M-708

Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for the Maywood Site, New Jersey

US Army Corps of Engineers®

Bechtel

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Job No. 14501, FUSRAP Project
USACE Contract No. DACW45-98-D-0028
WBS: 138

FEB 18 1998

U.S. Army Corps of Engineers
CENAN-CO
26 Federal Plaza
New York, NY 10278-0090

Attention: Mr. Ben Wood

Subject: Maywood Site - FY96 Vicinity Properties PRAR - Final

Dear Mr. Wood:

Enclosed for your reference are 2 copies of the subject document.

This document and all attachments were prepared under my direction or supervision in accordance with a system designed to ensure that the information submitted was properly gathered and evaluated. To the best of my knowledge and belief, they are true, accurate, and complete.

If you have any questions, please call me at (201) 843-7080, extension 201.

Sincerely,

S.G. Wilkinson

Stephen G. Wilkinson, PE
Project Manager - FUSRAP

RJH:csc:NJ98L016.doc
Enclosure: Maywood Vicinity Properties PRAR

Concurrence: R.J. Howard @ RJH

DACW45-98-D-0028-414

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DACW45-98-D-0028

Post-Remedial Action Report for the Maywood Site Vicinity Properties at 7 Branca Court, 11 Redstone Lane, 16 Long Valley Road, 18 Long Valley Road, 20 Long Valley Road, 22 Long Valley Road, 24 Long Valley Road, and 26 Long Valley Road

Lodi, New Jersey

JANUARY 1998

US Army Corps of Engineers®

Printed on recycled/recyclable paper.

DACW45-98-D-0028-414

POST-REMEDIAL ACTION REPORT
FOR THE
MAYWOOD SITE VICINITY PROPERTIES
AT 7 BRANCA COURT, 11 REDSTONE LANE,
16 LONG VALLEY ROAD, 18 LONG VALLEY ROAD,
20 LONG VALLEY ROAD, 22 LONG VALLEY ROAD,
24 LONG VALLEY ROAD, AND 26 LONG VALLEY ROAD
LODI, NEW JERSEY

JANUARY 1998

Prepared for

United States Army Corps of Engineers

New York District Office

Under Contract No. DACW45-98-D-0028

By

Bechtel National, Inc.

Oak Ridge, Tennessee

Bechtel Job No. 14501

CONTENTS

FIGURES

FIGURES
(continued)

TABLES

ACRONYMS

BNI	Bechtel National, Inc.
DCG	derived concentration guide
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FUSRAP	Formerly Utilized Sites Remedial Action Program
IVC	independent verification contractor
MCW	Maywood Chemical Works
MISS	Maywood Interim Storage Site
ORNL	Oak Ridge National Laboratory
PCB	polychlorinated biphenyl
PIC	pressurized ionization chamber
PPE	personal protective equipment
RCRA	Resource Conservation and Recovery Act

UNITS OF MEASURE

cm	centimeter
ft	foot
g	gram
h	hour
in.	inch
km	kilometer
L	liter
m	meter
μR	microroentgen
mi	mile
mrem	millirem
pCi	picocurie
yd	yard
yr	year

1.0 INTRODUCTION

1.1 BACKGROUND

This report documents the remedial action conducted during 1996 at eight vicinity properties that are part of the Maywood site. The Maywood site is located in Bergen County, New Jersey, approximately 20 km (12 mi) north-northwest of New York City and 21 km (13 mi) northeast of Newark, New Jersey (Figure 1-1). The Maywood site consists of the Maywood Interim Storage Site (MISS) and 87 vicinity properties in the boroughs of Maywood and Lodi and the Township of Rochelle Park.

Twenty-five of the vicinity properties were remediated during 1984-1985. Five other properties that were remediated in October 1995 are located at 79 Avenue B, 90 Avenue C, 108 Avenue E, 112 Avenue E, and 113 Avenue E in Lodi. The eight properties that are the subject of this post-remedial action report are located at 7 Branca Court, 11 Redstone Lane, 16 Long Valley Road, 18 Long Valley Road, 20 Long Valley Road, 22 Long Valley Road, 24 Long Valley Road, and 26 Long Valley Road. The properties are approximately 1 km (0.6 mi) from MISS (Figure 1-2).

Remedial actions at these vicinity properties were performed as part of the U.S. Department of Energy's (DOE's) Formerly Utilized Sites Remedial Action Program (FUSRAP). FUSRAP was established to identify and clean up or otherwise control sites where residual radioactive contamination remains from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has authorized DOE to remedy. The remedial action was conducted as a non-time-critical removal action under the Comprehensive Environmental Response, Compensation, and Liability Act.

The objectives of FUSRAP, as they apply to the Maywood site, are

- to remove or otherwise control contamination on sites identified as contaminated above current DOE guidelines, and
- to achieve and maintain compliance with applicable criteria for the protection of human health and the environment.

FUSRAP was established in 1974 and currently includes 46 sites in 14 states. Congress assigned responsibility for the Maywood site to DOE in 1984 under the Energy and Water Development Appropriations Act; the site was then assigned to FUSRAP.

Bechtel National, Inc. (BNI), the project management contractor, assists DOE in the planning, management, and implementation of the cleanup of the Maywood site, including the vicinity properties. DOE-Headquarters uses Oak Ridge National Laboratory (ORNL) as an independent verification contractor (IVC) to provide autonomous assurance that site conditions after the remedial action meet the cleanup criteria.

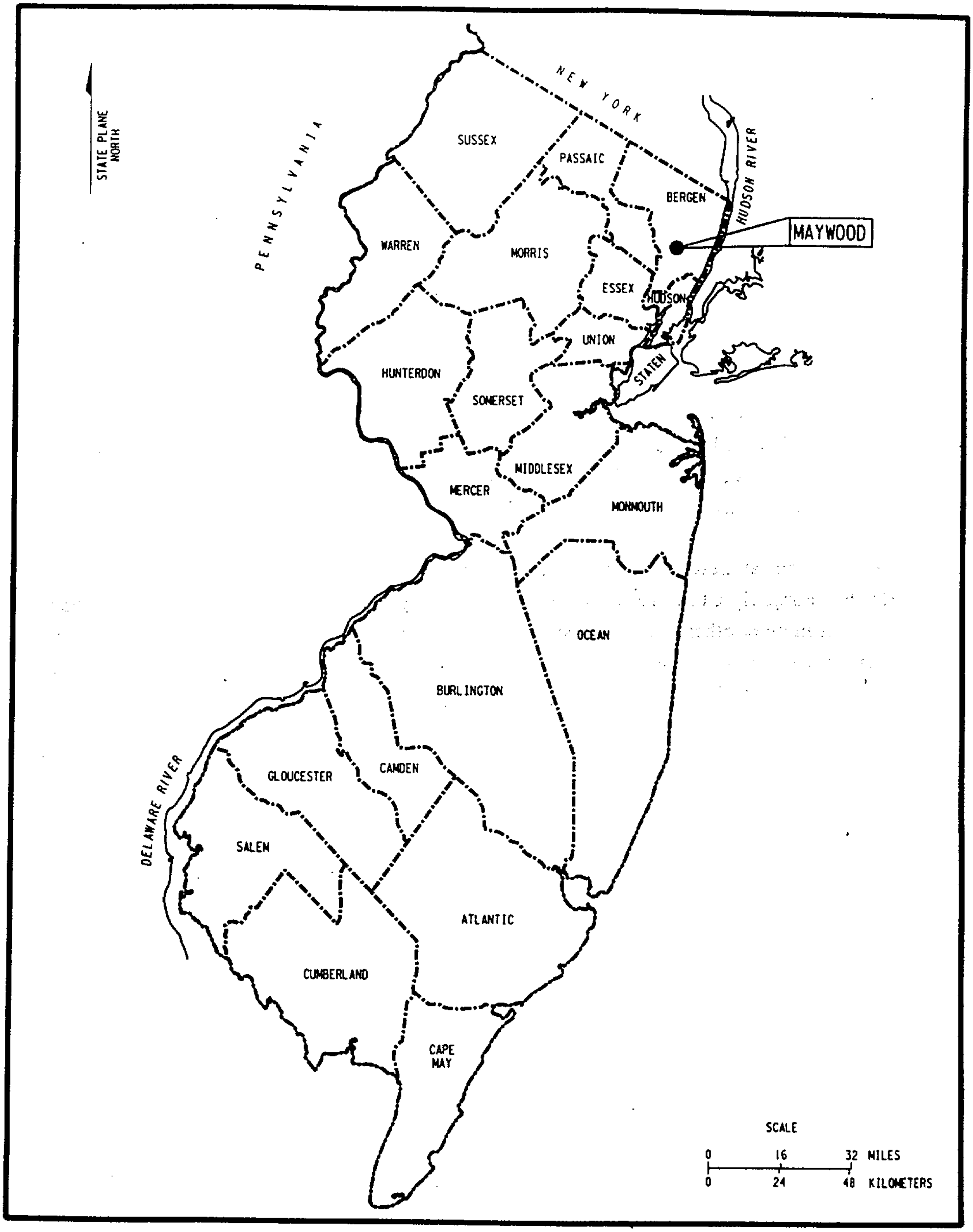

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Figure 1-1
Location of Maywood, Bergen County, New Jersey

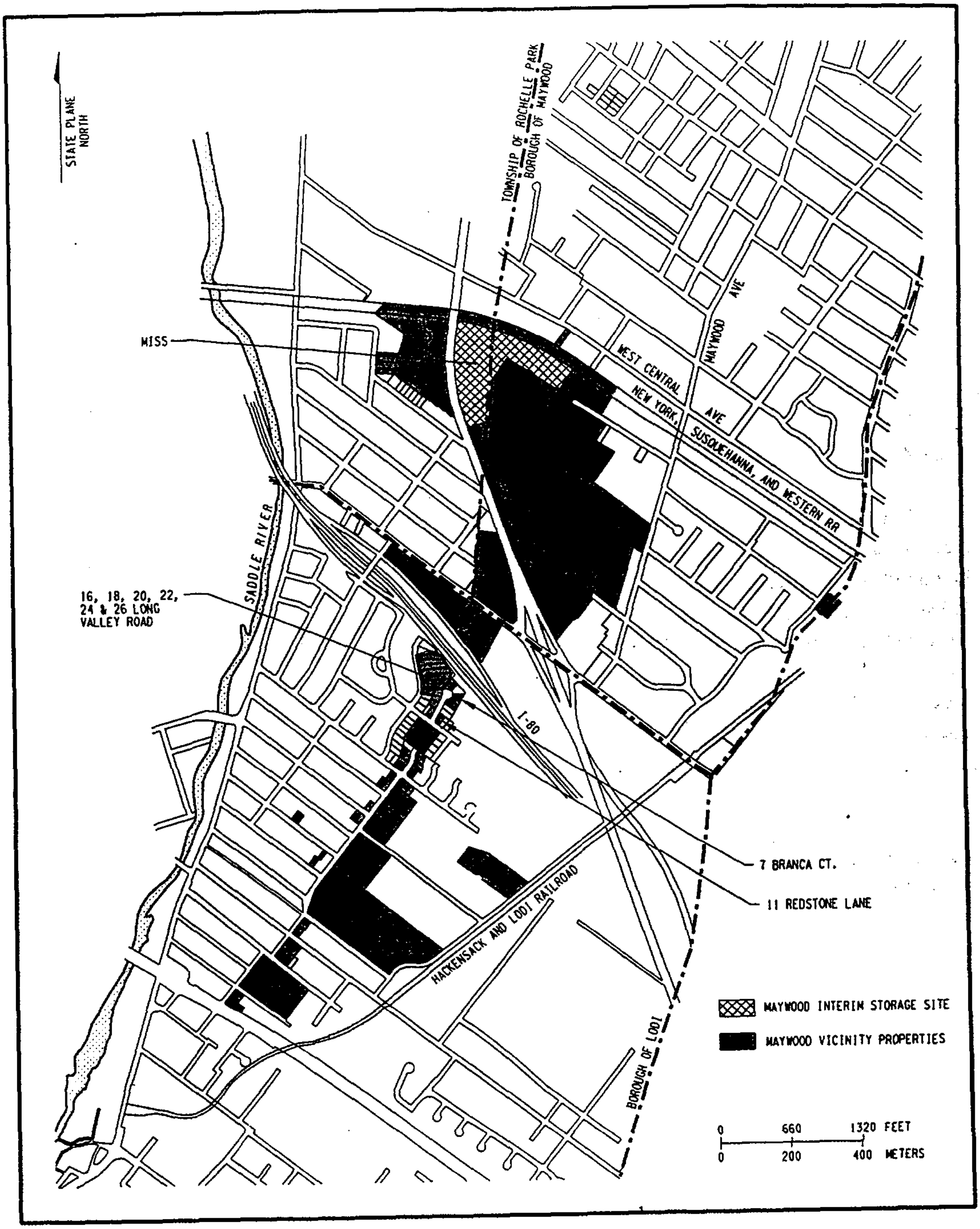

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Figure 1-2
Locations of the Maywood Site Vicinity Properties

1.2 HISTORY

1.2.1 Prior Remedial Actions

From 1916 to 1959, the former Maywood Chemical Works (MCW) extracted radioactive thorium and rare earths from monazite sand for use in manufacturing industrial products such as mantles for gas lanterns. Slurry that contained waste from the thorium-processing operations was pumped to earthen diked areas. Nearby properties became contaminated when some process wastes, along with tea and coca leaves from other MCW operations, were removed from the MCW property and used as mulch and fill. Additional waste apparently migrated off the MCW property through natural drainage associated with the former Lodi Brook. In all, 87 commercial, governmental, and residential vicinity properties were radioactively contaminated by these transport mechanisms. Twenty-five residential properties were remediated during 1984-1985. Five additional residential properties were remediated during 1995.

1.2.2 Characterization Before Current Remedial Action

Typically, FUSRAP conducts characterization before remediating designated properties. Results of radiological and chemical characterization of the eight vicinity properties remediated in 1996 are reported in individual characterization reports (BNI 1988a, BNI 1988b, BNI 1988c, BNI 1988d, BNI 1988e, BNI 1988f, BNI 1988g, BNI 1989). In 1995, further characterization was performed on all the properties discussed in this report except for 7 Branca Court to better delineate the areas of contamination. Results of this effort indicated that in some cases, the volume of soil above cleanup guidelines was lower than anticipated. For example, it was determined that there was no radioactive contamination beneath the basement of the residence at 26 Long Valley Road. Results of the 1995 effort are reported in *Results of Maywood Vicinity Property Data Gap Characterization* (BNI 1995).

The previous radiological characterization of the eight vicinity properties indicated that the radioactive contamination was primarily located in the top 30-60 cm (1-2 ft) of soil. Areas inferred to be radioactively contaminated on each property before remediation are discussed in Section 4.0 (and shown in figures in that section). Analytical results from the limited chemical sampling performed did not indicate the presence of chemical contamination in excess of regulatory guidelines or the presence of hazardous waste as defined by the Resource Conservation and Recovery Act.

2.0 REMEDIAL ACTION GUIDELINES

Historical data indicate that radioactive contamination at the five vicinity properties consisted primarily of thorium-232 but also included uranium-238 and radium-226 and their respective decay products. Table 2-1 lists the DOE residual contamination guidelines for release of the Maywood Phase I vicinity properties without radiological restrictions. These guidelines were adopted by DOE based on an agreement with the U.S. Environmental Protection Agency (EPA) in 1994 (DOE 1994). Appendix A provides a brief introduction to the nature, sources, and basic units of radiation.

For the remediation of the eight vicinity properties, the DOE radiological soil cleanup guideline was 5 pCi/g above background regardless of depth (see Table 2-1). This guideline applied to thorium-232 and radium-226 concentrations in soil and included only concentrations exceeding naturally occurring background radioactivity in soils near the site. The DOE site-specific guideline for residual radioactive material is 100 pCi/g of total uranium above background regardless of depth. The resulting uranium-238 guideline is 50 pCi/g, assuming the uranium exists in the naturally occurring abundance of 1:1:0.046 for uranium-234, uranium-238, and uranium-235, respectively (Shleien 1992). The site-specific uranium guideline for Maywood was developed based on the reasonable exposure pathways that could be hypothesized for the site to ensure that the annual radiation dose (excluding radon) received by an individual member of the general public is less than 100 millirem (the unit used to measure radiation dose to man) per year.

These remedial action guidelines are applied in a sum-of-the-ratios calculation. Five isotopes (uranium-238, radium-226, thorium-230, thorium-232, and radium-228) are considered in this calculation. The calculation is performed by first subtracting the background concentration for each isotope from the reported value for that isotope. The subtraction of background concentrations can cause the values for some isotopes to be reduced to zero, and in some cases this causes the sum of ratios to be zero as well. Next, uranium-238 is divided by a specific guideline number (50 pCi/g in this case). Then the larger value of radium-226 or thorium-230 is chosen and divided by the appropriate guideline number (5 pCi/g for Maywood). The larger value of thorium-232 or radium-228 is also chosen and divided by the appropriate guideline number. Finally, the three calculated values are summed. If the sum of the three calculated values is 1.0 or less, the soil is below the applicable DOE guideline for radioactive contamination at Maywood and is thus considered clean.

Because the cleanup guidelines are based on activities in addition to background levels, it is important to establish the levels of naturally occurring background radioactivity in soils near the site. Background data serve as a frame of reference for evaluating analytical data from the vicinity properties because they represent conditions typical of the areas unaffected by former MCW activities. During the remedial investigation, soil samples were obtained from three remote background locations in the general area of the vicinity properties. The locations were selected on the basis of their proximity to the site, relative independence from potential influence of the site, and representativeness of area land uses. The

Table 2-1
Summary of DOE Guidelines for Residual Radioactive Contamination[a]

Basic Dose Limits

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as-low-as-reasonably-achievable (ALARA) principles to set site-specific guidelines.

Soil Guidelines[b,c,d,e]

Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g when averaged over any 15-cm (6-in.)-thick layer of soil regardless of depth.
Uranium[f]	100 pCi/g total uranium, 50 pCi/g uranium-238.

Radionuclide[g]	Allowable Surface Residual Contamination[g] (dpm/100 cm^2) Average[h,i]	Maximum[h,j]	Removable[h,k]
Transuranics, Ra-226, Ra-228, Th-230, Th-228, Pa-231, Ac-227, I-124, 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 a	15,000 a	1,000 a
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission except Sr-90 and others noted above)	5,000 b-g	15,000 b-g	1,000 b-g

[a]Department of Energy, 1990, Order 5400.5, "Radiation Protection of the Public and the Environment" (February 8). The soil guideline of 5 pCi/g regardless of depth is from DOE 1994.

[b]Soil guidelines are also used for sediment because there are no sediment guidelines.

[c]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 must 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 the radionuclide will not exceed 1 ("unity").

[d]These guidelines represent allowable residual concentration exceeding background levels averaged across any 15-cm (6-in.)-thick layer to any depth and over any contiguous 100-m^2 (1,076-ft^2) surface area, except as noted.

[e]If the average concentration in any surface or below-surface area less than or equal to 25 m^2 (269 ft^2) exceeds the authorized limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters, limits for "hot spots" will also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the supplement. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective of the average concentration in the soil.

[f]Guidelines are calculated on a site-specific basis using a DOE manual developed for this use.

[g]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.

[h]Measurements of average contamination should not be averaged over more than 1 m^2 (10.8 ft). For objects of less surface area, the average must be derived for each such object.

[i]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 (0.4 in.).

[j]The maximum contamination level applies to an area of not more than 100 cm^2 (16 $in.^2$).

[k]The amount of removable radioactive material per 100 cm^2 (16 $in.^2$) 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 (16 $in.^2$) is determined, the activity per unit area should be based on the actual area or the entire surface should be wiped. The number in this column are maximum amounts.

background locations are shown in Figure 2-1. Samples from these background areas were analyzed for radium-226, thorium-232, and uranium-238. Background external gamma radiation exposure rates were also measured at these three background locations using a pressurized ionization chamber (PIC). The average concentration of thorium-232 in background samples was 1.0 pCi/g, with a range of 0.9 to 1.1 pCi/g. The average background concentration of radium-226 was 0.7 pCi/g, with a range of 0.5 to 0.8 pCi/g. And the average background concentration for uranium-238 was 2.9 pCi/g, with a range of 2.4 to 3.5 pCi/g (BNI 1992). The average background external radiation exposure rate was determined to be 9.0 μR/h.

