M-734

Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for the Maywood Site, New Jersey

US Army Corps of Engineers®

M-734

ORNL/TM-11118

HEALTH AND SAFETY RESEARCH DIVISION

Nuclear and Chemical Waste Programs
(Activity No. AH 10 05 00 0; ONLWCO1)

RESULTS OF THE RADIOLOGICAL SURVEY AT METPATH INCORPORATED, 1 MALCOLM AVENUE, TETERBORO, NEW JERSEY (TJ003)

R. D. Foley and L. M. Floyd

Date Published – February, 1989

Investigation Team

R. E. Swaja – Measurement Applications and Development Manager
W. D. Cottrell – FUSRAP Project Director
R.D. Foley – Field Survey Supervisor

Survey Team Members

A. C. Butler
C. Johnson
J. H. Rice
C. A. Muhr
W. Winton

Work performed as part of the
MEASUREMENT APPLICATIONS AND DEVELOPMENT GROUP

Prepared by the
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831–6285
operated by
MARTIN MARIETTA ENERGY SYSTEMS, INC.
for the
U. S. DEPARTMENT OF ENERGY
under Contract No. DE-AC05-84OR21400

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

Research for this project was sponsored by the Division of Facility and Site Decommissioning Projects, U.S. Department of Energy, under Contract No. DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc. The authors wish to acknowledge the support of J. E. Baublitz, Acting Director, Office of Remedial Action and Waste Technology; J. J. Fiore, Director, Division of Facility and Site Decommissioning Projects; and members of their staffs. The authors also appreciate the contributions of J. L. Rich, B. C. Littleton and L. J. Jeffers of the Publications Division, and B. S. Ellis, D. A. Roberts, and T. R. Stewart of the Measurement Applications and Development group for participation in the collection, analyses, and reporting of data for this survey.

ABSTRACT

An investigative survey was conducted at Metpath Incorporated, 1 Malcolm Avenue, Teterboro, New Jersey (TJ003), 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 Metpath, 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 METPATH INCORPORATED, 1 MALCOLM AVENUE, TETERBORO, NEW JERSEY (TJ003)*

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 MCW. The principal radionuclide of concern is thorium-232. The radiological

*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.

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 1 Malcolm Avenue, Teterboro, New Jersey, was conducted during 1986 and 1988. The survey and sampling of the ground surface over a major portion of the property were carried out on November 16–20, 1986. An unused parking area was surveyed on January 21, 1988 (Fig. 1). 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 licenced by the Nuclear Regulatory Commission to use thorium in an onsite Navy/Bendix process. Around 1976, the property was subdivided into three parcels, and one parcel of about 30 acres was purchased by Metpath Incorporated. Subsequent to this purchase, Metpath leased the General Engineering Test Building (Fig. 1) back to Bendix Aerospace, the present occupants of the building.

SURVEY METHODS

The radiological survey of the property included: (1) a gamma scan of the entire property surface outdoors and (2) collection of 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.

Gamma Radiation Levels

Gamma radiation levels measured during a gamma scan of the surface of the property are given in Fig. 2, and in the enlargement of the northeastern section of the property shown in Fig. 3. Gamma exposure rates over the major portion of the property ranged from 9 to 28 μR/h. Higher measurements were found along the fence in the northeastern section of the property and are indicated by shading in Figure 3. Most gamma readings were near normal background for the northern New Jersey area (Table 2). Some slightly elevated gamma levels were detected in certain areas of the main parking lot. These elevated measurements originated from a particular type of asphalt used in both paving and patching various sections of the parking lot. This type of asphalt has been used in other locations in the Maywood area, where it was also found to have elevated gamma levels. Based on asphalt sampling of a property in one of these other areas, the fill aggregate is thought to contain slightly elevated, naturally occurring radionuclides.

Two of the three regions having elevated gamma exposure rates were on the north and south sides of the General Engineering Test Building, each spot being less than 0.1 m^2 in size; the maximum level found for each was 28 μR/h (Fig. 3). The third region, referred to as Unused Parking in the Figures, was a fenced and mostly paved area which has not been utilized for several years. The area was overgrown in places with a sturdy, grass-like vegetation. The southwestern corner was not paved and was covered with small brush and briars. This corner also had a section of abandoned railroad track, approximately 30 meters long. The gamma range for the entire area inside the fence was from 4 to 7 μR/h. Adjacent to the north side of the fence line, a small area, approximately 2 meters long, read up to 17 μR/h. This spot was sampled (B10A&B).

