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of Energy

COMPREHENSIVE RADIOLOGICAL SURVEY

OFF-SITE PROPERTY T

NIAGARA FALLS STORAGE SITE

LEWISTON, NEW YORK

A. J. BOERNER

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

FINAL REPORT

March 1984

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Prepared for

U.S. Department of Energy
as part of the
Formerly Utilized Sites -- Remedial Action Program

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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, (now known as the Niagara Falls Storage Site (NFSS) and associated 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 from 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]

SCA Chemical Services, Inc. (SCA) is the current owner of a tract identified as off-site property T (see Figure 1). A radiological survey of that tract, conducted in May-August 1983, is the subject of this report.

SITE DESCRIPTION

Figure 2 is a plot plan of off-site property T. The property is approximately 420 m long and 235 m wide and occupies a total area of 9.9 hectares. The site is bounded on all four sides by roads: "I" Street on the north, "M" Street on the south, Wesson Road on the east, and Lutts Road on the west. A fence borders "I" Street along the width of the property and for much of the length along Lutts Road. Portions of the West and Central Drainage Ditches pass through the property. "L" Street crosses the property in an east/west direction. Out-of-service railroad tracks are located on the western portion of the site.

Two structures on property T are used by SCA for miscellaneous materials storage. There are also three smaller buildings which are in poor condition and are unoccupied. All of the present buildings on the property and three water reservoirs were constructed for the Mathieson rocket fuel operations. There are scattered foundations and concrete pads indicating that additional structures were present on this site. Property T is partially overgrown with brush, weeds, and trees.

Radiological History

There is no evidence that contaminated waste was buried on property T. Temporary storage of contaminated material may have occurred - particularly along the railroad tracks and roads.[1] Following the 1972 decontamination efforts elevated gamma levels remained along the tracks and Wesson Road and at locations in the west-central, northwestern, and northeastern sections of the site.[2] The 1980 mobile scan by ORNL identified above background levels along Lutts Road, Wesson Road, "M" Street, and "L" Street.[3] Some of the direct radiation may be due to natural radioactivity in the rock fill used on this property. The Central and West Drainage Ditches and areas along their banks remained contaminated from previous run-off of residues stored on the DOE site.

SURVEY PROCEDURES

The comprehensive survey of NFSS off-site property T was performed by the Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU), during May-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 objective 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 T. Radiological information collected included:

1. direct radiation exposure rates and surface beta-gamma dose rates,
2. locations of contaminated surface areas,
3. concentrations of radionuclides in surface and subsurface soil,
4. concentrations of radionuclides in surface and ground water,
5. concentrations of radionuclides in sediment samples, and
6. radiation levels inside structures.

The Central Drainage Ditch, an easement of 13 m on each side of that ditch, and the West Drainage Ditch are being decontaminated and surveyed by Bechtel National, Inc. These areas were therefore not included in the ORAU survey operations.

Procedures

1. Brush and weeds were cleared as needed to provide access for gridding and surveying and a 20 m grid system was established by McIntosh and McIntosh of Lockport, NY, under subcontract. The grid system is shown on Figure 3.

2. Walkover surface scans were conducted over all accessible areas of the property. Traverses were at 2-5 m intervals on those areas that were relatively inaccessible and had no history of radioactive use. Scanning intervals were 1-2 m along all roads, railroads, in areas previously identified as having elevated radiation levels, and in other areas where direct radiation measurements suggested possible contaminated residues. Portable gamma NaI(Tl) scintillation survey meters were used for the scans. Locations of elevated contact radiation levels were noted.

3. Gamma exposure rate measurements were made at the surface and at 1 m above the surface at 20 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 at 1 cm above the surface at 20 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 nonpenetrating beta and low-energy gamma radiations. Meter readings were converted to dose rates 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 each accessible 20 m grid interval.

6. 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 samples were obtained from these locations and, following sampling, the surface exposure levels were remeasured for comparison with presampling levels.

7. Detection Sciences Group of Carlisle, MA, performed ground penetrating radar surveys at proposed borehole locations to assure that subsurface piping and utilities were not damaged during drilling. In many cases, boreholes were relocated slightly.

8. Boreholes were drilled to provide a mechanism for logging subsurface direct radiation profiles and collecting subsurface soil and water samples. Twenty-three boreholes were drilled by Site Engineers, Inc., of Cherry Hill, NJ, using a truck mounted 20 cm diameter hollow-stem auger. Two additional shallow boreholes were drilled by the ORAU survey team. The locations of these boreholes are shown on Figure 4.

Gamma radiation scans were performed in the boreholes to identify the locations of elevated direct radiation levels which might indicate subsurface residues. Radiation profiles in the boreholes were determined by measuring gamma radiation at 15-30 cm intervals between the surface and ground water or the hole bottom. A collimated gamma scintillation detector and portable scaler were used for these measurements.

Ground water samples of approximately 3.5 liters were collected from seven borehole locations. The samples were collected 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.

9. Four water samples were collected from areas of standing water (see Figure 5).

10. One sediment sample was collected from a drainage ditch (see Figure 5).

11. Walkover surface scans were performed in the buildings on this property and on the concrete foundations of demolished structures. NaI gamma scintillation detectors were used for these scans.

12. Twenty soil samples and seven water samples were collected from the Lewiston area (but not on 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 6.

Sample Analysis and Interpretation of Results

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

Additional information concerning analytical equipment and procedures is 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 6) 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, measured at 20 m grid intervals, are presented in Table 2. The gamma exposure rates at 1 m above the surface at these grid points ranged from 5 to 16 μR/h (average 8 μR/h). Surface contact gamma exposure rates and beta-gamma dose rates were 5 to 21 μR/h (average 8 μR/h) and 6 to 110 μrad/h (average 16 μrad/h), respectively. 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.

The walkover survey identified numerous areas with elevated contact radiation levels. These areas are indicated on Figure 7 and associated radiation levels are presented in Table 3. Surface contact gamma exposure rates at these locations ranged from 12-220 μR/h; the maximum contact level was measured at grid point 35N,18W. Exposure rates at 1 m above the surface ranged to 20 μR/h. Beta-gamma dose rates ranged from 17-1730 μrad/h. The maximum dose rate was measured near grid point 80N,40W. Sampling at many locations of elevated radiation levels did not significantly reduce the contact exposure rates; at some locations levels actually increased following sampling.

Although elevated areas were noted throughout property T, there appeared to be concentrations of such areas on certain portions of the site. Along the banks of the West Drainage Ditch there were mounds of soil up to 4 m in diameter and 1.5 m in height. These mounds are likely material dredged from the drainage ditch. Numerous small isolated "hot spots" were also noted along the railroad tracks and in several areas along the interior and perimeter roads. Additional generally elevated areas were associated with regions of rock and gravel fill around buildings and on the surface of old parking areas, e.g. in the northwest portion of the property.

Radionuclide Concentrations in Surface Soil

Table 4 lists the concentrations of radionuclides measured in surface soil from 20 m grid intervals. These samples contained Ra-226 concentrations ranging from 0.19 to 11.5 pCi/g. The highest level was in the sample collected at grid point 4N,97W along the edge of "M" Street and near the Central Drainage Ditch. Although many of the samples contained Ra-226 concentrations exceeding those in the baseline soil samples, only eight samples contained more than 5 pCi/g above the baseline level. Concentrations of U-235, U-238, Th-232, and Cs-137 were not significantly different from those in baseline samples. No other gamma emitting radionuclides were noted in these samples.

Radionuclide concentrations in samples from locations of elevated contact radiation levels are presented in Table 5. These samples appear to fall into three different categories. The first category is rocks or soil containing primarily Ra-226; included are samples B1, B10, B11, B12, B14, B16, B17, B21, B23, B24, B25, B27, B31, and B32. The highest Ra-226 content (570 pCi/g) was in a rock sample, B1. Similar rocks have been noted on other SCA properties in the vicinity of property T. Other samples in this category contained from 5.24 to 86.0 pCi/g of Ra-226.

Samples B2, B3, B4, B5, B6, B26, B29, and B35 represent a second general type of material. These are all rocks containing a high Th-232 content. Levels range from 153 pCi/g (B26) to 1180 pCi/g (B4). Ra-226 and U-238 concentrations are also elevated in these samples; levels of these two radionuclides are approximately the same.

The remainder of the samples are rock, gravel, and soil containing approximately equal quantities of Ra-226 and U-238, but with baseline or undetectable levels of Th-232. Concentrations of Ra-226 and U-238 in these samples typically range up to 50 pCi/g. This material is similar to that used on other off-site properties and throughout the Niagara Falls area as construction fill and paving base.

The latter two categories of material are believed to contain radionuclide levels of natural origin and are not likely attributable to previous MED/AEC activities at NFSS. The first category of material, containing primarily Ra-226, is probably associated with the MED/AEC operations at this site. Areas included in this group are primarily individual pieces of rock-like material or are piles of dredged sediments located along the West Drainage Ditch.

Borehole Gamma-Logging Measurements

The results of gamma scintillation measurements in boreholes indicate that contamination is confined to the upper 30 cm of soil, with the exception of areas near the West Drainage Ditch, where contamination extends to at least 60 cm. As evidenced by sample analysis, the gamma count rates determined by the borehole measurements were reliable indicators of elevated subsurface radionuclide levels. However, the gamma logging data was not useful in quantifying radionuclide concentrations in the subsurface soil, because of the varying ratios of Ra-226, U-235, U-238, Th-232, and Cs-137 occurring in soils from this site.

Radionuclide Concentrations in Borehole Soil Samples

Table 6 presents the radionuclide concentrations measured in soil samples from boreholes. The thirteen boreholes (H1-H13), located to provide a representative coverage of the property, contained radionuclide concentrations in the range of baseline levels. Most of the boreholes, H14-H24, drilled at locations identified by the walkover scan, contained elevated concentrations. The highest subsurface Ra-226 levels were measured in the piles of soil along the West Drainage Ditch; the maximum concentration of 36.4 pCi/l was at the 30 cm depth in borehole B20. Borehole H22 contained a Ra-226 concentration of 32.1 pCi/g at 15 cm deep. Subsurface concentrations of U-235, U-238, Cs-137, and Th-232 were not significantly different than baseline levels.

Radionuclide Concentrations in Water

Surface Water

Samples W1-W4 were collected from areas of standing water (refer to Table 7). These samples contained gross alpha concentrations ranging from <0.30 to <1.67 pCi/l. Gross beta concentrations ranged from 1.76 to 20.3 pCi/l. These values do not differ significantly from baseline levels.

Subsurface Water

Gross alpha and beta concentrations in subsurface water samples, collected from boreholes, ranged from 1.07 to 17.0 pCi/l and 2.27 to 11.6 pCi/l, respectively. The highest gross alpha concentration was in sample W11 from borehole H17. This sample was also analyzed for Ra-226 and contained <0.22 pCi/l of that radionuclide.

Radionuclide Concentrations in Sediment

One sediment sample was collected from a ditch located in the northwest portion of the property (see Table 8). An elevated Ra-226 concentration (9.15 pCi/g) was measured in this sample possibly due to its proximity to the Central Drainage Ditch. Levels of U-235, U-238, Cs-137, and Th-232 were in the ranges of baseline concentrations.

Building Surveys

Walkover radiation surface scans in buildings indicated gamma exposure rates ranging from 5-7 μR/h. No areas of elevated direct radiation levels, which would suggest the presence of contaminated residues, were noted and no further measurements were performed.

COMPARISON OF SURVEY RESULTS WITH GUIDELINES

The guidelines applicable to cleanup of off-site properties at the Niagara Falls Storage Site are presented in Appendix B. Radiation levels

and radionuclide concentrations, associated with small areas of surface or near-surface contamination, exceed these guideline values. However, when considered in terms of potential exposures or averaged over larger surface areas, many of these levels and concentrations meet the cleanup criteria.

The maximum exposure rate of 220 μR/h, in contact with one of the isolated areas of surface contamination, exceeds the guideline of 60 μR/h for open land areas accessible by the general public. Exposure rates at 1 m above the surface ranged from 8-20 μR/h and are well within the 60 μR/h criterion.

Most areas of surface contamination, identified by the walkover scan, contained Ra-226 concentrations in excess of 5 pCi/g. U-238 and Th-232 concentrations at some of these locations also exceeded the criteria of 150 pCi/g and 15 pCi/g, respectively. Many of these areas of contamination were small and isolated, and concentrations would be below the guidelines when averaged over an area of 100 m^2. The areas exceeding guidelines are summarized in Table 9 and shown on Figure 7.

Elevated radionuclide levels along the railroad tracks, roads, parking lots, and near buildings appear to be associated, in most cases, with rock or slag materials used as a fill and paving base. Radium, uranium, and thorium levels in this material are of natural origin and do not arise from previous government activities on this site. Similar materials have been noted on other properties at NFSS and in the Lewiston and Niagara Falls areas.

Mounds of sediment and debris - the result of dredging activities along the West Drainage Ditch - are also a source of elevated direct radiation levels and contain surface and subsurface Ra-226 concentrations exceeding guidelines. It is estimated that a total volume of approximately 216 m^3 of this material is present on property T.

Surface water contained radionuclide concentrations below the EPA limits of 15 pCi/l, gross alpha and 50 pCi/l, gross beta. One subsurface water sample contained a gross alpha concentration of 17.0 pCi/l. This

sample was analyzed for Ra-226 and found to contain <0.22 pCi/l - well below the EPA limit for that radionuclide. Gamma scans of buildings and foundations did not identify evidence of contaminated residues.

SUMMARY

A comprehensive survey of off-site property T at the Niagara Falls Storage Site was conducted during May-August 1983. The survey included: surface radiation scans, measurements of direct radiation levels, and analyses for radionuclide concentrations in soil and water samples, both surface and subsurface. Analyses of sediment samples were also performed. Ground penetrating radar was used to identify subsurface utilities which might preclude borehole drilling.

The results of the survey indicated small areas and isolated "hot spots" of Ra-226, U-238, and Th-232 contamination, which result in elevated direct radiation levels. The contamination is principally in the form of crushed rock or slag commonly used for fill and as a paving base in the Niagara Falls area; this material is not attributable to previous radioactive waste handling and storage activities at this site. Piles of Ra-226 contaminated sediment from dredging activities along the West Drainage Ditch were also identified. These piles and adjacent surface areas contain a volume of about 216 m^3.

Although the contaminated residues on small portions of this property exceed the guidelines established for release of the site for unrestricted use by the general public, the contaminants do not pose potential health risks to the public or site workers. There is no evidence that migration of the radioactive materials is adversely affecting adjacent properties or the ground water.

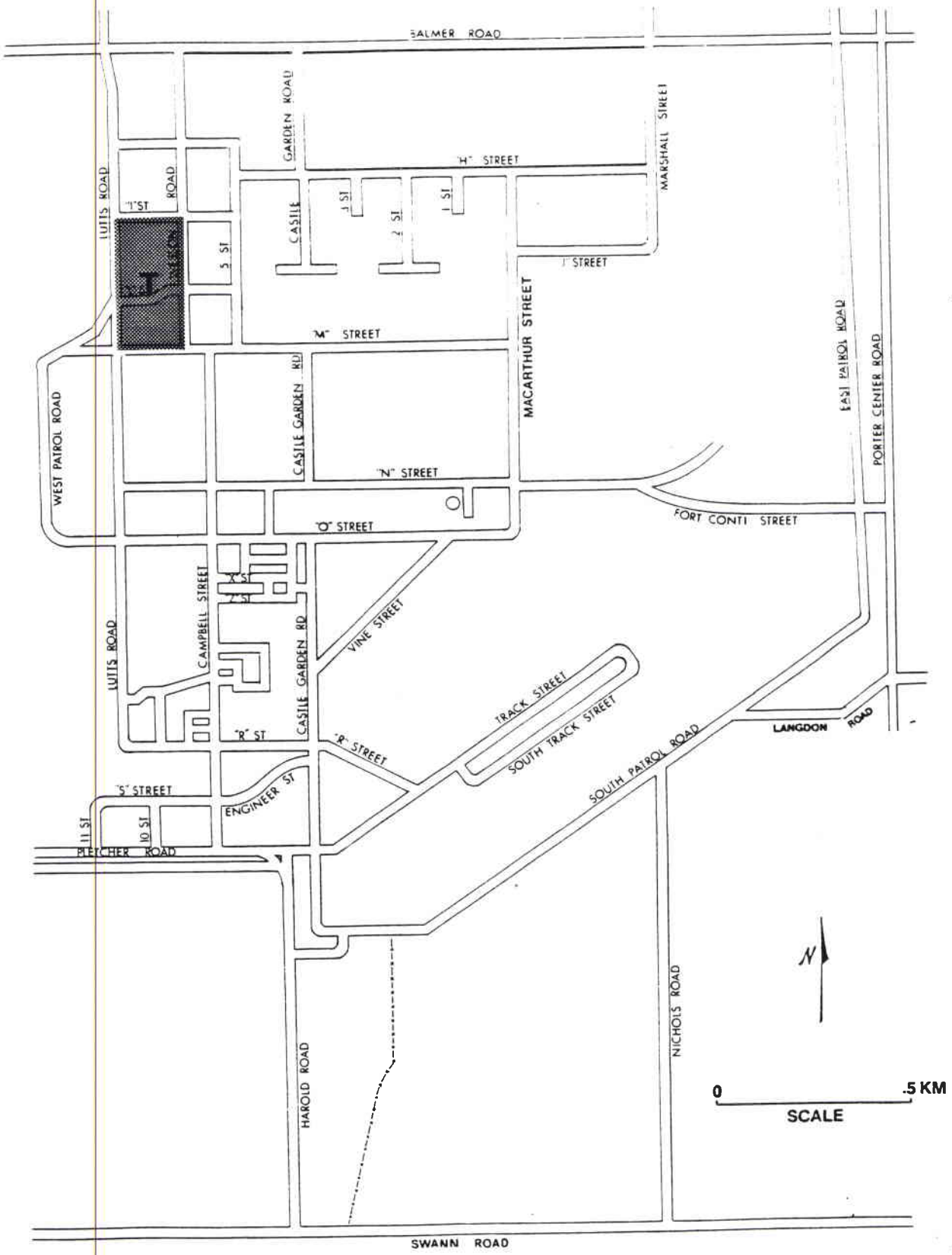

FIGURE 1. Map of Niagara Falls Storage Site and Off-Site Properties, Lewiston, New York, Indicating the Location of Off-Site Property T.