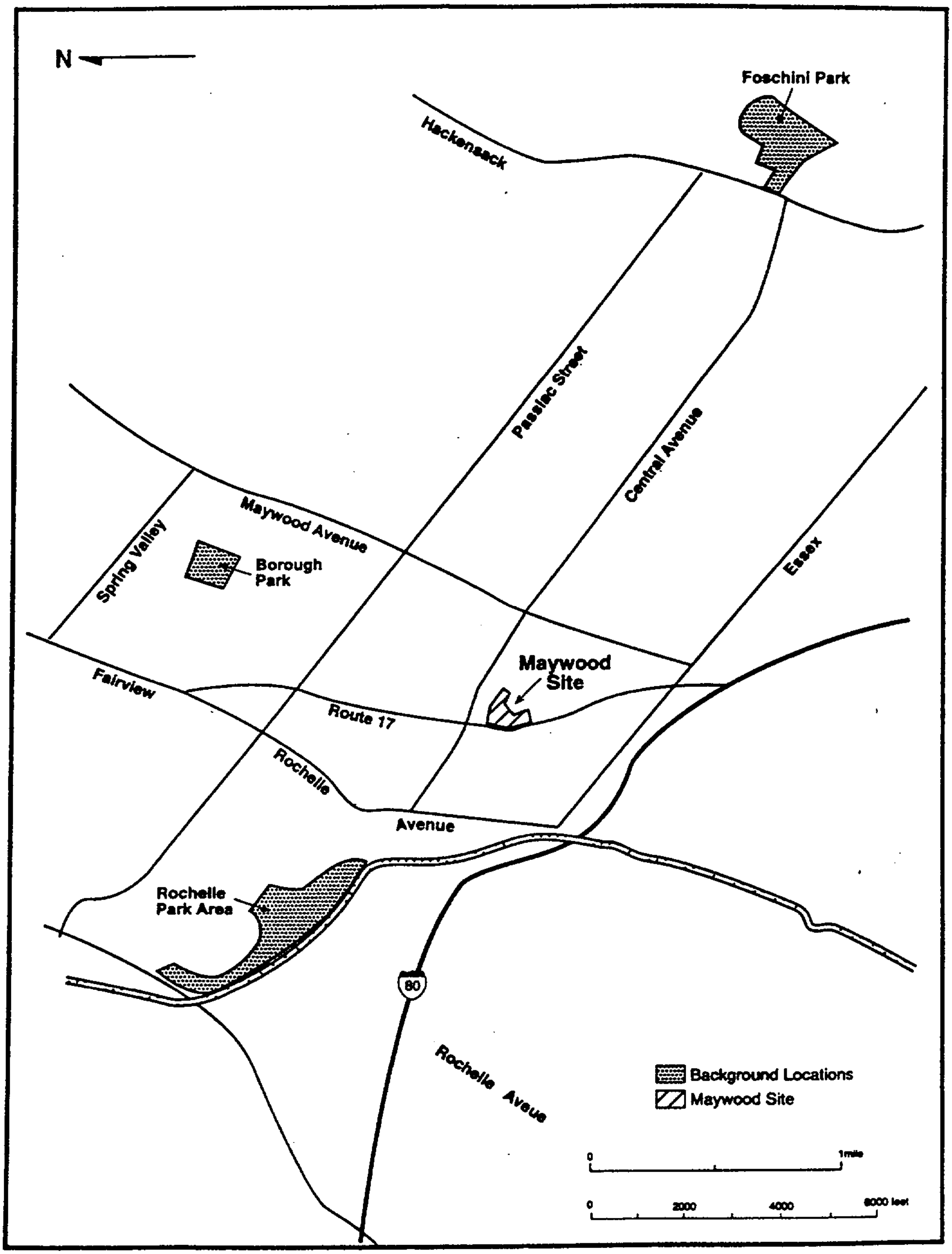

Figure 2-1
Background Sampling Locations in Relation to the Maywood Interim Storage Site

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3.0 REMEDIAL ACTION

3.1 CLEANUP ACTIVITIES

In addition to the characterization programs conducted during the 1980s and in 1995, the eight vicinity properties were surveyed immediately before remediation in 1996 to more accurately define the boundaries of radioactive contamination. Waste classification sampling was performed before remediation began to characterize the waste stream (soil) for disposal. Walkover surface scans and soil samples were also taken during remediation to direct the excavation. As remediation was completed, exposure rate measurements were taken with a PIC to confirm that residual radiation levels were in compliance with applicable DOE guidelines (Table 2-1), and soil samples were collected and analyzed to verify that residual radioactive material exceeding the applicable DOE guidelines had been removed.

The primary technique used in the remedial action was excavation of the contaminated materials. A jackhammer was used to break up concrete, asphalt, and debris before removal. Because of the limited working space available in some areas, small volumes of soil from the residential properties were removed with picks and shovels, while a backhoe was used to remove larger volumes. After remedial action, areas were restored to the condition agreed upon by the property owners.

After the material was excavated, direct gamma measurements were taken with an Eberline SPA-3 gamma scintillation detector. After survey results indicated that remediation was complete, post-remediation soil samples were collected from the excavated areas in accordance with the *FUSRAP Post-Remedial Action Survey Plan* (BNI 1996). The soil samples were sent to the Wayne Interim Storage Site in Wayne, New Jersey, for gamma spectral analysis to ensure that all soils contaminated above the DOE criteria had been removed. If the analysis showed that residual radioactive material above criteria remained, then additional excavation occurred and additional post-remedial action samples were collected and analyzed. The rationale for the sampling program and the analytical results are presented in Section 4. The use of the Wayne sample preparation and gamma spectroscopy system provided either same-day or one-day analysis of samples. A substantial cost savings for the project resulted from reduced stand-down time, and the remedial action guidelines were met.

The remedial action was conducted from April to December 1996. During remediation, approximately 4,593 m^3 (6,008 yd^3) of radioactively contaminated soil was removed from the eight properties. Excavated material was transported to MISS, where it was loaded into railcars and shipped to Envirocare of Utah. Table 3-1 lists the volume of soil removed from each vicinity property.

The final costs of the removal actions totaled $1,175.000.

Table 3-1

Volume of Contaminated Soil Removed at Each Vicinity Property

Vicinity Property	Soil Removed, m^3 (yd^3)
7 Branca Court	25 (33)
11 Redstone Lane	180 (236)
16 Long Valley Road	195 (255)
18 Long Valley Road	189 (247)
20 Long Valley Road	805 (1,053)
22 Long Valley Road	718 (939)
24 Long Valley Road	2,141 (2,800)
26 Long Valley Road	340 (445)

3.2 CONTAMINATION CONTROL DURING REMEDIAL ACTION

During the removal action, engineering and administrative controls (such as dust control, hazardous work permits, and installation of a silt fence) and personal protective equipment (PPE) were used to protect remediation workers and members of the public from exposure to radiation in excess of applicable standards. These measures also controlled the migration of radioactive material to uncontaminated areas next to these vicinity properties.

All personnel working in contaminated areas were required to wear disposable coveralls, safety glasses, rubber boots, a hard hat, and gloves.

Workers exiting controlled areas were subjected to a radioactive contamination survey (frisked) at the control point with a hand-held radiation detection instrument. The frisk was conducted by personnel who have received Radiological Worker II training. This procedure ensured that workers were not contaminated and prevented the potential spread of radioactive material from the work area. A frisk is simply a search for radioactive material that may have been transferred onto the skin or clothing of individuals inside the work area. The hand-held Geiger-Mueller radiation detection instrument is held approximately 1 cm away from the area to be frisked and moved slowly (about 5 cm per second) across the body or clothing by the worker. Portions of the PPE worn by the workers that were suspected or known to be contaminated were packaged and shipped to Envirocare for permanent offsite disposal.

The primary pathways by which persons onsite and offsite could be exposed to radioactive material during removal activities at the site were inhalation and ingestion of radioactively contaminated airborne dust generated during excavation. During remedial action, the spread of contamination and personnel exposure were minimized by the following measures:

- A fine water mist was sprayed as needed to control dust during soil removal and transport.
- Trucks hauling contaminated materials were fitted with liners, and the loads were covered with tarps to prevent spillage.
- Silt fences were placed around excavated areas to prevent runoff of potentially contaminated sediment and were maintained until sampling results confirmed that contamination had been removed.

Area air particulate sampling was also performed adjacent to areas where loading operations took place to ensure that no member of the general public was exposed above DOE guidelines (DOE Order 5400.5). The limits expressed in DOE Order 5400.5 are derived concentration guides (DCGs); a DCG is the concentration of a particular radionuclide that would provide an effective dose equivalent of 100 mrem/yr, DOE's primary dose limit, to an individual continuously inhaling the radionuclide for an entire year. These guidelines were established by the International Commission on Radiation Protection and the National Commission on Radiation Protection and adopted by DOE to protect the environment and members of the general public. Eberline RAS-1 high-volume and SKC low-volume samplers were used, and the filters were collected daily and counted after four days to allow for radon decay. As an extra precaution, the area air monitors were placed well within the site perimeter.

Concentrations of thorium-232 measured by area air particulate monitors ranged from -8.1×10^{-7} to 3.4×10^{-5} pCi/L. The average of all perimeter air monitoring results was 3.8×10^{-6} pCi/L. The DCG is 1.0×10^{-5} pCi/L for thorium-232. Even though the DCG was exceeded for a few 8-h periods, a person would need to be exposed to the thorium-232 DCG continuously for one year to receive a dose greater than the 100-mrem/yr guideline. Most results were below the DCG even though the air samplers were actually within the perimeter of the site. Additionally, the loading activities occurred infrequently during the 9 months, and measurements were collected over an 8-h period. The actual dose to a member of the general public from the activities at MISS has been calculated to be 1.2×10^{-6} mrem, which is well below the 100-mrem/yr guideline (BNI 1997).

4.0 POST-REMEDIAL ACTION MEASUREMENTS

After each portion of the property was decontaminated, a radiological survey of that area was conducted to confirm that all radioactive contamination above the cleanup criteria (Table 2-1) had been removed. Initial post-remediation surveys were conducted by Thermo Nutech (TN) on behalf of BNI. Survey techniques including walkover gamma scans, external gamma radiation exposure rate measurements, and soil sampling were conducted as specified in the *FUSRAP Post-Remedial Action Survey Plan* (BNI 1996). ORNL, as the IVC, performed independent verification surveys of the remediated areas using similar or identical survey techniques. The IVC survey data and conclusions will be issued as a separate report by ORNL.

As excavation proceeded in exterior areas, walkover surface scans were conducted with an Eberline SPA-3 gamma scintillation detector to determine whether all soil that was radioactively contaminated in excess of DOE remedial action guidelines had been removed from the remediated areas. The walkover survey provided immediate feedback so that additional excavation could be performed if residual contamination appeared to exceed remedial action guidelines. Soil samples were also collected throughout the excavation and analyzed at the onsite laboratory at the Wayne Interim Storage Site. The sample analyses provided an additional check on the surface scans. The area was scanned after each lift of soil was excavated to verify that the contamination had been removed.

External gamma radiation exposure rates were measured with a PIC at 1 m (3 ft) above the ground surface in each remediated area. Readings taken at this height provide an estimate of the potential exposure from external gamma radiation to the critical body organs. PIC readings are compared with the background exposure rate (9.0 μR/h) established for the area.

Composite post-remediation soil samples were also taken from the excavated areas and analyzed to determine the radionuclide concentrations in the remaining soil before the excavations were backfilled. Samples were composited to be representative of each 100-m^2 (1,076-ft^2) area remediated as specified in the *FUSRAP Post-Remedial Action Survey Plan* (BNI 1996). All soil results presented in the tables include the background levels of each radioisotope. Soil sampling was the primary method used to confirm that all radioactive contamination exceeding DOE cleanup guidelines had been removed. Soil samples were analyzed using gamma spectroscopy.

As work progressed on the properties remediated in 1996, it was discovered that numerous small rivulets, or "veins," of contamination meandered through all the properties. These rivulets were approximately 0.3 to 0.6 m (1 to 2 ft) deep and contained only slightly elevated levels of contamination. This pattern of contamination deposition is typical of areas that are frequently flooded; Lodi Brook frequently flooded the backyards of the Long Valley properties and the front yard of 11 Redstone Lane.

Additionally, the assumed areas of contamination were based on very limited characterization data, which consisted primarily of gross gamma radiation readings that are not radionuclide specific. Gross gamma radiation readings ranging from approximately 25,000 counts per minute (cpm) to 35,000 cpm indicate areas where it is difficult to determine (without radionuclide-specific analysis of soil samples) whether the radionuclide concentrations will exceed the site criteria. This the result of contributions from naturally occurring radionuclides such as potassium-40 in the gross readings. Because of the presence of rivulets and absence of soil sampling data, some of the excavations were larger than predicted; this difference is reflected in the figures for each property.

In the tables included in this section, use of the "less than" (<) notation in reporting survey results indicates that radioactivity was not present at levels that were quantifiable with the instruments and techniques used. Each "less than" value represents the lower limit of the quantitative capacity of the instrument and technique and depends on various factors, including the type of detector used, the counting time, and the background count rate. The actual level of radioactivity is less than the value preceded by the "less than" symbol.

4.1 7 BRANCA COURT

Figure 4-1 shows the area of proposed excavation at 7 Branca Court based on 1988 characterization data. Figure 4-2 shows the actual areas of excavation, locations of post-remedial action soil samples, and post-remedial action radionuclide concentrations. Figure 4-3 shows the locations and results of post-remedial action gamma exposure rate measurements using the PIC. The extent of the excavation was reduced from the proposed area because additional data gathered just before excavation showed that the area of contamination was smaller than the 1988 data had indicated. The additional data were collected to support remedial design and planning for remedial action.

The area shown in Figure 4-1 that extends under the patio and around the northern corner of the house was delineated on the basis of one surface soil sample with a thorium-232 result of 5.1 pCi/g, including background. Because this result almost exceeded the soil criteria, the area was designated for further investigation (BNI 1988a). The preconstruction walkover survey showed no elevated radiation readings in this area. Surface soil samples were collected in the area around the northern corner of the house. The results showed that no residual radioactive material above criteria was present.

Figure 4-2 presents the results of the post-remedial action soil analyses, and Figure 4-3 lists the external gamma radiation exposure rates. Only two post-remedial action samples were collected from 7 Branca Court because of the small area of contamination.

The results of thorium-232 analysis of the two soil samples at this property were 1.76 pCi/g and 2.20 pCi/g; the radium-226 results were 0.56 pCi/g and 0.61 pCi/g; the uranium-238 results were < 2.15 pCi/g and 2.60 pCi/g; and the sums of the ratios were 0.109 and 0.216. These results are below the cleanup criteria presented in Table 2-1. The two exposure rates measured at 7 Branca Court were 10.1 μR/h and 10.3 μR/h. These values are comparable to the average background exposure rate of 9.0 μR/h; hence, any exposure to the public would be essentially indistinguishable from background.

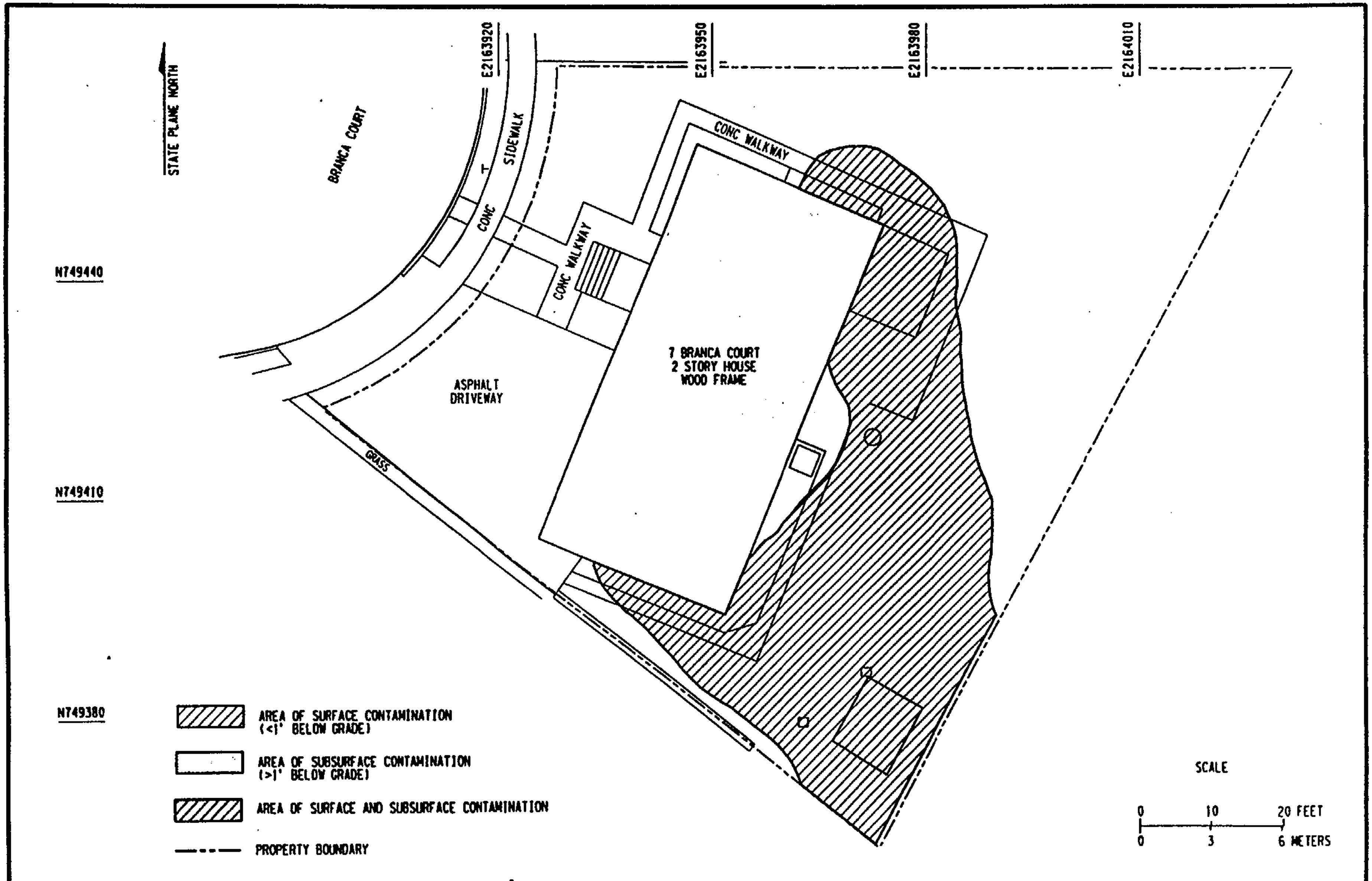

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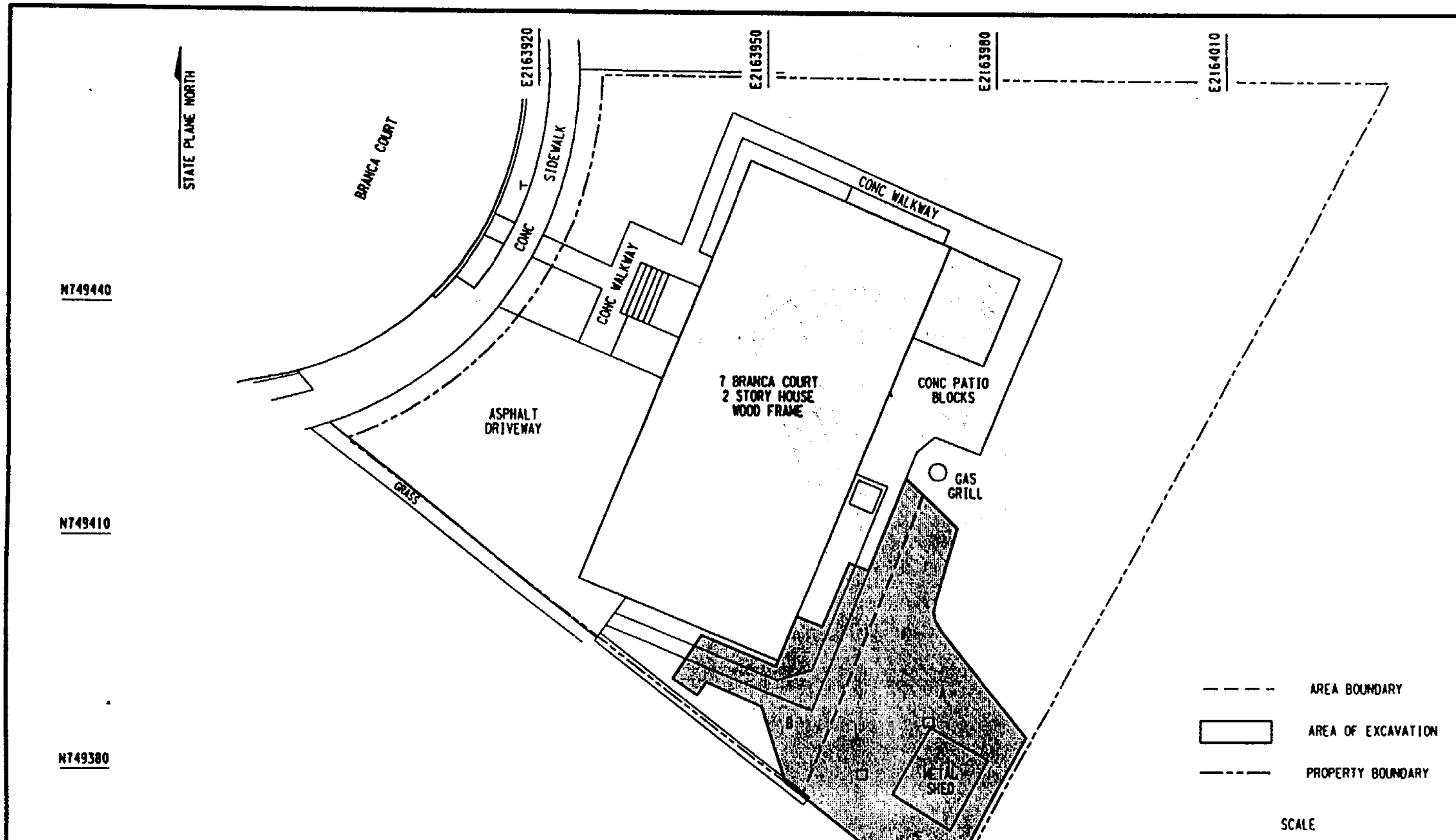
Figure 4-1
Assumed Areas of Surface and Subsurface Contamination
7 Branca Court