North of this unused parking area was an industrial ditch, located outside of and parallel to the fence. The ditch bank continued north of the fence for approximately 0.6 to 0.9 meters and then dropped to the water at about a 45 degree angle. The distance from the fence to the water's edge was about 3.0 meters. The gamma readings on the surface of the ditch bank, outside the fence, ranged from 8 to 1100 μR/h.

Beginning at the northeastern corner of the lot and progressing west for 10 meters, the ditch bank consisted of broken concrete. At this point, 55–gallon, metal drums could be seen sticking out of the bank and are indicated in Figs. 2–5 with shading. These drums continued intermittently for another 38 meters, until the bank dropped from about 1.5 m to 0.3 m above the water level. This lower level of the bank continued downstream to the eastern property line. There were remains of approximately 24 drums in various stages of decay. Several of these drums had rusted open, and the contents were visibly migrating into the ditch water. Some of the drums were open and appeared empty, while others were still closed. None of the closed drums were opened by the survey team. The contents of one drum was hard and caked, resembling defective concrete. Sample B11 was chipped out with some effort. The surface gamma reading was 85 μR/h; 15 cm inside the drum read 230 μR/h. Another sample (B12) was taken from the contents of a drum in which the exposed metal portion had completely rusted away. The gamma level for this drum was 1100 μR/h at the surface and 2600 μR/h at a depth of 15 cm. The material in the drum was a light, whitish-gray color and had the granular texture and consistency of sand.

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. 4 and in the enlargement of the northeastern section of the property shown in Fig. 5, with results of laboratory analyses provided in Table 3 Concentrations of radium, thorium, and uranium in the systematic samples ranged from 0.33 to 77 pCi/g, 0.39 to 31 pCi/g, and 0.38 to 1.0 pCi/g, respectively. Areas of the highest concentrations of radium and thorium in the systematic samples (S8A&B and S9A&B) were found on the north and south sides of the Engineering Test Building. The maximum values for these samples were 77 pCi/g for radium in S8A and 31 pCi/g for thorium in S9A. In both locations, these values were for areas no greater than 0.1 m^2 and therefore, not above DOE criteria for areas averaged over one square meter (Table 1).

Concentrations of radium, thorium, and uranium in the biased samples ranged from 0.51 to 14 pCi/g, 0.45 to 1300 pCi/g, and <3.2 to <12 pCi/g, respectively. Biased samples were taken from three locations, one south (B10A&B) and two north (B11 & B12) of the fence bordering the ditch on the north side of the unused parking area. Soil samples B10A&B had radium and thorium values slightly below normal background levels for the northern New Jersey area (Table 2) and uranium values below minimum detectable amounts (MDA). Sample B11 was taken from a drum which had rusted open and contained 1.4 pCi/g of ^{226}Ra, 74 pCi/g of ^{232}Th, and MDA of ^{238}U. Sample B12 was taken from the area where the contents of an open drum were visibly migrating into the ditch water and contained 14 pCi/g of radium and 1300 pCi/g of thorium. These last two samples were in excess of relevant government criteria (Table 1). Analyses of elemental rare earths for Metpath Incorporated and MCW are given in Table 4.

SIGNIFICANCE OF FINDINGS

Measurements taken at 1 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. This contamination was found adjacent to the northern fence of the unused parking area and along the bank of the ditch bordering this fence in several decaying 55–gallon drums. Some of these drums contained radioactive material with concentrations up to 1300 pCi/g of ^{232}Th and 14 pCi/g of ^{226}Ra. However, DOE 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 radium contamination is not known, but it is clearly atypical of material generated by MCW. Table 4 indicates that the contaminated soil from 1 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 Metpath'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.

REFERENCES

1. W. D. Cottrell, ORNL, to A. J. Whitman, DOE/HQ, correspondence, "Radiological Survey of Private Properties in Lodi, New Jersey" (August 15, 1984).
2. T. E. Myrick, B. A. Berven, W. D. Cottrell, W. A. Goldsmith, and F. F. Haywood, *Procedures Manual for the ORNL Radiological Survey Activities (RASA) Program* Oak Ridge National Laboratory, ORNL/TM-8600 (April 1987).
3. U.S. Department of Energy, *Guidelines for Residual Radioactivity at Formerly Utilized Sites, Remedial Action Program and Remote Surplus Facilities Management Program Sites* (Rev. 2, March 1987).
4. T. E. Myrick and B. A. Berven, *State Background Radiation Levels: Results of Measurements Taken During 1975-1979*, Oak Ridge National Laboratory, ORNL/TM-7343 (November 1981).

