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**RESULTS OF THE
RADIOLOGICAL SURVEY
AT
7 HANCOCK STREET,
LODI, NEW JERSEY
(LJ027)**

W. D. Cottrell
L. M. Floyd
M. W. Francis
J. O. Mynatt

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DEPARTMENT OF ENERGY

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GRNL/RASA-87/37

HEALTH AND SAFETY RESEARCH DIVISION

Waste Management Research and Development Programs
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(LJ027)

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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 ^{230}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, 7 Hancock Street, Lodi, New Jersey (LJ027), was conducted during 1985 and 1986.

Results of the survey demonstrated radionuclide concentrations in excess of the DOE Formerly Utilized Sites Remedial Action Program criteria. The radionuclide distributions are typical of the type of material originating from the MCW site.

**RESULTS OF THE RADIOLOGICAL SURVEY
AT 7 HANCOCK STREET, LODI,
NEW JERSEY (LJ027)***

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 feet 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-AC05-84OR21400.

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 7 Hancock Street, Lodi, New Jersey, was conducted during 1985 and 1986. The survey and sampling of the ground surface were carried out on October 16, 1985, and the follow-up subsurface investigation was performed on September 17, 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. 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 2.6 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 property surface are given in Fig. 1. Gamma exposure rates over the major portion of the property ranged from 5 to 11 $\mu\text{R}/\text{h}$. One area of approximately one square-foot measured 16 $\mu\text{R}/\text{h}$ (Fig. 1).

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 uranium, radium, and thorium in the systematic samples were 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 1.8 to 1.9 pCi/g, 8.7 to 9.9 pCi/g, and 1.9 to 2.0 pCi/g, respectively. Radium and uranium levels were approximately twice background levels, while thorium concentrations were approximately 9 times background. The sum of the ^{226}Ra and ^{232}Th concentrations in sample B1A was 10.5 pCi/g from 0 to 15 cm. This value is about 10 percent of the DOE guideline value of 50 pCi/g for isolated spots of less than one square meter.³

Auger Hole Soil Samples and Gamma Logging

Varying thicknesses of subsurface soil were sampled from depths of 60 to 185 cm in auger (A) holes which were drilled at 4 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 0.98 to 2.4 and 1.5 to 13 pCi/g, respectively. The concentrations of these radionuclides were below their respective guidelines, when considered separately (Table 1). However, the sum of radium and thorium concentrations in sample A3A was 15 pCi/g, and this value is essentially equal to the guideline value of 15 pCi/g for samples taken more than 15 cm below the surface (Table 1).

Gamma logging was performed in each of 3 auger holes to characterize and further define the extent of possible contamination. Soil conditions in A3 prevented collecting gamma data for this hole. 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 5. Elevated readings were found in all logged holes from approximately 0.5 to 1.5 m, with the highest measurement of 2299 cpm in hole 4 at 0.9 m. The areas of highest gamma activity correspond to the greatest concentrations of radionuclides shown in Table 3.

SIGNIFICANCE OF FINDINGS

Measurements and results of soil sample analyses taken at 7 Hancock Street indicate that radionuclide concentrations on this property were below applicable DOE guidelines. However, significant concentrations of ^{226}Ra and ^{232}Th were found at locations B1 and A3. The combined concentration of ^{226}Ra and ^{232}Th in the soil was about 10 percent of the DOE guideline at location B1 (0-15 cm) and was essentially equal to the guideline at location A3 (60-75 cm). Elevated gamma levels were indicated in auger holes A2 and A4. These data suggest there is significant subsurface contamination on the property. When coupled with unpublished data collected by Bechtel National Incorporated (BNI) and data on the adjacent property (5 Hancock Street), the data indicate that this site warrants consideration for inclusion in the DOE Formerly Utilized Sites Remedial Action Program.