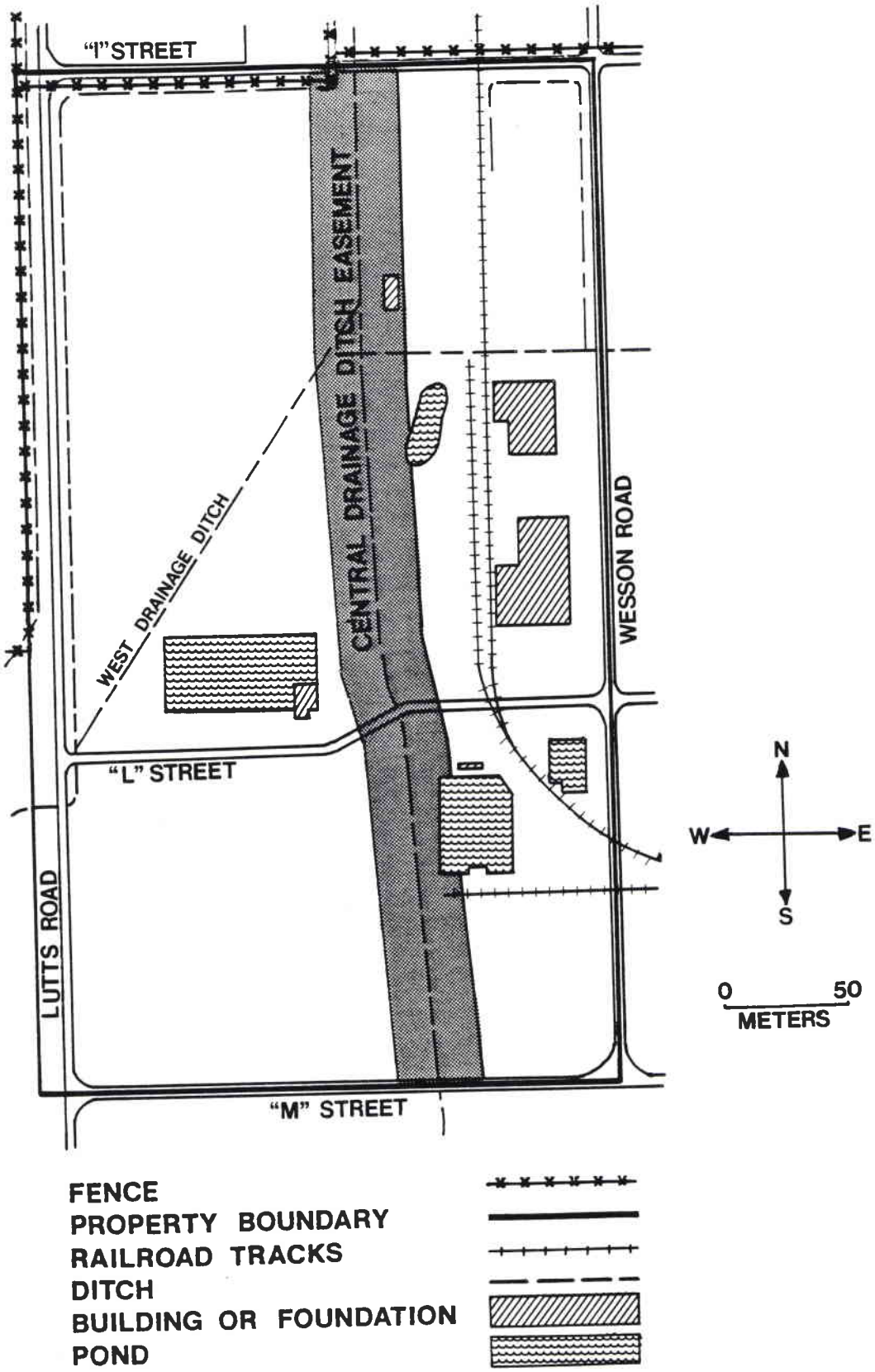

FIGURE 2. Plan View of NFSS Off-Site Property T Indicating Prominent Surface Features.

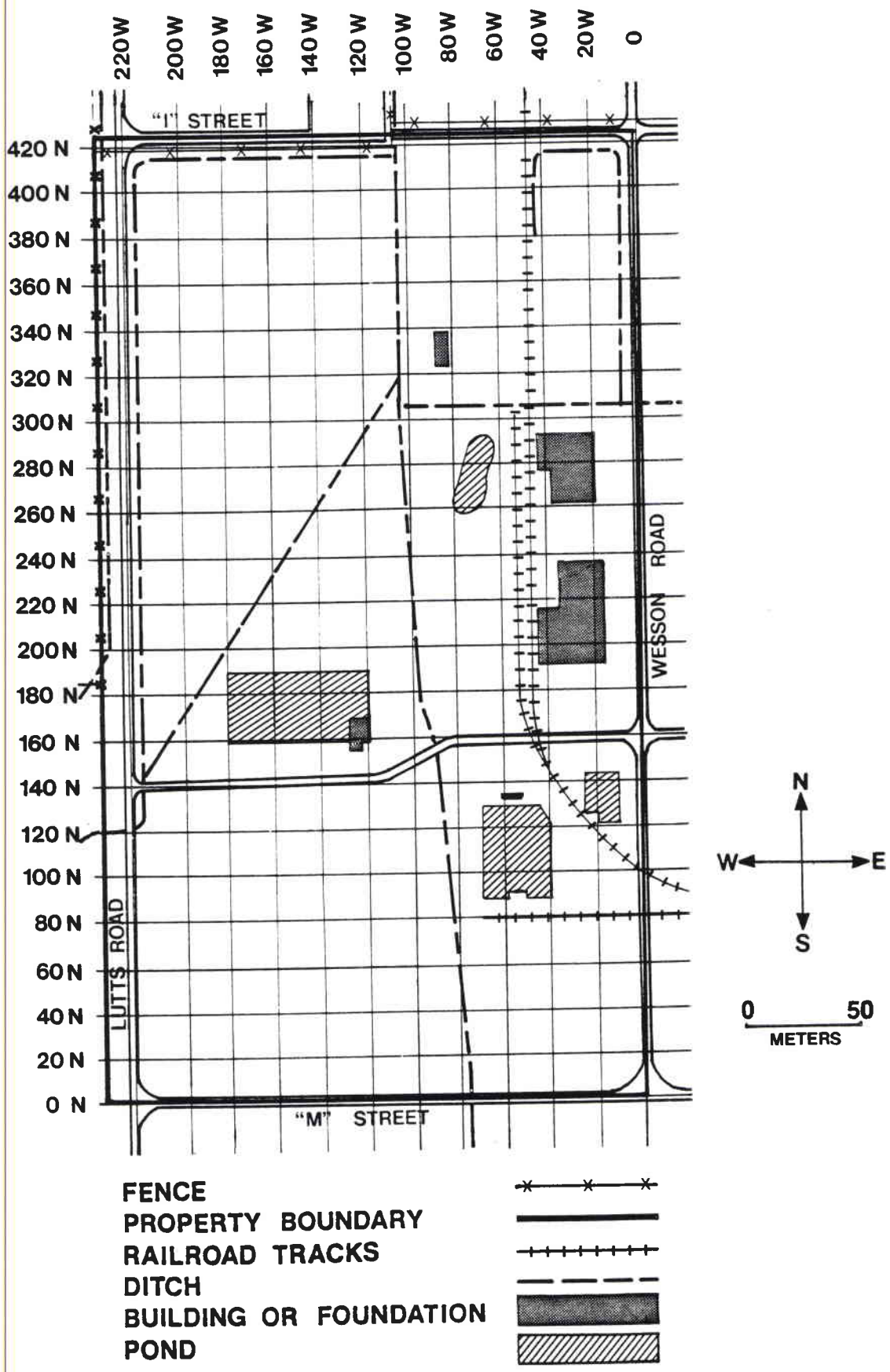

FIGURE 3. Plan View of NFSS Off-Site Property T Indicating the Grid System Established for Survey Reference.

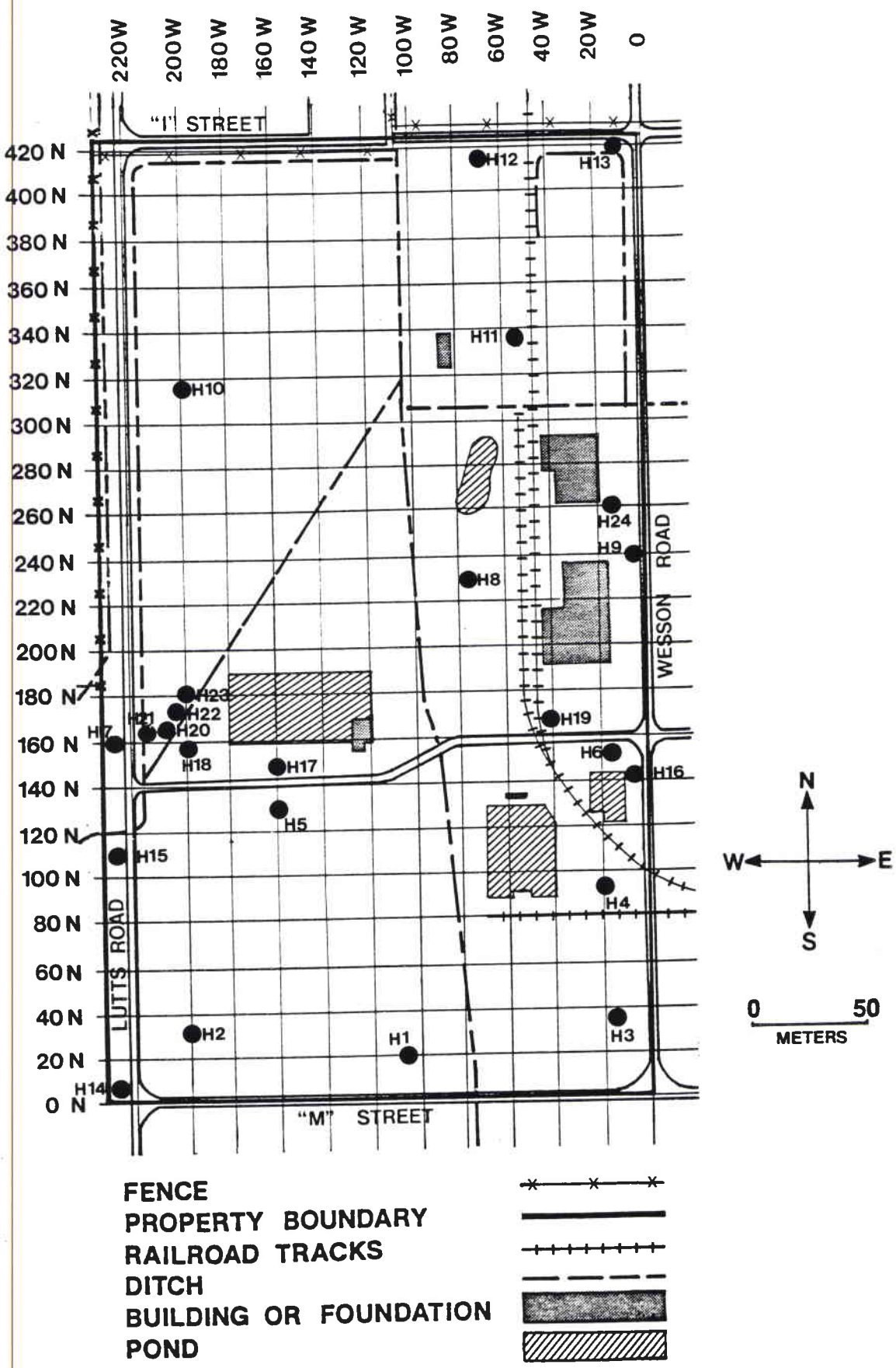

FIGURE 4. Locations of Boreholes for Subsurface Investigations.

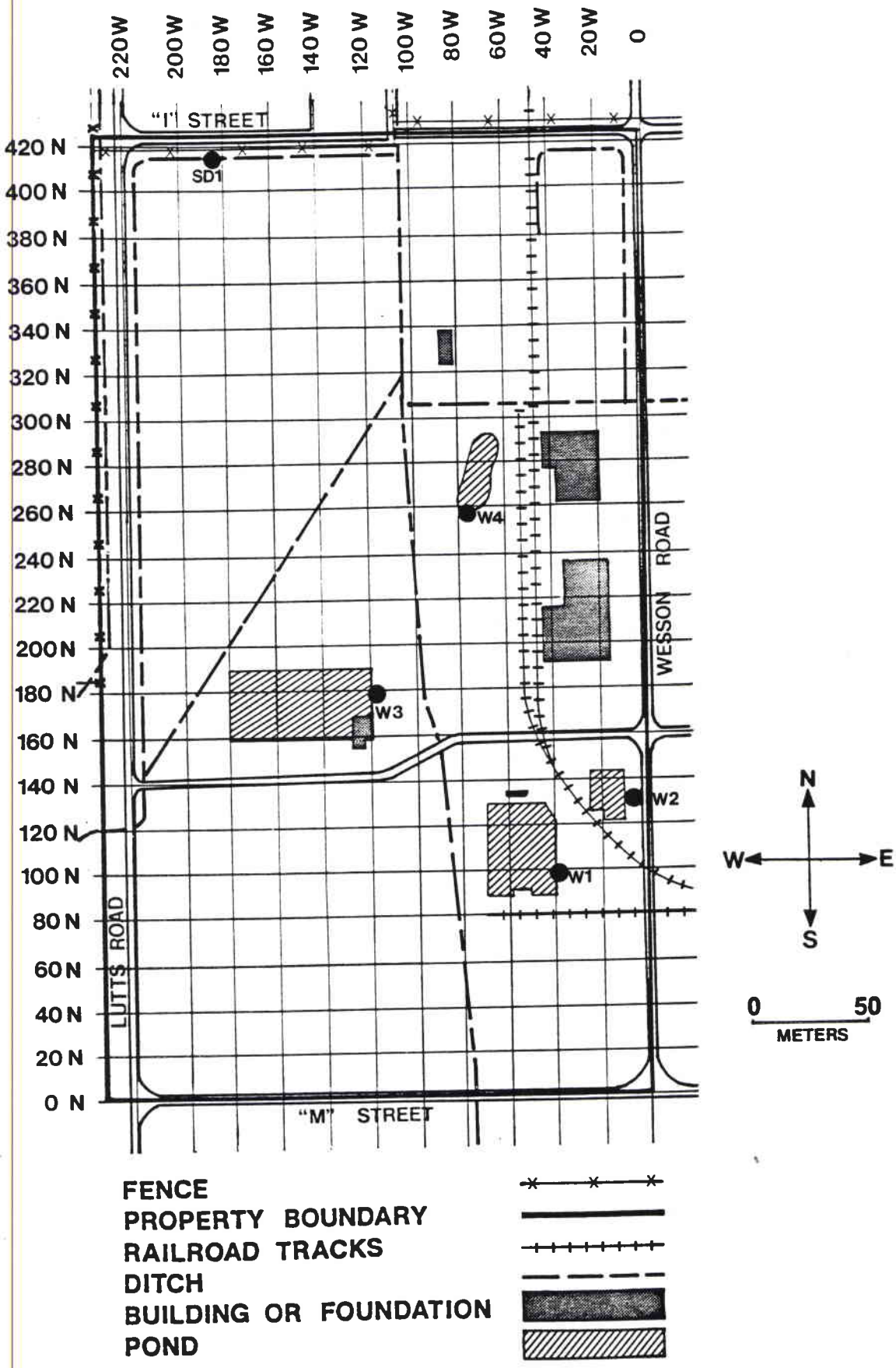

FIGURE 5. Locations of Water and Sediment Samples from Areas of Standing Water and Drainage Ditches.