AREA	COMPOSITE SAMPLE ID	Th-232 (pCi/g)		Ra-226 (pCi/g)		U-238 (pCi/g)		SUM OF RATIOS
		RESULT	ERROR +/-	RESULT	ERROR +/-	RESULT	ERROR +/-	
A	138VP120	1.76	0.14	0.56	0.05	< 2.15		0.1090
B	138VP122	2.20	0.17	0.61	0.06	< 2.60		0.2160

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Figure 4-2
Areas of Excavation and Post-Remedial Action Samples
7 Branca Court

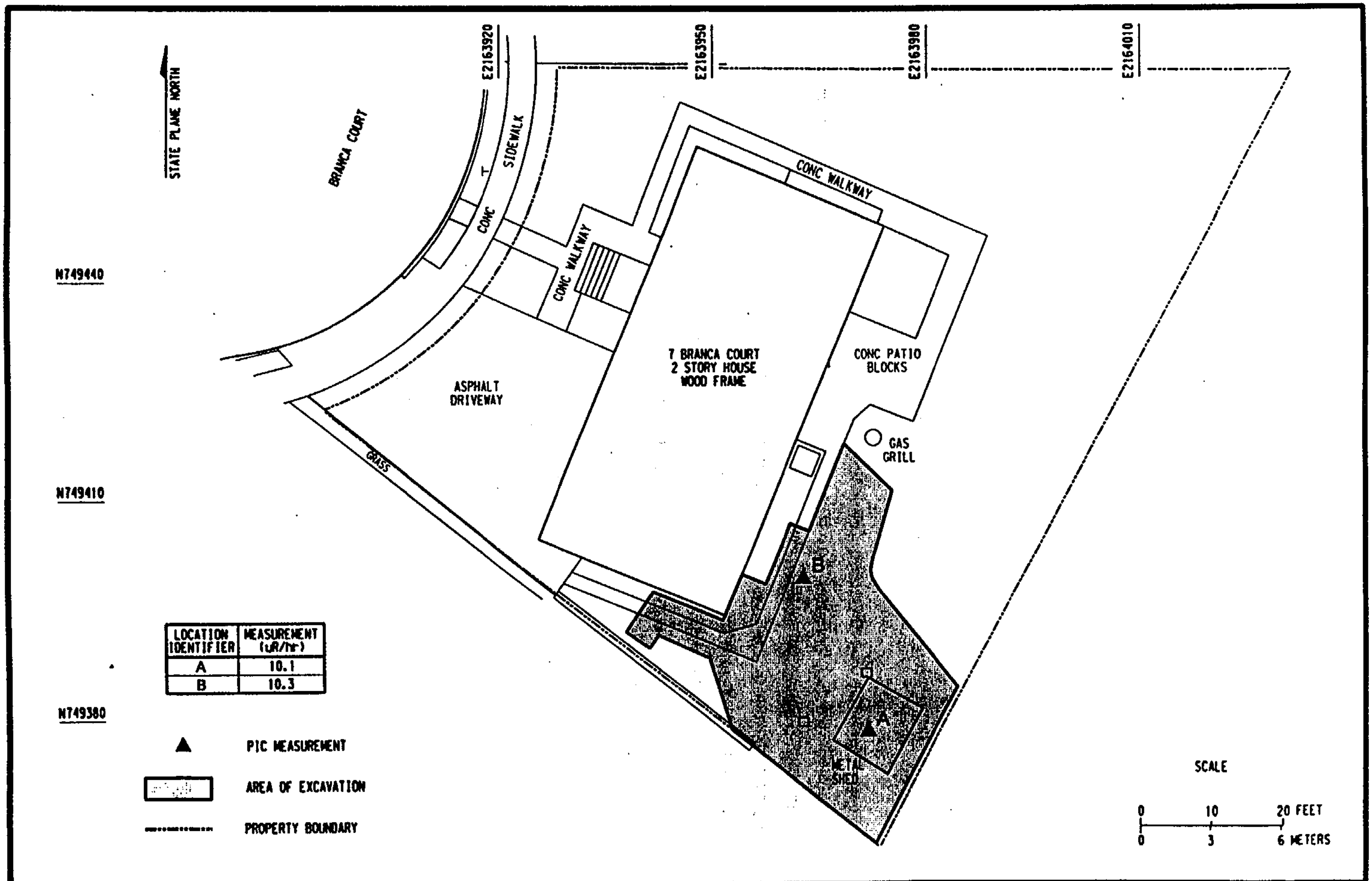

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Figure 4-3
PIC Readings
7 Branca Court

4.2 11 REDSTONE LANE

Figure 4-4 shows the area of assumed surface and subsurface contamination at 11 Redstone Lane based on 1988 and 1995 characterization data gathered before excavation. Areas of excavation and post-remedial action soil sampling locations and results at 11 Redstone Lane are shown in Figure 4-5. Figure 4-6 presents the external gamma exposure rate measurement locations and results. The area of excavation shown in Figure 4-5 is slightly larger than was proposed. The additional excavation occurred because subsurface radioactive contamination approximately 1.5 m (5 ft) deep extended farther from the road than was expected. Only gamma radiation readings, but no soil samples, had been previously collected from the area at this depth (BNI 1988b). Just before remediation, test pits were dug throughout the front and side yards, and samples were collected to determine whether areas exceeded criteria. The pre-remedial action sample results showed contamination in the front of the house to 1.5 m (5 ft) deep and around the side to 0.3 m (1 ft) deep. The contaminated areas under the sidewalk and roads are inaccessible at this time and will be remediated when Branca Court and Redstone Lane are remediated.

As excavation progressed, it was determined that low levels of contamination extended into a small area under the driveway (Figure 4-5, Location D). Remediation would have required the homeowner to relocate because all entrances into the house would have become inaccessible because of the excavation. In an effort to keep the homeowner at home, an alternate criteria as defined in DOE Order 5400.5 (DOE 1990) was applied to this small area. Five samples were collected from the sidewall of the excavation leading under the driveway. Only one sample exceeded criteria, with a thorium-232 concentration of 7.5 pCi/g. To delineate the contamination, seven boreholes were placed in the driveway, and soil samples were collected to define the area of remaining radioactive contamination. All soil samples were below criteria except 138VP670 (as shown in Figure 4-5), which had a thorium-232 concentration of 11.52 pCi/g at a depth of 1.5 m (5 ft). The pattern of boreholes established a maximum area of 3 m^2 (32 ft^2) containing contamination exceeding criteria. This area meets the alternate criteria established in DOE Order 5400.5 (DOE 1990) which allows areas less than 25 m^2 to exceed the established criteria for the site by a factor of $(100/A)^{0.5}$, where A is the area in square meters. Thus, an area of 3 m^2 could exceed the criteria of 5 pCi/g by a factor of 5.77, which yields an allowable thorium-232 concentration of 28.9 pCi/g. The maximum thorium-232 concentration of 11.52 pCi/g present in the area is well below the acceptable level of 28.9 pCi/g. Therefore, the area meets the criteria established for the site, and the property may be released without radiological restrictions.

Figure 4-5 presents soil analysis results, and Figure 4-6 lists gamma radiation exposure rates for this property. Three post-remedial action soil samples were collected from this vicinity property and analyzed for thorium-232, radium-226, and uranium-238. The results for thorium-232 showed concentrations ranging from 0.92 to 1.30 pCi/g, the results for radium-226 were between 0.43 pCi/g and 0.57 pCi/g, and the uranium-238 results were between <2.13 pCi/g and <2.46 pCi/g. The sums of the ratios ranged from -0.0844 to 0.0252, which are well below cleanup criteria. At this property, three gamma exposure rate measurements ranged from 8.9 to 12.4 μR/h, with an average of 10.6 μR/h, including background. This is comparable to the background exposure rate of 9.0 μR/h because the measurement of 12.4 μR/h

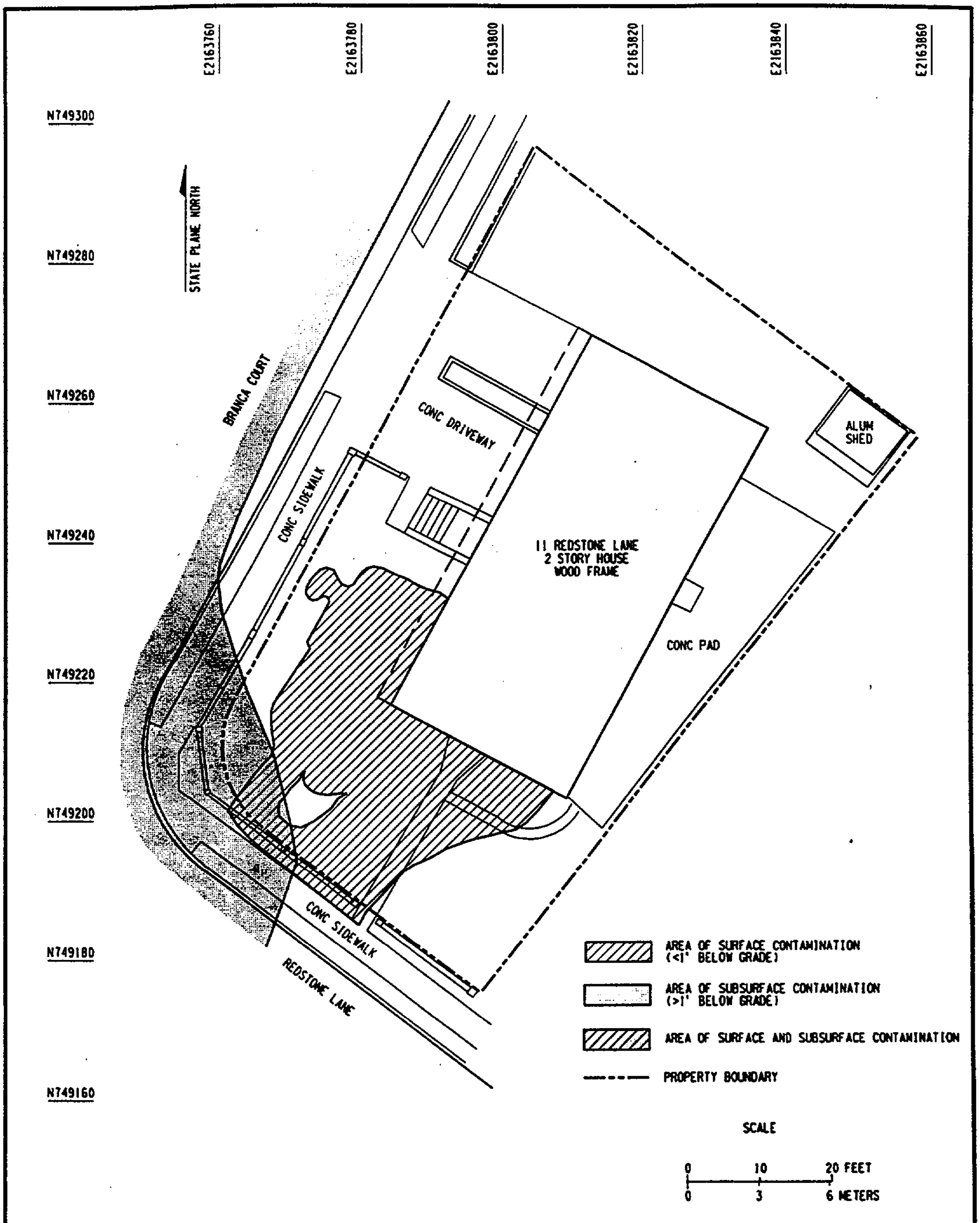

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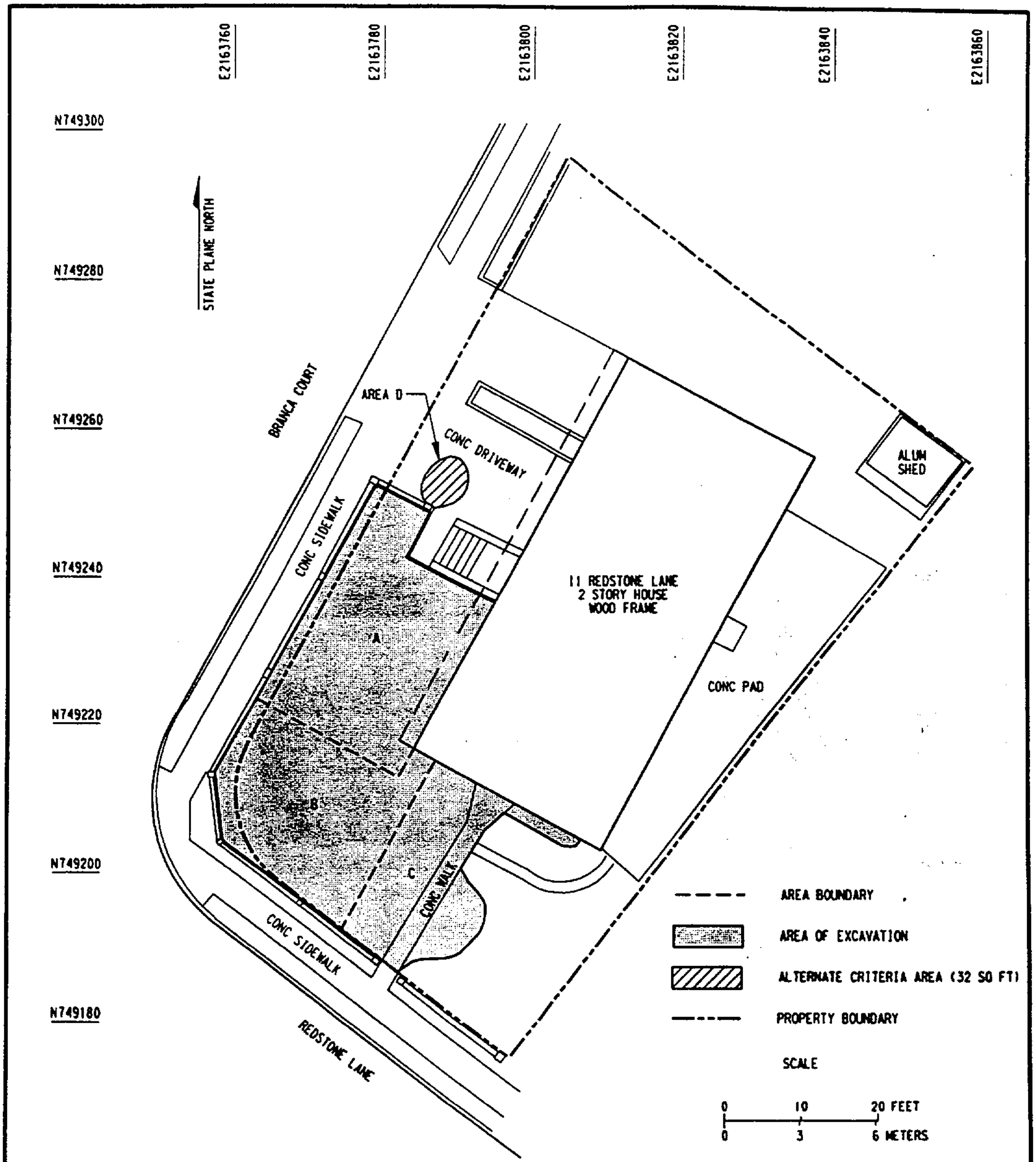
Figure 4-4
Assumed Areas of Surface and Subsurface Contamination
11 Redstone Lane



AREA	COMPOSITE SAMPLE ID	Th-232 (pCi/g)		Ra-226 (pCi/g)		U-238 (pCi/g)		SUM OF RATIOS
		RESULT	ERROR +/-	RESULT	ERROR +/-	RESULT	ERROR +/-	
A	138VP143	0.94	0.13	0.48	0.06	< 2.13		-0.0714
B	138VP144	0.92	0.13	0.43	0.06	< 2.18		-0.0844
C	138VP150	1.30	0.14	0.57	0.06	< 2.46		0.0252
D	138VP670	11.52	0.58	1.58	0.15	< 6.27		2.3474

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Figure 4-5
Areas of Excavation and Post-Remedial Action Samples
11 Redstone Lane

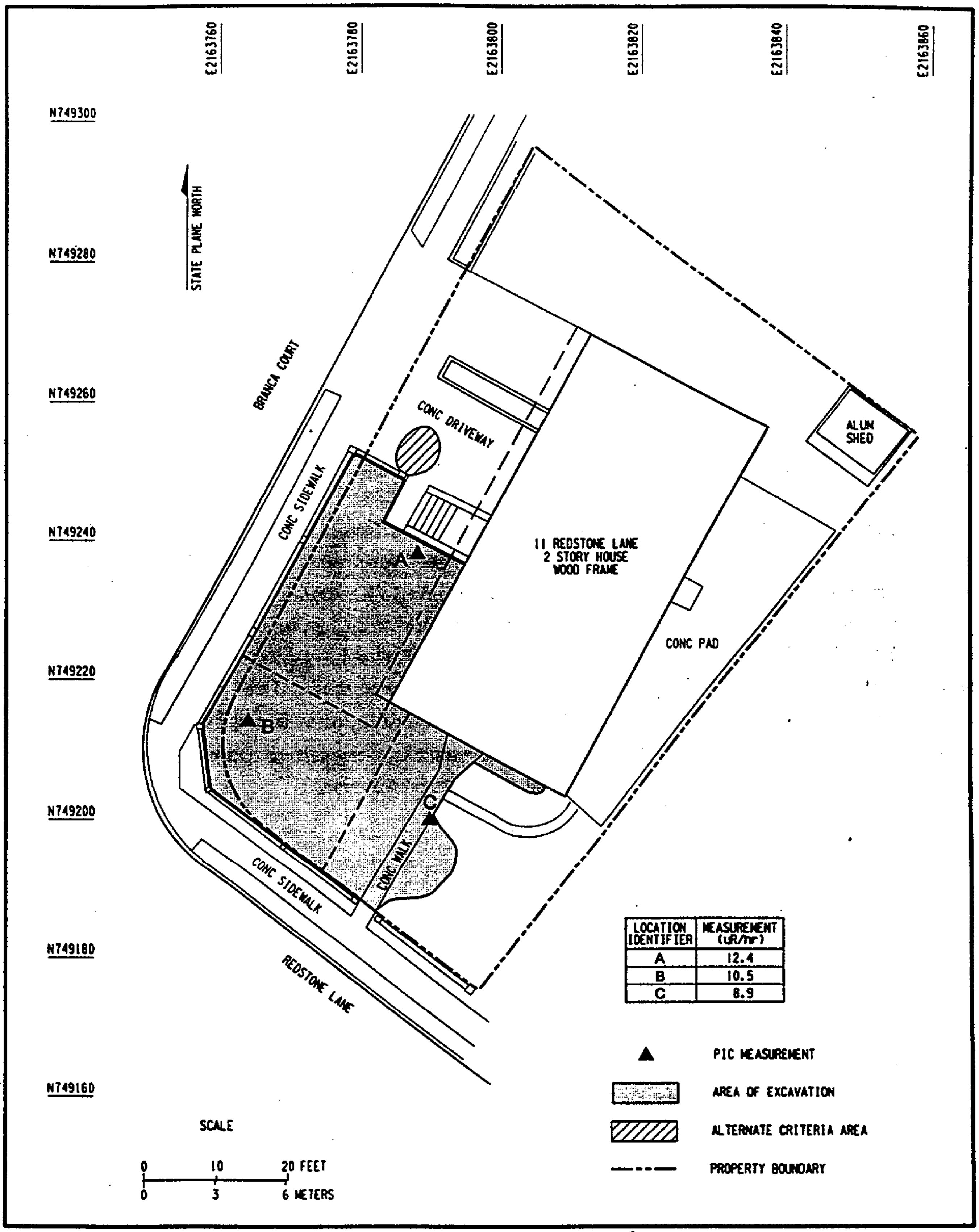

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Figure 4-6
PIC Readings
11 Redstone Lane

was near the foundation of the home. The increase in exposure rate measurements from concrete blocks used in foundations is the result of naturally occurring radionuclides in the concrete. Hence, any exposure to the public would be essentially equivalent to background.

