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RESULTS OF THE RADIOLOGICAL SURVEY AT 160 ESSEX STREET, LODI, NEW JERSEY (LJ072)

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DEPARTMENT OF ENERGY

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ACKNOWLEDGMENTS

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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, 160 Essex Street, Lodi, New Jersey (LJ072), was conducted during 1987.

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 160 ESSEX STREET, LODI, NEW JERSEY (LJ072)*

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 commercial property, owned by the National Community Bank, at 160 Essex Street, Lodi, New Jersey, was conducted during 1987. The survey and sampling of the ground surface were carried out on June 11, 1987, and the subsurface investigation was performed on June 10, 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 readings 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.

To define the extent of possible subsurface soil contamination, 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. 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]

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 3 to 11 μR/h.

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 radium and thorium in these samples ranged from 0.37 to 3.0 pCi/g and 0.35 to 26 pCi/g, respectively. Thorium levels in samples S2C, S2D, and B1A were above DOE guidelines (Table 1).

Auger Hole Soil Samples and Gamma Logging

Varying thicknesses of subsurface soil were sampled from depths of 15 to 135 cm in auger holes (A) drilled at eight separate locations indicated in Fig. 2, except for auger holes A6 and A7 which were drilled but not sampled. The results of analyses of these samples are given in Table 3. Concentrations of ^{226}Ra and ^{232}Th in the auger samples ranged from 0.41 to 1.5 and 0.65 to 11 pCi/g, respectively. All auger hole samples were below DOE criteria (Table 1).

Gamma logging was performed in each of the eight 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 the logged auger holes are graphically represented in Figs. 3 through 10. All readings in hole 1 were below 1000 cpm. Readings in auger hole 2 were elevated between 0.3 and 0.8 m, with a maximum of 2498 cpm at 0.6 m. In hole 3, elevated readings were between 0.3 and 0.8 m, with a maximum of 1853 cpm at 0.5 m. There were no elevated readings in hole 4. Readings in hole 5 were elevated between 0.3 m and 0.5 m (1204 cpm maximum). Hole 6 read 1645 cpm to 1279 cpm between 0.3 and 0.6 m, with the maximum reading at 0.3 m. The highest levels in hole 7 were found at 0.3 m (2401 cpm). Finally, hole 8 had elevated levels between 0.3 and 0.6 m, with maximum reading of 1798 cpm.

SIGNIFICANCE OF FINDINGS

Measurements taken at 160 Essex Street indicate that the property contained radioactive contamination primarily from the ^{232}Th decay chain, with slight contamination from ^{226}Ra. These radionuclide distributions are typical of the type of material originating from the processing operations at the MCW site. The concen-

tration and extent of ^{232}Th on this property were in excess of the applicable DOE criteria (Table 1). As shown in Fig. 2, this material was found at sample locations S2 and B1. Based on the results of this radiological assessment, it is recommended that this site be considered for inclusion in the DOE remedial action program.

REFERENCES

1. W. D. Cottrell, ORNL, to A. J. Whitman, DOE/HQ, correspondence, "Radiological Survey of Private Properties in Lodi, New Jersey" (August 15, 1984).
2. 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* Oak Ridge National Laboratory, ORNL/TM-8600 (April 1987).
3. 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).
4. 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).

