

RADIOLOGICAL SURVEY
AT
1411 CENTRAL AVENUE
DETROIT, MICHIGAN

Prepared by

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AT
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INTRODUCTION

Between 1942 and 1952, the University of Chicago conducted research and development activities under contract to the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC) - predecessors of the Department of Energy (DOE). Wolverine Tube Division used the facility at 1411 Central Avenue in Detroit, Michigan to perform work under subcontract to the University of Chicago. From June 1943 through January 1946, Wolverine Tube Division provided the personnel, facilities, and equipment to fabricate uranium slugs, perform aluminum canning fabrication studies, and extrude beryllium rod and thorium metal. Additional work, of similar nature, was performed later under separate contract to the AEC. At the time the work was performed, Wolverine Tube Division was owned by the Calumet and Hecla Consolidated Copper Company. The facility was later sold to Star Tool, and eventually, to the present occupant, Hermes Automotive.

The DOE has reviewed available historical documentation which describes the previous MED/AEC activities conducted at this facility. Based upon this review, the DOE determined that there was not a potential for significant residual radioactive material to be present as a result of the past MED/AEC conducted at these facilities; however, there was not adequate documentation to determine whether the radiological condition at the termination of the MED/AEC activities of the site satisfied the current guidelines. As a result, DOE requested that a preliminary survey be performed in order to determine if additional investigations are required under the Formerly Utilized Sites Remedial Action Program (FUSRAP) or if the site can be eliminated from the program.

The Environmental Survey and Site Assessment Program of Oak Ridge Associated Universities (ORAU) was requested by DOE's Decontamination and Decommissioning Division to conduct a preliminary survey of the facility and property at 1411 Central Avenue, Detroit, Michigan.

FACILITY DESCRIPTION

The facility is located at the corner of Central Avenue and Pershing Avenue in the west-southwest section of downtown Detroit (Figure 1). It is of brick veneer over concrete block construction; the building is situated on a concrete slab. The total facility floor area (ground level) is about 30,000 m² (330,000 ft²). Major internal walls are also of concrete block construction; steel support beams separate the facility into a series of bays (Figures 2 and 3). There is a second story (Figure 4) in the southeast corner of the facility; otherwise, it is a single story structure. The building is presently used as a warehouse. There was no evidence that the western portion of this facility was used in support of MED and AEC activities; therefore, it was not included in this survey.

PROCEDURES

During the period of October 23-26, 1989 ORAU performed a preliminary survey at 1411 Central Avenue, Detroit, Michigan. The objective of this survey was to obtain sufficient radiological data, upon which to base a decision for inclusion or exclusion from the Formerly Utilized Sites Remedial Action Program.

Procedures

1. Access consent was obtained from the site owner prior to performing the survey.
2. Surface scans were performed on accessible areas of the floors, lower walls, roof and the outside area, immediately surrounding the facility, to identify areas of elevated direct radiation. Gamma scans were performed on interior and exterior surfaces using NaI(Tl) gamma scintillation

detectors coupled to countrate meters with audible indicators. Alpha and beta-gamma scans were performed on interior surfaces, using ZnS scintillators, thin window GM detectors, and large area alpha/beta gas proportional detectors coupled to countrate meters with audible indicators. Beta-gamma scans were performed on the roof and exterior surfaces using thin window GM detectors coupled to countrate meters with audible indicators.

3. Measurements of total and removable alpha and beta-gamma activity were made at randomly selected locations. Measurement locations were referenced to prominent features of the property and building.
4. Exposure rates were measured at 1 meter (3.3 ft) above the surface at representative locations.
5. Paint samples were collected from 100 cm² areas on the walls at ten representative locations throughout the facility.
6. Samples of dust and residue were collected from ten representative locations on the floor and overhead structures.
7. Samples and direct measurement data were returned to Oak Ridge, Tennessee, for analysis and interpretation. Smears were analyzed for gross alpha and beta. Residue and paint samples were analyzed by alpha spectroscopy for either isotopic uranium or isotopic thorium; results were converted to units of surface activity (dpm/100 cm²) or volume activity (pCi/g) for comparison with appropriate guidelines.

Additional information concerning major instrumentation, sampling equipment, and analytical procedures is provided in Appendix A. Results of the survey were compared with DOE's Guidelines for Residual Radioactivity at Formerly Utilized Sites, Remedial Action Program and Remote Surplus Facilities Management Program Sites, which is included as Appendix B.

FINDINGS AND RESULTS

Scans for alpha, beta and gamma activity of the facility perimeter, building interior, and roof did not identify any areas of elevated contact radiation. Two hundred and fifty-four measurements for total and removable activity were performed and the results are summarized in Table 1. Total activity levels ranged from <19 to 50 dpm/100 cm² for alpha and <320 to 1100 dpm/100 cm² for beta-gamma. Removable activity levels ranged from <3 to 7 dpm/100 cm² for alpha and <6 to 12 dpm/100 cm² for beta. For comparison, the DOE surface contamination guideline levels for uranium are;

5,000 dpm/100 cm², averaged over 1 m²
15,000 dpm/100 cm², maximum in 100 cm²
1,000 dpm/100 cm², removable

and for thorium are:

1,000 dpm/100 cm², averaged over 1 m²
3,000 dpm/100 cm², maximum in 100 cm²
200 dpm/100 cm², removable

Total activity levels at several locations ranged to 100 dpm/100 cm² for beta-gamma radiation; this is slightly above the more restrictive thorium contamination average guideline level of 1000 dpm/100 cm², but well within the maximum thorium guideline level of 3000 dpm/100 cm² and the uranium guideline levels of 5000 dpm/100 cm², average, and 15000 dpm/100 cm², maximum. Surface scans of these measurement locations indicated that there were no areas on immediately adjacent surfaces, having elevated activity levels. It is therefore concluded that the activity levels averaged over 1 m² are less than 1000 dpm/100 cm² and that all measurements are therefore within the DOE surface activity guidelines values.

Exposure rates measured at 27 locations throughout and immediately outside the facility ranged from 7 to 13 $\mu\text{R}/\text{h}$ (Table 2). Such levels are typical in buildings of masonry construction; measurement locations 1 and 2 were in a portion of the building with similar construction but having no history of radioactive materials use, thus establishing approximately 10 $\mu\text{R}/\text{h}$ as an average background level. All exposure rates were within the DOE external gamma radiation guideline for habitable structures of 20 $\mu\text{R}/\text{h}$ above background.

Results of analyses of paint samples are presented in Table 3. Surface activity levels for total uranium ranged from 5 to 22 $\text{dpm}/100 \text{ cm}^2$ and 11 to 71 $\text{dpm}/100 \text{ cm}^2$ for total thorium. All values are well within the DOE surface contamination guidelines given above.

Radionuclide concentrations in residue samples are presented in Table 4. Total uranium ranged from 1.0 to 1.9 pCi/g ; total thorium (Th-228 plus Th-232) ranged from 1.4 to 2.6 pCi/g . These levels are in the range of typical background concentrations of natural uranium and thorium in soil and masonry construction materials. Guidelines being used at DOE FUSRAP sites are 10 pCi/g for total thorium (5 pCi/g Th-232) and 35 to 90 pCi/g for total uranium. Concentrations in these residues are well below such levels. Separate analyses for Th-230 indicates concentrations from 0.4 to 3.7 pCi/g . The DOE guideline is 5 pCi/g above background; all samples were within this guideline and most were typical background levels.

SUMMARY

During the period of October 23-26, 1989, ORAU performed a preliminary survey of the facility and property at 1411 Central Avenue, Detroit, Michigan. Survey activities included scans for alpha, beta, and gamma activity; measurements of total and removable surface activity and exposure rates; and determination of radionuclide concentrations in residue samples. No areas of residual activity in excess of the guideline levels were identified.

Based upon the results of this survey, the radiological conditions of this facility satisfy the current DOE guidelines. It is, therefore, recommended that this facility be eliminated from further consideration under FUSRAP.

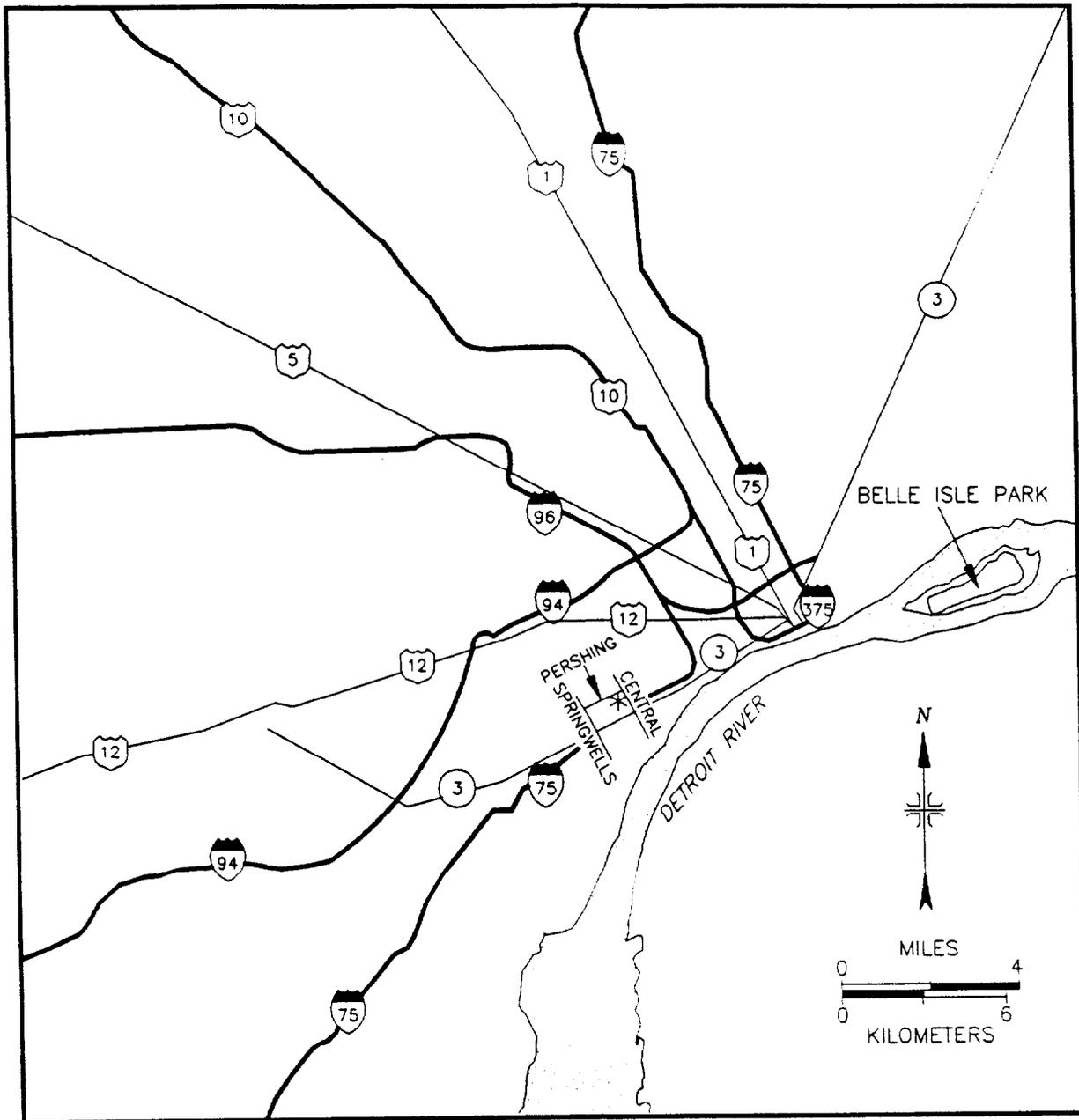


FIGURE 1: Map of Detroit, Michigan Indicating the Location of the Facility at 1411 Central Avenue

