

COMPREHENSIVE RADILOGICAL SURVEY

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OFF-SITE PROPERTY V  
NIAGARA FALLS STORAGE SITE  
LEWISTON, NEW YORK

Prepared for

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

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TABLE OF CONTENTS

|  | <u>Page</u> |
|--|-------------|
| List of Figures . . . . .                              | ii          |
| List of Tables . . . . .                               | iii         |
| Introduction . . . . .                                 | 1           |
| Site Description . . . . .                             | 1           |
| Survey Procedures . . . . .                            | 2           |
| Results . . . . .                                      | 6           |
| Comparison of Survey Results with Guidelines . . . . . | 10          |
| Summary . . . . .                                      | 11          |
| References . . . . .                                   | 49          |
| Appendices   |             |

    Appendix A: Instrumentation and Analytical Procedures

    Appendix B: Summary of Radiation Guidelines Applicable  
                to Off-Site Properties at the Niagara Falls  
                Storage Site

LIST OF FIGURES

|   | <u>Page</u> |
|---|-------------|
| FIGURE 1. Map of Niagara Falls Storage Site and Off-Site Properties, Lewiston, New York, Indicating the Location of Off-Site Property V . . . . .                         | 12          |
| FIGURE 2. Plan View of NFSS Off-Site Property V Indicating Prominent Surface Features . . . . .   | 13          |
| FIGURE 3. Plan View of NFSS Off-Site Property V Indicating the Grid System Established for Survey Reference . . . . .   | 14          |
| FIGURE 4. Locations of Boreholes for Subsurface Investigations . . . . .  | 15          |
| FIGURE 5. Locations of Water Samples from Standing Water . . . . .  | 16          |
| FIGURE 6. Map of Northern Niagara County, New York, Showing Locations of Background Measurements and Baseline Samples . . . . .   | 17          |
| FIGURE 7. Map of NFSS Off-Site Property V Indicating Areas of Elevated Direct Radiation and Locations Where Radionuclide Concentrations in Soil Exceed Criteria . . . . . | 18          |

LIST OF TABLES

|  | <u>Page</u> |
|--|-------------|
| TABLE 1-A: Background Exposure Rates and Radionuclide Concentrations in Baseline Soil Samples . . . . .          | 19          |
| TABLE 1-B: Radionuclide Concentrations in Baseline Water Samples . . . . .                                       | 20          |
| TABLE 2: Direct Radiation Levels Measured at 20 M Grid Intervals . . . . .                                       | 21          |
| TABLE 3: Direct Radiation Levels at Locations Identified by the Walkover Surface Scan . . . . .                  | 29          |
| TABLE 4: Radionuclide Concentrations in Surface Soil Samples from 20 M Grid Intervals . . . . .                  | 32          |
| TABLE 5: Radionuclide Concentrations in Surface Samples from Locations Identified by the Walkover Scan . . . . . | 43          |
| TABLE 6: Radionuclide Concentrations in Borehole Soil Samples . . . . .  | 44          |
| TABLE 7: Radionuclide Concentrations in Water Samples . . . . .  | 46          |
| TABLE 8: Summary of Results of Building Surveys . . . . .  | 47          |
| TABLE 9: Summary of Areas on Property V Which Exceed Residual Contamination Criteria . . . . .                   | 48          |

## COMPREHENSIVE RADILOGICAL SURVEY

### OFF-SITE PROPERTY V NIAGARA FALLS STORAGE SITE LEWISTON, NEW YORK

#### 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.<sup>1</sup>

Somerset Group, Inc. is the current owner of a tract identified as off-site property V (see Figure 1). A radiological survey of that tract, conducted in June through August 1983, is the subject of this report.

#### SITE DESCRIPTION

Figure 2 is a plot plan of off-site property V. This property is rectangular in shape and measures approximately 360 m long by 310 m wide; it occupies an area of 11 hectares. The site is bounded by Balmer Road on the north and "H" Street on the south. Property V originally extended eastward to Castle Garden Road; however the eastern portion is currently owned by SCA Chemical Services and that portion was surveyed as part of off-site property A. Security fencing presently delineates the eastern property boundary, as well as the western boundary; fencing also parallels Balmer Road near the northern perimeter.

There are several interior roads including Wesson Road and "5" Street. Major drainage ditches are parallel to and outside the east, west, and north security fences; smaller ditches are located throughout the property. The major ditch to the west of the property is the Central Drainage Ditch - the major surface drainage route for the Niagara Falls Storage Site. There are five buildings on the site (one of these buildings is partially on adjacent property U). Numerous foundations and slabs remain from previous structures. The land is generally level, with the exception of a large mound of topsoil in the north-central section of the property. Some dense brush and trees occupy the northeast corner; otherwise the site is relatively clear and portions are maintained.

#### Radiological History

There is no history indicating burials of contaminated material on property V; however, residues may have been temporarily stored along "H" Street near its intersection with "5" Street.<sup>1</sup> Because of construction activities associated with the Mathieson rocket fuel facilities, it is likely that any surface contamination from earlier MED/AEC operations would have been disturbed and/or relocated. The 1971-72 AEC survey identified elevated gamma radiation levels along Wesson Road and east of the intersection of "5" Street with an unnamed east/west road.<sup>2</sup> The 1980 mobile scan by ORNL confirmed these findings.<sup>3</sup> Previous surveys also identified contamination of the adjacent Central Drainage Ditch, resulting in elevated direct radiation levels in its vicinity.<sup>2,3</sup>

#### SURVEY PROCEDURES

The comprehensive survey of NFSS off-site property V was performed by the Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU), during June-August 1983. The survey was in accordance with a plan dated March 18, 1983, approved by the Department of 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 on property V. 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, and
5. contamination levels on interior building surfaces.

### 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, 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 ( $\mu\text{R}/\text{h}$ ) was in accordance with cross calibration with a pressurized ionization chamber.

4. Beta-gamma dose rate measurements were performed 1 cm above the surface at 20 m grid intervals. These measurements were conducted using thin-window ( $<7$  mg/cm<sup>2</sup>) 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 (urad/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 20 m grid intervals.
6. At selected locations of elevated surface radiation levels, beta-gamma dose rates at 1 cm above the surface and exposure rates at 1 m above the surface were also measured. Surface samples were obtained from these locations and, following sampling, surface exposure rates 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 some 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. Fourteen boreholes were drilled by Site Engineers, Inc., of Cherry Hill, NJ, using truck mounted 20 cm diameter hollow-stem augers. 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 nine borehole locations using a hand bailer. Soil samples of approximately 1 kg each were collected from various depths in selected holes by scraping the sides of each borehole with an ORAU designed sampling tool.

9. Two water samples were collected from areas of standing (surface) water (see Figure 5).
10. Gamma scans and exploratory measurements of direct alpha and beta-gamma levels were performed in existing buildings. On the basis of the negative results of these measurements, further surveying of interior building surfaces was not performed.
11. 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 Analyses 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.

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 exposures 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  $\mu\text{R}/\text{h}$  (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 locations ranged from 4 to 20  $\mu\text{R}/\text{h}$  (average 7  $\mu\text{R}/\text{h}$ ). Surface contact gamma exposure rates and beta-gamma dose rates were 5 to 29  $\mu\text{R}/\text{h}$  (average 8  $\mu\text{R}/\text{h}$ ) and 5 to 69  $\mu\text{rad}/\text{h}$  (average 14  $\mu\text{rad}/\text{h}$ ), respectively. At most locations, 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 small areas and isolated spots of elevated contact radiation levels. These locations are indicated on Figure 8 and associated radiation levels are presented in Table 3. Surface contact gamma exposure rates ranged from 12-240  $\mu$ R/h; the maximum was measured at grid point 541N, 123E. Exposure rates at 1 m above the surface ranged from 13 to 26  $\mu$ R/h. Beta-gamma dose rates ranged from 20-450  $\mu$ rad/h. The maximum dose rate was also recorded at grid coordinate 541N, 123E. Contact exposure and beta-gamma dose rates were not reduced by soil sampling at many of these locations; the most notable example occurred at grid point 541N, 179E where the contact exposure rate increased from 220 to 1100  $\mu$ R/hr following sampling.

#### 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 <0.14 to 3.54 pCi/g. The highest level was in the sample collected at grid point 820N, 40W. The walkover surface scan identified this general area as having slightly elevated contact gamma readings. A few additional samples contained Ra-226 concentrations exceeding those in the baseline soil, but none exceeded 5 pCi/g above the baseline level. Three of these samples also contained U-238 concentrations slightly above baseline levels; the highest was 7.00 pCi/g in the samples from grid coordinates 600N, 50W and 580N, 60E. Slightly elevated concentrations of U-235, Th-232, and Cs-137 were also present in a few samples, but levels were generally comparable to the ranges in baseline soil. No other gamma emitting radionuclides were present at levels exceeding those normally occurring in soil.

Radionuclide concentrations in samples from locations of elevated contact radiation levels are presented in Table 5. Concentrations of Ra-226 in these samples ranged from 23.7 to 4,280 pCi/g; the maximum concentration was measured in a piece of rock-like material (sample B10) from grid point 541N, 179E. Sample B9 (541N, 123E), also a large rock, contained 990 pCi/g of Ra-226 and elevated U-238 and Th-232 concentrations (94.8 and 84.5 pCi/g, respectively).

Samples B1-B8 contained Ra-226 levels between 20 and 50 pCi/g with comparable concentrations of U-238. These samples were all small rocks associated with construction fill or paving. Similar material has been noted on other NFSS properties and throughout the Niagara Falls area; the radionuclide levels in this particular type of rock is believed to be of natural origin and not the result of previous MED/AEC operations on this site.

#### Borehole Gamma-Logging Measurements

The results of gamma scintillation measurements in boreholes indicate elevated radionuclide levels to a depth of 30-60 cm in several areas. As evidenced by analyses of subsurface samples, the gamma borehole measurements were reliable indicators of elevated 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 radionuclides measured in soil samples from boreholes. At borehole locations H1-H9, located to be representative of the general property conditions, logging measurements did not identify evidence of elevated subsurface radionuclide levels. Therefore, only samples of surface soil were collected at these locations.

Subsurface samples from boreholes H10, H12, and H13, drilled in areas of elevated direct surface radiation, contained concentrations of Ra-226 above the baseline soil levels. The highest concentration was 20.6 pCi/g, from the 15 cm depth in borehole H10. This sample also contained 39.1 pCi/g of U-238. The activity in this sample was associated with small pieces of rock; similar rock and radionuclide levels were noted in the surface sample from this location. In borehole H12 the Ra-226 levels were slightly elevated at the 90 cm depth; however the concentration was only 2.16 pCi/g. Samples from 30 cm and 120 cm deep in borehole H13 contained

12.3 and 3.65 pCi/g of Ra-226. The high direct radiation level measured at this location after surface sampling, and the borehole logging measurements indicate, however, that material (possibly individual rocks) containing radionuclide levels considerably greater than those observed in the subsurface sample, are present at approximately 30 cm deep in this area.

#### Radionuclide Concentrations in Water

##### Surface Water

Samples W1 and W2 from standing water on property V (refer to Table 7) contained gross alpha concentrations of 1.62 and 1.83 pCi/l, respectively. Gross beta concentrations of 2.77 pCi/l (W1) and 10.3 pCi/l (W2) were present. These values are within the range measured in baseline water samples.

##### Subsurface Water

Water samples collected from boreholes contained from 1.08 to 10.6 pCi/l of gross alpha and 1.15 to 14.7 pCi/l of gross beta. The alpha level is higher than those measured in baseline samples; however, both alpha and beta levels are within the EPA Drinking Water criteria. It should be noted that high concentrations of dissolved solids in many of these samples resulted in residues which adversely affected the relative errors of the analytical procedure.

#### Building Surveys

Results of the gamma scans and measurements and exploratory measurements of direct alpha and beta-gamma levels, performed in five buildings, are presented in Table 8. Gamma exposure rates at 1 m above the floor ranged from 4.2 to 6.7  $\mu$ R/h. Beta-gamma dose rates ranged from 0.01-0.03 mrad/h. Total alpha contamination levels ranged from <26 to 103 d/m<sup>2</sup>/100 cm<sup>2</sup>; beta-gamma levels were all <394 d/m<sup>2</sup>/100 cm<sup>2</sup> with the exception of an isolated area in one of the buildings where a surface beta-gamma measurement of 634 d/m<sup>2</sup>/100 cm<sup>2</sup> was recorded.

#### 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 at small, isolated spots of surface or near-surface contamination exceed these guideline values.

The exposure rates in contact with two of the isolated areas of surface contamination exceed the NRC guideline of 60  $\mu\text{R}/\text{h}$  for open land areas accessible by the general public. The highest level measured (before sampling) was 240  $\mu\text{R}/\text{h}$  at grid point 541N, 123E. At grid coordinate 541N, 179E contact exposure levels increased from 220 to 1100  $\mu\text{R}/\text{h}$  following sampling. The average exposure rate of 7  $\mu\text{R}/\text{h}$  at 1 m above the surface is well within the 60  $\mu\text{R}/\text{h}$  guideline.

Concentrations of Ra-226 in excess of 5 pCi/g above the baseline level are present on the surface of the property. Most of these locations are associated with small areas of rock fill, which also contains equivalent concentrations of U-238. The radionuclide content is therefore believed to be of natural origin and not attributable to previous MED/AEC activities at this site. At several locations, Ra-226 levels exceeding 15 pCi/g were identified in subsurface rock fill. Isolated pieces of rock-like material with higher levels of Ra-226, but without comparable U-238 concentrations, were also noted. This material is considered to have resulted from MED/AEC activities. Direct surface and borehole logging measurements indicate subsurface deposits of this material to 30 cm deep at grid coordinate 541N, 179E. The total volume of this material is estimated to be less than 1  $\text{m}^3$  and the Ra-226 concentration averaged over 100  $\text{m}^2$  would be within the criteria.

Surface and subsurface water contained radionuclide concentrations below the EPA Interim Drinking Water Standards of 15 pCi/l, gross alpha, and 50 pCi/l, gross beta.

Exposure rates inside buildings are comparable to background levels. Alpha surface contamination levels are less than the criteria of 100 d/m<sup>2</sup>/100 cm<sup>2</sup> average and 300 d/m<sup>2</sup>/100 cm<sup>2</sup> maximum (based on Ra-226). Beta-gamma surface contamination levels were, with one exception, below detection limits.

#### SUMMARY

A comprehensive survey of off-site property V at the Niagara Falls Storage Site was conducted during June-August 1983. The survey included surface radiation scans, measurements of direct radiation levels, analyses for radionuclide concentrations in surface and subsurface soil and water samples, and measurements of contamination levels in buildings. Ground-penetrating radar was used to identify subsurface utilities, which might preclude borehole drilling.

The survey identified small isolated areas of elevated direct radiation and soil contamination. The major contaminant is Ra-226; however, U-238 and Th-232 are also present. Most of these areas are associated with rock material similar to that commonly used as a fill and paving base in the Niagara Falls area. It is believed to be of natural origin and not attributable to previous MED/AEC activities on this site. Several isolated pieces of rock-like material, containing primarily Ra-226 at higher concentrations than in the rock fill, were also located; this material is also similar to residues identified on other off-site properties.

Subsurface contamination was identified at 15-30 cm deep at two borehole locations.

Radionuclide concentrations in surface and subsurface water are within EPA Drinking Water Standards and contamination was not identified in buildings on the property.

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 and are not migrating from the property.

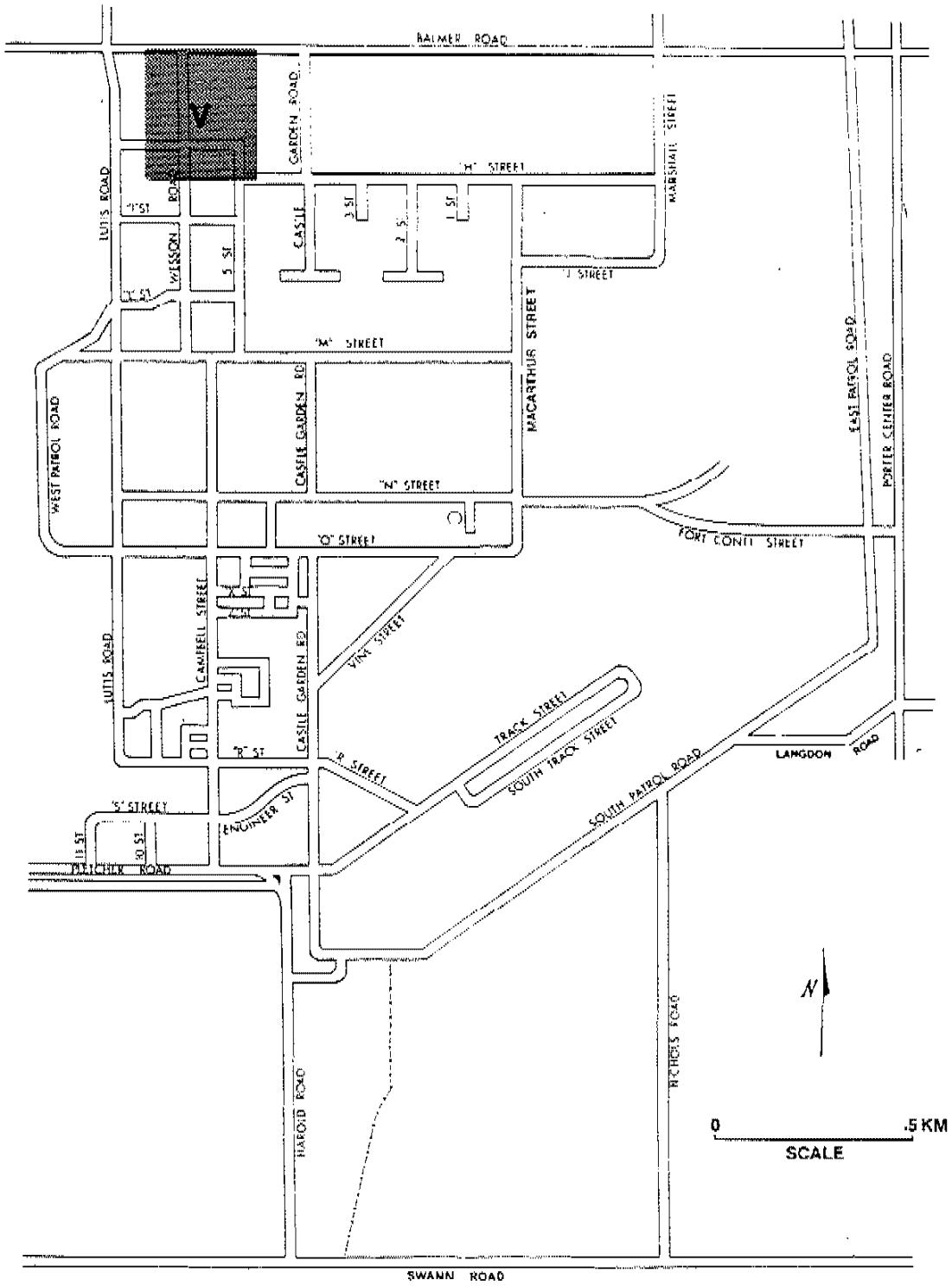


FIGURE 1. Map of Niagara Falls Storage Site and Off-Site Properties, Lewiston, New York, Indicating the Location of Off-Site Property V.

