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RESULTS OF THE RADIOLOGICAL SURVEY AT 28 LONG VALLEY ROAD, LODI, NEW JERSEY (LJ047)

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ABSTRACT

Maywood Chemical Works (MCW) of Maywood, New Jersey, generated process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores from 1916 to 1956. MCW supplied rare earth metals and thorium compounds to the Atomic Energy Commission and various other government agencies from the late 1940s to the mid–1950s. Area residents used the sandlike waste from this thorium extraction process mixed with tea and cocoa leaves as mulch in their yards. Some of these contaminated wastes were also eroded from the site into Lodi Brook. At the request of the U.S. Department of Energy (DOE), a group from Oak Ridge National Laboratory conducts investigative radiological surveys of properties in the vicinity of MCW to determine whether a property is contaminated with radioactive residues, principally ^{232}Th, derived from the MCW site. The survey typically includes direct measurement of gamma radiation levels and soil sampling for radionuclide analyses. The survey of this site, 28 Long Valley Road, Lodi, New Jersey (LJ047), was conducted during 1985, 1986, and 1987.

Some radionuclide measurements were greater than typical background levels in the northern New Jersey area. However, results of the survey demonstrated no radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria.

RESULTS OF THE RADIOLOGICAL SURVEY AT 28 LONG VALLEY ROAD, LODI, NEW JERSEY (LJ047)*

INTRODUCTION

From 1916 to 1956, process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores were generated by the Maywood Chemical Works (MCW), Maywood, New Jersey. During the latter part of this period, MCW supplied rare earth metals and thorium compounds to various government agencies. In the 1940s and 1950s, MCW produced thorium and lithium, under contract, for the Atomic Energy Commission (AEC). These activities ceased in 1956, and, approximately three years later, the 30-acre real estate was purchased by the Stepan Company. The property is located at 100 Hunter Avenue in a highly developed area in Maywood and Rochelle Park, Bergen County, New Jersey.

During the early years of operation, MCW stored wastes and residues in low-lying areas west of the processing facilities. In the early 1930s, these areas were separated from the rest of the property by the construction of New Jersey State Highway 17. The Stepan property, the interim storage facility, and several vicinity properties have been designated for remedial action by the U.S. Department of Energy (DOE).

The waste produced by the thorium extraction process was a sandlike material containing residual amounts of thorium and its decay products, with smaller quantities of uranium and its decay products. During the years 1928 and 1944 to 1946, area residents used these process wastes mixed with tea and cocoa leaves as mulch in their lawns and gardens. In addition, some of the contaminated wastes were apparently eroded from the site into Lodi Brook and carried downstream.

Lodi Brook is a small stream flowing south from Maywood with its headwaters near the Stepan waste storage site. Approximately 150 ft after passing under State Route 17, the stream has been diverted underground through concrete or steel culverts until it merges with the Saddle River in Lodi, New Jersey. Only a small section near Interstate 80 remains uncovered. From the 1940s to the 1970s when the stream was being diverted underground, its course was altered several times. Some of these changes resulted in the movement of contaminated soil to the surface of a few properties, where it is still in evidence. In other instances, the contaminated soil was covered over or mixed with clean fill, leaving no immediate evidence on the surface. Therefore, properties in question may be

*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division at Oak Ridge National Laboratory under U.S. DOE contract DE-AC05-840R21400.

drilled in search of former streambed material, even in the absence of surface contamination.

As a result of the Energy and Water Appropriations Act of Fiscal Year 1984, the property discussed in this report and properties in its vicinity contaminated with residues from the former MCW were included as a decontamination research and development project under the DOE Formerly Utilized Sites Remedial Action Program. As part of this project, DOE is conducting radiological surveys in the vicinity of the site to identify properties contaminated with residues derived from the MCW. The principal radionuclide of concern is thorium-232. The radiological surveys discussed in this report are part of that effort and were conducted, at the request of DOE, by members of the Measurement Applications and Development Group of the Oak Ridge National Laboratory.

A radiological survey of the private, residential property at 28 Long Valley Road, Lodi, New Jersey, was conducted during 1985, 1986, and 1987. The survey and sampling of the ground surface was carried out on October 23, 1985, and follow-up subsurface investigations were performed on September 14, 1986 and June 12, 1987.

SURVEY METHODS

The radiological survey of the property included: (1) a gamma scan of the entire property outdoors, (2) collection of surface and subsurface soil samples, and (3) gamma profiles of auger holes. No indoor survey measurements were performed.

Using a portable gamma scintillation meter, ranges of measurements were recorded for areas of the property surface. If the gamma exposure rates were elevated, a biased soil sample was taken at the point showing the highest gamma radiation level. Systematic soil samples were taken at various locations on the property, irrespective of gamma radiation levels. These survey methods followed the plan outlined in Reference 1.

To define the extent of possible subsurface soil contamination, the auger holes were drilled to depths of approximately 2.3 m. A plastic pipe was placed in each hole, and a NaI scintillation probe was lowered inside the pipe. The probe was encased in a lead shield with a horizontal row of collimating slits on the side. This collimation allows measurement of gamma radiation intensities resulting from contamination within small fractions of the hole depth. Measurements were usually made at 15- or 30-cm intervals. If the gamma readings in the hole were elevated, a soil sample was scraped from the wall of the auger hole at the point showing the highest gamma radiation level. The auger hole loggings were used to select locations where further soil sampling would be useful. A split-spoon sampler was used to collect subsurface samples at known depths. In some auger holes, a combination of split-spoon sampling and side-wall scraping was used to collect samples. A comprehensive description of the survey methods and instrumentation has been presented in another report.[2]

SURVEY RESULTS

Applicable federal guidelines are summarized in Table 1.[3] The normal background radiation levels for the northern New Jersey area are presented in Table 2.[4,5] These data

are provided for comparison with survey results presented in this section. All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in environmental samples.

