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RESULTS OF THE RADIOLOGICAL SURVEY AT 8 HANCOCK STREET (LJ026), LODI, NEW JERSEY

R. D. Foley
R. F. Carrier
L. M. Floyd
J. W. Crutcher

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HEALTH AND SAFETY RESEARCH DIVISION

Nuclear and Chemical Waste Programs
(Activity No. AH 10 05 00 0; ONLWCO1)

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R. D. Foley, R. F. Carrier, L. M. Floyd, and J. W. Crutcher

Date of Issue – March 1989

Investigation Team

R. E. Swaja – Measurement Applications and Development Manager
W. D. Cottrell – FUSRAP Project Director
R. W. Doane* – Field Survey Supervisor

*Former employee of Martin Marietta Energy Systems, Inc.

Survey Team Members

A. C. Butler	C. A. Johnson
K. S. Dickerson	C. A. Muhr
B. S. Ellis	E. M. Pilz
D. S. Foster	W. H. Shinpaugh†
D. W. Greene	W. Winton

†Stone Associates

Work performed by the
MEASUREMENT APPLICATIONS AND DEVELOPMENT GROUP

Prepared by the
OAK RIDGE NATIONAL LABORATORY
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RESULTS OF THE RADIOLOGICAL SURVEY AT 8 HANCOCK STREET (LJ026), LODI, NEW JERSEY*

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 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 for 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

*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.

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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 survey discussed in this report is part of that effort and was conducted, at the request of DOE, by members of the Measurement Applications and Development group of the Oak Ridge National Laboratory (ORNL).

A radiological survey of the private, residential property at 8 Hancock Street, Lodi, New Jersey, was conducted during 1985 and 1986. Preliminary results were obtained on October 16, 1985; the survey and sampling of the ground surface, as well as the subsurface investigation, were carried out September 13–18, 1986. 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.

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 then obtained at randomly selected locations irrespective of gamma exposure rates. In addition, biased soil samples were collected in areas of elevated gamma levels. 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. 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. These survey methods followed the plan outlined in Reference 1. A comprehensive description of the survey methods and instrumentation has been presented in another report.[2]

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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. 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 8 to 15 μR/h. The area indicated by shading on the drawing (at the rear of the house near the deck) represents a region of elevated gamma levels which ranged from 32 to 40 μR/h. The area was approximately 3 m^2.

Systematic and Biased Soil Samples

Two systematic (S) and two biased (B) samples were taken from three different locations on the property for radionuclide analyses. The systematic samples were removed from a depth of 0–15 cm at two locations while the two biased samples were from different depths of the same hole. Locations of the samples are shown in Fig. 2 with results of laboratory analyses provided in Table 3. Concentrations of radium and thorium in the systematic samples were 0.56 and 0.68 pCi/g, and 0.67 and 0.76 pCi/g, respectively. Uranium-238 concentrations were 0.74 and 0.76 pCi/g. In the biased samples, ^{226}Ra and ^{232}Th values were 51 and 66 pCi/g, and 1.1 and 1.3 pCi/g, respectively, with ^{238}U concentrations of 0.84 and 1.1 pCi/g. All radionuclide concentrations in systematic samples are below background for the northern New Jersey area (Table 2). In biased samples, ^{232}Th and ^{238}U concentrations approximate background. However, ^{226}Ra values of 66 pCi/g in surface soil, and 51 pCi/g in subsurface soil (samples B1A and B1B, respectively) exceed both the applicable DOE criteria.

Auger Hole Soil Samples and Gamma Logging

Varying thicknesses of subsurface soil were sampled from depths of 0 to 195 cm in auger holes (A) drilled at five separate locations indicated in Fig. 1. The results of analyses of these samples are given in Table 3 (A1A-A5C). Concentrations of ^{226}Ra and ^{232}Th in soil samples from the auger holes ranged from 0.95 to 3.1 pCi/g and 1.4 to 10 pCi/g, respectively. Radionuclide concentrations exceed background levels, indicating contamination from both ^{226}Ra and ^{232}Th, but are below the DOE criterion for subsurface soil (Table 1).

