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RESULTS OF THE RADIOLOGICAL SURVEY AT 4 BRANCA COURT LODI, NEW JERSEY (LJ037)

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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, 4 Branca Court, Lodi, New Jersey (LJ037), was conducted during 1985 and 1986.

Results of the survey demonstrated no radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. However, this property is apparently located directly over the old Lodi Brook streambed. This factor in combination with the elevated gamma logs of several auger holes is sufficient to recommend this site for inclusion in the DOE remedial action program.

RESULTS OF THE RADIOLOGICAL SURVEY AT 4 BRANCA COURT, LODI, NEW JERSEY (LJ037)*

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 drilled in search of former stream bed 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

*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 DOE contract DE-AC05-84OR21400.

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 4 Branca Court, Lodi, New Jersey, was conducted by ORNL during 1985 and 1986. The survey and sampling of the ground surface were carried out on October 21, 1985, and the follow-up subsurface investigation was performed on September 11, 1986.

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. 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 ORNL protocol included the drilling of auger holes to depths of approximately 2.4 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] 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. The reported results are augmented by hole logging

data obtained during a separate, independent investigation of the property by Bechtel National Incorporated (BNI) on November 6, 1986. BNI equipment and procedures differ from those of ORNL; therefore, count rates are not directly comparable. BNI survey methods and instrumentation are outlined in Reference 5.

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. The highest gamma levels were from the bricks on the front of the house and the front steps, ranging from 11 to 17 μR/h. The yard on either side of the house measured 7 to 10 μR/h.

Systematic Soil Samples

Systematic soil samples were taken from various locations on the property for radionuclide analyses. Locations of the samples (S) are shown in Fig. 2, with results of laboratory analyses provided in Table 3. Concentrations of radium, thorium, and uranium in the samples ranged from 0.63 to 0.94 pCi/g, 0.69 to 1.1 pCi/g, and 0.80 to 1.1 pCi/g, respectively. All samples were below DOE guidelines (Table 1).

Auger Hole Soil Samples and Gamma Logging

Varying thicknesses of subsurface soil were sampled from depths of 0 to 225 cm in auger holes (A) drilled at eight separate locations indicated in Fig. 2. The results of analyses of the ORNL samples (A1A-A3C) are given in Table 3. Concentrations of ^{226}Ra and ^{232}Th in soil samples ranged from 0.60 to 1.1 pCi/g and 0.78 to 2.3 pCi/g, respectively. All samples were below DOE criteria (Table 1).

Gamma logging was performed by ORNL in each of the three 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 counts per minute (cpm) or greater generally indicate the presence of elevated concentrations of ^{226}Ra and/or ^{232}Th. Data from the gamma profiles of these logged auger holes are graphically represented in Figs. 3 through 5. Readings in auger hole 1 were elevated from 1.4 to 1.5 m, with a maximum of 1416 cpm at 1.4 m. All readings in hole 2 were below 1000 cpm. In hole 3, elevated readings existed from 1.2 to 1.7 m, with a maximum of 2192 cpm at 1.5 m.

Locations of the five auger holes [A(BNI)] drilled by BNI are indicated in Fig. 2. Gamma logging was conducted in this case with a partially shielded scintillation probe rather than with the shielded instrument used by ORNL. Results of these logged holes are given in Table 4. According to BNI, a value greater than 40,000 cpm using their system usually indicates that the DOE criterion of 15 pCi/g

for ^{226}Ra and/or ^{232}Th has been exceeded.[5] Hole A(BNI)7 had gamma levels indicating significant contamination with a maximum measurement of 153,000 cpm at 2.3 m. No measurements above 32,000 cpm were observed in holes 4, 5, 6, and 8.

SIGNIFICANCE OF FINDINGS

Measurements taken at 4 Branca Court indicate that the property contained no radionuclide concentrations in excess of DOE criteria. The apparent location of this property directly over the old Lodi Brook streambed must be considered along with the elevated gamma logs of several auger holes found by both ORNL and BNI. The combination of all these factors is sufficient to recommend this site for inclusion in the DOE remedial action program.

