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Results of the Independent Radiological Verification Survey at 79 Avenue B, Lodi, New Jersey (LJ091V)

R. E. Rodriguez
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ORNL/RASA-96/6

HEALTH SCIENCES RESEARCH DIVISION

Environmental Restoration and Waste Management Non-Defense Programs
(Activity No. EX 20 20 01 0; ADS1310AA)

Results of the Independent Radiological Verification Survey at 79 Avenue B, Lodi, New Jersey (LJ091)

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Date Issued - September 1996

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ABSTRACT

Prior to remediation, thorium residues in excess of DOE applicable guidelines were found in the eastern corner of the backyard on property at 79 Avenue B, Lodi, New Jersey. Decontamination, which consisted of excavation and removal of contaminated soil, was performed by subcontractors under the direction of Bechtel National, Inc. The independent radiological verification survey described in this report was performed by the Measurement Applications and Development Group at Oak Ridge National Laboratory to verify that the final remedial action had reduced contamination levels to within authorized limits.

The property at 79 Avenue B, Lodi, New Jersey, was thoroughly investigated outdoors for radionuclide residues. Surface gamma exposure rates were below guideline levels and comparable to typical background values for the area. The results of soil radionuclide analysis for ^{238}U, ^{226}Ra, and ^{232}Th indicated that all soil concentration measurements were below limits prescribed by DOE applicable guidelines for protection against radiation.

Analysis of data contained in the post-remedial action report (DOE/OR/21949-405) and results of this independent radiological verification survey by ORNL confirm that all radiological measurements fall below the limits prescribed by DOE guidelines established for this site. The property at 79 Avenue B successfully meets the DOE remedial action objectives.

Results of the Independent Radiological Verification Survey at 79 Avenue B, Lodi, New Jersey (LJ091)*

INTRODUCTION

Thorium ores were processed by the Maywood Chemical Works (MCW),[1] Maywood, New Jersey, between 1916 and 1959. The MCW ceased thorium processing in 1959, and the 30-acre property was sold that same year to Stepan Chemical Company. During the early years of operation, MCW stored wastes and residues in low-lying areas west of the processing facilities, now called the Maywood Interim Storage Site. Subsequently, residuals containing radioactive materials migrated off-site to the surrounding area, and the Stepan property and several vicinity properties, along with other sites, were designated by Congress for remedial action as a result of the 1984 Energy and Water Development Appropriations Act.

The waste produced by the thorium extraction process was a sand-like material containing residual amounts of thorium and its decay products, with smaller quantities of uranium and its decay products. Because some of the wastes had been carried downstream by Lodi Brook, and some area residents had also used the sand-like wastes as mulch in their yards, the properties in the vicinity of the MCW were included as a decontamination research and development project under the Department of Energy (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP).

At the request of the DOE, the Measurement Applications and Development Group at Oak Ridge National Laboratory (ORNL) conducted investigative radiological surveys of properties surrounding the former processing plant. In May 1988, a radiological survey was conducted on the private, residential property at 79 Avenue B, Lodi, New Jersey.[2] The location of the Stepan property and the DOE-owned Maywood Interim Storage Site relative to Avenue B in Lodi, New Jersey, is shown in Fig. 1.

The survey consisted of a complete gamma scan of the property outdoors, both at the surface and 1 m above the surface, and the collection of soil samples. Survey results, published in June 1989,[2] reported elevated gamma exposure rates in the eastern corner of the backyard. Soil sample analyses indicated that the property contained radioactive contamination primarily from the ^{232}Th decay chains. Both the concentration and extent of ^{232}Th on the property were in excess of the applicable DOE criteria, and the property was scheduled for remedial action.

Decontamination of the property to current guidelines was conducted by subcontractor personnel in the fall of 1995 under the direction of Bechtel National, Inc. (BNI), the project management contractor for FUSRAP. Thermo NuTech was the radiological support subcontractor.

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*The survey was performed by members of the Measurement Applications and Development Group of the Health Sciences Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

The independent radiological verification survey of the fall 1995 remediation was performed in October 1995 under the FUSRAP program by members of the Measurement Applications and Development Group at ORNL, the independent verification contractor for this property. The DOE's policy to assign an independent verification contractor ensures the effectiveness of remedial actions performed within FUSRAP and confirms the site's compliance with DOE guidelines.

This report describes the radiological verification survey of the residential property at 79 Avenue B, Lodi, New Jersey. The property is a single family dwelling with concrete walks and driveway. A diagram of the property is shown in Fig. 2.