Surface Gamma Radiation Levels

Gamma radiation levels measured during a gamma scan of the surface of the property are given in Fig. 1. Gamma exposure rates over the major portion of the property ranged from 5 to 10 μR/h, which is typical of background radiation in open areas of New Jersey. A narrow strip along the foundation of the house measured from 10 to 12 μR/h. An area at the northwestern corner of the house exhibited gamma levels from 11 to 13 μR/h, and a piece of granite on the eastern property line measured from 15 to 26 μR/h. An isolated area of approximately 4 m^2 in the front yard measured 21 μR/h. The western end of the asphalt driveway produced exposure rates from 11 to 21 μR/h. These slight elevations in gamma levels are typical of the naturally occurring radioactive substances present in bricks, concrete, granite, and other such materials used in paving and building construction. Otherwise, none of the readings were elevated, and none of the areas on this property exceed guidelines.

Systematic and Biased Soil Samples

Systematic and biased soil samples were taken from various locations on the property for radionuclide analyses. Locations of the systematic (S) and biased (B) samples are shown in Fig. 2, with results of laboratory analyses provided in Table 3. Concentrations of radionuclides in the systematic samples were all within normal background levels for the northern New Jersey area (Table 2). Radionuclide concentrations for ^{226}Ra, ^{232}Th, and ^{238}U in biased soil samples ranged from 1.2 to 2.1 pCi/g, 3.0 to 13 pCi/g, and 1.5 to 2.6 pCi/g, respectively. The highest concentrations of radionuclides were found at sample location B1, with ^{232}Th values ranging from 6.1 to 13 pCi/g. The peak concentration was from 15 to 30 cm in depth. Based on the gamma surface measurements, the areal extent of the elevated concentrations was less than 4 m^2. The average concentration and volume of residual radioactive material in this location were near or within the general DOE guidelines for soil when averaged over 100 m^2 (Table 1). However, to provide an increased margin of safety for the general public, DOE applies additional guidelines ("hot spot" criteria) for localized spots of residual radioactivity in areas less than 25 m^2. These criteria require that radionuclide concentrations in localized spots of this size (<4 m^2) be less than 15 pCi/g in the surface layer (0 to 15 cm) and less than 45 pCi/g for each 15-cm layer below the surface layer.[3] Radionuclide conditions at this property were in compliance with the general guidelines and the "hot spot" criteria shown in Table 1. Samples collected from location B2 showed concentrations of ^{226}Ra and ^{232}Th above background levels but below guidelines (Table 1).

Auger Hole Soil Samples and Gamma Logging

Varying thicknesses of subsurface soil were sampled from depths of 0 to 185 cm in auger (A) holes which were drilled at 6 separate locations indicated in Fig. 2. The results of analyses of these samples are given in Table 3. Concentrations of ^{226}Ra and ^{232}Th in

soil samples from all auger holes ranged from 0.61 to 2.0 pCi/g and 0.74 to 3.0 pCi/g, respectively; all values were well below DOE criteria (Table 1).

Gamma logging was performed in each of the 6 auger holes to characterize and further define the extent of possible contamination. The logging technique used here is not radionuclide specific. However, logging data, in conjunction with soil analyses data, may be used to estimate regions of elevated radionuclide concentrations in auger holes when compared with background levels for the area. Following a comparison of these data, it appears that any shielded scintillator readings of 1000 cpm or greater generally indicate the presence of elevated concentrations of ^{226}Ra and/or ^{232}Th. Data from the gamma profiles of the logged auger holes are graphically represented in Fig. 3 through Fig. 8.

Auger samples A4 were taken from the same location as B1. Readings from auger hole 4 ranged from 801 to 1997 cpm, with the maximum reading at 0.2 m. The gamma levels in all other logged holes were below 1000 cpm.

SIGNIFICANCE OF FINDINGS

While some radiological measurements taken at 28 Long Valley Road were greater than background levels typically encountered in the northern New Jersey area, radiation levels and radionuclide concentrations do not exceed the applicable general federal guidelines or the "hot spot" criteria (Table 1).

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3. 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).

4. U.S. Department of Energy, *Radiological Survey of the Middlesex Municipal Landfill, Middlesex, New Jersey*, DOE/EV-00005/20 (April 1980).

