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CHARACTERIZATION SURVEY OF PORTIONS 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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ALIQUIPPA FORGE SITE
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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
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

CHARACTERIZATION SURVEY OF PORTIONS OF THE ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

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 Laboratory (ANL) identified residual radioactive contamination above current guidelines on floors, walls, and overhead beams above the furnaces that were used for heating the 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 of still being 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.

In May 1992, the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Institute for Science and Education (ORISE) performed a radiological survey of the buildings and grounds (excluding Building 3) to determine the radiological status of the entire site, prior to characterization and remediation activities in Building 3.[3] Residual uranium contamination was identified in Building 8, which shares a common wall with and has direct access to Building 3 (See Figure 2). As a result of that survey, DOE requested that ESSAP perform a radiological characterization survey to determine the areal extent of residual uranium contamination in Building 3 (to include the outdoor soil area along the west side) and portions of Building 8 of the Aliquippa Forge Site.

SITE DESCRIPTION

The Aliquippa Forge Site is located in a mixed industrial/residential area on a 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, 2 water towers, a cooling tower, and a small cooling basin (Figure 2). This 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 weeds and brush surrounding the buildings. A residential community is located 15.2 m (50 ft) south of the site boundary.

Building 3 contains approximately 2,400 m^2 (25,500 ft^2) of floor space. It is constructed primarily of sheet-metal with steel structural beams and concrete block foundation. The floor is mostly concrete with small areas of brick over dirt around the furnaces and bare dirt (brick removed) or gravel. Pallets of fire brick and dismantled equipment cover large areas at the south end of the building. The roof is corrugated aluminum with the two apexes at approximately 11 m (36 ft) each. Vent openings and/or fans are present at the apexes. The area of known uranium contamination is designated with a wood and metal fence. Located inside the fenced area are two furnaces (1 partially dismantled) and a large wooden box. The wooden box covers a pit excavation from an interim remediation effort (Figure 3). An area identified as a "Suspected Mica Pit" was allegedly used for storage of contaminated material (Figure 3).

Building 8 has a total floor space of approximately 500 m^2 (5400 ft^2). There are four separate rooms which are designated A-D. Wall and ceiling construction are the same as in Building 3. The floor is mostly concrete with the exception of Room B which is mainly brick over dirt. The mezzanine above Room D has a wooden floor. The wall separating Buildings 3 and 8 is constructed of sheet-metal (Figure 4).

The outdoor area along the west side of Building 3 is bare soil, approximately 42 m (140 ft) in length and averages 6 m (20 ft) wide. A water cooling tower and holding pond, surrounded by a chain link fence, border the area to the north; a packed dirt and gravel parking area borders the west (Figure 2).

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 only.

OBJECTIVES

The objectives of the survey were to provide sufficient information to determine the radiological status of the site, relative to current DOE residual contamination guidelines, and to provide sufficient information for design of a remedial action work plan. This report summarizes the procedures and results of the survey.

PROCEDURES

During the periods from May 17-22, 1992 and from June 8-12, 1992, ESSAP performed a characterization survey of Building 3, Building 8, and the outdoor area along the west side of Building 3. The survey was in accordance with a survey plan submitted to, and approved by, the DOE.[4]

SURVEY PROCEDURES: INTERIOR

Reference Grid

A 2 m x 2 m reference grid was established by ESSAP on portions of the floors and lower walls (up to 2 m) in Building 3 and in Room B of Building 8 (Figures 5 and 6). The reference grid was subdivided into a 1 m x 1 m grid when it was necessary to perform grid block measurements. Ceilings and upper walls were not gridded. Measurement and samples from ungridded surfaces were referenced to the floor grid or to prominent building surfaces.

Surface Scans

Surface scans were performed on floors, upper and lower walls, equipment, ceilings, ducts, and drains in Building 3 and in Building 8. The scans were used to identify locations of residual activity for which the boundaries were later defined by direct measurements. Gas proportional detectors were used to perform alpha-beta scans on floors and lower walls. Gamma scans were performed using NaI scintillation detectors. Locations with limited accessibility, such as upper walls, ceilings, ducts, ledges, piping, and overhead support beams, were scanned using GM detectors. All detectors were coupled to ratemeters or ratemeter-scalers with audible indicators. Locations of elevated direct radiation identified by surface scans were marked for further investigation.

Surface Activity Measurements

The radionuclide of concern is processed natural uranium, i.e. uranium separated from its long lived daughter products, 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 activity levels.

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 levels in grid blocks were systematically performed at the center and four points, midway between the center and grid block corners. Single-point measurements were also performed at locations of elevated direct radiation within each grid block and at locations of elevated direct radiation identified by surface scans on ungridded surfaces. These measurements were performed to define the boundaries of those areas which exceeded guidelines.

A total of 114 grid block measurements were performed within the gridded area on the floors and lower walls. Additional single-point direct measurements were performed on interior surfaces: 262 measurements were performed on the floors and lower walls, 116 measurements on upper surfaces, and 118 measurements on equipment surfaces, such as furnaces and exhaust fans. A smear sample for determining removable activity was obtained from each grid block, at the location corresponding to the maximum direct measurement, and from each single-point measurement location. Measurement and sampling locations for total and removable activity are illustrated on Figures 7 thru 21.

Miscellaneous Sampling

Several soil samples were collected from sub-floor locations to determine the extent of residual contamination. Two soil samples were collected from underneath brick flooring at locations where direct measurements identified surface contamination in excess of guidelines. Measurement locations are shown on Figures 8 and 19.

Three holes were drilled at the suspected Mica Pit and surface and subsurface soil samples were collected. The first and second locations were sampled to depths of 45 and 60 cm, respectively. Soil samples from greater depths at these locations were unobtainable due to obstructions. The

third hole drilled in the Mica Pit was sampled to a depth of 90 cm. Based on the absence of elevated activity through direct radiation monitoring techniques, soil samples at depths greater than 90 cm were not collected. Measurement locations are indicated on Figure 22.

To confirm the contaminant was processed natural uranium, dust and residue samples collected from various locations within Building 3 were analyzed for uranium. Sampling locations are shown on Figures 19 and 21.

SURVEY PROCEDURES: EXTERIOR

Reference Grid

A 2 m x 2 m grid system, established by ESSAP outside the loading dock doors on the west side of Building 3, was used for reference (Figure 23).

Surface Scans

Gamma surface scans were conducted at 1 to 2 m intervals 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.

Soil Sampling

Surface soil (0 to 15 cm) samples were collected from grid intersections and from locations of elevated direct radiation identified by surface scans. Subsurface soil samples were collected at 15 cm intervals from 5 boreholes which measured in depth from 0 to 45 cm. Borehole locations were selected from areas of elevated direct radiation identified by surface scans (Figure 23).

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. Several soil samples were analyzed by alpha spectrometry to determine uranium isotopic abundances. 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 disintegrations per minute/100 cm^2. 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.

GUIDELINES

The detailed DOE guidelines for residual radioactive material are included as Appendix C. The radionuclide of concern at the Aliquippa Forge Site is processed natural uranium. The surface contamination guidelines for natural uranium are as follows:

Total Activity

5,000 α dpm/100 cm^2, averaged over 1 m^2
15,000 α dpm/100 cm^2, maximum in 100 cm^2

Removable Activity

1,000 α dpm/100 cm^2

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

FINDINGS AND RESULTS

INTERIOR SURVEY

Surface Scans

Surface scans of Buildings 3 and 8 identified elevated direct radiation on overhead structural supports, on horizontal surfaces such as ledges and platforms, on the lower walls, on the exterior shell of the furnaces, and on the floor. These locations were noted for additional measurements.

Surface Activity Levels

Surface activity measurements in Buildings 3 and 8, exceeding the DOE guidelines, are presented in Tables 1 thru 4. Direct measurements on the floor identified 68 grid blocks in which the average beta activity over the 1 m^2 area was greater than 5,000 dpm/100 cm^2 (Figures 8 and 19); 52 single-point measurements on the floors and lower walls which exceeded 15,000 dpm/100 cm^2 (Figures 19 and 20); 51 single-point measurements on upper surfaces which exceeded 5,000 dpm/100 cm^2, of which 38 exceeded 15,000 dpm/100 cm^2 (Figure 21); and 29 single-point measurements on the furnaces which exceeded 15,000 dpm/100 cm^2 (Figures 13 thru 18). Removable activity levels ranged from < 12 to 350 dpm/100 cm^2 and < 15 to 410 dpm/100 cm^2 for alpha and beta, respectively.

The remaining surface activity measurements in Building 3 and Building 8 are summarized in Table 5. There were 411 single-point measurements performed on the floors, lower walls, upper surfaces, and equipment which were within guidelines. Removable activity levels for these locations were < 12 dpm/100 cm^2 for alpha and ranged from < 15 to 30 dpm/100 cm^2 for beta.

Uranium Concentrations in Miscellaneous Samples

Uranium concentrations in soil samples collected from the Mica Pit in Building 3 are provided in Table 6. With one exception, the total uranium concentration within these samples, ranged from 0.5 to 23 pCi/g. A soil sample collected from borehole 3 at 75 to 90 cm had a total

uranium concentration of 1,600 pCi/g (Figure 22). It should be noted that, although only one soil sample from the Mica Pit exceeded the guidelines, that sample was the only sample collected at that depth.

Uranium concentrations from soil samples collected near the furnace in Building 3 and from Room B in Building 8 are presented in Table 7. The total uranium concentrations in these samples were 3,500 pCi/g for the soil sample near the furnace and 29 pCi/g for the soil sample in Building 8.

Residue samples collected from the floor and overhead structural support beams of Building 3 had a total uranium concentration range from 220 to 3,100 pCi/g. These samples indicate that residual contamination is removable. The results are summarized in Table 7.

EXTERIOR SURVEY

Surface Scans

Surface scans of the area to the west of Building 3 identified several locations of elevated direct radiation. These areas were noted for additional measurements and sampling.

Radionuclide Concentrations in Soils

Concentrations of radionuclides in soil samples, collected from systematic and elevated direct radiation sampling locations (Figure 23), are summarized in Tables 8 and 9. Alpha spectrometry analysis of several soil samples confirm that the isotopic abundances are consistent with those of natural uranium. Radionuclide concentration ranges for systematic surface soil (0 to 15 cm) samples (Table 8) are as follows: U-235, 0.1 to 11.8 pCi/g; U-238, 1.0 to 310 pCi/g; and total uranium, 2.1 to 630 pCi/g. The uranium concentration ranges for surface and subsurface soil samples collected from locations of elevated direct radiation (Table 9) are as follows: U-235, 0.1 to 87 pCi/g; U-238, 2.5 to 2,680 pCi/g; and total uranium, 5.1 to 5,400 pCi/g.

SUMMARY

At the request of the U.S. Department of Energy, the Oak Ridge Institute for Science and Education's Environmental Survey and Site Assessment Program conducted a characterization survey of Building 3, Building 8, and the exterior soil area adjacent to the west wall of Building 3 at Aliquippa Forge in West Aliquippa, Pennsylvania. Survey activities included surface scans, surface activity measurements, and soil and residue sampling.

Residual uranium activity, exceeding the DOE surface contamination guideline levels, was identified in numerous locations on the floors and lower walls in Buildings 3 and 8. The majority of the contamination (as indicated on Figure 24), was confined to four major areas: between the west wall and the west furnace and raised platform (approximately 60 m^2); in and around the north-south railroad track; a residue pile south of the barricade area (approximately 12 m^2); and Room B of Building 8 (approximately 8 m^2). Some floor surfaces in these areas were inaccessible due to equipment and material storage; it is possible that additional areas of residual contamination were present.

Residual activity, exceeding guideline levels, was also identified on upper surfaces and equipment in Building 3. Removable activity levels, for all areas, were within the guidelines; however, dust samples from horizontal surfaces in these areas were found to contain elevated concentrations of uranium. Upper surface and equipment measurements were not averaged over 1 m^2 due to the difficulty in establishing a reference grid on uneven surfaces and on structural beams that support the roof. Single-point measurements were performed at locations which were representative of the contamination that was widespread throughout the upper surface support beams in the West Bay and on the exterior surfaces of the furnaces.

A guideline value for U-238 in soil and other volumetric sources has not been established for this site; however, guidelines at other FUSRAP sites have typically ranged from 30 to 50 pCi/g. Residue samples from the support beams and the contaminated pile outside the barricade fence, in Building 3, exceeded those typical levels. Soil samples collected from the floor and the Mica Pit also exceeded those levels. Twenty-five surface soil samples, collected from the exterior

area west of Building 3, exceeded 30 pCi/g. Four of these sampling locations had uranium concentrations exceeding those levels in sub-surface samples. The extent of contamination in soil west of Building 3, based on systematic surface sample analysis, appears to be an area of approximately 40 to 50 m^2 (430 to 540 ft^2) as indicated on Figure 24; however, further investigation may be necessary to more accurately determine the extent of the contamination.

