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Results of the Radiological Survey of the Excelsior Steel Ball Company, Tonawanda, New York (TNY005)

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LIFE SCIENCES DIVISION

Department of the Army - Corps of Engineers
(Activity No. W0M11202; DAG)

Results of the Radiological Survey of the Excelsior Steel Ball Company, Tonawanda, New York (TNY005)

S. P. McKenzie and K. S. Brown

Report Issued -July 1998

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ACKNOWLEDGMENTS

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ABSTRACT

At the request of the U.S. Department of Energy (DOE), a team from Oak Ridge National Laboratory conducted two radiological surveys of property belonging to the Excelsior Steel Ball Company, which is surrounded on three sides by the former site of the Linde Uranium Refinery, Tonawanda, New York. The surveys were performed in September 1997 and February 1998. The purpose of the first survey was to determine if radioactive residuals were present from previous activities at the former Linde site. The Linde Air Products Division of Union Carbide Corporation, Tonawanda, New York, had used radioactive materials at that location for work performed under government contract from 1942 through 1948. The purpose of the second survey was to collect additional biased samples from an area of the site where biased sample results showed slightly elevated levels of thorium-232.

The surveys were performed in response to the DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP) requirements. These requirements dictate that the radiological status of certain vicinity properties shall be assessed and documented according to prescribed procedures prior to certification of the property for release for unrestricted use. Such release can only be granted if the property is found to be within current applicable authorized limits.

The first survey included a surface gamma scan in accessible areas inside and outside the buildings, and the collection and radionuclide analysis of soil samples. The second survey included collection and analysis of seven additional biased samples and a piece of terra-cotta roofing material. A comparison of these data to the current DOE guidelines shows that all radionuclide concentrations and radioactivity levels found on the property are below the current guidelines. Therefore, this property should not be included in the FUSRAP program for remediation.

Results of the Radiological Survey of the Excelsior Steel Ball Company, Tonawanda, New York (TNY005)*

INTRODUCTION

From 1942 through approximately 1948, the Linde Air Products Division of Union Carbide Corporation, Tonawanda, New York, was one of many companies performing work associated with the development of nuclear energy for defense-related projects. This work was conducted under government contract to the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC). During the first 3 years, pitchblende ore from the Belgian Congo and concentrates from the Colorado Plateau ore were converted to U_3O_8. A second process yielding UO_2 was conducted for about a year, and a third process, converting UO_2 to green salt (UF_4), operated during World War II and the following 2 years. Linde also developed and produced barrier material for the Oak Ridge Gaseous Diffusion Plant. Other contracts have been identified, but the exact nature of the work involved is unknown.[1]

As a result of these and similar activities, equipment, buildings, and land at some of the sites became radiologically contaminated resulting in low levels of contamination on the properties. At contract termination, sites used by contractors were decontaminated in accordance with the standards and survey methods in use at that time. Since the original assessments, radiological criteria and guidelines for the release of such sites for unrestricted use have become more stringent. In some instances, records documenting decontamination efforts cannot be found, and the final radiological conditions of the site cannot be adequately determined. As a result, the Formerly Utilized Sites Remedial Action Program (FUSRAP) was established in 1974 to identify these formerly used sites and to reevaluate their radiological status.[1] The radiological assessment showing the presence of radioactive residuals at the Linde site had been performed in 1978.[2]

Occasionally, nearby private and commercial properties also became contaminated through migration or redistribution of the radioactive residuals from the original site.[3] The radiological survey detailed in this report was performed under the FUSRAP program as a follow-up to earlier investigations and as a precaution to ensure that no residual radioactive materials exceeding current U.S. Department of Energy (DOE) guidelines were present on the Excelsior Steel Ball Company property. The Excelsior Steel Ball Company manufactures specialized steel ball bearings. The property is surrounded on three sides by the former Linde site.

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*The survey was performed by members of the Measurement Applications and Development Group of the Life Sciences Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

In September 1997 and February 1998, radiological surveys were conducted at the Excelsior Steel Ball Company property by personnel from Oak Ridge National Laboratory at the request of DOE. Results of that survey are presented in this report. The general location of the property in relation to the former Linde site is shown in Fig. 1.