ORNL-DWG-89-6935

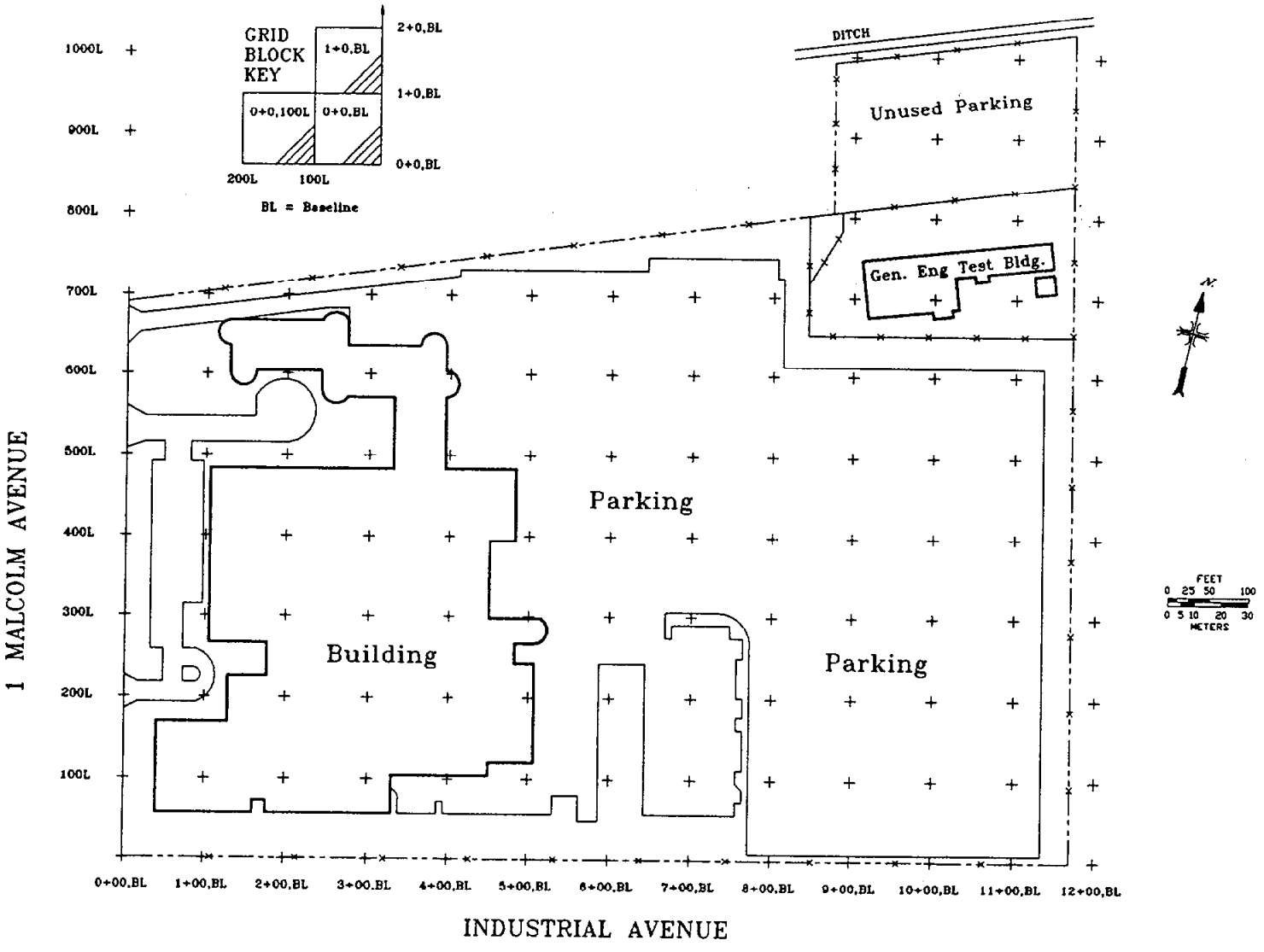

Fig. 1. Diagram showing grid lines for the property at Metpath Incorporated, 1 Malcolm Avenue, Teterboro, New Jersey (TJ003).