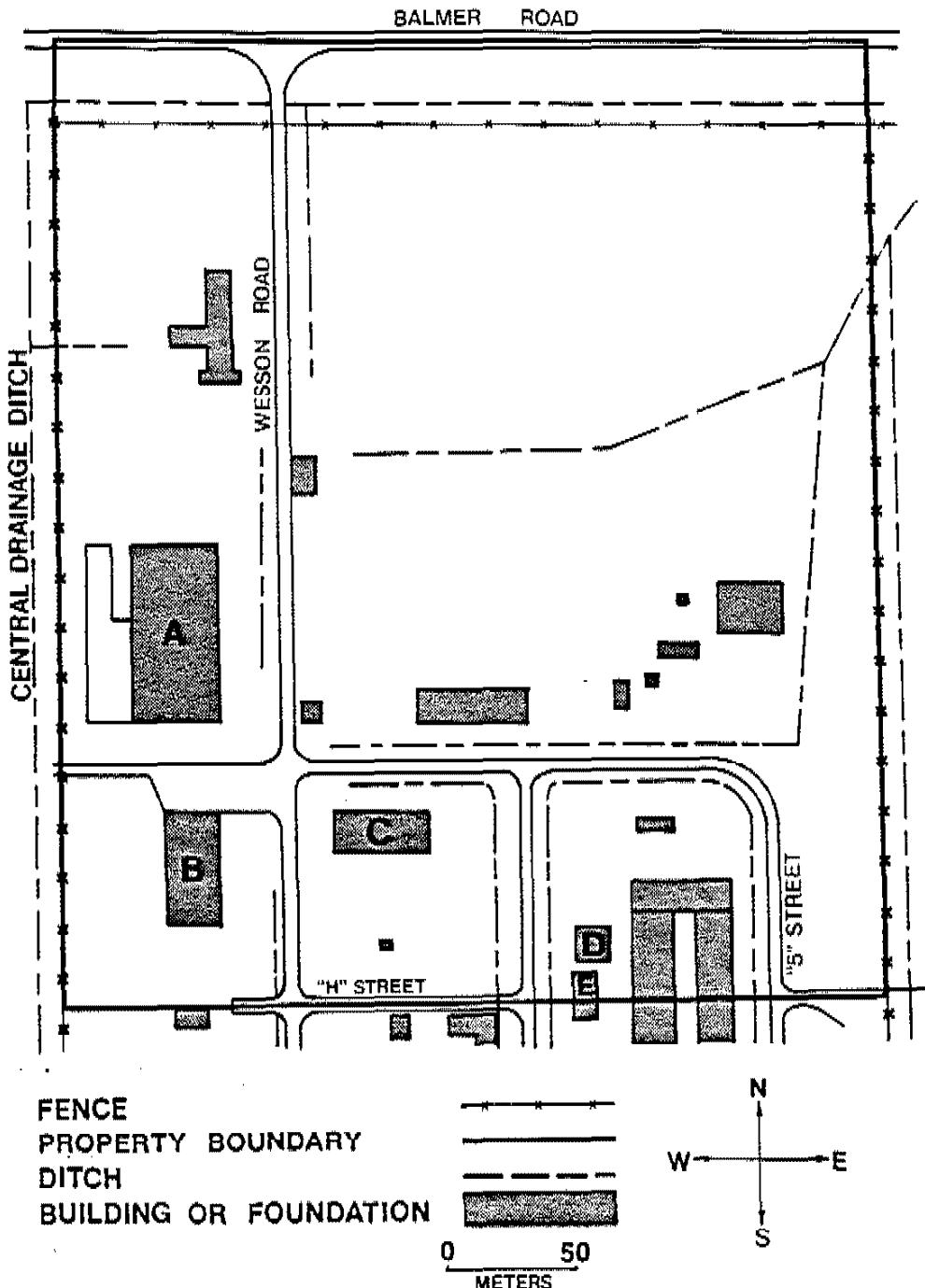


FIGURE 2. Plan View of NFSS Off-Site Property V Indicating Prominent Surface Features.

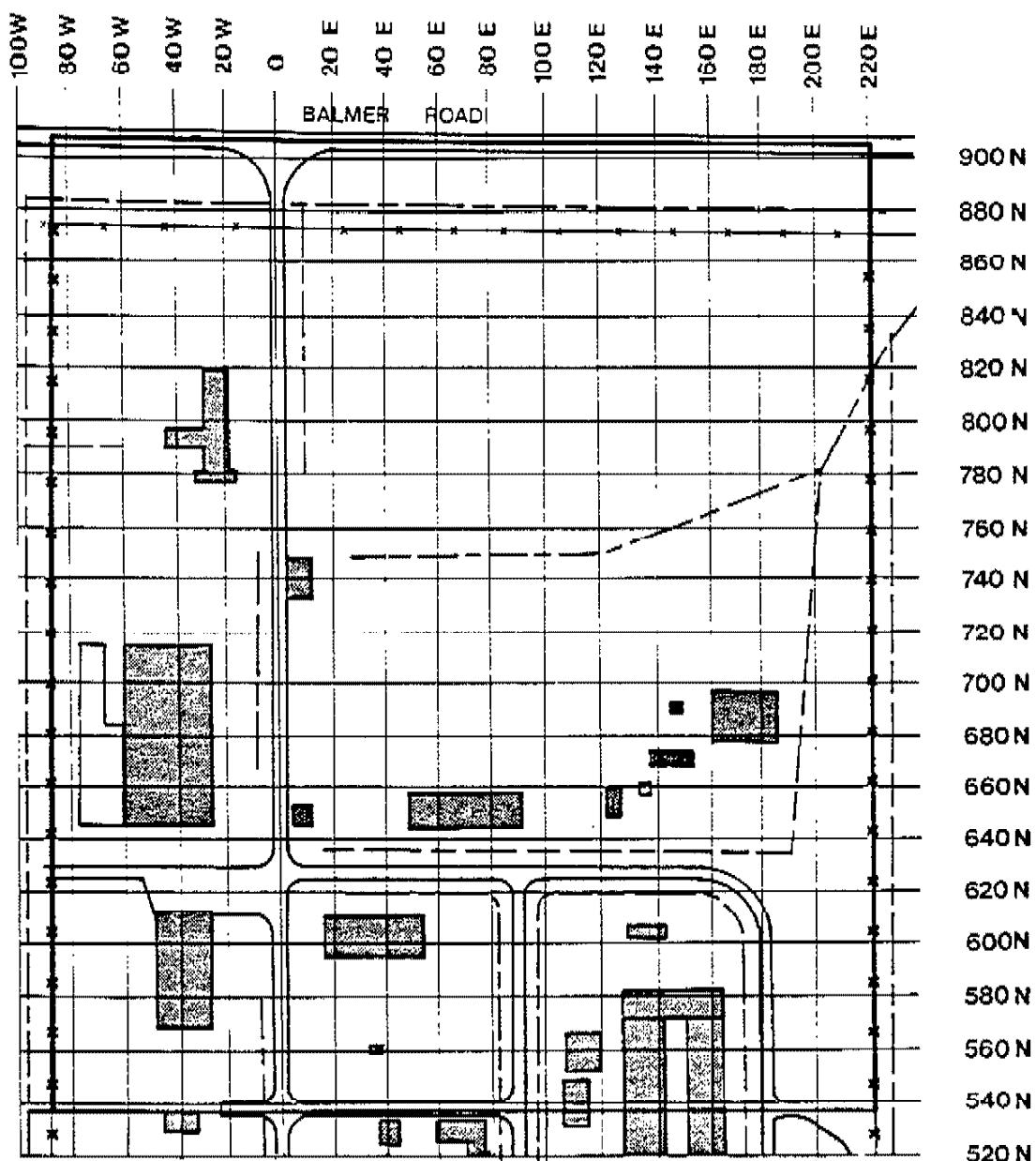


FIGURE 3. Plan View of NFSS Off-Site Property V Indicating the Grid System Established for Survey Reference.

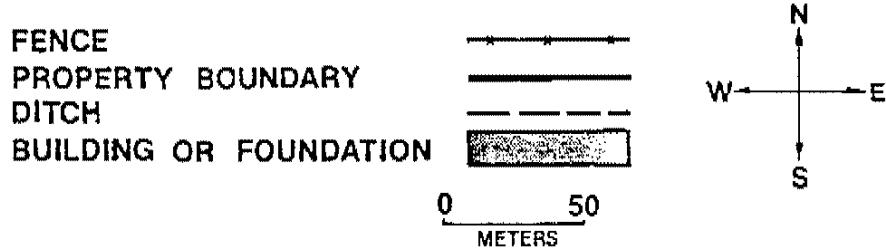
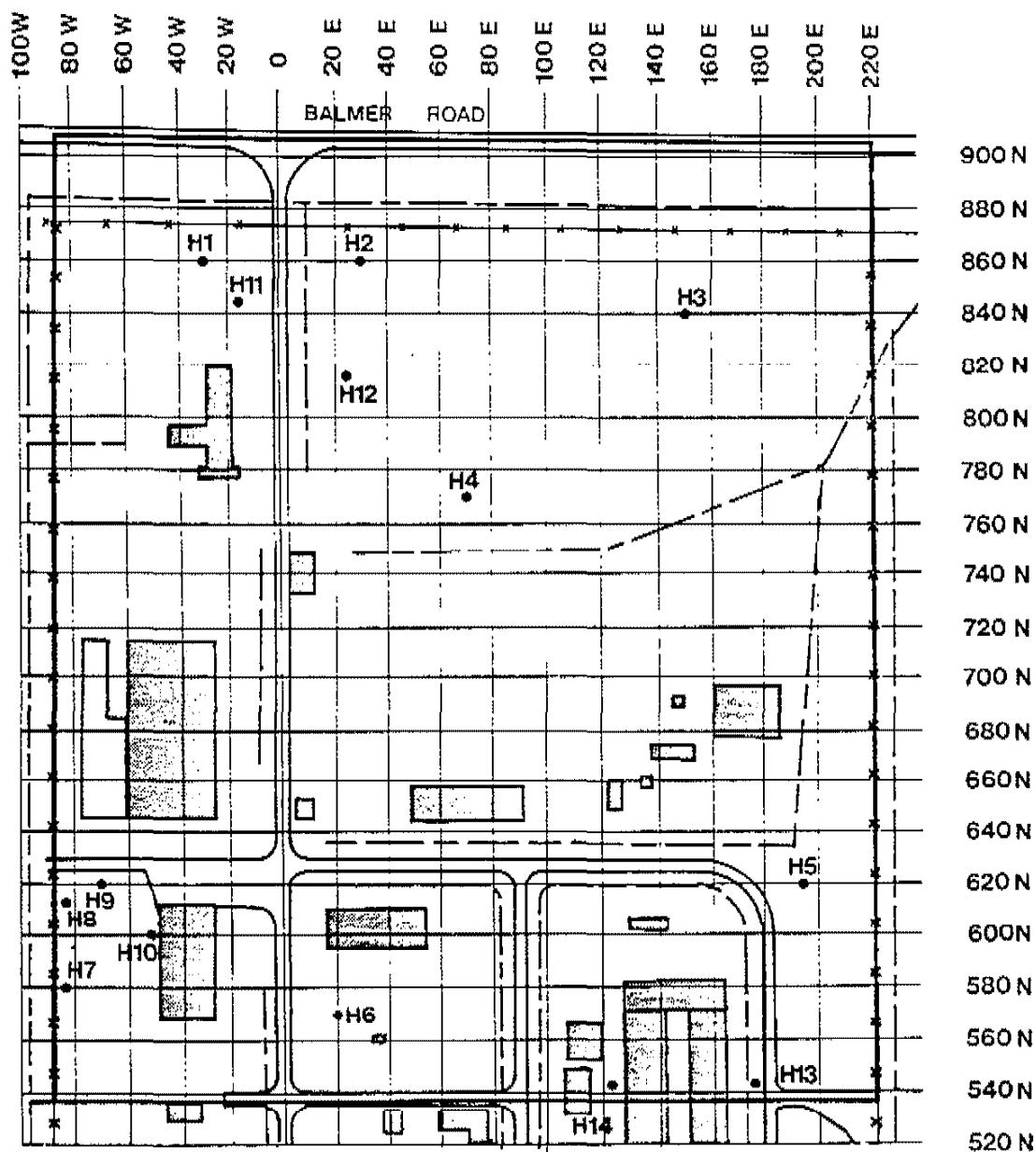


FIGURE 4. Locations of Boreholes for Subsurface Investigations.

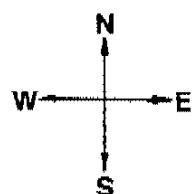
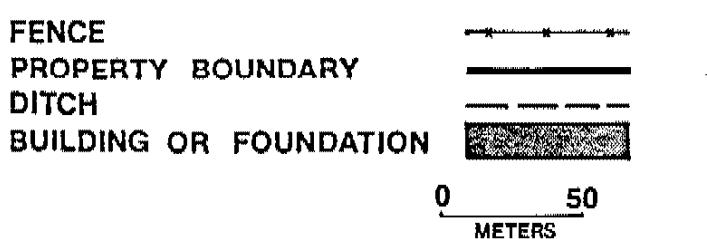
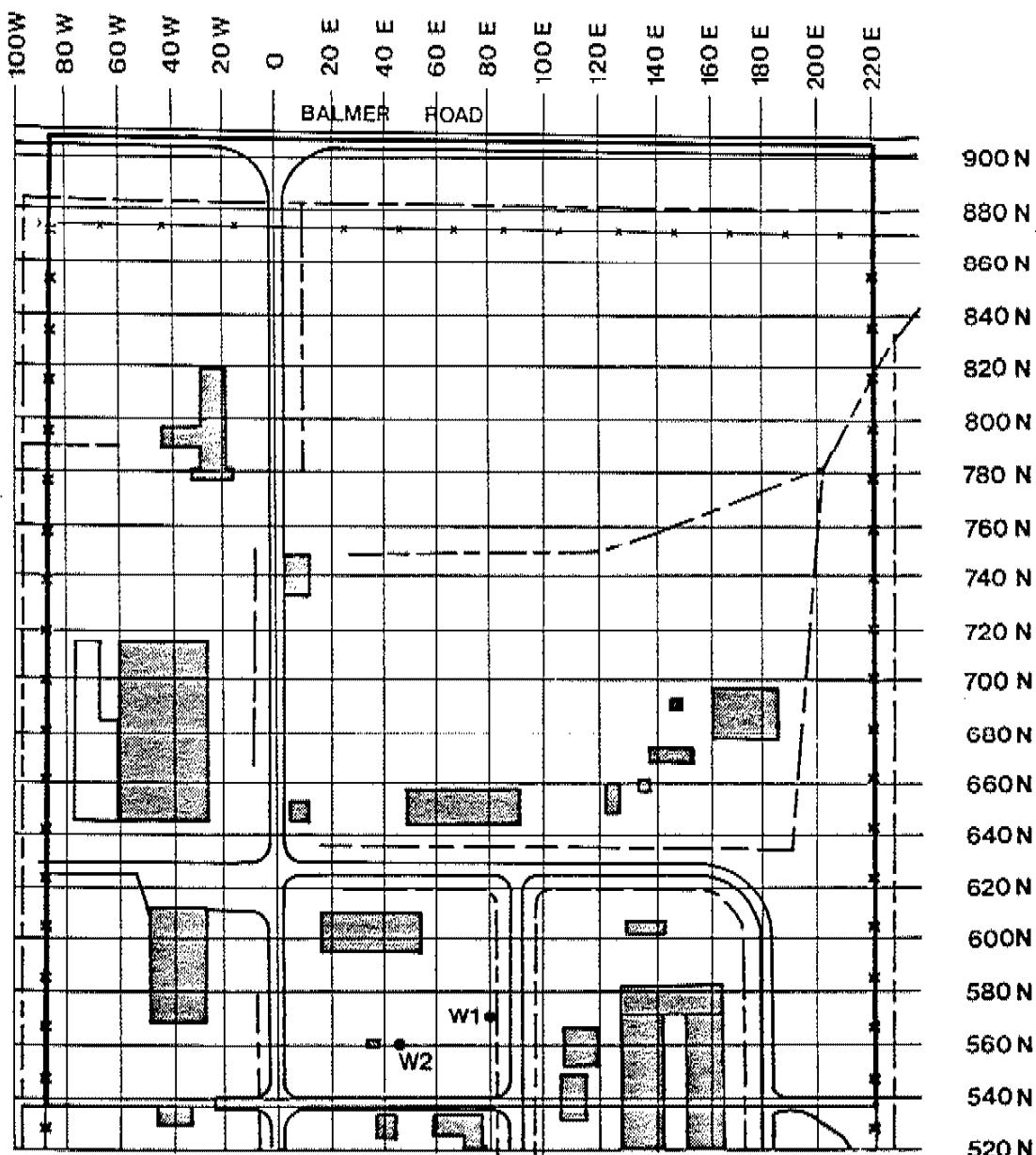


FIGURE 5. Locations of Water Samples from Standing Water.

