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

**POST-REMEDIATION ACTION REPORT FOR
THE RESIDENTIAL PROPERTIES ON
DAVISON AND LATHAM STREETS**

Maywood, New Jersey

February 1986



**Bechtel National, Inc.
Advanced Technology Division**

35011

DOE/OR/20722-77

POST-REMEDIAL ACTION REPORT
FOR THE
RESIDENTIAL PROPERTIES ON DAVISON AND LATHAM STREETS
MAYWOOD, NEW JERSEY

FEBRUARY 1986

Prepared for
UNITED STATES DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE
Under Contract No. DE-AC05-81OR20722

By

Bechtel National, Inc.
Advanced Technology Division
Oak Ridge, Tennessee

Bechtel Job No. 14501

TABLE OF CONTENTS

	<u>Page</u>
Abbreviations	v
1.0 Introduction	1
2.0 Remedial Action Guidelines	2
3.0 Remedial Action	2
4.0 Post-Remedial Action Sampling	4
5.0 Post-Remedial Action Status	6
References	42
Glossary	44

LIST OF FIGURES

<u>Figure</u>	<u>Title</u>	<u>Page</u>
1	Monitoring Locations at 454 Davison Street	9
2	Remedial Action at 454 Davison Street	11
3	Monitoring Locations at 459 Davison Street	12
4	Remedial Action at 459 Davison Street	14
5	Monitoring Locations at 460 Davison Street	16
6	Remedial Action at 460 Davison Street	18
7	Monitoring Locations at 464 Davison Street	21
8	Remedial Action at 464 Davison Street	23
9	Monitoring Locations at 468 Davison Street	26
10	Remedial Action at 468 Davison Street	28
11	Monitoring Locations at 459 Latham Street	30
12	Remedial Action at 459 Latham Street	32
13	Monitoring Locations at 461 Latham Street	34
14	Remedial Action at 461 Latham Street	36
15	Monitoring Locations at 467 Latham Street	38
16	Remedial Action at 467 Latham Street	40

LIST OF TABLES

<u>Table</u>	<u>Title</u>	<u>Page</u>
1	Summary of Residual Contamination Guidelines for the Maywood Site	7
2	Remedial Action Monitoring Results at 454 Davison Street	10
3	Remedial Action Monitoring Results at 459 Davison Street	13
4	Post-Remedial Action Soil Sample Results for 459 Davison Street	15
5	Remedial Action Monitoring Results at 460 Davison Street	17
6	Post-Remedial Action Soil Sample Results for 460 Davison Street	19
7	Remedial Action Monitoring Results at 464 Davison Street	22
8	Post-Remedial Action Soil Sample Results for 464 Davison Street	24
9	Remedial Action Monitoring Results at 468 Davison Street	27
10	Post-Remedial Action Soil Sample Results for 468 Davison Street	29
11	Remedial Action Monitoring Results at 459 Latham Street	31
12	Post-Remedial Action Soil Sample Results for 459 Latham Street	33
13	Remedial Action Monitoring Results at 461 Latham Street	35
14	Post-Remedial Action Soil Sample Results for 461 Latham Street	37
15	Remedial Action Monitoring Results at 467 Latham Street	39
16	Post-Remedial Action Soil Sample Results for 467 Latham Street	41

ABBREVIATIONS

dpm	disintegrations per minute*
g	gram
h	hour
l	liter
uR	microroentgens
mrem	millirem
pCi	picocurie
WL	working level
yr	year

*Words appearing in boldface print are explained in the glossary.
Additional technical terms are also explained in the glossary.

1.0 INTRODUCTION

Bechtel National Inc. (BNI) removed radioactive contamination from residential properties on Davison and Latham Streets in Maywood, New Jersey. BNI's work is part of the Department of Energy's (DOE) Formerly Utilized Sites Remedial Action Program (FUSRAP). The purpose of this report is to document BNI post-remedial action sampling of properties in the vicinity of the Stepan Company plant which is also in Maywood, New Jersey. This report briefly describes the origin of the radioactive contamination on the properties, the methods used to determine the extent of it, and the types of remedial action performed. It also provides the guidelines used in performing the remedial action and data on the current radiological status of the properties.

Background

From about 1916 until 1956, Maywood Chemical Works extracted thorium compounds and rare earths from a natural, sand-like ore called monazite. The thorium was used to manufacture a number of products including mantles for gas lanterns. Stepan Company acquired the site in 1959. In 1984, Congress directed the DOE to initiate a research and development effort for the decontamination project involving the site and vicinity properties in Maywood. The Maywood site and vicinity properties, which include the residential properties on Davison and Latham, were assigned by the DOE to FUSRAP. FUSRAP is a DOE effort to identify, decontaminate, or otherwise control sites where low-level radioactive contamination (exceeding current guidelines) remains from the early days of the nation's atomic energy program. Although the contamination at the Maywood site and the Davison and Latham properties did not result from the atomic energy program, it was included as part of FUSRAP by Congress. FUSRAP is currently being managed by DOE's Oak Ridge Operations Office. BNI is the Project Management Contractor and acts as DOE's representative in the planning, management, and implementation of FUSRAP.

The Davison and Latham properties became contaminated when thorium-bearing residues, considered at the time to be "organic mulch," were removed from the Maywood Chemical Works site and used as fill around and under the residences. The Nuclear Regulatory Commission conducted surveys that located the areas of contamination, and Oak Ridge National Laboratory (ORNL) (Refs. 1 through 8) documented the radiological conditions in 1981.

2.0 REMEDIAL ACTION GUIDELINES

The radioactive contamination on the Davison and Latham properties consisted primarily of thorium-232, with lesser amounts of radium-226 and uranium. Table 1 (Ref. 9) lists the DOE guidelines for residual contamination. DOE used the thorium-232 and radium-226 limits listed in Table 1 for the remedial actions at these properties. DOE implemented these guidelines on the basis of their compatibility with the criteria used by the Environmental Protection Agency (EPA) (Ref. 10). If these guidelines are exceeded, contaminated soil is removed from the property until concentrations are within guidelines. Once the guidelines have been met, the property can be released for unrestricted use.

3.0 REMEDIAL ACTION

Based on the results of the 1981 radiological surveys of these properties, DOE "designated" them for remedial action. This means that each property designated was contaminated above DOE guidelines and that the contamination would be cleaned up. The residents were notified at this time, and BNI began engineering design work and related activities to hire local subcontractors to perform the cleanup work (Ref. 11).

Cleanup/Decontamination Activities

When the design work had been completed and permission (a construction access agreement) received from the property owner to perform the remedial action, the local subcontractor began work.

The subcontractor excavated the property based on drawings that showed the extent of the contamination for each property. The shaded areas on Figures 2, 4, 6, 8, 10, 12, 14, and 16 show these limits of contamination. The subcontractor then removed the soil as indicated in the drawings, placed it in watertight dump trucks, and transported it to the storage pile on the Maywood Interim Storage Site (MISS) which is adjacent to Stepan Company plant. The soil will be stored at the MISS until a permanent disposal site is selected for this material.

After the radioactively contaminated soil was removed, the property was restored to its original condition. This included backfilling the excavation followed by sodding and/or seeding. If shrubbery or trees were removed during the cleanup, they were replaced or alternative arrangements were made with the individual property owners. In some cases, removing the contamination necessitated alterations to buildings, fences, or pavement. If this occurred, the affected structures were also restored to their original status. Figures 2, 4, 6, 8, 10, 12, 14, and 16 show what types of remedial actions were required on each property.

Contamination Control During the Cleanup

During the cleanup, several procedures were implemented to control the radioactive materials being removed from the Davison and Latham residences. These procedures were designed to keep the workers and residents from being exposed to radiation.

The primary pathway by which residents could be exposed to radiation would be from dust released during the excavation. To avoid this, the subcontractor was required to keep all excavations and work areas free from dust by keeping the soil moistened. Air sampling was performed at the perimeter of the excavation areas to demonstrate compliance with DOE standards for airborne radioactivity. These samples are collected by pulling large quantities of air through a filter. Airborne dust which could potentially contain radioactive materials is captured by the

filter. The filters are then removed and analyzed for radioactivity. Because the amount of air drawn through the filter is known, the amount of radioactivity in the air can be calculated. None of the measured radioactivity concentrations in air exceeded the applicable DOE standards. Air sampling results are included in Tables 5, 7, and 9.

To keep uncontaminated areas clean during excavation work, trucks were draped with tarpaulins prior to filling. This kept the contaminated dirt from getting on the truck exterior and later falling off on clean property. If trucks were to be loaded on a clean area, the ground was covered with a tarpaulin before the truck pulled onto it for loading. If contaminated soil was spilled during the loading of the truck, this tarpaulin prevented the contamination of clean ground. Finally, all trucks hauling radioactively contaminated soil were loaded only to about 80 percent of their capacity and were covered before moving. This too prevented soil from falling out of the truck onto clean ground or roadways.

Using this combination of procedures, the subcontractor could control the contamination and prevent its spread onto areas accessible to the general public.

4.0 POST-REMEDIAL ACTION SAMPLING

After the soil containing the radioactive contaminants was removed, another radiological survey was conducted to ensure that the property was indeed clean (no radionuclide concentrations in excess of DOE criteria). This survey used several techniques.

Surface Gamma Radiation Scans - Two types of gamma radiation scans were conducted to determine whether all radioactively contaminated soil was removed. The first was a "walkover" scan. In this type of survey, the technician holds the radiation detector a few inches above the surface and moves it slowly from side to side as he "walks over" the excavated area. The purpose of a walkover scan is to

quickly detect areas of residual contamination. The advantage of this type of survey is that the detector quickly scans the area as the excavation proceeds.

The second gamma radiation scan was performed after all contamination detected by the walkover scan was removed. This survey used a lead-shielded detector to ensure that the only radiation detected was coming from the ground under the detector. Measurements were made on each property at 10-ft intervals to ensure that the property had been cleaned of radioactively contaminated soil.

Soil Sampling - The primary method of ensuring that the DOE cleanup guidelines were met was to take soil samples. These samples were analyzed in a laboratory to determine the concentration of radium-226, thorium-232, and uranium-238. Soil sampling locations and depths are shown in Figures 2, 4, 6, 8, 10, 12, 14, and 16.

Exposure Rate Measurements - Pressurized ionization chamber (PIC) readings were taken to measure the gamma radiation exposure rate after removal of the contamination. The PIC was set up at the locations shown in Figures 1, 3, 5, 7, 9, 11, 13, and 15.

Exposure to gamma radiation was also measured by placing thermoluminescent dosimeters (TLD) at the homes. A TLD is a radiation measuring device that was left in place for an extended period, typically a month, and then removed and sent to a laboratory for analysis. This analysis determines how much gamma radiation was absorbed by the TLD, and this dose is an indication of the radiation exposure of the resident.

Measured gamma radiation exposure rates were used to calculate annual "doses" assuming continuous exposure at the point of measurement. A background radiation contribution of 100 mrem/yr was subtracted from the calculated dose. Doses are reported in

Tables 2, 3, 5, 7, 9, 11, 13, and 15. For comparison, the DOE radiation protection standard is 100 mrem/yr. None of the PIC or TLD readings exceed this level.

Radon Monitoring - Because radium is one of the radioactive materials found in the Maywood Chemical wastes, radon and radon daughter monitoring was performed within some of the homes on Davison and Latham. Radon is produced from the radioactive decay of radium and can be used as an indicator of the presence of radium. The DOE standard for radon and radon daughters is 3 pCi/l and 0.02 WL, respectively. Radon concentrations are reported in Tables 2, 3, 5, 7, 9, 11, 13, and 15.

5.0 POST-REMEDIAL ACTION STATUS

As shown in Tables 4, 6, 8, 10, 12, 14, and 16, the soil samples taken after removing the radioactive materials show that there is no area where radioactive contamination still exists in excess of the remedial action guidelines established by DOE. An independent review of the remedial action performed on the parcels discussed in this report has been conducted by the Oak Ridge National Laboratory, Radiological Survey Activities Group. The purpose of the assessment was to verify the data supporting the adequacy of the remedial action and to confirm the site's compliance with remedial action criteria (Ref. 12).

Based on all data collected, these parcels conform to all applicable DOE radiological guidelines established for release of these properties for unrestricted use.

In addition to the surveys that have been performed on behalf of DOE, measures have been taken by the New Jersey Department of Environmental Protection to monitor remedial action activities. These measures include observing on-site operations and procedures, and analyzing archived soil samples.

