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RADIOLOGICAL SURVEY OF THE ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

W. C. ADAMS AND J. L. PAYNE

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

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

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RADIOLOGICAL SURVEY
OF THE
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

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ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm/100 cm^2	disintegrations per minute per 100 square centimeters
ft	foot
ft^2	square foot
GM	Geiger-Mueller
h	hour
km	kilometer
m	meter
m^2	square meter
mrad/h	millirad per hour
mrem	millirem
NaI	sodium iodide
μR/h	microroentgens per hour
pCi/g	picocuries per gram

ACRONYMS

AEC	Atomic Energy Commission
ANL	Argonne National Laboratory
BNI	Bechtel National, Inc.
DOE	U.S. Department of Energy
ESSAP	Environmental Survey and Site Assessment Program
FSRD	Former Sites Restoration Division
FUSRAP	Formerly Utilized Sites Remedial Action Program
ORFO	Oak Ridge Field Office
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
PIC	Pressurized Ionization Chamber
PMC	Project Management Contractor

RADIOLOGICAL SURVEY
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INTRODUCTION AND SITE HISTORY

From July 1948 to late 1949, Vulcan Crucible Steel Company operated a uranium-rolling process for the Atomic Energy Commission (AEC) in Building 3 of the facility formerly owned by Universal Cyclops Specialty Steel Division of the Cyclops Corporation and currently owned by Aliquippa Forge, Inc. Uranium billets were sent to the Vulcan facility where, during the rolling operation, the billets were formed into rods; finished rods were boxed and shipped to other AEC facilities. The site was decontaminated to then-applicable guidelines in 1950 following completion of AEC operations.[1]

In 1978, a radiological survey performed in and around Building 3 by Argonne National Laboratories (ANL) identified radioactive contamination above current guidelines on floors, walls, and overhead beams above the furnaces that were used for heating billets.[1] In addition, some contaminated steel flooring was found outside the building alongside the cooling basin. The residual contamination exceeded guidelines for release to unrestricted use, therefore, the property was included in DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP) in August 1983. Bechtel National, Inc. (BNI) is the FUSRAP Project Management Contractor (PMC).

In December 1987, a limited radiological characterization survey, performed by BNI, indicated that there were 14 areas of contamination in and around Building 3.[2] Interim remedial activities were conducted by BNI in 1988 to enable restricted use of the building by Aliquippa Forge, Inc. Most of the building was remediated by removing contaminated materials/equipment and placing a barricade around the remaining contaminated area.

Post-remedial action surveys of Building 3 indicated that contamination was successfully removed from a large portion of the building. Areas inside Building 3 that are suspected to be contaminated include the walls above 2 meters, interior and exterior surfaces of the two furnaces, floor surfaces within the barricaded area, and structural steel and ceiling surfaces. Exterior soil areas around the perimeter of Building 3 are also known to contain limited contamination.

As a result of previous surveys conducted in Building 3, DOE requested the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Institute for Science and Education (ORISE) perform a radiological survey of all buildings and grounds (excluding Building 3) to determine the radiological status of the entire site prior to characterization and remediation of Building 3.

SITE DESCRIPTION

The Aliquippa Forge Site is located in a mixed industrial/residential area on 3.2 hectare (8 acre) parcel of land along the Ohio River in West Aliquippa, Pennsylvania. The facility is north of First Street and between Beaver Avenue and Route 51 (Figures 1 and 2). The property, which is approximately 25 km (16 miles) northwest of Pittsburgh, Pennsylvania currently contains 10 buildings, 4 of which are interconnected, an office trailer, a metal shed, 2 water towers, a cooling tower, and a small cooling basin (Figure 2). The site is fenced on the west and north sides; the outer walls of Buildings 1, 2, and 3 limit access to the east and south sides of the property. The land is generally level, sloping to the west side into a small creek, with large weeds and brush surrounding the buildings. A residential community is located 15.2 m (50 ft) south of the site boundary.

Eleven buildings were included in the survey, four of which are interconnected with Building 3 (Figure 2). Building 17 was not included due to inaccessibility. Total floor space, for all buildings, is 5,300 m^2 (57,000 ft^2) much of which is covered by equipment and debris. Generally, all buildings are constructed of cinderblock foundation walls and sheet metal walls

and roofs. Floor materials include soil, brick, and concrete. All utilities to the site have been discontinued and most equipment is in various stages of deterioration.

Building 1, which forms the majority of the east boundary of the property, is divided into 4 major sections, designated Buildings 1, 1A, 1B, and 1C. Because of the size of this area, ESSAP subdivided the building into four sections, designated Sections A, B, C, and D, as shown in Figures 3 thru 7. Total floor space is approximately 3380 m^2 (36,400 ft^2) much of which is occupied by smelting furnaces and processing equipment . The south end, approximately half the length of the building, has a soil floor, the north half is mostly brick and concrete. Walls are approximately 15 m (50 ft) with the roof apex at 20 m. A roof vent runs along the apex the entire length of the building.

Building 2, which has direct access to Building 3, contains 710 m^2 (7,640 ft^2) of floor space. The majority of the floor is constructed of concrete; the east side, adjoining Building 1, is soil covered. Walls are approximately 6 m (20 ft) high with a roof apex at 8 m (26 ft) (Figure 8).

Building 8, which shares a common wall with and has direct access to the north end of Building 3, consists of 5 areas, designated Rooms A-D and D-Mezzanine. Total floor space, excluding the mezzanine, is approximately 500 m^2 (5380 ft^2) and is constructed of concrete or brick (Room B). Much of the floor in Room D and the along the south wall of Room A is littered with construction debris making it inaccessible. Walls are approximately 6 m (20 ft) high (Figures 9 and 10).

The remaining 5 buildings included in the survey (Buildings 9, 10, 16, trailer, and shed) are apart from Building 3. These buildings appear to have been support function areas such as maintenance, storage, office, and personnel shower and locker space. Total floor space in these areas is approximately 670 m^2 (7,210 ft^2). Floors vary in construction material from soil (Buildings 10 and the shed) to concrete (Buildings 9 and 16). Walls vary in height from 3 m (10 ft) to 6 m (20 ft) (Figures 11 thru 15).

The outdoor area of the site consists of approximately 27,000 m^2 (290,000 ft^2). Much of the area to the north of the buildings is covered with heavy brush and discarded equipment making the area inaccessible. The waste pile area, located in the northwest section of the site is open in the center; the perimeter is covered with piles of construction debris. The southwest section, west of Buildings 2 and 3, consists of a hard-packed, soil and gravel parking area, bordered to the west by a small creek. The area between the buildings is mostly paved with brick or concrete, or covered with gravel.

PROJECT ORGANIZATION AND RESPONSIBILITY

DOE Headquarters provides overview and coordination for all FUSRAP activities. The DOE Oak Ridge Field Office (DOE-ORFO) is responsible for implementation of FUSRAP and the Former Sites Restoration Division (FSRD) of DOE-ORFO, manages the daily activities.

Under the standard FUSRAP protocol, an initial investigation survey of a potential site is performed by ORISE or Oak Ridge National Laboratory (ORNL), under contract to DOE Headquarters. If appropriate, DOE Headquarters designates the site into FUSRAP based upon the results provided by the initial investigation. DOE's Project Management Contractor (PMC) for FUSRAP is Bechtel National, Inc. (BNI). BNI is responsible for the planning and the implementation of FUSRAP activities and managing the site characterization and remedial actions. The final phase for a FUSRAP site is independent verification which is provided by ORISE or ORNL after remedial action is complete. This verification process provides independent (third party) data to assist DOE in evaluating the accuracy of the post-remedial action status of the site, as presented by the PMC, and in assuring that the documentation accurately and adequately describes the condition of the site. DOE Headquarters uses the information developed by the remediation and verification activities to certify that a site can be released for use, without restrictions.

The Aliquippa Forge site was selected for remediation under a proposed expedited protocol being considered within FUSRAP. In contrast to the standard protocol, under the expedited protocol, the designation contractor functions as the organization responsible for the characterization and verification activities, while BNI is responsible for conducting the remedial action and post-remedial action survey. Since the Aliquippa Forge Site had previously been designated, ORISE will function as the organization responsible for characterization and verification activities only.

OBJECTIVE

The objective of the survey was to determine the radiological status of the buildings and grounds, relative to the DOE guidelines. The results will be used by the DOE-HQ to determine if additional portions of the site should be included in the proposed expedited protocol, prior to characterization and remediation of Building 3 and adjacent grounds. This report summarizes the procedures and results of the survey.

PROCEDURES

During the period of May 17 thru May 21, 1992 ESSAP performed a radiological survey of the Buildings and outdoor area of Aliquippa Forge, Inc. The survey was in accordance with a survey plan, which was submitted to and approved by the DOE.[3]

SURVEY PROCEDURES: INTERIOR

Surface Scans

Surface scans for beta and gamma activity were performed on all accessible floors, lower walls (up to 2 m), and equipment using gas proportional, GM, and gamma scintillation detectors. All detectors were coupled to ratemeters or ratemeter-scalers with audible indicators. Locations of elevated direct radiation, suggesting the presence of surface contamination, were marked for further investigation.

Surface Activity Measurements

The radionuclide of concern is processed natural uranium, i.e. uranium separated from its long-lived daughters, but in its naturally occurring isotopic abundances. Processed natural uranium emits both alpha and beta radiation in approximately equal proportions; either beta activity levels or alpha activity levels may, therefore, be measured for determining uranium surface contamination.

Previous survey results indicate that measurements for beta activity levels, rather than alpha activity, provide a more accurate representation of uranium surface activity due to conditions of the building surfaces (e.g. dusty, porous, or rough), which may selectively attenuate the alpha activity. Therefore, beta activity levels were used for comparison with the guideline values.

Measurements for total beta activity were performed at 207 locations on floors, lower walls, upper walls, and equipment throughout the areas surveyed. A smear sample for determining removable activity was obtained from each direct measurement location. Measurement and sampling locations for total and removable activity were referenced to prominent building features and are illustrated on Figures 4 thru 15.

Exposure Rate Measurements

Exposure rate measurements were performed at 1 m (3.3 ft) above the surface at 12 interior locations throughout the surveyed areas, using a pressurized ionization chamber (PIC). Measurement locations are illustrated on Figure 21.

Soil Sampling

Samples of surface soil (0 to 15 cm) were collected from 23 locations in buildings with dirt flooring. Sample locations are indicated on Figures 9 and 16 thru 20.

SURVEY PROCEDURES: EXTERIOR

Surface Scans

Surface scans for gamma activity were performed at 1 to 2 m intervals in all accessible areas, using NaI scintillation detectors coupled to ratemeters with audible indicators. Areas of elevated direct radiation, suggesting the presence of surface or near surface contamination, were marked for further investigation.

Exposure Rate Measurements

Exposure rate measurements were performed at 1 m above the surface at 9 locations using a PIC. Measurement locations are illustrated on Figure 21.

Soil Sampling

Surface soil samples were collected from 11 locations believed to have the greatest potential of soil contamination (e.g. roof drip line to assess water runoff areas and under exhaust fans). Sample locations were referenced to prominent site features and are illustrated on Figure 22.

SAMPLE ANALYSIS AND DATA INTERPRETATION

Samples and survey data were returned to the ESSAP Oak Ridge laboratory for analyses and interpretation. Soil and miscellaneous samples were analyzed by gamma spectrometry; spectra were reviewed for radionuclides of interest and any other identifiable photopeaks. Soil samples results were reported in pCi/g. Smears were analyzed for gross alpha and gross beta activity. Direct measurement data and smear data were converted to units of disintegration per minute/100 cm^2 and exposure rate measurements were reported in μR/h.

Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendices A and B. Results were compared to the DOE guidelines which are provided in Appendix C.

FINDINGS AND RESULT

INTERIOR SURVEY

Surface Scans

Surface scans of interior surfaces identified several locations of elevated surface activity on floors and lower walls in Building 8. The locations, identified on Figures 9 and 10, were marked for further investigation.

Surface Activity Levels

Surface activity levels are summarized in Table 1. Activity levels throughout the surveyed areas ranged from <830 to 70,000 dpm/100 cm^2. Removable activity levels ranged from <12 to 52 dpm/100 cm^2 for alpha and from <15 to 48 dpm/100 cm^2 for beta.

Exposure Rate Measurements

Exposure rate measurements, performed using the PIC, are presented in Table 2. Rates ranged from 7 μR/h to 14 μR/h; the highest rates were measured in Room B, Building 8. This area of Room B has a brick floor which was found to have elevated surface activity. Two additional measurement locations in Building 1, performed on brick flooring, were also elevated at 12 and 13 μR/h.

Uranium Concentrations in Soil Samples

Uranium concentrations in soil samples collected from interior locations are presented in Table 3. Concentrations of U-235, U-238, and total uranium ranged from <0.1 to 0.2 pCi/g, 0.2 to 3.8 pCi/g, and 0.5 to 7.8 pCi/g, respectively.

EXTERIOR SURVEY

Surface Scans

Gamma scans of all accessible surfaces (excluding the area west of and adjacent to Building 3) did not identify any locations of elevated direct radiation on the soil surface. Surface scans did identify elevated direct radiation to the east of Building 1-A and in the waste pile in the northwest section of the site. The elevated direct radiation was associated with disgarded grinding wheels near Building 1-A and fire brick in the waste pile.

Exposure Rate Measurements

Exposure rate measurements performed using a PIC are presented in Table 2. Rates ranged from 7 μR/h to 10 μR/h.

Uranium Concentrations in Soil Samples

Uranium concentrations in soil samples are presented in Table 4. Concentrations of U-235, U-238, and total uranium ranged from <0.1 to 0.4 pCi/g, 0.3 to 5.1 pCi/g, and <0.7 to 10.5 pCi/g, respectively.

COMPARISON OF RESULTS WITH GUIDELINES

The DOE surface contamination guideline levels applicable for processed natural uranium are as follows:[4-5] The applicable DOE guidelines are presented in Appendix C.