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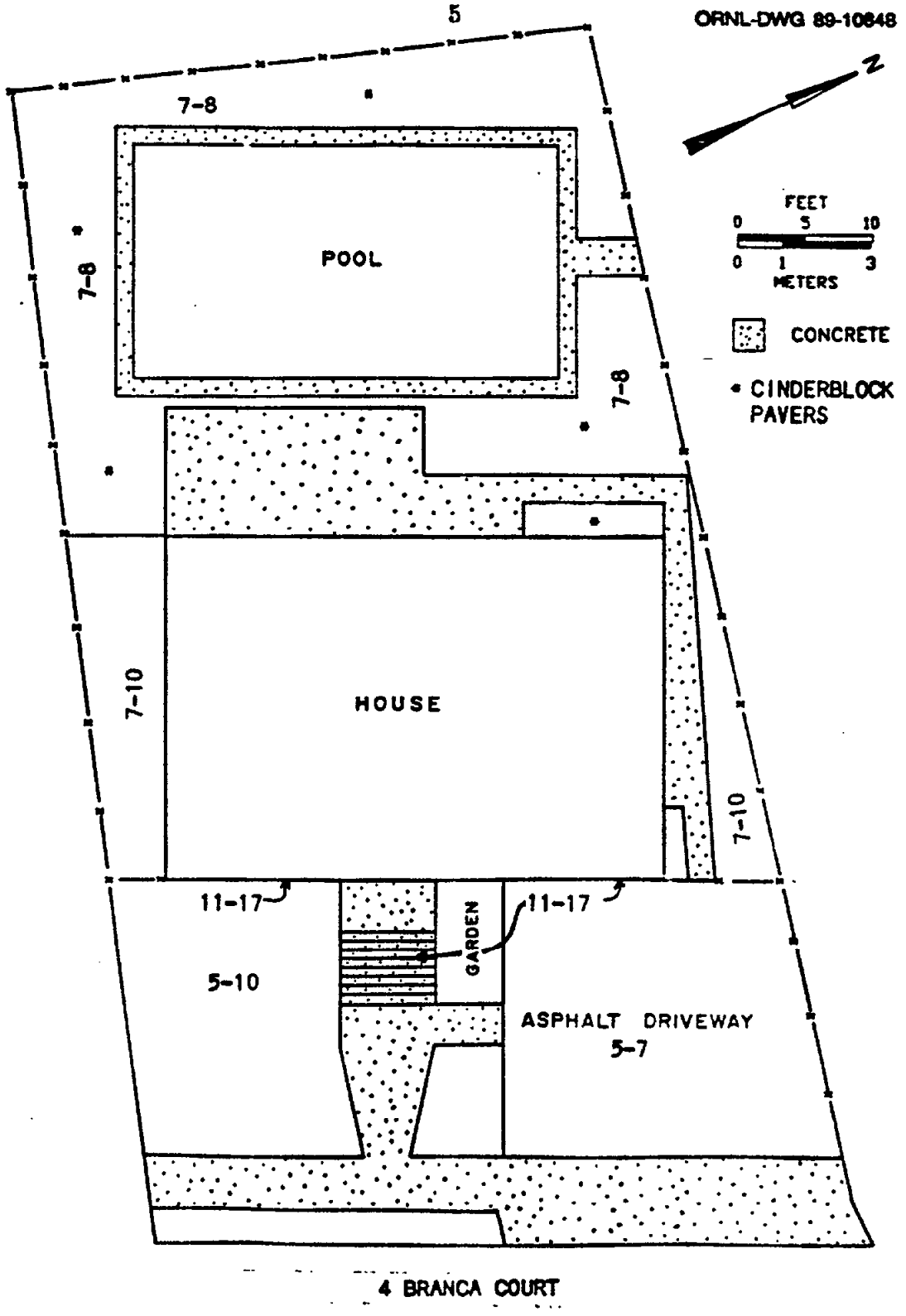

Fig. 1. Gamma radiation levels (μR/h) measured on the surface at 4 Branca Court, Lodi, New Jersey (LJ037).