TABLE I
SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES
FOR THE MAYWOOD SITE

BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 500 mrem/yr for a period of exposure not to exceed 5 years and an average of 100 mrem/yr over a lifetime.

SOIL (LAND) GUIDELINES (MAXIMUM LIMITS FOR UNRESTRICTED USE)

<u>Radionuclide</u>	<u>Soil Concentration (pCi/g) above background^{a,b,c}</u>
Radium-226	5 pCi/g, averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Radium-228	
Thorium-230	
Thorium-232	
Other radionuclides	Soil guidelines will be calculated on a site-specific basis using the DOE manual developed for this use.

STRUCTURE GUIDELINES (MAXIMUM LIMITS FOR UNRESTRICTED USE)

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 are intended for unrestricted 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.

Indoor/Outdoor Structure Surface Contamination

<u>Radionuclide^f</u>	<u>Allowable Surface Residual Contamination^g</u> (dpm/100 cm ²)		
	<u>Average^{g,h}</u>	<u>Maximum^g</u>	<u>Removable^g</u>
Transuranics, Ra-226, Ra-228, Th-230, Th-232, 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

TABLE I
(Continued)

Indoor/Outdoor Structure Surface Contamination (continued)

<u>Radionuclide^f</u>	<u>Allowable Surface Residual Contamination^e</u> (dpm/100 cm ²)		
	<u>Average^{g,h}</u>	<u>Maximum^{g,i}</u>	<u>Removable^{g,j}</u>
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

^aIn the event of occurrence of mixtures of radionuclides, the fraction contributed by each radionuclide to its limit shall be determined, and the sum of these fractions shall not exceed 1.

^bThese guidelines represent unrestricted-use residual concentrations above background averaged across any 15-cm thick layer to any depth and over any contiguous 100-m² surface area.

^cLocalized concentrations in excess of these limits are allowable provided that the average over 100 m² is not exceeded.

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

^eAs 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.

^fWhere surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides shall apply independently.

^gMeasurements of average contamination should not be averaged over more than 1 m². For objects of less surface area, the average shall be derived for each such object.

^hThe average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h at 1 cm and 1.0 mrad/h at 1 cm respectively, measured through not more than 7 mg/cm² of total absorber.

ⁱThe maximum contamination level applies to an area of not more than 100 cm².

^jThe amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, 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 cm² 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.

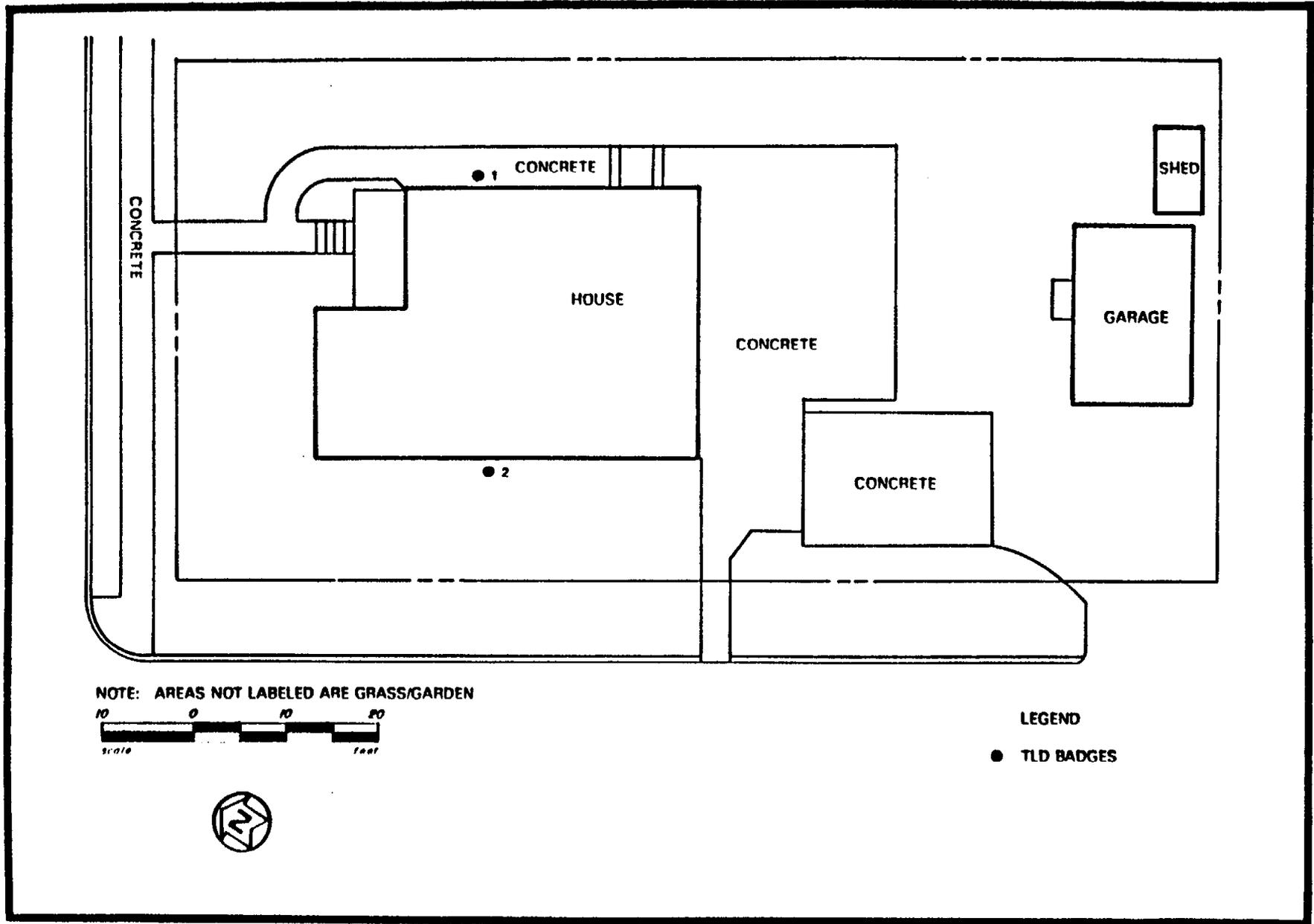


FIGURE 1 MONITORING LOCATIONS AT 454 DAVISON STREET

35011

TABLE 2
REMEDIAL ACTION MONITORING RESULTS
AT 454 DAVISON

Type Measurement	Units	Number of Measurements	Average	Range	DOE Guideline ^a
Gamma exposure rate (TLD-1) ^b	mrem/yr	3	<1	0-30	100
Gamma exposure rate (TLD-2) ^b	mrem/yr	3	0	0-20	100

^aDOE guidelines are specified to be "above natural background values."

^bCalculated from exposure rate measurements assuming continuous occupancy at point of measurement. The natural background radiation of 100 mrem/yr has been subtracted.