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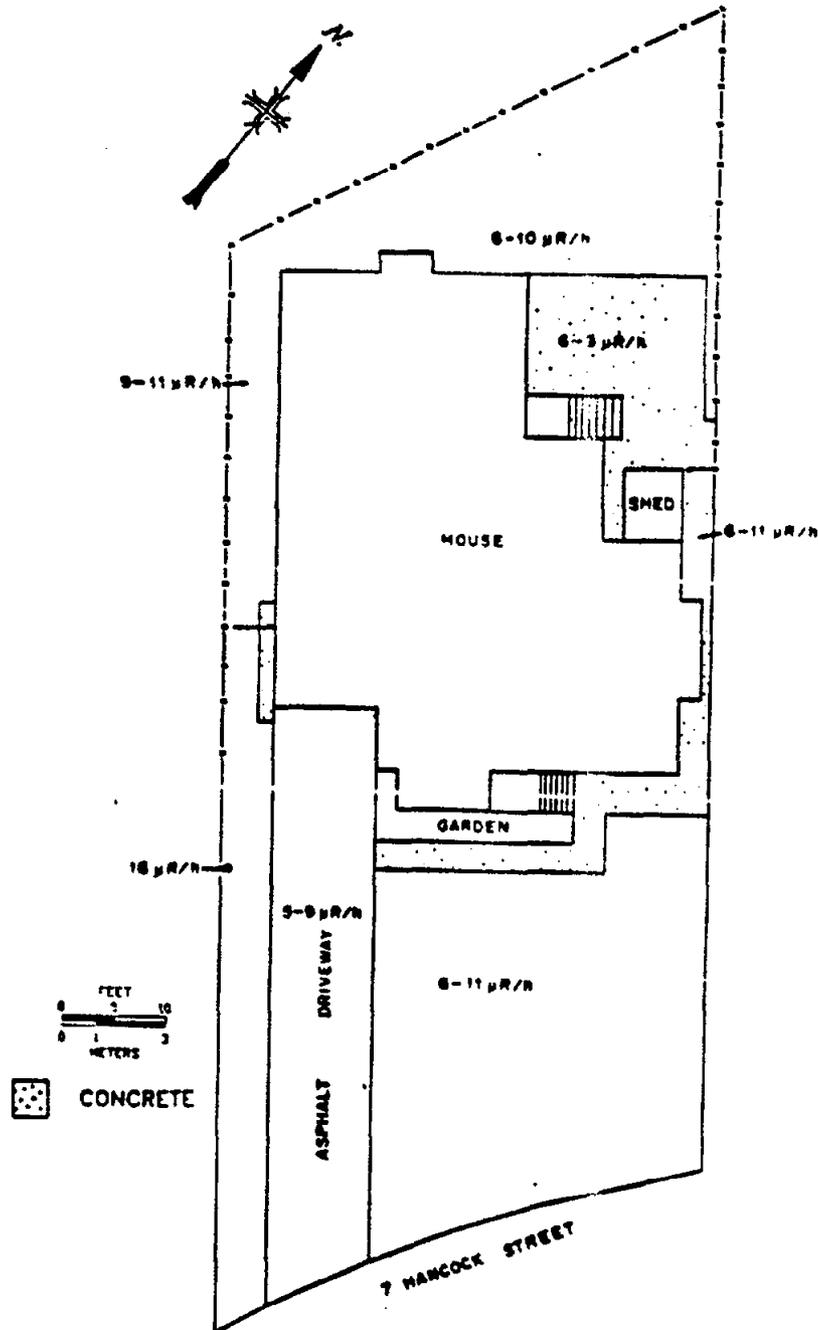


Fig. 1. Gamma radiation levels ($\mu\text{R/h}$) measured on the surface at 7 Hancock Street, Lodi, New Jersey (LJ027).