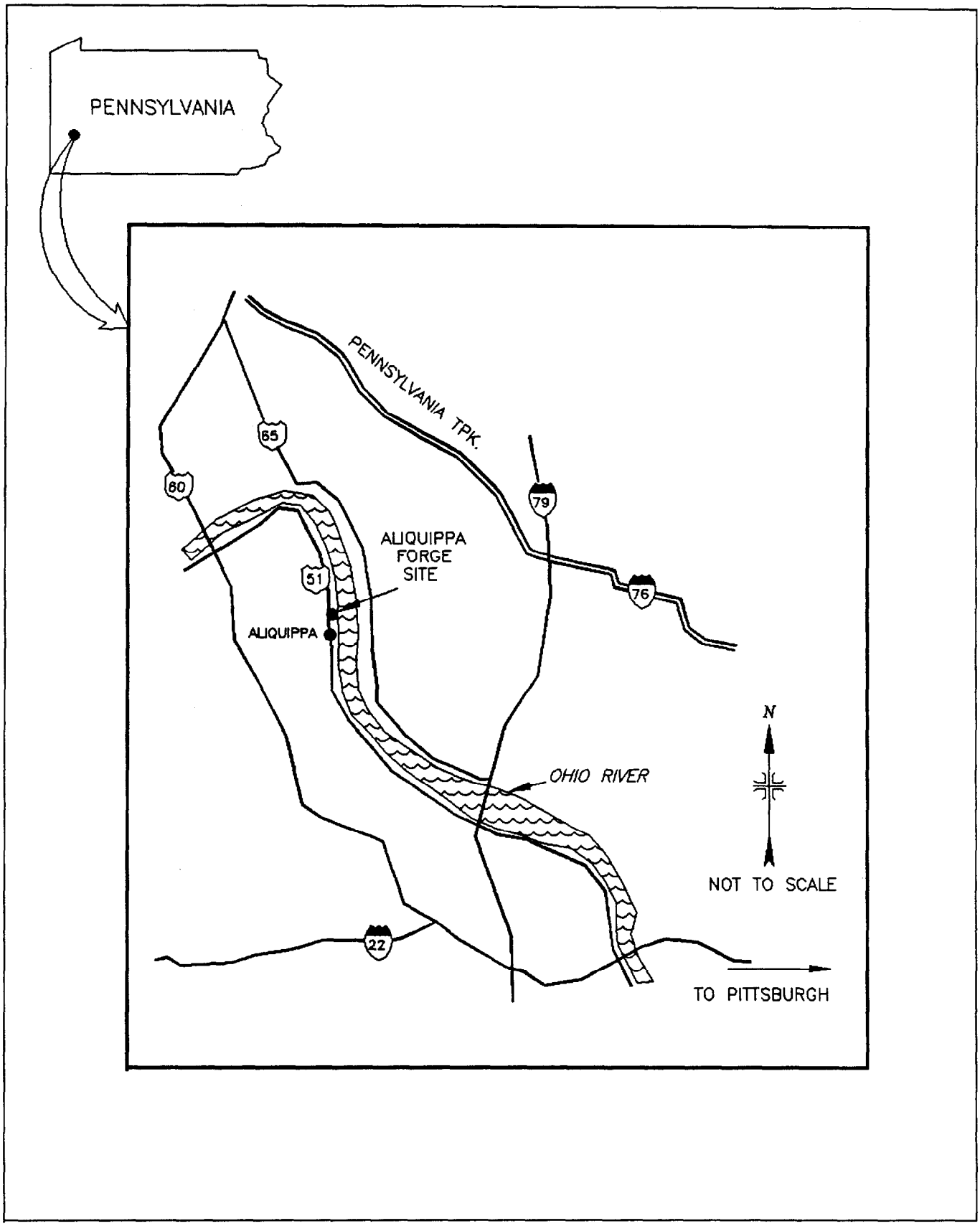


FIGURE 1: Location of the Aliquippa Forge Site, West Aliquippa, Pennsylvania

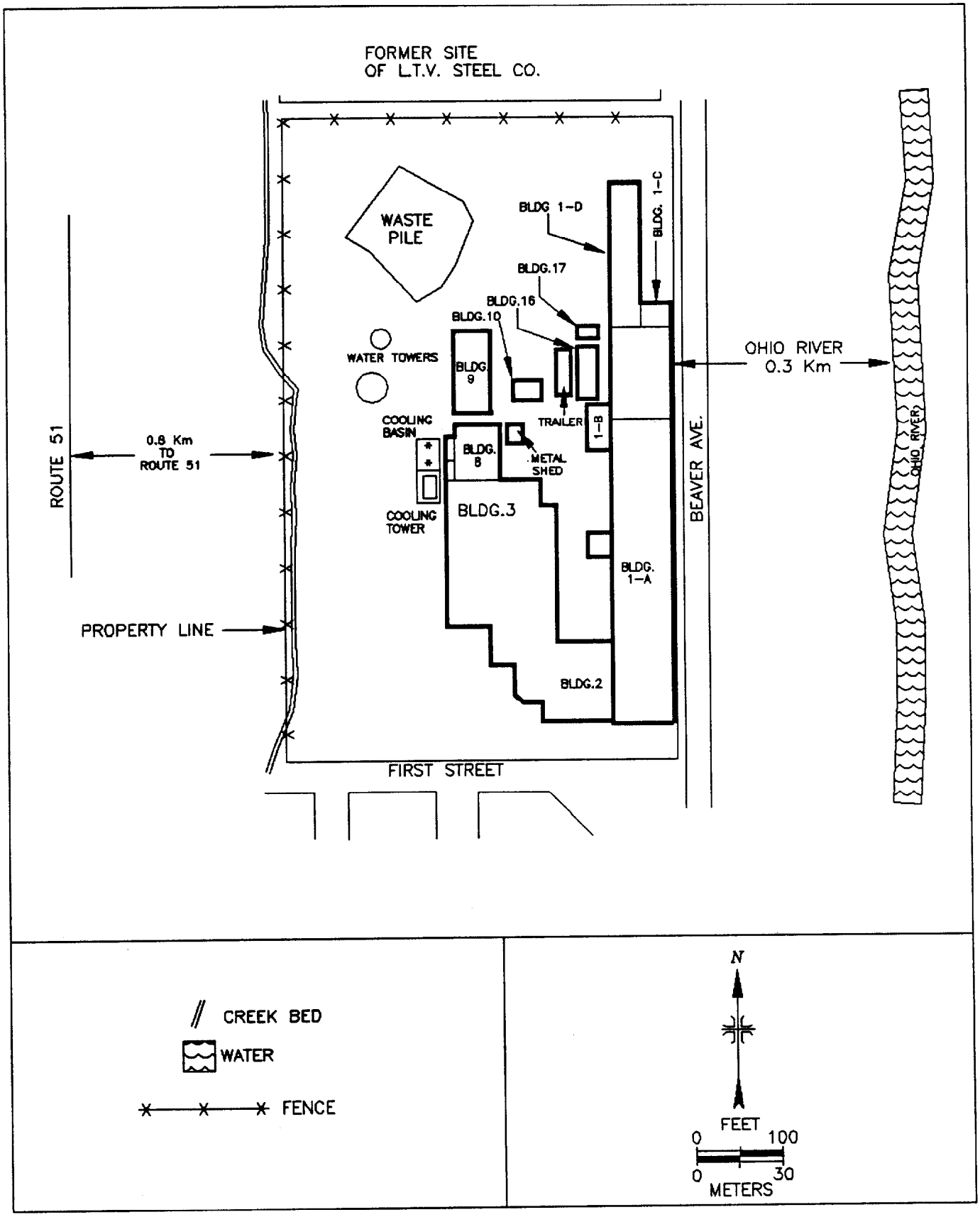


FIGURE 2: Plot Plan of the Aliquippa Forge Site, West Aliquippa, Pennsylvania

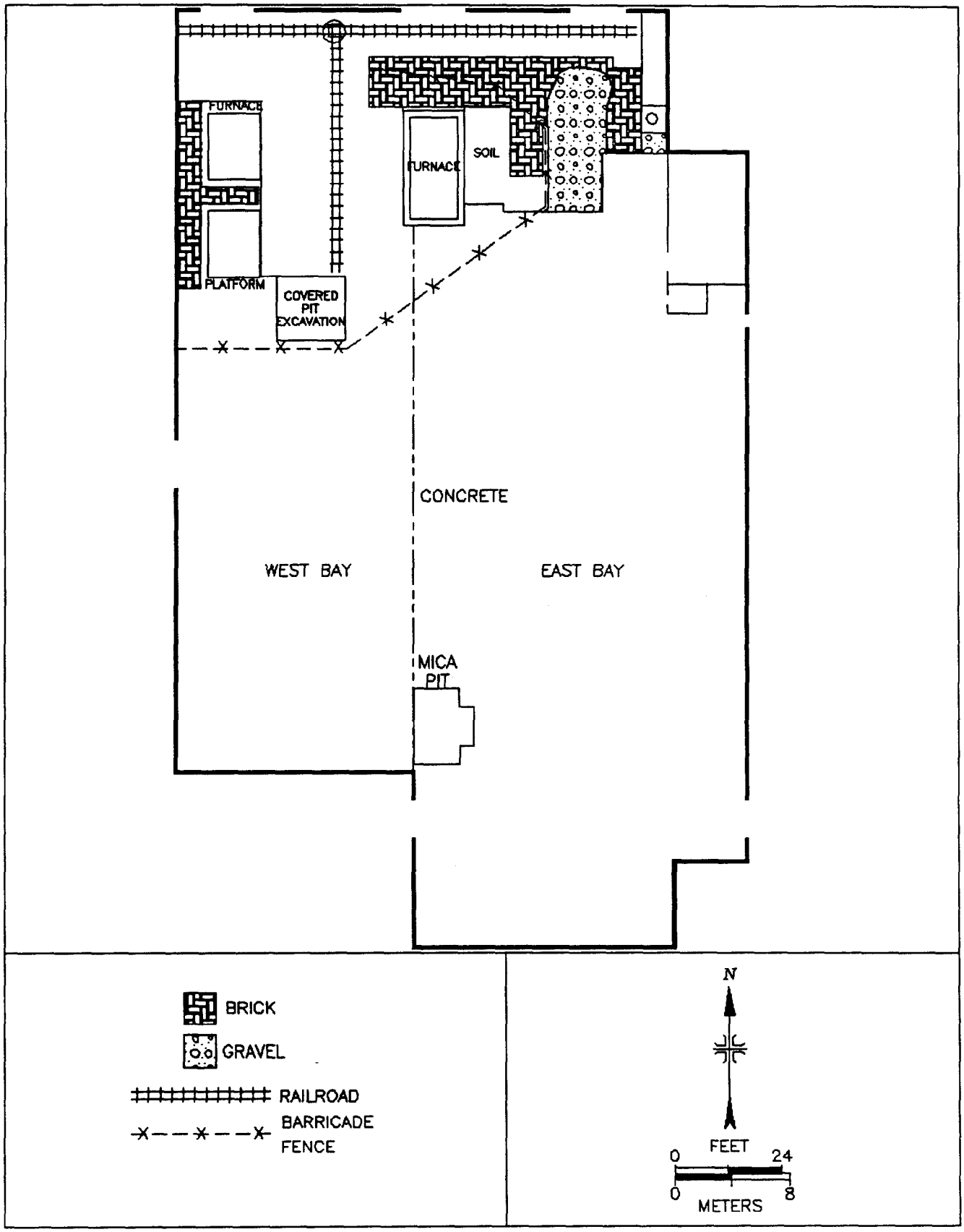


FIGURE 3: Floor Plan of Building 3

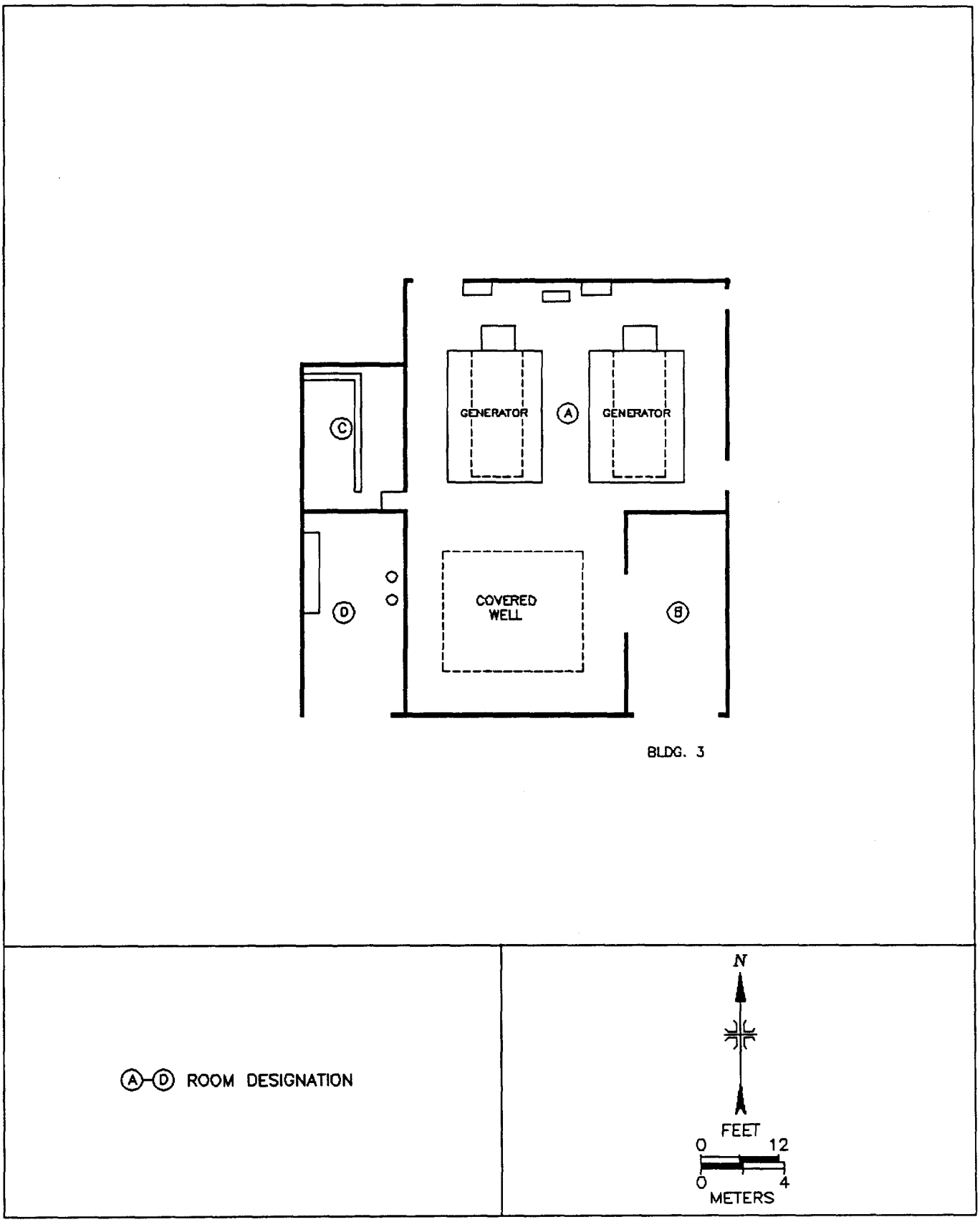


FIGURE 4: Floor Plan of Building 8

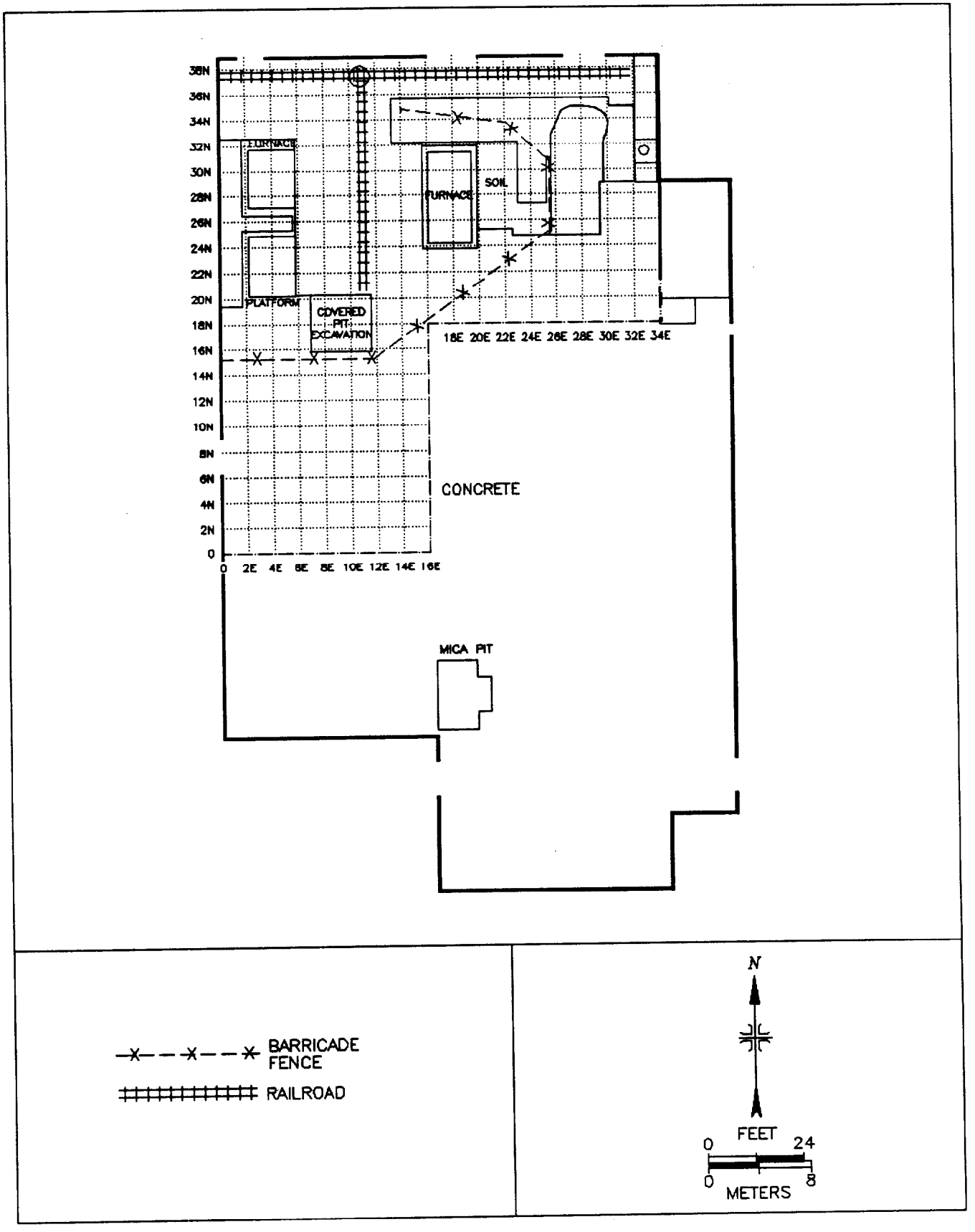


