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Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-81OR20722

RADIOLOGICAL CHARACTERIZATION REPORT FOR THE RESIDENTIAL PROPERTY AT 16 LONG VALLEY ROAD

Lodi, New Jersey

November 1988

Bechtel National, Inc.

057116

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NOV 1 [illegible] 1988

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Attention: Peter J. Gross, Director
Technical Services Division

Subject: Bechtel Job No. 14501, FUSRAP Project
DOE Contract No. DE-AC05-81OR20722
Publication of the Radiological Characterization Reports for the Residential Properties at 7 Branca Court, 11 Branca Court, 16 Long Valley Road, 18 Long Valley Road, 20 Long Valley Road, 22 Long Valley Road, 26 Long Valley Road, 11 Redstone Lane, and the Lodi Municipal Park, in Lodi, New Jersey
Code: 7310/WBS: 138

Reference: Letter from S. K. Oldham (DOE), 88-669 dated October 19, 1988, to B. W. Clemens (BNI), "Final Comments on the Prepublication Draft of the Radiological Characterization Reports for the Residential Properties at 7 Branca Court, 11 Branca Court, 16 Long Valley Road, 18 Long Valley Road, 20 Long Valley Road, 22 Long Valley Road, 26 Long Valley Road, 11 Redstone Lane, and the Lodi Municipal Park, in Lodi, New Jersey," CCN 056527.

Dear Mr. Gross:

Enclosed are six copies each of the published version of the nine characterization reports listed above. Incorporated in these reports are comments based on the reference above and additional discussions between N. C. Ring and S. K. Oldham of your office and J. D. Berger of ORAU.

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These publications also incorporate changes in wording regarding site release as requested by S. K. Oldham and A. Avel.

Please notify me should you require additional copies (6-1677).

Very truly yours,

D Sherwood

B. W. Clemens for
Project Manager - FUSRAP

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DOE/OR/20722-169

RADIOLOGICAL CHARACTERIZATION REPORT FOR THE RESIDENTIAL PROPERTY AT 16 LONG VALLEY ROAD LODI, NEW JERSEY

NOVEMBER 1988

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

N. C. Ring and S. K. Livesay

Bechtel National, Inc.

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Bechtel Job No. 14501

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ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm	disintegrations per minute
ft	foot
h	hour
in.	inch
l	liter
l/min	liters per minute
m	meter
m^2	square meter
MeV	million electron volts
μR/h	microroentgens per hour
mi	mile
mi^2	square mile
min	minute
mrad/h	millirad per hour
mrem	millirem
mrem/yr	millirem per year
pCi/g	picocuries per gram
pCi/l	picocuries per liter
WL	working level
yd	yard
yd^3	cubic yards

1.0 INTRODUCTION AND SUMMARY

1.1 INTRODUCTION

The 1984 Energy and Water Appropriations Act authorized the U.S. Department of Energy (DOE) to conduct a decontamination research and development project at four sites, including the site of the former Maywood Chemical Works (now owned by the Stepan Company) and its vicinity properties. The work is being administered by the Formerly Utilized Sites Remedial Action Program (FUSRAP), one of two remedial action programs under the direction of the DOE Division of Facility and Site Decommissioning Projects. The residential properties in Lodi, New Jersey, are included in FUSRAP as vicinity properties. Figure 1-1 shows the location of the Lodi vicinity properties in relation to the former Maywood Chemical Works.

The United States Government initiated FUSRAP in 1974 to identify, clean up, or otherwise control sites where low activity radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program or from commercial operations that resulted in conditions Congress has mandated DOE to remedy (Ref. 1).

FUSRAP is currently being managed by DOE Oak Ridge Operations. As the Project Management Contractor for FUSRAP, Bechtel National, Inc. (BNI) is responsible to DOE for planning, managing, and implementing FUSRAP.

1.2 PURPOSE

The purpose of the 1986 survey performed by BNI was to locate the horizontal and vertical boundaries of radionuclide concentrations exceeding remedial action guidelines.

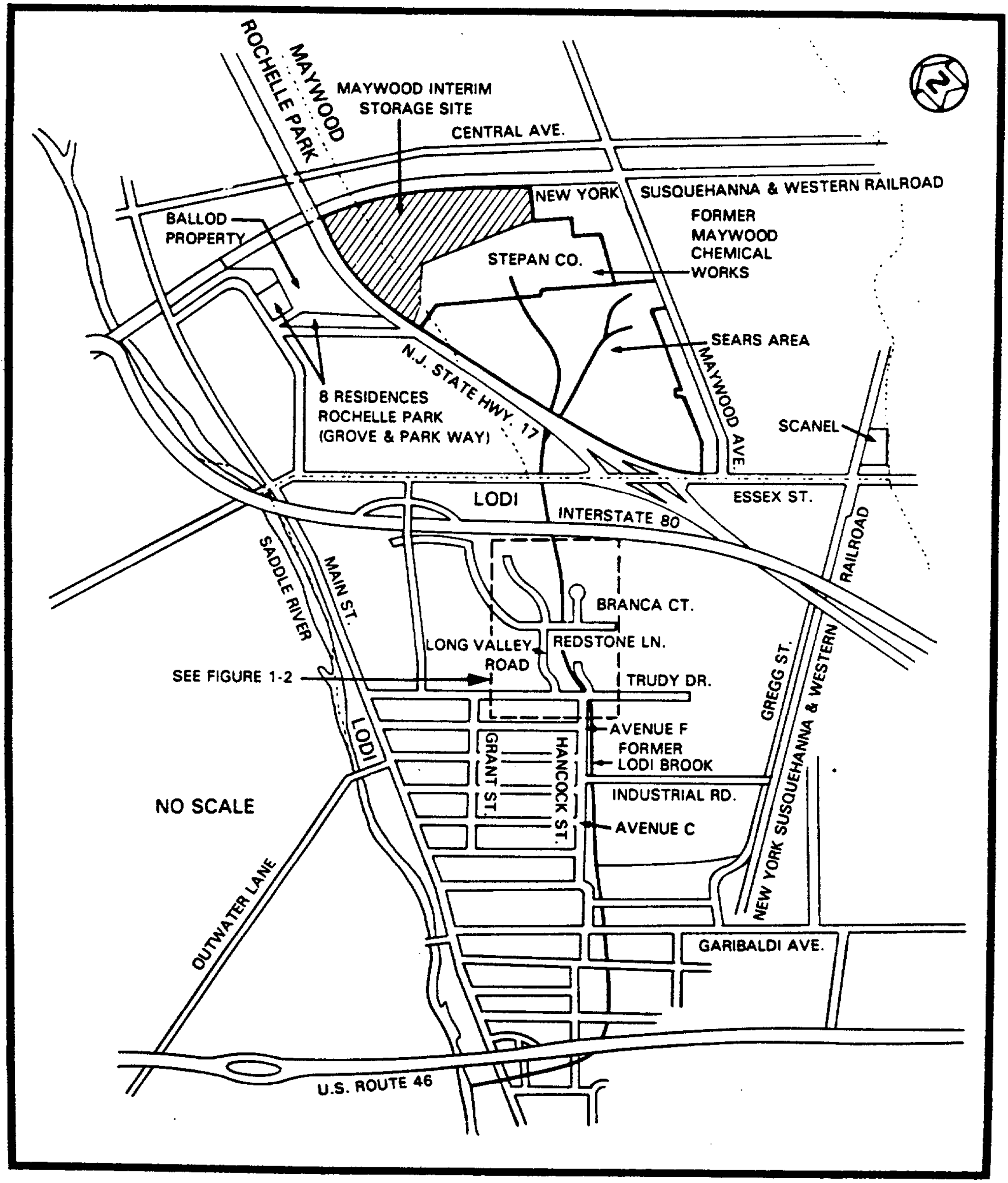

FIGURE 1-1 LOCATION OF LODI VICINITY PROPERTIES

123.2

1.3 SUMMARY

This report summarizes the procedures and results of the radiological characterization of the property at 16 Long Valley Road (Figure 1-2) in Lodi, New Jersey, conducted from September through December 1986.

Ultimately, the data generated during the radiological characterization will be used to define the complete scope of remedial action necessary to release the site.

This characterization confirmed that thorium-232 is the primary radioactive contaminant at this property. Results of surface soil samples for 16 Long Valley Road showed maximum concentrations of thorium-232 and radium-226 to be 27.2 and 2.5 pCi/g, respectively.