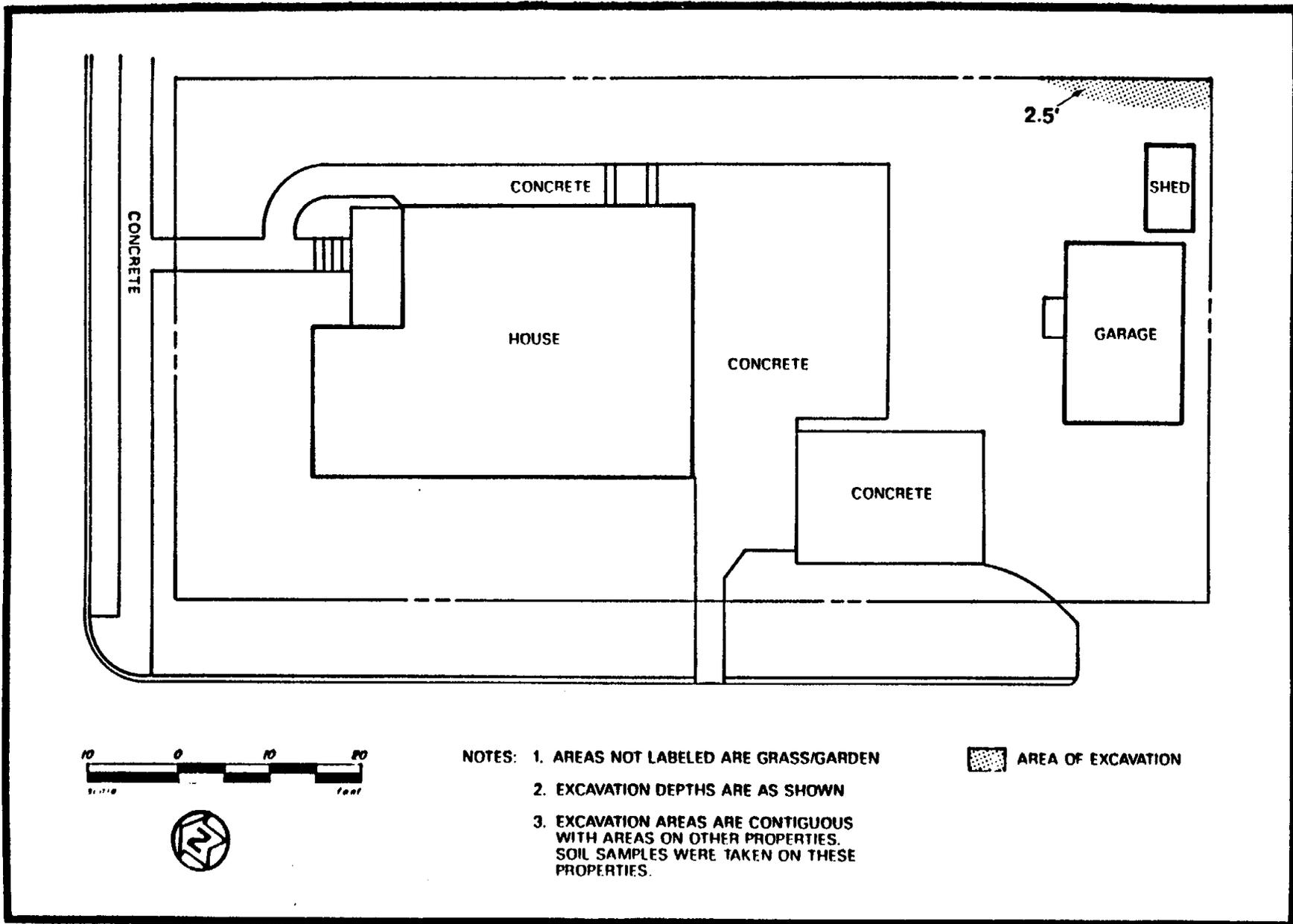


FIGURE 2 REMEDIAL ACTION AT 454 DAVISON STREET

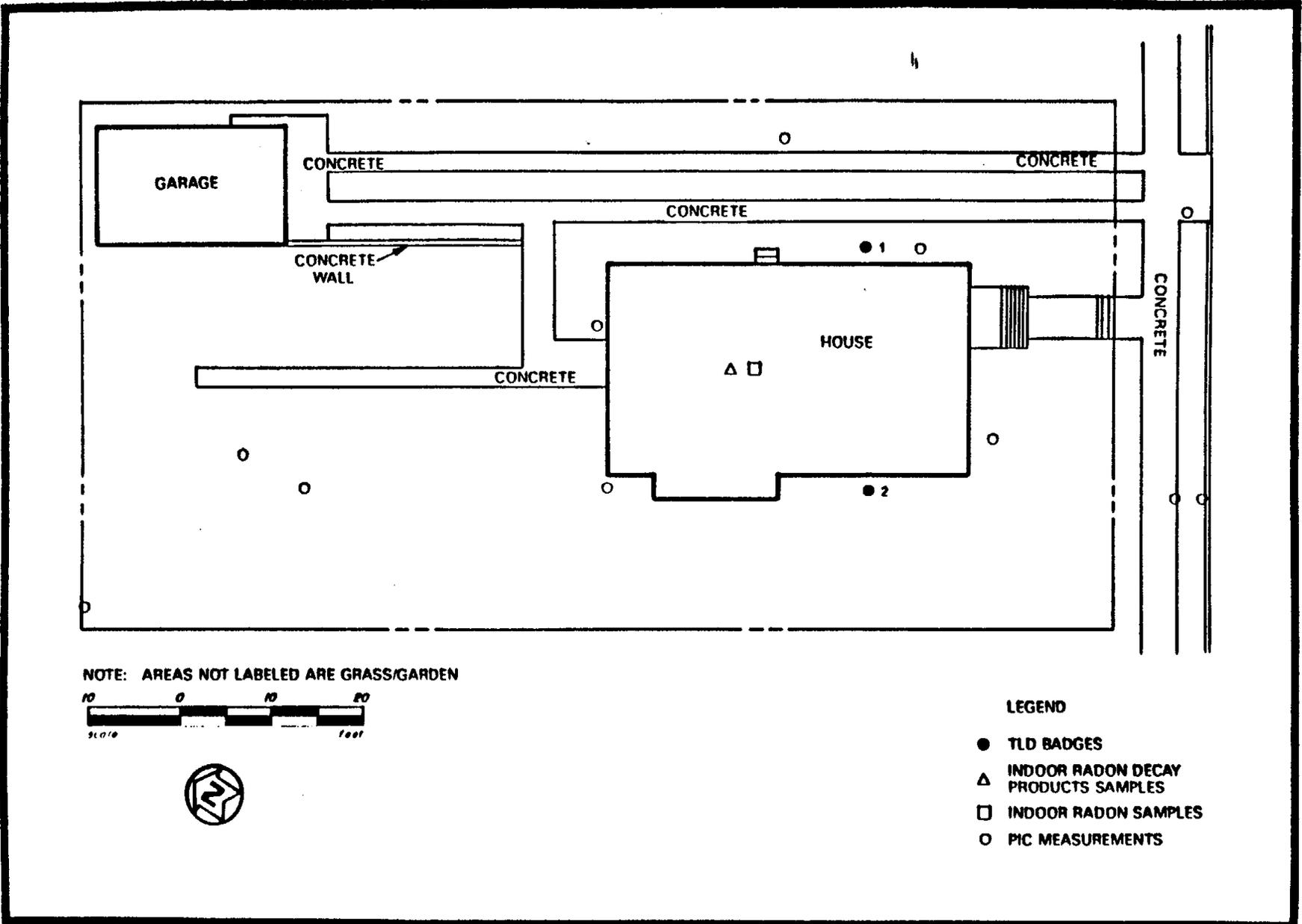


FIGURE 3 MONITORING LOCATIONS AT 459 DAVISON STREET

35011

TABLE 3
REMEDIAL ACTION MONITORING RESULTS
AT 459 DAVISON

Type Measurement	Units	Number of Measurements	Average	Range	DOE Guideline ^a
Gamma exposure rate (TLD-1) ^b	mrem/yr	3	9	0-20	100
Gamma exposure rate (TLD-2) ^b	mrem/yr	2	1	0-4	100
Air sampling for radon ^c	pCi/l	1	0.8	NA	3.0
Air sampling for radon decay products ^d	WL	4	<0.001	<0.001-0.002	0.02
Gamma exposure rate (PIC) ^b	mrem/yr	11	0	0-0	100

^aDOE guidelines are specified to be "above natural background values."

^bCalculated from exposure rate measurements assuming continuous occupancy at point of measurement. The natural background radiation of 100 mrem/yr has been subtracted.

^cAverage background contribution of 0.5 pCi/l has been subtracted.

^dAverage background contribution of 0.005 WL has been subtracted.

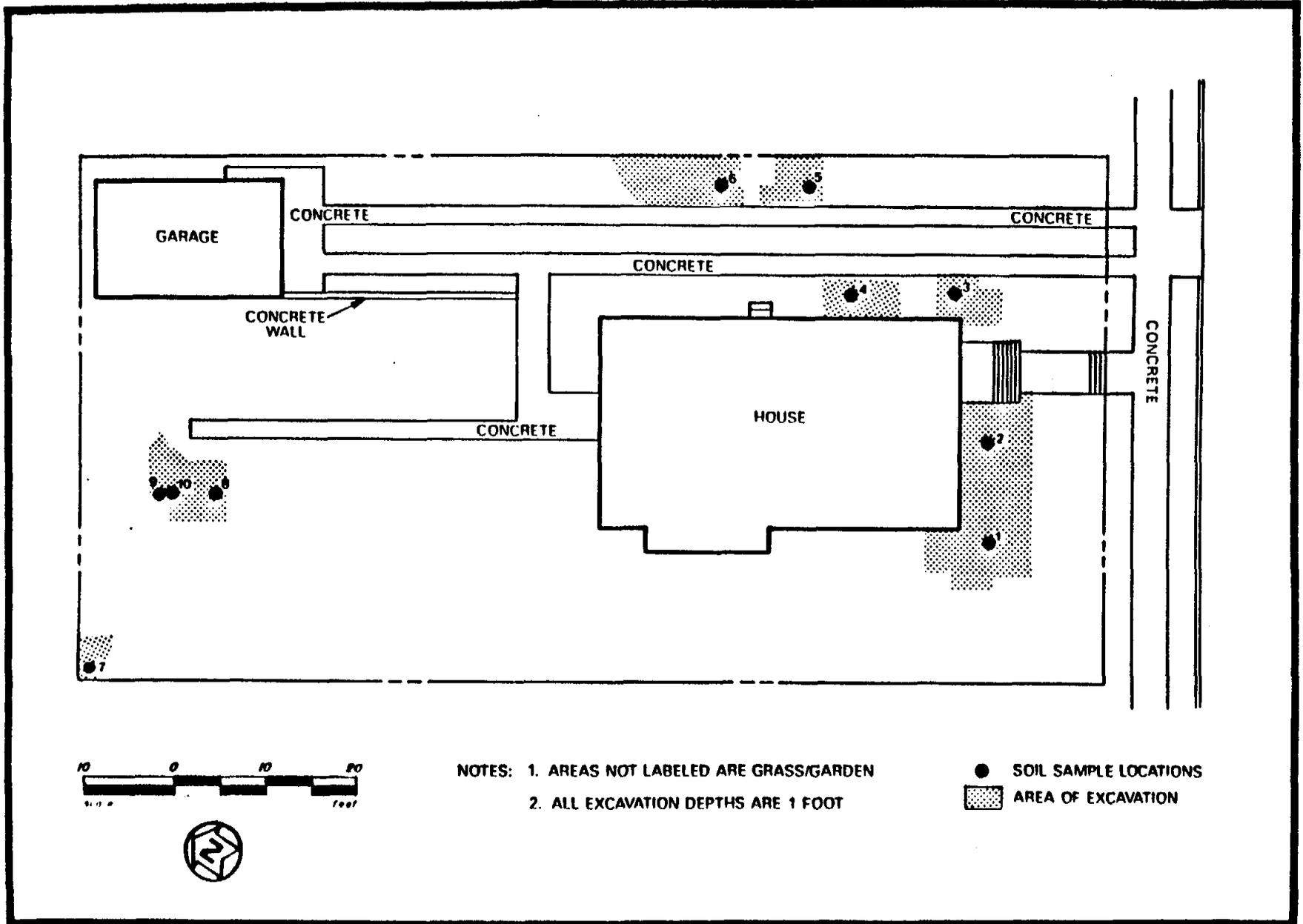


FIGURE 4 REMEDIAL ACTION AT 459 DAVISON STREET

35011

TABLE 4
POST-REMEDIAL ACTION SOIL SAMPLE RESULTS FOR
459 DAVISON STREET

Soil Sample Number	Uranium-238	Radium-226	Thorium-232
	picocuries per gram \pm 2 sigma		
1	1.0 \pm 0.4	1.0 \pm 0.1	2.3 \pm 0.2
2	0.4 \pm 0.2	0.7 \pm 0.1	1.0 \pm 0.1
3	<5.0	1.1 \pm 0.1	2.1 \pm 0.2
4	<5.0	0.7 \pm 0.1	1.0 \pm 0.1
5	1.0 \pm 0.3	0.8 \pm 0.1	0.8 \pm 0.1
6	<5.0	0.7 \pm 0.1	0.9 \pm 0.1
7	1.2 \pm 0.3	0.8 \pm 0.1	1.1 \pm 0.1
8	<5.0	1.0 \pm 0.1	1.4 \pm 0.1
9	<5.0	1.0 \pm 0.1	2.8 \pm 0.2
10	<5.0	1.8 \pm 0.1	2.6 \pm 0.2

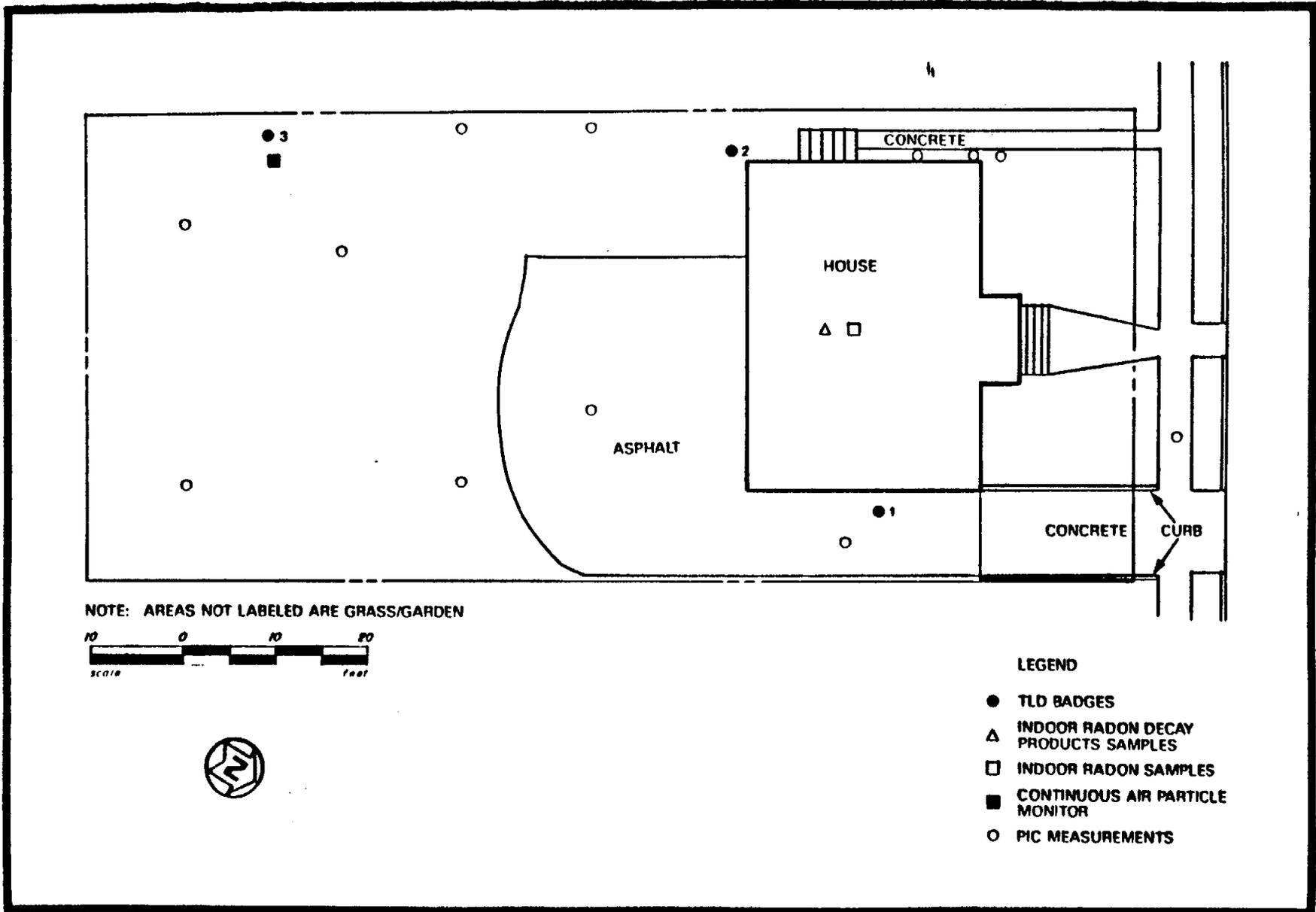


FIGURE 5 MONITORING LOCATIONS AT 460 DAVISON STREET

35011

TABLE 5
REMEDIAL ACTION MONITORING RESULTS
AT 460 DAVISON

Type Measurement	Units	Number of Measurements	Average	Range	DOE Guideline ^a
Gamma exposure rate (TLD-1) ^b	mrem/yr	3	13	0-56	100
Gamma exposure rate (TLD-2) ^b	mrem/yr	3	20	4-46	100
Gamma exposure rate (TLD-3) ^b	mrem/yr	2	0	0-4	100
Air sampling for radon ^c	pCi/l	2	1.3	1.2-1.3	3.0
Air sampling for radon decay products ^d	WL	7	<0.001	<0.001-0.011	0.02
Gamma exposure rate (PIC) ^b	mrem/yr	12	0	0-40	100
Air sampling for particulates ^e	10 ⁻¹⁴ uCi/ml (gross alpha)	52	0.4	0.05-2	100

^aDOE guidelines are specified to be "above natural background values."

