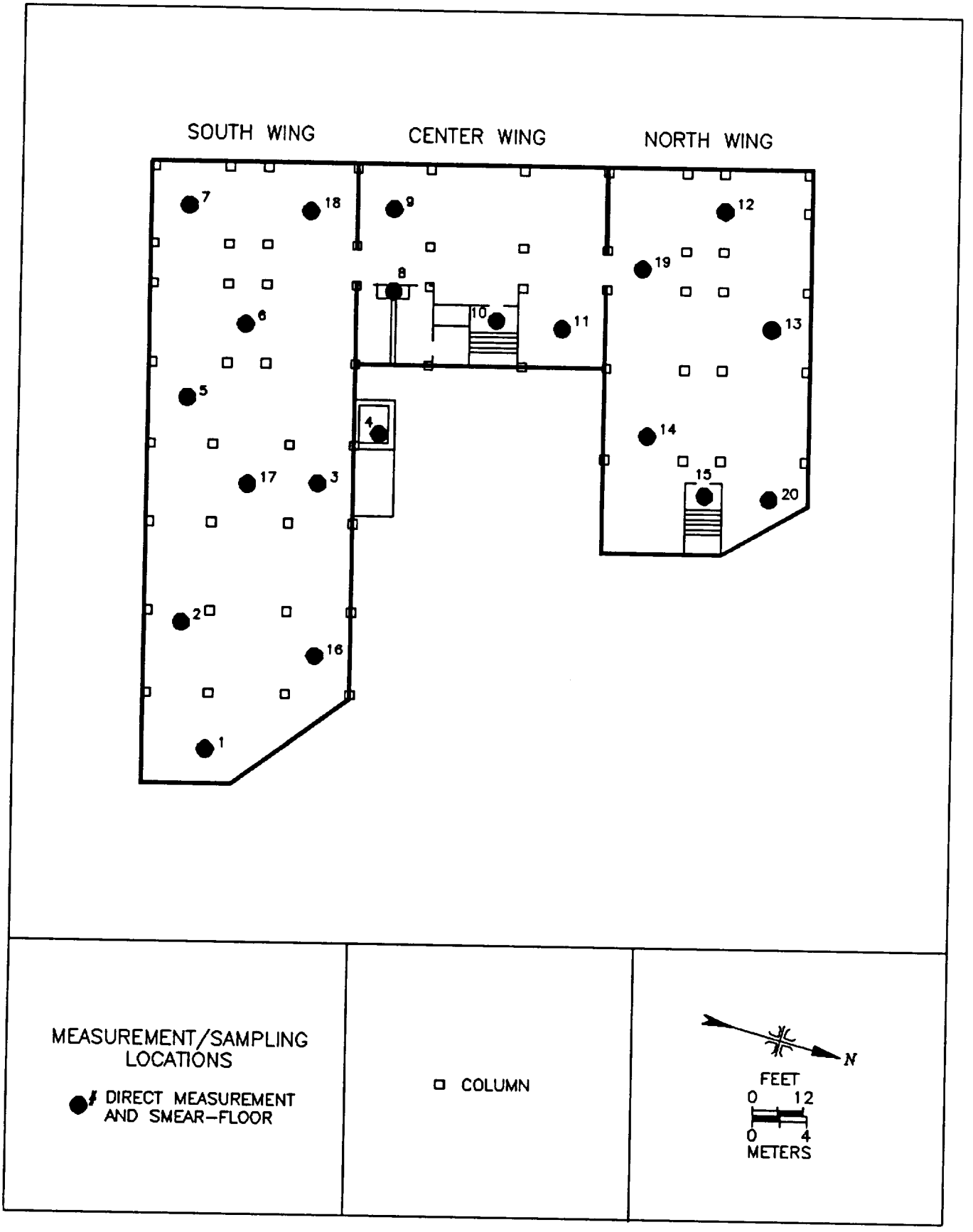

FIGURE 4: Building 7 Second Floor – Measurement and Sampling Locations

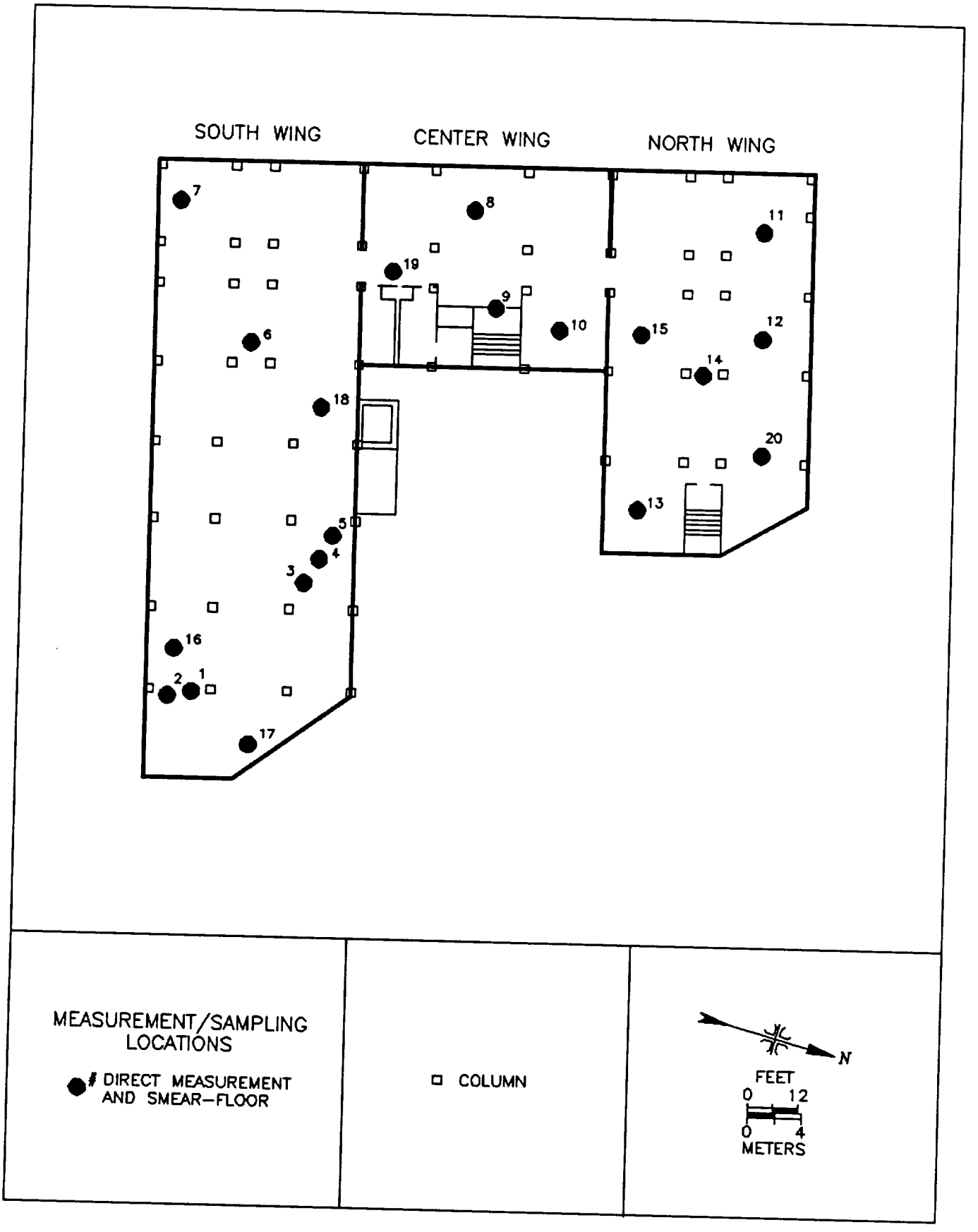

FIGURE 5: Building 7, Third Floor – Measurement and Sampling Locations

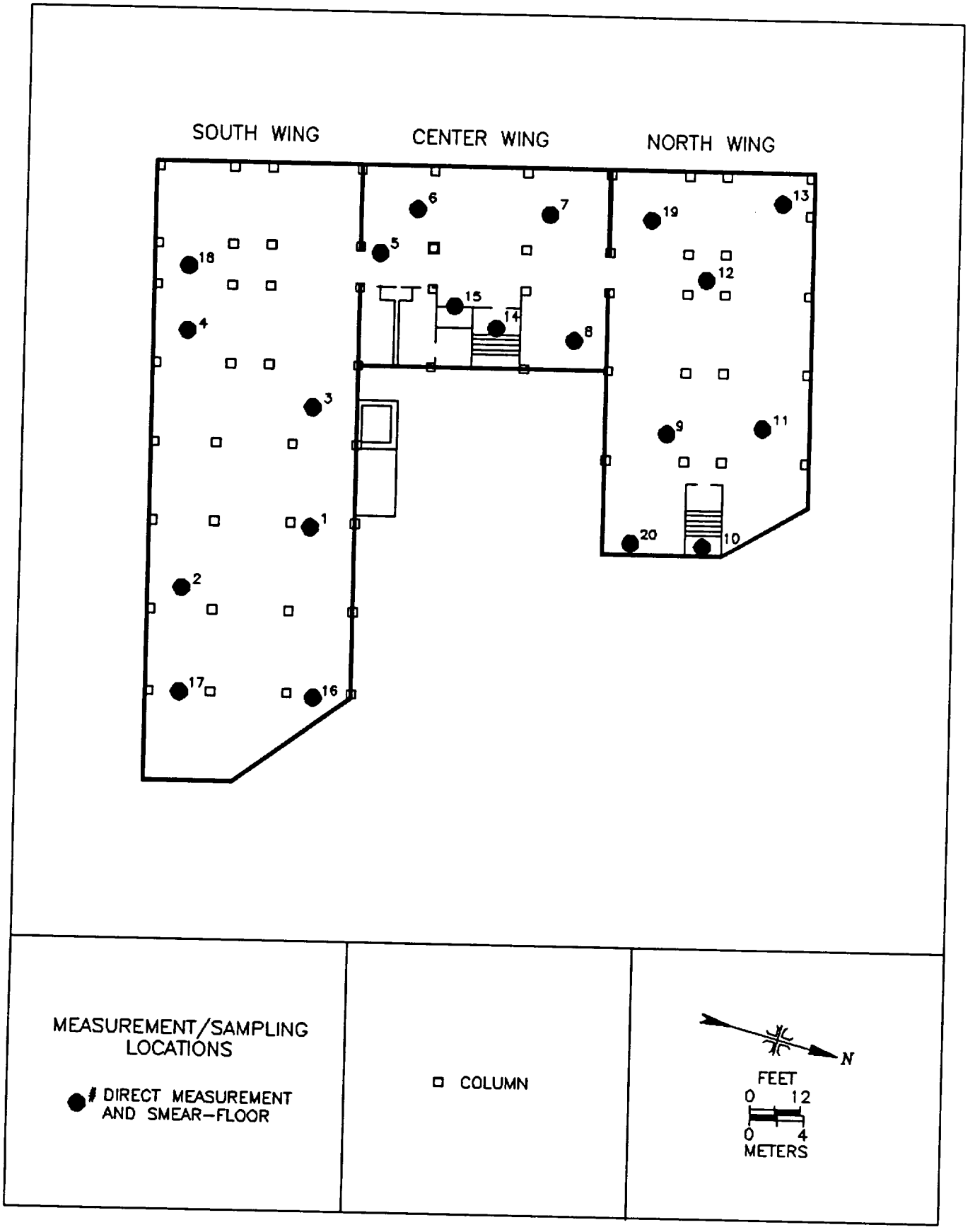

FIGURE 6: Building 7, Fourth Floor – Measurement and Sampling Locations

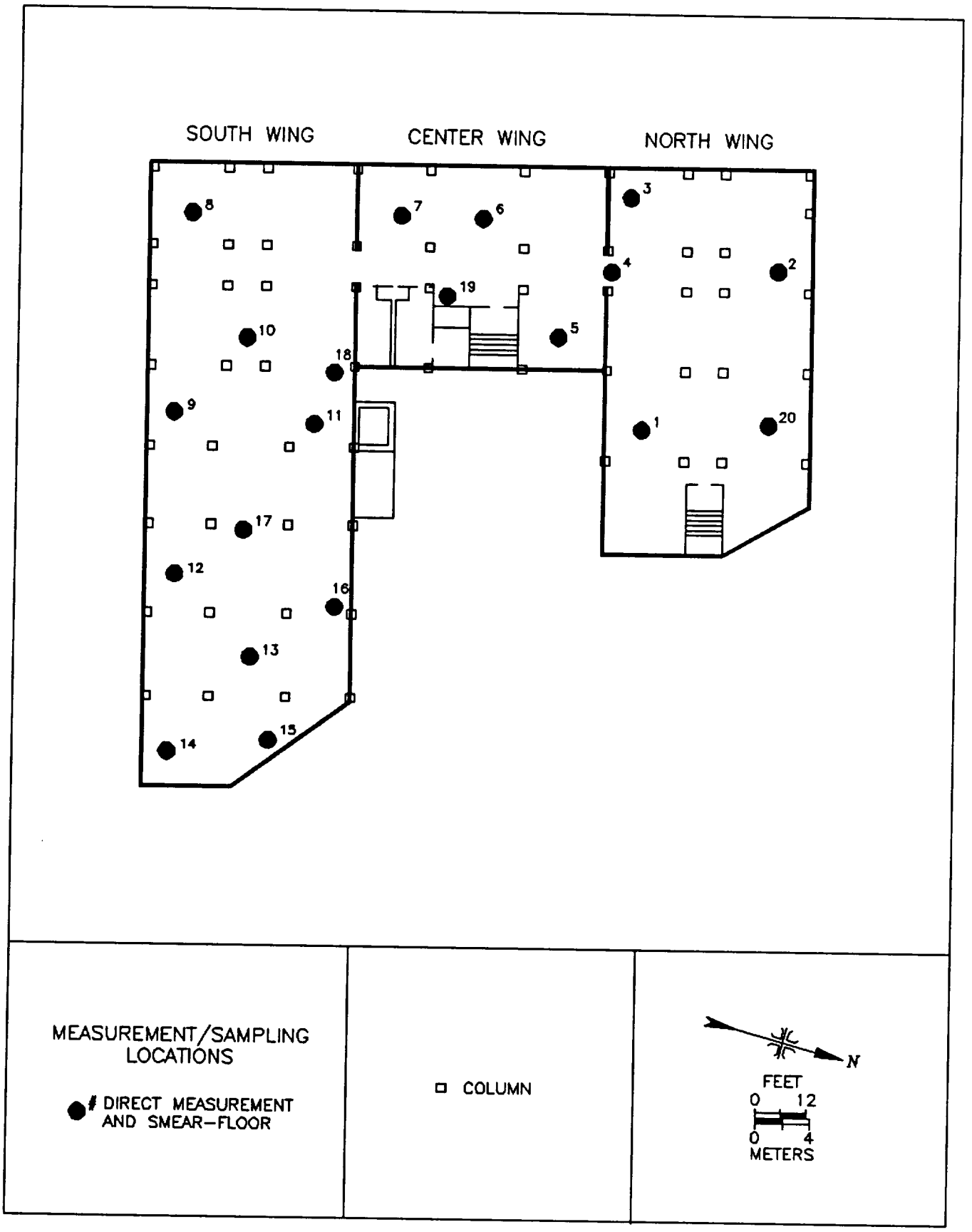

FIGURE 7: Building 7, Fifth Floor – Measurement and Sampling Locations

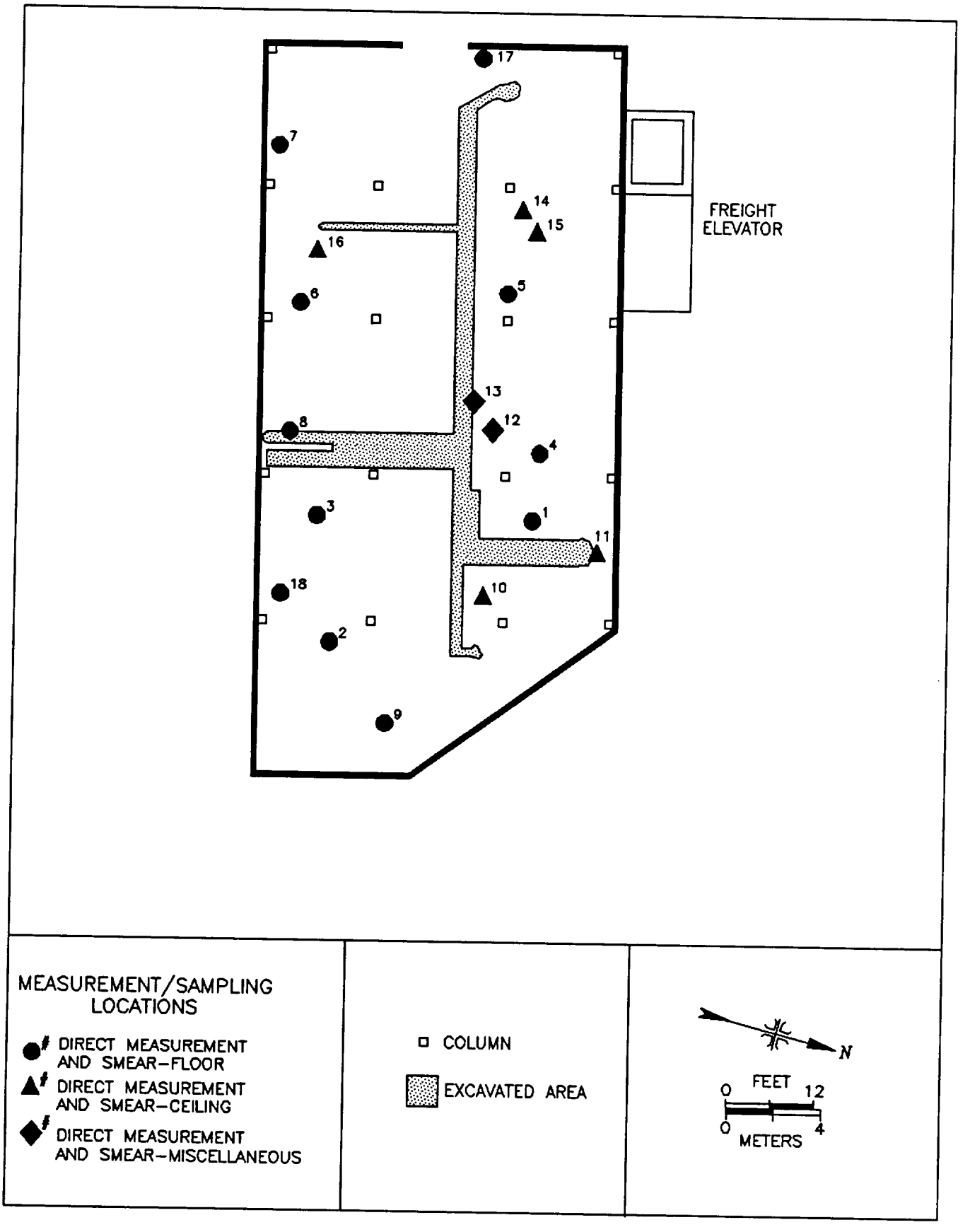

FIGURE 8: Building 7 Basement – Measurement and Sampling Locations

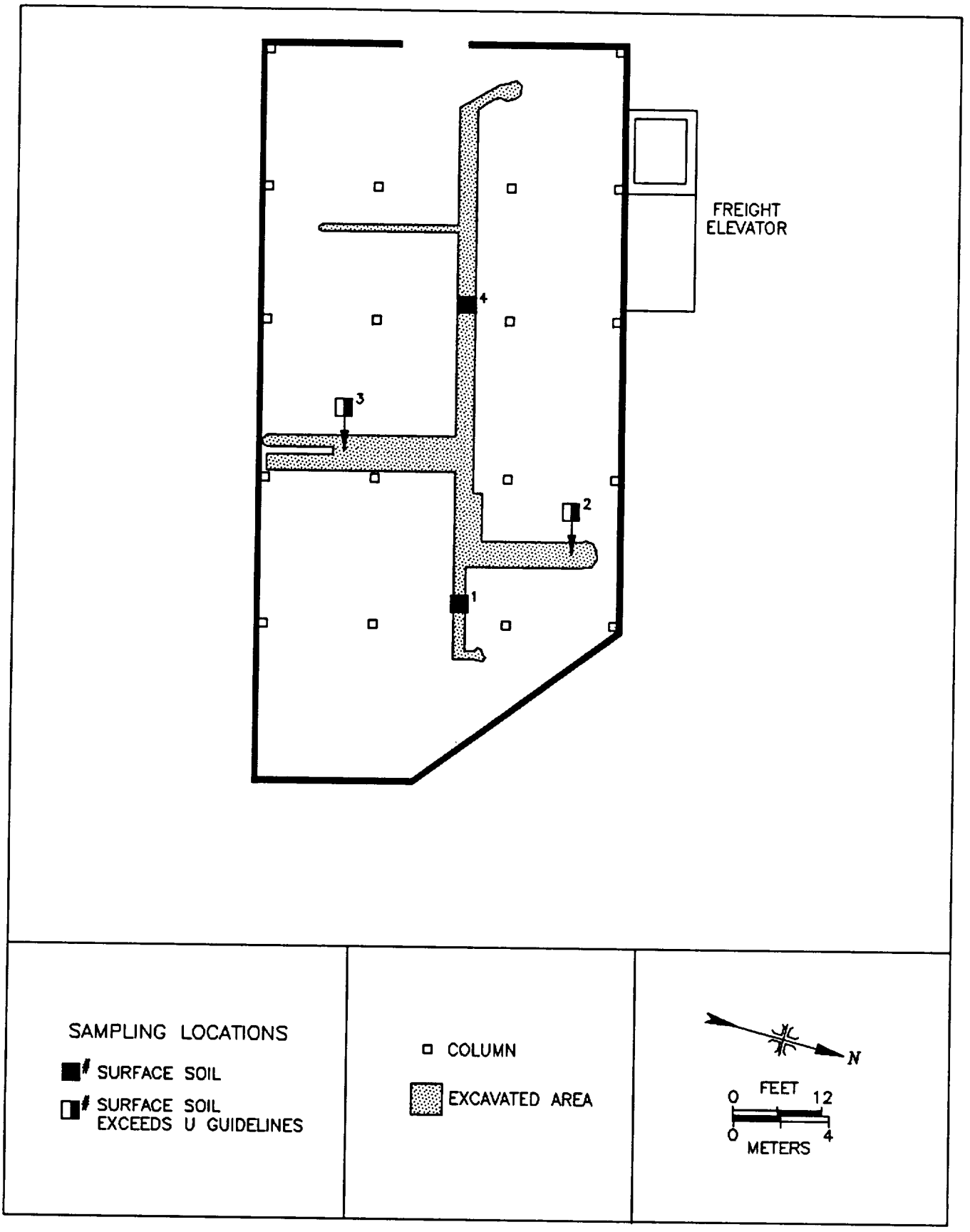

FIGURE 9: Building 7, Basement – Soil Sampling Locations

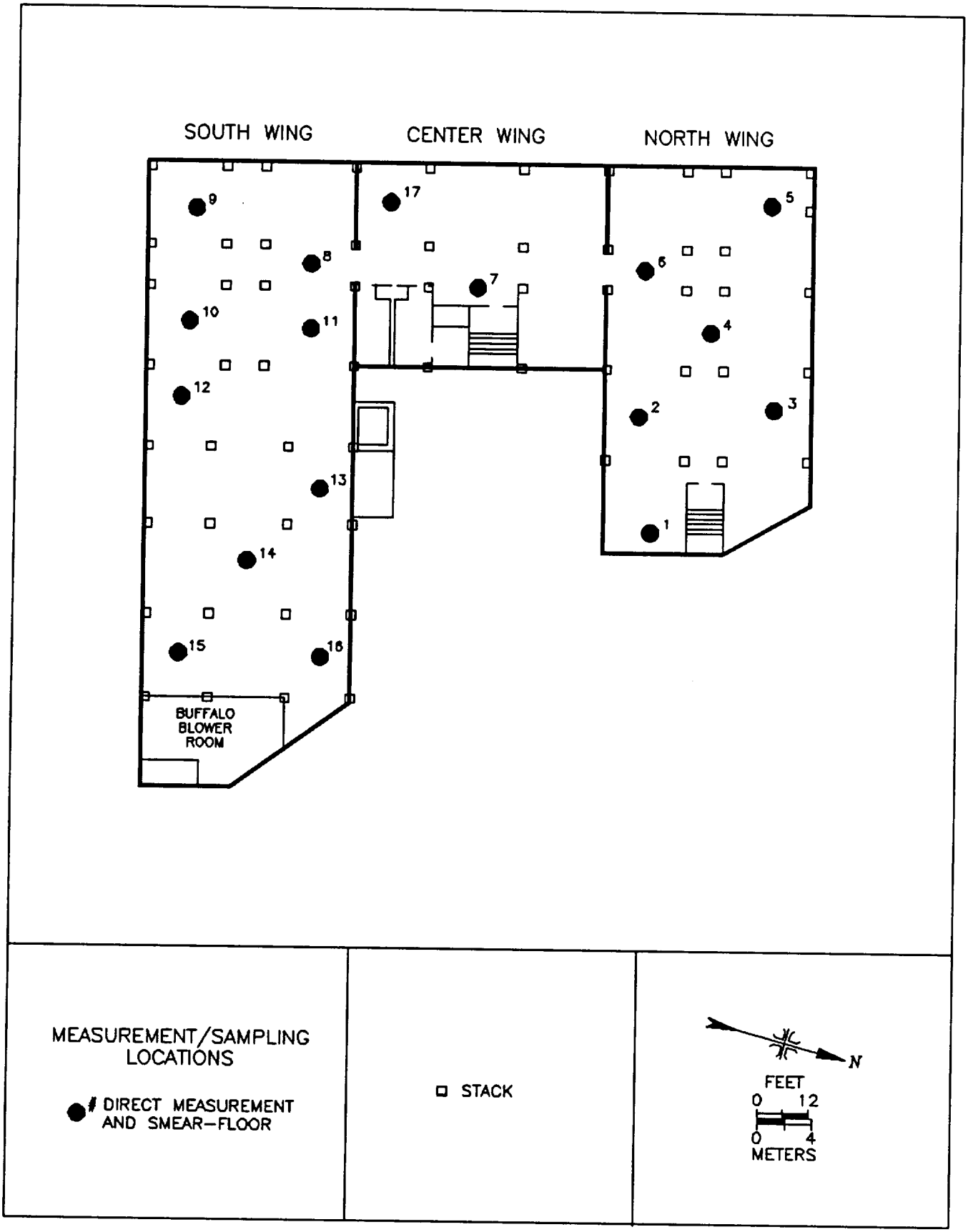

FIGURE 10: Building 7, Roof – Measurement and Sampling Locations

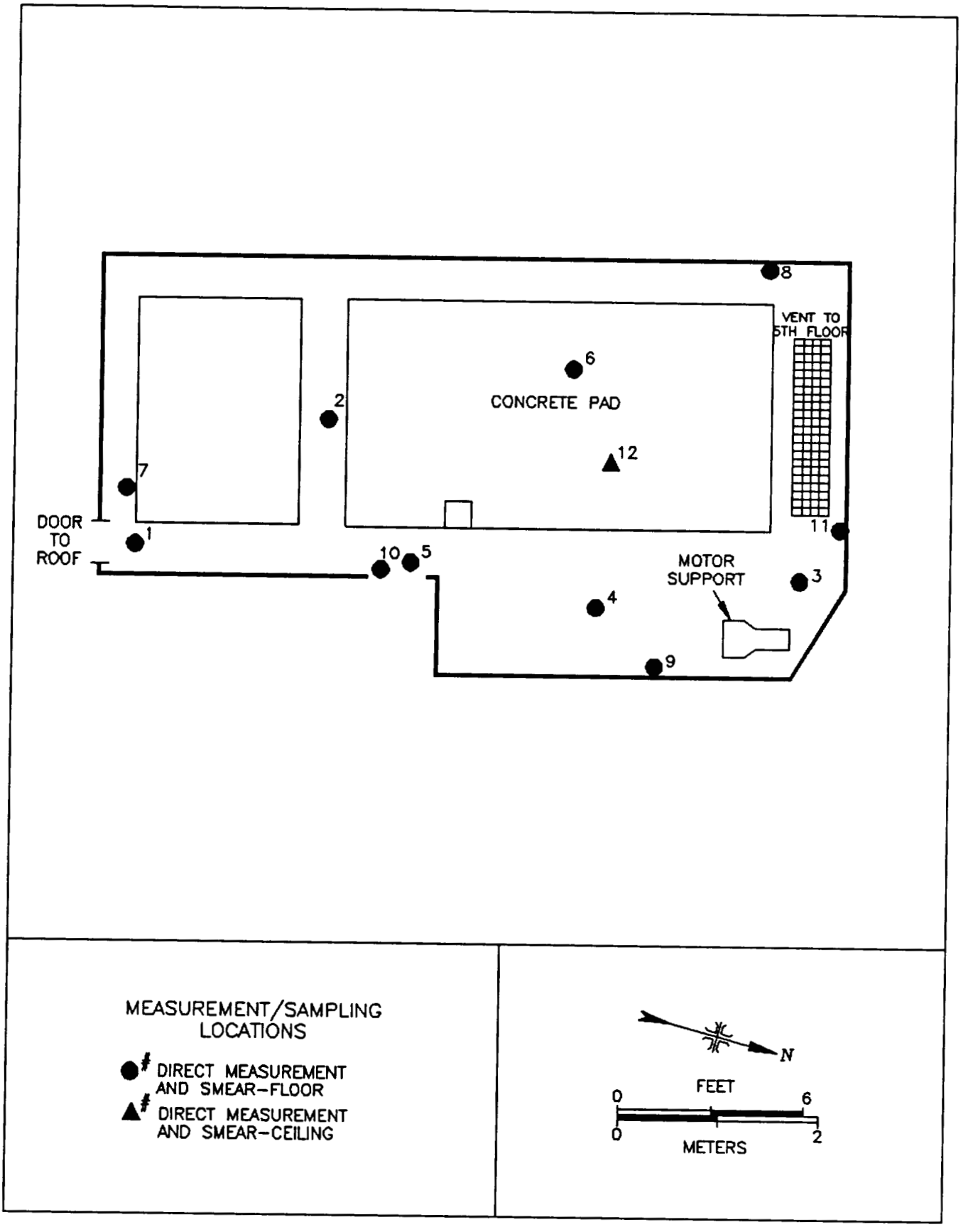

FIGURE 11: Building 7, Buffalo Blower Room – Measurement and Sampling Locations

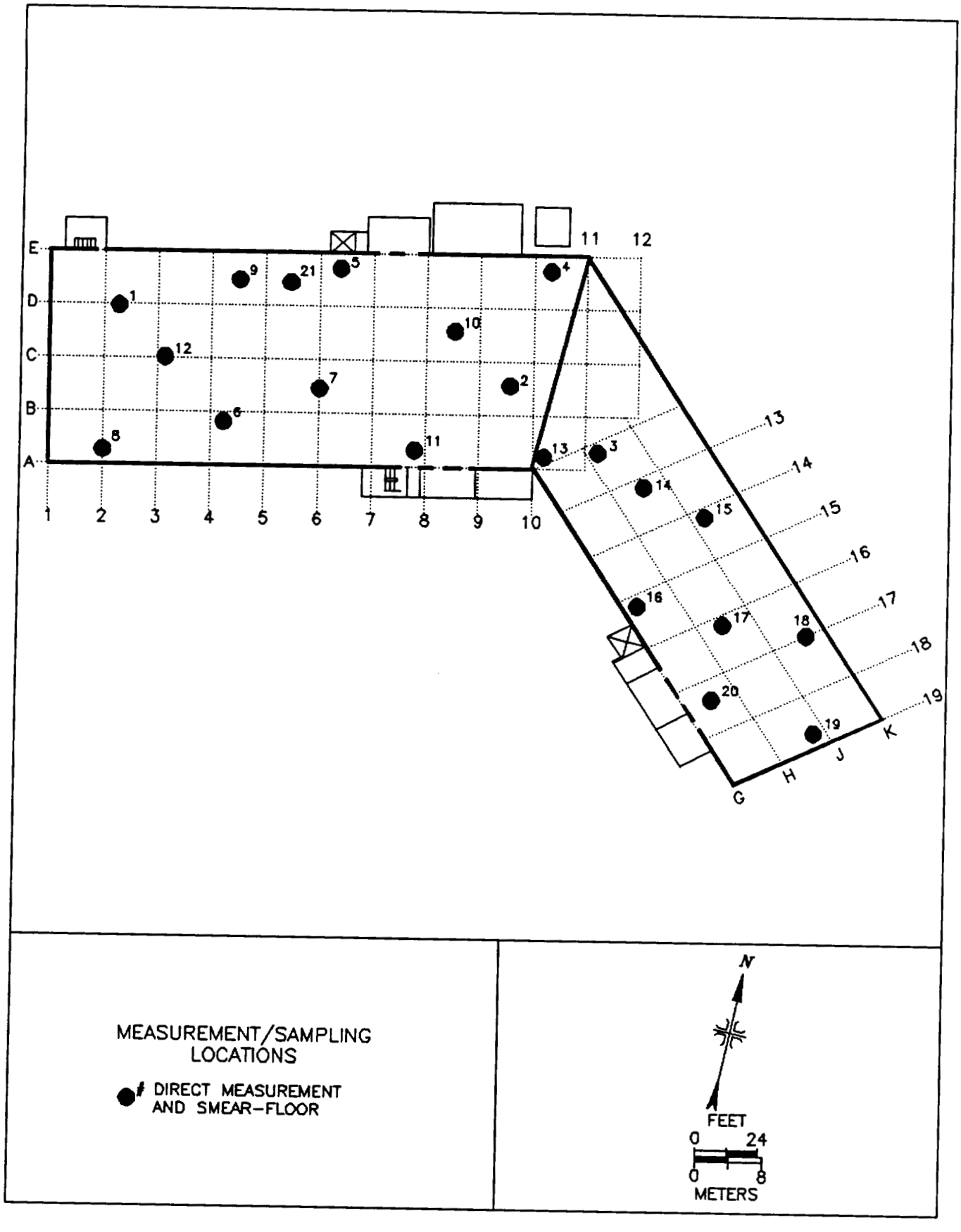

FIGURE 12: Building 8, First Floor – Measurement and Sampling Locations

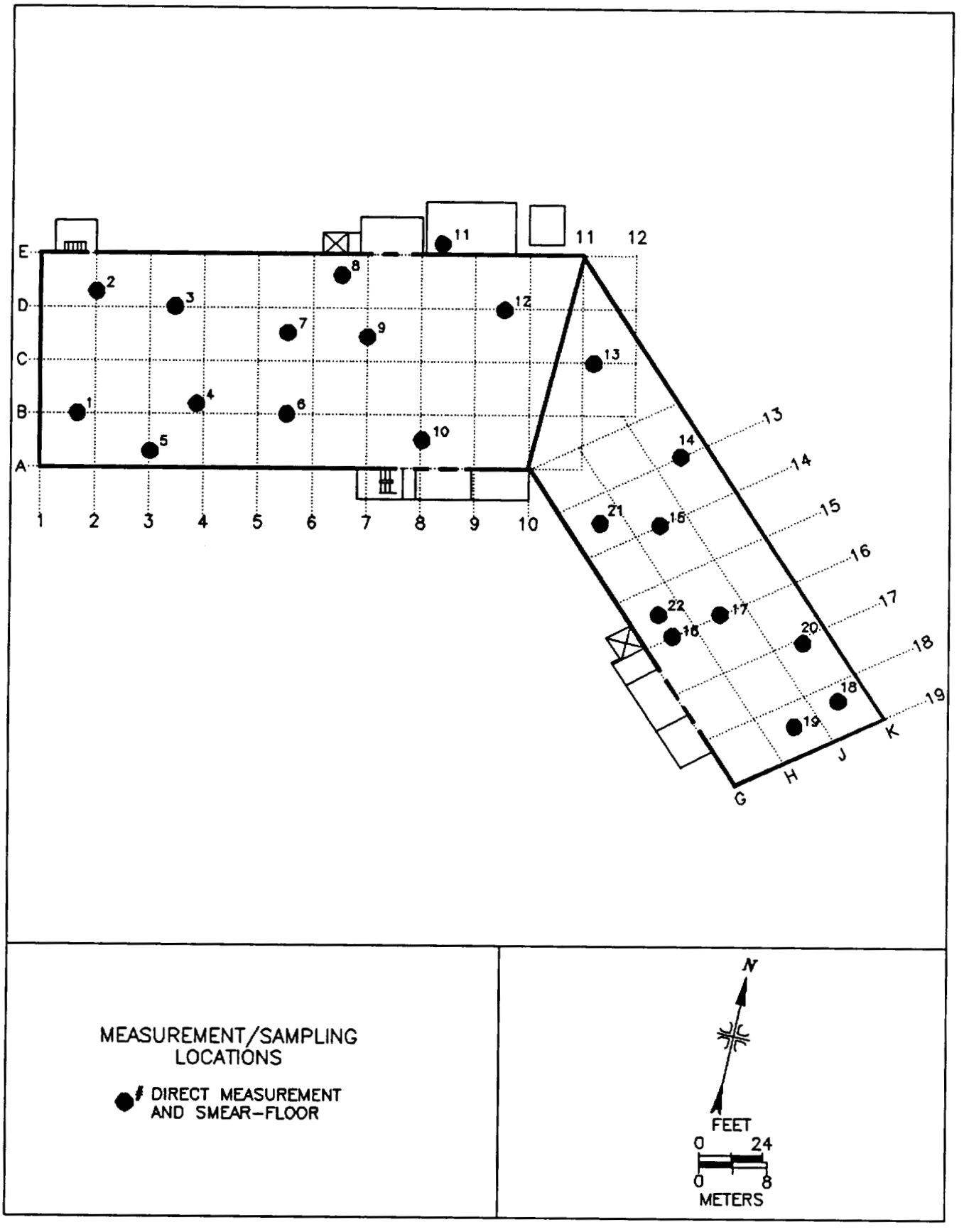

FIGURE 13: Building 8, Second Floor – Measurement and Sampling Locations

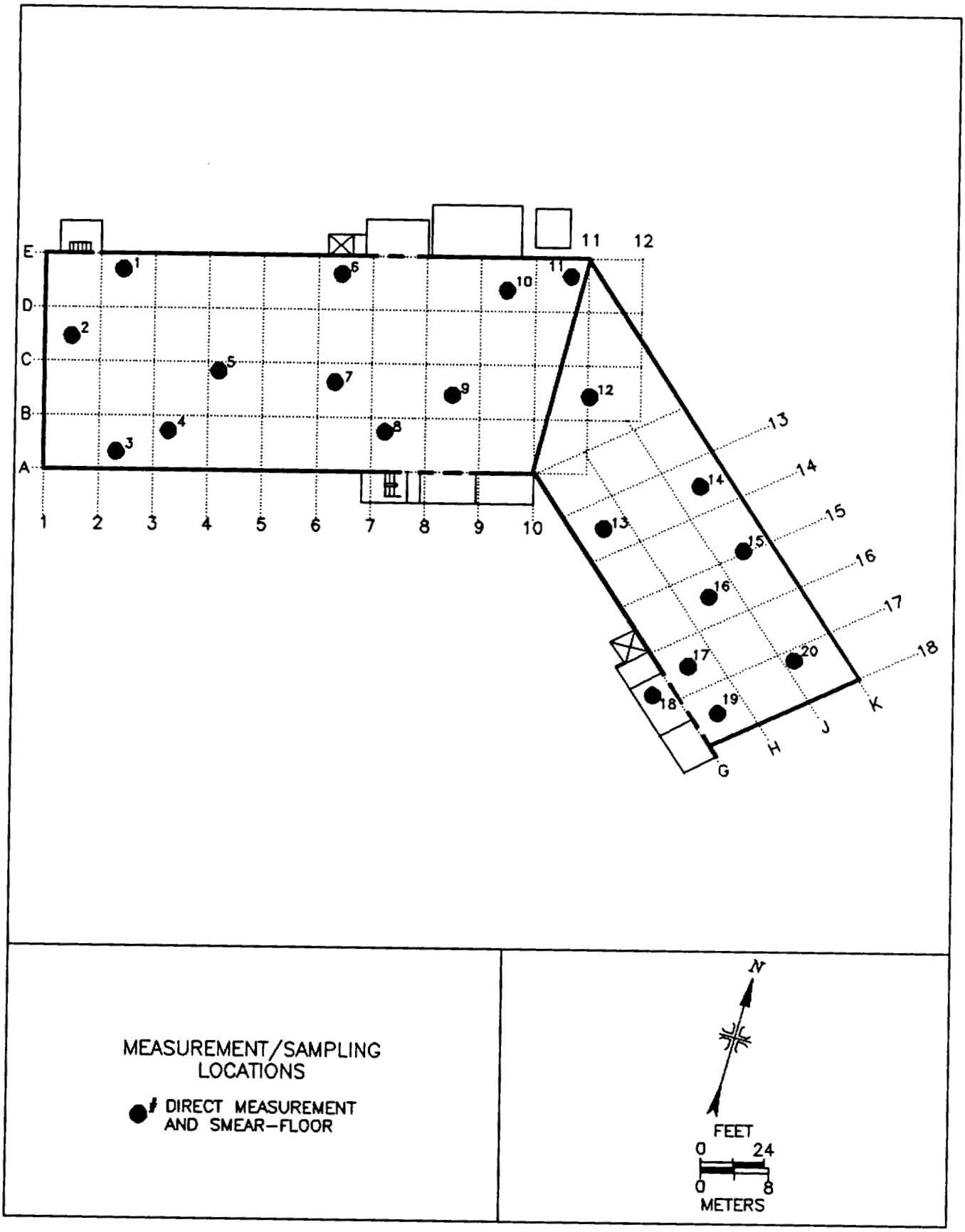

FIGURE 14: Building 8, Third Floor – Measurement and Sampling Locations

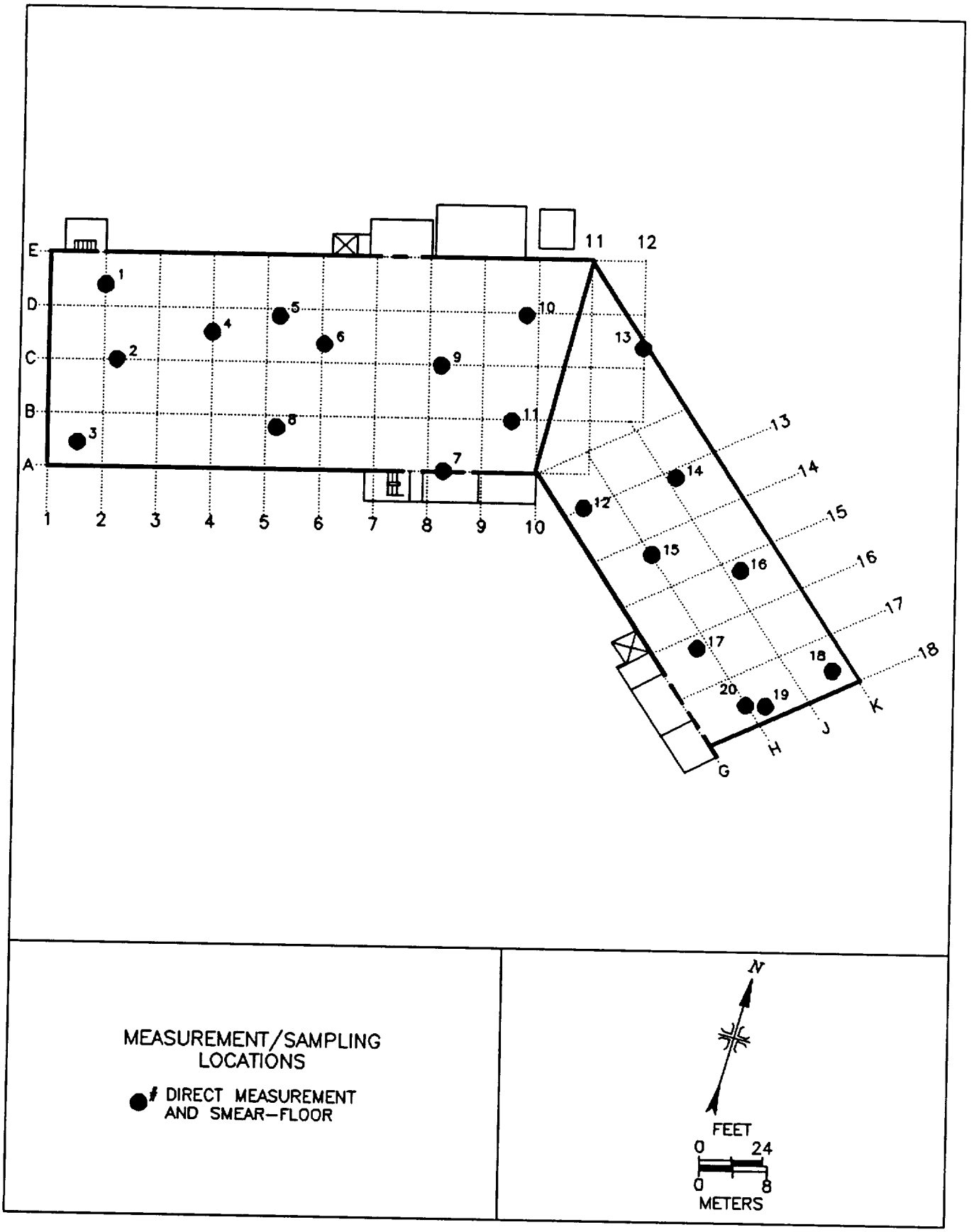

FIGURE 15: Building 8, Fourth Floor – Measurement and Sampling Locations

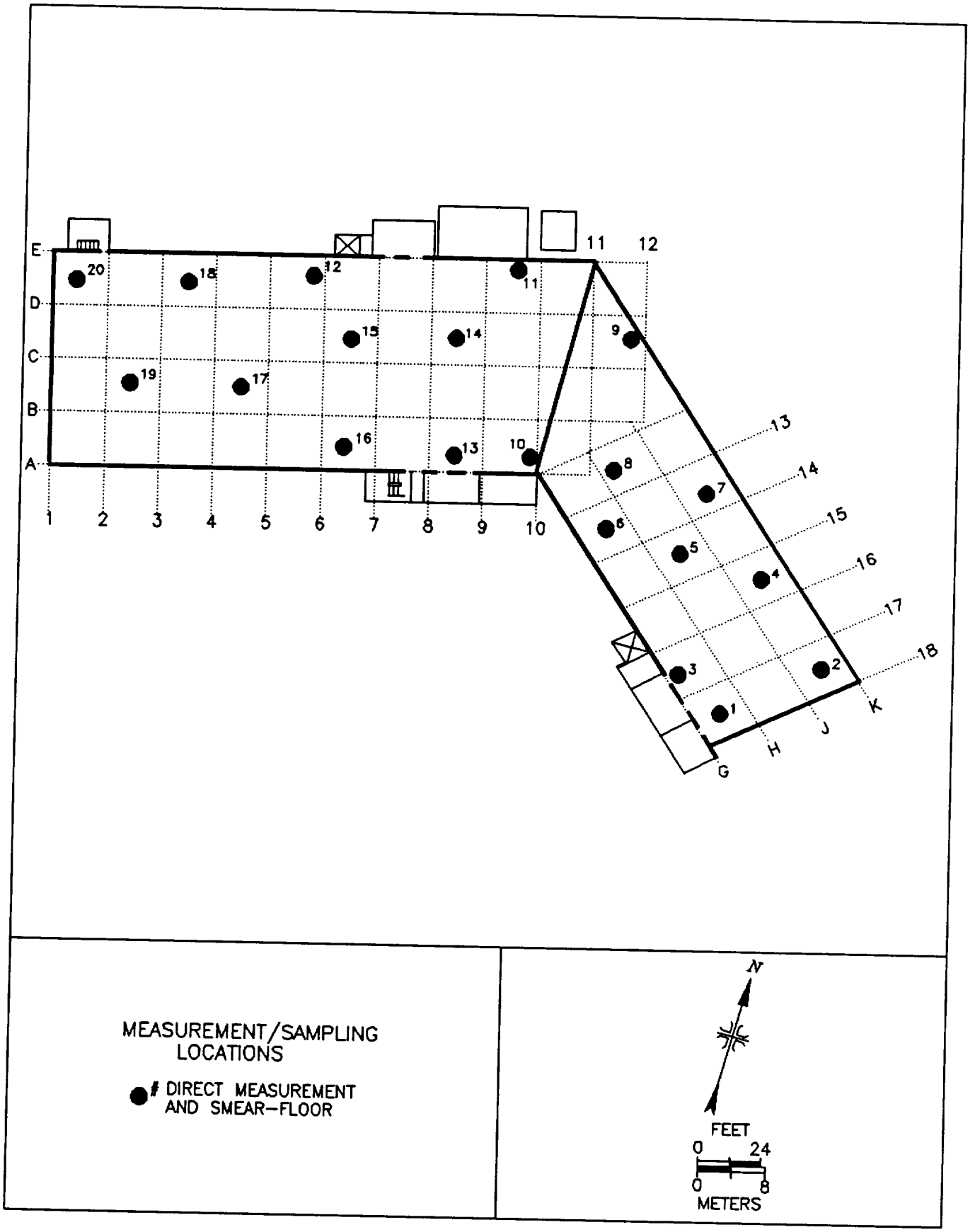

FIGURE 16: Building 8, Fifth Floor – Measurement and Sampling Locations

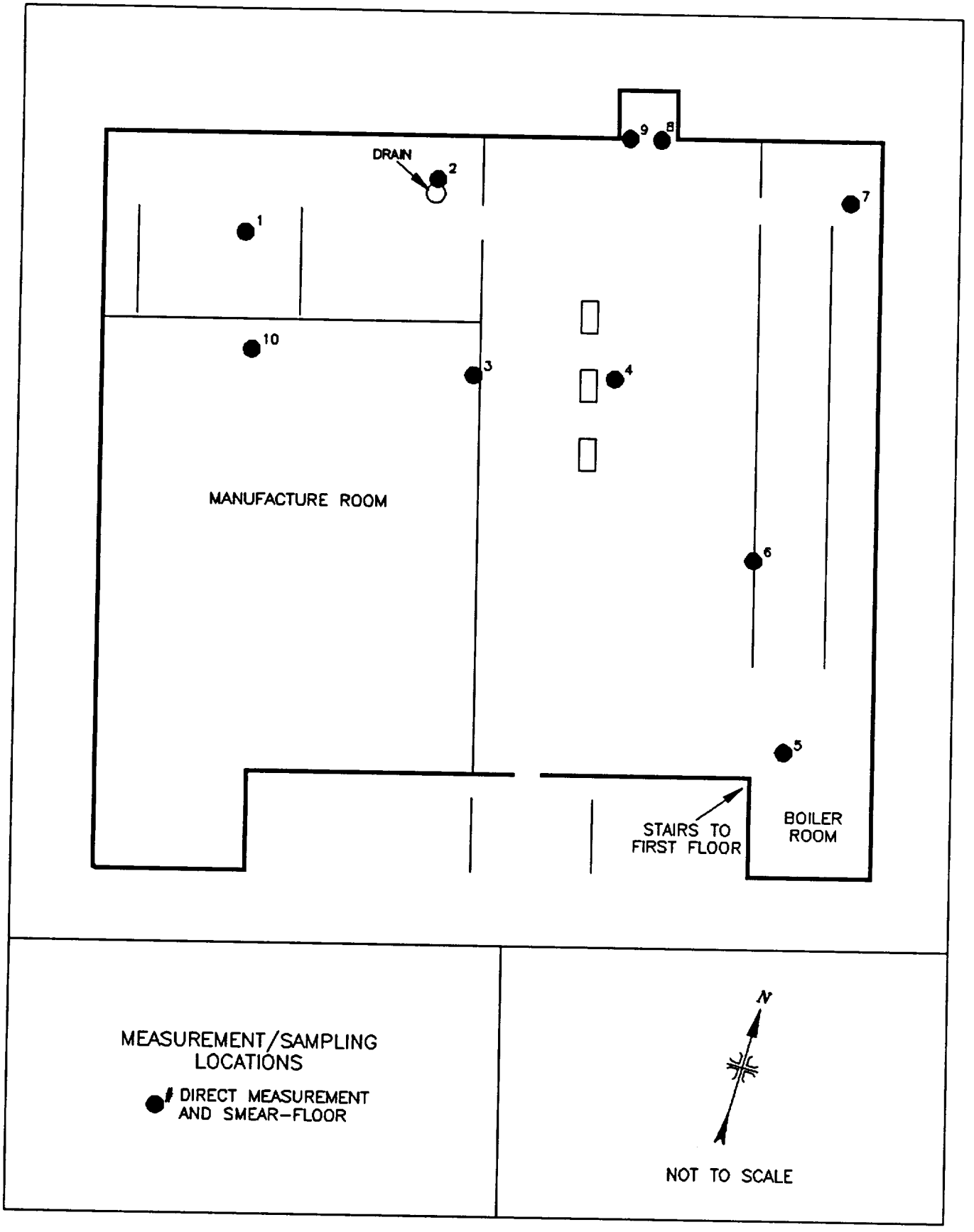

FIGURE 17: Building 8, Basement – Measurement and Sampling Locations

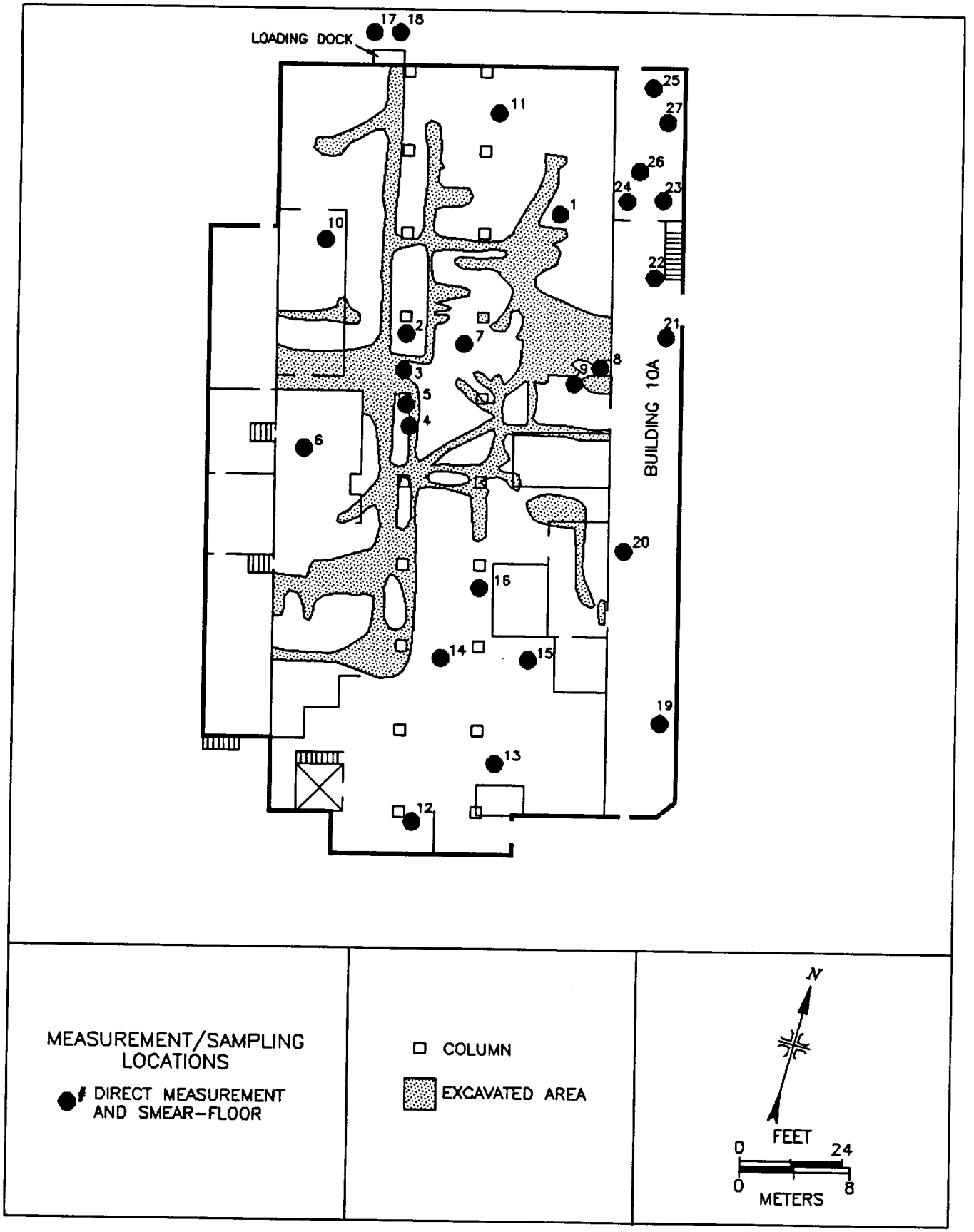

FIGURE 18: Buildings 9 and 10A – Measurement and Sampling Locations

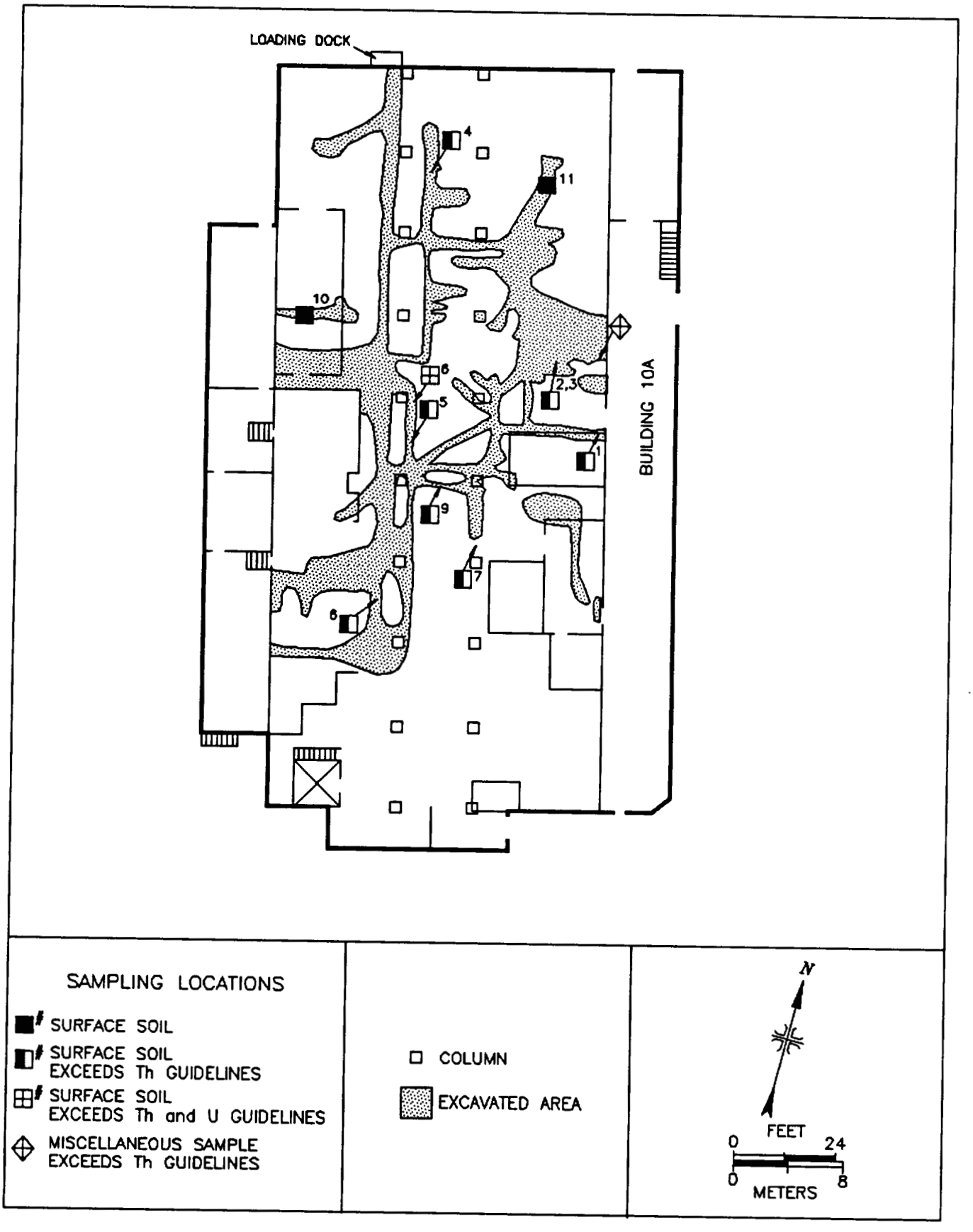

FIGURE 19: Buildings 9and 10A – Soil Sampling Locations

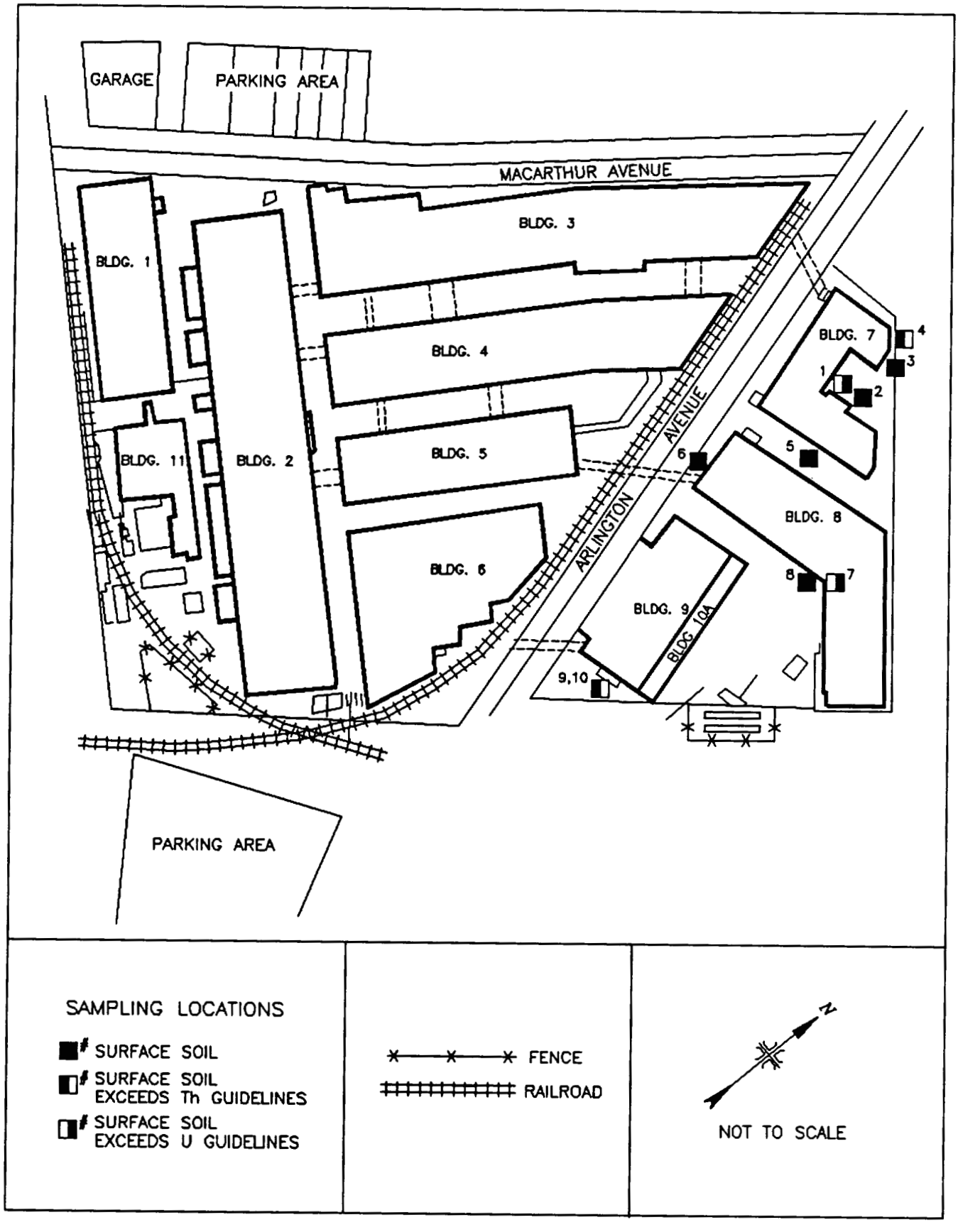

FIGURE 20: Outdoor Areas – Soil Sampling Locations

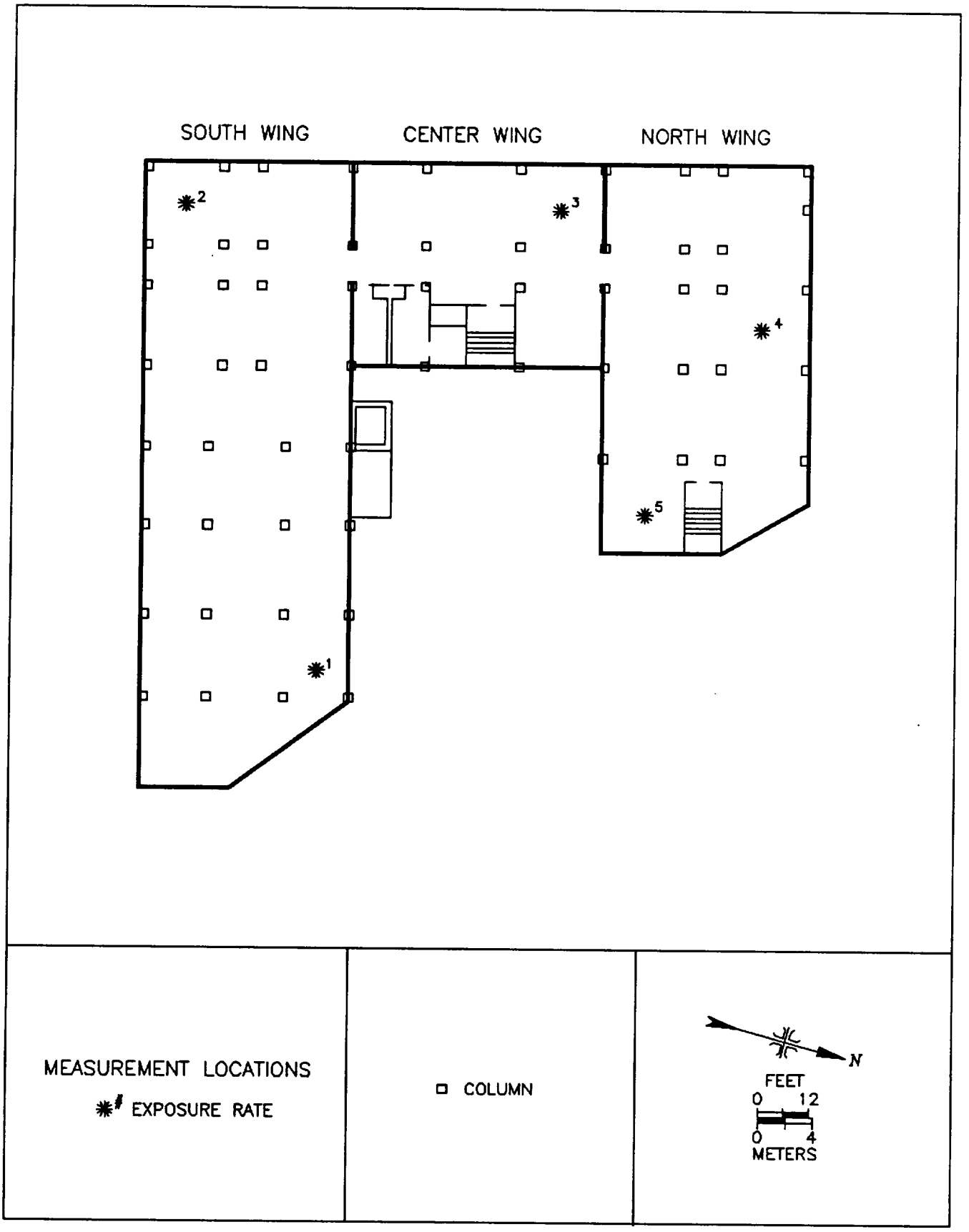