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Gamma logging was performed by ORNL in each of the five 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 1,000 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 the logged auger holes are graphically represented in Figs. 3 through 7. All but one reading measured 1,000 cpm or more. Measurements between depths of 0.61 and 1.7 m exceeded 1,000 cpm in hole 1 with a maximum of 1,600 cpm at 1.2 m. Readings at depths between 0.3 and 2.1 m were greater than 1,000 cpm in auger hole 2, with a maximum reading of 6,900 cpm at 1.8 m. Readings in auger hole 3 were elevated from the surface to the greatest depth at which measurements were performed (2.4 m), with a maximum of 2,000 cpm at 2 m. In hole 4, gamma levels were elevated from 0.30 to 2.3 m; the maximum number of cpm was 4,000. Finally, the maximum measurement in hole 5 was at the surface (1,900 cpm) with elevated readings at each depth down to 1.4 m. The areas of highest gamma readings generally correspond to the greatest concentrations of radionuclides shown in Table 3.

Nine auger holes [A(BNI)] were drilled by BNI in the locations 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. According to BNI,[4] 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. Gamma logging results for holes A(BNI)6 through A(BNI)14 are given in Table 4. Holes A(BNI)8, A(BNI)11, A(BNI)13, and A(BNI)14 had gamma levels indicating significant contamination with maximum measurements of 210,000, 41,000, 150,000, and 120,000 cpm, respectively. Three of these readings were obtained at a depth of 230 cm. The maximum gamma level in hole A(BNI)8 was at 240 cm. No measurements above 14,000 cpm were observed in holes 6 and 10. The highest reading observed in hole 7 was 30,000 cpm at 180 cm. The maximum gamma levels in holes 9 and 12 were 39,000 cpm at a depth of 230 cm, and 22,000 cpm at 180 cm, respectively.

SIGNIFICANCE OF FINDINGS

Measurements taken at 8 Hancock Street indicate that the property contained radioactive contamination from both the ^{232}Th and ^{238}U decay chains, with the major contaminant from the ^{238}U decay chain being ^{226}Ra. Although it was not found in concentrations exceeding DOE criteria, ^{232}Th is the primary contaminant in some soil samples and is typically the dominant radionuclide from the type of wastes and residues originating from the processing operations at the MCW. The soil samples in which ^{226}Ra is the primary contaminant, however, are atypical of the material generated at the Maywood site. The two biased soil samples had high radium to thorium ratios, which is the reverse of the usual ratio in material from the MCW site. However, the high thorium to radium ratios found for several of the auger hole samples are consistant with the usual findings from the Maywood site. The considerable diversity in radium to thorium ratios in soil samples from this property suggests that the contamination may have originated from more than one source.

The concentration and extent of ^{226}Ra at this location are in excess of the applicable DOE criteria. Furthermore, elevated gamma logs of the five ORNL auger holes and of four unsampled BNI holes (A(BNI)8, A(BNI)11, A(BNI)13, and A(BNI)14) also indicate radionuclide concentrations in excess of subsurface criteria. These findings, combined with the location of the property (directly over the Lodi Brook streambed and adjacent to several other properties already designated) would dictate that this site be considered for inclusion in the DOE remedial action program.

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4. N. C. Ring and S. K. Livesay, *Characterization Report for New Jersey Vehicle Inspection Station Property, Lodi, New Jersey*, Bechtel National Incorporated, DOE/OR/20722 (June 1987).
5. T. E. Myrick and B. A. Berven, *State Background Radiation Levels: Results of Measurements Taken During 1975- 1979*, Oak Ridge National Laboratory, ORNL/TM-7343 (November 1981).