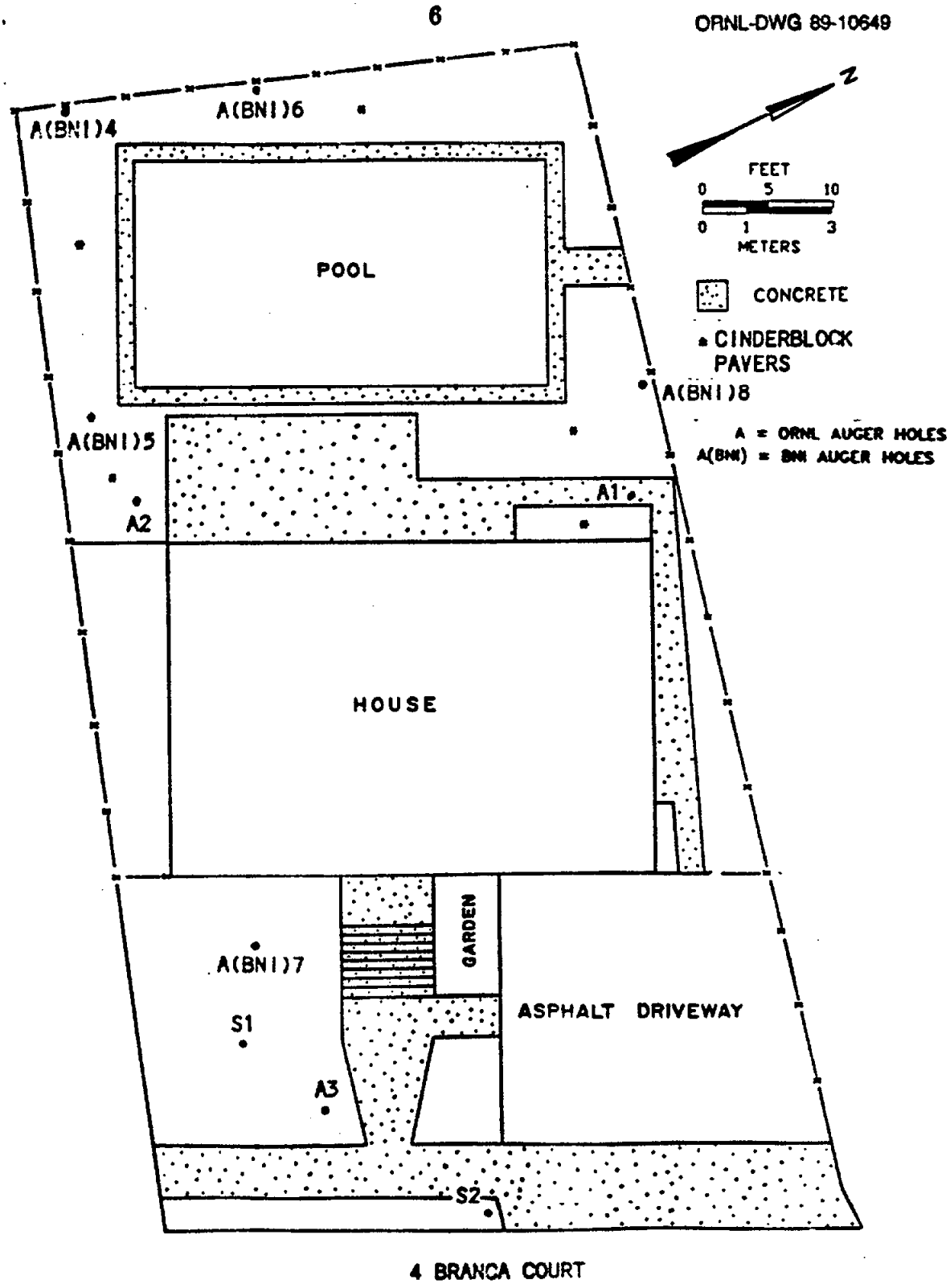

Fig. 2. Diagram showing locations of soil samples taken at 4 Branca Court, Lodi, New Jersey (LJ037).

