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ADMINISTRATIVE RECORD

for Maywood, New Jersey



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**RESULTS OF THE INDEPENDENT
RADIOLOGICAL VERIFICATION SURVEY**

**AT
464 DAVISON STREET, MAYWOOD,
NEW JERSEY (MJ16L)**

**M. G. Yalcintas
C. A. Johnson***

***Biology Division**

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Investigation Team

**B. A. Berven — RASA Program Manager
W. D. Cottrell — FUSRAP Project Director
M. G. Yalcintas — Field Survey Supervisor**

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RESULTS OF THE INDEPENDENT RADIOLOGICAL VERIFICATION SURVEY AT 464 DAVISON STREET, MAYWOOD, NEW JERSEY (MJ16L)*

INTRODUCTION

Processing of thorium ores was performed in Maywood, New Jersey, between 1916 and 1956 by the Maywood Chemical Works.¹ During the course of thorium processing the wastes from the operations were pumped to diked areas west of the plant. Additional material was placed in two piles surrounded by earthen dikes. In 1932, Route 17 was built through this disposal area. The Maywood Chemical Works ceased thorium processing in 1956 and subsequently was sold to Stepan Chemical Company in 1959. After 1963, on several occasions wastes were removed from the west side of New Jersey Route 17. This area is now owned by Ballod and Associates. In 1984, the U.S. Department of Energy (DOE) was assigned the responsibility by Congress for the decontamination project involving the site and vicinity properties in Maywood and Rochelle Park under the Formerly Utilized Sites Remedial Action Program (FUSRAP).

This site, referred to as the Maywood site, had surface and subsurface radionuclide concentrations in excess of the DOE criteria listed in Table 1. It has been identified through radiological assessment procedures by Oak Ridge Associated Universities and Nuclear Safety Associates, Inc.,^{1,2} for the purpose of decontamination based on DOE's remedial action objectives. The Maywood site and vicinity properties, which include the residential properties on Latham and Davison Streets in Maywood, were assigned by DOE to FUSRAP although the contamination at the Maywood site did not result from the Atomic Energy Program.

From June to December, 1984, Bechtel National, Inc. (BNI), the project management contractor designated by DOE, performed remedial action on this residential property. This remedial action is on one of six designated properties in the Maywood area (Fig. 1). Based on drawings showing the extent of contamination, the property was excavated and the contaminated material transported to the Maywood Interim Storage Site (MISS), adjacent to the Stepan Company plant.³ After removal of all contaminated soil, the property was restored to its original condition. By using a combination of procedures, the contamination was controlled and prevented from spreading to other areas. A post-remedial radiological survey was conducted by BNI to ensure compliance with DOE remedial action guidelines.⁴

The DOE adopted a policy to assign an independent verification contractor to ensure the effectiveness of remedial actions performed within FUSRAP. The Radiological Survey Activities Group of Oak Ridge National Laboratory (ORNL) has been assigned the responsibility for this task at the Maywood site. This report describes the methods and results of that verification.

*The survey was performed by members of the Radiological Survey Activities Group of the Health and Safety Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

From January to June, 1986, ORNL conducted the verification activity for the Maywood properties, including this location at 464 Davison St., located southeast of the Ballod property. A diagram of the property showing the approximate property boundaries and grid network established for measurements outside the buildings is shown in Fig. 2. This location is one in a series of vicinity properties near the Maywood site that was suspected of being radioactively contaminated, and that has been surveyed by BNI³ to identify horizontal and vertical boundaries of radionuclide concentrations exceeding remedial action criteria. (Verification of these properties will be completed in 1986.) A contaminated area of ~650 m² that exceeded the guidelines encompassed the entire property, including the right-of-way and sidewalk in front of the house, and was excavated.

PROCEDURES

Objectives

The objective of the verification activities was to confirm (1) that available documentation adequately and accurately describes the post-remedial action radiological conditions of the entire property that is to be certified and (2) that the remedial action reduced contamination levels to within authorized limits.

Document Reviews

Review of the designation/characterization report³ prepared by BNI indicates that the contamination was a shallow deposit and, according to residents, was hauled in from the Maywood site; thus, it was appropriate to designate this property for remedial action.

