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ADDITIONAL CHARACTERIZATION SURVEY OF BUILDINGS 3 AND 8 ALIQUIPPA FORGE SITE WEST ALIQUIPPA, PENNSYLVANIA

E. W. ABELQUIST

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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ADDITIONAL CHARACTERIZATION SURVEY
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ABBREVIATIONS AND ACRONYMS

AEC	Atomic Energy Commission
ANL	Argonne National Laboratory
BNI	Bechtel National, Inc.
cm	centimeter
cm^2	square centimeter
cpm	counts per minute
DOE	U.S. Department of Energy
DOE-ORO	DOE Oak Ridge Operations
dpm/100 cm^2	disintegrations per minute/100 square centimeters
ESSAP	Environmental Survey and Site Assessment Program
FSRD	Former Sites Restoration Division
FUSRAP	Formerly Utilized Sites Remedial Action Program
GM	Geiger-Mueller
h	hour
kg	kilogram
km	kilometer
m	meter
m^2	square meter
μR/h	microroentgens per hour
MDA	minimum detectable activity
NaI	sodium iodide
NIST	National Institute of Standards and Technology
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
pCi/g	picocuries per gram
PIC	pressurized ionization chamber
PMC	Project Management Contractor
ZnS	zinc sulfide

ADDITIONAL CHARACTERIZATION SURVEY OF BUILDINGS 3 AND 8 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. Processed natural uranium billets were sent to the Vulcan facility, where, during the rolling operation, the billets were formed into rods and finished rods were boxed and shipped to other AEC facilities. The site was decontaminated 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 radioactive contamination above current guidelines on floors and walls and on overhead beams above the furnaces that were used to heat the billets.[1] In addition, contaminated steel flooring was found outside the building, alongside the cooling tower.

Radiological surveys that have been conducted since 1978 have identified other areas of residual uranium, both within Building 3 and on the surrounding grounds. The residual contamination exceeded current guidelines for release to unrestricted use; therefore, the property was included in DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP) in August 1983.

In December 1987, a limited radiological characterization survey, performed by Bechtel National, Inc. (BNI), identified 14 areas of contamination in and around Building 3.[2] Interim remedial activities were conducted by BNI in 1988 to allow 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.

During the periods of May 17-22, 1992 and June 8-12, 1992, the Environmental Survey and Site Assessment Program (ESSAP) of Oak Ridge Institute for Science and Education (ORISE) performed an initial characterization survey of Building 3, Building 8, and the outdoor area along the west side of Building 3.[3] Additional characterization of areas within and adjacent to Buildings 3 and 8, that were inaccessible during the initial characterization efforts, was performed during the period of July through October, 1993. Results of characterization survey activities were provided to the DOE to facilitate the timely exchange of survey data and allow for consideration of contaminated areas in remedial action planning.[4,5,6,7] Verification survey activities commenced in late August 1993 and included areas that were characterized both during the previous characterization surveys and during the recent additional characterization surveys.

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 (Figure 1). The property, which is approximately 25 km northwest of Pittsburgh, Pennsylvania currently contains 10 buildings, 8 of which are interconnected; 2 water towers; a cooling tower, and a small water basin (Figure 2).

Building 3 (Figure 3) is divided into two bays: the west bay, which has been roped-off and posted as a controlled area, has a medium pitch corrugated aluminum roof topped by two large turret ventilators and three round ventilators. The east bay has an off-center corrugated aluminum roof characterized with skylights and topped with an elliptical ventilator that extends along the ridge. The two roof apexes are approximately 11 m in height. Roof drains extend from the gutter between the apexes to the concrete floor. Building 3 contains approximately 2,400 m^2 of floor space. It is constructed primarily of sheet-metal with steel structural beams and has a raised concrete foundation. The floor is mostly concrete with small areas of brick over dirt around the furnaces and bare dirt (where brick has been removed) or gravel. Pallets

of fire brick and dismantled equipment cover large areas at the south end of the building. Two furnaces (1 partially dismantled) and the cutter pit are also located within the west bay. An area identified as a "suspected mica pit," allegedly used for cooling the rolled uranium billets, is located in the east bay.

Building 8, which extends from the north end of Building 3, houses two large 2-piston air compressors. Building 8, also posted as a controlled area, consists of 4 areas, designated rooms A-D (Figure 4) and has a total floor space of approximately 500 m^2. Wall and ceiling construction are the same as in Building 3. Two round ventilators are present on the roof apex. The floor is mostly concrete with the exception of Room B, which is mainly brick over dirt. The mezzanine above Room D (Tool Room) has a wooden floor. The wall separating Buildings 3 and 8 is constructed of corrugated sheet-metal.

The outdoor area along the west side of Building 3 (adjacent to the loading dock) is bare soil, approximately 42 m in length and averages 6 m in width. A cooling tower and water basin, surrounded by a chain link fence, border the area to the north; a packed dirt and gravel parking area borders to the west. A drain line extends along the west side of Building 3 and fourteen pipe penetrations exist on this same side of the building.

PROJECT ORGANIZATION AND RESPONSIBILITY

DOE Headquarters provides overview and coordination for all FUSRAP activities. The DOE Oak Ridge Operations (DOE-ORO) is responsible for implementation of FUSRAP and the Former Sites Restoration Division (FSRD) of DOE-ORO, 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 BNI. BNI is responsible for the planning and the implementation of FUSRAP activities and managing the site characterization and remedial actions.

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, for this site ORISE, 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.

OBJECTIVE

The objective of the survey was to provide sufficient information to delineate areas of contamination in excess of guidelines and allow for design of a remedial action plan.

PROCEDURES

During the period from July through October, 1993, ESSAP performed additional characterization surveys of Buildings 3 and 8, and outdoor areas on the site. The survey was in accordance with a survey plan dated July 1, 1993 submitted to and approved by the DOE.[8] This report summarizes the procedures and results of the additional characterization surveys.

INTERIOR

ESSAP used the following procedures for the interior portions of the survey.

Reference Grid

A 1 m^2 reference grid was established by ESSAP on the floors and lower walls (up to 2 m) of the Basement, Tool Room and Mezzanine in Building 8. The existing 2 m^2 floor reference grid in Building 3, previously established by ESSAP, was used by ESSAP for survey reference. Measurements and samples from the overhead purlins and trusses were referenced to purlin and truss maps established by the PMC and/or to prominent building features. Ceilings, upper walls

and areas smaller than 10 m^2 (e.g., pipe chase manhole, compressor pits, etc.) were not gridded. Measurements and samples from ungridded surfaces were referenced to the floor grid or to prominent building/equipment surfaces.

Surface Scans

Surface scans for alpha, beta and gamma activity were performed on floors, upper and lower walls, overhead purlins and trusses, equipment, ceilings, fans, and drains using GM and NaI scintillation detectors 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 because rough, dirty or damp surfaces may selectively attenuate alpha radiation. Therefore, beta activity levels were used for comparison with the guideline values.

Grid block averaging was performed on the Tool Room and Mezzanine floors; 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 the structural purlins/trusses that support the roof. For the widespread contamination encountered in the overhead areas, it was more cost-effective to use scanning and single-point measurement data to characterize the areas requiring decontamination.

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 surface activity guidelines.

Thirteen grid block measurements were performed within the gridded area on the Tool Room and Mezzanine floors. Four hundred and ninety single-point direct measurements were performed on interior surfaces: 238 measurements were performed on the floors and lower walls, 183 measurements on upper surfaces, and 69 measurements on equipment and miscellaneous surfaces, such as the air compressors, scrap equipment, drains, etc. 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 direct measurement location. Measurement and sampling locations for total and removable activity are illustrated on Figures 5, 7-14, and 20-39.

Miscellaneous Sampling

Eight residue and sediment samples were collected from overhead beams, air compressors, and drains. Sampling locations are shown in Figures 8, 12, 13, 20 and 40.

Ninety-one soil samples were collected from Building 3 subfloor locations to determine the extent of residual contamination. Subfloor soil sampling locations are shown in Figure 40.

EXTERIOR

ESSAP used the following procedures for outdoor portions of the survey.

Reference Grid

Measurements and samples from outdoor surfaces (e.g., rooftops, roof turrets and vents, roof and pipe penetrations) were referenced to prominent building surfaces.

Surface Scans

Surface scans for alpha, beta and gamma activity were performed on rooftops, roof turrets and vents, drain line, pipe penetrations, cooling tower, and the driveway between Buildings 8 and 9 (Figure 6) using large area gas proportional detectors and NaI scintillation detectors coupled to ratemeters or ratemeter-scalers with audible indicators. Areas of elevated direct radiation, suggesting the presence of surface contamination, were marked for further investigation.

Surface Activity Measurements

Eighty-two single-point measurements were performed on randomly selected outdoor surfaces (e.g., roof vents and turrets, rooftops and gutters, pipe penetrations, drain lines, cooling tower, etc.) and at locations of elevated direct radiation identified by surface scans. These measurements were performed to define the boundaries of those areas which exceeded surface activity guidelines. A smear sample for determining removable activity was obtained from each direct measurement location. Measurement and sampling locations for total and removable activity are illustrated on Figures 13 through 19.

Miscellaneous Sampling

Thirteen residue and sediment samples were collected from roof penetrations and gutters, pipe penetration #6, the water basin, the cooling tower and the outside drain line. Sampling locations are shown in Figures 15, 17, and 18.

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 U-235 and U-238, and any other identifiable photopeaks. Soil and miscellaneous 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, and exposure rate measurements were recorded in units of 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 RESULTS

INTERIOR

Surface Scans

Surface scans of Buildings 3 and 8 identified elevated direct radiation on overhead trusses and purlins, the superstructure, the floor and lower walls in the Tool Room, Mezzanine and Basement, and equipment surfaces (e.g., air compressors, scrap equipment, etc.). These locations were noted for additional surface activity measurements.

Surface Activity Levels

Surface activity measurements in Buildings 3 and 8, meeting the DOE guidelines, are presented in Table 1. Three hundred and fifty single-point measurements on interior surfaces were within 5,000 dpm/100 cm^2 (Figures 5 through 39). Removable activity levels were <12 and <16 dpm/100 cm^2 for alpha and beta, respectively.

The surface activity measurements in Buildings 3 and 8 exceeding 5,000 dpm/100 cm^2 are summarized in Table 2. Direct measurements on the Tool Room and Mezzanine floors identified 13 grid blocks in which the average beta activity over the 1 m^2 area exceeded 5,000 dpm/100 cm^2 (Figures 7 and 11). One hundred and forty single-point measurements exceeded 5,000 dpm/100 cm^2 (Figures 5 through 39). Removable activity levels for these locations ranged from <12 to 73 dpm/100 cm^2 for alpha and <16 to 76 dpm/100 cm^2 for beta.

Uranium Concentrations in Miscellaneous Samples

Uranium concentrations in miscellaneous samples collected from overhead beams, air compressors, and drains are presented in Table 3. The total uranium concentrations in these samples ranged from 5.5 to 2700 pCi/g.

Uranium concentrations in Building 3 subfloor soil samples collected are provided in Table 4. The total uranium concentration in these samples ranged from 1.3 to 970 pCi/g. The eight subfloor soil sampling locations exceeding guidelines are shown in Figure 41.

EXTERIOR

Surface Scans

Surface scans for alpha, beta and gamma activity on the rooftops, roof penetrations, outside drain line, cooling tower and driveway between Buildings 8 and 9 were within the range of ambient background levels.

Surface scans of the turrets, roof vents, and pipe penetrations identified several locations of elevated direct radiation. These areas were noted for additional measurements and sampling.

Surface Activity Levels

Surface activity measurements on outdoor surfaces, meeting the DOE guidelines, are presented in Table 1. Sixty-nine single-point measurements on exterior surfaces were within 5,000 dpm/100 cm^2 (Figures 13 through 19). Removable activity levels were < 12 and < 16 dpm/100 cm^2 for alpha and beta, respectively.

The surface activity measurements on exterior surfaces exceeding 5,000 dpm/100 cm^2 are summarized in Table 2. Thirteen single-point measurements exceeded 5,000 dpm/100 cm^2 (Figures 13 through 18). Removable activity levels were < 12 and < 16 dpm/100 cm^2 for alpha and beta, respectively.

Uranium Concentrations in Miscellaneous Samples

Uranium concentrations in miscellaneous samples collected from the driveway west of Building 3, roof penetrations, roof gutters, drain line, pipe penetration, water basin and cooling tower are presented in Table 3. The total uranium concentrations in these samples ranged from 0.5 to 160 pCi/g.

COMPARISON OF RESULTS WITH GUIDELINES

The DOE guidelines for residual radioactive material are summarized in Appendix C. The DOE surface contamination guidelines for processed natural uranium are as follows:[9]

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

The site-specific uranium guideline for soil is 100 pCi/g for total uranium above background.[10]

Residual uranium activity, exceeding 5,000 dpm/100 cm^2, was identified in numerous locations in Buildings 3 and 8 (Table 2). Total uranium concentrations in soil and miscellaneous samples exceeded the site-specific soil guideline at several locations (Tables 3 and 4). Figure 41 illustrates the subfloor soil locations in Building 3 that exceed guidelines.

Additional areas of residual contamination were detected adjacent to those areas identified in this report as remedial actions progressed. These areas of residual contamination included surface contamination on the I-beam columns along the east-west bay centerline and in the scale apparatus pit in the east bay. Locations of subfloor soil contamination were identified extending into the east bay.

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 additional characterization surveys of Buildings 3 and 8 at the Aliquippa Forge Site in West Aliquippa, Pennsylvania. Survey activities included surface scans, surface activity measurements, and soil and residue sampling.

Residual uranium activity, exceeding 5,000 dpm/100 cm^2, was identified in numerous locations in Buildings 3 and 8 (Table 2). The majority of the contamination identified by the additional characterization surveys was confined to three major areas in Building 3: subfloor soil; superstructure surfaces; and the overhead roof vents and turrets. The majority of the contamination in Building 8 included four major areas: Tool Room and Mezzanine floor and lower walls; air compressor surfaces and pits; overhead trusses and purlins; and Room B walls and overhead surfaces. Removable activity levels for all areas were within the guidelines;

however, residue samples collected from the overhead surfaces in the Building 8 Mezzanine, the I-beam near Vent #3 in Building 3, and Truss 1 in Building 8 exceeded guideline levels for concentrations of total uranium.

Soil samples collected from beneath the Building 3 floor exceeded guideline levels at eight borehole locations (Figure 41). Total uranium concentrations in these soil samples ranged from 100 to 970 pCi/g.

Additional areas of surface contamination on the centerline I-beam columns and in the scale apparatus pit were identified as remedial actions progressed. Locations of subfloor soil contamination extending into the east bay were detected during the soil remediation activities in the west bay.

