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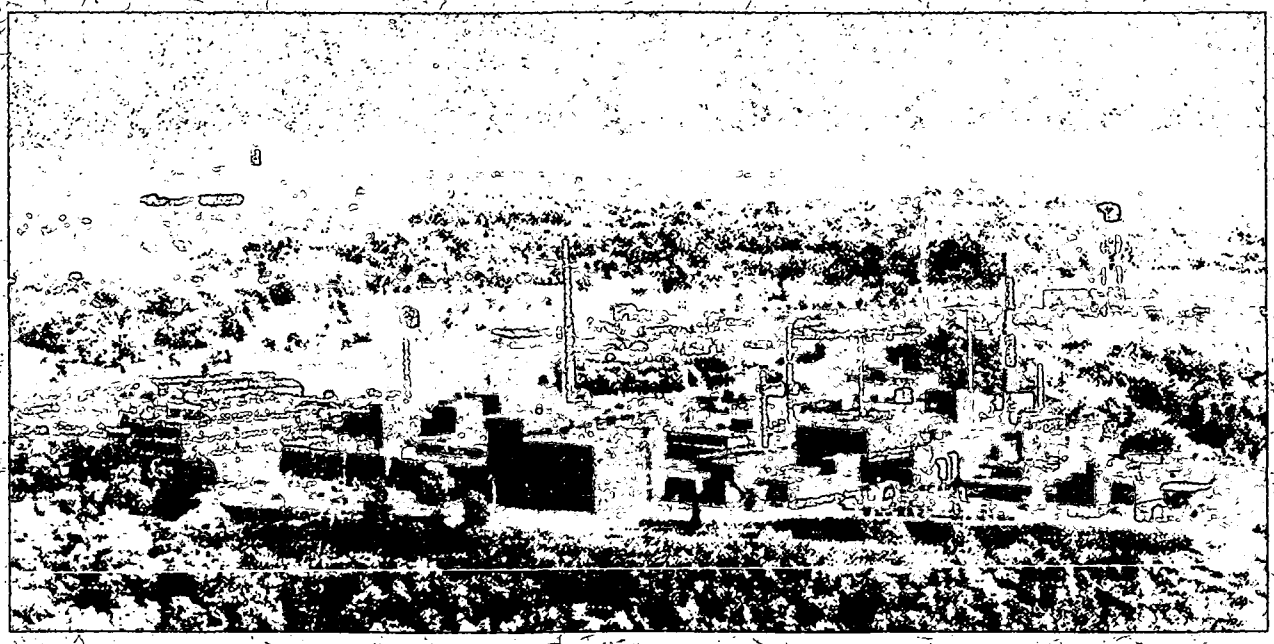
Environmental
Restoration
Program

Miamisburg Closure Project
Potential Release Site Package

PRS 154/238

Public Review Draft
January 2003



Environmental Restoration Program

MIAMISBURG CLOSURE PROJECT
POTENTIAL RELEASE SITE PACKAGE
Notice of Public Review Period

The following Potential Release Site (PRS) package is available for public review in the CERCLA Public Reading Room, 305 E. Central Ave., Miamisburg, Ohio. Public comment on this document will be accepted 22 January 2003 through 20 February 2003.

PRS 154/238: WD Hillside, Area 23

Questions can be referred to Paul Lucas at (937) 865-4578.

PRS 154/238 Package Tracking Sheet

REVISION	DESCRIPTION	DATE
Working Draft (to DOE)		
Draft (to Core Team)		
Draft Proposed Final	Binned FA on 10 July 1997. Submitted Addendum 1 with FA results and received RA bin on 11 December 2002. Revised Addendum 1 text and recommendation page per OEPA comments. No USEPA comments. Added Addendum 1 to original Package for Public Review.	
Public Review Draft	Public review period 22 Jan-20 Feb 2003.	**January 2003**
Final		

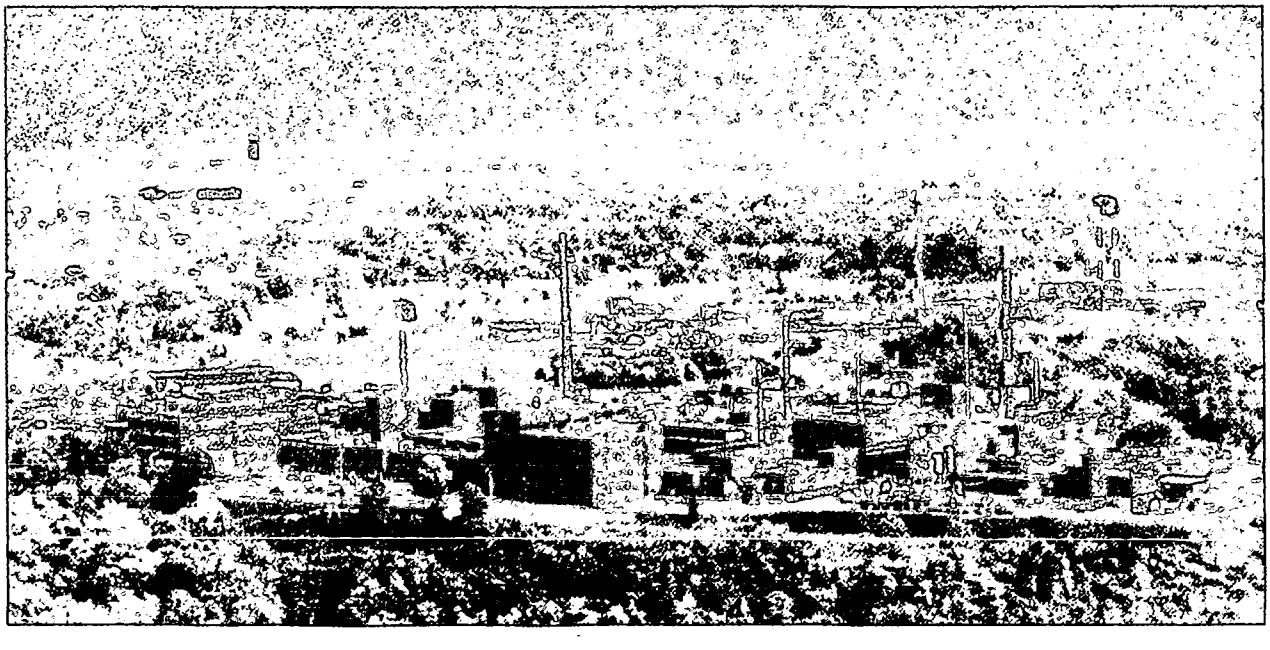
ADDENDUM 1

SUPPORTING RA RECOMMENDATION

Environmental
Restoration
Program

Miamisburg Closure Project
Potential Release Site Package
PRS 154/238
Addendum 1

Public Review Draft
January 2003



PRS HISTORY:

Potential Release Sites (PRSs) 154 and 238 (hereinafter 154/238) are shown in Figure 1. PRS 154, also known as Area 23, is an area of potential soil contamination located on the WD hillside. The main contaminant of concern for PRS 154 is plutonium-238, with several other isotopes identified sporadically in the area. PRS 238 was identified as PRS based on historic sample results of plutonium-238, radium-226, and uranium-238 at unacceptable levels. PRS 154/238 was binned Further Assessment (FA) by the Core Team on 10 July 1997.

FURTHER ASSESSMENT ACTIVITY:

The potential contaminants of concern (plutonium-238, actinium-227, thorium-230, thorium-232, radium-226, and uranium-238) were identified based on historic sample results above acceptable levels.

Further Assessment sampling was completed between July and August of 2002 per the Sampling and Analysis Plan (**SAP**)[1] approved by the Core Team.

All soil samples (49 plus 5 duplicates) were analyzed per the SAP by onsite gamma and alpha (isotopic thorium and uranium) spec and 10% (6 plus 1 duplicate) were forwarded offsite for gamma spec and isotopic plutonium, thorium, and uranium analysis by alpha spec.

FA sample locations are presented on Figure 2. The FA **Data Report**[2] presents a full account of soil sampling activities and sample results (onsite and offsite laboratory analyses).

Maximum sample detections above screening levels (10^{-6} Risk-Based Guideline Value (RBGV) plus background) are presented in Table 1. None of the plutonium-238 results were greater than the screening level.

Table 1: FA Results above Screening Levels (pCi/g)
(footnotes on next page)

Radionuclide	No. >SL	No.>CO	Max. Result	Location & depth	SL	CO
Actinium-227+D	7 of 49	3 of 49	104	SD05, 0'	0.56	4.6
Bismuth-210m	1 of 49	0 of 49	4.88	SD05, 0'	1.0	8.3
Cerium-141	3 of 6	0 of 6	36.1	SD05, 0'	3.8	38
Cesium-137+D	1 of 49	0 of 49	0.856	SD05, 0'	0.76	3.8
Cobalt-60	1 of 49	0 of 49	0.158	SD04, 0'	0.07	0.7
Lead-210+D	7 of 49	3 of 49	22.45	SD05, 0'	1.8	7.4
Neptunium-237+D	1 of 2	0 of 2	1.7	SD05, 0'	1.04	10.4
Niobium-95	2 of 2	2 of 2	3.41	SD05, 0'	0.25	2.5
Protactinium-231+D	all*	3 of 49	80.1	SD05, 0'	4.0	4.0
Radium-226+D	5 of 49	3 of 49	19.1	SD05, 0'	2.1	2.9
Radium-228+D	7 of 7	7 of 7	1.69	SD05, 0'	0.07	0.7
Thorium-230+D	9 of 49	8 of 49	1020	SD05, 0'	2.0	2.8
Thorium-232+D	2 of 49	1 of 49	2.44	SD05, 0'	1.47	2.1
Uranium-234+D	2 of 49	2 of 49	3.45	SD05, 0'	1.2	2.0
Uranium-238+D	2 of 49	1 of 49	4.12	SD05, 0'	1.3**	2.2**

Footnotes on next page

RBGV: Risk-Based Guideline Value
SL: screening level
CO: cleanup objective
*The CRDL is greater than the screening level and will have to be updated.
**The RBGV in the SAP did not include daughter products. Daughter products included herein.

FIGURES:

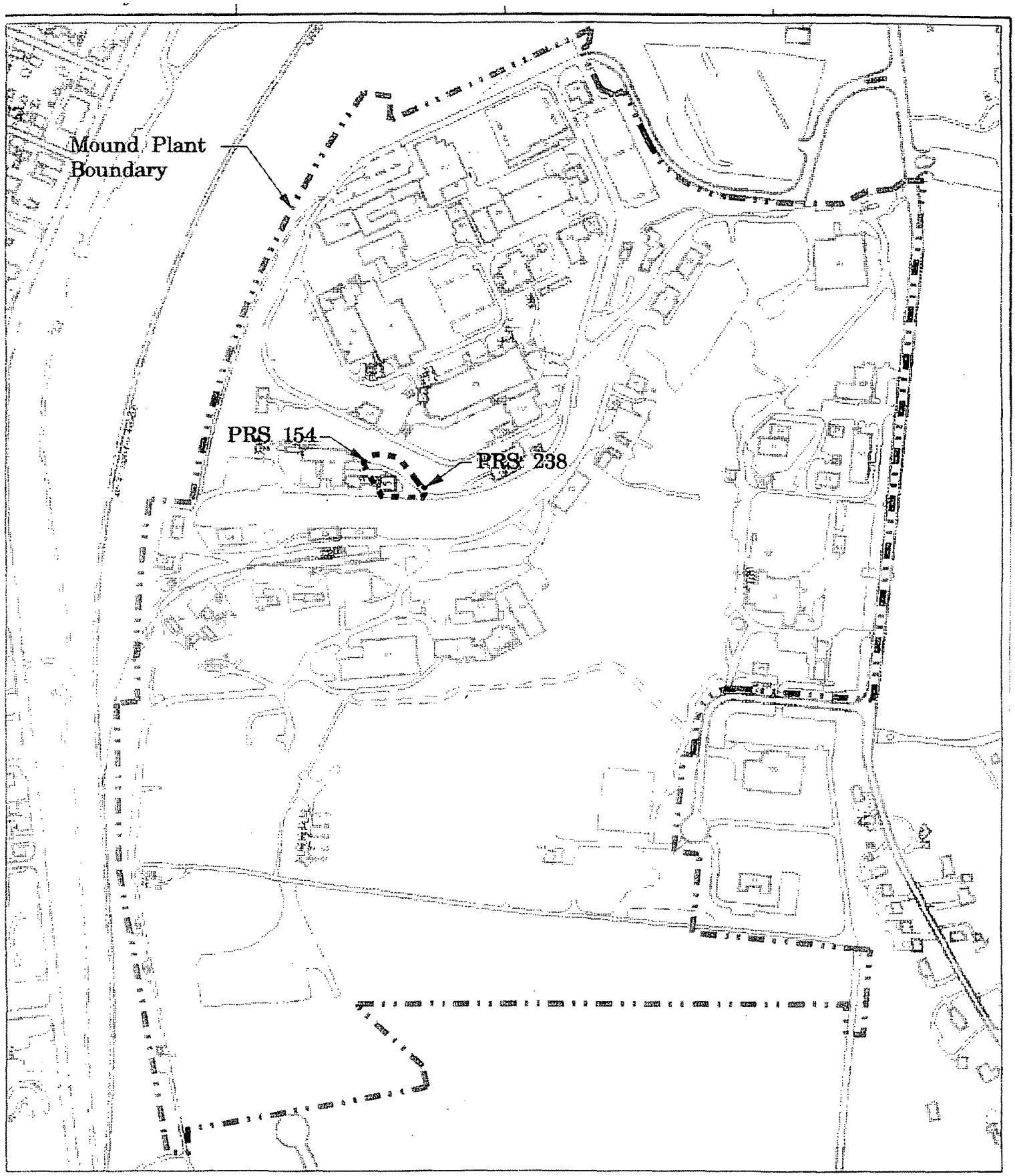
Figure 1: Location of PRS 154/238
Figure 2: PRS 154/238 Sample Locations

REFERENCES:

1) PRS 154/238 Sampling & Analysis Plan, Final, June 2002
2) PRS 154/238 Data Report, Rev. 0, November 2002

PREPARED BY:

Karen M. Arthur, CH2MHill, ER QA
Gary Miller, CH2MHill, ER Technical Staff



Legend

Structures
Paved roadway
Unpaved roadway
Mound Plant boundary
Railroad

0 100 200 400 600 800 1000
Scale in Feet

ISS	DATE	REVISION	BY	CHKR	ENG	LPMEE	APVD	#
	05/30/02	*	SSP					

MOUND

Environmental Restoration Geographic Information System

SHEET	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ISSUE																					

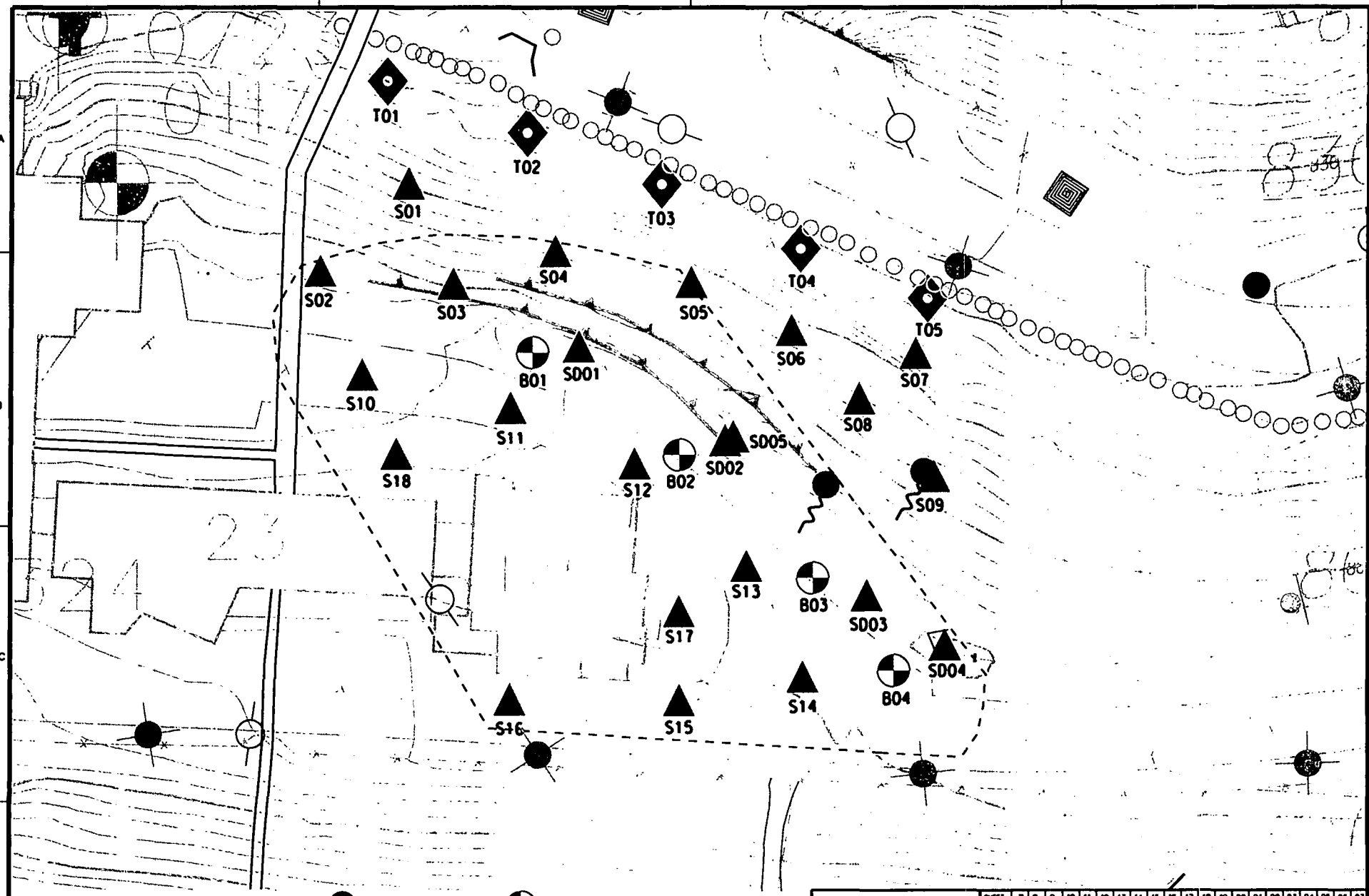
SHEET	1	2	3	4	5	6
ISSUE						

PART CLASSIFICATION

Figure 1
Location of PRS 154/238

DRAWING CLASSIFICATION: UNCLASSIFIED
SIZE
DRAWING NUMBER: gen_site_plan.dgn
JOB NUMBER
DWG TYPE: STE
PRNG: ER-GIS
CADD
SCALE
SHEET 1 OF
STATUS: MD-REL -**/**/**
ORIGIN: MSTATION / .1

3 of 5



MOUND

Environmental Restoration Geographic Information System

SHEET	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
ISSUE																					
SHEET	1	2	3	4	5	6															
ISSUE	A																				

PART CLASSIFICATION

FIGURE 2
PRS 154/238
SAMPLE LOCATIONS

DRAWING CLASSIFICATION: UNCLASSIFIED | SIZE | DRAWING NUMBER: fig2_samp_loc.dgn | JOB NUMBER: *

DWG TYPE: STE | PRNG: ER-GIS | CADD: | SCALE: GRAPHIC | SHEET 1 OF 1

STATUS: MD-REL-04/22/02 | ORIGIN: MSTATION / J

ISS	DATE	REVISION	BY	CHKR	DWG	UPDC	APVD	U
A	04/22/02	ISSUE FOR SAMPLING PLAN	KRW	*			*	

4 of 5

MIAMISBURG CLOSURE PROJECT
PRS 154/238

RECOMMENDATION:

Potential Release Site (PRS) 154, also known as Area 23, is located on the WD hillside and was identified as a PRS based on historic soil sample results of plutonium-238, radium-226, and uranium-238 at unacceptable levels. Further Assessment (FA) was performed and confirmed radionuclide contamination excess of cleanup objectives (10^{-5} Risk-Based Guideline Values plus background) for numerous radionuclides including actinium-227, lead-210, niobium-95, protactinium-231, radium-226 and 228, thorium-230 and 232, and uranium-234 and 238.

Therefore, the Core Team recommends a **Removal Action** for PRS 154/238.

This Removal Action will be performed under a specific Action Memorandum or under the Action Memorandum for Contingent Removal Actions. Successful completion of the Removal Action will be documented via an On-Scene Coordinator (OSC) Report signed by the Core Team, which will be placed in the Public Reading Room.