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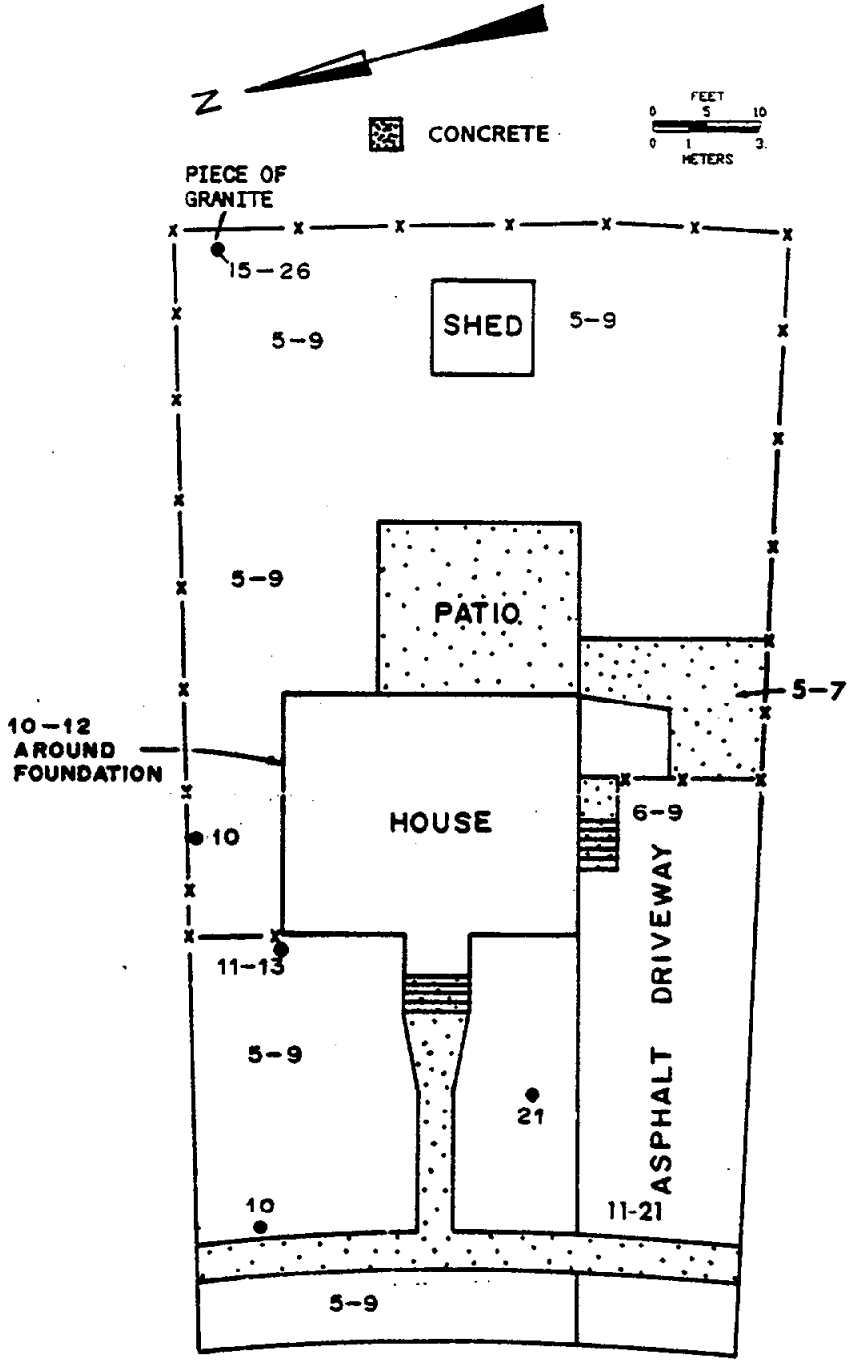

Fig. 1. Gamma radiation levels (μR/h) measured on the surface at 28 Long Valley Road, Lodi, New Jersey (LJ047).

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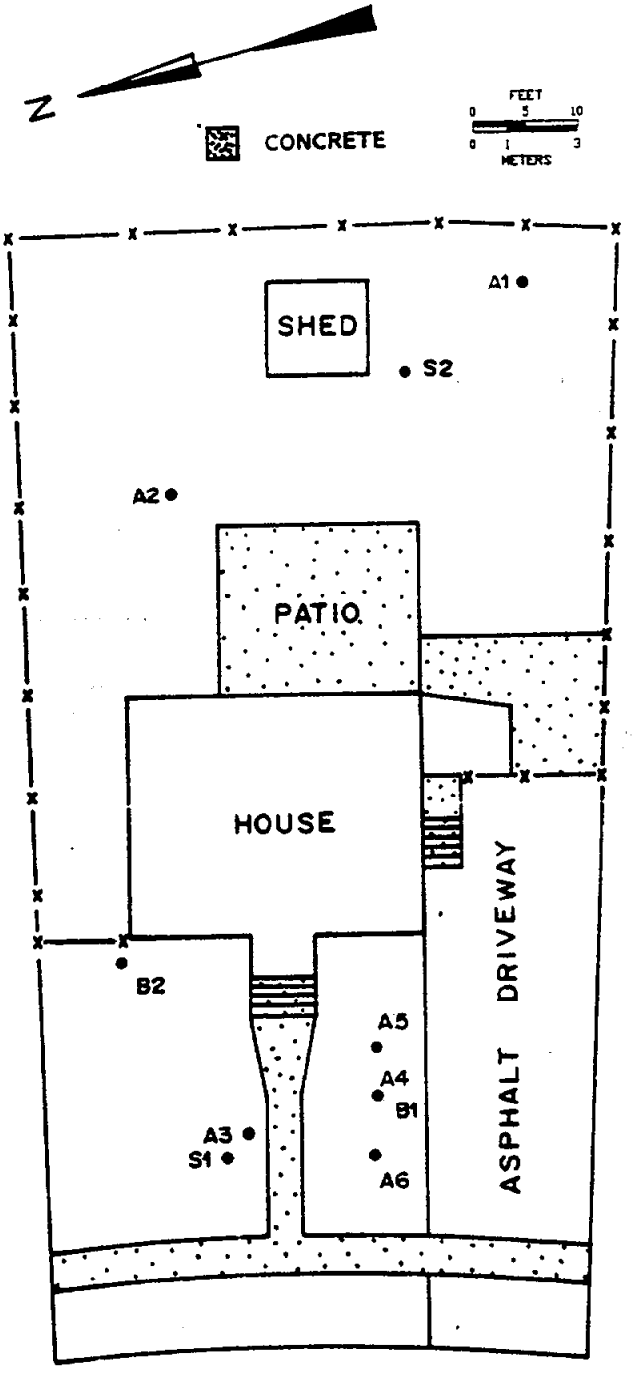

Fig. 2. Diagram showing locations of soil samples taken at 28 Long Valley Road, Lodi, New Jersey (LJ047).