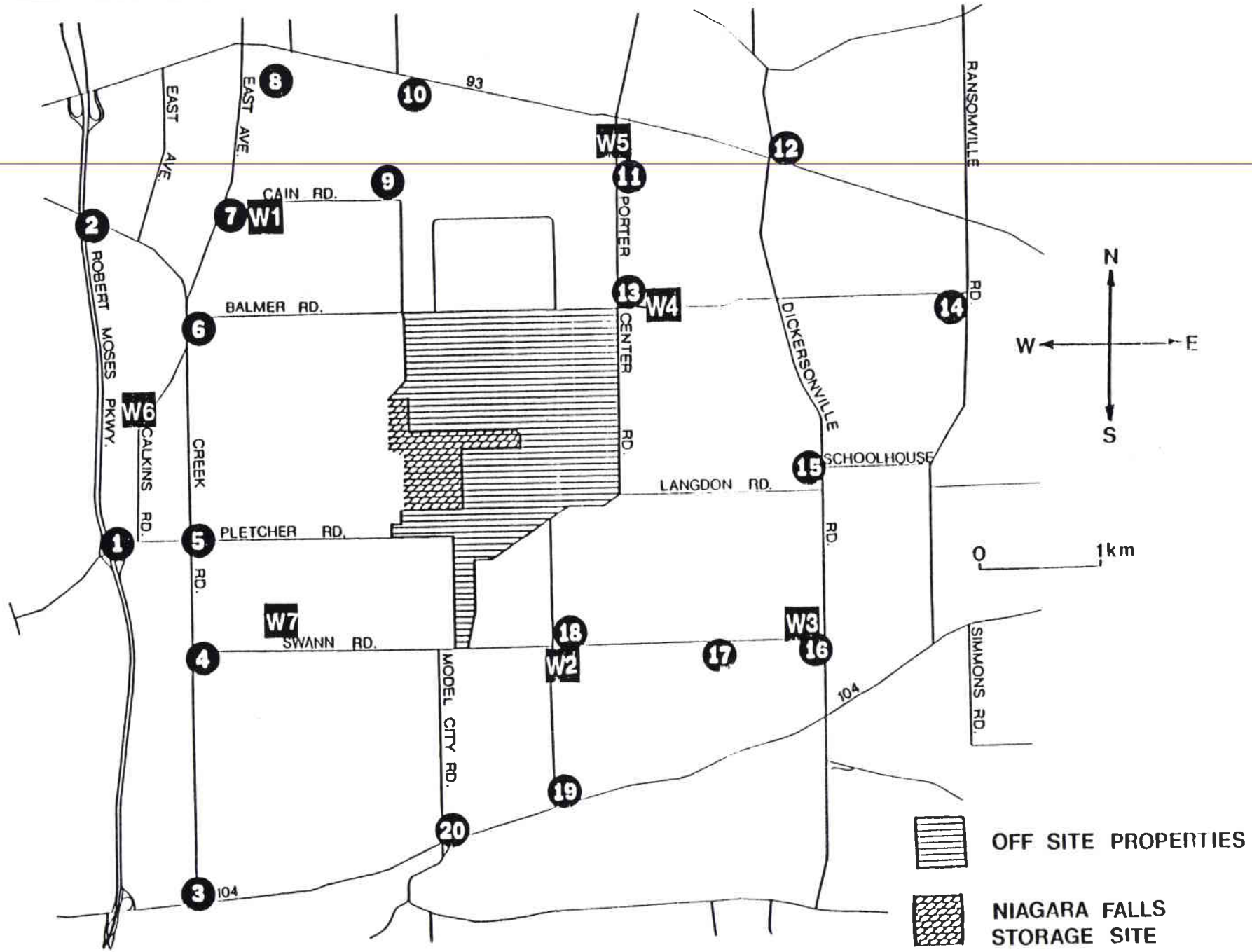

FIGURE 6. Map of Northern Niagara County, New York, Showing Locations of Background Measurements and Baseline Samples. (#1-20: soil samples and direct measurements; W1-W7: water samples.)

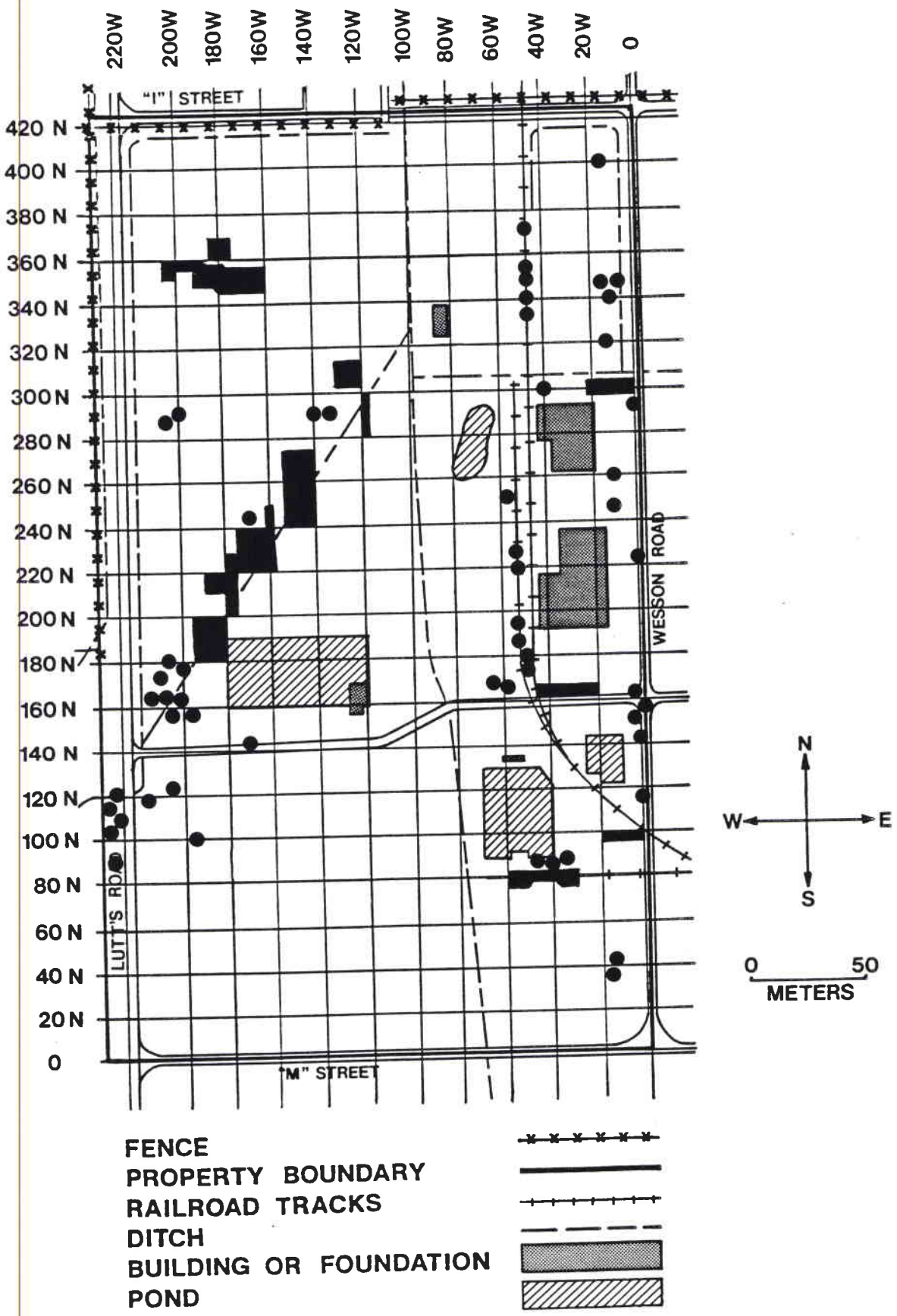

FIGURE 7. Locations of Areas of Elevated Direct Radiation and Areas Where Radionuclide Concentrations in Soil Exceed Criteria.

TABLE 1-A

BACKGROUND EXPOSURE RATES
AND
RADIONUCLIDE CONCENTRATIONS IN BASELINE SOIL SAMPLES

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	0.84 ± 0.24	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	0.59 ± 0.25	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	1.01 ± 0.44	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	0.32 to 1.18	<0.02 to 1.05

[a] Refer to Figure 6.
[b] Measured at 1 m above the surface.
[c] Errors are 2σ based on counting statistics.

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 6.
[b] Errors are 2σ based on counting statistics.

TABLE 2

DIRECT RADIATION LEVELS
MEASURED AT 20 M GRID INTERVALS

Grid Location N	Grid Location W	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)
0	0	9	10	22
0	20	10	9	9
0	40	9	10	20
0	55	10	10	18
0	80	a	a	a
0	97	8	9	16
0	100	8	9	9
0	120	9	9	19
0	140	9	10	25
0	160	9	8	14
0	180	10	10	11
0	200	8	8	11
0	220	9	9	13
0	235	6	6	6
20	0	8	8	17
20	20	7	7	21
20	40	7	7	7
20	55	7	7	9
20	97	9	9	13
20	100	8	8	14
20	120	8	8	11
20	140	7	7	26
20	160	8	8	8
20	180	8	8	21
20	200	7	7	14
20	220	8	8	8
20	235	7	7	17
40	0	8	9	20
40	20	9	8	19
40	40	7	7	9
40	57	8	9	19
40	97	8	8	10
40	100	8	8	21
40	120	7	7	17
40	140	8	7	7
40	160	7	7	7
40	180	7	7	16
40	200	7	7	13
40	220	8	8	8
40	235	8	8	24

TABLE 2, cont.

DIRECT RADIATION LEVELS
MEASURED AT 20 M GRID INTERVALS

Grid Location N	Grid Location W	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)
60	0	10	10	33
60	20	7	7	7
60	40	7	7	12
60	55	7	8	29
60	60	a	a	a
60	80	a	a	a
60	100	9	8	8
60	120	8	8	11
60	140	8	8	8
60	160	7	7	17
60	180	7	7	7
60	200	8	8	15
60	220	7	7	16
60	235	8	8	15
80	0	7	7	12
80	20	6	6	12
80	40	8	21	110
80	60	8	10	10
80	80	a	a	a
80	100	a	a	a
80	102	8	8	8
80	120	7	8	21
80	140	7	8	8
80	160	8	8	9
80	180	7	7	22
80	200	7	7	13
80	220	8	8	28
80	235	9	9	23
100	0	9	10	14
100	20	9	10	31
100	40	6	6	8
100	60	a	a	a
100	80	a	a	a
100	100	a	a	a
100	102	8	8	8
100	120	7	7	13
100	140	8	11	22
100	160	8	8	19
100	180	8	7	7
100	200	12	12	21

TABLE 2, cont.

DIRECT RADIATION LEVELS
MEASURED AT 20 M GRID INTERVALS

Grid Location N	Grid Location W	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)
100	220	8	7	12
100	235	12	10	27
120	0	11	9	11
120	20	8	7	12
120	40	7	7	13
120	60	a	a	a
120	80	a	a	a
120	100	a	a	a
120	105	7	7	10
120	120	7	8	12
120	140	7	7	7
120	160	7	8	12
120	180	7	7	7
120	200	12	13	35
120	220	10	9	12
120	235	a	a	a
140	0	9	9	17
140	20	a	a	a
140	40	6	6	6
140	60	7	8	19
140	64	7	7	7
140	105	7	7	14
140	120	7	7	7
140	140	9	8	15
140	160	8	8	24
140	180	9	8	16
140	200	10	10	35
140	220	11	7	16
140	235	8	8	15
160	0	12	11	17
160	20	8	8	31
160	40	11	10	25
160	60	12	12	32
160	67	12	14	29
160	106	7	7	16
160	120	6	7	12
160	140	a	a	a
160	160	a	a	a
160	181	7	7	7

TABLE 2, cont.

DIRECT RADIATION LEVELS
MEASURED AT 20 M GRID INTERVALS

Gird Location N	Gird Location W	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)
160	200	16	16	70
160	220	9	10	10
160	235	7	7	14
180	0	9	8	8
180	20	7	7	7
180	40	8	8	8
180	60	13	17	37
180	71	9	9	27
180	110	7	8	8
180	120	7	7	15
180	140	a	a	a
180	160	a	a	a
180	181	7	7	7
180	200	16	15	72
180	220	8	8	10
180	235	7	7	17
200	0	8	9	32
200	16	7	7	8
200	40	6	6	6
200	60	7	8	8
200	70	8	9	19
200	113	8	8	8
200	120	7	7	7
200	140	7	7	19
200	160	6	7	7
200	180	10	10	16
200	200	7	7	7
200	220	8	8	8
200	235	7	7	20
220	0	9	8	13
220	20	5	5	14
220	40	7	7	10
220	60	6	6	12
220	75	8	8	26
220	100	a	a	a
220	116	8	8	8
220	120	7	7	7
220	140	7	7	7
220	160	8	9	19

TABLE 2, cont.

DIRECT RADIATION LEVELS
MEASURED AT 20 M GRID INTERVALS

Grid Location N	Grid Location W	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)
220	180	13	12	18
220	200	7	8	16
220	220	7	7	7
220	235	6	7	15
240	0	9	9	32
240	20	8	8	17
240	40	8	8	21
240	60	7	7	8
240	79	8	8	21
240	100	a	a	a
240	118	8	8	16
240	120	8	8	13
240	140	8	8	16
240	160	12	13	26
240	180	8	8	14
240	200	8	8	14
240	220	6	7	14
240	235	7	7	10
260	0	7	7	7
260	20	7	7	8
260	40	7	7	22
260	60	7	7	26
260	78	7	8	28
260	100	a	a	a
260	118	10	10	40
260	120	8	8	8
260	140	10	10	24
260	160	8	8	14
260	180	6	6	11
260	200	7	7	7
260	220	7	7	12
260	235	6	6	6
280	0	10	10	31
280	20	6	6	6
280	40	6	6	20
280	60	7	7	16
280	78	7	8	22
280	100	a	a	a
280	119	9	9	9

TABLE 2, cont.

DIRECT RADIATION LEVELS
MEASURED AT 20 M GRID INTERVALS

Grid Location N	Grid Location W	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)
280	120	9	8	8
280	140	11	12	29
280	160	9	10	26
280	180	7	7	7
280	200	7	7	7
280	220	6	6	11
280	235	6	7	18
300	0	9	9	29
300	20	11	12	19
300	40	10	12	25
300	60	7	7	20
300	80	7	7	15
300	100	a	a	a
300	118	10	10	11
300	120	8	8	22
300	140	10	12	25
300	160	8	8	12
300	180	8	8	10
300	200	7	7	7
300	220	6	7	11
300	235	7	7	11
320	0	8	9	17
320	20	7	7	14
320	40	7	7	10
320	60	7	7	7
320	79	7	7	12
320	100	a	a	a
320	121	9	9	27
320	140	8	8	24
320	160	7	8	9
320	180	8	8	15
320	200	8	8	16
320	220	7	7	16
320	235	7	7	12
340	0	9	8	36
340	20	7	7	20
340	40	7	8	15
340	60	7	8	22
340	78	6	7	7

TABLE 2, cont.

DIRECT RADIATION LEVELS
MEASURED AT 20 M GRID INTERVALS

Grid Location N	Grid Location W	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)
340	100	a	a	a
340	118	10	11	34
340	120	10	11	27
340	140	12	12	30
340	160	11	11	21
340	180	8	8	18
340	200	8	8	8
340	200	8	8	8
340	220	7	7	17
340	235	7	7	23
360	0	8	8	27
360	20	7	7	7
360	40	7	7	8
360	60	8	8	12
360	78	8	8	8
360	100	a	a	a
360	117	12	12	32
360	120	8	8	24
360	140	9	9	13
360	160	9	9	19
360	180	9	10	16
360	200	12	12	18
360	220	7	7	12
360	235	7	7	19
380	0	8	8	15
380	20	7	8	8
380	40	7	7	7
380	60	7	7	23
380	78	9	9	24
380	100	a	a	a
380	118	8	8	8
380	120	8	7	7
380	140	7	7	11
380	160	7	7	20
380	180	7	7	11
380	200	7	7	7
380	220	7	7	10
380	235	7	7	7

TABLE 2, cont.

