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of Energy

COMPREHENSIVE RADIOLOGICAL SURVEY

OFF-SITE PROPERTY X

NIAGARA FALLS STORAGE SITE

LEWISTON, NEW YORK

J. D. BERGER

Radiological Site Assessment Program
Manpower Education, Research, and Training Division

FINAL REPORT

May 1984

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LEWISTON, NEW YORK

Prepared for

U.S. Department of Energy
as part of the
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

COMPREHENSIVE RADIOLOGICAL SURVEY

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INTRODUCTION

Beginning in 1944, the Manhattan Engineer District and its successor, the Atomic Energy Commission (AEC), used portions of the Lake Ontario Ordnance Works (presently referred to as the Niagara Falls Storage Site (NFSS) and off-site properties), approximately 3 km northeast of Lewiston, New York, for storage of radioactive wastes. These wastes were primarily residues from uranium processing operations; however, they also included: contaminated rubble and scrap from decommissioning activities, biological and miscellaneous wastes form the University of Rochester, and low-level fission-product waste from contaminated-liquid evaporators at the Knolls Atomic Power Laboratory (KAPL). Receipt of radioactive waste was discontinued in 1954, and, following cleanup activities by Hooker Chemical Co., 525 hectares of the original 612-hectare site were declared surplus. This property was eventually sold by the General Services Administration to various private, commercial, and governmental agencies.[1]

The Town of Lewiston, New York, is the current owner of a tract from the NFSS, identified as off-site property X (see Figure 1). A radiological survey of that tract, conducted July and August 1983, is the subject of this report.

SITE DESCRIPTION

Figure 2 is a plot plan of off-site property X. The property is roughly rectangular in shape (approximately 223 m x 404 m) and occupies approximately 8.84 hectares. M Street forms the northern boundary; West Patrol Road and Lutts Road traverse the property in the north/south direction along the western and eastern perimeters, respectively. The Department of Energy's NFSS is located to the south of property X.

Facilities, previously used for treatment of sanitary sewage effluents from the Lake Ontario Ordnance Works, are located near the center of the property. Operation of the sewage treatment plant was discontinued in the mid-1970's; the facilities have deteriorated and are in a state of general disrepair. The property is presently unused and portions are overgrown with heavy brush. The West Drainage Ditch passes through the property in a north-south direction. A chain link fence restricts access to the site.

Radiological History

There is no evidence of contaminated waste burial or storage on property X; however, past surveys have identified elevated direct radiation levels along the West Drainage Ditch and near the southern property boundary.[1-3] Previous runoff from residues stored on the NFSS has been indicated as the source of contamination in the West Drainage Ditch. Elevated radiation levels on the southern portion of the property are believed to be due to radioactive materials still present on the adjacent federal government site. Elevated levels have also been noted near several buildings of the sewage treatment plant. The source of these higher levels may be naturally occurring radionuclides in rock used as fill and for cover roads and parking areas.

SURVEY PROCEDURES

The comprehensive survey of off-site property X was performed by the Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU), during the period of July and August 1983. The survey was in accordance with a plan dated March 18, 1983, approved by the Department of Energy's Office of Nuclear Energy. The objectives and procedures from that plan are presented in this section.

Objective

The objective of the survey was to provide a comprehensive assessment of the radiological conditions and associated potential health effects, if any, on property X. Radiological information collected included:

1. direct radiation exposure rates and surface beta-gamma dose rates,

2. locations of elevated surface residues,

3. concentrations of radionuclides in surface and subsurface soil,

4. concentrations of radionuclides in ground water, and

5. concentrations of radionuclides in sediment and water from sewage treatment plant facilities.

It should be noted that the survey did not include measurements and sampling of the West Drainage Ditch. The ditch is being cleaned by Bechtel National, Inc., and that organization will be responsible for radiological surveys following the cleaning.

Procedures

1. Brush and weeds were cleared as needed to provide access for gridding and surveying. This operation was performed by Modern Landfill, Inc., of Model City, NY, under subcontract.

2. Under subcontract, McIntosh and McIntosh of Lockport, NY, established a 40 m grid system. This grid is shown on Figure 3.

3. Gamma exposure rate measurements were made at the surface and at 1 m above the surface at 40 m grid intervals. Measurements were performed using portable gamma NaI (Tl) scintillation survey meters. Conversion of these measurements to exposure rates in microroentgens per hour (μR/h) was in accordance with cross calibration with a pressurized ionization chamber.

4. Beta-gamma dose rate measurements were performed 1 cm above the surface at 40 m grid intervals. These measurements were

conducted using thin-window (7 mg/cm^2) G-M detectors and portable scaler/ratemeters. Measurements were also obtained with the detector shielded to evaluate contributions of non-penetrating beta and low-energy gamma radiations. Meter readings were converted to dose rate in microrads per hour (μrad/h) based on cross calibration with a thin-window ionization chamber.

5. Surface (0-15 cm) soil samples of approximately 1 kg each were collected at 40 m grid intervals.

6. Walkover surface scans were conducted at 1-2 m intervals over all accessible areas of the property. Portable gamma scintillation survey meters were used for these scans. Locations of elevated contact radiation levels were noted (see Figure 4) and surface exposure rates were measured at these locations.

7. At selected locations of elevated surface radiation levels, beta-gamma dose rates and exposure rates at 1 m above the surface were also measured. Surface soil samples were obtained from these locations and, following sampling, the surface exposure levels were remeasured to evaluate the effectiveness of shallow sampling on removal of the radiation source.

8. Detection Sciences Group of Carlisle, MA, performed ground penetrating radar surveys at locations of proposed subsurface investigations to identify the presence of underground piping or utilities which would preclude borehole drilling.

9. Boreholes were drilled to provide a mechanism for logging subsurface direct radiation profiles and collecting subsurface soil and water samples. Boreholes were drilled by Site Engineers, Inc., of Cherry Hill, NJ, using a truck mounted 20 cm diameter hollow-stem auger. Seven holes were drilled at locations selected to be representative of the average property

conditions; nine holes were drilled in areas identified as having elevated direct radiation levels. The locations of these boreholes are shown on Figure 5.

A gamma scan of the boreholes was performed to identify elevated radiation levels, which would indicate subsurface residues. Radiation profiles in the boreholes were determined by measuring gamma radiation at 15-30 cm intervals between the surface and the hole bottom. A collimated gamma scintillation detector and portable scaler were used for these measurements.

A sample of the ground water was collected from four of the boreholes using a hand bailer. Soil samples of approximately 1 kg each were collected from various depths in the holes by scraping the sides of each borehole with an ORAU designed sampling tool.

10. Samples of sediment and water were collected from facilities of the sewage treatment plant. Locations of these samples are indicated on Figure 6.

