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DOE/OR/20722-246

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

RADIOLOGICAL CHARACTERIZATION REPORT FOR THE RESIDENTIAL PROPERTY AT 99 GARIBALDI AVENUE

Lodi, New Jersey

September 1989

Bechtel National, Inc.

0489-0820.11

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Bechtel National, Inc.
Systems Engineers — Constructors

Jackson Plaza Tower
800 Oak Ridge Turnpike
Oak Ridge, Tennessee 37830

Mail Address: P.O. Box 350, Oak Ridge, TN 37831-0350
Telex: 3785873

SEP 29 1989

U.S. Department of Energy
Oak Ridge Operations
Post Office Box 2001
Oak Ridge, Tennessee 37831-8723

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

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DOE/OR/20722-246

RADIOLOGICAL CHARACTERIZATION REPORT FOR THE RESIDENTIAL PROPERTY AT 99 GARIBALDI AVENUE 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.

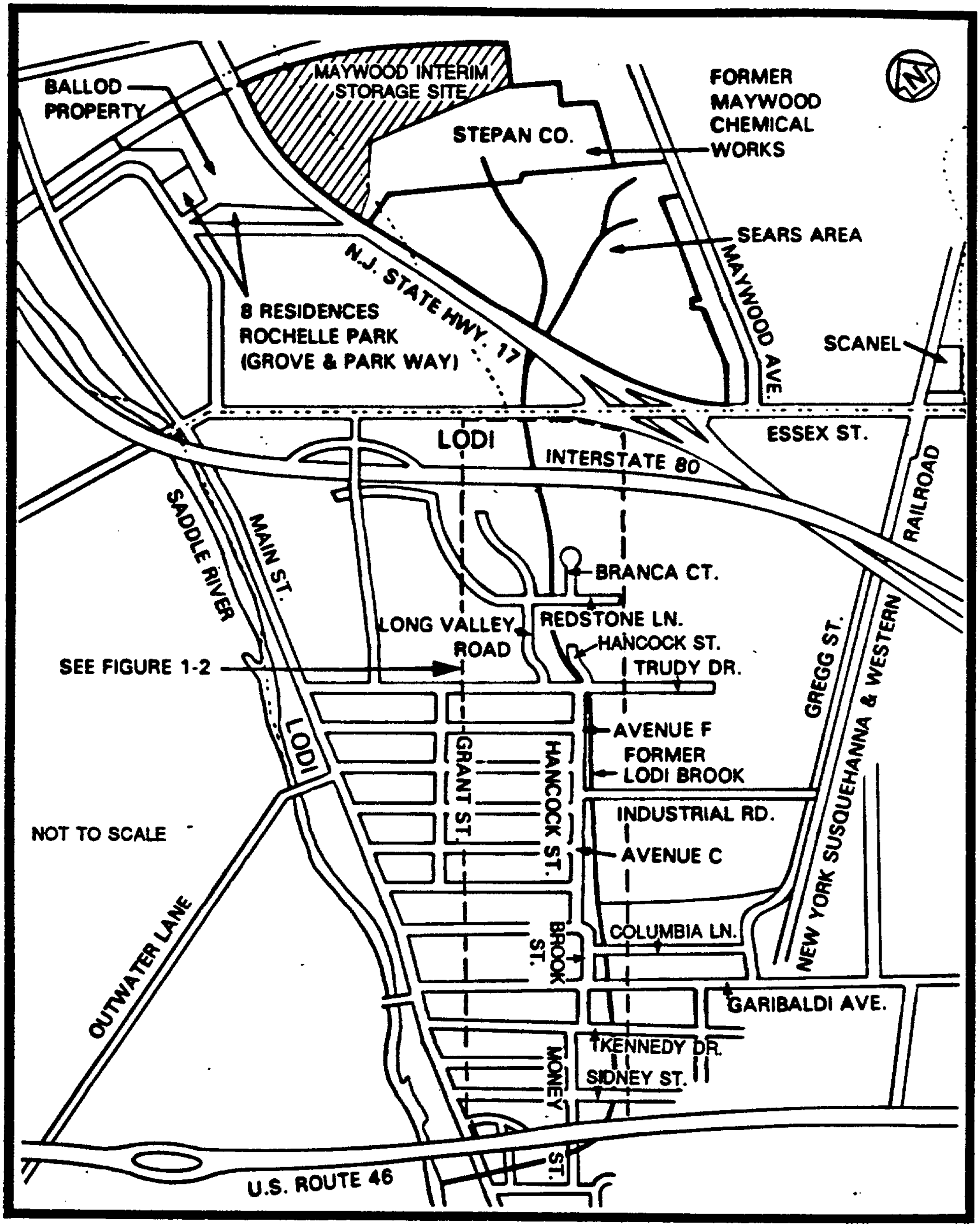

FIGURE 1-1 LOCATION OF LODI VICINITY PROPERTIES

1.2 PURPOSE

The purpose of the 1987 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 99 Garibaldi Avenue (Figure 1-2) in Lodi, New Jersey, which was conducted in October and November 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 99 Garibaldi Avenue showed maximum concentrations of thorium-232 and radium-226 to be 11.1 and less than 1.2 pCi/g, respectively. The maximum concentration of uranium-238 in surface soil samples was less than 7.1 pCi/g.

Subsurface soil sample concentrations ranged from less than 0.7 to 25.2 pCi/g for thorium-232 and from less than 0.4 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 1.9 to 37.4 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