The post-remedial action report⁴ indicates that the area excavated on this property was as identified in the designation report. The post-remedial action survey was performed on this property as described for a generic site in Ref. 5. This survey consists of ground-level beta-gamma measurements, surface gamma measurements, and systematic soil sampling. From the review of the post-remedial action report, it can be concluded that the BNI survey procedure used for this property is satisfactory. All reported ²³⁸U, ²²⁶Ra, and ²³²Th soil sample concentrations are below the average guideline limits set by DOE (Table 1).

VERIFICATION SURVEY AND ANALYSIS

Typical background radiation levels for the Maywood, New Jersey, area are presented in Table 2. The data are provided for purposes of comparison with the survey results presented in this section.

All measurements presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations in soil samples.

Gamma Measurements

Results of grid point measurements made by BNI are presented in the confirmatory report (Ref. 4). Gamma measurements were made approximately 30 cm above each grid point using a Primary Excavation Control Instrument (PECI). Gamma exposure rates at 30 cm above ground surface ranged from 4080 to 12,076 counts per minute (cpm). The maximum gamma exposure rate of 12,076 cpm was measured in the excavated area at the back side of the property at approximately grid location E323, N111. It was indicated by BNI that, on this site, a reading of 13,000 cpm on the PEGI corresponds to a concentration of 5 pCi (picocuries*) of ^{232}Th per gram of soil.

Fifteen pressurized ionization chamber (PIC) readings were taken at this property by BNI. The results and the locations of these readings are presented in Table 3. Gamma exposure rates at 1 m above ground surface ranged from 9 to 16 $\mu\text{R}/\text{h}$ (microroentgen† per hour) and averaged 12 $\mu\text{R}/\text{h}$.

Soil Sampling

Before backfilling, thirty-nine soil samples were taken by BNI in the excavated area. The procedures used for soil sample analysis have been described in Ref. 3. Results of the soil sample analysis and the locations of the samples are given by BNI in the post-remedial confirmatory report.

Seven of the thirty-nine systematic soil samples from different locations and various depths were selected for independent verification by ORNL (see Table 4). The seven samples have been analyzed for ^{238}U , ^{226}Ra , and ^{232}Th according to the procedure described in Ref. 6.

Concentrations of ^{238}U in the soil samples ranged from 0.5 to 2.0 pCi/g and averaged 1.3 pCi/g. Concentrations of ^{226}Ra in the soil samples ranged from 0.55 to 1.4 pCi/g and averaged 0.93 pCi/g. Concentrations of ^{232}Th in the soil samples ranged from 0.89 to 3.2 pCi/g and averaged 1.9 pCi/g. Locations of the soil samples are shown in Fig. 3. Results of ORNL analyses for the aforementioned seven soil samples are given in Table 4, with results by BNI in parentheses for comparison. The significance of difference between average ORNL values and average BNI values was tested by a single-sample *t*-test assuming ratios of paired values are log normally distributed. For 12 degrees of freedom and a 0.05 level of significance, the values in the critical range for a *t*-test of the null hypothesis are greater than 2.2. The observed *t* values for ^{226}Ra and ^{232}Th are 1.7 and 0.56, respectively,

*The curie is a unit used to define the radioactivity in a substance and equals that quantity of any radioactive isotope undergoing 2.2×10^{12} disintegrations per minute. The picocurie is one million-millionth of a curie or that amount yielding 2.2 disintegrations per minute.

†The roentgen (R) is a unit which was defined for radiation protection purposes for people exposed to penetrating X rays or gamma radiation. A microroentgen (μR) is one millionth of a roentgen. A milliroentgen (mR) is one thousandth of a roentgen or one thousand microroentgens.

neither of which is significant. The associated P values are 0.1 and 0.6, respectively. Hence, there is no evidence in these data to indicate that the average log ratio is different from zero. Because BNI's results for ^{238}U were not absolute (see Table 4), no statistical test was performed for this radionuclide.

CONCLUSION

Measurements of the gamma exposure levels taken from the excavated area before backfilling determined that the exposure rate at 1 m above the ground surface ranged from 9 to 16 $\mu\text{R}/\text{h}$ and averaged 12 $\mu\text{R}/\text{h}$. For comparison, the background for the state of New Jersey⁷⁻⁹ averages ~ 8 $\mu\text{R}/\text{h}$ and ranges from 6 to 11 $\mu\text{R}/\text{h}$ based on 1968 measurements. The results of soil radionuclide analyses for ^{238}U , ^{226}Ra , and ^{232}Th show that all soil concentration measurements are within the limits prescribed by DOE radiological guidelines.¹⁰

Based upon the results of the post-remedial action data, which were confirmed by the verification survey data, soil concentration measurements fall well below the limits prescribed by DOE radiological guidelines established for this site. It is concluded that the site successfully meets the DOE remedial action objectives.