DIRECT RADIATION LEVELS
MEASURED AT 20 M GRID INTERVALS

Grid Location N	Grid Location W	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)
400	0	8	8	26
400	20	7	7	7
400	40	7	7	20
400	60	7	8	12
400	79	9	10	20
400	100	a	a	a
400	119	7	8	18
400	120	8	7	7
400	140	7	7	6
400	160	7	7	7
400	180	7	7	7
400	200	7	6	16
400	220	7	7	16
400	235	7	7	20
420	0	8	8	23
420	20	8	8	8
420	40	7	8	10
420	60	10	12	72
420	78	8	8	20
420	100	a	a	a
420	117	8	9	17
420	120	8	7	23
420	140	7	7	18
420	160	7	8	8
420	180	7	7	9
420	200	6	6	7
420	220	6	6	6
420	235	7	7	24

[a] No measurement taken due to presence of the West and Central Drainage Ditches, areas of standing water, or buildings.

TABLE 3

DIRECT RADIATION LEVELS AT LOCATIONS
IDENTIFIED BY THE WALKOVER SURFACE SCAN

Grid Location[a]		Exposure Rate (μR/h)		Surface Dose Rate (μrad/h)	Sample Identification	Contact Exposure Rates After Sample Removal (μR/h)
N	W	Contact	1 m Above Surface			
35	18	220	17	380	B1	240
35	19	76	----[b]	----	----	----
41	18	20	13	----	----	----
79	37	20	----	----	----	----
79	50	68	----	----	----	----
79	52	37	----	----	----	----
79	55	68	----	----	----	----
80	34	68	----	----	----	----
80	35	68	12	1020	B2	12
80	38	84	----	----	----	----
80	39	59	----	----	----	----
80	40	84	13	1730	B3	10
80	43	72	----	----	----	----
80	45	29	----	----	----	----
80	46	84	12	1330	B4	8
80	50	33	12	390	B5	8
80	51	68	----	----	----	----
80	53	84	----	----	----	----
80	56	84	11	1550	B6	9
85	40	17	12	17	B7	17
87	43	21	14	68	B8	27
90	32	23	12	26	B9	37
90	230	21	13	42	B10	20
94-99	4-18	23-29	----	----	----	----
95	5	29	20	43	----	----
97	7	40	----	----	----	----

TABLE 3, cont.

DIRECT RADIATION LEVELS AT LOCATIONS
IDENTIFIED BY THE WALKOVER SURFACE SCAN

Grid Location		Exposure Rate (μR/h)		Surface Dose Rate (μrad/h)	Sample Identification	Contact Exposure Rates After Sample Removal (μR/h)
N	W	Contact	1 m Above Surface			
99	15	23	8	110	----	----
100	196	36	12	52	B11	46
105	228	21	14	30	B12	29
103-106	230-234	25-27	----	----	----	----
107-116	224-229	20-40	----	----	----	----
109	228	30	----	----	----	----
110	228	39	----	----	----	----
111	228	35	18	85	B13	35
114	228	40	----	----	B14	----
112	1	35	----	----	----	----
113	0	40	----	----	----	----
115	7	31	17	60	B15	33
115	228	31	20	130	B16	44
119	214	27	----	----	----	----
119	215	42	----	----	----	----
119	230	24	----	----	----	----
120	234	31	14	92	B17	34
123	203	45	----	----	----	----
123	205	42	----	----	----	----
143	6	40	12	110	B18	----
143-146	169-170	21-25	----	----	B19	----
154	202	40	----	----	----	----
155	2	29	----	----	----	----
155	4	30	18	69	B20	----
156	2	31	----	----	----	----
159	2	26	----	----	----	----

TABLE 3, cont.

DIRECT RADIATION LEVELS AT LOCATIONS
IDENTIFIED BY THE WALKOVER SURFACE SCAN

Grid Location N	Grid Location W	Exposure Rate (μR/h) Contact	Exposure Rate (μR/h) 1 m Above Surface	Surface Dose Rate (μrad/h)	Sample Identification	Contact Exposure Rates After Sample Removal (μR/h)
159	51	20	----	----	----	----
159	52	20	----	----	----	----
159	198	29	----	----	B21	----
162	43	26	----	----	----	----
162	46	23	----	----	----	----
162	202	40	----	----	----	----
164	7	21	----	----	----	----
162-164	20-40	14-27	----	----	----	----
164	24	27	----	----	----	----
164	26	24	----	----	----	----
163-164	44-46	17-29	----	----	B22	----
164	212	29	----	----	B23	----
165	60	27	----	----	----	----
165	209	22	----	----	B24	----
167	65	22	----	----	----	----
168	210	22	----	----	B25	----
173	49	38	----	----	----	----
177	49	95	----	----	B26	----
178	201	23	----	----	B27	----
178	207	33	----	----	----	----
180	49	40	----	----	----	----
180	52	76	----	----	----	----
180-200	180-196	12-84	----	----	B28	----
181	192	84	----	----	----	----
184	52	95	----	----	B29	----
185	52	84	----	----	----	----

TABLE 3, cont.

DIRECT RADIATION LEVELS AT LOCATIONS
IDENTIFIED BY THE WALKOVER SURFACE SCAN

Grid Location		Exposure Rate (μR/h)		Surface Dose Rate (μrad/h)	Sample Identification	Contact Exposure Rates After Sample Removal (μR/h)
N	W	Contact	1 m Above Surface			
185	56	84	----	----	----	----
187	56	50	----	----	----	----
189	52	43	----	----	----	----
189	56	36	----	----	----	----
190	52	38	----	----	----	----
190	56	53	----	----	----	----
195	56	31	----	----	----	----
215	54	45	----	----	----	----
220	54	44	----	----	----	----
206-211	114-118	17-40	----	----	----	----
207	114	40	----	----	----	----
209	118	22	----	----	----	----
200-217	175-180	23-25	----	----	----	----
210-219	183-187	17-27	----	----	----	----
215	186	27	----	----	----	----
221	0	22	----	----	----	----
221	3	44	----	----	----	----
221	175	40	----	----	----	----
221	178	40	----	----	----	----
222-240	160-174	29-40	----	----	----	----
225	178	25	----	----	----	----
228	54	50	----	----	----	----
228	55	31	----	----	----	----
241-247	6-7	29-40	----	----	----	----
242	6	32	----	----	----	----
242	7	40	----	----	----	----

TABLE 3, cont.

DIRECT RADIATION LEVELS AT LOCATIONS
IDENTIFIED BY THE WALKOVER SURFACE SCAN

Grid Location N	Grid Location W	Exposure Rate (μR/h) Contact	Exposure Rate (μR/h) 1 m Above Surface	Surface Dose Rate (μrad/h)	Sample Identification	Contact Exposure Rates After Sample Removal (μR/h)
245	6	38	----	----	----	----
244	13	25	----	----	----	----
250	59	47	----	----	----	----
260	14	27	----	----	B30	----
240-274	140-157	12-33	----	----	B31	----
243-247	159-162	14-25	----	----	B32	----
243-245	165-168	14-38	----	----	----	----
290	201	106	----	----	----	----
292	136	20	----	----	----	----
292	138	22	----	----	----	----
292	200	21	----	----	----	----
294	4	27	14	56	B33	28
298-300	4-20	17-28	----	----	----	----
300	40	20	----	----	----	----
280-300	118-119	17-20	----	----	----	----
300-305	8-22	17-29	----	----	----	----
304-314	120-129	14-20	----	----	----	----
323	14	22	----	----	----	----
332	47	56	----	----	----	----
333	47	84	----	----	----	----
340	47	129	----	----	----	----
342	15	25	----	----	----	----
348	14	25	----	----	----	----
348	15	29	----	----	----	----
348	49	27	----	----	----	----
349	49	29	----	----	----	----

TABLE 3, cont.

DIRECT RADIATION LEVELS AT LOCATIONS
IDENTIFIED BY THE WALKOVER SURFACE SCAN

Grid Location N	Grid Location W	Exposure Rate (μR/h) Contact	Exposure Rate (μR/h) 1 m Above Surface	Surface Dose Rate (μrad/h)	Sample Identification	Contact Exposure Rates After Sample Removal (μR/h)
356	47	58	----	----	----	----
346-354	161-180	17-22	----	----	----	----
343-347	183-187	20-29	----	----	----	----
353-355	184-187	20-27	----	----	----	----
355-357	188-191	29-48	----	----	B34	----
355-357	192-196	17-22	----	----	----	----
351-357	203-206	29-40	----	----	----	----
360-366	179-183	17-40	----	----	----	----
369	48	76	----	----	B35	----
372	48	36	----	----	----	----
400	15	29	----	----	----	----

a Refer to Figure 7.
b Dash indicates measurement or sampling was not performed.

TABLE 4

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
9	5	2.84 ± 0.40[a]	<0.40	5.19 ± 1.54	1.58 ± 0.18	0.80 ± 0.28
4	20	b	b	b	b	b
4	40	2.85 ± 0.48	<0.27	<0.93	0.79 ± 1.30	1.08 ± 0.32
4	55	1.99 ± 0.32	<0.34	3.84 ± 1.26	0.46 ± 0.14	0.67 ± 0.28
4	97	11.5 ± 0.8	<0.45	<1.31	0.54 ± 1.24	<0.35
4	100	1.15 ± 0.22	<0.30	<0.98	0.54 ± 0.10	1.12 ± 0.46
4	120	1.91 ± 0.30	<0.23	<0.82	0.60 ± 0.12	0.85 ± 0.42
4	140	0.91 ± 0.20	<0.24	<0.68	0.14 ± 0.06	0.86 ± 0.26
4	160	3.21 ± 0.48	<0.27	1.50 ± 1.80	0.89 ± 0.12	0.51 ± 0.38
4	180	8.09 ± 0.78	<0.45	2.62 ± 2.98	1.12 ± 0.20	0.87 ± 0.52
4	200	2.30 ± 0.28	<0.28	<0.91	0.48 ± 0.10	0.89 ± 0.34
4	201	3.26 ± 0.38	<0.37	2.33 ± 1.60	0.78 ± 0.14	0.68 ± 0.42
4	220	0.94 ± 0.18	<0.24	1.17 ± 1.28	<0.04	0.81 ± 0.24
2	235	0.96 ± 0.36	<0.27	1.18 ± 1.28	0.11 ± 0.04	1.06 ± 0.42
20	3	0.51 ± 0.16	<0.15	<0.49	<0.03	0.74 ± 0.28
20	20	0.89 ± 0.22	<0.21	<0.81	<0.49	1.01 ± 0.38
20	40	0.73 ± 0.20	<0.31	<0.90	0.57 ± 0.12	0.84 ± 0.32
20	55	0.69 ± 0.28	<0.18	<0.70	0.45 ± 0.12	0.72 ± 0.28
20	97	1.44 ± 0.38	<0.24	1.60 ± 1.54	0.68 ± 0.12	1.31 ± 0.42
20	100	1.30 ± 0.28	<0.32	0.81 ± 1.44	0.81 ± 0.14	0.97 ± 0.38
20	120	0.91 ± 0.28	<0.21	<0.73	0.75 ± 0.12	0.64 ± 0.38
20	140	0.98 ± 0.40	<0.31	<0.96	0.86 ± 0.16	0.93 ± 0.40
20	160	1.16 ± 0.22	<0.23	0.87 ± 1.60	0.48 ± 0.10	0.68 ± 0.26
20	180	1.39 ± 0.40	<0.33	1.43 ± 0.98	0.42 ± 1.56	1.11 ± 0.50
20	200	1.28 ± 0.22	<0.31	0.86 ± 1.36	0.67 ± 0.12	1.12 ± 0.34
20	220	1.20 ± 0.22	<0.31	<0.97	0.54 ± 0.16	0.97 ± 0.34

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
20	235	1.11 ± 0.26	<0.29	1.18 ± 1.56	0.11 ± 0.10	1.12 ± 0.54
40	2	2.46 ± 0.38	0.53 ± 0.27	<0.77	0.48 ± 0.12	0.50 ± 0.38
40	20	b	b	b	b	b
40	40	0.79 ± 0.22	<0.21	<0.85	0.33 ± 0.10	0.95 ± 0.34
40	57	0.54 ± 0.20	<0.19	<0.66	0.40 ± 0.10	0.77 ± 0.28
40	97	0.70 ± 0.20	<0.36	4.06 ± 2.64	0.53 ± 0.12	0.78 ± 0.48
40	100	1.01 ± 0.26	<0.23	<0.93	0.56 ± 0.18	0.87 ± 0.40
40	120	0.85 ± 0.26	<0.22	1.47 ± 1.70	0.35 ± 0.12	0.68 ± 0.26
40	140	0.95 ± 0.28	<0.29	1.90 ± 1.80	0.48 ± 0.12	1.13 ± 0.74
40	160	0.75 ± 0.28	<0.22	<0.89	0.38 ± 0.12	0.85 ± 0.50
40	180	0.83 ± 0.20	<0.21	1.43 ± 1.90	0.40 ± 0.12	0.87 ± 0.30
40	200	0.79 ± 0.26	<0.30	3.53 ± 2.12	0.36 ± 0.14	1.46 ± 0.54
40	220	0.88 ± 0.22	<0.21	1.72 ± 1.74	0.63 ± 0.14	0.66 ± 0.32
40	235	1.00 ± 0.22	<0.20	1.41 ± 1.28	0.07 ± 0.08	0.53 ± 0.36
60	3	1.35 ± 0.32	<0.33	<1.01	0.87 ± 0.14	1.04 ± 0.44
60	20	0.76 ± 0.32	<0.23	<0.80	0.36 ± 0.10	1.07 ± 0.36
60	40	0.63 ± 0.28	<0.22	1.39 ± 1.84	0.29 ± 0.10	0.96 ± 0.38
60	59	1.40 ± 0.36	0.31 ± 0.48	1.53 ± 1.62	0.40 ± 0.12	0.86 ± 0.42
60	100	2.29 ± 0.32	<0.26	<0.74	0.07 ± 0.14	1.18 ± 0.40
60	120	0.94 ± 0.22	<0.24	<0.92	0.47 ± 0.12	0.77 ± 0.42
60	140	0.66 ± 0.22	0.36 ± 0.58	<0.92	0.63 ± 0.12	0.76 ± 0.34
60	160	0.79 ± 0.28	<0.30	1.21 ± 0.94	0.64 ± 0.14	1.46 ± 0.60
60	180	0.83 ± 0.20	0.14 ± 0.06	1.31 ± 1.99	0.36 ± 0.08	0.93 ± 0.55
60	200	0.70 ± 0.28	<0.30	1.74 ± 1.40	0.39 ± 0.14	0.78 ± 0.30
60	220	1.01 ± 0.22	<0.21	0.71 ± 2.22	0.44 ± 0.12	0.53 ± 0.36
60	235	0.98 ± 0.26	<0.31	1.31 ± 0.94	<0.04	1.02 ± 0.32

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
80	4	1.14 ± 0.30	<0.22	<0.75	0.71 ± 0.14	0.67 ± 0.36
80	20	0.91 ± 0.26	<0.29	<0.94	0.36 ± 0.10	1.52 ± 0.46
79	40	1.23 ± 0.36	<0.35	2.93 ± 2.72	1.01 ± 0.56	1.45 ± 0.56
80	60	1.05 ± 0.14	<0.23	<0.89	0.50 ± 0.14	0.73 ± 0.30
80	102	0.78 ± 0.28	<0.22	2.21 ± 2.26	0.47 ± 0.16	0.67 ± 0.44
80	120	0.91 ± 0.22	<0.20	0.90 ± 2.12	0.65 ± 0.12	0.70 ± 0.40
80	140	0.89 ± 0.22	<0.22	1.37 ± 2.02	0.52 ± 0.10	1.68 ± 0.56
80	160	1.06 ± 0.30	<0.19	<0.85	0.66 ± 0.18	0.97 ± 0.50
80	180	1.06 ± 0.28	<0.28	<1.00	0.49 ± 0.14	1.30 ± 0.42
80	200	1.00 ± 0.26	<0.30	<0.90	0.54 ± 0.14	1.17 ± 0.46
80	220	1.29 ± 0.32	<0.20	1.38 ± 1.28	0.70 ± 0.12	0.24 ± 0.18
80	235	2.29 ± 0.35	<0.33	<1.03	0.30 ± 0.10	1.26 ± 0.49
100	2	3.33 ± 0.58	<0.29	2.60 ± 2.60	0.36 ± 0.14	0.50 ± 0.36
100	20	1.43 ± 0.28	<0.24	1.90 ± 2.24	0.24 ± 0.10	0.69 ± 0.36
100	40	0.79 ± 0.36	<0.20	1.83 ± 0.18	<0.04	0.77 ± 0.36
100	102	0.96 ± 0.31	<0.23	0.84 ± 1.58	0.30 ± 0.12	0.93 ± 0.43
100	120	0.70 ± 0.28	<0.34	2.39 ± 1.66	0.73 ± 0.14	0.97 ± 0.42
100	140	0.90 ± 0.38	<0.31	<0.99	0.62 ± 0.14	0.69 ± 0.26
100	160	1.51 ± 0.32	<0.24	0.70 ± 1.64	0.39 ± 0.14	0.92 ± 0.36
100	180	0.75 ± 0.28	<0.19	<0.77	0.52 ± 0.14	1.03 ± 0.40
100	200	2.60 ± 0.36	<0.38	<1.13	0.52 ± 0.16	1.43 ± 0.42
100	220	1.21 ± 0.22	<0.28	<0.83	0.80 ± 0.12	0.59 ± 0.28
100	235	3.58 ± 0.40	<0.40	<1.16	<0.04	0.95 ± 0.30
120	4	b	b	b	b	b
120	20	0.83 ± 0.28	<0.21	<0.82	0.30 ± 0.14	0.74 ± 0.36
120	40	1.23 ± 0.32	<0.28	0.70 ± 0.88	0.09 ± 0.08	1.11 ± 0.40
120	120	1.26 ± 0.40	<0.32	3.29 ± 1.20	0.60 ± 0.12	0.89 ± 0.34