SCOPE OF THE SURVEYS

The radiological survey of September 1997 included a surface gamma scan of accessible areas inside and outside three buildings, systematic measurements with a FIDLER (field instrument for detection of low-energy radiation) inside the buildings, a scan of accessible floor surfaces with a floor monitor probe, and a scan of less accessible areas with a beta/gamma pancake probe. Systematic and biased soil samples were collected for radionuclide analysis. Systematic samples were collected in a fixed order without regard to radiation level; biased soil samples were collected at locations of slightly elevated gamma levels. The survey of February 1998 included collection and analysis of seven additional biased samples and a piece of terra-cotta roofing material.

SURVEY METHODS

A comprehensive description of the methods and instrumentation used in this survey and in the laboratory analyses is given in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600 (April 1987)[4] and *Measurement Applications and Development Group Guidelines*, ORNL-6782 (January 1995).[5]

A grid was established over the entire property to define the precise location of measurements and samples. Grid blocks measured ten meters by ten meters. The southwestern corner of the property was designated as 0N, 0E. A sample was then located by number of meters directly north and then directly east of the southwest corner.

GAMMA RADIATION MEASUREMENTS

Gamma radiation levels were determined using portable NaI gamma scintillation meters. Because NaI gamma scintillators are energy dependent, measurements of gamma radiation levels in counts per minute are normalized to pressurized ionization chamber (PIC) measurements to estimate gamma exposure rates in μR/h.

The FIDLER was used to measure the relative gamma fluence at the interior floor surface with the purpose of detecting gamma-emitting radionuclide contamination beneath floor surfaces. The FIDLER is a NaI(Tl) scintillation probe that is designed to be particularly sensitive to low-energy gamma and x-ray radiation. The sensitive volume is 5 in. in diameter by 0.0063 in. thick, and the instrument is very efficient at measuring gamma

fluence rates entering perpendicular to the entrance window. Systematic measurements in counts per 30 seconds were taken with two different instruments and then converted to counts per minute and normalized so observed values would appear to come from only a single detector.

Bicron miniscaler/ratemeters with Geiger-Mueller (GM) pancake detectors were used to detect beta-gamma radiation. Radiation levels in counts per minute (cpm) were converted to disintegrations per minute (dpm) per 100 cm^2.

Floors were surveyed with the Ludlum Model 239-1F gas flow proportional detector system ("floor monitor"), which includes a Ludlum Model 2221 scaler/ratemeter connected to a Ludlum Model 43-37 detector probe mounted on a roll-around cart. The monitor was set in the "beta" mode, where it is primarily used to detect beta radiation.

SOIL SAMPLING AND ANALYSES

Systematic soil samples were taken from the ground between and adjacent to the three buildings on the property, and biased samples were taken from an area of soil with slightly elevated gamma levels at the northwest corner of the property. Samples were analyzed by gamma spectrometry. Sampling locations are shown on Fig. 2.

SURVEY RESULTS

DOE guidelines are summarized in Table 1. Typical background radiation levels for the Tonawanda, New York, area are presented in Table 2. These data are provided for comparison with survey results presented in this section. Gamma radiation levels are presented in gross microroentgen per hour and FIDLER measurements in gross counts per minute. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in soil samples.

GAMMA EXPOSURE RATE MEASUREMENTS

Gamma exposure rates on the property generally ranged from 7 to 11 μR/h. These values are similar to typical background radiation levels in the Tonawanda area (8 to 11 μR/h, Table 2). The highest gamma exposure measurements found at four biased sampling locations ranged from 13 to 18 μR/h at the ground surface and from 11 to 13 μR/h at 1 m above the surface, and may be attributed to natural radioactive substances present in the cinders and outcroppings of slag scattered throughout the Tonawanda area.

OTHER RADIATION MEASUREMENTS

FIDLER measurements of floors in the three buildings and the scan of interior areas with a floor monitor probe and beta/gamma pancake probe showed no elevated radiation levels above background levels.

SYSTEMATIC AND BIASED SOIL SAMPLES

Systematic and biased soil sample locations are shown in Fig. 2, and results of analyses are listed in Table 3. Concentrations of ^{238}U and ^{226}Ra in surface soil (0–15 cm) ranged from 0.1 to 5.4 pCi/g and from 0.25 to 3.4 pCi/g, respectively. Because slag, cinders, and other similar materials scattered throughout the Tonawanda–Niagara Falls area contain naturally occurring radionuclides that may cause slight elevations in radionuclide concentrations, the biased samples are considered to be within typical background levels for ^{238}U and ^{226}Ra in the Tonawanda area (Table 2). Naturally occurring uranium contains roughly equal amounts of ^{226}Ra and ^{238}U.