The maximum concentration of uranium-238 in surface soil samples was less than 15.3 pCi/g. Subsurface soil sample concentrations ranged from 1.4 pCi/g to 10.4 pCi/g for thorium-232 and from 0.7 to less than 1.7 pCi/g for radium-226. The average background level in this area for both radium-226 and thorium-232 is 1.0 pCi/g. The concentrations of uranium-238 in subsurface soil samples ranged from less than 5.7 to 19.3 pCi/g. Because the major contaminants at the vicinity properties are thorium and radium, the decontamination guidelines provide the appropriate guidance for the cleanup activities. DOE believes that these guidelines are conservatively low for considering potential adverse health effects that might occur in the future from any residual contamination. The dose contributions from uranium and any other radionuclides not numerically specified in these guidelines are not expected to be significant following decontamination. In addition, because the vicinity properties will be decontaminated in a manner to reduce future doses to levels that are as low as reasonably achievable (ALARA), DOE will ensure that most of the radioactivity present at these vicinity properties will be removed during the cleanup (Ref. 2).

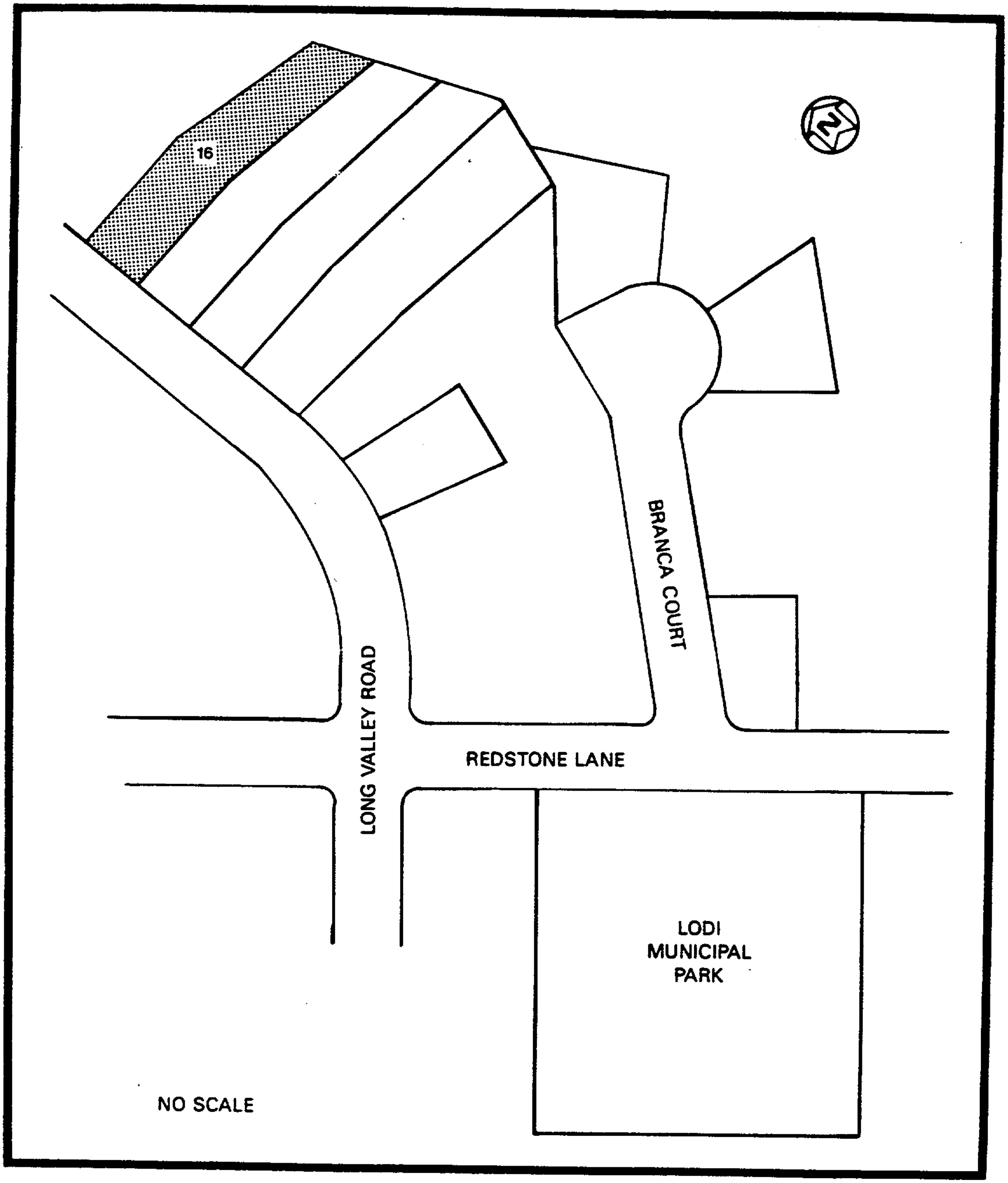

FIGURE 1-2 LOCATION OF 16 LONG VALLEY ROAD

Soil analysis data for this property showed surface contamination. Subsurface investigation by gamma logging indicated contamination to a depth of 1.0 ft.

Exterior gamma radiation exposure rates ranged from 8 to 34 μR/h, including background. The indoor measurement showed a rate of 5 μR/h, including background.

The radon-222 measurements inside the residence indicated a concentration less than 0.2 pCi/l, which is within the DOE guideline of 3.0 pCi/l.

Measurements for radon daughters ranged from 0.001 to 0.002 WL, and measurements for thoron daughters ranged from less than the lower limit of detection to 0.0007 WL.

2.0 SITE HISTORY

The Maywood Chemical Works was founded in 1895. During World War I (in 1916), the company began processing thorium from monazite sand for use in manufacturing gas mantles for various lighting devices. The company continued this work until 1956. Process wastes from manufacturing operations were pumped to two areas surrounded by earthen dikes (northern and southern diked areas) on property west of the plant. Subsequently, some of the contaminated wastes migrated onto adjacent and vicinity properties.

In 1928 and again between 1944 and 1946, some of the residues from the processing operations were moved from the company's property and used as mulch and fill in nearby low-lying areas. The fill material consisted of tea and cocoa leaves mixed with other material resulting from operations at the plant and apparently also contained thorium process wastes (Ref. 3).

It is not known for certain how the properties in Lodi were contaminated. According to an area resident, fill from an unknown source was brought to Lodi and spread over large portions of the previously low-lying and swampy area. For several reasons, however, a more plausible explanation is that the contamination migrated along a drainage ditch originating on the Maywood Chemical Works property. It can be seen from photographs and tax maps of the area that the course of a previously existing stream known as Lodi Brook, which originated at the former Maywood Chemical Works, generally coincides with the path of contamination in Lodi. The brook was subsequently replaced by a storm drain system as the area was developed. Secondly, samples taken from Lodi properties indicate elevated concentrations of a series of elements known as rare earths. Rare earth elements are typically found in monazite sands, which also include thorium. This type of sand was feedstock at the Maywood Chemical Works, and elevated levels are known to exist in the by-product of the extraction process. Third, the ratio of thorium to other radionuclides found in these Lodi properties is comparable to the ratio found in contaminated material on other properties in Lodi (Ref. 4). And finally, long-time residents of Lodi recall chemical odors in and around the brook in Lodi and steam rising off the water. These observations suggest discharges of contaminants occurring upstream.

The Stepan Chemical Company (now called the Stepan Company) purchased Maywood Chemical Works in 1959. The Stepan Company itself has never been involved in the manufacture or processing of any radioactive materials (Ref. 5).

2.1 PREVIOUS RADIOLOGICAL SURVEYS

January 1981 - The Nuclear Regulatory Commission (NRC) directed that a survey of the Stepan Company property and its vicinity be conducted. Using the Stepan Company plant as the center, a 4-mi^2 aerial survey conducted by the EG&G Energy Measurements Group identified anomalous concentrations of thorium-232 to the north and south of the Stepan Company property. The Lodi residential properties were included in this survey (Ref. 6).

June 1984 - In June 1984, Oak Ridge National Laboratory (ORNL) conducted a "drive by" survey of Lodi using its "scanning van." Although not comprehensive, the survey indicated areas requiring further investigation (Ref. 7).

September 1986 - At the request of DOE, ORNL conducted radiological surveys of the vicinity properties in Lodi, New Jersey, for the purpose of determining which properties contained radioactive contamination in excess of guidelines and would require remedial action (Ref. 8).

2.2 REMEDIAL ACTION GUIDELINES

Table 2-1 summarizes the DOE guidelines for residual contamination. The thorium-232 and radium-226 limits listed in Table 2-1 will be used to determine the extent of remedial action required at the vicinity properties. DOE developed these guidelines to be consistent with the guidelines established by the Environmental Protection Agency (EPA) for the Uranium Mill Tailings Remedial Action Program.