FIGURE 21: Building 7, First Floor – Exposure Rate Measurement Locations

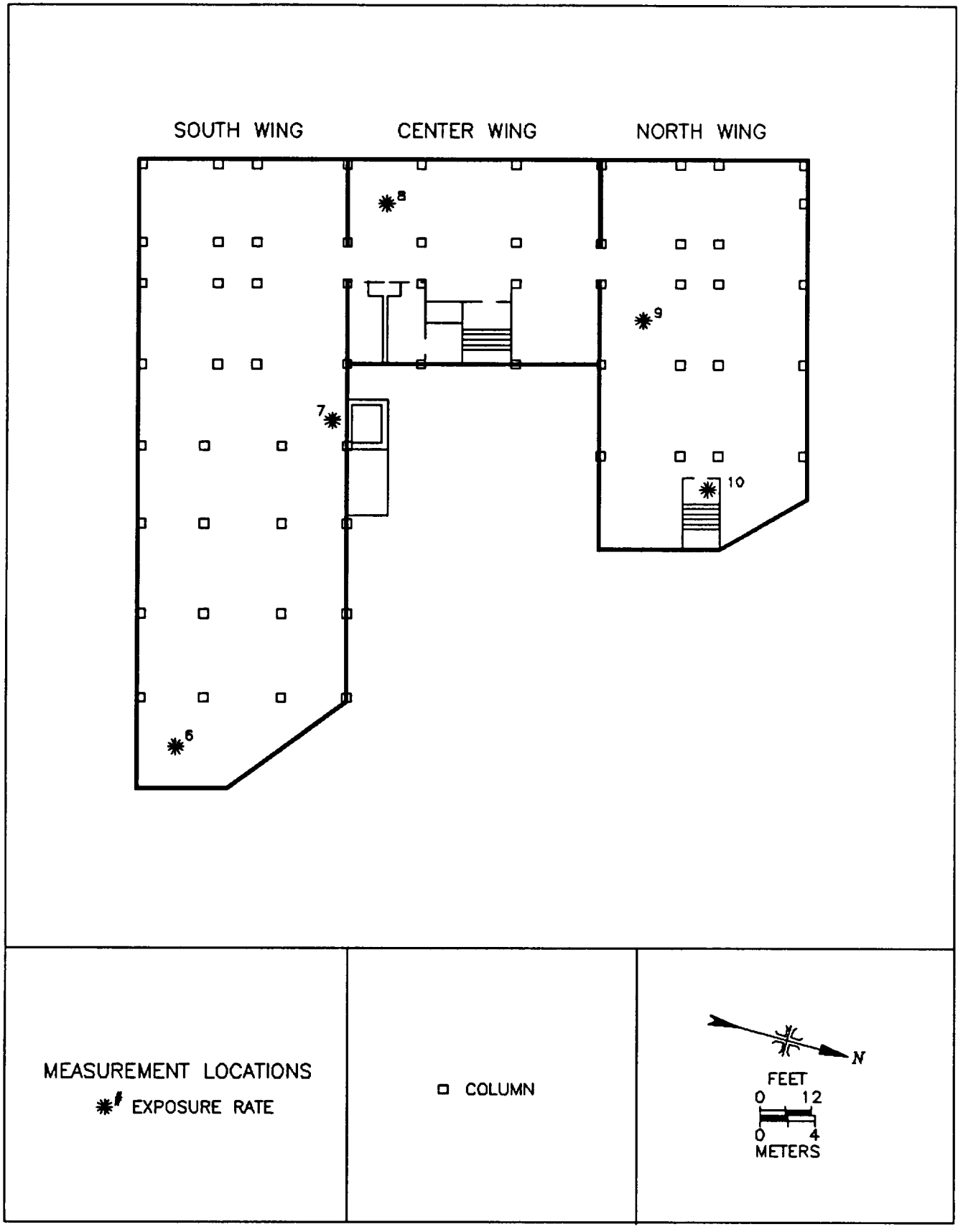

FIGURE 22: Building 7, Second Floor – Exposure Rate Measurement Locations

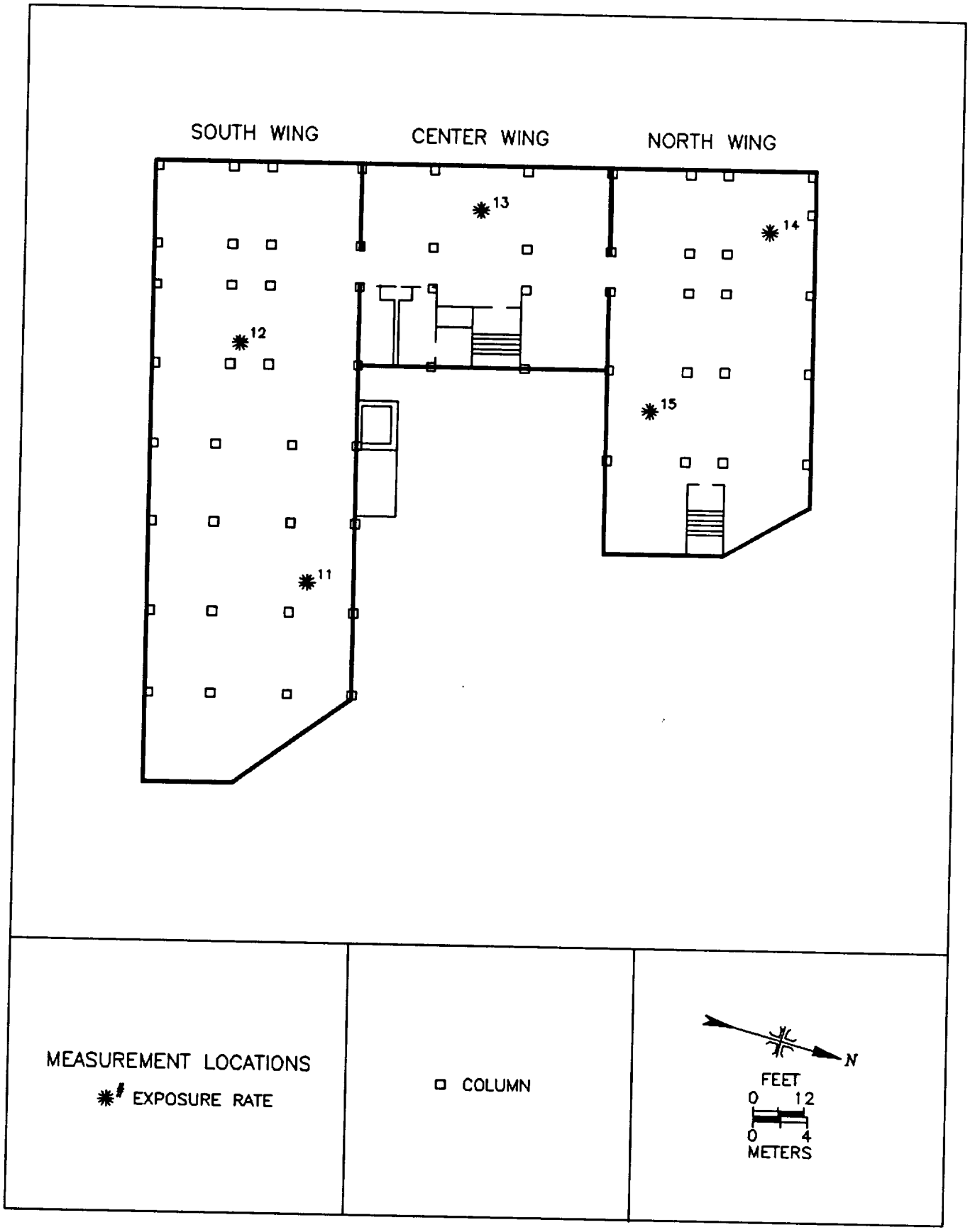

FIGURE 23: Building 7, Third Floor – Exposure Rate Measurement Locations

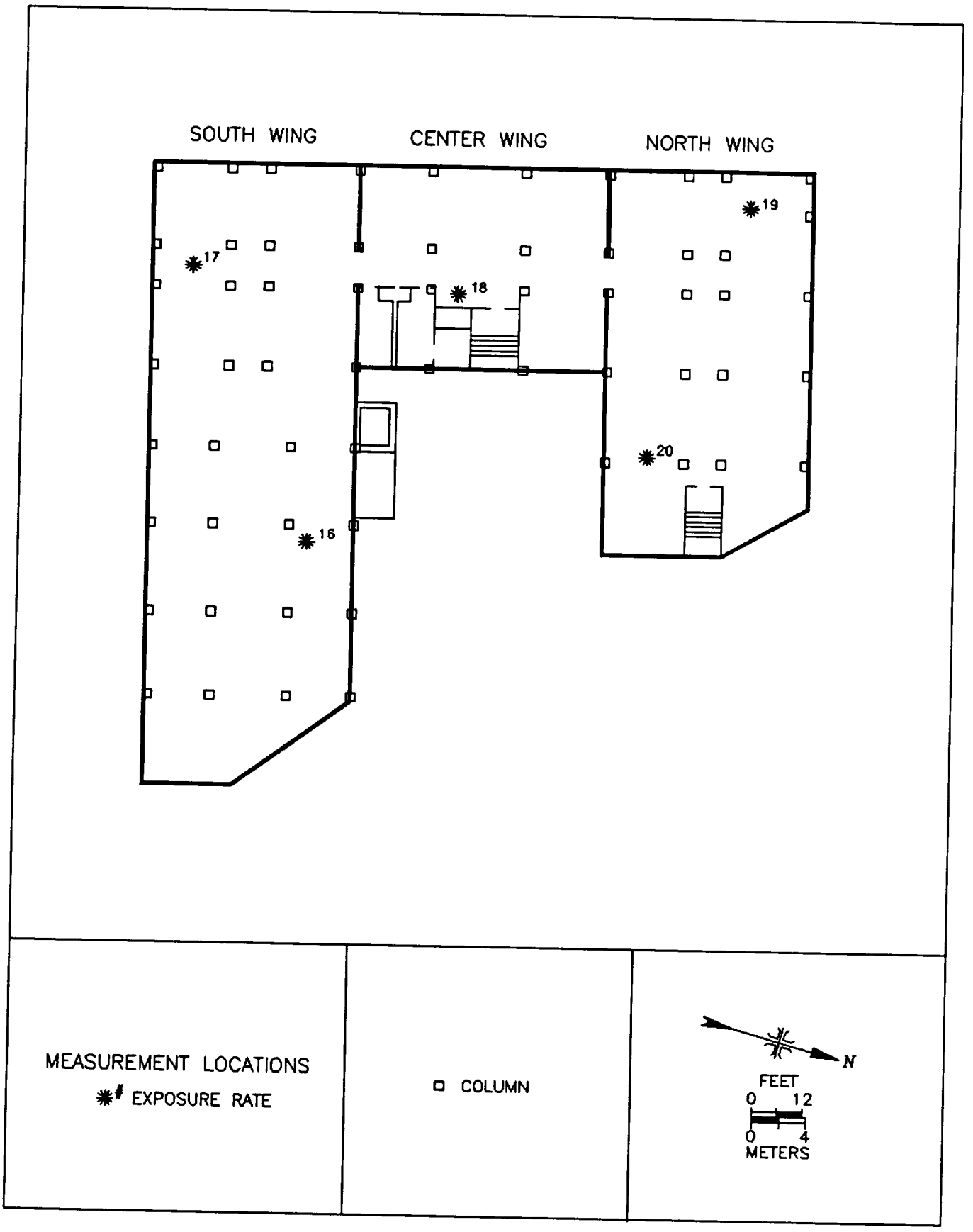

FIGURE 24: Building 7, Fourth Floor – Exposure Rate Measurement Locations

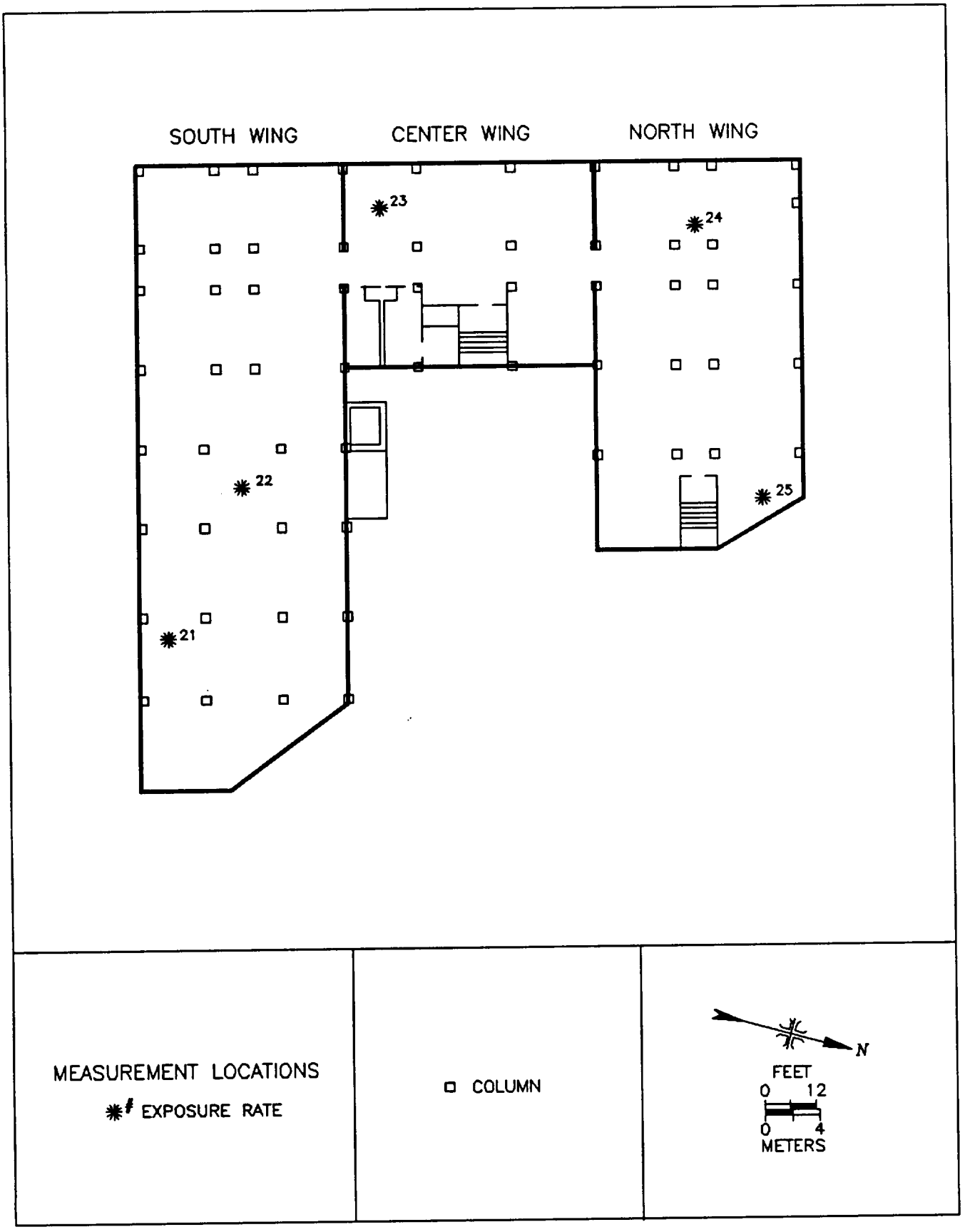

FIGURE 25: Building 7, Fifth Floor – Exposure Rate Measurement Locations

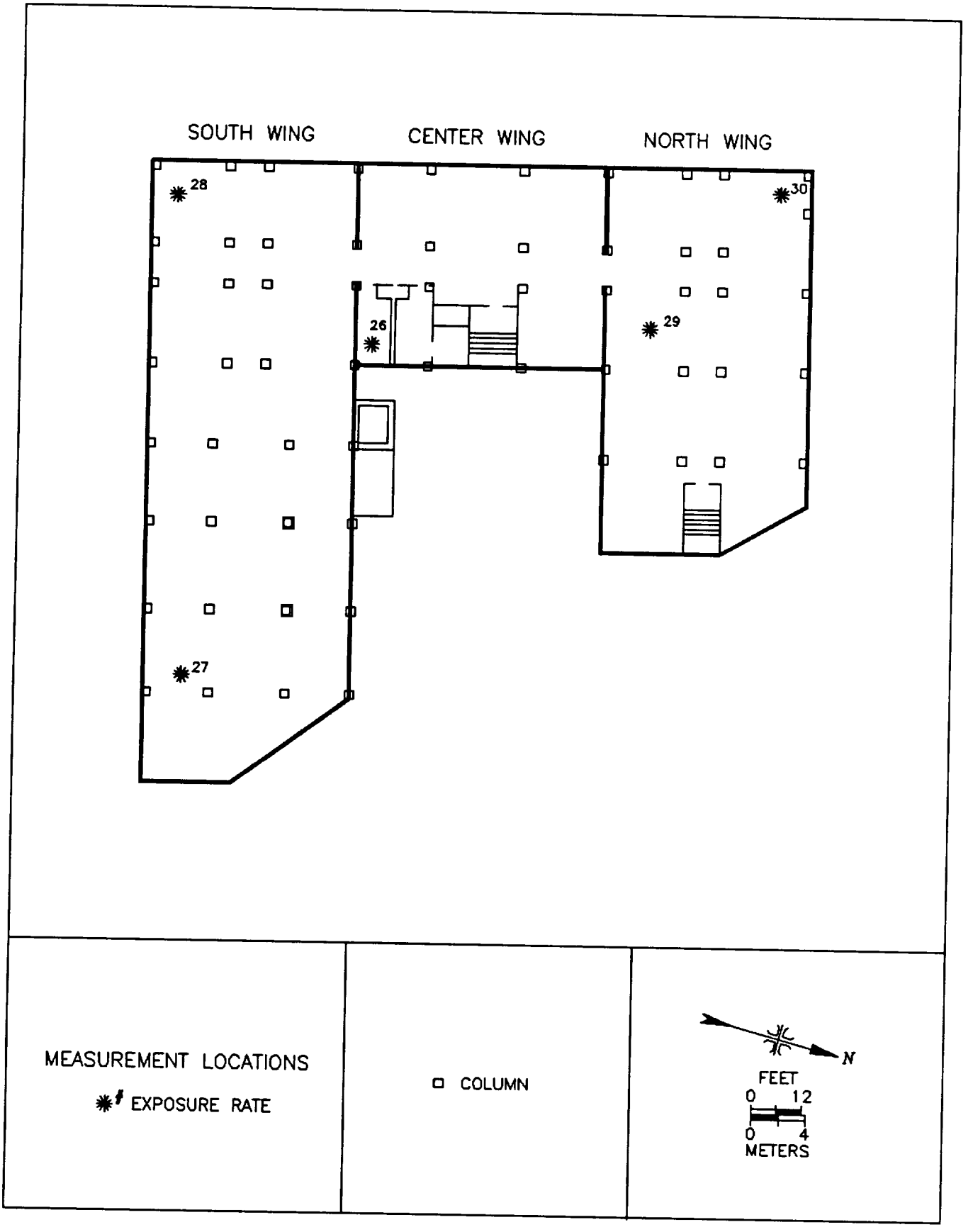

FIGURE 26: Building 7, Roof – Exposure Rate Measurement Locations

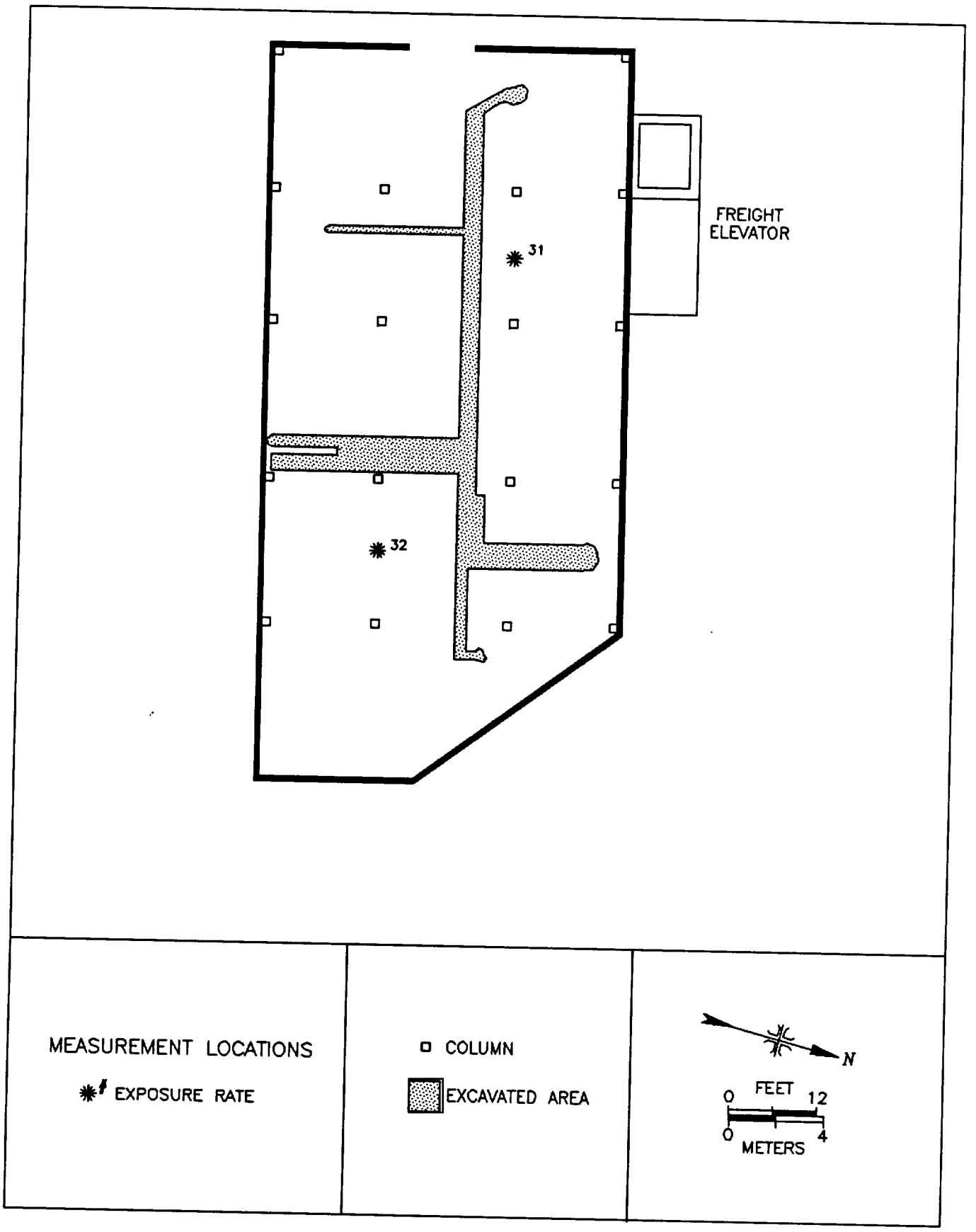

FIGURE 27: Building 7, Basement – Exposure Rate Measurement Locations

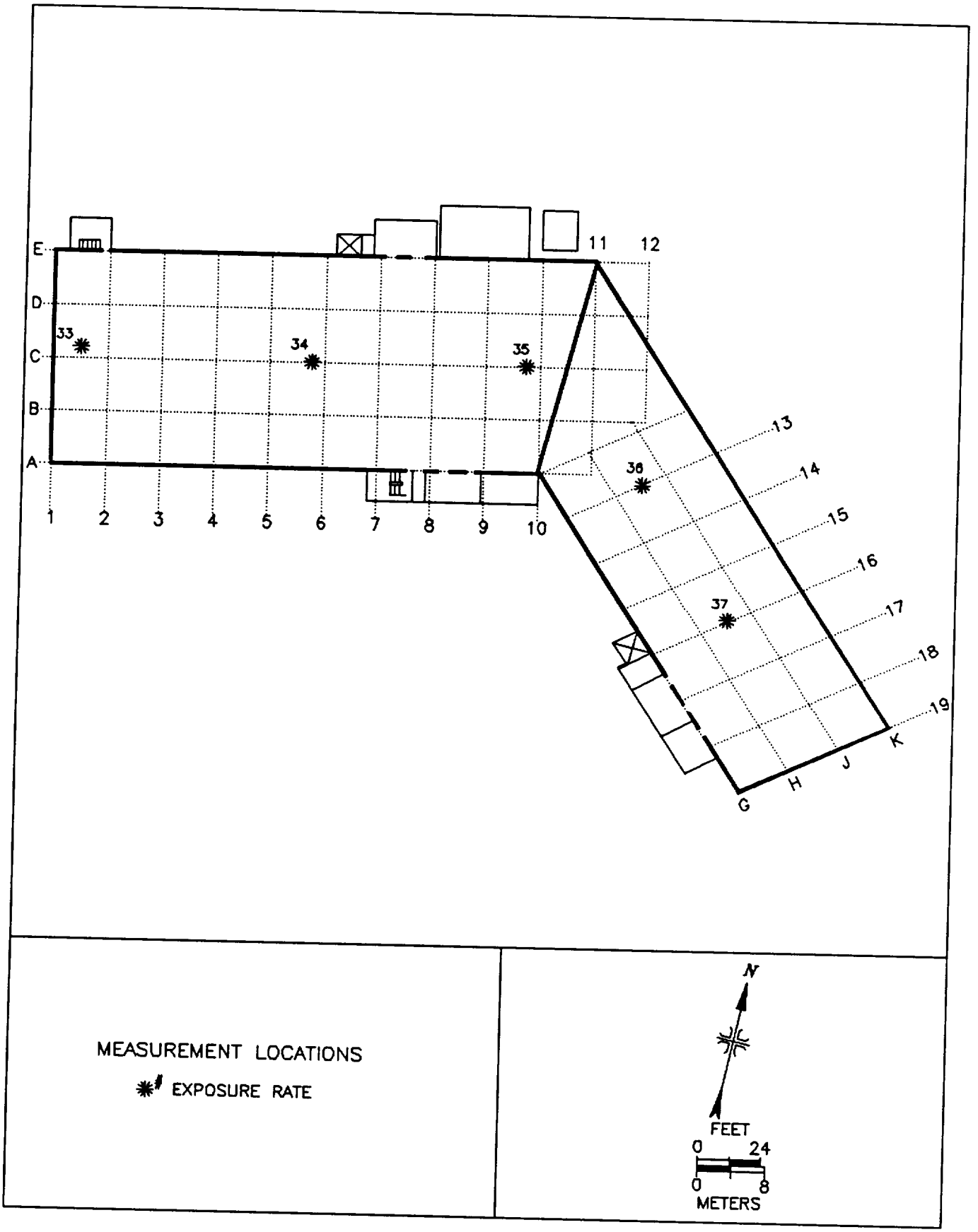

FIGURE 28: Building 8, First Floor – Exposure Rate Measurement Locations

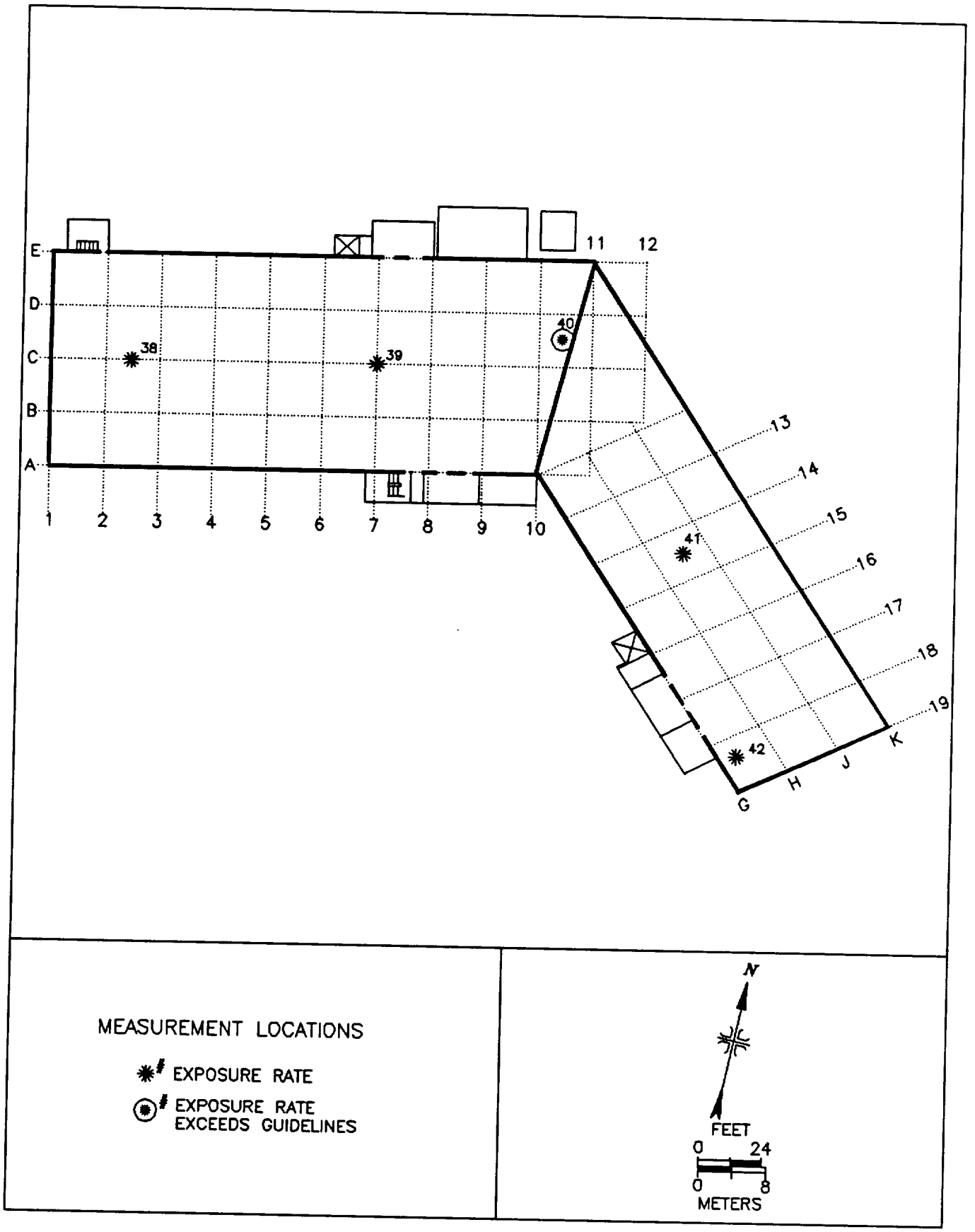

FIGURE 29: Building 8, Second Floor – Exposure Rate Measurement Locations

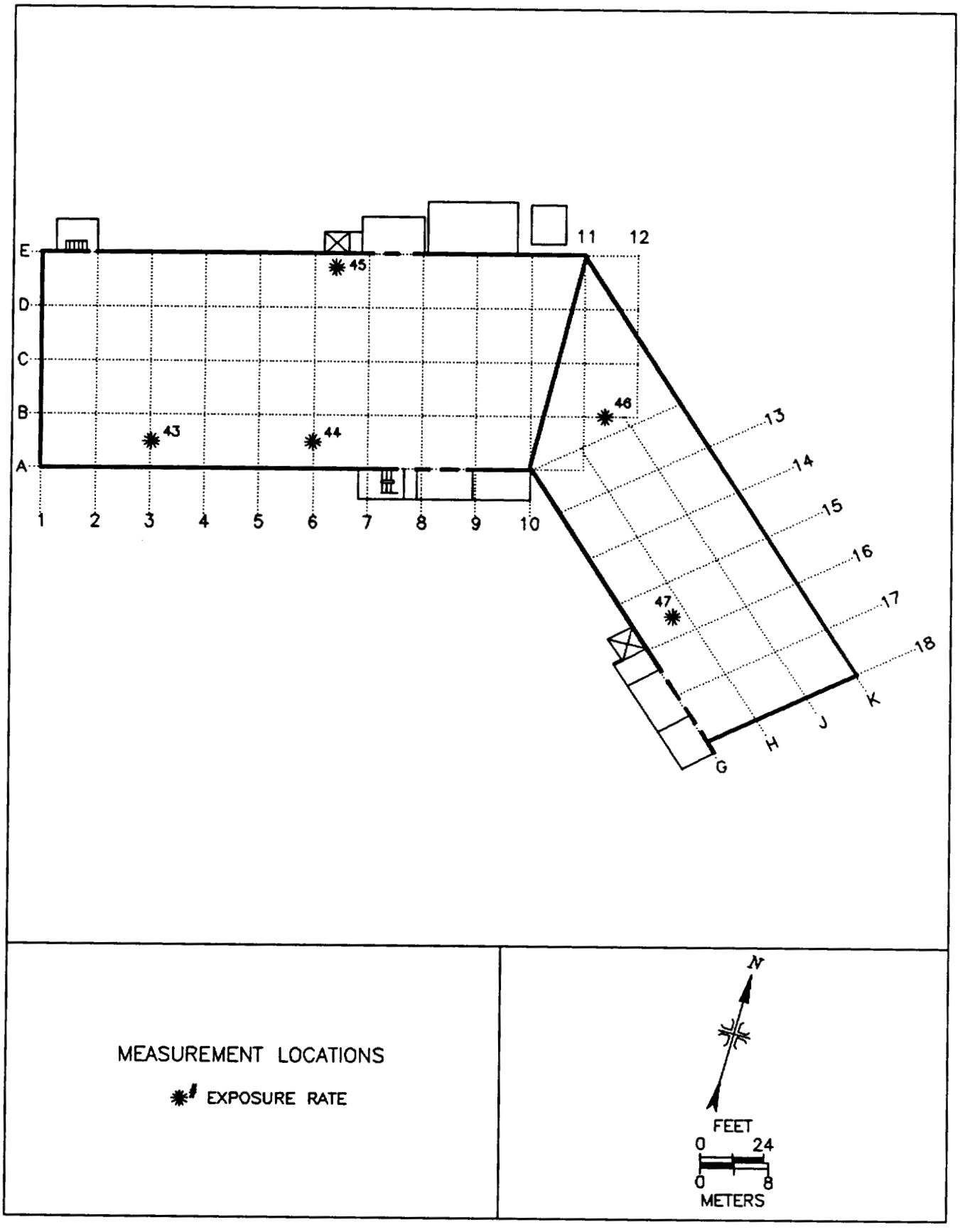

FIGURE 30: Building 8, Third Floor – Exposure Rate Measurement Locations

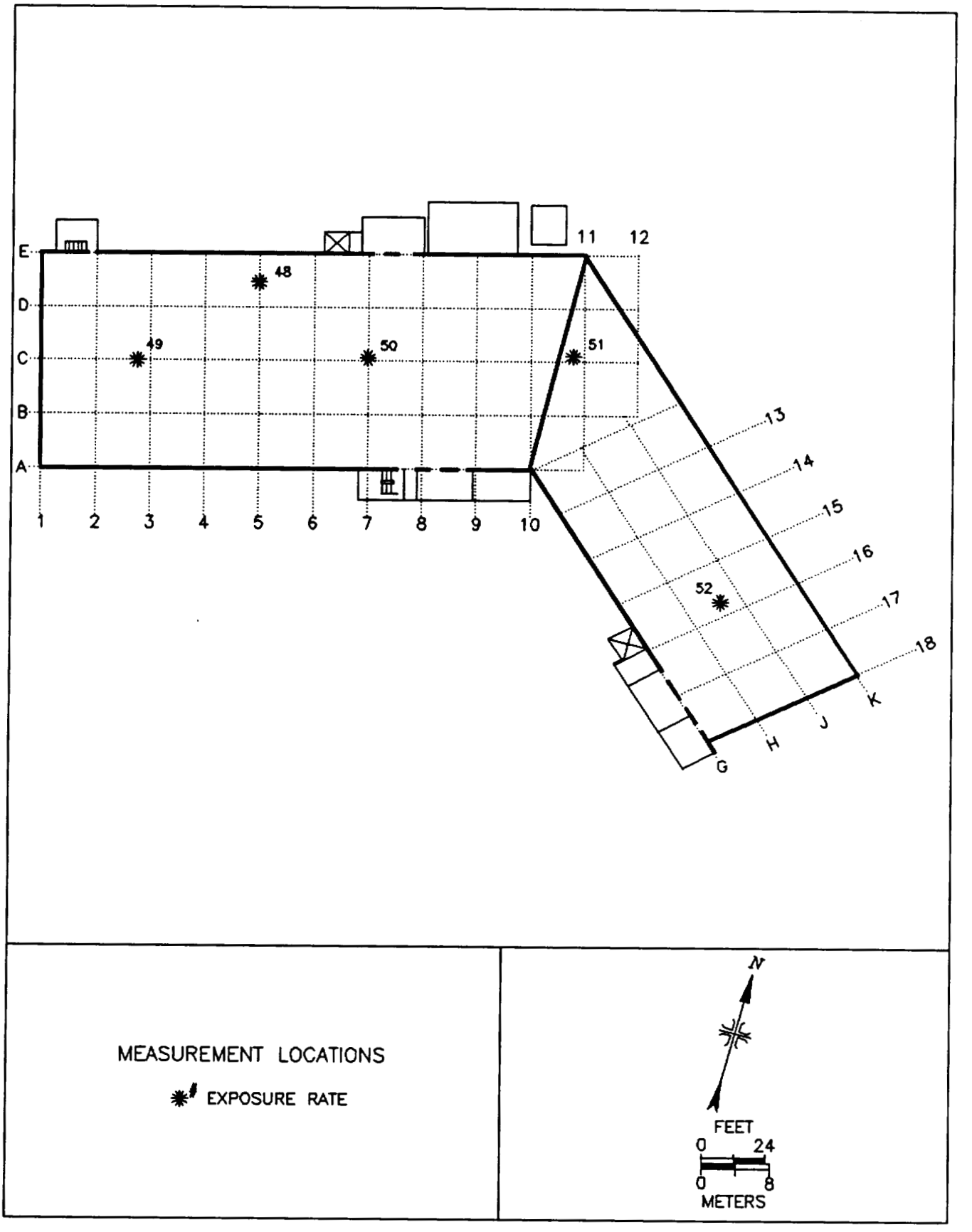

FIGURE 31: Building 8, Fourth Floor – Exposure Rate Measurement Locations

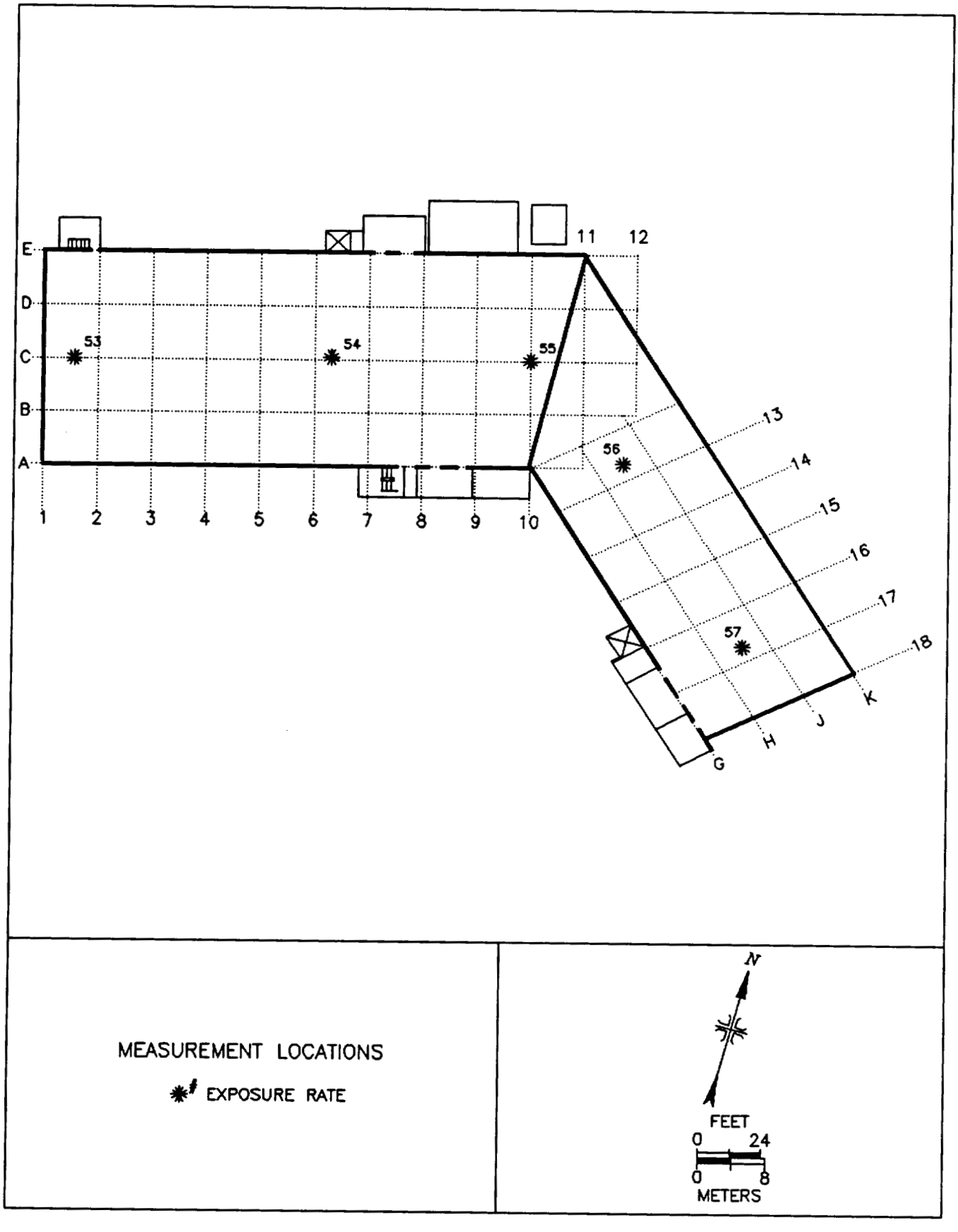

FIGURE 32: Building 8, Fifth Floor – Exposure Rate Measurement Locations

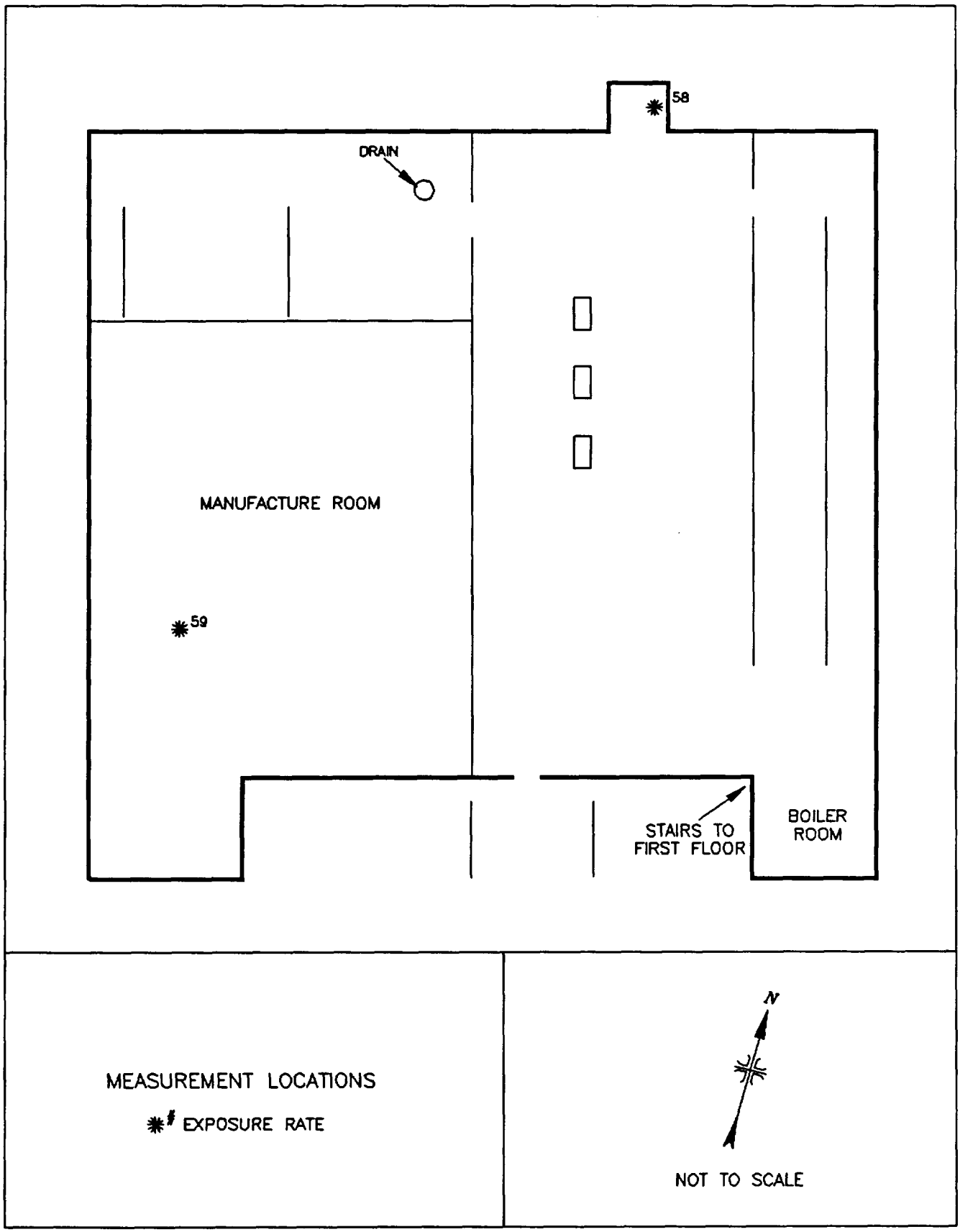

FIGURE 33: Building 8, Basement – Exposure Rate Measurement Locations

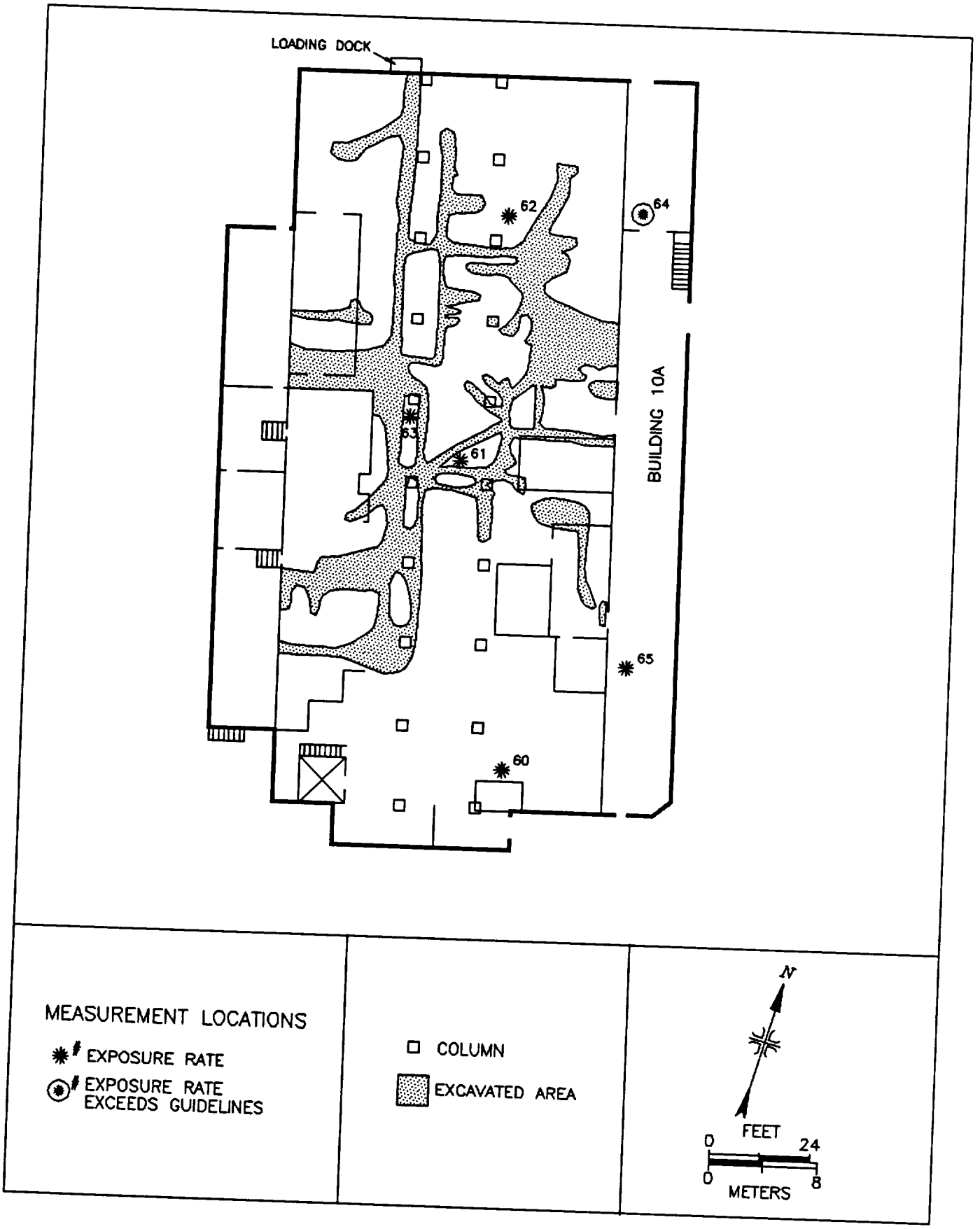

FIGURE 34: Buildings 9 and 10A – Exposure Rate Measurement Locations

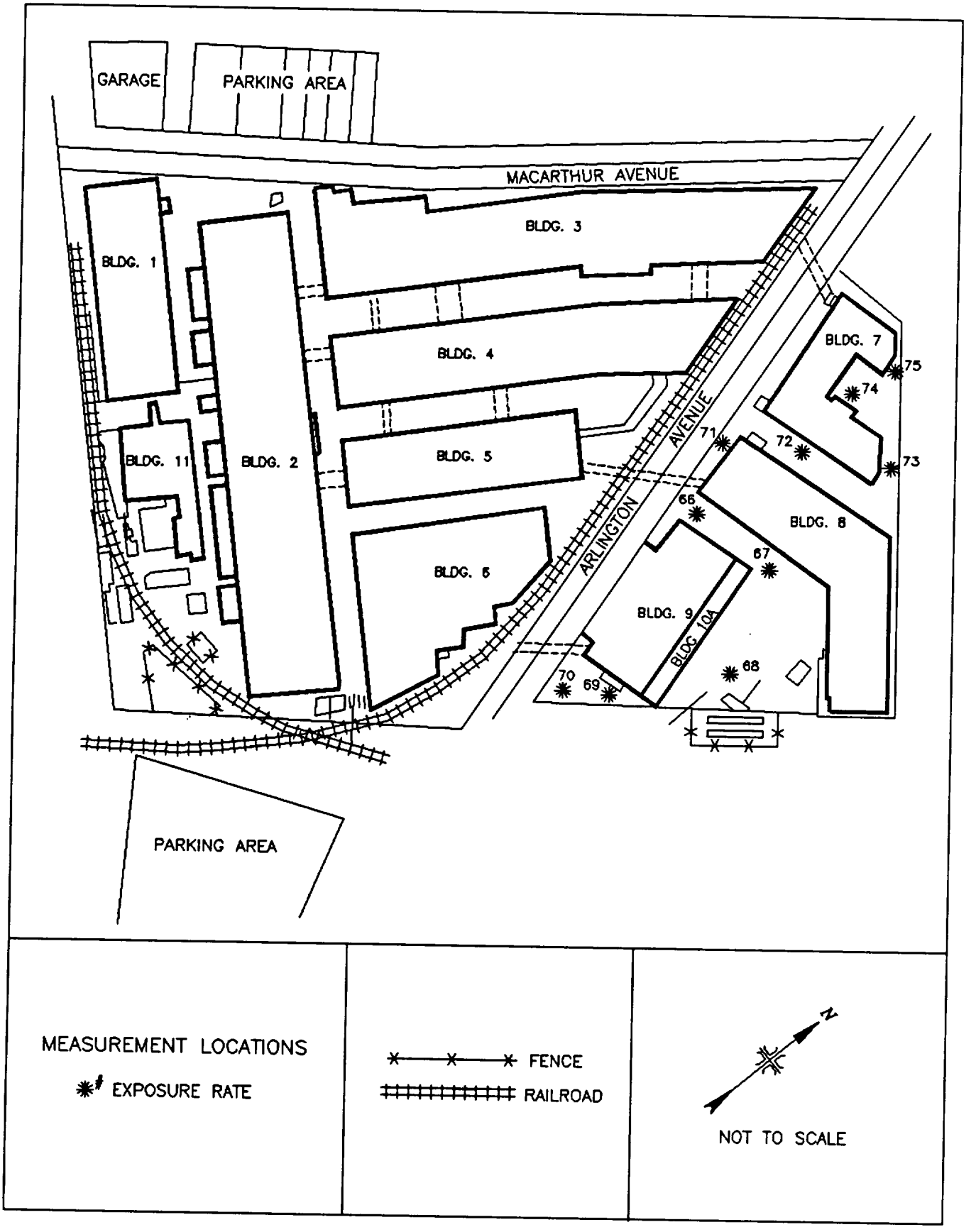

FIGURE 35: Outdoor Areas – Exposure Rate Measurement Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS FOR BUILDING 7 WESTINGHOUSE ELECTRIC CORPORATION BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)	
	Alpha	Beta	Alpha	Beta
First Floor				
Location 1	74	6,300	<12	<20
Location 2	<49	<630	<12	<20