CONCURRENCE:

DOE/MCP: _____ 1/22/03
Robert S. Rothman, Remedial Project Manager (date)

USEPA: _____ 1/22/03
Timothy J. Fischer, Remedial Project Manager (date)

OEPA: _____ 1/22/03
Brian K. Nickel, Project Manager (date)

ORIGINAL DOCUMENT

SUPPORTING FA RECOMMENDATION

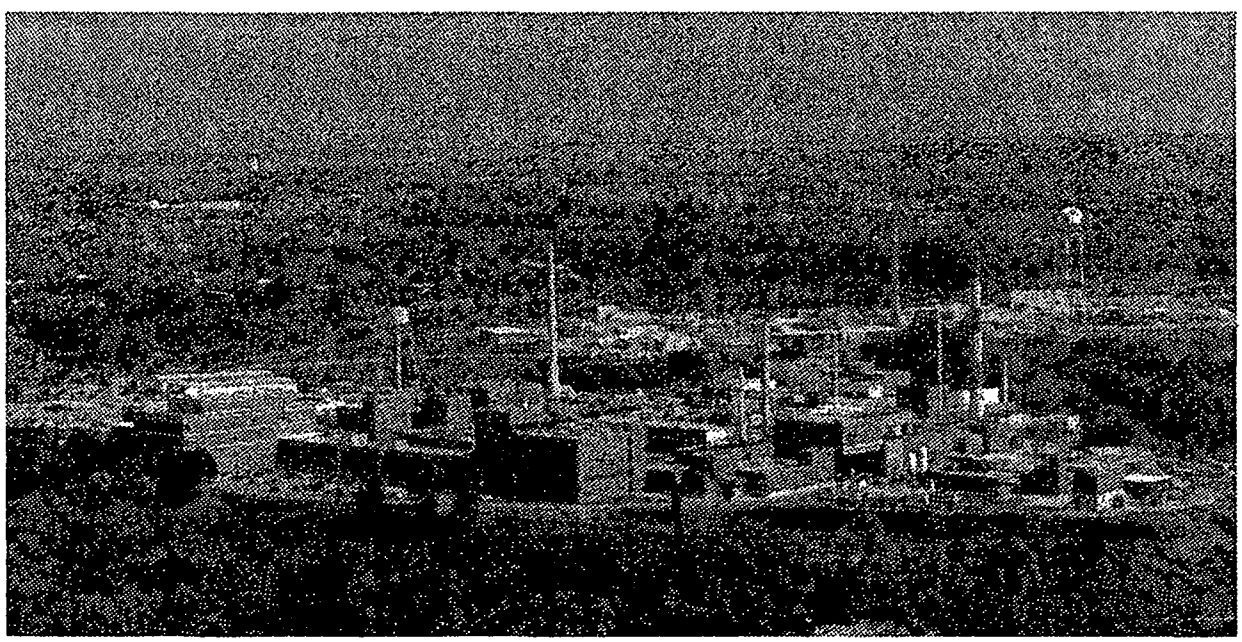
MOUND

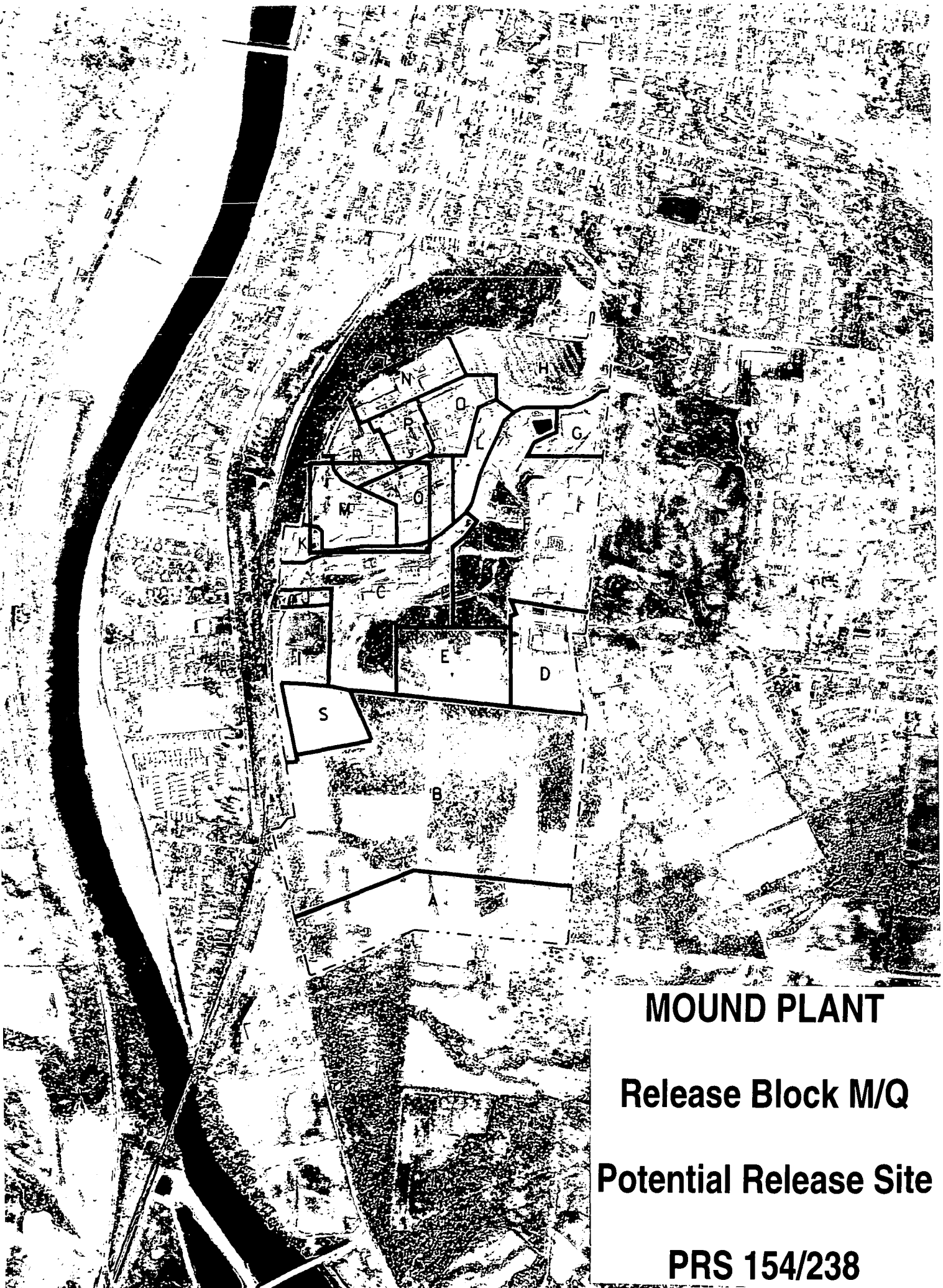
Environmental
Restoration
Program

MOUND PLANT

Potential Release Site Package

PRS # 154/238





MOUND PLANT

Release Block M/Q

Potential Release Site

PRS 154/238

H
N
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R
154
O
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238
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K
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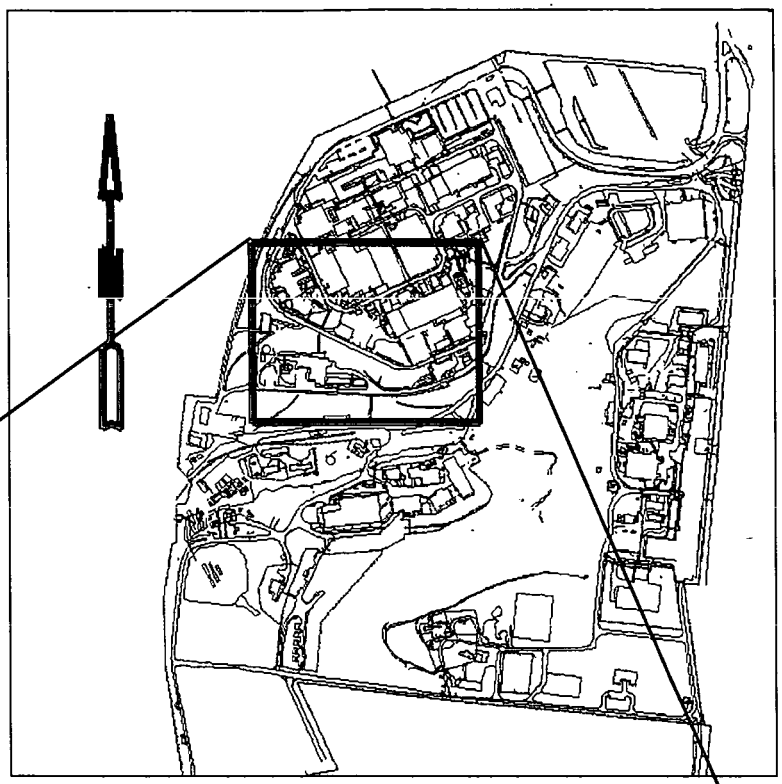
D
S
B
A

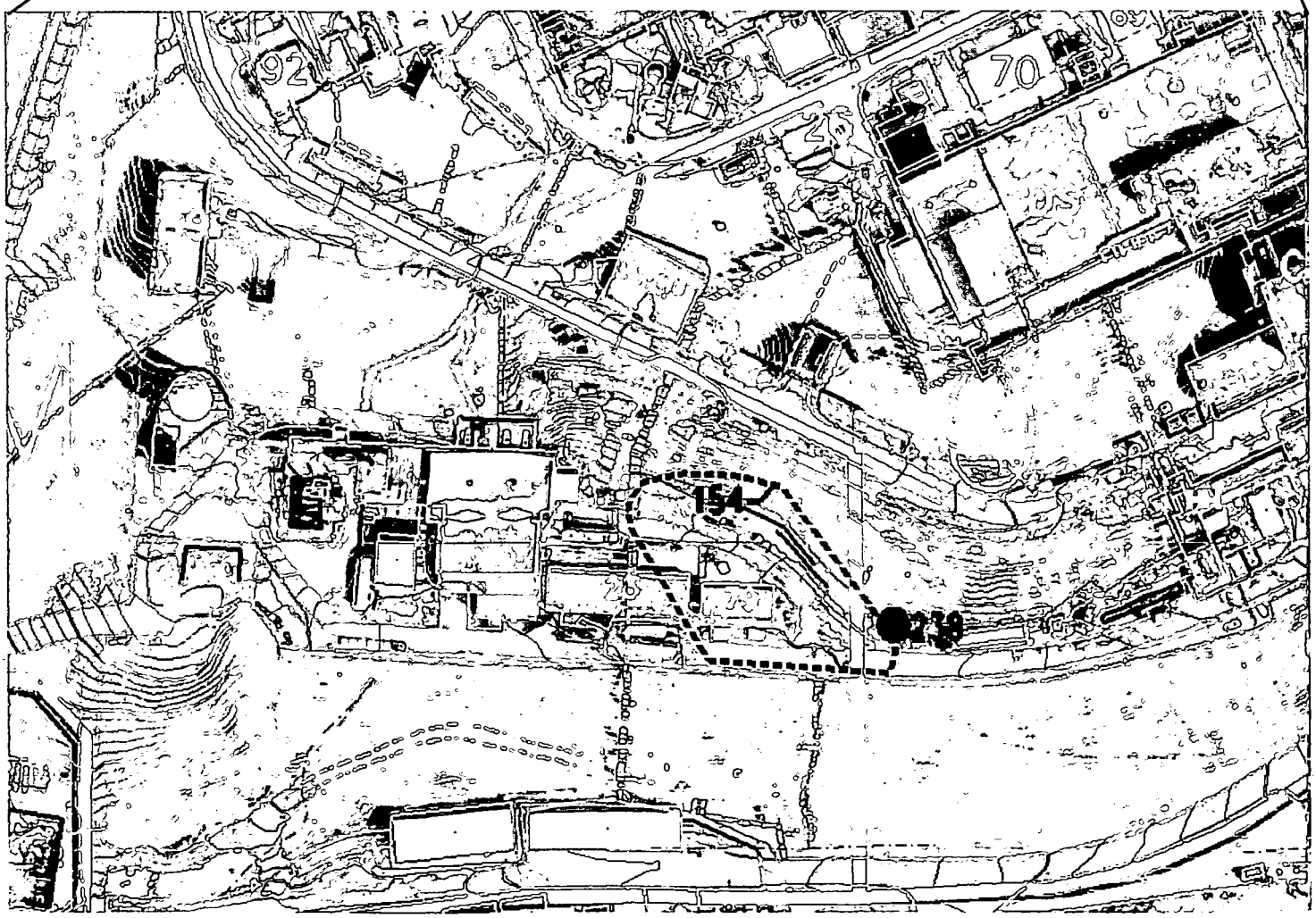
Mound Plant

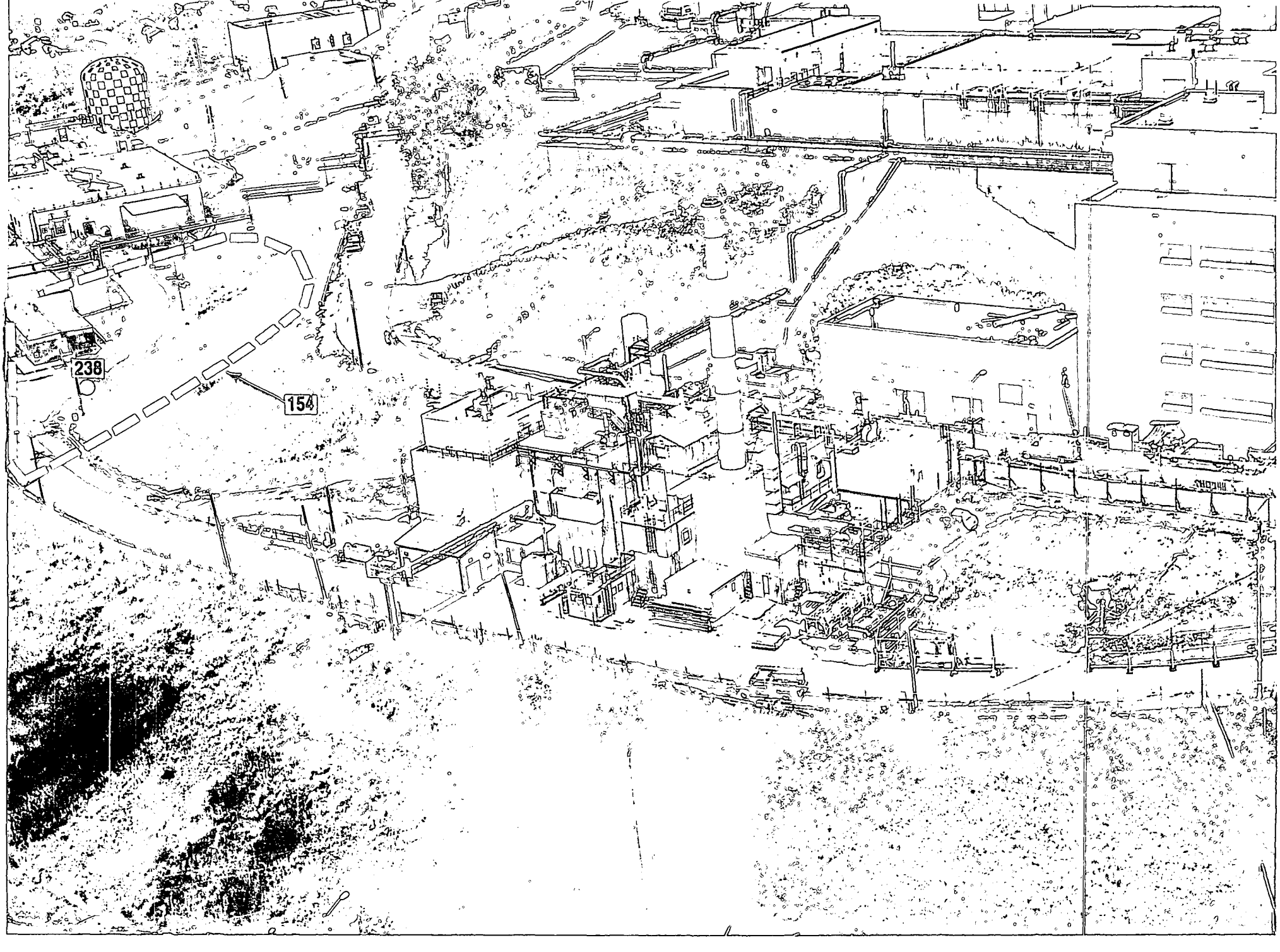
Release Block M/Q

Potential Release Site

PRS 154/238






238
154

PRS 154/238

PRS HISTORY:

Potential Release Site (PRS) 154 is identified as the hillside northeast of Building 23 and east of WD Building. This radiological soils contamination area is also known as Area 23. PRS 238 is identified as a radiological hot spot located within Area 23.[1] PRS 238 (hot spot S1092) was identified in the mid-1980s by the Site Survey Project. The larger Area 23 was identified in 1990 by field surveys and sampling that identified elevated levels of thorium-230.[2]

The thorium-230 contamination may have resulted from either the thorium-230, known as ionium (page 16), or protactinium-231 separation (page 18) programs. Both programs were active in the mid-1950s, and may have used the area for storage of wastes. Locations of the leaking waste containers from the protactinium-231 program are not accurately documented.[3]

An underground radioactive waste line passed through the upper boundaries of PRS 154. This waste line originally carried liquid radioactive waste from the Hydrolysis House (HH) Building to the Waste Disposal (WD) Building. This line was removed in May 1994 and is covered by PRS 153.

CONTAMINATION:

Radiological Site Survey[2]

In 1983, soil was analyzed for radioactivity via Mound Soil Screening, gamma spectroscopy, and radiochemical analysis. One surface sample was taken from PRS 238 and fourteen samples (thirteen surface and one core boring) were taken in the vicinity of PRS 154. The samples were analyzed for plutonium-238 and thorium. Results showed:

Contaminant	Maximum Concentration Detected	Guideline Criteria
Plutonium-238	19.8 pCi/g at PRS 154 0.31 pCi/g at PRS 238	25 pCi/g (Mound ALARA in surface soil)
Thorium-230	No results at PRS 154 323.5 pCi/g at PRS 238	5 pCi/g (40 CFR 192)[7]
Thorium-232	7.5 pCi/g at PRS 154 No results at PRS 238	5 pCi/g (40 CFR 192)[7]

NOTE: ALARA = as low as reasonably achievable, pCi/g = picocuries per gram

Building 23 Survey[2]

In 1990, a radiological survey, east of Building 23, collected and analyzed soil samples by gamma spectroscopy. Thorium-230 was detected at concentrations as high as 4,590 pCi/g.[2]

Soil Gas Survey[4]

In 1992, this survey indicated levels of Freon 11 at 801 ppb and Freon 13 at 13 ppb.[4] There are no guideline values for Freon 11 or Freon 13. Equivalent soil contamination concentrations cannot be calculated for these freon species, as no chemical specific parameters are available. Alternately the values are below the Permissible Exposure Limit (PEL) at 1000 ppm established by the Occupational Safety & Health Agency (OSHA) for worker chemical exposures.

Other Soils Characterization[5]

In 1995, PRS 154 and 238 were divided into 15 foot by 15 foot grids by the Other Soils characterization and soil samples were analyzed for organics (by organic vapor analyzer and organic vapor meter), metals (by x-ray fluoroscope) and radionuclides (field analysis by FIDLER and lab analysis by gamma spectroscopy). Samples were collected every four feet until a depth of 12 feet or refusal was reached. Sample results showed:

PRS 154

- Maximum soil radiological concentrations detected were 63 pCi/g for plutonium-238, 5 pCi/g for subsurface thorium-232 and 13.44 pCi/g for subsurface thorium-230.[5] Mound ALARA guideline criteria for plutonium is 25 pCi/g and the regulatory guideline for subsurface thorium is 15 pCi/g.
- All metal detections were below their respective 10^{-6} Risk Based Guideline Criteria for soils.
- Volatile organic compounds (VOCs) were detected in six samples (no quantitative data is available).[5]

PRS 238

- Radiological soil concentrations in excess of guideline criteria were 14 pCi/g for uranium-238 and 39 pCi/g for thorium-230.[5] The 10^{-6} Risk Based Guideline Criteria for uranium-238 is 11 pCi/g and the Regulatory Guideline Criteria for subsurface thorium-230 is 15 pCi/g.[6,7]
- All metal detections were below their respective 10^{-6} Risk Based Guideline Criteria for soils.
- Volatile organic compounds were detected in four samples (no quantitative data is available).