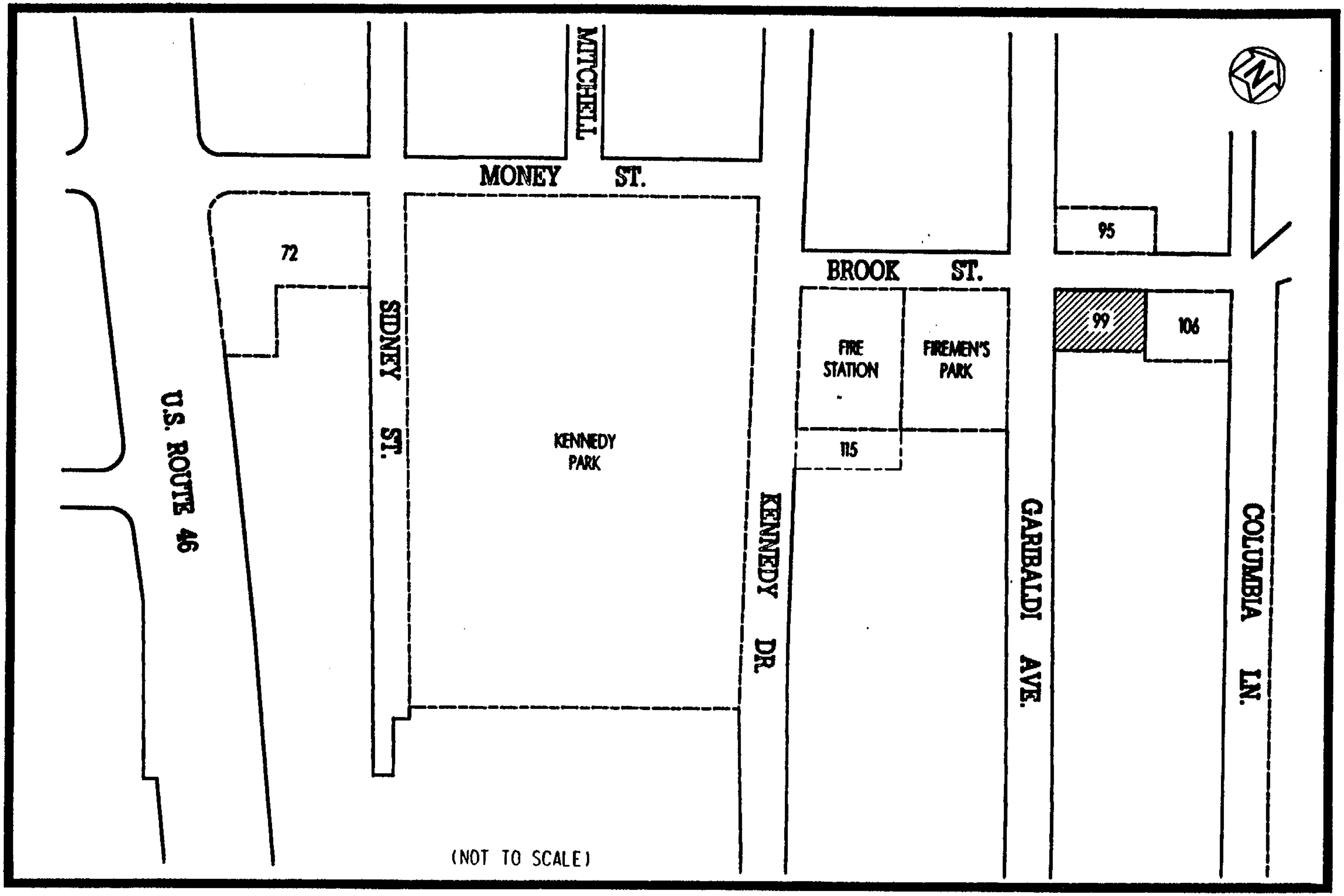

FIGURE 1-2 LOCATION OF 99 GARIBALDI AVENUE

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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 indicated surface contamination. Subsurface investigation by gamma logging indicated contamination to a depth of 0.60 m (2.0 ft) on the property and to a depth of 1.22 m (4.0 ft) in the street (Brook Street) adjacent to the property.

Exterior gamma radiation exposure rates ranged from 7 to 16 μR/h, including background. No indoor measurement could be obtained because of scheduling conflicts associated with obtaining access to the residence.

No indoor measurements for radon and its progeny (radon and thoron daughters) could be obtained.

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 99 Garibaldi Avenue. This contamination is primarily subsurface contamination ranging from a depth of 15.2 cm (6.0 in.) to 0.60 m (2.0 ft). In addition, there is a high probability that the contamination extends beneath the concrete drive, a portion of the detached garage, and the street (Brook Street) adjacent to the property. The total affected area is estimated to be approximately 30 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. 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 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

Radionuclide[f]	Allowable Surface Residual Contamination[e] (dpm/100 cm^2)		
	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.

- o 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 property.

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 six boreholes on the property and four boreholes in the streets (Brook Street and Garibaldi Avenue) adjacent to the property (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).

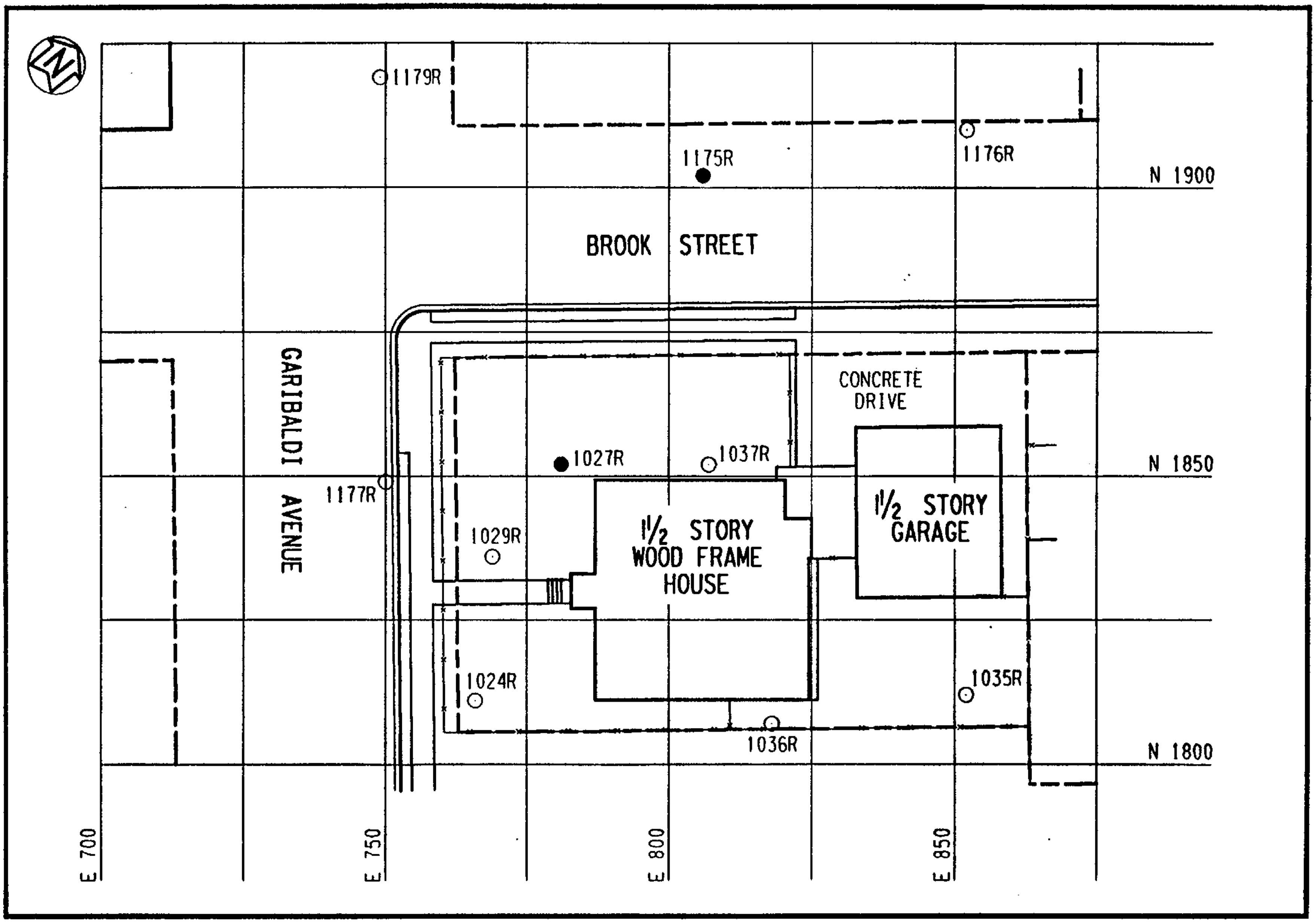

FIGURE 4-1 BOREHOLE LOCATIONS AT 99 GARIBALDI AVENUE

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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 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 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 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 ten locations (Figure 4-2) using a 7.6-cm (3.0-in.) outside diameter (O.D.) split-spoon sampler mounted on a tripod or attached to a truck-mounted auger stem. The subsurface soil samples were analyzed for radium-226, uranium-238, and thorium-232 in the same manner as the surface soil samples.

