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Results of the Independent Radiological Verification Survey at 7 Hancock Street, Lodi, New Jersey (LJ027V)

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DRAFT

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LIFE SCIENCES DIVISION

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ABSTRACT

This report documents the results of an independent radiological verification survey of the property at 7 Hancock Street, Lodi, New Jersey. The survey was conducted in August 1998 by a team from the Life Sciences Division of the Oak Ridge National Laboratory (ORNL). Independent verification of completed cleanup work at DOE FUSRAP sites is performed and documented according to prescribed procedures prior to certification of the property for release for unrestricted use. Prior to remediation, significant concentrations of thorium and radium were found in portions of the yard on this property.

A thorough investigation of the outdoor property at 7 Hancock Street was conducted after remediation to confirm that all radioactive residues above applicable guidelines had been removed by the project management contractor. The survey included directly measured radiation levels and soil sample collection and analysis to determine concentrations of thorium and certain other radionuclides, and to compare these data to the guidelines.

The results of the independent verification survey of the property demonstrate that all contaminated areas have been remediated to radionuclide concentrations and activity levels below the applicable guideline limits. Furthermore, from a visual examination of the site and a review of the project management contractor's radiological survey data, it is concluded that the remediation activities at 7 Hancock Street, Lodi, New Jersey, satisfy the objectives of the FUSRAP program. *

*The post remedial action report for this property, which will be issued by the remedial action contractor, has not been received or reviewed by ORNL. When this document is received and reviewed, and USACE comments are incorporated, a final report will be issued.

Results of the Independent Radiological Verification Survey at 7 Hancock Street, Lodi, New Jersey (LJ027V)*

INTRODUCTION

Processing of thorium ores was performed in Maywood, New Jersey between 1916 and 1959 by the Maywood Chemical Works (MCW)[1], partially under contract to the Atomic Energy Commission (AEC). In 1959, the MCW ceased thorium processing and the 30-acre property was sold to Stepan Chemical Company. During the early years of operation, MCW stored the wastes and residues in low-lying areas west of the processing facilities, in what is now called the Maywood Interim Storage Site (MISS). 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.

Residuals containing radioactive materials subsequently migrated off-site to the surrounding area, and the Stepan property and several vicinity properties were designated by Congress for remedial action as a result of the 1984 Energy and Water Development Appropriations Act, and were included as a decontamination research and development project under the Department of Energy's (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP).

Some area residents had used the sand-like wastes as mulch in their yards. Additionally, some of the contaminated wastes were apparently eroded from the site and carried downstream by Lodi Brook, a small stream flowing south from Maywood with its headwaters near the Stepan waste storage site. From the 1940s to the 1970s, the stream was diverted underground and its course altered several times, resulting in the movement of contaminated soil to the surface where, in some cases, it was covered over or mixed with clean fill. Thus, even in the absence of surface contamination, some properties in question were drilled in search of former stream bed material. At the request of the DOE, Oak Ridge National Laboratory (ORNL) conducted investigative radiological surveys of this and other properties surrounding the former processing plant.

In October 1985, a radiological survey and sampling of the ground surface was conducted on this private, residential property by the Measurement Applications and Development (MAD) Group at ORNL.[2] In September 1986, a follow-up subsurface

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*The survey was performed by members of the Measurement Applications and Development Group of the Life Sciences Division of Oak Ridge National Laboratory under DOE contract DE-AC05-96OR22464.

investigation was performed. Results of the surveys indicated that the property contained significant concentrations of ^{226}Ra and ^{232}Th in the soil. Elevated gamma levels were measured in auger holes in the backyard. These data and data on the adjacent property (5 Hancock St.) suggested that there was significant subsurface contamination on this property, and it was recommended that it be included in the remedial action program.

In the spring of 1998, the project management contractor for FUSRAP, Bechtel National, Incorporated (BNI), directed the decontamination of the 7 Hancock Street property to current guidelines. The location of Hancock Street and Lodi, New Jersey, relative to the Stepan property and the DOE-owned Maywood Interim Storage Site is shown in Fig. 1.