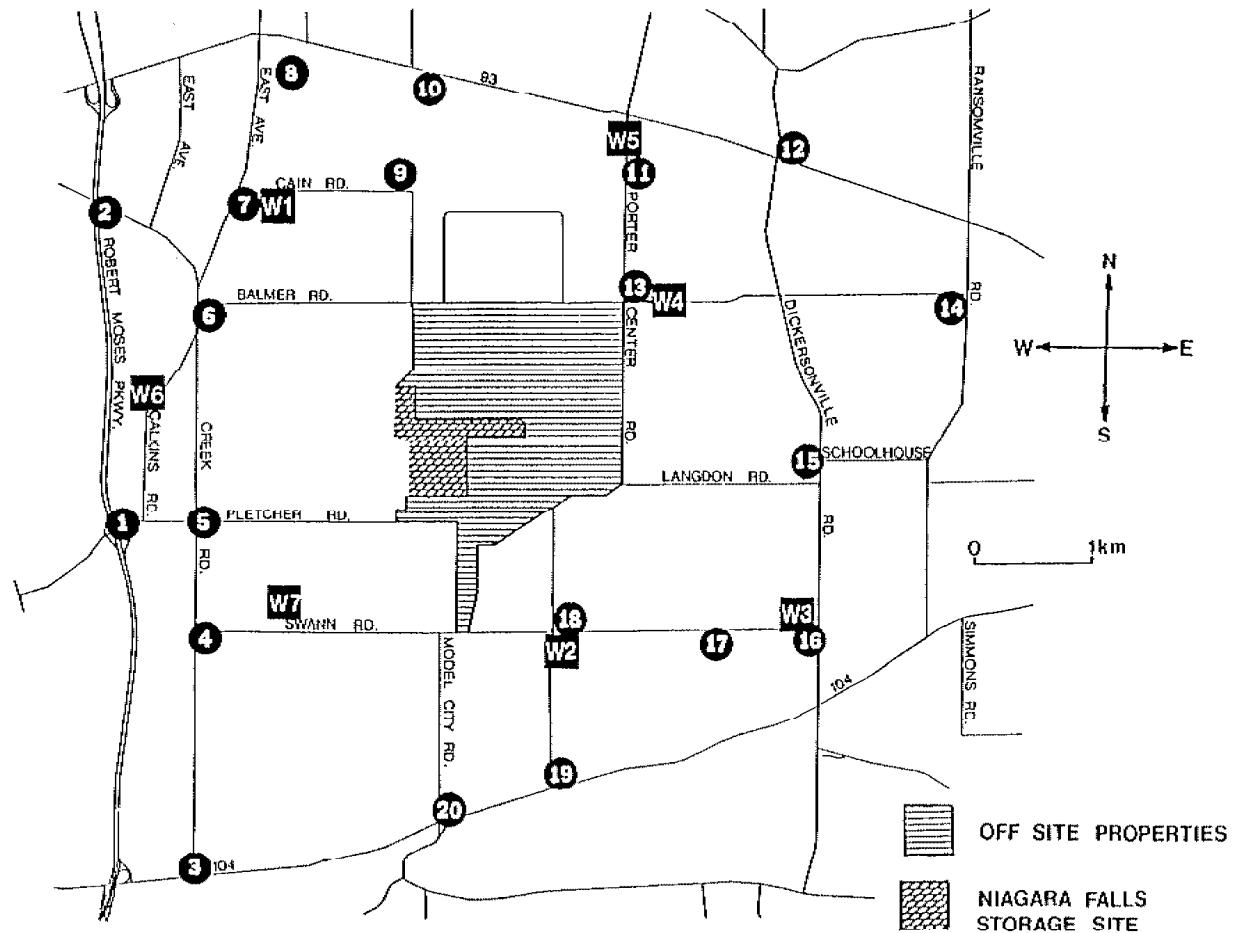


FIGURE 6. Map of Northern Niagara County, New York, Showing Locations of Background Measurements and Baseline Samples. (#1-20: soil samples and direct measurements; W1-W7: water samples.)

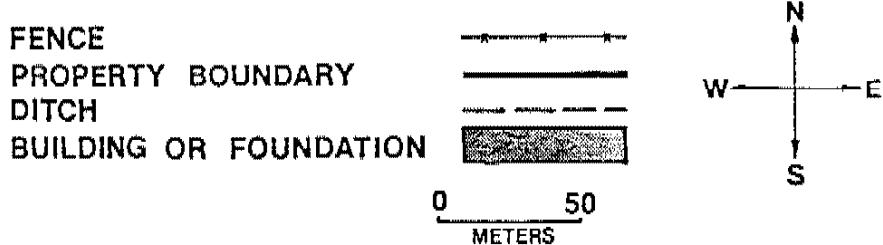
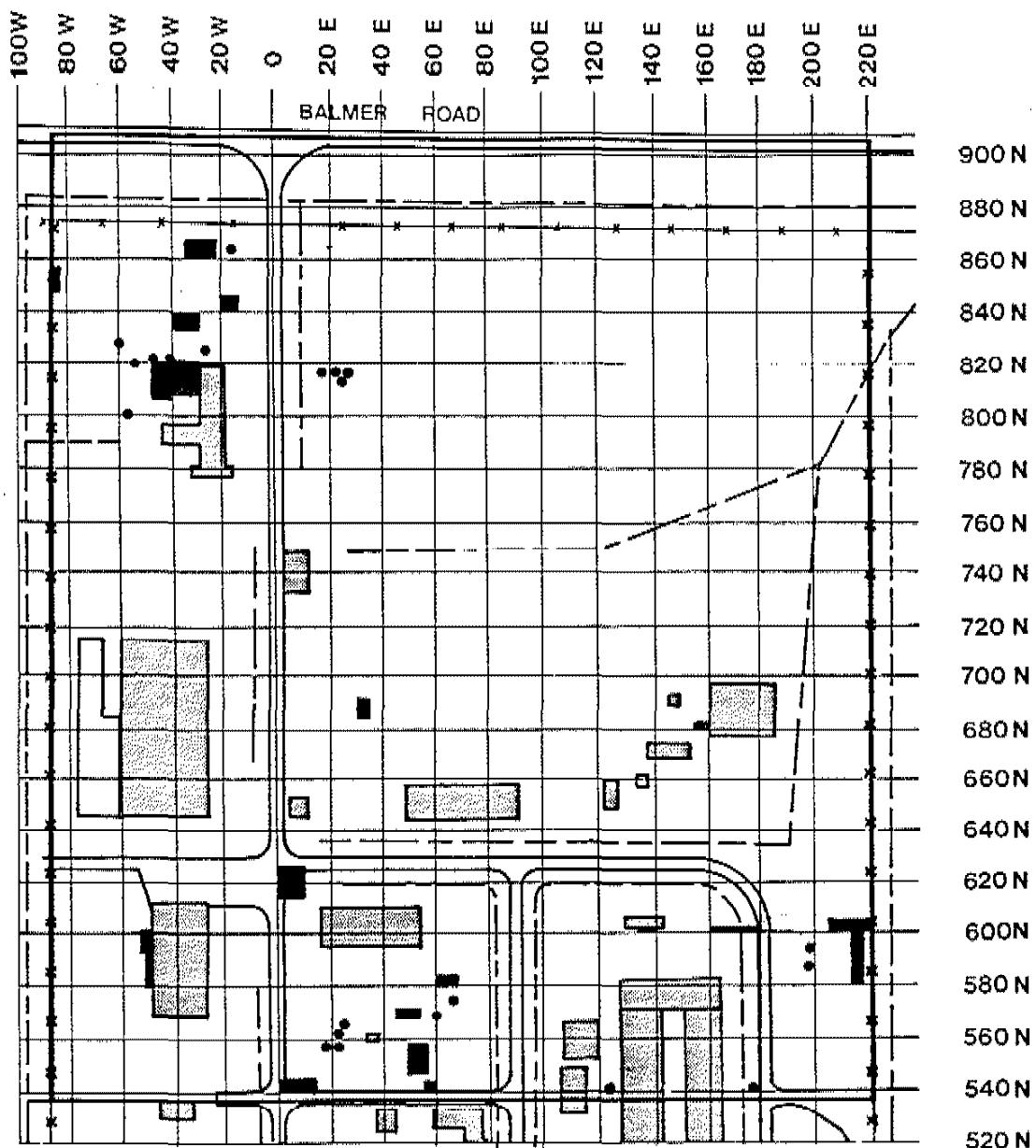


FIGURE 7. Map of NFSS Off-Site Property V Indicating Areas of Elevated Direct Radiation and Locations Where Radionuclide Concentrations in Soil Exceed Criteria.

TABLE I-A  
BACKGROUND EXPOSURE RATES  
AND  
RADIONUCLIDE CONCENTRATIONS IN BASELINE SOIL SAMPLES

| Location <sup>a</sup> | Exposure Rate <sup>b</sup><br>( $\mu$ R/h) | Radionuclide Concentrations (pCi/g) |               |               |               |              |               |
|-----------------------|--|-------------------------------------|---------------|---------------|---------------|--------------|---------------|
|                       |  | Ra-226                              | U-235         | U-238         | Th-232        | Cs-137       |               |
| 1                     | 6.8  | 0.74 ± 0.16 <sup>c</sup>            | <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 |

<sup>a</sup> Refer to Figure 6.

<sup>b</sup> Measured at 1 m above the surface.

<sup>c</sup> Errors are 2 $\sigma$  based on counting statistics.

TABLE 1-B  
RADIONUCLIDE CONCENTRATIONS IN BASELINE WATER SAMPLES

| Location <sup>a</sup> | Radionuclide Concentrations (pCi/l) |                 |
|-----------------------|-------------------------------------|-----------------|
|                       | Gross Alpha                         | Gross Beta      |
| W1                    | 0.95 $\pm$ 0.93 <sup>b</sup>        | 4.79 $\pm$ 1.15 |
| W2                    | 0.95 $\pm$ 0.94                     | 9.17 $\pm$ 1.31 |
| W3                    | 0.55 $\pm$ 0.78                     | 2.73 $\pm$ 1.05 |
| W4                    | 0.63 $\pm$ 0.89                     | 5.37 $\pm$ 1.17 |
| W5                    | 0.73 $\pm$ 0.58                     | <0.64           |
| W6                    | 1.87 $\pm$ 1.84                     | 14.3 $\pm$ 2.4  |
| W7                    | 1.16 $\pm$ 0.66                     | <0.63           |
| Range                 | 0.55 to 1.87                        | <0.63 to 14.3   |

<sup>a</sup> Refer to Figure 6.

<sup>b</sup> Errors are  $2\sigma$  based on counting statistics.

TABLE 2  
DIRECT RADIATION LEVELS  
MEASURED AT 20 M GRID INTERVALS

| Grid Location |      | Gamma Exposure<br>Rates at 1 m Above<br>the Surface<br>( $\mu\text{R}/\text{h}$ ) | Gamma Exposure<br>Rates at the<br>Surface<br>( $\mu\text{R}/\text{h}$ ) | Beta-Gamma<br>Dose Rates at 1 cm<br>Above the Surface<br>( $\mu\text{rad}/\text{h}$ ) |
|---------------|------|---|---|---|
| 900N          | 90W  | 7   | 8   | 14  |
| 900N          | 80W  | 8   | 8   | 10  |
| 900N          | 60W  | 7   | 8   | 28  |
| 900N          | 40W  | 7   | 7   | 7   |
| 900N          | 20W  | 8   | 8   | 20  |
| 900N          | OE   | 9   | 9   | 18  |
| 900N          | 2OE  | 7   | 8   | 12  |
| 900N          | 4OE  | 7   | 7   | 9   |
| 900N          | 6OE  | 7   | 8   | 8   |
| 900N          | 8OE  | 7   | 8   | 8   |
| 900N          | 10OE | 7   | 7   | 17  |
| 900N          | 12OE | 7   | 7   | 7   |
| 900N          | 14OE | 7   | 7   | 13  |
| 900N          | 16OE | 7   | 8   | 13  |
| 900N          | 18OE | 7   | 7   | 7   |
| 900N          | 20OE | 6   | 7   | 13  |
| 900N          | 22OE | 7   | 7   | 10  |
| 880N          | 90W  | 8   | 8   | a   |
| 880N          | 80W  | 8   | 8   | a   |
| 880N          | 60W  | 8   | 8   | a   |
| 880N          | 40W  | 8   | 8   | a   |
| 880N          | 20W  | 8   | 8   | a   |
| 880N          | OE   | 9   | 9   | 11  |
| 880N          | 2OE  | 8   | 8   | a   |
| 880N          | 4OE  | 8   | 8   | a   |
| 880N          | 6OE  | 8   | 8   | a   |
| 880N          | 8OE  | 8   | 8   | a   |
| 880N          | 10OE | 8   | 8   | a   |
| 880N          | 12OE | 8   | 8   | a   |
| 880N          | 14OE | 8   | 8   | a   |
| 880N          | 16OE | 8   | 8   | a   |
| 880N          | 18OE | 8   | 8   | a   |
| 880N          | 20OE | 8   | 8   | a   |
| 880N          | 22OE | 8   | 8   | a   |
| 860N          | 90W  | 9   | 10  | 27  |
| 860N          | 80W  | 9   | 10  | 21  |
| 860N          | 60W  | 9   | 10  | 23  |
| 860N          | 40W  | 10  | 12  | 19  |
| 860N          | 20W  | 9   | 9   | 13  |
| 860N          | OE   | 9   | 9   | 12  |
| 860N          | 2OE  | 7   | 8   | 12  |
| 860N          | 4OE  | 7   | 7   | 19  |

TABLE 2, cont.

DIRECT RADIATION LEVELS  
MEASURED AT 20 M GRID INTERVALS

| Grid Location |      | Gamma Exposure Rates at 1 m Above the Surface ( $\mu\text{R/h}$ ) | Gamma Exposure Rates at the Surface ( $\mu\text{R/h}$ ) | Beta-Gamma Dose Rates at 1 cm Above the Surface ( $\mu\text{rad/h}$ ) |
|---------------|------|---|---|---|
| 860N          | 60E  | 7   | 8   | 8   |
| 860N          | 80E  | 7   | 7   | 7   |
| 860N          | 100E | 7   | 7   | 16  |
| 860N          | 120E | 7   | 8   | 18  |
| 860N          | 140E | 7   | 8   | 19  |
| 860N          | 160E | 7   | 7   | 13  |
| 860N          | 180E | 7   | 8   | 16  |
| 860N          | 200E | 7   | 8   | 24  |
| 860N          | 220E | 7   | 7   | 19  |
| 840N          | 90W  | 8   | 8   | 18  |
| 840N          | 80W  | 9   | 9   | 16  |
| 840N          | 60W  | 10  | 10  | 30  |
| 840N          | 40W  | 11  | 11  | 22  |
| 840N          | 20W  | 9   | 9   | 21  |
| 840N          | 0E   | 9   | 9   | 21  |
| 840N          | 20E  | 8   | 7   | 12  |
| 840N          | 40E  | 7   | 7   | 20  |
| 840N          | 60E  | 7   | 8   | 10  |
| 840N          | 80E  | 7   | 8   | 8   |
| 840N          | 100E | 8   | 8   | 8   |
| 840N          | 120E | 8   | 8   | 31  |
| 840N          | 140E | 7   | 7   | 13  |
| 840N          | 160E | 7   | 7   | 13  |
| 840N          | 180E | 7   | 8   | 8   |
| 840N          | 200E | 8   | 7   | 7   |
| 840N          | 220E | 7   | 7   | 9   |
| 820N          | 90W  | 8   | 8   | 11  |
| 820N          | 80W  | 8   | 8   | 22  |
| 820N          | 60W  | 8   | 8   | 24  |
| 820N          | 40W  | 20  | 29  | 69  |
| 820N          | 20W  | 7   | 6   | 19  |
| 820N          | 0E   | 9   | 12  | 19  |
| 820N          | 20E  | 9   | 8   | 18  |
| 820N          | 40E  | 8   | 8   | 15  |
| 820N          | 60E  | 8   | 8   | 14  |
| 820N          | 80E  | 8   | 8   | 25  |
| 820N          | 100E | 8   | 9   | 22  |
| 820N          | 120E | 8   | 8   | 28  |
| 820N          | 140E | 7   | 7   | 7   |
| 820N          | 160E | 7   | 7   | 16  |
| 820N          | 180E | 7   | 7   | 12  |
| 820N          | 200E | 7   | 8   | 12  |

TABLE 2, cont.