READING ROOM REFERENCES:

1) Operable Unit 9 (OU9), Site Scoping Report: Volume 12: Site Summary Report, Final, December 1994. (pages 6-14)
2) OU9, Site Scoping Report: Volume 3 - Radiological Site Survey, Final, June 1993. (pages 23-38.4)
3) OU9, Site Scoping Report: Volume 7 - Waste Management, Final, February 1993. (pages 15-22)
4) Soil Gas Survey & Geophysical Investigations, Main Hill and SM/PP Hill Areas, Reconnaissance Sampling, February 1993. (pages 39-41)
5) Other Soils Characterization Report, Volumes I and II, May 1996. (pages 42-51)

OTHER REFERENCES:

6) Code of Federal Regulations, 40 CFR 192.41 and 40 CFR 192.12.
7) Risk Based Guideline Values, May 1995.

PREPARED BY:

Richard Bauer, Member of EG&G Technical Staff
Eric Horstman, Member of EG&G Technical Staff

MOUND PLANT
PRS 154/238
SOIL CONTAMINATION - BUILDING 23

RECOMMENDATION:

CONCURRENCE:

DOE/MB: _____

Arthur W. Kleinrath, Remedial Project Manager (date)

USEPA: _____

Timothy J. Fischer, Remedial Project Manager (date)

OEPA: _____

Brian K. Nickel, Project Manager (date)

SUMMARY OF COMMENTS AND RESPONSES:

Comment period from _____ to _____.

☐ No comments were received during the comment period.

☐ Comment responses can be found on page _____ of this package.

REFERENCE MATERIAL
PRS 154/238

Document Control No. _____

Environmental Restoration Program

OPERABLE UNIT 9 SITE SCOPING REPORT: VOLUME 12 – SITE SUMMARY REPORT

MOUND PLANT
MIAMISBURG, OHIO

December 1994

Final

U.S. Department of Energy
Ohio Field Office

EG&G Mound Applied Technologies

Description of History and Nature of Waste Handling						Hazardous Conditions and Incidents			Environmental Data		
No.	Site Name	Location	Status	Potential Hazardous Substances	Ref	Releases	Media	Ref	Analytes[a]	Results	Re
147	HH Building Soils	F-7	Grounds	Polonium-210, cobalt-60, tritium	4, 18	Indicated by Soil Gas Survey	S	12	1	SGS[b] Table B.4 Locations 1114, 1119, 1206, 1207, 1230	12
148	HH Building Solidification Unit	F-7	Historical	Cobalt-60, Polonium-210	4	Unknown			No Data		
149	HH Building Pilot Incinerator	F-7	Historical	Polonium-210	4	Probable air releases in 1951	A		No Data		
150	Room HH-15 Beta Wastewater Sump (Tank 236)	F-7	Inactive	Beta wastewater from restrooms and process area floor drains - tritium	3	Unknown			No Data		
151	Room HH-6 Alpha Wastewater Sump (Tank 237)	F-7	Historical	Alpha wastewater from process area floor drains. Possible contaminants include polonium-210, cobalt-60, and bismuth.	3, 4	Unknown - filled with concrete			No Data		
152	HH Building Beta Wastewater Sump (Tank 24)	F-7	In service	Beta wastewater from process area sinks and floor drains	3, 4	Unknown			No Data		
153	Area 20, Radioactive Waste Line Break	G-7	Grounds	Sodium nitrate, Plutonium-238, Cesium-137, Thorium, Cobalt-60	4, 5, 18	Cobalt-60	S	6, 18	1 2, 14, 16	SGS[b] Table B.4 Locations 1119 and 1120 Table B.1 (Table III.8 in Ref. 6)	1 6
154	Area 23, Thorium Contaminated Soil	F-6 G-6	Grounds	Thorium-230	18	Thorium-230	S	6	1 2	SGS[b] Table B.4 Location 1122 Table B.1 RSS[c] Location S1092 (Appendix E in Ref. 6)	1 6
155	Old Sanitary Disposal (SD) Plant (AKA Old Sanitary Wastewater Treatment Plant)	F-6	Surplus	Chromic acid, Calcium cyanide, Nickel sulfate, Nickel chloride, Black oxide, Copper cyanide	4, 5, 18	Unknown			No Data		
156	Old SD plant Tank (Tank 205)	F-6	Surplus	Polonium-210, Cobalt-60	3, 5						

1 - Soil Gas Survey - Freon 11, Freon 113, Trans-1,2-Dichloroethylene, Cis-1,2-Dichloroethylene, 1,1,1-Trichloroethane, Perchloroethylene, Trichloroethylene, Toluene
2 - Gamma Spectroscopy - Thorium-228, -230, Cobalt-60, Cesium-137, Radium-224, -226, -228, Americium-241, Actinium-227, Bismuth-207, Bismuth-210m, Potassium-40

Reference List
6. DOE 1993d 18. DOE 1992a

Description of History and Nature of Waste Handling						Hazardous Conditions and Incidents			Environmental Data		
No.	Site Name	Location	Status	Potential Hazardous Substances	Ref	Releases	Media	Ref	Analytes[a]	Results	Ref
231	T Building, Corridor 8 Alpha Wastewater Sump (Tank 233)	F-7	Historical Filled with concrete 1982	Alpha wastewater from process area floor drains	3, 4	Unknown - filled with concrete			No Data		
232	T Building, Corridor 7 Alpha Wastewater Sump (Tank 234)	F-7	Historical Filled with concrete 1982	Alpha wastewater from process area floor drains	3, 4	Unknown - filled with concrete			No Data		
233	Room T-63 Alpha Wastewater Sump (Tank 235)	F-7	Historical Filled with concrete 1982	Alpha wastewater from process area floor drains	3, 4	Unknown - filled with concrete			No Data		
234	Building 58 Diesel Fuel Storage Tank (Tank 222)	E-6	Historical	Diesel fuel	3	Tank Removed			No Data		
235	Area of Possible Elevated Thorium Activity	E-8	Grounds	Thorium	6	Possible fugitive dust	S	4, 6	1 14, 15	SGS[b] Table B.3 Locations 2021, 2148, and 2149 Table B.1	12 6
236	Site Survey Project Potential Hot Spot Location S0166	F-6	Grounds	Plutonium-238	6	Isolated activity from unknown sources			13	Table B.9 (Appendix E in Ref. 6)	6
237	Site Survey Project Potential Hot Spot Location S0175	E-5 E-6	Grounds	Cobalt-60, Cesium-137	6				14, 15	Table B.9 (Appendix E in Ref. 6)	6
238	Site Survey Project Potential Hot Spot Location S1092	G-7	Grounds	Thorium	6				14	Table B.9 (Appendix E in Ref. 6)	6
239	Site Survey Project Potential Hot Spot Location S0208	F-5	Grounds	Plutonium-238	6				13	Table B.9 (Appendix E in Ref. 6)	6
240	Site Survey Project Potential Hot Spot Location S0472	G-6	Grounds	Thorium	6				14	Table B.9 (Appendix E in Ref. 6)	6

Reference List

6. DOE 1993d
18. DOE 1992a

Table V.3. Potential Release Sites Currently in D&D Program and Sites Recommended for Inclusion in D&D Program

No.	Site Name	Status*	Historic Activities		Further Action Recommended	FFA OU
			Evidence of Release	Response Authority		
40	Building 66 Lot	Grounds	Yes	AEA	D&D	
75	Railroad Siding	Inactive	Yes	AEA	D&D	
78	Warehouse 13	Historical	Yes	AEA	D&D	
86	Building 29 Septic Tank (Tank 224)	Historical	Yes	AEA	Yes	6
90	Site Survey Project Potential Hot Spot Location S0425	Grounds	Yes	AEA	Yes	6
122	Underground Radioactive Waste Lines (Main Hill)	Inactive	Yes	AEA	Yes	6
123	Area 5, Radioactive Waste Line Break	Grounds	Yes	AEA	Yes	6
124	Building 48 Hillside	Inactive	Yes	AEA	D&D	
132	Area 15, Entombed SW Cave (Room SW 1-B)	Historical	Yes	AEA	D&D	
133	SW Building Room 1-A	Historical	Yes	AEA	D&D	
138	Room SW-137 Alpha Wastewater Sump (Tank 23)	Surplus	No	AEA	Yes	6
139	Room SW-10 Beta Wastewater Sump (Tank 226)	Inactive	No	AEA	D&D	
146	R Building Rooms 121, 144, 146 and 148 Drains	Historical	Yes	AEA	D&D	
150	Room HH-15 Beta Wastewater Sump (Tank 236)	Inactive	No	AEA	D&D	
151	Room HH-6 Alpha Wastewater Sump (Tank 237)	Historical	No	AEA	D&D	
153	Area 20, Radioactive Waste Line Break	Grounds	Yes	AEA	Yes	6
154	Area 23, Thorium Contaminated Soil	Grounds	Yes	AEA	Yes	6
155	Old Sanitary Disposal (SD) Plant (AKA Old Sanitary Wastewater Treatment Plant)	Surplus	Yes	AEA	Yes	6
156	Old SD plant Tank (Tank 205)	Surplus	Yes	AEA	Yes	6
157	Old SD plant Tank (Tank 206)	Surplus	Yes	AEA	Yes	6

Table V.3. (page 3 of 4)

No.	Site Name	Status[a]	Historic Activities		Further Action Recommended	FFA OU
			Evidence of Release	Response Authority		
231	T Building, Corridor 8 Alpha Wastewater Sump (Tank 233)	Historical Inactive Filled with concrete 1982	No	AEA	D&D	
232	T Building, Corridor 7 Alpha Wastewater Sump (Tank 234)	Historical Inactive Filled with concrete 1982	No	AEA	D&D	
233	Room T-63 Alpha Wastewater Sump (Tank 235)	Historical Inactive Filled with concrete 1982	No	AEA	D&D	
235	Area of Possible Elevated Thorium Activity	Grounds	Yes	AEA	Yes	6
237	Hot Spot Location S1092	Grounds	Yes	AEA	Yes	6
238	Site Survey Project Hotspot S1029	Grounds	Yes	AEA	Yes	6
240	Site Survey Project Potential Hot Spot Location S0472	Grounds	Yes	AEA	Yes	6
252	B Building Stack	Inactive	No	AEA	D&D	
266	Area 8, Thorium-Contaminated Soils from Areas 1 and 9	Inactive	Yes	AEA	Yes	6
267	Area 9, Thorium Storage and Redrumming Area (AKA Former Throium Storage)	Inactive	Yes	AEA	Yes	6
272	Area 10, Concrete Debris	Inactive	Yes	AEA	Yes	6
273	Area 12, Throium-Contaminated Soil from Area 1	Inactive	Yes	AEA	Yes	6
283	Area 1, Bulk Transfer of Thorium Drums (AKA Plutonium Recoverable Waste Storage)	Grounds	Yes	AEA	Yes	6
284	Building 21, Thorium Sludge Storage Facility	Surplus	Yes	AEA	Yes	6
285	Area 11, Contamination from SM Building Operations	Historical	Yes	AEA	Yes	6
286	Area 16, SM Building Sanitary Sewage Septic Tank\Leach Field	Surplus	Yes	AEA	Yes	6

				Operational Jurisdiction				Historic Activities			
No.	Site Name	Location	Status	Regulated Units	Regulatory Authority	Spill Response	SWMU	Evidence Of Release	Response Authority	Further Action Recommended	FFA OU
138	Room SW-137 Alpha Wastewater Sump (Tank 23)	E-6 F-6	Surplus		AEA	AEA		No	AEA	Yes	6
139	Room SW-10 Beta Wastewater Sump (Tank 226)	F-6	Inactive		AEA	AEA		No	AEA	D&D	
140	Beta Waste Solidification Facility - SW Building	E-6 F-6	In Service		AEA	AEA		No	NA	OM	
141	Tritium Effluent Removal System	E-6	In Service		AEA	AEA		No	NA	OM	
142	SW/R Building Solid Radioactive Waste Compactor	E-6 F-6	In Service		AEA	AEA		No	NA	OM	
143	R/SW/T Building Stack Diesel Fuel Storage Tank (Tank 117)	F-6	In Service		BUSTR	BUSTR		No	NA	OM	
144	R Building Sanitary Waste Collection Tank (Tank 120)	F-6	In Service	effluent to wastewater treatment	CWA	AEA		No	NA	OM	
145	Room R-128 Alpha Wastewater Tank (Tank 19)	E-6	In Service		AEA	AEA		No	NA	OM	
146	R Building Rooms 121, 144, 146 and 148	F-6	Historical		AEA	AEA		Yeo	AEA	D&D	
147	HH Building Soils	F-7	Grounds		AEA	AEA		Yes	CERCLA	Yes	2
148	HH Building Solidification Unit	F-7	Historical		NA	NA		No	AEA	No	
149	HH Building Pilot incinerator	F-7	Historical		NA			No	AEA	No	
150	Room HH-15 Beta Wastewater Sump (Tank 236)	F-7	Inactive		NA			No	AEA	D&D	
151	Room HH-6 Alpha Wastewater Sump (Tank 237)	F-7	Historical		NA				AEA	D&D	
152	HH Building Beta Wastewater Sump (Tank 24)	F-7	In Service		AEA	AEA			NA	OM	
153	Area 20, Radioactive Waste Line Break	G-7	Grounds		NA			Yes	AEA	Yes	6
154	Area 23, Thorium Contaminated Soil	F-6 G-6	Grounds		AEA	AEA		Yes	AEA	Yes	6
155	Old Sanitary Disposal (SD) Plant (AKA Old Sanitary Wastewater Treatment Plant)	F-6	Surplus		NA		SWMU	Yes	AEA	D&D	
6	Old SD plant Tank (Tank 205)	F-6	Surplus		NA		SWMU	Yes	AEA	Yes	6

AEA - Atomic Energy Act of 1954

No.	Site Name	Location	Status	Operational Jurisdiction: Regulated Units	Operational Jurisdiction: Regulatory Authority	Operational Jurisdiction: Spill Response	SWMU	Historic Activities: Evidence Of Release	Historic Activities: Response Authority	Further Action Recommended	FFA OU
227	Room T-40 Alpha Wastewater Sump (Tank 229)	F-7	Historical Filled with concrete		NA			No	AEA	D&D	
228	Room T-41 Alpha Wastewater Sump (Tank 230)	F-7	Historical Filled with concrete		NA			No	AEA	D&D	
229	Room T-50 Alpha Wastewater Sump (Tank 231)	F-7	Historical Filled with concrete 1975		NA			No	AEA	D&D	
230	Room T-50 Alpha Wastewater Sump (Tank 232)	F-7	Historical Filled with concrete 1975		NA			No	AEA	D&D	
231	T Building, Corridor 8 Alpha Wastewater Sump (Tank 233)	F-7	Historical Filled with concrete 1982		NA			No	AEA	D&D	
232	T Building, Corridor 7 Alpha Wastewater Sump (Tank 234)	F-7	Historical Filled with concrete 1982		NA			No	AEA	D&D	
233	Room T-63 Alpha Wastewater Sump (Tank 235)	F-7	Historical Filled with concrete 1982		NA			No	AEA	D&D	
234	Building 58 Diesel Fuel Storage Tank (Tank 222)	E-6	Historical		NA			No	CERCLA	Yes	2
235	Area of Possible Elevated Thorium Activity	E-8	Grounds		AEA	AEA		Yes	AEA	Yes	6
236	Site Survey Project Potential Hot Spots Location S0166	F-6	Grounds		AEA			Yes	CERCLA	Yes	2
237	Site Survey Project Potential Hot Spots Location S0175	E-5 E-6	Grounds		AEA			Yes	AEA	Yes	6
238	Site Survey Project Potential Hot Spot Location S1092	G-7	Grounds		AEA			Yes	AEA	Yes	6
239	Site Survey Project Potential Hot Spot Location S0208	F-5	Grounds		AEA			Yes	CERCLA	Yes	2

Table B.9. Summary of Radiological Data[a,b]

Site Name	Radiological Contaminants															
	Potassium-40	Plutonium-239	Plutonium-238	Cesium-137	Thorium-Total	Tritium	Thorium-232	Cobalt-60	Radium-224, -226, -228	Radon-222	Americium-241	Actinium-227	Uranium-233, -234, -238	Bismuth-210m	Bismuth-207	Reference
172. WDA Building Basement Wash Sump (AKA Glass Melter Room Sump)			257,000			1302 (c)	65.7									7
174. WD Building Drum Staging Area			1,302			ND										7
236. Site Survey Project Potential Hot Spot Location S0166			1.76			12.73										6
237. Site Survey Project Potential Hot Spot Location S0175				10				82	.8							6
238. Site Survey Project Potential Hot Spot Location S1092			0.31		323	.5										6
239. Site Survey Project Potential Hot Spot Location S0208			61			.72										6
240. Site Survey Project Potential Hot Spot Location S0472			1.2		7.5											6
258. Area H Open Burn Pit (AKA Pyrotechnic Waste Disposal Area)			0.81		<2											6
9. Pyrotechnic Waste Shed			0.31		<2											7
0. Thermal Treatment Unit			0.81		<2											7
8. Building 31, Contaminated Material Storage Building			8.15		150											6
. Underground Sewer Lines G6 and G7						ND										7
. Old Firing Range Drum Storage Area	26.2			0.121	1.48				12.2							7
. Waste Oil Drum Field Area			NR		9.2											7
. Warehouse 14 (AKA Pad 14)			10.2	<2												
. Site Survey Project Potential Hot Spot Location C0007			.39		47.6											6

1 - Soil Gas Survey - Freon 11, Freon 113, Trans-1,2-Dichloroethylene, Cis-1,2-Dichloroethylene, 1,1,1-Trichloroethane, Perchloroethylene, Trichloroethylene, Toluene
2 - Gamma Spectroscopy - Thorium-228, -230, Cobalt-60, Cesium-137, Radium-224, -226, -228, Americium-241, Actinium-227, Bismuth-207, Bismuth-210m, Potassium-40
3 - Target Analyte List
4 - Target Compound List (VOC)
5 - Target Compound List (SVOC)
6 - Target Compound List (Pesticides/Polychlorinated Biphenyl)
7 - Dioxins/Furans
8 - Extractable Petroleum Hydrocarbons (EPH)/Total Petroleum Hydrocarbons (TPH)
9 - Lithium
10 - Nitrate/Nitrite
11 - Chloride
12 - Explosives
13 - Plutonium-238
14 - Plutonium-238, Thorium-232
15 - Cobalt-60, Cesium-137, Radium-226, Americium-241
16 - Tritium

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1. DOE 1986 "Phase I Installation Assessment Mound (DRAFT)."
2. DOE 1992a "Remedial Investigation/Feasibility Study, Operable Unit 9, Site-Wide Work Plan (Final)."
3. DOE 1992c "Mound Plant Underground Storage Tank Program Plan & Regulatory Status Review (Final)."
4. DOE 1993a "Site Scoping Report: Volume 7 - Waste Management (Final)."
5. EPA 1988a "Preliminary Review/Visual Site Inspection for RCRA Facility Assessment of Mound Plant."
6. DOE 1993d "Operable Unit 9, Site Scoping Report: Volume 3 - Radiological Site Survey (Final)."
7. DOE 1993c "Operable Unit 3, Miscellaneous Sites Limited Field Investigation Report."
8. DOE 1992d "Reconnaissance Sampling Report Decontamination & Decommissioning Areas, OU6, (Final)."
9. Fentiman 1990 "Characterization of Mound's Hazardous, Radioactive and Mixed Wastes."
10. DOE 1992f "Operable Unit 9, Site Scoping Report: Volume 11 - Spills and Response Actions (Final)."
11. Styron and Meyer 1981 "Potable Water Standards Project: Final Report."
12. DOE 1993b "Reconnaissance Sampling Report - Soil Gas Survey & Geophysical Investigations, Mound Plant Main Hill and SM/PP Hill (Final)."
13. DOE 1993d "Operable Unit 9, Site Scoping Report: Volume 3 - Radiological Site Survey (Final)."
14. DOE 1991b "Main Hill Seeps, Operable Unit 2, On-Scene Coordinator Report for CERCLA Section 104 Remedial Action, West Powerhouse PCB Site."
15. Halford 1990 "Results of South Pond Sampling."
16. DOE 1993e "Operable Unit 4, Special Canal Sampling Report, Miami Erie Canal."
17. DOE 1990 "Preliminary Results of Reconnaissance Magnetic Survey of Mound Plant Areas 2, 6, 7, and C."
18. DOE 1992a "Remedial Investigation/Feasibility Study, Operable Unit 9, Site-Wide Work Plan (Final)."
19. Rogers 1975 "Mound Laboratory Environmental Plutonium Study, 1974."
20. DOE 1992h "Ground Water and Seep Water Quality Data Report Through First Quarter, FY92."
21. Dames and Moore 1976 a, b "Potable Water Standards Project Mound Laboratory" and "Evaluation of the Buried Valley Aquifer Adjacent to Mound Laboratory."
22. DOE 1992i "Closure Report, Building 34 - Aviation Fuel Storage Tank."
23. DOE 1992j "Closure Report, Building 51 - Waste Storage Tank."
24. DOE 1994 "Operable Unit 1, Remedial Investigation Report."
25. EG&G 1994 "Active Underground Storage Tank Plan."