^bCalculated from exposure rate measurements assuming continuous occupancy at point of measurement. The natural background radiation of 100 mrem/yr has been subtracted.

^cAverage background contribution of 0.5 pCi/l has been subtracted.

^dAverage background contribution of 0.005 WL has been subtracted.

^eThis standard is for thorium-232. It is the most restrictive standard applicable to the mixture of radionuclides present in the Maywood waste. Background contributions have not been subtracted.

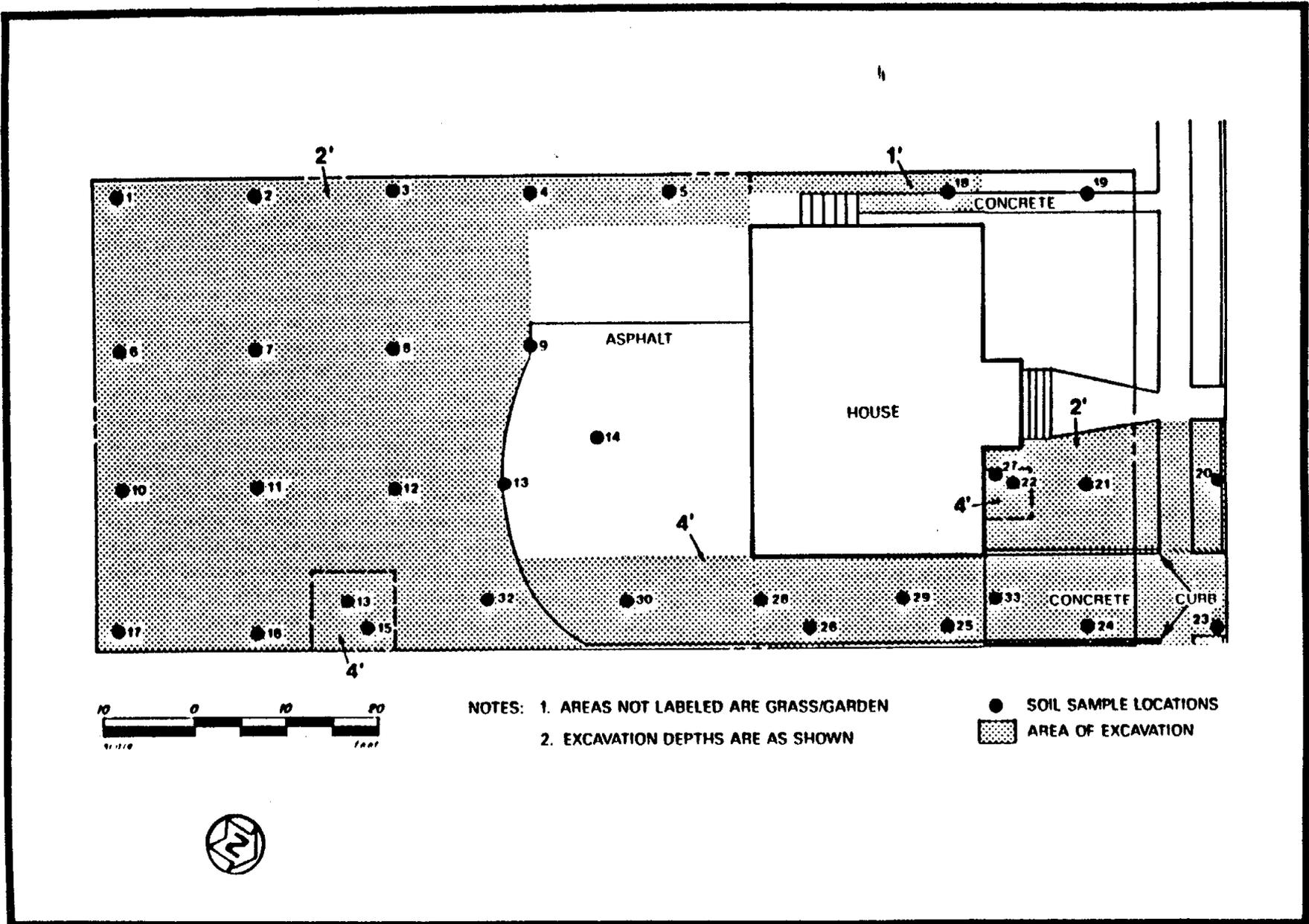


FIGURE 6 REMEDIAL ACTION AT 460 DAVISON STREET

35011

35011

TABLE 6
 POST-REMEDIAL ACTION SOIL SAMPLE RESULTS FOR
 460 DAVISON STREET

Page 1 of 2

Soil Sample Number	Uranium-238 (picocuries per gram \pm 2 sigma)	Radium-226 (picocuries per gram \pm 2 sigma)	Thorium-232 (picocuries per gram \pm 2 sigma)
1	<5.0	1.5 \pm 0.1	3.0 \pm 0.2
2	<5.0	1.2 \pm 0.1	2.0 \pm 0.1
3	<5.0	0.4 \pm 0.1	0.7 \pm 0.1
4	<0.8	0.3 \pm 0.1	0.6 \pm 0.1
5	<5.0	0.6 \pm 0.1	1.0 \pm 0.1
6	0.8 \pm 0.5	1.0 \pm 0.1	1.4 \pm 0.1
7	<0.6	0.4 \pm 0.1	0.5 \pm 0.1
8	<5.0	0.5 \pm 0.1	0.8 \pm 0.1
9	<5.0	0.4 \pm 0.1	0.6 \pm 0.1
10	0.7 \pm 0.3	0.8 \pm 0.1	0.9 \pm 0.1
11	<5.0	1.1 \pm 0.1	1.3 \pm 0.1
12	<5.0	0.7 \pm 0.1	0.8 \pm 0.1
13	<5.0	0.8 \pm 0.1	1.4 \pm 0.1
14	<5.0	0.4 \pm 0.1	0.4 \pm 0.1
15	<5.0	0.8 \pm 0.1	1.4 \pm 0.1
16	1.6 \pm 0.4	1.0 \pm 0.1	2.0 \pm 0.2
17	0.5 \pm 0.2	0.7 \pm 0.1	0.8 \pm 0.1
18	<2.0	0.6 \pm 0.1	0.3 \pm 0.3
19	<2.5	1.5 \pm 0.1	2.2 \pm 0.2
20	<5.0	0.4 \pm 0.1	0.7 \pm 0.1
21	1.3 \pm 0.2	0.7 \pm 0.1	0.7 \pm 0.1
22	<5.0	3.3 \pm 0.1	5.5 \pm 0.1
23	<5.0	0.4 \pm 0.1	0.7 \pm 0.1
24	<5.0	0.8 \pm 0.1	1.6 \pm 0.1
25	<5.0	0.8 \pm 0.1	1.7 \pm 0.1
26	<5.0	0.6 \pm 0.1	0.8 \pm 0.1

TABLE 6
(Continued)

Page 2 of 2

Soil Sample Number	Uranium-238	Radium-226	Thorium-232
	picocuries per gram \pm 2 sigma		
27	2.2 \pm 0.3	0.7 \pm 0.1	0.8 \pm 0.1
28	<7.1	1.3 \pm 0.2	4.3 \pm 0.4
29	<1.6	0.5 \pm 0.1	0.7 \pm 0.1
30	<2.7	1.1 \pm 0.1	2.2 \pm 0.3
31	<1.9	0.6 \pm 0.1	1.1 \pm 0.2
32	<5.0	0.7 \pm 0.1	1.2 \pm 0.1
33	<5.0	1.1 \pm 0.1	2.3 \pm 0.1

TABLE 7
 REMEDIAL ACTION MONITORING RESULTS
 AT 464 DAVISON

Type Measurement	Units	Number of Measurements	Average	Range	DOE Guideline ^a
Gamma exposure rate (TLD-1) ^b	mrem/yr	2	0	0-14	100
Gamma exposure rate (TLD-2) ^b	mrem/yr	2	0	0-25	100
Air sampling for radon ^c	pCi/l	1	0.9	NA	3.0
Air sampling for radon decay products ^d	WL	22	0.006	<0.001-0.020	0.02
Gamma exposure rate (PIC) ^b	mrem/yr	15	5	0-40	100
Air sampling for particulates ^e	10 ⁻¹⁴ uCi/ml (gross alpha)	40	4.6	0.1-22	100

^aDOE guidelines are specified to be "above natural background values."

^bCalculated from exposure rate measurements assuming continuous occupancy at point of measurement. The natural background radiation of 100 mrem/yr has been subtracted.

^cAverage background contribution of 0.5 pCi/l has been subtracted.

^dAverage background contribution of 0.005 WL has been subtracted.

^eThis standard is for thorium-232. It is the most restrictive standard applicable to the mixture of radionuclides present in the Maywood wastes. Background contributions have not been subtracted.

35011

TABLE 8
 POST-REMEDIAL ACTION SOIL SAMPLE RESULTS FOR
 464 DAVISON STREET

Page 1 of 2

Soil Sample Number	Uranium-238 picocuries per gram ± 2 sigma	Radium-226 picocuries per gram ± 2 sigma	Thorium-232 picocuries per gram ± 2 sigma
1	0.5 \pm 0.2	0.8 \pm 0.1	1.3 \pm 0.1
2	<5.0	0.7 \pm 0.1	1.2 \pm 0.1
3	<5.0	0.8 \pm 0.1	1.2 \pm 0.1
4	1.1 \pm 0.4	0.7 \pm 0.1	0.9 \pm 0.2
5	0.7 \pm 0.3	0.8 \pm 0.1	1.1 \pm 0.1
6	<5.0	0.8 \pm 0.1	1.2 \pm 0.1
7	1.0 \pm 0.3	0.9 \pm 0.1	2.3 \pm 0.1
8	1.1 \pm 0.3	0.8 \pm 0.1	1.1 \pm 0.1
9	1.0 \pm 0.3	0.7 \pm 0.1	0.8 \pm 0.1
10	0.8 \pm 0.3	0.8 \pm 0.1	1.2 \pm 0.1
11	<5.0	0.6 \pm 0.1	0.8 \pm 0.1
12	<5.0	1.3 \pm 0.1	3.1 \pm 0.1
13	1.1 \pm 0.3	0.5 \pm 0.1	0.7 \pm 0.1
14	<5.0	0.7 \pm 0.1	0.7 \pm 0.1
15	<5.0	0.8 \pm 0.1	2.1 \pm 0.1
16	1.3 \pm 0.3	0.6 \pm 0.1	1.1 \pm 0.1
17	<5.0	0.6 \pm 0.1	0.8 \pm 0.1
18	<5.0	1.0 \pm 0.1	2.0 \pm 0.1
19	<5.0	1.1 \pm 0.1	1.8 \pm 0.2
20	<5.0	0.5 \pm 0.1	1.4 \pm 0.3
21	<1.8	0.4 \pm 0.1	1.2 \pm 0.2
22	<2.0	0.6 \pm 0.1	0.6 \pm 0.3
23	<5.0	0.7 \pm 0.2	1.5 \pm 0.3
24	<2.1	0.4 \pm 0.1	1.7 \pm 0.2
25	<5.0	3.1 \pm 0.2	1.4 \pm 0.5
26	<5.0	0.9 \pm 0.1	1.7 \pm 0.3
27	<5.0	0.8 \pm 0.1	1.8 \pm 0.2

35011

TABLE 8
(Continued)

POST-REMEDIAL ACTION SOIL SAMPLE RESULTS FOR
464 DAVISON STREET

Page 2 of 2

Soil Sample Number	Uranium-238	Radium-226	Thorium-232
	picocuries per gram \pm 2 sigma		
28	<5.0	0.8 \pm 0.1	1.8 \pm 0.2
29	<2.3	0.5 \pm 0.1	0.9 \pm 0.3
30	<2.2	0.8 \pm 0.1	1.8 \pm 0.2
31	<1.8	0.6 \pm 0.1	1.0 \pm 0.2
32	<2.5	1.1 \pm 0.1	1.5 \pm 0.2
33	<5.0	0.7 \pm 0.1	1.0 \pm 0.3
34	<1.8	0.7 \pm 0.7	0.9 \pm 0.1
35	<5.0	0.5 \pm 0.1	0.8 \pm 0.1
36	<1.8	0.7 \pm 0.1	1.5 \pm 0.2
37	<5.0	1.0 \pm 0.2	1.9 \pm 0.5
38	<5.0	1.0 \pm 0.2	2.9 \pm 0.4
39	<1.9	0.6 \pm 0.1	1.6 \pm 0.2

