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

RADIOLOGICAL CHARACTERIZATION REPORT FOR THE RESIDENTIAL PROPERTY AT 8 HANCOCK STREET

Lodi, New Jersey

September 1989

Bechtel National, Inc.

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Attention: Robert G. Atkin
Technical Services Division

Subject: Bechtel Job No. 14501, FUSRAP Project
DOE Contract No. DE-AC05-81OR20722
Publication of Radiological Characterization Report for seventeen residential properties, four municipal properties, and seven commercial properties in Lodi and Maywood, New Jersey
Code: 7315/WBS: 138

Dear Mr. Atkin:

Enclosed is one copy each of the 28 subject published reports for the properties listed in Attachment 1. These reports incorporate all comments received in this review cycle (CCNs 063165, 063327, 062285, and 061568) and are being published with approval of Steve Oldham, as reported in CCN 063868.

Also enclosed (as Attachment 2) is a proposed distribution list for these reports. Please send us any changes to the proposed distribution list at your earliest convenience so we may distribute the reports.

BNI would like to express our thanks to Mr. Oldham for his cooperation and efforts to review these drafts in an accelerated manner. His efforts have allowed us to publish these reports on schedule. If you have any questions about these documents, please call me at 576-4718.

Very truly yours,

R C Robertson

R. C. Robertson
Project Manager - FUSRAP

RCR:wfs:1756x
Enclosure: As stated

cc: J. D. Berger, ORAU (w/e)
N. J. Beskid, ANL (w/e)

CONCURRENCE

ws	rci			

DOE/OR/20722-241

RADIOLOGICAL CHARACTERIZATION REPORT FOR THE RESIDENTIAL PROPERTY AT 8 HANCOCK STREET LODI, NEW JERSEY

SEPTEMBER 1989

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

N. C. Ring, D. J. Whiting, and W. F. Stanley

Bechtel National, Inc.

Oak Ridge, Tennessee

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
km^2	square kilometer
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 yard

1.0 INTRODUCTION AND SUMMARY

This section provides a brief description of the history and background of the Maywood site and its vicinity properties. Data obtained from the radiological characterization of this vicinity property are also presented.

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 under the Formerly Utilized Sites Remedial Action Program (FUSRAP) under the direction of the DOE Division of Facility and Site Decommissioning Projects. Several residential, commercial, and municipal 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 U.S. 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 that DOE 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.

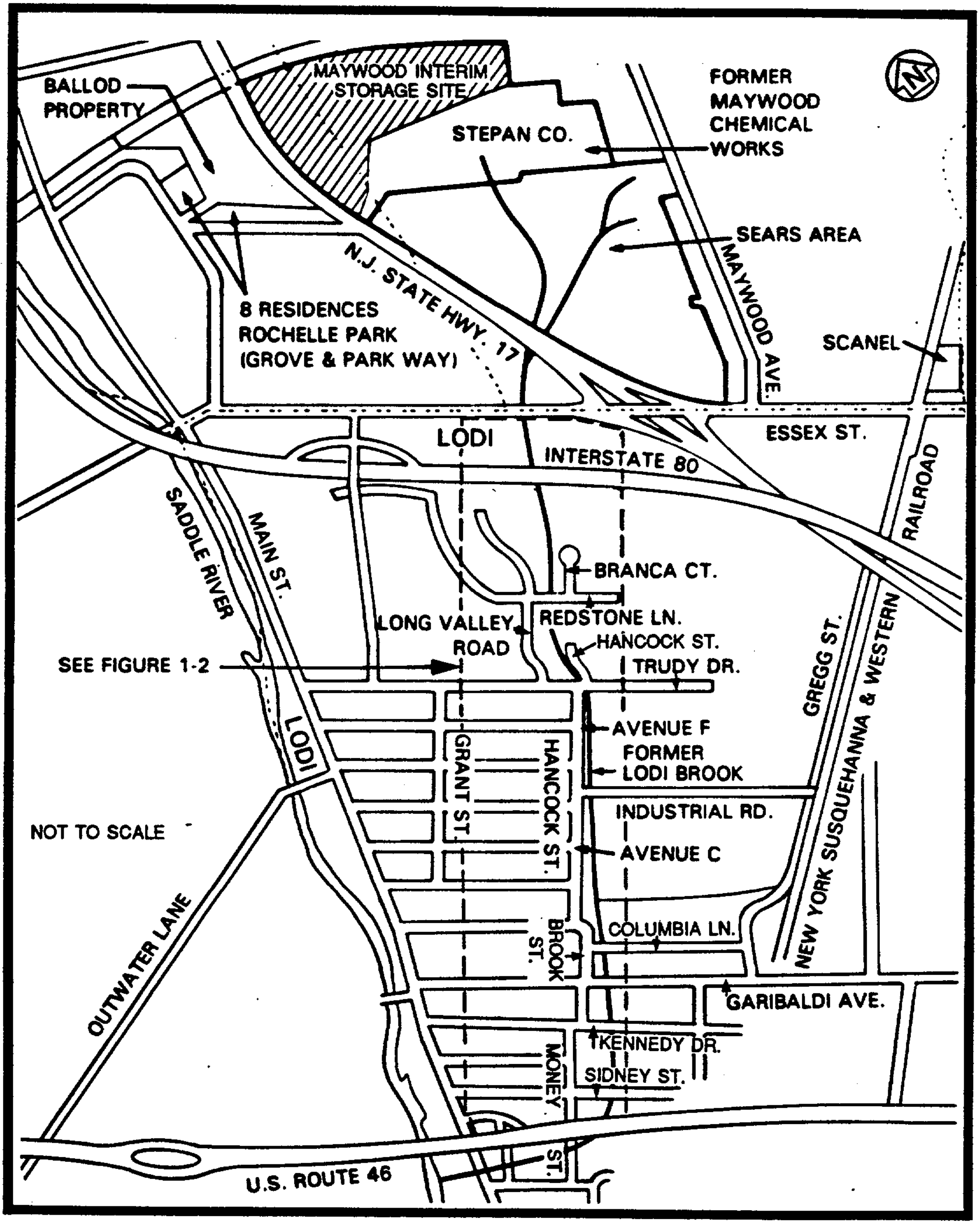

FIGURE 1-1 LOCATION OF LODI VICINITY PROPERTIES

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.

1.3 SUMMARY

This report details the procedures and results of the radiological characterization of the property at 8 Hancock Street (Figure 1-2) in Lodi, New Jersey, which was conducted in November 1986 and January 1987.

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 8 Hancock Street showed maximum concentrations of thorium-232 and radium-226 to be 3.8 and 5.6 pCi/g, respectively. The maximum concentration of uranium-238 in surface soil samples was less than 13.6 pCi/g.

Subsurface soil sample concentrations ranged from 2.3 to 4.6 pCi/g for thorium-232 and from 0.8 to 5.6 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 6.3 to less than 13.3 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 conservative for