FIGURE 5: Floor Plan of Building 3 – Reference Grid

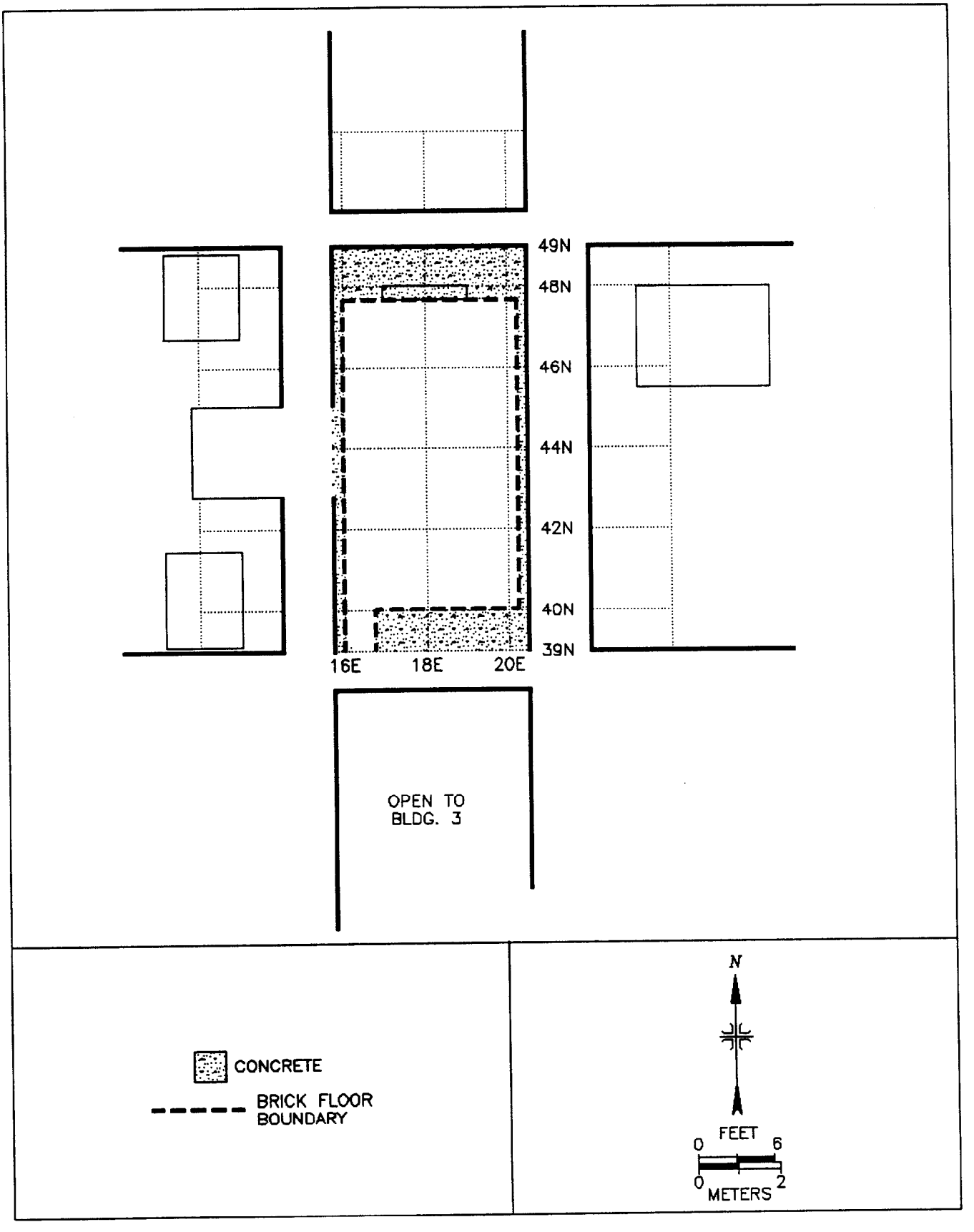


FIGURE 6: Floor Plan of Building 8, Room B – Reference Grid

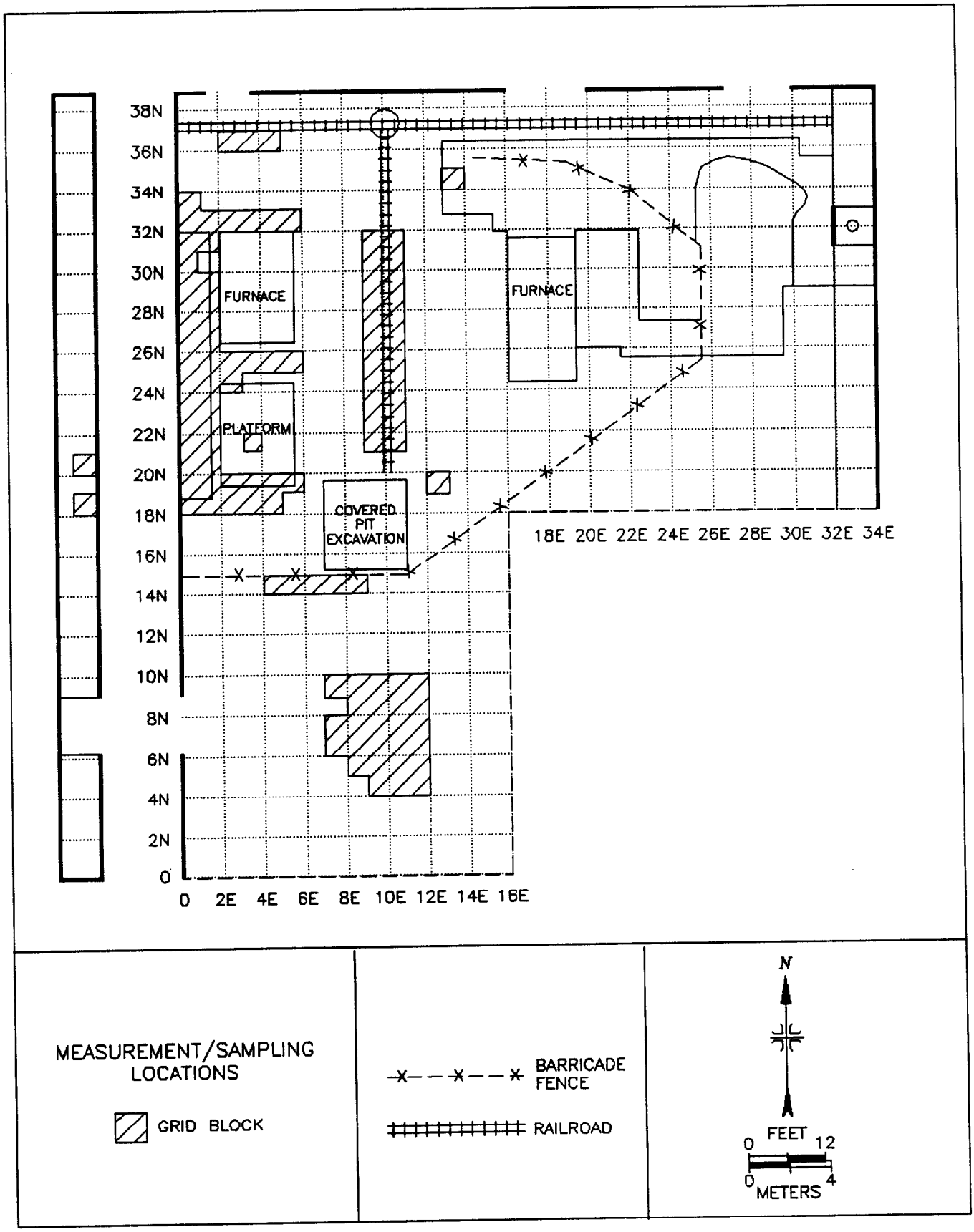


FIGURE 7: Building 3 – Measurement and Sampling Locations

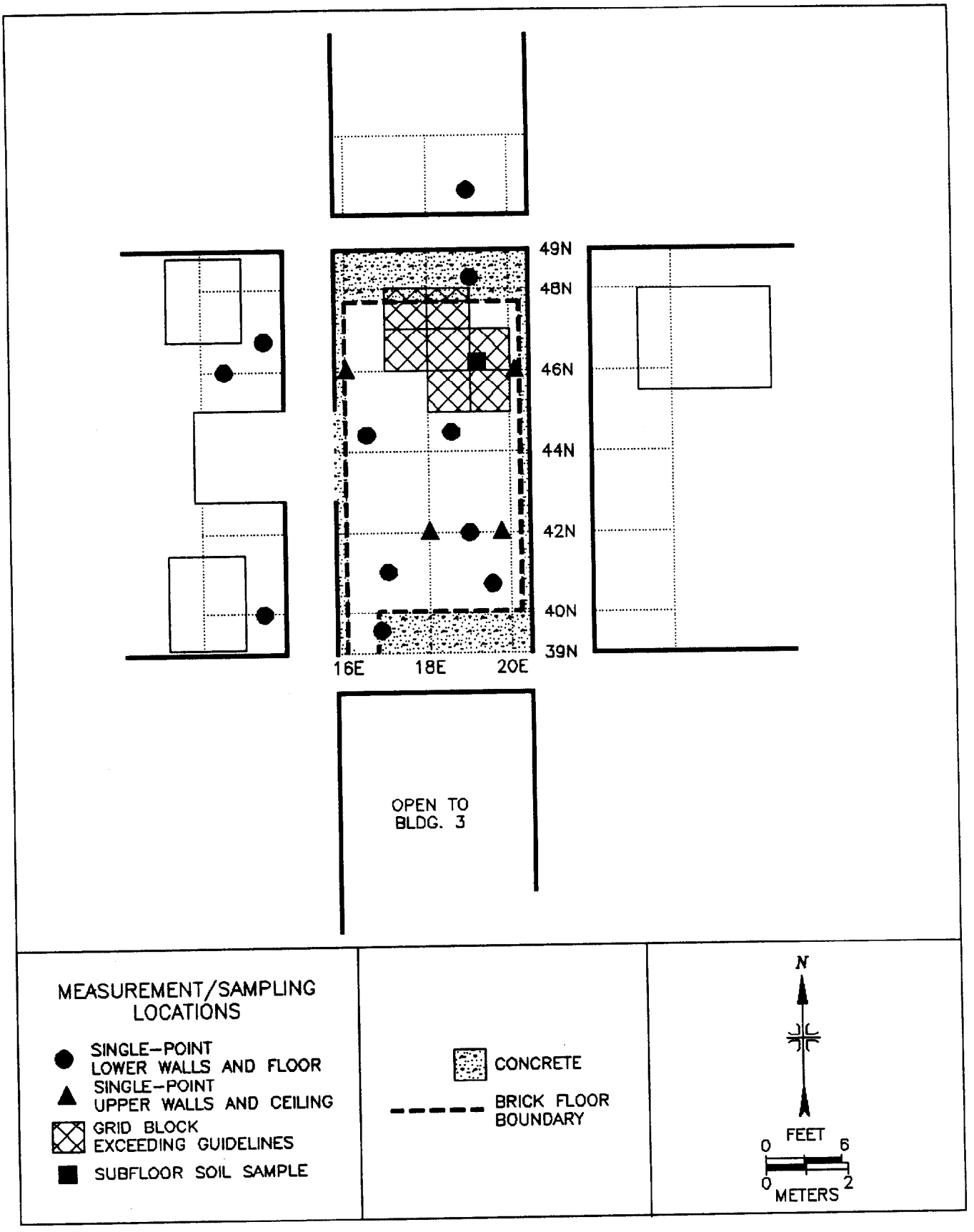


FIGURE 8: Building 8, Room B – Measurement and Sampling Locations

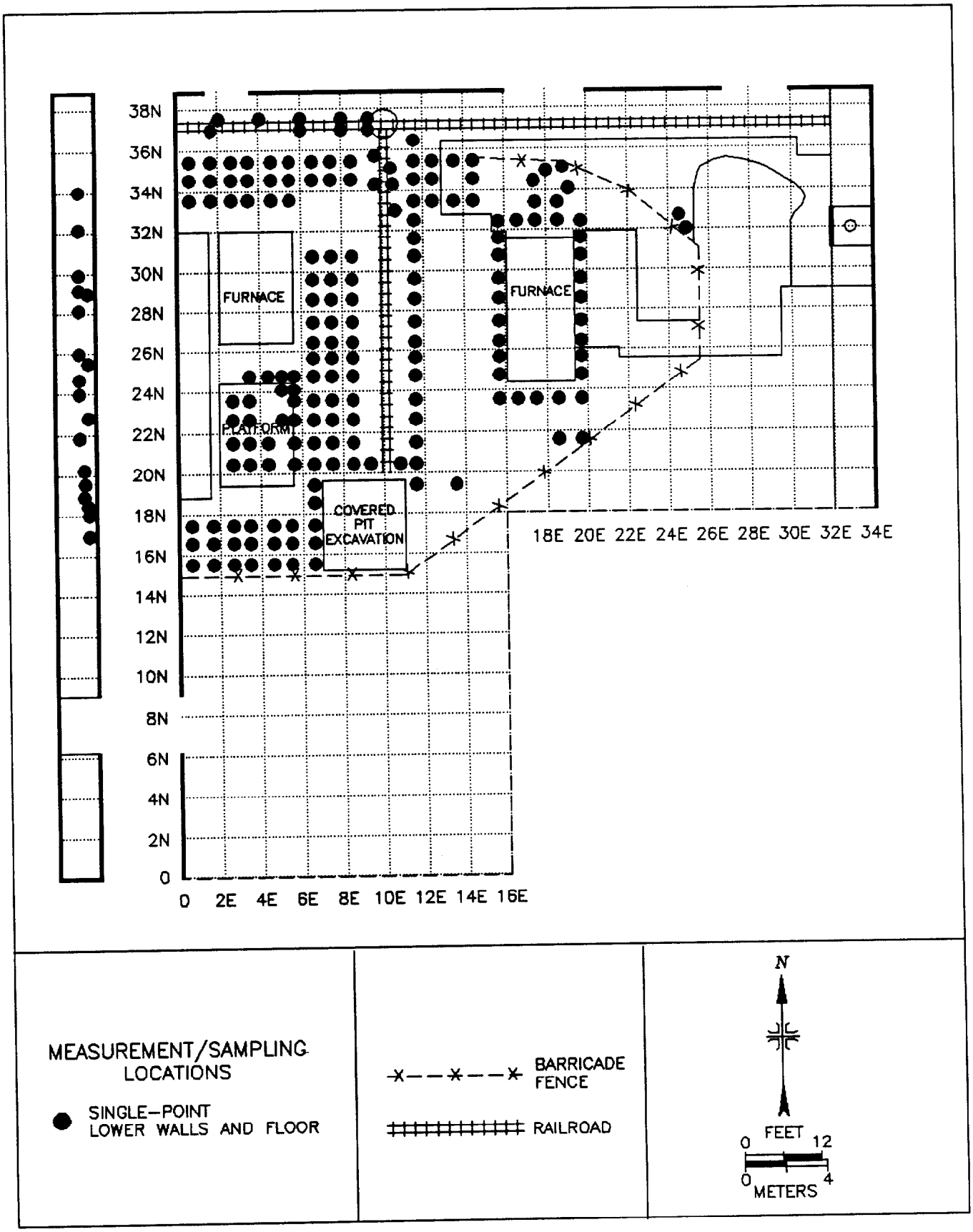


FIGURE 9: Building 3, Inside Barricade Fence – Measurement and Sampling Locations