4.3 16 LONG VALLEY ROAD

Figure 4-7 shows the areas of surface and subsurface contamination at 16 Long Valley Road as indicated by characterization data gathered before excavation. Figure 4-8 shows where excavation and post-remedial action soil sampling were conducted at 16 Long Valley Road. Figure 4-9 shows the locations and results of the post-remedial action PIC readings. Several additional areas of excavation shown in Figure 4-8) were not identified by characterization data (Figure 4-7); it is possible that human disturbance is responsible for the differences in contaminant distributions. In the backyard, the excavation is larger in area than was proposed because, as mentioned, many areas had gross gamma readings in the indiscriminate range, and rivulets of contamination were present. Generally, the property was excavated to 0.3 m (1 ft) below grade.

Figure 4-8 shows the results of post-remedial action soil analyses, and Figure 4-9 shows the post-remedial external gamma exposure rate measurements. Nine post-remedial action soil samples were collected from this vicinity property and analyzed for thorium-232, radium-226, and uranium-238. The results indicated thorium-232 concentrations ranging from 0.94 to 2.05 pCi/g, radium-226 results ranging from 0.58 to 0.75 pCi/g, uranium-238 results ranging from 0.48 to <3.97 pCi/g, and sum-of-ratio results ranging from -0.0078 to 0.231. All results are below the cleanup criteria. At this property, 11 external gamma exposure rate measurements ranged from 8.4 to 11.0 μR/h, with an average of 9.5 μR/h, including background. This is comparable to the average background external gamma exposure rate of 9.0 μR/h. Hence, any exposure to the public is indistinguishable from background.

4.4 18 LONG VALLEY ROAD

Figure 4-10 shows the area of surface and subsurface contamination at 18 Long Valley Road as indicated by 1988 and 1995 characterization data gathered before excavation. Figure 4-11 shows the areas of excavation, locations of post-remedial action soil samples, and post-remedial action radionuclide concentrations. Figure 4-12 shows the locations and results of post-remedial action gamma exposure rate measurements using the PIC. A comparison of Figures 4-10 and 4-11 reveals differences between the proposed and actual areas of excavation. Several areas of marginally elevated gamma readings in the western portion of the backyard were hand excavated to ensure that no material above guidelines was left at the property. The area of excavation in the eastern portion of the yard is slightly larger than was anticipated because small rivulets of contamination were found to extend throughout the backyard. These rivulets were generally 0.3 m (1 ft) deep and contained only slightly elevated levels of contamination.

Figure 4-11 presents the results of soil analyses, and Figure 4-12 lists external gamma radiation exposure rates. Analyses of eight post-remedial action soil samples from this vicinity property revealed

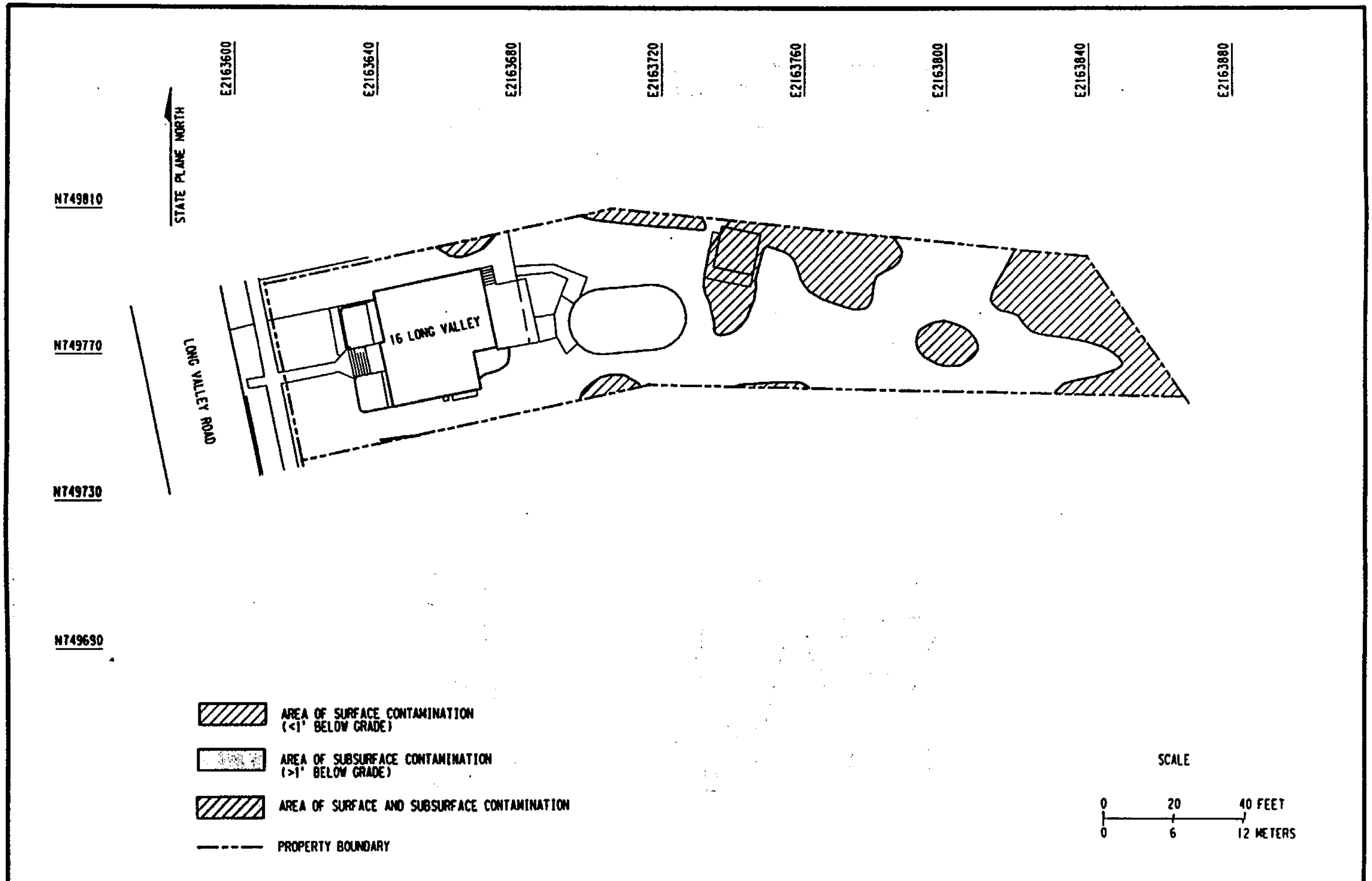

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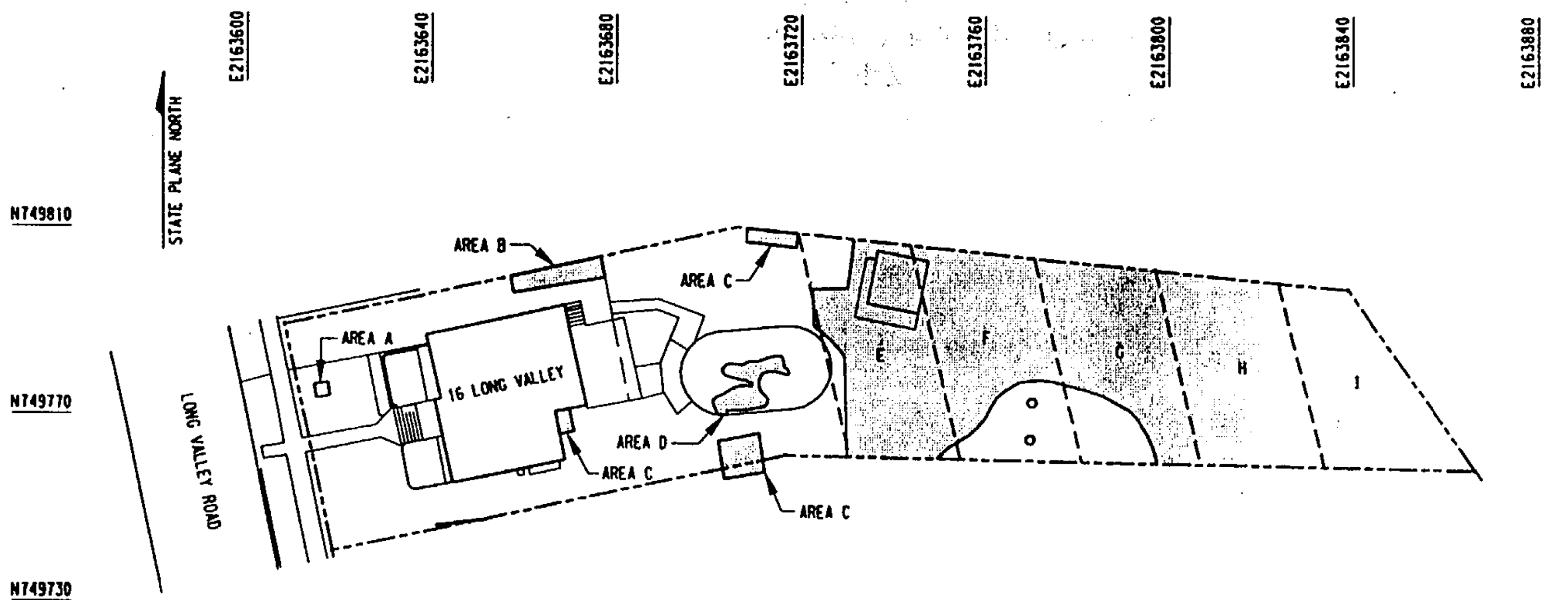
Figure 4-7
Assumed Areas of Surface and Subsurface Contamination
16 Long Valley Road



AREA	COMPOSITE SAMPLE ID	Th-232 (pCi/g)		Ra-226 (pCi/g)		U-238 (pCi/g)		SUM OF RATIOS
		RESULT	ERROR +/-	RESULT	ERROR +/-	RESULT	ERROR +/-	
A	138VP136	1.76	0.18	0.58	0.06	0.48	0.61	0.0796
B	138VP151	1.35	0.14	0.61	0.06	< 2.35		0.0410
C	138VP137	1.99	0.17	0.73	0.07	< 2.71		0.2002
D	138VP322	2.05	0.25	0.70	0.11	< 3.97		0.2314
E	138VP304	1.25	0.14	0.74	0.07	< 2.52		0.0504
F	138VP307	1.52	0.19	0.70	0.10	< 3.49		0.1158
G	138VP306	1.13	0.19	0.73	0.10	< 3.22		0.0384
H	138VP305	0.94	0.14	0.75	0.07	< 2.61		-0.0078
I	138VP302	1.51	0.15	0.73	0.07	< 2.65		0.1030

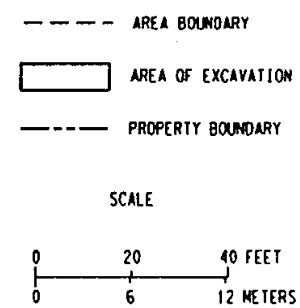


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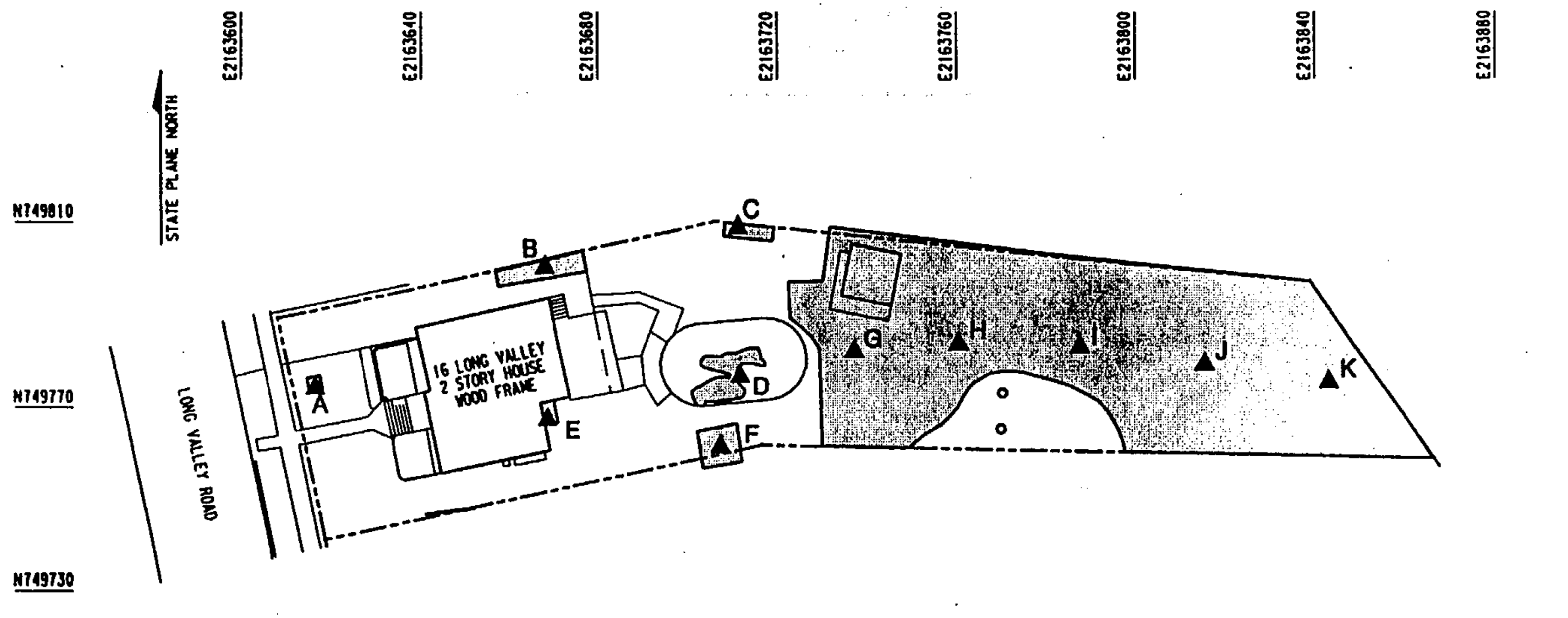
Figure 4-8
Areas of Excavation and Post-Remedial Action Samples
16 Long Valley Road



LOCATION IDENTIFIER	MEASUREMENT (uR/hr)
A	10.1
B	9.5
C	11.0
D	9.2
E	10.7
F	8.4
G	9.4
H	8.7
I	8.6
J	8.9
K	9.8

▲ PIC MEASUREMENT

AREA OF EXCAVATION

---- PROPERTY BOUNDARY

SCALE

0 20 40 FEET

0 6 12 METERS

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Figure 4-9
PIC Readings
16 Long Valley Road

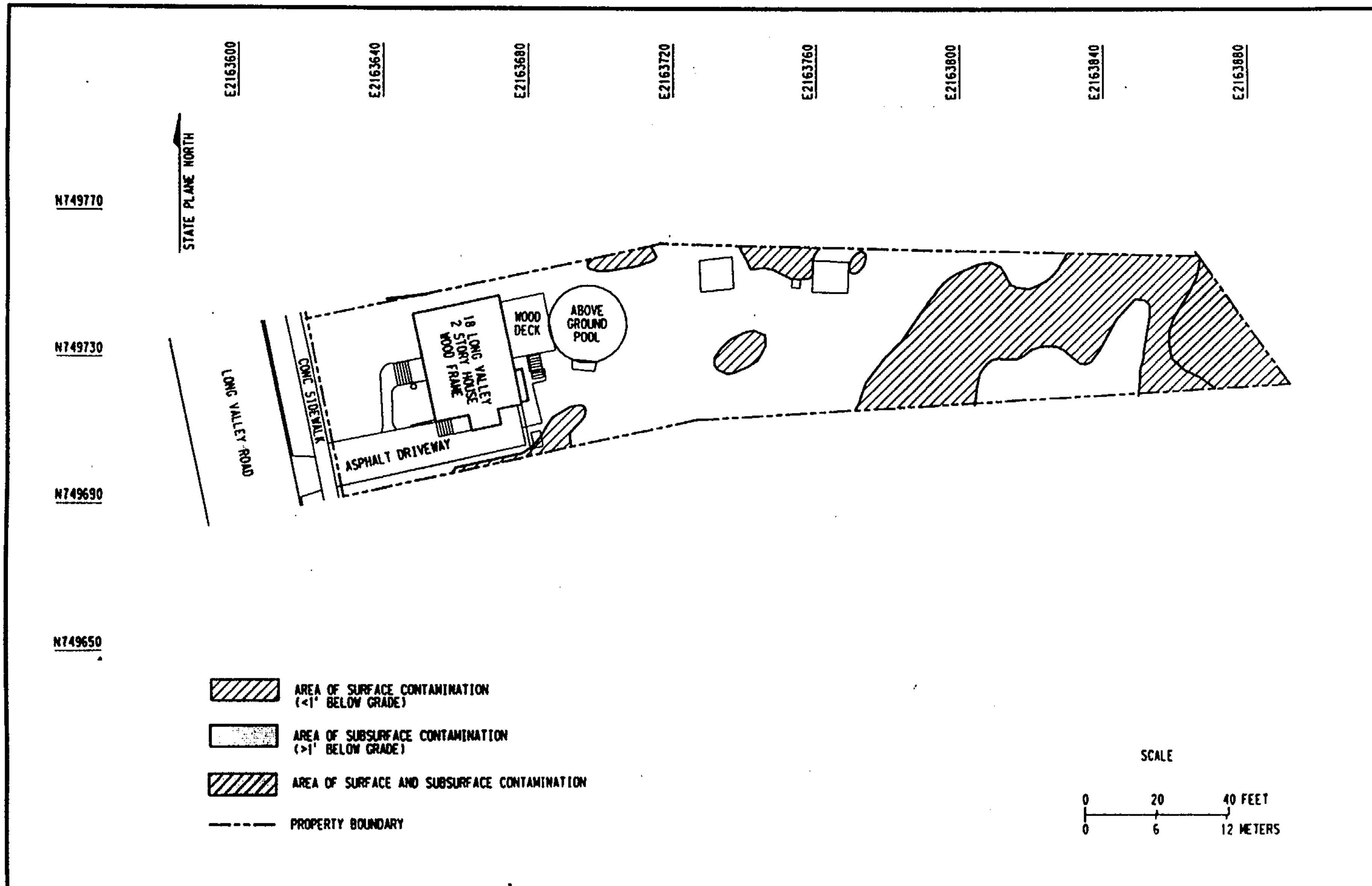

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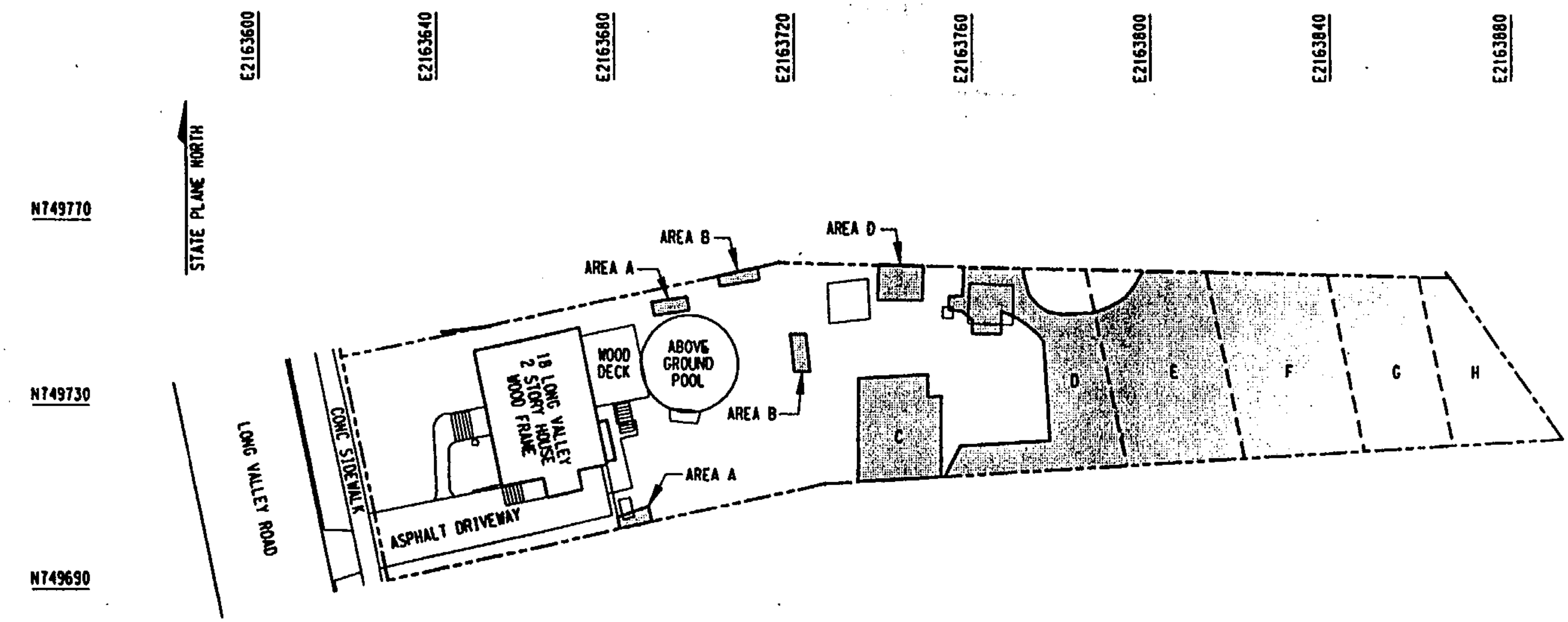
Figure 4-10
Assumed Areas of Surface and Subsurface Contamination
18 Long Valley Road