Total Activity

5,000 dpm α/100 cm^2, averaged over a 1 m^2 area

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

Removable Activity

1,000 dpm α/100 cm^2

Floor locations in Building 8, Room B, had total beta activity levels exceeding the 15,000 dpm/100 cm^2 (maximum) limit (Figure 10). In addition, 8 other locations had total beta activity exceeding the 5,000 dpm/100 cm^2 (average) guideline (Figures 9 and 10). There were no measurement locations where removable activity exceeded the guideline.

A guideline value for U-238 in soil and other volumetric sources has not been established for this site; however, for comparison purposes, guidelines at other FUSRAP sites have typically ranged from 30 to 50 pCi/g. Samples collected from the areas listed, both interior and exterior, contain less than those typical levels.

A site specific uranium guideline is currently being developed for this site by Argonne National Laboratory.

SUMMARY

In May 1992, at the request of the U.S. Department of Energy, ESSAP performed a radiological survey of the buildings and outdoor areas (excluding Building 3 and outside areas of known contamination) of Aliquippa Forge, Inc. in West Aliquippa, Pennsylvania. The following buildings were included in this survey: Buildings 1-A, 1-B, 1-C, 1-D, 2, 8, 9, 10, and 16. Also included in the survey was a Metal Shed that is east of Building 8 and an office trailer east of Building 10. Survey activities included surface scans, surface activity measurements, and exposure rate measurements, and soil sampling.

Residual beta activity levels exceeding the DOE surface contamination guideline levels were identified on the floor of Room B, Building 8. The contamination appears to be a uranium residue which has been ground into the soil between the bricks. Loose residue, exceeding the average guideline value (5,000 dpm/100 cm^2) was also identified on wall ledges and floors in other areas of Building 8. Some floor surfaces in Building 8 were inaccessible, due to equipment and debris; it is possible that additional areas of residual contamination are present.

With the exeption of the grinding wheels and fire brick previously identified, gamma surface scans and soil samples of the surrounding outdoor areas (excluding the area west of and adjacent to Building 3) did not identify any locations of elevated activity. All accessible outdoor areas were scanned.