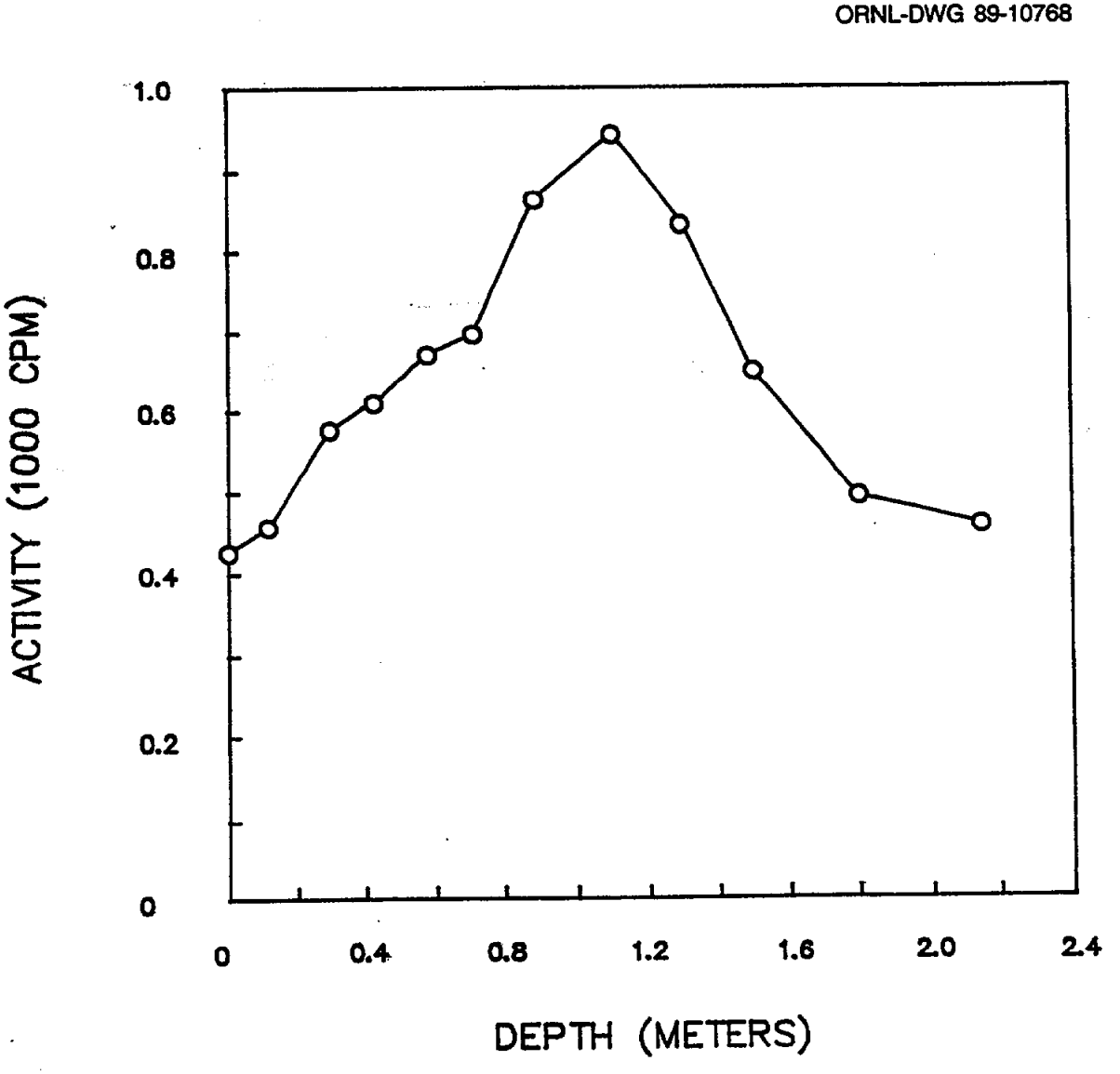

Fig. 3. Gamma profile for auger hole 1 (LJ047A1) at 28 Long Valley Road, Lodi, New Jersey.

