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RESULTS OF THE RADIOLOGICAL SURVEY AT SUMITOMO MACHINERY CORPORATION OF AMERICA, 7 MALCOLM AVENUE, TETERBORO, NEW JERSEY (TJ001)

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CONTENTS

LIST OF FIGURES v

LIST OF TABLES vii

ACKNOWLEDGMENTS ix

ABSTRACT xi

INTRODUCTION 1

SURVEY METHODS 2

SURVEY RESULTS 2

Surface Gamma Radiation Levels 3
Systematic and Biased Soil Samples 3

SIGNIFICANCE OF FINDINGS 3

REFERENCES 4

LIST OF FIGURES

1 Diagram showing grid lines for the property at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001) . . . 5

2 Gamma radiation levels (μR/h) measured on the surface at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001) 6

3 Diagram showing locations of soil samples taken at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001) . . . 7

LIST OF TABLES

1 Applicable guidelines for protection against radiation 8

2 Background radiation levels for the northern New Jersey area 8

3 Results of gamma exposure rate measurements taken at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001) 9

4 Concentrations of radionuclides in soil at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001) 12

5 Mass spectroscopy for elemental rare earths at various sites in the Teterboro and Maywood areas of New Jersey 15

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ABSTRACT

An investigative survey was conducted at Sumitomo Machinery Corporation of America, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001), by the Measurement Applications and Development Group of the Health and Safety Research Division of Oak Ridge National Laboratory during November, 1986. The survey included a gamma radiation scan and radionuclide soil sampling. The survey objective was to determine whether this site was contaminated with radioactive residues derived from the Maywood Chemical Works (MCW) of Maywood, New Jersey, principally, ^{232}Th. MCW supplied rare earth metals and thorium compounds to various government agencies from the late 1940s to the mid 1950s.

Results of the survey demonstrated radionuclide concentrations in excess of DOE criteria for both ^{232}Th and ^{226}Ra. However, when rare earth concentrations from both sites are compared, MCW does not appear to be the source of the radium contamination, nor is there a history of residues from MCW ever being moved to this site. Prior to ownership by Sumitomo, the property was part of the Bendix Aerospace Corporation; during which time, Bendix was licensed by the Nuclear Regulatory Commission to use thorium in an on-site Navy/Bendix process. The source of the thorium contamination is probably associated with this process and not the MCW project.

RESULTS OF THE RADIOLOGICAL SURVEY AT SUMITOMO MACHINERY CORPORATION OF AMERICA, 7 MALCOLM AVENUE, TETERBORO, NEW JERSEY, (TJ001)*

INTRODUCTION

From 1916 to 1956, process wastes and residues associated with the production and refining of thorium and thorium compounds from monazite ores were generated by the Maywood Chemical Works (MCW), Maywood, New Jersey. During the latter part of this period, MCW supplied rare earth metals and thorium compounds to various government agencies. In the 1940s and 1950s, MCW produced thorium and lithium, under contract, for the Atomic Energy Commission (AEC). These activities ceased in 1956, and approximately three years later, the 30-acre real estate was purchased by the Stepan Company. The property is located at 100 Hunter Avenue in a highly developed area in Maywood and Rochelle Park, Bergen County, New Jersey.

During the early years of operation, MCW stored wastes and residues in low-lying areas west of the processing facilities. In the early 1930s, these areas were separated from the rest of the property by the construction of New Jersey State Highway 17. The Stepan property, the interim storage facility, and several vicinity properties have been designated for remedial action by the Department of Energy (DOE).

The waste produced by the thorium extraction process was a sandlike material containing residual amounts of thorium and its decay products, with smaller quantities of uranium and its decay products. During the years 1928 and 1944 to 1946, area residents used these process wastes mixed with tea and cocoa leaves as mulch in their lawns and gardens. In addition, some of the contaminated wastes were apparently eroded from the site into Lodi Brook and carried downstream.

Lodi Brook is a small stream flowing south from Maywood with its headwaters near the Stepan waste storage site. Approximately 150 ft after passing under State Route 17, the stream has been diverted underground through concrete or steel culverts until it merges with the Saddle River in Lodi, New Jersey. Only a small section near Interstate 80 remains uncovered. From the 1940s to the 1970s when the stream was being diverted underground, its course was altered several times. Some of these changes resulted in the movement of contaminated soil to the surface of a few properties, where it is still in evidence. In other instances, the contaminated soil was covered over or mixed with clean fill, leaving no immediate evidence on the surface. Therefore, properties in question may be drilled in search of former stream bed material, even in the absence of surface contamination.