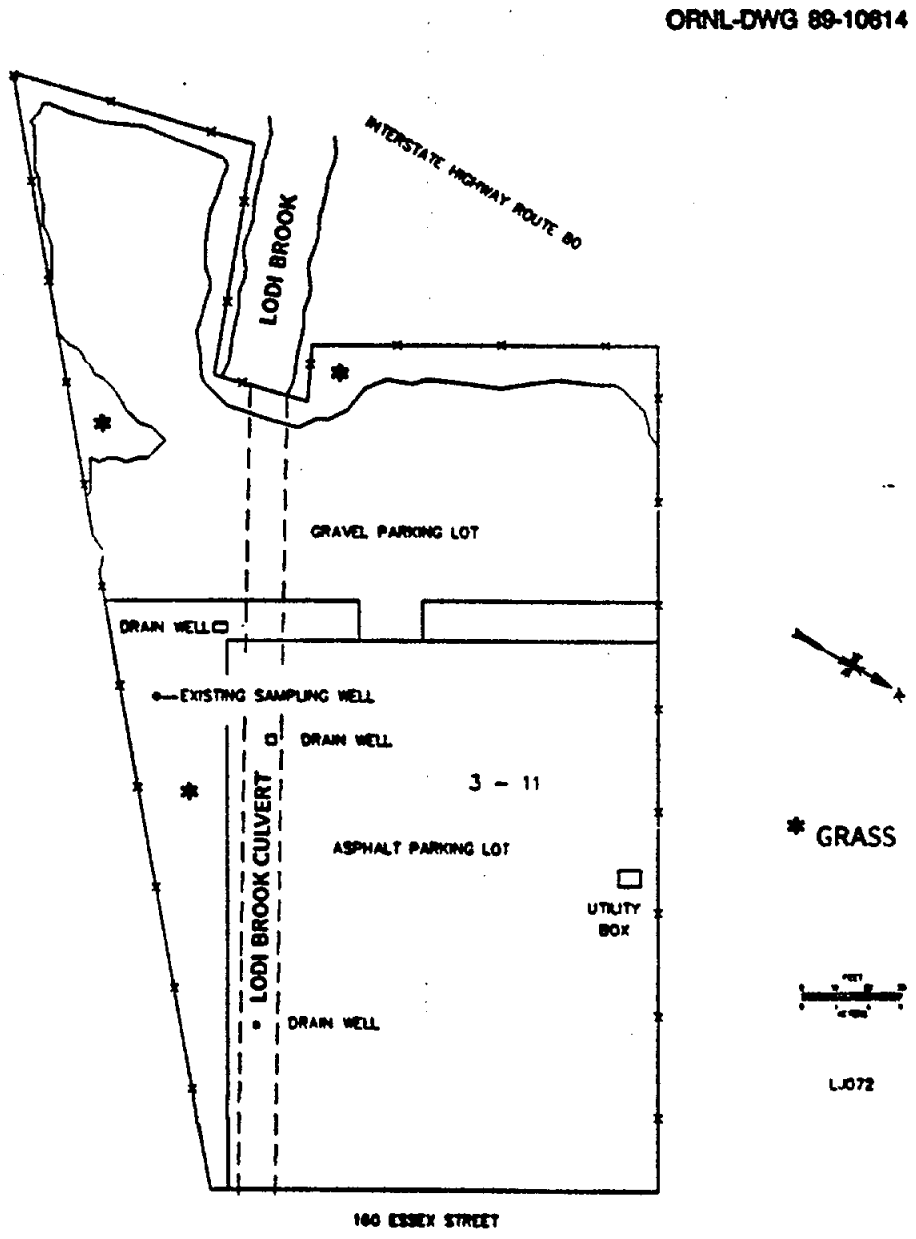

Fig. 1. Gamma radiation levels (μR/h) measured on the surface at 160 Essex Street, Lodi, New Jersey (LJ072).