DIRECT RADIATION LEVELS  
MEASURED AT 20 M GRID INTERVALS

| Grid Location |      | Gamma Exposure Rates at 1 m Above the Surface ( $\mu\text{R/h}$ ) | Gamma Exposure Rates at the Surface ( $\mu\text{R/h}$ ) | Beta-Gamma Dose Rates at 1 cm Above the Surface ( $\mu\text{rad/h}$ ) |
|---------------|------|---|---|---|
| 820N          | 220E | 7   | 7   | 10  |
| 800N          | 90W  | 8   | 8   | 28  |
| 800N          | 80W  | 9   | 9   | 23  |
| 800N          | 60W  | 8   | 8   | 19  |
| 800N          | 40W  | 7   | 7   | 10  |
| 800N          | 20W  | 6   | 5   | 14  |
| 800N          | 0E   | 9   | 11  | 28  |
| 800N          | 20E  | 8   | 8   | 11  |
| 800N          | 40E  | 7   | 9   | 8   |
| 800N          | 60E  | 9   | 8   | 19  |
| 800N          | 80E  | 7   | 7   | 14  |
| 800N          | 100E | 7   | 8   | 13  |
| 800N          | 120E | 8   | 3   | 17  |
| 800N          | 140E | 7   | 8   | 8   |
| 800N          | 160E | 7   | 7   | 15  |
| 800N          | 180E | 7   | 7   | 9   |
| 800N          | 200E | 7   | 7   | 10  |
| 800N          | 220E | 7   | 7   | 13  |
| 780N          | 90W  | 8   | 8   | 15  |
| 780N          | 80W  | 7   | 7   | 23  |
| 780N          | 60W  | 7   | 8   | 12  |
| 780N          | 40W  | 8   | 12  | 25  |
| 780N          | 20W  | 6   | 6   | 6   |
| 780N          | 0E   | 9   | 10  | 18  |
| 780N          | 20E  | 7   | 7   | 7   |
| 780N          | 40E  | 8   | 7   | 13  |
| 780N          | 60E  | 7   | 7   | 11  |
| 780N          | 80E  | 7   | 7   | 7   |
| 780N          | 100E | 7   | 7   | 9   |
| 780N          | 120E | 7   | 8   | 11  |
| 780N          | 140E | 7   | 7   | 7   |
| 780N          | 160E | 7   | 8   | 9   |
| 780N          | 180E | 7   | 8   | 15  |
| 780N          | 200E | 7   | 8   | 12  |
| 780N          | 220E | 7   | 8   | 11  |
| 760N          | 90W  | 8   | 8   | 18  |
| 760N          | 80W  | 7   | 8   | 22  |
| 760N          | 60W  | 7   | 7   | 7   |
| 760N          | 40W  | 7   | 7   | 9   |
| 760N          | 20W  | 7   | 8   | 9   |
| 760N          | 0E   | 9   | 10  | 28  |
| 760N          | 20E  | 8   | 8   | 21  |

TABLE 2, cont.  
 DIRECT RADIATION LEVELS  
 MEASURED AT 20 M GRID INTERVALS

| Grid Location |      | Gamma Exposure<br>Rates at 1 m Above<br>the Surface<br>( $\mu\text{R}/\text{h}$ ) | Gamma Exposure<br>Rates at the<br>Surface<br>( $\mu\text{R}/\text{h}$ ) | Beta-Gamma<br>Dose Rates at 1 cm<br>Above the Surface<br>( $\mu\text{rad}/\text{h}$ ) |
|---------------|------|---|---|---|
| 760N          | 40E  | 7   | 7   | 23  |
| 760N          | 60E  | 7   | 7   | 13  |
| 760N          | 80E  | 7   | 7   | 7   |
| 760N          | 100E | 7   | 7   | 15  |
| 760N          | 120E | 7   | 7   | 7   |
| 760N          | 140E | 7   | 7   | 12  |
| 760N          | 160E | 7   | 7   | 20  |
| 760N          | 180E | 7   | 8   | 25  |
| 760N          | 200E | 8   | 8   | 8   |
| 760N          | 220E | 7   | 7   | 7   |
| 740N          | 90W  | 7   | 7   | 9   |
| 740N          | 80W  | 6   | 6   | 11  |
| 740N          | 60W  | 7   | 8   | 16  |
| 740N          | 40W  | 7   | 7   | 19  |
| 740N          | 20W  | 7   | 7   | 12  |
| 740N          | 0E   | 9   | 9   | 18  |
| 740N          | 20E  | 6   | 6   | 8   |
| 740N          | 40E  | 5   | 5   | 5   |
| 740N          | 60E  | 6   | 6   | 14  |
| 740N          | 80E  | 5   | 5   | 5   |
| 740N          | 100E | 5   | 6   | 6   |
| 740N          | 120E | 6   | 7   | 7   |
| 740N          | 140E | 7   | 7   | 10  |
| 740N          | 160E | 7   | 7   | 12  |
| 740N          | 180E | 7   | 7   | 16  |
| 740N          | 200E | 7   | 7   | 9   |
| 740N          | 220E | 8   | 7   | 7   |
| 720N          | 90W  | 9   | 9   | 12  |
| 720N          | 80W  | 7   | 7   | 7   |
| 720N          | 60W  | 6   | 7   | 10  |
| 720N          | 40W  | 6   | 6   | 8   |
| 720N          | 20W  | 7   | 7   | 11  |
| 720N          | 0E   | 9   | 8   | 8   |
| 720N          | 20E  | 6   | 5   | 5   |
| 720N          | 40E  | 6   | 7   | 7   |
| 720N          | 60E  | 5   | 6   | 6   |
| 720N          | 80E  | 6   | 6   | 6   |
| 720N          | 100E | 5   | 5   | 5   |
| 720N          | 120E | 7   | 6   | 11  |
| 720N          | 140E | 6   | 7   | 7   |
| 720N          | 160E | 7   | 7   | 7   |
| 720N          | 180E | 7   | 7   | 7   |

TABLE 2, cont.

DIRECT RADIATION LEVELS  
MEASURED AT 20 M GRID INTERVALS

| Grid Location |      | Gamma Exposure Rates at 1 m Above the Surface ( $\mu\text{R/h}$ ) | Gamma Exposure Rates at the Surface ( $\mu\text{R/h}$ ) | Beta-Gamma Dose Rates at 1 cm Above the Surface ( $\mu\text{rad/h}$ ) |
|---------------|------|---|---|---|
| 720N          | 200E | 7   | 7   | 11  |
| 720N          | 220E | 7   | 7   | 7   |
| 700N          | 90W  | 8   | 9   | 9   |
| 700N          | 80W  | 6   | 6   | 6   |
| 700N          | 60W  | 6   | 5   | 5   |
| 700N          | 40W  | a   | a   | a   |
| 700N          | 20W  | 7   | 7   | 7   |
| 700N          | 0E   | 9   | 9   | 15  |
| 700N          | 20E  | 5   | 5   | 5   |
| 700N          | 40E  | 5   | 5   | 5   |
| 700N          | 60E  | 5   | 5   | 5   |
| 700N          | 80E  | 6   | 6   | 6   |
| 700N          | 100E | 5   | 6   | 6   |
| 700N          | 120E | 7   | 7   | 7   |
| 700N          | 140E | 6   | 6   | 6   |
| 700N          | 160E | 7   | 7   | 7   |
| 700N          | 180E | 7   | 7   | 7   |
| 700N          | 200E | 7   | 7   | 7   |
| 700N          | 220E | 7   | 7   | 7   |
| 680N          | 90W  | 8   | 8   | 18  |
| 680N          | 80W  | 7   | 7   | 7   |
| 680N          | 60W  | a   | a   | a   |
| 680N          | 40W  | a   | a   | a   |
| 680N          | 20W  | 7   | 7   | 7   |
| 680N          | CE   | 8   | 9   | 21  |
| 680N          | 20E  | 5   | 5   | 11  |
| 680N          | 40E  | 5   | 6   | 14  |
| 680N          | 60E  | 6   | 5   | 5   |
| 680N          | 80E  | 6   | 6   | 6   |
| 680N          | 100E | 6   | 6   | 6   |
| 680N          | 120E | 6   | 8   | 15  |
| 680N          | 140E | 6   | 5   | 5   |
| 680N          | 160E | 8   | 12  | 26  |
| 680N          | 180E | 7   | 7   | 13  |
| 680N          | 200E | 6   | 7   | 24  |
| 680N          | 220E | 7   | 7   | 11  |
| 660N          | 90W  | 8   | 7   | 23  |
| 660N          | 80W  | 6   | 7   | 20  |
| 660N          | 60W  | a   | a   | a   |
| 660N          | 40W  | a   | a   | a   |
| 660N          | 20W  | 5   | 6   | 10  |
| 660N          | 0E   | 7   | 8   | 24  |

TABLE 2, cont.  
 DIRECT RADIATION LEVELS  
 MEASURED AT 20 M GRID INTERVALS

| Grid Location |      | Gamma Exposure<br>Rates at 1 m Above<br>the Surface<br>( $\mu\text{R}/\text{h}$ ) | Gamma Exposure<br>Rates at the<br>Surface<br>( $\mu\text{R}/\text{h}$ ) | Beta-Gamma<br>Dose Rates at 1 cm<br>Above the Surface<br>( $\mu\text{rad}/\text{h}$ ) |
|---------------|------|---|---|---|
| 660N          | 20E  | 5   | 5   | 5   |
| 660N          | 40E  | 5   | 5   | 5   |
| 660N          | 60E  | 5   | 5   | 9   |
| 660N          | 80E  | 5   | 6   | 6   |
| 660N          | 100E | 5   | 5   | 11  |
| 660N          | 120E | 6   | 7   | 17  |
| 660N          | 140E | 6   | 7   | 7   |
| 660N          | 160E | 7   | 7   | 37  |
| 660N          | 180E | 7   | 7   | 15  |
| 660N          | 200E | 7   | 7   | 10  |
| 660N          | 220E | 6   | 7   | 14  |
| 640N          | 90W  | 8   | 8   | 9   |
| 640N          | 80W  | 6   | 6   | 6   |
| 640N          | 60W  | 5   | 5   | 8   |
| 640N          | 40W  | 6   | 6   | 6   |
| 640N          | 20W  | 4   | 5   | 5   |
| 640N          | 0E   | 8   | 8   | 8   |
| 640N          | 20E  | 6   | 7   | 30  |
| 640N          | 40E  | 7   | 7   | 9   |
| 640N          | 60E  | 7   | 7   | 7   |
| 640N          | 80E  | 7   | 7   | 10  |
| 640N          | 100E | 6   | 7   | 21  |
| 640N          | 120E | 7   | 8   | 28  |
| 640N          | 140E | 7   | 7   | 14  |
| 640N          | 160E | 7   | 7   | 12  |
| 640N          | 180E | 7   | 8   | 31  |
| 640N          | 200E | 7   | 7   | 7   |
| 640N          | 220E | 7   | 7   | 7   |
| 620N          | 90W  | 7   | 7   | 7   |
| 620N          | 80W  | 7   | 7   | 19  |
| 620N          | 60W  | 7   | 8   | 23  |
| 620N          | 40W  | 5   | 5   | 12  |
| 620N          | 20W  | 6   | 5   | 9   |
| 620N          | 0E   | 14  | 18  | 35  |
| 620N          | 20E  | 6   | 6   | 10  |
| 620N          | 40E  | 6   | 7   | 10  |
| 620N          | 60E  | 5   | 5   | 5   |
| 620N          | 80E  | 6   | 6   | 6   |
| 620N          | 100E | 8   | 9   | 19  |
| 620N          | 120E | 7   | 7   | 20  |
| 620N          | 140E | 8   | 7   | 12  |
| 620N          | 160E | 7   | 7   | 7   |
| 620N          | 180E | 7   | 8   | 18  |

TABLE 2, cont.

DIRECT RADIATION LEVELS  
MEASURED AT 20 M GRID INTERVALS

| Grid Location |      | Gamma Exposure<br>Rates at 1 m Above<br>the Surface<br>( $\mu\text{R}/\text{h}$ ) | Gamma Exposure<br>Rates at the<br>Surface<br>( $\mu\text{R}/\text{h}$ ) | Beta-Gamma<br>Dose Rates at 1 cm<br>Above the Surface<br>( $\mu\text{rad}/\text{h}$ ) |
|---------------|------|---|---|---|
| 620N          | 200E | 7   | 8   | 15  |
| 620N          | 220E | 7   | 8   | 24  |
| 600N          | 90Q  | 8   | 8   | 8   |
| 600N          | 80W  | 7   | 7   | 23  |
| 600N          | 60W  | 6   | 6   | 15  |
| 600N          | 40W  | a   | a   | a   |
| 600N          | 20W  | 7   | 7   | 12  |
| 600N          | 0E   | 9   | 9   | 9   |
| 600N          | 20E  | a   | a   | a   |
| 600N          | 40E  | a   | a   | a   |
| 600N          | 60E  | 7   | 7   | 16  |
| 600N          | 80E  | 5   | 5   | 11  |
| 600N          | 100E | 7   | 6   | 6   |
| 600N          | 120E | 7   | 7   | 7   |
| 600N          | 140E | 8   | 9   | 20  |
| 600N          | 160E | 8   | 10  | 23  |
| 600N          | 180E | 7   | 8   | 12  |
| 600N          | 200E | 14  | 14  | 31  |
| 600N          | 220E | 12  | 12  | 25  |
| 580N          | 90W  | 9   | 8   | 9   |
| 580N          | 80W  | 8   | 8   | 18  |
| 580N          | 60W  | 7   | 7   | 10  |
| 580N          | 40W  | a   | a   | a   |
| 580N          | 20W  | 7   | 7   | 27  |
| 580N          | 0E   | 9   | 9   | 9   |
| 580N          | 20E  | 10  | 12  | 15  |
| 580N          | 40E  | 9   | 9   | 25  |
| 580N          | 60E  | 13  | 13  | 13  |
| 580N          | 80E  | 9   | 12  | 18  |
| 580N          | 100E | 8   | 7   | 7   |
| 580N          | 120E | 7   | 7   | 16  |
| 580N          | 140E | a   | a   | a   |
| 580N          | 160E | a   | a   | a   |
| 580N          | 180E | 6   | 6   | 15  |
| 580N          | 200E | 7   | 7   | 13  |
| 580N          | 220E | 7   | 7   | 15  |
| 560N          | 90W  | 8   | 8   | 24  |
| 560N          | 80W  | 8   | 8   | 17  |
| 560N          | 60W  | 7   | 7   | 7   |
| 560N          | 40W  | 7   | 7   | 20  |
| 560N          | 20W  | 6   | 6   | 6   |
| 560N          | 0E   | 9   | 9   | 22  |

TABLE 2, cont.

DIRECT RADIATION LEVELS  
MEASURED AT 20 M GRID INTERVALS

| Grid Location |      | Gamma Exposure Rates at 1 m Above the Surface ( $\mu\text{R}/\text{h}$ ) | Gamma Exposure Rates at the Surface ( $\mu\text{R}/\text{h}$ ) | Beta-Gamma Dose Rates at 1 cm Above the Surface ( $\mu\text{rad}/\text{h}$ ) |
|---------------|------|--|--|--|
| 560N          | 20E  | 12   | 13   | 13   |
| 560N          | 40E  | 8  | 12   | 12   |
| 560N          | 60E  | 9  | 8  | 18   |
| 560N          | 80E  | 9  | 8  | 8  |
| 560N          | 100E | 6  | 6  | 18   |
| 560N          | 120E | 6  | 7  | 16   |
| 560N          | 140E | a  | a  | a  |
| 560N          | 160E | a  | a  | a  |
| 560N          | 180E | 6  | 5  | 8  |
| 560N          | 200E | 7  | 7  | 7  |
| 560N          | 220E | 7  | 7  | 7  |
| 540N          | 90W  | 11   | 11   | 20   |
| 540N          | 80W  | 8  | 9  | 12   |
| 540N          | 60W  | 7  | 8  | 8  |
| 540N          | 40W  | 6  | 6  | 9  |
| 540N          | 20W  | 5  | 5  | 5  |
| 540N          | 0E   | 9  | 8  | 17   |
| 540N          | 20E  | 7  | 9  | 16   |
| 540N          | 40E  | 9  | 9  | 29   |
| 540N          | 60E  | 9  | a  | a  |
| 540N          | 80E  | 8  | 9  | 9  |
| 540N          | 100E | 6  | 6  | 6  |
| 540N          | 120E | 9  | 8  | 11   |
| 540N          | 140E | a  | a  | a  |
| 540N          | 160E | a  | a  | a  |
| 540N          | 180E | 11   | 8  | 8  |
| 540N          | 200E | 10   | 12   | 19   |

\* Measurement not taken due to presence of building surface water, or other obstruction.

TABLE 3  
DIRECT RADIATION LEVELS AT LOCATIONS  
IDENTIFIED BY THE WALKOVER SURFACE SCAN

| Grid Location <sup>a</sup> |          | Exposure Rate ( $\mu\text{R}/\text{h}$ ) |                   | Surface Dose Rate<br>( $\mu\text{rad}/\text{h}$ ) | Sample Identification <sup>b</sup> | Contact Exposure Rate<br>After Sample Removal<br>( $\mu\text{R}/\text{h}$ ) |
|----------------------------|----------|--|-------------------|---|------------------------------------|---|
|                            |          | Contact                                  | 1 m Above Surface |   |                                    |   |
| 862-870N                   | 21-31W   | 20-39                                    | ---               | ---   | ---                                | ---   |
| 864N                       | 27W      | 39                                       | 23                | 57  | B1                                 | 43  |
| 862N                       | 16W      | 20                                       | ---               | ---   | ---                                | ---   |
| 852-856N                   | 90-91W   | 17-20                                    | ---               | ---   | ---                                | ---   |
| 840-846N                   | 14-20W   | 22-48                                    | ---               | ---   | ---                                | ---   |
| 844N                       | 17W      | 48                                       | 26                | 109   | B2                                 | 36  |
| 834-840N                   | 32-40W   | 12-20                                    | ---               | ---   | ---                                | ---   |
| 827N                       | 60W      | 29                                       | ---               | ---   | ---                                | ---   |
| 824N                       | 26W      | 29                                       | ---               | ---   | ---                                | ---   |
| 821N                       | 48W      | 38                                       | ---               | ---   | ---                                | ---   |
| 821N                       | 43W      | 27                                       | ---               | ---   | ---                                | ---   |
| 820N                       | 56W      | 29                                       | ---               | ---   | ---                                | ---   |
| 816N                       | 18E      | 23                                       | ---               | ---   | ---                                | ---   |
| 816N                       | 21E      | 28                                       | ---               | ---   | ---                                | ---   |
| 816N                       | 24E      | 30                                       | ---               | ---   | ---                                | ---   |
| 815N                       | 23E      | 38                                       | 21                | 69  | B3                                 | 29  |
| 809-820N                   | 40-47W   | 17-29                                    | ---               | ---   | ---                                | ---   |
| 812-820N                   | 29-40W   | 29                                       | ---               | ---   | ---                                | ---   |
| 800N                       | 58W      | 27                                       | ---               | ---   | ---                                | ---   |
| 687-691N                   | 32-35E   | 17-36                                    | ---               | ---   | ---                                | ---   |
| 689N                       | 33E      | 36                                       | ---               | ---   | ---                                | ---   |
| 616-625N                   | 0-7E     | 14-31                                    | ---               | ---   | ---                                | ---   |
| 621N                       | 1E       | 21                                       | ---               | ---   | ---                                | ---   |
| 600-603N                   | 134-140E | 17-29                                    | ---               | ---   | ---                                | ---   |
| 602N                       | 136E     | 29                                       | 14                | 40  | B4                                 | 48  |
| 600-602N                   | 160-176E | 14-21                                    | ---               | ---   | ---                                | ---   |

TABLE 3, CONT.