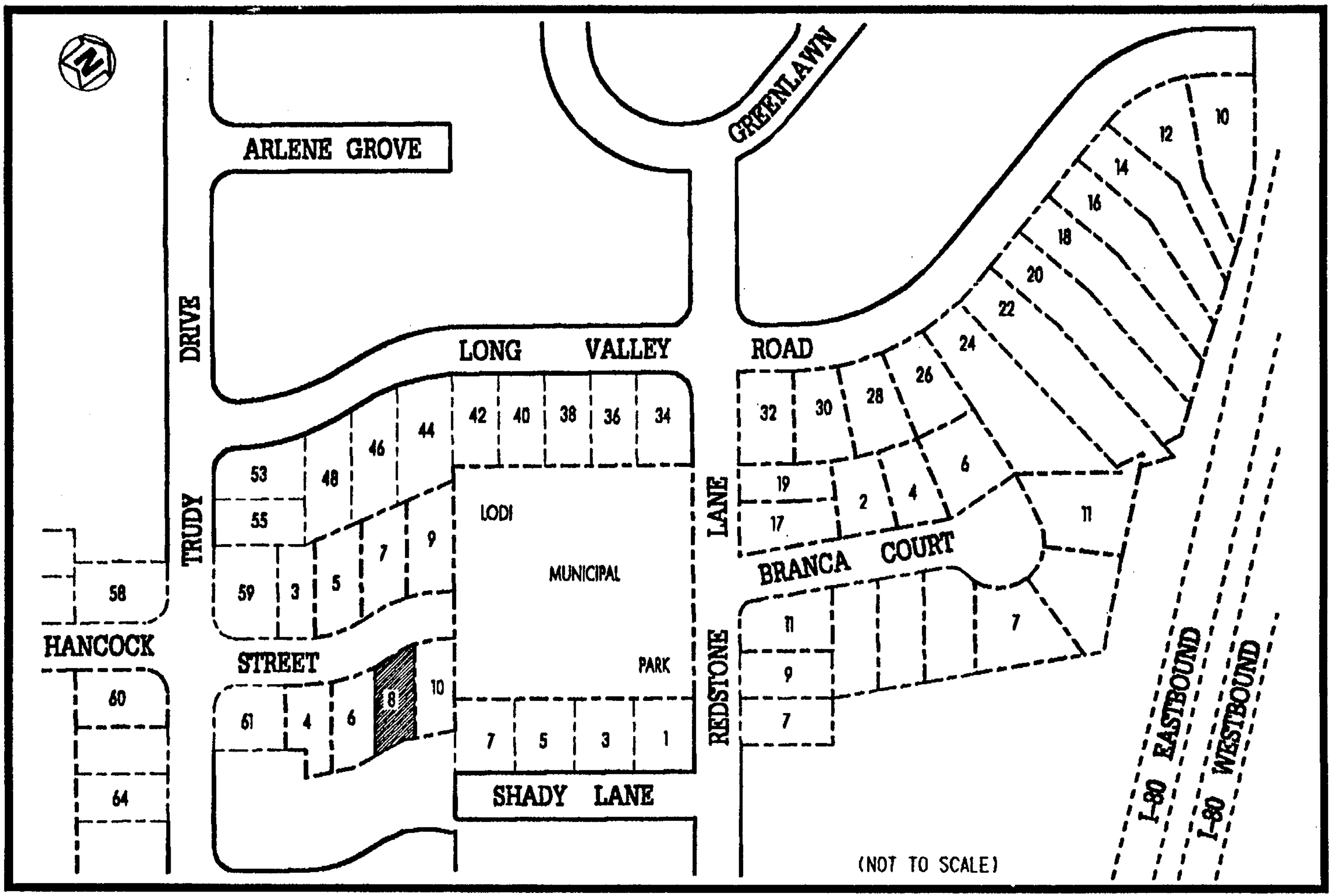

FIGURE 1-2   LOCATION OF 8 HANCOCK STREET

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, the vicinity properties will be decontaminated in a manner so as to reduce future doses to levels that are as low as reasonably achievable (ALARA) (Ref. 2).

Soil analysis data for this property did not indicate surface contamination. Subsurface investigation by gamma logging indicated contamination to a depth of 2.89 m (9.5 ft).

Exterior gamma radiation exposure rates ranged from 8 to 10 μR/h, including background. The indoor measurement showed a rate of 7 μR/h, including background.

The radon-222 measurements inside the residence indicated concentrations of 0.2 and 0.6 pCi/L, respectively, which are within the DOE guideline of 3.0 pCi/L.

Measurements for radon daughters ranged from 0.002 to 0.003 working level (WL), and measurements for thoron daughters ranged from 0.001 to 0.0032 WL.

All data tables for this property appear at the end of this report.

1.4 CONCLUSIONS

Evaluation of data collected, analyses performed, and historical documentation reviewed indicates the presence of radiological contamination on the property located at 8 Hancock Street. This contamination is primarily subsurface contamination ranging from a depth of 15.2 cm (0.5 in.) to

2.89 m (9.5 ft). In addition, the contamination appears to extend beneath the residence as well as into the street in front of the residence. The total affected area is estimated to be approximately 75 percent of the property. These conclusions are supported by documentation that establishes the presence of the former channel of Lodi Brook in this area. This channel is the suspected transport mechanism for the radiological contamination.

2.0 SITE HISTORY

The Maywood Chemical Works was founded in 1895. The company began processing thorium from monazite sand in 1916 (during World War I) 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 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 coca leaves mixed with other material resulting from operations at the plant. Some fill material apparently contained thorium process wastes (Ref. 3).

Uncertainty exists as to 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. First, 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. Second, 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 contain 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 on 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 recalled chemical odors in and around the brook in Lodi and steam rising off the water. These observations suggest that discharges of contaminants occurred 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

Numerous surveys of the Maywood site and its vicinity properties have been conducted. Among the past surveys, three that are pertinent to this vicinity property are detailed in this section.

January 1981--The Nuclear Regulatory Commission (NRC) directed that a survey be conducted of the Stepan Company property and its vicinity properties in January 1981. Using the Stepan Company plant as the center, a 10.3-km^2 (4-mi^2) aerial survey was conducted by the EG&G Energy Measurements Group, which identified anomalous concentrations of thorium-232 to the north and south of the Stepan Company property. The Lodi vicinity 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 in September 1986 to determine which properties contained radioactive contamination in excess of DOE guidelines and would, therefore, 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 U.S. Environmental Protection Agency (EPA) for the Uranium Mill Tailings Remedial Action Program.

TABLE 2-1
SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES

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 GUIDELINES

Radionuclide	Soil Concentration (pCi/g) Above Background[a,b,c]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g when 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.
Other Radionuclides	Soil guidelines will be calculated on a site-specific basis using the DOE manual developed for this use.

STRUCTURE GUIDELINES

Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that has no radiological restrictions on its use; 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 that has no radiological restrictions on its use shall not exceed the background level by more than 20 µR/h.

Indoor/Outdoor Structure Surface Contamination

	Allowable Surface Residual 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
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

TABLE 2-1
(CONTINUED)

[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 1) the dose for the mixtures will not exceed the basic dose limit, or 2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

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

[c]Localized concentrations in excess of these limits are allowable, provided that the average concentration over a 100-m^2 area does not exceed these limits. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate soil limit, regardless of the average concentration in the soil.

[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 x 105 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 were required to comply with the provisions of BNI health and safety requirements and as directed by the on-site BNI Health and Safety Officer.

3.1 SUBCONTRACTOR TRAINING

Before the start of work, all subcontractor personnel attended an orientation session presented by the BNI Health and Safety Officer to explain the nature of the material to be encountered in the work and the personnel monitoring and safety measures that are required.

3.2 SAFETY REQUIREMENTS

Subcontractor personnel complied with the following BNI requirements:

- Bioassay--Subcontractor personnel submitted 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.
- Protective Clothing/Equipment--Subcontractor personnel were required to wear the protective clothing/equipment specified in the subcontract or as directed by the BNI Health and Safety Officer.
- Dosimetry--Subcontractor personnel were required to wear and return daily the dosimeters and monitors issued by BNI.
- Controlled Area Access/Egress--Subcontractor personnel and equipment entering areas where access and egress were controlled for radiation and/or chemical safety purposes were surveyed by the BNI Health and Safety Officer (or personnel representing BNI) for contamination before leaving those areas.

- Medical Surveillance--Upon written direction from BNI, subcontractor personnel who work in areas where hazardous chemicals might exist were 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 was under the direct supervision of personnel representing BNI.

Health and safety-related requirements for all activities involving exposure to radiation, radioactive material, chemicals, and/or chemically contaminated materials and other associated industrial safety hazards are generated in compliance with applicable regulatory requirements and industry-wide standards. Copies of these requirements are located at the BNI project office for use by project 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 was adjusted to characterize each property adequately. 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 with the east and north coordinates is shown on all figures included in Sections 4.0 and 5.0 of this report.

4.1 FIELD RADIOLOGICAL CHARACTERIZATION

This section provides a description of the instrumentation and methodologies used to obtain exterior surface and subsurface measurements during radiological characterization of this project.