TABLE 2-1

SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES FOR THE LODI VICINITY PROPERTIES

BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr.

SOIL (LAND) GUIDELINES (MAXIMUM ALLOWABLE LIMITS)

Radionuclide	Soil Concentration (pCi/g) above background[a,b,c]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.

STRUCTURE GUIDELINES (MAXIMUM ALLOWABLE LIMITS)

Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL.[d] In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site shall not exceed the background level by more than 20 μR/h.

Indoor/Outdoor Structure Surface Contamination

	Allowable Residual Surface Contamination[e] (dpm/100 cm²)		
Radionuclide[f]	Average[g,h]	Maximum[h,i]	Removable[h,j]
Transuranics, Ra-226, Ra-228, Th-230, Th-228 Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224 U-232, I-126, I-131, I-133	1,000	3,000	200

Indoor/Outdoor Structure Surface Contamination (continued)

Radionuclide[f]	Allowable Residual Surface Contamination[e] ($dpm/100\ cm^2$) Average[g,h]	Maximum[h,i]	Removable[h,j]
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β-γ	15,000 β-γ	1,000 β-γ

[a]These guidelines take into account ingrowth of radium-226 from thorium-230 and of radium-228 from thorium-232, and assume secular equilibrium. If either thorium-230 and radium-226 or thorium-232 and radium-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that the dose for the mixtures will not exceed the basic dose limit.

[b]These guidelines represent residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous $100\text{-}m^2$ surface area.

[c]Localized concentrations in excess of these limits are allowable provided that the average concentration over a $100\text{-}m^2$ area does not exceed these limits.

[d]A working level (WL) is any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of 1.3×10^5 MeV of potential alpha energy.

[e]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[f]Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[g]Measurements of average contamination should not be averaged over more than 1 m^2. For objects of less surface area, the average shall be derived for each such object.

[h]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[i]The maximum contamination level applies to an area of not more than 100 cm^2.

[j]The amount of removable radioactive material per 100 cm^2 of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

3.0 HEALTH AND SAFETY PLAN

BNI is responsible for protecting the health of personnel assigned to work at the site. As such, all subcontractors and their personnel are required to comply with the provisions of the applicable project instructions cited in this section or as directed by the on-site BNI representative.

3.1 SUBCONTRACTOR TRAINING

Before the start of work, all subcontractor personnel attend an orientation session presented by the BNI representative to explain the nature of the material to be encountered in the work and the required personnel monitoring and safety measures.

3.2 SAFETY REQUIREMENTS

Subcontractor personnel must comply with the following BNI requirements.

- o Bioassay - Subcontractor personnel submit bioassay samples before or at the beginning of on-site activity, upon completion of the activity, and periodically during site activities as requested by BNI.
- o Protective Clothing/Equipment - Subcontractor personnel are required to wear the protective clothing/equipment specified in the subcontract or as directed by the BNI representative.
- o Dosimetry - Subcontractor personnel are required to wear, and return daily, the dosimeters and monitors issued by BNI.
- o Controlled Area Access/Egress - Subcontractor personnel and equipment entering areas wherein access and egress are controlled for radiation and/or chemical safety purposes are surveyed by the BNI representative for contamination before leaving those areas.
- o Medical Surveillance - Upon written direction from BNI, subcontractor personnel who work in areas where hazardous chemicals might exist are given a baseline and periodic health assessment defined in BNI's Medical Surveillance Program.

Radiation and/or chemical safety surveillance of all activities related to the scope of work is under the direct supervision of personnel representing BNI.

The health physics requirements for all activities involving radiation or radioactive material are defined in Project Instruction No. 20.01, the Project Radiation Protection Manual and implementing procedures.

The industrial hygiene requirements for activities involving chemicals or chemically contaminated materials are defined in Project Instruction No. 26.00, the Environmental Hygiene Manual and implementing procedures.

Copies of these project instructions and manuals are located on-site for the use of subcontractor personnel.

4.0 CHARACTERIZATION PROCEDURES

A master grid was established by the surveyor; BNI's radiological support subcontractor, Thermo Analytical/Eberline (TMA/E), established a grid on individual properties. The size of the grid blocks is adjusted to adequately characterize each property. The grid origin allows the grid to be reestablished during remedial action and is correlated with the New Jersey state grid system. All data correspond to coordinates on the characterization grid. The grid and its east and north coordinates are shown on all figures of the property (Sections 4 and 5).

4.1 FIELD RADIOLOGICAL CHARACTERIZATION

4.1.1 Measurements Taken and Methods Used

An initial walkover survey using unshielded gamma scintillation detectors (2-in. by 2-in. thallium-activated sodium iodide probe) to identify areas of elevated radionuclide activity was performed. Near-surface gamma measurements taken using a cone-shielded gamma scintillation detector were also used in determining areas of surface contamination. Using the shielded detector ensured that the majority of the radiation detected by the instrument originated from the ground directly beneath the unit. Shielding against lateral gamma flux, or shine, from nearby areas of contamination minimized potential sources of error in the measurements. The measurements were taken 12 in. above the ground at the intersections of 10-ft grid lines. The shielded detector was calibrated at the Technical Measurements Center (TMC) in Grand Junction, Colorado, to provide a correlation of counts per minute (cpm) to picocuries per gram (pCi/g). This calibration demonstrated that 11,000 cpm corresponds to the DOE guideline of 5 pCi/g plus local average background of 1 pCi/g for thorium-232 in surface soils (Ref. 9).

A subsurface investigation was conducted to determine the depth to which the previously identified surface contamination extends and to locate subsurface contamination where there is no surface manifestation. The subsurface characterization consisted of drilling and gamma logging eight boreholes (Figure 4-1) using either a 3-in.- or 6-in.-diameter auger bit; holes were drilled to depths determined in the field by the radiological and geological support representatives.

The downhole gamma logging technique was used because the procedure can be completed more quickly than collecting soil samples, and it eliminates the need for analyzing these samples in a laboratory. A 2-in. by 2-in. sodium iodide gamma scintillation detector was used to perform the downhole logging. The instrument was calibrated at TMC where it was determined that a count rate of approximately 40,000 cpm corresponds to the 15-pCi/g subsurface contamination guideline for thorium-232. This relationship has also been corroborated in results from previous characterizations where thorium-232 was found (Ref. 9).

Gamma radiation measurements were taken at 6-in. vertical intervals, and determined the depth and concentration of the contamination. The gamma logging data were reviewed to identify trends, regardless of whether concentrations exceeded the guidelines.

4.1.2 Sample Collection and Analysis

To identify surface areas where the level of contamination exceeded the DOE guideline of 5 pCi/g for thorium-232, areas with measurements of more than 11,000 cpm were plotted. Using these data as well as data from previous surveys (Refs. 5, 6, 7, and 8), the locations of biased surface soil samples were selected to better define the limits of contamination. Surface soil samples were taken at eight locations (Figure 4-2) and analyzed for thorium-232, uranium-238, and radium-226. Each sample was dried, pulverized, and counted for 10 min using an intrinsic germanium detector housed in a lead counting cave lined with cadmium and copper. The pulse height distribution was sorted using a computer-based, multichannel