DIRECT RADIATION LEVELS AT LOCATIONS  
IDENTIFIED BY THE WALKOVER SURFACE SCAN

| Grid Location |          | Exposure Rate ( $\mu\text{R}/\text{h}$ ) |                   | Surface Dose Rate            | Sample Identification | Contact Exposure Rate After Sample Removal ( $\mu\text{R}/\text{h}$ ) |
|---------------|----------|--|-------------------|------------------------------|-----------------------|---|
|               |          | Contact                                  | 1 m Above Surface | ( $\mu\text{rad}/\text{h}$ ) |                       |   |
| 600N          | 160E     | 21                                       | 10                | 21                           | B5                    | 37  |
| 600N          | 170E     | 21                                       | ----              | ----                         | ----                  | ----  |
| 600-604N      | 206-220E | 17-40                                    | ----              | ----                         | ----                  | ----  |
| 600N          | 215E     | 40                                       | ----              | ----                         | ----                  | ----  |
| 580-600N      | 212-214E | 14-29                                    | ----              | ----                         | ----                  | ----  |
| 595N          | 213E     | 29                                       | ----              | ----                         | ----                  | ----  |
| 597N          | 196E     | 37                                       | ----              | ----                         | ----                  | ----  |
| 595-600N      | 48-52W   | 14-31                                    | ----              | ----                         | ----                  | ----  |
| 600N          | 51W      | 31                                       | 14                | 43                           | B6                    | 58  |
| 595N          | 51W      | 31                                       | ----              | ----                         | ----                  | ----  |
| 591-594N      | 48W      | 27                                       | ----              | ----                         | ----                  | ----  |
| 580-592N      | 49-51W   | 14-29                                    | ----              | ----                         | ----                  | ----  |
| 590N          | 49W      | 29                                       | ----              | ----                         | ----                  | ----  |
| 590N          | 196E     | 32                                       | ----              | ----                         | ----                  | ----  |
| 584-588N      | 47-48W   | 29                                       | ----              | ----                         | ----                  | ----  |
| 580-582N      | 60-63E   | 14-22                                    | ----              | ----                         | ----                  | ----  |
| 581N          | 62E      | 20                                       | 14                | 20                           | B7                    | 25  |
| 575N          | 64E      | 20                                       | ----              | ----                         | ----                  | ----  |
| 569-572N      | 49-52E   | 14-20                                    | ----              | ----                         | ----                  | ----  |
| 564N          | 24E      | 23                                       | ----              | ----                         | ----                  | ----  |
| 561N          | 22E      | 20                                       | ----              | ----                         | ----                  | ----  |
| 559N          | 19E      | 31                                       | 17                | 43                           | B8                    | 31  |
| 559N          | 21E      | 23                                       | ----              | ----                         | ----                  | ----  |
| 550-558N      | 50-56E   | 14-20                                    | ----              | ----                         | ----                  | ----  |
| 540-545N      | 1-11E    | 14-20                                    | ----              | ----                         | ----                  | ----  |

TABLE 3, cont.

DIRECT RADIATION LEVELS AT LOCATIONS  
IDENTIFIED BY THE WALKOVER SURFACE SCAN

| Grid Location |      | Exposure Rate ( $\mu\text{R}/\text{h}$ ) | Surface Dose Rate | Sample Identification | Contact Exposure Rate ( $\mu\text{R}/\text{h}$ ) |
|---------------|------|--|-------------------|-----------------------|--|
|               |      | Contact                                  | 1 m Above Surface |                       | After Sample Removal                             |
| 544N          | 57E  | 27                                       | ----              | ----                  | ----   |
| 543N          | 57E  | 33                                       | ----              | ----                  | ----   |
| 541N          | 123E | 240                                      | 21                | 450                   | B9   |
| 541N          | 179E | 220                                      | 25                | 220                   | B10  |
|               |      |  |                   |                       | 280  |
|               |      |  |                   |                       | 1100   |

<sup>a</sup> Refer to Figure 7.<sup>b</sup> Radionuclide analyses of samples presented in Table 5.<sup>c</sup> Dash indicates measurement or sampling not performed.

TABLE 4  
RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|---------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|               |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 900N          | 90W  | 1.08 ± 0.29 <sup>a</sup>            | <0.33       | 1.92 ± 1.47 | 0.67 ± 0.15 | 0.67 ± 0.53 |
| 900N          | 80W  | 1.20 ± 0.41                         | <0.32       | <1.01       | 0.65 ± 0.13 | 1.36 ± 0.45 |
| 900N          | 60W  | 0.58 ± 0.19                         | <0.12       | 0.78 ± 0.60 | 0.46 ± 0.12 | 0.51 ± 0.25 |
| 900N          | 40W  | 1.04 ± 0.36                         | <0.33       | 2.07 ± 1.15 | 0.61 ± 0.15 | 0.86 ± 0.32 |
| 900N          | 20W  | 0.85 ± 0.24                         | <0.15       | 0.80 ± 0.88 | 0.57 ± 0.11 | 0.84 ± 0.35 |
| 900N          | 9W   | 0.85 ± 0.24                         | <0.13       | 1.18 ± 0.64 | 0.94 ± 0.13 | 0.51 ± 0.29 |
| 900N          | 20E  | 1.03 ± 0.23                         | <0.32       | <0.98       | 0.72 ± 0.19 | 1.84 ± 0.48 |
| 900N          | 40E  | 1.01 ± 0.21                         | <0.18       | 0.71 ± 0.87 | 0.40 ± 0.09 | 1.35 ± 0.35 |
| 900N          | 60E  | 0.90 ± 0.24                         | <0.26       | <0.84       | 0.62 ± 0.11 | 0.61 ± 0.51 |
| 900N          | 80E  | 0.98 ± 0.28                         | <0.31       | <0.93       | 0.68 ± 0.12 | 0.77 ± 0.34 |
| 900N          | 100E | 0.98 ± 0.23                         | <0.17       | 0.90 ± 0.61 | 0.46 ± 0.10 | 1.10 ± 0.33 |
| 900N          | 120E | 0.98 ± 0.24                         | <0.34       | 2.08 ± 1.12 | 0.74 ± 0.14 | 0.98 ± 0.49 |
| 900N          | 140E | 0.83 ± 0.34                         | <0.18       | 1.29 ± 0.93 | 0.80 ± 0.15 | 0.89 ± 0.45 |
| 900N          | 160E | 0.80 ± 0.20                         | <0.32       | 2.12 ± 1.55 | 0.57 ± 0.11 | 1.10 ± 0.46 |
| 900N          | 180E | 0.73 ± 0.25                         | <0.15       | 0.51 ± 1.26 | 0.52 ± 0.12 | 0.58 ± 0.33 |
| 900N          | 200E | 0.70 ± 0.20                         | <0.14       | 1.45 ± 0.43 | 0.38 ± 0.09 | 0.62 ± 0.28 |
| 900N          | 220E | 0.96 ± 0.29                         | <0.27       | <0.86       | 0.27 ± 0.08 | 0.84 ± 0.34 |
| 880N          | 90W  | 0.95 ± 0.30                         | <0.18       | 0.75 ± 0.59 | 0.98 ± 0.15 | 0.87 ± 0.44 |
| 880N          | 80W  | 1.20 ± 0.33                         | 0.89 ± 0.70 | 3.64 ± 2.21 | 1.43 ± 0.18 | 1.26 ± 0.36 |
| 880N          | 60W  | 0.88 ± 0.25                         | <0.13       | 0.65 ± 0.96 | 1.01 ± 0.16 | 0.89 ± 0.37 |
| 880N          | 40W  | 1.45 ± 0.33                         | <0.39       | <1.22       | 1.95 ± 0.22 | 1.12 ± 0.40 |
| 880N          | 20W  | 1.58 ± 0.38                         | <0.24       | 0.90 ± 0.80 | 2.57 ± 0.29 | 0.92 ± 0.56 |
| 880N          | 4W   | 0.93 ± 0.21                         | <0.29       | <0.83       | 0.63 ± 0.12 | 0.65 ± 0.40 |
| 882N          | 10E  | 1.09 ± 0.28                         | <0.29       | <0.98       | 0.60 ± 0.12 | 1.16 ± 0.29 |
| 880N          | 20E  | 0.83 ± 0.25                         | <0.15       | 1.62 ± 0.62 | 0.68 ± 0.11 | 0.60 ± 0.25 |
| 880N          | 40E  | 1.13 ± 0.28                         | <0.29       | 2.16 ± 1.92 | 0.40 ± 0.12 | 0.78 ± 0.44 |
| 880N          | 60E  | 1.08 ± 0.41                         | <0.21       | 0.66 ± 1.13 | 0.92 ± 0.18 | 0.68 ± 0.43 |

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|---------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|               |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 880N          | 80E  | 0.48 ± 0.28                         | <0.17       | 1.04 ± 0.81 | 0.74 ± 0.14 | 0.70 ± 0.34 |
| 880N          | 100E | 1.10 ± 0.29                         | <0.20       | 1.42 ± 1.77 | 0.77 ± 0.13 | 1.19 ± 0.39 |
| 880N          | 120E | 1.09 ± 0.24                         | <0.17       | 0.71 ± 0.51 | 0.61 ± 0.13 | 0.78 ± 0.41 |
| 880N          | 140E | 1.31 ± 0.26                         | <0.30       | 1.59 ± 1.01 | 0.48 ± 0.13 | 1.21 ± 0.37 |
| 880N          | 160E | 0.60 ± 0.23                         | <0.16       | 1.17 ± 0.53 | 0.64 ± 0.12 | 0.66 ± 0.33 |
| 880N          | 180E | 0.94 ± 0.23                         | <0.32       | 1.76 ± 1.93 | 0.83 ± 0.17 | 0.63 ± 0.29 |
| 880N          | 200E | 0.91 ± 0.21                         | <0.17       | 1.38 ± 0.92 | 1.16 ± 0.16 | 1.13 ± 0.46 |
| 860N          | 90W  | 0.39 ± 0.49                         | <0.46       | 2.23 ± 2.05 | 0.63 ± 0.16 | 0.92 ± 0.58 |
| 860N          | 80W  | 1.84 ± 0.31                         | <0.20       | 1.74 ± 0.72 | 0.48 ± 0.13 | 0.90 ± 0.55 |
| 860N          | 60W  | 1.19 ± 0.25                         | <0.15       | 0.72 ± 0.51 | 0.43 ± 0.12 | 0.50 ± 0.29 |
| 860N          | 40W  | 1.58 ± 0.38                         | <0.38       | <1.27       | 0.96 ± 0.20 | 1.41 ± 0.67 |
| 860N          | 20W  | 1.83 ± 0.30                         | <0.35       | 3.79 ± 1.16 | 0.24 ± 0.08 | 1.10 ± 0.32 |
| 860N          | 3W   | 1.15 ± 0.24                         | <0.16       | 1.54 ± 0.53 | 0.96 ± 0.15 | 0.54 ± 0.39 |
| 860N          | 20E  | 0.84 ± 0.23                         | <0.15       | 0.47 ± 0.42 | 0.08 ± 0.08 | 1.12 ± 0.37 |
| 860N          | 40E  | 0.79 ± 0.24                         | 0.66 ± 0.50 | 2.25 ± 1.15 | 0.19 ± 0.06 | 1.45 ± 0.39 |
| 860N          | 60E  | 0.94 ± 0.26                         | <0.27       | <0.87       | 0.65 ± 0.11 | 1.35 ± 0.38 |
| 860N          | 80E  | 1.00 ± 0.24                         | <0.17       | 2.17 ± 0.62 | <0.05       | 1.10 ± 0.42 |
| 860N          | 100E | 0.83 ± 0.26                         | <0.14       | 0.96 ± 0.72 | <0.04       | 0.66 ± 0.44 |
| 860N          | 120E | 0.70 ± 0.16                         | 0.12 ± 0.40 | 1.22 ± 0.45 | 0.13 ± 0.07 | 0.66 ± 0.30 |
| 860N          | 140E | 0.85 ± 0.29                         | 0.32 ± 0.55 | 1.59 ± 1.78 | 0.63 ± 0.13 | 1.35 ± 0.38 |
| 860N          | 160E | 0.80 ± 0.24                         | <0.16       | 0.55 ± 1.24 | 0.17 ± 0.09 | 1.10 ± 0.33 |
| 860N          | 180E | 0.78 ± 0.24                         | <0.15       | <0.41       | 0.14 ± 0.08 | 0.50 ± 0.24 |
| 860N          | 200E | 0.80 ± 0.23                         | <0.26       | 0.28 ± 1.32 | 0.07 ± 0.06 | 1.45 ± 0.38 |
| 860N          | 220E | 0.73 ± 0.21                         | <0.12       | 0.24 ± 0.44 | <0.03       | 0.55 ± 0.36 |
| 840N          | 90W  | 1.00 ± 0.26                         | <0.16       | 0.19 ± 0.89 | 0.15 ± 0.09 | 1.04 ± 0.45 |
| 840N          | 80W  | 0.99 ± 0.21                         | <0.16       | 1.51 ± 0.66 | 0.60 ± 0.12 | 0.95 ± 0.59 |
| 840N          | 60W  | 1.13 ± 0.33                         | <0.28       | <0.97       | 0.82 ± 0.14 | 0.94 ± 0.34 |

TABLE 4, cont.  
 RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES  
 FROM 20 M GRID INTERVALS

| Grid Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|---------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|               |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 840N          | 40W  | 1.78 ± 0.34                         | <0.36       | <1.10       | 0.56 ± 0.17 | 1.06 ± 0.45 |
| 840N          | 20W  | 1.36 ± 0.26                         | <0.16       | 0.84 ± 0.79 | <0.04       | 0.37 ± 0.16 |
| 840N          | 3W   | 0.79 ± 0.30                         | <0.14       | 0.54 ± 0.76 | 0.83 ± 0.11 | 0.42 ± 0.32 |
| 840N          | 20E  | 1.14 ± 0.29                         | <0.30       | <0.92       | 0.26 ± 0.09 | 1.60 ± 0.44 |
| 840N          | 40E  | 1.04 ± 0.30                         | <0.34       | 2.85 ± 2.30 | 0.23 ± 0.12 | 1.19 ± 0.49 |
| 840N          | 60E  | 1.06 ± 0.20                         | <0.28       | 1.42 ± 1.29 | <0.05       | 1.10 ± 0.35 |
| 840N          | 80E  | 0.78 ± 0.19                         | 0.22 ± 0.32 | 1.06 ± 0.46 | <0.04       | 0.75 ± 0.29 |
| 840N          | 100E | 0.86 ± 0.23                         | <0.16       | 1.43 ± 0.59 | 0.35 ± 0.11 | 0.64 ± 0.24 |
| 840N          | 120E | 0.91 ± 0.21                         | <0.26       | 1.00 ± 1.16 | 0.10 ± 0.06 | 0.84 ± 0.30 |
| 840N          | 140E | 0.91 ± 0.21                         | <0.17       | 1.08 ± 0.52 | 0.31 ± 0.11 | 1.18 ± 0.36 |
| 840N          | 160E | 0.74 ± 0.21                         | <0.15       | 0.95 ± 0.47 | 1.18 ± 0.06 | 0.53 ± 0.33 |
| 840N          | 180E | 0.84 ± 0.31                         | <0.30       | <0.91       | 0.68 ± 0.12 | 0.96 ± 0.29 |
| 840N          | 200E | 0.84 ± 0.19                         | 0.33 ± 0.31 | 0.71 ± 0.92 | 0.19 ± 0.07 | 0.93 ± 0.24 |
| 840N          | 220E | 1.11 ± 0.25                         | <0.16       | 1.18 ± 0.49 | 0.47 ± 0.10 | 0.98 ± 0.56 |
| 820N          | 90W  | 0.96 ± 0.23                         | <0.28       | 1.76 ± 1.06 | 0.16 ± 0.06 | 1.13 ± 0.36 |
| 820N          | 80W  | 0.79 ± 0.18                         | <0.13       | 0.71 ± 0.12 | 0.31 ± 0.09 | 0.69 ± 0.37 |
| 820N          | 60W  | 0.85 ± 0.24                         | <0.29       | 1.07 ± 0.87 | <0.04       | 1.25 ± 0.34 |
| 820N          | 40W  | 3.54 ± 0.34                         | <0.18       | 1.93 ± 0.64 | 0.36 ± 0.07 | 0.53 ± 0.26 |
| 820N          | 18W  | 1.04 ± 0.29                         | <0.36       | 2.12 ± 3.48 | 0.93 ± 0.17 | 1.65 ± 0.79 |
| 820N          | 3W   | 0.83 ± 0.19                         | <0.26       | <0.78       | 0.44 ± 0.10 | 0.73 ± 0.24 |
| 820N          | 20E  | 0.95 ± 0.16                         | <0.15       | 1.06 ± 0.57 | 0.73 ± 0.12 | 0.67 ± 0.31 |
| 820N          | 40E  | 0.75 ± 0.31                         | <0.15       | 1.54 ± 0.81 | 0.40 ± 0.13 | 0.67 ± 0.43 |
| 820N          | 60E  | 0.65 ± 0.24                         | <0.15       | 0.91 ± 0.54 | 0.83 ± 0.07 | 0.72 ± 0.37 |
| 820N          | 80E  | 0.94 ± 0.26                         | <0.14       | 0.56 ± 1.07 | 0.12 ± 0.05 | 0.85 ± 0.24 |
| 820N          | 100E | 1.18 ± 0.31                         | <0.36       | 1.96 ± 1.17 | 0.54 ± 0.17 | 1.06 ± 0.52 |
| 820N          | 120E | 0.85 ± 0.24                         | <0.26       | <0.85       | 0.47 ± 0.13 | 0.99 ± 0.38 |
| 820N          | 140E | 0.81 ± 0.25                         | <0.14       | 1.46 ± 0.61 | 0.21 ± 0.10 | 0.79 ± 0.39 |