AREA	COMPOSITE SAMPLE ID	Th-232 (pCi/g)		Ra-226 (pCi/g)		U-238 (pCi/g)		SUM OF RATIOS
		RESULT	ERROR +/-	RESULT	ERROR +/-	RESULT	ERROR +/-	
A	138VP139	3.08	0.19	0.65	0.07	< 2.76		0.4032
B	138VP138	1.94	0.17	0.77	0.07	< 2.72		0.1984
C	138VP359	2.60	0.26	1.07	0.11	< 4.30		0.4220
D	138VP327	1.08	0.14	0.40	0.06	0.42	0.52	-0.0936
E	138VP328	0.99	0.13	0.48	0.06	< 2.54		-0.0532
F	138VP329	1.14	0.15	0.72	0.08	< 3.01		0.0342
G	138VP326	0.95	0.16	0.69	0.09	2.42	0.78	-0.0216
H	138VP330	2.64	0.32	0.96	0.13	< 4.96		0.4212

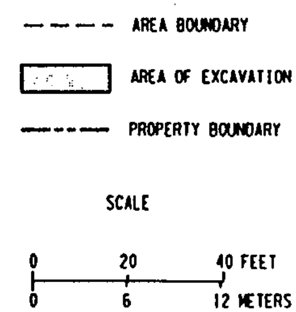


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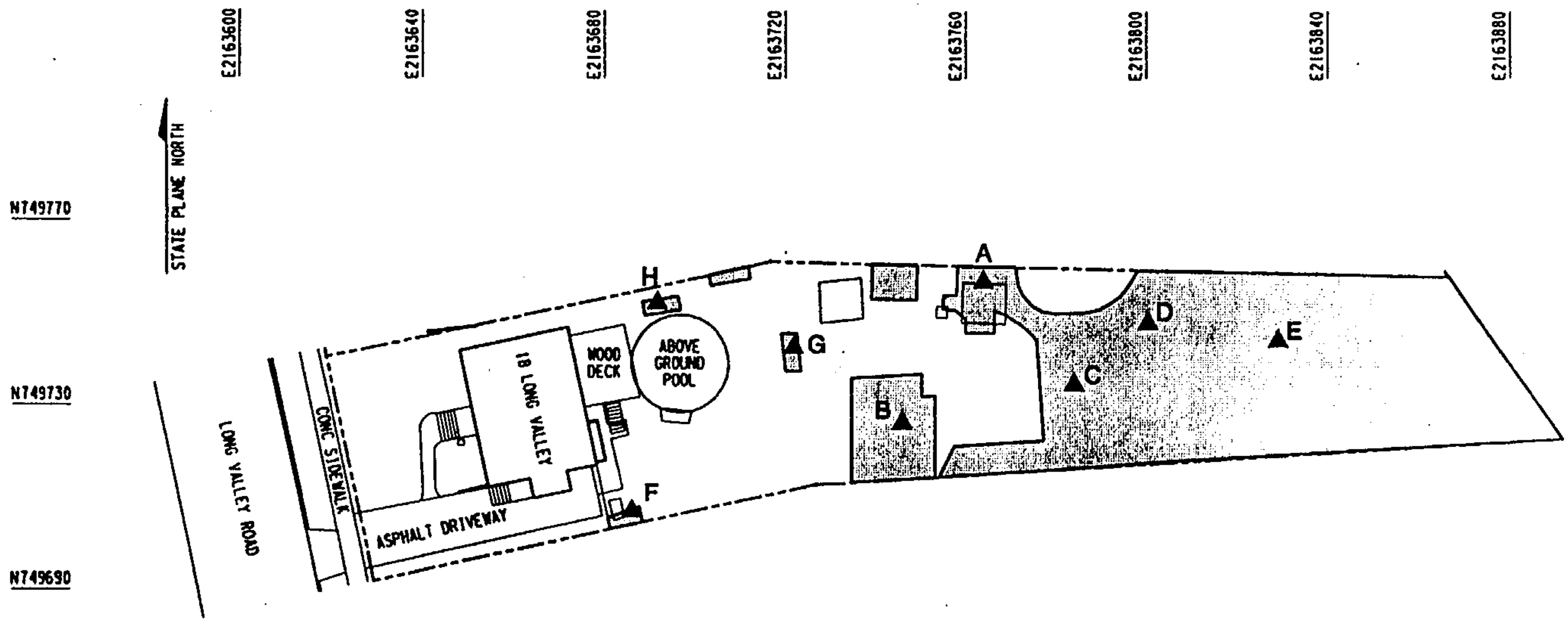
Figure 4-11
Areas of Excavation and Post-Remedial Action Samples
18 Long Valley Road



LOCATION IDENTIFIER	MEASUREMENT (uR/hr)
A	8.9
B	9.7
C	9.1
D	8.5
E	9.1
F	7.9
G	8.9
H	7.9

▲ PIC MEASUREMENT

AREA OF EXCAVATION

PROPERTY BOUNDARY

SCALE

0 20 40 FEET

0 6 12 METERS

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Figure 4-12
PIC Readings
18 Long Valley Road

thorium-232 levels ranging from 0.95 to 3.08 pCi/g, radium-226 levels ranging from 0.40 to 1.07 pCi/g, uranium-238 levels ranging from 0.42 to <4.96 pCi/g, and sums of the ratios ranging from -0.0936 to 0.422. These results are below the cleanup criteria presented in Table 2-1. Eight external gamma exposure rates measured at this property ranged from 7.9 to 9.7 μR/h; the average was 8.8 μR/h, including background. This is comparable to the average background exposure rate of 9.0 μR/h. Hence, any exposure to the public is essentially equivalent to background.

4.5 20 LONG VALLEY ROAD

Figure 4-13 shows the area of surface and subsurface contamination at 20 Long Valley Road as indicated by 1988 and 1995 characterization data gathered before excavation. Areas of excavation and post-remedial action soil sampling locations and results at 20 Long Valley Road are shown in Figure 4-14. Figure 4-15 shows the external gamma exposure rate measurement locations and results. The anticipated areas of contamination and the actual excavation correspond closely except for a small area of contamination assumed to be under the pool which was found during remedial action to be less than criteria. A walkover survey and soil sampling were conducted beneath the aboveground pool to verify that the contamination had not spread under the pool. All results were below the guidelines for residual radioactive material that were established for the site.

The results of soil analyses are provided in Figure 4-14, and Figure 4-15 lists gamma radiation exposure rates. Ten soil samples from this vicinity property contained thorium-232 at levels ranging from 0.45 to 1.76 pCi/g, radium-226 at levels ranging from 0.40 to 0.72 pCi/g, uranium-238 at levels ranging from 0.92 to <3.94 pCi/g, and sums of the ratios ranging from -0.174 to 0.133. These results are below the cleanup criteria in Table 2-1. Nine gamma exposure rates measured at 20 Long Valley Road ranged from 7.8 to 9.0 μR/h; the average was 8.5 μR/h, including background. This is comparable to the background exposure rate of 9.0 μR/h. Hence, any exposure to the public would be essentially equivalent to background.

4.6 22 LONG VALLEY ROAD

Figure 4-16 shows the assumed area of surface and subsurface contamination at 22 Long Valley Road. Figure 4-17 shows the areas of excavation, locations of post-remedial action soil samples, and post-remedial action radionuclide concentrations. Figure 4-18 shows the locations and results of post-remedial action gamma exposure rate measurements obtained with the PIC. A comparison of Figures 4-16 and 4-17 reveals significant differences between the proposed and actual areas of excavation. Several areas of marginally elevated gamma readings in the western portion of the backyard and the front yard were hand excavated to ensure that no material above guidelines was left at the property. The area of excavation in the eastern portion of the property is much larger than was anticipated because, as mentioned, small rivulets of contamination were found to extend through the backyard. The rivulets were approximately 0.3 to 0.6 m (1 to 2 ft) deep and contained only slightly elevated levels of contamination. Other areas with gross gamma radiation readings in the indiscriminate range of 25,000 cpm to 35,000 cpm were considered

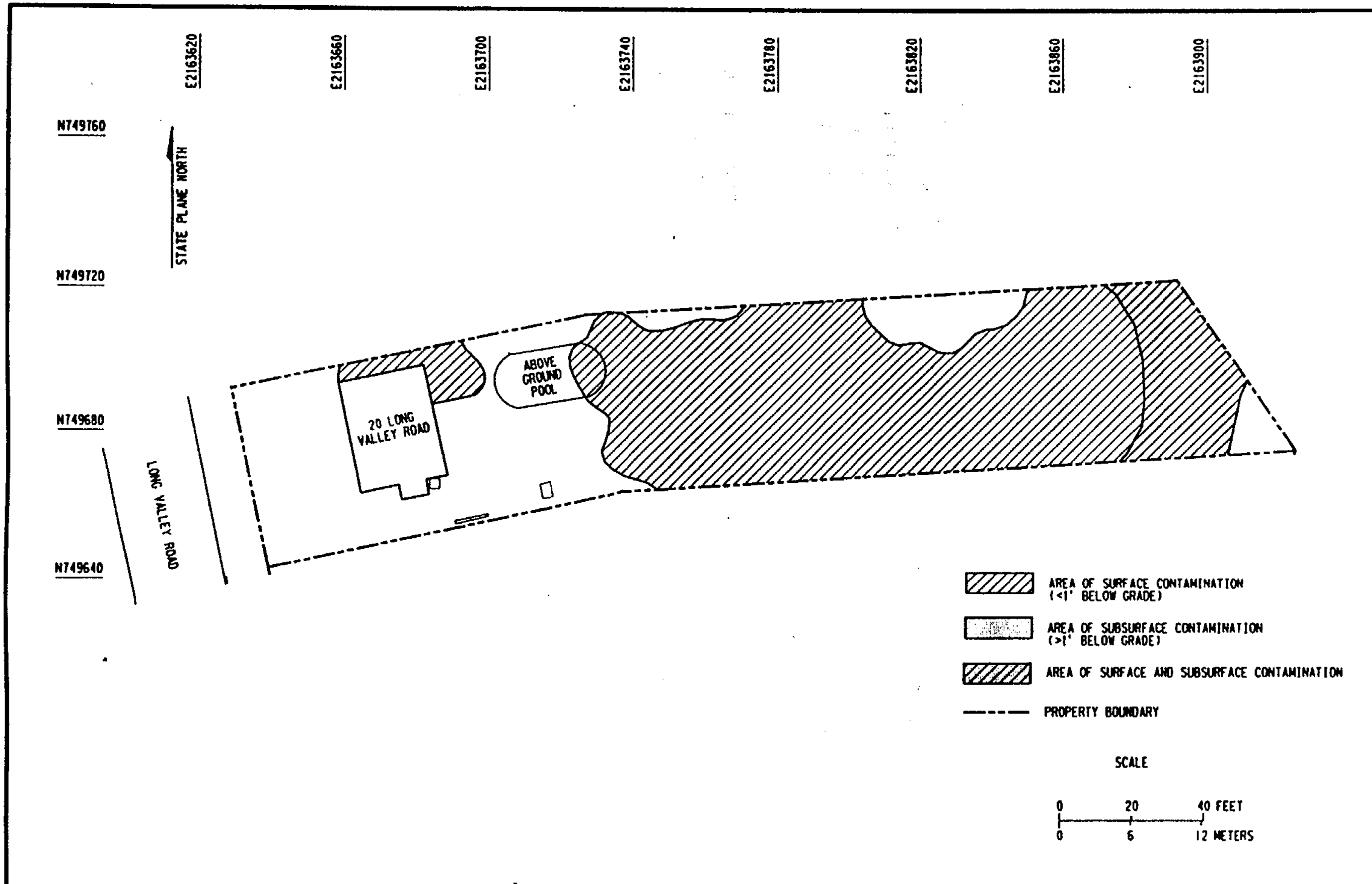

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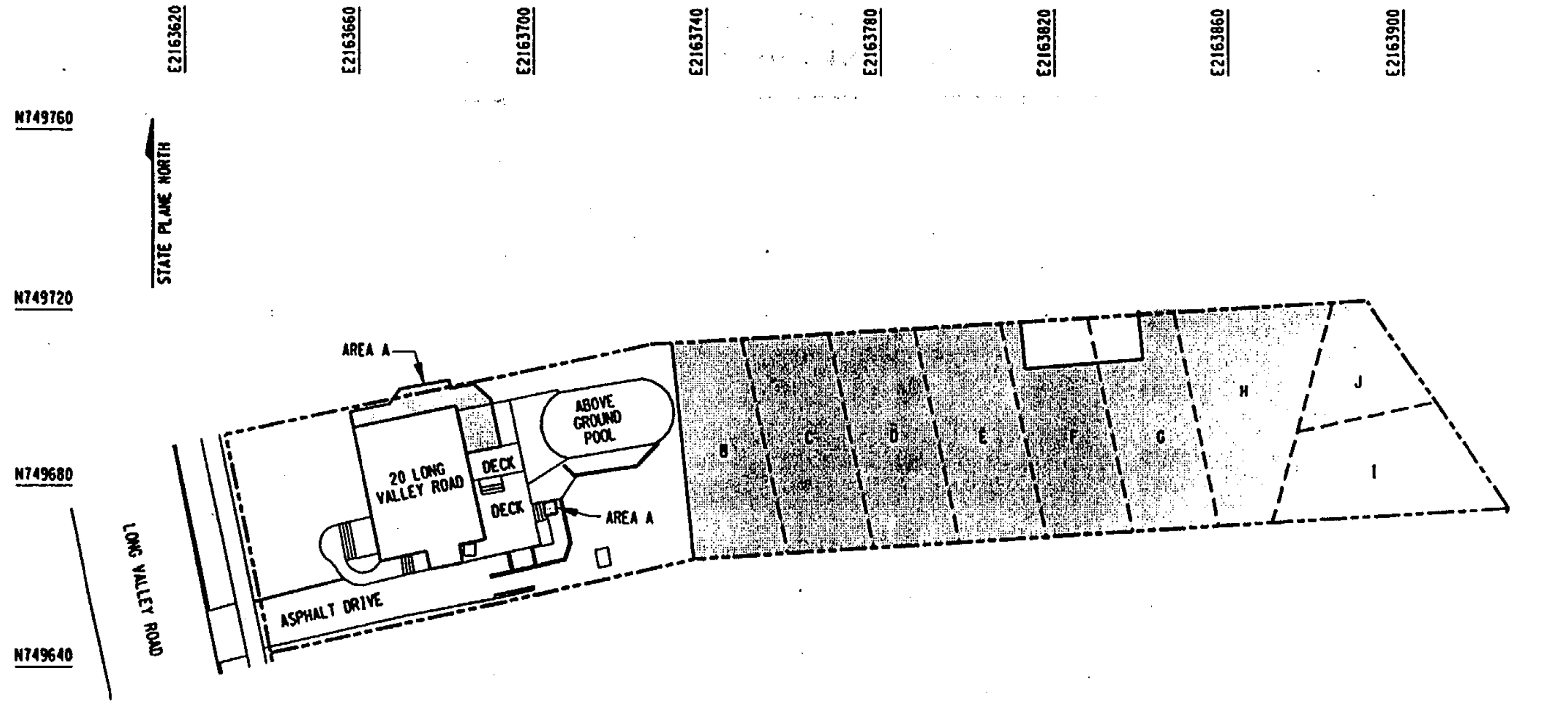
Figure 4-13
Assumed Areas of Surface and Subsurface Contamination
20 Long Valley Road



AREA	COMPOSITE SAMPLE ID	Th-232 (pCi/g)		Ra-226 (pCi/g)		U-238 (pCi/g)		SUM OF RATIOS
		RESULT	ERROR +/-	RESULT	ERROR +/-	RESULT	ERROR +/-	
A	138VP140	1.76	0.14	0.60	0.06	< 2.34		0.1208
B	138VP383	1.71	0.22	0.55	0.09	< 3.94		0.1328
C	138VP384	0.58	0.16	0.43	0.09	< 3.15		-0.1330
D	138VP386	0.48	0.13	0.53	0.07	< 2.49		-0.1462
E	138VP387	0.87	0.13	0.49	0.06	0.92	0.58	-0.1076
F	138VP388	0.45	0.12	0.40	0.07	< 2.69		-0.1742
G	138VP389	0.83	0.18	0.56	0.08	< 3.37		-0.0526
H	138VP390	1.21	0.19	0.72	0.09	< 3.53		0.0586
I	138VP547	1.45	0.16	0.58	0.07	< 2.81		0.0642
J	138VP549	1.24	0.16	0.72	0.08	< 2.99		0.0538

