Document Control No. _____

Environmental Restoration Program

29-01 -01 -07 -03 -9406140006

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

MOUND PLANT
MIAMISBURG, OHIO

June 1993

FINAL

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Department of Energy
Albuquerque Field Office

Environmental Restoration Program
EG&G Mound Applied Technologies

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ENVIRONMENTAL RESTORATION PROGRAM

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
EG&G MOUND APPLIED TECHNOLOGIES

FINAL

Signature Page

This report is Volume 3 of a multiple-volume Site Scoping Report providing the background information pertinent to the remedial investigation/feasibility study (RI/FS) of the Mound Plant. Under the terms of the Federal Facility Agreement between DOE and US EPA, this report is submitted to US EPA for approval.

This report is approved by US EPA only for the purposes of scoping the RI/FS, and approval does not imply concurrence with the interpretations presented herein. It is recognized that additional information will be collected during the RI/FS and may supersede information contained in this report.

APPROVED: Diana Mally
Remedial Project Manager
U.S. Environmental Protection Agency
Region V

Diana Mally

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WESTON
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505-884-5050 • FAX: 505-884-5388

29 June 1993

EG&G Mound Applied Technologies, Inc.
Attention: Mr. Charles S. Friedman, Project Officer
Bldg. OSE-2
P.O. Box 3000
Miamisburg, Ohio 45343-3000

RE: ER Program, Mound Plant
BOA No. 24251
Site Scoping Report: Volume 3 RFW WO # 5376-39-02

Dear Mr. Friedman:

Enclosed are four copies of the Final covers, title, approval and change pages for the Site Scoping Report: Volume 3 - Radiological Site Survey. This report was conditionally approved by the US Environmental Protection Agency, pending response to comments. The comments in question are EPA specific comments 7 to 11, dated December 1992. Due to a transmission error, these comments were not formally addressed during the March 1993 revision. Response to comments and the necessary change pages are included in the Final document. Also included are change pages that respond to a verbal comments from Ohio EPA that a sentence appeared to be missing from the bottom of page 3-26.

Under cover of this letter, Final covers, title, approval and change pages for Volume 3 are being supplied to the project managers to complete and finalize their copies of this volume. Under separate cover we will be submitting two complete copies to you for placement in the public repository.

If you have any questions regarding this matter, please call Bill Criswell at (505) 884-5050 or the Alternate Project Manager, Mr. John Price, at (513) 825-3440.

Sincerely,

ROY F. WESTON, INC.

for William M. Little

John W. Thorsen, P.E.
ER Program, Subcontractor
Project Manager

CWC/gy

Attachments

29-01-01-07-03
9406140006

M9SSV3_3.LT 6/29/93

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B. Huntsman TERRAN (1)
E. Brown ICF-Kaiser (1)

w/o att: ER Project File

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29 June 1993

RECEIVED
C. S. FRIEDMAN
JUL 1 1993
Action to
Reply Due
Route Copy to

EG&G Mound Applied Technologies, Inc.
Attention: Mr. Charles S. Friedman, Project Officer
Bldg. OSE-2
P.O. Box 3000
Miamisburg, Ohio 45343-3000

RE: ER Program, Mound Plant
BOA No. 24251
Site Scoping Report: Volume 3

RFW WO # 5376-39-02

Dear Mr. Friedman:

Enclosed are four copies of the Final covers, title, approval and change pages for the Site Scoping Report: Volume 3 - Radiological Site Survey. This report was conditionally approved by the US Environmental Protection Agency, pending response to comments. The comments in question are EPA specific comments 7 to 11, dated December 1992. Due to a transmission error, these comments were not formally addressed during the March 1993 revision. Response to comments and the necessary change pages are included in the Final document. Also included are change pages that respond to a verbal comments from Ohio EPA that a sentence appeared to be missing from the bottom of page 3-26.

Under cover of this letter, Final covers, title, approval and change pages for Volume 3 are being supplied to the project managers to complete and finalize their copies of this volume. Under separate cover we will be submitting two complete copies to you for placement in the public repository.

If you have any questions regarding this matter, please call Bill Criswell at (505) 884-5050 or the Alternate Project Manager, Mr. John Price, at (513) 825-3440.

Sincerely,

ROY F. WESTON, INC.

for William M. Little

John W. Thorsen, P.E.
ER Program, Subcontractor
Project Manager

CWC/gy

Attachments

M9SSV3_3.LT 6/29/93

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M. Williams EG&G MAT (1)
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F - OU-9
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11 May 1993

EG&G Mound Applied Technologies
Attention: Karen L. Zimmerman
PO Box 3000, M.S. OSE-3
Miamisburg, Ohio 45343

Work Order No. 05376-039-002

RE: BOA No. 24251, Task Order 16494
Change Order Request No. 1
Scoping Report Additions

Dear Ms. Zimmerman:

Additional revisions are required to the Volume 3 Site Scoping Report and Volume 7 Site Scoping Report because of a partial transmittal of regulatory review comments to Roy F. Weston, Inc. (WESTON®) and discrepancies in the Glass Melter history, respectively. A copy of the latter is attached. WESTON is requesting an increase in the not to exceed cost from $71,878 to $83,836 not including definitization costs, which are estimated separately.

Pursuant to an AOS message to you from John Price, Alternate Project Manager, standard estimating sheets are provided as backup to the estimated costs. These are $4,721.27 for Volume 3 and $6,237.32 for Volume 7. WESTON had previously requested authorization for less than $1000 to republish the Volume 9 Site Scoping Report: attached is a supporting standard estimating sheet showing an estimated cost of $749.04. Please note that the costs for Volume 7 include travel to Mound, which may not be required; as always, only actual costs will be charged for this time & materials task order.

If you have any questions please contact Mr. Price or Mr. William Little.

Very truly yours,

ROY F. WESTON, INC.

Angela C. Gay /for

John W. Thorsen, P.E.
Project Manager

JBP/acg

Attachments

cc (w/ Att): Kathy Koehler
cc (w/o Att): Monte Williams ✓

29-01-01-07-03
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(4)

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#9406140006

WESTON
MANAGERS DESIGNERS/CONSULTANTS
6501 AMERICAS PARKWAY, N.E.
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30 March 1993

EG&G Mound Applied Technologies, Inc.
Attention: Mr. Charles S. Friedman, Project Officer
Bldg. OSE-2
P.O. Box 3000
Miamisburg, Ohio 45343-3000

RE: ER Program, Mound Plant
BOA No. 24251
Site Scoping Report: Volume 3

RFW WO # 5376-39-02

Dear Mr. Friedman:

Enclosed are the change pages and responses to comments for the Draft Final Site Scoping Report: Volume 3 - Radiological Site Survey. The change pages are submitted in response to EPA and Ohio EPA comments on the revised document submitted December 1992. At the direction of Art Kleinrath, DOE Dayton Area Office, the revised document is being distributed to the project managers.

The set of change pages includes both pages revised in response to comments, as well as pages revised to include new descriptions of areas of older cleanup or potential contamination. Many new cross-references have been added to guide the reader through the report where descriptions of some areas may be parceled according to process information. Also in response to comments, included are additional data sheets that should be inserted into Appendix E. These supporting data have been incorporated into the text discussions.

If you have any questions regarding this matter, please do not hesitate to call me at (708) 918-4102 or the Alternate Project Manager, Mr. John Price, at (513) 825-3440.

Sincerely,

ROY F. WESTON, INC.

for William M. Little

John W. Thorsen, P.E.
ER Program, Subcontractor
Project Manager

CWC/gy

Attachments

WESTON

pc w/att:	D. Mally, USEPA Reg. V
	D. Spencer, USEPA Reg. V
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	J. Kwasniewski, OEPA
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	K. Hacker, EG&G
	B. Huntsman, Terran
	M. Walsh, SAIC
	J. Register, IT
	E. Brown, ICF Kaiser
w/o att:	ER Project File

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:

HSRM-6J

February 16, 1993

VIA FACSIMILE AND
FIRST CLASS MAIL

Mr. Arthur Kleinrath
U.S. Department of Energy
Dayton Area Office
P.O Box 66
Miamisburg, Ohio 45343

RE: U.S. DOE Mound Plant Review Comments
Site Scoping Report, Volume 3

Dear Mr. Kleinrath:

Enclosed are the United States Environmental Protection Agency's (U.S. EPA's) comments on the "Site Scoping Report, Volume 3 - Radiological Site Survey" for the Mound Plant site. Please provide revised pages and responses to these comments within forty-five days of your receipt of this letter, or by April 2, 1993.

Please feel free to call me at (312) 353-6287 if you have any questions.

Sincerely,

Diana Mally

Diana Mally
Remedial Project Manager

Enclosure

cc: M. Hatcher, OEPA
C. Friedman, EG&G Mound
M. Williams, EG&G Mound
D. Neff, Geotech, DAO
W. Rummel, Geotech, DAO

OPTIONAL FORM 99 (7-90)
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To C. Friedman M. Williams	From Diana Mally
Dept./Agency EG&G Mound	Phone # 312-353-6287
Fax # 513-865-3835	Fax # 312-353-5541

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US DOE Mound Plant
Operable Unit 9
Site Scoping Report, Volume 3 - Radiological Site Survey
December 1992
US EPA

General Comments:

1. Section 4, General
Add some discussions in this section concerning the elevated concentrations of Pu-238 (1,235 pCi/g) found in the sewage drying beds in Area 3 discussed on page 5-11, and the elevated concentrations (up to 573 pCi/g) found at the railroad siding discussed on page 5-30. Carry through any discussions into Section 11 and Table XI.1 if appropriate.

2. Table XI.1, General
Table XI.1 should be revised to show maximum radioactive soil concentrations for each area, based on the discussions in the text. The maximum concentrations found were not always a result of the Site Survey Project (which this table seemed to primarily rely on), but may be from D&D work, subsequent investigations, or reports from the soil screening facility.

Specific Comments:

1. Table II.1, pages 2-10 through 2-16
Please include the concentration units of the values to the table.

2. Section 3.3.7, last para, page 3-26
Please offer an explanation why elevated levels of Co-60 and Cs-137 were found at location S0175 if possible.

3. Section 4.1.4, para 3, page 4-21
Correct the last sentence to refer to the correct plate.

4. Figure 8.2, page 8-3
The units indicated on this figure (pCi/g) are not consistent with the corresponding discussion on page 8-4. Please correct.

5. Section 11, para 1, page 11-4
The text states that the highest values of Co-60 were in Area 21. Table XI.1, page 11-2, shows "LDL" for Co-60 in Area 21. Correct the text or the table.

6. Table XI.1, page 11-2 and 11-3
Add the Building 48 hillside (discussed on page 11-6), Area 23 (discussed on page 11-7), and the old railroad siding (discussed on page 11-7) and the corresponding soil radioactivity concentrations to this table.

7. Table XI.1, page 11-2
Please correct the table to indicate in Area 3 the maximum thorium concentration found was 63 pCi/g (from page 5-11).

8. Table XI.1, page 11-2
Please correct the table to indicate in Area 3 the maximum Pu-238 concentration found was 1,235 pCi/g (from page 5-11).

9. Section 11, Pu-238 discussion, para 2, page 11-4
Areas also showing elevated Pu-238 concentrations from Plate 4 and/or Table XI.1 are Areas 12 and 4/4a. Include these areas in the discussion.

10. Section 11, Pu-238 discussion, bullet 6, page 11-4
Why is Area 18 included as an area associated with highest Pu-238 concentrations? Information in the report does not seem to support this.

11. Plates 4 and 5
Plates 4 and 5 incorrectly show Area 1 as Area 21. Please correct.

OhioEPA
State of Ohio Environmental Protection Agency

Southwest District Office
40 South Main Street
Dayton, Ohio 45402-2086
(513) 285-6357
FAX (513) 285-6404

F- OU-9 COMMENTS
EG+G-29-01-01-07-03
#9406140006

George V. Voinovich
Governor

February 16, 1993

RE: Operable Unit 9 Site Scoping Report Vol. III Radiological Soils

Mr. Arthur Kleinrath
U.S. Department of Energy
Dayton Area Office
1 Mound Road
Miamisburg, Ohio 45343

Mr. Kleinrath:

This letter is to inform you that the Ohio EPA has reviewed DOE's Operable Unit 9, Site Scoping Report Vol. III, Radiological Soils submitted to this office on December 29, 1992. Attached are Ohio EPA's comments on the document.

Please let me know if you have any questions.

Sincerely,

Martha L. Hatcher

Martha L. Hatcher
Division of Emergency and Remedial Response

TAS

cc: D. Mally, USEPA/Region V
C. Friedman, EG&G Mound
M. Williams, EG&G Mound
R. Neff, Geotech, DAO
W. Rummel, Geotech, DAO
J. Kwasniewski, OEPA/DERR/CO

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OhioEPA
State of Ohio Environmental Protection Agency

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To Art Kleinrath, DOE	From Martha Hatcher
Co. Diana Mally, USEPA	Co. OEPA
Dept. Chuck Friedman, EG&G	Phone # (513) 285-6052
Fax #	Fax #

February 16, 1993

RE: Operable Unit 9 Site Scoping Report Vol. III Radiological Soils

Mr. Arthur Kleinrath
U.S. Department of Energy
Dayton Area Office
1 Mound Road
Miamisburg, Ohio 45343

Mr. Kleinrath:

This letter is to inform you that the Ohio EPA has reviewed DOE's Operable Unit 9, Site Scoping Report Vol. III, Radiological Soils submitted to this office on December 29, 1992. Attached are Ohio EPA's comments on the document.

Please let me know if you have any questions.

Sincerely,

Martha L Hatcher

Martha L. Hatcher
Division of Emergency and Remedial Response

TAS

cc: D. Mally, USEPA/Region V
C. Friedman, EG&G Mound
M. Williams, EG&G Mound
R. Neff, Geotech, DAO
W. Rummel, Geotech, DAO
J. Kwasniewski, OEPA/DERR/CO

CC: CSF
MAW
KGK

FAX TO JOHN PRICE

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US DOE MOUND PLANT
RI/FS
OPERABLE UNIT 9, SITE-SCOPING REPORT VOL. III
RADIOLOGICAL SITE SURVEY
DECEMBER 1992
OHIO ENVIRONMENTAL PROTECTION AGENCY

General Comments

1. DOE failed to respond to Ohio EPA's October 25, 1991 comments on DOE's responses and did not revise the Scoping report in accordance with those comments.

Specific Comments

1. The Executive Summary was not revised/submitted. The Executive Summary should be revised to reflect the change in document format and Ohio EPA's May 24, 1991 comments.

2. Section 3.3.6, pg. 3-26, 3rd paragraph: The text should be revised to refer to Section 10, General Use Areas rather than the "general section of this report."

3. Section 4.1.1., pg. 4-6, 4th paragraph: The fourth sentence incorrectly cites section 3. The correct citation should probably be section 5.

4. Section 4.1.4, pg. 4-21, last full paragraph: The last sentence refers to Plate 6. No Plate 6 was included in the document revision. The correct citation is probably Plate 4.

5. Table IV.5, pgs. 4-22 to 4-26: Define the footnotes cited in the table.

6. Section 4.1.7, pg. 4-34, 3rd paragraph: The second sentence should include location #7 as one which detected plutonium-238 in excess of 100 pCi/g.

7. Section 6.2, pg. 6-3, 3rd paragraph: DOE may wish to reconsider the use of the word "dubious", due to the various interpretations the reader may choose.

8. Table VII.1, pg. 7-2: Ohio EPA provided DOE with a more detailed analysis of K-65 material from the USDOE FEMP site. Inclusion of that data would be informative.

9. Section 8.2, pg. 8-4, 1st paragraph: This paragraph refers to samples in relation to 20 nCi/g, yet Figure 8.2 provides data in pCi/g. Either the figure or the text should be revised to reflect the 20 ? cutoff level.

10. Table IX.1, pg. 9-2: Correct third column or footnote (IIDW or IIADW).

EG&G-29-01-01-07-03
#9406140006

US DOE MOUND PLANT
OPERABLE UNIT 9
SITE SCOPING REPORT, VOLUME 3 RADIOLOGICAL SITE SURVEY
DECEMBER 1992
US ENVIRONMENTAL PROTECTION AGENCY

SPECIFIC COMMENTS

7. Table XI.1, page 11-2. Please correct the table to indicate in Area 3 the maximum thorium concentration found was 63 pCi/g (from page 5-11).

   Table corrected and a change page submitted.

8. Table XI.1, page 11-2. Please correct the table to indicate in Area 3 the maximum Pu-238 concentration found was 1,235 pCi/g (from page 5-11).

   This correction was made in the March 1993 Revision 2.

9. Section 11, Pu-238 discussion, paragraph 2, page 11-4. Areas also showing elevated Pu-238 concentrations from Plate 4 and/or Table XI.1 are Areas 12 and 4/4a. Include these in the discussion.

   A bullet has been added for Area 4\4a. A cross-reference was also added to subsection 4.1 (page 4-4) to state that the description of Area 4\4a is included in subsection 3.3.

10. Section 11, Pu-238 discussion, bullet 6, page 11-4. Why is Area 18 included as an area associated with highest Pu-238 concentrations? Information in the report does not seem to support this.

    We agree, Area 18 should not be included in the areas with elevated plutonium-238. The bullet for Area 18 was removed from the text (page 11-4).

11. Plates 4 and 5. Plates 4 and 5 incorrectly show Area 1 as Area 21. Please correct.

    Plates 4 and 5 have been corrected to depict Area 1 and not Area 21. On Plate 4, the 50 pCi/g contour near Area 14 was also corrected.

E6+6-29-01-01-07-03
#9406140006

US DOE MOUND PLANT
RI/FS
OPERABLE UNIT 9, SITE SCOPING REPORT: VOLUME 3
RADIOLOGICAL SITE SURVEY
SPECIAL METALLURGICAL BUILDING ANNEX (AREA 17)
RESPONSE TO COMMENTS
APRIL 1991
OHIO ENVIRONMENTAL PROTECTION AGENCY

GENERAL COMMENTS

1. Response to General Comment #1:
If "the intent of the Site Scoping Report is to identify existing data that will be useful in determining additional work at the site needed to meet CERCLA requirements," available information such as solubility and soil bonding affinities should be incorporated into the report. This information would be useful in determining likely migration routes for contaminants and in estimating the extent of that migration. The addition of information on the physicochemical properties of radionuclides specific to the site will be useful in determining the scope of additional sampling activities at the site.

DOE agrees that data on solubility and soil bonding affinities are useful in determining likely migration routes, but reiterates that such data are beyond the scope of this document. We have, however, provided references in Section 1 to other existing reports published by the Agency for Toxic Substance and Disease Registry (ATSDR). These bibliographies in these references will provide additional sources for the data requested.

2. Response to Specific Comment #2:
a) Add bismuth-207 as a radionclide contaminant as was suggested in the original comment and stated in the Site Scoping Report.

Bismuth-207 and bismuth-210m are discussed in the text in subsection 3.3.6. Additional discussion is added to state that bismuth-207 could be a co-contaminent with cobalt-60.

b) The section states a spill occurred in 1969 and the bismuth-210m was detected during the 1985 excavation. When did bismuth processing end in the HH building? The short half-life of bismuth-210 would suggest all of this material should be gone; what explanation can DOE suggest for this?

Bismuth-210m should not be confused with bismuth-210. We have added additional text to state that bismuth-210m is a rare isotope of long half-life that was apparently produced with bismuth-210. Bismuth-210m was never an intended product or by-product of polonium processing. To the best of our knowledge, the other statements concerning the time periods of polonium processing are still true.

c) If bismuth-210m is no longer present, then its decay product(s) should be added to the list.

The decay products of bismuth-210m are thallium-206, a very short-lived isotope, and then stable lead-206. A discussion of these has been added to the text in subsection 3.3.6.

3. Response to Specific Comment #29:
The isotope of bismuth referred to in the original comment, as well as in the Site Scoping Report, was bismuth-207, which must be radioactive if bismuth-209 is the stable form. Additionally, the decay product of bismuth-210m should be added as a contaminant of Area 22.

See responses to comment 2 above for bismuth-210m. We have added additional text to describe a possible origin for bismuth-207. Bismuth-207 decays through a process of electron capture to metastable lead-207, which decays by gamma radiation to stable lead-207.

4. Response to Specific Comment #30:
DOE should be aware that risk assessment-based remediation levels must be developed in future documents. Remediation that is protective of human health and the environment is the goal of the CERCLA activities at this site.

DOE concurs with this commment. The table includes current published remediation guidelines for reference purposes only. We have additionally removed some values from the table (actinium-227 and cobalt-60) as they were assumed from isotope values of similar character.

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US DOE MOUND PLANT
RI/FS
OPERABLE UNIT 9, SITE SCOPING REPORT: VOLUME 3
RADIOLOGICAL SITE SURVEY
RESPONSE TO COMMENTS
DECEMBER 1992
OHIO ENVIRONMENTAL PROTECTION AGENCY

GENERAL COMMENTS

1. DOE failed to respond to Ohio EPA's October 25, 1991 comments on DOE's responses and did not revise the Scoping report in accordance with those comments.

   See responses attached.

SPECIFIC COMMENTS

1. The Executive Summary was not revised/submitted. The Executive Summary should be revised to reflect the change in document format and Ohio EPA's May 24, 1991 comments.

   The Executive Summary was indeed not revised, but it was incorporated into the Summary. This is in accordance with discussions via teleconference with EPA and Ohio EPA on March 24, 1992. During those discussions, it was agreed that several sections of the report would be deleted as they were not appropriate. The Executive Summary was to be combined with the residual materials from the former Summary and Conclusion section. All comments relevant to the former Executive Summary are incorporated into the new Summary section.

2. Section 3.3.6, pg. 3-26, 3rd paragraph: The text should be revised to refer to Section 10, General Use Areas rather than the "general section of this report."

   We concur; the text is changed to reflect these words.

3. Section 4.1.1, pg. 4-6, 4th paragraph: The fourth sentence incorrectly cites section 3. The correct citation should probably be section 5.

   We concur; the text is changed to reflect these words.

4. Section 4.1.4, pg 4-21, last full paragraph: The last sentence refers to Plate 6. No Plate 6 was included in the document revision. The correct citation is probably Plate 4.

   We concur; the text is changed to cite Figure 1.2.

5. Table IV.5, pgs. 4-22 to 4-26: Define the footnotes cited in the table.

   We do not understand this comment, as the footnotes are defined in the tables. Page 4-22 is a single page table with the footnotes at the bottom; pages 4-23 to 4-26 are a separate four-page table in which the footnotes are defined only at the bottom of the first page of the table. The latter is a standard convention used throughout this report.

6. Section 4.1.7, pg. 4-34, 3rd paragraph: The second sentence should include location #7 as one which detected plutonium-238 in excess of 100 pCi/g.

   We concur; the text is changed to include location #7 in the text.

7. Section 6.2, pg. 6-3, 3rd paragraph: DOE may wish to reconsider the use of the word "dubious," due to the various interpretations the reader may choose.

We concur; the text is changed to clarify the meaning.

8. Table VII.1, pg 7-2: Ohio EPA provided DOE with a more detailed analysis of K-65 material from the USDOE FEMP site. Inclusion of that data would be informative.

We concur that Ohio EPA provided a more detailed analysis of the K-65 residues. Discussions thereafter indicated that representatives of Ohio EPA were not convinced that foreign materials were not added to the residues and that the data represented only the K-65. With these doubts, we saw that there was no advantage in relying on data of questionable value. We have not added the data to this report.

9. Section 8.2, pg. 8-4, 1st paragraph: This paragraph refers to samples in relation to 20 nCi/g, yet Figure 8.2 provides data in pCi/g. Either the figure or the text should be revised to reflect the 20 ? cutoff level.

The text actually refers to sample results in nCi/L of soil moisture. The figure erroneously had a label in pCi/g. The figure label is corrected to nCi/L.

10. Table IX.1, pg. 9-2: Correct third column or footnote (IIDW or IIADW).

The footnote is corrected to read IIAW.

US DOE MOUND PLANT
OPERABLE UNIT 9, SITE SCOPING REPORT: VOLUME 3
RADIOLOGICAL SITE SURVEY
RESPONSE TO COMMENTS
DECEMBER 1992
US ENVIRONMENTAL PROTECTION AGENCY

GENERAL COMMENTS

1. Section 4, General
   Add some discussions in this section concerning the elevated concentrations of Pu-238 (1,235 pCi/g) found in the sewage drying beds in Area 3 discussed on page 5-11, and the elevated concentrations (up to 573 pCi/g) found at the railroad siding discussed on page 5-30. Carry through any discussions into Section 11 and Table XI.1 if appropriate.

   We have added additional cross references in subsections, where appropriate, and new statements in subsection 4.1.11.

2. Table XI.1, General
   Table XI.1 should be revised to show maximum radioactive soil concentrations for each area, based on the discussions in the text. The maximum concentrations found were not always a result of the Site Survey Project (which this table seemed to primarily rely on), but may be from D&D work, subsequent investigations, or reports from the soil screening facility.

   We have revised the table to include all the pertinent data as requested.

SPECIFIC COMMENTS

1. Table II.1, pages 2-10 through 2-16
   Please include the concentration units of the values to the table.

   Concentration units are added to the table.

2. Section 3.3.7, last para, page 3-26
   Please offer an explanation why elevated levels of Co-60 and Cs-137 were found at location S0175 if possible.

   The statement that there is no knowledge of the origin of these species is added to the text.

3. Section 4.1.4, para 3, page 4-21.
   Correct the last sentence to refer to the correct plate.

   The text is revised to refer to Figure 1.2.

4. Figure 8.2, page 8-3
   The units indicated on this figure (pCi/g) are not consistent with the corresponding discussion on page 8-4. Please correct.

   The label on the figure is revised to indicate nCi/L.

5. Section 11, para 1, page 11-4
The text states that the highest values of Co-60 were in Area 21. Table XI.1, page 11-2, shows "LDL" for Co-60 in Area 21. Correct the text or the table.

The text is revised to cite Area 22.

6. Table XI.1, page 11-2 and 11-3
Add the Building 48 hillside (discussed on page 11-6), Area 23 (discussed on page 11-7), and the old railroad siding (discussed on page 11-7) and the corresponding soil radioactivity concentrations to this table.

The table is revised to include all appropriate locations. The summary section was revised to the extent that the entire section is replaced, except for the Figures 11.1, 11.2, and 11.3.

EG+G-29-01-01-07-03
#9406140006

ROY F. WESTON, INC.
6501 AMERICAS PARKWAY, NE
SUITE 800
ALBUQUERQUE, NM 87110
505-884-5050

28 December 1992

EG&G Mound Applied Technologies, Inc.
Attention: Mr. Charles S. Friedman
Bldg. OSE-2
P.O. Box 3000
Miamisburg, Ohio 45343-3000

RE: ER Program, Mound Plant
BOA No. 24251
Site Scoping Report: Volume 3

RFW WO # 5376-39-02

Dear Mr. Friedman:

Enclosed is the revised copy of the Draft Final Volume 3 - Radiological Survey Report. This document was revised in response to EPA and Ohio EPA comments. This report was submitted to the regulatory agencies as a Draft in April 1991. Response to comments were transmitted in July 1991, but the revision was postponed until the completion of the companion Site Scoping Report: Volume 7 - Waste Management. Volume 7 is now in the Draft Final stage and is nearing completion. The Draft Final Volume 3 was reviewed by EG&G Mound Applied Technologies (D. Carfagno) for technical content and approved for distribution. At the direction of Art Kleinrath, DOE Dayton Area Office, the revised document is being distributed to the project managers.

The Draft Final Volume 3 - Radiological Survey Report has undergone extensive revision and complete reorganization. This effort was required in order to put the radiological data into perspective with regards to process knowledge. The reorganizaton is in large part the response to regulatory comments. In keeping with this strategy, Volumes 3 and 7 of the Site Scoping Report provide a valuable resource of data on the historic process, treatment, storage and disposal (TSD) of radioactive materials (Volume 7), as well as the availability of analytical data for those areas sampled (Volume 3). The changes incorporated in the Draft Final Volume 3 include the following:

- the executive summary is deleted and the information incorporated into new section 11, Summary;
- miscellaneous older sources of radiologic data are summarized in section 1, Introduction;
- section 2, Site Survey Project, remains largely unchanged, but includes additional information in response to comments;
- old section 3 is deleted and the information incorporated into the revised report, including additional information requested by agency comments:

WESTON

- new sections 3 through 10 were added to present the major programs that dealt with radionuclides and the areas where TSD activities occurred, and to present the detailed descriptions of the major areas at Mound Plant currently designated as radiologically contaminated soils;

- section 11, Summary, is revised to summarize environmental data and the results of the Site Survey Project;

- old section 4, Contaminant Fate and Transport and Risk Analysis, is deleted at EPA request;

- old subsection 5.2.1, Areas Requiring Additional Investigation, and subsection 5.2.2, Data Limitations and Recommendations for Future Work, are deleted at EPA request;

- new section 12, References, replaces old section 6, References, and includes new information;

- Plate 1, Project Sampling Locations (1 of 2), is revised to include additional information;

- Plate 1, Project Sampling Locations (2 of 2), is not revised (the original issue will suffice); and

- Plate 4, Plutonium Concentration Contour Map, and Plate 5, Thorium Concentration Contour Map, are recalculated and revised accordingly.

To facilitate the process of updating this report, the text is submitted in its entirety. Also enclosed are the new plates noted and two change pages for Appendix E. All other plates and appendixes remain unchanged.

If you have any questions regarding this matter, please call Bill Criswell, the Principal Investigator, at (505) 884-5050 or the Alternate Project Manager, Mr. John Price, at (513) 825-3440.

Sincerely,

ROY F. WESTON, INC.

for William M. Little

John W. Thorsen, P.E.
ER Program, Subcontractor
Project Manager

CWC/cs

Attachments

WESTON

pc w/att: D. Mally, USEPA Reg. V
D. Spencer, USEPA Reg. V
M. Hatcher, OEPA
J. Kwasniewki, OEPA
D. Flynn, DOE AL
A. Kleinrath, DOE DAO
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M. Williams, EG&G MAT
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J. Rigano, EG&G
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J. Register, IT
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w/o att: ER Project File

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#9406140006

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

F- OU-9
COMMENTS

REPLY TO THE ATTENTION OF:

HSRM-6J

February 16, 1993

VIA FACSIMILE AND
FIRST CLASS MAIL

Mr. Arthur Kleinrath
U.S. Department of Energy
Dayton Area Office
P.O Box 66
Miamisburg, Ohio 45343

RE: U.S. DOE Mound Plant Review Comments
Site Scoping Report, Volume 3

Dear Mr. Kleinrath:

Enclosed are the United States Environmental Protection Agency's (U.S. EPA's) comments on the "Site Scoping Report, Volume 3 - Radiological Site Survey" for the Mound Plant site. Please provide revised pages and responses to these comments within forty-five days of your receipt of this letter, or by April 2, 1993.

Please feel free to call me at (312) 353-6287 if you have any questions.

Sincerely,

Diana Mally

Diana Mally
Remedial Project Manager

Enclosure

cc: M. Hatcher, OEPA
C. Friedman, EG&G Mound
M. Williams, EG&G Mound
D. Neff, Geotech, DAO
W. Rummel, Geotech, DAO

Printed on Recycled Paper

US DOE Mound Plant
Operable Unit 9
Site Scoping Report, Volume 3 - Radiological Site Survey
December 1992
US EPA

General Comments:

1. Section 4, General
Add some discussions in this section concerning the elevated concentrations of Pu-238 (1,235 pCi/g) found in the sewage drying beds in Area 3 discussed on page 5-11, and the elevated concentrations (up to 573 pCi/g) found at the railroad siding discussed on page 5-30. Carry through any discussions into Section 11 and Table XI.1 if appropriate.

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Specific Comments:

1. Table II.1, pages 2-10 through 2-16
Please include the concentration units of the values to the table.

2. Section 3.3.7, last para, page 3-26
Please offer an explanation why elevated levels of Co-60 and Cs-137 were found at location S0175 if possible.

3. Section 4.1.4, para 3, page 4-21
Correct the last sentence to refer to the correct plate.

4. Figure 8.2, page 8-3
The units indicated on this figure (pCi/g) are not consistent with the corresponding discussion on page 8-4. Please correct.

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The text states that the highest values of Co-60 were in Area 21. Table XI.1, page 11-2, shows "LDL" for Co-60 in Area 21. Correct the text or the table.

6. Table XI.1, page 11-2 and 11-3
Add the Building 48 hillside (discussed on page 11-6), Area 23 (discussed on page 11-7), and the old railroad siding (discussed on page 11-7) and the corresponding soil radioactivity concentrations to this table.

7. Table XI.1, page 11-2
Please correct the table to indicate in Area 3 the maximum thorium concentration found was 63 pCi/g (from page 5-11).

8. Table XI.1, page 11-2
Please correct the table to indicate in Area 3 the maximum Pu-238 concentration found was 1,235 pCi/g (from page 5-11).

9. Section 11, Pu-238 discussion, para 2, page 11-4
Areas also showing elevated Pu-238 concentrations from Plate 4 and/or Table XI.1 are Areas 12 and 4/4a. Include these areas in the discussion.

10. Section 11, Pu-238 discussion, bullet 6, page 11-4
Why is Area 18 included as an area associated with highest Pu-238 concentrations? Information in the report does not seem to support this.

11. Plates 4 and 5
Plates 4 and 5 incorrectly show Area 1 as Area 21. Please correct.

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ACRONYMS

ALARA	as low as reasonably achievable
ATSDR	Agency for Toxic Substance and Disease Registry
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	Decontamination and Decommissioning
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration (Program)
FFA	Federal Facilities Agreement
FIDLER	field instrument for the detection of low-energy radiation
FS	feasibility study
LDL	lower detection limit
MRC	Monsanto Research Corporation
NPL	National Priority List
RI	remedial investigation
RMC	Radiation Management Corporation
RPD	relative percent difference
RTG	radioisotopic thermoelectric generator
TSD	treatment, storage, and disposal
WTS	waste transfer system

ACKNOWLEDGEMENTS

This report is based on a Mound Plant report, *The Mound Site Survey Project for the Characterization of Radioactive Materials in Site Soils*, by Robert L. Stought, Don A. Edling, and Douglas G. Draper (Mound Plant Report MLM-3517, May 16, 1988). Extended sections of the original report, primarily site descriptions, are included in this report verbatim, without quotation. Except for this acknowledgement, no other attribution is included in the body of text in this report. When discussions or conclusions of the original report are paraphrased or summarized in this report, a citation is included. The contribution of the original authors is gratefully acknowledged.

This report was prepared by Roy F. Weston, Inc., Albuquerque, New Mexico, initially under subcontract 9-XS8-0146R-1 to the University of California, Los Alamos National Laboratory, and revised under BOA No. 24251, EG&G Mound Applied Technologies, Mound Plant, Miamisburg, Ohio.

1. INTRODUCTION

The U.S. Department of Energy (DOE) Mound Plant, Miamisburg, Ohio, was placed on the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, also known as Superfund) National Priorities List (NPL) on November 21, 1989 (54 Federal Register 48184). The placement of the Mound Plant on the NPL occurred as a consequence of historic disposal practices and releases of contaminants to the environment. The Mound Plant received an overall Hazards Ranking System score of 34.61, which exceeded the threshold (28.51) for NPL listing. Pursuant to its NPL status, the DOE signed a CERCLA Section 120 Federal Facilities Agreement (FFA) with the U.S. Environmental Protection Agency (EPA) that became effective October 11, 1990 (Administrative Docket #VW-'90-C-075). A similar agreement is in negotiation between the DOE and Ohio EPA (December 1992). The terms of the FFA require that the DOE develop and implement remedial investigations (RIs) and feasibility studies (FSs) and conduct interim remedial actions in order to ensure that environmental impacts associated with past and present activities at the site are thoroughly investigated and that appropriate action is taken to protect the public health, welfare, and the environment.

The Albuquerque Operations Office of the DOE established the Environmental Restoration (ER) Program in 1984 to collect and assess environmental data in order to develop a conceptual site model, to assess both the nature and extent of radioactive contamination, and to identify potential exposure pathways and potential human and environmental receptors. These activities have been conducted under the DOE policy requiring all facilities to comply with applicable environmental regulations. In order to provide the EPA with sufficient information and data gathered during these previous investigations, a multivolume scoping report, providing background information, has been prepared. The Site Scoping Report will provide descriptions and summaries of the current conditions and characteristics of Mound Plant and will consist of at least the following volumes:

1. Groundwater Data: February 1987 - July 1990 with Addendum
2. Geologic Log and Well Information Report with Addendum
3. Radiological Site Survey
4. Engineering Map Series
5. Topographic Map Series
6. Photo History
7. Waste Management
8. Environmental Monitoring Data
9. Annotated Bibliography
10. Permits and Enforcement Actions
11. Spills and Response Actions

1.1. SCOPE OF REPORT

This report is intended to assist in assessing the known or suspected nature and extent of radiological contamination within the Mound Plant boundary. This report provides a summary of the extensive radiological characterization that was completed during the Site Survey Project (Stought et al. 1988). The Site Survey Project (Stought et al. 1988) was initiated in response to a DOE request for estimates of the cost and time required to stabilize or remove radioactively contaminated soils within the Mound Plant boundary. While the survey was not conducted with the purpose of fulfilling regulatory requirements, the FFA requires a review of existing data. This report largely reviews the activities performed during the Site Survey Project, including:

- descriptions and evaluations the sample collection, handling, and analytical procedures;
- tabulation of the Site Survey Project analytical data; and
- review of the on-plant areas of known or suspected radiological contamination.

This report is arranged to provide an overview of the areas used for the processing and treatment, storage, and disposal (TSD) of radioactive materials at Mound Plant and what levels, if any, of radiologic contamination was identified by the Site Survey Project. Although summaries are provided, detailed information on the major projects and TSD areas are provided in the Site Scoping Report: Volume 7 - Waste Management (DOE 1992g). A tabulated set of the Site Survey Project analytical data is provided in the appendixes because the project report (Stought et al. 1988) provided only data summaries. The data are presented in basically the same format as they were received from Mound Plant.

Throughout the discussion of the extent of contamination of each area, any observed differences are noted between either the extent of the areas sampled or in the concentrations of radionuclides present in comparison with results presented in the Site Survey Project Report (Stought et al. 1988). Because the original project report did not present actual concentrations for each sample location, a direct comparison of conclusions and interpretation will not be made, and only a very general comparison will be included in this report.

The known or suspected contaminated areas where sampling was performed during the Site Survey Project and identified by this report are presented in Plate 1. The boundaries of these areas were identified for this report by

- the historical descriptions of the potential sites;

- the extent of contamination, as identified by significantly elevated concentrations of radionuclide(s);
- physical boundaries, such as ponds, runoff channels, or parking lots.

In general, a boundary was drawn approximately half the distance between an obviously contaminated location (the outermost locations) and a location that appeared to contain levels of radionuclide(s) near Mound Plant baseline or background levels. These boundaries are not definitive of the areas encompassed and are probably very conservative. They are only intended to give an estimate of the location and extent of the areas of interest.

With a few exceptions, the results of the gamma surveys performed using a field instrument for the detection of low-energy radiation (FIDLER) in the initial phase of the Site Survey Project (subsection 2.1.1) are not discussed in this report. The generalized results for these gamma surveys for plutonium and thorium are shown in Plates 2 and 3, respectively. This is due to problems that could affect the accuracy and documentation of the surveys, as discussed in section 2.1.

This report is not intended to supply a complete listing, but provides references to and summary descriptions of other sampling project and program reports that provide additional radiologic data and information concerning the nature and extent of radiologic contamination. These other projects generally do not have the records of sample collection and handling, nor do they cover as broad a spectrum of activities as the Site Survey Project. The results of other sampling activities are included in the descriptions of the areas of concern where appropriate.

1.2. OVERVIEW OF MOUND PLANT OPERATIONS

Mound Plant, originally called Mound Laboratory, is a government-owned and contractor-operated facility. It has its roots in the Dayton Project that was part of the World War II Manhattan Project. In 1946, a 182-acre site on the outskirts of the town of Miamisburg in Montgomery County, Ohio (Figure 1.1) was selected as the location of the permanent research facility in support of the Manhattan Project. It consisted of 14 original buildings and was the first permanent facility of the Atomic Energy Commission, which had succeeded the wartime Manhattan Engineering District. The Mound Laboratory was occupied in May 1948, and in January 1949 operations involving radionuclides began. In January 1975, the plant formally came under the Energy Research and Development Administration upon dissolution of the Atomic Energy Commission. In October 1977, the plant was incorporated into the DOE complex. An additional 124 acres of land adjacent to the original 182 acres were purchased in 1981 and remain largely undeveloped. This area is known as the new property or south property. There are currently over 100 buildings on the 306-acre Mound Plant.

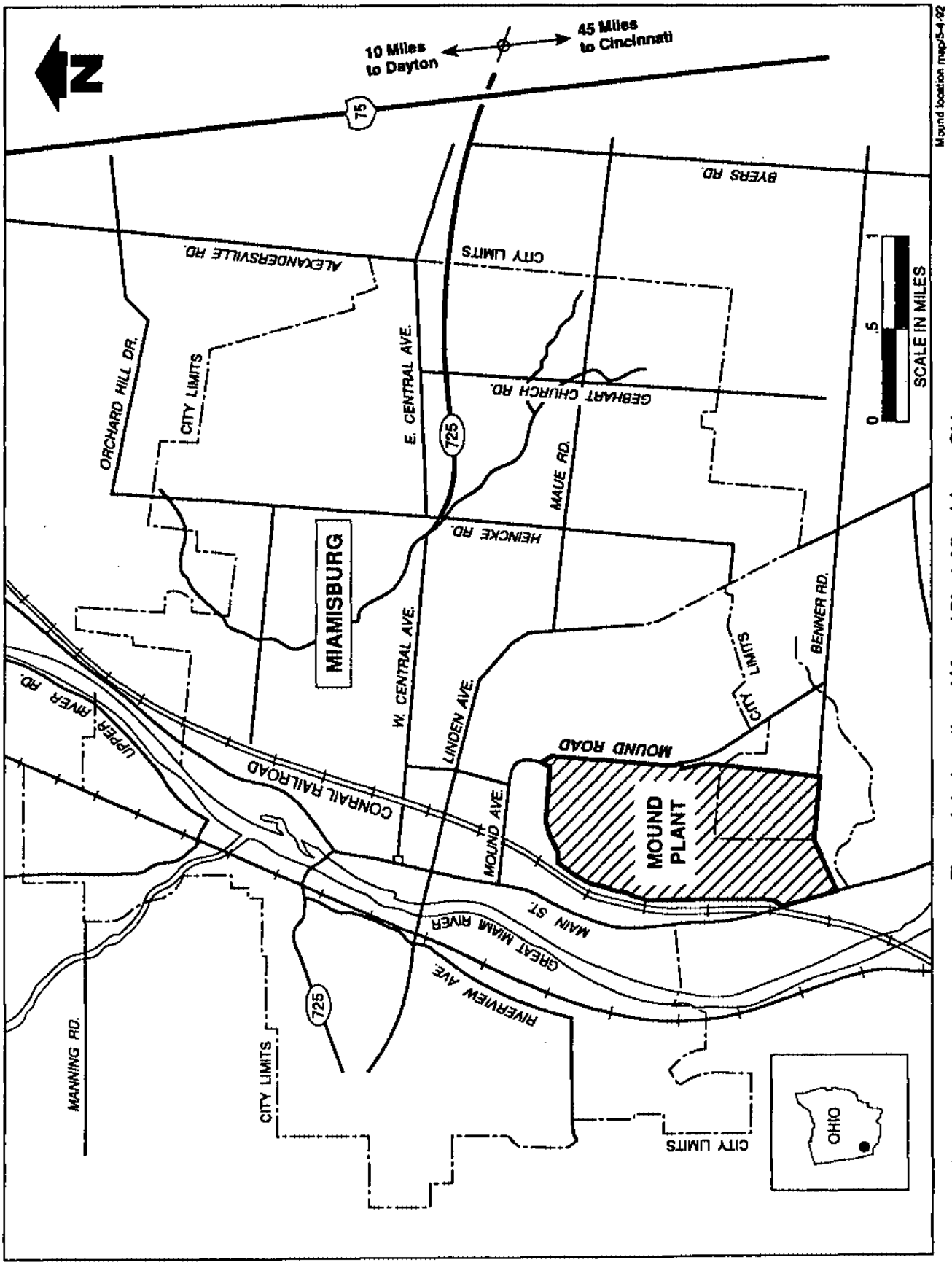


Figure 1.1. Location of Mound Plant, Miamisburg, Ohio.

The early Mound Plant programs investigated the chemical, metallurgical and biological properties of polonium-210 and its applications in the fabrication of neutron and alpha sources for weapons and non-weapons use. Much of the early work at the plant involved development of mechanical, electronic and caloric methods of measuring quantities of radionuclides. The biological program was designed to assess the acute and chronic effects of polonium-210 and later actinium-227. During the early 1950s, actinium-227 was separated from radium-226 in an attempt to find a substitute for polonium-210 weapons components.

Physical and chemical investigations involving the extraction and purification of protactinium-231, thorium-228, thorium-230 and plutonium-239 from uranium sludges were performed from 1955 to 1970, partly in support of the national civilian power reactor program. In 1954, separation of the stable isotopes of noble gases was begun, as was a program to separate thorium-232 for research in breeder reactors. Approximately 5,900 55-gallon drums of thorium hydroxide, oxalate, and oxide were received in anticipation of construction of a thorium refinery at Mound Plant. A pilot plant was assembled and tested, but the refinery was halted in the middle of construction. From 1955 to 1965, the thorium ore and sludges were repackaged three times and the drums were stored in large groups throughout the plant grounds. As many as 20,000 empty, but corroded drums were buried. In 1966, the thorium was moved to a bulk-type storage silo (Building 21) and then was removed from the silo in 1974.

In 1961, the development of plutonium-238 heat sources was started at Mound Plant. Plutonium-238 was used because of its high specific activity and longer half-life (87.74 years). Since that time, heat sources fueled with plutonium-238 have been developed and fabricated by Mound Plant for use in thermoelectric generators and for lunar experiments, weather satellites, navigational satellites, and Mariner and Pioneer spacecraft, as well as life-support systems, swimsuit heaters, artificial hearts, and cardiac pacemakers.

The first of several programs requiring tritium-handling technology was initiated at Mound Plant in 1954, and today the plant has extensive capabilities for handling and studying tritium and tritium compounds for weapons or non-weapons applications. Plant facilities exist for the recovery and purification of tritium from all types of wastes generated at DOE sites that handle tritium, and for the development of tritium-containing materials and processes for weapons applications and possible manufacture.

In 1956, Mound Plant began to develop, produce, and provide surveillance of detonators for military applications. Development of explosives timers in 1959 led to their manufacture at the plant starting in 1963. This work involved research in plastics, adhesives and ceramic materials. The development

and manufacture of ferroelectric transducers and firing sets (components that control initiation of detonators) began at Mound Plant in 1962. Many these programs continue today.

Mound Plant is currently an integrated research, development, and production facility performing work in support of DOE weapons and energy programs, with emphasis on explosives and nuclear technology. Energy-related activities support the DOE programs and include research, development, and fabrication of radioisotope-fueled heat sources for space, terrestrial, and marine applications; radioisotopic thermoelectric generator (RTG) fabrication and testing; the separation, purification, and worldwide sales of stable noble gas isotopes (such as helium-3 and carbon-13); the production of a selected group of other radionuclides; the development of measurement technology for nuclear materials as required for safeguards; basic research in metal hydrides, solar fluids, gas dynamics and isotope separation; research and development of nuclear waste management techniques; and the development of instrumentation and verification procedures for radioactive studies of radiation workers.

Detailed information on the ownership and operations of the Mound Plant can be found in the Site Scoping Report: Volume 7 - Waste Management (DOE 1992g). Additional information concerning land use near Mound Plant and the area's population, historic and archaeological resources, ecology, sensitive environments, geology, hydrogeology, and surface hydrology can be found in the Operable Unit 9 Site-Wide RI/FS Work Plan (DOE 1992c).

The years of production and handling of radionuclides at the current location of Mound Plant have resulted in the relatively widespread, low-level radioactive contamination throughout most of the property. For example, the background for plutonium-238 in the soils of this portion of Ohio, as a result of radioactive fallout from atmospheric nuclear weapons testing, has been estimated to be 0.0002 picocuries per gram (pCi/g) (Stought et al. 1988). However, the baseline level (inside the Mound Plant boundary background level) at Mound Plant is approximately 0.01 pCi/g (Stought et al. 1988). The background for thorium, which is naturally occurring in the soils, is approximately 2 pCi/g (Stought et al. 1988). The background or baseline levels for tritium, cobalt-60, cesium-137, americium-241, and actinium-227 have not been established. Background levels for radium-226 range from 0.2 to 2.06 pCi/g (Eisenbud 1973). Efforts are currently underway at Mound Plant to establish facility-specific, residual soil guidelines for these radionuclides (Zimmerman 1991).

1.2.1. Overview of Environmental Monitoring Program

Interest in the health and safety of Mount Plant employees and the public is manifested by an environmental monitoring program that has been in existence continuously since the plant began operations in 1949. Reports and data summaries have been published annually since 1959 by Mound

Plant and are currently available through the National Technical Information Service, U.S. Department of Commerce.

The fundamental objectives of the environmental monitoring program are the containment of radioactive waste and control of nonradioactive effluents to levels well within existing or proposed standards. As part of this control, all effluents containing polluting materials are controlled at each operating step and any releases of low-level airborne and liquid wastes to the environment are carefully managed and monitored.

As part of the environmental monitoring program, air, water, vegetation, foodstuffs, and sediment samples are collected from the environment at distances up to 48 kilometers (km) (30 mi) from the plant. These samples are then analyzed for the specific radionuclides handled at the plant. Particulate samples are collected offsite by the Air Pollution Control Section of the Montgomery County Combined General Health District, which acts as the Regional Air Pollution Control Agency for the Ohio EPA. Other sampling is performed by personnel in the Mound Plant Environmental Section. Sample analysis and data reduction are performed by the Mount Plant Environmental Laboratory Group. A summary of the 1988 background concentrations of radionuclides is given in Table I.1 (EG&G 1989).

Data collected through the Mound Plant environmental monitoring program from 1975 to 1989 is addressed in the Site Survey Report: Volume 8 - Environmental Monitoring Data (DOE 1991d). Further discussions are beyond the scope of this report.

1.2.2. Overview of Decommission and Decontamination Program

The Mound Plant Decommissioning and Decontamination (D&D) Program is an ongoing program that provides a coordinated system for funding and scheduling of the D&D of inactive radioactively contaminated areas of the plant. The program originated in 1949 with the deactivation of the pre-Mound Plant Dayton units and has continued at Mound Plant as projects were terminated and facilities were used for other activities (Garner and Davis 1975). D&D activities at Mound Plant include (1) the "old cave" in the SW Building, which had been used for processing radium-226 and actinium-227; (2) the T Building, which had been used for polonium processing; (3) the Waste Transfer System (WTS), which had piped liquid wastes from the SM Building and Building 38 to the WD Building; and (4) many other smaller projects (Combs et al. 1982).

The D&D of the older Dayton facilities included both decontamination of buildings that were left in place and complete removal of those more contaminated. Contaminated buildings, debris, and equipment were taken to Mound Plant, because the short-lived polonium-210 isotope with a 138-day

Table I.1. Background Concentrations of Radionuclides for the Mound Plant

Medium	Location	Radionuclide	Concentration
Air	Station 119, 28 miles NW of plant	Plutonium-238	$0.2 \pm 0.6 \times 10^{-18}$ µCi/mL
		Tritium oxide	$2.0 \pm 1.5 \times 10^{-12}$ µCi/mL
River water	20 miles upstream of plant on Great Miami River	Plutonium-238	n.d.
		Tritium	n.d.
		Uranium-233, 234	$0.7 \pm 0.1 \times 10^{-9}$ µCi/mL
		Uranium-238	$0.7 \pm 0.1 \times 10^{-9}$ µCi/mL
Surface water	Pond, 38 miles SE of Plant	Plutonium-238	n.d.
		Tritium	$0.02 \pm 0.09 \times 10^{-6}$ µCi/mL
Groundwater	Well, 36 miles SE of Plant	Plutonium-238	$0.1 \pm 1.4 \times 10^{-12}$ µCi/mL
		Tritium	$0.06 \pm 0.05 \times 10^{-6}$ µCi/mL
		Uranium-233, 234	$0.2 \pm 0.1 \times 10^{-9}$ µCi/mL
		Uranium-238	$0.2 \pm 0.1 \times 10^{-9}$ µCi/mL
River silt	20 miles upstream of plant on Great Miami River	Plutonium-238	$2.2 \pm 8.4 \times 10^{-9}$ µCi/g
Pond silt (surface water location)	Pond, 38 miles SE of plant	Plutonium-238	$0.6 \pm 1.7 \times 10^{-9}$ µCi/g

Source: EG&G 1989
µCi/g - microcuries per gram
µCi/mL - microcuries per milliliter

half-life would soon decay. Records of the projects indicate that 260 truckloads of contaminated scrap were moved to Mound Plant (Halbach 1949, 1950). It is unknown how much of this material was contaminated equipment and how much was just debris (DOE 1992g). Concrete and structural steel were disposed of on the west slope of the SM/PP hillside, now known as Area 10. Contaminated equipment was stored in temporary huts or shelters in the plant valley. Scrap wood and metal were stored in the open area behind the huts. Wood and other combustible materials were destroyed in 1955 by burning in the area adjacent to where they had been stored, now known as Area 13. The sampling of these areas are discussed in detail in this report.

In the mid-1950s, the radium-actinium processing facilities in the SW and R Buildings were decommissioned and decontaminated. The R Building cleanup included removal of glove boxes and general decontamination of some of the actinium facilities. The high-risk drain trenches in several rooms were filled with vermiculite and covered with concrete (DOE 1992g). These facilities included the hot cell or "old cave" in SW Building where the radium-actinium processing took place. The materials and equipment in the cave were packaged for burial off-plant in boxes staged just south of the building. Some equipment was too large to send offsite. The crane and track mechanisms that had been used to move heavy containers within the cave were laid down on the concrete floor with the dismantled shielding from the cave itself and covered or entombed with several inches of concrete. This area is now known as Area 15, discussed below. During excavation work in 1957 on the west side of the SW Building, associated with the thorium refinery, soils and gravels contaminated with radium-226 and actinium-227 were discovered. These soils were believed to have been contaminated by leakage from the high-level waste sump in the old cave that had previously been entombed. About 200 to 250 ft^3 of soil and gravel were excavated and placed in or near an old septic tank in the upper valley area of the plant. The septic tank is now included in Area 7, and is discussed in this report.

Until the 1970s, the principal concern of the D&D Program was buildings and structures and their decontamination for further use, although minor soil cleanups have occurred throughout the history of the plant. With growing environmental concerns, the D&D Program realized the need for decontamination of contaminated soils. A survey of known historical low-level waste burial sites was conducted in early 1971 resulting in the identification and general mapping of 15 areas known or suspected to be contaminated with radionuclides (MRC 1972). The original map is reproduced in Appendix A of the Site Scoping Report: Volume 7 - Waste Management (DOE 1992g). Over the next 10 years, additional areas were identified. In the early 1980s, the Site Survey Project was funded to collect and analyze soil samples from the known areas of contamination. The project was initiated largely by the needs of the D&D Program in order to estimate the quantities and types of radionuclides,

the volumes and locations of contaminated soil, and the costs of stabilizing or removing the contaminated soils (Stought et al. 1988).

Two areas of contaminated soils were identified by the Site Survey Project as the priority areas for D&D removal, both associated with the WTS pipeline from the SM Building and Building 38 to the WD Building. One area was located south of the WD Building where the high-risk waste line had ruptured in 1969, and the other was the entire WTS pipeline itself. These areas are now referred to as Areas 14 and 19, respectively, and are discussed in detail in this report.

1.2.3. Overview of the Site Survey Project

As noted above, until the 1970s, the principal concern of the D&D Program was buildings and structures and their decontamination for further use. With growing environmental concerns, the D&D Program realized the need for decontamination of contaminated soils. After the initial identification of areas known or suspected to be have been contaminated with radionuclides, an extensive analytical program was proposed. The Site Survey Project was initiated largely by the needs of the D&D Program in order to estimate the quantities and types of radionuclides, the volumes and locations of contaminated soil, and the costs of stabilizing or removing the contaminated soils (Stought et al. 1988). Over the 10 years required to obtain funding, four additional areas were identified and added to the original 15 for a total of 19 numbered areas identified at the start of the project. Samples were collected within the areas to establish contaminant levels, as well as between the areas to ensure that no areas were missed. Three additional areas were identified by field surveys during the project. The final project report was released in 1988 (Stought et al. 1988). A review of program activities is given in section 2 of this report.

The radiologically contaminated areas originally addressed by the Site Survey Project are shown on Plate 1 and are summarized below.

- 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 4, area surrounding the WD Building where influent tanks containing polonium-210, cobalt-60, and plutonium-238 overflowed;
- Area 4a, the old sewage disposal plant area contaminated by polonium-210, cobalt-60, and plutonium-238;

- Area 5, location of a waste-line break containing polonium-210 and cobalt-60;

- Area 6, a historic disposal trench for polonium-210-contaminated sand;

- 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, and including 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 10, a historic disposal area containing concrete contaminated with polonium-210;

- Area 11, a historic storage area for plutonium-238-contaminated wastes from the SM Building;

- Area 12, thorium-contaminated soils moved from Area 1;

- Area 13, a historic treatment area where debris contaminated with polonium-210 was burned;

- Area 14, the location of the 1969 waste transfer line (plutonium-238) break;

- Area 15, a historic radium-226/actinium-227 processing area entombed in concrete inside the SW Building;

- Area 16, a historic sanitary leach field for the SM Building (plutonium-238);

- Area 17, the area under and surrounding the SM Building contaminated with plutonium-238 from spills of plutonium wastes;

- Area 18, site sanitary landfill that may have received sediments from the ditch contaminated with plutonium-238;

- Area 19, the historic underground waste transfer lines for plutonium-238 liquid wastes;

During the initial gamma field measurements for the Site Survey Project, additional areas were identified:

- Area 20, the location of a waste-line break between the WD and the HH Buildings (cobalt-60, cesium-137, bismuth-210m, and bismuth-207);

- Area 21, a historic storage area used for storage of high-risk wastes from the SW Building (cesium-137 and radium-226); and

- Area 22, a soil storage area containing soil with cobalt-60, cesium-137, and plutonium-238 contamination moved from Area 20 and other areas of the plant.

1.2.4. Reconnaissance Sampling - 1989

A limited field investigation was performed in 1989 to sample those areas identified as part of the Mound Plant D&D Program. The effort focused largely on obtaining analyses of non-radioactive hazardous substances in areas of known radioactive contamination. Areas scheduled for D&D that were sampled include Area 1, Areas 4 and 4a, Area 11, Area 14, Area 16, Area 17, Area 19, and Area D. Some analyses were obtained for the radionuclides plutonium-238 and thorium-232. Sampling results and data may be found in the Reconnaissance Sampling Report, Decontamination and Decommissioning Areas, Operable Unit 6 (DOE 1992d).

1.2.5. Plutonium Study of Miami-Erie Canal - 1974

In 1969, a break in the waste line carrying liquid plutonium wastes from the plutonium processing area on the SM/PP Hill to the WDA treatment facility above the plant valley created significant soil contamination along the pipeline. Most of the soil was cleaned up, but some was washed off-plant and into the adjoining lands of the Miami-Erie canal. Contaminated areas on-plant, including areas 14 and 19, were addressed in the Site Survey Project Report (Stought et al. 1988); descriptions are included in this report. The off-plant areas are not included in this report. Project description, results, data, and interpretations can be found in the Mound Laboratory Environmental Plutonium Study (Rogers 1975) and the Mound Laboratory Plutonium-238 Study Off-Site Analytical Data (Robinson et al. 1974). As part of the 1974 investigations of plutonium-238 in the Miami-Erie Canal, a wide area survey was conducted. This survey included the sampling and analysis of sediments in the plant drainage ditch and other areas of the plant. Results were reported in "Investigation of the Circumstances Associated with the Appearance of Plutonium-238 Contamination in Waterways Adjacent to Mound Laboratory" (ERDA 1975). A figure depicting the onsite sample results is reproduced as Figure 1.2. The plant drainage ditch is described in section 10 of this report. Further discussions of the Miami-Erie canal are beyond the scope of this report.

1.2.6. Aerial Radiological Survey of Mound Plant - 1976

An aerial survey of Mound Plant and the surrounding area was performed in July 1976 to measure terrestrial gamma radiation (EG&G 1978). The survey was part of an effort to document background radiation levels around DOE facilities. It was performed using a helicopter that flew a series of east-west grid lines spaced 61 meters apart, flew slowly over several selected areas, and hovered at a height of 15 meters over several spots of interest. Results were reported in terms of exposure rates using units of microRoentgens per hour (μR/hr), reproduced in Figure 1.3.

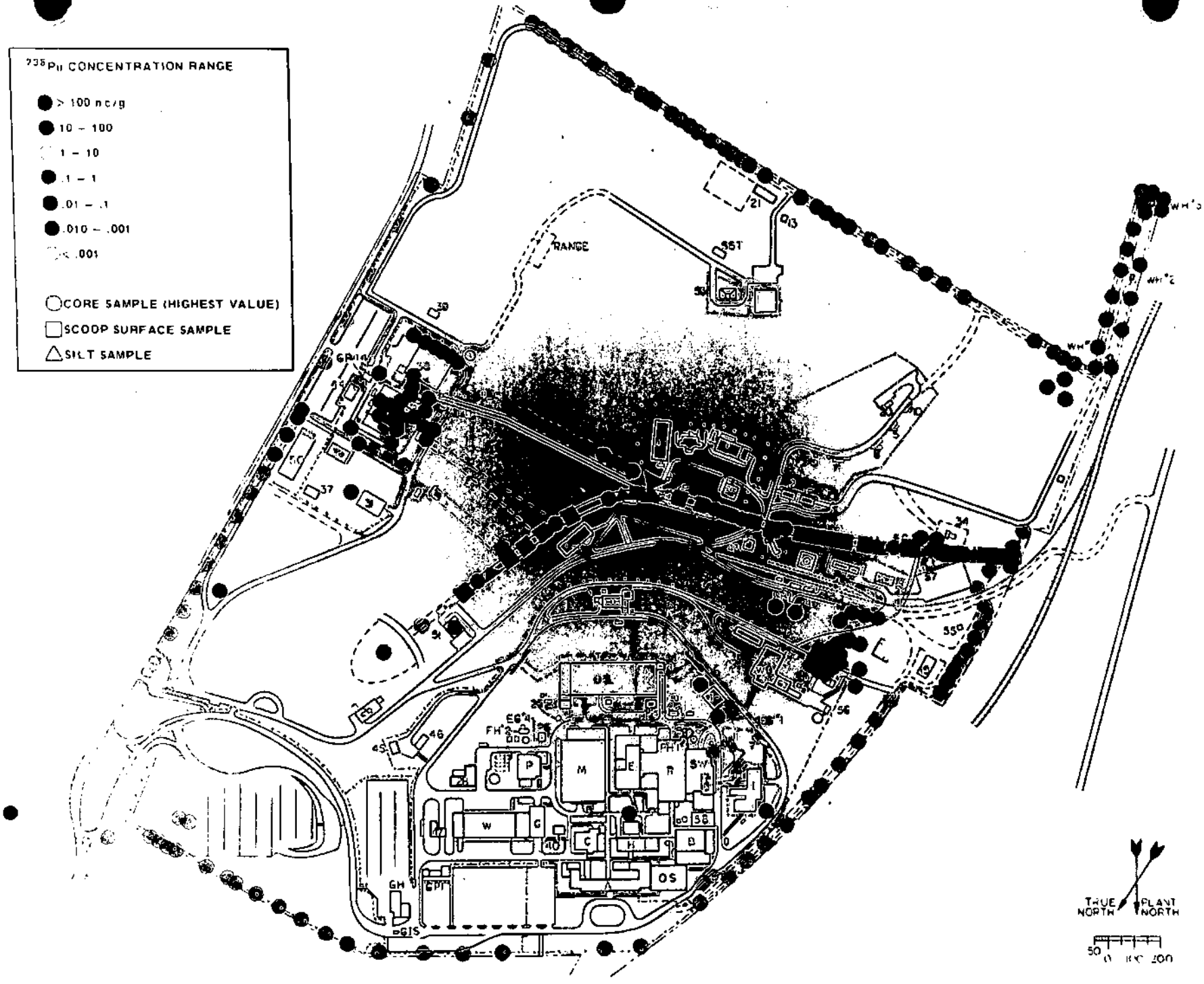
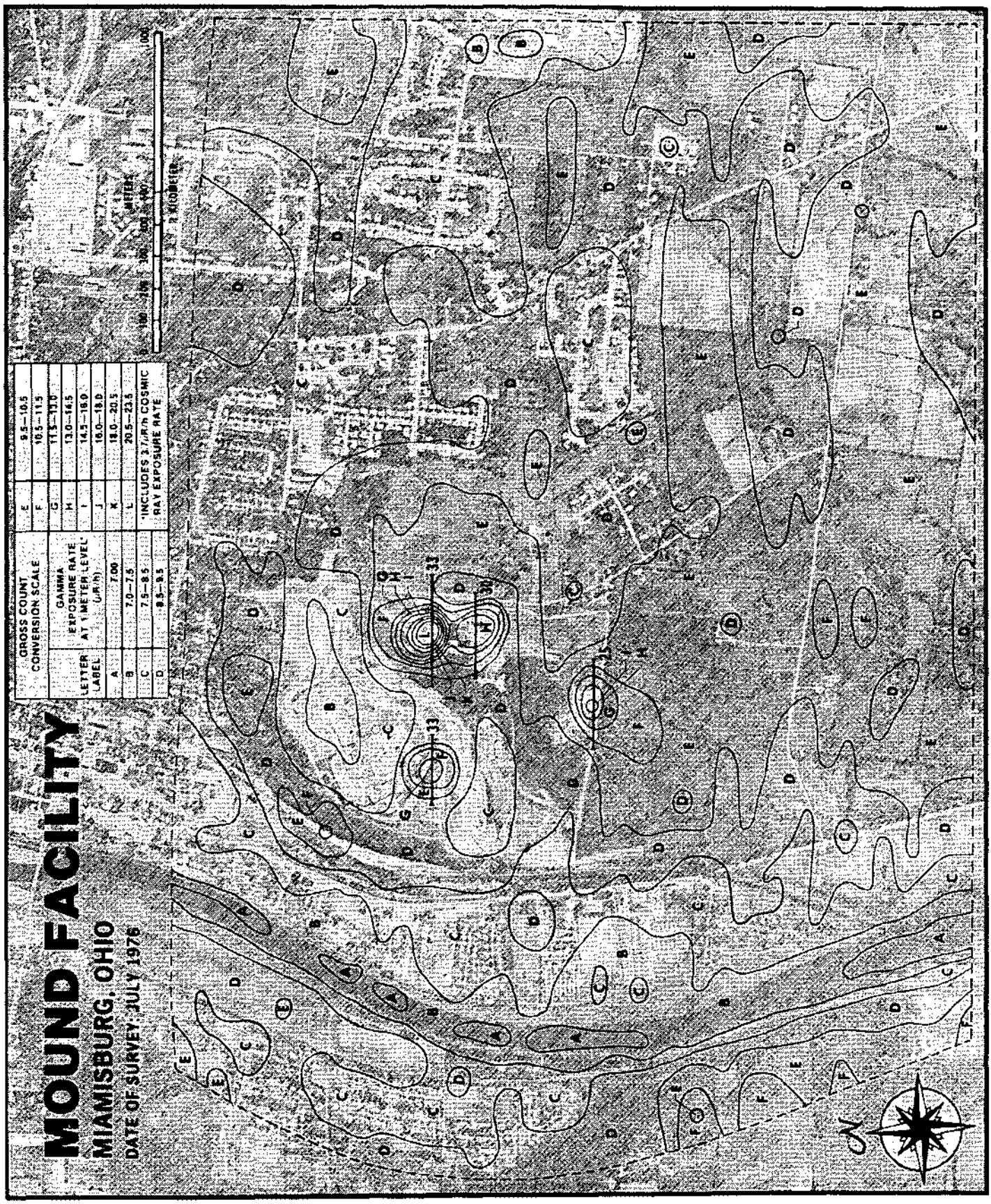


Figure 1.2. Concentrations of plutonium-238 compiled by Mound Plant, circa 1975.



Ref.: EG&G 1976

Figure 1.3. Gross count exposure rate isopleth photo overlay in units of μR/h.

The aerial survey determined that offsite radioactivity near Mound Plant was due mainly to naturally occurring radionuclides, such as thorium-232, uranium-238, and potassium-40. The maximum offsite exposure rates measured were 10 to 11 μR/hr in agricultural areas (EG&G 1978). Onsite, no plutonium-238 could be detected due to the low-energy gamma radiation detection limits of the aerial survey system used. (The low-energy gamma radiation from plutonium-238 would not be detectable at a height of 15 meters due to air attenuation.) Several regions of elevated cobalt-60 activity (maximum exposure rate of 4.5 to 7.5 μR/hr) were detected near the south side of the Main Hill, near HH and WD Buildings (Area 20). The maximum exposure rates recorded for Mound Plant were on the order of 20.5 to 23.5 μR/hr, around the SM Building and Building 38 on the SM/PP Hill (Area 17). Another area of elevated exposure rate was near Building 21 on south end of the SM/PP Hill (Area 1). Detailed descriptions of these areas are included in this report as appropriate.

1.3. SOURCES OF ADDITIONAL INFORMATION

Under the Superfund Amendments and Reauthorization Act of 1986 that extended and amended CERCLA, the Agency for Toxic Substance and Disease Registry (ATSDR) was directed to prepare toxicological profiles for hazardous substances commonly found at sites on the NPL and that pose significant potential threat to human health as determined by ATSDR and the EPA. The toxicological profiles are intended to characterize the toxicological and adverse health effects information as well as other pertinent data concerning chemical and physical properties, environmental fate and transport, levels monitored or estimated in the environment, and overviews of basic radiation physics. Hazardous substances for which toxicological profiles have been prepared include plutonium, thorium, radium, and uranium. For additional information see the following reports:

- "Toxicological Profile for Plutonium (TP-90-21)," December 1990, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service;

- "Toxicological Profile for Uranium (TP-90-29)," December 1990, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service;

- "Toxicological Profile for Thorium (TP-90-25)," October 1990, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service; and

- "Toxicological Profile for Radium (TP-90-22)," December 1990, Agency for Toxic Substances and Disease Registry, U.S. Public Health Service.

2. SITE SURVEY PROJECT INVESTIGATION

The objectives of the Site Survey Project were to conduct a systematic radiological survey of the exposed land areas at Mound Plant, concentrating on the original 182 acres, and to provide the DOE with a basis for estimates of the cost and time required to stabilize or remove contaminated soils. To achieve these objectives, the project included

- screening using a sodium iodide detector (FIDLER) to identify areas of suspected radioactivity contamination;
- sampling of surface and subsurface soil; and
- analysis of soil samples using one or more of the following methods: radiochemical analysis for plutonium-238 and the thorium isotopes, gamma spectroscopy, *in situ* gamma spectroscopy, and liquid scintillation for tritium.

The above activities are discussed in the following sections.

2.1. FIELD ACTIVITIES

2.1.1. Gamma Surveys

The initial phase of the Site Survey Project consisted of a systematic gamma survey. The most commonly occurring soil contaminants at Mound Plant have been plutonium-238 and thorium-bearing materials (Stought et al. 1988). Because of this, a FIDLER was used during screening to detect the low-energy gamma radiations emitted by plutonium-238 and thorium. The window settings of the FIDLER also permitted the detection of other gamma-emitting radionuclides, such as cobalt-60 and cesium-137, although the detection of these higher-energy gamma emitters would have been less efficient. (Some of the photons would possess sufficient energy to pass completely through the thin sodium iodide crystal of the FIDLER.) The presence of these other radionuclides could be identified by comparing the results of soil sample screening and radiochemical analyses (Stought et al. 1988).

To perform the survey, Mound Plant was divided into the grid blocks shown in Plates 2 and 3. The grid blocks were approximately 380 ft by 300 ft, with the blocks that overlapped the plant boundaries being smaller. The surveys were conducted in order to obtain a general idea of the location of contaminated areas, especially areas that had not been previously documented by historical records. Intensive surveys were conducted at the areas of known or suspected soil contamination (Areas 1 through 19 on Plate 1) to verify the existence of soil radioactivity contamination and to approximate the areal extent of radioactivity contamination. Less intensive surveys were conducted at the remaining portions of Mound Plant in order to identify any previously undocumented areas of soil

radioactivity contamination. These surveys of the remaining portion of exposed soils at Mound Plant resulted in the identification of Areas 20, 21, and 22 (Plate 1).

The gamma surveys were performed based on a mainly rectilinear pattern (Stought 1990). However, several biases were introduced during the surveying, as follows:

- areas covered by dense brush and woods were not thoroughly surveyed;
- areas covered by asphalt or buildings were not surveyed; and
- the grid blocks shown in Plates 2 and 3 were approximated by the field team, resulting in possible location errors.

Approximately 16,000 gamma survey readings were recorded: 12,000 on the original Mound Plant property and 4,000 on the new property. However, some problems were noted in the evaluation of these survey data for this report, including the following:

- the FIDLER is only accurate in detecting plutonium/thorium in the very near-surface soils because of attenuation of the low-energy gamma rays by the soils.
- there is no real documentation describing the pattern of the survey, such as the distance between transverses, or of the procedure for taking and recording readings, such as where the detector was held.
- there is no information available concerning instrument calibration.
- it is not known where readings were taken within each grid block.
- no actual data, other than the summaries presented in Plates 4 and 5, were available for the preparation of this report.
- the accuracy of the grid block summaries given in Plates 4 and 5 is suspect; because, the positions were estimated and not measured or surveyed by the field team.

2.1.2. Surface Soil Sampling

Surface soil samples were taken at Mound Plant as part of the Site Survey Project during 1983 and 1984. Five surface samples were taken in each of the grid blocks or strata, 300 ft by 380 ft, shown in Plates 2 and 3. The number of samples was chosen arbitrarily based on cost considerations, and the locations were chosen arbitrarily by the field team. The resulting locations are shown on Plate 1. Approximately 1,100 surface soil samples were taken: 1,000 on the original Mound Plant property and 100 on the new (south) property. Fewer samples were taken on the new property, which was purchased in 1981, because the gamma survey did not show significantly elevated levels in this area, and Mound Plant has not developed the area.

The positions of the surface sample locations were estimated by the field team relative to the grid system shown in Plates 2 and 3. Because the locations were not surveyed, the accuracy of the positions shown in Plate 1 has been estimated by Mound Plant to be ±25 ft. No samples were taken inside buildings or at paved areas, resulting in sampling within a limited space in many of the grid blocks. Surface locations shown on Plate 1 inside buildings or on roads are incorrect and probably result from errors by the field team in estimating positions and the assignment of digital coordinates.

The surface samples were collected using a sample collection tool capable of extracting a soil plug with a depth of 2 inches and a diameter of 3.5 inches. Two plugs were collected at each location, resulting in a total surface sample depth of approximately 4 inches. A hammer was used to facilitate driving the sample collection tool when necessary. The sample was then placed in an EPA sample dish with a 4-inch-diameter and a depth of 2.5 inches. Large rocks, twigs, and other non-earth matter were removed. Each dish was at least 80 percent full in order to obtain sufficient soil for analysis. The sampling tool was screened with an alpha scintillometer (zinc sulfide) detector after use, and excess soil was brushed out. However, no standard decontamination was performed.

2.1.3. Subsurface Soil (Core) Sampling

During the Site Survey Project, core samples were taken at locations of elevated gamma activity, as shown by the FIDLER surveys, or at locations where spills, leaks, or the disposal of radioactive materials was known or suspected to have occurred. The core sampling was, therefore, based on a biased sampling approach. A Mound Plant memorandum (Appendix A), providing a statistical evaluation of the project sampling strategy, notes that the absence of statistically based core locations (systematic or random) prevents adequate characterization of many areas. FIDLER screening at the ground surface would not provide information concerning subsurface radioactivity contamination due to attenuation of the gamma radiation. However, biased core sampling at selected locations where subsurface contamination is suspected is often used in RI/FS investigations to obtain data in a cost-efficient manner.

Approximately 1,200 core samples were collected: 1,000 on the original Mound Plant property and 200 on the new property. The majority of the core locations were sampled to a depth of about 8 ft to 10 ft, with some sampled as deep as 20 ft. In general, the depths of core locations on the Main and SM/PP Hills were limited by the presence of shallow bedrock; while in the valley, the depths of the core samples were limited by the capabilities of the drill rig, which encountered problems drilling and sampling below about 25 ft (Stought 1990). The boring logs that are available are included in Appendix B and additional boring logs are presented in the Scoping Report: Volume 2 Addendum (DOE 1992f).

The drilling and sampling were performed using an auger drill rig and a 2-ft, split-barrel sampler. As the split-barrel sampler was removed from the borehole, it was monitored for radioactivity contamination by Mound Plant health physics personnel using a FIDLER to detect radioactivity contamination that would pose a hazard to the workers present. After the soil was removed from the sampler and placed in sample containers, field team members wearing gloves brushed the remaining soil out of the sampler. The gloves were then monitored with an alpha scintillometer before the split-barrel sampler was used again. However, no standard decontamination was performed.

The core locations are shown in Plate 1. The core locations were surveyed by a licensed surveyor after drilling was completed. The available reports submitted to Mound Plant by the drilling subcontractors are presented in Appendix B.

2.1.4. Sample Analyses

2.1.4.1. FIDLER Screening

In order to identify samples with concentrations of plutonium-238 exceeding 25 pCi/g and total thorium exceeding 2 pCi/g, all of the soil samples collected were pulverized and then screened using a Bicron® FIDLER at the Mound Plant Soil Screening Facility, known as trailer 15 at the time of the Site Survey Project. The Soil Screening Facility is now located in the H Building at Mound Plant (Plate 1). The minimum detectable activity at which plutonium-238 can be reliably detected at the Mound Plant screening facility is estimated to be 25 pCi/g (Draper 1986b). The detection of plutonium-238 at lesser concentrations (12-25 pCi/g) was unreliable and had an estimated error of ±75 percent. The estimated error decreased with increasing sample activity; for samples with 25 to 100 pCi/g of plutonium-238, the estimated error was ±35 percent, and for samples with >100 pCi/g, the estimated error was ±30 percent (Casella and Bishop 1984). The minimum detectable activity for thorium from FIDLER screening was estimated to be about 2 pCi/g (Stought et al. 1988). The Mound Plant procedure for screening soil samples is provided in Appendix A.

2.1.4.2. Radiochemical Analysis for Plutonium-238

Because of the high error (±75 percent) involved in the FIDLER screening of samples containing less than 25 pCi/g of plutonium-238, all soil samples were radiochemically analyzed by Mound Plant for plutonium-238. The lower detection limit (LDL) for plutonium-238 by this method was estimated to be 0.01 pCi/g, with a relative precision (two standard deviations) of 25 percent. The overall precision of the plutonium-238 measurements was reported to be about 18 percent (DOE 1991b). The Mound

Plant procedure for the radiochemical analysis of soil samples for plutonium-238 is provided in Appendix A.

2.1.4.3. Radiochemical Analysis for Thorium

Samples with thorium concentrations in excess of 2 pCi/g by FIDLER screening were also radiochemically analyzed for thorium, resulting in the radiochemical analysis of about 12 percent of the samples. The LDLs for the thorium isotopes using radiochemical procedures were estimated to be

- 0.3 pCi/g for thorium-228, with a relative precision of 60 percent;
- 0.3 pCi/g for thorium-230, with a relative precision of 30 percent; and
- 0.1 pCi/g for thorium-232, with a relative precision of 70 percent.

The overall precision for the thorium measurement was reported to be about 25 percent. The thorium results were reported in pCi of total thorium per gram of soil, isotopes were not identified. The Mound Plant procedure for the radiochemical analysis of soil samples for thorium is provided in Appendix A.

2.1.4.4. Gamma Spectroscopy

Gamma spectroscopy was performed by Mound Plant on approximately 350 (18 percent) of the soil samples in order to verify the identity of the radionuclides present when screening indicated the presence of gamma-emitting radionuclides, but little excess plutonium or thorium was identified by radiochemical analysis. Gamma spectroscopy is capable of detecting a variety of gamma-emitting radionuclides; the radionuclides detected in samples collected during the Site Survey Project included cobalt-60, cesium-137, radium-226, actinium-227, and americium-241. No other gamma-emitting radionuclides with gamma energies below 1.5 millielectron volts (MeV) were detected, although the project report stated that subsequent sampling and analysis in some areas indicated bismuth-207 and bismuth 210m. No polonium-210 peaks were detected in the Site Survey Project samples, confirming that polonium-210, which was used at Mound Plant in the 1950s, is no longer present due to radioactive decay (half-life of 138.4 days). The LDLs for cesium-137, cobalt-60, and americium-241 were given with the original data, and were estimated to be 0.5 pCi/g for each. The LDLs for radium-226 and actinium-227 were estimated to be 1.0 pCi/g for both (Stought 1990). The Mound Plant procedure for gamma spectroscopy is provided in Appendix A.

2.1.4.5. *In Situ* Gamma Spectroscopy

In situ gamma spectroscopy was performed mainly at Areas 1 and 8, at two locations in Area 12, and at two locations not associated with a defined area, to determine subsurface thorium-232 concentrations. The *in situ* spectroscopy was performed by driving pipes to bedrock and lowering a sodium iodide detector down the pipes. The detector was coupled to a multichannel analyzer that was calibrated to thorium-232 with a measurement system sensitivity of about 1 pCi/g, or 0.5 pCi/g ±50 percent, at a confidence level of 95 percent. This procedure was performed by Radiation Management Corporation (RMC) and the pipes were put in place by Bowser-Morner, Inc., a local drilling contractor. The reports submitted to Mound Plant on this procedure are included in Appendix C. The logs of these borings are provided in Appendix B.1. The pipes were left in place at the completion of the Site Survey Project. A review of the data in Appendix B.1 and Appendix C indicates a lack of correlation between the depth of gamma surveys and borehole depths.

2.1.4.6. Tritium in Soil Moisture

Tritium has also been used at Mound Plant for many years, mainly at the SW Building. To evaluate possible tritium in soils, liquid scintillation analysis was performed by the Site Survey Project on approximately 5 percent of the soil samples collected. The soil moisture was distilled from the soil samples and then analyzed for tritium using the same method used for the analysis of tritium in urine. The procedure was capable of detecting 1.0 picocuries per milliliter (pCi/mL) of tritium. Soil samples that appeared to contain sufficient soil moisture were selected for tritium analysis.

The procedure for measuring tritium in urine samples is included in Appendix A. A review of this procedure reveals two potential problems:

- the quench curves used for urine may not be applicable to environmental (soil) samples, and
- if the soil moisture was distilled using a typical open system, the samples would have been prone to cross-contamination, which would have resulted in reduction or elimination of any quality control measures.

2.2. SUMMARY OF MEMORANDA DOCUMENTING FIELD ACTIVITIES

The memoranda prepared by Mound Plant concerning the Site Survey Project field activities and sample analyses are presented in Appendix A of this report. These memorandums include the following:

- a description of the surface sampling procedure (memo from B. Leahy to R. Stought of Mound Plant);

- a statistical evaluation of the Site Survey Project sampling strategy (memo from B.Leahy to R. Stought of Mound Plant);

- Mound Plant procedures for the radiochemical analysis of plutonium in soil samples, the radiochemical analysis of thorium in solid environmental soil samples (also includes uranium and lead-210), gamma spectroscopy, tritium in urine using liquid scintillation, and the procedure for screening soil samples for plutonium and thorium using a Bicron® FIDLER detector.

- LDLs for plutonium-238 and thorium, as determined by radiochemical procedures (memos from Bishop to Stought of Mound Plant);

- comparison of thorium concentrations, as determined by gamma spectroscopy and radiochemical procedures (memo from Bishop and Casella to Stought of Mound Plant);

- a description of the Mound Plant screening facility and the development of the FIDLER system for screening soil samples for plutonium and thorium; and

- a memo discussing the estimated error of the Mound Plant FIDLER system (memo from Casella and Bishop to Stought of Mound Plant).

2.3. EVALUATION OF SAMPLING AND ANALYSIS PROTOCOLS

Appendix D presents the results of the quality assurance/quality control evaluation associated with the Site Survey Project. Included are the 1984 results for Mound Plant from the DOE quality control program. This program includes the analysis of spiked samples containing known concentrations, which are distributed to participating laboratories from the Environmental Measurements Laboratory. The 1984 results demonstrated that the Mound Plant laboratories that analyzed the Site Survey Project samples were within 9 percent of the true values for plutonium-238 analysis. The DOE program considered this acceptable.

In addition to participation in the DOE quality control program, the Site Survey Project also included the reanalysis of samples by two independent, subcontracted laboratories, Accu-Labs Research, Inc., and EAL Corporation, in order to verify the accuracy of the Mound Plant sample results. Ten percent of the soil samples collected were reanalyzed by Accu-Labs Research, Inc. Of these 10 percent, approximately one percent were also reanalyzed by the EAL Corporation. The sample results from Accu-Labs Research, Inc., and EAL Corporation are presented in Appendix D and are discussed in the following section.

The purpose of this section is to evaluate sampling and analysis protocols in order to support a qualitative classification of the data quality that can serve as the basis for decisions about the future data usage.

2.3.1. Quality Assurance/Quality Control Data

Radiological sampling for RI/FS purposes should, at a minimum, consist of several types of laboratory and field quality assurance/quality control samples, including the following:

- field duplicates to evaluate the variation within a specific sample matrix;
- reagent blanks to determine the background of the reagents used in the laboratory;
- method blanks to determine interference introduced by reagents;
- blind repeats and laboratory duplicates to evaluate laboratory reproducibility and assess total error;
- laboratory spikes (matrix spikes) to determine laboratory accuracy; and
- standard reference samples/materials prepared by an external agency to determine laboratory accuracy.

For the above sample types, it is generally recommended that a collection or preparation rate of about 1 for every 20 (5 percent) samples collected during an RI/FS be used. Additional quality control is obtained by using a confidence level of at least 95 percent and an (attempted) precision of ±20 percent (EPA 1984).

It appears that these sample types were not prepared by either the field team or the laboratory during the Site Survey Project. However, the accuracy of the Mound Plant laboratory was evaluated by participation in the DOE quality control program, which involves the analysis of spike samples from the Environmental Measurements Laboratory. The DOE considered Mound Plant's results for this program to be satisfactory during the period when the Site Survey Project samples were analyzed.

Additional quality assurance/quality control information was obtained during the Site Survey Project when samples were split and verification samples sent to two outside laboratories, Accu-Labs Research, Inc., and EAL Corporation. Approximately 7 percent, slightly less than the 10 percent reported in the original report, of the samples collected (surface and subsurface) were also analyzed by Accu-Labs Research, Inc., and approximately 4 percent of those (or 0.4 percent of the total) were split again with EAL Corporation. The verification samples only included the analysis of plutonium and

thorium; no split samples were analyzed by gamma spectroscopy or for tritium. The original data from the verification laboratories are included in Appendix D.

The splitting of samples can serve several purposes, depending on when and where in the sampling process the sample was split. If a sample is split in the field, the resulting splits can provide information concerning the field handling and sample variation. If the sample is split after removal from the field environment, such as in the Mound Plant laboratory or field screening facility, the resulting splits only provide information concerning sample variation (EPA 1984). Based on the information received from Mound Plant personnel during the preparation of this report, it appears that the Site Survey Project samples were split at the Soil Screening Facility, after the field team brought the samples in from the sampling locations. Therefore, this information will only be used to evaluate sample variation. This was accomplished by calculating the relative percent differences (RPD) between the Monsanto Research Corporation (MRC) data and the corresponding sample results from the other laboratories.

$$RPD(\%) = \frac{S-D}{(S + D)/2} \times 100,$$

where S = the original (MRC) sample result, and
D = the duplicate sample result, from Accu-Labs Research, Inc., or EAL Corporation.

Table II.1 presents the results of these calculations. The RPDs ranged from 0 to almost 200 percent, illustrating a large amount of sample variation present. The average RPD for thorium results from Mound Plant and Accu-Labs Research, Inc., is 42 percent. The average RPD for thorium results from Mound Plant and EAL Corporation is 47 percent, although only two samples were analyzed for thorium by EAL. The average RPD for plutonium-238 results from Mound Plant and Accu-Labs Research, Inc., is 46 percent. The average RPD for plutonium-238 results from Mound Plant and EAL Corporation is 54 percent.

These high RPDs may be due to the chemical behavior of plutonium and thorium in the Mound Plant environs. Past studies have shown that, because of the cation-exchange capacity of the clays present in the soils at Mound Plant, plutonium-238, with a 4+ valence, readily sorbs onto the clay particles (Rodgers 1975). Thorium, which is also an actinide and has positively charged isotopes, may be expected to behave in a similar fashion. This sorption can result in isolated hot spots within a single sample, especially if the sample was obtained from a location or strata that was not homogeneous, as is the case with soils. Because of this, a high RPD among soil contaminants is not unusual and laboratory accuracy is most appropriately measured using standards, not split soil samples. The variation, or RPD, for samples containing radionuclides other than plutonium-238 and thorium could not be evaluated because the split samples were not analyzed for additional radionuclides.

Table II.1. Verification Samples

MRC ID	Analyte[a]	MRC value[b]	Accu-lab[b]	RPD(%)	EAL	RPD(%)[c]
1710	Plutonium-238	0.18	0.14	25		
1718	Plutonium-238	0.12	0.16	29		
1726	Plutonium-238	0.16	0.24	40		
2954	Plutonium-238	0.26	0.94	113		
	Thorium	5.44	5.3	3		
2956	Plutonium-238	0.59	0.33	57		
2965	Plutonium-238	3.47	2.5	32		
2969	Plutonium-238	0.45	0.27	50		
4063	Plutonium-238	1.07	0.66	47		
3027	Plutonium-238	2.57	0.73	112		
4087	Plutonium-238	1.23	0.89	32		
6199	Plutonium-238	0.41	0.46	11		
4077	Plutonium-238	0.26	0.22	17		
6177	Plutonium-238	0.18	0.15	18		
3048	Plutonium-238	0.06	0.02	100		
3095	Plutonium-238	0.27	0.18	40		
6211	Plutonium-238	0.22	1.2	138		
4081	Plutonium-238	0.17	0.13	27		
6188	Plutonium-238	0.96	1.2	22		
4003	Plutonium-238	1.05	0.62	51		
3085	Plutonium-238	61	73	18		
2979	Plutonium-238	1.34	1	29		
2867	Plutonium-238	10.35	12	15		

[a]When Accu-labs or EAL reported isotopic thorium results, the individual values were added so as to be comparable to Mound Plant's total thorium results.
[b]All values in pCi/g
[c]RPD - Relative percent difference
[d]Two samples (both from core location C0045) were assigned to this MRC ID. Therefore, the verification sample data appear invalid.
MRC ID - Monsanto Research Corporation identification
NR - No result given
NA - Not applicable

Table II.1. (page 2 of 7)

MRC ID	Analyte[a]	MRC value[b]	Accu-lab[b]	RPD(%)	EAL	RPD(%)[c]
6497	Plutonium-238	9	10	11		
	Thorium	3.73	6	47		
2862	Plutonium-238	0.05	0.11	75		
6359	Plutonium-238	3.6	3.5	3		
1738	Plutonium-238	0.03	0.07	80		
	Thorium	27.83	35.3	24		
1784	Plutonium-238	8.97	11	20		
	Thorium	37.69	49.5	27		
1747	Plutonium-238	0.15	0.26	54		
1757	Plutonium-238	0.06	0.1	50		
	Thorium	2.05	2.29	11		
1793	Plutonium-238	0.51	0.46	10		
5976	Plutonium-238	0.83	0.82	1		
	Thorium	4.03	3.9	3		
4091	Plutonium-238	7.4	7.4	0		
1831	Plutonium-238	0.12	0.1	18		
1815	Plutonium-238	0.37	0.35	6		
	Thorium	4.84	3.75	25		
1870	Plutonium-238	0.2	0.21	5		
	Thorium	6.94	7.51	8		
5984	Plutonium-238	1.56	1.1	35		
	Thorium	16.59	14.6	13		
1816	Plutonium-238	0.3	0.18	50		
	Thorium	4.02	4.9	20		
6508	Plutonium-238	1.7	2.1	21		
2817	Plutonium-238	6.28	6.7	6		
	Thorium	28.73	24.2	17		
1251	Plutonium-238	0.29	0.22	27		
	Thorium	29.45	35.2	18		
5988	Plutonium-238	0.45	1.4	102		
	Thorium	3.64	3.24	12		
1260	Plutonium-238	4.83	1.4	110		
	Thorium	32.2	31.62	2		
1244	Plutonium-238	0.84	0.78	7		
	Thorium	36.16	27.9	26		
1977	Plutonium-238	0.59	0.8	30		
	Thorium	5.62	5.7	3		

Table II.1. (page 3 of 7)

MRC ID	Analyte[a]	MRC value[b]	Accu-lab[b]	RPD(%)	EAL	RPD(%)[c]
1317	Plutonium-238	0.2	0.13	42		
6552	Plutonium-238	0.58	0.45	25		
1226	Plutonium-238	34.5	0.71	192		
	Thorium	2.53	3.05	19		
3064	Plutonium-238	0.08	0.04	67		
6229	Plutonium-238	0.15	0.02	153		
6263	Plutonium-238	0.76	1.1	37		
3077	Plutonium-238	0.19	3.8	181		
2873	Plutonium-238	1.9	2	5		
	Thorium	4.02	4.12	2		
5868	Plutonium-238	1.21	1.6	28		
4111	Plutonium-238	0.2	0.14	35		
1960	Plutonium-238	15.41	0.33	192		
1944	Plutonium-238	100.1	82	20		
1917	Plutonium-238	0.08	0.44	138		
	Thorium	3.36	2.06	48		
1951	Plutonium-238	355	220	47		
1957	Plutonium-238	4.95	3.4	37		
6699	Plutonium-238	1.62	1.9	16		
1604	Plutonium-238	7.49	5.8	25		
2919	Plutonium-238	0.04	0.05	22		
5882	Plutonium-238	2.83	1.7	50		
2689	Plutonium-238	7.28	9.2	23		
5891	Plutonium-238	0.59	1.2	68		
1621	Plutonium-238	0.07	0.08	13		
1638	Plutonium-238	0.16	0.07	78		
2577	Plutonium-238	0.06	0.03	67		
6459	Plutonium-238	0.3	0.28	7		
6468	Plutonium-238	0.11	0.15	31		
2879	Plutonium-238	1.05	1.8	53		
1325	Plutonium-238	9.98	15	40		
1361	Plutonium-238	0.13	0.58	127		
	Thorium	3.25	4.63	35		
4007	Plutonium-238	9	6	40		
2931	Plutonium-238	0.42	0.25	51		
	Thorium	2.48	0.01	198		
1320	Plutonium-238	79	79	0		

Table II.1. (page 4 of 7)

MRC ID	Analyte[a]	MRC value[b]	Accu-lab[b]	RPD(%)	EAL	RPD(%)[c]
1216	Plutonium-238	0.06	0.5	157		
1338	Plutonium-238	1.25	0.83	40		
	Thorium	9.99	8.4	17		
6785	Plutonium-238	12.1	12	1		
	Thorium	4.24	10.9	88		
1539	Plutonium-238	24	17	34		
1541	Plutonium-238	17.1	14	20		
1511	Plutonium-238	32.9	17	64		
1521	Plutonium-238	5.66	6	6		
	Thorium	2.16	1.82	17		
1285	Plutonium-238	4.78	710	197		
	Thorium	2.38	18.4	154		
1550	Plutonium-238	5.96	7.2	19		
	Thorium	5.65	5.48	3		
1356	Plutonium-238	76.1	100	27		
	Thorium	2.12	1.45	38		
1172	Plutonium-238	0.12	0.19	45		
1565	Plutonium-238	1.29	1	25		
1572	Plutonium-238	71.3	75	5		
	Thorium	2.03	3.76	60		
1592	Plutonium-238	0.67	0.83	21		
	Thorium	2.26	4.42	65		
4123	Plutonium-238	3.15	3.2	2		
2923	Plutonium-238	47.45	63	28		
2446	Plutonium-238	0.66	0.68	3		
	Thorium	30.42	25.4	18		
2829	Plutonium-238	8.56	5.6	42		
	Thorium	2.37	3.09	26		
2466	Plutonium-238	0.92	1.1	18		
2469	Plutonium-238	0.54	0.45	18		
	Thorium	7.11	5.57	24		
5832	Plutonium-238	0.37	0.35	6		
4037	Plutonium-238	0.96	0.81	17		
5909	Plutonium-238	0.48	0.75	44		
5856	Plutonium-238	7.84	8.5	8		
	Thorium	25.25	7.2	111		

Table II.1. (page 5 of 7)

MRC ID	Analyte[a]	MRC value[b]	Accu-lab[b]	RPD(%)	EAL	RPD(%)[c]
5858	Plutonium-238	88.4	110	22		
	Thorium	4.03	24.7	144		
2999	Plutonium-238	1.12	0.87	25		
2887	Plutonium-238	1.67	0.73	78		
4146	Plutonium-238	0.4	2	133		
4042	Plutonium-238	2.74	2.7	1		
2587	Plutonium-238	0.1	0.36	113		
6474	Plutonium-238	0.38	0.54	35		
5933	Plutonium-238	0.07	0.17	83		
4141	Plutonium-238	2.48	0.55	127		
2936	Plutonium-238	0.04	0.14	111		
5862	Plutonium-238	97.5	160	49		
	Thorium	13.69	22.3	48		
4025	Plutonium-238	4.32	3.3	27		
1648	Plutonium-238	2.25	1.8	22		
2591	Plutonium-238	0.02	0.06	100		
1663	Plutonium-238	0.18	0.03	143		
6384	Plutonium-238	4.68	4.5	4		
1696	Plutonium-238	0.01	0.04	120		
	Thorium	3.31	NR	NA		
1699	Plutonium-238	0.01	0.13	171		
2600	Plutonium-238	0.73	0.87	18		
6393	Plutonium-238	0.17	0.2	16		
	Thorium	2.46	2.91	17		
4050	Plutonium-238	2.03	1.7	18		
4114	Plutonium-238	5.97	5.9	1		
2889	Plutonium-238	2.23	2.4	7		
2893	Plutonium-238	0.75	0.72	4		
2891	Plutonium-238	1.23	2.5	68	1.16	6
2604	Plutonium-238	1.74	0.94	60	1.01	53
2949	Plutonium-238	0.76	0.81	6		
2950	Plutonium-238	0.39	0.58	39		
2948	Plutonium-238	1.78	0.95	61	0.929	63
2621	Plutonium-238	0.44	0.31	35		
1271	Plutonium-238	0.01	0.49	192	0.167	177
1292	Plutonium-238	186	210	12	147	23
	Thorium	36.87	247	148	52.17	36

Table II.1. (page 6 of 7)

MRC ID	Analyte[a]	MRC value[b]	Accu-lab[b]	RPD(%)	EAL	RPD(%)[c]
1275	Plutonium-238	2.72	3.6	28	2.63	3
	Thorium	13.13	38.9	99	24.02	59
1545	Plutonium-238	0.25	0.16	44		
1184	Plutonium-238	0.02	0.19	162		
8286	Plutonium-238	25	22	13		
2460	Plutonium-238	0.07	0.06	15		
2836	Plutonium-238	1.72	1.9	9		
3002	Plutonium-238	0.62	2.2	112		
1665	Plutonium-238	0.31	0.07	126		
2661	Plutonium-238	0.93	0.91	2		
2715	Plutonium-238	0.01	0	200		
2692	Plutonium-238	0.07	0.5	151		
2734	Plutonium-238	0.01	0.02	67		
2726	Plutonium-238	0.07	0.17	83		
2752	Plutonium-238	0.01	0.02	67		
2712	Plutonium-238	0.12	0.16	29		
2501	Plutonium-238	0.02	0.08	120		
4057	Plutonium-238	0.19	2.2	168		
3057	Plutonium-238	0.06	0.02	100		
4070	Plutonium-238	0.04	0.14	111		
8352	Plutonium-238	0.39	0.49	23		
	Thorium	41.63	15.2	93		
8353	Plutonium-238	0.08	0.07	13		
	Thorium	5.14	6.9	29		
4088	Plutonium-238	4.68	5.5	16		
1880	Plutonium-238	0.1	0.14	33		
8349	Plutonium-238	0.11	0.13	17		
	Thorium	42.38	32.6	26		
8414	Plutonium-238	0.97	2.6	91		
	Thorium	20.17	16.4	21		
8350[d]	Plutonium-238	4.66	8.8	62		
	Thorium	142.58	194	31		
8383	Plutonium-238	4.94	5.8	16		
1612	Plutonium-238	1.46	0.06	184		
2990	Plutonium-238	0.13	0.02	147		
1290	Plutonium-238	39	41	5		
5871	Plutonium-238	0.65	0.8	21		

Table II.1. (page 7 of 7)

MRC ID	Analyte[a]	MRC value[b]	Accu-lab[b]	RPD(%)	EAL	RPD(%)[c]
1624	Plutonium-238	0.26	0.46	56		
	Thorium	3.95	4.2	6		
1273	Plutonium-238	2.41	2.4	0		
6488	Plutonium-238	0.02	0.05	86		
2704	Plutonium-238	0.06	0.15	86		
2748	Plutonium-238	0.22	0.22	0		
2667	Plutonium-238	0.62	0.75	19		

2.3.2. Incomplete Data

During the examination of the Site Survey Project data for this report, it was noted that some data appear to be incomplete because

- sample results are available, but no location coordinates or depths are given; or
- the gamma spectroscopy results from Mound Plant (Appendix E) contain samples with MRC identifiers (IDs) that are not given in the tabulated Site Survey Project data package obtained from Mound Plant, and for which no coordinates or depths are available.

Table II.2 lists the data that appear to be incomplete. It is possible that the gamma spectroscopy data not included in the data package did not correspond to samples taken as part of the Site Survey Project, but were for samples taken at Mound Plant for other purposes. Incomplete data may generally not be considered valid.

2.3.2.1. Sample Collection and Handling

In general, the documentation of the sample collection procedures for the Site Survey Project samples is inadequate. Many of the problems can be attributed to the lack of a sampling plan containing procedures, describing sampling locations, and describing methods of documenting the sampling procedures, such as sample labels. Specific problems are noted below.

2.3.2.2. Surface Soil Sampling

After surface soil sampling was partially completed, Mound Plant addressed the statistical basis for the sampling strategy (5 samples per grid block). The technical memorandum discussing the statistical basis for this sampling is provided in Appendix A (Stought 1984). Mound Plant concluded that obtaining five random surface samples in a 300-ft by 380-ft area would have resulted in a probability of 0.0174 for sampling a single contaminated area 20 ft by 20 ft and a probability of 0.251 for sampling an area 80 ft by 80 ft (Table II.3). However, the surface locations were chosen arbitrarily by the field team and probably should not be considered random.

2.3.2.3. Decontamination of Sampling Equipment

During the Site Survey Project sampling, removable radioactivity contamination was removed from the sampling tools by Mound Plant personnel wearing gloves to brush out the excess soil. Removal of the radioactivity contamination was then confirmed by screening the gloves using an alpha scintillometer.

Table II.2. Incomplete Data

MRC ID No.	Plutonium-238 (pCi/g)	Thorium[a] (pCi/g)	Tritium (pCi/mL)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
Data listed on the Mound Plant gamma spectroscopy results							
1996	4.74	0.596[b]		LDL	0.9	0.9	LDL
2157				LDL	LDL	0.9	LDL
2201				LDL	LDL	0.8	LDL
2203				LDL	LDL	0.9	LDL
2204				LDL	LDL	1.4	LDL
2205				LDL	LDL	0.5	LDL
2206				LDL	LDL	0.9	LDL
2208				LDL	LDL	0.7	LDL
2223	19.9[b]	1.0[b]		LDL	LDL	0.7	LDL
2240	1.15	0.9[b]		LDL	LDL	0.9	LDL
2652	134.3[b]	1.1[b]		LDL	LDL	0.6	LDL
4892	1.97	29.7[b]		LDL	LDL	1.2	LDL
(The gamma spectroscopy results also showed 33 pCi/g of thorium-228 in this sample.)							
5551	4.25	0.7[b]		LDL	LDL	0.9	LDL
5912	1.47	1.2[b]		LDL	LDL	1.1	LDL
5914	1.67	1.5[b]		LDL	0.9	1.1	LDL
5918	1.64	1.5[b]		LDL	0.9	1.4	LDL
5941	3.54	80.11		LDL	LDL	6	LDL
(This sample also contained 13.4 pCi/g of uranium-238 and 41 pCi/g of thorium-228.)							

[a]Thorium results are listed as total thorium unless otherwise indicated.

[b]Results given are from the FIDLER screening of samples, not from radiochemical analysis.

FIDLER - field instrument for the detection of low-energy radiation.

LDL - The sample result was below the lower detection limit, estimated to be 0.5 pCi/g for cobalt-60, americium-241, and cesium-137. The LDL for radium-226 was estimated to be 1.0 pCi/g.

MRC ID - Monsanto Research Corporation identification.

pCi/g - picocuries per gram.

Table II.2. (page 2 of 4)

MRC ID No.	Plutonium-238 (pCi/g)	Thorium[a] (pCi/g)	Tritium (pCi/mL)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
6040	0.1	1.5[b]		LDL	LDL	0.9	LDL
6103	1.34	28.15		LDL	LDL	0.9	LDL
(This sample also contained 11 pCi/g of thorium-228.)							
6139	1.86	1.1[b]		LDL	LDL	0.8	LDL
6511	0.60	2.2[b]		LDL	LDL	1.0	LDL
6546	0.88	4.7[b]		LDL	LDL	1.0	LDL
(This sample also contained 5 pCi/g of thorium-228.)							
6614	1.47	18.9[b]		LDL	LDL	0.9	LDL
(This sample also contained 23 pCi/g of thorium-228.)							
6684	1.62	1.8[b]		LDL	LDL	0.8	LDL
6690	0.30	2.0[b]		LDL	0.6	1.2	LDL
6692	0.71	1.6[b]		LDL	0.8	1.0	LDL
6693	3.56	1.4[b]		LDL	1.7	1.0	LDL
6748	0.20	1.2[b]		LDL	LDL	0.8	LDL
7199	0.06	2.0[b]		LDL	LDL	1.4	LDL
7878	0.09	2.2[b]		LDL	0.8	1.2	LDL
7887	0.09	2.0[b]		LDL	0.6	1.0	LDL
8436	0.14	<2[b]		LDL	LDL	1.1	LDL
8440	0.15	<2[b]		LDL	LDL	1.4	LDL
8441	0.01	<2[b]		LDL	LDL	0.7	LDL
8442	0.06	<2[b]		LDL	LDL	0.6	LDL
10598				LDL	LDL	0.5	LDL
10599				LDL	LDL	0.6	LDL
10658				LDL	LDL	1.2	LDL
10684				LDL	LDL	0.7	LDL
10685				LDL	LDL	0.5	LDL

Table II.2. (page 3 of 4)

MRC ID No.	Plutonium-238 (pCi/g)	Thorium[a] (pCi/g)	Tritium (pCi/mL)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
10686				LDL	LDL	0.3	LDL
10687				LDL	LDL	0.7	LDL
10771				LDL	LDL	0.5	LDL
10773				LDL	LDL	0.4	LDL
10774				LDL	LDL	0.7	LDL
10776				LDL	LDL	0.8	LDL
10780				LDL	LDL	1.3	LDL
10784				LDL	LDL	0.7	LDL
10785				LDL	LDL	0.7	LDL
10795				LDL	LDL	0.7	LDL
10797				LDL	LDL	0.7	LDL
10803				LDL	LDL	0.8	LDL
10814				LDL	LDL	0.2	LDL
1001	20.0[b]	1.1[b]					
1006	1.44	0.5[b]					
1015	40.6	0.88					
1026	404.3	2.57					
1034	29.5	0.5[b]					
1265	0.04	0.22[b]					
1267	0.44	<0.01					
1269	0.03	<0.01					
1283	1.78	3.01					
1305	0.18	0.21[b]					
1342	11.80	2.87					

Table II.2. (page 4 of 4)

MRC ID No.	Plutonium-238 (pCi/g)	Thorium[a] (pCi/g)	Tritium (pCi/mL)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
1344	0.48	0.16[b]					
1764	0.39	0.51[b]					
1772	0.2	1.92					
1781	1.29	10.11					
1852	1.04	0.4[b]					
1860[b]	5.00[b]	0.5[b]					
2610	0.61	0.60[b]					
2613	8.40	4.37[b]					
2615	0.46	<2[b]					
2616	0.75	<2[b]					
2619	0.58	<2[b]					
2945	0.71	<2[b]					
2980	52.90	1.4[b]					
3035	0.04	1.0[b]					
4513	0.14	3.0[b]					
4516	0.05	<2[b]					
4523	2.48	<2[b]					
5820	0.80	1.5[b]					
6139	1.86	1.1[b]					
4032	0.08	0.3[b]					
6275	3.62	0.8[b]					
6283	0.13	0.8[b]					
6376	109.7	4.15					
6686	17.46	5.61					
6693	3.56	<2[b]					

Table II.3. Surface Sampling Probabilities

Contaminated Area (ft)	Probability of Sampling 1 Hot Spot with 5 Samples	P_{50}[a] Sample Size
10 x 10	0.0044	790
20 x 20	0.0174	197
40 x 40	0.0681	48
80 x 80	0.251	12

Reference: Stought et al. 1988.
[a]P_{50} values are the number of samples necessary to achieve a 50 percent probability of detecting a hot spot of the given size in a 380-ft by 300-ft grid.

This method is inadequate for decontamination and may have resulted in significant cross-contamination, considering the probable detection capabilities of the field screening. This cross-contamination probably resulted in substantial blurring of the variation between samples at each area.

2.3.2.4. Sample Handling and Documentation

It appears that chain-of-custody forms were not completed when samples were transferred from the field site to either the onsite analytical laboratories or to the offsite verification laboratories. In addition, other than a short memo (Stought 1984) describing the placement of surface samples in an EPA sample dish and the grinding of samples, there are no procedures available that describe how the samples were containerized, labeled, or logged at the onsite laboratory.

Because there are several samples with the same MRC ID, it is evident that errors in assigning sample numbers occurred. Other errors noted in the data include different sets of sample results with the same coordinates.

The memorandum describing surface sampling also stated that non-soil matter, such as rocks and twigs, was removed from the sample dish (Stought 1984). This was probably performed to remove items that would interfere with the sample preparation/grinding procedure. However, the EPA recommends that non-soil items be either retained in the sample, or collected in a separate sample for analysis (EPA 1984). The non-soil portions must also be considered as part of the site under investigation, and eliminating this portion may result in the loss of information.

2.3.2.5. Sampling Locations and Depth of Core Locations

As discussed below, the south and west coordinates of the surface locations shown on Plate 1 were estimated by the field team, based on the observed position relative to the grid block and known landmarks, such as buildings. Mound Plant has estimated that the resulting error in the coordinates of the surface locations is ±25 ft. However, the basis for this estimate is unknown, and it is possible that the error is much greater. The core locations were surveyed by a licensed surveyor.

With the exception of the drilling logs given in Appendix B, there is currently no documentation included in this report that discusses the strata observed during drilling, or whether bedrock was encountered at most of the drilling locations. Based on the depths to bedrock indicated by Mound Plant drawing #FSE16472, Mound Plant Site Plan Test Borings, reproduced in Site Scoping Report: Volume 2 Addendum (DOE 1992f), it appears that drilling/sampling at many of the core locations on

the Main and SM/PP hills may have reached bedrock. The majority of the locations in the valley area appear not to have reached bedrock.

2.3.3. Sample Analyses and Reporting

The original Site Survey Project Report (Stought, et al. 1988) stated that all samples collected were radiochemically analyzed for plutonium-238 and FIDLER screened for thorium. However, plutonium and thorium results are not reported for many of the samples, usually the samples that were analyzed by gamma spectroscopy. It is not known if the plutonium-238 and thorium analyses were not performed, or if they were performed and not reported. Although it was stated that gamma spectroscopy was performed if the activity screened exceeded the estimated amounts of plutonium and thorium, these initial results were not always available.

The evaluation of the Site Survey Project data for this report was not performed using the raw (laboratory) data. The data evaluated were already tabulated, and are reproduced in a similar fashion in Appendix E. The exceptions to this are the gamma spectroscopy data included at the end of Appendix E and the *in situ* gamma spectroscopy data given in Appendix C, which was performed at the locations given in Table II.4. These *in situ* data were checked against the tabulated data received, and any errors noted were corrected in the tabulated data. Not all of the results listed for the radionuclides analyzed by gamma spectroscopy, such as cobalt-60, cesium-137, radium-226, actinium-227, and americium-241, were included in the gamma spectroscopy printout in Appendix E. These data could not be verified and a note is included for the appropriate samples.

The estimated LDLs for the radionuclides detected are available, either from the original Site Survey Project Report, or from Mound Plant personnel, as follows:

- the LDL for tritium was approximately 1.0 pCi/mL of soil moisture, varying slightly depending on the amount of soil moisture present in the sample;
- the LDL for plutonium-238, using radiochemical analysis, was 0.01 pCi/g with a relative precision (2 standard deviations) of 25 percent;
- the LDLs and relative precisions (2 standard deviations) for the thorium isotopes were 0.3 pCi/g and 60 percent for thorium-228, 0.3 pCi/g and 30 percent for thorium-230, and 0.1 pCi/g and 70 percent for thorium-232 (however, thorium results were reported as total thorium, not isotopically);
- the LDLs for cobalt-60, cesium-137, and americium-241, using gamma spectroscopy, were 0.5 pCi/g (precisions for individual measurements are included in the gamma spectroscopy printout at the back of Appendix E); and
- the LDL for radium-226 and actinium-227 is estimated to be 1.0 pCi/g (Stought 1990).

Table II.4. In Situ Gamma Spectroscopy

Area	RMC Borehole Number	Coordinates Given by Mound or Drilling Logs South	West	Corresponding Plate 1 and Appendix E Location
Area 1	288	3777.2	3245.3	Core 0263
	289	3724.8	3254.3	Core 0264
	290	3752.4	3322.9	Core 0265
	291	3808.2	3328.7	Core 0266
	292	3670.8	3342.9	Core 0267
	293	3716.1	3400.6	Core 0268
	294	3751.3	3418.2	Core 0269
	295	3791.9	3441.5	Core 0270
	296	3865.9	3483.1	Core 0271
	297	3801.1	3524.0	Core 0272
	298	3682.1	3413.3	Core 0273
	299	3737.9	3478.5	Core 0274
	301	3648.1	3642.8	Core 0276
	302	3640.5	3587.2	Core 0277
	303	3628.3	3542.0	Core 0278
	304	3567.8	3565.3	Core 0279
	305	3705.2	3710.7	Core 0280
	306	3784.3	3591.4	Core 0281
	307	3679.3	3500.9	Core 0282
Area 8	318	2395.0	2063.6	Core 0030
	319	2371.9	2104.9	Core 0027
	320	2362.7	2142.4	Core 0026
	321	2374.1	2184.3	Core 0029
	322	2396.6	2204.7	Core 0031
	323	2405.8	2212.9	Core 0035
	324	2428.6	2178.0	Core 0037
	317	2411.5	2139.2	Core 0283
	326	2478.9	2212.0	Core 0285
	327	2464.1	2184.0	Core 0286
	328	2450.7	2151.6	Core 0287
	329	2438.6	2119.3	Core 0288
	330	2422.7	2081.0	Core 0289
	331	2401.5	2102.1	Core 0290
Area 12	286	2885.7	2498.9	Core 0145
	287	2915.3	2490.3	Core 0291
Locations not associated with a specific area	300	3529.9	3447.0	Core 0275
	325	2495.9	2236.2	Core 0284

RMC - Radiation Management Corporation (Appendix C)

2.3.4. Data Reporting Errors

Several errors have been noted in the tabulated Site Survey Project data (Appendix E). These include

- missing results, when coordinates and/or sample numbers were given, but no results;
- more than one set of sample results given for a set of coordinates;
- sample numbers (MRC IDs) assigned to more than one sample;
- incorrect sample dates (example: one sample date given was 08-74, when 07-84 was most likely the correct date); and
- incorrect sample depths (example, a depth of 81 inches was given for a sample when the correct depth was probably 18 inches).

The data were examined for these types of errors. When observed, a note was included below the sample result in both Appendix E and in the individual area tables throughout this report. Relatively few of these types of errors were found, considering the volume of data that was collected and the original purpose of the project.

3. POLONIUM PROCESSING AREAS

This section provides general descriptions of the scale and periods of operations of the polonium program at Mound Plant. Summaries are provided of the areas where process and TDS activities took place and whether environmental radiological data, through the Site Survey Project, are available. Additional information on the generation, treatment, and disposal activities is provided in Volume 7 - Waste Management (DOE 1992g).

3.1. PROGRAM SUMMARY

Polonium research and production activities were transferred from the Dayton units to Mound Plant in 1949 (DOE 1992c). The polonium was used in production of initiators for nuclear weapons and in neutron sources for research and industrial use. In 1954, research was expanded to include the applicability of converting nuclear energy from polonium-210 to electric power. In the same year, a polonium-powered, steam-to-electric plant was built, followed in 1958 by an RTG powered by polonium. Several polonium-powered RTG units were built for use in early space craft, but the short half-life of polonium limited the use of this substance in space technology applications. Polonium production declined in the 1960s until it was phased out entirely in 1971.

Polonium-210 was the isotope of choice. Some limited research was performed on other isotopes, but little material was actually produced. Polonium-210 was produced by neutron bombardment of stable bismuth-209 in reactors at Hanford. The irradiation resulted in bismuth-210 that decayed to polonium-210 over a 5.4 day half-life. The half-life of the resulting polonium-210 is 138 days. The bismuth slugs were sheathed in aluminum jackets or cans to prevent the slugs from breaking apart during irradiation. From the reactor, irradiated bismuth slugs were shipped to Mound Plant in lead casks by railroad. The casks were unloaded by crane along the railroad siding and moved to T Building for processing (Figure 3.1).

Trace metal impurities in the bismuth slugs and aluminum cans produced several radioactive by-products during the irradiation, including isotopes of iron, manganese, copper, lead, tin, zinc, silicon, titanium, nickel, cobalt, magnesium, chromium, vanadium, bismuth, and gallium in the aluminum, and silver, arsenic, calcium, cadmium, iron, magnesium, tellurium, selenium, and antimony in the bismuth. The most important of these impurities were silver 110 (half-life of 270 days), cobalt 60 (half-life of 5.3 years), iron 59 (half-life 45 days), selenium 75 (half-life 127 days), tellurium 125, 127, and 129 (half-life 30 to 90 days) and antimony 124 (half-life 60 days). Cobalt-60 is the only isotope that can be expected to still be present.

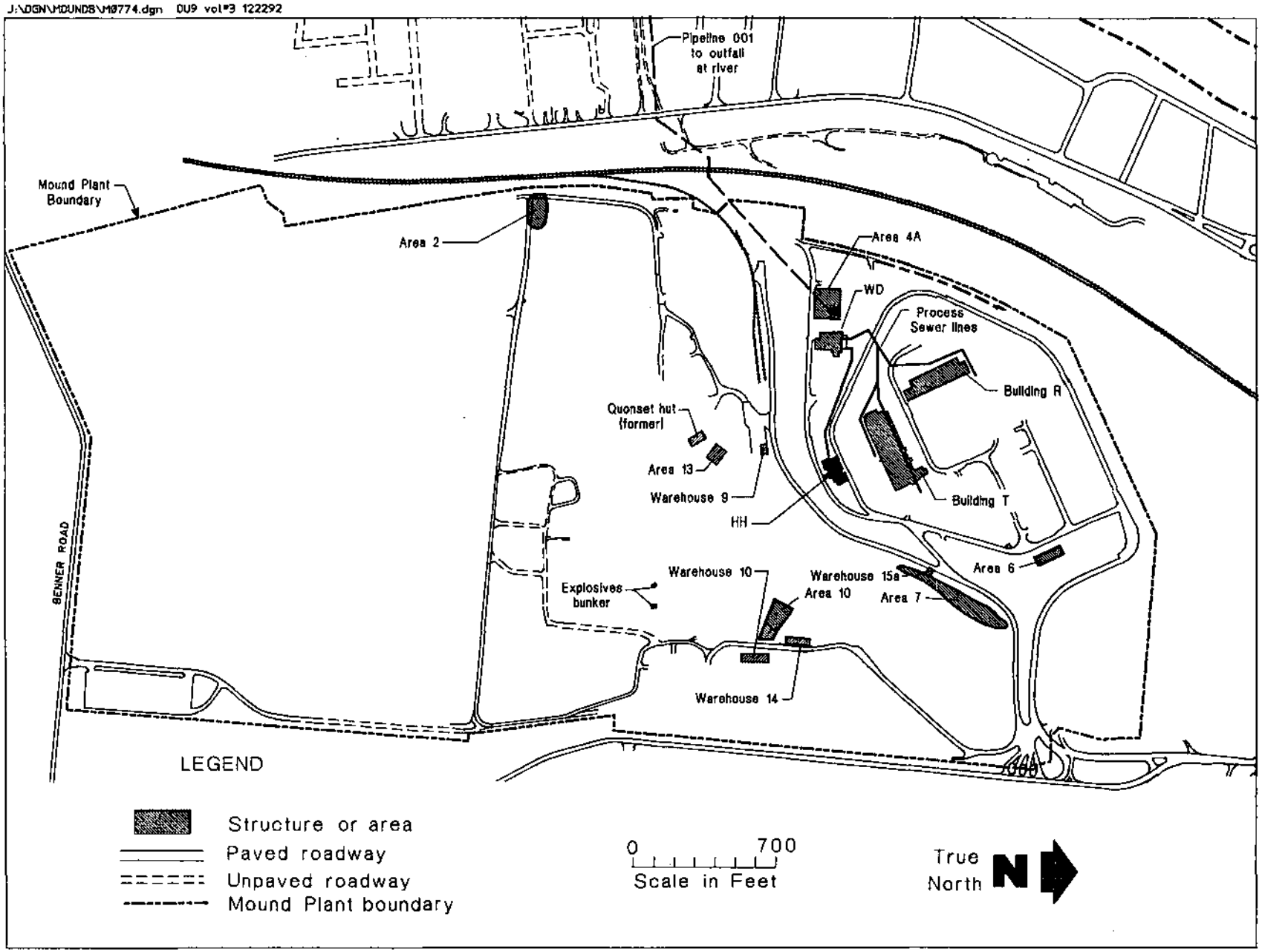


Figure 3.1. Polonium processing areas.

Most of the initial efforts at Mound Plant were in support of the polonium program. Research and development of polonium took place in R Building. Biological studies were conducted in B Building until 1954 when it was converted to other uses. The processing of the bismuth slugs and separation and purification of polonium occurred in T Building. Aqueous wastes containing polonium from these buildings were transferred by underground sewer lines to the treatment facility in WD Building. Wastes produced by the acid dissolution of the aluminum cans was transferred to HH Building. Wastewater from HH Building was also transferred to WD Building for final treatment.

As with other buildings and paved areas of the plant, none of the processing facilities themselves were directly investigated during the Site Survey Project.

The treatment facilities comprised integral parts of the polonium program. After removal of the polonium from the bismuth, the resulting bismuth chloride was either stored for the recovery of bismuth or shipped offsite for disposal. Until 1953, all the bismuth was stored in the old quonset hut in the plant valley for recovery. The plans for bismuth recovery were cancelled and the bismuth sludge that had accumulated was shipped offsite for burial. Thereafter, sludge that was produced was temporarily staged in T Building and shipped offsite weekly. The aluminum decanning and bismuth chloride solutions were transferred from T to HH Building via suspended Pyrex waste lines. In HH Building, the solutions were neutralized and drummed. Supernatant waters from the neutralizations were pumped from a holding sump to WD Building through a 3-inch, underground steel pipe. In the WD Building, aqueous wastes with polonium contamination were treated to produce a concentrated sludge that was drummed and dilute wastewater that was released through a closed pipe to the Great Miami river. In 1959 the waste treatment operations in HH Building were moved to the T Building. In 1971, the polonium wastewater treatment facilities in WD Building were converted to the treatment of plutonium-238.

The treatment facilities themselves were not included in the Site Survey Project, although adjacent and associated areas were investigated. Areas 4 and 4a include the soil areas surrounding the WD Building, influent tanks, and the old sewage disposal plant adjacent to the WD Building. Areas 5 and 20 include the pipelines from T and HH Buildings to WD Building, respectively. No data appears to exist for soils at or beneath the treatment facilities at either T or HH Building.

Several old warehouses and areas were used at different times for storage of polonium-contaminated wastes and materials. The storage facilities can easily be divided into those where contaminated equipment was stored and those in which waste products were stored. Several old warehouses that had remained from the plant construction were used during the early 1950s to store polonium contaminated equipment from the Dayton units. Locations where contaminated equipment was stored

include Warehouses 10 and 14, on the SM/PP Hill and Warehouse 9 on the railroad spur. In the plant valley, a number of temporary tents or shacks were erected to store debris or other contaminated materials. In 1955 and 1956, most of the polonium contamination had decayed. The flooring in Warehouse 10 was burned in place. In the plant valley, Warehouse 9, the temporary shacks and the flooring from Dayton Unit IV were also burned in place (DOE 1992g).

Wastes from the polonium production activities were stored in old warehouses or other areas that generally do not currently exist. The bismuth chloride sludge from the polonium separations were stored in the old quonset hut in the plant valley. In 1963, the quonset hut was moved to its present location as Building 19. The former location was adjacent to the temporary shacks in the plant valley. The decanning solution sludges were staged at either the old explosives bunker or T Building before shipment offsite. The latter contained high gamma radiation levels and were generally isolated for worker protection. Wastes destined for offsite burial were staged at old Warehouse 9 until 1954, Warehouse 15a until 1965, and finally Building 23 until the program terminated. When the polonium waste treatment equipment was removed from HH Building in 1959, it was stored in an open area south of the former location of the quonset hut in the plant valley. This areas has been called the lower storage area and is described in the companion reactor waste decontamination program section of this report.

3.2. AREA 2

Area 2, located along the west-central border of Mound Plant, forms the southern part of the historic landfill. Area 2 is the location of several disposal trenches for the remains of the polonium-210 contaminated debris from a 1955 fire in Area 13, thousands of empty crushed thorium drums in the late 1950s to early 1960s, and polonium-210-contaminated sand from the WD Building in 1963 (DOE 1991a). Additional discussions of Area 2 are provided in subsection 5.3.

Sampling for the Site Survey Project focused on plutonium-238 and thorium. No plutonium-238 concentrations in excess of 25 pCi/g were detected in any of the samples collected during the Site Survey Project. The maximum concentration was 17.1 pCi/g. This concentration was detected in a sample collected from core location 0189 at a depth of 18 inches (C0189 on Table III.1 and core location 0189 on Plate 1). The maximum thorium concentration detected, 3.31 pCi/g, was found in a sample collected from core location C0191 at a depth of 108 inches (Table III.1). The evaluation of data for this report indicates that the interpretations of data made in the project report (Stought et al. 1988) are correct. Insufficient data exist to fully evaluate the thorium concentrations depicted on Plate 5. The closed plutonium contour depicted on Plate 4 is probably an artifact of a single elevated data point. Insufficient data exists to evaluate the presence of cobalt-60 in Area 2. Only two surface samples (S0880 and S0881l Table III.1) were analyzed. No subsurface data are known.

Table III.1. Mound Site Survey Project - Area 2

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)
C0189	3050	4780	1541	04-83	18	17.10	b
			1542	04-83	36	1.79	b
			1543	04-83	54	0.96	b
			1544	04-83	72	0.73	b
			1545	04-83	90	0.19	b
			1546	04-83	108	0.25	b
			1547	04-83	126	0.28	b
			1548	04-83	144	0.15	b
			1549	04-83	162	0.08	b
C0191	3100	4675	1691	04-83	18	0.08	b
			1692	04-83	36	0.12	b
			1693	04-83	54	0.16	b
			1694	04-83	72	0.02	b
			1695	04-83	90	0.01	b
			1696	04-83	108	0.01	3.31
			1697	04-83	126	0.01	b
			1698	04-83	144	0.01	b
			1699	04-83	162	0.01	b
			1700	04-83	180	0.39	b
S0876	3030	4780	6376	08-84	0	0.21	b
S0879	3060	4795	2599	10-83	0	0.84	b
S0875	3025	4820	6385	08-84	0	6.77	b
S0878	3035	4705	6387	08-84	0	0.98	b
S0880[c]	3075	4845	6384	08-84	0	4.68	b
S0881[c]	3095	4830	7835	10-84	0	5.59	b
S0882	3100	4720	2600	10-83	0	0.73	b

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.
[c]Both samples 0880 and 0881 showed LDL values for cobalt-60, cesium-137, and americum-241, and 0.9 pCi/g radium-226.
FIDLER - field instrument for the detection of low-energy radiation
LDL - lower detection limit
MRC ID - Monsanto Research Corporation Identification
pCi/g - picocuries per gram

Area 2 is at least partially covered by the Site Sanitary Landfill constructed in 1977. A magnetic survey conducted in Area 2 in 1990 indicated that some of the burials may lie under the present position of the road intersection (DOE 1990). This is also supported by the interpretation of historic aerial photographs indicating that the historic landfill may have occupied areas presently under the paved roads (DOE 1992b).

Burial occurred in an irregular trench 12 or 14 ft deep which was covered by a few feet of soil (Thomas 1990). The depth to bedrock in this area of the facility appears to be a maximum of about 600 inches (50 ft) (Mound Plant drawing #FSE16472 [DOE 1992f]). The maximum depths sampled at the three core location were 36, 162, and 180 inches (Table III.1). Although the samples collected from 72 to 180 inches may have been of sufficient depth to sample the original trench, it is not known if any drums or debris were encountered during the core sampling. In addition, while providing information concerning probable surface radioactive contamination, the surface samples collected from Area 2 do not provide any information concerning the historic disposal trenches. The elevated thorium concentration detected in a sample collected from core location 0191 at a depth of 108 inches may be indicative of some subsurface elevated thorium activity.

3.3. AREAS 4 AND 4a

Areas 4 and 4a are located on the southern slope of the Main Hill, surrounding the WD Building (Plate 1). Area 4 mainly includes the northern side of the WD Building. WD Building and its annex housed the facilities for treatment of alpha and beta wastewater systems. The WD Building became operational in 1949 and supported the polonium operations until 1971, after which the facility was renovated for processing plutonium-238 wastewater. The building received polonium waste or waste by-products from R, T, and HH Buildings where research and processing took place, and also received wastewater from the laundry in H Building. Plutonium wastewater was received from R, SM, and PP Buildings. Area 4 was reportedly contaminated by overflows of the WD Building influent tanks, located on the northeastern end of the building (Plate 1). The influent tanks contained polonium-210 (with cobalt-60) and later plutonium-238. The polonium-210 is no longer present due to radioactive decay. Area 4a includes the area surrounding the old sanitary waste disposal plant (SD plant), located just south of the WD Building (Plate 1). Area 4a was reportedly contaminated by polonium-210 and cobalt-60 when a waste line broke near Building 48, located to the north of the WD Building. The area near Building 48 that was affected by this release is known as Area 5. This break occurred in December 1970 (Davis 1972) and resulted in a cross-contamination of the sanitary sewage and process (hot waste) lines in the area of the WD Building. As a result of this cross-contamination, the sewage treatment beds at the old SD plant were radioactively contaminated, and the bacterial population was destroyed. To accommodate the overflow that resulted from the interruption of operations at the SD plant, water and some sludge was pumped into a pit that was dug to the west

of the SD drying beds. In addition, some old piping that was in the area was also added to the pit, and the pit was backfilled with soil. During the soil excavation performed at the WTS hillside (Area 14), the D&D Program change-out trailer was placed directly over the former location of this pit; therefore, it was not sampled. Plutonium-238 contamination is also present in Areas 4 and 4a from a variety of possible sources, including the 1969 waste-line break in Area 14 from waste packaging and handling operations and overflow of the low-risk influent tanks (DOE 1992h).

The contaminant concentrations measured in samples collected near the WD Building are given in Table III.2. The extent of these combined areas (Areas 4 and 4a) shown on Plate 1 appears to be similar to the Area 4 depicted in the original Site Survey Project Report. It appears that the concentration ranges in Table III.2. are not in agreement with the summaries given in the original Site Survey Project Report. Although the plutonium concentration contours (Plate 4) are depicted under the WD Building, no samples were taken under the building.

Four of the core samples collected in Area 4 contained plutonium-238 concentrations greater than 100 pCi/g. One of these samples was collected from each of core locations 0085, and 0090, and two samples were collected from core location 0091 on Plate 1; C0085, C0090, and C0091 on Table III.2. The maximum concentration detected, 355 pCi/g, was found in the sample collected from core location C0091 at a depth of 18 inches (Table III.2). Plutonium-238 activity in excess of 25 pCi/g was detected in three additional samples. These samples were also collected from core location 0085. No thorium was detected above 2 pCi/g.

Three of the samples collected were analyzed by gamma spectroscopy. These samples were collected from surface locations S0455 and S0465, and core location C0085 at a depth of 18 inches (Table III.2). Thorium and plutonium-238 results for the two surface samples were not reported and are unknown. Radium-226 was detected in all three samples, ranging from 0.60 to 0.80 pCi/g. The only other radionuclide detected in these three samples above the LDL was americium-241, detected at 0.5 and 1.0 pCi/g in the samples collected from core location 0085 at a depth of 18 inches, and surface location 1493, respectively. No thorium concentrations above 2 pCi/g were detected in any of the samples collected in Areas 4 and 4a. Additional gamma analysis was not performed because it was believed that the gamma activity seen during the FIDLER screening was due to the plutonium present, or because no elevated gamma activity was seen during screening.

Samples were taken at the Area 4 and 4a core locations at depths ranging from 18 inches to 96 inches. The depth to bedrock in this area is about 24 to 96 inches (2 to 8 ft). It is possible that bedrock was encountered during drilling of several of the core locations, although boring logs are not

Table III.2. Mound Site Survey Project - Areas 4 and 4a

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)
C0077	1950	3680	1958	05-83	18	1.45	b					
			1959	05-83	36	0.64	b					
			1960	05-83	72	15.41	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					
S0455	2000	3680	2425	09-82	0	NR	NR		LDL	LDL	0.8	LDL
S0456	2025	3730	6274	08-84	0	3.62	b					
C0080	2050	3705	1965	05-83	18	3.53	b					
			1966	05-83	36	2.71	b					
			1967	05-83	54	0.13	b					
C0082	2080	3630	1968	05-83	18	2.99	b					
			1969	05-83	36	0.31	b					
			1970	05-83	72	0.31	b					
C0085	1915	3840	1944	05-83	18	100.10	b		LDL	LDL	0.6	0.5
			1945	05-83	36	51.35	b					
			1946	05-83	54	51.70	b					
			1947	05-83	60	34.95	b					
S0465	1925	3790	1493	03-83	0	NR	NR		LDL	LDL	0.7	1.0
S0466	1950	3770	6296	08-84	0	5.42	b					
C0090	1950	3910	1948	05-83	18	160.00	b					
			1949	05-83	36	7.44	b					
			1950	05-83	96	6.16	b					
C0091	1965	3790	1951	05-83	18	355.00	b					
			1952	05-83	36	150.00	b					
			1953	05-83	54	8.60	b					

Table III.2. (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)
C0092	1980	3825	1954	05-83	18	7.02	b					
			1955	05-83	36	0.75	b					
			1956	05-83	54	2.48	b					
			1957	05-83	72	4.95	b		LDL	LDL	1.2	LDL

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

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

available. The site history for this area suggests that significant subsurface radioactive contamination may be present; the releases that occurred here were either the result of surface water runoff from Area 5 described below, or the overflow of the influent tanks discussed above.

3.4. AREA 5

Area 5 is located on the southern side of the Main Hill at Mound Plant, adjacent to Building 48 (Plate 1). Area 5 is the result of a December 1970 waste-line break that released polonium-210 waste liquids to the surrounding soils. A total of 39 30-gallon drums of soil, with an estimated polonium content of 20 μCi, were boxed and shipped offsite (Davis 1972). No cleanup levels are documented. The boundaries of Area 5 (Plate 1) are based on an interpretation of the site survey data made in the preparation of this report. The area did not appear on the results reported from the aerial survey conducted in 1976 (EG&G 1978). Soil contamination identified near Area 5 on the Building 48 Hillside is described in subsection 4.1.9.

The evaluation of the Site Survey Project data for this report does not agree with the evaluation presented in the original report (Table III.3). The differences lie in the reporting of the cesium-137 concentrations detected by gamma spectroscopy. The laboratory results (gamma-spectroscopy printout in Appendix E) give the cesium-137 concentrations for the corresponding Area 5 samples as <LDL, which means that the results were less than the LDL of 0.5 pCi/g. The original report (Stought et al. 1988) indicated that these samples had between 0.1 and 0.99 pCi/g of cesium-137. Cesium-137 was detected nearby at 1.6 pCi/g in the sample collected from surface location 0373 (S0373 on Table III.3). The boundary of Area 5 (Plate 1) is drawn to include S0373.

The maximum cobalt-60 concentration found in Area 5, 250 pCi/g, was detected in the sample collected from core location 0064 at a depth of 108 inches (C0064 on Table III.3). All other detected concentrations were less than 40 pCi/g. Measurable concentrations of cobalt-60 were found as deep as 234 inches (Table III.3). Mound Plant drawing #FSE16472 (DOE 1992f) indicates the depth to bedrock in this area ranges from 16 to 22 ft. The boring logs are not available, so it is not known if the Area 5 core locations were sampled to bedrock.