SCOPE OF THE SURVEY

Objectives

The objectives of the verification activities were to confirm (1) that available documentation adequately and accurately describes the post-remedial action status of the property that is to be verified, and (2) that the remedial action reduced contamination levels to within authorized limits. Applicable DOE guidelines for protection against radiation are shown in Table 1.

Survey Methods

A comprehensive description of the survey methods and instrumentation used in this survey is given in *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program*, ORNL/TM-8600 (April 1987)[3] and *Measurement Applications and Development Group Guidelines*, ORNL-6782 (January 1995).[4]

The radiological verification survey of this property included (1) a complete surface gamma scan of the property outdoors, (2) the collection of surface and subsurface soil samples for analysis, and (3) the examination of additional data collected by BNI and Thermo NuTech. Gamma radiation levels were determined using a portable sodium iodide (NaI) gamma scintillation probe connected to a Victoreen Model 490 Thyac III ratemeter. Measurements were recorded in counts per minute (cpm) and converted to microroentgen per hour (μR/h).

Surface (0 to 15 cm) and subsurface (15 to 30 cm) soil samples were collected at various locations over the property. Systematic soil samples (VS1 through VS4) were taken irrespective of gamma exposure rates. One biased sample (VB1) was collected at the point of the highest surface gamma exposure rates in the remediated area. All soil samples were collected after excavation was completed and before a remediated area was backfilled with clean soil. Concentrations of ^{226}Ra, ^{232}Th, and ^{238}U were determined in soil samples using gamma spectrometry.

VERIFICATION SURVEY RESULTS

DOE guidelines are summarized in Table 1. Typical background radiation levels for the northern New Jersey area 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 soil.

Gamma Exposure Rate Measurements

Surface gamma exposure rates on the property generally ranged from 7 to 13 μR/h in the front and back yards, except in the remediated area where exposure rates ranged from 10 to 15 μR/h (see Fig. 2). These measurements are comparable to typical background radiation levels of 3 to 13 μR/h found in the northern New Jersey area (Table 2).

Soil Samples

Soil sample locations are shown in Fig. 2, and results of radionuclide analyses are listed in Table 3. Systematic and biased samples contained concentrations of ^{226}Ra ranging from 0.75 to 1.2 pCi/g and concentrations of ^{238}U ranging from 0.76 to 1.8 pCi/g, similar to the typical background concentrations found in the northern New Jersey area (Table 2). Concentrations of ^{232}Th in systematic samples ranged from 2.2 to 4.7 pCi/g with the highest concentration, 4.7 pCi/g, found at sample location VS3 outside the remediation area. All surface (0 to 15 cm) ^{232}Th concentrations are higher than typical background levels in the northern New Jersey area (Table 2) but below DOE applicable guidelines of 5 pCi/g averaged over the first 15 cm of soil below the surface (Table 1).

Concentration of ^{232}Th in the biased sample VB1A measured 6.1 pCi/g (gross measurement) at a depth of 0 to 15 cm. When average background for this area (Table 2) is subtracted, the value is reduced to 5.1 pCi/g, which is slightly above the guideline of 5 pCi/g.* Several 1-ft holes around sample location VB1 showed that the spot was very small and localized, occupying an area less than 1 m^2. When averaged with samples VS1, VS2, VS3, and VS4, the average guideline of 5 pCi/g averaged over a 100-m^2 area is met (Table 1). In addition, the area meets the guideline for non-homogenous contamination (Table 1): a 1-m^2 area can contain up to 50 pCi/g as long as the average guideline is also satisfied. Comparisons with additional sample results listed in the post-remedial action report (DOE/OR/21949-405)[5] support the conclusion that the property was remediated to levels below DOE guidelines.

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*For residential properties in the Lodi, New Jersey, area, the guideline for ^{232}Th is 5 pCi/g above background levels, averaged over a 100-m^2 area, for both surface and subsurface soil. *Source*: W. J. Muszynski, Deputy Regional Administrator, Environmental Protection Agency, Region II, correspondence to J. La Grone, Manager, Oak Ridge Operations Office, Department of Energy, March 1994, and J. La Grone, Manager, Oak Ridge Operations Office, Department of Energy, correspondence to W. J. Muszynski, Deputy Regional Administrator, Environmental Protection Agency, Region II, April 1995.

CONCLUSIONS

Prior to remediation, thorium residues in excess of DOE applicable guidelines were found in the eastern corner of the backyard on the property at 79 Avenue B, Lodi New Jersey. Decontamination, which consisted of excavation and removal of contaminated soil, was performed by subcontractors under the direction of BNI. This independent radiological verification survey was performed to verify that the remedial action had reduced contamination levels to within authorized limits.