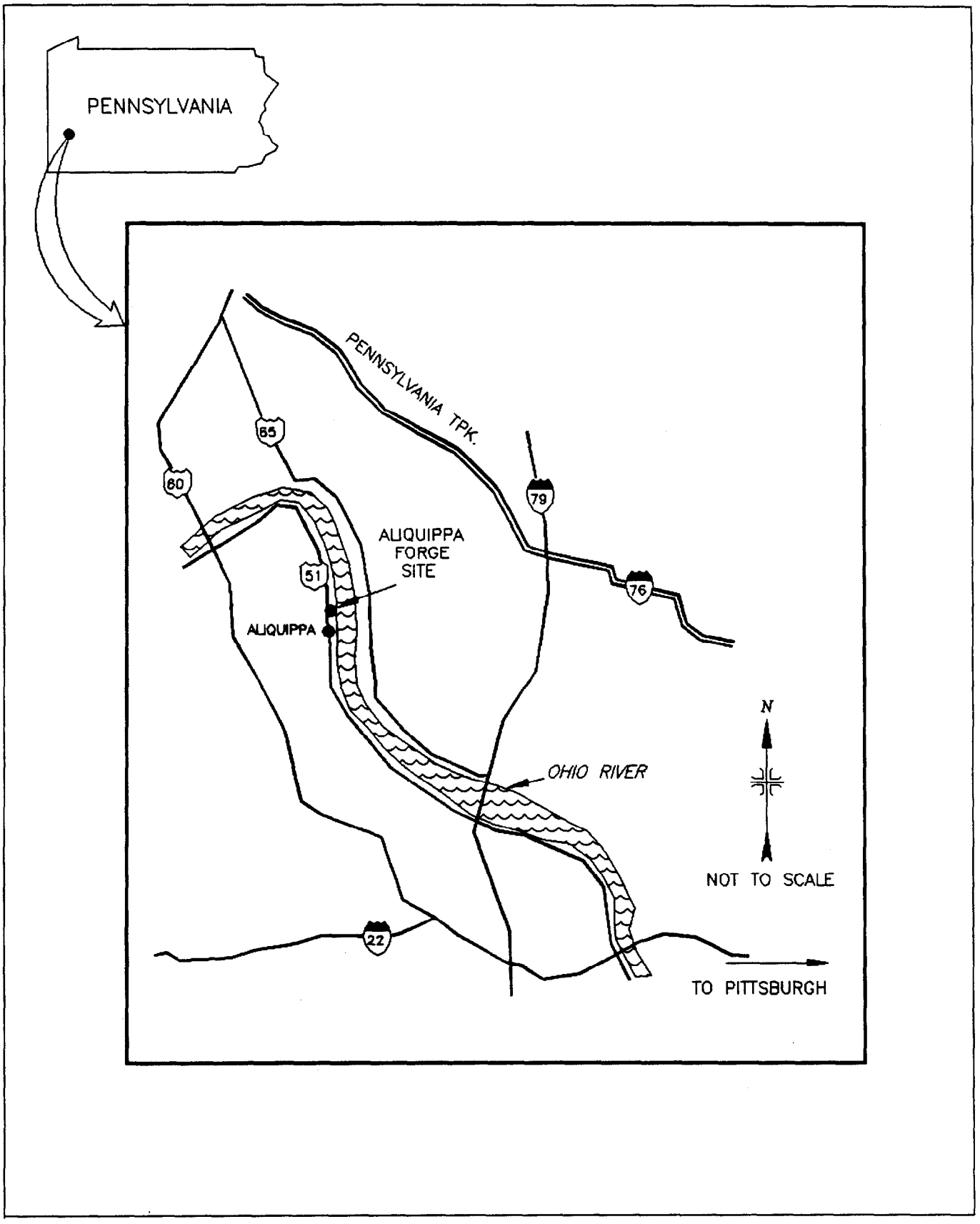

FIGURE 1: Location of the Aliquippa Forge Site, West Aliquippa, Pennsylvania

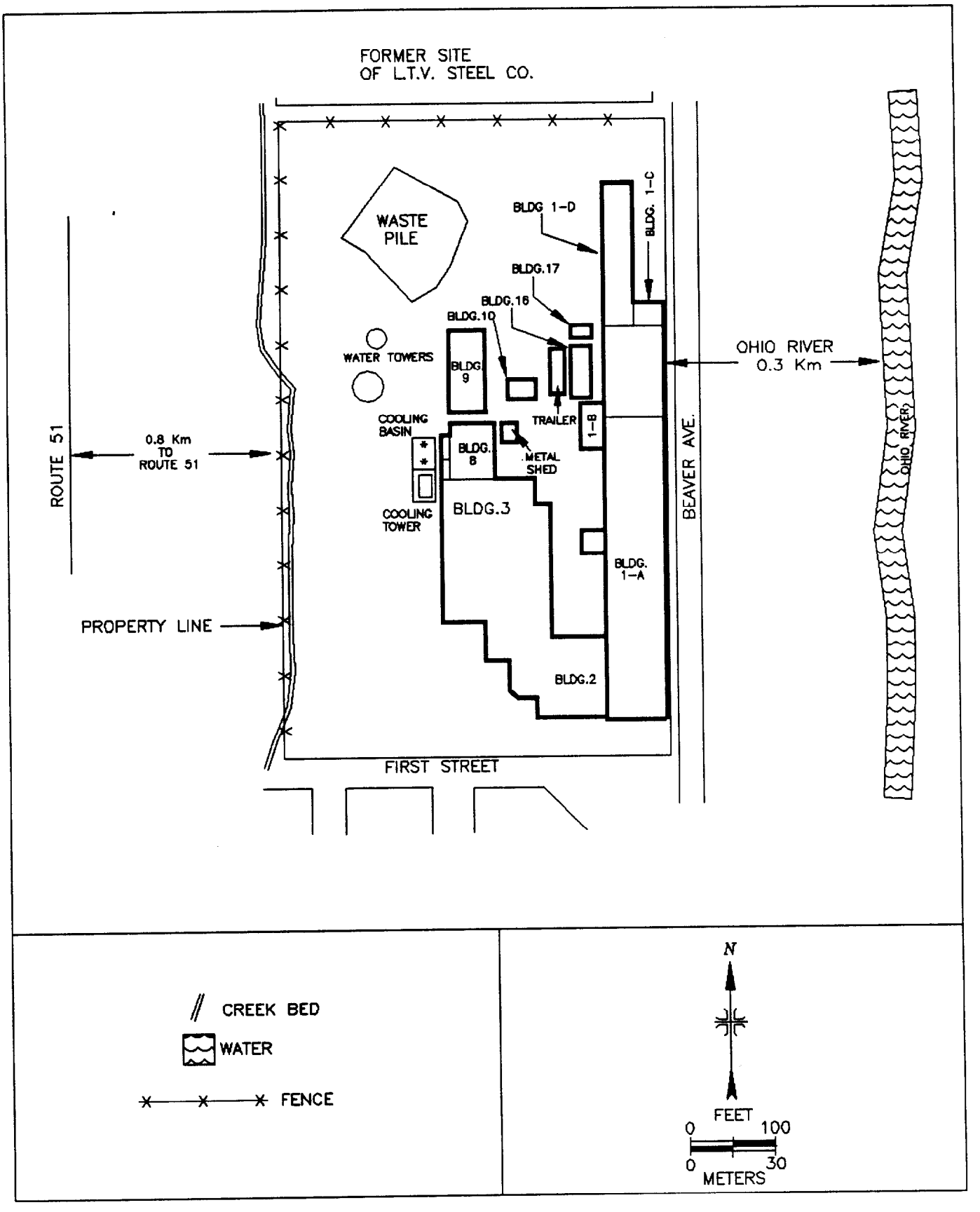

FIGURE 2: Plot Plan of the Aliquippa Forge Site, West Aliquippa, Pennsylvania

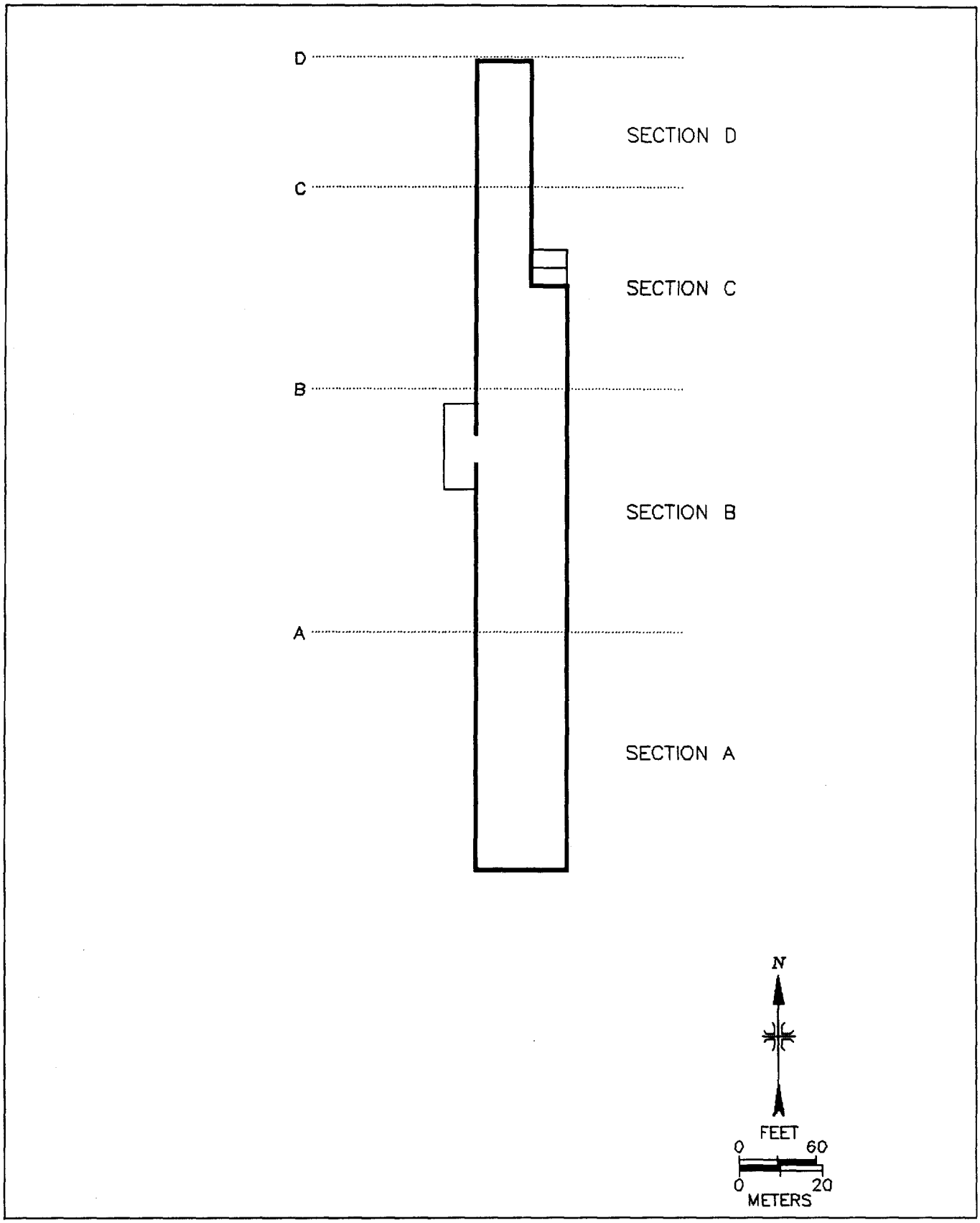

FIGURE 3: Overall Plan View of Building 1

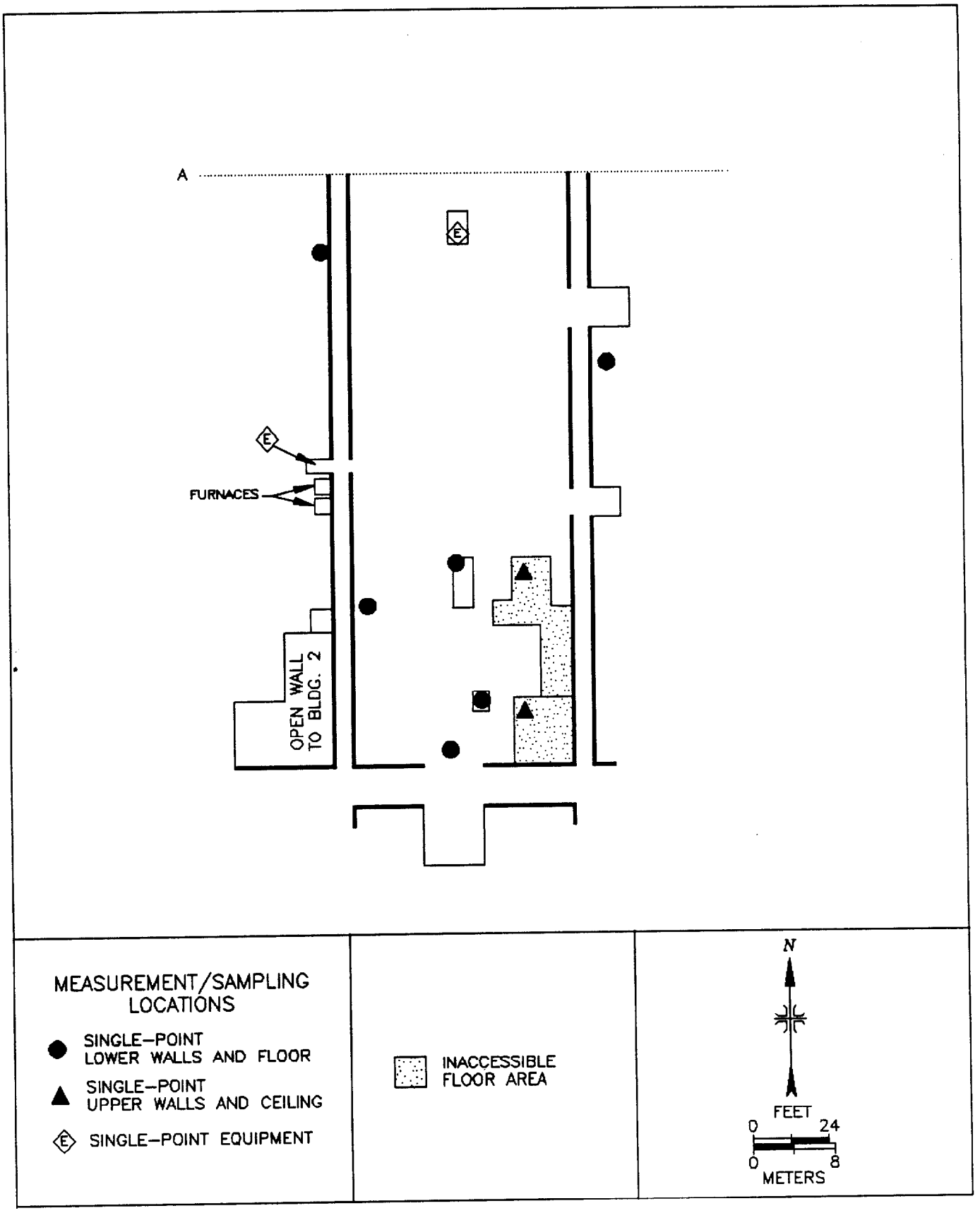

FIGURE 4: Building 1, Section A – Measurement and Sampling Locations

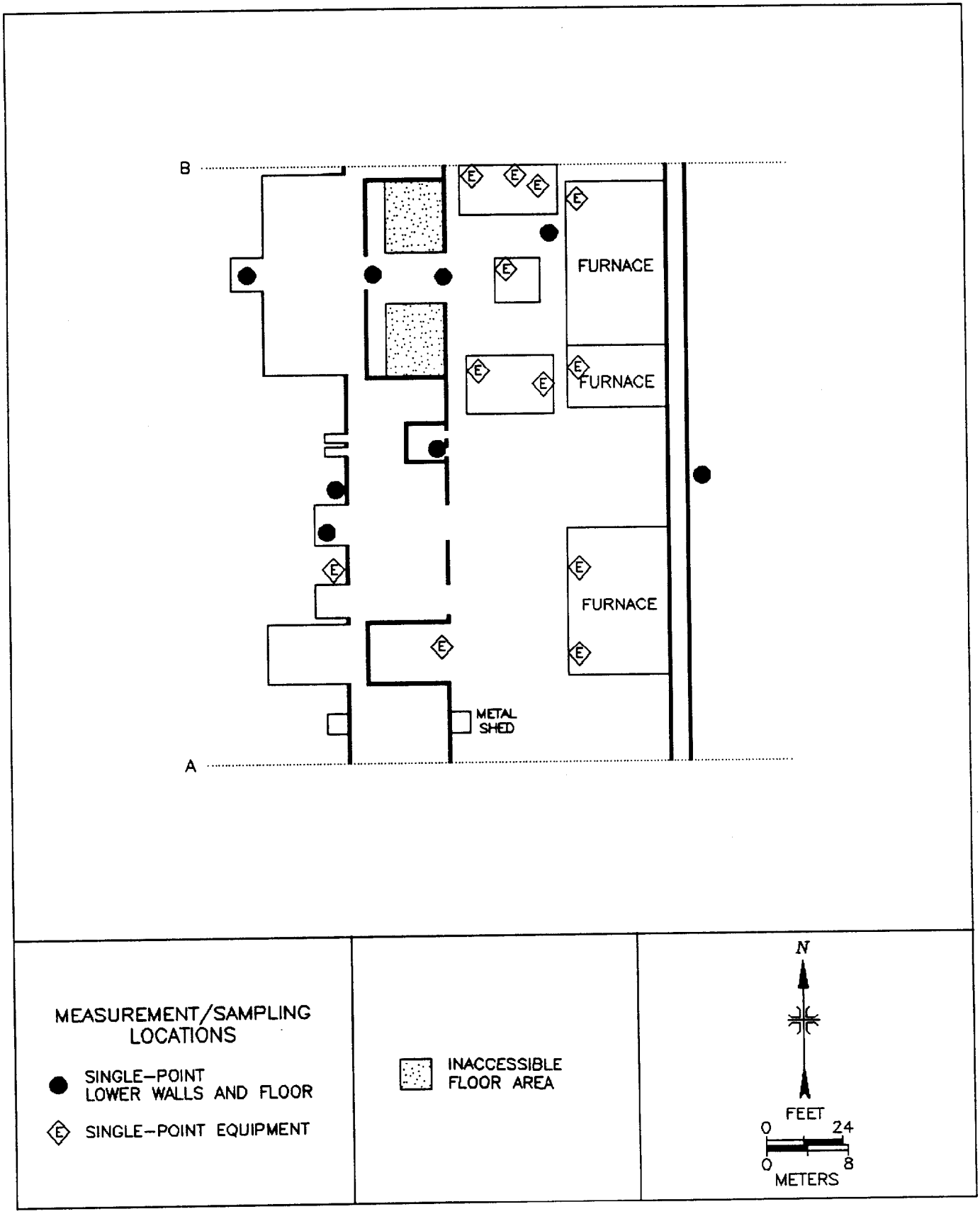