3.5. AREA 6

Area 6 is the location of a trench used for the disposal of approximately three drums of polonium-210-contaminated sand. It is located in what is now a parking lot on the northeast side of the Main Hill, near Buildings 45 and 60 (Plate 1). The location and extent of Area 6, shown on Plate 1, are estimates. In 1964, at least three 55-gallon drums of polonium-contaminated sand were placed in this area. The sand was contaminated during cleaning (sand-blasting) of the metal framework of the WD Building sand filters. The sand was originally contained in drums that were placed in Area 6,

Table III.3. Mound Site Survey Project - Area 5

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
C0064	1860	3340	10383	09-85	18	NR	NR	LDL	LDL	0.6	LDL
			10384	09-85	36	NR	NR	38	LDL	0.5	LDL
			10385	09-85	54	NR	NR	22	LDL	0.5	LDL
			10386	09-85	72	NR	NR	3.3	LDL	0.6	LDL
			10387	09-85	90	NR	NR	LDL	LDL	0.6	LDL
			10388	09-85	108	NR	NR	250	LDL	0.5	LDL
			10389	09-85	126	NR	NR	6.0	LDL	0.4	LDL
			10390	09-85	144	NR	NR	2.0	LDL	0.5	LDL
			10391	09-85	162	NR	NR	3.0	LDL	0.5	LDL
			10392	09-85	180	NR	NR	9.0	LDL	0.6	LDL
C0065	1870	3340	10393	09-85	18	NR	NR	15	LDL	0.4	LDL
			10394	09-85	36	NR	NR	26	LDL	0.7	LDL
			10395	09-85	54	NR	NR	15	LDL	0.5	LDL
			10396	09-85	72	NR	NR	26	LDL	0.8	LDL
			10397	09-85	90	NR	NR	23	LDL	0.5	LDL
			10398	09-85	108	NR	NR	5.0	LDL	0.4	LDL
			10399	09-85	126	NR	NR	6.0	LDL	0.5	LDL
			10400	09-85	144	NR	NR	LDL	LDL	0.5	LDL
			10401	09-85	162	NR	NR	1.3	LDL	0.5	LDL
			10402	09-85	180	NR	NR	LDL	LDL	0.5	LDL
			10403	09-85	198	NR	NR	1.1	LDL	0.6	LDL
			10404	09-85	216	NR	NR	LDL	LDL	0.5	LDL
			10405	09-85	234	NR	NR	1.3	LDL	0.7	LDL
C0066	1880	3320	10406	09-85	18	NR	NR	0.6	LDL	0.5	LDL
			10409	09-85	72	NR	NR	5.0	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	4.0	LDL	0.7	LDL
			10413	09-85	144	NR	NR	13	LDL	0.4	LDL
			10414	09-85	162	NR	NR	4.0	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

Table III.3. (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)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
C0063	1850	3370	10373	09-85	18	NR	NR	LDL	LDL	0.6	LDL
			10374	09-85	36	NR	NR	LDL	LDL	0.4	LDL
			10375	09-85	54	NR	NR	LDL	LDL	0.6	LDL
			10377	09-85	90	NR	NR	LDL	LDL	0.5	LDL
			10378	09-85	108	NR	NR	LDL	LDL	0.4	LDL
			10379	09-85	126	NR	NR	1.1	LDL	0.5	LDL
			10380	09-85	144	NR	NR	LDL	LDL	0.4	LDL
			10381	09-85	162	NR	NR	LDL	LDL	0.5	LDL
S0375	1825	3300	3079	10-83	0	0.35	b				
S0373	1810	3350	9830	08-84	0	NR	NR	1.0	1.6	0.8	LDL

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

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

in a 100-ft by 40-ft trench. The trench may also contain a polonium-contaminated washing machine. Polonium has a half-life of 138.4 days, and is no longer present due to radioactive decay.

No surface soil samples were collected during the Site Survey Project, and only one core location was sampled in Area 6, location C0003 (Plate 1; Table III.4). No results were given for plutonium-238 or thorium for the samples collected from this core location. Gamma spectroscopy results were given, with radium-226 being the only radionuclide detected above the LDLs and with all measurements below 1 pCi/g.

Area 6 may have been covered with up to 30 ft of fill when the parking lot was built. The core location sampled during the Site Survey Project was only sampled to 180 inches, or 15 ft. Because the boring log for location 0003 is not available, it is not known if drilling was stopped because bedrock was reached or if any signs of the original trench were observed during the sampling. The location of the buried drums may be indicated by the magnetic anomaly depicted in the Preliminary Results of Reconnaissance Magnetic Survey (DOE 1990).

3.6. AREA 7

Area 7 is a large area located in the upper valley at Mound Plant, in the area of Buildings 29, 51, 66, and 98 (Plate 1). This area was once a steep ravine (part of the plant drainage ditch) that has a long history of debris disposal and infilling, including the disposal of approximately 2,500 empty thorium drums (1955-1966) some of which may have been removed and placed in Area 2; a polonium-contaminated washing machine (date unknown); a thorium-contaminated flat bed truck (mid-1960s); and soil containing actinium-227, radium-226, and thorium-228 from the SW Building, which was placed in an old septic tank behind Building 29. When a parking lot was built in this area, up to 40 ft of fill was used to level the ravine, except where the septic tank was located. The extent of Area 7 shown on Plate 1 is based on an interpretation of the site survey data made in the preparation of this report, and is similar to the area depicted in the original Site Survey Project Report. In the mid-1960s, materials contaminated with polonium-210 were also buried on the side of the ravine (Figure 3.1). An exhaust system from the remodeling of T Building and a large stainless steel washing machine were among the items. Smaller items contaminated with polonium-210 may also have been buried (Garner 1991). Additional discussions of Area 7 are provided in subsections 5.5 and 7.2.

The samples from Area 7 were analyzed mainly for plutonium-238 and thorium. The maximum plutonium-238 concentration detected was 7.40 pCi/g in the surface sample from location S0286 (Table III.5). The maximum total thorium concentration detected, 20.52 pCi/g, was found in the surface sample collected from location S0298 (Table III.5). Other radionuclides detected in Area 7 included radium-226, cesium-137, and tritium. Maximum concentrations detected were 2 pCi/g, 1.2

Table III.4. Mound Site Survey Project - Area 6

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)
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

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.
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

Table III.5. Mound Site Survey Project - Area 7

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)
C0008	1885	2030	10611	09-85	18	NR	NR		LDL	LDL	0.5	LDL
			10612	09-85	36	NR	NR		LDL	LDL	0.6	LDL
			10613	09-85	54	NR	NR		LDL	LDL	0.7	LDL
			10614	09-85	72	NR	NR		LDL	1.2	0.7	LDL
			10615	09-85	90	NR	NR		LDL	LDL	0.9	LDL
			10616	09-85	108	NR	NR		LDL	LDL	0.5	LDL
			10617	09-85	126	NR	NR		LDL	LDL	1.0	LDL
			(MRC ID 10617 also contained 50 pCi/g of Actinium-227.)									
			10618	09-85	144	NR	NR		LDL	LDL	1.0	LDL
			(MRC ID 10618 also contained 1,400 pCi/g of Actinium-227.)									
			10619	09-85	162	NR	NR		LDL	LDL	0.9	LDL
			10620	09-85	180	NR	NR		LDL	LDL	0.5	LDL
			10621	09-85	198	NR	NR		LDL	LDL	1.0	LDL
			(MRC ID 10621 also contained 300 pCi/g of Actinium-227.)									
			10622	09-85	216	NR	NR		LDL	LDL	0.7	LDL
			(MRC ID 10622 also contained 10 pCi/g of Actinium-227.)									
C0009	1885	2040	10713	09-85	0	NR	NR		LDL	LDL	0.5	LDL
			10714	09-85	18	NR	NR		LDL	LDL	0.7	LDL
			10715	09-85	36	NR	NR		LDL	LDL	2.0	LDL
			10716	09-85	48	NR	NR		LDL	LDL	0.7	LDL
			10717	09-85	72	NR	NR		LDL	LDL	0.6	LDL
			(MRC ID 10717 also contained 30 pCi/g of Actinium-227.)									
			10718	09-85	90	NR	NR		LDL	LDL	1.2	LDL
			(MRC ID 10718 also contained 200 pCi/g of Actinium-227.)									
			10719	09-85	108	NR	NR		LDL	LDL	1.5	LDL
			10720	09-85	126	NR	NR		LDL	LDL	0.8	LDL
			(MRC ID 10720 also contained 20 pCi/g of Actinium-227.)									
			10721	09-85	144	No results given.						
			10722	09-85	156	NR	NR		LDL	LDL	0.7	LDL
			10723	09-85	180	No results given.						
			10724	09-85	198	NR	NR		LDL	LDL	0.8	LDL

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

[c]The data received from Mound Plant listed the depth of this sample as 81 inches. The numbers were probably reversed, and the true depth is 18 inches.

[d]These gamma spectrometry results could not be confirmed because they were not given in the printout included at the end of Appendix F.

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

Table III.5. (page 2 of 5)

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)
C0014	2025	2300	1701	05-83	18	0.31	b					
			1702	05-83	36	0.02	2.07					
			1703	05-83	54	0.02	2.18					
			1704	05-83	72	0.03	b					
			1705	05-83	90	0.87	b					
			1706	05-83	108	0.27	b					
			1707	05-83	126	0.50	b					
			1708	05-83	144	0.76	b					
			1709	05-83	162	0.23	2.74					
			1710	05-83	180	0.18	b					
			1711	05-83	198	0.45	2.48					
			1712	05-83	216	0.29	b					
C0020	2075	2315	5980	07-84	0	3.10	2.55		LDL	LDL	0.8	LDL
			1713	05-83	18	0.08	b					
			1714	05-83	36	0.01	b					
			1715	05-83	54	0.06	b					
			1716	05-83	72	0.17	b					
			1717	05-83	108	0.29	b					
			1718	05-83	126	0.12	b					
			1719	05-83	144	0.08	b					
			1720	05-83	162	0.11	b					
			1721	05-83	180	0.37	b					
			1722	05-83	198	0.07	b					
			1723	05-83	216	0.10	b					
C0015	2025	2315	1833	05-38	18	0.11	3.53		LDL	LDL	0.8	LDL
			1834	05-83	36	0.11	b					
			1835	05-83	54	0.10	b					
			1836	05-83	72	0.22	b		LDL	LDL	0.8	LDL
			1837	05-83	90	0.10	b					
			1838	05-83	108	0.08	b					
			1839	05-83	126	0.09	b					
			1840	05-83	144	0.09	b					
			1841	05-83	162	0.07	b					
			1842	05-83	180	0.07	b					
			1843	05-83	198	0.19	2.41					
			1844	05-83	216	0.34	b					
			1845	05-83	234	0.37	4.84					
			1846	05-83	240	0.25	b					

Table III.5. (page 3 of 5)

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)
C0016	2050	2350	1750	05-83	81[c]	0.19	b					
			1751	05-83	36	0.02	b					
			1752	05-83	54	0.02	b					
			1753	05-83	72	0.01	b					
			1754	05-83	90	0.08	b					
			1755	05-83	108	0.11	b					
			1756	05-83	126	0.06	b					
			1757	05-83	144	0.06	2.05					
			1758	05-83	180	0.11	b					
			1759	05-83	216	0.03	b					
			1760	05-83	234	0.07	b					
C0019	2025	2290	1823	05-83	18	0.54	2.61					
			1824	05-83	36	0.29	b					
			1825	05-83	54	0.27	b					
			1826	05-83	90	0.52	b					
			1827	05-83	108	0.10	b					
			1828	05-83	126	0.06	b					
			1829	05-83	144	0.14	b					
			1830	05-83	162	0.16	b					
			1831	05-83	180	0.12	b					
			1832	05-85	216	0.10	b					
C0021	2075	2340	5982	07-84	0	1.52	b					
			1867	05-83	12	0.86	3.23					
			1868	05-83	24	1.00	3.80					
			1869	05-83	36	NR	18.00					
			1870	05-83	48	0.20	6.94					
			1871	05-83	60	0.08	b					
			1872	05-83	72	0.12	b					
			1873	05-83	84	0.03	b					
			1874	05-83	96	0.04	b					
			1875	05-83	108	0.02	b					
			1876	05-83	120	0.04	b					
			1877	05-83	132	0.11	b					
			1878	05-83	144	0.13	b					
			1879	05-83	156	0.18	b					
			1880	05-83	168	0.10	b					
			1881	05-83	180	0.21	3.82					
			1882	05-83	192	0.09	b					
			1883	05-83	204	0.21	b					
			1884	05-83	216	0.17	b					
			1885	05-83	228	0.24	b					
			1886	05-83	240	0.18	b					

Table III.5. (page 4 of 5)

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)
C0024	2125	2200	1805	05-83	126	0.02	b					
			1806	05-83	144	0.01	b		LDL	LDL	0.8	LDL
			1807	05-83	156	0.02	b		LDL	LDL	0.9	LDL
C0025	2150	2290	1815	05-83	12	6.60	3.90					
			1816	05-83	36	0.30	4.02		LDL	LDL	1.0	LDL
			1817	05-83	72	0.09	b					
			1818	05-83	90	0.05	b					
			1819	05-83	144	0.05	2.43					
C0256	2100	2240	8385	11-84	18	0.03	2.79					
C0032	2175	2340	1808	05-83	18	0.64	3.14		LDL	LDL	1.0	LDL
			1809	05-83	36	2.19	b					
			1810	05-83	54	0.62	b					
			1811	05-83	90	0.08	b					
			1812	05-83	144	0.05	b					
			1813	05-83	162	0.08	b					
			1814	05-83	180	0.03	b					
S0274	1875	1985	5971	07-84	0	0.01	b					
S0275	1900	2135	5970	07-84	0	0.29	b					
S0276[d]	1925	2035	5973	07-84	0	1.27	b		LDL	LDL	1.5	LDL
S0278	2025	2010	5974	07-84	0	5.28	b		LDL	LDL	0.9	LDL
S0280	2075	2060	5975	07-84	0	0.56	b					
S0281	2075	2110	5976	07-84	0	0.83	4.03					
S0286	2025	2265	4091	10-83	0	7.40	b	5.23				
S0289	2050	2265	5983	07-84	0	0.64	b					
			5978	07-84	0	2.72	b					
S0290	2050	2290	6753	08-84	0	1.21	b					
S0293	2075	2265	5979	07-84	0	0.66	b					
S0295	2075	2390	4090	10-83	0	0.64	b					
S0298	2085	2315	6758	08-84	0	3.01	20.52					
S0299	2085	2355	6755	08-84	0	0.41	b		LDL	LDL	1.2	LDL

Table III.5. (page 5 of 5)

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)
S0300	2085	2365	6757	08-84	0	0.38	4.48					
S0302	2125	2110	6512	08-84	0	4.13	b					
S0303	2125	2160	2818	10-83	0	0.75	b					
S0316	2125	2365	4100	10-83	0	0.98	b	0.69	LDL	LDL	0.8	LDL
S0318	2175	2365	5990	08-84	0	0.72	b					
S0319	2210	2315	6852	08-84	0	1.17	b					
S0320	2210	2375	6850	08-84	0	6.81	6.73					
S0321	2225	2265	4099	10-83	0	0.61	b					
S0322	2225	2465	5989	08-84	0	0.78	b					
S0323	2225	2540	5988	08-84	0	0.45	3.64					
S0325	2275	2490	6849	08-84	0	1.73	b					
S0362	1835	2005	6227	08-84	0	0.25	b					

pCi/g, and 5.23 nCi/l, respectively. Seven coreholes and four surface samples (C0008, C0009, C0020, C0015, C0024, C0025, C0032 and S0276, S0278, S0299 and S0316, respectively; Table III.5) were analyzed for cobalt-60. All analyses indicate that nothing above the LDL was encountered.

The core locations in Area 7 were drilled and sampled to maximum depths of 96 to 234 inches (8 to 19.5 ft). Mound Plant drawing #FSE16472, reproduced in the Site Scoping Report: Volume 2 Addendum (DOE 1992f) indicates the depth to bedrock in this area is 9 to 15 ft at the north end of the area, and to 65 ft at the southern end near Building 51. Because a boring log is available for only one of the Area 7 locations, it is not known if bedrock was encountered during the drilling; however, it appears that the majority of the core sampling did not penetrate fill and reach the original disposal area.

3.7. AREA 10

Area 10 is located on the slope of the SM/PP Hill, adjacent to Area 12 (Plate 1). Area 10 contains concrete and debris contaminated with polonium-210 from the 1949 and 1950 demolition of the old Dayton operations (DOE 1992g). The debris was covered over with a layer of dirt. With a half-life of 138.4 days, the polonium-210 is no longer present due to radioactive decay. The actual size of the area affected by the debris disposal is unknown so the area depicted on Plate 1 should be viewed as schematic.

One surface sample was collected in Area 10 during the Site Survey Project, sample S0604 (Plate 1; Table III.6). This sample contained 11.8 pCi/g of plutonium-238, and less than 2 pCi/g of thorium. It is not known where this sample was collected in relation to the debris. No analyses are known for gamma spectroscopy that would have detected cobalt-60 or perhaps bismuth-207.

Because of its location on the slope of the SM/PP Hill, Area 10 is in a position to receive surface water runoff from areas upgradient, such as the adjacent Area 12. Since there are no other known contaminants associated with the concrete, it is believed that the plutonium-238 detected in the surface sample is the result of deposition from surface water runoff. The original Site Survey Project Report notes that more recent D&D Program core sampling in Area 10 indicated one sample with a plutonium-238 concentration between 10 and 99 pCi/g.

3.8. AREA 13

Area 13 is located near Building 49 in the valley between the Main and SM/PP Hills at Mound Plant. In 1950, wood contaminated with polonium-210 from the demolition of the Dayton operations was stored in this area along with equipment stored in tents. The wood, tents and other debris was burned in Area 13 in 1955 (DOE 1992g). Metal and other residual materials that survived the fire were subsequently buried in the historic landfill (Area 2). With a half-life of 138.4 days, the polonium-210

Table III.6. Mound Site Survey Project - Area 10

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)
S0603	2750	2415	6784	08-84	0	0.69	b
S0604	2750	2465	1319	08-84	0	11.80	b

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.
FIDLER - field instrument for the detection of low-energy radiation
MRC ID - Monsanto Research Corporation Identification
pCi/g - picocuries per gram

is no longer present due to radioactive decay. The exact location of Area 13 is not exactly known. The locations depicted on Plate 1 indicate the general locations and display the different variations published in various documents. The map of Hot Waste Burial Sites, reproduced in the Site Scoping Report: Volume 7 - Waste Management (DOE 1992g) depicted Area 13 to the far east of Building 49. The Site Survey Project Report (Stought et al. 1988) depicted Area 13 slightly farther west and overlapping Building 49. Evaluation of the historic relationships of the Quonset hut and other historic buildings in the area indicate the actual location was even farther west as shown by the dashed square on Plate 1. The Quonset hut was also moved from the Dayton units to the lower part of the plant valley and is described in the companion reactor waste decontamination subsection 9.3 of this report.

Two surface samples were taken in or near the reported location of Area 13 during the Site Survey Project. These locations are S0670 and S0671 (Plate 1; Table III.7). Plutonium-238 was detected at 0.34 and 5.74 pCi/g, respectively (Table III.7). No thorium was detected above 2 pCi/g in these samples. Area 13, like Area 10, is in a position to receive surface water runoff from areas upgradient on the SM/PP Hill, including Area 12, which contains plutonium contamination (subsection 3.1.12). It is believed that the plutonium present in the samples taken in Area 13 may be the result of surface water runoff and not the result of the polonium-contaminated wood placed in the area. No analyses for gamma spectroscopy are known for Area 13.

3.9. AREA 20

Area 20 is located on the southern slope of the Main Hill, just west of the HH Building (Plate 1). In the 1950s, an underground radioactive waste line in this area is reported to have ruptured, releasing polonium-210 and cobalt-60 to the soils in the area. At least two separate incidents are known (DOE 1992c). The aerial survey conducted in 1976 indicated gamma exposure levels of 4.5 to 7.5 μR/hr in Area 20 (EG&G 1978). During construction activities in 1985, radioactively contaminated soils from Area 20 were reportedly excavated and moved to Area 22. The old wasteline remains in place today.

Table III.8 presents the results of the Site Survey Project sampling in Area 20. The sampling locations are shown in Plate 1. No plutonium-238 or thorium results were given for the core locations sampled. Cesium-137 was detected at 1 pCi/g in the surface sample collected from core location 0070 (C0070 on Table III.8). Radium-226 was the only other radionuclide detected in the samples collected from the other core locations.

The samples from the surface locations in Area 20 were analyzed for plutonium-238 and thorium. The maximum concentrations detected were 1.9 and 4.02 pCi/g for plutonium-238 and thorium, respectively. Both of these concentrations were detected in samples collected from surface location 0406 (S0406, Table III.8).

Table III.7. Mound Site Survey Project - Area 13

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)
S0670	2705	3175	4029	10-83	0	0.34	b
S0671	2725	3075	4118	10-83	0	5.74	b
S0672	2725	3300	4027	10-83	0	0.43	b
S0673	2775	3275	4043	10-83	0	0.08	b
S0674	2775	3375	4028	10-83	0	0.54	b

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.
FIDLER - field instrument for the detection of low-energy radiation
MRC ID - Monsanto Research Corporation Identification
pCi/g - picocuries per gram

Table III.8. Mound Site Survey Project - Area 20

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
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	0.8	LDL
			10910	09-85	108	NR	NR	LDL	LDL	0.6	LDL
			10911	09-85	126	NR	NR	LDL	LDL	0.6	LDL
			10812	09-85	144	NR	NR	LDL	LDL	0.5	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
			10801	09-85	162	NR	NR	LDL	LDL	0.5	LDL
			10802	09-85	180	NR	NR	LDL	LDL	0.2	LDL
C0071	2245	3280	10781	09-85	0	NR	NR	LDL	LDL	0.5	LDL
			10782	09-85	18	NR	NR	LDL	LDL	0.2	LDL
			10783	09-85	36	NR	NR	LDL	LDL	0.2	LDL
			10786	09-85	90	NR	NR	LDL	LDL	0.5	LDL
			10787	09-85	108	NR	NR	LDL	LDL	0.2	LDL
			10788	09-85	126	NR	NR	LDL	LDL	0.6	LDL
			10789	09-85	144	NR	NR	LDL	LDL	0.2	LDL
			10790	09-85	162	NR	NR	LDL	LDL	0.6	LDL
			10789	09-85	180	NR	NR	LDL	LDL	0.9	LDL
C0072	2250	3260	10675	09-85	18	NR	NR	LDL	LDL	0.4	LDL
			10676	09-85	36	NR	NR	LDL	LDL	0.5	LDL
			10677	09-85	54	NR	NR	LDL	NR	0.6	LDL
			10678	09-85	72	NR	NR	LDL	LDL	0.4	LDL
			10679	09-85	90	NR	NR	LDL	LDL	0.3	LDL
			10680	09-85	108	NR	NR	LDL	LDL	0.4	LDL
			10681	09-85	126	NR	NR	LDL	LDL	0.5	LDL
			10682	09-85	144	NR	NR	LDL	LDL	0.6	LDL
			10683	09-85	162	NR	NR	LDL	LDL	0.2	LDL
C0073	2260	3240	10770	09-85	0	NR	NR	LDL	LDL	0.5	LDL
			10772	09-85	36	NR	NR	LDL	LDL	0.2	LDL
			10775	09-85	90	NR	NR	LDL	LDL	0.7	LDL
			10777	09-85	126	NR	NR	LDL	LDL	0.6	LDL
			10778	09-85	144	NR	NR	LDL	LDL	0.6	LDL
			10779	09-85	162	NR	NR	LDL	LDL	0.2	LDL

Table III.8. (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)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
C0074	2270	3210	10762	09-85	0	NR	NR	LDL	LDL	0.50	LDL
			10763	09-85	18	NR	NR	LDL	LDL	0.40	LDL
			10764	09-85	36	NR	NR	LDL	LDL	0.50	LDL
			10765	09-85	54	NR	NR	LDL	LDL	0.50	LDL
			10766	09-85	72	NR	NR	LDL	LDL	0.50	LDL
			10767	09-85	90	NR	NR	LDL	LDL	0.60	LDL
			10768	09-85	108	NR	NR	LDL	LDL	0.60	LDL
			10769	09-85	126	NR	NR	LDL	LDL	0.70	LDL
S0406	2200	3225	2873	10-83	0	1.90	4.02				
S0407	2210	3160	2872	10-83	0	0.13	b				
S0408	2235	3255	2913	10-83	0	NR	b				
S0409	2255	3235	2914	10-83	0	1.46	b				
S0410	2260	3200	5867	07-84	0	0.48	b				

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

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

The presentation of the Site Survey Project data for Area 20 made in this report does not agree with the presentation of data in the original Site Survey Report. The differences lie mainly in the reporting of the cesium-137 and cobalt-60 results. In the original report, cesium concentrations less or equal to the LDL of 0.5 pCi/g were reported as between 0.1 and 1.0 pCi/g. Cobalt concentrations less than the LDL of 0.5 pCi/g were reported as between 0.01 and 0.1 pCi/g (Table III.8).

The depth to bedrock in Area 20 is approximately 324 inches (27 ft) (Mound Plant drawing #FSE16472) (DOE 1992f). The maximum depth of the Site Survey Project boreholes was 180 inches, or 15 ft. Because boring logs are not available, it is not known if bedrock was reached during sampling.

The original Site Survey Project noted that more recent construction data for Area 20 indicated the presence of significant contamination (Garner 1985), as follows:

- 800 pCi/g of cobalt-60,
- 200 pCi/g of cesium-137,
- 400 pCi/g of bismuth-210m, and
- 70 pCi/g of bismuth-207.

This contamination was discovered during routine health physics screening of soil being excavated for sewer work in Area 20. It was reportedly removed to Area 22 during the sewer work. Area 22 is described in the companion General Use Areas section of this report. Other than cobalt-60, the original of these isotopes in Area 20 is not known for certain. Cesium-137 was probably associated with the processing of reactor wastes, as described in section 9 of this report. However, no connection between the HH Building and the reactor waste decontamination experiments was discovered during the research for this report.

Bismuth-210m and bismuth-207 were undoubtedly associated with the bismuth processing conducted to produce polonium-210, but up to that time were not recognized. Bismuth-210m is a long-lived metastable isotope with a half-life of nearly 3 million years. In addition to gamma radiation, it decays through alpha emission to thallium-206, which in turn decays over a very short half-life (4.3 minutes) to stable lead-206. Thallium-206 is generally known as a descendent in the uranium-238 decay chain. The origin of bismuth-207 is more speculative. It is, however, known to be produced by alpha particle bombardment of bismuth-209 to produce astatine-211, which decays over a very short half-life (7.2 hours) by alpha particle emission to bismuth-207. Bismuth-207 decays over a 30-year half-life by electron capture to lead-207 metastable (lead-207m). Lead-207m decays to stable lead-207 by

gamma radiation over a 0.8-second half-life. It is entirely conceivable, but speculative, that some of the bismuth-209 destined for neutron bombardment actually absorbed an alpha particle during irradiation in the nuclear reactor. Alpha particles could have been present from polonium-210, for instance. Based on their identification in Area 20, both bismuth-210m and bismuth-207 should be considered potential contaminants in areas affected by cobalt-60.

3.10. LOCATIONS WITH ELEVATED COBALT-60

Cobalt-60 is a radionuclide produced as a by-product of polonium production. In the production of polonium-210, bismuth metal was the prime target, but it was jacketed in an aluminum can because the bismuth was so brittle. The irradiation of trace quantities of nickel in the aluminum cans produced cobalt-60. Details of the process are described in the Site Scoping Report: Volume 7 - Waste Management (DOE 1992g).

Only one isolated occurrence of cobalt-60 was documented during the Site Survey Project. The sample taken at surface location S0175, located on the western edge of the Main Hill, contained 82 pCi/g of cobalt-60 (Plate 1; Table III.6). This sample also contained 10 pCi/g of cesium-137. Few samples were taken in this area, so it is not known if there are other locations of elevated cobalt-60. The source of the potential contamination at surface location S0175 is not currently known. Cobalt-60 may be present at other locations at Mound Plant associated with processing of polonium wastes, particularly the handling of the decanning solutions. The decanning solutions were handled in HH Building and moved to the old explosives bunker for storage before shipment offsite for disposal (DOE 1992g). The old explosives bunker, also known as the radium shack, is now known as Area 21 and is described in the companion radium/actinium section of this report. Bismuth-210m and bismuth-207 may be associated with cobalt-60, as noted above. These two isotopes were not formerly recognized as contaminants from the processing of polonium-210, but their occurrence within Area 20 suggests that they may be associated with cobalt-60. Cobalt-60, bismuth-210m, and bismuth-207 are typically analyzed by gamma spectroscopy and can be identified by that method.

4. PLUTONIUM PROCESSING AREAS

This section provides general descriptions of the scale and periods of operation of the plutonium program at Mound Plant. Summaries are provided of the areas where process and TSD activities took place and whether environmental radiological data, through the Site Survey Project, are available. Additional information on the generation, treatment, storage and disposal activities is provided in Volume 7 - Waste Management (DOE 1992g). The subsections that follow provide details on individual areas.

4.1. PROGRAM SUMMARY

Research and development activities involving plutonium began at Mound Plant in the mid-1950s. These activities included materials research; the development of processes for the production of heat source materials to replace polonium-210; the development of neutron sources; the development of metallurgical and fabrication technology that would ensure the containment and stability of heat source materials in RTGs; and the development of plutonium-238 recovery processes. Plutonium-239 was used by Mound Plant from the mid-1950s to early 1960s in the production of neutron sources. Plutonium-238 was used by Mound Plant in large quantities in production operations from 1960 to 1979. D&D activities at the facilities continue to the present.

Research, development and production of RTGs was by far the largest plutonium project conducted at Mound Plant. Plutonium-238 was supplied to Mound Plant by the Savannah River Plant in the form of plutonium oxalate, nitrate solutions, and oxides. A typical isotopic composition of Mound Plant's plutonium-238 is shown in Table IV.1. In addition to the isotopes of plutonium, plutonium-238 processed at Mound Plant contained trace amounts of americium-241, neptunium-239, and uranium-234.

Process areas included R and SM Buildings and Building 38 (Figure 4.1). Work began in the R Building with the first production of plutonium metal in 1960. In 1960, the SM Building was constructed to house plutonium production, plutonium recovery, process waste treatment facilities, research and development, and analytical laboratory support services (Flanagan 1976). This building processed plutonium-238 to produce plutonium metal and oxides used in the fabrication of neutron sources and RTG systems (MRC 1974). In 1966 and 1967, Building 38, also known as the PP Building, was constructed to replace the plutonium-238 production operations in the SM Building. Subsequent D&D of the SM Building was partially completed in 1974, but currently continues.

The essential process areas involved with the plutonium-238 program were included in the work performed by the Site Survey Project. The SM Building and Building 38 served as the central production areas. The area under and surrounding the SM Building is known as Area 17.

Table IV.1. Isotopic Composition (Typical of Mound Plant Plutonium-238)

Isotope	Principal Decay Mode	Half-Life (years)	Weight (%)
Plutonium-236	Alpha	2.85	0.0001
Plutonium-238[a]	Alpha	87.74	80.0
Plutonium-239	Alpha	24,082	16.5
Plutonium-240	Alpha	6,537	2.7
Plutonium-241	Beta	14.35	0.7
Plutonium-242	Alpha	3.87×10^5	0.1
Uranium-234[b]	Alpha	2.47×10^5	~0.19
Neptunium-237	Alpha	2.14×10^6	0.03
Americium-241[c]	Alpha	458	0.05
Protactinium-231	Alpha	3.25×10^4	<0.01
Thorium-232	Alpha	1.41×10^{10}	<0.01
Uranium-232	Alpha	72	<0.01
Uranium-235	Alpha	7.1×10^8	<0.01
Uranium-236	Alpha	2.39×10^7	<0.01
Actinium-227	Beta	21.6	<0.01

Reference: Rogers 1975, U.S. Department of Education and Welfare

[a]Plutonium-238 also produces low-energy K and L x-rays as it decays to uranium-234. The field instrument from the detection of low-energy radiation (FIDLER) and Phoswich™ systems detect these radiations.

[b]Uranium-234 increases with decay of plutonium-238.

[c]Americium-241 increases with decay of plutonium-241.

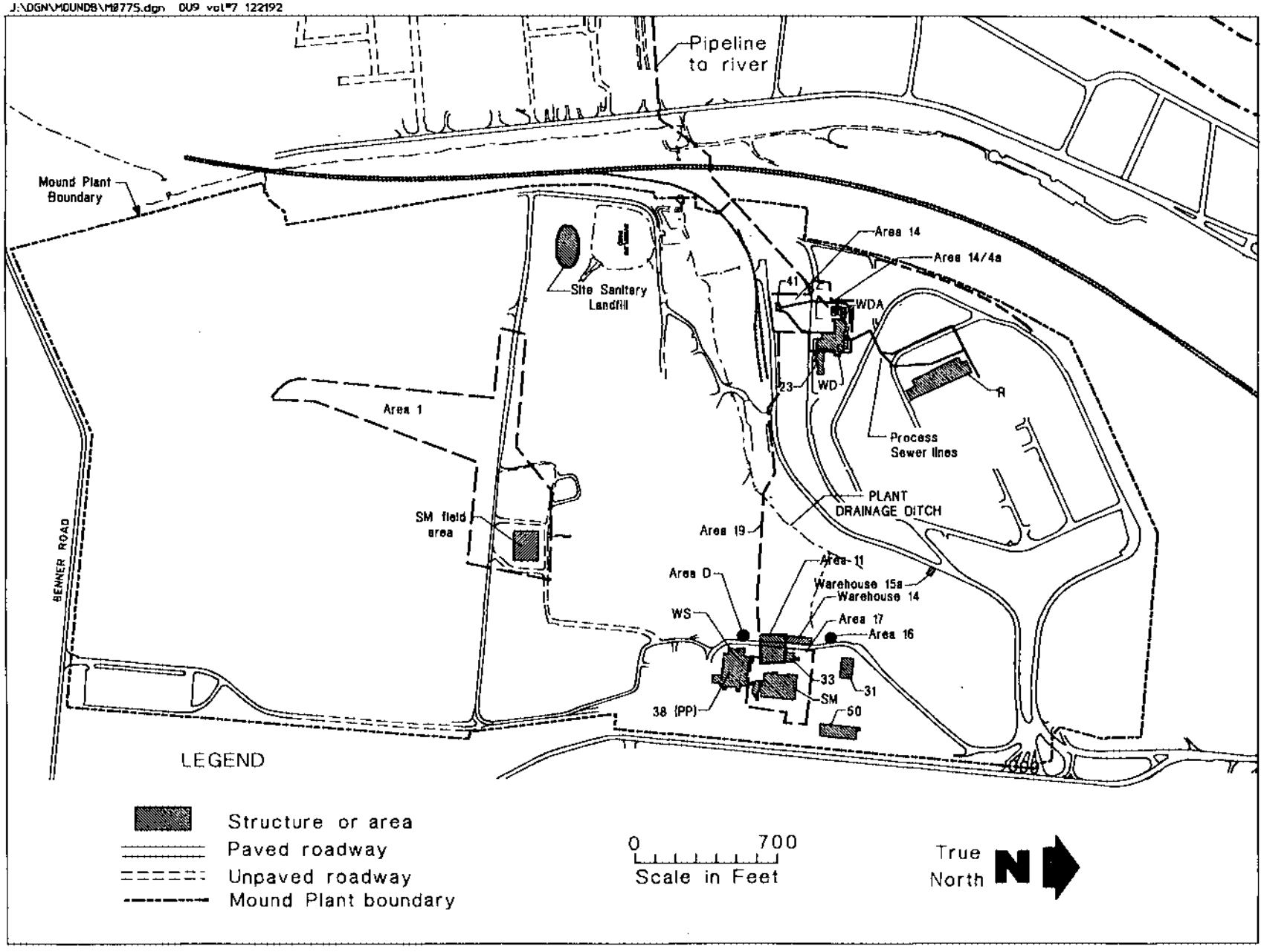


Figure 4.1. Plutonium processing areas.

Production, analytical services and decontamination activities generated low and high risk solid and liquid wastes, and liquid and solid wastes containing plutonium above the economic discard limit. Treatment of high and low risk wastewater was conducted in SM, WDA and WS Buildings.

From 1961 to 1967, all low- and high-risk process wastewater and waste containing plutonium-238 in excess of the economic discard limit was treated in the SM waste disposal facility, processed for plutonium-238 recovery, or drummed and stored in the SM drum storage area for future plutonium recovery. The SM waste disposal facility discharged the treated effluent and influent tank overflow through the storm sewer system to the plant drainage ditch. Spills and upsets in the SM waste treatment facility resulted in the SM Building septic tank, and subsequently the associated leach field, known as Area 16, receiving wastewater contaminated with plutonium-238. In 1963 or 1964, the SM Building septic tank was taken out of service and sanitary wastes were sent to the sanitary waste treatment plant. An acid leach field associated with Building 38 is known as Area D.

In 1967, a WTS was installed between the SM Building and a newly constructed addition to the WD Building and became known as the WDA facility. Low- and high-risk waste was transferred to the WDA facility via dual underground, saran-lined steel pipes. The pipes were buried up to depths of 20 ft. The WTS transferred the wastes by gravity from the SM/PP Building complex to a lift station located in Building 41 in the plant valley. From Building 41, the wastes were pumped up to the WDA treatment facility. Low-risk wastewater was treated in WDA until 1970. Overflow of the influent tanks is documented (DOE 1992b). Treated wastewater was released to the plant drainage ditch. Since the polonium program was phased out in 1970, the WD facility was utilized for treatment of low-risk plutonium wastewater released to the Great Miami river through a closed pipeline. The outfall is regulated under the National Pollution Discharge Elimination System. The low-risk waste lines were taken out of service in 1976 and replaced with tanker trucks for material transfer.

High-risk waste was transferred to WDA from 1967 until 1974, when it was taken out of service when the WS facility was constructed at Building 38 for high-risk waste processing. In 1969, a leak of the high-risk, pressure-feed waste line between Building 41 and the WDA Building resulted in significant soil contamination. The gravity-feed part of the waste line down from the SM/PP complex to Building 41 was removed in the mid-1980s.

Areas involved with treatment of wastes from the plutonium-238 program were largely included in the work performed by the Site Survey Project. The WDA and WD Buildings are included in Areas 4 and 4a described in subsection 3.3. The hillslope below WD Building where the WTS pressure waste line ruptured is known as Area 14. The former gravity feed segment of the WTS wasteline from the SM/PP complex to Building 41 is known as Area 19. The SM wastewater treatment facility was within the

SM Building and is within Area 17. The sanitary and acid leach fields for SM Building and Building 38 are known as Areas, 16 and D, respectively.

The areas along the storm sewers from SM Building and the plant drainage ditch were not included in the Site Survey Project. No analytical data is known for the storm sewer system. The plant drainage ditch was included in the 1974 survey of the Miami-Erie Canal (Rogers 1975).

Storage areas used in the plutonium-238 program included open areas adjacent to SM Building and subsequent buildings constructed for protected storage. A significant element of the plutonium program at Mound Plant was the recovery of plutonium-238 from wastes and products not meeting specifications. Sludges from the wastewater treatment plant, solidified high-risk wastes, and recoverable materials wastes were stored in at least two different open storage areas west and south of the SM Building. Wastes in these drums and boxes contaminated the soil with plutonium-238. In 1965, drums and wooden boxes were moved to a gravel pad storage area located near Building 21 (McMannon 1963-1966). In April 1966, containers containing recoverable materials were transferred to Building 31. The gravel pad used through the late 1960s for staging of wastes before offsite shipment.

The old Warehouses 14 and 15a were also used for storage or staging of plutonium-238 wastes for offsite shipment. Use of Warehouse 14 was abandoned for waste storage in 1966 when Building 31 was completed. It was subsequently used for contractor materials storage during the construction of Building 38 and was razed in the early 1970s, but the concrete pad was left in place. Warehouse 15a was used until 1967 when Building 23 was completed as a general facility for staging of radioactive wastes waiting offsite shipment.

Storage facilities investigated in the Site Survey Project include the open drum storage area west of SM Building (Area 11), and the gravel pad adjacent to Building 21 (Area 1). The old Warehouse 15a is included in Area 7. The concrete floor of old Warehouse 14 is still in place and is now known as pad 14. Pad 14 is partially enclosed in Area 11. The open field area south of SM Building is now covered by Building 38.

No waste materials from the plutonium-238 program were buried or disposed of onsite. However, soils with low-level plutonium-238 contamination do exist in many areas. Sediments dredged from the plant drainage ditch in the early 1970s were dumped in the historic landfill and subsequently incorporated into the Site Sanitary Landfill when it was built in 1976. Additionally, as part of engineering and construction projects at Mound Plant, radiation surveys for plutonium-238 are conducted routinely. As a general practice, if no plutonium or thorium is detected by soil screening, soils are placed in the

Spoils Disposal Area, located in the southwestern central portion of the plant. If levels are higher, the soils must be packaged for offsite disposal. Prior to the construction of the Spoils Disposal Area in 1985, a portion of the west slope of the SM/PP hillside was used for soil disposal.

Investigations by the Site Survey Project included several plutonium-238 disposal areas. Portions of the soils in the cover of the Site Sanitary Landfill are known as Area 18. The Spoils Disposal Area was not specifically addressed, as it is an engineered structure in which administrative control is maintained.

There are no known plutonium disposal areas that were not included in the Site Survey Project.

4.1.1. Area 1

Area 1 is located on the southwestern side of the SM/PP Hill (Plate 1). The area includes the general area that surrounds Building 21, but extends eastward to include an old plutonium waste package storage area, known as the SM field area in Figure 4.1. The area around Building 21 was contaminated with thorium from fugitive dust emissions from the handling and loading of thorium sludges into the building in 1966. These activities and the resulting thorium contamination are described in section 5. The eastward extension of Area 1 encompasses the open gravel pad area used for storage of recoverable plutonium waste packages in 1965 and 1966. Until the early 1970s, the gravel pad was additionally used for the staging of plutonium waste packages waiting offsite shipment. Although the Site Survey Project Report (Stought et al. 1988) reported that the packages leaked in 1969, no documentation of this event was found during the research for the report. Area 1 has a complex history of partial cleanups, as described in detail in subsection 5.2.

Area 1, as identified in Plate 1, covers essentially the same area as the Area 1 identified in the original Site Survey Project Report. The results for the locations sampled for plutonium content within Area 1 are given in Table IV.2. Contours of equal concentration of plutonium-238, known as isopleths, are depicted on Plate 4. The maximum plutonium-238 concentration measured in samples taken within Area 1 was 34,000 pCi/g, from the surface sample taken at location S0997 on Plate 1 (Table IV.2). It is not known if additional sampling was performed to confirm this plutonium value, which was apparently taken after a partial cleanup (see subsection 5.2). In general, the maximum concentrations of plutonium-238 were detected in samples taken at locations near Building 21, east and north of Building 21, along the drainage channel to the south, and at the beginning of the drainage channel that extends south onto the new property (Plate 4). Subsurface contamination as high as 17,000 pCi/g of plutonium-238 may remain in the historic SM field area (see subsection 5.2).

Table IV.2. Mound Site Survey Project - Area 1

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)
S0710	3425	4135	5854	07-84	0	0.30	b					
S0712	3475	4085	5856	07-84	0	7.84	25.25					
S0714	3525	3985	5857	07-84	0	3.01	b					
S0716	3545	4040	10466	08-85	0	3.06	b					
S0717	3550	4030	10465	08-85	0	12.05	b					
S0718	3550	4035	4020	10-83	0	0.28	b					
S0719	3555	4020	10464	08-85	0	17.10	b					
S0720	3560	4015	10463	08-85	0	25.00	b					
S0721	3565	4010	10462	08-85	0	20.40	b					
S0722	3570	4000	10461	08-85	0	28.30	10.20					
S0724	3575	3860	5858	07-84	0	88.40	4.03					

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.
[c]Boring logs indicate that these locations were sampled to bedrock (Appendix B).
[d]Boring logs indicate that these locations were not sampled to bedrock (Appendix B).
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
None - No MRC ID was assigned because *in situ* gamma spectroscopy for thorium-232 was performed. The report on this procedure is provided in Appendix B.
NR - No result given
pCi/g - picocuries per gram
pCi/mL - picocuries per milliliter

Table IV.2. (page 2 of 12)

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)
S0725	3575	3990	10460	08-85	0	119.00	8.50					
S0726	3580	3980	10459	08-85	0	163.00	32.60					
S0727	3583	3975	10458	08-85	0	36.80	6.10					
S0728	3585	3970	10457	08-85	0	116.00	20.40					
S0729	3590	3960	10456	08-85	0	45.90	b					
S0730	3595	3950	10455	08-85	0	15.50	b					
C0179	3580	3480	1289	12-82	18	1103.00	b					
			1290	12-82	36	39.00	b					
S0788	3550	3480	7234	09-84	0	234.00	b					
S0791	3575	3555	4146	11-83	0	0.40	b	0.49				
S0853	3375	4240	5862	07-84	0	97.50	13.69					
S0855	3425	4140	5863	07-84	0	1.29	b					
S0856	3475	4165	4022	10-83	0	1.10	b					
S0936	3700	3920	5927	07-84	0	0.65	b					
S0953	3925	3945	5950	07-84	0	0.07	b					
S0965	3925	3325	5963	07-84	0	0.77	b					
S0967	3950	3275	5962	07-84	0	0.51	b					

Table IV.2. (page 3 of 12)

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)
C0200	3675	3275	1279	12-82	18	0.25	b					
S0983	3625	3325	4517	01-84	0	0.28	b	0.28				
S0984	3650	3275	5939	07-84	0	2.95	b					
S0985	3675	3250	5940	07-84	0	8.53	7.73					
S0986	3875	3250	2943	10-83	0	1.54	7.13					
S0987	3875	3350	5942	07-84	0	1.36	b					
C0201[c]	3600	3380	8279	10-84	42	1.57	b					
			8280	10-84	108	1.88	b					
S0988	3605	3475	4531	01-84	0	0.40	b	1.67				
S0989	3605	3480	4528	01-84	0	93.30	b	1.18				
C0202	3625	3480	1287	12-82	18	13.04	b					
			1288	12-82	36	1.66	b					
S0990	3625	3630	7208	09-84	0	5.60	b					
S0991	3625	3680	7207	09-84	0	2.29	b					
S0992	3635	3580	4527	01-84	0	637.90	NR					
S0993	3650	3630	4526	01-84	0	6.73	b	0.17				
S0994	3650	3680	7206	09-84	0	5.67	18.99					
C0203[d]	3650	3760	7810	10-84	90	0.39	b					
			7811	10-84	180	0.04	b					

Table IV.2. (page 4 of 12)

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)
C0204	3675	3405	1281	12-82	18	1.21	b					
			1282	12-82	36	0.09	b					
C0205	3675	3515	1285	12-82	18	478.00	2.38					
			1286	12-82	36	124.00	2.90					
S0995	3705	3400	4530	01-84	0	3.85	b					
C0206	3725	3425	1271	12-82	18	0.01	b					
C0207	3725	3630	1277	12-82	18	67.00	b					
			1278	12-82	36	1.27	b					
C0208	3725	3680	1292	12-82	18	186.00	36.87					
			1293	12-82	36	4.45	3.01					
C0209	3730	3635	1294	12-82	18	2.00	b					
			1295	12-82	36	2.13	b					
C0210	3750	3605	1291	12-82	18	2.11	b					
S0996	3775	3405	4524	01-84	0	6.28	b	0.16				
S0997	3800	3450	1464	03-83	0	34,000	NR					
C0211	3780	3465	1273	12-82	18	2.41	10.16					
			1274	12-82	36	0.08	b					
C0212	3780	3505	1275	12-82	18	2.72	13.13					
			1276	12-82	36	0.07	b					
S0998	3800	3405	4519	01-84	0	1.12	b					
S0999	3800	3530	4522	01-84	0	6.80	b					

Table IV.2. (page 5 of 12)

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)
S1000	3800	3630	7205	09-84	0	1.27	b		LDL	0.6	1.1	LDL
S1001	3825	3405	4520	01-84	0	0.24	b	0.19				
S1002	3850	3400	1465	12-83	0	102.00	54.30					
S1003	3850	3430	4521	01-84	0	2.05	b	0.19				
C0215	3540	4100	2708	09-83	60	0.02	b		LDL	LDL	0.9	LDL
			2709	09-83	72	0.04	b					
			2710	09-83	96	0.01	b					
S1004	3720	3780	10553	08-85	0	7.58	b					
S1005	3720	3800	10528	08-85	0	4.21	b					
S1006	3720	3820	E-22	03-82	0	396.40	b					
S1007	3725	3820	E-8	03-82	0	216.30	b					
S1008	3730	3755	9137	05-85	0	124.20	b					
S1009	3730	3900	E-19	03-82	0	1.20	b					
C0217	3750	3740	2704	09-83	30	0.06	b					
S1010	3750	3795	E-17	03-82	0	23.30	b					
S1011	3760	3710	9136	05-85	0	56.20	8.79					
S1012	3760	3800	10554	08-85	0	13.00	b					
S1013	3760	3820	10529	08-85	0	1.34	b					

Table IV.2. (page 6 of 12)

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)
S1014	3775	4000	E-20	03-82	0	10.00	b					
S1015	3780	3870	E-18	03-82	0	30.00	b					
S1016	3800	3650	9135	05-85	0	0.14	b					
S1017	3800	3750	9233	05-85	0	0.31	b					
S1018	3800	3850	10530	08-85	0	23.70	b					
S1019	3805	3650	9134	05-85	0	0.36	b					
S1020	3810	3830	10555	08-85	0	23.50	b					
S1021	3810	3980	E-9	03-82	0	2.20	b					
S1022	3820	3610	9133	05-85	0	0.08	b					
S1023	3820	3700	9231	05-85	0	0.20	b					
S1024	3820	3895	10531	08-85	0	21.30	b					
S1025	3825	3590	9132	05-85	0	0.14	b					
S1026	3830	4130	E-10	03-82	0	33.70	b					
S1027	3840	3880	10556	08-85	0	6.16	b					
S1028	3850	3660	9229	05-85	0	0.56	b					
S1029	3850	3950	10532	08-85	0	4.20	b					
S1030	3860	3930	10557	08-85	0	12.80	b					

Table IV.2. (page 7 of 12)

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)
S1031	3870	3520	9131	05-85	0	2.86	b					
S1033	3880	3610	9227	05-85	0	0.70	b					
S1034	3890	3500	9130	05-85	0	0.95	b					
S1035	3895	3480	9129	05-85	0	0.61	b					
S1037	3900	3460	9128	05-85	0	0.99	b					
S1038	3900	3575	9225	05-85	0	1.07	b					
S1039	3900	3980	10558	08-85	0	8.52	b					
S1040	3900	4000	10533	08-85	0	5.58	2.50					
S1042	3925	3525	9223	05-85	0	0.55	b					
S1043	3930	4030	10534	08-85	0	52.30	5.80					
C0219	3940	3460	2698	08-83	30	0.02	b					
			2699	09-83	60	0.01	b		LDL	LDL	0.8	LDL
			2700	09-83	120	0.01	b					
S1044	3940	3480	9221	05-85	0	0.87	5.60					
S1046	3940	4020	10559	08-85	0	0.39	b					
S1047	3960	4070	10535	08-85	0	15.40	b					
S1049	3980	4060	10560	08-85	0	36.90	5.60					
S1051	4010	4110	10536	08-85	0	1.08	b					

Table IV.2. (page 8 of 12)

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)
S1052	4020	4090	10561	08-85	0	10.60	b					
S1053	4050	4140	10537	08-85	0	24.50	b					
S1054	4060	4120	10562	08-85	0	3.02	b					
S1055	4080	4200	10538	08-85	0	1.37	b					
S1056	4100	4180	10563	08-85	0	24.40	b					
S1057	4150	4220	10539	08-85	0	28.70	b					
S1058	4160	4200	10564	08-85	0	2.24	b					
S1059	4200	4230	10540	08-85	0	2.28	b					
S1060	4205	4205	10565	08-85	0	2.10	b					
S1061	4240	4260	10541	08-85	0	0.17	b					
S1062	4250	4240	10566	08-85	0	0.37	b					
S1063	4280	4300	10542	08-85	0	24.00	b					
S1064	4300	4280	10567	08-85	0	0.33	b					
S1065	4300	4340	10544	08-85	0	4.72	b					
C0263	3777.2	3245.3	None	04-84	0	NR	0.9					
			None	04-84	12	NR	0.6					
			None	04-84	36	NR	0.3					
			None	04-84	48	NR	0.3					
			None	04-84	60	NR	0.3					

Table IV.2. (page 9 of 12)

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)
C0264	3724.8	3254.3	None	04-84	0	NR	9.2					
			None	04-84	12	NR	1.7					
			None	04-84	24	NR	0.8					
			None	04-84	36	NR	0.5					
			None	04-84	48	NR	0.3					
C0265	3752.4	3322.9	None	04-84	0	NR	1.7					
			None	04-84	12	NR	1.3					
			None	04-84	24	NR	0.3					
			None	04-84	36	NR	0.3					
C0266	3808.2	3328.7	None	04-84	0	NR	1.0					
			None	04-84	12	NR	0.6					
			None	04-84	24	NR	0.4					
			None	04-84	36	NR	0.3					
			None	04-84	48	NR	0.4					
C0267	3670.8	3342.9	None	04-84	0	NR	0.4					
			None	04-84	12	NR	0.5					
			None	04-84	24	NR	0.4					
			None	04-84	36	NR	0.3					
C0268	3716.1	3400.6	None	04-84	0	NR	0.9					
			None	04-84	12	NR	0.4					
			None	04-84	24	NR	0.4					
			None	04-84	36	NR	0.4					
C0269	3751.3	3418.2	None	04-84	0	NR	0.6					
			None	04-84	12	NR	0.5					
			None	04-84	24	NR	0.2					
			None	04-84	36	NR	0.2					
			None	04-84	48	NR	0.3					

Table IV.2. (page 10 of 12)

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)
C0270	3791.9	3441.5	None	04-84	0	NR	0.3					
			None	04-84	12	NR	0.5					
			None	04-84	24	NR	0.5					
			None	04-84	36	NR	0.3					
			None	04-84	48	NR	0.3					
C0271	3865.9	3483.1	None	04-84	0	NR	0.6					
			None	04-84	12	NR	2.6					
			None	04-84	24	NR	0.5					
			None	04-84	36	NR	0.6					
			None	04-84	48	NR	0.3					
			None	04-84	60	NR	0.4					
			None	04-84	72	NR	0.3					
			None	04-84	96	NR	0.4					
			None	04-84	120	NR	0.4					
C0272	3801.1	3524.0	None	04-84	0	NR	0.6					
			None	04-84	12	NR	0.4					
			None	04-84	24	NR	0.5					
			None	04-84	36	NR	0.5					
			None	04-84	48	NR	<0.2					
C0273	3682.1	3413.3	None	04-84	0	NR	0.5					
			None	04-84	12	NR	0.9					
			None	04-84	24	NR	0.6					
			None	04-84	36	NR	0.4					
			None	04-84	48	NR	0.4					
			None	04-84	60	NR	0.3					

Table IV.2. (page 11 of 12)

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)
C0274	3737.9	3478.5	None	04-84	0	NR	0.5					
			None	04-84	12	NR	0.6					
			None	04-84	24	NR	0.3					
			None	04-84	36	NR	0.4					
C0276	3648.1	3642.8	None	04-84	0	NR	0.8					
			None	04-84	12	NR	0.9					
			None	04-84	24	NR	0.3					
			None	04-84	36	NR	0.4					
C0277	3640.5	3587.2	None	04-84	0	NR	0.5					
			None	04-84	12	NR	0.5					
			None	04-84	24	NR	0.4					
			None	04-84	36	NR	0.3					
C0278	3628.3	3542.0	None	04-84	0	NR	0.2					
			None	04-84	12	NR	0.3					
			None	04-84	24	NR	0.3					
C0279	3567.8	3565.3	None	04-84	0	NR	0.2					
			None	04-84	12	NR	0.3					
			None	04-84	24	NR	0.5					
C0280	3705.2	3710.7	None	04-84	0	NR	0.8					
			None	04-84	12	NR	0.9					
			None	04-84	24	NR	1.0					
C0281	3784.3	3591.4	None	04-84	0	NR	0.4					
			None	04-84	12	NR	1.0					
			None	04-84	24	NR	0.4					
			None	04-84	36	NR	0.4					
			None	04-84	48	NR	0.5					

Table IV.2. (page 12 of 12)

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)
C0282	3679.3	3500.9	None	04-84	0	NR	0.6					
			None	04-84	12	NR	0.4					
			None	04-84	24	NR	0.3					
			None	04-84	36	NR	0.4					
S1066	4320	4320	10568	08-85	0	55.40	b					
S1067	4340	4400	10544	08-85	0	14.30	b					
S1068	4350	4380	10569	08-85	0	6.19	b					
S1070	4360	4460	10545	08-85	0	0.28	b					
S1071	4380	4430	10570	08-85	0	11.30	b					
S1072	4410	4480	10546	08-85	0	36.90	b					
S1073	4420	4450	10571	08-85	0	2.50	b					

4.1.2. Area 11

Area 11 is located on the SM/PP Hill directly west of the SM Building (Plate 1). From the early 1960s to 1965, this area was used for the storage of plutonium-contaminated equipment and waste packages from the SM Building. Some of the drums of recoverable plutonium wastes were found to be leaking in 1964 and were moved to the open field south of SM Building for overpacking. The boundaries of Area 11 shown on Plate 1 are similar to the area depicted in the original Site Survey Project Report (Stought et al. 1988).

Five core locations were sampled in Area 11 during the Site Survey Project (Table IV.3). The samples were analyzed for plutonium-238 and thorium. The maximum thorium concentration measured was 5.65 pCi/g in a sample taken at a depth of 18 inches at core location 0141 (C0141 on Table IV.3). The maximum plutonium concentration measured was 870 pCi/g in the sample taken 18 inches deep at core location 0138 (C0138 on Table IV.3).

The concentrations of plutonium and thorium shown in Table IV.3 agree with the assessment of Area 11 given in the original report. However, the original Site Survey Project Report noted that more recent D&D data for Area 11 indicated plutonium-238 contamination in the 10 to 100 nanocuries per gram (nCi/g) (10,000 to 100,000 pCi/g) range. This was confirmed by the sampling performed in Area 11 in 1989 as part of the D&D Program, Operable Unit 6, reconnaissance sampling. This sampling found levels of plutonium as high as 64,000 pCi/g (64 nCi/g) and thorium as high as 69 pCi/g (DOE 1992d).

The maximum depth of the core locations sampled in Area 11 during the Site Survey Project was 108 inches (Table IV.3). Mound Plant drawing #FSE16472, reproduced in the Site Scoping Report: Volume 2 Addendum (DOE 1992f) indicates the depth to bedrock in this area of Mound Plant to be 120 to 228 inches (10 to 19 ft), although it may be as shallow as 96 inches (8 ft) or less. Because the boring logs are not available, it is not known if the Area 11 core locations were sampled to bedrock.

4.1.3. Area 14

Area 14 is located on the southern slope of the Main Hill, below the WD Building (Plate 1). Area 14 is the original site of the 1969 waste-line break. In January 1969, the pressurized length of the WTS waste line broke at the upper portion of the slope, releasing about 400 Ci of plutonium-238 in a nitric acid solution to the surrounding soils. The events are described in "Reinvestigation of the January, 1969 Plutonium-238 Waste Transfer Line Break" (MRC 1974). Erosion of soils from Area 14 are interpreted to have contributed to contamination of areas downslope in Area 3 and the Miami-Erie Canal, described in a companion thorium section of this report (Rodgers 1975; Robinson et al. 1974).

Table IV.3. Mound Site Survey Project - Area 11

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)
C0137	2875	2450	1285	12-82	18	4.78	2.38
			1286	12-82	36	1.24	2.90
C0138	2875	2340	1353	12-82	18	870.60	b
			1354	12-82	36	9.17	b
			1355	12-82	54	549.40	b
C0139	2875	2390	1555	04-83	18	2.71	3.38
			1556	04-83	36	0.53	2.94
			1557	04-83	54	0.41	b
			1558	04-83	72	0.24	3.13
			1559	04-83	90	0.03	b
			1560	04-83	108	0.48	b
C0141	2880	2400	1550	04-83	18	5.96	5.65
			1551	04-83	36	2.28	b
			1552	04-83	54	0.55	2.64
			1553	04-83	72	1.70	b
			1554	04-83	90	0.44	b
C0142	2900	2390	1356	12-82	18	76.10	2.12
			1357	12-82	36	1.03	b
C0143	2900	2415	1180	12-82	18	0.48	b
			1181	12-82	36	0.51	b
			1182	12-82	54	0.77	b
			1183	12-82	72	0.14	b
			1184	12-82	90	0.02	b

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

FIDLER - field instrument for the detection of low-energy radiation

MRC ID - Monsanto Research Corporation Identification

pCi/g - picocuries per gram

Several remedial actions to remove plutonium-contaminated soils have been performed by the D&D Program in this area, including 964 ft^3 of highly contaminated soil was removed and shipped to Maxey Flats, Kentucky, for burial in 1969; and in 1974, 2,700 ft^3 of soil containing 35 Ci of plutonium-238 was removed and shipped to Idaho National Engineering Laboratory (Black 1974).

Limited sampling was performed in Area 14 during the Site Survey Project because remedial actions by the D&D Program were pending. The results of the sampling are given in Table IV.4 and the sampling locations are shown on Plate 1. The maximum plutonium-238 and thorium concentrations measured were 133.9 and 2.24 pCi/g, respectively, in a sample taken 18 inches deep at core location C0094 on Plate 1 (Table IV.4). However, the Site Survey Project original report notes that activity as high as 3,500 nCi/g was measured in Area 14 during the D&D Program activities.

Additional soil removal was completed in January 1991 by D&D in this area, using a cleanup level of 100 pCi/g of plutonium-238. A verification plan to confirm cleanup levels in Area 14 was prepared and implemented by Argonne National Laboratory (Mosho and Robinet 1990). The verification report on this area indicates that there is a 90 percent confidence that the mean plutonium-238 concentration for surface soils is now no greater than 13 pCi/g, and the mean for subsurface soils is now no greater than 29 pCi/g (Mosho and Robinet 1990).

4.1.4. Area 16

Area 16, also known as the SM Leach Field, is located on the western slope of the SM/PP Hill, near Building 30 (Plate 1). Area 16 reportedly contained a sanitary sewage septic tank and septic leach field formerly used for the SM Building. The area contains plutonium-238 contamination, possibly from the sanitary sewage system or from a storm sewer present in the area. The boundaries of Area 16 shown on Plate 1 are similar to the area depicted in the original Site Survey Project Report (Stought et al. 1988), except the area on Plate 1 has been extended westward to the plant drainage ditch to be consistent with current D&D Program plans. Concurrently with the writing of this report, the D&D Program is removing radioactively contaminated soils from Area 16. During this field activity, the septic tank was not present. No documentation of its removal was found. The lower part of the slope was found to possess plutonium-238 levels as high 8 nCi/g, but these levels are unsubstantiated at this writing. Elevated levels of plutonium-238 at the base of this slope and along the contiguous portions of the former upper reach of the plant drainage ditch were recognized during the investigations in 1974. These are shown on Figure 1.2.

Table IV.5 presents the results of the Site Survey Project sampling in Area 16. The maximum plutonium-238 concentration measured was 144 pCi/g in the sample taken at 36 inches at core

Table IV.4. Mound Site Survey Project - Area 14

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)
S0468	2025	3825	6292	08-84	0	0.17	b		LDL	LDL	1.2	LDL
S0469	2025	3860	6291	08-84	0	18.90	b					
S0486	2125	3810	6706	08-84	0	10.27	b					
S0487	2125	3835	6704	08-84	0	5.96	b					
S0488	2135	3835	6703	08-84	0	18.77	b					
S0489	2150	3860	6705	08-84	0	14.10	b					
C0094	2160	3835	1595	04-83	18	133.90	2.24					
			1596	04-83	36	59.90	b					
			1597	04-83	54	70.90	b					
			1598	04-83	72	6.81	b					
			1599	04-83	90	11.82	b					
			1600	04-83	108	1.24	b					
			1601	04-83	126	3.54	b					
C0095	2160	3900	1602	04-83	18	7.87	b					
			1603	04-83	54	3.97	b					
			1604	04-83	72	7.49	b					
			1605	04-83	90	5.00	b					
			1606	04-83	108	5.05	b					
			1607	04-83	126	6.63	b					
C0096	2190	3875	1608	04-83	18	0.27	b					
			1609	04-83	36	2.18	b					
			1610	04-83	54	0.26	b					
			1611	04-83	72	0.45	b					
			1612	04-83	90	1.46	b					
			1613	04-83	108	0.62	b					
			1614	04-83	126	0.09	b					
			1615	04-83	144	0.07	b					

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

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

pCi/g - picocuries per gram

pCi/mL - picocuries per milliliter

Table IV.5. Mound Site Survey Project - Area 16

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)
S0347	2475	2440	4103	10-83	0	1.65	b					
C0046	2440	2550	10109	07-85	18	0.21	b					
			10110	07-85	42	1.42	b					
C0047	2485	2470	10106	07-85	18	29.10	b					
			10107	07-85	36	1.45	b					
			10108	07-85	54	0.02	b					
C0048	2500	2480	10103	07-85	18	0.23	b					
			10104	07-85	36	1.30	b					
			10105	07-85	54	0.06	b					
C0049	2515	2460	10100	07-85	18	2.30	b					
			10101	07-85	36	0.51	b					
			10102	07-85	54	0.17	b					
C0050	2530	2430	10097	07-85	18	0.39	b					
			10098	07-85	36	0.60	b					
			10099	07-85	54	0.11	b					

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.
[c]MRC IDs 10119 and 10120 were also assigned to the samples from core location C0059, also in Area 16.
[d]MRC IDs 10121 to 10124 were also assigned to the samples from core location C0060, also in Area 16.
[e]MRC IDs 10125 to 10128 were also assigned to the samples from core location C0061, also in Area 16. MRC ID 10128 was also assigned to the samples taken at 72 and 90 inches at C0058.
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

Table IV.5. (page 2 of 4)

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)
C0051	2540	2385	10111	07-85	18	0.99	b					
			10112	07-85	36	1.76	b					
			10113	07-85	54	0.16	b					
			10114	07-85	72	0.11	b					
			10115	07-85	90	0.40	b					
			10116	07-85	108	0.01	b					
S0348	2500	2540	4104	10-83	0	2.78	b	0.35	LDL	LDL	0.8	LDL
S0349	2500	2565	6549	08-84	0	3.55	b		LDL	LDL	1.2	LDL
S0350	2525	2365	6770	08-84	0	23.60	b					
S0354	2550	2465	6550	08-84	0	2.22	b					
C0052	2555	2405	10093	07-85	18	2.92	b					
			10094	07-85	36	8.12	b					
			10095	07-85	54	0.30	b					
			10096	07-85	72	0.36	b					
S0352	2550	2415	6769	08-84	0	37.80	b					
C0053	2570	2400	10085	07-85	18	68.50	b					
			10086	07-85	36	3.98	b					
			10087	07-85	54	0.79	b					
			10088	07-85	72	0.45	2.21					
C0054	2570	2380	10089	07-85	18	2.24	b					
			10090	07-85	36	43.10	b					
			10091	07-85	54	2.30	b					
			10092	07-85	84	1.76	b					
C0056[c]	2590	2420	10117	07-85	18	75.20	b					
			10118	07-85	36	144.00	b					
			10119	07-85	54	11.10	b					
			10120	07-85	72	3.20	b					

Table IV.5. (page 3 of 4)

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)
C0057[d]	2600	2405	10121	07-85	18	16.5	b					
			10122	07-85	36	7.73	b					
			10123	07-85	54	0.54	b					
			10124	07-85	72	0.42	2.56					
S0355	2600	2465	4106	10-83	0	4.49	b					
C0058[e]	2605	2395	10125	07-85	18	0.82	b					
			10126	07-85	36	0.73	3.46					
			10127	07-85	54	0.33	b					
			10128	07-85	72	1.08	b					
			10128	07-85	90	0.20	b					
C0059[c]	2610	2415	10119	06-85	54	NR	NR		LDL	LDL	0.6	LDL
			10120	06-85	72	NR	NR		LDL	LDL	0.7	LDL
C0060[d]	2620	2400	10121	06-85	18	NR	NR		LDL	LDL	0.8	LDL
			10122	06-85	36	NR	NR		LDL	LDL	1.0	LDL
			10123	06-85	54	NR	NR		LDL	LDL	0.8	LDL
			10124	06-85	72	NR	NR		LDL	LDL	0.8	LDL
S0356	2625	2365	4107	10-83	0	18.90	b					
C0061[e]	2630	2390	10125	06-85	18	NR	NR		LDL	LDL	0.9	LDL
			10126	06-85	36	NR	NR		LDL	LDL	1.2	LDL
			10127	06-85	54	NR	NR		LDL	LDL	0.8	LDL
			10128	06-85	72	NR	NR		LDL	LDL	0.8	LDL
			10129	06-85	90	NR	NR		LDL	LDL	1.0	LDL
C0062	2675	2315	1224	12-82	18	33.60	b					
			1225	12-82	36	0.31	b					
			1226	12-82	54	34.50	2.53					
			1227	12-82	108	1.07	b					
			1228	12-82	126	0.12	b					

Table IV.5. (page 4 of 4)

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)
S0357	2675	2340	6771	08-84	0	43.70	b					
C0075	2400	2620	8383	11-84	54	4.94	b					
			8384	11-84	90	0.25	2.73					
S0650	2400	2565	2832	10-83	0	1.29	b					

location C0056 on Plate 1 (Table IV.5). The maximum thorium concentration measured was 3.46 pCi/g in the sample taken 36 inches deep at core location C0058 on Plate 1 (Table IV.5).

Thirteen samples collected in Area 16 were analyzed by gamma spectroscopy (samples from locations C0059, C0060, C0061, SO348, and SO349 on Table IV.5). Radium-226 was the only radionuclide detected above the LDLs, at a maximum concentration of 1.2 pCi/g.

During core sampling performed in Area 16 in 1989, bedrock was encountered at depths ranging from 108 to 162 inches (9 to 13.5 ft) (Price 1989). The core locations sampled in the area as part of the Site Survey Project were sampled to depths from 72 to 126 inches. Because the boring logs for the Site Survey Project coring are not available, it is not known if individual Area 16 boreholes were sampled to bedrock, although this appears to be possible.

4.1.5. Area 17

Area 17 is located on the SM/PP Hill, under and surrounding the SM Building (Plate 1). The SM Building served as the central point of plutonium-238 processing in the early to mid-1960s (DOE 1992c). Plutonium processing operations in the SM Building and the storage of plutonium materials in tanks on the southwestern side of the building resulted in the release of plutonium to the soils under the concrete floor of the building and to the soils surrounding the building. Sampling performed in 1972 indicated that about 11.2 curies of plutonium-238 were present under or around the SM Building (Flanagan 1976). The SM Building is currently being decommissioned by the Mound Plant D&D Program. The concrete floor, contaminated soil, and drains with contamination in excess of 10 nCi/g, have been removed. In addition, the northern portion of the structure, known as the SM annex, has been removed. The cleanup level for this effort was 100 pCi/g. Since the D&D of Area 17 is an ongoing project, the Area 17 boundaries (Plate 1) are, by design, similar to the boundaries depicted in the original Site Survey Project Report (Stought et al. 1988).

The Site Survey Project sampling locations in Area 17 are shown on Plate 1. No sampling was performed inside the SM Building, potentially where the highest concentrations (10 nCi/g or greater) exist. (No sampling was performed in buildings during the project.) The analytical results of the sampling are given in Table IV.6. The maximum plutonium-238 concentration measured was 494 pCi/g in a sample taken at a depth of 18 inches at core location 0122 on Plate 1 (C0122 on Table IV.6). The maximum thorium concentration measured was 9.99 pCi/g in the sample taken at a depth of 54 inches at core location C0130 (Table IV.6). The original Site Survey Project Report noted that D&D Program screening in Area 17 showed plutonium-238 concentrations much higher than the Site Survey Project.

Table IV.6. Mound Site Survey Project - Area 17

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)
S0579	2775	2135	6374	08-84	0	3.94	b		LDL	LDL	0.9	LDL
S0580	2775	2160	6373	08-984	0	2.08	b					
C0119	2735	2210	1323	12-82	18	17.81	b					
			1324	12-82	36	1.78	b					
			1325	12-82	54	9.98	b					
			1326	12-82	72	2.29	b					
			1327	12-82	90	17.90	b					
			1328	12-82	120	6.24	b					
C0120	2805	2195	1329	12-82	18	83.70	b					
			1330	12-82	36	32.30	b					
			1331	12-82	54	0.18	b					
			1332	12-82	72	0.29	b					
			1333	12-82	90	83.00	b					
			1334	12-82	120	6.92	b					
			1335	12-82	144	0.56	b					
C0121	2810	2095	1309	12-82	18	5.08	b					
			1310	12-82	36	0.30	b					
S0581	2900	2010	6372	08-84	0	10.10	b					
S0582	2900	2085	2880	10-83	0	146.80	b					
C0122	2925	2010	1298	12-82	18	494.00	b					
			1299	12-82	36	0.68	b					
			1300	12-82	54	0.25	b					
			1301	12-82	72	0.39	b					
S0583	2950	2035	2881	10-83	0	7.96	b					
S0584	2950	2060	6371	08-84	0	18.80	b					

Table IV.6. (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)
C0123	2975	2115	1364	12-82	18	2.91	b					
			1365	12-82	36	0.51	b					
			1366	12-82	54	0.23	b					
C0125	3085	2185	1358	12-82	18	0.43	b					
			1359	12-82	36	0.25	3.11					
			1360	12-82	54	33.60	b					
			1361	12-82	72	0.13	3.25					
			1362	12-82	90	1.97	b					
			1363	12-82	108	0.19	b					
C0126	2725	2265	1319	12-82	18	5.57	b					
			1320	12-82	36	79.00	b					
			1321	12-82	54	6.51	b					
			1322	12-82	72	0.37	b					
C0130	2800	2265	1336	12-82	18	48.10	b					
			1337	12-82	36	1.41	b					
			1338	12-82	54	1.25	9.99					
			1339	12-82	90	0.39	b					
			1340	12-82	108	0.37	b					
C0137	2875	2290	1285	12-82	18	4.78	2.38					
			1286	12-82	36	1.24	2.90					

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

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 of radium-226.

MRC ID - Monsanto Research Corporation identification

pCi/g - picocuries per gram

pCi/mL - picocuries per milliliter

However, it is probable that limited sampling was performed during the Site Survey Project due to the upcoming D&D of the SM Building. Screening during the 1989 reconnaissance indicated plutonium-238 concentrations up to 3,300 pCi/g (DOE 1992d).

The Area 17 sampling results given in Table IV.6 do not agree with the assessment given in the original report. These differences lie in the reported thorium and radium-226 concentrations. The data summary in the original report indicated no measurements of radium in the soil, and showed concentrations of thorium between approximately 100 and 1,000 pCi/g. Table IV.6 presents the actual data which include one surface soil sample that contained 0.9 pCi/g of radium-226 and five core samples that exceeded the background level for thorium of 2.0 pCi/g. Thorium concentrations in the five samples ranged from 2.38 to 9.99 pCi/g, but did not exceed the 100 pCi/g level indicated in the original data summary (Stought et al. 1988). The results for cesium-137 at location S0579 were below the detection limit of 0.5 pCi/g. No other samples in the area are known to have been analyzed by gamma spectroscopy. The potential for cesium-137 contamination does exist in the area, as the SM Building site encloses the historic site of Warehouse 13, used in the 1950s for storage of waste sludges from the Reactor Waste Decontamination Project, described in companion section 9 of this report.

Mound Plant drawing #FSE16472, reproduced in the Site Scoping Report: Volume 2 Addendum (DOE 1992f) indicates the depth to bedrock in this area is 48 to 180 inches (4 to 15 ft). The Area 17 core locations were sampled to a maximum depth of 144 inches, but the total depths ranged from as low as 36 inches (Table IV.6). Therefore, it appears that some of the Area 17 coreholes may have been sampled to bedrock, although the boring logs are not available to confirm this.

4.1.6. Area 18

Area 18 is located adjacent to the overflow pond on the western border of Mound Plant (Plate 1). The area is described in many historical documents as the cover of the Site Sanitary Landfill. Contamination reportedly resulted from contaminated sediments being incorporated into the cover materials. Sediments, containing plutonium-238, from the plant drainage ditch were apparently dumped at the historic landfill in the early 1970s and were then incorporated into the Site Sanitary Landfill when it was built in 1977. It is reasonable to assume that the landfill liner, berms, and cover also received contaminated soils (DOE 1991a). The southwestern portion of Area 18 overlaps Area 2, where crushed thorium drums were buried. The extent of Area 18 shown in Plate 1 and the sample results discussed below appear to be similar to the area and samples given in the original Site Survey Project Report (Stought et al. 1988).

Core samples of the landfill cover material were taken at three locations during the Site Survey Project. These were locations C0185, C0187, and C0188 (Plate 1; Table IV.7. A limited number of locations were sampled and later replugged, in order to maintain the integrity of the landfill cover. The maximum plutonium-238 concentration found in the core samples was 3.71 pCi/g in the sample taken at a depth of 126 inches at location C0187 (Table IV.7). Bedrock was not encountered during the drilling of these core locations because the depths were limited in order to avoid the buried materials located within the Site Sanitary Landfill.

Eleven surface samples were taken in Area 18 (0862, 0864, 0866, 0867, 0869, 0870, 0872, 0873, 0874, 0877, and 0878 on Plate 1). The maximum plutonium-238 concentration measured in the samples from these surface samples was 0.98 pCi/g at location S0878 (Table IV.7). No thorium concentrations above 2 pCi/g were detected in any of the Area 18 samples (core or surface).

4.1.7. Area 19

The gravity portion of the underground WTS, which consisted of two waste lines travelling from the SM Building to Building 41, was located in Area 19 (Figure 4.1 and Plate 1). Figure 4.1 shows the former location of the WTS. The location and extent of Area 19 shown on Plate 1 was identified based on the verification sampling locations, which are designated 19-1 through 19-62. The waste lines that comprised the WTS actually extended into Area 14. During the Site Survey Project, no sampling was performed at Area 19, because this area was being addressed by the D&D Program.

The major portions of these lines in Area 19 were removed from 1982 to 1984; work continued on the portion of the lines just south of the WD Building until about 1986. As the waste lines were removed, the adjacent soils in the trench were screened, and contaminated soil was removed. The verification survey performed to document the removal of contaminated soil near these lines is discussed in "Verification Survey of the WTS Excavation Area at the Mound Facility" (Stenhouse and Kirsch 1986). It is not known how much soil was removed.

Removal of the waste lines included the excavation and removal of soils contaminated by leaks in the waste lines. The target cleanup level for actinides, mostly plutonium-238 with thorium-232 at some locations, was 100 pCi/g, which is equal to 4.5×10^{-6} ppm. The waste line removal was performed under the Mound Plant D&D Program, which followed a cleanup level of 100 pCi/g for plutonium-238 and 25 pCi/g as the as low as reasonably achievable (ALARA) level.

A study to verify the cleanup of Area 19 was performed by Battelle in 1986 and included the analysis of 248 soil samples from a total of 62 locations. One surface sample and three subsurface samples

Table IV.7. *Mound Site Survey Project - Area 18*

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)
S0862	2850	4620	6492	08-84	0	0.08	b
S0864	2875	4595	6490	08-84	0	0.50	b
S0866	2900	4495	6487	08-84	0	0.20	b
S0867	2900	4545	2589	09-83	0	0.28	b
S0869	2925	4620	2591	09-83	0	0.02	b
S0870	2950	4620	2592	09-83	0	0.87	b
C0185	2960	4605	10058	07-85	0	0.55	b
			10059	07-85	18	0.18	b
			10060	07-85	36	0.12	b
			10061	07-85	54	0.23	b
			10062	07-85	72	0.37	b
			10063	07-85	90	0.42	b
			10064	07-85	108	0.31	b
			10065	07-85	126	0.29	b
			10066	07-85	144	1.04	b
			10067	07-85	162	1.76	b
			10068	07-85	180	1.74	b
			10069	07-85	198	0.47	b
			10070	07-85	216	0.76	b
			10071	07-85	234	0.49	b
S0872	2975	4645	6491	08-84	0	0.12	b
S0873	2990	4620	2593	08-84	0	0.30	b
C0187	2995	4630	10072	07-85	18	0.10	b
			10073	07-85	36	0.02	b
			10074	07-85	54	0.02	b
			10075	07-85	72	0.21	b
			10076	07-85	90	0.55	b
			10077	07-85	108	0.51	b
			10078	07-85	126	3.71	b
			1007	07-85	144	0.60	b
			100	07-85	162	0.22	b
			100	07-85	180	0.22	b
			1008	07-85	198	0.23	b
			1008	07-85	216	0.80	b
			1008	07-85	234	0.12	b

(The MRC IDs for the last 6 samples of this core were obscured in the data. The sequence is probably 10079 through 10084)

Table IV.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)
C0188	3000	4520	7806	10-84	90	0.01	b
			7807	10-84	180	0.01	b
S0874	3025	4575	2603	10-83	0	0.24	b
S0877	3035	4640	6388	08-84	0	0.52	b
S0878	3035	4705	6387	08-84	0	0.98	b

[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 2.0 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).

FIDLER - field instrument for the detection of low-energy radiation

MRC ID - Monsanto Research Corporation identification

pCi/g - picocuries per gram

were taken at each location. Table IV.8 gives the locations and the sampling patterns. These locations were plotted on Plate 1; Area 19 was identified based on these locations. The verification sampling was apparently performed after the trench was backfilled. With a few exceptions, the Battelle report indicates that the greatest depth at which contamination typically exceeded 25 pCi/g before removal was approximately 3 to 4 ft (Stenhouse and Kirsch 1986). Assuming that the depth of the backfilled soil was, at a minimum, 3 ft, it is probable that three samples were taken of the backfill material at 1, 2, and possibly 3 ft. It is not known how much backfill was placed in the trench.

Table IV.9 gives the analytical results for the verification survey of Area 19. The plutonium-238 analyses were performed using a Phoswich™ detector coupled to a multichannel analyzer. The system was calibrated to detect the low-energy gamma emissions from plutonium-238, correcting for the presence of thorium-232 as necessary. The LDL for this system was 20 pCi/g for a 400-second count. Twenty-five, or 10 percent, of the samples were also radiochemically analyzed for plutonium-238 by an independent laboratory to confirm the Phoswich™ results. In general, the plutonium-238 levels measured by both methods were comparable, with some inconsistencies for samples containing thorium-232 or having a low sample weight (Stenhouse and Kirsch 1986).

The verification study concluded that more than 90 percent of the samples analyzed contained levels of plutonium-238/thorium-232 within one standard deviation of the 100 pCi/g cleanup level. Samples taken at test hole numbers 7, 14, 22, and 23 contained plutonium-238 in excess of 100 pCi/g (Table IV.9). Contaminated soil was removed from test hole numbers 14 and 22 (Tables IV.8 and IV.9) in September 1990 and was boxed and disposed of by the D&D Program. Samples taken of the excavation walls in 1990 showed plutonium-238 levels to be less than 100 pCi/g after the excavation was completed. This soil removal was documented in an internal Mound Plant memorandum (Rader 1990).

4.1.8. Area D

Area D is located on the SM/PP Hill, adjacent to Area 12, and is the location of an acid-leach field for Building 38, also know as the PP Building (Plate 1). The acid leach field was designed so that a pipe extending from trays holding polypropylene tanks containing nitric acid for use in plutonium-238 processing would release nitric acid to the acid leach field in the event of leaks or spills. The leach field contained limestone gravel/rocks that had been placed there in order to neutralize the nitric acid. Both the pipe and the limestone were below ground surface, but the exact depths are unknown.

One core location was sampled in the apparent vicinity of the Area D acid-leach field. This is location C0146 on Table IV.10 and location 0146 on Plate 1. No significant plutonium-238 or thorium activity

Table IV.8. Sampling Locations for Verification Survey of Former Waste Transfer System Pipeline

Test Hole Number[a]	Coordinates South	Coordinates West	Elevation (feet)	Subsurface Sampling Pattern[b,c]
1	2,917.99	2,389.22	877.1	1, 2, 6
2	2,905.89	2,474.63	873.0	3, 4, 6
3	2,901.81	2,419.20	875.8	3, 4, 8
4	2,893.98	2,435.14	874.7	2, 4, 5
5	2,901.09	2,446.61	874.4	3, 4, 8
6	2,899.40	2,459.51	873.8	2, 4, 7
7	2,884.00	2,478.77	872.5	4, 5, 3
8	2,890.94	2,492.89	869.8	2, 7, 8
9	2,906.29	2,498.91	866.0	2, 5, 7
10	2,912.81	2,533.61	858.9	3, 4, 6
11	2,891.07	2,567.69	846.2	3, 5, 7
12	2,864.84	2,607.83	833.7	1, 4; 5
13	2,843.67	2,646.08	824.4	2, 5, 7
14	2,817.72	2,694.28	812.8	2, 5, 7
15	2,791.35	2,735.84	802.4	2, 5, 8
16	2,775.76	2,764.85	795.0	2, 4, 6
17	2,736.96	2,825.90	778.6	1, 3, 4
18	2,712.64	2,869.02	769.5	1, 3, 4
19	2,684.47	2,910.83	762.9	3, 4, 6
20	2,659.29	2,958.42	760.0	2, 3, 8
21	2,635.91	2,996.07	753.6	4, 6, 7
22	2,611.46	3,042.02	748.4	3, 4, 5
23	2,613.27	3,060.62	748.4	2, 3, 8
24	2,607.32	3,049.10	746.2	3, 4, 7
25	2,586.23	3,081.72	751.3	1, 2, 3
26	2,574.70	3,085.81	751.9	1, 5, 6
27	2,561.41	3,096.70	751.8	3, 4, 5
28	2,544.13	3,100.38	752.1	1, 3, 4
29	2,528.50	3,080.17	753.5	3, 5, 7
30	2,518.45	3,114.58	752.1	1, 3, 4
31	2,505.45	3,126.78	750.7	1, 6, 7
32	2,490.97	3,176.97	750.2	1, 4, 5
33	2,517.09	2,936.47	749.8	4, 5, 8
34	2,461.90	3,266.02	749.7	3, 4, 7
35	2,448.51	3,312.99	748.2	2, 5, 6
36	2,438.96	3,362.09	747.6	3, 4, 7
37	2,410.91	3,426.84	746.6	2, 4, 7
38	2,406.09	3,455.03	745.4	1, 2, 4
39	2,393.77	3,467.81	745.4	6, 7, 8
40	2,383.51	3,482.24	745.0	2, 3, 5
41	2,377.83	3,493.48	744.8	2, 3, 8
42	2,355.72	3,487.74	745.6	3, 5, 7
43	2,319.78	3,513.25	744.9	3, 4, 5
44	2,294.67	3,555.80	744.1	2, 4, 5
45	2,279.81	3,602.66	744.0	3, 4, 6

Table IV.8. (page 2 of 2)

Test Hole Number[a]	Coordinates South	Coordinates West	Elevation (feet)	Subsurface Sampling Pattern[b,c]
46	2,242.47	3,650.82	744.6	4, 6, 7
47	2,230.57	3,688.55	743.1	2, 3, 5
48	2,304.08	3,577.89	744.2	1, 2, 3
49	2,285.48	3,537.70	745.5	5, 6, 8
50	2,344.32	3,510.81	745.2	2, 3, 7
51	2,395.15	3,489.36	744.9	1, 2, 6
52	2,404.77	3,468.02	744.9	2, 6, 7
53	2,481.14	3,188.67	750.2	3, 4, 5
54	2,492.90	3,146.88	750.7	2, 3, 4
55	2,503.36	3,144.19	750.9	2, 3, 6
56	2,516.19	3,134.08	751.4	2, 3, 6
57	2,504.63	3,108.15	751.3	3, 4, 8
58	2,579.94	3,099.82	751.4	2, 3, 5
59	2,596.64	3,095.49	750.4	2, 3, 6
60	2,620.15	3,027.87	751.9	2, 3, 6
61	2,581.59	3,071.20	751.5	1, 3, 4
62	2,596.55	3,051.79	NG	3, 4, 5

Reference: Stenhouse and Kirsch 1986.

[a]These locations are designated 19-1 through 19-62 on Plate 1. Not all of the coordinates resulted in the placement of sampling points near the WTS (Area 19), suggesting that some locations were sampled in other areas or that the coordinates are in error.
[b]Surface sample also taken at each test hole site.
[c]The subsurface sampling pattern is given as beginning depth in ft. 1, 2, 6 indicates that samples were taken at 1 ft, 2 ft, and 6 ft. If possible, a 1-ft core was obtained.
NG - Not given
WTS - waste transfer system

Table IV.9. Analytical Data

Test Hole/ Location No.[c]	Core Segment Depth (ft)	Plutonium-238 (pCi/g)
1	Surface	<LDL
	1 - 2	<LDL
	2 - 3	<LDL
	6 - 7	<LDL
2	Surface	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
	6 - 7	<LDL
3	Surface	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
	8 - 9	<LDL
4	Surface	<LDL
	2 - 3	<LDL
	4 - 5	<LDL
	7 - 8	<LDL
5	Surface	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
	6 - 7	<LDL
6	Surface	26
	2 - 3	<LDL
	4 - 5	24
	7 - 8	<LDL

[a]Denotes those samples which were subsequently submitted for independent radiochemical analysis.

[b]Absolute errors are not provided for each plutonium-238 activity value. As a guideline, the following minimum errors (at the $\pm 1\sigma$ level) may be taken for various plutonium-238 activity levels. These errors depend on how much thorium is present; the first ± value is calculated for a thorium concentration of 1 pCi/g and the other ± value for 10 pCi/g thorium.

25 pCi/g plutonium-238: ±8 pCi/g; ±38 pCi/g
50 pCi/g plutonium-238: ±9 pCi/g; ±38 pCi/g
100 pCi/g plutonium-238: ±9 pCi/g; ±37 pCi/g

[c]The locations are designated 19-1 through 19-62 on Plate 1.

[d]Contaminated soil was removed from test holes 14 and 22 in September 1990. Post-removal plutonium-238 soil levels were less than 100 pCi/g (Rader 1990).

LDL - Lower detection limit. LDL is taken as equal to or less than 20 pCi/g for a 400 second count.
pCi/g - picocuries per gram

Table IV.9. (page 2 of 7)

Test Hole/ Location No.[c]	Core Segment Depth (ft)	Plutonium-238 (pCi/g)
7	Surface	81
	4 - 5	181
	5 - 6	42
	7 - 8	33
8	Surface	35
	2 - 3	28
	7 - 8	21
	8 - 9	46
9	Surface	<LDL
	2 - 3	<LDL
	5 - 6	<LDL
	7 - 8	<LDL
10	Surface	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
	6 - 7	<LDL
11	Surface	<LDL
	3 - 4	<LDL
	5 - 6	<LDL
	7 - 8	<LDL
12	Surface	<LDL
	1 - 2	<LDL
	4 - 5	<LDL
	5 - 6	<LDL
13	Surface	23
	2 - 3	<LDL
	5 - 6	<LDL
	7 - 8	21
14[d]	Surface	<LDL
	2 - 3	23
	5 - 6	410
	7 - 8	34
15	Surface	<LDL
	2 - 3	<LDL
	5 - 6	<LDL
	8 - 9	<LDL
16	Surface	<LDL
	2 - 3	<LDL
	4 - 5	<LDL
	6 - 7	<LDL

Table IV.9. (page 3 of 7)

Test Hole/ Location No.[c]	Core Segment Depth (ft)	Plutonium-238 (pCi/g)
17	Surface	<LDL
	1 - 2	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
18	Surface	26
	1 - 2	<LDL
	3 - 4	22
	4 - 5	26
19	Surface	22
	3 - 4	<LDL
	4 - 5	<LDL
	6 - 7	<LDL
20	Surface	<LDL
	2 - 3	<LDL
	3 - 4	<LDL
	8 - 9	<LDL
21	Surface	24
	4 - 5	<LDL
	6 - 7	<LDL
	7 - 8	<LDL
22[d]	Surface	<LDL
	3 - 4	1057
	4 - 5	41
	5 - 6	<LDL
23	Surface	26
	2 - 3	114
	3 - 4	185
	8 - 9	<LDL
24	Surface	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
	7 - 8	<LDL
25	Surface	<LDL
	1 - 2	<LDL
	2 - 3	<LDL
	3 - 4	26
26	Surface	<LDL
	1 - 2	<LDL
	5 - 6	<LDL
	6 - 7	<LDL

Table IV.9. (page 4 of 7)

Test Hole/ Location No.[c]	Core Segment Depth (ft)	Plutonium-238 (pCi/g)
27	Surface	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
	5 - 6	<LDL
28	Surface	<LDL
	1 - 2	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
29	Surface	<LDL
	3 - 4	<LDL
	5 - 6	<LDL
	7 - 8	<LDL
30	Surface	<LDL
	1 - 2	<LDL
	3 - 4	<LDL
	4 - 5	21
31	Surface	<LDL
	1 - 2	<LDL
	6 - 7	31
	7 - 8	22
32	'Surface	<LDL
	1 - 2	<LDL
	4 - 5	24
	5 - 6	<LDL
33	Surface	<LDL
	4 - 5	<LDL
	5 - 6	<LDL
	8 - 9	23
34	Surface	27
	3 - 4	<LDL
	4 - 5	<LDL
	7 - 8	21
35	Surface	26
	2 - 3	<LDL
	5 - 6	26
	6 - 7	<LDL
36	Surface	<LDL
	3 - 4	22
	4 - 5	<LDL
	7 - 8	<LDL

Table IV.9. (page 5 of 7)

Test Hole/ Location No.[c]	Core Segment Depth (ft)	Plutonium-238 (pCi/g)
37	Surface	<LDL
	3 - 4	26
	5 - 6	28
	7 - 8	24
38	Surface	<LDL
	1 - 2	49
	2 - 3	50
	4 - 5	23
39	Surface	<LDL
	6 - 7	26
	7 - 8	24
	8 - 9	<LDL
40	Surface	<LDL
	2 - 3	35
	3 - 4	29
	5 - 6	38
41	Surface	<LDL
	2 - 3	21
	3 - 4	<LDL
	8 - 9	23
42	Surface	<LDL
	3 - 4	<LDL
	5 - 6	<LDL
	7 - 8	24
43	Surface	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
	5 - 6	24
44	Surface	<LDL
	2 - 3	38
	4 - 5	<LDL
	5 - 6	<LDL
45	Surface	<LDL
	3 - 4	<LDL
	4 - 5	<LDL
	6 - 7	<LDL
46	Surface	<LDL
	4 - 5	<LDL
	6 - 7	<LDL
	7 - 8	<LDL

Table IV.9. (page 6 of 7)

Test Hole/ Location No.[c]	Core Segment Depth (ft)	Plutonium-238 (pCi/g)
47	Surface	36
	2 - 3	<LDL
	3 - 4	<LDL
	5 - 6	<LDL
48	Surface	<LDL
	1 - 2	<LDL
	2 - 3	<LDL
	3 - 4	<LDL
49	Surface	<LDL
	5 - 6	<LDL
	6 - 7	<LDL
	8 - 9	<LDL
50	Surface	<LDL
	2 - 3	<LDL
	3 - 4	<LDL
	7 - 8	27
51	Surface	89
	1 - 2	<LDL
	2 - 3	26
	6 - 7	<LDL
52	Surface	<LDL
	2 - 3	41
	6 - 7	<LDL
	7 - 8	<LDL
53	Surface	22
	3 - 4	26
	4 - 5	<LDL
	5 - 6	22
54	Surface	25
	2 - 3	26
	3 - 4	23
	4 - 5	26
55	Surface	<LDL
	2 - 3	<LDL
	3 - 4	<LDL
	6 - 7	25
56	Surface	<LDL
	2 - 3	<LDL
	3 - 4	<LDL
	6 - 7	<LDL

Table IV.9. (page 7 of 7)

Test Hole/ Location No.[c]	Core Segment Depth (ft)	Plutonium-238 (pCi/g)
57	Surface	<LDL
	3 - 4	<LDL
	4 - 5	22
	8 - 9	<LDL
58	Surface	<LDL
	2 - 3	<LDL
	3 - 4	<LDL
	5 - 6	<LDL
59	Surface	<LDL
	2 - 3	<LDL
	3 - 4	<LDL
	6 - 7	<LDL
60	Surface	<LDL
	2 - 3	21
	3 - 4	27
	6 - 7	<LDL
61	Surface	<LDL
	1 - 2	29
	3 - 4	<LDL
	4 - 5	<LDL
62	Surface	21
	3 - 4	50
	4 - 5	<LDL
	5 - 6	<LDL

was detected in the samples from this location (a maximum of 0.98 pCi/g of plutonium-238 and less than 2 pCi/g of thorium).

Area D was not identified in the original Site Survey Project Report (Stought et al. 1988), but it has always been included as one of the sites to be addressed by the Mound Plant D&D Program. No significant radioactive contamination was identified during the Site Survey Project, either in the original report or by this evaluation. This is consistent with the site history for this area, which indicates that any nitric acid released would have been raw material prior to processing and, therefore, not contaminated. The D&D of Area D is being conducted as part of the D&D of Building 38 and its utility systems.

The maximum depth sampled in Area D was 180 inches. Borehole data in Mound Plant drawing #FSE16472, reproduced in the Site Scoping Report: Volume II Addendum (DOE 1992f) indicate that the depth to bedrock in this area of the SM/PP Hill ranges from approximately 108 to 228 inches, but this may vary greatly due to the presence of fill dirt. The boring log for location C0146 is not available, so it cannot be determined if bedrock was reached during the sampling.

4.1.9. Building 48 Hillside

A note in the Site Survey Project Report (Table 2.1 in Stought et al. 1988) indicated that elevated levels of plutonium-238 were discovered in an area designated as Block 19. The area of concern is actually located adjacent to a process sewer manhole northwest of Building 48 on the south slope of the Main Hill (Plate 1). This area is referred to as the Building 48 hillside in this report. The Building 48 hillside is also west of Area 5, but is not currently included in the boundaries of Area 5. Internal Mound Plant memoranda reviewed for this report substantiate the note in the project report (Stought et al. 1988) that plutonium-238 concentrations are as high as 32 nCi/g (Draper 1986a). The data sheets are included in Appendix E. The levels of plutonium-238 encountered required that the construction project be abandoned, so the initial holes were simply backfilled and the contamination left in place. The contamination encountered at the Building 48 hillside is attributed to a release of 7.64 mCi of plutonium-238 in November 1967. This incident is listed in the Site Scoping Report: Volume 11: Spills and Response Actions (DOE 1992h). As the Building 48 hillside is associated with the soils adjacent to the alpha waste water sewer lines, similar problems may be anticipated along the length of the lines. These lines are scheduled to undergo D&D.

Table IV.10. Mound Site Survey Project - Area D

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
C0146	2975	2465	1170	12-82	18	0.35	b				
			1171	12-82	36	0.98	b				
			1172	12-82	54	0.12	b				
			1173	12-82	72	0.36	b				
			1174	12-82	90	0.18	b				
			1175	12-82	108	0.21	b				
			1176	12-82	126	0.03	b				
			1177	12-82	144	0.05	b				
			1178	12-82	162	0.01	b				
			1179	12-82	180	0.03	b				

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

FIDLER - field instrument for the detection of low-energy radiation

MRC ID - Monsanto Research Corporation identification

pCi/g - picocuries per gram

pCi/mL - picocuries per milliliter

4.1.10. Building 66 Lot Site

A note in the Site Survey Project Report (Table 2.1 in Stought et al. 1988) indicated that elevated levels of plutonium-238 were discovered in an area designated as Block 33. The area of concern is actually located adjacent to Building 66 just south of Building 51 along the upper reach of the plant drainage ditch (Plate 1). This area is referred to as the Building 66 lot site in this report. The Building 66 lot site is enclosed within the boundaries of Area 7 (Plate 1). Internal Mound Plant memoranda reviewed for this report substantiate the note in the project report (Stought et al. 1988) that plutonium-238 concentrations are as high as 7 nCi/g (MRC 1986). Plutonium-238 concentrations, however, ranged widely from less than 25 pCi/g to 7 nCi/g, suggesting very spotty contamination. The data report is included in Appendix E. The levels of plutonium-238 encountered required that the construction project be abandoned at the Building 66 lot site, so the initial holes were simply backfilled and the contamination left in place.

4.1.11. Locations With Elevated Plutonium-238

The evaluation of the Site Survey Project data for the compilation of this report indicated that three potential hot spots contained levels of plutonium-238 in excess of 25 pCi/g. These are all surface locations, numbered S0166, S0208, and S0706 on Table IV.9. These areas indicated plutonium-238 values of 34.5, 61.0, and 28.9 pCi/g, respectively. Surface location 0166 is located near the SW and R Buildings on the Main Hill; surface location 0208 is located northwest of the WD Building; and surface location 0706 is located north of the Area 1 runoff channel that goes west toward Area 2 (Plate 1). The Area 1 runoff channel is located in a ditch, and location 0706 is either on the embankment or in the woods above Area 1. The review of process history indicates that the elevated plutonium-238 activity in the three potential hot spot locations cannot be easily associated with process information. Areas 3, 4 and 4a, 7, 8, 12, and J also indicated elevated levels of plutonium-238. The elevated concentrations are not directly ascribed to process history, but may be due to spills, runoff, or other unknown processes. Descriptions of these areas are provided in companion sections of this report. Areas 3, 7, 8, and 12 are included in section 5; additional descriptions of Area 7 are provided in section 7; areas 4 and 4a are included in section 3; and Area J is described in section 10.

As with several hot spots and other local areas of contamination described in this report, elevated levels of plutonium-238 were discovered in Area 3 during routine surveys conducted during construction activities. The surveys of construction activities have been conducted routinely since 1985, required partly by the specifications for soil destined for the spoils disposal area. In August 1988, during survey of the dismantling of a portion of the sludge drying beds adjacent to the wastewater treatment facility, elevated levels of thorium and plutonium were indicated. An internal

memorandum indicates that analysis shows 15 samples from bed #3 possessing thorium concentrations that range from less than 1 to 63 pCi/g and plutonium-238 concentrations that range from less than 20 to 1,235 pCi/g (Collins 1988). Notes on the memo indicate that the samples were collected at the surface, but during interviews with the personnel that collected the samples, it was indicated that the samples were collected below the drying bed at the surface of the underlying soil. As part of the construction, the contaminated soil was removed and boxed for offsite disposal. Considerable doubt exists among the decontamination workers that any of the identified contamination actually contained plutonium-238. All of the radioactivity was assumed to be thorium-232, as it is apparent with as much thorium activity as was present in the drying beds, considerable interference occurs on the plutonium-238 channel of the analytical equipment. The 1,235 pCi/g of plutonium-238 were considered to have occurred by this interference. The data report is included in Appendix E. Soil was removed to a level approximating 15 pCi/g thorium according to field screening with a FIDLER. No additional soil samples were taken before the area was backfilled.

Considering that Area 3 was historically used for storage and redrumming of the thorium sludges, it is entirely consistent that the contamination identified in the sludge drying beds was thorium-232. Descriptions of Area 3 are provided in subsection 5.4. No processes, other than perhaps runoff from Area 14, could account for plutonium-238 under the sludge drying beds. The drying beds themselves were constructed in 1974 as part of the wastewater treatment plant. During that era, routine surveys did not accompany construction activities and the beds may have been built over soils contaminated with thorium.

5. THORIUM ORE PROCESSING AREAS

This section provides general descriptions of the scale and periods of operation of the thorium ore processing program at Mound Plant. Summaries are provided of the areas where process, treatment, storage/repackaging, and disposal activities took place and whether environmental radiological data, through the Site Survey Project, are available. Additional information on the generation and TSD activities is provided in Volume 7 - Waste Management (DOE 1992g). The subsections that follow provide details on individual areas.

5.1. PROGRAM SUMMARY

In the mid-1950s, Mound Plant was directed to conduct a research and development effort that would lead to a process for the extraction of thorium from Brazilian monazite sludge and other thorium-bearing materials. The goal was to develop a production-scale process and to construct a refinery that would recover thorium from a variety of thorium-bearing ores and provide a thorium salt suitable for the preparation of high purity thorium metal.

A typical elemental analysis of the Brazilian sludge used in this process is provided in Table V.1. The major isotope in these ores sludges was thorium-232 with the major daughter products being radium-228, radium-224, and other daughters. Minor amounts of thorium-230 may have also been present in the naturally occurring ores, and thorium-228 would be present due to the decay of radium-228. No analytical data quantifying these isotopes in the original thorium sludges was found during the research for the scoping reports.

The thorium ore processing program was very short lived. Mound Plant began to receive sludge materials in early 1955 and the program was canceled in May 1955 (DOE 1992g). What little process developmental work there was took place in R Building and a pilot plant was assembled and tested in SW Building (Figure 5.1). Since the thorium program was short lived, little is known about related waste treatment processes. Aqueous wastes from the pilot plant went to the influent tanks in the WD Building. These wastes were not treated, but were diluted and released to the Great Miami River. Only limited sampling was conducted in the area surrounding the R and SW Buildings as part of the Site Survey Project. No elevated levels of thorium were detected in this area. None of the storm and process sewers were investigated as part of the Site Survey Project.

The thorium-bearing materials that were to be feedstocks for the refinery continued to be stored at Mound Plant for several years. The continued maintenance and repackaging of the sludges in the storage drums proved to be the biggest problem. Fugitive dust that settled in the areas immediately

Table V.1. Typical Elemental Analyses of Brazilian Sludge

Element	Concentration (Weight %)	Element	Concentration (Weight %)
Aluminum	0.01 - 0.1	Lead	0.01 - 1.0
Calcium	0.1 - 1.0	Praseodymium	1.0 - 10.0
Cerium	<10.0	Selenium	Not Detected
Copper	0.001 - 0.01	Silicon	1.0 - 10.0
Erbium	Not Detected	Samarium	1.0 - 10.0
Gadolinium	1. - 10.	Terbium	Not Detected
Holmium	Not Detected	Titanium	7.0
Lanthanum	<10.	Thulium	0.1 - 1.0
Lutetium	Not Detected	Yttrium	1.0 - 10.0
Magnesium	0.01 - 0.1	Ytterbium	0.1 - 1.0
Neodymium	1.0 - 10.0	Radium-228	Not Analyzed
Thorium oxide[a]	45	Radium-224	Not Analyzed
Rare earth oxide[a]	15	Zirconium oxide[a]	1.4
Silicon dioxide[a]	4.4	Phosphorous oxide[a]	5.3
Titanium oxide[a]	7.0	Uranium oxide[a]	
Iron oxide[a]	4.3	Chloride[a]	1.0
Loss on ignition[a]	14		1.4

Data from Mead et al. 1955

[a]Percentages on dry basis at 110°C; MRC 1973a,d.

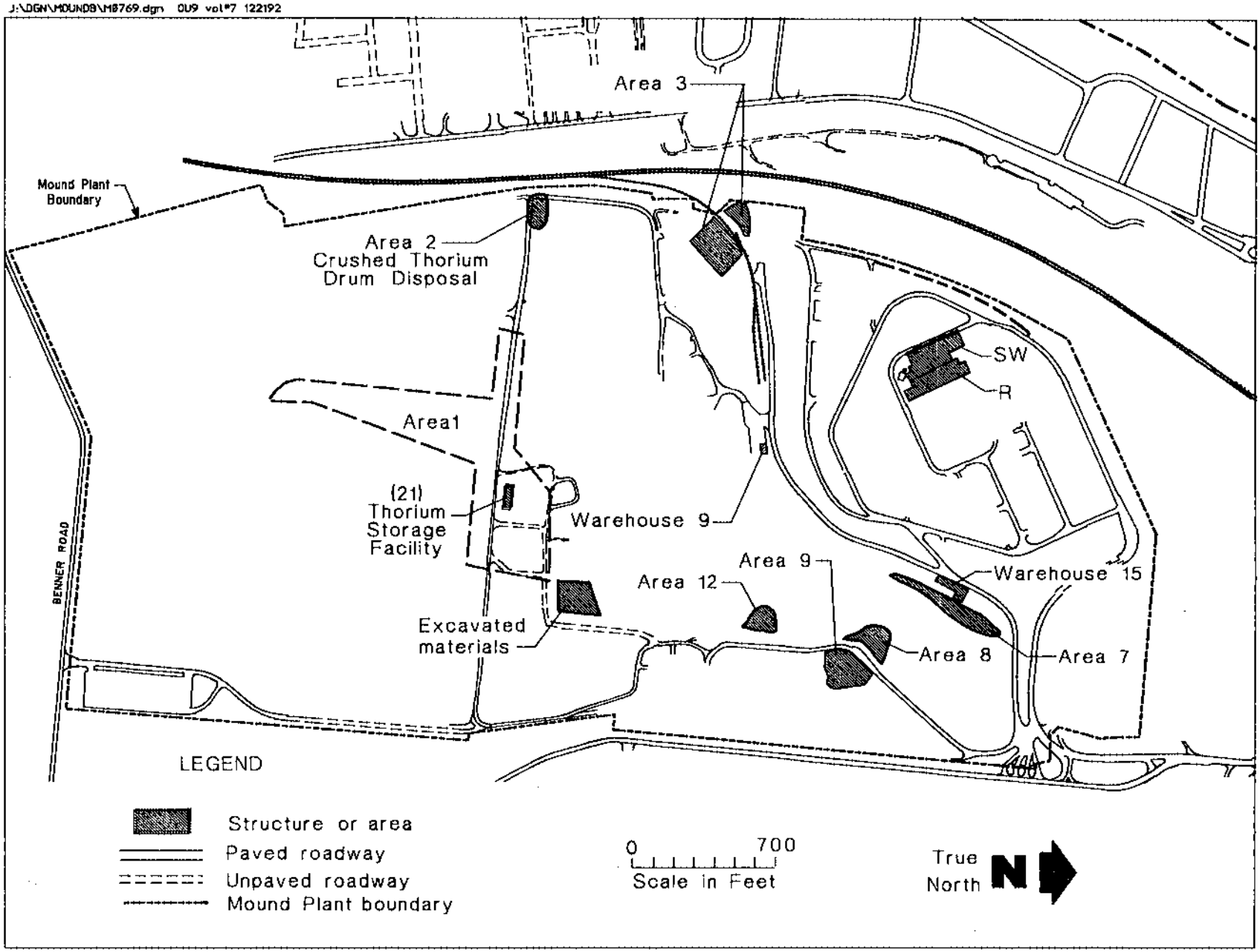


Figure 5.1. Thorium ore processing areas.

surrounding the storage areas produced soil contamination. Some wash water produced during repackaging activities were diluted and discharged via the storm sewer to the Great Miami River.

Storage areas for the thorium feed material included Area 3, Area 9, Warehouse 9, Warehouse 15, and Building 21 located in Area 1. Old Warehouse 9, along the railroad spur, received drums directly from the boxcars and served as an interim storage facility. Boxcars were washed and decontaminated as they sat on the spur. Warehouse 9 was razed and the walls sold as scrap, except the contaminated wooden floor of the building, which was burned in place. Much of the railroad spur is no longer visible. The upper portion that was adjacent to Warehouse 9 is now largely covered over with new soil and asphalt. Some of the track was removed during the excavations for the Area 19 D&D of the waste transfer lines in 1986.

Initially, drums were moved from Warehouse 9 to Warehouse 15 (previously located in the area now known as Area 7) where the sludges were repackaged into new 55-gallon drums. When radiation reached unsafe levels as a result of the repackaging, this activity was transferred to Areas 3 and 9, where the work was performed in the open air. The drums were also stored in these areas.

Repackaging continued almost annually until July 1964 when a permanent bulk thorium sludge storage facility, Building 21, was constructed (MRC, 1973). Fugitive dust was generated by dumping the material into the bulk storage bins through the roof. This dust contaminated soil north of the building. This area is now known as Area 1.

Storage and repackaging areas investigated in the Site Survey Project include Areas 1, 3, 7, and 9. Descriptions of these areas are in the subsections that follow. Warehouse 9 and the railroad spur was not investigated as part of the Site Survey Project, except the area where the waste transfer line crossed the old tracks (Plate 1).

No thorium sludge or ores are known to have been buried or disposed of on the site. Most of the surficial soil contaminated with thorium is due to material spills and fugitive dust emissions associated with the repackaging and storage efforts. The major isotope of concern from the thorium sludge is thorium-232. [Note - Soils on Mound Plant are known to be locally contaminated with thorium-230, but this would not be from the thorium sludge materials. Thorium-230 is largely a decay product of uranium and is discussed in this report with the uranium ore processes in section 6.] Corroded drums from the repackaging of thorium sludges were collapsed and buried in Areas 2 and 7, in the lower and upper valley areas, respectively. Soils with low-level thorium contamination do exist in many areas and these areas generally have a complex history of surficial contamination from the redrumming activities and shallow excavation. It is known that soils from Areas 1 and 9 were scraped and moved to Areas

8 and 12. Area 8 partially overlapped Area 19, the waste transfer line, and was again moved during the waste line excavation. Areas used for disposal of thorium-contaminated soils include Areas 2, 7, 8, and 12. All of these were included in the Site Survey Project investigations.

5.2. AREA 1

Area 1, located on the southwestern side of the SM/PP Hill (Plate 1), surrounding Building 21, includes two drainage pathways. This area was used for storage and repackaging of thorium sludges from 1966 to 1974. Part of the area was also used for the storage of plutonium-238 waste packages in the mid-1960s. Two portions of the area extend south onto the new property and west toward Area 2 (Plate 1) as a result of surface water runoff. The drainage channel that extends west was excavated and covered with concrete in the summer of 1989. During this effort, much of the original topsoil was removed and apparently placed in the spoils disposal area, as only one sample showed a thorium concentration above 5 pCi/g. Some soil may have been left on the bank next to the channel.

The Aerial Reconnaissance Survey in 1976 (EG&G 1978) noted a peak in the energy range of cobalt-60 in the vicinity of Building 21. As a result, a gamma survey of the area was performed by Mound Plant personnel. A single drum containing depleted bismuth slugs was found stored near the salt bin north of Building 21. The survey conducted after the drum was removed revealed no significant gamma readings (Garner 1976). No indication was given as to why the drum was stored there or its disposition.

Area 1 has a complex history of surficial soil contamination, sampling, and shallow excavation. Radioactively contaminated soils were removed from this area in 1975 and moved to Areas 8 and 12. No information was found during the research for the scoping report that would indicate the volumes or levels of thorium contamination involved. However, in 1980, seven 1-ft cores were drilled 1 ft north of the new property along the fenceline in the area of Building 21 (MRC 1980). Mound Plant personnel concluded that thorium-232 contamination was present based on the ratio of thorium-230 to thorium-232, but concentrations greater than 2 pCi/g were detected in only two of the 13 samples analyzed (one sample was lost). The highest concentration detected was 2.13 pCi/g. Four additional surface samples were collected further north of the fence in the vicinity of Building 21. Thorium concentration in excess of 2 pCi/g was detected the samples collected from three of these locations. The highest concentration detected was 924.2 pCi/g. All of the above samples were analyzed for plutonium-238 content. Levels above 100 pCi/g were detected in 2 of the 4 surface samples collected in the vicinity of Building 21. The highest plutonium-238 concentration detected was 860.4 pCi/g (MRC 1980).

Field surveys of the historic SM field area in Area 1 were conducted in February 1984. Five samples were analyzed for thorium-232 and plutonium-238. Plutonium-238 concentrations up to 226,564 pCi/g and thorium concentrations up to 218.9 pCi/g were noted (Draper 1984). The hot spots with the highest concentrations were cleaned up by the D&D program (Davis 1985). An internal memorandum states that the area was excavated and two 55-gallon drums were filled with soil. The remaining hole indicated a level of about 17 nCi/g plutonium-238 that was then backfilled (Sohn 1984).

A review of the site survey data during the preparation of this report determined the boundaries of Area 1 as depicted on Plate 1. The boundaries shown agree with those identified in the original Site Survey Project Report. The results for the locations sampled within Area 1 by the Site Survey Project are given in Table IV.2 and are contoured on Plate 4 and Plate 5 for plutonium-238 and thorium, respectively. The maximum plutonium-238 concentration reported for samples collected in Area 1 (34,000 pCi/g) was detected in the surface sample collected from location 0997 on Plate 1 (S0997 on Table IV.2). No thorium results were given for this sample. It is not known if additional sampling was performed to confirm this plutonium value. No cleanup activities are known to have occurred since these measurements were taken.

The maximum concentration of total thorium reported by the Site Survey Project for Area 1, 54.3 pCi/g, was detected in the surface sample collected from location 1002 (S1002 on Table IV.2 and surface location 1002 on Plate 1). In general, the maximum concentrations of both thorium and plutonium-238 were detected in samples taken at locations near Building 21, east and north of Building 21, along the drainage channel to the south, and at the beginning of the drainage channel that extends south onto the new property (Plates 4 and 5). Elevated plutonium-238 concentrations were also detected in samples collected in a drainage channel that extends west toward the overflow pond (Plate 1). Biased samples were taken along these channels after FIDLER screening in the first phase of the Site Survey Project showed increased activity in a number of locations. Contamination in these drainage channels is apparently the result of contaminated sediment transport by way of surface water runoff from contaminated soils within Area 1. There are also some other smaller areas of surface plutonium contamination on the nearby property, possibly indicating smaller runoff channels (Plate 4). Thorium (Plate 5) was also detected to a lesser extent in both drainage channels extending south from Area 1. In situ gamma spectroscopy for thorium-232 was performed at 19 locations in Area 1 (0263, 0264, 0265, 0266, 0267, 0268, 0269, 0270, 0271, 0272, 0273, 0274, 0276, 0277, 0278, 0279, 0280, 0281, and 0282 on Plate 1). The maximum thorium-232 concentration reported for these samples, 9.2 pCi/g, was detected at location 0264 (CO264 on Table IV.2).

The core locations in Area 1 were sampled to a depth of approximately 36 inches, although several were sampled much deeper, such as core location 0203 (sampled to 180 inches).

Mound Plant drawing #FSE16472, reproduced in the Site Scoping Report: Volume 2 Addendum - Stratigraphic and Lithologic Logs (DOE 1992f) indicates that the depth to bedrock in the area of the SM/PP Hill ranges from 24 inches to greater than 84 inches. The *in situ* gamma spectroscopy measurements included driving pipes to bedrock. These locations indicate that the depth to bedrock in Area 1 ranges from 24 to 120 inches. The drainage channel to the west onto the new property contains exposed bedrock in many places, and only a thin covering of soil along most of its length. Boring logs are available for locations 0201 and 0203 (Appendix B). Bedrock was reached at location 0201, but not at 0203.

5.3. AREA 2

Area 2, located along the west-central border of Mound Plant, is on the margin of the historic landfill (DOE 1991b). Reports of historic activities indicate that Area 2 is the location of disposal trenches for the remains of the polonium-210-contaminated debris from a fire in Area 13 in 1955; thousands of empty crushed thorium drums from the early 1960s; and polonium-210-contaminated sand from 1966 (DOE 1992c). A photo interpretive history of the historic landfill and Area 2 is provided in the Site Scoping Report: Volume 6- Photo History (DOE 1992b).

No plutonium-238 concentrations in excess of 25 pCi/g were detected in any of the samples collected during the Site Survey Project. The maximum concentration detected was 17.1 pCi/g in a sample collected from core location 0189 at a depth of 18 inches (C0189 on Table III.1, and core location 0189 on Plate 1). The maximum thorium concentration detected, 3.31 pCi/g, was found in a sample collected from core location C0191 at a depth of 108 inches (Table III.1).

The interpretation of data made in compiling this report is in basic agreement with the interpretation of data made in compiling the original Site Survey Project Report. Area 2 is at least partially covered by the Site Sanitary Landfill constructed in 1977. A magnetic survey conducted in Area 2 in 1990 indicated that some of the burials may lie under the present position of the road intersection (DOE 1990). This is also supported by the interpretation of historic aerial photographs indicating that the historic landfill may have occupied areas presently under the paved roads (DOE 1991).

Burial of debris reportedly occurred in an irregular trench 12 or 14 ft deep that was covered by a few feet of soil (DOE 1992g). The depth to bedrock in this area of the facility appears to be a maximum of about 600 inches or about 50 ft (DOE 1992f). The maximum depths sampled at the three core location were 36, 162, and 180 inches (Table III.1). Although the samples collected from 72 to 180 inches may have been of sufficient depth to sample the material in the original trench, it is not known if any drums or debris were encountered during the core sampling. The surface samples collected from

Area 2 do not provide any information concerning the historic disposal trenches. The elevated thorium concentration detected in a sample collected from core location 0191 at a depth of 108 inches may be indicative of some subsurface elevated thorium activity. It is not clear that C0190 was not deep enough to sample the buried thorium drums directly. Corehole 0190 was positioned in the right place to sample the area of drum burial, but it was only 36 inches deep.

5.4. AREA 3

Area 3, located in the area surrounding Buildings 19 and 72 on the western border of Mound Plant, was used for storage and redrumming of thorium in the late 1950s and early 1960s (MRC, 1973). As with Area 1, Area 3 has a varied and complex history. A photo interpretive history of the historic landfill and Area 2 is provided in the Site Scoping Report: Volume 6 - Photo History (DOE 1992b). In 1965, thorium-contaminated soil was reportedly scraped, and the area was graded (MRC, 1985; Stought et al., 1988). The excavated area was then backfilled with clean soil. No documentation of this activity was found during the research for the scoping reports. A small section of Area 3, near Building 19, may have been contaminated by either the 1969 plutonium-238 waste line break that created Area 14, or by the cleanup operations that followed the break. This event also resulted in the contamination of an offsite area, known as the runoff hollow, west of the fenceline at the western edge of Area 3 (Rogers 1975). Because the runoff hollow is outside the boundary of Mound Plant and was sampled as part of the Miami-Erie Canal investigation (Rogers 1975), it was not addressed by the Site Survey Project. The Miami-Erie Canal is not addressed in this report.

The extent of Area 3 shown on Plate 1 was determined by an evaluation of the site survey data conducted in preparation for this report, and appears to be in agreement with the Area 3 shown in the original Site Survey Project Report. Similarly, both this report and the original report show most of the elevated plutonium-238 activity as being present near Building 19 (core locations 0099, 0100, 0101, 0102, and 0104 on Plate 1; C099, C0100, C0101, C0102, and C0104 on Table V.2) and in the southwest corner of the area (surface locations 0547, 0548, 0550, 0552 on Plate 1; S0547, S0548, S0550, and S0552 on Table V.2). The maximum plutonium-238 concentration reported for samples collected from Area 3, 50.60 pCi/g, was detected in the sample collected from core location C0104 at a depth of 18 inches. Only five samples contained plutonium-238 concentrations greater than 25 pCi/g. These plutonium-238 concentrations were used to develop the isoconcentration lines shown on Plate 4.

Only four of the samples collected in Area 3 contained levels of total thorium in excess of 2 pCi/g. The maximum concentration, 5.30 pCi/g, was detected in a surface sample collected from location 0547 (S0547 on Table V.2). Review of the data for this report indicates that the summary provided

Table V.2. Mound Site Survey Project - Area 3

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)
C0099	1965	4265	10419	08-85	18	31.4	b
			10420	08-85	36	14.7	b
C0100	1975	4275	10421	08-85	18	32.4	b
			10422	08-85	36	17.7	b
			10423	08-85	54	12.4	b
			10424	08-85	72	10.1	b
C0101	1985	4285	10425	08-85	18	22.0	b
			10426	08-85	36	0.90	b
			10427	08-85	54	0.34	b
			10428	08-85	72	0.71	b
C0102	1995	4295	10429	08-85	18	10.4	b
			10430	08-85	36	6.44	b
			10431	08-85	54	2.16	b
			10432	08-85	72	0.93	b
C0103	2060	4300	1624	04-83	18	0.26	3.95
			1625	04-83	36	0.50	b
C0104	2085	4365	1622	04-83	18	50.60	b
			1623	04-83	36	5.28	b
C0105[c]	2100	4140	7804	10-84	90	0.47	b
			7805	10-84	180	0.01	b
C0106	2105	4315	1626	10-84	18	0.41	b
			1626	10-84	36	0.13	b
C0107	2170	4375	1620	04-83	18	0.69	b
			1621	04-83	36	0.07	2.56
C0108	2200	4250	1632	04-83	18	0.25	b
			1633	04-83	36	0.14	b
C0109	2225	4325	1658	04-83	18	2.30	b
			1659	04-83	36	0.66	b
			1660	04-83	54	0.47	b
C0110	2230	4390	1628	04-83	18	0.48	b
			1629	04-83	36	0.14	b
C0111	2250	4165	1636	04-83	18	0.82	b
			1637	04-83	36	0.21	b
C0112	2250	4300	1640	04-83	18	0.02	b
			1641	04-83	36	0.03	b
C0113[c]	2275	4140	7759	09-84	90	2.83	b
			7760	09-84	180	0.03	b
C0114	2275	4200	1638	04-83	18	0.16	b
			1639	04-83	36	0.01	b

Table V.2. (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)
C0115	2275	4395	1644	04-83	18	1.46	3.56
			1646	04-83	36	0.31	b
C0116	2305	4315	1642	04-83	18	0.05	b
			1643	04-83	36	0.24	b
S0490	2175	4135	2918	10-83	0	0.71	b
S0494	2275	4135	6974	08-74[d]	0	1.48	b
S0496	2300	4135	6873	08-84	0	0.02	b
S0499	2350	4135	2919	10-83	0	0.04	b
S0536	1950	4290	7167	09-84	0	2.20	b
S0537	1950	4315	2683	10-83	0	0.17	b
S0538	1975	4165	7165	09-84	0	5.94	b
S0539	2000	4340	7168	09-84	0	10.20	b
S0540	2050	4165	2685	10-83	0	36.94	b
S0541	2075	4265	2688	10-83	0	0.64	b
S0542	2075	4390	2684	10-83	0	0.83	b
S0543	2200	4265	6881	08-84	0	18.60	b
S0545	2350	4415	6876	08-84	0	4.16	b
S0547	2365	4375	10485	08-85	0	11.0	5.30
S0548	2370	4380	10488	08-85	0	5.77	b
S0549	2375	4165	6880	08-84	0	0.23	b
S0550	2375	4290	6879	08-84	0	12.10	b
S0551	2375	4390	6878	08-84	0	27.10	b
S0552	2380	4370	10486	08-85	0	41.70	b
S0553	2385	4375	10487	08-85	0	8.42	b

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

[c]Boring logs indicate that these locations were not sampled to bedrock (Appendix B)

[d]Date of 08-74 given in the data is suspect. The correct date is probably 08-84 or 07-84.

FIDLER - field instrument for the detection of low-energy radiation

MRC ID - Monsanto Research Corporation Identification

pCi/g - picocuries per gram

in the project report (Stought et al. 1988) is accurate. However, a more recent survey of the sanitary sewage drying beds in Area 3 indicate higher levels than reported by the Site Survey Project. Of 15 samples collected in the beds in 1988, the highest had a thorium-232 concentration of 63 pCi/g and a plutonium-238 concentration of 1235 pCi/g (Collins 1988). Additional discussion is provided in subsection 4.1.11.

The depth of the core samples collected in Area 3 during the Site Survey Project ranged from 18 inches to a maximum of 180 inches. Most core locations were only sampled to a depth of approximately 36 inches. The depth to bedrock in this area appears to range from 300 to 900 inches or about 25 to 75 ft (DOE 1992b). Boring logs are available for two Area 3 core locations, 0105 and 0113, and indicate that these locations were not sampled to bedrock (Appendix B).

5.5. AREA 7

Area 7 is a large area located in the upper valley at Mound Plant, behind or below Buildings 29, 51, 66, and 98 (Plate 1). This area was once a steep ravine that formed the upper reach of the plant drainage ditch. This area has a long history of debris disposal and infilling, including the disposal of approximately 10,000 empty thorium drums in the late 1950s to early 1960s, a polonium-contaminated washing machine (date unknown); a thorium-contaminated flat bed truck, and other equipment used in repackaging the thorium sludges. In the mid 1960s, materials contaminated with polonium-210 were also buried on the side of the ravine. An exhaust system from the remodeling of T Building and a large stainless steel washing machine were among the items. Smaller items contaminated with polonium-210, may also have been buried. The Site Scoping Report: Volume 6 - Photo History (DOE 1992b) documents several episodes of filling and construction. Plate 4 - Estimation of Fill Materials in Site Scoping Report: Volume 5 - Topographic Maps (DOE 1992a) indicates that over 30 feet of fill materials may exist in Area 7.

The current extent of Area 7 shown on Plate 1 is based on an interpretation of the site survey data made in the preparation of this report, and is similar to the area depicted in the original Site Survey Project Report (Stought et al. 1988). The area shown is actually larger than the estimate of the area used in the historic disposals. On the north end of Area 7 is an old buried septic tank that was first used during plant construction, and was the site of disposal of actinium- and radium-bearing soils excavated from the SW Building in 1955 (DOE 1992g), which is described in section 7 of this report.

The samples from the locations in Area 7 were analyzed mainly for plutonium-238 and thorium. The maximum plutonium-238 concentration detected was 7.40 pCi/g in the surface sample from location 0286 (S0286 on Table III.5). The maximum total thorium concentration detected, 20.52 pCi/g, was found in the surface sample collected from location S0298. Other radionuclides detected in Area 7

included radium-226, cesium-137, and tritium. Maximum concentrations detected were 2 pCi/g, 1.2 pCi/g, and 5.23 nCi/l, respectively.

The core locations in Area 7 were drilled and sampled to the maximum depths of 96 to 234 inches (8 to 19.5 ft). Mound Plant drawing #FSE16472 (DOE 1992f) indicates the depth to bedrock in this area is 9 to 15 ft at the north end of the area, and to 65 ft at the southern end near Building 51. Because a boring log is available for only one of the Area 7 locations, it is not known if bedrock was encountered during the drilling; however, it appears that the majority of the core sampling did not penetrate fill and reach the original disposal area. The area of thorium drum and other disposals of magnetic materials are depicted in the Preliminary Results of Reconnaissance Magnetic Survey (DOE 1990).

During the early 1970s, it is believed that some of the trash from the historic landfill was excavated and removed to the ravine (DOE 1991a). This fact was not substantiated during research for the scoping reports, but if true, it would suggest the possibility that some hazardous chemicals could have been relocated from the historic landfill to Area 7. Area 7 was one of the original areas identified in the early 1970s as a historic burial site for materials containing residual radionuclides. Some errors were apparent on the original map of Hot Waste Burial Sites compiled in the early 1970s and reproduced in the Site Scoping Report: Volume 7-Waste Management (DOE 1992g). For example, the thorium contamination was listed as thorium-228 when in fact thorium-232 was the dominant isotope in the Thorium Monex Process. Later versions of the map appeared in the Waste Management Site Plans of the mid 1970s with the correct thorium-232 isotope identified.

5.6. AREA 8

Area 8 is located on the SM/PP Hill in a low-lying area north of Building 31 (Plate 1). This area contains thorium-contaminated soils excavated from Areas 1 and 9 in 1966 and 1965, respectively. About 6 inches of topsoil was used as a cap. In 1984, a concrete pad was installed and some of the thorium contaminated soils were excavated. Soils with a contamination level greater than 15 pCi/g were boxed for offsite disposal and the remaining materials moved to the eastern, upper part of Area 12 (Draper 1985). The extent of Area 8 shown on Plate 1 is based on a review of Site Survey Project data conducted during the preparation this report, and is similar to the area described in the original report (Stought et al. 1988). The original report boundaries do not consider the isopleth contour shapes depicted on Plate 5.

In situ gamma spectroscopy for thorium-232 was performed at 14 core locations in Area 8. These analyses are identifiable in Table V.3 by a "None" given as the MRC ID. *In situ* analysis for thorium-232 was performed at core locations 0026, 0027, 0029, 0030, 0031, 0035, 0037, 0283,

Table V.3. Mound Site Survey Project - Area 8

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)
'C0026	2362.7	2142.4	None	07-84	0	NR	13					
			None	07-84	12	NR	17					
			None	07-84	24	NR	33					
			None	07-84	36	NR	37					
			None	07-84	48	NR	30					
			None	07-84	60	NR	34					
			None	07-84	72	NR	37					
			None	07-84	84	NR	36					
			None	07-84	96	NR	39					
			None	07-84	108	NR	39					
			None	07-84	120	NR	34					
			None	07-84	132	NR	29					
C0027	2371.9	2104.9	None	07-84	0	NR	8.3					
			None	07-84	12	NR	29					
			None	07-84	24	NR	35					
			None	07-84	36	NR	53					
			None	07-84	48	NR	43					
			None	07-84	60	NR	34					
			None	07-84	72	NR	18					
			None	07-84	84	NR	12					
			None	07-84	96	NR	12					
			None	07-84	108	NR	10					
			None	07-84	120	NR	5.3					

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

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

None - No MRC ID was assigned because *in situ* gamma spectroscopy for thorium-232 was performed. The report on this procedure is provided in Appendix C.

NR - No result given

pCi/g - picocuries per gram

pCi/mL - picocuries per milliliter

Table V.3. (page 2 of 5)

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)
C0029	2374.1	2184.3	None	07-84	0	NR	12					
			None	07-87	12	NR	17					
			None	07-87	24	NR	17					
			None	07-87	36	NR	38					
			None	07-87	48	NR	53					
			None	07-87	60	NR	42					
			None	07-87	72	NR	36					
			None	07-87	84	NR	38					
			None	07-87	96	NR	55					
			None	07-87	108	NR	48					
			None	07-87	120	NR	36					
			None	07-87	132	NR	21					
			None	07-87	144	NR	17					
C0030	2395	2063.6	None	07-84	0	NR	4.6					
			None	07-87	12	NR	26					
			None	07-87	24	NR	9.6					
			None	07-87	36	NR	5.9					
			None	07-87	48	NR	2					
			None	07-87	60	NR	1.4					
			None	07-87	72	NR	1.1					
			None	07-87	84	NR	0.8					
			None	07-87	96	NR	1.2					
			None	07-87	108	NR	1.0					
			None	07-87	120	NR	1.1					
			None	07-87	132	NR	0.9					
			None	07-87	144	NR	1.1					
			None	07-87	156	NR	1.7					
C0031	2396.6	2204.7	None	07-84	0	NR	8.4					
			None	07-87	12	NR	27					
			None	07-87	24	NR	36					
			None	07-87	36	NR	42					
			None	07-87	48	NR	43					
			None	07-87	60	NR	64					
			None	07-87	72	NR	64					
			None	07-87	84	NR	47					
			None	07-87	96	NR	32					
			None	07-87	108	NR	42					
			None	07-87	120	NR	54					
			None	07-87	132	NR	44					
C0034	2405	2010	1260	12-82	18	4.83	32.20					
			1261	12-82	72	0.48	9.12					
			1262	12-82	90	0.07	b					
			1263	12-82	108	0.03	b					

Table V.3. (page 3 of 5)

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)
C0035	2405.8	2212.9	None	07-84	0	NR	5.5					
			None	07-84	12	NR	11					
			None	07-84	24	NR	24					
			None	07-84	36	NR	29					
			None	07-84	48	NR	42					
			None	07-84	60	NR	18					
			None	07-84	72	NR	33					
			None	07-84	84	NR	28					
			None	07-84	96	NR	15					
			None	07-84	108	NR	11					
			None	07-84	120	NR	39					
			None	07-84	132	NR	31					
			None	07-84	144	NR	15					
C0283	2411.5	2139.2	None	07-84	0	NR	1.0					
			None	07-84	12	NR	1.8					
			None	07-84	24	NR	1.7					
			None	07-84	36	NR	1.4					
			None	07-84	48	NR	1.2					
			None	07-84	60	NR	0.8					
			None	07-84	72	NR	0.7					
			None	07-84	84	NR	0.9					
			None	07-84	96	NR	0.6					
			None	07-84	108	NR	0.7					
			None	07-84	120	NR	0.7					
			None	07-84	132	NR	0.5					
			None	07-84	144	NR	0.5					
C0285	2478.9	2212.0	None	07-84	0	NR	0.3					
			None	07-84	12	NR	0.8					
			None	07-84	24	NR	0.7					
			None	07-84	36	NR	0.8					
			None	07-84	48	NR	0.8					
			None	07-84	60	NR	0.6					
			None	07-84	72	NR	0.7					

Table V.3. (page 4 of 5)

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)
C0286	2464.1	2184.0	None	07-84	0	NR	0.3					
			None	07-84	12	NR	0.5					
			None	07-84	24	NR	0.5					
			None	07-84	36	NR	0.8					
			None	07-84	48	NR	0.9					
			None	07-84	60	NR	0.6					
			None	07-84	84	NR	0.8					
			None	07-84	96	NR	0.8					
C0287	2450.7	2151.6	None	07-84	0	NR	0.5					
			None	07-84	12	NR	1.3					
			None	07-84	24	NR	0.9					
			None	07-84	36	NR	0.8					
			None	07-84	48	NR	0.6					
			None	07-84	60	NR	0.7					
			None	07-84	72	NR	0.6					
C0288	2438.6	2119.3	None	07-84	0	NR	0.3					
			None	07-84	12	NR	0.8					
			None	07-84	24	NR	1.1					
			None	07-84	36	NR	0.8					
			None	07-84	48	NR	0.8					
			None	07-84	60	NR	0.5					
			None	07-84	72	NR	0.7					
C0289	2422.7	2081.0	None	07-84	0	NR	0.6					
			None	07-84	12	NR	1.1					
			None	07-84	24	NR	0.5					
			None	07-84	36	NR	0.8					
			None	07-84	48	NR	1.0					
			None	07-84	60	NR	0.8					

Table V.3. (page 5 of 5)

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)
C0290	2401.5	2102.1	None	07-84	0	NR	0.7					
			None	07-84	12	NR	0.8					
			None	07-84	24	NR	0.8					
			None	07-84	36	NR	0.8					
			None	07-84	48	NR	0.6					
			None	07-84	60	NR	0.9					
			None	07-84	72	NR	0.8					
C0036	2425	2220	1242	12-82	18	1.45	9.41					
			1243	12-82	48	NR	46.3					
			1244	12-82	114	0.84	36.16		LDL	LDL	1.0	LDL
C0037	2428.6	2178	None	07-84	0	NR	5.9					
			None	07-84	12	NR	11					
			None	07-84	24	NR	14					
			None	07-84	36	NR	5.8					
			None	07-84	48	NR	5.1					
			None	07-84	60	NR	6.3					
			None	07-84	72	NR	6.3					
			None	07-84	84	NR	5.1					
			None	07-84	96	NR	2.5					
C0038	2500	2210	7109	08-84	0	1.41	5.08					
			1236	12-82	18	2.39	b					
			1237	12-82	36	0.65	b					
			1238	12-82	54	2.24	b					
			1239	12-82	72	0.31	b					
			1240	12-82	90	0.64	b					
			1241	12-82	108	0.35	b					
C0045	2400	2240	8350	11-84	54	4.66	142.58					
			8350	11-84	80	0.51	254.30		LDL	LDL	3.3	LDL
S0311	2325	2135	6507	08-84	0	0.62	6.78					
S0312	2325	2185	6507	08-84	0	0.75	b					
S0313	2350	2060	2817	10-83	0	6.28	28.73	1.12				
S0333	2425	2060	7113	08-84	0	24.40	70.52					
S0334	2425	2135	7112	08-84	0	8.44	15.65					
S0335	2425	2185	7111	08-84	0	5.86	7.14					
S0337	2450	2160	7110	08-84	0	2.10	38.04					

0285, 0286, 0287, 0288, 0289, and 0290 (Plate 1). Appendix C contains the report provided by RMC on the *in situ* thorium analysis. Mound Plant personnel report that the *in situ* analysis was performed by driving pipes through the soils to bedrock and lowering the detector down the pipes. The logs for the drilling to install these pipes are located in Appendix B.