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
120	140	0.95 ± 0.28	<0.21	1.20 ± 1.62	0.08 ± 0.08	1.06 ± 0.38
120	160	0.81 ± 0.22	<0.23	<0.84	0.33 ± 0.12	0.73 ± 0.38
120	180	0.80 ± 0.21	<0.27	1.09 ± 0.72	0.21 ± 0.07	0.94 ± 0.38
120	200	1.74 ± 0.38	<0.25	0.99 ± 1.89	0.59 ± 0.16	0.57 ± 0.52
120	220	1.73 ± 0.30	0.22 ± 0.54	1.04 ± 1.46	0.85 ± 0.14	0.43 ± 0.22
120	235	0.74 ± 0.22	<0.28	0.70 ± 1.96	<0.05	1.07 ± 0.40
140	3	1.44 ± 0.26	<0.19	1.12 ± 1.10	0.66 ± 0.12	<0.14
140	20	b	b	b	b	b
140	40	1.14 ± 0.31	<0.40	0.46 ± 2.58	<0.06	1.11 ± 1.42
140	60	0.88 ± 0.22	0.22 ± 0.22	<0.68	0.18 ± 0.06	0.50 ± 0.38
140	64	2.33 ± 0.30	<0.23	1.67 ± 1.54	0.13 ± 0.08	0.57 ± 0.30
140	120	1.29 ± 0.30	<0.32	2.01 ± 1.52	0.37 ± 0.12	1.00 ± 0.38
140	140	0.94 ± 0.20	<0.31	1.69 ± 0.80	0.31 ± 0.14	1.07 ± 0.40
140	160	b	b	b	b	b
140	180	1.86 ± 0.40	<0.30	<0.99	0.15 ± 0.08	0.90 ± 1.42
140	200	2.99 ± 0.40	<0.43	5.10 ± 1.42	<0.04	2.29 ± 0.50
140	220	1.24 ± 0.28	0.07 ± 0.07	<1.00	0.23 ± 0.11	1.15 ± 0.47
140	235	1.20 ± 0.36	<0.31	<0.96	0.14 ± 0.10	1.14 ± 0.52
159	5	3.60 ± 0.42	<0.30	1.96 ± 2.10	0.43 ± 0.12	0.47 ± 0.36
160	20	1.40 ± 0.30	<0.31	1.56 ± 2.16	0.53 ± 0.14	0.81 ± 0.62
160	40	2.00 ± 0.28	<0.30	2.66 ± 1.30	0.34 ± 0.10	0.54 ± 0.26
160	60	b	b	b	b	b
160	106	0.94 ± 0.26	<0.22	<0.68	0.10 ± 0.06	0.99 ± 0.36
160	120	0.93 ± 0.26	<0.31	1.98 ± 0.88	0.14 ± 0.06	1.10 ± 0.38
160	140	0.99 ± 0.28	<0.21	2.05 ± 1.62	0.14 ± 0.06	0.87 ± 0.66
160	160	b	b	b	b	b
160	181	2.20 ± 0.32	<0.29	1.25 ± 1.80	0.32 ± 0.10	1.12 ± 0.36

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
160	200	9.24 ± 0.70	<0.46	<1.38	0.41 ± 0.20	1.28 ± 0.68
160	220	2.10 ± 0.40	<0.35	2.35 ± 1.66	0.79 ± 0.14	1.04 ± 0.44
160	235	1.00 ± 0.36	<0.18	<0.66	<0.05	1.08 ± 0.38
180	2	1.90 ± 0.40	<0.26	2.13 ± 1.90	0.93 ± 0.16	0.83 ± 0.48
180	20	0.90 ± 0.28	<0.23	<0.76	0.16 ± 0.08	0.93 ± 0.28
180	40	0.64 ± 0.20	<0.19	1.17 ± 1.60	0.36 ± 0.08	0.97 ± 0.32
180	60	0.84 ± 0.20	0.25 ± 0.26	3.11 ± 1.72	0.24 ± 0.08	1.18 ± 0.34
180	71	2.03 ± 0.38	<0.26	1.52 ± 2.14	0.35 ± 0.10	0.90 ± 0.42
180	100	0.79 ± 0.20	<0.17	2.05 ± 1.10	<0.04	0.86 ± 0.28
180	120	0.99 ± 0.20	<0.29	<0.92	0.06 ± 0.06	0.86 ± 0.42
180	140	1.30 ± 0.22	<0.30	2.97 ± 1.04	0.31 ± 0.08	1.22 ± 0.39
180	160	b	b	b	b	b
180	181	0.78 ± 0.26	0.27 ± 0.40	<0.85	0.19 ± 0.06	0.58 ± 0.42
180	200	10.1 ± 0.9	<0.49	<1.47	0.46 ± 0.12	1.12 ± 0.64
180	220	1.44 ± 0.32	<0.35	<1.08	0.45 ± 0.12	0.94 ± 0.50
180	235	0.74 ± 0.20	<0.25	<0.80	0.07 ± 0.06	0.93 ± 0.26
200	5	2.41 ± 0.46	<0.25	<1.10	0.66 ± 0.14	0.63 ± 1.12
200	20	b	b	b	b	b
200	40	b	b	b	b	b
200	60	1.45 ± 0.30	<0.21	1.32 ± 2.02	0.78 ± 0.14	0.56 ± 0.28
200	73	1.41 ± 0.25	<0.23	0.72 ± 3.44	<0.06	0.84 ± 0.36
200	113	1.05 ± 0.20	<0.29	3.48 ± 1.16	0.06 ± 0.02	1.25 ± 0.36
200	120	1.09 ± 0.30	<0.24	1.61 ± 1.90	0.09 ± 0.10	1.10 ± 0.44
200	140	0.74 ± 0.26	<0.25	1.43 ± 1.88	0.06 ± 0.04	1.15 ± 0.38
200	160	0.73 ± 0.18	<0.29	3.00 ± 1.08	0.09 ± 0.08	1.34 ± 0.50
200	180	0.83 ± 0.20	<0.20	<0.82	<0.04	0.81 ± 0.38
200	200	0.41 ± 0.28	<0.21	1.12 ± 1.02	0.44 ± 0.12	0.79 ± 0.40

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
200	220	1.55 ± 0.30	<0.34	<1.02	0.73 ± 0.12	0.92 ± 0.28
200	235	0.94 ± 0.23	<0.18	0.67 ± 1.16	0.20 ± 0.10	0.48 ± 0.44
220	3	1.83 ± 0.33	<0.24	2.01 ± 1.86	0.75 ± 0.06	<0.27
220	20	b	b	b	b	b
220	40	0.19 ± 0.28	<0.21	2.55 ± 1.92	0.62 ± 0.16	0.65 ± 0.48
220	60	0.99 ± 0.20	<0.22	<0.62	0.30 ± 0.08	<0.12
220	75	0.61 ± 0.25	0.20 ± 0.62	<0.91	0.12 ± 0.56	0.93 ± 0.62
220	120	1.13 ± 0.28	<0.30	1.34 ± 1.48	<0.05	1.36 ± 0.38
220	140	0.83 ± 0.30	<0.35	1.44 ± 0.16	<0.06	0.96 ± 0.32
220	160	0.98 ± 0.35	<0.25	<1.13	0.26 ± 0.16	0.98 ± 0.50
220	180	8.50 ± 0.75	<0.43	<1.50	0.66 ± 0.24	1.71 ± 0.78
220	200	1.00 ± 0.28	<0.29	2.12 ± 1.38	0.68 ± 0.16	0.97 ± 0.50
220	220	0.78 ± 0.25	<0.25	<0.87	0.70 ± 0.19	1.13 ± 0.46
220	235	0.54 ± 0.19	<0.23	0.96 ± 1.36	0.26 ± 0.10	0.59 ± 0.50
240	5	1.44 ± 0.25	<0.20	<0.78	<0.05	0.42 ± 0.40
240	20	1.18 ± 0.28	<0.22	0.91 ± 1.78	0.14 ± 0.06	0.84 ± 0.32
240	40	1.41 ± 0.35	<0.33	2.55 ± 2.06	0.27 ± 0.16	0.93 ± 0.36
240	60	0.59 ± 0.13	<0.17	<0.52	0.34 ± 0.08	0.40 ± 0.23
240	76	0.86 ± 0.25	<0.19	1.55 ± 0.75	0.09 ± 0.10	0.70 ± 0.52
240	116	0.98 ± 0.28	<0.23	1.92 ± 1.68	0.17 ± 0.10	1.00 ± 0.54
240	140	1.08 ± 0.33	0.55 ± 0.50	2.29 ± 1.90	0.49 ± 0.12	0.54 ± 0.56
240	160	9.61 ± 0.78	<0.46	<1.60	0.26 ± 0.10	0.62 ± 0.52
240	180	0.96 ± 0.19	<0.30	2.05 ± 2.56	1.00 ± 0.20	0.62 ± 0.60
240	200	0.94 ± 0.30	<0.31	1.87 ± 1.86	0.62 ± 0.14	0.94 ± 0.38
240	220	0.49 ± 0.28	<0.24	1.91 ± 1.61	1.21 ± 0.18	1.12 ± 0.67
240	235	0.81 ± 0.20	<0.30	<0.94	<0.04	0.83 ± 0.36
260	4	1.39 ± 0.35	<0.32	2.62 ± 0.24	<0.05	1.16 ± 0.38

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
260	18	0.73 ± 0.23	<0.17	0.85 ± 1.70	0.13 ± 0.08	0.55 ± 0.26
260	40	0.91 ± 0.28	<0.30	0.41 ± 1.70	0.84 ± 0.12	0.85 ± 0.30
260	60	0.86 ± 0.30	<0.21	<0.95	0.20 ± 0.08	0.72 ± 0.28
260	105	1.58 ± 0.30	0.56 ± 0.56	0.90 ± 1.90	0.51 ± 0.12	1.14 ± 0.48
260	120	0.83 ± 0.28	<0.32	3.41 ± 2.05	0.92 ± 0.16	1.10 ± 0.40
260	140	0.76 ± 0.24	<0.25	2.67 ± 1.85	0.76 ± 0.20	1.16 ± 0.42
260	160	0.96 ± 0.25	<0.24	<0.89	0.80 ± 0.12	0.61 ± 0.44
260	180	0.75 ± 0.24	<0.26	<1.06	0.79 ± 0.19	1.27 ± 0.60
260	200	1.01 ± 0.25	<0.26	3.14 ± 2.52	0.54 ± 0.16	1.00 ± 0.44
260	220	1.04 ± 0.33	<0.23	3.32 ± 2.14	0.67 ± 0.16	1.47 ± 1.03
260	235	0.65 ± 0.16	<0.27	2.39 ± 1.41	0.20 ± 0.07	1.79 ± 0.81
280	3	2.26 ± 0.39	<0.35	<1.07	<0.05	1.05 ± 0.39
280	20	b	b	b	b	b
280	40	b	b	b	b	b
280	60	0.19 ± 0.28	<0.30	1.96 ± 1.68	<0.40	1.43 ± 0.42
280	80	0.75 ± 0.38	<0.22	1.07 ± 2.01	0.07 ± 0.12	0.83 ± 0.34
280	106	1.29 ± 0.30	<0.27	2.25 ± 1.56	0.70 ± 0.14	0.90 ± 0.68
280	120	0.81 ± 0.35	<0.38	<1.18	0.80 ± 0.22	1.19 ± 0.72
280	140	4.74 ± 0.68	<0.39	6.38 ± 3.36	1.21 ± 0.22	2.27 ± 0.58
280	160	1.10 ± 0.35	<0.27	2.82 ± 1.78	0.85 ± 0.20	0.87 ± 0.34
280	180	0.98 ± 0.45	<0.46	<1.45	1.14 ± 0.24	0.71 ± 0.94
280	200	0.68 ± 0.35	<0.20	1.00 ± 2.00	0.31 ± 0.12	0.84 ± 0.42
280	220	0.61 ± 0.24	0.19 ± 0.53	0.84 ± 1.87	0.47 ± 0.10	0.47 ± 0.30
280	235	0.70 ± 0.20	<0.27	4.33 ± 1.92	0.10 ± 0.10	0.87 ± 0.42
300	3	1.16 ± 0.28	<0.23	1.77 ± 1.67	0.98 ± 0.18	0.82 ± 0.30
300	20	6.99 ± 0.50	0.41 ± 0.86	4.32 ± 2.10	<0.06	0.16 ± 0.23
300	40	2.19 ± 0.33	<0.22	2.05 ± 1.60	0.27 ± 0.09	0.55 ± 0.42

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
300	60	0.83 ± 0.29	0.42 ± 0.45	1.65 ± 0.80	<0.04	0.99 ± 0.30
300	80	0.93 ± 0.25	<0.19	1.41 ± 1.42	<0.04	1.02 ± 0.59
300	95	0.78 ± 0.20	<0.21	6.48 ± 1.71	0.23 ± 0.12	1.00 ± 0.30
300	105	2.83 ± 0.48	<0.42	<1.21	0.74 ± 0.16	1.53 ± 0.60
300	120	0.73 ± 0.29	<0.20	<0.75	0.40 ± 0.10	0.64 ± 0.40
300	140	0.50 ± 0.55	0.69 ± 0.75	0.19 ± 2.37	1.20 ± 0.22	0.76 ± 0.32
300	160	1.56 ± 0.38	<0.43	1.74 ± 1.32	1.27 ± 0.23	1.35 ± 0.45
300	180	0.95 ± 0.31	<0.31	2.96 ± 3.72	1.44 ± 0.23	1.32 ± 0.48
300	200	1.19 ± 0.38	<0.30	<1.03	0.58 ± 0.14	1.06 ± 0.60
300	220	0.60 ± 0.35	<0.26	0.76 ± 2.21	0.57 ± 0.16	0.90 ± 0.48
300	235	0.86 ± 0.20	<0.13	1.07 ± 0.48	0.11 ± 0.06	0.70 ± 0.30
320	4	1.26 ± 0.28	<0.23	0.93 ± 2.02	0.66 ± 0.12	0.49 ± 0.23
320	20	0.58 ± 0.31	0.72 ± 0.57	1.12 ± 1.04	0.52 ± 0.13	0.73 ± 0.31
320	40	0.65 ± 0.30	<0.23	1.48 ± 1.98	0.54 ± 0.12	1.09 ± 0.43
320	60	0.89 ± 0.38	0.37 ± 0.55	1.57 ± 0.16	0.37 ± 0.12	1.11 ± 0.48
320	80	0.54 ± 0.18	<0.16	1.19 ± 1.21	0.41 ± 0.08	0.56 ± 0.36
320	121	0.79 ± 0.24	<0.18	<0.72	0.57 ± 0.10	0.88 ± 0.33
320	140	1.24 ± 0.34	<0.23	3.76 ± 1.68	0.82 ± 0.17	0.55 ± 0.46
320	160	1.14 ± 0.31	<0.28	1.72 ± 1.61	0.84 ± 0.21	0.82 ± 0.46
320	180	1.53 ± 0.44	<0.29	<1.40	1.05 ± 0.21	0.70 ± 0.50
320	200	6.49 ± 0.55	<0.38	2.10 ± 3.65	1.02 ± 0.17	0.82 ± 0.40
320	220	0.69 ± 0.19	<0.21	1.02 ± 0.18	0.33 ± 0.10	0.62 ± 0.40
320	235	0.96 ± 0.24	<0.26	<0.52	0.25 ± 0.08	1.16 ± 0.48
340	3	2.49 ± 0.41	<0.28	0.94 ± 2.71	0.99 ± 0.17	0.66 ± 0.28
340	20	0.84 ± 0.26	<0.19	1.02 ± 1.86	0.54 ± 0.13	0.88 ± 0.28
340	40	1.03 ± 0.29	<0.20	<0.95	0.31 ± 0.12	0.98 ± 0.42
340	60	0.68 ± 0.23	<0.22	0.90 ± 1.50	0.71 ± 0.15	2.84 ± 0.54