Location 3	<49	<630	<12	<20
Location 4	<49	940	<12	<20
Location 5	74	2,000	<12	<20
Location 6	<49	4,100	<12	<20
Location 7	<49	850	<12	<20
Location 8	<49	<630	<12	<20
Location 9	<49	<630	<12	<20
Location 10	200	4,400	<12	<20
Location 11	63	1,500	<12	<20
Location 12	<49	1,100	<12	<20
Location 13	310	1,900	<12	<20
Location 14	<49	820	<12	<20
Location 15	<49	680	<12	<20
Location 16	120	1,500	<12	<20
Location 17	<49	650	<12	<20
Location 18	<49	<630	<12	<20
Location 19	<49	920	<12	<20
Location 20	<49	<630	<12	<20

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 7
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Location 21	<78	<1,300	<12	<20
Location 22	180	<1,300	<12	<20
Location 23	<78	<1,300	<12	<20
Location 24	<78	<1,300	<12	<20
Location 25	<78	<1,300	<12	<20
Location 26	<78	<1,300	<12	<20
Second Floor				
Location 1	660	6,600	<12	<20
Location 2	45	<560	<12	<20
Location 3	<41	580	<12	<20
Location 4	110	4,000	<12	<20
Location 5	<41	<560	<12	<20
Location 6	<41	<560	<12	<20
Location 7	<41	890	<12	<20
Location 8	<41	1,500	<12	<20
Location 9	<41	660	<12	<20
Location 10	<41	1,000	<12	<20
Location 11	<41	<560	<12	<20
Location 12	<41	<560	<12	<20
Location 13	<41	690	<12	<20
Location 14	<41	880	<12	<20
Location 15	290	27,000	<12	<20

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 7
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Location 16	<49	<630	<12	<20
Location 17	<49	<630	<12	<20
Location 18	<49	<630	<12	<20
Location 19	<49	<630	<12	<20
Location 20	<49	<630	<12	<20
Third Floor				
Location 1	110	7,200	<12	<20
Location 2	160	17,000	<12	<20
Location 3	<49	15,000	<12	<20
Location 4	110	8,600	<12	<20
Location 5	95	9,000	<12	<20
Location 6	<49	7,900	<12	<20
Location 7	11,000	36,000	130	90
Location 8	<49	<630	<12	<20
Location 9	<49	1,900	<12	<20
Location 10	<49	<630	<12	<20
Location 11	<49	<630	<12	<20
Location 12	<49	<630	<12	<20
Location 13	<49	<630	<12	<20