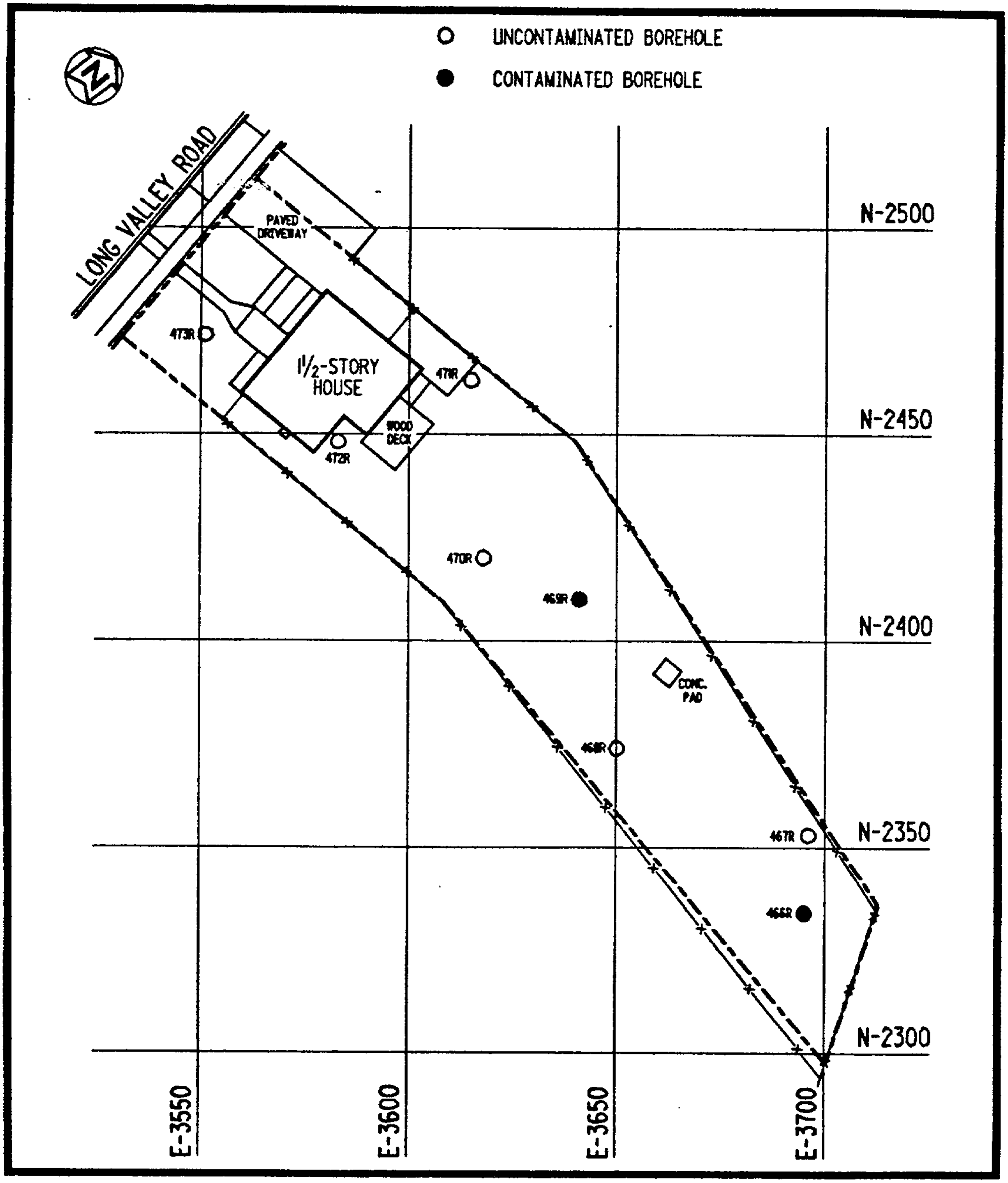

FIGURE 4-1 BOREHOLE LOCATIONS AT 16 LONG VALLEY ROAD

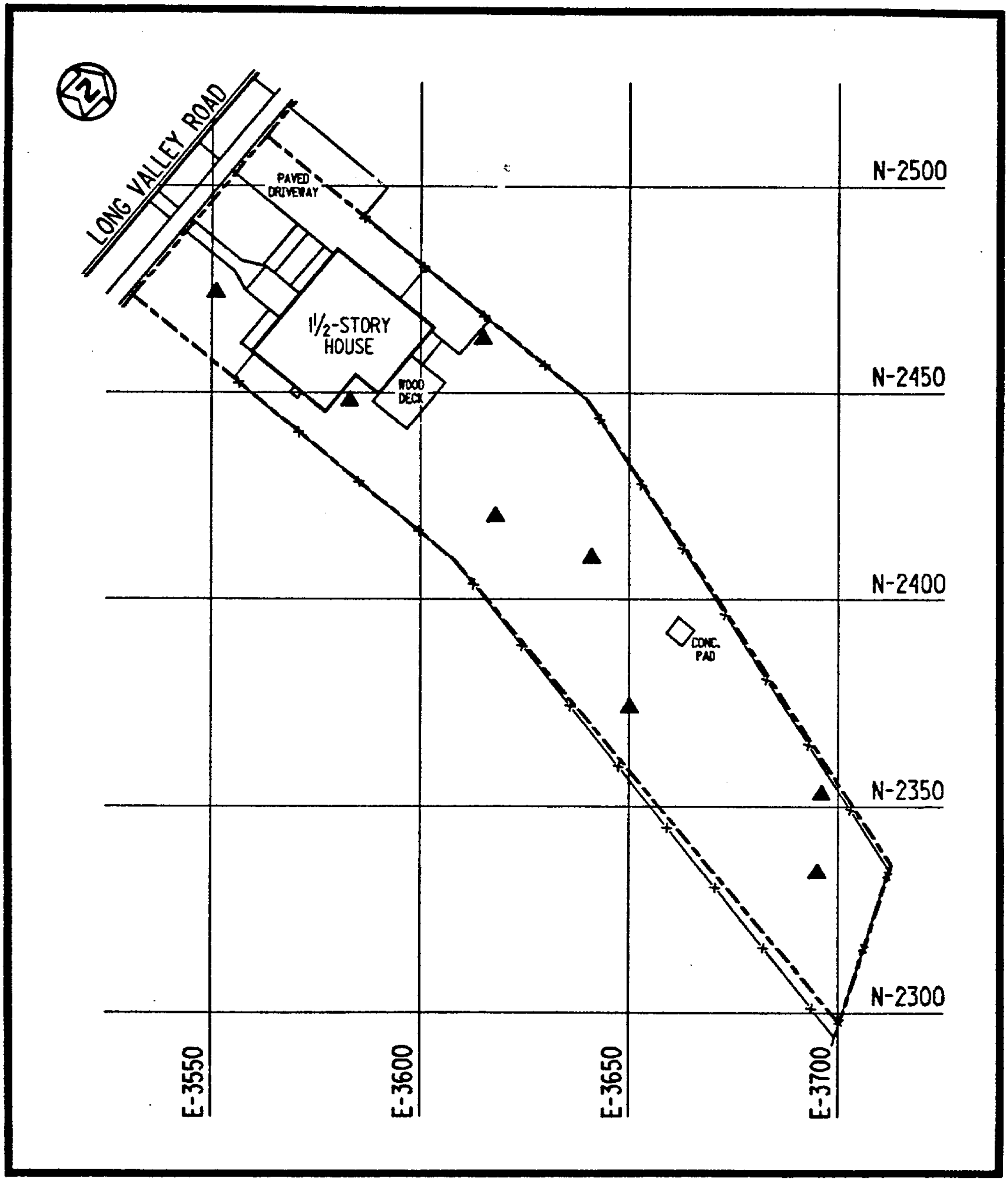

FIGURE 4-2 SURFACE AND SUBSURFACE SOIL SAMPLING LOCATIONS AT 16 LONG VALLEY ROAD

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analyzer. Radionuclide concentrations were determined by comparing the gamma spectrum of each sample with the spectrum of a certified counting standard for the radionuclide of interest.

Subsurface soil samples were collected from eight locations (Figure 4-2) using the side wall sampling method and were analyzed to compare laboratory soil sample results to downhole gamma radiation measurements. A cup or can attached to a steel pipe or wooden stake was inserted into the borehole and used to scrape samples off the side of the borehole at a specified depth. The subsurface soil samples were analyzed for radium-226, uranium-238, and thorium-232 in the same manner as the surface soil samples.

4.2 BUILDING RADIOLOGICAL CHARACTERIZATION

After evaluating previous radiological survey data as well as data from this characterization, it was suspected that contamination might be present under the foundation of the residence. A radon measurement was obtained to verify the presence of contaminated material under the residence and to estimate potential occupational exposures during future remedial actions.

Indoor radon measurements were taken using the Tedlar bag technique. Using this method, radon measurements are obtained by pumping air into a Tedlar bag at a rate of approximately 2 l/min and transferring the air sample directly into a scintillation cell with an interior coating of zinc sulfide and an end window for viewing the scintillations. Analysis of the sample was simplified by allowing the radon decay products to build up over time. This method allows all the radon decay products to come into secular equilibrium with the radon. The scintillation cell was placed in contact with a photomultiplier tube, and the scintillations were counted using standard nuclear counting instrumentation.

Indoor air sample collection was also performed to determine working levels (WL) of radon and thoron daughters. Measurement of radon daughters was done by collecting an air sample for exactly 5 min through a 0.45-micron membrane filter at a rate of 11 liters/min for a total sample volume of 55 l. Alpha particle activity on the filter paper was counted 40 to 90 min after sampling using an alpha scintillation detector coupled to a count-rate meter or a digital scaler. Measurements for thoron daughters were conducted using the same method as for radon daughters with the exception of the time between collection of the air sample and counting of the alpha particle activity. In the case of thoron daughters, the sample is allowed to age for at least 5 h after sampling before alpha activity is counted. This elapsed time allows radon daughters, which may be present with the thoron daughters, to decay sufficiently so as not to interfere in calculating the working levels for thoron daughters.