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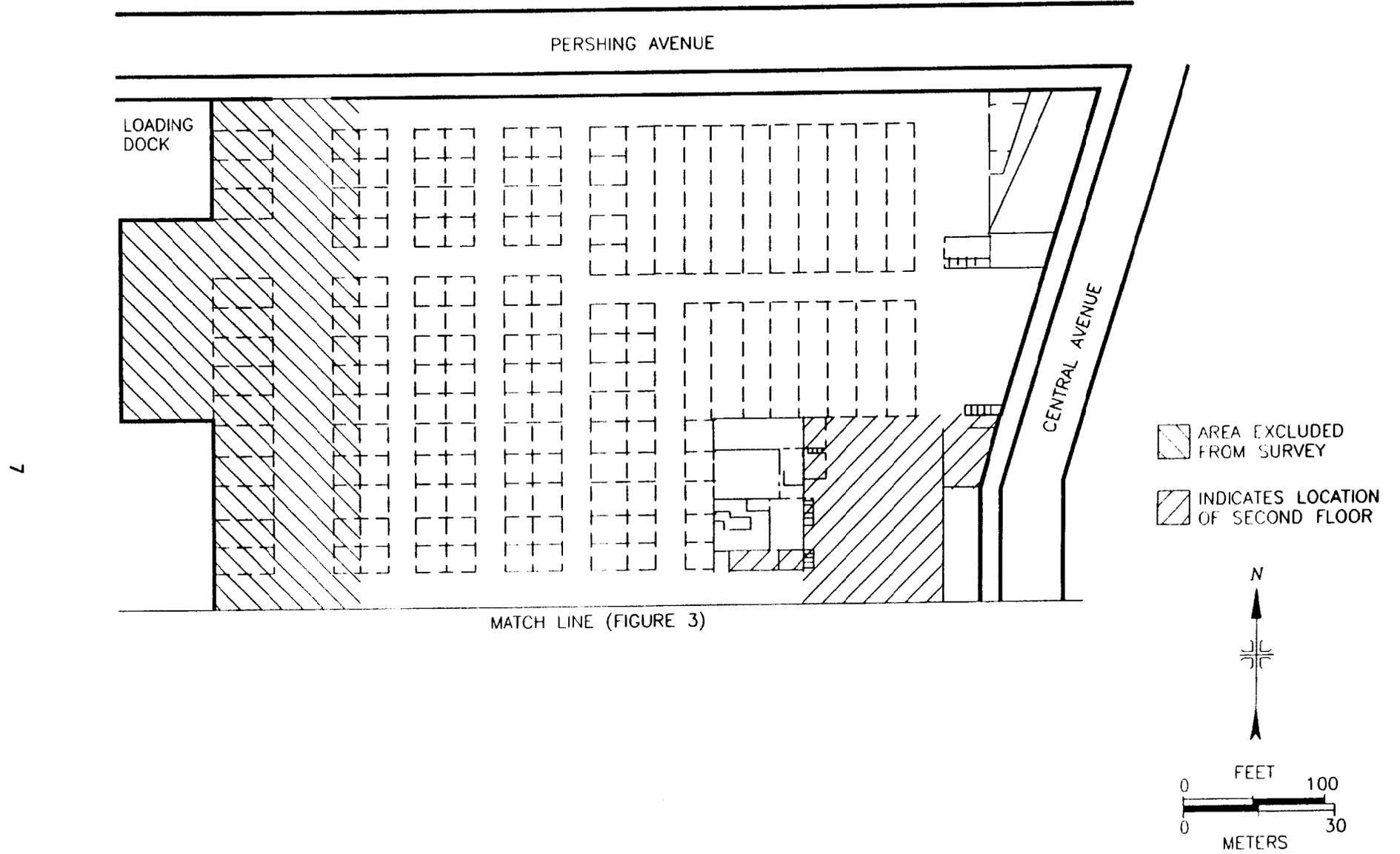


FIGURE 2: Plot Plan of the North Section of 1411 Central Avenue

WTD3c

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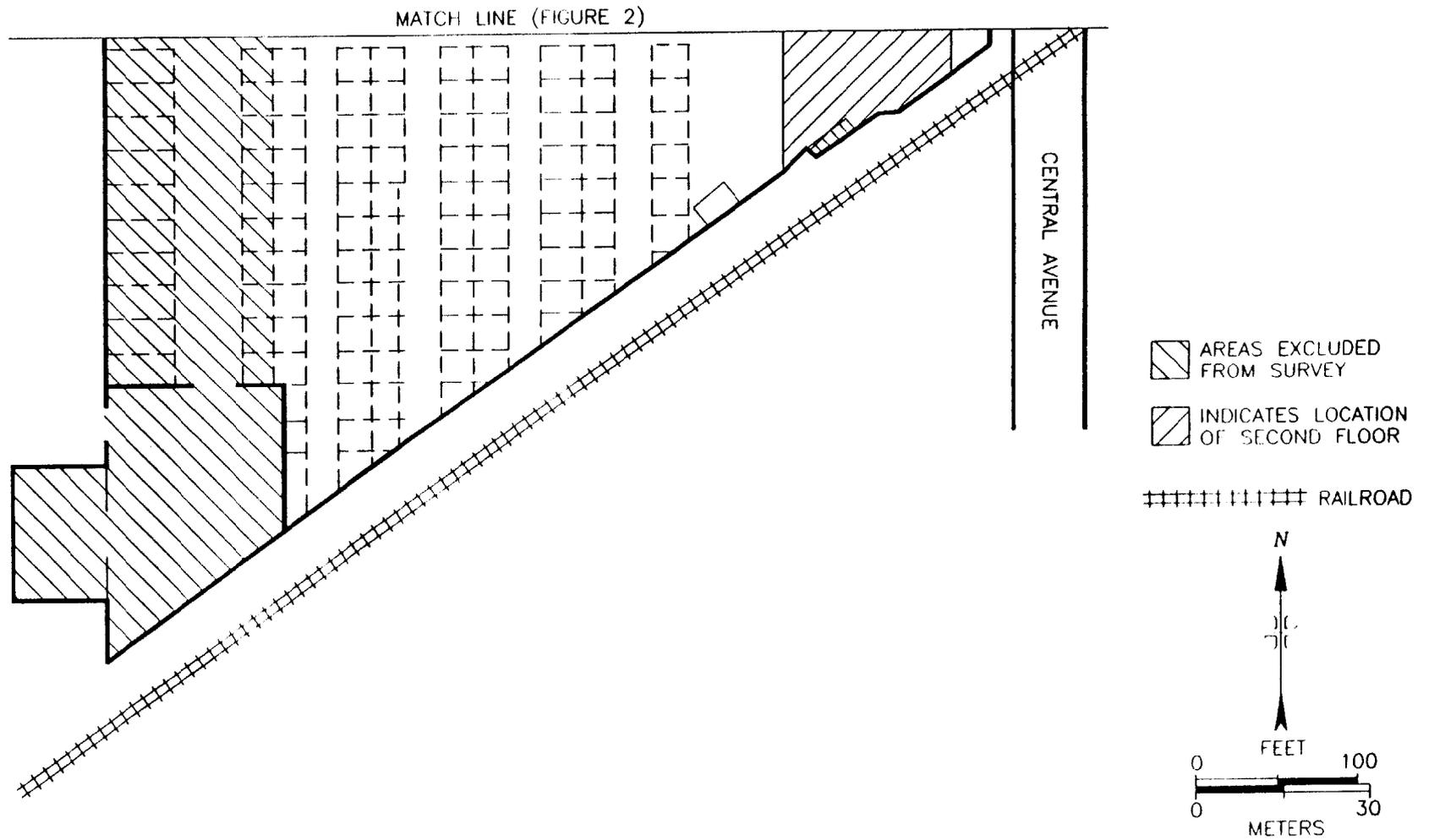


FIGURE 3: Plot Plan of the South Section of 1411 Central Avenue



WTD4c

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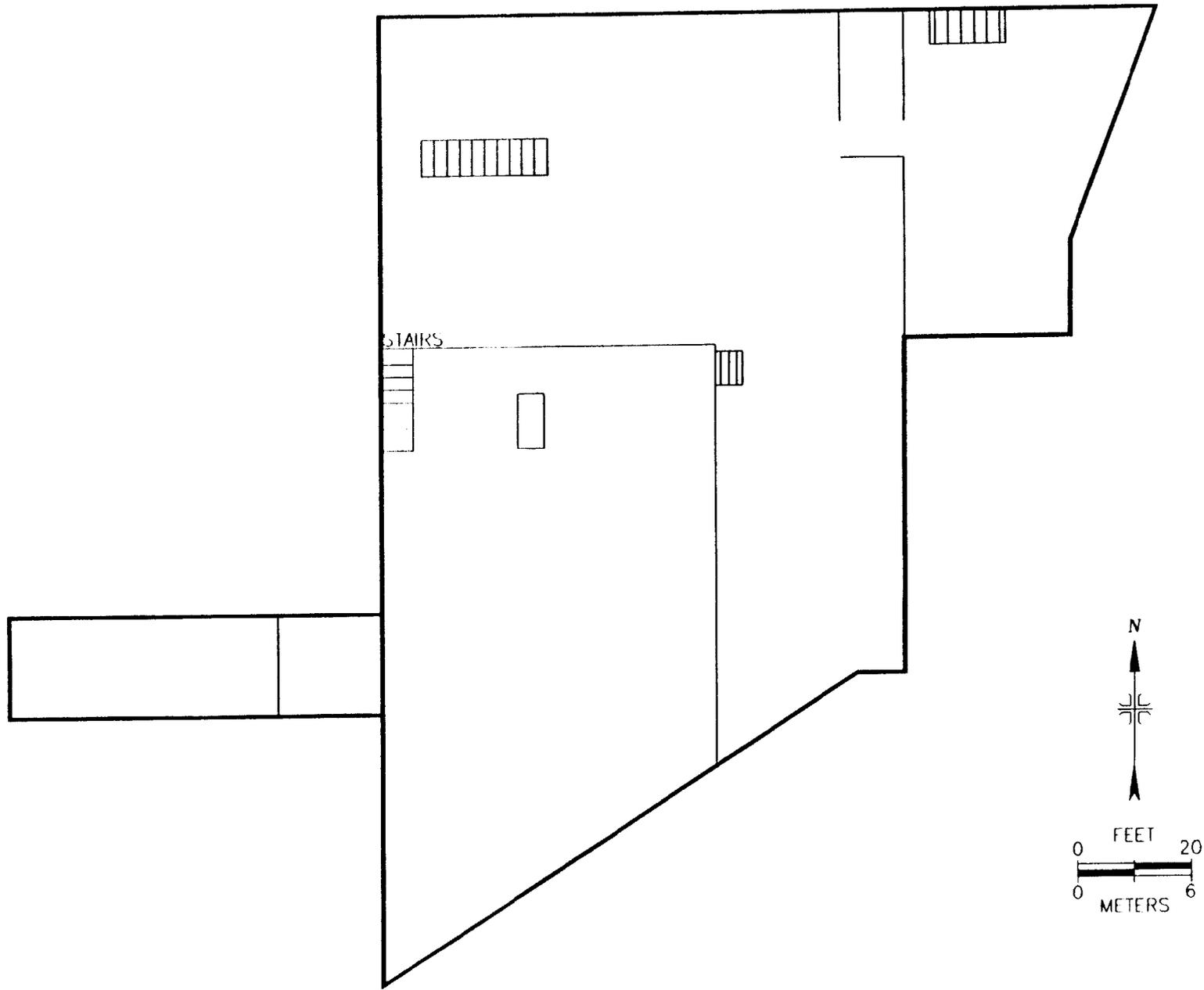