Location 14	<49	<630	<12	<20
Location 15	<49	<630	<12	<20
Location 16	<49	720	<12	<20

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 7
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Location 17	60	1,300	<12	<20
Location 18	<49	1,900	<12	<20
Location 19	<49	1,500	<12	<20
Location 20	<49	730	<12	<20
Fourth Floor				
Location 1	5,600	25,000	22	21
Location 2	<41	1,000	<12	21
Location 3	<41	<560	<12	<20
Location 4	<41	<560	<12	<20
Location 5	<41	2,300	<12	<20
Location 6	<41	<560	<12	<20
Location 7	<41	930	<12	<20
Location 8	<41	1,000	<12	<20
Location 9	70	1,800	<12	<20
Location 10	<41	<560	<12	<20
Location 11	<41	820	<12	<20
Location 12	<41	790	<12	<20
Location 13	<41	<560	<12	<20
Location 14	44	1,900	<12	<20
Location 15	<41	1,400	<12	<20
Location 16	<49	1,400	<12	<20
Location 17	<49	700	<12	<20

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 7
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Location 18	<49	<630	<12	<20
Location 19	<49	<630	<12	<20
Location 20	<49	<630	<12	<21
Fifth Floor				
Location 1	<49	680	<12	35
Location 2	<49	<630	<12	<20
Location 3	<49	<630	<12	<20
Location 4	<49	<630	<12	<20
Location 5	<49	960	<12	<20
Location 6	<49	720	<12	<20
Location 7	<49	<630	<12	<20
Location 8	52	960	<12	<20
Location 9	<49	910	<12	<20
Location 10	<49	670	<12	<20
Location 11	<49	<630	<12	<20
Location 12	<49	<630	<12	<20
Location 13	<49	<630	<12	<20
Location 14	<49	990	<12	<20
Location 15	<49	990	<12	<20
Location 16	52	<630	<12	<20
Location 17	<49	690	<12	<20
Location 18	<49	1,800	<12	<20

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 7
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Location 19	<49	1,600	<12	<20
Location 20	<49	790	<12	<20
Basement				
Location 1	85	6,600	<12	<20
Location 2	<78	24,000	<12	<20
Location 3	170	16,000	<12	<20
Location 4	130	29,000	<12	<20
Location 5	130	6,400	<12	<20
Location 6	280	10,000	<12	<20
Location 7	<78	4,000	<12	<20