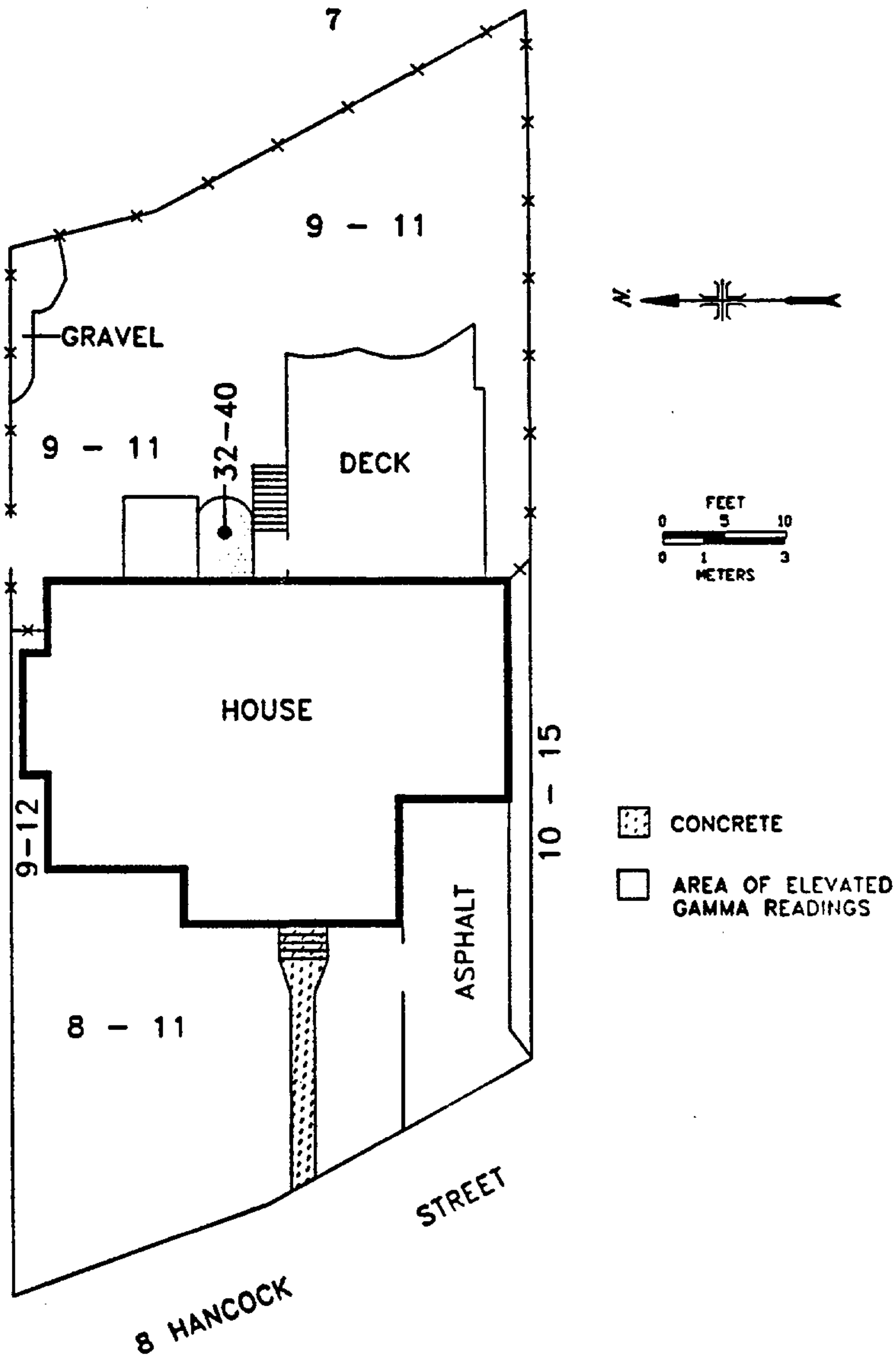

Fig. 1. Gamma radiation levels (μR/h) measured on the surface at 8 Hancock Street, Lodi, New Jersey (LJ026).