FIGURE 5: Building 1, Section B – Measurement and Sampling Locations

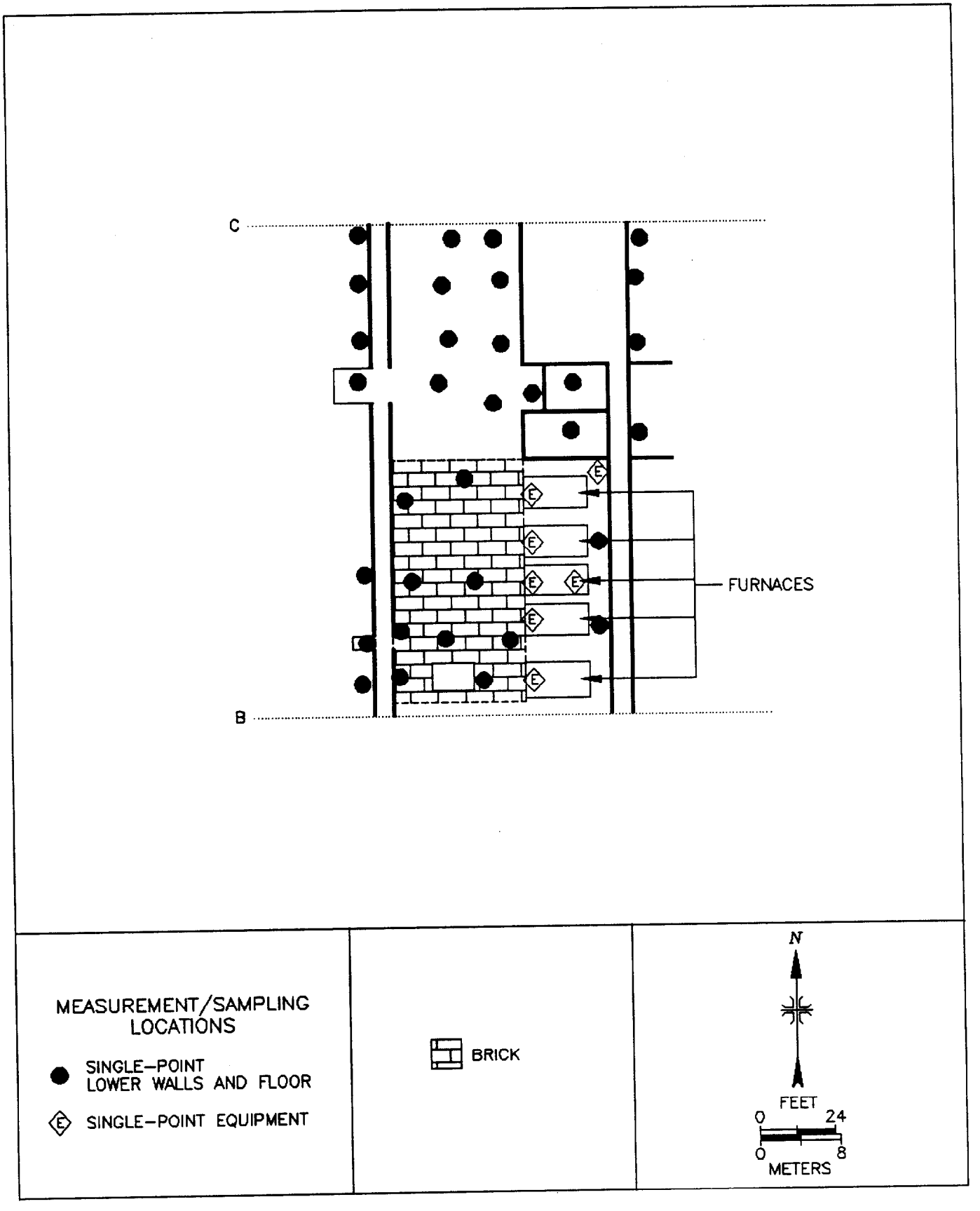

FIGURE 6: Building 1, Section C – Measurement and Sampling Locations

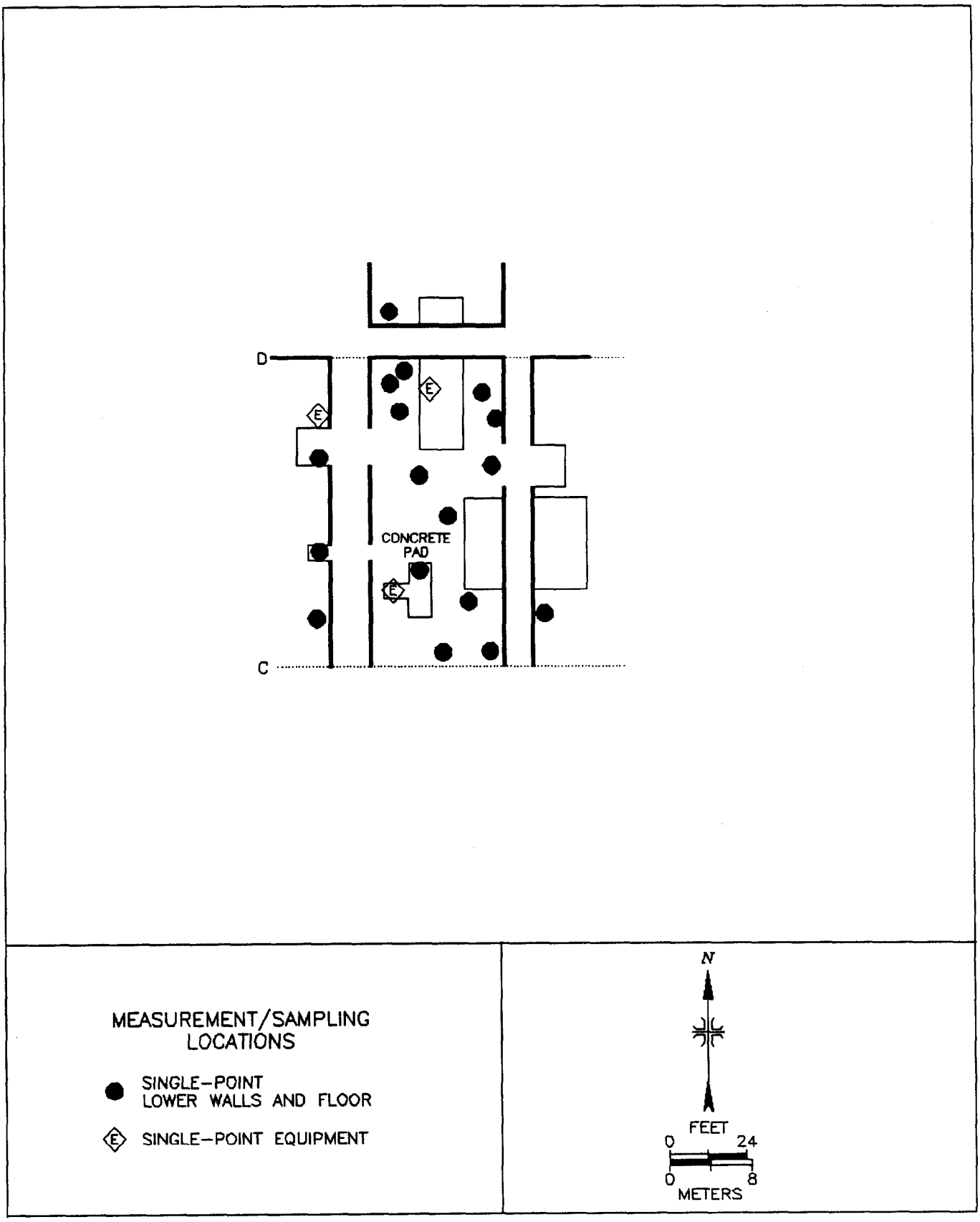

FIGURE 7: Building 1, Section D – Measurement and Sampling Locations

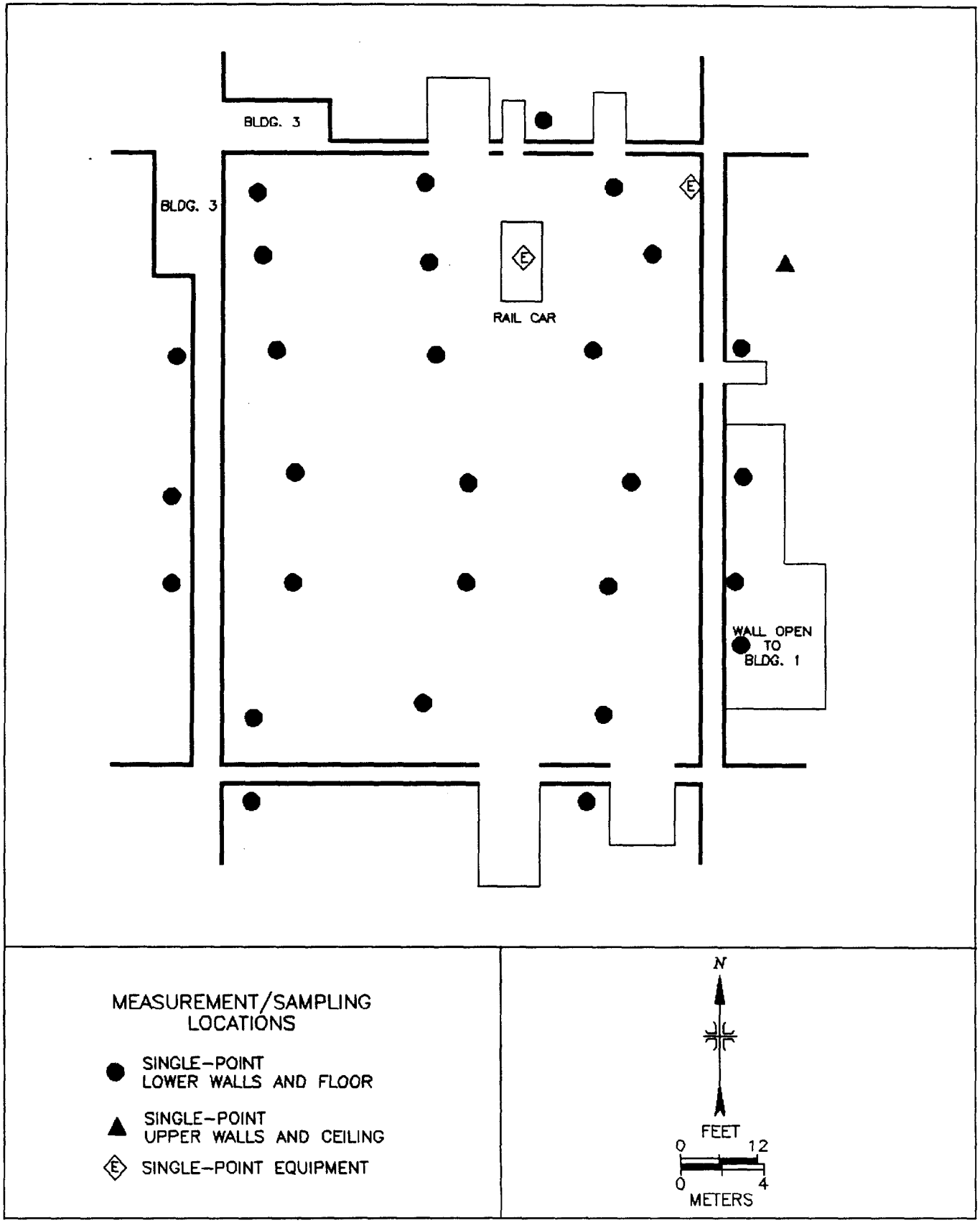

FIGURE 8: Building 2 – Measurement and Sampling Locations

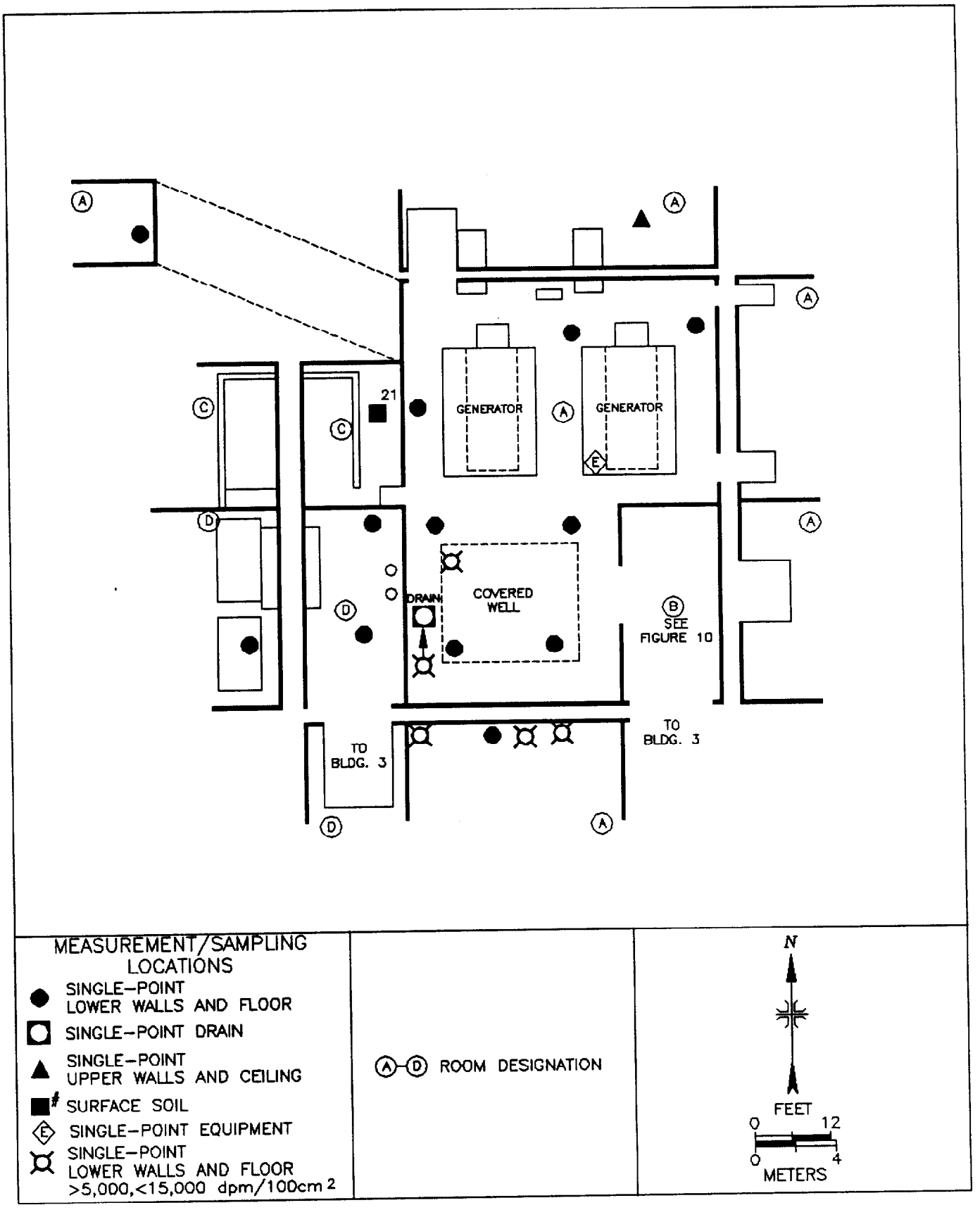

FIGURE 9: Building 8 – Measurement and Sampling Locations

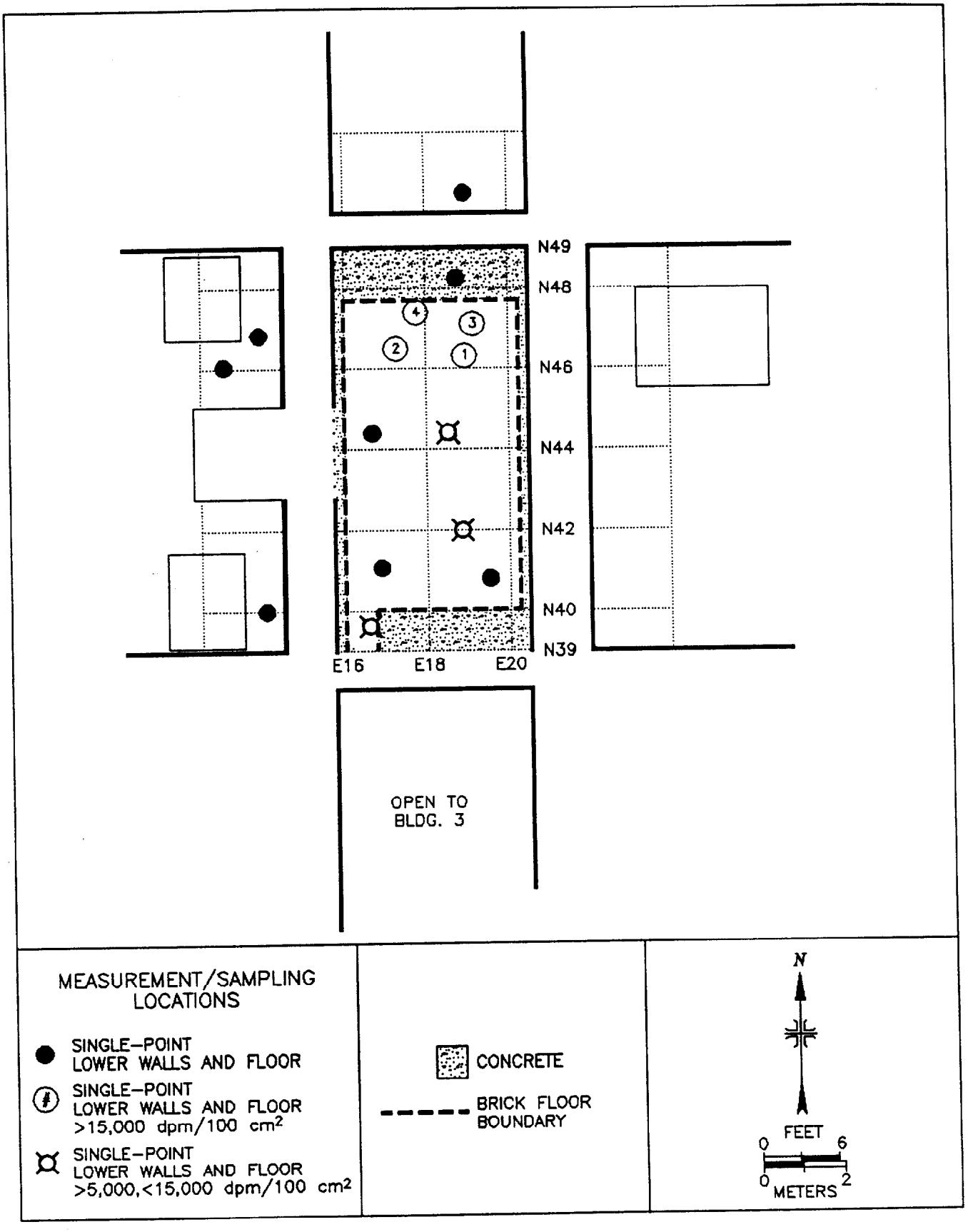