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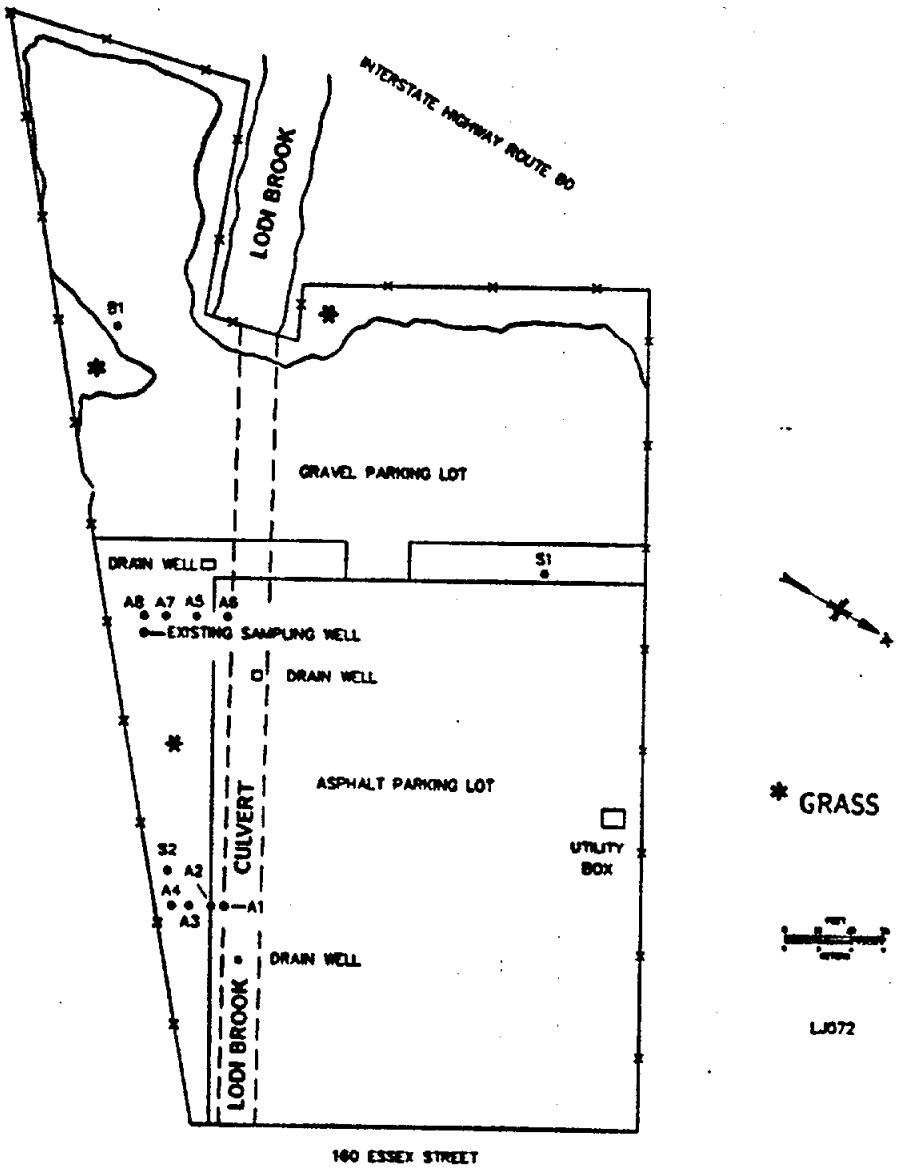

Fig. 2. Diagram showing locations of soil samples taken at 160 Essex Street, Lodi, New Jersey (LJ072).

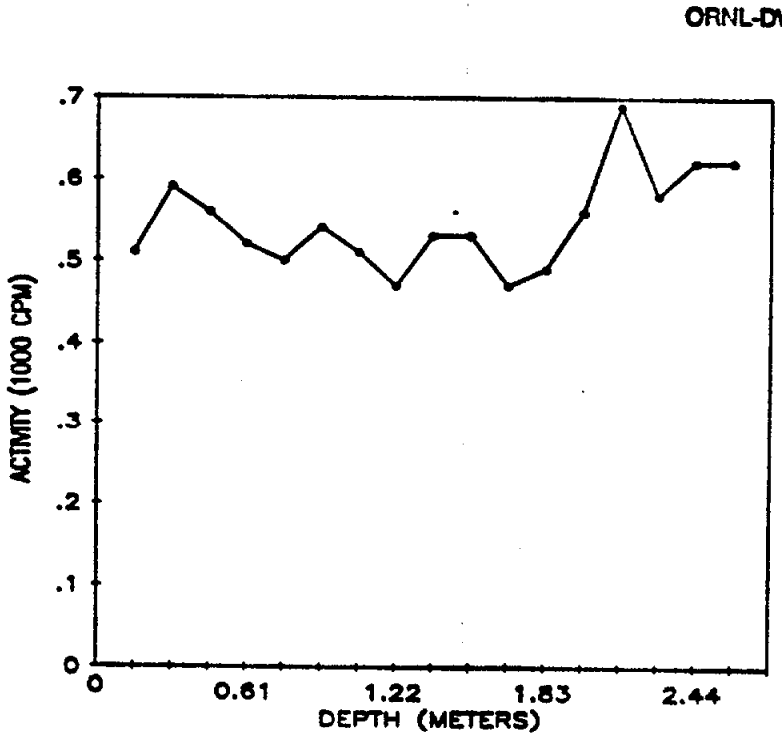

Fig. 3. Gamma profile for auger hole 1 (LJ072A1) at 160 Essex Street, Lodi, New Jersey.