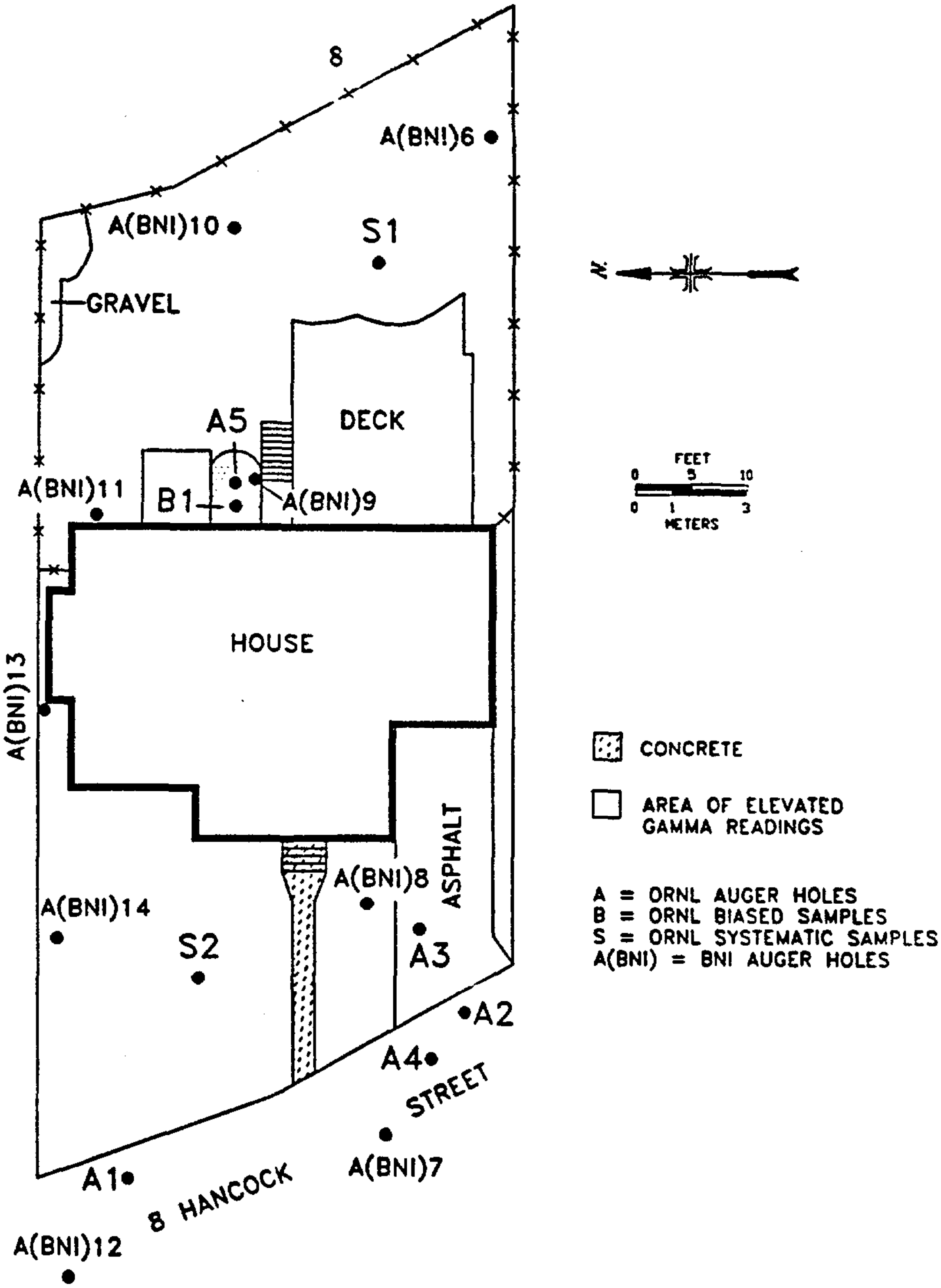

Fig. 2. Diagram showing locations of soil samples taken at 8 Hancock Street, Lodi, New Jersey (LJ026).