FIGURE 4: Plot Plan of the Second Floor of 1411 Central Avenue

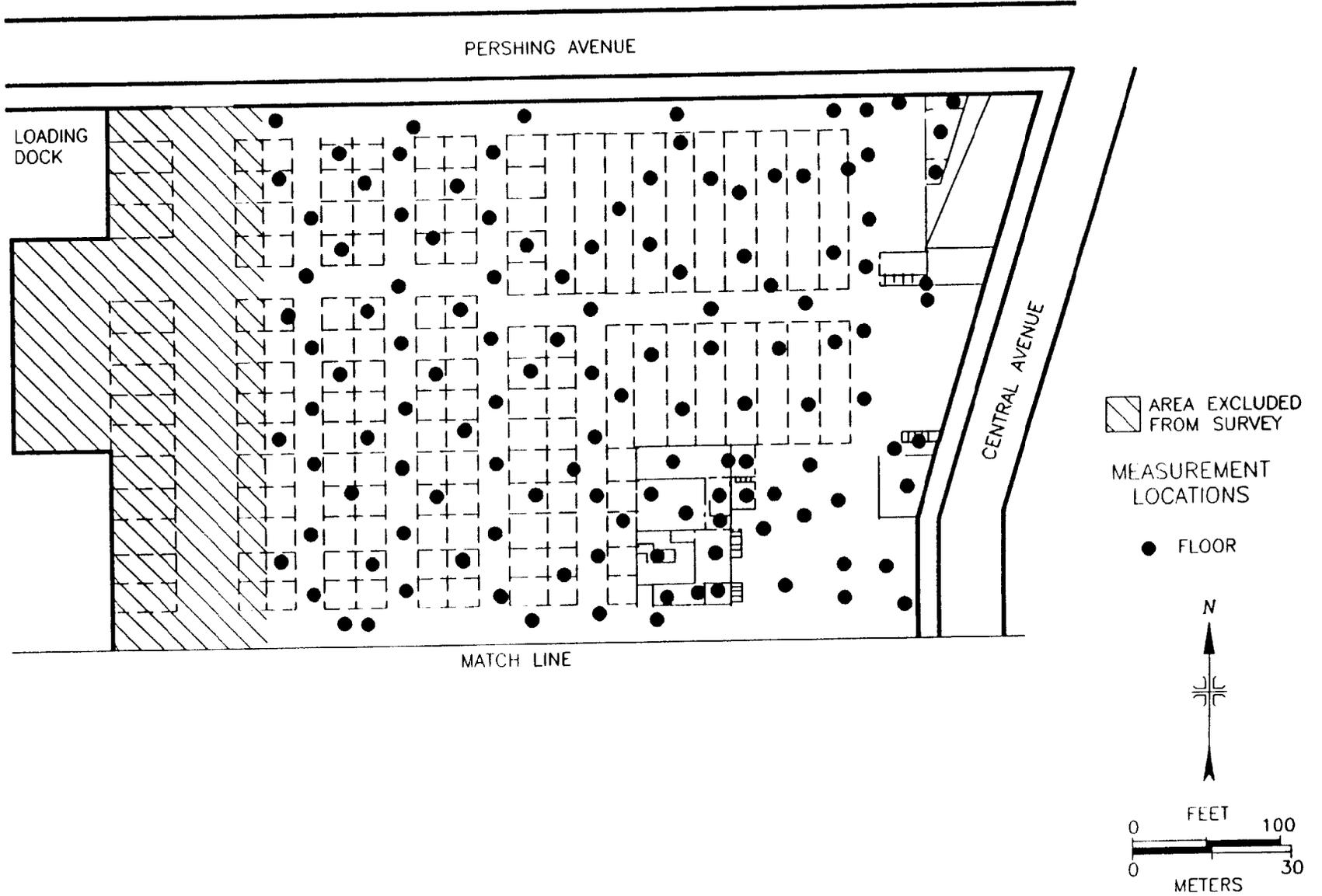


FIGURE 5: Plot Plan of the North Section of 1411 Central Avenue Indicating Locations of Activity Measurements on the Floor

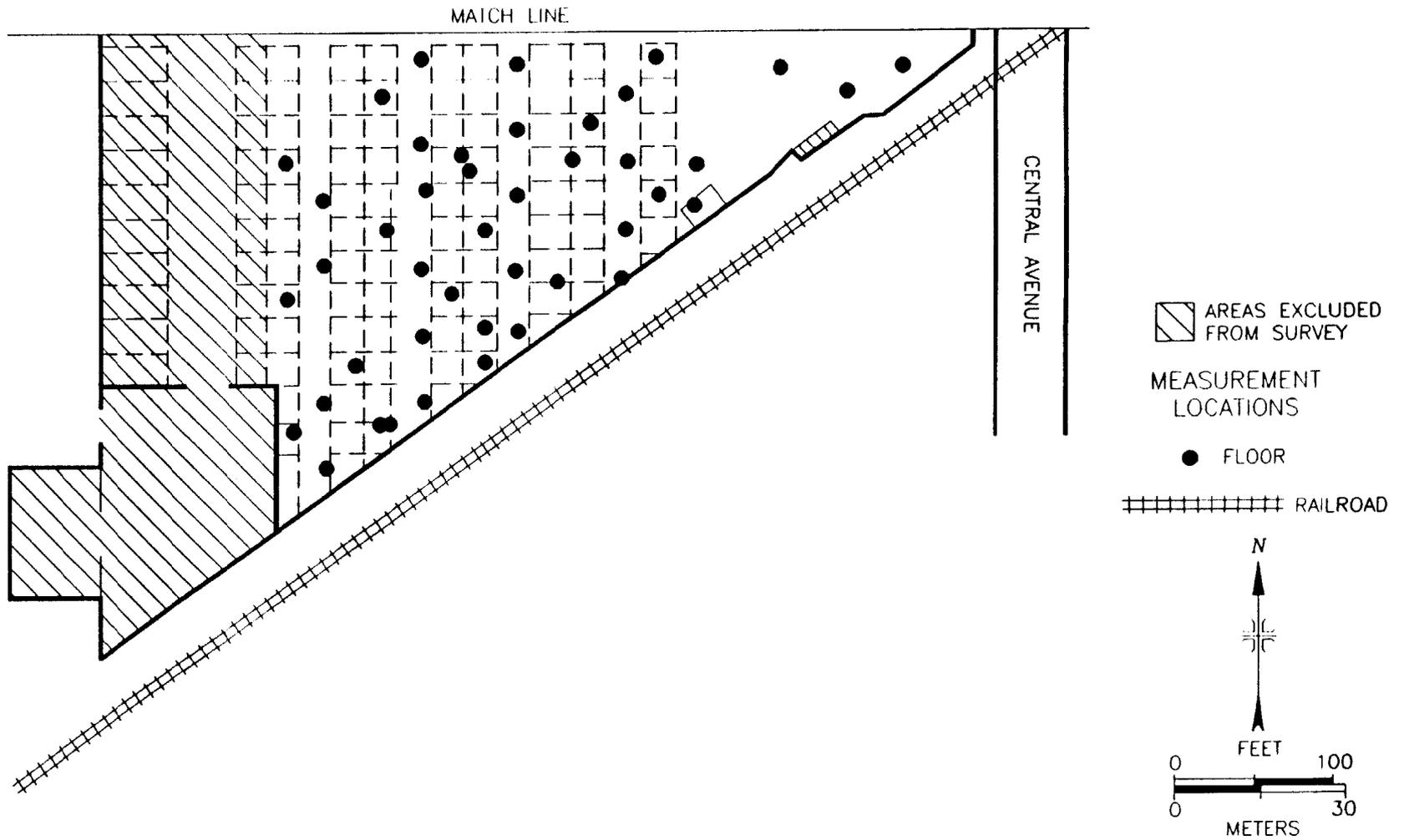


FIGURE 6: Plot Plan of the South Section of 1411 Central Avenue Indicating the Locations of Activity Measurements on the Floor

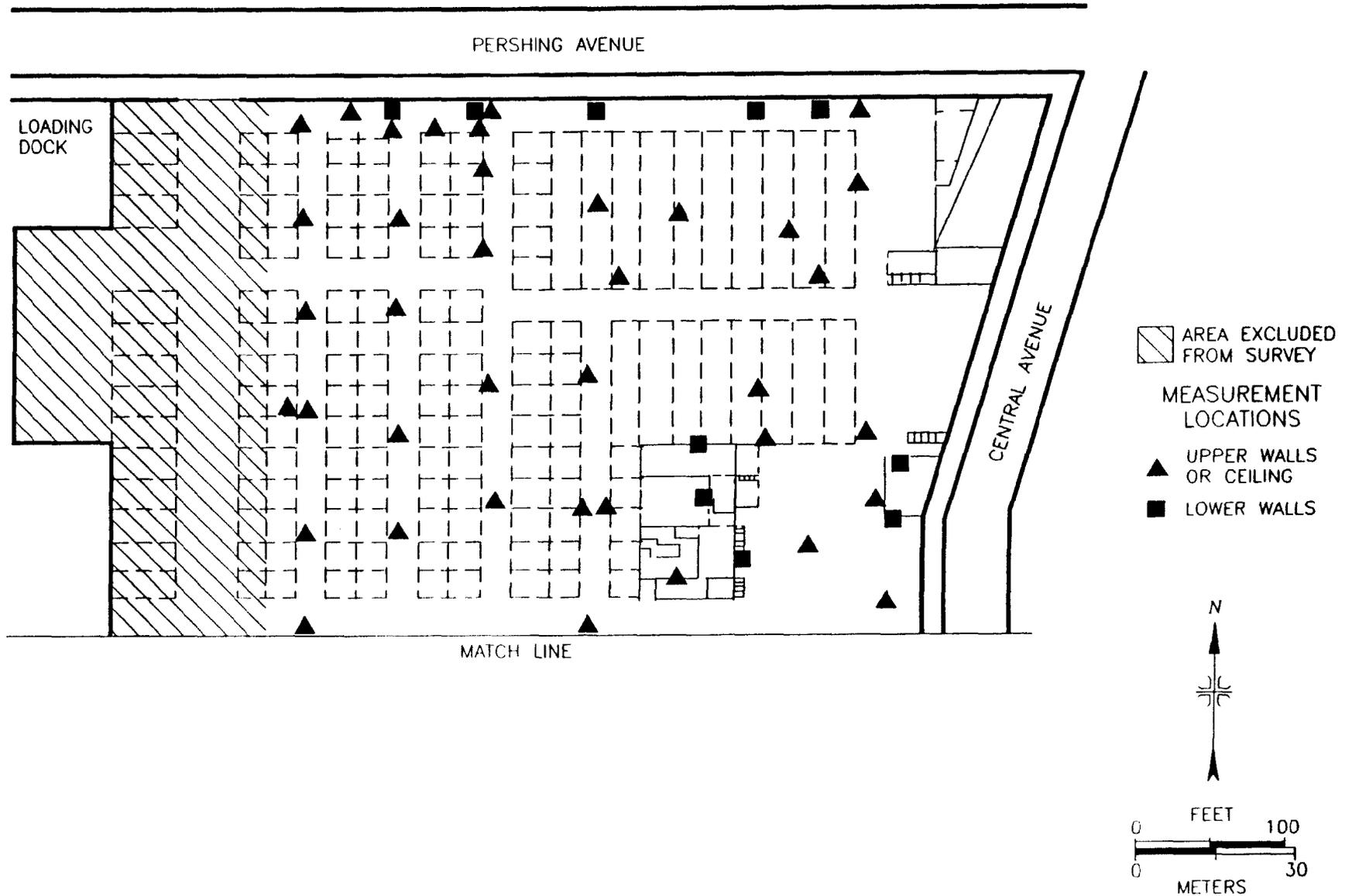


FIGURE 7: Plot Plan of the North Section of 1411 Central Avenue Indicating the Locations of Activity Measurements on the Walls and Ceiling