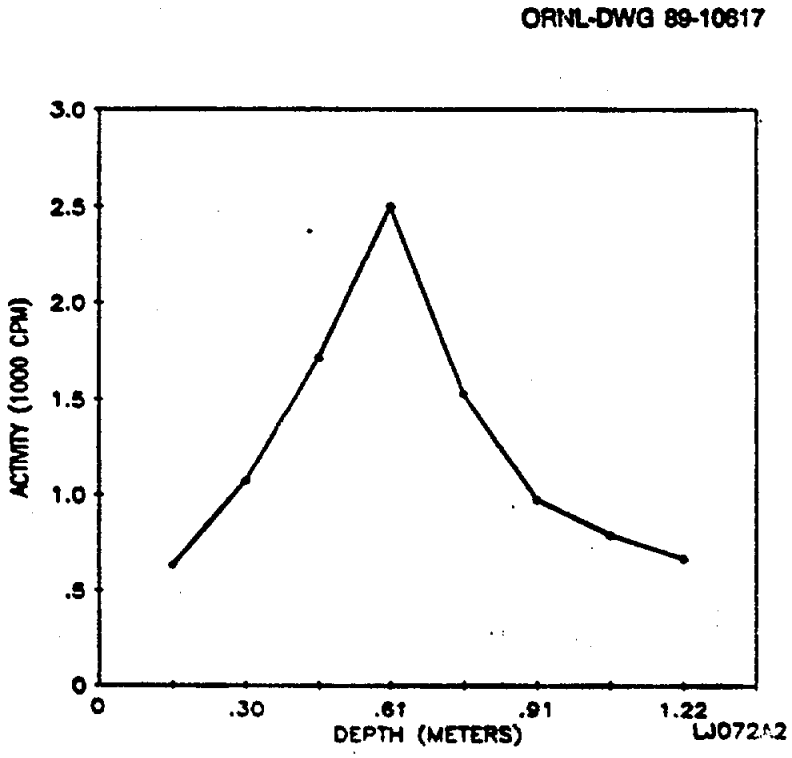

Fig. 4. Gamma profile for auger hole 2 (LJ072A2) at 160 Essex Street, Lodi, New Jersey.

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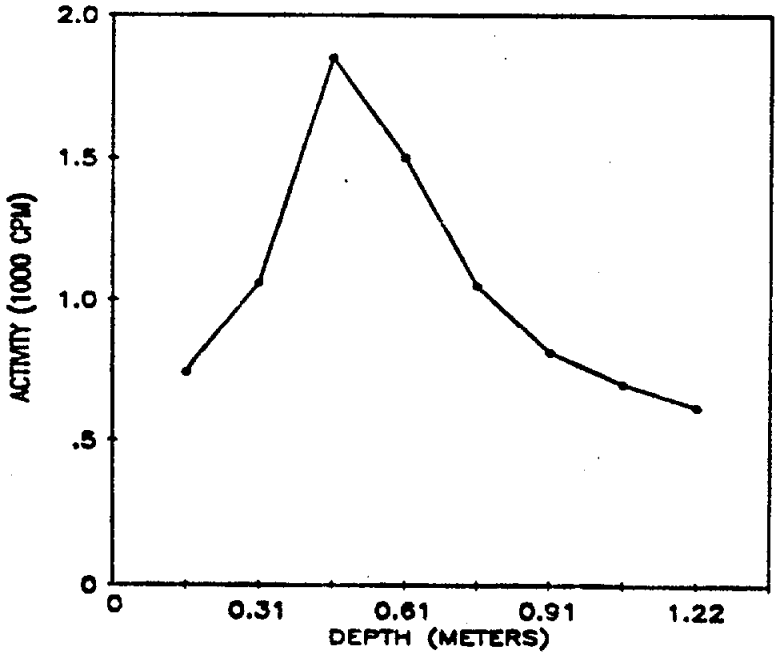

LJ072A3

Fig. 5. Gamma profile for auger hole 3 (LJ072A3) at 160 Essex Street, Lodi, New Jersey.