Location 8	85	6,800	<12	<20
Location 9	130	52,000	<12	<20
Location 10	<80	1,800	<12	<20
Location 11	<80	1,600	<12	<20
Location 12	370	13,000	<12	<20
Location 13	350	28,000	<12	<20
Location 14	95	9,700	<12	<20
Location 15	<78	35,000	<12	<20
Location 16	<78	4,300	<12	<20
Location 17	220	26,000	<12	<20
Location 18	120	11,000	<12	<20

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 7
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Roof				
Location 1	<78	<1,300	<12	<25
Location 2	<78	<1,300	<12	<20
Location 3	<78	<1,300	<12	<20
Location 4	<78	<1,300	<12	<20
Location 5	<78	<1,300	<12	<20
Location 6	<78	<1,300	<12	<20
Location 7	<78	<1,300	<12	<20
Location 8	<78	<1,300	<12	<20
Location 9	<78	<1,300	<12	<20
Location 10	<78	<1,300	<12	<20
Location 11	<78	<1,300	<12	<20
Location 12	<78	<1,300	<12	<20
Location 13	<78	<1,300	<12	<20
Location 14	<78	<1,300	<12	<20
Location 15	<78	<1,300	<12	<20
Location 16	<78	<1,300	<12	<20
Location 17	<78	<1,300	<12	<20
Buffalo Blower Room				
Location 1	150	1,700	<12	<20
Location 2	<78	<1,300	<12	<20
Location 3	<78	1,400	<12	<20

TABLE 1 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 7
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Location 4	<78	<1,300	<12	<20
Location 5	240	2,000	<12	<20
Location 6	95	<1,300	<12	<20
Location 7	<78	<1,300	<12	<20
Location 8	<78	<1,300	<12	<20
Location 9	<78	<1,300	<12	<20
Location 10	<78	<1,300	<12	<20
Location 11	<78	1,600	<12	<20
Location 12	<78	<1,300	<12	<20

[a]Refer to Figures 3 - 11.

TABLE 2

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS FOR BUILDING 8 WESTINGHOUSE ELECTRIC CORPORATION BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
First Floor				
Location 1	<49	630	<12	<20
Location 2[b]	<49	10,000[b]	<12	<20
Location 3	53	<630	<12	<20
Location 4	120	<630	<12	<20
Location 5	<49	<630	<12	<20
Location 6	<49	<630	<12	<20
Location 7	<49	<630	<12	<20
Location 8	68	<630	<12	<20
Location 9	<49	1,600	<12	<20