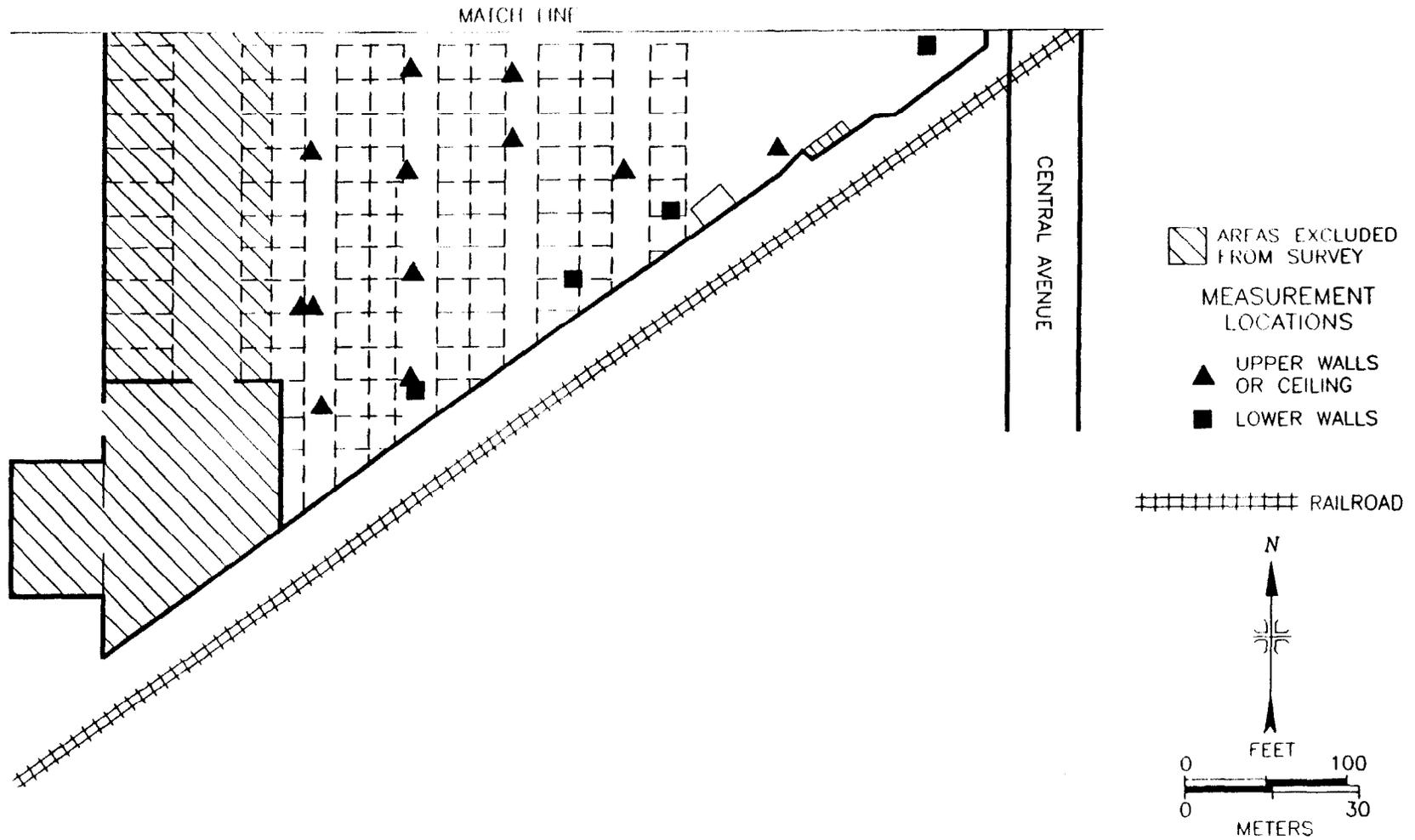


FIGURE 8: Plot Plan of the South Section of 1411 Central Avenue Indicating the Locations of Activity Measurements on the Walls and Ceiling

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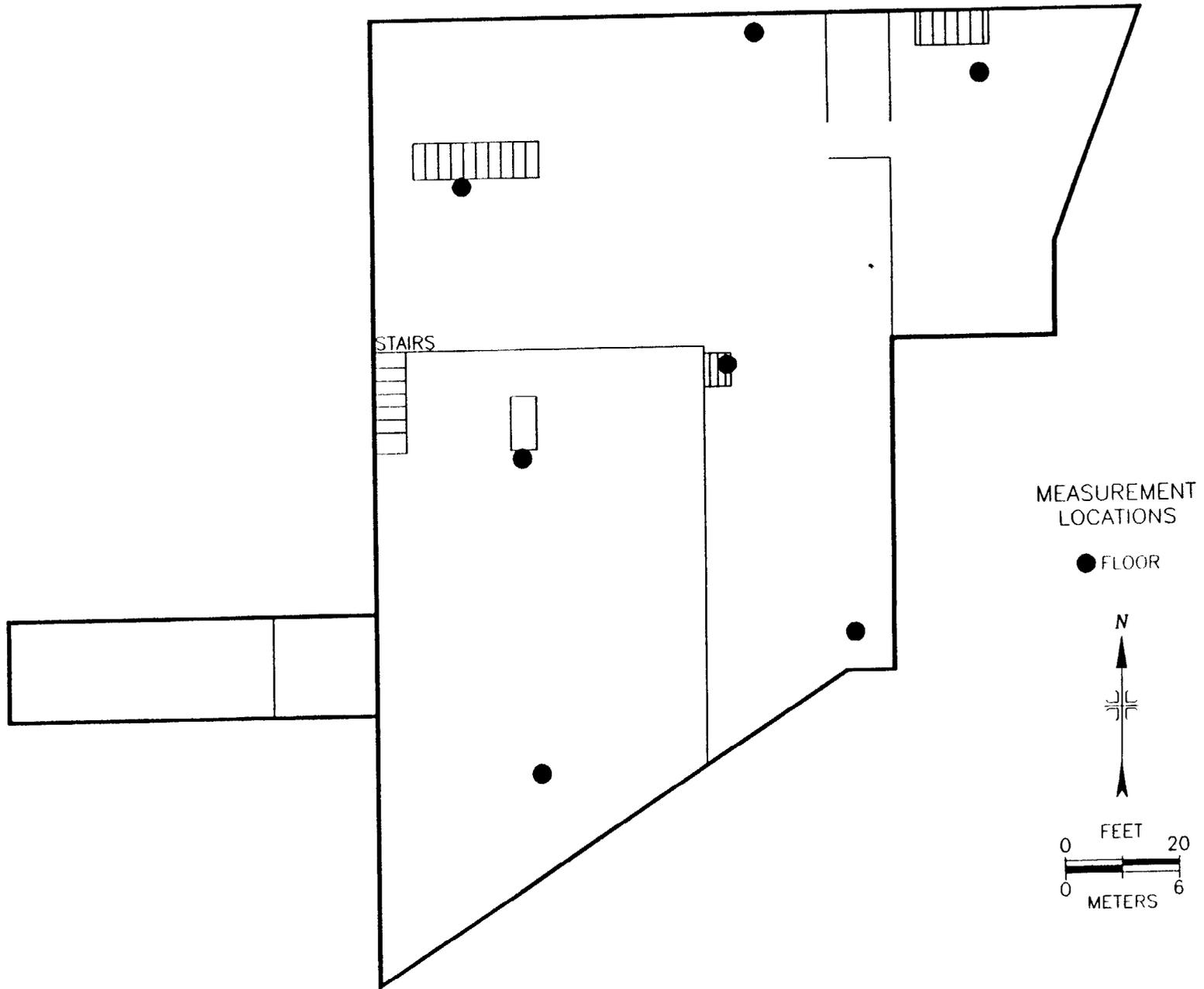


FIGURE 9: Plot Plan of the Second Floor of 1411 Central Avenue Indicating the Locations of Activity Measurements on the Floor

WTD4a

15

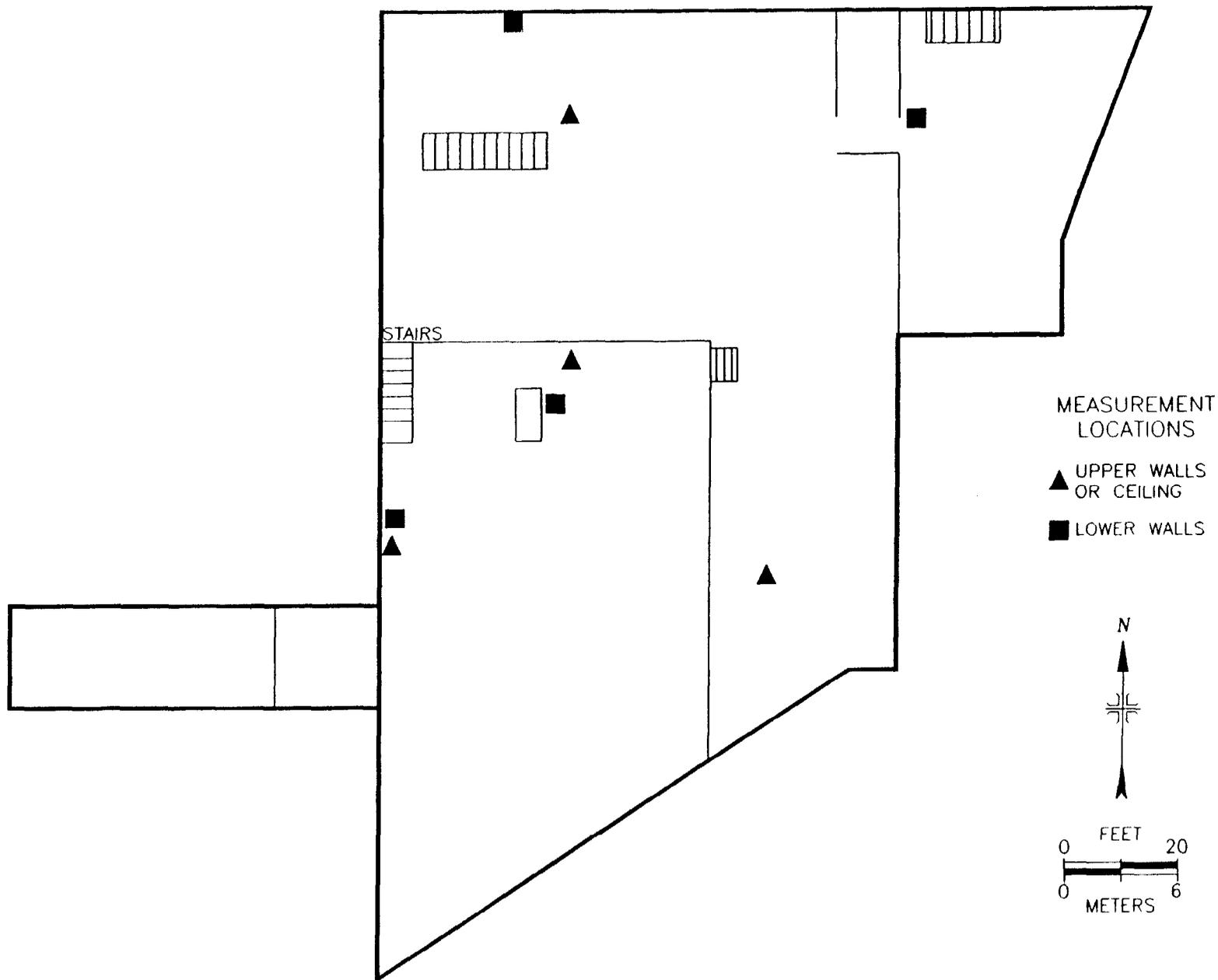


FIGURE 10: Plot Plan of the Second Floor of 1411 Central Avenue Indicating the Locations of Activity Measurements on the Walls and Ceiling