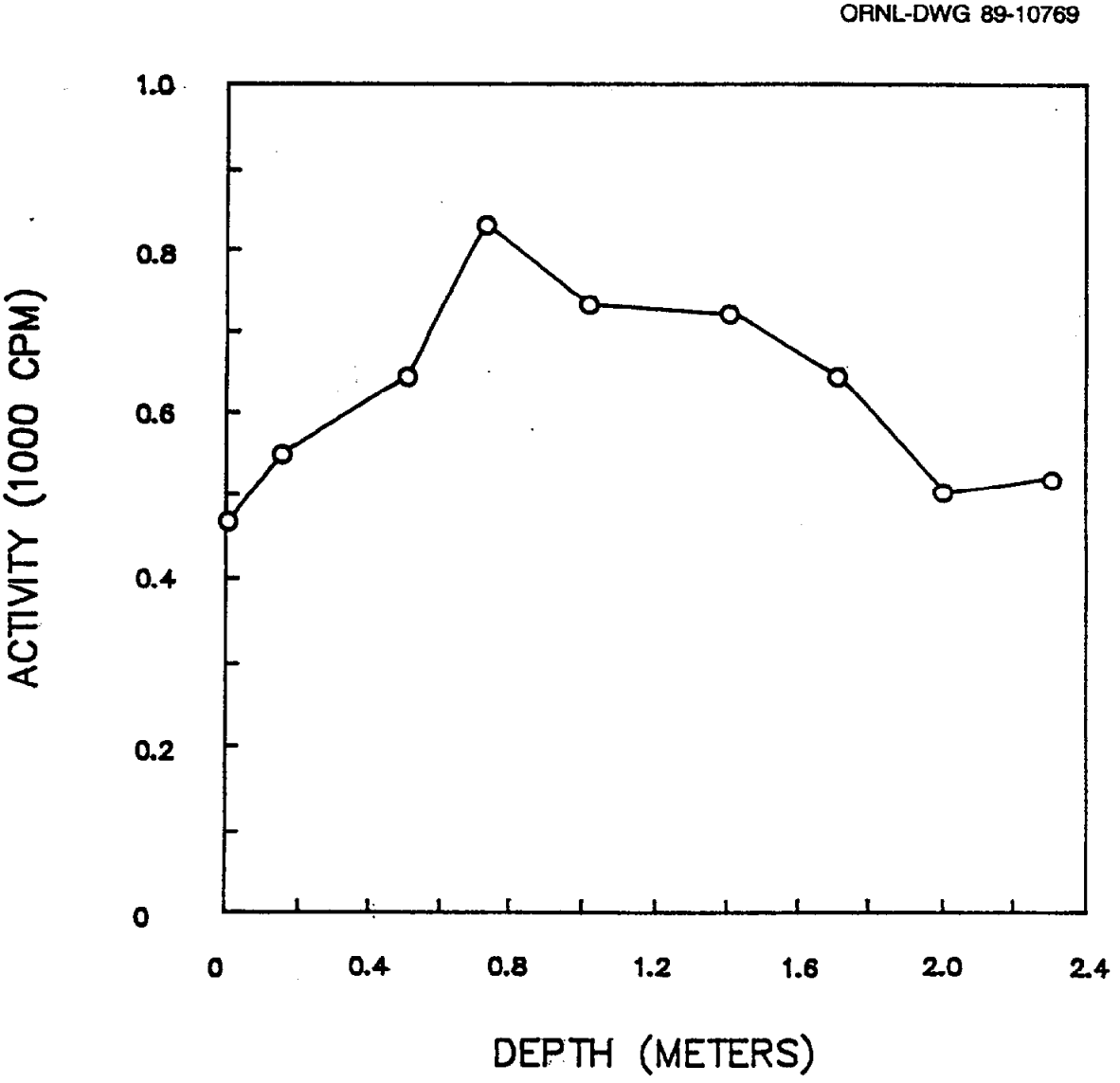

Fig. 4. Gamma profile for auger hole 2 (LJ047A2) at 28 Long Valley Road, Lodi, New Jersey.

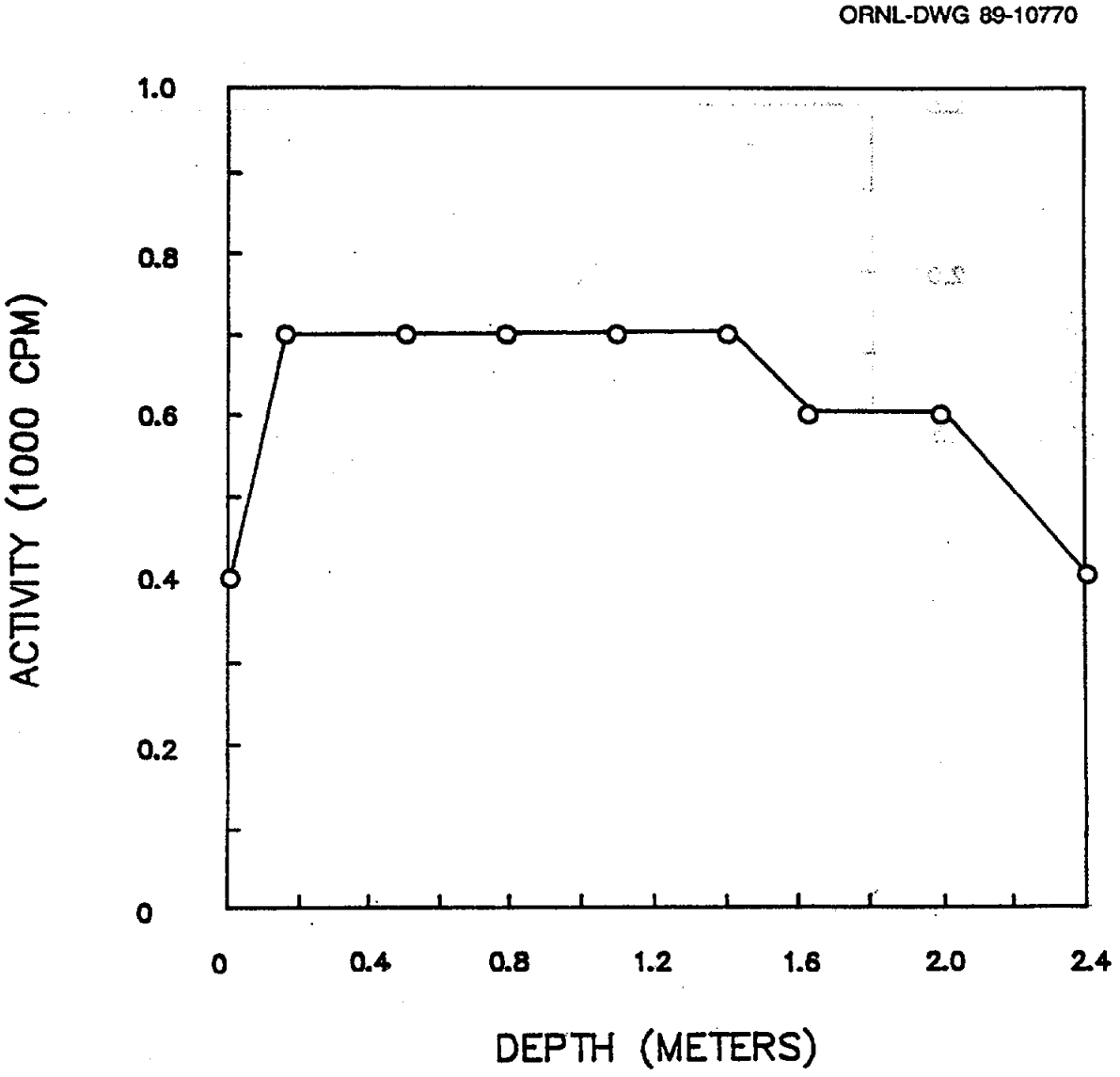

Fig. 5. Gamma profile for auger hole 3 (LJ047A3) at 28 Long Valley Road, Lodi, New Jersey.