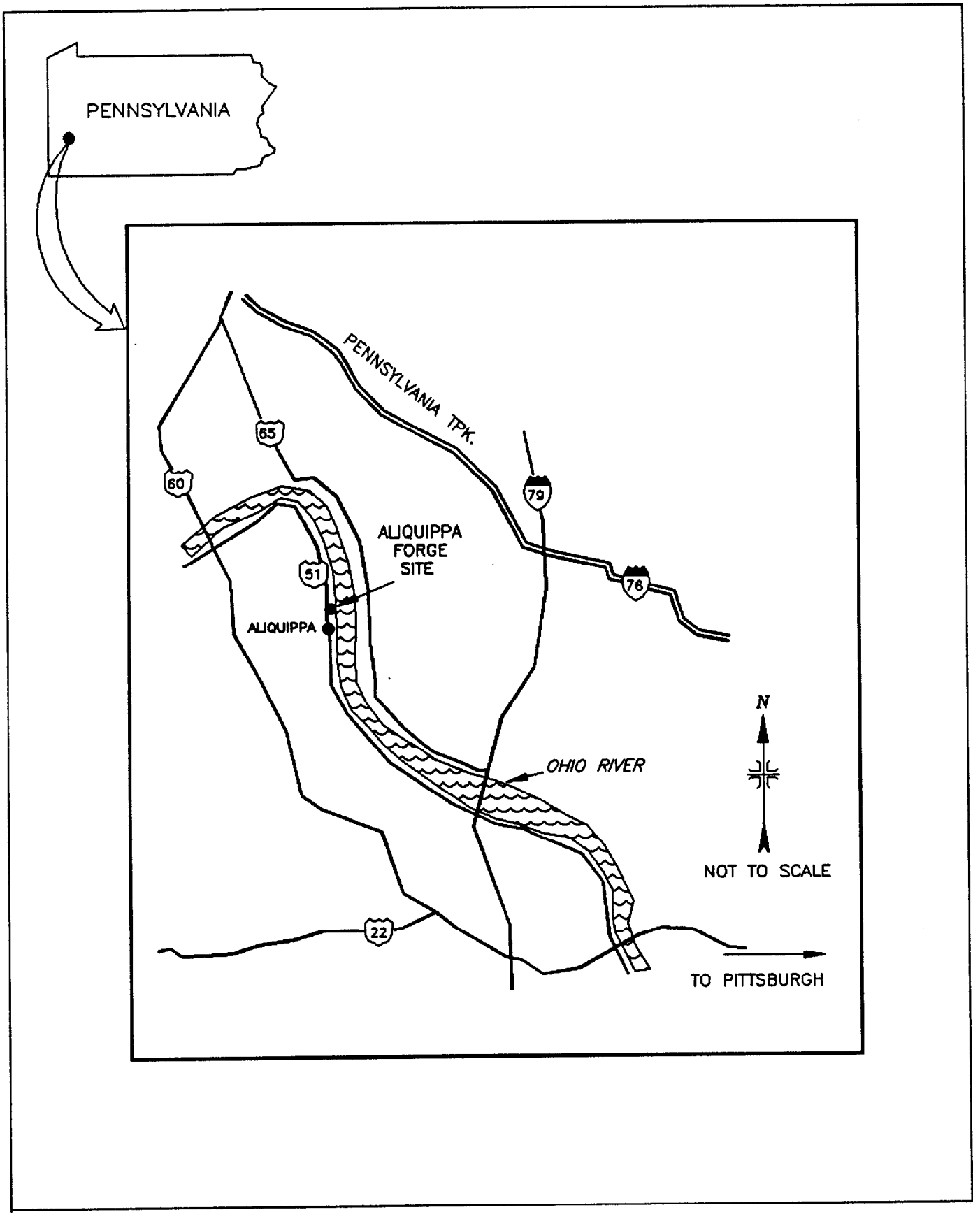


FIGURE 1: Location of the Aliquippa Forge Site, West Aliquippa, Pennsylvania

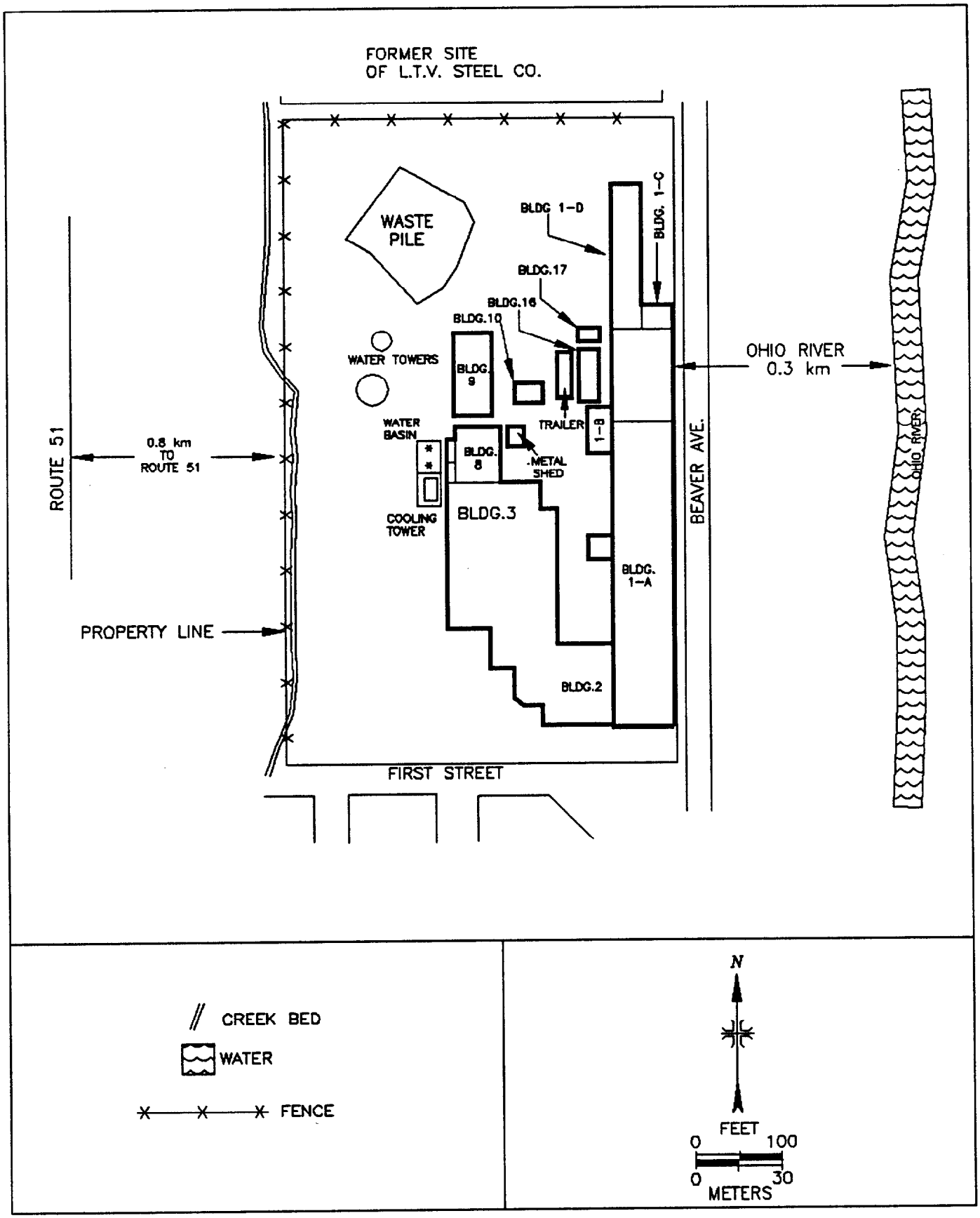


FIGURE 2: Plot Plan of the Aliquippa Forge Site, West Aliquippa, Pennsylvania

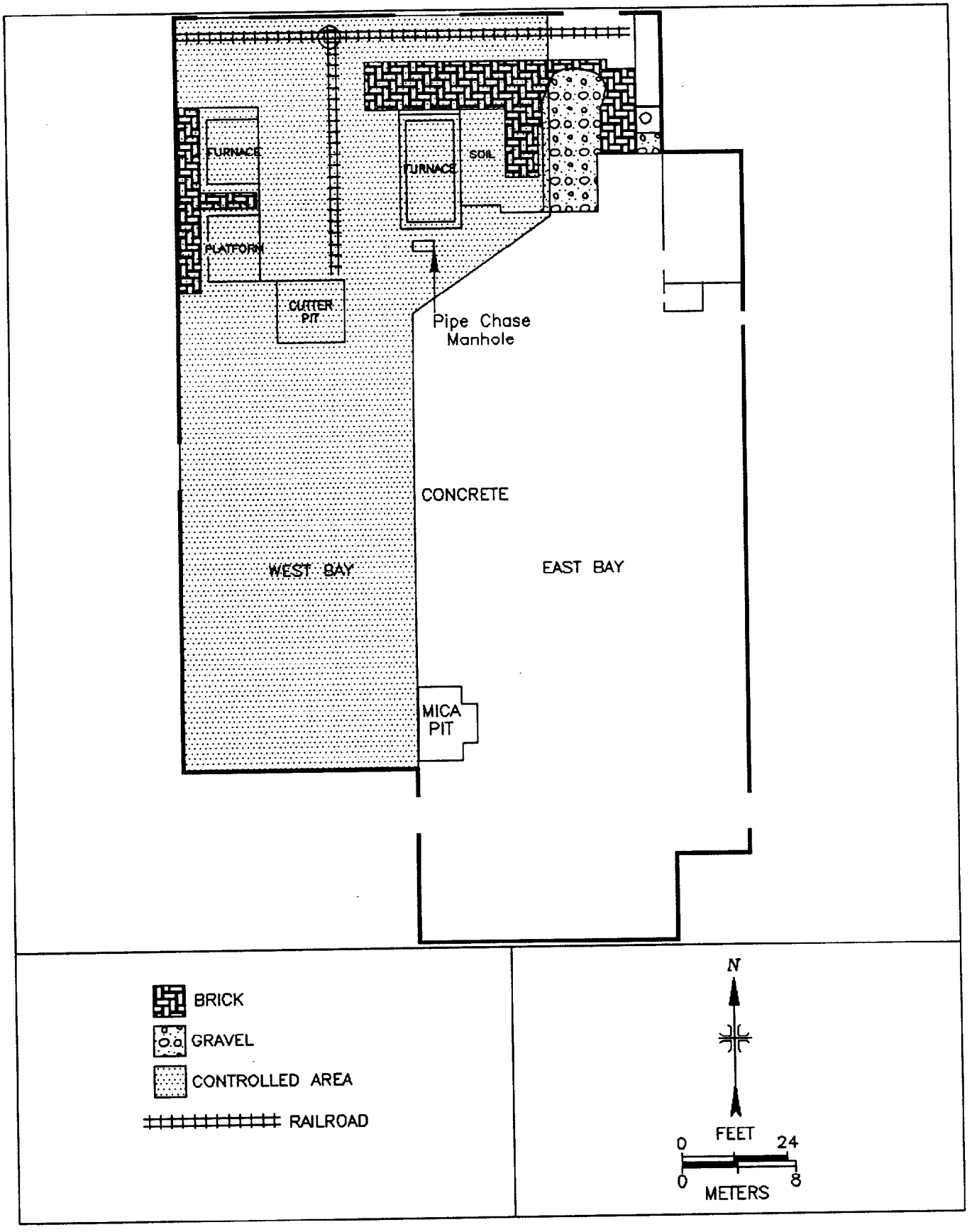


FIGURE 3: Floor Plan of Building 3

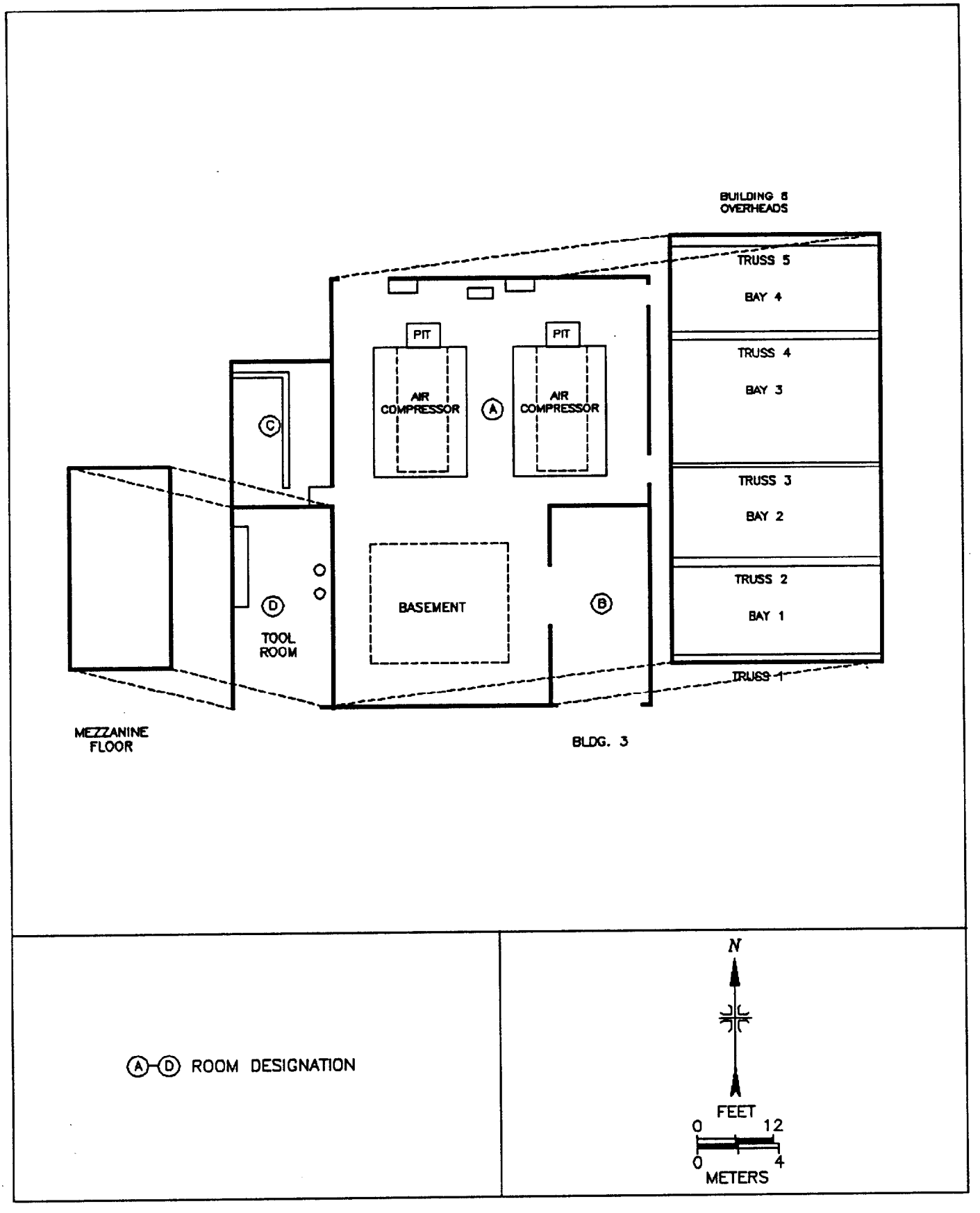


FIGURE 4: Floor Plan of Building 8

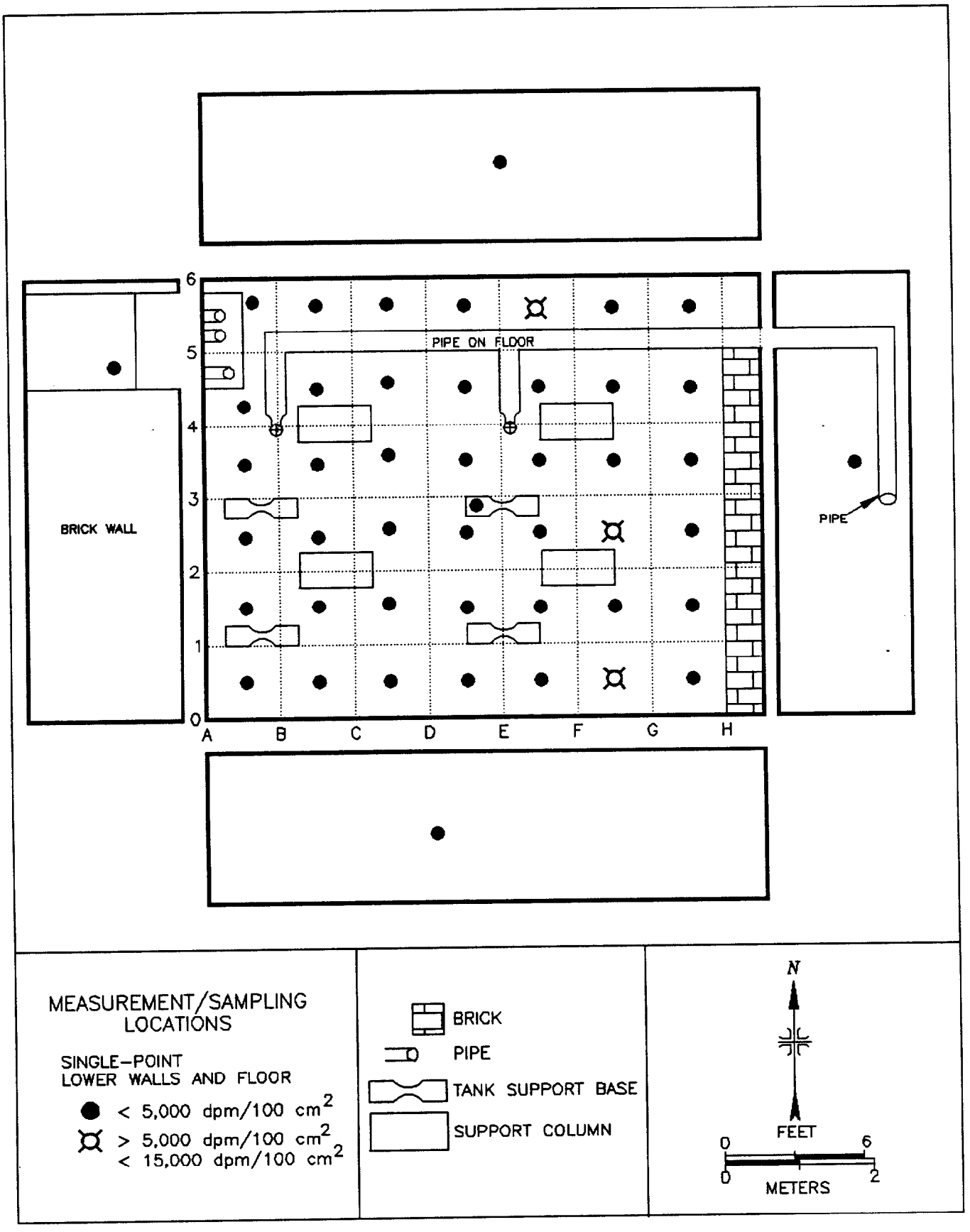


FIGURE 5: Building 8 Basement – Measurement and Sampling Locations

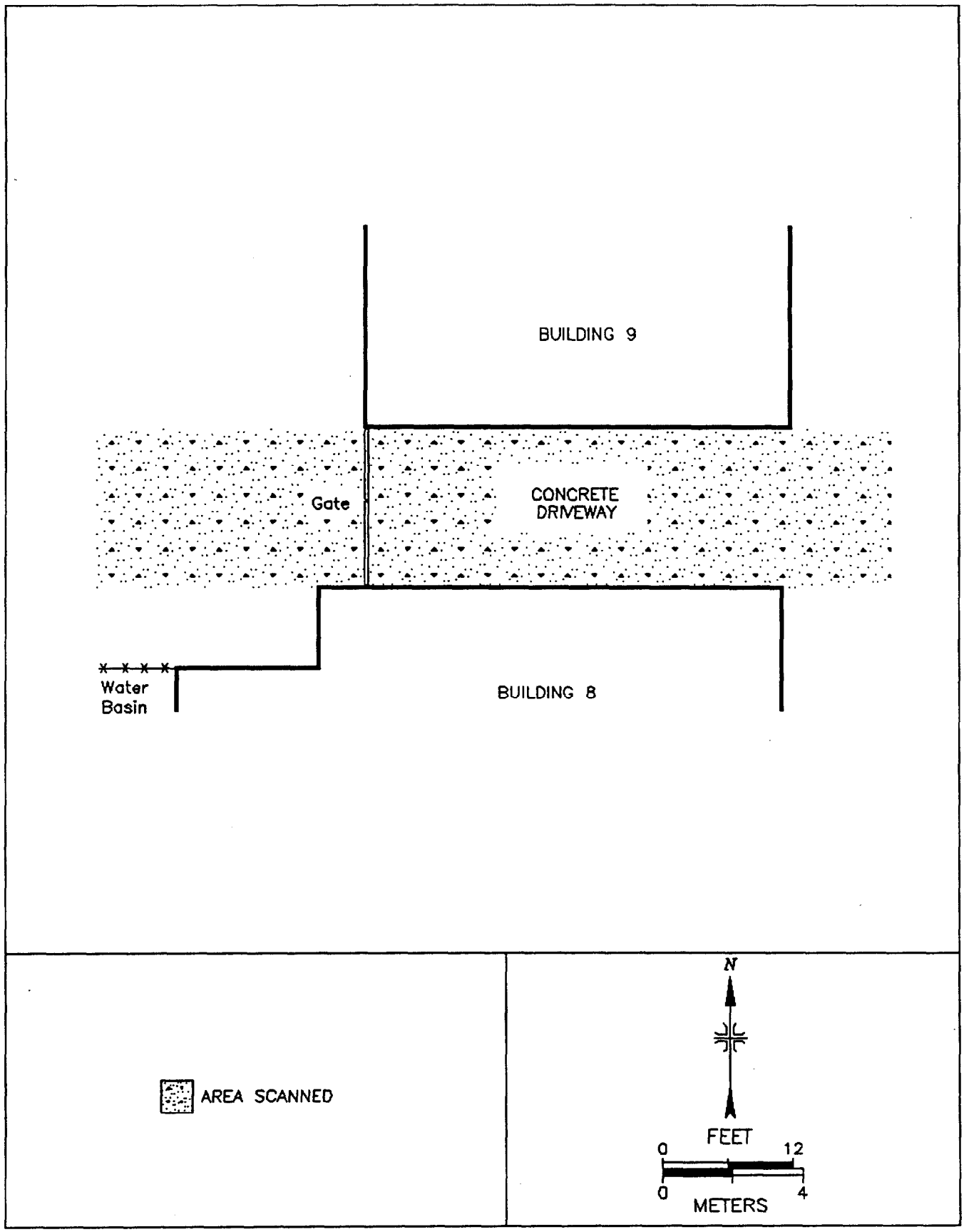


FIGURE 6: Driveway Between Buildings 8 and 9

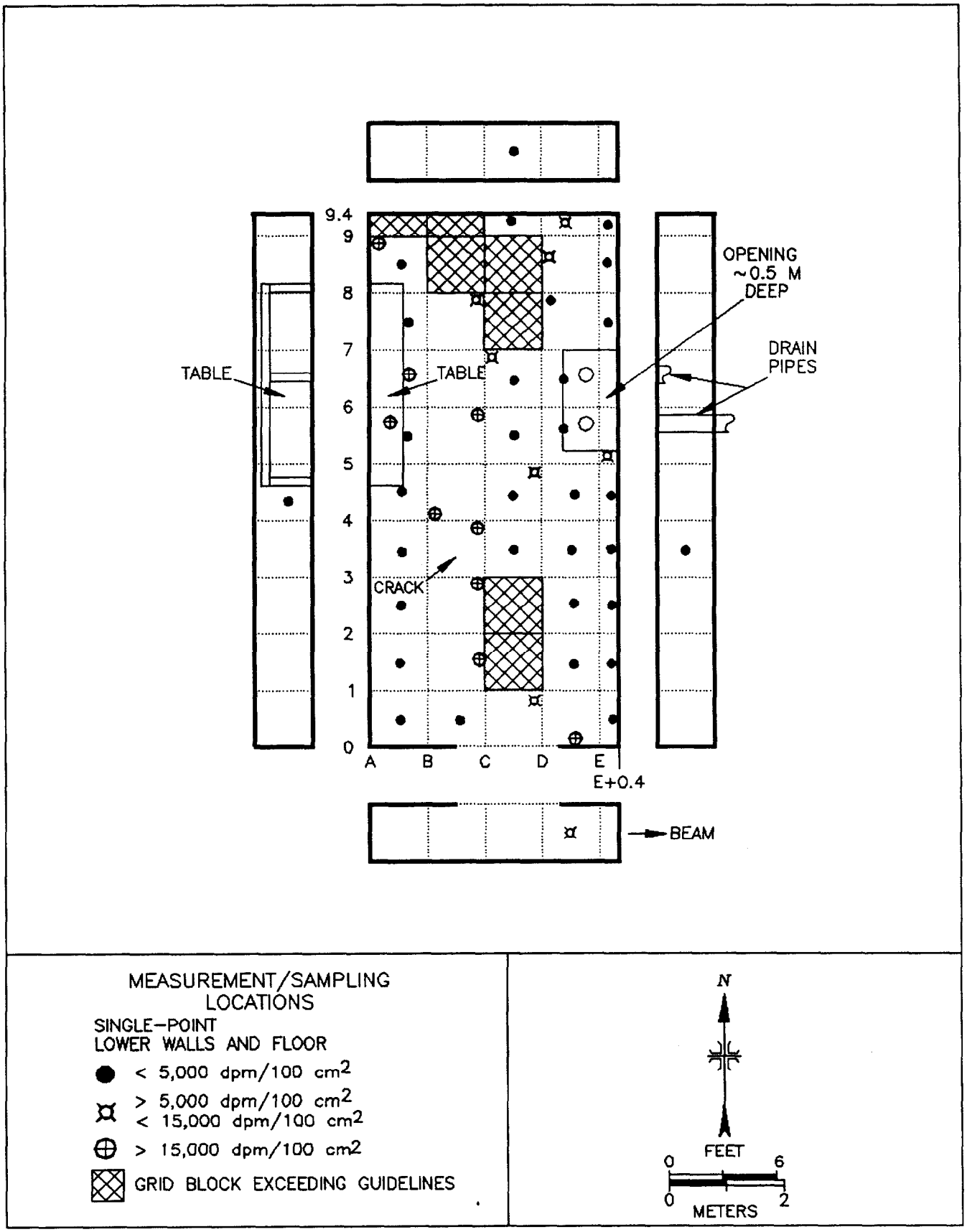


FIGURE 7: Building 8, Tool Room – Measurement and Sampling Locations

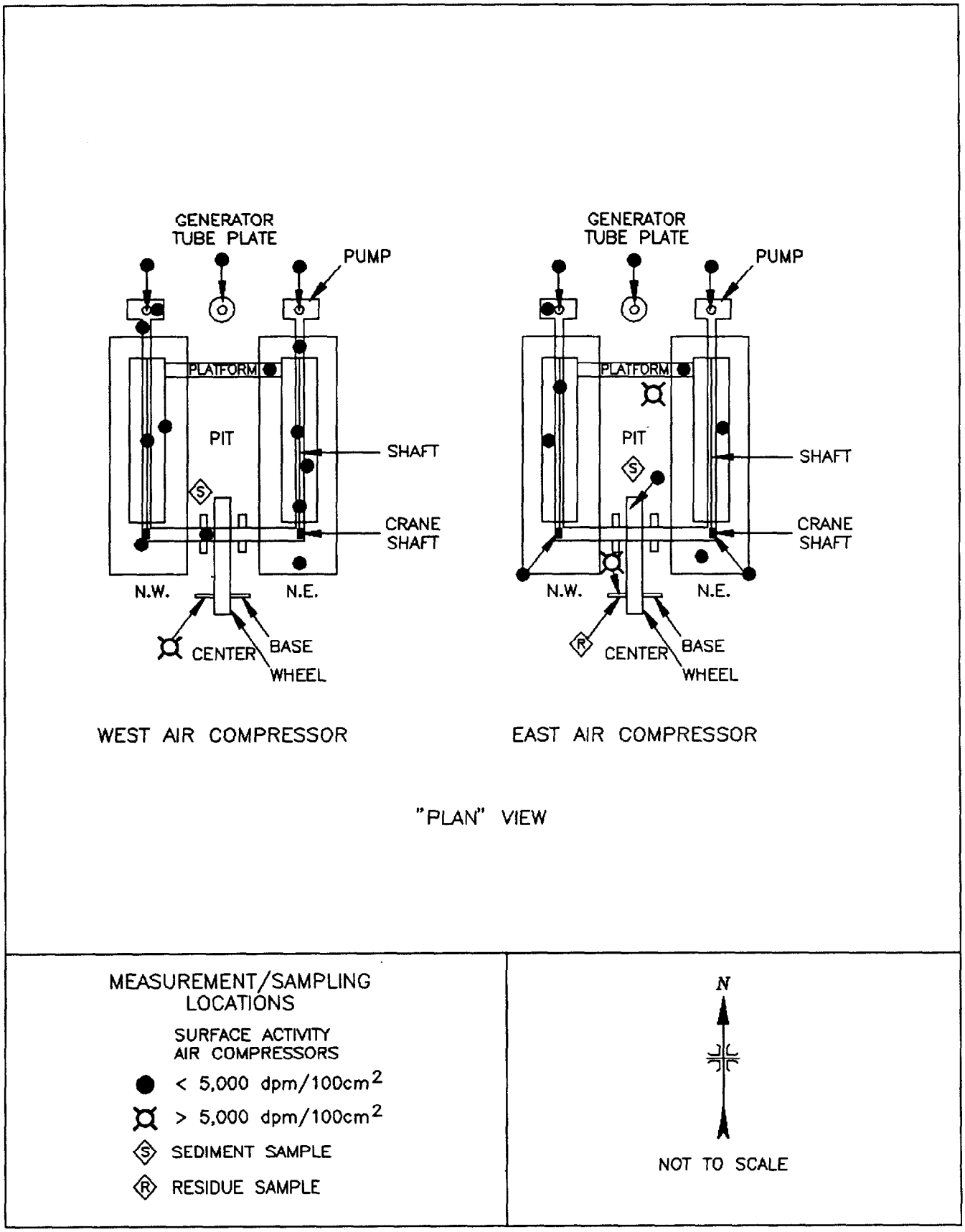


FIGURE 8: Air Compressors – Measurement and Sampling Locations

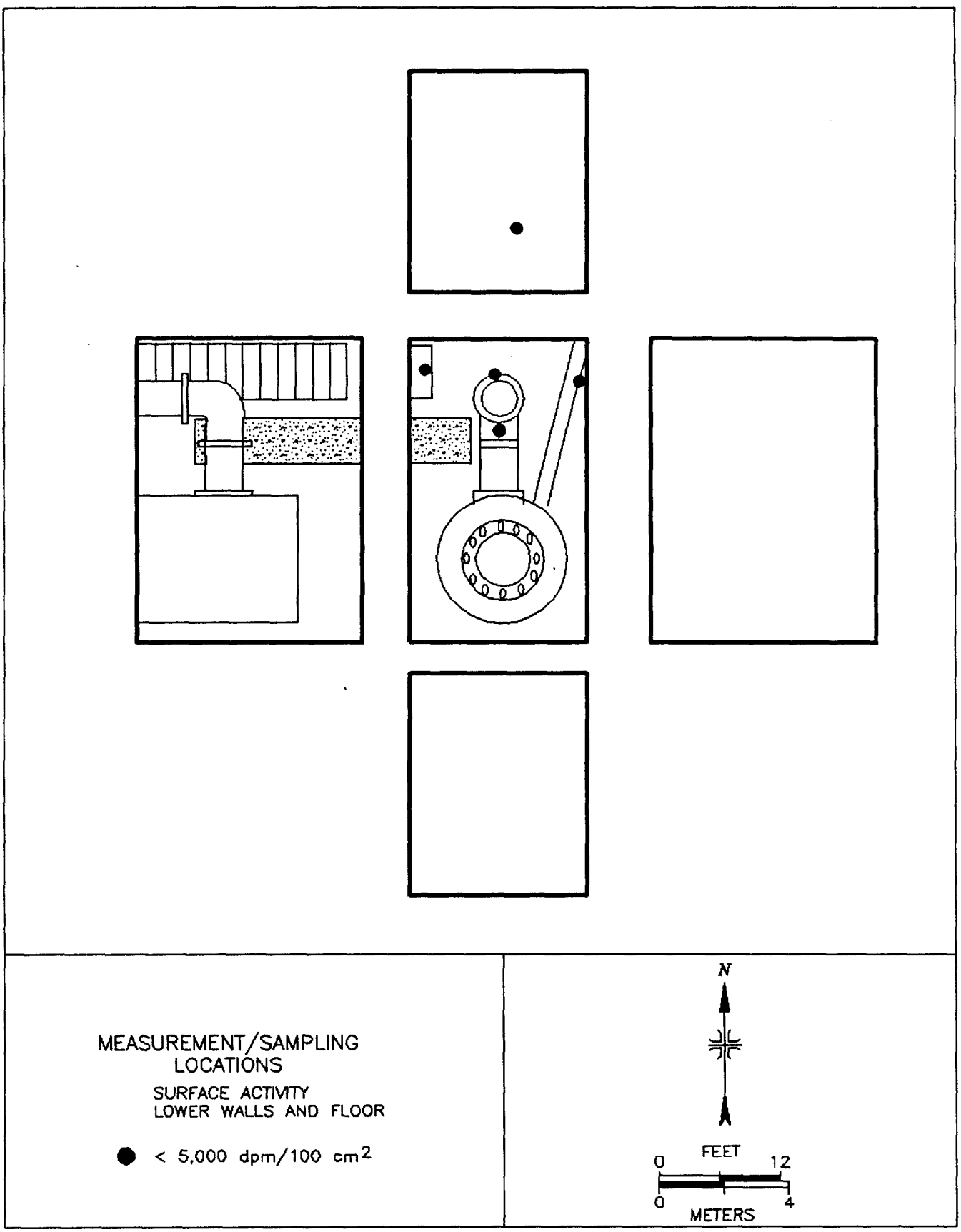


FIGURE 9: Building 8, Pit North of East Compressor – Measurement and Sampling Locations