The radiological verification survey was conducted in August 1998, shortly after remediation efforts of the property, by a team from ORNL's MAD Group. Verification surveys are performed in response to the Environmental Restoration Program requirements. These requirements dictate that independent verification of completed cleanup work at FUSRAP sites shall be performed and documented according to prescribed procedures prior to certification of the property for release for unrestricted use.[3,4]

This report documents the results of an independent radiological verification survey of the private, residential property at 7 Hancock Street. The verification survey was conducted to confirm that radioactive residuals previously identified on the grounds had been remediated to bring the property into compliance with current guidelines. Radiological guidelines are currently those provided by DOE for these FUSRAP properties.

The property at 7 Hancock Street is a one and one-half story brick frame house with basement. A concrete patio in back of the house and an asphalt drive to a garage in front were originally located in the excavated areas surrounding the house.

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 condition of the property that is to be verified, and (2) that the remedial action reduced contamination levels to within authorized limits. Applicable 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)[5] and *Measurement Applications and Development Group Guidelines*, ORNL-6782 (January 1995).[6]

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 its radiological support subcontractor, Scientific Ecology Group, Inc. (SEG). 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 microroentgens per hour (μR/h.)

Much of the front and back yards, in addition to the area under the foundation of the house, was excavated and remediated by BNI (Fig. 2). Surface (0 to 15 cm) and subsurface (15-60 cm) soil samples were collected at various locations, mainly in the excavated area. Excavations were up to 5 ft deep. Seven soil samples (VS2 through VS8) were taken in the front, side and back yards irrespective of gamma exposure rates (VS1 was renumbered VS8). Biased samples VB1 and VB2 were taken 4 and 5 ft below grade in the front yard where slightly elevated gamma levels had been detected. One auger hole ~4.5 ft deep was drilled in the front yard (see Fig. 2). 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 AND ANALYSIS

Table 1 summarizes current guidelines for sites included within FUSRAP and Table 2 lists typical background radiation levels for the Lodi, New Jersey area. These data are provided for purposes of comparison with the survey results presented in this section. All measurements presented in this report are gross (total) readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations in soil samples.

Gamma Exposure Rates

Gamma measurements were recorded in counts per minute (cpm) and converted to microroentgen per hour (μR/h). Surface gamma exposure rates generally ranged from 10 to 18 µR/h in the excavated basement area and in the front and back yards. Gamma rates were up to 22 µR/h in the garage area (see Fig. 2). An auger hole was dug and

logged in the front yard in the excavated area. Gamma readings in the hole were 12 to 15 µR/h. Because these measurements are slightly above the natural background levels for this area of New Jersey (Table 2), biased as well as systematic soil samples were taken from these areas to analyze for radionuclide concentrations.

Soil Samples

Soil samples were collected from the excavated areas in the front, side, and back yards, and under the foundation of the house. Systematic samples are collected without regard to measured gamma radiation levels. Biased samples are collected at locations of very slightly elevated surface gamma exposure rates. The samples were analyzed for radium (^{226}Ra), thorium (^{232}Th), and uranium (^{238}U). Soil sample locations are shown on Fig. 2, and results of radionuclide analyses are summarized in Table 3.

Radionuclide concentrations of ^{226}Ra in both systematic and biased samples ranged from 0.52 to 2.2 pCi/g. Concentrations of ^{232}Th in systematic and biased samples ranged from 0.60 to 2.0 pCi/g. These values are slightly above background concentrations for the area, but well below the current guidelines for these radionuclides in soil. The guideline for ^{226}Ra is 5 and 15 pCi/g above background averaged over 100 m^2 for surface and subsurface soil, respectively. For ^{232}Th, the guideline is 5 pCi/g above background for both surface and subsurface soil for this site (see Table 1).

Concentrations of ^{238}U in soil ranged from 0.89 to 2.3 pCi/g in both systematic and biased samples. These values are well below the site specific guidelines of 100 pCi/g for total uranium (50 pCi/g for ^{238}U) averaged over 100 m^2 for uranium in soil (Table 1). Soil analyses are shown in Table 3.

CONCLUSIONS

Prior to remediation, subsurface radium and thorium residues in excess of applicable guidelines were indicated on the property at 7 Hancock Street, Lodi, New Jersey. Decontamination, which consisted of excavation and removal of contaminated soil and backfilling with clean soil, was performed by subcontractors under the direction of BNI.