ORNL-DWG-89-6936

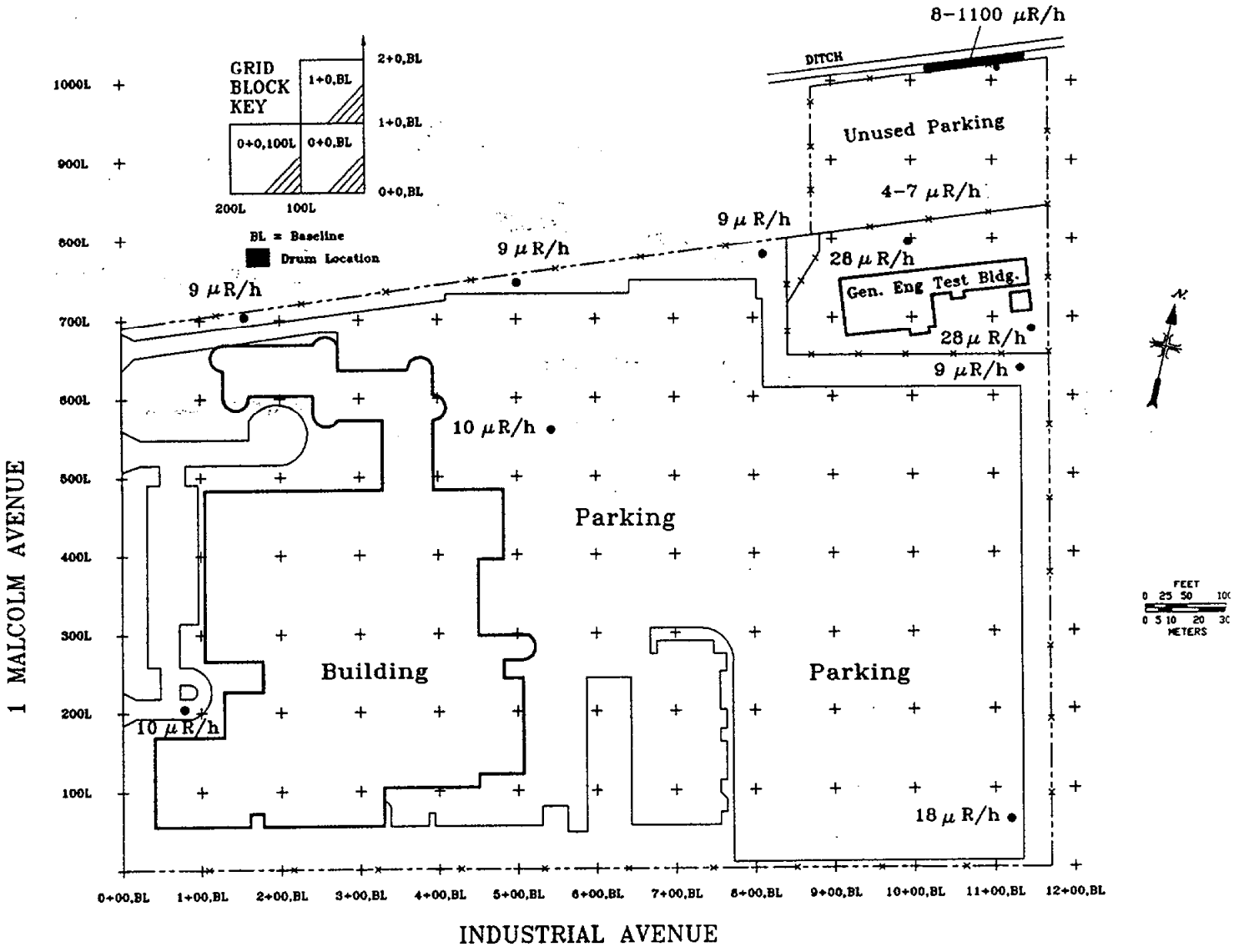

Fig. 2. Gamma radiation levels (μR/h) measured on the surface at Metpath Incorporated, 1 Malcolm Avenue, Teterboro, New Jersey (TJ003).