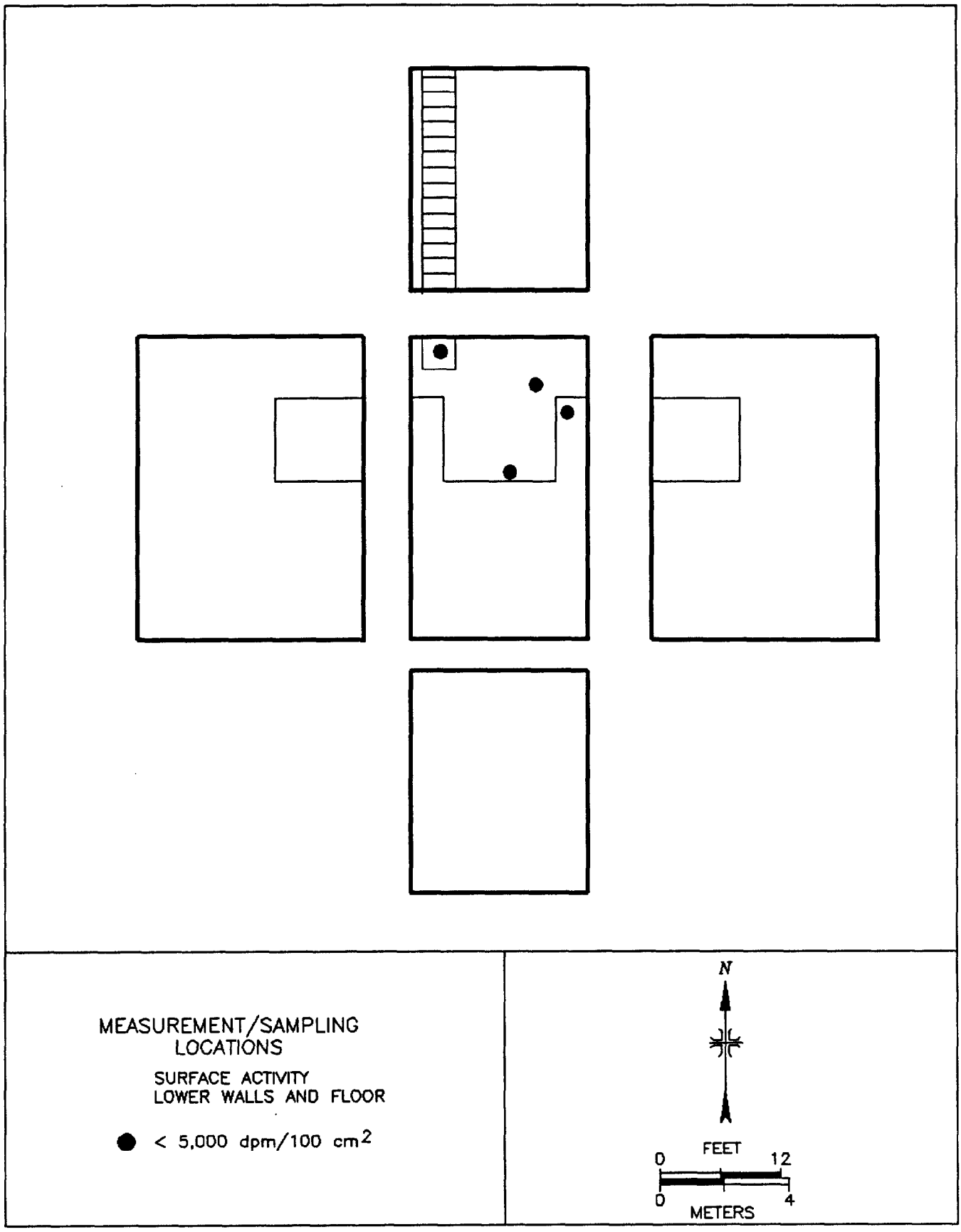


FIGURE 10: Building 8, Pit North of West Compressor – Measurement and Sampling Locations

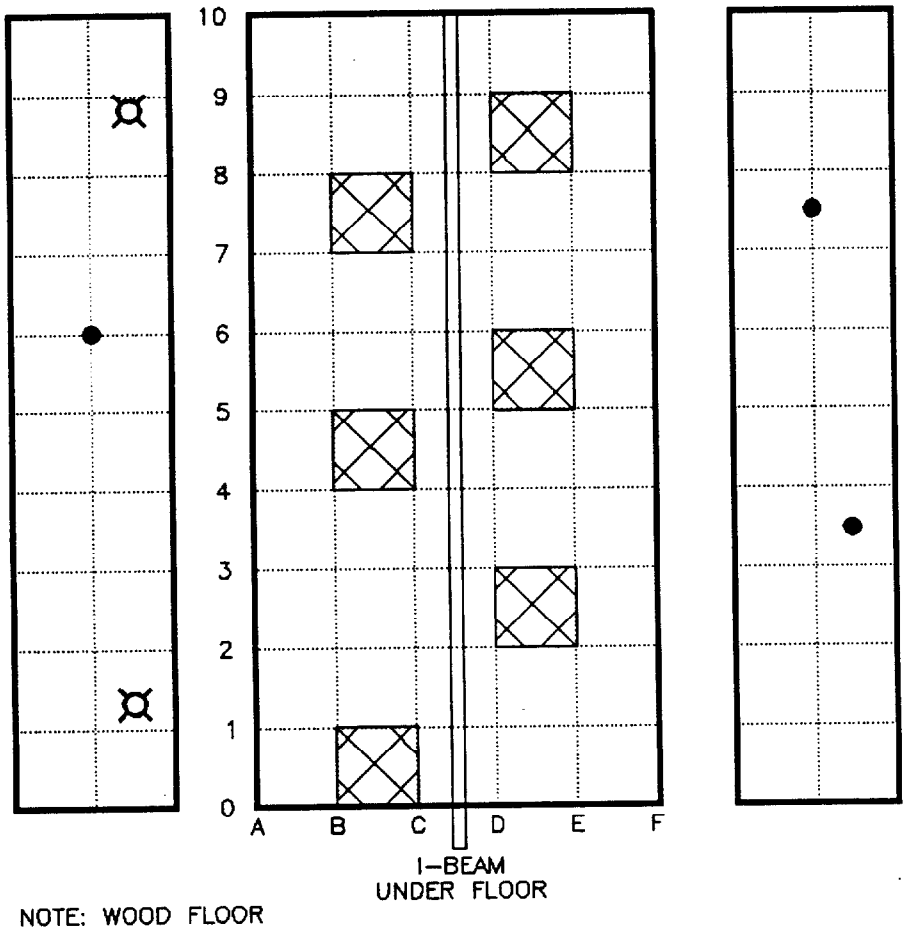


FIGURE 11: Mezzanine Floor and Walls – Measurement and Sampling Locations

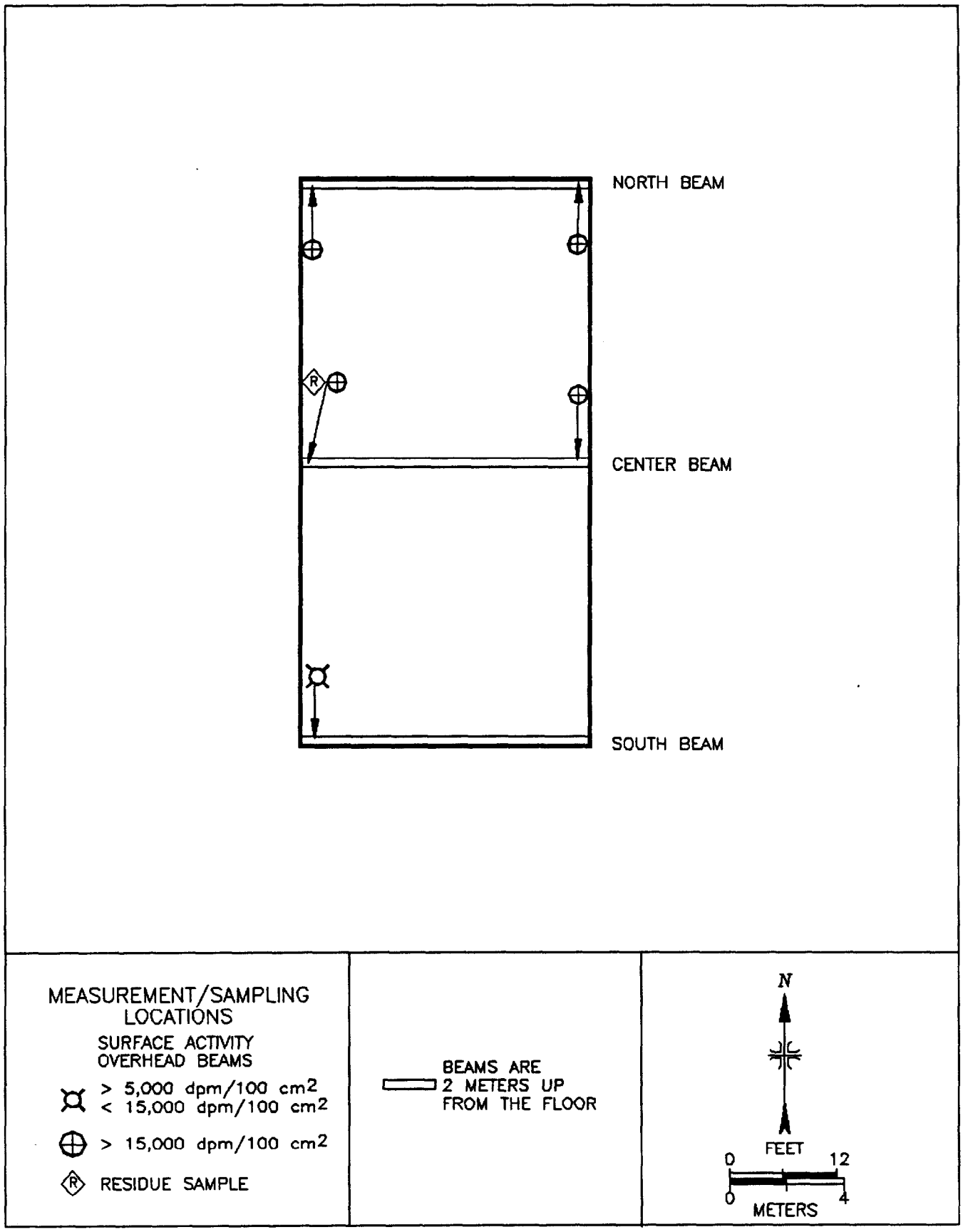


FIGURE 12: Mezzanine, Overhead Beams – Measurement and Sampling Locations

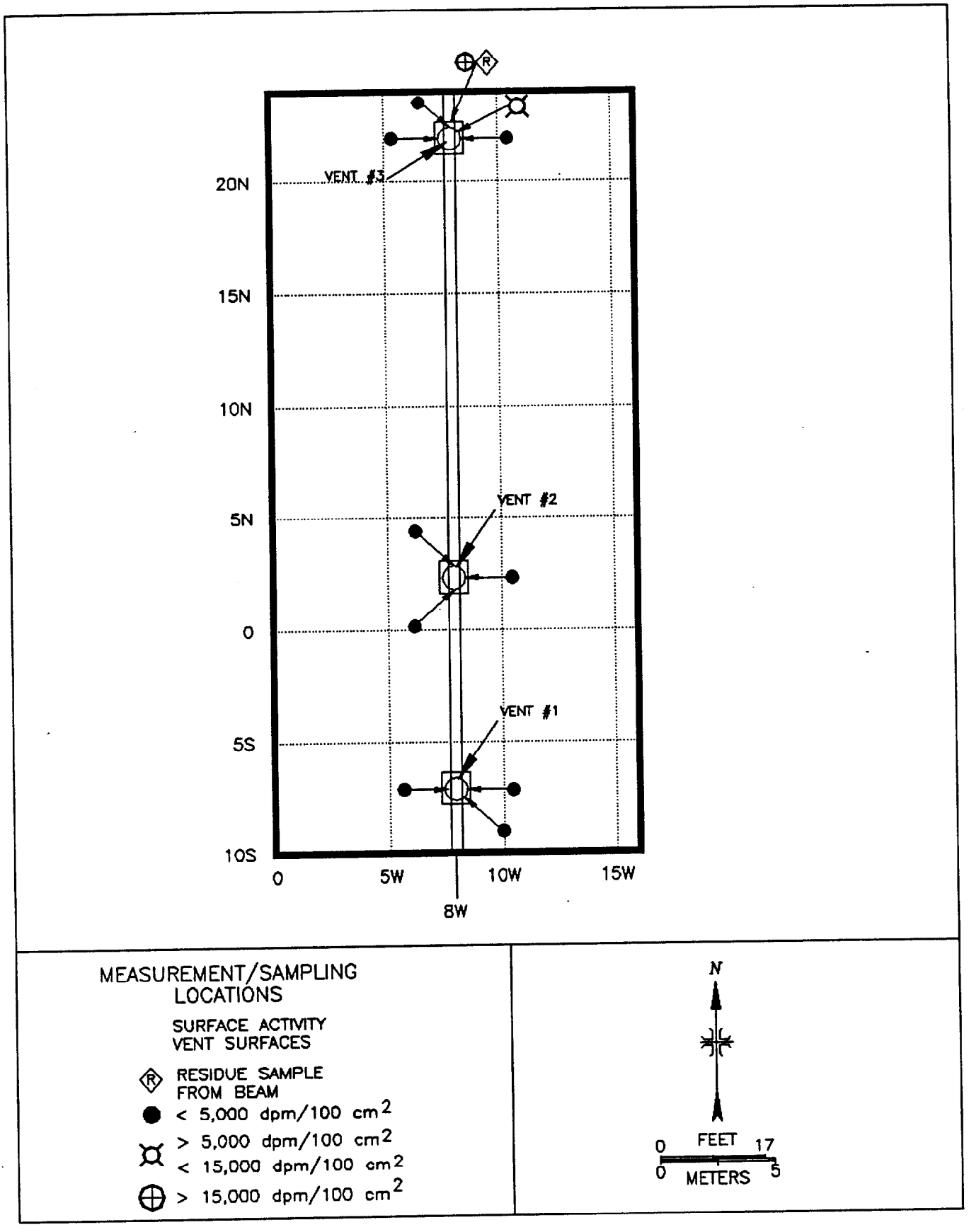


FIGURE 13: Building 3, Beam and Vent Surfaces – Measurement and Sampling Locations

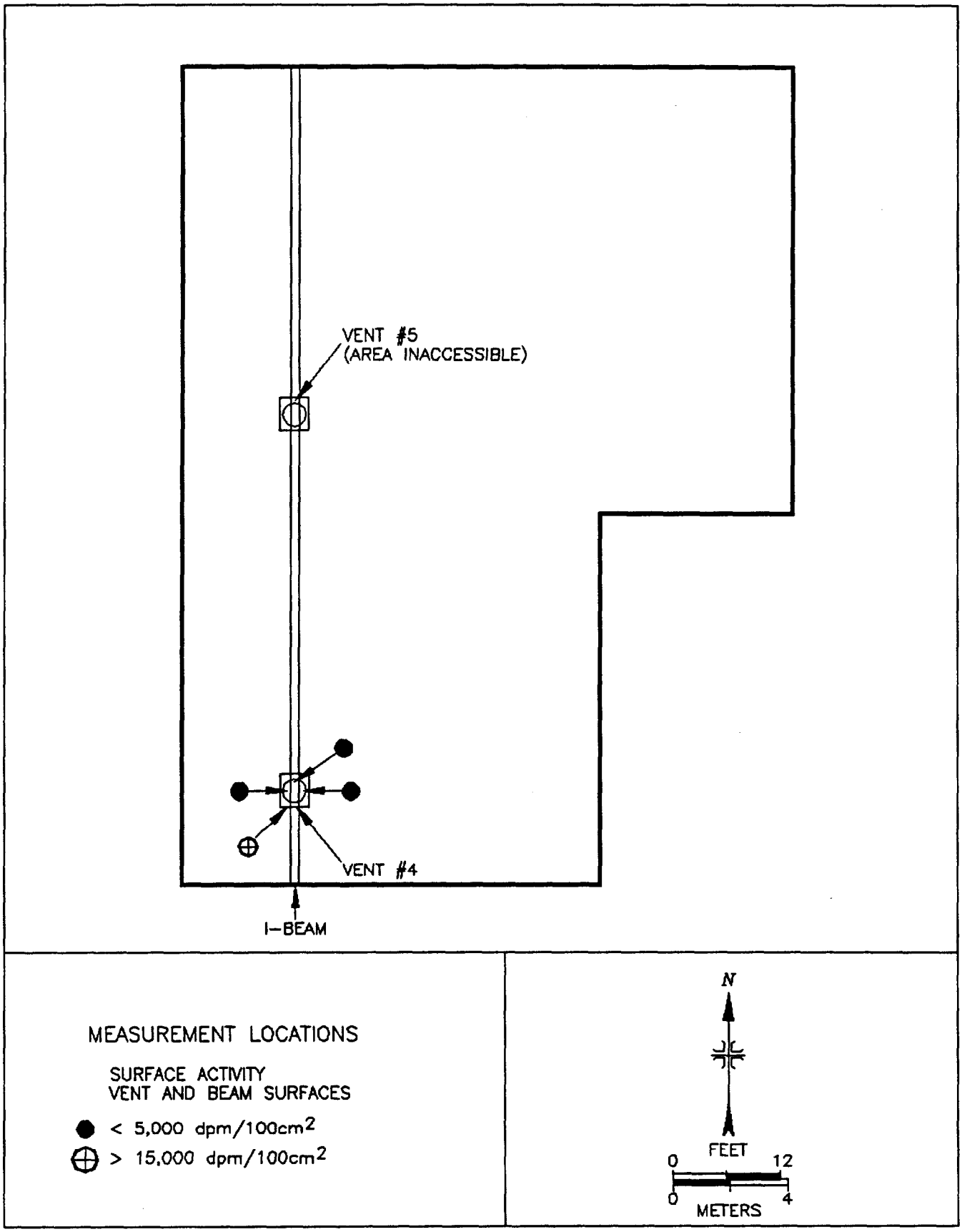


FIGURE 14: Building 8, Beam and Vent Surfaces – Measurement and Sampling Locations