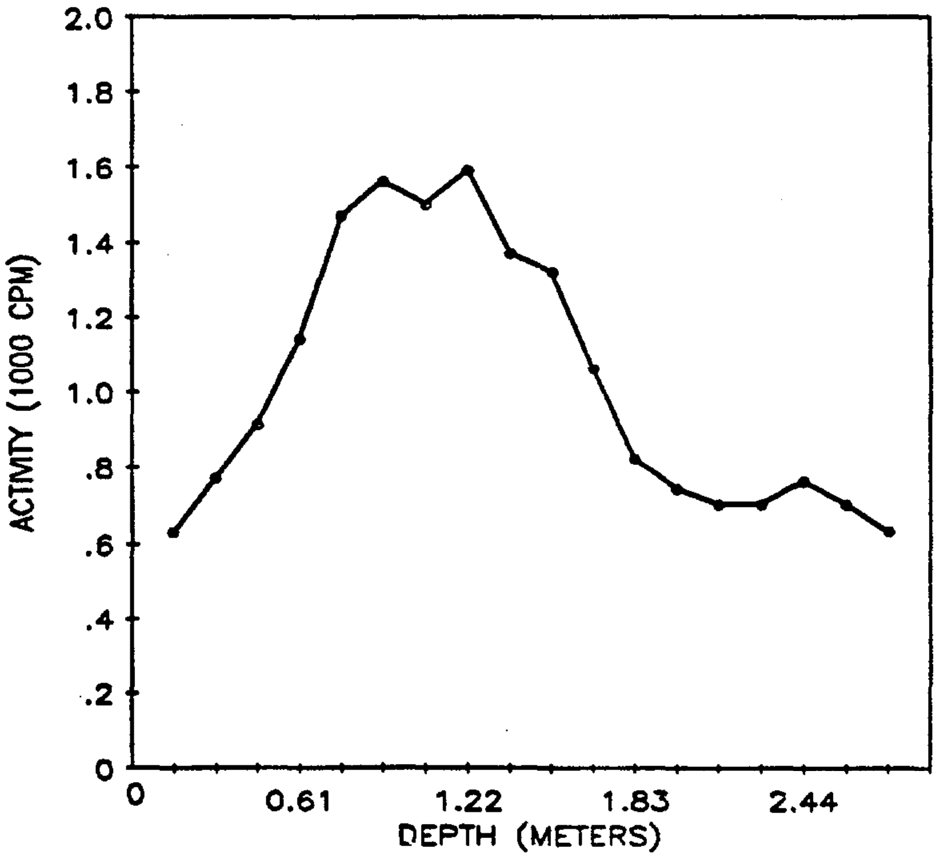

Fig. 3. Gamma profile for auger hole 1 (LJ026A1) at 8 Hancock Street, Lodi, New Jersey.

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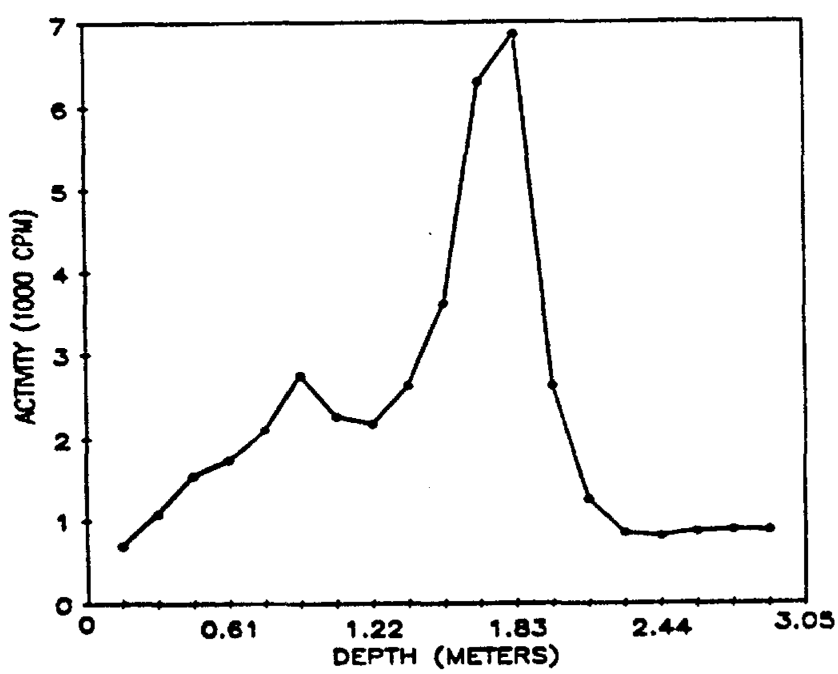

Fig. 4. Gamma profile for auger hole 2 (LJ026A2) at 8 Hancock Street, Lodi, New Jersey.