ENVIRONMENTAL RESTORATION PROGRAM

OPERABLE UNIT 9
SITE SCOPING REPORT:
VOLUME 7 - WASTE MANAGEMENT

MOUND PLANT
MIAMISBURG, OHIO

February 1993

DEPARTMENT OF ENERGY
ALBUQUERQUE FIELD OFFICE

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EG&G MOUND APPLIED TECHNOLOGIES

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~~7 (Figure 2.9). Used drums were not cleaned and contained residual amounts of the thorium sludges.~~ Soils contaminated with thorium at the areas of redrumming and around the silo (Building 21) were removed to other areas and were generally dumped over the western slopes of the SM/PP Hill. The areas of redrumming are now known as Areas 3 and 8. Area 1 surrounds the old silo, and Areas 8, 12, and perhaps 7 received the contaminated soils (DOE 1992a). Equipment used during redrumming operations, including a flatbed truck and a conveyor belt, is known to have been buried in Area 7 (Figure 2.9). Nothing is known of the fate of the thorium metal. Mound reviewed the options for disposal of the thorium in April 1973 (MRC 1973a). This report indicated that some material had been sold prior to 1973. There is no specific mention of the thorium metal. An inventory of the thorium that was stored at Mound as of April 1973 does not include thorium metal. When Mound decided to sell the thorium residues, the invitation to bid, dated November 1, 1973, did not mention thorium metal available for sale (MRC 1973d).

2.6. THORIUM-230 (IONIUM) PROGRAMS

Ionium is an alpha-active thorium isotope with a half-life of 8.05×10^4 years. Ionium and thorium-230 are names that have been used interchangeably to identify this isotope. The interest in ionium goes back to 1946 (Peppard 1949), when a survey was conducted to identify sources of ionium. This survey looked at various fractions obtained from processing uranium and its ores to identify sources of ionium and protactinium-231 (Bruehlman 1947). In 1949, the ionium program reached a second milestone when a pilot plant was constructed at ANL to process 3,600 gallons of Mallinckrodt sparged turbid liquor from a material referred to as the airport cake, a raffinate produced by the diethyl ether solvent extraction of uranium (Peppard 1949). The material containing ionium was being produced at the Mallinckrodt Chemical Works uranium refinery in St. Louis, Missouri (Fariss 1955; Eichelberger and Scott 1956a).

In July 1955, Mound submitted a proposal to the AEC to design and install a facility that would be used for process chemistry development. The work would isolate ionium from raffinates produced at Mallinckrodt (McCarthy 1955). In November 1955, Mound received a directive to proceed with the design and construction of this facility, with a target completion date of February 1956 (Johnson 1955). The process chemistry research and development took place in the R Building. The larger columns required for production separation also were assembled in the R Building. Ionium was to be used as a tracer element in the Redwing test program, and kilogram quantities of ionium were needed for weapons diagnostic tests. Between April 6 and May 18, 1956, five shipments of a total of 400 g of ionium were made to the AEC (Haubach 1956a, 1956b, 1956c, 1956d).

In July 1956, Mound was directed to produce an additional 500 g of ionium for the ORNL research stockpile and to refine the process chemistry for use in a future large-scale production program (Ager 1956). This required an additional supply of the Mallinckrodt feed solution, a delivery that was apparently never made. By November 1956, the remaining 73 L of feed had been processed to produce about 70 g of ionium (Eichelberger and Scott 1956c). Unfortunately, all of the undesirable impurities contained in the original feed solution were concentrated in the remaining solution. Forty-nine grams of the remaining ionium were shipped to the University of California Radiation Laboratory in December 1956 (Eichelberger and Scott 1957).

The ionium program was closely tied by chemistry and process development to the protactinium-231 program. In the late 1950s, capsules containing about 250 g of thorium oxide and apparently containing the remaining 22 g of ionium were sent to the MTR in Idaho for irradiation. This process was designed to produce protactinium-231 and protactinium-233 by neutron absorption by thorium-230 and thorium-232, respectively (Schuman 1960, 1961; Kirby 1960). The capsules were stored for at least a year in the reactor canal to allow the protactinium-233 to decay to a safe handling level. The capsules were returned to Mound, but it is not known if they were ever processed. They may remain in storage as research materials.

In the early 1960s, Mound conducted a search of ionium sources. Forty-nine samples from 17 uranium mills or processing sites were received and analyzed. Several samples of airport cake from the Mallinckrodt Chemical Works were used for comparison. Analysis of the samples by neutron activation analysis at ORNL indicated that the airport cake was the best source of ionium available (Eichelberger 1961b). These research efforts led to the procurement of additional quantities of airport cake some years later. The airport cake was also known as Cotter Concentrate and was processed for thorium-230 and protactinium-231 in the 1970s.

2.6.1. Process Description

Mallinckrodt raffinates that have been partially processed at the St. Louis uranium refinery were shipped to Mound in 55-gallon steel drums. This feedstock consisted of a caustic-neutralized fluoride slurry containing ionium, thorium-232, rare earths, scandium, uranium, and traces of protactinium.

The process equipment associated with separation and purification of ionium includes stainless steel storage tanks, mixers and mixing vessels, Pyrex glass contractors, mixer settlers, centrifuges, pulse columns, stainless steel process waste tanks, evaporator equipment, and Pyrex lines and valves for transfer of reagents and process liquids. The recovery of ionium began with the acidification of the Mallinckrodt material with nitric acid followed by centrifugation to remove solids. The supernatant

liquid was treated with aluminum nitrate to form a slurry that was removed in a mixer settler vessel. The supernatant liquid underwent a series of solvent extractions followed by aqueous scrubs. The solvent-solvent extraction steps used diethyl ether and pentaether (dibutoxytetraglycol). Aqueous scrub solutions contained nitric acid, ammonium nitrate, and ammonium hydroxide. The ionium was recovered from the process as the nitrate.

2.6.2. Waste Generation

The ionium process generated solid and liquid waste streams in the recovery of ionium from Mallinckrodt feedstocks. The solids and decant liquids from the centrifugation step were saved and processed to recover uranium and protactinium. The aqueous waste steam contained rare earths, scandium, and thorium. These waste steams could not be treated by the WD treatment facility to adequately decontaminate the waste effluent discharged to the Great Miami River. Therefore, the waste may have been transferred to the small waste evaporator treatment facility located in room 127 of the R Building. This facility, also known as the still, is described in the actinium-radium and reactor waste decontamination programs. The condensate from the evaporator was transferred to the WD Building for treatment, and the slurry from the evaporator was packaged in drums for off-plant disposal. This process used significant quantities of diethyl ether and pentaether.

Thirteen gallons of a solution containing 8 g of ionium leaked out of a drum in the high-risk corridor of R-121 where it was stored. The solution was washed to the WD Building influent tank where it was held and processed separately (Meyer 1957d). The solution was diluted and released to the river. The influent tank required subsequent cleaning and decontamination (Meyer 1958a).

At the completion of the 1956 production process, 250 gallons of organic waste, containing 1.232 g of ionium, were absorbed in sawdust, packed in 30-gallon drums, and shipped to ORNL for burial. One drum of the aqueous raffinate, precipitated with caustic and containing 0.473 g of ionium, was also shipped for burial (Eichelberger and Scott 1957). No information was found to indicate the disposition of the solid or sludge wastes from the process. The latter were probably also drummed and shipped for burial.

2.7. PROTACTINIUM-231

The need for protactinium-231 was generated in the early 1950s, when it was selected as a surrogate for protactinium-233 in the study of the physical and chemical properties of this element. Protactinium-233, an isotope with a half-life of 27 days, was to be created in the thorium-232 →

protactinium-233 → uranium-233 sequence, in the thorium breeder blankets of the breeder reactor program.

Programs at Mound involving the recovery and purification of protactinium-231 began in the early 1950s and continued intermittently to September 1979, at which time the demand for protactinium and thorium was significantly reduced. During this period, a number of separate programs were identified that separated and purified protactinium from a variety of source materials. Material processed came from the Mallinckrodt Chemical Works in St. Louis, Missouri; the AEC, Fernald Plant, Ohio; and the Cotter Corporation, Cannon City, Colorado. An attempt was made in the early 1960s to produce protactinium from irradiated thorium-230, but the materials were apparently never processed at Mound.

The first of the protactinium programs was initiated in 1954 at Mound at the request of the ORNL. The goal of the program was to isolate and purify 1 g of protactinium-231 from residues from previous uranium processing. The process chemistry research phase for this program took place in room 167 of the R Building. By October 1954, the procedures for separating the protactinium from the residues, sometimes referred to as raffinates, had been developed on a laboratory scale (Martin 1955). Some of the experimental work may have been done on residues supplied from Fernald Plant, Ohio. Equipment was then installed in room 145 of the R Building to process raffinate residues supplied by Mallinckrodt (MCC 1955 c,e). Batches weighing 5 kg each were run with a goal to separate milligram quantities of protactinium-231 and provide data for a small process plant. The pilot plant for this program was installed in the HH Building and completed in July 1955. Operations in HH Building were suspended in March of 1956 and moved to the SW Building. Equipment salvaged from the Monex thorium refinery pilot plant was adapted to the protactinium program (Meyer 1956c).

Approximately 80 drums, containing a total of about 20,000 pounds of residue, were shipped to Mound for processing. This feed material was referred to as the Sperry cake, Sperry filter cake, or Sperry press cake. This cake contained 0.1 to 0.2 ppm of protactinium in a matrix of iron, aluminum, calcium, magnesium, cobalt, and copper. When received, it appeared very inhomogeneous, and spectrographic analysis indicated that it was significantly different in composition from samples used during research phases. No two drums were alike. Since only about half of the quantity of the material was needed for 1 g of protactinium-231, individual batches were selected from the lot.

The first drum, containing 288 pounds of material, was processed in August 1955 (McCarthy 1955f). The extractions were very time-consuming because of the analytical procedures required for each step of the process. By August 1956, 700 mg of protactinium-231 had been recovered from 43 drums of raffinate. Fifty gallons of residual solids contained another 200 mg of protactinium-231 (Eichelberger and Scott 1956b).

After the first gram was successfully separated, work proceeded on the extraction of a second gram from the balance of the raffinate residues on hand. The gram of protactinium-231 had been requested in December 1954 by the AEC, Division of Research (Walker 1954). In researching the extraction process for the remaining, less desirable supply of the Sperry cake, it was found that the original sodium chloride process could be modified (Eichelberger and Scott 1956c). Experimental 1-inch columns were set up in room 1B of the SW Building for studying flow rates, extraction efficiencies, and other column parameters. The full-scale pilot plant was assembled in the HH Building, using 6-inch glass pipe columns. The plant was to be ready for operation by February 1957 (Eichelberger and Scott 1957), but general problems plagued the protactinium recovery and the fate of this program is not clearly known. Approximately 240 mg of protactinium-231 are known to have been recovered from the raffinates, residues, and analytical samples during the second attempt. The product was stored in approximately 140 mL of 50% diisobutyl carbinol in benzene (Eichelberger 1961a).

In the late 1950s, Mound submitted about 22 g of thorium-230, referred to as ionium, to the MTR in Idaho for transmutation to protactinium-231 by neutron irradiation. As of March 15, 1960, the ionium underwent neutron irradiation and was stored in the MTR canal, allowing the decay of protactinium-233 (from the irradiated thorium-232 [Schuman 1960, 1961; Kirby 1960]). The ionium remained in storage for over one year before it was shipped to Mound in lead casks. Some of the capsules swelled during either irradiation or storage and were probably never opened or processed. Although this program is no longer active at Mound, 10 or 11 lead capsules containing irradiated ionium have been stored as resource materials.

The last protactinium program carried out at Mound took place in the 1970s. The plan was to recover protactinium from the Cotter Concentrate and is described in a companion section of this report.

2.7.1. Process Description

The process used at Mound for the recovery of protactinium-231 was referred to as the sodium chloride process (NAS n.d.). The recovery of protactinium began with the dissolution of the raffinate in 2 N hydrochloric acid solution that was saturated with sodium chloride and contained titanium trichloride. The solution was boiled, resulting in the formation of a precipitate that contained

protactinium. The precipitate was separated from the supernatant liquid by filtration and was then digested with sodium hydroxide. The residue from the alkaline digestion step was treated with sodium hydroxide and 6 N hydrochloric acid. The resulting slurry was extracted with diisobutyl carbinal (DIBC) in Amsco kerosene. The protactinium was contained in the DIBC phase. In the next step, the DIBC phase was stripped with water containing hydrochloric acid and sulfuric acid. The protactinium was stripped from the acidic aqueous phase with DIBC. At this point in the process, the protactinium contained a solution of iron, niobium, and other metal impurities. These metals were removed in the protactinium purification step of the process.

Experiments continued on the efficiency of the protactinium-231 recovery process. After the initial project goals were achieved, the separation of the remaining raffinates posed a more difficult problem, because they had been highgraded and the remaining materials had lower protactinium concentration and higher quantities of impurities. Dissolution in nitric acid was tried, and it was found that nitric acid alone could not solubilize the protactinium; therefore, sulfuric acid was of prime importance. Efforts were taken to dissolve the raffinates directly and extract the resulting slurry. The pilot plant that was to have been assembled in the HH Building would have greatly decreased the time and labor involved with the extractions. Only the experimental column assembly in SW Building is known to have been used. In these experiments, sulfuric acid was made up with hydrochloric acid, and the raffinate was digested at fuming temperatures (about 230°C). Several extraction steps were apparently required, because the protactinium did not always come out in the first extraction, depending on the particular composition of the raffinate. The high iron content of the raffinates posed the most difficulty. It is not known whether this process was ever fully developed and used to process the remaining 43 drums of raffinate, but it does not appear so.

2.7.2. Waste Generation

The process equipment for recovery of protactinium-231 from uranium refining raffinate was located in the HH Building. Over 5 tons of the raffinate are known to have been processed to recover approximately 1 g of protactinium. The raffinate was dissolved in hydrochloric acid containing sodium chloride and titanium trichloride. The precipitate containing protactinium was separated by filtration, and the filtrate liquid was transferred to drums and stored. The precipitate, after treatment with sodium hydroxide and hydrochloric acid, underwent solvent extraction with DIBC. The acid aqueous phase from the extraction process was also drummed and stored. The protactinium was recovered from the DIBC and the solvent was recycled. The protactinium underwent purification resulting in a final acidic waste stream containing sulfuric, hydrochloric, and oxalic acids. The acid aqueous wastes collected were stored outside the HH Building in 200 55-gallon steel drums with polyethylene liners. It was originally planned that these materials would be neutralized and disposed of at the close of the

program. After a short period of storage, it was discovered that the liners were defective and the acid was eating out the drums and being spilled on the ground. Much of the material had to be redrummed. Since the waste contained quantities of radium-228 and its daughter products, it was deemed inappropriate to mix it into the polonium waste streams at the WD Building. The acid waste was finally disposed of by discharging it slowly into the Great Miami River so that the maximum permissible concentrations were not exceeded (Meyer 1957b). The discharge continued at least until December 1957 (Meyer 1958a). It is not known what happened to the used drums or where exactly the discharge took place, whether to a manhole in the storm sewer or a manhole to the NPDES Outfall 001 pipe to the Great Miami River. The disposition of 10 tons of raffinate that was not processed was not determined during the research for this report. Any residual solids generated by the process were probably drummed for off-plant disposal, as this was the general practice; however, no records were found.

In February 1960, 40-gallon drums of protactinium effluent (activity 0.01 Ci per drum) were separated from residue. The effluent was released to the "sewer in the lower area" and siphoned off at a rate of a liter per minute and diluted with rainwater at a rate of 150 gallons per minute. The residue was to be sent for offsite burial (MCC 1951-1961).

3.8 RARE ISOTOPE PROGRAMS

An important research and development program at Mound involved the production, separation, and purification of rare radioactive isotopes. This program, currently known as the Rare Isotope Program, has also been known as the Separation and Purification of Special Heavy Element Isotopes and Separations Technology. The isotopes that were processed included plutonium-238, protactinium-231, thorium-229, thorium-230, thorium-228, uranium-233, uranium-234, actinium-227, polonium-209, and radium-226. This work began at Mound in the mid-1950s (Miller 1955) and continued until 1985 (Figgins 1991). The separation processes were generally carried out in the SW, SM, and R buildings.

The Rare Isotope Program can be characterized as having numerous projects that are linked to the preparation of specific isotopes. The projects were started at different times during the 25-year period that the program was active, and they varied in size and duration. The source materials for the recovery of rare isotopes also differed. Protactinium-231 and thorium-230 were obtained from uranium-bearing ores or sludges. Uranium-234, a daughter product that "grows" as the plutonium-238 ages, was obtained from "milking" plutonium-238. Thorium-229 was obtained from milking uranium-233. The latter was produced by irradiation of thorium-232 to produce protactinium-233; the protactinium-233 then decays to uranium-233. An aged source was a[illegible] uranium-233. Other isotopes were produced by irradiation of an appro

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OPERABLE UNIT 9, SITE SCOPING REPORT: VOLUME 3 - RADIOLOGICAL SITE SURVEY

MOUND PLANT
MIAMISBURG, OHIO

June 1993

DEPARTMENT OF ENERGY
ALBUQUERQUE FIELD OFFICE

ENVIRONMENTAL RESTORATION PROGRAM
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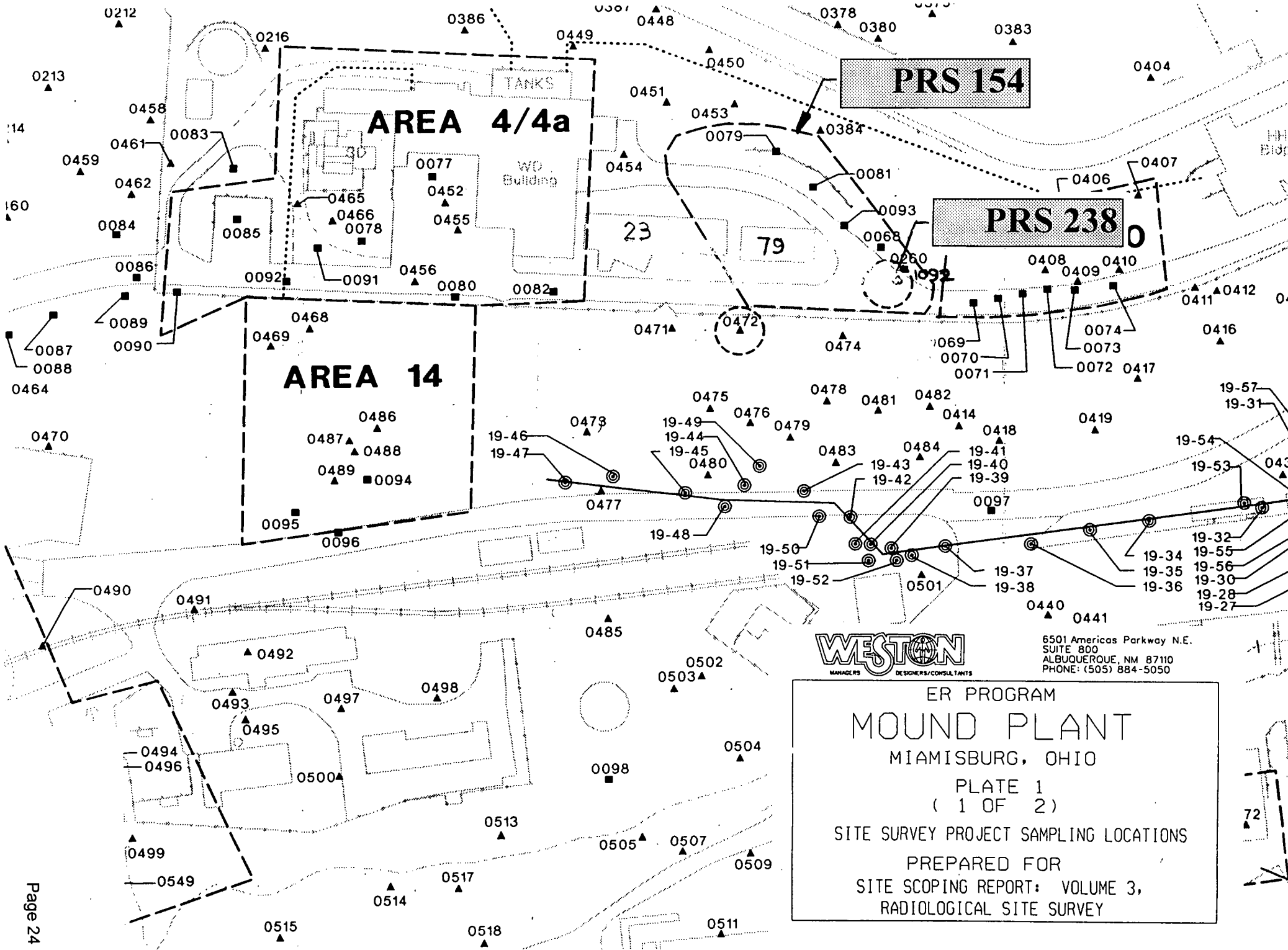
AREA 4/4a
AREA 14
PRS 154
PRS 238
TANKS
WO Building
23
79
WESTON
MANAGERS DESIGNERS/CONSULTANTS
6501 Americas Parkway N.E.
SUITE 800
ALBUQUERQUE, NM 87110
PHONE: (505) 884-5050
ER PROGRAM
MOUND PLANT
MIAMISBURG, OHIO
PLATE 1
(1 OF 2)
SITE SURVEY PROJECT SAMPLING LOCATIONS
PREPARED FOR
SITE SCOPING REPORT: VOLUME 3,
RADIOLOGICAL SITE SURVEY

Sample locations S0472 and S1092, shown on Plate 1 as possible hot spots, are probably not associated with the thorium project, as S1092 is largely thorium-230 and is associated with Area 23, described in a companion section of this report.