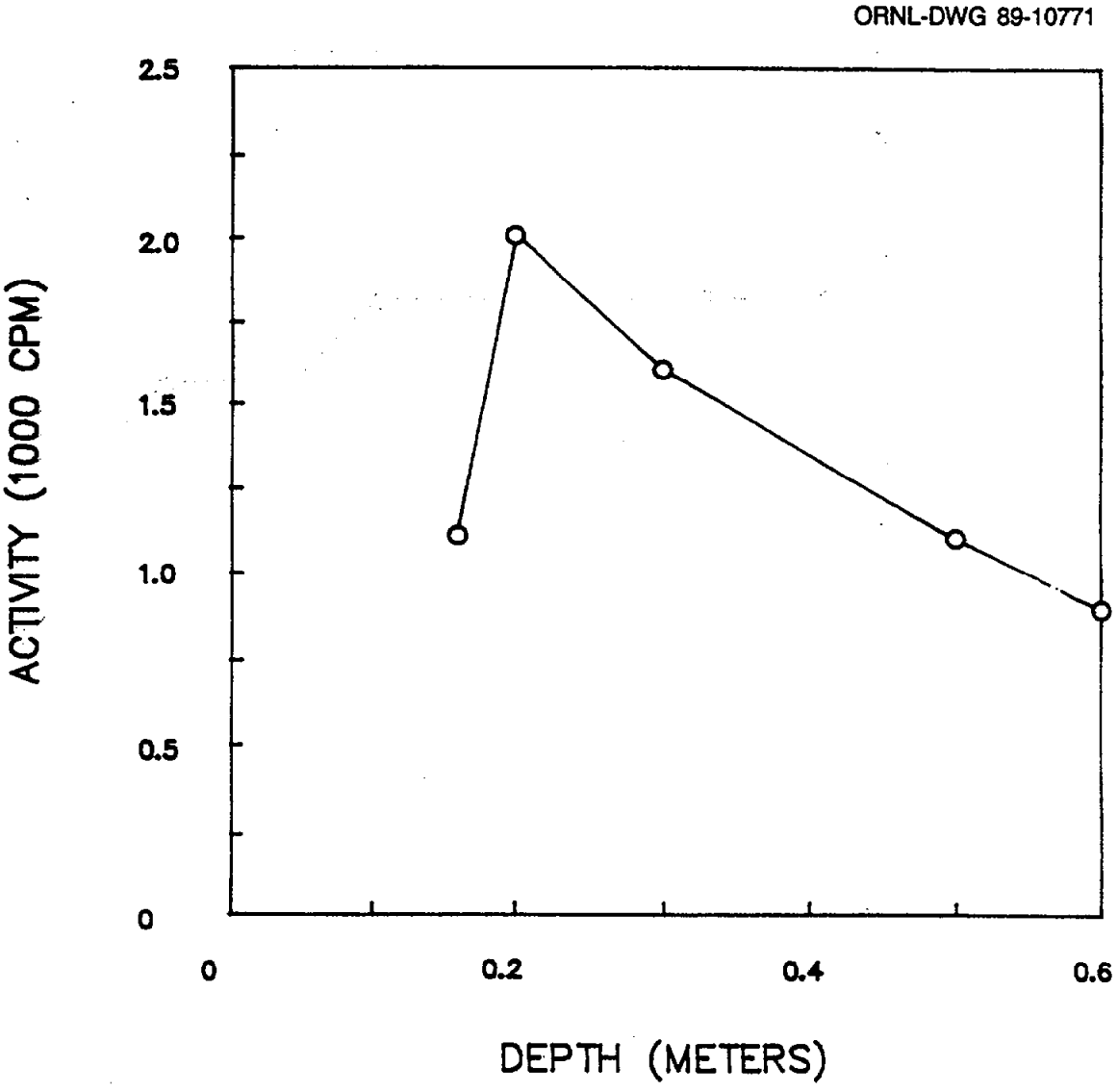

Fig. 6. Gamma profile for auger hole 4 (LJ047A4) at 28 Long Valley Road, Lodi, New Jersey.