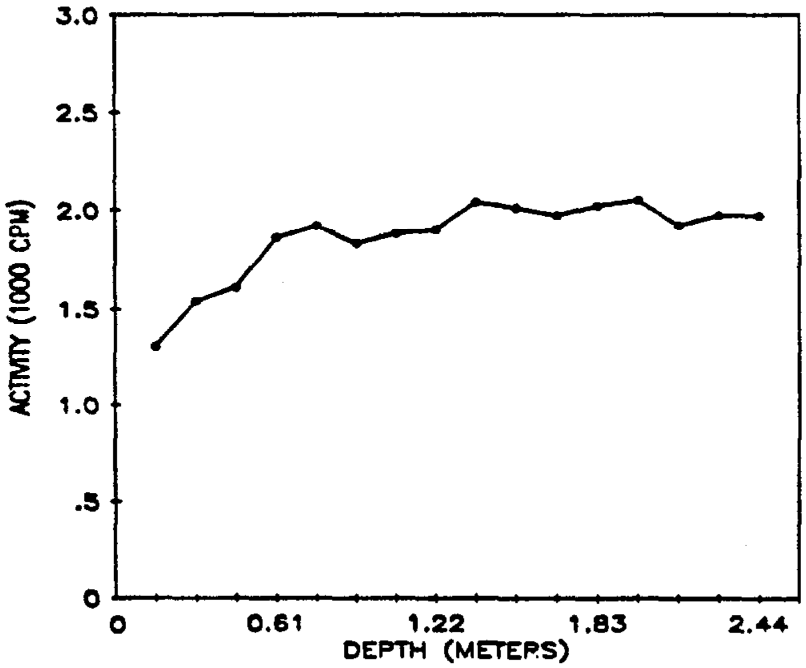

Fig. 5. Gamma profile for auger hole 3 (LJ026A3) at 8 Hancock Street, Lodi, New Jersey.

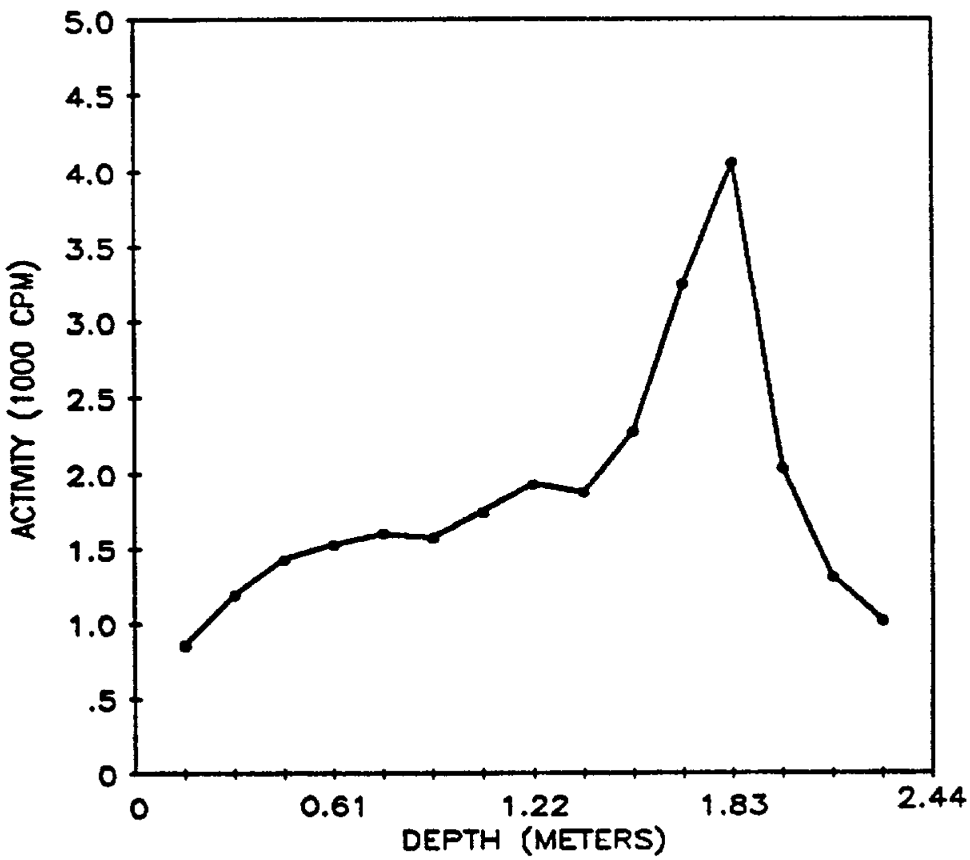

Fig. 6. Gamma profile for auger hole 4 (LJ026A4) at 8 Hancock Street, Lodi, New Jersey.