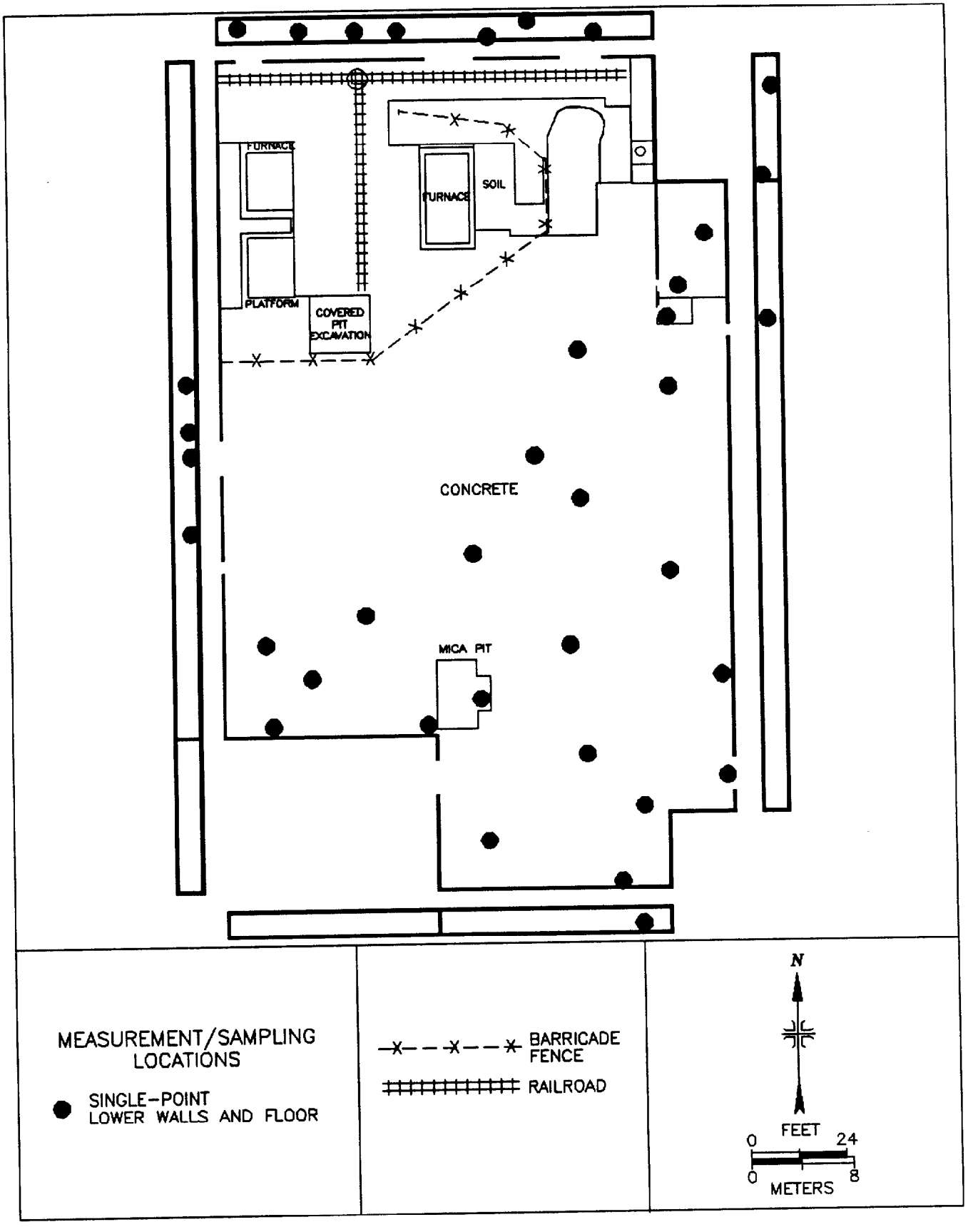


FIGURE 10: Building 3, Outside Barricade Fence – Measurement and Sampling Locations