5.10. EXCAVATED MATERIALS DISPOSAL AREA

The excavated materials disposal area is located on the SM/PP Hill adjacent to Area 1 and south of the water tower (Figure 5.1). The area is colloquially known as Rader's Hill. The area contains the overburden soils excavated during the D&D of the waste transfer line on the west slope of the SM/PP Hill. The excavation is known as Area 19. The excavation overlapped the southern margin of Area 12, known to be contaminated with thorium. During excavation, soils that had thorium concentrations were staged and later segregated depending on the thorium concentrations. Soil with thorium concentration greater than 5 pCi/g were boxed for offsite disposal and those with less were moved to the excavated materials disposal area (Draper 1985). About 52 samples were collected from the disposal area in 1984 and analyzed in the Mound soils screening facility. Results indicate total thorium levels around 1 pCi/g; the highest was 1.2 pCi/g (MRC 1984). The data sheets are included in Appendix E.

5.11. RAILROAD SIDING

The railroad siding or spur that enters Mound Plant from the west has been used extensively for shipping and receiving radioactive materials and radioactively contaminated wastes. Through the 1950s and 1960s, the siding was used for unloading lead casks containing the bismuth/polonium mixtures used in the polonium processing. In the mid-1950s, the siding was the site of the unloading of thorium drums, as well as the decontamination of the boxcars in which the drums were shipped. The siding historically extended about 500 feet east of their current location. The eastern portions were removed or simply buried at an unknown date. The portion that would underlie the waste transfer line, known as Area 19 (Plate 1), is gone and may have been removed when the line was built in 1967 (DOE 1992g). Portions of the siding east of Area 19 (Plate 1) are known to be in place, but covered by a thin layer of soil.

The siding itself was not a sampling target during the Site Survey Project (Stought et al. 1988); however, some limited sampling has been performed. Site Survey Project samples S0485 and S0491 (Appendix E) located near the siding (Plate 1) indicated levels of plutonium-238 below 5 pCi/g and less than 2 pCi/g of thorium. Subsequent sampling along the siding indicates that elevated thorium contamination may be very localized. Two samples collected in 1987 and analyzed by the Mound Plant

Table V.7. (page 2 of 2)

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)	Tritium (pCi/mL)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
S0647[d]	3340	2610	2778	10-83	0	NR	NR		LDL	270	LDL	LDL
S0706	3325	4035	4021	07-84	0	28.90	b					
S0971	4075	3025	5958	07-84	0	0.15	5.02					
S0982	3625	3025	5944	07-84	0	0.43	14.94					
S1092	2185	3362	8413	12-84	e	0.31	323.5[f]					

[a]Map locations are given using a "C" to designate core locations and an "S" to designate surface locations.
[b]A "b" indicates that the total thorium concentration was less than the background level of 2 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.
[c]The boring log for this location indicates that sampling was not performed to bedrock (Appendix B).
[d]Contaminated soil was excavated from this location in 1984. Post-cleanup soil concentrations of cesium-137 were less than 2 pCi/g (Draper 1984).
[e]The depth given for this sample was "SS." For mapping purposes (Plate 1), this is assumed to be a surface sample.
[f]Isotopic results are available for this sample and include 0.99 pCi/g of thorium-228; 321 pCi/g of thorium-230, and 1.5 pCi/g of thorium-232, for a total of 323.5 pCi/g of thorium.
FIDLER - field instrument for the detection of low-energy radiation
LDL - The measured concentration was below the lower detection limit, estimated to be 0.5 pCi/g for cobalt-60, cesium-137, and americium-241; and 1 pCi/g for radium-226.
MRC ID - Monsanto Research Corporation identification
NR - No result given
pCi/g - picocuries per gram
pCi/mL - picocuries per milliliter

~~as well as the aqueous processing wastes generated by the pilot plant operation. The processing~~ wastes ~~were first~~ treated in the HH Building and the aqueous effluent generated ~~by the~~ treatment was sent to WD Building for ~~further treatment~~.

All of the Cotter Concentrate ~~feed materials~~ and the process ~~residues~~ produced were stored in drums in Building 21. ~~In 1987~~, the Cotter Concentrate was shipped from Mound Plant ~~(MRC~~ 1987). No ~~onsite disposal area are known or suspected.~~

6.4. LOCATIONS WITH ELEVATED THORIUM

Review of the Site Survey Project data indicates that samples from eight locations contained levels of thorium in excess the Mound Plant cleanup levels (5 pCi/g for samples taken in the first 15 cm of soil, or 15 pCi/g for samples taken below 15 cm). These locations are widely distributed throughout the Mound Plant facility, but most are located either on the SM/PP Hill or on the SM/PP Hill slope. The maximum thorium activity from these locations, 323.5 pCi/g, was detected in the sample collected from location 1092, which is located slightly west of Area 20 (Plate 1). The depth of this sample was given as "SS" in the data obtained from Mound. For mapping purposes, this is assumed to be a surface sample. Isotopic results were available for this sample and included 0.99 pCi/g thorium-228, 321 pCi/g thorium-230, and 1.5 pCi/g of thorium-232, for a total of 323.5 pCi/g of thorium. This ratio indicates that the original material was separated from uranium ore.

~~Area J, described in section 10 of this report, also appears to have elevated levels of thorium (30.42 pCi/g). The reader is referred to subsection 10.2 for discussions.~~

6.5. AREA 23

Since the Site Survey Project was conducted, an area of elevated thorium-230 concentration has been identified north of Building 23 and west of the HH Building. This area has since been designated Area 23. The area appears to encompass the hot spot identified at location 1092 in the Site Survey Project data (Plate 1). Samples taken in 1990 and analyzed by alpha spectroscopy indicate thorium-230 at levels up to 6 nCi/g and traces of protactinium-231 and thorium-229 (Jenkins 1990; Jarvis 1990). As the area adjacent to the HH Building, east of Building 23, is known to have been used for both thorium-230 and protactinium-231 extraction programs, it is likely that the contamination is due to the leaking waste canisters described above.

Table XI.1. Maximum Radioactivity Concentrations in Soil Samples from Major Areas

Site	Plutonium-238 (pCi/g)	Thorium (pCi/g)	Tritium (pCi/mL)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)	Actinium-227 (pCi/g)	Bismuth-207 (pCi/g)	Bismuth-210m (pCi/g)
Area 1	34,000	924.2	1.67	LDL	0.6	1.1	LDL	--	--	--
Area 2	17.10	3.31	--	--	--	--	--	--	--	--
Area 3	1,235	63	--	--	--	--	--	--	--	--
Area 4/4a	355.00	<2	--	LDL	LDL	1.2	1.0	--	--	--
Area 5	0.35[b]	<2[b]	--	250	1.6	0.8	LDL	--	--	--
Area 6	--	--	--	LDL	LDL	0.9	LDL	--	--	--
Area 7	7.40[j]	20.52	5.23	LDL	1.2	2.0	LDL	1,400	--	--
Area 8	24.40	254.30	1.12	LDL	LDL	3.3	LDL	--	--	--
Area 9	8.15	150	--	--	--	--	--	--	--	--
Area 10	99	<2	--	--	--	--	--	--	--	--
Area 11	100,000	69	--	--	--	--	--	--	--	--
Area 12	313.00	189.90	--	LDL	LDL	1.1	LDL	--	--	--
Area 13	5.74	<2	--	--	--	--	--	--	--	--
Area 14	29[l]	2.24	--	LDL	LDL	1.2	LDL	--	--	--
Area 15[c]	--	--	--	--	--	--	--	--	--	--
Area 16	8,000	3.46	0.35	LDL	LDL	1.2	LDL	--	--	--
Area 17	3,300	1,000	--	LDL	LDL	0.9	LDL	--	--	--
Area 18	3.71	<2	--	--	--	--	--	--	--	--
Area 19[d]	185[m]	1.2	--	--	--	--	--	--	--	--
Area 20	1.90[b]	4.02[b]		800	200	0.9	LDL	--	70	400
Area 21	1.12	<2	0.77	LDL	31	1.2	LDL	--	--	--
Area 22	1.67	<2	0.99	143	7.0	0.7	LDL	--	--	--
Area 23	--	6,000[k]	--	--	--	--	--	--	--	--
Area D	0.98	<2	--	--	--	--	--	--	--	--
Area J	147	30.42	6.84	3.0	LDL	1.0	LDL	--	--	--
Spoils Disposal	8.30	<2	1.90	LDL	LDL	0.94	LDL	--	--	--

[k]value indicated is thorium-230 isotope

- Area 1, a historic thorium storage and redrumming area;
- Area 2, a historic disposal trench for empty thorium drums and for polonium-210-contaminated sand;
- Area 3, a historic thorium storage and redrumming area;
- Area 7, a historic disposal area used for the disposal of empty thorium drums, a thorium-contaminated dump truck, and a polonium-210-contaminated washing machine, enclosing an area containing a historic septic tank contaminated with actinium-227 from the old SW Building;
- Area 8, thorium-contaminated soils moved from Areas 1 and 9;
- Area 9, a historic thorium storage and redrumming area;
- Area 12, thorium-contaminated soils moved from Area 1;

Evaluation of the Site Survey Project for this report, as well as more recent data, indicates that isolated areas of elevated thorium concentrations are present at the plant. Areas not investigated by the Site Survey Project, but are known or suspected to be contaminated with thorium include:

- the railroad siding where thorium drums were unloaded and boxcars decontaminated;
- a widespread area on the north end of the SM/PP Hill adjacent to Area 8;

A large pile of soil on the south end of the SM/PP Hill, known as the excavated materials disposal area (or Rader's Hill) does not appear to contain concentrations of thorium above 2 pCi/g, thought to be the background level (Stought et al. 1988).

Processing of uranium ores at Mound Plant was performed on a relatively small scale from the mid-1950s to the late 1970s. The uranium ores were used to extract the daughter products thorium-230 and protactinium-231, among others. The Site Survey Project (Stought et al. 1988) did not include areas used specifically during the processing of these ores. Local contamination of thorium-230 has since been recognized in Area 23 between the HH and WD Buildings. Area 23 may be contaminated with up to 6 nCi/g of thorium-230. No other areas have positive identification of the thorium-230 isotope.

Processing of radium/actinium in the early 1950s appears to have resulted in local concentrations of actinium-227. Most of these areas were recognized by the Site Survey Project (Stought et al. 1988). Investigated areas known or suspected to be contaminated with radium or actinium included:

- Area 7, a historic disposal area used for the disposal of empty thorium drums, a thorium-contaminated dump truck, and a polonium-210-contaminated washing machine, enclosing an area containing a historic septic tank contaminated with actinium-227 from the old SW Building; and

Jarvis, J. V. 1990. "Nuclear Operation's Analytical Request for Analysis: Bldg. 23" EG&G Mound Applied Technologies, Mound Laboratory, Miamisburg, Ohio. August 28, 1990.

Map Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Pu-238 (pCi/g)	Thorium[b] (pCi/g)	Tritium (pCi/mL)	Co-60 (pCi/g)	Cs-137 (pCi/g)	Ra-226 (pCi/g)	Am-241 (pCi/g)
S0056	1050	2310	4056	10-83	0	0.19	b					
S0057	1150	1925	6765	08-84	0	0.55	b					
S0058	1150	2050	6761	08-84	0	0.57	b					
S0059	1150	2085	4061	10-83	0	1.68	b					
S0060	1175	1885	4060	10-83	0	0.28	b					
S0061	0925	2265	4064	10-83	0	1.50	b					
S0062	0925	2365	4065	10-83	0	1.50	b					
S0063	0925	2440	6766	08-84	0	17.60	b					
S0064	0925	2490	4066	10-83	0	0.25	b					
S0065	0950	2615	4067	10-83	0	0.02	b					
S0066	1050	2290	4063	10-83	0	1.07[c]	b					
C0002	1200	1860	8340	11-84	36	0.10	4.47					
			8341	11-84	72	0.01	2.49					
S0067	1225	1985	6433	08-84	0	0.24	b					
S0068	1225	2035	6434	08-84	0	0.45	b					
S0069	1225	2085	6435	08-84	0	0.10	b					
S0070	1225	2135	6436	08-84	0	0.60	b					
S0071	1250	1385	3030	10-83	0	0.17	b	1.92				
S0072	1350	1960	6439	08-84	0	0.24	b					

Map Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Pu-238 (pCi/g)	Thorium[b] (pCi/g)	Tritium (pCi/mL)	Co-60 (pCi/g)	Cs-137 (pCi/g)	Ra-226 (pCi/g)	Am-241 (pCi/g)
S0073	1350	2010	3031	10-83	0	0.57	b	1.66				
S0074	1350	2085	6440	08-84	0	0.48	b					
S0075	1350	2100	3032	10-83	0	0.40	b					
C0003	1420	2180	10665	10-85	18	NR	NR		LDL	LDL	0.4	LDL
			10666	10-85	36	NR	NR		LDL	LDL	0.6	LDL
			10667	10-85	54	NR	NR		LDL	LDL	0.7	LDL
			10668	10-85	72	NR	NR		LDL	LDL	0.7	LDL
			10669	10-85	90	NR	NR		LDL	LDL	0.8	LDL
			10670	10-85	108	NR	NR		LDL	LDL	0.9	LDL
			10671	10-85	126	NR	NR		LDL	LDL	0.7	LDL
			10672	10-85	144	NR	NR		LDL	LDL	0.5	LDL
			10673	10-85	162	NR	NR		LDL	LDL	0.4	LDL
			10674	10-85	180	NR	NR		LDL	LDL	0.5	LDL
S0076	1450	1885	3027	10-83	0	2.57[c]	b	1.31				
S0077	1450	2010	3028	10-83	0	0.76	b					
S0078	1450	2135	3029	10-83	0	1.59	b	1.54				
C0004	1200	2240	8342	11-84	36	0.10	4.47					
			8343	11-84	72	0.01	2.49					
S0079	1250	2440	3039	10-83	0	0.03	b	1.32				
S0080	1250	2615	3040	10-83	0	1.19	b					
S0081	1300	2415	6135	08-84	0	0.10	b					
S0082	1350	2365	3038	10-83	0	0.04	b					
S0083	1400	2390	3043	10-83	0	1.14	b					
S0084	1450	2440	6136	08-84	0	0.08	b					

Map Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Pu-238 (pCi/g)	Thorium[b] (pCi/g)	Tritium (pCi/mL)	Co-60 (pCi/g)	Cs-137 (pCi/g)	Ra-226 (pCi/g)	Am-241 (pCi/g)
S0085	1490	2415	3041	10-83	0	0.11	b					
S0086	1490	2465	3042	10-83	0	0.13	b					
S0087	1490	2515	6137	08-84	0	0.31	b					
S0088	1490	2590	6138	08-84	0	0.63	b					
C0249	1500	1860	8348	11-84	54	0.01	2.25					
S0090	1525	1970	6451	08-84	0	0.32	b					
S0091	1575	2185	4087	10-83	0	1.23	b					
S0092	1585	2085	4086	10-83	0	0.78	b	1.05				
S0093	1600	1935	6452	08-84	0	0.53	b					
S0094	1625	1885	6453	08-84	0	1.04	b					
S0095	1625	2210	7103	09-84	0	0.04	b					
S0096	1650	1960	4085	10-83	0	0.36	b	0.55				
S0097	1650	2060	7107	09-84	0	0.51	b					
S0098	1650	2160	7104	09-84	0	0.13	b					
S0099	1650	2235	7102	09-84	0	0.07	b					
S0100	1685	2045	4083	10-83	0	0.73	b	0.37				
S0101	1735	2160	7105	09-84	0	0.15	b					
S0102	1750	2010	7106	09-84	0	0.56	b					
S0103	1750	2110	7108	09-84	0	0.56	b					

Map Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Pu-238 (pCi/g)	Thorium[b] (pCi/g)	Tritium (pCi/mL)	Co-60 (pCi/g)	Cs-137 (pCi/g)	Ra-226 (pCi/g)	Am-241 (pCi/g)
S0252	2375	1780	6500	08-84	0	0.49	b					
S0253	2375	1830	2810	10-83	0	0.86	b	2.07				
S0254	2425	1500	2824	10-83	0	1.56	b					
S0255	2425	1605	6355	08-84	0	1.42	b					
S0256	2425	1705	2823	10-83	0	0.35	b					
S0257	2425	1730	6362	08-84	0	0.01	b					
S0258	2425	1830	2822	10-83	0	0.72	b					
S0259	2450	1755	6361	08-84	0	0.01	b					
S0260	2475	1630	6356	08-84	0	0.02	b					
S0261	2475	1855	6360	08-84	0	0.01	b					
S0262	2500	1650	6357	08-84	0	0.79	b					
S0263	2500	1655	6353	08-84	0	0.03	b					
S0264	2500	1730	6354	08-84	0	0.04	b					
S0265	2525	1655	6358	08-84	0	0.02	b					
S0266	2525	1680	6352	08-84	0	0.01	b					
S0267	2525	1730	2862	10-83	0	0.05[c]	b					
S0268	2575	1655	6359	08-84	0	3.60[c]	b					
S0269	2575	1830	6350	08-84	0	0.34	b					
S0270	2625	1730	6351	08-84	0	0.13	b					

Map Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Pu-238 (pCi/g)	Thorium[b] (pCi/g)	Tritium (pCi/mL)	Co-60 (pCi/g)	Cs-137 (pCi/g)	Ra-226 (pCi/g)	Am-241 (pCi/g)
C0066	1880	3320	10406	09-85	18	NR	NR		0.6	LDL	0.5	LDL
			10409	09-85	72	NR	NR		5	LDL	0.4	LDL
			10410	09-85	90	NR	NR		10	LDL	0.4	LDL
			10411	09-85	108	NR	NR		14	LDL	0.7	LDL
			10412	09-85	126	NR	NR		4	LDL	0.7	LDL
			10413	09-85	144	NR	NR		13	LDL	0.4	LDL
			10414	09-85	162	NR	NR		4	LDL	0.6	LDL
			10415	09-85	180	NR	NR		LDL	LDL	0.6	LDL
			10416	09-85	198	NR	NR		LDL	LDL	0.4	LDL
			10417	09-85	216	NR	NR		LDL	LDL	0.3	LDL
			10418	09-85	234	NR	NR		LDL	LDL	0.4	LDL
S0377	1900	3200	6260	08-84	0	4.02	b					
S0378	1975	3325	6262	08-84	0	0.26	b					
S0379	2000	3250	6261	08-84	0	0.51	b					
S0380	2000	3300	3072	10-83	0	0.66	b	3.52				
S0381	2025	3075	3071	10-83	0	0.12	b					
S0382	2025	3150	3070	10-83	0	0.02	b	3.43				
S0383	2050	3200	6263	08-84	0	0.76[c]	b					
(The same MRC ID was also assigned to the sample from surface location S0458.)												
S0384	2050	3375	3073	10-83	0	0.06	b					
S0385	1850	3505	6266	08-84	0	3.20	b					
S0386	1850	3605	4094	10-83	0	2.19	b					
S0387	1875	3480	6267	08-84	0	1.05	b					
C0067	2100	2620	8381	11-84	54	0.19	b					
			8382	11-84	90	0.02	3.61					