TABLE 4, CONT.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|---------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|               |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 820N          | 160E | 1.19 ± 0.24                         | <0.28       | 0.97 ± 2.25 | 0.17 ± 0.07 | 0.67 ± 0.25 |
| 820N          | 180E | b                                   | b           | b           | b           | b           |
| 820N          | 200E | 1.10 ± 0.26                         | <0.29       | 4.45 ± 1.98 | 0.34 ± 0.11 | 1.09 ± 0.64 |
| 820N          | 220E | 0.68 ± 0.36                         | <0.18       | 0.92 ± 1.08 | 0.18 ± 0.08 | 0.92 ± 0.58 |
| 780N          | 90W  | 0.85 ± 0.23                         | <0.27       | 2.83 ± 1.71 | 0.36 ± 0.10 | 1.05 ± 0.40 |
| 780N          | 80W  | 1.08 ± 0.26                         | <0.33       | <0.92       | 0.39 ± 0.09 | 0.78 ± 0.41 |
| 780N          | 60W  | 0.65 ± 0.20                         | <0.13       | 0.59 ± 0.66 | 0.25 ± 0.08 | 0.74 ± 0.27 |
| 780N          | 40W  | 1.01 ± 0.28                         | <0.17       | 1.33 ± 0.54 | 0.60 ± 0.11 | 0.44 ± 0.39 |
| 780N          | 20W  | 0.54 ± 0.15                         | <0.23       | <0.68       | 0.73 ± 0.11 | 0.40 ± 0.20 |
| 780N          | 3W   | 0.93 ± 0.20                         | <0.15       | 0.82 ± 0.91 | 0.73 ± 0.13 | 0.33 ± 0.30 |
| 780N          | 20E  | 0.86 ± 0.26                         | <0.32       | 2.25 ± 1.77 | 0.65 ± 0.13 | 0.88 ± 0.35 |
| 780N          | 40E  | 1.46 ± 0.33                         | <0.20       | 2.52 ± 0.70 | 0.41 ± 0.11 | 1.03 ± 0.50 |
| 780N          | 60E  | 0.86 ± 0.26                         | <0.15       | 1.34 ± 0.79 | 0.09 ± 0.05 | 0.79 ± 0.41 |
| 780N          | 80E  | 1.04 ± 0.25                         | <0.27       | 2.76 ± 1.25 | 0.19 ± 0.08 | 0.83 ± 0.37 |
| 780N          | 100E | 1.23 ± 0.25                         | 0.53 ± 0.46 | 1.40 ± 1.72 | 0.23 ± 0.13 | 1.04 ± 0.45 |
| 780N          | 120E | 1.03 ± 0.23                         | <0.33       | 3.49 ± 1.87 | 0.59 ± 0.12 | 1.13 ± 0.39 |
| 780N          | 140E | 0.78 ± 0.25                         | 0.24 ± 0.55 | 0.68 ± 0.57 | 0.43 ± 0.12 | 1.05 ± 0.37 |
| 780N          | 160E | 0.76 ± 0.21                         | <0.14       | 1.21 ± 1.19 | 0.58 ± 0.12 | 0.82 ± 0.41 |
| 780N          | 180E | 0.71 ± 0.19                         | <0.16       | 1.14 ± 1.04 | 0.28 ± 0.08 | 1.21 ± 0.42 |
| 780N          | 200E | 0.99 ± 0.35                         | <0.32       | 1.09 ± 1.90 | 0.46 ± 0.11 | 1.11 ± 0.40 |
| 780N          | 220E | 1.08 ± 0.39                         | <0.37       | 3.02 ± 2.72 | 0.92 ± 0.19 | 1.32 ± 0.43 |
| 760N          | 90W  | 0.88 ± 0.24                         | <0.29       | 0.96 ± 1.82 | 0.21 ± 0.09 | 0.98 ± 0.34 |
| 760N          | 80W  | 1.00 ± 0.28                         | <0.27       | <0.80       | 0.24 ± 0.08 | 0.96 ± 0.29 |
| 760N          | 60W  | 0.79 ± 0.21                         | <0.14       | 0.41 ± 0.44 | 0.05 ± 0.07 | 0.74 ± 0.26 |
| 760N          | 40W  | 0.88 ± 0.29                         | <0.28       | 1.22 ± 1.69 | <0.04       | 0.83 ± 0.31 |
| 760N          | 20W  | 0.89 ± 0.26                         | <0.18       | 1.65 ± 0.60 | 0.58 ± 0.13 | 0.81 ± 0.27 |

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|---------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|               |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 760N          | 4W   | 0.94 ± 0.25                         | <0.31       | 3.82 ± 1.81 | 0.74 ± 0.17 | 0.49 ± 0.41 |
| 760N          | 20E  | 1.11 ± 0.26                         | <0.30       | <0.93       | 0.76 ± 0.15 | 0.76 ± 0.37 |
| 760N          | 40E  | 1.03 ± 0.35                         | <0.18       | 2.82 ± 1.16 | 0.15 ± 0.12 | 1.31 ± 0.44 |
| 760N          | 60E  | 0.90 ± 0.28                         | <0.15       | 0.81 ± 0.72 | 0.15 ± 0.10 | 0.89 ± 0.32 |
| 760N          | 80E  | 1.11 ± 0.33                         | <0.28       | 1.59 ± 1.71 | <0.05       | 1.16 ± 0.35 |
| 760N          | 100E | 0.73 ± 0.31                         | 0.30 ± 0.18 | 1.05 ± 1.15 | 0.17 ± 0.06 | 0.85 ± 0.42 |
| 760N          | 120E | 0.99 ± 0.24                         | <0.30       | 1.74 ± 1.89 | 0.25 ± 0.14 | 0.91 ± 0.42 |
| 760N          | 140E | 0.74 ± 0.23                         | <0.29       | 2.06 ± 2.00 | 0.49 ± 0.11 | 0.74 ± 0.35 |
| 760N          | 160E | 0.73 ± 0.29                         | <0.17       | <0.44       | 0.42 ± 0.11 | 0.49 ± 0.24 |
| 760N          | 180E | 0.89 ± 0.20                         | <0.27       | 6.54 ± 1.53 | 0.60 ± 0.12 | 0.85 ± 0.45 |
| 760N          | 200E | 0.94 ± 0.19                         | <0.30       | <0.86       | <0.04       | 0.83 ± 0.35 |
| 760N          | 220E | 0.59 ± 0.20                         | 0.27 ± 0.25 | 0.76 ± 0.73 | 0.19 ± 0.07 | 0.78 ± 0.27 |
| 740N          | 90W  | 1.18 ± 0.26                         | <0.34       | 1.40 ± 1.46 | 0.21 ± 0.10 | 1.02 ± 0.45 |
| 740N          | 80W  | 1.13 ± 0.26                         | <0.14       | 0.94 ± 0.68 | 0.21 ± 0.07 | 0.34 ± 0.25 |
| 740N          | 60W  | 0.88 ± 0.23                         | <0.14       | 0.78 ± 1.32 | 0.18 ± 0.10 | 0.63 ± 0.26 |
| 740N          | 40W  | 0.83 ± 0.30                         | <0.31       | 1.97 ± 2.04 | 0.55 ± 0.14 | 1.04 ± 0.32 |
| 740N          | 20W  | 1.08 ± 0.29                         | <0.17       | 1.46 ± 0.62 | 0.25 ± 0.10 | 1.05 ± 0.34 |
| 740N          | 3W   | 1.96 ± 0.43                         | <0.20       | 1.71 ± 0.68 | 0.98 ± 0.16 | 0.62 ± 0.30 |
| 740N          | 20E  | 0.68 ± 0.20                         | <0.25       | <0.72       | 0.60 ± 0.11 | 0.44 ± 0.24 |
| 740N          | 40E  | 0.74 ± 0.16                         | <0.23       | <0.70       | 0.70 ± 0.11 | 0.85 ± 0.40 |
| 740N          | 60E  | 1.09 ± 0.26                         | <0.40       | <1.09       | 0.55 ± 0.16 | 1.09 ± 0.42 |
| 740N          | 80E  | b                                   | b           | b           | b           | b           |
| 740N          | 100E | 0.56 ± 0.17                         | <0.13       | 0.91 ± 0.80 | 0.86 ± 0.11 | 0.26 ± 0.21 |
| 740N          | 120E | 0.80 ± 0.25                         | <0.27       | 1.92 ± 1.14 | 0.48 ± 0.11 | 0.80 ± 0.54 |
| 740N          | 140E | 0.74 ± 0.21                         | <0.15       | 0.64 ± 0.51 | 0.46 ± 0.11 | 1.05 ± 0.40 |
| 740N          | 160E | 0.90 ± 0.23                         | <0.33       | 2.69 ± 2.36 | 0.33 ± 0.12 | 0.81 ± 0.41 |

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid<br>Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|------------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|                  |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 740N             | 180E | 0.65 ± 0.25                         | <0.16       | 2.10 ± 0.64 | 0.47 ± 0.13 | 0.83 ± 0.69 |
| 740N             | 200E | 0.89 ± 0.30                         | <0.15       | 0.64 ± 0.04 | 0.23 ± 0.10 | 0.97 ± 0.30 |
| 740N             | 220E | 0.74 ± 0.31                         | <0.34       | <1.10       | 0.54 ± 0.17 | 1.24 ± 0.36 |
| 720N             | 90W  | 0.59 ± 0.58                         | <0.26       | 0.82 ± 0.75 | 0.73 ± 0.13 | 0.78 ± 0.45 |
| 720N             | 80W  | 0.94 ± 0.38                         | <0.27       | 1.89 ± 1.23 | 0.10 ± 0.09 | <0.12       |
| 720N             | 60W  | 0.80 ± 0.25                         | <0.32       | <0.88       | 0.16 ± 0.06 | 1.09 ± 0.52 |
| 720N             | 40W  | 0.93 ± 0.24                         | <0.28       | <0.85       | 0.20 ± 0.09 | 0.79 ± 0.38 |
| 720N             | 20W  | 0.89 ± 0.25                         | <0.17       | 1.53 ± 0.58 | 0.64 ± 0.15 | 0.94 ± 0.40 |
| 720N             | 3W   | 1.41 ± 0.34                         | <0.20       | 2.50 ± 0.75 | 0.59 ± 0.12 | 1.21 ± 0.35 |
| 720N             | 20E  | 0.88 ± 0.19                         | <0.23       | 1.40 ± 1.21 | 0.39 ± 0.08 | 0.65 ± 0.23 |
| 720N             | 40E  | 0.70 ± 0.18                         | <0.13       | 1.17 ± 0.43 | 0.42 ± 0.10 | 0.41 ± 0.27 |
| 720N             | 60E  | 0.90 ± 0.30                         | <0.23       | 1.07 ± 1.44 | 0.35 ± 0.07 | 0.80 ± 0.29 |
| 720N             | 80E  | 0.46 ± 0.15                         | <0.22       | <0.62       | 0.64 ± 0.10 | 0.59 ± 0.23 |
| 720N             | 100E | 0.34 ± 0.14                         | <0.12       | 0.70 ± 0.37 | 0.78 ± 0.10 | 0.16 ± 0.24 |
| 720N             | 120E | 0.81 ± 0.21                         | <0.35       | 0.90 ± 3.93 | 0.37 ± 0.20 | 1.24 ± 0.40 |
| 720N             | 140E | 0.94 ± 0.21                         | <0.17       | 1.43 ± 0.50 | 0.13 ± 0.08 | 0.97 ± 0.37 |
| 720N             | 160E | 1.14 ± 0.34                         | <0.41       | <1.14       | 0.54 ± 0.15 | 1.19 ± 0.39 |
| 720N             | 180E | 0.89 ± 0.18                         | <0.14       | 1.02 ± 0.89 | 0.26 ± 0.08 | 0.87 ± 0.25 |
| 720N             | 200E | 0.80 ± 0.17                         | <0.12       | 0.23 ± 0.28 | 0.07 ± 0.05 | 0.63 ± 0.30 |
| 720N             | 220E | 0.74 ± 0.25                         | <0.32       | <1.00       | 0.24 ± 0.15 | <0.31       |
| 700N             | 87W  | 2.59 ± 0.45                         | <0.30       | 3.36 ± 1.94 | 0.66 ± 0.14 | 1.06 ± 0.53 |
| 700N             | 80W  | 1.00 ± 0.36                         | <0.27       | 2.48 ± 2.19 | 0.35 ± 0.18 | 0.51 ± 0.40 |
| 700N             | 60W  | b                                   | b           | b           | b           | b           |
| 700N             | 40W  | b                                   | b           | b           | b           | b           |
| 700N             | 20W  | 0.63 ± 0.28                         | 0.35 ± 0.76 | <1.14       | 0.50 ± 0.16 | 1.58 ± 0.46 |
| 700N             | 3W   | 1.01 ± 0.33                         | <0.26       | <0.90       | 0.69 ± 0.14 | 0.86 ± 0.41 |
| 700N             | 20E  | 0.49 ± 0.18                         | <0.11       | 0.52 ± 0.57 | 0.95 ± 0.11 | 0.29 ± 0.24 |

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|---------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|               |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 700N          | 40E  | 1.34 ± 0.24                         | <0.28       | 1.15 ± 1.66 | 0.37 ± 0.09 | 0.65 ± 0.27 |
| 700N          | 60E  | 0.40 ± 0.20                         | <0.14       | 0.88 ± 0.52 | 0.35 ± 0.09 | 0.38 ± 0.31 |
| 700N          | 80E  | 0.53 ± 0.20                         | <0.23       | <0.66       | 0.53 ± 0.11 | 0.39 ± 0.18 |
| 700N          | 100E | 0.80 ± 0.21                         | <0.12       | 0.61 ± 0.37 | 0.08 ± 0.08 | 0.69 ± 0.41 |
| 700N          | 120E | 1.03 ± 0.36                         | <0.16       | 1.24 ± 1.09 | 0.30 ± 0.15 | 1.15 ± 0.36 |
| 700N          | 140E | 1.00 ± 0.25                         | <0.29       | 3.28 ± 1.93 | 0.89 ± 0.15 | 1.04 ± 0.31 |
| 700N          | 160E | 1.46 ± 0.34                         | <0.36       | 1.77 ± 1.13 | 0.39 ± 0.19 | 1.92 ± 0.63 |
| 700N          | 180E | 0.94 ± 0.24                         | <0.18       | 0.95 ± 0.73 | 0.25 ± 0.13 | 1.08 ± 0.49 |
| 700N          | 200E | 0.89 ± 0.24                         | <0.16       | 0.66 ± 0.46 | 0.37 ± 0.10 | 0.63 ± 0.32 |
| 700N          | 220E | 0.89 ± 0.21                         | 0.49 ± 0.73 | 4.43 ± 1.53 | 0.45 ± 0.13 | 0.94 ± 0.44 |
| 680N          | 87W  | 0.99 ± 0.40                         | <0.31       | 2.57 ± 1.16 | 0.68 ± 0.20 | 0.95 ± 0.52 |
| 680N          | 80W  | 1.19 ± 0.30                         | <0.24       | <0.88       | 0.39 ± 0.14 | 0.60 ± 0.42 |
| 680N          | 60W  | b                                   | b           | b           | b           | b           |
| 680N          | 40W  | b                                   | b           | b           | b           | b           |
| 680N          | 20W  | 0.94 ± 0.30                         | <0.25       | 1.77 ± 1.10 | 0.65 ± 0.20 | 1.05 ± 0.70 |
| 680N          | 3W   | 1.13 ± 0.32                         | <0.34       | 2.75 ± 2.02 | 1.10 ± 0.16 | 1.14 ± 0.44 |
| 680N          | 3E   | 0.85 ± 0.22                         | <0.19       | <0.73       | 1.64 ± 0.22 | 0.95 ± 0.38 |
| 680N          | 20E  | 0.71 ± 0.26                         | 0.19 ± 0.40 | <0.56       | 0.46 ± 0.10 | 0.35 ± 0.28 |
| 680N          | 40E  | 0.76 ± 0.22                         | <0.18       | <0.65       | 0.40 ± 0.12 | 0.78 ± 0.32 |
| 680N          | 60E  | 0.43 ± 0.28                         | <0.15       | <0.50       | 0.55 ± 0.10 | 0.32 ± 0.20 |
| 680N          | 80E  | 0.50 ± 0.20                         | <0.13       | <0.64       | 0.11 ± 0.05 | 0.56 ± 0.24 |
| 680N          | 100E | 0.45 ± 0.18                         | <0.15       | 0.31 ± 0.87 | 0.64 ± 0.10 | 0.44 ± 0.24 |
| 680N          | 120E | 0.48 ± 0.52                         | <0.41       | 4.84 ± 1.92 | 0.63 ± 0.11 | 0.60 ± 0.76 |
| 680N          | 140E | 1.10 ± 0.24                         | <0.29       | 1.73 ± 1.72 | <0.09       | 0.95 ± 0.40 |
| 680N          | 160E | 0.29 ± 0.21                         | <0.16       | <0.63       | 1.10 ± 0.16 | 0.26 ± 0.34 |
| 680N          | 180E | 0.74 ± 0.38                         | <0.19       | 2.15 ± 1.74 | 0.49 ± 0.13 | 1.10 ± 0.46 |
| 680N          | 200E | 0.89 ± 0.30                         | <0.28       | 0.90 ± 1.67 | <0.04       | 0.94 ± 0.40 |