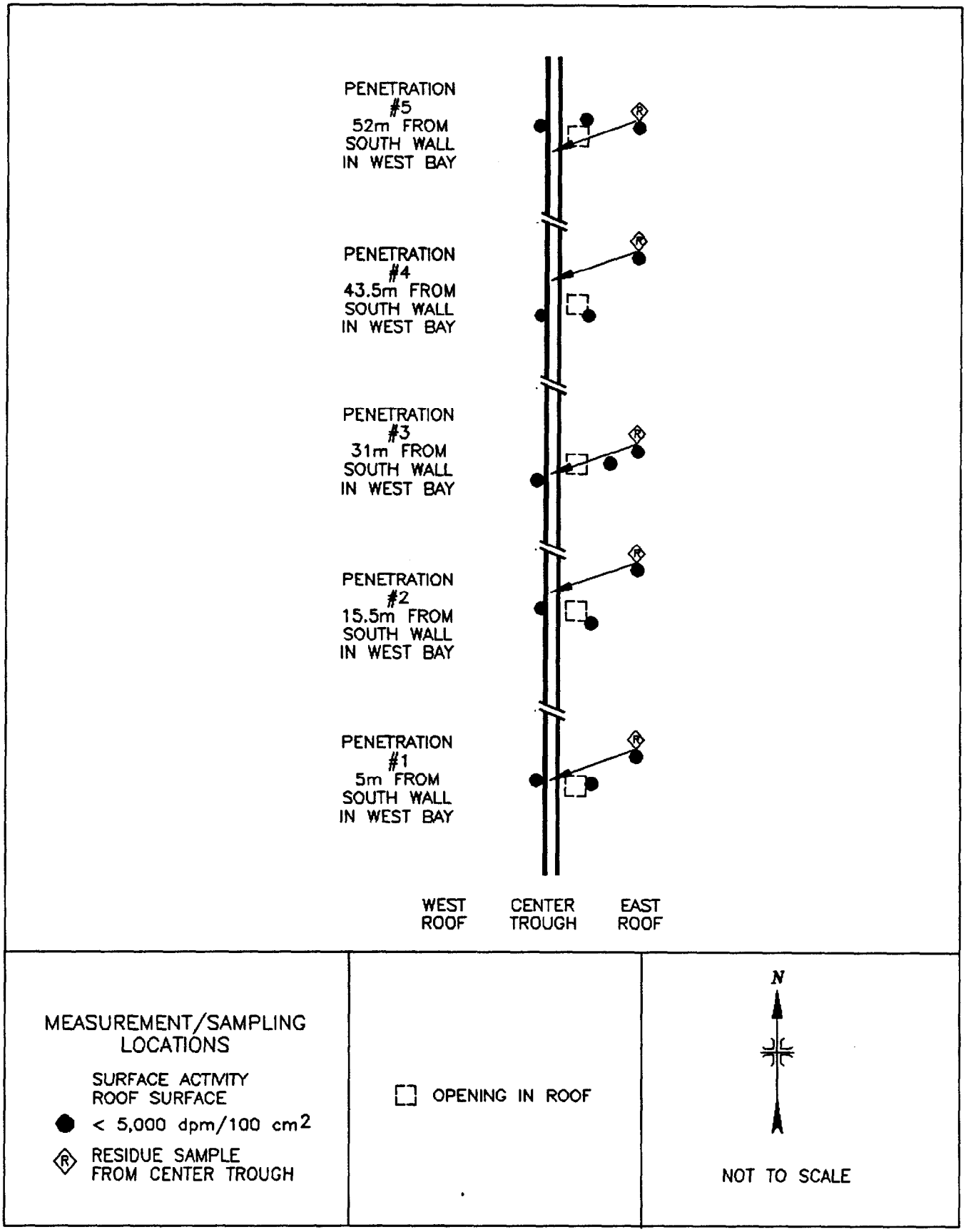


FIGURE 15: Building 3, Roof Penetrations – Measurement and Sampling Locations

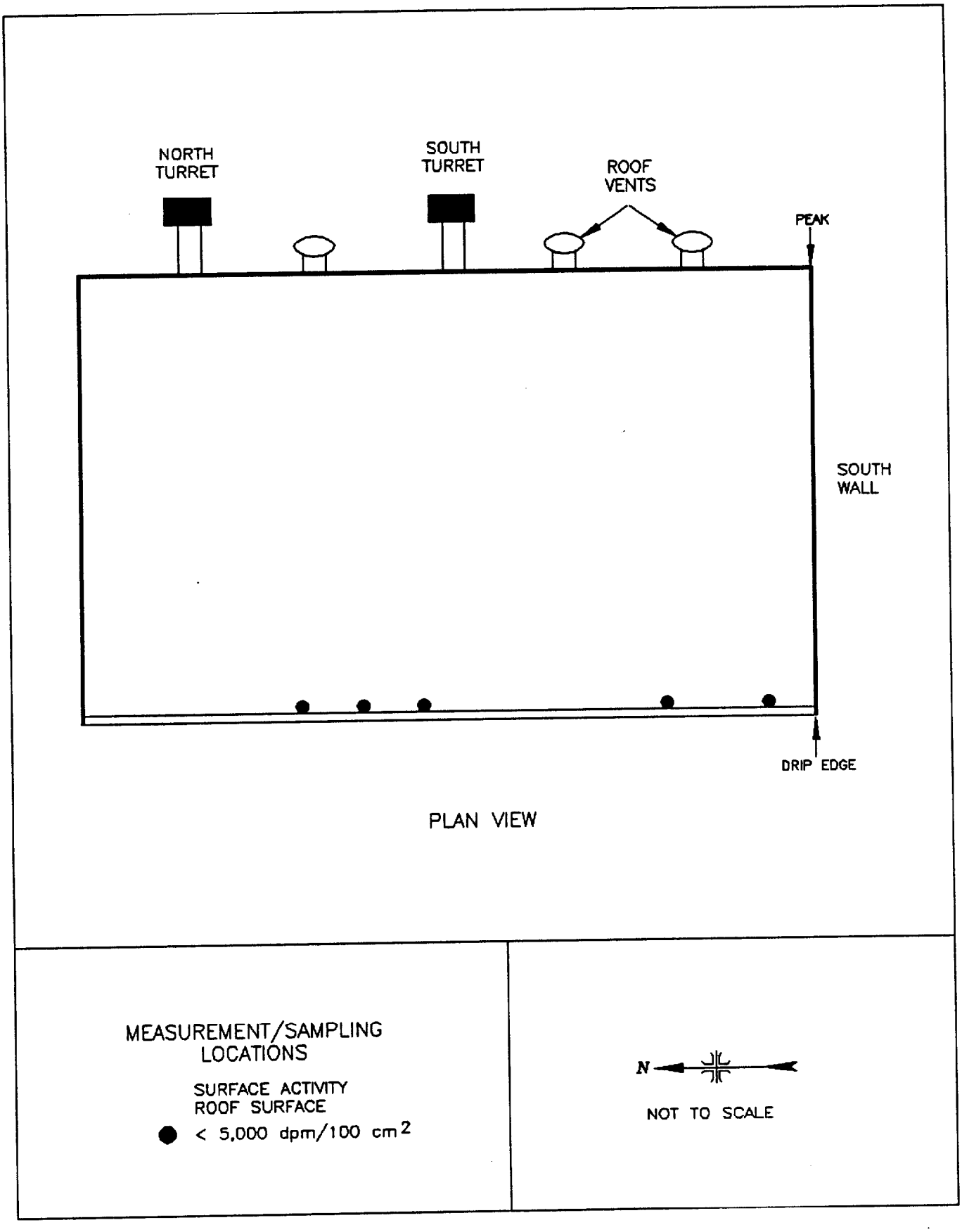


FIGURE 16: Building 3, West Roof – Measurement and Sampling Locations

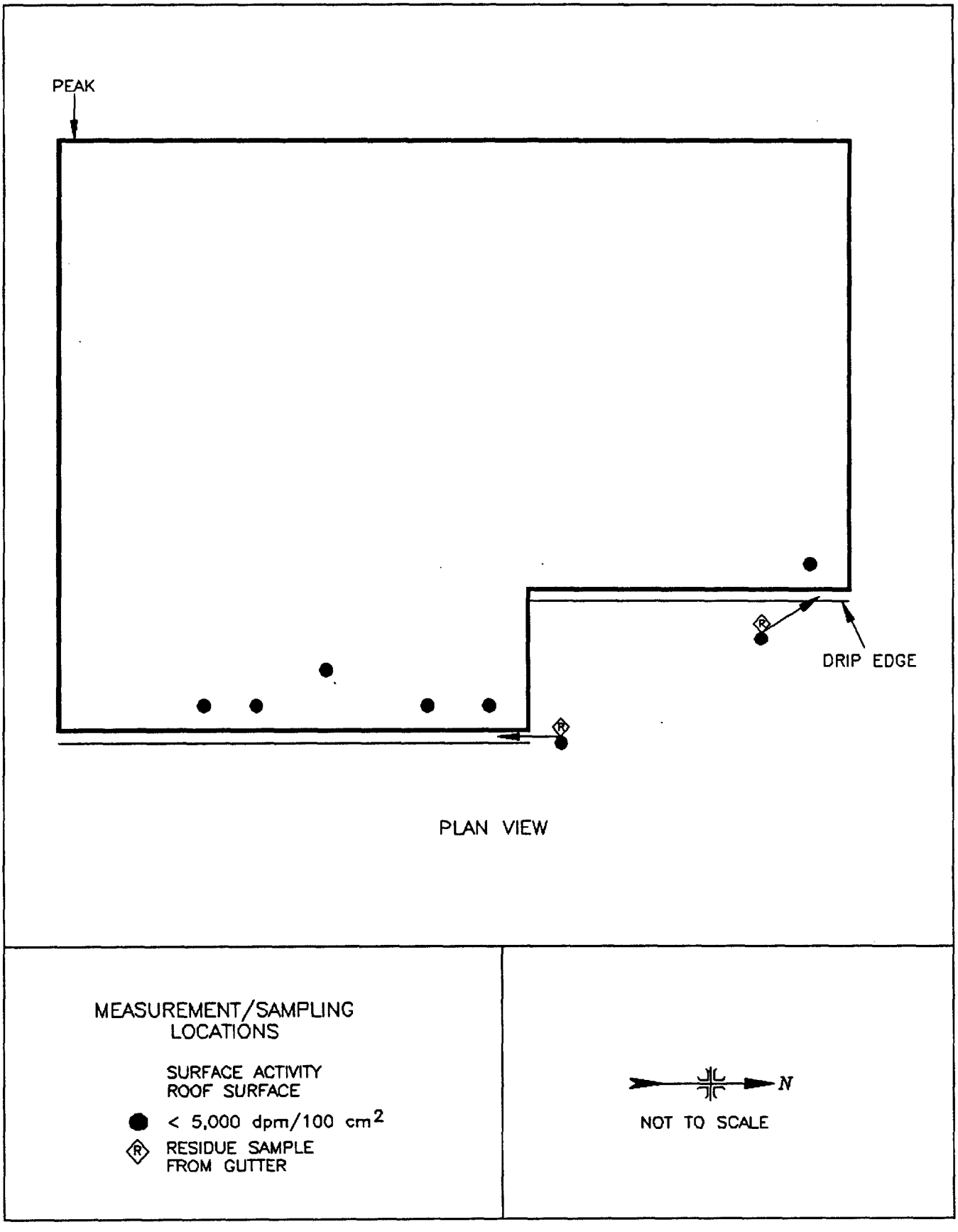


FIGURE 17: Building 3, East Roof – Measurement and Sampling Locations

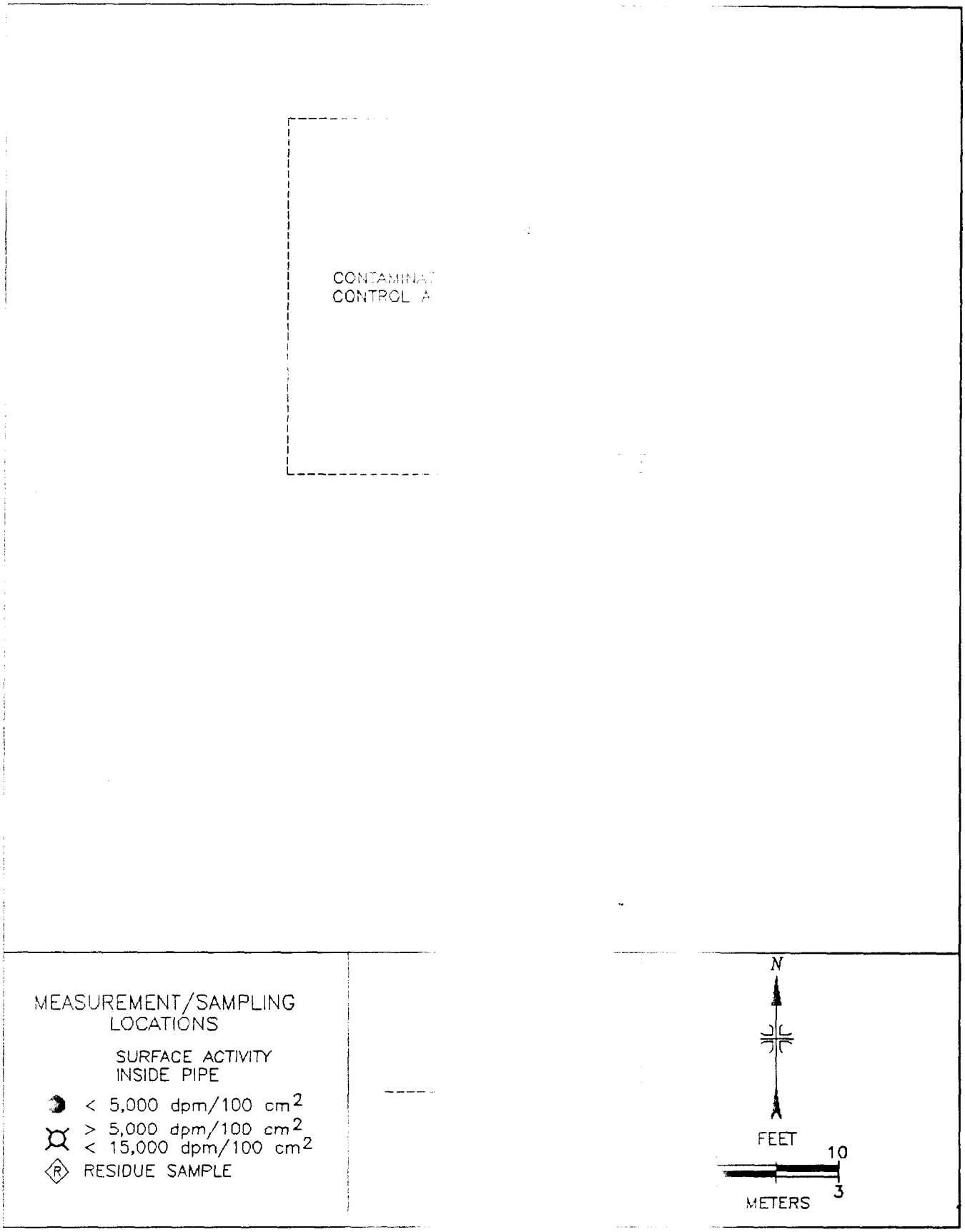
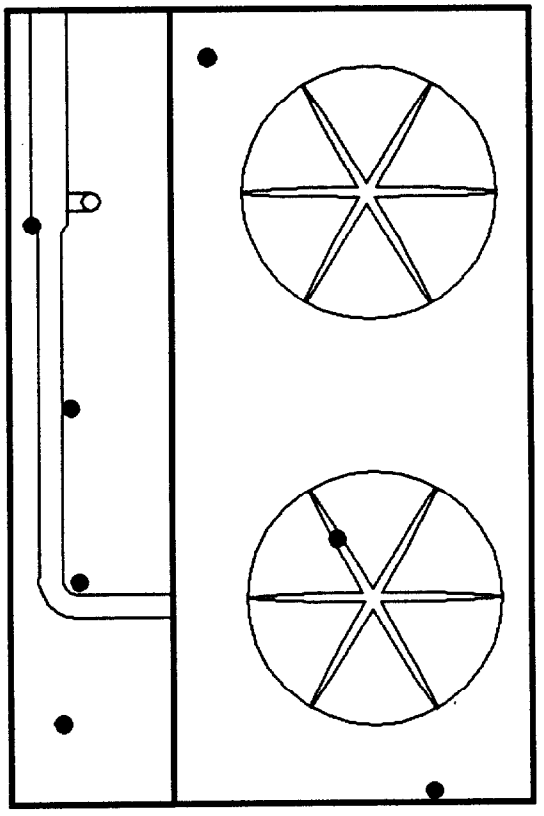