11. Twenty soil samples and seven water samples were collected from the Lewiston area (but not on the NFSS or associated off-site properties) to provide baseline concentrations of radionuclides for comparison purposes. Direct background radiation levels were measured at locations where baseline soil samples were collected. The locations of the baseline samples and background measurements are shown on Figure 7.

Sample Analyses and Interpretation of Results

Soil and sediment samples were analyzed by gamma spectrometry. Radium-226 was the major radionuclide of concern, although spectra were reviewed for U-235, U-238, Cs-137, Th-232, and other gamma emitters. Water was analyzed for gross alpha and beta concentrations. One water sample was also analyzed for Ra-226.

Additional information concerning analytical equipment and procedures is contained in Appendix A.

Results of this survey were compared to the applicable guidelines for formerly utilized radioactive materials handling sites, which are presented in Appendix B.

RESULTS

Background Levels and Baseline Concentrations

Background exposure rates and baseline radionuclide concentrations in soil, determined for 20 locations (Figure 7) in the vicinity of the NFSS, are presented in Table 1-A. Exposure rates ranged from 6.8 to 8.8 μR/h (typical levels for this area of New York). Concentrations of radionuclides in soil were: Ra-226, <0.09 to 1.22 pCi/g (picocuries per gram); U-235, <0.14 to 0.46 pCi/g; U-238, <2.20 to 6.26 pCi/g; Th-232, 0.32 to 1.18 pCi/g; and Cs-137, <0.02 to 1.05 pCi/g. These concentrations are typical of the radionuclide levels normally encountered in surface soils.

Radioactivity levels in baseline water samples are presented in Table 1-B. The gross alpha and gross beta concentrations ranged from 0.55 to 1.87 pCi/l (picocuries per liter) and <0.63 to 14.3 pCi/l, respectively. These are typical of concentrations normally occurring in surface water.

Direct Radiation Levels

Direct radiation levels, systematically measured at 40 m grid intervals, are presented in Table 2. The gamma exposure rates at 1 m above the surface ranged from 6 to 12 μR/h (average 8 μR/h). At surface contact, the rates ranged from 6 to 13 μR/h (average 8 μR/h). Beta-gamma dose rates ranged from 6 to 47 μrad/h (average 19 μrad/h). Measurements performed with the detector shielded averaged approximately 20% less than those with the unshielded detector. This indicates only a small portion of the surface dose rate is due to nonpenetrating beta or low-energy photon

radiations. Direct radiation levels were generally slightly higher near the south central portion of the property.

The walkover survey identified five general areas and additional small isolated spots having elevated surface radiation levels. These locations are indicated on Figure 4 and associated direct radiation levels are presented in Table 3. Contact gamma exposure rates ranged from 12 to 84 μR/h. The maximum level was at grid location 392S, 352W - this location was within a larger area of generally elevated radiation levels. The maximum exposure level at 1 m above the surface was 26 μR/h, also measured at this same location. Contact beta-gamma dose rates ranged from 20 to 280 μrad/h. The highest dose rate was measured at grid point 172S, 350W; the dose rate measured at the location of the highest gamma exposure was 220 μrad/h. Sampling was performed at twelve of these areas of elevated direct radiation. This sampling was not effective in completely removing the source of the radiation levels; at some locations the levels remained unchanged or increased slightly following sample removal.

Radionuclide Concentrations in Surface Soil

Table 4 lists the concentrations of radionuclides measured in surface soil from 40 m grid intervals. These samples contained Ra-226 concentrations ranging from 0.41 to 4.21 pCi/g. Fifteen of the 82 systematic samples exceeded the range of Ra-226 in baseline soil samples. Concentrations of other radionuclides were not significantly different from those in the baseline samples.

Samples from locations of elevated contact radiation levels contained Ra-226 concentrations ranging from 7.55 to 349 pCi/g (see Table 5). The maximum level of Ra-226 was in sample B3 from grid location 172S, 350W. Most of the samples also contained elevated levels of U-235 and U-238. Sample B3 contained the maximum U-235 concentration of 17.4 pCi/g; sample B4 had the highest level of U-238 at 29.7 pCi/g. Sample B5 contained 2.37 pCi/g of Cs-137. There were no significant concentrations of other radionuclides noted in these samples.

Relative concentrations of Ra-226 and U-238 in samples B5 and B6 indicate that the source of contamination at these locations may be naturally occurring. Both of these samples were obtained in areas where gravel and rock have been used as fill material, following construction activities.

Borehole Gamma Logging Measurements

Gamma scintillation measurements performed in boreholes indicated that contamination was limited to the upper 15-30 cm of soil. Gamma logging data was not used to quanitify radionuclide concentrations in the subsurface soil because of the varying ratios of Ra-226, U-235, U-238, Cs-137, and Th-232 occurring in soils from this site.

Radionuclide Concentrations in Subsurface Soil

Table 6 presents the radionuclide concentrations measured in soil samples from boreholes. Boreholes H1 to H7, located to provide representative coverage of the property, did not contain radionuclide concentrations significantly different from baseline soil concentrations. Boreholes H8 through H16 were at locations selected on the basis of elevated direct radiation levels measured in their vicinity. Borehole H11 was located near the West Drainage Ditch; it contained no elevated radionuclide levels. Of the other boreholes, only H15, at grid location 392S, 352W, contained a subsurface Ra-226 concentration exceeding 15 pCi/g. The highest subsurface Ra-226 level at this location was 17.9 pCi/g at the 15 cm depth. At 30 cm the level of Ra-226 in this borehole decreased to 12.8 pCi/g.

Radionuclide Concentrations in Water

Water obtained from four of the boreholes contained gross alpha and gross beta concentrations ranging from 0.55 to 4.54 pCi/1 and 1.25 to 6.23 pCi/1, respectively (see Table 7). A water sample, collected from a manhole associated with the sewage treatment plant, contained a gross alpha

concentration of 7.04 pCi/l and a gross beta concentration of 16.0 pCi/l. This sample also contained 0.26 pCi/l of Ra-226.

Radionuclide Concentrations in Sediments from Sewage Treatment Facilities

Radionuclide concentrations in sediment samples from facilities in the sewage treatment plant are presented in Table 8. Samples SD10 and SD11 from the outfall settling tank contained U-238 concentrations of 75.3 and 32.5 pCi/g, respectively. Samples from the Chlorination Pit and Runoff Tank also had slightly elevated U-238 levels. The maximum Ra-226 concentration in these samples was 3.70 pCi/g in the Outfall Settling Tank sediment; this sample also had the highest levels of Cs-137 (4.93 pCi/g) and Th-232 (1.73 pCi/g). Other facilities in this plant did not contain radionuclide concentrations differing from baseline levels.