4.1.1 Measurements Taken and Methods Used

An initial walkover survey was performed using an unshielded gamma scintillation detector [5.0- by 5.0-cm (2- by 2-in.) thallium-activated sodium iodide probe] to identify areas of elevated radionuclide activity. Near-surface gamma measurements taken using a cone-shielded gamma scintillation detector were also used to determine areas of surface contamination. 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 30.4 cm (12 in.) above the ground at the intersections of

3.0-m (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 approximately 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 extended and to locate subsurface contamination where there was no surface manifestation. The subsurface characterization consisted of drilling nine boreholes (Figure 4-1) [using either a 7.6-cm- (3-in.-) or 15.2-cm- (6-in.-) diameter auger bit], and gamma logging them. The boreholes 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 accomplished in less time than collecting soil samples, and the need for analyzing these samples in a laboratory is eliminated. A 5.0- by 5.0-cm (2- 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 by results from previous characterizations where thorium-232 was found (Ref. 9).

Gamma radiation measurements were taken at 15.2-cm (6-in.) vertical intervals to determine the depth and concentration of the contamination. The gamma-logging data were reviewed

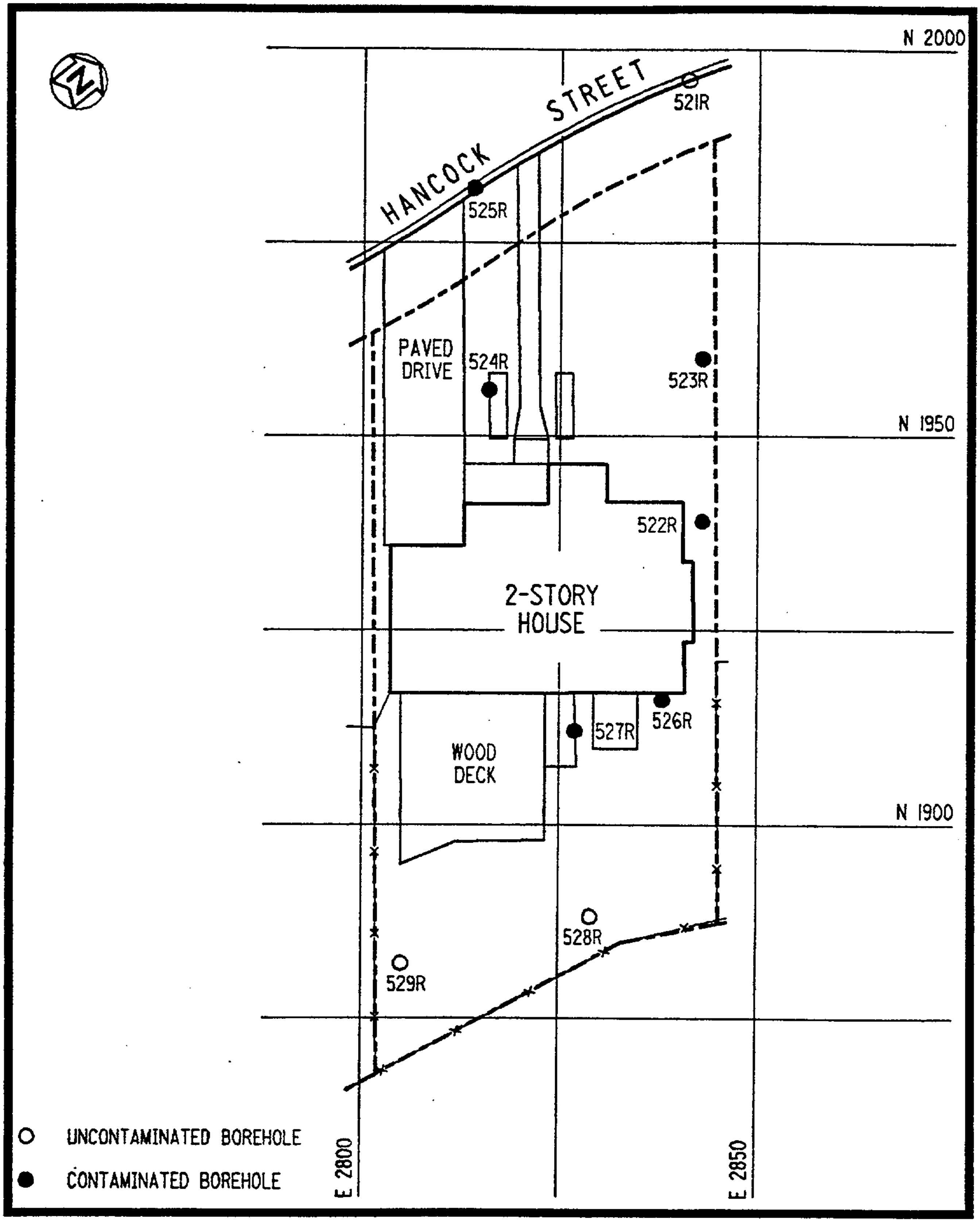

FIGURE 4-1 BOREHOLE LOCATIONS AT 8 HANCOCK STREET

to identify trends, whether or not 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 nine 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 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 nine 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.