Map Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Pu-238 (pCi/g)	Thorium[b] (pCi/g)	Tritium (pCi/mL)	Co-60 (pCi/g)	Cs-137 (pCi/g)	Ra-226 (pCi/g)	Am-241 (pCi/g)
C0068	2160	3370	10688	09-85	18	NR	NR		LDL	LDL	0.6	LDL
			10689	09-85	36	NR	NR		LDL	LDL	0.6	LDL
			10690	09-85	54	NR	NR		LDL	LDL	0.7	LDL
			10691	09-85	72	NR	NR		LDL	LDL	0.5	LDL
			10692	09-85	90	NR	NR		LDL	LDL	0.6	LDL
			10693	09-85	108	NR	NR		LDL	LDL	0.8	LDL
			10694	09-85	126	NR	NR		LDL	LDL	0.6	LDL
			10695	09-85	144	NR	NR		LDL	LDL	0.6	LDL
			10696	09-85	162	NR	NR		LDL	LDL	0.6	LDL
			10697	09-85	180	NR	NR		LDL	LDL	0.6	LDL
			10698	09-85	198	NR	NR		LDL	LDL	0.6	LDL
			10699	09-85	216	NR	NR		LDL	LDL	0.6	LDL
C0260	2185	3360	5413	11-84	36	0.11	b					
S0406	2200	3225	2873	10-83	0	1.90[c]	4.02[c]					
S0407	2210	3160	2872	10-83	0	0.13	b					
S0408	2235	3255	2913	10-83	0	NR	b					
C0069	2235	3320	10804	09-85	0	NR	NR		LDL	LDL	0.5	LDL
			10805	09-85	18	NR	NR		LDL	LDL	0.4	LDL
			10806	09-85	36	NR	NR		LDL	LDL	0.4	LDL
			10807	09-85	54	NR	NR		LDL	LDL	0.6	LDL
			10808	09-85	72	NR	NR		LDL	LDL	0.4	LDL
			10809	09-85	90	NR	NR		LDL	LDL	0.5	LDL
			10810	09-85	108	NR	NR		LDL	LDL	0.6	LDL
			10811	09-85	126	NR	NR		LDL	LDL	0.6	LDL
			10812	09-85	144	NR	NR		LDL	LDL	0.2	LDL
C0070	2240	3300	10792	09-85	0	NR	NR		LDL	1.0	0.7	LDL
			10794	09-85	36	NR	NR		LDL	LDL	0.2	LDL
			10796	09-85	72	NR	NR		LDL	LDL	0.9	LDL
			10798	09-85	108	NR	NR		LDL	LDL	0.5	LDL
			10799	09-85	126	NR	NR		LDL	LDL	0.7	LDL
			10800	09-85	144	NR	NR		LDL	LDL	0.6	LDL

Map Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Pu-238 (pCi/g)	Thorium[b] (pCi/g)	Tritium (pCi/mL)	Co-60 (pCi/g)	Cs-137 (pCi/g)	Ra-226 (pCi/g)	Am-241 (pCi/g)
S0442	2550	3375	2985	10-83	0	1.49	b					
S0443	2575	3300	2981	10-83	0	1.16	b					
S0444	2600	3100	2986	10-83	0	0.79	b					
S0445	2635	3010	2987	10-83	0	2.18	b					
S0446	2650	3375	2983	10-83	0	0.47	b					
S0447	2675	3025	5881	07-84	0	9.57	b					
S0448	1900	3455	4095	10-83	0	1.02	b					
S0449	1900	3530	6269	08-84	0	6.21	b					
S0450	1950	3430	6268	08-84	0	3.57	b					
C0077	1950	3680	1958	05-83	18	1.45	b					
			1959	05-83	36	0.64	b					
			1960	05-83	72	15.41[c]	b					
S0451	1975	3480	6271	08-84	0	0.49	b					
S0452	1975	3680	6273	08-84	0	19.10	b					
C0078	1975	3755	1961	05-83	18	1.14	b					
			1962	05-83	30	0.35	b					
			1963	05-83	42	0.18	b					
			1964	05-83	72	0.97	b					
S0453	2000	3430	6272	08-84	0	19.80	b		LDL	LDL	0.8	LDL
S0454	2000	3530	6270	08-84	0	4.87	b					
S0455	2000	3680	2425	09-82	0	NR	NR		LDL	LDL	0.8	LDL

Map Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Pu-238 (pCi/g)	Thorium[b] (pCi/g)	Tritium (pCi/mL)	Co-60 (pCi/g)	Cs-137 (pCi/g)	Ra-226 (pCi/g)	Am-241 (pCi/g)
C0093	2130	3390	10600	09-85	18	NR	NR		LDL	LDL	0.6	LDL
			10601	09-85	36	NR	NR		LDL	LDL	0.6	LDL
			10602	09-85	54	NR	NR		LDL	LDL	0.6	LDL
			10603	09-85	72	NR	NR		LDL	LDL	0.5	LDL
			10604	09-85	90	NR	NR		LDL	LDL	0.4	LDL
			10605	09-85	108	NR	NR		LDL	LDL	0.5	LDL
			10606	09-85	126	NR	NR		LDL	LDL	0.5	LDL
			10607	09-85	144	NR	NR		LDL	LDL	0.9	LDL
			10608	09-85	162	NR	NR		LDL	LDL	0.5	LDL
			10609	09-85	180	NR	NR		LDL	LDL	0.6	LDL
			10610	09-85	198	NR	NR		LDL	LDL	0.8	LDL
S0471	2150	3555	7602	08-84	0	5.27	b					
S0472	2175	3505	6701	08-84	0	1.20	7.50					
S0473	2200	3655	5877	07-84	0	1.83	b		LDL	1.2	0.9	LDL
S0474	2215	3430	6700	08-84	0	1.10	b					
S0475	2225	3555	5875	07-84	0	6.61	b					
S0476	2250	3530	5874	07-84	0	1.02	b					
S0477	2250	3665	6696	08-84	0	0.02	b					
S0478	2260	3465	5872	07-84	0	0.36	b					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0.65	[illegible]					

NR - Not recorded
NC - No sample/reading taken
NA - Reading not taken; contamination criteria not exceeded.
a - Mound Soil Screening Facility detection level not exceeded.
b - Concentration at or above the Mound Soil Screening Facility detection level.
c - Results of the wipe sample were less than 20 disintegrations per minute.
CPM - Counts per minute
KCPM - Counts per minute x 1000

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Keith McMahon Mail Station: Bldg 30 Phone: _____

Product Code or Project No. _____ Q.C. No. _____ Requested Completion Date _____

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 23 #1 (4 kilograms)

Sample Disposition: ☐ Discard ☑ Return

If request is for product/material quality control, enter the specification drawing number. If not, enter none:

Analysis Desired, Comments: Gamma

(±50%)

Anal. Sample ID's: 590-1397

Results:

Nuclide:	Concentration ± 1 Sigma (pCi/g)
Pa-231	134. ± 67.
Pb-210	241. ± 121.
Th-227	198. ± 99.
Pb-214	398. ± 199.
Th-230	4590. ± 2295.
Ra-223	192. ± 96.
U-235	7. ± 4.
Rn-219	188. ± 94.
Bi-211	200. ± 100.
Bi-214	39. ± 20.

DISTRIBUTION:

WHITE COPY - REQUESTOR
YELLOW COPY - DATA PROCESSING ____ GR. LEADER
PINK COPY - ANALYTICAL LOG BOOK
GOLDENROD COPY - REQUESTOR'S RECEIPT

ML-1527 (7-82)
17-1394

Received by _____

Analyzed by: Jack G Jarvis 8/28/90

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Keith McMahon Mail Station: Bldg 20 Phone:

Product Code or Project No.: Q.C. No.: Requested Completion Date:

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 23 #2 (582 grams)

Sample Disposition: ☐ Discard ☑ Return

If request is for product/material quality control, enter the specification drawing number. If not, enter none:

Analysis Desired, Comments: Gamma

(±50%) Anal. Sample ID's: 540 - 1398

Results:

Nuclide:	Concentration (Pci/g) ± 1 Sigma
Pb-210	78. ± 39.
Th-227	57. ± 29.
Pb-214	10. ± 5.
Th-230	946. ± 473.
Ra-223	56. ± 28.
U-235	1.6 ± 0.8
Rn-219	55. ± 28.
Bi-211	63. ± 32.
Bi-214	12. ± 6
K-40	11. ± 6.

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ML-1527 (7-82)

Received by:

Analyzed by: Jack Y. Jarvis 8/29/90

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Keith McMahon Mail Station: Bldg 30 Phone: _____

Product Code or Project No. _____ Q.C. No. _____ Requested Completion Date _____

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 23 # 3 (483 grams)

Sample Disposition: ☐ Discard ☑ Return

If request is for product/material quality control, enter the specification drawing number. If not, enter none:

Analysis Desired, Comments: Gamma

(±50%)

Anal. Sample ID's: 540-1399

Results:

Nuclide:	Concentration (pCi/g) ± 1 sigma
Pa-231	18.5 ± 9.3
Pb-210	46.1 ± 23.1
Th-227	31.7 ± 15.9
Pb-214	5.2 ± 2.6
Th-230	462. ± 231.
Ra-223	33.8 ± 16.9
U-235	1.7 ± 0.9
Rn-219	31.3 ± 15.7
Bi-214	5.6 ± 2.8
K-40	8.9 ± 4.5

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Analyzed by Jack Y. Jarvis 8/28/90

ML-1527 (7-82)
17-1294

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Keith McMahon Mail Station: Bldg 30 Phone: _____

Product Code or Project No. _____ Q.C. No. _____ Requested Completion Date _____

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 33 #4

Sample Disposition: ☐ Discard ☑ Return

If request is for product/material quality control, enter the specification drawing number. If not, enter none:

Analysis Desired, Comments: Gamma

(± 50%)

Anal. Sample ID's: 540 – 1400

Results:

Nuclide:	pCi/g Concentration ± 1 Sigma
Th-227	58.3 ± 29.
Pb-214	12.0 ± 6.0
Th-230	812. ± 96.
RA-223	56. ± 28.
U-235	2.3 ± 1.2
Rn-219	56. ± 28.
Bi-211	61. ± 31.
Bi-214	12. ± 6.
K-40	14. ± 7.

DISTRIBUTION:

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ML-1527 (7-82)
17-1794

Received by _____

Analyzed by Jack Y. Jarvis 8/28/90

ENVIRONMENTAL RESTORATION PROGRAM

SOIL GAS SURVEY AND GEOPHYSICAL INVESTIGATIONS
MAIN HILL AND SM/PP HILL AREAS
RECONNAISSANCE SAMPLING

MOUND PLANT
MIAMISBURG, OHIO

February 1993

DEPARTMENT OF ENERGY
ALBUQUERQUE OFFICE

ENVIRONMENTAL RESTORATION PROGRAM
EG&G MOUND APPLIED TECHNOLOGIES

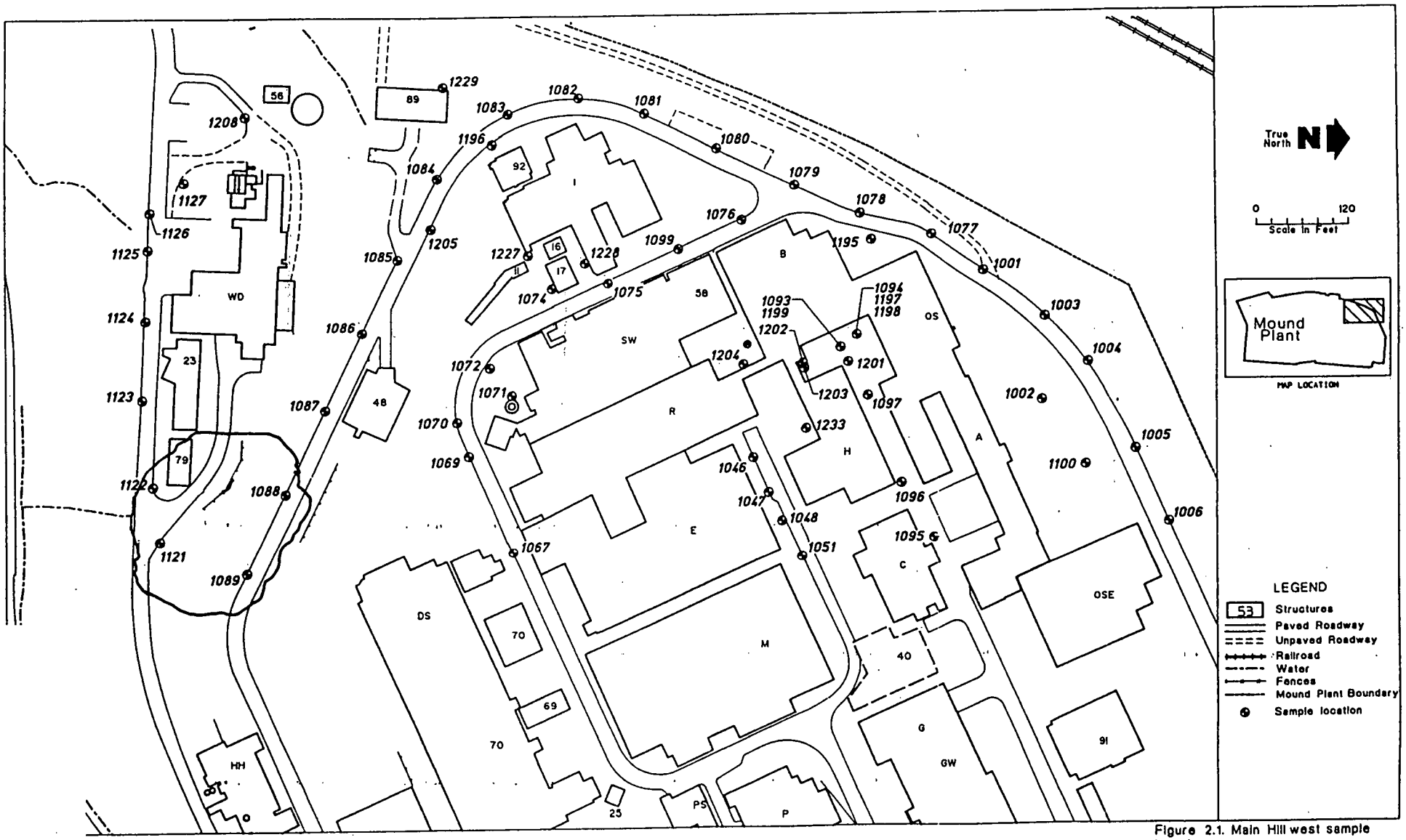

Figure 2.1. Main Hill west sample location map.

TABLE II.4 SUMMARY OF POSITIVE DETECTIONS – MAIN HILL
(ppb)

SAMPLE ID	SAMPLE DATE	FREON 11	FREON 113	TRAN-12DCE	CIS-12DCE	111TCA	PCE	TCE	TOLUENE
MND-01-1113-0005	17 AUG 92	---	---	---	---	---	---	11	---
MND-01-1114-0005	17 AUG 92	---	9	---	---	315	10	357	5 *
MND-01-1114-1005	17 AUG 92	---	---	---	---	259	8	263	3 *
MND-01-1115-0005	17 AUG 92	---	---	---	---	56	---	13	---
MND-01-1117-0005	18 AUG 92	---	---	---	---	---	12	8	---
MND-01-1117-1005	18 AUG 92	---	---	---	---	---	15	9	---
MND-01-1118-0005	18 AUG 92	---	---	---	---	---	3	---	---
MND-01-1119-0005	18 AUG 92	---	---	---	---	---	---	---	213
MND-01-1122-0005	18 AUG 92	801	13	---	---	---	---	---	---
MND-01-1123-0005	18 AUG 92	---	---	---	---	---	---	---	5 *
MND-01-1124-0005	18 AUG 92	---	---	---	---	---	---	---	8884 *
MND-01-1127-0005	18 AUG 92	---	---	---	---	---	4	---	27 *
MND-01-1129-0005	18 AUG 92	---	10	---	---	37	12	4	11 *
MND-01-1190-0005	24 SEP 92	240	477	---	---	---	---	---	3 *
MND-01-1190-1005	24 SEP 92	287	707	---	---	---	---	---	3 *
MND-01-1192-0005	24 SEP 92	---	---	---	---	---	---	---	5 *
MND-01-1193-0005	24 SEP 92	---	---	---	---	---	---	---	18 *
MND-01-1196-0005	25 SEP 92	---	---	---	---	---	---	4	64
MND-01-1197-0002	25 SEP 92	---	---	---	---	---	---	23	5
MND-01-1198-0008	25 SEP 92	---	24	13	518	33	---	474	5
MND-01-1199-0002	25 SEP 92	---	10218	---	120	---	---	479	---
MND-01-1201-0007	25 SEP 92	---	4716	13	811	---	---	130	48
MND-01-1201-1007	25 SEP 92	---	5895	---	612	---	---	117	43
MND-01-1202-0002	25 SEP 92	---	6419	66	2499	8	---	1921	3
MND-01-1202-1002	25 SEP 92	---	9301	41	1706	---	---	1737	---
MND-01-1203-0002	25 SEP 92	---	1475	---	334	---	---	45	192
MND-01-1204-0005	25 SEP 92	---	453	---	---	---	---	11	5
MND-01-1205-0005	25 SEP 92	---	---	---	---	---	---	---	21
MND-01-1206-0005	26 SEP 92	---	---	---	---	---	---	---	23142
MND-01-1207-0005	26 SEP 92	---	---	---	---	---	---	---	90 -
MND-01-1227-0005	28 SEP 92	---	10	---	---	---	---	---	4788
MND-01-1228-0005	28 SEP 92	---	---	---	---	---	---	---	11
MND-01-1230-0005	28 SEP 92	---	---	---	---	---	---	---	13
MND-01-1230-1005	28 SEP 92	---	---	---	---	---	---	---	5
MND-01-1231-0005	28 SEP 92	---	48	---	---	---	34	21	5
MND-01-1232-0005	28 SEP 92	---	4	---	---	---	13	8	24
MND-01-1233-0002	29 SEP 92	---	29	---	---	---	---	---	72
MND-01-1233-1002	29 SEP 92	---	29	---	---	---	---	---	64

otes:

Only sample locations having positive detections are shown.

*: Associated trip, ambient, equipment or field blank contained specified compound.

B: Indicates blank sample.

w: Indicates water sample.

**: Freon 113 & TCE Off – Scale

Document Control No. _____

Environmental Restoration Program

OTHER SOILS CHARACTERIZATION REPORT

MOUND PLANT
MIAMISBURG, OHIO

Volume I – Text

May 1996

Final
(Revision 0)

U.S. Department of Energy
Ohio Field Office

Environmental Restoration Program
EG&G Mound Applied Technologies

S0472

Four samples from hot spot S0472 (Area 91) triggered field screening action levels:

- One sample exceeded limits for hazardous compounds
- Three samples exceeded limits for radionuclides

Elevated concentrations of chromium were detected by the PXRF in soil samples collected from the site. Elevated concentrations of Pu238 were found in excess of 124 pCi/g in soil samples collected from the site.

Table 5.15 shows Hot Spot S0472 field results exceeding action levels. Figure 5.20 graphically represents Hot Spot S0472 field sampling results.

Table 5.15 Hot Spot S0472 Field Sampling Results

Sample ID	FIDLER		Organics		Rad Laboratory				
	Channel 1 (1K)	Channel 2 (5K)	OVA	OVM	Pu 238 (25)	Th 232 (5)	Ra 226 (5)	Cs 137 (15)	Am 241(20)
9101-5014	<1000	<5000	<1	NA	118.5 *	0.99	<1.32	0.12	0.16
9103-5001	<1000	<5000	<1	<1	124.5 *	0.81	3.17	<0.15	<0.17
9104-5012	<1000	<5000	<1	<1	120.9 *	0.68	2.19	<0.09	<0.15
9105-5001	<1000	<5000	<1	<1	<120.2 U	0.56	1.52	0.19	<0.13

Sample ID	PXRF Metals								
	As (102.07)	Ba (1489)	Cd	Cr HI	Cr LO (164.43)	Pb (172)	Hg	Se	Ag (2559)
9101-5014	<34	269.35	<44.5	<347	<60.7	<10	<37	18.082	51.4189
9103-5001	<34	224.45	<44.5	<347	<60.7	<10	<37	16.062	<29
9104-5012	77.629	227.02	<44.5	<347	<60.7	<10	<37	<14	41.1578
9105-5001	84.481	187.86	<44.5	<347	229.98 *	<10	<37	<14	<29

S1092

Four samples from hot spot S1092 (Area 92) triggered field screening action levels:

- Four samples exceeded limits for hazardous compounds

Organic vapors from soil samples peaked at 30 meter units on the OVA.