Thorium-232 concentrations in samples taken during the survey trip of September 1997 ranged from 0.15 to 7.0 pCi/g. Sample results for biased samples B1A and B1B are 5.1 and 3.9 pCi/g, respectively. Sample results for biased samples B2A and B2B are 7.0 and 5.1 pCi/g, respectively. Sample results from the survey trip of February 1998 ranged from 1.4 to 7.3 pCi/g. The concentrations of ^{232}Th in these biased samples exceed typical background ^{232}Th levels from the Tonawanda area (Table 2), but do not exceed DOE guideline values for surface and subsurface soil when averaged over 100 m^2 in accordance with Table 1.

DEBRIS SAMPLE

A sample of terra-cotta roofing debris was taken in the vicinity of the biased sampling area on the survey trip of February 1998. Results of radionuclide analysis of the material were negligible.

SIGNIFICANCE OF FINDINGS

A survey was conducted at the request of the Department of Energy to document the radiological status of the Excelsior Steel Ball Company property, Tonawanda, New York. All radionuclide concentrations and radioactivity levels found on the property are below current guidelines. Therefore, this property should not be included in the FUSRAP program for remediation.

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3. R. E. Rodriguez, M. E. Murray, and M. S. Uziel, *Results of the Radiological Survey at the Town of Tonawanda Landfill, Tonawanda, New York (TNY001)*, ORNL/RASA-92/12, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., October 1992.

4. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., April 1987.

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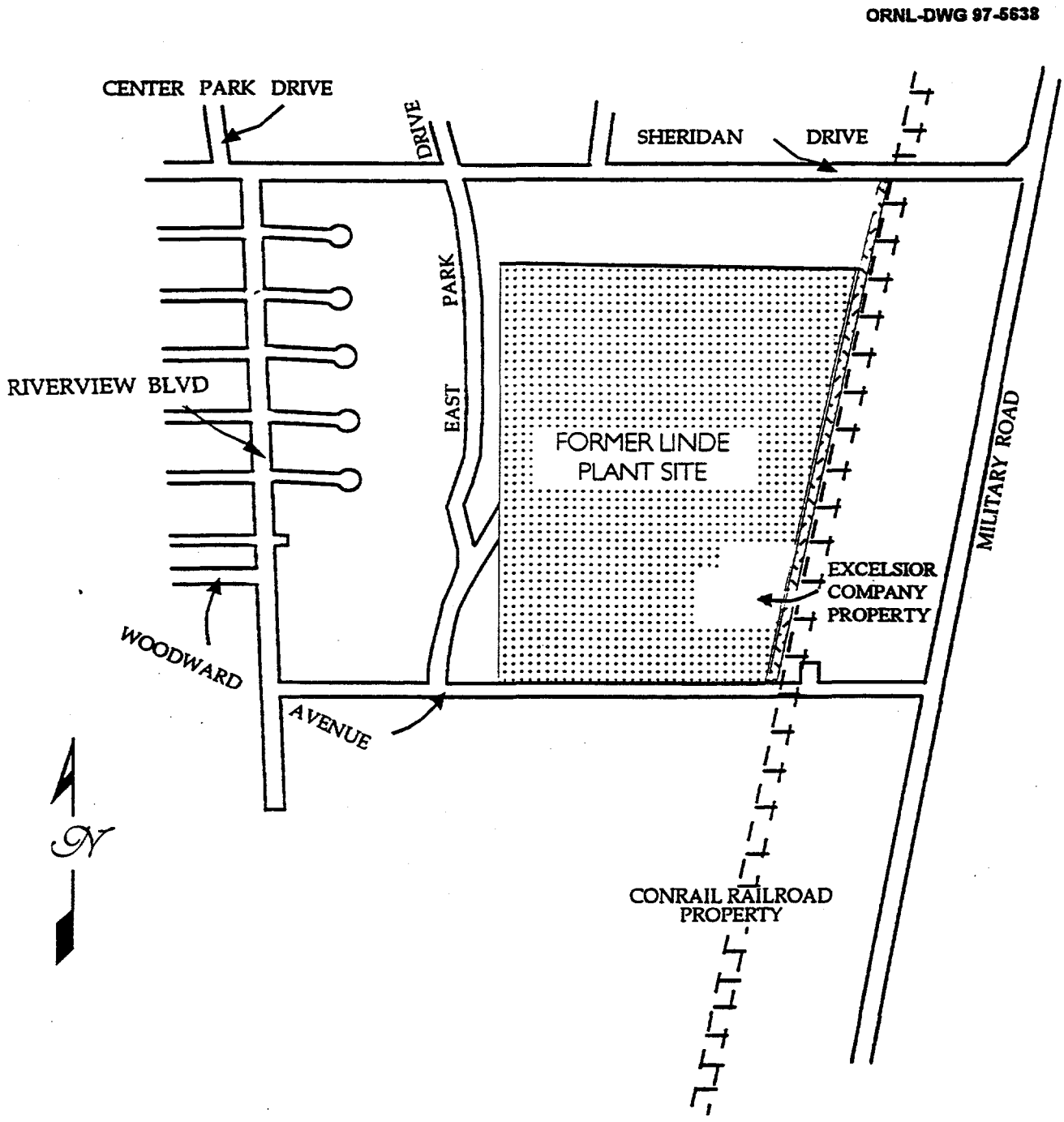