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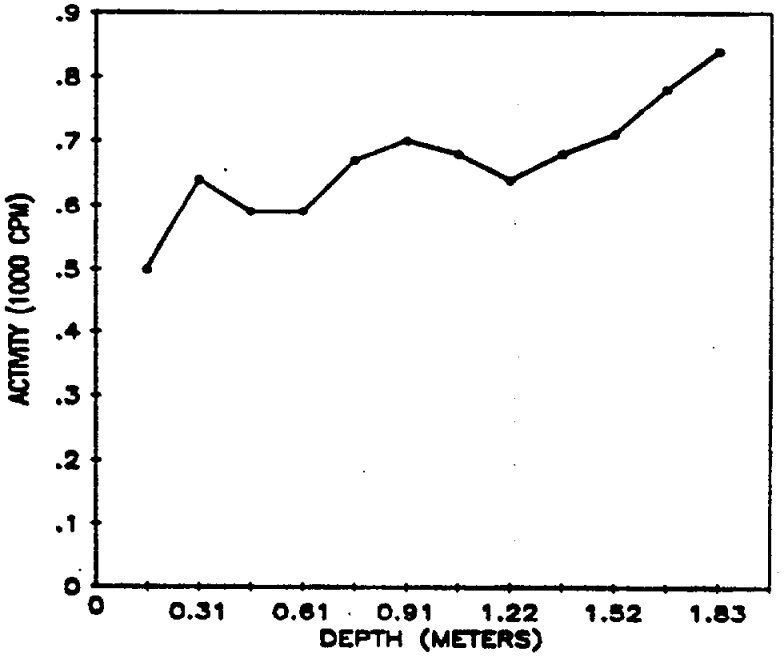

LJ072A4

Fig. 6. Gamma profile for auger hole 4 (LJ072A4) at 160 Essex Street, Lodi, New Jersey.

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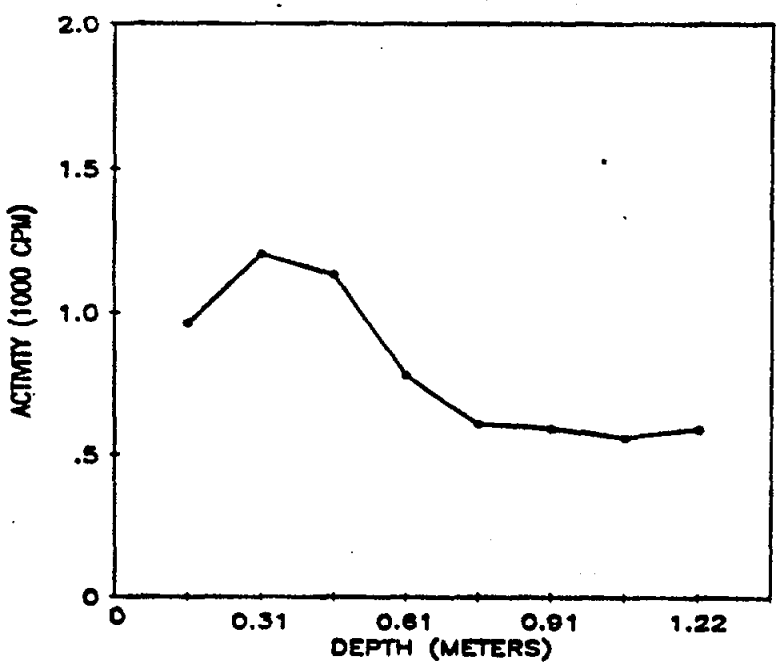

LJ072A5

Fig. 7. Gamma profile for auger hole 5 (LJ072A5) at 160 Essex Street, Lodi, New Jersey.