ORNL-DWG-89-6937

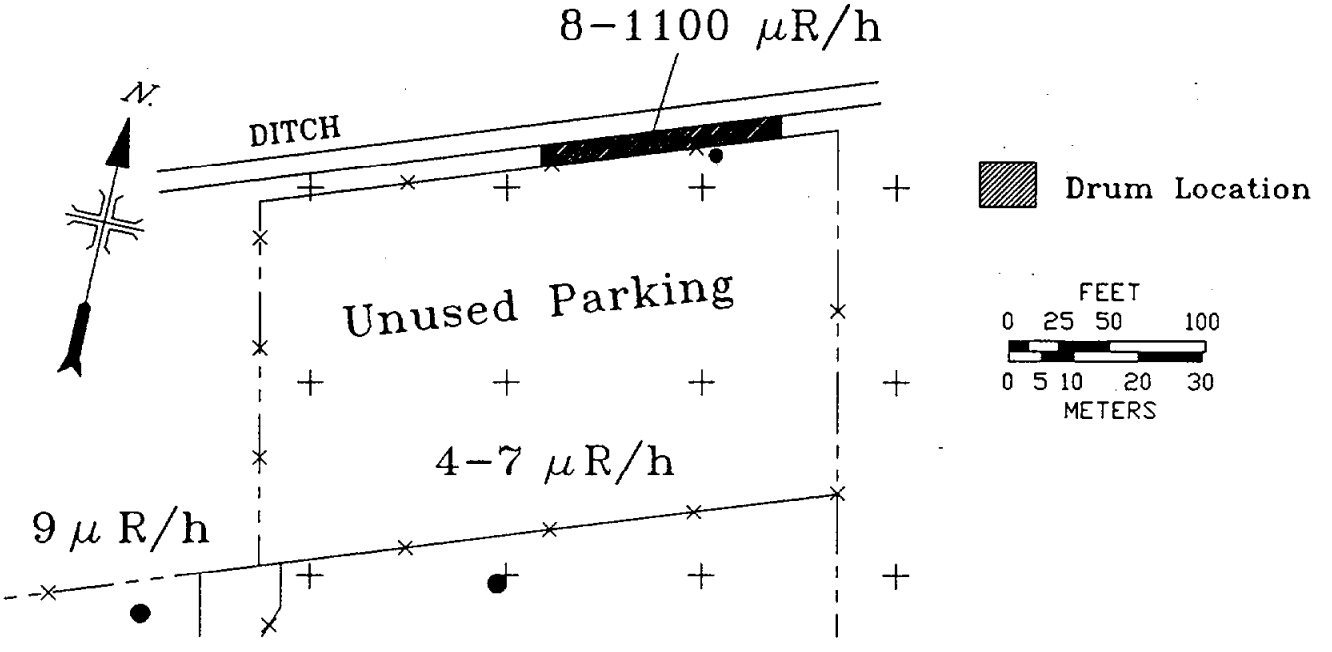

Fig. 3. Enlargement of the northeastern section of Metpath Incorporated, 1 Malcolm Avenue, Teterboro, New Jersey (TJ003), with gamma radiation levels (μR/h) measured on the surface.