COMPARISON OF RESULTS WITH GUIDELINES

The guidelines applicable to cleanup of the off-site properties at NFSS are presented in Appendix B. All exposure rates at 1 m above the ground surface on property X are less than 20 μR/h above the background level. The average level of 8 μR/h is well below the guideline of 60 μR/h applicable to open land areas.

Areas of surface contamination, identified by the walkover scan, contain Ra-226 concentrations in excess of the 5 pCi/g guideline. Many of these areas of contamination are small and isolated; averaged over an area of 100 m^2 the resulting concentration of Ra-226 would satisfy the criteria of 5 pCi/g above background. Two areas of general contamination at 230-235S, 288-293W (near the sewage treatment pumphouse) and 355-404S, 340-360W (in the south central portion of the site) would exceed the 5 pCi/g criteria. The areas exceeding the Ra-226 criteria concentrations are shown on Figure 8 and the grid locations listed on Table 9. There are no surface soil areas exceeding criteria for other radionuclides.

Subsurface measurements and sampling indicate that the Ra-226 contamination below 15 cm is within the 15 pCi/g guideline.

Radionuclides in subsurface water are within the EPA Interim Drinking Water Standard of 15 pCi/l gross alpha, 50 pCi/l gross beta, and 3 pCi/l Ra-226.

Samples of sediment from the sewage treatment plant facilities, identified elevated levels of U-238, in the Outfall Settling Tank; however, the average concentration is below 75 pCi/g. Other sediments were also within the concentration guidelines for all radionuclides.

SUMMARY

A comprehensive survey of off-site property X at the Niagara Falls Storage Site was conducted during July and August 1983. The survey included surface radiation scans, measurements of direct radiation levels, and analyses of radionuclide concentrations in surface and subsurface soil, subsurface water, and sewage treatment plant sediments.

The survey identified areas of Ra-226 contamination in surface soil attributable to previous MED/AEC activities at this site (see Figure 8 and Table 9). Two general areas of approximately 25 m^2 and 980 m^2 and 15 cm deep would require removal of a total of about 150 m^3 of soil. Other areas are mainly small isolated spots; each of these could be eliminated by the removal of small amounts (<1 m^3) of surface soil.

Although there are small areas of contaminated residues on portions of this property, the contaminants do not pose potential health risks. There is no evidence that the migration of the radioactive materials is adversely affecting adjacent properties or the ground water.

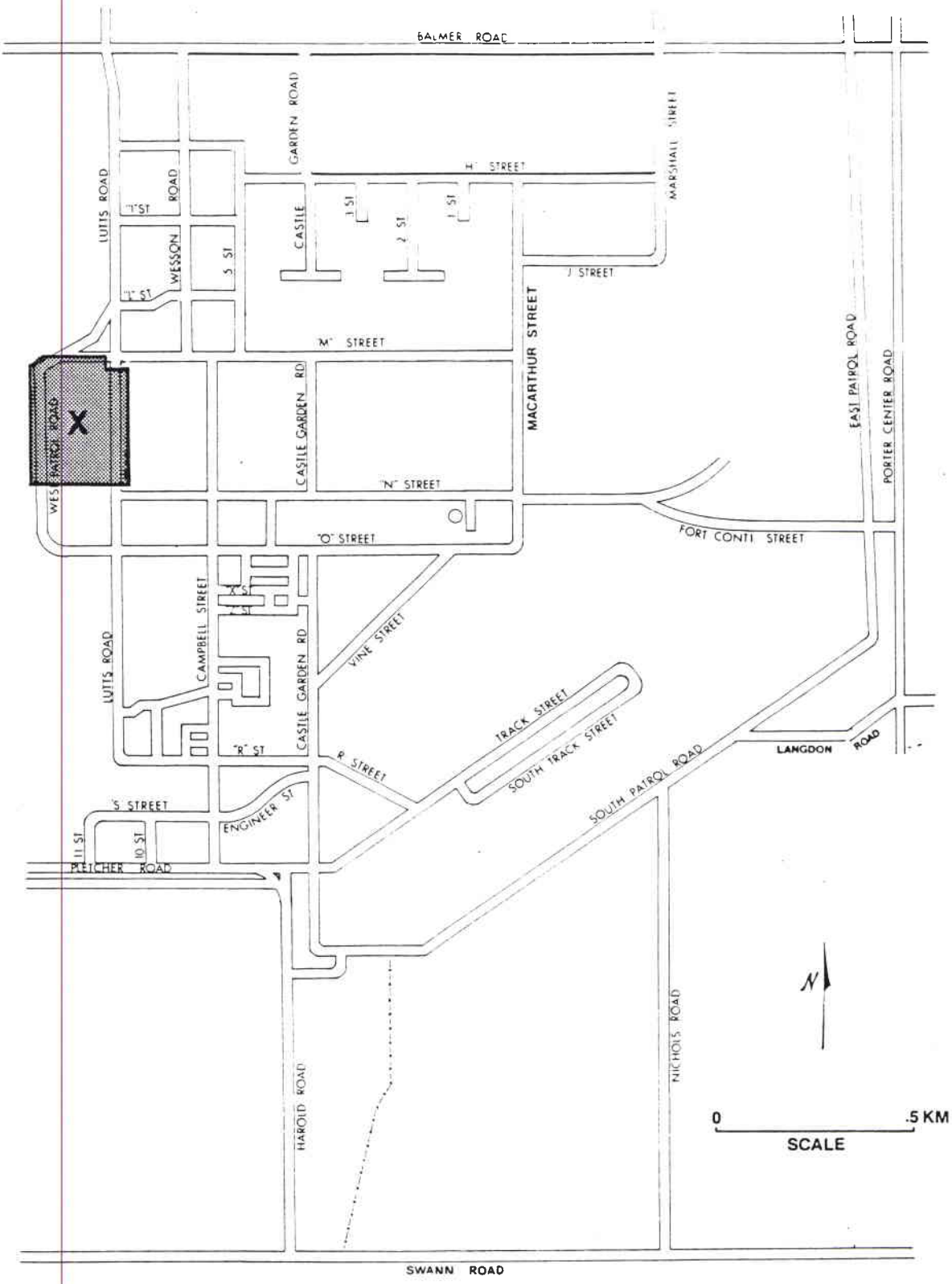

FIGURE 1. Map of Niagara Falls Storage Site and Off-Site Properties, Lewiston, New York, Indicating the Location of Off-Site Property X.