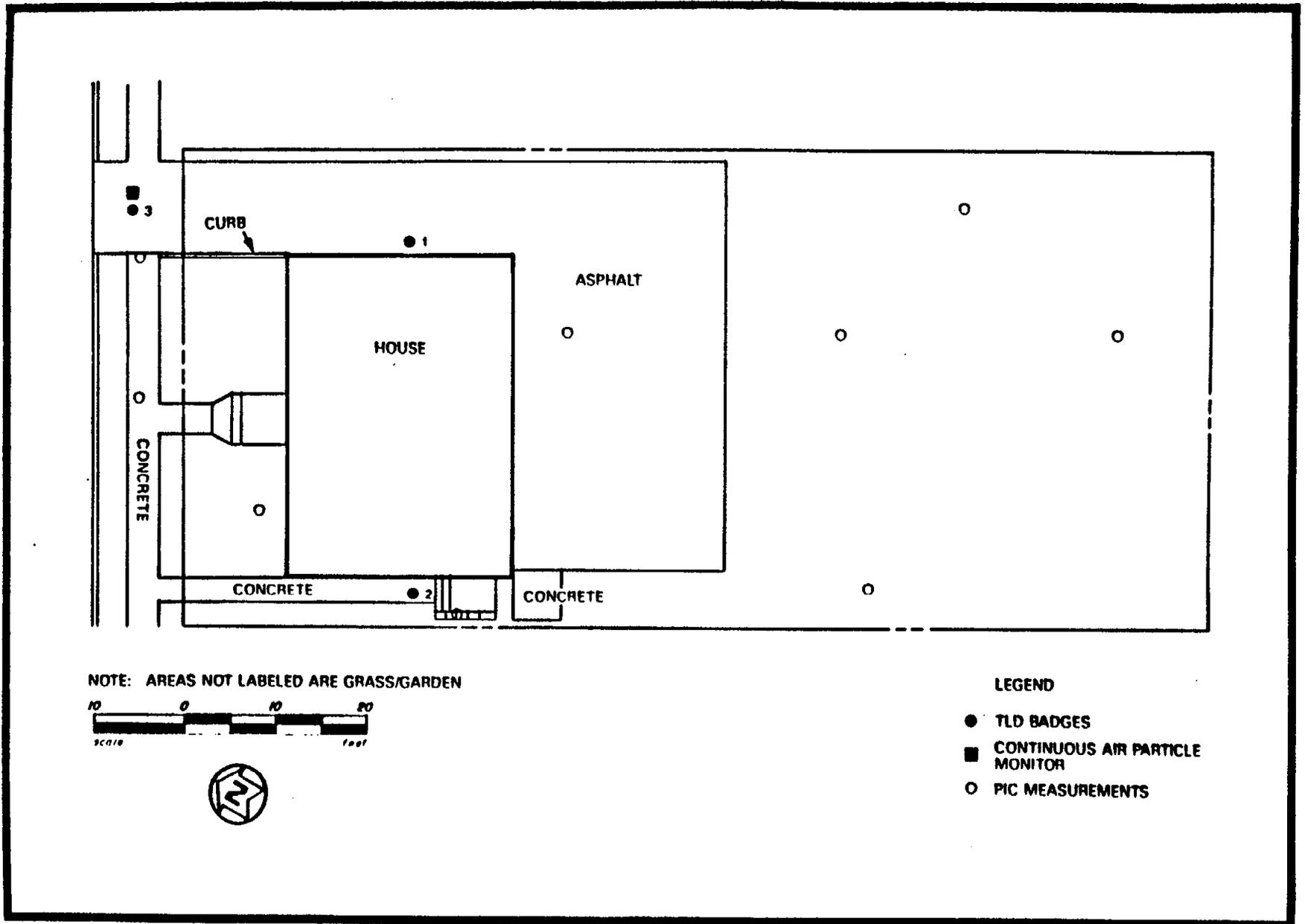


FIGURE 9 MONITORING LOCATIONS AT 468 DAVISON STREET

32011

35011

TABLE 9
REMEDIAL ACTION MONITORING RESULTS
AT 468 DAVISON

Type Measurement	Units	Number of Measurements	Average	Range	DOE Guideline ^a
Gamma exposure rate (TLD-1) ^b	mrem/yr	3	6	0-20	100
Gamma exposure rate (TLD-2) ^b	mrem/yr	3	0	0-25	100
Gamma exposure rate (TLD-3) ^b	mrem/yr	1	14	NA	100
Gamma exposure rate (PIC) ^b	mrem/yr	9	0	0-23	100
Air sampling for particulates ^c	10-14 uCi/ml (gross alpha)	43	0.3	0.07-2	100

^aDOE guidelines are specified to be "above natural background values."

^bCalculated from exposure rate measurements assuming continuous occupancy at point of measurement. The natural background radiation of 100 mrem/yr has been subtracted.

^cThis standard is for thorium-232. It is the most restrictive standard applicable to the mixture of radionuclides present in the Maywood wastes. Background contributions have not been subtracted.

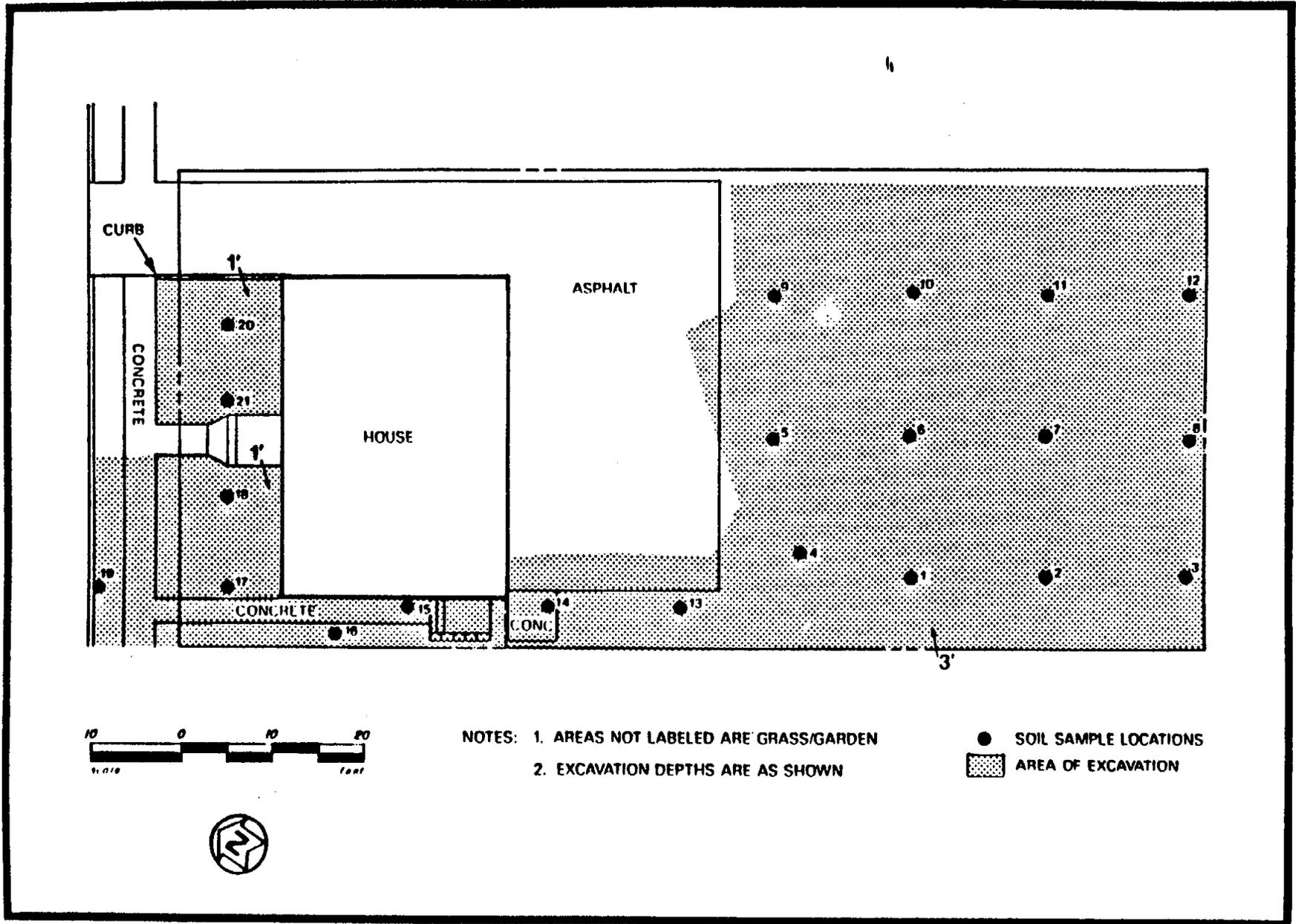


FIGURE 10 REMEDIAL ACTION AT 468 DAVISON STREET

35011

TABLE 10
 POST-REMEDIAL ACTION SOIL SAMPLE RESULTS FOR
 468 DAVISON STREET

Soil Sample Number	Uranium-238 picocuries per gram \pm 2 sigma	Radium-226 picocuries per gram \pm 2 sigma	Thorium-232 picocuries per gram \pm 2 sigma
1	<5.0	0.6 \pm 0.1	0.8 \pm 0.1
2	<5.0	1.0 \pm 0.1	1.2 \pm 0.1
3	<5.0	0.8 \pm 0.1	1.2 \pm 0.1
4	<5.0	0.6 \pm 0.1	0.9 \pm 0.1
5	<5.0	0.8 \pm 0.1	1.3 \pm 0.2
6	1.1 \pm 0.3	0.9 \pm 0.4	1.8 \pm 0.1
7	<5.0	0.9 \pm 0.1	2.2 \pm 0.1
8	0.9 \pm 0.2	0.9 \pm 0.1	1.6 \pm 0.1
9	<5.0	1.2 \pm 0.1	3.2 \pm 0.2
10	2.2 \pm 0.4	1.1 \pm 0.1	3.1 \pm 0.1
11	1.2 \pm 0.5	1.3 \pm 0.1	4.9 \pm 0.2
12	0.9 \pm 0.3	1.2 \pm 0.1	2.3 \pm 0.1
13	<2.2	0.8 \pm 0.1	1.5 \pm 0.2
14	<5.0	1.0 \pm 0.1	0.8 \pm 0.3
15	<1.6	0.5 \pm 0.1	0.5 \pm 0.2
16	0.9 \pm 0.3	0.6 \pm 0.1	2.5 \pm 0.1
17	<5.0	0.8 \pm 0.1	1.3 \pm 0.1
18	<5.0	0.8 \pm 0.1	0.8 \pm 0.1
19	<0.8	0.7 \pm 0.1	1.4 \pm 0.1
20	<5.0	0.9 \pm 0.1	1.5 \pm 0.1
21	<2.2	0.1 \pm 0.1	2.4 \pm 0.2