Exterior gamma exposure rate measurements were made at seven locations throughout the property grid system and at one location inside the residence using either a 2-in. by 2-in. thallium-activated sodium iodide gamma scintillation detector used to detect gamma radiation only, or a pressurized ionization chamber (PIC) (Figure 4-3). The PIC instrument has a response to gamma radiation that is proportional to exposure in roentgens. A conversion factor for gamma scintillation to the PIC was established through a correlation of these two measurements at four locations in the vicinity of the property. The unshielded gamma scintillation detector readings were then used to estimate gamma exposure rates for each location. These measurements were taken 3 ft above the ground, and the locations were determined to be representative of the entire property. Interior measurements are generally obtained with the gamma scintillation instrument rather than the PIC because of its smaller size and the desire to minimize the technician's time inside the residence.

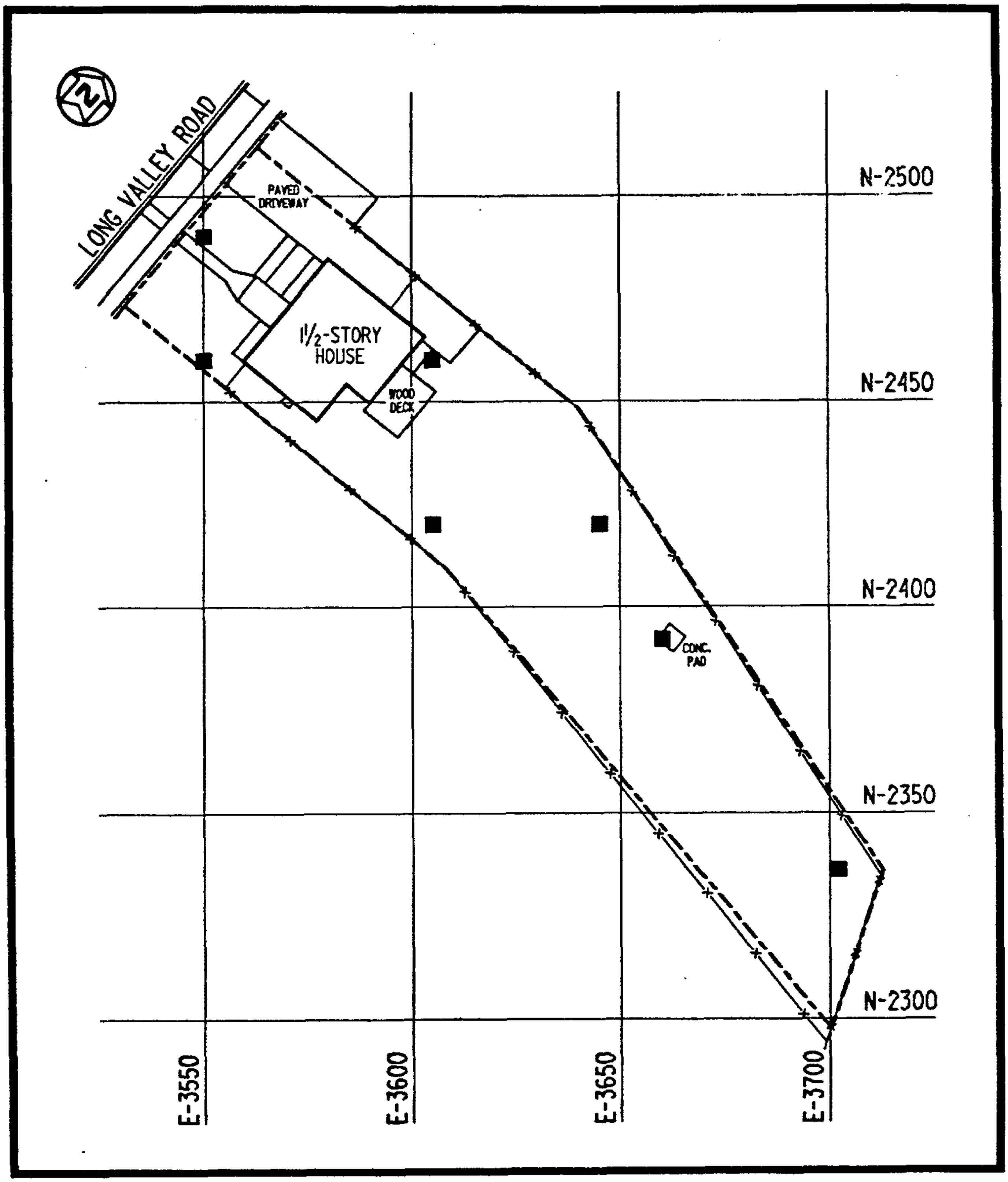

FIGURE 4-3 EXPOSURE RATE MEASUREMENT LOCATIONS AT 16 LONG VALLEY ROAD

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5.0 CHARACTERIZATION RESULTS

5.1 FIELD RADIOLOGICAL CHARACTERIZATION

Near-surface gamma radiation measurements on the property ranged from 3,000 cpm to approximately 29,000 cpm. The average background level for this area is 5,000 cpm. A measurement of 11,000 cpm is approximately equal to the DOE guideline for thorium-232 of 5 pCi/g above background for surface soil contamination. Using this correlation, the near-surface gamma measurements were used to determine the extent of surface contamination as well as the basis for selecting the locations of soil samples. Areas of surface contamination are shown in Figure 5-1.

Surface soil samples (depths from 0.0 to 0.5 ft) were taken from eight locations on the property (Figure 4-2). These samples were analyzed for thorium-232, uranium-238, and radium-226. The concentrations in these samples ranged from less than 1.6 pCi/g to less than 15.3 for uranium-238, from less than 0.4 to 27.2 pCi/g for thorium-232, and from 1.3 to 2.5 pCi/g for radium-226. Analysis results for surface soils are provided in Table 5-1. Results showed concentrations of thorium-232 in excess of DOE guidelines (5 pCi/g plus background of 1 pCi/g for surface soils) with a maximum concentration of 27.2 pCi/g. Use of the "less than" (<) notation in reporting results indicates that the radionuclide was not present in concentrations that are quantitative with the instruments and techniques used. The "less than" value represents the lower bound of the quantitative capacity of the instrument and technique used and is based on various factors, including the volume, size, and weight of the sample; the type of detector used; the counting time, and the background count rate. The actual concentration of the radionuclide is less than the value indicated. In addition, since radioactive decay is a random process, a correlation between the rate of disintegration and a given radionuclide concentration cannot be precisely established. For this reason, the exact concentration of the radionuclide cannot be determined. As such, each value that