As a result of the Energy and Water Appropriations Act of Fiscal Year 1984, the property discussed in this report and properties in its vicinity contaminated with residues from the former MCW, were included as a decontamination research and development project under the DOE Formerly Utilized Sites Remedial Action Program. As part of this project, DOE is conducting radiological surveys in the vicinity of the site to identify properties contaminated with residues derived from

*The survey was performed by members of the Measurement Applications and Development Group of the Health and Safety Research Division at Oak Ridge National Laboratory under DOE contract DE-AC05-84OR21400.

the MCW. The principal radionuclide of concern from the MCW site is ^{232}Th. The radiological surveys discussed in this report are part of that effort and were conducted, at the request of DOE, by members of the Measurement Applications and Development group of the Oak Ridge National Laboratory.

A radiological survey of the commercial property at 7 Malcolm Avenue, Teterboro, New Jersey, was conducted on November 12-20, 1986. Samples of the soil surface were taken for further analyses during this time. Conversations with property owners revealed that originally this site was part of a single property of approximately 107 acres owned entirely by the Bendix Aerospace Corporation. During this period of total property ownership, Bendix was licensed by the Nuclear Regulatory Commission to use thorium in an on-site Navy/Bendix process. Around 1976, the property was subdivided into three parcels, and one parcel of about 7 acres was purchased by Sumitomo Corporation.

SURVEY METHODS

The radiological survey of the property included: (1) a gamma scan of the entire property outdoors and (2) collection of surface and subsurface soil samples. No indoor survey measurements were performed.

To provide better definition of the area to be surveyed, the site was subdivided into grid blocks of approximately 100 x 100 ft, as shown in Fig. 1. Each grid block is identified by the coordinates in one corner of that grid block. Shading shown in the Grid Block Key of Fig. 1 indicates the designating corner. These coordinates represent the intersection of grid lines, relative to the baseline. These intersections are referred to as the grid points. A gamma scan of each accessible grid block was performed using portable gamma scintillation (NaI) survey meters with the detectors held approximately three inches above the ground surface. Gamma radiation levels for a grid block were recorded as a range of lowest to highest, and the locations of any anomalous levels were noted. The ranges for all the blocks together constitute a scan of the total surveyed ground surface. On the bases of these grid blocks, soil samples were taken from the surface at systematically selected locations, irrespective of the gamma scintillation readings. Biased samples were taken at selected locations where elevated gamma levels were found; not all elevated areas were sampled. The samples were analyzed for ^{226}Ra, ^{232}Th, and ^{238}U content. These survey methods followed the plan outlined in Reference 1. A comprehensive description of the survey methods and instrumentation has been presented in another report.[2]

SURVEY RESULTS

Applicable federal guidelines are summarized in Table 1.[3] The normal background radiation levels for the northern New Jersey area are presented in Table 2. These data are provided for comparison with survey results presented in this section. All direct measurement results presented in this report are gross readings; background radiation levels have not been subtracted. Similarly, background concentrations have not been subtracted from radionuclide concentrations measured in environmental samples.

Surface Gamma Radiation Levels

Gamma radiation levels measured during a gamma scan of the surface of the property are given in Fig. 2 and detailed in Table 3. Gamma exposure rates over the major portion of the property ranged from 5 to 12 μR/h. However, gamma levels on significant portions of the property (8 to 10%) read up to 390 μR/h, with three areas reaching 1300 μR/h or greater. One of these three areas covered the eastern corner of the property; the other two spots were located on the bank of a ditch running along the western side of the building. Areas with elevated gamma levels are indicated in Fig. 2. Gamma readings along the entire ditch ranged from 10 to 1300 μR/h. A paved area used for loading docks on the northeastern side of the building showed gamma levels between 31 and 390 μR/h; the source being either in the asphalt or under it. No samples were taken from this paved area. Table 3 shows gamma exposure levels at the surface and corresponding levels one meter above ground surface for selected grid blocks. One–meter gamma readings ranged from 1 to 30 μR/h. Nineteen of the approximately 35 grid blocks had gamma radiation levels in excess of 12 μR/h, which exceeds the average state background level of 8 μR/h by 50%.