The maximum thorium concentration reported for Area 8, 254.3 pCi/g, was detected in the sample collected from core location 0045 at a depth of 80 inches (C0045 on Table V.3 and core location 0045 on Plate 1). Plutonium-238 was detected in several samples. The maximum concentration, 24.4 pCi/g, was detected in the sample collected from surface location 0333 (S0333 on Table V.3). As shown in Plate 5, the area of elevated thorium concentrations appears to extend north, down the slope of the hill, and in general, extends beyond the original boundaries of the low-lying area. Therefore, it is probable that some transport of contaminated sediments by surface water has occurred from Area 8. All other values detected were less than 10 pCi/g. The original Site Survey Project Report (Stought et al. 1988) noted that post site survey D&D FIDLER screening data indicated thorium levels much higher than 10,000 counts per minute. This information suggests that levels of thorium greater than those given in Table V.3 may be present in Area 8.

Based on the *in situ* analysis performed in Area 8, which involved driving pipes to bedrock, the depth to bedrock ranges from 72 to 144 inches (8 to 12 ft). The remaining core locations in the area (0034, 0036, and 0038), which were sampled to depths of 108, 114, and 108 inches, may also have been sampled to bedrock, but boring logs are not available for these locations.

5.7. AREA 9

Area 9 is located on the north end of the SM/PP Hill, surrounding Building 31 (Plate 1). This area was used for storage and redrumming operations of thorium sludges from the mid-1950s to the early 1960s. The Site Scoping Report: Volume 6 - Photo History (DOE 1992b) documents the use of the area for open drum storage through 1959. In 1966, thorium-contaminated soils were pushed over the edge of the hillside to the adjacent Area 8. Area 9 was backfilled with clean soil and is currently covered with asphalt. Area 9, as shown in Plate 1, is based on a review of the site survey data conducted during the preparation of this report, and is similar to that depicted in the original report.

The samples collected in Area 9 during the Site Survey Project were analyzed for plutonium-238 and thorium (Table V.4). Only relatively low levels of plutonium-238, with a maximum level of 8.15 pCi/g were detected at location C0040. Three of the samples collected contained thorium concentrations in excess of 2 pCi/g. These were the samples collected from core location 0039 at a depth of 18 inches (5.62 pCi/g), from core location 0043 at a depth of 18 inches (6.22 pCi/g), and from surface location 0339 (12 pCi/g). This evaluation of the Area 9 samples is based on a review of the site

Table V.4. Mound Site Survey Project - Area 9

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)
C0039	2525	2110	1977	05-83	18	0.59	5.62
			1978	05-83	36	0.04	b
C0040	2525	2185	1979	05-83	18	0.82	b
			1980	05-83	36	8.15	b
			1981	05-83	54	0.82	b
C0041	2550	2210	1982	05-83	18	2.30	b
			1983	05-83	54	0.29	b
C0042	2575	2060	1974	05-83	18	1.36	b
			1975	05-83	24	0.07	b
C0043	2625	2210	1971	05-83	18	0.65	6.22
			1972	05-83	36	0.14	b
S0339	2475	2110	7114	08-84	0	0.74	12
C0257	2550	2010	1976	05-83	18	0.47	b
C0258	2600	2235	1985	05-83	36	0.04	b
C0259	2675	2085	1973	05-83	18	0.55	b

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

FIDLER - field instrument for the detection of low-energy radiation

MRC ID - Monsanto Research Corporation Identification

pCi/g - picocuries per gram

survey data conducted during the preparation of this report, and appears to be relatively comparable to the summaries presented in the original Site Survey Project Report. The original report did note that post site survey D&D Program core sampling was conducted in this area. Thorium concentrations as high as 150 pCi/g were detected, but thorium concentrations were generally in the range of 5 to 15 pCi/g. No data reports of the D&D Program were found during research for this report.

Mound Plant drawing #FSE16472 (DOE 1992f) indicates the depth to bedrock in this area is approximately 48 to 96 inches (4 to 8 ft). The maximum depth sampled during the Site Survey Project was 54 inches, or 4.5 ft. Most of the core locations were sampled at depths of 18 to 36 inches. Because the boring logs for Area 9 are not available, it is not known if sampling was performed until bedrock was reached.

5.8. AREA 12

Area 12 is located on the SM/PP Hill, adjacent to Areas 10 and 11 (Plate 1). In 1965, thorium-contaminated soils from Area 1 were buried in a trench in Area 12. Pipelines that carried radioactive wastes from the PP Building to the WD Building passed through this area. This area contains elevated levels of plutonium-238, perhaps from work performed at the WTS (Area 19) or runoff from Area 11 (subsections 4.1.2 and 4.1.7). Another smaller area of plutonium-238 contamination was located west and downgradient of Area 12. This contamination may also be the result of surface water transport from Areas 11 and 12. The boundaries of Area 12 shown on Plate 1 are based on a review of the site survey data during preparation of this report, and are similar to the area depicted in the original Site Survey Project Report.

Table V.5 gives the results of the Site Survey Project sampling in Area 12, which are similar to the results summarized in the original Site Survey Project Report. The maximum plutonium-238 and thorium concentrations reported were 313 pCi/g and 189.9 pCi/g, respectively. These concentrations were detected in a sample collected from core location 0131 at a depth of 54 inches (Plate 1; C0131 on Table V.5).

In situ gamma spectroscopy for thorium-232 was performed at two core locations (CO145 and CO291, Table V.5). The maximum thorium-232 concentration measured using this technique was 22 pCi/g. This concentration was detected in the samples collected from location CO145 at depths of 24 and 36 inches. Most core locations were sampled to a total depth of 132 to 180 inches; however, the maximum sampling depth was 234 inches (Table V.5). Mound Plant drawing #FSE16472 (DOE 1992f) indicates the depth to bedrock in this area is 120 to 234 inches. It appears that the Area 12 core locations may have been sampled until bedrock was reached, but the boring logs are not available.

Table V.5. Mound Site Survey Project - Area 12

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
C0131	2800	2500	1198	12-82	18	82.60	76.90				
			1199	12-82	36	NR	174.80				
			1200	12-82	54	313.00	189.90				
			1201	12-82	72	68.10	37.90				
			1202	12-82	90	0.03	b				
			1203	12-82	108	0.03	b				
			1204	12-82	144	0.03	b				
			1205	12-82	192	0.09	6.72				
			1206	12-82	222	0.14	b				
C0132	2825	2465	6785	08-84	0	12.10	4.24	LDL	LDL	1.1	LDL
			1185	12-82	18	11.13	b				
			1186	12-82	36	0.57	b				
			1187	12-82	72	0.58	b				
			1188	12-82	90	0.13	b				
C0134	2850	2465	1533	04-83	18	7.26	b				
			1534	04-83	36	3.39	b				
			1535	04-83	54	0.15	b				
			1536	04-83	72	NR	157				
			1538	04-83	108	3.99	2.93				
			1539	04-83	126	24.00	b				
			1540	04-83	135	29.40	b				
C0135	2850	2490	1541	04-83	18	17.10	b				
			1542	04-83	36	0.96	b				
			1543	04-83	54	0.73	b				
			1544	04-83	72	0.19	b				
			1545	04-83	90	0.25	b				
			1546	04-83	108	0.28	b				
			1547	04-83	126	0.15	b				
			1548	04-83	144	0.41	b				
			1549	04-83	153	0.08	b				

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.
[c]A "none" for MRC ID indicates that *in situ* gamma spectrocopy was performed for thorium-232. The report on this procedure is provided in Appendix C.

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

Table V.5. (page 2 of 3)

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
C0136	2850	2515	1511	04-83	18	32.90	b				
			1512	04-83	36	12.30	b				
			1513	04-83	54	1.95	b				
			1514	04-83	72	8.88	b				
			1515	04-83	90	4.50	b				
			1517	04-83	108	3.37	b				
			1518	04-83	126	7.72	b				
			1519	04-83	144	1.74	b				
			1520	04-83	162	0.55	b				
			1521	04-83	180	5.66	2.16				
C0140	2875	2450	1522	04-83	18	0.67	b				
			1523	04-83	36	0.17	b				
			1524	04-83	54	0.11	b				
			1525	04-83	72	0.64	b				
			1526	04-83	90	0.39	b				
			1527	04-83	108	0.48	b				
			1528	04-83	126	0.50	b				
			1529	04-83	162	0.15	b				
			1530	04-83	198	0.41	b				
			1531	04-83	216	0.05	b				
			1532	04-83	234	0.04	b				
C0144	2900	2500	1189	12-82	18	7.41	b				
			1190	12-82	36	164.80	25.70				
			1191	12-82	54	5.30	18.30				
			1192	12-82	72	1.30	b				
			1193	12-82	90	0.23	b				
			1194	12-82	108	0.07	b				
			1195	12-82	126	0.02	b				
			1196	12-82	144	0.04	b				
			1197	12-82	162	0.02	b				
C0145	2885.7	2498.9	None	02-84	0	NR	1.4				
			None	02-84	1	NR	1.4				
			None	02-84	24	NR	22				
			None	02-84	36	NR	22				
			None	02-84	48	NR	9.4				
			None	02-84	60	NR	14				
			None	02-84	72	NR	12				
S1087	2825	2515	6788	08-84	0	2.63	9.79				
S0606	2800	2440	9551	06-85	0	NR	NR	LDL	LDL	0.8	LDL
S0607	2850	2450	6789	08-84	0	1.19	b				

Table V.5. (page 3 of 3)

Plate 1 Location[a]	Coordinates South	Coordinates West	MRC ID No.	Mo-Yr	Depth (inch)	Plutonium-238 (pCi/g)	Thorium[b] (pCi/g)	Cobalt-60 (pCi/g)	Cesium-137 (pCi/g)	Radium-226 (pCi/g)	Americium-241 (pCi/g)
C0291	2915.3	2490.3	None	07-84	0	NR	0.6				
			None	07-84	12	NR	0.4				
			None	07-84	24	NR	0.5				
			None	07-84	36	NR	0.4				
			None	07-84	48	NR	0.4				
			None	07-84	60	NR	0.3				
			None	07-84	72	NR	0.5				
			None	07-84	84	NR	0.4				
			None	07-84	96	NR	0.7				
			None	07-84	108	NR	0.6				
			None	07-84	120	NR	0.3				
			None	07-84	132	NR	0.3				

5.9. AREAS OF POSSIBLE ELEVATED THORIUM ACTIVITY

Evaluation of the Site Survey Project data indicates that both isolated and contiguous areas of elevated thorium activity, above the Mound Plant guidelines of 5 (surface) and 15 (subsurface) pCi/g, may exist beyond the areas with numerical indicators. Inspection of Plate 5 suggests that low-level thorium activity may be spread to the areas northwest of Areas 8 and 9 across Area 7. Considering that the thorium project actually involved redrumming operations in Areas 7 and 9, the mechanism of contaminant transport would have been fugitive dust emissions. This is largely consistent with the distribution of thorium depicted in Plate 5. Since this region of the upper valley of the plant has under gone considerable new construction and has been paved with asphalt since the redrumming operations, the isopleth concentrations depicted in Plate 5 may now be represented by spotty contamination in actual field conditions. Samples from locations C0007, C0028, S0307, S0425 are indicated as possible hot spots on Plate 1.

Indications of elevated levels of thorium adjacent to Area 8 (Plate 5) are substantiated by samples collected since the Site Survey Project. Sample were apparently collected north and west of the fenceline and south of Building 61 (Plate 1). Results reported from the Mound Plant Soil Screening Facility (MRC 1985) indicate thorium concentration that ranged from 1 to 28 pCi/g and plutonium-238 concentrations from 3 to 58 pCi/g. Approximately 24 samples were collected and analyzed, but the individual sample locations were not established for this report. The data sheets are included in Appendix E.

An area of possible elevated thorium activity is noted on Plate 1, west of Area 7. This area is located slightly uphill and to the southwest of Building 98. Table V.6 presents the results of the locations that have been included in this area. The maximum concentration of thorium reported, 37.69 pCi/g, was detected in the sample collected from core location C0011 at a depth of 18 inches. Thorium levels in excess of the Mound Plant cleanup levels (5 pCi/g for the first 15 cm of soil and 15 pCi/g for below 15 cm depth) were also measured in samples from core location C0010 and surface locations S0287 and S0288 (Table V.6).

Mound Plant drawings #FSE16472 (DOE 1992f) indicates the depth to bedrock in this area of Mound Plant is approximately 180 inches, or about 15 ft. The core locations in this area were sampled to at least 216 inches. Based on the Mound Plant drawing referenced above, it appears that the core locations in this area were sampled to bedrock, although boring logs are not available.

A second area of low-level but possibly wide-spread thorium contamination is indicated in Area 1 (Plates 1 and 5). This area was also involved with thorium storage and repackaging, but has experienced several cleanup activities, as previously described. Sample locations S0971 and S0982 (Table V.7), indicated as possible hot spots on Plate 1, may represent outlying areas of contamination associated with operations in Area 1.

Table V.6. Mound Site Survey Project - Area of Possible Elevated Thorium Activity

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)
C0010	1900	2350	1734	05-83	18	0.36	b					
			1735	05-83	36	0.16	11.15					
			1736	05-83	54	NR	18.00					
			1737	05-83	90	0.03	14.41					
			1738	05-83	108	0.03	27.83					
			1739	05-83	162	0.01	5.76					
			1740	05-83	180	0.01	b					
			1741	05-83	198	<0.01	b					
			1742	05-83	216	0.01	5.44					
			1743	05-83	228	<0.01	b					
C0011	1925	2400	1784	05-83	18	8.97	37.69		LDL	LDL	1.5	LDL
			1785	05-83	72	0.42	4.43					
			1786	05-83	90	0.20	b					
			1787	05-83	108	0.31	b					
			1788	05-83	126	0.46	b					
			1789	05-83	198	0.44	b					
			1790	05-83	216	0.84	11.13					

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

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

Table V.6. (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)
C0012	1950	2300	1725	05-83	18	0.13	b					
			1726	05-83	36	0.16	5.44		LDL	LDL	1.0	LDL
			1727	05-83	54	0.20	5.88					
			1728	05-83	72	0.05	b					
			1729	05-83	108	0.05	b					
			1744	05-83	126	0.01	b					
			1730	05-83	162	0.03	b					
			1731	05-83	180	0.02	2.96					
			1732	05-83	216	0.02	b					
			1733	05-83	234	0.02	b					
C0013	2000	2375	1745	05-83	18	0.06	b					
			1746	05-83	72	0.05	b					
			1747	05-83	90	0.15	b					
			1748	05-83	108	0.29	b					
			1749	05-83	117	0.05	3.18					
S0284	1925	2390	6752	08-84	0	0.03	b					
S0285	1950	2440	4092	10-83	0	0.07	b					
S0287	2025	2440	5985	07-84	0	0.95	8.94		LDL	LDL	0.8	LDL
S0288	2025	2465	5986	07-84	0	0.29	8.09					
S0296	2075	2440	5984	07-84	0	1.56	16.59					

Table V.7. Isolated Locations of Elevated Activity

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)
C0007[c]	1800	1860	8352	11-84	54	0.39	41.63					
			8353	11-84	108	0.08	5.14					
C0028	2375	1755	1245	12-82	18	11.40	5.61					
			1246	12-82	48	NR	109.00					
			1247	12-82	66	NR	109.00					
			1248	12-82	102	NR	58.00					
			1250	12-82	156	NR	97.00					
			1251	12-82	216	0.29	29.45					
			1252	12-82	234	0.06	b					
			1253	12-82	252	0.03	b					
S0166	1750	3350	4000	10-83	0	34.50	b					
S0175	1375	3580	9845	06-85	0	NR	NR		82	10	0.8	LDL
S0208	1660	3765	3085	10-83	0	61.00	b	0.72				
S0307	2175	2060	2821	10-83	0	5.36	6.46					
S0425	2500	2945	4108	10-83	0	1.08	5.74					
S0472	2175	3505	6701	08-84	0	1.20	7.50					

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

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

Soil Screening Facility indicate plutonium-238 levels of 16 to 573 pCi/g and thorium levels of 13 and 107 pCi/g (MRC 1987). The data sheet is included in Appendix E.

6. URANIUM ORE PROCESSING AREAS

From the early 1950s to the early 1980s, Mound Plant conducted numerous programs that involved the extraction and purification of radium-226, actinium-227, thorium-230 and protactinium-231. These programs, although viewed as distinct projects, all involved the use of source materials that were derived from the processing of uranium ores. The ores used at Mound Plant had typically undergone some sort of previous chemical extraction process that had depleted the ores in uranium content, but left them enriched in the daughter products of uranium. The most abundant isotope in the group is thorium-230, being derived in the decay chain of uranium-238, the most abundant uranium isotope in nature. The subsections that follow give brief overviews of the various uranium ore extraction programs; the areas where the process and TSD of feed materials and wastes took place (Figure 6.1); and whether these areas were sampled as part of the Site Survey Project. A related program was the experimental extraction of radium-226 from a pitchblende residue described in the companion radium-actinium section of this report.

6.1. PROGRAM SUMMARY

In November 1955, Mound Plant undertook the design and construction of a facility that would produce thorium-230, also known as ionium (Johnson 1955). The source material for the extraction of ionium was a uranium ore residue known as the airport cake. In addition to ionium, the caustic-neutralized slurry reportedly contained minor amounts of thorium-232, rare earth elements, scandium, uranium, and traces of protactinium (DOE 1992g). Decay products such as radium-226 and its daughters would have also been present. No analysis of the airport cake was found during the research for the scoping reports, although by the description, it is probably very similar to the Cotter Concentrate, described below. A total of about 449 g (94 ci) of ionium was produced by 1956 from an unknown quantity of feed materials.

The research and process chemistry for the ionium process took place in the R Building (Figure 6.1). Most of the ionium processing wastes were generated in the R Building and perhaps in the HH Building. In the R Building processing waste was sent to a small evaporator that was previously used to process wastes generated by the actinium-radium program. The steam condensate was transferred to the WD facility via the process sewer pipe serving the R Building. During this time 13 gallons of a solution containing 8 g (<2 Ci) of ionium leaked into the corridor of R-121 where it was being stored. The solution was washed to the process sewer line to the WD influent tank where it was stored before being diluted and released to the Great Miami River (Meyer 1957).

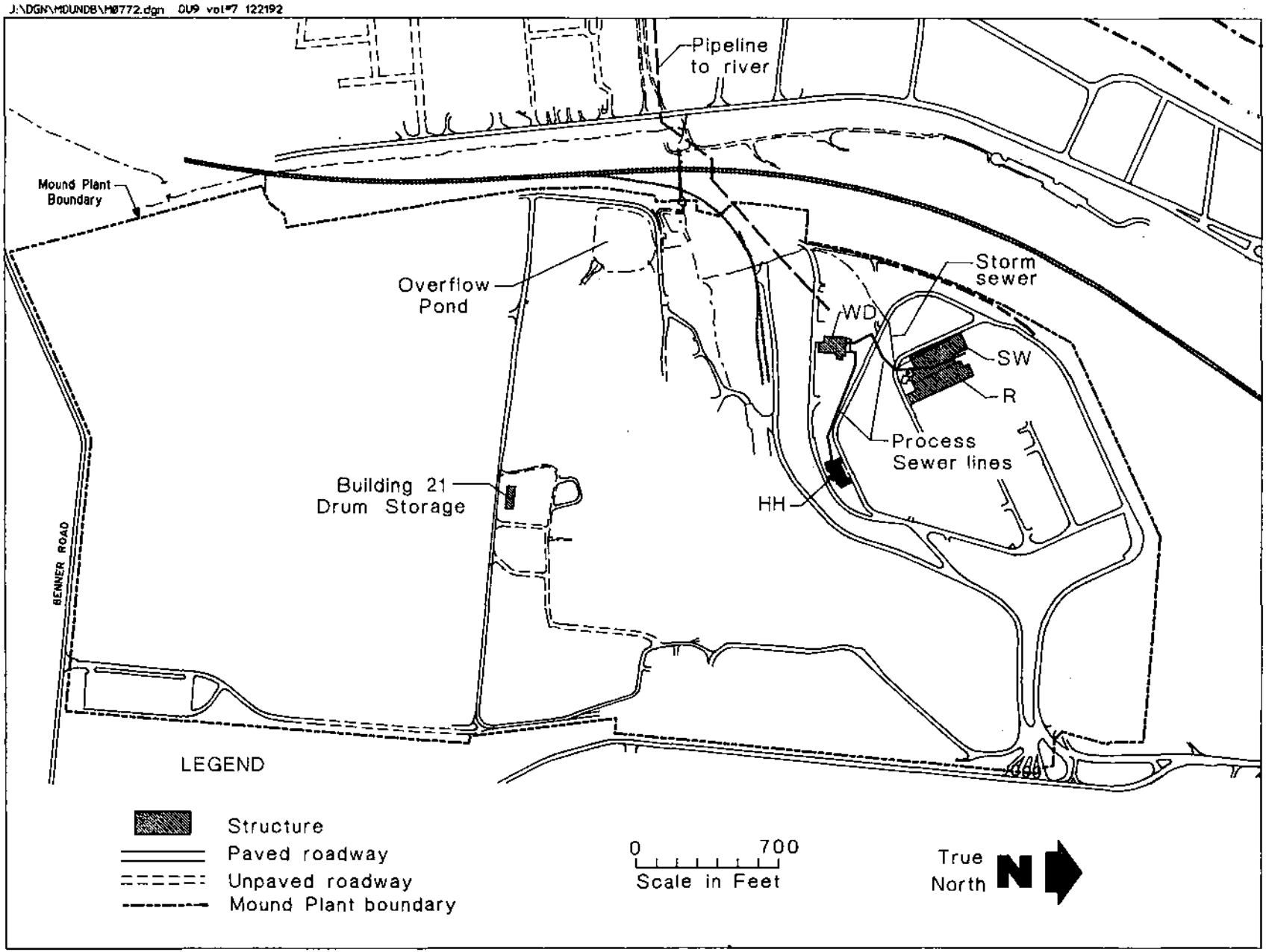


Figure 6.1. Uranium ore processing areas.

The disposition of ionium processing wastes is generally not known. Few records or reports of the ionium project were located during the research for the scoping reports. Some liquid wastes were drummed and shipped offsite for burial (DOE 1992g). Where the feed and waste materials were stored until their final disposition is unknown. No treatment facility is known or suspected, as at least some of the liquid wastes were handled in the WD Building. No onsite disposals are known or suspected.

6.2. PROTACTINIUM-231 PROGRAM

In the early 1950s, Mound Plant was requested to develop a program of recovery and purification of protactinium-231. Approximately 80 drums containing 20,000 pounds of uranium ore residues, also known as sperry cake, were shipped to Mound Plant as the source material. The feed materials contained 0.1 to 0.2 ppm protactinium-231 in a matrix of iron, aluminum, calcium, magnesium, cobalt and copper. About 1 g (0.05 Ci) of protactinium-231 was extracted during the processing of 10,000 pounds of ore (DOE 1992g).

The research and development phase began in the R Building in 1954. In 1955, a pilot plant was constructed in the HH Building and in March 1956 this facility was moved to the SW Building. A larger facility was installed in HH Building. The extent of the facility's use is unknown, but is thought to have been experimental, as the program remained relatively small in nature (DOE 1992g). Few records or reports of the protoactinium-231 project were located during the research for the scoping reports. Acidic processing waste generated from the protactinium program are known to have been stored around the HH Building. This waste reportedly leaked from defective drum liners and contaminated the soils with radionuclides such as thorium-230. Over a period of several months this waste was diluted and discharged to the Great Miami River through either the sanitary sewer or the storm sewer to the river (DOE 1992c). No onsite disposals are known or suspected.

6.3. COTTER CONCENTRATE PROGRAM

In the early 1970s Mound Plant undertook a program to recover protactinium-231 and thorium-230 from a material known as the airport cake or more commonly as the Cotter Concentrate (DOE 1992g). The analysis of the Cotter Concentrate received by Mound Plant is shown in Table VI.1. Mound Plant received 1,251 55-gallon drums of residue in 1970 and stored it in sealed drums in Building 21 until 1987.

From 1974 until 1979, 22 drums of Cotter material was processed in the SW Building to produce 339 g (72 Ci) of thorium-230 and 80 mg (4 Ci) of protactinium-231. The pilot plant scale project was operated in a hot cell in the SW Building. The hot cell operation was required because the gamma emitting isotope radium-226 and its decay products were present in the original Cotter Concentrate

Table VI.1. General Composition of Cotter Concentrate

Element	Concentration (Weight %)
Sodium	>0.1
Iron	>0.1
Silicon	>0.1
Vanadium	>0.1
Molybdenum	>0.1
Aluminum	0.05
Titanium	0.04
Copper	0.02
Zirconium	0.02
Nickel	0.03
Beryllium	<0.005
Manganese	0.007
Magnesium	<0.005
Silver	<0.005
Uranium oxide	21,740 g/drum
Thorium-232	99.9 g/drum
Protactinium-231	0.060 g/drum
Thorium-230	11.1 g/drum
Average moisture content	47% (wt/wt)

Data from Watrous 1973; Rawlings 1951

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.

7. ACTINIUM-227 AND RADIUM-226 PROCESSING AREAS

This section provides general descriptions of the scale and periods of operation of the actinium-227 and radium-226 program at Mound Plant. Summaries are provided of the areas where process and TSD activities took place and whether environmental radiological data, through the Site Survey Project, are available. Additional information on the generation, treatment, and disposal activities is provided in Volume 7 - Waste Management (DOE 1992g).

7.1. PROGRAM SUMMARY

In 1949, Mound Plant was requested to undertake the production of actinium-227 to support the Atomic Energy Commission's substitution materials program. Since actinium-227 was not present in sufficient quantities in natural source materials to allow for economical recoveries, it was be produced by the transmutation of radium-226 with neutrons in a nuclear reactor. Mound Plant actually conducted two separate, but related actinium programs. The first was experimental separation of radium-226 from a barium-rich uranium ore, pitchblende residue known as K-65. A typical composition of the K-65 residue is shown in Table VII.1, no other detailed analyses have been found as a result of the research for the scoping reports. The second and most productive source of actinium-227 was a concentrated radium material that had been irradiated in the Hanford nuclear reactor (DOE 1992g).

The experimental extraction of radium-226 from the K-65 was conducted in R Building (Figure 7.1; Plate 1). In October 1949, Mound Plant received 200 pounds of K-65 in a single drum. This material was stored at Mound Plant in an old explosives bunker that became known as the radium shack.

In June 1951, a special shielded facility, known as the old cave, was constructed on the east side of the SW Building to separate and purify actinium-227 from the irradiated radium-226. Liquid wastes generated in the cave area were directed by trenches in the floor to separate sumps and to a small evaporative treatment system located within the building. The waste sludge and the spent ion exchange resins were drummed and stored at the radium shack, now known as Area 21, discussed below. Water from the evaporation and ion exchange column was released to the sanitary sewer. Other low-level liquids, such as washwater was drummed and stored at the old Warehouse 13 site on what is now the SM/PP Hill. Warehouse 13 was razed in the mid-1950s and the site is now enclosed in Area 17 around the SM Building.

As part of the D&D of the cave, the waste evaporator equipment was dismantled, decontaminated, and stored on the ground for several years in the what was known then as the lower storage area. This area was located in the lower plant valley south of the present location of Building 3 (Figure 7.1;

Table VII.1. Composition of K-65 Residue

Constituent	Concentration Weight %
Water	30
Lead oxide	19
Barium sulfate[a]	7
Silicon dioxide	35
Metals[b]	9

Source: Rawlings 1951
[a]375 mg of radium contained with the barium.
[b]Trace metals that may be found in the K-65 residues are similar to those identified in Cotter concentrate (see Table VI.1).

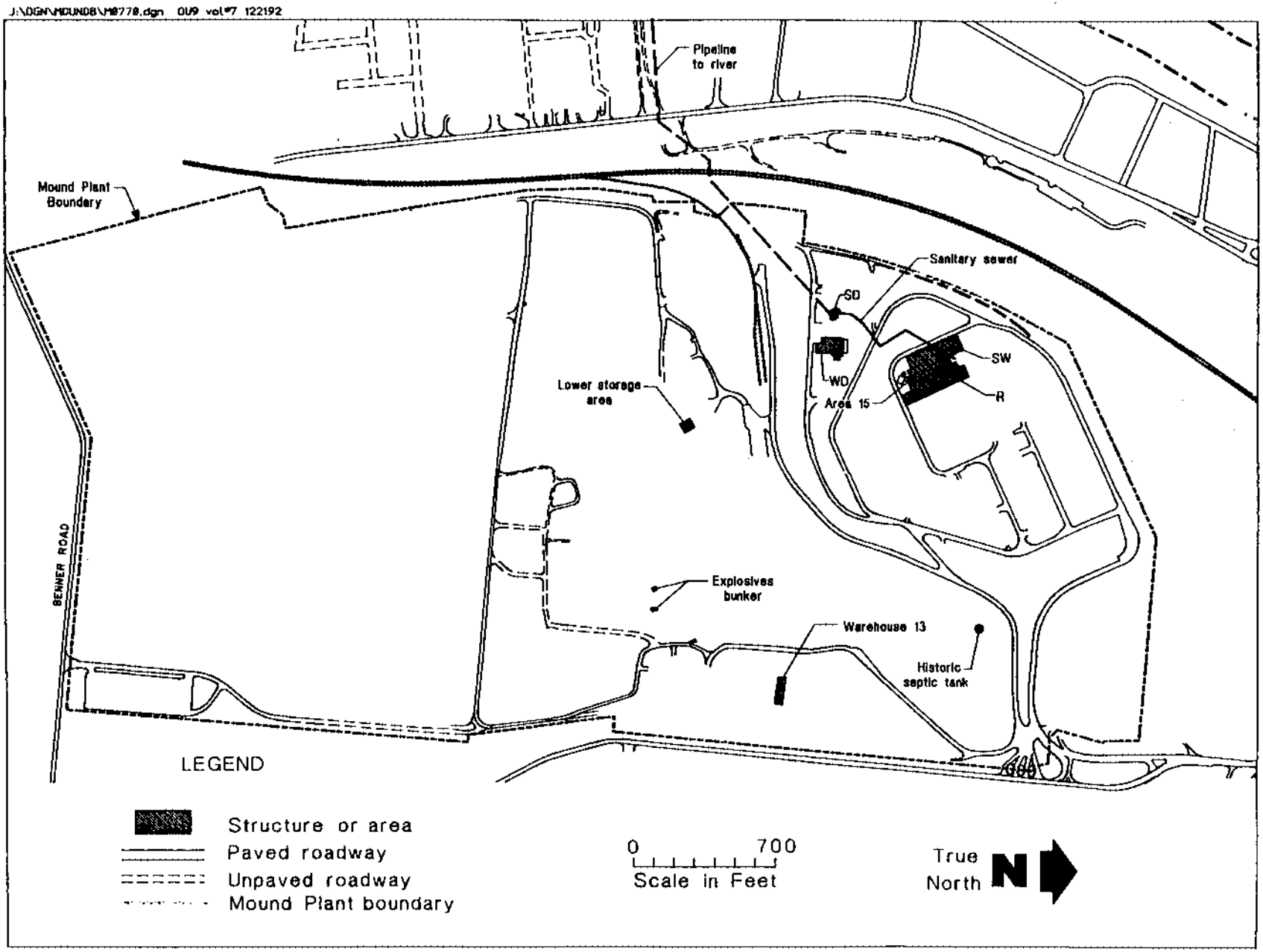


Figure 7.1. Radium-226/actinium-227 processing areas.

Plate 1). This site was reportedly surveyed during the initial field survey of the Site Survey Project, but it is not mentioned in the project report (Stought et al. 1988).

As part of the D&D of the old cave, most equipment was boxed and shipped off-site for burial. Some of the cave walls and crane system were, however, dismantled and entombed in concrete over the floor of the cave itself. This entombed area is now known as Area 15, described below. After the cave entombment, in early 1955, the soil beneath the adjacent area of the SW Building was found to be contaminated with actinium-227 and radium-226 from an apparent leakage of one of the floor sumps. The contaminated soils were disposed in and possibly around an old septic tank in the upper plant valley (DOE 1992g). The old septic tank is known part of Area 7, also described below. No other disposal areas associated with the radium/actinium program are known or suspected.

7.2. AREA 7

Area 7 is a large area located in the upper valley at Mound Plant, behind or below Buildings 29, 51, 66, and 98 (Plate 1). This area was once a steep ravine that formed the upper reach of the plant drainage ditch. This area has a long history of debris disposal and infilling and is described in detail in the companion thorium subsection (5.5) in this report. The Site Scoping Report: Volume 6 - Photo History (DOE 1992d) documents several episodes of filling and construction. Plate 4 - Estimation of Fill Materials in Site Scoping Report: Volume 5 - Topographic Maps (DOE 1992a) indicates that over 30 feet of fill materials may exist in Area 7.

The current extent of Area 7 shown on Plate 1 is based on an interpretation of the site survey data made in the preparation of this report, and similar to the area depicted in the original Site Survey Project Report (Stought et al. 1988). The area shown is actually bigger than the estimate of area used in the historic disposals. On the north end of Area 7 is an old buried septic tank (Figure 7.1) that was first used during plant construction, but was the site of disposal of actinium and radium bearing soils excavated from the SW Building in 1955 (DOE 1992g).

As part of the Site Survey Project, two core locations were sampled at the septic tank behind Building 29. These are core locations 0008 and 0009 on Plate 1, and C0008 and C0009 in Table III.5. Actinium-227 was detected in samples from both locations, with the maximum concentration of 1,400 pCi/g detected in a sample collected from location 0008 at a depth of 144 inches. This contamination appears to be subsurface and extends to a depth of at least 216 inches, or 18 ft. Mound Plant employees report that at locations 0008 and 0009, the septic tank was penetrated during drilling and the material inside was sampled. No plutonium or thorium results were given for these samples. These

samples were not sampled for tritium. Although tritium was used extensively in the SW Building, the tritium projects postdate the actinium disposal (DOE 1992g).

7.3. AREA 15

The location of Area 15 is shown on Plate 1. Although this room is not underground, it has been known historically as "the old cave" at Mound Plant. The room was used for remote, high-level radioactive work, similar to work usually performed in a hot cell. In 1955, the contaminated equipment was crushed and the room was filled with about 2 ft of concrete, effectively entombing the equipment. Due to practical limitations posed by the presence of the concrete, no intrusive investigations have been performed at this area. However, approximately 1 Ci of radon-222 is released per year through a stack vent from the room, indicating the presence of radium-226 contamination within the concrete.

7.4. AREA 21

Area 21 is located on the SM/PP Hill, northeast of Building 53 and Area 22 (Plate 1). Area 21 is also known as the radium shack or old explosives bunker. Originally there were two bunkers, one used for explosives and the other for detonators. Both were used in the early 1950s for storage of radioactive materials that had high gamma radiation levels. These materials included feed and waste solutions from the radium/actinium program and wastes from the reactor waste decontamination program (DOE 1992g). The latter is described in section 9 of this report.

The boundary of Area 21 as shown on Plate 1 is slightly larger than the Area 21 depicted in the project report (Stought et al. 1988). This area was not included in the original compilation of known radiation areas at the beginning of the Site Survey Project, but was reportedly found during the gamma surveys. It is not known whether the boundaries depicted enclose both of the original bunker locations.

The results of the Area 21 sampling are given in Table VII.2. As noted on Table VII.2, several of the analytical results for the gamma-emitting radionuclides could not be found in the gamma spectroscopy results given in Appendix E. These results were handwritten in the original tabulated data, reproduced in Appendix E. The sampling locations are shown on Plate 1.

Cesium-137 was detected in several of the Area 21 samples, with a maximum concentration of 31 pCi/g measured in the sample taken at 60 inches at core location 0165 (C0165 on Table VII.2). Plutonium-238, tritium, and radium-226 were also detected in several samples, although at relatively low levels (1.67, 0.99, and 1.2 pCi/g, respectively).

Table VII.2. Mound Site Survey Project - Area 21

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)
S0740	3250	3100	2997	10-83	0	0.54	b	0.77	LDL	29	1.2	LDL
S0739	3250	3025	7335	09-84	0	0.75	b					
S0742	3275	3050	7337	09-84	0	0.37	b					
			2998	10-83	0	0.18	b	0.67				
S0743	3275	3075	7334	09-84	0	0.33	b					
S0745	3285	3010	2999	10-83	0	1.12	b	0.64				
S0746	3295	3005	9790	06-85	0	NR	NR			0.5[c]		
S0747	3295	3010	9794	06-85	0	NR	NR			5.0[c]		
S0644	3275	2970	6558	08-84	0	NR	NR		LDL[c]	29[c]	1.2[c]	LDL[c]
S0645	3290	2990	9789	06-85	0	NR	NR			28[c]		
S0646	3290	2995	9788	06-85	0	NR	NR			0.5[c]		
S0763	3325	3075	2885	10-83	0	0.79	b	0.152				
C0173	3250	3000	10436	08-85	18	NR	NR		LDL	6.7	0.8	LDL
			10437	08-85	36	NR	NR		LDL	5.6	0.8	LDL
			10438	08-85	54	NR	NR		LDL	1.9	0.9	LDL
			10439	08-85	60	NR	NR		LDL	9.7	0.9	LDL
C0176	3310	3010	10433	08-85	18	NR	NR		LDL	2.2	0.8	LDL
			10434	08-85	36	NR	NR		LDL	3.1	0.7	LDL
			10435	08-85	54	NR	NR		LDL	1.2	0.7	LDL
C0177	3310	3090	10444	08-85	18	NR	NR		LDL	2.3	0.9	LDL
			10445	08-85	36	NR	NR		LDL	5.3	0.9	LDL
			10446	08-85	54	NR	NR		LDL	4.5	0.9	LDL
C0165	3325	2980	10440	08-85	18	NR	NR		LDL	3.0	0.9	LDL
			10441	08-85	36	NR	NR		LDL	LDL	1.0	LDL
			10442	08-85	54	NR	NR		LDL	2.5	1.0	LDL
			10443	08-85	60	NR	NR		LDL	31	0.7	LDL

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

[c]These results could not be confirmed because they were not listed in the gamma spec results included at the end of Appendix F.

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

The sample results presented in Table VII.2 do not agree with the evaluation given in the original Site Survey Project Report (Stought et al. 1988). The project report indicated significant radium-226 activity, but no indications of radium-226 in Area 21 were found during the evaluation for this report. Mound Plant drawings (DOE 1992f) indicate that the depth to bedrock in this area as about 36 to 48 inches. The Area 21 core locations were sampled to 54 to 60 inches, and it is probable that bedrock was reached. However, the boring logs for the Area 21 locations are not available.

8. TRITIUM PROCESSING AREAS

This section provides general descriptions of the scale and periods of operation of the tritium program at Mound Plant. Summaries are provided of the areas where process and TSD activities took place and whether environmental radiological data, through the Site Survey Project, are available. Additional information on the generation, treatment, and disposal activities is provided in Volume 7 - Waste Management (DOE 1992g).

8.1. PROGRAM SUMMARY

Tritium-related operations began at Mound Plant in the mid-1950's and have continued to the present day. Tritium processing activities included production, disassembly, analysis, and development of nuclear components containing tritium. In support of these activities, Mound Plant has been involved in development of tritium enrichment and recovery process technology, and the processing and containment of tritium-contaminated wastes. Currently, Mound Plant has the facilities to perform these activities for all types of materials and wastes generated by other DOE facilities.

Tritium processing activities take place in the T, SW, R, and HH Buildings (Figure 8.1). The T, SW, and R Buildings also house the treatment and disposal operations. The entire tritium operation is geared toward a treatment and containment system. Effluents are minimized as the goal of the program is to recover as much as possible. Gaseous effluents from processes in the HH Building were originally vented to the atmosphere. Beginning in 1970, the gas was collected in cylinders for transport to the SW Building. This gas is now piped to the SW Building for recovery.

Aqueous wastes from the gaseous effluent treatment are drummed and shipped to the T Building for recovery. Low-level liquid wastes generated in the SW and R Buildings are pumped to the WDA facility through a low-risk beta wastewater line. In 1975, the underground line from SW to WDA was abandoned and an aboveground line was installed. Until the early 1970s, the tritiated wastewater was diluted and released to the river. Since then it has been solidified, and drummed for offsite disposal. High-level liquid wastes are drummed in the SW Building for offsite disposal. Solid wastes are containerized for offsite disposal in the SW or R Building.

8.2. SAMPLING SUMMARY

The Site Survey Project reportedly performed liquid scintillation analysis on 5 percent of the soil samples collected (Stought et al. 1988). The available data from the Site Survey Project for tritium included 111 sample locations (Appendix E). Figure 8.2 shows the distribution of samples collected

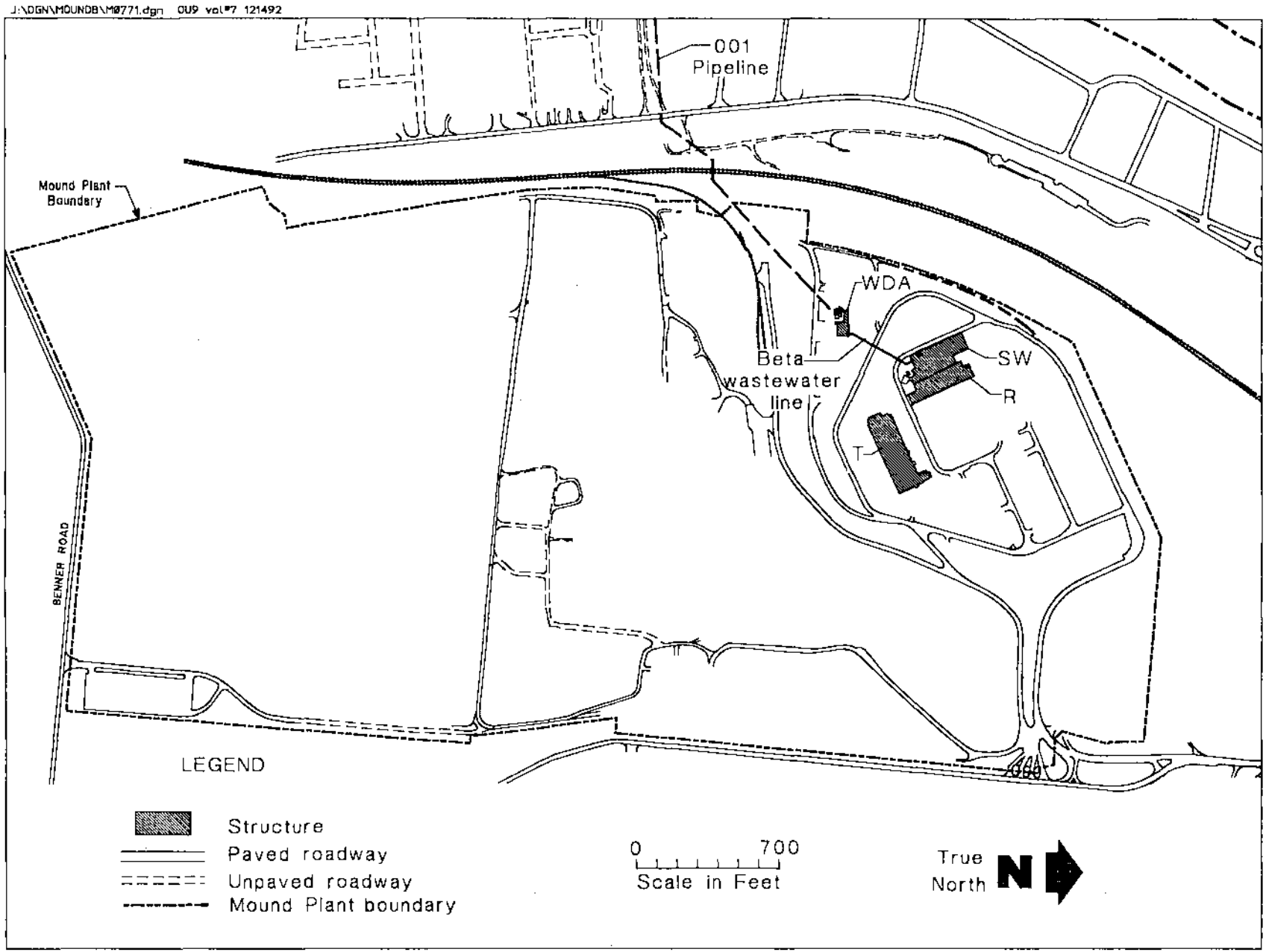


Figure 8.1. Tritium processing areas.

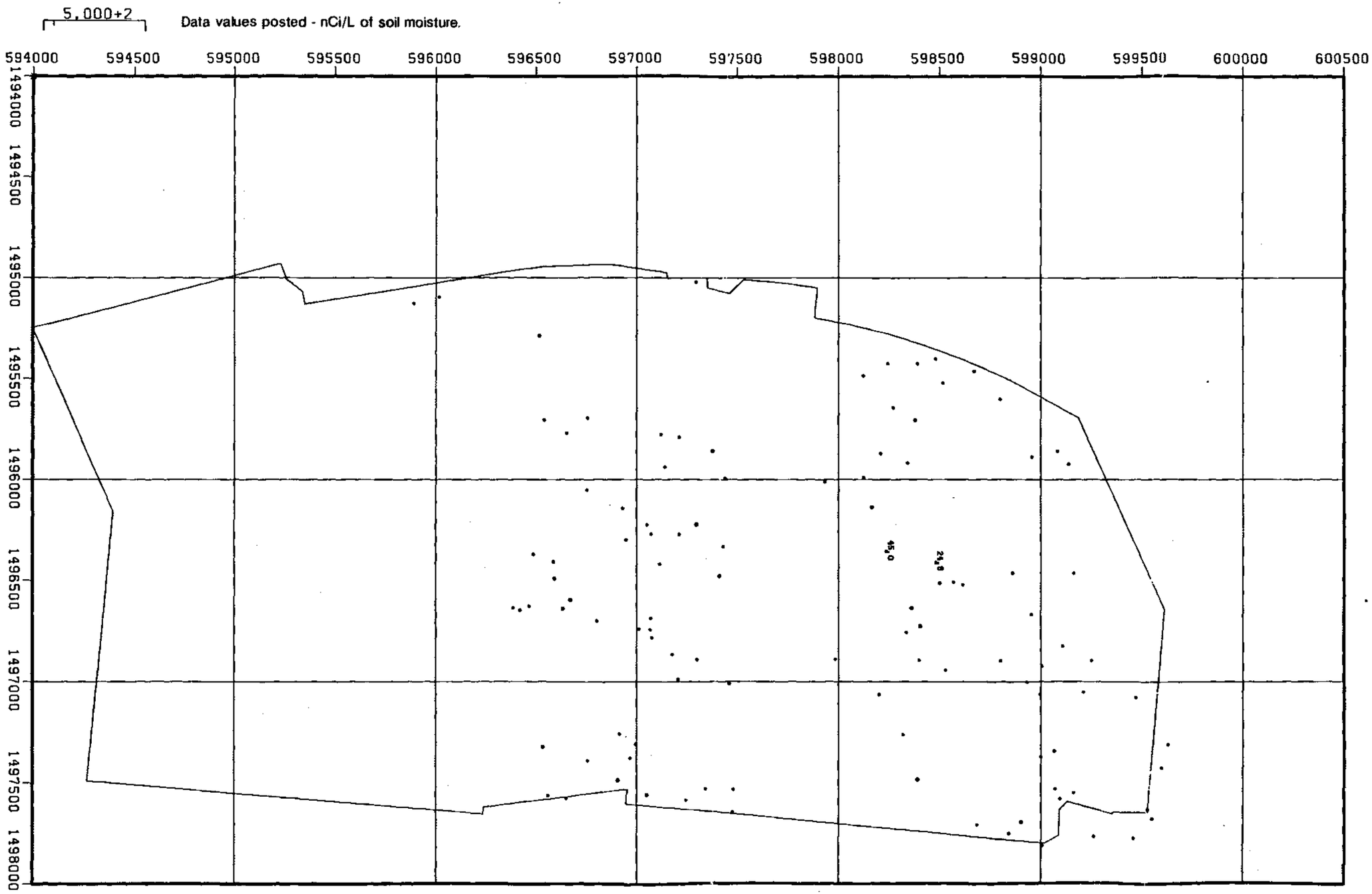


Figure 8.2. Distribution of samples analyzed for tritium by Site Survey Project (Stought et al. 1988).

for tritium analysis. The soils beneath the SW Building and the area surrounding the T and HH Buildings were not included as part of the Site Survey Project, but were the focus of a study in the mid-1970s, described below. All but two samples indicated tritium values below 20 nCi/L. The highest concentration of tritium measured in soils was reported to be 45 pCi/mL of soil moisture (45 nCi/L; Appendix E) in sample S0372 on the southeast part of the Main Hill (Plate 1).

8.3. TRITIUM STUDY IN AREA OF OVERFLOW POND

As part of the Potable Water Project conducted in the mid-1970s, Mound Plant performed scintillation analyses for tritium in soils adjacent to the historic landfill. The soil samples were obtained in 1976, in conjunction with a site engineering study in preparation of the overflow pond (Dames and Moore 1976a). Soil moisture from 14 subsurface soil boring samples (Figure 8.3) indicate tritium concentrations ranged from 2 to 268 nCi/L of soil moisture (Table VIII.1). All but the highest values were less than 100 nCi/L (Hopkins 1976). Soils from the area were reworked during the construction of the Site Sanitary Landfill and overflow pond (DOE 1992g).

Additional investigations at Mound Plant have addressed the presence of tritium in soils and in the Buried Valley aquifer. This information is provided in the Phase I Potable Water Standards Project (Dames and Moore 1976b), Potable Water Standards Project (Dames and Moore 1976c), Potable Water Standards Project: Final Report (Styron and Meyer 1981) and the Buried Valley Aquifer Evaluation Project (Dames and Moore 1976d).

8.4. CONTAMINATED SOILS UNDER THE SW BUILDING

The SW Building, adjacent to R Building on the Main Hill (Plate 1), has long been suspected as the principal source of the tritium contamination in groundwater seeps on the Main Hill (DOE 1989b). This conclusion was based on

- the historic use of tritium in the SW Building;
- tritium concentrations in the soils and soil moisture in samples taken under the building (Dames and Moore 1977);
- the presence of low-level uranium-233 in samples from some of the seeps, because it was processed exclusively in the SW Building (DOE 1991g);
- the spatial distribution of tritium concentrations in groundwater seeps, pipe chases, and observation pits (DOE 1991d); and
- the impact of the SW Building capture pit system on the tritium concentration in groundwater (DOE 1991e).

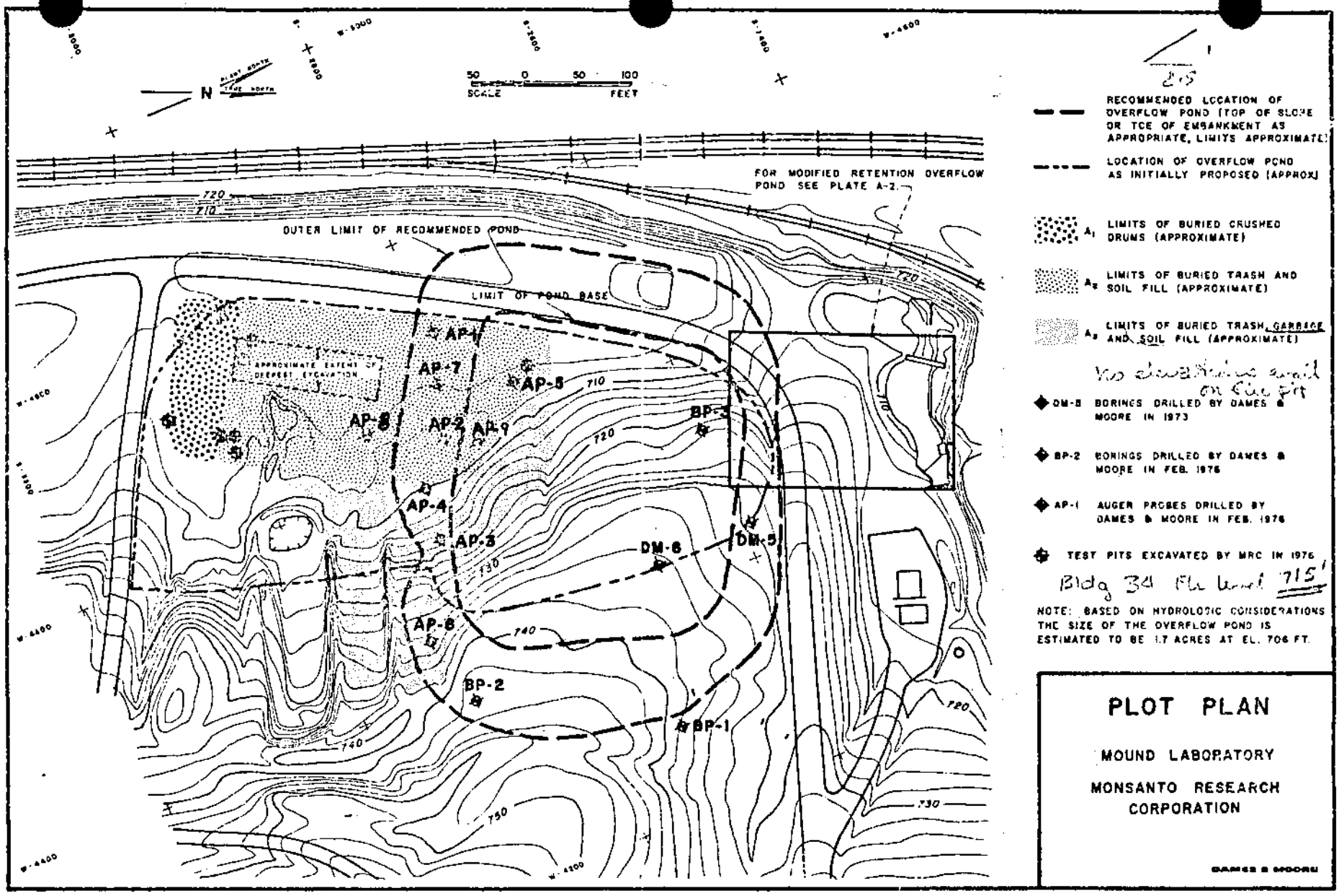


Figure 8.3. Soil borings conducted for construction of overflow pond (from Dames & Moore 1976a)

Table VIII.1. Tritium Concentrations in Soil Moisture from Borings for Overflow Pond Construction (from Hopkins 1976).

Borehole ID	Depth (feet)	Distillate uCi/L	nCi/L
A-1	8.5-10	0.0321	32
A-2	30-31.5	0.0456	46
A-2	18.5-20	0.0505	51
A-3	12-13.5	0.0031	3
A-4	13.5-15	0.0456	46
A-4	28.5-30	0.0884	88
A-5	13.5-15	0.0955	96
A-5	18.5-20	0.0334	33
A-5	23.5-25	0.0201	20
A-6	13.5-15	0.0253	25
A-6	18.5-20	0.0513	52
A-6	23.5-25	0.0181	18
A-7	8.5-10	0.0218	22
A-7	13.5-15	0.0236	24
A-7	18.5-20	0.0509	51
A-8	18.5-20	0.0248	25
A-8	23.5-25	0.0171	17
A-9	11-12.5	0.2685	268
B-2	8.5-10	0.0306	31
B-2	13.5-15	0.0165	17
B-2	18.5-20	0.063	6
B-2	28.5-30	0.0040	4
B-2	33.5-35	0.045	5
B-3	3.5-5	0.0747	75
B-3	18.5-20	0.0180	18
B-3	28.5-30	0.0049	5
B-3	33.5-35	0.0051	5
B-3	38.5-40	0.0021	2
B-5	3.5-5	0.0059	6
B-5	8.5-10	0.0067	7
B-5	23.5-25	0.0445	45
B-5	28.5-30	0.0218	22
B-5	33.5-35	0.0085	9
B-5	38.5-40	0.0278	28
B-5	43.5-45	0.0311	31

The tritium in the soils is apparently the result of the release of contamination from sumps in the SW Building. These sumps received processing wastewater, spills from processing upsets, and wastewater from decontamination activities.

In 1977, soil samples were collected from under the SW and R Buildings (Dames and Moore 1977). Figure 8.4 shows the seven core locations. Soil moisture was distilled from samples obtained from these core locations and analyzed for tritium (Table VIII.2). Based on these samples, it was estimated that the total tritium inventory in the soils was approximately 1,300 Ci. Radioactive decay since 1977 should have reduced this inventory to approximately 625 Ci in 1990 (half-life of tritium is 12.3 years).

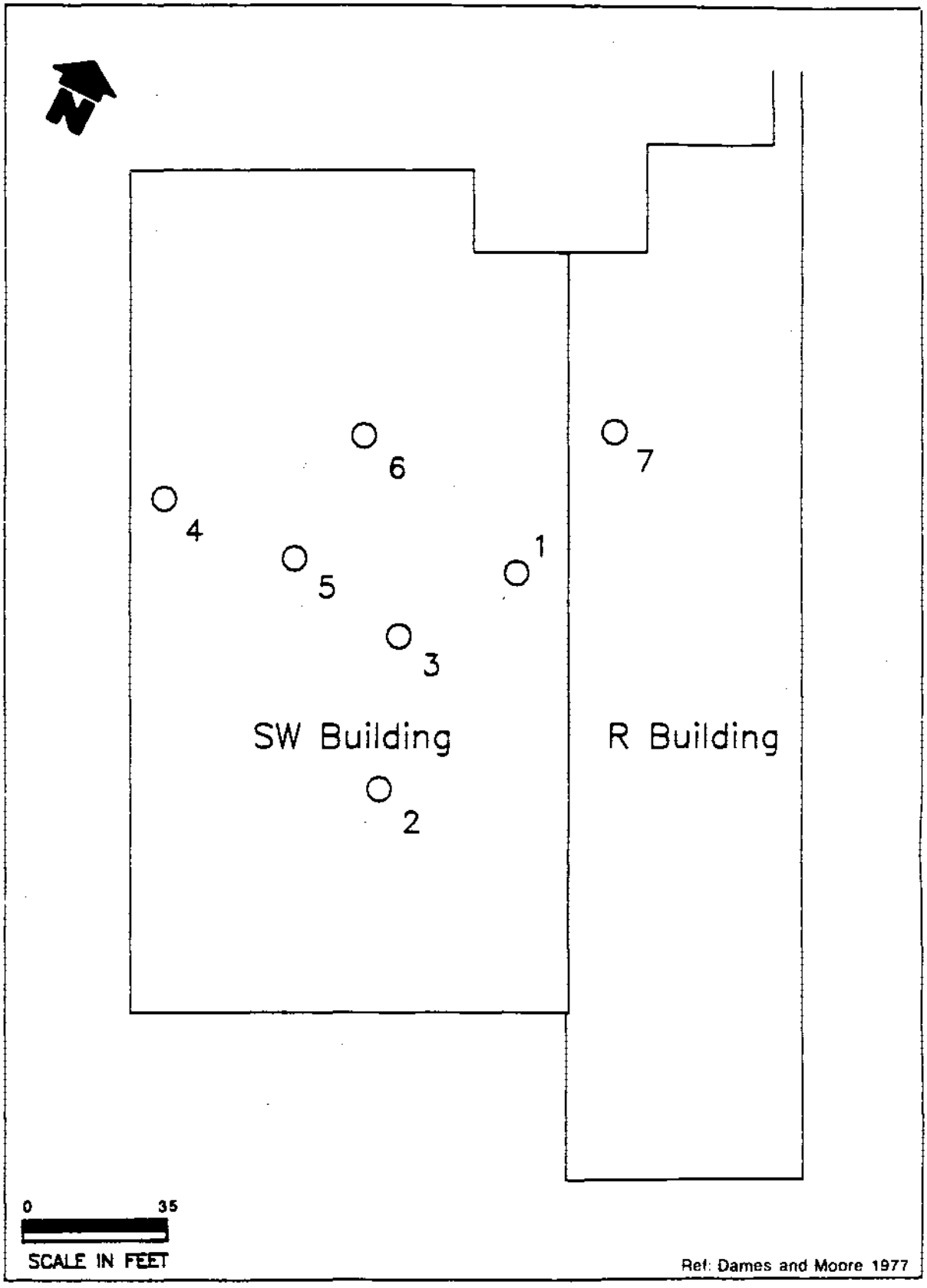


Figure 8.4. Soil boring locations for tritium inventory below SW and R Buildings.

Table VIII.2. Tritium Inventory Beneath SW and R Buildings in 1977 (Dames and Moore 1977)

Location (Figure 3.3)	Depth (inches)	Dry Weight (g)	Moisture Content (%)	Soil Distillate Concentrations Tritium (nCi/L) (1000s)
1	6 to 12	89.99	13.4	851.14
	12 to 24	89.35	13.0	783.45
	24 to 36	96.05	11.5	831.81
	36 to 58	93.02	11.3	632.95
	58 to 72	90.83	13.2	270.58
	72 to 84	92.18	16.1	673.50
2	10 to 22	105.72	1.4	3833.9
	22 to 27	101.1	7.9	782.50
	27 to 34	92.97	12.2	579.78
3	4 to 12	101.06	1.7	97.276
	12 to 24	97.01	4.5	35.720
	24 to 35	87.93	15.5	93.124
4	9 to 18	48.86	5.9	3.93
	18 to 31	65.26	2.6	0.552
	31 to 38	103.4	2.1	0.7953
	38 to 48	114.94	2.1	1.6174
	48 to 51	139.15	2.1	1.6862
	51 to 72	102.71	10.6	0.19106
t	72 to 84	97.49	13.3	0.0997
	84 to 96	88.02	14.6	0.2398
	96 to 108	86.89	15.4	0.5162
	108 to 120	89.06	28.1	0.2193
5	6 to 12	100.88	2.5	110.05
	12 to 24	102.55	1.5	240.37
	24 to 36	115.74	1.8	285.01
	36 to 48	102.08	1.4	152.04
	48 to 58	96.71	4.2	42.753
6	6 to 12	104.79	2.7	41.577
	12 to 24	101.92	1.5	31.904
	24 to 36	99.04	3.1	24.081
	36 to 48	103.5	3.3	22.336
	48 to 57	97.5	3.2	6.5168
7	6 to 12	96.33	4.4	33.793
	12 to 24	99.75	2.9	23.382
	24 to 34	94.67	8.4	34.208

nCi/L - nanocuries per liter

9. REACTOR WASTE PROCESSING AREAS

This section provides general descriptions of the scale and periods of operation of the reactor waste program at Mound Plant. Summaries are provided of the areas where process and TSD activities took place and whether environmental radiological data, through the Site Survey Project, are available. Additional information on the generation, treatment, and disposal activities is provided in Volume 7 - Waste Management (DOE 199g).

9.1. PROJECT SUMMARY

In 1949, Mound Plant undertook a study of processes for the decontamination of radioactive wastes that were generated by plutonium production at other Atomic Energy Commission facilities. Plutonium-239 is made by the neutron irradiation of uranium metal in production reactors at the Hanford Reservation, Richland, Washington. The plutonium-239 is separated from uranium-238 and fission by-products by one of several aqueous-phase chemical processes. The objective of the Mound Plant program was to develop a process that would concentrate the radioactive constituents such as cesium-137, ruthenium-106, strontium-90, zirconium-93, cobalt-60, niobium-94, antimony-125, tellurium-123, nickel-63, rare earths elements, and plutonium-239, and that would effect a significant volume reduction of the waste (Lowe et al., 1952).

From 1948 to 1952, three different types of processing wastes were studied at Mound Plant in this program. These included bismuth phosphate wastes, tributyl phosphate wastes, and Purex processing wastes. Mound Plant began laboratory experiments in 1949 to develop the process chemistry and process parameters that would be transferred to a pilot-scale operation. Numerous shipments of wastes were received from Hanford and the Purex processing pilot plant at Oak Ridge in 1949. Mound also received three types of high-acid Purex wastes. A radiochemical analysis of the Purex wastes is given in Table IX.1. This analysis is typical of all of the reactor wastes.

The bench-scale process chemistry research and development was performed in R Building. In 1952 a pilot plant was installed in the northeast corner of the SW Building (Figure 9.1). The aqueous waste generated by the research and pilot plant studies were treated by local evaporator systems. During the laboratory experiments, aqueous wastes were routed to a holding tank, then to a small evaporator. The condensate was transferred to the WD Building through the process sewer. From the WD Building, the wastes were probably diluted and released to the river. The steam condensate from the larger evaporator in SW Building was discharged to the plant sanitary sewer. Several spills occurred during the operation and dismantlement of the pilot plant. Gamma radiation readings of the sludge at a distance of 1 foot from the surface ranged from 1.5 to 8 REM (Bradley, 1953). At least one spill of

Table IX.1. Radiochemical Analyses of High-Acid Purex Waste

	Waste Stream		
Activity	IAW (cts/min/mL)	IDW (cts/min/mL)	IIAW (cts/min/mL)
Gross beta	2.2×10^{10}	1.6×10^{6}	2.4×10^{7}
Cesium	1.5×10^{9}	7.4×10^{4}	2.7×10^{5}
Ruthenium	3.5×10^{9}	8.6×10^{5}	9.9×10^{6}
Antimony	5.1×10^{7}	1.5×10^{4}	4.6×10^{5}
Zirconium	1.4×10^{8}	5.1×10^{4}	2.2×10^{6}
Niobium	3.2×10^{9}	1.1×10^{5}	2.3×10^{6}
Rare earths	7.0×10^{9}	2.6×10^{4}	4.5×10^{5}
Strontium	5.3×10^{9}	1.0×10^{3}	7.8×10^{4}
Tellurium	3.8×10^{8}	2.2×10^{4}	7.5×10^{4}
Plutonium (alpha)	6.0×10^{5}	6.0×10^{3}	3.5×10^{5}
Iron content	0.1 mg/mL	1.0 mg/mL	4.0 mg/mL
Acidity	2m HNO_3	2m HNO_3	5m HNO_3

Ref.: Aponyi et al. 1953
IAW — waste stream from first column separation
IDW — waste stream from second column uranium purification cycle
IIAW — waste stream from second column plutonium purification cycle
HNO_3 — molar concentration of nitric acid
cts/min/mL — counts/minute/milliliter

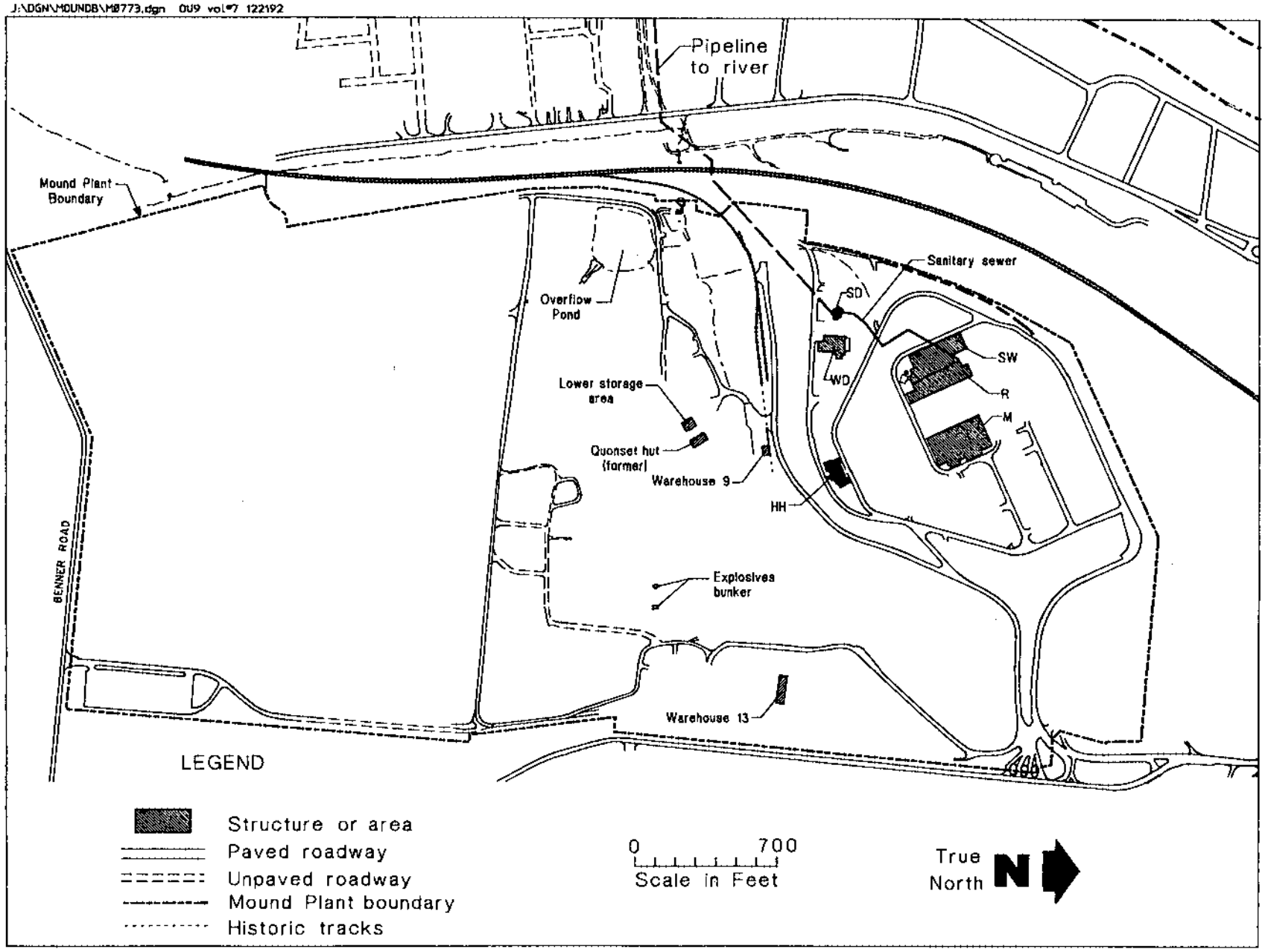


Figure 9.1. Reactor waste processing areas.

the sludge in SW Building was cleaned up to 70 mREM activity and was then capped over (DOE 1992g). The pilot plant demonstration lasted only a few months and the equipment was either dismantled and removed from the SW Building or reused in the radium/actinium program.

Few records remain of the treatment and storage areas used during this program. The feed solutions are known to have been brought in and stored at the former location of the quonset hut, now known as Building 19 in its new location. The quonset hut used to be located in the lower valley west of Building 3 (Figure 9.1). The dismantled equipment and waste sludges went into storage in either Warehouse 13 or the old explosives bunker. The drums of sludge are known to have leaked and contaminated the wooden floor in Warehouse 13 that was located in the area now occupied by the SM Building (DOE 1992g). The drums were moved again to Warehouse 9 along the old extension of the railroad spur for shipment offsite and the floors of Warehouse 9 were washed down. The old explosives bunker, also known as the radium shack, was used as a general storage area for high-risk wastes and was located on the westfacing slope of the SM/PP Hill. There are no other known or suspected areas where materials from the reactor waste decontamination program may have been stored or disposed of. Treatment facilities appear to be limited to the SW, R, WD and perhaps the HH Building areas.

Since the reactor waste decontamination program was so short lived, few records of its existence have survived at Mound Plant and few individuals knew of its existence. None of the process, treatment, or storage areas were listed in the known areas of radiological contamination before the Site Survey Project began. Some of the areas were included in the Site Survey Project investigation; some were not. As with other buildings, the processing areas used in the reactor waste program were not addressed by the Site Survey Project nor were the process and sanitary sewers on the Main Hill. Warehouse 13 is now occupied by the SM Building and is enclosed in Area 17. The old explosives bunker, or radium shack, is now known as Area 21 and was identified during the gamma surveys of the Site Survey Project (Stought et al. 1988). The former location of the quonset hut and the lower storage area (DOE 1992g) were not explicitly included in the Site Survey Project, but some data may be available, as discussed below. The project report (Stought et al. 1988) did not discuss the results in outlying areas. Areas 17 and 21 are described in the companion section on plutonium and radium/actinium, respectively.

Area 20 was described in the project report (Stought et al. 1988) as having cesium-137 contamination, but no process attributes could be made. The reactor waste decontamination program is certainly the most likely candidate for the presence of cesium-137 at Mound Plant, but no real tie to the process has been firmly established. The presence of cesium-137 in Area 21, on the other hand, can be established through records and summary reports that state the area was for storage (DOE 1992c).

If these areas were contaminated with cesium-137 during the reactor waste decontamination program, it is very likely that strontium-90 may also be present. None of the analytical procedures used during the Site Survey Project was capable of identifying strontium-90 contamination.

9.2. LOWER STORAGE AREA

The process waste treatment equipment used in the reactor waste decontamination program was diverted to use in the radium-actinium program. Once that program was terminated in 1955, the equipment was dismantled and stored on the ground in the vicinity of Building 3. These process/units underwent decontamination prior to their removal from the SW Building. No information is available as to the level of decontamination achieved. The soil in this area has the potential to be contaminated with radium-226 and its daughters, as well as fission products such as strontium-90 and cesium-137.

Few samples appear to have been collected in the approximate location of the historic lower storage area. No cores were obtained from the area. Surface samples S0689 and S0690 (Plate 1) indicate plutonium-238 concentrations of 0.21 and 0.73 pCi/g, respectively (Appendix E). Neither of these samples were analyzed for gamma radiation. Sample S0692 is slightly uphill from the other two sample points with cesium-137 and radium-226 contamination at 1.3 and 0.9 pCi/g, respectively. The exact location of the historic lower storage area is speculative, but may be indicated by the trace contamination noted in the Site Survey Project data.

9.3. FORMER QUONSET HUT AREA

The quonset hut, now known as Building 19, has a long history at Mound Plant. The structure was first moved to Mound Plant during the D&D of the historic Dayton units (DOE 1992g). It was first erected in the lower valley area and served as a central point for shipping, receiving and storing radioactive feed and waste materials. In the early 1960s, it was moved to its present location along the western border of the plant. In the early 1950s, the quonset hut served as a storage facility for the bismuth sludges from the polonium processing program. It also served as the central receiving and storage facility for the reactor wastes that came in from Hanford and Oak Ridge (DOE 1992c).

Few samples appear to have been collected in the former location of the quonset hut. No cores were obtained from the area. Surface samples S0674, 0683, 0684 and S0693 (Plate 1) indicate plutonium-238 concentrations of 0.54, 0.3, 0.04 and 0.96 pCi/g, respectively (Appendix E). The sample from location S0693 also indicated 0.4 pCi/mL tritium (Appendix E). None of these samples appear to have been analyzed by gamma spectrometry.

9.4. HOT SPOTS WITH CESIUM-137 ACTIVITY

Several localized areas of cesium-137 were noted in the Site Survey Project Report (Stought et al. 1988) and others are identified by the evaluation of the Site Survey Project data during compilations for this report. The sample taken at surface location 0647 on Plate 1, located south of Building 95 on the SM/PP Hill, contained 270 pCi/g of cesium-137. The Site Survey Project data sheet noted that this location was not included in the original report because it was cleaned up immediately (Appendix E). Documentation of this cleanup was provided in an internal Mound Plant memorandum that stated activity was as high as 4nCi/g (Draper 1984). Post-cleanup sampling indicated that the remaining cesium-137 levels were less than 2 pCi/g. Indications from the Site Survey Project data (Appendix E) suggest that there may be additional low-level cesium contamination in this area of Mound Plant. Several locations contained less than or equal to 1.3 pCi/g of cesium-137 (Appendix E). These are locations 0920, 0921, 0925, 0928, 0929, and 0940 (Plate 1). Building 105 has since been constructed in the area of samples 0920 and 0922 (Plate 1). None of the isolated areas of cesium-137 contamination at location 0647, or the others on the south portion of the SM/PP Hill, or the possible hot spot at location 0175 (Plate 1) on the Main Hill can be explained by the evaluation of historic operations. Other than the fact that some of the Purex sludge was spilled at the SW Building and at the old warehouse 13 location on the SM/PP hill, additional comments are merely speculation. Neither the hot spot at location 0647, nor any of the others with much lower activity were indicated by the aerial flyover survey conducted by EG&G in 1976 (EG&G 1978). Results of that survey are summarized in section 1 of this report.

10. GENERAL USE AREAS

Several areas of the Mound Plant were included in the investigations of the Site Survey Project or are known to contain low levels of radioactivity, but are not associated with a specific program or project. These areas include the Orphan Soils Area 22, the Hillside Disposal Area J, and the spoils disposal area. These areas and any results reported in the Site Survey Project report are described in the subsections that follow.

10.1. AREA 22

Area 22 is located on the south part of the SM/PP Hill adjacent to Building 53 (Plate 1). This area consists of many piles of soil excavated from other areas at Mound Plant, including Area 20 (subsection 3.9). It is also called the "orphan soils" area because it was created when construction projects did not have funding for disposal of unexpected contaminated soil, which was then staged at Area 22 while waiting for funding. Area 22 was not part of the original compilation of radioactively contaminated areas when the Site Survey Project began, but was identified by the initial gamma surveys (Stought et al. 1988).

The Area 22 sampling results are given in Table X.1 and the sampling locations are shown on Plate 1. Only surface locations were sampled. Cobalt-60 was detected in two of the samples, at levels of 143 and 54 pCi/g. The same samples showed radium-226 present in concentrations of 0.4 and 0.7 pCi/g, respectively. The sample from location S0787 also contained 7.0 pCi/g of cesium-137. The remaining two samples contained relatively low levels of plutonium-238, with a maximum level of 1.67 pCi/g, but these samples were not analyzed by gamma spectroscopy. No results were indicated for bismuth-207 or bismuth-210m, which may be expected to occur with cobalt-60 from speculation of process (see subsection 3.3.6 for discussion). Since cesium-137 was identified, it is possible that strontium-90 may also be present, but was not included in the analyses conducted by the Site Survey Project.

10.2. AREA J

Area J, known as the hillside disposal area, is located on the west slope of the SM/PP Hill, south of Areas D and 12 (Plate 1). This area was used from the early 1970s to the early 1980s for the disposal

Table X.1. Mound Site Survey Project - Area 22

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)
S0787	3550	3400	9807	06-85	0	NR	NR	NA	143	7.0	0.4	LDL
S0775	3575	3350	2883	10-83	0	1.61	b	0.99				
S0773	3500	3200	2887	10-83	0	1.67	b	0.15				
S0790	3560	3390	9810	06-85	0	NR	NR	NA	54	LDL	0.7	LDL

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

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

of construction residues, such as excavated soils, pieces of concrete, piping, metal banding, plumbing fixtures, and roofing materials, which were either dumped or bulldozed over the side of the hill (DOE 1992c). Area J also includes three areas of ponded water at the base of the slope (DOE 1992g).

Twelve core locations and nine surface locations were sampled, either within or near Area J, as part of the Site Survey Project (Plate 1, and Table X.2). The maximum plutonium-238 concentration measured in these samples was 71.30 pCi/g in the sample taken at a depth of 18 inches at core location 0156 on Plate 1 (C0156 on Table X.2). The maximum thorium activity measured was 30.42 pCi/g in a sample taken at a depth of 162 inches at core location 0160 on Plate 1 (C0160 on Table X.2). Of the nine surface locations sampled, four (0634, 0635, 0636, and 0639 on Plate 1) appear to have been located on the slope of the SM/PP Hill. The other five surface locations and the 12 core locations were probably located in the more level area at the top of the hill.

The maximum depth of the core locations in Area J was 234 inches (C0152 and C0156 on Table X.2), and most were sampled at 54 to 72 inches. Mound Plant drawing #FSE 16472 (DOE 1992f) indicates that the depth to bedrock in this area is approximately 36 inches, but this depth probably varies greatly due to the presence of fill material. It is likely that the Area J core locations were sampled to bedrock, but drilling logs are not available to confirm this.

The upper, relatively flat portion of Area J was historically used to stage soils contaminated with thorium and plutonium. Soils and possible other debris were placed in the area as part of excavation projects, including a water line repair below the adjacent water tower, and possible plutonium-contaminated soils from the construction of the overflow pond in the mid-1970s (DOE 1992g). The area may have also been referred to as the dredged materials disposal area (Area 11a) in the map of Hot Waste Burial Sites, reproduced in the Site Scoping Report: Volume 7 - Waste Management (DOE 1992c). In 1988, 150 half-size low specific activity boxes (approximately 150 cubic yards) of soil were removed from the area. Subsequent screening by the Mound Plant soil screening facility indicated levels of thorium and plutonium-238 below 2 and 147 pCi/g, respectively (Rader 1988). The data sheets are included in Appendix E.

10.3. SPOILS DISPOSAL AREA

The spoils disposal area (also known as the construction spoils area) is located south of the overflow pond and Area 18 (Plate 1). This is an engineered disposal area that has been in use since 1985. Soils containing less than 25 pCi/g of plutonium-238 and less than 5 pCi/g of thorium from construction areas at Mound Plant are dumped onto the ground surface, graded, and compacted. This area was not identified in the original Site Survey Project Report, probably because it is only used for the disposal of soils with radioactivity below the guidelines.

Table X.2. Mound Site Survey Project - Area J

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)
C0148	3040	2590	10471	08-85	18	0.72	b					
			10472	08-85	36	0.87	b					
			10473	08-85	54	1.29	b					
			10474	08-85	72	4.94	b					
C0149	3040	2610	10475	08-85	18	0.38	b					
			10476	08-85	36	0.45	b					
			10477	08-85	54	5.40	b					
			10478	08-85	72	4.80	b					
C0150	3055	2590	10479	08-85	18	3.94	b					
			10480	08-85	36	1.55	b		3.0	LDL	0.2	LDL
			10481	08-85	54	3.94	b					
C0151	3055	2610	10482	08-85	18	3.58	b					
			10483	08-85	36	10.30	b					
			10484	08-85	54	7.88	b					
C0152	3065	2565	1561	04-83	18	2.60	2.80					
			1562	04-83	36	0.46	b					
			1563	04-83	90	1.89	b					
			1564	04-83	108	1.12	b					
			1565	04-83	126	1.29	b					
			1566	04-83	144	0.06	b					
			1567	04-83	162	0.08	b					
			1568	04-83	180	0.07	b					
			1569	04-83	198	0.27	b					
			1570	04-83	216	0.60	b					
			1571	04-83	234	5.22	b					

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.

[c]Boring logs indicate that these locations were not sampled to bedrock.

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

Table X.2. (page 2 of 3)

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)
C0153	3070	2610	10505	08-85	18	0.86	b					
			10506	08-85	36	1.14	b					
			10507	08-85	54	1.16	b					
			10508	08-85	72	0.89	b					
C0154	3080	2610	10509	08-85	18	0.56	b					
			10510	08-85	36	0.14	b					
			10511	08-85	54	0.89	b					
C0155	3090	2600	10512	08-85	18	0.27	b					
			10513	08-85	36	2.24	b					
			10514	08-85	54	11.40	b					
C0156	3075	2600	1572	04-83	18	71.30	2.03					
			1573	04-83	36	NR	4.30					
			1574	04-83	54	6.59	b					
			1575	04-83	72	6.45	b					
			1576	04-83	90	4.81	2.02					
			1577	04-83	108	40.90	2.33					
			1578	04-83	126	1.08	b					
			1579	04-83	144	5.22	b					
			1580	04-83	162	3.42	b					
			1581	04-83	180	8.67	b					
			1582	04-83	198	0.72	b					
			1583	04-83	216	4.10	b					
			1584	04-83	234	9.93	3.02					
	3075	2600	10515	08-85	18	0.83	b					
(Two sets of results were given for the 18-inch depth at these coordinates; however, the dates are different [04-83 and 08-85].)												
C0158[c]	3000	2620	8285	10-84	36	1.95	b					
			8286	10-84	72	25.00	b					
C0159[c]	3100	2620	8283	10-84	108	18.90	b					
			8284	10-84	198	6.91	b					
S0633	3025	2645	2923	10-83	0	47.45	b	6.84				

Table X.2. (page 3 of 3)

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)
S0622	3025	2590	4126	10-83	0	17.40	b					
C0160	3180	2745	2441	08-83	18	0.80	b					
			2442	08-83	36	2.60	b		LDL	LDL	0.94	LDL
			2443	08-83	108	0.53	b					
			2444	08-83	126	0.62	b					
			2446	08-83	162	0.66	30.42		LDL	LDL	1	LDL
			2447	08-83	180	3.09	14.58		LDL	LDL	0.9	LDL
			2448	08-83	198	2.60	10.32		LDL	LDL	0.7	LDL
			2449	08-83	216	2.42	b					
			2450	08-83	234	1.70	5.07					
S0621	2950	2645	4113	10-83	0	3.35	b					
S0634	3050	2845	8667	12-84	0	0.31	b					
S0635	3075	2870	8669	12-84	0	0.34	b					
S0636	3100	2820	8666	12-84	0	1.84	b					
S0637	3125	2670	6791	08-84	0	1.45	b					
S0638	3125	2720	6792	08-84	0	0.28	b					
S0639	3125	2820	2924	10-83	0	3.00	b	3.09				

Twenty-six surface samples were taken in the spoils disposal area during the Site Survey Project (Plate 1 and Table X.3). The maximum plutonium-238 activity concentration measured in these samples was 8.30 pCi/g in the sample from S0895; no thorium activity greater than 2 pCi/g was measured. Two samples (S0851 and S0810) were also analyzed using gamma spectroscopy. Radium-226 was the only radionuclide detected using this technique. It was detected at 0.9 pCi/g in both samples.

10.4. PLANT DRAINAGE DITCH

The plant drainage ditch at Mound Plant serves as the natural channel for surface water, following roughly an east-to-west course (Figure 10.1 and Plate 1). As the collection point for surface water runoff for both the SM/PP and Main Hills, the ditch is in a position to receive contamination from multiple sources at Mound Plant. The ditch currently begins just south of Building 51 and extends southwestward to a series of three connected retention basins on the western border of the facility (Plate 1). From the retention basins, the water is released from the plant at an outfall permitted under the National Pollution Discharge Elimination System (Plate 1). After release at outfall 002, the water flows through a section of the Miami-Erie Canal, now abandoned, and on to the Great Miami River. Historically, the upper reach of the ditch extended further north than Building 51, below what is now known as Area 7, but has been infilled to provide construction pads. Changes in the geomorphology of both the upper and lower reaches of the ditch are documented in the Site Scoping Report: Volume 6 - Photo History (DOE 1992b).

In 1974, an investigation was performed as part of the Miami-Erie Canal investigations to document the levels of plutonium-238 present in the sediments of the plant drainage ditch (see section 1 for additional information). Because the drainage ditch was investigated in 1974, no further sampling was performed as part of the Site Survey Project. During the 1974 study, sediment samples were taken at 11 locations in the ditch proper and 1 location (#12) slightly upgradient of the recognized start of the ditch (Figure 10.1). (These locations are not shown on Plate 1 because coordinates were not documented.) Plutonium-238 concentrations measured using a radiochemical procedure ranged from less than 1 pCi/g to a maximum of 535 pCi/g at location #6. These results are presented in Table X.4. The portions of the ditch most highly contaminated appear to be at the northern end of the ditch (#11) and at the center (#5 and #6). The top 0 to 3 ft of ditch sediments appear to contain roughly 95 percent of the plutonium-238, although elevated levels of plutonium-238 were found in sediments as deep as 5 to 6 ft (Table X.4). More recently, samples taken by the Mound Plant D & D Program in selected portions of the drainage ditch (as part of the Area 19 verification study) and Area 16 have shown similar concentrations.

Table X.3. Mound Site Survey Project - Spoils Disposal Area

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)
S0851	3350	4365	4026	10-83	0	1.82	b					
S0880	3075	4845	6384	08-84	0	4.68	b		LDL	LDL	0.9	LDL
S0881	3095	4830	7835	10-84	0	5.59	b		LDL	LDL	0.9	LDL
S0883	3125	4740	7836	10-84	0	1.22	b					
S0884	3135	4580	6389	08-84	0	2.93	b					
S0885	3160	4770	7843	10-84	0	0.01	b					
S0886	3175	4605	2601	10-83	0	0.55	b	1.90				
S0887	3175	4675	7837	10-84	0	0.08	b					
S0888	3180	4840	7844	10-84	0	0.15	b					
S0889	3200	4695	7842	10-84	0	0.01	b					
S0890	3210	4530	2602	10-83	0	0.28	b					
S0891	3210	4610	7836	10-84	0	0.23	b					
S0892	3225	4775	7845	10-84	0	0.47	b					
S0893	3230	4630	7841	10-84	0	0.01	b					

Table X.3. (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)
S0894	3230	4815	7850	10-84	0	0.02	b					
S0895	3260	4680	7846	10-84	0	8.30	b					
S0896	3260	4870	7854	10-84	0	0.06	b					
S0897	3270	4535	7839	10-84	0	0.03	b					
S0898	3270	4575	7840	10-84	0	0.02	b					
S0899	3275	4820	7853	10-84	0	0.04	b					
S0900	3280	4730	7848	10-84	0	0.62	b					
S0901	3290	4630	7847	10-84	0	1.29	b					
S0902	3290	4790	7849	10-84	0	0.37	b					
S0903	3295	4830	7851	10-84	0	0.09	b					
S0904	3295	4875	7852	10-84	0	0.03	b					
S0911	3440	4900	4050	10-83	0	2.03	b					

[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 2.0 pCi/g, using FIDLER screening. Therefore, radiochemical analysis was not performed.
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

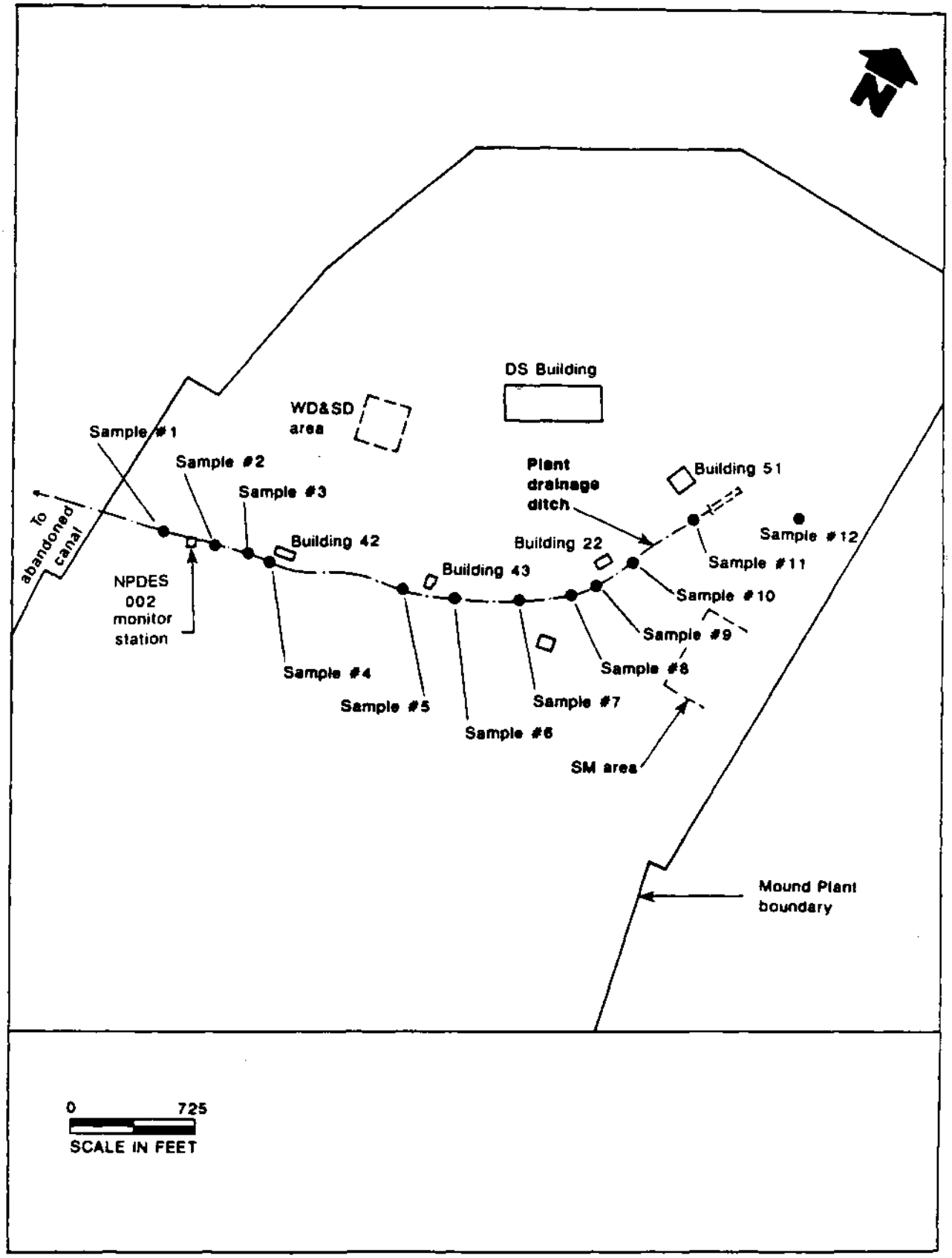


Figure 10.1. 1974 plutonium sample locations.

Table X.4. 1974 Plutonium-238 Results for the Plant Drainage Ditch

Sample	Concentration (pCi/g)					
	0-1 ft	1-2 ft	2-3 ft	4-5 ft	5-6 ft	Average
1	11.6±5.4	0.611±6.58	0.059±0.123	0.379±0.468	0.506±0.576	2.6±5.0
2	97.5±24.9	43.3±13.9	0.682±0.713	0.290±0.386	0.095±0.174	28.4±42.9
3	2.97±2.04	0.136±0.224	0.269±0.376	0.321±0.416	0.440±0.520	0.83±1.2
4	44.4±14.2	0.619±0.664	0.033±0.082	0.068±0.137	0.056±0.119	9.0±19.8
5	115±88	244±8	144±33	0.129±0.216	0.034±0.084	100±103
6	535±84	55.6±16.6	2.17±1.63	0.816±0.810	0.507±0.577	118±233
7	62±36	11.8±5.5	0.0009±0.494	0.427±0.510	0.203±0.299	14.9±26.8
8	----	1.2±1.0	0.246±0.344	0.027±0.070	0.067±0.136	0.38±0.55
9	2.08±1.58	----	0.211±0.308	0.143±0.233	0.181±0.216	.065±0.95
10	6.81±3.72	0.293±0.389	0.057±0.121	0.078±0.152	1.29±1.12	1.7±2.9
11	11.1±5.3	508±81	236±47	72.1±20	52.5±16	176±204
12	0.277±0.374	0.211±0.307	0.025±0.067	0.133±0.221	0.028±0.072	0.13±0.11
Maximum	535±84	508±81	236±47	72.1±20	52.5±16	
Average[b]	89±162	86±166	35±79	6.8±21	5.1±15.7	

[a] The background concentration of plutonium-238 from fallout in the Mound Plant region soils is 0.0002 pCi/g. The plant baseline level from past Mound Plant activities is 0.01 pCi/g (Stought et al. 1988).

[b] Location 12 not included because it is not in the drainage ditch.

pCi/g - picocuries per gram

The maximum sample depth during the 1974 study at the plant drainage ditch was 5 to 6 ft. Although the depth of the ditch sediments is not known, the depth to bedrock ranges from 30 to 40 ft near Building 51, at the beginning of the ditch, to approximately 70 ft at the western end, where the ditch exits the plant boundary. This depth to bedrock includes the ditch sediments, the older stream sediments, glacial outwash, and glacial till (DOE 1992f).

Radioactively contaminated sediments are also present in the asphalt-lined pond in the northeastern portion of the plant and in the storm water retention (overflow) pond and retention basins near Area 2 in the southwestern portion of Mound Plant (Plate 1). Both of these are used to settle the sediments in storm water runoff. No characterization was done during the Site Survey Project because of their operational status. The ponds and other basins are described in detail in the Site Scoping Report: Volume 7 - Waste Management (DOE 1992g) and the Operable Unit 9 Site-Wide RI/FS Work Plan (DOE 1992c).

10.5. FENCE LINE SAMPLING CONDUCTED IN 1974

As part of the 1974 investigations of plutonium-238 in the Miami-Erie Canal, surface and core samples were collected around the Mound Plant perimeter and fence line. Samples were analyzed only for plutonium-238. Sample results indicate concentrations up to 125 pCi/g in the area of the canal and 1 to 2 pCi/g elsewhere. The data sheets are included in Appendix E.

10.6. DEPLETED URANIUM CLEANUP AT FIRE FIGHTER TRAINING PITS

A cleanup of uranium contamination in the fire fighter training pit area occurred in the early spring of 1989. The pits are located south of Building 34 (Figure 10.2). The uranium contamination was detected during routine surveys being conducted as part of the repair of a water line adjacent to Building 34 in January 1988. The uranium was found to occur as metallic scraps about 1-inch square and 1/4-inch thick. Analysis of a metallic sample indicated concentrations of uranium-238 and uranium-235 at 500,000 and 3,000 pCi/g, respectively (Jarvis 1988), thus indicating a much greater uranium-238 content than occurs naturally. The metallic scraps were thus determined to consist of depleted uranium, a metal used for its very high density. The origin of the metallic scraps in the pit area is unknown. The actual concentration of depleted uranium in soil was measured to be about 6,340 pCi/g (Jarvis 1989).

On March 16, 1989, the cleanup of the depleted uranium was accomplished by excavation and placement of soil into low-specific activity (LSA) boxes for shipment offsite. The cleanup goal was 5

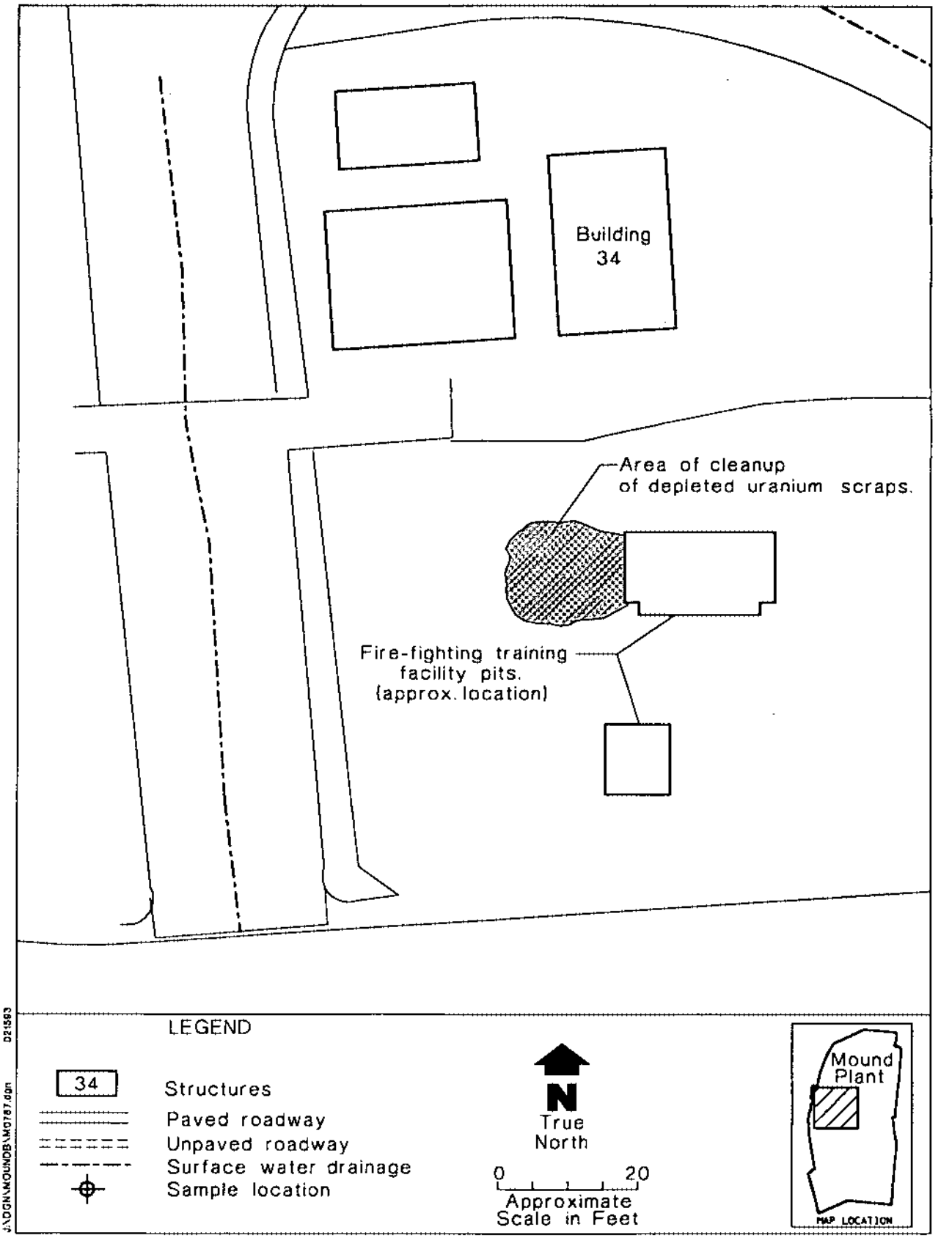


Figure 10.2. Area of cleanup of depleted uranium.

pCi/g of uranium in soil. Ten soil samples were collected in the pit area (Figure 10.2) and analyzed by gamma spectroscopy. The highest concentration of uranium detected after cleanup was 3 pCi/g (Dickey and McMahan 1989). The data sheets are included in Appendix E.

11. SUMMARY

During the years 1982 through 1985, Mound Plant performed a systematic survey of radiologic contamination of plant soils. The purposes of the Site Survey Project were to document the radionuclide levels present in the exposed land areas within the Mound Plant boundary and to characterize environmental radiological contaminants on a site-wide basis in order to provide the DOE with the basis for estimates of the cost and time required for stabilizing or removing contaminated soils. On the basis of records searches and employee interviews, the Site Survey Project identified 19 original areas of concern. Site characterization then proceeded using a combination of screening, radiochemical analysis of surface and subsurface soil samples, and *in situ* analysis. More than 16,000 individual gamma measurements were taken. Over 2,000 soil samples were collected and analyzed, using a biased sampling strategy and several different types of analyses. Since the Site Survey Project was conducted, maintenance and engineering activities have identified other areas of radiological contamination. These areas are described throughout this report. Table XI.1 summarizes the highest suspected contaminant values for each site or area. Radionuclides present at levels above background include plutonium-238, thorium (total and the isotope thorium-230), cobalt-60, cesium-137, tritium, actinium-227, americium-226, bismuth-207, and bismuth-210m. Depleted uranium (uranium-238) is suspected to be present in the metallic form in some areas. The following discussions summarize suspected radiologic contamination recognized from the polonium, plutonium, thorium, uranium, radium, and tritium programs at Mound.

Polonium processing in the 1950s and 1960s appears to have produced isolated areas contaminated with cobalt-60. Polonium-210, with a half-life of 138 days, has long since decayed from any sources directly related to the processing operations. Polonium-210, however, may be present in trace quantities because it is part of the natural decay chain of uranium. Cobalt-60, on the other hand, has a half-life of 5.3 years and has been found in a few locations identified with aqueous wastes from the polonium processing operations. Results of analysis by gamma spectroscopy of samples from 288 locations were reported for cobalt-60; one area reported contamination of bismuth-207 and bismuth-210m. Areas investigated by the Site Survey Project (Stought et al. 1988) include

- Area 4, the area surrounding the WD Building where influent tanks containing polonium-210 and cobalt-60 overflowed;
- Area 4a, the old sewage disposal plant area contaminated by polonium-210, cobalt-60 and plutonium-238;
- Area 5, location of a waste-line break containing polonium-210 and cobalt-60;
- Area 6, a historic disposal trench for polonium-210-contaminated sand;
- 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, encloses

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	824.2	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	--	--	--

Table XI.1. (page 2 of 2)

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)
Possible Elevated Thorium	8.97	37.69	--	LDL	LDL	1.5	LDL	--	--	--
Drainage Ditch	535.00	--	--	--	--	--	--	--	--	--
Railroad Siding	573	107	--	--	--	--	--	--	--	--
Overflow Pond	--	268	--	--	--	--	--	--	--	--
SW Building[e] Soils	--	--	3.83×10^{6}	--	--	--	--	--	--	--
Building 48 Hillside	32,000	--	--	--	--	--	--	--	--	--
Building 66 Lot	7,000	--	--	--	--	--	--	--		--
Cobalt-60 Hot Spots	NR	NR		82	10	0.8	LDL	--	--	--
Plutonium-238 Hot Spots	61.0	<2	--	--	--	--	--	--	--	--
Remedial Action Guidelines[f]	100/25[g]	5 surface[h] 15 subsurface	5,200[i]	NE	60[j]	5 surface[h] 15 subsurface	20[j]	NE	NE	NE

[a]The total thorium concentration was less than the background level of 2 pCi/g, using FIDLER screening; therefore, radiochemical analysis was not performed.
[b]Most of the results for this radionuclide for this area are reported as NR. See the area-specific tabulated results.
[c]Area 15 emits 1 Ci per year of radon, indicating the presence of radium-226.
[d]Sampling of Area 19 was verification sampling conducted after remedial action.
[e]SW Building soils were sampled in 1977 (Dames and Moore 1977).
[f]Current remedial action guidelines are subject to change, pending additional pathways analysis and risk assessment.
[g]Current D&D cleanup level is 100 pCi/g (DOE 1983); 25 pCi/g, if feasible (as low as reasonably achievable (ALARA)).
[h]remedial action guideline (CFR 1990)
[i]remedial action guideline (DOE 1983)
[j]value for Area 7 does not include value at Building 66
[k]value indicated is thorium-230 isotope
[l]value is mean during verification sampling after cleanup
[m]highest residual level after verification cleanup
-- Dashes indicate that no data are available for the given area and given radionuclide.
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 and actinium-227.
NE - Not established
NR - No result
pCi/g - picocuries per gram
pCi/mL - picocuries per milliliter
Ci - curie

an area containing a historic septic tank contaminated with actinium-227 from the old SW Building;

- Area 10, a historic disposal area containing concrete contaminated with polonium-210;
- Area 13, a historic treatment area where debris contaminated with polonium-210 was burned;
- Area 20, the location of a waste-line break between the WD and the HH Buildings (cobalt-60, cesium-137, bismuth-210m, and bismuth-207);
- Area 22, with cobalt-60 concentrations up to 143 pCi/g (believed to be contaminated soil excavated from Area 20);

Figure 11.1 shows the distribution of sample locations with results reported for cobalt-60. The highest values of cobalt-60 reported were in Area 5 on the Main Hill and in Area 22 on the SM/PP Hill. Most samples indicated values below the detection limit of 0.5 pCi/g, including Area 20, a historic polonium processing waste line. No systematic sampling of the waste lines was performed. An isolated hot spot on the west side of the Main Hill containing elevated cobalt-60 and cesium-137 cannot be explained by process knowledge. Through the gamma spectrographic analysis of soils in Area 20, bismuth-210m and bismuth-207 were identified in 1985 as potential contaminants. As with cobalt-60, it is speculated that these rare radionuclides may have been produced as part of the production of polonium-210 from bismuth-209. Other areas known to have cobalt-60 contamination, such as Area 22, may also have bismuth-210m and bismuth-207.

Plutonium-238 processing activities in the 1960s and 1970s produced widespread low-level contamination associated with airborne and surface water emissions. Plate 4 depicts a contoured plot of plutonium-238 concentrations determined by the Site Survey Project (Stought et al. 1988). Evaluation of Plate 4 indicates that the highest concentrations are associated with the following former processing areas, as identified by the Site Survey Project:

- Area 1, a historic plutonium waste storage area;
- Areas 4 and 4a, the area surrounding the WD Building where influent tanks containing plutonium-238 overflowed;
- Area 11, a historic storage area for plutonium-238-contaminated wastes from the SM Building;
- Area 12, a thorium-soil disposal area contaminated with plutonium-238 by runoff from Area 11;
- Area 14, the location of the 1969 waste transfer line (plutonium-238) break;
- Area 16, a historic sanitary leach field for the SM Building (plutonium-238);
- Area 17, the area under and surrounding the SM Building contaminated with plutonium-238 from spills of plutonium wastes;
- Area 19, the historic underground waste transfer lines for plutonium-238 liquid wastes.

Areas 14, 16, 17 and 19 have undergone at least partial D&D and some verification has occurred at this writing. Verification of Areas 14 and 17 is in progress at this writing. Verification of the D&D

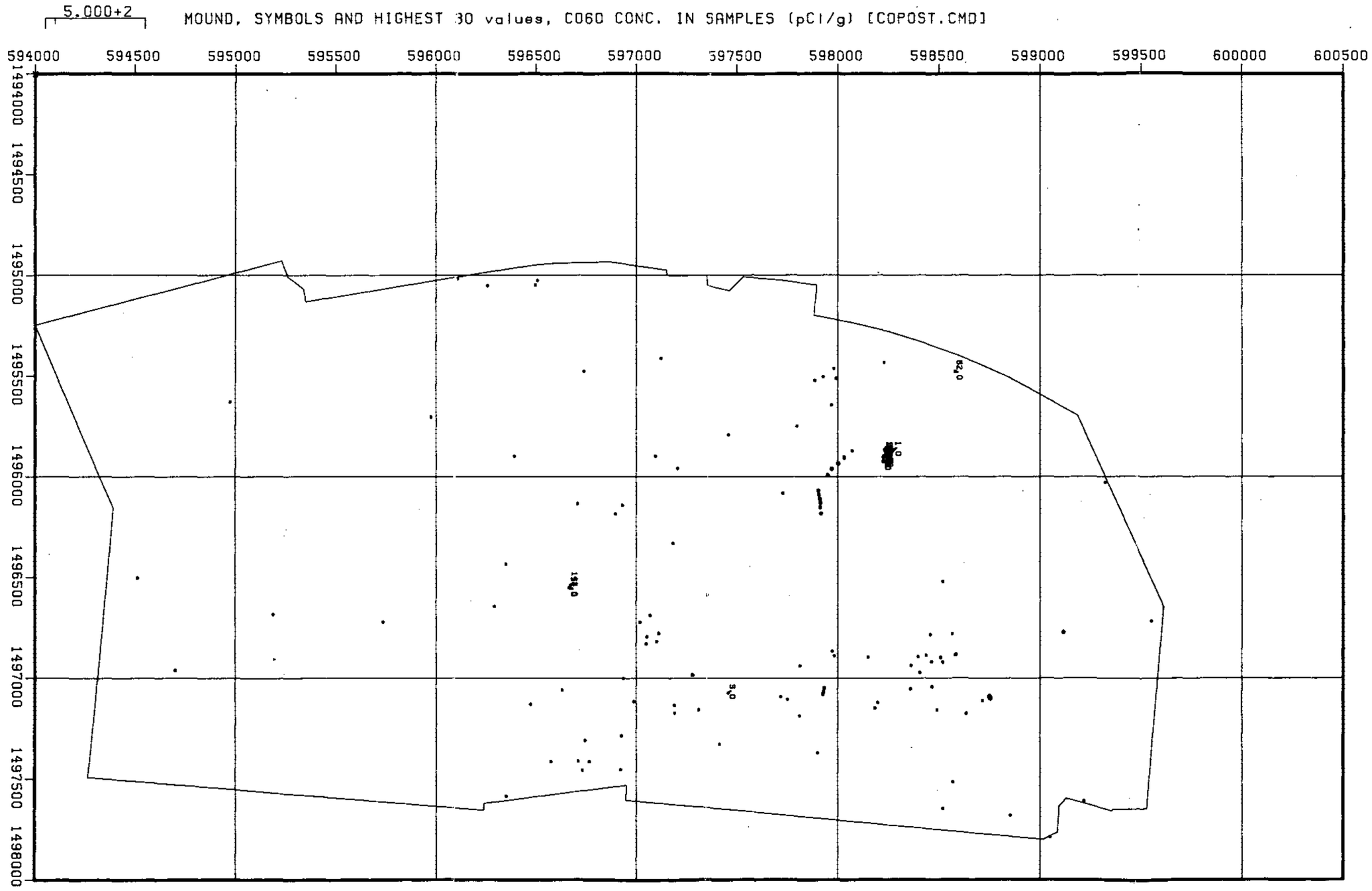


Figure 11.1. Locations of cobalt-60 analyses reported by Site Survey Project (Stought et al. 1988).

work in Area 19 was completed in 1986 (Stenhouse and Kirsch 1986). Areas with lower levels of plutonium contamination are evident. Evaluation of the Site Survey Project data for this report, as well as more recent data indicates that isolated areas of elevated plutonium-238 concentrations are present at the plant. Areas not investigated by the Site Survey Project, but are known or suspected to be contaminated with plutonium-238, include

- the plant drainage ditch, which has received contaminants such as plutonium-238 from several areas of the plant;
- Building 48 hillside (waste-line break) contaminated with up to 32 nCi/g plutonium-238;
- Building 66 lot site contaminated with up to 7 nCi/g plutonium-238; and
- Area J, with plutonium-238 concentrations up to 71.30 pCi/g and thorium levels up to 30.42 pCi/g.

Other isolated hot spots of plutonium-238 appear from the evaluation of the Site Project Data. These include two hot spots on the Main Hill (S0208 and S0166) and one on the runoff creek on the south end of the SM/PP Hill (S0706) with plutonium-238 values at 61.0, 34.5, and 28.9, respectively. The Main Hill spots cannot be explained by process information. Areas of elevated plutonium-238 along the railroad siding beneath Area 3 are also not explained by process information. The source of contamination is unknown, but it may be due to runoff form Area 14. Plutonium-238 in the area of the sludge drying beds may be an artifact of interference from elevated thorium-232 known to be as high as 63 pCi/g in the area. Elevated plutonium-238 in Areas 7, 8, and 12 and Area J is interpreted to be due to runoff from Areas 11, 16, and 17. There are little data to suggest elevated levels of plutonium-238 in Area 18.

Low-level contamination of plutonium-238 appears to be widespread. Many samples results indicate levels below 25 pCi/g. The plutonium-238 background level from atmospheric nuclear weapons testing is approximately 0.0002 pCi/g in the Mound Plant region; whereas, the baseline level, or onsite background level, of the Mound Plant was reported by the Site Survey Project (Stought et al. 1988) to be approximately 0.01 pCi/g. This baseline level can be seen in the analytical results of three locations sampled either in the extreme southwest corner of the new property, or just outside the plant boundary (core locations C0228, C0238, and C0243 on Plate 1, and Appendix E).

Thorium processing, largely the redrumming of thorium sludges because of container deterioration, resulted in apparent widespread contamination due to fugitive dust emission. Local burials of empty corroded drums are known to have occurred in two locations. Plate 5 depicts a contoured plot of thorium concentrations determined by the Site Survey Project (Stought et al. 1988). Evaluation of Plate 5 indicates that the highest concentrations are associated with the former redrumming areas, as identified by the Site Survey Project. Isolated hot spots are rare and are generally associated with very low levels of thorium that surround the historic redrumming sites. The thorium areas identified by the Site Survey Project (Stought et al. 1988) include:

- 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

- Area 21, a historic storage area used formerly used for storage of high-risk wastes from the SW Building (cesium-137 and radium-226).

Area 21 was not known at the beginning of the project, but was identified during the initial gamma surveys. Area 15 a historic radium-226/actinium-227 process area entombed in concrete inside the SW Building was not sampled during the investigation. It is known to give off 1 Ci of radon gas per year from the radioactive decay of radium-226. Results of analysis by gamma spectroscopy of samples from 288 locations were reported for radium-226. The distribution of sample locations is shown in Figure 11.2. The highest radium value (3.3 pCi/g) appears to be associated with the thorium areas, except for an isolated location on the far south part of the plant property. Most of the samples results were less than 1 pCi/g, only 65 samples were greater than 1 pCi/g. No samples were collected in the area around the entombed equipment in the SW Building (Area 15).

The experimental processing of reactor wastes from the Hanford and Oak Ridge nuclear reactors was a relatively unknown project conducted at Mound Plant in the early 1950s. Until the research for this report, the source of cesium-137 contamination at Mound Plant was highly speculative. Although no proof exists, the wastes generated in experimental processes probably serve as the principal source of the contaminant. An associated fission product of strontium-90 probably accompanied the cesium-137, but has not heretofore been an analyte of concern at Mound Plant. No data on the latter have been found. During or subsequent to the Site Survey Project (Stought et al. 1988), four principal areas of cesium-137 contamination have been described:

- Area 20, the location of a waste-line break between the WD and the HH Buildings (cobalt-60, cesium-137, bismuth-210m, and bismuth-207);
- Area 21, a historic storage area used for storage of high-risk wastes from the SW Building (cesium-137 and radium-226);
- Area 22, with cesium-137 concentrations up to 7 pCi/g (believed to be contaminated soil excavated soil from Area 20);
- Hot spot 0175 on the west side of the Main Hill; and
- Hot Spot 0647 on the south end of the SM/PP Hill.

Results of analysis by gamma spectroscopy of samples from 292 locations were reported for cesium-137. The distribution of the sampling locations is shown in Figure 11.3. The highest value reported (270 pCi/g) was at a hot spot (0647) on the south part of the SM/PP Hill. Subsequent sampling indicated that values as high as 4 nCi/g were present. No apparent explanations exist for either of the hot spots. Hot spot 0647 was cleaned up to less than 2 pCi/g soon after it was discovered. No records have been found for the area at location 0175. Subsequent samples taken in Area 20 also indicated much higher values than those reported by the Site Survey Project, but were discovered during a construction excavation. Area 21, an old bunker used for waste storage indicated values up to 31 pCi/g. Most reported values of cesium-137 were less than 1 pCi/g; only 55 samples had values

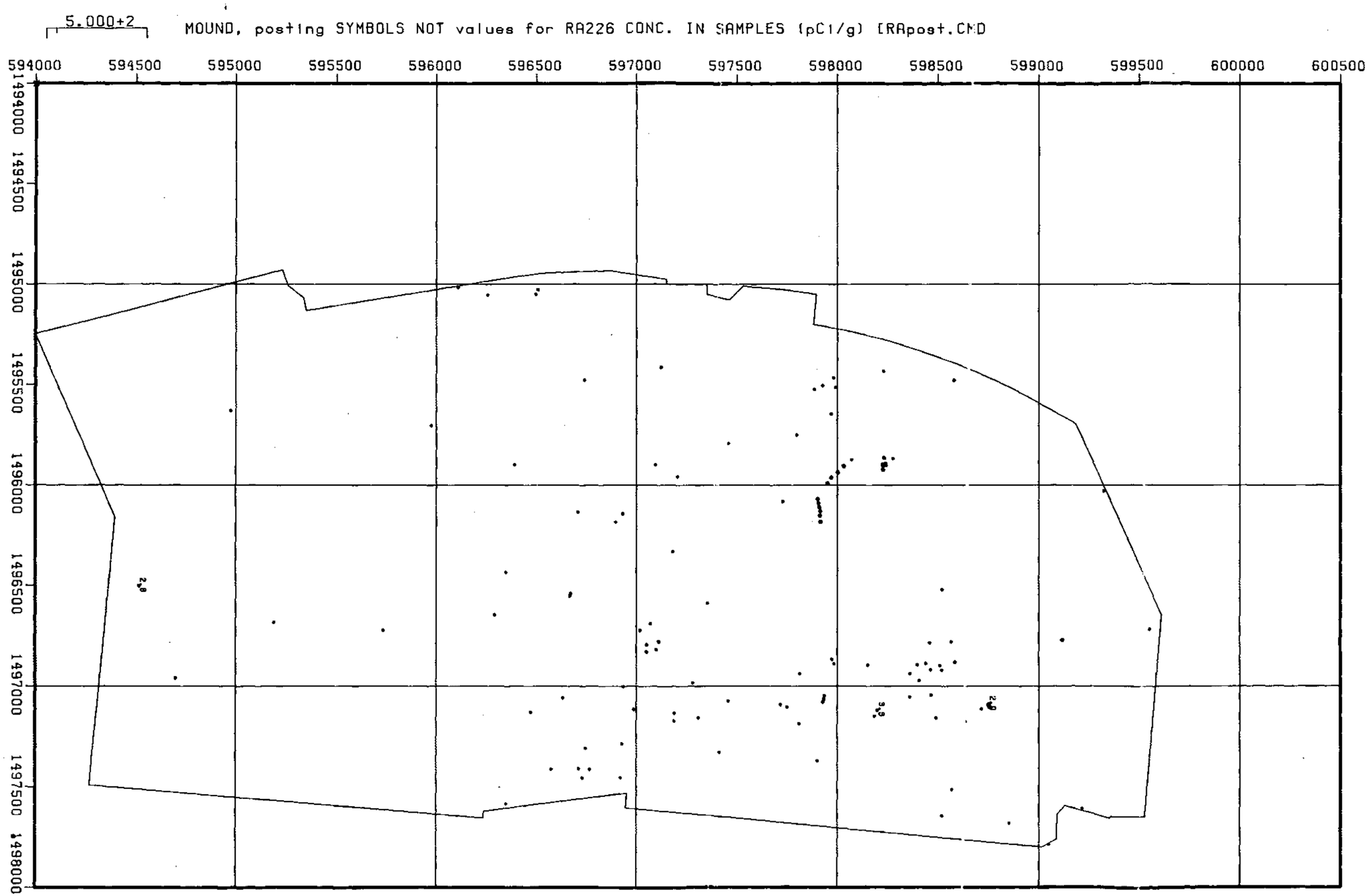


Figure 11.2. Locations of radium-226 analyses reported by Site Survey Project (Stought et al. 1988).

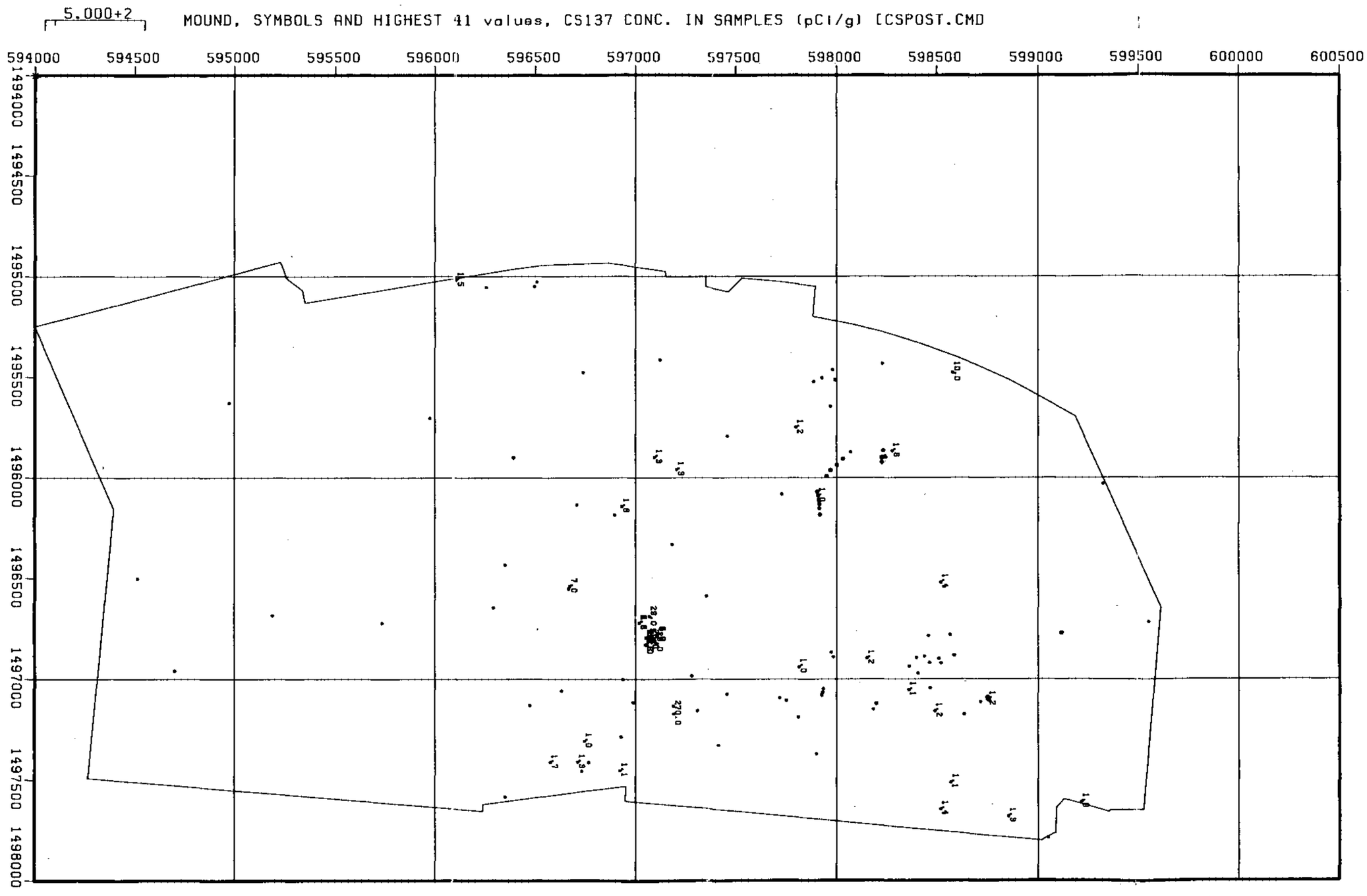


Figure 11.3. Locations of cesium-137 analyses reported by Site Survey Project (Stought et al. 1988).

higher than the 0.5 detection limit of 0.5 pCi/g. Low levels of cesium-137 are indicated in groups on the plant: along the eastern part of the plant, and on the western and southern slopes of the SM/PP Hill. Area 15, the old cave, includes an entombed area that may contain residual levels of the reactor waste sludge. Storage locations used for drums of waste sludge include the old Warehouse 13, but its site is now occupied by the SM Building. Some of the equipment used in both the reactor waste and radium/actinium programs was dismantled and stored for several years in a storage lot in the lower valley area. That area is now occupied by several buildings, but traces of cesium-137 at one location suggests low-level activity.

The tritium processes have been restricted to the Main Hill. Historical tritium processing activities are known to have contaminated the soils beneath the SW Building. Studies conducted in the mid-1970s indicated that 1) several hundred curies of tritium are present in the soils beneath the SW Building (Dames and Moore 1977); and 2) slightly elevated levels of tritium (up to 268 nCi/L of soil moisture) were present in the area of the historic landfill during investigations conducted for construction of the overflow pond (Dames and Moore 1976a).

Results of analysis for tritium performed by liquid scintillation of samples from 111 locations across the plant are included in this report (Appendix E). The distribution of sample locations for tritium is shown in Figure 8.2. The highest value reported (45 nCi/L of soil moisture) was on the southern part of the Main Hill. All but two locations indicated values less than 20 nCi/L of soil moisture.

Research and development activities in the 1960s included metallurgical investigations of depleted uranium. Depleted uranium is an especially desirable metal of usually high density and low radioactive hazard because the other shorter-lived isotopes have been substantially removed. Disposal of metallic scraps could have occurred in the historic landfill, now known as Area B, and possibly in Area 7. Scraps of metallic depleted uranium were discovered in the area of the fire fighter training pits as part of the routine monitoring of construction in late 1988. A cleanup of the pits in 1989 removed contaminated soil to an apparent level of 3 pCi/g.

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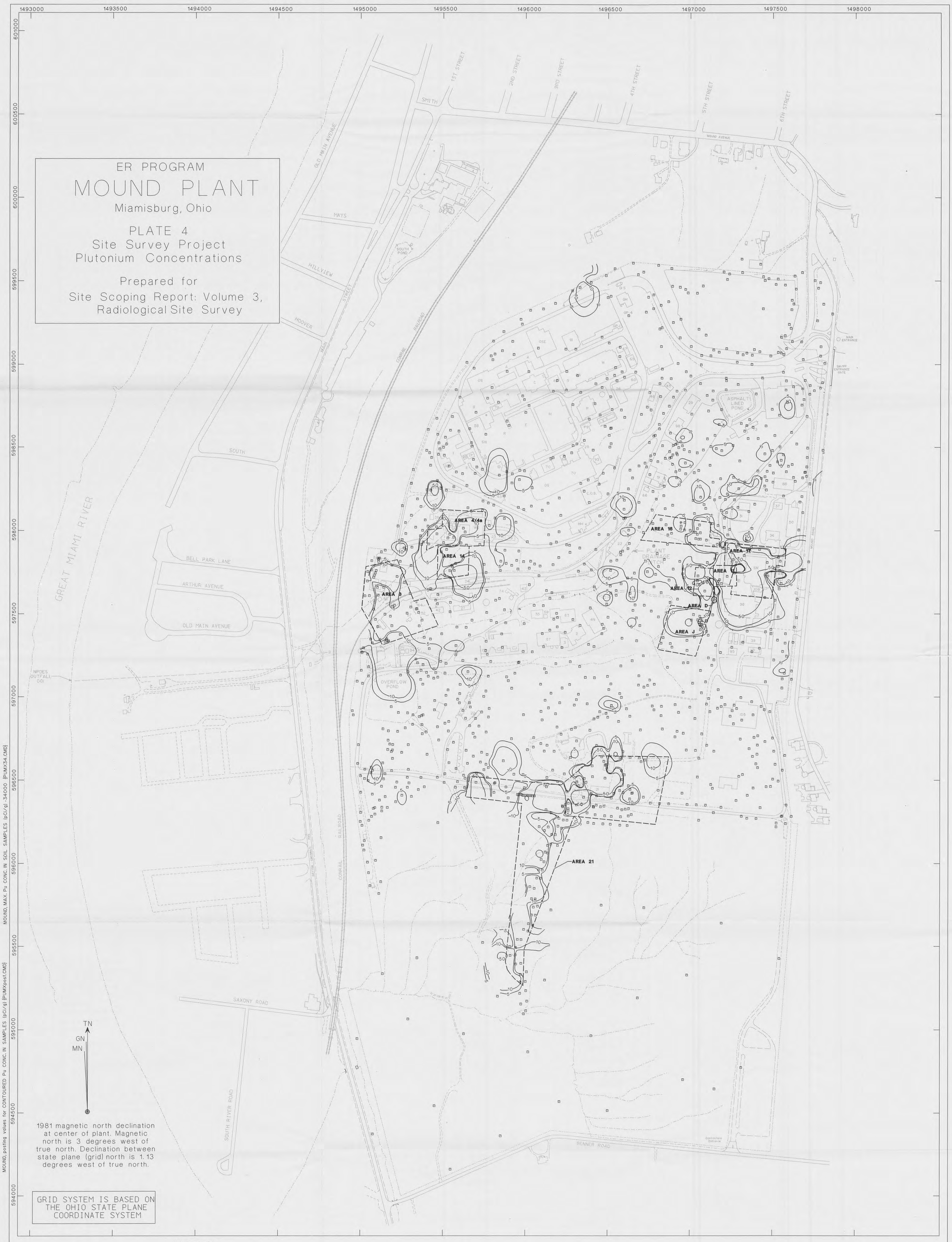
ER PROGRAM

MOUND PLANT

Miamisburg, Ohio

PLATE 4
Site Survey Project
Plutonium Concentrations

Prepared for
Site Scoping Report: Volume 3,
Radiological Site Survey



TN
GN
MN

1981 magnetic north declination at center of plant. Magnetic north is 3 degrees west of true north. Declination between state plane (grid) north is 1.13 degrees west of true north.

GRID SYSTEM IS BASED ON THE OHIO STATE PLANE COORDINATE SYSTEM

MOUND, posting values for CONTOURED Pu CONC. IN SAMPLES (pCi/g) (PUMXpost.CMD)

MOUND, MAX. Pu CONC. IN SOIL SAMPLES (pCi/g) -34000 (PUMX34.CMD)

J:\DGN\MOUNDB\M0765 121892

NOTES:

1. The electronic base map data file was obtained by WESTON from Woolpert Consultants, Inc., Dayton, Ohio. The data were photogrammetrically complied from aerial photography dated 12/08/85.

2. WESTON converted MOUND plant coordinates to Ohio State Plane Coordinates using an algorithm provided by Oak Ridge National Laboratory, Grand Junction Project Office.

3. Area west of Dayton-Cincinnati Pike was digitized from a hand drafted map, dated 3/12/86 from Monstanto Research Corp.

The data used in this map are from the Site Survey Project. Contours were generated by computer software (Radian Corporation, Contour Plotting System×, "CPS/PC"×) using the highest reported concentration at each sample location regardless of sample type (surface of subsurface). The combination of 1,138 surface sample locations and 291 core sample locations resulted in a total of 1,280 plutonium subsurface/surface soil data points. The concentrations of plutonium ranged from 0.01 pCi/g to 34,000 pCi/g. For the purposes of contouring only, the peak value of 34,000 pCi/g was removed prior to contouring. The next highest value was 1,103 pCi/g.