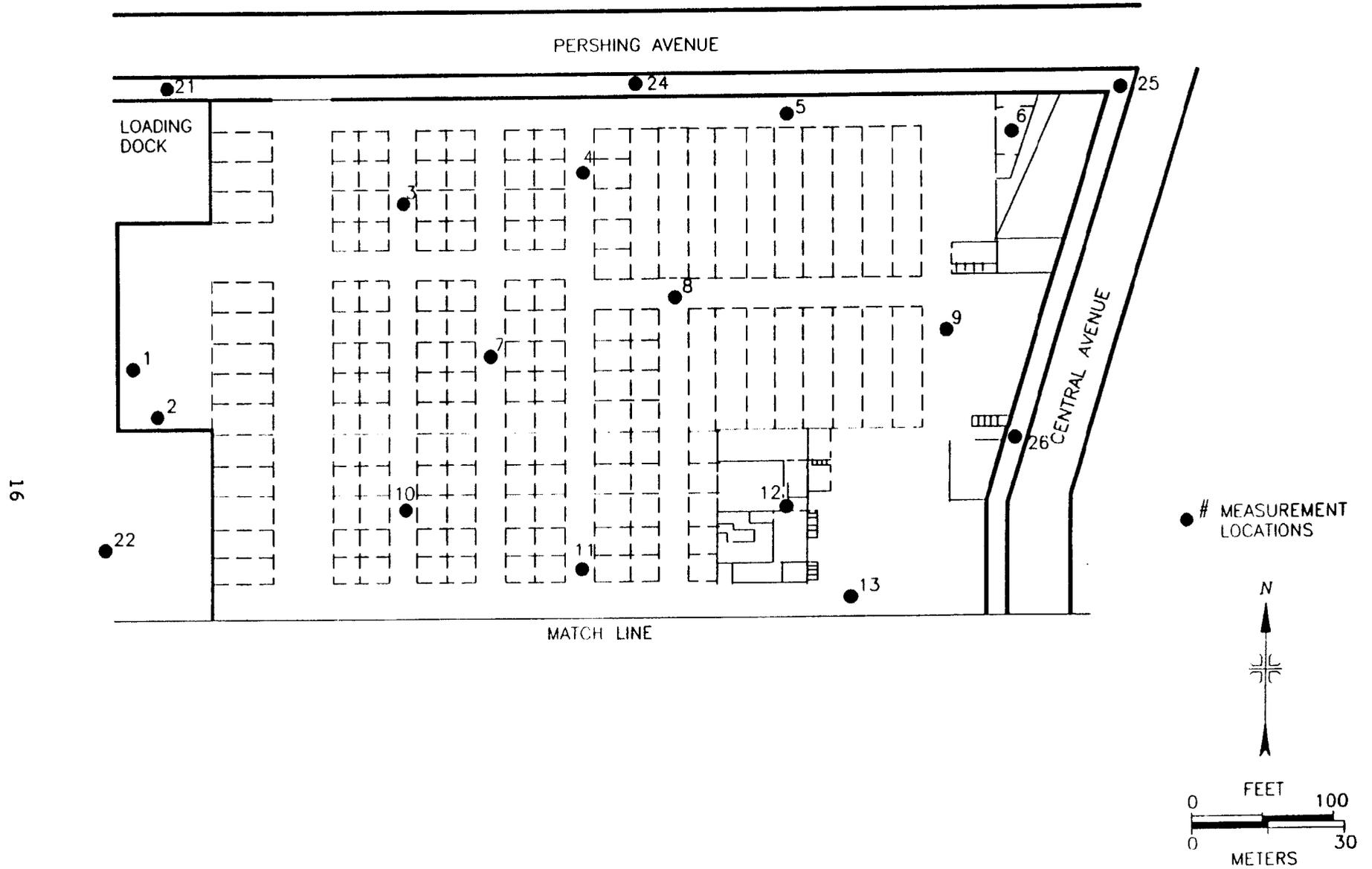


FIGURE 11: Plot Plan of the North Section of 1411 Central Avenue Indicating the Locations of Exposure Rate Measurements

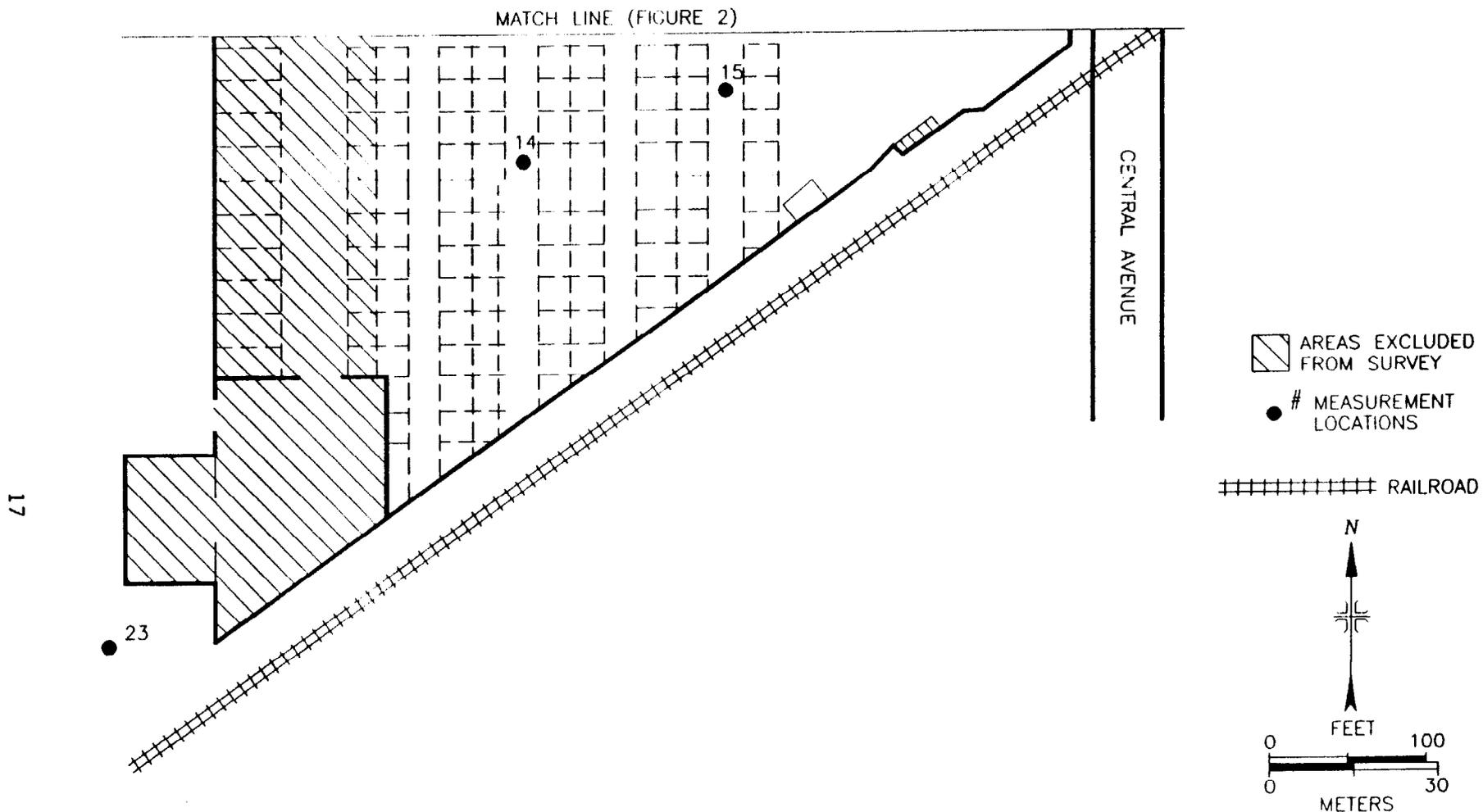


FIGURE 12: Plot Plan of the South Section of 1411 Central Avenue Indicating the Locations of Exposure Rate Measurements

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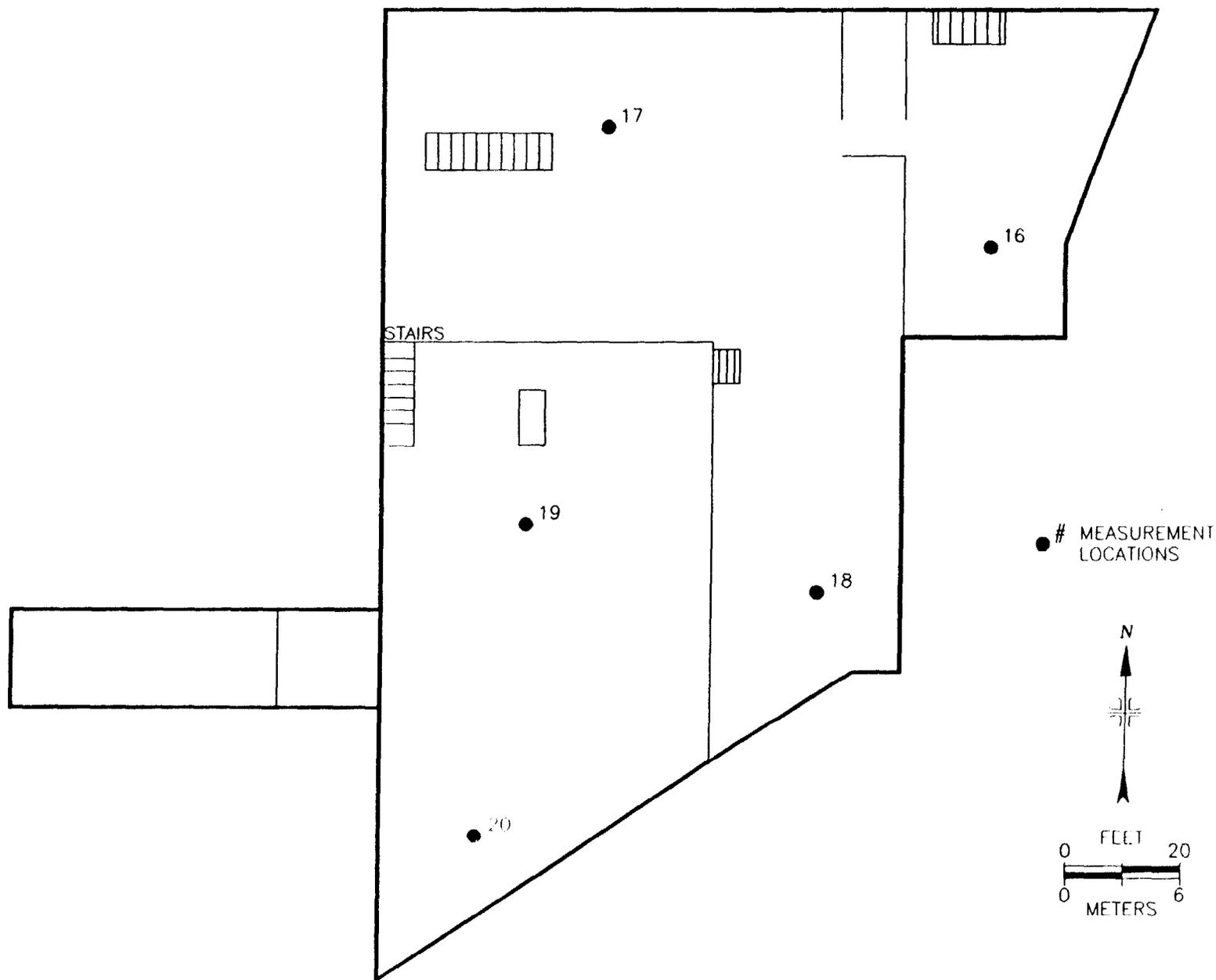


FIGURE 13: Plot Plan of the Second Floor of 1411 Central Avenue Indicating the Locations of Exposure Rate Measurements