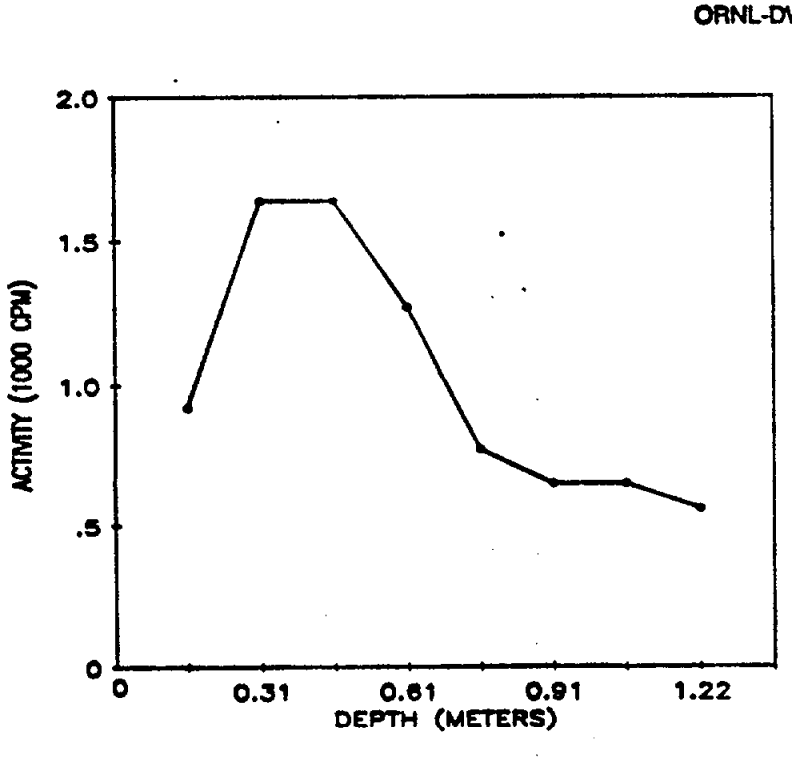

Fig. 8. Gamma profile for auger hole 6 (LJ072A6) at 160 Essex Street, Lodi, New Jersey.

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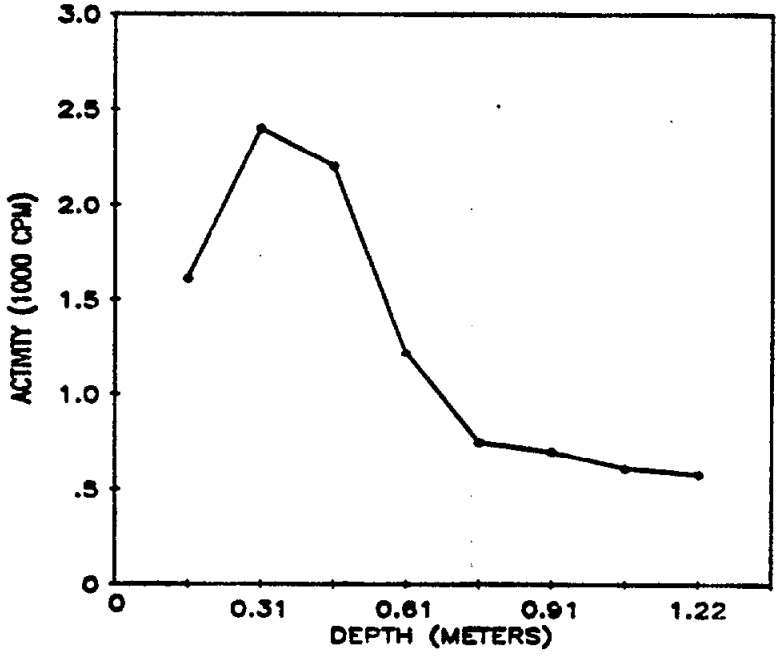

LJ072A7

Fig. 9. Gamma profile for auger hole 7 (LJ072A7) at 160 Essex Street, Lodi, New Jersey.