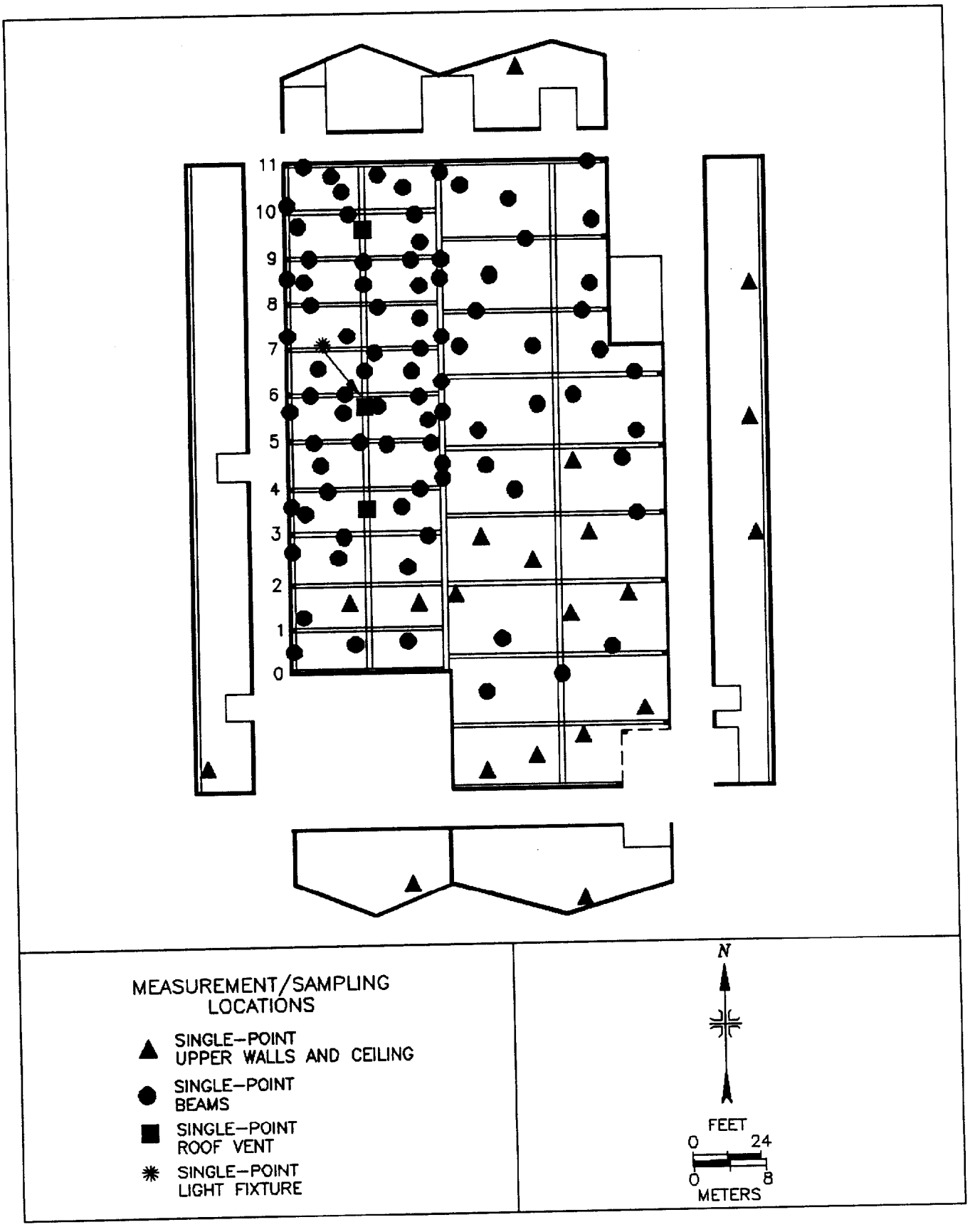


FIGURE 11: Building 3, Upper Surfaces – Measurement and Sampling Locations

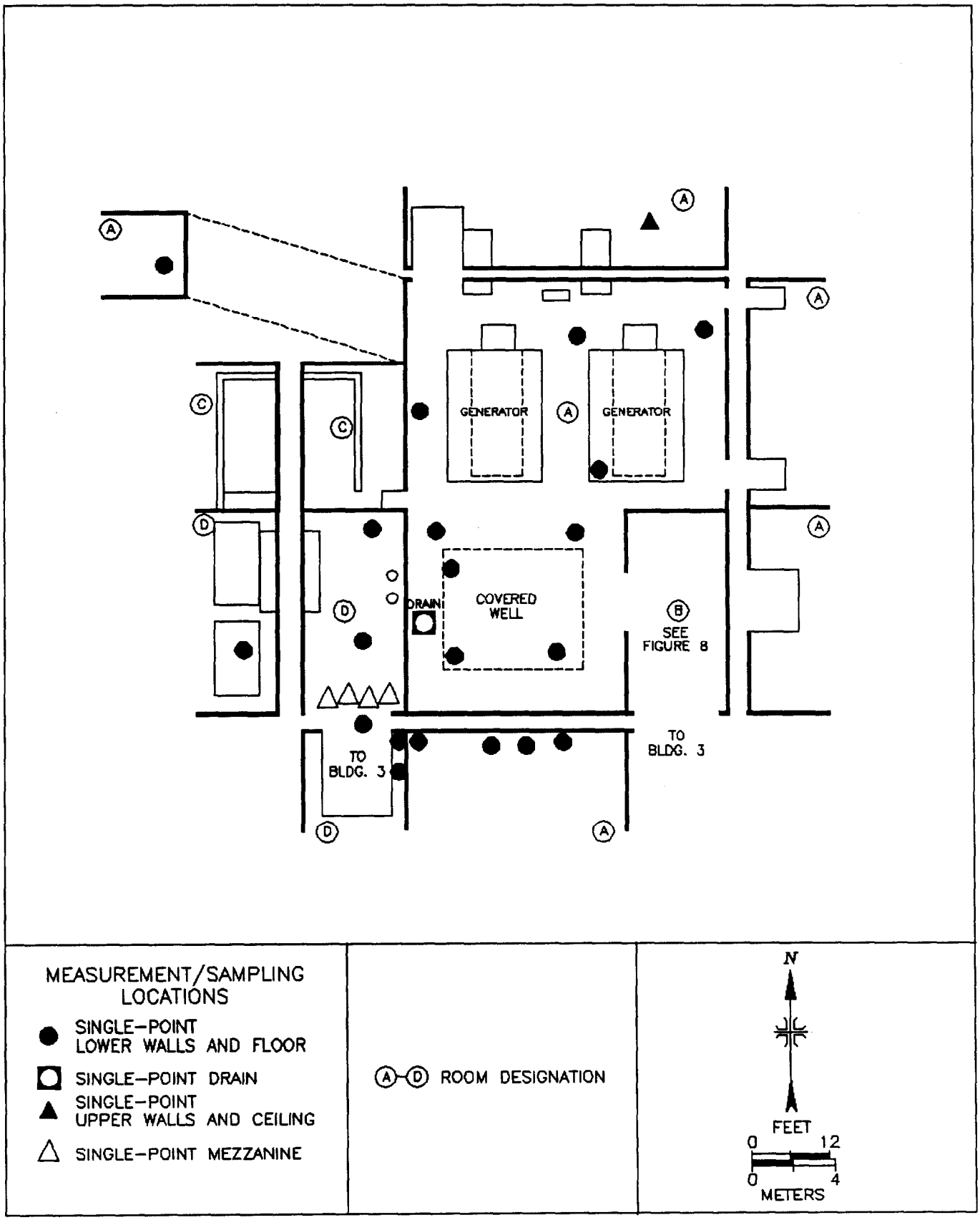


FIGURE 12: Building 8 – Measurement and Sampling Locations

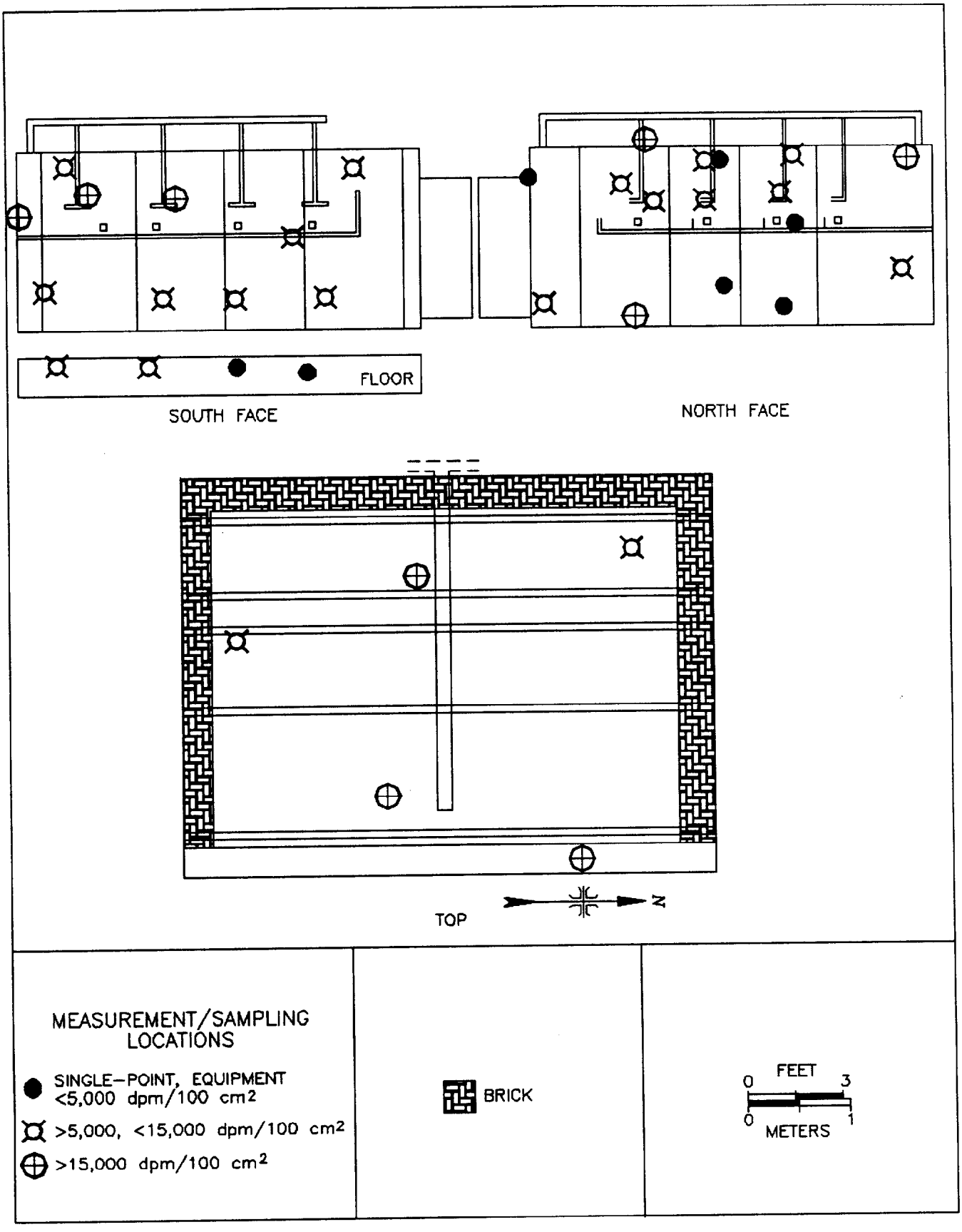


FIGURE 13: Building 3, West Furnace – Measurement and Sampling Locations

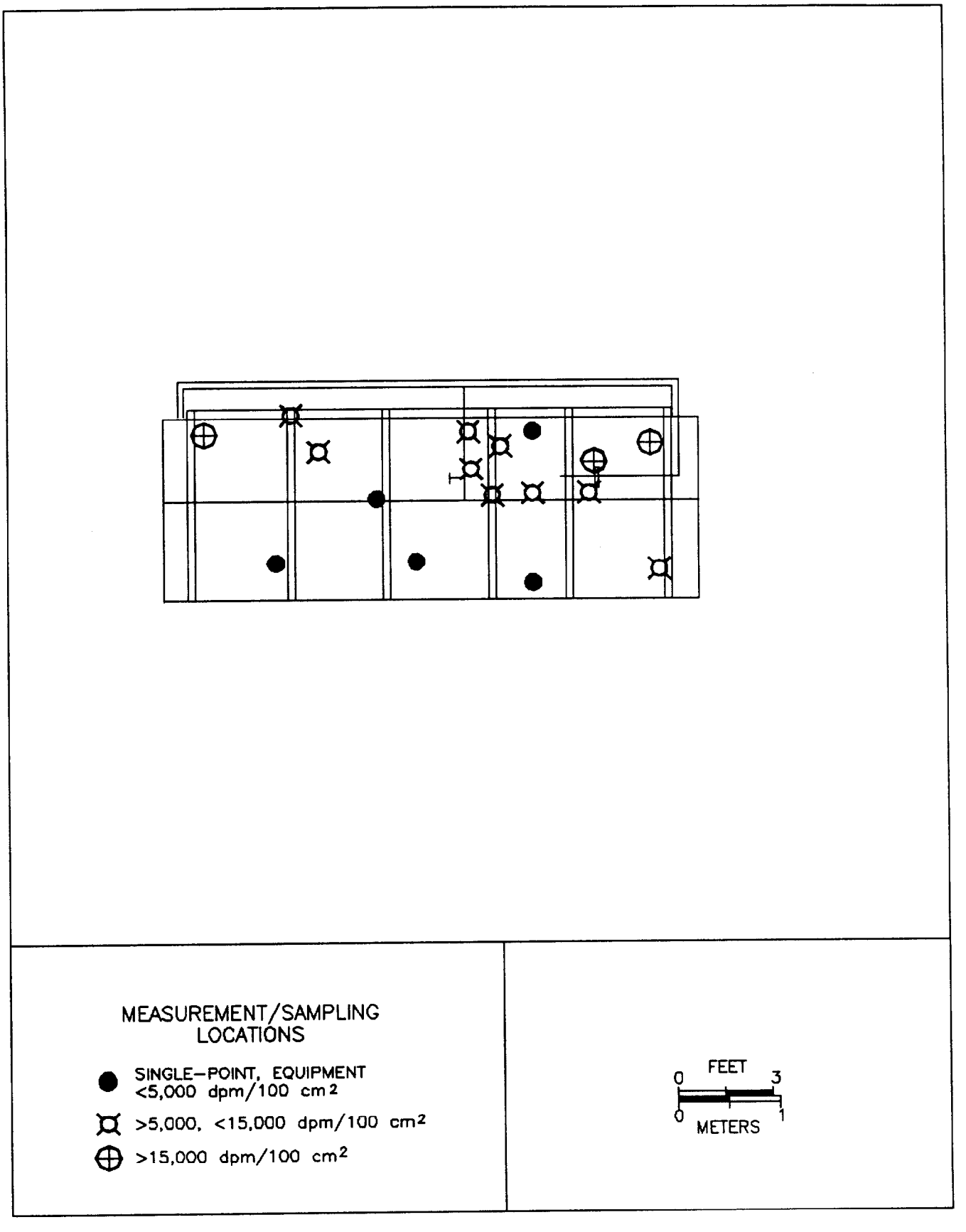


FIGURE 14: Building 3, West Furnace, West Face – Measurement and Sampling Locations

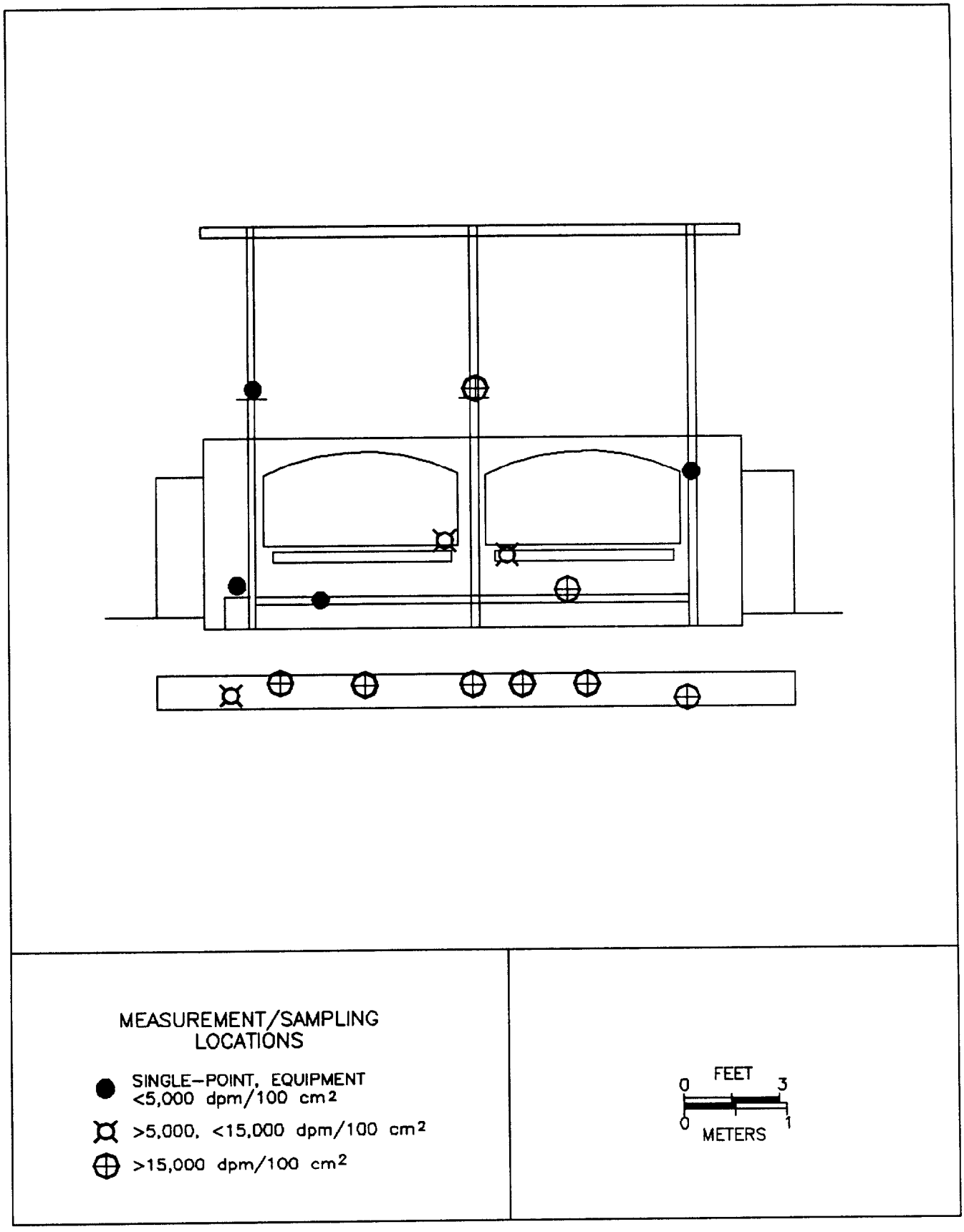


FIGURE 15: Building 3, West Furnace, East Face – Measurement and Sampling Locations

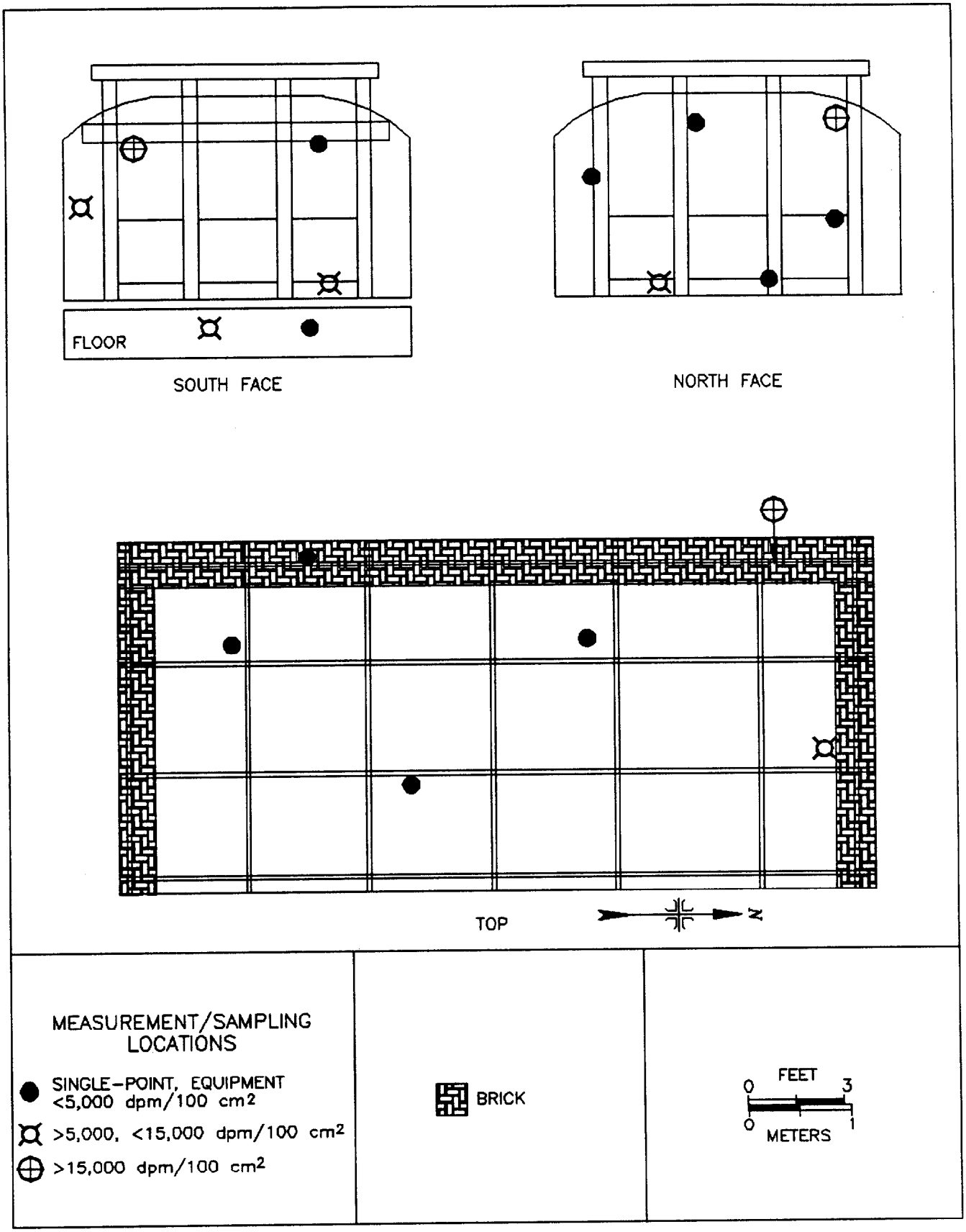
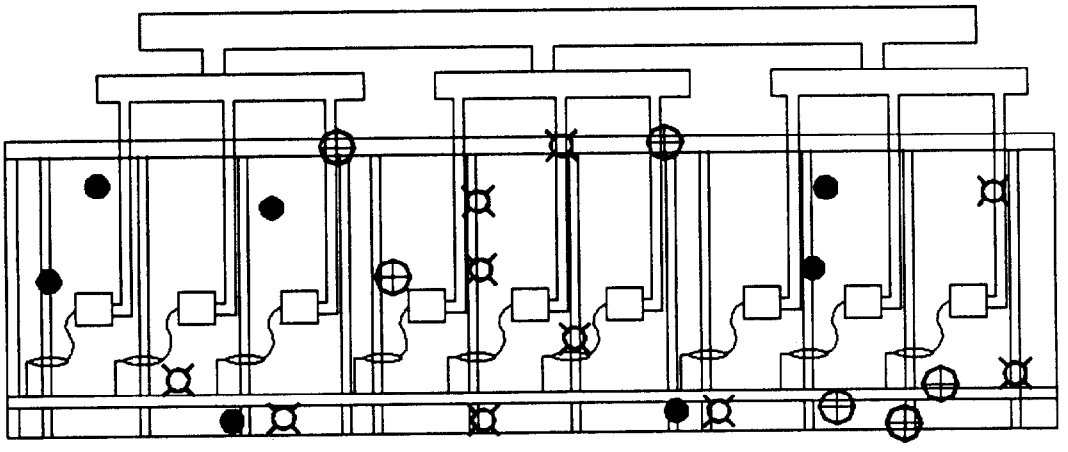


FIGURE 16: Building 3, East Furnace – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

- SINGLE-POINT, EQUIPMENT <5,000 dpm/100 cm2
- >5,000, <15,000 dpm/100 cm2
- >15,000 dpm/100 cm2

FEET 0 3

0 METERS 1

FIGURE 17: Building 3, East Furnace, West Face – Measurement and Sampling Locations