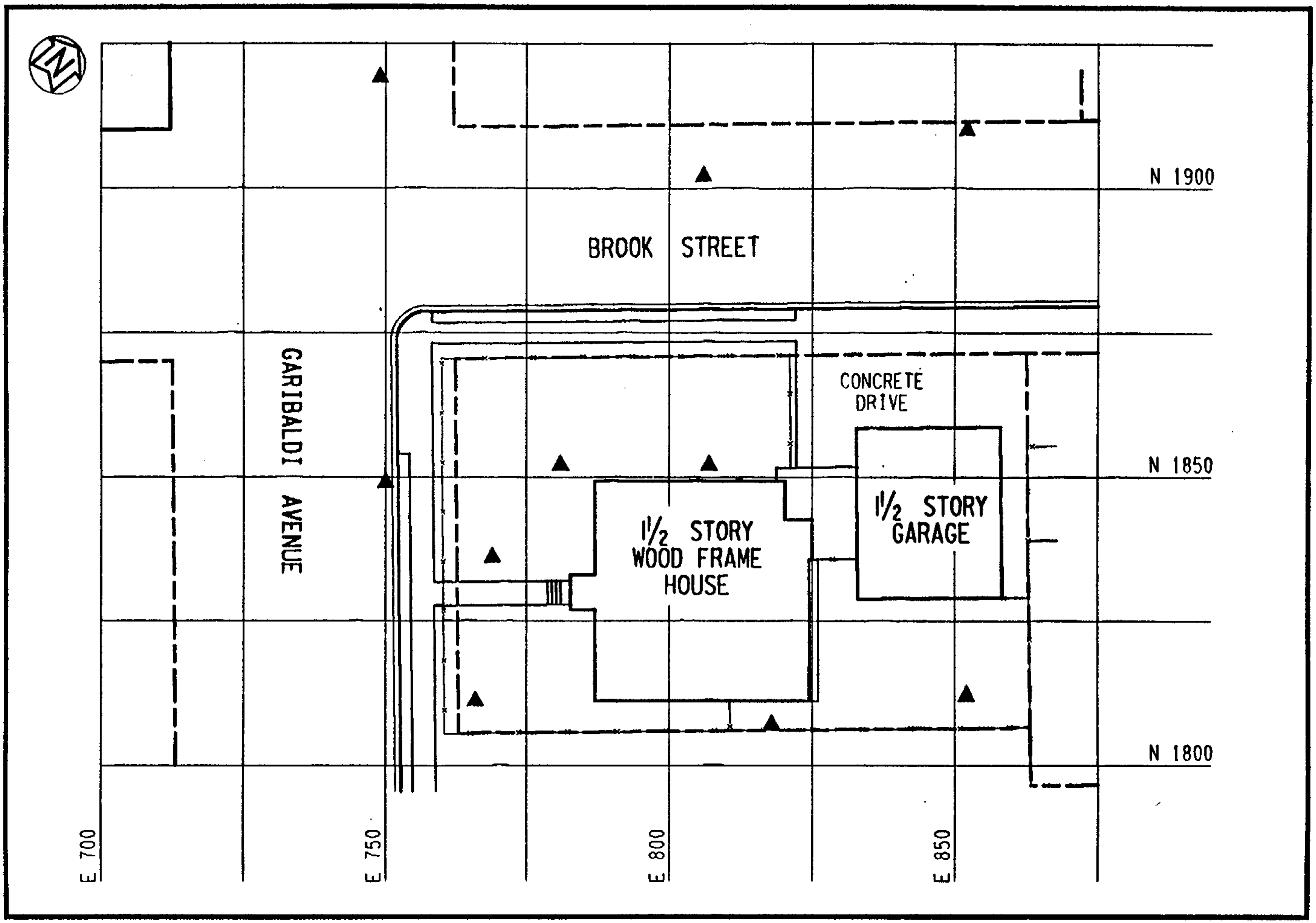

FIGURE 4-2 SURFACE AND SUBSURFACE SOIL SAMPLING LOCATIONS AT 99 GARIBALDI AVENUE

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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. Because of scheduling conflicts associated with obtaining access to the residence, a radon measurement could not be obtained to verify the presence of contaminated material under the residence and to estimate potential occupational exposures during future remedial actions.

Indoor measurements for radon and its progeny (radon and thoron daughters) could not be obtained.

Exterior gamma exposure rate measurements were made at six locations throughout the property grid system. To obtain exterior 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.

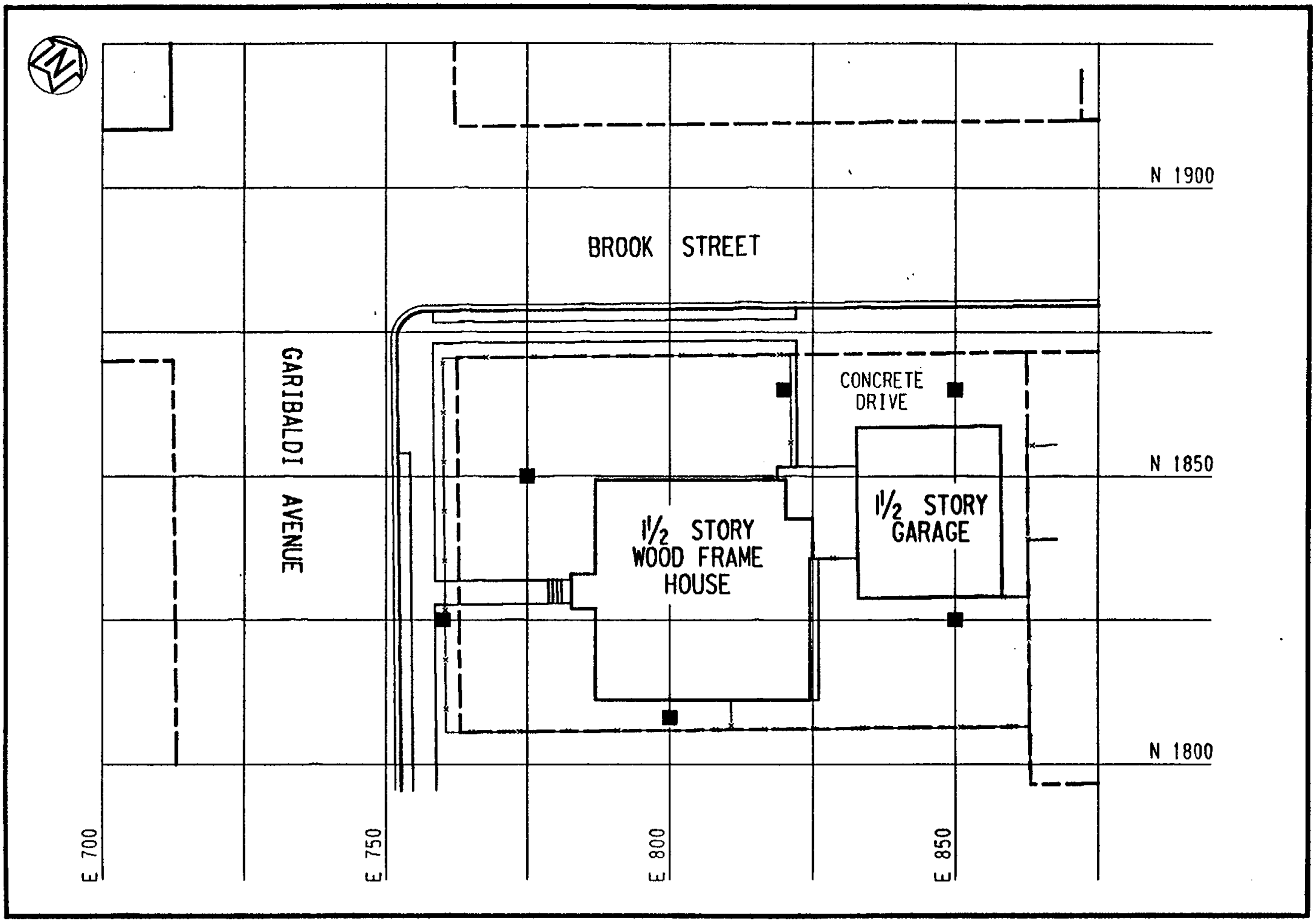

FIGURE 4-3 GAMMA EXPOSURE RATE MEASUREMENT LOCATIONS AT 99 GARIBALDI AVENUE

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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 4,000 cpm to approximately 12,000 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 are shown in Figure 5-1.

Surface soil samples [depths from 0.0 to 15.2 cm (6.0 in.)] were taken at four locations on the property and four locations in the street adjacent to 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 2.5 to less than 7.1 pCi/g for uranium-238, from less than 0.9 to 11.1 pCi/g for thorium-232, and from less than 0.6 to less than 1.2 pCi/g for radium-226. Analytical results for surface soils are provided in Table 5-1; these data showed that concentrations of thorium-232 exceeded DOE guidelines (5 pCi/g plus background of 1 pCi/g for surface soils) with a maximum concentration of 11.1 pCi/g. Use of the "less than" (<) notation in reporting results indicates that the radionuclide was not present in concentrations that are quantitative with