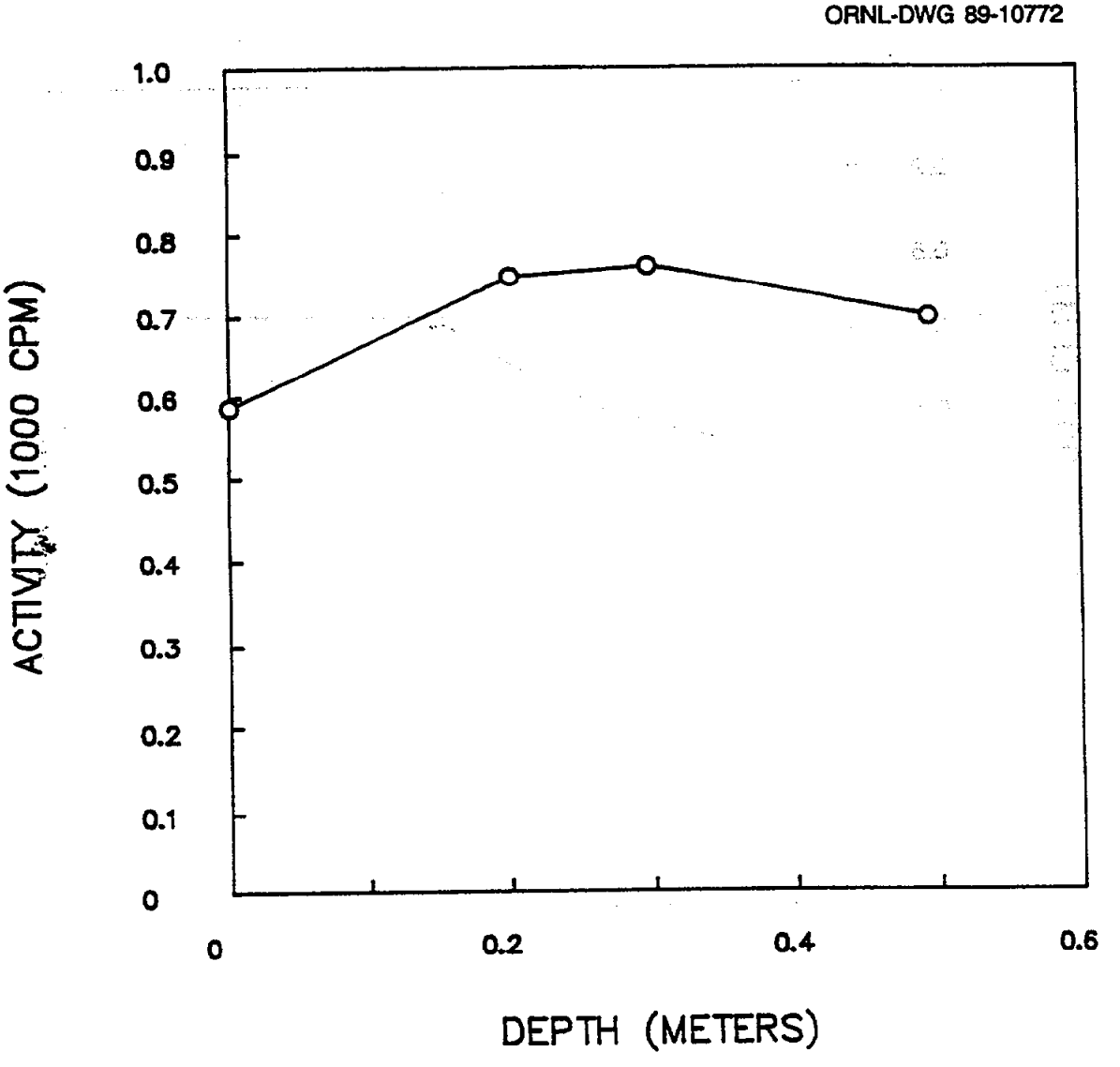

Fig. 7. Gamma profile for auger hole 5 (LJ047A5) at 28 Long Valley Road, Lodi, New Jersey.