FIGURE 18: Pipe Penetr[illegible]g Locations



PLAN VIEW

MEASUREMENT/SAMPLING LOCATIONS

SURFACE ACTIVITY
COOLING TOWER ROOF

● < 5,000 dpm/100 cm^2

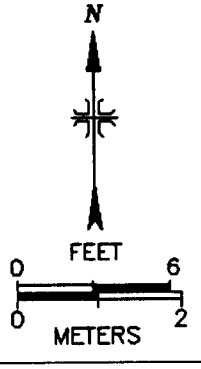


FIGURE 19: Cooling Tower – Measurement and Sampling Locations

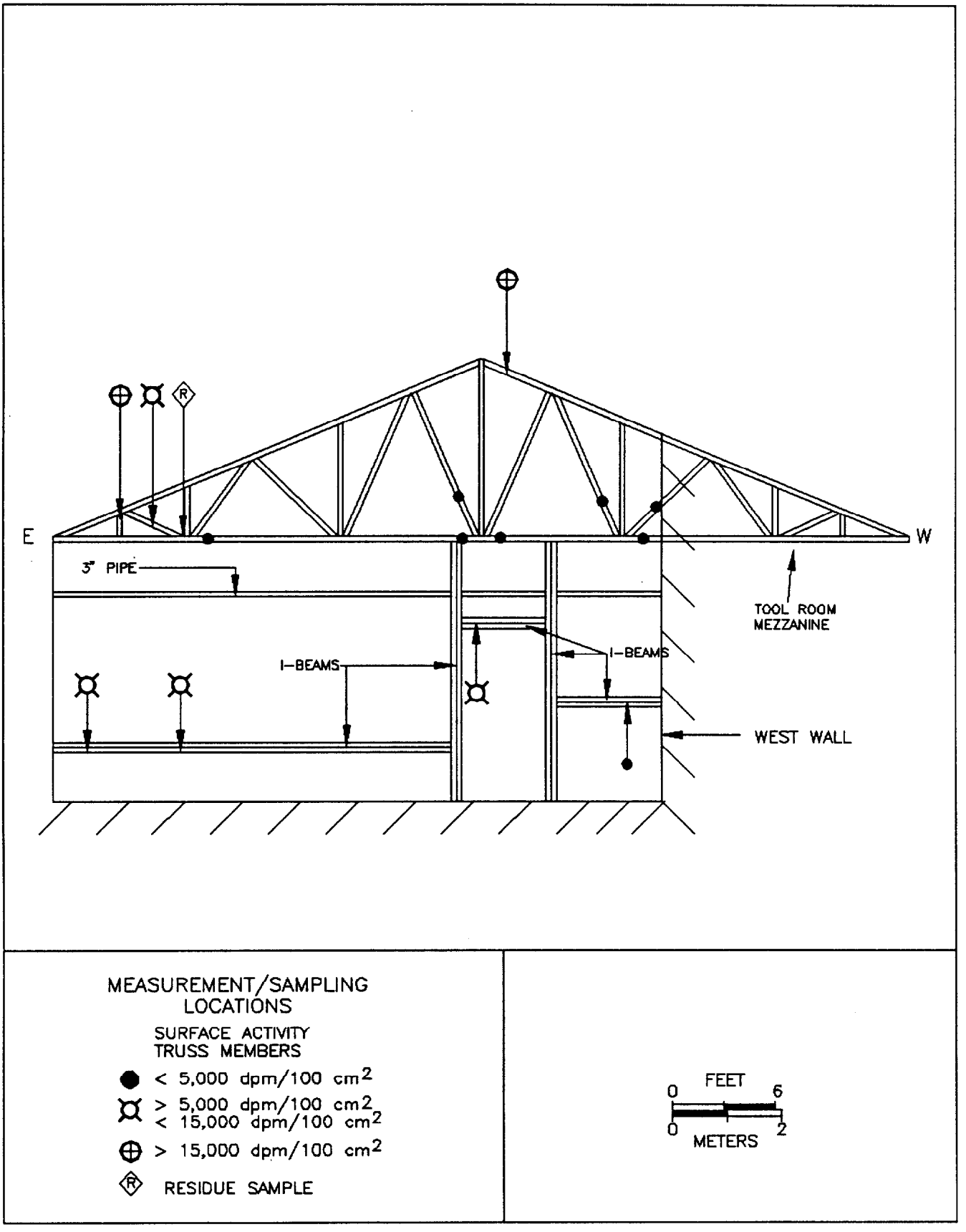


FIGURE 20: Building 8, Truss 1 (South Wall) – Measurement and Sampling Locations

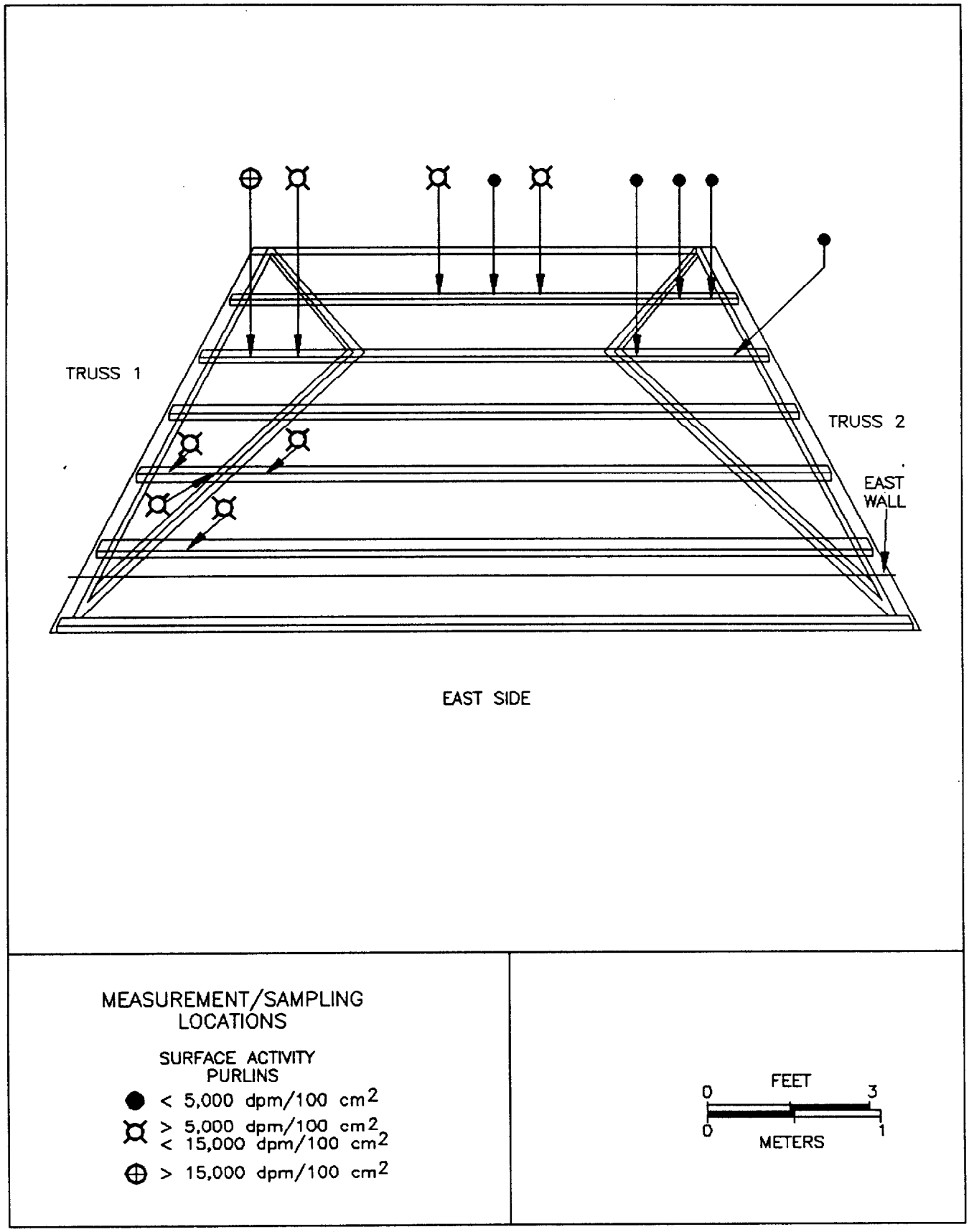


FIGURE 21: Building 8, Bay 1, East – Measurement and Sampling Locations

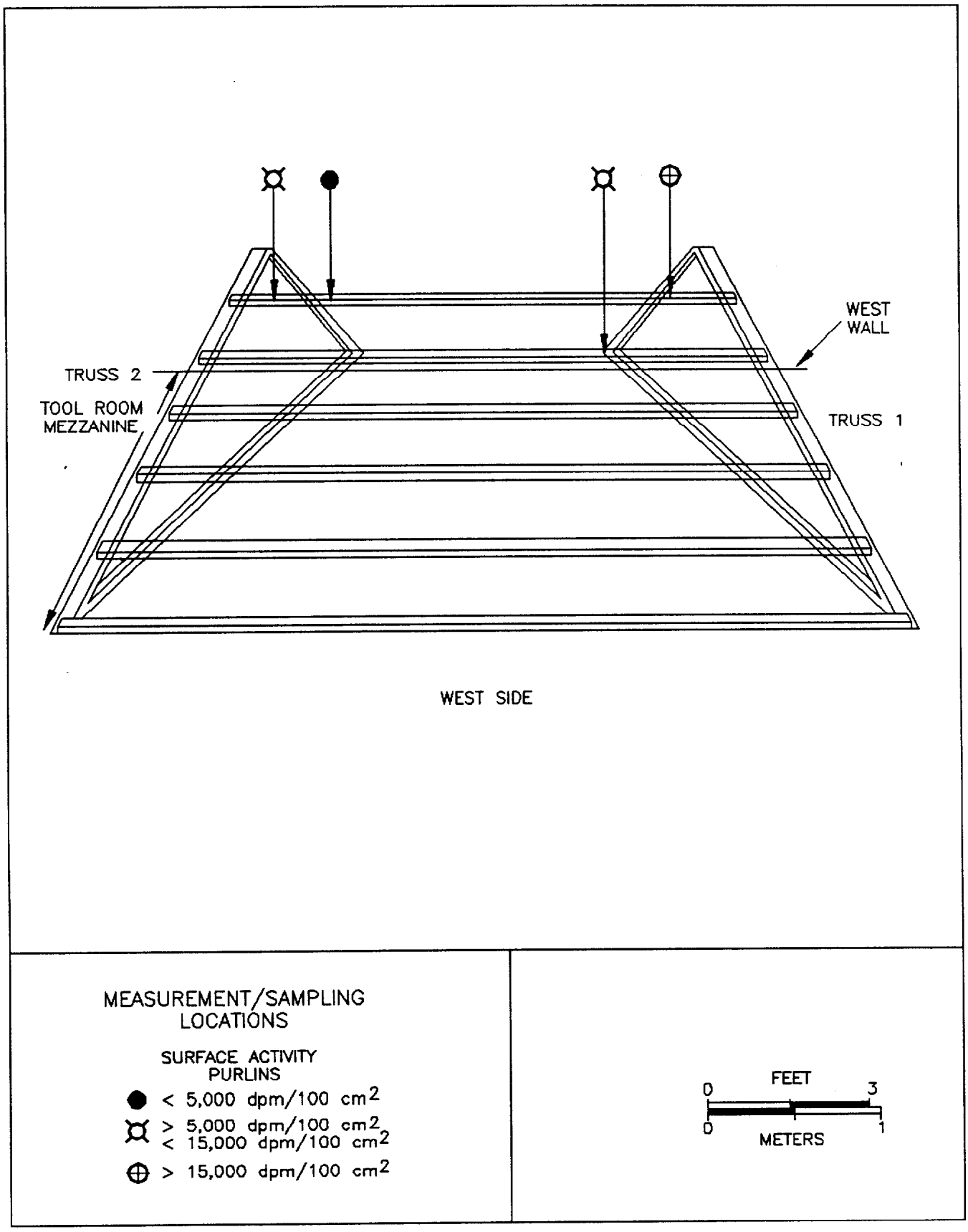


FIGURE 22: Building 8, Bay 1, West – Measurement and Sampling Locations

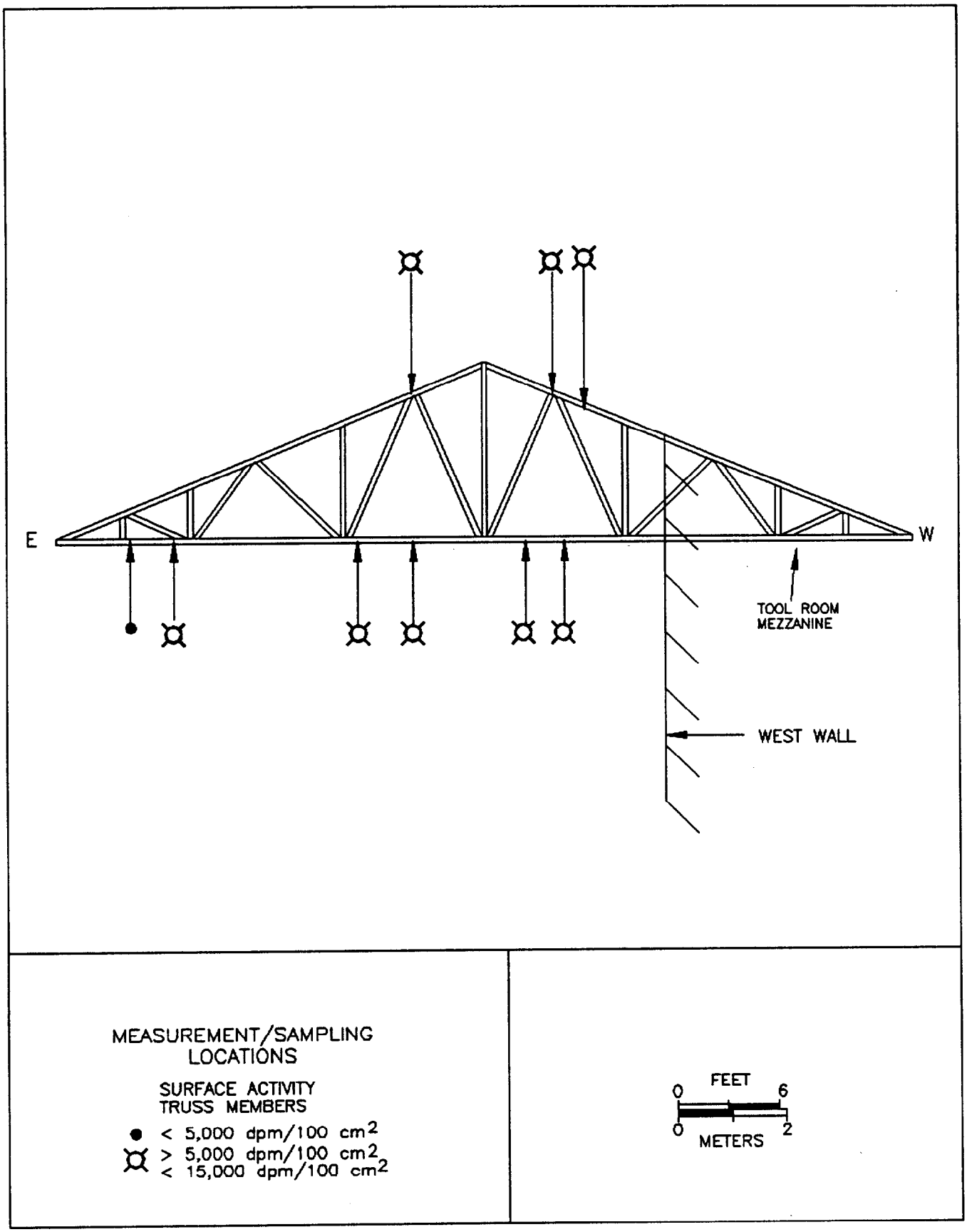


FIGURE 23: Building 8, Truss 2 — Measurement and Sampling Locations

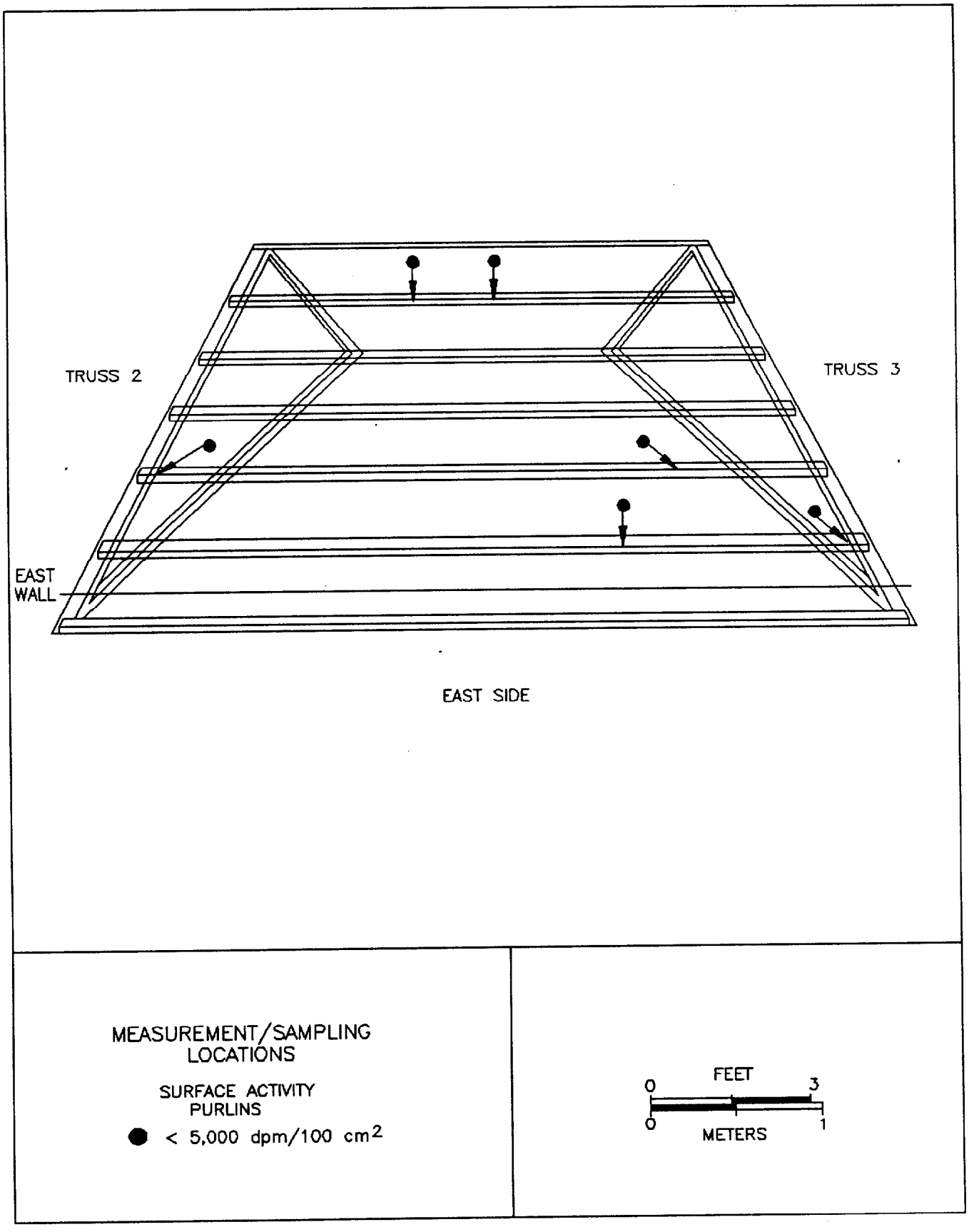


FIGURE 24: Building 8, Bay 2, East – Measurement and Sampling Locations

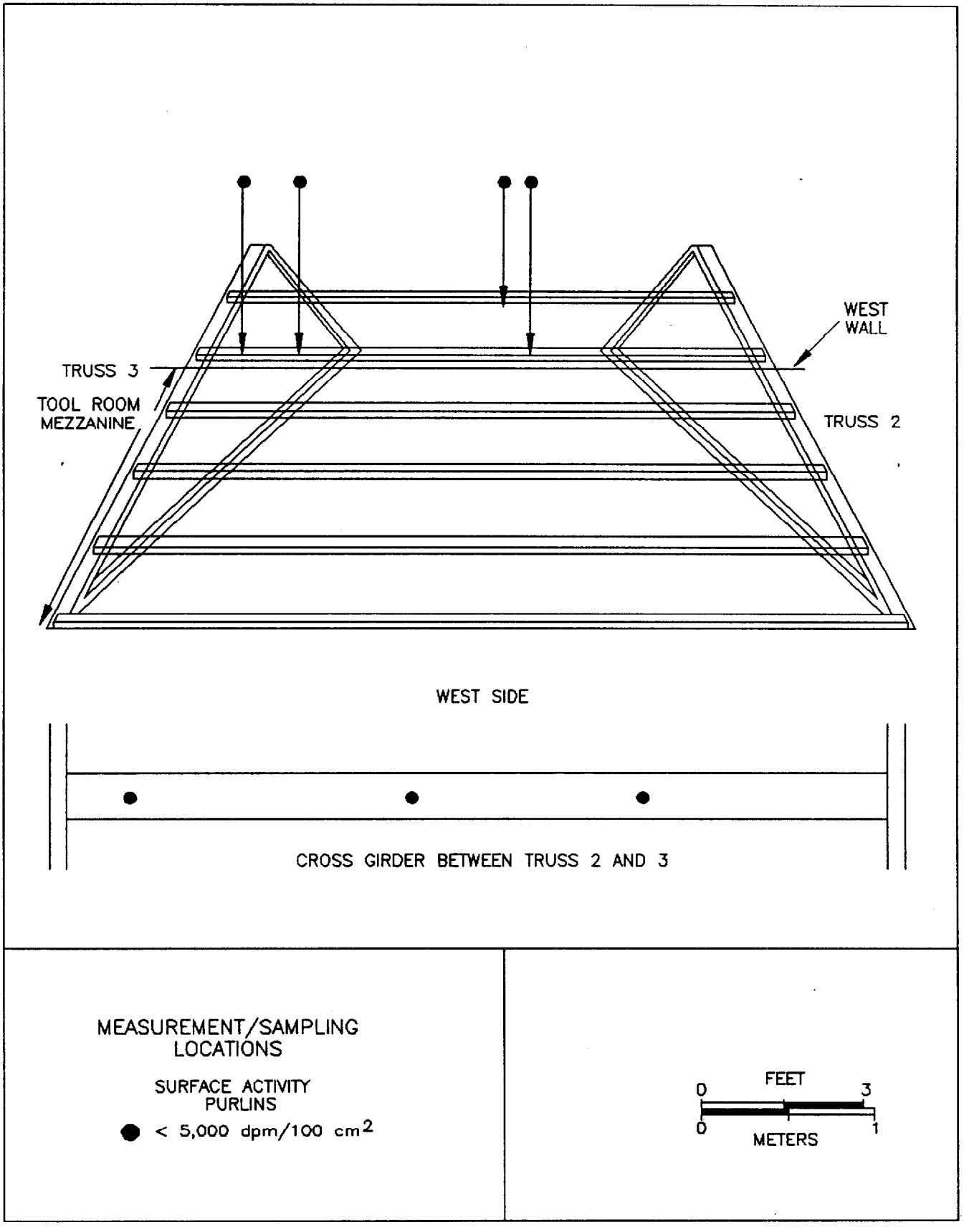
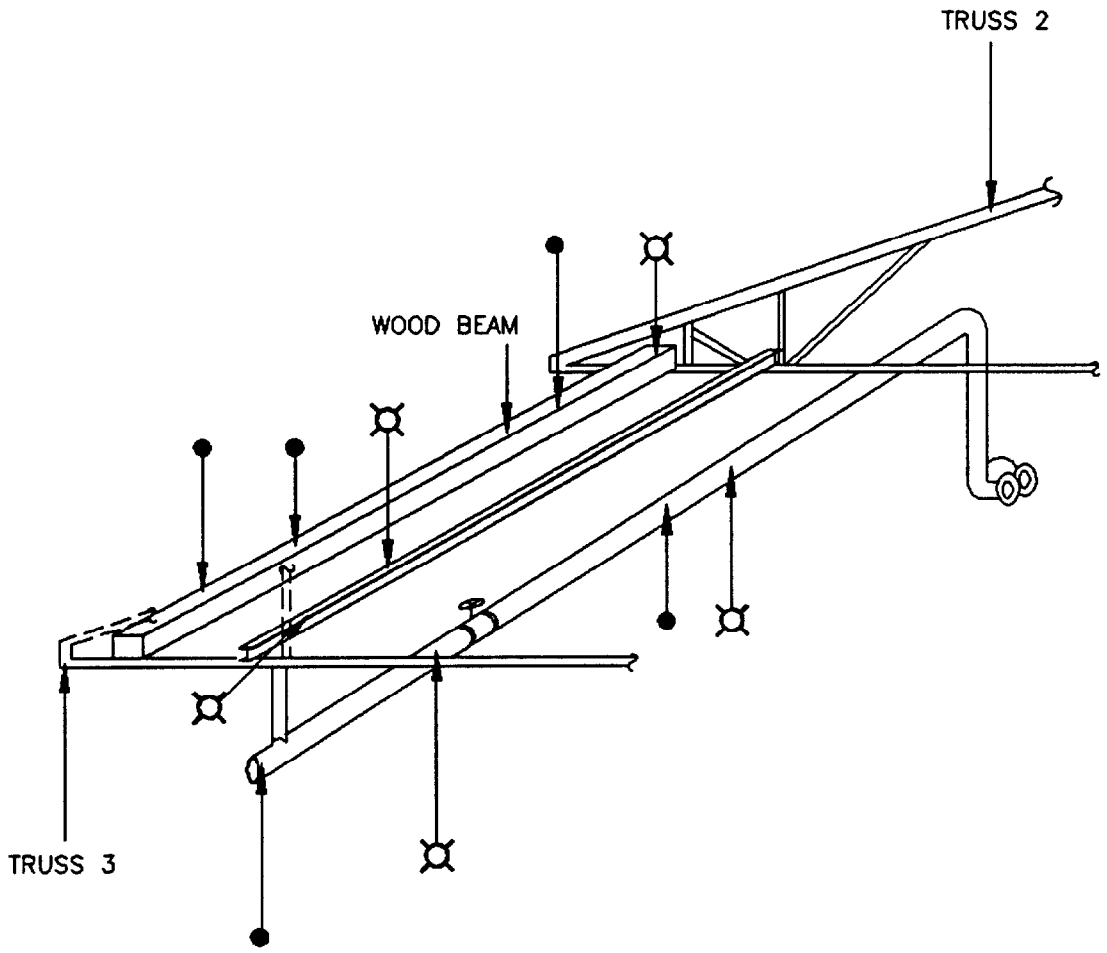


FIGURE 25: Building 8, Bay 2, West – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