The excavated and remediated areas on the grounds of the property were thoroughly investigated 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 applicable guidelines for protection against radiation.

Results of the independent radiological verification survey of this property by ORNL confirm that the remedial action has reduced contamination levels to within authorized limits.

Based on a review of the project management contractor's radiological survey data and post remedial action report, and confirmed by the verification survey data, all radiological measurements fall below the limits prescribed by radiological guidelines established for this site, and the property at 7 Hancock Street, Lodi, New Jersey, successfully meets the remedial action objectives.*

REFERENCES

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4. R. P. Whitfield, Deputy Assistant Secretary for Environmental Restoration, U.S. DOE, memorandum to J. J. Fiore, Director, Office of Eastern Area Programs, Office of Environmental Restoration, U.S. DOE, May 6, 1992.

5. 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,* ORNL/TM-8600, Martin Marietta Energy Systems, Inc., Oak Ridge Natl. Lab., April 1987.

6. Oak Ridge National Laboratory, Health Sciences Research Division, *Measurement Applications and Development Group Guidelines,* ORNL-6782, Martin Marietta Energy Systems, Inc., January 1995.

*The post remedial action report for this property, which will be issued by the remedial action contractor, has not been received or reviewed by ORNL. When this document is received and reviewed, and USACE comments are incorporated, a final report will be issued.