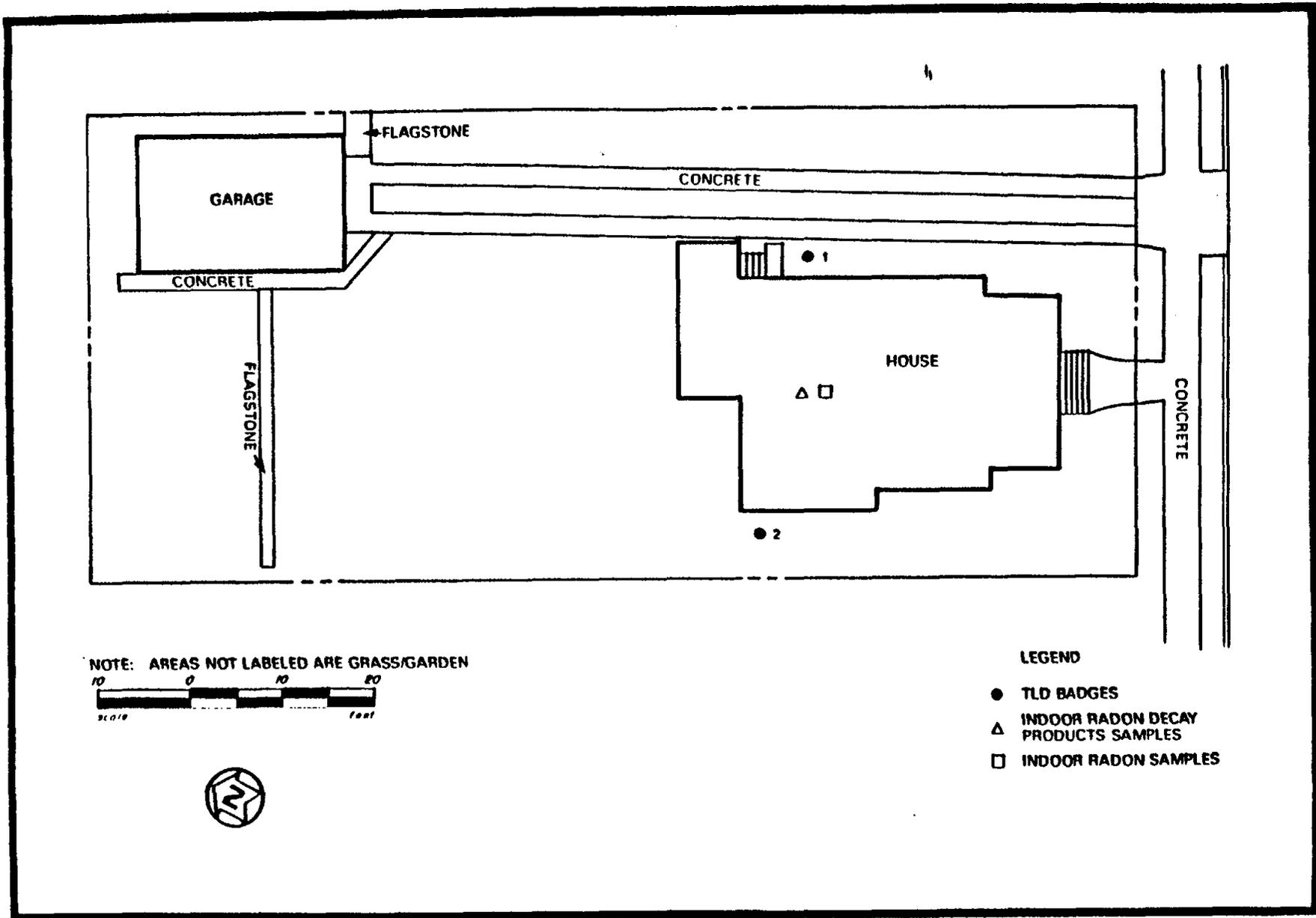


FIGURE 11 MONITORING LOCATIONS AT 459 LATHAM STREET

35011

35011

TABLE 11
 REMEDIAL ACTION MONITORING RESULTS
 AT 459 LATHAM

Type Measurement	Units	Number of Measurements	Average	Range	DOE Guideline ^a
Gamma exposure rate (TLD-1) ^b	mrem/yr	3	7	0-14	100
Gamma exposure rate (TLD-2) ^b	mrem/yr	2	0	0-14	100
Air sampling for radon ^c	pCi/l	2	0.3	0.1-0.8	3.0
Air sampling for radon decay products ^d	WL	4	<0.001	<0.001-0.002	0.02

^aDOE guidelines are specified to be "above natural background values."

^bCalculated from exposure rate measurements assuming continuous occupancy at point of measurement. The natural background radiation of 100 mrem/yr has been subtracted.

^cAverage background contribution of 0.5 pCi/l has been subtracted.

^dAverage background contribution of 0.005 WL has been subtracted.

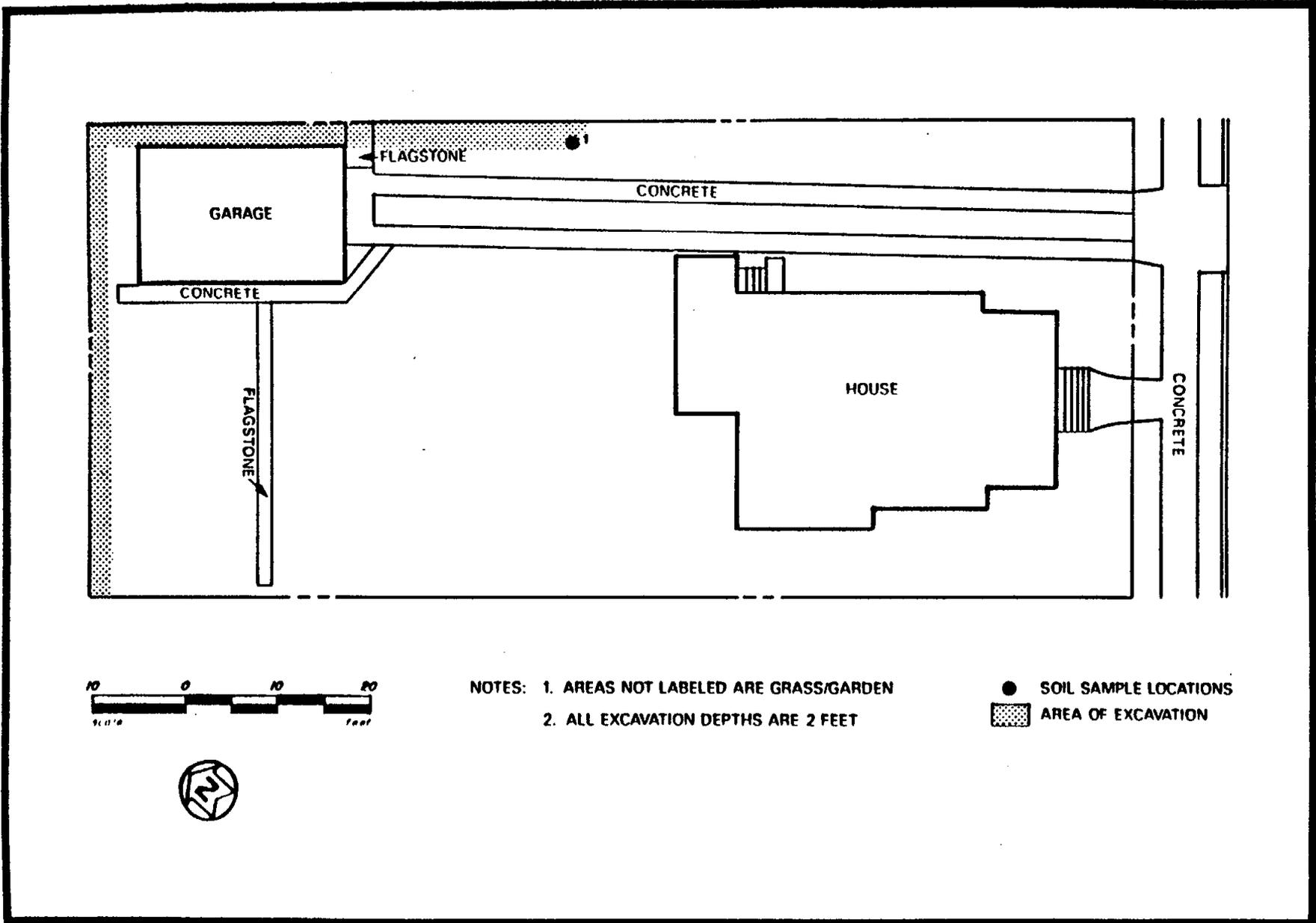


FIGURE 12 REMEDIAL ACTION AT 459 LATHAM STREET

35011

35011

TABLE 12
POST-REMEDIAL ACTION SOIL SAMPLE RESULTS FOR
459 LATHAM STREET

Soil Sample Number	Uranium-238	Radium-226	Thorium-232
	picocuries per gram ± 2 sigma		
1	<5.0	0.7 \pm 0.1	0.8 \pm 0.1

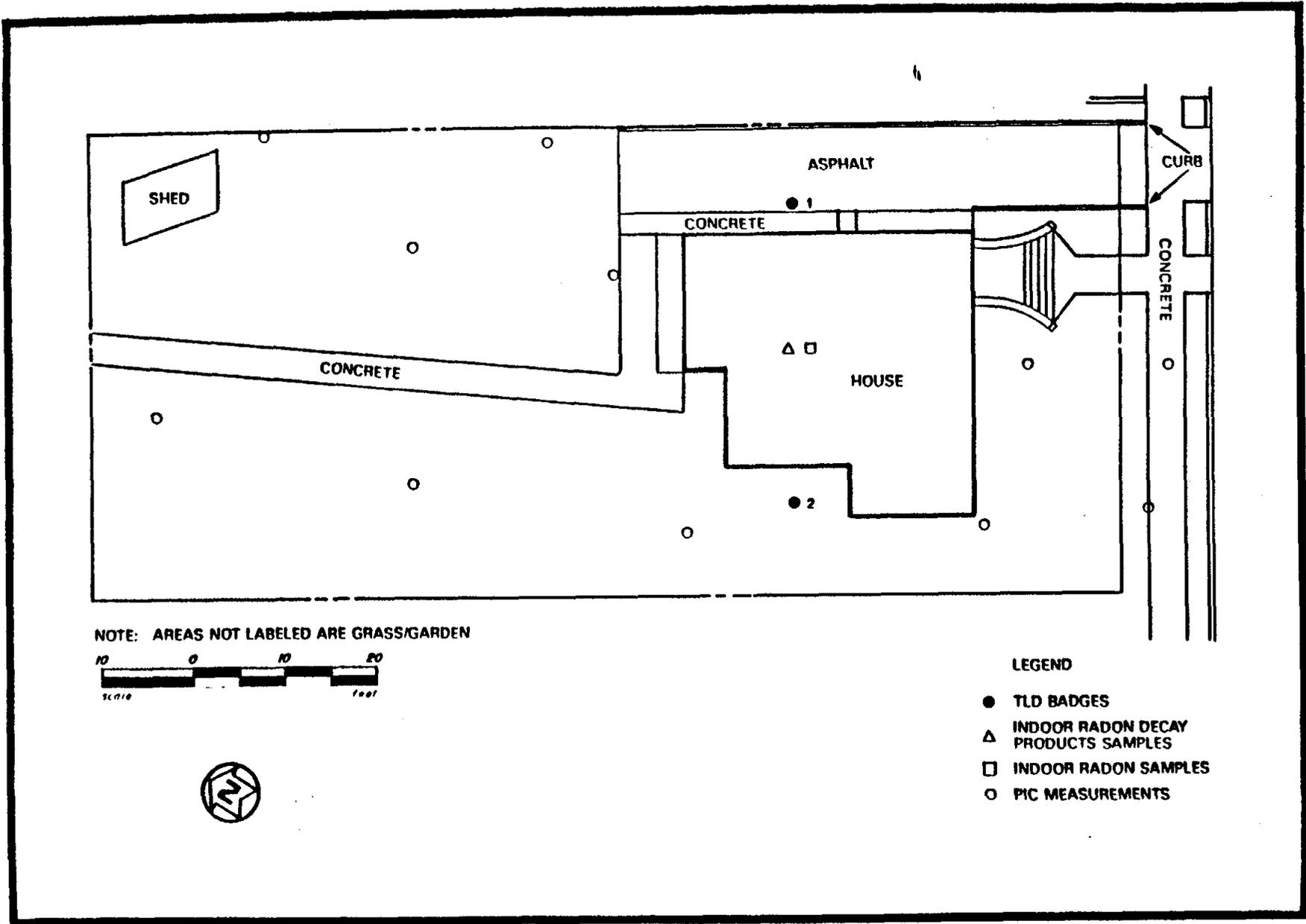


FIGURE 13 MONITORING LOCATIONS AT 461 LATHAM STREET

35211

35011

TABLE 13
 REMEDIAL ACTION MONITORING RESULTS
 AT 461 LATHAM

Type Measurement	Units	Number of Measurements	Average	Range	DOE Guideline ^a
Gamma exposure rate (TLD-1) ^b	mrem/yr	3	4	0-20	100
Gamma exposure rate (TLD-2) ^b	mrem/yr	3	32	20-40	100
Air sampling for radon ^c	pCi/l	2	0.2	0-0.4	3.0
Air sampling for radon decay products ^d	WL	4	<0.001	<0.001-0.001	0.02
Gamma exposure Rate (PIC) ^b	mrem/yr	11	0	0-14	100

^aDOE guidelines are specified to be "above natural background values."

^bCalculated from exposure rate measurements assuming continuous occupancy at point of measurement. The natural background radiation of 100 mrem/yr has been subtracted.

^cAverage background contribution of 0.5 pCi/l has been subtracted.

^dAverage background contribution of 0.005 WL has been subtracted.