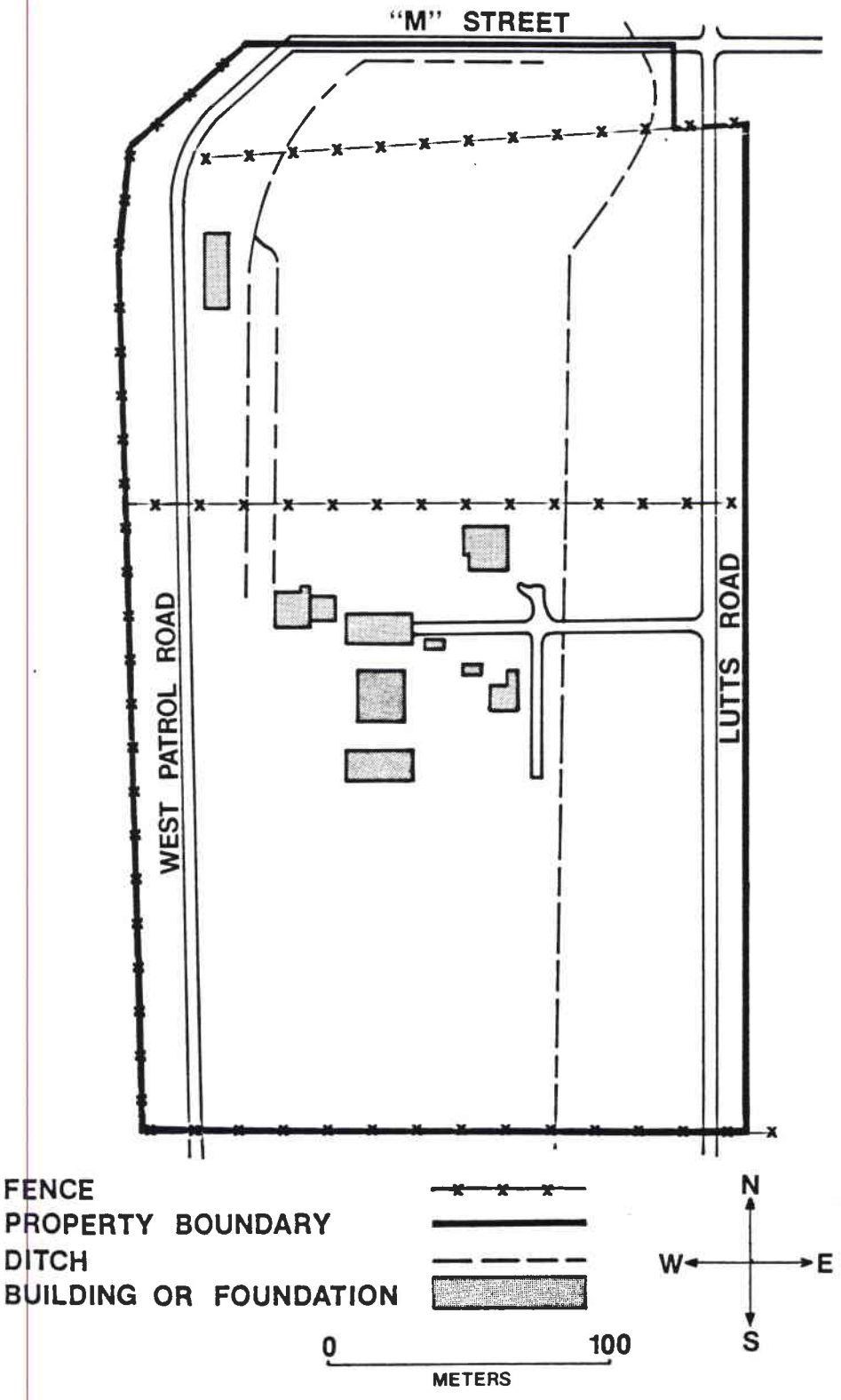

FIGURE 2. Plan View of NFSS Off-Site Property X Indicating Prominent Surface Features.

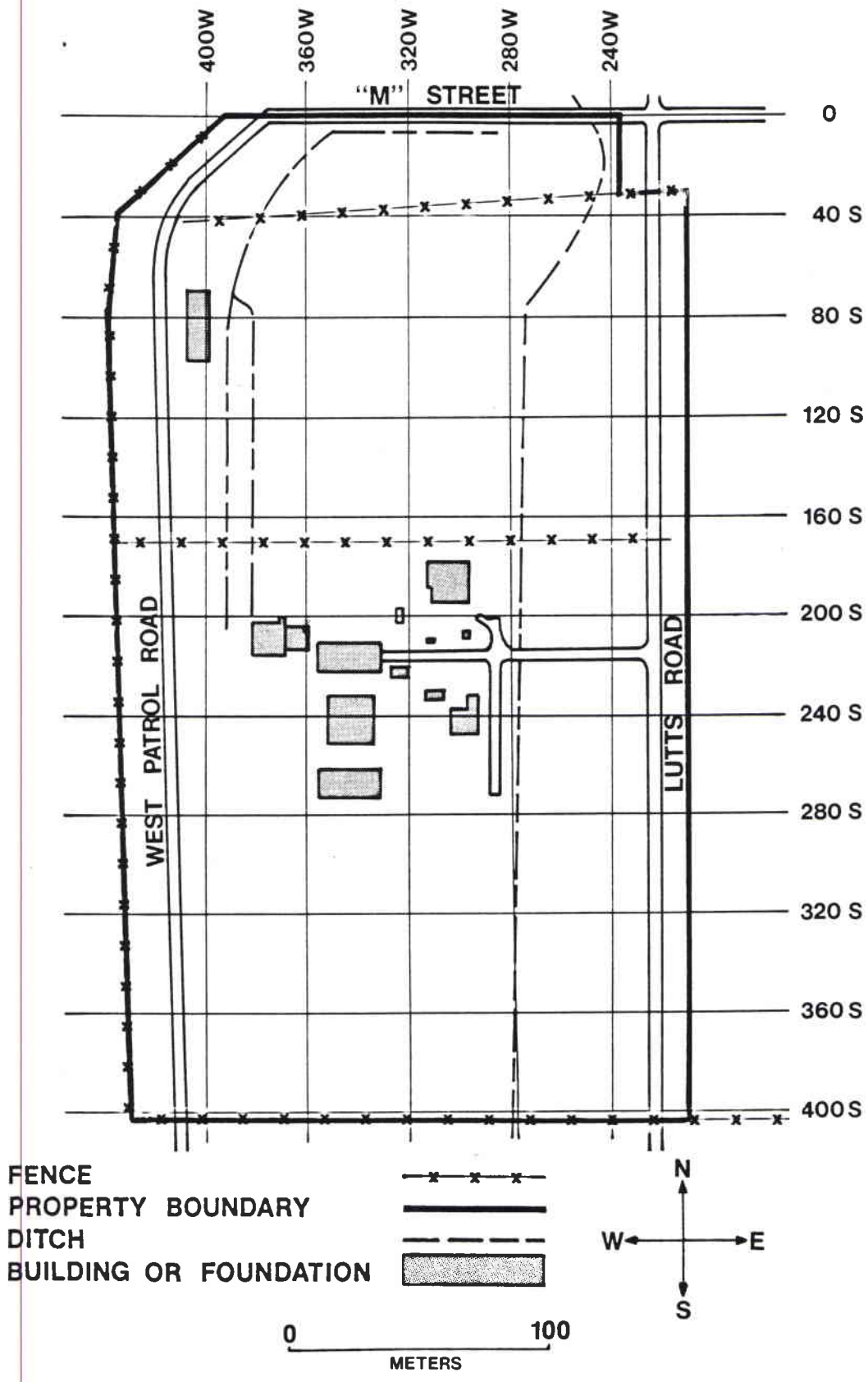

FIGURE 3. Plan View of NFSS Off-Site Property X Indicating the Grid System Established for Survey Reference.