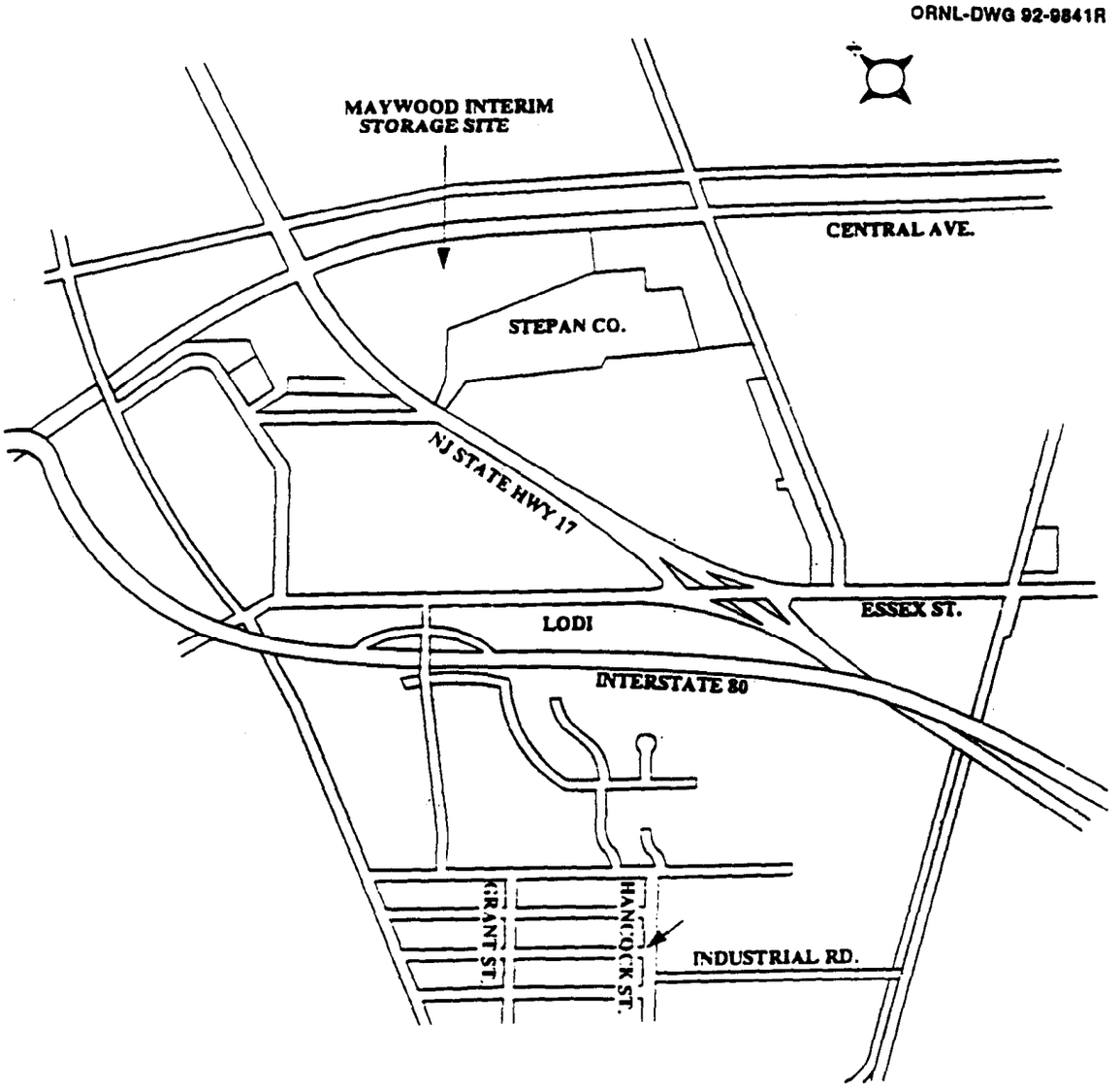

Fig. 1. Diagram showing general location of the **Stepan** property and the **Maywood** Interim Storage Site in relation to Hancock Street, Lodi, New Jersey