Systematic and Biased Soil Samples

Systematic and biased soil samples were taken from various locations on the property for radionuclide analyses. Locations of the systematic (S) and biased (B) samples are shown in Fig. 3, with results of laboratory analyses provided in Table 4. Concentrations of radium, thorium, and uranium in the systematic samples ranged from 0.66 to 22 pCi/g, 0.41 to 5.2 pCi/g, and 0.36 to 3.6 pCi/g, respectively. Systematic samples (S6C and S21C) with the highest concentrations of radium and thorium were found along the ditch bank at depths in excess of 30 cm. Sample S21C was above DOE guidelines for radium (Table 1). Concentrations of radium, thorium, and uranium in the biased samples ranged from 0.76 to 11000 pCi/g, 0.68 to 270 pCi/g, and 0.66 to 4.6 pCi/g, respectively. The biased samples containing levels of radium and thorium in excess of relevant government criteria (Table 1) were B1A&B, B2, B3A, B4, B5D&E, B6B, B7B, B8A&B, B9A&B, B10A, and B11B. These samples were all located along the ditch bank, with the exception of samples B4, B8A&B, and B9A&B. Sample B4 was found in the flower bed beside the parking lot on the southern side of the building. Samples B8A&B and B9A&B came from the eastern corner of the property. Samples B7B and B10A were not processed because they exceeded the counting capacity of standard analytical equipment and clearly exceeded the environmental guidelines. Gamma emitting radionuclide concentrations in samples B7B and B10A were estimated by comparison with an established soil sample; the point of commonality was the known gamma level of each. The estimated radium concentrations for samples B7B and B10A are 11,000 and 6,000 pCi/g, respectively. Analyses of elemental rare earths for Sumitomo Machinery Corporation and MCW are given in Table 5.

SIGNIFICANCE OF FINDINGS

Measurements taken at 7 Malcolm Avenue indicate that the property contained radioactive contamination in excess of DOE guidelines, both from the ^{232}Th decay chain and from ^{226}Ra. However, these guidelines are not applicable to this property as the contamination does not appear to have originated from a DOE site or from activity over which DOE has authority. The source of the specific radium con-

tamination is not known, but it is clearly atypical of material generated by MCW. Table 5 indicates that the contaminated soil from 7 Malcolm Avenue did not originate at the former MCW site, as demonstrated by the dissimilar concentrations of rare earths from each site. Furthermore, no historical data has been identified which would suggest residues from MCW were ever moved to this site. However, there is some history of thorium use at the site when it was being operated for the Navy by Bendix, prior to Sumitomo's purchasing the property. As a result, the source of the thorium contamination on site is probably associated with the Navy/Bendix thorium processing operations and not the MCW project.

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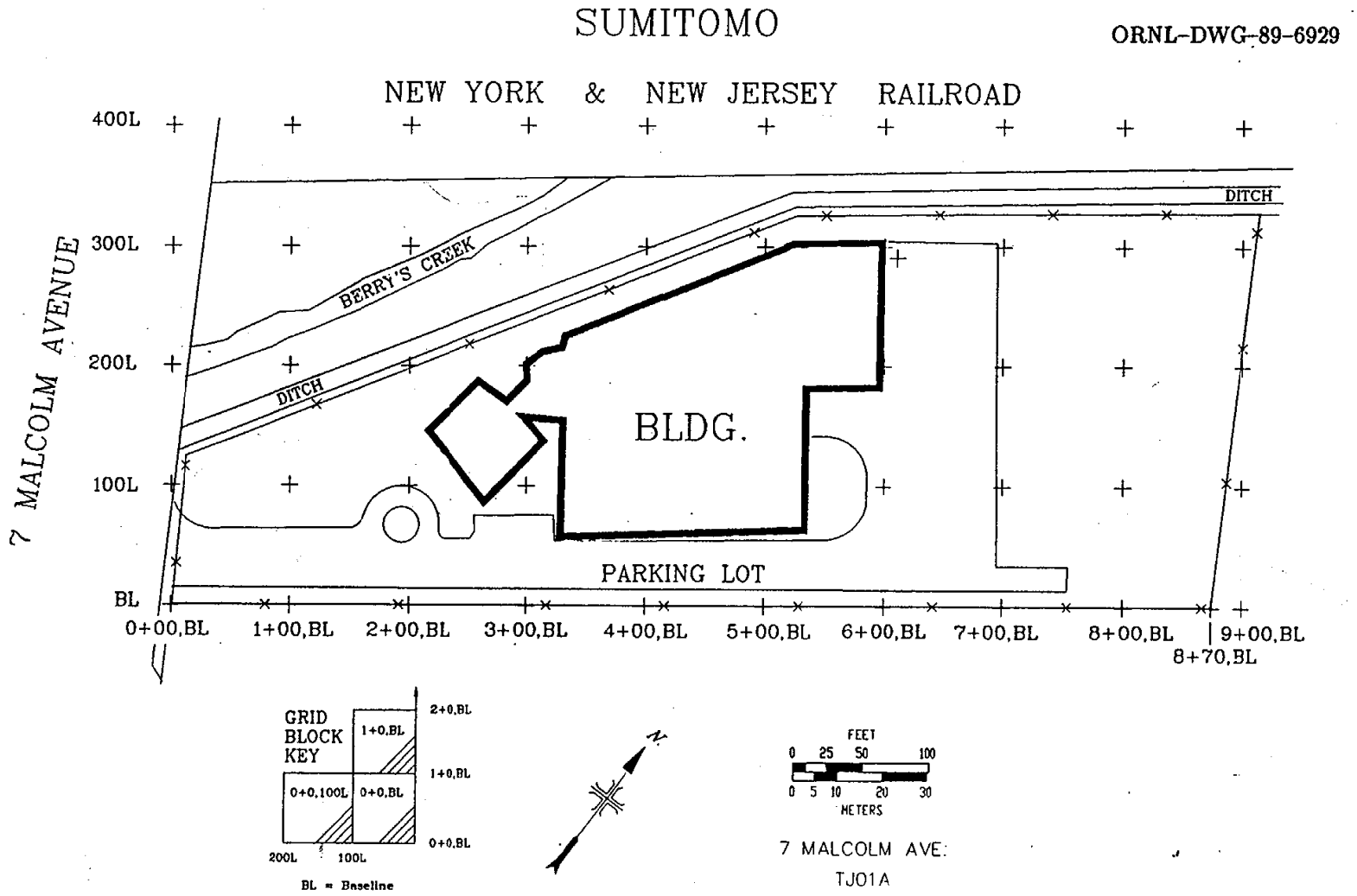