SURFACE ACTIVITY
OVERHEAD SURFACES

● < 5,000 dpm/100 cm^2

⌑ > 5,000 dpm/100 cm^2
< 15,000 dpm/100 cm^2

N

NOT TO SCALE

FIGURE 26: Building 8, Overheads, Bay 2 – Measurement and Sampling Locations

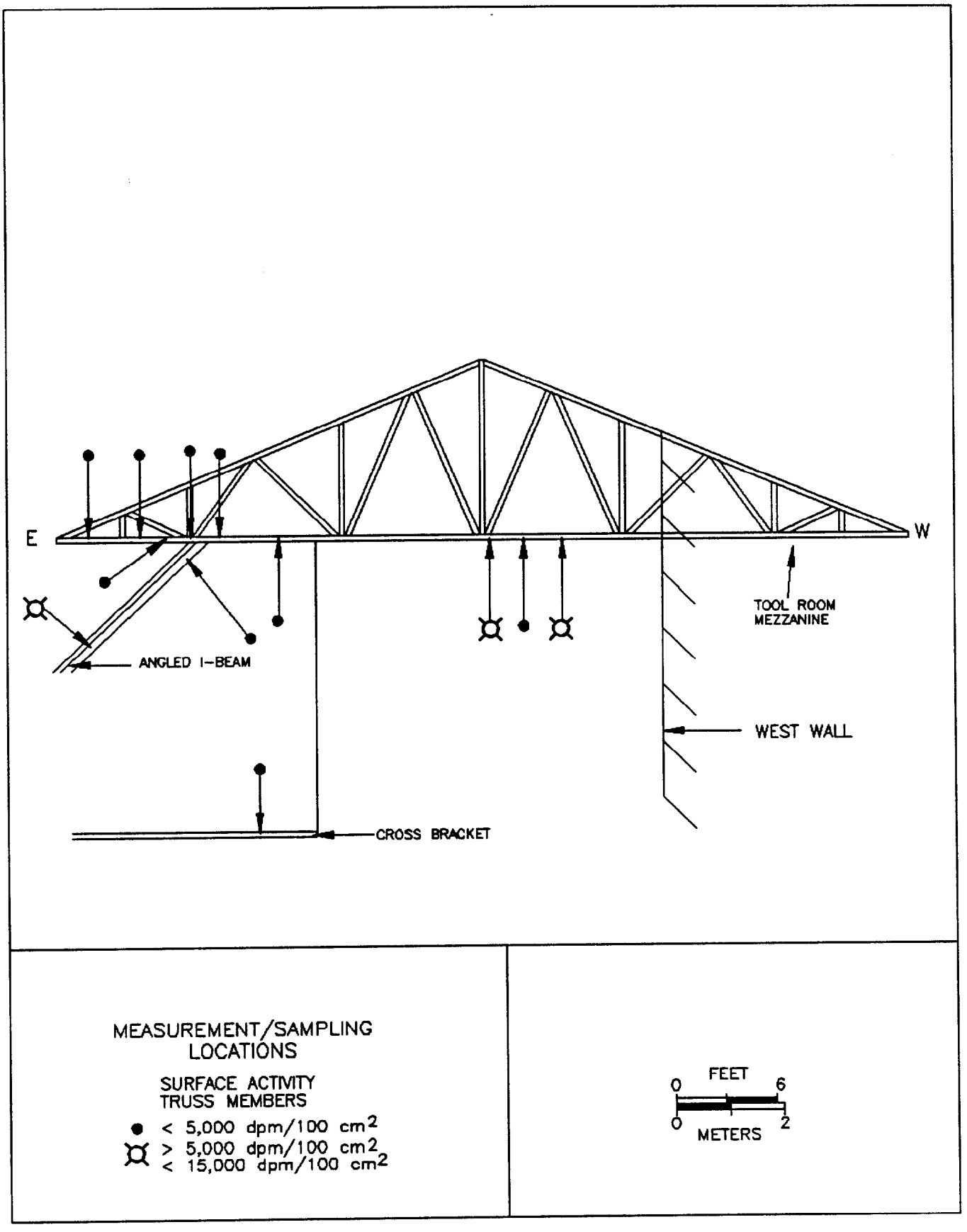


FIGURE 27: Building 8, Truss 3 – Measurement and Sampling Locations

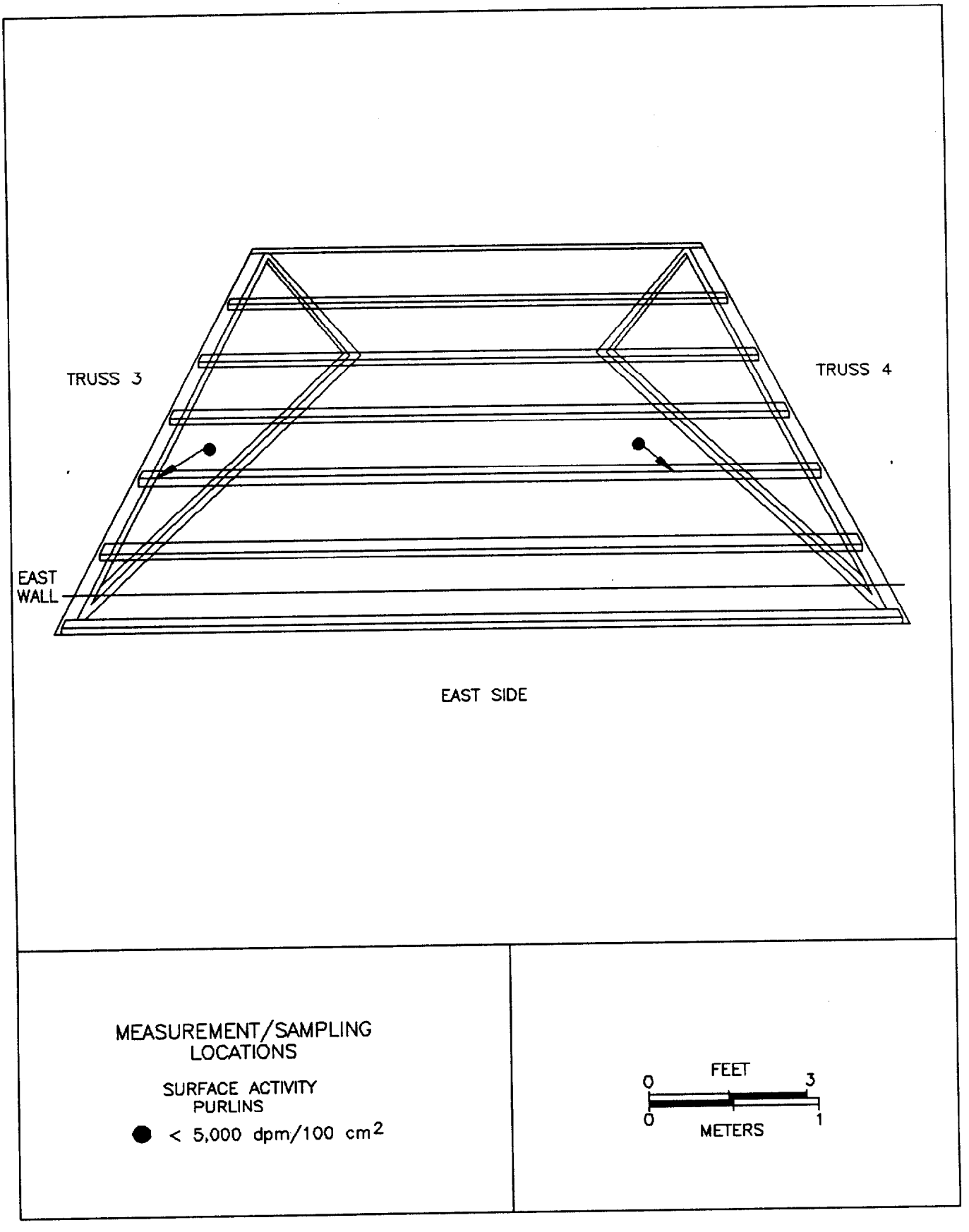


FIGURE 28: Building 8, Bay 3, East – Measurement and Sampling Locations

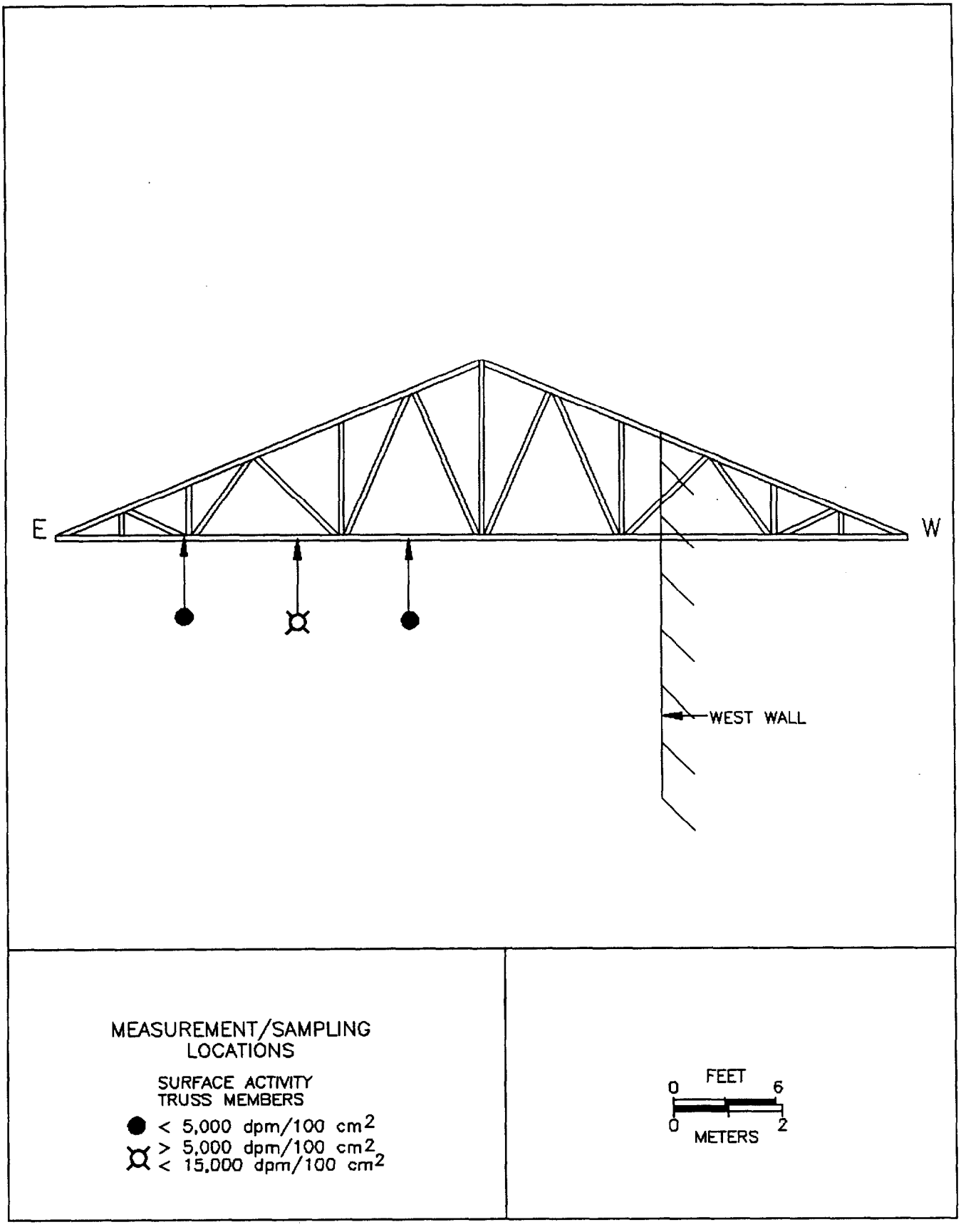


FIGURE 29: Building 8, Truss 4 – Measurement and Sampling Locations

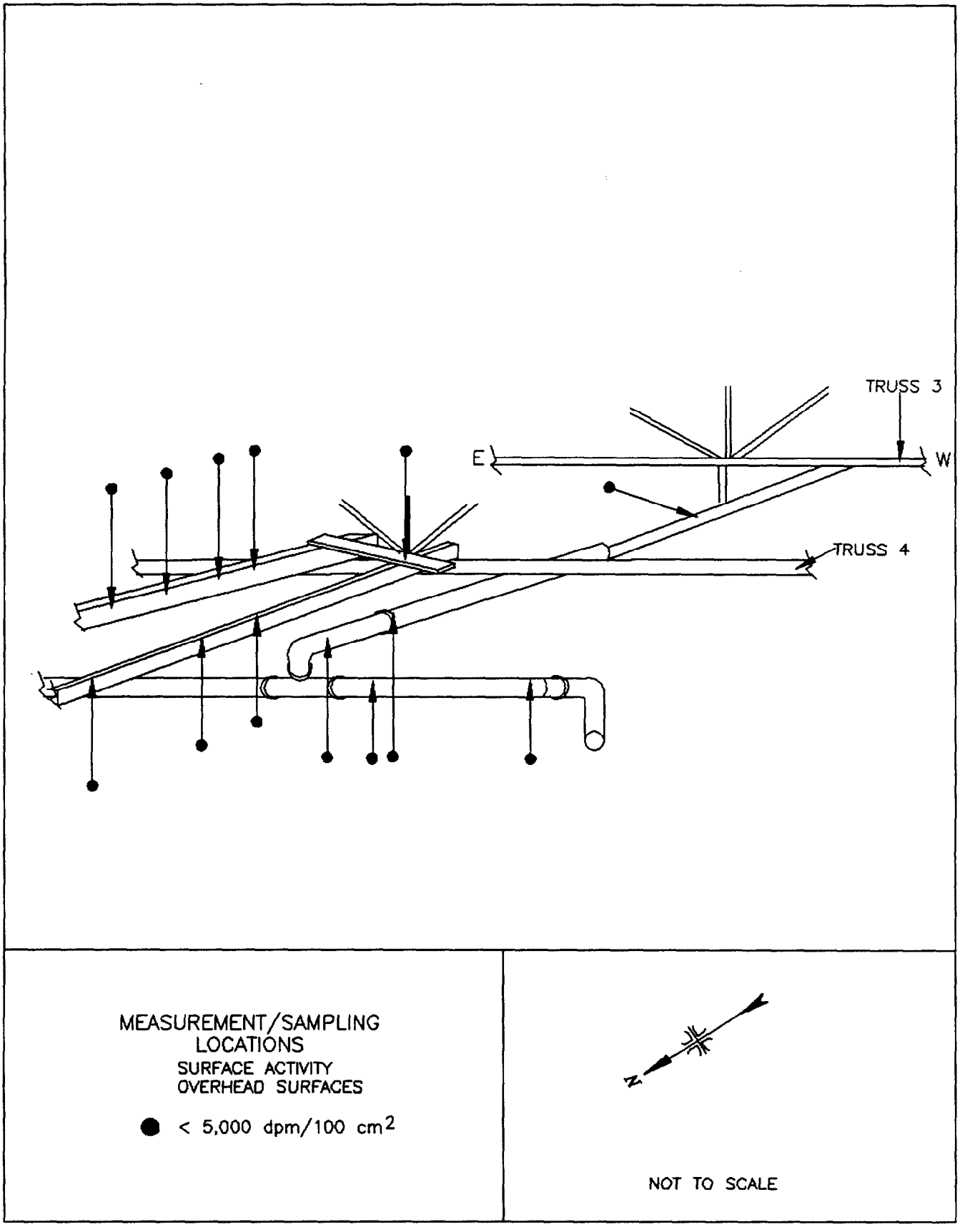
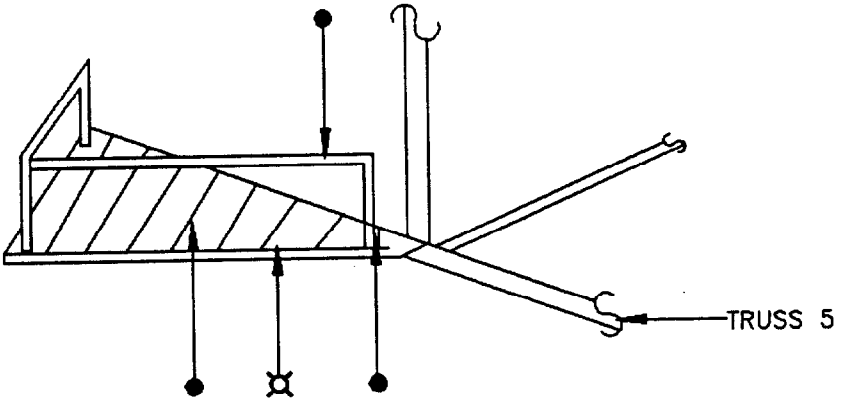


FIGURE 30: Building 8, Overheads, Bay 4 – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

SURFACE ACTIVITY PLATFORM

● < 5,000 dpm/100 cm^2

⌑ > 5,000 dpm/100 cm^2
< 15,000 dpm/100 cm^2

N

NOT TO SCALE

FIGURE 31: Building 8, Truss 5 Platform – Measurement and Sampling Locations

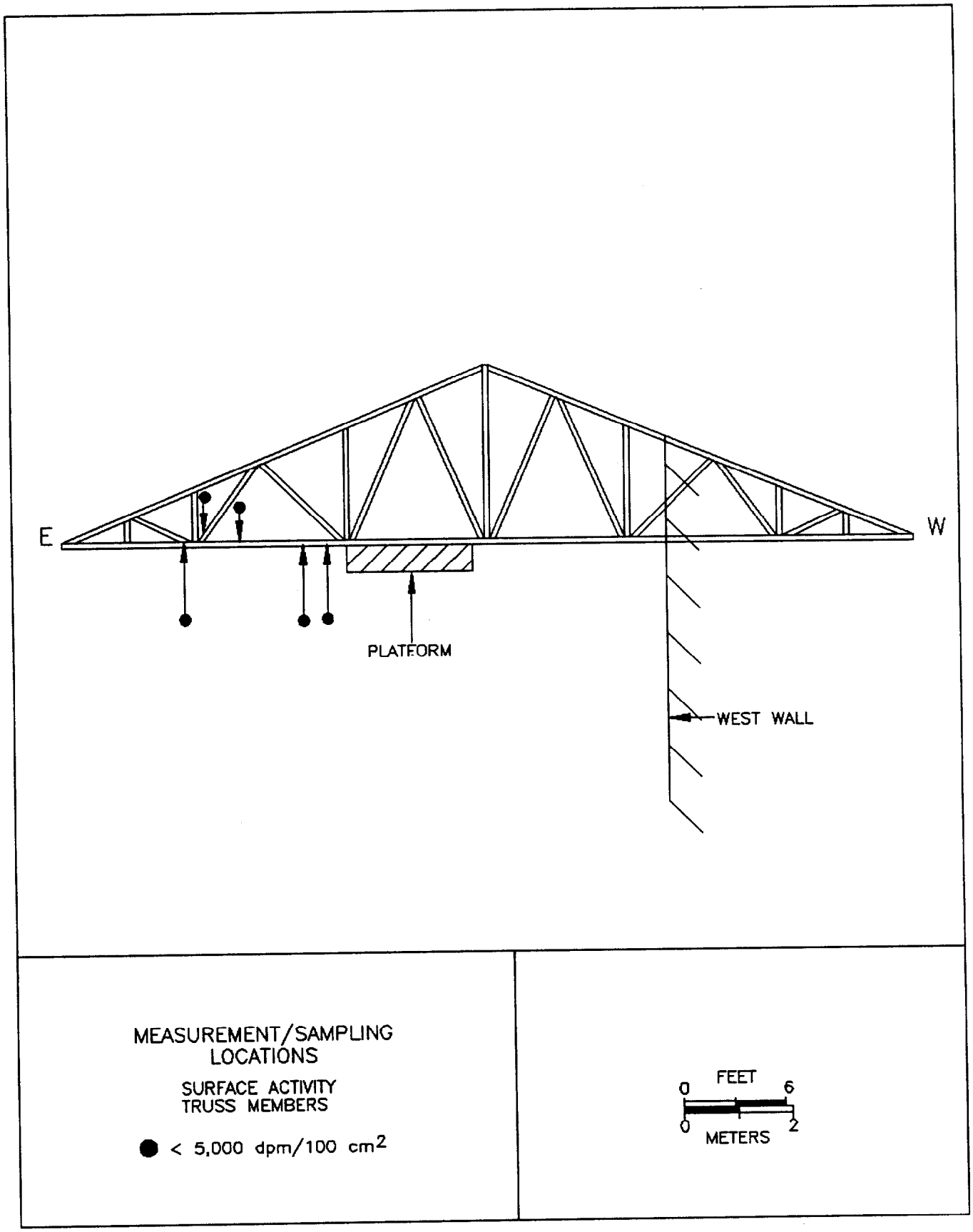
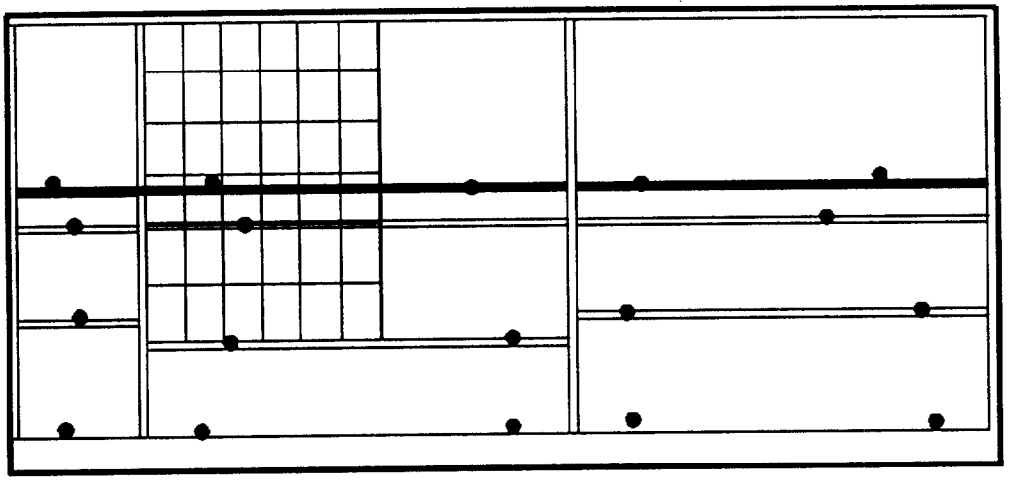


FIGURE 32: Building 8, Truss 5 – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