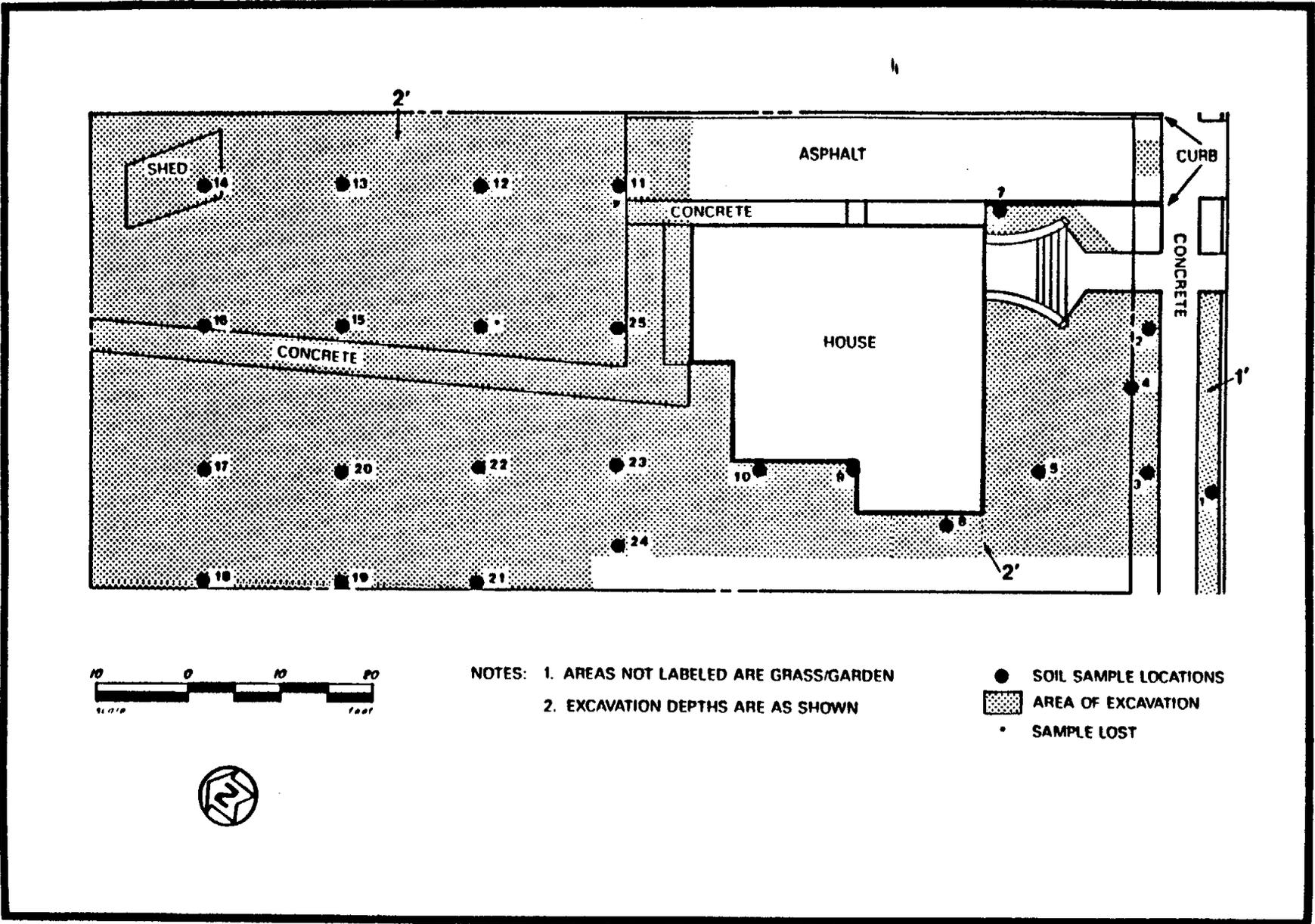


FIGURE 14 REMEDIAL ACTION AT 461 LATHAM STREET

TABLE 14
 POST-REMEDIAL ACTION SOIL SAMPLE RESULTS FOR
 461 LATHAM STREET

Soil Sample Number	Uranium-238	Radium-226 picocuries per gram \pm 2 sigma	Thorium-232
1	<5.0	2.0 \pm 0.1	4.6 \pm 0.2
2	<5.0	1.7 \pm 0.1	3.2 \pm 0.1
3	<5.0	1.0 \pm 0.1	2.1 \pm 0.1
4	0.9 \pm 0.2	0.6 \pm 0.1	1.0 \pm 0.1
5	0.5 \pm 0.2	0.6 \pm 0.1	1.1 \pm 0.1
6	<5.0	1.1 \pm 0.1	3.4 \pm 0.2
7	0.7 \pm 0.4	0.8 \pm 0.1	1.3 \pm 0.1
8	<5.0	0.5 \pm 0.1	0.7 \pm 0.1
9	0.6 \pm 0.3	0.7 \pm 0.1	1.1 \pm 0.1
10	1.7 \pm 0.4	1.6 \pm 0.1	4.9 \pm 0.1
11	<5.0	0.9 \pm 0.1	1.9 \pm 0.1
12	<5.0	1.7 \pm 0.1	4.9 \pm 0.1
13	<5.0	1.2 \pm 0.1	2.5 \pm 0.2
14	<5.0	0.9 \pm 0.1	1.9 \pm 0.1
15	<5.0	1.9 \pm 0.1	5.8 \pm 0.2
16	<5.0	1.2 \pm 0.1	2.4 \pm 0.1
17	<5.0	0.8 \pm 0.1	1.0 \pm 0.1
18	1.4 \pm 0.3	1.3 \pm 0.1	2.0 \pm 0.1
19	<5.0	0.9 \pm 0.1	1.1 \pm 0.1
20	<5.0	0.8 \pm 0.1	1.4 \pm 0.1
21	<5.0	0.7 \pm 0.1	0.8 \pm 0.1
22	<5.0	0.6 \pm 0.1	0.8 \pm 0.1
23	1.0 \pm 0.4	0.8 \pm 0.1	1.8 \pm 0.1
24	<5.0	0.6 \pm 0.1	1.1 \pm 0.1
25	<5.0	0.8 \pm 0.1	1.5 \pm 0.1

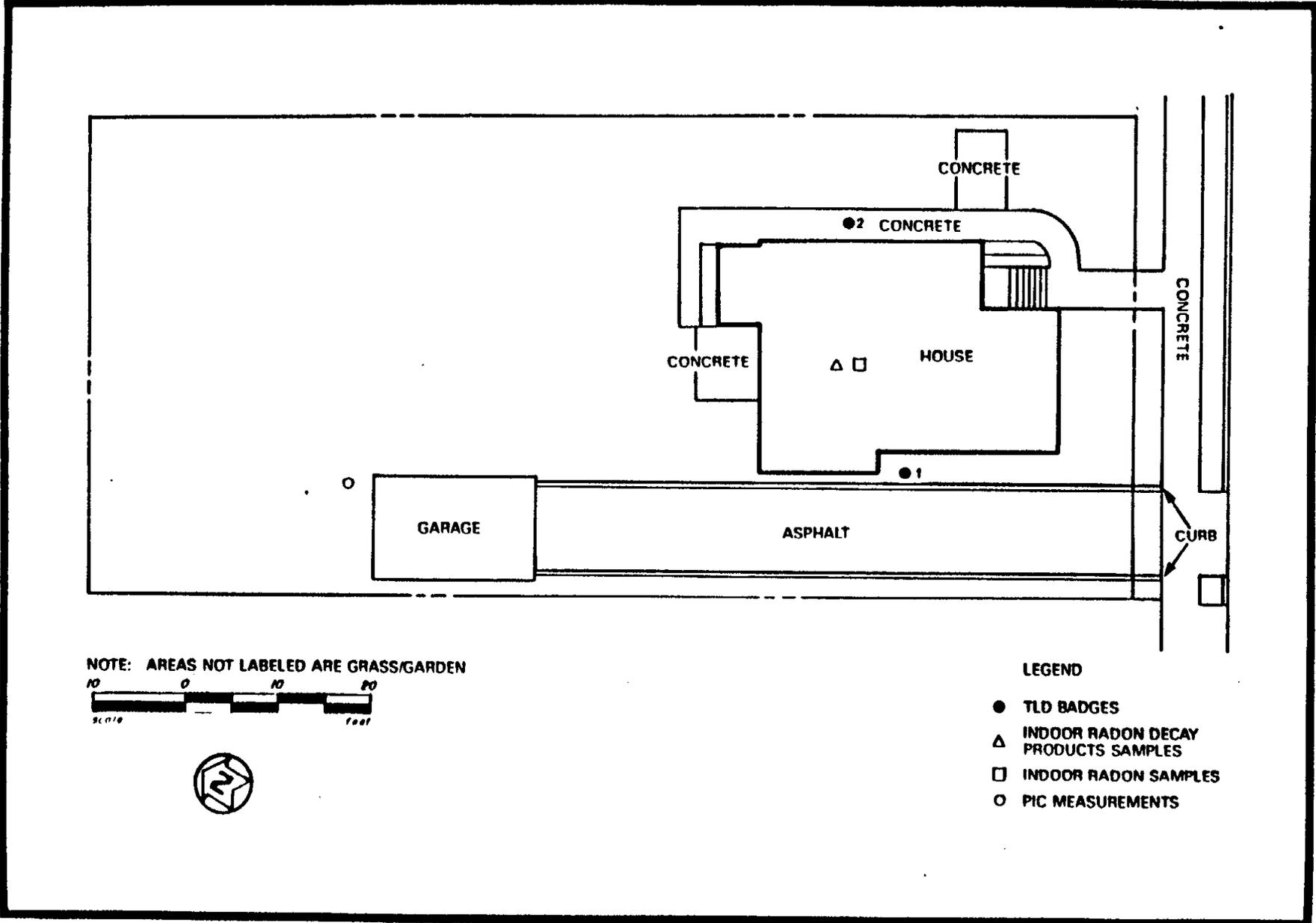


FIGURE 15 MONITORING LOCATIONS AT 467 LATHAM STREET

35011

35011

TABLE 15
 REMEDIAL ACTION MONITORING RESULTS
 AT 467 LATHAM

Type Measurement	Units	Number of Measurements	Average	Range	DOE Guideline ^a
Gamma exposure rate (TLD-1) ^b	mrem/yr	2	4	0-9	100
Gamma exposure rate (TLD-2) ^b	mrem/yr	3	16	4-25	100
Air sampling for radon ^c	pCi/l	2	1.0	0.8-1.2	3.0
Air sampling for radon decay products ^d	WL	2	<0.001	<0.001-0.001	0.02
Gamma exposure rate (PIC) ^b	mrem/yr	1	0	NA	100