Fig. 1. Diagram showing grid lines for the property at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001).

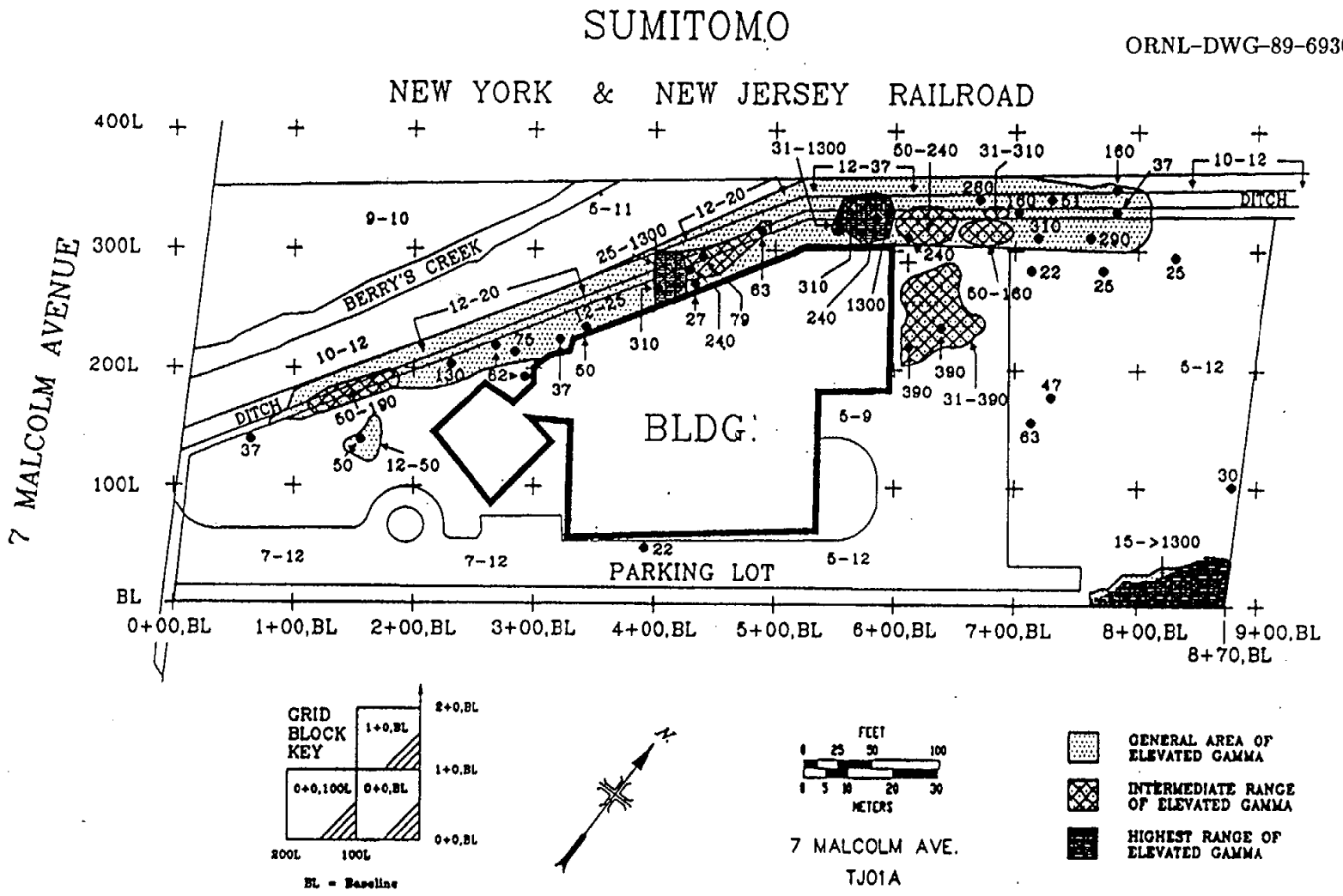

Fig. 2. Gamma radiation levels measured on the surface at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001).