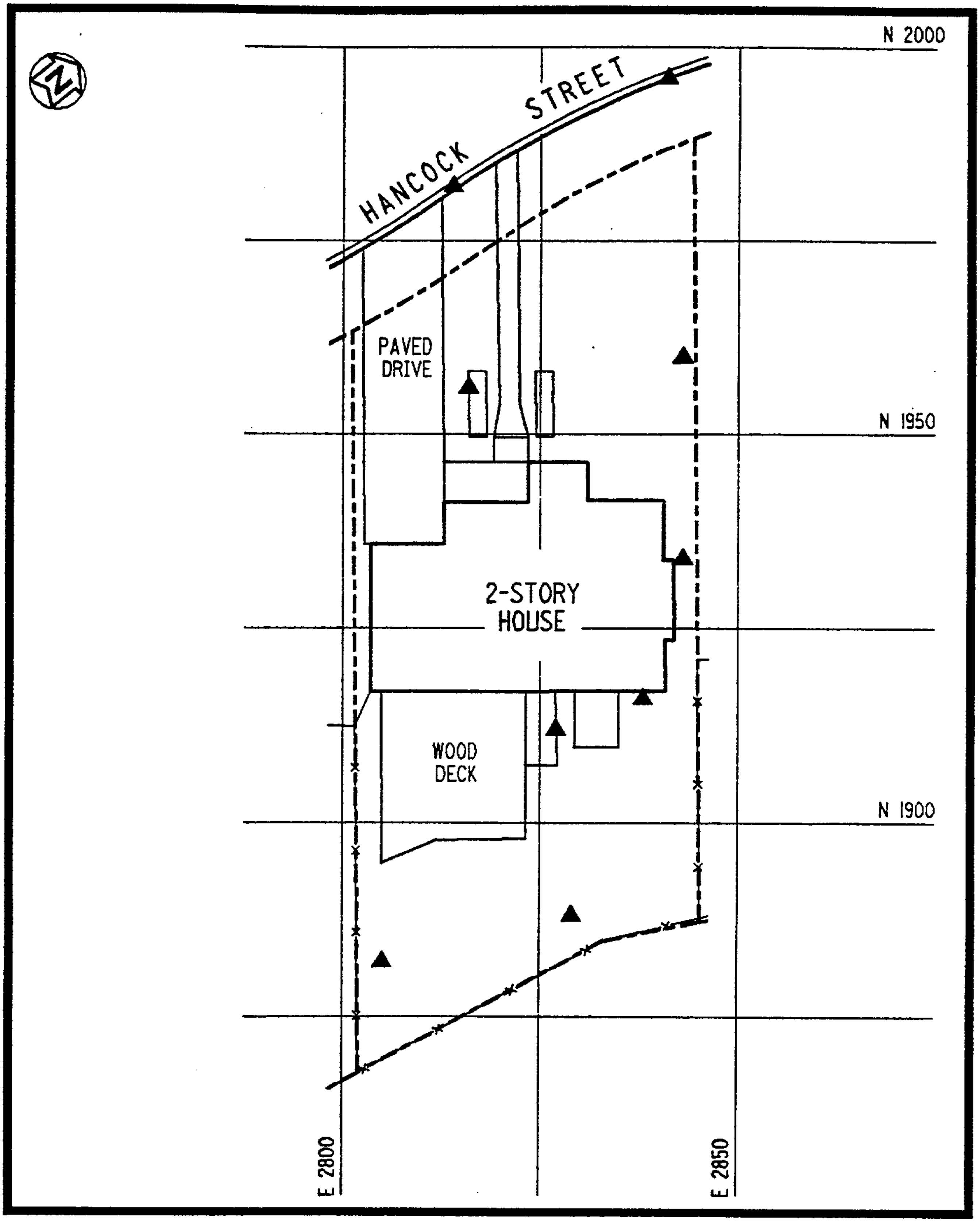

FIGURE 4-2 SURFACE AND SUBSURFACE SOIL SAMPLING LOCATIONS AT 8 HANCOCK STREET

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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 made using the Tedlar bag method. Samples were collected by pumping air into a Tedlar bag at a rate of approximately 2 L/min. The air sample was transferred 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 allowed 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 samples were collected to determine a WL for radon and thoron daughters. To measure radon daughters, an air sample was collected for exactly 5 min through a 0.45-micron filter at a rate of 11 L/min for a total sample volume of 55 L. Alpha particle activity on the filter paper was counted from 40 to 90 min after sampling. An alpha scintillation detector coupled to a count-rate meter or digital scaler was used. Measurements for thoron daughters were made 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 was allowed to age for at least 5 h after sampling before alpha activity was counted. This elapsed time allowed radon daughters, which may have been present with the thoron daughters, to decay sufficiently so as not to interfere in calculating the WL for thoron daughters.

Exterior gamma exposure rate measurements were made at three locations throughout the property grid system and at one location inside the residence. To obtain these measurements, either a 5.0- by 5.0-cm (2- by 2-in.) thallium-activated sodium iodide gamma scintillation detector designed to detect gamma radiation only or a pressurized ionization chamber (PIC) was used. Measurement locations are shown in 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 1 m (3 ft) above the ground. 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.

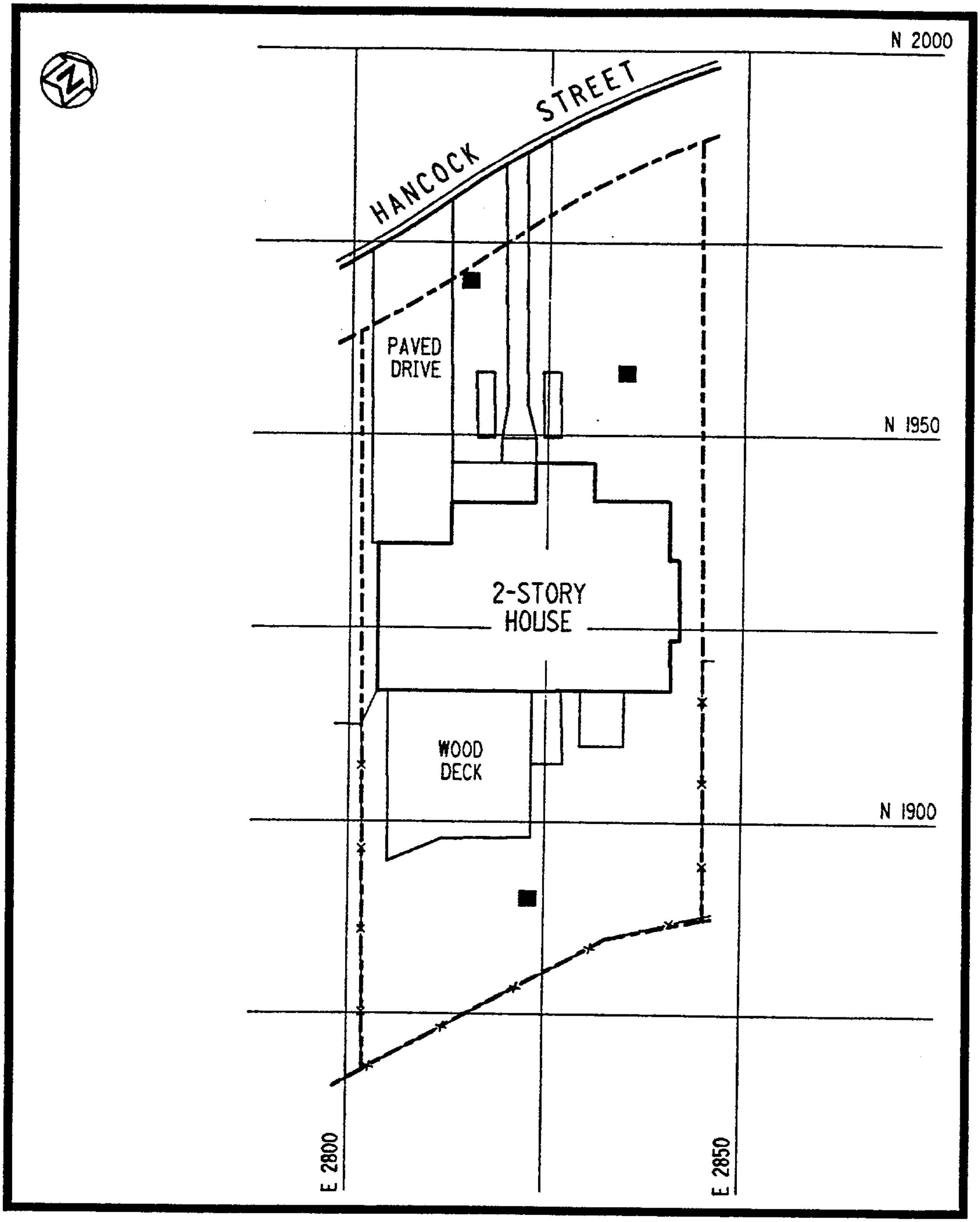

FIGURE 4-3 GAMMA EXPOSURE RATE MEASUREMENT LOCATIONS AT 8 HANCOCK STREET

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5.0 CHARACTERIZATION RESULTS

Radiological characterization results are presented in this section. The data included represent exterior surface and subsurface radiation measurements and interior radiation measurements.

5.1 FIELD RADIOLOGICAL CHARACTERIZATION

Near-surface gamma radiation measurements on the property ranged from 2,100 cpm to approximately 20,000 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 and the basis for selecting the locations of soil samples. Areas of surface contamination indicated by near-surface gamma measurements are shown in Figure 5-1.

Surface soil samples [depths from 0.0 to 15.2 cm (0.5 in.)] were taken at nine 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 6.1 to less than 13.6 pCi/g for uranium-238, from 1.8 to 3.8 pCi/g for thorium-232, and from 0.8 to 5.6 pCi/g for radium-226. Analytical results for surface soils are provided in Table 5-1; these data showed that concentrations of thorium-232 do not exceed DOE guidelines (5 pCi/g plus background of 1 pCi/g for surface soils) with a maximum concentration of 3.8 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