53 Structures
Paved Roadway
Unpaved Roadway
Railroad
Water
Fences
Retaining Wall
Mound Plant Boundary
Isopleth contour line

0 100 200 400 600 800 1000
Scale in Feet

WESTON
MANAGERS DESIGNERS/CONSULTANTS
6501 Americas Parkway N.E.
SUITE 800
ALBUQUERQUE, NM 87110
PHONE: (505) 884-5050

POINT	COORDINATES NORTH	COORDINATES WEST	DISTANCE	BEARING BY GRID NORTH FROM CENTER OF MOUND	BEARING FROM GRID NORTH CLOCKWISE FROM CENTER OF MOUND
101	39° 39' 02" N	84° 16' 54" W	8,150 FT.	11° NE	11°
102	39° 38' 15.25" N	84° 16' 47" W	3,975 FT.	33° NE	33°
103	39° 37' 59.75" N	84° 16' 37.25" W	3,400 FT.	59° NE	59°
104	39° 37' 03.25" N	84° 17' 31.3" W	4,100 FT.	8° 38' SW	188° 38'
105	39° 37' 43.75" N	84° 18' 0.5" W	3,550 FT.	87° 30' NW	272° 30'
108	39° 45' 34" N	84° 11' 22" W	52,200 FT.	29° 15' NE	29° 15'
110	39° 37' 25" N	84° 09' 52.7" W	34,700 FT.	87° SE	93°
111	39° 33' 11.25" N	84° 19' 06.9" W	28,700 FT.	8° SW	188°
112	39° 38' 28" N	84° 17' 45" W	5,150 FT.	27° NW	333°
115	39° 37' 33.5" N	84° 22' 25.7" W	24,225 FT.	87° 45' SW	267° 45'
118	39° 37' 26.5" N	84° 16' 12.5" W	5,125 FT.	72° 25' SE	107° 35'
119	39° 50' 13.75" N	84° 43' 16.3" W	145,200 FT.	58° 15' NW	301° 45'
122	39° 38' 05.5" N	84° 17' 24.2" W	2,450 FT.	18° NW	342°
123	39° 37' 42" N	84° 17' 33.9" W	1,500 FT.	89° 45' NW	270° 15'
124	39° 37' 52.5" N	84° 16' 46" W	2,400 FT.	64° NE	64°
POND BKG.	39° 11' 12" N	83° 53' 30" W	195,360 FT.	35° SE	145°
10	39° 41' 12" N	84° 22' 00" W	30,800 FT.	46° 30' NW	313° 30'
11	39° 34' 26" N	84° 21' 2.57" W	26,700 FT.	42° 15' SW	222° 15'
12	39° 33' 54" N	84° 11' 52.3" W	34,150 FT.	47° 15' SE	112° 45'
13	39° 39' 58" N	84° 11' 57" W	28,325 FT.	61° NE	61°
14	39° 39' 27" N	84° 19' 00" W	13,350 FT.	38° NW	322°
15	39° 36' 14.75" N	84° 18' 32" W	10,725 FT.	34° 40' SW	214° 40'
16	39° 35' 37.25" N	84° 16' 24" W	13,650 FT.	17° SE	163°
17	39° 38' 15" N	84° 15' 42" W	7,900 FT.	65° 45' NE	65° 45'
RIVER BKG.	39° 51' 18.5" N	84° 10' 17" W	88,375 FT.	21° 10' NE	21° 10'
R-1	39° 43' 50" N	84° 12' 06" W	44,300 FT.	33° NE	33°
R-2	39° 32' 35.25" N	84° 21' 15.4" W	36,225 FT.	31° 30' SW	211° 30'
R-3	39° 35' 16" N	84° 17' 14" W	14,800 FT.	0° S	180°
R-4	39° 36' 27" N	84° 17' 10.7" W	7,600 FT.	2° 30' SE	177° 30'
R-5	39° 36' 58.5" N	84° 17' 40.3" W	4,850 FT.	25° SW	205°
WATER BKG.	39° 13' 00" N	83° 54' 30" W	183,216 FT.	35° 45' SE	126° 15'
CENTER OF MOUND	39° 37' 42" N	84° 17' 15" W			

- • AIR SAMPLE POINT
- ■ RIVER SAMPLE POINT
- ▲ POND SAMPLE POINT

Supplied as Plate 1
Mound Site Scoping Report, Volume 8
May 1991

MONSANTO RESEARCH CORPORATION
MOUND
MIAMISBURG, OHIO

PROGRAM TITLE

DRAWING TITLE
OFF SITE SAMPLING POINTS

DWG TYPE STE
DWG CLASSIFICATION
LEVEL CAT **UNCL**
DERIVATIVE CLASSIFIER
BY TOVS
TITLE
DATE 1-22-88

DESIGNER K WEAVER | SPONS | PROJ MGR
CHECKER R.L. Rost | LP&EC | ENG SUPV
DESIGN ENG B.M. Yeomans | ENG MGR
APVD W.B. Clark | DATE 1-26-88
SCALE GRAPHIC | W.O. NO
JOB NO | DWG NO FSE880093 | SHT 1 of 1

CODE IDENT NO 14065

ISS	DATE	REVISION	BY	CHK'D	ENG	LP&EC	APVD	M
A	1-26-88	ORIGINAL ISSUE	KRW				DVD	

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ER PROGRAM

MOUND PLANT

Miamisburg, Ohio

PLATE 5
Site Survey Project
Thorium Concentrations

Prepared for

Site Scoping Report: Volume 3, Radiological Site Survey

TN
GN
MN

1981 magnetic north declination at center of plant. Magnetic north is 3 degrees west of true north. Declination between state plane (grid) north is 1.13 degrees west of true north.

Grid system is based on the Ohio State Plane Coordinate System

NOTES:

53 Structures
Paved Roadway
Unpaved Roadway
Railroad
Water
Fences
Retaining Wall
Mound Plant Boundary
Isopleth contour line

1. The electronic base map data file was obtained by WESTON from Woolpert Consultants, Inc., Dayton, Ohio. The data were photogrammetrically complied from aerial photography dated 12/08/85.

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3. Area west of Dayton-Cincinnati Pike was digitized from a hand drafted map, dated 3/12/86 from Monsanto Research Corp.

The data used in this map are from the Site Survey Project. Contours were generated by computer software (Radian Corporation, Contour Plotting System®, "CPS/PC"®) using the highest reported concentration at each sample location regardless of sample type (surface of subsurface). The combination of the 1,138 surface sample locations and 291 core sample locations resulted in a total of 1,315 thorium subsurface/surface data points. The thorium concentrations ranged from 0.3 pCi/g to 254.3 pCi/g.

0 100 200 400 600 800 1000
Scale in Feet

WESTON
MANAGERS DESIGNERS/CONSULTANTS
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SUITE 800
ALBUQUERQUE, NM 87110
PHONE: (505) 884-5050

J:\DGN\MOUNDB\M0766.DGN 062193
MOUND, posting values for CONTOURED Th CONC. IN SAMPLES (pCi/g) (THMXpost.CMD)
MOUND, CONTOURED Th CONC. IN SAMPLES (pCi/g) (THMAX.CMD)

APPENDIX A

TECHNICAL MEMORANDUMS

EQUIPMENT, PROCEDURES, AND LIMITATIONS OF THE MOUND SITE CHARACTERIZATION

1: Soil Sample Surveys
2: Radiochemical Analyses of Soil Samples
3: Soil Screening of Samples

MOUND

Inter-Office Correspondence

From: R. L. Stought
Health Physicist

Date: July 26, 1984

Subject: Procedure for Collection of Surface Soil Samples

Reference:

cc: W. P. Davis
D. G. Draper
J. M. Garner
L. C. Hopkins
M. A. Whitney
D. J. Rhude
File

TO: Brian T. Leahy

In response to your concern about the procedures used in the collection of random surface soil samples in support of Site Survey, the following procedures are in effect:

(1) An EAP sample collection tool is used. It is capable of extracting a soil plug of 3 1/2 inch diameter by 2 inch depth.

(2) Since the standard size EPA dish used for sample collection is of 4 inch diameter and 2 1/2 inch depth, its volume is greater than the plug of soil obtained by the soil collection tool. Therefore, the tool is used to obtain a second soil plug at a depth of 2 to 4 inches where the first one was obtained.

(3) Large rocks, twigs and other non-earth matter will be discarded. However, enough soil must be obtained that the EPA dish is 80 per cent or more full.

(4) In the event that the ground is hard, a hammer or other tool may be required to aid in driving the sample collection tool into the surface.

(5) Sample locations will be marked on appropriate maps. Sample identification will be noted on the labels of EPA sample collection dishes.

(6) Soil samples may be obtained by means other than with the use of the EAP sample collection tool providing the soil is obtained from a hole in the earth that is not greater than 4 inches diameter or 4 inches depth.

R. L. Stought

R. L. Stought

RLS:mjc

MOUND

Inter-Office Correspondence

From: Applied Analysis and Systems Design

Date: June 8, 1984

Subject: Mound Site Survey Reviewed With Empahsis on Statistical Sampling Strategy

Reference:

To: Bob Stougnt

cc: D. B. Armstrong
W. P. Davis
M. D. Hale
File

As related to you in the memo of March 15, 1984, from D. B. Armstrong, the Experimental Design Group envisioned the following tasks in order to evaluate statistically Mound's site survey sampling ideas.

1. Review literature of similar geographic surveys.
2. Review Mound's overall site survey plan
   a. Survey objectives
   b. Survey sampling plan design
   c. Sample selection and analysis methods.
   d. Current status of Survey.

The purpose of this memo is to describe our activities in evaluating the site survey by identifying your request, our observations, recommendations, important concerns, and an appendix which describes briefly the statistical qualities of plans which have been used successfully in geographic studies. These sections are individually addressed within the scope of the objectives as we understand them. We understand your objectives to be:

1. Provide LASL with an evaluation of radiation levels at Monsanto Research Corporation Mound Laboratory (DOE).

2. Identify potential building sites which require remedial clean-up.

3. Identify all areas requiring remedial clean-up as specified by the activity levels of 25 pCi/gr plutonium 238 and plutonium 239, and 5 pCi/gr for all isotopes of thorium. These levels are understood to be the remedial action levels.

Generally, the site survey plan has some attributes found in a well defined sampling scheme. Recommendations which are made later are supplied to enhance the present survey such that confidence and precision are gained in the analysis of the data. In familiarizing ourselves with the current work and to gain an appreciation of radionuclide surveys, an account of our efforts is given.

INVESTIGATION

The initial thrust into understanding geographical radionuclide surveys was reviewing similar surveys and reports which you provided. These reports are listed in the reference section found after Appendix A. The reference list includes previous radionuclide monitoring studies at Mound, monitoring sites where nuclear devices have been tested, and statistical literature addressing surveys and sampling. In addition to the literature reviews the two maps indicating the field instrument for detecting low energy radiation (FIDLER) surveys for thorium and plutonium isotopes were reviewed. A third map indicating the current sampling of the site for surface and core samples was closely reviewed. On several occasions we discussed the organization of the survey maps, how the samples were located and additonal information.

SURVEY PLAN AND ASSUMPTIONS

The following represents our understanding of the way the sampling has been formed and other pertinent assumptions. Presently, the site survey consists of FIDLER surveys, surface samples, and core samples. Each set of samples is expected to yield data useful to characterizing the overall site. The FIDLER surveys have been used to gain a brief idea of where contaminated areas are located. The surface samples are collected and analyzed to achieve representative values for the site. The core samples are gathered and analyzed to gain information describing the depth and level of radionuclide contamination.

The FIDLER surveys are complete for thorium and plutonium isotopes and as mentioned in the recommendations section the measurement capabiltity and correlation with surface samples are of concern.

The site plan for surface samples is based upon the use of grids of 82 strata. Most often a grid represents and area 380' by 300'. Some grids are smaller in area as they use the boundary line for the site as an edge. Five surface samples are randomly selected from each of the grids. Some areas of the laboratory have buildings which cover a majority of the grid so selection of a surface samples becomes random in a limited space. Overall the presence of the five samples in each grid does create an unaligned systematic sampling scheme. This gives the surface sampling part of the survey a spatial distribution.

Additional information which we discussed and is pertinent to the site survey is as follows:

1. No samples are taken inside of buildings.
2. No surface or core samples are taken from paved areas.
3. The cost for analyzing a surface sample is approxiamately $120.00. The cost for a core sample is found by multiplying the number of subsections of the core sample by $120.00.
4. Normal core samples are 8 - 10 feet in depth with some as shallow as 6 feet and some as deep as 20 feet.

5. The natural background counts are given to be 3 pCi/gr plutonium, 0.5 pCi/gr thorium, and a 0.0004 pCi/gr fallout of plutonium 238 in Ohio.

Exploring the present surface sampling strategy will give us an appreciation for its level of confidence in characterizing the site. As an example, if we have a known area of contamination 20' by 20' in the surface sampling then we conceivably could divide our 380' by 300' grids into a pattern of 19 by 15, 20' by 20' grids. This is the worst case because we know the developed site which was not sampled reduces the area of many grids. Table 1, Surface Sampling Probabilities, contains the probabilities of finding a "hot" spot for certain sizes of contaminated areas. The last column in this table contains the P_{50} value for the number of samples needed for a 380' by 300' grid which results in finding a "hot" spot 50% of the time.

Table 1
Surface Sampling Probabilities

Contaminated Area	Probability of 1 "hot" spot in 5 samples	P_{50} Sample Size
10' x 10'	0.0044	790
20' x 20'	0.0174	197
40' x 40'	0.0681	48
80' x 80'	0.251	12

From this table our example gives a probability of 0.0174 of finding a given single "hot" spot using five samples in the 380' x 300' grid. In order to have an even chance of finding a "hot" spot, we would need to select a minimum of 197 samples from the 380' x 300' grid where there was a single contaminated area 20' x 20'. There are twelve grids on the current site survey which fit this worse case description. As the area of some grids are reduced by the presence of permanent structures and paved areas, similar examples can be developed when the total square footage of the grids is known. The use of grids in geographic surveys is supported by numerous sources and is a good device to use for the surface and core samples.

The current site survey has the core samples concentrated in contaminated areas as revealed by the FIDLER surveys. An interpolation method can be used for these smaller localized areas to estimate the volume of contamination. The overall plan lacks spatially collected core samples for the entire site and their absence prevents characterizing the volume of contamination for many sections of the site. A recommendation referencing the core samples is supplied later.

One final observation is the relative precision of the EAP lab, trailer 15, and the FIDLER instruments. We have been told the EAP analyses are the most precise of the three and the most time consuming in running the samples. The exact precision of the three varieties of measuring devices is not documented. It is known that trailer 15 analyses have a quicker turn-a-round time than the EAP analyses.

Recommendations

Based on the literature searches, our discussions, and findings regarding the present sampling plan, recommendations to Mound's site survey are made to improve the efficiency of the sampling and the integrity of the characterization of the 180 acre laboratory site. The recommendations made cover four general areas, documentation of measuring capabilities, standardizing the sampling procedure, establishing a second phase sampling plan, and identification of grids and sampled areas.

The site survey must have validated measuring capabilities. Validating measuring capabilities needs to be done with the first phase of sampling to provide the answer to Mound's measurement error. This should be done with the field instrument for determining low energy radiation (FIDLER) the instruments in trailer 15, and the instruments used by the EAP laboratory. One suggested scheme is to take multiple, (3), FIDLER readings for each of five "hot", "medium", and "cold" areas over varying weather conditions. For trailer 15 we need to know the variance of the samples and not the measuring technique. Hence, multiple analysis of the same samples analyzed by trailer 15 is important. Along with this, the actual steps taken in retrieving samples should be documented to ensure a standardized procedure among the personnel.

Since we know from the example a low potential for discovering a "hot" spot can be realized, the use of composite sampling within the grids for surface samples and core samples should be explored. One way to improve the probability is to use composite sampling. This technique allows us to take many samples from an area and combine them. After combining the samples, the radiochemistry analysis is done. Composite sampling allows us to characterize a large grid of nonhomogeneous samples. We know less about a particular spot, but have more information about a larger area. Not only do we need to consider composite sampling for core samples but also the addition of more core samples is imperative. Adding core samples to the plan in a systematic fashion will do two things. First it improves the site plan's characterization of the level of subsurface contamination by allowing volumetric interpolation of well spaced data. Also, it improves our liklihood of finding unknown but suspected burial sites. When composite sampling is used we must make use of decision rules as to the implementation of subsequent sampling to locate the "hot" spots. Contaminated areas requiring remedial action are not just the sampled surface points and it is important to find the boundary of contaminated areas.

Another recommendation is to prepare for a phase 2 sampling collection based upon smaller grid sizes and dependent upon the results of the original plan. The second phase sampling should make use of the smaller grid size and placement of these smaller grids should be systematically influenced from the original surface sampling points. How do we determine which points from the original survey require

continued sampling? To answer this we can employ acceptance sampling operating characteristic curves. We need to reach this decision by plotting these operating characteristic curves and discuss what risks of the types of error we are willing to accept. In addition to the risks there needs to be defined the activity level at which remedial action is not to be taken. From this planning of a second phase we will find the number of secondary samples needed and be able to construct the boundaries for contaminated areas. It is important that the second phase of sampling be described in detail before the first phase is finished. To make the composite sampling and the second phase of sampling worthwhile, provisions for identifying grid boundaries and sampling points must be incorporated. In geographical studies where precision is important stratification results in improving the precision when the level of reading is closely related to the size of the area, which in this case is the known existence of burial sites, the variability is suspected to be heterogenous, and the size of the overall area is large enough that setting the size of a strata relies upon the cost of a sample and funds available. When a researcher considers these factors along with his objectives, and historical records the number of strata and size of the strata can be determined. The attached appendix addresses this and other statistical considerations needed in finalizing a plan. I have mentioned the use of strata here because of the work done with the FIDLER instruments in doing preliminary monitoring of Mound Laboratory. FIDLER readings could be used to adjust the grid pattern for further sampling, by setting strata for certain levels of contamination and estimating the overall variability of the site.

The recommendations and the following questions should be given your attention in order to assure good results in the data analysis which follows the sampling. Responses to the queries listed are needed to confirm a good sampling strategy.

How large an area is represented by a surface sample reading?

Which samples have been processed through radiochemistry?

What are the levels of low energy radiation for which we must always take remedial action for thorium and plutonium isotopes?

What are the levels of low energy radiation for which remedial action will not be taken for thorium and plutonium isotopes?

When the questions are answered, the sampling strategy confirmed to have good probability of finding known "hot" spots, a precise second phase procedure agreed, and the measuring capabilities of the instruments known, the data analysis can proceed smoothly.

One additional note to bring to your attention is an analytical method for use when the data from the core samples study has been collected and the spatial distribution of the sampling scheme has remained in tact. The presence of well spaced data can be handled in data analysis by an interpolation precedure known as Kriging. This method provides a way of interpolating spatial data to characterize Mound's

isotope levels as though the entire site was to be totally sampled. The Kriging method was developed as a means to estimate volumes of ore in the mining industry. In the site survey we are interested in estimating the volume by determining the depth of contamination found in core samples. I would be glad to explore the Kriging method prior to the completion of the survey.

B T Leahy

B. T. Leahy

TYPES OF SAMPLING:

Geographic studies in the area of enviromental radionuclides have made use of several sampling strategies. Simple random sampling, stratified random sampling, systematic sampling, and sequential sampling techniques have been used successfully and are mentioned here with emphasis upon when to use them and what estimates are expected. These sampling strategies deserve careful consideration before implementation. Each has certain assumptions affecting its proper use. Correct sampling gives us reliable and representative data of the site. Since one of the objectives is to gather information about contaminated sites and potential building sites a scheme that plans for remedial clean-up is important. As each sampling technique is discussed estimates for the mean and variance of the mean are given.

Simple random sampling is the selection of n surface or core samples from a population of size N. Where we are concerned the N refers to the possible number of samples taken in the 180 acre site and is determined by the quantity of a single sample. More often we have a fixed budget within which all sampling must be done and the site should be covered thoroughly. Interest of samples is focused upon the mean, variance, and proportions estimates of the population and attempting to specify where the samples should be taken. In simple random sampling the assignment of the locations for the samples can be done with a random number table and associated geographical location. The mean of an isotope y is given by expression (1). The mean is the sum of all the observations divided by the number of samples.

$$\bar{y} = \sum_{i=1}^{n} y_i/n \qquad (1)$$

The spread of the data, the variance, is expressed as the sum of the squares of the individual observations minus the sample mean which is divided by the size of the sample less one. This is contained in expression (2) and denoted by s^2.

$$s^2 = \sum_{i=1}^{n} (y_i - \bar{y})^2/(n-1) \qquad (2)$$

Probability theory maintains that the distribution of means follows a normal distribution and good sampling practice keeps the normal approximation useful. In populations where extreme values are found their effect upon the mean and variance can cause concern. An extreme value can influence the mean in its direction and increase the variance of the sample. This circumstance hinders the use of the normal approximation. Separating the sample into subsections helps to deal with extreme values. Mound Laboratory has known burial sites and has justification for expecting extreme values. Stratified random sampling is one technique which removes extreme values or areas from the rest of the sample and retains the use of the normal approximation.

Stratified random sampling derives its name from the establishment of nonoverlapping areas such that all the areas comprise the total population of interest. In each stratum created a random sample is drawn. Some of the reasons for employing stratified random sampling are;

1. Convenience in collecting the sample. Some areas may be of more interest at the present so we treat them as a unit.

2. Sampling within a region or area has known information and its treatment as an entity enhances understanding of the population.

3. The researcher wants to gain precision in estimating characteristics of the population where variability in readings is not expected to remain constant.

Stratification is a weighting of the strata such that estimates for the overall population can be derived. In a sample of h strata we let the mean for a particular stratum be denoted by the sum of the observations within the stratum divided by the number of items in the stratum. Expression (3) is the representation for a stratum average.

$$\bar{y}_h = \sum_{i=1}^{n_h} y_{hi}/n_h \qquad (3)$$

Using this expression the estimate for the population mean from stratified sampling denoted with the (st) in the subscript is the sum of the product of the weights given to the strata and the strata means. This estimate of the population mean is the same as the one from simple random sampling when the weights in each stratum is the same. W_h in expression (4) is the weight of stratum h determined by the ratio of the size of stratum h to the overall population size. In geographical studies this is often a ratio found by using the area of the stratum, where we have from 1 to l strata, divided by the overall area of the site.

$$\bar{y}_{st} = \sum_{h=1}^{l} W_h \bar{y}_h \qquad (4)$$

By stratifying we make the variance of the stratified mean $\bar{y}_{st}$ dependent upon the collection of variances in the strata and therefore have given proper attention to the higher weighted strata. Expression (5) shows that the variance of the stratified mean is equal to the sum of the product of the strata weights squared and their respective variances.

$$V(\bar{y}_{st}) = \sum_{h=1}^{l} W_h^2 V(\bar{y}_h) \qquad (5)$$

Properly stratifying the sample improves the precision of the study. This is observed by comparing the variances of the estimated means of stratified random sampling and simple random sampling. Generally we find stratification with optimal allocation resulting in the smaller

variance of the estimated mean followed by proportional allocation and then random sampling. Optimal allocation and proportional allocation are not topics here, but as with stratified random sampling there are times when they can be very useful. As each set of samples is collected and analyzed, a decision regarding remedial action is made. We can initiate clean-up steps, decide no remedial action is necessary or take more samples if the decision is not clear. This order of events falls under sequential sampling and needs to be integrated into a good geographical study of the surface samples.

Sequential sampling or acceptance sampling makes use of operating characteristic curves. These curves assist in the decision of the number of samples necessary to meet prescribed probabilities of decision error. The two types of error we are concerned with are taking remedial action when it is not justified and failing to take remedial action when it is justified. The second of the above errors is the one the site survey should keep as low as reasonably attainable. An error of this type would allow a "hot" spot to remain in place. Making an error of the first type adds time and money to the remedial action steps.

There are two ways to use an operating characteristic curve. The first is to specify the levels of risk you are willing to take in making the two types of error mentioned in the above paragraph along with the activity levels. The activity levels of interest are where remedial clean-up action is not to be taken and the activity level where remedial action must always be taken. Together with an estimate of the overall variability of the activity readings for Mound, the sample size, n, can be determined. The second approach is to specify the sample size, the estimate of the variance and the two activity levels and determine the risk levels of your plan. The first approach is the preferred one for Mound's survey. Please note that acceptance sampling is difficult to apply to subsurface monitoring because volume and depth determinations compound the use of operating characteristic curves and there has been recorded a potential problem of cross contamination of samples from other depths via equipment use. In surface sampling we remain free of volume considerations and acceptance sampling can be used here.

The final sampling technique of potential use to us is systematic sampling. Employing systematic sampling is reached by indicating a starting point and moving equidistant in all directions until the site is covered. The first surface or core sample would then determine the placement of the other samples in the survey. In effect this method does stratify the area into n strata and we should expect precision to be close to the precision of the stratified random sampling. The mean would be computed the same as stratified random sampling, expression (4). The benefit of using systematic sampling is revealed in understanding the variance of the mean of the systematic sample (y_{sy}). The variance of the systematic mean is the difference between two quantities. The first quantity is the fraction of the population size less one and the population multiplied by the population variance. The second quantity is the fraction of the number of possible systematic samples, k, times the sample size less

one divided by the population size, multiplied by the variance among the units in the same systematic sample. Expression (6) is the variance for systematic mean. and Expression (7) is the variance among the units within the same systematic sample.

$$V(\overline{y}_{sy}) = (N-1)/N*S^2 - k(n-1)/N*S^2_{wsy} \qquad (6)$$

$$S^2_{wsy} = 1/(k(n-1)\sum_{i=1}^{k}\sum_{j=1}^{n}(\overline{y}_{ij}-y_{i.})^2 \qquad (7)$$

In expression (7) y_{ij} is the jth member of the ith systematic sample and we know there are n members of k systematic samples. Also, $y_{i.}$ is the mean of the ith sample.

When the quantity in expression (7), the variance within the systematic sample, is greater than the overall population variance, systematic sampling provides better precision than simple random sampling. This occurs in geographical surveys where burial sites make up part of the area of interest. The presence of burial sites or known contaminated areas creates the large variability in the readings, thus systematic sampling provides a gain in precision of the survey. We know the reason for stratification is to gain precision by isolating areas of different levels of readings. Stratification deals with widely varying readings in samples. Where stratification gains over systematic sampling is not as uniformly clear as finding where systematic sampling gains precision over simple random sampling. Systematic sampling has been used successfully in agricultural studies, forest mapping, and many radionuclide surveys of test sites. Employing a systematic sampling plan will yield data depicting spatial distribution and can be used to characterize the site via contours, whereas gathering data for inventory reasons does not always reveal the spatial distribution of the data.

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5. "Procedure for Measurement of Plutonium and Thorium in Soil Samples Using the Bicron Detector," interoffice memo, April 16, 1984.

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2: Radiochemical Analyses of Soil Samples

MONSANTO RESEARCH CORPORATION
MOUND FACILITY

OPERATION SHEET

PROGRAM	SHEET	MANUAL NUMBER	OPERATION
ENVIRONMENTAL ANALYTICAL PROCEDURE	1 of 7	PD-80030	1343

AUTHORIZATION	CLASSIFICATION	EFFECTIVITY	ECNIS INCORPORATED
Carl T. Bishop	Unclassified	3-1-84	None

MINIMUM ANALYSIS TIME	BIAS	PRECISION, 2σ	SUBMITTED BY
16 Hrs/12 Samples	∿±5%	∿±10 to ±25%	C. A. Phillips A. A. Glosby/MD777

OPERATION TITLE
Plutonium in Small (0.5 to 5.0 grams) Soil Samples by an Acid-Leach Anion Exchange Method

1. SCOPE

This procedure has been successfully tested and is applicable to soil samples containing as little as 0.01 pCi/g of plutonium. The procedure can be applied to soil samples from 0.5 to 5.0 grams with chemical yields greater than 50% for 5.0-gram samples.

2. SUMMARY

The procedure consists of an acid leach, an anion exchange separation and electrodeposition, followed by alpha pulse height analysis. The soil sample is dried and ground to < 60 mesh, from which representative aliquots are taken for analysis. Plutonium-242 (or Pu-236 if the Pu-238, -239 activity is high) is added to the sample as a tracer.

The soil sample is leached with a boiling solution of 3:1 HNO_3/HCl. The slurry is centrifuged and the leachate adjusted to 8 M HNO_3. The plutonium in the leachate is converted to Pu-IV with sodium nitrite and absorbed onto an anion exchange resin column. Thorium is removed from the column with 12 M HCl, and the plutonium is eluted by reduction to Pu-III with iodide ion.

After evaporation of the eluate, the plutonium is electrodeposited onto a stainless steel slide for counting by alpha pulse height analysis. Alpha particle energies of Pu-238, Pu-239, and Pu-242 (or Pu-236) are readily resolved with a silicon surface barrier detector. The absolute amounts of Pu-238 and Pu-239 and the recovery of the Pu-242 (or Pu-236) tracer can be calculated from the known amount of tracer added and from the counter efficiency.

NOTE: This procedure does not include sample preparation. See Operation 1302 for information on sample preparation.

3. SPECIAL APPARATUS

- Alpha pulse height analysis system
- Balance, Mettler, for 0 to 1600 g
- Beakers, 100, 150, 250 ml
- Bottles, heavy-walled, for centrifuge, 250 ml
- Centrifuge--capable of handling 250-ml centrifuge bottles; Model K, Damon/IEC Division
- Electrodeposition apparatus
- Heat lamp--mounted on a ring stand for drying slides
- Ion exchange columns--approximately 1.3 cm (0.5 in.) ID. 15 cm (6 in.) long with 100-ml reservoir
- pH meter
- Stainless steel slides, 1.91 cm (0.75 in.) diameter, 0.05 cm (0.02 in.) thick

4. REAGENTS

- Ammonium hydroxide (NH_4OH), concentrated (15 M), 1.5 M, 0.15 M
- Ammonium iodide (NH_4I), 1 M (prepared fresh daily)
- Anion exchange resin; Bio Rad AG1-X4 (100-200 mesh), chloride or nitrate form
- Ethyl alcohol, slightly basic with a few drops of 15 M NH_4OH to 100 ml of alcohol
- Hydrochloric acid (HCl), concentrated (12 M), 0.5 M
- National Bureau of Standards (NBS) plutonium-242 solution, with the concentration certified to ±1% of its stated activity, or a dilution of this standard
- Nitric acid (HNO_3), concentrated (16 M), 8 M
- Pre-adjusted electrolyte, 1 M; ammonium sulfate adjusted to pH 3.5 with 15 M NH_4OH and 18 M H_2SO_4
- Sodium hydrogen sulfate ($NaHSO_4$), ~5% in 1 M H_2SO_4
- Sodium nitrite ($NaNO_2$)
- Sulfuric acid (H_2SO_4), concentrated (18 M), 1.8 M

5. PROCEDURE

5.1. SAMPLE LEACHING

5.1.1. Weigh, to the nearest 0.01 gram, a soil sample that has been ground to 60 mesh.

5.1.2. Save the remainder of the soil for possible future use.

5.1.3. Transfer the aliquot to a 250-ml beaker.

5.1.4. Add approximately 10 dis/min of NBS calibrated Pu-242 to the sample.

5.1.5. Add 100 ml of 16 M HNO_3 to the sample, allow it to react, and then cool.

5.1.6. Add 30-50 ml of 12 M HCl to the sample.

CAUTION

Add slowly. In some cases a vigorous reaction occurs.

5.1.7. Add a magnetic stirring bar to the slurry. Allow the slurry to remain in a fume hood overnight.

5.1.8. Stir the slurry while boiling until the volume is about 75 ml and then allow the slurry to cool to room temperature.

5.1.9. Transfer the slurry to centrifuge bottles and centrifuge at 3500 rpm for 10 minutes.

5.1.10. Decant the supernate into a clean 150-ml beaker and evaporate to 5 to 10 ml.

5.1.11. Add an equal volume of water to this sample and then add 8 M HNO_3 to the sample to adjust the final volume to about 80-100 ml.

5.2. ANION EXCHANGE

5.2.1. Add 200 mg of $NaNO_2$ (as a solid or dissolved in 1 ml of water) to the 8 M HNO_3 sample solution, bring to a low boil, and then cool overnight.

NOTE: The sample can be cooled in an ice bath if it is necessary to continue at this time.

5.2.2. Prepare an ion exchange column with about 10 cm^3 of Bio Rad resin AG1-X4 (or AG1-X8), 100-200 mesh (nitrate form). Slurry the resin in 8 M HNO_3 before using.

5.2.3. Pass 100 ml of 8 M HNO_3 through the column at a flow rate of 4-6 ml/min and discard the rinse.

5.2.4. Pass the sample from step 5.2.1 through the column at a flow rate of 1-2 ml/min and discard the effluent. This flow rate should not be exceeded, otherwise some plutonium may pass through the column.

5.2.5. Rinse the column with 100-150 ml of 8 M HNO_3 at a flow rate of 1-2 ml/min and discard the rinse.

5.2.6. Rinse the column with 60-80 ml of 12 M HCl at a flow rate of 1-2 ml/min. If thorium is to be determined, save this eluate; if not, it can be discarded.

5.2.7. Elute the plutonium with 60 ml of 12 M HCl containing 2 ml of 1 NH_4I at a flow rate no greater than 2 ml/min, collecting the rinse in a 100-ml beaker.

NOTE: Prepare fresh NH_4I/HCl solution before eluting.

5.2.8. Rinse the column with 20 ml of 12 M HCl, collecting this eluate in the same 100-ml beaker used in step 5.2.7.

5.2.9. Evaporate the plutonium eluate of about 80 ml to about 20 ml.

5.2.10. Add 20 ml of 16 M HNO_3 and evaporate to near dryness.

5.2.11. Add 10 ml of 16 M HNO_3 and evaporate to about 2 ml.

5.3. ELECTRODEPOSITION

5.3.1. Add 2 ml of 5% solution of $NaHSO_4 \cdot H_2O$ in 1 M H_2SO_4 to this solution and evaporate to dryness. Cool to room temperature.

> NOTE: If the sample in step 5.2.11 had evaporated to dryness, 5 ml of 15 M HNO_3 should be added before evaporation at this step.

5.3.2. Dissolve the sample in 10 ml of the preadjusted electrolyte 1 M ammonium sulfate (warming to hasten the dissolution). Adjust to pH 2.0 with 1.5 M NH_4OH or 1.8 M H_2SO_4.

5.3.3. Transfer the sample to a prepared electrodeposition cell. Rinse the beaker that had contained the sample with additional electrolyte and transfer to the electrodeposition cell.

5.3.4. Place the platinum anode in the solution approximately 1 cm from the cathode (stainless steel disk).

5.3.5. Connect the electrodes to the power source and adjust the power supply to give a current of 1.2 ampere.

5.3.6. Continue electrodeposition for two hours.

5.3.7. Terminate electrodeposition by adding 1 ml of 15 M NH_4OH and continue the electrodeposition for one minute. Remove the anode while the power is still on.

5.3.8. Discard the solution from the cell and rinse the cell three times with 0.15 M NH_4OH or deionized water.

5.3.9. Disassemble the cell and wash the slide with ethyl alcohol made basic with NH_4OH.

5.3.10. Dry the slide, label the back of it with the last three digits of the laboratory ID number, and place it in a labeled box to be submitted for alpha pulse height analysis.

6. CALCULATIONS

6.1. CALCULATION OF PLUTONIUM CONCENTRATIONS

6.1.1. The concentration of Pu-238 or Pu-239 in the aliquot of soil taken for analysis is given by

$$X_i = \frac{R_i A_t}{R_t W_s}$$

where x_i = the concentration Pu-238 or Pu-239 in the soil in disintegrations per minute (dis/min) per gram,

R_i = the net sample counting rate in the Pu-238 or Pu-239 energy region of the alpha spectrum,

A_t = the activity of the Pu-242 tracer in dis/min,

R_t = the net sample counting rate in the Pu-242 tracer region of the alpha spectrum, and

W_s = the weight in grams of the soil taken for analysis.

6.2. CALCULATION OF PLUTONIUM RECOVERY OF THE CHEMICAL ANALYSIS

6.2.1. The plutonium recovery efficiency, expressed as a percentage E, is given by

$$E = \frac{R_t}{A_t e} \times 100\%$$

where e = the absolute counting efficiency of the alpha pulse height analysis system,

and the other terms as defined in section 6.1.1.

7. REFERENCE

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PROGRAM	SHEET	MANUAL NUMBER	OPERATION
ENVIRONMENTAL ANALYTICAL PROCEDURES	1 of 10	PD-80030	1302

AUTHORIZATION	CLASSIFICATION	EFFECTIVITY	ECN(S) INCORPORATED
H E Meyer	Unclassified	March 1977	None

MINIMUM ANALYSIS TIME	BIAS	PRECISION, 2σ	SUBMITTED BY
24 hours/4 samples	Unknown	Unknown	C. A. Phillips/MD777

OPERATION TITLE
Plutonium in Large Soil Samples by an Acid-Leach Anion Exchange Method

1. SCOPE

This procedure has been successfully tested and is applicable to soil samples containing trace quantities of plutonium. The procedure can be applied to soil samples from 10 to 1000 grams with chemical yields greater than 60% for 1000-gram samples.

2. SUMMARY

The procedure consists of an acid leach, an anion exchange separation and electrodeposition, followed by alpha pulse height analysis. The soil sample is dried at 200°C and ground to <60 mesh, from which representative aliquots are taken for analysis. Plutonium-242 tracer is added to the sample which is then heated for 4 to 5 hours at 600°C.

The ashed sample is leached with a boiling solution of 3:1 HNO_3/HCl. The slurry is centrifuged and the leachate adjusted to 8 M HNO_3. The plutonium in the leachate is converted to Pu-IV with sodium nitrite and adsorbed onto an anion exchange column. Thorium is removed from the column with 12 M HCl, and the plutonium is eluted by reduction to Pu-III with the iodide ion. After evaporation of the eluate, this anion exchange step is repeated to ensure that essentially all of the residue is removed prior to electrodeposition.

The plutonium is electrodeposited onto a stainless steel slide for counting by alpha pulse height analysis. Alpha particle energies of Pu-238, Pu-239, and Pu-242 are readily resolved with a silicon surface barrier detector. The absolute amounts of Pu-238 and Pu-239 and the recovery of the Pu-242 tracer can be

2. Continued

calculated from the known amount of tracer added, correcting for counter efficiency.

3. SPECIAL APPARATUS

- Alpha pulse height analysis system
- Balance, Mettler, for 10 to 10,000 g
- Beakers, 1000, 2000, 4000 ml
- Bottles, heavy-walled, for centrifuge, 1000 ml
- Casserole, Pyrex, 5-1/4 x 10-1/2 x 3-1/2 in.
- Centrifuge--capable of handling 1000 ml centrifuge bottles; Model K, Damon/IEC Division
- Drying oven, Thelco Model 28
- Drying pan, aluminum, 12 x 20 x 3-3/8 in.; #06-0066, Warehouse Item
- Electrodeposition apparatus
- Filter paper, Whatman #1, 18.5 cm
- Furnace, muffle, Model M25A-2A, Blue M, 20-1100°C
- Heat lamp--mounted on a ring stand for drying slides
- Ion exchange columns--approximately 1.3 cm (0.5 in.) ID. 15 cm (6 in.) long with 100-ml reservoir
- pH meter
- Pulverizer, Soil Model No. 500; Holmes Brothers, Inc.

3. Continued

- Riffle for silt or soil, Model CL244A; Soil Test, Inc.
- Stainless steel slides, 1.91-cm (0.75 in.) diameter, 0.05 cm (0.02 in.) thick

4. REAGENTS

- Ammonium hydroxide (NH_4OH), concentrated (15 M), 1.5 M, 0.15 M
- Ammonium iodide (NH_4I), 1 M, (prepared fresh daily)
- Anion exchange resin; Bio Rad AG1-X4 (100-200 mesh) or the chloride or nitrate form
- Ethyl alcohol, slightly basic with a few drops of 15 M, NH_4OH to 100 ml of alcohol
- Hydrochloric acid (HCl), concentrated (12 M), 0.5 M
- National Bureau of Standards (NBS) plutonium-242 solution, SRM #4334 or #4335, with the concentration certified to ±1% of its stated activity, or a dilution of this standard
- Nitric acid (HNO_3), concentrated (16 M), 8 M
- Phenolphthalein indicator solution
- Pre-adjusted electrolyte, 1 M; ammonium sulfate adjusted to pH 3.5 with 15 M NH_4OH and 18 M H_2SO_4
- Sodium hydrogen sulfate ($NaHSO_4$), ~5% in 1 M H_2SO_4
- Sodium nitrite ($NaNO_2$)
- Sulfuric acid (H_2SO_4), concentrated (18 M), 1.8 M

5. PROCEDURE

5.1. Sample Preparation and Firing

5.1.1. Place the sample in an aluminum pan.

5.1.2. Break up the sample and discard any large stones or gravel.

5.1.3. Dry the sample in a drying oven at 200°C for 24 hours.

5.1.4. Grind the dried sample in a soil pulverizer to 60 mesh.

5.1.5. Record the following weights: sample plus container, container, sample.

5.1.6. Riffle the sample through a soil riffle to obtain desired sample size.

5.1.7. Weigh the aliquot to the nearest 0.1 g.

5.1.8. Save the remainder of the soil for future use.

5.1.9. Transfer the aliquot to a casserole.

5.1.10. Add approximately 10 dis/min Pu-242 of NBS calibrated Pu-242 to the sample.

5.1.11. Place the sample in a furnace and heat at 600°C for 4-5 hours.

5.1.12. Remove the sample from the furnace and cool to room temperature.

5.2. Sample Leaching

5.2.1. Transfer the sample to a clean 2000 or 4000-ml beaker using a minimum amount of 16 M HNO_3 to rinse the casserole.

*5.2.2. Add 300 ml of 16 M HNO_3 to the sample, allow it to react and then cool.

*5.2.3. Add 100 ml of 12 M HCl to the sample.

CAUTION

Add slowly. In some cases a vigorous reaction occurs.

5.2.4. Add a magnetic stir bar to the slurry.

5.2.5. Stir the slurry while boiling for 60 minutes and allow the slurry to cool to room temperature.

5.2.6. Transfer the slurry to centrifuge bottles and centrifuge at 3500 rpm.

5.2.7. Decant the supernate and save in a clean 1000-ml beaker.

5.2.8. Transfer the residue in the centrifuge bottles back into the original 2000-ml beaker using 16 M HNO_3 for rinsing.

5.2.9. Repeat steps 5.2.2 through 5.2.7.

5.2.10. Combine both supernates and evaporate to a volume of about 200 ml.

5.2.11. Transfer the volume of solution in the 1000-ml beaker to a 500-ml graduate and record the volume to the nearest milliliter.

*See Table 1 for samples greater than 100 g of soil.

5.2.12. Add an equal amount of distilled water to the sample, thus adjusting the molarity to approximately 8 M in HNO_3. The exact molarity of the HNO_3 in solution should be determined with standardized NaOH and adjusted to 8 M as described in paragraphs 5.2.13 through 5.2.15.

5.2.13. Titrate 0.5 ml of the unknown HNO_3 solution with standardized 0.1 M NaOH and phenolphthalein as an indicator. Calculate the molarity of the unknown HNO_3 solution as follows:

$$M_1 = (M_2V_2)/V_1 \qquad (1)$$

where M_1 = molarity of the sample solution

M_2 = molarity of the standardized NaOH solution

V_2 = volume of the standardized NaOH solution

V_1 = volume of the HNO_3 solution aliquot = 0.5 ml

SAMPLE WEIGHT (GRAMS)	HNO_3 VOLUME (ML)	HCl VOLUME (ML)
100	300	100
200	375	125
300	475	160
400	550	180
500	650	220
600	725	240
700	800	270
800	850	280
900	925	300
1000	1000	330

TABLE 1 - VOLUME OF REAGENTS VS SAMPLE SIZE

5.2.14. Determine the amount of 16 M HNO_3 to be added to the unknown solution for adjusting to 8 M in HNO_3 as follows:

$$M_s V_s + 16V_x = 8V_s + 8V_x \qquad (2)$$

or $$V_x = \frac{V_s\ (8 - M_s)}{8} \qquad (3)$$

where: V_x = volume of 16 M HNO_3 to be added

V_s = total volume of sample solution

M_s = calculated HNO_3 molarity from step 5.2.13 = M_1

5.2.15. Pass the sample through a Whatman #1 filter paper and rinse the filter with 20-25 ml of 8 M HNO_3.

5.3. Anion Exchange

5.3.1. Add 200 mg of $NaNO_3$ to the 8 M HNO_3 sample solution, bring to a low boil, and then cool in an ice bath or allow to cool overnight.

5.3.2. Prepare an ion exchange column with ∿10 cm^3 of Bio Rad resin AG 1x4, 100-200 mesh (nitrate form). Slurry the resin in 8 M HNO_3 before using.

5.3.3. Pass 60 ml of 8 M HNO_3 through the column at a flow rate of 4-6 ml/min and discard the rinse.

5.3.4. Pass the sample from step 5.3.1 through the column at a flow rate of 1-2 ml/min and discard the effluent.

5.3.5. Rinse the column with 150 ml of 8 M HNO_3 at a flow rate of 1-2 ml/min and discard the rinse.

5.3.6. Rinse the column with 60 ml of 12 M HCl at a flow rate of 1-2 ml/min and discard the rinse.

5.3.7. Elute the plutonium with four column volumes of 12 M HCl containing 1 ml of 1 M NH_4I per 30 ml of 12 M HCl at a flow rate no greater than 2 ml/min, and collect the rinse in a 100-ml beaker.

NOTE: Prepare fresh NH_4I in 12 M HCl solution before elution.

5.3.8. Rinse the column with 20 ml of 12 M HCl and save the rinse.

5.3.9. Evaporate the plutonium eluate of ∿80 ml to near dryness.

5.3.10. Add 20 ml of 16 M HNO_3 and evaporate to dryness.

5.3.11. Dissolve the residue from step 5.3.10 in 10 ml of 16 M HNO_3 and evaporate to dryness.

5.3.12. Dissolve the residue from step 5.3.11 in 40 ml of 8 M HNO_3 and repeat the preceding anion exchange separation, steps 5.3.1 through 5.3.11. (The volume of 8 M HNO_3 used in step 5.3.5 should be reduced to 60 ml.)

5.4. Electrodeposition

5.4.1. Dissolve the residue produced in paragraph 5.3.11 in 2 ml of 5% solution of $NaHSO_4 \cdot H_2O$ in 1 M H_2SO_4.

5.4.2. Add 5 ml of 16 M HNO_3, mix well, and evaporate to dryness. Cool to room temperature.

5.4.3. Dissolve the sample in 5 ml of the preadjusted electrolyte 1 M ammonium sulfate (warming to hasten the dissolution). Adjust to pH 2.0 with 1.5 M NH_4OH or 1.8 M H_2SO_4.

5.4.4. Transfer the sample to a prepared electrodeposition cell using 10-15 ml of electrolyte in small increments.

5.4.5. Place the platinum anode in the solution approximately 2 cm from the cathode (stainless steel disk).

5.4.6. Connect the electrodes to the power source and adjust the power supply to give a current of 1.2 ampere.

5.4.7. Continue electrodeposition for two hours.

5.4.8. Terminate electrodeposition by adding 1 ml of 15 M NH_4OH and continue the electrodeposition for one minute. Remove the anode while the power is still running.

5.4.9. Discard the solution from the cell and rinse the cell three times with 0.15 M NH_4OH.

5.4.10. Disassemble the cell and wash the slide with ethyl alcohol made basic with NH_4OH.

5.4.11. Dry the slide and place it in a labeled box for counting.

6. CALCULATIONS

6.1. Calculation of Plutonium Concentrations - The concentration of plutonium-238 or plutonium-239 in the aliquot of soil taken for analysis is given by

$$X_i = \frac{R_i \; A_t}{R_t \; W_s}$$

6.1. Continued

where: X_i = the concentration Pu-238 or Pu-239 in the soil in disintegrations per minute (dis/min) per gram,

R_i = the net sample counting rate in the Pu-238 or Pu-239 energy region of the alpha spectrum,

A_t = the activity of the Pu-242 tracer in dis/min,

R_t = the net sample counting rate in the Pu-242 tracer region of the alpha spectrum, and

W_s = the weight in grams of the soil taken for analysis.

6.2. Calculation of Plutonium Recovery of the Chemical Analysis - The plutonium recovery efficiency expressed as a percentage, E, is given by

$$E = \frac{R_t}{A_t\ e} \times 100\%$$

where: e = the absolute counting efficiency of the alpha pulse height analysis system,

and the other terms as defined in section 6.1.

7. REFERENCE

7.1. Norton Y. Chu, "Plutonium Determination in Soil by Leaching and Ion-Exchange Separation", Anal. Chem., 43:3, 449-452 (March 1971).

PROGRAM	SHEET	MANUAL NUMBER	OPERATION
ENVIRONMENTAL ANALYTICAL PROCEDURES	1 of 3	PD-80030	4613

AUTHORIZATION	CLASSIFICATION	EFFECTIVITY	ECN(S) INCORPORATED
[illegible]	Unclassified	5-1-79	None

MINIMUM ANALYSIS TIME	BIAS	PRECISION, 2σ	SUBMITTED BY
2 Hours/Sample	∿±4%	∿±8%	V. R. Casella and J. G. Fleissner

OPERATION TITLE: RADIUM-226 AND OTHER GAMMA EMITTERS IN COAL, COAL ASH, AND OTHER SOLID SAMPLES BY GAMMA SPECTROSCOPY

1. SCOPE

This procedure can be used for the determination of radium-226 or other gamma emitters in coal, coal ash, and other solid samples. In general, the accuracy of the method is better than ±10%, providing that counting statistic errors are relatively low.

2. SUMMARY

Samples to be analyzed are dried, if necessary, and packed into aluminum containers which are hermetically sealed to ensure that no radon-222 escapes. After aging for about three weeks, which is sufficient time for achieving secular equilibrium of the uranium-238 decay products, the sample is gamma counted using a Ge(Li) detector. The gamma spectrum is stripped to obtain the gamma peak areas and corresponding counting errors. After correcting these peak areas for counting efficiency (including gamma abundance and geometry) and self-absorption, the absolute disintegration rate of the sample is obtained.

3. SPECIAL APPARATUS

- Aluminum can body, 208 x 107 (93 cm^3): Central States Can Corporation, Massillon, Ohio
- Aluminum can lid, 209.5: Central States Can Corporation, Massillon, Ohio
- Automatic portable electric can sealer: Wisconsin Aluminum Foundry Co., Inc., Manitowac, Wisconsin, No. EL-12253-110V
- Gamma Spectroscopy System, 70 cm^3 Ge(Li), 4000 channel multi-channel analyzer system with on-line computer for gamma stripping: Canberra Scorpio System

4. REAGENTS

None

5. PROCEDURE

5.1. Weigh an aluminum can and pack this can with the dried sample (coal is ground to 60 mesh), putting as much sample into the can as possible without hampering closure of the lid.

5.2. Reweigh the can to obtain the sample weight and seal the lid with an automatic portable electric can sealer.

5.3. Allow to age for three weeks after sealing.

5.4. Count for an appropriate time, usually 50 000 or 200 000 seconds (overnight or over a weekend), using the gamma spectroscopy system and obtain a stripped spectrum.

6. CALCULATIONS

6.1. Calculate the Ra-226 (or other nuclide) concentration for each gamma peak as follows:

$$\text{Ra-226 (pCi/g)} = \left(\frac{C_p - C_b}{EFF \cdot T \cdot WT}\right) e^{(\mu_p \cdot \rho x)}$$

Where:

C_p = total absorption peak counts for a given time period

C_b = total absorption peak background counts for the same time period

WT = sample weight, g

EFF = empirically determined counting efficiency which corrects for sample geometry, detector efficiency, and gamma ray abundance for a sample of zero mass and for conversion of dis/min to pCi (photon/pCi)

μ_p = mass attentuation coefficient for sample at the given energy (cm^2/g)

ρ = density equal to weight of sample divided by volume (93 cm^3) of the aluminum can

x = average distance a gamma ray at the given energy travels through the sample (1.48 cm)

T = count time in seconds

6.2. Calculate the Ra-226 (or other nuclide) concentration from the weighted average of the concentrations determined from each gamma peak as follows:

6.2. Continued

$$\text{Ra-226 (pCi/g)} = \frac{\Sigma W_i X_i}{\Sigma W_i}$$

Where: $W_i = 1/\sigma_i^2$, where σ is the counting error for each peak as calculated from the gamma stripping code

X_i = the concentration of Ra-226 from each gamma peak

6.3. Calculate the standard deviation due to counting for the Ra-226 concentration given in step 6.2 as follows:

$$\sigma\,(\text{pCi/g}) = \sqrt{\frac{1}{\Sigma W_i}}$$

TABLE 1 - Attentuation Coefficients and Empirically Determined Efficiencies for Ge(Li) Detector PGT813 (the detector in use as of June 1979)

Nuclide	Peak Energy (KeV)	μ_p (cm^2/g)	EFF·10^{-4} (photon/pCi)	EFF·T (50 000 sec)	EFF·T (200 000 sec)
Ra-226	186	0.134	1.29	6.46	25.8
Ra-226	242	0.122	1.39	6.96	27.8
Ra-226	296	0.107	2.25	11.30	45.1
Ra-226	352	0.0998	3.56	17.80	71.3
Ra-226	609	0.0794	2.14	10.70	42.7
Th-228	239	0.116	6.83	34.3	137
Th-228	583	0.0811	1.48	7.38	29.5
Ra-228	338	0.101	1.17	5.87	23.5
Ra-228	911	0.0666	0.926	4.63	18.5

7. REFERENCE

7.1. C. V. Gogolak and K. M. Miller, New Developments in Field Gamma-Ray Spectrometry, Environmental Measurements Laboratory Report, EML-332, December 1977.

PROGRAM	SHEET	MANUAL NUMBER	OPERATION
ENVIRONMENTAL ANALYTICAL PROCEDURES	1 of 10	PD-80030	3605

AUTHORIZATION	CLASSIFICATION	EFFECTIVITY	ECNISI INCORPORATED
	Unclassified	1-1-79	None

MINIMUM ANALYSIS TIME	BIAS	PRECISION, 2σ	SUBMITTED BY
32 Hours/4 Samples	∿±3%	∿±6%	V.R.Casella, A.A.Glosby, C. A. Phillips and C. T. Bishop

OPERATION TITLE: URANIUM, THORIUM, AND LEAD-210 IN COAL AND OTHER SOLID ENVIRONMENTAL SAMPLES

1. SCOPE

This procedure is used for the determination of uranium and thorium isotopes, and lead-210 in solid environmental samples. It is applicable to 10-gram soil samples, but, for samples which have a great deal of carbon (for example, coal or vegetation), 1-gram samples of ash should be used. If only uranium and lead-210 are measured, larger samples may by analyzed.

In general, levels greater than 0.1 dis/min/g of these radioactivities can be detected, and chemical yields for uranium, lead, and thorium are generally 70-90%, 80-95%, and 50-80%, respectively.

2. SUMMARY

Uranium-232, thorium-229, and stable lead tracers are added to representative soil, coal, vegetation, or other environmental samples to evaluate the recoveries of the analyses. The samples are decomposed by ashing, followed by a nitric acid-hydrofluoric acid digestion. The radioactivities to be measured are coprecipitated with iron hydroxide. Since large amounts of iron interfere with subsequent ion exchange separations, the iron hydroxide precipitate is dissolved in hydrochloric acid and an isopropyl ether extraction is used to remove most of the iron. This hydrochloric acid solution is passed through an anion exchange column which adsorbs the uranium, while the thorium and lead-210 pass through. Plutonium(IV) and any unextracted iron(III), which are also adsorbed by the column, are eluted after reduction with hydrogen iodide. The uranium is then removed from the column with 1.0 M HCl and electrodeposited onto a stainless steel slide for measurement by alpha spectrometry.

The effluent from the anion exchange separation, containing the lead-210 and thorium, is adjusted to 1.5 M HCl and passed through another anion

2. Continued

exchange column. Lead-210 is adsorbed onto the column while the thorium remains in the sample solution. After elution of the lead-210 with distilled water and 8 M HCl, the lead-210 is measured by beta-counting of the bismuth-210 daughter ingrowth.

Thorium is coprecipitated from the 1.5 M HCL effluent of the previous separation with lanthanum fluoride and isolated and purified by a third ion exchange column. The thorium is electrodeposited onto stainless steel slides and measured by alpha spectrometry.

3. SPECIAL APPARATUS

- Alpha pulse height analysis counting system
- Beta counter with low background for low level measurements
- Centrifuge, capable of handling 250-mL centrifuge bottles, Model K: Damon/IEC Division
- Centrifuge bottles, 250 mL
- Electrodeposition apparatus
- Heat lamps, mounted on a ring stand for drying slides
- Ion exchange columns, approximately 1.3 cm ID, 15 cm long, with 100-mL reservoir
- pH paper, pH range 2 to 10
- Stainless steel slides, 1.91-cm (0.75-inch) diameter by 0.05-cm (0.02-inch) thick, and 4.76-cm (1.875-inch) diameter by 0.067-cm (0.026-inch) thick
- Teflon beaker, 250 mL

4. REAGENTS

NOTE: The preparation and standardization of reagents will be found in Appendix A of this manual.

- Ammonium hydroxide (NH_4OH), concentrated (15 M), 1.5 M, 0.15 M
- Ammonium sulfate ($(NH_4)_2SO_4$), 1 M
- Anion exchange resin, BioRad AG1-X8, 100-200 mesh, chloride or nitrate form: Bio Rad Laboratories, Third and Griffin Avenues, Richmond, California 94804
- Boric acid (H_3BO_3), saturated solution of H_3BO_3 in 4 M HNO_3

4. Continued

- Electrolyte, preadjusted (1 M $(NH_4)_2SO_4$ adjusted to pH 3.5 with 1.5 M NH_4OH and 1.8 M H_2SO_4)
- Ethyl alcohol, made basic with a few drops of 15 M NH_4OH per 100 mL of alcohol
- Ferric chloride ($FeCl_3$) in 0.5 M HCl to give 50 mg iron per mL of solution
- Hydrochloric acid (HCl), concentrated (12 M), 8 M, 6 M, 1 M, 0.1 M
- Hydrofluoric acid (HF), concentrated (48% or 29 M)
- Hydriodic acid (HI), concentrated (48% or 6 M)
- Isopropyl ether
- Lanthanum chloride ($LaCl_3$) in water to give 10 mg lanthanum per mL of solution
- Lead nitrate ($Pb(NO_3)_2$)
- Nitric acid (HNO_3), concentrated (16 M), 12 M
- Sodium hydrogen sulfate ($NaHSO_4$), ∿5% in 1 M H_2SO_4
- Sulfuric acid (H_2SO_4), concentrated (18 M), 1.8 M
- Thorium-229 solution, standardized by 2π counting or liquid scintillation counting of a freshly purified solution of thorium-229, and an alpha pulse height analysis of an electrodeposited sample of the tracer solution to measure the percent of thorium-228 present
- Thymol blue indicator, sodium salt, 0.04% solution: Fisher Scientific
- Uranium-232 solution, standardized by 2π counting of a freshly purified sample of urnaium-232 or by electroplating the uranium-232 with a known amount of another standard solution, such as uranium-236

5. PROCEDURE

5.1. SAMPLE DECOMPOSITION

5.1.1. Weigh 1 to 10 grams of representative sample and transfer it to a casserole.

5.1.2. Add 25 mg of $Pb(NO_3)_2$ and ∿10 dis/min of U-232 and ∿10 dis/min of Th-229 tracer solutions.

5.1.3. Heat the casserole containing the coal sample at 500°C overnight in a muffle furnace. Remove and cool.

5.1.4. Transfer the sample to a 250-mL Teflon beaker, rinsing the casserole with 10-mL portions of 16 M HNO_3 to a final volume of 60 mL.

CAUTION

HF is very hazardous. Perform this work in a fumehood and wear rubber gloves, safety glasses or goggles, and a laboratory coat. Avoid breathing HF fumes. Clean up all spills and wash thoroughly after using HF.

5.1.5. Add 30 mL of 48% HF, cover with a Teflon watchglass, and heat on a magnetic hotplate for one hour while stirring continuously with a Teflon-coated stirring bar. Remove from the hotplate and cool.

5.1.6. Add 30 mL each of 16 M HNO_3 and 48% HF and digest while stirring for an additional hour. Remove from the hotplate and cool to room temperature.

5.1.7. Add 20 mL of 12 M HCl and heat on a hotplate while stirring, until the solution has evaporated to a volume of about 30 mL.

5.1.8. Add 50 mL of distilled water and digest on a hotplate while stirring for 10 minutes to dissolve the soluble salts.

5.1.9. Cool and transfer the total sample into a 250-mL centrifuge bottle with a minimum of distilled water from a wash bottle.

5.1.10. If any insoluble residue is present, centrifuge the sample and transfer the supernate into another centrifuge bottle.

5.1.11. Wash the residue with 10 mL of 0.1 M HCl and add it to the supernate. Discard the insoluble residue and proceed to section 5.2.

5.2. COPRECIPITATION

5.2.1. Add 20 mg of iron as $FeCl_3$ in 0.5 M HCl to the centrifuge bottle and stir. (This step is not necessary for samples containing iron.)

5.2.2. Add 15 mL NH_4OH (carbonate free) while stirring to precipitate the iron. Continue adding 15 M NH_4OH to raise the pH to 9-10 as determined by pH paper.

5.2.3. Centrifuge for about five minutes, decant, and discard the supernate.

5.2.4. Dissolve the precipitate in 8 M HCl to a volume of about 50 mL. Proceed to section 5.3.

5.3. ETHER EXTRACTION

5.3.1. Transfer the solution to a 250-mL separatory funnel using two 5-mL rinses of 8 M HCl.

5.3.2. Add 60 mL of isopropyl ether to the separatory funnel and shake the solution for two minutes. Allow the phases to separate and then transfer the aqueous (lower) phase to a second separatory funnel.

5.3.3. Repeat step 5.3.2. (The bulk of iron is removed as evidenced by the appearance of a yellow color in the organic phase. If the sample has a very high concentration of iron, additional extractions may be necessary.)

5.3.4. Transfer the aqueous phase to a 150-mL beaker and boil for 15 minutes.

5.3.5. Add 20 mL of 12 M HCl to this solution and proceed to section 5.4.

5.4. ANION EXCHANGE SEPARATION OF URANIUM

5.4.1. Prepare an anion exchange column of BioRad AG1-X8 (100-200 mesh), height 8 cm, and inside diameter 1.3 cm, and condition the resin by rinsing the column with 60 mL of 8 M HCl. Discard the rinse.

5.4.2. Transfer the sample from step 5.3.5 to the conditioned anion exchange resin.

5.4.3. Rinse the column with three column volumes of 8 M HCl.

5.4.4. Evaporate this effluent, containing the lead and thorium, to about 20 mL and save for section 5.5.

5.4.5. Elute any remaining iron from the column with six column volumes of 6 M HCl containing one mL of concentrated HI per 50 mL of 6 M HCl (freshly prepared).

5.4.6. Rinse the column with an additional two column volumes of 6 M HCl.

5.4.7. Elute the uranium with six column volumes of 1 M HCl.

5.4.8. Evaporate the sample to about 20 mL and add 5 mL of 16 M HNO_3.

5.4.9. Evaporate the sample to near dryness and proceed to section 5.8.

5.5. ANION EXCHANGE SEPARATION OF LEAD

5.5.1. Adjust the molarity of the effluent from step 5.4.4 to about 1.5 M HCl by adding an amount of distilled water equal to three times the volume of this effluent. (If the effluent volume is 20 mL, add 60 mL of distilled water, for a total volume of 80 mL.)

5.5.2. Prepare an anion exchange column of BioRad AG1-X8 (100-200 mesh), height 8 cm, and inside diameter 1.4 cm, and rinse the column with three column volumes of 1.5 M HCl.

5.5.3. Transfer the sample to the anion exchange resin column and allow to pass through the column at a flow rate of about one mL/minute.

5.5.4. Rinse the column with additional 1.5 M HCl at a flow rate of ∿1 mL/minute, collecting a total volume of 100 mL (sample + 1.5 M HCl).

5.5.5. Check the effluent to verify the absence of lead using atomic absorption and save for section 5.6.

5.5.6. Elute the lead with 50 mL of distilled water and then with 50 mL of 8 M HCl. Note the time of separation.

5.5.7. Determine the lead recovery by atomic absorption spectroscopy and proceed to section 5.9.

5.6. LANTHANUM FLUORIDE PRECIPITATION OF THORIUM

5.6.1. Transfer the effluent from step 5.5.5 into a 200-mL centrifuge bottle and add 1 mL of a 10 mg/mL La^{3+} solution.

5.6.2. Add five mL of 29 M HF to form a lanthanum fluoride precipitate.

5.6.3. Centrifuge for about five minutes, decant, and discard the supernate.

5.6.4. Dissolve this precipitate in a minimum (5-10 mL) of 4 M HNO_3 saturated with boric acid.

5.6.5. Add 25 mL distilled water and make basic with 15 M NH_4OH until a precipitate is formed.

5.6.6. Centrifuge, discard the supernate, and wash the precipitate with 10 mL of 0.1 M NH_4OH.

5.6.7. Dissolve the precipitate in a minimum (1-2 mL) of 16 M HNO_3 and add 20 mL of 12 M HNO_3.

5.7. ANION EXCHANGE SEPARATION OF THORIUM

5.7.1. Prepare an anion exchange column of BioRad AG1-X8 (100-200 mesh), height 4 cm, and inside diameter 1.3 cm, and convert to the nitrate form by passing 10 column volumes of 12 M HNO_3 through the column.

5.7.2. Pass the sample solution from step 5.6.6 through the anion exchange column at a flow rate no greater than four mL/minute.

5.7.3. Rinse the column with about 100 mL of 12 M HNO_3, again at a flow rate no greater than four mL/minute, and discard the effluent.

5.7.4. Elute the thorium from the column with 80 mL of 8 M HCl at a flow rate no greater than two mL/minute.

5.7.5. Evaporate the sample to about 20 mL and add 10 mL of 16 M HNO_3.

5.7.6. Evaporate the sample to near dryness and proceed to section 5.8.

5.8. ELECTRODEPOSITION

5.8.1. Add two mL of a 5% solution of $NaHSO_4 \cdot H_2O$ in 1 M H_2SO_4 to the sample containing the isotope to be electrodeposited.

5.8.2. Add five mL of 16 M HNO_3, mix well and evaporate to dryness, but do not bake. Cool to room temperature.

5.8.3. Dissolve the sample in five mL of the preadjusted electrolyte (adjusted to pH 3.5) warming to hasten the dissolution.

5.8.4. Transfer the solution to the electrodeposition cell using an additional 5-10 mL of the electrolyte in small increments to rinse the sample container.

5.8.5. Add three or four drops of Thymol blue indicator solution. If the color is not salmon pink, add 1.8 M H_2SO_4 (or 1.5 M NH_4OH) until this color is obtained.

5.8.6. Place the platinum anode into the solution so that it is about one cm above the stainless steel slide which serves as the cathode.

5.8.7. Connect the electrodes to the source of current, turn on the power, and adjust the power supply to give a current of 1.2 A. (Constant current power supplies will require no further adjustments during the electrodeposition.)

5.8.8. Continue the electrodeposition for a total of one hour for uranium or two hours for thorium.

5.8.9. When the electrodeposition is to be terminated, add one mL of 15 M NH_4OH and continue the electrodeposition for one minute.

5.8.10. Remove the anode from the cell and then turn off the power.

5.8.11. Discard the solution in the cell and rinse the cell two or three times with 0.15 M NH_4OH.

5.8.12. Disassemble the cell and wash the slide with ethyl alcohol that has been made basic with NH_4OH.

5.8.13. Touch the edge of the slide with a tissue to absorb the alcohol from the slide.

5.8.14. Dry the slide, place it in a box, and label for counting.

NOTE: Slides for uranium analysis should be counted within a week after separation, while slides for thorium analysis should be counted the same day that the samples are removed from the column.

5.9. BETA COUNTING OF LEAD-210

5.9.1. Evaporate the sample from step 5.5.7, containing the lead, to about 10 mL.

5.9.2. Add 10 mL of 16 M HNO_3 and evaporate to dryness.

5.9.3. Dissolve the residue in about three mL of 0.1 M HNO_3. Heating may be necessary.

5.9.4. Transfer this solution to a stainless steel slide and dry the slide.

5.9.5. Rinse the beaker with an additional three mL of 0.1 M HNO_3 and add to the slide and dry.

5.9.6. Cover the slide with an appropriate thickness ($\sim$5 mg/cm^2) of aluminum foil to degrade any alpha and low-energy beta activities and count the 1.6 MeV beta activity from the ingrowth of bismuth-210.

6. CALCULATIONS

6.1. CALCULATION OF URANIUM OR THORIUM

The concentration, X_i, in dis/min/g of a particular uranium or thorium isotope (except Th-228) in the sample is given by

$$X_i = \frac{R_i \times A_t}{R_t \times W}$$

where: R_i = the net counting rate in the energy region of the alpha spectrum resulting from the uranium or thorium isotope being measured

A_t = the activity of the added Th=229 or U-232 tracer in dis/min

R_t = the net sample counting rate in the Th-229 or U-232 tracer energy region of the alpha spectrum

W = sample weight in grams.

6.2. CALCULATION OF THE THORIUM-228 CONCENTRATION

The concentration of thorium-228, X_i(Th-228), in dis/min/g is given by

$$X_i(\text{Th-228}) = \frac{(R_i - YR_t) \times A_t}{R_t \times W} - ZA_{232}$$

where Y = the Th-228/Th-229 activity ratio for the Th-229 tracer

Z = the Th-228/U-232 activity ratio for the U-232 tracer

A_{232} = the activity of the added U-232 tracer in dis/min

Other terms as defined in section 6.1.

6.3. CALCULATION OF TRACER RECOVERY OF THE CHEMICAL ANALYSIS

The tracer recovery efficiency expressed as a percent, E, is given by

$$E = \frac{R_t \times 100}{A_t \times e}$$

where e = the absolute counting efficiency of the alpha pulse height analysis system

100 = factor to convert to percent

and the other terms as defined in step 6.1.

6.4. CALCULATION OF LEAD-210 CONCENTRATION

The concentration of lead-210, X_i(Pb-210), in dis/min/g is given by

$$X_i(\text{Pb-210}) = \frac{(R_s - R_b)}{e \times E \times W}$$

where R_s = the counting rate of the sample after equilibrium between Pb-210 and Bi-210 is achieved (counted after three weeks or determined from growth and decay analysis)

R_b = the counting rate due to counter background

e = the absolute counting efficiency of the beta counter

E = tracer recovery as determined by atomic absorption spectroscopy

W = sample weight in grams

7. REFERENCES

7.1. Kenneth W. Edwards, Isotopic Analysis of Uranium in Natural Waters by α-Spectrometry, U. S. Geological Survey Water Supply Paper 1969-F, U. S. Government Printing Office, Washington, D. C., 1968.

7.2. Walter M. Gibson, The Radiochemistry of Lead, USAEC Report NAS-NS 3040, 1961.

7.3. Johann Korkisch, Modern Methods for the Separation of Rarer Metal Ions, Pergamon Press, New York, 1969.

1. SCOPE

This procedure is applicable to urine samples containing trace quantities of tritium oxide. The procedure uses 3 mL of sample and can detect a minimum concentration of 0.01 μCi/L based on a constant counting efficiency, constant background rate, and a constant counting time, which are all specified in this method. Greater sensitivity can be achieved by increasing the sample size and counting time.

2. A 3-mL aliquot of a urine sample is delivered to a bar-coded 20-mL polyethylene counting vial containing a measured volume of scintillation solution.

The samples are counted in a liquid scintillation spectrometer which measures the beta radiation from the tritium. To determine the counting efficiency, the scintillation counter also counts the samples in the presence of an external standard, radium-226. From the external standard count, some type of Quench Indicating Parameter (QIP), such as a Spectral Index of the External Standard (SEI) number is obtained (see reference 7.4). This number is related to the efficiency of the liquid scintillation counting by the Quench Curve (see reference 7.3). The concentration of the tritium is finally printed out is units of μCi/L.

The spectrometer is interfaced with a personal computer and laser reader. The laser reader reads a sample number from the bar codes and then inputs this number to the computer. The computer receives counting data output from the spectrometer and then stores the data to generate a printed final report.

The minimum analysis time is 20 samples/1 hr.

3. SPECIAL APPARATUS

- o Bar code labels
- o Gloves, rubber
- o Laser Reader
- o Liquid Scintillation Spectrometer, Packard Model 4530, 460CD, 2000 CA, or equivalent
- o Pen, felt-tipped marking
- o Personal Computer, IBM XT
- o Pipet tip, disposable, polypropylene, 5 mL; Stock No. 01-2485
- o Pipeter, Eppendorf or equivalent, 1000 λ, and Oxford Laboratories 0-5 mL.
- o Repipet dispenser; Lab Industries
- o Vial holder, cardboard, Packard Servo-Tray or cassette
- o Vial, polyethylene with cap, 20 mL, Packard Instrument Company, or equivalent; Stock No. 01-4790.

4. REAGENTS

- * o Tritium water standard, certified by NBS
- o Scintillation solution, Atomlight, New England Nuclear

5. PROCEDURE

5.1. The technician responsible for analyzing tritium in urine will pick up bar coded urine samples at collection points specified by Health Physics in T and SW buildings.

5.2. Put on rubber gloves before handling urine samples.

5.3. If the individual submitting the urine sample has received a radioisotope for medical diagnostic purposes, then the sample must be distilled as follows:

5.3.1. Deliver about 40 mL of the urine to a distillation apparatus.

5.3.2. Distill about 10 mL of the sample, discarding the first 5 mL of distillate.

5.3.3. Pipet 3 mL of the remaining distillation into a 20-mL counting vial.

5.3.4. Proceed with step 5.4.

5.4. Arrange the samples into row of 10 samples per row.

5.5. Pipet a 3-mL aliquot from each urine sample to a 20-mL counting vial.

5.6. Deliver 10 mL of prepared scintillation solution into the 20-mL vial.

5.7. Place the lids on the vials and then wipe the vials clean with Kimwipes to remove residual solution from the vials.

5.8. Transfer the bar code label from the lid of the sample container to the top of the 20-mL counting vial.

*5.9. Transfer the 20-mL vials to the cassette containing the appropriate program chip (#15 with the dot set at 1 for one count) for the Liquid Scintillation Spectrometer. The first sample loaded into the first cassette must be a background sample. Place a bar code label on this background counting vial. This vial contains 10 mL of counting solution only. In addition, two bar coded standard samples (Spike-1 and Spike-2) are included in each sample run. They are prepared by adding 1 mL of tritium standard, 2 mL of urine and 10 mL of scintillation solution. One is placed after the background sample, the other is placed after the bar code samples.

* 5.10. Load all samples which do not contain bar codes into the cassette after the second standard sample. For Mound employees without bar codes, mark their HP numbers on top of the counting vial. For Mound visitors, use the full name and social security number of the individual submitting the urine sample.

5.11. Start the counting sequence as follows:

5.11.1. Set the Data Director to "Bar Code".

5.11.2. Turn on the Master Switch. This loads the system and menu appears.

5.11.3. Select P-Base by pressing "P". The monitor will direct the following:

5.11.3.1. Input the total number of samples with the laser by scanning the appropriate bar codes.

5.11.3.2. Scan the "OK" bar code with the laser.

5.11.4. Scan all bar coded samples in the cassette in the same order that they will be counted in the Liquid Scintillation Spectrometer. For samples which do not contain bar codes, scan the work KEYBOARD with the laser reader and then input the I.D. through the computer keyboard. Press RETURN to enter input data. These samples always follow the samples which have bar codes.

5.11.5. Scan the "OK" bar code with the laser.

5.11.6. Change the Data Director to "Tri-Carb".

5.11.7. Press any key to continue.

5.12. Count the samples as follows:

5.12.1. Load the cassettes containing bar coded counting vials into the Liquid Scintillation Spectrometer in the order in which they were scanned with the laser.

5.12.2. Start sample counting by simultaneously pressing the FORWARD and ENABLE buttons on the liquid scintillation counter.

5.12.3. Count each urine sample for one minute.

5.12.4. After the samples have been counted, the monitor will prompt: ALL SAMPLES HAVE BEEN TESTED.

5.13. After counting, generate a printed report as follows:

5.13.1. Change the Data Director switch to "Bar Code".

5.13.2. Press any key to return to the menu. After about two minutes, the data will be printed as a daily report.

5.13.3. The monitor will display IS IT OK TO ADD THIS DAILY REPORT TO WEEKLY REPORT (Y/N)? Review the printout to ensure that the value for the spike #1 and #2, measured in μCi/L, is within -25% to +50% of the reference value for accuracy. The precision of measuring the spikes should be 40%. If accuracy (bias) or precision do not meet the above criteria, the standards, equipment, and pipets should be checked for calibration, proper functions, and malfunction of the liquid scintillation counter.

5.13.4. Press Y for yes and data will be

- o Stored historically
- o Added to the Weekly Report (printed every Friday), and
- * o Added to the Quarterly or Monthly Report.

* 5.13.5. Upon completion, the menu will be displayed. Place the daily printout (hard copy) in a bound binder notebook to be maintained as permanent records.

* 5.13.6. On Friday or the last working day of the week, print the weekly report. The menu will display "1 PRINT WEEKLY REPORT". Either enter the #1 or bring cursor down to 1 and press RETURN. The weekly report will then be printed.

6. CALCULATIONS

6.1. Calculate the tritium concentration, T, in μCi/L as follows:

$$T = \frac{(C-C_b) \times 1000 \text{ mL/L}}{E \times 2.22 \times 10^6 \times V}$$

where C = gross counts/min

C_b = background in counts/min

E = efficiency of the counter based on the predetermined quench curve (see Reference 7.3)

V = sample volume in mL

2.22×10^6 = factor to convert dis/min to μCi

NOTE: Data from duplicate analyses are evaluated every week to calculate the precision of the method. The lower detection limit is evaluated weekly from daily background measurements.

7. REFERENCES

7.1. Frank E. Bulter, "Determination of Tritium in Water and Urine: Liquid Scintillation Counting and Rate of Drift Determination", Anal. Chem., 33:3, p. 409-414 (March 1961).

7.2. Donald L. Horrocks, Application of Liquid Scintillation Counting, Academic Press, NY, 1964.

7.3. "Tritium Quench Curve Determination", Operation 2208, Technical Manual PD-80030, Environmental Analytical Procedures, Mound Facility, Miamisburg, Ohio, 1981

7.4. Tri-Carb 4000 Series Systems, Auto-Gamma 5000 Series Systems, Service Manual (Liquid Scintillation Counter Manual), Publication No. 169-3009, Packard Instrument Co., Downers Grove, Illinois, 1983.

MOUND

Inter-Office Correspondence

From : C. T. Bishop

Date : June 14, 1984

Subject : Analytical Results - Site Survey Soils

Reference :

cc : C. S. Friedman
L. C. Hopkins
A. A. Glosby
C. A. Phillips

TO : Bob Stought

By analyzing blanks, duplicates and standards, the Environmental Section is obtaining data on the determination of plutonium-238 and thorium isotopes in site survey and WTS soils regarding lower detection limits and experimental errors. The purpose of this correspondence is to give you some estimates based on data accumulated through the end of May, 1984. Final data will be given to you before you prepare your final report.

The lower detection limit (LDL) for the determination of plutonium-238 in soil is estimated to be 0.01 pCi/g; for the determination of one of the thorium isotopes the LDL is estimated to be 0.2 pCi/g. LDL's were calculated by taking 4.65 times the standard deviation of the blank value.

The precision (two times the standard deviation calculated from duplicates measurements) of the plutonium-238 in soil measurements is about 18%. For thorium in soil this precision is about 25%.

If you have any questions, give me a call.

Carl T. Bishop

Carl T. Bishop

CTB:km

MOUND

Inter-Office Correspondence

From C. T. Bishop

cc C. S. Friedman
A. A. Glosby
C. A. Phillips
L. C. Hopkins

Date September 17, 1985

Subject Analytical Results - Site Survey Soils

Reference June 14, 1984 Memo C. T. Bishop to R. L. Stought

TO Bob Stought

Since June of last year, additional data has been accumulated to evaluate lower detection limits (LDL) and precisions of the radiochemical analysis procedures used to determine plutonium-238 and thorium-228, -230, -232 in Site Survey soil samples. The additional data generally confirm the values reported to you on June 14, 1984.

The following data summarize our best estimates of our lower detection limits and precisions for the chemical analysis of Site Survey soil samples during 1984 and 1985..

Radionuclide	LDL	Relative Precision (Two standard deviations)
Plutonium-238	0.01 pCi/g	25%
Thorium-228	0.3 pCi/g	60%
Thorium-230	0.3 pCi/g	30%
Thorium-232	0.1 pCi/g	70%

In a number of samples where duplicates were analyzed for plutonium, there was disagreement between the results that was considerably greater than 25%. It is believed that these disagreements occurred because ofthe presence of a "hot-particle in one sample and not the other. This problem occurred more frequently at plutonium-238 concentrations greater than 10 pCi/g.

In view of these lower detection limits and precisions, data entries in the final report should be limited as follows. A result for plutonium-238 should contain no more than two places behind the decimal point and no more than three significant figures. For example, present plutonium-238 entries listed as 12.22 pCi/g and 355.00 pCi/g should be listed as 12.2 pCi/g and 355 pCi/g, respectively. A result for thorium should contain no more than one place behind the decimal point, and no more than two significant figures. For example, present thorium entries listed as 41.63 pCi/g and 5.14 pCi/g should be reported as 42 pCi/g and 5.1 pCi/g, respectively.

Carl T. Bishop

Carl T. Bishop
Supervisor
Environmental Evaluation

CTB:km

MOUND

Inter-Office Correspondence

From : Environmental Section

cc A. A. Glosby
C. A. Phillips

Date : November 30, 1984

Subject : Thorium Measurements

Reference : Site Survey Program

TO : Bob Stought

In order to evaluate the quality of our radiochemical thorium results, several samples were analyzed by gamma spectrometry. Gamma counting gives a concentration for Th-228 which may be compared to the radiochemical value. Results are given in the attached table.

Agreement between radiochemistry and gamma counting was generally good with a 14% average deviation between the two values. For the three samples where the deviation between radiochemistry and gamma spectrometry was greater than 25%, this deviation may be due to sample inhomogeneity. In gamma counting approximately 100 grams of soil are counted, whereas in the radiochemical analysis only a one-half gram sample is analyzed.

In summary, we believe our acid dissolution procedure gives good thorium results when analyzing thorium contaminated soils.

Carl T. Bishop

Carl T. Bishop

Vito R. Casella

Vito R. Casella

/km
Enc.

COMPARISON OF RADIOCHEMICAL AND GAMMA
SPECTROMETRY THORIUM ANALYSIS OF SITE SURVEY SAMPLES

Sample ID	Measured Thorium Concentration			Th-228 Ratio (Radiochem/Gamma)
	Radiochemical		Gamma Spec.	
	Th-232 (pCi/g)*	Th-228 (pCi/g)	Th-228 (pCi/g)	
2613	8.96	7.26	7.2 ± 0.3	1.01
6322	16.9	21.0	21 ± 1	1.00
6324	4.29	6.09	4.8 ± 0.3	1.27
6330	6.32	5.85	6.4 ± 0.4	0.91
6331	34.6	37.6	41 ± 2	0.92
6333	3.69	3.90	3.6 ± 0.3	1.08
6334	61.9	53.5	84 ± 6	0.64
6335	51.6	48.4	38 ± 3	1.26

*If a radiochemical equilibrium exists, Th-232 and Th-228 concentrations would be the same.

3: Soil Screening of Samples

MOUND SCREENING FACILITY

Monsanto Mound established a soil screening facility in 1982 to provide rapid screening of soil samples contaminated with Pu-238. It was determined that the minimum detectable activity required was 25 pCi/g.

Monsanto Mound Decommissioning and Decontamination activities often involve cleanup of soil which may be contaminated with Pu-238, Thorium, or possibly other radionuclides. It is desired to rapidly detect 25 pCi/g of Pu-238 in soil; however, at this time no field instrumentation has this capability. Radiochemical analysis is time-consuming and costly. Therefore, a screening facility was established to support soil decontamination.

Upon review of literature and visitation of various other DOE contractor sites it was found that Los Alamos National Laboratory had established a soil screening facility with instrumentration which might be applicable at Mound. A Harsahw Model 201 Phoswich detector with Davidson Multichannel Analyzer was installed in the Mound screening facility with a detection capability of approximately 100 pCi/g. It was determined that only by increasing the count time to a number of hours could a detection capability of 25 pCi/g be achieved. Another system that showed promise was a 5-inch diameter mylar alpha scintillation detector coupled to a Ludlum Model 2000 Scaler. Although this system appears suitable for use with sandy soil, the shale and clay type soils found in southwestern Ohio presented unacceptable matrix effects problems.

Because neither of these systems provided exactly the required capabilities, a system consisting of a a Bicron Corporation five-inch diameter, one-sixteenth inch thick NaI (Tl) detector coupled to a Davidson Multichannel Analyzer has been assembled. It provides the necessary detection limit with a 400 second count time when the detector is housed in a graded shield to reduce background. With the gain setting which provides best resoltuion for the 17 kev Pu x-ray, the energy range over the spectrum is 10 kev to 100 kev. Therefore, the 60 kev gamma from Am-241, if present, is easily distinguishable from the Pu x-ray. Thorium, whose daughters have a complex 88 kev x-ray, can also be detected with this sytem. Large concentrations of Am-241 or Thorium, greater than 100 pCi/g do interfere with concentrations of Pu-238 less than 100 pCi/g; however, this has not presented significant problems at Mound.

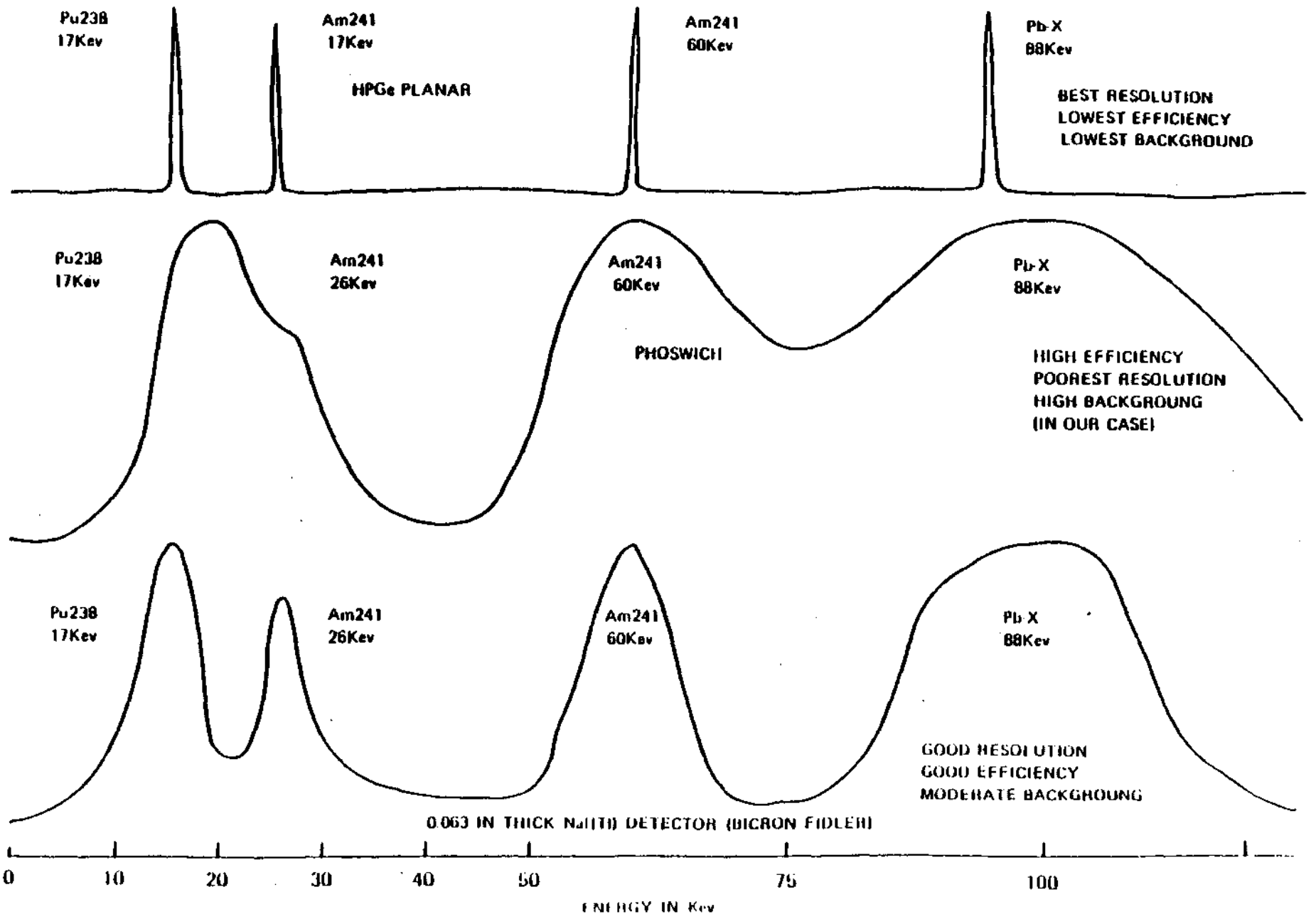
Standard soil samples prepared with various concentrations of Pu-238 solution indicate a minimum detectable activity of 12 pCi/g ± 50%. Approximately 900 samples were screened in the

facility for Pu-238, then analyzed by radiochemistry. The results indicated that a Type I error, that is, activity greater than 25 pCi/g is present when the screening facility says it is not, was approximately 1%. A Type II error, that is, the screening facility reports that activity is greater than 25 pCi/g when it is not, occurs about 30% of the time.

Screening facility reports less than 25 pCi/g	816
Radiochemistry reports less than 25 pCi/g	807
Radiochemistry reports greater than 25 pCi/g	9
Screening facility reports greater than 25 pCi/g	72
Radiochemistry reports greater than 25 pCi/g	50
Radiochemistry reports less than 25 pCi/g	22

Mound is currently evaluating new equipment that is expected to significantly reduce the interference that mixtures of radionuclides cause in the screening facility. A Canberra Reverse Electrode Hyperpure Germanium detector with portable multichannel analyzer has been purchased. This detector has a resolution of approximately 200 ev at 17 kev and an energy range from 5 kev to 1300 kev. Although resolution is much better, counting times are expected to increase significantly. Therefore, this system will be used only when the Bicron/Davidson system indicates a mixture of isotopes is present.

COMPARISON OF LOW ENERGY GAMMA DETECTORS



PROCEDURE FOR MEASUREMENT OF PLUTONIUM AND THORIUM
IN SOIL SAMPLES USING THE BICRON DETECTOR

I. INITIAL SCREENING OF SAMPLE

1. Log soil sample contained in a 5-inch diameter polyethylene container in a log book or locate the sample to be scanned and remove from the storage rack.

2. Place the sample so that is is centered on top of the 5-inch diameter NaI detector contained in lead shielding. Place cover over the detector and count for 60 seconds with a scaler or 40 seconds with a multichannel analyzer.

3. Record the results for plutonium on channel 1 of the scaler or at about channels 85-184 of the Davidson 4106 multichannel analyzer (MCA) and for thorium on channel 2 of the scaler or at about channels 400-499 of the MCA. (Exact position of peaks on the MCA should be determined from plutonium and thorium standards.)

4. Based upon the efficiency of the count, if the amount of plutonium or thorium activity is greater than 1 nCi/g (800 counts above background in channel 1 or 2000 counts above background in channel 2) do not open the sample and place it on a shelf with "hot samples" and label appropriately. Recount the "hot samples" as described in Section IV.

5. If plutonium and thorium activities are less than 1 nCi/g, proceed with the drying procedure in Section II.

II. DRYING OF SOIL SAMPLES

1. Weigh the wet sample to the nearest gram.

2. Remove the cover and place the polyethylene dish on an 8-inch watch glass; cover the sample with a 2-liter beaker (inverted).

3. Put the sample in a microwave oven and dry for about 3 minutes. Check to see if the sample is dry; if it is not dry, continue heating in the microwave until the sample is dry.

4. Pour the water collected in the watch glass and beaker into a 25-ml liquid scintillation vial. After the vial is about half full, the rest of the water collected can be discarded appropriately.

5. Weigh the dry sample before pulverizing.

III. PULVERIZING OF THE SAMPLE

1. Crush the dried sample with a large mortar and pestal.

2. Pass the soil sample through a 9-mesh sieve.

3. Put the sample in the feed hopper of a Holmes Model 350 pulverizer with a 60-mesh screen in place.

4. Pulverize the sample and transfer to a 4-inch x 1-3/8-inch polyethylene container.

5. Weigh the sample and label for counting. (A sample size of at least 100 g is preferred for analysis.)

6. Pass about 50 grams of salt or low radioactivity soil through the pulverizer, open pulverizer door, clean the grinding assembly with a brush, and vacuum excess salt or soil so the grinder is clean for the next use.

IV. PLUTONIUM AND THORIUM MEASUREMENTS

1. Shake the sample container to make the soil of approximately uniform thickness in the container.

2. Place a plutonium standard container centered on top of a 5-inch diameter NaI detector, which is contained in a lead well, and cover the well top with shielding.

3. Accumulate a spectrum for at least 400 seconds and preferably 1000 seconds on a Davidson 4106 multichannel analyzer with a gain setting of approximately 2.2 (corresponding to an energy range of about 0-90 keV).

4. Set the region of interest for plutonium (about channel 85-184) recording counts, and repeat step 3 for two more standards storing each spectrum in consecutive 512 channel regions of the Davidson analyzer.

5. Repeat step 3 for a thorium standard and set the region of interest on the Davidson analyzer (about channel 400-499). Record the counts in the thorium and in the plutonium regions of interest.

6. Count a background sample and record the count in the plutonium and thorium regions of interest.

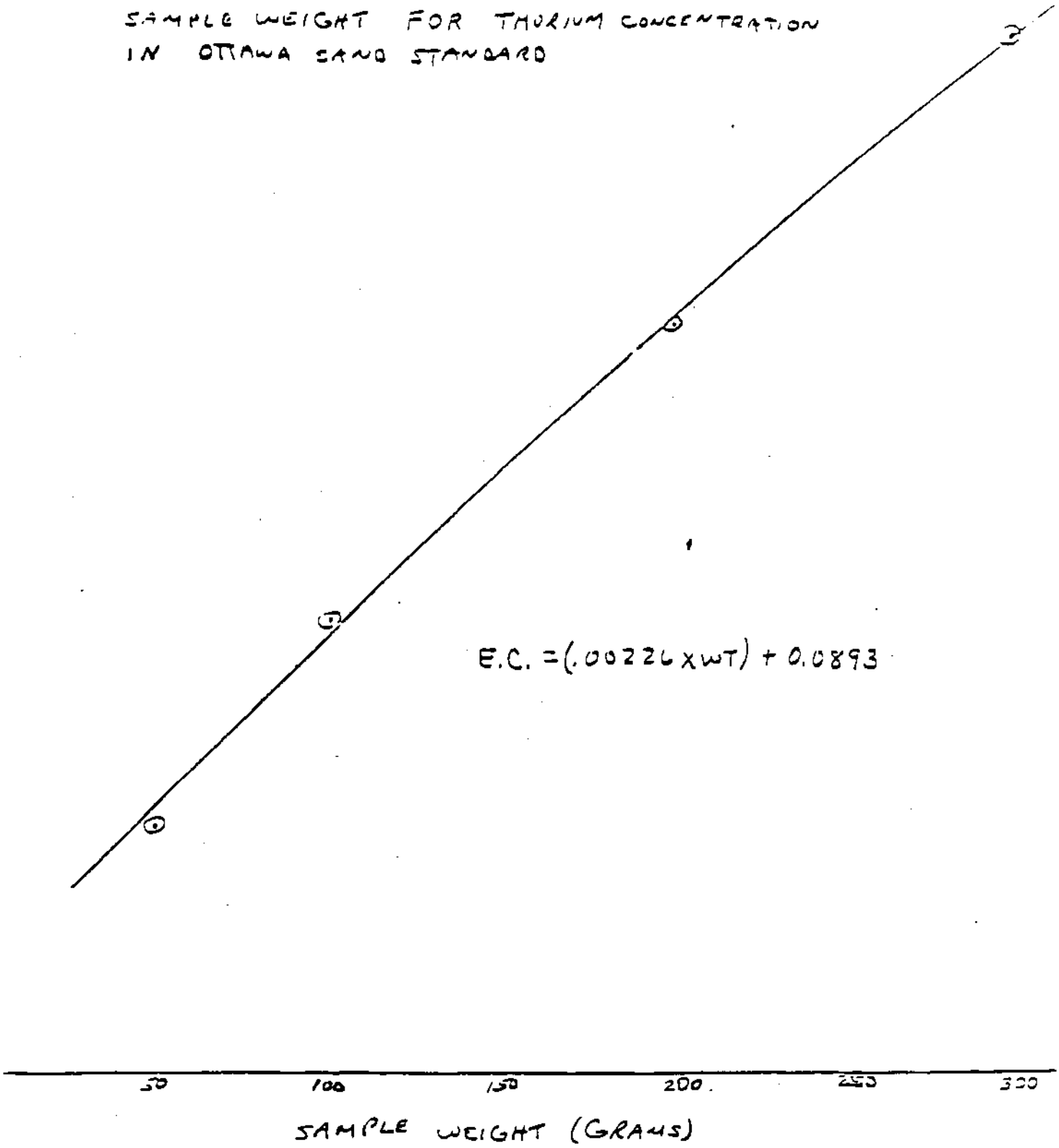
7. Calculate the plutonium and thorium efficiencies and thorium cross-over from the following equations:

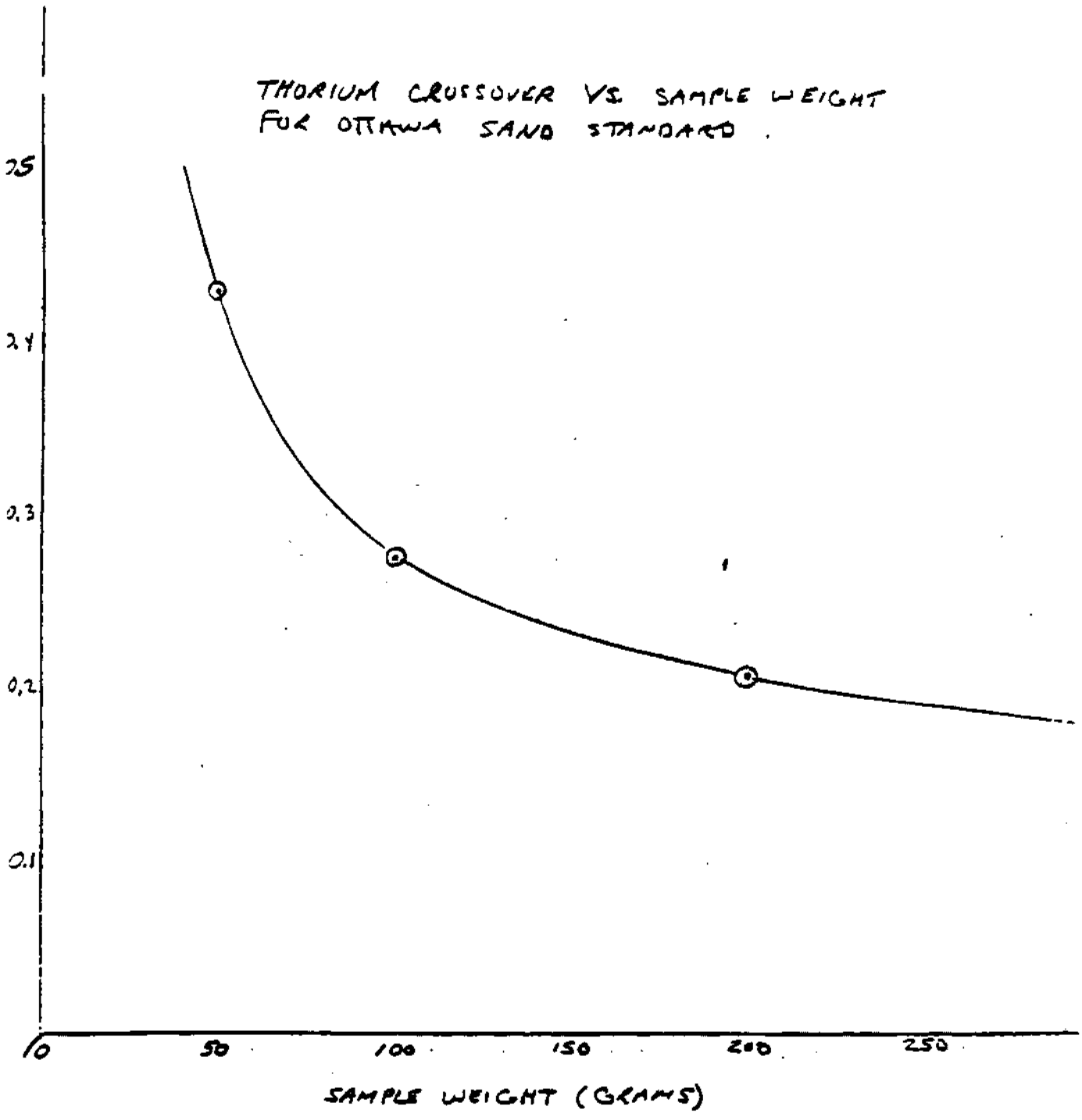
$$EFF(Pu) = \frac{C(PuROI) - B(PuROI)}{S(Pu) \times CT}$$

$$EFF(Th) = \frac{C(ThROI) - B(ThROI)}{S(Th) \times CT}$$

$$Th(CO) = \frac{C(PuROI) - B(PuROI)}{C(ThROI) - B(ThROI)}$$

EFFICIENCY CORRECTION VS.
SAMPLE WEIGHT FOR THORIUM CONCENTRATION
IN OTTAWA SAND STANDARD




THORIUM CROSSOVER VS. SAMPLE WEIGHT
FOR OTTAWA SAND STANDARD.
0.5
0.4
0.3
0.2
0.1
0
50
100
150
200
250
SAMPLE WEIGHT (GRAMS)

where: EFF(Pu) and EFF(Th) are plutonium and thorium efficiencies, respectively

C(PuROI) and C(ThROI) are counts in plutonium and thorium regions of interest, respectively

B(PuROI) and B(ThROI) are counts in a background soil at the plutonium and thorium regions of interest, respectively

S(Pu) and S(Th) are the concentrations of plutonium and thorium in pCi/g of each standard, respectively

CT is the count time of the standard

Th(CO) the thorium crossover is the amount of counts observed in the plutonium region of interest from the thorium standard and varies with sample weight (self-absorption)

8. Count at least 100 g of sample centered on the NaI detector and record the counts in the plutonium and thorium regions of interest.

9. Calculate the plutonium and thorium concentrations in the unknown soil as follows:

$$Pu(pCi/g) = \frac{[C(PuROI) - B(PuROI)] - [C(ThROI) \times Th(CO)]}{EFF(Pu) \times CT}$$

$$Th(pCi/g) = \frac{C(ThROI) - B(ThROI)}{EFF(Th) \times CT}$$

where Pu(pCi/g) and Th(pCi/g) are the concentrations of plutonium and thorium in pCi/g in the unknown soil. Other symbols are given in Step 6.

EC is the correction of the thorium efficiency due to different sample weights.

COMPARISON OF TRAILER-15 AND ENVIRONMENTAL SECTION RESULTS FOR PLUTONIUM-238 IN SOIL

With the increased emphasis a few years ago on the Site Survey and Waste Transfer System (WTS) programs, it became apparent that a great many soil samples would have to be analyzed for these programs. In order to accomplish this task, it became necessary to put a system in place for drying and grinding the soils, screening the soils for high level radioactivities, and subsequent radiochemical analysis of the soils for radionuclides of interest, usually plutonium or thorium. Equipment for drying, grinding, and screening the soils was set up in Trailer-15 (TR-15).

For screening the soils for plutonium or other radioactivities, a 5 x 0.063 in. NaI (Tl) (manufactured by Bicron) detector was used with a portable multi-channel analyzer. The 0.01 in. Be entrance window, along with the very large detector area, provided a highly efficient way of detecting plutonium L x-rays (17 keV) which resulted in very low detection levels (~ 12 pCi/g for Pu-238). Since the highest acceptable level of contamination for the WTS project was 25 pCi/g of plutonium-238, it was necessary to achieve a detection limit at, or preferably below, this level. Radiochemical analysis of soils by the Environmental Section (ES) provided data on the accuracy of the Tr-15 results.

Table 1. Comparison of Tr-15 and ES Pu-238 Results for the period of July-December 1984

	Number of Samples Analyzed				
Conc Range	<12 pCi/g	12-25 pCi/g	25-50 pCi/g	50-100 pCi/g	>100 pCi/g
Tr-15	818	607	50	29	12
ES	817 (99.9%)	594(<25pCi/g) (97.9%)	47(<50pCi/g) (94%)	27(<100pCi/g) (93%)	10

A comparison of the plutonium-238 results from Trailer-15 and those obtained by radiochemical analysis (ES) during July-December, 1984 is presented in Table 1. In this table are listed the number of samples found by Tr-15 to be within the concentration range given and the number of samples found by ES to be below the upper limit of this concentration range. There were 818 samples analyzed by Tr-15 to be less than 12 pCi/g, and ES found that 817 (99.9%) of these samples were less than 12 pCi/g. The one descrepancy was 17 pCi/g which was close to the detection limit. Of the 607 samples reported by Tr-15 to be between 12 and 25 pCi/g, ES found that 594 (97.9%) were less than 25 pCi/g. For 50 samples reported by Tr-15 to be in the range of 25-50 pCi/g and for 29 samples reported by Tr-15 to be in the range of 50-100 pCi/g, ES found that 93-94% of these samples were less than the upper limit of these ranges.

In general, this comparison of Tr-15 and ES results up to 100 pCi/g of plutonium-238 shows that Tr-15 has been an effective screening facility to determine the concentration range of plutonium-238 in soil and, more importantly, to establish that the concentration of plutonium-238 in a soil sample does not exceed a specific limit, such as 25 pCi/g for WTS samples. Results of Tr-15 may be higher than those of ES if photons from other radioactivities present in the soil are detected in the plutonium energy region of the multi-channel analyzer, or if a "hot particle" of plutonium is detected by the NaI(Tl) detector but not analyzed in the 0.5-5g samples taken from the sample container by ES. Since Tr-15 may obtain much higher values for plutonium than ES in these instances, a large difference in Tr-15 and ES results would indicate that a particular sample may need additional analysis for other radioactivities or that a "hot particle" may exist in the sample.

Also presented in Table I is a comparison of samples which Tr-15 found to be greater than 100 pCi/g. For 10 of 12 samples, ES also found that the plutonium-238 concentrations were greater than 100 pCi/g, and the higher Tr-15 plutonium-238 concentration for two of the samples compared to the ES analyses may be explained as previously discussed. Generally, the Tr-15 and ES plutonium-238 results for samples screened by Tr-15 to contain greater than 50 pCi/g agreed to within 25-30% of each other.

It was concluded from this data that WTS samples analyzed by Tr-15 to be less than 12 pCi/g fo plutonium-238 and site survey samples analyzed by Tr-15 to be greater than 100 pCi/g need not be analyzed by ES. (V. R. Casella - 3930)

MOUND

Inter-Office Correspondence

From: V. R. Casella, C. T. Bishop

Date: July 19, 1984

Subject: Estimated Error of Bicron Detector (Trailer 15) Pu-238 in Soil Measurements

Reference:

cc: C. S. Friedman
M. A. Whitney
D. S. Draper
H. E. Meyer
W. P. Davis
J. M. Garner

TO: Bob Stought

Considerable data has been accumulated on the determination of plutonium-238 in soil by using the Bicron detector in trailer-15, and by radiochemical analysis using an acid leach procedure. Based on comparisons of these data, the following statements can be made regarding the reliability of the Bicron detector data:

1. When the Bicron detector indicates a plutonium-238 value of less than 25 pCi/g, radiochemical measurements will also indicate less than 25 pCi/g in more than 95% of the measurements.

2. Total estimated error of the Bicron detector measurements in trailer-15 varies with the plutonium-238 concentration in the soil and is as follows:

Pu-238 Conc. Range (pCi/g)	Total Estimated Error*
12-25	± 75%
25-100	± 35%
> 100	± 30%

$$*\text{Error} = \frac{\sum_{i=1}^{n} \frac{Pu_{CHEM} - Pu_{BICRON}}{Pu_{CHEM}} \times 100\%}{n}$$

where Pu_{CHEM} = Pu-238 concentration in pCi/g as measured by radiochemistry

Pu_{BICRON} = Pu-238 concentration in pCi/g as measured by the Bicron detector

n = number of samples measured by both methods used to calculate error.

Based on these results it is recommended that the following samples be analyzed by radiochemical analysis:

1. WTS samples found by the Bicron detector to be > 12 pCi/g and < 50 pCi/g.

2. Site survey samples < 100 pCi/g.

As in the case of the estimated errors associated with radiochemical results, additional data will be accumulated as many additional soils are measured and the best estimates of the precision of the Bicron detector will be given to you before you prepare your final report.

If you have any questions at this time, give either one of us a call.

Vito Casella

Vito R. Casella

Carl T. Bishop

Carl T. Bishop

/km

PROGRAM	MANUAL NUMBER	SHEET	OPERATION	ISSUE
ENVIRONMENTAL ANALYTICAL PROCEDURES	PD-80030	1 of 10	1355	1

OPERATION TITLE	EFFECTIVITY DATE
Plutonium and Thorium in Soil Using the Bicron Detector (Soil Screening)	1-1-88

SUBMITTED BY	ECN(S) INCORPORATED
C. T. Bishop, D. G. Draper, J. Y. Jarvis, T. J. Pearson	890905MD-C

CLASSIFICATION	CLASSIFIER	SUPERVISOR	SECTION MANAGER
Unclassified		Carl T. Bishop	

1. SCOPE

This procedure is a rapid screening method for the measurement of plutonium and thorium in soil. It involves the measurement of x-rays or gamma rays from these two radioactive elements with a thin sodium iodide detector. Plutonium can be measured down to concentrations of about 25 pCi/g and thorium can be measured to about 5 pCi/g.

2. SUMMARY

Plutonium-238 (or -239) is measured by detecting the 17 keV plutonium x-ray with a 1/16-inch thick, 5-inch diameter NaI (Tl) detector manufactured by the Bicron Corporation. Thorium-232 is measured by counting lead x-rays at an energy of 88 keV. Soil samples are counted in disposable polyethylene containers 4 inches in diameter and 2-5/8 inches high.

Standards were prepared by adding known amounts of plutonium-238 or thorium-232 standard solutions to a soil that had been found to be free of these two isotopes. The counting system is calibrated on a monthly basis, but a standard is counted daily to evaluate the accuracy of the counting system, and to give assurance that the system is not out of calibration.

A multichannel analyzer is used to accumulate counts in the region of interest for both plutonium-238 or thorium-232. A sample is normally counted for 400 seconds, but can be counted for a longer or shorter period of time depending on the activity present in the sample being measured.

2. Continued

A computer program has been prepared to calculate the plutonium and thorium concentrations in picocuries per gram based on the sample counts and the data on the standards.

If a high plutonium concentration is observed, reliable thorium concentrations can also be observed. However, if the thorium concentration is high, the plutonium concentration computed will not be reliable since the x-ray detected for thorium is higher in energy than the plutonium x-ray and its Compton distribution will interfere with the plutonium measurement. In general any high energy (> 17 keV) x-ray or gamma ray will interfere with the plutonium peak because of the Compton distribution.

3. SPECIAL APPARATUS

- Three Davidson multichannel analyzers, Model 4106
- Three Bicron scintillation detectors
- Three high voltage power supplies
- Three Bicron pre-amplifiers
- Three amplifiers
- One IBM/PC with printer
- Assorted soil standards in varing concentration of plutonium and thorium along with background soils.

4. REAGENTS

Does not apply.

5. SOIL SCREENING PROCEDURE

5.1. Gamma Pulse Height Analysis

5.1.1. If the sample container is less than half full, weigh it.

5.1.2. If the weight is less than 250 grams, record the weight.

5.1.3. Place the sample over the center of the detector and place the lid on top of the shielded well.

5.1.4. Check to see that the multichannel analyzer (MCA) parameters are properly set. (See Section 5.3 in this procedure.)

5.1.5. Press the display button.

5.1.6. Move RESET DATA/TIME switch up and down (this resets the time and date).

5.1.7. Start the count by pressing the accumulate button (ACCUM.). Normally the count time is set at 400 seconds.

5.1.8. After counts have been accumulated, display the data by pressing the DISPLAY button.

5.1.9. Adjust the marker location knob to give the channels corresponding to the region of interest for plutonium (example: channels 71 - 170). This region of interest has been determined from calibration with the plutonium standard.

5.1.10. Record the number of counts as displayed on the screen corresponding to the plutonium activity.

5.1.11. Continue to turn the Marker Location Knob counter-clockwise to give the channels corresponding to the region of interest for thorium (example: channels 279 - 338). This region of interest has been determined from calibration with a thorium standard.

5.1.12. Record the number of the counts as displayed on the screen corresponding to the thorium activity.

5.2. Using PC for Calculating and Logging System (C&L).

5.2.1. Hardware configuration:

IBM or compatible PC
640K of memory
IBM compatible printer
10M or higher hard drive

5.2.2. Software requirements:

dBase III Plus
DOS 2.1 or Higher
Soil menu program to run in dBase environment

5.2.3. Move switch on right side of PC up. (This will boot up PC.)

5.2.4. When menu appears on screen, select key associated with Soil Data Management System.

5.2.5. The Soil program (Soil menu) will appear. Select [D] Input Well (A,B, & C) Data.

5.2.6. The next screen asks you to [enter cal date you are looking for]. The date that you see is the last known calibration date. Press return.

5.2.7. The next screen that appears is [Soil data].

Enter sample type:

CONT....: constructions
SM.....: SM building
PP.....: PP building
HS3.....: hot spot No. 3
Misc....: miscellaneous

Enter sample condition:

This is always wet unless you process it through Bldg. 30 microwave.

Sampler initials:

This information is obtained from sample label.

Enter collection date:

Enter the date the sample was collected.

Enter date screen:

This is always the date on which you put the sample result into the computer.

5.2.8. Input gross data from MCA:

Enter gross cts Pu-238:

Enter the gross count from the (MCA) (ROI) for plutonium

Enter gross cts Th-232:

Enter the gross count from the (MCA) (ROI) for thorium

5.2.8. Continued

Enter sample weight in grams:
(Use 300 g when sample is not weighed.)
Enter the sample weight

Enter sample grid & location:
Enter the remarks from the container

Was the sample counted in A, B, or C:
Enter the well where sample was counted

NOTE: At the bottom of the screen will appear the calculated results for this sample. You may continue from here if the following conditions are the same: sample type, condition, sampler, and collection date.

5.2.9. After this you will see the sample renumbered after returning to the Soil Menu program's main menu.

5.2.10. To print the report, press [E]. Select the report best suited for your needs.

5.3. Calibration of Multichannel Analyzer (MCA).

5.3.1. Move the memory selector knob to position 1 (at 12:00 on the dial). This displays all 4096 channels.

5.3.2. Move ROI/ALL switch to ALL.

5.3.3. Clear all data from the channels by pressing Reset DATA/TIME up and down.

5.3.4. Press ROI ENTER/RESET switch down to reset

5.3.5 Set the analyzer to the following:

HV.....:	+ 1100 volts
Conversion gain....:	4
Mode.....:	T
Offset.....:	off
ULD.....:	10
LDL.....:	0
Gain.....:	variable
Time.....:	(400) variable
Memory location....:	1-8 (512 channels)
Data.....:	add
Time.....:	add
ROI.....:	variable
PMT-AMP.....:	AMP
CNC-F-ANC.....:	F

5.3.6. Move ROI/ALL switch to ROI (Region of Interest).

5.3.7. Place standard No. 1 into a detector well.

5.3.8. Move the memory selector knob to position 1 of 8 (the memory selector knob must correspond with the standard ID).

5.3.9. Press the acquire button and accumulate spectrum for a preset time. (Repeat step 5.3.7 - 5.3.9 until all the standards have been counted.)

5.3.10. Move the memory location knob to 5 of 8.

5.3.11. Set the ROI/ALL switch to ALL.

5.3.12. Move the marker location knob right or left, to find the peak, and place the CRT highlight over the entire peak area of interest.

5.3.13. Press the ROI ENTER/RESET switch to enter.

5.3.14. Move the ROI/ALL switch to ROI.

5.3.15. Move the marker location knob until the ROI channel and gross counts appear on the top left corner of the screen.

5.3.16. The number to the right of the "=" is the gross count of the standard.

5.3.17. Move the memory location knob to 4 of 8.

5.3.18. Set ROI/ALL switch to ALL.

5.3.19. Position the marker location knob on the entire peak of interest.

5.3.20. Move ROI ENTER/RESET/ switch to ENTER.

5.3.21. Move ROI/ALL switch to ROI.

5.3.22. Move the marker location knob until the ROI channel and gross counts appear on the top left corner of the screen.

5.3.23. This is the ROI for the plutonium standards.

5.3.24. Move the memory location knob to the next location(s).

5.3.25. Repeat steps 5.3.18 - 5.3.22.

5.3.26. Move the memory location knob to 1 of 8.

5.3.27. Use the ROI channel previous setting (highlighted area) to set up 1 of 8, unknown sample region.

6. CALCULATIONS

6.1 Calculate the plutonium and thorium efficiencies and thorium cross-over from the following equations:

$$EFF(Pu) = \frac{C(PuROI) - B(PuROI)}{S(Pu) \times CT}$$

$$EFF(Th) = \frac{C(ThROI) - B(ThROI)}{S(Th) \times CT}$$

$$Th(CO) = \frac{C(PuROI) - B(PuROI)}{C(ThROI) - B(ThROI)}$$

Where: EFF(Pu) and EFF(Th) are plutonium and thorium efficiencies, respectively.

C(PuROI) and C(ThROI) are counts in plutonium and thorium regions of interest, respectively.

B(PuROI) and B(ThROI) are counts in a background soil at the plutonium and thorium regions of interest, respectively.

S(Pu) and S(Th) are the concentrations of plutonium and thorium in pCi/g of each standard, respectively.

CT is the counting time.

Th(CO) - The thorium crossover is the amount of counts observed in the plutonium region of interest from the thorium standard and varies with sample weight (self-absorption).

6.2 Calculate the plutonium and thorium concentrations in the unknown sample:

$$Pu(pCi/g) = \frac{[C(PuROI) - B(PuROI)] - [C(ThROI \times Th(Co)]}{EFF(Pu) \times CT}$$

$$Th(pCi/g) = \frac{C(ThROI) - B(ThROI)}{EFF(Th) \times CT \times EC}$$

Where: Pu(pCi/g) and Th(pCi/g) are the concentrations of plutonium and thorium in pCi/g in the unknown sample. Other symbols are given in Step 6.1.

EC is the correction of the thorium efficiency due to different sample weights.

7. REFERENCES

7.1 Operating Manual, Bicron Scintillation Detectors (1984), Bicron Corporation Newbury, Ohio.

7.2 Casella, V. R., Environmental Science Report, MLM-MU-85-63-0001 (Fourth Quarter, 1984) pp 14-15.

7.3 Stought, R. L., D. A. Edling, and D. G. Draper, The Mound Site Survey Project for the Characterization of Radioactive Materials in Site Soils, MLM-3517 (May 16, 1988) Appendix A-3, Soil Screening of Samples, pp 82-96.

7.4 Umbarger, C. J., "Soil Monitoring Instrumentation", CONF-791234, Environmental Decontamination Workshop, Oak Ridge, TN, 1979, pp 41-45.

7.5 Umbarger, C. J. and M. A. Wolf, "A Battery Operated Portable Phoswich Detector for Field Monitoring of Low Levels of Transuranic Contaminants," Nucl. Inst. and Meth. 155, p. 453 (1978).

APPENDIX B

DRILLING REPORTS

B.1. BORING LOGS FOR CORE SAMPLING LOCATIONS

Table B.1. Summary of Available Boring Logs for Core Sampling Locations

Coordinates		Bedrock	Corresponding
South	West	Reached	Map Location
2470	3760	No	0098
2100	4140	No	0105
2275	4140	No	0113
2400	4520	No	0117
2700	3760	No	0180
2700	4140	No	0181
3000	4140	Yes	0182
3300	4140	No	0183
3000	4520	No	0188
3650	3760	No	0203
2700	4750	Yes	0262
2100[a]	3860[a]	--[a]	NA
3000[b]	4900[b]	No	NA
3300[a]	3700[a]	--[a]	NA
2700[c]	4520[c]	No	NA

[a]No boring logs or data available for these coordinates.
[b]Although a boring log and surveyed coordinates are given, no data are available.
[c]Boring log available, but coordinates were not listed by the surveyor. There are also no data available for these coordinates.
NA - Not applicable because no data are available.

Table
B.1. (continued)

Coordinates South	Coordinates West	Bedrock Reached	Corresponding Map Location
2400	3000	No	0076
2400	3380	Yes	0097
2700	2620	Yes	0147
3000	2620	No	0158
3100	2620	No	0159
3300	2240	Yes	0161
3300	2620	No	0162
2700	3000	No	0170
3100	3000	Yes	0172
3000	3380	Yes	0174
3300	3380	Yes	0178
3600	2240	Yes	0194
3600	2620	Yes	0195
3600	3000	Yes	0199
3600	3380	Yes	0201
3300	3000	No	NA

NA - Not applicable because no data are available.

Table B.1. (continued)

Coordinates South	Coordinates West	Bedrock Reached	Corresponding Map Location
1500	1480	No	0001
1200	1860	Yes	0002
1200	2240	Yes	0004
1800	1480	No	0005
2100	1480	Yes	0006
1800	1860	No	0007
1800	2240	Yes	0018
2100	1800	Yes	0022
2400	1860	Yes	0033
2400	2240	Yes	0045
2100	2620	Yes	0067
2400	2620	Yes	0075
1500	1100	Yes	0248
1500	1860	Yes	0249
2100	2240	Yes	0256

Table B.1. (contiuned)

Coordinates		Bedrock	Corresponding
South	West	Reached	Map Location
1255	2931/2930[d]	Yes	0250[e]
1525	2589	Yes	NA
1670	2516	Yes	NA
1792	3009	Yes	NA
1743	3404	Yes	NA
1447/1445[d]	3016/3015[d]	Yes	0252[e]
1505	3428/3425[d]	Yes	0255
2151	3011	Yes	NA
2185	3362/3360[d]	Yes	0260[e]
1323/1325[d]	3631/3630[d]	Yes	0254[e]
2400	1860	Yes	0033[e]
2700	3760	No (?)	0180
NE[f]	NE[f]	Yes	NA
NE[g]	NE[g]	Yes	NA

[d]There were descrepancies between the coordinates given in the boring logs and these given in the tabulated data (Appendix F). The second coordinate is from the tabulated data.

[e]The sample depth for the samples taken at these locations was given as 3 ft. However, the boring logs show maximum borehole depths as 1.5 to 2.5 ft.

[f]This location is described as next to the perimeter fence at I Building.

[g]This location is described as South of trailer 7G.

LOG OF BORING No. 1500 S - 1480 W

282632

BORING LOCATION: 77 loc, Bluestone Blackstone

DATE STARTED: 11-3-84

SURFACE ELEVATION:

DATE COMPLETED: 11-3-84

	STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS/FT	SAMPLE RECOVERY %
Fill	0.0	Topsoil					
Fill	V. stiff 0.3	Br. & Br. silt some clay some sand, tr. gravel, tr. rock frag dampl	1A	0.0-1.5	9-13-7	20	16"
org?	V. stiff 3.5	Br. silt some clay some sand tr. gravel, wet	2A	3.5-5.0	9-9-13	22	18"
hard 6.0		Br. silt some clay some sand tr. gravel, tr. rock frag. moist	3A	6.0-7.5	9-18-26	44	16"
			4A	8.5-10.0	18-26-31	57	17"
			5A	11.0-12.5	18-26-30	53	18"
hard 12.5		Br. silt some clay some sand tr. gravel, with wet sand lens.	6A	13.5-15.0	18-26-34	60	18"
		Bg B. 15.0					

DRILLING METHOD: Hollow stem.

DRILLER: OH - CJ

JOB NO.: 282632

WATER OBSERVATIONS

INITIAL DEPTH: 3.5 Med. 13.5 strong

COMPLETION DEPTH: 8.0

DEPTH AFTER 10 HRS stable

TYPE SAMPLER:

- [x] A. SPLIT SPOON
- [ ] B.
- [ ] C. SHELBY TUBE

BOWSER-MORNER

2B12

BOWSER-MORNER, INC.
P. O. Box 51
DAYTON, OHIO 45401
(513) 253-8805

JOB 28263
SHEET NO 1 OF 1
CALCULATED DH DATE 11-3-84
CHECKED BY _____ DATE _____
SCALE _____

Boring No.	1500S-1480W
Soil Boring, Ft.	15.0
Rock Coring, Ft.	
Std. Pen. Tests	6
Shelby Tubes	
Access Time	.25 Note: Used 1/4 Bag Bentonite for Backfill

ROCK CORING INFORMATION

Rock Coring Hrs.	
Rock Pressure Tests	
Rock Press. Test, Hrs.	
Hauling Water, Hrs.	
Pumping Water, Ft.	
No. of Core Boxes	

WATER PIPE INFORMATION

Size of Pipe	
Ft. of Pipe & Point.	
Ft. of Guard Pipe	
Bags of Sand	
Bags of Bentonite	
Time Developing	

GROUT INFORMATION

Bags of Cement	
Bags of Bentonite	
Bags of Sand	
Total Time	

CHARGEABLE OTHER TIME

Date	
Staking Time	
Daily Travel, Hrs.	
Daily Miles, Rig	
Daily Miles, No Rig	
Supervision	
Man Hrs. Clearing	
Dozer Hrs.	

LOG OF BORING No. 1200 S – 1860 W

28263

BORING LOCATION: on loc.

DATE STARTED: 11-3-84

SURFACE ELEVATION:

DATE COMPLETED: 11-3-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY IN
orig? 0.0	Topsoil					
hard 0.5	~~Br. sandy sp. shale with rock frag, moist~~ sandy. Br. & Br. silt & clay, t. gray, damp	1A	1.0-2.5	40-20-48	68	15"
		2A	3.5-4.5	14-50	64	6"
		3A	6.0-7.5	17-20-43	63	16"
hard 8.0	Br. & Br. shale with rock frag damp	4A	8.5-10.0	15-20-23	43	17"
	oppt. rock 11.0	5A	10.0-11.5	50+ / 1"	50+ / 1"	0"
	Auger refusal at 12.0					
	B.G. B. 12.0					

DRILLING METHOD: Hollow stem.

DRILLER: DH-BJ

JOB NO.: 28263

WATER OBSERVATIONS

INITIAL DEPTH: N

COMPLETION DEPTH: N/A

DEPTH AFTER N HRS. T

TYPE SAMPLER:

- [x] A. SPLIT SPOON
- [ ] B.
- [ ] C. SHELBY TUBE

BOWSER-MORNER

2B12

BOWSER-MORNER, INC.
P. O. Box 51
DAYTON, OHIO 45401
(513) 253-8805

JOB 29263
SHEET NO. 1 OF 1
CALCULATED BY DF DATE 11-3-84
CHECKED BY DATE
SCALE

Boring No.	12005-1800W
Soil Boring, Ft.	12.0
Rock Coring, Ft.	—
Std. Pen. Tests	5
Shelby Tubes	—
Access Time	.25 Note: Used 1/4 Bag Bentonite for Backfill
ROCK CORING INFORMATION	
Rock Coring Hrs.	
Rock Pressure Tests	
Rock Press. Test, Hrs.	
Hauling Water, Hrs.	
Pumping Water, Ft.	
No. of Core Boxes	
WATER PIPE INFORMATION	
Size of Pipe	
Ft. of Pipe & Point.	
Ft. of Guard Pipe	
Bags of Sand	
Bags of Bentonite	
Time Developing	
GROUT INFORMATION	
Bags of Cement	
Bags of Bentonite	
Bags of Sand	
Total Time	
CHARGEABLE OTHER TIME	
Date	
Staking Time	
Daily Travel, Hrs.	
Daily Miles, Rig	
Daily Miles, No Rig	
Supervision	
Man Hrs. Clearing	
Dozer Hrs.	

LOG OF BORING No. 2240W-1200S

28263 2

BORING LOCATION: ~~98~~ at ~~98~~ orig loc, Insane z blacktop DATE STARTED: 11-3-84

SURFACE ELEVATION: DATE COMPLETED: 11-3-84

	STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS FT	SAMPLE RECOVERY %
Fill	0.0	Topsoil					
Fill	Vistta 0.5	Br. silt some clay some sand some gravel, some rock frag - damp	1A	1.0-2.5	8-10-11	21	18"
Fill	stff 3.5	Br. silt some clay some sand some organic, tr gravel, - moist	2A	3.5-5.0	5-7-8	15	18"
org?	Hard 6.5	Br. + Lbr. sft shale with rock frag, damp	3A	6.0-7.5	6-19-23	42	18"
			4A	8.5-9.5	40-50/2"	90+/8"	8"
		Auger refusal at 10.5					
		Bottom of Boring 10.5					
		Note: Boring filled in with orig soil then left 2' open and filled with bentonite then covered with soil.					

DRILLING METHOD: Hollow stem

DRILLER: OH-GJ

JOB NO.: ~~28263~~

WATER OBSERVATIONS

INITIAL DEPTH: 6.0 Trace

COMPLETION DEPTH: None

DEPTH AFTER Not HRS. Taken

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

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P. O. Box 51
DAYTON, OHIO 45401
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JOB 28E-3
SHEET NO. 1 OF 1
CALCULATED BY DH DATE 11-3-84
CHECKED BY DATE
SCALE

Boring No.	2240W - 1200-S										
Soil Boring, Ft.	10.5										
Rock Coring, Ft.	—										
Std. Pen. Tests	4										
Shelby Tubes	—										
Access Time	.25	Note: Used ½ Bag Bentonite for Backfill.									
ROCK CORING INFORMATION											
Rock Coring Hrs.											
Rock Pressure Tests											
Rock Press. Test, Hrs.											
Hauling Water, Hrs.											
Pumping Water, Ft.											
No. of Core Boxes											
WATER PIPE INFORMATION											
Size of Pipe											
Ft. of Pipe & Point.											
Ft. of Guard Pipe											
Bags of Sand											
Bags of Bentonite											
Time Developing											
GROUT INFORMATION											
Bags of Cement											
Bags of Bentonite											
Bags of Sand											
Total Time											
CHARGEABLE OTHER TIME											
Date											
Staking Time											
Daily Travel, Hrs.											
Daily Miles, Rig											
Daily Miles, No Rig											
Supervision											
Man Hrs. Clearing											
Dozer Hrs.											

LOG OF BORING No. 18005-1480W

282632

BORING LOCATION: on loc

DATE STARTED: 11-3-84

SURFACE ELEVATION:

DATE COMPLETED: 11-3-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY %
Fill 0.0	Gravel					
Fill Vi-Stff 0.4	Br. silt some clay some sand tr. gravel, tr. organic moist	1A	0.4-1.5	6-9-8	17	16"
rig? Vi-Stff 3.5	Br. silt some clay some sand tr. gravel, damp	2A	3.5-5.0	6-7-14	21	16"
	(Becomes moist at 6.0)	3A	6.0-7.5	9-15-14	29	16"
	(Becomes stiff at 8.5)	4A	8.5-10.0	6-6-9	15	18"
	(Becomes hard + wet at 11.0)	5A	11.0-12.5	7-12-23	35	16"
		6A	13.5-15.0	15-16-24	40	16"
	B.y.B. 15.0					

DRILLING METHOD: Hollow stem

DRILLER: DN-GJ

JOB NO.: 28263

WATER OBSERVATIONS

INITIAL DEPTH: 11.0 heavy

COMPLETION DEPTH: 10.0

DEPTH AFTER Not HRS. Taken

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

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JOB 28-23
SHEET NO. 1 OF 1
CALC. BY D.L. DATE 11-3-84
CHEC. BY DATE
SCALE

Boring No.	1800S - 1480W
Soil Boring, Ft.	15.0
Rock Coring, Ft.	—
Std. Pen. Tests	6
Shelby Tubes	—
Access Time	.25 NOTE: Used ¼ Bag Bentonite for Backfill
ROCK CORING INFORMATION	
Rock Cor Hrs.	
Rock Pre e Tests	
~~Rock Pres. Test, Hrs.~~	
Hauling Water, Hrs.	
Pumping Water, Ft.	
No. of Core Boxes	
WATER PIPE INFORMATION	
Size of Pipe	
Ft. of Pipe & Point.	
Ft. of Guard Pipe	
~~Bags of Sand~~	
Bags of Bentonite	
Time Developing	
GROUT INFORMATION	
Bags of Cement	
Bags of Bentonite	
Bags of Sand	
Total Time	
CHARGEABLE OTHER TIME	
Date	
Staking Time	
~~Daily Travel, Hrs.~~	
Daily Miles, Rig	
Daily Miles, No Rig	
Supervision	
~~Man Hrs. Clearing~~	
Dozer Hrs.	

LOG OF BORING No. 21005-1480W

282632

BORING LOCATION: ~~off~~ loc (asphalt)

DATE STARTED: 11-5-84

SURFACE ELEVATION:

DATE COMPLETED: 11-5-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	UNIT BLOWS/FT	SAMPLE RECOVERY %
Fill 0.0	Topsoil					
Fill 2ty 0.6	Br. silt some clay some sand to gravel, tr glass frag. tr organic, moist	1A	0.0-1.5	6-5-6	11	18"
Fill? ~~Bag~~? hard 4.0	Br. shale with rock layer deep	2A	3.5-5.0	6-14-18	32	16"
Fill? 0'-0' V stiff 6.0	Br. silt some clay some sand to gravel, moist	3A	6.0-7.5	6-10-14	24	16"
		4A	8.5-10.0	6-9-11	20	15"
	Appt. rock 11.0					
	Augur refusal at 11.0					
	Bottom 11.0					

DRILLING METHOD: Hollow stem

DRILLER: DH-65

JOB NO.: 28263

WATER OBSERVATIONS

INITIAL DEPTH: 8.5 Trace

COMPLETION DEPTH: 11 dry

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

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2B12

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JOB 2-263
SHEET NO. 1 OF 1
CALCULATED BY DH DATE 11-5-84
CHECKED BY DATE
SCALE

Boring No.	2005-1480W
Soil Boring, Ft.	16.0
Rock Coring, Ft.	
Std. Pen. Tests	4
Shelby Tubes	—
Access Time	.25 Not Used Yet Bag Bentonite for Backfill
ROCK CORING INFORMATION	
Rock Coring Hrs.	
Rock Pressure Tests	
~~Rock Press. Test, Hrs.~~	
Hauling Water, Hrs.	
Pumping Water, Ft.	
No. of Core Boxes	
WATER PIPE INFORMATION	
Size of Pipe	
Ft. of Pipe & Point.	
Ft. of Guard Pipe	
Bags of Sand	
Bags of Bentonite	
Time Developing	
GROUT INFORMATION	
Bags of Cement	
Bags of Bentonite	
Bags of Sand	
Total Time	
CHARGEABLE OTHER TIME	
Date	
Staking Time	
~~Daily Travel, Hrs.~~	
Daily Miles, Rig	
Daily Miles, No Rig	
Supervision	
Man Hrs. Clearing	
Dozer Hrs.	

LOG OF BORING No. 1800 S – 1860 W

282632

BORING LOCATION: N. loc.

DATE STARTED: 11-5-84

SURFACE ELEVATION:

DATE COMPLETED: 11-5-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS 6"	SAMPLE RECOVERY
Fill 0.0	Gravel + Crushed stone w/ rt.					
Fill Vrbly 0.4	Br. silt some clay some sand to gravel, trace fine, trace organics, moist	1A	0.0-1.5	5-8-12	20	16"
	(Becomes hard at 3.5)	2A	3.5-4.0	50+/6"	50+/6"	6"
		3A	6.0-6.5	55+/3"	55+/3"	3"
ig? Vrbly 8.5	Br. silt some clay some sand to gravel, moist	4A	8.5-10.0	5-13-15	28	16"
		5A	11.0-12.5	6-9-11	20	18"
		6A	13.5-15.0	6-12-13	25	18"
	B.G.B. 15.0					

DRILLING METHOD: Hollow stem.

DRILLER: DH-BJ

JOB NO.: ~~28265~~

WATER OBSERVATIONS

INITIAL DEPTH: 13.5 Trace

COMPLETION DEPTH: None

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

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2B12

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JOB 28063
SHEET 1 OF 1
CALCULATED BY DH DATE 11-5-84
CHECKED BY DATE
SCALE

Boring No.	1800S - 1800W
Soil Boring, Ft.	15.0
Rock Coring, Ft.	—
Std. Pen. Tests	6
Shelby Tubes	—
Access Time	.25 Note: Used ½ Bag Bentonite for Backfill.
ROCK CORING INFORMATION	
Rock Coring Hrs.	
Rock Pressure Tests	
~~Rock Press. Test, Hrs.~~	
Hauling Water, Hrs.	
Pumping Water, Ft.	
No. of Core Boxes	
WATER PIPE INFORMATION	
Size of Pipe	
Ft. of Pipe & Point.	
Ft. of Guard Pipe	
~~Bags of Sand~~	
Bags of Bentonite	
Time Developing	
GROUT INFORMATION	
Bags of Cement	
Bags of Bentonite	
Bags of Sand	
Total Time	
CHARGEABLE OTHER TIME	
Date	
Staking Time	
~~Daily Travel, Hrs.~~	
Daily Miles, Rig	
Daily Miles, No Rig	
Supervision	
Man Hrs. Clearing	
Dozer Hrs.	

LOG OF BORING No. 1800S - 2240W

2826 ~~B~~2

BORING LOCATION on loc.

DATE STARTED: 11-5-84

SURFACE ELEVATION:

DATE COMPLETED: 11-5-84

	STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS FT.	SAMPLE RECOVERY %
Fill	0.0	Concrete					
Fill	Vistty 0.2	Bu. silt sandy sand sand, tr. rock frag. damp	1A	1.0-2.5	15-21-6	27	10"
orig?	Vistty 1.0	Br. + Bu. shale with rock frag. damp	2A	3.5-5.0	5-8-13	21	16"
		(Becomes hard at 6.0)	3A	6.0-6.5	51+ 6"	51+ 6"	6"
hard	8.5	Br. shale with rock layers wet	4A	8.5-9.0	54+ 6"	54+ 6"	6"
		Auger refusal 11.0					
		B of B. 11.0					

DRILLING METHOD: Hollow stem

DRILLER: DH-GJ

JOB NO.: ~~28263~~

WATER OBSERVATIONS

INITIAL DEPTH: 8.5 Med.

COMPLETION DEPTH: 8.0

DEPTH AFTER N HRS. T

TYPE SAMPLER

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

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JOB 28563
SHEET NO. 1 OF 1
CALCULATED BY DH DATE 11-5-84
CHECKED BY DATE
SCALE

Boring No.	B005-2240W
Soil Boring, Ft.	14.0
Rock Coring, Ft.	—
Std. Pen. Tests	4
Shelby Tubes	—
Access Time	.25 Note: Used 1/4 Bag Bentonite for Backfill.
ROCK CORING INFORMATION	Note: Approved 1 Bag Blacktop Patch
Rock Coring Hrs.	
Rock Pressure Tests	
Rock Press. Test, Hrs.	
Hauling Water, Hrs.	
Pumping Water, Ft.	
No. of Core Boxes	
WATER PIPE INFORMATION	
Size of Pipe	
Ft. of Pipe & Point.	
Ft. of Guard Pipe	
Bags of Sand	
Bags of Bentonite	
Time Developing	
GROUT INFORMATION	
Bags of Cement	
Bags of Bentonite	
Bags of Sand	
Total Time	
CHARGEABLE OTHER TIME	
Date	
Staking Time	
Daily Travel, Hrs.	
Daily Miles, Rig	
Daily Miles, No Rig	
Supervision	
Man Hrs. Clearing	
Dozer Hrs.	