Table 5.16 shows Hot Spot S1092 field results exceeding action levels. Figure 5.21 graphically represents Hot Spot S1092 field sampling results.

Table 5.16 Hot Spot S1092 Field Sampling Results

Sample ID	FIDLER		Organics		Rad Laboratory				
	Channel 1 (1K)	Channel 2 (5K)	OVA	OVM	Pu 238 (25)	Th 232 (5)	Ra 226 (5)	Cs 137 (15)	Am 241(20)
9201-5008	<1000	<5000	120 *	NA	<138.5 U	0.74	<1.26	<0.08	<0.18
9201-5012	<1000	<5000	30 *	NA	<47.19 U	0.65	2.43	<0.08	<0.11
9205-5008	<1000	<5000	130 *	NA	<142.4 U	0.64	<2.03	<0.09	<0.19
9205-5012	<1000	<5000	40 *	NA	<147.1 U	0.93	<1.86	<0.1	0.16

Sample ID	PXRF Metals								
	As (102.07)	Ba (1489)	Cd	Cr HI	Cr LO (164.43)	Pb (172)	Hg	Se	Ag (2559)
9201-5008	NA	NA	NA	NA	NA	NA	NA	NA	NA
9201-5012	NA	NA	NA	NA	NA	NA	NA	NA	NA
9205-5008	NA	NA	NA	NA	NA	NA	NA	NA	NA
9205-5012	NA	NA	NA	NA	NA	NA	NA	NA	NA

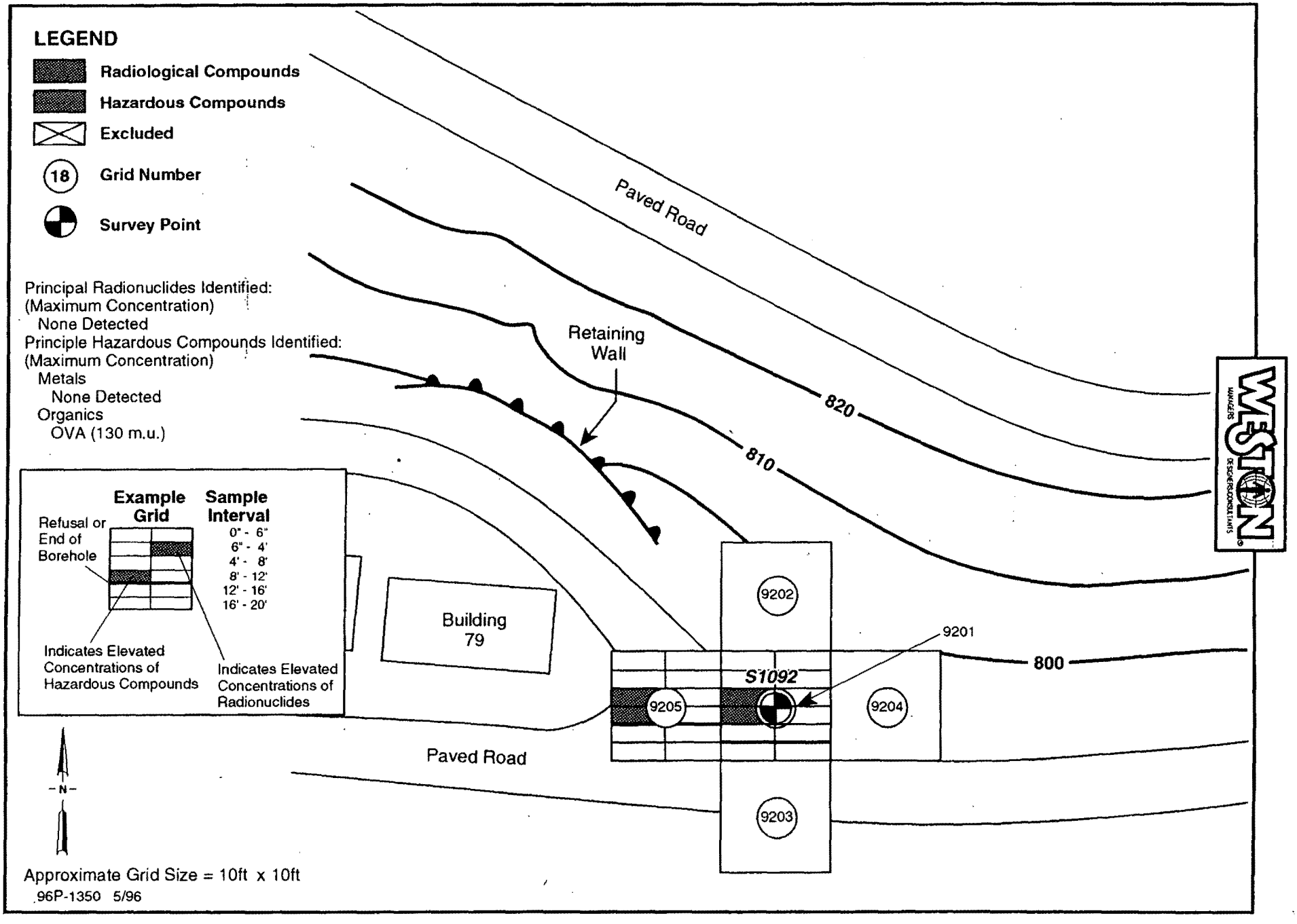

FIGURE 5.21 HOT SPOT S1092

Area 23

Eleven samples in Area 23 triggered field screening action levels:

- Six samples exceeded limits for hazardous compounds
- Five samples exceeded limits for radionuclides

Organic vapors from soil samples peaked at 100 meter units on the OVA. Elevated concentrations of Pu238 and Th232 were found in respective concentrations of up to 63 and 5 pCi/g in soil samples collected from the site.

Table 5.10 shows Area 23 field results exceeding action levels. Figure 5.9 graphically represents Area 23 field sampling results.

Table 5.10 Area 23 Field Sampling Results

Sample ID	FIDLER		Organics		Rad Laboratory				
	Channel 1 (1K)	Channel 2 (5K)	OVA	OVM	Pu 238 (25)	Th 232 (5)	Ra 226 (5)	Cs 137 (15)	Am 241(20)
2307-5012	<1000	<5000	<1	<1	36 •	<5	NA	NA	NA
2319-5004	<1000	<5000	NA	<1	44 •	<5	NA	NA	NA
2319-5008	<1000	<5000	NA	<1	43 •	<5	NA	NA	NA
2319-5012	<1000	<5000	NA	<1	63 •	<5	NA	NA	NA
2336-5001	<1000	<5000	10 •	10 •	<25	<5	NA	NA	NA
2348-5004	NA	NA	<1	<1	<25	5 •	NA	NA	NA
2354-5004	<1000	<5000	10 •	<1	<25	<5	NA	NA	NA
2354-5012	<1000	<5000	10 •	<1	<25	<5	NA	NA	NA
2387-5004	NA	NA	50 •	NA	<134.3 U	1.05	<2.02	<0.09	<0.13
2389-5004	<1000	<5000	100 •	NA	<142 U	0.4	2.74	<0.08	<0.1
2391-5012	<1000	<5000	5 •	10 •	<25	<5	NA	NA	NA

Sample ID	PXRF Metals								
	As (102.07)	Ba (1489)	Cd	Cr HI	Cr LO (164.43)	Pb (172)	Hg	Se	Ag (2559)
2307-5012	NA	NA	NA	NA	NA	NA	NA	NA	NA
2319-5004	<34	232.08	<44.5	<347	<60.7	<10	<37	21.824	42.2697
2319-5008	35.7218	254.854	<44.5	<347	<60.7	<10	<37	<14	50.2894
2319-5012	35.815	232.9	<44.5	<347	<60.7	<10	<37	38.129	<29
2336-5001	<34	232	<44.5	<347	<60.7	33.253	<37	<14	48.1513
2348-5004	62.976	128.4	<44.5	<347	<60.7	<10	<37	<14	50.8491
2354-5004	<34	263.86	<44.5	<347	<60.7	43.729	<37	<14	56.9253
2354-5012	NA	NA	NA	NA	NA	NA	NA	NA	NA
2387-5004	NA	NA	NA	NA	NA	NA	NA	NA	NA
2389-5004	NA	NA	NA	NA	NA	NA	NA	NA	NA
2391-5012	64.7053	307.244	<44.5	486.308	<60.7	<10	<37	<14	31.466

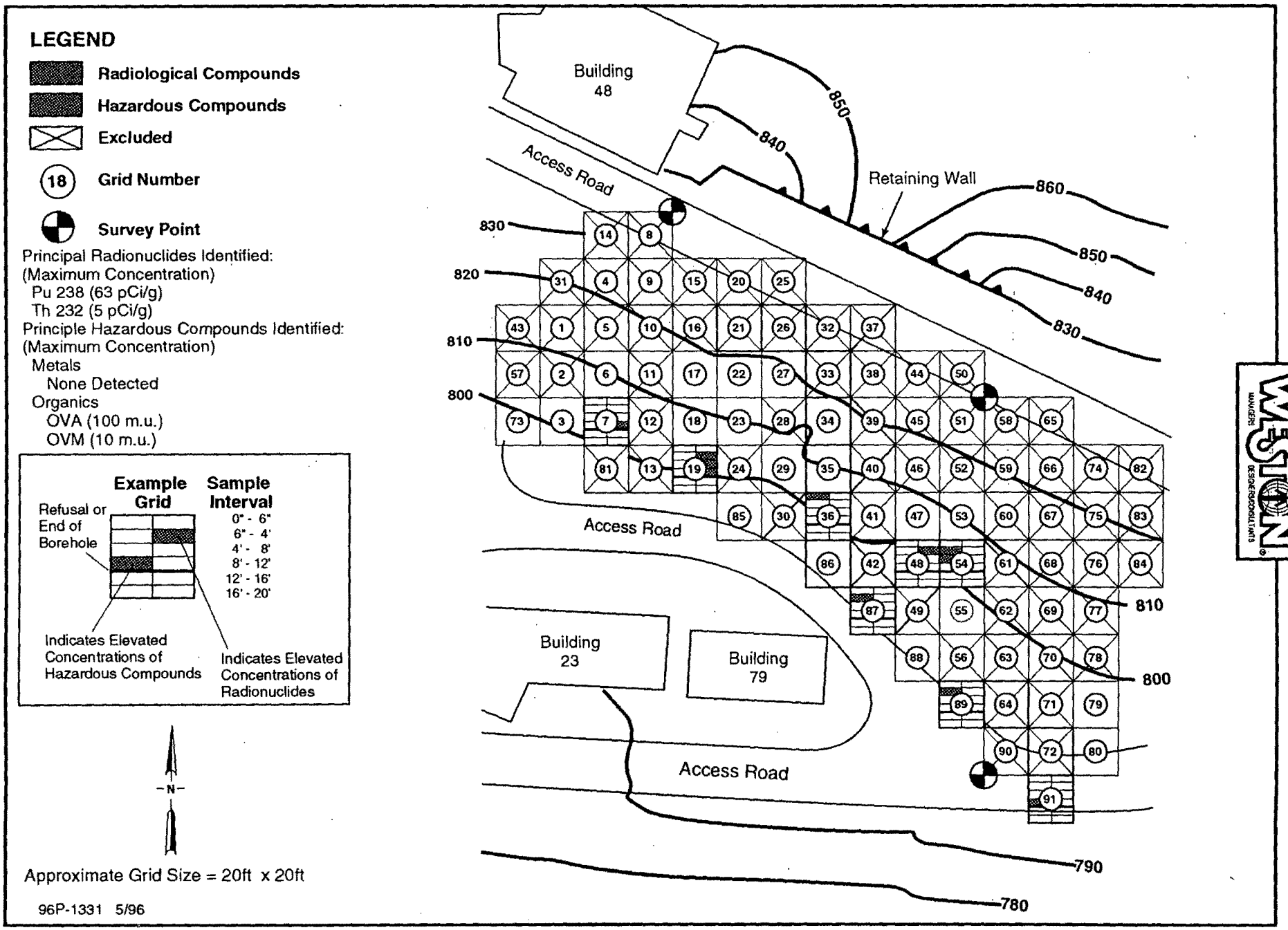

FIGURE 5.9 AREA 23

Sample ID		Co 60	Cs 137	Ra 226	Ac 227	Th 230	Th 232	Pa 231	U 238	Pu 238	Am 241
1284-5008	D	<0.02	<0.02	0.5	<0.1	<3.4	0.4	<0.5	0.4	<36.9	<0.04
1284-5008		<0.05	<0.04	2	<0.3	<7.1	0.5	<1.6	<5.8	<76.2	0.1
1284-5012	D	<0.02	<0.02	1.7	<0.15	<4.3	0.85	<1.1	<3.4	<37	<0.05
1284-5012		<0.08	<0.05	1.9	<0.4	<9.9	0.8	<2.9	<8.6	<90.3	<0.09
1288-5001	D	<0.02	0.06	1.2	<0.1	<3.7	0.4	<1	<3	<29.4	<0.04
1288-5001		<0.02	0.07	0.5	<0.2	1.6	1	<0.6	0.4	26.5	0.07
1288-5004	D	<0.02	0.1	1.5	<0.2	<4.1	1	<1	<2.9	<33.8	<0.04
1288-5004		<0.02	0.2	0.8	<0.1	<4.2	<1.2	<0.6	0.4	<44.8	<0.04
1288-5008		<0.03	0.02	0.8	<0.2	<11.2	4.7	<0.6	0.4	301.3	<0.2
1288-5012	D	<0.02	<0.02	0.5	<0.2	<3.9	0.8	<0.5	0.5	<39.9	0.02
1288-5012		<0.02	<0.02	1.1	<0.2	<3.7	0.7	<1	<3.4	<56.7	<0.04
1289-5001		<0.06	0.1	1.9	<0.3	<8.7	1.1	3.1	<5.8	104.1	<0.09
1289-5004	D	<0.01	0.06	1.1	<0.13	<3.31	0.53	<0.67	<2.32	<27.15	<0.03
1289-5004		<0.04	0.05	2.3	<0.3	<7.8	0.5	<1.9	<5.9	<77.6	<0.08
1290-5001	D	<0.03	0.37	1.9	0.65	5.8	1.69	<1.28	<4.24	<225.5	<0.06
1290-5001		<0.08	0.4	2.7	<0.5	<11.4	1.7	<3.4	<8.5	145.7	<0.1
1290-5004	D	<0.03	0.23	2.3	<0.18	<5.3	1.5	<1.1	<4.1	<43	<0.05
1290-5004		<0.06	0.3	2.4	<0.5	<11.6	1.6	<3.3	<8.2	<95.8	<0.1
1290-5008	D	<0.02	0.04	0.5	<0.15	<4.3	1	<0.5	0.6	<43.2	<0.04
1290-5008		<0.05	<0.05	<1.1	<0.4	<10.1	1	<2.1	<7.2	<90.6	<0.1
1290-5012	D	<0.02	<0.02	0.5	<0.1	<3.8	0.7	<0.5	0.5	<39.3	<0.04
1290-5012		<0.07	<0.04	1.7	<0.3	<7.9	0.7	<1.9	<8.1	<90.7	<0.08
1294-5001	D	<0.02	0.07	1.4	<0.15	<3.9	0.6	<0.9	<3.5	<38	<0.04
1294-5001		<0.06	<0.06	1.2	<0.4	<7.8	0.4	<2.9	<7.9	<91.4	<0.09
1294-5004		<0.01	0.04	1.6	<0.1	<2.9	0.31	<0.6	<2.2	<31	<0.03
1294-5008	D	<0.03	0.13	1.75	<0.34	<11.15	15.32	<0.91	1.77	<90.8	<0.11
1294-5008		<0.09	0.1	3.8	1.8	<29.1	13.1	15	<11.8	<199.8	<0.3
1294-5012		<0.07	0.3	<2	<0.9	<21.9	8.4	<10.3	<10.1	<177.3	<0.2
1295-5001	D	<0.03	0.04	0.6	<0.2	<6.5	3.6	<0.7	0.9	<57.3	<0.07
1295-5001		<0.06	<0.07	<1.4	<0.6	<16	3.2	<4.2	<7.2	<124.7	<0.2
1295-5004		<0.06	<0.05	1.2	<0.4	<12	1.9	<3.2	<5.4	158.7	0.1
1295-5008	D	<0.02	0.07	1.41	<0.16	<3.46	0.65	<0.67	<2.89	<35.64	<0.04
1295-5008		<0.04	0.09	2.1	<0.3	<8.9	0.7	<2.4	<5.7	<78.2	<0.09
1295-5012	D	<0.02	0.04	1.54	<0.17	<4.07	0.68	<0.77	<3.03	<37.72	<0.04
1295-5012		<0.06	<0.05	1.3	<0.4	<9	0.8	<2.2	<7.1	<81.6	<0.09
1296-5001		<0.02	<0.02	1.7	<0.2	<3.8	0.65	<0.73	<2.5	<38	<0.04
1296-5004		<0.02	<0.02	2	<0.13	<3.9	0.54	<0.9	<3.5	<35	<0.04
1296-5008		<0.02	0.01	0.9	<0.2	<3.3	0.43	<0.69	<2.8	<32	<0.04
1296-5012		<0.02	<0.02	0.46	<0.14	<3.76	0.67	<0.49	0.35	<39.5	<0.04
2386-5001		<0.08	<0.1	<1.8	3.88	<23.77	<0.37	<2.11	<11.34	<227.3	<0.29
2386-5004		<0.1	0.05	1.63	<0.62	<14.43	0.97	<3.16	<16.56	<152.4	<0.16
2386-5008		<0.13	0.1	1.83	<0.61	<16	0.67	<3.15	<14.07	<125.2	<0.16
2386-5012		<0.1	<0.09	1.97	<0.88	<16.96	0.69	<3.75	<18.02	<147.2	<0.19
2387-5001		<0.07	<0.1	<1.21	<0.48	<16.79	0.64	<3.76	<14.12	<124.5	<0.16
2387-5004		<0.07	<0.09	<2.02	<0.55	<14.27	1.05	<3.14	<11.23	<134.3	<0.13
2387-5008		<0.11	<0.06	2.04	<0.61	<17.54	0.81	<3.16	<15.71	<161.9	<0.18
2387-5012		<0.1	<0.09	1.79	0.77	<16.34	0.79	<4.66	<14.55	<160.1	<0.18
2389-5001		<0.08	<0.08	2.74	<0.77	<16.26	0.4	<3.46	<8.25	<142	<0.1
2389-5004		<0.08	<0.08	2.74	<0.77	<16.26	0.4	<3.46	<8.25	<142	<0.1
2389-5008		<0.07	<0.07	<1.8	<1.82	<16.7	0.88	<3.85	<19.4	<151.4	<0.15
2389-5012		<0.11	<0.09	2.01	<0.59	13.44	0.82	<3.58	<16.01	<111.4	<0.14
7202-5001	D	<0.01	0.1	1.2	<0.08	<1.5	0.4	<0.3	<1.3	<14	<0.01
7202-5001		<0.04	0.13	<0.82	0.45	<7.15	0.29	<1.46	<6.72	<63.12	0.07
7202-5004	D	<0.02	0.08	0.4	<0.1	<3.4	0.5	<0.5	0.4	<35.3	<0.04
7202-5004		<0.04	0.05	0.53	<0.25	<7.25	0.49	<0.97	0.45	<75.05	<0.07
7202-5008	D	<0.01	0.01	0.6	0.1	1	0.9	<0.2	0.6	<14.5	<0.01
7202-5008		<0.05	<0.04	2.2	<0.47	<10.4	0.85	<2	<8.4	<90	<0.09
7203-5001	D	<0.02	0.08	1.1	<0.17	<3.96	1.16	<0.83	<2.55	<40.65	<0.04
7203-5001		<0.02	0.11	0.66	0.14	2.31	1.08	<0.57	0.44	<42.95	<0.04
7203-5004	D	<0.02	0.1	1.29	<0.16	<4.19	0.89	<0.83	<3.2	<36.68	<0.04
7203-5004		<0.04	0.09	<0.97	<0.36	<9.2	1	<1.9	<5.8	<90	0.15
7203-5008	D	<0.02	<0.02	1.6	<0.15	<4	0.66	<0.87	<3.34	<36.17	<0.04
7203-5008		<0.06	<0.04	<0.95	0.62	<8.48	0.66	<1.91	<6.43	109.2	<0.08
7204-5001	D	<0.02	0.04	1.1	<0.1	<3.7	1.3	<1	<2.4	<31.5	<0.04
7204-5001		<0.04	0.08	<1	<0.3	<9	1	<2.3	<5.3	<70.7	<0.1
7204-5004		<0.05	0.06	1.7	<0.3	<8	1	<2.6	<7.8	<69	<0.09
7204-5008	D	<0.02	<0.02	1.35	<0.16	<3.87	0.66	<0.78	3.57	<154.6	<0.04
7204-5008		<0.08	<0.05	1.1	<0.4	<9.1	0.8	<2.6	<10.2	<94	<0.2
7204-5012		<0.05	0.04	<0.9	<0.3	<7.3	0.6	<1.8	<6.1	<60.1	<0.07

PRS 154

CLIENT/SUBJECT Area 23 W.O. NO.