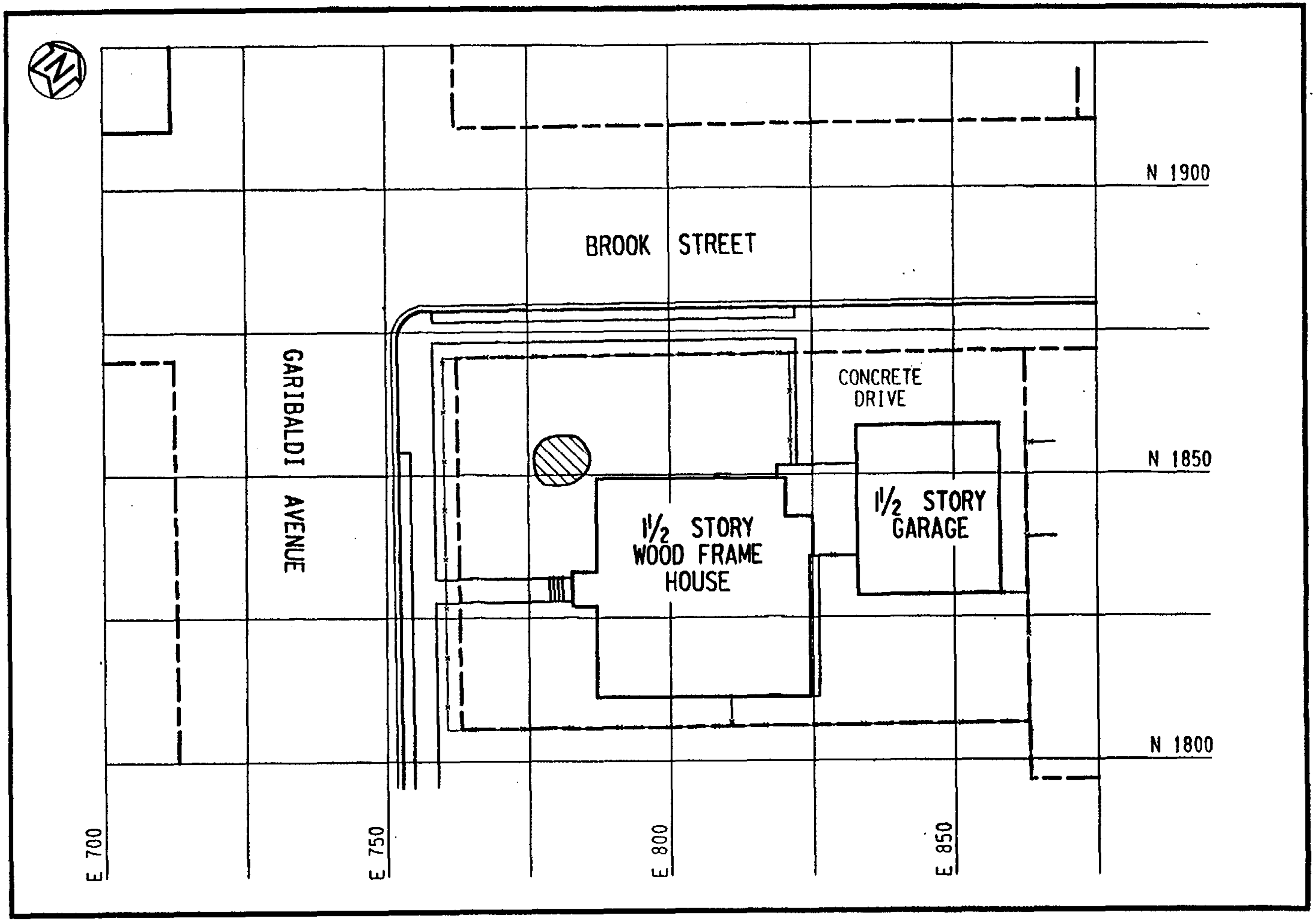

FIGURE 5-1 AREAS OF SURFACE CONTAMINATION AT 99 GARIBALDI AVENUE

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the instruments and techniques used. The "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 7,000 cpm to 146,000 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 indicated uranium-238 concentrations ranging from less than 1.9 to 37.4 pCi/g, thorium-232 concentrations ranging from less than 0.7 to 25.2 pCi/g, and radium-226 concentrations ranging from less than 0.4 to less than 1.7 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 (6.0 in.) to 0.60 m (2.0 ft). The areas of subsurface contamination are shown in Figure 5-2. The subsurface contamination appears to extend beneath the concrete drive, a portion of detached garage, and the street (Brook Street) adjacent to the property from depths of approximately 1.21 m (4.0 ft) to 1.52 m (5.0 ft).

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

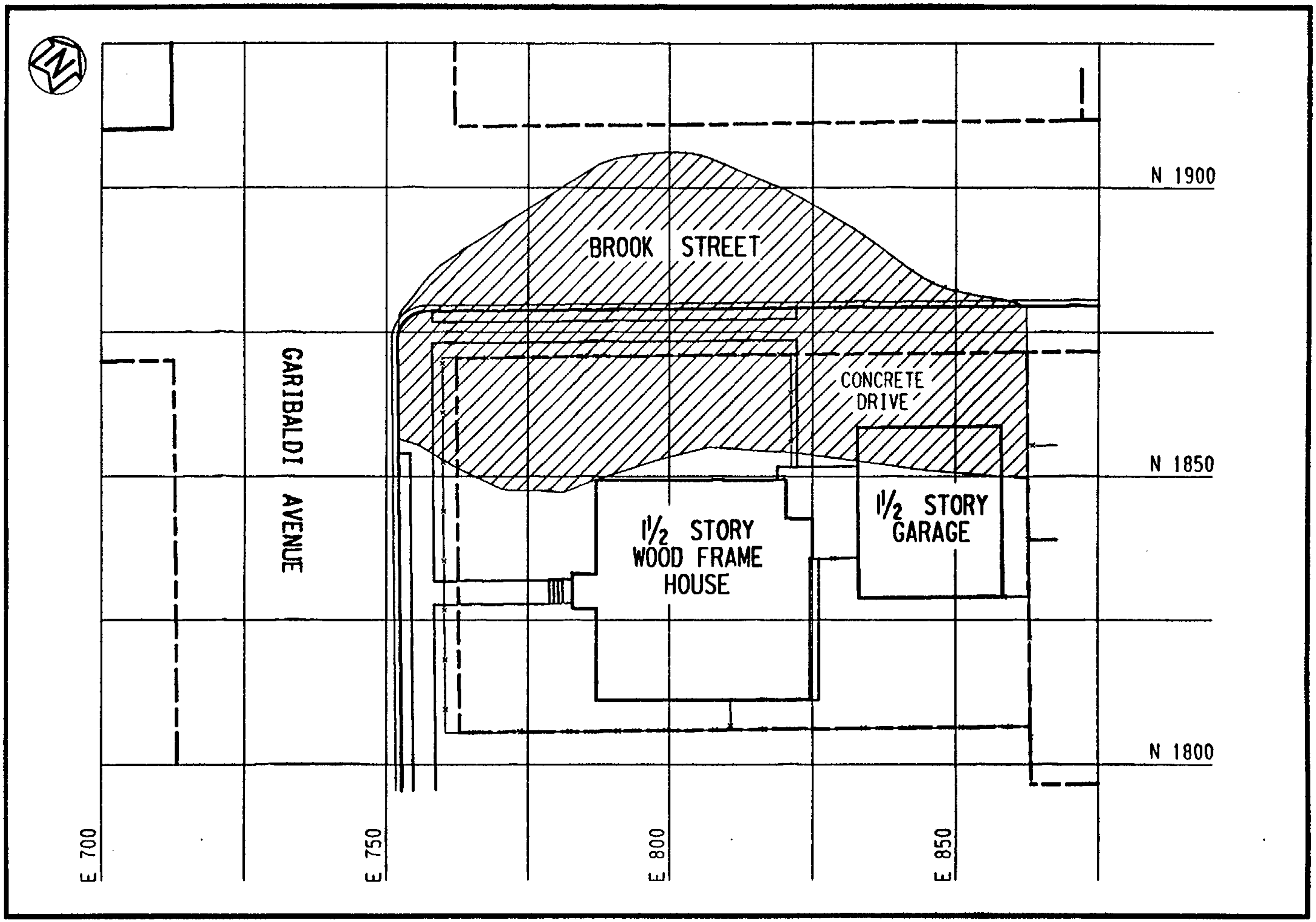

FIGURE 5-2 AREAS OF SUBSURFACE CONTAMINATION AT 99 GARIBALDI AVENUE

M38W9852.DGN

subsurface contamination on this property lies along the former channel of Lodi Brook and its associated floodplain. The contamination on this property is similar to contamination found on a residential property in close proximity to this property and a nearby municipal 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 99 Garibaldi Avenue. 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

Indoor measurements for radon and its progeny (radon and thoron daughters) could not be obtained because of scheduling conflicts associated with obtaining access to the residence.