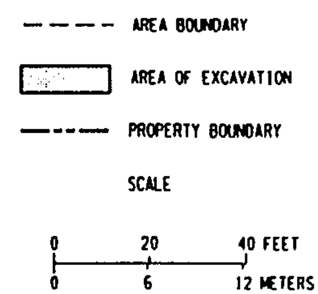


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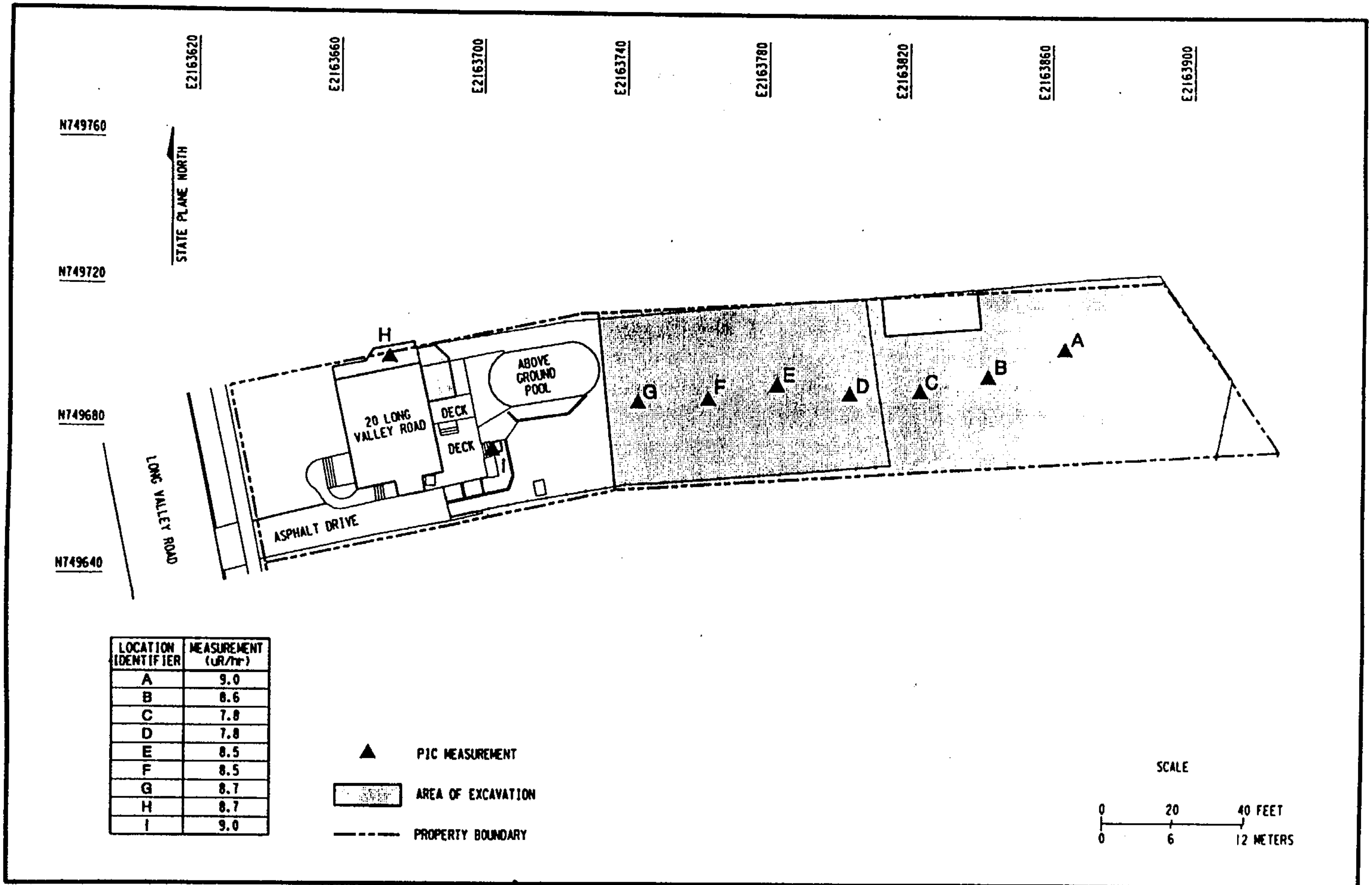
Figure 4-14
Areas of Excavation and Post-Remedial Action Samples
20 Long Valley Road



LOCATION IDENTIFIER	MEASUREMENT (uR/hr)
A	9.0
B	8.6
C	7.8
D	7.8
E	8.5
F	8.5
G	8.7
H	8.7
I	9.0

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Figure 4-15
PIC Readings
20 Long Valley Road

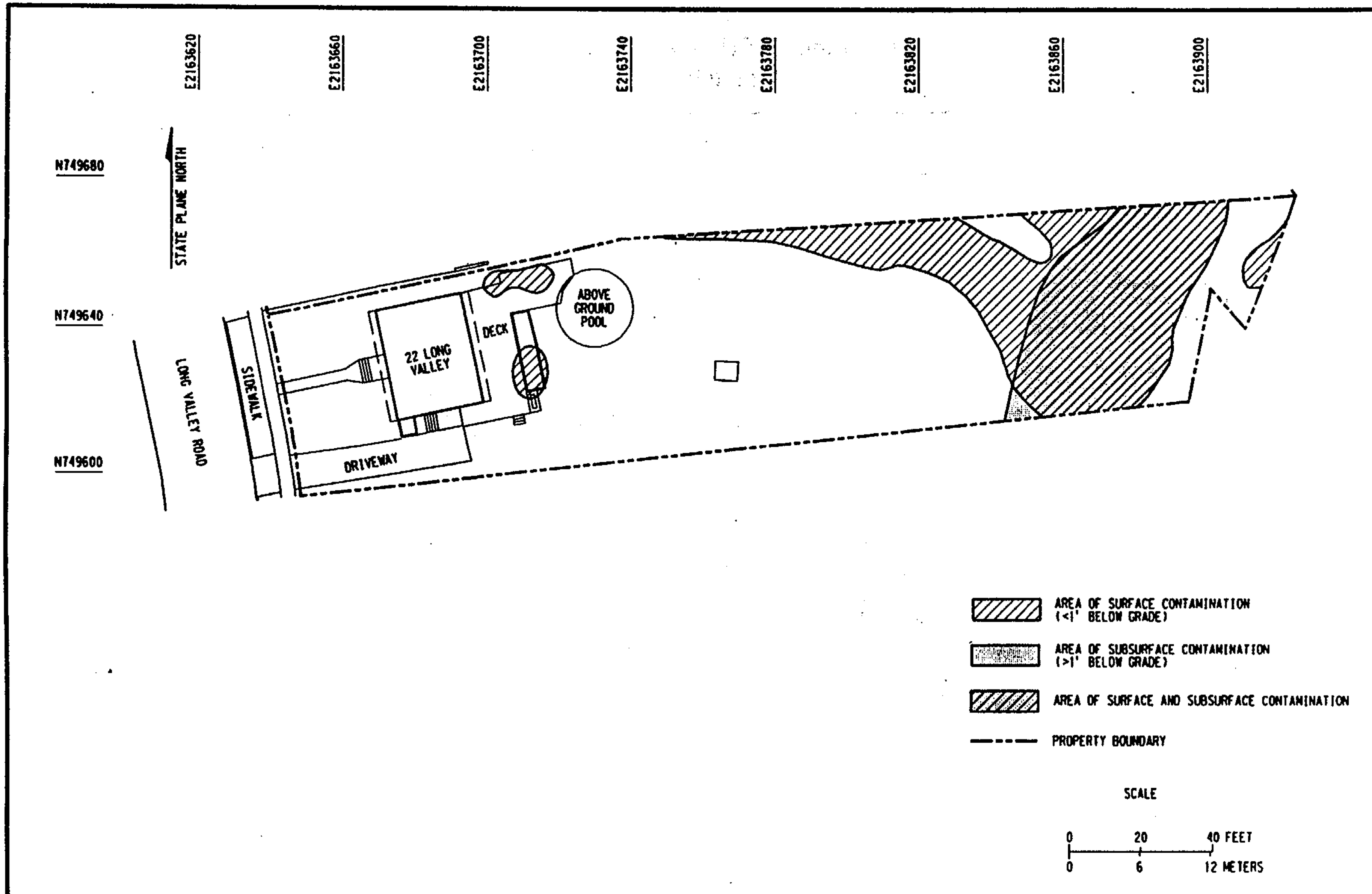

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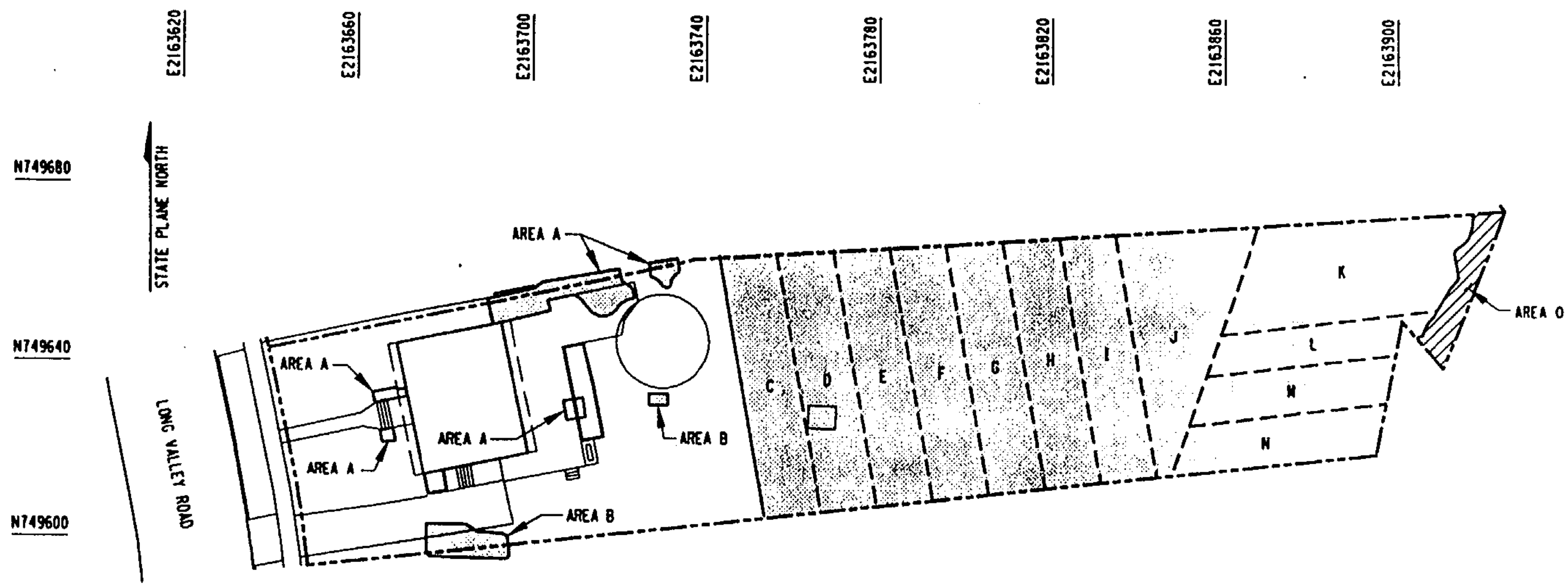
Figure 4-16
Assumed Areas of Surface and Subsurface Contamination
22 Long Valley Road



AREA	COMPOSITE SAMPLE ID	Th-232 (pCi/g)		Ra-226 (pCi/g)		U-238 (pCi/g)		SUM OF RATIOS
		RESULT	ERROR +/-	RESULT	ERROR +/-	RESULT	ERROR +/-	
A	138VP251	2.39	0.17	0.57	0.06	< 2.50		0.2440
B	138VP264	1.53	0.14	0.76	0.07	< 2.32		0.1064
C	138VP393	0.81	0.17	0.75	0.09	< 3.75		-0.0110
D	138VP392	0.72	0.17	0.54	0.08	< 3.21		-0.0818
E	138VP395	0.78	0.17	0.52	0.07	< 3.07		-0.0766
F	138VP397	0.71	0.15	0.60	0.67	< 2.52		-0.0856
G	138VP396	0.77	0.16	0.59	0.10	< 3.44		-0.0572
H	138VP398	0.80	0.17	0.55	0.09	< 3.50		-0.0580
I	138VP399	0.69	0.14	0.59	0.07	< 2.69		-0.0882
J	138VP400	0.83	0.19	0.60	0.09	< 3.61		-0.0398
K	138VP552	0.96	0.15	0.68	0.08	< 2.81		-0.0138
L	138VP550	1.65	0.18	0.64	0.07	< 2.91		0.1182
M	138VP561	0.63	0.10	0.33	0.05	< 1.88		-0.1684
N	138VP559	0.74	0.10	0.27	0.06	< 2.09		-0.1542
O	138VP560	8.57	0.34	0.99	0.12	< 5.83		1.6306

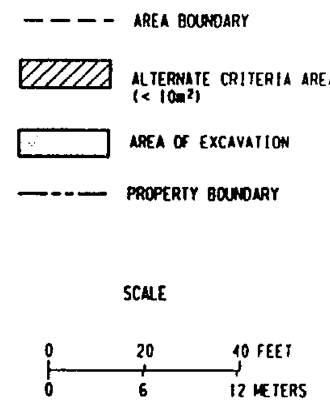


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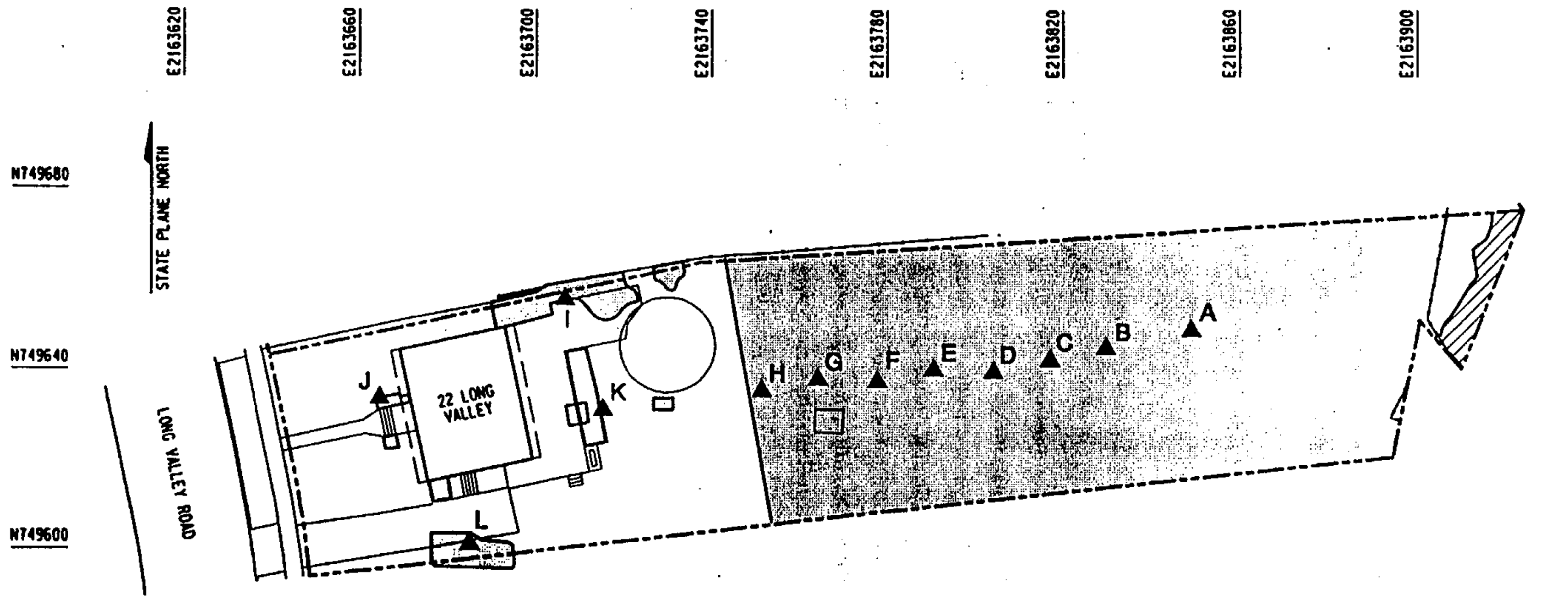
Figure 4-17
Areas of Excavation and Post-Remedial Action Samples
22 Long Valley Road



LOCATION IDENTIFIER	MEASUREMENT (uR/hr)
A	10.2
B	9.4
C	8.5
D	7.7
E	8.3
F	8.0
G	8.1
H	8.1
I	11.0
J	10.0
K	9.5
L	8.0

SCALE
0 20 40 FEET
0 6 12 METERS

▲ PIC MEASUREMENT
ALTERNATE CRITERIA AREA
AREA OF EXCAVATION
PROPERTY BOUNDARY

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Figure 4-18
PIC Readings
22 Long Valley Road

to be uncontaminated before excavation, but analysis of soil samples collected during remediation revealed elevated levels of contamination.

Figure 4-17 presents the results of soil analyses, and Figure 4-18 lists external gamma radiation exposure rates. Analyses of 14 post-remedial action soil samples from this vicinity property revealed thorium-232 levels ranging from 0.63 to 2.39 pCi/g, radium-226 levels ranging from 0.27 to 0.76 pCi/g, uranium-238 levels ranging from <1.88 to <3.75 pCi/g, and sums of the ratios ranging from -0.168 to 0.244. These results are below the cleanup criteria listed in Table 2-1. Twelve external gamma exposure rates measured at this property ranged from 7.7 to 11.0 μR/h; the average was 8.9 μR/h, including background. This is comparable to the average background exposure rate of 9.0 μR/h. Hence, any exposure to the public is essentially equivalent to background.

One area at the very back of the property is shown on Figure 4-17 as an alternate criteria area. Lodi Brook runs without any culvert behind the Long Valley properties with an elevation difference of about 1.5 m (5 ft). The property boundary of 22 Long Valley Road includes the bank of the brook. If the soil on the bank were excavated, the bank would collapse, and contaminated soil would be transported downstream through the section of the brook that runs through a culvert. In these situations, DOE Order 5400.5 allows areas less than 25 m^2 to exceed the DOE residual contamination guideline by a factor of (100/A)0.5, where A is the area in square meters. Seven samples were collected from the bank to delineate the area of remaining contamination. Six of the samples had thorium-232 concentrations ranging from 0.67 to 3.0 pCi/g. Only one sample was above criteria with a thorium-232 concentration of 8.57 pCi/g, including background, and the area was estimated to be less than 10 m^2. An area less than 10 m^2 has an allowable concentration of 15.8 pCi/g. The maximum sample concentration was well below this alternate criterion, so the property may be released without radiological restrictions.

4.7 24 LONG VALLEY ROAD

Figure 4-19 shows the assumed area of surface and subsurface contamination at 24 Long Valley Road. Figure 4-20 shows the areas of excavation, locations of post-remedial action soil samples, and post-remedial action radionuclide concentrations. Figure 4-21 shows the locations and results of post-remedial action gamma exposure rate measurements obtained with the PIC .

A comparison of Figures 4-19 and 4-20 reveals significant differences between the proposed and actual areas of excavation. The contamination encountered between the area of proposed excavation shown in Figure 4-19 and the house was spotty and of much lower radionuclide concentration than that encountered in the easternmost portion of the property. These circumstances, together with statements made by long-time homeowners in the area, support the inference that the contaminant deposition mechanism in the rear of the property was the brook, but the contamination in the middle of the property up to the house is the result of fill material either directly from MCW or from another contaminated vicinity property in the area. This inference is further supported by the fact that the elevation of the backyard of this property was approximately 1.5 m (3 ft) higher than the backyards of 16, 18, 20, and 22 Long Valley Road.