Location 10	<49	<630	<12	<20
Location 11	<49	<630	<12	<20
Location 12	120	<630	<12	<20
Location 13	<49	<630	<12	<20
Location 14	<49	<630	<12	<20
Location 15	84	<630	<12	<20
Location 16	<49	<630	<12	<20
Location 17	<49	<630	<12	<20
Location 18	<49	<630	<12	<20
Location 19	74	<630	<12	<20
Location 20	<49	<630	<12	<20
Location 21	<49	<630	<12	<20

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 8
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Second Floor				
Location 1	53	2,800	<12	<20
Location 2	<49	<630	<12	<20
Location 3	<49	<630	<12	<20
Location 4	<49	<630	<12	<20
Location 5	<49	<630	<12	<20
Location 6	<49	<630	<12	<20
Location 7	<49	<630	<12	<20
Location 8	<49	<630	<12	<20
Location 9	<49	<630	<12	<20
Location 10	<49	<630	<12	<20
Location 11	<49	<630	<12	<20
Location 12	<49	<630	<12	<20
Location 13	<49	<630	<12	<20
Location 14	<49	1400	<12	<20
Location 15	63	650	<12	<20
Location 16	<49	<630	<12	<20
Location 17	<49	<630	<12	<20
Location 18	<49	1,200	<12	<20
Location 19	58	<630	<12	<20
Location 20	74	1,100	<12	<20
Location 21	110	<1,300	<12	<20
Location 22	<78	<1,300	<12	<20

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 8
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Third Floor				
Location 1	<41	<560	<12	<20
Location 2	<41	<560	<12	<20
Location 3	110	6,100	<12	<20
Location 4	610	15,000	<12	<20
Location 5	<41	<560	<12	<20
Location 6	44	13,000	<12	<20
Location 7	110	<560	<12	<20
Location 8	50	9,500	<12	<20
Location 9	<41	<560	<12	<20
Location 10	<41	<560	<12	<20
Location 11	<41	<560	<12	<20
Location 12	<41	<560	<12	<20
Location 13	<41	<560	<12	<20
Location 14	<41	<560	<12	<20
Location 15	<41	<560	<12	<20
Location 16	<41	<560	<12	<20
Location 17	<41	<560	<12	<20
Location 18	44	920	<12	<20
Location 19	<41	<560	<12	<20
Location 20	50	850	<12	<20

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 8
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Fourth Floor				