Exterior gamma radiation exposure rate measurements ranged from 7 to 16 μR/h, including background. These results can be found in Table 5-3. Assuming the average indoor exposure rate is equivalent to the average exterior exposure rate of 11 μR/h, and assuming the resident remains on the property every hour of the year (8,760 hours or 24 hours per day for 52 weeks per year), the yearly dose would be 15 mrem above background (after subtracting average background of 9 μR/h) (Ref. 10). The DOE guideline is 100 mrem/yr above background.

Based on the above information, the exposure rates and doses at 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 99 GARIBALDI AVENUE

Coordinates[a] East	North	Depth (ft)	Concentration (pCi/g ± 2 sigma) Uranium-238	Radium-226	Thorium-232
749	1919	0.0 - 0.5	< 4.2	< 0.8	< 1.2
749	1919	0.0 - 2.0	< 6.0	< 1.1	< 1.5
749	1919	6.0 - 7.0	< 2.0	< 0.6	< 0.8
749	1919	9.0 - 10.0	< 7.4	< 1.3	< 1.7
750	1849	0.0 - 0.5	< 6.4	< 1.1	< 2.3
750	1849	0.0 - 2.0	< 3.0	< 0.5	< 0.8
750	1849	6.0 - 7.0	< 6.8	< 1.1	< 1.7
750	1849	8.0 - 9.0	< 5.1	< 0.9	< 1.3
750	1849	9.0 - 10.0	< 6.8	< 0.7	< 1.6
766	1811	0.0 - 1.0	< 4.7	< 1.4	< 1.8
766	1811	4.0 - 5.0	< 4.8	< 1.0	< 1.5
766	1811	9.0 - 10.0	< 3.4	< 0.8	< 1.1
769	1836	0.0 - 1.8	< 2.3	< 0.5	< 1.0
769	1836	2.8 - 3.8	< 3.2	< 0.7	< 1.1
769	1836	4.8 - 6.1	< 1.9	< 0.5	< 0.7
769	1836	10.5 - 11.5	< 2.8	< 0.7	< 1.2
781	1853	0.0 - 0.5	< 6.1	< 1.2	11.1 ± 0.6
781	1853	0.0 - 1.0	< 5.4	< 1.0	8.1 ± 0.3
781	1853	1.0 - 2.0	< 6.6	< 1.3	14.8 ± 0.7
781	1853	2.0 - 3.5	< 7.3	< 0.6	5.4 ± 0.7
781	1853	4.5 - 5.5	< 3.2	< 0.9	< 1.3

TABLE 5-1

(continued)

Coordinates[a]		Depth	Concentration (pCi/g ± 2 sigma)		
East	North	(ft)	Uranium-238	Radium-226	Thorium-232
806	1902	0.0 - 0.5	< 7.1	< 1.0	< 2.0
806	1902	0.0 - 2.0	< 3.5	< 0.5	< 0.9
806	1902	2.0 - 4.0	8.4 ± 1.4	< 0.7	< 1.3
806	1902	4.0 - 5.0	37.4 ± 6.7	< 1.6	25.2 ± 1.1
806	1902	6.0 - 7.0	< 9.0	< 1.2	< 2.6
806	1902	8.0 - 9.0	< 4.4	< 0.7	3.0 ± 0.5
806	1902	9.0 - 10.0	< 7.4	< 1.1	< 1.8
807	1852	0.0 - 0.5	< 2.6	< 0.8	< 1.1
807	1852	0.0 - 1.0	< 3.0	< 0.7	< 1.3
807	1852	5.2 - 5.7	< 3.4	< 0.8	< 1.4
807	1852	7.5 - 8.5	< 2.4	< 0.5	< 1.0
807	1852	8.5 - 9.5	< 3.2	< 0.6	< 1.2
807	1852	9.5 - 10.7	< 2.0	< 0.5	< 0.7
818	1807	0.0 - 0.5	< 2.6	< 0.7	< 0.9
818	1807	0.0 - 1.0	< 3.0	< 0.9	< 1.1
818	1807	3.5 - 5.5	< 1.9	< 0.4	< 0.8
818	1807	6.6 - 7.6	< 2.7	< 0.6	< 0.8
818	1807	7.6 - 8.5	< 1.9	< 0.5	< 0.7
818	1807	8.5 - 9.5	< 2.9	< 0.7	< 1.0
818	1807	9.5 - 10.2	< 2.3	< 0.5	< 0.9
852	1812	0.0 - 0.5	< 2.5	< 0.6	< 1.1
852	1812	0.0 - 1.0	< 3.1	< 0.8	< 1.2
852	1812	6.5 - 7.5	< 2.8	< 1.7	< 1.0
852	1812	7.5 - 8.3	< 2.8	< 0.6	< 1.1
852	1812	8.3 - 9.3	< 2.1	< 0.4	< 0.8

TABLE 5-1

(continued)

Coordinates[a]		Depth	Concentration (pCi/g ± 2 sigma)		
East	North	(ft)	Uranium-238	Radium-226	Thorium-232
852	1812	9.3 - 9.7	< 2.9	< 0.7	< 0.9
852	1812	9.7 - 10.7	< 2.7	< 0.7	< 1.1
852	1812	10.7 - 11.3	< 2.8	< 0.7	< 1.1
852	1910	0.0 - 0.5	< 5.5	< 0.8	< 1.3
852	1910	0.0 - 2.0	< 2.7	< 0.6	< 0.9
852	1910	6.0 - 8.0	< 3.1	< 0.6	< 0.8
852	1910	8.0 - 9.0	< 5.7	< 0.9	< 1.3
852	1910	9.0 - 10.0	< 4.5	< 0.8	< 1.2

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

TABLE 5-2

DOWNHOLE GAMMA LOGGING RESULTS

FOR 99 GARIBALDI AVENUE

Coordinates[a] East	Coordinates[a] North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 1179R[d]			
749	1919	0.5	7000
749	1919	1.0	10000
749	1919	1.5	10000
749	1919	2.0	9000
749	1919	2.5	8000
749	1919	3.0	7000
749	1919	3.5	8000
749	1919	4.0	10000
749	1919	4.5	11000
749	1919	5.0	11000
749	1919	5.5	11000
749	1919	6.0	10000
749	1919	6.5	10000
749	1919	7.0	10000
749	1919	7.5	10000
749	1919	8.0	10000
749	1919	8.5	10000
749	1919	9.0	10000
Borehole 1177R[d]			
750	1849	0.5	7000
750	1849	1.0	9000
750	1849	1.5	9000
750	1849	2.0	9000
750	1849	2.5	8000
750	1849	3.0	8000
750	1849	3.5	7000
750	1849	4.0	7000
750	1849	4.5	7000
750	1849	5.0	8000
750	1849	5.5	8000
750	1849	6.0	8000
750	1849	6.5	8000
750	1849	7.0	8000
750	1849	7.5	11000
750	1849	8.0	12000

TABLE 5-2

(continued)

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 1024R[d]			
766	1811	0.5	9000
766	1811	1.0	9000
766	1811	1.5	9000
766	1811	2.0	10000
766	1811	2.5	10000
766	1811	3.0	10000
766	1811	3.5	9000
766	1811	4.0	9000
766	1811	4.5	8000
766	1811	5.0	8000
766	1811	5.5	9000
766	1811	6.0	10000
766	1811	6.5	11000
Borehole 1029R[d]			
769	1836	0.5	9000
769	1836	1.0	8000
769	1836	1.5	8000
769	1836	2.0	8000
769	1836	2.5	8000
769	1836	3.0	8000
769	1836	3.5	8000
769	1836	4.0	8000
769	1836	4.5	8000
769	1836	5.0	7000
769	1836	5.5	7000
769	1836	6.0	8000
Borehole 1027R[d]			
781	1853	0.5	33000
781	1853	1.0	47000
781	1853	1.5	60000
781	1853	2.0	46000
781	1853	2.5	23000
781	1853	3.0	13000
781	1853	3.5	10000
781	1853	4.0	11000

TABLE 5-2

(continued)