ORNL-DWG-89-6938

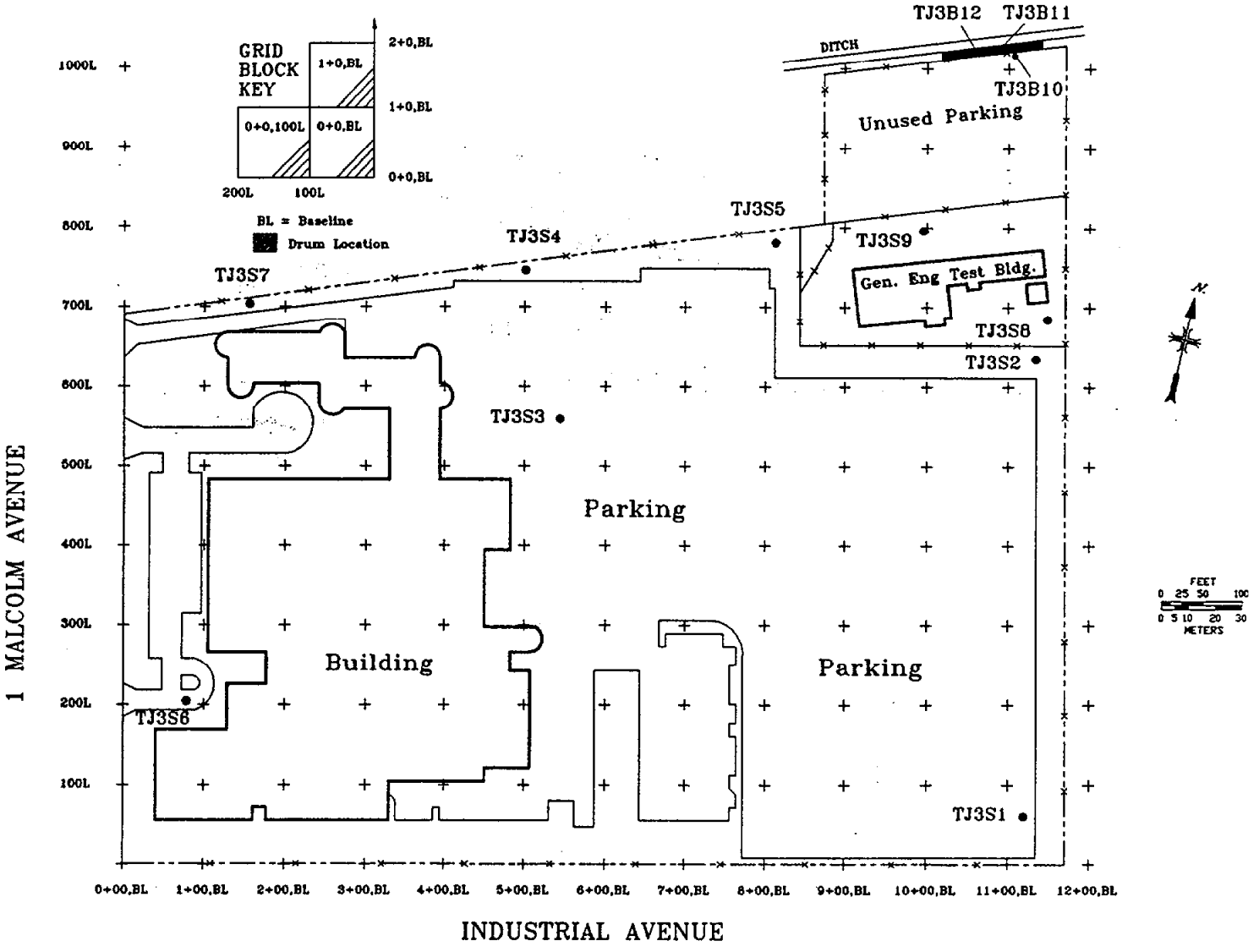

Fig. 4. Diagram showing locations of soil samples taken at Metpath Incorporated, 1 Malcolm Avenue, Teterboro, New Jersey (TJ003).