TASK DESCRIPTION PRS 154 TASK NO.

PREPARED BY DEPT DATE

MATH CHECK BY DEPT DATE

METHOD REV. BY DEPT DATE

APPROVED BY

DEPT DATE

	Sample ID	Rad Laboratory (2T) Plutonium	(5) Thorium	Fidler (1K) Channel 1	(5K) Channel 2	α	β	Organics OVA	OVM	Metals
OTH →	2386-5001		—					—		
	5004		—	SEE	SURVEY	SHEET		—		
	5008		—					—		
	5012		—					—		
	2387-5001		—					—		
	5004		—	SEE	SURVEY	SHEET		50		
	5008		—					—		
	5012		—					—		
	2388-5001			—	—	—	—	—	—	
	5004			—	—	—	—	—	—	
	5008			—	—	—	—	—	—	
	5012			—	—	—	—	—	—	
	2389-5001		ASPHALT	&	GRAVEL			—		
	5004		—	—	—	—	—	100		
	5008		—	—	—	—	—	—		
OTH →	5012		—	—	—	—	—	—		
	2391-5001	—	—	—	—	—	—	—	—	
	5004	—	—	—	—	—	—	—	—	
	5008	—	—	—	—	—	—	—	—	
	5012	—	—	—	—	—	—	5	10	

— Indicates that Measured Values were Below Action Levels or Non Detect

CLIENT/SUBJECT Area 23 W.O. NO.

TASK DESCRIPTION TASK NO.

PREPARED BY PRS 1/54 DEPT DATE

MATH CHECK BY DEPT DATE

METHOD REV. BY DEPT DATE

APPROVED BY

DEPT DATE

Sample ID	Rad Laboratory (2T) Plutonium	(5) Thorium	Fidler (1K) Channel 1	(5K) Channel 2	α	β	Organics OVA	OVM	Metals
2327-5001	—	—	—	—	—	—		—	
5004	—	—	—	—	—	—		—	
5008	—	—	—	—	—	—		—	
5012	—	—	—	—	—	—		—	
2328-5001	—	—	—	—	—	—		—	
5004	—	—	—	—	—	—		—	
5008	—	—	—	—	—	—		—	
5012	—	—	—	—	—	—		—	
2329-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	—	—	—	—	—	—	—	—	
2335-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	—	—	—	—	—	—	—	—	
2336-5001	—	—	—	—	—	—	10	10	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	—	—	—	—	—	—	—	—	
2341-5001	PRE-SCAN ELIMINATE → 40K				—	—			
5004									
5008									
5012									
2347-5001	—	—	—	—	—	—	—	—	
[redacted]	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	—	—	—	—	—	—	—	—	
2348-5001	—	—					—	—	
5004	—	50					—	—	
5008	—	—							
5012	—	—							

SHEET ____ OF ____

CLIENT/SUBJECT Area 23 W.O. NO. ____

TASK DESCRIPTION ____ TASK NO. ____

PREPARED BY PRS DEPT ____ DATE 1/84

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____ DEPT ____ DATE ____

Sample ID	Rad Laboratory (27) Plutonium	(51) Thorium	Fidler (1K) Channel 1	(5K) Channel 2	α	β	Organics OVA	OVM	Metals
2303-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	—	—	—	—	—	—	—	—	
2306-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	—	—	—	—	—	—	—	—	
2307-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	36	—	—	—	—	—	—	—	
2317-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	—	—	—	—	—	—	—	—	
2318-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5010	—	—	—	—	—	—	—	—	
2319-5001	—	—	—	—	—	—		—	
5004	44	—	—	—	—	—		—	
5008	43	—	—	—	—	—		—	
5012	63	—	—	—	—	—		—	
2322-5001	—	—	—	—	—	—		—	
5004	—	—	—	—	—	—		—	
5008	—	—	—	—	—	—		—	
5012	—	—	—	—	—	—		—	
2323-5001	—	—	—	—	—	—		—	
5004	—	—	—	—	—	—		—	
5008	—	—	—	—	—	—			
5012	—	—	—	—	—	—			

WESTON

SHEET ____ of ____

CLIENT/SUBJECT: AREA 23

W.O. NO. ____

TASK DESCRIPTION: PRS 154

TASK NO. ____

PREPARED BY ____ DEPT ____ DATE ____

MATH CHECK BY ____ DEPT ____ DATE ____

METHOD REV. BY ____ DEPT ____ DATE ____

APPROVED BY ____

DEPT ____ DATE ____

Sample ID	Rad Laboratory (27) Plutonium	(51) Thorium	Fidler (1K) Channel 1	(5K) Channel 2	α	β	Organics OVA	OVM	Metals
2353-5001									
5004							—		
5008									
5012									
2354-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	10	—	
5008	—	—	—	—	—	1,000	—	—	
5012	—	—	—	—	—	1,173	10	—	
2355-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	—	—	—	—	—	—	—	—	
2373-5001	—	—					—	—	
5004	—	—					—	—	
5008	—	—					—	—	
5012	—	—					—	—	
2375-5001			—	—	—	—			
5004			—	—	—	—			
5008			—	—	—	—			
5012			—	—	—	—			
2379-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012	—	—	—	—	—	—	—	—	
2380-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—	—	—	
5008	—	—	—	—	—	—	—	—	
5012			REFUSAL @ 5010						
2385-5001	—	—	—	—	—	—	—	—	
5004	—	—	—	—	—	—			
5008	—	—	—	—	—	—			
5012	—	—	—	—	—	—			

PRS 238

Sample ID		Co 60	Cs 137	Ra 226	Ac 227	Th 230	Th 232	Pa 231	U 238	Pu 238	Am 241
9108-5008		<0.02	<0.02	1.6	<0.2	<5.5	0.6	<1.3	<3.9	<55	<0.06
9201-5004		<0.11	<0.12	3.28	<0.68	<14.96	1.14	<3.36	<17.67	<117.7	<0.15
9201-5008		<0.14	<0.08	<1.26	<0.75	<17.54	0.74	<4.95	<19.99	<138.5	<0.18
9201-5012		<0.08	<0.08	2.43	<0.48	<11.53	0.65	<2.87	<13.86	<47.19	<0.11
9201-5012		<0.03	<0.03	2	<0.3	<5.6	0.9	<1.2	<4.5	<65.7	<0.07
9201-5016		<0.1	0.09	1.99	<0.49	<13.27	0.96	<3.39	14.15	<106.1	<0.16
9202-5004		<0.11	<0.1	3.29	3.55	38.77	0.43	2.93	<7.18	<266.3	<0.3
9202-5008	D	<0.08	<0.05	2.05	<0.64	<15.56	0.72	<2.94	<15.47	<144.6	<0.17
9202-5008		<0.12	0.13	3.05	<0.64	<14.11	0.95	<2.91	<18.78	<125.7	<0.15
9202-5012		<0.14	0.17	<1.43	<0.75	<16.54	0.95	<2.91	<16.95	<142.1	<0.14
9203-5004		<0.12	<0.08	2.63	<0.65	<13.69	0.69	<3.25	<13.97	<146.9	<0.18
9203-5008		<0.12	0.13	3.05	<0.64	<14.11	0.95	<2.91	<18.78	<125.7	<0.15
9203-5012		<0.08	<0.08	<1.05	0.6	<14.16	0.8	<2.81	<11.68	<168.1	<0.17
9203-5016		<0.1	0.05	2.76	<0.49	<13.7	0.67	<3.18	10.23	<113.1	<0.15
9203-5020		<0.07	<0.09	1.56	<0.56	<12.91	0.65	<2.8	<10.65	<131.9	0.11
9203-5020		<0.03	<0.03	1.9	<0.2	<4.5	0.8	<0.9	<3.8	<55.1	<0.05
9204-5004		<0.08	0.06	<1.86	<0.61	14.89	0.84	<3.46	<18.63	<109.4	<0.15
9204-5008		<0.1	<0.1	<1.67	<0.82	<13.89	0.83	<3.58	<14.39	<179.5	<0.15
9204-5012		<0.11	<0.09	2.28	<0.66	<17.32	0.54	<4.01	<16.14	<171	<0.18
9204-5016		<0.13	<0.1	<1.95	<0.62	<17.14	0.94	<3.65	14.24	<129.9	<0.13
9205-5004		<0.06	<0.05	<1.73	<0.7	<17.23	0.67	<3.76	<15.52	<147.9	<0.15
9205-5008		<0.09	<0.09	<2.03	<0.6	<14.81	0.64	<4.26	8.54	<142.4	<0.19
9205-5012		<0.11	<0.1	<1.86	0.94	<16.2	0.93	<3.43	<9.18	<147.1	0.16
9205-5012		<0.04	<0.03	1.4	<0.3	<5.3	1.1	<1.2	<4.6	<59	<0.06
9301-5002		<0.02	<0.01	0.9	<0.08	2.6	0.2	<0.7	[illegible]	<28	<0.03
9302-5002		<0.02	0.04	1.19	<0.14	<3.39	0.54	<0.57	<2.71	<30.83	<0.04
9303-5002		<0.01	<0.02	0.96	<0.14	<3.5	0.52	<0.61	<2.69	<34.74	<0.04
9304-5002		<0.02	<0.02	0.6	<0.1	<3	0.3	<0.4	0.4	<33.6	<0.03
9405-5008		<0.01	<0.01	0.8	<0.1	<2.5	0.3	<0.6	<2.2	<23	<0.03
9403-5001		<0.01	<0.01	0.7	<0.1	<2.12	0.15	<0.5	<1.9	<22.6	<0.02
9403-5004	D	<0.01	0.03	1.45	<0.07	<1.62	0.06	<0.29	<1.34	<15.95	0.02
9403-5004		<0.02	<0.02	0.79	<0.21	<2.75	0.31	<0.53	<2.45	<25.62	<0.03
9403-5008	D	<0.01	0.02	0.96	<0.06	<1.3	0.37	<0.25	<1.18	<12.09	<0.01
9403-5008		<0.02	0.02	1.3	<0.16	5.78	0.71	<0.66	<2.86	37.08	<0.04
9403-5009		<0.02	<0.02	1.05	<0.13	<3.15	0.5	<0.7	<2.63	<30.43	<0.03
9404-5001		<0.01	0.03	1.3	<0.1	<3.2	0.4	<0.8	<2.3	<29.8	<0.03
9404-5004	D	<0.02	0.02	1.1	<0.1	<3.2	0.4	<0.7	2.6	<28	<0.03
9404-5001		<0.02	<0.01	1.3	<0.1	<3.2	0.4	<0.8	<2.3	<35.9	<0.03
9404-5008		<0.03	<0.05	0.78	<0.26	<5.13	0.23	<1.08	<3.81	80.7	<0.05
9405-5001		<0.02	0.12	1.47	<0.15	<3.5	0.48	0.63	<2.61	<33.08	<0.04
9405-5009		<0.02	<0.02	1.63	<0.18	<4.11	0.68	<0.75	<2.89	<38.01	<0.04
9901-5004		<0.02	<0.02	1.4	<0.16	<3.87	0.7	<0.71	<2.81	<34.59	<0.04
9901-5007		<0.02	<0.02	0.85	<0.14	<3.21	0.47	<0.66	<2.78	156.2	<0.03
9909-5004		<0.02	<0.02	1.4	<0.14	<3.5	0.59	<0.73	<2.95	<30.61	<0.03
9909-5008		<0.02	<0.02	1.07	<0.12	<2.98	0.41	<0.68	<2.92	41.1	<0.03
9909-5009		<0.02	<0.02	1.72	<0.17	3.67	0.51	<0.88	<3.95	<32.5	<0.04

NIOSH

POCKET GUIDE TO CHEMICAL HAZARDS

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health

CDC
CENTERS FOR DISEASE CONTROL

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Chemical name, structure/formula, CAS and RTECS Nos., and DOT ID and guide Nos.	Synonyms, trade names, and conversion factors	Exposure limits (TWA unless noted otherwise)	IDLH	Physical description	Chemical and physical properties: MW, BP, SOL Fl.P, IP, Sp.Gr, flammability	Chemical and physical properties: VP, FRZ UEL, LEL	Incompatibilities and reactivities	Measurement method (See Table 1)
Fluorides (as F) 1: NaF 2: Na_3AlF_6 1: 7681-49-4/ WB0350000 2: 15096-52-3/ WA9625000 1690 54 (NaF)	1: Sodium fluoride, Floridine 2: Cryolite, Cryocide, Cryodust, Sodium aluminum fluoride, Sodium hexafluoroaluminate Synonyms of other compounds vary depending upon the specific compound.	NIOSH/OSHA 2.5 mg/m³	500 mg/m³	1: Odorless white powder or colorless crystals. [Note: Pesticide grade is often dyed blue.] 2: Colorless to dark odorless solid. [Note: Loses color on heating.] [pesticide]	MW: 42.0/209.9 BP: 3099°F/ Decomposes Sol: 4/0.04% Fl.P: NA/NA IP: NA/NA Sp.Gr: 2.78/2.90 Noncombustible Solids	VP: 0/0 mm (approx) MLT: 1819/ 1832°F UEL: NA/NA LEL: NA/NA	Strong oxidizers	None available
Fluorine F_2 7782-41-4 LM6475000 9192 25 (cryogenic liquid) 1045 20 (compressed)	Fluorine-19 1 ppm = 1.58 mg/m³	NIOSH/OSHA 0.1 ppm (0.2 mg/m³)	25 ppm	Pale yellow to greenish gas with a pungent, irritating odor.	MW: 38.0 BP: -307°F Sol: Reacts Fl.P: NA IP: 15.70 eV Nonflammable Gas, but an extremely strong oxidizer.	VP: >1 atm FRZ: -363°F UEL: NA LEL: NA	Water, nitric acid, oxidizers, organic compounds [Note: Reacts violently with all combustible materials, except the metal containers in which it is shipped. Reacts with H_2O to form hydrofluoric acid.]	None available
Fluorotrichloromethane CCl_3F 75-69-4 PB6125000 1078 12 (gas)	Freon® 11, Monofluorotrichloromethane, Trichlorofluoromethane, Trichloromonofluoromethane, Refrigerant 11 1 ppm = 5.71 mg/m³	NIOSH/OSHA C 1000 ppm (5600 mg/m³)	10,000 ppm	Colorless to water-white, nearly odorless liquid or gas (above 75°F).	MW: 137.4 BP: 75°F Sol(77°F): 0.1% Fl.P: NA IP: 11.77 eV Sp.Gr: 1.47 (Liquid at 75°F) Noncombustible Liquid	VP: 690 mm FRZ: -168°F UEL: NA LEL: NA	Chemically-active metals such as sodium, potassium, calcium, powdered aluminum, zinc magnesium & lithium shavings; granular barium	Char: CS_2; GC/FID; III [#1006, Trichlorofluoromethane]
Formaldehyde HCHO 50-00-0 LP8925000 1198 29 (formalin) 2209 29 (formalin)	1) Gaseous form: Methanal, Methyl aldehyde, Methylene oxide 2) Aqueous solution: Formalin (30 to 50% formaldehyde by weight, which usually contains 6 to 12% methanol)	NIOSH Ca See Appendix A 0.016 ppm C 0.1 ppm [15-min] OSHA (1910.1048) 1 ppm ST 2 ppm	Ca [30 ppm] ACGIH A2	Nearly colorless gas with a pungent, suffocating odor. [Note: Often used in an aqueous solution.]	MW: 30.0 BP: -6/207 to 214°F Sol: Miscible Fl.P: NA(Gas) 140-185°F IP: 10.88 eV? Sp.Gr(77°F): 1.06-1.10 (Formalin) Flammable Gas Class IIIB Combustible Liquid (Formalin)	VP: >1 atm/ 1 mm FRZ: -134°F/? UEL: 73%/? LEL: 7.0%/?	Strong oxidizers, alkalis & acids; phenols; urea [Note: Pure formaldehyde has a tendency to polymerize.]	Filter/Imp(2); none; Vis; III [#3500] [Note: Also XAD-2; Toluene; GC/FID; #2541.]

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Chemical name, structure/formula, CAS and RTECS Nos., and DOT ID and guide Nos.	Synonyms, trade names, and conversion factors	Exposure limits (TWA unless noted otherwise)	IDLH	Physical description	Chemical and physical properties: MW, BP, SOL Fl.P, IP, Sp.Gr, flammability	Chemical and physical properties: VP, FRZ UEL, LEL	Incompatibilities and reactivities	Measurement method (See Table 1)
Trichloronaphthalene $C_{10}H_5Cl_3$ 1321-65-9 QK4025000	Halowax®, Nibren wax, Seekay wax	NIOSH/OSHA 5 mg/m³ [skin]	Unknown	Colorless to pale-yellow solid with an aromatic odor.	MW: 231.5 BP: 579-669°F Sol: Insoluble Fl.P(oc): 392°F IP: ? Sp.Gr: 1.58 Combustible Solid	VP: <1 mm MLT: 199°F UEL: ? LEL: ?	Strong oxidizers	Filter/Bub; none; GC/FID; II(2) [#S128]
1,2,3-Trichloropropane $CH_2ClCHClCH_2Cl$ 96-18-4 TZ9275000	Allyl trichloride, Glycerol trichlorohydrin, Glyceryl trichlorohydrin, Trichlorohydrin 1 ppm = 6.13 mg/m³	NIOSH Ca See Appendix A 10 ppm (60 mg/m³) [skin] OSHA 10 ppm (60 mg/m³)	Ca [1000 ppm]	Colorless liquid with a chloroform-like odor.	MW: 147.4 BP: 314°F Sol: 0.1% Fl.P(oc): 180°F IP: ? Sp.Gr: 1.39 Class IIIA Combustible Liquid	VP(115°F): 10 mm FRZ: 6°F UEL: ? LEL: ?	Chemically-active metals, strong caustics & oxidizers	Char: CS_2; GC/FID; III [#1003, Halogenated Hydrocarbons]
1,1,2-Trichloro-1,2,2-trifluoroethane CCl_2FCClF_2 76-13-1 KJ4000000	Chlorofluorocarbon-113, CFC-113, Freon® 113, Genetron® 113, Halocarbon 113, Refrigerant 113, TTE 1 ppm = 7.79 mg/m³	NIOSH/OSHA 1000 ppm (7600 mg/m³) ST 1250 ppm (9500 mg/m³)	4500 ppm	Colorless to water-white liquid with an odor like carbon tetrachloride at high concentrations. [Note: A gas above 118°F.]	MW: 187.4 BP: 118°F Sol(77°F): 0.02% Fl.P: ? IP: 11.99 eV Sp.Gr(77°F): 1.56 Noncombustible Liquid at ordinary temperatures, but the gas will ignite and burn weakly at 1256°F	VP: 285 mm FRZ: -31°F UEL: ? LEL: ?	Chemically-active metals such as calcium, powdered aluminum, zinc, magnesium & beryllium [Note: Decomposes if in contact with alloys containing >2% magnesium.]	Char: CS_2; GC/FID; III [#1020]
Triethylamine $(C_2H_5)_3N$ 121-44-8 YEO175000 1296 68	TEA 1 ppm = 4.21 mg/m³	NIOSH See Appendix D OSHA 10 ppm (40 mg/m³) ST 15 ppm (60 mg/m³)	1000 ppm	Colorless liquid with a strong, ammonia-like odor.	MW: 101.2 BP: 193°F Sol: 2% Fl.P(oc): 16°F IP: 7.50 eV Sp.Gr: 0.73 Class IB Flammable	VP: 54 mm FRZ: -175°F UEL: 8.0% LEL: 1.2%	Strong oxidizers, strong acids	Bub: NaOH; GC/FID; II(3) [#S152]