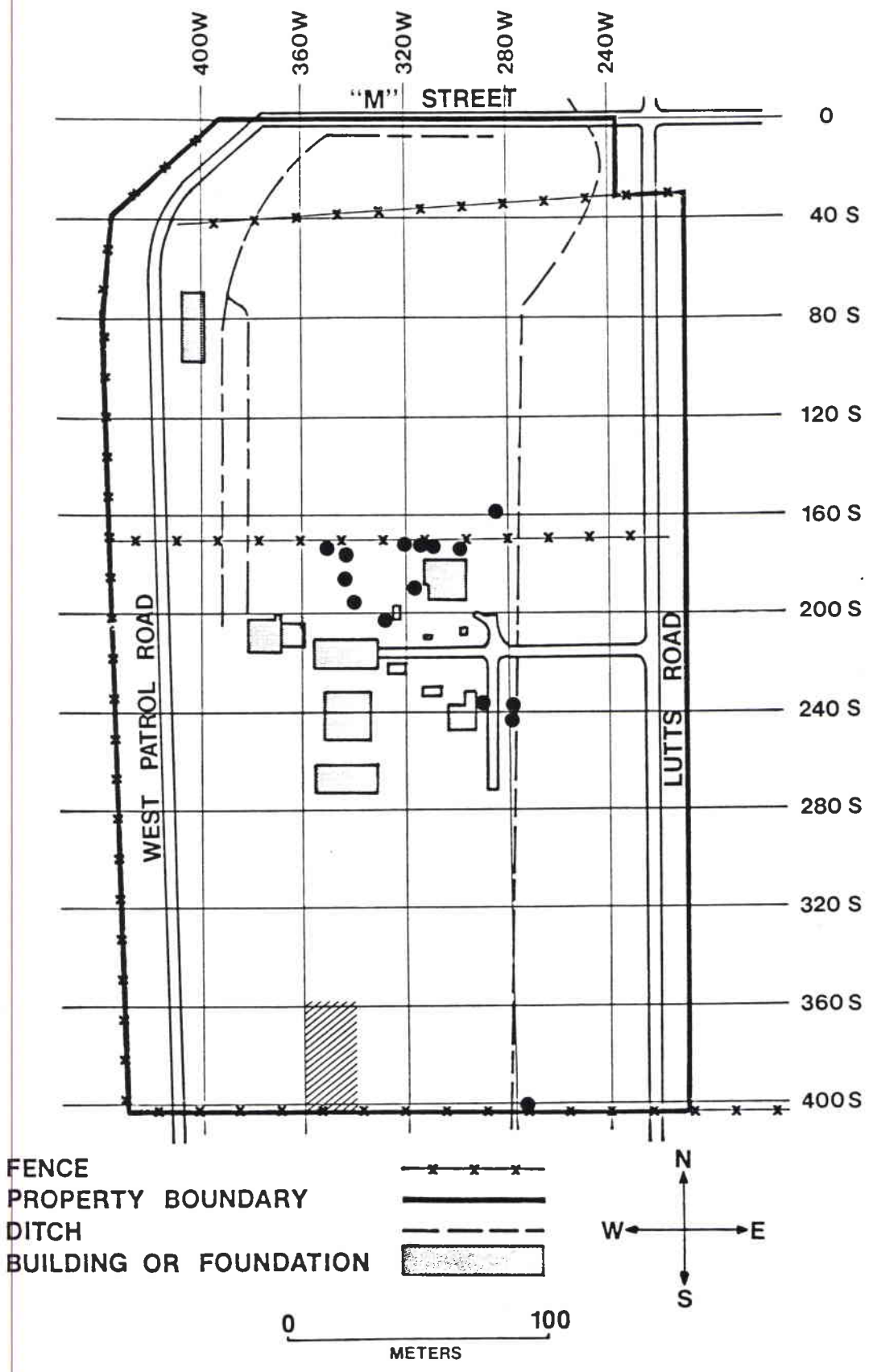

FIGURE 4. Locations of Areas of Elevated Direct Radiation. (Dots indicate small areas and cross hatching indicates a larger general area.)