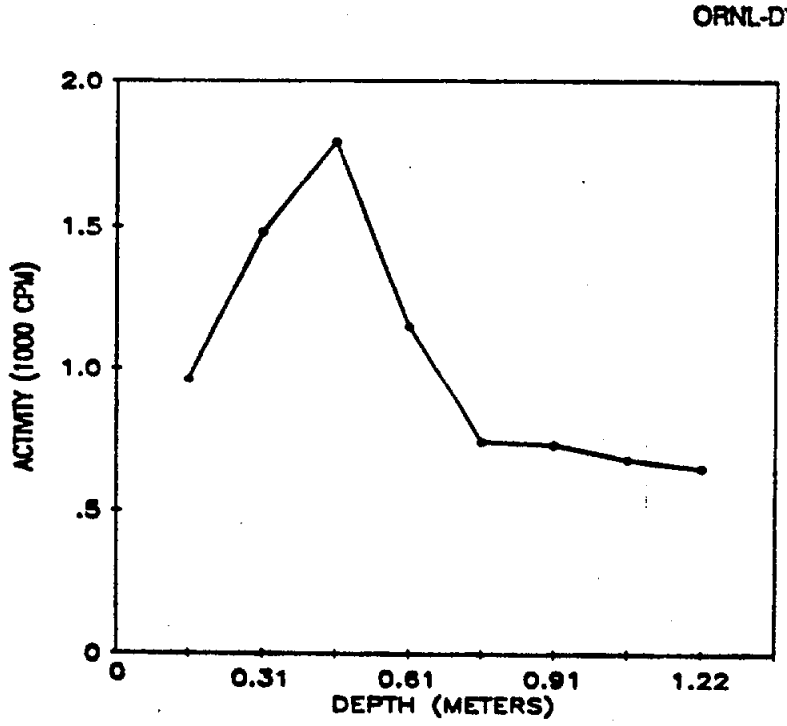

Fig. 10. Gamma profile for auger hole 8 (LJ072A8) at 160 Essex Street, Lodi, New Jersey.

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 160 Essex Street, Lodi, New Jersey (LJ072)

Sample[a]	Depth (cm)	Radionuclide concentration (pCi/g)	
		^{226}Ra[b]	^{232}Th[b]
		Systematic samples[c]	
S1	0–15	0.37 ± 0.03	0.35 ± 0.1
S2A	0–15	0.45 ± 0.09	0.54 ± 0.08
S2B	15–30	0.67 ± 0.04	0.40 ± 0.1
S2C	30–45	3.0 ± 0.4	26 ± 1.2
S2D	45–60	2.5 ± 0.2	17 ± 1.1
		Biased samples[d]	
B1A	0–15	1.3 ± 0.1	9.0 ± 0.6
B1B	15–30	0.84 ± 0.1	2.8 ± 0.2
		Auger samples[e]	
A1A	30–45	0.45 ± 0.09	0.74 ± 0.2
A1B	120–135	0.41 ± 0.05	0.65 ± 0.1
A2A	15–30	0.61 ± 0.1	1.3 ± 0.2
A2B	30–45	1.5 ± 0.2	9.7 ± 0.3
A2C	45–60	1.5 ± 0.1	11 ± 1
A2D	60–75	1.2 ± 0.2	6.9 ± 0.3
A2E	75–90	1.0 ± 0.09	1.5 ± 0.3
A2F	90–105	0.86 ± 0.02	1.1 ± 0.3
A3A	15–30	0.81 ± 0.1	2.9 ± 0.1
A3B	30–45	0.83 ± 0.06	3.4 ± 0.3
A3C	45–60	1.4 ± 0.2	11 ± 0.3
A3D	60–75	1.1 ± 0.05	5.3 ± 0.4
A3E	75–90	1.07 ± 0.03	1.7 ± 0.16
A3F	90–105	1.0 ± 0.09	1.4 ± 0.3
A4	120–135	0.58 ± 0.06	1.2 ± 0.08
A5A	15–30	0.97 ± 0.09	4.9 ± 0.3
A5B	30–45	1.3 ± 0.2	4.1 ± 0.7
A5C	45–60	1.1 ± 0.04	1.0 ± 0.07
A5D	60–75	0.64 ± 0.02	0.76 ± 0.03
A8A	15–30	0.81 ± 0.06	1.8 ± 0.1
A8B	30–45	1.0 ± 0.1	3.6 ± 0.08
A8C	45–60	1.5 ± 0.1	4.4 ± 0.2
A8E	75–90	0.97 ± 0.1	1.2 ± 0.2

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

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

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

[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.

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