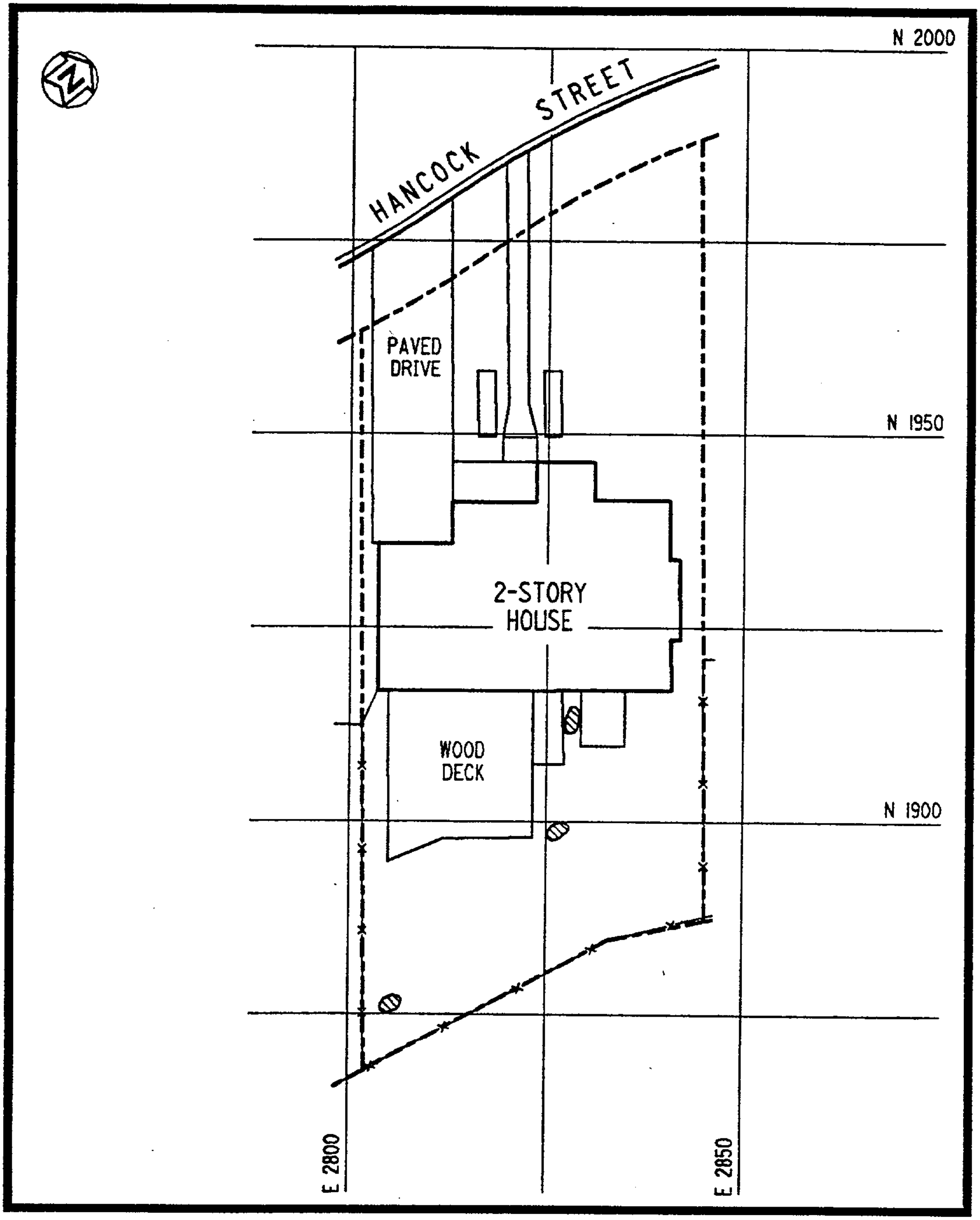

FIGURE 5-1 AREAS OF SURFACE CONTAMINATION AT 8 HANCOCK STREET

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"less than" value represents the lower bound of the quantitative capacity of the instrument and technique used. The "less than" value 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 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.

Analytical results for subsurface soil samples are given in Table 5-1, and gamma logging data are given in Table 5-2. The results in Table 5-2 showed a range from 8,000 cpm to 214,000 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 [taken at depths from 15.2 to 30.4 cm (0.5 to 1.0 ft)] indicated uranium-238 concentrations ranging from less than 6.3 to less than 13.3 pCi/g, thorium-232 concentrations ranging from 2.3 to 4.6 pCi/g, and radium-226 concentrations ranging from 0.8 to less than 5.6 pCi/g.

On the basis of near-surface gamma radiation measurements, surface and subsurface soil sample analyses, and downhole gamma logging, contamination on this property is believed to consist primarily of subsurface contamination at depths ranging from 15.2 cm (0.5 in.) to 2.89 m (9.5 ft). The areas of subsurface contamination are shown in Figure 5-2. The subsurface contamination appears to extend beneath the residence as well as into the street in front of the property.

It is apparent from review of historical documentation (e.g., aerial photographs of the area, interviews with local residents, and previous radiological surveys) that the subsurface contamination on this property lies along the former channel of Lodi Brook and its associated floodplain.

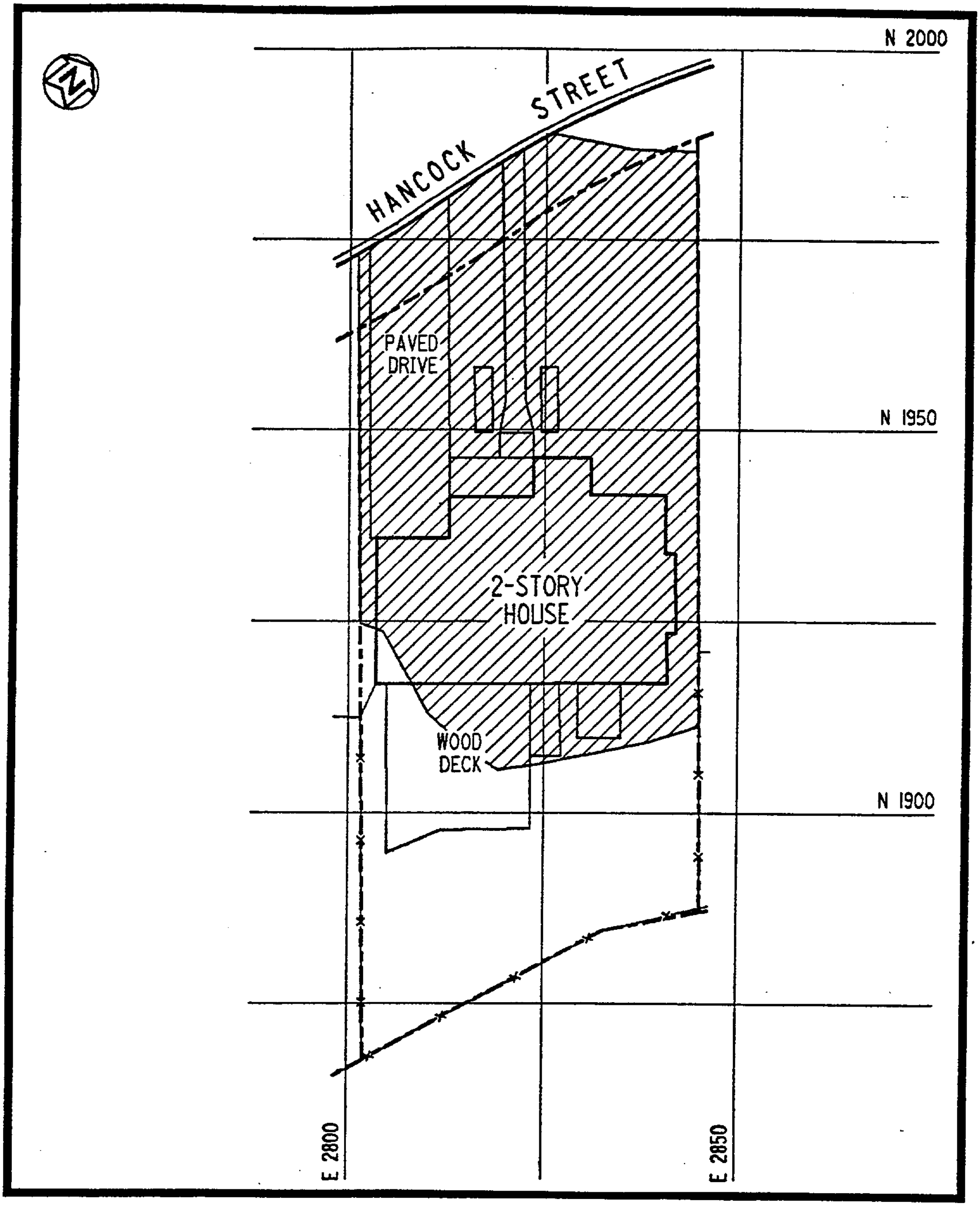

FIGURE 5-2 AREAS OF SUBSURFACE CONTAMINATION AT 8 HANCOCK STREET

The contamination on this property is similar to contamination found on residential properties in close proximity to this property. It has been established that the Lodi Brook channel through these neighboring properties once occupied locations connecting to those where stream sediments were found at 8 Hancock Street. Thus, the elevated gamma readings shown on gamma logs from boreholes drilled on this property serve as further indication of the suspected mechanism of transport for radiological contamination (i.e., stream deposition from Lodi Brook).