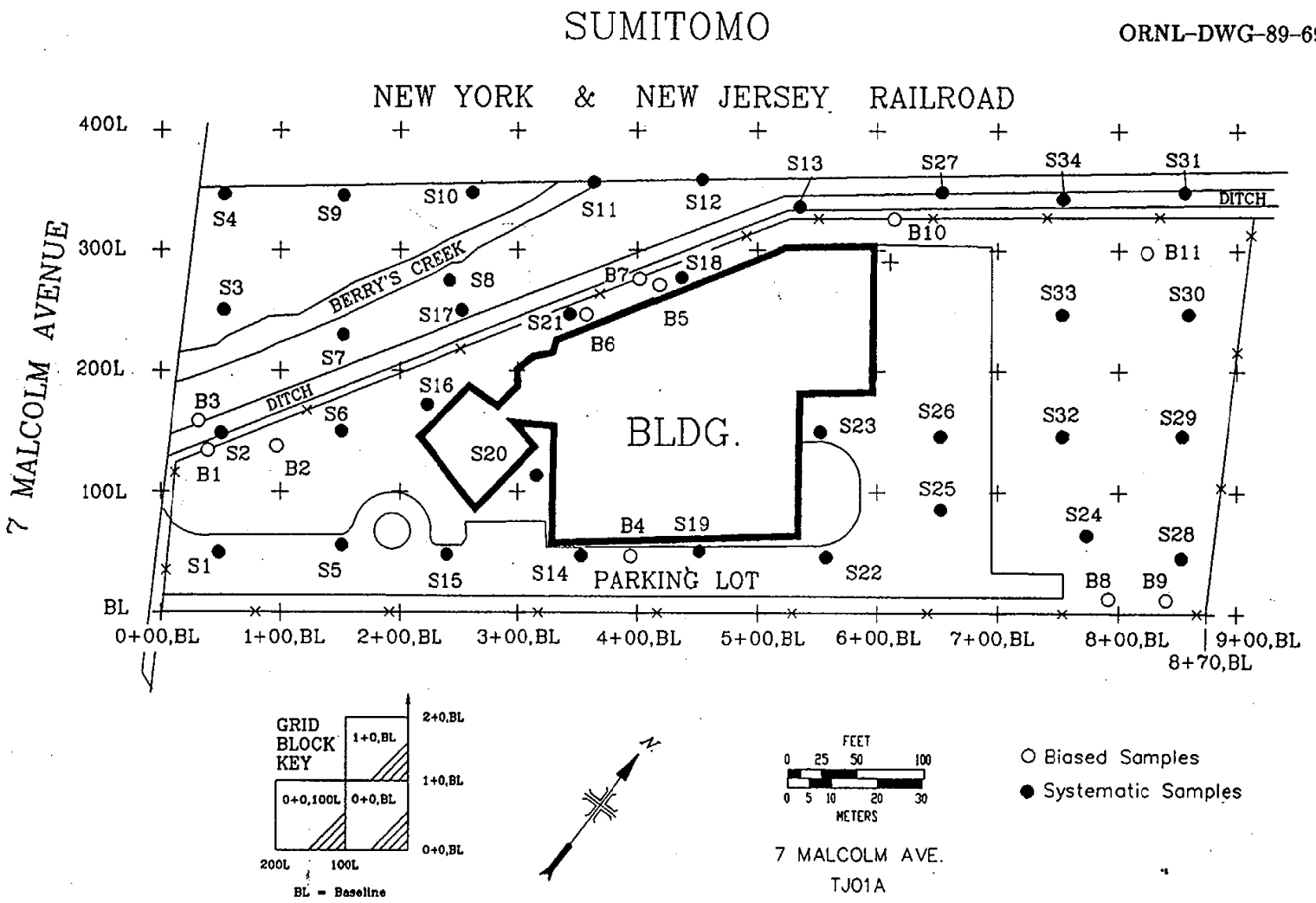

Fig. 3. Diagram showing locations of soil samples taken at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001).

Table 1. Applicable guidelines for protection against radiation[a]

Mode of exposure	Exposure conditions	Guideline value
Radionuclide concentrations in soil	Maximum permissible concentration of the following radionuclides in soil above background levels averaged over 100 m^2 area ^{232}Th ^{230}Th ^{228}Ra ^{226}Ra	5 pCi/g averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over 15-cm thick soil layers more than 15 cm below the surface

[a]Reference 3.