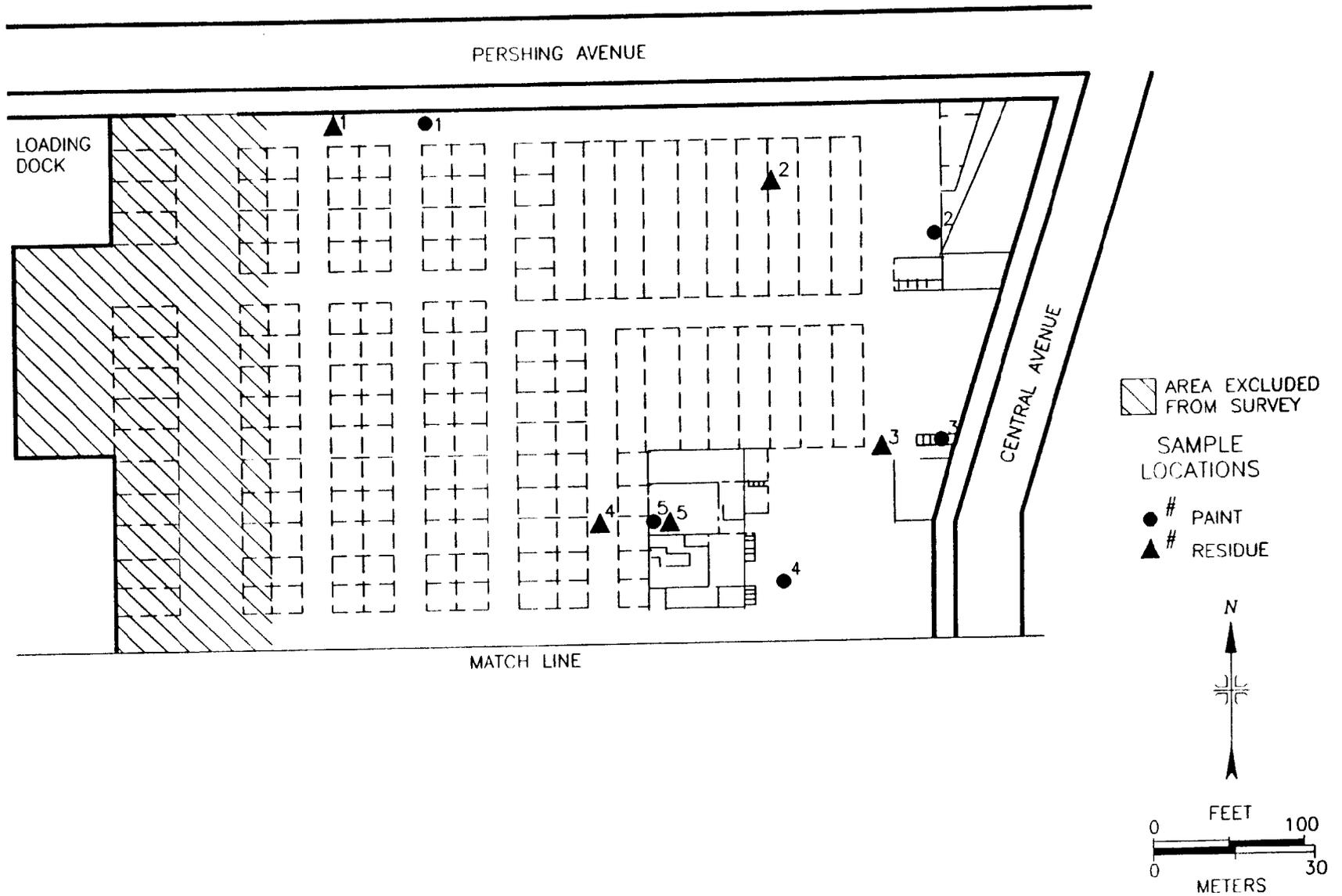


FIGURE 14: Plot Plan of the North Section of 1411 Central Avenue Indicating Paint and Residue Sampling Locations

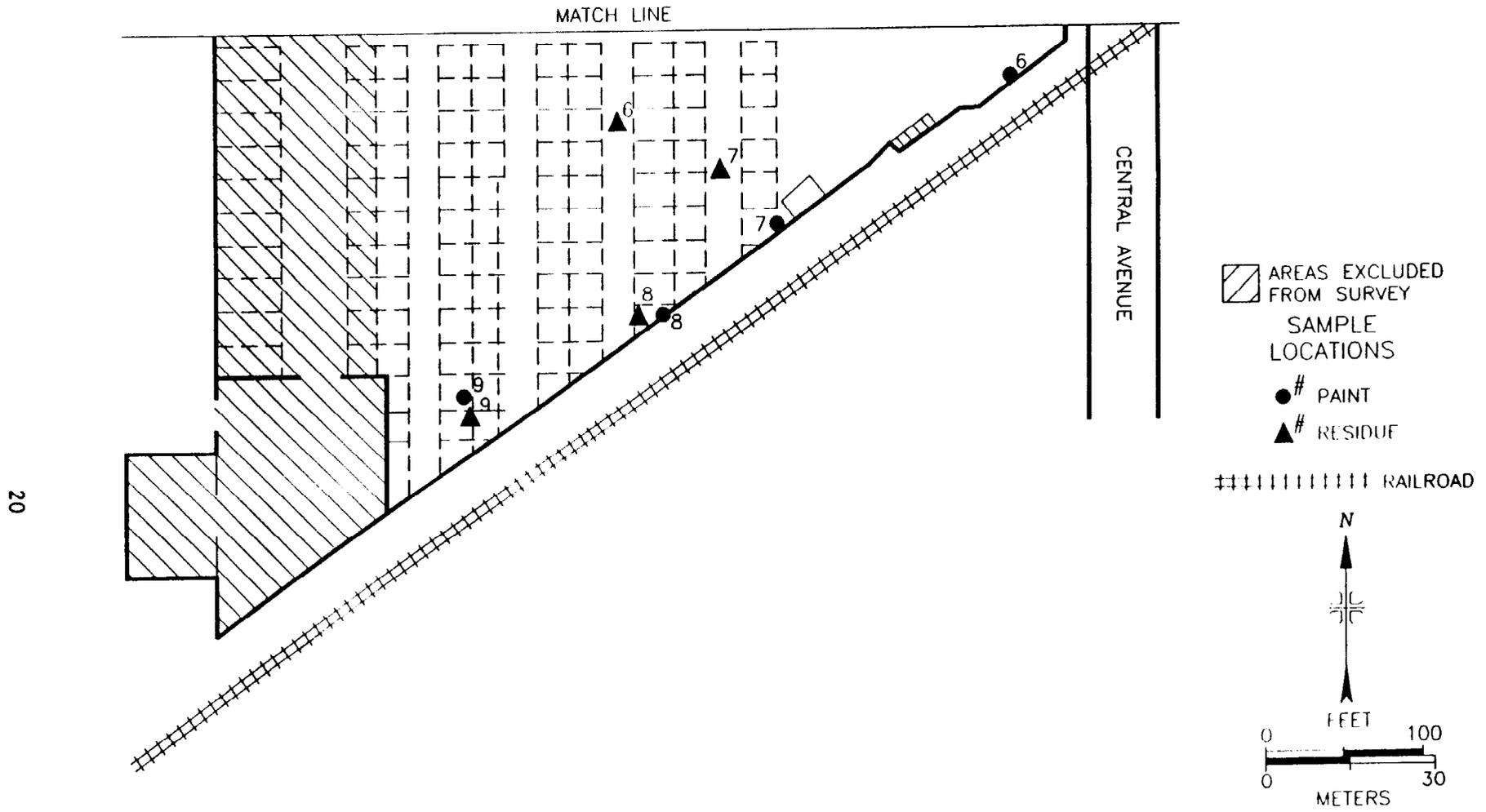


FIGURE 15: Plot Plan of the South Section of 1411 Central Avenue Indicating Paint and Residue Sampling Locations

WTD4

21

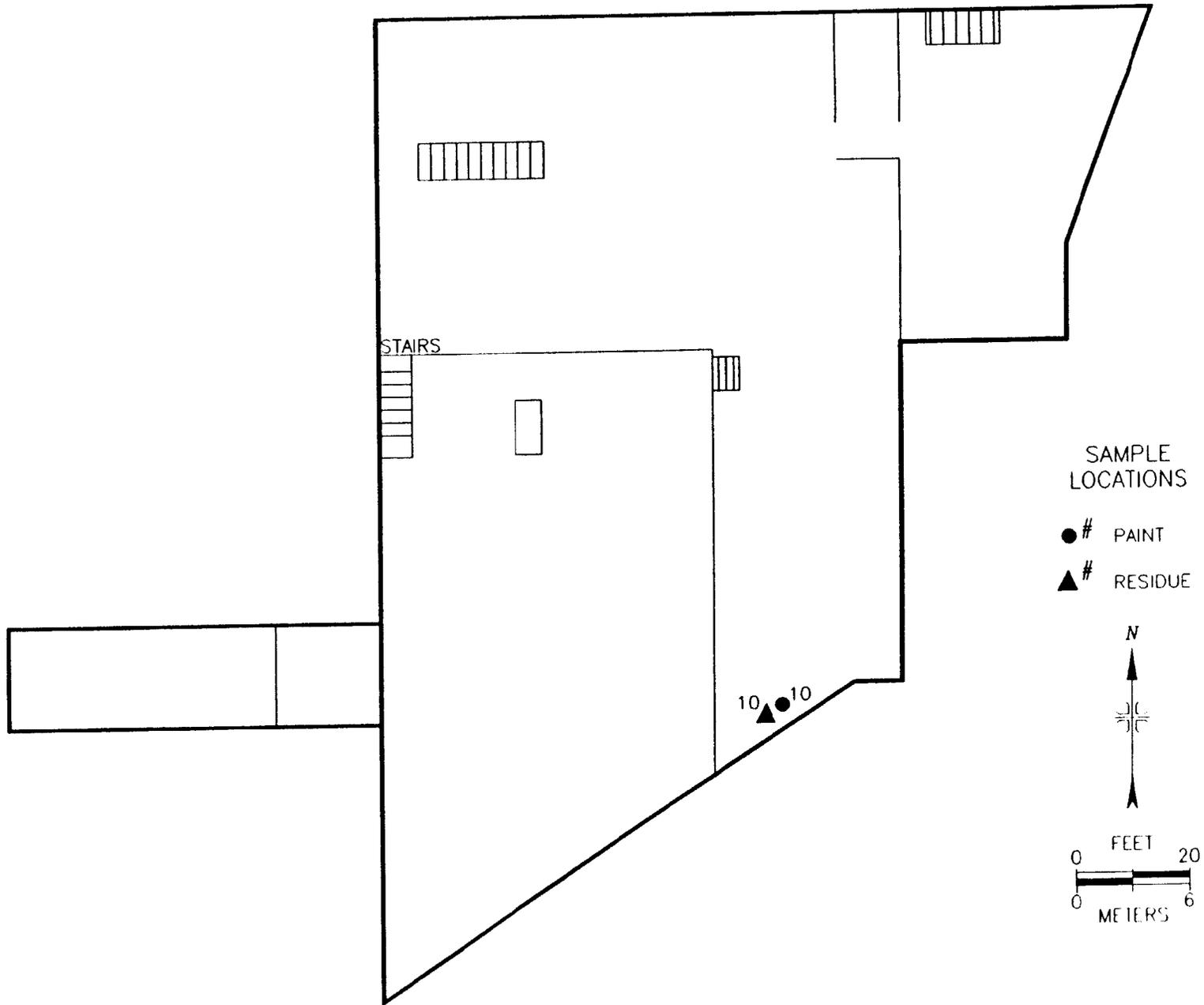


FIGURE 16: Plot Plan of the Second Floor of 1411 Central Avenue Indicating Paint and Residue Sampling Locations

TABLE 1

SUMMARY OF SURFACE ACTIVITY MEASUREMENTS
1411 CENTRAL AVENUE
DETROIT, MICHIGAN

Location	Number of Measurements	Total Activity		Removable Activity	
		Range of Alpha Measurements (dpm/100 cm ²)	Range of Beta-Gamma Measurements (dpm/100 cm ²)	Range of Alpha Measurements (dpm/100 cm ²)	Range of Beta Measurements (dpm/100 cm ²)
<u>First Floor</u>					
Floor ^a	170	<20-50	<320-1100	<3-7	<6-10
Lower Walls ^b	16	<20	<320-1100	≤3	<6- 7
Upper Walls & Ceiling ^b	49	<19-47	<320- 590	<3-7	<6-12
<u>Second Floor</u>					
Floor ^c	10	<20	<320- 750	<3-5	<6- 9
Lower Walls ^d	4	<30	<320-1100	≤3	<6
Upper Walls & Ceiling ^d	5	<19-38	<320-1100	<3-5	≤6

^aRefer to Figures 5 and 6.

^bRefer to Figures 7 and 8.

^cRefer to Figure 9.

^dRefer to Figure 10.

TABLE 2
 EXPOSURE RATE MEASUREMENTS
 1411 CENTRAL AVENUE
 DETROIT, MICHIGAN

Location ^a	Exposure Rate (μ R/h)
Inside	
1	10
2	10
3	8
4	7
5	10
6	13
7	8
8	8
9	8
10	8
11	7
12	11
13	9
14	9
15	9
16	8
17	7
18	7
19	9
20	10
Outside	
21	9
22	10
23	10
24	11
25	9
26	10
27	11

^aRefer to Figures 11-13.

TABLE 3

RESULTS OF URANIUM AND THORIUM ANALYSES
 OF PAINT SAMPLES
 1411 CENTRAL AVENUE
 DETROIT, MICHIGAN

Sample Location ^a	Total Activity (dpm/100 cm ²)	
	Uranium	Thorium
1	--- ^b	11
2	---	11
3	5	---
4	---	71
5	14	---
6	20	---
7	---	17
8	22	---
9	---	25
10	---	55

^aRefer to Figures 14-16.