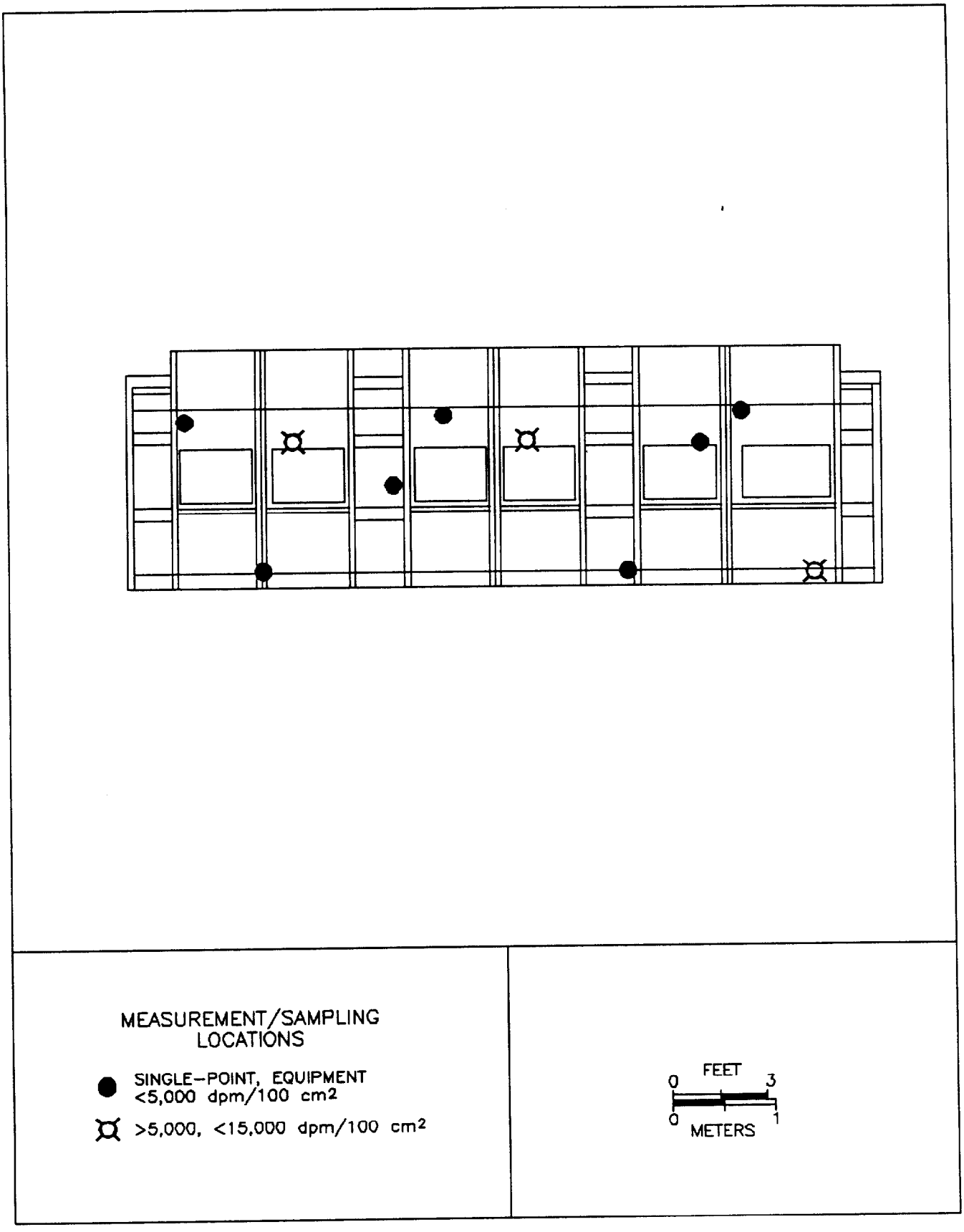


FIGURE 18: Building 3, East Furnace, East Face – Measurement and Sampling Locations

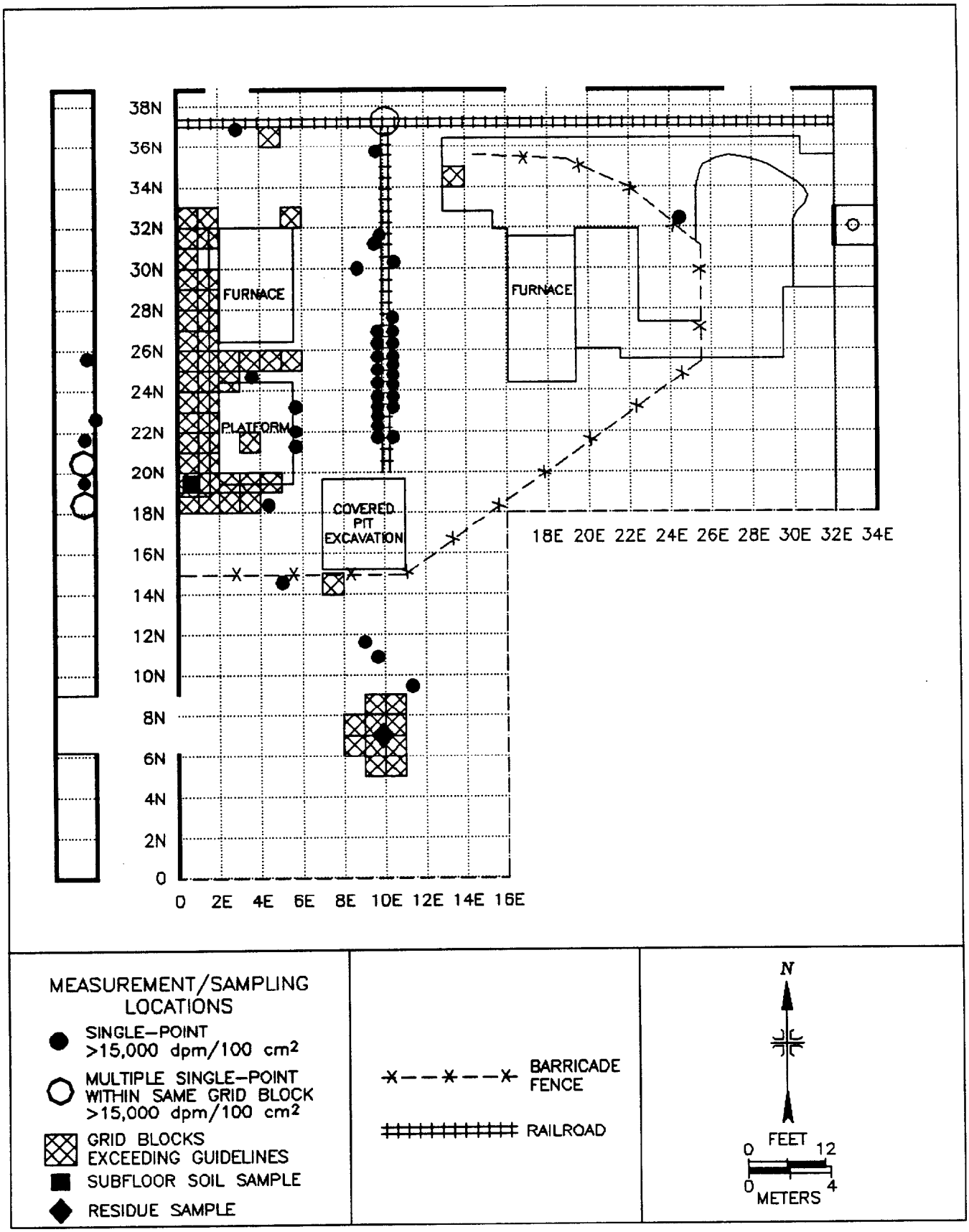


FIGURE 19: Building 3 – Measurement Locations Exceeding Guidelines and Miscellaneous Sampling Locations

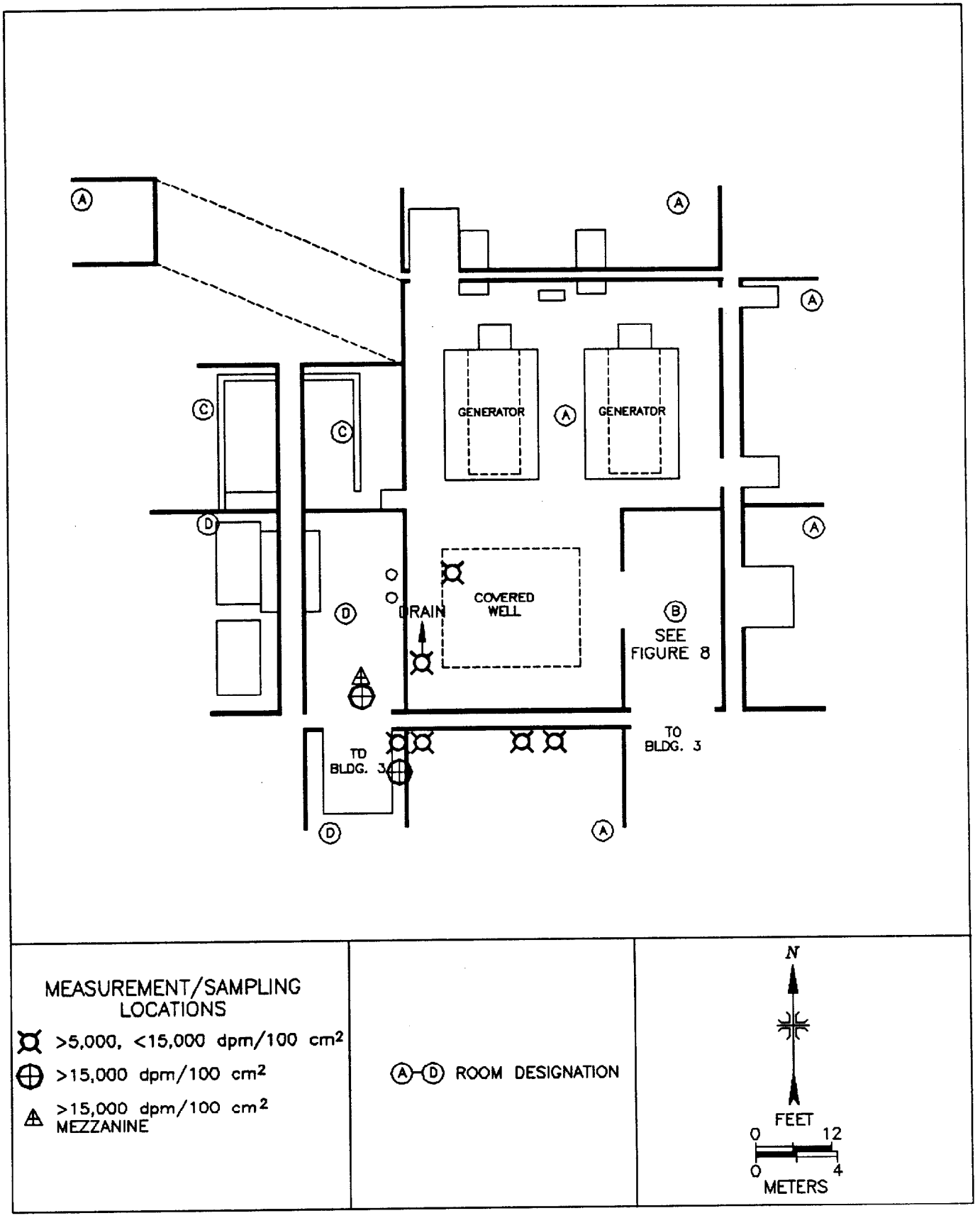


FIGURE 20: Building 8 – Measurement and Sampling Locations Exceeding Guidelines

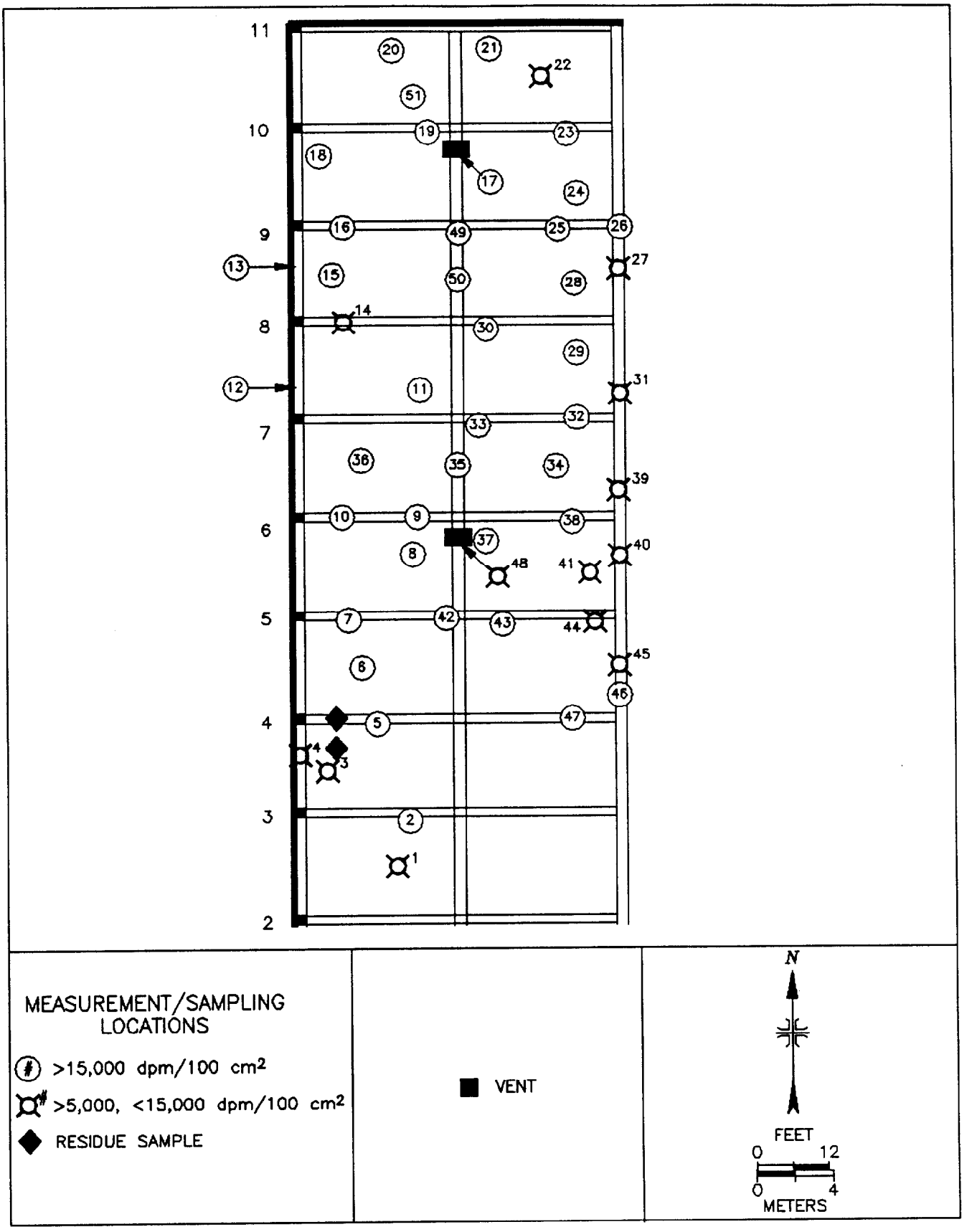


FIGURE 21: Building 3, Upper Surfaces – Measurement Locations Exceeding Guidelines and Residue Sampling Locations