Table 2. Background radiation levels for the northern New Jersey area

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Gamma exposure at 1 m above ground surface (μR/h)	8[a]
Concentration of radionuclides in soil (pCi/g)	
^{232}Th	0.9[b]
^{238}U	0.9[b]
^{226}Ra	0.9[b]

[a]Reference 4.
[b]Reference 5.

Table 3. Results of gamma exposure measurements taken at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001)

Grid location[a]	Gamma exposure rate (μR/h)		
	at the surface	at one meter	range during scan of grid block[b]
0+00, BL	9	3	5–10
0+00, 100L	7	8	7–37
0+00, 200L			10–12
0+00, 300L	11		9–11
0+33, 160L	37		
0+50, 50L	7		
0+50, 150L	8		
0+50, 250L	9		
0+50, 350L	9		
1+00, BL	7		5–10
1+00, 100L	7	9	6–190
1+00, 170L	20		
1+00, 200L			9–12
1+00, 300L	9		9–10
1+50, 60L	7		
1+50, 150L	15		
1+50, 250L	9		
1+50, 350L	9		
2+00, BL	7		5–12
2+00, 100L	7	6	7–62
2+00, 200L	9		9–130
2+00, 300L			10–12
2+30, 230L	130		
2+37, 164L	10		
2+39, 52L	7		
2+40, 275L	10		
2+50, 100L	8	8	
2+50, 250L	11		
2+60, 350L	11		
3+00, BL	7		7–22
3+00, 100L	10	9	7–12
3+00, 200L	12		11–310
3+00, 300L			5–11
3+15, 115L	12		
3+50, 50L	11		
3+50, 250L	12		
3+55, 360L	10		
3+56, 225L	50		
3+94, 57L	22		
3+98, 277L	310		

Table 3. (Continued)

Grid location[a]	Gamma exposure rate (μR/h)		
	at the surface	at one meter	range during scan of grid block[b]
4+00, BL	7		7–11
4+00, 60L	11	1	
4+00, 200L	12		9–1300
4+00, 300L			10–60
4+20, 265L	27		
4+37, 270L	15		
4+50, 55L	10		
4+50, 360L	11		
4+85, 350L	63		
5+00, BL	7		5–10
5+00, 60L	6	6	
5+00, 100L			5–9
5+00, 200L			5–9
5+00, 300L	18		7–1300
5+45, 345L	11		
5+50, 50L	6		
5+50, 150L	7		
5+99, 351L	1300		
6+00, BL	7		5–10
6+00, 14L	6	6	
6+00, 100L	5	6	5–12
6+00, 200L	5	8	6–390
6+00, 300L	7	9	7–310
6+00, 350L	16	13	
6+10, 327L	310		
6+50, 88L	7		
6+50, 148L	8		
6+50, 350L	10		
7+00, BL	7		5–>1300
7+00, 14L	6	6	
7+00, 100L	7	8	5–63
7+00, 200L	10	9	7–25
7+00, 300L	8	10	6–310
7+00, 345L	9	10	
7+04, 170L	63		
7+10, 304L	310		
7+50, 150L	11		
7+50, 250L	11		
7+50, 345L	9		
7+70, 68L	9		
7+70, 285L	25		
7+88, 10L	50		
7+90, 17L	30		

Table 3. (Continued)

Grid location[a]	Gamma exposure rate (μR/h)		
	at the surface	at one meter	range during scan of grid block[b]
8+00, BL	35		6–>1300
8+00, 14L	30	30	
8+00, 100L	8	8	5–12
8+00, 200L	8	9	7–12
8+00, 300L	10	10	7–4
8+00, 345L	9	9	
8+00, 400L	8		
8+20, 300L	10	10	
8+20, 345L	10	9	
8+38, 15L	55		
8+50, 50L	11		
8+50, 150L	9		
8+50, 350L	9		
8+52, 33L	>1300		
8+55, 250L	7		
8+70, 14L	11	11	
8+70, 100L	9	8	
8+70, 150L	8	9	
8+70, 200L	9	6	
8+90, 200L	8	9	

[a] Grid location shown on Fig. 1.

[b] These figures are grid block measurements which are obtained by a gamma scan of the entire block.