LOG OF BORING No. 2100S-1800W

282632

BORING LOCATION: gy loc (Bldg-top)

DATE STARTED: 11-6-84

SURFACE ELEVATION:

DATE COMPLETED: 11-6-84

	STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS FT	SAMPLE RECOVERY %
Fill	0.0	Topsoil					
Fill	Fill 0.5	Rubble, with rock frag. damp	1A	0.0-1.5	10-20-11	31	16"
Fill	Vstg 3.5	Br silt some clay some sand to gravel, tr gy loc frag. damp	2A	3.5-5.0	3-5-9	14	15"
		(Become lstg at 6.5)	3A	6.0-7.5	4-7-11	18	16"
?	Vstg 8.5	Br & gy, silt some clay some sand, tr gravel, damp	4A	8.5-10.0	7-11-18	29	18"
		appt. rock 10.5					
		augering refusal at 11.0					
		B.O.B. 11.0					

DRILLING METHOD: Hollow stem

DRILLER: JN-GJ

JOB NO.: ~~28203~~

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER R HRS. T

TYPE SAMPLER:

[X] A. SPLIT SPOON

[ ] B.

[ ] C. SHELBY TUBE

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JOB 28263
SHEET NO. 1 OF 1
CALCULATED BY DH DATE 11-6-84
CHECKED BY DATE
SCALE

Boring No.	2400S-1800W
Soil Boring, Ft.	11.0
Rock Coring, Ft.	—
Std. Pen. Tests	4
Shelby Tubes	—
Access Time	.25 Note: Used 1/4 Bag Bentonite for Backfill
ROCK CORING INFORMATION	
Rock Coring Hrs.	
Rock Pressure Tests	
Rock Press. Test, Hrs.	
Hauling Water, Hrs.	
Pumping Water, Ft.	
No. of Core Boxes	
WATER PIPE INFORMATION	
Size of Pipe	
Ft. of Pipe & Point.	
Ft. of Guard Pipe	
Bags of Sand	
Bags of Bentonite	
Time Developing	
GROUT INFORMATION	
Bags of Cement	
Bags of Bentonite	
Bags of Sand	
Total Time	
CHARGEABLE OTHER TIME	
Date	
Staking Time	
Daily Travel, Hrs.	
Daily Miles, Rig	
Daily Miles, No Rig	
Supervision	
Man Hrs, Clearing	
Dozer Hrs.	

LOG OF BORING No.

2826 ~~B~~ 2 — 24005 - 1860W

BORING LOCATION: off site (Hillside) — DATE STARTED: 11-5-84

SURFACE ELEVATION: — DATE COMPLETED: 11-5-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY "
FILL 0.0	Topsoil					
FILL hard 0.5	Br. silt some clay some sand, tr. gravel, tr. rock frag. tr. organic, moist	1A	0.0-1.5	9-12-40	52	16"
orig. hard 4.0	Br. shale with rock layers damp	2A	35-40	50+/5"	50+/5"	5"
		3A	6.0-7.0	31-32	63	12"
	Auger refusal at 8.0					
	B.B.B.O					

DRILLING METHOD: Hollow stem.

DRILLER: NH-G5

JOB NO.: 282-63

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

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2B12

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JOB 28-63
SHEET NO. 1 OF 1
CALCULATED BY DH DATE 11-5-84
CHECKED BY DATE
SCALE

Boring No.	2400 S-1860 W											
Soil Boring, Ft.	8.0											
Rock Coring, Ft.	—											
Std. Pen. Tests	3											
Shelby Tubes	—											
Access Time	.25	Note: Used ¼ Bag Bentonite for Backfill										
ROCK CORING INFORMATION												
Rock Coring Hrs.												
Rock Pressure Tests												
~~Rock Press. Test, Hrs.~~												
Hauling Water, Hrs.												
Pumping Water, Ft.												
No. of Core Boxes												
WATER PIPE INFORMATION												
Size of Pipe												
Ft. of Pipe & Point.												
Ft. of Guard Pipe												
Bags of Sand												
Bags of Bentonite												
Time Developing												
GROUT INFORMATION												
Bags of Cement												
Bags of Bentonite												
Bags of Sand												
Total Time												
CHARGEABLE OTHER TIME												
Date												
Staking Time												
~~Daily Travel, Hrs.~~												
Daily Miles, Rig												
Daily Miles, No Rig												
Supervision												
Man Hrs. Clearing												
Dozer Hrs.												

LOG OF BORING No. 24005 - 2240W

28263 L

BORING LOCATION: off loc. (Hilliard)

DATE STARTED: 11-5-84

SURFACE ELEVATION:

DATE COMPLETED: 11-5-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY ""
Fill? 0.0	Topsoil					
Fill? 0.4	Br. silt some clay some sand to gravel to f. rock, frag-ments	1A	1.0-1.5	18-12-14	26	10"
		2A	3.5-5.0	9-11-12	23	16"
	(Becomes hard at 6.0)	3A	6.0-7.0	21-45	66	10"
	(Becomes stiff at 8.5)	4A	8.5-10.0	4-5-6	11	10"
hard orig. 11.0	Br. shale with rock layers clay	5A	11.0-12.5	9-13-50/2"	63+/8"	13"
	augering refusal at 13.0 B/B. 13.0					

DRILLING METHOD: Hollow stem

DRILLER: OH-G5

JOB NO. ~~28263~~

WATER OBSERVATIONS

INITIAL DEPTH: 6.0 Trace

COMPLETION DEPTH: None

DEPTH AFTER N HRS. T

TYPE SAMPLER:

- [x] A. SPLIT SPOON
- [ ] B.
- [ ] C. SHELBY TUBE

BOWSER-MORNER

2B12

JOB 28243

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SHEET NO. 1 OF 1

CALCULATED BY DH DATE 11-5-84

CHECKED BY _____ DATE _____

SCALE _____

Boring No.	24005 - 2240W										
Soil Boring, Ft.	13.0										
Rock Coring, Ft.	—										
Std. Pen. Tests	5										
Shelby Tubes	—										
Access Time	.25	Note: Used 1/4 Bag Bentonite for our Backfill									
ROCK CORING INFORMATION											
Rock Coring Hrs.											
Rock Pressure Tests											
~~Rock Press. Test, Hrs.~~											
Hauling Water, Hrs.											
Pumping Water, Ft.											
No. of Core Boxes											
WATER PIPE INFORMATION											
Size of Pipe											
Ft. of Pipe & Point.											
Ft. of Guard Pipe											
Bags of Sand											
Bags of Bentonite											
Time Developing											
GROUT INFORMATION											
Bags of Cement											
Bags of Bentonite											
Bags of Sand											
Total Time											
CHARGEABLE OTHER TIME											
Date											
Staking Time											
~~Daily Travel, Hrs.~~											
Daily Miles, Rig											
Daily Miles, No Rig											
Supervision											
Man Hrs. Clearing											
Dozer Hrs.											

LOG OF BORING No. 2100S-2620W

28262

BORING LOCATION: 77 loc (Nillside)

DATE STARTED: 11-6-84

SURFACE ELEVATION:

DATE COMPLETED: 11-6-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS FT.	SAMPLE RECOVERY %
Fill 0.0	Gravel & Crushed stone					
Fill hard 0.2	Br. & Brn silt some clay some sand, & gravel, etc. grade from rock frag. clay	1A	0.0-1.5	16-19-13	32	16"
	(Becomes v. stiff at 3.5)	2A	3.5-5.0	8-12-7	29	18"
		3A	6.0-7.5	6-7-9	16	6"
	(Becomes stiff + wet at 8.5)	4A	8.5-10.0	9-9-3	12	10"
hard. 11.0	Br. shale with rock frag. clay	5A	11.0-11.5	50/4"	50/4"	4"
		6A	13.5-14.0	50/2"	50/2"	2"
	B. of B. 14.0					

DRILLING METHOD: Hollow stem.

DRILLER: CH-BJ

JOB NO.: 28263

WATER OBSERVATIONS

INITIAL DEPTH: 2.5 Med.

COMPLETION DEPTH: None

DEPTH AFTER N HRS. T

TYPE SAMPLER

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

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JOB 28-63
SHEET NO 1 OF 1
CALCULATED BY JH DATE 11-6-84
CHECKED BY DATE
SCALE

Boring No.	2100S - 3620W	
Soil Boring, Ft.	14.0	
Rock Coring, Ft.	—	
Std. Pen. Tests	6	
Shelby Tubes	—	
Access Time	.25	Note: Used 1/4 Bag Bentonite for Backfill
ROCK CORING INFORMATION		
Rock Coring Hrs.		
Rock Pressure Tests		
~~Rock Press. Test~~ Hrs.		
Hauling Water, Hrs.		
Pumping Water, Ft.		
No. of Core Boxes		
WATER PIPE INFORMATION		
Size of Pipe		
Ft. of Pipe & Point.		
Ft. of Guard Pipe		
~~Bags of Sand~~		
Bags of Bentonite		
Time Developing		
GROUT INFORMATION		
Bags of Cement		
Bags of Bentonite		
Bags of Sand		
Total Time		
CHARGEABLE OTHER TIME		
Date		
Staking Time		
~~Daily Travel, Hrs.~~		
Daily Miles, Rig		
Daily Miles, No Rig		
Supervision		
Man Hrs. Clearing		
Dozer Hrs.		

LOG OF BORING No. 24005-2620W

2826 ~~3~~2

BORING LOCATION: off loc. (creek) DATE STARTED 11-6-84

SURFACE ELEVATION: DATE COMPLETED: 11-6-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS FT	SAMPLE RECOVERY %
Fill 0.0	Gravel & Crushed stone					
Fill Vi stiff 0.3	Brown silt some clay some sand, some gravel, trace of asphalt, trace organic, moist	1A	0.0-1.5	6-9-13	22	10"
orig? stiff 4.5	Brown silt some clay some sand, trace gravel, wet	2A	3.5-5.0	6-9-3	12	10"
	(Becomes Vi stiff at 7.0)	3A	6.0-7.5	5-4-7	21	10"
	(Becomes Mu stiff at 8.5)	4A	8.5-10.0	3-3-3	6	6"
hard 11.5	Brown shale with rock frag. wet	5A	11.0-12.0	4-50+/2"	50+/8"	6"
		6A	13.5-14.0	50+/2"	50+/2"	2"
	B. of B. 14.0					

DRILLING METHOD: Hollow stem

DRILLER: JH-GJ

JOB NO.: 2826~~5~~

WATER OBSERVATIONS

INITIAL DEPTH: 4.5 Wed.

COMPLETION DEPTH: 4.0

DEPTH AFTER N HRS. T

TYPE SAMPLER

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

BOWSER-MORNER, INC.
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JOB 28 63
SHEET NO. 1 OF 1
CALCULATED BY DH DATE 11-6-84
CHECKED BY DATE
SCALE

Boring No.	2400S - 2620W										
Soil Boring, Ft.	14.0										
Rock Coring, Ft.	—										
Std. Pen. Tests	6										
Shelby Tubes	—										
Access Time	.25	Note: Used 1/2 Bag Bentonite for Backfill									
ROCK CORING INFORMATION											
Rock Coring Hrs.											
Rock Pressure Tests											
Rock Press. Test, Hrs.											
Hauling Water, Hrs.											
Pumping Water, Ft.											
No. of Core Boxes											
WATER PIPE INFORMATION											
Size of Pipe											
Ft. of Pipe & Point.											
Ft. of Guard Pipe											
Bags of Sand											
Bags of Bentonite											
Time Developi											
GROUT INFORMATION											
Bags of Cement											
Bags of Bentonite											
Bags of Sand											
Total Time											
CHARGEABLE OTHER TIME											
Date											
Staking Time											
Daily Travel, Hrs.											
Daily Miles, Rig											
Daily Miles, No Rig											
Supervision											
Man Hrs. Clearing											
Dozer Hrs.											

LOG OF BORING No.

2400 S 3000 W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-24-84

SURFACE ELEVATION:

DATE COMPLETED: 10-24-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY %
Fill 0.0	TOPSOIL					
V.STIFF 0.3	BR SILT, SM CLAY, TR SAND TR ORGANICS MOIST	1A	0.0-1.5	2-8-9	17	12"
HARD 2.0	BR SILT, TR CLAY, TR GRAV SM ROCK FRAGS. DAMP	2A	2.5-4	20-30-45	75	12"
HARD 5.0	WEATHERED BR SHALE w/ LIMESTONE FRAGS	3A	5-6.5	23-32-29	61	12"
V.STIFF 7.5	BR GR CLAY, SM SILT TR GRAV, TR ROCK FRAGS MOIST	4A	7.5-9	22-10-12	22	12"
	(BECOMES STIFF AT 10.0)	5A	10-11.5	15-10-5	15	6"
		6A	12.5-14	19-10-20	30	6"
		7A	15-16	9-93/3	100/9	6" *
	EOFB 16.0					

DRILLING METHOD: H.S.A.

DRILLER: TB-JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: 15.0

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12 * DRIVE ON COBBLE

LOG OF BORING No.

2400-S - 3380-W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-22-84

SURFACE ELEVATION:

DATE COMPLETED: 10-22-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS FT	SAMPLE RECOVERY IN
Fill 0.0	CRUSHED STONE					
M. STIFF 0.5 Fill	GR CLAY, SM SILT, TR GRAV moist	1A	0.0-1.5	5-5-5	10	12"
2.5	GR. SHALE w/ LIMESTONE FRAGS.	2A	2.5-3	100/4	100/4	3"
		3A	5-6	40-60/4	100/10	10"
	B OF B 6.0					

DRILLING METHOD: H.S.A.

DRILLER: TB-JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: 0.25

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 2470 W 3760 **DATE STARTED:** 9/25/84

SURFACE ELEVATION: 738.3 **DATE COMPLETED:** 9/25/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Hard brown silt, some clay, trace of sand, trace of gravel - damp	1A	1.0-2.5	20-20-20	40
4.5'	Gray shale - damp	2A	3.5-5.0	25-32-30	62
6.0'	Very stiff brown silt, some clay, trace of sand, trace of gravel - damp	3A	6.0-7.5	6-11-13	24
5'	(Becomes hard at 8.5')	4A	8.5-10.0	21-21-20	41
10'					
11.5'	Hard gray and brown silt, some clay, trace of sand, trace of gravel - moist	5A	11.0-12.5	21-17-20	37
13.0'	Hard brown silt, some clay, trace of sand, trace of gravel - moist	6A	13.5-15.0	11-12-16	28
15'	Bottom of boring at 15.0'				
20'					
25'					
30'					

METHOD: HOLLOW STEM AUGER
TECHNICIAN: KB-JP
JOB NO.: 28216 (bw)

WATER OBSERVATIONS
INITIAL DEPTH: None
COMPLETION DEPTH: None
DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:
X A. SPLIT SPOON
___ B.
___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 2100 W 4140

DATE STARTED: 9/26/84

SURFACE ELEVATION: 744.9

DATE COMPLETED: 9/26/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Very dense brown sand and gravel, trace of silt, trace of cobbles - moist	1A	1.0-2.5	19-63-37/3"	100+
2.5'	(ORIGINAL) Hard brown silt, trace of clay, trace of gravel, trace of sand - moist	2A	3.5-5.0	40-60	100+
6.0'	Hard brown silt, some clay, trace of sand, trace of gravel - moist	3A	6.0-7.5	7-12-24	36
		4A	8.5-10.0	7-18-18	36
		5A	11.0-12.5	24-20-31	51
13.5'	Very stiff gray silt, some clay, trace of gravel - moist	6A	13.5-15.0	12-14-14	28
	Bottom of boring at 15.0'				

5' 10' 15' 20' 25' 30'

METHOD: HOLLOW STEM AUGER

TECHNICIAN: KB-TB

JOB NO.: 28216 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 2275 W 4140 **DATE STARTED:** 9/25/84

SURFACE ELEVATION: 730.59 **DATE COMPLETED:** 9/25/85

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Medium dense brown sand and gravel, trace of cobbles - moist	1A	1.0-2.5	6- 8-11	19
3.0'	(ORIGINAL) Very stiff black silt, some clay, trace of gravel - moist	2A	3.5-5.0	6-11-14	25
5' 6.5'	Stiff black clay, some silt, trace of sand, trace of gravel - moist	3A	6.0-7.5	4- 5- 9	14
10' 11.5'	(Becomes very stiff at 8.5')	4A	8.5-10.0	6- 7-10	17
13.0'	Very stiff gray clay, trace of silt, trace of sand, trace of gravel - moist	5A	11.0-12.5	6- 8-10	18
15'	Hard brown silt, some sand, trace of clay, trace of gravel - moist	6A	13.5-15.0	7-21-20	41
	Bottom of boring at 15.0'				
20'					
25'					
30'					

METHOD: HOLLOW STEM AUGER

TECHNICIAN: KB-JP

JOB NO.: 28216 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 2400 W 4520

DATE STARTED: 9/24/84

SURFACE ELEVATION: 711.9'

DATE COMPLETED: 9/24/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Stiff brown silt, some sand, trace of clay, trace of gravel - damp				
		1A	1.0-2.5	4- 5- 8	13
5'		2A	3.5-5.0	14- 8- 7	15
6.0'	(FILL) Stiff gray clay, some sand, trace of silt, trace of gravel, trace of wood - moist	3A	6.0-7.5	4- 5- 9	14
8.0'					
10'	(ORIGINAL) Hard brown silt, some clay, trace of sand, trace of gravel - moist	4A	8.5-10.0	9-17-21	38
11.5'	Hard gray silt, some clay, trace of sand, trace of gravel - moist	5A	11.0-12.5	15-18-19	37
15'		6A	13.5-15.0	13-16-19	35
	Bottom of boring at 15.0'				
20'					
25'					
30'					

METHOD: HOLLOW STEM AUGER

TECHNICIAN: KB-JP

JOB NO.: 28216 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: 8.0'

COMPLETION DEPTH: _____

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING No.

S-2700 - W-2620

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-20-84

SURFACE ELEVATION:

DATE COMPLETED: 10-20-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY %
DRIL 0.0	TOPSOIL					
V.STIFF 0.5	BR CLAY, Sm S.H, TR GRAV moist	1A	0.0-1.5	5-10-13	23	16"
HARD 3.0	BR S.H, TR CLAY, TR SAND TR GRAV, Sm ROCK FRAGS DAMP	2A	2.5-4	5-18-21	39	16"
		3A	5-6	23-62	85/R	10"
HARD 7.0	BR BR CLAY, Sm S.H, TR GRAV TR ROCK FRAGS moist	4A	7.5-9	10-40-45	85	16"
		5A	10-11.5	20-25-35	60	12"
		6A	12.5-13.5	25-75	100/R	8"
13.5	POSSIBLE GR SHALE? AUGER REFUSAL 13.5					

DRILLING METHOD: H. S. A.

DRILLER: TB-JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING No.
3000 S - 2620 -W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-18-84

SURFACE ELEVATION:

DATE COMPLETED: 10-18-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY ""	
V. STIFF Fill 0.0	BR GR CLAY, SM S. IF TR CLAY, TR CONCRETE & COBBLES moist	1A	0.0-1.5	5-10-8	18	12"	
		2A	2.5-4	10-21-5	26	12"	
	(BECOMES HARD AT 5.0)	3A	5-6	6-94	100/12	10"	*
		4A	7.5-8	100/3	100/3	3"	*
	(BECOMES STIFF AT 10.0)	5A	10-11.5	10-7-7	14	18"	
V. STIFF Fill 12.5	BR GR CLAY, SM S. IF, TR CLAY TR COBBLES moist	6A	12.5-14	20-8-8	16	16"	
		7A	15-16.5	30-27-12	39	7"	
	BOFB 16.5						

DRILLING METHOD: H.S.A.

DRILLER: TB-JP

JOB NO.: 28236

WATER OBSERVATIONS
INITIAL DEPTH: NONE
COMPLETION DEPTH: NONE
DEPTH AFTER N HRS. T

TYPE SAMPLER:
☒ A. SPLIT SPOON
☐ B.
☐ C. SHELBY TUBE

* DRIVE ON COBBLE

BOWSER-MORNER

2B12

LOG OF BORING No.

3166-S → 2620-W

BORING LOCATION: ~~TS~~ DIRECTED

DATE STARTED: 10-18-84

SURFACE ELEVATION:

DATE COMPLETED: 10-18-84

	STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS FT	SAMPLE RECOVERY IN	
Fill	M STIFF 0.0	BR SILT, Sm CLAY, TR GRAV TR COBBLES & CONCRETE moist	1A	0.0-1.5	2-4-6	10	7"	*
		(BECOMES V. STIFF AT 2.5)	2A	2.5-4	12-10-12	22	4"	*
		(BECOMES M-STIFF AT 5.0)	3A	5-6.5	3-4-6	10	12"	
			4A	7.5-9	55-9-6	15	6"	*
Fill	HARD 9.5	GR BR CLAY, Sm SILT TR GRAV Sm COBBLES, TR ASPHALT moist	5A	10-11.5	60-26-14	40	16"	
		(BECOMES V. STIFF AT 12.5)	6A	12.5-14	20-9-12	21	16"	
Fill	HARD 14.5	GR & BR SILT, Sm CLAY, TR ROCK FRAGS moist	7A	15-16.5	30-40-50	90	1	
		BOFD 16.5						

DRILLING METHOD: H.S.A.

DRILLER: TB - JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2812

* COBBLE BLOCKED TIP

LOG OF BORING No.

S-3300 - 2240 -W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-23-84

SURFACE ELEVATION:

DATE COMPLETED: 10-23-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS FT	SAMPLE RECOVERY %
Fill 0.0	CRUSHED STONE					
V. STIFF 0.5 (Drill?)	BR CLAY, Sm Silt, Tr GRAV Tr ROCK FRAGS moist	1A	0.0-1.5	16-12-18	30	12"
	(BECOMES HARD & DAMP AT 2.5)	2A	2.5-4	40-42-50/4	100/10	6"
HARD 5.0	GREENISH BR Silt, Sm CLAY Tr GRAV, Sm ROCK FRAGS DAMP	3A	5-6	37-63/2	100/8	5"
		4A	7.5-8	100/4	100/4	4"
8.0?	GR SHALE w/ LIMESTONE FRAGS	5A	8.5-9	100/4	100/4	4"
9.0	AUGER REFUSAL B OF B 9.0					

DRILLING METHOD: H.S.A.

DRILLER: TB-JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING No. ——

3300 S - 2620 W

BORING LOCATION: ON LINE

DATE STARTED: 10-18-84

SURFACE ELEVATION:

DATE COMPLETED: 10-18-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY IN
HARD 0.0	BR SILT, SM CLAY, SM ROCK FRAGS., TR GRAV MOIST	1A	0.0-1.5	14-26-37	63	8" *
		2A	2.5-4	29-32-49	81	12"
		3A	5-6.5	26-26-18	44	12"
		4A	7-8.5	35-26-39	65	12"
HARD 10.0	GR BR SILT SM CLAY, TR SAND SM ROCK FRAGS DAMP	5A	10-10.5	100/6	100/6	4"
		6A	12.5-14	29-20-51	71	12"
		7A	15-15.5	100/3	100/3	3"
	BOT-B 15.5					

DRILLING METHOD: H.S.A.

DRILLER: TB-JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER ... HRS. ...

TYPE SAMPLER:

- [x] A. SPLIT SPOON
- [ ] B.
- [ ] C. SHELBY TUBE

BOWSER-MORNER

2B12

* CABLE BLOCKED TIP

LOG OF BORING No.

S-2700 - 3000-W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-22-84

SURFACE ELEVATION:

DATE COMPLETED: 10-22-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS FT	SAMPLE RECOVERY %
Fill 0.0	CRUSHED STONE					
M. STIFF 0.25	DARK BR SILT, TR CLAY					
Orig	DAMP					
V. STIFF 1.5	BR SILT, SM CLAY, TR GRAV					
	moist	1A	0.0-1.5	4-6-11	27	16"
	(DAMP BECOMES HARD AT 2.5)	2A	2.5-4	8-15-23	38	16"
		3A	5-6.5	12-23-25	48	16"
		4A	7.5-9	13-24-35	59	16"
		5A	10-11	47-63/5	100/11	11"
	(TRACES OF ROCK FRAGS AT 12.0)	6A	12.5-13.5	30-58	88	10"
		7A	15-16.5	24-40-60/4	100/10	7"
	B 11F B 16.5					

DRILLING METHOD: H.S.A.

DRILLER: TB-JP

JOB NO.: 28250 28256

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER

☑ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING No.

3100-S — 3000 W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-18-84

SURFACE ELEVATION:

DATE COMPLETED: 10-18-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY %
V. STIFF 0.0	BR SILT, SM CLAY, TR GRAV TR ROCK FRAGS., TR SAND DAMP	1A	0.0-1.5	10-14-16	30	12"
	(BECOMES HARD AT 2.5)	2A	2.5-4	21-16-18	34	12"
		3A	5-6.5	33-24-22	46	16"
HARD 7.5	GREENISH BR CLAY, SM SILT TR GRAV, TR ROCK FRAGS moist	4A	7.5-9	24-30-27	57	16"
		5A	10-10.5	100/2	100/2	0"
12.0	GR SHALE	6A	12.5-13.5	25-75/1	100/1	7"
	BUFB 13.5					

DRILLING METHOD: H.S.A.

DRILLER: TB-JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12 * DROP ON TABLE

ORIG

LOG OF BORING No.

S-3000 - W - 3380

BORING LOCATION: AS DIRECTED

DATE STARTED: 10 20 84

SURFACE ELEVATION:

DATE COMPLETED: 10-20-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY %
HARD 0.0	BR S.Y, SmCLAY, TR GRAV Sm ROCK FRAGS. DAMP	1A	0.0-1.5	13-43-34	78	10"
		2A	2.5-4	22-33-39	72	12"
HARD 5.0	GREENISH BR CLAY, Sm S.Y. TR GRAV, TR ROCK FRAGS MOIST	3A	5-6	24-76/5	100/11	11"
		4A	7.5-8.5	41-53	94/12	12"
11.0	GR SHALE, WEATHERED	5A	10-11.5	23-45-39	84	14"
	AUGER REFUSAL 12.0					
	B OF B 12.0					

DRILLING METHOD: H.S.A.

DRILLER: TB - JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER 1V HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING No.

3300-S — 3380-W

BORING LOCATION: As Directed

DATE STARTED: 10-23-84

SURFACE ELEVATION:

DATE COMPLETED: 10-23-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS FT	SAMPLE RECOVERY IN
ORIG 0.0						
V.STIFF 0.5	BR CLAY, Sm S.lt, TR GRAV MOIST	1A	0.0-1.5	2-2-16	18	12"
HARD 2.0	BR S.lt, TR CLAY, Sm ROCK FRAGS, TR GRAV DAMP	2A	2.5-3	100/3	100/3	3"
		3A	5-6	67-33/1	100/7	7"
		4A	7.5-8.5	51-49/2	100/8	6"
		5A	10-11	55-45/3	100/9	9"
		6A	12.5-13.5	63-37/2	100/8	8"
14.0	AUGER REFUSAL					
	BUFB 14.0					

DRILLING METHOD: H.S.A.

DRILLER: TB JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS.

TYPE SAMPLER

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 2700 W ~~3750~~ 3760 = correct W Susan Wilson 5-31-90

DATE STARTED: 9/25/84

SURFACE ELEVATION: ~~70~~ 751.1

DATE COMPLETED: 9/25/85

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Hard brown silt, trace of clay, trace of sand, trace of gravel - damp	1A	1.0-2.5	12-16-18	34
3.5'	Hard brown silt, some clay, some sand, trace of gravel - moist	2A	3.5-5.0	11-21-19	40
	(Becomes very stiff at 6.0')	3A	6.0-7.5	7- 8-11	19
5'	(Becomes hard at 8.5')	4A	8.5-10.0	9-14-19	33
10'					
11.0'	Hard gray silt, some clay, trace of sand, trace of gravel - moist	5A	11.0-12.5	14-19-25	44
		6A	13.5-15.0	15-16-24	40
15'	Bottom of boring at 15.0'				
20'					
25'					
30'					

METHOD: HOLLOW STEM AUGER

TECHNICIAN: KB-JP

JOB NO.: 28216 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 2700 W 4140.

DATE STARTED: 9/20/84

SURFACE ELEVATION: 731.6.

DATE COMPLETED: 9/20/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Very stiff brown silt, trace of sand, trace of clay - damp	1A	1.0-2.5	7-11-14	25
4.0'	Hard brown silt, trace of sand, trace of clay, trace of gravel - moist	2A	3.5-5.0	11-15-17	32
	(Becomes very stiff at 6.0')	3A	6.0-7.5	9-13-17	30
10'	(Becomes hard at 8.5')	4A	8.5-10.0	12-17-25	42 ~~42~~
11.5'	Hard gray silt, trace of clay, trace of sand, trace of gravel - damp	5A	11.0-12.5	10-21-27	48
15'		6A	13.5-15.0	12-35-37	72
	Bottom of boring at 15.0'				

METHOD: HOLLOW STEM AUGER

TECHNICIAN: KB-JP

JOB NO.: 28216 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 3000 W 4140 **DATE STARTED:** 9/20/84

SURFACE ELEVATION: 764.0 **DATE COMPLETED:** 9/20/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Very stiff brown silt, some sand, trace of clay, trace of gravel - damp	1A	1.0-2.5	7-10-14	24
4.5'	Hard brown silt, some clay, trace of sand, trace of gravel - damp	2A	3.5-5.0	13-14-22	36
6.5'	Hard gray silt, some clay, trace of gravel - damp	3A	6.0-7.5	45-55	100
9.0'	Gray shale	4A	8.5-10.0 ~~8.510.0~~	25-40-35	75
	Bottom of boring at 10.0'				

5' 10' 15' 20' 25' 30'

METHOD: HOLLOW STEM AUGER
TECHNICIAN: KB-JP
JOB NO.: 28216 (bw)

WATER OBSERVATIONS
INITIAL DEPTH: None
COMPLETION DEPTH: None
DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:
X A. SPLIT SPOON
___ B.
___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 3380 W 4140

DATE STARTED: 9/26/84

SURFACE ELEVATION: 796.7

DATE COMPLETED: 9/26/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Topsoil				
0.3'	(FILL) Dense brown sand, some silt, some cobbles, trace of gravel - moist	1A	1.0-2.5	7- 9-12	21
3.5'	(ORIGINAL) Hard brown silt, some clay, trace of sand, trace of gravel - moist	2A	3.5-5.0	9-15-17	32
5'		3A	6.0-7.5	14-17-17	34
8.5'	Very stiff gray silt, some clay, trace of gravel - moist	4A	8.5-10.0	10-11-18	29
10'	(Becomes hard at 11.0')	5A	11.0-12.5	14-16-18	34
15'		6A	13.5-15.0	17-18-19	37
	Bottom of boring at 15.0'				
20'					
25'					
30'					

METHOD: HOLLOW STEM AGER

TECHNICIAN: KB-JP

JOB NO.: 28216 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILTIY, MIAMISBURG, OHIO

BORING LOCATION: S 3000 W 4520 **DATE STARTED:** 9/26/84

SURFACE ELEVATION: 756.1 **DATE COMPLETED:** 9/26/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
0.3'	Hard brown silt, some sand, trace of gravel, trace of clay - moist	1A	1.0-2.5	7-24-31	55
5'		2A	3.5-5.0	24-32-32	64
6.0'	Hard brown silt, some clay, trace of gravel - moist	3A	6.0-7.5	16-17-20	37
8.5'	Very stiff gray and brown silt, some clay, trace of gravel - moist	4A	8.5-10.0	7-10-16	26
10.0'	Very stiff gray silt, some clay, trace of gravel - moist	5A	11.0-12.5	7- 9-10	19
15'		6A	13.5-15.0	14-15-15	30
	Bottom of boring at 15.0'				
20'					
25'					
30'					

METHOD: HOLLOW STEM AUGER
TECHNICIAN: KB-TB
JOB NO.: 28216 (bw)

WATER OBSERVATIONS
INITIAL DEPTH: None
COMPLETION DEPTH: None
DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:
X A. SPLIT SPOON
___ B.
___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING No.

3600 - S - 2240-W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-24-84

SURFACE ELEVATION:

DATE COMPLETED: 10-24-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS FT	SAMPLE RECOVERY %
ORIG? 0.0	TOPSOIL					
M. STIFF 0.3	BR CLAY, SM SILT, TR GRAV moist	1A	0.0-1.5	2-3-6	9	16
HARD 2.5	BR SILT, TR CLAY, TR GRAV SM ROCK FRAGS DAMP	2A	2.5-3	100	100/6	4"
		3A	5-5.5	100/3	100/3	3"
		4A	7.5-8	100/3	100/3	3"
8.5	GR SHALE w/ LIMESTONE FRAGS	5A	8.5-9	100/3	100/3	3"
9.0	AUGER REFUSAL					
	BOF @ 9.0					

DRILLING METHOD: H. S. A.

DRILLER: TB-JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING No.

3600-S - 2620-W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-23-84

SURFACE ELEVATION:

DATE COMPLETED: 10-23-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS 6"	SAMPLE RECOVERY %
V. STIFF 0.0	BR SILT, SM CLAY, TR GRAV MOIST	1A	0.0-1.5	5-5-12	17	16"
HARD 2.0	BR SILT, TR CLAY, TR GRAV SM ROCK FRAGS DAMP	2A	2.5-3	100/3	100/3	3"
		3A	5-5.5	100/4	100/4	4"
6.0?	GR SHALE w/ LIMESTONE FRAGS.	4A	6.5-7	100/2	100/2	[illegible]"
	BOFB 7.0					

OR 16?

DRILLING METHOD: H.S.A.

DRILLER: TB - JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

- [x] A. SPLIT SPOON
- [ ] B.
- [ ] C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING No.

3600-S — 3000-W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-23-84

SURFACE ELEVATION:

DATE COMPLETED: 10 27 84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS PER FT	SAMPLE RECOVERY %
VISIFF 0.0	BR SILT, SM CLAY, TR GRAV moist	1A	0.0-1.5	3-16-12	29	16"
HARD 2.0	BR SILT, TR GRAV, TR CLAY SM ROCK FRAGS DAMP	2A	2.5-3.5	27-73/3	100/9	9"
		3A	5-6	47-53/2	100/8	4"
		4A	7.5-8	100/2	100/2	0"
8.5	GR SHALE, W/ LIMESTONE FRAGS	5A	8.75-9	100/2	100/2	2"
9.0	AUGER REFUSAL					
	BOFB 9.0					

DRILLING METHOD: H.S.A.

DRILLER: TB - JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH:

COMPLETION DEPTH:

DEPTH AFTER ..... HRS.

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING No.

3600-S — 3380-W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10 23-84

SURFACE ELEVATION:

DATE COMPLETED: 10 23-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	BLOWS PER FT	SAMPLE RECOVERY %
Fill 0.0	BR SAND GRAV w/ CRUSHED STONE MOIST					
ORIG. 0.75	BR SILT, SM CLAY, TR GRAV MOIST	1A	0.0-1.5	10-12-13	25	16"
HARD 3.0	BR SILT, TR CLAY, TR GRAV SM ROCK FRAGS DAMP	2A	2.5-3.5	10-99/3	100/9	9"
		3A	5-5.5	100/6	100/6	6"
7.0	AUGER REFUSAL					
	BOF B 7.0					

DRILLING METHOD: H.S.A.

DRILLER: TB-JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 3650 W 3760

DATE STARTED: 9/26/84

SURFACE ELEVATION: 857.7

DATE COMPLETED: 9/26/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Hard brown silt, some clay, trace gravel - moist	1A	1.0-2.5	7-24-23	47
3.5'	Hard brown silt, some rock fragments, trace of clay, trace of gravel - damp	2A	3.5-4.0	100/4"	100+
		3A	6.0-6.5	100/3"	100+
		4A	8.5-10.0	27-47-53/3"	100
		5A	11.0-12.5	23-77/5"	100
		6A	13.5-14.0	100/5"	100+
	Bottom of boring at 14.0'				

5' 10' 15' 20' 25' 30'

METHOD: HOLLOW STEM AUGER

TECHNICIAN: KB-TB

JOB NO.: 28216 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

BOWSER-MORNER, INC.
P. O. Box 51
DAYTON, OHIO 45401
(513) 253-8805

JOB 2P263
SHEET NO. 1 OF 1
CALCULATED BY DH DATE 11-6-84
CHECKED BY DATE
SCALE

Boring No.	21005-2240W	
Soil Boring, Ft.	5.5	
Rock Coring, Ft.	—	
Std. Pen. Tests	2	
Shelby Tubes	—	
Access Time	.25	Note: Used 1/4 Bag Bentonite for Backfill
ROCK CORING INFORMATION		
Rock Coring Hrs.		
Rock Pressure Tests		
Rock Press. Test, Hrs.		
Hauling Water, Hrs.		
Pumping Water, Ft.		
No. of Core Boxes		
WATER PIPE INFORMATION		
Size of Pipe		
Ft. of Pipe & Point.		
Ft. of Guard Pipe		
Bags of Sand		
Bags of Bentonite		
Time Developing		
GROUT INFORMATION		
Bags of Cement		
Bags of Bentonite		
Bags of Sand		
Total Time		
CHARGEABLE OTHER TIME		
Date		
Staking Time		
Daily Travel, Hrs.		
Daily Miles, Rig		
Daily Miles, No Rig		
Supervision		
Man Hrs. Clearing		
Dozer Hrs.		

LOG OF BORING No. 2100 S - 2240 W

28262

BORING LOCATION on loc.

DATE STARTED: 11-6-84

SURFACE ELEVATION:

DATE COMPLETED: 11-6-84

	STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS FT	SAMPLE RECOVERY IN
Fill	0.0	Topsoil					
Fill	M. Stiff 0.5	Br. & Gr. silt, some clay some sand, trace gravel, etc. [illegible] moist	1A	0.0-1.5	1-3-4	7	18"
rig?	V. stiff 4.0	Br. & Gr. sandy shale with rock frag. damp	2A	3.5-5.0	8-9-11	20	16"
		Auger refusal 5.5					
		B.B. 5.5					

DRILLING METHOD: Hollow stem.

DRILLER: DN-GJ

JOB NO.: 28262

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER N HRS. T

TYPE SAMPLER

- [x] A. SPLIT SPOON
- [ ] B.
- [ ] C. SHELBY TUBE

BOWSER-MORNER

2B12

BOWSER-MORNER, INC.
P. O. Box 51
DAYTON, OHIO 45401
(513) 253-8805

JOB 28-63
SHEET NO. 1 OF 1
CALCULATED BY DH DATE 11-3-84
CHECKED BY DATE
SCALE

Boring No.	1500S - 1860W
Soil Boring, Ft.	8.0
Rock Coring, Ft.	—
Std. Pen. Tests	3
Shelby Tubes	—
Access Time	.25 Note: Used Volclay Bentonite for Backfill
ROCK CORING INFORMATION	
Rock Coring Hrs.	
Rock Pressure Tests	
~~Rock Press. Test, Hrs.~~	
Hauling Water, Hrs.	
Pumping Water, Ft.	
No. of Core Boxes	
WATER PIPE INFORMATION	
Size of Pipe	
Ft. of Pipe & Point.	
Ft. of Guard Pipe	
~~Bags of Sand~~	
Bags of Bentonite	
Time Developing	
GROUT INFORMATION	
Bags of Cement	
Bags of Bentonite	
Bags of Sand	
Total Time	
CHARGEABLE OTHER TIME	
Date	
Staking Time	
~~Daily Travel, Hrs.~~	
Daily Miles, Rig	
Daily Miles, No Rig	
Supervision	
Man Hrs. Clearing	
Dozer Hrs.	

LOG OF BORING No. 1500 S – 1860 W

28263

BORING LOCATION: ~~also~~ grass off parking lot DATE STARTED: 11-3-84

SURFACE ELEVATION: DATE COMPLETED: 11-3-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY IN
Dig. 0.0	Topsoil					
V stiff 0.8	Br. to Gr. silt some clay some sand, trace gravel, trace rock frag. moist	1A	1.0-2.5	6-11-13	24	10"
		2A	3.5-5.0	5-7-9	16	16"
hard 5.0	Br. to Gr. shale with rock frag. damp	3A	6.0-7.5	15-26-23	49	16"
	Auger refusal at 8.0					
	6, B. 8.0					

DRILLING METHOD: Hollow stem.

DRILLER: DH-GJ

JOB NO.: 28263

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER ~ HRS. ~

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

BOWSER-MORNER, INC.
P. O. Box 51
DAYTON, OHIO 45401
(513) 253-8805

JOB 28273
SHEET NO. 1 OF 1
CALCULATED BY DH DATE 11-6-84
CHECKED BY DATE
SCALE

Boring No.	15005 - 1100W										
Soil Boring, Ft.	8.5										
Rock Coring, Ft.	—										
Std. Pen. Tests	3										
Shelby Tubes	—										
Access Time	.25	Note: Used 1/4 Bag Bentonite for Backfill									
ROCK CORING INFORMATION											
Rock Coring Hrs.											
Rock Pressure Tests											
Rock Press. Test, Hrs.											
Hauling Water, Hrs.											
Pumping Water, Ft.											
No. of Core Boxes											
WATER PIPE INFORMATION											
Size of Pipe											
Ft. of Pipe & Point.											
Ft. of Guard Pipe											
Bags of Sand											
Bags of Bentonite											
Time Developing											
GROUT INFORMATION											
Bags of Cement											
Bags of Bentonite											
Bags of Sand											
Total Time											
CHARGEABLE OTHER TIME											
Date											
Staking Time											
Daily Travel, Hrs.											
Daily Miles, Rig											
Daily Miles, No Rig											
Supervision											
Man Hrs. Clearing											
Dozer Hrs.											

LOG OF BORING No. 1500S-1100W

282685 2

BORING LOCATION: on loc.

DATE STARTED: 11-6-84

SURFACE ELEVATION:

DATE COMPLETED: 11-6-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM.	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	UNIT BLOWS FT	SAMPLE RECOVERY %
Fill 0.0	Topsoil					
Fill hard 2.3	Br. silt sandy clay some and to gravel, tr. of rock frag. to inorganic, moist	1A	0.0-1.5	4-31-6	37	16"
	(Becomes V. stiff at 3.5)	2A	3.5-5.0	8-6-11	17	16"
hard orig. 6.0	Br. shale with rock frag. moist	3A	6.0-7.0	30-32	62	12"
	augered first 6.5					
	B. B. 8.5					

DRILLING METHOD: Hollow-stem

DRILLER: OH-GJ

JOB NO.: 2 ~~82403~~

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER N HRS. T

TYPE SAMPLER

[X] A. SPLIT SPOON

[ ] B.

[ ] C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 2700 W 4750 **DATE STARTED:** 9/25/84

SURFACE ELEVATION: 703.9 **DATE COMPLETED:** 9/25/84

STRATUM	DESCRIPTION OF MATERIAL (FILL)	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	(FILL) Hard brown silt, trace of clay, trace of sand, trace of gravel, trace of wood - damp	1A	1.0-2.5	13-32-19	51
4.0'	(ORIGINAL) Very dense brown sand and gravel, trace of silt - moist	2A	3.5-5.0	17-32-28	60
5'	(Auger refusal at ~~8~~ 6.0')				
	Bottom of boring at 6.0')				
10'					
15'					
20'					
25'					
30'					

METHOD: HOLLOW STEM AUGER

TECHNICIAN: KB-JP

JOB NO.: 28216 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING No.

BORING LOCATION:

DATE STARTED: 11-14-84

SURFACE ELEVATION:

DATE COMPLETED:

	STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS FT	SAMPLE RECOVERY %
1255-S 931-W	LOC #1	0.0 TOPSOIL ROCK 1.5' B of B 2.0'					
LOC 2	1525 S 2589 W	0.0 BR CLAY SM SILT, MO. ROCK 2.5' B of B 3.0'					
LOC. 3	1670 S 2516 W	BR SAND & GRAV, MOIST 2.0'					
LOC. 4	1792 S. 3009 W.	0.0 CRUSHED STONE 0.5 BR SAND, MOIST 2.0 BR CLAY SM SILT, MOIST ROCK 3.5' B of B 4.0'					
LOC.	1743 S 3404 W	0.0 BR SAND SM SILT, MOIST 1.5 Shale B of B 2.5'					
LOC. 6	1449 S 3016 W	0.0 BR SAND & GRAV, MO. 0.5 BR CLAY SM SILT, MO. ROCK 1.0 B of B 1.5'					
LOC. 7	1505 S. 3428 W	0.0 CRUSHED STONE 0.5 BR SAND & GRAV, MOIST ROCK 4.5' B of B 4.5'					
11-15 LOC. 8.	2151 S 3011 W	0.0 BR SAND & GRAV, MO 1.0 Shale B of B 2.5'					
LOC. 9	2185 S 3362 W	0.0 CRUSHED STONE 0.5 BR CLAY, C SILT, MOIST ROCK 2.0 B of B 2.0'					
LOC. 10	1323 S 3631 W	0.0 CRUSHED STONE 0.3 BR SHALE B of B 2.0'					

DRILLING METHOD: 2¼ HSA

DRILLER: RG -

JOB NO.: 28280

WATER OBSERVATIONS

INITIAL DEPTH:

COMPLETION DEPTH:

DEPTH AFTER ..... HRS.

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING No.

BORING LOCATION:

DATE STARTED: 11-14-84

SURFACE ELEVATION:

DATE COMPLETED: 11-15-85

	STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS/FT	SAMPLE RECOVERY %
LOC. 11	I BRIDGE NEXT TO PERIMETER FENCE	0.0 ASPHALT (OLD) 2" BR SAND + GRAV, MOIST 3.0' BR CLAY w/ SILTS, MOIST 5.5' ROCK B of B 6.0'					
LOC. #12	2400 S 1860 W	0.0 TOPSOIL 2" BR CLAY w/ ROCK FRAGS. B of B 2.0'					
LOC. 13	SO. OF TRAILER 74	0.0 TOPSOIL 3" BR CLAY w/ ROCK FRAGS. Appt. ROCK 2.5' B of B 3.5'					
LOC. 14	2700 S 3760 W	0.0 TOPSOIL 0.5 BR CLAY w/ SILTS, MOIST 3.0' BR CLAY w/ ROCK FRAGS, MOIST B of B 4.5'					

DRILLING METHOD:

DRILLER:

JOB NO.: 2P2P0

WATER OBSERVATIONS

INITIAL DEPTH: .....

COMPLETION DEPTH: .....

DEPTH AFTER ..... HRS. .....

TYPE SAMPLER:

- ☐ A. SPLIT SPOON
- ☐ B.
- ☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 3000 W 4900

DATE STARTED: 9/25/84

SURFACE ELEVATION: 703.8

DATE COMPLETED: 9/25/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Stiff dark brown silt, some clay, trace of sand, trace of gravel - moist	1A	1.0-2.5	5- 7- 7	14
3.0'	Very stiff brown silt, some clay, trace of sand, trace of gravel - moist	2A	3.5-5.0	8-10-10	20
5' 6.5'	Medium dense brown sand, some silt, trace of gravel - moist (Becomes very dense at 8.5')	3A	6.0-7.5	5- 6- 7	13
		4A	8.5-10.0	40-30-30	60
10' 10.5'	Hard brown silt, some clay, trace of sand, trace of gravel, trace of cobbles - moist	5A	11.0-12.5	7-17-24	41
14.0' 15'	Hard gray silt, trace of clay, trace of sand, trace of gravel - moist	6A	13.5-15.0	12-17-21	38
	Bottom of boring at 15.0'				
20'					
25'					
30'					

METHOD: HOLLOW STEM AUGER

TECHNICIAN: KB-JP

JOB NO.: 28216 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO.

MONSANTO RESEARCH CORPORATION,
MOUND FACILITY, MIAMISBURG, OHIO

BORING LOCATION: S 2700 W 4520 — Susan Wilson 5-31-90

DATE STARTED: 9/25/84

SURFACE ELEVATION:

DATE COMPLETED: 9/25/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Topsoil				
1.0'	Hard brown silt, some sand, trace of clay, trace of gravel - damp	1A	1.0-2.5	6-20-23	43
4.0'	Very stiff brown clay, trace of sand and gravel , trace of silt - moist	2A	3.5-5.0	6- 9- 9	18
6.0'	Hard gray silt, some sand, trace of gravel - damp	3A	6.0-7.5	22-23-31	54 ~~53~~
10'		4A	8.5-10.0	45-30-25	55
11.5'	Stiff gray and brown clay, some silt, trace of sand, trace of gravel - moist	5A	11.0-12.5	7- 5- 9	14
14.5'	Stiff black clay, some silt, trace of gravel - moist	6A	13.5-15.0	11- 6- 9	15
15'	Bottom of boring at 15.0'				
20'					
25'					
30'					

METHOD: HOLLOW STEM AUGER

TECHNICIAN:

JOB NO.:

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

X A. SPLIT SPOON

___ B.

___ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING No.

2700 S + 4520 W

BORING LOCATION: ON LOC

DATE STARTED: 9-25-84

SURFACE ELEVATION:

DATE COMPLETED: 9-25-84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS FT	SAMPLE RECOVERY IN
ORG? 0.0	TOPSOIL					
1.0	HARD BR SILT, SM SAND TR CLAY, TR GRAVEL DAMP	1A	1-2.5	6-20-23	43	12"
4.0	V. STIFF BR CLAY, TR SAND + GRAVEL TR SILT, MOIST	2A	3.5-5.0	6-9-9	18	12"
6.0	HARD GR SILT, SM SAND TR GRAVEL DAMP	3A	6.0-7.5	22-23-31	53	18"
		4A	8.5-10	45-30-25	55	12"
11.5	STIFF GR BR CLAY, SM SILT TR SAND, TR GRAVEL MOIST	5A	11-12.5	7-5-9	14	12"
14.5	STIFF BR CLAY, SM SILT TR GRAVEL MOIST	6A	13.5-15	11-6-9	15	12"
	BOTB 15.0					

DRILLING METHOD: HOLLOW STEM

DRILLER: KBJP

JOB NO.: 25216

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER 0 HRS. 1

TYPE SAMPLER:

☒ A. SPLIT SPOON

☐ B.

☐ C. SHELBY TUBE

BOWSER-MORNER

2B12

LOG OF BORING No.

3300 - S — 3000 W

BORING LOCATION: AS DIRECTED

DATE STARTED: 10-20-84

SURFACE ELEVATION:

DATE COMPLETED: 10 20 84

STRATUM	DESCRIPTION OF MATERIAL SOIL CLASSIFICATION SYSTEM:	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS	SAMPLE RECOVERY
DRILL 0.0	TOPSOIL					
STIFF 0.5	BR SILT, SOME CLAY, TRACE SAND	1A	0.0-1.5	2-3-8	11	16"
HARD 2.5	BR. SILT, SOME CLAY, TRACE SOME ROCK FRAGS. DAMP	2A	2.5-3.5	21-77/2	100/8	8"
		3A	5-5.5	100/6	100/6	6"
		4A	7.5-8.5	47-57	104/12	10"
	BUFB 8.5					

DRILLING METHOD: H. S. A.

DRILLER: T.B-JP

JOB NO.: 28238

WATER OBSERVATIONS

INITIAL DEPTH: NONE

COMPLETION DEPTH: NONE

DEPTH AFTER N HRS. T

TYPE SAMPLER:

- [x] A. SPLIT SPOON
- [ ] B.
- [ ] C. SHELBY TUBE

BOWSER-MORNER

2B12

B.2. LOGS OF PIPES INSTALLED IN AREAS 1, 8, AND 12 FOR

IN SITU GAMMA SPECTROSCOPY

BOWSER-MORNER, INC.

REPORT TO: Monsanto Research Corporation
Mound Facility
P.O. Box 32
Miamisburg, Ohio 45342

REPORT DATE: February 17, 1984

REPORT NO.: 27298-284-141

REPORT ON: Soil Boring and Installation of Monitor Wells, Mound Facility, Miamisburg, Ohio

Bowser-Morner, Inc., was authorized by Purchase Order No. 43059, Change No. 02, dated October 17, 1983, to proceed with the soil borings and monitor well installations at locations and to depths as directed.

Two (2) soil borings and monitor wells were located west of Building #38 (Boring Nos. 286-1 and 287-1) and twenty (20) were located around Building #21 (Boring Nos. 288-1 through 307-1) at the approximate locations as shown on the attached site plan. The borings were made with a truck-mounted "Mobile B-61" rotary rig using 6-inch solid earth augers to advance the boring. No soil samples were taken or required by the client. The soil was visually classified from auger cuttings and recorded on the attached boring logs.

A monitoring well was installed in each of the borings. The wells were installed using 4-inch Schedule 40 PVC pipe with a glued on bottom cap set to the bottom of the boring. Clean sand was placed between the pipe and the surrounding soil. The top 6 inches was filled with a dry bentonite clay to seal off surface water. A 6" x 5' long steel guard pipe with a hinged locking cap and lock was installed over the top of the PVC pipe.

All Reports Remain The Confidential Property Of Bowser-Morner And No Publication Or Distribution Of Reports May Be Made Without Our Express Written Consent Except As Authorized By Contract

Surface elevations and exact locations are to be determined by other than Bowser-Morner, Inc.

Please contact the writer if there are any questions, or if we can be of further service.

Respectfully submitted,

Bowser-Morner, Inc.

Robert L. Disney, Manager
Field Exploration Department

RLD/mjj(#56)
3-Client
2-MRC, Attn: Mr. Dick Bertram
2-File

BOWSER MORNER

LOG OF BORING NO. 286-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 2885.666
West 2498.921

DATE STARTED: 1-23-84

SURFACE ELEVATION: 871.07

DATE COMPLETED: 1-23-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, trace of sand, trace of concrete fragments - damp				
3.0'	(ORIGINAL) Brown clay, trace of silt, trace of sand, trace of gravel-moist				
5'					
10'					
12.0'	Gray clay, trace of silt, trace of sand, trace of gravel - moist				
15.0'	Apparent rock (auger refusal)				
	Bottom of boring at 15.0'				
20'					
25'	Note: 4" PVC pipe installed with bottom at 14.5' with 2.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 287-1

MONITORING WELLS IN OLD FILLS SITES

BORING LOCATION: South 2915.293
West 2490.347

DATE STARTED: 1-23-84

SURFACE ELEVATION: 874.17

DATE COMPLETED: 1-23-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, trace of sand, trace of gravel, trace of concrete fragments - damp				
3.0'	(ORIGINAL) Brown clay, trace of sand, trace of silt, trace of gravel-moist				
5'					
10'					
12.0'	Apparent rock (auger refusal)				
	Bottom of boring at 12.0'				
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 11.5' with 2.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 288-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3777.190
West 3245.281

DATE STARTED: 1-23-84

SURFACE ELEVATION: 888.87

DATE COMPLETED: 1-23-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Brown silt, trace of sand, trace of gravel - damp				
2.0'	Brown clay, trace of silt, trace of gravel - damp				
5.0'	Limestone layers, 6" to 1' thick				
8.0'	Apparent rock (auger refusal)				
10'	Bottom of boring at 8.0'				
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 7.0' with 2.0' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

_____ A. SPLIT SPOON

_____ B.

_____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 289-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3724.774
West 3254.302

DATE STARTED: 1-23-84

SURFACE ELEVATION: 891.24

DATE COMPLETED: 1-23-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.2'					
2.0'	(ORIGINAL) Brown silt, trace of sand, trace of gravel - damp				
5'	Brown clay and silt, trace of sand, trace of gravel - damp				
5.5'	Apparent rock (auger refusal)				
	Bottom of boring at 5.5'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 5.5' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

_____ A. SPLIT SPOON

_____ B.

_____ C. SHELBY TUBE

BOWSER - MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 290-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3752.358
West 3322.860

DATE STARTED: 1-23-84

SURFACE ELEVATION: 888.69

DATE COMPLETED: 1-23-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.8'	(ORIGINAL) Brown clay, trace of sand, trace of gravel - moist (6" limestone layers at 2.5')				
5.0'	Apparent rock (auger refusal)				
	Bottom of boring at 5.0'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 5.0' with 2.0' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 291-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3808.217
West 3323.569

DATE STARTED: 1-24-84

SURFACE ELEVATION: 886.12

DATE COMPLETED: 1-24-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.5'	(ORIGINAL) Brown silt, trace of sand, trace of gravel - damp				
2.0'	Brown clay, trace of sand, trace of gravel - moist				
5'					
5.5'	Apparent rock (auger refusal)				
	Bottom of boring at 5.5'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 5.0' with 1.0' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-RH

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER ____ HRS ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 292-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3670.827
West 3342.887

DATE STARTED: 1-24-84

SURFACE ELEVATION: 889.39

DATE COMPLETED: 1-24-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.5'					
1.0'	(ORIGINAL) Brown silt, trace of sand, trace of gravel - moist				
4.0'	Brown clay, trace of silt, trace of sand, trace of gravel - moist				
5'	Apparent rock (auger refusal)				
	Bottom of boring at 4.0'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 4.0' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-RH

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 293-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3716.055
West 3400.604

DATE STARTED: 1-24-84

SURFACE ELEVATION: 886.19

DATE COMPLETED: 1-24-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.5'	(ORIGINAL) Brown silt, trace of sand, trace of gravel - moist				
2.0'	Red and brown clay, trace of silt, trace of sand, trace of gravel-moist				
4.5'	Apparent rock (auger refusal)				
	Bottom of boring at 4.5'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom 4.5' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-RH

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 294-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3751.261
West 3418.167

DATE STARTED: 1-24-84

SURFACE ELEVATION: 884.19

DATE COMPLETED: 1-24-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.5'	(ORIGINAL) Brown silt, trace of sand, trace of gravel - moist				
1.5'	Brown clay, trace of sand, trace of gravel - moist				
4.5'	Apparent rock (auger refusal)				
5'	Bottom of boring at 4.5'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 4.5' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-RH

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 295-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3791.907
West 3441.524

DATE STARTED: 1-24-84

SURFACE ELEVATION:

DATE COMPLETED: 1-24-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.5'	(ORIGINAL) Brown silt, trace of sand, trace of gravel - damp				
4.5'	Apparent rock (auger refusal)				
	Bottom of boring at 4.5'				
5'					
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 4.5' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-RH

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 296-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3865.887
West 3483.068

DATE STARTED: 1-24-84

SURFACE ELEVATION: 872.57

DATE COMPLETED: 1-24-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Topsoil				
0.25'	(ORIGINAL) Brown clay, some silt, trace of sand, trace of gravel - moist				
5.0'	Light brown silt, some clay, trace of sand, trace of gravel - damp				
10'					
11.0'	Apparent rock (auger refusal)				
	Bottom of boring at 11.0'				
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 11.0' with 2.0' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-RH

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 297-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3801.142
West 3524.052

DATE STARTED: 1-24-84

SURFACE ELEVATION: 376.32

DATE COMPLETED: 1-24-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Brown silt, trace of sand, trace of gravel, trace of cobbles - damp				
5.0'					
	Weathered rock				
6.0'					
	Apparent rock (auger refusal)				
	Bottom of boring at 6.0'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 6.0' with 2.0' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-RH

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 298-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3682.070
West 3413.341

DATE STARTED: 1-24-84

SURFACE ELEVATION: 886.39

DATE COMPLETED: 1-24-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.75'	(ORIGINAL) Red and brown clay, some silt, trace of sand, trace of gravel - damp				
3.5'	Weathered rock				
5'					
6.5'	Apparent rock (auger refusal)				
	Bottom of boring at 6.5'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 6.5' with 2.0' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-RH

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 299-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3737.870
West 3478.508

DATE STARTED: 1-25-84

SURFACE ELEVATION: 881.72

DATE COMPLETED: 1-25-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.1'	(ORIGINAL) Brown clay, trace of sand, trace of gravel - damp				
4.5'					
5'	Apparent rock (auger refusal)				
	Bottom of boring at 4.5'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 4.5' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 300-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3529.943
West 3447.023

DATE STARTED: 1-25-84

SURFACE ELEVATION: 687.24

DATE COMPLETED: 1-25-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Brown clay, trace of silt, trace of gravel - moist				
2.5'	Weathered rock				
5'					
6.0'	Apparent rock (auger refusal)				
	Bottom of boring at 6.0'				
10'					
15'					
20'					
25'	Note" 4" PVC pipe installed with bottom at 6.0' with 2.0' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 301-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3648.130
West 3642.829

SURFACE ELEVATION: 874.47

DATE STARTED: 1-25-84

DATE COMPLETED: 1-25-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Brown clay, trace of sand, trace of gravel - moist				
3.0'	Weathered rock				
5'					
6.0'	Apparent rock (auger refusal)				
	Bottom of boring at 6.0'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 6.0' with 1.5' above ground				
30'					

METHOD:	SOLID AUGER	WATER OBSERVATIONS	TYPE SAMPLER:
TECHNICIAN:	RF-BP	INITIAL DEPTH: None	____ A. SPLIT SPOON
JOB NO.:	27298 (mjj)	COMPLETION DEPTH: None	____ B.
		DEPTH AFTER: ____ HRS. ____	____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 302-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3640.540
West 3587.254

DATE STARTED: 1-25-84

SURFACE ELEVATION: 878.92

DATE COMPLETED: 1-25-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone				
0.1'					
2.0'	(OIRGINAL) Brown clay, trace of silt, trace of gravel - moist				
	Weathered rock				
4.0'					
5'	Apparent rock (auger refusal)				
	Bottom of boring at 4.0'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 4.0' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: _____ HRS. _____

TYPE SAMPLER:

_____ A. SPLIT SPOON

_____ B.

_____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 303-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3628.301
West 3541.960

DATE STARTED: 1-25-84

SURFACE ELEVATION: 882.67

DATE COMPLETED: 1-25-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Brown clay, trace of sand, trace of gravel - moist				
1.0'	Weathered rock				
3.0'	Apparent rock (auger refusal)				
5'	Bottom of boring at 3.0'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 2.0' with 1.5' above ground				
30'					

METHOD:	SOLID AUGER	**WATER OBSERVATIONS**	**TYPE SAMPLER:**
TECHNICIAN:	RF-BP	INITIAL DEPTH: None	____ A. SPLIT SPOON
JOB NO.:	27298 (mjj)	COMPLETION DEPTH: None	____ B.
		DEPTH AFTER ____ HRS. ____	____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 304-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3567.768
West 3565.347

DATE STARTED: 1-25-84

SURFACE ELEVATION: 884.17

DATE COMPLETED: 1-25-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Brown sand and gravel - damp				
0.6'	Brown silt, trace of sand, trace of gravel - moist				
3.0'	Weathered rock				
4.5'	Apparent rock (auger refusal)				
	Bottom of boring at 4.5'				
5'					
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 4.5' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 305-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3705.192
West 3710.715

DATE STARTED: 1-25-84

SURFACE ELEVATION: 863.22

DATE COMPLETED: 1-25-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Brown silt, trace of sand, trace of gravel - moist				
3.0'	Apparent rock (auger refusal)				
5'	Bottom of boring at 3.0'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 3.0' with 2.0' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 306-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3784.253
West 3591.393

DATE STARTED: 1-25-84

SURFACE ELEVATION: 870.22

DATE COMPLETED: 1-25-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	Cinders, trace of sand, trace of gravel - damp				
0.5'	Brown silt, trace of sand, trace of gravel - damp				
2.0'	Weathered rock				
5'					
6.0'	Apparent rock (auger refusal)				
	Bottom of boring at 6.0'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 6.0' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.

LOG OF BORING NO. 307-1

MONITORING WELLS IN OLD FILL SITES

BORING LOCATION: South 3679.278
West 3500.858

DATE STARTED: 1-25-84

SURFACE ELEVATION: 882.72

DATE COMPLETED: 1-25-84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Crushed stone and sand				
1.0'	moist				
	(ORIGINAL) Weathered rock				
4.5'					
	Apparent rock (auger refusal)				
	Bottom of boring at 4.5'				
10'					
15'					
20'					
25'	Note: 4" PVC pipe installed with bottom at 4.5' with 1.5' above ground				
30'					

METHOD: SOLID AUGER

TECHNICIAN: RF-BP

JOB NO.: 27298 (mjj)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER ____ HRS. ____

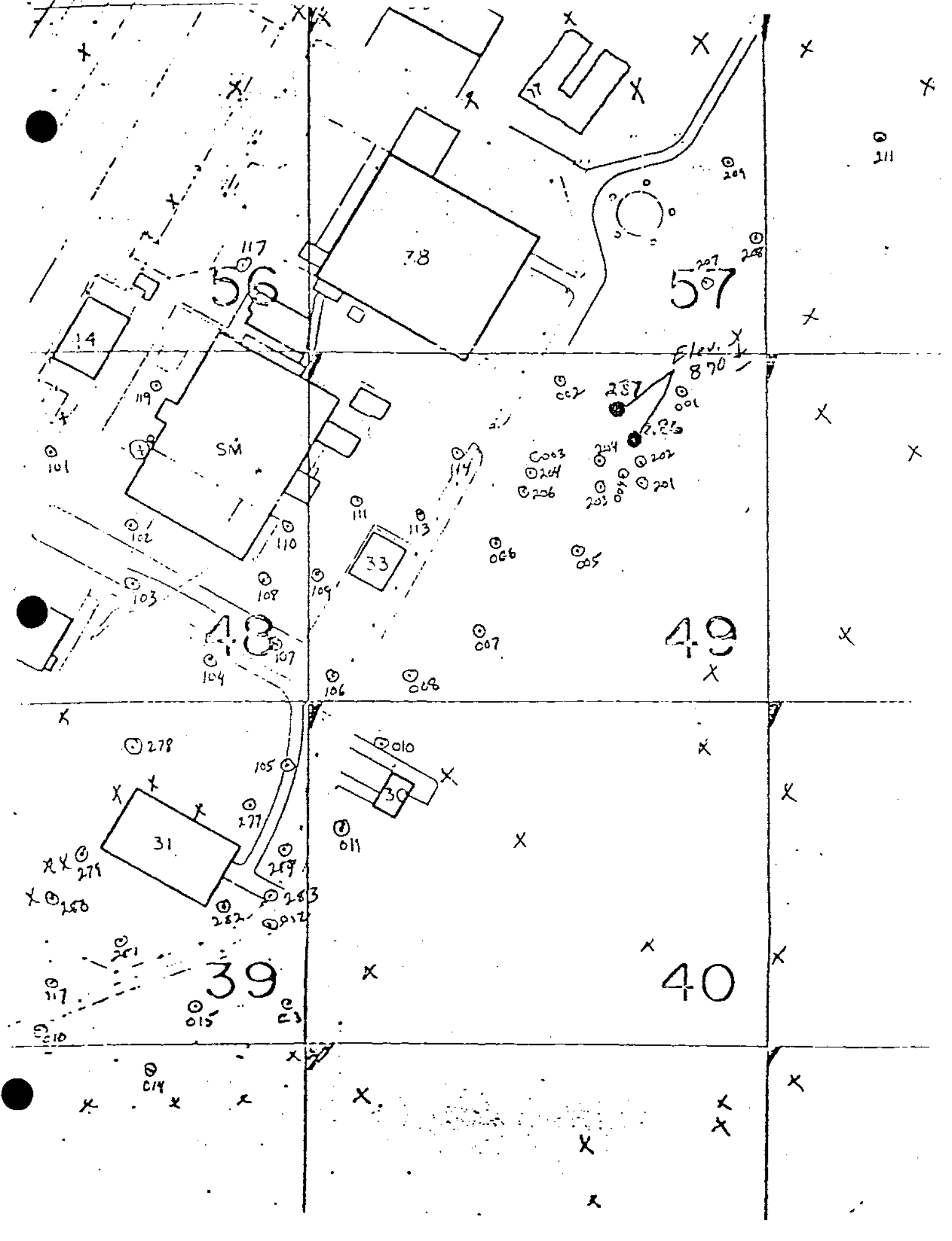
TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER
TESTING LABORATORIES, INC.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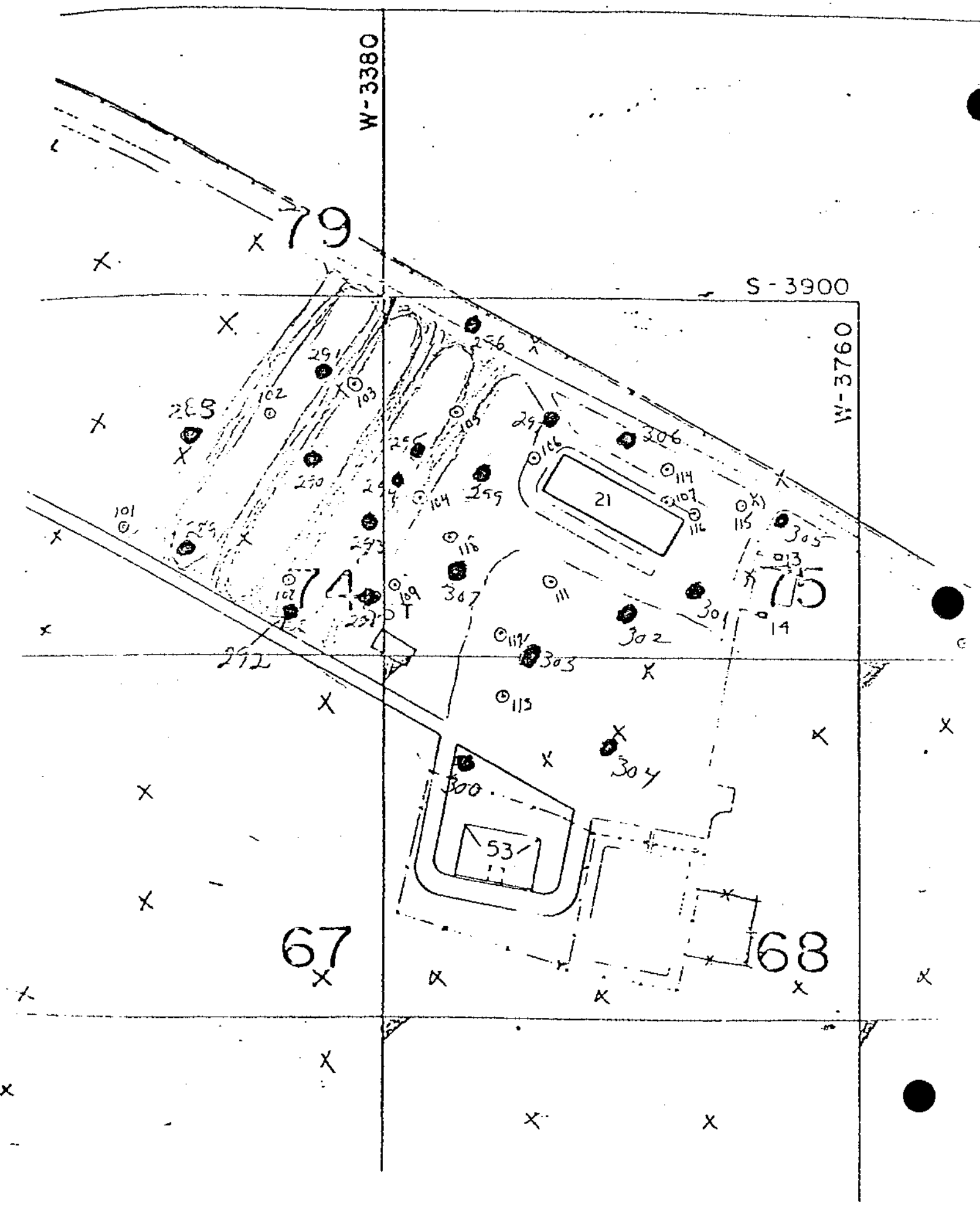
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LOG OF BORING NO. 317

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2411.54 S.; 2139.18 W. **DATE STARTED:** 6/13/84

SURFACE ELEVATION: 863.6' **DATE COMPLETED:** 6/13/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Topsoil				
0.5'	(FILL) Gray shale, with rock fragments - damp				
5'					
10'					
15'	(Auger refusal at 14.5')				
	Bottom of boring at 14.5'				
20'					
25'					
30'	NOTE: Set 4" PVC pipe 14.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 318

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2395.01 S.; 2063.57 W. **DATE STARTED:** 6/13/84

SURFACE ELEVATION: 862.3' **DATE COMPLETED:** 6/13/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, some gravel, trace of cobbles, trace of rock fragments - damp				
5'					
10'					
	(Auger refusal at 12.5')				
15'	Bottom of boring at 12.5'				
20'					
25'					
30'	NOTE: Set 4" PVC pipe 12.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 319

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2371.92 S.; 2104.88 W. **DATE STARTED:** 6/13/84

SURFACE ELEVATION: 861.2' **DATE COMPLETED:** 6/13/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of cobbles, trace of rock fragments - moist				
5'					
7.0'	(FILL) Black and gray clay, some silt, some sand, some organic material - moist				
10'					
11.0'	(FILL) Gray silt, some clay, some sand, trace of rock fragments - moist (Auger refusal at 13.5')				
15'	Bottom of boring at 13.5'				
20'					
25'					
30'	NOTE: Set 4" PVC pipe 13.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 320

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2362.67 S.; 2142.37 W. **DATE STARTED:** 6/13/84

SURFACE ELEVATION: 860.7' **DATE COMPLETED:** 6/13/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of cobbles, trace of rock fragments - moist				
2.5'	(FILL) Gray and black silt and clay, some sand, trace of gravel - moist				
5'					
10'					
15'	(Auger refusal at 14.0')				
	Bottom of boring at 14.0'				
20'					
25'					
30'	NOTE: Set 4"PVC pipe 14.0' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 321

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2374.12 S.; 2184.29 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 860.2' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of cobbles, trace of rock fragments - moist				
5'					
10'					
11.0'	(FILL) Gray silt, some clay, some sand, trace of rock fragments, trace of gravel - moist (Auger refusal at 13.5')				
15'	Bottom of boring at 13.5				
20'					
25'					
30'	NOTE: Set 4" PVC pipe 13.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 322

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2396.63 S.; 2204.70 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 860.2' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of rock fragments, trace of cobbles - moist				
5'					
10'	(Auger refusal at 9.5')				
	Bottom of boring at 9.5'				
15'					
20'					
25'					
30'	NOTE: Set 4" PVC pipe 9.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 323

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2405.82 S.; 2212.91 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 860.6' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of rock fragments, trace of cobbles, trace of gravel - moist				
5' 5.5'	(FILL) Gray silt, some clay, some sand, trace of rock fragments, trace of gravel - moist (Auger refusal at 7.0')				
10'	Bottom of boring at 7.0'				
15'					
20'					
25'					
30'	NOTE: Set 4" PVC pipe 7.0' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 324

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2428.62 S.; 2178.04 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 863.7' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of cobbles, trace of rock fragments - moist				
5'					
10'					
10.5'	(FILL) Gray silt, some clay, some sand, trace of gravel, trace of rock fragments - moist (Auger refusal at 11.5')				
15'	Bottom of boring at 11.5'				
20'					
25'					
30'	NOTE: Set 4" PVC pipe 11.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 325

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2495.90 S.; 2236.24 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 866.5' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of rock fragments, trace of gravel, trace of cobbles - moist				
5'					
7.5'	(FILL) Gray silt, some clay, some rock fragments - moist (Auger refusal at 9.5')				
10'	Bottom of boring at 9.5'				
15'					
20'					
25'					
30'	NOTE: Set 4" PVC pipe 9.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 326

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2478.86 S.; 2212.03 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 866.2' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of rock fragments, trace of cobbles - moist				
5'					
7.0'	(FILL) Gray silt, some clay, some sand, trace of gravel, trace of rock fragments - moist (Auger refusal at 9.5')				
10'					
	Bottom of boring at 9.5'				
15'					
20'					
25'					
30'	NOTE: Set 4" PVC pipe 9.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 327

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2464.14 S.; 2183.99 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 865.8' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of rock fragments - moist				
5'					
6.0'	(FILL) Gray silt, some clay, some sand, trace of rock fragments, trace of gravel - moist (Auger refusal at 7.5')				
10'	Bottom of boring at 7.5'				
15'					
20'					
25'					
30'	NOTE: Set 4" PVC pipe 7.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 328

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2450.73 S.; 2151.55 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 865.0' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of rock fragments - moist				
5'					
5.5'	(FILL) Gray silt, some clay, some sand, trace of rock fragments, trace cobbles - moist (Auger refusal at 7.5')				
10'	Bottom of boring 7.5'				
15'					
20'					
25'					
30'	NOTE: Set 4" PVC pipe 7.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 329

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2438.63 S.; 2119.34 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 864.5' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of rock fragments, trace of gravel - moist				
5'					
10'					
11.0'	(FILL) Gray silt, some clay, some sand, trace of rock fragments, trace of gravel - moist (Auger refusal at 12.5')				
15'	Bottom of boring at 12.5'				
20'					
25'					
30'	NOTE: Set 4" PVC pipe 12.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 330

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2422.74 S.; 2080.99 W. **DATE STARTED:** 6/14/84

SURFACE ELEVATION: 863.4' **DATE COMPLETED:** 6/14/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	SLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of rock fragments - moist				
5'					
5.5'	(FILL) Gray silt, some clay, some sand, trace of rock fragments - moist (Auger refusal at 6.5')				
10'	Bottom of boring at 6.5'				
15'					
20'					
25'					
30'	NOTE: Set 4" PVC pipe 6.5' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

LOG OF BORING NO. 331

MONITORING WELL INSTALLATION AT OLD FILL SITE

BORING LOCATION: 2401.45 S.; 2102.09 W. **DATE STARTED:** 6/13/84

SURFACE ELEVATION: 863.1' **DATE COMPLETED:** 6/13/84

STRATUM	DESCRIPTION OF MATERIAL	SAMPLE NO. & TYPE	SAMPLE DEPTH	BLOWS PER 6" ON SAMPLER	"N" BLOWS /FT. OR CORE REC.
0.0'	(FILL) Brown silt, some clay, some sand, trace of gravel, trace of cobbles, trace of rock fragments - moist				
5'					
7.0'	(FILL) Gray shale with rock fragments - damp				
10'					
15'	Bottom of boring at 15.0'				
20'					
25'					
30'	NOTE: Set 4" PVC pipe 15.0' deep with locking steel cover				

METHOD: 8" SOLID AUGER

TECHNICIAN: DH-GJ

JOB NO.: 28070 (bw)

WATER OBSERVATIONS

INITIAL DEPTH: None

COMPLETION DEPTH: None

DEPTH AFTER: ____ HRS. ____

TYPE SAMPLER:

____ A. SPLIT SPOON

____ B.

____ C. SHELBY TUBE

BOWSER – MORNER

APPENDIX C

IN SITU GAMMA SPECTROSCOPY REPORTS

RADIOLOGICAL CHARACTERIZATION OF SUBSURFACE SOIL NEAR BUILDING 31 AT THE MOUND LAB FACILITY

PREPARED FOR:

MONSANTO RESEARCH CORPORATION

PREPARED BY:

RADIATION MANAGEMENT CORPORATION

AUGUST 1, 1984

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INTRODUCTION

This report describes the subsurface radiological characterization survey performed by Radiation Management Corporation (RMC) in July, 1984 at the Monsanto Research Corporation (MRC) Mound Lab facility. The purpose of the survey was to identify and quantify the radiological content of subsurface soil in an area designated by Mound Lab as "area 8 vicinity", which included approximately 30,000 square feet of ground surface north of Building 31. Survey measurement results were used to estimate the volume of soil present in this area with Th-232 activity concentrations above 5 pCi/g and above 20 pCi/g.

Measurements were performed on July 9, 10 and 11, 1984. A total of 15 boreholes were logged at one-foot depth intervals using an intrinsic germanium detector gamma spectroscopy system. Spectral data was stored on cassette tape, and manual photopeak area determinations were performed in the field. Analysis results are presented for each activity concentration calculation in Appendix A and B, and Th-232 activity results are summarized in the text of this report. A significant volume of subsurface soil was found to contain elevated levels of Th-232, and a graphical model defining the estimated boundaries of soil above 5 pCi/g and 20 pCi/g is presented in the text of this report. No Th-232 activity

concentrations above 100 pCi/g were observed during this survey.

SCOPE OF WORK

This survey was performed in accordance with MRC Purchase Order No. 11806 dated 6/27/84. The primary goal of the survey was to determine the volume of soil in the area of interest with Th-232 activity concentrations above 5 pCi/g, above 20 pCi/g, and above 100 pCi/g (if any). Because 5 pCi/g was established as the lowest action level, it was agreed that the measurement system sensitivity should be 1 pCi/g Th-232 (i.e. system MDA equal to 20% of the target criterion).

MRC had previously contracted a drilling crew to place 15 boreholes in the area of interest. The boreholes ranged in depth from six to thirteen feet below surface, and were lined with four-inch diameter PVC pipe. Each borehole was logged at one-foot depth intervals, with each activity determination assumed to represent the average activity value in a one-foot thick layer of soil centered at that measurement depth.

DESCRIPTION OF EQUIPMENT AND MEASUREMENT PROCEDURE

The detector employed for this project was a custom designed EG&G Ortec detector, S/N 21-P-735C. The detector, preamp, cryostat and dewar are all housed in 2.75 inch O.D. casing which allows sufficient room for the assembly to be lowered into 4-inch PVC casing which is used to line all boreholes. The detector has a relative efficiency of 10% and a resolution of about 2 keV. The entire assembly is outfitted with 100 feet of cables.

The detector assembly was connected to a small portable multichannel analyzer (MCA) for data acquisition. The MCA selected for this use was the Canberra Series 10 MCA. The Series 10 is a lightweight, battery operated MCA which contains a spectroscopy amplifier and bias power supply for the IG detector. A mini-cassette recorder was interfaced to the MCA for data storage.

All acquisitions were made for a total of 300 seconds. Data was accumulated over 2048 channels, at an energy setting of 1 keV per channel. The MCA was set up so that the gross integral counts and net photopeak counts were automatically calculated and displayed for four regions of interest (ROI) following each acquisition. Count data for each ROI was recorded and converted to activity concentrations manu-

ally in the field following each acquisition. These regions included the K-40 photopeak at 1461 keV, and Ra-226 daughter Bi-214 photopeak at 609 keV, and Th-232 daughter Tl-208 photopeak at 583 keV and Ac-228 photopeak at 911 keV. Net photopeak count rates were converted to pCi/g values using the efficiency factors established during system calibration. Calibration data is presented in Appendix C.

DISCUSSION OF RESULTS

For each depth interval at each borehole, the spectral data were examined and photopeak integral and area calculations were made using the computation functions available on the Canberra Series 10 MCA. These calculations were performed for the 583 keV Tl-208, 609 keV Bi-214, 911 keV Ac-228 and 1461 keV K-40 photopeaks in each spectrum. The soil at Mound Lab was expected to have Bi-214 and K-40 activity concentrations in the normal background ranges of 0.5-1.5 pCi/g and 5-15 pCi/g, respectively. These expected values were observed for the majority of spectral acquisitions, and provided good quality control checks for the Th-232 results. The complete set of photopeak calculation data is presented in Appendix B.

It was assumed the Th-232/Th-228 and all daughter nuclides in the thorium decay chain were in equilibrium in the soil under investigation. Hence, the Ac-228 activity concentration was assumed equal to the Th-232 activity concentration, and the ratio of Tl-208 to Th-232 activity was assumed equal to 0.36. Final values of Th-232 activity concentration presented in this report were calculated as follows: the Tl-208 pCi/g value was divided by 0.36, and the resulting value was averaged with the Ac-228 pCi/g value. Th-232 pCi/g and estimated uncertainty values are summarized

in Appendix A.

The highest Th-232 activity concentration observed was 64 pCi/g, at the five and six foot depth intervals in borehole no. 322. The measurement values were divided into three ranges: less than 5 pCi/g Th-232, greater than 5 pCi/g but less than 20 pCi/g, and greater than 20 pCi/g.

Elevated Th-232 pCi/g values were observed in a total of seven boreholes: 318, 319, 320, 321, 322, 323 and 324. All of these boreholes showed Th-232 activity concentrations greater than 20 pCi/g, except for borehole no. 324. (The maximum value observed in borehole 324 was 14 pCi/g at a depth of two feet below ground surface.) Th-232 pCi/g values in the remaining eight boreholes were all within the range of normal background values (typically 0.5 - 1.5 pCi/g).

The locations of the 15 boreholes relative to the survey grid system established by Mound Lab is shown in Figure 1. Figure 2 shows the borehole locations with the addition of shaded regions designating the areas of elevated Th-232 activity. It is difficult to estimate the exact lateral perimeter of the area of elevated activity, especially to the north of boreholes 319, 320, and 321 because no additional boreholes could be placed in this direction (due to the steep decrease in elevation to the north beginning at

approximately 2340 S). The shaded regions drawn in Figure 2 are believed to represent reasonable estimates of the areal extent of material with elevated Th-232 activity.

A depth profile of Th-232 activity concentration for the 15 boreholes is shown in Figure 3. Of the seven boreholes exhibiting elevated activity results, borehole nos. 318 and 324 were sufficiently deep so that the layer of contaminated material could be bounded at a lower depth interval. Borehole nos. 319, 320, 321, 322 and 323 exhibited elevated readings even at the bottom depth of the hole, and therefore the exact lower boundary of the elevated activity is not known. However, if the boreholes were drilled down to the depth of solid bedrock, it is unlikely that elevated activity material extends to lower depths. No extrapolation to greater depths has been made in determining the total volume estimates of contaminated material presented below.

In order to estimate the volumes of material with Th-232 activity concentration greater than 5 pCi/g and greater than 20 pCi/g, a numerical estimate of the surface area represented by each borehole was made. At a specific depth interval, the soil was assumed to be uniform throughout a one-foot thick layer bounded by that surface area for each borehole. The surface area assigned to each

borehole was multiplied by the number of one-foot thick layers observed to have Th-232 pCi/g values above 5 or above 20 in that borehole, to obtain a volume estimate (in cubic feet) of material above 5 pCi/g and above 20 pCi/g represented by each borehole. These borehole-specific volume estimates were made only to simplify the calculation of an estimated total volume of material in the surveyed area with Th-232 pci/g values above the limits of interest. The volume estimates are presented in Table 1.

TABLE 1

ESTIMATED VOLUMES OF SOIL WITH ELEVATED TH-232 ACTIVITY

BOREHOLE NUMBER	SURROUNDING SURFACE AREA CHARACTERIZED BY BOREHOLE*	VERTICAL THICKNESS OF SOIL LAYER WITH TH-232 GREATER THAN 5 PCI/G	VOLUME OF SOIL WITH TH-232 GREATER THAN 5 PCI/G**	VERTICAL THICKNESS OF SOIL LAYER WITH TH-232 GREATER THAN 20 PCI/G	VOLUME OF SOIL WITH TH-232 GREATER THAN 20 PIC/G
318	1350 SQ FT	3 FT	4,050 CU FT	1 FT	1,350 CU FT
319	1450 SQ FT	10.5 FT	15,200 CU FT	5 FT	7,250 CU FT
320	1650 SQ FT	11.5 FT	19,000 CU FT	10 FT	16,500 CU FT
321	1650 SQ FT	12.5 FT	20,600 CU FT	9 FT	14,900 CU FT
322	950 SQ FT	11.5 FT	10,900 CU FT	11 FT	10,500 CU FT
323	900 SQ FT	12.5 FT	11,300 CU FT	7 FT	6,300 CU FT
324	1500 SQ FT	7.5 FT	11,300 CU FT	0	0
TOTAL VOLUMES			92,400 CU FT (2,620 CU METERS)		56,800 CU FT (1,610 CU METERS)

* NOTE: Surface area values determined by dividing shaded areas in Figure 2 into non-overlapping sub-sections, bounded by area perimeter and lines bisecting straight lines drawn between adjacent boreholes.

** NOTE: Includes volume of soil with Th-232 activity concentration greater than 20 pCi/g.

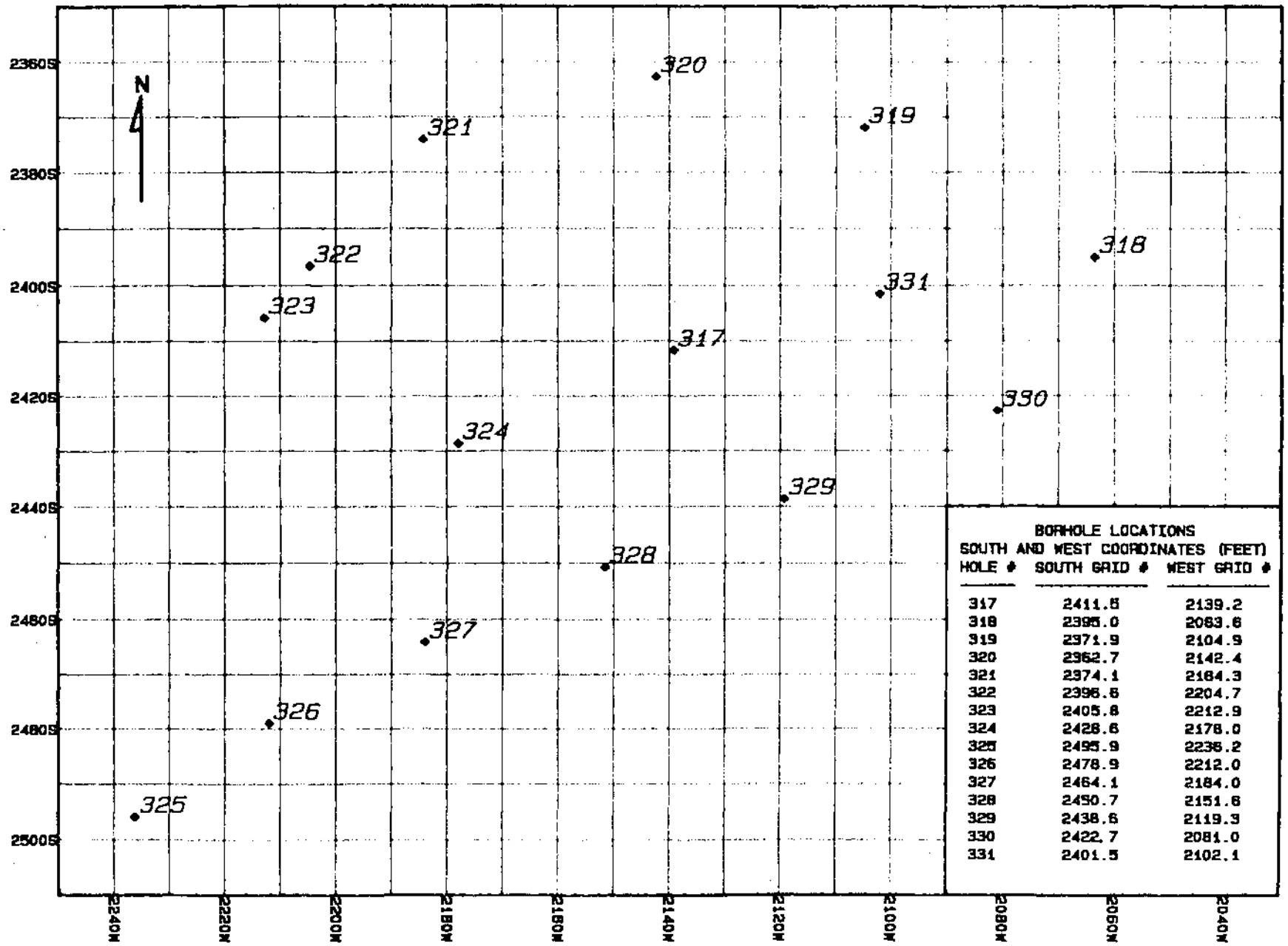
CONCLUSION

As shown in Table 1, an estimated total volume of 92,400 cubic feet (2,620 cubic meters) was found to exhibit Th-232 activity concentrations greater than 5 pCi/g. Of this volume of soil, 56,800 cubic feet (1,610 cubic meters) exhibited Th-232 levels greater than 20 pCi/g. The highest level observed was 64 pCi/g Th-232.

These volume estimates should be considered approximations only. The exact vertical boundaries of contaminated soil could not be determined in several boreholes, because elevated activity results were observed to extend to the bottom of the holes. More significantly, the lateral surface area boundaries are approximations only due to the absence of additional boreholes to the north of the 2360 S grid line and due to the potential non-uniformity of soil at a given depth interval. Nevertheless, RMC believes that these volume determinations are reasonably good estimates. RMC recommends that these volume estimates be considered minimum values.

The soil with elevated Th-232 activity was fairly homogeneous, with most measured Th-232 activity concentration values ranging between 30 and 50 pCi/g. The contaminated material extends from just beneath the surface to approxi-

mately 10 feet beneath the surface in a contiguous layer surrounding borehole numbers 319, 320, 321, 322 and 323. A thinner layer of elevated activity material extends into the areas surrounding borehole numbers 318 and 324.



BORHOLE LOCATIONS
SOUTH AND WEST COORDINATES (FEET)

HOLE #	SOUTH GRID #	WEST GRID #
317	2411.6	2139.2
318	2395.0	2063.6
319	2371.9	2104.9
320	2362.7	2142.4
321	2374.1	2164.3
322	2396.6	2204.7
323	2405.8	2212.9
324	2428.6	2178.0
325	2495.9	2236.2
326	2478.9	2212.0
327	2464.1	2184.0
328	2450.7	2151.6
329	2438.6	2119.3
330	2422.7	2081.0
331	2401.5	2102.1

Figure 1. Survey Grid Coordinate System Showing Borehole Locations

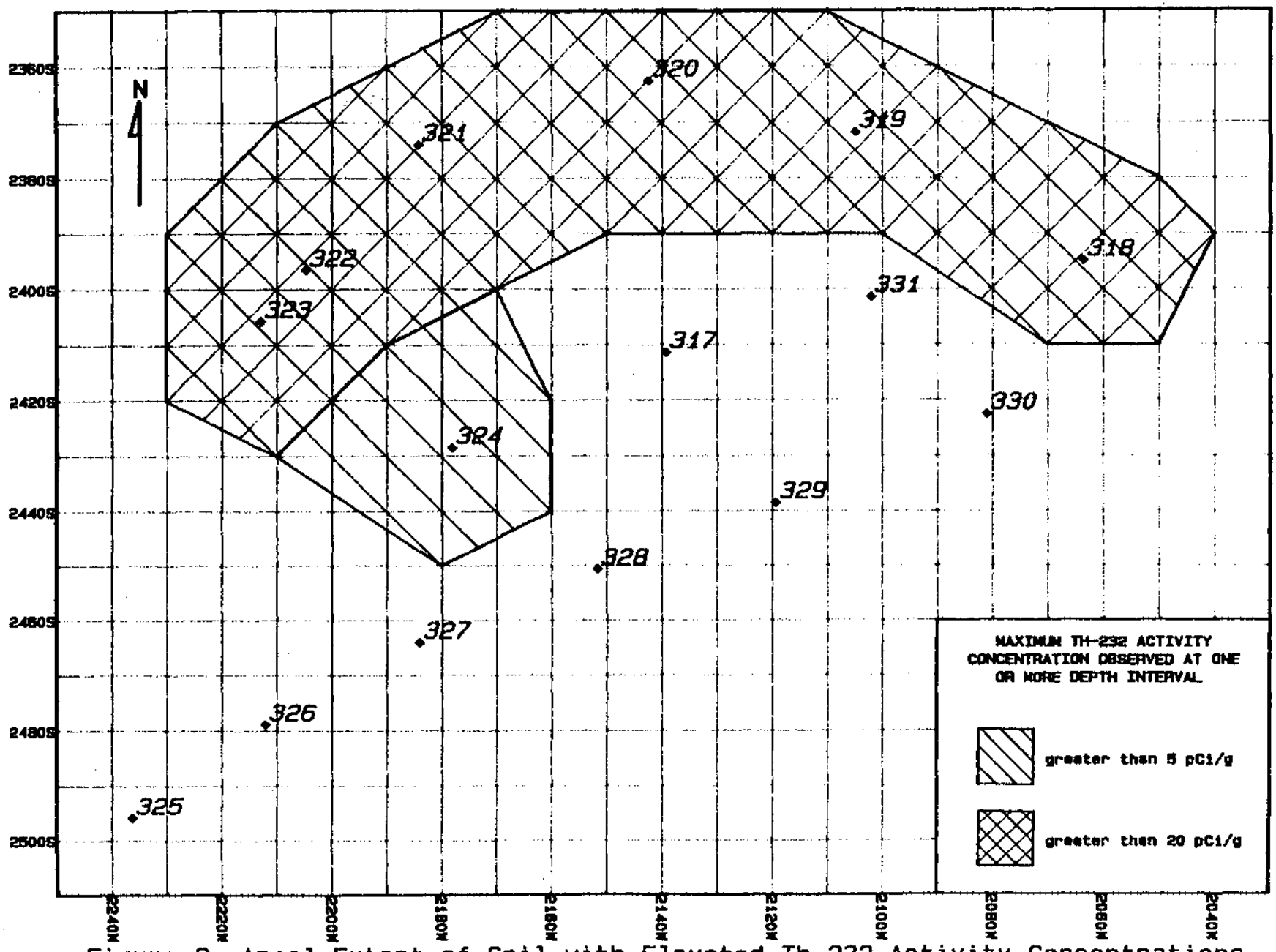


Figure 2. Areal Extent of Soil with Elevated Th-232 Activity Concentrations

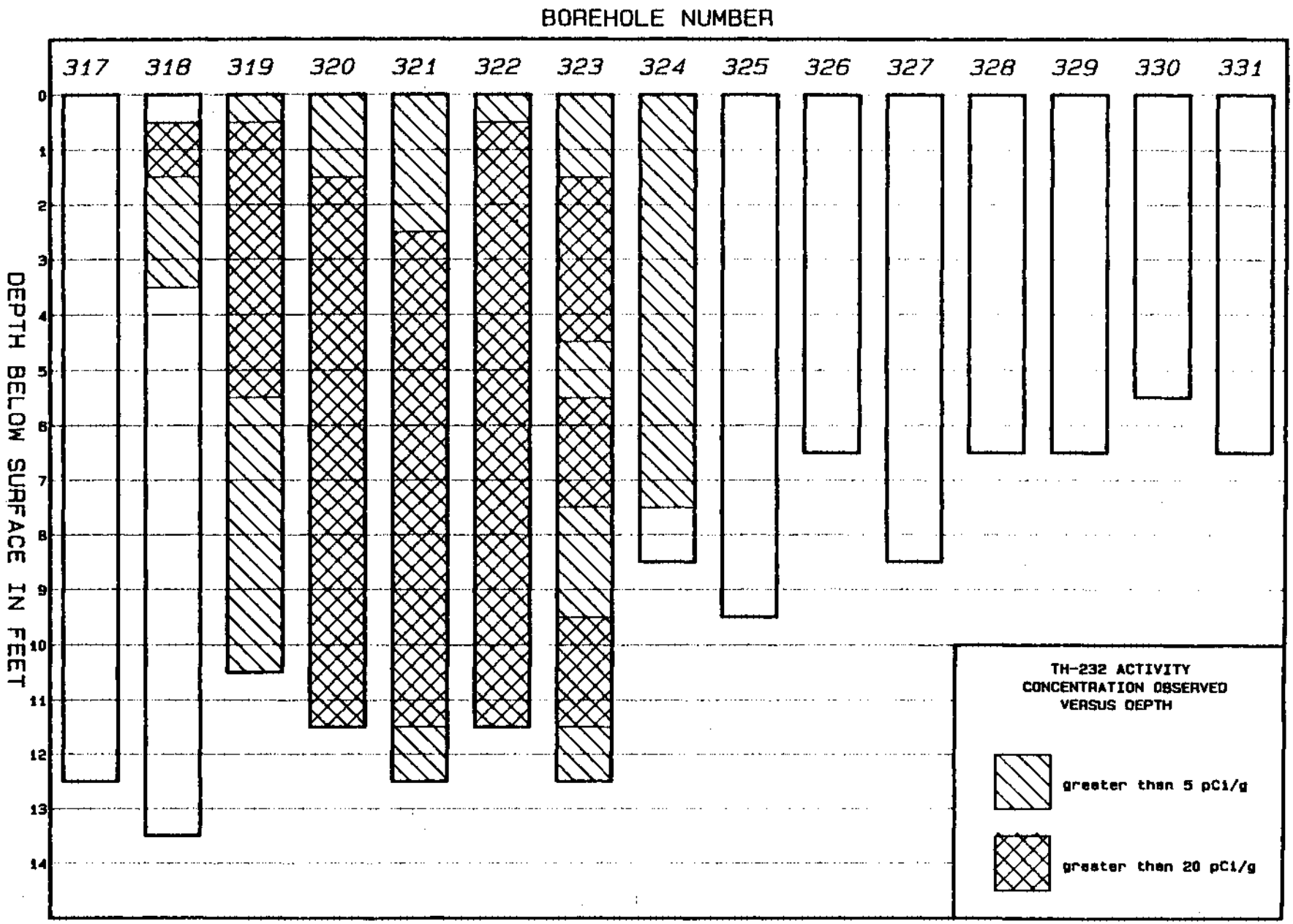


Figure 3. Depth Profile of Elevated Th-232 Activity in Soil

APPENDIX A

SUMMARY OF TH-232 ACTIVITY CONCENTRATION RESULTS

APPENDIX A. SUMMARY OF TH-232 ACTIVITY CONCENTRATION RESULTS

Well Number	Depth Below Surface (ft)	Th-232 pCi/g
317	0	1.0
	1	1.8
	2	1.7
	3	1.4
	4	1.2
	5	0.8
	6	0.7
	7	0.9
	8	0.6
	9	0.7
	10	0.7
	11	0.5
	12	0.5
318	0	4.6
	1	26
	2	9.6
	3	5.9
	4	2.0
	5	1.4
	6	1.1
	7	0.8
	8	1.2
	9	1.0
	10	1.1
	11	0.9
	12	1.1
	13	1.7
319	0	8.3
	1	29
	2	35
	3	53
	4	43
	5	34
	6	18
	7	12
	8	12
	9	10
	10	5.3
320	0	13
	1	17
	2	33
	3	37
	4	30
	5	34
	6	37
	7	36
	8	39
	9	39
	10	34
	11	29
321	0	12
	1	17
	2	17
	3	38
	4	53
	5	42
	6	36
	7	38
	8	55
	9	48
	10	36
	11	21
	12	17
322	0	8.4
	1	27
	2	36
	3	42
	4	43
	5	64
	6	64
	7	47
	8	32
	9	42
	10	54
	11	44
323	0	5.5
	1	11
	2	24
	3	29
	4	42
	5	18
	6	33
	7	28
	8	15
	9	11
	10	39
	11	31
	12	15
324	0	5.9
	1	11
	2	14
	3	5.8
	4	5.1
	5	6.3
	6	6.3
	7	5.1
	8	2.5

APPENDIX A. SUMMARY OF TH-232 ACTIVITY CONCENTRATION RESULTS

Well Number	Depth Below Surface (ft)	Th-232 pCi/g
325	0	0.8
	1	1.2
	2	0.9
	3	0.8
	4	0.8
	5	0.5
	6	0.6
	7	0.8
	8	0.8
	9	0.5
326	0	0.3
	1	0.8
	2	0.7
	3	0.8
	4	0.8
	5	0.6
	6	0.7
327	0	0.3
	1	0.5
	2	0.5
	3	0.8
	4	0.9
	5	0.6
	7	0.8
	8	0.8
328	0	0.5
	1	1.3
	2	0.9
	3	0.8
	4	0.6
	5	0.7
	6	0.6
329	0	0.3
	1	0.8
	2	1.1
	3	0.8
	4	0.8
	5	0.5
	6	0.7
330	0	0.6
	1	1.1
	2	0.5
	3	0.8
	4	1.0
	5	0.8
331	0	0.7
	1	0.8
	2	0.8
	3	0.8
	4	0.6
	5	0.9
	6	0.8

NOTE: In order to assign a numerical estimate of the uncertainty associated with these Th-232 pCi/g values, several simplifying assumptions have been made, as described below. The random uncertainty associated with photopeak area determinations (for the Ac-228 and Tl-208 peaks) are the dominate sources of uncertainty for low count rate, low activity results. A systematic calibration uncertainty is associated with each activity calculation, independent of count rate. Approximate uncertainty values are tabulated below for various ranges of Th-232 pCi/g results.

Th-232 pCi/g	% 2-Sigma Random Counting Uncert.	% 2-Sigma Systematic Calibration Uncert.	% Total Uncert.
0.5-1.0	50	20	70
1.0-5.0	20	20	40
5.0-20	10	20	30
20-70	5	20	25

APPENDIX B

SPECTRAL PHOTOPEAK DATA FOR ALL BOREHOLE MEASUREMENTS

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
317	0	Integral	145	101	85	120	11/292
		Net Area	84	57	59	96	
		% Uncert.	23	27	25	29	
		pCi/g	0.4	0.5	0.9	4.9	
317	1	Integral	239	212	142	160	11/315
		Net Area	141	98	110	144	
		% Uncert.	17	25	18	15	
		pCi/g	0.6	0.9	1.7	7.4	
317	2	Integral	242	216	169	197	11/338
		Net Area	135	129	109	159	
		% Uncert.	18	17	21	15	
		pCi/g	0.6	1.2	1.7	8.2	
317	3	Integral	214	222	126	214	11/360
		Net Area	116	104	76	201	
		% Uncert.	20	24	24	12	
		pCi/g	0.5	0.9	1.2	10.3	
317	4	Integral	201	164	134	219	11/381
		Net Area	102	67	71	209	
		% Uncert.	22	28	29	12	
		pCi/g	0.5	0.6	1.1	10.7	
317	5	Integral	159	167	91	250	11/402
		Net Area	71	99	37	241	
		% Uncert.	28	22	43	11	
		pCi/g	0.3	0.4	0.6	12.4	
317	6	Integral	170	167	73	264	11/422
		Net Area	58	70	41	254	
		% Uncert.	35	27	40	11	
		pCi/g	0.3	0.6	0.6	13.0	
317	7	Integral	147	150	90	215	11/442
		Net Area	64	72	56	210	
		% Uncert.	30	28	30	12	
		pCi/g	0.3	0.7	0.9	10.8	
317	8	Integral	144	150	55	276	11/462
		Net Area	59	78	28	262	
		% Uncert.	32	24	38	11	
		pCi/g	0.3	0.7	0.4	13.4	

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
317	9	Integral	136	149	93	238	11/481
		Net Area	57	67	45	227	
		% Uncert.	32	30	35	11	
		pCi/g	0.3	0.6	0.7	11.7	
317	10	Integral	134	164	82	297	11/500
		Net Area	57	79	46	287	
		% Uncert.	32	24	29	10	
		pCi/g	0.3	0.7	0.7	14.7	
317	11	Integral	126	137	59	288	11/518
		Net Area	38	73	27	279	
		% Uncert.	46	26	39	10	
		pCi/g	0.2	0.7	0.4	14.3	
317	12	Integral	117	127	81	276	11/537
		Net Area	47	45	28	269	
		% Uncert.	36	36	43	10	
		pCi/g	0.2	0.4	0.4	13.8	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
318	0	Integral	795	460	453	159	6/036
		Net Area	360	38	291	76	
		% Uncert.	12	93	12	28	
		pCi/g	1.6	0.3	4.6	3.9	
318	1	Integral	4139	1590	2349	435	6/069
		Net Area	2015	125	1651	183	
		% Uncert.	5	44	5	20	
		pCi/g	9.2	1.1	26.1	9.4	
318	2	Integral	1471	804	827	288	6/100
		Net Area	759	138	607	166	
		% Uncert.	8	34	8	17	
		pCi/g	3.5	1.3	9.6	8.5	
318	3	Integral	800	307	443	263	6/130
		Net Area	508	83	327	221	
		% Uncert.	9	30	11	12	
		pCi/g	2.3	0.8	5.2	11.3	
318	4	Integral	339	209	194	253	6/158
		Net Area	174	69	116	205	
		% Uncert.	17	39	20	13	
		pCi/g	0.8	0.6	1.8	10.5	
318	5	Integral	219	130	122	269	6/185
		Net Area	123	53	68	243	
		% Uncert.	20	32	27	11	
		pCi/g	0.6	0.5	1.1	12.5	
318	6	Integral	187	162	104	257	6/211
		Net Area	106	72	60	231	
		% Uncert.	20	29	28	12	
		pCi/g	0.5	0.7	0.9	11.9	
318	7	Integral	187	143	98	287	6/236
		Net Area	89	73	30	274	
		% Uncert.	25	25	54	10	
		pCi/g	0.4	0.7	0.5	14.1	
318	8	Integral	215	202	122	299	6/260
		Net Area	119	100	60	277	
		% Uncert.	19	23	30	10	
		pCi/g	0.5	0.9	0.9	14.2	

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
318	9	Integral	182	137	81	268	6/284
		Net Area	102	52	43	250	
		% Uncert.	22	33	35	11	
		pCi/g	0.5	0.5	0.7	12.8	
318	10	Integral	186	133	99	249	6/306
		Net Area	105	47	59	216	
		% Uncert.	21	40	28	12	
		pCi/g	0.5	0.4	0.9	11.1	
318	11	Integral	173	121	78	314	6/328
		Net Area	69	52	50	303	
		% Uncert.	31	31	29	10	
		pCi/g	0.3	0.5	0.8	15.6	
318	12	Integral	159	147	100	281	6/350
		Net Area	100	77	58	252	
		% Uncert.	20	26	28	11	
		pCi/g	0.5	0.7	0.9	12.9	
318	13	Integral	243	123	136	275	6/370
		Net Area	145	41	96	257	
		% Uncert.	18	39	20	11	
		pCi/g	0.7	0.4	1.5	13.2	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
319	0	Integral	1226	502	735	182	10/036
		Net Area	663	73	511	84	
		% Uncert.	8	42	9	29	
		pCi/g	3.0	0.7	8.1	4.3	
319	1	Integral	4380	1860	2435	498	10/069
		Net Area	2433	48	1675	170	
		% Uncert.	4	148	5	23	
		pCi/g	11.1	0.4	26.5	8.7	
319	2	Integral	5910	2153	3052	662	10/101
		Net Area	3098	81	1955	190	
		% Uncert.	4	78	5	25	
		pCi/g	14.2	0.7	30.9	9.8	
319	3	Integral	10184	4771	5413	919	10/128
		Net Area	4216	241	3287	141	
		% Uncert.	4	47	4	38	
		pCi/g	19.3	2.2	51.9	7.2	
319	4	Integral	7685	2897	4208	846	10/157
		Net Area	3495	80	2577	141	
		% Uncert.	4	91	4	38	
		pCi/g	16.0	0.7	40.7	7.2	
319	5	Integral	5680	2405	2924	606	10/184
		Net Area	2942	197	1996	211	
		% Uncert.	4	41	4	20	
		pCi/g	13.4	1.8	31.5	10.8	
319	6	Integral	2764	936	1398	379	10/210
		Net Area	1623	92	992	215	
		% Uncert.	5	46	7	16	
		pCi/g	7.4	0.8	15.7	11.0	
319	7	Integral	1535	553	733	285	10/236
		Net Area	1087	121	605	228	
		% Uncert.	6	32	7	12	
		pCi/g	5.0	1.1	9.6	11.7	
319	8	Integral	1564	420	823	322	10/260
		Net Area	1155	135	611	266	
		% Uncert.	6	22	8	11	
		pCi/g	5.3	1.2	9.7	13.7	

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
319	9	Integral	1294	433	657	301	10/284
		Net Area	947	123	549	259	
		% Uncert.	6	28	8	11	
		pCi/g	4.3	1.1	8.7	13.3	
319	10	Integral	1117	348	549	312	10/307
		Net Area	823	108	404	263	
		% Uncert.	7	25	10	11	
		pCi/g	3.8	1.0	6.4	13.5	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
320	0	Integral	1575	486	948	154	10/328
		Net Area	1103	89	763	81	
		% Uncert.	6	35	7	27	
		pCi/g	5.0	0.8	12.1	4.2	
320	1	Integral	2261	773	1122	266	10/350
		Net Area	1503	137	898	151	
		% Uncert.	5	33	6	18	
		pCi/g	6.9	1.2	14.2	7.6	
320	2	Integral	4549	1458	2548	478	10/371
		Net Area	2765	173	1897	200	
		% Uncert.	4	31	5	20	
		pCi/g	12.6	1.6	30.0	10.3	
320	3	Integral	5242	2034	2740	508	10/392
		Net Area	3214	102	2042	219	
		% Uncert.	4	73	4	18	
		pCi/g	14.7	0.9	32.3	11.2	
320	4	Integral	4504	1443	2358	484	10/412
		Net Area	2773	114	1590	213	
		% Uncert.	4	50	5	19	
		pCi/g	12.7	1.0	25.1	10.9	
320	5	Integral	4862	1841	2490	429	10/432
		Net Area	2964	217	1880	160	
		% Uncert.	4	33	4	22	
		pCi/g	13.5	2.0	29.7	8.2	
320	6	Integral	5564	1855	3008	549	10/453
		Net Area	3175	166	2102	227	
		% Uncert.	4	36	5	19	
		pCi/g	14.5	1.5	33.2	11.7	
320	7	Integral	5500	2156	2821	523	10/471
		Net Area	3182	230	1987	159	
		% Uncert.	4	30	4	25	
		pCi/g	14.5	2.1	31.4	8.2	
320	8	Integral	6092	2094	3322	581	10/489
		Net Area	3342	199	2190	203	
		% Uncert.	4	32	5	22	
		pCi/g	15.3	1.8	34.6	10.4	

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
320	9	Integral	6366	2709	3446	634	10/508
		Net Area	3342	171	2290	189	
		% Uncert.	4	50	4	23	
		pCi/g	15.3	1.6	36.2	7.1	
320	10	Integral	5819	2359	3364	630	10/526
		Net Area	2775	195	2101	163	
		% Uncert.	4	34	5	28	
		pCi/g	12.7	1.8	33.2	8.4	
320.	11	Integral	4610	2146	2500	586	10/544
		Net Area	2404	246	1694	189	
		% Uncert.	4	31	5	22	
		pCi/g	11.0	2.2	26.8	9.7	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
321	0	Integral	1501	465	896	179	10/560
		Net Area	1007	56	690	102	
		% Uncert.	6	53	7	23	
		pCi/g	4.6	0.5	10.9	5.2	
321	1	Integral	2246	708	1171	265	10/577
		Net Area	1531	86	951	176	
		% Uncert.	5	51	5	16	
		pCi/g	7.0	0.8	15.0	9.0	
321	2	Integral	2413	785	1253	320	10/594
		Net Area	1571	158	945	173	
		% Uncert.	5	25	6	18	
		pCi/g	7.2	1.4	14.9	8.9	
321	3	Integral	5901	2319	3074	524	11/003
		Net Area	3273	271	2206	131	
		% Uncert.	4	29	4	30	
		pCi/g	15.0	2.5	34.9	6.7	
321	4	Integral	9487	3530	5357	864	11/038
		Net Area	4351	148	3224	173	
		% Uncert.	4	55	4	31	
		pCi/g	19.9	1.3	50.9	8.9	
321	5	Integral	7196	3268	3905	663	11/071
		Net Area	3450	232	2521	173	
		% Uncert.	4	41	4	26	
		pCi/g	15.8	2.1	39.8	8.9	
321	6	Integral	5529	1989	3143	589	11/102
		Net Area	2909	262	2158	220	
		% Uncert.	4	24	5	20	
		pCi/g	13.3	2.4	34.1	11.3	
321	7	Integral	6006	2499	3257	599	11/131
		Net Area	3252	241	2217	232	
		% Uncert.	4	34	4	18	
		pCi/g	14.9	2.2	35.0	11.9	
321	8	Integral	9492	3343	5292	888	11/160
		Net Area	4600	238	3304	258	
		% Uncert.	3	33	4	21	
		pCi/g	21.0	2.2	52.2	13.2	

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
321	9	Integral	8182	3312	4120	763	11/187
		Net Area	4046	282	2794	149	
		% Uncert.	4	34	4	32	
		pCi/g	18.5	2.6	44.1	7.6	
321	10	Integral	5649	2033	3230	614	11/213
		Net Area	3054	199	2126	243	
		% Uncert.	4	31	5	19	
		pCi/g	14.0	1.8	33.6	12.5	
321	11	Integral	3054	1397	1717	456	11/239
		Net Area	1795	183	1259	267	
		% Uncert.	5	34	5	14	
		pCi/g	8.2	1.7	19.9	13.7	
321	12	Integral	2223	683	1207	423	11/263
		Net Area	1552	144	908	297	
		% Uncert.	5	26	7	12	
		pCi/g	7.1	1.3	14.3	15.2	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
322	0	Integral	1081	425	646	143	9/186
		Net Area	639	49	544	84	
		% Uncert.	8	69	8	26	
		pCi/g	2.9	0.4	8.6	4.3	
322	1	Integral	3823	1127	1937	419	9/212
		Net Area	2301	98	1528	225	
		% Uncert.	5	52	5	16	
		pCi/g	10.5	0.9	24.1	11.6	
322	2	Integral	5050	1621	2531	540	9/238
		Net Area	3304	149	1897	228	
		% Uncert.	4	44	4	19	
		pCi/g	15.1	1.4	30.0	11.7	
322	3	Integral	6584	2014	3359	578	9/263
		Net Area	3774	112	2330	232	
		% Uncert.	4	60	4	19	
		pCi/g	17.2	1.0	36.8	11.9	
322	4	Integral	6861	2558	3419	737	9/287
		Net Area	3733	138	2373	198	
		% Uncert.	4	60	4	26	
		pCi/g	17.1	1.3	37.5	10.2	
322	5	Integral	12161	4118	5864	1039	9/310
		Net Area	5784	207	3479	215	
		% Uncert.	3	47	4	28	
		pCi/g	26.4	1.9	55.0	11.0	
322	6	Integral	12177	5139	6158	1255	9/333
		Net Area	5457	119	3674	231	
		% Uncert.	3	99	4	31	
		pCi/g	24.9	1.1	58.0	11.9	
322	7	Integral	8265	2937	4214	725	9/355
		Net Area	4018	56	2653	209	
		% Uncert.	4	140	4	24	
		pCi/g	18.4	0.5	41.9	10.7	
322	8	Integral	5134	2157	2700	611	9/377
		Net Area	2638	65	1874	189	
		% Uncert.	4	118	5	26	
		pCi/g	12.1	0.6	29.6	9.7	

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
322	9	Integral	6958	2355	3633	654	9/398
		Net Area	3556	136	2445	231	
		% Uncert.	4	54	4	20	
		pCi/g	16.3	1.2	38.6	11.9	
322	10	Integral	9141	3498	3633	948	9/418
		Net Area	4743	116	3029	300	
		% Uncert.	4	84	4	20	
		pCi/g	21.7	1.1	47.9	15.4	
322	11	Integral	7360	2472	3761	667	9/439
		Net Area	3755	100	2519	221	
		% Uncert.	4	47	4	21	
		pCi/g	17.2	0.9	39.8	11.3	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
323	0	Integral	718	299	398	121	8/481
		Net Area	476	63	314	94	
		% Uncert.	9	45	10	21	
		pCi/g	2.2	0.6	5.0	4.8	
323	1	Integral	1591	572	802	254	8/499
		Net Area	987	163	548	188	
		% Uncert.	7	23	9	15	
		pCi/g	4.5	1.5	8.7	9.7	
323	2	Integral	3272	1165	1620	445	8/517
		Net Area	2160	71	1292	263	
		% Uncert.	4	79	5	15	
		pCi/g	9.9	0.6	20.4	13.5	
323	3	Integral	5129	1779	2611	531	8/534
		Net Area	2761	235	1443	246	
		% Uncert.	4	27	6	17	
		pCi/g	12.6	2.1	22.8	12.6	
323	4	Integral	6636	2592	3479	752	8/552
		Net Area	3538	188	2493	258	
		% Uncert.	4	45	4	21	
		pCi/g	16.2	1.7	39.4	13.2	
323	5	Integral	3020	1256	1683	425	8/569
		Net Area	1614	264	983	154	
		% Uncert.	6	21	7	24	
		pCi/g	7.4	2.4	15.5	7.9	
323	6	Integral	4948	1997	2580	587	8/585
		Net Area	2872	203	1844	229	
		% Uncert.	4	36	5	21	
		pCi/g	13.1	1.8	29.1	11.7	
323	7	Integral	4928	1865	2651	530	9/003
		Net Area	2680	209	1443	212	
		% Uncert.	4	31	6	20	
		pCi/g	12.2	1.9	22.8	10.9	
323	8	Integral	2291	1166	1191	408	9/038
		Net Area	1225	186	867	200	
		% Uncert.	6	30	7	19	
		pCi/g	5.6	1.7	13.7	10.3	

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
323	9	Integral	1777	967	959	339	9/071
		Net Area	925	325	587	199	
		% Uncert.	8	15	9	16	
		pCi/g	4.2	3.0	9.3	10.2	
323	10	Integral	6297	2751	3371	731	9/102
		Net Area	3295	365	2299	179	
		% Uncert.	4	29	4	31	
		pCi/g	15.1	3.3	36.3	9.2	
323	11	Integral	6382	2717	3376	679	9/132
		Net Area	2872	185	1582	216	
		% Uncert.	5	42	6	22	
		pCi/g	13.1	1.7	25.0	11.1	
323	12	Integral	2075	918	1111	431	9/160
		Net Area	1285	132	813	265	
		% Uncert.	6	38	7	14	
		pCi/g	5.9	1.2	12.8	13.6	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
324	0	Integral	772	420	417	167	8/303
		Net Area	442	90	267	76	
		% Uncert.	11	38	13	33	
		pCi/g	2.0	0.8	4.2	3.9	
324	1	Integral	1893	766	1012	254	8/325
		Net Area	1013	142	604	100	
		% Uncert.	7	27	9	29	
		pCi/g	4.6	1.3	9.5	5.1	
324	2	Integral	2028	965	1189	264	8/347
		Net Area	1112	99	871	122	
		% Uncert.	7	52	7	25	
		pCi/g	5.1	0.9	13.8	6.3	
324	3	Integral	820	311	461	238	8/367
		Net Area	528	71	317	196	
		% Uncert.	9	30	11	13	
		pCi/g	2.4	0.6	5.0	10.1	
324	4	Integral	686	272	356	225	8/387
		Net Area	476	94	278	195	
		% Uncert.	9	29	11	13	
		pCi/g	2.2	0.9	4.4	10.0	
324	5	Integral	760	277	388	233	8/407
		Net Area	558	99	268	202	
		% Uncert.	8	26	12	13	
		pCi/g	2.6	0.9	4.2	10.4	
324	6	Integral	842	318	403	294	8/426
		Net Area	592	102	319	232	
		% Uncert.	8	29	10	13	
		pCi/g	2.7	0.9	5.0	11.9	
324	7	Integral	699	272	359	292	8/445
		Net Area	487	108	251	257	
		% Uncert.	9	24	12	11	
		pCi/g	2.2	1.0	4.0	13.2	
324	8	Integral	347	211	167	239	8/464
		Net Area	247	77	117	217	
		% Uncert.	12	31	18	12	
		pCi/g	1.1	0.7	1.8	11.1	

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Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
325	0	Integral	114	124	82	63	8/004
		Net Area	57	74	48	55	
		% Uncert.	30	25	31	25	
		pCi/g	0.3	0.7	0.8	2.8	
325	1	Integral	191	143	83	135	8/039
		Net Area	101	53	61	98	
		% Uncert.	23	33	25	20	
		pCi/g	0.5	0.5	1.0	5.0	
325	2	Integral	174	151	91	167	8/071
		Net Area	84	71	45	148	
		% Uncert.	25	29	35	15	
		pCi/g	0.4	0.6	0.7	7.6	
325	3	Integral	144	182	102	193	8/102
		Net Area	64	78	52	190	
		% Uncert.	31	25	32	12	
		pCi/g	0.3	0.7	0.8	9.8	
325	4	Integral	173	212	91	244	8/132
		Net Area	75	124	35	236	
		% Uncert.	27	19	50	11	
		pCi/g	0.3	1.1	0.6	11.9	
325	5	Integral	158	186	81	203	8/160
		Net Area	46	99	21	184	
		% Uncert.	45	21	71	13	
		pCi/g	0.2	0.9	0.3	9.4	
325	6	Integral	120	194	66	183	8/186
		Net Area	41	140	40	172	
		% Uncert.	41	16	34	13	
		pCi/g	0.2	1.3	0.6	8.8	
325	7	Integral	140	239	102	246	8/212
		Net Area	62	117	42	222	
		% Uncert.	31	20	40	12	
		pCi/g	0.3	1.1	0.7	11.4	
325	8	Integral	184	280	100	266	8/237
		Net Area	86	186	30	247	
		% Uncert.	26	15	55	11	
		pCi/g	0.4	1.7	0.5	12.7	

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
325	9	Integral	169	196	94	229	8/261
		Net Area	51	111	24	212	
		% Uncert.	42	19	67	12	
		pCi/g	0.2	1.0	0.4	10.9	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
326	0	Integral	81	63	51	69	7/467
		Net Area	35	33	13	53	
		% Uncert.	42	36	91	26	
		pCi/g	0.2	0.3	0.2	2.7	
326	1	Integral	136	126	68	155	7/485
		Net Area	71	56	36	27	
		% Uncert.	26	33	38	81	
		pCi/g	0.3	0.5	0.6	1.4	
326	2	Integral	163	177	87	233	7/503
		Net Area	65	90	35	189	
		% Uncert.	32	22	44	13	
		pCi/g	0.3	0.8	0.6	9.7	
326	3	Integral	182	289	103	300	7/521
		Net Area	44	179	55	48	
		% Uncert.	47	16	30	63	
		pCi/g	0.2	1.6	0.9	2.5	
326	4	Integral	153	204	95	216	7/538
		Net Area	69	124	41	155	
		% Uncert.	30	18	39	16	
		pCi/g	0.3	1.1	0.6	8.0	
326	5	Integral	151	181	75	245	7/555
		Net Area	46	101	39	237	
		% Uncert.	38	22	37	11	
		pCi/g	0.2	0.9	0.6	12.2	
326	6	Integral	160	186	79	276	7/572
		Net Area	68	77	33	198	
		% Uncert.	31	26	44	14	
		pCi/g	0.3	0.7	0.5	10.2	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
327	0	Integral	69	71	40	92	7/284
		Net Area	21	46	16	81	
		% Uncert.	65	29	65	20	
		pCi/g	0.1	0.4	0.3	4.2	
327	1	Integral	132	126	71	201	7/304
		Net Area	41	58	33	166	
		% Uncert.	42	32	42	14	
		pCi/g	0.2	0.5	0.5	8.5	
327	2	Integral	130	132	59	174	7/329
		Net Area	54	97	18	158	
		% Uncert.	35	19	70	14	
		pCi/g	0.2	0.9	0.3	8.1	
327	3	Integral	159	173	106	200	7/350
		Net Area	52	99	50	145	
		% Uncert.	37	22	24	16	
		pCi/g	0.2	0.9	0.8	7.4	
327	4	Integral	158	164	83	221	7/371
		Net Area	84	92	37	210	
		% Uncert.	25	21	41	12	
		pCi/g	0.4	0.8	0.6	10.8	
327	5	Integral	115	185	61	209	7/391
		Net Area	50	123	41	105	
		% Uncert.	33	18	31	24	
		pCi/g	0.2	1.1	0.6	5.4	
327	6	Integral	129	166	96	218	7/411
		Net Area	43	97	34	202	
		% Uncert.	44	20	48	12	
		pCi/g	0.2	0.9	0.5	10.4	
327	7	Integral	152	192	87	255	7/431
		Net Area	54	98	49	125	
		% Uncert.	35	23	31	22	
		pCi/g	0.2	0.9	0.8	6.4	
327	8	Integral	149	172	100	312	7/450
		Net Area	61	85	42	275	
		% Uncert.	33	23	39	11	
		pCi/g	0.3	0.8	0.7	14.1	

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
328	0	Integral	105	105	57	67	7/103
		Net Area	35	47	35	62	
		% Uncert.	45	36	36	22	
		pCi/g	0.2	0.4	0.6	3.2	
328	1	Integral	253	143	117	167	7/132
		Net Area	119	61	61	154	
		% Uncert.	22	24	29	14	
		pCi/g	0.5	0.6	1.0	7.9	
328	2	Integral	139	152	86	205	7/160
		Net Area	67	62	48	189	
		% Uncert.	28	33	32	13	
		pCi/g	0.3	0.6	0.8	9.7	
328	3	Integral	135	228	87	211	7/187
		Net Area	65	144	53	189	
		% Uncert.	29	16	29	13	
		pCi/g	0.3	1.3	0.8	9.7	
328	4	Integral	129	205	91	227	7/213
		Net Area	46	87	35	194	
		% Uncert.	38	27	45	13	
		pCi/g	0.2	0.8	0.6	10.0	
328	5	Integral	153	164	82	235	7/238
		Net Area	55	85	42	224	
		% Uncert.	37	23	36	11	
		pCi/g	0.3	0.8	0.7	11.5	
328	6	Integral	97	67	146	206	7/262
		Net Area	25	33	58	175	
		% Uncert.	60	41	34	14	
		pCi/g	0.1	0.3	0.9	9.0	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
329	0	Integral	76	57	38	57	6/502
		Net Area	35	27	14	48	
		% Uncert.	39	46	73	26	
		pCi/g	0.2	0.2	0.2	2.5	
329	1	Integral	132	141	87	149	6/519
		Net Area	68	67	43	136	
		% Uncert.	28	26	36	15	
		pCi/g	0.3	0.6	0.6	7.0	
329	2	Integral	176	210	119	174	6/537
		Net Area	100	96	57	130	
		% Uncert.	21	25	32	17	
		pCi/g	0.5	0.9	0.9	6.7	
329	3	Integral	162	198	125	256	6/554
		Net Area	56	114	59	243	
		% Uncert.	38	19	31	11	
		pCi/g	0.3	1.0	0.9	12.5	
329	4	Integral	168	207	82	244	6/571
		Net Area	70	91	36	159	
		% Uncert.	29	26	42	17	
		pCi/g	0.3	0.8	0.6	8.2	
329	5	Integral	137	138	77	272	6/588
		Net Area	51	73	25	250	
		% Uncert.	38	24	58	11	
		pCi/g	0.2	0.7	0.4	12.8	
329	6	Integral	158	163	95	295	7/003
		Net Area	64	81	33	186	
		% Uncert.	31	26	49	16	
		pCi/g	0.3	0.7	0.5	9.5	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

IG DETECTOR BOREHOLE LOGGING SYSTEM---FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
330	0	Integral	93	95	72	77	6/389
		Net Area	49	50	34	72	
		% Uncert.	32	30	41	20	
		pCi/g	0.2	0.5	0.5	3.7	
330	1	Integral	191	219	123	203	6/409
		Net Area	77	125	67	157	
		% Uncert.	28	20	27	13	
		pCi/g	0.4	1.1	1.1	9.6	
330	2	Integral	130	151	81	255	6/429
		Net Area	34	94	37	242	
		% Uncert.	55	20	40	11	
		pCi/g	0.2	0.9	0.6	12.4	
330	3	Integral	165	183	91	248	6/448
		Net Area	69	111	35	226	
		% Uncert.	29	20	45	12	
		pCi/g	0.3	1.0	0.6	11.6	
330	4	Integral	169	198	103	309	6/467
		Net Area	71	114	67	289	
		% Uncert.	30	18	25	10	
		pCi/g	0.3	1.0	1.1	14.8	
330	5	Integral	156	214	90	327	6/485
		Net Area	66	112	46	277	
		% Uncert.	31	22	34	11	
		pCi/g	0.3	1.0	0.7	14.2	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

IG DETECTOR BOREHOLE LOGGING SYSTEM--FIELD DATA SHEET

Borehole Number	Depth (Feet Below Surface)	Quantity	Tl-208 583 keV Peak	Bi-214 609 keV Peak	Ac-228 911 keV Peak	K-40 1461keV Peak	Spectrum Stored: Tape/ Counter Numbers
331	0	Integral	117	98	67	96	9/495
		Net Area	59	44	41	82	
		% Uncert.	30	37	33	20	
		pCi/g	0.3	0.4	0.6	4.2	
331	1	Integral	168	122	73	203	9/532
		Net Area	68	52	35	184	
		% Uncert.	31	35	40	13	
		pCi/g	0.3	0.5	0.6	9.4	
331	2	Integral	143	139	115	209	9/514
		Net Area	56	69	49	195	
		% Uncert.	34	27	39	12	
		pCi/g	0.3	0.6	0.8	10.0	
331	3	Integral	151	158	97	215	9/551
		Net Area	72	108	41	208	
		% Uncert.	27	19	43	12	
		pCi/g	0.3	1.0	0.6	10.7	
331	4	Integral	115	175	88	221	9/569
		Net Area	48	107	36	208	
		% Uncert.	33	20	43	12	
		pCi/g	0.2	1.0	0.6	10.7	
331	5	Integral	134	137	113	210	9/586
		Net Area	68	87	52	207	
		% Uncert.	27	27	36	12	
		pCi/g	0.3	0.8	0.8	10.6	
331	6	Integral	159	171	81	194	10/004
		Net Area	78	89	39	176	
		% Uncert.	25	24	38	13	
		pCi/g	0.4	0.8	0.6	9.0	
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					
		Integral					
		Net Area					
		% Uncert.					
		pCi/g					

APPENDIX C

SMALL DIAMETER IG DETECTOR
GAMMA SPECTROSCOPY SYSTEM CALIBRATION--
BOREHOLE LOGGING GEOMETRY

RADIATION MANAGEMENT CORPORATION

31-MAR-84

PURPOSE

This report is to document the calibration of the RMC intrinsic germanium (IG) detector borehole logging system. System efficiency values are defined and tabulated for a 4-inch inner diameter PVC-lined borehole geometry.

SYSTEM DESCRIPTION

The IG detector (Ortec Model GEM-101955, S/N 21-P-735C) was designed to minimize the cryostat and dewar outer diameters, and is shown in Figure 1. A Canberra Series 10 MCA and Ortec Model 469 Bias Shutdown interface were used with this detector. MCA parameters were adjusted to provide a 2048 channel acquisition region at 1.0 keV per channel. An external 6-volt battery pack was used in anticipation of the battery power likely to be required during routine field use.

CALIBRATION MODEL

The counting configuration provided by a borehole in an essentially uniform, semi-infinite matrix was simulated by the calibration rig model shown in Figure 2. This model consists of a group of four concentric rings of hollow plastic tubes surrounding a 4-inch inner diameter (4.5-inch

outer diameter) PVC pipe casing. The individual plastic tubes are 1.2 inches in (outer) diameter and 36 inches long.

A set of 1.0-inch diameter plastic tubes was filled with plaster of paris for insertion into the concentric ring tubes to simulate a semi-infinite soil matrix surrounding the PVC casing. Another set of 1.0-inch tubes was filled with plaster of paris spiked with Eu-152 to obtain a uniform concentration of 440 pCi/g (on 1-Jul-81) in the plaster matrix. The decay-corrected concentration value on the date of final calibration (31-Mar-84) was 380 pCi/g. Plaster of paris was used because its density (1.3 g/cc) is close to that of soil, and because the distribution of Eu-152 source solution throughout the plaster matrix (before hardening) was easily performed. A third set of tubes, spiked with Cd-109 (180 pCi/g on 21-Mar-84) was also prepared.

The Eu-152 and Cd-109 source tubes could be placed in any of the four concentric 1.2-inch diameter tube rings. When this was done, the volume of plaster present represented 45.2% of the total ring volume. This factor of 45.2% was correct, to very good approximation, for each of the four rings.

EFFICIENCY DETERMINATION

The detector crystal was positioned at the center of the 36-inch long cylindrical PVC casing. Spectral data were acquired with the Eu-152 and Cd-109 tubes in the first ring and the balance of the rings filled with blank plaster tubes. Similarly, counts were performed with the Eu-152 and Cd-109 tubes in rings 2-4. Each acquired spectrum was examined and net count rates determined at nine photopeak energies between 88 keV and 1408 keV. The net count rate values were divided by the factor of 0.452 to correct for the partial volume of each ring not filled with spiked plaster. These volume-corrected count rate values are listed in Attachments 1-9. For each photon energy, the volume-corrected count rate values were integrated (using a graphical technique) to obtain an efficiency value, in units of counts per gamma/gram, appropriate for characterizing system response when the detector is positioned in a borehole surrounded by a semi-infinite matrix.

The efficiency values were calculated using the following equation:

efficiency (counts per gamma/gram) = (cps)(1/abund.)(27.03)(1/conc.

where cps = the calculated integral count rate (counts per second) expected for a uniform soil matrix extending from 2.25 inches to greater than 14 inches (essentially to "infinity") away from the

detector axis,

abund. = fractional gamma abundance (photons emitted per disintegration),

27.03 = factor to correct disintegrations per second to pCi, and

conc. = the concentration of the source material in the plaster matrix (pCi/gram).

An examination of the graphical integration values in Attachments 1-9 indicates that the photon flux at the detector is due almost entirely to material distributed in a sphere of relatively small radius (less than 12 inches) immediately surrounding the detector. The actual radius of this sphere, beyond which the contribution to the flux at the detector becomes insignificant (less than a few per cent of the total), is dependent on photon energy. Even for the highest energy photon examined (1408 keV), approximately 90% of the total flux at the detector is due to material in a sphere of radius 12 inches surrounding the detector.

The efficiency values calculated in Attachments 1-9 were plotted and fit to a smooth curve in Figure 3. These efficiency values allow the calculation of <u>in situ</u> activity concentrations in soil. These activity concentrations will be calculated on a per-gram-of-wet-(moist)-soil basis. A moisture correction factor must be applied to obtain activity per gram (dry) soil values.