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 1175R[d]			
806	1902	0.5	11000
806	1902	1.0	13000
806	1902	1.5	14000
806	1902	2.0	15000
806	1902	2.5	24000
806	1902	3.0	54000
806	1902	3.5	146000
806	1902	4.0	97000
806	1902	4.5	21000
806	1902	5.0	13000
806	1902	5.5	12000
806	1902	6.0	12000
806	1902	6.5	11000
806	1902	7.0	12000
806	1902	7.5	10000
806	1902	8.0	11000
806	1902	8.5	11000
Borehole 1037R[d]			
807	1852	0.5	13000
807	1852	1.0	13000
807	1852	1.5	12000
807	1852	2.0	11000
807	1852	2.5	11000
807	1852	3.0	10000
807	1852	3.5	9000
807	1852	4.0	9000
807	1852	4.5	8000
807	1852	5.0	9000
807	1852	5.5	10000
807	1852	6.0	10000
807	1852	6.5	11000
807	1852	7.0	12000
807	1852	7.5	12000
807	1852	8.0	12000

TABLE 5-2

(continued)

Coordinates[a] East	Coordinates[a] North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 1036R[d]			
818	1807	0.5	9000
818	1807	1.0	9000
818	1807	1.5	9000
818	1807	2.0	8000
818	1807	2.5	9000
818	1807	3.0	8000
818	1807	3.5	9000
818	1807	4.0	9000
818	1807	4.5	9000
818	1807	5.0	9000
818	1807	5.5	9000
818	1807	6.0	9000
818	1807	6.5	8000
818	1807	7.0	7000
Borehole 1035R[d]			
852	1812	0.5	10000
852	1812	1.0	10000
852	1812	1.5	9000
852	1812	2.0	8000
852	1812	2.5	8000
852	1812	3.0	8000
852	1812	3.5	8000
852	1812	4.0	8000
852	1812	4.5	8000
852	1812	5.0	9000
852	1812	5.5	8000
852	1812	6.0	8000
852	1812	6.5	8000

TABLE 5-2

(continued)

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 1176R[d]			
852	1910	0.5	9000
852	1910	1.0	9000
852	1910	1.5	10000
852	1910	2.0	10000
852	1910	2.5	9000
852	1910	3.0	9000
852	1910	3.5	8000
852	1910	4.0	8000
852	1910	4.5	8000
852	1910	5.0	8000
852	1910	5.5	8000
852	1910	6.0	9000
852	1910	6.5	10000
852	1910	7.0	11000
852	1910	7.5	11000
852	1910	8.0	11000
852	1910	8.5	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 99 GARIBALDI AVENUE

Coordinates[a] East	Coordinates[a] North	Rate[b] (μR/h)
760	1825	10
775	1850	15
800	1815	7
820	1865	16
850	1825	9
850	1865	7

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

[b]Measurements include background.

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APPENDIX A

GEOLOGIC DRILL LOGS FOR 99 GARIBALDI AVENUE

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1179R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
Brook St. (LODI)	N 1,919 E 749	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
12-1-87	12-1-87	E.D.I.	Mobile B-57	6.5"	10.0		10.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
4.6/46		5			/	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 lbs./ 30 in.	NONE	D. Harnish

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	DESCRIPTION AND CLASSIFICATION
SS	2.0	0.2	21-7-7 3						0.0 - 2.0 Ft. Sandy GRAVEL and SILT FILL (GW, OL). 0.0-1.0 Ft. Sandy GRAVEL, broken basalt gravel. 1.0-2.0 Ft. SILT, black.
SS	2.0	0.2	5-3-2-7						2.0 - 4.4 Ft. Silty SAND (FILL?) (SM). Brown (10YR5/3), minor subrounded small gravel of Brunswick sandstone. Fill or natural brook sediments.
SS	2.0	1.0	4-10-7 11					5	4.4 - 6.0 Ft. SILT (ML). Weak red and light gray mottled, minor iron-oxide stain, slightly stiff, disturbed?
SS	2.0	1.5	7-10 11-18						6.0 - 10.0 Ft. SILT and SAND (ML, SM-SP). Weak red (5R5/3) and gray, sand is very fine-grained and increases fraction downward; sand and silt are interbedded, beds 3-7 mm thick.
SS	2.0	1.7	5-6-10 16					10	

Bottom of borehole at 10.0 ft.
Borehole backfilled with spoils, 12/1/87.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Borehole advanced 0-10 Ft. using 6.5 in. o.d. hollow-stem auger.
Sampled and gamma-logged by TMA-Eberline, Inc.

0.0-4.0 Ft. Sample from auger flights.

Identification and classification of soils by visual examination.

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

SITE: Brook St. (LODI) | HOLE NO. 1179R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1177R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Brook St. (LODI)	N 1,849 E 750	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-30-87	11-30-87	E.D.I.	Mobile B-57	6.5"	10.0		10.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
/		5			/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
--	NONE	David Harnish

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	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
SS	2.0	1.4	20-17 12-7						0.0 - 4.1 ft. Sandy GRAVEL and Silty SAND FILL (GW, SM).	Borehole advanced 0-10 Ft. with 6.5" o.d. hollow stem auger. Boring radiologically sampled and gamma-logged by TMA-Eberline, Corp.
SS	2.0	0.9	3-6-5 17						0.0-1.4 ft. Sandy GRAVEL, black sand, broken basalt gravel.	
SS	2.0	1.4	6-11 16-19					5	1.4-4.0 ft. Silty SAND, dark brown (10YR3/3), fine- to medium-grained, some gravel, loose, slightly damp.	2" of asphalt at the surface. 6-8 Ft. Wet below this sample interval.
SS	2.0		7-9-8-7						1.4-2.7 ft. Fine-grained.	
SS	2.0		3-12 15-23						2.7-4.0 ft. Medium-grained.	
									4.0-4.1 ft. SILT, black.	
									4.1 - 8.8 ft. SAND (SP). Fine- to medium-grained, subrounded, damp, loose. Coarsening downwards.	
									4.1-6.0 ft. Dark grayish brown (10YR4/2).	
									6.0-7.0 ft. Silty SAND, dark grayish brown.	
									7.0-8.0 ft. Silty SAND, light olive brown.	
									8.0-8.8 ft. Dark yellowish brown (10YR4/6), gravelly.	
									8.8 - 10.0 ft. SILT (ML). Dark brown (10YR4/6) becoming dark gray (10YR4/1) with depth, slightly stiff, damp.	
									Bottom of borehole at 10.0 ft. Borehole backfilled with spoils, 11/30/87.	Identification and classification of soils by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE: Brook St. (LODI)	HOLE NO. 1177R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1024R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
99 Garibaldi Ave. (LODI)	N 1,811 E 766	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-15-87	10-15-87	G. Engel; BNI	Minuteman Auger	4"	10.2		10.2

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
4.8/47		7			/	/

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

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY
SS	1.0	0.4	
SS	1.0	0.5	
SS	1.7	0.9	
SS	0.5	0.5	
SS	0.8	0.6	
AU	3.2		
SS	1.1	1.0	
SS	0.9	0.9	

WATER PRESSURE TESTS: LOSS IN G.P.M | PRESS. P.S.I. | TIME IN MIN. — ELEV. — DEPTH — GRAPHICS — SAMPLE

DEPTH: 5, 10

DESCRIPTION AND CLASSIFICATION

0.0 - 0.3 Ft. Silty Clayey SAND (SC). Grayish brown (5YR3/2), fine- to coarse-grained with scattered pebbles (to 0.5 in.). Humus.

0.3 - 4.1 Ft. SAND (SP). Moderate yellowish brown (10YR5/4) fine- to medium-grained.

1.0-2.9 Ft. Light brown (5YR5/6).

2.9-3.4 Dark yellowish brown (10YR4/2) to moderate yellowish brown (10YR5/4).

3.4-3.6 Ft. Silty. Dusky yellowish brown (10YR2/2).

3.6-4.1 Ft. Increasingly more coarse-grained, poorly sorted with small pebbles (to 0.5 in.) of quartz.

4.1 - 5.0 Ft. Silty Sandy CLAY (CL-ML). Dusky yellowish brown (10YR2/2), fine- to coarse-grained sand.