SURFACE ACTIVITY
WALL SURFACES

● < 5,000 dpm/100 cm^2

N

FEET
0 6

0 2
METERS

FIGURE 33: Building 8, Room B, East Wall – Measurement and Sampling Locations

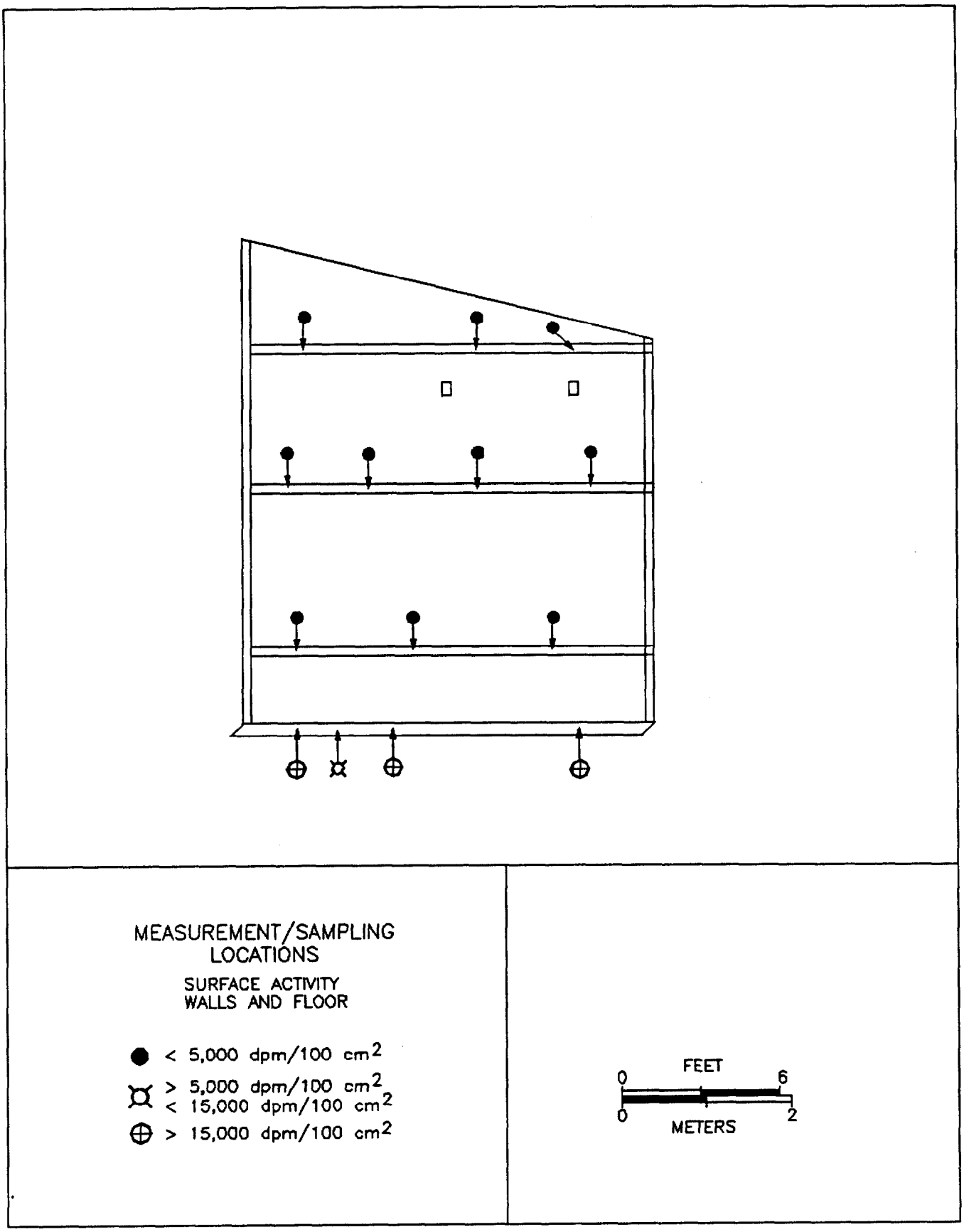


FIGURE 34: Building 8, Room B, North Wall – Measurement and Sampling Locations

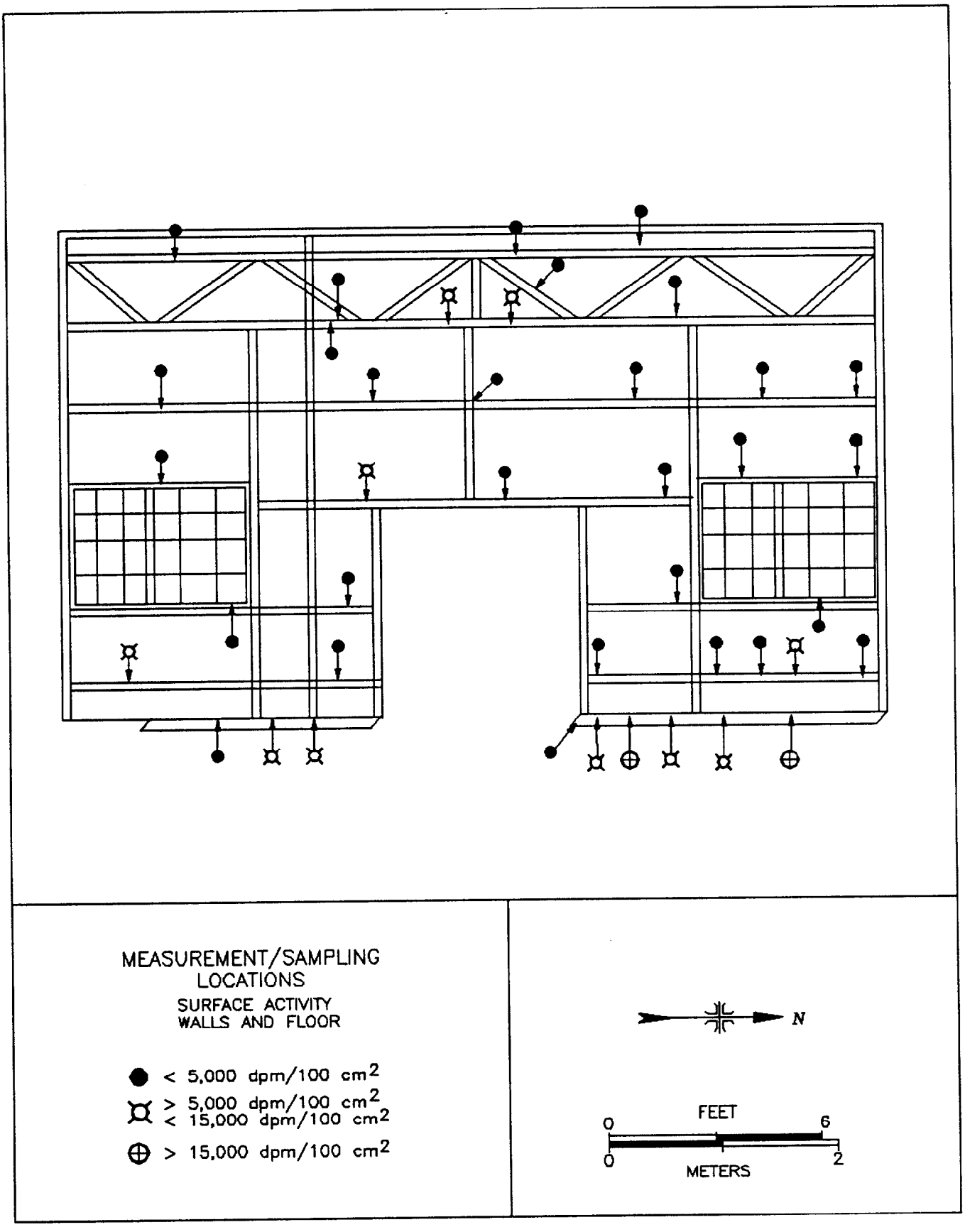


FIGURE 35: Building 8, Room B, West Wall – Measurement and Sampling Locations

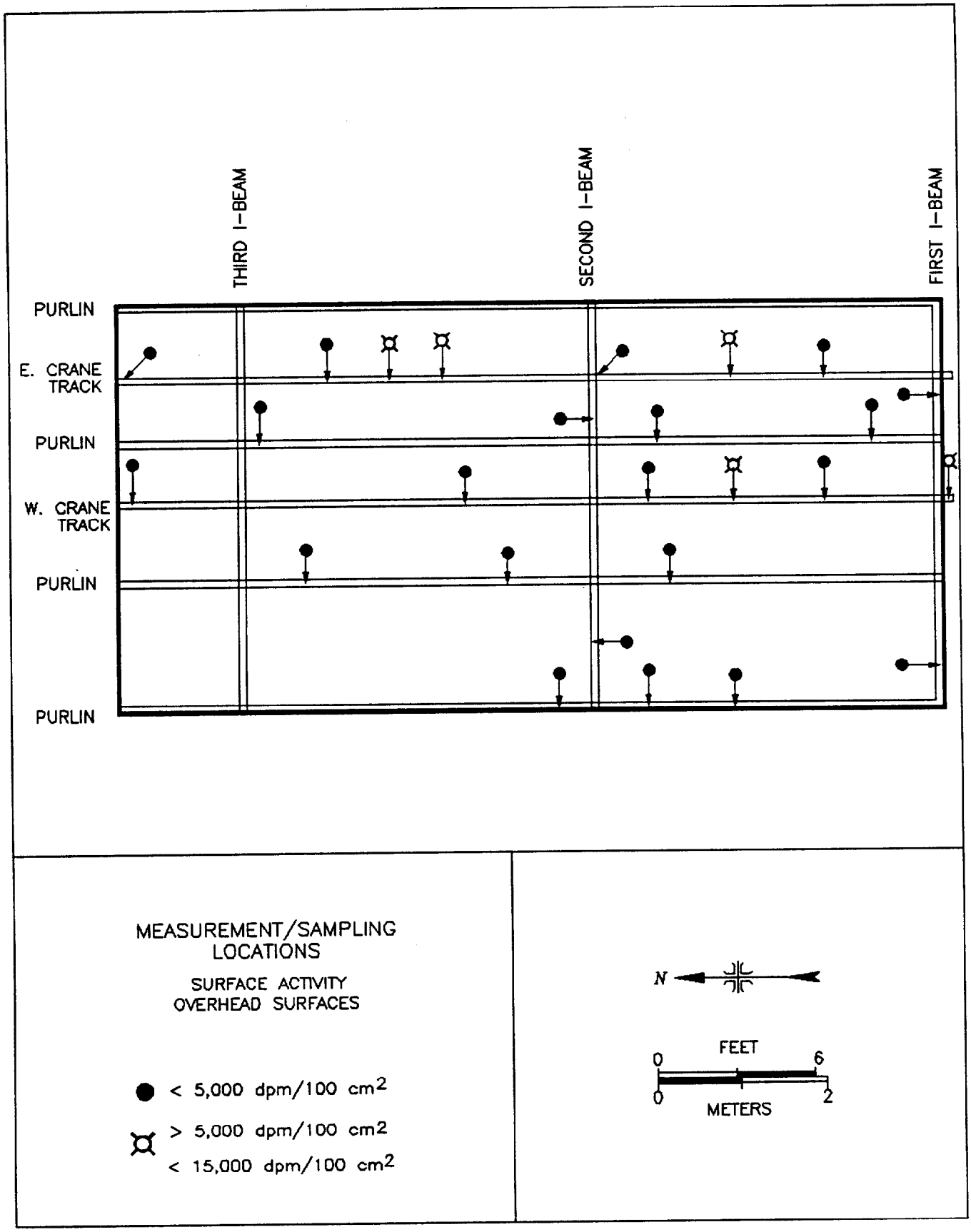


FIGURE 36: Building 8, Room B, Overheads – Measurement and Sampling Locations

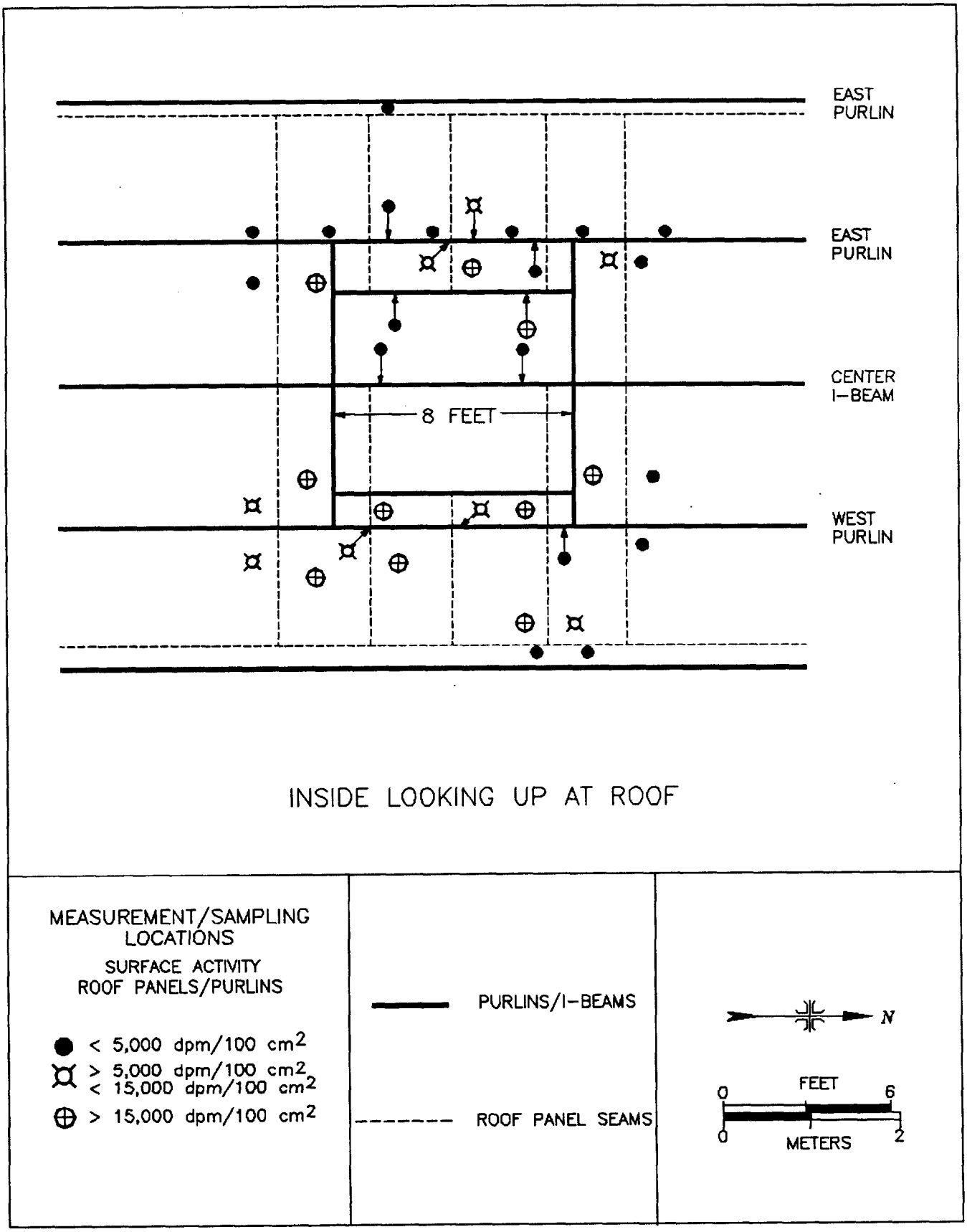
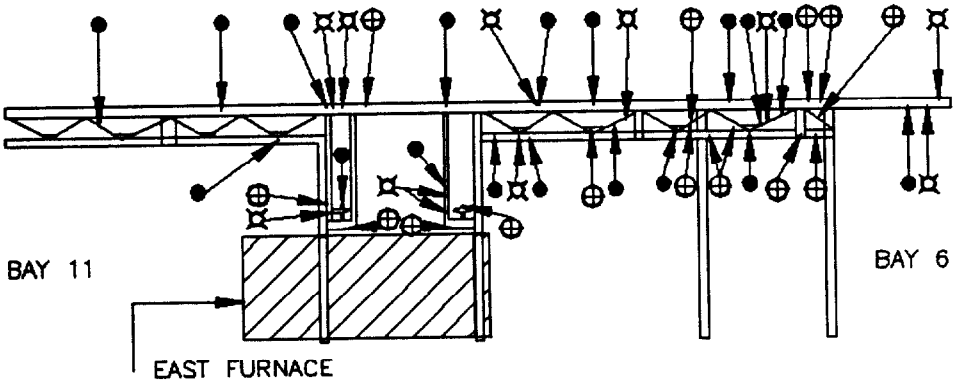


FIGURE 37: Building 3, North Turret Penetration – Measurement and Sampling Locations



MEASUREMENT/SAMPLING LOCATIONS

SURFACE ACTIVITY SUPERSTRUCTURE

- ● < 5,000 dpm/100 cm^2
- ⌘ > 5,000 dpm/100 cm^2 < 15,000 dpm/100 cm^2
- ⊕ > 15,000 dpm/100 cm^2

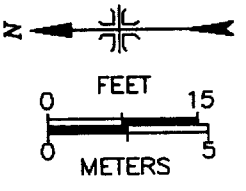


FIGURE 38: Building 3, Superstructure – Measurement and Sampling Locations

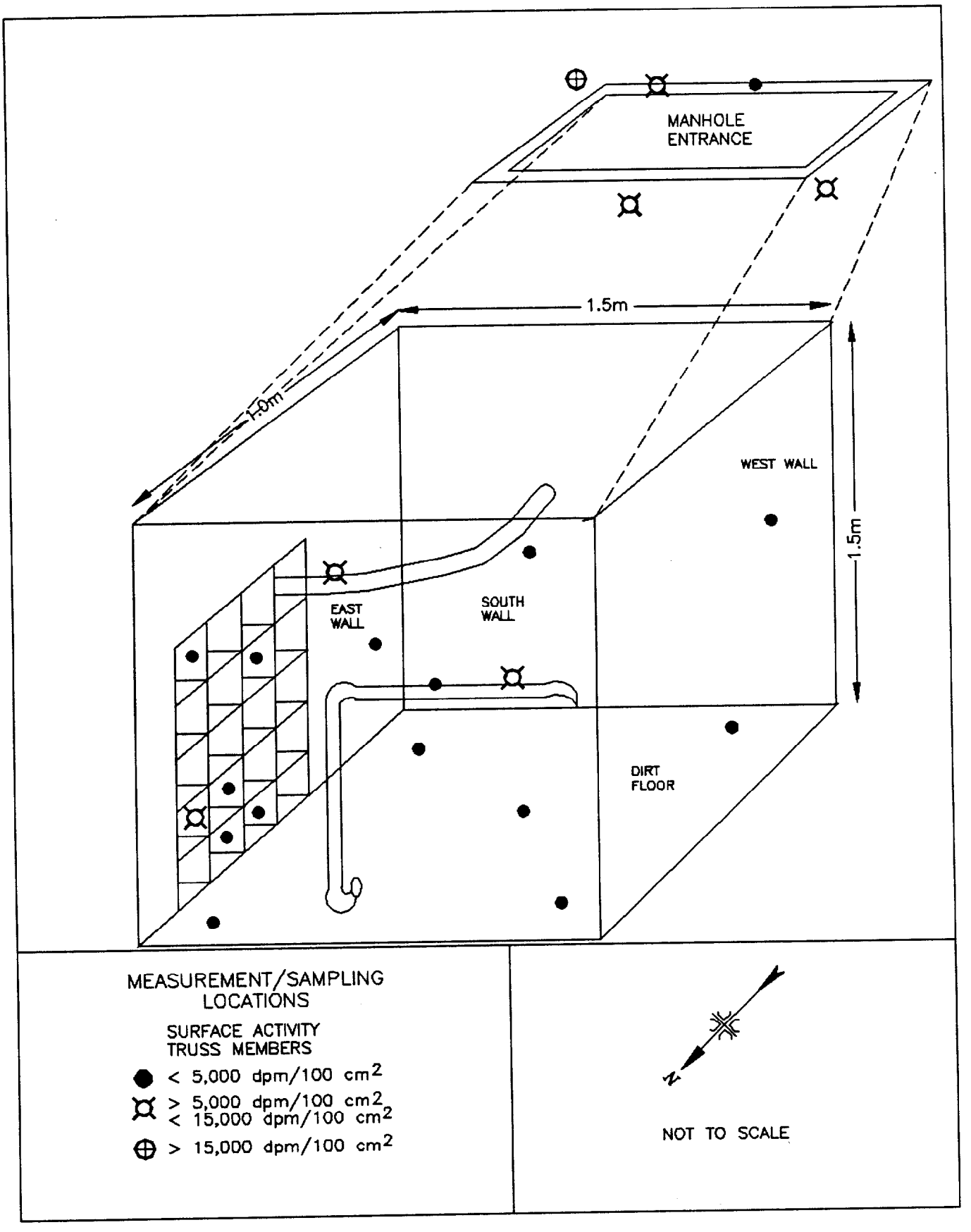


FIGURE 39: Building 3, Pipe Chase Manhole – Measurement and Sampling Locations

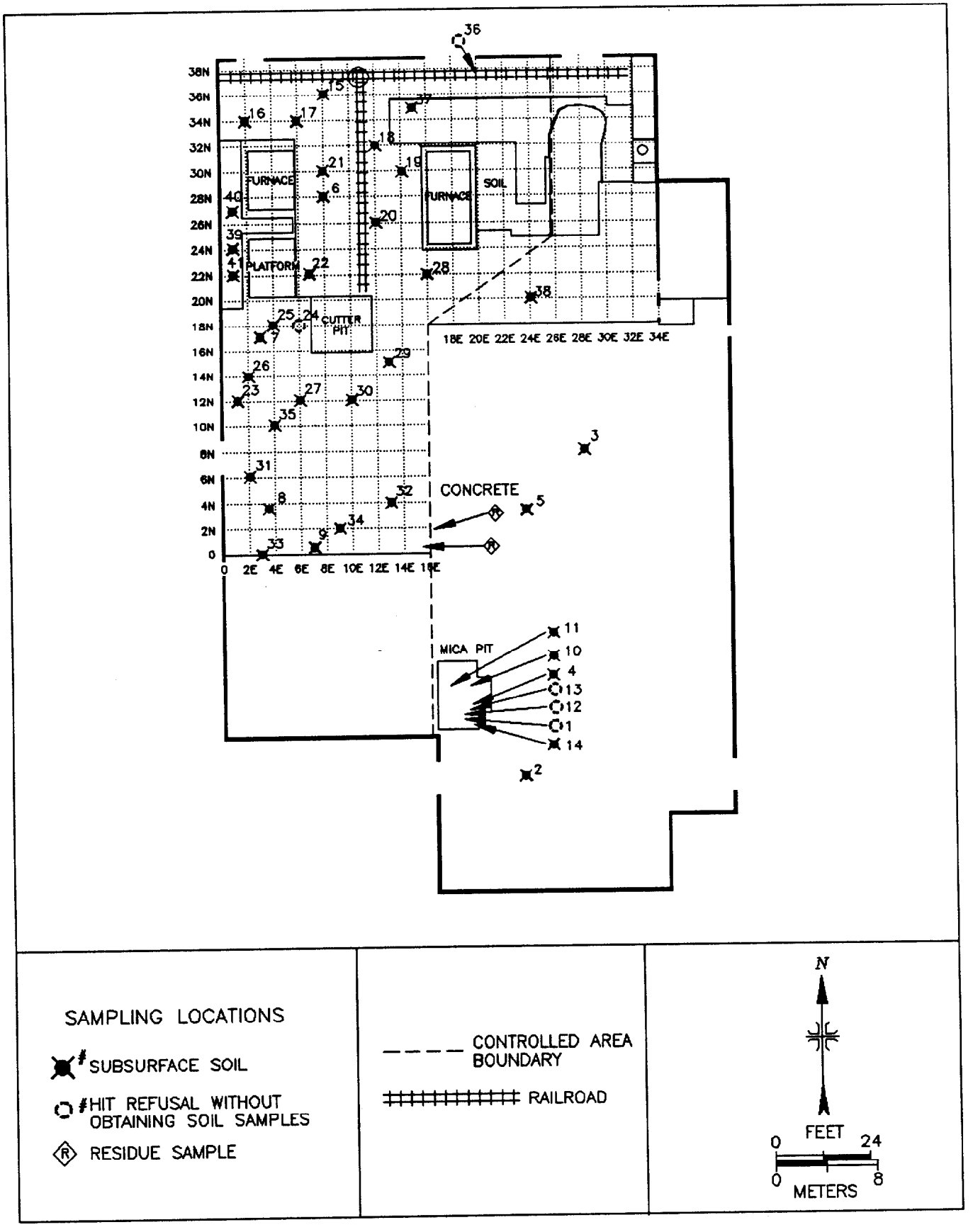


FIGURE 40: Building 3 – Sampling Locations

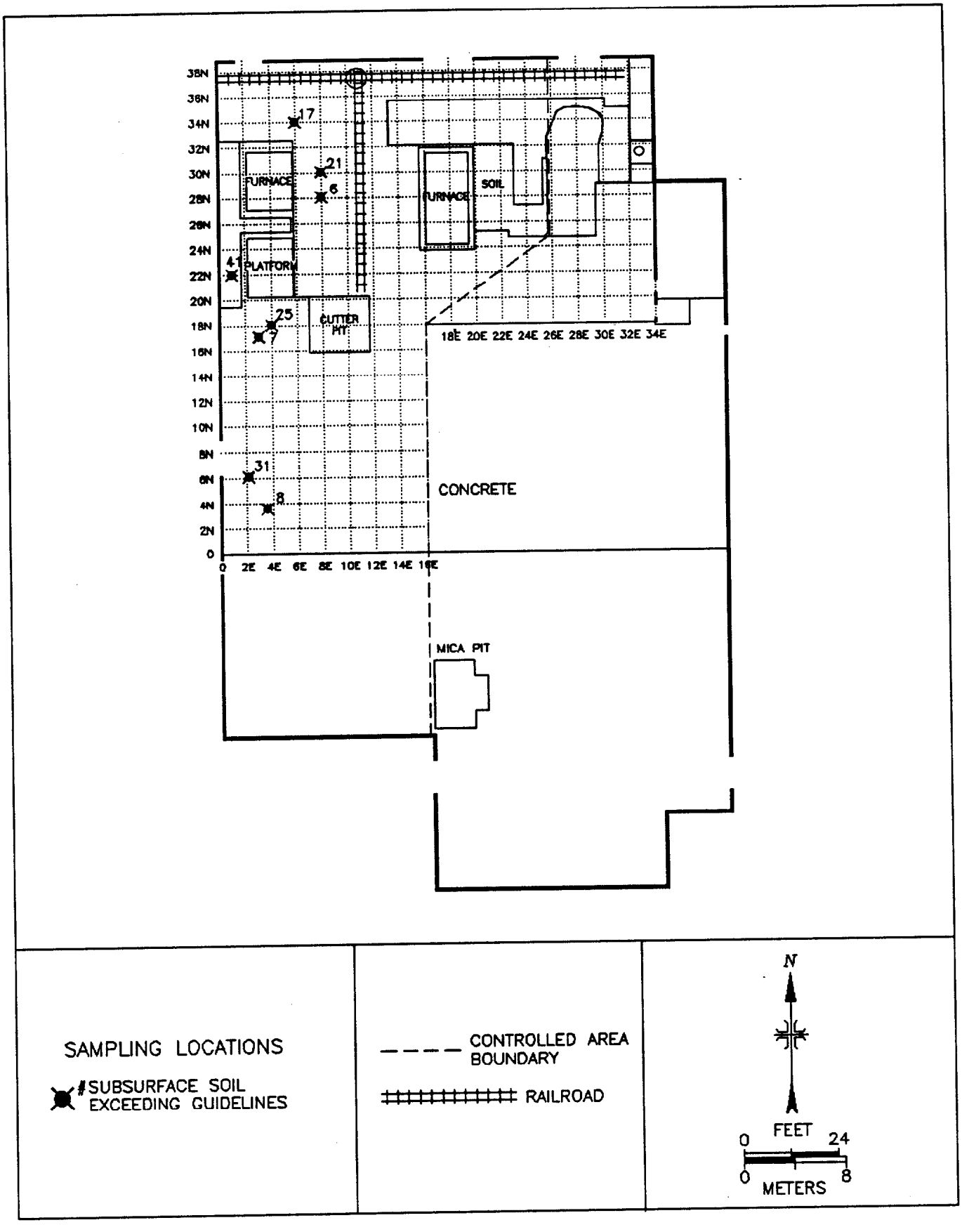


FIGURE 41: Building 3, Floor – Subfloor Soil Locations Exceeding Guidelines

TABLE 1

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

Location	Figure(s)	Number of Measurement Locations[a]		Range of Total Beta Activity (dpm/100 cm²)		Range of Removable Activity (dpm/100 cm²)	
		Single-Point	Grid Block	Individual Measurement	Grid Block Average	Alpha	Beta
INTERIOR							
Basement	5	44	N/A	<1,200-5,000	N/A	<12	<16
Tool Room	7	32	N/A	<1,200-5,000	N/A	<12	<16
Air Compressors	8	28	N/A	<1,200-3,000	N/A	<12	<16
Pits North of Compressors	9,10	9	N/A	<1,400-1,700	N/A	<12	<16
Mezzanine	11,12	3	N/A	<1,200	N/A	<12	<16
Scrap Equipment	N/A	36	N/A	<1,400-3,800	N/A	<12	<16
Bldg. 8, Trusses/Purlins	20-32	66	N/A	<1,300-4,900	N/A	<12	<16
Bldg. 8, Room B	33-36	78	N/A	<1,300-4,900	N/A	<12	<16
North Turret Penetration	37	19	N/A	<1,300-4,600	N/A	<12	<16
Bldg. 3 Superstructure	38	18	N/A	<1,300-4,600	N/A	<12	<16
Pipe Chase Manhole	39	15	N/A	<1,300-5,000	N/A	N/A	N/A
Roof Drain at Floor Level	40	2	N/A	<1,200-2,400	N/A	N/A	N/A