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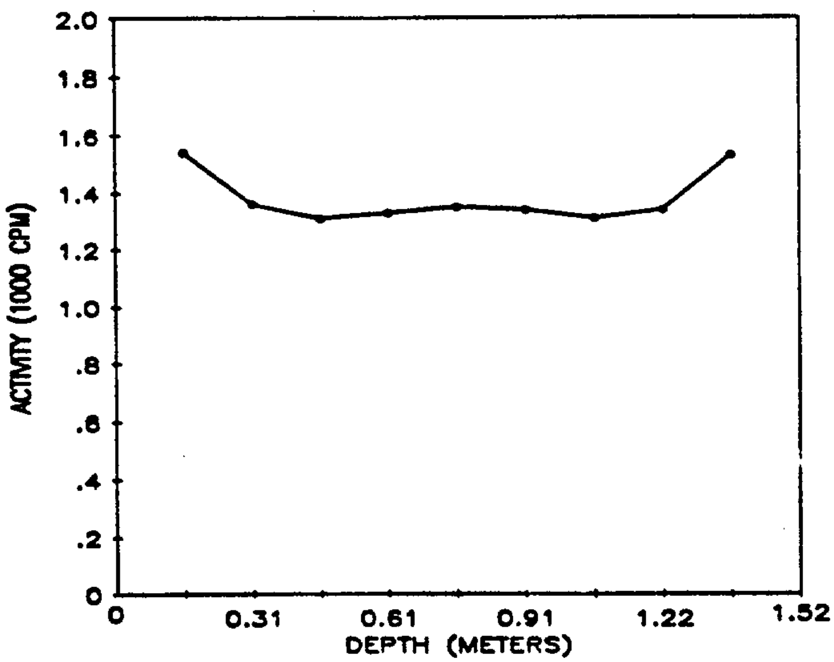

Fig. 7. Gamma profile for auger hole 5 (LJ026A5) at 8 Hancock Street, Lodi, New Jersey.

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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]U.S. Department of Energy, *Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites* (Rev. 2, March 1987).

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

Type of sample	Radionuclide concentration
Concentration of radionuclides in soil (pCi/g)	
^{232}Th	0.9[b]
^{238}U	0.9[b]
^{226}Ra	0.9[b]

[a]Reference 5.

Table 3. Concentrations of radionuclides in soil at 8 Hancock Street, Lodi, New Jersey (LJ026)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)		
		^{226}Ra[b]	^{232}Th[b]	^{238}U[c]
		Systematic samples		
S1	0–15	0.68 ± 0.09	0.76 ± 0.3	0.74
S2	0–15	0.56 ± 0.2	0.67 ± 0.3	0.76
		Biased samples[d]		
B1A	0–15	66 ± 2	1.1 ± 0.7	0.84
B1B	15–30	51 ± 2	1.3 ± 0.1	1.1
		Auger samples[e]		
A1A	30–60	0.95 ± 0.04	1.4 ± 0.07	*f*
A1B	60–90	1.3 ± 0.06	2.0 ± 0.06	*f*
A1C	90–120	1.9 ± 0.1	1.7 ± 0.10	*f*
A1D	120–150	2.0 ± 0.1	1.9 ± 0.20	*f*
A1E	150–185	2.1 ± 0.09	1.9 ± 0.1	*f*
A2A	60–90	1.4 ± 0.07	3.9 ± 0.3	*f*
A2B	120–150	2.4 ± 0.2	5.1 ± 0.8	*f*
A2C	150–185	2.1 ± 0.2	10 ± 0.5	*f*
A3A	60–90	2.1 ± 0.08	2.1 ± 0.03	*f*
A3B	120–150	1.8 ± 0.1	1.8 ± 0.2	*f*
A3C	150–185	2.1 ± 0.2	1.8 ± 0.2	*f*
A4A	165–195	3.1 ± 0.08	6.7 ± 0.6	*f*
A5A	0–30	2.1 ± 0.09	1.6 ± 0.1	*f*
A5B	30–60	1.8 ± 0.06	1.5 ± 0.1	*f*
A5C	90–120	2.2 ± 0.1	1.8 ± 0.1	*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]Biased samples are taken from areas shown to have elevated 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]Auger samples were not analyzed for ^{238}U.