As a check on this calibration, RMC performed measurements at the DOE calibration facility operated by Bendix Corporation at Grand Junction, Colorado. This facility maintains wells constructed from concrete containing known amounts of uranium, Ra-226, Th-232 and K-40. Results of this comparison are presented in Table 1, and show close agreement between measurements. The values obtained during the RMC calibration have been used to determine concentrations at the Mound Lab site.

TABLE 1

EG&G ORTEC DETECTOR - BOREHOLE GEOMETRY (4.5 IN. O.D.)
COMPARISON OF EFFICIENCY VALUES DETERMINED AT
GRAND JUNCTION FACTILITY (8/2/82) AND RMC NORTHBROOK (3/31/84)

PHOTOPEAK ENERGY (MEV)	EFFICIENCY (COUNTS PER GAMMA/GRAM) RMC LAB	GRAND JUNCTION	RATIO: RMC LAB/ GRAND JUNCTION
0.186	52	56.6	0.92
0.295	43	37.5	1.15
0.352	34	34.8	0.98
0.583	23.5	21.0	1.12
0.609	23	25.3	0.91
0.727	21	19.5	1.08
0.860	19	16.8	1.13
1.120	17	15.2	1.12
1.461	16	16.7	0.96
1.764	15	12.7	1.18

WORST CASE DISCREPANCY: + 18%

AVERAGE DISCREPANCY (ALL DATA WEIGHTED EQUALLY): 10%

The observed flux at the detector, for a given photon energy and given concentration value (pCi/g), will be (to good first-order approximation) independent of soil density. As soil density increases, the radius of the sphere of material surrounding the detector and contributing significantly to the flux will decrease due to increased attenuation, but the number of atoms emitting photons <u>per unit volume</u> will increase to cancel this effect. This implies that no soil density correction factors are required when determining activity concentrations in the field.

Nuclide concentrations in soil, on per gram (wet) basis, can be calculated from <u>in situ</u> measurement data using the following equation:

concentration (pCi/g) = (cps)(1/eff.)(1/abund.)(27.03)

where cps = the observed net photopeak count rate in counts per second for the field measurement,

eff. = the system efficiency value for the photon energy of interest (in units of counts per gamma/gram),

abund. = the fractional gamma abundance (photons emitted per disintegration), and

27.03 = factor to convert disintegrations per second to pCi.

FIGURE I

Well Logging Detector

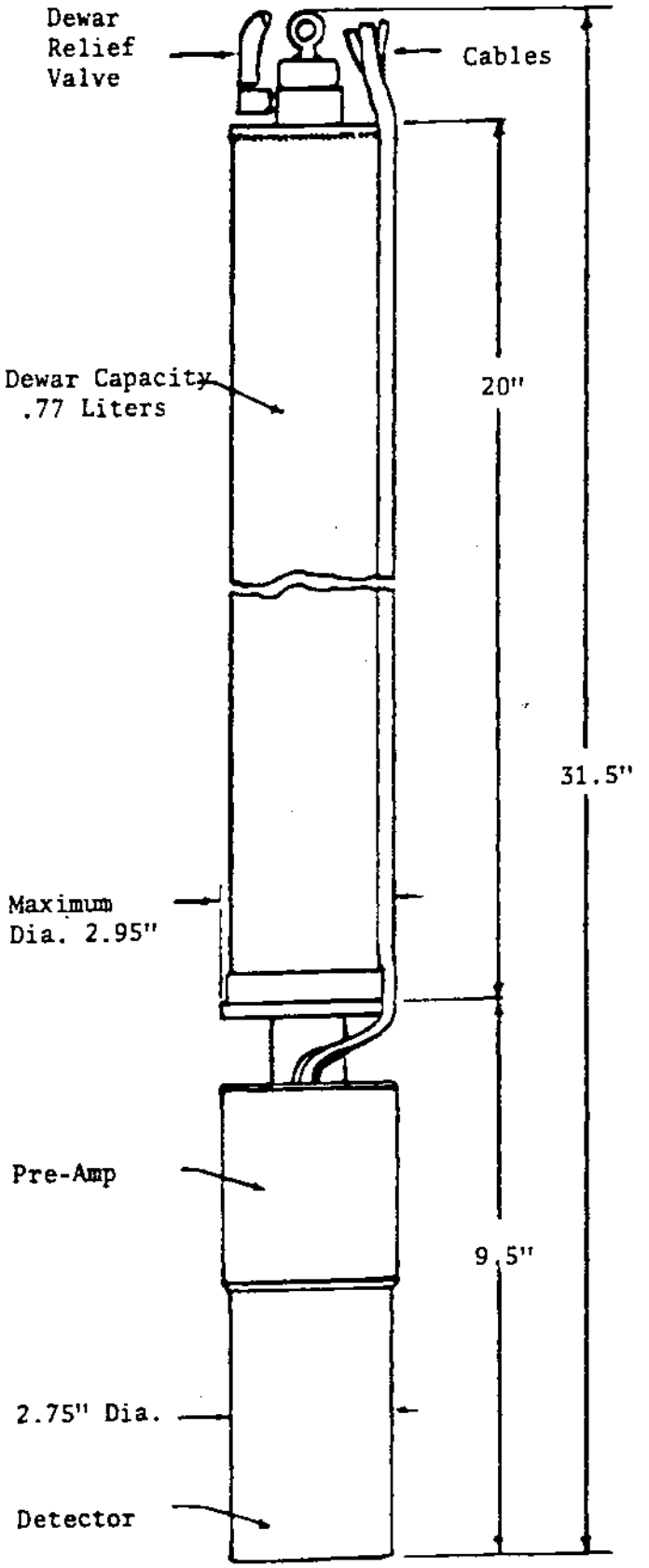
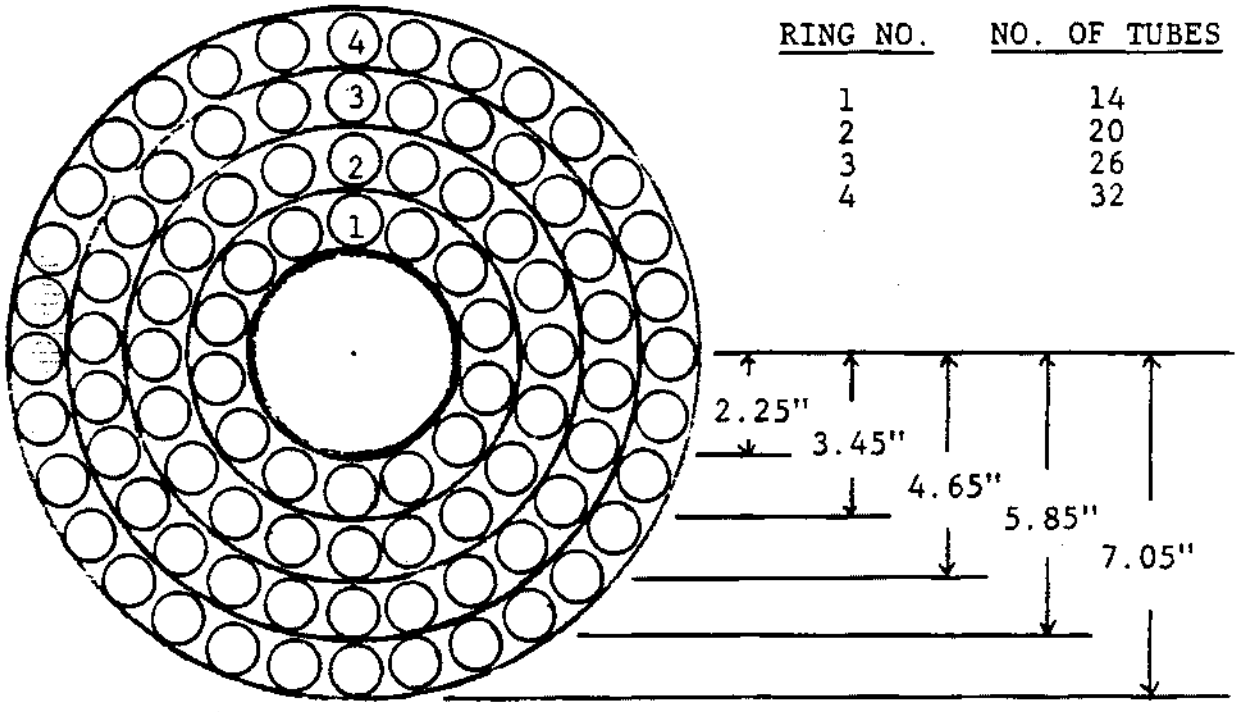


FIGURE 2.

BOREHOLE MODEL CALIBRATION RIG: 4-INCH PVC CASING GEOMETRY

TOP VIEW



RING NO.	NO. OF TUBES
1	14
2	20
3	26
4	32

SIDE VIEW

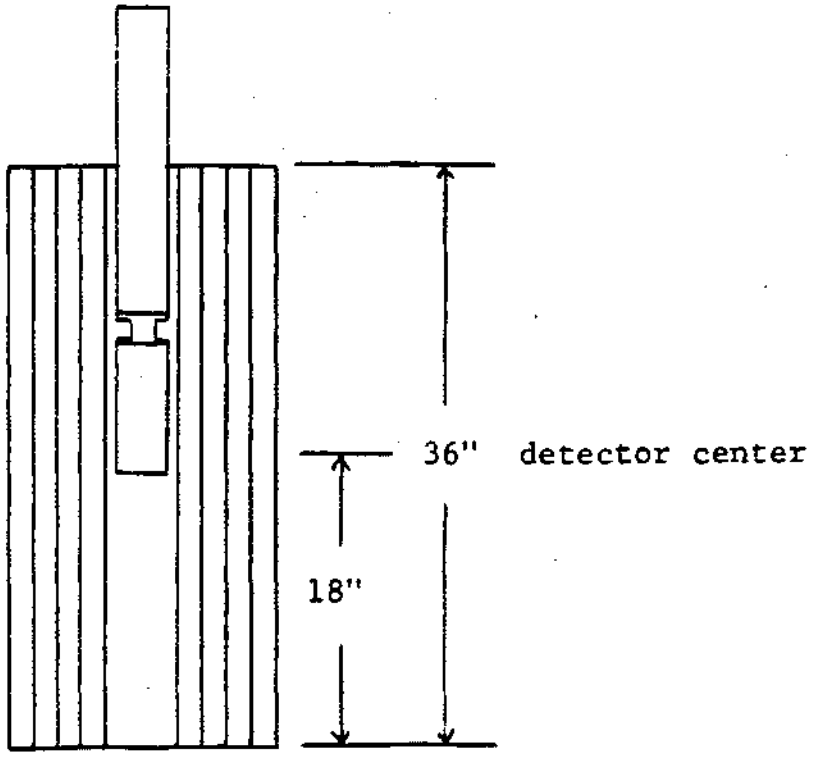
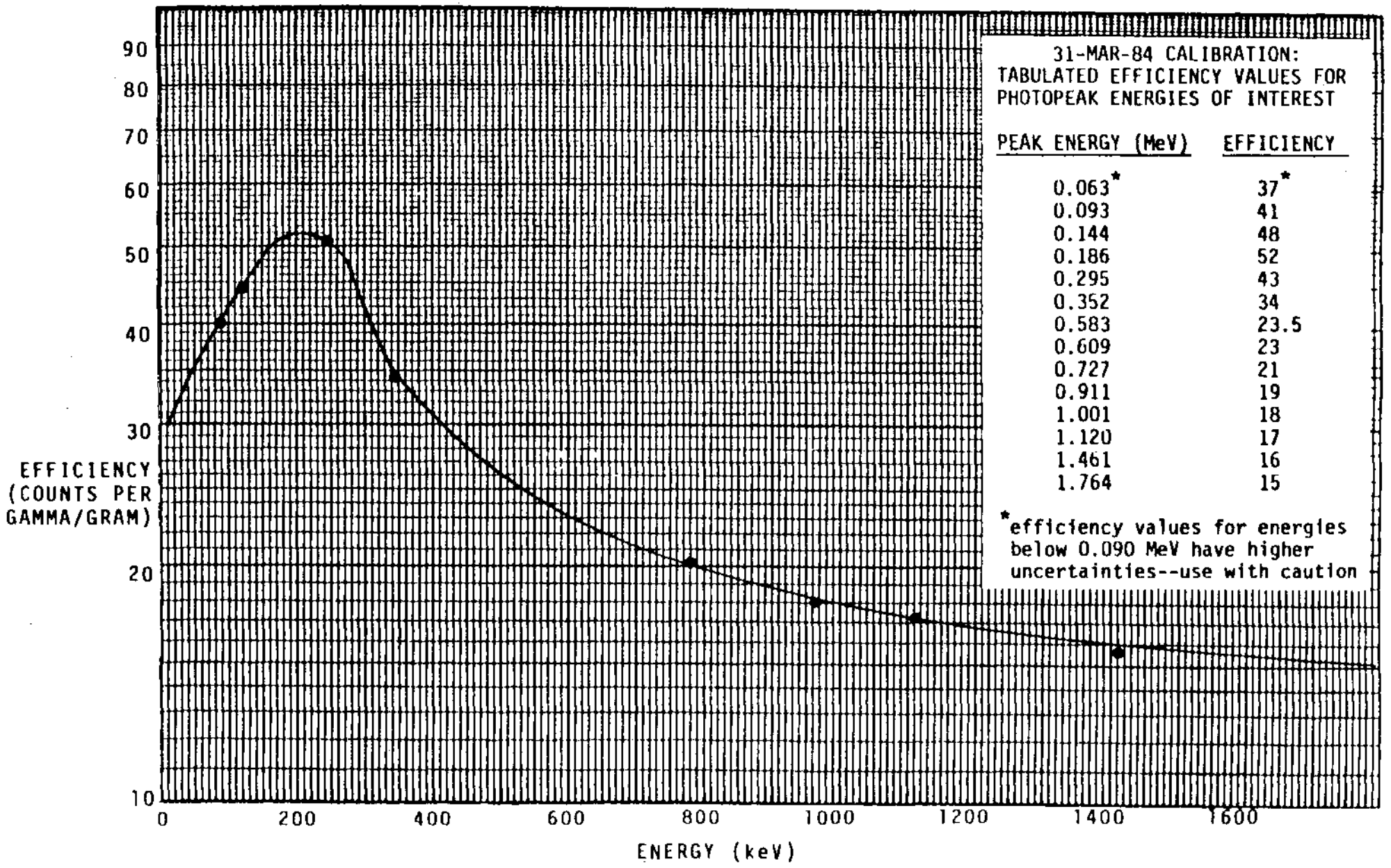


FIGURE 3.

EG&G ORTEC IG DETECTOR--BOREHOLE LOGGING GEOMETRY--4.5 INCH OUTER DIAMETER PVC-LINED HOLES

EFFICIENCY (COUNTS PER GAMMA/GRAM) VERSUS PHOTON ENERGY



31-MAR-84 CALIBRATION:
TABULATED EFFICIENCY VALUES FOR PHOTOPEAK ENERGIES OF INTEREST

PEAK ENERGY (MeV)	EFFICIENCY
0.063*	37*
0.093	41
0.144	48
0.186	52
0.295	43
0.352	34
0.583	23.5
0.609	23
0.727	21
0.911	19
1.001	18
1.120	17
1.461	16
1.764	15

*efficiency values for energies below 0.090 MeV have higher uncertainties--use with caution

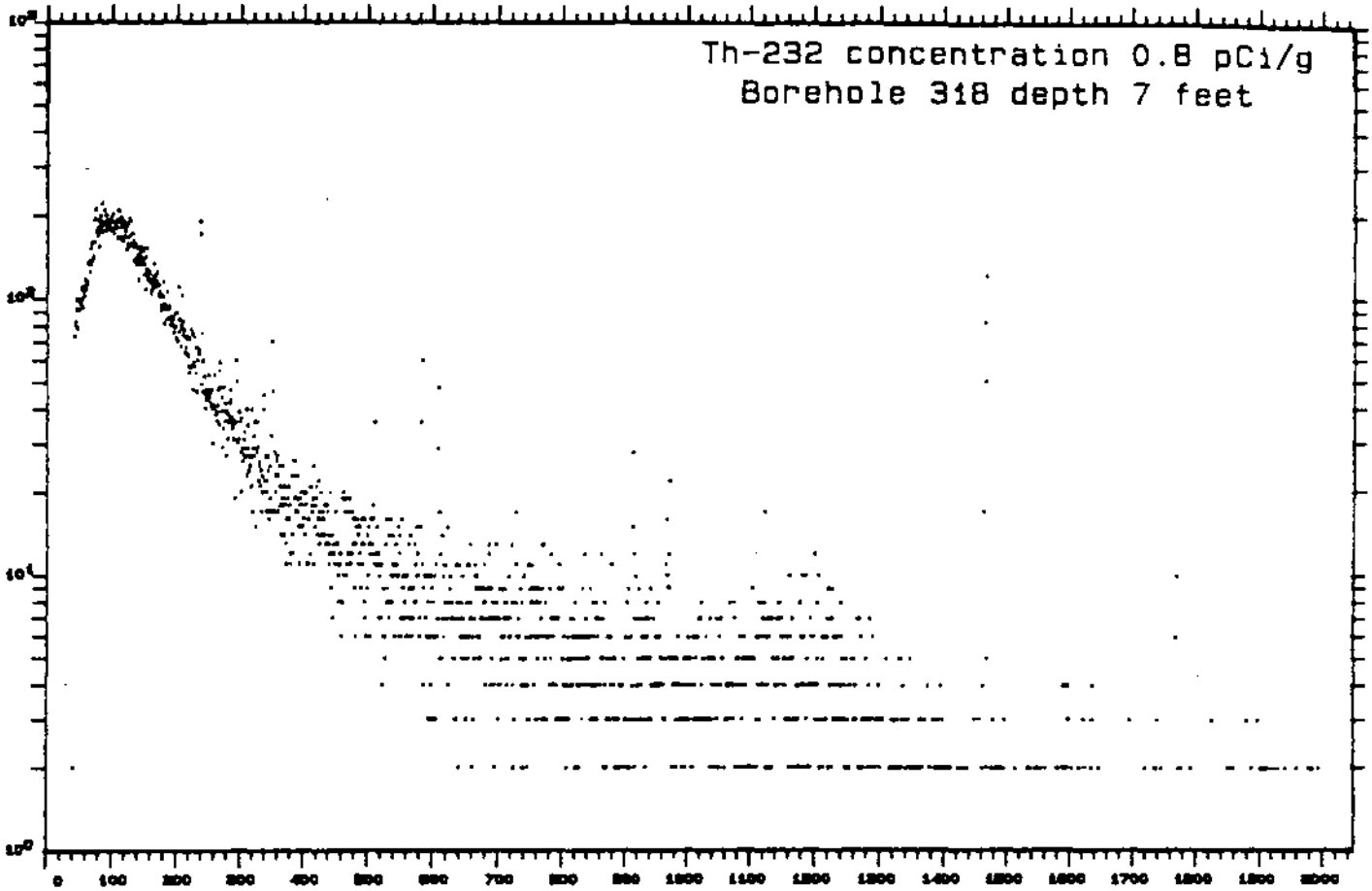
(This section intentionally deleted.)

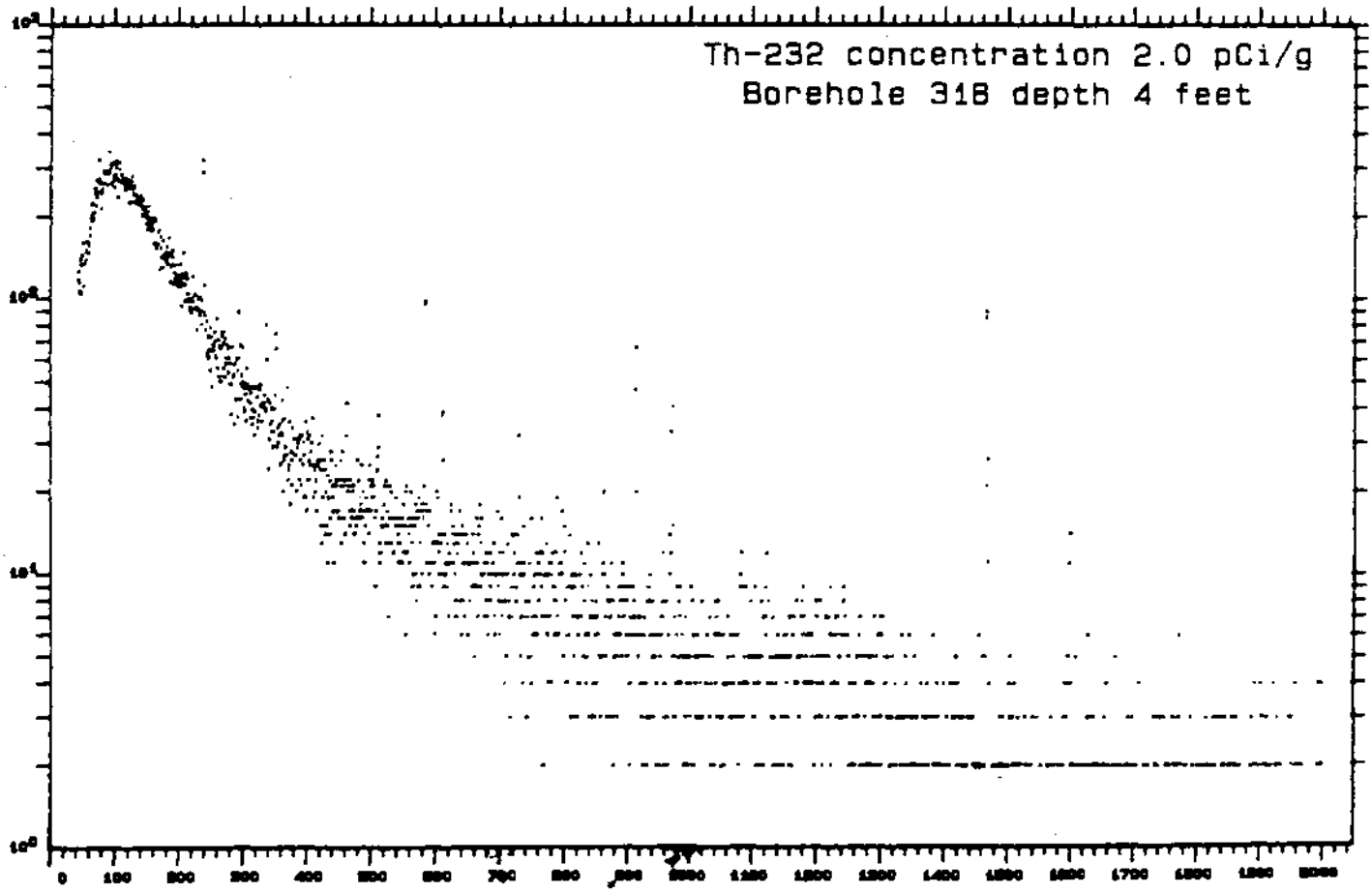
APPENDIX D

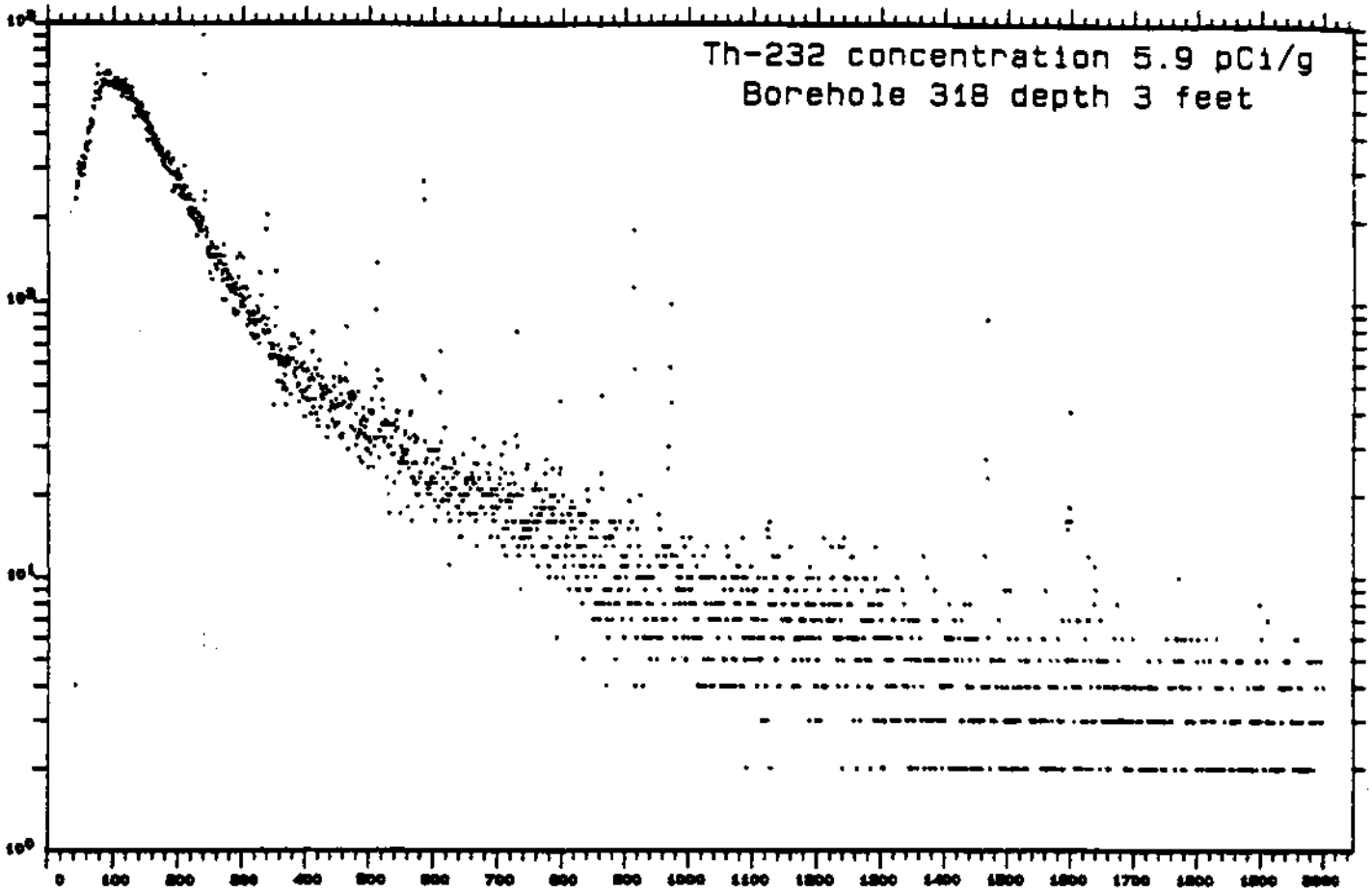
REPRESENTATIVE SPECTRAL PLOTS

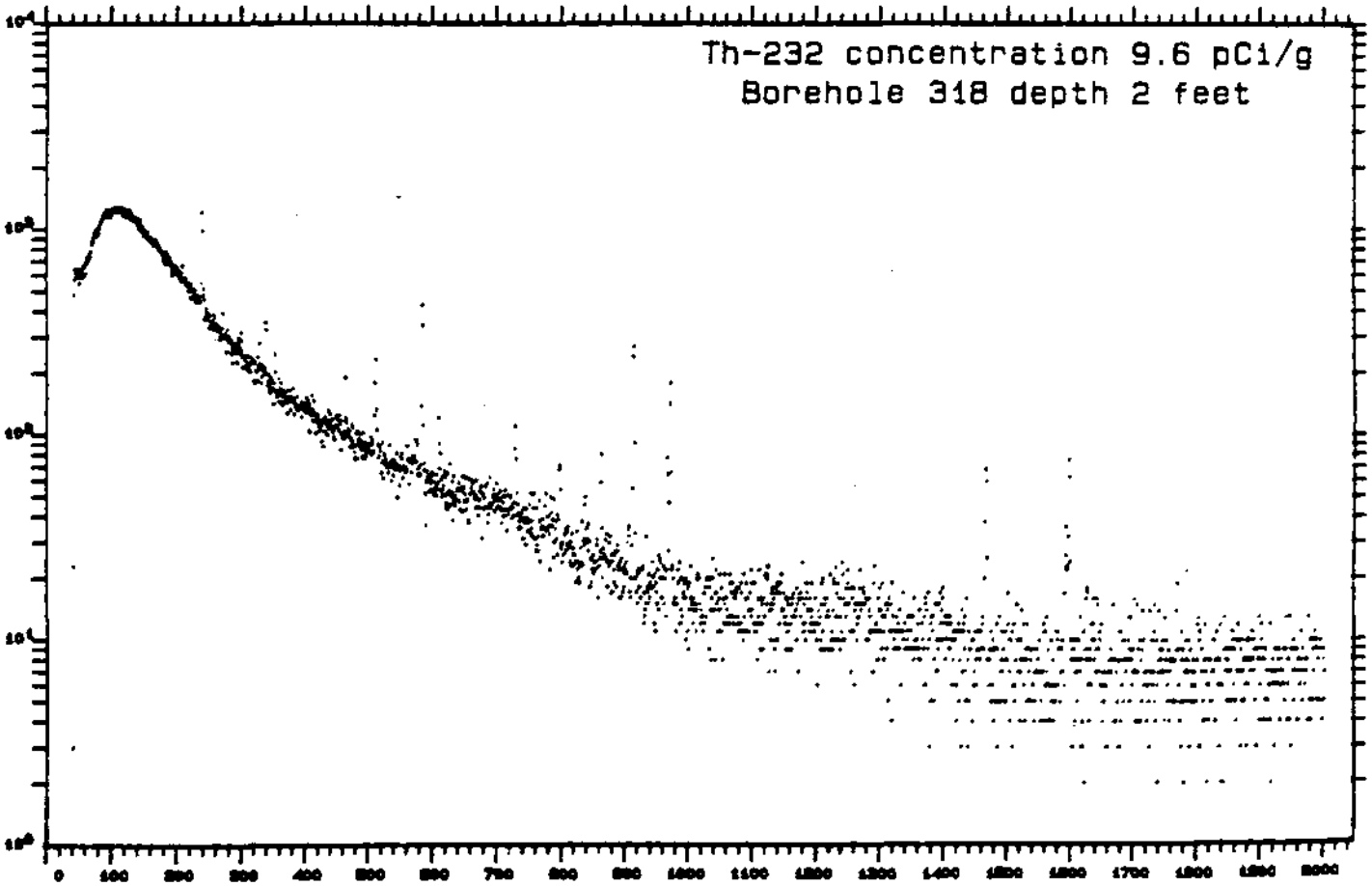
NOTE: Each of the following eight spectra was acquired for 300 seconds live time.

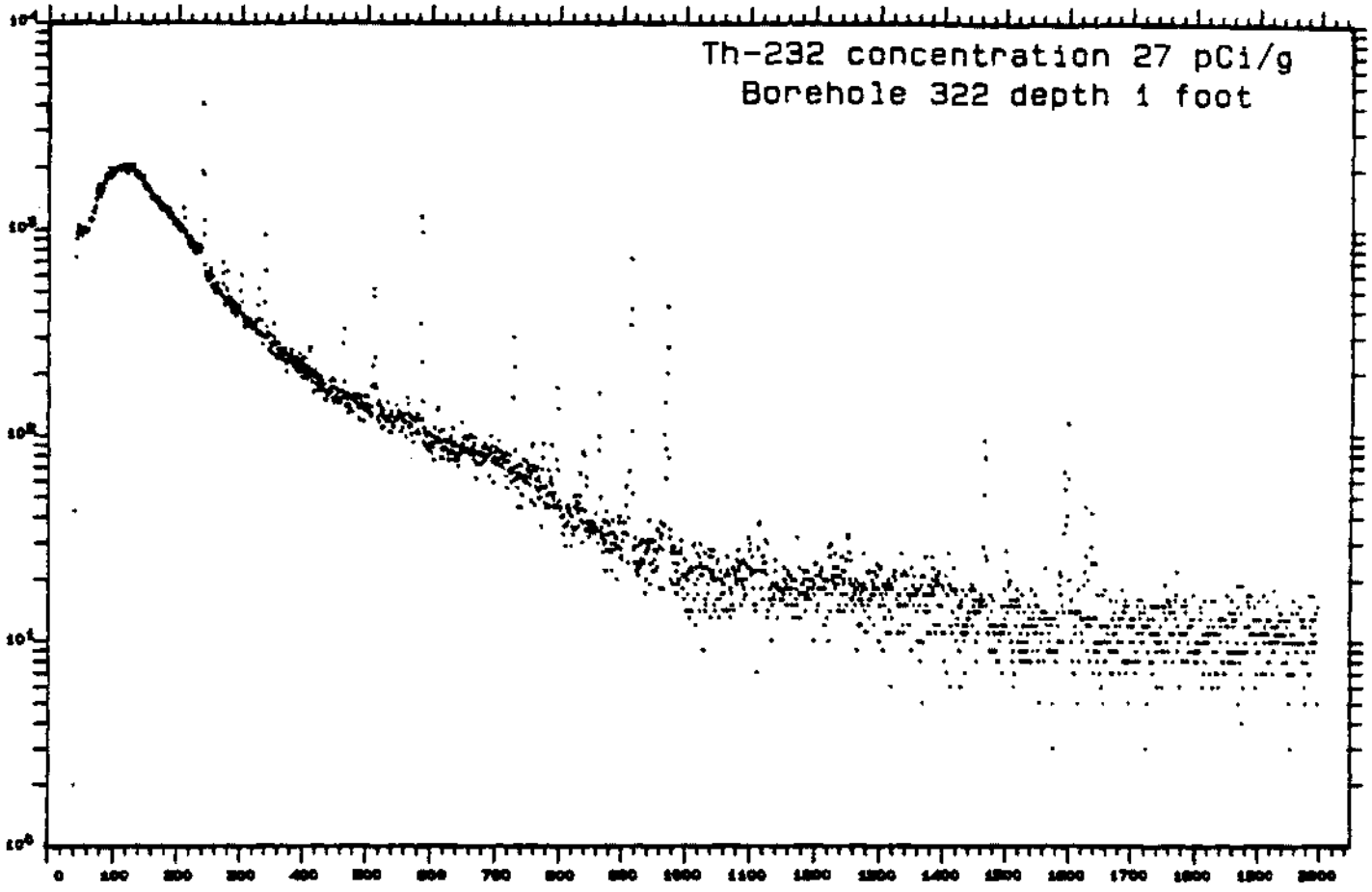
For these plots, the vertical axes show total counts in a given channel and the horizontal axes show channel numbers (which to good approximation equal the energies of detected photons in units of keV).

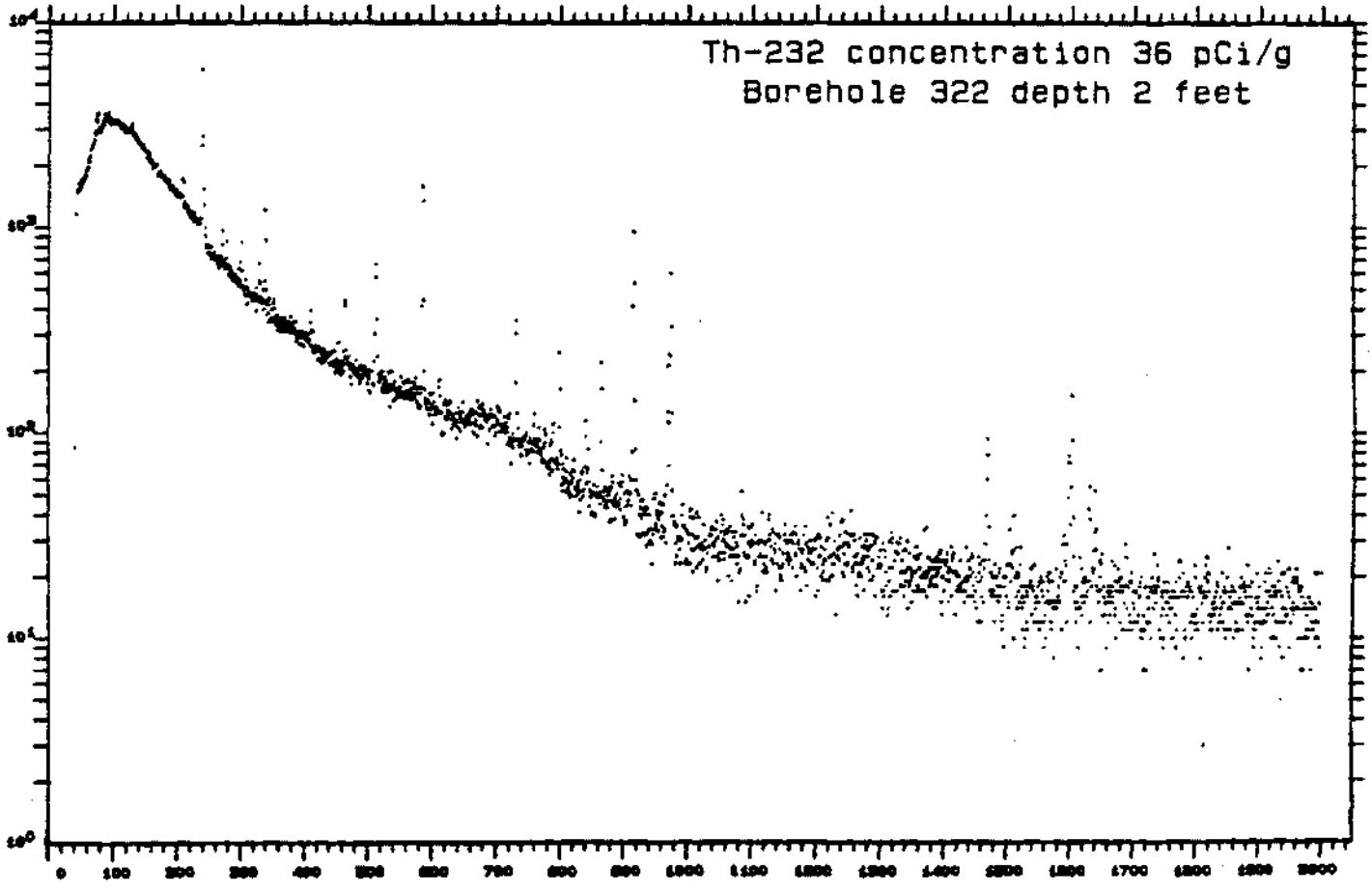

Th-232 concentration 0.8 pCi/g
Borehole 318 depth 7 feet

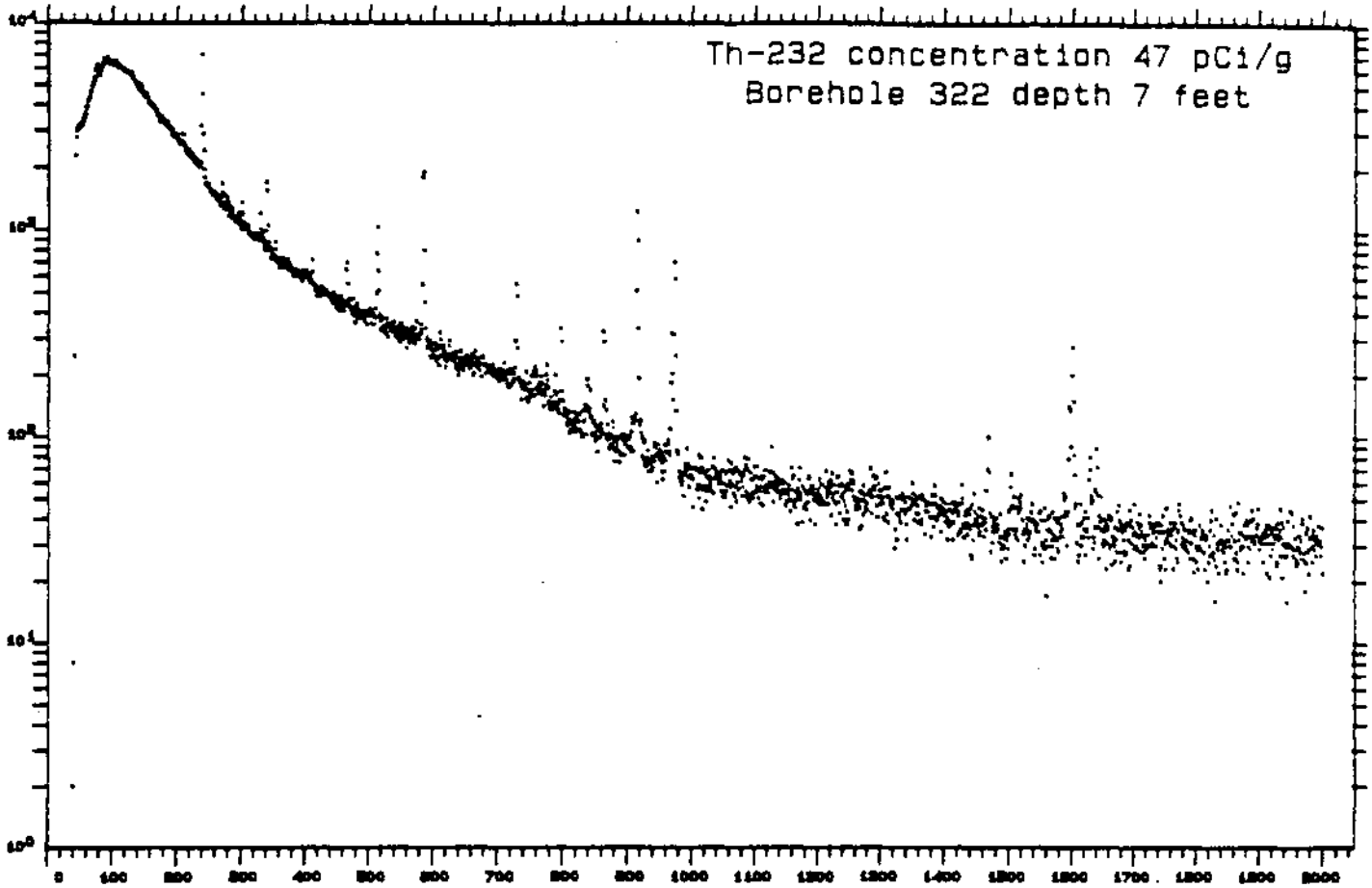

Th-232 concentration 2.0 pCi/g
Borehole 318 depth 4 feet

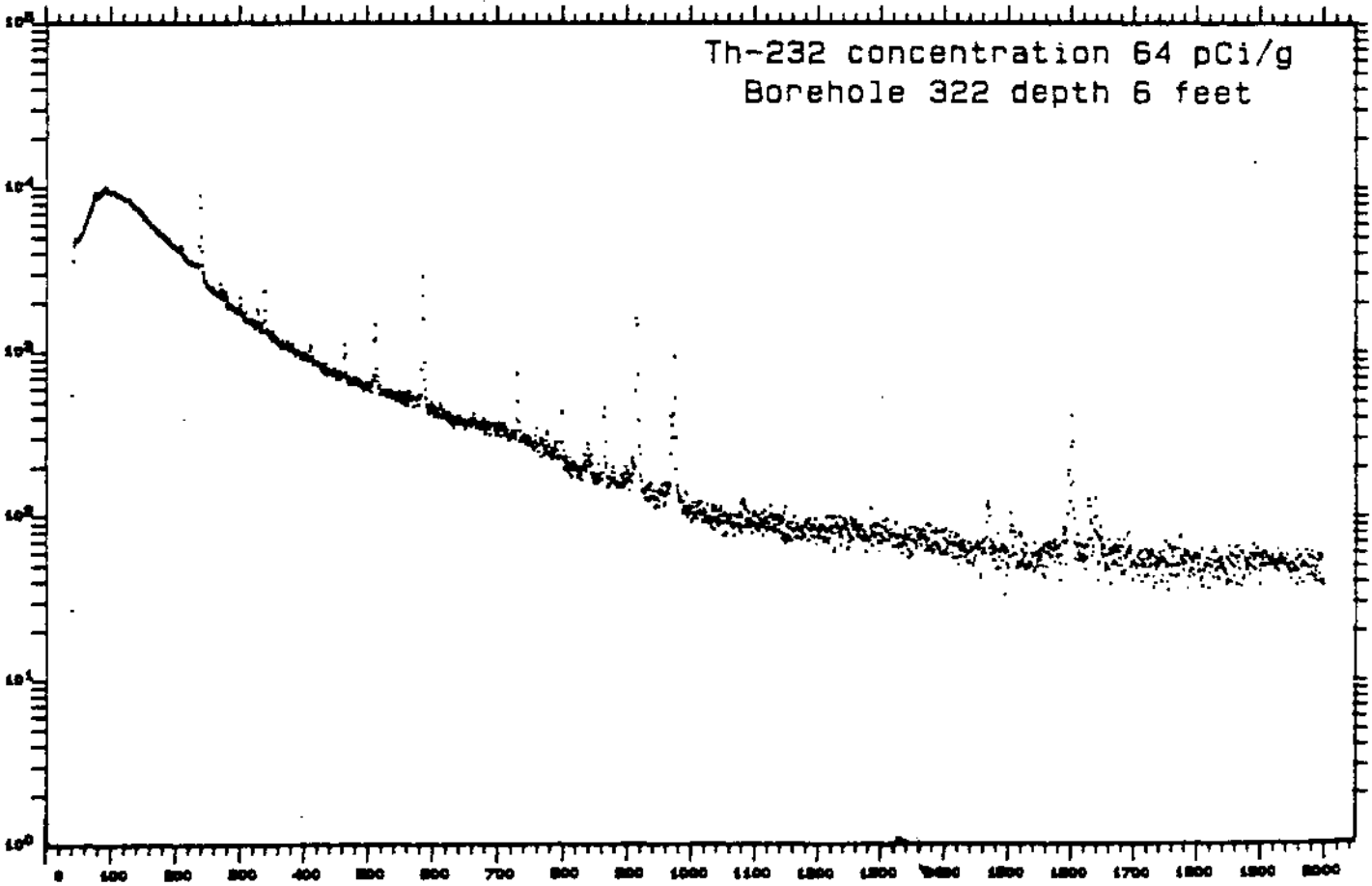

Th-232 concentration 5.9 pCi/g
Borehole 318 depth 3 feet


Th-232 concentration 9.6 pCi/g
Borehole 318 depth 2 feet


Th-232 concentration 27 pCi/g
Borehole 322 depth 1 foot


Th-232 concentration 36 pCi/g
Borehole 322 depth 2 feet


Th-232 concentration 47 pCi/g
Borehole 322 depth 7 feet


Th-232 concentration 64 pCi/g
Borehole 322 depth 6 feet

CHARACTERIZATION OF WASTE BURIAL AREAS

FINAL REPORT

PREPARED FOR:

MONSANTO RESEARCH CORPORATION

MOUND LABORATORY

PREPARED BY:

RADIATION MANAGEMENT CORPORATION

MAY 21, 1984

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INTRODUCTION

In February, 1984, Monsanto Research Corporation (Mound Lab) contracted Radiation Management Corporation (RMC) to assist in the characterization of surface and below surface contamination in the vicinity of Bld 21, located in the south corner of the plant site. This area has been identified as Area #1 by Mound Labs. In addition, limited measurements were to be made in an area west of Bld 38.

The purpose of these measurements was to define thorium contamination in soils. To accomplish this task, RMC employed a field measurement system to perform *in situ* gamma spectroscopy. Results of these measurements were displayed and recorded in the field at the time of measurement, and the raw spectral data was stored on cassette tape for future analyses, as required. Measurements were performed during April 3-6 and May 17, 1984.

Survey results are summarized in the text of this report, while each individual measurement is shown in the Appendices. As can be seen, the majority of measurements are negative (i.e. within natural background limits) indicating the absence of significant thorium contamination in the areas surveyed.

SCOPE OF WORK

The scope of this project was defined in the purchase order and in subsequent discussions between Mound Lab and RMC personnel. The primary goal of the study was to identify thorium (and daughters) contamination in soil in the areas of interest. This was done by characterizing the ambient gamma ray fields at all locations through the use of a field gamma spectroscopy system.

The target criteria (i.e. action level) for all measurements was established to be 5 pCi/g for Th-228/Th-232, as determined from daughter measurements. Therefore, it was agreed that the measurement system sensitivity should be 1 pCi/g (i.e. MDA = 20% of target criteria). In addition, it was specified that RMC would provide three dimensional models (three dimensional cross sections) of all areas, and volume estimates, for soils containing more than (1) 25 pCi/g, (2) 100 pCi/g, and (3) 1000 pCi/g, respectively.

These assessments were to be made by lowering an intrinsic germanium (IG) detector down 4 inch PVC lined borings, through the areas to be investigated, and acquiring gamma spectral data. Approximately 20 dry wells were scheduled for logging.

DESCRIPTION OF EQUIPMENT AND MEASUREMENTS

The detector employed for this project was a custom designed EG&G Ortec detector, S/N 21-P-735C. The detector, preamp, cryostat and dewar are all housed in 2.75 O.D. casing which allows sufficient room for the assembly to be lowered into 4-inch PVC casing which is used to line all boreholes. The detector has a relative efficiency of 10% and a resolution of about 2 keV at 662 keV. The entire assembly is outfitted with 100 feet of cables.

The detector assembly was connected to a small portable multichannel analyzer (MCA) for data acquisition. The MCA selected for this use was the Canberra Series 10 MCA. The Series 10 is a lightweight, battery operated MCA which contains a spectroscopy amplifier and bias power supply for the IG detector. A mini-cassette recorder was interfaced to the MCA for data storage.

A total of 22 monitoring wells were installed, of which 18 were logged during the April 3-6 site visit. The remaining 4 wells were logged on May 17, 1984. With one exception, measurements were made at 1 foot intervals from the surface to the bottom of each well. For that exception, (Hole No. 296) measurements were made at one foot intervals to a depth of 6 feet, and then at 2 foot intervals to a

final depth of 10 feet.

All acquisitions were made for a total of 300 seconds. Data was accumulated over 2048 channels, at an energy setting of 1 keV per channel. The MCA was set up so that the gross integral counts and net photopeak counts were automatically calculated and displayed for four regions of interest (ROI) following each acquisition. Count data for each ROI was recorded and converted to activity concentrations manually in the field following each acquisition. These regions included the K-40 photopeak at 1461 keV, the Ra-226 daughter, Bi-214 photopeak at 609 keV, and the Th-232 daughters, Tl-208 photopeak at 583 keV and Ac-228 photopeak at 911 keV. All data is shown in Appendix A.

Net photopeak count rates were converted to soil concentrations using the efficiency factors established during calibration of the RMC *in situ* gamma spectroscopy system. Calibration data is shown in Appendix B.

RESULTS AND CONCLUSIONS

Results for each measurement are shown in Appendix A. Representative spectra of the loggings with results greater than or equal to 1 pCi/g are shown in Appendix C. Listed are the gross region counts, net photopeak counts with relative counting error at the 95% confidence level, and the calculated concentrations. The total uncertainties for concentration values will not be much larger (e.g. 5 to 10% larger) than the photopeak counting uncertainty. Therefore, the data show that the Th-232 and Ra-226 daughters can be detected at 0.5 pCi/g concentrations with an uncertainty of about +/- 50% at the 95% confidence level.

The location of monitoring wells are shown in Figs. 1 and 2. The highest thorium concentrations were detected in well 286, indicating a layer of contaminated material extending between 1.5 and 6.5 feet below ground surface. Concentration values ranged up to 22 pCi/g in this material layer. It is not practical to estimate the volume of contaminated material based on measurement data from one monitoring well, because the areal extent of contamination is not known. However, the contaminated material appears to be bounded between wells 286 and 287, due to the absence of elevated concentrations detected in well 287.

For the remaining 21 wells, the highest level detected below surface was 2.5 pCi/g Th-232 at the 1 foot depth in hole 296. Fewer than five additional measurements were less than 2 pCi/g but above 1 pCi/g. All other measurements of Th-232 daughters were less than 1 pci/g.

The elevated below-surface concentrations are shown in Table 1.

Table 1
Elevated below-surface concentrations
of Thorium and daughters

Hole	Depth(ft)	Concentration(pCi/g)
286	0	1.4
	1	1.4
	2	22
	3	22
	4	9.4
	5	14
	6	12
	7	.8
289	0	9
	1	1.7
290	0	.3
	1	1.2
296	0	.5
	1	2.5
	2	.6
305	0	.8
	1	.8
	2	1.0
306	0	.4
	1	1.1

Except for well 286, elevated levels are found within the first foot or two of the surface. Levels below a 2 foot

depth in all wells except 286 were consistent with natural background concentrations. The presence of elevated concentrations in holes 296, 305 and 306 indicates the likelihood of a thin, near surface layer of activity south of Bld 21, between the building and the unfinished road near the site boundary fence. Fig. 3 shows an estimated area of near surface contamination, as identified by the well logging. This area is probably not greater than 1 foot in depth, and contains concentrations in the 1-2 pCi/g range. There is no indication of activities exceeding 5 pCi/g, the assumed action level, in the area near Building 21.

At several locations, measurements 1 foot above the surface were made. In each case, these results have been recorded as equivalent soil concentrations, even though they are air measurements. Evaluation of the data suggests that the elevated readings above ground level are due to direct or "shine" radiation from surface or above surface material. This is confirmed by the fact that elevated readings above ground decrease as the detector is lowered to and below the surface in the monitoring wells. For example, the highest level recorded was at the 1 foot above ground elevation at hole 289 (11 pCi/g equivalent). This level dropped rapidly to 1.7 pCi/g at 1 foot below surface. The conclusion is that the above ground reading is likely due in part or completely to a known surface hot spot near hole 289, and that

it is unlikely that any material on or below surface near this monitoring well exceeds 5 pCi/g.

Also of interest are the results for wells 302, 303 and 304. These wells were located inside an area posted as a radioactive materials area, which was believed to contain thorium contaminated soils. However, no activities above normal background levels could be found there.

For each thorium determination, both Ac-228 and Tl-208 activities were estimated. Results show that these daughter activities were consistent with the range of errors quoted. Therefore, it is concluded that Th-232 appears to be in equilibrium with its daughters, including Th-228.

A preliminary examination of spectra well-logging failed to reveal any nuclides other than natural sources of K-40 and uranium and daughters. Additional analyses are being performed to confirm the absence of isotopes such as Am-241.

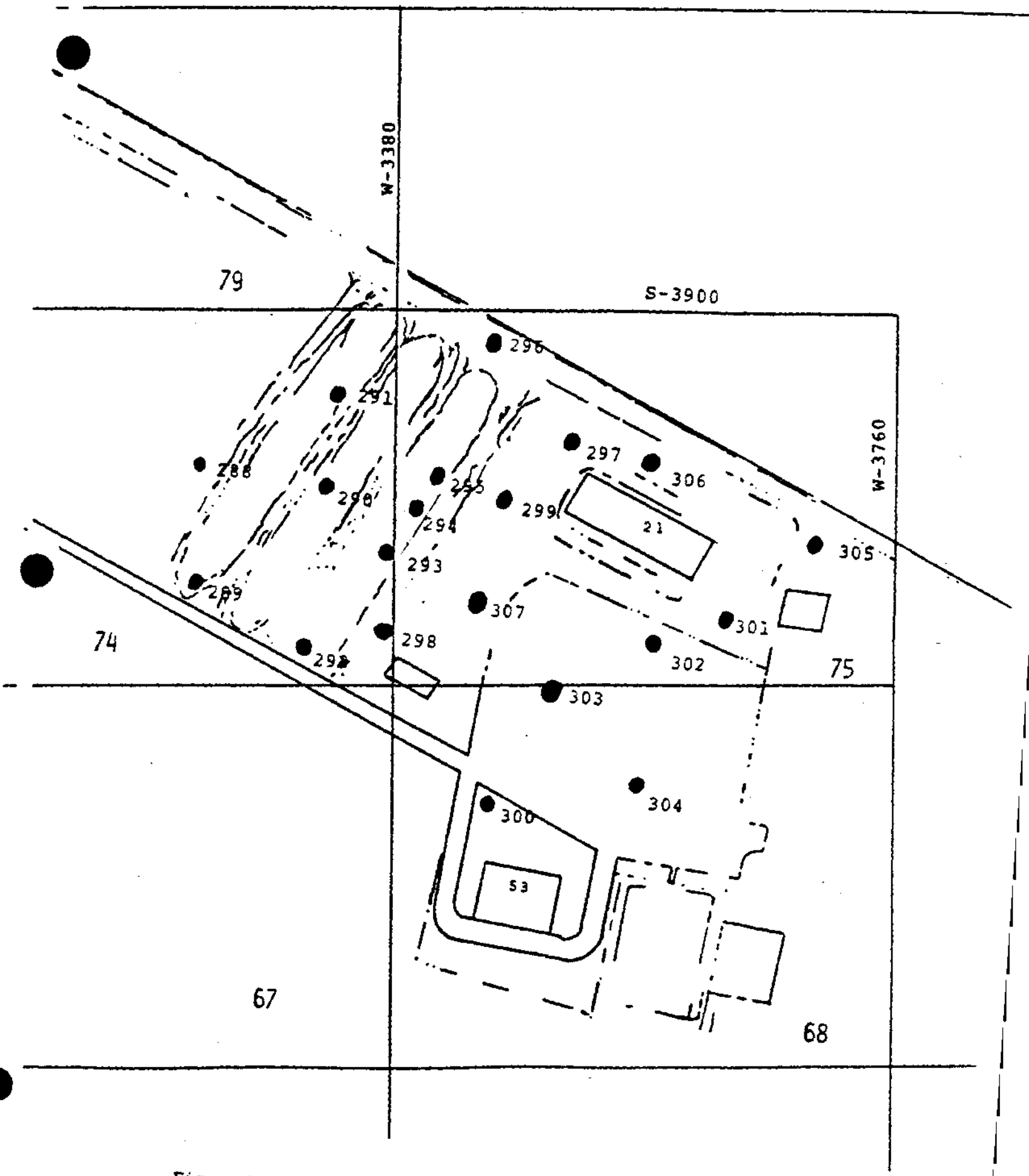


Figure 1. Location of monitoring wells in the vicinity of Building 21.

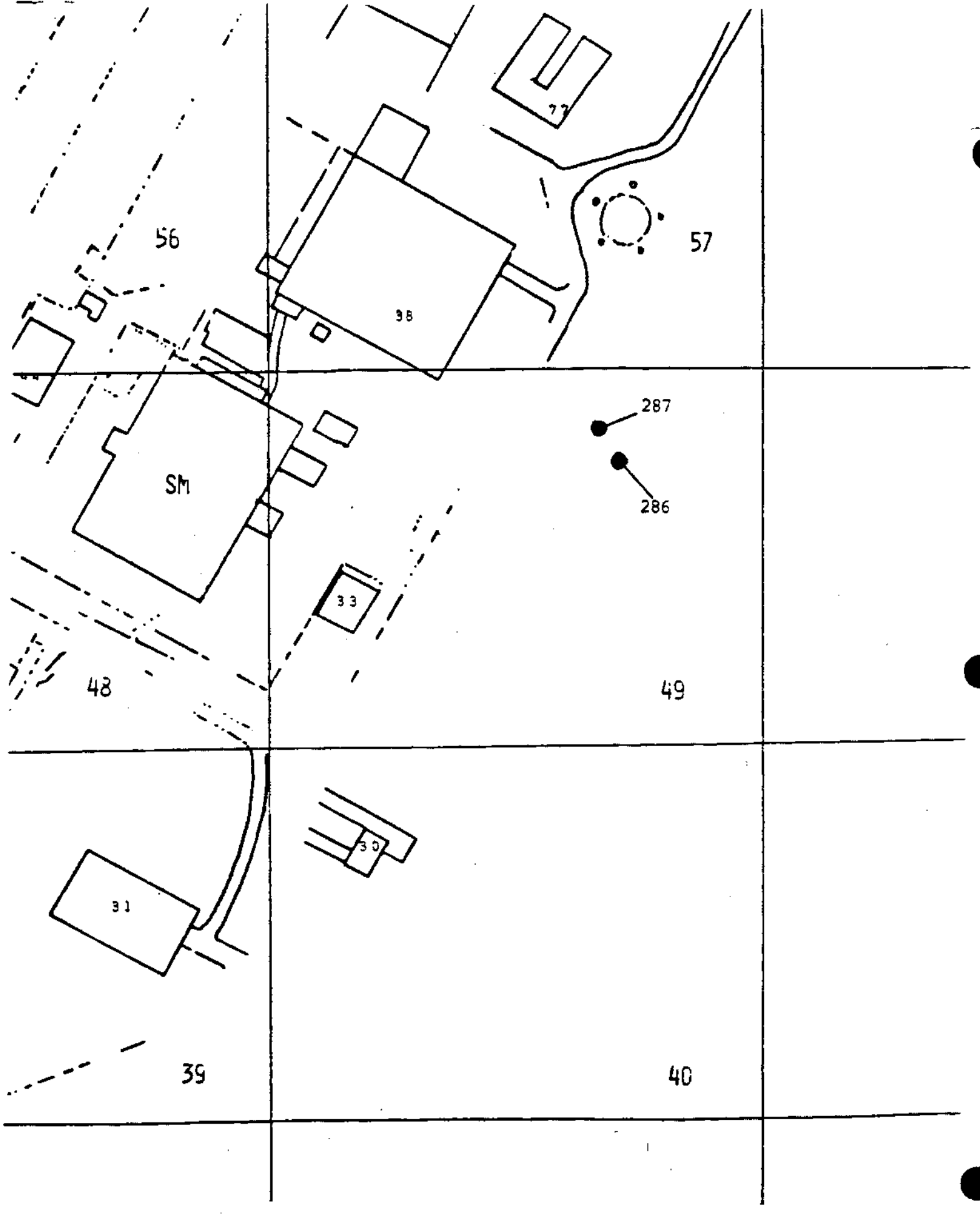


Figure 2. Location of monitoring wells in the vicinity of Building 38.

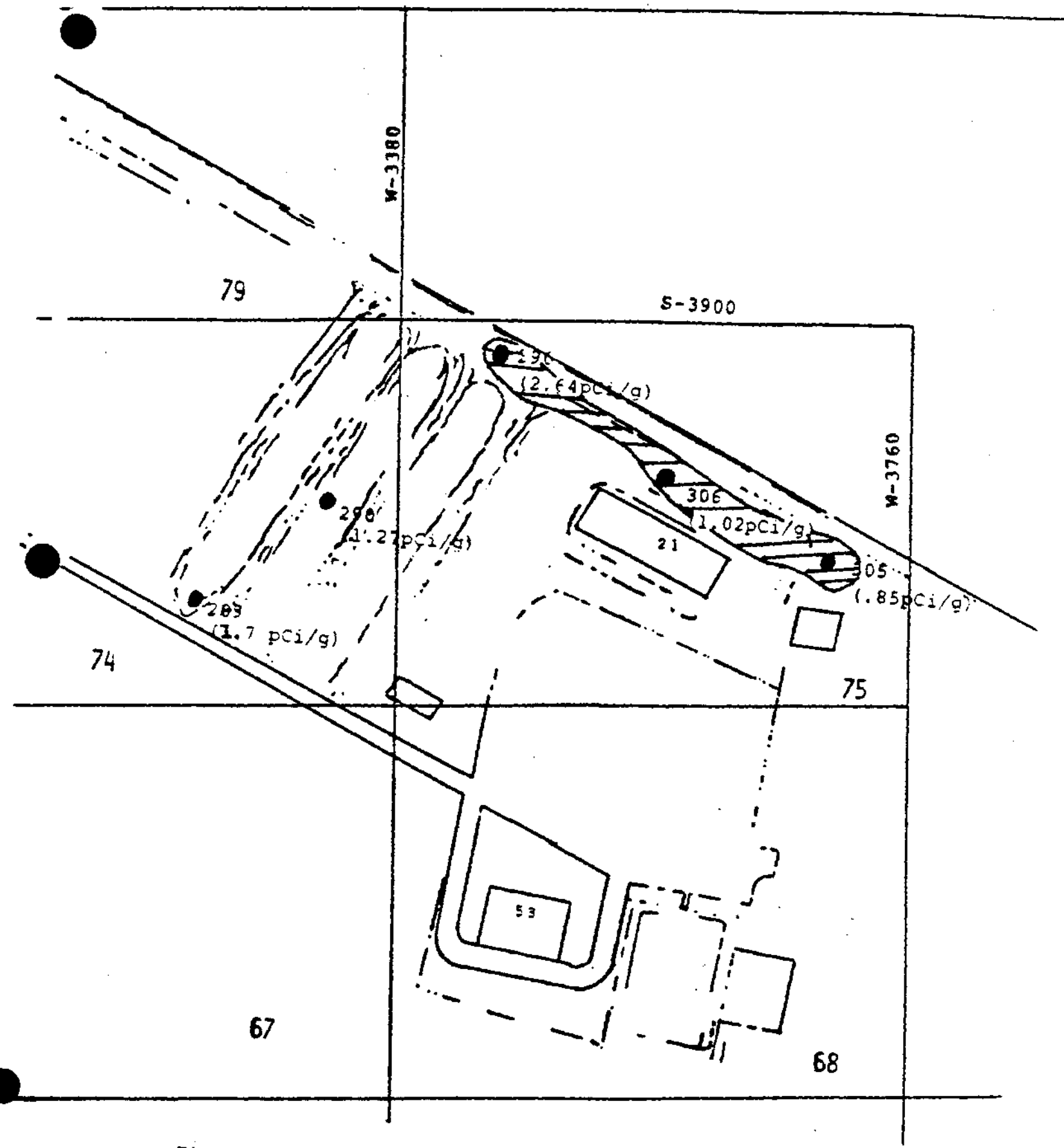


Figure 3. Location of montoring wells where subsurface deposits exceed 1 pCi/g Thorium. Lined area indicates estimated location of a thin layer near surface of approximately 1 and 2 pCi/g.

Appendix A

Measurement Results

SUMMARY OF TH-232 CONCENTRATION RESULTS*

Well Number	Depth Below Surface (ft)	Th-232 pCi/g
286	0	1.4
	1	1.4
	2	22
	3	22
	4	9.4
	5	14
	6	12
	7	0.8
	8	0.7
	9	0.9
	10	0.6
	11	0.7
287	0	0.6
	1	0.4
	2	0.5
	3	0.4
	4	0.4
	5	0.3
	6	0.5
	7	0.4
	8	0.7
	9	0.6
	10	0.3
	11	0.3
288	0	0.9
	1	0.6
	3	0.3
	4	0.3
	5	0.3
289	0	9.2
	1	1.7
	2	0.8
	3	0.5
	4	0.3
290	0	1.7
	1	1.3
	2	0.3
	3	0.3
291	0	1.0
	1	0.6
	2	0.4
	3	0.3
	4	0.4
292	0	0.4
	1	0.5
	2	0.4
	3	0.3
293	0	0.9
	1	0.4
	2	0.4
	3	0.4
294	0	0.6
	1	0.5
	2	0.2
	3	0.2
	4	0.3
295	0	0.3
	1	0.5
	2	0.5
	3	0.3
	4	0.3
296	0	0.6
	1	2.6
	2	0.5
	3	0.6
	4	0.3
	5	0.4
	6	0.3
	8	0.4
	10	0.4
297	0	0.6
	1	0.4
	2	0.5
	3	0.5
	4	<0.2
298	0	0.5
	1	0.9
	2	0.6
	3	0.4
	4	0.4
	5	0.3
299	0	0.5
	1	0.6
	2	0.3
	3	0.4
300	0	0.3
	1	0.6
	2	0.7
	3	0.4
301	0	0.8
	1	0.9
	2	0.3
	3	0.4

* average of Tl-208 and Ac-228 concentration values

SUMMARY OF TH-232 CONCENTRATION RESULTS*

Well Number	Depth Below Surface (ft)	Th-232 pCi/g
302	0	0.5
	1	0.5
	2	0.4
	3	0.3
303	0	0.2
	1	0.3
	2	0.3
304	0	0.2
	1	0.3
	2	0.5
305	0	0.8
	1	0.9
	2	1.0
306	0	0.4
	1	1.0
	2	0.4
	3	0.4
	4	0.5
307	0	0.6
	1	0.4
	2	0.3
	3	0.4

* average of Tl-208 and Ac-228 concentration values

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
286	0	*	094	Gross Integral		225	131	148	108
				Net Area		126±19%	81±24%	50±37%	76±22%
				pCi/g		1.56	1.25	0.46	3.9
286	1	*	123	Gross Integral		299	181	251	155
				Net Area		112±24%	93±23%	45±53%	116±18%
				pCi/g		1.39	1.47	0.41	6.0
286	2	*	152	Gross Integral		3544	1934	1501	393
				Net Area		1844±5%	1318±6%	146±39%	133±23%
				pCi/g		22.8	20.8	1.33	6.8
286	3	*	181	Gross Integral		3583	1952	1443	353
				Net Area		1894±5%	1325±5%	74±58%	109±32%
				pCi/g		23.4	20.9	0.67	5.6
286	4	*	208	Gross Integral		1603	870	825	271
				Net Area		809±8%	562±8%	135±32%	120±21%
				pCi/g		10.0	8.9	1.23	6.6
286	5	*	232	Gross Integral		2261	1147	946	324
				Net Area		1274±6%	773±7%	97±48%	150±21%
				pCi/g		15.8	12.2	0.88	7.7
286	6	*	256	Gross Integral		1955	1091	822	278
				Net Area		1032±7%	731±8%	110±40%	142±19%
				pCi/g		12.8	11.5	1.00	7.3

Notes: * tag no. is given by: aaabb where aaa is hole no. and bb is depth

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
286	7	*	281	Gross Integral		181	98	199	187
				Net Area		71±27%	41±38%	98±23%	154±15%
				pCi/g		0.88	0.65	0.77	7.9
286	8	*	302	Gross Integral		138	82	166	172
				Net Area		68±27%	32±49%	98±21%	158±14%
				pCi/g		0.84	0.81	0.89	8.1
286	9	*	324	Gross Integral		165	107	145	222
				Net Area		64±31%	63±26%	73±26%	206±12%
				pCi/g		0.79	1.00	0.66	10.6
286	10	*	345	Gross Integral		115	87	147	253
				Net Area		47±37%	41±37%	73±26%	243±11%
				pCi/g		0.58	0.65	0.66	12.5
286	11	*	366	Gross Integral		177	101	196	275
				Net Area		63±33%	38±41%	104±21%	251±11%
				pCi/g		0.78	0.60	0.95	12.9
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	* tag	no.	given	by:	aaabb	where	aaa is bb is	hole no depth	and

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
287	0	2	030	Gross Integral	791	114	59	116	
287	0	2	030	Net Area	67±57%	57±30%	35±35%	81±21%	
287	0	2	030	pCi/g	<3.9	.70	.55	.74	
287	1	3	089	Gross Integral	949	88	40	80	
287	1	3	089	Net Area	54±57%	53±28%	10±90%	36±35%	
287	1	3	089	pCi/g	< 3.9	.66	.16	.33	
287	2	4	119	Gross Integral	1222	97	60	99	
287	2	4	119	Net Area	49±85%	31±49%	34±36%	42±37%	
287	2	4	119	pCi/g	< 3.9	.38	.54	.38	
287	3	5	145	Gross Integral	1046	84	59	95	
287	3	5	145	Net Area	4±600%	32±44%	24±47%	51±27%	
287	3	5	145	pCi/g	< 3.9	.40	.38	.46	
287	4	6	172	Gross Integral	1193	89	44	120	
287	4	6	172	Net Area	9±400%	28±50%	23±44%	79±22%	
287	4	6	172	pCi/g	< 3.9	.35	.36	.72	
287	5	7	198	Gross Integral	1084	92	50	108	
287	5	7	198	Net Area	0	24±61%	16±62%	64±24%	
287	5	7	198	pCi/g	< 3.9	.30	.25	.58	
287	6	8	222	Gross Integral	1555	105	62	150	
287	6	8	222	Net Area	0	35±45%	41±30%	74±26%	
287	6	8	222	pCi/g	< 3.9	.43	.65	.67	
Notes:									

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
287	7	9	246	Gross Integral	1347	128	67	132	
287	7	9	246	Net Area	27±130%	43±40%	18±63%	60±27%	
287	7	9	246	pCi/g	<3.9	.53	.28	.55	
287	8	10	269	Gross Integral	1682	148	74	135	
287	8	10	269	Net Area	0	65±29%	42±32%	65±28%	
287	8	10	269	pCi/g	<3.9	.80	.66	.59	
287	9	11	292	Gross Integral	1266	119	75	121	
287	9	11	292	Net Area	0	47±36%	36±35%	67±24%	
287	9	11	292	pCi/g	<3.9	.58	.57	.61	
287	10	12	314	Gross Integral					
287	10	12	314	Net Area	22±170%	34±46%	11±95%	62±26%	
287	10	12	314	pCi/g	<3.9	.42	.17	.56	
287	11	13	336	Gross Integral	990	85	49	99	
287	11	13	336	Net Area	0	26±54%	17±59%	42±33%	
287	11	13	336	pCi/g	<3.9	.32	.27	.38	
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	Bottom = 11.5'								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
288	0	2 *	541	Gross Integral		192	76	121	74
288	0	2	541	Net Area		73±24%	61±22%	56±29%	61±23%
288	0	2	541	pCi/g		.90	.96	.51	3.13
288	1	3	558	Gross Integral		159	97	190	186
288	1	3	558	Net Area		54±32%	37±39%	100±22%	168±13%
288	1	3	558	pCi/g		.67	.58	.91	8.62
288	3	4	574	Gross Integral		87	43	108	143
288	3	4	574	Net Area		27±50%	16±59%	49±31%	133±15%
288	3	4	574	pCi/g		.33	.25	.45	6.83
288	4	5	591	Gross Integral		69	52	114	174
288	4	5	591	Net Area		27±42%	11±86%	44±38%	132±17%
288	4	5	591	pCi/g		.33	.17	.40	6.78
288	5	6	608	Gross Integral		71	35	101	176
288	5	6	608	Net Area		27±45%	13±65%	49±31%	152±14%
288	5	6	608	pCi/g		.33	.21	.45	7.80
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	H_2O at 6'	*Reset tag							

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
289	0	15	407	Gross Integral	5550	1196	703	331	
289	0	15	407	Net Area	0	734±7%	591±7%	57±35%	
289	0	15	407	pCi/g	<3.9	9.08	9.34	.52	
289	1	16	426	Gross Integral	2070	290	184	208	
289	1	16	426	Net Area	0	130±20%	116±19%	85±23%	
289	1	16	426	pCi/g	<3.9	1.61	1.83	.77	
289	2	17	445	Gross Integral	1897	181	101	194	
289	2	17	445	Net Area	20±250%	66±30%	52±29%	71±24%	
289	2	17	445	pCi/g	<3.9	.82	.82	.65	
289	3	18	464	Gross Integral	1406	87	72	131	
289	3	18	464	Net Area	0	32±43%	32±44%	78±22%	
289	3	18	464	pCi/g	<3.9	.40	.51	.71	
289	4	19	482	Gross Integral	1027	66	48	91	
289	4	19	482	Net Area	0	29±41%	18±56%	37±33%	
289	4	19	482	pCi/g	<3.9	.36	.28	.34	
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	Bottom = 4.3'								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
290	0	14	436	Gross Integral		410	263	262	71
290	0	14	436	Net Area		220±15%	193±14%	56±58%	38±40%
290	0	14	436	pCi/g		.27	3.05	.51	1.95
290	1	15	454	Gross Integral		289	131	216	160
290	1	15	454	Net Area		104±29%	79±22%	48±57%	136±15%
290	1	15	454	pCi/g		1.29	1.25	.44	6.98
290	2	16	472	Gross Integral		179	75	185	163
290	2	16	472	Net Area		35±63%	13±110%	59±45%	138±16%
290	2	.16	472	pCi/g		.43	.21	.52	7.08
290	3 *	17	490	Gross Integral		70	50	96	134
290	3	17	490	Net Area		29+44%	16+62%	44+39%	120+16%
290	3	17	490	pCi/g		.36	.25	.40	6.16
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	*H_2O at 3.5'								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
291	0	*	452	Gross Integral		166	106	122	41
				Net Area		61±33%	75±23%	46±37%	29±36%
				pCi/g		0.75	1.19	0.42	1.5
291	1	*	470	Gross Integral		149	94	164	209
				Net Area		46±41%	40±37%	92±22%	196±12%
				pCi/g		0.58	0.63	0.84	10.1
291	2	*	488	Gross Integral		108	81	141	189
				Net Area		38±42%	22±70%	86±22%	179±17%
				pCi/g		0.47	0.35	0.78	9.2
291	3	*	506	Gross Integral		85	54	88	167
				Net Area		26±54%	17±60%	33±44%	160±13%
				pCi/g		0.32	0.27	0.30	8.2
291	4	*	524	Gross Integral		98	52	108	230
				Net Area		32±48%	21±57%	53±31%	218±11%
				pCi/g		0.39	0.33	0.48	11.2
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	* tag	no.	given	by:	aaabb	where	aaa is bb is	hole no depth	and

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
292	0	22	541	Gross Integral		85	50	75	48
292	0	22	541	Net Area		25±53%	31±35%	20±50%	42±27%
292	0	22	541	pCi/g		.31	.49	.18	2.16
292	1	23	558	Gross Integral		135	82	176	231
292	1	23	558	Net Area		31±52%	34±44%	89±21%	191±13%
292	1	23	558	pCi/g		.38	.54	.81	9.80
292	2	24	575	Gross Integral		99	52	98	170
292	2	24	575	Net Area		34±43%	18±55%	58±26%	160±13%
292	2	24	575	pCi/g		.42	.28	.35	9.24
292	3	25	591	Gross Integral		82	53	93	194
292	3	25	591	Net Area		29±42%	20±57%	38±40%	180±13%
292	3	25	591	pCi/g		.36	.32	.35	9.24
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	Bottom = 3.5'								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
293	0	*	541	Gross Integral		155	65	93	35
				Net Area		87±23%	52±26%	39±38%	30±30%
				pCi/g		1.08	0.82	0.35	1.5
293	1	*	558	Gross Integral		128	68	143	177
				Net Area		32±53%	22±58%	73±25%	157±14%
				pCi/g		0.40	0.35	0.66	8.1
293	2	*	575	Gross Integral		143	89	203	191
				Net Area		40±46%	21±75%	122±19%	183±12%
				pCi/g		0.49	0.33	1.11	9.4
293	3	*	591	Gross Integral		120	77	171	198
				Net Area		44±30%	20±67%	92±22%	189±12%
				pCi/g		0.54	0.32	0.84	9.7
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					

Notes: * tag no. is given by: aaabb where aaa is hole no and bb is depth

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
294	0	34	204	Gross Integral		102	65	195	39
294	0	34	204	Net Area		45±33%	35±35%	123±18%	31±32%
294	0	34	204	pCi/g		.56	.55	1.12	1.59
294	1	35	227& 250 *	Gross Integral		98	66	184	162
294	1	35	"	Net Area		33±40%	26±46%	118±18%	151±14%
294	1	35	"	pCi/g		.41	.41	1.07	7.75
294	2	36	273	Gross Integral		79	53	161	188
294	2	36	273	Net Area		12±100%	13±80%	116±17%	162±14%
294	2	36	273	pCi/g		<.25	.21	1.06	8.32
294	3	37	295	Gross Integral		83	51	139	150
294	3	37	295	Net Area		21±55%	14±72%	76±24%	143±14%
294	3	37	295	pCi/g		.26	.22	.69	7.34
294	4	38	317	Gross Integral		88	66	144	241
294	4	38	317	Net Area		29±46%	17±66%	85±21%	219±12%
294	4	38	317	pCi/g		.36	.27	.77	11.24
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:			* Spectra stored twice						

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
295	0	28	036 *	Gross Integral		73	29	107	46
295	0	28	036	Net Area		29±43%	12±65%	70±22%	40±27%
295	0	28	036	pCi/g		.36	.19	.64	2.05
295	1	29	068	Gross Integral		105	58	119	185
295	1	29	068	Net Area		51±29%	26±43%	64±27%	180±12%
295	1	29	068	pCi/g		.63	.41	.58	9.24
295	2	30	091	Gross Integral		100	53	105	215
295	2	30	091	Net Area		46±32%	26±42%	50±31%	144±12%
295	2	30	091	pCi/g		.57	.41	.46	7.39
295	3	31	126	Gross Integral		75	54	103	207
295	3	31	126	Net Area		21±54%	17±62%	48±33%	200±12%
295	3	31	126	pCi/g		.26	.27	.44	10.27
295	4	32	153	Gross Integral		67	50	86	184
295	4	32	153	Net Area		20±58%	16±62%	37±37%	165±13%
295	4	32	153	pCi/g		.25	.25	.34	8.47
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:									

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
296	0	40	358	Gross Integral		124	85	99	48
296	0	40	358	Net Area		41±39%	42±30%	52±29%	37±29%
296	0	40	358	pCi/g		.51	.66	.47	1.90
296	1	41	377	Gross Integral					
296	1	41	377	Net Area		202±14%	176±13%	59±38%	124±17%
296	1	41	377	pCi/g		2.50	2.78	.54	6.37
296	2	42	397	Gross Integral		119	89	137	188
296	2	42	397	Net Area		35±44%	40±35%	63±27%	177±13%
296	2	42	397	pCi/g		.43	.63	.57	9.09
296	3	43	416	Gross Integral		109	78	148	222
296	3	43	416	Net Area		44±32%	43±31%	69±28%	215±11%
296	3	43	416	pCi/g		.54	.68	.63	11.04
296	4	44	435	Gross Integral		89	41	102	187
296	4	44	435	Net Area		35±39%	12±73%	47±32%	168±13%
296	4	44	435	pCi/g		.43	.19	.43	8.62
296	5	45	454	Gross Integral		92	57	105	230
296	5	45	454	Net Area		39±34%	25±44%	46±35%	221±11%
296	5	45	454	pCi/g		.48	.40	.42	11.34
296	6	46	472	Gross Integral		96	69	103	231
296	6	46	472	Net Area		31±46%	14±84%	43±35%	203±12%
296	6	46	472	pCi/g		.38	.22	.39	10.42
Notes:									

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
296	8	47	490	Gross Integral		110	55	139	260
296	8	47	490	Net Area		36±37%	21±50%	63±29%	242±11%
296	8	47	490	pCi/g		.45	.31	.57	12.42
296	10	48	507	Gross Integral		91	67	113	296
296	10	48	507	Net Area		41±35%	23±50%	64±25%	272±10%
296	10	48	507	pCi/g		.51	.36	.58	13.96
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	Bottom =11.5'								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
297	0	1 *	150	Gross Integral		154	66	111	65
297	0	1	150	Net Area		44±45%	36±37%	19±91%	44±29%
297	0	1	150	pCi/g		.54	.57	<.18	2.26
297	1	2	176	Gross Integral		93	43	103	139
297	1	2	176	Net Area		28±52%	28±37%	41±41%	127±15%
297	1	2	176	pCi/g		.35	.44	.37	6.52
297	2	3	201	Gross Integral		116	60	106	149
297	2	3	201	Net Area		38±47%	34±38%	38±45%	141±14%
297	2	3	201	pCi/g		.47	.54	.35	7.24
297	3	4	226	Gross Integral		93	70	160	221
297	3	4	226	Net Area		19±75%	29±44%	68±31%	207±12%
297	3	4	226	pCi/g		<.25	.46	.62	10.63
297	4	5	249	Gross Integral		78	46	89	163
297	4	5	249	Net Area		18±81%	0	39±40%	153±14%
297	4	5	249	pCi/g		<.25	<.14	.35	7.85
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:		*Reset tag							

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
298	0	*	002	Gross Integral		96	57	88	63
				Net Area		33±45%	33±38%	36±40%	53±25%
				pCi/g		0.41	0.52	0.33	2.7
298	1	*	035	Gross Integral		165	114	198	162
				Net Area		95±21%	40±41%	110±20%	157±15%
				pCi/g		1.17	0.63	1.00	8.1
298	2	*	066	Gross Integral		154	94	164	190
				Net Area		53±36%	35±47%	81±25%	156±15%
				pCi/g		0.66	0.55	0.74	8.0
298	3	*	095	Gross Integral		94	62	152	206
				Net Area		46±33%	12±97%	76±25%	186±13%
				pCi/g		0.57	0.20	0.69	9.6
298	4	*	123	Gross Integral		77	40	108	119
				Net Area		29±47%	16±67%	60±27%	103±17%
				pCi/g		0.36	0.25	0.55	5.3
298	5	*	150	Gross Integral		69	45	75	159
				Net Area		21±60%	26±60%	32±41%	150±14%
				pCi/g		0.26	0.41	0.29	7.7
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	* tag	no.	given	by:	aaabb	where	aaa is bb is	hole no depth	and

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
299	0	38	003	Gross Integral		149	56	126	39
299	0	38	003	Net Area		51±39%	24±51%	46±40%	31±32%
299	0	38	003	pCi/g		.63	.38	.42	1.59
299	1	39	036& 065	Gross Integral		151	93	174	166
299	1	39	"	Net Area		64±29%	31±51%	112±19%	149±14%
299	1	39	"	pCi/g		.79	.49	1.02	7.65
299	2	40	095	Gross Integral		87	49	110	185
299	2	40	095	Net Area		27±57%	21±55%	40±43%	166±13%
299	2	40	095	pCi/g		.33	.33	.36	8.52
299	3 *	41	123	Gross Integral		70	55	88	184
299	3	41	123	Net Area		0	23±49%	42±37%	177±13%
299	3	41	123	pCi/g		<.25	.36	.38	9.09
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	* H_2O at 3.5'								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
300	0	11	036 *	Gross Integral		88	51	165	79
300	0	11	036	Net Area		27±53%	15±78%	115±18%	71±21%
300	0	11	036	pCi/g		.33	.24	1.05	3.64
300	1	12	067	Gross Integral		146	79	156	193
300	1	12	067	Net Area		50±37%	31±47%	64±30%	176±13%
300	1	12	067	pCi/g		.62	.49	.58	9.03
300	2	13	098	Gross Integral		141	91	162	200
300	2	13	098	Net Area		51±36%	47±33%	85±24%	184±17%
300	2	13	098	pCi/g		.63	.74	.77	9.45
300	3	14	125	Gross Integral		93	69	136	254
300	3	14	125	Net Area		32±46%	21±65%	59±31%	240±11%
300	3	14	125	pCi/g		.40	.33	.54	12.32
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:			* New Tape						

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
301	0	17	224	Gross Integral		158	87	90	89
301	0	17	224	Net Area		70±28%	49±31%	35±42%	71±22%
301	0	17	224	pCi/g		.87	.77	.32	3.64
301	1	18	248	Gross Integral		160	95	151	192
301	1	18	248	Net Area		70±28%	53±30%	77±25%	164±14%
301	1	18	248	pCi/g		.87	.84	.70	8.42
301	2	19	271	Gross Integral		94	66	145	172
301	2	19	271	Net Area		24±61%	16±83%	60±31%	152±19%
301	2	19	271	pCi/g		.30	.25	.55	7.80
301	3 *	20	293	Gross Integral		89	64	96	170
301	3	20	293	Net Area		28±51%	22±60%	44±34%	146±15%
301	3	20	293	pCi/g		.35	.35	.40	7.49
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	*Absorball plug at 3'								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
302	0	23	357	Gross Integral		154	70	77	47
302	0	23	357	Net Area		25±74%	44±31%	18±67%	33±36%
302	0	23	357	pCi/g		.31	.70	<.18	1.69
302	1	24	377	Gross Integral		107	67	125	149
302	1	24	377	Net Area		53±30%	23±59%	53±33%	139±15%
302	1	24	377	pCi/g		.66	.36	.48	7.14
302	2	25	396	Gross Integral		100	57	101	185
302	2	25	396	Net Area		28±59%	25±50%	44±39%	171±13%
302	2	.25	396	pCi/g		.35	.40	.40	8.78
302	3	26	416	Gross Integral		72	53	75	157
302	3	26	416	Net Area		18±70%	19±63%	34±39%	140±15%
302	3	26	416	pCi/g		<.25	.30	.31	7.19
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:									

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
303	0	30	489	Gross Integral		75	35	64	61
303	0	30	489	Net Area		19±75%	15±65%	14±90%	61±21%
303	0	30	489	pCi/g		<.25	.24	<.18	3.13
303	1	31	507	Gross Integral		76	35	61	175
303	1	31	507	Net Area		21±64%	5±200%	32±35%	168±13%
303	1	31	507	pCi/g		.26	<.14	.29	8.62
303	2	32	524	Gross Integral		98	56	102	232
303	2	32	524	Net Area		22±74%	12±100%	34±49%	199±13%
303	2 *	32	524	pCi/g		.27	.19	.31	10.22
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	* End of pipe 2'2"								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
304	0	27	435	Gross Integral		50	21	51	41
304	0	27	435	Net Area		4±290%	15±50%	27±45%	36±21%
304	0	27	435	pCi/g		<.25	.24	.25	1.85
304	1	28	453	Gross Integral		55	41	103	105
304	1	28	453	Net Area		16±70%	17±62%	60±26%	93±18%
304	1	28	453	pCi/g		<.25	.27	.55	4.77
304	2 *	29	471	Gross Integral		82	63	138	187
304	2	29	471	Net Area		0	17±77%	55±37%	180±13%
304	2	29	471	pCi/g		<.25	.27	.50	9.24
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	*Absorball at 2'								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
305	0	11	378	Gross Integral					
305	0	11	378	Net Area		72±23%	50±27%	48±45%	60±24%
305	0	11	378	pCi/g		.89	.79	.44	3.08
305	1	12	398	Gross Integral		157	79	131	184
305	1	12	398	Net Area		73±31%	50±27%	51±40%	163±14%
305	1	12	398	pCi/g		.90	.79	.46	8.73
305	2 *	13	417	Gross Integral		156	87	170	203
305	2	13	417	Net Area		90±23%	51±30%	63±40%	188±13%
305	2	13	417	pCi/g		1.11	.81	.57	9.65
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:	* Bottom at 2.5'								

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
306	0	6	272	Gross Integral		100	51	103	46
306	0	6	272	Net Area		32±48%	27±42%	35±48%	29±40%
306	0	6	272	pCi/g		.40	.43	.32	1.49
306	1	7	294	Gross Integral		162	80	154	115
306	1	7	294	Net Area		94±22%	56±26%	92±22%	102±18%
306	1	7	294	pCi/g		1.16	.88	.84	5.24
306	2	8	316	Gross Integral		103	53	111	196
306	2	8	316	Net Area		33±47%	20±57%	37±47%	189±12%
306	2	8	316	pCi/g		.41	.32	.34	9.70
306	3	9	337	Gross Integral		88	47	118	170
306	3	9	337	Net Area		32±53%	0	46±46%	160±14%
306	3	9	337	pCi/g		.40	<.14	.42	8.21
306	4	10	358	Gross Integral		134	60	124	206
306	4	10	358	Net Area		47±44%	25±48%	56±35%	199±12%
306	4	10	358	pCi/g		.58	.40	.51	10.22
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:									

Bore Hole Number	Depth (ft)	Tag	Tape Number		Ac-228 93 keV	Tl-228 583 keV	Ac-228 911 keV	Bi-214 609 keV	K-40 1461 keV
307	0	34	558	Gross Integral		136	56	125	42
307	0	34	558	Net Area		46±42%	40±31%	43±43%	38±28%
307	0	34	558	pCi/g		.57	.63	.39	1.95
307	1	35	574	Gross Integral		76	58	53	134
307	1	35	574	Net Area		30±45%	30±42%	30±35%	127±15%
307	1	35	574	pCi/g		.37	.47	.27	6.52
307	2	36	590	Gross Integral		96	38	101	192
307	2	36	590	Net Area		34±47%	16±63%	55±30%	175±13%
307	2	36	590	pCi/g		.42	.25	.50	8.98
307	3	37	606	Gross Integral		75	61	93	211
307	3	37	606	Net Area		27±49%	23±56%	45±35%	201±12%
307	3	37	606	pCi/g		.33	.36	.41	10.32
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
				Gross Integral					
				Net Area					
				pCi/g					
Notes:									

APPENDIX B

The EG&G Ortec IG well logging detector was calibrated using a RMC designed calibration rig consisting of a 55 gallon drum with 4 concentric rings surrounding a 4 inch PVC tube. Source tubes filled with plaster of paris containing an NBS traceable Eu-152 solution, were loaded into each of the 4 rings sequentially, and counts performed. The configurations corresponded to uniformly distributed source material in a "soil approximate" matrix at radial distances of 3.75, 5.00, 6.25 and 7.50 inches from the detector axis. These points were then plotted as shown in Fig. 1, for 334 keV, and the area under curve from 2 inches to infinity calculated. When this was done for several photons of varying energy, the efficiency curve shown in Fig. 2 was generated. This curve represents the response of the detector, in terms of counts per gamma per gram, for gamma emitters uniformly distributed to an infinite distance in soil.

As a check on this calibration, RMC performed measurements at the DOE calibration facility operated by Bendix Corporation at Grand Junction, Colorado. This facility maintains wells constructed from concrete containing known amounts of uranium, Ra-226, Th-232 and K-40. Results of this comparison are presented in Table 1, and show close agreement between measurements. The values obtained during

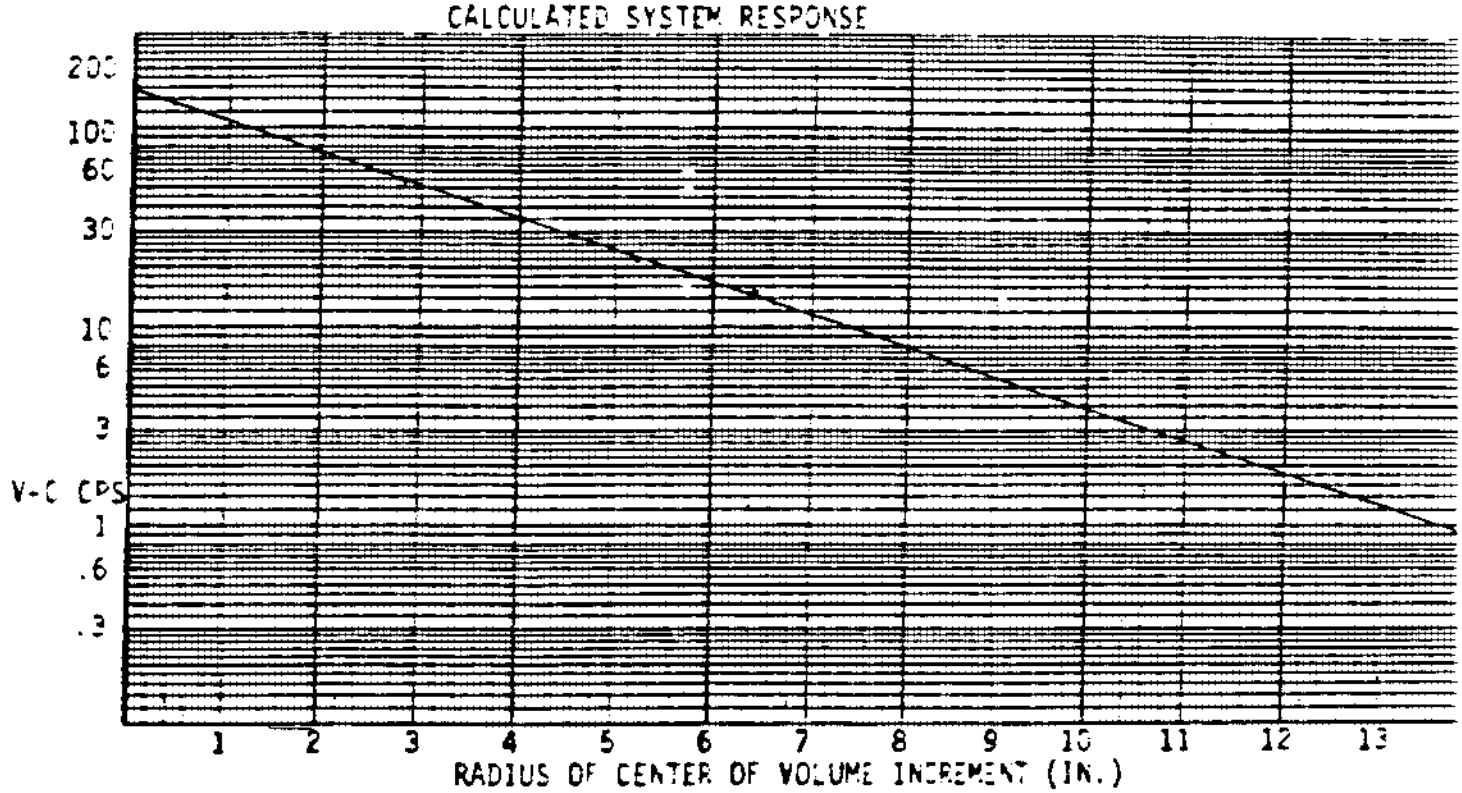
the RMC calibration have been used to determine concentrations at the Mound Lab site.

EG&G ORTEC IG DETECTOR SYSTEM
BOREHOLE LOGGING GEOMETRY CALIBRATION

OBSERVED SYSTEM RESPONSE PHOTON ENERGY: 0.344 Mev.

CYLINDRICAL VOLUME INCREMENT INNER RADIUS	OUTER RADIUS	NET CPS	VOLUME-CORRECTED CPS (V-C CPS)
2.25 in.	3.45 in.	24.8	54.87
3.45 in.	4.65 in.	16.0	35.40
4.65 in.	5.85 in.	9.79	21.66
5.85 in.	7.05 in.	7.09	15.69
7.05 in.	8.25 in.	(CALCULATED)	0.0

CALCULATED SYSTEM RESPONSE



CYLINDRICAL VOLUME INCREMENT OF SOURCE MATERIAL INNER RADIUS	OUTER RADIUS	CENTER RADIUS	V-C CPS
8.25 in.	9.45 in.	8.85 in.	6.0
9.45 in.	10.65 in.	10.05 in.	3.8
10.65 in.	11.85 in.	11.25 in.	2.4
11.85 in.	13.05 in.	12.45 in.	1.6
13.05 in.	14.25 in.	13.65 in.	1.0

INTEGRAL V-C CPS (RADIUS 2.25 IN. TO INFINITY): 152

EFFICIENCY (counts per gamma/gram): 34.4

Figure 1.

TABLE 1

EG&G ORTEC DETECTOR - BOREHOLE GEOMETRY (4.5 IN. O.D.)
COMPARISON OF EFFICIENCY VALUES DETERMINED AT
GRAND JUNCTION FACTILITY (8/2/82) AND RMC NORTHBROOK (3/31/84)

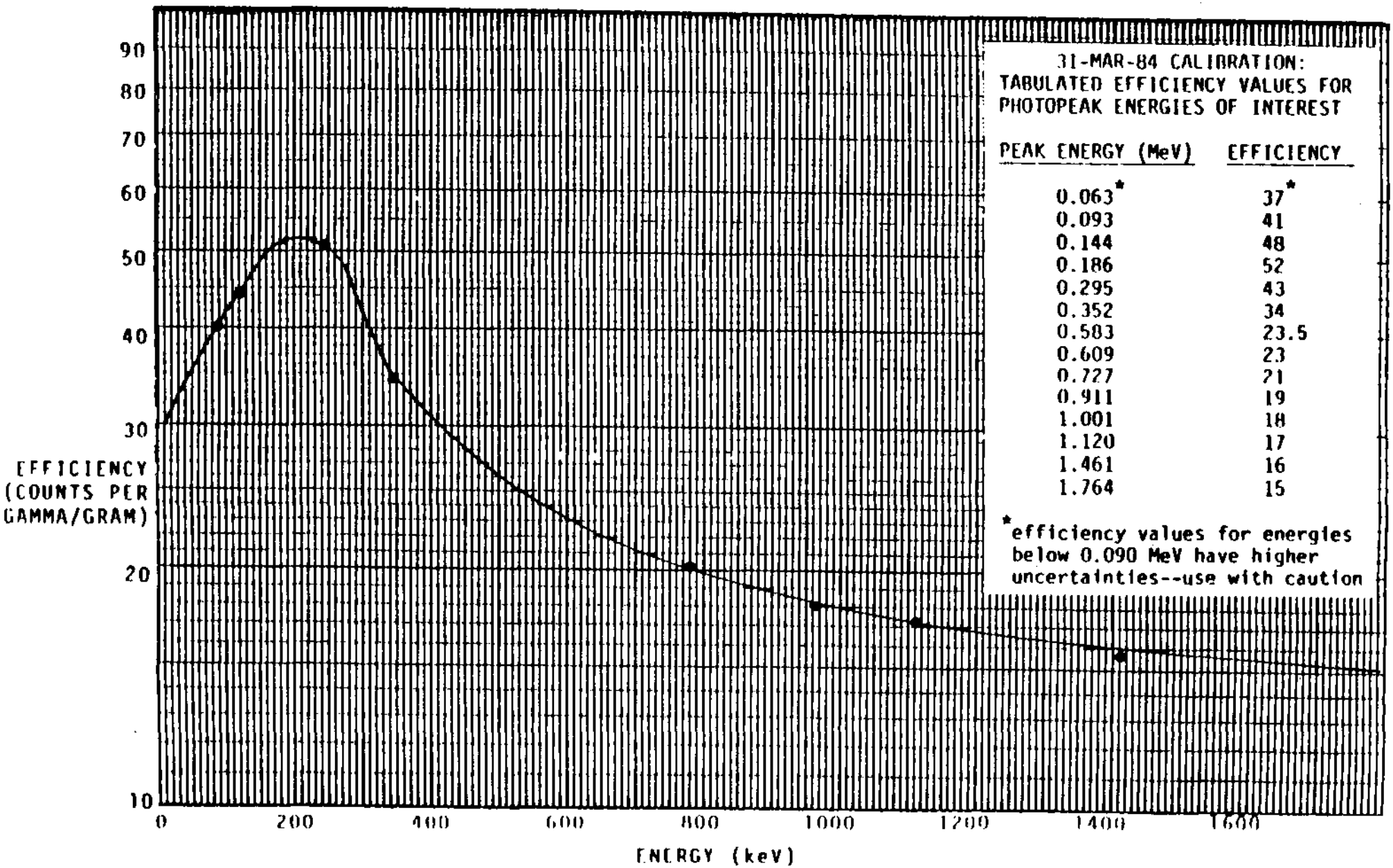
PHOTOPEAK ENERGY (MEV)	EFFICIENCY (COUNTS PER GAMMA/GRAM) RMC LAB	GRAND JUNCTION	RATIO: RMC LAB/ GRAND JUNCTION
0.186	52	56.6	0.92
0.295	43	37.5	1.15
0.352	34	34.8	0.98
0.583	23.5	21.0	1.12
0.609	23	25.3	0.91
0.727	21	19.5	1.08
0.860	19	16.8	1.13
1.120	17	15.2	1.12
1.461	16	16.7	0.96
1.764	15	12.7	1.18

WORST CASE DISCREPANCY: + 18%

AVERAGE DISCREPANCY (ALL DATA WEIGHTED EQUALLY): 10%

EG&G ORTEC IG DETECTOR--BOREHOLE LOGGING GEOMETRY--4.5 INCH OUTER DIAMETER PVC-LINED HOLES

EFFICIENCY (COUNTS PER GAMMA/GRAM) VERSUS PHOTON ENERGY



31-MAR-84 CALIBRATION:
TABULATED EFFICIENCY VALUES FOR PHOTOPEAK ENERGIES OF INTEREST

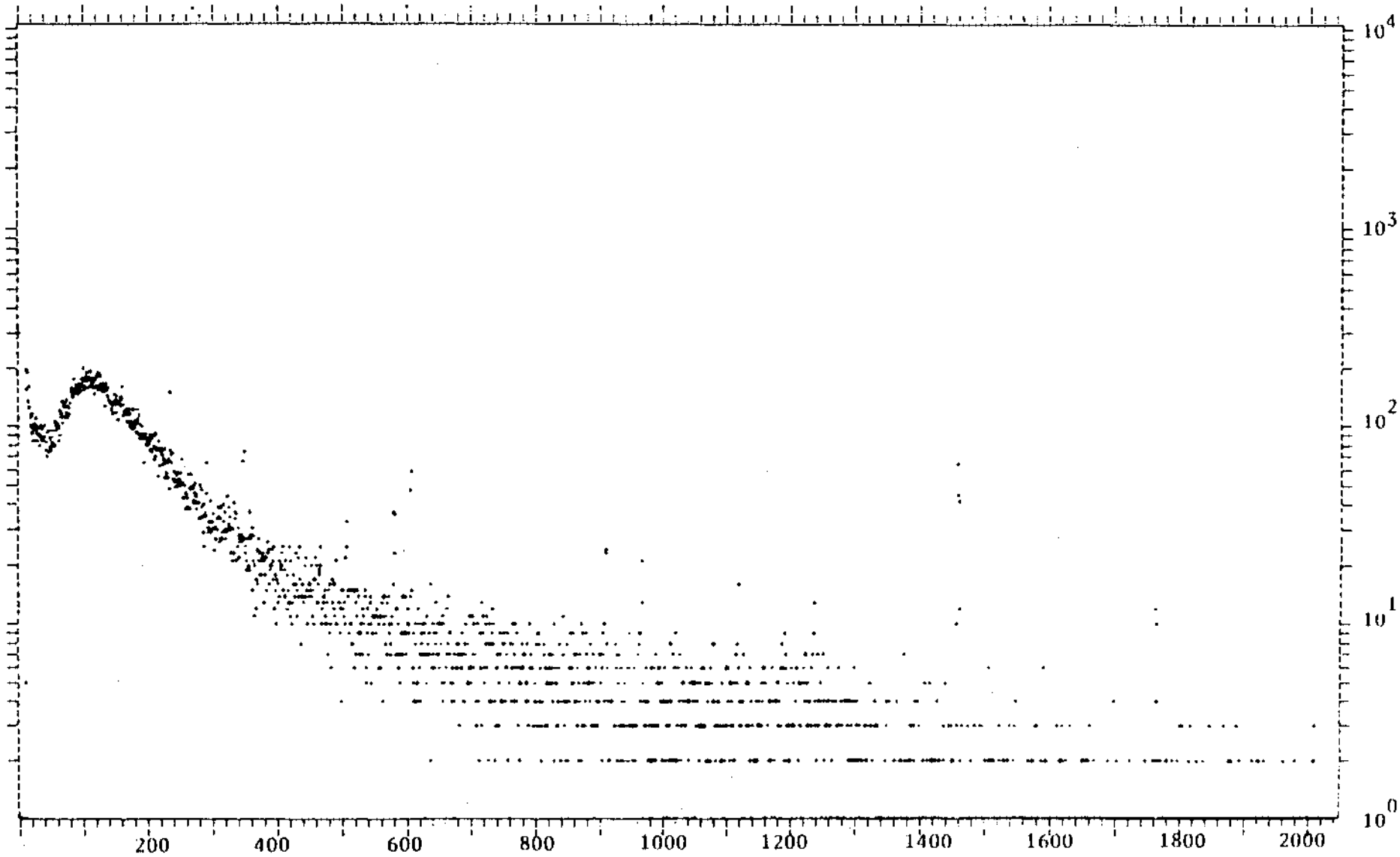
PEAK ENERGY (MeV)	EFFICIENCY
0.063*	37*
0.093	41
0.144	48
0.186	52
0.295	43
0.352	34
0.583	23.5
0.609	23
0.727	21
0.911	19
1.001	18
1.120	17
1.461	16
1.764	15

*efficiency values for energies below 0.090 MeV have higher uncertainties--use with caution

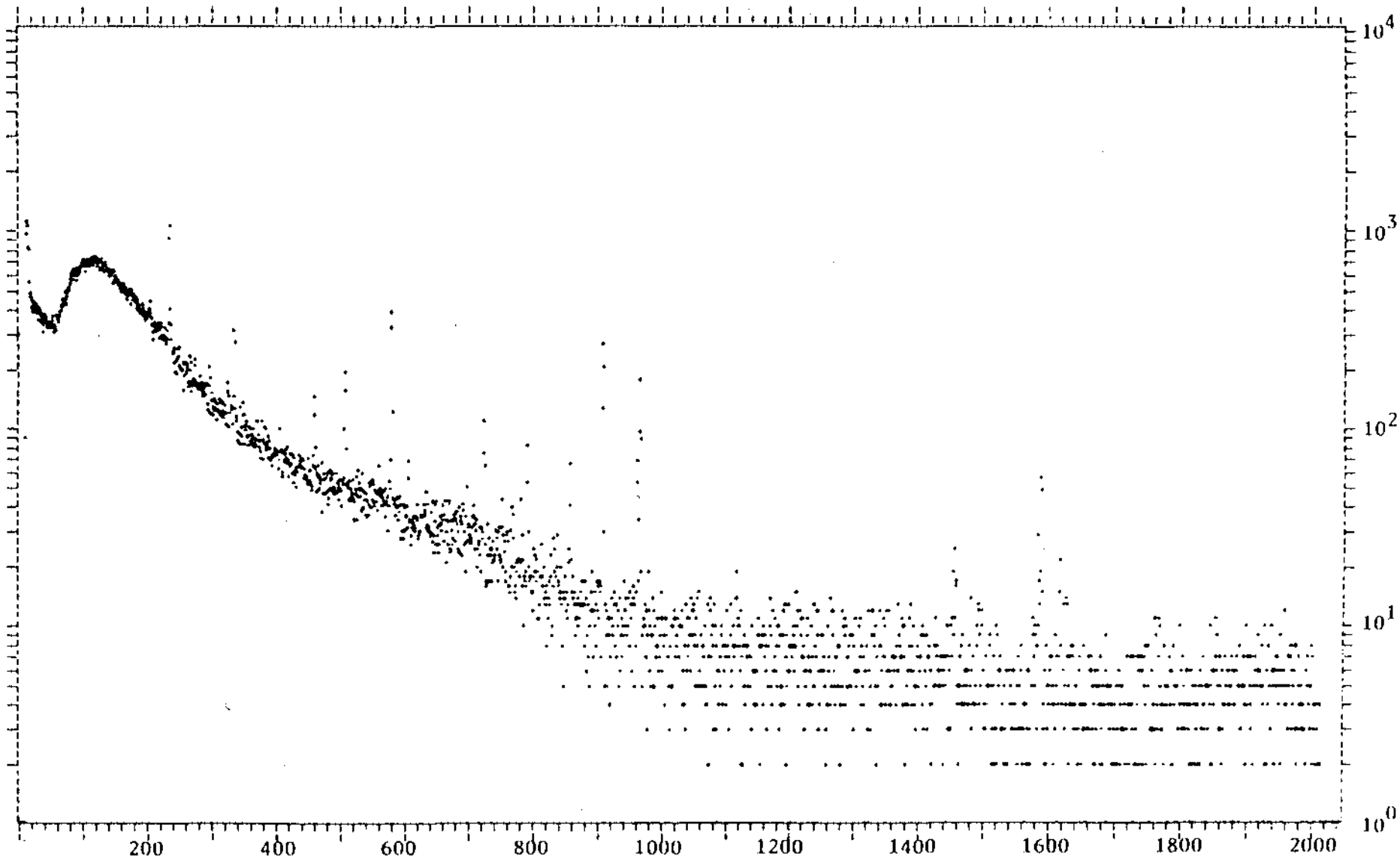
Figure 2.

Appendix C

Representative Spectra

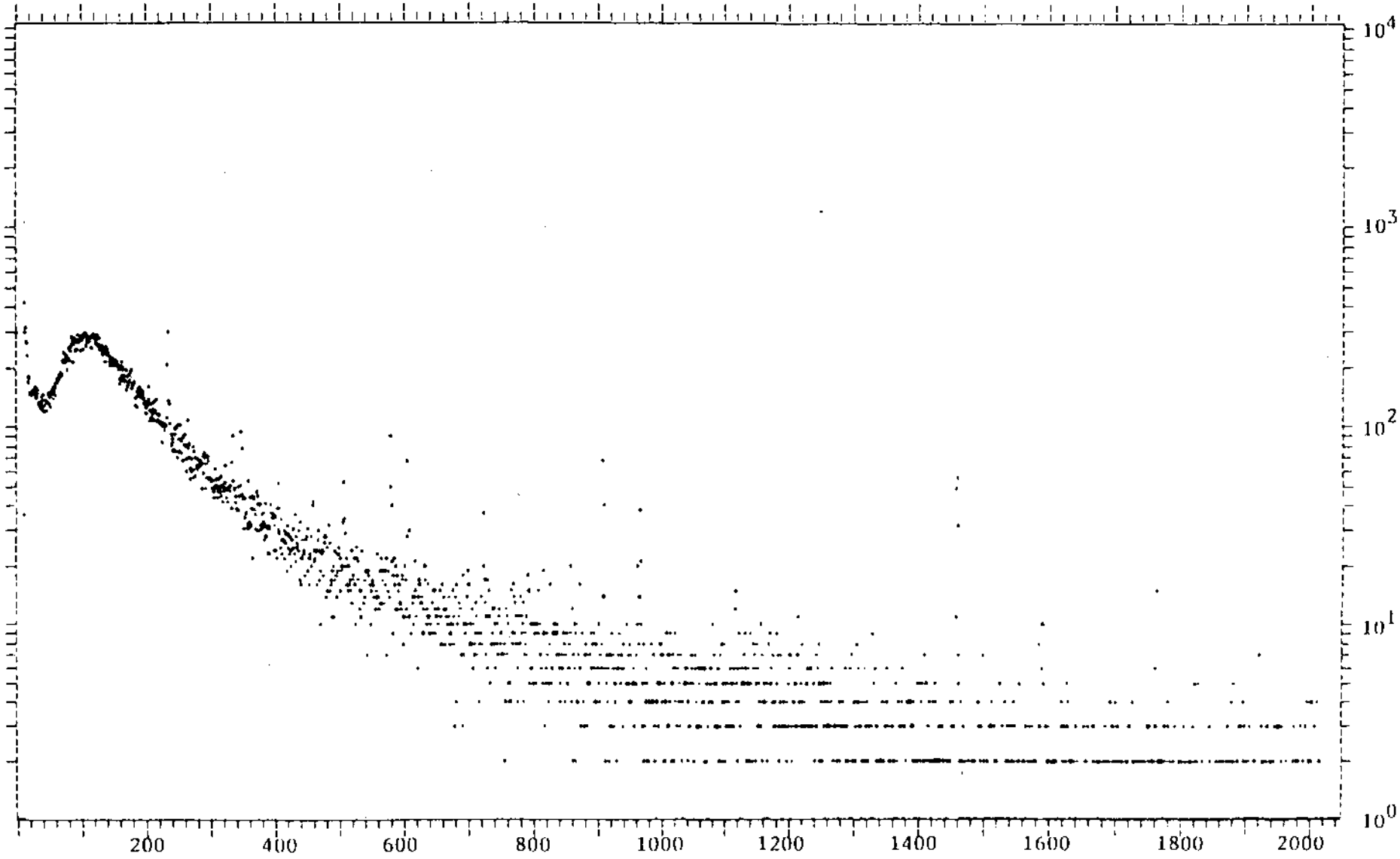


Bore Hole Number 288; Depth 1'

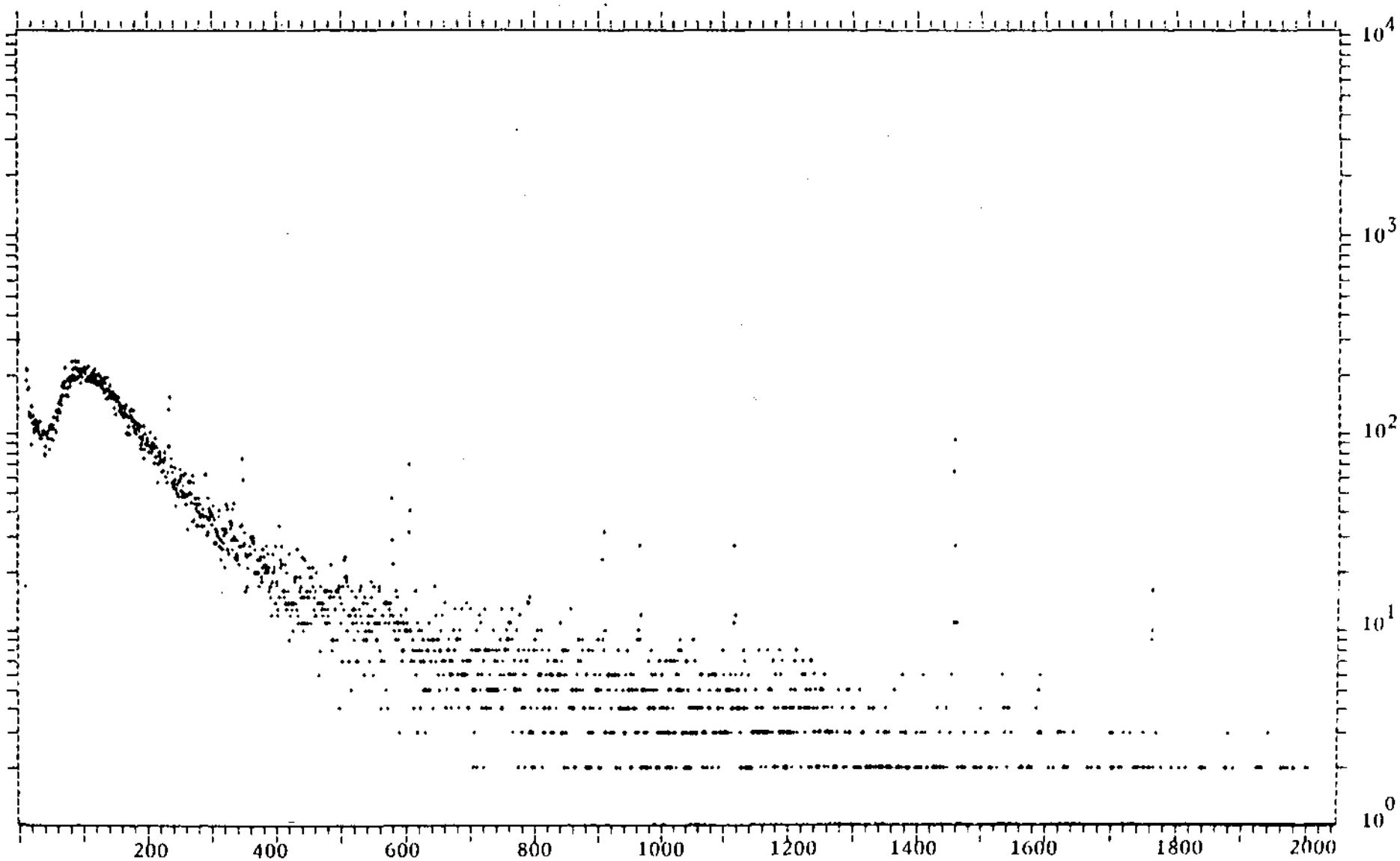


Bore Hole Number 289; Depth 0'

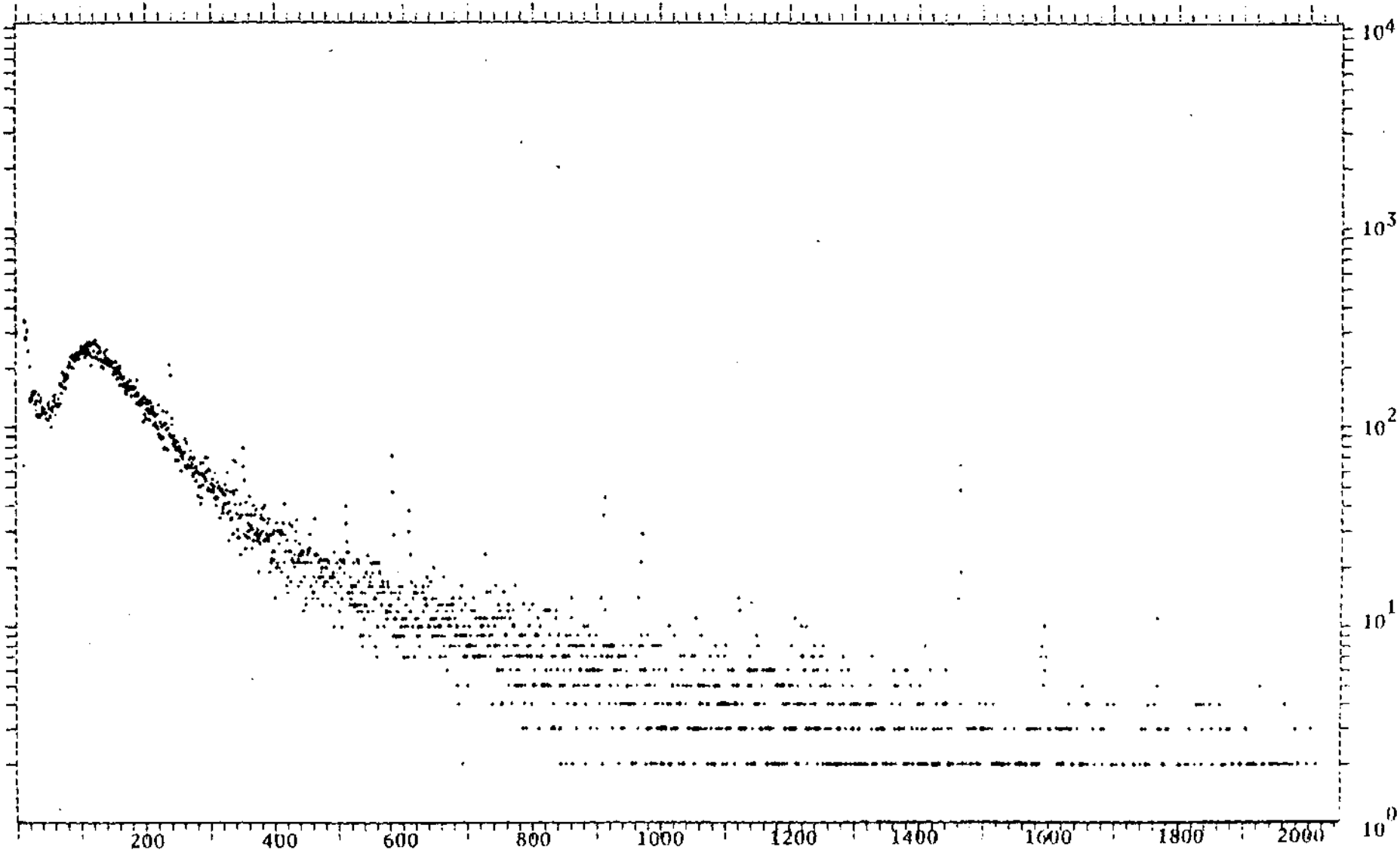
HOLE 289 DEPTH 0



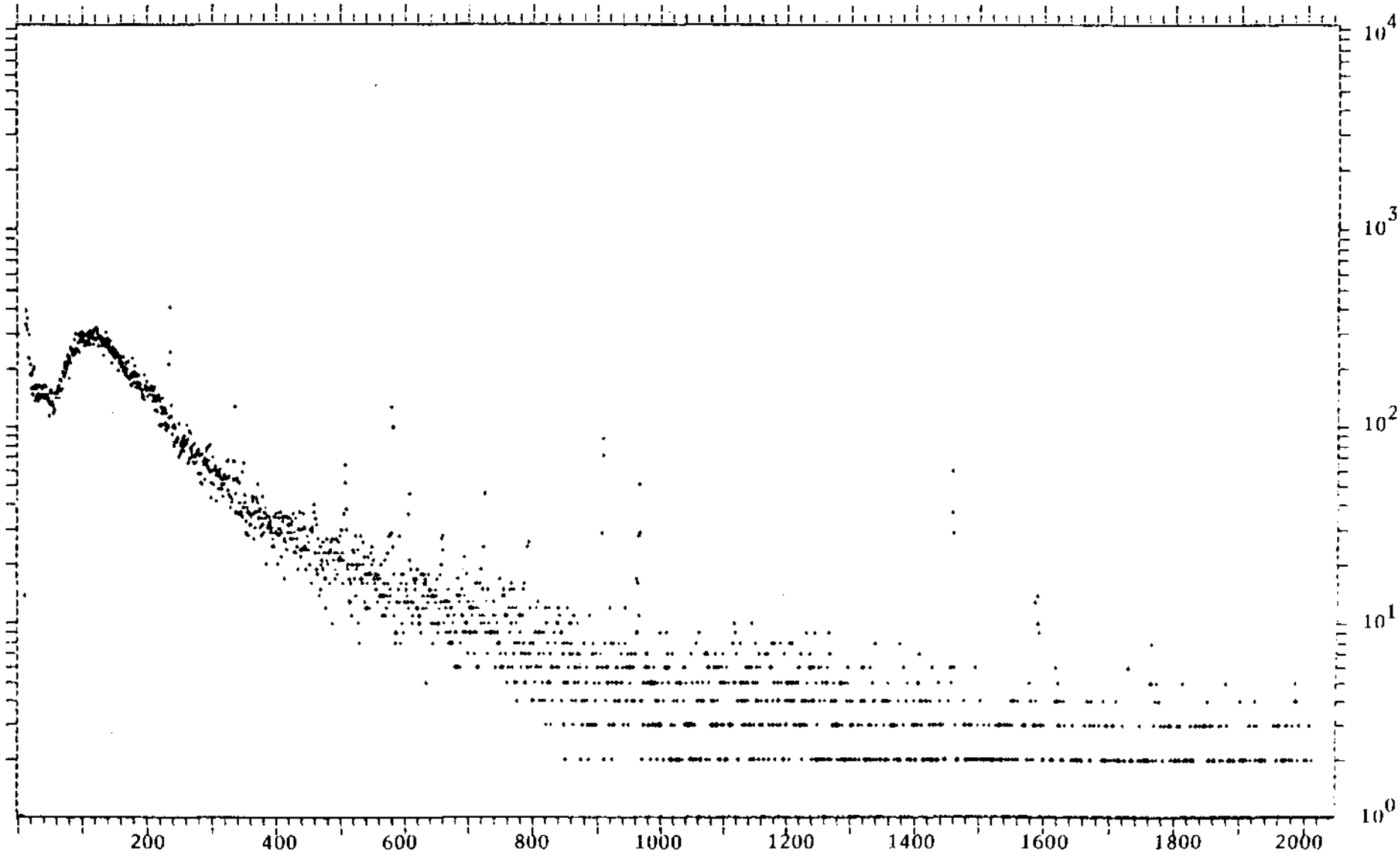
Bore Hole Number 289; Depth 1'



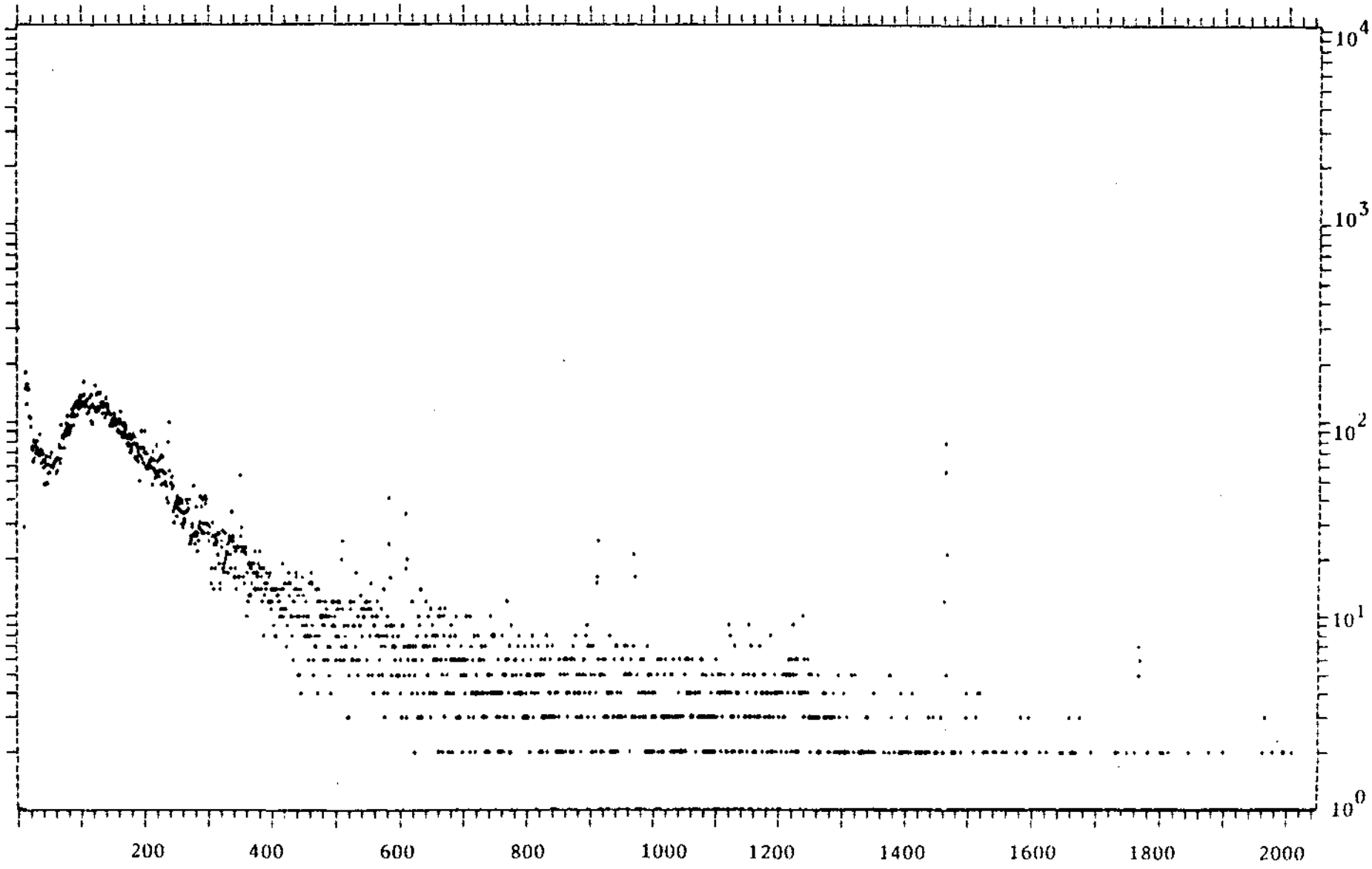
Bore Hole Number 289; Depth 2'



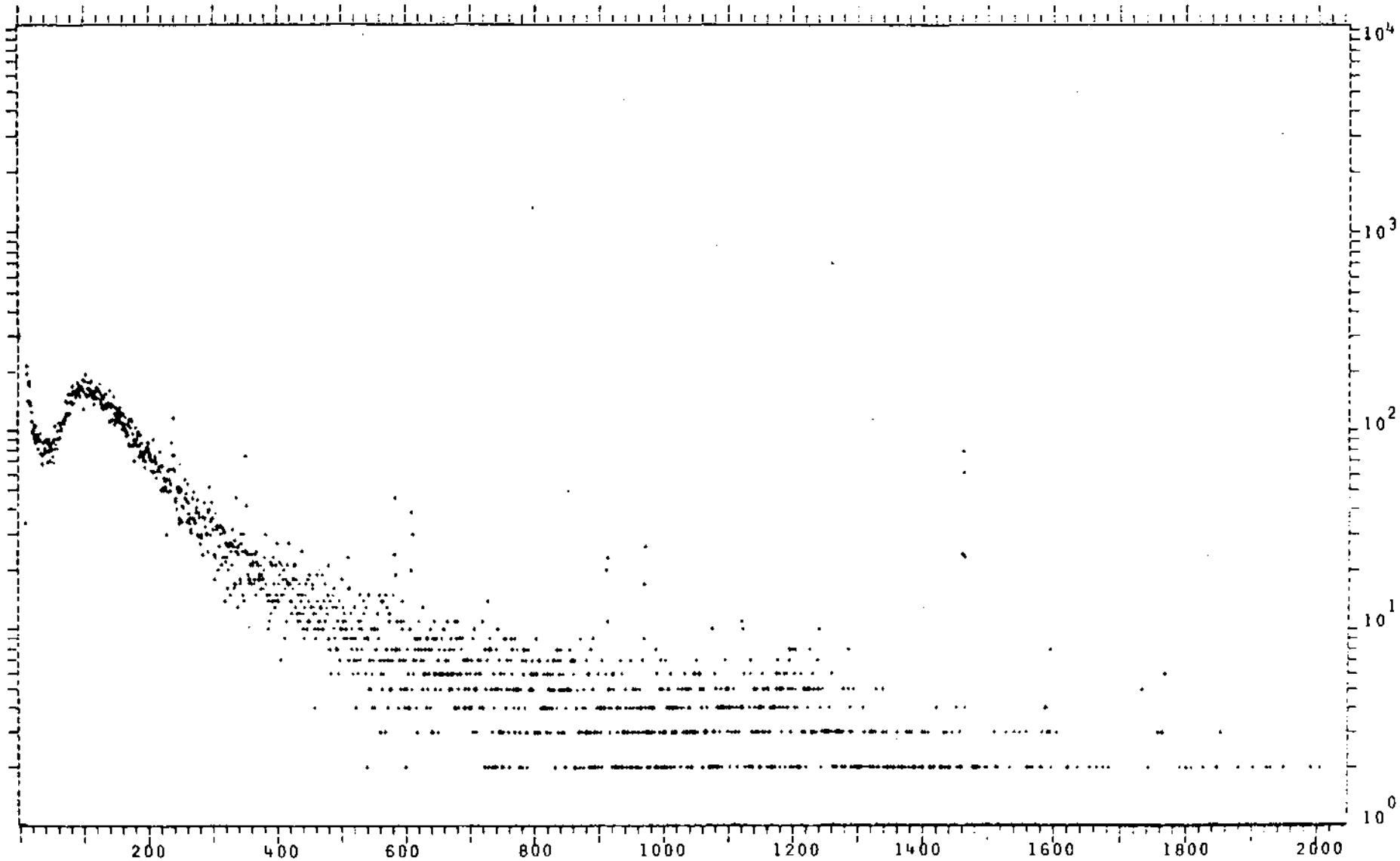
Bore Hole Number 290; Depth 1'



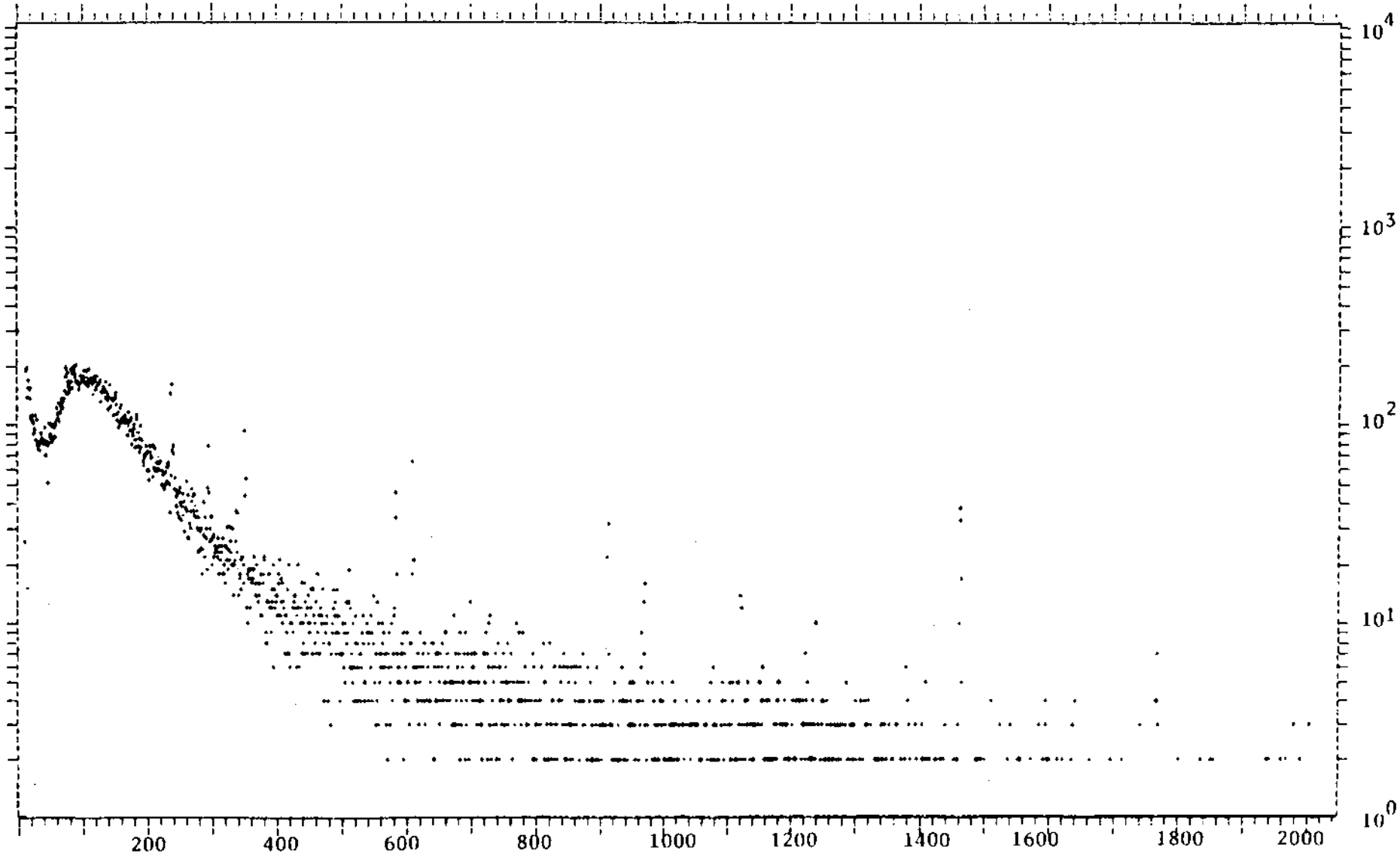
Bore Hole Number 296; Depth 1'



Bore Hole Number 305; Depth 1'



Bore Hole Number 305; Depth 2'



Bore Hole Number 306; Depth 1'

APPENDIX D

QUALITY ASSURANCE/QUALITY CONTROL DATA

QUALITY ASSURANCE OF MOUND SOIL ANALYSES RESULTS

1: Mound EML Quality Assurance Program - 1984
2: Radiochemical Analysis Results Compared for Four Laboratories
3: Radiochemical Analysis Quality Assurance Results as Reported by Two Subcontractors

MOUND

Inter-Office Correspondence

From : Carl T. Bishop cc D. G. Carfagno

Date : September 19, 1984

Subject : Plutonium in Soil-Quality Control

Reference : EML Quality Assurance Program - 1984 - First half

TO : Bob Stought

As I have mentioned to you in the past, Mound participates in a regular DOE quality control program twice a year. Here are the most recent results for plutonium in soil, including the Accu-Labs Research, Inc. report to us on August 10, 1984.