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
340	78	0.45 ± 0.19	<0.15	<0.67	0.42 ± 0.10	0.56 ± 0.49
340	120	0.83 ± 0.18	<0.19	<0.63	0.08 ± 0.06	0.74 ± 0.26
340	140	<0.31	<0.28	3.11 ± 2.09	<0.11	0.90 ± 0.43
340	160	3.60 ± 0.45	<0.38	2.72 ± 2.06	1.10 ± 0.15	0.70 ± 0.43
340	180	0.93 ± 0.24	<0.20	0.42 ± 1.34	0.07 ± 0.06	0.64 ± 0.25
340	200	0.83 ± 0.20	<0.25	<0.82	0.36 ± 0.09	1.00 ± 0.52
340	220	0.75 ± 0.21	<0.22	0.67 ± 2.83	0.49 ± 0.12	<0.22
340	235	0.85 ± 0.29	<0.27	2.14 ± 1.48	<0.04	1.08 ± 0.40
360	3	1.43 ± 0.38	<0.25	2.76 ± 2.02	0.88 ± 0.15	0.80 ± 0.29
360	20	0.66 ± 0.23	0.92 ± 0.45	<0.83	0.62 ± 0.12	0.68 ± 0.44
360	40	0.83 ± 0.26	<0.20	<0.75	0.30 ± 0.10	1.03 ± 0.30
360	60	1.66 ± 0.33	<0.27	1.71 ± 2.29	0.44 ± 0.13	1.03 ± 0.42
360	78	1.00 ± 0.30	<0.23	<0.84	0.81 ± 0.16	0.75 ± 0.49
360	120	1.39 ± 0.34	<0.34	2.71 ± 0.17	0.67 ± 0.12	0.74 ± 0.48
360	140	1.24 ± 0.31	<0.34	<1.11	0.85 ± 0.15	1.67 ± 0.42
360	160	1.94 ± 0.29	<0.33	1.65 ± 1.52	0.63 ± 0.12	1.21 ± 0.61
360	180	1.30 ± 0.33	<0.34	3.57 ± 1.46	0.82 ± 0.14	0.70 ± 0.70
360	200	2.63 ± 0.36	<0.27	<0.82	0.81 ± 0.12	0.46 ± 0.46
360	210	1.80 ± 0.34	<0.28	3.13 ± 1.69	0.60 ± 0.15	1.27 ± 0.38
360	220	1.05 ± 0.28	0.36 ± 0.66	<0.90	0.43 ± 0.11	0.85 ± 0.33
360	235	0.78 ± 0.20	<0.26	1.39 ± 0.99	0.13 ± 0.09	1.23 ± 0.58
380	3	1.21 ± 0.30	<0.25	0.72 ± 1.93	0.99 ± 0.14	0.76 ± 0.34
380	20	0.61 ± 0.24	<0.22	1.65 ± 1.00	0.79 ± 0.15	0.74 ± 0.46
380	40	0.74 ± 0.31	<0.21	<0.77	0.50 ± 0.11	0.67 ± 0.37
380	60	1.09 ± 0.43	<0.22	1.61 ± 0.16	0.26 ± 0.09	1.14 ± 0.44
380	78	1.45 ± 0.41	<0.22	2.12 ± 2.23	0.29 ± 0.11	1.10 ± 0.32
380	120	0.55 ± 0.07	0.08 ± 0.09	0.48 ± 0.33	0.07 ± 0.01	0.15 ± 0.07

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
380	140	1.11 ± 0.30	<0.31	1.61 ± 1.44	0.68 ± 0.14	0.83 ± 0.31
380	160	0.90 ± 0.40	<0.32	<1.06	0.75 ± 0.16	1.15 ± 0.38
380	180	0.89 ± 0.28	<0.30	1.49 ± 1.61	0.85 ± 0.13	0.47 ± 0.52
380	200	0.28 ± 0.38	<0.41	<1.18	1.22 ± 0.19	1.31 ± 0.54
380	220	b	b	b	b	b
380	235	0.71 ± 0.26	<0.20	0.81 ± 0.76	<0.04	0.60 ± 0.43
400	3	1.24 ± 0.54	<0.21	<0.92	0.45 ± 0.12	0.56 ± 0.38
400	20	1.44 ± 0.29	<0.22	1.42 ± 1.49	0.43 ± 0.27	0.33 ± 0.27
400	40	0.85 ± 0.20	<0.18	<0.83	0.72 ± 0.12	0.61 ± 0.39
400	60	1.23 ± 0.25	<0.24	1.03 ± 1.69	0.28 ± 0.04	0.92 ± 0.31
400	77	5.96 ± 0.55	<0.52	<1.40	0.62 ± 0.15	1.29 ± 0.76
400	120	0.36 ± 0.68	<0.19	<0.59	<0.05	<0.20
400	140	0.34 ± 0.06	<0.05	1.10 ± 0.30	0.21 ± 0.03	0.14 ± 0.08
400	160	1.04 ± 0.39	<0.35	<1.11	0.88 ± 0.13	0.86 ± 0.43
400	180	0.53 ± 0.11	0.19 ± 0.22	0.96 ± 0.34	0.38 ± 0.04	0.31 ± 0.11
400	200	b	b	b	b	b
400	220	0.80 ± 0.40	<0.22	0.54 ± 1.49	0.78 ± 0.14	1.00 ± 0.47
400	235	0.75 ± 0.21	<0.28	<0.85	0.22 ± 0.10	0.65 ± 0.29
420	4	2.51 ± 0.39	<0.36	4.01 ± 1.24	0.52 ± 0.12	<0.24
420	20	0.58 ± 0.31	<0.41	<1.11	0.85 ± 0.20	<0.33
420	40	1.00 ± 0.43	<0.28	<0.91	1.01 ± 0.19	1.08 ± 0.36
420	60	2.26 ± 0.43	<0.28	<1.21	0.37 ± 0.14	0.91 ± 0.50
420	78	1.75 ± 0.38	<0.28	<0.92	1.08 ± 0.17	0.99 ± 0.44
420	120	2.60 ± 0.34	<0.34	<0.98	0.36 ± 0.13	0.87 ± 0.36
420	140	1.68 ± 0.39	<0.32	1.96 ± 1.49	0.80 ± 0.14	0.42 ± 0.27
416	160	1.55 ± 0.34	<0.25	<0.90	0.74 ± 0.17	1.17 ± 0.42
419	180	0.85 ± 0.21	<0.33	2.20 ± 1.49	1.05 ± 0.15	0.69 ± 0.35

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES
FROM 20 M GRID INTERVALS

Grid Location		Radionuclide Concentrations (pCi/g)				
N	W	Ra-226	U-235	U-238	Cs-137	Th-232
400	200	1.21 ± 0.29	<0.31	<0.95	0.72 ± 0.13	1.16 ± 0.34
419	220	1.80 ± 0.43	<0.38	4.00 ± 0.25	0.57 ± 0.16	4.21 ± 0.66
420	235	0.78 ± 0.35	<0.28	1.64 ± 1.24	0.07 ± 0.08	1.17 ± 0.33
430	10	1.46 ± 0.35	<0.33	2.14 ± 1.23	1.69 ± 0.25	0.85 ± 0.57
430	20	1.51 ± 0.35	<0.27	2.08 ± 2.25	0.99 ± 0.17	0.76 ± 0.68
430	40	1.98 ± 0.35	<0.37	1.86 ± 2.02	1.14 ± 0.16	0.92 ± 0.33
430	60	1.03 ± 0.24	<0.30	2.20 ± 0.10	0.25 ± 0.10	0.94 ± 0.34
430	80	2.76 ± 0.38	<0.38	<1.18	0.41 ± 0.11	0.95 ± 0.29
430	100	3.24 ± 0.40	<0.39	1.59 ± 2.24	1.11 ± 0.20	1.00 ± 0.72

[a] Errors are 2σ based on counting statistics.
[b] No sample collected; grid point inaccessible due to presence of standing water, buildings, or drainage ditches.

TABLE 5

RADIONUCLIDE CONCENTRATIONS IN SURFACE SAMPLES
FROM LOCATIONS IDENTIFIED BY THE WALKOVER SCAN

Sample Identification	Sample Description	Grid[a] Location N	Grid[a] Location W	Radionuclide Concentrations (pCi/g) Ra-226	U-235[b]	U-238[b]	Cs-137[b]	Th-232[b]
B1	Rock	35	18	570 ± 8[c]	<5.29	<8.72	<0.67	19.6 ± 5.8
B2	Rock	80	35	244 ± 6	22.8 ± 15.1	272 ± 170	<1.21	973 ± 15
B3	Rock	80	40	179 ± 16	<11.4	213 ± 3	<2.68	804 ± 38
B4	Rock	80	46	247 ± 7	10.9 ± 16.3	257 ± 205	<1.29	1180 ± 20
B5	Rock	80	50	84.4 ± 3.6	6.79 ± 7.05	91.4 ± 1.4	<0.55	189 ± 8
B6	Rock	80	56	165 ± 5	25.5 ± 11.8	184 ± 1.7	<0.97	674 ± 12
B7	Rock	85	40	32.5 ± 0.8	3.11 ± 1.23	40.6 ± 17.1	<0.07	<0.31
B8	Rock	87	43	13.1 ± 0.7	1.21 ± 1.02	10.1 ± 7.6	0.60 ± 0.13	1.03 ± 0.61
B9	Rock	90	32	12.2 ± 0.7	<0.55	12.0 ± 2.8	0.11 ± 0.08	0.45 ± 0.51
B10	Soil	90	230	12.0 ± 0.8	0.56 ± 0.90	<1.35	0.15 ± 0.09	0.70 ± 0.56
B11	Soil	100	196	37.0 ± 1.5	4.47 ± 1.67	7.08 ± 5.37	0.61 ± 0.61	0.95 ± 0.77
B12	Soil	105	228	31.6 ± 1.4	0.69 ± 1.51	<2.21	0.50 ± 0.14	0.63 ± 0.96
B13	Soil	110	228	3.26 ± 0.39	<0.34	<1.06	<0.06	<0.25
B14	Soil	111	228	44.8 ± 1.5	<1.16	<3.20	0.61 ± 0.16	<0.55
B15	Rock	115	7	19.2 ± 0.9	1.73 ± 1.50	14.4 ± 2.9	0.28 ± 0.11	0.71 ± 0.86
B16	Soil	115	228	78.1 ± 2.0	2.79 ± 2.46	8.87 ± 6.61	<0.23	<0.75
B17	Soil	120	234	86.0 ± 2.7	3.59 ± 2.79	<3.77	<0.16	<0.68
B18	Soil & Gravel	143	6	10.7 ± 0.6	<0.56	6.20 ± 2.64	<0.06	1.04 ± 0.52
B19	Soil	146	160	0.94 ± 0.30	<0.22	1.70 ± 1.12	<0.03	0.71 ± 0.26
B20	Soil & Gravel	155	4	33.3 ± 1.1	3.28 ± 1.59	31.5 ± 3.5	<0.08	0.59 ± 0.47
B21	Soil	159	198	31.5 ± 1.1	<0.90	7.14 ± 2.97	0.37 ± 0.12	2.93 ± 0.93
B22	Rock	164	45	9.09 ± 0.56	1.41 ± 0.79	10.6 ± 2.0	0.06 ± 0.05	0.64 ± 0.34
B23	Soil	164	212	24.8 ± 1.1	<0.92	<2.44	1.02 ± 0.17	<0.43
B24	Soil	165	209	47.8 ± 1.6	<0.79	<2.05	1.18 ± 0.19	1.04 ± 0.87
B25	Soil	168	210	67.8 ± 1.6	2.04 ± 1.30	<1.22	<0.11	<0.45
B26	Rock	177	49	38.4 ± 0.9	2.89 ± 2.10	41.3 ± 0.4	<0.35	153 ± 2

TABLE 5, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SAMPLES
FROM LOCATIONS IDENTIFIED BY THE WALKOVER SCAN

Sample Identification	Sample Description	Grid Location N	Grid Location W	Radionuclide Concentrations (pCi/g) Ra-226	U-235	U-238	Cs-137	Th-232
B27	Soil	178	201	39.0 ± 1.4	<0.81	<2.07	0.25 ± 0.12	0.60 ± 0.83
B28	Soil	198	193	1.41 ± 0.30	<0.17	0.99 ± 0.80	0.21 ± 0.08	1.13 ± 0.45
B29	Rock	184	52	63.0 ± 2.7	<3.42	62.4 ± 0.6	<0.53	241 ± 6
B30	Soil	260	14	0.91 ± 0.28	<0.24	1.06 ± 0.82	<0.03	1.15 ± 0.31
B31	Soil	256	142	24.2 ± 1.0	1.30 ± 1.04	<0.81	0.80 ± 0.13	1.01 ± 0.50
B32	Soil	244	160	5.24 ± 0.46	<0.42	<1.21	0.09 ± 0.05	1.49 ± 0.58
B33	Soil & Gravel	294	4	14.8 ± 0.6	1.50 ± 0.97	15.7 ± 2.2	<0.07	0.82 ± 0.42
B34	Rock	357	189	54.9 ± 1.2	4.48 ± 1.56	61.5 ± 14.3	<0.11	<0.38
B35	Rock	369	48	63.6 ± 2.4	<3.83	70.5 ± 0.6	<0.56	267 ± 7

[a] Refer to Figure 7.
[b] Large relative errors and minimum detectable activities are the result of high continuum count rates caused by high Ra-226 levels.
[c] Errors are 2σ based on counting statistics.

TABLE 6

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

Borehole No.[a]	Grid Location N	Grid Location W	Depth (m)	Radionuclide Concentrations (pCi/g) Ra-226	U-235	U-238	Cs-137	Th-232
H1	20	106	Surface	0.69 ± 0.26[b]	<0.16	0.78 ± 1.50	0.10 ± 0.09	0.79 ± 0.32
			0.5	0.98 ± 0.30	<0.30	1.93 ± 1.24	<0.04	0.97 ± 0.44
			1.0	1.08 ± 0.28	<0.21	1.01 ± 1.64	<0.04	0.92 ± 0.71
			2.0	0.98 ± 0.13	<0.21	<0.74	<0.03	0.96 ± 0.34
H2	31	200	Surface	0.89 ± 0.33	<0.28	<0.85	0.37 ± 0.11	0.97 ± 0.31
			2.0	1.28 ± 0.26	<0.23	0.76 ± 0.63	<0.04	1.30 ± 0.64
H3	37	19	Surface	0.88 ± 0.25	<0.20	<0.69	0.18 ± 0.06	0.70 ± 0.41
			0.5	0.83 ± 0.23	<0.24	2.18 ± 1.49	<0.03	1.12 ± 0.31
			1.0	0.66 ± 0.24	<0.13	0.62 ± 0.53	<0.02	0.54 ± 0.21
			2.0	0.58 ± 0.19	<0.18	1.36 ± 1.24	<0.03	0.48 ± 0.38
H4	94	20	Surface	1.01 ± 0.25	<0.26	<0.79	0.07 ± 0.06	0.65 ± 0.41
			0.5	1.33 ± 0.28	<0.17	0.94 ± 0.76	<0.03	0.85 ± 0.27
			1.0	1.15 ± 0.23	<0.28	0.79 ± 1.53	<0.04	1.00 ± 0.42
			2.0	0.85 ± 0.21	<0.15	0.57 ± 0.45	<0.03	1.12 ± 0.36
H5	130	160	Surface	1.20 ± 0.36	<0.36	<1.07	<0.05	1.70 ± 0.38
			0.5	0.89 ± 0.28	<0.19	1.26 ± 1.70	0.08 ± 0.13	1.29 ± 0.48
			1.0	1.35 ± 0.30	<0.34	<1.07	<0.05	1.16 ± 0.54
			2.0	1.10 ± 0.30	<0.19	0.91 ± 0.83	<0.03	1.08 ± 0.36
H6	148	18	Surface	0.80 ± 0.24	<0.29	3.99 ± 1.24	0.42 ± 0.14	0.36 ± 0.42
			0.5	0.83 ± 0.19	<0.27	<0.77	<0.03	1.08 ± 0.33
			1.0	1.00 ± 0.45	<0.32	4.23 ± 2.03	<0.05	2.13 ± 0.62
			2.0	1.15 ± 0.21	<0.28	1.07 ± 1.52	<0.04	1.32 ± 0.40

TABLE 6, cont.