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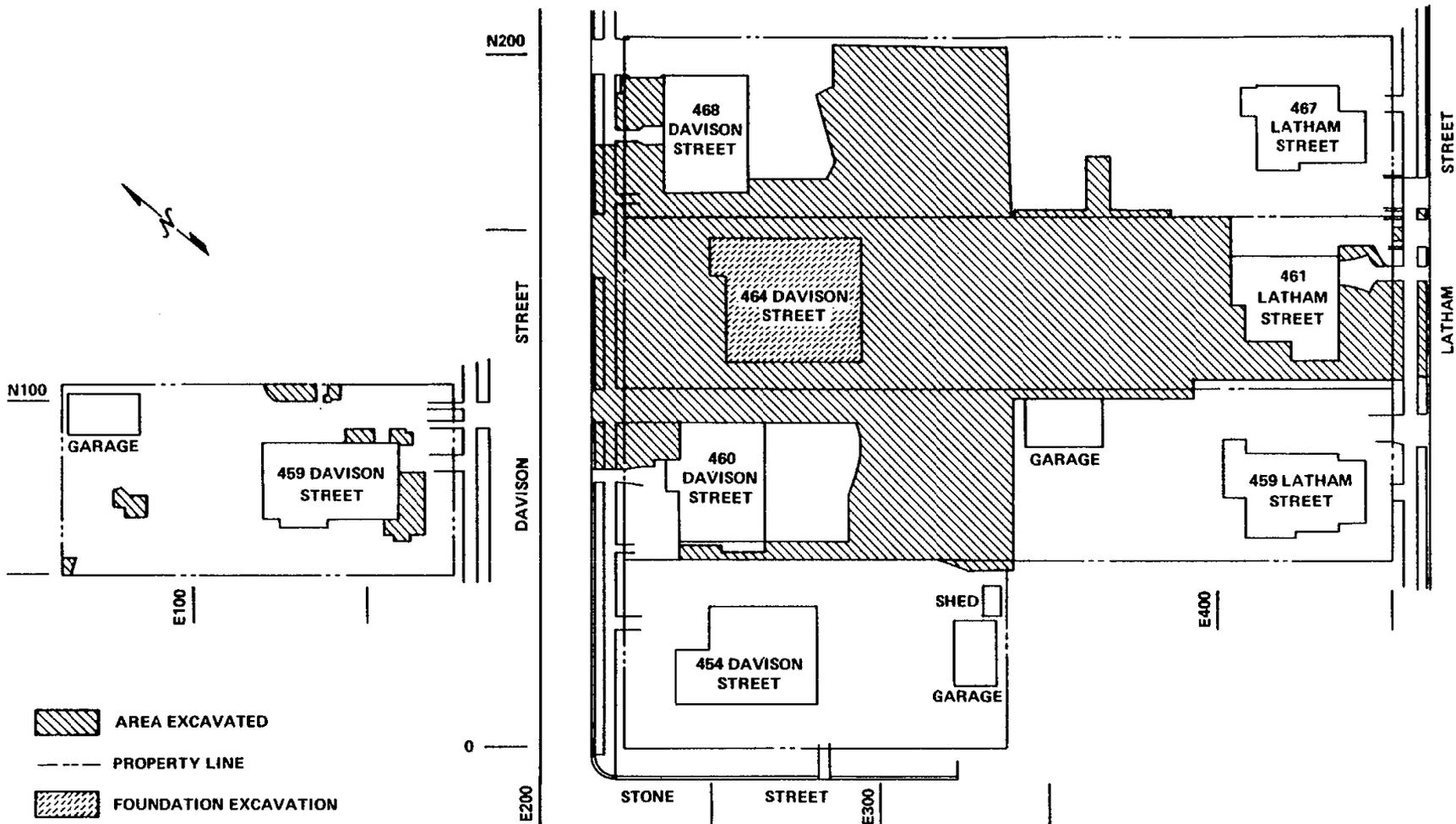


Fig. 1. Vicinity properties in the Maywood, New Jersey, area.