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid<br>Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|------------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|                  |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 680N             | 220E | 0.96 ± 0.27                         | <0.31       | 4.02 ± 1.65 | 0.41 ± 0.12 | 1.05 ± 0.66 |
| 660N             | 87W  | 1.10 ± 0.34                         | <0.31       | 1.60 ± 1.70 | 0.26 ± 0.10 | 0.92 ± 0.30 |
| 660N             | 80W  | 0.61 ± 0.21                         | <0.20       | 0.92 ± 1.31 | 0.86 ± 0.14 | 0.57 ± 0.24 |
| 660N             | 60W  | b                                   | b           | b           | b           | b           |
| 660N             | 40W  | b                                   | b           | b           | b           | b           |
| 660N             | 20W  | b                                   | b           | b           | b           | b           |
| 660N             | 4E   | 1.24 ± 0.22                         | <0.24       | <0.74       | 0.34 ± 0.09 | 0.92 ± 0.42 |
| 660N             | 20E  | 0.40 ± 0.16                         | <0.09       | <0.52       | 0.75 ± 0.11 | 0.28 ± 0.18 |
| 660N             | 40E  | 0.39 ± 0.13                         | <0.12       | <0.42       | 0.04 ± 0.03 | 0.47 ± 0.34 |
| 660N             | 60E  | 0.49 ± 0.21                         | <0.20       | 0.77 ± 0.96 | 1.07 ± 0.12 | 0.81 ± 0.20 |
| 660N             | 80E  | 0.69 ± 0.19                         | <0.13       | 1.17 ± 1.32 | 0.46 ± 0.11 | 0.68 ± 0.42 |
| 660N             | 100E | 2.11 ± 0.45                         | <0.29       | <0.87       | 1.34 ± 0.18 | 0.58 ± 0.29 |
| 660N             | 120E | 0.84 ± 0.25                         | <0.26       | <0.77       | 0.92 ± 0.17 | 1.19 ± 0.42 |
| 660N             | 140E | 0.74 ± 0.26                         | <0.25       | 1.04 ± 1.30 | 0.30 ± 0.12 | 0.82 ± 0.34 |
| 660N             | 160E | 1.31 ± 0.24                         | <0.28       | 2.58 ± 1.54 | 0.29 ± 0.14 | 0.74 ± 0.43 |
| 660N             | 180E | 0.56 ± 0.22                         | <0.19       | 0.98 ± 1.22 | 0.12 ± 0.06 | 0.70 ± 0.31 |
| 660N             | 200E | 0.76 ± 0.25                         | <0.18       | 1.28 ± 2.16 | <0.04       | 0.71 ± 0.40 |
| 660N             | 220E | 0.59 ± 0.22                         | <0.21       | 1.36 ± 1.41 | <0.05       | 0.70 ± 0.37 |
| 640N             | 87W  | 0.64 ± 0.30                         | <0.22       | <0.94       | 0.79 ± 0.14 | 0.65 ± 0.41 |
| 640N             | 80W  | 1.03 ± 0.29                         | <0.26       | 1.01 ± 0.75 | 0.24 ± 0.11 | 0.78 ± 0.29 |
| 640N             | 60W  | b                                   | b           | b           | b           | b           |
| 640N             | 40W  | b                                   | b           | b           | b           | b           |
| 640N             | 20W  | b                                   | b           | b           | b           | b           |
| 640N             | 0    | b                                   | b           | b           | b           | b           |
| 640N             | 20E  | 0.65 ± 0.29                         | <0.23       | <0.67       | 0.66 ± 0.13 | 0.88 ± 0.32 |
| 640N             | 40E  | 1.03 ± 0.28                         | 0.35 ± 0.73 | 4.34 ± 1.97 | 0.64 ± 0.12 | 1.17 ± 0.46 |
| 640N             | 60E  | 0.88 ± 0.33                         | <0.23       | 1.58 ± 2.89 | 0.56 ± 0.16 | 1.19 ± 0.43 |

TABLE 4, CONT.

RADIONUCLIDE CONCENTRATIONS IN SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|---------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|               |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 640N          | 80E  | 0.86 ± 0.23                         | <0.23       | 1.11 ± 2.23 | 0.26 ± 0.09 | 1.29 ± 0.36 |
| 640N          | 100E | 0.91 ± 0.23                         | <0.27       | <0.86       | 0.45 ± 0.10 | 1.35 ± 0.38 |
| 640N          | 120E | 0.86 ± 0.19                         | <0.29       | 3.72 ± 1.97 | 0.50 ± 0.10 | 0.97 ± 0.33 |
| 640N          | 140E | 0.63 ± 0.26                         | <0.21       | 1.14 ± 1.60 | 0.65 ± 0.11 | 0.63 ± 0.27 |
| 640N          | 160E | 1.09 ± 0.34                         | <0.26       | 4.35 ± 2.35 | 0.40 ± 0.13 | 1.09 ± 0.52 |
| 640N          | 180E | 1.43 ± 0.29                         | <0.31       | <1.05       | 0.67 ± 0.11 | 0.87 ± 0.33 |
| 640N          | 200E | 3.29 ± 0.56                         | <0.28       | 1.00 ± 4.29 | 0.06 ± 0.10 | 0.92 ± 0.75 |
| 640N          | 220E | 1.41 ± 0.39                         | <0.24       | <0.77       | 0.43 ± 0.23 | 0.73 ± 0.84 |
| 620N          | 90W  | 0.81 ± 0.25                         | <0.23       | <0.83       | 0.15 ± 0.09 | 1.09 ± 0.60 |
| 620N          | 80W  | 1.04 ± 0.26                         | <0.24       | 1.17 ± 2.11 | 0.70 ± 0.16 | 0.56 ± 0.28 |
| 620N          | 60W  | 0.65 ± 0.23                         | <0.22       | <0.63       | 0.33 ± 0.12 | 0.66 ± 0.36 |
| 620N          | 40W  | b                                   | b           | b           | b           | b           |
| 620N          | 20W  | b                                   | b           | b           | b           | b           |
| 620N          | 0E   | b                                   | b           | b           | b           | b           |
| 620N          | 20E  | 0.65 ± 0.23                         | <0.18       | <0.69       | 0.61 ± 0.12 | 0.58 ± 0.36 |
| 620N          | 40E  | 1.33 ± 0.30                         | <0.25       | 1.23 ± 2.06 | 0.61 ± 0.16 | 0.89 ± 0.49 |
| 620N          | 60E  | b                                   | b           | b           | b           | b           |
| 620N          | 80E  | 0.69 ± 0.30                         | <0.23       | 1.02 ± 1.72 | 0.45 ± 0.12 | 0.80 ± 0.42 |
| 620N          | 100E | 0.70 ± 1.24                         | <0.27       | 1.74 ± 1.37 | 0.36 ± 0.10 | 1.24 ± 0.35 |
| 620N          | 120E | 0.70 ± 0.26                         | <0.18       | 0.91 ± 1.86 | 0.25 ± 0.12 | 0.91 ± 0.41 |
| 620N          | 140E | 0.69 ± 0.27                         | <0.21       | 0.65 ± 1.81 | 0.65 ± 0.14 | 0.95 ± 0.29 |
| 620N          | 160E | 1.03 ± 0.40                         | 0.76 ± 0.51 | 1.41 ± 1.82 | 1.24 ± 0.22 | 0.67 ± 0.46 |
| 620N          | 180E | 1.51 ± 0.28                         | 0.29 ± 0.70 | <0.93       | 0.34 ± 0.14 | 0.75 ± 0.54 |
| 620N          | 200E | 1.19 ± 0.40                         | 0.23 ± 0.62 | 2.35 ± 1.48 | 0.53 ± 0.16 | 0.89 ± 0.44 |
| 620N          | 220E | 0.83 ± 0.18                         | <0.25       | <0.80       | 0.43 ± 0.11 | 0.86 ± 0.32 |
| 600N          | 90W  | 0.96 ± 0.26                         | <0.24       | 0.91 ± 2.02 | 0.61 ± 0.14 | 1.08 ± 0.41 |
| 600N          | 80W  | 0.66 ± 0.25                         | <0.27       | <1.05       | 0.46 ± 0.12 | 0.90 ± 0.36 |
| 600N          | 60W  | 0.59 ± 0.23                         | <0.23       | <0.99       | 0.35 ± 0.14 | 0.71 ± 0.32 |

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|---------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|               |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 600N          | 50W  | 7.40 ± 0.65                         | 0.85 ± 0.89 | 7.00 ± 1.83 | 0.23 ± 0.08 | <0.26       |
| 600N          | 40W  | b                                   | b           | b           | b           | b           |
| 600N          | 20W  | 0.44 ± 0.29                         | 0.40 ± 0.52 | 1.51 ± 2.03 | 0.43 ± 0.14 | 1.00 ± 0.67 |
| 600N          | 3W   | 0.61 ± 0.23                         | 0.52 ± 0.37 | 2.01 ± 1.22 | 0.41 ± 0.10 | 1.21 ± 0.33 |
| 600N          | 20E  | b                                   | b           | b           | b           | b           |
| 600N          | 40E  | b                                   | b           | b           | b           | b           |
| 596N          | 60E  | 0.75 ± 0.29                         | <0.23       | 1.94 ± 1.89 | 0.52 ± 0.14 | 0.78 ± 0.40 |
| 596N          | 80E  | 0.59 ± 0.20                         | <0.18       | 0.69 ± 2.20 | 0.29 ± 0.10 | 0.32 ± 0.10 |
| 600N          | 100E | 0.91 ± 0.26                         | <0.20       | 1.20 ± 1.50 | <0.04       | 0.68 ± 0.25 |
| 600N          | 120E | 0.76 ± 0.26                         | <0.25       | 3.20 ± 1.45 | 0.53 ± 0.10 | 0.81 ± 0.41 |
| 600N          | 140E | 1.01 ± 0.25                         | <0.19       | 2.05 ± 1.21 | 0.23 ± 0.11 | 0.78 ± 0.38 |
| 600N          | 160E | 1.43 ± 0.31                         | <0.19       | 1.93 ± 1.93 | 0.33 ± 0.11 | 0.64 ± 0.57 |
| 600N          | 180E | 1.14 ± 0.26                         | <0.25       | 2.80 ± 1.05 | 0.52 ± 0.09 | 0.81 ± 0.32 |
| 600N          | 200E | 0.69 ± 0.23                         | <0.29       | 3.33 ± 1.36 | <0.04       | 0.88 ± 0.38 |
| 600N          | 220E | 2.94 ± 0.44                         | <0.27       | 2.50 ± 2.27 | <0.05       | 0.76 ± 0.31 |
| 580N          | 90W  | 0.88 ± 0.19                         | <0.17       | 1.16 ± 1.35 | 0.36 ± 0.07 | 0.70 ± 0.34 |
| 580N          | 80W  | 0.76 ± 0.29                         | <0.22       | 1.68 ± 1.59 | 0.22 ± 0.12 | 0.68 ± 0.40 |
| 580N          | 60W  | 0.58 ± 0.26                         | <0.24       | 1.49 ± 1.80 | 0.39 ± 0.16 | 0.67 ± 0.31 |
| 580N          | 50W  | 0.91 ± 0.25                         | <0.27       | 2.12 ± 2.04 | 1.24 ± 0.23 | 0.65 ± 0.31 |
| 580N          | 40W  | b                                   | b           | b           | b           | b           |
| 580N          | 20W  | 0.60 ± 0.20                         | <0.21       | 1.62 ± 2.05 | 0.37 ± 0.11 | 0.76 ± 0.30 |
| 580N          | 3W   | 0.65 ± 0.20                         | 0.17 ± 0.63 | 1.84 ± 0.98 | 0.57 ± 0.13 | 0.77 ± 0.38 |
| 580N          | 20E  | 1.10 ± 0.34                         | <0.36       | <1.10       | 0.69 ± 0.17 | <0.30       |
| 580N          | 40E  | 2.00 ± 0.34                         | <0.36       | 3.54 ± 1.52 | 0.82 ± 0.15 | 0.44 ± 0.31 |
| 580N          | 60E  | 3.51 ± 0.45                         | 0.82 ± 0.75 | 7.00 ± 1.76 | 0.67 ± 0.14 | <0.29       |
| 580N          | 80E  | 0.95 ± 0.24                         | <0.23       | <0.89       | 0.57 ± 0.14 | 0.61 ± 0.56 |
| 580N          | 100E | 1.00 ± 0.23                         | <0.34       | <1.15       | 0.58 ± 0.11 | 1.32 ± 0.51 |

TABLE 4, cont.

RADIONUCLIDE CONCENTRATIONS IN SURFACE SOIL SAMPLES  
FROM 20 M GRID INTERVALS

| Grid Location |      | Radionuclide Concentrations (pCi/g) |             |             |             |             |
|---------------|------|-------------------------------------|-------------|-------------|-------------|-------------|
|               |      | Ra-226                              | U-235       | U-238       | Cs-137      | Th-232      |
| 580N          | 120E | 0.76 ± 0.26                         | <0.22       | <0.71       | <0.04       | 0.55 ± 0.32 |
| 580N          | 140E | b                                   | b           | b           | b           | b           |
| 580N          | 160E | b                                   | b           | b           | b           | b           |
| 580N          | 178E | 1.36 ± 0.29                         | <0.32       | <1.01       | 0.51 ± 0.12 | 0.74 ± 0.43 |
| 580N          | 200E | 0.55 ± 0.20                         | <0.22       | 2.06 ± 1.03 | 0.59 ± 0.14 | 0.74 ± 0.33 |
| 580N          | 220E | 0.44 ± 0.26                         | <0.22       | <0.98       | 0.40 ± 0.12 | 1.09 ± 0.61 |
| 560N          | 90W  | 0.95 ± 0.34                         | <0.21       | 1.61 ± 1.73 | 0.28 ± 0.09 | 0.75 ± 0.42 |
| 560N          | 80W  | 1.29 ± 0.38                         | 0.36 ± 0.58 | <1.03       | 0.26 ± 0.08 | 1.21 ± 0.42 |
| 560N          | 60W  | 1.59 ± 0.31                         | <0.33       | 1.40 ± 1.60 | 0.44 ± 0.11 | 0.98 ± 0.39 |
| 560N          | 40W  | 0.73 ± 0.26                         | <0.20       | 1.22 ± 1.51 | 0.04 ± 0.05 | 0.90 ± 0.40 |
| 560N          | 20W  | 0.55 ± 0.21                         | <0.16       | <0.72       | 0.30 ± 0.10 | 0.66 ± 0.27 |
| 560N          | 3W   | 1.08 ± 0.45                         | <0.24       | 1.21 ± 0.95 | 1.00 ± 0.16 | 0.67 ± 0.34 |
| 560N          | 20E  | 1.78 ± 0.41                         | <0.34       | 1.66 ± 1.65 | 0.71 ± 0.13 | 0.86 ± 0.42 |
| 560N          | 40E  | 1.03 ± 0.26                         | <0.21       | 1.62 ± 1.54 | 0.20 ± 0.12 | 0.97 ± 0.39 |
| 560N          | 60E  | 2.15 ± 0.40                         | <0.43       | 2.77 ± 2.20 | 0.63 ± 0.15 | 1.26 ± 0.47 |
| 560N          | 80E  | 1.13 ± 0.26                         | <0.22       | 1.38 ± 1.40 | 0.37 ± 0.16 | 0.83 ± 0.40 |
| 560N          | 100E | 0.34 ± 0.16                         | <0.14       | 2.92 ± 1.67 | 0.51 ± 0.12 | 0.40 ± 0.35 |
| 560N          | 120E | 0.73 ± 0.29                         | <0.21       | <0.82       | 0.36 ± 0.10 | 0.33 ± 0.34 |
| 560N          | 140E | b                                   | b           | b           | b           | b           |
| 560N          | 160E | b                                   | b           | b           | b           | b           |
| 560N          | 178E | 0.89 ± 0.35                         | <0.38       | 2.69 ± 3.02 | 1.28 ± 0.19 | 0.78 ± 0.36 |
| 560N          | 200E | 0.63 ± 0.39                         | <0.22       | 0.98 ± 3.08 | 0.90 ± 0.20 | 0.79 ± 0.36 |
| 560N          | 220E | 0.56 ± 0.25                         | <0.21       | <0.75       | 0.21 ± 0.08 | 0.86 ± 0.40 |

<sup>a</sup> Errors are 2σ based on counting statistics.<sup>b</sup> No soil sample collected due to presence of building, water, or other surface conditions.

TABLE 5  
RADIONUCLIDE CONCENTRATIONS IN SURFACE SAMPLES  
FROM LOCATIONS IDENTIFIED BY THE WALKOVER SCAN

| Sample No. | Sample Type | Grid Location | Radionuclide Concentrations (pCi/g) <sup>a</sup> |                    |                    |             |             |  |
|------------|-------------|---------------|--|--------------------|--------------------|-------------|-------------|--|
|            |             |               | Ra-226   | U-235 <sup>b</sup> | U-238 <sup>b</sup> | Cs-137      | Th-232      |  |
| B1         | Rock        | 864N, 27W     | 36.1 ± 1.0 <sup>c</sup>                          | 2.81 ± 1.20        | 36.8 ± 2.3         | <0.09       | <0.36       |  |
| B2         | Rock        | 844N, 17W     | 49.5 ± 2.0                                       | 12.1 ± 3.3         | 33.4 ± 8.5         | <0.18       | <0.76       |  |
| B3         | Rock        | 815N, 23E     | 34.8 ± 1.5                                       | 2.28 ± 2.20        | 36.6 ± 9.8         | <0.14       | <0.61       |  |
| B4         | Rock        | 602N, 136E    | 23.7 ± 1.3                                       | <0.91              | 25.3 ± 7.8         | 0.19 ± 0.13 | <0.43       |  |
| B5         | Rock        | 600N, 160E    | 43.7 ± 1.1                                       | 4.82 ± 1.89        | 72.0 ± 26.2        | 0.13 ± 0.11 | <0.53       |  |
| B6         | Rock        | 600N, 51W     | 25.3 ± 0.9                                       | 1.86 ± 1.08        | 30.7 ± 2.7         | 0.03 ± 0.05 | 0.75 ± 0.60 |  |
| B7         | Rock        | 581N, 62E     | 37.6 ± 1.7                                       | 3.72 ± 3.01        | 43.4 ± 7.4         | <0.15       | <0.69       |  |
| B8         | Rock        | 559N, 19E     | 26.7 ± 1.4                                       | 2.59 ± 2.03        | 19.0 ± 8.0         | <0.13       | <0.52       |  |
| B9         | Rock        | 541N, 123E    | 990 ± 12   | 58.8 ± 16.2        | 94.8 ± 26.9        | <1.01       | 84.5 ± 7.1  |  |
| B10        | Rock        | 541N, 179E    | 4280 ± 30  | 170 ± 35           | <58.3              | <3.11       | 95.7 ± 22.8 |  |

<sup>a</sup> Refer to Table 3 for direct radiation levels.