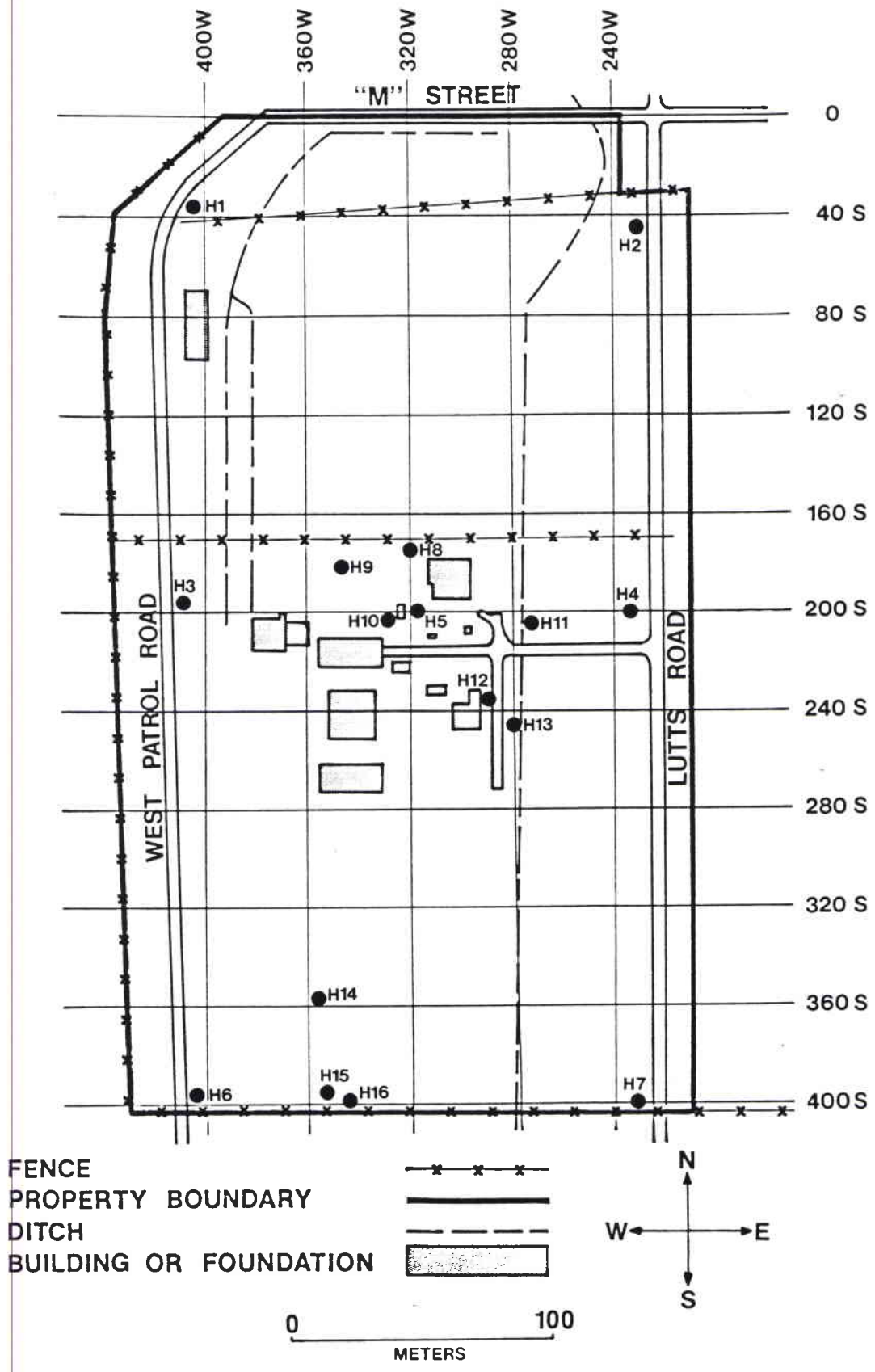

FIGURE 5. Locations of Boreholes for Subsurface Investigations.

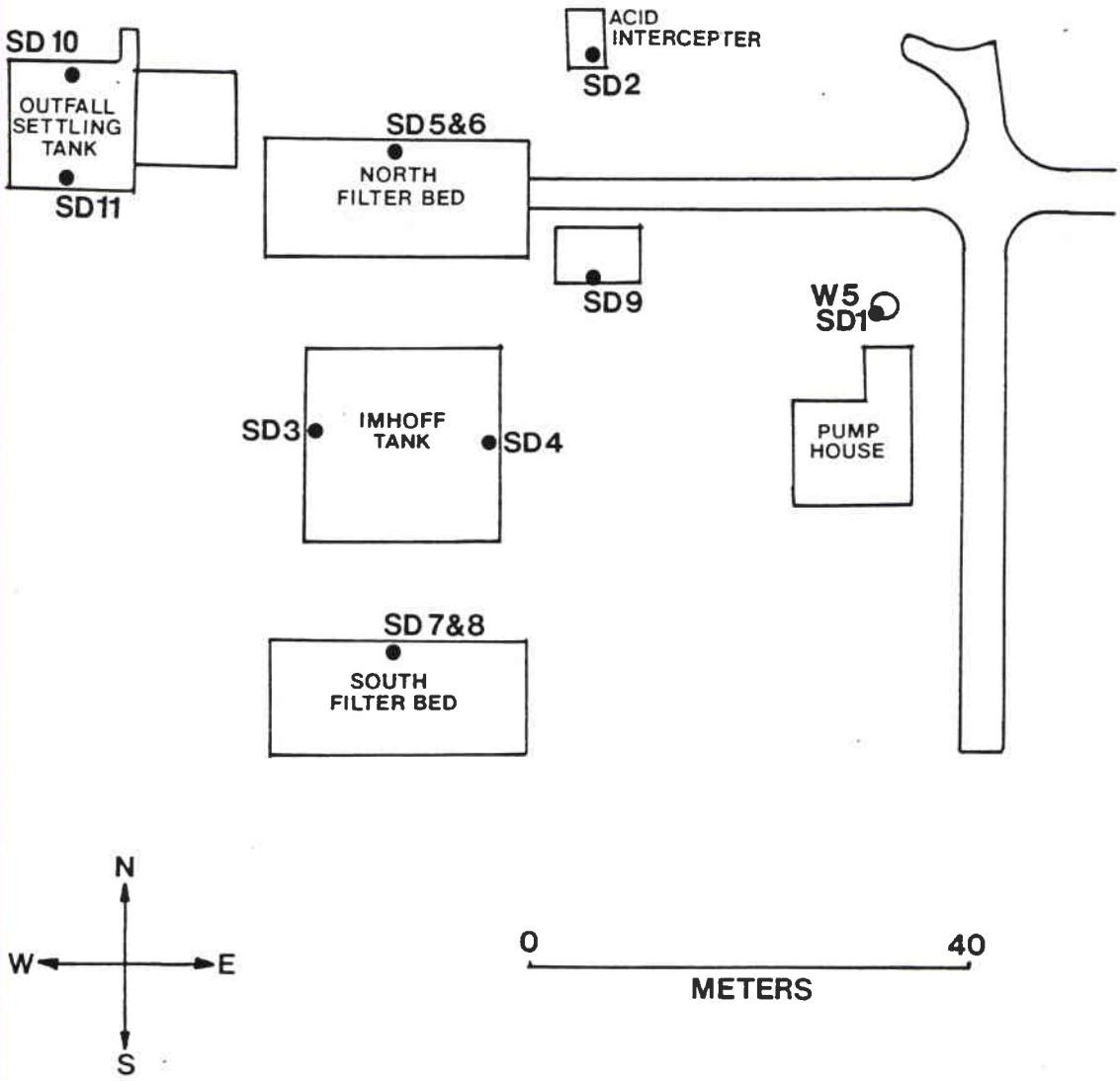

FIGURE 6. Sewage Treatment Facilities, Indicating Locations of Sediment and Water Samples.