5.0 - 8.2 Ft. SAND (SW). Clean.

8.2 - 10.2 Ft. Silty CLAY (CL-ML). Pale brown (5YR5/2).

Bottom of borehole at 10.2 Ft.
Borehole backfilled with spoils, 10/15/87.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Borehole advanced 0-10.2 Ft. using 3" i.d. split-spoon sampler and 4" o.d. solid stem augers.

Borehole was radiologically sampled and gamma-logged by TMA-Eberline, Corp. Augered and gamma-logged to 6.5 Ft.

Description and classification of soils by visual examination.

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

SITE: 99 Garibaldi Ave. (LODI) — HOLE NO. 1024R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1029R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
99 Garibaldi Ave. (LODI)	N 1,836 E 769	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-21-87	10-21-87	G. Engel; BNI	Minuteman Auger	4"	11.5		11.5

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
8.7/75		9			/	/

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

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY
SS	1.8	0.7	
SS	1.0	0.5	
SS	1.0	0.7	
SS	1.0	0.6	
SS	1.3	1.2	
SS	1.1	1.1	
SS	2.3	1.9	
SS	1.0	1.0	
SS	1.0	1.0	

WATER PRESSURE TESTS: LOSS IN G.P.M | PRESS. P.S.I. | TIME IN MIN. — ELEV. — DEPTH (5, 10) — GRAPHICS — SAMPLE

DESCRIPTION AND CLASSIFICATION

0.0 - 6.1 Ft. Silty SAND (SM). Dusky brown (5YR2/2) with patches of moderate reddish brown (10R4/6), fine- to medium-grained.

1.6-4.8 Ft. Light brown (5YR5/6).

4.8-5.2 Ft. Light brown (5YR5/6) with some dusky brown patches.

5.2-5.8 Ft. Pale brown (5YR5/2).

5.8-6.1 Ft. Grayish brown (5YR3/2).

6.1 - 9.8 Ft. SAND (S). Pale yellowish brown (10YR6/2) with silt patches of brownish gray (5YR4/1) and some pale yellow brown (10YR6/2).

9.8 - 11.5 ft. CLAY (CL). Pale brown (5YR6/2).

Bottom of borehole at 11.5 Ft.
Borehole backfilled with spoils, 10/21/87.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Borehole advanced 0-11.5 Ft. using 3" i.d. split-spoon sampler and 4" o.d. solid stem augers.

Borehole was radiologically sampled and gamma-logged by TMA-Eberline, Corp. Augered and gamma-logged to 6.0 Ft.

Description and classification of soils by visual examination.

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

SITE	HOLE NO.
99 Garibaldi Ave. (LODI)	1029R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1027R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
99 Garibaldi Ave. (LODI)	N 1,853 E 781	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-16-87	10-16-87	G. Engel; BNI	Minuteman Auger	4"	5.4		10.2

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
3.4/62		6			0.2/	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	NONE	R. Migues JPC

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.
SS	1.0	0.3									0.0 - 4.2 Ft. Silty Clayey SAND (SM-SC). Grayish brown (5YR3/2), fine- to medium-grained.	Borehole advanced 0-5.4 Ft. using 3" i.d. split-spoon sampler and 0-4.5 Ft. using 4" o.d. solid stem augers.
SS	1.0	0.6									1.0-3.5 Ft. Dark yellowish brown (10YR4/2) with streaks of dusky yellowish brown (10R2/2).	
SS	1.5	0.6										
SS	0.7	0.7										
SS	0.6	0.6										
SS	0.6	0.6						5			4.2 - 5.4 Ft. Silty SAND (SM). Moderate reddish brown (10R4/6), fine- to very coarse-grained.	Borehole was radiologically sampled and gamma-logged by TMA-Eberline, Corp. Augered and gamma-logged to 4.5 Ft.
											4.8-5.4 Ft. Decrease in silt content; some light brown sand (5YR5/4)	
											Bottom of borehole at 5.4 Ft. Borehole backfilled with grout, 10/16/87.	
												Description and classification of soils by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	99 Garibaldi Ave. (LODI)	1027R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1175R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Brook St. (LODI)	N 1,902 E 806	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-25-87	11-25-87	E.D.I.	Mobile B-57	6.5"	10.0		10.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
6.2/62		5			/	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 lbs./ 30 in.	NONE	David Harnish

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY	LOSS IN G.P.M.	PRESS. P.S.I.	TIME IN MIN.	ELEV.	DEPTH
SS	2.0	1.6	5-9-16 17					
SS	2.0	0.6	10-16-14 8					
SS	2.0	0.2	5-6					5
SS	2.0	2.0	3-6-6-8					
SS	2.0	1.8	2-8-8 10					10

DESCRIPTION AND CLASSIFICATION

0.0 - 4.9 ft. Silty GRAVEL, Sandy SILT, SILT FILL (GM, ML, OL).

0.0-2.5 ft. Silty GRAVEL, broken basalt and New Brunswick sandstone; silt is dark gray, black, very dusky red.

2.5-4.0 ft. Sandy SILT, light brownish gray (10YR6/2), fine- to very fine-grained sand.

4.0-4.9 ft. SILT, very dark grayish brown, black in places, woody stems, some medium-grained sand.

4.3-4.4 ft. Black.

4.7-4.9 ft. Some medium-grained sand.

4.9 - 5.5 ft. Silty SAND (SP). Greenish gray (5Y6/2), fine- to medium-grained, some round to subround gravel, brook sediments.

5.5 - 10.0 ft. SILT and SAND (ML, SP). Weak red (5YR5/3) with some gray and dark gray beds; sand is very fine-grained, laminated 2-10 mm thick.

5.5-6.7 ft. Greenish gray, minor iron-oxide mottling.

8.2-8.3 ft. Silty SAND, dark grayish brown (2.5Y4/2), saturated, soft.

Bottom of borehole at 10.0 ft.
Borehole backfilled with spoils, 11/25/87.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Borehole advanced 0-10 Ft. with 6.5" o.d. hollow stem auger.
Boring radiologically sampled and gamma-logged by TMA-Eberline, Corp.
Black silt 4.3-4.4 radiologically above background, detected by hand with "pancake" probe.
Auger sample 4-6 ft. OVA 150 ppm in open 4 ft. hole.
4.9-5.5 sample has distinct chemical odor.

Identification and classification of soils by visual examination.

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

SITE	HOLE NO.
Brook St. (LODI)	1175R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1037R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
99 Garibaldi Ave. (LODI)	N 1,852 E 807	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-29-87	10-29-87	G. Engel; BNI	Minuteman Auger	4"	10.7		10.7

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
8.1/75		11			2.0/	/

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

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY
SS	1.0	0.5	
SS	1.0	0.6	
SS	1.5	0.6	
SS	1.3	0.8	
SS	0.4	0.4	
SS	0.5	0.7	
SS	0.8	0.7	
SS	1.0	1.0	
SS	1.0	0.8	
SS	1.0	1.0	
SS	1.0	1.0	

WATER PRESSURE TESTS: LOSS IN G.P.M. | PRESS. P.S.I. | TIME IN MIN. — ELEV. — DEPTH (5, 10) — GRAPHICS — SAMPLE

DESCRIPTION AND CLASSIFICATION

0.0 - 1.2 Ft. Silty Sandy CLAY (CL-ML). Very dark red (5R2/6), fine- to medium-grained.

0.5-1.2 Ft. Dark reddish brown (10R3/4).

1.2 - 5.8 Ft. Sandy CLAY (CL). Dark reddish brown (10R3/4), fine- to medium-grained sand.

2.0-3.5 Ft. Moderate reddish brown (10R4/6).

3.5-5.3 Ft. Moderate yellowish brown (10YR5/4).

5.3-5.8 Ft. Sand fraction coarsening with depth.

5.8 - 7.4 Ft. Silty SAND (SM).

5.8-6.5 Ft. Dark yellowish brown (10YR4/2) and light brown (5YR4/6), fine-grained.

6.5-7.4 Ft. Fine- to medium-grained.

7.4 - 8.3 ft. CLAY (CL). Moderate reddish brown (10R4/6).