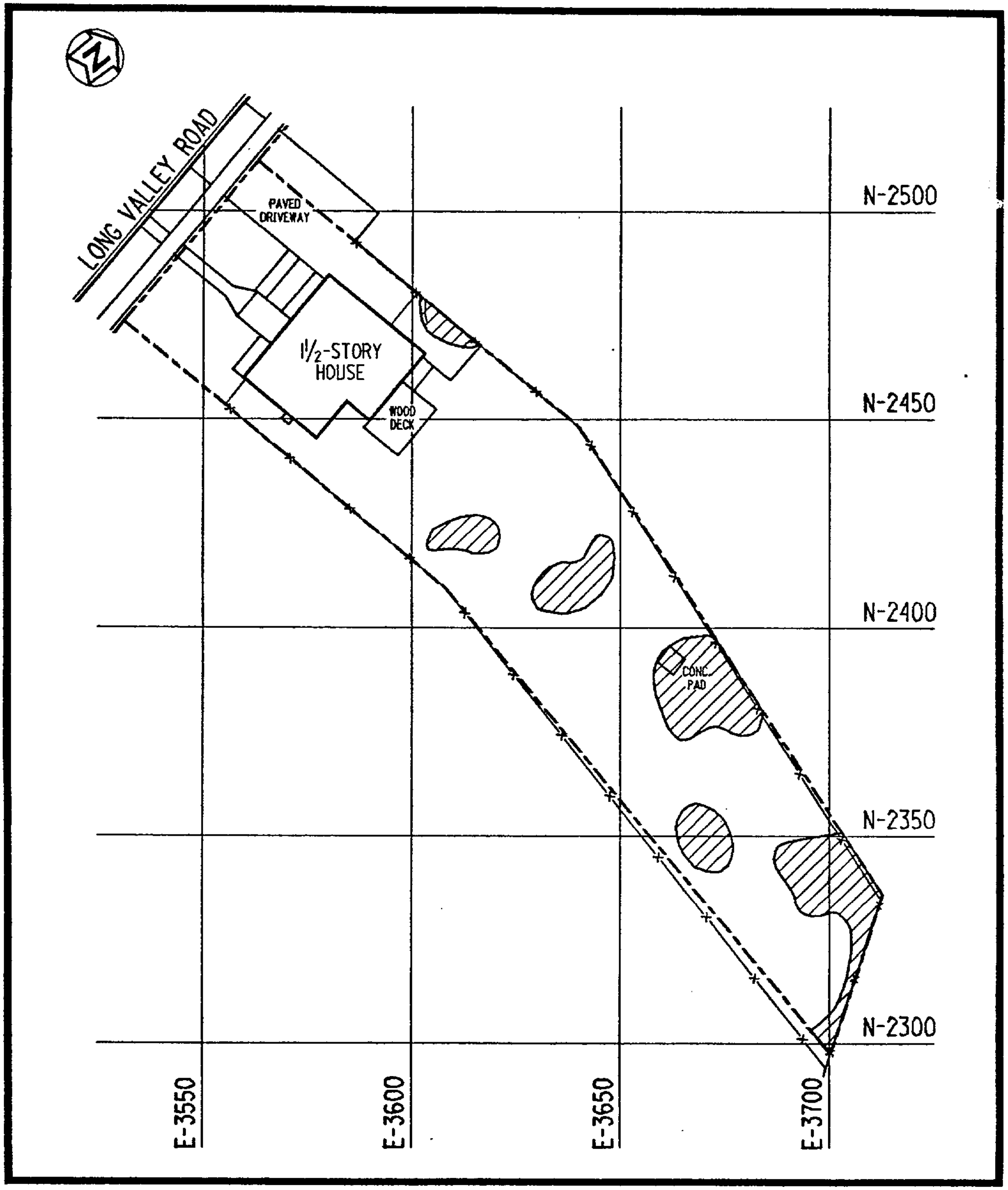

FIGURE 5-1 AREAS OF SURFACE CONTAMINATION AT 16 LONG VALLEY ROAD

can be quantitatively determined has an associated uncertainty term (±), which represents the amount by which the actual concentration can be expected to differ from the value given in the table. The uncertainty term has an associated confidence level of 95 percent.

Thorium-232, the primary contaminant at the site, is the radionuclide most likely to exceed a specific DOE guideline in soil. Parameters for soil sample analysis were selected to ensure that the thorium-232 would be detected and measured at concentrations well below the lower guideline value of 5 pCi/g in excess of background level. Radionuclides of the uranium series, specifically uranium-238 and radium-226, are also potential contaminants but at lower concentrations than thorium-232. Therefore, these radionuclides, considered secondary contaminants, would not be present in concentrations in excess of guidelines unless thorium-232 was also present in concentrations in excess of its guideline level. Parameters selected for the thorium-232 analyses also provide detection sensitivities for uranium-238 and radium-226 that demonstrate that concentrations of these radionuclides are below guidelines. However, because of the relatively low gamma photon abundance of uranium-238, many of the uranium-238 concentrations were below the detection sensitivity of the analytical procedure; these concentrations are reported in the data tables as "less than" values. To obtain more sensitive readings for the uranium-238 radionuclide with these analytical methods, much longer instrument counting times would be required than were necessary for analysis of thorium-232, the primary contaminant.

Analysis results for subsurface soil samples given in Table 5-1 are consistent with the gamma logging data in Table 5-2. The results in Table 5-2 showed a range from 6,000 cpm to 46,000 cpm. A measurement of 40,000 cpm is approximately equal to the DOE guideline for subsurface contamination of 15 pCi/g. Analyses of subsurface soil samples (depths from 0.5 to 1.0 ft) indicated uranium-238 concentrations ranging from less than 5.7 to less than 19.3 pCi/g, thorium-232 concentrations ranging from 1.4 to 10.4 pCi/g, and radium-226 concentrations ranging from 0.7 to less than 1.7 pCi/g.

On the basis of near-surface gamma radiation measurements, surface soil sample analysis, and downhole gamma logging, contamination of this property is believed to consist primarily of surface contamination with subsurface contamination from 0.5 to 1.0 ft deep. The areas of subsurface contamination are shown in Figure 5-2.

The vertical and horizontal limits of contamination as determined by this characterization effort are being evaluated to determine the volume of contaminated material that will require remedial action. To develop this estimate, BNI will consider the location of the contamination, construction techniques, and safety procedures.

5.2 BUILDING RADIOLOGICAL CHARACTERIZATION

Results of two indoor radon measurements made with the Tedlar bag method indicated concentrations of less than 0.2 pCi/l. These measurements were substantially less than the applicable DOE guideline of 3.0 pCi/l (Ref. 10).

Results of measurements for radon daughters ranged from 0.001 to 0.002 WL and were substantially less than the applicable generic guideline (40 CFR 192) (Ref. 10) of an annual average (or equivalent) radon decay product concentration not to exceed 0.02 WL.

Results of measurements for thoron daughters ranged from less than the lower limit of detection to 0.0007 WL. The generic guideline is more restrictive for radon-222 (radon) than for radon-220 (thoron) according to NCRP Report No. 50 (Ref. 11), which was used as the guideline for thoron daughter measurements.