FIGURE 10: Building 8, Room B – Measurement and Sampling Locations

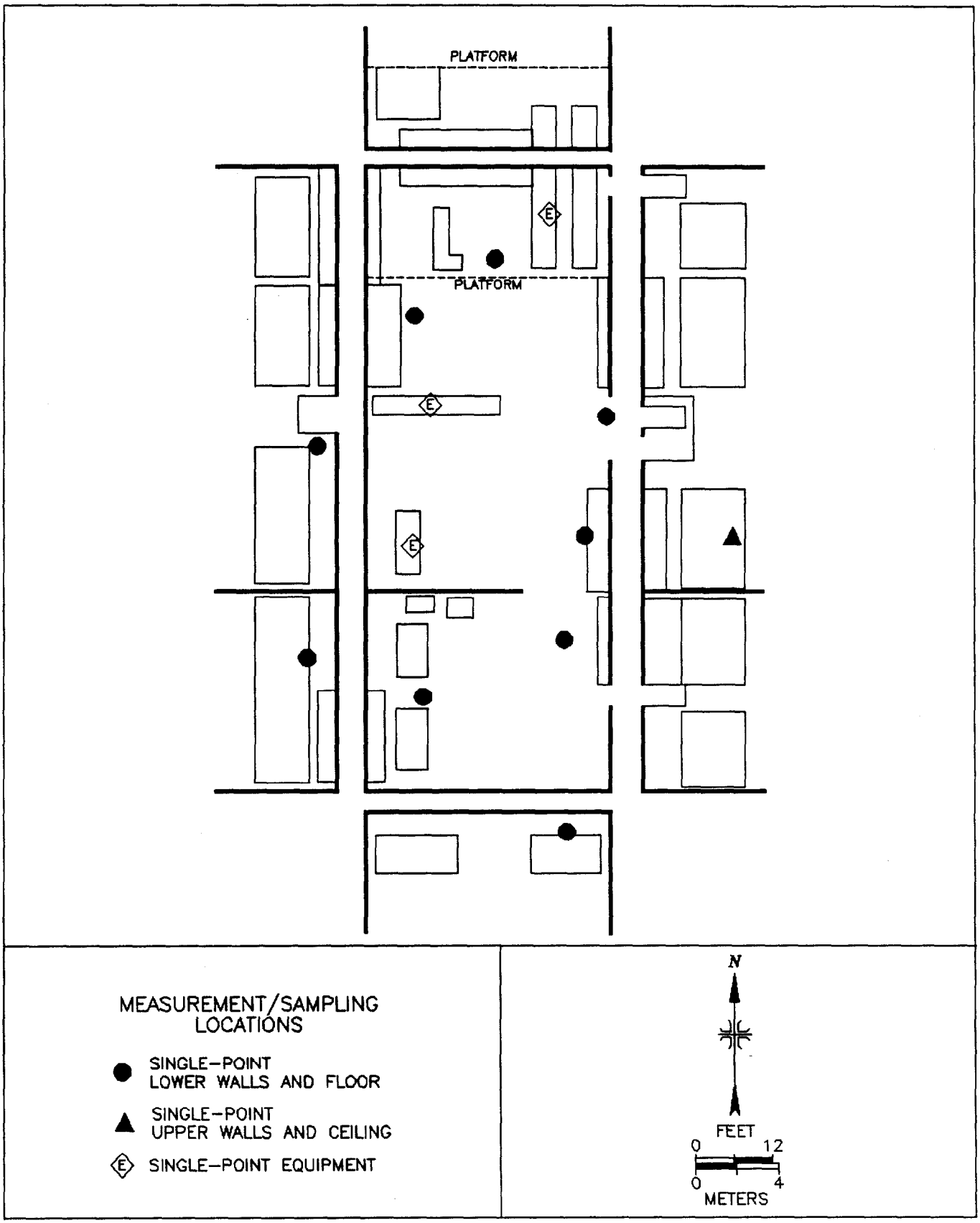

FIGURE 11: Building 9 – Measurement and Sampling Locations

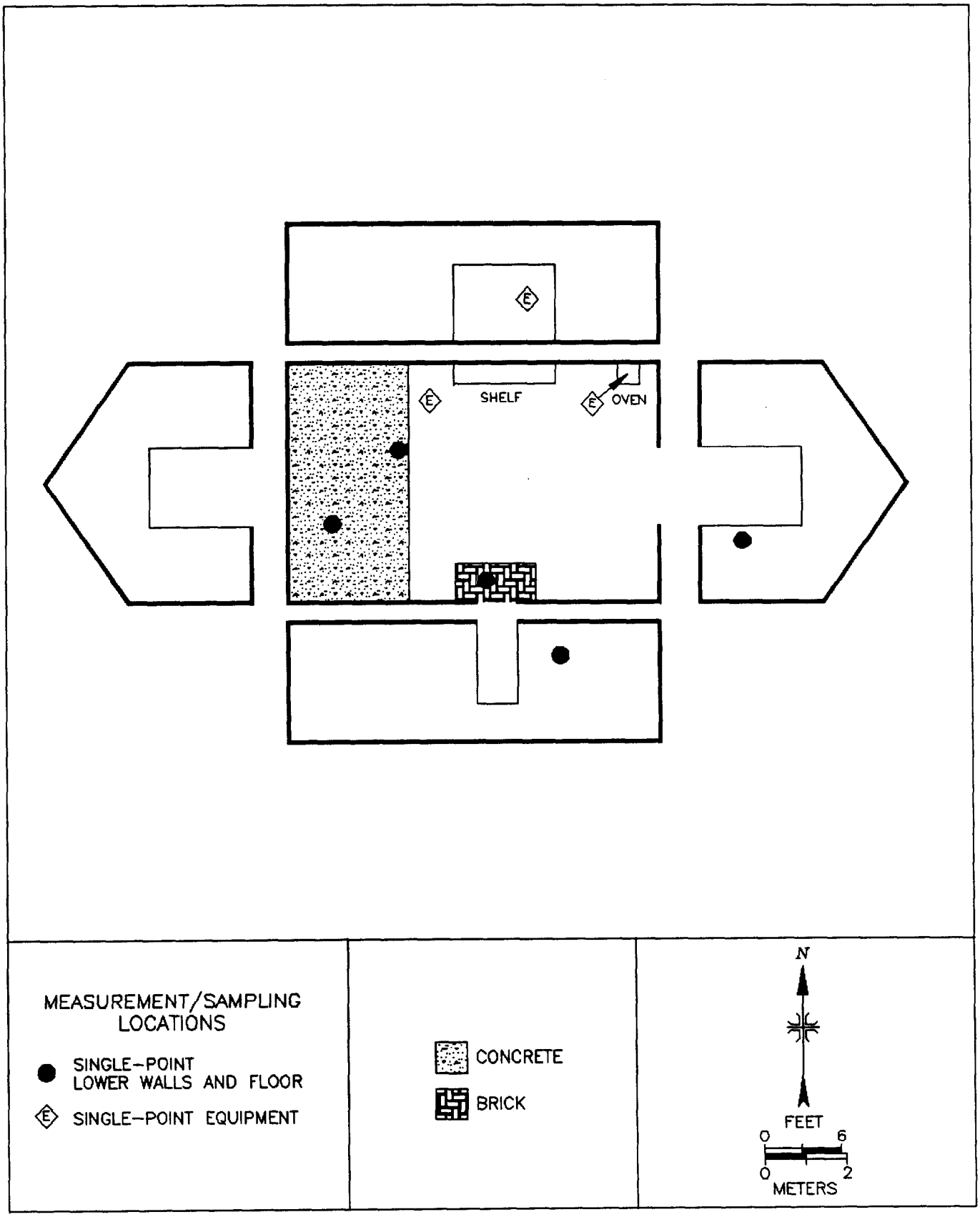

FIGURE 12: Building 10 – Measurement and Sampling Locations

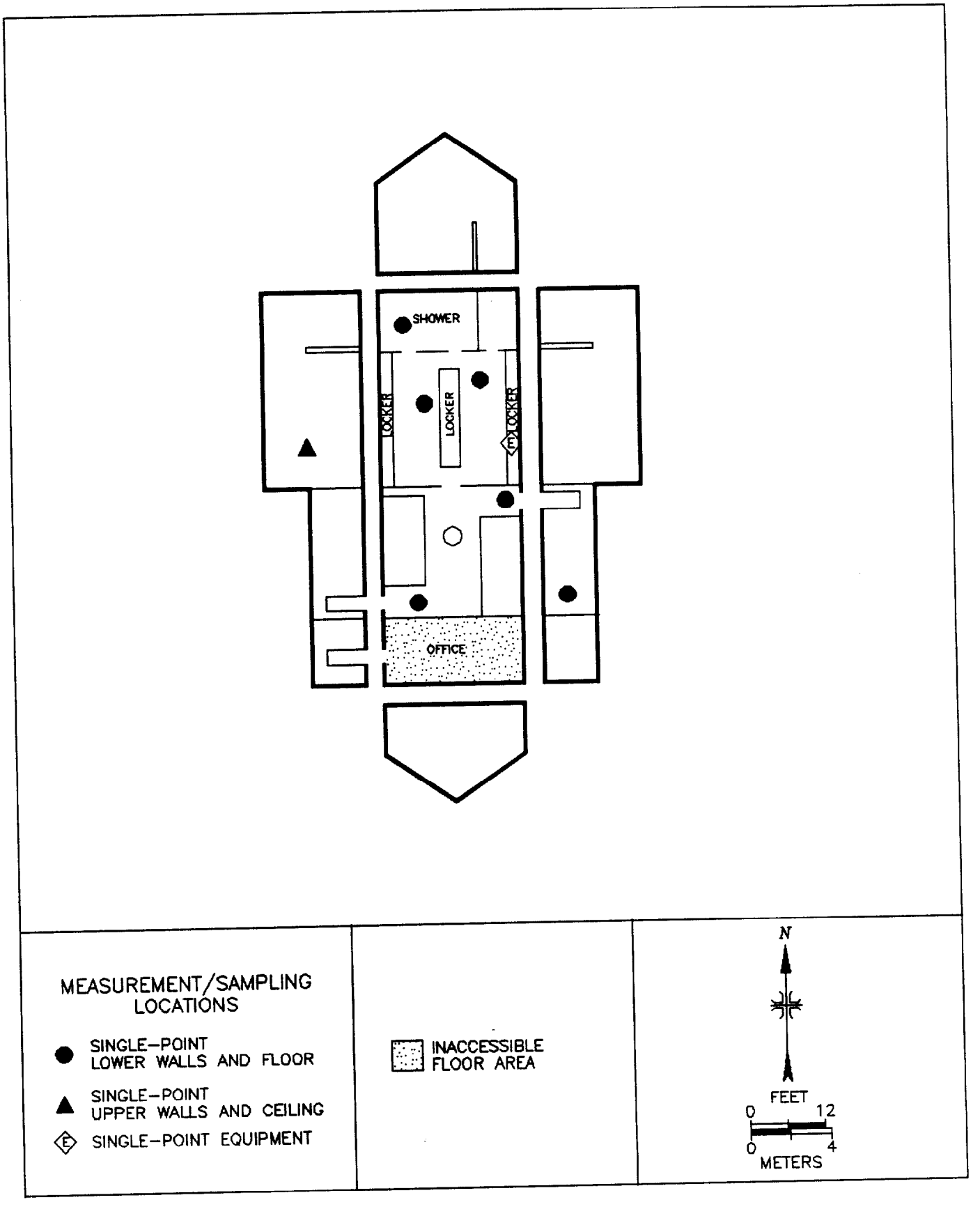

FIGURE 13: Building 16 – Measurement and Sampling Locations

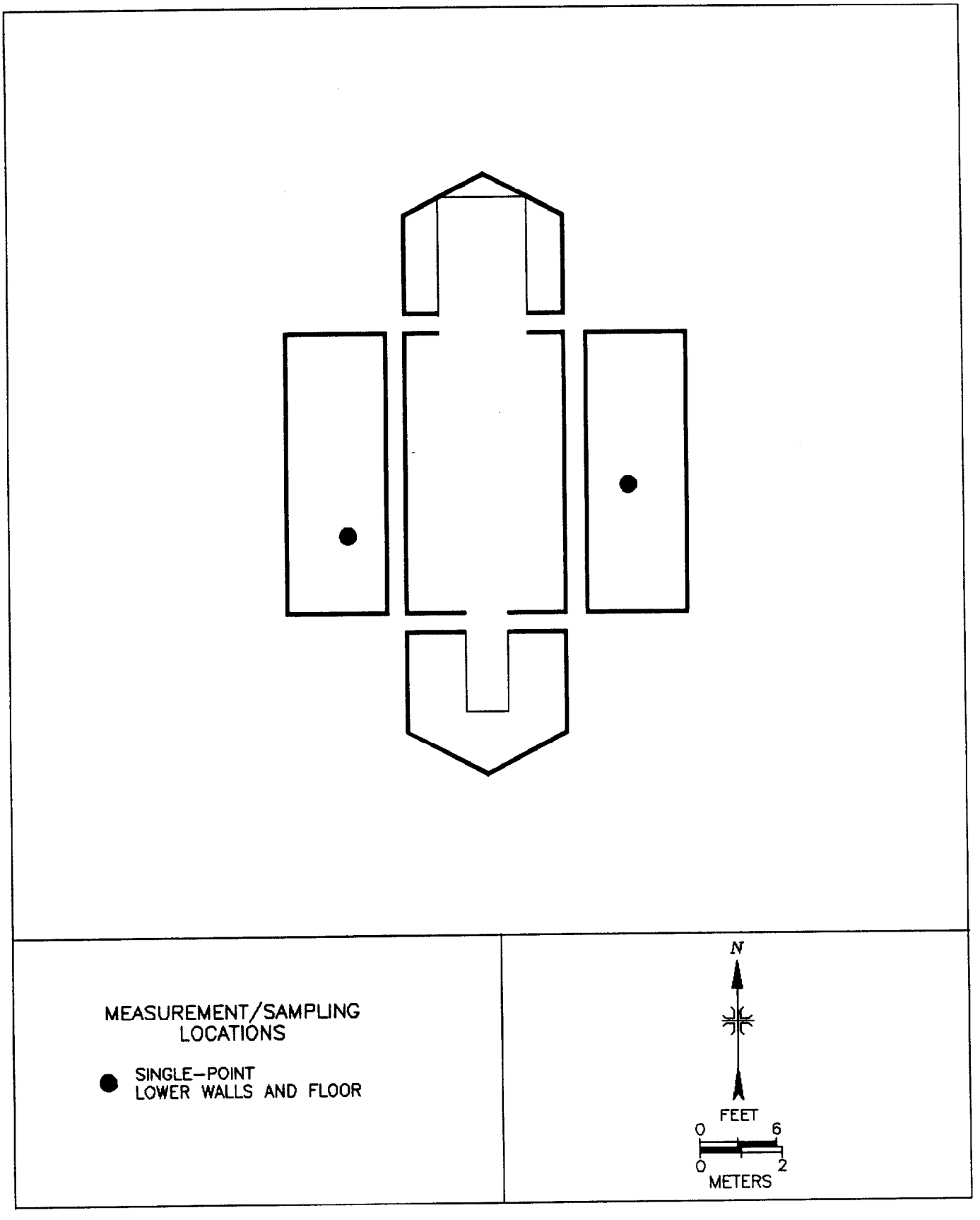

FIGURE 14: Metal Shed Outside (East) of Building 8 – Measurement and Sampling Locations