Fig. 1. Diagram showing general location of the Excelsior Steel Ball Company in relation to the former Linde site, Tonawanda, New York.

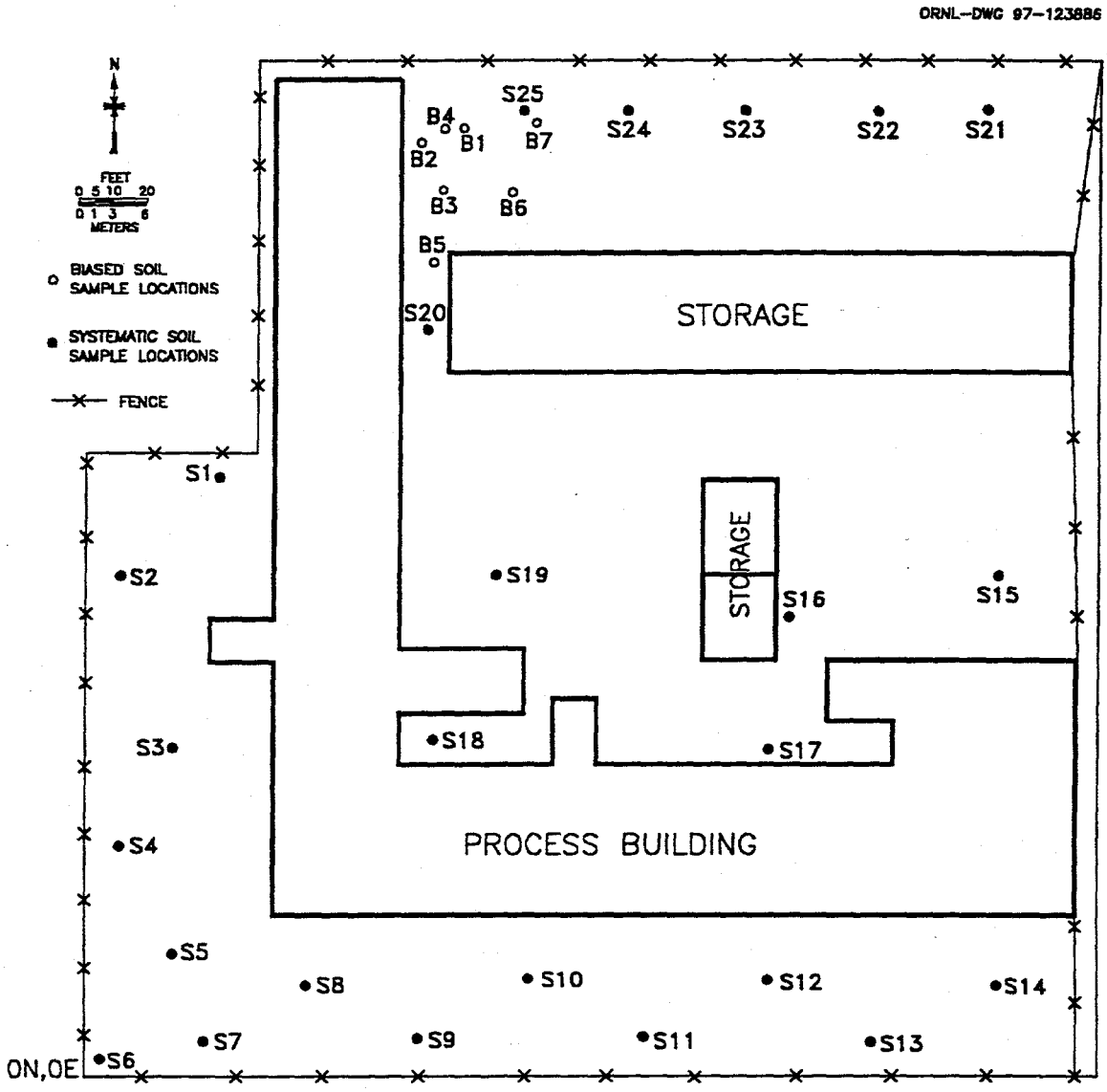

Fig. 2. Diagram showing systematic and biased soil sampling locations on the Excelsior Steel Ball Company property.

Table 1. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 μR/h[a]
Radionuclide concentrations in soil (generic)	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m^2 area ^{226}Ra ^{232}Th ^{230}Th	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
Derived concentrations	^{238}U	Site specific[b]
Guideline for non-homogeneous contamination (used in addition to the 100-m^2 guideline)[c]	Applicable to locations with an area $\leq$25 m^2, with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i(100/A)^{1/2}$, where G_A = guideline for "hot spot" of area (A) G_i = guideline averaged over a 100-m^2 area

[a]The 20 μR/h shall comply with the basic dose limit (100 mrem/year) when an appropriate-use scenario is considered.

[b]DOE guidelines for uranium are derived on a site-specific basis. A total uranium guideline of 60 pCi/g will be applied at the Excelsior Steel Ball Company site. This corresponds to a ^{238}U concentration of ~ 30 pCi/g.

[c]DOE guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area (adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987).

Sources: Adapted from U.S. Department of Energy, DOE Order 5400.5, April 1990; U.S. Department of Energy, *Guidelines for Residual Radioactive Material at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites*, Rev. 2, March 1987; and U.S. Department of Energy, *Radiological Control Manual*, DOE/EH-0256T (DOE N 5480.6), June 1992.

Table 2. Background radiation levels and concentrations of selected radionuclides in soil near Tonawanda, New York

Type of radiation measurement or sample	Radiation level or radionuclide concentration	
	Range	Average
Gamma exposure rate at ground surface (μR/h)[a]	8–11	9
Concentration of radionuclides in soil (pCi/g)[a]		
^{238}U	0.8–1.1	1.0
^{226}Ra	0.7–1.1	0.9
^{232}Th	0.5–0.9	0.8

[a]Values obtained from four locations in the Tonawanda area.

Source: R. E. Rodriguez, M. E. Murray, and M. S. Uziel, *Results of the Radiological Survey at the Town of Tonawanda Landfill, Tonawanda, New York (TNY001)*, ORNL/RASA-92/12, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., October 1992.

Table 3. Concentrations of radionuclides in soil samples, Excelsior Steel Ball Company, Tonawanda, New York