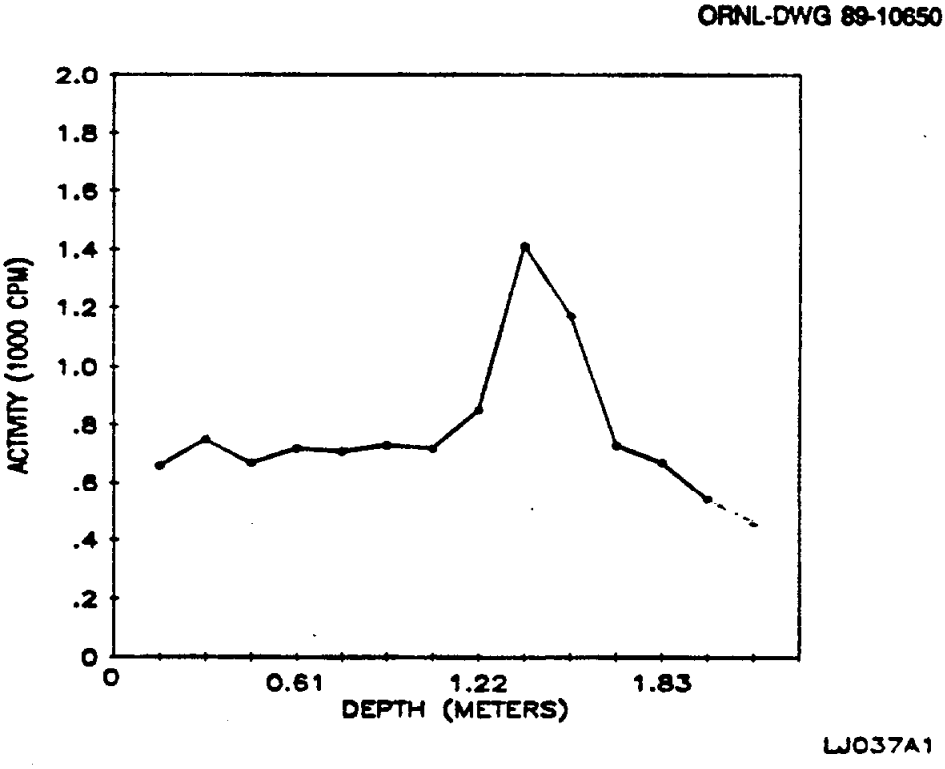

Fig. 3. Gamma profile for auger hole 1 (LJ037A1) at 4 Branca Court, Lodi, New Jersey.