8.3 - 8.8 ft. Silty SAND (SM). Pale yellowish brown (10YR6/2), fine- to medium-grained.

8.8 - 10.7 Ft. CLAY (CL). Brownish gray (5YR4/1). A quartz pebble (1.5") found in bit tip.

Bottom of borehole at 10.7 Ft.
Borehole backfilled with spoils, 10/29/87.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Borehole advanced 0-10.7 Ft. using 3" i.d. split-spoon sampler and 4" o.d. solid stem augers.

Borehole was radiologically sampled and gamma-logged by TMA-Eberline, Corp. Augered and gamma-logged to 8.0 Ft.

Description and classification of soils by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE: 99 Garibaldi Ave. (LODI)	HOLE NO. 1037R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1036R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
99 Garibaldi Ave. (LODI)	N 1,807 E 818	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-28-87	10-28-87	G. Engel; BNI	Minuteman Auger	4"	10.2		10.2

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
7.8/93		10			/	/

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

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY
SS	1.0	0.6	
SS	1.0	0.5	
SS	1.5	0.6	
SS	2.0	1.5	
~~SS~~	~~0.2~~	~~0.2~~	
SS	0.9	0.9	
SS	1.0	1.0	
SS	0.9	0.8	
SS	1.0	1.0	
SS	0.7	0.7	

WATER PRESSURE TESTS: LOSS IN G.P.M. | PRESS. P.S.I. | TIME IN MIN. — ELEV. — DEPTH — GRAPHICS — SAMPLE

DEPTH: 5, 10

DESCRIPTION AND CLASSIFICATION

0.0 - 1.1 Ft. Sandy Silty CLAY (CL-ML). Dusky brown (5YR2/2), fine- to medium-grained sand. Humus.

1.1 - 2.0 Ft. Silty SAND (SM). Moderate brown (5YR4/4), fine- to medium-grained.

2.0 - 3.5 Ft. Sandy Silty CLAY (CL-ML). Dusky brown mottled with brownish black (5YR2/1) and moderate brown.

3.5 - 5.3 Ft. Silty SAND (SM). Moderate yellowish brown (10YR5/4), fine- to medium-grained.

4.9-5.3 Ft. Dusky yellowish brown (10YR2/2).

5.3 - 8.5 Ft. Silty SAND (SM). Moderate brown, fine- to medium-grained.

5.5-5.6 Ft. Clayey zone.

5.8-6.0 Ft. Dusky yellowish brown specks.

6.0-6.6 Ft. Dark yellowish brown.

7.9-8.4 Ft. Dark yellowish brown.

8.4-8.5 Ft. Moderate reddish brown (10R4/6).

8.5 - 8.7 ft. SAND (SP). Pale brown (5YR5/2), fine- to coarse-grained.

8.7 - 10.2 Ft. CLAY (CL). Moderate reddish brown.

Bottom of borehole at 10.2 Ft.
Borehole backfilled with spoils, 10/28/87.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Borehole advanced 0-10.2 Ft. using 3" i.d. split-spoon sampler and 4" o.d. solid stem augers.

Borehole was radiologically sampled and gamma-logged by TMA-Eberline, Corp. Augered and gamma-logged to 7.0 Ft.

Description and classification of soils by visual examination.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	99 Garibaldi Ave. (LODI)	1036R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1035R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
99 Garibaldi Ave. (LODI)	N 1,812 E 852	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
10-28-87	10-28-87	G. Engel; BNI	Minuteman Auger	4"	11.3		11.3

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
9.4/93		12			/	/

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

SAMP. TYPE AND DIAM.	SAMP. ADV. LEN CORE	SAMPLE REC. CORE REC.	SAMPLE BLOWS "N" % CORE RECOVERY
SS	1.0		
SS	1.0		
SS	1.4		
SS	1.0		
SS	0.9		
SS	1.2		
SS	1.0		
SS	0.5		
SS	1.0		
SS	0.4		
SS	1.0		
SS	0.6		

WATER PRESSURE TESTS: LOSS IN G.P.M. | PRESS. P.S.I. | TIME IN MIN. — ELEV. — DEPTH — GRAPHICS — SAMPLE

DESCRIPTION AND CLASSIFICATION

0.0 - 2.7 Ft. Silty Sandy CLAY (CL-ML). Very dusky red (10R2/2) with mottling of moderate reddish brown (10R4/6) fine- to medium-grained sand.

0.0-1.0 Ft. Humus.

1.0-2.0 Ft. Brownish black (5YR2/1) in large clumps.

1.0-2.7 Ft. Increasing sand content with Brunswick Formation sandstone fragments.

2.7 - 4.2 Ft. Clayey SAND (SC). Moderate brown (5YR4/4), fine- to medium-grained sand.

4.2 - 5.4 Ft. Silty Clayey SAND (SM-SC). Dark yellowish brown (10YR4/2), fine- to coarse-grained.

5.3-5.4 Ft. Moderate yellowish brown (10YR5/4).

5.4 - 5.6 Ft. SILT (ML). Medium gray (N5).

5.6 - 5.9 Ft. Silty SAND (SM). Pale brown (5YR5/2), fine- to medium-grained sand.

5.9 - 7.7 Ft. SAND (SW). Pale yellowish brown (10YR6/2), fine- to medium-grained.

7.7 - 8.1 Ft. CLAY (CL). Moderate brown (5YR4/4) with a thin (<0.1') lense of dark gray (N3) silt.

8.1 - 8.6 Ft. SAND (SW). Same as 5.9 - 7.7 Ft.

8.6 - 11.3 Ft. CLAY (CL). Grayish red (10R4/2).

Bottom of hole at 11.3 ft.
Borehole backfilled with spoils, 10/28/87.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Borehole advanced 0-11.3 Ft. using 3" i.d. split-spoon sampler and 4" o.d. solid stem augers.

Borehole was radiologically sampled and gamma-logged by TMA-Eberline, Corp. Augered and gamma-logged to 7.0 Ft.

Description and classification of soils by visual examination.

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

SITE: 99 Garibaldi Ave. (LODI)

HOLE NO. 1035R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	1176R

SITE	COORDINATES	ANGLE FROM HORIZ	BEARING
Brook St. (LODI)	N 1,910 E 852	Vertical	------

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	SIZE	OVERBURDEN	ROCK (FT.)	TOTAL DEPTH
11-30-87	11-30-87	E.D.I.	Mobile B-57	6.5"	10.0		10.0

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
6.6/66		5			/ /	/

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 lbs./ 30 in.	NONE	D. Harnish

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
SS	2.0	1.5	6-7-10 14					
SS	2.0	0.4	5-11-7 4					
SS	2.0	1.5	1-2-8 16					5
SS	2.0	1.3	12-12 9-10					
SS	2.0	1.9	4-8-12 20					

DESCRIPTION AND CLASSIFICATION

0.0 - 4.5 Ft. Sandy SILT, SILT (ML, OL).

0.0-1.0 Ft. Sandy SILT, dark yellowish brown (10YR4/4), some gravel.

1.0-3.0 Ft. SILT, weak red and grayish brown (10YR5/2) mixed, some broken basalt gravel.

3.0-4.5 Ft. SILT, black, soft.

4.5 - 5.3 Ft. Gravelly SAND (SW). Dark gray (5Y4/1), some silt. Gravel is round, bedded. Brook sediments.

5.3 - 10.0 Ft. SILT and SAND (SP, ML). Sand is very fine- and fine-grained, sand and silt are interbedded with beds 8-20 mm thick.

5.3-6.2 Ft. Sand, light gray (5Y6/1).

6.2-8.7 Ft. SILT, brown (7.5YR4/4) and yellowish brown.

8.7-10 Ft. SILT and SAND, dark reddish gray (5YR4/2) and gray (10YR5/1).

Bottom of borehole at 10.0 ft.
Borehole backfilled with spoils, 11/30/87.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Borehole advanced 0-10 Ft. using 6.5 in. o.d. hollow-stem auger.
2" asphalt at surface.
Sampled and gamma-logged by TMA-Eberline, Inc.
2.0-4.0 Ft. Sample from auger flights.

Identification and classification of soils by visual examination.

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

SITE: Brook St. (LODI) HOLE NO. 1176R