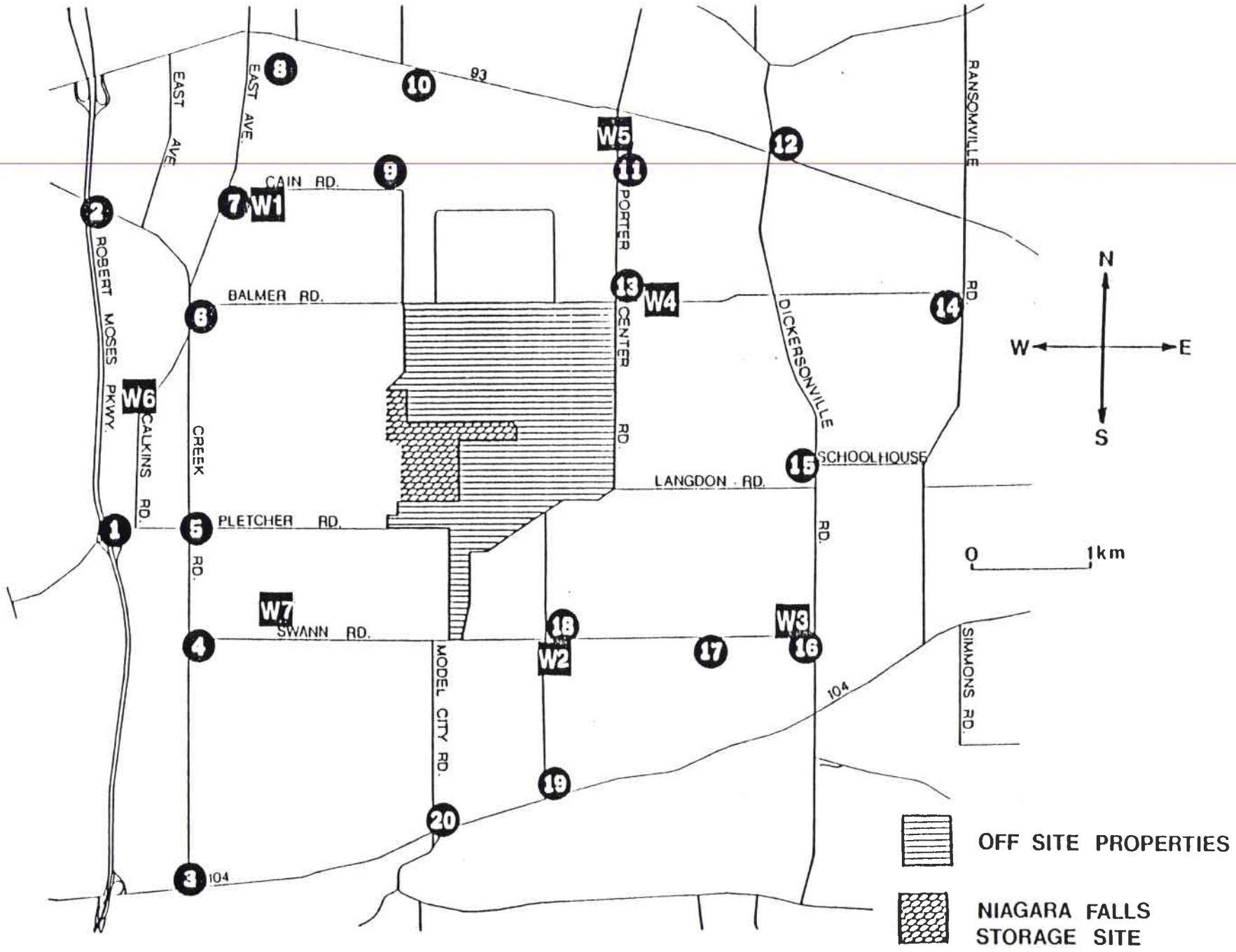

FIGURE 7. Map of Northern Niagara County, New York, Showing Locations of Background Measurements and Baseline Samples. (#1-20: soil samples and direct measurements; W1-W7: water samples)

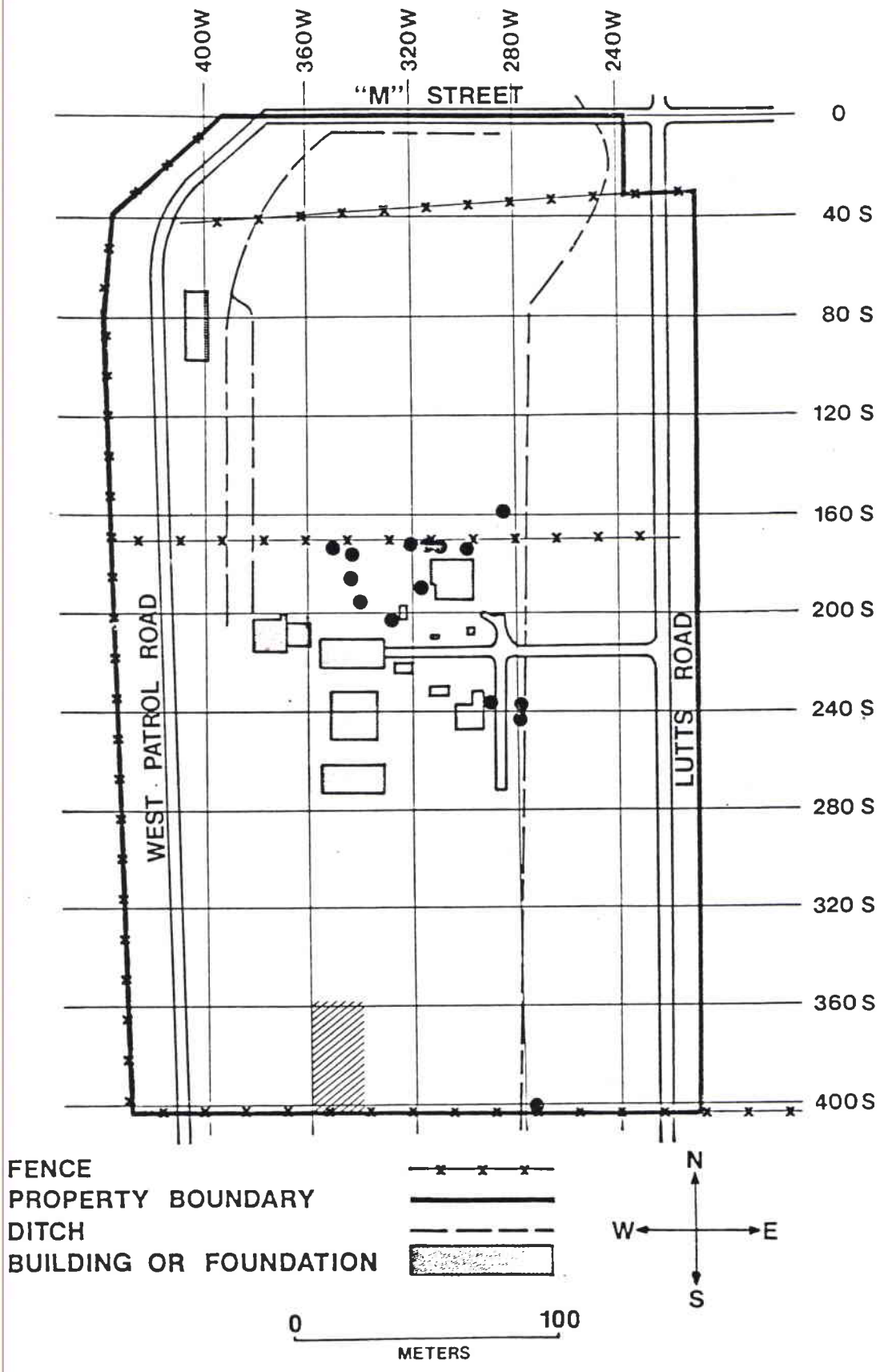

FIGURE 8. Map of NFSS Off-Site Property X Indicating Areas Where Radionuclide Concentrations in Soil Exceed Criteria. (Cross hatching indicates a large general area and dots indicate small isolated areas or "hot spots.")