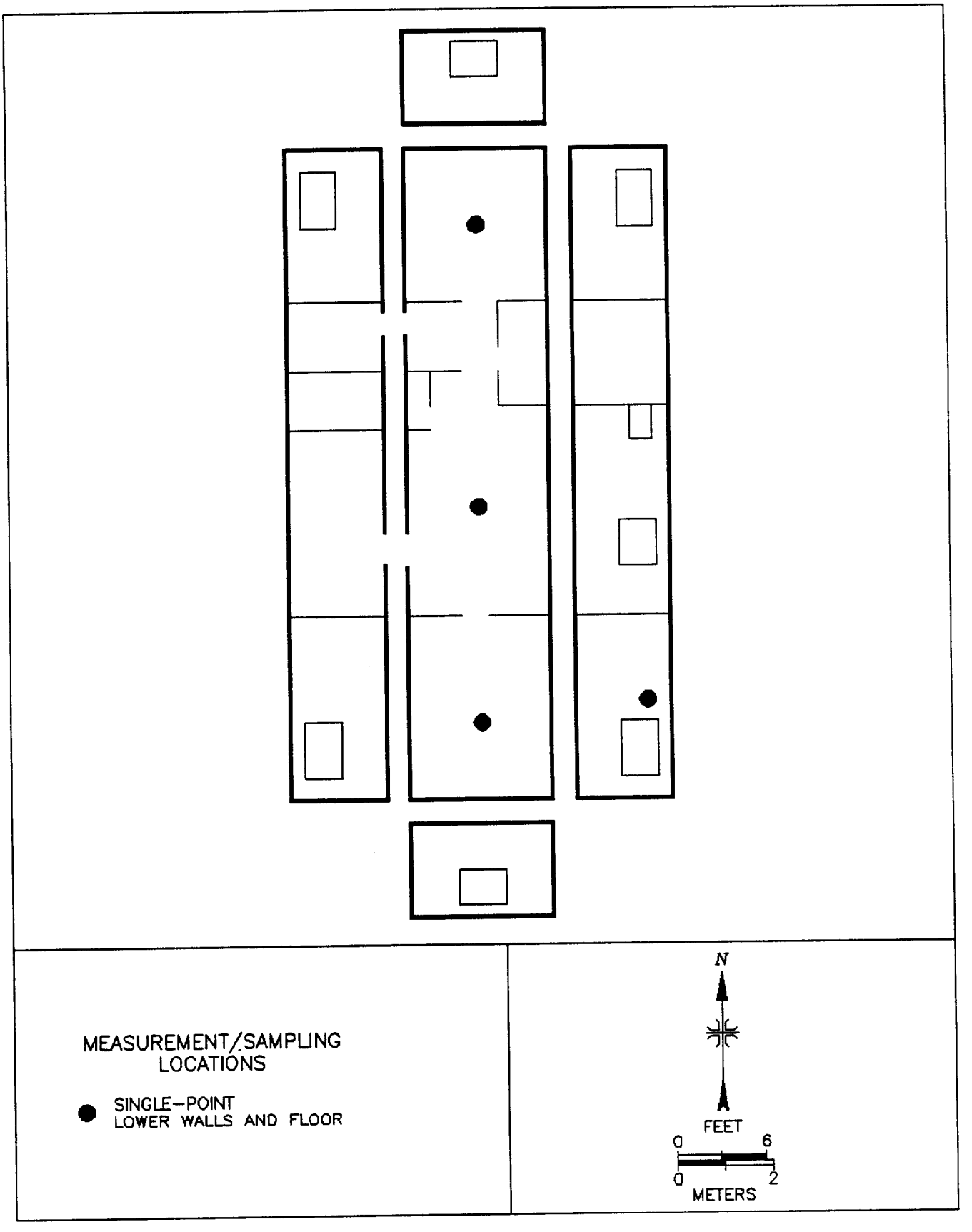

FIGURE 15: Office Trailer – Measurement and Sampling Locations

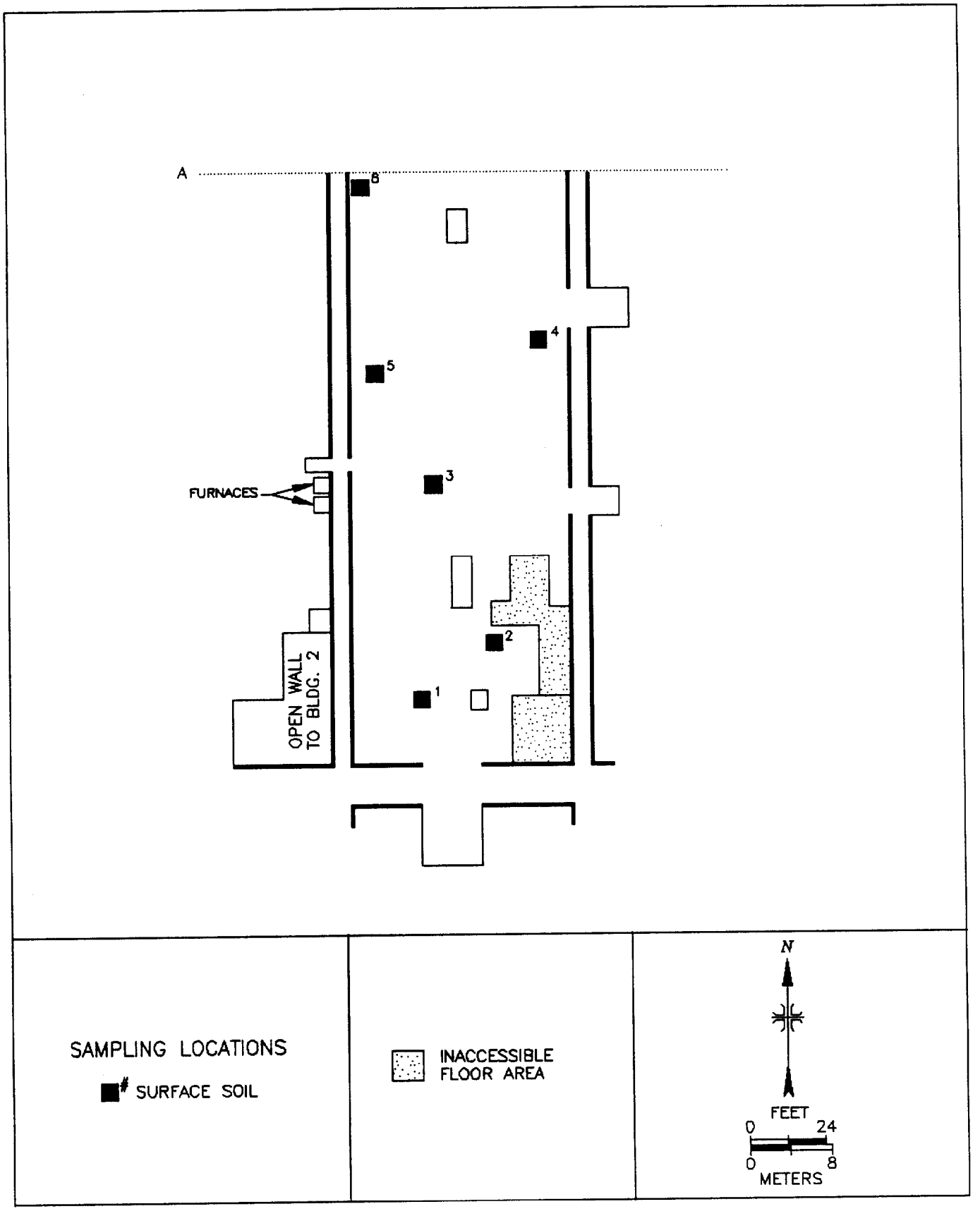

FIGURE 16: Building 1, Section A – Soil Sampling Locations

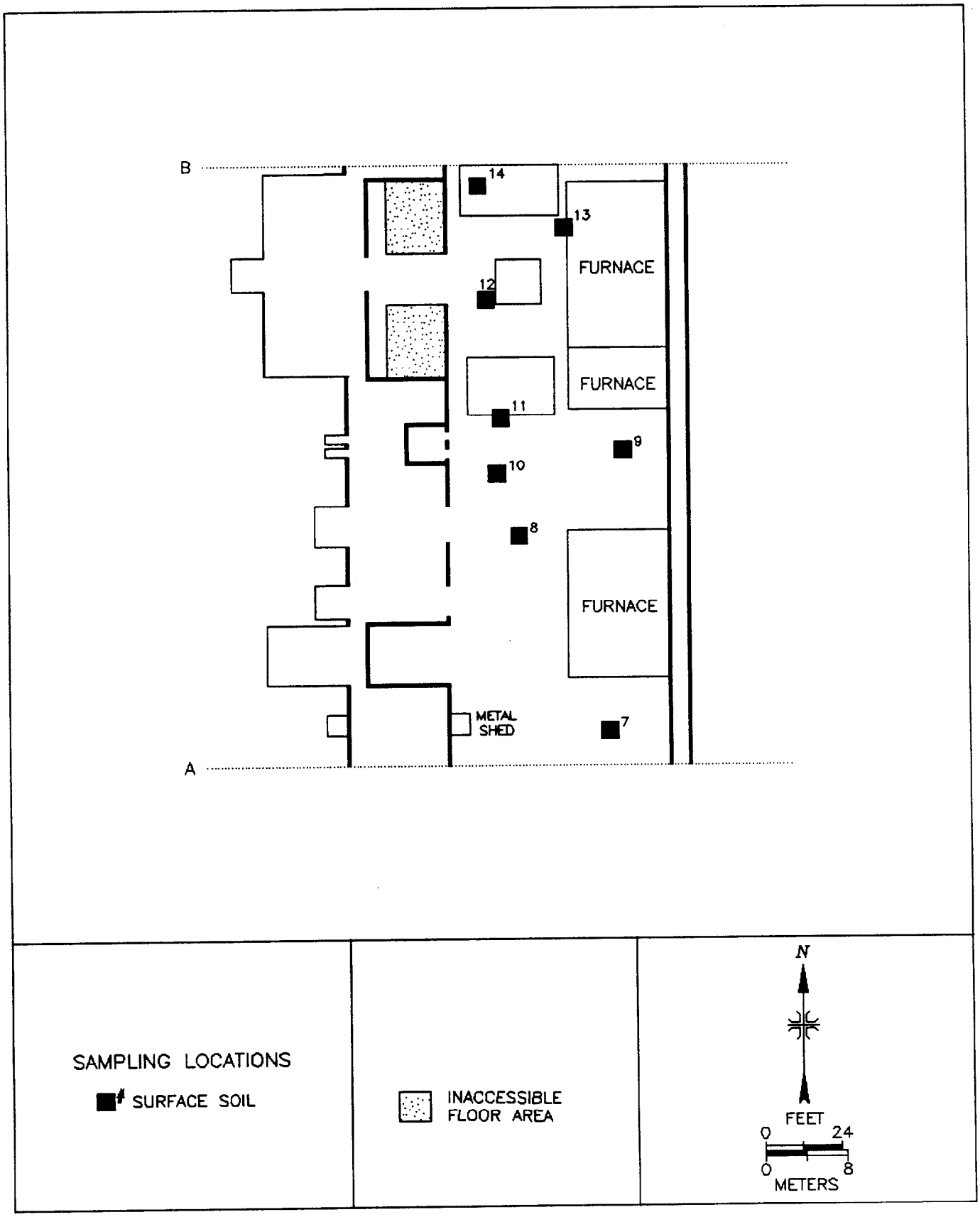

FIGURE 17: Building 1, Section B – Soil Sampling Locations

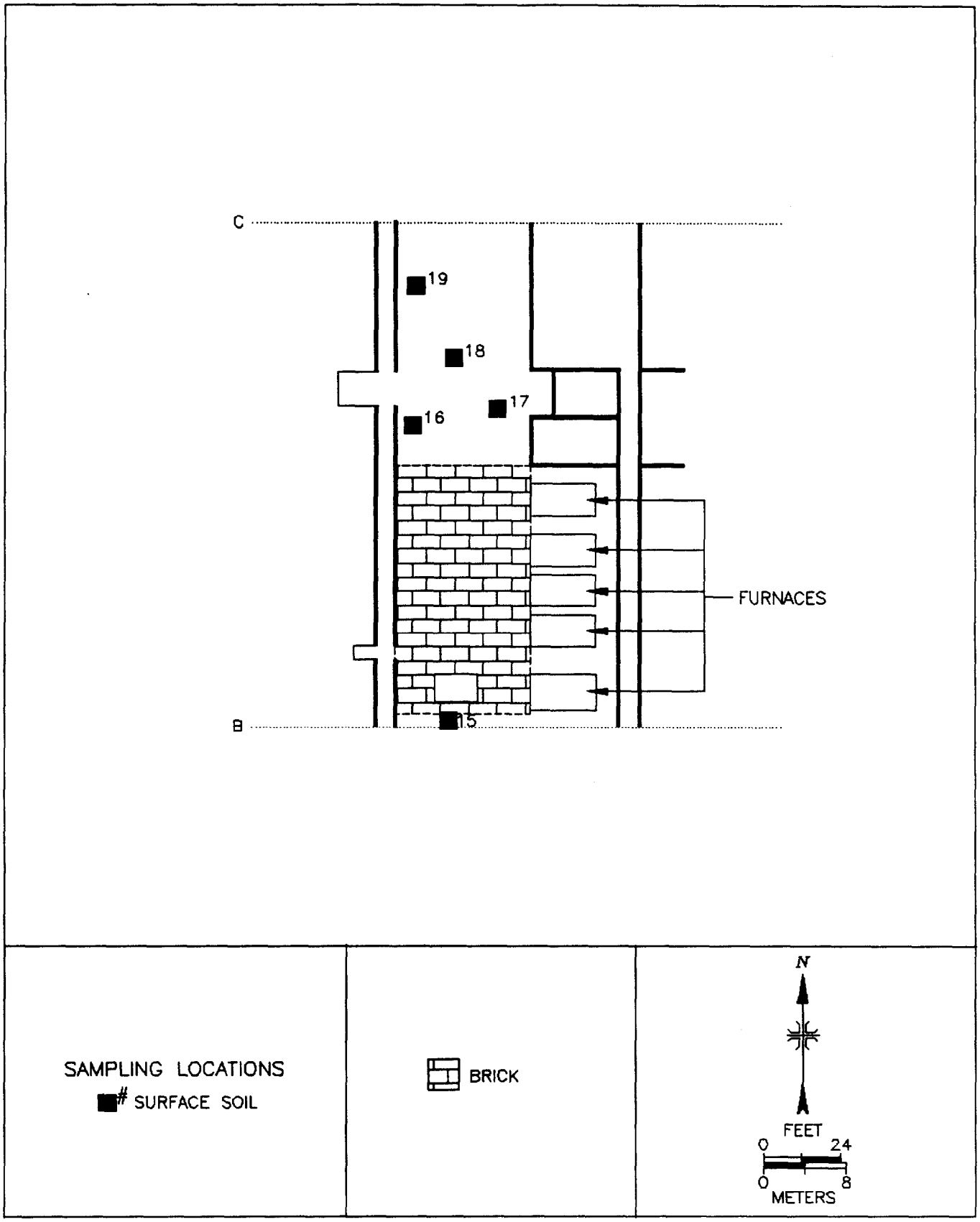

FIGURE 18: Building 1, Section C – Soil Sampling Locations

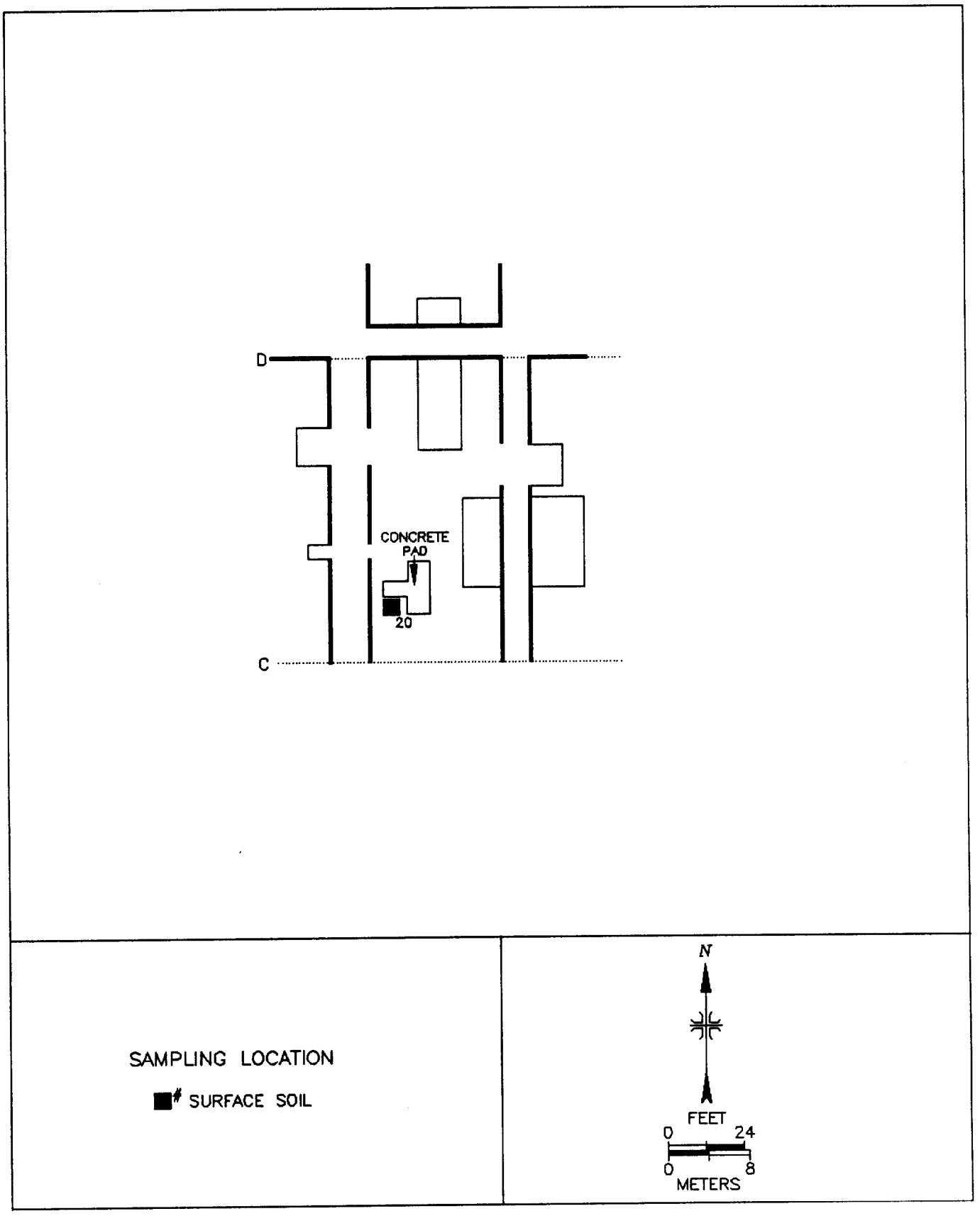

FIGURE 19: Building 1, Section D – Soil Sampling Location

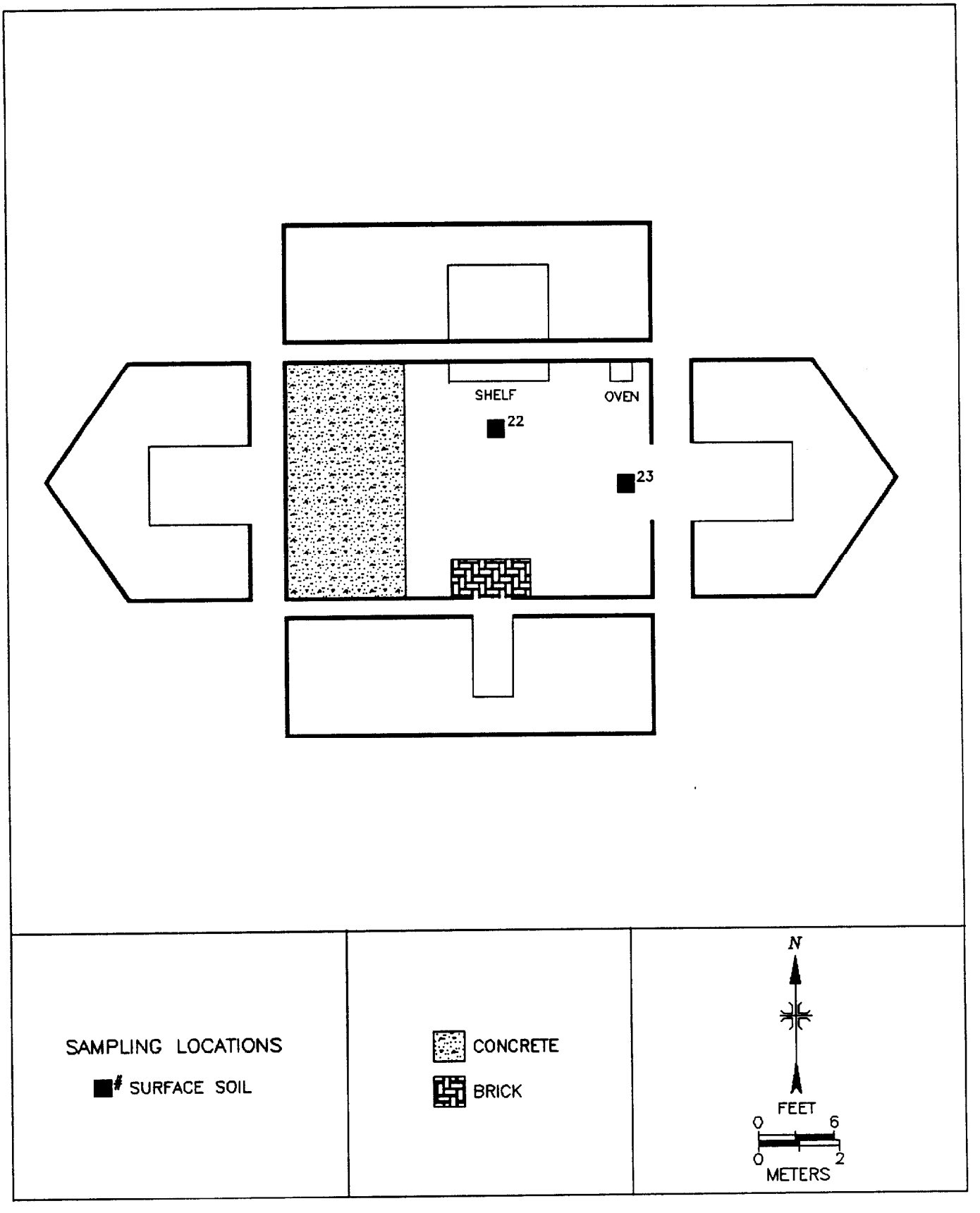

FIGURE 20: Building 10 – Soil Sampling Locations

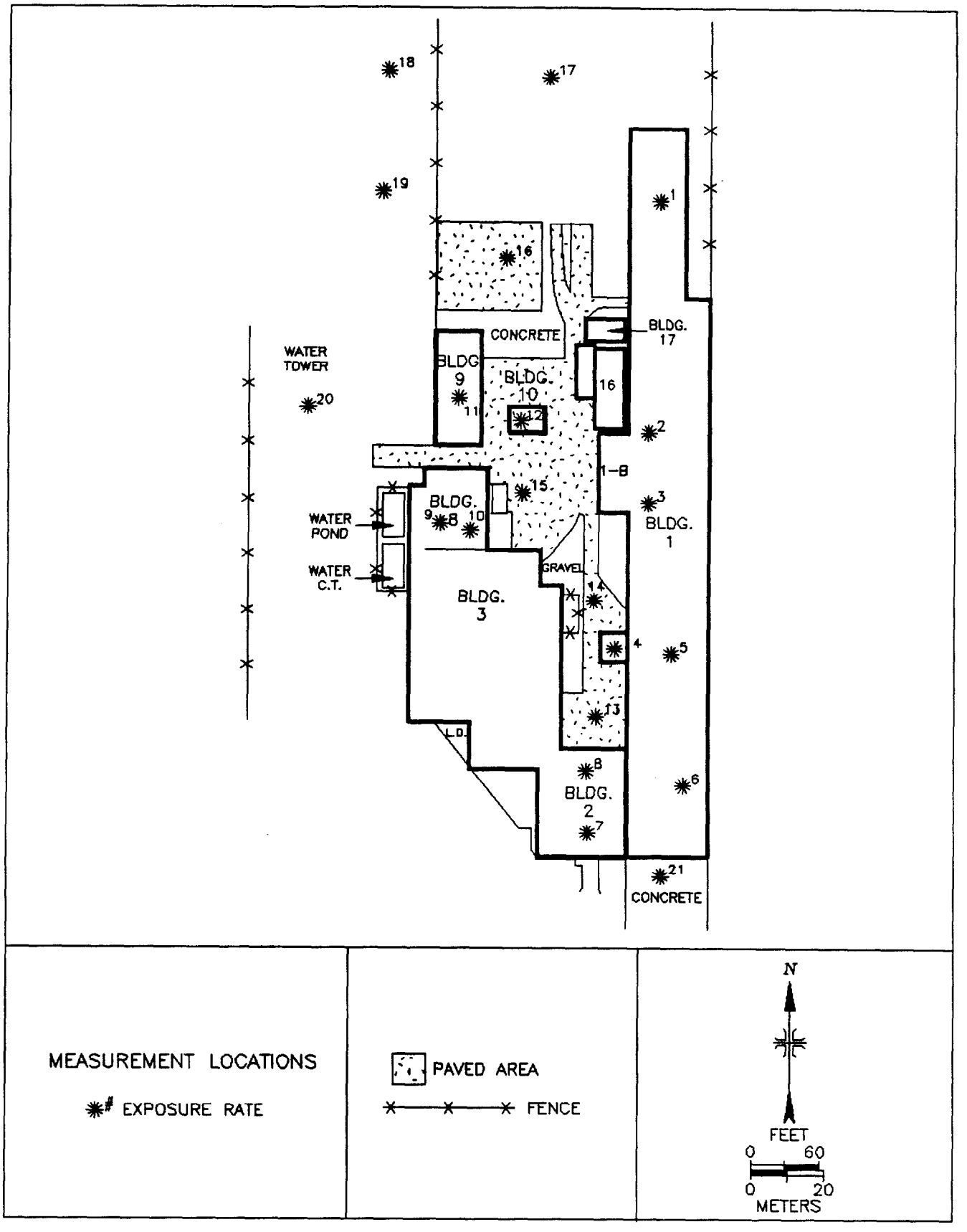

FIGURE 21: Plan View of Site – Exposure Rate Measurement Locations

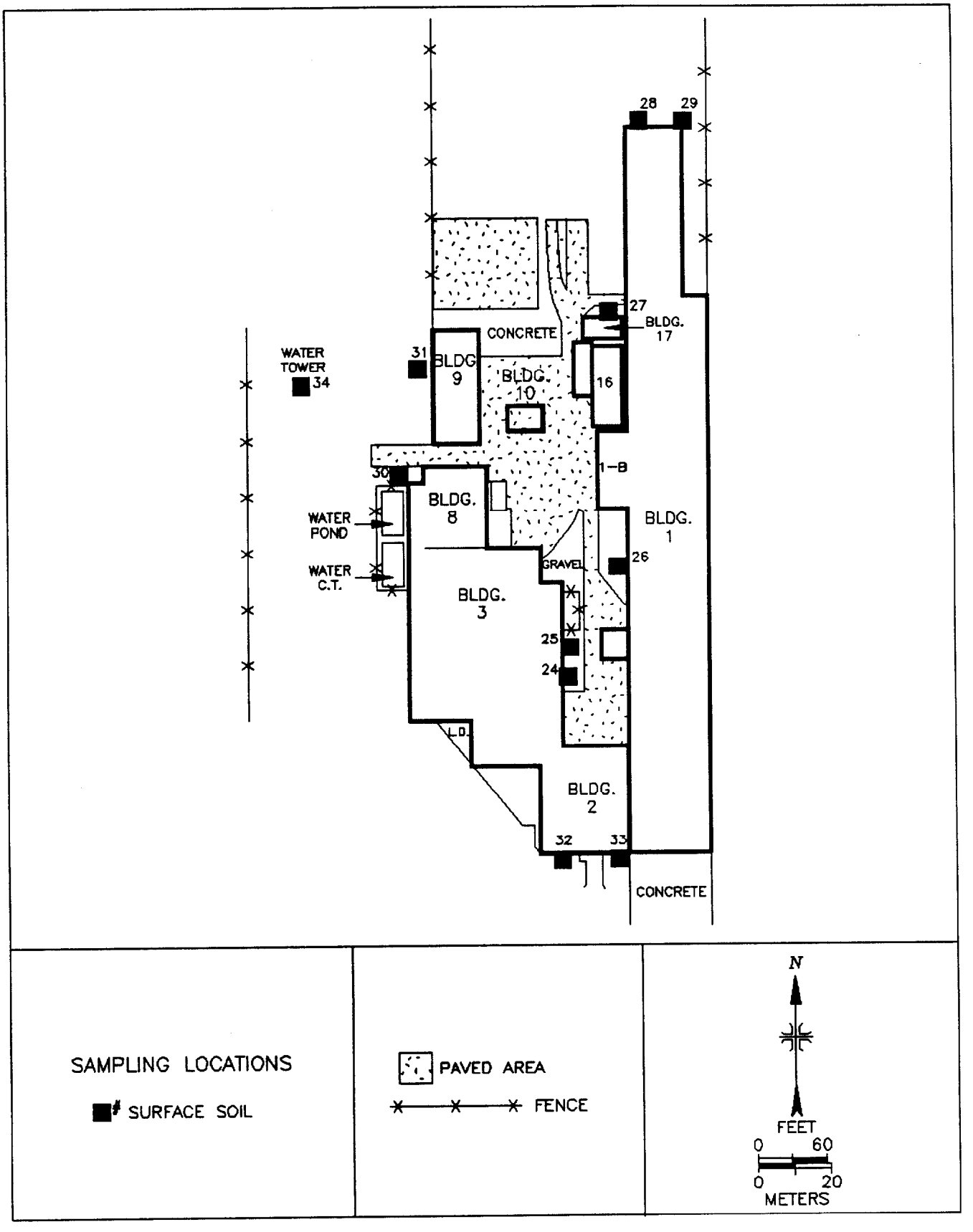

FIGURE 22: Plan View of Site – Exterior Soil Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location		Figure(s)	Number of Single-Point Measurement Locations[a]	Range of Beta Activity (dpm/100 cm^2)	Range of Removable Activity (dpm/100 cm^2)	
Building	Surface				Alpha	Beta
1	Lower Wall & Floor	4-7	64	<830-1,500	<12	<15
	Upper Wall	4-7	2	<830	<12	<15
	Equipment	4-7	24	<830-2,100	<12	<15
2	Lower Wall & Floor	8	28	<830	<12	<15
	Equipment	8	2	<830	<12	<15
	Upper Wall	8	1	<830	<12	35
8A	Lower Wall & Floor	9	13 (5)	<830-9,900	<12	<15-30
	Upper Wall	9	1	<830	<12	<15
	Equipment	9	1	<830	<12	<15
8B	Lower Wall & Floor	10	15 (6)	<830-70,000	<12-52	<15-48
8D	Lower Wall & Floor	9	3	<830-3,800	<12	<15

TABLE 1 (CONTINUED)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location		Figure(s)	Number of Single-Point Measurement Locations[a]	Range of Beta Activity (dpm/100 cm^2)	Range of Removable Activity (dpm/100 cm^2)	
Building	Surface				Alpha	Beta
9	Lower Wall & Floor	11	9	<830	<12	<15-29
	Equipment	11	3	<830	<12	<15
	Upper Wall	11	1	<830	<12	<15
10	Lower Wall & Floor	12	5	<830-980	<12	<15
	Equipment	12	3	<830-1,700	<12	<15
16	Lower Wall & Floor	13	6	<830-2,000	<12	<15
	Equipment	13	1	<830	<12	<15
	Upper Wall	13	1	1,700	<12	<15
Metal Shed	Lower Wall	14	2	<830	<12	<15
Office Trailer	Lower Wall & Floor	15	4	<830	<12	<15

[a]Parentheses indicate number of measurements ≥ 5,000 dpm/100 cm^2.

TABLE 2

EXPOSURE RATE MEASUREMENTS
ALIQUIPPA FORGE
WEST ALIQUIPPA FORGE, PENNSYLVANIA

Location[a]	Building/Area	Exposure Rate @ 1 m Above Surface (μR/h)
Interior		
1	1	7
2	1	13[b]
3	1	12[b]
4	1	9
5	1	9
6	1	9
7	2	8
8	2	8
9	8	14[b]
10	8	14[b]
11	9	8
12	10	9
Exterior		
13	Between Bldgs. 1,2 and 3	7[c]
14	Between Bldgs. 1 and 3	8[c]
15	Courtyard Near Bldg. 8	10[c]
16	Concrete Pad	8
17	Waste Area	7
18	Waste Area	9[d]
19	Waste Area	10[d]
20	Water Tower	10[e]
21	South of Bldg. 1	9

[a]Refer To Figure 21.
[b]Brick Floor
[c]Paved Area
[d]Soil Area
[e]Gravel

TABLE 3

URANIUM CONCENTRATIONS IN SOIL-INTERIOR LOCATIONS
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Soil Sample Number	Figure #	Uranium Concentration (pCi/g)[a]		
			U-235	U-238	Total Uranium[b]
Bldg. 1	1	16	0.1 ± 0.1	1.0 ± 0.7	2.1
Bldg. 1	2	16	0.1 ± 0.1	1.0 ± 1.0	2.1
Bldg. 1	3	16	0.1 ± 0.1	0.4 ± 0.6	0.9
Bldg. 1	4	16	0.1 ± 0.1	<1.0	<2.1
Bldg. 1	5	16	0.1 ± 0.1	2.0 ± 0.9	4.1
Bldg. 1	6	16	0.1 ± 0.1	1.5 ± 0.8	3.1
Bldg. 1	7	17	0.1 ± 0.1	0.2 ± 0.5	0.5
Bldg. 1	8	17	0.1 ± 0.1	0.4 ± 0.6	0.9
Bldg. 1	9	17	0.1 ± 0.1	1.6 ± 0.8	3.3
Bldg. 1	10	17	0.1 ± 0.1	0.6 ± 0.5	1.3
Bldg. 1	11	17	0.1 ± 0.1	0.4 ± 0.4	0.9
Bldg. 1	12	17	<0.1	<0.5	<1.1
Bldg. 1	13	17	0.1 ± 0.1	0.8 ± 0.6	1.7