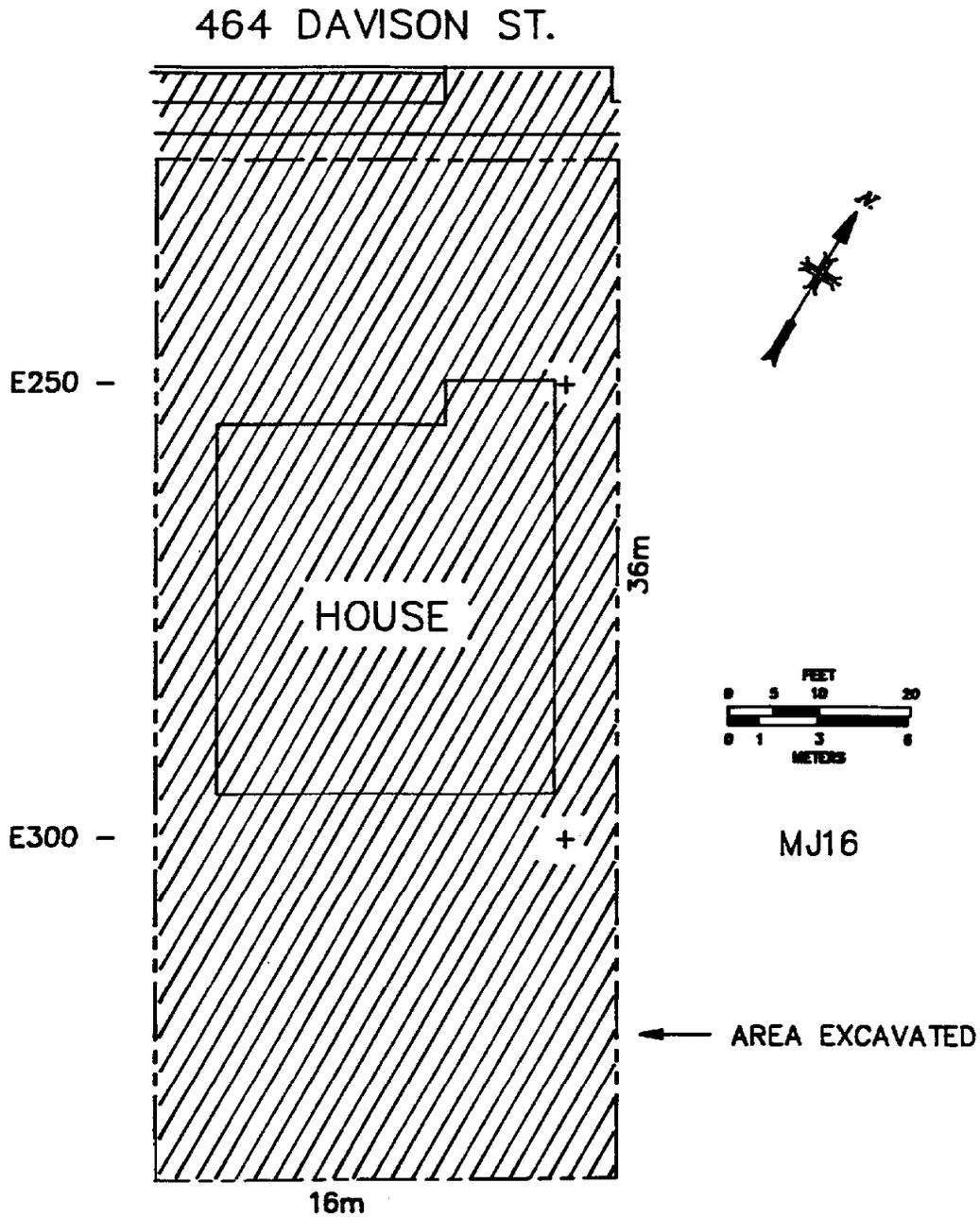


Fig. 2. Diagram showing grid point and grid block locations outdoors on the property at 464 Davison St., Maywood, New Jersey (MJ16L).