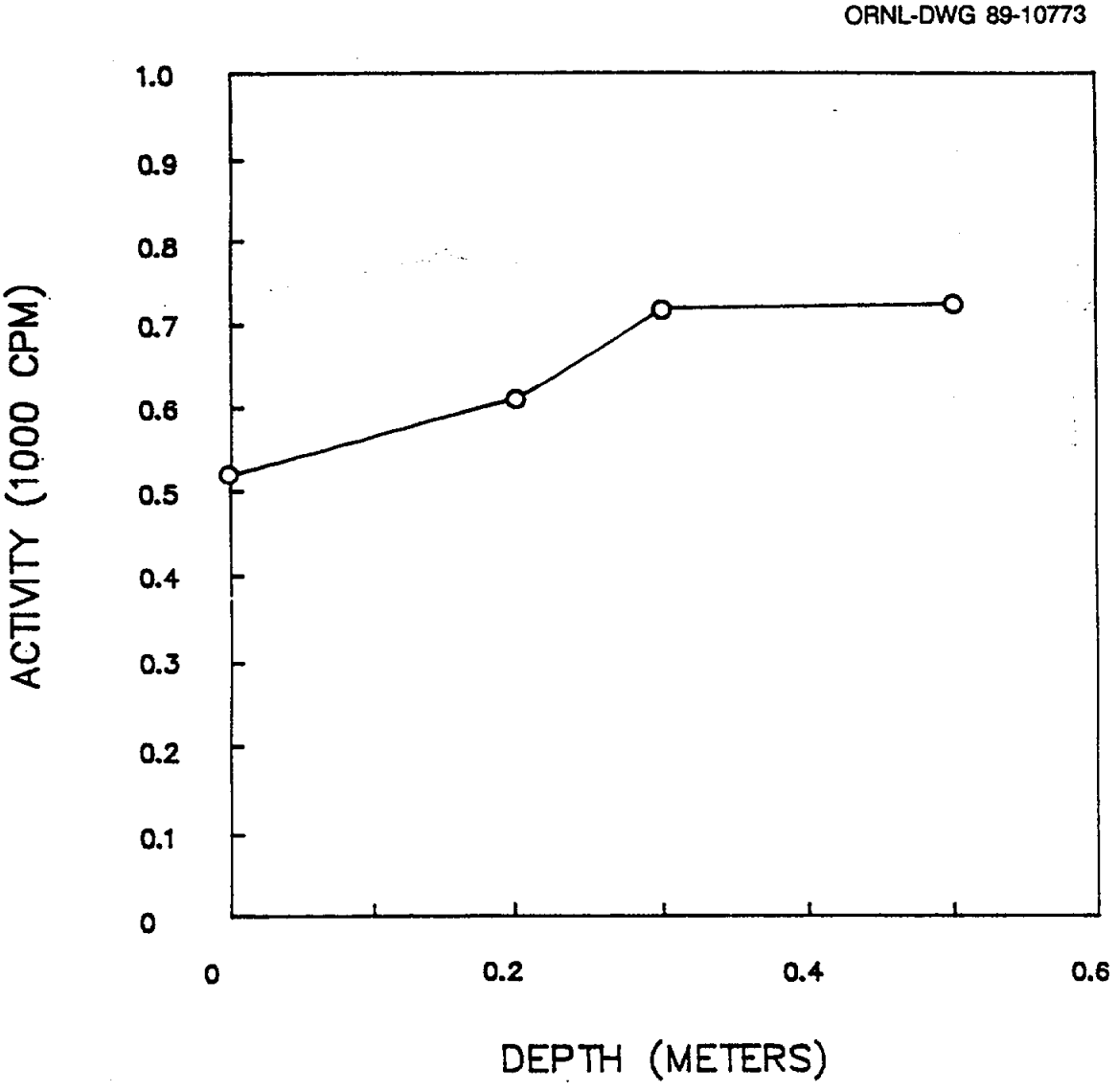

Fig. 8. Gamma profile for auger hole 6 (LJ047A6) at 28 Long Valley Road, Lodi, New Jersey.

Table 1. Applicable guidelines for protection against radiation[a]

Mode of exposure	Exposure conditions	Guideline value
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels averaged over 100 m^2 area ^{232}Th ^{230}Th ^{228}Ra ^{226}Ra	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
Guidelines for nonhomogeneous contamination (used in addition to the 100 m^2 guideline)[b]	Applicable to locations meeting the above criterion but ≤25 m^2 with significantly elevated concentrations of radionuclides	Concentration limits for application to "hot spots" varying in size as follows: (m^2) / (pCi/g)[c] <1 / 50 1-<3 / 30 3-<10 / 15 10-25 / 10

[a]Reference 3.

[b]"Every reasonable effort shall be made to identify and remove any source which has a concentration exceeding 30 times the guideline value, irrespective of area;" see Reference 3.

[c]These guideline values are applicable to surface concentrations of ^{232}Th, ^{230}Th, ^{228}Ra, and ^{226}Ra only; for other radionuclides and subsurface values, see Reference 3.

Table 2. Background radiation levels for the northern New Jersey area

Type of radiation measurement or sample	Radiation level or radionuclide concentration[a]
Gamma exposure at 1 m above ground surface (μR/h)	8[b]
Concentration of radionuclides in soil (pCi/g)	
^{226}Ra	0.9[c]
^{232}Th	0.9[c]
^{238}U	0.9[c]

[a]These values represent an average of normal radionuclide concentrations in this part of the state. Actual values may fluctuate.

[b]Reference 4.

[c]Reference 5.

Table 3. Concentrations of radionuclides in soil at 28 Long Valley Road, Lodi, New Jersey (LJ047)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)		
		^{226}Ra[b]	^{232}Th[b]	^{238}U[c]
		Systematic samples[d]		
S1	0-15	0.74 ± 0.2	0.85 ± 0.5	0.77
S2	0-15	0.60 ± 0.1	0.85 ± 0.3	0.75
		Biased samples[e]		
B1A[f]	0-15	1.2 ± 0.2	6.1 ± 2	1.5
B1B	15-30	2.1 ± 0.2	13 ± 1	2.4
B1C	30-45	1.7 ± 0.2	8.6 ± 0.6	1.7
B2A	0-15	1.3 ± 0.2	3.0 ± 1	2.3
B2B	15-30	1.5 ± 0.08	3.5 ± 0.6	2.6
B2C	30-45	1.5 ± 0.1	3.3 ± 0.2	2.6
		Auger samples[g]		
A1A	60-90	1.8 ± 0.06	2.5 ± 0.4	[h]
A1B	90-120	0.75 ± 0.05	0.94 ± 0.2	[h]
A1C	120-150	2.0 ± 0.08	1.1 ± 0.3	[h]
A1D	150-185	0.78 ± 0.05	0.74 ± 0.2	[h]
A2A	30-60	0.61 ± 0.04	0.90 ± 0.2	[h]
A2B	60-90	1.1 ± 0.07	2.5 ± 0.2	[h]
A3A	60-90	0.73 ± 0.04	0.95 ± 0.2	[h]
A3B	120-150	0.82 ± 0.04	1.0 ± 0.1	[h]
A3C	150-185	1.4 ± 0.1	0.74 ± 0.09	[h]
A4[f]	45-60	0.96 ± 0.06	3.0 ± 0.02	[h]
A5A	0-15	0.76 ± 0.07	1.7 ± 0.2	[h]
A5B	15-30	0.65 ± 0.1	1.1 ± 0.06	[h]
A5C	30-45	0.67 ± 0.09	1.1 ± 0.08	[h]
A6A	0-15	0.70 ± 0.04	0.92 ± 0.2	[h]
A6B	15-30	0.68 ± 0.2	1.1 ± 0.3	[h]
A6C	30-45	0.76 ± 0.05	1.2 ± 0.03	[h]

[a]Locations of soil samples are shown on Fig. 2.

[b]Indicated counting error is at the 95% confidence level ($\pm 2\sigma$).

[c]Total analytical error of measurement results is less than ±5% (95% confidence level).

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

[e]Biased samples are taken from areas shown to have elevated gamma exposure rates.

[f]Biased samples B1 and auger sample A4 were taken from the same location.

[g]Auger samples are taken from holes drilled to further define the depth and extent of radioactive material. Holes may be drilled in either contaminated or uncontaminated regions.

[h]Sample was not analyzed for ^{238}U.

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