Bldg. 1	14	17	0.1 ± 0.1	2.3 ± 0.8	4.7
Bldg. 1	15	18	0.1 ± 0.1	0.6 ± 0.5	1.3
Bldg. 1	16	18	0.1 ± 0.1	0.5 ± 0.5	1.1
Bldg. 1	17	18	0.1 ± 0.1	0.6 ± 0.4	1.3
Bldg. 1	18	18	0.1 ± 0.1	0.5 ± 0.4	1.1
Bldg. 1	19	18	0.1 ± 0.1	0.4 ± 0.3	0.9
Bldg. 1	20	19	0.1 ± 0.1	0.6 ± 0.4	1.3
Bldg. 8	21	9	0.2 ± 0.1	3.8 ± 1.3	7.8
Bldg.10	22	20	0.1 ± 0.1	0.8 ± 0.5	1.7
Bldg.10	23	20	0.1 ± 0.1	0.7 ± 0.3	1.5

[a]Uncertainties represent the 95% confidence level, based only on counting statistics.
[b]Total uranium concentrations are calculated based on natural isotopic abundances.

TABLE 4

URANIUM CONCENTRATIONS IN SOIL-EXTERIOR LOCATIONS
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Location[a]	Soil Sample Number	Uranium Concentration (pCi/g)[b]		
		U-235	U-238	Total Uranium[c]
Bldg. 3	24	0.1 ± 0.1	1.4 ± 1.0	2.9
Bldg. 3	25	0.2 ± 0.1	1.7 ± 0.8	3.6
Bldg. 1	26	<0.1	0.3 ± 0.5	<0.7
Bldg. 1	27	0.1 ± 0.1	1.6 ± 0.9	3.3
Bldg. 1	28	0.1 ± 0.1	0.7 ± 0.5	1.5
Bldg. 1, NE Corner	29	0.1 ± 0.1	<0.8	<1.7
Bldg. 8	30	0.4 ± 0.1	5.0 ± 1.4	10.4
Bldg. 9	31	0.2 ± 0.1	1.8 ± 0.9	3.8
Bldg. 9	32	0.3 ± 0.1	0.7 ± 0.7	1.7
Bldg. 2 SE Corner	33	0.3 ± 0.1	5.1 ± 1.7	10.5
Water Tower	34	0.1 ± 0.1	0.9 ± 0.9	1.9

[a]Refer To Figure 22.
[b]Uncertainties represent the 95% confidence level, based only on counting statistics.
[c]Total uranium concentrations are calculated based on natural isotopic abundances.

REFERENCES

1. "Radiological Survey of Universal Cyclops, Inc., Titusville Plant (Formerly Vulcan Crucible Steel Company), Aliquippa, Pennsylvania," Argonne National Laboratory, May 1982.

2. "Site Plan for Universal Cyclops, Aliquippa Forge Site, Aliquippa, Pennsylvania," DOE/OR/20722-122, Bechtel National, Inc., August 1988.

3. "Radiological Survey Plan of the Aliquippa Forge Site, Aliquippa, Pennsylvania," Environmental Survey and Site Assessment Program, Oak Ridge Institute for Science and Education, May 15, 1992.

4. "Radiation Protection of the Public and the Environment," DOE Order 5400.5, U.S. Department of Energy, February 8, 1990.

5. "Radiological Control Manual," U.S. Department of Energy, June 1992.

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 author 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

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

Eberline GM Detector
Model HP-260
Effective Area, 15.5 cm^2
(Eberline, Santa Fe, NM)

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

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)

High-Purity Germanium Coaxial Well Detector
Model GWL-110210-PWS-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Applied Physical Technology, Atlanta, GA) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Intrinsic Germanium Detector
Model IGC25, 25% Eff.
(Princeton Gamma-Tech, Princeton, NJ)
Used in conjunction with:
Lead Shield
(Nuclear Data, Schaumburg, 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-Beta	-	gas proportional detector with ratemeter-scaler
Beta	-	GM detector with ratemeter-scaler
Gamma	-	NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements of total beta activity levels were performed on floors, lower walls, upper surfaces, equipment, beams and joists at locations of elevated direct radiation, using GM detectors with ratemeter-scalers.

Count rates (cpm), which were integrated over 1 minute in a static position, were converted to activity levels (dpm/100 cm^2) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. The beta activity background count rates for the GM detectors