The property was thoroughly investigated outdoors for radionuclide residues. Surface gamma exposure rates were below guideline levels and comparable to typical background values for the area. The results of soil radionuclide analysis for ^{238}U, ^{226}Ra, and ^{232}Th indicated that all soil concentration measurements were below limits prescribed by the DOE applicable guidelines for protection against radiation.

Analysis of data contained in the post-remedial action report (DOE/OR/21949-405)[5] and results of this independent radiological verification survey by ORNL confirm that all radiological measurements fall below the limits prescribed by DOE guidelines established for this site. The property at 79 Avenue B successfully meets the DOE remedial action objectives.

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4. *Measurement Applications and Development Group Guidelines*, ORNL-6782, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., January 1995.

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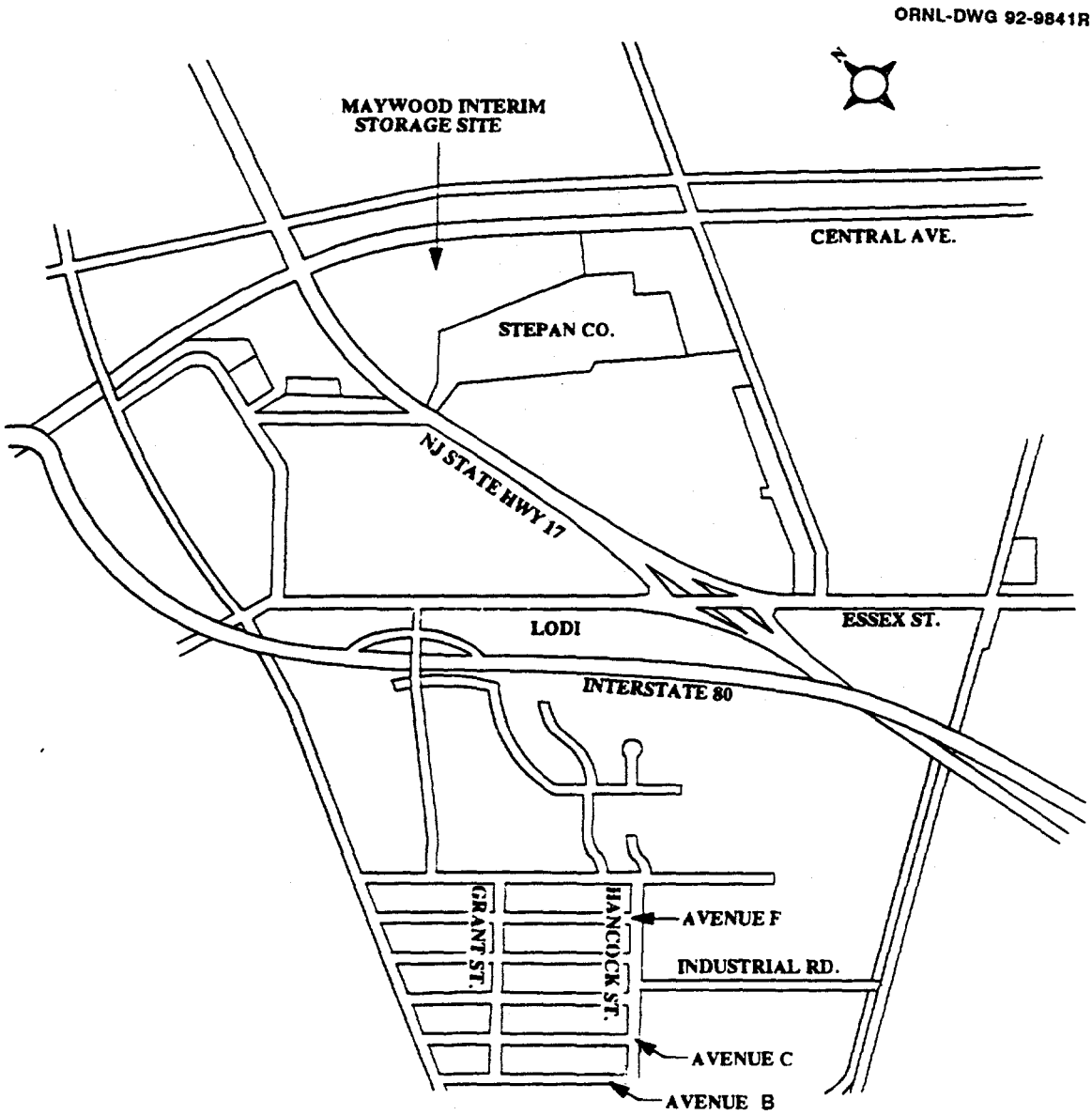

Fig. 1. Diagram showing general location of the Stepan property and the Maywood Interim Storage Site in relation to Avenue B, Lodi, New Jersey.