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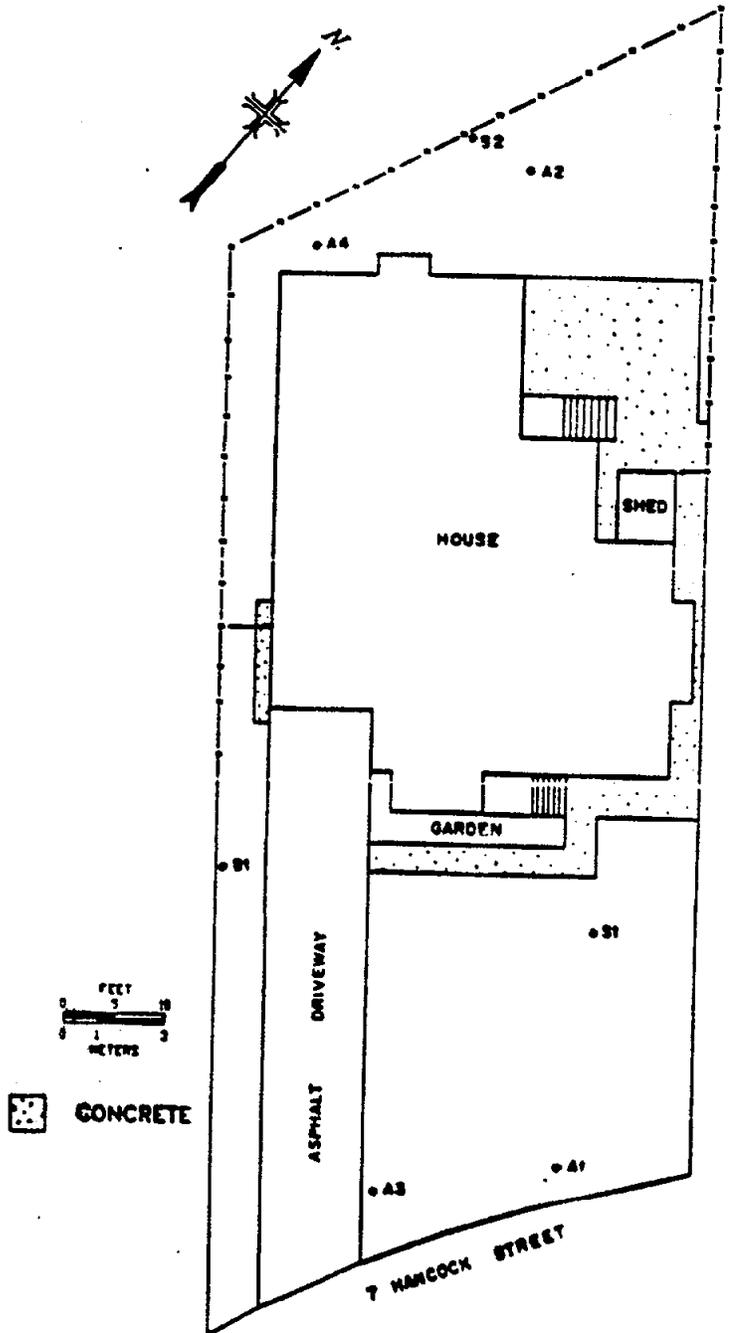


Fig. 2. Diagram showing locations of soil samples taken at 7 Hancock Street, Lodi, New Jersey (LJ027).

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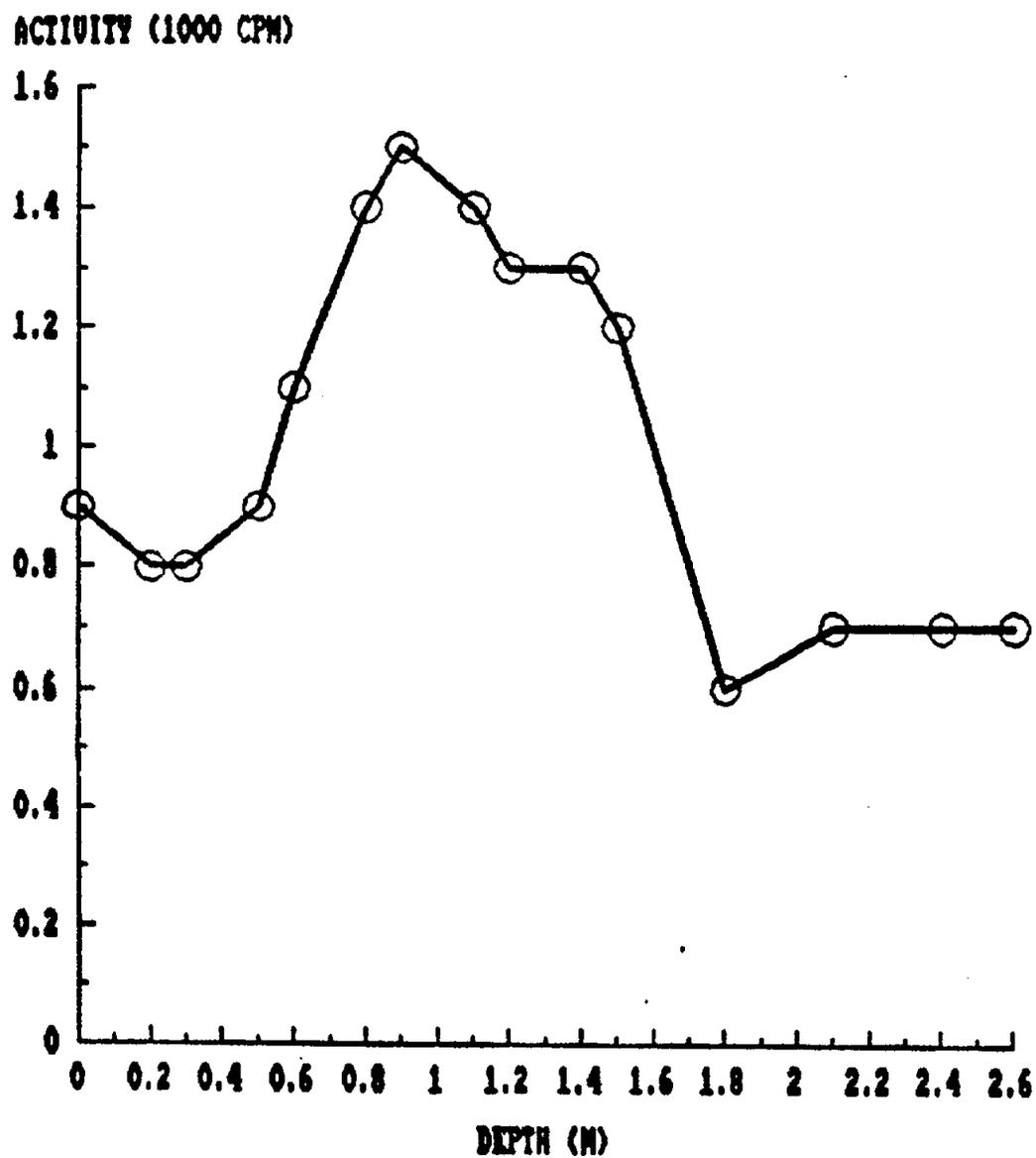