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 using the Tedlar bag method indicated concentrations of 0.2 and 0.6 pCi/L, respectively. These measurements were substantially less than the applicable DOE guideline of 3.0 pCi/L above background (Ref. 10).

Results of two measurements for radon daughters ranged from 0.002 to 0.003 WL. These results were substantially less than the applicable generic guideline detailed in the Code of Federal Regulations, 40 CFR 192 (Ref. 10), which states that an annual average (or equivalent) radon decay product concentration not exceed 0.02 WL.

Results of measurements for thoron daughters ranged from 0.001 to 0.002 WL. The generic guideline is more restrictive for radon-222 (radon) than for radon-220 (thoron) according to the National Council on Radiological Protection [see NCRP Report No. 50 (Ref. 11), which was used as the guideline for thoron daughter measurements].

Exterior gamma radiation exposure rate measurements ranged from 8 to 10 μR/h, including background. These results can be found in Table 5-3. These measurements are consistent with the average background exposure rate of 9 μR/h (Ref. 12).

The indoor exposure rate measurement was 7 μR/h, including background (Table 5-3). The indoor exposure rate does not exceed average background. For comparison, the DOE guideline for indoor exposure rate is 20 μR/h.

Based on the above information, the exposure rates for this property are within DOE guidelines. Further, it should be emphasized that natural background exposure rates vary widely across the United States and are often significantly higher than average background for this area.

TABLE 5-1

SURFACE AND SUBSURFACE RADIONUCLIDE CONCENTRATIONS IN SOIL

FOR 8 HANCOCK STREET

Coordinates[a]		Depth	Concentration (pCi/g ± 2 sigma)		
East	North	(ft)	Uranium-238	Radium-226	Thorium-232
2805	1882	0.0 - 0.5	< 6.1	1.0 ± 0.02	1.8 ± 0.2
2805	1882	0.5 - 1.0	< 9.8	0.8 ± 0.3	< 3.0
2814	1982	0.0 - 0.5	<12.9	1.4 ± 0.2	2.7 ± 0.7
2814	1982	0.5 - 1.0	< 7.6	1.6 ± 0.7	4.6 ± 1.0
2816	1956	0.0 - 0.5	<10.3	1.1 ± 0.1	1.8 ± 1.2
2816	1956	0.5 - 1.0	< 6.3	1.5 ± 0.3	3.1 ± 0.7
2827	1912	0.0 - 0.5	<13.6	5.6 ± 0.5	3.0 ± 1.0
2827	1912	0.5 - 1.0	<13.3	5.6 ± 0.7	3.4 ± 0.9
2829	1888	0.0 - 0.5	< 6.7	0.8 ± 0.4	< 3.0
2829	1888	0.5 - 1.0	< 9.4	1.6 ± 0.6	< 3.3
2838	1916	0.0 - 0.5	< 8.0	1.9 ± 0.1	3.8 ± 0.3
2838	1916	0.5 - 1.0	< 6.6	0.8 ± 0.3	2.3 ± 1.0
2841	1996	0.0 - 0.5	<11.3	< 1.7	2.2 ± 0.8
2841	1996	0.5 - 1.0	< 7.2	1.3 ± 0.2	3.6 ± 0.7
2843	1939	0.0 - 0.5	<12.7	2.5 ± 0.3	2.2 ± 0.9
2843	1939	0.5 - 1.0	< 6.8	1.9 ± 0.1	4.2 ± 1.0
2843	1960	0.0 - 0.5	<12.1	1.9 ± 0.5	2.8 ± 0.8
2843	1960	0.5 - 1.0	< 7.9	1.0 ± 0.1	2.8 ± 0.1

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

TABLE 5-2

DOWNHOLE GAMMA LOGGING RESULTS

FOR 8 HANCOCK STREET

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 529R[d]			
2805	1882	0.5	10000
2805	1882	1.0	12000
2805	1882	1.5	12000
2805	1882	2.0	12000
2805	1882	2.5	12000
2805	1882	3.0	12000
2805	1882	3.5	12000
2805	1882	4.0	12000
2805	1882	4.5	12000
2805	1882	5.0	12000
2805	1882	5.5	12000
2805	1882	6.0	10000
2805	1882	6.5	10000
2805	1882	7.0	10000
2805	1882	7.5	11000
Borehole 525R[d]			
2814	1982	0.5	16000
2814	1982	1.0	15000
2814	1982	1.5	16000
2814	1982	2.0	28000
2814	1982	2.5	27000
2814	1982	3.0	23000
2814	1982	3.5	23000
2814	1982	4.0	23000
2814	1982	4.5	25000
2814	1982	5.0	25000
2814	1982	5.5	28000
2814	1982	6.0	30000
2814	1982	6.5	29000
2814	1982	7.0	25000
2814	1982	7.5	17000
2814	1982	8.0	14000
2814	1982	8.5	9000

TABLE 5-2

(continued)

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 524R[d]			
2816	1956	0.5	12000
2816	1956	1.0	14000
2816	1956	1.5	16000
2816	1956	2.0	16000
2816	1956	2.5	18000
2816	1956	3.0	21000
2816	1956	3.5	24000
2816	1956	4.0	26000
2816	1956	4.5	27000
2816	1956	5.0	27000
2816	1956	5.5	29000
2816	1956	6.0	33000
2816	1956	6.5	42000
2816	1956	7.0	45000
2816	1956	7.5	86000
2816	1956	8.0	214000
2816	1956	8.5	190000
2816	1956	9.0	54000
2816	1956	9.5	41000
2816	1956	10.0	22000
Borehole 527R[d]			
2827	1912	0.5	32000
2827	1912	1.0	30000
2827	1912	1.5	28000
2827	1912	2.0	27000
2827	1912	2.5	24000
2827	1912	3.0	26000
2827	1912	3.5	24000
2827	1912	4.0	23000
2827	1912	4.5	22000
2827	1912	5.0	22000
2827	1912	5.5	23000
2827	1912	6.0	23000
2827	1912	6.5	25000

TABLE 5-2

(continued)

Coordinates[a] East	Coordinates[a] North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 527R (continued)[d]			
2827	1912	7.0	31000
2827	1912	7.5	39000
2827	1912	8.0	15000
2827	1912	8.5	11000
2827	1912	9.0	10000
2827	1912	9.5	10000
Borehole 528R[d]			
2829	1888	0.5	12000
2829	1888	1.0	13000
2829	1888	1.5	14000
2829	1888	2.0	11000
2829	1888	2.5	13000
2829	1888	3.0	12000
2829	1888	3.5	12000
2829	1888	4.0	11000
2829	1888	4.5	10000
2829	1888	5.0	10000
2829	1888	5.5	9000
2829	1888	6.0	10000
2829	1888	6.5	10000
2829	1888	7.0	8000
2829	1888	7.5	9000
Borehole 526R[d]			
2838	1916	0.5	16000
2838	1916	1.0	19000
2838	1916	1.5	19000
2838	1916	2.0	21000
2838	1916	2.5	20000
2838	1916	3.0	20000
2838	1916	3.5	22000
2838	1916	4.0	22000
2838	1916	4.5	22000

TABLE 5-2

(continued)

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 526R (continued)[d]			
2838	1916	5.0	22000
2838	1916	5.5	22000
2838	1916	6.0	23000
2838	1916	6.5	27000
2838	1916	7.0	34000
2838	1916	7.5	41000
2838	1916	8.0	14000
2838	1916	8.5	10000
2838	1916	9.0	10000
2838	1916	9.5	11000
Borehole 521R[d]			
2841	1996	0.5	12000
2841	1996	1.0	15000
2841	1996	1.5	15000
2841	1996	2.0	15000
2841	1996	2.5	17000
2841	1996	3.0	18000
2841	1996	3.5	19000
2841	1996	4.0	20000
2841	1996	4.5	21000
2841	1996	5.0	22000
2841	1996	5.5	22000
2841	1996	6.0	22000
2841	1996	6.5	20000
2841	1996	7.0	18000
2841	1996	7.5	15000
Borehole 522R[d]			
2843	1939	0.5	14000
2843	1939	1.0	15000
2843	1939	1.5	13000
2843	1939	2.0	14000
2843	1939	2.5	15000