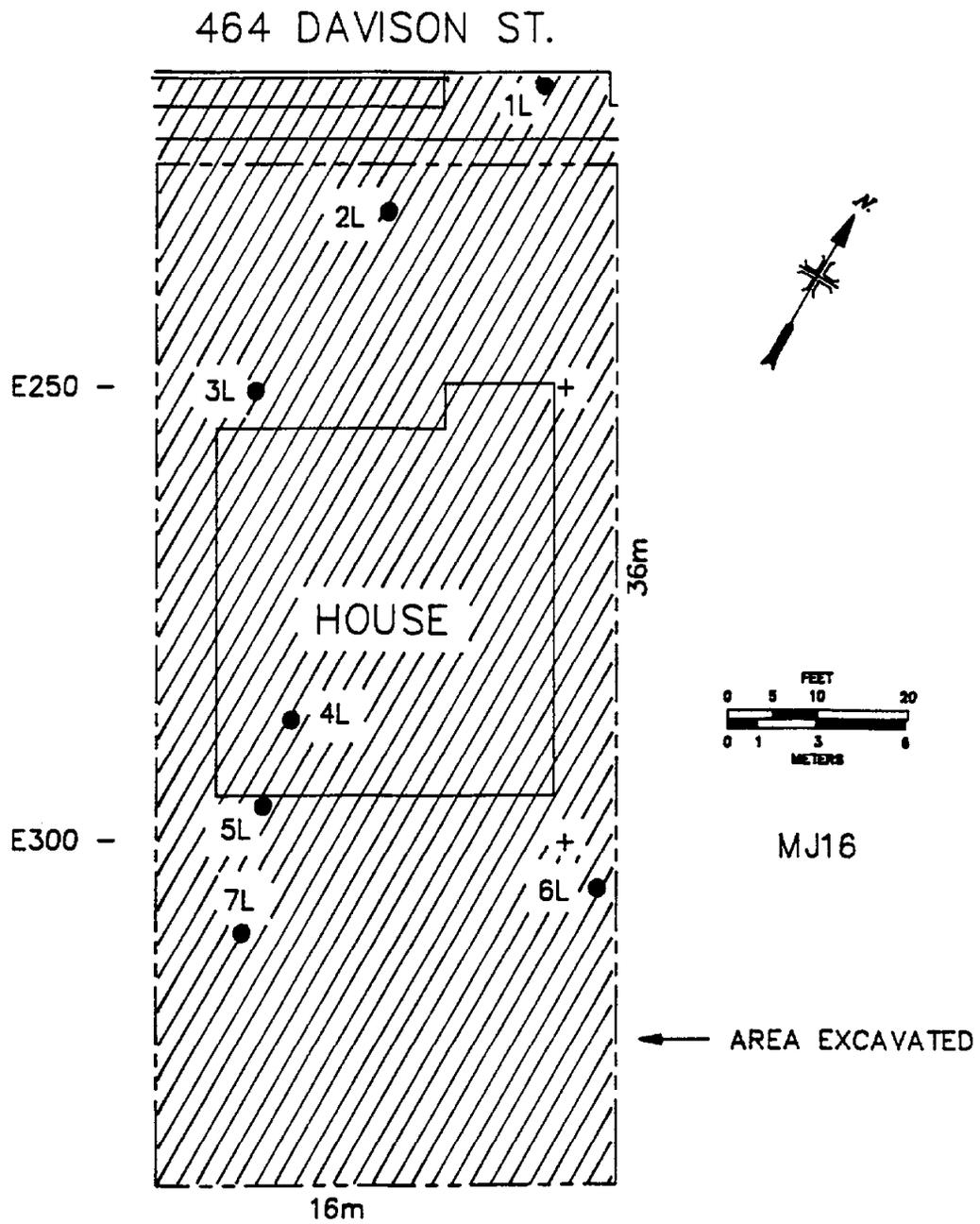


Fig. 3. Locations of soil samples on the property at 464 Davison St., Maywood, New Jersey (MJ16L).

**Table 1. Summary of residual contamination guidelines
for the Maywood, New Jersey, site**

Soil (Land) Guidelines (Maximum Limits for Unrestricted Use)	
Radionuclide	Soil concentration (pCi/g) above background ^{a,b}
²²⁶ Ra ²²⁸ Ra ²³⁰ Th ²³² Th	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
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)

Indoor Radon Decay Products

For ²²²Ra and ²²⁰Rn concentrations in buildings, the average annual radon decay product concentration (including background) due to uranium or thorium by-products should not exceed 0.02 WL after remedial action. When remedial action has been performed and it would be unreasonably difficult and costly to reduce the level below 0.03 WL, the remedial action may be terminated, and the reasons for termination should be documented. Remedial action shall be undertaken for any building that exceeds an annual average radon decay product concentration (including background) of 0.03 WL.