^bDash indicates analyses not performed.

TABLE 4

RESULTS OF URANIUM AND THORIUM ANALYSES
OF RESIDUE SAMPLES
1411 CENTRAL AVENUE
DETROIT, MICHIGAN

Sample Location ^a	Radionuclide Concentrations (pCi/g)		
	Total Uranium (U-234 & U-235 & U-238)	Total Thorium (Th-228 & Th-232)	Th-230
1	1.9 ± 0.3 ^b	--- ^c	---
2	1.0 ± 0.3	---	---
3	---	1.7 ± 0.3	1.8 ± 1.0
4	1.3 ± 0.3	---	---
5	1.6 ± 0.3	---	---
6	1.5 ± 0.3	---	---
7	---	1.4 ± 0.3	1.5 ± 1.1
8	1.9 ± 0.3	---	---
9	---	1.6 ± 0.4	3.7 ± 1.3
10	---	2.6 ± 0.4	0.4 ± 1.3

^aRefer to Figures 14-16.

^bUncertainties represent the 95% confidence levels, based only on counting statistics; additional laboratory uncertainties of ±6 to 10% have not been propagated into these data.

^cDash indicates analyses not performed.

APPENDIX A
MEASUREMENT AND ANALYTICAL PROCEDURES

APPENDIX A

MEASUREMENT AND ANALYTICAL 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 (0.4 in). Identification of elevated levels was based on increases in the audible signal from the recording or indicating instrument. Combinations of detectors and instruments used for the scans are given in Table A-1.

Alpha and Beta-Gamma Surface Activity Measurements

Measurements of total alpha surface activity levels were performed using the detectors and instruments identified in Table A-1. Count rates (cpm) were converted to disintegration rates (dpm/100 cm²) by dividing the net rate by the 4 π efficiency and correcting for the active area of the detector. Effective window areas were 59 cm² for the ZnS detectors and 15 cm² for the GM detectors. The background count rate for ZnS alpha probes averaged approximately 2 cpm; the average background count rate was approximately 40 cpm for the GM detectors.

Removable Activity Measurements

Smears for determination of removable activity were performed by wiping approximately 100 cm² of the surface area, using prenumbered 47 mm diameter filter paper disks. The filter papers were returned to the Oak Ridge laboratory, where they were counted on a low-background alpha-beta gas proportional instrument.

Exposure Rate Measurements

Measurements of gamma exposure rates were performed using a Reuter Stokes Model RSS-111 pressurized ionization chamber.

Residue and Paint Sample Analysis (Alpha Spectrometry)

Aliquots of residue and paint were acidified and evaporated to dryness. The residues were then dissolved by pyrosulfate fusion and precipitated with barium sulfate. The barium sulfate precipitates were redissolved and uranium and thorium were separated by liquid - liquid extraction, precipitated with a cerium fluoride carrier, and counted using surface barrier detectors (ORTEC), alpha spectrometers (Tennelec), and an ND-66 Multichannel analyzer (Nuclear Data).

Uncertainties and Detection Limits

Uncertainties associated with the analytical data presented in the tables of this report, represent the 95% confidence levels 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 the 95% statistical deviation of the background count, the sample concentration was reported as less than the detection limit of the procedure. Because of variation in background levels, sample weights or volumes, and Compton contributions from other radionuclides in samples, the detection limits differ from sample to sample and instrument to instrument. Additional uncertainties of ± 6 to 10%, associated with sampling and laboratory procedures have not been propagated into the data presented in this report.

Calibration and Quality Assurance

Laboratory and field survey procedures are documented in manuals developed specifically for the Oak Ridge Associated Universities' Environmental Survey and Site Assessment Program.

Instruments were calibrated with NIST-traceable standards. Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operation within acceptable statistical fluctuations. The ORAU laboratory participates in the EPA and DOE/EML Quality Assurance Programs.

TABLE A-1
INSTRUMENTATION FOR MEASUREMENTS

Type Measurement	Detector	Recording Instrument
<u>SURFACE SCANS</u>		
Alpha	Eberline ZnS Scintillator - Model AC-3-7	Eberline Scaler/Ratemeter - Model PRS-1
	Ludlum Proportional Floor Monitor - Model 239-1	Ludlum Scaler/Ratemeter - Model 2220
Beta-Gamma	Eberline Pancake GM - Model HP-260	Eberline Scaler/Ratemeter - Model PRS-1
	or	or
	Victoreen Pancake GM Model 489-110	Eberline Ratemeter - Model PRM-6
	Ludlum Proportional Floor Monitor - Model 239-1	Ludlum Scaler/Ratemeter - Model 2220
Gamma	Victoreen NaI Scintillator - Model 489-55	Eberline Ratemeter - Model PRM-6
<u>SURFACE ACTIVITY</u>		
Alpha	Eberline ZnS Scintillator Model AC-3-7	Eberline Scaler/Ratemeter - Model PRS-1
Beta-Gamma (Total)	Eberline Pancake GM - Model HP-260	Eberline Scaler/Ratemeter - Model PRS-1
Beta Smears (Removable)	Thin Window Proportional Chamber	Tennelec Low Background Alpha Beta Counter - Model LB5110
<u>EXPOSURE RATE</u>	Reuter Stokes Pressurized Ionization Chamber - Model RSS-111	Same as Detector
<u>ALPHA SPECTROSCOPY</u>	EG&G ORTEC Surface Barrier Detector - Model CR-25-450-100 used in conjunction with: Tennelec Counting Chamber Model TC-256	Nuclear Data Multichannel Analyzer - Model ND-66

APPENDIX B

U.S. DEPARTMENT OF ENERGY GUIDELINES FOR RESIDUAL
RADIOACTIVE MATERIAL AT FORMERLY UTILIZED SITES
REMEDIAL ACTION PROGRAM AND REMOTE SURPLUS
FACILITIES MANAGEMENT PROGRAM SITES

(REVISION 2, MARCH 1987)

U.S. DEPARTMENT OF ENERGY GUIDELINES
FOR RESIDUAL RADIOACTIVE MATERIAL AT
FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM
AND
REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

(Revision 2, March 1987)

A. INTRODUCTION

This document presents U.S. Department of Energy (DOE) radiological protection guidelines for cleanup of residual radioactive materials and management of the resulting wastes and residues. It is applicable to sites identified by the Formerly Utilized Sites Remedial Action Program (FUSRAP) and remote sites identified by the Surplus Facilities Management Program (SFMP).^{*} The topics covered are basic dose limits, guidelines and authorized limits for allowable levels of residual radioactive material, and requirements for control of the radioactive wastes and residues.

Protocols for identification, characterization, and designation of FUSRAP sites for remedial action; for implementation of the remedial action; and for certification of a FUSRAP site for release for unrestricted use are given in a separate document (U.S. Department of Energy 1986) and subsequent guidance. More detailed information on applications of the guidelines presented herein, including procedures

* A remote SFMP site is one that is excess to DOE programmatic needs and is located outside a major operating DOE research and development or production area.

for deriving site-specific guidelines for allowable levels of residual radioactive material from basic dose limits, is contained in "A Manual for Implementing Residual Radioactive Material Guidelines" (U.S. Department of Energy 1987) referred to herein as the "supplement".

"Residual radioactive material" is used in these guidelines to describe radioactive materials derived from operations or sites over which the Department of Energy has authority. Guidelines or guidance to limit the levels of radioactive material to protect the public and environment are provided for: (1) residual concentrations of radionuclides in soil material, (2) concentrations of airborne radon decay products, (3) external gamma radiation level, (4) surface contamination levels, and (5) radionuclide concentrations in air or water resulting from or associated with any of the above.

A "basic dose limit" is a prescribed standard from which limits for quantities that can be monitored and controlled are derived; it is specified in terms of the effective dose equivalent as defined by the International Commission on Radiological Protection (ICRP 1977, 1978). The basic dose limits are used for deriving guidelines for residual concentrations of radionuclides in soil material. Guidelines for residual concentrations of thorium and radium in soil, concentrations of airborne radon decay products, allowable indoor external gamma radiation levels, and residual surface contamination concentrations are based on existing radiological protection standards or guidelines (U.S. Environmental Protection Agency 1983; U.S. Nuclear Regulatory Commission 1982; and Departmental Orders). Derived guidelines or limits based on the basic dose limits for those quantities are only used when the guidelines provided in the existing standards cited above are shown to be inappropriate.

A "guideline" for residual radioactive material is a level of radioactivity or of the radioactive material that is acceptable if the use of the site is to be unrestricted. Guidelines for residual radioactive material presented herein are of two kinds: (1) generic,

site-independent guidelines taken from existing radiation protection standards, and (2) site-specific guidelines derived from basic dose limits using site-specific models and data. Generic guideline values are presented in this document. Procedures and data for deriving site-specific guideline values are given in the supplement. The basis for the guidelines is generally a presumed worst case plausible scenario for a site.

An "Authorized Limit" is a level of residual radioactive material or radioactivity that must not be exceeded if the remedial action is to be considered completed and the site is to be released for unrestricted use. The Authorized Limit for a site will include limits for each radionuclide or group of radionuclides, as appropriate, associated with the residual radioactive material in the soil or in surface contamination of structures and equipment, and in the air or water, and, where appropriate, a limit on external gamma radiation resulting from the residual material. Under normal circumstances, expected to occur at most sites, Authorized Limits for residual radioactive material or radioactivity are set equal to guideline values. Exceptional conditions for which Authorized Limits might differ from guideline values are specified in Sections D and F. A site may be released for unrestricted use only if the conditions do not exceed the Authorized Limits or approved supplemental limits as defined in Section F.1 at the time remedial action is completed. Restrictions and controls on use of the site must be established and enforced if the site conditions exceed the approved limits, or if there is potential to exceed the dose limit if the site use was not restricted (Section F.2). The applicable controls and restrictions are specified in Section E.

DOE policy requires that all exposures to radiation be limited to levels that are as low as reasonably achievable (ALARA). For sites to be released for unrestricted use, the intent is to reduce residual radioactive material to levels that are as far below Authorized Limits as reasonable considering technical, economic, and social factors. At sites where the residual material is not reduced to levels that permit release for unrestricted use, ALARA policy is implemented by establishing controls to reduce exposure to levels that are as low as reasonably achievable. Procedures for implementing ALARA policy are discussed in the supplement. ALARA policies,

procedures, and actions shall be documented and filed as a permanent record upon completion of remedial action at a site.

B. BASIC DOSE LIMITS

The basic dose limit for the annual radiation dose received by an individual member of the general public is 100 mrem/year. The internal committed effective dose equivalent, as defined in ICRP Publication 26 (ICRP 1977) and calculated by dosimetry models described in ICRP Publication 30 (ICRP 1978), plus dose from penetrating radiation sources external to the body shall be used for determining the dose. This dose shall be described as the "Effective Dose Equivalent". Every effort shall be made to ensure that actual doses to the public are as far below the dose limit as is reasonably achievable.

Under unusual circumstances it will be permissible to allow potential doses to exceed 100 mrem/year where such exposures are based upon scenarios which do not persist for long periods and where the annual life time exposure to an individual from the subject residual radioactive material would be expected to be less than 100 mrem/year. Examples of such situations include conditions that might exist at a site scheduled for remediation in the near future or a possible, but improbable, one-time scenario that might occur following remedial action. These levels should represent doses that are as low as reasonably achievable for the site. Further, no annual exposure should exceed 500 mrem.

C. GUIDELINES FOR RESIDUAL RADIOACTIVE MATERIAL

C.1 Residual Radionuclides in Soil

Residual concentrations of radionuclides in soil shall be specified as above-background concentrations averaged over an area of 100 sq meters. Generic guidelines for thorium and radium are specified below. Guidelines for residual concentrations of other radionuclides shall be derived from the basic dose limits by means of an environmental pathway analysis using

site-specific data where available. Procedures for these derivations are given in the supplement.

If the average concentration in any surface or below surface area less than or equal to 25 sq meters exceeds the Authorized Limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters, limits for "Hot Spots" shall also be applicable. These Hot Spot Limits depend on the extent of the elevated local concentrations and are given in the supplement. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate soil limit irrespective of the average concentration in the soil.