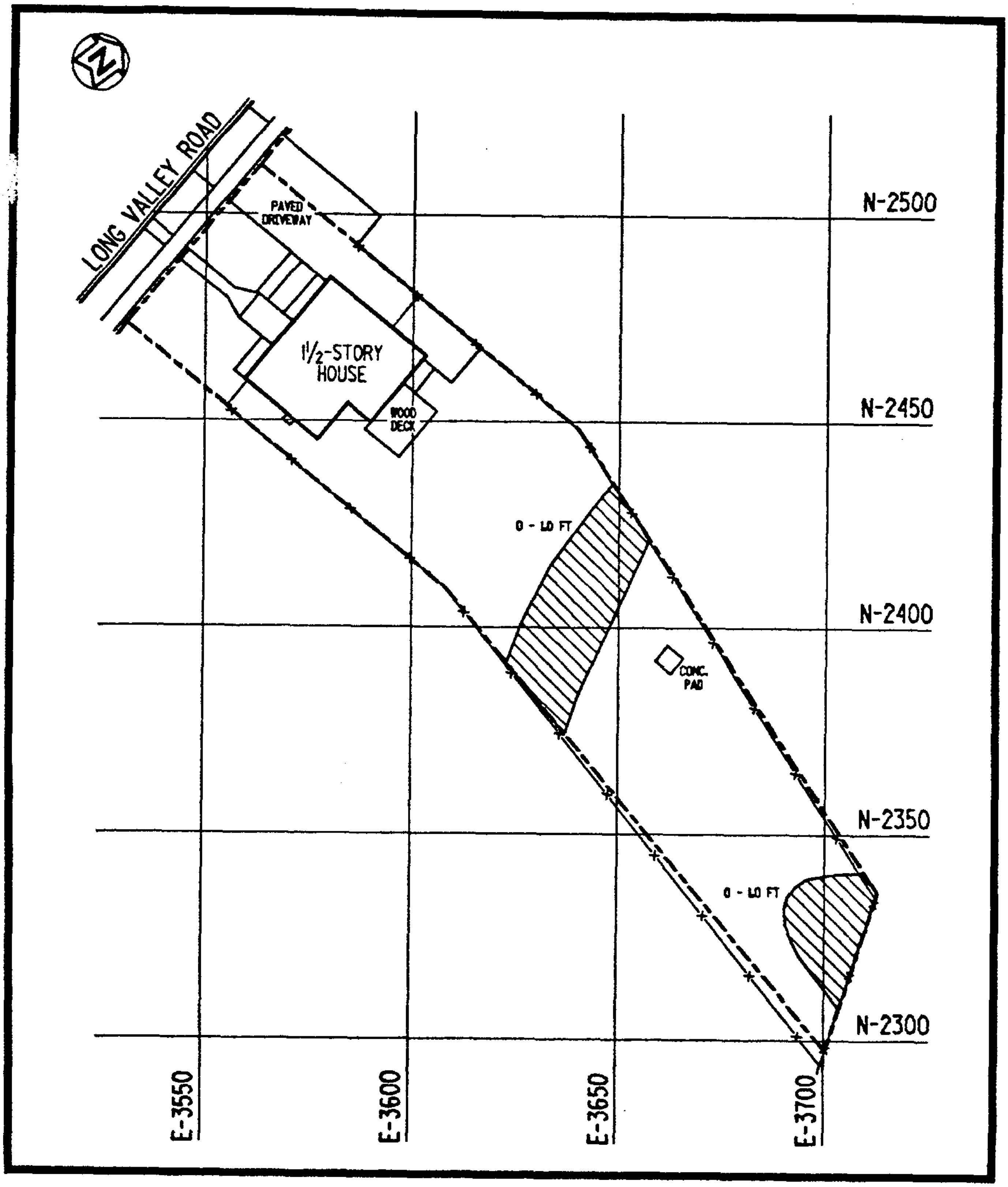

FIGURE 5-2 AREAS OF SUBSURFACE CONTAMINATION AT 16 LONG VALLEY ROAD

Exterior gamma radiation exposure rate measurements ranged from 8 μR/h to 34 μR/h, including background. The indoor exposure rate measurement was 5 μR/h, including background. One of the seven exterior measurements exceeds the DOE guideline of 100 mrem/yr for public exposure. This is based on the assumption of 16 hours occupancy per day for 365 days per year (5,840 hours) and subtracting average background of 9 μR/h (Ref. 12). The highest measurement, 34 μR/h, which exceeds the guideline, was taken in the area where the surface soil analysis indicated a concentration of 18.0 pCi/g for thorium-232. These results can be found in Table 5-3.

TABLE 5-1

SURFACE AND SUBSURFACE RADIONUCLIDE CONCENTRATIONS IN SOIL
FOR 16 LONG VALLEY ROAD[a]

Coordinates East	Coordinates North	Depth (ft)	Concentration (pCi/g +/- 2 sigma) Uranium-238	Radium-226	Thorium-232
3551	2474	0.0 - 0.5	<10.5	1.5 +/- 0.6	< 2.7
3551	2474	0.5 - 1.0	<10.3	1.2 +/- 0.1	< 2.9
3583	2448	0.0 - 0.5	< 8.6	< 1.7	< 0.4
3583	2448	0.5 - 1.0	< 7.2	0.7 +/- 0.1	< 2.3
3615	2463	0.0 - 0.5	< 9.6	1.1 +/- 0.6	1.6 +/- 0.9
3615	2463	0.5 - 1.0	< 7.8	< 1.2	2.6 +/- 0.6
3618	2420	0.0 - 0.5	<15.3	1.4 +/- 0.2	6.5 +/- 1.8
3618	2420	0.5 - 1.0	<11.4	< 1.7	3.1 +/- 0.3
3641	2410	0.0 - 0.5	< 1.6	2.5 +/- 1.0	27.2 +/- 7.9
3641	2410	0.5 - 1.0	<19.3	1.1 +/- 0.7	10.4 +/- 1.5
3650	2374	0.0 - 0.5	<10.0	1.3 +/- 0.4	1.5 +/- 0.7
3650	2374	0.5 - 1.0	< 9.7	< 1.7	1.4 +/- 0.5
3695	2334	0.0 - 0.5	<11.2	2.5 +/- 0.6	18.0 +/- 4.6
3695	2334	0.5 - 1.0	< 5.7	1.3 +/- 0.1	7.9 +/- 0.4
3696	2353	0.0 - 0.5	<14.5	< 1.9	< 3.9
3696	2353	0.5 - 1.0	< 8.5	1.3 +/- 0.4	1.8 +/- 1.1

[a]Sampling locations are shown in Figure 4-2.

TABLE 5-2

DOWNHOLE GAMMA LOGGING RESULTS

FOR 16 LONG VALLEY ROAD[a]

Page 1 of 3

Coordinates East	Coordinates North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 466R[d]			
3695	2334	0.5	38000
3695	2334	1.0	32000
3695	2334	1.5	19000
3695	2334	2.0	13000
3695	2334	2.5	12000
3695	2334	3.0	11000
3695	2334	3.5	11000
3695	2334	4.0	11000
3695	2334	4.5	10000
3695	2334	5.0	10000
Borehole 467R			
3696	2353	0.5	10000
3696	2353	1.0	12000
3696	2353	1.5	11000
3696	2353	2.0	11000
3696	2353	2.5	11000
3696	2353	3.0	11000
3696	2353	3.5	11000
3696	2353	4.0	11000
3696	2353	4.5	10000
Borehole 468R[d]			
3650	2374	0.5	9000
3650	2374	1.0	11000
3650	2374	1.5	12000
3650	2374	2.0	12000
3650	2374	2.5	11000
3650	2374	3.0	11000
3650	2374	3.5	11000
3650	2374	4.0	12000
3650	2374	4.5	12000
3650	2374	5.0	12000
Borehole 469R[d]			
3641	2410	0.5	46000
3641	2410	1.0	34000
3641	2410	1.5	18000

TABLE 5-2
(continued)

Coordinates East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 469R (continued)[d]			
3641	2410	2.0	13000
3641	2410	2.5	12000
3641	2410	3.0	11000
3641	2410	3.5	11000
3641	2410	4.0	11000
Borehole 470R[d]			
3618	2420	0.5	11000
3618	2420	1.0	15000
3618	2420	1.5	15000
3618	2420	2.0	13000
3618	2420	2.5	13000
3618	2420	3.0	12000
3618	2420	3.5	11000
3618	2420	4.0	11000
3618	2420	4.5	10000
3618	2420	5.0	10000
Borehole 471R[d]			
3615	2463	0.5	9000
3615	2463	1.0	11000
3615	2463	1.5	13000
3615	2463	2.0	12000
3615	2463	2.5	12000
3615	2463	3.0	12000
3615	2463	3.5	12000
3615	2463	4.0	13000
3615	2463	4.5	12000
3615	2463	5.0	11000
3615	2463	5.5	8000
3615	2463	6.0	9000
Borehole 472R[d]			
3583	2448	0.5	10000
3583	2448	1.0	10000
3583	2448	1.5	11000
3583	2448	2.0	12000
3583	2448	2.5	11000
3583	2448	3.0	12000

TABLE 5-2

(continued)

Coordinates East	Coordinates North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 472R (continued)[d]			
3583	2448	3.5	12000
3583	2448	4.0	11000
3583	2448	4.5	12000
3583	2448	5.0	12000
3583	2448	5.5	11000
3583	2448	6.0	10000
3583	2448	6.5	8000
3583	2448	7.0	8000
3583	2448	7.5	7000
3583	2448	8.0	6000
Borehole 473R[d]			
3551	2474	0.5	11000
3551	2474	1.0	12000
3551	2474	1.5	13000
3551	2474	2.0	12000
3551	2474	2.5	11000
3551	2474	3.0	11000
3551	2474	3.5	10000
3551	2474	4.0	10000
3551	2474	4.5	11000
3551	2474	5.0	12000
3551	2474	5.5	13000

[a] Borehole locations are shown in Figure 4-1.

[b] The variations in depths of boreholes and corresponding results given in this table are based on the boreholes penetrating the contamination or the drill reaching refusal.

[c] Instrument used was 2-in. by 2-in. thallium-activated sodium iodide gamma scintillation detector.

[d] Bottom of borehole collapsed.

TABLE 5-3

GAMMA RADIATION EXPOSURE RATES

FOR 16 LONG VALLEY ROAD

Coordinates		
East	North	μR/h
3550	2460	9
3550	2490	8
3605	2420	14
3605	2460	8
3645	2420	12
3660	2392	15
3702	2326	34
INTERIOR OF RESIDENCE		5

Measurements include background.