Laboratory	Isotope	Activity (pCi/g)	Ratio Meas./EML
Environmental Measurements Laboratory (EML)*	Pu-238	0.054	
	Pu-239	3.13	
Mound E Building	Pu-238	0.049	0.91
	Pu-239	2.72	0.87
Mound H Building	Pu-238	0.056	1.04
	Pu-239	3.34	1.07
Accu-Labs Research	Pu-239	2.0	0.64

*The EML values are considered to be the "true" values.

As you can see, Mound's values are within 15% of the "true" values. Accu-Labs is about 35% low.

Carl T. Bishop

Carl T. Bishop

CTB:ww

2: Radiochemical analyses results compared for four laboratories

MOUND

Inter-Office Correspondence

From: Brian T. Leahy, Experimental Design Group

Date: May 9, 1984

Subject: Evaluation of Four Lab Study of Isotopes as Related to Mound Site Survey

Reference:

To: D. B. Armstrong
W. P. Davis
File

Bob Stought:

This memo contains the explanation for the comparison of the four labs which evaluated soil samples for contamination of Thorium-232, Plutonium-238, Plutonium-239, Thorium total, Plutonium total, and all isotopes as indicated by your heading on the data sheets. Within the text of this memo the special nature of your data collection, analyses, and findings are discussed.

The data can be viewed in two ways, each leading to the same conclusions. First, the data can be treated as a three way classification analysis of variance with the isotope a fixed effect variable, the labs as a fixed effect variable, and the sample a random effect variable. The other way in which to examine the data is to treat each isotope as a separate analysis of variance problem. This creates six two way classification analysis of variance problems with lab as a fixed effect variable and sample as a random effect variable. At this point the distinction between fixed and random effect variables needs to be made.

The four labs submitting data to the study are the only four labs of interest to us. They comprise a group of special interest and we are interested in detecting differences among them and not interested in extending our conclusion to all labs capable of doing the analyses. Since we are interested in these four labs and no others we say the labs are fixed and we want to test for the equality of mean readings, pico-curies per gram. The sample is deemed a random effect variable because they do not comprise the entire set of samples possible. We could continue the study by collecting another set of soil samples and instead of focusing upon the effect of a particular set of soil samples, we focus upon the variation of the population of possible soil samples. The ultimate distinction lies in the hypothesis to be tested in viewing fixed effects and random effects. In an hypothesis concerning fixed effects we are interested in testing whether the mean readings of the four labs are identical versus at least one mean is not equal. The hypothesis of interest for random effects tests whether the variance is zero or greater than zero. Since both fixed and random effect variables are present the analysis of variance model is a mixed effects model. The next feature of the data needing attention is the design.

We expect to find different mean readings among the isotopes and comparing these levels is not an immediate concern. For this reason the results of interest are comparing the mean readings for the labs and reviewing the variation of the samples. Particularly, we want to know if significant differences exist with lab 4, the EAP laboratory. Each set of data for the six isotopes is unbalanced and incomplete. That is to say not all labs have the same number of samples nor did the labs submit readings for all samples. Knowing that the data is unbalanced and incomplete leads to specialized handling of the data.

Results from the six, two way classification analysis of variance procedures are found in Table 1, Lab and Sample Evaluation. Each isotope has two conclusions, one regarding the comparison of the labs and the other regarding the variability of the samples. Some specifics concerning signifcance levels testing the mean reading from EAP, lab 4 and the other labs have been omitted, but were used in deciding which of the labs is closest to lab 4. The conclusions in the table are based upon statistical decisions using 0.05 as the level of significance.

TABLE 1
Lab and Sample Evaluation

Isotope	Lab and Sample Conclusions
ALL ISOTOPES	There is insufficient evidence to reject the hypothesis that all lab mean readings are equal. There is sufficient evidence to indicate significant variability from sample to sample.
PLUTONIUM 238	There is sufficient evidence that not all lab mean readings are equal. Lab 3 and lab 4 are not equal. There is sufficient evidence to indicate significant variability in Plutonium 238 readings from sample to sample.
PLUTONIUM 239	There is insufficient evidence to reject the hypothesis that all lab mean Plutonium 239 readings are equal. There is insufficient evidence to indicate significant variability in Plutonium 239 readings from sample to sample.
TOTAL PLUTONIUM	There is sufficient evidence that not all lab mean readings are equal. Lab 3 and lab 4 are not equal. There is sufficient evidence to indicate significant variability in Total Plutonium readings from sample to sample.

TOTAL THORIUM	There is sufficient evidence that not all lab mean readings are equal. Lab 3 and lab 4 are not equal. There is insufficient evidence to indicate significant variability in Total Thorium readings from sample to sample.
THORIUM 232	There is sufficient evidence that not all lab mean readings are equal. Lab 3 and lab 4 are not equal. Lab 1 and lab 4 are not equal. There is sufficient evidence to indicate significant variability in Thorium 232 readings from sample to sample.

Using the results in Table 1 and the probabilities of finding significant levels between lab 4 and labs 1, 2, and 3, lab 2 has the overall performance closest to lab 4.

Attached you will find six plots which illustrate the labs' performances using the raw data. Places where the lines are broken indicate the samples which were not analyzed by a particular lab.

Summarizing, the data sets for the isotopes support the use of lab 2 in conjunction with lab 4 for the analyses of soil samples in Mound's site survey. The actual statistical tests will be kept on file with a copy of this memo. If I can be of additional assistance, please contact me.

Brian T. Leahy

Brian T. Leahy

MOUND

Inter-Office Correspondence

From: C. T. Bishop, Ext. 3927

Date: August 14, 1984

Subject: Soil Sample Analysis - Independent Verification

Reference: Accu-Labs Research, Inc. Results Dated August 3, 1984

TO: Bob Stought

cc: D. G. Carfagno/L. D. T
C. A. Phillips/A. E. D
W. P. Davis
D. G. Draper
H. E. Meyer
J. M. Garner
C. S. Friedman

As you indicated last week most of Mound's radiochemical analysis results were in agreement with the Accu-Labs values. Where there is disagreement, I suggest that Mound analyze the samples again and also that you send the samples to EAL Corporation for a third analysis. Mound has had good results from EAL over many years, and although they are a little more expensive, EAL has a good reputation with many DOE laboratories throughout the country.

Where Mound values disagree with Accu-Lab values, the Mound values are more likely to be correct. This is not based on a personal opinion, but is based on information in a recent data evaluation report prepared by DOE's Pacific Northwest Laboratory (PNL). On the second half of last year, both Mound and Accu-Labs participated in the Environmental Measurements Laboratory (EML) Quality Assessment Program. In this program, laboratories analyze unknown samples and report their results to EML; PNL then evaluated the data. Mound made a total of 15 measurements all of which were within limits established by PNL. Accu-Labs made 12 measurements, 6 of which were within the established limits. This data is documented in DOE report PNL-5079 (a copy of which is enclosed). Table 4 on pages 17-18 summarizes the data. Mound is designated as ML, and Accu-Labs is designated as PA; they did the analytical work for the Pantex Plant.

To assure sample homogeneity, I suggest that the samples to be re-analyzed be returned to H Building. We will completely mix them, take a sample for analysis and return them to you. I suggest that you then send samples to EAL before September 15, 1984 so that they can also analyze the samples.

Carl T. Bishop

Carl T. Bishop

CTB:ww

3: Radiochemical analyses quality assurance results as reported by two subcontractor laboratories

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

February 26, 1985
Page 1 of 1

Mr. Carl Bishop
Monsanto Research Corp.
Mound Laboratory
Miamisburg, OH 45342

RE: 66-19089-3
Date Samples Rec'd 12-29-85
Request No. 21568

REPORT OF ANALYSIS

ALR Designation	66-19089-3-1	66-19089-3-2	66-19089-3-3
Sponsor Designation	8411SOML1	8411TIML1	8411VEML1
Determination: pCi/g (dry)			
Uranium (as U), µg/g (dry)	4.2	2.5	0.82
Plutonium-239, ± counting error*	0.011 ± 0.079	0.05 ± 0.18	1.3 ± 0.3
Plutonium-238, ± counting error*	-0.01 ± 0.10	0.00 ± 0.21	0.10 ± 0.11
% Ash	--	--	15.1

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.
These samples are scheduled to be disposed of 45 days after the date of this report.

Bud Summers
Radiochemistry
Supervisor

BS/dh

cc: Bob Stought

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

August 10, 1984
Page 1 of 1

Dr. Carl Bishop
Monsanto Research Corp.
Mound Facility
P.O. Box 32
Miamisburg, Ohio 45342

RE: 66-18264-2
Date Samples Rec'd 6-25-84

REPORT OF ANALYSIS

ALR Designation	66-18264-2-1	66-18264-2-2
Sponsor Designation	8405 SOML-1	8405 VEML-1
Determination pCi/g		
Plutonium, ± counting error*	2.0 ± 0.3	0.062 ± 0.042
Uranium (as U), µg/g dry	1.9	0.14

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.
These samples are scheduled to be disposed of 45 days after the date of this report.

Bud Summers
Radiochemistry
Supervisor

BS/dh

cc: Bob Stought

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

March 20, 1984

D. Draper
Monsanto Research Corp.
P.O. Box 32
Miamisburg, Ohio 45342

RE: 9000-17509-10
Date Samples Rec'd 1-25-84
P.O. No. 56566

REPORT OF ANALYSIS

ALR Designation	9000-17509-10-1	9000-17509-10-2	9000-17509-10-3	9000-17509-10-4	9000-17509-10-5
Sponsor Designation	1001	1006	1015	1026	1034
	<100	<10	<100	<500	<100
Determination pCi/g					
Plutonium-238, ± counting error*	20 ± 1	4.9 ± 0.5	160 ± 10	370 ± 10	5.4 ± 1.2
Plutonium-239, ± counting error*	-0.02 ± 0.14	0.02 ± 0.07	0.37 ± 0.25	0.85 ± 0.47	-0.05 ± 0.11
Thorium-228, ± counting error*	1.2 ± 0.4	0.25 ± 0.14	1.1 ± 0.3	0.39 ± 0.53	0.56 ± 0.27
Thorium-230, ± counting error*	0.93 ± 0.27	0.36 ± 0.15	0.49 ± 0.20	0.68 ± 0.41	0.90 ± 0.25
Thorium-232, ± counting error*	0.90 ± 0.26	0.24 ± 0.10	0.26 ± 0.15	0.58 ± 0.36	0.39 ± 0.17

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

August 3, 1984

Mr. Bob Stought
Monsanto Research Corp.
Mound Facility
P.O. Box 32
Miamisburg, Ohio 45342

RE: 9000-18265-25
Date Samples Rec'd 6-26-84
P.O. No. 10984

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18265-25-1 1265	9000-18265-25-2 1267	9000-18265-25-3 1269	9000-18265-25-4 1271	9000-18265-25-5 1273
Determination pCi/g					
Plutonium-238, ± counting error*	-0.03 ± 0.15	0.29 ± 0.20	0.04 ± 0.15	0.49 ± 0.40	2.4 ± 0.4
Plutonium-239, ± counting error*	0.04 ± 0.13	-0.02 ± 0.11	-0.03 ± 0.10	-0.01 ± 0.24	0.02 ± 0.13
Thorium-228, ± counting error*	--	--	--	1.3 ± 0.4	--
Thorium-230, ± counting error*	--	--	--	1.8 ± 0.4	--
Thorium-232, ± counting error*	--	--	--	2.0 ± 0.4	--
Duplicate Results**:					
Plutonium-238, ± counting error*	--	--	--	--	2.2 ± 0.4
Plutonium-239, ± counting error*	--	--	--	--	0.01 ± 0.12

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.
**Note: The duplicate results indicate non-homogeneity in some samples.

August 3, 1984

Mr. Bob Stought
Monsanto Research Corp.

RE: 9000-18265-25
Date Samples Rec'd 6-26-84
P.O. No. 10984

REPORT OF ANALYSIS

ALR Designation	9000-18265-25-6	9000-18265-25-7	9000-18265-25-8	9000-18265-25-9	9000-18265-25-10
Sponsor Designation	1275	1283	1292	2604	2610
Determination pCi/g					
Plutonium-238, ± counting error*	3.6 ± 0.8	1.7 ± 0.3	210 ± 10	0.94 ± 0.25	0.51 ± 0.23
Plutonium-239, ± counting error*	0.08 ± 0.30	0.01 ± 0.12	0.73 ± 0.76	0.06 ± 0.13	0.03 ± 0.12
Thorium-228, ± counting error*	17 ± 1	--	110 ± 10	--	--
Thorium-230, ± counting error*	3.9 ± 0.7	--	17 ± 3	--	--
Thorium-232, ± counting error*	18 ± 2	--	120 ± 10	--	--

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

August 3, 1984

Mr. Bob Stought
Monsanto Research Corp.

RE: 9000-18265-25
Date Samples Rec'd 6-26-84
P.O. No. 10984

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18265-25-11 2613	9000-18265-25-12 2615	9000-18265-25-13 2616	9000-18265-25-14 2619	9000-18265-25-15 2621
Determination pCi/g					
Plutonium-238, ± counting error*	0.17 ± 0.33	0.71 ± 0.23	0.58 ± 0.22	0.40 ± 0.21	0.31 ± 0.18
Plutonium-239, ± counting error*	0.06 ± 0.24	0.13 ± 0.14	-0.04 ± 0.11	0.03 ± 0.14	0.00 ± 0.11
Thorium-228, ± counting error*	14 ± 1	--	--	--	--
Thorium-230, ± counting error*	3.9 ± 0.7	--	--	--	--
Thorium-232, ± counting error*	16 ± 1	--	--	--	--
Duplicate Results**:					
Plutonium-238, ± counting error*	--	--	--	--	47 ± 1
Plutonium-239, ± counting error*	--	--	--	--	0.46 ± 0.18

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.
**Note: The duplicate results indicate non-homogeneity in some samples.

August 3, 1984

Mr. Bob Stought
Monsanto Research Corp.

RE: 9000-18265-25
Date Samples Rec'd 6-26-84
P.O. No. 10984

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18265-25-16 2889	9000-18265-25-17 2891	9000-18265-25-18 2893	9000-18265-25-19 2945	9000-18265-25-20 2948
Determination pCi/g					
Plutonium-238, ± counting error*	2.4 ± 0.3	2.5 ± 0.4	0.72 ± 0.23	0.48 ± 0.21	0.95 ± 0.26
Plutonium-239, ± counting error*	0.01 ± 0.12	0.08 ± 0.14	0.00 ± 0.11	0.04 ± 0.13	0.10 ± 0.13
Thorium-228, ± counting error*	--	--	--	--	--
Thorium-230, ± counting error*	--	--	--	--	--
Thorium-232, ± counting error*	--	--	--	--	--

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

August 3, 1984

Mr. Bob Stought
Monsanto Research Corp.

RE: 9000-18265-25
Date Samples Rec'd 6-26-84
P.O. No. 10984

REPORT OF ANALYSIS

ALR Designation	9000-18265-25-21	9000-18265-25-22	9000-18265-25-23	9000-18265-25-24	9000-18265-25-25
Sponsor Designation	2949	2950	4513	4516	4523
Determination pCi/g					
Plutonium-238, ± counting error*	0.81 ± 0.23	0.58 ± 0.22	0.24 ± 0.20	0.14 ± 0.18	2.0 ± 0.3
Plutonium-239, ± counting error*	-0.03 ± 0.10	0.07 ± 0.14	0.02 ± 0.11	0.00 ± 0.12	0.06 ± 0.13
Thorium-228, ± counting error*	--	--	--	--	--
Thorium-230, ± counting error*	--	--	--	--	--
Thorium-232, ± counting error*	--	--	--	--	--
Duplicate Results**:					
Plutonium-238, ± counting error*	--	--	--	--	4.7 ± 0.5
Plutonium-239, ± counting error*	--	--	--	--	0.01 ± 0.12

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.
**Note: The duplicate results indicate non-homogeneity in some samples.
These samples are scheduled to be disposed of 45 days after the date of this report.

Bud Summers
Radiochemistry
Supervisor

S/dh

Sample No.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1265	13.57	0.22	0.04	—	0.07	—
1267	14.80	0.40	0.44	—	0.27	—
1269	12.19	0.52	0.03	—	0.07	—
1271	11.04	0.22	0.01	—	0.48	6.1
* 1273	14.48	1.75	2.41	10.16	2.60	—
1275	11.96	1.45	2.72	13.30	4.40	38.
1253	16.75	1.88	1.78	3.01	1.71	—
[illegible]	169.72	5.41	186.0	36.87	210.73	247
2604	11.10	1.04	1.74	—	1.00	—
2610	11.24	0.60	0.61	—	0.54	—
1613	8.40	4.37	0.55	17.60	0.23	28.
[illegible]	15.80	1.30	0.46	—	0.84	—
[illegible]	12.10	1.00	0.75	—	0.54	—
[illegible]	13.50	1.10	0.58	—	0.43	—
** [illegible]	13.70	0.80	0.44	—	0.31	—
[illegible]	20.92	—	2.23	1.23	2.41	—
[illegible]	15.40	—	1.23	—	2.58	—
[illegible]	14.70	—	0.75	—	0.72	—
[illegible]	18.50	1.10	0.71	—	0.52	—
[illegible]	10.00	1.40	1.78	—	1.05	—
[illegible]	20.20	1.60	0.76	—	0.78	—
2950	14.30	1.40	0.39	—	0.65	
4513	18.40	3.00	0.14	5.88	0.26	—
4516	12.00	0.90	0.05	—	0.14	—
*** 523	20.60	0.60	2.48	—	2.06	—

* When run 2nd results agreed with 1st time

** When run 2nd results did not agree; Du was 47.46 pli/g, but spoke suspicious

*** When run 2nd time results were nigh; Du = 4.71 pli/g

EAL Corporation

Thermo Electron Corporation

2030 Wright Avenue
Richmond, California 94804
(415) 235-2633
(TWX) 910-382-8132

November 8, 1984

Ref: Your P.O. No. 19701
EAL W.O. No. 25-3000

Mr. Robert L. Stought
Monsanto Research Corporation
Miamisburg, Ohio 45342

Dear Mr. Stought:

Enclosed are the isotopic thorium and plutonium analyses results of eight soils sent to us for analysis on the referenced purchase order.

A two-gram sample aliquot was completely dissolved by $HF-HNO_3-HCl$ treatment and the resulting solution was made to a known volume. A one-gram aliquot solution was equilibrated with a known amount of thorium tracer and thorium was separated by radiochemical methods. The remaining one-gram aliquot solution was equilibrated with plutonium tracer and plutonium was separated by radiochemical methods. The purified plutonium and thorium extracts were electroplated on stainless steel discs for alpha spec analysis. The results are reported as pCi/gram soil.

Please contact me if you have any questions.

Very truly yours,

Dinkar P. Kharkar, PhD
Manager, Nuclear Projects
Nuclear Science Department

DPK/sc
Enclosure: Table 1

TABLE 1 ISOTOPIC THORIUM AND ISOTOPIC PLUTONIUM ANALYSIS OF THE SOILS FROM MONSANTO RESEARCH CORPORATION

Customer I.D.	EAL No.	Concentration, pCi/gram ± % Error (a)					Chemical Yield Percent	
		^{228}Th	^{230}Th	^{232}Th	^{238}Pu	$^{239,240}Pu$	Th	Pu
1269	513-1				0.0744 ± 19	<0.02		72
1271	2				0.167 ± 16	<0.02		41
1275	3	8.51 ± 2	2.21 ± 3	13.3 ± 2	2.63 ± 4	0.024 ± 45	60	66
1292	4	24.3 ± 2	3.87 ± 4	24.0 ± 2	147 ± 3	0.394 ± 9	38	70
2604	5				1.01 ± 6	0.025 ± 40		62
2613	6	7.94 ± 2	2.20 ± 3	8.64 ± 2	0.431 ± 8	0.051 ± 22	66	71
2891	7				1.16 ± 7	0.017 ± 60		46
2948	8				0.929 ± 7	0.023 ± 43		50
Blank	10	0.056 ± 42	0.019 ± 50	0.028 ± 50	<0.03	<0.02	27	23

(a) Less than values are based on 95% confidence limit.

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

February 5, 1985

Mr. R. L. Stought
Monsanto Research Corp.
Mound Facility
P.O. Box 32
Miamisburg, OH 45342

RE: 9000-18926-45
Date Samples Rec'd 10-25-84
P.O. No. 21357

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18926-45-1 1710	9000-18926-45-2 1718	9000-18926-45-3 1726	9000-18926-45-4 1738	9000-18926-45-5 1747
Determination: pCi/g					
Plutonium-238, ± counting error*	0.14 ± 0.14	0.16 ± 0.16	0.24 ± 0.18	0.07 ± 0.15	0.26 ± 0.17
Plutonium-239, ± counting error*	0.00 ± 0.08	0.07 ± 0.11	-0.01 ± 0.09	-0.01 ± 0.09	0.00 ± 0.09
Thorium-228, ± counting error*	0.66 ± 0.20	--	2.1 ± 0.4	16 ± 1	--
Thorium-230, ± counting error*	0.70 ± 0.15	--	1.1 ± 0.2	2.3 ± 0.5	--
Thorium-232, ± counting error*	0.65 ± 0.14	--	2.1 ± 0.3	17 ± 1	--

February 5, 1985

Mr. R. L. Stought
Monsanto Research Corp.

RE: 9000-18926-45
Date Samples Rec'd 10-25-84
P.O. No. 21357

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18926-45-6 1757	9000-18926-45-7 1764	9000-18926-45-8 1772	9000-18926-45-9 1781	9000-18926-45-10 1784
Determination: pCi/g					
Plutonium-238, ± counting error*	0.10 ± 0.14	0.56 ± 0.23	0.20 ± 0.16	1.0 ± 0.2	11 ± 1
Plutonium-239, ± counting error*	0.00 ± 0.08	0.00 ± 0.10	0.06 ± 0.10	0.07 ± 0.11	0.01 ± 0.24
Thorium-228, ± counting error*	0.78 ± 0.23	--	0.66 ± 0.21	3.7 ± 0.9	26 ± 2
Thorium-230, ± counting error*	0.80 ± 0.19	--	0.63 ± 0.16	0.83 ± 0.39	3.5 ± 0.8
Thorium-232, ± counting error*	0.71 ± 0.18	--	0.66 ± 0.16	4.3 ± 0.8	20 ± 2

February 5, 1985

Mr. R. L. Stought
Monsanto Research Corp.

RE: 9000-18926-45
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P.O. No. 21357

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18926-45-11 1793	9000-18926-45-12 1831	9000-18926-45-13 1845	9000-18926-45-14 1870	9000-18926-45-15 1880
Determination: pCi/g					
Plutonium-238, ± counting error*	0.46 ± 0.18	0.10 ± 0.15	0.35 ± 0.17	0.21 ± 0.16	0.14 ± 0.17
Plutonium-239, ± counting error*	0.04 ± 0.09	-0.03 ± 0.08	0.05 ± 0.11	0.01 ± 0.09	0.05 ± 0.11
Thorium-228, ± counting error*	0.72 ± 0.21	--	1.6 ± 0.3	3.9 ± 0.5	1.0 ± 0.2
Thorium-230, ± counting error*	0.99 ± 0.19	--	0.75 ± 0.17	0.91 ± 0.23	1.0 ± 0.2
Thorium-232, ± counting error*	0.58 ± 0.14	--	1.4 ± 0.2	2.7 ± 0.4	0.85 ± 0.18

February 5, 1985

Mr. R. L. Stought
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RE: 9000-18926-45
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P.O. No. 21357

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18926-45-16 2867	9000-18926-45-17 2954	9000-18926-45-18 2956	9000-18926-45-19 2965	9000-18926-45-20 2969
Determination: pCi/g					
Plutonium-238, ± counting error*	12 ± 1	0.94 ± 0.23	0.33 ± 0.17	2.5 ± 0.5	0.27 ± 0.17
Plutonium-239, ± counting error*	0.37 ± 0.31	0.03 ± 0.10	0.02 ± 0.10	0.08 ± 0.11	0.00 ± 0.08
Thorium-228, ± counting error*	--	--	--	--	--
Thorium-230, ± counting error*	--	--	--	--	--
Thorium-232, ± counting error*	--	--	--	--	--

February 5, 1985

Mr. R. L. Stought
Monsanto Research Corp.

RE: 9000-18926-45
Date Samples Rec'd 10-25-84
P.O. No. 21357

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18926-45-21 2979	9000-18926-45-22 3027	9000-18926-45-23 3035	9000-18926-45-24 3048	9000-18926-45-25 3057
Determination: pCi/g					
Plutonium-238, ± counting error*	1.0 ± 0.2	0.73 ± 0.22	0.05 ± 0.14	0.02 ± 0.14	0.02 ± 0.13
Plutonium-239, ± counting error*	0.00 ± 0.05	0.00 ± 0.09	0.08 ± 0.10	-0.01 ± 0.08	0.02 ± 0.09
Thorium-228, ± counting error*	--	--	--	--	--
Thorium-230, ± counting error*	--	--	--	--	--
Thorium-232, ± counting error*	--	--	--	--	--

February 5, 1985

Mr. R. L. Stought
Monsanto Research Corp.

RE: 9000-18926-45
Date Samples Rec'd 10-25-84
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REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18926-45-26 3064	9000-18926-45-27 3085	9000-18926-45-28 3095	9000-18926-45-29 4003	9000-18926-45-30 4057
Determination: pCi/g					
Plutonium-238, ± counting error*	0.04 ± 0.14	73 ± 6	0.18 ± 0.15	0.62 ± 0.21	2.2 ± 0.3
Plutonium-239, ± counting error*	0.01 ± 0.08	0.20 ± 0.87	0.05 ± 0.10	0.03 ± 0.09	0.07 ± 0.09
Thorium-228, ± counting error*	--	--	--	--	--
Thorium-230, ± counting error*	--	--	--	--	--
Thorium-232, ± counting error*	--	--	--	--	--

February 5, 1985

Mr. R. L. Stought
Monsanto Research Corp.

RE: 9000-18926-45
Date Samples Rec'd 10-25-84
P.O. No. 21357

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18926-45-31 4063	9000-18926-45-32 4070	9000-18926-45-33 4077	9000-18926-45-34 4081	9000-18926-45-35 4087
Determination: pCi/g					
Plutonium-238, ± counting error*	0.66 ± 0.23	0.14 ± 0.08	0.22 ± 0.15	0.13 ± 0.14	0.89 ± 0.22
Plutonium-239, ± counting error*	0.03 ± 0.10	0.01 ± 0.05	-0.01 ± 0.08	0.01 ± 0.07	0.03 ± 0.09
Thorium-228, ± counting error*	--	--	--	--	--
Thorium-230, ± counting error*	--	--	--	--	--
Thorium-232, ± counting error*	--	--	--	--	--

February 5, 1985
Page 8 of 9

Mr. R. L. Stought
Monsanto Research Corp.

RE: 9000-18926-45
Date Samples Rec'd 10-25-84
P.O. No. 21357

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18926-45-36 4091	9000-18926-45-37 5976	9000-18926-45-38 5984	9000-18926-45-39 6139	9000-18926-45-40 6177
Determination: pCi/g					
Plutonium-238, ± counting error*	7.4 ± 1.0	0.82 ± 0.20	1.1 ± 0.3	1.8 ± 0.3	0.15 ± 0.17
Plutonium-239, ± counting error*	0.04 ± 0.24	0.04 ± 0.07	0.00 ± 0.04	0.04 ± 0.07	0.07 ± 0.07
Thorium-228, ± counting error*	--	1.4 ± 0.3	6.5 ± 1.3	--	--
Thorium-230, ± counting error*	--	1.2 ± 0.3	1.8 ± 0.6	--	--
Thorium-232, ± counting error*	--	1.3 ± 0.3	6.3 ± 1.2	--	--

February 5, 1985

Mr. R. L. Stought
Monsanto Research Corp.

RE: 9000-18926-45
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REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-18926-45-41 6188	9000-18926-45-42 6199	9000-18926-45-43 6211	9000-18926-45-44 6229	9000-18926-45-45 6263
Determination: pCi/g					
Plutonium-238, ± counting error*	1.2 ± 0.3	0.46 ± 0.19	1.2 ± 0.3	0.02 ± 0.14	1.1 ± 0.3
Plutonium-239, ± counting error*	0.09 ± 0.09	0.06 ± 0.10	0.03 ± 0.05	0.02 ± 0.04	0.05 ± 0.07
Thorium-228, ± counting error*	--	--	--	--	--
Thorium-230, ± counting error*	--	--	--	--	--
Thorium-232, ± counting error*	--	--	--	--	--

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.
These samples are scheduled to be disposed of 45 days after the date of this report.

Bud Summers
Radiochemistry
Supervisor

BS/dh

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

February 25, 1985

R. L. Stought
Monsanto Research Corp.
Mound Facility
P.O. Box 32
Miamisburg, Ohio 45342

RE: 9000-19061-47
Date Samples Rec'd 11-21-84
P.O. No. 22516

PARTIAL REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-1 1226	9000-19061-47-2 1244	9000-19061-47-3 1251	9000-19061-47-4 1260	9000-19061-47-5 1317
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.71 ± 0.58	0.78 ± 0.24	0.22 ± 0.19	1.4 ± 0.3	0.15 ± 0.17
Plutonium-239, total, ± counting error*	-0.26 ± 0.33	-0.02 ± 0.05	-0.08 ± 0.11	0.06 ± 0.08	0.02 ± 0.08
Thorium-228, total, ± counting error*	1.1 ± 0.3	12 ± 2	22 ± 4	18 ± 4	--
Thorium-230, total, ± counting error*	0.85 ± 0.23	2.9 ± 1.0	2.2 ± 1.2	0.62 ± 0.90	--
Thorium-232, total, ± counting error*	1.1 ± 0.3	13 ± 2	11 ± 2	13 ± 4	--

February 25, 1985

R. L. Stought
Monsanto Research Corp.

RE: 9000-19061-47
Date Samples Rec'd 11-21-84
P.O. No. 22516

PARTIAL REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-6 1604	9000-19061-47-7 1612	9000-19061-47-8 1621	9000-19061-47-9 1624	9000-19061-47-10 1638
Determination: pCi/g					
Plutonium-238, total, ± counting error*	5.8 ± 0.5	0.06 ± 0.09	0.08 ± 0.13	0.46 ± 0.19	0.07 ± 0.06
Plutonium-239, total, ± counting error*	0.00 ± 0.07	-0.03 ± 0.06	-0.05 ± 0.13	-0.03 ± 0.13	-0.02 ± 0.06
Thorium-228, total, ± counting error*	--	--	1.0 ± 0.3	2.0 ± 0.4	--
Thorium-230, total, ± counting error*	--	--	0.51 ± 0.29	1.1 ± 0.3	--
Thorium-232, total, ± counting error*	--	--	1.0 ± 0.3	1.1 ± 0.3	--

February 25, 1985

R. L. Stought
Monsanto Research Corp.

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P.O. No. 22516

PARTIAL REPORT

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ALR Designation Sponsor Designation	9000-19061-47-11 1665	9000-19061-47-12 1816	9000-19061-47-13 1852	9000-19061-47-14 1860	9000-19061-47-15 1917
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.07 ± 0.08	0.18 ± 0.11	1.6 ± 0.3	0.06 ± 0.14	0.44 ± 0.23
Plutonium-239, total, ± counting error*	-0.04 ± 0.05	-0.03 ± 0.06	0.01 ± 0.05	0.11 ± 0.17	-0.03 ± 0.07
Thorium-228, total, ± counting error*	--	1.4 ± 0.3	--	--	0.61 ± 0.23
Thorium-230, total, ± counting error*	--	2.4 ± 0.4	--	--	0.81 ± 0.24
Thorium-232, total, ± counting error*	--	1.1 ± 0.2	--	--	0.64 ± 0.21

February 25, 1985
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R. L. Stought
Monsanto Research Corp.

RE: 9000-19061-47
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PARTIAL REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-16 1925	9000-19061-47-17 1944	9000-19061-47-18 1951	9000-19061-47-19 1957	9000-19061-47-20 1960
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.16 ± 0.11	82 ± 5	220 ± 10	3.4 ± 0.5	0.33 ± 0.19
Plutonium-239, total, ± counting error*	0.02 ± 0.09	-0.15 ± 0.49	0.15 ± 0.62	0.00 ± 0.12	-0.08 ± 0.12
Thorium-228, total, ± counting error*	0.32 ± 0.15	1.9 ± 0.4	--	--	--
Thorium-230, total, ± counting error*	0.43 ± 0.17	0.26 ± 0.13	--	--	--
Thorium-232, total, ± counting error*	0.13 ± 0.09	0.20 ± 0.11	--	--	--

February 25, 1985

R. L. Stought
Monsanto Research Corp.

RE: 9000-19061-47
Date Samples Rec'd 11-21-84
P.O. No. 22516

PARTIAL REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-21 1977	9000-19061-47-22 2577	9000-19061-47-23 2689	9000-19061-47-24 2817	9000-19061-47-25 2862
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.80 ± 0.33	0.03 ± 0.14	9.2 ± 0.6	6.7 ± 0.5	0.11 ± 0.12
Plutonium-239, total, ± counting error*	0.06 ± 0.15	-0.04 ± 0.10	0.16 ± 0.13	-0.02 ± 0.09	-0.06 ± 0.08
Thorium-228, total, ± counting error*	2.2 ± 0.5	0.62 ± 0.23	--	13 ± 3	--
Thorium-230, total, ± counting error*	1.6 ± 0.5	0.88 ± 0.26	--	1.7 ± 0.9	--
Thorium-232, total, ± counting error*	1.9 ± 0.5	0.28 ± 0.15	--	9.5 ± 2.0	--

February 25, 1985

R. L. Stought
Monsanto Research Corp.

RE: 9000-19061-47
Date Samples Rec'd 11-21-84
P.O. No. 22516

PARTIAL REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-26 2873	9000-19061-47-27 2919	9000-19061-47-28 2980	9000-19061-47-29 2990	9000-19061-47-30 3077
Determination: pCi/g					
Plutonium-238, total, ± counting error*	2.0 ± 0.3	0.05 ± 0.12	53 ± 4	0.02 ± 0.12	3.8 ± 0.5
Plutonium-239, total, ± counting error*	0.20 ± 0.13	-0.04 ± 0.09	-0.34 ± 0.70	-0.01 ± 0.10	0.01 ± 0.10
Thorium-228, total, ± counting error*	0.66 ± 0.22	--	--	--	--
Thorium-230, total, ± counting error*	3.0 ± 0.5	--	--	--	--
Thorium-232, total, ± counting error*	0.46 ± 0.18	--	--	--	--

February 25, 1985

R. L. Stought
Monsanto Research Corp.

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PARTIAL REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-31 4111	9000-19061-47-32 5868	9000-19061-47-33 5871	9000-19061-47-34 5882	9000-19061-47-35 5891
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.14 ± 0.13	1.6 ± 0.3	0.80 ± 0.22	1.7 ± 0.3	1.2 ± 0.2
Plutonium-239, total, ± counting error*	-0.05 ± 0.08	-0.02 ± 0.10	-0.03 ± 0.10	0.00 ± 0.09	0.05 ± 0.09
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

February 25, 1985

R. L. Stought
Monsanto Research Corp.

RE: 9000-19061-47
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ALR Designation Sponsor Designation	9000-19061-47-36 5988	9000-19061-47-37 6275	9000-19061-47-38 6283	9000-19061-47-39 6359	9000-19061-47-40 6459
Determination: pCi/g					
Plutonium-238, total, ± counting error*	1.4 ± 0.3	4.3 ± 1.3	0.47 ± 0.18	3.5 ± 0.4	0.28 ± 0.15
Plutonium-239, total, ± counting error*	-0.03 ± 0.08	0.38 ± 0.54	0.06 ± 0.10	0.03 ± 0.08	-0.02 ± 0.11
Thorium-228, total, ± counting error*	1.3 ± 0.3	--	--	--	--
Thorium-230, total, ± counting error*	0.74 ± 0.24	--	--	--	--
Thorium-232, total, ± counting error*	1.2 ± 0.3	--	--	--	--

February 25, 1985

R. L. Stought
Monsanto Research Corp.

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ALR Designation Sponsor Designation	9000-19061-47-41 6468	9000-19061-47-42 6497	9000-19061-47-43 6508	9000-19061-47-44 6552	9000-19061-47-45 6686
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.15 ± 0.15	10 ± 1	2.1 ± 0.3	0.45 ± 0.18	18 ± 2
Plutonium-239, total, ± counting error*	0.06 ± 0.10	0.21 ± 0.13	0.05 ± 0.10	0.00 ± 0.07	-0.01 ± 0.36
Thorium-228, total, ± counting error*	--	2.5 ± 0.4	--	--	2.1 ± 0.4
Thorium-230, total, ± counting error*	--	1.2 ± 0.2	--	--	0.94 ± 0.26
Thorium-232, total, ± counting error*	--	2.3 ± 0.3	--	--	1.6 ± 0.3

R. L. Stought
Monsanto Research Corp.

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ALR Designation Sponsor Designation	9000-19061-47-46 6693	9000-19061-47-47 6699
Determination: pCi/g		
Plutonium-238, total, ± counting error*	5.6 ± 0.8	1.9 ± 0.3
Plutonium-239, total, ± counting error*	0.00 ± 0.08	0.44 ± 0.16
Thorium-228, total, ± counting error*	--	--
Thorium-230, total, ± counting error*	--	--
Thorium-232, total, ± counting error*	--	--

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

Bud Summers
Radiochemistry
Supervisor

BS/dh

Sample	MRC	BL	MRC	BL	Age
1226	34.5	0.71	[illegible]	2.05	40
1244	0.84	0.78	36.16	27.9	39
1251	0.29	0.22	29.45	35.2	31
1260	4.83	1.4	32.2	31.62	39
1317	0.20	0.02	—	—	39
1604	7.49	5.8	—	—	36
1612	0.62	0.06	—	—	36
1624	0.36	0.46	3.95	4.0	29
1638	0.16	0.07	—	—	37
1665	0.31	0.07	—	—	37
1816	0.30	0.18	4.02	4.9	32
1856	1.04	1.6	—	—	32
1860	0.03	0.06	—	—	32
1917	0.08	0.44	2.36	2.06	28
192[illegible]	0.27	0.16	0.92	0.89	28
1944	100.1	82.0	0.85	2.36	28
195[illegible]	355.0	220.0	—	—	28
1957	4.95	3.4	—	—	28
1960	15.41	0.33	—	—	27
1977	0.59	0.80	5.62	5.70	39
2577	0.06	0.03	1.53	1.78	45
2689	7.28	9.2	—	—	55
2817	6.28	6.7	28.73	24.2	51
2862	0.05	0.11	—	—	38
					?)

Sample	MRC	BL	MRC	BL	Age
2873	1.90	2.0	4.02	4.12	[illegible]
2919	0.04	0.05	—	—	[illegible]
2981	52.89	53.0	—	—	[illegible]
2990	0.13	0.07	—	—	[illegible]
3077	0.19	3.8	—	—	[illegible]
4111	0.20	0.14	—	—	[illegible]
5868	1.21	1.60	—	—	[illegible]
5871	0.65	0.80	—	—	[illegible]
5882	2.82	[illegible]	—	—	[illegible]
5891	0.59	1.20	—	—	[illegible]
5988	0.45	1.40	3.64	3.24	[illegible]
6275	25.3	4.3	—	—	27
6283	0.13	0.47	—	—	[illegible]
6359	3.60	3.5	—	—	[illegible]
6457	0.30	0.25	—	—	[illegible]
6468	0.11	0.15	—	—	[illegible]
6497	9.0	10.0	3.73	6.0	[illegible]
6508	1.7	[illegible]	—	—	[illegible]
6552	0.55	0.45	—	—	[illegible]
6686	17.46	18.0	5.61	[illegible]	[illegible]
6693	3.50	5.6	—	—	[illegible]
6699	1.62	1.90	—	—	[illegible]
[illegible]	0.07	0.08	2.50	2.51	[illegible]

47 Samples

2-28-85
R.E.

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

February 25, 1985

R. L. Stought
Monsanto Research Corp.
Mound Facility
P.O. Box 32
Miamisburg, Ohio 45342

RE: 9000-19150-66
Date Samples Rec'd 12-14-84
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ALR Designation Sponsor Designation	9000-19150-66-1 1172	9000-19150-66-2 1184	9000-19150-66-3 1216	9000-19150-66-4 1285	9000-19150-66-5 1290
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.19 ± 0.14	0.19 ± 0.12	0.50 ± 0.18	710 ± 10	411 ± 1
Plutonium-239, total, ± counting error*	-0.05 ± 0.12	0.01 ± 0.05	0.01 ± 0.06	1.6 ± 0.7	0.17 ± 0.10
Thorium-228, total, ± counting error*	0.51 ± 0.17	--	0.42 ± 0.15	14 ± 1	--
Thorium-230, total, ± counting error*	0.84 ± 0.18	--	0.40 ± 0.13	1.3 ± 0.3	--
Thorium-232, total, ± counting error*	0.46 ± 0.13	--	0.56 ± 0.14	3.1 ± 0.5	--

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R. L. Stought
Monsanto Research Corp.

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ALR Designation Sponsor Designation	9000-19150-66-6 1305	9000-19150-66-7 1320	9000-19150-66-8 1325	9000-19150-66-9 1338	9000-19150-66-10 1342
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.30 ± 0.14	79 ± 5	15 ± 2	0.83 ± 0.27	8.9 ± 2.4
Plutonium-239, total, ± counting error*	-0.01 ± 0.03	-0.13 ± 0.87	-0.09 ± 0.46	-0.03 ± 0.15	-0.33 ± 0.83
Thorium-228, total, ± counting error*	--	--	--	3.6 ± 0.5	--
Thorium-230, total, ± counting error*	--	--	--	1.3 ± 0.3	--
Thorium-232, total, ± counting error*	--	--	--	3.5 ± 0.4	--

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ALR Designation Sponsor Designation	9000-19150-66-11 1344	9000-19150-66-12 1356	9000-19150-66-13 1361	9000-19150-66-14 1511	9000-19150-66-15 1521
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.44 ± 0.19	100 ± 10	0.58 ± 0.36	17 ± 3	6.0 ± 1.3
Plutonium-239, total, ± counting error*	0.03 ± 0.07	-0.26 ± 0.81	0.15 ± 0.27	-0.21 ± 0.74	-0.22 ± 0.45
Thorium-228, total, ± counting error*	--	0.24 ± 0.50	1.8 ± 0.8	--	0.65 ± 0.63
Thorium-230, total, ± counting error*	--	0.69 ± 0.44	2.3 ± 0.7	--	0.80 ± 0.55
Thorium-232, total, ± counting error*	--	0.52 ± 0.31	0.53 ± 0.32	--	0.37 ± 0.34

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ALR Designation Sponsor Designation	9000-19150-66-16 1539	9000-19150-66-17 1541	9000-19150-66-18 1545	9000-19150-66-19 1550	9000-19150-66-20 1565
Determination: pCi/g					
Plutonium-238, total, ± counting error*	17 ± 2	14 ± 4	0.16 ± 0.15	7.2 ± 0.8	1.0 ± 0.3
Plutonium-239, total, ± counting error*	-0.32 ± 0.56	-0.3 ± 1.1	-0.07 ± 0.12	0.02 ± 0.21	0.00 ± 0.11
Thorium-228, total, ± counting error*	1.2 ± 0.4	--	0.41 ± 0.18	2.4 ± 0.7	--
Thorium-230, total, ± counting error*	0.66 ± 0.25	--	0.66 ± 0.20	0.98 ± 0.42	--
Thorium-232, total, ± counting error*	0.82 ± 0.27	--	0.44 ± 0.16	2.1 ± 0.6	--

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ALR Designation Sponsor Designation	9000-19150-66-21 1572	9000-19150-66-22 1592	9000-19150-66-23 1648	9000-19150-66-24 1663	9000-19150-66-25 1696
Determination: pCi/g					
Plutonium-238, total, ± counting error*	75 ± 6	0.83 ± 0.26	1.8 ± 0.9	0.03 ± 0.15	0.04 ± 0.13
Plutonium-239, total, ± counting error*	0.04 ± 0.85	0.01 ± 0.11	-0.18 ± 0.45	-0.01 ± 0.11	-0.08 ± 0.12
Thorium-228, total, ± counting error*	2.2 ± 0.8	1.8 ± 1.1	--	--	--
Thorium-230, total, ± counting error*	1.1 ± 0.5	2.0 ± 1.0	--	--	--
Thorium-232, total, ± counting error*	0.46 ± 0.29	0.62 ± 0.54	--	--	--

February 25, 1985

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ALR Designation Sponsor Designation	9000-19150-66-26 1699	9000-19150-66-27 2446	9000-19150-66-28 2460	9000-19150-66-29 2466	9000-19150-66-30 2469
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.13 ± 0.14	0.68 ± 0.25	-0.06 ± 0.14	1.1 ± 0.3	0.45 ± 0.18
Plutonium-239, total, ± counting error*	-0.03 ± 0.14	-0.05 ± 0.09	0.04 ± 0.12	-0.05 ± 0.08	-0.05 ± 0.07
Thorium-228, total, ± counting error*	--	11 ± 2	--	--	3.0 ± 0.9
Thorium-230, total, ± counting error*	--	1.4 ± 0.9	--	--	0.77 ± 0.47
Thorium-232, total, ± counting error*	--	13 ± 2	--	--	1.8 ± 0.6

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ALR Designation Sponsor Designation	9000-19150-66-31 2587	9000-19150-66-32 2591	9000-19150-66-33 2600	9000-19150-66-34 2829	9000-19150-66-35 2836
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.36 ± 0.16	0.06 ± 0.16	0.87 ± 0.23	5.6 ± 1.1	1.9 ± 0.3
Plutonium-239, total, ± counting error*	-0.05 ± 0.13	-0.07 ± 0.16	0.01 ± 0.09	0.14 ± 0.63	-0.02 ± 0.16
Thorium-228, total, ± counting error*	--	--	--	1.2 ± 0.6	--
Thorium-230, total, ± counting error*	--	--	--	1.1 ± 0.5	--
Thorium-232, total, ± counting error*	--	--	--	0.79 ± 0.39	--

February 25, 1985

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ALR Designation Sponsor Designation	9000-19150-66-36 2879	9000-19150-66-37 2887	9000-19150-66-38 2923	9000-19150-66-39 2931	9000-19150-66-40 2936
Determination: pCi/g					
Plutonium-238, total, ± counting error*	1.8 ± 0.4	0.73 ± 0.26	63 ± 4	0.25 ± 0.18	0.14 ± 0.18
Plutonium-239, total, ± counting error*	-0.01 ± 0.16	0.08 ± 0.19	-0.1 ± 1.0	0.01 ± 0.11	-0.05 ± 0.16
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

February 25, 1985

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ALR Designation Sponsor Designation	9000-19150-66-41 2999	9000-19150-66-42 3002	9000-19150-66-43 4007	9000-19150-66-44 4025	9000-19150-66-45 4032
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.87 ± 0.23	2.2 ± 0.4	6.0 ± 1.0	3.3 ± 1.1	0.11 ± 0.16
Plutonium-239, total, ± counting error*	-0.06 ± 0.16	0.05 ± 0.19	-0.22 ± 0.39	0.07 ± 0.82	-0.07 ± 0.15
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

February 25, 1985

R. L. Stought
Monsanto Research Corp.

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ALR Designation Sponsor Designation	9000-19150-66-46 4037	9000-19150-66-47 4042	9000-19150-66-48 4050	9000-19150-66-49 4088	9000-19150-66-50 4114
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.81 ± 0.24	2.7 ± 0.8	1.7 ± 0.8	5.5 ± 0.5	5.9 ± 0.9
Plutonium-239, total, ± counting error*	-0.09 ± 0.15	0.02 ± 0.54	-0.11 ± 0.57	-0.01 ± 0.15	-0.08 ± 0.24
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

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R. L. Stought
Monsanto Research Corp.

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ALR Designation Sponsor Designation	9000-19150-66-51 4123	9000-19150-66-52 4141	9000-19150-66-53 4146	9000-19150-66-54 5820	9000-19150-66-55 5832
Determination: pCi/g					
Plutonium-238, total, ± counting error*	3.2 ± 1.0	0.55 ± 0.21	2.0 ± 0.3	0.85 ± 0.24	0.35 ± 0.15
Plutonium-239, total, ± counting error*	0.20 ± 0.54	0.22 ± 0.14	0.06 ± 0.10	0.03 ± 0.10	0.05 ± 0.09
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

R. L. Stought
Monsanto Research Corp.

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ALR Designation Sponsor Designation	9000-19150-66-56 5856	9000-19150-66-57 5858	9000-19150-66-58 5862	9000-19150-66-59 5909	9000-19150-66-60 5933
Determination: pCi/g					
Plutonium-238, total, ± counting error*	8.5 ± 1.2	110 ± 10	160 ± 10	0.75 ± 0.20	0.17 ± 0.10
Plutonium-239, total, ± counting error*	-0.09 ± 0.29	-0.03 ± 0.54	0.20 ± 0.82	-0.02 ± 0.07	0.03 ± 0.08
Thorium-228, total, ± counting error*	4.3 ± 1.7	11 ± 2	13 ± 3	--	--
Thorium-230, total, ± counting error*	1.7 ± 1.0	1.7 ± 0.7	2.4 ± 1.2	--	--
Thorium-232, total, ± counting error*	1.2 ± 0.8	12 ± 2	6.9 ± 1.8	--	--

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R. L. Stought
Monsanto Research Corp.

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ALR Designation Sponsor Designation	9000-19150-66-61 6376	9000-19150-66-62 6384	9000-19150-66-63 6393	9000-19150-66-64 6474	9000-19150-66-65 6488
Determination: pCi/g					
Plutonium-238, total, ± counting error*	140 ± 10	4.5 ± 1.2	0.20 ± 0.16	0.54 ± 0.18	0.05 ± 0.09
Plutonium-239, total, ± counting error*	0.43 ± 0.54	0.32 ± 0.54	-0.05 ± 0.08	0.09 ± 0.11	-0.02 ± 0.06
Thorium-228, total, ± counting error*	6.9 ± 1.6	--	0.70 ± 0.52	--	--
Thorium-230, total, ± counting error*	1.3 ± 0.7	--	1.6 ± 0.40	--	--
Thorium-232, total, ± counting error*	1.3 ± 0.7	--	0.61 ± 0.24	--	--

February 25, 1985

R. L. Stought
Monsanto Research Corp.

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ALR Designation	9000-19150-66-66
Sponsor Designation	6785

Determination: pCi/g

Plutonium-238, total, ± counting error*	12 ± 2
Plutonium-239, total, ± counting error*	0.05 ± 0.66
Thorium-228, total, ± counting error*	5.8 ± 1.3
Thorium-230, total, ± counting error*	1.1 ± 0.6
Thorium-232, total, ± counting error*	4.0 ± 1.0

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.

Bud Summers
Radiochemistry
Supervisor

BS/dh

Sample	MPC	AL	MPC	AL	[illegible]
172	0.12	[illegible]	[illegible].28	1.81	49
[illegible]89	0.02	0.19	—	—	49
1216	0.06	0.52	1.7	1.38	49
1285	4.78	710	2.38	18.4	49
1290	59.0	41.8	—	—	68
1305	0.18	0.30	—	—	48
1320	79.0	79.0	—	—	49
1325	9.98	15.0	—	—	48
1338	[illegible].25	0.82	9.99	8.[illegible]	49
1342	11.8	8.9	—	—	48
1344	0.48	0.44	—	—	49
1358	76.1	100.0	2.12	1.45	49
1361	0.13	0.58	3.25	4.63	57
1511	32.9	17.0	—	—	49
1521	5.66	6.0	2.16	1.82	49
1539	24.0	17.0	1.92	2.68	49
1541	17.1	14.0	—	—	49
15	0.28	0.16	1.96	1.51	49
250	5.96	7.2	5.65	5.48	49
1565	1.29	1.0	—	—	57
1572	71.3	75.0	2.03	3.76	57
1592	0.67	0.83	2.26	4.42	57
1648	2.25	1.8	—	—	53
1663	0.18	0.03	—	—	55
1672	0.01	0.04	—	—	63
1677	0.01	-0.13	—	—	63
2446	0.66	0.68	30.42	25.4	58
2460	0.07	-0.06	—	—	66
2466	0.66	1.1	—	—	66
2469	0.54	0.45	7.11	5.57	66
[illegible]51	0.10	-0.36	—	—	54
259[illegible]	0.02	0.06	—	—	55
2600	0.73	0.87	—	—	63

Sample	MPC	AL	MPC	AL	[illegible]
2829	3.56	5.6	2.37	3.09	65
2836	1.72	1.9	—	—	56
2879	1.05	1.8	—	—	47
2887	1.67	0.73	—	—	67
2923	42.45	43.0	—	—	58
2931	0.42	0.25	—	—	54
2936	0.40	0.14	—	—	62
2939	1.12	0.27	—	—	57
3002	0.62	2.2	—	—	60
4007	9.00	6.0	—	—	56
4025	4.32	3.3	—	—	70
4032	0.08	0.11	—	—	51
4037	0.96	0.81	—	—	52
4042	2.74	2.7	—	—	[illegible]
4050	2.03	1.7	—	—	70
4088	4.68	5.5	—	—	24
4114	5.97	5.9	—	—	50
4123	3.15	3.2	—	—	57
4141	2.48	0.55	—	—	
4146	0.40	2.0	—	—	
5820	0.80	0.85	—	—	[illegible]
5832	0.37	0.35	—	—	66
5836	7.84	8.5	25.2[illegible]	[illegible]	[illegible]
5845	88.4	110	[illegible].03	24.7	[illegible]
[illegible]	77.5	160	[illegible]	[illegible]	[illegible]
[illegible]19	0.43	[illegible].75	—	—	[illegible]
[illegible]	0.07	0.17	—	—	[illegible]
[illegible]	109.7	140	—	—	45
[illegible]	4.68	4.5	—	—	[illegible]
[illegible]	0.17	0.20	2.46	2.91	71
[illegible]	0.38	0.54	—	—	54
[illegible]	0.37	0.05	—		[illegible]
[illegible]	12.1	12.0	4.2[illegible]	10.9	4[illegible]

65 Samples

2-28-85

RLL

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

March 1, 1985

R. L. Stought
Monsanto Research Corp.
Mound Facility
P.O. Box 32
Miamisburg, Ohio 45342

RE: 9000-19061-47
Date Samples Rec'd 11-21-84
P.O. No. 22516

COMPLETED REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-1 1226	9000-19061-47-2 1244	9000-19061-47-3 1251	9000-19061-47-4 1260	9000-19061-47-5 1317
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.71 ± 0.58	0.78 ± 0.24	0.22 ± 0.19	1.4 ± 0.3	0.13 ± 0.17
Plutonium-239, total, ± counting error*	-0.26 ± 0.33	-0.02 ± 0.05	-0.08 ± 0.11	0.06 ± 0.08	0.02 ± 0.08
Thorium-228, total, ± counting error*	1.1 ± 0.3	12 ± 2	22 ± 4	18 ± 4	--
Thorium-230, total, ± counting error*	0.85 ± 0.23	2.9 ± 1.0	2.2 ± 1.2	0.62 ± 0.90	--
Thorium-232, total, ± counting error*	1.1 ± 0.3	13 ± 2	11 ± 2	13 ± 4	--

March 1, 1985

R. L. Stought
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ALR Designation Sponsor Designation	9000-19061-47-6 1604	9000-19061-47-7 1612	9000-19061-47-8 1621	9000-19061-47-9 1624	9000-19061-47-10 1638
Determination: pCi/g					
Plutonium-238, total, ± counting error*	5.8 ± 0.5	0.06 ± 0.09	0.08 ± 0.13	0.46 ± 0.19	0.07 ± 0.06
Plutonium-239, total, ± counting error*	0.00 ± 0.07	-0.03 ± 0.06	-0.05 ± 0.13	-0.03 ± 0.13	-0.02 ± 0.06
Thorium-228, total, ± counting error*	--	--	1.0 ± 0.3	2.0 ± 0.4	--
Thorium-230, total, ± counting error*	--	--	0.51 ± 0.29	1.1 ± 0.3	--
Thorium-232, total, ± counting error*	--	--	1.0 ± 0.3	1.1 ± 0.3	--

March 1, 1985

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ALR Designation Sponsor Designation	9000-19061-47-11 1665	9000-19061-47-12 1816	9000-19061-47-13 1852	9000-19061-47-14 1860	9000-19061-47-15 1917
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.07 ± 0.08	0.18 ± 0.11	1.6 ± 0.3	0.06 ± 0.14	0.44 ± 0.23
Plutonium-239, total, ± counting error*	-0.04 ± 0.05	-0.03 ± 0.06	0.01 ± 0.05	0.11 ± 0.17	-0.03 ± 0.07
Thorium-228, total, ± counting error*	--	1.4 ± 0.3	--	--	0.61 ± 0.23
Thorium-230, total, ± counting error*	--	2.4 ± 0.4	--	--	0.81 ± 0.24
Thorium-232, total, ± counting error*	--	1.1 ± 0.2	--	--	0.64 ± 0.21

March 1, 1985

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COMPLETED REPORT

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ALR Designation Sponsor Designation	9000-19061-47-16 1925	9000-19061-47-17 1944	9000-19061-47-18 1951	9000-19061-47-19 1957	9000-19061-47-20 1960
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.16 ± 0.11	82 ± 5	220 ± 10	3.4 ± 0.5	0.33 ± 0.19
Plutonium-239, total, ± counting error*	0.02 ± 0.09	-0.15 ± 0.49	0.15 ± 0.62	0.00 ± 0.12	-0.08 ± 0.12
Thorium-228, total, ± counting error*	0.32 ± 0.15	1.9 ± 0.4	--	--	--
Thorium-230, total, ± counting error*	0.43 ± 0.17	0.26 ± 0.13	--	--	--
Thorium-232, total, ± counting error*	0.13 ± 0.09	0.20 ± 0.11	--	--	--

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REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-21 1977	9000-19061-47-22 2577	9000-19061-47-23 2689	9000-19061-47-24 2817	9000-19061-47-25 2862
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.80 ± 0.33	0.03 ± 0.14	9.2 ± 0.6	6.7 ± 0.5	0.11 ± 0.12
Plutonium-239, total, ± counting error*	0.06 ± 0.15	-0.04 ± 0.10	0.16 ± 0.13	-0.02 ± 0.09	-0.06 ± 0.08
Thorium-228, total, ± counting error*	2.2 ± 0.5	0.62 ± 0.23	--	13 ± 3	--
Thorium-230, total, ± counting error*	1.6 ± 0.5	0.88 ± 0.26	--	1.7 ± 0.9	--
Thorium-232, total, ± counting error*	1.9 ± 0.5	0.28 ± 0.15	--	9.5 ± 2.0	--

March 1, 1985

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REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-26 2873	9000-19061-47-27 2919	9000-19061-47-28 2980	9000-19061-47-29 2990	9000-19061-47-30 3077
Determination: pCi/g					
Plutonium-238, total, ± counting error*	2.0 ± 0.3	0.05 ± 0.12	53 ± 4	0.02 ± 0.12	3.8 ± 0.5
Plutonium-239, total, ± counting error*	0.20 ± 0.13	-0.04 ± 0.09	-0.34 ± 0.70	-0.01 ± 0.10	0.01 ± 0.10
Thorium-228, total, ± counting error*	0.66 ± 0.22	--	--	--	--
Thorium-230, total, ± counting error*	3.0 ± 0.5	--	--	--	--
Thorium-232, total, ± counting error*	0.46 ± 0.18	--	--	--	--

March 1, 1985

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ALR Designation Sponsor Designation	9000-19061-47-31 4111	9000-19061-47-32 5868	9000-19061-47-33 5871	9000-19061-47-34 5882	9000-19061-47-35 5891
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.14 ± 0.13	1.6 ± 0.3	0.80 ± 0.22	1.7 ± 0.3	1.2 ± 0.2
Plutonium-239, total, ± counting error*	-0.05 ± 0.08	-0.02 ± 0.10	-0.03 ± 0.10	0.00 ± 0.09	0.05 ± 0.09
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

March 1, 1985

R. I. Stought
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REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-36 5988	9000-19061-47-37 6275	9000-19061-47-38 6283	9000-19061-47-39 6359	9000-19061-47-40 6459
Determination: pCi/g					
Plutonium-238, total, ± counting error*	1.4 ± 0.3	4.3 ± 1.3	0.47 ± 0.18	3.5 ± 0.4	0.28 ± 0.15
Plutonium-239, total, ± counting error*	-0.03 ± 0.08	0.38 ± 0.54	0.06 ± 0.10	0.03 ± 0.08	-0.02 ± 0.11
Thorium-228, total, ± counting error*	1.3 ± 0.3	--	--	--	--
Thorium-230, total, ± counting error*	0.74 ± 0.24	--	--	--	--
Thorium-232, total, ± counting error*	1.2 ± 0.3	--	--	--	--

March 1, 1985

R. L. Stought
Monsanto Research Corp.

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Date Samples Rec'd 11-21-84
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COMPLETED REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19061-47-41 6468	9000-19061-47-42 6497	9000-19061-47-43 6508	9000-19061-47-44 6552	9000-19061-47-45 6686
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.15 ± 0.15	10 ± 1	2.1 ± 0.3	0.45 ± 0.18	18 ± 2
Plutonium-239, total, ± counting error*	0.06 ± 0.10	0.21 ± 0.13	0.05 ± 0.10	0.00 ± 0.07	-0.01 ± 0.36
Thorium-228, total, ± counting error*	--	2.5 ± 0.4	--	--	2.1 ± 0.4
Thorium-230, total, ± counting error*	--	1.2 ± 0.2	--	--	0.94 ± 0.26
Thorium-232, total, ± counting error*	--	2.3 ± 0.3	--	--	1.6 ± 0.3

March 1, 1985

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RE: 9000-19061-47
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COMPLETED REPORT — REPORT OF ANALYSIS

ALR Designation	9000-19061-47-46	9000-19061-47-47
Sponsor Designation	6693	6699
Determination: pCi/g		
Plutonium-238, total, ± counting error*	5.6 ± 0.8	1.9 ± 0.3
Plutonium-239, total, ± counting error*	0.00 ± 0.08	0.44 ± 0.16
Thorium-228, total, ± counting error*	--	--
Thorium-230, total, ± counting error*	--	--
Thorium-232, total, ± counting error*	--	--

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.
These samples are scheduled to be disposed of 45 days after the date of this report.

Bud Summers
Radiochemistry
Supervisor

BS/dh

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

March 1, 1985

R. L. Stought
Monsanto Research Corp.
Mound Facility
P.O. Box 32
Miamisburg, Ohio 45342

RE: 9000-19150-66
Date Samples Rec'd 12-14-84
P.O. No. 24525

COMPLETED REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19150-66-1 1172	9000-19150-66-2 1184	9000-19150-66-3 1216	9000-19150-66-4 1285	9000-19150-66-5 1290
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.19 ± 0.14	0.19 ± 0.12	0.50 ± 0.18	710 ± 10	41 ± 1
Plutonium-239, total, ± counting error*	-0.05 ± 0.12	0.01 ± 0.05	0.01 ± 0.06	1.6 ± 0.7	0.17 ± 0.10
Thorium-228, total, ± counting error*	0.51 ± 0.17	--	0.42 ± 0.15	14 ± 1	--
Thorium-230, total, ± counting error*	0.84 ± 0.18	--	0.40 ± 0.13	1.3 ± 0.3	--
Thorium-232, total, ± counting error*	0.46 ± 0.13	--	0.56 ± 0.14	3.1 ± 0.5	--

March 1, 1985

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COMPLETED REPORT

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ALR Designation Sponsor Designation	9000-19150-66-6 1305	9000-19150-66-7 1320	9000-19150-66-8 1325	9000-19150-66-9 1338	9000-19150-66-10 1342
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.30 ± 0.14	79 ± 5	15 ± 2	0.83 ± 0.27	8.9 ± 2.4
Plutonium-239, total, ± counting error*	-0.01 ± 0.03	-0.13 ± 0.87	-0.09 ± 0.46	-0.03 ± 0.15	-0.33 ± 0.83
Thorium-228, total, ± counting error*	--	--	--	3.6 ± 0.5	--
Thorium-230, total, ± counting error*	--	--	--	1.3 ± 0.3	--
Thorium-232, total, ± counting error*	--	--	--	3.5 ± 0.4	--

March 1, 1985

R. L. Stought
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REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19150-66-11 1344	9000-19150-66-12 1356	9000-19150-66-13 1361	9000-19150-66-14 1511	9000-19150-66-15 1521
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.44 ± 0.19	100 ± 10	0.58 ± 0.36	17 ± 3	6.0 ± 1.3
Plutonium-239, total, ± counting error*	0.03 ± 0.07	-0.26 ± 0.81	0.15 ± 0.27	-0.21 ± 0.74	-0.22 ± 0.45
Thorium-228, total, ± counting error*	--	0.24 ± 0.50	1.8 ± 0.8	--	0.65 ± 0.63
Thorium-230, total, ± counting error*	--	0.69 ± 0.44	2.3 ± 0.7	--	0.80 ± 0.55
Thorium-232, total, ± counting error*	--	0.52 ± 0.31	0.53 ± 0.32	--	0.37 ± 0.34

March 1, 1985

R. L. Stought
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REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19150-66-16 1539	9000-19150-66-17 1541	9000-19150-66-18 1545	9000-19150-66-19 1550	9000-19150-66-20 1565
Determination: pCi/g					
Plutonium-238, total, ± counting error*	17 ± 2	14 ± 4	0.16 ± 0.15	7.2 ± 0.8	1.0 ± 0.3
Plutonium-239, total, ± counting error*	-0.32 ± 0.56	-0.3 ± 1.1	-0.07 ± 0.12	0.02 ± 0.21	0.00 ± 0.11
Thorium-228, total, ± counting error*	1.2 ± 0.4	--	0.41 ± 0.18	2.4 ± 0.7	--
Thorium-230, total, ± counting error*	0.66 ± 0.25	--	0.66 ± 0.20	0.98 ± 0.42	--
Thorium-232, total, ± counting error*	0.82 ± 0.27	--	0.44 ± 0.16	2.1 ± 0.6	--

March 1, 1985

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ALR Designation Sponsor Designation	9000-19150-66-21 1572	9000-19150-66-22 1592	9000-19150-66-23 1648	9000-19150-66-24 1663	9000-19150-66-25 1696
Determination: pCi/g					
Plutonium-238, total, ± counting error*	75 ± 6	0.83 ± 0.26	1.8 ± 0.9	0.03 ± 0.15	0.04 ± 0.13
Plutonium-239, total, ± counting error*	0.04 ± 0.85	0.01 ± 0.11	-0.18 ± 0.45	-0.01 ± 0.11	-0.08 ± 0.12
Thorium-228, total, ± counting error*	2.2 ± 0.8	1.8 ± 1.1	--	--	--
Thorium-230, total, ± counting error*	1.1 ± 0.5	2.0 ± 1.0	--	--	--
Thorium-232, total, ± counting error*	0.46 ± 0.29	0.62 ± 0.54	--	--	--

March 1, 1985

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ALR Designation Sponsor Designation	9000-19150-66-26 1699	9000-19150-66-27 2446	9000-19150-66-28 2460	9000-19150-66-29 2466	9000-19150-66-30 2469
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.13 ± 0.14	0.68 ± 0.25	-0.06 ± 0.14	1.1 ± 0.3	0.45 ± 0.18
Plutonium-239, total, ± counting error*	-0.03 ± 0.14	.05 ± 0.09	0.04 ± 0.12	-0.05 ± 0.08	-0.05 ± 0.07
Thorium-228, total, ± counting error*	--	11 ± 2	--	--	3.0 ± 0.9
Thorium-230, total, ± counting error*	--	1.4 ± 0.9	--	--	0.77 ± 0.47
Thorium-232, total, ± counting error*	--	13 ± 2	--	--	1.8 ± 0.6

March 1, 1985

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ALR Designation Sponsor Designation	9000-19150-66-31 2587	9000-19150-66-32 2591	9000-19150-66-33 2600	9000-19150-66-34 2829	9000-19150-66-35 2836
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.36 ± 0.16	0.06 ± 0.16	0.87 ± 0.23	5.6 ± 1.1	1.9 ± 0.3
Plutonium-239, total, ± counting error*	-0.05 ± 0.13	-0.07 ± 0.16	0.01 ± 0.09	0.14 ± 0.63	-0.02 ± 0.16
Thorium-228, total, ± counting error*	--	--	--	1.2 ± 0.6	--
Thorium-230, total, ± counting error*	--	--	--	1.1 ± 0.5	--
Thorium-232, total, ± counting error*	--	--	--	0.79 ± 0.39	--

March 1, 1985

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ALR Designation Sponsor Designation	9000-19150-66-36 2879	9000-19150-66-37 2887	9000-19150-66-38 2923	9000-19150-66-39 2931	9000-19150-66-40 2936
Determination: pCi/g					
Plutonium-238, total, ± counting error*	1.8 ± 0.4	0.73 ± 0.26	63 ± 4	0.25 ± 0.18	0.14 ± 0.18
Plutonium-239, total, ± counting error*	-0.01 ± 0.16	0.08 ± 0.19	-0.1 ± 1.0	0.01 ± 0.11	-0.05 ± 0.16
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

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REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19150-66-41 2999	9000-19150-66-42 3002	9000-19150-66-43 4007	9000-19150-66-44 4025	9000-19150-66-45 4032
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.87 ± 0.23	2.2 ± 0.4	6.0 ± 1.0	3.3 ± 1.1	0.11 ± 0.16
Plutonium-239, total, ± counting error*	-0.06 ± 0.16	0.05 ± 0.19	-0.22 ± 0.39	0.07 ± 0.82	-0.07 ± 0.15
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

March 1, 1985

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ALR Designation Sponsor Designation	9000-19150-66-46 4037	9000-19150-66-47 4042	9000-19150-66-48 4050	9000-19150-66-49 4088	9000-19150-66-50 4114
Determination: pCi/g					
Plutonium-238, total, ± counting error*	0.81 ± 0.24	2.7 ± 0.8	1.7 ± 0.8	5.5 ± 0.5	5.9 ± 0.9
Plutonium-239, total, ± counting error*	-0.09 ± 0.15	0.02 ± 0.54	-0.11 ± 0.57	-0.01 ± 0.15	-0.08 ± 0.24
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

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ALR Designation Sponsor Designation	9000-19150-66-51 4123	9000-19150-66-52 4141	9000-19150-66-53 4146	9000-19150-66-54 5820	9000-19150-66-55 5832
Determination: pCi/g					
Plutonium-238, total, ± counting error*	3.2 ± 1.0	0.55 ± 0.21	2.0 ± 0.3	0.85 ± 0.24	0.35 ± 0.15
Plutonium-239, total, ± counting error*	0.20 ± 0.54	0.22 ± 0.14	0.06 ± 0.10	0.03 ± 0.10	0.05 ± 0.09
Thorium-228, total, ± counting error*	--	--	--	--	--
Thorium-230, total, ± counting error*	--	--	--	--	--
Thorium-232, total, ± counting error*	--	--	--	--	--

March 1, 1985

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COMPLETED REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19150-66-56 5856	9000-19150-66-57 5858	9000-19150-66-58 5862	9000-19150-66-59 5909	9000-19150-66-60 5933
Determination: pCi/g					
Plutonium-238, total, ± counting error*	8.5 ± 1.2	110 ± 10	160 ± 10	0.75 ± 0.20	0.17 ± 0.10
Plutonium-239, total, ± counting error*	-0.09 ± 0.29	-0.03 ± 0.54	0.20 ± 0.82	-0.02 ± 0.07	0.03 ± 0.08
Thorium-228, total, ± counting error*	4.3 ± 1.7	11 ± 2	13 ± 3	--	--
Thorium-230, total, ± counting error*	1.7 ± 1.0	1.7 ± 0.7	2.4 ± 1.2	--	--
Thorium-232, total, ± counting error*	1.2 ± 0.8	12 ± 2	6.9 ± 1.8	--	--

March 1, 1985

R. L. Stought
Monsanto Research Corp.

RE: 9000-19150-66
Date Samples Rec'd 12-14-84
P.O. No. 24525

COMPLETED REPORT

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19150-66-61 6376	9000-19150-66-62 6384	9000-19150-66-63 6393	9000-19150-66-64 6474	9000-19150-66-65 6488
Determination: pCi/g					
Plutonium-238, total, ± counting error*	140 ± 10	4.5 ± 1.2	0.20 ± 0.16	0.54 ± 0.18	0.05 ± 0.09
Plutonium-239, total, ± counting error*	0.43 ± 0.54	0.32 ± 0.54	-0.05 ± 0.08	0.09 ± 0.11	-0.02 ± 0.06
Thorium-228, total, ± counting error*	6.9 ± 1.6	--	0.70 ± 0.32	--	--
Thorium-230, total, ± counting error*	1.3 ± 0.7	--	1.6 ± 0.4	--	--
Thorium-232, total, ± counting error*	1.3 ± 0.7	--	0.61 ± 0.24	--	--

R. L. Stought
Monsanto Research Corp.

RE: 9000-19150-66
Date Samples Rec'd 12-14-84
P.O. No. 24525

COMPLETED REPORT	REPORT OF ANALYSIS
ALR Designation	9000-19150-66-66
Sponsor Designation	6785
Determination: pCi/g	
Plutonium-238, total, ± counting error*	12 ± 2
Plutonium-239, total, ± counting error*	0.05 ± 0.66
Thorium-228, total, ± counting error*	5.8 ± 1.3
Thorium-230, total, ± counting error*	1.1 ± 0.6
Thorium-232, total, ± counting error*	4.0 ± 1.0

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.
These samples are scheduled to be disposed of 45 days after the date of this report.

Bud Summers
Radiochemistry
Supervisor

BS/dh

Accu-Labs Research, Inc.
11485 W. 48th Avenue Wheat Ridge, Colorado 80033
(303) 423-2766

June 26, 1985

Mr. R.L. Stought
Monsanto Research Corp.
P.O. Box 32
Miamisburg, Ohio 45342

RE: 9000-19842-21
Date Samples Rec'd 4-29-85
P.O. No. 36785

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19842-21-1 2501	9000-19842-21-2 2661	9000-19842-21-3 2667	9000-19842-21-4 2692	9000-19842-21-5 2704
Determination: pCi/g					
Plutonium-238, ± counting error*	0.08 ± 0.11	0.91 ± 0.23	0.75 ± 0.19	0.50 ± 0.18	0.15 ± 0.13
Plutonium-239, ± counting error*	0.08 ± 0.09	0.08 ± 0.09	0.00 ± 0.05	0.03 ± 0.07	0.00 ± 0.07
Thorium-228, ± counting error*	1.0 ± 0.4	--	--	--	--
Thorium-230, ± counting error*	1.5 ± 0.4	--	--	--	--
Thorium-232, ± counting error*	0.62 ± 0.24	--	--	--	--

June 26, 1985

Mr. R.L. Stought
Monsanto Research Corp.

RE: 9000-19842-21
Date Samples Rec'd 4-29-85
P.O. No. 36785

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19842-21-6 2712	9000-19842-21-7 2715	9000-19842-21-8 2726	9000-19842-21-9 2734	9000-19842-21-10 2748
Determination: pCi/g					
Plutonium-238, ± counting error*	0.16 ± 0.13	0.00 ± 0.09	0.17 ± 0.14	0.02 ± 0.10	0.22 ± 0.14
Plutonium-239, ± counting error*	0.06 ± 0.08	0.02 ± 0.06	0.09 ± 0.10	0.05 ± 0.08	0.07 ± 0.09
Thorium-228, ± counting error*	--	--	--	--	--
Thorium-230, ± counting error*	--	--	--	--	--
Thorium-232, ± counting error*	--	--	--	--	--

Mr. R.L. Stought
Monsanto Research Corp.

RE: 9000-19842-21
Date Samples Rec'd 4-29-85
P.O. No. 36785

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19842-21-11 2752	9000-19842-21-12 8286	9000-19842-21-13 8340	9000-19842-21-14 8349	9000-19842-21-15 8350
Determination: pCi/g					
Plutonium-238, ± counting error*	0.02 ± 0.10	22 ± 1	0.18 ± 0.13	0.13 ± 0.14	8.8 ± 0.7
Plutonium-239, ± counting error*	0.01 ± 0.06	0.00 ± 0.07	0.01 ± 0.07	0.04 ± 0.09	0.11 ± 0.10
Thorium-228, ± counting error*	--	--	0.81 ± 0.24	16 ± 2	94 ± 6
Thorium-230, ± counting error*	--	--	0.24 ± 0.16	2.6 ± 0.7	12 ± 2
Thorium-232, ± counting error*	--	--	0.83 ± 0.22	14 ± 2	88 ± 5

June 26, 1985

Mr. R.L. Stought
Monsanto Research Corp.

RE: 9000-19842-21
Date Samples Rec'd 4-29-85
P.O. No. 36785

REPORT OF ANALYSIS

ALR Designation Sponsor Designation	9000-19842-21-16 8351	9000-19842-21-17 8352	9000-19842-21-18 8353	9000-19842-21-19 8383	9000-19842-21-20 8413
Determination: pCi/g					
Plutonium-238, ± counting error*	0.87 ± 0.25	0.49 ± 0.20	0.07 ± 0.11	5.8 ± 0.5	0.45 ± 0.18
Plutonium-239, ± counting error*	-0.01 ± 0.05	0.04 ± 0.08	-0.01 ± 0.05	0.01 ± 0.06	0.02 ± 0.08
Thorium-228, ± counting error*	190 ± 10	6.3 ± 1.1	2.9 ± 0.9	--	1.0 ± 1.1
Thorium-230, ± counting error*	24 ± 4	1.5 ± 0.5	1.4 ± 0.7	--	380 ± 10
Thorium-232, ± counting error*	190 ± 10	7.4 ± 1.2	2.6 ± 0.8	--	0.24 ± 0.26

June 26, 1985

Mr. R.L. Stought
Monsanto Research Corp.

RE: 9000-19842-21
Date Samples Rec'd 4-29-85
P.O. No. 36785

REPORT OF ANALYSIS

ALR Designation	9000-19842-21-21
Sponsor Designation	8414
Determination: pCi/g	
Plutonium-238, ± counting error*	2.6 ± 0.4
Plutonium-239, ± counting error*	0.05 ± 0.08
Thorium-228, ± counting error*	1.1 ± 0.8
Thorium-230, ± counting error*	14 ± 2
Thorium-232, ± counting error*	1.3 ± 0.5

*Variability of the radioactive disintegration process (counting error) at the 95% confidence level, 1.96σ.
These samples are scheduled to be disposed of 45 days after the date of this report.

Bud Summers
Radiochemistry
Supervisor

BS/dh

Sample	Pu MRC	Pu AL	Th MRC	Th AL
2501	0.02	[illegible]	3.38	3.12
2661	0.93	0.91		
2667	0.67	0.75		
2692	0.44	0.50		
2704	0.06	0.10		
2712	0.12	0.16		
2715	0.01	0.00		
2726	0.03	0.17		
2734	<0.01	0.02		
2748	0.22	0.22		
2752	<0.01	0.02		
8286	25.00	22.00		
8340	0.01	0.18	4.47	1.88
8349	0.11	0.13	42.38	32.6
8360	4.66	8.8	142.58	194.0
8357	0.51	0.87	254.30	404
8352	0.39	0.49	41.03	15.2
8353	0.08	0.07	5.14	6.9
8383	4.94	5.8	-2.0	~~[illegible]~~
8413	0.31	0.45	333.50	38[illegible]
8414	0.97	8.6	20.17	16.4

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APPENDIX E

ANALYTICAL DATA

APPENDIX E
ANALYTICAL DATA

This appendix provides a tabulated set of the Site Survey Project analytical data because the project report (Stought et al. 1988) provided only data summaries. The data are presented in basically the same format as they were received from Mound Plant. Because the original report stated that all samples were radiochemically analyzed for plutonium-238 and FIDLER screened for thorium (at a minimum), when these data were absent it is assumed that the results were not recorded, so an "NR" for no result is entered in the tabulated results. Additionally, because only selected samples collected were analyzed for tritium, or by gamma spectroscopy for radionuclides such as cobalt-60, cesium-137, radium-226, and americium-241, when these data were absent, it is assumed that the analyses were not performed, so the table entries were left blank.

The data presented in Appendix E give the sample locations in terms of south and west coordinates because this is the system used by Mound Plant. Since the data are reported here in exactly the format received, these coordinates are reported as such. Since the Mound Plant ER Program currently uses the Ohio State Plane coordinate system, which includes north (y) and east coordinates (x), as in Plate 1, a conversion system is required. Therefore, to correlate the data in Appendix E with the Plate 1 locations and future ER Program documents, conversion tables are given in Appendix F that list the coordinates for the sampling locations given in Plate 1 (surface and core) in both the south/west and north/east systems.

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)
S0001	1175	1475	2955	10-83	0	0.44	b	0.36				
S0002	1325	1400	6429	08-84	0	1.34	b					
S0003	1350	1375	6428	08-84	0	1.01	b					
S0004	1350	1400	6430	08-84	0	3.54	b					
S0005	1375	1325	6426	08-84	0	0.62	b					
S0006	1400	1175	2953	10-83	0	2.17	b	0.52				
S0007	1400	1225	2951	10-83	0	0.74	b	0.72				
S0008	1400	1350	6427	08-84	0	0.72	b					
S0009	1425	1300	6425	08-84	0	1.18	b					
S0010	1475	1125	2954	10-83	0	0.27[c]	b					
S0011	1475	1250	2952	10-83	0	0.88	b					
S0012	1200	1605	2957	10-83	0	0.52	b					
S0013	1225	1580	6432	08-84	0	0.70	b					
S0014	1225	1755	2958	10-83	0	0.37	b	0.77				
S0015	1225	1855	2960	10-83	0	0.45	b					
S0016	1250	1505	2956	10-83	0	0.59[c]	b					
S0017	1250	1605	6431	08-84	0	2.14	b					
S0018	1250	1805	2959	10-83	0	0.64	b					
C0248	1500	1100	8386	11-84	54	2.75	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)
S0020	1525	1125	2961	10-83	0	0.56	b	0.21				
S0021	1525	1300	6447	08-84	0	0.95	b					
S0022	1550	1300	6446	08-84	0	0.70	b					
S0023	1575	1325	6445	08-84	0	1.57	b					
S0024	1625	1135	2962	10-83	0	0.56	b					
S0025	1650	1375	6444	08-84	0	2.34	b					
S0026	1675	1375	6443	08-84	0	2.58	b		LDL	1.9	1.1	LDL
S0027	1700	1110	2963	10-83	0	0.02	b					
S0028	1700	1210	2964	10-83	0	0.07	b	0.55				
S0029	1700	1425	6442	08-84	0	2.69	b					
S0030	1700	1450	2966	10-83	0	0.80	b	0.64				
S0031	1750	1400	6448	08-84	0	1.47	b					
S0032	1775	1350	6449	08-84	0	0.04	b					
S0033	1775	1450	2965	10-83	0	3.47[c]	b	0.65				
C0001	1500	1480	8346	11-84	54	0.30	b					
			8347	11-84	108	0.03	b					
S0034	1600	1855	2971	10-83	0	0.31	b					
S0035	1625	1780	6739	08-84	0	0.13	b					
S0036	1625	1830	6740	08-84	0	0.28	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)
S0037	1675	1730	6738	08-84	0	1.09	b					
S0038	1700	1630	6735	08-84	0	0.18	b					
S0039	1700	1680	2970	10-83	0	0.22	b	0.76				
S0040	1700	1705	6737	08-84	0	1.52	b					
S0041	1725	1605	6734	08-84	0	0.91	b					
S0042	1725	1655	6736	08-84	0	0.33	b					
S0043	1725	1755	6741	08-84	0	0.48	b					
S0044	1775	1505	2969	10-83	0	0.45[c]	b	0.72				
S0045	1775	1555	6733	08-84	0	1.49	b					
S0046	1775	1680	2972	10-83	0	0.86	b	1.06				
S0047	1785	1490	6732	08-84	0	0.44	b					
S0048	1785	1855	2973	10-83	0	0.28	b					
S0049	0900	1860	No MRC results given.									
S0050	0910	2200	6762	08-84	0	0.36	b					
S0051	0925	2085	4058	10-83	0	0.19	b					
S0052	1000	1950	6764	08-84	0	0.89	b					
S0053	1000	2050	6763	08-84	0	3.46	b		LDL	LDL	1	LDL
S0054	1000	2085	4057	10-83	0	0.19[c]	b					
S0055	1050	1885	4059	10-83	0	0.62	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)
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[c]	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)
S0104	1760	2195	4082	10-83	0	0.18	b	0.38				
S0105	1525	2340	3056	10-83	0	0.01	b	0.90				
S0106	1525	2415	6202	08-84	0	0.06	b					
S0107	1525	2465	6201	08-84	0	0.52	b					
S0108	1525	2565	3061	10-83	0	0.36	b	2.87				
S0109	1600	2540	6197	08-84	0	0.55	b					
S0110	1675	2315	6203	08-84	0	0.41	b					
S0111	1675	2565	6198	08-84	0	0.72	b					
S0112	1700	2515	6200	08-84	0	0.12	b					
S0113	1725	2265	3057	10-83	0	0.06[c]	b					
S0114	1750	2365	6204	08-84	0	0.07	b					
S0115	1750	2515	6199	08-84	0	0.41[c]	b					
S0116	1775	2340	6205	08-84	0	0.04	b					
S0117	1775	2415	3058	10-83	0	0.01	b					
S0118	1775	2615	3060	10-83	0	0.62	b	2.13				
S0119	0925	2770	6767	08-83	0	0.42	b		LDL	0.5	0.9	LDL
S0120	0950	2695	4068	10-83	0	0.25	b					
S0121	0950	2845	4069	10-83	0	0.46	b					
S0122	0975	2970	4070	10-83	0	0.04[c]	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)
C0251	0980	2850	8509	12-84	36	0.05	b					
S0124	1050	2945	4071	10-83	0	0.30	b	0.75				
S0125	1125	2970	4072	10-83	0	0.25	b					
S0126	1150	2820	4073	08-83	0	0.40	b					
S0127	1000	3050	4075	10-83	0	0.30	b					
S0128	1050	3250	4077	10-83	0	0.26[c]	b					
S0129	1075	3025	4074	10-83	0	0.51	b	0.20				
S0130	1075	3075	7101	09-84	0	0.95	b					
S0131	1075	3100	4076	10-83	0	0.26	b					
S0132	1100	3100	7100	09-84	0	0.67	b					
S0133	1100	3225	4078	10-83	0	0.03	b					
S0134	1175	3375	4079	10-83	0	0.47	b					
S0135	1225	2670	3033	10-83	0	0.64	b					
C0250	1255	2930	8395	12-84	36	0.01	b					
S0137	1350	2720	6177	08-84	0	0.18[c]	b					
S0138	1375	2795	6178	08-84	0	0.12	b					
S0139	1400	2670	3034	10-83	0	0.23	b					
S0140	1425	2845	3037	10-83	0	0.36	b					
S0141	1450	2770	6179	08-84	0	0.68	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)
S0142	1500	2695	6181	08-84	0	0.43	b					
S0143	1200	3050	3049	10-83	0	0.46	b	1.34				
S0144	1225	3375	3045	10-83	0	0.03	b	6.33				
S0145	1250	3175	6182	08-84	0	0.02	b					
S0146	1300	3225	6183	08-84	0	0.64	b					
S0147	1350	3175	3047	10-83	0	0.02	b					
S0148	1350	3325	3046	10-83	0	0.20	b					
S0149	1375	3025	3044	10-83	0	0.15	b					
S0150	1400	3025	3048	10-83	0	0.06[c]	b					
C0252	1445	3015	8400	12-84	36	0.13	b					
S0152	1475	3050	6184	08-84	0	0.20	b					
S0153	1475	3175	6185	08-84	0	0.20	b					
S0154	1495	3325	6186	08-84	0	0.03	b					
S0155	1550	2770	3090	10-83	0	0.54	b					
S0156	1600	2645	3095	10-83	0	0.27[c]	b					
C0253	1670	2715	8396	12-84	36	0.11	b					
S0158	1675	2645	3094	10-83	0	0.73	b					
S0159	1750	2645	6210	08-84	0	0.17	b					
S0160	1775	2620	6209	08-84	0	0.17	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)
S0161	1775	2795	3093	10-83	0	1.19	b					
S0162	1775	2845	6206	08-84	0	0.62	b					
S0163	1775	2870	6207	08-84	0	0.34	b					
S0164	1505	3175	3096	10-83	0	0.25	b					
S0165	1750	3300	6211	08-84	0	0.22[c]	b					
S0166	1750	3350	4000	10-83	0	34.50	b					
S0167	1775	3225	6212	08-84	0	0.81	b					
S0168	1775	3275	3099	10-83	0	1.76	b	12.73				
S0169	1790	3010	8424	11-84	0	0.05	b					
S0170	1790	3025	3097	10-83	0	0.41	b					
S0171	1790	3200	3098	10-83	0	1.87	b					
S0172	1285	3555	4081	10-83	0	0.17	b	1.65				
S0173	1315	3465	3050	10-83	0	0.17[c]	b					
C0254	1325	3630	8415	11-84	36	0.22	b					
S0175	1375	3580	9845	06-85	0	NR	NR		82	10	0.8	LDL
S0176	1375	3590	3051	10-83	0	2.82	b					
S0177	1385	3510	3055	10-83	0	1.17	b					
S0178	1410	3465	6187	08-84	0	0.55	b					
S0179	1410	3555	6189	08-84	0	0.48	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)
S0180	1425	3400	6188	08-84	0	0.96[c]	b					
S0181	1425	3605	6190	08-84	0	0.42	b					
S0182	1435	3690	4080	10-83	0	0.06	b	1.70				
S0183	1450	3565	3052	10-83	0	0.08	b	1.16				
S0184	1455	3680	6193	08-84	0	1.24	b					
S0185	1460	3590	6192	08-84	0	0.57	b					
S0186	1460	3615	6191	08-84	0	0.38	b					
S0187	1485	3635	3053	10-83	0	0.41	b					
S0188	1485	3680	3054	10-83	0	0.50	b					
C0255	1505	3425	8423	11-84	36	0.09	b					
S0190	1505	3605	4004	10-83	0	0.97	b					
S0191	1525	3430	4002	10-83	0	0.10	b					
S0192	1525	3705	4005	10-83	0	0.81	b	1.11				
S0193	1575	3605	6213	08-84	0	1.87	b					
S0194	1600	3455	6217	08-84	0	0.50	b					
S0195	1625	3580	6214	08-84	0	0.42	b					
S0196	1650	3455	4001	10-83	0	0.44	b	4.11				
S0197	1650	3550	6215	08-84	0	0.23	b					
S0198	1675	3705	4006	10-83	0	1.32	b					

Map Location[a]	Coordinates South	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)
S0199	1680	3480	6216	08-84	0	1.71	b					
S0200	1725	3555	4003	10-83	0	1.05[c]	b	2.95				
S0201	1625	3705	6219	08-84	0	2.21	b					
S0202	1675	3430	6218	08-84	0	1.15	b					
S0203	1700	3630	6221	08-84	0	2.61	b					
S0204	1700	3680	6220	08-84	0	2.03	b					
S0205	1505	3810	3089	10-83	0	0.54	b					
S0206	1575	3855	3087	10-83	0	1.87	b					
S0207	1650	3785	6278	08-84	0	0.75	b					
S0208	1660	3765	3085	10-83	0	61.00[c]	b	0.72				
S0209	1675	3765	9849	06-85	0	NR	NR		0.5	0.8	0.8	LDL
S0210	1675	3860	3088	10-83	0	0.84	b					
S0211	1675	3960	6280	08-84	0	0.39	b					
S0212	1725	3860	6277	08-84	0	1.17	b					
S0213	1750	3935	6279	08-84	0	1.79	b					
S0214	1775	3985	6281	08-84	0	0.82	b					
S0215	1775	4035	3084	10-83	0	1.03	NR					
S0216	1795	3760	3086	10-83	0	0.20	b	1.99				
S0217	1850	1255	2976	10-83	0	2.72	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)
S0218	1875	1385	2977	10-83	0	2.03	b					
S0219	1900	1280	6742	08-84	0	3.94	b		LDL	0.6	0.7	LDL
S0220	1950	1275	2978	10-83	0	1.50	b	0.71				
S0221	1995	1425	2974	10-83	0	0.74	b	0.52				
S0222	2035	1410	6743	08-84	0	2.34	b					
S0223	2035	1460	6746	08-84	0	2.56	b		LDL	1.3	1.2	LDL
S0224	2050	1335	2979	10-83	0	1.34[c]	b					
S0225	2075	1360	6744	08-84	0	2.47	b					
S0226	2075	1400	2975	10-83	0	3.78	b	0.99				
S0227	2085	1435	6745	08-84	0	2.96	b					
C0005	1800	1480	8344	11-84	54	0.01	b					
			8345	11-84	108	0.04	b					
S0228	1850	1805	2866	10-83	0	1.07	b					
S0229	1875	1655	2865	10-83	0	1.06	b					
S0230	1895	1525	2868	10-83	0	3.34	b					
S0231	1950	1530	6747	08-84	0	0.04	b					
S0232	1950	1730	2863	10-83	0	0.56	b					
S0233	2000	1505	6749	08-84	0	1.52	b					
S0234	2000	1555	6748	08-84	0	0.20	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)
S0235	2050	1505	6750	08-84	0	0.09	b					
S0236	2075	1580	2867	10-83	0	10.35[c]	b					
S0237	2075	1680	6751	08-84	0	0.02	b					
S0238	2075	1830	2864	10-83	0	0.09	b					
C0006	2100	1480	8354	11-84	54	0.03	3.24					
			8355	11-84	108	0.05	2.65					
S0239	2125	1505	2815	10-83	0	0.21	b					
S0240	2125	1655	6494	08-84	0	4.45	b					
S0241	2150	1755	2809	10-83	0	4.51	b					
S0242	2200	1505	2812	10-83	0	2.18	b	0.62				
S0243	2200	1830	6496	08-84	0	0.77	b					
S0244	2225	1730	6495	08-84	0	3.82	b		LDL	1.1	1.2	LDL
S0245	2250	1630	6498	08-84	0	0.46	b					
S0246	2300	1730	2811	10-83	0	0.92	b					
S0247	2300	1780	6499	08-84	0	3.82	b					
S0248	2300	1830	6497	08-84	0	9.00[c]	3.73[c]					
S0249	2325	1630	6502	08-84	0	3.92	b		LDL	1.4	1.2	LDL
S0250	2350	1730	6501	08-84	0	4.63	b					
S0251	2375	1580	2814	10-83	0	2.13	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)
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)
S0271	2650	1755	2826	10-83	0	0.01	b					
C0007	1800	1860	8352	11-84	54	0.39[c]	41.63[c]					
			8353	11-84	108	0.08[c]	5.14[c]					
S0272	1825	1960	5972	07-84	0	0.37	b					
S0273	1850	1885	2871	10-83	0	0.04	b					
S0274	1875	1985	5971	07-84	0	0.01	b					
C0008	1885	2030	10611	09-85	18	NR	NR		LDL	LDL	0.5	LDL
			10612	09-85	36	NR	NR		LDL	LDL	0.8	LDL
			10613	09-85	54	NR	NR		LDL	LDL	0.7	LDL
			10614	09-85	72	NR	NR		LDL	1.2	0.7	LDL
			10615	09-85	90	NR	NR		LDL	LDL	0.9	LDL
			10616	09-85	108	NR	NR		LDL	LDL	0.5	LDL
			10617	09-85	126	NR	NR		LDL	LDL	1	LDL
			(Note: 50 pCi/g of Ac-227 was detected in this sample using gamma spec.)									
			10618	09-85	144	NR	NR		LDL	LDL	1	LDL
			(Note: 1400 pCi/g of Ac-227 was detected in this sample using gamma spec.)									
			10619	09-85	162	NR	NR		LDL	LDL	0.9	LDL
			10620	09-85	180	NR	NR		LDL	LDL	0.5	LDL
			10621	09-85	198	NR	NR		LDL	LDL	1	LDL
			(Note: 300 pCi/g of Ac-227 was detected in this sample using gamma spec.)									
			10622	09-85	216	NR	NR		LDL	LDL	0.7	LDL
			(Note: 10 pCi/g of Ac-227 was detected in this sample using gamma spec.)									
C0009	1885	2040	10713	09-85	0	NR	NR		LDL	LDL	0.5	LDL
			10714	09-85	18	NR	NR		LDL	LDL	0.7	LDL
			10715	09-85	36	NR	NR		LDL	LDL	2.0	LDL
			10716	09-85	48	NR	NR		LDL	LDL	0.7	LDL
			10717	09-85	72	NR	NR		LDL	LDL	0.6	LDL
			(Note: 30 pCi/g of Ac-227 was detected in this sample using gamma spec.)									
			10718	09-85	90	NR	NR		LDL	LDL	1.2	LDL
			(Note: 200 pCi/g of Ac-227 was detected in this sample using gamma spec.)									
			10719	09-85	108	NR	NR		LDL	LDL	1.5	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)
			10720	09-85	126	NR	NR		LDL	LDL	0.8	LDL
			(Note: 20 pCi/g of Ac-227 was detected in this sample using gamma spec.)									
			10721	09-85	144	NR	NR					
			10722	09-85	156	NR	NR		LDL	LDL	0.7	LDL
			10723	09-85	180	NR	NR					
			10724	09-85	198	NR	NR		LDL	LDL	0.8	LDL
S0275	1900	2135	5970	07-84	0	0.29	b					
C0010	1900	2350	1734	05-83	18	0.36	b					
			1735	05-83	36	0.16	11.15					
			1736	05-83	54	NR	18.00					
			1737	05-83	90	0.03	14.41					
			1738	05-83	108	0.03[c]	27.83[c]					
			1739	05-83	162	0.01	5.76					
			1740	05-83	180	0.01	b					
			1741	05-83	198	<0.01	b					
			1742	05-83	216	0.01	5.44					
			1743	05-83	228	<0.01	b					
S0276	1925	2035	5973	07-84	0	1.27	b		LDL[e]	LDL[e]	1.5[e]	LDL[e]
C0011	1925	2400	1784	05-83	18	8.97[c]	37.69[c]		LDL	LDL	1.5	LDL
			1785	05-83	72	0.42	4.43					
			1786	05-83	90	0.20	b					
			1787	05-83	108	0.31	b					
			1788	05-83	126	0.46	b					
			1789	05-83	198	0.44	b					
			1790	05-83	216	0.84	11.13					
S0277	1950	1960	2870	10-83	0	0.53	b					
C0012	1950	2300	1725	05-83	18	0.13	b					
			1726	05-83	36	0.16[c]	5.44[c]		LDL	LDL	1.0	LDL
			1727	05-83	54	0.20	5.88					
			1728	05-83	72	0.05	b					
			1729	05-83	108	0.05	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)
			1744	05-83	126	0.01	b					
			1730	05-83	162	0.03	b					
			1731	05-83	180	0.02	2.96					
			1732	05-83	216	0.02	b					
			1733	05-83	234	0.02	b					
C0013	2000	2375	1745	05-83	18	0.06	b					
			1746	05-83	72	0.05	b					
			1747	05-83	90	0.15[c]	b					
			1748	05-83	108	0.29	b					
			1749	05-83	117	0.05	3.18					
S0278	2025	2010	5974	07-84	0	5.28	b		LDL	LDL	0.9	LDL
C0014	2025	2300	1701	05-83	18	0.31	b					
			1702	05-83	36	0.02	2.07					
			1703	05-83	54	0.02	2.18					
			1704	05-83	72	0.03	b					
			1705	05-83	90	0.87	b					
			1706	05-83	108	0.27	b					
			1707	05-83	126	0.50	b					
			1708	05-83	144	0.76	b					
			1709	05-83	162	0.23	2.74					
			1710	05-83	180	0.18[c]	b					
			1711	05-83	198	0.45	2.48					
			1712	05-83	204	0.29	b					
C0020	2075	2315	1713	05-83	18	0.08	b					
			1714	05-83	36	0.01	b					
			1715	05-83	54	0.06	b					
			1716	05-83	72	0.17	b					
			1717	05-83	108	0.29	b					
			1718	05-83	126	0.12[c]	b					
			1719	05-83	144	0.08	b					
			1720	05-83	162	0.11	b					
			1721	05-83	180	0.37	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)
			1722	05-83	198	0.07	b					
			1723	05-83	216	0.10	b					
			5980	07-84	0	3.10	2.55		LDL	LDL	0.8	LDL
C0015	2025	2315	1833	05-83	18	0.11	3.53		LDL	LDL	0.8	LDL
			1834	05-83	36	0.11	b					
			1835	05-83	54	0.10	b					
			1836	05-83	72	0.22	b		LDL	LDL	0.8	LDL
			1837	05-83	90	0.10	b					
			1838	05-83	108	0.08	b					
			1839	05-83	126	0.09	b					
			1840	05-83	144	0.09	b					
			1841	05-83	162	0.07	b					
			1842	05-83	180	0.07	b					
			1843	05-83	198	0.19	2.41					
			1844	05-83	216	0.34	b					
			1845	05-83	234	0.37[c]	4.84[c]					
			1846	05-83	240	0.25	b					
C0016	2050	2350	1750	05-83	81	0.19	b					
			1751	05-83	36	0.02	b					
			1752	05-83	54	0.02	b					
			1753	05-83	72	0.01	b					
			1754	05-83	90	0.08	b					
			1755	05-83	108	0.11	b					
			1756	05-83	126	0.06	b					
			1757	05-83	144	0.06[c]	2.05[c]					
			1758	05-83	180	0.11	b					
			1759	05-83	216	0.03	b					
			1760	05-83	234	0.07	b					

(The depth on the first sample from this core location should probably be 18 in, not 81 as given in the data received.)

C0017	2050	2475	1791	05-83	18	0.59	2.29					
			1792	05-83	36	0.21	b					
			1793	05-83	54	0.51[c]	b					
			1794	05-83	72	0.22	b					
			1795	05-83	90	0.15	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)
			1796	05-83	108	0.15	b					
			1797	05-83	126	0.75	b					
			1798	05-83	144	0.09	b					
			1799	05-83	162	0.22	b					
			1800	05-83	216	0.15	b					
S0279	2075	1885	2869	10-83	0	0.33	b					
S0280	2075	2060	5975	07-84	0	0.56	b					
S0281	2075	2110	5976	07-84	0	0.83[c]	4.03[c]					
C0018	1800	2240	8356	11-84	36	0.01	4.52					
			8357	11-84	72	0.02	2.53					
S0282	1825	2290	4093	10-83	0	0.26	b					
S0283	1875	2340	5987	07-84	0	0.10	b					
S0284	1925	2390	6752	08-84	0	0.03	b					
S0285	1950	2440	4092	10-83	0	0.07	b					
S0286	2025	2265	4091	10-83	0	7.40[c]	b	5.23				
C0019	2025	2290	1823	05-83	18	0.54	2.61					
			1824	05-83	36	0.29	b					
			1825	05-83	54	0.27	b		LDL	LDL	0.7	LDL
			1826	05-83	90	0.52	b					
			1827	05-83	108	0.10	b					
			1828	05-83	126	0.06	b					
			1829	05-83	144	0.14	b					
			1830	05-83	162	0.16	b					
			1831	05-83	180	0.12[c]	b					
			1832	05-83	216	0.10	b					
S0287	2025	2440	5985	07-84	0	0.95	8.94		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)
S0288	2025	2465	5986	07-84	0	0.29	8.09					
S0289	2050	2265	5983	07-84	0	0.64	b					
			5978	07-84	0	2.72	b					
S0290	2050	2290	6753	08-84	0	1.21	b					
S0291	2050	2515	4088	10-83	0	4.68[c]	b	1.29				
S0292	2050	2615	4089	10-83	0	0.40	b	0.25				
S0293	2075	2265	5979	07-84	0	0.66	b					
C0021	2075	2340	5982	07-84	0	1.52	b					
			1867	05-83	12	0.86	3.23					
			1868	05-83	24	1.00	3.80					
			1869	05-83	36	NR	18.00					
			1870	05-83	48	0.20[c]	6.94[c]					
			1871	05-83	60	0.08	b					
			1872	05-83	72	0.12	b					
			1873	05-83	84	0.03	b					
			1874	05-83	96	0.04	b					
			1875	05-83	108	0.02	b					
			1876	05-83	120	0.04	b					
			1877	05-83	132	0.11	b					
			1878	05-83	144	0.13	b					
			1879	05-83	156	0.18	b					
			1880	05-83	168	0.10[c]	b					
			1881	05-83	180	0.21	3.82					
			1882	05-83	192	0.09	b					
			1883	05-83	204	0.21	b					
			1884	05-83	216	0.17	b					
			1885	05-83	228	0.24	b					
			1886	05-83	240	0.18	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)
S0295	2075	2390	4090	10-83	0	0.64	b					
S0296	2075	2440	5984	07-84	0	1.56[c]	16.59[c]					
S0297	2075	2515	6756	08-84	0	0.31	b					
S0298	2085	2315	6758	08-84	0	3.01	20.52					
S0299	2085	2355	6755	08-84	0	0.41	b		LDL	LDL	1.2	LDL
S0300	2085	2365	6757	08-84	0	0.38	4.48					
C0022	2100	1860	8379	11-84	54	0.05	4.16					
			8380	11-84	80	0.02	2.53					
C0023	2125	1830	1801	05-83	18	0.18	2.81					
			1802	05-83	72	0.05	b					
			1803	05-83	90	0.03	b					
			1804	05-83	108	0.04	b					
C0024	2125	2200	1805	05-83	126	0.02	b					
			1806	05-83	144	0.01	b		LDL	LDL	0.8	LDL
			1807	05-83	156	0.02	b		LDL	LDL	0.9	LDL
S0301	2125	1885	6504	08-84	0	1.42	b					
S0302	2125	2110	6512	08-84	0	4.13	b					
S0303	2125	2160	2818	10-83	0	0.75	b					
S0304	2150	2085	6510	08-84	0	5.22	b		LDL	1.2	1.1	LDL
C0025	2150	2290	1815	05-83	12	6.60	3.90					
			1816	05-83	36	0.30[c]	4.02[c]		LDL	LDL	1	LDL
			1817	05-83	72	0.09	b					
			1818	05-83	90	0.05	b					
			1819	05-83	144	0.05	2.43					

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)
S0305	2175	1885	2819	10-83	0	0.09	b					
S0306	2175	1985	6505	08-84	0	4.82	b					
S0307	2175	2060	2821	10-83	0	5.36	6.46					
S0308	2225	2160	6509	08-84	0	1.06	b					
S0309	2225	2235	6508	08-84	0	1.70[c]	b		LDL	1.1	1.2	LDL
S0310	2275	1985	6506	08-84	0	0.59	b					
S0311	2325	2135	6507	08-84	0	0.62	6.76					
S0312	2325	2185	6507	08-84	0	0.75	b					
S0313	2350	2060	2817	10-83	0	6.28[c]	28.73[c]	1.12				
C0026	2362.7	2142.4	None[d]	07-84	0	NR	13					
			None[d]	07-84	12	NR	17					
			None[d]	07-84	24	NR	33					
			None[d]	07-84	36	NR	37					
			None[d]	07-84	48	NR	30					
			None[d]	07-84	60	NR	34					
			None[d]	07-84	72	NR	37					
			None[d]	07-84	84	NR	36					
			None[d]	07-84	96	NR	39					
			None[d]	07-84	108	NR	39					
			None[d]	07-84	120	NR	34					
			None[d]	07-84	132	NR	29					
C0027	2371.9	2104.9	None[d]	07-84	0	NR	8.3					
			None[d]	07-84	12	NR	29					
			None[d]	07-84	24	NR	35					
			None[d]	07-84	36	NR	53					
			None[d]	07-84	48	NR	43					
			None[d]	07-84	60	NR	34					

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)
			None[d]	07-84	72	NR	18					
			None[d]	07-84	84	NR	12					
			None[d]	07-84	96	NR	12					
			None[d]	07-84	108	NR	10					
			None[d]	07-84	120	NR	5.3					
C0028	2375	1755	1245	12-82	18	11.40	5.61					
			1246	12-82	48	NR	109.00					
			1247	12-82	66	NR	109.00					
			1248	12-82	102	NR	58.00					
			1250	12-82	156	NR	97.00					
			1251	12-82	216	0.29[c]	29.45[c]					
			1252	12-82	234	0.06	b					
			1253	12-82	252	0.03	b					
S0314	2375	1910	2820	10-83	0	0.78	b					
C0029	2374.1	2184.3	None[d]	07-84	0	NR	12					
			None[d]	07-84	12	NR	17					
			None[d]	07-84	24	NR	17					
			None[d]	07-84	36	NR	38					
			None[d]	07-84	48	NR	53					
			None[d]	07-84	60	NR	42					
			None[d]	07-84	72	NR	36					
			None[d]	07-84	84	NR	38					
			None[d]	07-84	96	NR	55					
			None[d]	07-84	108	NR	48					
			None[d]	07-84	120	NR	36					
			None[d]	07-84	132	NR	21					
			None[d]	07-84	144	NR	17					

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)
C0030	2395.0	2063.6	None[d]	07-84	0	NR	4.6					
			None[d]	07-84	12	NR	26					
			None[d]	07-84	24	NR	9.6					
			None[d]	07-84	36	NR	5.9					
			None[d]	07-84	48	NR	2					
			None[d]	07-84	60	NR	1.4					
			None[d]	07-84	72	NR	1.1					
			None[d]	07-84	84	NR	0.8					
			None[d]	07-84	96	NR	1.2					
			None[d]	07-84	108	NR	1.0					
			None[d]	07-84	120	NR	1.1					
			None[d]	07-84	132	NR	0.9					
			None[d]	07-84	144	NR	1.1					
			None[d]	07-84	156	NR	1.7					

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)
C0031	2396.6	2204.7	None[d]	07-84	0	NR	8.4					
			None[d]	07-84	12	NR	27					
			None[d]	07-84	24	NR	36					
			None[d]	07-84	36	NR	42					
			None[d]	07-84	48	NR	43					
			None[d]	07-84	60	NR	64					
			None[d]	07-84	72	NR	64					
			None[d]	07-84	84	NR	47					
			None[d]	07-84	96	NR	32					
			None[d]	07-84	108	NR	42					
			None[d]	07-84	120	NR	54					
			None[d]	07-84	132	NR	44					
C0256	2100	2240	6385	11-84	18	0.03	2.79					
S0316	2125	2365	4100	10-83	0	0.98	b	0.69	LDL	LDL	0.8	LDL
S0317	2125	2515	4101	10-83	0	0.20	b	0.15				
C0032	2175	2340	1808	05-83	18	0.64	3.14		LDL	LDL	1.0	LDL
			1809	05-83	36	2.19	b					
			1810	05-83	54	0.62	b					
			1811	05-83	90	0.08	b					
			1812	05-83	144	0.05	b					
			1813	05-83	162	0.08	b					
			1814	05-83	180	0.03	b					
S0318	2175	2365	5990	08-84	0	0.72	b					
S0319	2210	2315	6852	08-84	0	1.17	b					
S0320	2210	2375	6850	08-84	0	6.81	6.73					
S0321	2225	2265	4099	10-83	0	0.61	b					
S0322	2225	2465	5989	08-84	0	0.78	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)
S0323	2225	2540	5988	08-84	0	0.45[c]	3.64[c]					
S0324	2275	2540	6848	08-84	0	1.86	b					
S0325	2275	2490	6849	08-84	0	1.73	b					
S0326	2325	2590	4096	10-83	0	3.91	b					
S0327	2350	2515	6847	08-84	0	1.50	b					
S0328	2350	2465	4097	10-83	0	0.73	b		LDL	1.2	1.1	LDL
S0329	2375	2290	4098	10-83	0	15.88	b	1.39				
S0330	2375	2340	6846	08-84	0	2.02	b					
C0033	2400	1860	8349	11-84	36	0.11[c]	42.38[c]					
			8414	11-84	48	0.97[c]	20.17[c]					
C0034	2405	2010	1260	12-82	18	4.83[c]	32.20[c]					
			1261	12-82	72	0.48	9.12					
			1262	12-82	90	0.07	b					
			1263	12-82	108	0.03	b					
C0035	2405.8	2212.9	None[d]	07-84	0	NR	5.5					
			None[d]	07-84	12	NR	11					
			None[d]	07-84	24	NR	24					
			None[d]	07-84	36	NR	29					
			None[d]	07-84	48	NR	42					
			None[d]	07-84	60	NR	18					
			None[d]	07-84	72	NR	33					
			None[d]	07-84	84	NR	28					
			None[d]	07-84	96	NR	15					
			None[d]	07-84	108	NR	11					
			None[d]	07-84	120	NR	39					
			None[d]	07-84	132	NR	31					
			None[d]	07-84	144	NR	15					

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)
S0331	2425	1885	6365	08-84	0	0.01	b					
S0332	2425	1910	6367	08-84	0	8.17	b					
S0333	2425	2060	7113	08-84	0	24.40	70.52					
S0334	2425	2135	7112	08-84	0	8.44	15.65					
S0335	2425	2185	7111	08-84	0	5.86	7.14					
C0036	2425	2220	1242	12-82	18	1.45	9.41					
			1243	12-82	48	NR	46.30					
			1244	12-82	114	0.84[c]	36.16[c]		LDL	LDL	1.0	LDL
C0037	2428.6	2178	None[d]	07-84	0	NR	5.9					
			None[d]	07-84	12	NR	11					
			None[d]	07-84	24	NR	14					
			None[d]	07-84	36	NR	5.8					
			None[d]	07-84	48	NR	5.1					
			None[d]	07-84	60	NR	6.3					
			None[d]	07-84	72	NR	6.3					
			None[d]	07-84	84	NR	5.1					
			None[d]	07-84	96	NR	2.5					
S0336	2450	1885	6366	08-84	0	0.06	b					
S0337	2450	2160	7110	08-84	0	2.10	38.04					
S0338	2475	1910	6368	08-84	0	0.05	b					
S0339	2475	2110	7114	08-84	0	0.74	12.00					
S0340	2500	1910	6369	08-84	0	0.19	b					
C0038	2500	2210	7109	08-84	0	1.41	5.08					
			1236	12-82	18	2.39	b					
			1237	12-82	36	0.65	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)
			1238	12-82	54	2.24	b					
			1239	12-82	72	0.31	b					
			1240	12-82	90	0.64	b					
			1241	12-82	108	0.35	b					
C0039	2525	2110	1977	05-83	18	0.59[c]	5.62[c]					
			1978	05-83	36	0.04	b					
C0040	2525	2185	1979	05-83	18	0.82	b					
			1980	05-83	36	8.15	b					
			1981	05-83	54	0.82	b					
C0257	2550	2010	1976	05-83	18	0.47	b					
C0041	2550	2210	1982	05-83	18	2.30	b					
			1983	05-83	54	0.29	b					
C0042	2575	2060	1974	05-83	18	1.36	b					
			1975	05-83	24	0.07	b					
C0258	2600	2235	1985	05-83	36	0.04	b					
C0043	2625	2210	1971	05-83	18	0.65	6.22					
			1972	05-83	36	0.14	b					
C0044	2650	2235	1316	12-82	18	0.66	b					
			1317	12-82	36	0.20[c]	b					
			1318	12-82	54	0.19	b					
C0259	2675	2085	1973	05-83	18	0.55	b					
C0045	2400	2240	6350	11-84	54	4.66[c]	142.58[c]					
			6351	11-84	60	0.51[c]	254.30[c]		LDL	LDL	3.3	LDL
S0344	2425	2290	6552	08-84	0	0.58[c]	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)
C0046	2440	2550	10109	07-85	18	0.21	b					
			10110	07-85	42	1.42	b					
S0345	2450	2290	4102	10-83	0	1.37	b					
S0346	2450	2365	6551	08-84	0	0.93	b					
S0347	2475	2440	4103	10-83	0	1.65	b					
C0047	2485	2470	10106	07-85	18	29.10	b					
			10107	07-85	36	1.45	b					
			10108	07-85	54	0.02	b					
C0048	2500	2480	10103	07-85	18	0.23	b					
			10104	07-85	36	1.30	b					
			10105	07-85	54	0.06	b					
S0348	2500	2540	4104	10-83	0	2.78	b	0.35	LDL	LDL	0.8	LDL
S0349	2500	2565	6549	08-84	0	3.55	b		LDL	LDL	1.2	LDL
C0049	2515	2460	10100	07-85	18	2.30	b					
			10101	07-85	36	0.51	b					
			10102	07-85	54	0.17	b					
S0350	2525	2365	6770	08-84	0	23.60	b					
C0050	2530	2430	10097	07-85	18	0.39	b					
			10098	07-85	36	0.60	b					
			10099	07-85	54	0.11	b					
C0051	2540	2385	10111	07-85	18	0.99	b					
			10112	07-85	36	1.76	b					
			10113	07-85	54	0.16	b					
			10114	07-85	72	0.11	b					
			10115	07-85	90	0.40	b					
			10116	07-85	108	0.01	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)
S0351	2550	2290	6553	08-84	0	7.71	b					
S0352	2550	2415	6769	08-84	0	37.80	b					
S0353	2550	2590	6554	08-84	0	0.97	b					
S0354	2550	2465	6550	08-84	0	2.22	b					
C0052	2555	2405	10093	07-85	18	2.92	b					
			10094	07-85	36	8.12	b					
			10095	07-85	54	0.30	b					
			10096	07-85	72	0.36	b					
C0053	2570	2400	10085	07-85	18	68.50	b					
			10086	07-85	36	3.98	b					
			10087	07-85	54	0.79	b					
			10088	07-85	72	0.45	2.21					
C0054	2570	2380	10089	07-85	18	2.24	b					
			10090	07-85	36	43.10	b					
			10091	07-85	54	2.30	b					
			10092	07-85	84	1.76	b					
C0055	2575	2265	1229	12-82	18	1.19	b					
			1230	12-82	36	0.32	b					
			1231	12-82	54	1.16	b					
			1232	12-82	72	0.50	b					
			1233	12-82	90	0.08	b					
			1234	12-82	108	0.02	b					
			1235	12-82	126	0.42	b					
C0056	2590	2420	10117	07-85	18	75.20	b					
			10118	07-85	36	144.00	b					
			10119	07-85	54	11.10	b					
			10120	07-85	72	3.20	b					

(MRC IDs 10119 and 10120 were also assigned to samples taken at location C0059.)

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)
C0057	2600	2405	10121	07-85	18	16.5	b					
			10122	07-85	36	7.73	b					
			10123	07-85	54	0.54	b					
			10124	07-85	72	0.42	2.56					
(Note: The same sequence of MRC IDs is repeated for location C0060.)												
S0355	2600	2465	4106	10-83	0	4.49	b					
C0058	2605	2395	10125	07-85	18	0.82	b					
			10126	07-85	36	0.73	3.46					
			10127	07-85	54	0.33	b					
			10128	07-85	72	1.08	b					
			10128	07-85	90	0.20	b					
(Note: This same sequence of MRC IDs is repeated for C0061 below.)												
C0059	2610	2415	10119	06-85	54	NR	NR		LDL	LDL	0.6	LDL
			10120	06-85	72	NR	NR		LDL	LDL	0.7	LDL
C0060	2620	2400	10121	06-85	18	NR	NR		LDL	LDL	0.8	LDL
			10122	06-85	36	NR	NR		LDL	LDL	1.0	LDL
			10123	06-85	54	NR	NR		LDL	LDL	0.8	LDL
			10124	06-85	72	NR	NR		LDL	LDL	0.8	LDL
S0356	2625	2365	4107	10-83	0	18.90	b					
C0061	2630	2390	10125	06-85	18	NR	NR		LDL	LDL	0.9	LDL
			10126	06-85	36	NR	NR		LDL	LDL	1.2	LDL
			10127	06-85	54	NR	NR		LDL	LDL	0.8	LDL
			10128	06-85	72	NR	NR		LDL	LDL	0.8	LDL
			10129	06-85	90	NR	NR		LDL	LDL	1	LDL
C0062	2675	2315	1224	12-82	18	33.60	b					
			1225	12-82	36	0.31	b					
			1226	12-82	54	34.50[c]	2.53[c]					
			1227	12-82	108	1.07	b					
			1228	12-82	126	0.12	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)
S0357	2675	2340	6771	08-84	0	43.70	b					
S0358	2675	2565	4105	10-83	0	1.33	b		LDL	1	1.2	LDL
S0359	1810	2645	3065	10-83	0	0.06	b	5.12				
S0360	1810	2895	6224	08-84	0	0.36	b					
S0361	1810	2945	6222	08-84	0	0.53	b					
S0362	1835	2005	6227	08-84	0	0.25	b					
S0363	1850	2770	3064	10-83	0	0.08[c]	b	24.84				
S0364	1860	2655	6228	08-84	0	0.99	b		LDL	1.4	1.5	LDL
S0365	1875	2670	3063	10-83	0	0.43	b	3.81				
S0366	2000	2695	3062	10-83	0	1.41	b					
S0367	2000	2770	6225	08-84	0	0.12	b					
S0368	2000	2870	6230	08-84	0	1.22	b					
S0369	2000	2920	6229	08-84	0	0.15[c]	b					
S0370	2050	2555	6226	08-84	0	0.12	b					
S0371	2050	2820	3066	10-83	0	0.07	b					
S0372	2050	2920	3067	10-83	0	0.57	b	44.98				
S0373	1810	3350	9830	06-85	0	NR	NR		1.00	1.6	0.8	LDL
S0374	1825	3250	6259	08-84	0	8.14	b					
S0375	1825	3300	3079	10-83	0	0.35	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)
C0063	1850	3370	10373	09-85	18	NR	NR		LDL	LDL	0.6	LDL
			10374	09-85	36	NR	NR		LDL	LDL	0.4	LDL
			10375	09-85	54	NR	NR		LDL	LDL	0.6	LDL
			10377	09-85	90	NR	NR		LDL	LDL	0.5	LDL
			10378	09-85	108	NR	NR		LDL	LDL	0.4	LDL
			10379	09-85	126	NR	NR		1.1	LDL	0.5	LDL
			10380	09-85	144	NR	NR		LDL	LDL	0.4	LDL
			10381	09-85	162	NR	NR		LDL	LDL	0.5	LDL
C0064	1860	3340	10383	09-85	18	NR	NR		LDL	LDL	0.6	LDL
			10384	09-85	36	NR	NR		38	LDL	0.5	LDL
			10385	09-85	54	NR	NR		22	LDL	0.5	LDL
			10386	09-85	72	NR	NR		3.3	LDL	0.6	LDL
			10387	09-85	90	NR	NR		LDL	LDL	0.5	LDL
			10388	09-85	108	NR	NR		250	LDL	0.5	LDL
			10389	09-85	126	NR	NR		6	LDL	0.4	LDL
			10390	09-85	144	NR	NR		2	LDL	0.5	LDL
			10391	09-85	162	NR	NR		3	LDL	0.5	LDL
			10392	09-85	180	NR	NR		9	LDL	0.6	LDL
C0065	1870	3340	10393	09-85	18	NR	NR		15	LDL	0.4	LDL
			10394	09-85	36	NR	NR		26	LDL	0.7	LDL
			10395	09-85	54	NR	NR		15	LDL	0.5	LDL
			10396	09-85	72	NR	NR		26	LDL	0.8	LDL
			10397	09-85	90	NR	NR		23	LDL	0.5	LDL
			10398	09-85	108	NR	NR		5	LDL	0.4	LDL
			10399	09-85	126	NR	NR		6	LDL	0.5	LDL
			10400	09-85	144	NR	NR		LDL	LDL	0.5	LDL
			10401	09-85	162	NR	NR		1.3	LDL	0.5	LDL
			10402	09-85	180	NR	NR		LDL	LDL	0.5	LDL
			10403	09-85	198	NR	NR		1.1	LDL	0.6	LDL
			10404	09-85	216	NR	NR		LDL	LDL	0.5	LDL
			10405	09-85	234	NR	NR		1.3	LDL	0.7	LDL
S0376	1875	3375	3068	10-83	0	0.05	b	4.19				

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)
S0388	2125	2795	3076	10-83	0	0.88	b					
S0389	2125	2920	3075	10-83	0	0.74	b					
S0390	2150	2670	6860	08-84	0	1.14	b					
S0391	2200	2720	6854	08-84	0	11.90	b					
S0392	2225	2895	3074	10-83	0	1.77	b					
S0393	2250	2645	6861	08-84	0	0.82	b					
S0394	2250	2745	6855	08-84	0	18.10	b					
S0395	2275	2820	6856	08-84	0	0.82	b					
S0396	2300	2760	6859	08-84	0	0.75	b					
S0397	2300	2770	6863	08-84	0	0.18	b					
S0398	2325	2945	3079	10-83	0	2.39	b					
S0399	2350	2745	6858	08-84	0	0.65	b					
S0400	2350	2895	6857	08-84	0	0.77	b					
S0401	2375	2645	3077	10-83	0	0.19[c]	b					
S0402	2375	2770	3078	10-83	0	6.47	b					
S0403	2385	2705	6862	08-84	0	0.87	b					
S0404	2125	3110	2876	10-83	0	0.67	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)
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)
			10801	09-85	162	NR	NR		LDL	LDL	0.5	LDL
			10802	09-85	180	NR	NR		LDL	LDL	0.2	LDL
C0071	2245	3280	10781	09-85	0	NR	NR		LDL	LDL	0.5	LDL
			10782	09-85	18	NR	NR		LDL	LDL	0.2	LDL
			10783	09-85	36	NR	NR		LDL	LDL	0.2	LDL
			10786	09685	90	NR	NR		LDL	LDL	0.5	LDL
			10787	09-85	108	NR	NR		LDL	LDL	0.2	LDL
			10788	09-85	126	NR	NR		LDL	LDL	0.6	LDL
			10789	09-85	144	NR	NR		LDL	LDL	0.2	LDL
			10790	09-85	162	NR	NR		LDL	LDL	0.6	LDL
			10791	09-85	180	NR	NR		LDL	LDL	0.9	LDL
C0072	2250	3260	10675	09-85	18	NR	NR		LDL	LDL	0.4	LDL
			10676	09-85	36	NR	NR		LDL	LDL	0.5	LDL
			10677	09-85	54	NR	NR		LDL	LDL	0.6	LDL
			10678	09-85	72	NR	NR		LDL	LDL	0.4	LDL
			10679	09-85	90	NR	NR		LDL	LDL	0.3	LDL
			10680	09-85	108	NR	NR		LDL	LDL	0.4	LDL
			10681	09-85	126	NR	NR		LDL	LDL	0.5	LDL
			10682	09-85	144	NR	NR		LDL	LDL	0.6	LDL
			10683	09-85	162	NR	NR		LDL	LDL	0.2	LDL
S0409	2255	3235	2914	10-83	0	1.46	b					
S0410	2260	3200	5867	07-84	0	0.48	b					
C0073	2260	3240	10770	09-85	0	NR	NR		LDL	LDL	0.5	LDL
			10772	09-85	36	NR	NR		LDL	LDL	0.2	LDL
			10775	09-85	90	NR	NR		LDL	LDL	0.7	LDL
			10777	09-85	126	NR	NR		LDL	LDL	0.6	LDL
			10778	09-85	144	NR	NR		LDL	LDL	0.6	LDL
			10779	09-85	162	NR	NR		LDL	LDL	0.2	LDL
C0074	2270	3210	10762	09-85	0	NR	NR		LDL	LDL	0.5	LDL
			10763	09-85	18	NR	NR		LDL	LDL	0.4	LDL
			10764	09-85	36	NR	NR		LDL	LDL	0.5	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)
			10765	09-85	54	NR	NR		LDL	LDL	0.5	LDL
			10766	09-85	72	NR	NR		LDL	LDL	0.5	LDL
			10767	09-85	90	NR	NR		LDL	LDL	0.6	LDL
			10768	09-85	108	NR	NR		LDL	LDL	0.6	LDL
			10769	09-85	126	NR	NR		LDL	LDL	0.7	LDL
S0411	2300	3150	5869	07-84	0	1.15	b					
S0412	2310	3135	6864	08-84	0	0.08	2.97					
S0413	2325	3050	5868	07-84	0	1.21[c]	b					
S0414	2325	3375	6865	08-84	0	1.04	b					
S0415	2350	3085	2875	10-83	0	1.25	b					
S0416	2350	3150	6868	08-84	0	1.18	b					
S0417	2350	3225	6867	08-84	0	1.45	b					
S0418	2350	3350	6866	08-84	0	0.95	b					
S0419	2375	3275	2877	10-83	0	1.09	b					
C0075	2400	2620	8383	11-84	54	4.94[c]	b					
			8384	11-84	90	0.25	2.73					
S0420	2425	2695	6776	08-84	0	0.12	b					
S0421	2450	2800	10470	08-85	0	1.68	b					
S0422	2475	2820	6775	08-84	0	1.45	b					
S0423	2475	2855	10469	08-85	0	2.40	b					
S0424	2490	2875	10468	08-85	0	1.23	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)
S0425	2500	2945	4108	10-83	0	1.08	5.74					
S0426	2510	2910	10467	08-85	0	1.00	b					
S0427	2525	2670	6777	08-84	0	1.58	b					
S0428	2550	2970	6772	08-84	0	11.80	b					
S0429	2575	2670	6774	08-84	0	3.43	b					
S0430	2625	2645	4111	10-83	0	0.20[c]	b					
S0431	2625	2845	4110	10-83	0	1.79	b					
S0432	2635	2895	6780	08-84	0	5.78	b					
S0433	2650	2695	6778	08-84	0	0.98	b					
S0434	2650	2770	6773	08-84	0	12.10	b					
S0435	2650	2945	4109	10-83	0	0.83	b					
S0436	2685	2730	6779	08-84	0	7.83	b					
C0076	2400	3000	8290	11-84	36	0.15	b					
			8291	11-84	72	0.16	b					
			8292	11-84	126	0.11	b					
S0437	2450	3100	5878	07-84	0	1.52	b					
S0438	2474	3150	5879	07-84	0	0.27	b					
S0439	2500	3075	5880	07-84	0	0.49	b					
S0440	2500	3375	2984	10-83	0	0.96	b					
S0441	2525	3350	2982	10-83	0	0.07	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)
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)
S0456	2025	3730	6274	08-84	0	3.62	b					
S0457	2675	3405	2989	10-83	0	0.25	b					
C0079	2050	3415	10635	09-85	18	NR	NR					
			10636	09-85	36	NR	NR		LDL	LDL	0.7	LDL
			10637	09-85	54	NR	NR		LDL	LDL	0.6	LDL
			10638	09-85	72	NR	NR		LDL	LDL	0.4	LDL
			10639	09-85	90	NR	NR		LDL	LDL	0.6	LDL
			10640	09-85	108	NR	NR		LDL	LDL	0.3	LDL
			10641	09-85	126	NR	NR		LDL	LDL	0.6	LDL
			10642	09-85	144	NR	NR		LDL	LDL	0.6	LDL
			10643	09-85	162	NR	NR		LDL	LDL	0.7	LDL
			10644	09-85	180	NR	NR		LDL	LDL	0.5	LDL
			10645	09-85	198	NR	NR		LDL	LDL	0.9	LDL
C0080	2050	3705	1965	05-83	18	3.53	b					
			1966	05-83	36	2.71	b					
			1967	05-83	54	0.13	b					
C0081	2090	3400	10623	09-85	18	NR	NR		LDL	LDL	0.8	LDL
			10624	09-85	36	NR	NR		LDL	LDL	0.6	LDL
			10625	09-85	54	NR	NR		LDL	LDL	0.5	LDL
			10626	09-85	72	NR	NR		LDL	LDL	0.8	LDL
			10627	09-85	90	NR	NR		LDL	LDL	0.4	LDL
			10628	09-85	108	NR	NR		LDL	LDL	0.7	LDL
			10629	09-85	126	NR	NR		LDL	LDL	0.4	LDL
			10630	09-85	144	NR	NR		LDL	LDL	0.6	LDL
			10631	09-85	162	NR	NR		LDL	LDL	0.5	LDL
			10632	09-85	180	NR	NR		LDL	LDL	0.5	LDL
			10633	09-85	198	NR	NR		LDL	LDL	0.5	LDL
			10634	09-85	216	NR	NR		LDL	LDL	0.6	LDL
C0082	2080	3630	1968	05-83	18	2.99	b					
			1969	05-83	36	0.31	b					
			1970	05-83	72	0.31	b					
S0458	1810	3870	6263	08-84	0	0.13[c]	b					

(The same MRC ID was also assigned to the sample from surface location S0383.)