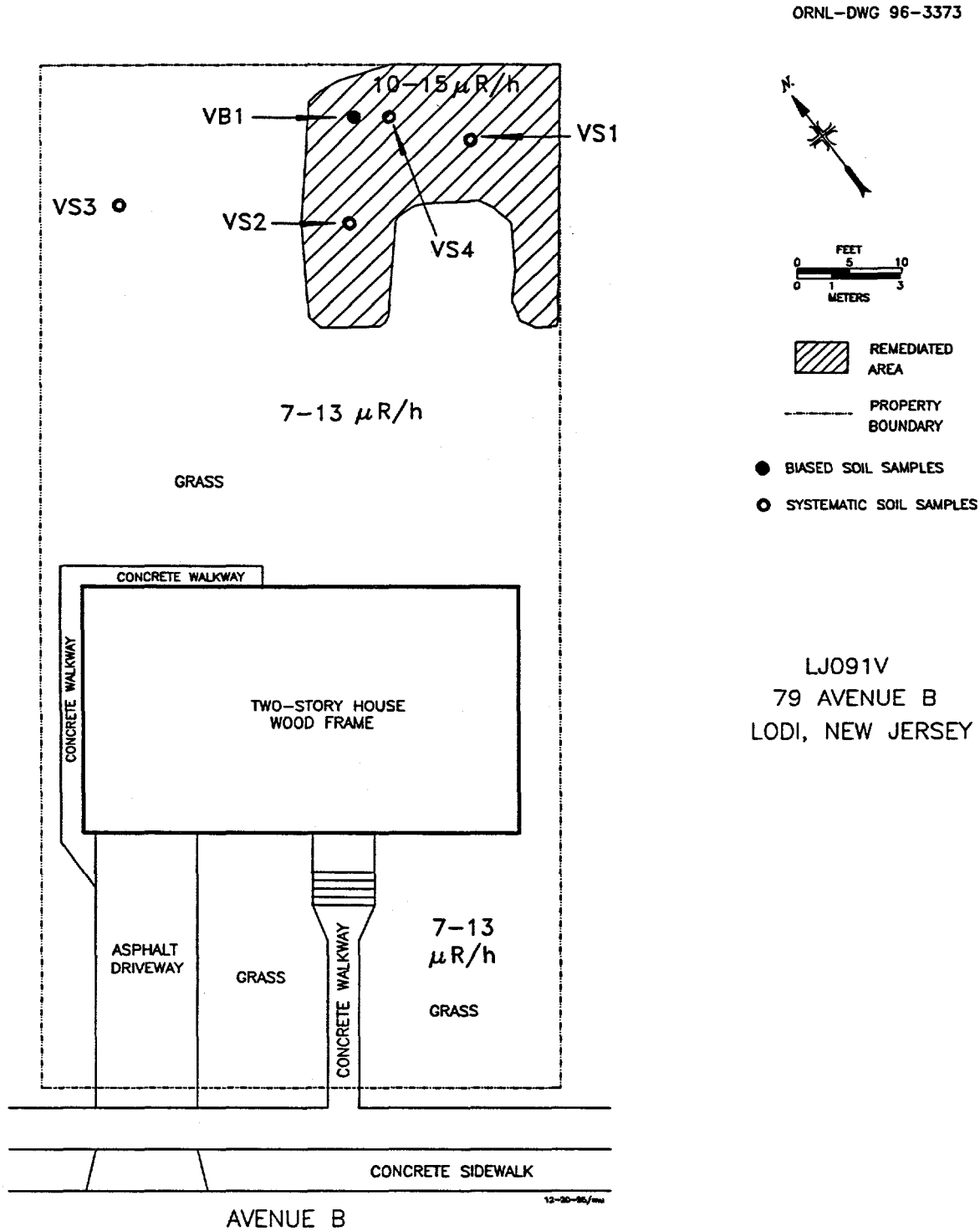

Fig. 2. Diagram of the property at 79 Avenue B, Lodi, New Jersey, showing surface gamma exposure rates and soil sampling locations.