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APPENDIX A

GEOLOGIC DRILL LOGS FOR 16 LONG VALLEY ROAD

LODI, NEW JERSEY

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	466R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
16 Long Valley Rd. (LODI)	N 2334; E 3695	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-13-86	10-13-86	MORETRENCH	B&S Little Beaver	4"	2.0	4.0	6.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				42.0	/ 10-13-86 /	2.0/40.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	NONE	D. McGRANE

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							42.0				0.0-2.0 ft. <u>SILTY SAND</u> (SM). Color stratified; fine-to medium-grained; soft; poorly consolidated (loose); dry. 0.0-1.0 ft. moderate brown (5YR3/4); numerous organics and grass roots. 1.0-2.0 ft. dark yellowish brown (10YR4/2).	Borehole drilled 0.0-6.0 ft. using 4" solid-stem augers.
							40.0				2.0-6.0 ft. <u>DECOMPOSED SANDSTONE</u>. Dark reddish brown (10R3/4); fine-grained (argillaceous); soft;poorly cemented; totally decomposed; moist. Drill spoils consist of silty sand and gravel mixture.	Site checked for radioactive contamination and hole gamma-logged by Eberline-TMA, Corporation. No ground water observed.
								5				
							36.0				Bottom of borehole at 6.0 ft. Auger spoils were immediately replaced in the hole, 10-13-86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	16 Long Valley Rd. (LODI)	466R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	467R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
16 Long Valley Rd. (LODI)	N 2353; E 3696	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-13-86	10-13-86	MORETRENCH	B&S Little Beaver	4"	3.0	2.0	5.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				42.2	4.5/37.7 10-13-86 /	3.0/39.2

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	NONE	D. McGRANE

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							42.2					
											0.0-0.5 ft. SILTY SAND (SM). Color stratified; fine-to medium-grained; soft; poorly consolidated (loose); dry. 0.0-1.0 ft. moderate brown (5YR3/4); numerous organics and grass roots. 1.0-3.0 ft. dark yellowish brown (10YR4/2).	Borehole drilled 0.0-5.0 ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by Eberline-TMA, Corporation. 4.5 ft. ground water observed. 5.0 ft. auger refusal (cobble?).
							39.2				3.0-5.0 ft. DECOMPOSED SANDSTONE. Dark reddish brown (10R3/4); fine-grained (argillaceous); soft-moderately hard; poorly-well cemented; totally decomposed-highly weathered; moist-saturated at 4.5 ft. Drill spoils consist of silty sand and gravel mixture.	
							37.2	5			Bottom of borehole at 5.0 ft. Auger spoils were immediately replaced in the hole, 10-13-86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: 16 Long Valley Rd. (LODI) — HOLE NO. 467R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	468R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
16 Long Valley Rd. (LODI)	N 2374; E 3650	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-13-86	10-13-86	MORETRENCH	B&S Little Beaver	4"	3.0	3.0	6.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				43.0	/	3.0/40.0

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	NONE	D. McGRANE

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							43.0				0.0-3.0 ft. <u>SILTY SAND</u> (SM). Color stratified; fine-to medium-grained; soft; poorly consolidated (loose); dry. 0.0-0.5 ft. moderate brown (5YR3/4); numerous organics and grass roots. 0.5-3.0 ft. dark yellowish brown (10YR4/2).	Borehole drilled 0.0-6.0 ft. using 4" solid-stem augers.
							40.0				3.0-6.0 ft. <u>DECOMPOSED SANDSTONE</u>. Dark reddish brown (10R3/4); fine-grained (argillaceous); soft; poorly cemented; totally decomposed; moist. Drill spoils consist of silty sand and gravel mixture.	Site checked for radioactive contamination and hole gamma-logged by Eberline-TMA, Corporation. No ground water observed.
								5				
							37.0				Bottom of borehole at 6.0 ft. Auger spoils were immediately replaced in the hole, 10-13-86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	16 Long Valley Rd. (LODI)	468R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	469R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
16 Long Valley Rd. (LODI)	N 2410; E 3641	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-13-86	10-13-86	MORETRENCH	B&S Little Beaver	4"	6.0		6.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				43.5	/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	NONE	D. McGRANE

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							43.5				0.0-6.0 ft. <u>SILTY SAND</u> (SM). Color stratified; fine-to medium-grained; soft; poorly consolidated (loose); dry-moist. 0.0-1.0 ft. grayish black (N2); few pieces of various lithologies (fill?); few roots and organics. 1.0-3.0 ft. dark yellowish brown (10YR4/2); dry. 3.0-6.0 ft. dark reddish brown (10YR3/4); few pieces of black carboniferous gravel; moist; decomposed sandstone?	Borehole drilled 0.0-6.0 ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by Eberline-TMA, Corporation. No ground water observed.
								5				
							37.5				Bottom of borehole at 6.0 ft. Auger spoils were immediately replaced in the hole, 10-13-86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	16 Long Valley Rd. (LODI)	469R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	470R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
16 Long Valley Rd. (LODI)	N 2420; E 3618	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-13-86	10-13-86	MORETRENCH	B&S Little Beaver	4"	6.0		6.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				43.6	5.5/38.1 10-13-86 /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	NONE	D. McGRANE

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							43.6					
							37.6	5			0.0-6.0 ft. SILTY SAND (SM). Color stratified; fine-to medium-grained; soft; poorly consolidated (loose); dry-saturated at 5.5 ft. 0.0-1.0 ft. moderate brown (5YR3/4); numerous grass roots and organics. 1.0-3.0 ft. dark yellowish brown (10YR4/2); dry. 3.0-6.0 ft. dark reddish brown (10YR3/4); decomposed sandstone?	Borehole drilled 0.0-6.0 ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by Eberline-TMA, Corporation. 5.5 ft. ground water observed.
											Bottom of borehole at 6.0 ft. Auger spoils were immediately replaced in the hole, 10-13-86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: 16 Long Valley Rd. (LODI) — HOLE NO. 470R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	471R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
16 Long Valley Rd. (LODI)	N 2463; E 3615	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-13-86	10-13-86	MORETRENCH	B&S Little Beaver	4"	4.0	3.0	7.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				44.5	/ /	4.0/40.5

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	NONE	D. McGRANE

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							44.5					
							41.0				0.0-4.0 ft. **SILTY SAND** (SM). Fill and indigenous material; fine-to medium-grained; soft; poorly consolidated (loose); numerous pieces of gravel of various lithologies (fill?) 0.0-3.5 ft.; moist. 0.0-3.5 ft. dark reddish brown (10R3/4). 3.5-4.0 ft. moderate brown (5YR3/4); native upper soil horizon?	Borehole drilled 0.0-7.0 ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by Eberline-TMA, Corporation. No ground water observed. 7.0 ft. auger refusal.
							37.5	5			4.0-7.0 ft. **DECOMPOSED SANDSTONE**. Dark reddish brown (10R3/4); fine-grained (argillaceous); soft-moderately hard; poorly-well cemented; totally decomposed; highly weathered; moist. Drill spoils consist of silty sand and gravel mixture.	
											Bottom of borehole at 7.0 ft. Auger spoils were immediately replaced in the hole, 10-13-86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE 16 Long Valley Rd. (LODI)	HOLE NO. 471R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	472R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
16 Long Valley Rd. (LODI)	N 2448; E 3583	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-13-86	10-13-86	MORETRENCH	B&S Little Beaver	4"	9.0		9.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				45.0	/	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	NONE	D. McGRANE

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							45.0				0.0-9.0 ft. **SILTY SAND** (SM-SC). Fill and indigenous material; fine-to medium-grained; soft; poorly consolidated (loose); moist. 0.0-1.0 ft. moderate brown (5YR3/4); numerous grass roots and organics. 1.0-4.5 ft. dark reddish brown (10R3/4); few pebbles of various lithologies; fill? 4.5-5.0 ft. moderate brown; clayey (SC). 5.0-9.0 ft. mottled moderate brown and dark reddish brown; difficult to distinguish between fill or natural material.	Borehole drilled 0.0-9.0 ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by Eberline-TMA, Corporation. No ground water observed.
								5				
							36.0				Bottom of borehole at 9.0 ft. Auger spoils were immediately replaced in the hole, 10-13-86.	Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	16 Long Valley Rd. (LODI)	472R

GEOLOGIC DRILL LOG

PROJECT: FUSRAP	JOB NO.: 14501-138	SHEET NO.: 1 OF 1	HOLE NO.: 473R	
SITE: 16 Long Valley Rd. (LODI)	COORDINATES: N 2474; E 3551	ANGLE FROM HORIZ: Vertical	BEARING: ------	

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-13-86	10-13-86	MORETRENCH	B&S Little Beaver	4"	7.0		7.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				46.7	/	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	NONE	D. McGRANE

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH	GRAPHICS	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							46.7				0.0-7.0 ft. SILTY SAND (SM-SC). Fill and indigenous material; fine-to medium-grained; soft; poorly consolidated (loose); moist. 0.0-2.0 ft. moderate brown (5YR3/4) with pieces of dark reddish brown (10R3/4) sandstone; numerous grass roots and organics. 2.0-4.0 ft. dark reddish brown; few pieces of sandstone gravel; piece of plastic; fill. 4.0-4.5 ft. grayish black (N2); numerous organics; indigenous upper soil horizon? 4.5-6.0 ft. dark yellowish brown (10YR4/2). 6.0-7.0 ft. dark reddish brown; decomposed sandstone?	Borehole drilled 0.0-7.0 ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by Eberline-TMA, Corporation. No ground water observed.
								5				
							39.7				Bottom of borehole at 7.0 ft. Auger spoils were immediately replaced in the hole, 10-13-86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: 16 Long Valley Rd. (LODI) — HOLE NO. 473R