Table 4. BNI scintillation probe loggings for auger holes at 8 Hancock Street, Lodi, New Jersey (LJ026)

Hole number[a]	Depth (m)	Count rate (cpm)	Hole number[a]	Depth (m)	Count rate (cpm)
A(BNI)6	0.0	8,000	A(BNI)7	0.0	15,000
	0.15	10,000		0.15	16,000
	0.3	12,000		0.3	15,000
	0.46	12,000		0.46	16,000
	0.61	12,000		0.61	28,000
	0.76	12,000		0.76	27,000
	0.91	12,000		0.91	23,000
	1.1	12,000		1.1	23,000
	1.2	12,000		1.2	23,000
	1.4	12,000		1.4	25,000
	1.5	12,000		1.5	25,000
	1.7	12,000		1.7	28,000
	1.8	10,000		1.8	30,000
	2.0	10,000		2.0	29,000
	2.1	10,000		2.1	25,000
	2.3	11,000		2.3	17,000
				2.4	14,000
				2.6	9,000
A(BNI)8	0.0	11,000	A(BNI)9	0.0	12,000
	0.15	12,000		0.15	32,000
	0.3	14,000		0.3	30,000
	0.46	16,000		0.46	28,000
	0.61	16,000		0.61	27,000
	0.76	18,000		0.76	24,000
	0.91	21,000		0.91	26,000
	1.1	24,000		1.1	24,000
	1.2	26,000		1.2	23,000
	1.4	27,000		1.4	22,000
	1.5	27,000		1.5	22,000
	1.7	29,000		1.7	23,000
	1.8	33,000		1.8	23,000
	2.0	42,000		2.0	25,000
	2.1	45,000		2.1	31,000
	2.3	86,000		2.3	39,000
	2.4	214,000		2.4	15,000
	2.6	190,000		2.6	11,000
	2.7	54,000		2.7	10,000
	2.9	41,000		2.9	10,000
	3	22,000			

Table 4. (continued)

Hole number[a]	Depth (m)	Count rate (cpm)	Hole number[a]	Depth (m)	Count rate (cpm)
A(BNI)10	0.0	9,000	A(BNI)11	0.0	12,000
	0.15	12,000		0.15	16,000
	0.3	13,000		0.3	19,000
	0.46	14,000		0.46	19,000
	0.61	11,000		0.61	21,000
	0.76	13,000		0.76	20,000
	0.91	12,000		0.91	20,000
	1.1	12,000		1.1	22,000
	1.2	11,000		1.2	22,000
	1.4	10,000		1.4	22,000
	1.5	10,000		1.5	22,000
	1.7	9,000		1.7	22,000
	1.8	10,000		1.8	23,000
	2.0	10,000		2.0	27,000
	2.1	8,000		2.1	34,000
	2.3	9,000		2.3	41,000
				2.4	14,000
				2.6	10,000
				2.7	10,000
				2.9	11,000
A(BNI)12	0.0	11,000	A(BNI)13	0.0	15,000
	0.15	12,000		0.15	14,000
	0.3	15,000		0.3	15,000
	0.46	15,000		0.46	13,000
	0.61	15,000		0.61	14,000
	0.76	17,000		0.76	15,000
	0.91	18,000		0.91	18,000
	1.1	19,000		1.1	17,000
	1.2	20,000		1.2	28,000
	1.4	21,000		1.4	23,000
	1.5	22,000		1.5	23,000
	1.7	22,000		1.7	23,000
	1.8	22,000		1.8	45,000
	2.0	20,000		2.0	65,000
	2.1	18,000		2.1	134,000
	2.3	15,000		2.3	150,000
				2.4	67,000
				2.6	21,000
				2.7	22,000
				2.9	13,000

Table 4. (continued)

Hole number[a]	Depth (m)	Count rate (cpm)	Hole number[a]	Depth (m)	Count rate (cpm)
A(BNI)14	0.0	11,000		1.5	29,000
	0.15	13,000		1.7	24,000
	0.3	15,000		1.8	25,000
	0.46	16,000		2.0	57,000
	0.61	18,000		2.1	93,000
	0.76	21,000		2.3	117,000
	0.91	23,000		2.4	74,000
	1.1	23,000		2.6	31,000
	1.2	23,000		2.7	15,000
	1.4	23,000		2.9	11,000

[a]Locations of holes are shown on Fig. 2.

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32. L. R. Levis, Roy F. Weston, Inc., 20030 Century Blvd., Germantown, MD 20874
33. G. P. Turi, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874
34. J. W. Wagoner, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874
35-37. Andrew Wallo III, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874
38. Office of Assistant Manager, Energy Research and Development, Oak Ridge Operations Office, Oak Ridge, TN 37831
39-40. Office of Scientific and Technical Information, DOE, Oak Ridge, TN 37831