ORNL-DWG-89-6939

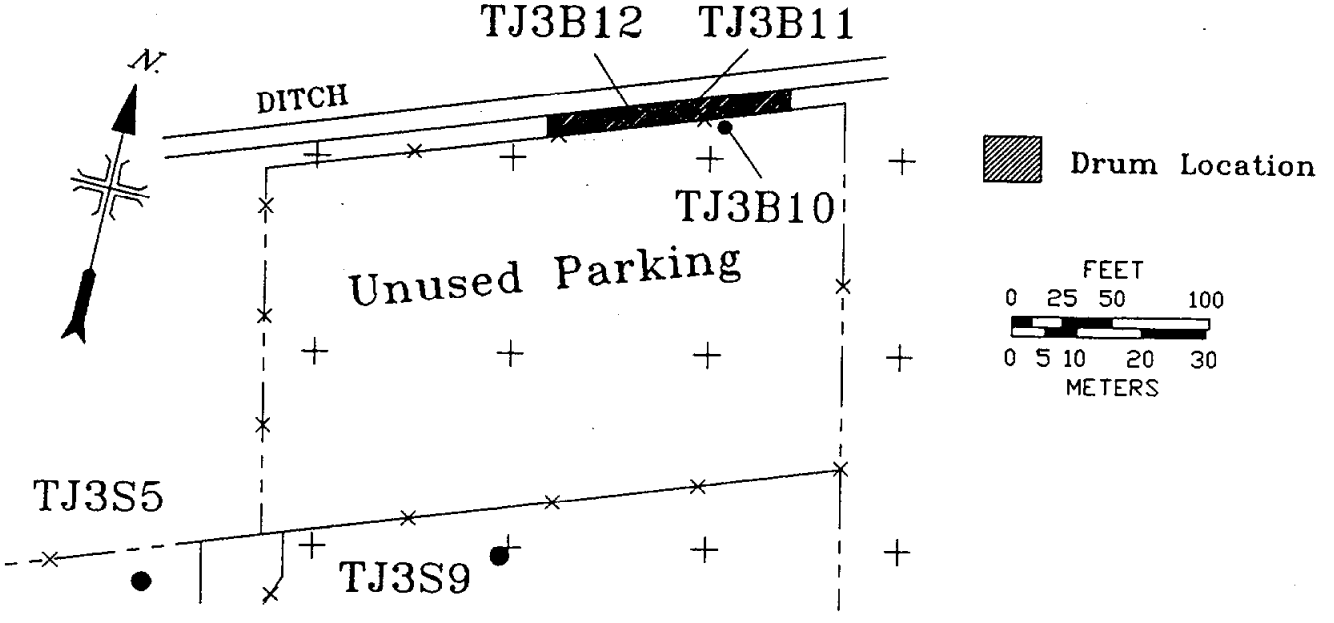

Fig. 5. Enlargement of the northeastern section of Metpath Incorporated, 1 Malcolm Avenue, Teterboro, New Jersey (TJ003), showing the locations of soil samples.

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
Guidelines for nonhomogeneous contamination (used in addition to the 100 m^2 guideline)[b]	Applicable to locations meeting the above criterion but $\leq$25 m^2 with significantly elevated concentrations of radionuclides	Concentration limits for application to "hot spots" varying in size as follows: (m^2) (pCi/g)[c] <1 50 1–<3 30 3–<10 15 10–25 10

[a]From Reference 3.

[b]"Every reasonable effort shall be made to identify and remove any source which has a concentration exceeding 30 times the guideline value, irrespective of area."

[c]These guideline values are applicable to surface concentrations of ^{232}Th, ^{230}Th, ^{228}Ra, and ^{226}Ra only; for other radionuclides and subsurface values, see Reference 3.

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

Type of radiation measurement or sample	Radiation level or radionuclide concentration
Concentration of radionuclides in soil (pCi/g)	
^{232}Th	0.9[a]
^{238}U	0.9[a]
^{226}Ra	0.9[a]

[a]Reference 4.

Table 4. Concentrations of radionuclides in soil at Metpath Incorporated, 1 Malcolm Avenue, Teterboro, New Jersey (TJ003)

Sample	Location[a]	Depth (cm)	Radionuclide concentration(pCi/g)		
			^{226}Ra[b]	^{232}Th[b]	^{238}U[c]
		Systematic samples[d]			
S1A	11+18 ,55L	0–15	0.46±0.06	2.5 ±0.2	0.55
S1B	11+18 ,55L	15–30	0.53±0.08	1.1 ±0.2	0.43
S1C	11+18 ,55L	30–45	0.56±0.06	0.95±0.2	0.61
S2A	11+41 ,618L	0–15	0.58±0.07	0.65±0.08	0.88
S2B	11+41 ,618L	15–30	0.46±0.05	0.50±0.1	0.40
S2C	11+41 ,618L	30–45	0.56±0.09	0.55±0.09	0.81
S2D	11+41 ,618L	45–60	0.44±0.04	0.49±0.09	0.54
S2E	11+41 ,618L	60–75	0.50±0.08	0.60±0.06	0.52
S2F	11+41 ,618L	75–90	0.56±0.02	0.64±0.04	0.53
S3A	5+46 ,555L	0–15	0.70±0.07	0.75±0.26	0.56
S3B	5+46 ,555L	15–30	0.33±0.2	1.9 ±0.3	0.46
S4A	5+05 ,736L	0–15	0.66±0.1	0.61±0.2	0.75
S4B	5+05 ,736L	15–30	0.61±0.03	0.63±0.1	0.48
S4C	5+05 ,736L	30–45	0.55±0.04	0.59±0.08	0.41
S5A	8+14 ,773L	0–15	0.58±0.05	0.49±0.1	0.55
S5B	8+14 ,773L	15–30	0.51±0.05	0.39±0.07	0.39
S6A	0+85 ,209L	0–15	0.77±0.07	0.78±0.09	0.86
S6B	0+85 ,209L	15–30	0.75±0.05	0.82±0.2	0.84
S6C	0+85 ,209L	30–45	0.74±0.08	0.77±0.1	0.83
S6D	0+85 ,209L	45–75	0.68±0.04	0.78±0.08	0.72
S7A	1+64 ,709L	0–15	0.71±0.06	0.69±0.1	0.93
S7B	1+64 ,709L	15–30	0.65±0.1	0.69±0.2	0.99
S7C	1+64 ,709L	30–45	0.72±0.05	0.75±0.1	0.88
S7D	1+64 ,709L	45–60	0.45±0.08	0.66±0.2	0.47
S8A	11+46 ,677L	0–15	77 ±3	0.42±0.2	0.39
S8B	11+46 ,677L	15–30	28 ±0.9	0.52±0.2	0.38
S9A	10+00 ,800L	0–15	1.3 ±0.3	31 ±2.4	0.83
S9B	10+00 ,800L	15–30	1.1 ±0.3	12 ±1.5	1.0