TABLE 5-2

(continued)

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 522R (continued)[d]			
2843	1939	3.0	18000
2843	1939	3.5	17000
2843	1939	4.0	28000
2843	1939	4.5	23000
2843	1939	5.0	23000
2843	1939	5.5	23000
2843	1939	6.0	45000
2843	1939	6.5	65000
2843	1939	7.0	134000
2843	1939	7.5	150000
2843	1939	8.0	67000
2843	1939	8.5	21000
2843	1939	9.0	22000
2843	1939	9.5	13000
Borehole 523R[d]			
2843	1960	0.5	13000
2843	1960	1.0	15000
2843	1960	1.5	16000
2843	1960	2.0	18000
2843	1960	2.5	21000
2843	1960	3.0	23000
2843	1960	3.5	23000
2843	1960	4.0	23000
2843	1960	4.5	23000
2843	1960	5.0	29000
2843	1960	5.5	24000
2843	1960	6.0	25000
2843	1960	6.5	57000

TABLE 5-2

(continued)

Page 6 of 6

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 523R (continued)[d]			
2843	1960	7.0	93000
2843	1960	7.5	117000
2843	1960	8.0	74000
2843	1960	8.5	31000
2843	1960	9.0	15000
2843	1960	9.5	11000

[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 5.0- by 5.0-cm (2- by 2-in.) thallium-activated sodium iodide gamma scintillation detector.

[d]Bottom of borehole collapsed.

TABLE 5-3

GAMMA RADIATION EXPOSURE RATES

FOR 8 HANCOCK STREET

Coordinates[a]		Rate[b]
East	North	(μR/h)
2815	1970	8
2823	1890	10
2835	1958	9
Interior of Residence		7

[a]Measurement locations are shown in Figure 4-3.

[b]Measurements include background.

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APPENDIX A

GEOLOGIC DRILL LOGS FOR 8 HANCOCK STREET

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	529R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
8 Hancock St. (LODI)	N 1,882 E 2,805	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-4-86	11-4-86	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
/				43.4	/	/

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.
							43.4				0.0 - 9.0 Ft. Silty SAND (SM). Fill (0.0-5.0) and indigenous (5.0-9.0) material. Color stratified. Fine- to medium-grained with few to numerous pieces of rounded to angular gravel (and occasional cobbles) of various lithologies in the fill material. Soft, unconsolidated (loose), sometimes clayey (SC-OH). Moist.	Borehole drilled 0.0-9.0 Ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by TMA-Eberline, Corp.
								5			0.0-0.3 Ft. Moderate brown (5YR3/4). Numerous grass roots and organics.	
											0.3-5.0 Ft. Dark reddish brown (10R3/4).	
											5.0-6.0 Ft. Moderate brown. Clayey. May be buried upper soil horizon.	No groundwater observed.
							34.4				6.0-9.0 Ft. Dark yellowish brown (10YR4/2). May be decomposed sandstone.	
											Bottom of borehole at 9.0 Ft. Auger spoils were replaced in hole, 11/4/86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	8 Hancock St. (LODI)	529R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	525R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
8 Hancock St. (LODI)	N 1,982 E 2,814	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-4-86	11-4-86	MORETRENCH	B&S Little Beaver	4"	12.0		12.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				43.8	10.0/33.8 11/4/86 /	/

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

ELEV.	DEPTH	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
43.8		0.0 - 4.0 Ft. Silty SAND (SM). Fill material. Multi-colored. Fine- to medium-grained. Soft, unconsolidated (loose), moist. Numerous grass roots and organics. 0.0-0.3 Ft. Moderate brown (5YR3/4). Numerous grass roots and organics. 0.3-4.0 Ft. Moderate brown and dark reddish brown (10R3/4).	Borehole drilled 0.0-12.0 Ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by TMA-Eberline, Corp.
39.8	5	4.0 - 6.0 Ft. SAND. Coal ash fill. Black (N1). Fine- to coarse-grained. Very low density. Soft, unconsolidated, moist.	
37.8	10	6.0 - 12.0 Ft. Silty SAND (SM). Undisturbed, natural material. Color stratified. Fine- to medium-grained. Soft, poorly consolidated (loose), saturated at 10.0 Ft. 6.0-9.0 Ft. Moderate brown (5YR3/4) and mottled grayish black (N2). May be mixed stream sediments and buried upper soil horizon. 9.0-12.0 Ft. Dark yellowish brown (10YR4/2). May be decomposed sandstone.	10 Ft., groundwater observed.
31.8		Bottom of borehole at 12.0 Ft. Auger spoils were replaced in the hole, 11/4/86.	Description and classification of soil samples by visual examination.

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

SITE: 8 Hancock St. (LODI) — HOLE NO. 525R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	524R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
8 Hancock St. (LODI)	N 1,956 E 2,816	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-4-86	11-4-86	MORETRENCH	B&S Little Beaver	4"	11.0		11.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				43.8	/ 11/4/86 /	/

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

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.
							43.8				0.0 - 3.5 Ft. Silty SAND (SM). Fill material. Color stratified. Fine- to medium-grained with few to numerous pieces of rounded to angular gravel. Gravel is of various lithologies. Occasional cobbles. Soft, unconsolidated (loose), moist. 0.0-0.3 Ft. Moderate brown (5YR3/4). Numerous grass roots and organics. 0.3-3.5 Ft. Dark yellowish brown (10YR4/2), mottled dark reddish brown (10R3/4).	Borehole drilled 0.0-11.0 Ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by TMA-Eberline, Corp. No groundwater observed.
							40.3	5			3.5 - 10.0 Ft. SAND. Mixed carbonaceous sand (coal ash fill) and indigenous stream sediments. Black (N1). Fine- to coarse-grained. Some inorganic silt or clay due to mechanical mixing at time of fill emplacement. Very low density. Soft, unconsolidated, moist. 5.0 Ft. Piece of metal.	
							33.8	10			10.0 - 11.0 Ft. Silty SAND (SM). Undisturbed, natural material. Fine- to medium-grained. Soft, poorly consolidated (loose), moist. Dark reddish brown (10R3/4). Few cobbles, possible debris above buried upper soil horizon.	
							32.8				Bottom of borehole at 11.0 Ft. Auger spoils were replaced in the hole, 11/4/86.	Description and classification of soil samples by visual examination.

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

SITE	HOLE NO.
8 Hancock St. (LODI)	524R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	527R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
8 Hancock St. (LODI)	N 1,912 E 2,827	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-4-86	11-4-86	MORETRENCH	B&S Little Beaver	4"	12.0		12.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				43.5	11.0/32.5 11/4/86 /	/

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.
							43.5				0.0 - 3.0 Ft. <u>Silty SAND</u> (SM). Fill material. Moderate brown (5YR3/4). Fine- to medium-grained with few to numerous pieces of rounded to angular gravel of various lithologies. Occasional cobbles. Soft, unconsolidated (loose), moist. 0.0-0.3 Ft. Numerous grass roots and organics.	Borehole drilled 0.0-12.0 Ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by TMA-Eberline, Corp.
							40.5	5			3.0 - 7.0 Ft. <u>SAND</u>. Coal ash fill. Black (N1). Fine- to coarse-grained. Very low density. Soft, unconsolidated, moist. 5.0-6.0 Ft. A few sandstone cobbles and pieces of metal.	
							36.5	10			7.0 - 12.0 Ft. <u>Silty SAND</u> (SM-SC). Undisturbed, natural material. Color stratified. Fine- to medium-grained. Soft, poorly consolidated (loose), saturated at 11.0 Ft. 7.0-8.0 Ft. Black (N1). Numerous organics, clayey. May be stream sediments. 8.0-10.0 Ft. Moderate brown. May be buried upper soil horizon. 10.0-12.0 Ft. Dark yellowish brown (10YR4/2). May be decomposed sandstone.	11 Ft., groundwater observed.
							31.5				Bottom of borehole at 12.0 Ft. Auger spoils were replaced in the hole, 11/4/86.	Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE: 8 Hancock St. (LODI)	HOLE NO. 527R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	528R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
8 Hancock St. (LODI)	N 1,888 E 2,829	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-4-86	11-4-86	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
/				43.5	/	/