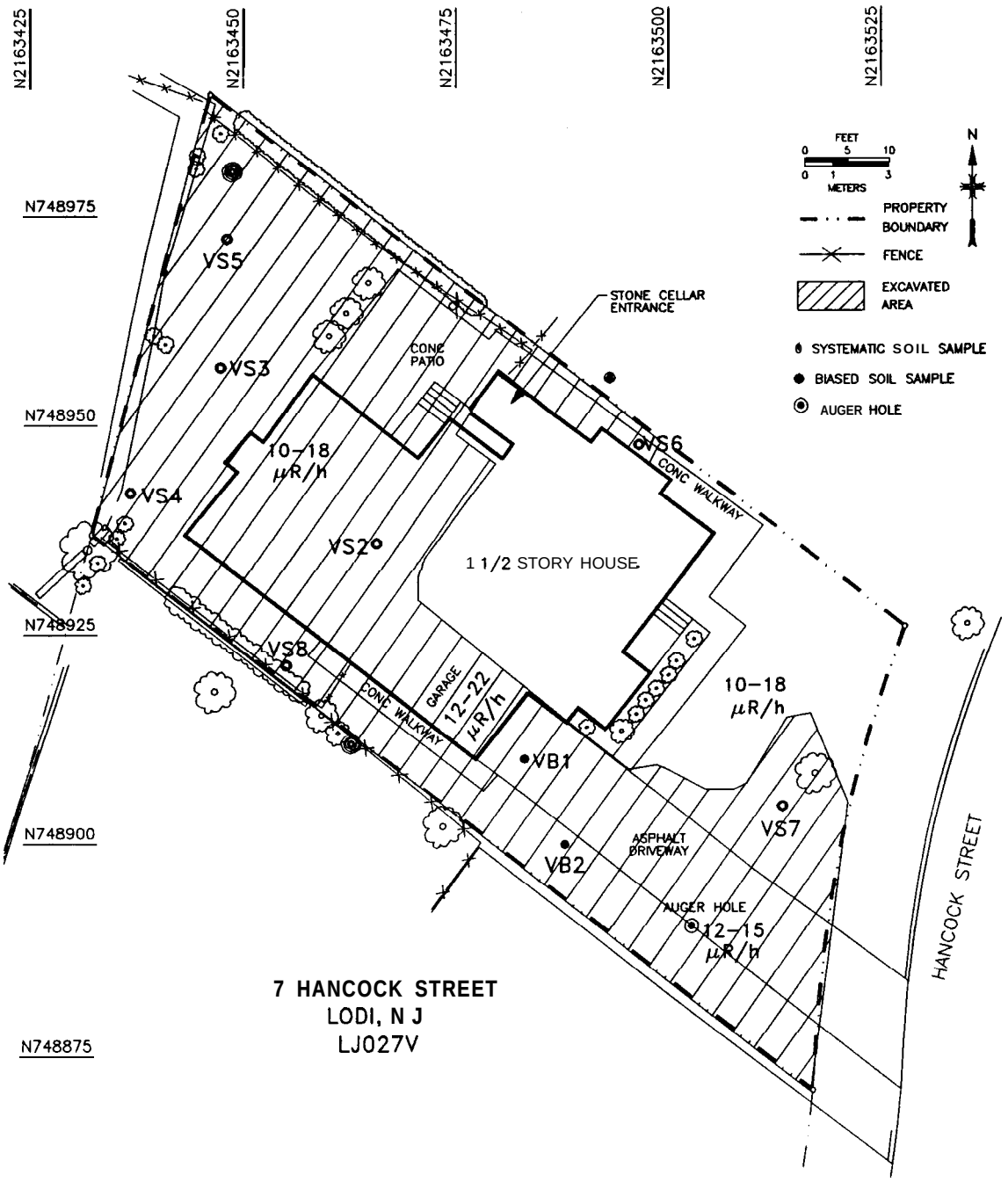

Figure 2. Diagram of the property at 7 Hancock Street, Lodi, New Jersey, **showing gamma measurements and locations of soil samples.**

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

Mode of exposure	Exposure conditions	Guideline value
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[a,b]
Derived concentrations	Total uranium	100 pCi/g[c]
Guideline for non-homogeneous contamination (used in addition to the 100-m^2 guideline)[d]	Applicable to locations with an area 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]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. *Sources:* 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.

[b]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.

[c]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, Environmental Restoration, Department of Energy, memorandum to L. Price, Oak Ridge Operations Office, Department of Energy, April 1994.

[d]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, *Radiation Protection of the Public and the Environment,* DOE Order 5400.5, April 1990 and U.S. Department of Energy, *Guidelines for Residual Radioactive Material at FUSRAP and Remote SFMP Sites,* Rev. 2, March 1987; and *U. S. Department of Energy Radiological Control Manual,* DOE N5480.6 (DOE/EH-256T), June 1992.

Table 2. Background radiation levels and concentrations of selected radionuclides in soil samples in the 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 dry wt)[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, B. A. Berven, and F. F. Haywood, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, ORNL/TM-7343, Union Carbide Corp., Oak Ridge Natl. Lab., November 1981.

[b]U.S. Department of Energy, *Radiological Survey of the Middlesex Municipal Landfill, Middlesex, New Jersey*, DOE/EV-0005/20, April 1980.

[c]Values obtained from 15 locations in the northern New Jersey area. *Source:* Myrick et al., ORNL/TM-7343, 1981.

Table 3. Concentrations of selected radionuclides in soil samples collected at 7 Hancock Street, Lodi, New Jersey (LJ027V)

Sample ID[b]	Depth (cm)[c]	Radionuclide concentration (pCi/g)[a]		
		^{232}Th	^{238}U	^{226}Ra
		Systematic samples[d]		
VS2	0–15	1.1 ± 0.2	2.0 ± 1.3	1.1 ± 0.1
VS3	0-15	0.72 ± 0.1	1.5 ± 0.3	0.52 ± 0.1
VS4	0-15	0.99 ± 0.1	1.5 ± 0.3	0.84 ± 0.1
VS5	0-15	0.60 ± 0.1	1.7 ± 0.2	0.79 ± 0.1
VS6	0-15	2.0 ± 0.2	1.9 ± 0.2	2.0 ± 0.2
VS7	0-15	1.7 ± 0.2	1.[illegible] ± 0.2	2.2 ± 0.2
VS8	0-15	0.68 ± 0.[illegible]	0.97 ± 0.3	0.58 ± 0.1
		Biased samples[e]		
VB1	0-15	[illegible].6 ± 0.2	1.6 ± 0.2	1.8 ± 0.1
VB2A	0-15	1.7 ± 0.2	1.5 ± 1.4	1.9 ± 0.1
VB2B	15-30	1.7 ± 0.2	1.6 ± 0.3	1.9 ± 0.2
VB2C	[illegible]-45	1.5 ± 0.2	2.3 ± 0.5	1.7 ± 0.2
VB2D	45-60	1.2 ± 0.2	0.89 ± 0.3	1.1 ± 0.1

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

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

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

[d]Systematic samples are collected without regard to measured gamma radiation levels.

[e]Biased samples are collected at locations of very slightly elevated surface gamma exposure rates.