Fig. 3. Gamma profile for auger hole 1 (LJ027A1) at 7 Hancock Street, Lodi, New Jersey.

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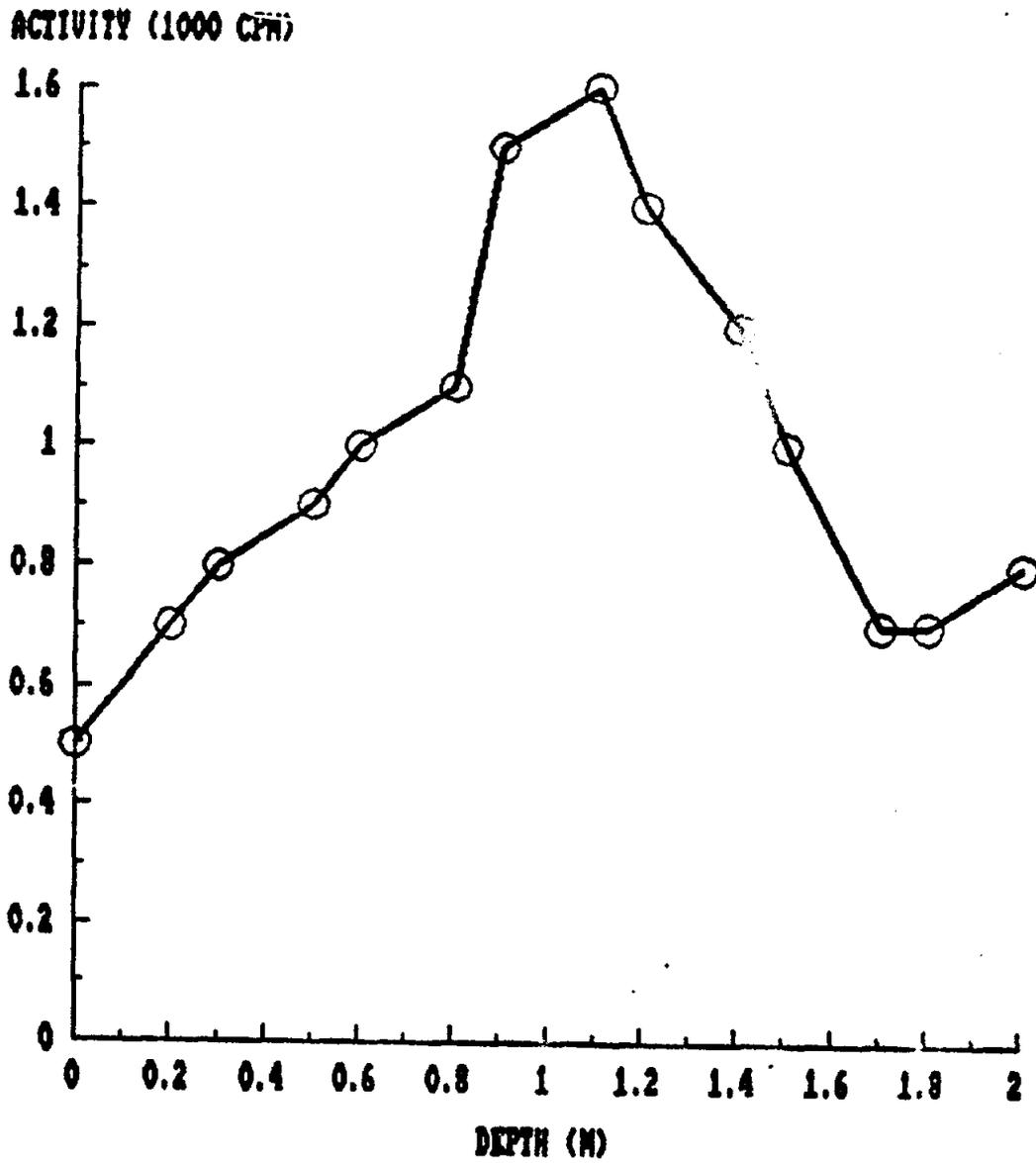