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

SAMP. TYP. 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 - 9.0 Ft. Silty SAND (SM). Fill (0.0-4.0) and indigenous (4.0-9.0) material. Color stratified. Fine- to medium-grained with few to numerous pieces of rounded to angular gravel (and occasional cobbles) of various lithologies in the fill material. Soft, unconsolidated (loose), sometimes clayey (SC-OH). Moist.	Borehole drilled 0.0-9.0 Ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by TMA-Eberline, Corp.
								5			0.0-0.3 Ft. Moderate brown (5YR3/4). Numerous grass roots and organics.	
											0.3-4.0 Ft. Dark reddish brown (10R3/4).	
											4.0-5.0 Ft. Moderate brown. May be buried upper soil horison.	No groundwater observed.
							34.5				5.0-9.0 Ft. Dark yellowish brown (10YR4/2). May be decomposed sandstone.	
											Bottom of borehole at 9.0 Ft. Auger spoils were replaced in hole, 11/4/86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	8 Hancock St. (LODI)	528R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	526R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
8 Hancock St. (LODI)	N 1,916 E 2,838	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-4-86	11-4-86	MORETRENCH	B&S Little Beaver	4"	12.0		12.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				43.5	10.0/33.5 11/4/86 /	/

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.
							43.5					
							43.0				0.0 - 0.3 Ft. <u>Silty SAND</u> (SM). Fill material. Moderate brown (5YR3/4). Fine- to medium-grained. Soft, unconsolidated (loose), moist. Numerous grass roots and organics.	Borehole drilled 0.0-12.0 Ft. using 4" solid-stem augers.
								5			0.3 - 7.0 Ft. <u>SAND</u>. Coal ash fill. Black (N1). Fine- to coarse-grained. Very low density. Soft, unconsolidated, moist. 4.5 Ft. Piece of metal.	Site checked for radioactive contamination and hole gamma-logged by TMA-Eberline, Corp.
							36.5	10			7.0 - 12.0 Ft. <u>Silty SAND</u> (SM). Undisturbed, natural material. Fine- to medium-grained. Soft, poorly consolidated (loose). Moist to saturated at 10.0 Ft. 7.0-8.0 Ft. Black (N1). Clayey, numerous organics. May be stream sediments. 8.0-10.0 Ft. Moderate brown (5YR3/4). May be buried upper soil horizon. 10.0-12.0 Ft. Dark yellowish brown (10YR4/2). May be decomposed sandstone.	10 Ft., groundwater observed.
							31.5				Bottom of borehole at 12.0 Ft. Auger spoils were replaced in the hole, 11/4/86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	8 Hancock St. (LODI)	526R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	521R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
8 Hancock St. (LODI)	N 1,996 E 2,841	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-4-86	11-4-86	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
/				43.8	/	/

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

ELEV.	DEPTH	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
43.8		0.0 - 4.0 Ft. Silty SAND (SM). Fill material. Color stratified. Fine- to medium-grained with few to numerous pieces of rounded to angular gravel. Gravel is of various lithologies. Occasional cobbles. Soft, unconsolidated (loose), moist.	Borehole drilled 0.0-9.0 Ft. using 4" solid-stem augers.
39.8	5	0.0-2.5 Ft. Moderate brown (5YR3/4). Numerous grass roots and organics, 0.0-0.3 Ft. 2.5-4.0 Ft. Dark yellowish brown (10YR4/2).	Site checked for radioactive contamination and hole gamma-logged by TMA-Eberline, Corp. No groundwater observed.
35.8		4.0 - 8.0 Ft. SAND. Mixed carbonaceous sand (coal ash fill) and indigenous stream sediments. Black (N1). Fine- to coarse-grained. Some inorganic silt or clay due to mechanical mixing at time of fill emplacement. Very low density. Soft, unconsolidated, moist.	
34.8		8.0 - 9.0 Ft. Silty SAND (SM). Undisturbed, natural material. Fine- to medium-grained. Soft, poorly consolidated (loose), moist. Dark yellowish brown (10YR4/2). May be decomposed sandstone.	
		Bottom of borehole at 9.0 Ft. Auger spoils were replaced in the hole, 11/4/86.	Description and classification of soil samples by visual examination.

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

SITE: 8 Hancock St. (LODI) — HOLE NO. 521R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	522R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
8 Hancock St. (LODI)	N 1,939 E 2,843	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-4-86	11-4-86	MORETRENCH	B&S Little Beaver	4"	12.0		12.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				43.5	9.0/34.5 11/4/86 /	/

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

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 - 7.0 Ft. <u>Silty SAND</u> (SM). Fill material. Color stratified. Fine- to medium-grained with few to numerous pieces of rounded to angular gravel. Gravel is of various lithologies. Occasional cobbles. Soft, unconsolidated (loose), moist. 0.0-5.0 Ft. Dark yellowish brown (10YR4/2). Few garden roots, 0.0-0.3 Ft. 5.0-7.0 Ft. Moderate brown (5YR3/4).	Borehole drilled 0.0-9.0 Ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by TMA-Eberline, Corp.
								5				
							36.5				7.0 - 9.0 Ft. <u>SAND</u>. Mixed carbonaceous sand (coal ash fill) and indigenous stream sediments. Black (N1). Fine- to coarse-grained. Some inorganic silt or clay due to mechanical mixing at time of fill emplacement. Very low density. Soft, unconsolidated, moist to saturated at 9.0 Ft.	
							34.5 ▽					9.0 Ft., groundwater observed.
								10				
							31.5				9.0 - 12.0 Ft. <u>Silty SAND</u> (SM). Undisturbed, natural material. Fine- to medium-grained. Soft, poorly consolidated (loose), moist. Dark yellowish brown (10YR4/2). May be decomposed sandstone.	
											Bottom of borehole at 12.0 Ft. Auger spoils were replaced in the hole, 11/4/86.	
												Description and classification of soil samples by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	8 Hancock St. (LODI)	522R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	523R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
8 Hancock St. (LODI)	N 1,960 E 2,843	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-4-86	11-4-86	MORETRENCH	B&S Little Beaver	4"	12.0		12.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/				43.7	10.0/33.7 11/4/86	/

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

SAMP. 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.
							43.7	0			0.0 - 4.5 Ft. Silty SAND (SM). Fill material. Color stratified. Fine- to medium-grained with few to numerous pieces of rounded to angular gravel. Gravel is of various lithologies. Occasional cobbles. Soft, unconsolidated (loose), moist. 0.0-2.5 Ft. Moderate brown (5YR3/4). Numerous grass roots and organics, 0.0-0.3 Ft. 2.5-4.5 Ft. Dark yellowish brown (10YR4/2).	Borehole drilled 0.0-12.0 Ft. using 4" solid-stem augers. Site checked for radioactive contamination and hole gamma-logged by TMA-Eberline, Corp.
							39.2	5				
							36.7				4.5 - 7.0 Ft. SAND. Coal ash fill. Black (N1). Fine- to coarse-grained. Very low density. Soft, unconsolidated, moist.	
								10 ▽			7.0 - 12.0 Ft. Silty SAND (SM). Undisturbed, natural material. Fine- to medium-grained. Soft, poorly consolidated (loose), moist to saturated at 10.0 Ft. 7.0-8.0 Ft. Grayish black (N2). Clayey, numerous organics. May be stream sediments. 8.0-11.0 Ft. Moderate brown (5YR3/4). Few sandstone cobbles. May be buried upper soil horizon. 11.0-12.0 Ft. Dark yellowish brown (10YR4/2). May be decomposed sandstone.	10.0 Ft., groundwater observed.
							31.7				Bottom of borehole at 12.0 Ft. Auger spoils were replaced in the hole, 11/4/86.	Description and classification of soil samples by visual examination.

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

SITE	HOLE NO.
8 Hancock St. (LODI)	523R