Table 1. Applicable guidelines for protection against radiation
(Limits for uncontrolled areas)

Mode of exposure	Exposure conditions	Guideline value
Gamma radiation	Indoor gamma radiation level (above background)	20 μR/h[a]
Radionuclide concentrations in soil (generic)	Maximum permissible concentration of the following radionuclides in soil above background levels, averaged over a 100-m^2 area ^{226}Ra ^{232}Th ^{230}Th	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[b,c]
Derived concentrations	Total uranium	100 pCi/g[d]
Guideline for non-homogeneous contamination (used in addition to the 100-m^2 guideline)[e]	Applicable to locations with an area $\leq$25 m^2, with significantly elevated concentrations of radionuclides ("hot spots")	$G_A = G_i(100/A)^{1/2}$, where G_A = guideline for "hot spot" of area (A) G_i = guideline averaged over a 100-m^2 area

[a]The 20 μR/h shall comply with the basic dose limit (100 mrem/year) when an appropriate-use scenario is considered.

[b]For residential properties in the Lodi, New Jersey, area, the guideline for ^{232}Th is 5 pCi/g above background levels, averaged over a 100-m^2 area, for both surface and subsurface soil. *Source*: W. J. Muszynski, Deputy Regional Administrator, Environmental Protection Agency, Region II, correspondence to J. La Grone, Manager, Oak Ridge Operations Office, Department of Energy, March 1994, and J. La Grone, Manager, Oak Ridge Operations Office, Department of Energy, correspondence to W. J. Muszynski, Deputy Regional Administrator, Environmental Protection Agency, Region II, April 1995.

[c]The concentration of any single radionuclide above normal background levels shall not exceed the guideline value. If more than one radionuclide is present, the sum of the ratios of the measured soil concentration of each radionuclide to its corresponding guideline value shall not exceed unity.

[d]DOE guidelines for uranium are derived on a site-specific basis. A guideline of 100 pCi/g for total uranium above background levels has been approved for this site. *Source*: J. W. Wagoner II, Director, Division of Off-Site Programs, Office of Eastern Areas Programs, Office of Environmental Restoration, Department of Energy, memorandum to L. Price, Oak Ridge Operations Office, Department of Energy, April 1995.

[e]DOE guidelines specify that every reasonable effort shall be made to identify and to remove any source that has a concentration exceeding 30 times the guideline value, irrespective of area. *Source*: Adapted from *Revised Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites*, April 1987.

Sources: Adapted from U.S. Department of Energy, DOE Order 5400.5, April 1990; 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; and U.S. Department of Energy, *Radiological Control Manual*, DOE/EH-0256T (DOE N 5480.6), June 1992.

Table 2. Background radiation levels and concentrations of selected radionuclides in soil, northern New Jersey area

Type of radiation measurement or sample	Radiation level or radionuclide concentration	
	Range	Average
Gamma exposure rate at 1 m above ground surface (μR/h)	3–13[a]	8[b]
Concentration of radionuclides in soil (pCi/g)[c]		
^{226}Ra	0.55–1.4	1.0
^{232}Th	0.53–1.5	1.0
^{238}U	0.46–1.4	1.0

[a]Values obtained from 14 locations in the northern New Jersey area. *Source:* T. E. Myrick and B. A. Berven, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, ORNL/TM-7343, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., November 1981.

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

[c]Values obtained from 15 locations in northern New Jersey area. *Source:* T. E. Myrick and B. A. Berven, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, ORNL/TM-7343, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., November 1981.

Table 3. Concentrations of radionuclides in soil at 79 Avenue B, Lodi, New Jersey (LJ091)

Sample number[a]	Grid location[b]	Depth[c] (cm)	Radionuclide concentration (pCi/g)[d]		
			^{226}Ra	^{232}Th	^{238}U
		Systematic soil samples[e]			
VS1	N747895 E2162625	0–15	0.75±0.09	2.5±0.2	1.5 ±0.4
VS2	N797898 E2162612	0–15	0.86±0.05	2.2±0.08	0.76±0.4
VS3	N747912 E2162592	0–15	1.2 ±0.1	4.7±0.2	1.8 ±0.4
VS4	N747904 E2162621	0–15	0.97±0.1	2.7±0.2	1.5 ±0.5
		Biased soil sample[f]			
VB1A	N747905 E2162631	0–15	0.96±0.06	6.1±0.1	1.3 ±0.2
VB1B	N747905 E2162631	15–30	0.77±0.1	3.5±0.2	0.96±0.2

[a]Sample locations are shown on Fig. 2.

[b]Grid location based on state plane.

[c]Samples taken after excavation completed and before a remediated area was backfilled with clean soil.

[d]Indicated counting error is at the 95% confidence level (±2σ). Background concentrations (see Table 2) have not been subtracted.

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

[f]Biased sample taken from area with very slightly elevated surface gamma exposure rates.

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