TABLE 1 (Continued)

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

Location	Figure(s)	Number of Measurement Locations[a]		Range of Total Beta Activity (dpm/100 cm²)		Range of Removable Activity (dpm/100 cm²)	
		Single-Point	Grid Block	Individual Measurement	Grid Block Average	Alpha	Beta
EXTERIOR							
Roof Vents	13,14	12	N/A[b]	<1,200-3,000	N/A	<12	<16
Turrets	N/A	1	N/A	<1,500	N/A	<12	<16
Roof Penetrations	15	15	N/A	<1,200	N/A	<12	<16
Roof Surface/Gutter	16,17	15[c]	N/A	<1,500-4,300	N/A	<12	<16
Pipe Penetrations	18	12	N/A	<1,200-1,600	N/A	<12	<16
Outside Drain Line	N/A	4	N/A	<1,200	N/A	<12	<16
Cooling Tower	19	7	N/A	<1,400	N/A	<12	<16
Ventilation Fan, Bldg. 8 North Wall	N/A	3	N/A	<1,500-1,800	N/A	N/A	N/A

[a]Measurement locations exceeding guidelines are not included in this table.
[b]Not Applicable.
[c]Two measurements on Building 8 roof not shown in Figures.

TABLE 2

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS EXCEEDING 5,000 dpm/100 cm^2 BUILDINGS 3 AND 8 ALIQUIPPA FORGE WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure(s)	Number of Measurement Locations[a]		Range of Total Beta Activity (dpm/100 cm^2)		Range of Removable Activity (dpm/100 cm^2)	
		Single-Point	Grid Block	Individual Measurement	Grid Block Average	Alpha	Beta
INTERIOR							
Basement	5	3	N/A	6,000-8,000	N/A	<12	<16
Tool Room	7	17	7	6,100-60,000	5,400-12,000	<12	<16
Air Compressors	8	3	N/A	5,100-9,700	N/A	<12	<16
Mezzanine	11,12	7	6	5,900-34,000	6,600-20,000	<12	<16-21
Scrap Equipment	N/A	2	N/A	6,500-13,000	N/A	<12	17
Bldg. 8 Trusses/Purlins	20-32	35	N/A	5,100-39,000	N/A	<12-19	<16-31
Bldg.8, Room B	33-36	21	N/A	5,400-44,000	N/A	≤12	<16
North Turret Penetration	37	18	N/A	5,300-180,000	N/A	<12-21	<16-18
Bldg. 3 Superstructure	38	27	N/A	5,900-260,000	N/A	<12-73	<16-76
Pipe Chase Manhole	39	7	N/A	5,100-22,000	N/A	N/A	N/A

TABLE 2 (Continued)

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
EXCEEDING 5,000 dpm/100 cm^2
BUILDINGS 3 AND 8
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure(s)	Number of Measurement Locations[a]		Range of Total Beta Activity (dpm/100 cm^2)		Range of Removable Activity (dpm/100 cm^2)	
		Single-Point	Grid Block	Individual Measurement	Grid Block Average	Alpha	Beta
EXTERIOR							
Roof Vents	13,14	3	N/A[b]	7,200-29,000	N/A	< 12	< 16
Turrets	N/A	9	N/A	23,000-150,000	N/A	< 12	< 16
Pipe Penetrations	18	1	N/A	5,600	N/A	< 12	< 16

[a]Measurement locations meeting guidelines are not included in this table.
[b]Not Applicable.

TABLE 3

URANIUM CONCENTRATIONS IN MISCELLANEOUS SAMPLES
BUILDINGS 3 AND 8
ALIQUIPPA FORGE
WEST ALIQUIPPA, PENNSYLVANIA

Location	Figure	Uranium Concentration (pCi/g)[a]		
		U-235	U-238	Total Uranium[b]
INTERIOR				
Air Compressor Base	8	7.2 ± 0.5	127.1 ± 8.7	260
E. Air Compressor Pit	8	2.6 ± 0.7	62 ± 13	130
W. Air Compressor Pit	8	0.5 ± 0.1	9.4 ± 2.1	19
Overhead Beam, Mezzanine	12	32.5 ± 1.1	740 ± 22	1500
Overhead Beam, Vent #3	13	80.5 ± 1.5	1300 ± 23	2700
Bldg. 8, Truss 1	20	4.2 ± 0.7	65 ± 13	130
Bldg. 3, Roof Drain 0.4N, 15.8E (Floor Level)	40	0.3 ± 0.1	2.6 ± 0.8	5.5
Bldg. 3, 2N, 16.5E	40	0.4 ± 0.1	6.2 ± 1.4	13
EXTERIOR				
Roof Penetration #1	15	0.1 ± 0.1	2.0 ± 1.5	4.1
Roof Penetration #2	15	0.4 ± 0.2	2.2 ± 2.0	4.8
Roof Penetration #3	15	0.3 ± 0.1	5.5 ± 2.4	11
Roof Penetration #4	15	0.3 ± 0.2	2.3 ± 1.4	4.9
Roof Penetration #5	15	0.2 ± 0.1	1.7 ± 1.4	3.6
East Roof, N. Gutter	17	0.1 ± 0.1	1.2 ± 0.9	2.5
East Roof, S. Gutter	17	0.1 ± 0.1	0.9 ± 1.3	1.9
Pipe Penetration #6	18	4.7 ± 0.4	78.8 ± 7.0	160
Bldg. 8, West Roof Gutter	N/A	0.5 ± 0.2	5.1 ± 3.5	11
Bldg. 3, Outside Drainline	N/A	0.3 ± 0.1	3.7 ± 2.2	7.7
Water Basin Sediment	N/A	0.2 ± 0.1	1.3 ± 1.3	2.8
Cooling Tower Sediment	N/A	0.1 ± 0.1	0.2 ± 0.4	0.5
Driveway, West of Bldg. 3	N/A	0.2 ± 0.1	1.8 ± 1.1	3.8

[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 SUBFLOOR SOIL SAMPLES 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	Refusal	---	---	---
2	15 - 30	0.3 ± 0.1	2.5 ± 1.0	5.3
	30 - 35	0.4 ± 0.1	3.6 ± 1.3	7.6
3	11 - 30	0.1 ± 0.1	1.5 ± 1.3	3.1
	30 - 55	0.1 ± 0.1	1.7 ± 0.7	3.5
	55 - 75	0.1 ± 0.1	1.1 ± 0.9	2.3
	75 - 95	0.1 ± 0.1	1.8 ± 1.2	3.7
4	19 - 28	0.3 ± 0.1	3.6 ± 1.1	7.5
	28 - 39	0.1 ± 0.1	2.9 ± 1.3	5.9
	39 - 63	0.1 ± 0.1	1.9 ± 0.8	3.9
	63 - 86	0.1 ± 0.1	1.1 ± 0.9	2.3
	86 - 109	0.2 ± 0.1	1.5 ± 1.2	3.2
5	15 - 25	0.2 ± 0.1	2.2 ± 1.1	4.6
6	15 - 25	3.7 ± 0.2	60.8 ± 3.2	130
7	20 - 40	31.3 ± 0.5	352.9 ± 5.8	740
	40 - 70	1.5 ± 0.2	24.8 ± 2.6	51
8	28 - 35	7.2 ± 0.2	60.7 ± 2.3	130
	35 - 60	7.9 ± 0.2	86.0 ± 2.9	180
	60 - 85	14.1 ± 0.4	197.7 ± 5.4	410
	85 - 90	6.4 ± 0.5	81.5 ± 7.1	170
9	20 - 50	1.2 ± 0.1	11.1 ± 1.0	23
	50 - 70	1.1 ± 0.1	10.0 ± 1.3	21
10	19 - 27	0.2 ± 0.1	2.7 ± 1.0	5.6
11	16 - 22	1.3 ± 0.1	18.0 ± 2.9	37
	28 - 52	0.4 ± 0.1	5.1 ± 1.3	11
12	Refusal	---	---	---
13	Refusal	---	---	---

TABLE 4 (Continued)

URANIUM CONCENTRATIONS IN SUBFLOOR SOIL SAMPLES
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]
14	23 - 46	0.1 ± 0.1	1.3 ± 1.2	2.7
	46 - 74	0.1 ± 0.1	1.7 ± 1.1	3.5
15	20 - 32	0.3 ± 0.1	3.2 ± 1.6	6.7
16	20 - 38	0.5 ± 0.1	5.2 ± 1.1	11
	38 - 51	0.2 ± 0.1	1.6 ± 1.0	3.4
	51 - 71	0.2 ± 0.1	2.4 ± 1.7	5.0
17	20 - 31	27.5 ± 0.6	425.9 ± 7.9	880
	31 - 41	6.1 ± 0.3	99.5 ± 5.2	210
	41 - 43	4.8 ± 0.2	86.8 ± 4.5	180
18	14 - 30	0.3 ± 0.1	2.0 ± 1.2	4.3
	30 - 47	0.1 ± 0.1	2.2 ± 0.7	4.5
	47 - 65	0.2 ± 0.1	2.3 ± 1.5	4.8
19	17 - 36	0.2 ± 0.1	1.8 ± 1.2	3.8
	36 - 61	0.2 ± 0.1	1.4 ± 1.3	3.0
20	18 - 31	0.5 ± 0.1	6.9 ± 1.4	14
	31 - 42	0.4 ± 0.1	5.3 ± 1.6	11
	42 - 55	0.2 ± 0.1	2.1 ± 1.5	4.4
21	16 - 29	7.7 ± 0.3	132.7 ± 4.7	270
	29 - 34	2.3 ± 0.2	42.0 ± 3.9	87
22	17 - 31	0.2 ± 0.1	1.4 ± 1.0	3.0
	31 - 42	0.3 ± 0.1	1.6 ± 1.0	3.5
	42 - 53	0.1 ± 0.1	1.9 ± 0.6	3.9
23	15 - 27	1.8 ± 0.2	32.5 ± 3.2	67
	27 - 37	0.4 ± 0.1	5.2 ± 2.2	11
24	Refusal	---	---	---

TABLE 4 (Continued)

URANIUM CONCENTRATIONS IN SUBFLOOR SOIL SAMPLES
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]
25	16 - 24	3.6 ± 0.2	48.8 ± 2.5	100
	24 - 33	2.3 ± 0.1	29.7 ± 2.4	62
	33 - 38	2.4 ± 0.1	30.0 ± 2.0	62
26	17 - 26	2.8 ± 0.2	46.5 ± 2.7	96
	26 - 37	0.8 ± 0.2	11.9 ± 1.7	25
	37 - 46	0.6 ± 0.1	5.7 ± 2.1	12
	46 - 62	0.4 ± 0.1	3.0 ± 1.7	6.4
27	14 - 30	3.0 ± 0.2	33.5 ± 2.0	70
	30 - 40	0.5 ± 0.2	7.2 ± 2.3	15
	40 - 43	0.2 ± 0.1	1.6 ± 0.8	3.4
28	15 - 29	0.1 ± 0.1	1.6 ± 1.0	3.3
	29 - 40	0.1 ± 0.1	1.5 ± 1.0	3.1
	40 - 56	0.1 ± 0.1	2.1 ± 1.1	4.3
29	17 - 30	1.2 ± 0.1	20.6 ± 2.4	42
	30 - 40	0.3 ± 0.1	2.9 ± 1.5	6.1
	40 - 48	0.3 ± 0.1	3.2 ± 1.5	6.7
30	19 - 30	0.5 ± 0.1	7.6 ± 1.5	16
	30 - 40	0.1 ± 0.1	<1.2	<2.5
	40 - 47	0.3 ± 0.1	2.9 ± 0.9	6.1
31	12 - 25	0.4 ± 0.1	3.6 ± 1.3	7.6
	25 - 35	5.4 ± 0.2	91.2 ± 3.6	190
	35 - 48	0.1 ± 0.1	1.1 ± 0.7	2.3
32	20 - 32	1.7 ± 0.1	17.3 ± 1.5	36
	32 - 41	1.7 ± 0.1	28.6 ± 2.3	59
	41 - 54	1.1 ± 0.1	15.2 ± 2.1	32

TABLE 4 (Continued)

URANIUM CONCENTRATIONS IN SUBFLOOR SOIL SAMPLES
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]
33	21 - 41	1.3 ± 0.1	15.8 ± 1.6	33
	41 - 59	2.0 ± 0.2	34.4 ± 3.1	71
34	17 - 33	1.4 ± 0.1	16.6 ± 1.5	35
	33 - 45	0.2 ± 0.1	2.6 ± 1.4	5.4
	45 - 61	0.3 ± 0.1	1.0 ± 0.8	2.3
35	20 - 36	1.2 ± 0.1	19.2 ± 1.7	40
	36 - 44	0.3 ± 0.1	4.1 ± 1.6	8.5
	44 - 56	0.3 ± 0.1	3.8 ± 1.2	7.9
36	Refusal	---	---	---
37	17 - 25	0.1 ± 0.1	1.4 ± 0.8	2.9
	25 - 39	0.1 ± 0.1	0.9 ± 0.5	1.9
38	18 - 35	0.1 ± 0.1	2.0 ± 1.0	4.1
	35 - 49	0.2 ± 0.1	1.8 ± 1.4	3.8
	49 - 68	0.1 ± 0.1	1.3 ± 1.0	2.7
39	0 - 10	0.3 ± 0.1	4.2 ± 1.2	8.7
	10 - 22	0.1 ± 0.1	0.6 ± 0.3	1.3
40	0 - 9	1.2 ± 0.1	19.5 ± 1.9	40
	9 - 17	0.3 ± 0.1	2.9 ± 0.6	6.1
41	0 - 8	40.8 ± 0.6	462.5 ± 7.2	970

[a]Refer to Figure 40.
[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. "Characterization Survey of Portions of the Aliquippa Forge Site, West Aliquippa, Pennsylvania," Environmental Survey and Site Assessment Program, Oak Ridge Institute for Science and Education, December 1992.

4. Oak Ridge Institute for Science and Education, letter from E.W. Abelquist to W.A. Williams, Designation and Certification Manager, U.S. DOE, "Additional Contaminated Areas/Items at the Aliquippa Forge Site," July 29, 1993.

5. Oak Ridge Institute for Science and Education, letter from E.W. Abelquist to W.A. Williams, Designation and Certification Manager, U.S. DOE, "Additional Contaminated Areas/Items at the Aliquippa Forge Site," August 20, 1993.

6. Oak Ridge Institute for Science and Education, letter from E.W. Abelquist to W.A. Williams, Designation and Certification Manager, U.S. DOE, "Additional Contaminated Areas at the Aliquippa Forge Site," September 10, 1993.

7. Oak Ridge Institute for Science and Education, letter from E.W. Abelquist to W.A. Williams, Designation and Certification Manager, U.S. DOE, "Additional Contaminated Areas at the Aliquippa Forge Site," September 24, 1993.

8. "Radiological Survey Plan for Additional Characterization at the Aliquippa Forge Site, West Aliquippa, Pennsylvania," Environmental Survey and Site Assessment Program, Oak Ridge Institute for Science and Education, July 1, 1993.

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

10. DOE Memorandum from J. Wagoner to W. Seay, "Uranium Guidelines for the Aliquippa, Pennsylvania, Site," April 2, 1993.

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)

Detectors (Continued)

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 and Ion Implanted Detectors
(Canberra, Meriden, CT and
Tennelec, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High Purity Extended Range Intrinsic Detectors
Model No: ERVDS30-25195
(Tennelec, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-11
(Nuclear Lead, Oak Ridge, TN) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

High-Purity Germanium Detector
Model GMX-23195-S, 23% Eff.
(EG&G ORTEC, Oak Ridge, TN)
Used in conjunction with:
Lead Shield Model G-16
(Gamma Products, Palos Hills, IL) and
Multichannel Analyzer
3100 Vax Workstation
(Canberra, Meriden, CT)

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-W
(Oxford, Oak Ridge, TN)

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

APPENDIX B

SURVEY AND ANALYTICAL PROCEDURES

SURVEY PROCEDURES

Surface Scans

Surface scans were performed by passing the probes slowly over the surface; the distance between the probe and the surface was maintained at a minimum—nominally about 1 cm. A large surface area, gas proportional floor monitor was used to scan the Tool Room and Basement floors and the outside driveway. Other surfaces were scanned using small area (15.5 cm^2) hand-held detectors. Identification of elevated levels was based on increases in the audible signal from the recording and/or indicating instrument. Combinations of detectors and instruments used for the scans were:

Alpha	—	gas proportional detector with ratemeter-scaler
Beta	—	gas proportional detector with ratemeter-scaler
Beta	—	GM detector with ratemeter-scaler
Gamma	—	NaI scintillation detector with ratemeter

Surface Activity Measurements

Measurements for total beta activity levels were performed 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 4π 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 0.15-0.18 for the GM detectors. The effective probe area 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.

Miscellaneous Sampling

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.

Residue Sampling

Residue (e.g., dust, dirt, etc.) was collected at each sample location. Collected samples were placed in a plastic bag, sealed, and labeled in accordance with ESSAP survey procedures.

Sediment Sampling

Approximately 1 kg of sediment was collected at each sample location. Collected samples were placed in a plastic container, 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.

Miscellaneous Samples

Samples of soil, residue and sediment were dried, mixed, crushed, and/or homogenized as necessary, and a portion sealed in a 0.5-liter Marinelli beaker or other appropriate container. The quantity placed in the beaker was chosen to reproduce the calibrated counting geometry. Net material weights were determined and the samples counted using intrinsic germanium detectors coupled to a pulse height analyzer system. Background and Compton stripping, peak search, peak identification, and concentration calculations were performed using the computer capabilities inherent in the analyzer system. Energy peaks used for determination of radionuclides of concern were:

U-235	0.186 MeV
U-238	0.063 MeV or 0.093 MeV from Th-234*

*Secular equilibrium assumed.
Spectra were also reviewed for other identifiable photopeaks.

UNCERTAINTIES AND DETECTION LIMITS

The uncertainties associated with the analytical data presented in the tables of this report represent the 95% confidence level for that data. These uncertainties were calculated based on both the gross sample count levels and the associated background count levels. Additional uncertainties, associated with sampling and measurement procedures, have not been propagated into the data presented in this report.

Detection limits, referred to as minimum detectable activity (MDA), were based on 2.71 plus 4.66 times the standard deviation of the background count: $2.71+(4.66\sqrt{BKG})$. When the activity was determined to be less than the MDA of the measurement procedure, the result was reported as less than MDA. Because of variations in background levels, measurement efficiencies, the detection limits differ from sample to sample and instrument to instrument.

CALIBRATION AND QUALITY ASSURANCE

Analytical and field survey activities were conducted in accordance with procedures from the following documents of the Environmental Survey and Site Assessment Program:

- Survey Procedures Manual, Revisions 7 and 7.1 (May 1992 and September 1993)
- Laboratory Procedures Manual, Revision 8 (August 1993)
- Quality Assurance Manual, Revision 6 (July 1993)

The procedures contained in these manuals were developed to meet the requirements of DOE Order 5700.6C and ASME NQA-1 for Quality Assurance and contain measures to assess processes during their performance.

Calibration of all field and laboratory instrumentation was based on standards/sources, traceable to NIST, when such standards/sources were available. In cases where they were not available, standards of an industry recognized organization were used. Calibration of pressurized ionization chambers was performed by the manufacturer.

Quality control procedures include:

- Daily instrument background and check-source measurements to confirm that equipment operation is within acceptable statistical fluctuations.
- Participation in EPA and EML laboratory Quality Assurance Programs.
- Training and certification of all individuals performing procedures.
- Periodic internal and external audits.

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES[1]

APPENDIX C

SUMMARY OF DEPARTMENT OF ENERGY RESIDUAL RADIOACTIVE MATERIAL GUIDELINES[1]

BASIC DOSE LIMITS

The basic dose limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr.[2] In implementing this limit, DOE applies as low as reasonably achievable principles to set site-specific guidelines.

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.

SURFACE CONTAMINATION GUIDELINES

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

[a] 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.

[b] 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.

[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. The numbers in this column are maximum amounts.

SOIL GUIDELINES

Radionuclides	Soil Concentration (pCi/g) Above Background[a,b,c]
Radium-226, Radium-228, Thorium-230, Thorium-232	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.
Total Uranium	100 pCi/g[3]

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

[b] 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.

[c] 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.[4] 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. "Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites," U.S. Department of Energy, Revision 2, March 1987.

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

3. DOE Memorandum from J. Wagoner to W. Seay, "Uranium Gudelines for the Aliquippa, Pennsylvania, Site," April 2, 1993.

4. Argonne National Laboratory "A Manual for Implementing Residual Radioactive Material Guidelines," DOE/CH8901, June 1989.