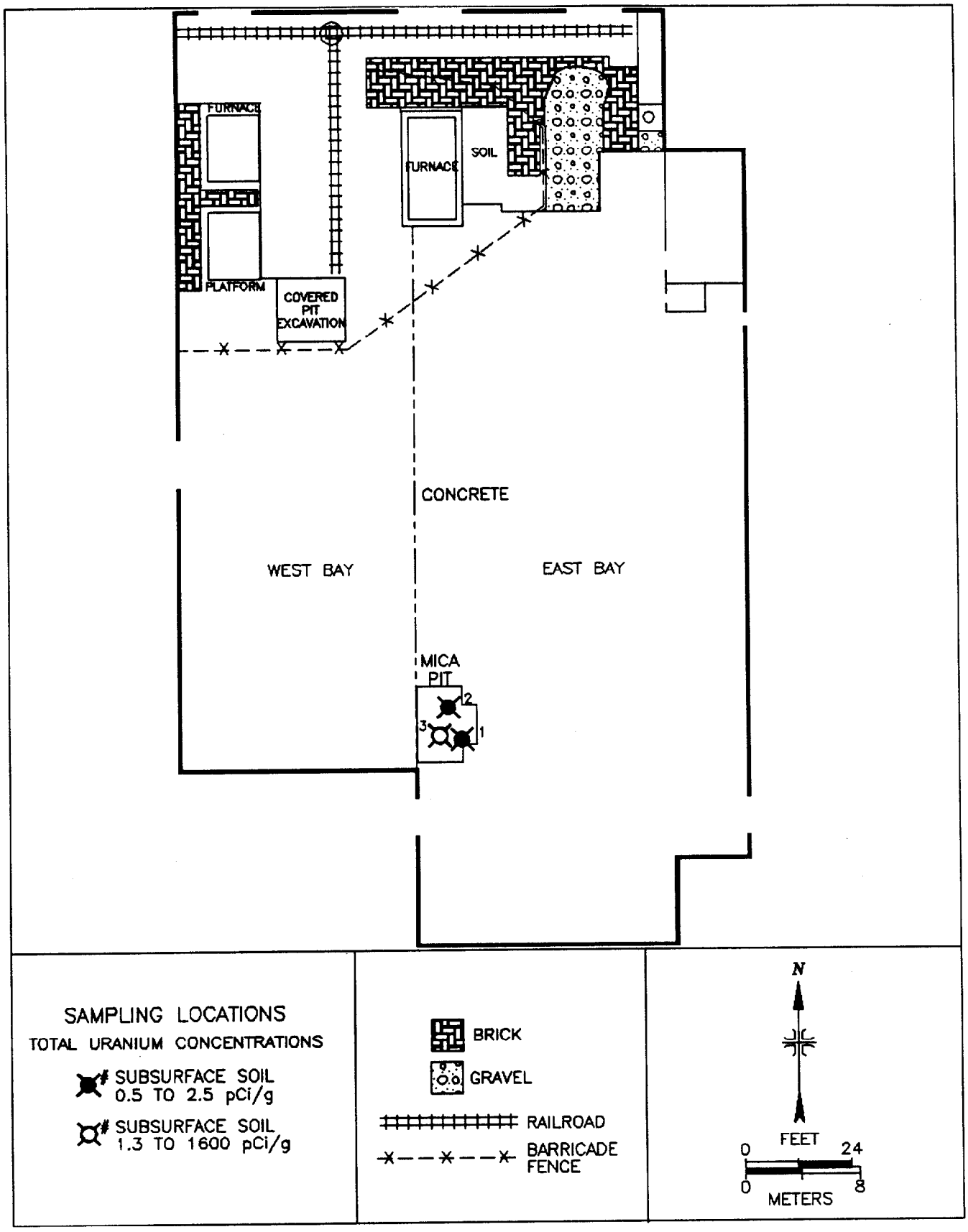


FIGURE 22: Building 3, Mica Pit – Subsurface Soil Sampling Locations

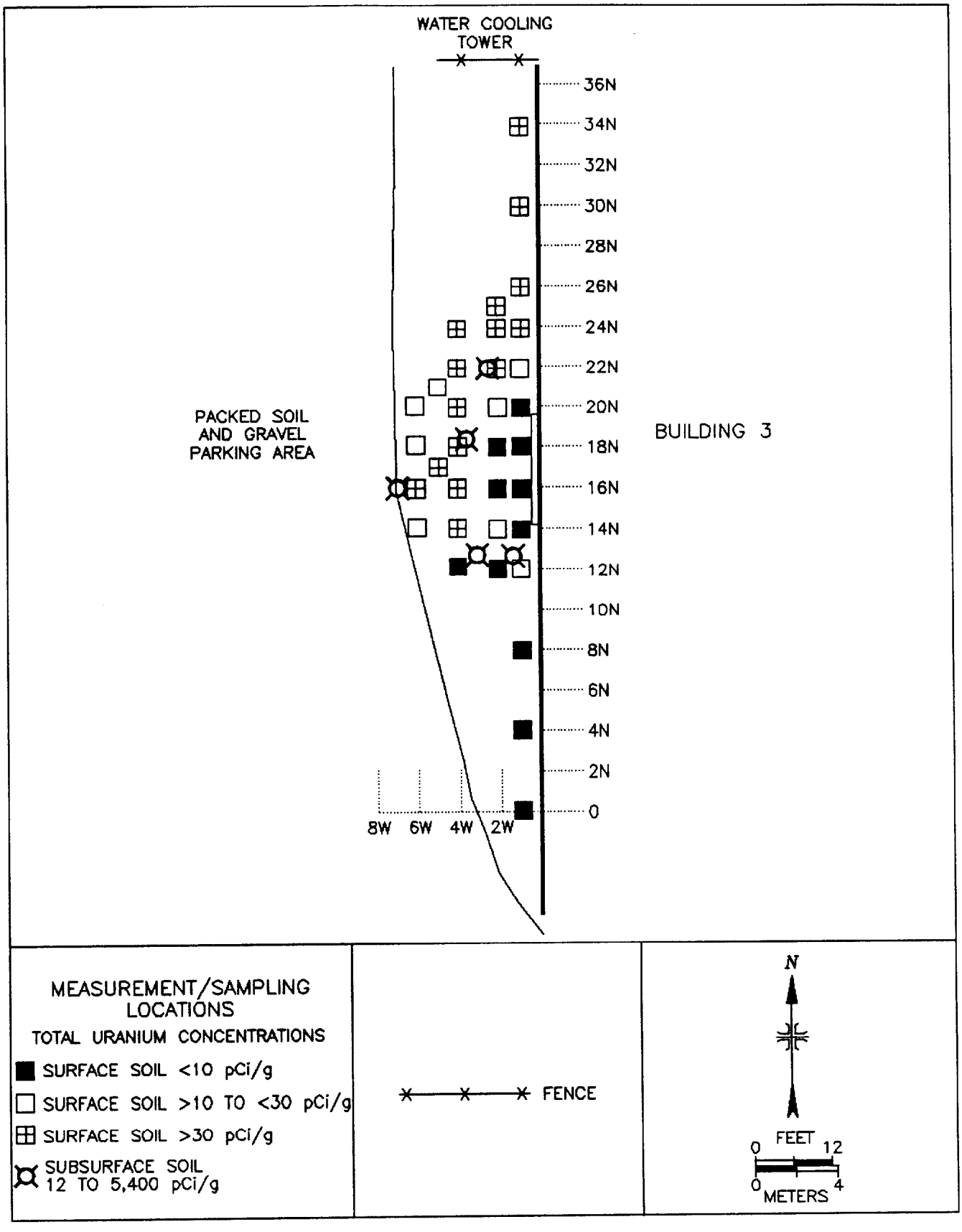


FIGURE 23: West Side of Building 3 – Measurement and Sampling Locations

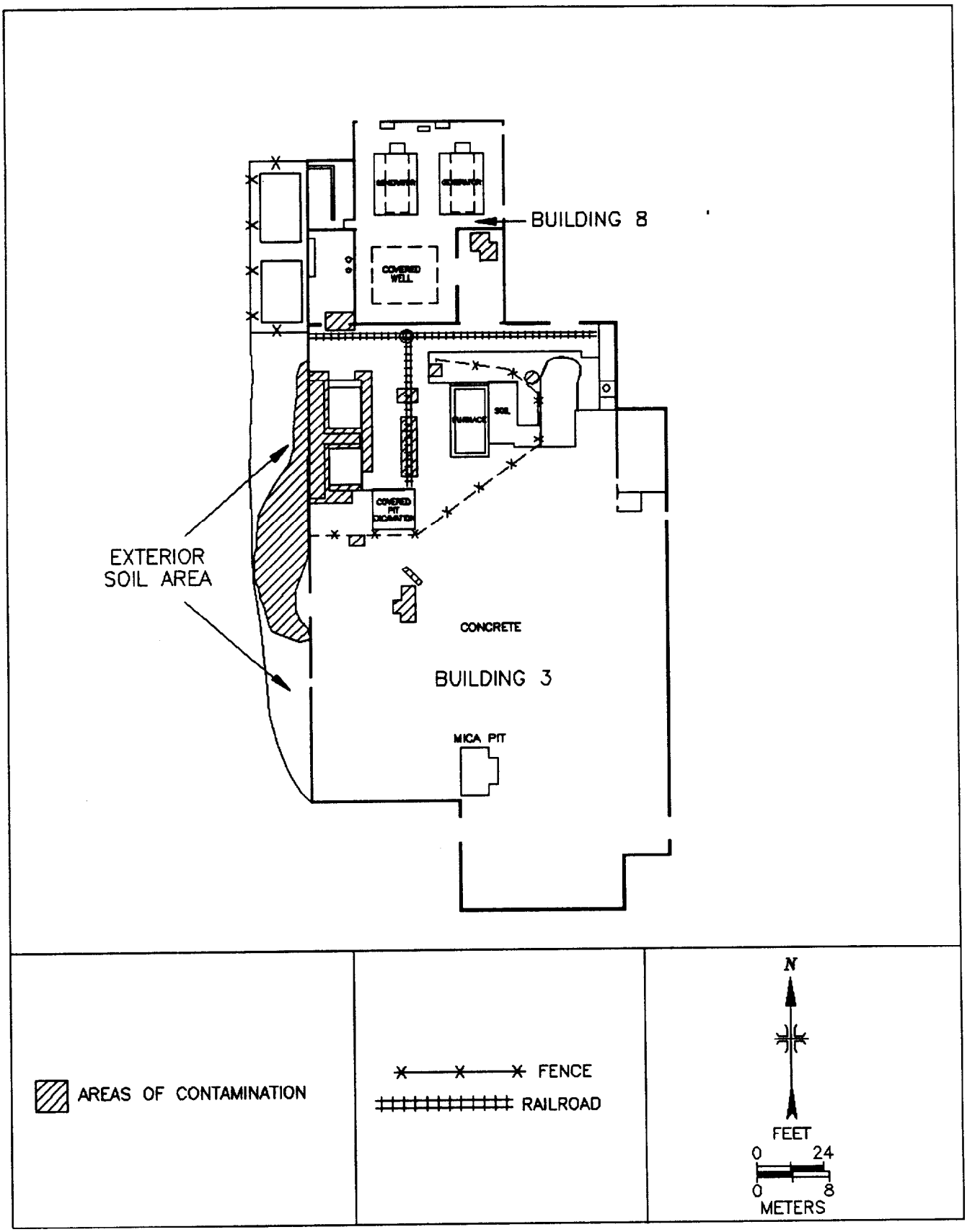


FIGURE 24: Aliquippa Forge, Areas Included in Survey – Major Areas of Residual Contamination

TABLE 1

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
FLOOR GRID BLOCKS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location/Grid Block	Beta Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)	
	Maximum	Grid Block Average	Alpha	Beta
BUILDING 3[a]				
18N, 0E	590,000	94,000	21	16
19N, 0E	270,000	95,000	33	36
20N, 0E	140,000	68,000	33	49
21N, 0E	520,000	230,000	72	100
22N, 0E	290,000	100,000	< 12	< 15
23N, 0E	410,000	120,000	15	16
24N, 0E	44,000	29,000	< 12	< 15
25N, 0E	130,000	49,000	< 12	19
26N, 0E	130,000	32,000	25	25
27N, 0E	23,000	14,000	< 12	18
28N, 0E	31,000	15,000	13	16
29N, 0E	22,000	16,000	< 12	< 15
30N, 0E	26,000	13,000	< 12	< 15
31N, 0E	28,000	19,000	< 12	< 15
32N, 0E	15,000	6,500	< 12	< 15
18N, 1E	77,000	17,000	< 12	< 15
19N, 1E	700,000	130,000	21	21
20N, 1E	510,000	58,000	130	260
21N, 1E	31,000	17,000	< 12	< 15
22N, 1E	48,000	17,000	< 12	< 15

TABLE 1 (CONTINUED)

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
FLOOR GRID BLOCKS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location/Grid Block	Beta Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)	
	Maximum	Grid Block Average	Alpha	Beta
23N, 1E	72,000	39,000	< 12	< 15
24N, 1E	31,000	15,000	< 12	< 15
25N, 1E	63,000	23,000	42	46
26N, 1E	51,000	21,000	< 12	39
27N, 1E	58,000	33,000	< 12	< 15
28N, 1E	38,000	22,000	< 12	< 15
29N, 1E	31,000	19,000	< 12	< 15
31N, 1E	28,000	14,000	< 12	< 15
32N, 1E	13,000	5,000	< 12	< 15
18N, 2E	24,000	7,200	< 12	< 15
19N, 2E	23,000	8,900	< 12	< 15
24N, 2E	27,000	13,000	< 12	< 15
25N, 2E	180,000	62,000	< 12	88
18N, 3E	45,000	9,200	< 12	< 15
19N, 3E	27,000	12,000	< 12	< 15
21N, 3E	15,000	7,900	< 12	< 15
25N, 3E	250,000	110,000	150	230
19N, 4E	24,000	7,900	< 12	< 15
25N, 4E	170,000	82,000	54	76
36N, 4E	76,000	11,000	< 12	< 15
19N, 5E	37,000	13,000	< 12	< 15

TABLE 1 (CONTINUED)

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
FLOOR GRID BLOCKS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location/Grid Block	Beta Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)	
	Maximum	Grid Block Average	Alpha	Beta
25N, 5E	78,000	14,000	< 12	< 15
32N, 5E	18,000	5,900	< 12	< 15
27N, 9E	17,000	6,600	< 12	< 15
28N, 9E	55,000	14,000	< 12	< 15
29N, 9E	16,000	5,900	13	16
30N, 9E	28,000	6,300	< 12	< 15
28N, 10E	47,000	8,700	< 12	< 15
29N, 10E	37,000	11,000	< 12	< 15
34N, 13E	35,000	14,000	< 12	< 15
5N, 9E	35,000	12,000	< 12	< 15
5N, 10E	29,000	11,000	< 12	< 15
6N, 8E	42,000	16,000	< 12	< 15
6N, 9E	950,000	220,000	27	42
6N, 10E	570,000	120,000	< 12	< 15
7N, 8E	170,000	44,000	< 12	< 15
7N, 9E	510,000	100,000	< 12	< 15
7N, 10E	300,000	93,000	< 12	< 15
8N, 9E	310,000	63,000	< 12	< 15
8N, 10E	30,000	12,000	< 12	< 15
14N, 5E	11,000	5,300	< 12	< 15

TABLE 1 (CONTINUED)

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
FLOOR GRID BLOCKS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location/Grid Block	Beta Activity (dpm/100 cm^2)		Removable Activity (dpm/100 cm^2)	
	Maximum	Grid Block Average	Alpha	Beta
BUILDING 8[b]				
45N, 18E	18,000	11,000	< 12	< 15
45N, 19E	33,000	11,000	< 12	< 15
46N, 17E	20,000	16,000	< 12	< 15
46N,18E	47,000	23,000	< 12	< 15
46N, 19E	140,000	44,000	< 12	< 15
47N, 17E	41,000	22,000	< 12	< 15
47N, 18E	25,000	17,000	< 12	< 15

[a]Refer to Figure 19.
[b]Refer to Figure 8.