Two types of guidelines are provided, generic and derived. The generic guidelines for residual concentrations of the Ra-226, Ra-228, Th-230, and Th-232 are:

- 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

These guidelines take into account ingrowth of Ra-226 from Th-230 and of Ra-228 from Th-232, 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 appropriate guideline is applied as a limit to the radionuclide with 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 the ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity"). Explicit formulas for calculating residual concentration guidelines for mixtures are given in the supplement.

C.2 Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property

that are intended for unrestricted use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and a reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.* In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions by DOE are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

C.3 External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site to be released for unrestricted use shall not exceed the background level by more than 20 μ R/h and shall comply with the basic dose limit when an appropriate use scenario is considered. This requirement shall not necessarily apply to structures scheduled for demolition or to buried foundations. External gamma radiation levels on open lands shall also comply with the basic dose limit considering an appropriate use scenario for the area.

C.4 Surface Contamination

The generic guidelines provided in the Table 1, Surface Contamination Guidelines are applicable to existing structures and equipment. These guidelines are adapted from standards of the U.S. Nuclear Regulatory

* A working level (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

TABLE 1 SURFACE CONTAMINATION GUIDELINES

Radionuclides ²	Allowable Total Residual Surface Contamination (dpm/100 cm ²) ¹		
	Average ^{3, 4}	Maximum ^{4, 5}	Removable ^{4, 6}
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	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 B-Y	15,000 B-Y	1,000 B-Y

- ¹ 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.
- ² 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.
- ³ Measurements of average contamination should not be averaged over an area of more than 1 m². For objects of less surface area, the average should be derived for each such object.
- ⁴ 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 1 cm.
- ⁵ The maximum contamination level applies to an area of not more than 100 cm².
- ⁶ The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area 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 cm² 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.

Commission (1982)* and will be applied in a manner that provides a level of protection consistent with the Commission's guidance. These limits apply to both interior and exterior surfaces. They are not directly intended for use on structures to be demolished or buried, but, should be applied to equipment or building components that are potentially salvageable or recoverable scrap. If a building is demolished, the guidelines in Section C.1 are applicable to the resulting contamination in the ground.

C.5 Residual Radionuclides in Air and Water

Residual concentrations of radionuclides in air and water shall be controlled to levels required by DOE Environmental Protection Guidance and Orders, specifically DOE Order 5480.1A and subsequent guidance. Other Federal and/or state standards shall apply when they are determined to be appropriate.

D. AUTHORIZED LIMITS FOR RESIDUAL RADIOACTIVE MATERIAL

The Authorized Limits shall be established to: 1) ensure that, as a minimum, the Dose Limits specified in Section B will not be exceeded under the worst case plausible use scenario consistent with the procedures and guidance provided, or 2) where applicable generic guidelines are provided, be consistent with such guidelines. The Authorized Limits for each site and vicinity properties shall be set equal to the generic or derived guidelines except where it can be clearly established on the basis of site specific data, including health, safety and socioeconomic considerations, that the guidelines are not appropriate for use at the specific site. Consideration

* These guidelines are functionally equivalent to Section 4 - Decontamination for Release for Unrestricted Use of NRC Regulatory Guide 1.86, but are applicable to Non-Reactor facilities.

should also be given to ensure that the limits comply with or provide an equivalent level of protection as other appropriate limits and guidelines (i.e., state, or other Federal). Documentation supporting such a decision should be similar to that required for supplemental limits and exceptions (Section F), but should be generally more detailed because it covers an entire site.

Remedial actions shall not be considered complete unless the residual radioactive material levels comply with the Authorized Limits. The only exception to this requirement will be for those special situations where the supplemental limits or exceptions are applicable and approved as specified in Section F. However, the use of supplemental limits and exceptions should only be considered if it is clearly demonstrated that it is not reasonable to decontaminate the area to the Authorized Limit or guideline value. The Authorized Limits are developed through the project offices in the field (Oak Ridge Technical Services Division for FUSRAP) and approved by the headquarters program office (the Division of Facility and Site Decommissioning Projects).

E. CONTROL OF RESIDUAL RADIOACTIVE MATERIAL AT FUSRAP AND REMOTE SFMP SITES

Residual radioactive material above the guidelines at FUSRAP and remote SFMP sites must be managed in accordance with applicable DOE Orders. The DOE Order 5480.1A and subsequent guidance or superceding orders require compliance with applicable Federal, and state environmental protection standards.

The operational and control requirements specified in the following DOE Orders shall apply to interim storage, interim management, and long-term management.

- a. 5440.1C, Implementation of the National Environmental Policy Act
- b. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations as revised by DOE 5480.1 change orders and the 5 August 1985 memorandum from Vaughan to Distribution
- c. 5480.2, Hazardous and Radioactive Mixed Waste Management

- d. 5480.4, Environmental Protection, Safety, and Health Protection Standards
- e. 5482.1A, Environmental Safety, and Health Appraisal Program
- f. 5483.1A, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities
- g. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements
- h. 5000.3, Unusual Occurrence Reporting System
- i. 5820.2, Radioactive Waste Management

E.1 Interim Storage

- a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 50 years and, in any case, at least 25 years.
- b. Above-background Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not exceed: (1) 100 pCi/L at any given point, (2) an annual average concentration of 30 pCi/L over the facility site, and (3) an annual average concentration of 3 pCi/L at or above any location outside the facility site (DOE Order 5480.1A, Attachment XI-1).
- c. Concentrations of radionuclides in the groundwater or quantities of residual radioactive materials shall not exceed existing Federal, or state standards.
- d. Access to a site shall be controlled and misuse of onsite material contaminated by residual radioactive material shall be prevented through appropriate administrative controls and physical barriers--active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These control features should be designed to ensure, to the extent reasonable, an effective life of at least 25 years. The Federal government shall have title to the property or shall have a long-term lease for exclusive use.

E.2 Interim Management

- a. A site may be released under interim management when the residual radioactive material exceeds guideline values if the residual radioactive material is in inaccessible locations and would be unreasonably costly to remove, provided that administrative controls are established to ensure that no member of the public shall receive a radiation dose exceeding the basic dose limit.
- b. The administrative controls, as approved by DOE, shall include but not be limited to periodic monitoring as appropriate, appropriate shielding, physical barriers to prevent access, and appropriate radiological safety measures during maintenance, renovation, demolition, or other activities that might disturb the residual radioactivity or cause it to migrate.
- c. The owner of the site or appropriate Federal, state, or local authorities shall be responsible for enforcing the administrative controls.

E.3 Long-Term Management

Uranium, Thorium, and Their Decay Products

- a. Control and stabilization features shall be designed to ensure, to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years.
- b. Control and stabilization features shall be designed to ensure that Rn-222 emanation to the atmosphere from the waste shall not: (1) exceed an annual average release rate of 20 pCi/m²/s, and (2) increase the annual average Rn-222 concentration at or above any location outside the boundary of the contaminated area by more than 0.5 pCi/L. Field verification of emanation rates is not required.

- c. Prior to placement of any potentially biodegradable contaminated wastes in a long-term management facility, such wastes shall be properly conditioned to ensure that (1) the generation and escape of biogenic gases will not cause the requirement in paragraph b. of this section (E.3) to be exceeded, and (2) biodegradation within the facility will not result in premature structural failure in violation of the requirements in paragraph a. of this section (E.3).
- d. Groundwater shall be protected in accordance with Appropriate Departmental orders and Federal and state standards, as applicable to FUSRAP and remote SFMP sites.
- e. Access to a site should be controlled and misuse of onsite material contaminated by residual radioactive material should be prevented through appropriate administrative controls and physical barriers--active and passive controls as described by the U.S. Environmental Protection Agency (1983--p. 595). These controls should be designed to be effective to the extent reasonable for at least 200 years. The Federal government shall have title to the property.

Other Radionuclides

- f. Long-term management of other radionuclides shall be in accordance with Chapters 2, 3, and 5 of DOE Order 5820.2, as applicable.

F. SUPPLEMENTAL LIMITS AND EXCEPTIONS

If special site specific circumstances indicate that the guidelines or Authorized Limits established for a given site are not appropriate for a portion of that site or a vicinity property, then the field office may request that supplemental limits or an exception be applied. In either case, the field must justify that the subject guidelines or Authorized Limits are not appropriate and that the alternative action will provide adequate protection giving due consideration to health and safety,

environment and costs. The field office shall obtain approval for specific supplemental limits or exceptions from headquarters as specified in Section D of these guidelines and shall provide to headquarters those materials required for the justification as specified in this section and in the FUSRAP and SFMP protocols and subsequent guidance documents. The field office shall also be responsible for coordination with the state or local government of the limits or exceptions and associated restrictions as appropriate. In the case of exceptions, the field office shall also work with the state and/or local governments to insure that restrictions or conditions of release are adequate and mechanisms are in place for their enforcement.

F1. Supplemental Limits

The supplemental limits must achieve the basic dose limits set forth in this guideline document for both current and potential unrestricted uses of the site and/or vicinity property. Supplemental limits may be applied to a property or portion of a property or site if, on the basis of a site specific analysis, it is determined that certain aspects of the property or portion of the site were not considered in the development of the established Authorized Limits and associated guidelines for the site, and as a result of these unique characteristics, the established limits or guidelines either do not provide adequate protection or are unnecessarily restrictive and costly.

F2. Exceptions

Exceptions to the Authorized Limits defined for unrestricted use of the site may be applied to a portion of a site or a vicinity property when it is established that the Authorized Limits cannot be achieved and restrictions on use of the site or vicinity property are necessary to provide adequate protection of the public and environment. The field office must clearly demonstrate that the exception is necessary, and the restrictions will provide the necessary degree of protection and that they comply with the requirements for control of residual radioactive material as set forth in Part E of these guidelines.

F3. Justification for Supplemental Limits and Exceptions

Supplemental limits and exceptions must be justified by the field office on a case by case basis using site specific data. Every effort should be made to minimize the use of the supplemental limits and exceptions. Examples of specific situations that warrant the use of supplemental standards and exceptions are:

- a. Where remedial actions would pose a clear and present risk of injury to workers or members of the general public, notwithstanding reasonable measures to avoid or reduce risk.
- b. Where remedial actions--even after all reasonable mitigative measures have been taken--would produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near affected sites, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that can reasonably be anticipated.
- c. Where it is clear that the scenarios or assumptions used to establish the Authorized Limits do not under plausible current or future conditions, apply to the property or portion of the site identified and where more appropriate scenarios or assumptions indicate that other limits are applicable or necessary for protection of the public and the environment.
- d. Where the cost of remedial actions for contaminated soil is unreasonably high relative to long-term benefits and where the residual radioactive materials do not pose a clear present or future risk after taking necessary control measures. The likelihood that buildings will be erected or that people will spend long periods of time at such a site should be considered in evaluating this risk. Remedial actions will generally not be necessary where only minor quantities of residual radioactive

materials are involved or where residual radioactive materials occur in an inaccessible location at which site-specific factors limit their hazard and from which they are costly or difficult to remove. Examples are residual radioactive materials under hard-surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. A site-specific analysis must be provided to establish that it would not cause an individual to receive a radiation dose in excess of the basic dose limits stated in Section B, and a statement specifying the residual radioactive material must be included in the appropriate state and local records.

- e. Where there is no feasible remedial action.

G. SOURCES

Limit or Guideline	Source
<u>Basic Dose Limits</u>	
Dosimetry Model and Dose Limits	International Commission on Radiological Protection (1977, 1978)
<u>Generic Guidelines for Residual Radioactivity</u>	
Residual Concentrations of Radium and Thorium in Soil Material	40 CFR 192
Airborne Radon Decay Products	40 CFR 192
External Gamma Radiation	40 CFR 192
Surface Contamination	Adapted from U.S. Nuclear Regulatory Commission (1982)
<u>Control of Radioactive Wastes and Residues</u>	
Interim Storage	DOE Order 5480.1A and subsequent guidance
Long-Term Management	DOE Order 5480.1A and subsequent guidance; 40 CFR 192; DOE order 5820.2

H. REFERENCES

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