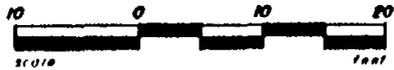
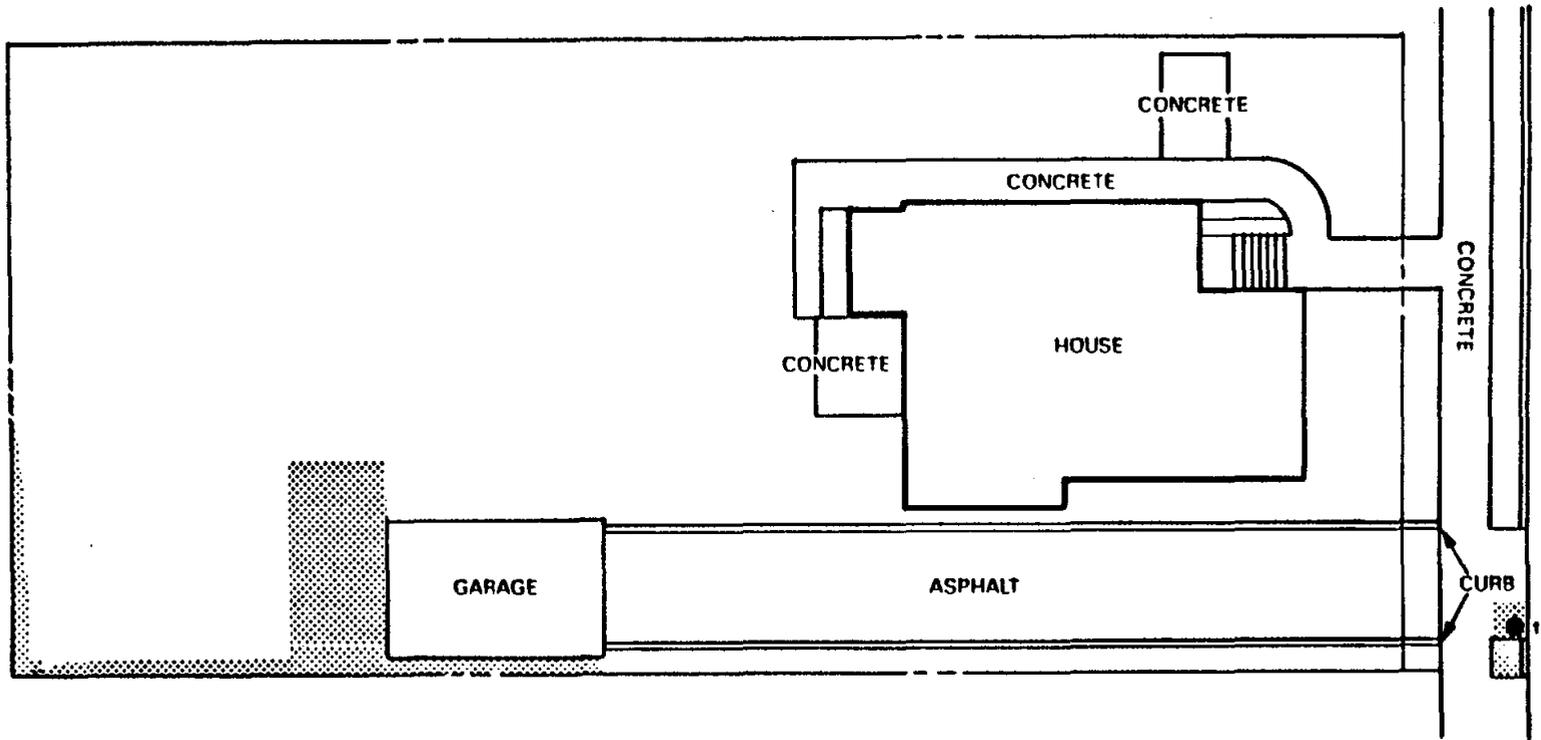
^aDOE guidelines are specified to be "above natural background values."

^bCalculated from exposure rate measurements assuming continuous occupancy at point of measurement. The natural background radiation of 100 mrem/yr has been subtracted.

^cAverage background contribution of 0.5 pCi/l has been subtracted.

^dAverage background contribution of 0.005 WL has been subtracted.

40



- NOTES: 1. AREAS NOT LABELED ARE GRASS/GARDEN
2. ALL EXCAVATION DEPTHS ARE 1 FOOT
3. EXCAVATION AREAS ARE CONTIGUOUS WITH AREAS ON OTHER PROPERTIES. SOIL SAMPLES WERE TAKEN ON THESE PROPERTIES.

- SOIL SAMPLE LOCATIONS
▨ AREA OF EXCAVATION

FIGURE 16 REMEDIAL ACTION AT 467 LATHAM STREET

35011

35011

TABLE 16
POST-REMEDIAL ACTION SOIL SAMPLE RESULTS FOR
467 LATHAM STREET

Soil Sample Number	Uranium-238 picocuries per gram \pm 2 sigma	Radium-226 picocuries per gram \pm 2 sigma	Thorium-232 picocuries per gram \pm 2 sigma
1	0.7 \pm 0.4	0.8 \pm 0.1	1.3 \pm 0.1

REFERENCES

1. Oak Ridge National Laboratory. Results of the Radiological Survey 454 Davison Avenue, Maywood, New Jersey, Oak Ridge, TN, July 1984.
2. Oak Ridge National Laboratory. Results of the Radiological Survey at 459 Davison Avenue, Maywood, New Jersey, Oak Ridge, TN, September 1981.
3. Oak Ridge National Laboratory. Results of the Radiological Survey at 460 Davison Avenue, Maywood, New Jersey, Oak Ridge, TN, September 1981.
4. Oak Ridge National Laboratory. Results of the Radiological Survey at 464 Davison Avenue, Maywood, New Jersey, Oak Ridge, TN, September 1981.
5. Oak Ridge National Laboratory. Results of the Radiological Survey at 468 Davison Avenue, Maywood, New Jersey, Oak Ridge, TN, September 1981.
6. Oak Ridge National Laboratory. Results of the Radiological Survey at 461 Latham Street, Maywood, New Jersey, Oak Ridge, TN, September 1981.
7. Oak Ridge National Laboratory. Results of the Radiological Survey at 459 Latham Street, Maywood, New Jersey, Oak Ridge, TN, September 1981.
8. Oak Ridge National Laboratory. Results of the Radiological Survey at 467 Latham Street, Maywood, New Jersey, Oak Ridge, TN, September 1981.

35011

9. Letter, Clarence E. Miller, Jr. to Addressees. "Guidelines for Residual Radioactivity at FUSRAP and Remote SFMP Sites" (Attachment: U.S. Department of Energy Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites, Rev. 1, July 1985), August 5, 1985.
10. U.S. Code of Federal Regulations. 40 CFR 192, "Health and Environmental Protection for Uranium and Thorium Mill Tailings," Washington, DC, July 1985.
11. Department of Energy. Remedial Action Work Plan for the Maywood Site, ORO-850, Revision 1, Oak Ridge, TN, April 1985.
12. Letter. M. Guven Yalcintas (ORNL) to A.J. Whitman (DOE). "Verification Statement for Maywood Properties," December 5, 1985.

GLOSSARY

Alpha radiation - See radiation.

Background radiation - Background radiation refers to naturally occurring radiation emitted from either cosmic (e.g., from the sun) or terrestrial (e.g., from the earth) sources. Exposure to this type of radiation is unavoidable and its level varies greatly depending on geographic location, e.g., New Jersey typically receives 100 mrem/yr, Colorado receives about 300 mrem/yr, and some areas in South America receive up to 7000 mrem/yr. Naturally occurring terrestrial radionuclides include uranium, radium, potassium, thorium, etc.

Beta radiation - See radiation.

Contamination - Contamination means a concentration of radioactive materials in the soil exceeding that permitted by DOE guidelines.

Counts per minute - A count is the unit of measurement registered by a radiation detection instrument when radiation imparts its energy within the sensitive range of the detector probe. The number of counts registered per minute can be related to the number of disintegrations per minute occurring from a radioactive material.

Disintegrations per minute - Disintegrations per minute is the measurement indicating the amount of radiation being released from a substance per minute. See the definition of picocurie for more information.

Dose - Dose is used to relate radiation exposure to an effect on the body. Dose is measured in mrem. Examples of dose are: a dose of 500,000 mrem to the whole body in a short time causes death in 50 percent of the people who receive it; a dose of 5,000,000 mrem may be delivered to a cancerous tumor during radiation treatment; normal background radiation results in an annual dose of about 100 mrem; DOE radiation protection standards limit the dose to members of the

general public to 100 mrem/yr above background levels; a typical chest x-ray gives a dose of about 40 mrem; living in a brick house results in a dose of about 75 mrem/yr.

Exposure rate - Exposure rate is the rate at which radiation imparts energy to the air. Exposure is typically measured in uR and the exposure rate is typically given as uR/h. The dose to the whole body can be approximated by multiplying the exposure rate by the number of hours of exposure. For example, if an individual were exposed to gamma radiation at a rate of 20 uR/h for 168 hours per week (continuous exposure) for 52 weeks per year, the whole-body dose would be 170 mrem.

Gamma radiation - See radiation.

Gram - A gram is a metric unit for weight. It takes 454 grams to make 1 pound; 1 ounce equals 28 grams.

Leaching - Leaching is a chemical process whereby the radionuclides from the ore residues were dissolved in water (runoff following precipitation) and seeped into the surrounding soil. Storage piles of radioactive materials are usually covered with waterproof materials to prevent leaching.

Liter - A liter (l) is a metric unit of volume or capacity. One liter equals 1.057 quarts of liquid.

Meter - A meter is a metric unit of measurement for length; 1 meter is equal to approximately 39 inches.

Microcurie - A microcurie (uCi) is 1,000,000 picocuries (see picocuries for additional explanation).

Microroentgens - Microroentgens (uR) is a unit used to measure radiation exposure. For further information, see the definition of radiation exposure.

Milliliter - A milliliter is a unit of measure for volume. There are 3785 ml in 1 gallon.

Millirad - Millirad is a measure of the amount of energy imparted by radiation to a unit of mass. It is generally expressed in terms of a rate per hour, i.e., mrad/h.

Millirem - Millirem is the unit used to measure radiation doses to man. The DOE limit is 100 mrem above background radiation levels for members of the general public in any one year. For comparison, a typical chest x-ray is about 40 mrem. In New Jersey, naturally occurring radioactive substances in the ground result in a yearly exposure to everyone of about 100 mrem. To date, no difference can be detected in the health of population groups exposed to 100 mrem/yr above background and in the health of groups who are not exposed.

Monazite - Monazite is a mineral which contains unusually high concentrations of thorium and rare earth metals. Monazite is often found in sand and gravel deposits.

Picocuries - A picocurie is the unit of measure for radioactivity just as an ounce is a unit to measure weight. One picocurie means that one radioactive particle is released on the average of every 27 seconds.

Radiation - There are three primary types of radiation: alpha, beta, and gamma. Alpha radiation travels less than an inch in air before it stops. Alpha radiation cannot penetrate the outer layer of skin on the body. Beta radiation can penetrate the outer layers of skin, but cannot reach the internal organs of the body. Gamma radiation is the most penetrating type and can usually reach the internal organs. For radioactive material external to the body, gamma radiation is the principal concern. For radioactive material that enters the body by ingestion or inhalation, alpha and beta radiation are also of concern.

Radioactive Decay - Radioactive decay is the change in chemical composition of a radioactive material that accompanies the emission of alpha or beta particles from that material. The radioactive element becomes a different element, which may or may not be radioactive. For example, the following chain describes the radioactive decay of uranium-238: uranium-238 -- thorium-234 -- protactinium-234 -- uranium-234 -- thorium-230 -- radium-226 -- radon-222 -- polonium-218 -- lead-214 -- bismuth-214 -- polonium-214 -- lead-210 -- bismuth-210 -- polonium-210 -- lead-206. Lead-206 is stable; therefore the original atom of uranium-238 has become one of lead-206 and is no longer radioactive.

Radionuclide - A radionuclide is another word meaning a particular radioactive element. For example, radium-226 is a radionuclide, uranium-238 is another, thorium-232 another, and so on.

Radium-226 - Radium-226 is one of the radioactive materials found in the wastes from the Maywood Chemical Works plant. When it releases radiation, it becomes radon.

Radon - Radon is a noble gas generated when radium-226 radioactively decays. Because it is a gas, it seeps out of the soil containing the radium-226 and concentrates in confined areas. The pressure of radon can be used to infer the presence of radium-226.

Radon Daughters - When radon undergoes radioactive decay, it emits alpha radiation. After this occurs, it is no longer radon and has become polonium. This is also radioactive and decays to radioactive lead by emitting alpha radiation. This process continues (see radioactive decay) until the material becomes stable lead and is no longer radioactive. The "parent" radionuclide for this chain of radioactive decay was the radon. All radioactive material resulting from the decay of the radon are called radon daughters.

Rare earths - Rare earths refers to various types of metals present in the monazite sands. These were extracted from the monazite for their value. Rare earth metals include cerium, lanthanum, praeaseodymium, and neodymium.

Remedial action - Remedial action is a general term typically used to mean "cleanup of contamination." With reference to cleanup of the Davison and Latham properties, it means any action required to bring the property to a condition which will permit its release for unrestricted use. In practice, this may mean removing grass and soil, cutting trees, removing asphalt, etc.

Thorium - Thorium is a naturally occurring element which is recovered from monazite for commercial purposes. Monazite contains from 3 to 9 percent thorium oxide. The principal use of thorium to date has been in the preparation of gas lantern mantels because thorium oxide burns with a brilliant white light. Thorium oxide is also commonly found in high quality glasses and camera lenses because of its good optical characteristics.

Unrestricted Use - Unrestricted use means that the property can be used for any purpose without regard to the radioactivity which used to be on the property. These uses could include anything - farming, a residence, a playground, etc.

Uranium - Uranium is a naturally occurring, radioactive element. The principal use of uranium -- when refined -- is for the production of fuel for nuclear reactors. Uranium in its natural form (as it exists on the Davison and Latham properties) is not suitable for use as a fuel source.

Working level - Working level is a unit to measure the energy expended in air by radon or its radioactive decay products. The term was derived for use with uranium mine workers and has become the accepted unit for environmental measurements.