Location 1	<49	<630	12	21
Location 2	<49	<630	<12	21
Location 3	<49	<630	<12	<20
Location 4	<49	<630	<12	<20
Location 5	<49	<630	<12	<20
Location 6	<49	<630	<12	<20
Location 7	<49	<630	<12	<20
Location 8	<49	<630	<12	<20
Location 9	<49	<630	<12	<20
Location 10	170	<630	<12	<20
Location 11	<49	<630	<12	<20
Location 12	89	1,300	<12	<20
Location 13	<49	<630	<12	<20
Location 14	<49	<630	<12	<20
Location 15	<49	<630	<12	<20
Location 16	53	<630	<12	<20
Location 17	58	<630	<12	<20
Location 18	53	<630	<12	<20
Location 19	1,200	2,900	<12	<20
Location 20	3,300	21,000	12	<20

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 8
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Fifth Floor				
Location 1	<49	<630	<12	<20
Location 2	<49	<630	<12	<20
Location 3	<49	<630	<12	<20
Location 4	<49	<630	<12	<20
Location 5	<49	<630	<12	<20
Location 6	<49	<630	<12	<20
Location 7	<49	<630	<12	<20
Location 8	<49	<630	<12	<20
Location 9	<49	<630	<12	<20
Location 10	<49	<630	<12	<20
Location 11	<49	<630	<12	<20
Location 12	<49	<630	<12	<20
Location 13	<49	<630	<12	<20
Location 14	<49	<630	<12	<20
Location 15	<49	<630	<12	<20
Location 16	<49	<630	<12	<20
Location 17	<49	<630	<12	<20
Location 18	<49	<630	<12	<20
Location 19	<49	<630	<12	<20
Location 20	<49	1,000	<12	<20

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 8
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
Basement				
Location 1	<49	<630	<12	<20
Location 2	<49	890	<12	<20
Location 3	<49	<630	<12	<20
Location 4	110	25,000	<12	<20
Location 5	160	5,300	<12	<20
Location 6	<49	<630	<12	<20
Location 7	<49	<630	<12	<20
Location 8	2,100	50,000	38	27
Location 9	<49	850	<12	<20
Location 10	<49	<630	<12	<20

[a]Refer to Figures 12 - 17.
[b]The area of elevated activity at this location was approximately 100 m^2. A five-point measurement was performed at location #2. The average activity over the 1 m^2 area was 6,600 dpm/100 cm.