averaged approximately 45 cpm. Beta efficiency factors ranged from 0.24 to 0.27 for the GM detectors. The effective window for GM detectors is 15.5 cm^2.

Removable Activity Measurements

Removable activity levels were determined using numbered filter paper disks, 47 mm in diameter. Moderate pressure was applied to the smear with two or three fingers, 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, and/or crushed then placed in an appropriate container 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:

U-235	0.186 MeV
U-238	0.063 MeV from Th-234* (or 1.001 MeV from Pa-234 m)*

*Secular equilibrium assumed.

Spectra were also reviewed for other identifiable photopeaks.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. When the net sample count was less than 95% statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the measurement procedures. Because of variations in background levels, measurement efficiencies, and contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument. 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 6 (February 1991)

-Laboratory Procedures Manual Revision 6 (April 1991) and Revision 7 (Implemented June 15, 1992)

-Quality Assurance Manual Revision 5 (June 1991) and Revision 6 (Implemented June 1, 1992)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6B and 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 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 fluctuations.

- Participation in EPA and EML laboratory Quality Assurance Programs.

- Training and certification of all individuals performing procedures.

- Periodic internal and external audits.

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

APPENDIX C

RESIDUAL RADIOACTIVE MATERIAL GUIDELINES SUMMARIZED FROM DOE ORDER 5400.5

BASIC DOSE LIMITS

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

STRUCTURE GUIDELINES

DOE Order 5400.5 was used to establish the guidelines.[1]

Indoor/Outdoor Structure Surface Contamination

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

External Gamma Radiation

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

SOIL GUIDELINES

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

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

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

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

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

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

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

[g] Guideline values for these radionuclides are not provided in DOE Order 5400.5.

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

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

[j] If the average concentration in any surface or below-surface area, less than or equal to 25 m^2, exceeds the authorized limit of guideline by a factor of $(100/A)^{½}$, where A is the area or the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/8901.[2] In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

REFERENCES

1. "Radiation Protection of the Public and the Environment", DOE Order 5400.5, U.S. Department of Energy, February 8, 1990.

2. Argonne National Laboratory "A Manual for Implementing Residual Radioactive Material Guidelines", DOE/CH/8901, June 1989.