Fig. 4. Gamma profile for auger hole 2 (LI027A2) at 7 Hancock Street, Lodi, New Jersey.

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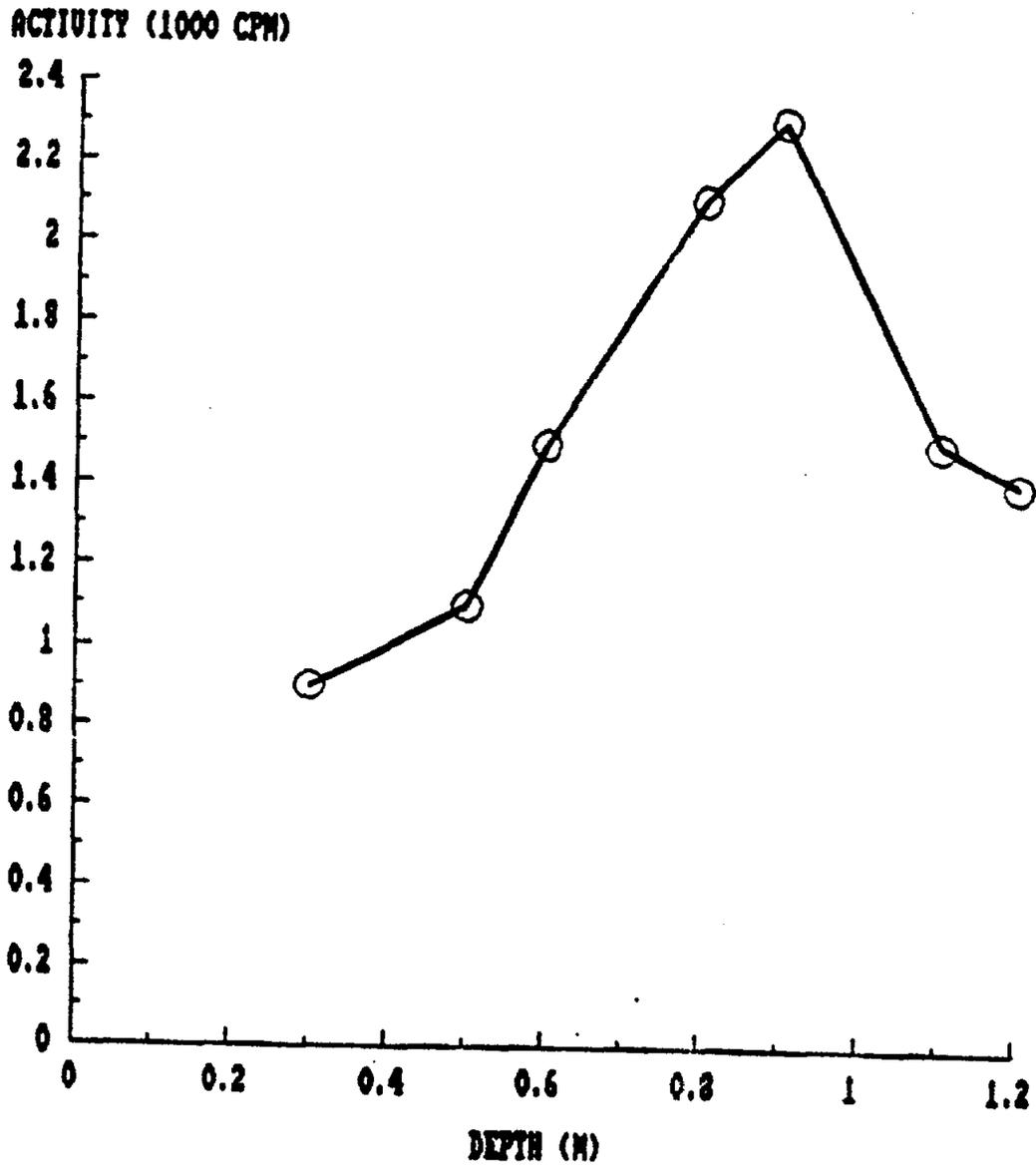