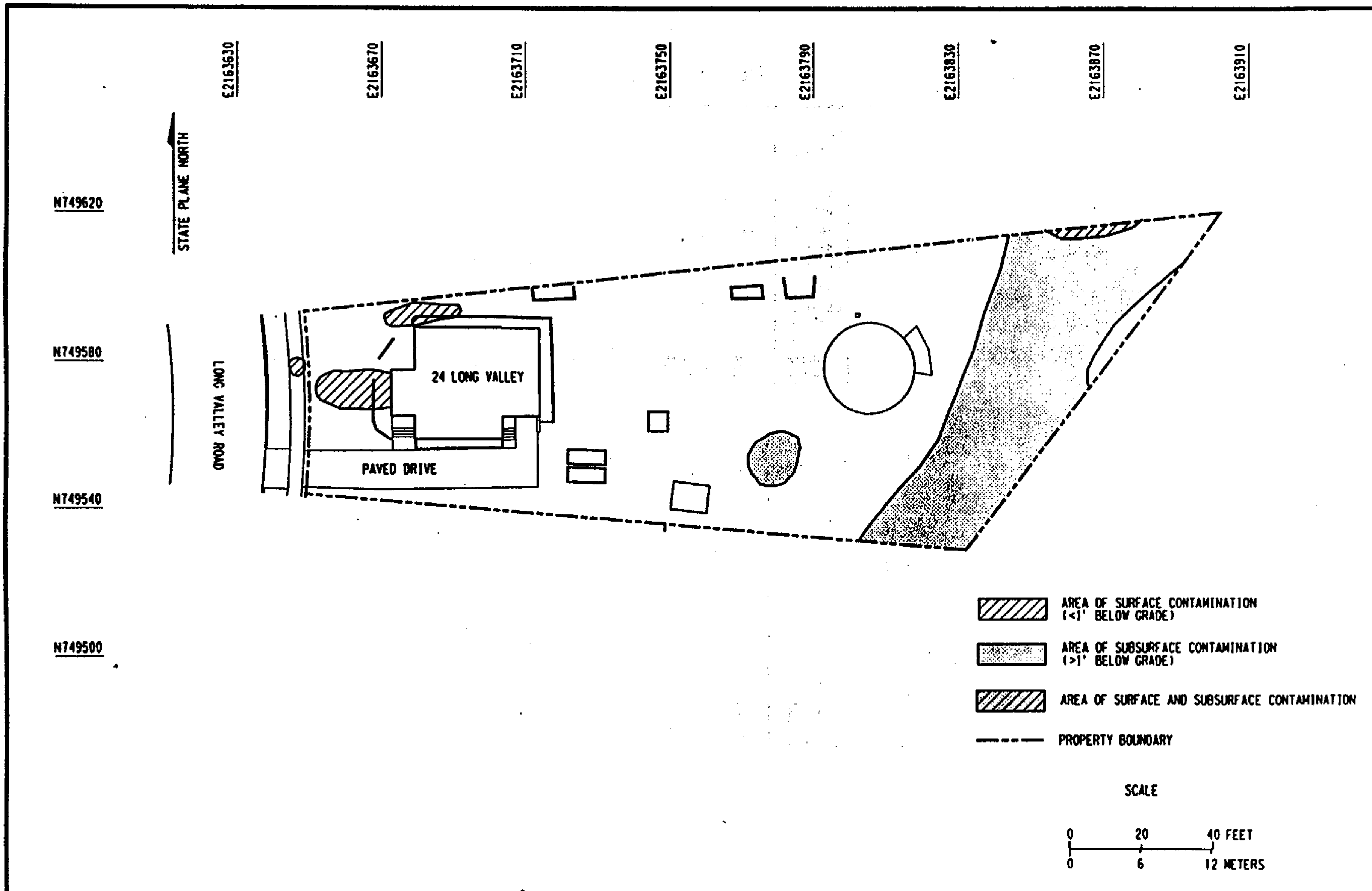

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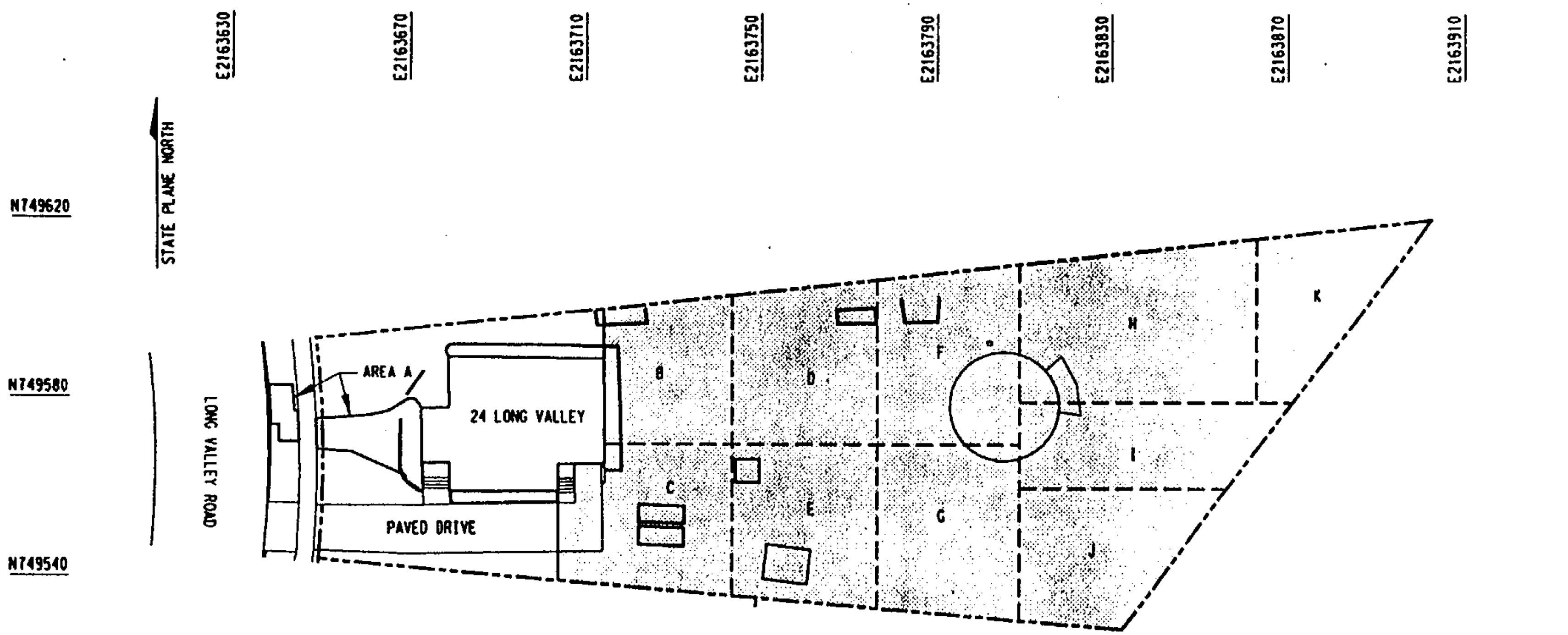
Figure 4-19
Assumed Areas of Surface and Subsurface Contamination
24 Long Valley Road



AREA	COMPOSITE SAMPLE ID	Th-232 (pCi/g)		Ra-226 (pCi/g)		U-238 (pCi/g)		SUM OF RATIOS
		RESULT	ERROR +/-	RESULT	ERROR +/-	RESULT	ERROR +/-	
A	138VP262	1.57	0.13	0.57	0.06	< 2.41		0.0782
B	138PT001	1.00	0.09	0.54	0.08	< 1.9		-0.0520
C	138PT004	0.52	0.09	0.48	0.07	< 1.9		-0.1600
D	138PT005	< 0.37		< 0.21		< 1.3		-0.2560
E	138PT008	1.10	0.10	0.40	0.07	< 2.4		-0.0500
F	138PT012	< 0.46		0.40	0.07	< 1.4		-0.1980
G	138PT011	0.53	0.08	0.42	0.06	0.96	0.64	-0.1888
H	138PT003	0.44	0.07	0.39	0.05	< 1.4		-0.2040
I	138PT010	0.58	0.09	0.47	0.07	< 1.8		-0.1520
J	138PT002	0.60	0.08	0.39	0.05	< 1.5		-0.1700
K	138PT009	0.70	0.08	0.35	0.05	< 1.6		-0.1560

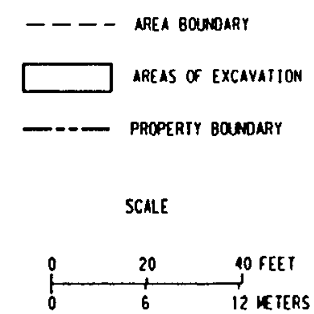


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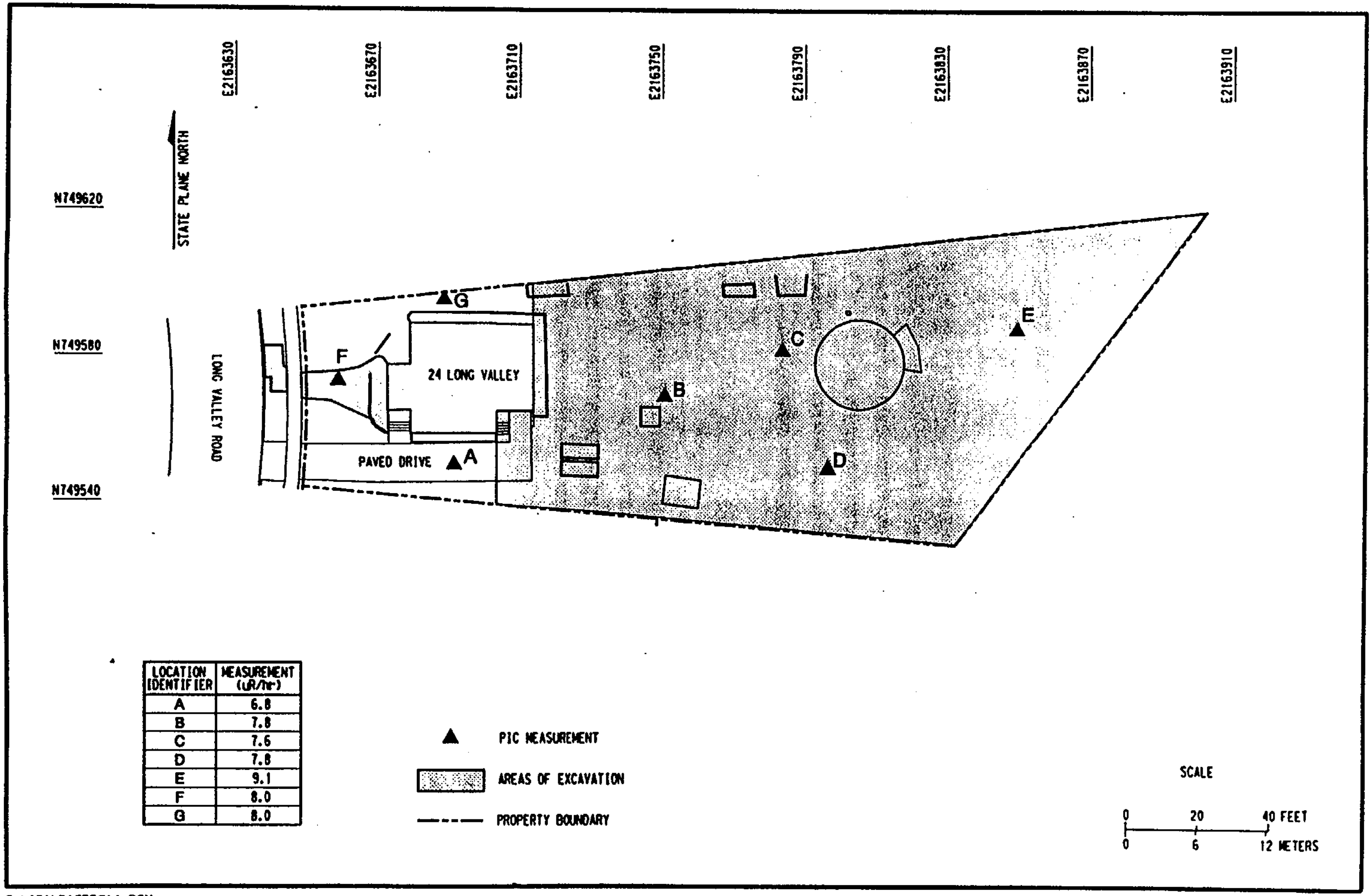
Figure 4-20
Areas of Excavation and Post-Remedial Action Samples
24 Long Valley Road



LOCATION IDENTIFIER	MEASUREMENT (µR/hr)
A	6.8
B	7.8
C	7.6
D	7.8
E	9.1
F	8.0
G	8.0

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Figure 4-21
PIC Readings
24 Long Valley Road

During remedial action on 24 Long Valley Road to remove residual radioactive contamination, approximately 2,400 yd^3 of PCBs and pieces of deteriorated drums were discovered on a portion of the property. The PCBs did not result from thorium processing operations at the former MCW; however, DOE remediated these areas as part of the remedial action effort. Sampling results showed that concentrations of radionuclides in the PBCs were below DOE's criteria for release without radiological restrictions and were not considered to be 11e(2) byproduct material subject to controls under the Atomic Energy Act. Therefore, the PBC-contaminated soil was shipped offsite for disposal at a landfill permitted under the Toxic Substances Control Act to accept this type of waste.

After all radioactively contaminated material had been removed from the property, post-remediation surveying and sampling were performed. Figure 4-20 presents the results of soil analyses, and Figure 4-21 lists external gamma radiation exposure rates. Analyses of post-remedial action soil samples from this vicinity property revealed thorium-232 levels ranging from <0.37 to 1.57 pCi/g, radium-226 levels ranging from <0.21 to 0.57 pCi/g, uranium-238 levels ranging from 0.96 to <2.41 pCi/g, and sums of the ratios ranging from -0.256 to 0.078. These results are below the cleanup criteria presented in Table 2-1. Seven external gamma exposure rates measured at this property ranged from 6.8 to 9.1 μR/h; the average was 7.9 μR/h, including background. This is comparable to the average background exposure rate of 9.0 μR/h. Hence, any exposure to the public is essentially equivalent to background.

4.8 26 LONG VALLEY ROAD

Figure 4-22 shows the area of excavation at 26 Long Valley Road proposed on the basis of 1988 and 1995 characterization data. Figure 4-23 shows the actual areas of excavation, locations of post-remedial action soil samples, and post-remedial action radionuclide concentrations. Figure 4-24 shows the locations and results of post-remedial action gamma exposure rate measurements obtained with the PIC. A comparison of Figures 4-22 and 4-23 reveals significant differences between the proposed and actual areas of excavation. The actual excavation in the front yard and southeastern corner of the property correspond relatively closely to the proposed excavation. The front yard was excavated to approximately 0.6 m (2 ft) deep, while the southeastern corner was excavated to approximately 1.5 m (5 ft) deep. The area of excavation on the northeastern side of the backyard was not anticipated; spotty areas of contamination were discovered during remediation that seemed to extend from 24 Long Valley Road. The area along the house was excavated to approximately 0.3 m (1 ft) deep, while the area bordering the excavation at 24 Long Valley Rd was excavated to 1.5 m (5 ft) deep. Around the house, boreholes were drilled from the bottom of the excavation to below the depth of the basement to ensure that no residual radioactive material was present below the house. All borehole samples met criteria.

Figure 4-23 presents the results of soil analyses, and Figure 4-24 lists external gamma radiation exposure rates. Analyses of four post-remedial action soil samples from this vicinity property revealed thorium-232 levels ranging from 1.06 to 1.65 pCi/g, radium-226 levels ranging from 0.50 to 0.70 pCi/g, uranium-238 levels ranging from <2.47 to <3.35 pCi/g, and sums of the ratios ranging from -0.0022 to 0.112. These results are below the cleanup criteria listed in Table 2-1. Three external gamma

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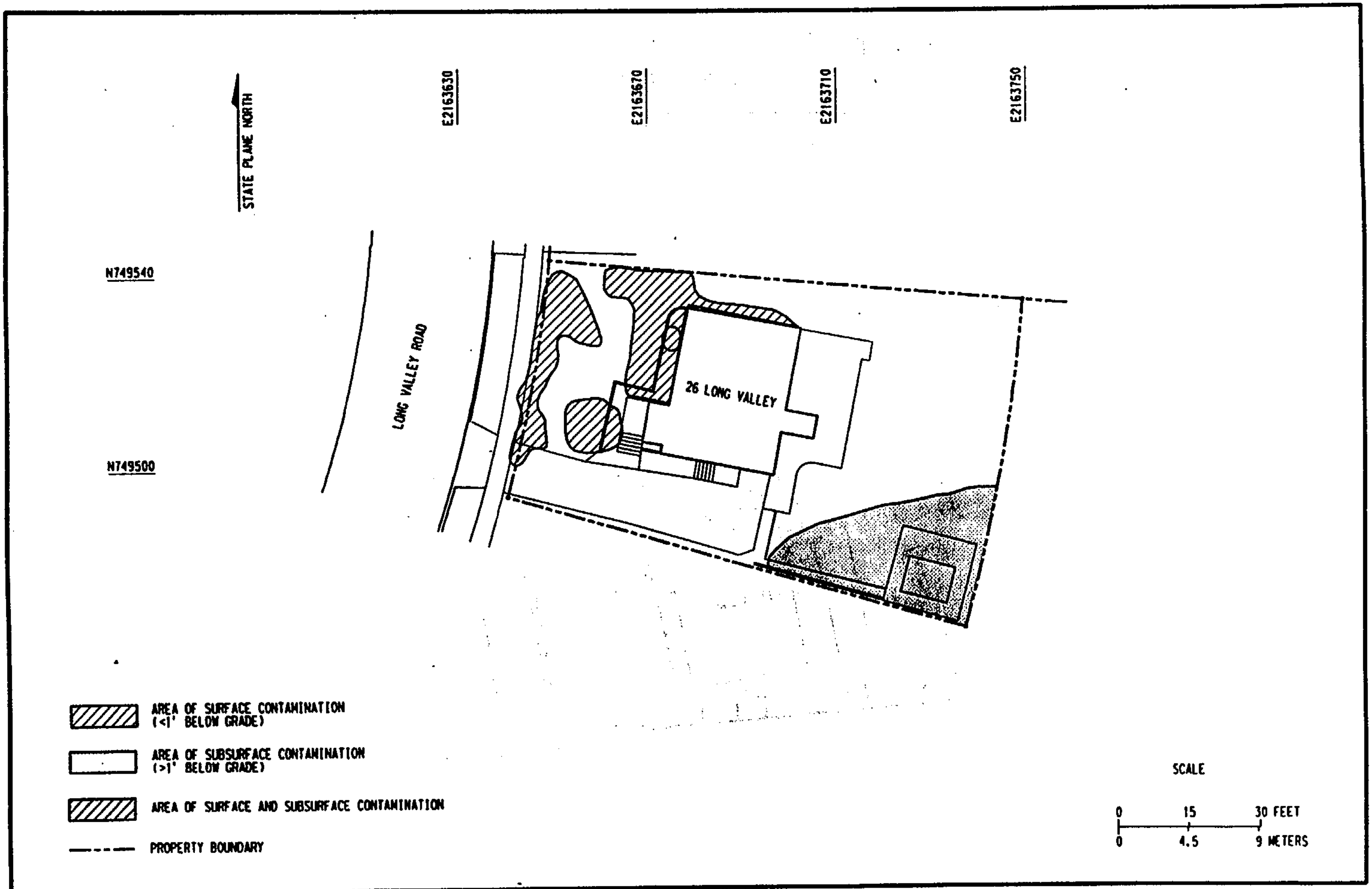

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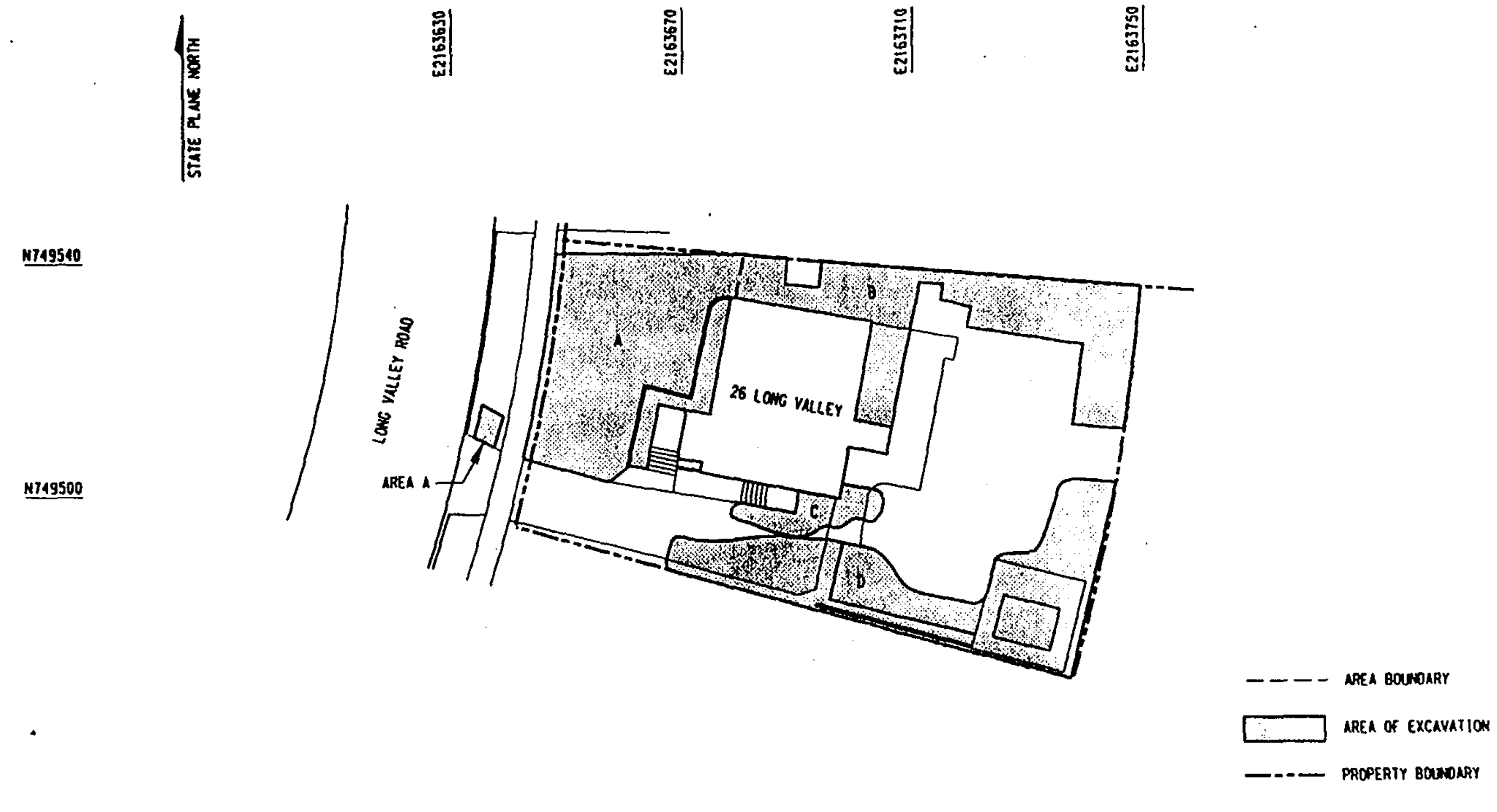
Figure 4-22
Assumed Areas of Surface and Subsurface Contamination
26 Long Valley Road