Table 4. (Continued)

Sample	Location[a]	Depth (cm)	Radionuclide concentration(pCi/g)		
			^{226}Ra[b]	^{232}Th[b]	^{238}U[c]
			Biased samples[e]		
B10A	11+05 ,1003L	0–13	0.51±0.04	0.45± 0.06	<7
B10B	11+05 ,1003L	13–20	0.53±0.1	0.50± 0.2	<3.2
B11	10+90 ,1005L	0–10	1.4 ±0.4	74 ± 13	<12
B12	10+50 ,1005L	0–15	14 ±4	1300 ±250	

[a]Locations of soil samples are shown on Fig. 2.

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

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

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

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

Table 4. Mass Spectroscopy for Elemental Rare Earths at Various Sites in the Teterboro and Maywood, New Jersey, Areas

	Metpath Site[a] Sample Numbers		Maywood Chemical Works Site[b] Sample Numbers									
Rare Earths (ppm)	TJ3–S8A	TJ3–S9A	354	355	356	357	358	359	360	361	362	363
Ce	<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
Er	<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
Gd	<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
La	<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
Nd	<5	<5	<5	350	2400	2100	30	140	<5	<5	145	145
Pr	<5	<5	70	80	550	520	20	20	10	20	20	25
Sm	<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
Y	<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
Tm	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

[a]Metpath Incorporated, 1 Malcolm Avenue, Teterboro, New Jersey.
[b]Maywood Chemical Works, Maywood, New Jersey.

INTERNAL DISTRIBUTION

1. B. A. Berven
2. W. D. Cottrell
3. A. G. Croff
4. J. T. Ensminger
5. L. M. Floyd
6–10. R. D. Foley
11. S. V. Kaye
12. P. T. Owen
13–15. R. E. Swaja
16. J. K. Williams
17. Central Research Library
18. ORNL Technical Library, Y–12
19. Information Analysis Library
20. IR&A Publications Office
21–22. Laboratory Records
23. Laboratory Records – RC
24. ORNL Patent Section

EXTERNAL DISTRIBUTION

25. J. D. Berger, Oak Ridge Associated Universities, P. O. Box 117, Oak Ridge, TN 37831
26. R. W. Doane, Eberline, Inc., 800 Oak Ridge Turnpike, P. O. Box 350, Oak Ridge, TN 37831
27. J. J. Fiore, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874
28–30. G. K. Hovey, Bechtel National, Inc., 800 Oak Ridge Turnpike, P. O. Box 350, Oak Ridge, TN 37831
31. L. R. Levis, Roy F. Weston, Inc., 20030 Century Blvd., Germantown, MD 20874
32. G. P. Turi, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874
33. J. W. Wagoner, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874
34–36. Andrew Wallo III, U.S. Department of Energy, 19901 Germantown Road, Germantown, MD 20874
37. Office of Assistant Manager for Energy Research and Development, Oak Ridge Operations Office, P. O. Box 2001, Oak Ridge, TN 37831–8600
38–39. Office of Scientific and Technical Information, DOE, P. O. Box 62, Oak Ridge, TN 37831