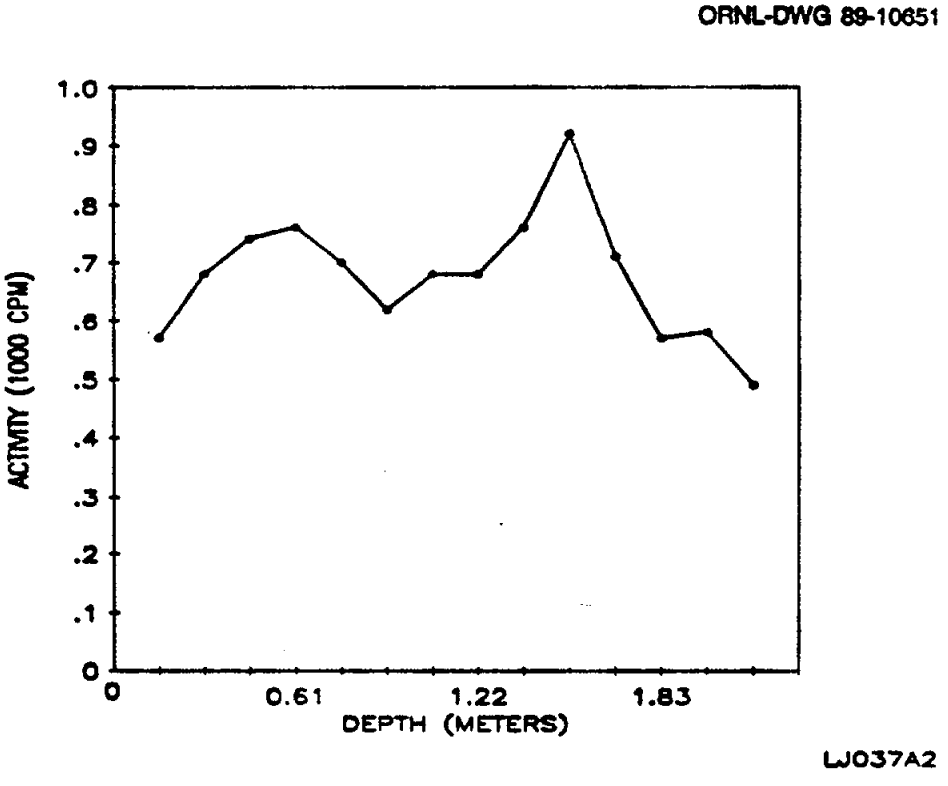

Fig. 4. Gamma profile for auger hole 2 (LJ037A2) at 4 Branca Court, Lodi, New Jersey.

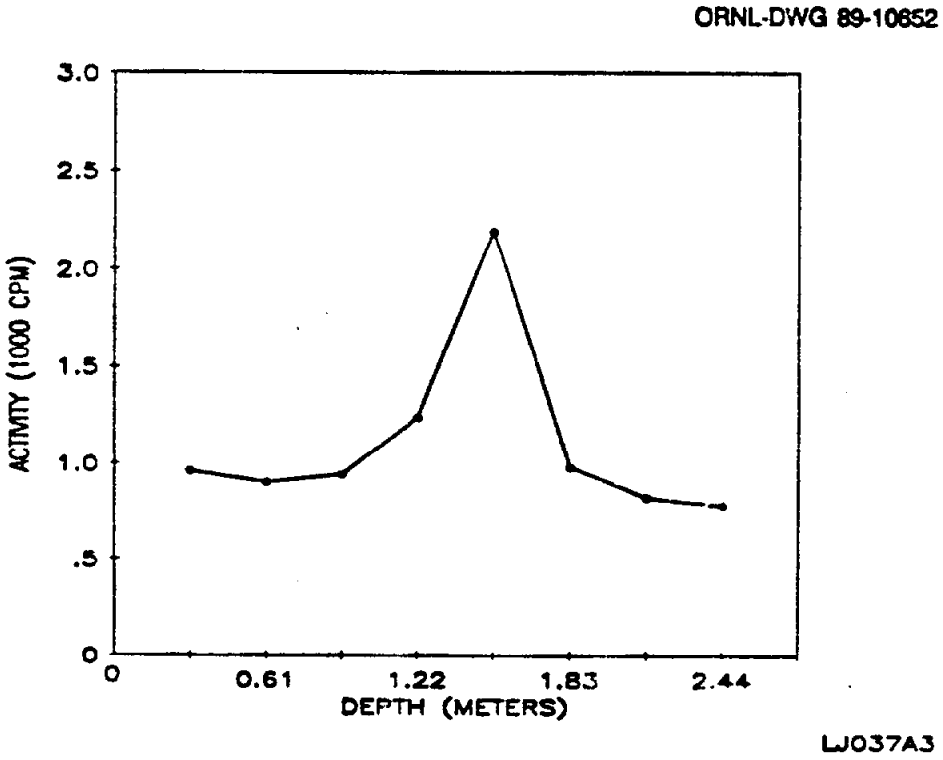

Fig. 5. Gamma profile for auger hole 3 (LJ037A3) at 4 Branca Court, Lodi, New Jersey.

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

[a]Reference 3.

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

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Concentration of radionuclides in soil (pCi/g)	
^{232}Th	0.9[a]
^{238}U	0.9[a]
^{226}Ra	0.9[a]

[a]Reference 4.