AREA	COMPOSITE SAMPLE ID	Th-232 (pCi/g)		Ra-226 (pCi/g)		U-238 (pCi/g)		SUM OF RATIOS
		RESULT	ERROR +/-	RESULT	ERROR +/-	RESULT	ERROR +/-	
A	138VP270	1.06	0.14	0.70	0.07	< 2.47		0.0034
B	138VP343	1.17	0.16	0.50	0.07	< 3.09		-0.0022
C	138VP428	1.65	0.18	0.61	0.08	< 2.88		0.1116
D	138VP344	1.33	0.19	0.65	0.09	< 3.35		0.0650

SCALE
0 15 30 FEET
0 4.5 9 METERS

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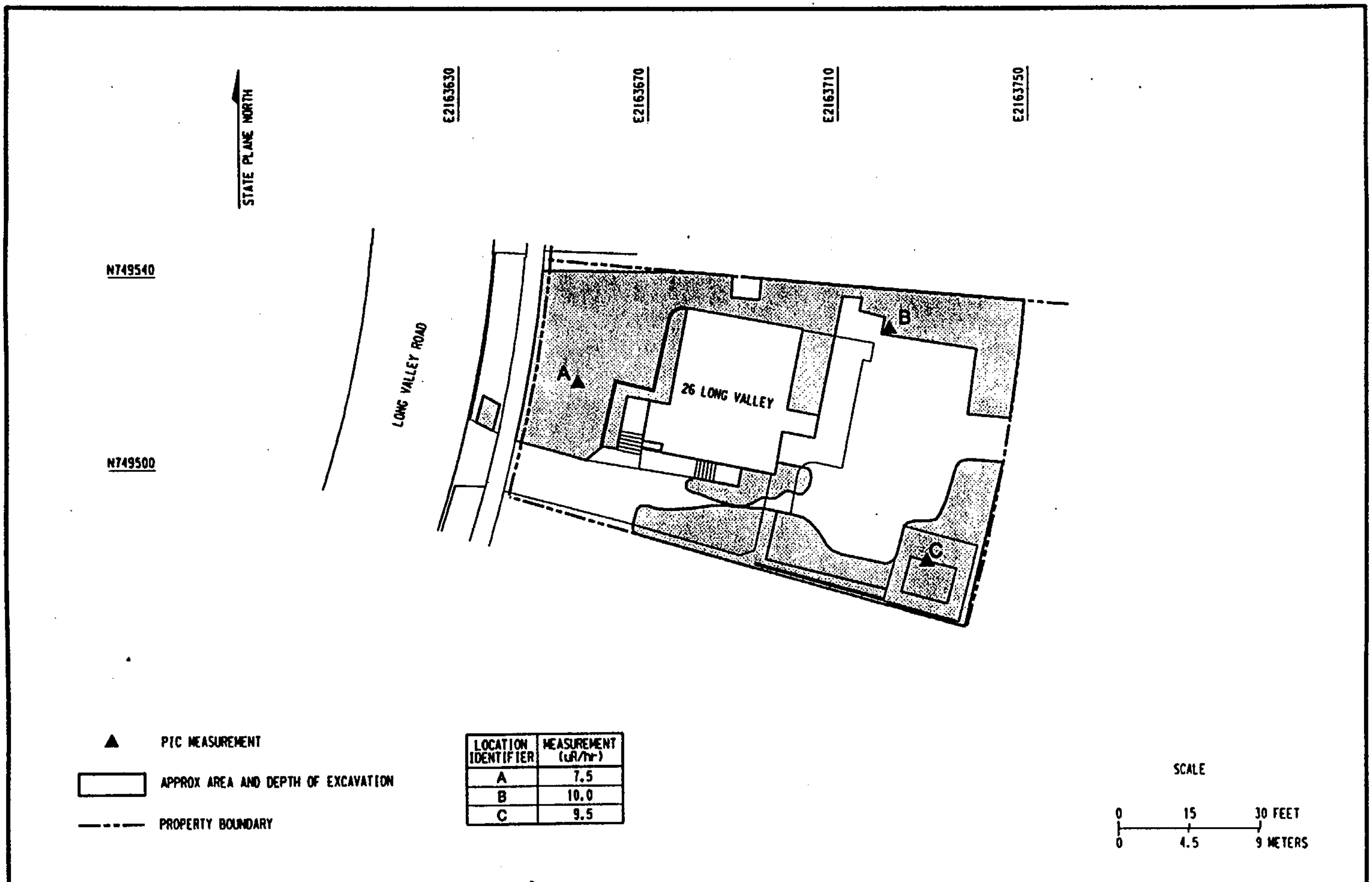
Figure 4-23
Areas of Excavation and Post-Remedial Action Samples
26 Long Valley Road



LOCATION IDENTIFIER	MEASUREMENT (uR/hr)
A	7.5
B	10.0
C	9.5

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Figure 4-24
PIC Readings
26 Long Valley Road

exposure rates measured at this property ranged from 7.5 to 10.0 μR/h; the average was 9.0 μR/h, including background. This is comparable to the average background exposure rate of 9.0 μR/h. Hence, any exposure to the public is essentially equivalent to background.

5.0 POST-REMEDIAL ACTION STATUS

Analytical results of post-remedial action surveys indicate that the levels of radioactivity in the remediated areas are in compliance with applicable DOE cleanup guidelines for radioactive contamination. The IVC reviewed the post-remedial action surveys and results to determine whether the measurements obtained verify that these areas comply with the established DOE guidelines for the site.

The IVC is responsible for preparing a plan outlining the procedures used in conducting verification activities. These procedures specify a verification process requiring two methods of review (Types A and B). The IVC conducted both types, in full conformance to the approved verification plan.

Type A verification consisted of reviewing the post-remedial action survey results and collecting and analyzing additional samples as required. In performing the Type B verification review, the IVC conducted a survey of the site that included direct measurements, review of the post-remedial action survey methods and results, sampling, and laboratory analysis of separate soil samples.

After completing the verification study, the IVC will report its findings and recommendations to DOE Headquarters and the DOE Oak Ridge Operations Office. DOE will review the report to verify that the remedial action was successful. The IVC's published verification report will then become part of the CERCLA Administrative Record file for the Maywood site.

6.0 REFERENCES

Bechtel National, Inc. (BNI), 1988a. *Radiological Characterization Report for the Residential Property at 7 Branca Court, Lodi, New Jersey*, DOE/OR/20722-167, Oak Ridge, Tenn. (November).

BNI, 1988b. *Radiological Characterization Report for the Residential Property at 11 Redstone Lane, Lodi, New Jersey*, DOE/OR/20722-174, Oak Ridge, Tenn. (November).

BNI, 1988c. *Radiological Characterization Report for the Residential Property at 16 Long Valley Road, Lodi, New Jersey*, DOE/OR/20722-169, Oak Ridge, Tenn. (November).

BNI, 1988d. *Radiological Characterization Report for the Residential Property at 18 Long Valley Road, Lodi, New Jersey*, DOE/OR/20722-170, Oak Ridge, Tenn. (November).

BNI, 1988e. *Radiological Characterization Report for the Residential Property at 20 Long Valley Road, Lodi, New Jersey*, DOE/OR/20722-171, Oak Ridge, Tenn. (November).

BNI, 1988f. *Radiological Characterization Report for the Residential Property at 22 Long Valley Road, Lodi, New Jersey*, DOE/OR/20722-172, Oak Ridge, Tenn. (November).

BNI, 1988g. *Radiological Characterization Report for the Residential Property at 26 Long Valley Road, Lodi, New Jersey*, DOE/OR/20722-173, Oak Ridge, Tenn. (November).

BNI, 1989. *Radiological Characterization Report for the Residential Property at 24 Long Valley Road, Lodi, New Jersey*, DOE/OR/20722-236, Oak Ridge, Tenn. (September).

BNI, 1992. *Remedial Investigation Report for the Maywood Site, Maywood, New Jersey*, DOE/OR/21949-337, Oak Ridge, Tenn. (December).

BNI, 1995. "Results of Maywood Vicinity Property Data Gap Characterization," Rev. 1, Technical Memorandum from A. George to M. Redmon, Oak Ridge, Tenn. (August).

BNI, 1996. *FUSRAP Post-Remedial Action Survey Plan*, CCN 144856, Oak Ridge, Tenn. (August).

BNI, 1997. "Dose from 1996 Vicinity Property Remedial Action Activities Conducted at MISS," Calc. No. 138-CV-096 (May).

U.S. Department of Energy (DOE), 1990. "Radiation Protection of the Public and the Environment," DOE Order 5400.5, Washington, D.C. (June).

DOE, 1994. "DOE Acceptance of EPA's Proposed Cleanup Levels," Letter from J. La Grone to W. Muszynski (April 13).

Shleien, B., 1992. *The Health Physics and Radiological Health Handbook*, Revised Edition, Scinta Inc., Silver Spring, Maryland.

10 CFR 835, *Occupational Radiation Protection.*

APPENDIX A RADIATION AT A GLANCE

RADIATION AT A GLANCE

Of all activities at FUSRAP sites, those associated with radiation receive the most attention. What exactly is radiation and where does it come from? To answer these questions, it is best to start with a few basics.

All matter is made up of extremely small particles called atoms. Atoms contain even smaller particles called protons, neutrons, and electrons. When an atom has a stable mix of protons and neutrons, it is nonradioactive. However, when atoms have too many of either protons or neutrons, these unstable atoms can break apart, or decay, in an attempt to become stable. As atoms decay, energy is released; this released energy is called radiation.

Sources of Radiation

Radiation originates from natural events that happen all the time, but it can also be made by man. Most of the radiation that people are exposed to occurs naturally. It has always been present, and every person who has ever lived has been exposed to radiation. Although modern technology may seem to have greatly increased the exposure rate, this is not necessarily the case. Exposure to man-made radiation varies greatly based on a given individual's lifestyle choices and medical treatments.

Sources of natural, or background, radiation include internal radiation from food (we all have approximately 500,000 atoms disintegrating in our bodies every minute), cosmic radiation from the sun and from outside the solar system, and terrestrial radiation from rocks, soils, and minerals (Figure A-1). People have no control over the amount of natural radiation around them, and the amount of natural radiation stays about the same over time. The natural radiation present in the environment today is not much different than it was hundreds of years ago. In general, over 80 percent of the radiation the average person is exposed to is from natural sources. Man-made radiation accounts for less than 20 percent of the total; most of it is from medical procedures.

Man-made sources of radiation include consumer products, medical procedures, and the nuclear industry. Some consumer products such as smoke detectors and even porcelain dentures contain radioactive elements. Probably the best-known source of man-made radiation is nuclear medicine. For example, to conduct a brain, liver, lung, or bone scan, doctors inject patients with radioactive compounds and then use radiation detectors to make a diagnosis by examining the resulting image of the organ.

Man-made radioactive materials also include cesium-137 and strontium-90, present in the environment as a result of previous nuclear weapons testing. As with background radiation, exposure to other sources of radiation varies greatly depending on individual choices, such as smoking tobacco products (polonium-210) and eating certain foods (bananas contain potassium-40).

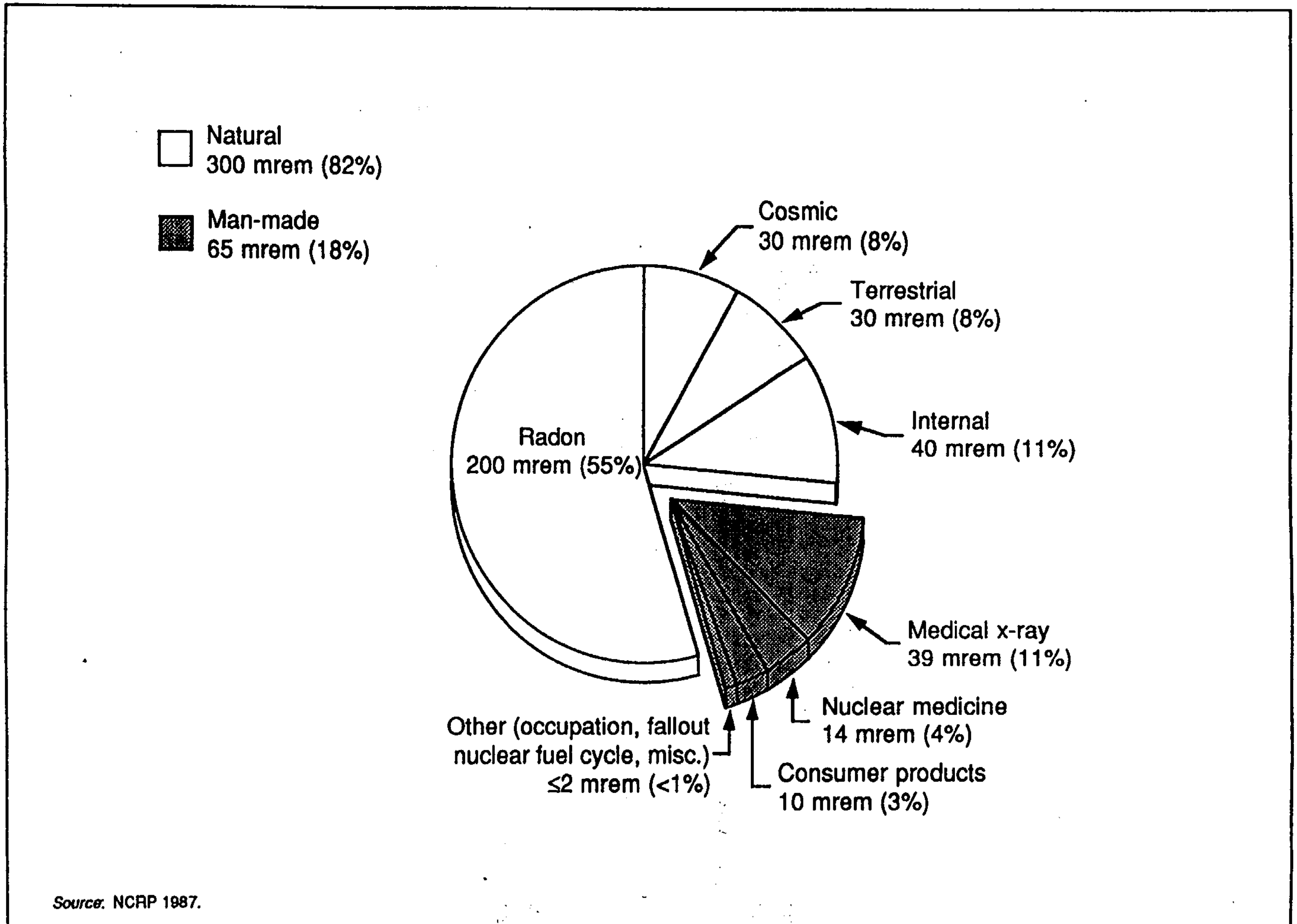

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Figure A-1
Typical Annual Radiation Doses from Natural and Man-Made Sources

Levels of Radiation

The average dose caused by background radiation varies widely. In the United States, the average is about 300 mrem/yr; some people in other parts of the world receive a dose more than four times this amount. For example, in some areas of Brazil, doses to inhabitants can be more than 2,000 mrem/yr from background radiation. These wide variations are the result of several factors, most notably the types and amounts of radionuclides in the soil.

This diversity in background radiation is responsible for the large differences in doses. Because people live in areas with high levels of background radiation without proven harm, it is assumed by most in the scientific community that small variations in environmental radiation levels have an inconsequential effect, if any, on humans.

Measuring Radiation

To determine the possible effects of radiation on the health of the environment and people, these effects must be measured. More precisely, the potential for radiation to cause damage must be ascertained. Measurements of these potential effects are derived from the activity of each isotope and are expressed in terms of the absorbed dose to an individual and the effective dose or potential to cause biological damage.

Activity

When we measure the amount of radiation in the environment, what is actually being measured is the rate of radioactive decay, or radioactivity, of a given element. This radioactivity is expressed in a unit of measure known as a curie (Ci). A curie is a measure of radioactivity, not a set quantity of material. More specifically, one curie equals 37,000,000,000 (3.7×10^{10}) radioactive disintegrations per second. One gram of a radioactive substance may contain the same amount of radioactivity as several tons of another radioactive substance. For example, one gram of tritium (a radioactive form of hydrogen) emits about 10,000 Ci, while one gram of uranium emits about 0.000000333 (333×10^{-9}) Ci. Because the levels of radioactive contamination at most FUSRAP sites are very low, the picocurie is commonly used in reporting contaminant levels. One picocurie is equal to 1×10^{-12} curies. Contaminants in water are reported in picocuries per liter (pCi/L), and contaminants in soil are reported in picocuries per gram (pCi/g).

Absorbed Dose

The total amount of absorbed energy per unit mass as a result of exposure to radiation is expressed in a unit of measure known as a rad. However, in terms of human health, it is the relative effectiveness of the absorbed energy in causing biological damage that is important, not the actual amount of energy absorbed.

Dose Equivalent

The absorbed dose needed to achieve a given level of biological damage is different for different kinds of radiation. To allow for the different biological effectiveness of different kinds of radiation, the concept of dose equivalent is used. The dose equivalent is the product of the absorbed dose and a dimensionless quality factor. The unit of dose equivalent is called the rem (roentgen-equivalent-man). A rem is a fairly large dose; therefore, the most common unit of dose equivalent is the millirem (mrem), or 1/1,000 of a rem. Table A-1 describes some potential health effects over a wide range of radiation doses.

Table A-1
Comparison and Description of Various Dose Levels

Dose	Description
1 mrem	Approximate daily dose from natural background radiation, including that due to radon.
2.5 mrem	Cosmic dose to a person on a one-way airplane flight from New York to Los Angeles.
4 mrem	Annual exposure limit set by EPA from manmade radiation in drinking water.
10 mrem	Typical dose from one chest X-ray using modern equipment.
10 mrem	Annual exposure limit, set by EPA, for exposures from airborne emissions (excluding radon) from operations of nuclear fuel cycle facilities, including power plants, uranium mines, and mills.
25 mrem	Annual exposure limit set by EPA from low-level waste-related exposures.
65 mrem	Average yearly dose to people in the United States from man-made sources.
60-80 mrem	Average yearly dose from cosmic radiation to people in the Rocky Mountain states.
83 mrem	Estimate of the largest dose any offsite person could have received from the March 28, 1979, Three Mile Island nuclear accident.
100 mrem	Annual limit of dose from all DOE facilities to a member of the public who is not a radiation worker.
110 mrem	Average occupational dose received by United States commercial radiation workers in 1980.
170 mrem	Average yearly dose to an airline flight crew member from cosmic radiation.
300 mrem	Average yearly dose to people in the United States from all sources of natural background radiation.
900 mrem	Average dose from a lower-intestine diagnostic X-ray series.
1,000-5,000 mrem	EPA's Protective Action Guidelines state that public officials should take emergency action when the dose to a member of the public from a nuclear accident will likely reach this range.
5,000 mrem	Annual limit for occupational exposure of radiation workers set by the U.S. Nuclear Regulatory Commission and DOE.

8,000 mrem	Average yearly dose to the lungs from smoking 1½ packs of cigarettes per day.
10,000 mrem	The BEIR V report estimated that an acute dose at this level would result in a lifetime excess risk of death from cancer, caused by the radiation, of 0.8 percent.
25,000 mrem	EPA's guideline for voluntary maximum dose to emergency workers for non-lifesaving work during an emergency.
75,000 mrem	EPA's guideline for maximum dose to emergency workers volunteering for lifesaving work.
50,000-600,000 mrem	Doses in this range received over a short period of time will produce radiation sickness in varying degrees. At the lower end of this range, people are expected to recover completely, given proper medical attention. At the top of this range, most people will die within 60 days.