Indoor Gamma Radiation

The indoor gamma radiation after decontamination shall not exceed 20 microrentgen per hour (20 μ R/h) above background in any occupied or habitable building.

Indoor/Outdoor Structure Surface Contamination

Radionuclide ^d	Allowable Surface Residual Contamination ^c (dpm/100 cm ²)		
	Average ^{e,f}	Maximum ^e	Removable ^e
Transuranics, ²²⁶ Ra, ²²⁸ Ru, ²³⁰ Th, ²²⁸ Th, ²³¹ Pa, ²²⁷ Ac, ¹²⁵ I, ¹²⁹ I	100	300	20
Natural Th, ²³² Th, ⁹⁰ Sr, ²²³ Ra, ²²⁴ Ra, ²³² U, ¹²⁶ I, ¹³¹ I, ¹³³ I	1,000	3,000	200
Natural U, ²³⁵ U, ²³⁸ U, and associated decay products	5,000	15,000	1,000

Table 1 (continued)

Radionuclide ^d	Indoor/Outdoor Structure Surface Contamination		
	Allowable Surface Residual Contamination ^c (dpm/100 cm ²)		
	Average ^{e,f}	Maximum ^e	Removable ^e
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except ⁹⁰ Sr and others noted above	5,000	15,000	1,000

^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.

^cAs 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.

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

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

^fThe 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.

Table 2. Background radiation levels in the Maywood, New Jersey, area

Type of radiation measurement or sample	Radiation level or radionuclide concentration	
	Range	Average
Gamma exposure rate at 1 m above floor or ground surface ($\mu\text{R}/\text{h}$) ^a	8-11	9
Concentration of radionuclides in soil (pCi/g) ^b		
²³⁸ U	0.13-1.4	0.86
²²⁶ Ra	0.24-1.4	0.87
²³² Th	0.31-1.5	0.9

^aValues obtained from 35 locations in the Rochelle Park area.⁸

^bSoil samples obtained from locations around the Maywood area.⁶

Table 3. Results and locations of the pressurized ionization chamber (PIC) measurements at 464 Davison St., Maywood, New Jersey (MJ16L)^a

Coordinates		Gamma exposure rate ($\mu\text{R}/\text{h}$)
East	North	
216	118	11
220	150	13
225	125	11
238	130	16
250	110	11
250	140	11
265	125	9
280	110	9
280	140	10
290	155	10
295	125	11
310	110	11
310	140	11
317	123	16
327	165	13

^aRef. 4.

**Table 4. Results of soil sample analysis at 464 Davison St.,
Maywood, New Jersey (MJ016L)**

BNI results are shown in parentheses

Sample	Location ^a		Depth (cm)	Radionuclide concentration (pCi/g)		
	East	North		²²⁶ Ra ^b	²³² Th ^b	²³⁸ U ^c
Systematic Samples^d						
1L	216	148	15-30	1.4 ± 0.2 (1.3)	3.2 ± 0.2 (3.1)	2.0 (<5)
2L	230	130	15-30	0.68 ± 0.07 (0.8)	1.0 ± 0.1 (1.6)	0.5 (<5)
3L	250	115	225-240	0.55 ± 0.06 (0.5)	0.89 ± 0.04 (1.4)	1.1 ± 0.6 (<5)
4L	288	118	75-90	0.97 ± 0.1 (0.7)	2.4 ± 0.1 (2.5)	1.6 ± 0.8 (<5)
5L	295	115	105-120	0.64 ± 0.05 (0.6)	1.0 ± 0.1 (1.0)	0.9 (<5)
6L	305	155	75-90	1.2 ± 0.2 (1.1)	2.4 ± 0.1 (1.4)	2.0 (<2.5)
7L	310	115	75-90	1.1 ± 0.02 (1.0)	2.7 ± 0.2 (2.9)	1.0 (<5)

^aLocations of soil samples are shown on Fig. 3.

^bIndicated counting error is at the 95% confidence level ($\pm 2\sigma$).

^cAnalytical error of measurement results is less than $\pm 5\%$ (95% confidence level).

^dSystematic samples are taken at grid locations irrespective of gamma exposure.

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