Fig. 5. Gamma profile for auger hole 4 (LJ027A4) at 7 Hancock Street, Lodi, New Jersey.

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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										
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: <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>(m²)</th> <th>(pCi/g)^c</th> </tr> </thead> <tbody> <tr> <td><1</td> <td>50</td> </tr> <tr> <td>1-<3</td> <td>30</td> </tr> <tr> <td>3-<10</td> <td>15</td> </tr> <tr> <td>10-25</td> <td>10</td> </tr> </tbody> </table>	(m ²)	(pCi/g) ^c	<1	50	1-<3	30	3-<10	15	10-25	10
(m ²)	(pCi/g) ^c											
<1	50											
1-<3	30											
3-<10	15											
10-25	10											

^aReference 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.

^cThese guideline values are applicable to surface concentrations of ²³²Th, ²³⁰Th, ²²⁸Ra, and ²²⁶Ra 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

^aThese values represent an average of normal radionuclide concentrations in this part of the state. Actual values may fluctuate.

^bReference 4.

^cReference 3.

Table 3. Concentrations of radionuclides in soil at 7 Hancock Street,
Lodi, New Jersey (LJ027)

Sample ^a	Depth (cm)	Radionuclide concentration (pCi/g)		
		²²⁶ Ra ^b	²³² Th ^b	²³⁸ U ^c
<i>Systematic samples^d</i>				
S1	0-15	0.81 ± 0.09	0.63 ± 0.4	0.76
S2	0-15	0.82 ± 0.1	1.1 ± 0.3	0.90
<i>Biased samples^e</i>				
B1A	0-15	1.8 ± 0.1	8.7 ± 0.5	2.0
B1B	15-30	1.9 ± 0.07	9.9 ± 0.6	1.9
<i>Auger samples^f</i>				
A1A	75-105	1.5 ± 0.04	1.5 ± 0.3	§
A1B	120-150	2.1 ± 0.4	1.9 ± 0.3	§
A1C	150-185	2.0 ± 0.07	1.8 ± 0.3	§
A2A	60-90	0.98 ± 0.05	2.2 ± 0.3	§
A2B	90-120	1.9 ± 0.2	4.7 ± 0.4	§
A3A	60-75	2.0 ± 0.5	13 ± 0.4	§
A3B	75-90	1.8 ± 0.6	5.3 ± 0.6	§
A3C	90-105	2.1 ± 0.09	1.9 ± 0.2	§
A4A	60-75	1.9 ± 0.1	2.5 ± 0.6	§
A4B	75-90	1.7 ± 0.09	6.5 ± 0.6	§
A4C	90-105	1.5 ± 0.1	6.3 ± 0.4	§
A4D	105-120	2.4 ± 0.08	2.2 ± 0.6	§

^aLocations of soil samples are shown on Fig. 2.

^bIndicated counting error is at the 95% confidence level ($\pm 2\sigma$).

^cTotal analytical error of measurement results is less than $\pm 5\%$ (95% confidence level).

^dSystematic samples are taken at locations irrespective of gamma exposure.

^eBiased samples are taken from areas shown to have elevated gamma exposure rates.

^fAuger 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.

[§]Sample was not analyzed for ²³⁸U.

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