TABLE 3

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS FOR BUILDINGS 9 AND 10A WESTINGHOUSE ELECTRIC CORPORATION BLOOMFIELD, NEW JERSEY

Location[a]	Single-Point Measurements Total Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)	
	Alpha	Beta	Alpha	Beta
Building 9				
Location 1	72	700	<12	<20
Location 2	9,300	61,000	<12	<20
Location 3	2,500	13,000	<12	<20
Location 4	24,000	44,000	<12	<20
Location 5	1,800	8,500	<12	<20
Location 6	170	1,000	<12	<20
Location 7	110	940	<12	<20
Location 8	14,000	49,000	<12	<20
Location 9	17,000	33,000	<12	<20
Location 10	4,100	28,000	<12	<20
Location 11	310	1,200	<12	<20
Location 12	2,500	6,400	<12	<20
Location 13	89	3,900	<12	<20
Location 14	130	2,900	<12	<20
Location 15	120	950	<12	<20
Location 16	94	890	<12	<20
Location 17	570	8,200	<12	<20
Location 18	340	9,000	<12	<20
Building 10A				
Location 19	210	1,600	<12	<20
Location 20	150	860	<12	<20
Location 21	67	860	<12	<20
Location 22	13,000	110,000	<12	<20
Location 23	67,000	530,000	130	88
Location 24	69,000	830,000	67	71
Location 25	1,400	5,200	<12	<20
Location 26	2,100	7,300	<12	<20
Location 27	2,300	4,200	<12	<20

[a]Refer to Figure 18.

TABLE 4

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS FOR BUILDING 7 FREIGHT ELEVATOR, STAIRWELLS, AND PIPE CHASE WESTINGHOUSE ELECTRIC CORPORATION BLOOMFIELD, NEW JERSEY

Location	Single Point Measurements Total Activity (dpm/100 cm²)		Removable Activity (dpm/100 cm²)	
	Alpha	Beta	Alpha	Beta
FREIGHT ELEVATOR				
Floor, Center	<80	<1,300	<12	<20
Floor, Front Near Door	<80	<1,300	<12	<20
Under Floor, Left Front	<80	<1,300	<12	<20
Under Floor, Center Front	<80	<1,300	<12	<20
Under Floor, Right Front	<80	<1,300	<12	<20
Door, Bottom Center	170	3,800	<12	<20
Left Track at Door	N/A[a]	92,000	24	54
Right Track at Door	N/A	20,000	22	25
SOUTHEAST STAIRS				
First Floor, Landing	100	4,400	<12	<20
First Floor, Upper	720	10,000	<12	<20
Second Floor, Lower	140	4,000	<12	<20
Second Floor, Upper	95	2,100	<12	<20
Fourth Floor, Lower	100	2,500	<12	<20
Fourth Floor, Upper	200	2,900	<12	<20
Fifth Floor, Lower	120	2,500	<12	<20
Fifth Floor, Upper	80	1,700	<12	<20

TABLE 4 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
FOR BUILDING 7 FREIGHT ELEVATOR, STAIRWELLS, AND PIPE CHASE
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location	Single Point Measurements Total Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)	
	Alpha	Beta	Alpha	Beta
MIDDLE STAIRS				
First Floor, Lower	<50	1,200	<12	<20
First Floor, Upper	<50	1,300	<12	<20
Second Floor, Lower	<50	990	<12	<20
Second Floor, Upper	<50	820	<12	<20
Third Floor, Lower	<50	1,200	<12	<20
Third Floor, Upper	60	<630	<12	<20
Fourth Floor, Lower	<50	1,600	<12	<20
Fourth Floor, Upper	50	3,200	<12	<20
Fifth Floor, Lower	<50	1,700	<12	<20
Fifth Floor, Upper	50	2,100	<12	<20
PIPE CHASE				
First Floor, S.E. Corner Floor	110	2,000	<12	<20
Second Floor, NW Corner	310	4,700	<12	<20
Third Floor, Floor Center	200	11,000	<12	<20
Fourth Floor, Short Concrete Runner	85	10,000	<12	<20
Fifth Floor, North Pipe	690	1,800	<12	<20

[a]Measurement not performed due to inaccessibility to probe.

TABLE 5

BUILDING INTERIORS
EXPOSURE RATES
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Exposure Rate at 1 m above surface (uR/h)
BUILDING 7	
First Floor	
Location 1, Room 124	11
Location 2, Room 118	10
Location 3, Room 112	10
Location 4, Room 109	10
Location 5, Room 106	9
Second Floor	
Location 6, South Stairwell	11
Location 7, Freight Elevator	11
Location 8, Room 217	11
Location 9, Room 202	13
Location 10, North Stairwell	12
Third Floor	
Location 11, Room 316	12
Location 12, Hallway at Room 311	13
Location 13, Room 308 B	11
Location 14, Room 306	11
Location 15, Room 303	11
Fourth Floor	
Location 16	10
Location 17, Room 418	9
Location 18, Hallway at Elevator	13

TABLE 5 (Continued)

BUILDING INTERIORS
EXPOSURE RATES
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Exposure Rate at 1 m above surface (uR/h)
Location 19, Room 408	11
Location 20, Room 403	11
Fifth Floor	
Location 21	9
Location 22	9
Location 23, Room 515	10
Location 24	10
Location 25	10
Roof	
Location 26	7
Location 27	7
Location 28	9
Location 29	8
Location 30	7
Basement	
Location 31	7
Location 32	7
BUILDING 8	
First Floor	
Location 33	6
Location 34	7
Location 35	7
Location 36	6

TABLE 5 (Continued)

BUILDING INTERIORS
EXPOSURE RATES
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Exposure Rate at 1 m above surface (uR/h)
Location 37	6
Second Floor	
Location 38, between columns C2, C3	7
Location 39, C7	7
Location 40, between C11, D11	8
Location 41, Room 8	16
Location 42, Hallway	10
Third Floor	
Location 43, High Temp Room A3	10
Location 44, High Temp Room B7	8
Location 45, Freight Elevator Door D7	7
Location 46, B12	8
Location 47, Furnace Fire Area G15	6
Fourth Floor	
Location 48, Shipping Area	7
Location 49, Shipping Area C3	7
Location 50, Tungsten Annealing Area	7
Location 51	7
Location 52	7
Fifth Floor	
Location 53	8
Location 54	8
Location 55	7

TABLE 5 (Continued)

BUILDING INTERIORS
EXPOSURE RATES
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Exposure Rate at 1 m above surface (uR/h)
Location 56	7
Location 57	7
Basement	
Location 58	6
Location 59	7
BUILDING 9	
Location 60	9
Location 61	9
Location 62	8
Location 63	9
BUILDING 10A	
Location 64	18
Location 65	8

[a]Refer to Figures 21-34

TABLE 6

EXPOSURE RATES
OUTDOOR AREAS
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Exposure Rate at 1 m above surface (μR/h)
Location 66	8
Location 67	8
Location 68	9
Location 69	9
Location 70	9
Location 71	9
Location 72	8
Location 73	8
Location 74	14
Location 75	7

[a]Refer to Figure 35.

TABLE 7

THORIUM AND URANIUM CONCENTRATIONS IN SOIL
INTERIOR LOCATIONS
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location	Radionuclide Concentrations (pCi/g)					
	Th-232	Th-228	Total Th[a]	U-238	U-235	Total U[b]
Building 7						
Room 104[c], Location 1	3.5 ± 0.5[d]	3.5 ± 0.2	7	3.9 ± 1.1	0.1 ± 0.1	8
Location 2	32.1 ± 1.5	28.5 ± 0.6	61	5.8 ± 3.9	0.2 ± 0.2	12
Basement[e] Location 1	1.4 ± 0.4	1.3 ± 0.1	3	14.0 ± 1.9	0.9 ± 0.1	29
Location 2	1.8 ± 0.4	1.8 ± 0.2	4	101.3 ± 4.8	6.0 ± 0.2	209
Location 3	1.4 ± 0.4	1.4 ± 0.2	3	34.4 ± 2.9	2.0 ± 0.1	71
Location 4	0.4 ± 0.2	0.3 ± 0.1	1	10.4 ± 1.8	0.6 ± 0.1	21
Building 9[f]						
Location 1	21.9 ± 1.3	19.9 ± 0.5	42	4.6 ± 2.9	0.1 ± 0.1	9
Location 2	126.3 ± 3.1	111.6 ± 1.2	238	5.3 ± 6.7	<0.5	11
Location 3	606.2 ± 8.2	424.0 ± 2.7	1030	41 ± 1.5	0.9 ± 0.7	83
Location 4	13.2 ± 1.0	10.7 ± 0.4	24	2.0 ± 2.5	0.2 ± 0.2	4
Location 5	88.7 ± 2.9	76.3 ± 1.1	165	8.7 ± 5.9	<0.6	17
Location 6	26.8 ± 1.8	25.3 ± 0.7	52	2.6 ± 0.5	0.1 ± 0.1	5
Location 7	21.0 ± 1.1	18.5 ± 0.4	40	2.8 ± 1.7	<0.2	6
Location 8	26.7 ± 1.4	23.8 ± 0.6	51	2.9 ± 1.0	0.1 ± 0.1	6
Location 9	6.9 ± 0.7	6.3 ± 0.3	13	1.9 ± 1.7	0.2 ± 0.1	4
Location 10	1.6 ± 0.5	1.7 ± 0.2	3	1.9 ± 1.6	0.1 ± 0.1	4
Location 11	1.2 ± 0.3	1.1 ± 0.1	2	1.2 ± 0.6	0.1 ± 0.1	3

[a]Calculated by adding Th-232 and Th-228 concentrations.
[b]Calculation based on U-238 to U-234 activity ratio of 1:1 for natural uranium.
[c]Refer to Figure 3.
[d]Uncertainties represent the 95% confidence level, based only on counting statistics.
[e]Refer to Figure 9.
[f]Refer to Figure 19.

TABLE 8

THORIUM AND URANIUM CONCENTRATIONS IN SOIL
EXTERIOR LOCATIONS
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMFIELD, NEW JERSEY

Location[a]	Radionuclide Concentrations (pCi/g)					
	Th-232	Th-228	Total Th[b]	U-238	U-235	Total U[c]
Building 7						
Outside Freight Elevator, Loc. 1	1.2 ± 0.3[d]	1.1 ± 0.2	2	39.9 ± 3.0	2.3 ± 0.2	82
Outside Transformer Room, 2	0.8 ± 0.3	1.0 ± 0.1	2	16.0 ± 1.8	0.9 ± 0.1	33
Northeast Corner, dirt pile 3	1.2 ± 0.3	1.1 ± 0.1	2	1.1 ± 0.7	0.1 ± 0.1	2
Northeast Corner 4	15.4 ± 1.2	15.5 ± 0.5	31	2.2 ± 1.0	0.1 ± 0.2	5
South Side, 5	1.0 ± 0.3	1.1 ± 0.1	2	1.3 ± 1.3	0.1 ± 0.1	3
Building 8						
Front West Side, 6	1.1 ± 0.3	1.4 ± 0.2	3	3.4 ± 1.4	0.3 ± 0.1	7
Near Manhole, 7	1.3 ± 0.3	1.3 ± 0.2	3	22.7 ± 2.5	1.3 ± 0.1	47
In Manhole, 8	0.5 ± 0.2	0.8 ± 0.1	1	17.9 ± 2.0	1.1 ± 0.1	37
Building 9						
Excavation South Side, (0-15 cm) 9	6.7 ± 0.7	7.3 ± 0.3	14	3.4 ± 1.4	0.2 ± 0.1	7
Excavation South Side, (15-30 cm) 10	9.4 ± 0.6	8.3 ± 0.3	18	2.5 ± 1.8	0.2 ± 0.1	5

[a]Refer to Figure 20.
[b]Calculated by adding Th-232 and Th-228 concentrations.
[c]Calculation based on a U-238 to U-234 activity ratio of 1:1 for natural uranium.
[d]Uncertainties represent the 95% confidence level, based only on counting statistics.

REFERENCES

1. Oak Ridge Institute for Science and Education, "Radiological Survey of Portions of the Bloomfield Lamp Plant, Westinghouse Electric Corporation, Bloomfield, New Jersey," April 1992.

2. Canberra Industries, Nuclear Services Division, "Radiological Decontamination Confirmation Survey, Westinghouse Bloomfield Lamp Plant, Building 7, 8, and 9," August 1992.

3. Oak Ridge Institute for Science and Education, "Confirmatory Survey Plan for Buildings 7, 8, 9, Westinghouse Electric Corporation Bloomfield Lamp Plant, Bloomfield, New Jersey," May 6, 1993.

4. Letter from A. Jaberaboansari (ORISE) to M. C. Roberts (NRC, Region I), Reference: "Comments on Radiological Decontamination Confirmation Survey for Westinghouse Bloomfield Lamp Plant Building 7, 8, 9" October 5, 1992.

5. Letter from C. W. Bickerstaff (Westinghouse) to J. D. Kinneman (NRC, Region I), Reference: "Additional Information Regarding Bloomfield, New Jersey Facility," December 4, 1992.

6. U.S. Nuclear Regulatory Commission, "Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source or Special Nuclear Materials," August 1987.

7. U.S. Nuclear Regulatory Commission, "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations," 46 FR 52061, Washington, D.C., October 23, 1981.

8. U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, "Review Plan: Evaluating Decommissioning Plans for Licenses Under 10 CFR Parts 30, 40, and 70," Washington, D.C. 1991.

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 employer.

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)

Eberline ZnS Scintillation Detector
Model AC-3-7
Effective Area, 59 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 Ionization 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
Tennelec Electronics Model
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Surface Barrier Detectors
(EG&G ORTEC, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(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-5100-W
(Oxford, 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	—	ZnS scintillation detector with ratemeter-scaler
Alpha-Beta	—	gas proportional detector with ratemeter-scaler
Beta	—	pancake GM detector with ratemeter-scaler
Gamma	—	NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements of total alpha and beta activity levels were primarily performed using gas proportional 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 4π efficiency and correcting for the active area of the detector. The alpha activity background countrates for the gas proportional

detectors and the ZnS scintillation detectors averaged 1 cpm for each detector. Alpha efficiency factors ranged from 0.18 to 0.19 for the gas proportional detectors and was 0.16 for the ZnS scintillation detectors. The beta activity background count rates for the proportional detectors and the GM detectors averaged 250 and 45 cpm, respectively. Beta efficiency factors was 0.13 for the gas proportional detectors and ranged from 0.15 to 0.17 for the GM detector. The effective windows for the gas proportional, ZnS scintillation, and GM detectors were 100 cm^2, 59 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 at 1 m above surface 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.

Miscellaneous Sampling

Approximately 8 g of material from an expansion joint was collected. The sample was placed in a plastic beaker, 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.

Miscellaneous Samples

Gamma Spectrometry

Solid Samples

Samples of solid material 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. Energy peaks used for determination of radionuclides of concern were:

Th-228	0.239 MeV from Pb-212*
Th-232	0.911 MeV from Ac-228*
U-235	0.186 MeV
U-238	0.063 MeV from Th-234*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

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, based only on counting statistics. 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 4.66 times the standard deviation of the background count. 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 radionuclide in samples, the detection limits differ from sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

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

- Survey Procedures Manual, Revision 7 (May 1992)
- Laboratory Procedures Manual, Revision 7 (April 1992)
- Quality Assurance Manual, Revision 5 (May 1992)

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.

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 was 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 MATERIALS

AND

GUIDELINES FOR RESIDUAL CONCENTRATIONS OF THORIUM AND URANIUM WASTES IN SOIL

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

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.

Guidelines for Residual Concentrations of Thorium and Uranium Wastes in Soil

On October 23, 1981, the Nuclear Regulatory Commission published in the Federal register a notice of Branch Technical Position on "Disposal or Onsite Storage of Thorium and Uranium Wastes from Past Operations." This document established guidelines for concentrations of uranium and thorium in soil, that will limit maximum radiation received by the public under various conditions of future land usage. These concentrations are as follows:

Material	Maximum Concentrations (pCi/g) for various options			
	1[a]	2[b]	3[c]	4[d]
Natural Thorium (Th-232 + Th-228) with daughters present and in equilibrium	10	50	--	500
Natural Uranium (U-238 + U-234) with daughters present and in equilibrium	10	--	40	200
Depleted Uranium:				
Soluble	35	100	--	1,000
Insoluble	35	300	--	3,000
Enriched Uranium:				
Soluble	30	100	--	1,000
Insoluble	30	250	--	2,500

[a]Based on EPA cleanup standards which limit radiation to 1 mrad/yr to lung and 3 mrad/yr to bone from ingestion and inhalation and 10 μR/h above background from direct external exposure.
[b]Based on limiting individual dose to 170 mrem/yr.
[c]Based on limiting equivalent exposure to 0.02 working level or less.
[d]Based on limiting individual dose to 500 mrem/yr and in case of natural uranium, limiting exposure to 0.02 working level or less.