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

Borehole No.	Grid Location N	Grid Location W	Depth (m)	Radionuclide Concentrations (pCi/g) Ra-226	U-235	U-238	Cs-137	Th-232
H7	160	229	Surface	0.83 ± 0.20	<0.25	1.36 ± 1.43	0.12 ± 0.04	1.01 ± 0.29
			0.5	0.79 ± 0.21	<0.21	<0.69	<0.03	0.85 ± 0.34
			1.0	1.01 ± 0.24	<0.26	2.19 ± 1.93	<0.04	0.70 ± 0.26
			2.0	0.98 ± 0.29	<0.25	1.72 ± 1.81	<0.04	0.62 ± 0.44
H8	229	78	Surface	1.09 ± 0.20	<0.30	<0.81	<0.04	2.52 ± 0.83
			2.0	1.08 ± 0.35	<0.33	2.91 ± 1.39	<0.05	1.09 ± 0.40
H9	240	2	Surface	1.24 ± 0.23	<0.26	<0.9	0.16 ± 0.08	0.41 ± 0.18
			0.5	0.73 ± 0.20	<0.24	1.96 ± 1.47	<0.03	0.87 ± 0.50
			1.0	0.73 ± 0.15	<0.24	<0.72	<0.03	1.21 ± 0.37
			2.0	1.08 ± 0.28	<0.31	1.45 ± 1.49	<0.04	0.87 ± 0.37
H10	316	200	Surface	0.90 ± 0.25	<0.28	1.93 ± 1.60	<0.04	0.80 ± 0.37
			0.5	1.08 ± 0.24	<0.16	0.99 ± 1.05	0.05 ± 0.17	1.47 ± 0.80
			1.0	1.15 ± 0.33	<0.21	1.83 ± 1.74	<0.03	0.96 ± 0.40
			2.0	1.26 ± 0.26	<0.32	2.57 ± 1.19	<0.05	1.20 ± 0.45
H11	339	53	Surface	0.55 ± 0.14	<0.24	1.64 ± 1.55	0.17 ± 0.09	1.03 ± 0.39
			0.5	0.91 ± 0.26	<0.15	0.79 ± 0.46	<0.03	0.77 ± 0.30
			1.0	0.83 ± 0.19	<0.20	<0.72	<0.03	1.00 ± 0.38
			2.0	<0.16	<0.26	2.72 ± 1.55	<0.03	1.15 ± 0.35
H12	418	70	Surface	0.91 ± 0.23	0.42 ± 0.64	5.01 ± 2.35	<0.03	0.82 ± 0.28
			0.5	0.78 ± 0.29	<0.22	1.42 ± 1.53	<0.03	1.19 ± 0.36
			1.0	1.11 ± 0.25	<0.27	1.86 ± 0.89	<0.04	1.07 ± 0.39
			2.0	0.89 ± 0.19	<0.19	1.25 ± 1.73	<0.03	0.79 ± 0.33

TABLE 6, cont.

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

Borehole No.	Grid Location N	Grid Location W	Depth (m)	Radionuclide Concentrations (pCi/g) Ra-226	U-235	U-238	Cs-137	Th-232
H13	419	10	Surface	1.18 ± 0.26	<0.29	1.57 ± 0.89	0.11 ± 0.07	1.21 ± 0.41
			0.5	1.03 ± 0.26	<0.30	<0.88	<0.04	1.15 ± 0.37
			1.0	0.69 ± 0.19	<0.22	2.18 ± 1.55	<0.05	0.57 ± 0.42
			2.0	1.03 ± 0.23	<0.17	0.74 ± 0.71	<0.02	0.63 ± 0.42
H14	4	235	Surface	4.00 ± 0.49	<0.29	1.75 ± 1.89	0.25 ± 0.08	0.73 ± 0.24
			0.3	1.15 ± 0.25	<0.28	<0.92	<0.04	0.86 ± 0.33
			0.6	1.29 ± 0.25	<0.26	1.61 ± 1.77	0.08 ± 0.13	1.26 ± 0.32
H15	110	228	Surface	3.26 ± 0.39	<0.34	<1.06	<0.06	<0.25
			0.5	1.46 ± 0.31	<0.32	<1.08	<0.04	1.18 ± 0.42
			1.0	1.38 ± 0.26	<0.23	0.75 ± 0.14	0.04 ± 0.04	0.68 ± 0.33
H16	143	6	Surface	10.7 ± 0.6	<0.56	6.20 ± 2.64	<0.06	1.04 ± 0.52
			0.5	6.61 ± 0.59	<0.32	3.82 ± 0.95	<0.05	0.90 ± 0.46
			1.0	1.80 ± 0.33	<0.26	2.16 ± 1.88	<0.04	0.96 ± 0.55
H17	146	160	Surface	0.94 ± 0.30	<0.22	1.70 ± 1.12	<0.03	0.71 ± 0.26
H18	159	198	Surface	31.5 ± 1.1	<0.90	7.14 ± 2.97	0.37 ± 0.12	2.93 ± 0.93
			1.0	1.46 ± 0.25	<0.14	1.07 ± 0.73	<0.03	0.84 ± 0.30
H19	164	45	Surface	9.09 ± 0.56	1.41 ± 0.79	10.6 ± 2.0	0.06 ± 0.05	0.64 ± 0.34
			0.15	1.18 ± 0.24	<0.16	1.57 ± 0.47	<0.03	0.93 ± 0.32
			0.6	1.60 ± 0.30	<0.25	1.23 ± 1.72	<0.05	0.94 ± 0.46

TABLE 6, cont.

RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

Borehole No.	Grid Location N	Grid Location W	Depth (m)	Radionuclide Concentrations (pCi/g) Ra-226	U-235	U-238	Cs-137	Th-232
H20	165	209	Surface	47.8 ± 1.6	<0.79	<2.05	1.18 ± 0.19	1.04 ± 0.87
			0.3	36.4 ± 1.3	<0.98	<2.69	0.92 ± 0.16	3.78 ± 1.53
			0.6	9.59 ± 0.84	<0.42	<1.14	0.44 ± 0.10	0.40 ± 0.31
H21	164	212	Surface	24.8 ± 1.1	<0.92	<2.44	1.02 ± 0.17	<0.43
			0.3	3.49 ± 0.49	<0.45	<1.40	0.33 ± 0.15	0.87 ± 0.67
H22	168	210	Surface	67.8 ± 1.6	2.04 ± 1.30	<1.22	<0.11	<0.45
			0.15	32.1 ± 1.5	<0.77	<2.17	0.19 ± 0.12	1.49 ± 0.58
H23	178	201	Surface	39.0 ± 1.4	<0.81	<2.07	0.25 ± 0.12	0.60 ± 0.83
H24	260	14	Surface	0.91 ± 0.28	<0.24	1.06 ± 0.82	<0.03	1.15 ± 0.31

[a] Refer to Figure 4.
[b] Errors are 2σ based on counting statistics.

TABLE 7

RADIONUCLIDE CONCENTRATIONS IN WATER SAMPLES

Sample No.	Sample Type	Grid Location N	Grid Location W	Radionuclide Concentrations (pCi/l) Gross Alpha	Gross Beta	Ra-226
W1	Surface[a]	100	41	<1.35	20.3 ± 3.0[c]	----[d]
W2	Surface[a]	130	10	<0.30	5.13 ± 0.83	----
W3	Surface[a]	180	120	<1.67	7.39 ± 3.31	----
W4	Surface[a]	255	75	0.86 ± 0.54	1.76 ± 0.67	----
W5	Subsurface, Borehole H5[b]	130	160	4.73 ± 1.39	5.71 ± 1.26	----
W6	Subsurface, Borehole H6[b]	148	18	8.29 ± 3.41	11.6 ± 3.7	----
W7	Subsurface, Borehole H7[b]	160	229	4.23 ± 1.49	6.62 ± 1.42	----
W8	Subsurface, Borehole H11[b]	339	53	1.07 ± 0.79	2.47 ± 0.89	----
W9	Subsurface, Borehole H12[b]	418	70	5.27 ± 1.29	5.59 ± 1.15	----
W10	Subsurface, Borehole H13[b]	419	10	6.63 ± 1.90	2.27 ± 1.63	----
W11	Subsurface, Borehole H17[b]	146	160	17.0 ± 5.5	8.22 ± 5.12	<0.22

a Refer to Figure 5.
b Refer to Figure 4.
c Errors are 2σ based on counting statistics.
d Dash indicates analysis was not performed.

TABLE 8

RADIONUCLIDE CONCENTRATIONS IN SEDIMENT SAMPLE FROM DRAINAGE DITCH

Sample No.	Grid Location[a]		Radionuclide Concentrations (pCi/g)				
	N	W	Ra-226	U-235	U-238	Cs-137	Th-232
SD1	415	182	9.15 ± 0.80[b]	0.63 ± 0.91	<1.58	0.16 ± 0.09	0.56 ± 1.26

a Refer to Figure 5.
b Errors are 2σ based on counting statistics.

TABLE 9

LISTING OF AREAS ON PROPERTY T WHICH
EXCEED RESIDUAL CONTAMINATION CRITERIA

Grid Location[a] N	Grid Location[a] W	Radionuclides[b]	Estimated Quantities of Material Exceeding Guidelines: Area (m^2)	Avg. Depth (m)	Volume (m^3)	Remarks
94-99	4-18	Ra-226, U-238[c]	70	0.15	10.5	Areas of rock fill or paving. Rock contains approximately equal amounts of Ra-226 and U-238 and its radionuclide content is considered of natural origin.
143-146	169-170	Ra-226, U-238[c]	3	0.15	.5	
162-164	20-40	Ra-226, U-238[c]	40	0.30	12	
163-164	44-46	Ra-226, U-238[c]	2	0.30	0.6	
241-247	6-7	Ra-226, U-238[c]	6	0.15	0.9	
298-300	4-20	Ra-226, U-238[c]	32	0.15	4.8	
300-305	8-22	Ra-226, U-238[c]	70	0.15	10.5	
346-354	161-180	Ra-226, U-238[c]	152	0.15	22.8	
343-347	183-187	Ra-226, U-238[c]	16	0.15	2.4	
353-355	184-187	Ra-226, U-238[c]	6	0.15	0.9	
355-357	188-191	Ra-226, U-238[c]	6	0.15	0.9	
355-357	192-196	Ra-226, U-238[c]	8	0.15	1.2	
351-357	203-206	Ra-226, U-238[c]	18	0.15	2.7	
360-366	179-183	Ra-226, U-238[c]	24	0.15	3.6	
103-106	230-234	Ra-226	12	0.30	3.6	Areas of contamination associated with material dredged from the West or Central Drainage Ditches.
107-116	224-229	Ra-226	45	0.15	6.8	
180-200	180-196	Ra-226	320	0.15	48	
200-217	175-180	Ra-226	85	0.15	12.8	
206-211	114-118	Ra-226	20	0.30	6.0	
210-219	183-187	Ra-226	36	0.30	10.8	
222-240	160-174	Ra-226	112	0.15	16.8	
240-274	140-157	Ra-226	578	0.15	86.5	
243-247	159-162	Ra-226	12	0.30	3.6	
243-245	165-168	Ra-226	6	0.30	1.8	
280-300	118-119	Ra-226	20	0.30	6	
304-314	120-129	Ra-226	90	0.15	13.5	

TABLE 9, cont.

LISTING OF AREAS ON PROPERTY T WHICH
EXCEED RESIDUAL CONTAMINATION CRITERIA

Grid Location N	Grid Location W	Radionuclides	Estimated Quantities of Material Exceeding Guidelines: Area (m^2)	Avg. Depth (m)	Volume (m^3)	Remarks
35	18	Ra-226	----	----	----	Small isolated surface or near surface "hot-spot" (<1 m^2 area) or individual piece of contaminated rock-like material. The total value represented by these locations is estimated to be less than 15 m^3.
35	19	Ra-226	----	----	----	
41	18	Ra-226	----	----	----	
79	37	Th-232, Ra-226, U-238[c]	----	----	----	
79	50	Th-232, Ra-226, U-238[c]	----	----	----	
79	52	Th-232, Ra-226, U-238[c]	----	----	----	
79	55	Th-232, Ra-226, U-238[c]	----	----	----	
80	34	Th-232, Ra-226, U-238[c]	----	----	----	
80	38	Th-232, Ra-226, U-238[c]	----	----	----	
80	39	Th-232, Ra-226, U-238[c]	----	----	----	
80	43	Th-232, Ra-226, U-238[c]	----	----	----	
80	45	Th-232, Ra-226, U-238[c]	----	----	----	
80	51	Th-232, Ra-226, U-238[c]	----	----	----	
80	53	Th-232, Ra-226, U-238[c]	----	----	----	
85	40	Ra-226, U-238[c]	----	----	----	
87	43	Ra-226, U-238[c]	----	----	----	
90	32	Ra-226, U-238[c]	----	----	----	
90	230	Ra-226	----	----	----	
100	196	Ra-226	----	----	----	
105	228	Ra-226	----	----	----	
112	1	Ra-226, U-238[c]	----	----	----	
113	0	Ra-226, U-238[c]	----	----	----	
115	7	Ra-226, U-238[c]	----	----	----	
119	214	Ra-226	----	----	----	
119	215	Ra-226	----	----	----	
119	230	Ra-226	----	----	----	
120	234	Ra-226	----	----	----	

TABLE 9, cont.

LISTING OF AREAS ON PROPERTY T WHICH
EXCEED RESIDUAL CONTAMINATION CRITERIA

Grid Location N	Grid Location W	Radionuclides	Estimated Quantities of Material Exceeding Guidelines: Area (m^2)	Avg. Depth (m)	Volume (m^3)	Remarks
120	203	Ra-226	----	----	----	Small isolated surface or near surface "hot-spot" (<1 m^2 area) or individual piece of contaminated rock-like material. The total value represented by these locations is estimated to be less than 15 m^3.
123	205	Ra-226	----	----	----	
143	6	Ra-226, U-238[c]	----	----	----	
154	202	Ra-226	----	----	----	
155	2	Ra-226, U-238[c]	----	----	----	
155	4	Ra-226, U-238[c]	----	----	----	
156	2	Ra-226, U-238[c]	----	----	----	
159	2	Ra-226, U-238[c]	----	----	----	
159	51	Ra-226, U-238[c]	----	----	----	
159	52	Ra-226, U-238[c]	----	----	----	
159	198	Ra-226	----	----	----	
162	43	Ra-226, U-238[c]	----	----	----	
162	46	Ra-226, U-238[c]	----	----	----	
162	202	Ra-226	----	----	----	
164	7	Ra-226, U-238[c]	----	----	----	
164	212	Ra-226	----	----	----	
165	60	Ra-226, U-238[c]	----	----	----	
165	209	Ra-226	----	----	----	
167	65	Ra-226, U-238[c]	----	----	----	
168	201	Ra-226	----	----	----	
173	49	Th-232, Ra-226, U-238[c]	----	----	----	
177	49	Th-232, Ra-226, U-238[c]	----	----	----	
178	201	Ra-226	----	----	----	
178	207	Ra-226	----	----	----	
180	49	Th-232, Ra-226, U-238[c]	----	----	----	
180	52	Th-232, Ra-226, U-238[c]	----	----	----	
184	52	Th-232, Ra-226, U-238[c]	----	----	----	

TABLE 9, cont.

LISTING OF AREAS ON PROPERTY T WHICH
EXCEED RESIDUAL CONTAMINATION CRITERIA

Grid Location N	Grid Location W	Radionuclides	Estimated Quantities of Material Exceeding Guidelines: Area (m^2)	Avg. Depth (m)	Volume (m^3)	Remarks
185	56	Th-232, Ra-226, U-238[c]	----	----	----	Small isolated surface or near surface "hot-spot" (<1 m^2 area) or individual piece of contaminated rock-like material. The total value represented by these locations is estimated to be less than 15 m^3.
187	56	Th-232, Ra-226, U-238[c]	----	----	----	
189	52	Th-232, Ra-226, U-238[c]	----	----	----	
189	56	Th-232, Ra-226, U-238[c]	----	----	----	
190	52	Th-232, Ra-226, U-238[c]	----	----	----	
190	56	Th-232, Ra-226, U-238[c]	----	----	----	
195	56	Th-232, Ra-226, U-238[c]	----	----	----	
215	54	Th-232, Ra-226, U-238[c]	----	----	----	
220	54	Th-232, Ra-226, U-238[c]	----	----	----	
221	0	Ra-226, U-238[c]	----	----	----	
221	3	Ra-226, U-238[c]	----	----	----	
221	175	Ra-226	----	----	----	
221	178	Ra-226	----	----	----	
225	178	Ra-226	----	----	----	
228	54	Th-232, Ra-226, U-238[c]	----	----	----	
228	55	Th-232, Ra-226, U-238[c]	----	----	----	
244	13	Ra-226, U-238[c]	----	----	----	
250	59	Th-232, Ra-226, U-238[c]	----	----	----	
260	14	Ra-226, U-238[c]	----	----	----	
290	201	Ra-226, U-238[c]	----	----	----	
292	136	Ra-226, U-238[c]	----	----	----	
292	138	Ra-226, U-238[c]	----	----	----	
292	200	Ra-226, U-238[c]	----	----	----	
294	4	Ra-226, U-238[c]	----	----	----	
300	40	Ra-226, U-238[c]	----	----	----	
323	14	Ra-226, U-238[c]	----	----	----	
332	47	Th-232, Ra-226, U-238[c]	----	----	----	

TABLE 9, cont.