Sample ID[a]	Grid Location[a,b]	Depth (cm)	Radionuclide concentrations (pCi/g)[c]		
			^{238}U	^{226}Rn	^{232}Th
		Systematic samples[d]			
S1	55N, 11E	0-15	2.5 ± 0.4	1.5 ± 0.1	1.8 ± 0.2
S2	45N, 3E	0-15	1.5 ± 0.4	1.1 ± 0.1	1.1 ± 0.2
S3	30N, 8E	0-15	3.4 ± 0.5	1.4 ± 0.1	1.4 ± 0.2
S4	20N, 3E	0-15	1.6 ± 0.4	1.1 ± 0.1	1.0 ± 0.2
S5	10N, 8E	0-15	0.8 ± 0.2	0.6 ± 0.1	0.4 ± 0.1
S6	1N, 1E	0-15	0.8 ± 0.3	0.96 ± 0.1	0.66 ± 0.1
S7	3N, 10E	0-15	1.3 ± 0.3	1.2 ± 0.1	1.2 ± 0.2
S8	8N, 20E	0-15	1.6 ± 0.3	0.9 ± 0.1	0.9 ± 0.1
S9	3N, 30E	0-15	1.9 ± 0.4	1.3 ± 0.1	1.1 ± 0.2
S10	8N, 40E	0-15	1.8 ± 0.4	1.2 ± 0.1	1.1 ± 0.1
S11	3N, 50E	0-15	1.8 ± 0.4	1.3 ± 0.1	1.2 ± 0.2
S12	8N, 60E	0-15	0.72 ± 0.2	0.6 ± 0.1	0.4 ± 0.1
S13	3N, 70E	0-15	1.0 ± 0.3	0.6 ± 0.1	0.5 ± 0.1
S14	8N, 80E	0-15	1.2 ± 0.3	1.0 ± 0.1	0.7 ± 0.1
S15	45N, 80E	0-15	2.2 ± 0.4	1.6 ± 0.1	1.3 ± 0.2
S16	40N, 60E	0-15	2.6 ± 0.4	1.5 ± 0.1	1.2 ± 0.1
S17	28N, 60E	0-15	1.9 ± 0.4	1.5 ± 0.1	1.0 ± 0.2
S18	30N, 30E	0-15	2.1 ± 0.4	1.2 ± 0.1	1.1 ± 0.1
S19A	44N, 35E	0-15	1.2 ± 0.3	1.0 ± 0.1	0.77 ± 0.1
S19B	44N, 35E	15-30	3.0 ± 0.4	3.0 ± 0.2	2.0 ± 0.2
S19C	44N, 35E	30-45	3.7 ± 0.5	3.4 ± 0.2	1.8 ± 0.2
S20	70N, 25E	0-15	1.9 ± 0.4	1.5 ± 0.1	1.1 ± 0.1
S21	90N, 80E	0-15	0.13 ± 0.2	0.25 ± 0.03	0.15 ± 0.1
S22	90N, 70E	0-15	1.9 ± 0.3	1.1 ± 0.1	2.4 ± 0.02

Table 3. Concentrations of radionuclides in soil samples, Excelsior Steel Ball Company, Tonawanda, New York

Sample ID[a]	Grid Location[a,b]	Depth (cm)	Radionuclide concentrations (pCi/g)[c]		
			^{238}U	^{226}Rn	^{232}Th
S23	90N, 60E	0-15	1.8 ± 0.4	0.87 ± 0.1	2.1 ± 0.2
S24	90N, 50E	0-15	1.4 ± 0.4	0.85 ± 0.1	1.7 ± 0.2
S25	90N, 40E	0-15	0.88 ± 0.3	0.56 ± 0.1	1.4 ± 0.1
		Biased samples[e]			
B1A	88N, 28E	0-15	4.2 ± 0.5	1.7 ± 0.1	5.1 ± 0.4
B1B	88N, 28E	15-30	3.0 ± 0.4	1.2 ± 0.1	3.9 ± 0.3
B2A	86N, 20E	0-15	5.4 ± 0.5	2.9 ± 0.2	7.0 ± 0.5
B2B	86N, 20E	15-30	4.4 ± 0.5	2.6 ± 0.2	5.1 ± 0.4
B3A	85N, 28E	0-15	6.5 ± 0.6	2.2 ± 0.1	7.3 ± 0.5
B3B	85N, 28E	15-30	4.6 ± 0.5	2.0 ± 0.1	4.2 ± 0.3
B4	88N, 29E	0-15	3.6 ± 0.5	2.2 ± 0.1	1.4 ± 0.2
B5	79N, 29E	0-15	2.9 ± 0.5	1.4 ± 0.1	2.1 ± 0.2
B6	84N, 33E	0-15	2.6 ± 0.4	1.0 ± 0.1	3.2 ± 0.3
B7A	88N, 38E	0-15	3.7 ± 0.5	1.2 ± 0.1	4.6 ± 0.3
B7B	88N, 38E	15-30	3.0 ± 0.5	1.2 ± 0.1	3.8 ± 0.3

[a]Sample locations are shown on Fig. 2.

[b]Sample location determined by number of meters north and east of southwest corner of property.

[c]Indicated counting error is at the 95% confidence level ($\pm 2\sigma$). Results for other radionuclides are typical of background concentrations and are not included in the table.

[d]Systematic samples are taken at locations irrespective of gamma exposure rates.

[e]Biased samples are taken from areas with elevated gamma exposure rates. Samples B1 and B2 were taken on the survey trip of September 1997. Samples B3 through B7 were collected on the survey trip of February 1998.

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