Table 4. Concentrations of radionuclides in soil at Sumitomo Machinery Corporation, 7 Malcolm Avenue, Teterboro, New Jersey (TJ001)

Sample	Location[a]	Depth (cm)	Radionuclide concentration (pCi/g)		
			^{226}Ra[b]	^{232}Th[b]	^{238}U[c]
		Systematic samples[d]			
S1	0+50, 50L	0–15	0.88 ± 0.02	0.85 ± 0.1	1.5
S2	0+50, 150L	0–15	0.94 ± 0.04	1.1 ± 0.09	0.98
S3	0+50, 250L	0–15	0.90 ± 0.1	0.80 ± 0.02	0.84
S4	0+50, 350L	0–15	0.97 ± 0.06	0.70 ± 0.03	0.98
S5	1+50, 60L	0–15	1.0 ± 0.03	0.94 ± 0.1	0.84
S6A	1+50, 150L	0–15	2.8 ± 0.07	2.5 ± 0.03	0.78
S6B	1+50, 150L	15–30	5.2 ± 0.09	5.1 ± 0.08	1.1
S6C	1+50, 150L	30–60	11 ± 0.4	5.1 ± 0.6	0.64
S7A	1+50, 250L	0–15	0.66 ± 0.04	0.53 ± 0.02	0.72
S7B	1+50, 250L	45–60	0.77 ± 0.1	0.90 ± 0.02	0.84
S8A	2+40, 275L	0–15	1.5 ± 0.03	0.95 ± 0.03	0.99
S8B	2+40, 275L	45–60	0.94 ± 0.07	0.84 ± 0.02	1.7
S9	1+50, 350L	0–15	1.3 ± 0.04	0.87 ± 0.02	2.3
S10A	2+60, 350L	0–15	0.99 ± 0.1	0.89 ± 0.1	1.5
S10B	2+60, 350L	15–30	1.1 ± 0.05	0.90 ± 0.02	1.6
S10C	2+60, 350L	45–60	1.4 ± 0.03	0.90 ± 0.02	1.5
S11	3+55, 360L	0–15	0.91 ± 0.1	0.84 ± 0.03	1.1
S12A	4+50, 360L	0–15	2.4 ± 0.06	0.88 ± 0.03	3.6
S12B	4+50, 360L	30–45	3.6 ± 0.1	0.85 ± 0.3	3.1
S13A	5+45, 345L	0–15	9.2 ± 0.2	0.86 ± 0.2	0.94
S13B	5+45, 345L	15–30	3.7 ± 0.03	0.79 ± 0.3	2.5
S14	3+50, 50L	0–15	0.78 ± 0.06	0.61 ± 0.6	0.62
S15	2+39, 52L	0–15	0.95 ± 0.07	0.66 ± 0.09	0.79
S16	2+37, 164L	0–15	0.82 ± 0.09	0.76 ± 0.2	0.95
S17	2+50, 250L	0–15	2.1 ± 0.08	1.5 ± 0.3	0.81
S18A	4+37, 270L	0–15	4.8 ± 0.2	0.86 ± 0.3	0.76
S18B	4+37, 270L	15–30	7.0 ± 0.1	0.91 ± 0.4	0.82
S19	4+50, 55L	0–15	0.73 ± 0.05	0.68 ± 0.04	0.54
S20	3+15, 115L	0–15	0.73 ± 0.08	0.64 ± 0.2	0.67
S21A	3+50, 250L	0–15	1.5 ± 0.03	0.83 ± 0.2	0.76
S21B	3+50, 250L	15–30	7.2 ± 0.1	2.2 ± 0.7	0.79
S21C	3+50, 250L	45–60	22 ± 0.7	5.2 ± 0.4	0.59
S22	5+55, 50L	0–15	0.72 ± 0.09	0.68 ± 0.2	0.62
S23	5+50, 150L	0–15	0.68 ± 0.09	0.59 ± 0.2	0.83

Table 4. (Continued)