TABLE 1-A

BACKGROUND EXPOSURE RATES
AND
BASELINE RADIONUCLIDE CONCENTRATIONS IN SOIL

Location[a]	Exposure Rate[b] (μR/h)	Radionuclide Concentrations (pCi/g)				
		Ra-226	U-235	U-238	Th-232	Cs-137
1	6.8	0.74 ± 0.16[c]	<0.19	<2.89	0.70 ± 0.46	0.29 ± 0.08
2	6.8	0.75 ± 0.19	<0.19	<3.35	<0.22	0.24 ± 0.08
3	8.3	0.71 ± 0.18	0.46 ± 0.41	<3.72	0.88 ± 0.33	0.34 ± 0.09
4	7.9	0.67 ± 0.18	<0.22	<4.10	1.18 ± 0.35	0.12 ± 0.07
5	7.3	0.70 ± 0.16	<0.17	<3.34	0.68 ± 0.24	0.14 ± 0.07
6	7.7	0.50 ± 0.15	<0.16	<2.33	0.52 ± 0.38	0.17 ± 0.09
7	7.7	0.63 ± 0.13	<0.17	<2.73	0.83 ± 0.24	0.35 ± 0.08
8	7.6	0.59 ± 0.12	<0.14	<2.20	0.54 ± 0.23	<0.02
9	7.1	0.63 ± 0.20	<0.23	<4.16	0.83 ± 0.38	0.69 ± 0.11
10	7.1	0.70 ± 0.16	<0.19	<2.98	<0.18	0.69 ± 0.10
11	6.7	<0.09	<0.19	<2.83	0.49 ± 0.31	0.48 ± 0.14
12	7.1	0.48 ± 0.13	<0.16	<2.84	0.65 ± 0.26	0.68 ± 0.10
13	6.7	0.57 ± 0.14	<0.17	<2.36	0.49 ± 0.26	0.41 ± 0.08
14	6.8	0.68 ± 0.17	<0.19	<3.24	0.67 ± 0.25	0.70 ± 0.10
15	8.2	0.65 ± 0.14	<0.17	<3.20	0.72 ± 0.35	0.23 ± 0.08
16	7.4	0.91 ± 0.17	<0.71	<3.58	0.83 ± 0.28	0.61 ± 0.09
17	7.0	0.48 ± 0.14	<0.16	<2.73	0.32 ± 0.22	0.38 ± 0.08
18	7.7	0.73 ± 0.16	<0.18	6.26 ± 9.23	<0.23	0.32 ± 0.12
19	8.8	1.22 ± 0.22	<0.23	<3.79	1.08 ± 0.49	1.05 ± 0.13
20	8.6	0.83 ± 0.17	<0.21	<3.59	0.84 ± 0.29	0.08 ± 0.07
Range	6.8 to 8.8	<0.09 to 1.22	<0.14 to 0.46	<2.20 to 6.26	<0.18 to 1.18	<0.02 to 1.05

[a] Refer to Figure 7.
[b] Measured at 1 m above the surface.
[c] Errors is 2σ based on counting statistics only.

TABLE 1-B

RADIONUCLIDE CONCENTRATIONS IN BASELINE WATER SAMPLES

Location[a]	Radionuclide Concentrations (pCi/l)	
	Gross Alpha	Gross Beta
W1	0.95 ± 0.93 [b]	4.79 ± 1.15
W2	0.95 ± 0.94	9.17 ± 1.31
W3	0.55 ± 0.78	2.73 ± 1.05
W4	0.63 ± 0.89	5.37 ± 1.17
W5	0.73 ± 0.68	<0.64
W6	1.87 ± 1.84	14.3 ± 2.4
W7	1.16 ± 0.66	<0.63
Range	0.55 to 1.87	<0.63 to 14.3

[a] Refer to Figure 7.
[b] Errors are 2σ based on counting statistics.

TABLE 2

DIRECT RADIATION LEVELS SYSTEMATICALLY MEASURED
AT 40 M GRID INTERVALS

Grid Location		Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
S	W			
0	240	6	6	7
0	280	6	6	6
0	320	6	6	6
0	360	6	6	6
0	380	7	7	30
40	212	8	9	19
40	240	9	9	24
40	280	9	10	37
40	320	7	7	30
40	360	8	8	38
40	400	8	9	12
40	435	8	8	21
80	212	8	9	25
80	240	8	8	32
80	280	10	11	29
80	320	8	8	21
80	360	8	8	9
80	400	8	8	9
80	435	7	8	14
120	212	8	8	8
120	240	7	8	17
120	280	9	9	13
120	320	8	9	12
120	360	8	8	8
120	400	8	8	21
120	438	7	8	19
160	212	8	8	10
160	240	7	8	8
160	280	9	9	17
160	320	8	9	28
160	360	8	9	24
160	400	8	8	19
160	436	8	8	16
200	212	7	8	16
200	240	8	9	13
200	280	8	8	8

TABLE 2, cont.

DIRECT RADIATION LEVELS SYSTEMATICALLY MEASURED
AT 40 M GRID INTERVALS

Grid Location		Gamma Exposure Rates at 1 m Above the Surface (μR/h)	Gamma Exposure Rates at the Surface (μR/h)	Beta-Gamma Dose Rates at 1 cm Above the Surface (μrad/h)
S	W			
200	320	7	7	7
200	360	9	9	28
200	400	7	7	11
200	440	7	8	9
240	212	8	8	8
240	240	8	9	9
240	280	10	10	47
240	320	6	6	6
240	360	8	9	9
240	400	7	8	26
240	438	8	8	21
280	212	8	8	21
280	240	8	8	24
280	280	9	8	24
280	320	7	7	13
280	360	7	7	11
280	400	8	7	32
280	432	8	8	12
320	212	8	9	9
320	240	8	8	23
320	280	10	10	23
320	320	8	8	8
320	360	8	8	27
320	400	9	9	22
320	432	7	7	13
360	212	8	8	16
360	240	8	8	22
360	280	12	12	24
360	320	10	10	24
360	360	12	13	29
360	400	9	9	29
360	428	8	8	8
400	212	8	9	9
400	240	8	9	23
400	280	11	11	24
400	320	8	9	9