TABLE 2

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
FLOOR AND LOWER WALL SINGLE-POINTS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Beta activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)		Surface Area of Elevated Activity (cm^2)
		Alpha	Beta	
BUILDING 3[a] Floor				
7.75N, 11.25E	17,000	< 12	< 15	100
9N, 9.9E	18,000	N/A[c]	N/A	300
9.2N, 9.5E	15,000	N/A	N/A	400
14.5N, 5E	20,000	N/A	N/A	100
36.9N, 2.9E	15,000	N/A	N/A	100
18.5N, 4.2E	64,000	N/A	N/A	500
21.75N, 9.75E	170,000	< 12	< 15	500
22.75N, 9.75E	240,000	< 12	< 15	500
22.25N, 9.75E	17,000	N/A	N/A	500
23.75N, 9.75E	57,000	N/A	N/A	500
23.25N, 9.75E	98,000	< 12	< 15	500
24.5N, 9.75E	170,000	N/A	N/A	1,000
25.25N, 9.75E	130,000	N/A	N/A	500
25.75N, 9.75E	140,000	78	82	500
26.75N, 9.75E	20,000	N/A	N/A	500
26.25N, 9.75E	28,000	21	< 15	500
31.75N, 9.75E	27,000	17	21	500
31.3N, 9.7E	33,000	N/A	N/A	500
21.9N, 10.6E	25,000	N/A	N/A	300
23.5N, 10.5E	61,000	< 12	< 15	600

TABLE 2 (CONTINUED)

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
FLOOR AND LOWER WALL SINGLE-POINTS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Beta Activity (dpm/100 cm²)	Removable Activity (dpm/100 cm²)		Surface Area of Elevated Activity (cm²)
		Alpha	Beta	
Floor (continued)				
23.3N, 10.5E	170,000	N/A	N/A	400
24.5N, 10.5E	210,000	350	410	500
24.3N, 10.5E	350,000	N/A	N/A	500
25.5N, 10.5E	120,000	< 12	< 15	600
25.1N, 10.6E	320,000	N/A	N/A	400
26.1N, 10.6E	750,000	N/A	N/A	500
26.9N, 10.6E	12,000	N/A	N/A	500
27.4N, 10.6E	88,000	N/A	N/A	1000
30.1N, 10.3E	23,000	N/A	N/A	200
21.2N, 5.8E	15,000	< 12	< 15	100
22N, 5.9E	85,000	< 12	< 15	100
23.2N, 5.8E	17,000	< 12	< 15	100
24.5N, 3.5E	31,000	< 12	< 15	100
30N, 8.8E	43,000	23	55	100
35.8N, 9.5E	22,000	< 12	< 15	100
32N, 24.9E	24,000	< 12	< 15	5,000
18N,0E,Ledge	23,000	< 12	< 15	100

TABLE 2 (CONTINUED)

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
FLOOR AND LOWER WALL SINGLE-POINTS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)		Surface Area of Elevated Activity (cm^2)
		Alpha	Beta	
Lower Walls				
18.8N, 0E,Ledge	24,000	< 12	< 15	100
18.2N, 0E,Wall	17,000	< 12	< 15	50
19.2N, 0E, Ledge	20,000	< 12	< 15	100
22.8N, 0.5E, Shelf	15,000	< 12	< 15	100
21.7N, 0E, Wall	260,000	< 12	< 15	50
25.6N, 0E, Wall	70,000	15	35	50
18.1N, 0E, Wall	17,000	< 12	< 15	100
18.4N, 0E, Wall	36,000	N/A	N/A	250
18.5N, 0E, Wall	20,000	N/A	N/A	300
20.1N, 0E, Wall	15,000	N/A	N/A	300
20.7N, 0E, Ledge	28,000	< 12	< 15	500
20.7N, 0E, Wall	16,000	N/A	N/A	450
BUILDING 8[b] Section "D"				
39N, 3E, Floor	25,000	< 12	21	100
39N, 4E, Wall	16,000	< 12	< 15	300
39.5N, 2.2E, Mezzanine	25,000	< 12	< 15	100

[a]Refer to Figure 19.
[b]Refer to Figure 20.
[c]Not Applicable. Measurement location was 1 of 5 performed in a grid block location, smear was not collected at this point.

TABLE 3

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
UPPER SURFACE LOCATIONS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location Number[a]	Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)	
		Alpha	Beta
1	7,100	< 12	< 15
2	16,000	< 12	< 15
3	14,000	< 12	< 15
4	11,000	13	23
5	19,000	13	15
6	27,000	21	27
7	21,000	< 12	< 15
8	28,000	13	20
9	93,000	19	36
10	31,000	< 12	< 15
11	37,000	13	< 15
12	32,000	< 12	< 15
13	41,000	< 12	< 15
14	14,000	< 12	< 15
15	17,000	< 12	< 15
16	45,000	< 12	< 15
17	120,000	< 12	< 15
18	46,000	27	25
19	19,000	< 12	< 15
20	50,000	< 12	< 15

TABLE 3 (Continued)

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
UPPER SURFACE LOCATIONS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location Number[a]	Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)	
		Alpha	Beta
21	16,000	< 12	< 15
22	12,000	< 12	< 15
23	19,000	< 12	< 15
24	24,000	< 12	< 15
25	40,000	39	32
26	19,000	< 12	< 15
27	9,200	< 12	< 15
28	36,000	< 12	< 15
29	31,000	< 12	16
30	31,000	< 12	< 15
31	6,800	< 12	< 15
32	35,000	17	< 15
33	43,000	< 12	< 15
34	29,000	< 12	< 15
35	20,000	< 12	< 15
36	37,000	< 12	< 15
37	120,000	46	42
38	100,000	13	< 15
39	12,000	< 12	< 15
40	14,000	< 12	< 15

TABLE 3 (Continued)

SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES
UPPER SURFACE LOCATIONS
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location Number[a]	Beta Activity (dpm/100 cm^2)	Removable Activity (dpm/100 cm^2)	
		Alpha	Beta
41	7,600	< 12	< 15
42	140,000	13	27
43	20,000	< 12	29
44	14,000	< 12	< 15
45	11,000	< 12	< 15
46	20,000	< 12	< 15
47	20,000	21	< 15
48	10,000	< 12	< 15
49	110,000	25	28
50	34,000	< 12	< 15
51	17,000	< 12	< 15

[a]Refer to Figure 21.

TABLE 4

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS EXCEEDING GUIDELINES BUILDING 3 FURNACES ALIQUIPPA FORGE WEST ALIQUIPPA, PENNSYLVANIA

Furnace	Number of Locations Exceeding Guidelines	Range of Beta Activity (dpm/100 cm^2)	Range of Removable Activity (dpm/100 cm^2)	
			Alpha	Beta
West[a]	20[c]	15,000-760,000	< 12-88	< 15-220
East[b]	9[c]	15,000-41,000	< 12-19	< 15-19

[a]Refer to Figures 13 thru 15.
[b]Refer to Figures 16 thru 18.
[c]Includes measurement locations on adjacent floor.

TABLE 5

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS MEETING GUIDELINES BUILDINGS 3 AND 8 ALIQUIPPA FORGE WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure(s)	Number of Grid Block Measurement Locations	Number of Single-Point Measurement Locations[a]	Maximum Grid Block Average (dpm/100 cm²)	Range of Total Activity (dpm/100 cm²)	Range of Removable Activity (dpm/100 cm²)	
						Alpha	Beta
Building 3							
Floor	7, 9 and 10	46	190	4700	820-14,000	< 12	< 15
Lower Walls	7, 9 and 10	2	26	4800	< 830-12,000	< 12	< 15
Upper Surfaces	11	N/A[b]	69	N/A	< 950-14,000	< 12	< 15
Equipment	13-18	N/A	88	N/A	< 950-14,000	< 12	< 15
Building 8							
Floor	8 and 12	N/A	19	N/A	< 830-14,000	< 12	< 15-30
Lower Walls	8 and 12	N/A	12	N/A	< 830-6,700	< 12	< 15
Upper Surfaces	8 and 12	N/A	5	N/A	< 830-7,000	< 12	< 15
Mezzanine	12	N/A	4	N/A	7,300-9,700	---[c]	---

[a]Measurement locations exceeding guidelines are not included in this table.
[b]Not Applicable.
[c]Dash indicates measurement not obtained.

TABLE 6

URANIUM CONCENTRATIONS IN SUBSURFACE SOIL SAMPLES FROM THE SUSPECTED MICA PIT BUILDING 3 ALIQUIPPA FORGE WEST ALIQUIPPA, PENNSYLVANIA

Location[a]	Depth of Sample (cm)	Uranium Concentrations (pCi/g)[b]		
		U-235	U-238	Total Uranium[c]
1	0-15	0.1 ± 0.1	0.4 ± 0.4	0.9
	15-30	0.1 ± 0.1	0.2 ± 0.3	0.5
	30-45	0.1 ± 0.1	1.2 ± 0.4	2.5
2	0-15	0.1 ± 0.1	0.6 ± 0.4	1.3
	15-30	<0.1	<0.5	<1.1
	30-45	0.1 ± 0.1	0.7 ± 0.4	1.5
	45-60	0.1 ± 0.1	1.2 ± 0.5	2.5
3	0-15	0.6 ± 0.1	11.3 ± 1.9	23
	15-30	0.4 ± 0.1	6.6 ± 1.6	14
	30-45	0.1 ± 0.1	0.6 ± 0.7	1.3
	45-60	0.1 ± 0.1	3.9 ± 1.5	7.9
	60-75	0.2 ± 0.1	1.8 ± 0.8	3.8
	75-90	38.0 ± 4.5	760 ± 110	1,600

[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.

TABLE 7

URANIUM CONCENTRATIONS IN MISCELLANEOUS SAMPLES
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Sample Type	Uranium Concentrations (pCi/g)[c]		
		U-235	U-238	Total Uranium[d]
Building 3[a]				
19N, 0.75E Floor	Soil	57.6 ± 7.6	1700 ± 230	3,500
7N, 10E Floor	Residue	63.8 ± 8.6	1540 ± 230	3,100
3.5N, 1E Beam	Residue	4.6 ± 0.5	107 ± 17	220
4N, 1.75E Beam	Residue	22.6 ± 2.5	527 ± 64	1,100
Building 8[b]				
46.2N, 18.5E Floor	Soil	0.7 ± 0.1	14.3 ± 9.6	29

[a]Refer to Figures 19 and 21.
[b]Refer to Figure 8.
[c]Uncertainties represent the 95% confidence level, based only on counting statistics.
[d]Total uranium concentrations are calculated based on natural isotopic abundances.

TABLE 8

URANIUM CONCENTRATIONS IN SYSTEMATIC SURFACE SOIL SAMPLES OUTSIDE BUILDING 3 WEST LOADING DOCK DOOR ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

Sample Location[a]	Uranium Concentrations (pCi/g)[b]		
	U-235	U-238	Total Uranium[c]
0N,1W	0.2 ± 0.1	2.2 ± 1.4	4.6
4N,1W	0.2 ± 0.1	2.0 ± 1.3	4.2
8N,1W	0.3 ± 0.2	2.1 ± 1.7	4.5
12N,1W	0.4 ± 0.1	7.2 ± 2.1	15
14N,1W	0.2 ± 0.1	4.3 ± 1.5	8.8
16N,1W	0.3 ± 0.1	2.8 ± 1.1	5.9
18N,1W	0.2 ± 0.1	2.5 ± 0.9	5.2
20N,1W	0.1 ± 0.1	1.0 ± 0.4	2.1
22N,1W	1.7 ± 0.2	33.7 ± 9.3	70
24N,1W	1.5 ± 0.2	44 ± 11	90
26N,1W	2.6 ± 0.4	55 ± 14	110
30N,1W	1.0 ± 0.2	20 ± 12	41
34N,1W	1.3 ± 0.2	32.3 ± 7.0	66
12N,2W	0.6 ± 0.1	6.8 ± 2.2	14
14N,2W	0.3 ± 0.1	8.4 ± 5.5	17
16N,2W	0.3 ± 0.1	5.9 ± 1.5	12
18N,2W	0.1 ± 0.1	1.1 ± 0.4	2.3
20N,2W	0.5 ± 0.1	14.0 ± 6.0	29

TABLE 8 (CONTINUED)

URANIUM CONCENTRATIONS IN SYSTEMATIC SURFACE SOIL SAMPLES
OUTSIDE BUILDING 3 WEST LOADING DOCK DOOR
ALIQUIPPA FORGE SITE
WEST ALIQUIPPA, PENNSYLVANIA

Sample Location[a]	Uranium Concentrations (pCi/g)[b]		
	U-235	U-238	Total Uranium[c]
22N,2W	11.8 ± 1.6	310 ± 43	630
24N,2W	4.7 ± 0.6	85 ± 20	170
12N,4W	0.6 ± 0.1	16.2 ± 6.6	33
14N,4W	3.3 ± 0.4	71 ± 15	150
16N,4W	1.2 ± 0.2	22.0 ± 4.9	45
18N,4W	3.0 ± 0.4	69 ± 12	140
20N,4W	3.9 ± 0.5	80 ± 15	160
22N,4W	9.8 ± 1.4	270 ± 41	550
24N,4W	1.6 ± 0.2	32.7 ± 6.7	67
14N,6W	0.3 ± 0.1	5.2 ± 1.5	11
16N,6W	4.0 ± 0.5	84 ± 16	170
18N,6W	0.6 ± 0.1	22.0 ± 6.3	45
20N,6W	1.2 ± 0.2	31.6 ± 7.3	65

[a]Refer to Figure 23.
[b]Uncertainties represent the 95% confidence level,based only on counting statistics.
[c]Total uranium concentrations are calculated based on natural isotopic abundances.

TABLE 9

URANIUM CONCENTRATIONS IN SOIL SAMPLES AT LOCATIONS OF ELEVATED DIRECT RADIATION OUTSIDE BUILDING 3 WEST LOADING DOCK DOOR ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

Sample Location[a]	Depth of Sample (cm)	Uranium Concentrations (pCi/g)[b]		
		U-235	U-238	Total Uranium[c]
12.3N, 12W	0-15	0.1 ± 0.1	2.5 ± 1.5	5.1
12.4N,1.2W	0-15	61.7 ± 8.1	1,500 ± 200	3,100
	15-30	5.4 ± 0.7	120 ± 27	250
	30-45	0.8 ± 0.2	18.0 ± 4.6	37
12.5N,3W	0-15	2.8 ± 0.4	61 ± 16	130
	15-30	0.3 ± 0.1	5.6 ± 2.5	12
22N,2.1W	0-15	5.3 ± 0.8	150 ± 27	310
	15-30	1.6 ± 0.2	45 ± 13	92
	slag @ 30 cm	87 ± 12	2,680 ± 360	5,400
25N, 2W	0-15	1.8 ± 0.3	36 ± 10	74
21N, 5W	0-15	1.5 ± 0.2	28 ± 11	58
18.2N,3.7W	0-15	83 ± 10	1,860 ± 240	3,800
	15-30	78 ± 10	1,950 ± 250	4,000
	30-45	9.0 ± 1.1	133 ± 29	280
17.5N, 4.5W	0-15	6.2 ± 0.8	152 ± 25	310
16.2N,6.8W	0-15	4.2 ± 0.6	104 ± 18	210
	15-30	3.8 ± 0.5	79 ± 17	160

[a]Refer to Figure 23.
[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, Pennsylvania," DOE/OR/20722-122, Bechtel National, Inc., August 1988.

3. "Radiological Survey of the Aliquippa Forge Site, West Aliquippa, Pennsylvania," Environmental Survey and Site Assessment Program, Oak Ridge Institute for Science and Education, Draft - October, 1992.

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

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 ND66
(Nuclear Data, Schaumburg, IL)

Alpha Spectrometry System
Tennelec Electronics Model
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Passivated Ion-implanted Detectors
(Tennelec, Oak Ridge, TN) and
Multichannel Analyzer ND66
(Nuclear Data, Schaumburg, IL)

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 0.24-0.27 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, and approximately 100 cm^2 of the surface was wiped. Smears were placed in labeled envelopes with the location and other pertinent information recorded.

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.

Alpha Spectrometry

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

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) and Revision 7 (Implemented June 1, 1992)
-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 were used. Calibration of pressurized ionization chambers was performed by the manufacturer.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable 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 and the Radiological Control Manual were used to establish the guidelines.[1,2]

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 the 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.[3] 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. U.S. Department of Energy, "Radiological Control Manual", U.S. Department of Energy, June 1992.

3. Argonne National Laboratory, "A Manual for Implementing Residual Radioactive Material Guidelines," DOE/CH/9801, June 1989.