LISTING OF AREAS ON PROPERTY T WHICH
EXCEED RESIDUAL CONTAMINATION CRITERIA

Grid Location N	Grid Location W	Radionuclides	Estimated Quantities of Material Exceeding Guidelines: Area (m^2)	Avg. Depth (m)	Volume (m^3)	Remarks
333	47	Th-232, Ra-226, U-238[c]	----	----	----	Small isolated surface or near surface "hot-spot" (<1 m^2 area) or individual piece of contaminated rock-like material. The total value represented by these locations is estimated to be less than 15 m^3.
340	47	Th-232, Ra-226, U-238[c]	----	----	----	
342	15	Ra-226, U-238[c]	----	----	----	
348	14	Ra-226, U-238[c]	----	----	----	
348	15	Ra-226, U-238[c]	----	----	----	
348	49	Th-232, Ra-226, U-238[c]	----	----	----	
349	49	Th-232, Ra-226, U-238[c]	----	----	----	
356	47	Th-232, Ra-226, U-238[c]	----	----	----	
369	48	Th-232, Ra-226, U-238[c]	----	----	----	
372	48	Th-232, Ra-226, U-238[c]	----	----	----	
400	15	Ra-226, U-238[c]	----	----	----	

[a] Refer to Figure 7.
[b] Based on locations, physical appearance, direct radiation levels and analyses of similiar materials.
[c] Naturally occuring material in rock fill.

REFERENCES

1. E.A. Vierzba and A. Wallo, Background and Resurvey Recommendations for the Atomic Energy Commission Portion of the Lake Ontario Ordnance Works, Aerospace Corp., November 1982.

2. Oak Ridge Operations, U.S. Atomic Energy Commission, Radiation Survey and Decontamination Report of the Lake Ontario Ordnance Works Site, Oak Ridge, TN, January 1973.

3. T.E. Myrick, et al., Preliminary Results of the Ground-Level Gamma-Ray Scan Survey of the Former Lake Ontario Ordnance Works Site - Draft Report, ORNL, Oak Ridge, TN, 1981.

APPENDIX A

INSTRUMENTATION AND ANALYTICAL PROCEDURES

APPENDIX A

Instrumentation and Analytical Procedures

Gamma Scintillation Measurement

Walkover surface scans and measurements of gamma exposure rates were performed using Eberline Model PRM-6 portable ratemeters with Victoreen Model 489-55 gamma scintillation probes containing 3.2 cm x 3.8 cm NaI(Tl) scintillation crystals. Count rates were converted to exposure levels (μR/h) using factors determined by comparing the response of the scintillation detector with that of a Reuter Stokes model RSS-111 pressurized ionization chamber at several locations on the Niagara Falls Storage Site and off-site properties.

Beta-Gamma Dose Rate Measurements

Measurements were performed using Eberline "Rascal," Model PRS-1, portable scaler/ratemeters with Model HP-260 thin-window, pancake G-M, beta probes. Dose rates (μrad/h) were determined by comparison of the response of a Victoreen Model 440 ionization chamber survey meter to that of the G-M probes.

Borehole Logging

Borehole gamma radiation measurements were performed using a Victoreen Model 489-55 gamma scintillation probe, connected to a Ludlum Model 2200 portable scaler. The scintillation probe was shielded by a 1.25 cm thick lead shield with four 2.5 cm x 7 mm holes evenly spaced around the region of the scintillation crystal. The probe was lowered into each hole using a tripod holder with a small winch. Measurements were performed at 15-30 cm intervals in all holes. The logging data was used to identify regions of possible residues and guide the selection of subsurface soil sampling locations. Due to the varying ratios of Ra-226, U-235, U-238, Th-232, and Cs-137 there was no attempt to estimate soil radionuclide concentrations directly from the logging results.

Soil and Sediment Sample Analysis

Gamma Spectrometry

Soil and sediment samples were dried, mixed, and a portion placed in a 0.5 liter Marinelli beaker. The quantity placed in each beaker was chosen to reproduce the calibrated counting geometry and ranged from 600 to 800 g of soil. Net soil weights were determined and the samples counted using solid state intrinsic germanium and Ge(Li) detectors coupled to a Nuclear Data model ND-680 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:

Ra-226 - 0.609 MeV from Bi-214 (corrected for equilibrium conditions)
U-235 - 0.143 MeV
U-238 - 0.093 MeV from Th-234 (secular equilibrium assumed)
Th-232 - 0.911 MeV from Ac-228 (secular equilibrium assumed)
Cs-137 - 0.662 MeV

Water Sample Analysis

Water samples were rough-filtered through Whatman No. 2 filter paper. Remaining suspended solids were removed by subsequent filtration through 0.45 μm membrane filters. The filtrate was acidified by addition of 10 ml of concentrated nitric acid. A known volume of each sample was evaporated to dryness and counted for gross alpha and gross beta using a Tennelec Model LB 5100 low-background proportional counter.

Analysis for Ra-226 was performed using the standard technique EPA 600/4-80-032 (August 1980).

Calibration and Quality Assurance

With the exception of the exposure and dose rate conversion factors for portable survey gamma and beta-gamma meters, all survey and laboratory instruments were calibrated with NBS-traceable standards. The calibration procedures for these portable instruments are described above.

Quality control procedures on all instruments included daily background and check-source measurements to confirm equipment operation within expected statistical fluctuations. The ORAU laboratory participates in the EPA Quality Assurance Program.

APPENDIX B

SUMMARY OF RADIATION GUIDELINES APPLICABLE TO OFF-SITE PROPERTIES AT THE NIAGARA FALLS STORAGE SITE

U. S. DEPARTMENT OF ENERGY

INTERIM RESIDUAL CONTAMINATION AND WASTE CONTROL GUIDELINES FOR FORMERLY UTILIZED SITES REMEDIAL ACTION PROGRAM (FUSRAP) AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM (SFMP) SITES

(Review Within DOE Continuing)

Presented here are the residual contamination cleanup and waste control guidelines of general applicability to the FUSRAP project and remote SFMP sites[1/]. A site-specific analysis will be prepared for each FUSRAP and remote SFMP site prior to determining residual contamination guidelines for a specific site. In addition, it is the policy of the DOE to decontaminate sites in a manner consistent with DOE's as-low-as-reasonably-achievable (ALARA) policy. ALARA will be considered in reducing levels of residual contamination below applicable dose limits. ALARA will be implemented using cost/benefit considerations, and applied on a site-specific basis.

The soil residual contamination guidelines were developed on the basis of limiting maximum individual radiation exposure to DOE limits specified in DOE Order 5480.1A exclusive of exposure from natural background radiation or medical procedures. The radium-226 and thorium-230 guidelines include an additional limitation for buildup of radon-222 decay products in buildings. The aggregate of the contribution from all major pathways, based on scenarios for permanent intrusion, e.g., establishing residences on the site, was assumed. In most circumstances, the probability is low that such an intrusion will occur. Also, conservative assumptions were used in deriving these guidelines to ensure that a particular dose limit would not be exceeded. Use of these guidelines is additionally conservative because the pathways considered in the derivation of the guidelines assume all water intake and most food intake is from the site. Also, the FUSRAP and remote SFMP sites often have limited agricultural capability and the contamination is generally not homogeneous. The combined effect of these factors is such that the probable radiation exposure to the average population on, or in the vicinity of, FUSRAP or remote SFMP sites decontaminated to these guidelines will not be appreciably different from that normally received from natural background radiation.

The residual contamination guidelines for surface contamination of structures were adapted from guidelines developed by the U. S. Nuclear Regulatory Commission (NRC) for decontamination of facilities and equipment prior to release for unrestricted use or termination of licenses for byproduct, source, or special nuclear material[2/]. The waste control guidelines are consistent with applicable DOE Orders and EPA's regulations for inactive uranium milling sites, 40 CFR Part 192.

[1/] A remote SFMP site is one that is excess to DOE programmatic needs and is

located outside a major operating DOE R&D or production area. Remote sites are more likely to be released to the public or excessed to other government agencies after decontamination than are sites located with major R&D or production areas.

2/ U. S. Nuclear Regulatory Commission 1982 Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material. Division of Fuel Cycle and Material Safety, Washington, DC.

A. RESIDUAL CONTAMINATION GUIDELINES FOR FORMERLY UTILIZED SITES AND REMOTE SURPLUS FACILITIES MANAGEMENT PROGRAM SITES

The following guidelines represent the maximum residual contamination limits for unrestricted use of land and structures contaminated with radionuclides related to the nuclear fuel cycle at FUSRAP and remote SFMP sites. A site-specific analysis will be prepared for each site prior to determining residual contamination guidelines for a specific site. It is the policy of DOE to decontaminate sites to contamination levels at or below the limits and in a manner consistent with DOE's as-low-as-is-reasonably-achievable (ALARA) policy on a site-specific basis. Site-specific guidelines and ALARA policy will be determined by DOE on a site-specific basis and an ALARA report filed on completion of remedial action at a site. Existing state and federal standards will be applied for water protection. Residual contamination limits for other nuclides will be developed when required using the same methodology 1/ as was used for those represented here.

1. Soil (Land) Guidelines (Maximum Limits for Unrestricted Use)

Radionuclide	Soil Criteria 2/,3/,4/ (pCi/g above background)
U-Natural 5/	75
U-238 6/	150
U-234 6/	150
Th-230 7/	15
Ra-226	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15 cm thick soil layers more than 15 cm below the surface and less than 1.5m below the surface.
U-235 6/	140
Pa-231	40
Ac-227	190
Th-232	15
Am-241	60
Pu-241 8/	2400
Pu-238, 239, 240	300
Cs-137	80

Sr-90	300
H-3 (pCi/ml soil moisture)	5,200

1/ Described in ORO-831 and ORO-832.

2/ In the event of occurrence of mixtures of radionuclides, the fraction contributed by each radionuclide to its guideline shall be determined, and the sum of these fractions shall not exceed 1. There are two special cases for which this rule must be modified:

(a) If Ra-226 is present, then the fraction for Ra-226 should not be included in the sum if the Ra-226 concentration is less than or equal to the Th-230 concentration. If the Ra-226 concentration exceeds the Th-230 concentration, then the sum shall be evaluated by replacing the Ra-226 concentration by the difference between the Ra-226 and Th-230 concentrations.

(b) If Ac-227 is present, then the same rule given in (a) for Ra-226 relative to Th-230 applies for Ac-227 relative to Pa-231.

3/ Except for Ra-226, these guidelines represent unrestricted-use residual concentrations above background averaged across any 15 cm thick layer to any depth and over any contiguous 100 m^2 surface area. The same conditions prevail for Ra-226 except for soil layers beneath 1.5 m; beneath 1.5 m, the allowable Ra-226 concentration may be affected by site-specific conditions and must be evaluated accordingly.

4/ Localized concentrations in excess of these guidelines are allowable provided that the average over 100 m^2 is not exceeded. However, DOE ALARA policy will be considered on a site-specific basis when dealing with elevated localized concentrations.

5/ A curie of natural uranium means the sum of 3.7×10^{10} disintegrations per second (dis/s) over any 15cm thick layers from U-238 plus 3.7×10^{10} dis/s from U-234 plus 1.7×10^{9} dis/s from U-235. One curie of natural uranium is equivalent to 3,000 kilograms or 6,600 pounds of natural uranium.

6/ Assumes no other uranium isotopes are present.

7/ The Th-230 guideline is 15 pCi/g to account for ingrowth of Ra-226 as Th-230 decays. Ra-226 is a limiting radionuclide because its decay product is Rn-222 gas.

8/ The Pu-241 guideline was derived from the Am-241 concentration.

2. Structure Guidelines (Maximum Limits for Unrestricted Use)

a. Indoor Radon Decay Products

A structure located on private property and intended for unrestricted use shall be subject to remedial action as necessary

to ensure the annual average concentration of radon decay products is less than 0.03 WL within the structure.

b. Indoor Gamma Radiation

The indoor gamma radiation after decontamination shall not exceed 20 microroentgen per hour (20 R/h) above background in any occupied or habitable building.

c. Indoor/Outdoor Structure Surface Contamination

Radionuclides 2/	Allowable Surface Residual Contamination 1/ (dpm/100 cm^2) 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
U-Natural, Th-232, Sr-90, Fr-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	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000	15,000	1,000

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 observed 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 shall apply independently.

3/ Measurements of average contaminant should not be averaged over more than 1 m^2. For objects of less surface area, the average shall be derived for each such object.

4/ The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should

not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm, respectively, measured through not more than 7 mg/cm^2 of total absorber.

5/ The maximum contamination level applies to an area of not more than 100 cm^2.

6/ The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and assessing the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of less surface area is determined, the pertinent levels shall be reduced proportionately and the entire surface shall be wiped.

B. CONTROL OF RADIOACTIVE WASTES AND RESIDUES FROM FUSRAP AND REMOTE SFMP SITES

Specified here are the control requirements for radioactive wastes and residues related to the nuclear fuel cycle at FUSRAP and remote SFMP sites. It is the policy of DOE to store radioactive wastes in a manner representing sound engineering practices consistent with DOE's ALARA policy.

1. Interim Storage

All operational and control requirements specified in the following DOE Orders and other items shall apply:

a. 5480.1A, Environmental Protection, Safety, and Health Protection Program for DOE Operations.

b. 5480.2, Hazardous and Radioactive Mixed Waste Management.

c. 5483.1, Occupational Safety and Health Program for Government-Owned Contractor-Operated Facilities.

d. 5484.1, Environmental Protection, Safety, and Health Protection Information Reporting Requirements.

e. 5484.2, Unusual Occurrence Reporting System.

f. 5820, Radioactive Waste Management.

g. Control and stabilization features will be designed to ensure, to the extent reasonably achievable, an effective life of 50 years, and in any case, at least 25 years.

h. Rn-222 concentrations in the atmosphere above facility surfaces or openings shall not (1) exceed 100 pCi/l at any given point, or an average concentration of 30 pCi/l for the facility site, or (2) exceed an average Rn-222 concentration at or above any location outside the facility site of 3.0 pCi/l (above background).

i. For water protection, use existing state and federal standards; apply site-specific measures where needed.

2. Long-Term Management

a. All operational requirements specified for Interim Storage Facilities (B.1) will apply.

b. Control and stabilization features will be designed to ensure to the extent reasonably achievable, an effective life of 1,000 years and, in any case, at least 200 years. Other disposal site design features shall conform with 40 CFR Part 192 performance guidelines/requirements.

c. Rn-222 emanation to the atmosphere from facility surfaces or opening shall not (1) exceed an average release rate of 20 $pCi/m^2/s$, or (2) increase the annual average Rn-222 concentration at or above any location outside the facility site by more than 0.5 pCi/l.

d. For water protection, use existing state and federal standards; apply site-specific measures where needed.

e. Prior to placement of any potentially biodegradable contaminated wastes in a Long-Term Management Facility, such wastes will be properly conditioned to (1) ensure that the generation and escape of biogenic gases will not cause the requirement in paragraph 2.c. to be exceeded, and (2) ensure that biodegradation within the facility will not result in premature structural failure not in accordance with the requirements in paragraph 2.b.. If biodegradable wastes are conditioned by incineration, incineration operations will be carried out in compliance with all applicable federal, state, and local air emission standards and requirements, including any standards for radionuclides established pursuant to 40 CFR Part 61, National Emission Standards for Hazardous Air Pollutants (NESHAPS).

C. EXCEPTIONS

Exceptions may be made to the guidelines presented herein following analysis of the site-specific aspects of a candidate site. Specific situations that warrant consideration for modifying these guidelines are:

1. Where remedial actions would pose a clear and present risk of injury to workers or members of the public, notwithstanding reasonable measures to avoid or reduce risk.

2. Where remedial actions 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, notwithstanding reasonable measures to limit damage to the environment. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

3. Where the cost of remedial actions for contaminated soil is unreasonably high relative to long-term benefits and the residual radioactive materials do not pose a clear present or future hazard. 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 hazard. Remedial actions will generally not be necessary where residual radioactive materials have been placed semipermanently in a location where site-specific factors limit their hazard and from which they are costly or difficult to remove, or where only minor quantities of residual radioactive materials are involved. Examples are residual radioactive materials under hard surface public roads and sidewalks, around public sewer lines, or in fence-post foundations. Supplemental standards shall not be applied at such sites, however, if individuals are likely to be exposed for long periods of time to radiation from such materials at levels above those that would prevail in Subpart A.

4. Where the cost of cleanup of a contaminated building is clearly unreasonably high relative to the benefits. Factors that shall be included in this judgment are the anticipated period of occupancy, the incremental radiation level that would be affected by remedial actions, the residual useful lifetime of the building, the potential for future construction at the site, and the applicability of less costly remedial methods than removal of residual radioactive materials.

5. Where there is no known remedial action.

D. GUIDELINE SOURCE

Guideline	Source
Residual Contamination Criteria[1/]	
Soil Guideline	DOE Order 5480.1A, 40 CFR Part 192[2/]
Structure Guideline	40 CFR Part 192, NRC Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for Byproduct, Source, or Special Nuclear Material (July 1982).
Control of Radioactive Wastes and Residues	
Interim Storage	DOE Order 5480.1A
Long-Term Management	40 CFR Part 192

1/ The bases of the residual contamination guidelines are developed in ORO-831 and ORO-832.

2/ Based on limiting the concentration of Ra-222 decay products to 0.03 WL within structures.