Table 3. Concentrations of radionuclides in soil at 4 Branca Court, Lodi, New Jersey (LJ037)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)		
		^{226}Ra[b]	^{232}Th[b]	^{238}U[c]
		Systematic samples[d]		
S1	0–15	0.68 ± 0.1	0.82 ± 0.5	0.93
S2A	0–15	0.63 ± 0.1	0.69 ± 0.4	0.80
S2B	15–30	0.94 ± 0.06	1.1 ± 0.2	1.1
		Auger samples[e]		
A1A	30–60	0.71 ± 0.09	0.84 ± 0.2	*f*
A1B	60–90	0.60 ± 0.05	0.84 ± 0.1	*f*
A1C	90–120	0.76 ± 0.04	0.82 ± 0.05	*f*
A1D	120–150	0.90 ± 0.06	2.3 ± 0.09	*f*
A1E	150–185	1.1 ± 0.06	2.2 ± 0.3	*f*
A2A	30–60	0.81 ± 0.07	0.97 ± 0.3	*f*
A2B	120–150	0.77 ± 0.05	0.91 ± 0.05	*f*
A2C	150–165	0.74 ± 0.04	1.4 ± 0.2	*f*
A3A	135–185	0.63 ± 0.1	0.78 ± 0.2	*f*
A3B	185–215	0.69 ± 0.03	0.88 ± 0.2	*f*
A3C	215–225	0.76 ± 0.03	0.91 ± 0.2	*f*

[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 rates.

[e]Auger samples are taken from holes drilled to further define the depth and extent of radioactive material. Holes are drilled where the surface may or may not be contaminated.

[f]ORNL auger samples were not analyzed for ^{238}U.

Table 4. BNI scintillation probe loggings for selected auger holes at 4 Branca Court, Lodi, New Jersey (LJ037)

Hole number[a]	Depth (m)	Count rate (cpm)	Hole number[a]	Depth (m)	Count rate (cpm)
A(BNI)4	0.0	7,000	A(BNI)6	0.0	6,000
	0.15	8,000		0.15	8,000
	0.3	11,000		0.3	10,000
	0.5	11,000		0.5	12,000
	0.6	12,000		0.6	11,000
	0.8	12,000		0.8	11,000
	0.9	12,000		0.9	12,000
	1.1	11,000		1.1	12,000
	1.2	16,000		1.2	12,000
	1.4	21,000		1.4	15,000
	1.5	18,000		1.5	19,000
	1.7	12,000		1.7	18,000
	1.8	9,000		1.8	12,000
	2.0	8,000		2.0	9,000
	2.1	8,000		2.1	10,000
				2.3	10,000
				2.4	9,000
A(BNI)5	0.0	7,000	A(BNI)7	0.0	17,000
	0.15	7,000		0.15	17,000
	0.3	10,000		0.3	19,000
	0.5	12,000		0.5	18,000
	0.6	13,000		0.6	18,000
	0.8	12,000		0.8	18,000
	0.9	13,000		0.9	19,000
	1.1	13,000		1.1	19,000
	1.2	14,000		1.2	20,000
	1.4	13,000		1.4	25,000
	1.5	14,000		1.5	27,000
	1.7	22,000		1.7	32,000
	1.8	32,000		1.8	51,000
	2.0	30,000		2.0	134,000
	2.1	23,000		2.1	135,000
	2.3	19,000		2.3	153,000
	2.4	12,000		2.4	130,000
				2.6	55,000

Table 4 (continued)

Hole number[a]	Depth (m)	Count rate (cpm)	Hole number[a]	Depth (m)	Count rate (cpm)
A(BNI)8	0.0	10,000		1.2	18,000
	0.15	11,000		1.4	25,000
	0.3	15,000		1.5	28,000
	0.5	16,000		1.7	22,000
	0.6	17,000		1.8	17,000
	0.8	17,000		2.0	15,000
	0.9	16,000		2.1	10,000
	1.1	16,000		2.3	9,000

[a]Locations of holes are shown on Fig. 1.

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