Sample	Location[a]	Depth (cm)	Radionuclide concentration (pCi/g)		
			^{226}Ra[b]	^{232}Th[b]	^{238}U[c]
S24	7+70, 68L	0–15	2.0 ±0.06	0.82±0.1	0.76
S25	6+50, 88L	0–15	1.3 ±0.08	0.80±0.08	0.84
S26	6+50, 148L	0–15	1.3 ±0.1	0.81±0.09	0.74
S27	6+50, 350L	0–15	2.3 ±0.1	0.73±0.2	0.92
S28	8+50, 50L	0–15	3.5 ±0.2	0.82±0.2	0.54
S29	8+50, 150L	0–15	1.3 ±0.06	0.54±0.2	0.55
S30	8+50, 250L	0–15	0.86±0.07	0.41±0.1	0.36
S31	8+50, 350L	0–15	0.98±0.05	0.41±0.2	0.38
S32A	7+50, 150L	0–15	1.5 ±0.03	1.1 ±0.09	0.93
S32B	7+50, 150L	15–30	1.7 ±0.06	1.1 ±0.1	0.98
S32C	7+50, 150L	30–45	1.2 ±0.07	0.86±0.1	0.70
S33A	7+50, 250L	0–15	1.6 ±0.04	1.4 ±0.1	0.73
S33B	7+50, 250L	15–30	1.5 ±0.06	1.4 ±0.3	0.72
S33C	7+50, 250L	30–45	1.7 ±0.03	1.4 ±0.1	0.76
S34A	7+50, 345L	0–15	2.3 ±0.06	1.1 ±0.3	0.69
S34B	7+50, 345L	15–30	0.97±0.07	0.60±0.09	0.71
			Biased samples[e]		
B1A	0+—, —L[f]	0–15	2.2 ±0.7	99 ±30	1.8
B1B	0+—, —L	15–30	11 ±2	270 ±90	4.6
B2	1+00, 170L	0–15	3.0 ±0.9	140 ±35	2.8
B3A	0+33, 160L	0–15	1.3 ±0.2	20 ±3.0	1.1
B3B	0+33, 160L	15–30	0.76±0.09	9.6 ±1	0.68
B4	3+94, 57L	0–15	42 ±2	0.68±0.2	0.84
B5A	4+20, 265L	0–15	4.0 ±0.1	1.0 ±0.1	0.83
B5B	4+20, 265L	15–30	3.7 ±0.2	1.1 ±0.3	0.75
B5C	4+20, 265L	30–45	2.8 ±0.2	1.2 ±0.1	0.67
B5D	4+20, 265L	45–60	15 ±0.7	54 ±5	1.7
B5E	4+20, 265L	60–65	7.6 ±0.5	30 ±2	0.98
B6A	3+56, 225L	0–15	2.0 ±0.05	1.2 ±0.2	1.1
B6B	3+56, 225L	15–30	1000 ±30	1.3 ±2	1.4
B7A	3+98, 277L	0–15	2.9 ±0.1	0.87	0.79
B7B[g]	3+98, 277L	15–30	11000		
B8A	7+90, 17L	0–15	26 ±0.7	1.1 ±0.4	0.67
B8B	7+90, 17L	15–30	99 ±5	2.1 ±0.6	0.76
B9A	8+38, 15L	0–15	70 ±2	2.2 ±0.9	0.96
B9B	8+38, 15L	15–30	22 ±0.8	1.5 ±0.6	0.95

Table 4. (Continued)

Sample	Location[a]	Depth (cm)	Radionuclide concentration (pCi/g)		
			$^{226}Ra^{b}$	$^{232}Th^{b}$	$^{238}U^{c}$
B9C	8+38, 15L	30–45	11 ±0.1	1.5 ±0.2	0.87
B9D	8+38, 15L	45–60	4.2 ±0.2	1.1 ±0.4	0.80
B10A[g]	6+10, 327L	0–15	6000		
B10B	6+10, 327L	15–25	4.2 ±0.3	1.6 ±0.4	0.87
B11A	8+20, 300L	0–15	1.2 ±0.05	1.0 ±0.07	0.70
B11B	8+20, 300L	15–30	21 ±0.5	1.1 ±0.2	0.66
B11C	8+20, 300L	30–45	1.4 ±0.08	0.95±0.08	0.66

[a]Locations of soil samples are shown on Fig. 3.

[b]Indicated counting error is at the 95% confidence level ($\pm 2\sigma$).

[c]Total analytical error of measurement results is less than ±5% (95% confidence level).

[d]Systematic samples are taken at grid locations irrespective of gamma exposure rates.

[e]Biased samples are taken from areas shown to have elevated gamma exposure rates.

[f]Samples B1A and B1B were taken from ditch bank near Malcolm Avenue before grid was established.

[g]Concentrations in biased samples B7B and B10A were estimated by comparison with an established soil sample. See text for details.

Table 5. Mass spectroscopy for elemental rare earths at various sites in the Teterboro and Maywood areas of New Jersey

Rare Earths (ppm)	Sumitomo Site[a] Sample Numbers					Maywood Chemical Works Site[b] Sample Numbers									
	TJ1–S6B	TJ1–B3B	TJ1–B5D	TJ1–B9B	TJ1–B10B	354	355	356	357	358	359	360	361	362	363
Ce	<5	<5	<5	<5	<5	1650	1600	>10,000	>10,000	320	400	140	320	260	275
Dy	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Er	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Eu	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Gd	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ho	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
La	<5	<5	<5	<5	<5	250	250	1725	1500	40	60	30	55	75	80
Lu	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nd	<5	<5	<5	<5	<5	<5	350	2400	2100	30	140	<5	<5	145	145
Pr	<5	<5	<5	<5	<5	70	80	550	520	20	20	10	20	20	25
Sm	<5	<5	<5	<5	<5	<5	<5	600	600	<5	<5	<5	<5	<5	<5
Tb	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Y	<5	<5	<5	<5	<5	10	8	55	30	5	<5	10	10	10	10
Yb	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Tm	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

[a]Sumitomo Machinery Corporation of America, 7 Malcolm Avenue, Teterboro, New Jersey.
[b]Maywood Chemical Works, Maywood, New Jersey.

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