<sup>b</sup> Large errors and poor detection sensitivities result from high activity of Ra-226.

<sup>c</sup> Errors are 2σ based on counting statistics.

TABLE 6  
RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

| Borehole No. <sup>a</sup> | Grid Location | Depth (m)            | Radionuclide Concentrations (pCi/g) |  |  |                               |                                     |
|---------------------------|---------------|----------------------|-------------------------------------|--|--|-------------------------------|-------------------------------------|
|                           |               |                      | Ra-226                              | U-235                                    | U-238                                    | Cs-137                        | Th-232                              |
| H1                        | 860N, 30W     | Surface <sup>b</sup> | 1.09 ± 0.26 <sup>c</sup>            | <0.30                                    | 0.85 ± 1.86                              | <0.03                         | 1.42 ± 0.32                         |
| H2                        | 860N, 30E     | Surface <sup>b</sup> | 0.88 ± 0.21                         | <0.17                                    | 0.90 ± 0.97                              | 0.38 ± 0.12                   | 0.71 ± 0.40                         |
| H3                        | 840N, 152E    | Surface <sup>b</sup> | 1.43 ± 0.31                         | <0.30                                    | 1.73 ± 1.65                              | <0.04                         | 1.80 ± 0.45                         |
| H4                        | 770N, 70E     | Surface <sup>b</sup> | 0.91 ± 0.24                         | 0.13 ± 0.33                              | 1.40 ± 0.77                              | 0.07 ± 0.09                   | 1.00 ± 0.33                         |
| H5                        | 620N, 195E    | Surface <sup>b</sup> | 0.80 ± 0.16                         | <0.26                                    | 1.63 ± 1.31                              | 0.12 ± 0.08                   | 0.92 ± 0.31                         |
| H6                        | 570N, 20E     | Surface <sup>b</sup> | 0.93 ± 0.20                         | <0.14                                    | 0.58 ± 0.81                              | <0.02                         | 0.77 ± 0.27                         |
| H7                        | 580N, 83W     | Surface <sup>b</sup> | 0.93 ± 0.41                         | <0.32                                    | <0.98                                    | 0.31 ± 0.11                   | 2.06 ± 0.55                         |
| H8                        | 614N, 85W     | Surface <sup>b</sup> | 0.89 ± 0.28                         | <0.17                                    | 0.77 ± 0.53                              | 0.56 ± 0.10                   | 0.54 ± 0.42                         |
| H9                        | 620N, 70W     | Surface <sup>b</sup> | 1.28 ± 0.36                         | <0.36                                    | 1.77 ± 1.85                              | 0.59 ± 0.16                   | 0.90 ± 0.35                         |
| H10                       | 600N, 51W     | Surface              | 25.3 ± 0.9<br>0.15<br>0.30          | 1.86 ± 1.08<br>2.60 ± 1.35<br><0.14      | 30.7 ± 2.7<br>39.1 ± 3.5<br>1.22 ± 0.47  | 0.03 ± 0.05<br><0.09<br><0.03 | 0.75 ± 0.60<br><0.38<br>0.82 ± 0.31 |
| H11                       | 844N, 17W     | Surface              | 49.5 ± 2.0<br>0.15<br>0.90          | 12.1 ± 3.5<br>0.98 ± 0.20<br>1.16 ± 0.23 | 53.4 ± 8.5<br>1.55 ± 0.54<br>1.35 ± 0.95 | <0.18<br><0.02<br><0.04       | <0.76<br>0.97 ± 0.35<br>1.06 ± 0.31 |

TABLE 6, cont.  
RADIONUCLIDE CONCENTRATIONS IN BOREHOLE SOIL SAMPLES

| Borehole No. | Grid Location | Depth (m)               | Radionuclide Concentrations (pCi/g) |             |             |        |             |  |
|--------------|---------------|-------------------------|-------------------------------------|-------------|-------------|--------|-------------|--|
|              |               |                         | Ra-226                              | U-235       | U-238       | Cs-137 | Th-232      |  |
| H12          | 815N, 23E     | Surface<br>0.15<br>0.90 | 34.8 + 1.5                          | 2.28 + 2.20 | 36.6 + 9.8  | <0.14  | <0.61       |  |
|              |               |                         | 1.16 + 0.29                         | <0.15       | 1.11 + 0.87 | <0.02  | 0.98 + 0.56 |  |
|              |               |                         | 2.16 + 0.39                         | <0.33       | 2.79 + 1.24 | <0.04  | 1.15 + 0.33 |  |
| H13          | 541N, 179E    | Surface<br>0.30<br>1.20 | 4280 + 30                           | 170 + 35    | <58.3       | <3.11  | 95.7 + 22.8 |  |
|              |               |                         | 12.3 + 0.8                          | <0.64       | <1.68       | <0.07  | 2.34 + 0.64 |  |
|              |               |                         | 3.65 + 0.41                         | <0.19       | <0.47       | <0.03  | 0.78 + 0.31 |  |
| H14          | 541N, 123E    | Surface<br>0.15         | 990 + 12                            | 58.8 + 16.2 | 94.8 + 26.9 | <1.01  | 84.5 + 7.1  |  |
|              |               |                         | 1.04 + 0.30                         | <0.26       | <0.79       | <0.03  | 0.93 + 0.38 |  |

a Refer to Figure 4.

b Subsurface sampling was not performed based on negative findings of the borehole gamma scans.

c Errors are  $2\sigma$  based on counting statistics.

TABLE 7  
RADIONUCLIDE CONCENTRATIONS IN WATER SAMPLES

| Sample No. | Sample Type                          | Grid Location | Radionuclide Concentrations (pCi/l) |             |
|------------|--------------------------------------|---------------|-------------------------------------|-------------|
|            |                                      |               | Gross Alpha <sup>c</sup>            | Gross Beta  |
| W1         | Surface <sup>a</sup>                 | 570N, 79E     | 1.62 + 0.47 <sup>d</sup>            | 2.77 + 0.47 |
| W2         | Surface <sup>a</sup>                 | 560N, 45E     | 1.83 + 0.51                         | 10.3 + 0.7  |
| W3         | Subsurface Borehole H1 <sup>b</sup>  | 860N, 30W     | 7.01 + 1.65                         | 4.20 + 1.19 |
| W4         | Subsurface Borehole H2 <sup>b</sup>  | 860N, 30E     | 10.2 + 2.1                          | 6.98 + 1.58 |
| W5         | Subsurface Borehole H4 <sup>b</sup>  | 770N, 70E     | 8.85 + 3.78                         | 11.2 + 4.3  |
| W6         | Subsurface Borehole H9 <sup>b</sup>  | 620N, 70W     | 7.59 + 3.79                         | 4.74 + 4.01 |
| W7         | Subsurface Borehole H5 <sup>b</sup>  | 620N, 195E    | 3.84 + 1.06                         | 5.03 + 0.98 |
| W8         | Subsurface Borehole H8 <sup>b</sup>  | 614N, 85W     | 10.6 + 3.4                          | 14.7 + 3.3  |
| W9         | Subsurface Borehole H6 <sup>b</sup>  | 570N, 20E     | 6.54 + 1.63                         | 7.89 + 1.59 |
| W10        | Subsurface Borehole H13 <sup>b</sup> | 541N, 179E    | 1.54 + 0.80                         | 2.65 + 0.88 |
| W11        | Subsurface Borehole H14 <sup>b</sup> | 541N, 123E    | 1.08 + 0.66                         | 1.15 + 0.80 |

<sup>a</sup> Refer to Figure 5.

<sup>b</sup> Refer to Figure 4.

<sup>c</sup> Large amounts of dissolved solids resulted in relatively poor detection sensitivities and high errors for gross alpha analysis.

<sup>d</sup> Errors are 2 $\sigma$  based on counting statistics.

TABLE 8  
SUMMARY OF RESULTS OF BUILDING SURVEYS

| Building <sup>a</sup> | Gamma Exposure<br>Rates 1 Meter Above<br>the Floor<br>( $\mu\text{R}/\text{h}$ ) | <u>Directly Measured Surface Contamination Levels</u> |  |  |
|-----------------------|--|---|--|--|
|                       |  | Alpha<br>( $\text{d}/\text{m}^2/100 \text{ cm}^2$ )   | Beta-Gamma<br>( $\text{d}/\text{m}^2/100 \text{ cm}^2$ ) | Beta-Gamma Dose Rate<br>( $\text{mrad}/\text{h}$ ) |
| A                     | 4.4-6.7  | <26-103   | <394-634   | .01-.03  |
| B                     | 4.2-5.5  | <26-77  | <394   | .01-.02  |
| C                     | 4.9-5.7  | <26-64  | <394   | .01  |
| D                     | 5.5-5.9  | 51-103  | <394   | .01-.02  |
| E                     | 5.9-6.4  | <26-51  | <394   | .01  |

<sup>a</sup> Refer to Figure 2.

TABLE 9

SUMMARY OF AREAS ON PROPERTY V WHICH  
EXCEED RESIDUAL CONTAMINATION CRITERIA

| Grid Location <sup>a</sup> |          | Principal Radionuclides <sup>b</sup> | Estimated Quantities of Material Exceeding Guidelines |                   |                          | Remarks  |
|----------------------------|----------|--------------------------------------|---|-------------------|--------------------------|--|
|                            |          |                                      | Area (m <sup>2</sup> )                                | Average Depth (m) | Volume (m <sup>3</sup> ) |  |
| 862-870N                   | 21-31W   | Ra-226, U-238 <sup>c</sup>           | 80  | 0.15              | 12                       |  |
| 852-856N                   | 90-91W   | Ra-226, U-238 <sup>c</sup>           | 4   | 0.15              | 0.6                      |  |
| 840-846N                   | 14-20W   | Ra-226, U-238 <sup>c</sup>           | 36  | 0.15              | 5.4                      |  |
| 834-840N                   | 32-40W   | Ra-226, U-238 <sup>c</sup>           | 48  | 0.15              | 7.2                      |  |
| 809-820N                   | 40-47W   | Ra-226, U-238 <sup>c</sup>           | 77  | 0.15              | 11.6                     |  |
| 812-820N                   | 29-40W   | Ra-226, U-238 <sup>c</sup>           | 88  | 0.15              | 13.2                     |  |
| 687-691N                   | 32-35E   | Ra-226, U-238 <sup>c</sup>           | 12  | 0.15              | 1.8                      | General areas of crushed rock fill.  |
| 616-625N                   | 0-7E     | Ra-226, U-238 <sup>c</sup>           | 63  | 0.15              | 9.5                      |  |
| 600-603N                   | 134-140E | Ra-226, U-238 <sup>c</sup>           | 18  | 0.15              | 2.7                      |  |
| 600-602N                   | 160-176E | Ra-226, U-238 <sup>c</sup>           | 32  | 0.15              | 4.8                      |  |
| 600-604N                   | 206-220E | Ra-226, U-238 <sup>c</sup>           | 56  | 0.15              | 8.4                      |  |
| 580-600N                   | 212-214E | Ra-226, U-238 <sup>c</sup>           | 40  | 0.15              | 6                        |  |
| 580-600N                   | 47-52W   | Ra-226, U-238 <sup>c</sup>           | 100   | 0.15              | 15                       |  |
| 580-582N                   | 60-63E   | Ra-226, U-238 <sup>c</sup>           | 6   | 0.15              | 0.9                      |  |
| 569-572N                   | 49-52E   | Ra-226, U-238 <sup>c</sup>           | 9   | 0.15              | 1.4                      |  |
| 550-558N                   | 50-56E   | Ra-226, U-238 <sup>c</sup>           | 48  | 0.15              | 7.2                      |  |
| 540-545N                   | 1-11E    | Ra-226, U-238 <sup>c</sup>           | 50  | 0.15              | 7.5                      |  |
| 862N                       | 16W      | Ra-226, U-238 <sup>c</sup>           | -- <sup>d</sup>                                       | --                | --                       | Isolated "hot spots" containing crushed rock or individual pieces of rock-like material. |
| 827N                       | 60W      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 824N                       | 26W      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 821N                       | 48W      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 821N                       | 43W      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 820N                       | 56W      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 816N                       | 18E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       | Unless indicated otherwise,  |
| 816N                       | 21E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 818N                       | 24E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       | average depth is approx. 0.15 m.   |
| 815N                       | 23E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 800N                       | 58W      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       | The volume of  |
| 597N                       | 196E     | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       | material at each   |
| 590N                       | 196E     | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       | of these locations is  |
| 575N                       | 64E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       | estimated to be  |
| 564N                       | 24E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       | less than 1 m. <sup>e</sup>  |
| 561N                       | 22E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 559N                       | 19E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 559N                       | 21E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 544N                       | 57E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| 543N                       | 57E      | Ra-226, U-238 <sup>c</sup>           | --  | --                | --                       |  |
| / 541N                     | 123E     | Ra-226 <sup>g</sup>                  | --  | --                | --                       |  |
| / 541N                     | 179E     | Ra-226 <sup>g</sup>                  | --  | 0.30              | --                       |  |

<sup>a</sup> Refer to Figure 7.<sup>b</sup> Based on information from sample analysis, direct radiation levels, locations, distribution, and physical characteristics.<sup>c</sup> Believed to be of natural origin and not attributable to previous MED/AEC operations.<sup>d</sup> Dash indicates determination not made.<sup>e</sup> Considered to have resulted from previous MED/AEC activities.

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APPENDIX A  
INSTRUMENTATION AND ANALYTICAL PROCEDURES

## APPENDIX A

### Instrumentation and Analytical Procedures

#### Gamma Scintillation Measurements

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 rates ( $\mu\text{R}/\text{h}$ ) using factors determined by comparing the response of the scintillation detector with that of a Reuter Stokes model RSS-III pressurized ionization chamber at 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 ( $\mu\text{rad}/\text{h}$ ) 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 Sample Analysis

#### Gamma Spectrometry

Soil samples were dried, mixed, and a portion placed in a 0.5 l 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 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 - 0.094 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  $\mu\text{m}$  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.

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 performance was within expected statistical fluctuations. The ORAU laboratory participates in the EPA Quality Assurance Program.

APPENDIX 3

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 REEDICAL 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<sup>1/</sup>. 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<sup>2/</sup>, or termination of licenses for byproduct, source, or special nuclear material<sup>2/</sup>. The waste control guidelines are consistent with applicable DOE Orders and EPA's regulations for inactive uranium milling sites, 40 CFR Part 192.

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<sup>1/</sup>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.

- <sup>2/</sup> 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<sup>1/</sup> as was used for those represented here.

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

| <u>Radionuclide</u>     | <u>Soil Criteria<sup>2/,3/,4/</sup><br/>(pCi/g above background)</u>  |
|-------------------------|---|
| U-Natural <sup>5/</sup> | 75  |
| U-238 <sup>6/</sup>     | 150   |
| C-234 <sup>6/</sup>     | 150   |
| Th-230 <sup>7/</sup>    | 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 <sup>6/</sup>     | 140   |
| Pa-231                  | 40  |
| Ac-227                  | 190   |
| Th-232                  | 15  |
| Am-241 <sup>8/</sup>    | 60  |
| Pu-241 <sup>8/</sup>    | 2400  |
| Pu-238, 239, 240        | 300   |
| Cs-137                  | 80  |

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

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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<sup>2</sup> 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<sup>2</sup> 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  $3.7 \times 10^{10}$  disintegrations per second (dis/s) over any 15cm thick layers from U-238 plus  $3.7 \times 10^{10}$  dis/s from U-234 plus  $1.7 \times 10^9$  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 Ra-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 <sup>2/</sup>   | Average <sup>3/,4/</sup> | Maximum <sup>4/,5/</sup> | Removable <sup>4/,6/</sup> |
|---|--------------------------|--------------------------|----------------------------|
| Transuranics, Ra-226,<br>Ra-228, Th-230, Th-228,<br>Pa-231, Ac-227, I-125,<br>I-129   | 100                      | 300                      | 20                         |
| U-Natural, Th-232,<br>Sr-90, Fr-223, Ra-224,<br>U-232, I-126, I-131,<br>I-133   | 1,000                    | 3,000                    | 200                        |
| U-Natural, U-235, U-238,<br>and associated decay<br>products  | 5,000                    | 15,000                   | 1,000                      |
| Beta-gamma emitters<br>(radionuclides with<br>decay modes other than<br>alpha emission or<br>spontaneous fission)<br>except Sr-90 and others<br>noted above | 5,000                    | 15,000                   | 1,000                      |

<sup>1/</sup> 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.

<sup>2/</sup> 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.

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

<sup>4/</sup> 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<sup>2</sup>, respectively, measured through not more than 7 mg/cm<sup>2</sup> of total absorber.

- 5/ The maximum contamination level applies to an area of not more than 100 cm<sup>2</sup>.
- 6/ The amount of removable radioactive material per 100 cm<sup>2</sup> 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.

? 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<sup>2</sup>/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**

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

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- 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.