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)
S0459	1825	3940	6284	08-84	0	2.20	b					
S0460	1835	4010	6285	08-84	0	1.05	b					
S0461	1850	3870	6293	08-84	0	1.05	b					
S0462	1860	3910	6282	08-84	0	0.21	b					
S0463	1860	4045	6286	08-84	0	2.03	b					
C0083	1875	3825	1935	05-83	12	4.42	b					
			1936	05-83	24	1.96	b					
			1937	05-83	36	2.19	b					
			1938	05-83	54	1.09	b					
			1939	05-83	72	2.99	b					
C0084	1885	3935	1906	05-83	18	0.05	b					
			1907	05-83	36	4.92	b					
			1908	05-83	54	1.09	b					
S0464	1910	4055	6287	08-84	0	14.80	b					
C0085	1915	3840	1944	05-83	18	100.10[c]	b		LDL	LDL	0.6	0.5
			1945	05-83	36	51.35	b					
			1946	05-83	54	51.70	b					
			1947	05-83	60	34.95	b					
S0465	1925	3790	1493	03-83	0	NR	NR		LDL	LDL	0.7	1.0
C0086	1925	3935	1910	05-83	18	10.50	b					
			1911	05-83	36	5.53	b					
			1912	05-83	54	1.23	b					
			1913	05-83	72	0.23	b					
C0087	1925	4010	1914	05-83	18	0.95	3.29					
			1915	05-83	36	0.65	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)
			1916	05-83	54	0.12	b					
			1917	05-83	66	0.08[c]	3.36[c]					
C0088	1925	4050	1902	05-83	18	0.05	b					
			1903	05-83	36	2.44	b					
			1904	05-83	54	3.48	b					
			1905	05-83	72	2.29	b					
C0089	1935	3950	1940	05-83	18	5.64	b					
			1941	05-83	36	0.46	b					
			1942	05-83	54	2.06	b					
			1943	05-83	72	0.12	b					
S0466	1950	3770	6296	08-84	0	5.42	b					
C0090	1950	3910	1948	05-83	18	160.00	b					
			1949	05-83	36	7.44	b					
			1950	05-83	96	6.16	b					
C0091	1965	3790	1951	05-83	18	355.00[c]	b					
			1952	05-83	36	150.00	b					
			1953	05-83	54	8.60	b					
S0467	1975	4110	6289	08-84	0	0.31	b					
C0092	1980	3825	1954	05-83	18	7.02	b					
			1955	05-83	36	0.75	b					
			1956	05-83	54	2.48	b					
			1957	05-83	72	4.95[c]	b		LDL	LDL	1.2	LDL
S0468	2025	3825	6292	08-84	0	0.17	b		LDL	LDL	1.2	LDL
S0469	2025	3860	6291	08-84	0	18.90	b					
S0470	2025	4060	6290	08-84	0	1.07	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)
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					
S0479	2275	3505	5873	07-84	0	0.65	b					
S0480	2275	3580	6697	08-84	0	0.05	b					
S0481	2285	3430	5871	07-84	0	0.65[c]	b					
S0482	2300	3390	5870	07-84	0	0.68	b					
S0483	2310	3480	6698	08-84	0	0.41	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)
S0484	2335	3415	6699	08-84	0	1.62[c]	b					
S0485	2350	3705	2915	10-83	0	0.13	b					
S0486	2125	3810	6706	08-84	0	10.27	b					
S0487	2125	3835	6704	08-84	0	5.96	b					
S0488	2135	3835	6703	08-84	0	18.77	b					
S0489	2150	3860	6705	08-84	0	14.10	b					
C0094	2160	3835	1595	04-83	18	133.90	2.24					
			1596	04-83	36	59.90	b					
			1597	04-83	54	70.90	b					
			1598	04-83	72	6.81	b					
			1599	04-83	90	11.82	b					
			1600	04-83	108	1.24	b					
			1601	04-83	126	3.54	b					
C0095	2160	3900	1602	04-83	18	7.87	b					
			1603	04-83	54	3.97	b					
			1604	04-83	72	7.49[c]	b					
			1605	04-83	90	5.00	b					
			1606	04-83	108	5.05	b					
			1607	04-83	126	6.63	b					
S0490	2175	4135	2918	10-83	0	0.71	b					
C0096	2190	3875	1608	04-83	18	0.27	b					
			1609	04-83	36	2.18	b					
			1610	04-83	54	0.26	b					
			1611	04-83	72	0.45	b					
			1612	04-83	90	1.46[c]	b					
			1613	04-83	108	0.62	b					
			1614	04-83	126	0.09	b					
			1615	04-83	144	0.07	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)
S0491	2200	4010	2917	10-83	0	5.26	b					
S0492	2250	3985	6872	08-84	0	0.02	b					
S0493	2275	4010	6870	08-84	0	0.03	b					
S0494	2275	4135	6874	08-74	0	1.48	b					
(The collection date of 08-74 should probably be either 08-84 or 07-84)												
S0495	2300	4010	2920	10-83	0	0.03	b					
S0496	2300	4135	6873	08-84	0	0.02	b					
S0497	2325	3935	6871	08-84	0	0.04	b					
S0498	2350	3860	2922	10-83	0	0.10	b					
S0499	2350	4135	2919	10-83	0	0.04[c]	b					
S0500	2375	3960	2921	10-83	0	0.54	b					
C0097	2400	3380	8278	10-84	72	0.46	b		LDL	LDL	1	LDL
S0501	2425	3455	2994	10-83	0	2.91	b					
S0502	2425	3655	2993	10-83	0	2.32	b					
S0503	2425	3680	2992	10-83	0	0.13	b					
S0504	2500	3655	5884	07-84	0	0.18	b					
S0505	2525	3755	5887	07-84	0	0.87	b		LDL	LDL	0.9	LDL
S0506	2550	3480	5883	07-84	0	1.32	b					
S0507	2550	3730	5886	07-84	0	1.05	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)
S0508	2575	3430	5882	07-84	0	2.83[c]	b					
S0509	2575	3680	5885	07-84	0	2.24	b					
S0510	2625	3580	2990	10-83	0	0.13[c]	b	0.19				
S0511	2625	3730	2991	10-83	0	0.69	b	1.52				
S0512	2675	3380	2988	10-83	0	0.03	b					
S0457	2675	3405	2989	10-83	0	0.25[c]	b					
C0098	2470	3760	7755	10-84	90	0.16	b					
			7756	10-84	180	0.02	b					
S0513	2475	3860	5888	07-84	0	4.57	b					
S0514	2475	3960	5896	07-84	0	0.17	b					
S0515	2475	4060	5895	07-84	0	0.26	b					
S0516	2475	4135	5894	07-84	0	1.31	b					
S0517	2500	3910	5897	07-84	0	1.43	b					
S0518	2550	3910	5898	07-84	0	1.12	b					
S0519	2575	4010	2689	09-83	0	7.28[c]	b					
S0520	2625	3835	2688	09-83	0	0.03	b					
S0521	2625	4035	5893	07-84	0	1.71	b					
S0522	2625	4135	2690	09-83	0	0.05	b					
S0523	2650	4110	5892	07-84	0	1.09	b					
S0524	2675	3860	5889	07-84	0	0.88	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)
S0525	2675	4010	5891	07-84	0	0.59[c]	b					
S0526	2700	3860	2687	09-83	0	4.46	b					
S0527	2700	3935	5890	07-84	0	0.20	b					
S0528	1875	4165	7165	09-84	0	0.27	b					
S0529	1875	4190	7166	09-84	0	0.51	b					
S0530	1900	4225	10497	08-85	0	0.41	b					
S0531	1900	4265	2862	10-83	0	1.27	b					
S0532	1905	4215	10498	08-85	0	0.48	b					
S0533	1905	4220	10496	08-85	0	1.84	b					
S0534	1910	4225	10495	08-85	0	1.13	b					
S0535	1920	4230	10494	08-85	0	0.51	b					
S0536	1950	4290	7167	09-84	0	2.20	b					
S0537	1950	4315	2683	10-83	0	0.17	b					
C0099	1965	4265	10419	08-85	18	31.40	b					
			10420	08-85	36	14.70	b					
S0538	1975	4165	7165	09-84	0	5.94	b					
C0100	1975	4275	10421	08-85	18	32.40	b					
			10422	08-85	36	17.70	b					
			10423	08-85	54	12.40	b					
			10424	08-85	72	10.10	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)
C0101	1985	4285	10425	08-85	18	22.00	b					
			10426	08-85	36	0.90	b					
			10427	08-85	54	0.34	b					
			10428	08-85	72	0.71	b					
C0102	1995	4295	10429	08-85	18	10.40	b					
			10430	08-85	36	6.44	b					
			10431	08-85	54	2.16	b					
			10432	08-85	72	0.93	b					
S0539	2000	4340	7168	09-84	0	10.20	b					
S0540	2050	4165	2685	10-83	0	36.94	b					
C0103	2060	4300	1624	04-83	18	0.26[c]	3.95[c]					
			1625	04-83	36	0.50	b					
S0541	2075	4265	2688	10-83	0	0.64	b					
S0542	2075	4390	2684	10-83	0	0.83	b					
C0104	2085	4365	1622	04-83	18	50.60	b					
			1623	04-83	36	5.28	b					
C0105	2100	4140	7804	10-84	90	0.47	b					
			7805	10-84	180	0.01	b					
C0106	2105	4315	1626	04-83	18	0.41	b					
			1626	04-83	36	0.13	b					
(Both samples from this core location were assigned MRC ID 1626.)												
C0107	2170	4375	1620	04-83	18	0.69	b					
			1621	04-83	36	0.07[c]	2.56					
C0108	2200	4250	1632	04-83	18	0.25	b					
			1633	04-83	36	0.14	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)
S0543	2200	4265	6881	08-84	0	18.60	b					
C0109	2225	4325	1658	04-83	18	2.30	b					
			1659	04-83	36	0.66	b					
			1660	04-83	54	0.47	b					
C0110	2230	4390	1628	04-83	18	0.48	b					
			1629	04-83	36	0.14	b					
C0111	2250	4165	1636	04-83	18	0.82	b					
			1637	04-83	36	0.21	b					
C0112	2250	4300	1640	04-83	18	0.02	b					
			1641	04-83	36	0.03	b					
C0113	2275	4140	7759	09-84	90	2.83	b					
			7760	09-84	180	0.03	b					
C0114	2275	4200	1638	04-83	18	0.16[c]	b					
			1639	04-83	36	0.01	b					
C0115	2275	4395	1644	04-83	18	1.46	3.56					
			1646	04-83	36	0.31	b					
C0116	2305	4315	1642	04-83	18	0.05	b					
			1643	04-83	36	0.24	b					
S0544	2325	4465	6877	08-84	0	13.40	b					
S0545	2350	4415	6876	08-84	0	4.16	b					
S0546	2350	4465	6875	08-84	0	4.90	b					
S0547	2365	4375	10485	08-85	0	11.00	5.30					
S0548	2370	4380	10488	08-85	0	5.77	b					
S0549	2375	4165	6880	08-84	0	0.23	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)
S0550	2375	4290	6879	08-84	0	12.10	b					
S0551	2375	4390	6878	08-84	0	27.10	b					
S0552	2380	4370	10486	08-85	0	41.70	b					
S0553	2385	4375	10487	08-85	0	8.42	b					
S0554	2450	4165	2577	09-83	0	0.06[c]	b					
S0555	2525	4165	2578	09-83	0	7.46	b					
S0556	2550	4265	2576	09-83	0	6.65	b					
S0557	2575	4265	6465	08-84	0	0.41	b					
S0558	2600	4240	6464	08-84	0	1.66	b					
S0559	2600	4340	6457	08-84	0	0.58	b					
S0560	2600	4390	6456	08-84	0	34.20	b					
S0561	2625	4265	6458	08-84	0	0.25	b					
S0562	2625	4290	2575	09-83	0	0.14	b					
S0563	2650	4190	2574	09-83	0	8.56	b					
S0564	2650	4240	6459	08-84	0	0.30[c]	b					
S0565	2675	4190	6463	08-84	0	0.71	b					
S0566	2675	4240	6461	08-84	0	0.35	b		LDL	LDL	1.2	LDL
S0567	2675	4290	6462	08-84	0	0.06	b					
S0568	2700	4215	6460	08-84	0	0.26	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)
C0117	2400	4520	7750	09-84	90	4.98	b					
			7750	09-84	180	0.08	b					
(The same MRC ID was given for both depths)												
S0569	2475	4545	6470	08-84	0	0.36	b					
S0570	2475	4595	6469	08-84	0	2.77	b					
S0571	2525	4645	6468	08-84	0	0.11[c]	b					
S0572	2525	4570	6471	08-84	0	0.99	b					
S0573	2550	4620	6467	08-84	0	2.47	b					
S0574	2675	4745	6466	08-84	0	1.20	b					
S0575	2355	4525	4130	10-83	0	12.22	b	7.09				
S0576	2375	4545	6882	08-84	0	2.24	b					
S0577	2715	1765	2878	10-83	0	0.06	b					
S0578	2800	1830	2879	10-83	0	1.05[c]	b					
C0118	2725	2145	1314	12-82	18	11.30	b					
			1315	12-82	36	3.13	b					
C0119	2735	2210	1323	12-82	18	17.81	b					
			1324	12-82	36	1.78	b					
			1325	12-82	54	9.98[c]	b					
			1326	12-82	72	2.29	b					
			1327	12-82	90	17.90	b					
			1328	12-82	120	6.24	b					
S0579	2775	2135	6374	08-84	0	3.94	b		LDL	LDL	0.9	LDL
S0580	2775	2160	6373	08-984	0	2.08	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)
C0120	2805	2195	1329	12-82	18	83.70	b					
			1330	12-82	36	32.30	b					
			1331	12-82	54	0.18	b					
			1332	12-82	72	0.29	b					
			1333	12-82	90	83.00	b					
			1334	12-82	120	6.92	b					
			1335	12-82	144	0.56	b					
C0121	2810	2095	1309	12-82	18	5.08	b					
			1310	12-82	36	0.30	b					
S0581	2900	2010	6372	08-84	0	10.10	b					
S0582	2900	2085	2880	10-83	0	146.80	b					
C0122	2925	2010	1298	12-82	18	494.00	b					
			1299	12-82	36	0.68	b					
			1300	12-82	54	0.25	b					
			1301	12-82	72	0.39	b					
S0583	2950	2035	2881	10-83	0	7.96	b					
S0584	2950	2060	6371	08-84	0	18.80	b					
S0585	2975	2035	6370	08-84	0	5.18	b					
C0123	2975	2115	1364	12-82	18	2.91	b					
			1365	12-82	36	0.51	b					
			1366	12-82	54	0.23	b					
C0124	3000	1855	8508	12-84	60	0.12	b					
S0586	3025	1910	4011	10-83	0	4.07	b					
S0587	3050	2060	7124	09-84	0	13.40	b					
S0588	3075	2085	7125	09-84	0	1.23	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)
C0125	3085	2185	1358	12-82	18	0.43	b					
			1359	12-82	36	0.25	3.11					
			1360	12-82	54	33.60	b					
			1361	12-82	72	0.13[c]	3.25[c]					
			1362	12-82	90	1.97	b					
			1363	12-82	108	0.19	b					
S0589	3125	2135	4007	10-83	0	9.00[c]	b					
S0590	3175	2010	4010	10-83	0	1.05	b					
S0591	3225	2160	4008	10-83	0	6.12	b	0.15				
S0592	3275	2060	4009	10-83	0	4.72	b	0.33				
S0593	3275	2230	4012	10-83	0	1.07	b					
S0594	3320	2095	2928	10-83	0	6.55	2.70					
S0595	3335	2160	2932	10-83	0	0.14	b					
S0596	3350	2220	2933	10-83	0	0.02	b	1.63				
S0597	3385	2185	5813	07-84	0	3.67	b					
S0598	3400	2140	2929	10-83	0	5.30	4.30					
S0599	3425	2220	5814	07-84	0	1.45	b					
S0600	3460	2210	2930	10-83	0	4.06	2.27	0.69				
S0601	3555	2220	2931	10-83	0	0.42[c]	2.48[c]	0.58				
C0126	2725	2265	1319	12-82	18	5.57	b					
			1320	12-82	36	79.00[c]	b					
			1321	12-82	54	6.51	b					
			1322	12-82	72	0.37	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)
C0127	2725	2340	1212	12-82	18	1.57	b					
			1213	12-82	36	1.40	b					
			1214	12-82	54	0.15	b					
			1215	12-82	72	0.54	b					
			1216	12-82	90	0.06[c]	b					
			1217	12-82	120	0.11	b					
S0602	2725	2565	4112	10-83	0	5.13	b					
C0128	2750	2365	1207	12-82	18	7.97	b					
			1208	12-82	36	6.15	b					
			1209	12-82	54	10.20	b					
			1210	12-82	72	0.94	b					
			1211	12-82	84	0.23	b					
S0603	2750	2415	6784	08-84	0	0.69	b					
C0129	2715	2290	1218	12-82	18	3.70	b					
			1219	12-82	36	0.41	b					
			1220	12-82	54	0.92	b					
			1221	12-82	72	0.85	b					
			1222	12-82	90	0.05	b					
			1223	12-82	108	0.04	b					
S0604	2750	2465	1319	08-84	0	11.80	b					
S0605	2780	2340	9549	06-85	0	NR	NR		LDL	LDL	0.7	LDL
C0130	2800	2265	1336	12-82	18	48.10	b					
			1337	12-82	36	1.41	b					
			1338	12-82	54	1.25[c]	9.99[c]					
			1339	12-82	90	0.39	b					
			1340	12-82	108	0.37	b					
C0131	2800	2500	1198	12-82	18	82.60	76.90					
			1199	12-82	36	NR	174.80					
			1200	12-82	54	313.00	189.90					

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)
			1201	12-82	72	68.10	37.90					
			1202	12-82	90	0.03	b					
			1203	12-82	108	0.03	b					
			1204	12-82	144	0.03	b					
			1205	12-82	192	0.09	6.72					
			1206	12-82	222	0.14	b					
S0606	2800	2440	9551	06-85	0	NR	NR		LDL	LDL	0.8	LDL
C0132	2825	2465	6785	08-84	0	12.10[c]	4.24[c]		LDL	LDL	1.1	LDL
			1185	12-82	18	11.13	b					
			1186	12-82	36	0.57	b					
			1187	12-82	72	0.58	b					
			1188	12-82	90	0.13	b					
C0134	2850	2465	1533	04-83	18	7.26	b					
			1534	04-83	36	3.39	b					
			1535	04-83	54	0.15	b					
			1536	04-83	72	NR	157.00					
			1538	04-83	108	3.99	2.93					
			1539	04-83	126	24.00[c]	b					
			1540	04-83	135	29.40	b					
C0135	2850	2490	1541	04-83	18	17.10[c]	b					
			1542	04-83	36	0.96	b					
			1543	04-83	54	0.73	b					
			1544	04-83	72	0.19	b					
			1545	04-83	90	0.25[c]	b					
			1546	04-83	108	0.28	b					
			1547	04-83	126	0.15	b					
			1548	04-83	144	0.41	b					
			1549	04-83	153	0.08	b					
C0136	2850	2515	1511	04-83	18	32.90[c]	b					
			1512	04-83	36	12.30	b					
			1513	04-83	54	1.95	b					
			1514	04-83	72	8.88	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)
			1515	04-83	90	4.50	b					
			1517	04-83	108	3.37	b					
			1518	04-83	126	7.72	b					
			1519	04-83	144	1.74	b					
			1520	04-83	162	0.55	b					
			1521	04-83	180	5.66[c]	2.16[c]					
S0607	2850	2450	6789	08-84	0	1.19	b					
C0137	2875	2290	1285	12-82	18	4.78[c]	2.38[c]					
			1286	12-82	36	1.24	2.90					
C0138	2875	2340	1353	12-82	18	870.60	b					
			1354	12-82	36	9.17	b					
			1355	12-82	54	549.40	b					
C0139	2875	2390	1555	04-83	18	2.71	3.38					
			1556	04-83	36	0.53	2.94					
			1557	04-83	54	0.41	b					
			1558	04-83	72	0.24	3.13					
			1559	04-83	90	0.03	b					
			1560	04-83	108	0.48	b					
C0140	2875	2450	1522	04-83	18	0.67	b					
			1523	04-83	36	0.17	b					
			1524	04-83	54	0.11	b					
			1525	04-83	72	0.64	b					
			1526	04-83	90	0.39	b					
			1527	04-83	108	0.48	b					
			1528	04-83	126	0.50	b					
			1529	04-83	162	0.15	b					
			1530	04-83	198	0.41	b					
			1531	04-83	216	0.05	b					
			1532	04-83	234	0.04	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)
C0141	2880	2400	1550	04-83	18	5.96[c]	5.65[c]					
			1551	04-83	36	2.28	b					
			1552	04-83	54	0.55	2.64					
			1553	04-83	72	1.70	b					
			1554	04-83	90	0.44	b					
C0142	2900	2390	1356	12-82	18	76.10[c]	2.12[c]					
			1357	12-82	36	1.03	b					
C0143	2900	2415	1180	12-82	18	0.48	b					
			1181	12-82	36	0.51	b					
			1182	12-82	54	0.77	b					
			1183	12-82	72	0.14	b					
			1184	12-82	90	0.02[c]	b					
C0144	2900	2500	1189	12-82	18	7.41	b					
			1190	12-82	36	164.80	25.70					
			1191	12-82	54	5.30	18.30					
			1192	12-82	72	1.30	b					
			1193	12-82	90	0.23	b					
			1194	12-82	108	0.07	b					
			1195	12-82	126	0.02	b					
			1196	12-82	144	0.04	b					
			1197	12-82	162	0.02	b					
S0608	2925	2540	6786	08-84	0	0.99	b					
C0145	2885.7	2498.9	None[d]	02-84	0	NR	1.4					
			None[d]	02-84	0	NR	1.4					
			None[d]	02-84	24	NR	22.00					
			None[d]	02-84	36	NR	22.00					
			None[d]	02-84	48	NR	9.40					
			None[d]	02-84	60	NR	14.00					
			None[d]	02-84	72	NR	12.00					
C0146	2975	2465	1170	12-82	18	0.35	b					
			1171	12-82	36	0.98	b					
			1172	12-82	54	0.12[c]	b					
			1173	12-82	72	0.36	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)
			1174	12-82	90	0.18	b					
			1175	12-82	108	0.21	b					
			1176	12-82	126	0.03	b					
			1177	12-82	144	0.05	b					
			1178	12-82	162	0.01	b					
			1179	12-82	180	0.03	b					
C0147	2700	2620	8270	10-83	72	0.10	b					
			8271	10-83	162	0.01	b					
S0609	2750	2845	4115	10-83	0	0.14	b					
S0610	2800	2645	8656	12-84	0	6.09	b					
S0611	2800	2745	8658	12-84	0	0.65	b					
S0612	2800	2920	8664	12-84	0	0.28	b					
S0613	2825	2870	8655	12-84	0	2.97	b					
S0614	2825	2945	8663	12-84	0	1.10	b					
S0615	2875	2670	8657	12-84	0	1.85	b					
S0616	2875	2845	8661	12-84	0	1.69	b					
S0617	2875	2720	8659	12-84	0	0.68	b					
S0618	2875	2945	4116	10-83	0	6.42	b					
S0619	2925	2820	8660	12-84	0	0.15	b					
S0620	2925	2945	8663	12-84	0	1.10	b					
S0621	2950	2645	4113	10-83	0	3.35	b					
S0622	3025	2590	4126	10-83	0	17.40	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)
C0148	3040	2590	10471	08-85	18	0.72	b					
			10472	08-85	36	0.87	b					
			10473	08-85	54	1.29	b					
			10474	08-85	72	4.94	b					
C0149	3040	2610	10475	08-85	18	0.38	b					
			10476	08-85	36	0.45	b					
			10477	08-85	54	5.40	b					
			10478	08-85	72	4.80	b					
S0623	3050	2515	6556	08-84	0	0.35	b					
C0150	3055	2590	10479	08-85	18	3.94	b					
			10480	08-85	36	1.55	b		3	LDL	0.2	LDL
			10481	08-85	54	3.94	b					
C0151	3055	2610	10482	08-85	18	3.58	b					
			10483	08-85	36	10.30	b					
			10484	08-85	54	7.88	b					
C0152	3065	2565	1561	04-83	18	2.60	2.80					
			1562	04-83	36	0.46	b					
			1563	04-83	90	1.89	b					
			1564	04-83	108	1.12	b					
			1565	04-83	126	1.29[c]	b					
			1566	04-83	144	0.06	b					
			1567	04-83	162	0.08	b					
			1568	04-83	180	0.07	b					
			1569	04-83	198	0.27	b					
			1570	04-83	216	0.60	b					
			1571	04-83	234	5.22	b					
C0153	3070	2610	10505	08-85	18	0.86	b					
			10506	08-85	36	1.14	b					
			10507	08-85	54	1.16	b					
			10508	08-85	72	0.89	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)
C0154	3080	2610	10509	08-85	18	0.56	b					
			10510	08-85	36	0.14	b					
			10511	08-85	54	0.89	b					
C0155	3090	2600	10512	08-85	18	0.27	b					
			10513	08-85	36	2.24	b					
			10514	08-85	54	11.40	b					
C0156	3075	2600	1572	04-83	18	71.30[c]	2.03[c]					
			1573	04-83	36	NR	4.30					
			1574	04-83	54	6.59	b					
			1575	04-83	72	6.45	b					
			1576	04-83	90	4.81	2.02					
			1577	04-83	108	40.90	2.33					
			1578	04-83	126	1.08	b					
			1579	04-83	144	5.22	b					
			1580	04-83	162	3.42	b					
			1581	04-83	180	8.67	b					
			1582	04-83	198	0.72	b					
			1583	04-83	216	4.10	b					
			1584	04-83	234	9.93	3.02					
	3075	2600	10515	08-85	18	0.83	b					
(Two sets of results were given for the 18 inch depth at these coordinates. However, the dates are different: 04-83 and 08-85.)												
C0157	3125	2590	1585	04-83	18	2.90	b					
			1586	04-83	36	1.64	b					
			1587	04-83	54	4.63	b					
			1588	04-83	72	1.46	b					
			1589	04-83	90	2.20	b					
			1590	04-83	108	0.83	b					
			1591	04-83	126	0.39	b					
			1592	04-83	144	0.67[c]	2.26[c]					
			1593	04-83	162	0.37	b					
			1594	04-83	180	0.21	b					
S0625	3150	2590	6555	08-84	0	2.99	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)
S0626	3200	2375	2393	08-83	0	NR	NR		LDL	LDL	1.1	LDL
S0627	3225	2365	4122	10-83	0	1.64	b					
S0628	3225	2575	4124	10-83	0	1.14	b		LDL	0.5	1.2	LDL
S0629	3275	2265	4121	10-83	0	0.42	b					
S0630	3275	2415	6557	08-84	0	2.29	b					
S0631	3275	2490	4123	10-83	0	3.15[c]	b					
S0632	3275	2565	4125	10-83	0	2.18	b					
C0158	3000	2620	8285	10-84	36	1.95	b					
			8286	10-84	72	25.00[c]	b					
S0633	3025	2645	2923	10-83	0	47.45[c]	b	6.84				
S0634	3050	2845	8667	12-84	0	0.31	b					
S0635	3075	2870	8669	12-84	0	0.34	b					
C0159	3100	2620	8283	10-84	108	18.90	b					
			8284	10-84	198	6.91	b					
S0636	3100	2820	8666	12-84	0	1.84	b					
S0637	3125	2670	6791	08-84	0	1.45	b					
S0638	3125	2720	6792	08-84	0	0.28	b					
S0639	3125	2820	2924	10-83	0	3.00	b	3.09				
C0160	3180	2745	2441	08-83	18	0.80	b					
			2442	08-83	36	2.60	b		LDL	LDL	0.90	LDL
			2443	08-83	108	0.53	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)
			2444	08-83	126	0.62	b					
			2446	08-83	162	0.66[c]	30.42[c]		LDL	LDL	1	LDL
			2447	08-83	180	3.09	14.58		LDL	LDL	0.9	LDL
			2448	08-83	198	2.60	10.32		LDL	LDL	0.7	LDL
			2449	08-83	216	2.42	b					
			2450	08-83	234	1.70	5.07					
S0640	3225	2895	2925	10-83	0	1.56	b	1.53				
S0641	3250	2770	2926	10-83	0	0.12	b	2.17				
S0642	3240	2795	6793	08-84	0	0.44	b					
S0643	3275	2645	2927	10-83	0	0.82	b					
S0644	3275	2970	6558	08-84	0	NR	NR		LDL[e]	29[e]	1.2[e]	LDL[e]
S0645	3290	2990	9789	06-85	0	NR	NR			28[e]		
S0646	3290	2995	9788	06-85	0	NR	NR			0.5[e]		
C0161	3300	2240	8266	10-84	72	0.04	b					
			8267	10-84	108	0.01	b					
S0647	3340	2610	2778	10-83	0	NR	NR		LDL	270	1.3	LDL
(A hand-written note was included below this sample result stating that this sample was not included in the original Site Survey Project report because the location was cleaned up immediately.												
S0648	3350	2340	5818	07-84	0	0.32	b					
S0649	3350	2390	2833	10-83	0	1.11	2.08					
S0650	2400	2565	2832	10-83	0	1.29	b					
S0651	3450	2290	5817	07-84	0	1.48	b					
S0652	3550	2265	2829	10-83	0	8.56[c]	2.37[c]	4.02				

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)
			2461	08-83	162	0.08	b					
			2462	08-83	180	0.04	b					
			2463	08-83	198	0.06	b					
			2464	08-83	216	0.01	b					
			2465	08-83	234	0.02	b					
S0657	3400	2720	5835	07-84	0	0.35	b					
S0658	3400	2870	2835	10-83	0	0.70	b					
S0659	3450	2945	5836	07-84	0	0.39	b					
C0167	3450	2770	2466	08-83	54	0.92[c]	b					
			2467	08-83	72	0.40	b					
			2468	08-83	90	0.04	b					
C0168	3475	2670	2469	08-83	18	0.54[c]	7.11[c]					
			2470	08-83	36	0.06	b					
			2471	08-83	72	0.02	b					
			2472	08-83	78	0.02	b					
S0660	2475	2870	5833	07-84	0	0.36	b					
S0661	3500	2745	5834	07-84	0	0.21	b		LDL	LDL	0.8	LDL
S0662	3500	2870	2838	10-83	0	0.17	b		LDL	LDL	0.8	LDL
S0663	3500	2945	5832	07-84	0	0.37[c]	b					
S0664	3525	2670	5829	07-84	0	1.73	b					
S0665	3525	2770	2836	10-83	0	1.72[c]	b					
S0666	3575	2670	5828	07-84	0	0.95	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)
C0169	3575	2720	2473	08-83	18	0.07	b					
			2474	08-83	36	0.03	b					
			2475	08-83	54	0.21	b					
S0667	3575	2770	5830	07-84	0	0.38	b					
S0668	3575	2870	5831	07-84	0	0.02	b					
			2837	10-83	0	0.02	b					
C0170	2700	3000	8264	10-84	72	0.24	b					
			8264	10-84	162	0.03	b					
(The same MRC ID was given for both depths.)												
S0670	2705	3175	4029	10-83	0	0.34	b					
S0671	2725	3075	4118	10-83	0	5.74	b					
S0672	2725	3300	4027	10-83	0	0.43	b					
S0673	2775	3275	4043	10-83	0	0.08	b	0.15				
S0674	2775	3375	4028	10-83	0	0.54	b					
S0675	2800	3100	7196	09-84	0	0.28	b					
S0676	2825	3150	7193	09-84	0	0.09	b					
S0677	2850	3075	7197	09-84	0	0.11	b					
S0678	2850	3151	4030	10-83	0	0.21	b	0.98				
S0679	2875	3175	7194	09-83	0	0.05	b					
S0680	2900	3275	7195	09-84	0	0.34	b					
S0681	2925	3250	4031	10-83	0	0.28	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)
S0653	3550	2390	2830	10-83	0	0.70	2.43					
S0654	3575	2290	5815	07-84	0	1.51	b					
S0655	3575	2565	2828	10-83	0	1.01	2.28	1.08				
	3575	2565	2827	10-83	0	1.41	2.74	1.23				
(Two sets of results were given for coordinates 3575 south/2565 west.)												
C0162	3300	2620	8281	10-84	72	0.72	b					
			8282	10-84	144	0.07	b					
C0163	3325	2645	2451	08-83	18	0.18	b					
			2452	08-83	36	0.48	b		LDL	LDL	0.9	LDL
			2453	08-83	54	0.05	b					
			2454	08-83	72	0.23	b					
			2455	08-83	78	0.06	b					
C0164	3325	2720	2434	08-83	18	0.13	b					
			2435	08-83	36	0.31	b					
			2436	08-83	54	0.05	b					
			2437	08-83	72	0.45	b					
			2438	08-83	90	0.08	b					
			2439	08-83	126	0.02	b					
			2440	08-83	144	0.06	b					
C0165	3325	2980	10440	08-85	18	NR	NR		LDL	3.0	0.9	LDL
			10441	08-85	36	NR	NR		LDL	LDL	1	LDL
			10442	08-85	54	NR	NR		LDL	2.5	1	LDL
			10443	08-85	60	NR	NR		LDL	31	0.7	LDL
S0656	3375	2695	2834	10-83	0	4.31	b					
C0166	3375	2795	2456	08-83	18	0.07	b					
			2457	08-83	90	0.05	b					
			2458	08-83	108	0.30	b					
			2459	08-83	126	0.42	b					
			2460	08-83	144	0.07[c]	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)
S0682	2950	3075	7198	09-84	0	0.07	b		LDL	LDL	1.1	LDL
S0683	2725	3405	4036	10-83	0	0.30	b					
S0684	2725	3455	7115	09-84	0	0.04	b					
S0685	2725	3505	4035	10-83	0	0.60	b					
S0686	2750	2580	7116	09-84	0	0.06	b					
S0689	2775	2580	7118	09-84	0	0.25	b					
S0688	2775	3655	4034	10-83	0	0.40	b					
S0689	2800	3530	7119	09-84	0	0.21	b					
S0690	2800	3605	7117	09-84	0	0.73	b					
S0691	2825	3705	7122	09-84	0	1.03	b					
S0692	2825	3710	7123	09-84	0	2.51	b		LDL	1.3	0.9	LDL
S0693	2850	3430	4037	10-83	0	0.96[c]	b	0.40				
S0694	2875	3755	4033	10-83	0	0.40	b	0.38				
S0695	2925	3505	7120	09-84	0	0.11	b					
S0696	2925	3580	7121	09-84	0	0.78	b					
S0697	2950	3420	4038	10-83	0	0.10	b	0.15				
S0698	2950	3580	4119	10-83	0	0.28	b					
S0699	3250	4390	5980	07-84	0	0.22	b					
S0700	3250	4440	5909	07-84	0	0.48[c]	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)
S0701	3275	4165	2937	10-83	0	0.37	b					
S0702	3295	4415	2934	10-83	0	0.16	b					
S0703	3325	3785	5851	07-84	0	0.51	b					
S0704	3325	3835	4019	10-83	0	0.11	b					
S0705	3325	3875	5852	07-84	0	0.24	b					
S0706	3325	4035	4021	07-84	0	28.90	b					
S0707	3325	4135	5853	07-84	0	0.37	b					
S0708	3375	3785	5850	07-84	0	0.05	b					
S0709	3425	4010	5855	07-84	0	7.67	b					
S0710	3425	4135	5854	07-84	0	0.30	b					
S0711	3450	3960	4018	10-83	0	1.88	b					
S0712	3475	4085	5856	07-84	0	7.84[c]	25.25[c]					
S0713	3500	3785	5849	07-84	0	0.23	b					
S0714	3525	3985	5857	07-84	0	3.01	b					
S0715	3525	3835	4017	10-83	0	0.45	b					
S0716	3545	4040	10466	08-85	0	3.06	b					
S0717	3550	4030	10465	08-85	0	12.05	b					
S0718	3550	4035	4020	10-83	0	0.28	b					
S0719	3555	4020	10464	08-85	0	17.10	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)
S0720	3560	4015	10463	08-85	0	25.00	b					
S0721	3565	4010	10462	08-85	0	20.40	b					
S0722	3570	4000	10461	08-85	0	28.30	10.20					
S0723	3575	3785	5848	07-84	0	0.24	b					
S0724	3575	3860	5858	07-84	0	88.40[c]	4.03[c]					
S0725	3575	3990	10460	08-85	0	119.00	8.50					
S0726	3580	3980	10459	08-85	0	163.00	32.60					
S0727	3583	3975	10458	08-85	0	36.80	6.10					
S0728	3585	3970	10457	08-85	0	116.00	20.40					
S0729	3590	3960	10456	08-85	0	45.90	b					
S0730	3595	3950	10455	08-85	0	15.50	b					
C0171	3000	3000	8276	10-84	42	0.10	b					
			8277	10-84	102	0.02	b					
S0731	3075	3375	7328	09-84	0	0.34	b					
C0172	3100	3000	8288	10-84	72	0.04	b					
			8289	10-84	120	0.15	b					
S0732	3100	3075	7330	09-84	0	0.47	b					
S0733	3100	3150	2996	10-83	0	0.29	b					
S0734	3100	3325	2995	10-83	0	0.35	b	0.34				
S0735	3125	3250	7329	09-84	0	0.73	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)
S0736	3175	3250	7332	09-84	0	0.79	b					
S0737	3200	3075	7331	09-84	0	1.04	b					
S0738	3200	3275	7333	09-84	0	0.15	b					
C0173	3250	3000	10436	06-85	18	NR	NR		LDL	6.7	0.6	LDL
			10437	06-85	36	NR	NR		LDL	5.6	0.6	LDL
			10438	06-85	54	NR	NR		LDL	1.9	0.9	LDL
			10439	06-85	60	NR	NR		LDL	9.7	0.9	LDL
S0739	3250	3025	7335	09-84	0	0.75	b					
S0740	3250	3100	2997	10-83	0	0.54	b	0.77	LDL	29	1.2	LDL
S0741	3250	3225	7338	09-84	0	0.64	b					
S0742	3275	3050	2998	10-83	0	0.18	b	0.67				
			7337	09-84	0	0.37	b					
S0743	3275	3075	7334	09-84	0	0.33	b					
S0744	3275	3225	7336	09-84	0	0.36	b					
S0745	3285	3010	2999	10-83	0	1.12[c]	b	0.64				
S0746	3295	3005	9790	06-85	0	NR	NR			0.5[e]		
S0747	3295	3010	9794	06-85	0	NR	NR			5.0[e]		
S0748	3295	3300	4127	10-84	0	12.10	b					
C0174	3000	3380	8274	10-84	72	0.03	b					
			8275	10-84	138	0.01	b		LDL	LDL	0.8	LDL
C0175	3000	3640	8518	12-84	90	0.03	b					
			8519	12-84	180	0.01	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)
S0764	3325	3350	2884	10-83	0	0.32	b					
S0765	3350	3225	7339	09-84	0	0.55	b					
S0766	3350	3350	7340	09-84	0	1.13	b					
S0767	3400	3075	7344	09-84	0	0.43	b					
S0768	3400	3225	2888	10-83	0	0.61	b					
S0769	3400	3300	7347	09-84	0	0.61	b					
S0770	3425	3025	7346	09-84	0	0.54	b					
S0771	3425	3075	7342	09-84	0	0.45	b					
S0772	3475	3050	7343	09-84	0	0.23	b					
S0773	3500	3200	2887	10-83	0	1.67[c]	b	0.15				
S0774	3550	3075	2886	10-83	0	0.54	b					
S0775	3575	3350	2883	10-83	0	1.61	b	0.99				
C0178	3300	3380	8262	10-84	72	0.15	b					
			8263	10-84	162	0.01	b					
S0776	3325	3405	4148	11-83	0	0.53	b					
S0777	3325	3430	7203	09-84	0	1.66	3.71					
S0778	3325	3555	4144	11-83	0	0.14	b					
S0779	3325	3580	4147	11-83	0	0.16	b					
S0780	3325	3650	4145	11-83	0	0.31	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)
S0796	2850	4110	7176	09-84	0	0.34	b					
S0797	2875	3810	7170	09-84	0	0.18	b					
S0798	2875	4135	7177	09-84	0	0.16	b					
S0799	2900	3960	7172	09-84	0	0.15	b					
S0800	2900	3810	7171	09-84	0	0.17	b		LDL	1.30	1.1	LDL
S0801	2900	4135	4042	10-83	0	2.74[c]	b					
S0802	2925	3985	7173	09-84	0	0.24	2.88					
S0803	2925	4080	7174	09-84	0	0.23	2.59					
S0804	2950	3810	4044	10-83	0	0.39	b					
S0805	2950	4085	4043	10-83	0	0.96	b					
S0806	2950	4135	7171	09-84	0	0.18	b					
C0181	2700	4140	7746	09-84	90	0.01	b					
			7747	09-84	180	0.02	b					
S0807	2705	4190	2588	09-83	0	0.27	b					
S0808	2705	4290	2587	09-83	0	0.10[c]	b					
S0809	2800	4165	2586	09-83	0	0.05	b					
S0810	2825	4190	6474	08-84	0	0.38[c]	b					
S0811	2825	4265	6473	08-84	0	0.13	b					
S0812	2825	4365	6472	08-84	0	0.10	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)
S0781	3350	3755	7236	09-84	0	0.50	b		LDL	LDL	1.3	LDL
S0782	3375	3480	7233	09-84	0	1.45	b					
S0783	3400	3580	7202	09-84	0	0.81	b					
S0784	3400	3730	7201	09-84	0	0.23	b					
S0785	3475	3480	7235	09-84	0	1.23	b					
S0786	3475	3655	7237	09-84	0	0.08	b					
S0787	3550	3400	9807	06-85	0	NR	NR		143	7.0	0.4	LDL
S0788	3550	3480	7234	09-84	0	234.00	b					
S0789	3550	3730	7200	09-84	0	0.25	b					
S0790	3560	3390	9810	06-85	0	NR	NR		54	LDL	0.7	LDL
S0791	3575	3555	4146	11-83	0	0.40[c]	b	0.49				
C0179	3580	3480	1289	12-82	18	1103.00	b					
			1290	12-82	36	39.00	b					
C0180	2700	3760	7757	09-84	48	0.03	b					
			7758	09-84	108	0.10	b					
			8425	09-84	144	0.07	b					
S0792	2750	3860	4039	10-83	0	1.50	b	0.64				
S0793	2750	4010	4040	10-83	0	18.40	b					
S0794	2800	4085	4041	10-83	0	0.50	b					
S0795	2825	3910	4120	10-83	0	0.97	b	0.55				

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)
S0749	3075	3480	3000	10-83	0	0.85	b	5.27				
S0750	3075	3530	3003	10-83	0	0.33	b	0.97				
S0751	3075	3605	3001	10-83	0	0.81	b					
S0752	3100	3655	7357	09-84	0	0.52	b					
S0753	3150	3455	7355	09-84	0	0.14	b					
S0754	3150	3580	7356	09-84	0	0.42	b					
S0755	3150	3655	3004	10-83	0	0.73	b	0.44	LDL	1.6	1	LDL
S0756	3150	3705	7358	09-84	0	0.21	b					
S0757	3175	3480	7352	09-84	0	0.44	b					
S0758	3200	3505	3002	10-83	0	0.62[c]	b	0.52				
S0759	3200	3630	7353	09-84	0	0.64	b		LDL	0.9	1.2	LDL
S0760	3200	3720	7354	09-84	0	0.05	b					
S0761	3225	3430	7351	09-84	0	0.95	b					
S0762	3275	3655	7349	09-84	0	0.65	b					
C0176	3310	3010	10433	08-85	18	NR	NR		LDL	2.2	0.8	LDL
			10434	08-85	36	NR	NR		LDL	3.1	0.7	LDL
			10435	08-85	54	NR	NR		LDL	1.2	0.7	LDL
C0177	3310	3090	10444	08-85	18	NR	NR		LDL	2.3	0.9	LDL
			10445	08-85	36	NR	NR		LDL	5.3	0.9	LDL
			10446	08-85	54	NR	NR		LDL	4.5	0.9	LDL
S0763	3325	3075	2885	10-83	0	0.79	b	0.152				

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)
S0813	2875	4215	6475	08-84	0	0.17	b					
S0814	2875	4290	6476	08-84	0	0.08	b					
S0815	2875	4365	6477	08-84	0	0.07	b					
S0816	2875	4390	2584	09-83	0	0.20	b					
S0817	2975	4240	6480	08-84	0	0.09	b					
S0818	2975	4265	6481	08-84	0	0.04	b					
S0819	2975	4315	6479	08-84	0	0.07	b					
S0820	2975	4390	6478	08-84	0	0.13	b					
S0821	2975	4415	2585	09-83	0	0.40	b					
S0822	3005	3985	5938	07-84	0	0.30	b					
S0823	3005	4035	5937	07-84	0	0.07	b					
S0824	3025	4085	5935	07-84	0	0.03	b					
S0825	3125	4135	4129	10-83	0	0.11	b	0.15				
S0826	3050	4010	4128	10-83	0	0.17	b					
S0827	3050	4135	5933	07-84	0	0.07[c]	b					
S0828	3075	4085	5936	07-84	0	0.09	b					
S0829	3100	4135	5932	07-84	0	0.04	b					
S0830	3125	3810	4143	11-83	0	0.91	b					
S0831	3125	4060	5934	07-84	0	0.04	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)
S0832	3225	3935	4141	11-83	0	2.48[c]	b					
S0833	3225	4135	4139	11-83	0	0.24	b					
S0834	3250	4110	4140	11-83	0	0.36	b	0.28				
S0835	3275	3810	4142	11-83	0	0.91	b	0.26				
C0182	3000	4140	7748	09-84	90	0.04	b					
			7749	09-84	150	0.21	b					
S0836	3025	4265	5905	07-84	0	0.09	b					
S0837	3050	4340	5906	07-84	0	0.08	b		LDL	LDL	1.1	LDL
S0838	3100	4265	5904	07-84	0	0.18	b					
S0839	3100	4440	5907	07-84	0	0.12	b					
S0840	3125	4315	5899	07-84	0	0.14	b					
S0841	3175	4215	2936	10-83	0	0.04[c]	b					
S0842	3200	4340	5900	07-84	0	0.12	b					
S0843	3225	4190	5903	07-84	0	0.08	b					
S0844	3250	4240	5902	07-84	0	0.13	b					
S0845	3250	4315	5901	07-84	0	0.30	b					
C0183	3300	4140	7808	10-84	90	0.02	b					
			7809	10-84	180	0.05	b					
S0846	3305	4290	5860	07-84	0	0.27	b					
S0847	3325	4165	5910	07-84	0	1.21	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)
S0848	3325	4290	5861	07-84	0	0.70	b					
S0849	3325	4215	4024	10-83	0	0.44	b	12.59				
S0850	3325	4340	5859	07-84	0	0.43	b					
S0851	3350	4365	4026	10-83	0	1.82	b					
S0852	3375	4165	4023	10-83	0	0.42	b					
S0853	3375	4240	5862	07-84	0	97.50[c]	13.69[c]					
S0854	3375	4315	4025	10-83	0	4.32[c]	b					
S0855	3425	4140	5863	07-84	0	1.29	b					
S0856	3475	4165	4022	10-83	0	1.10	b					
C0262	2700	4750	7754	09-84	90	1.08	b					
S0858	2750	4520	2590	09-83	0	0.61	b					
S0859	2800	4495	6483	08-84	0	0.30	b					
S0860	2825	4445	6484	08-84	0	0.70	b					
S0861	2850	4420	6485	08-84	0	0.56	b					
S0862	2850	4620	6492	08-84	0	0.08	b					
S0863	2875	4375	6486	08-84	0	0.06	b					
S0864	2875	4595	6490	08-84	0	0.50	b					
C0184	2875	4795	1648	04-83	18	2.25[c]	b					
			1649	04-83	36	0.45	b					
			1650	04-83	54	0.87	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)
			1651	04-83	72	0.34	b					
			1652	04-83	90	0.62	b					
			1653	04-83	108	0.44	b					
			1654	04-83	126	0.07	b					
			1655	04-83	144	0.07	b					
			1656	04-83	162	0.05	b					
			1657	04-83	180	0.05	b					
S0865	2900	4445	6488	08-84	0	0.02[c]	b					
S0866	2900	4495	6487	08-84	0	0.20	b					
S0867	2900	4545	2589	09-83	0	0.28	b					
S0868	2925	4395	6489	08-84	0	0.37	b					
S0869	2925	4620	2591	09-83	0	0.02[c]	b					
S0870	2950	4620	2592	09-83	0	0.87	b					
C0185	2960	4605	10058	07-85	0	0.55	b					
			10059	07-85	18	0.16	b					
			10060	07-85	36	0.12	b					
			10061	07-85	54	0.23	b					
			10062	07-85	72	0.37	b					
			10063	07-85	90	0.42	b					
			10064	07-85	108	0.31	b					
			10065	07-85	126	0.29	b					
			10066	07-85	144	1.04	b					
			10067	07-85	162	1.76	b					
			10068	07-85	180	1.74	b					
			10069	07-85	198	0.47	b					
			10070	07-85	216	0.76	b					
			10071	07-85	234	0.49	b					
S0872	2975	4645	6491	08-84	0	0.12	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)
C0186	2975	4845	1658	04-83	18	2.30	b					
			1659	04-83	36	0.66	b					
			1660	04-83	54	0.47	b					
			1661	04-83	72	0.16	b					
			1662	04-83	90	0.06	b					
			1663	04-83	108	0.18[c]	b					
			1664	04-83	126	0.52	b					
			1665	04-83	144	0.31[c]	b					
			1666	04-83	162	0.05	b					
			1667	04-83	180	0.01	b					
S0873	2990	4620	2593	08-84	0	0.30	b					
C0187	2995	4630	10072	07-85	18	0.10	b					
			10073	07-85	36	0.02	b					
			10074	07-85	54	0.02	b					
			10075	07-85	72	0.21	b					
			10076	07-85	90	0.55	b					
			10077	07-85	108	0.51	b					
			10078	07-85	126	3.71	b					
			1007	07-85	144	0.60	b					
			100	07-85	162	0.22	b					
			100	07-85	180	0.22	b					
			1008	07-85	198	0.23	b					
			1008	07-85	216	0.80	b					
			1008	07-85	234	0.12	b					
(The MRC IDs for the last 6 samples of this core were not legible in the data received. The sequence is probably 10079 through 10084.)												
C0188	3000	4520	7806	10-84	90	0.01	b					
			7807	10-84	180	0.01	b					
S0874	3025	4575	2603	10-83	0	0.24	b					
S0875	3025	4820	6385	08-84	0	6.77	b					
S0876	3030	4780	6386	08-84	0	0.21	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)
S0877	3035	4640	6388	08-84	0	0.52	b					
S0878	3035	4705	6387	08-84	0	0.98	b					
C0189	3050	4780	1541	04-83	18	17.10	b					
			1542	04-83	36	1.79	b					
			1543	04-83	54	0.96	b					
			1544	04-83	72	0.73	b					
			1545	04-83	90	0.19	b					
			1546	04-83	108	0.25	b					
			1547	04-83	126	0.28	b					
			1548	04-83	144	0.15	b					
			1549	04-83	162	0.08	b					
C0190	3050	4860	1974	05-83	18	1.36	b					
			1975	05-83	36	0.07	b					
S0879	3060	4795	2599	10-83	0	0.84	b					
S0880	3075	4845	6384	08-84	0	4.68[c]	b		LDL	LDL	0.9	LDL
S0881	3095	4830	7835	10-84	0	5.59	b		LDL	LDL	0.9	LDL
C0191	3100	4675	1691	04-83	18	0.08	b					
			1692	04-83	36	0.12	b					
			1693	04-83	54	0.16	b					
			1694	04-83	72	0.02	b					
			1695	04-83	90	0.01	b					
			1696	04-83	108	0.01[c]	3.31					
			1697	04-83	126	0.01	b					
			1698	04-83	144	0.01	b					
			1699	04-83	162	0.01[c]	b					
			1700	04-83	180	0.39	b					
S0882	3100	4720	2600	10-83	0	0.73[c]	b					
S0883	3125	4740	7836	10-84	0	1.22	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)
S0884	3135	4580	6389	08-84	0	2.93	b					
S0885	3160	4770	7843	10-84	0	0.01	b					
S0886	3175	4605	2601	10-83	0	0.55	b	1.90				
S0887	3175	4675	7837	10-84	0	0.08	b					
S0888	3180	4840	7844	10-84	0	0.15	b					
S0889	3200	4695	7842	10-84	0	0.01	b					
S0890	3210	4530	2602	10-83	0	0.28	b					
S0891	3210	4610	7836	10-84	0	0.23	b					
S0892	3225	4775	7845	10-84	0	0.47	b					
S0893	3230	4630	7841	10-84	0	0.01	b					
S0894	3230	4815	7850	10-84	0	0.02	b					
S0895	3260	4680	7846	10-84	0	8.30	b					
S0896	3260	4870	7854	10-84	0	0.06	b					
S0897	3270	4535	7839	10-84	0	0.03	b					
S0898	3270	4575	7840	10-84	0	0.02	b					
S0899	3275	4820	7853	10-84	0	0.04	b					
S0900	3280	4730	7848	10-84	0	0.62	b					
S0901	3290	4630	7847	10-84	0	1.29	b					
S0902	3290	4790	7849	10-84	0	0.37	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)
S0903	3295	4830	7851	10-84	0	0.09	b					
S0904	3295	4875	7852	10-84	0	0.03	b					
C0192	3140	4900	8510	12-84	90	0.02	b					
			5811	12-84	180	0.01	b					
S0905	3250	4950	6393	08-84	0	0.17[c]	2.46[c]					
C0193	3300	4900	7752	09-84	90	0.89	b					
			7753	09-84	180	0.29	b					
S0906	3300	4975	6391	08-84	0	9.92	b					
S0907	3315	4925	6392	08-84	0	1.15	b		LDL	0.6	1.2	LDL
S0908	3325	4975	4047	10-83	0	1.08	b					
S0909	3415	5000	4045	10-83	0	1.85	b					
S0910	3435	5020	6390	08-84	0	0.22	b		LDL	1.5	1.4	LDL
S0911	3440	4900	4050	10-83	0	2.03[c]	b					
S0912	3465	5025	6397	08-84	0	0.19	b					
S0913	3540	5035	6396	08-84	0	0.08	b					
S0914	3550	4986	4049	10-83	0	2.29	b	0.45				
S0915	3600	5055	6395	08-84	0	2.19	b					
S0916	3675	5080	6394	08-84	0	0.69	b					
S0917	3680	5010	4048	10-83	0	2.32	b	0.21				

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)
C0194	3600	2240	8293	10-84	54	0.30	b					
			8294	10-84	108	0.32	b					
S0918	3625	2315	2891	10-83	0	1.23[c]	b	0.15				
S0919	3625	2515	2894	10-83	0	2.18	b	0.54				
S0920	3625	2615	5819	07-84	0	1.64	b		LDL	0.9	1.1	LDL
S0921	3700	2465	5915	07-84	0	1.08	b		LDL	1.1	1.1	LDL
S0922	3700	2540	2892	10-83	0	1.72	b					
S0923	3700	2615	5919	07-84	0	0.40	b					
S0924	3725	2440	2889	10-83	0	2.23[c]	b	1.04				
S0925	3825	2565	5916	07-84	0	0.65	b		LDL	0.9	1.3	LDL
S0926	3825	2590	2893	10-83	0	0.75[c]	b	0.40				
S0927	3875	2490	2890	10-83	0	1.41	b					
S0928	3875	2540	5917	07-84	0	0.58	b		LDL	0.9	1.3	LDL
S0929	3875	2590	5920	07-84	0	0.70	b		LDL	1.3	1.5	LDL
C0195	3600	2620	8272	10-84	36	0.05	b					
			8273	10-84	90	0.06	b					
S0930	3625	2645	2967	10-83	0	0.35	b	0.35				
S0931	3625	2970	5930	07-84	0	0.82	b					
S0932	3650	2670	2939	10-83	0	1.14	b					
S0933	3675	2475	5921	07-84	0	1.25	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)
S0934	3675	2870	5926	07-84	0	0.40	b					
S0935	3700	2670	5922	07-84	0	1.10	b					
S0936	3700	3920	5927	07-84	0	0.65	b					
S0937	3725	2995	5928	07-84	0	1.17	b					
S0938	3750	2870	5925	07-84	0	0.40	b					
S0939	3750	2945	5931	07-84	0	0.33	b					
S0940	3800	2670	5923	07-84	0	0.56	b		LDL	1	1.2	LDL
S0941	3800	2845	5924	07-84	0	0.90	b					
S0942	3800	2945	5929	07-84	0	0.52	b		LDL	0.9	1.3	LDL
S0943	3875	2645	2938	10-83	0	3.78	b					
S0944	3925	2615	2608	09-83	0	0.94	b					
S0945	3950	2515	2607	09-84	0	0.61	b					
S0946	4000	2465	2604	09-83	0	1.74[c]	b	0.93				
S0947	4025	2540	5865	07-84	0	0.23	b					
S0948	4075	2515	2605	09-83	0	0.67	b	0.76				
S0949	4100	2590	2606	09-83	0	1.20	b					
S0950	4125	2565	5864	07-84	0	0.05	b					
S0951	3925	2645	5953	07-84	0	0.03	b					
S0952	3925	3870	5951	07-84	0	0.05	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)
S0953	3925	3945	5950	07-84	0	0.07	b					
S0954	3975	2645	5954	07-84	0	0.45	b					
S0955	3975	2945	5949	07-84	0	1.73	b		LDL	LDL	1	LDL
S0956	4000	2645	2949	10-83	0	0.76[c]	b		LDL	1.7	1	LDL
S0957	4000	2745	2950	10-83	0	0.39[c]	b	0.15				
S0958	4000	2770	5952	07-84	0	0.01	b					
S0959	4000	2945	5947	07-84	0	0.08	b					
S0960	4100	2720	5955	07-84	0	0.49	b					
S0961	4125	2645	2948	10-83	0	1.78[c]	b					
S0962	4125	2770	5956	07-84	0	0.41	b					
S0963	4125	2845	5957	07-84	0	0.14	b					
S0964	4125	2945	5948	07-84	0	0.07	b					
C0196	4135	3000	8515	12-84	90	0.01	b					
C0197	3900	3000	8513	12-84	30	0.43	b					
			8514	12-84	60	0.02	b					
S0965	3925	3325	5963	07-84	0	0.77	b					
S0966	3950	3125	2942	10-83	0	0.57	b					
S0967	3950	3275	5962	07-84	0	0.51	b					
S0968	3975	3225	5961	07-84	0	0.10	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)
S0969	4025	3125	5959	07-84	0	0.12	b					
S0970	4050	3075	2941	10-83	0	0.52	b					
S0971	4075	3025	5958	07-84	0	0.15	5.02					
C0198	4135	2620	8512	12-84	30	0.19	b					
S0972	4225	2730	2623	09-83	0	0.02	b					
S0973	4225	2855	2622	09-83	0	0.02	b					
S0974	4250	2830	5969	07-84	0	0.59	b					
S0975	4275	2580	5964	07-84	0	0.75	b		LDL	LDL	1.1	LDL
S0976	4275	2780	5968	07-84	0	0.30	b					
S0977	4325	2630	5966	07-84	0	0.77	b					
S0978	4325	2635	5967	07-84	0	0.43	b					
S0979	4350	2580	2620	09-83	0	0.40	b					
S0980	4350	2680	5965	07-84	0	1.02	b					
S0981	4375	2630	2621	09-83	0	0.44[c]	b					
C0199	3600	3000	8268	10-84	72	0.16	b					
			8269	10-84	108	0.02	b					
S0982	3625	3025	5944	07-84	0	0.43	14.94					
S0983	3625	3325	4517	01-84	0	0.28	b	0.28				
S0984	3650	3275	5939	07-84	0	2.95	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)
S0985	3675	3250	5940	07-84	0	8.53	7.73					
C0200	3675	3275	1279	12-82	18	0.25	b					
S0986	3875	3250	2943	10-83	0	1.54	7.13					
S0987	3875	3350	5942	07-84	0	1.36	b					
C0201	3600	3380	8279	10-84	42	1.57	b					
			8280	10-84	108	1.88	b					
S0988	3605	3475	4531	01-84	0	0.40	b	1.67				
S0989	3605	3480	4528	01-84	0	93.30	b	1.18				
C0202	3625	3480	1287	12-82	18	13.04	b					
			1288	12-82	36	1.66	b					
S0990	3625	3630	7208	09-84	0	5.60	b					
S0991	3625	3680	7207	09-84	0	2.29	b					
S0992	3635	3580	4527	01-84	0	637.90						
S0993	3650	3630	4526	01-84	0	6.73	b	0.17				
S0994	3650	3680	7206	09-84	0	5.67	18.99					
C0203	3650	3760	7810	10-84	90	0.39	b					
			7811	10-84	180	0.04	b					
C0204	3675	3405	1281	12-82	18	1.21	b					
			1282	12-82	36	0.09	b					
C0205	3675	3515	1285	12-82	18	478.00	2.38					
			1286	12-82	36	124.00	2.90					

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)
S0995	3705	3400	4530	01-84	0	3.85	b					
C0206	3725	3425	1271	12-82	18	0.01[c]	b					
C0207	3725	3630	1277	12-82	18	67.00	b					
			1278	12-82	36	1.27	b					
C0208	3725	3680	1292	12-82	18	186.00[c]	36.87[c]					
			1293	12-82	36	4.45	3.01					
C0209	3730	3635	1294	12-82	18	2.00	b					
			1295	12-82	36	2.13	b					
C0210	3750	3605	1291	12-82	18	2.11	b					
S0996	3775	3405	4524	01-84	0	6.28	b	0.16				
C0211	3780	3465	1273	12-82	18	2.41[c]	10.16					
			1274	12-82	36	0.08	b					
C0212	3780	3505	1275	12-82	18	2.72[c]	13.13[c]					
			1276	12-82	36	0.07	b					
S0997	3800	3450	1464	03-83	0	34,000	NR					
S0998	3800	3405	4519	01-84	0	1.12	b					
S0999	3800	3530	4522	01-84	0	6.80	b					
S1000	3800	3630	7205	09-84	0	1.27	b		LDL	0.6	1.1	LDL
S1001	3825	3405	4520	01-84	0	0.24	b	0.19				
S1002	3850	3400	1465	12-83	0	102.00	54.30					
S1003	3850	3430	4521	01-84	0	2.05	b	0.19				

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)
C0213	3260	4860	2660	09-83	30	0.18	b					
			2661	09-83	60	0.93[c]	b					
			2662	09-83	240	0.16	b					
C0214	3500	4550	2714	09-83	30	0.01	b					
			2715	09-83	60	0.01[c]	b					
			2716	09-83	180	0.01	b					
C0215	3540	4100	2708	09-83	60	0.02	b		LDL	LDL	0.9	LDL
			2709	09-83	72	0.04	b					
			2710	09-83	96	0.01	b					
S1004	3720	3780	10553	08-85	0	7.58	b					
S1005	3720	3800	10528	08-85	0	4.21	b					
S1006	3720	3820	E-22	03-82	0	396.40	b					
S1007	3725	3820	E-8	03-82	0	216.30	b					
S1008	3730	3755	9137	05-85	0	124.20	b					
S1009	3730	3900	E-19	03-82	0	1.20	b					
C0216	3740	5050	2663	09-83	30	0.24	b					
			2664	09-83	60	0.49	b					
			2665	09-83	240	0.72	b					
C0217	3750	3740	2704	09-83	30	0.06[c]	b					
S1010	3750	3795	E-17	03-82	0	23.30	b					
S1011	3760	3710	9136	05-85	0	56.20	8.79					
S1012	3760	3800	10554	08-85	0	13.00	b					
S1013	3760	3820	10529	08-85	0	1.34	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)
S1014	3775	4000	E-20	03-82	0	10.00	b					
S1015	3780	3870	E-18	03-82	0	30.00	b					
S1016	3800	3650	9135	05-85	0	0.14	b					
S1017	3800	3750	9233	05-85	0	0.31	b					
S1018	3800	3850	10530	08-85	0	23.70	b					
S1019	3805	3650	9134	05-85	0	0.36	b					
S1020	3810	3830	10555	08-85	0	23.50	b					
S1021	3810	3980	E-9	03-82	0	2.20	b					
S1022	3820	3610	9133	05-85	0	0.08	b					
S1023	3820	3700	9231	05-85	0	0.20	b					
S1024	3820	3895	10531	08-85	0	21.30	b					
S1025	3825	3590	9132	05-85	0	0.14	b					
S1026	3830	4130	E-10	03-82	0	33.70	b					
S1027	3840	3880	10556	08-85	0	6.16	b					
C0218	3840	4450	2717	09-83	30	0.02	b		LDL	LDL	1.5	LDL
			2718	09-83	60	0.02	b					
			2719	09-83	180	0.01	b					
S1028	3850	3660	9229	05-85	0	0.56	b					
S1029	3850	3950	10532	08-85	0	4.20	b					
S1030	3860	3930	10557	08-85	0	12.80	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)
S1031	3870	3520	9131	05-85	0	2.86	b					
S1032	3875	3720	9230	05-85	0	0.28	b					
S1033	3880	3610	9227	05-85	0	0.70	b					
S1034	3890	3500	9130	05-85	0	0.95	b					
S1035	3895	3480	9129	05-85	0	0.61	b					
S1036	3895	3690	9228	05-85	0	0.21	b					
S1037	3900	3460	9128	05-85	0	0.99	b					
S1038	3900	3575	9225	05-85	0	1.07	b					
S1039	3900	3980	10558	08-85	0	8.52	b					
S1040	3900	4000	10533	08-85	0	5.58	2.50					
S1041	3920	3640	9226	05-85	0	0.58	b					
S1042	3925	3525	9223	05-85	0	0.55	b					
S1043	3930	4030	10534	08-85	0	52.30	5.80					
C0219	3940	3460	2698	08-83	30	0.02	b					
			2699	09-83	60	0.01	b		LDL	LDL	0.8	LDL
			2700	09-83	120	0.01	b					
S1044	3940	3480	9221	05-85	0	0.87	5.60					
S1045	3940	3600	9224	05-85	0	0.23	b					
S1046	3940	4020	10559	08-85	0	0.39	b					
S1047	3960	4070	10535	08-85	0	15.40	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)
S1048	3970	3550	9222	05-85	0	3.88	b					
S1049	3980	4060	10560	08-85	0	36.90	5.60					
S1050	3990	3510	9220	05-85	0	1.32	b					
S1051	4010	4110	10536	08-85	0	1.08	b					
S1052	4020	4090	10561	08-85	0	10.60	b					
S1053	4050	4140	10537	08-85	0	24.50	b					
S1054	4060	4120	10562	08-85	0	3.02	b					
S1055	4080	4200	10538	08-85	0	1.37	b					
S1056	4100	4180	10563	08-85	0	24.40	b					
C0220	4140	3100	2747	09-83	30	0.04	b					
			2748	09-83	60	0.22[c]	b					
			2749	09-83	120	0.10	b					
S1057	4150	4220	10539	08-85	0	28.70	b					
S1058	4160	4200	10564	08-85	0	2.24	b					
C0221	4190	5000	2666	09-83	30	0.33	b					
			2667	09-83	60	0.62	b					
			2668	09-83	240	0.08	b					
C0222	4190	5230	2672	09-83	30	0.09	b					
S1059	4200	4230	10540	08-85	0	2.28	b					
S1060	4205	4205	10565	08-85	0	2.10	b					
S1061	4240	4260	10541	08-85	0	0.17	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)
S1062	4250	4240	10566	08-85	0	0.37	b					
C0223	4260	4140	2656	09-83	60	0.02	b					
			2657	09-83	90	0.01	b					
C0224	4270	4600	2720	09-83	30	0.03	b					
			2721	09-83	50	0.01	b					
			2722	09-83	180	0.01	b					
S1063	4280	4300	10542	08-85	0	24.00	b					
S1064	4300	4280	10567	08-85	0	0.33	b					
S1065	4300	4340	10544	08-85	0	4.72	b					
S1066	4320	4320	10568	08-85	0	55.40	b					
S1067	4340	4400	10544	08-85	0	14.30	b					
S1068	4350	4380	10569	08-85	0	6.19	b					
C0225	4360	3850	2705	09-83	30	0.02	b					
			2706	09-83	60	0.06	b					
			2707	09-83	180	0.01	b					
S1070	4360	4460	10545	08-85	0	0.28	b					
C0226	4370	2690	2692	09-83	30	0.07[c]	b					
			2693	09-83	60	0.44	b					
			2694	09-83	84	0.05	b					
S1071	4380	4430	10570	08-85	0	11.30	b					
S1072	4410	4480	10546	08-85	0	36.90	b					
S1073	4420	4450	10571	08-85	0	2.50	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)
S1074	4470	4470	10547	08-85	0	0.44	b					
C0227	4480	3620	2701	09-83	30	0.04	b					
			2702	09-83	60	0.10	b					
			2703	09-83	120	0.02	b		LDL	LDL	1	LDL
S1076	4480	4440	10572	08-85	0	0.67	b					
C0228	4480	5530	2732	09-83	30	0.01	b					
			2733	09-83	60	0.01	b					
			2734	09-83	180	0.01[c]	b					
C0229	4500	5200	2729	09-83	30	0.01	b					
			2730	09-83	60	0.01	b					
			2731	09-83	240	0.01	b					
S1077	4540	4430	10573	08-85	0	1.16	b					
S1078	4540	4470	10548	08-85	0	1.58	b					
S1079	4580	4490	10549	08-85	0	13.80	b					
S1080	4590	4460	10574	08-85	0	0.08	b					
C0230	4600	4650	2723	09-83	30	0.01	b					
			2724	09-83	60	0.01	b					
			2725	09-83	180	0.01	b					
C0231	4630	4350	2762	09-83	30	0.04	b					
			2763	09-83	60	0.04	b					
			2764	09-83	240	0.01	b					
S1081	4640	4480	10575	08-85	0	0.20	b					
S1082	4640	4520	10550	08-85	0	0.20	b					
S1083	4700	4500	10576	08-85	0	0.28	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)
S1084	4700	4540	10551	08-85	0	0.10	b					
C0232	4720	4930	2726	09-83	30	0.07[c]	b					
			2727	09-83	60	0.03	b		LDL	LDL	0.9	LDL
			2728	09-83	240	0.01	b					
S1085	4750	4530	10577	08-85	0	0.13	b					
C0233	4760	3230	2695	09-83	30	0.20	b					
			2696	09-83	60	0.06	b					
			2697	09-83	120	0.03	b					
S1086	4760	4550	10552	08-85	0	0.18	b					
C0234	4960	3550	2750	09-83	30	0.04	b					
			2751	09-83	60	0.01	b					
			2752	09-83	120	0.01[c]	b					
C0235	4960	3880	2756	09-83	30	0.04	b					
			2757	09-83	60	0.01	b					
			2758	09-83	180	0.01	b		LDL	LDL	0.9	LDL
C0236	4980	4620	2711	09-83	30	0.01	b					
			2712	09-83	60	0.12[c]	b					
			2713	09-83	240	0.01	b					
C0237	5040	5270	2669	09-83	30	0.03	b					
			2670	09-83	60	0.02	b					
			2671	09-83	240	0.06	b					
C0238	5040	5680	2735	09-83	30	0.01	b					
			2736	09-83	60	0.01	b					
			2737	09-83	300	0.01	b					
C0239	5050	4230	2765	09-83	30	0.01	b					
			2766	09-83	60	0.01	b					
			2767	09-83	168	0.01	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)
C0240	5100	3000	2501	09-83	18	0.02[c]	b					
			2502	09-83	36	0.01	b					
			2503	09-83	54	0.01	b					
			2504	09-83	72	0.01	b					
			2505	09-83	90	0.01	b					
			2505	09-83	108	0.01	b					
			2506	09-83	126	0.01	b					
(The samples from 90 and 108 in were given the same MRC ID.)												
C0241	5330	4570	2640	09-83	30	0.06	b					
			2640	09-83	60	0.02	b					
			2640	09-83	198	0.03	b					
(All samples from this core location were given the same MRC ID.)												
C0242	5370	4980	2643	09-83	30	0.01	b					
			2644	09-83	60	0.01	b					
			2645	09-83	198	0.01	b					
C0243	5430	5340	2646	09-83	30	0.01	b					
			2647	09-83	60	0.01	b					
			2648	09-83	198	0.01	b					
C0244	5500	4325	2637	09-83	30	0.04	b		LDL	0.5	2.8	LDL
			2638	09-83	60	0.04	b					
			2639	09-83	180	0.01	b					
C0245	5520	3830	2759	09-83	30	0.03	b					
			2760	09-83	60	0.02	b		LDL	LDL	0.9	LDL
			2761	09-83	210	0.01	b		LDL	LDL	1	LDL
C0246	5600	3480	2753	09-83	30	0.01	b					
			2754	09-83	42	0.01	b					
			2755	09-83	60	0.03	b					
C0247	5650	3680	2768	09-83	30	0.01	b					
			2769	09-83	96	0.01	b					
			2770	09-83	162	0.01	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)
S1087	2825	2515	6788	08-84	0	2.63	9.79					
S1089	2725	2920	8665	12-82	0	10.50	b					
S1090	2750	2670	4114	10-83	0	5.97[c]	b					
S1091	2750	2770	8654	12-82	0	1.16	b					
C0263	3777.2	3245.3	None[d]	04-84	0	NR	0.9					
			None[d]	04-84	12	NR	0.6					
			None[d]	04-84	36	NR	0.3					
			None[d]	04-84	48	NR	0.3					
			None[d]	04-84	60	NR	0.3					
C0264	3724.8	3254.3	None[d]	04-84	0	NR	9.2					
			None[d]	04-84	12	NR	1.7					
			None[d]	04-84	24	NR	0.8					
			None[d]	04-84	36	NR	0.5					
			None[d]	04-84	48	NR	0.3					
C0265	3752.4	3322.9	None[d]	04-84	0	NR	1.7					
			None[d]	04-84	12	NR	1.3					
			None[d]	04-84	24	NR	0.3					
			None[d]	04-84	36	NR	0.3					
C0266	3808.2	3328.7	None[d]	04-84	0	NR	1.0					
			None[d]	04-84	12	NR	0.6					
			None[d]	04-84	24	NR	0.4					
			None[d]	04-84	36	NR	0.3					
			None[d]	04-84	48	NR	0.4					

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)
C0267	3670.8	3342.9	None[d]	04-84	0	NR	0.4					
			None[d]	04-84	12	NR	0.5					
			None[d]	04-84	24	NR	0.4					
			None[d]	04-84	36	NR	0.3					
C0268	3716.1	3400.6	None[d]	04-84	0	NR	0.9					
			None[d]	04-84	12	NR	0.4					
			None[d]	04-84	24	NR	0.4					
			None[d]	04-84	36	NR	0.4					
C0269	3751.3	3418.2	None[d]	04-84	0	NR	0.6					
			None[d]	04-84	12	NR	0.5					
			None[d]	04-84	24	NR	0.2					
			None[d]	04-84	36	NR	0.2					
			None[d]	04-84	48	NR	0.3					
C0270	3791.9	3441.5	None[d]	04-84	0	NR	0.3					
			None[d]	04-84	12	NR	0.5					
			None[d]	04-84	24	NR	0.5					
			None[d]	04-84	36	NR	0.3					
			None[d]	04-84	48	NR	0.3					
C0271	3865.9	3483.1	None[d]	04-84	0	NR	0.6					
			None[d]	04-84	12	NR	2.6					
			None[d]	04-84	24	NR	0.5					
			None[d]	04-84	36	NR	0.6					
			None[d]	04-84	48	NR	0.3					
			None[d]	04-84	60	NR	0.4					
			None[d]	04-84	72	NR	0.3					
			None[d]	04-84	96	NR	0.4					
			None[d]	04-84	120	NR	0.4					
C0272	3801.1	3524.0	None[d]	04-84	0	NR	0.6					
			None[d]	04-84	12	NR	0.4					
			None[d]	04-84	24	NR	0.5					
			None[d]	04-84	36	NR	0.5					
			None[d]	04-84	48	NR	<0.2					

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)
C0273	3682.1	3413.3	None[d]	04-84	0	NR	0.5					
			None[d]	04-84	12	NR	0.9					
			None[d]	04-84	24	NR	0.6					
			None[d]	04-84	[illegible]	NR	0.4					
			None[d]	04-84	48	NR	0.4					
			None[d]	04-84	60	NR	0.3					
C0274	3737.9	3478.5	None[d]	04-84	0	NR	0.5					
			None[d]	04-84	12	NR	0.6					
			None[d]	04-84	24	NR	0.3					
			None[d]	04-84	36	NR	0.4					
C0275	3529.9	3447.0	None[d]	04-84	0	NR	0.3					
			None[d]	04-84	12	NR	0.6					
			None[d]	04-84	24	NR	0.7					
			None[d]	04-84	36	NR	0.4					
C0276	3648.1	3642.8	None[d]	04-84	0	NR	0.8					
			None[d]	04-84	12	NR	0.9					
			None[d]	04-84	24	NR	0.3					
			None[d]	04-84	36	NR	0.4					
C0277	3640.5	3587.2	None[d]	04-84	0	NR	0.5					
			None[d]	04-84	12	NR	0.5					
			None[d]	04-84	24	NR	0.4					
			None[d]	04-84	36	NR	0.3					
C0278	3628.3	3542.0	None[d]	04-84	0	NR	0.2					
			None[d]	04-84	12	NR	0.3					
			None[d]	04-84	24	NR	0.3					
C0279	3567.8	3565.3	None[d]	04-84	0	NR	0.2					
			None[d]	04-84	12	NR	0.3					
			None[d]	04-84	24	NR	0.5					
C0280	3705.2	3710.7	None[d]	04-84	0	NR	0.8					
			None[d]	04-84	12	NR	0.9					
			None[d]	04-84	24	NR	1.0					

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)
C0281	3784.3	3591.4	None[d]	04-84	0	NR	0.4					
			None[d]	04-84	12	NR	1.0					
			None[d]	04-84	24	NR	0.4					
			None[d]	04-84	36	NR	0.4					
			None[d]	04-84	48	NR	0.5					
C0282	3679.3	3500.9	None[d]	04-84	0	NR	0.6					
			None[d]	04-84	12	NR	0.4					
			None[d]	04-84	24	NR	0.3					
			None[d]	04-84	36	NR	0.4					
C0283	2411.5	2139.2	None[d]	07-84	0	NR	1.0					
			None[d]	07-84	12	NR	1.8					
			None[d]	07-84	24	NR	1.7					
			None[d]	07-84	36	NR	1.4					
			None[d]	07-84	48	NR	1.2					
			None[d]	07-84	60	NR	0.8					
			None[d]	07-84	72	NR	0.7					
			None[d]	07-84	84	NR	0.9					
			None[d]	07-84	96	NR	0.6					
			None[d]	07-84	108	NR	0.7					
			None[d]	07-84	120	NR	0.7					
			None[d]	07-84	132	NR	0.5					
			None[d]	07-84	144	NR	0.5					
C0284	2495.9	2236.2	None[d]	07-84	0	NR	0.8					
			None[d]	07-84	12	NR	1.2					
			None[d]	07-84	24	NR	0.9					
			None[d]	07-84	36	NR	0.8					
			None[d]	07-84	48	NR	0.8					
			None[d]	07-84	60	NR	0.5					
			None[d]	07-84	72	NR	0.6					
			None[d]	07-84	84	NR	0.8					
			None[d]	07-84	96	NR	0.8					
			None[d]	07-84	108	NR	0.5					

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)
C0285	2478.9	2212.0	None[d]	07-84	0	NR	0.3					
			None[d]	07-84	12	NR	0.8					
			None[d]	07-84	24	NR	0.7					
			None[d]	07-84	36	NR	0.8					
			None[d]	07-84	48	NR	0.8					
			None[d]	07-84	60	NR	0.6					
			None[d]	07-84	72	NR	0.7					
C0286	2464.1	2184.0	None[d]	07-84	0	NR	0.3					
			None[d]	07-84	12	NR	0.5					
			None[d]	07-84	24	NR	0.5					
			None[d]	07-84	36	NR	0.8					
			None[d]	07-84	48	NR	0.9					
			None[d]	07-84	60	NR	0.6					
			None[d]	07-84	84	NR	0.8					
			None[d]	07-84	96	NR	0.8					
C0287	2450.7	2151.6	None[d]	07-84	0	NR	0.5					
			None[d]	07-84	12	NR	1.3					
			None[d]	07-84	24	NR	0.9					
			None[d]	07-84	36	NR	0.8					
			None[d]	07-84	48	NR	0.6					
			None[d]	07-84	60	NR	0.7					
			None[d]	07-84	72	NR	0.6					
C0288	2438.6	2119.3	None[d]	07-84	0	NR	0.3					
			None[d]	07-84	12	NR	0.8					
			None[d]	07-84	24	NR	1.1					
			None[d]	07-84	36	NR	0.8					
			None[d]	07-84	48	NR	0.8					
			None[d]	07-84	60	NR	0.5					
			None[d]	07-84	72	NR	0.7					

f Map Location[a]	Coordinates South	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)
C0289	2422.7	2081.0	None[d]	07-84	0	NR	0.6					
			None[d]	07-84	12	NR	1.1					
			None[d]	07-84	24	NR	0.5					
			None[d]	07-84	36	NR	0.8					
			None[d]	07-84	48	NR	1.0					
			None[d]	07-84	60	NR	0.8					
C0290	2401.5	2102.1	None[d]	07-84	0	NR	0.7					
			None[d]	07-84	12	NR	0.8					
			None[d]	07-84	24	NR	0.8					
			None[d]	07-84	36	NR	0.8					
			None[d]	07-84	48	NR	0.6					
			None[d]	07-84	60	NR	0.9					
			None[d]	07-84	72	NR	0.8					
C0291	2915.3	2490.3	None[d]	07-84	0	NR	0.6					
			None[d]	07-84	12	NR	0.4					
			None[d]	07-84	24	NR	0.5					
			None[d]	07-84	36	NR	0.4					
			None[d]	07-84	48	NR	0.4					
			None[d]	07-84	60	NR	0.3					
			None[d]	07-84	72	NR	0.5					
			None[d]	07-84	84	NR	0.4					
			None[d]	07-84	96	NR	0.7					
			None[d]	07-84	108	NR	0.6					
			None[d]	07-84	120	NR	0.3					
			None[d]	07-84	132	NR	0.3					
S1092	2185	3362	8413	12-84	f	0.31	323.5[g]					

[a]C denotes core location and S denotes surface sample location on Plate 1.

[b]Thorium results of ≤ 2 pCi/g are listed as "b".

[c]Verification sample analyzed for QA/QC.

[d]No MRC ID assigned because *in situ* gamma spectrometry was performed for thorium-232.

[e]Gamma results could not be confirmed using the gamma spectroscopy printout given in this appendix.

[f]The depth for this sample was given as "SS". For mapping purposes (Plates 1 and 5), this is assumed to be a surface sample.

[g]Sample results were given isotopically for this sample and included 0.99 pCi/g thorium-228; 321 pCi/g thorium-230; and 1.5 pCi/g thorium-232, for a total of 323.5 pCi/g.

LDL - The sample result was below the Lower Detection Limit, which was estimated to be 0.5 pCi/g for cesium-137, cobalt-60, and americium-241. The LDL for radium-226 or actinium-227 was estimated to be 1 pCi/g.

NR - No result provided. (Note: no samples were taken for plutonium-238 when *in situ* gamma spectrometry was performed.)

Results of Gamma Spectroscopy Analyses of Soil Samples

DATE: 13-Nov-85

Analyzed by:Environmental Evaluation Group

Submitted to:Bob Stought,Health Physics

LDL = Lower Detection Limit
The value of these lower detection limits is estimated to be 0.5pCi/g for Cs-137, Co-60 and Am-241

ND = None Detected
No gamma emitting radionuclides having gamma energies below 1.5 MeV were detected above background.

Concentrations (pCi/g)

SAMPLE	U-238	Ra-226	Th-228	Cs-137	Co-60	Am-241	OTHER
1244	<2	1.0 +/- 0.2	13 +/- 1	<LDL	<LDL	<LDL	ND
1493	<2	0.7 +/- 0.1	0.5 +/- 0.1	<LDL	<LDL	1.0 +/- 0.2	ND
1784	<2	1.5 +/- 0.3	25 +/- 2	<LDL	<LDL	<LDL	ND
1806	<2	0.8 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
1807	<2	0.9 +/- 0.1	1.2 +/- 0.1	<LDL	<LDL	<LDL	ND
1808	<2	1.0 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
1816	<2	1.0 +/- 0.3	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
1825	<2	0.7 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
1833	2 +/- 1	0.8 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
1836	<2	0.8 +/- 0.1	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
1944	<2	0.6 +/- 0.1	0.4 +/- 0.1	<LDL	<LDL	0.5 +/- 0.2	ND
1996	<2	0.9 +/- 0.1	0.9 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	ND
2157	<2	0.9 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
2201	<2	0.8 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
2203	<2	0.9 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
2204	<2	1.4 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
2205	<2	0.5 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
2206	<2	0.9 +/- 0.2	0.4 +/- 0.2	<LDL	<LDL	<LDL	ND
2208	<2	0.7 +/- 0.1	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
2223	<2	0.7 +/- 0.1	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
2240	2 +/- 1	0.9 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
2393	<2	1.1 +/- 0.1	1.1 +/- 0.1	<LDL	<LDL	<LDL	ND
2425	<2	0.8 +/- 0.1	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
2442	<2	0.9 +/- 0.2	0.7 +/- 0.1	<LDL	<LDL	<LDL	ND
2446	<2	1.0 +/- 0.2	12 +/- 1	<LDL	<LDL	<LDL	ND
2447	<2	0.9 +/- 0.1	4.3 +/- 0.4	<LDL	<LDL	<LDL	ND
2448	<2	0.7 +/- 0.1	4.3 +/- 0.4	<LDL	<LDL	<LDL	ND
2452	<2	0.9 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
2637	<2	2.8 +/- 0.2	0.7 +/- 0.1	0.5 +/- 0.2	<LDL	<LDL	ND
2652	<2	0.6 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
2699	<2	0.8 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
2703	<2	1.0 +/- 0.1	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
2708	<2	0.9 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
2717	<2	1.5 +/- 0.2	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
2727	<2	0.9 +/- 0.2	0.7 +/- 0.1	<LDL	<LDL	<LDL	ND
2758	<2	0.9 +/- 0.1	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
2760	<2	0.9 +/- 0.2	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
2761	<2	1.0 +/- 0.2	1.3 +/- 0.2	<LDL	<LDL	<LDL	ND
2778	<2	1.3 +/- 0.2	1.5 +/- 0.3	270 +/- 30	<LDL	<LDL	ND
2949	<2	1.0 +/- 0.1	1.0 +/- 0.1	1.7 +/- 0.3	<LDL	<LDL	ND
2997	<2	1.2 +/- 0.1	1.0 +/- 0.1	29 +/- 2	<LDL	<LDL	ND

3004	<2	1.0 +/- 0.2	1.2 +/- 0.2	1.6 +/- 0.3	<LDL	<LDL	ND
4097	<2	1.1 +/- 0.2	1.2 +/- 0.2	1.2 +/- 0.3	<LDL	<LDL	ND
4100	<2	0.8 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
4104	<2	0.8 +/- 0.2	1.5 +/- 0.2	<LDL	<LDL	<LDL	ND
4105	<2	1.2 +/- 0.2	1.2 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	ND
4124	<2	1.2 +/- 0.2	1.0 +/- 0.2	0.5 +/- 0.2	<LDL	<LDL	ND
4892	<2	1.2 +/- 0.2	33 +/- 3	<LDL	<LDL	<LDL	ND
5551	<2	0.9 +/- 0.1	0.6 +/- 0.1	<LDL	<LDL	<LDL	ND
5834	<2	0.8 +/- 0.1	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
5877	<2	0.9 +/- 0.2	1.0 +/- 0.2	1.2 +/- 0.2	<LDL	<LDL	ND
5887	<2	1.0 +/- 0.2	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
5906	<2	1.1 +/- 0.1	1.1 +/- 0.1	<LDL	<LDL	<LDL	ND
5912	<2	1.1 +/- 0.2	1.3 +/- 0.2	<LDL	<LDL	<LDL	ND
5914	<2	1.1 +/- 0.2	1.2 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	ND
5915	<2	1.1 +/- 0.2	1.0 +/- 0.2	1.1 +/- 0.2	<LDL	<LDL	ND
5916	<2	1.3 +/- 0.5	1.0 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	ND
5917	<2	1.3 +/- 0.2	0.8 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	ND
5918	<2	1.4 +/- 0.1	1.0 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	ND
5920	<2	1.5 +/- 0.2	1.0 +/- 0.2	1.3 +/- 0.2	<LDL	<LDL	ND
5923	<2	1.2 +/- 0.2	1.0 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	ND
5929	<2	1.3 +/- 0.2	0.9 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	ND
5941	13.4 +/- 4	6 +/- 1	41 +/- 3	<LDL	<LDL	<LDL	ND
5949	<2	1.0 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
5964	<2	1.1 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
5974	<2	0.9 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
5980	<2	0.8 +/- 0.1	1.4 +/- 0.1	<LDL	<LDL	<LDL	ND
5985	<2	0.8 +/- 0.1	3.0 +/- 0.3	<LDL	<LDL	<LDL	ND
6040	<2	0.9 +/- 0.1	1.5 +/- 0.2	<LDL	<LDL	<LDL	ND
6103	<2	0.9 +/- 0.1	11 +/- 1	<LDL	<LDL	<LDL	ND
6139	<2	0.8 +/ -0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
6228	<2	1.5 +/- 0.2	1.0 +/- 0.2	1.4 +/- 0.2	<LDL	<LDL	ND
6272	<2	0.8 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
6292	<2	1.2 +/- 1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
6374	<2	0.9 +/- 0.2	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
6384	<2	0.9 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
6390	<2	1.4 +/- 0.2	0.8 +/- 0.1	1.5 +/- 0.2	<LDL	<LDL	ND
6392	<2	1.2 +/- 0.1	0.6 +/- 0.1	0.6 +/- 0.1	<LDL	<LDL	ND
6443	<2	1.1 +/- 0.2	0.9 +/- 0.2	1.9 +/- 0.3	<LDL	<LDL	ND
6461	<2	1.2 +/- 0.2	0.6 +/- 0.1	<LDL	<LDL	<LDL	ND
6495	<2	1.2 +/- 0.2	2.0 +/- 0.2	1.1 +/- 0.2	<LDL	<LDL	ND
6502	<2	1.2 +/- 0.2	2.3 +/- 0.2	1.4 +/- 0.2	<LDL	<LDL	ND
6508	<2	1.2 +/- 0.2	1.6 +/- 0.2	1.1 +/- 0.2	<LDL	<LDL	ND
6510	<2	1.1 +/- 0.2	1.9 +/- 0.2	1.2 +/- 0.2	<LDL	<LDL	ND
6511	<2	1.0 +/- 0.2	2.3 +/- 0.3	<LDL	<LDL	<LDL	ND
6546	<2	1.0 +/- 0.2	5.0 +/- 0.5	<LDL	<LDL	<LDL	ND
6549	<2	1.2 +/- 0.2	1.3 +/- 0.2	<LDL	<LDL	<LDL	ND
6614	<2	0.9 +/- 0.2	23 +/- 2	<LDL	<LDL	<LDL	ND
6684	<2	0.8 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
6690	<2	1.2 +/- 0.2	1.0 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	ND
6692	<2	1.0 +/- 0.1	1.0 +/- 0.1	0.8 +/- 0.2	<LDL	<LDL	ND
6693	<2	1.0 +/- 0.2	0.9 +/- 0.2	1.7 +/- 0.3	<LDL	<LDL	ND
6742	<2	0.7 +/- 0.2	1.1 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	ND
6746	<2	1.2 +/- 0.1	1.4 +/- 0.1	1.3 +/- 0.2	<LDL	<LDL	ND
6755	<2	1.2 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
6762	<2	1.0 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
6767	<2	0.9 +/- 0.2	0.9 +/- 0.2	0.5 +/- 0.2	<LDL	<LDL	ND

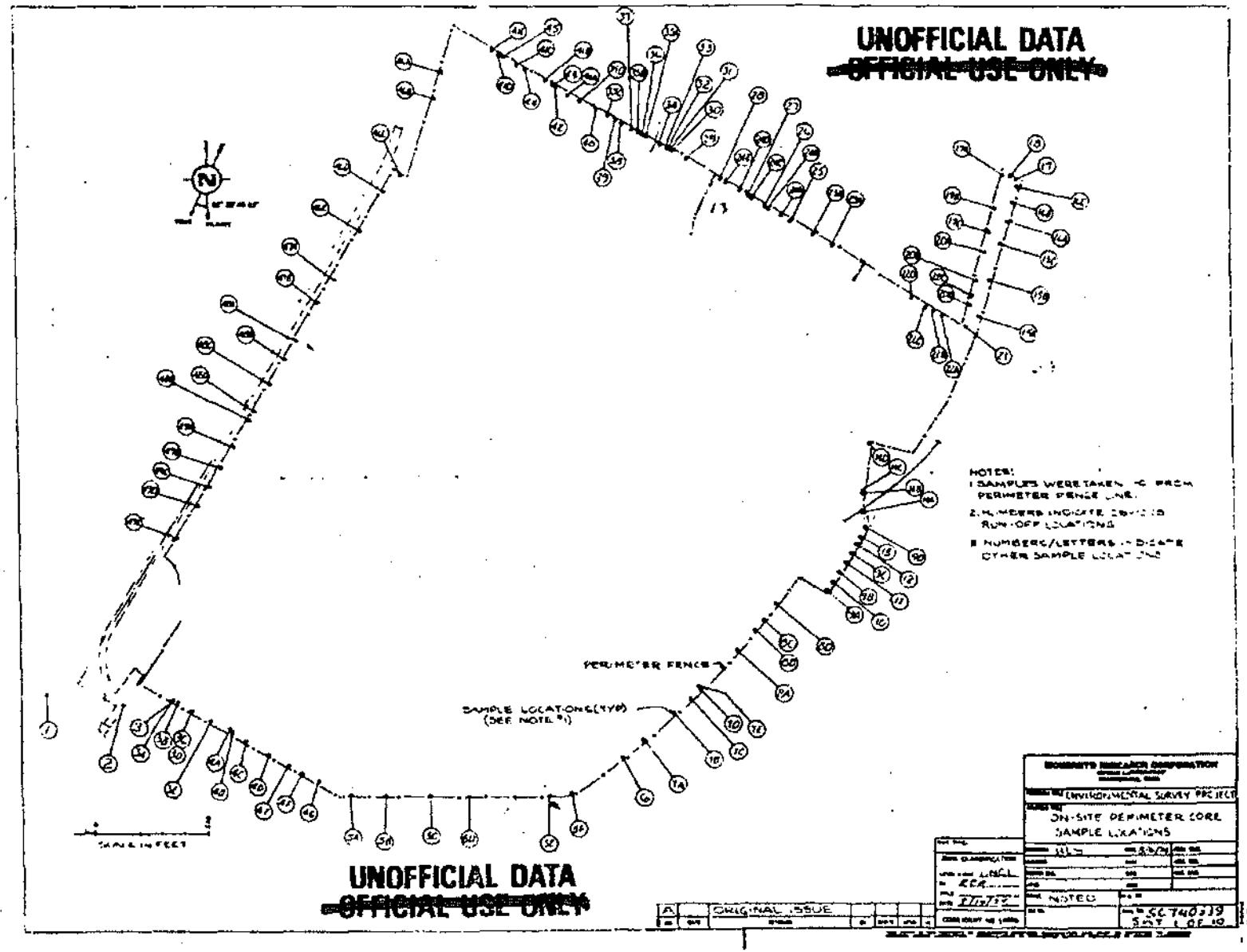
6768	<2	0.8 +/- 0.1	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
6785	2 +/- 1	1.1 +/- 0.2	4.4 +/- 0.4	<LDL	<LDL	<LDL	ND
7123	<2	0.9 +/- 0.2	0.8 +/- 0.2	1.3 +/- 0.2	<LDL	<LDL	ND
7171	<2	1.1 +/- 0.2	1.1 +/- 0.2	1.3 +/- 0.2	<LDL	<LDL	ND
7198	<2	1.1 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
7199	<2	1.4 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
7205	<2	1.1 +/- 0.1	1.6 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	ND
7236	<2	1.3 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
7353	<2	1.2 +/- 0.1	1.0 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	ND
7878	<2	1.2 +/- 0.2	1.0 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	ND
7887	<2	1.0 +/- 0.2	0.9 +/- 0.1	0.6 +/- 0.2	<LDL	<LDL	ND
8275	<2	0.8 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
8278	<2	1.0 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
8350	10 +/- 5	3.3 +/- 0.4	110 +/- 10	<LDL	<LDL	<LDL	ND
8436	<2	1.1 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
8440	<2	1.4 +/- 0.2	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
8441	<2	0.7 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
8442	<2	0.6 +/- 0.1	0.7 +/- 0.1	<LDL	<LDL	<LDL	ND
9549	<2	0.7 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
9551	<2	0.8 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
9807	<2	0.4 +/- 0.1	0.4 +/- 0.2	7 +/- 1	143 +/- 28	<LDL	ND
9810	<2	0.7 +/- 0.1	0.5 +/- 0.1	<LDL	54 +/- 11	<LDL	ND
9830	<2	0.8 +/- 0.1	0.6 +/- 0.1	1.6 +/- 0.2	1.0 +/- 0.2	<LDL	ND
9845	<2	0.8 +/- 0.2	0.6 +/- 0.2	10 +/- 1	82 +/- 16	<LDL	ND
9849	<2	0.8 +/- 0.1	0.8 +/- 0.1	0.8 +/- 0.1	0.5 +/- 0.2	<LDL	ND
10119	<2	0.6 +/- 0.1	1.1 +/- 0.1	<LDL	<LDL	<LDL	ND
10120	<2	0.7 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
10121	<2	0.8 +/- 0.2	1.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10122	<2	1.0 +/- 0.1	1.1 +/- 0.1	<LDL	<LDL	<LDL	ND
10123	<2	0.8 +/- 0.1	1.2 +/- 0.1	<LDL	<LDL	<LDL	ND
10124	<2	0.8 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
10125	2 +/- 1	0.9 +/- 0.1	1.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10126	<2	1.2 +/- 0.2	1.3 +/- 0.2	<LDL	<LDL	<LDL	ND
10127	<2	0.8 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
10128	<2	0.8 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
10129	<2	1.0 +/- 0.1	2.3 +/- 0.2	<LDL	<LDL	<LDL	ND
10373	<2	0.6 +/- 0.2	0.7 +/- 0.3	<LDL	<LDL	<LDL	ND
10374	<2	0.4 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10375	<2	0.6 +/- 0.1	0.6 +/- 0.1	<LDL	<LDL	<LDL	ND
10377	<2	0.5 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10378	<2	0.4 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10379	<2	0.5 +/- 0.2	0.5 +/- 0.2	<LDL	1.1 +/- 0.6	<LDL	ND
10380	<2	0.4 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10381	<2	0.5 +/- 0.1	0.5 +/- 0.2	<LDL	<LDL	<LDL	ND
10383	<2	0.6 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10384	<2	0.5 +/- 0.2	0.4 +/- 0.2	<LDL	38 +/- 8	<LDL	ND
10385	<2	0.5 +/- 0.3	0.4 +/- 0.2	<LDL	22 +/- 5	<LDL	ND
10386	<2	0.6 +/- 0.2	0.2 +/- 0.2	<LDL	3.3 +/- 0.7	<LDL	ND
10387	<2	0.5 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10388	<2	0.5 +/- 0.2	0.2 +/-0.2	<LDL	250 +/-50	<LDL	ND
10389	<2	0.4 +/- 0.2	0.8 +/- 0.2	<LDL	6 +/- 1	<LDL	ND
10390	<2	0.5 +/- 0.2	0.8 +/- 0.2	<LDL	2 +/- 0.5	<LDL	ND
10391	<2	0.5 +/- 0.2	0.8 +/- 0.2	<LDL	3 +/- 1	<LDL	ND
10392	<2	0.5 +/- 0.2	0.5 +/- 0.2	<LDL	3 +/- 2	<LDL	ND
10393	<2	0.4 +/- 0.2	0.6 +/- 0.2	<LDL	15 +/- 3	<LDL	ND
10394	<2	0.7 +/- 0.2	0.5 +/- 0.2	<LDL	16 +/- 5	<LDL	ND

[illegible]	1	[illegible]	[illegible]	<LDL	[illegible]	ND
[illegible]	1	[illegible]	[illegible]	<LDL	[illegible]	ND
[illegible]	1	[illegible]	[illegible]	LDL	[illegible]	ND
[illegible]	1	0.4 +/- 0.1	[illegible]	LDL	5 +/- 1	LDL	ND
[illegible]	1	[illegible]	[illegible]	LDL	[illegible]	LDL	ND
10400	1	[illegible]	[illegible]	LDL	LDL	<LDL	ND
10401	2	[illegible]	[illegible]	<LDL	1.0 +/- 0.3	LDL	ND
10402	2	0.5 +/- 0.2	[illegible]	<LDL	LDL	LDL	ND
10402	2	0.5 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10403	2	0.6 +/- 0.1	0.7 +/- 0.1	<LDL	1.1 +/- 0.1	<LDL	ND
10404	2	0.5 +/- 0.1	0.7 +/- 0.1	<LDL	<LDL	<LDL	ND
10405	2	0.7 +/- 0.2	0.7 +/- 0.2	<LDL	1.0 +/- 0.5	LDL	ND
10406	<2	0.5 +/- 0.2	0.6 +/- 0.2	<LDL	0.6 +/- 0.2	<LDL	ND
10407	<2	0.4 +/- 0.2	0.5 +/- 0.2	<LDL	5 +/- 1	<LDL	ND
10410	<2	0.4 +/- 0.2	0.9 +/- 0.2	<LDL	10 +/- 2	<LDL	ND
10411	2	0.7 +/- 0.2	0.7 +/- 0.2	<LDL	14 +/- 3	<LDL	ND
10412	<2	0.7 +/- 0.2	0.7 +/- 0.2	<LDL	4 +/- 1	<LDL	ND
10413	2	0.4 +/- 0.2	[illegible]	<LDL	13 +/- 2	LDL	ND
[illegible]	1	0.6 +/- 0.2	0.6 +/- 0.2	LDL	4 +/- 1	LDL	ND
10415	1	0.6 +/- 0.2	0.5 +/- 0.2	<LDL	<LDL	<LDL	ND
[illegible]	1	0.4 +/- 0.2	0.6 +/- 0.2	LDL	<LDL	LDL	ND
10417	1	0.7 +/- 0.2	0.6 +/- 0.2	<LDL	LDL	LDL	ND
[illegible]	1	0.4 +/- 0.2	0.5 +/- 0.2	LDL	LDL	LDL	ND
10477	2	0.8 +/- 0.2	0.7 +/- 0.1	2.2 +/- 0.2	LDL	<LDL	ND
10474	<2	0.7 +/- 0.1	0.9 +/- 0.5	3.1 +/- 0.3	<LDL	<LDL	ND
10475	<2	0.7 +/- 0.1	0.9 +/- 0.1	1.2 +/- 0.2	LDL	<LDL	ND
10476	<2	0.8 +/- 0.1	0.9 +/- 0.1	9.7 +/- 0.7	<LDL	<LDL	ND
10477	1	0.9 +/- 0.1	0.9 +/- 0.1	5.6 +/- 0.6	LDL	<LDL	ND
10478	1	0.9 +/- 0.1	1.0 +/- 0.1	1.9 +/- 0.2	LDL	LDL	ND
10479	2	0.9 +/- 1.0	0.9 +/- 0.1	9.7 +/- 1.0	<LDL	LDL	ND
[illegible]	2	0.9 +/- 0.1	0.9 +/- 0.1	3.0 +/- 0.4	LDL	LDL	ND
[illegible]	1	1.0 +/- 0.1	0.9 +/- 0.1	LDL	<LDL	LDL	ND
[illegible]	1	1.0 +/- 0.2	0.9 +/- 0.1	2.5 +/- 0.7	LDL	LDL	ND
[illegible]	2	0.7 +/- 0.1	0.8 +/- 0.1	21 +/- 2	LDL	LDL	ND
[illegible]	1	0.9 +/- 0.1	0.9 +/- 0.1	2.0 +/- 0.7	LDL	LDL	ND
10445	<2	0.9 +/- 0.1	0.8 +/- 0.1	5.7 +/- 0.6	LDL	LDL	ND
10446	<2	0.9 +/- 0.1	0.8 +/- 0.2	4.5 +/- 0.6	<LDL	<LDL	ND
10450	1	0.2 +/- 0.2	0.8 +/- 0.2	<LDL	2 +/- 1	<LDL	ND
[illegible]	1	0.5 +/- 0.2	0.6 +/- 0.2	<LDL	LDL	LDL	ND
10599	<2	0.6 +/- 0.3	1.0 +/- 0.2	<LDL	<LDL	LDL	ND
10600	<2	0.6 +/- 0.2	1.0 +/- 0.3	<LDL	<LDL	<LDL	ND
10601	<2	0.6 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10602	<2	0.6 +/- 0.2	0.9 +/- 0.3	<LDL	<LDL	LDL	ND
10603	<2	0.5 +/- 0.2	0.9 +/- 0.1	<LDL	<LDL	LDL	ND
10604	<2	0.4 +/- 0.2	1.0 +/- 0.2	LDL	<LDL	LDL	ND
10605	<2	0.5 +/- 0.2	1.0 +/- 0.2	<LDL	LDL	LDL	ND
10606	2	0.5 +/- 0.2	0.8 +/- 0.2	<LDL	LDL	LDL	ND
10607	2	0.9 +/- 0.2	1.4 +/- 0.3	<LDL	LDL	LDL	ND
10608	2	[illegible]	[illegible]	<LDL	LDL	<LDL	ND
10609	2	0.6 +/- 0.2	0.9 +/- 0.2	<LDL	LDL	<LDL	ND
10610	2	0.8 +/- 0.1	1.1 +/- 0.1	LDL	LDL	LDL	ND
[illegible]	2	0.5 +/- 0.2	1.0 +/- 0.2	LDL	LDL	LDL	ND
[illegible]	2	[illegible]	[illegible]	LDL	LDL	LDL	ND
[illegible]	2	[illegible]	[illegible]	LDL	LDL	LDL	ND
[illegible]	1	[illegible]	[illegible]	[illegible]	LDL	LDL	ND
[illegible]	1	[illegible]	[illegible]	[illegible]	LDL	LDL	ND

10616	<2	0.5 +/- 0.2	0.5 +/- 0.2	<LDL	<LDL	<LDL	ND
10617	<2	1.0 +/- 1.0	0.2 +/- 0.2	<LDL	<LDL	<LDL	Ac-227(~50 pCi/g)
10618	<2	1.0 +/- 1.0	0.6 +/- 0.4	<LDL	<LDL	<LDL	Ac-227(~1400 pCi/g)
10619	<2	0.9 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10620	<2	0.5 +/- 0.3	0.4 +/- 0.2	<LDL	<LDL	<LDL	ND
10621	<2	1.0 +/- 1.0	0.5 +/- 0.5	<LDL	<LDL	<LDL	Ac-227(~300 pCi/g)
10622	<2	0.7 +/- 0.2	0.5 +/- 0.2	<LDL	<LDL	<LDL	Ac-227(~10 pCi/g)
10623	<2	0.8 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
10624	<2	0.6 +/- 0.1	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10625	<2	0.6 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10625	<2	0.5 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10626	<2	0.8 +/- 0.4	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10627	<2	0.4 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10628	<2	0.7 +/- 0.2	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
10629	<2	0.4 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10630	<2	0.6 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10631	<2	0.5 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10632	<2	0.5 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10633	<2	0.5 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10634	<2	0.6 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10636	<2	0.7 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
10637	<2	0.6 +/- 0.2	0.7 +/- 0.4	<LDL	<LDL	<LDL	ND
10638	<2	0.4 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10639	<2	0.6 +/- 0.4	1.1 +/- 0.3	<LDL	<LDL	<LDL	ND
10640	<2	0.3 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
10641	<2	0.6 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10642	<2	0.6 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
10643	<2	0.7 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10644	<2	0.5 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10645	<2	0.9 +/- 0.2	1.3 +/- 0.3	<LDL	<LDL	<LDL	ND
10658	<2	1.2 +/- 0.3	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10665	<2	0.4 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10666	<2	0.6 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10667	<2	0.7 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10668	<2	0.7 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10669	<2	0.8 +/- 0.2	0.4 +/- 0.2	<LDL	<LDL	<LDL	ND
10670	<2	0.9 +/- 0.2	0.7 +/-0.2	<LDL	<LDL	<LDL	ND
10671	<2	0.7 +/- 0.3	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10673	<2	0.5 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10672	<2	0.4 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10674	<2	0.5 +/- 0.2	0.7 +/- 0.1	<LDL	<LDL	<LDL	ND
10675	<2	0.4 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10676	<2	0.5 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10677	<2	0.6 +/- 0.2	0.3 +/- 0.2	<LDL	=	<LDL	ND
10678	<2	0.4 +/- 0.3	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10679	<2	0.3 +/- 0.2	0.4 +/- 0.2	<LDL	<LDL	<LDL	ND
10680	<2	0.4 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10681	<2	0.5 +/- 0.1	0.5 +/- 0.1	<LDL	<LDL	<LDL	ND
10682	<2	0.6 +/- 0.2	0.5 +/- 0.2	<LDL	<LDL	<LDL	ND
10683	<2	0.2 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10684	<2	0.7 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10685	<2	0.5 +/- 0.2	0.4 +/- 0.2	<LDL	<LDL	<LDL	ND
10686	<2	0.3 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10687	<2	0.7 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
[illegible]	<2	[illegible] +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
[illegible]	<2	[illegible] +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND

10690	<2	0.7 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10691	<2	0.5 +/- 0.1	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10692	<2	0.6 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10693	<2	0.8 +/- 0.6	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10694	<2	0.6 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10695	<2	0.6 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
10696	<2	0.6 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
10697	<2	0.6 +/- 0.1	0.8 +/- 0.1	<LDL	<LDL	<LDL	ND
10698	<2	0.6 +/- 0.2	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
10699	<2	0.6 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10713	<2	0.5 +/- 0.2	0.5 +/- 0.1	<LDL	<LDL	<LDL	ND
10714	<2	0.7 +/- 0.1	0.7 +/- 0.1	<LDL	<LDL	<LDL	ND
10715	<2	2.0 +/- 0.3	0.3 +/- 0.2	<LDL	<LDL	<LDL	ND
10716	<2	0.7 +/- 0.2	0.6 +/- 0.1	<LDL	<LDL	<LDL	ND
10717	<2	0.6 +/- 0.2	0.6 +/- 0.1	<LDL	<LDL	<LDL	Ac-227(~30 pCi/g)
10718	<2	1.2 +/- 0.2	0.5 +/- 0.1	<LDL	<LDL	<LDL	Ac-227(~200 pCi/g)
10719	<2	1.5 +/- 0.1	0.6 +/- 0.1	<LDL	<LDL	<LDL	ND
10720	<2	0.8 +/- 0.2	0.8 +/- 0.1	<LDL	<LDL	<LDL	Ac-227(~20 pCi/g)
10722	<2	0.7 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
10724	<2	0.8 +/- 0.1	0.7 +/- 0.1	<LDL	<LDL	<LDL	ND
10762	<2	0.5 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10763	<2	0.4 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10763	<2	0.4 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10764	<2	0.5 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10765	<2	0.5 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10766	<2	0.5 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10767	<2	0.6 +/- 0.3	1.1 +/- 0.2	<LDL	<LDL	<LDL	ND
10768	<2	0.6 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10769	<2	0.7 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10770	<2	0.5 +/- 0.2	0.4 +/- 0.2	<LDL	<LDL	<LDL	ND
10771	<2	0.5 +/- 0.2	0.9 +/- 0.3	<LDL	<LDL	<LDL	ND
10772	<2	0.2 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10773	<2	0.4 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10774	<2	0.7 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10775	<2	0.7 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10776	<2	0.8 +/- 0.3	1.0 +/- 0.3	<LDL	<LDL	<LDL	ND
10777	<2	0.6 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10778	<2	0.6 +/- 0.2	0.6 +/- 0.2	<LDL	<LDL	<LDL	ND
10779	<2	0.2 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10780	<2	1.3 +/- 0.3	1.9 +/- 0.4	<LDL	<LDL	<LDL	ND
10781	<2	0.5 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10782	<2	0.2 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10783	<2	0.2 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10784	<2	0.7 +/- 0.3	0.8 +/- 0.3	<LDL	<LDL	<LDL	ND
10785	<2	0.7 +/-0.1	1.0 +/- 0.1	<LDL	<LDL	<LDL	ND
10786	<2	0.5 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
10787	<2	0.2 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10788	<2	0.6 +/- 0.1	0.9 +/- 0.1	<LDL	<LDL	<LDL	ND
10789	<2	0.2 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10790	<2	0.6 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10791	<2	0.9 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10792	<2	0.7 +/- 0.1	0.8 +/- 0.1	1.0 +/- 0.1	<LDL	<LDL	ND
10794	<2	0.2 +/- 0.3	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10795	<2	0.7 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10796	<2	0.9 +/- 0.3	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10797	<2	0.7 +/- 0.3	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND

10798	<2	0.5 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10799	<2	0.7 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
10800	<2	0.6 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10801	<2	0.5 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10802	<2	0.2 +/- 0.2	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10803	<2	0.8 +/- 0.2	1.0 +/- 0.3	<LDL	<LDL	<LDL	ND
10804	<2	0.5 +/- 0.2	0.5 +/- 0.2	<LDL	<LDL	<LDL	ND
10805	<2	0.4 +/- 0.2	0.7 +/- 0.2	<LDL	<LDL	<LDL	ND
10806	<2	0.4 +/- 0.2	1.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10807	<2	0.6 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10808	<2	0.4 +/- 0.2	0.8 +/- 0.2	<LDL	<LDL	<LDL	ND
10809	<2	0.8 +/- 0.3	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10810	<2	0.6 +/- 0.2	1.0 +/- 0.2	<LDL	<LDL	<LDL	ND
10811	<2	0.6 +/- 0.2	0.9 +/- 0.3	<LDL	<LDL	<LDL	ND
10812	<2	0.5 +/- 0.2	0.9 +/- 0.2	<LDL	<LDL	<LDL	ND
10812	<2	0.2 +/- 0.21	0.2 +/- 0.2	<LDL	<LDL	<LDL	ND
10814	<2	0.2 +/- 0.2	0.4 +/- 0.2	<LDL	<LDL	<LDL	ND


UNOFFICIAL DATA
~~OFFICIAL USE ONLY~~
NOTES:
1 SAMPLES WERE TAKEN ~6' FROM PERIMETER FENCE LINE.
2. NUMBERS INDICATE INDIVIDUAL RUN-OFF LOCATIONS
3 NUMBERS/LETTERS INDICATE OTHER SAMPLE LOCATIONS
PERIMETER FENCE
SAMPLE LOCATIONS (TYP) (SEE NOTE #1)
SCALE IN FEET
UNOFFICIAL DATA
~~OFFICIAL USE ONLY~~
ORIGINAL ISSUE
ENVIRONMENTAL SURVEY PROJECT
ON-SITE PERIMETER CORE SAMPLE LOCATIONS
NOTED
SHT 1 OF 10

UNOFFICIAL DATA

~~OFFICIAL USE ONLY~~

Number = 0.01000016 ~~%~~ (LFE)

CORE SAMPLE RESULTS

1-1	0.00273 (LFE)
1-2	0.00273 (LFE)
1-3	
1-4	
1-5	

2-1	0.000658 ± 0.000655
2-2	0.000028 ± 0.000073
2-3	0.000094 ± 0.000112
2-4	ND

3A-1	0.000174 ± 0.000268

3B-1	0.000476 ± 0.000551

3C-1	0.000221 ± 0.000318
3C-2	0.000047 ± 0.000105
3C-3	0.000074 ± 0.000145
3C-4	ND
3C-5	ND

3D-1	0.000017 ± 0.000051
3D-2	0.000062 ± 0.000128
3D-3	0.000048 ± 0.000097
3D-4	ND
3D-5	ND

3E-1	0.000087 ± 0.000164
3E-2	0.000055 ± 0.000118
3E-3	0.000005 ± 0.000021
3E-4	ND
3E-5	ND

4A-1	ND

4B-1	0.000060 ± 0.000125
4B-2	0.000036 ± 0.000087
4B-3	0.000041 ± 0.000095
4B-4	ND

4C-1	0.000089 ± 0.000167
4C-2	0.000028 ± 0.000012
4C-3	0.000045 ± 0.000102
4C-4	ND

4D-1	0.000071 ± 0.000142
4D-2	0.000001 ± 0.000008
4D-3	0.000296 ± 0.000393
4D-4	ND

4E-1	0.000073 ± 0.000144
4E-2	0.000103 ± 0.000184
4E-3	ND
4E-4	ND

4F-1	0.000232 ± 0.000329
4F-2	0.000208 ± 0.000305
4F-3	0.000128 ± 0.000215
4F-4	ND
4F-5	ND

4G-1	0.00179 ± 0.00142
4G-2	0.00133 ± 0.00094
4G-3	0.000107 ± 0.000189
4G-4	ND

NOTES:

1. FIRST NUMBER OR NUMBER/LETTER INDICATES THE SAMPLE LOCATION REFER TO NRC DWG NO. SC740539
2. THE NUMBER FOLLOWING THE DASH REPRESENTS A ONE (1) FOOT SECTION OF THE CORE AT THE INDICATED DEPTH
3. ALL VALUES ARE IN NANOCURIES/GRAM (nCi/g) NANOCURIES= 10^{-9} CURIES = 2220 DISINTEGRATION/MIN

UNOFFICIAL DATA

MONSANTO RESEARCH CORPORATION

PROGRAM TITLE ENVIRONMENTAL SURVEY PROJ.

DRAWING TITLE ON-SITE PERIMETER CORE SAMPLE LOCATIONS

DRAWN BY HLS DATE 8/4/78

SCALE NONE

JOB NO. 740533

DWG. NO. SC 740539 SH 2 OF 10

DWG. CLASSIFICATION

LEVEL & CAT. UNCL.

BY RFA

TITLE

DATE 7/17/79

CODE IDENT. NO 14085

REV	DATE	REVISION	BY	CHK'D	APVD
0		ORIGINAL ISSUE			

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CORE SAMPLE RESULTS

5A-1	0.000149 ± 0.000240
5A-2	0.000045 ± 0.000102

5B-1	0.000343 ± 0.000436
5B-2	0.000091 ± 0.000169

5C-1	0.000323 ± 0.000418
5C-2	0.000009 ± 0.000031
5C-3	0.000059 ± 0.000114

5D-1	0.000065 ± 0.000132
5D-2	0.000022 ± 0.000061
5D-3	0.000009 ± 0.000032

5E-1	0.000234 ± 0.000331
5E-2	0.000017 ± 0.000052
5E-3	0.000054 ± 0.000116
5E-4	NO
5E-5	NO

5F-1	0.000046 ± 0.000104
5F-2	0.000016 ± 0.000048
5F-3	0.000018 ± 0.000053
5F-4	NO

6-1	0.000042 ± 0.000097
6-2	0.000077 ± 0.000150
6-3	0.000059 ± 0.000116
6-4	NO

7A-1	0.000098 ± 0.000178
7A-2	0.000020 ± 0.000056
7A-3	0.000008 ± 0.000030
7A-4	
7A-5	

7B-1	0.000035 ± 0.000090
7B-2	0.000051 ± 0.000112
7B-3	YES

7C-1	0.000137 ± 0.000226
7C-2	0.000029 ± 0.000074

7D-1	0.000039 ± 0.000091
7D-2	0.000138 ± 0.000227
7D-3	0.000049 ± 0.000106
7D-4	

7E-1	0.000063 ± 0.000129
7E-2	0.000030 ± 0.000076
7E-3	0.000030 ± 0.000075
7E-4	
7E-5	

8A-1	0.000045 ± 0.000102
8A-2	NO
8A-3	0.000109 ± 0.000192
8A-4	NO
8A-5	NO

8B-1	0.000029 ± 0.000074
8B-2	0.000027 ± 0.000072
8B-3	0.000165 ± 0.000258
8B-4	NO

8C-1	0.000037 ± 0.000088
8C-2	YES
8C-3	0.000118 ± 0.000202
8C-4	NO
8C-5	NO

NOTES:

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2. THE NUMBER FOLLOWING THE DASH REPRESENTS A ONE (1) FOOT SECTION OF THE CORE AT THE INDICATED DEPTH
3. ALL VALUES ARE IN NANOCURIES/GRAM (nCi/g) · NANOCURIES = 10^{-9} CURIES = 2220 DISINTEGRATION/MIN

UNOFFICIAL DATA

MONSANTO RESEARCH CORPORATION
MIAMISBURG, OHIO

PROGRAM TITLE: ENVIRONMENTAL SURVEY PROJ.

DRAWING TITLE: ON-SITE PERIMETER CORE SAMPLE LOCATIONS

DWG. TYPE:
DWG. CLASSIFICATION
LEVEL & CAT. UNCLASS.
BY R.C.A.
TITLE
DATE 7/19/74

DESIGNED HLC DATE 8/4/11
CHECKED DATE
DESIGN ENG. DATE
APVD DATE
SCALE NONE
JOB NO. 740533
DWG NO. SC 740539 SH 3 OF 10
CODE IDENT NO 14065

REV	DATE	REVISION	BY	CHKD	APVD	M
A		ORIGINAL ISSUE				

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CORE SAMPLE RESULTS

8D-1	0.000079 ± 0.000153
8D-2	0.000151 ± 0.000242
8D-3	0.000095 ± 0.000174
8D-4	N.O.
8D-5	N.O.

8E-1	0.000027 ± 0.000070
8E-2	0.000019 ± 0.000056
8E-3	0.000088 ± 0.000165
8E-4	N.O.
8E-5	N.O.

9A-1	YES
9A-2	0.000762 ± 0.000772
9A-3	0.000169 ± 0.000256
9A-4	N.O.
9A-5	N.O.

9B-1	0.000038 ± 0.000091
9B-2	0.000016 ± 0.000048
9B-3	0.000030 ± 0.000076
9B-4	N.O.
9B-5	N.O.

9C-1	0.0360 ± 0.0124
9C-2	0.0153 ± 0.0066
9C-3	0.000706 ± 0.000731
9C-4	
9C-5	

9D-1	0.000132 ± 0.000220
9D-2	0.000045 ± 0.000101
9D-3	0.000641 ± 0.000828
9D-4	0.000691 ± 0.000720
9D-5	YES

10-1	0.000155 ± 0.000246
10-2	0.000085 ± 0.000161
10-3	N.O.
10-4	N.O.
10-5	N.O.

11-1	0.000583 ± 0.000637
11-2	0.000466 ± 0.000543
11-3	YES
11-4	YES
11-5	0.000145 ± 0.000235

12-1	0.0510 ± 0.00301
12-2	0.00208 ± 0.00158
12-3	0.00130 ± 0.00113
12-4	N.O.
12-5	N.O.

13-1	0.000526 ± 0.000591
13-2	0.00137 ± 0.00117
13-3	0.000678 ± 0.000705
13-4	N.O.
13-5	N.O.

14A-1	0.000333 ± 0.000427
14A-2	0.00101 ± 0.00095
14A-3	0.000093 ± 0.000171
14A-4	N.O.
14A-5	N.O.

14B-1	0.000349 ± 0.000441
14B-2	0.000353 ± 0.000445
14B-3	N.O.
14B-4	N.O.
14B-5	N.O.

NOTES:

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UNOFFICIAL DATA

MONSANTO RESEARCH CORPORATION
MIAMISBURG, OHIO

PROGRAM TITLE ENVIRONMENTAL SURVEY PROJECT

DRAWING TITLE ON SITE PERIMETER CORE SAMPLE LOCATIONS

DWG. TYPE

DWG. CLASSIFICATION

LEVEL & CAT. N/A
BY R.E.R.
TITLE
DATE 7/27/77

DRAWN HLS DATE 8/14/77
CHECKED DATE
DESIGN ENG. DATE
APPD DATE

SCALE NONE
JOB NO 740533
DWG NO SC 740539 SH 4 OF 10

CODE IDENT NO 14065

REV	DATE	REVISION	BY	CHK'D	APPD	M
A		ORIGINAL ISSUE				

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CORE SAMPLE RESULTS

14C-1	0.125 ± 0.030
14C-2	0.000740 ± 0.000756
14C-3	0.000085 ± 0.000161
14C-4	"
14C-5	"

? X

14D-1	0.000699 ± 0.000725
14D-2	0.000090 ± 0.000168
14D-3	0.000085 ± 0.000161
14D-4	"
14D-5	"

15A-1	0.000862 ± 0.000843
15A-2	0.000046 ± 0.000104
15A-3	0.00126 ± 0.00110
15A-4	0.00108 ± 0.00099
15A-5	0.000139 ± 0.000229

15B-1	0.000562 ± 0.000620
15B-2	0.000162 ± 0.000255
15B-3	0.000976 ± 0.000921
15B-4	0.000471 ± 0.000546
15B-5	0.000129 ± 0.000216

15C-1	0.000083 ± 0.000158
15C-2	NOT DETECTED
15C-3	0.000017 ± 0.000051
15C-4	"
15C-5	"

16A-1	0.000099 ± 0.000179
16A-2	0.000020 ± 0.000057
16A-3	0.000067 ± 0.000136
16A-4	"
16A-5	"

16B-1	0.000134 ± 0.000222
16B-2	0.000035 ± 0.000085
16B-3	0.00281 ± 0.00196
16B-4	0.000069 ± 0.000138
16B-5	0.000090 ± 0.000094

16C-1	0.000145 ± 0.000235
16C-2	0.000196 ± 0.000237
16C-3	0.000073 ± 0.000100
16C-4	"
16C-5	"

17-1	0.000312 ± 0.000407
17-2	0.000085 ± 0.000160
17-3	0.000064 ± 0.000120
17-4	"
17-5	"

18-1	0.000250 ± 0.000347
18-2	0.000126 ± 0.000212
18-3	0.000059 ± 0.000123
18-4	"
18-5	"

19A-1	0.000048 ± 0.000107
19A-2	0.000049 ± 0.000109
19A-3	0.000139 ± 0.000228
19A-4	"
19A-5	"

19B-1	0.000389 ± 0.000477
19B-2	0.000147 ± 0.000238
19B-3	0.000139 ± 0.000229
19B-4	"
19B-5	"

NOTES:

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UNOFFICIAL DATA

~~OFFICIAL USE ONLY~~

MONSANTO RESEARCH CORPORATION

PROGRAM TITLE ENVIRONMENTAL SURVEY PROJECT

DRAWING TITLE ON-SITE PERIMETER CORE SAMPLE LOCATIONS

DWG CLASSIFICATION

LEVEL & CAT. UNCL

BY RCB

TITLE

DATE 5/14/74

DRAWN HLS DATE 5/14/74

SCALE NONE

TOP NO. 740539

DWG NO. SC740539 SH 5 OF 10

CONFIDENT NO. 4065

A		ORIGINAL ISSUE				
	DATE	REMARKS	BY	CHKD	APPD	

SC740539
SH 6 OF 10

UNOFFICIAL DATA

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CORE SAMPLE RESULTS

19C-1	0.000199 ±0.000295
19C-2	0.000042 ±0.000097
19C-3	0.000071 ±0.000142
19C-4	" "
19C-5	" "

21-1	0.004377 ±0.00269
21-2	0.000825 ±0.000816
21-3	0.000753 ±0.000765
21-4	" "
21-5	" "

22E-1	0.000019 ±0.000055
22E-2	0.000021 ±0.000039
22E-3	0.000007 ±0.000028
22E-4	" "
22E-5	" "

20A-1	0.000119 ±0.000203
20A-2	0.000045 ±0.000102
20A-3	0.000055 ±0.000118
20A-4	" "
20A-5	" "

22A-1	0.000069 ±0.000138
22A-2	0.000037 ±0.000177
22A-3	" "
22A-4	" "
22A-5	" "

23A-1	0.000129 ±0.000216
23A-2	0.000015 ±0.000047
23A-3	0.000050 ±0.000168
23A-4	"
23A-5	"

20B-1	0.000198 ±0.000294
20B-2	0.000175 ±0.000269
20B-3	0.000360 ±0.000451
20B-4	" "
20B-5	"

22B-1	0.000050 ±0.000109
22B-2	0.000008 ±0.000030
22B-3	0.000016 ±0.000049
22B-4	0.000010 ±0.000035
22B-5	0.000335 ±0.000428

NOTES:

1. FIRST NUMBER OR NUMBER/LETTER INDICATES THE SAMPLE LOCATION REFER TO MRC DWG NO SC740539
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3. ALL VALUES ARE IN NANOCURIES/GRAM (nCi/g) NANOCURIES = 10^{-9} CURIES = 2220 DISINTEGRATION/MIN.

20C-1	0.0208 ±0.0082
20C-2	0.000338 ±0.000431
20C-3	0.00106 ±0.00098
20C-4	" "
20C-5	" "

22C-1	0.000148 ±0.000239
22C-2	0.000554 ±0.000614
22C-3	0.000049 ±0.000108
22C-4	0.000027 ±0.000071
22C-5	0.000052 ±0.000113

20D-1	0.00385 ±0.00246
20D-2	0.000570 ±0.000627
20D-3	0.000701 ±0.000727
20D-4	
20D-5	"

22D-1	0.000261 ±0.000358
22D-2	0.000038 ±0.000030
22D-3	0.000011 ±0.000038
22D-4	"
22D-5	" "

UNOFFICIAL DATA

MONSANTO RESEARCH CORPORATION
MIAMISBURG LABORATORY
MIAMISBURG, OHIO

PROGRAM TITLE: ENVIRONMENTAL SURVEY PROJECT

DRAWING TITLE: ON-SITE PERIMETER CORE SAMPLE LOCATIONS

DWG TYPE

DWG CLASSIFICATION

TEMPLATE: UNCL.
BY: [illegible]
TITLE
DATE: [illegible]

DRAWN: LILS DATE: 11/14/74
CHECKED
DESIGN ENG.
APPD
SCALE: NONE
JOB NO: 740523
W.O. NO.
DWG NO: SC 740539 SH 6 OF 10
CODE IDENT NO 14065

REV	DATE	REVISION	BY	CHK'D	APP'D	M
A		ORIGINAL ISSUE				

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UNOFFICIAL DATA

~~OFFICIAL USE ONLY~~

CORE SAMPLE RESULTS

23B-1	0.000041 ± 0.000095
23B-2	YES
23B-3	0.000166 ± 0.000259
23B-4	
23B-5	

23C-1	0.000045 ± 0.000103
23C-2	0.000047 ± 0.000.05
23C-3	0.000057 ± 0.000121
23C-4	

24A-1	0.000498 ± 0.000569
24A-2	0.000087 ± 0.000163
24A-3	0.000277 ± 0.000374
24A-4	
24A-5	

24B-1	0.00487 ± 0.00291
24B-2	0.000064 ± 0.000131
24B-3	YES
24B-4	

24C-1	0.000197 ± 0.000293
24C-2	0.000042 ± 0.000097
24C-3	0.000126 ± 0.000213
24C-4	

24D-1	0.00526 ± 0.00307
24D-2	0.000505 ± 0.000575
24D-3	0.000270 ± 0.000368
24D-4	

24E-1	0.00790 ± 0.0041
24E-2	YES
24E-3	0.000343 ± 0.000436
24E-4	

24F-1	0.0326 ± 0.0113
24F-2	0.00134 ± 0.00115
24F-3	0.000586 ± 0.000639
24F-4	
24F-5	

25-1	0.000291 ± 0.000388
25-2	0.000067 ± 0.000136
25-3	0.000121 ± 0.000207
25-4	

26-1	0.000211 ± 0.000307
26-2	YES

27-1	0.00864 ± 0.00439
27-2	0.00304 ± 0.00208
27-3	0.000.26 ± 0.000212

28-1	0.0141 ± 0.0062
28-2	0.00232 ± 0.00171
28-3	0.00149 ± 0.00125
28-4	
28-5	

29-1	0.0106 ± 0.00098
29-2	0.000114 ± 0.000139
29-3	0.000255 ± 0.000353
29-4	
29-5	

NOTES:

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2. THE NUMBER FOLLOWING THE DASH REPRESENTS A ONE (1) FOOT SECTION OF THE CORE AT THE INDICATED DEPTH
3. ALL VALUES ARE IN NANOCURIES/GRAM (nCi/g) NANOCURIES= 10^{-9} CURIES = 2220 DISINTEGRATION/MIN

UNOFFICIAL DATA

MONSANTO RESEARCH CORPORATION

PROGRAM TITLE ENVIRONMENTAL SURVEY PROJ.

DRAWING TITLE ON SITE PERIMETER CORE SAMPLE LOCATIONS

DRAWN HLS

SCALE NONE

DWG NO SC740539 SH 7 OF 10

CODE IDENT NO 14065

REV	DATE	REVISION	BY	CHK'D	APPD	M
A		ORIGINAL ISSUE				

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SC740539
SH 8 OF 10

UNOFFICIAL DATA

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CORE SAMPLE RESULTS

30-1	0.00309 ± 0.00210
30-2	0.000291 ± 0.000387
30-3	0.000071 ± 0.000141
30-4	0.000118 ± 0.000203
30-5	0.000021 ± 0.000059

31-1	0.000168 ± 0.000241
31-2	0.000021 ± 0.000060
31-3	YES
31-4	NO
31-5	NO

32-1	0.000154 ± 0.000245
32-2	0.000071 ± 0.000141
32-3	0.000171 ± 0.000265
32-4	NO
32-5	NO

33-1	0.000252 ± 0.000350
33-2	0.000023 ± 0.000063
33-3	0.000071 ± 0.000141
33-4	NO
33-5	NO

34-1	0.000164 ± 0.000257
34-2	0.000045 ± 0.000102
34-3	0.000069 ± 0.000139
34-4	NO
34-5	NO

35A-1	0.000074 ± 0.000146
35A-2	YES
35A-3	0.000107 ± 0.000190
35A-4	NO

35B-1	0.000037 ± 0.000088
35B-2	0.000007 ± 0.000026
35B-3	0.000073 ± 0.000153
35B-4	NO
35B-5	NO

35C-1	0.000083 ± 0.000158
35C-2	0.000016 ± 0.000048
35C-3	0.000007 ± 0.000026
35C-4	YES
35C-5	NO

35D-1	0.000060 ± 0.000126
35D-2	0.000751 ± 0.000764
35D-3	0.000100 ± 0.000180
35D-4	NO
35D-5	NO

36-1	0.000032 ± 0.000080
36-2	0.000009 ± 0.000033
36-3	NO
36-4	NO
36-5	NO

37-1	0.000274 ± 0.000371
37-2	0.000091 ± 0.000165
37-3	0.000906 ± 0.000873
37-4	NO
37-5	NO

NOTES:

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3. ALL VALUES ARE IN NANOCURIES/GRAM (nCi/g) NANOCURIES = 10^{-9} CURIES = 2220 DISINTEGRATION/MIN

UNOFFICIAL DATA

MONSANTO RESEARCH CORPORATION
MIAMISBURG, OHIO

PROGRAM TITLE: ENVIRONMENTAL SURVEY PROJECT

DRAWING TITLE: ON-SITE PERIMETER CORE SAMPLE LOCATIONS

DRAWN: HLS DATE: 8/4/76

CHECKED: DATE:

DESIGN ENG: DATE:

APVD: DATE:

SCALE: NONE

PO NO:

JOB NO: 74-533

DWG NO: SC740539 SHEET 8 OF 10

DWG CLASSIFICATION
LEVEL & CAT. UNCL.
BY RCA
TITLE
DATE 2/9/77

CODE IDENT NO 14065

A		ORIGINAL ISSUE			
REV	DATE	REVISION	BY	CHK'D	APVD

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SC740539
SH 5 OF 10

UNOFFICIAL DATA

~~OFFICIAL USE ONLY~~

CORE SAMPLE RESULTS

38-1	YES
38-2	0.000081 ± 0.000135
38-3	0.000041 ± 0.000096
38-4	N.D.
38-5	N.D.

39-1	0.000028 ± 0.000073
39-2	0.000036 ± 0.000088
39-3	0.000077 ± 0.000149
39-4	N.D.

40-1	0.000102 ± 0.000183
40-2	0.000032 ± 0.000080
40-3	0.000118 ± 0.000202
40-4	N.D.
40-5	N.D.

41A-1	0.000198 ± 0.000294
41A-2	0.000017 ± 0.000050
41A-3	0.000088 ± 0.000164
41A-4	N.D.
41A-5	N.D.

41B-1	0.000050 ± 0.000110
41B-2	0.000023 ± 0.000063
41B-3	0.000432 ± 0.000514
41B-4	[illegible]

41C-1	0.000080 ± 0.000154
41C-2	0.000070 ± 0.000140

41D-1	0.000257 ± 0.000355
41D-2	0.000157 ± 0.000249
41D-3	0.000018 ± 0.000053
41D-4	N.D.

41E-1	0.000765 ± 0.000774
41E-2	0.000052 ± 0.000114
41E-3	0.000446 ± 0.000526
41E-4	N.D.
41E-5	N.D.

42-1	0.000286 ± 0.000383

43-1	0.000033 ± 0.000082
43-2	0.000026 ± 0.000068

44-1	0.000036 ± 0.000086
44-2	0.000040 ± 0.000093
44-3	0.000057 ± 0.000121

45-1	0.000034 ± 0.000084
45-2	0.000008 ± 0.000030
45-3	0.000091 ± 0.000169
45-4	[illegible]

46A-1	0.000074 ± 0.000145
46A-2	0.000085 ± 0.000160
46A-3	0.000153 ± 0.000244
46A-4	N.D.
46A-5	N.D.

46B-1	0.000089 ± 0.000165
46B-2	0.000473 ± 0.000548
46B-3	0.000008 ± 0.000029
46B-4	N.D.

NOTES:

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UNOFFICIAL DATA

MONSANTO RESEARCH CORPORATION
MIAMISBURG, OHIO

PROGRAM TITLE: ENVIRONMENTAL SURVEY PROJECT

DRAWING TITLE: ON-SITE PERIMETER CORE SAMPLE LOCATIONS

DRAWN BY: HLS DATE: 8/18/78

CHECKED DATE

DESIGN ENG DATE

APVD DATE

SCALE: NONE

JOB NO: 740533

DWG NO: SC740539 SH 5 OF 10

DWG. CLASSIFICATION
LEVEL & CAT. UU
BY KEA
TITLE
DATE 7/10/79

CODE IDENT. NO 14065

REV	DATE	REVISION	BY	CHK'D	APV'D	M
A		ORIGINAL ISSUE				

~~OFFICIAL USE ONLY~~

SC740539 SH 10 OF 10

UNOFFICIAL DATA

~~OFFICIAL USE ONLY~~

CORE SAMPLE RESULTS

46C-1	0.000117 ±0.000272
46C-2	0.000119 ±0.000204
46C-3	0.000073 ±0.000144
46C-4	NO

46D-1	0.000088 ±0.000164
46D-2	0.000014 ±0.000044
46D-3	0.000009 ±0.000033
46D-4	NO
46D-5	NO

46E-1	0.000053 ±0.000114
46E-2	0.000045 ±0.000102
46E-3	0.000072 ±0.000142

47A-1	0.000056 ±0.000163
47A-2	0.000049 ±0.000108
47A-3	0.000094 ±0.000172

47B-1	0.000543 ±0.000606
47B-2	0.000149 ±0.000240
47B-3	0.000035 ±0.000084
47B-4	NO
47B-5	NO

48A-1	0.00205 ± 0.00157
48A-2	YES
48A-3	0.000114 ±0.000199
48A-4	NO

48B-1	0.00158 ±0.00130
48B-2	0.000195 ±0.000291

48C-1	0.00120 ±0.00106
48C-2	0.000145 ±0.000235
48C-3	0.000334 ±0.000427

48D-1	0.000738 ±0.000754
48D-2	0.000127 ±0.000213
48D-3	0.000124 ±0.000210

48E-1	0.000532 ±0.000596
48E-2	0.000323 ±0.000417
48E-3	0.000404 ±0.000490

49A-1	0.000086 ±0.000161
49A-2	0.000216 ±0.000313

49B-1	0.000341 ±0.000434
49B-2	0.000126 ±0.000213
49B-3	NO
49B-4	NO
49B-5	NO

49C-1	YES
49C-2	0.000178 ±0.000273
49C-3	YES
49C-4	NO

49D-1	0.000060 ±0.000125
49D-2	0.000093 ±0.000171
49D-3	0.000059 ±0.000124

49E-1	0.000486 ±0.000559
49E-2	0.000207 ±0.000304
49E-3	0.000051 ±0.000111
49E-4	NO
49E-5	NO

NOTES:

1. FIRST NUMBER OR NUMBER/LETTER INDICATES THE SAMPLE LOCATION. REFER TO MRC DRG NO SC740539
2. THE NUMBER FOLLOWING THE DASH REPRESENTS A ONE (1) FOOT SECTION OF THE CORE AT THE INDICATED DEPTH.
3. ALL VALUES ARE IN NANOCURIES/GRAM (nC)/g). NANOCURIES = 10^{-9} CURIES = 2220 DISINTEGRATION/MIN

UNOFFICIAL DATA

MONSANTO RESEARCH CORPORATION
MOUND LABORATORY
MIAMISBURG, OHIO

PROGRAM TITLE: ENVIRONMENTAL SURVEY PROJ
DRAWING TITLE: ON-SITE PERIMETER CORE SAMPLE LOCATIONS

DWG TYPE
DWG CLASSIFICATION
LEVEL & CAT. Unclas
BY NSA
TITLE
DATE 8/9/74

DR NUMBER 111.5	DATE 8/14/74	PROJ NUM.	
CHECKER	DATE	ORIG. DR.	
REVIEW ENG	DATE	ORIG. DATE	
APVD	DATE		
SCALE NONE		P.O. NO	
JOB NO. 740533		DWG NO SC740539 SH 10 OF 10	

CODE IDENT NO 14065

ISS	DATE	REVISION	BY	CHK'D	APV'D	N
A		ORIGINAL ISSUE				

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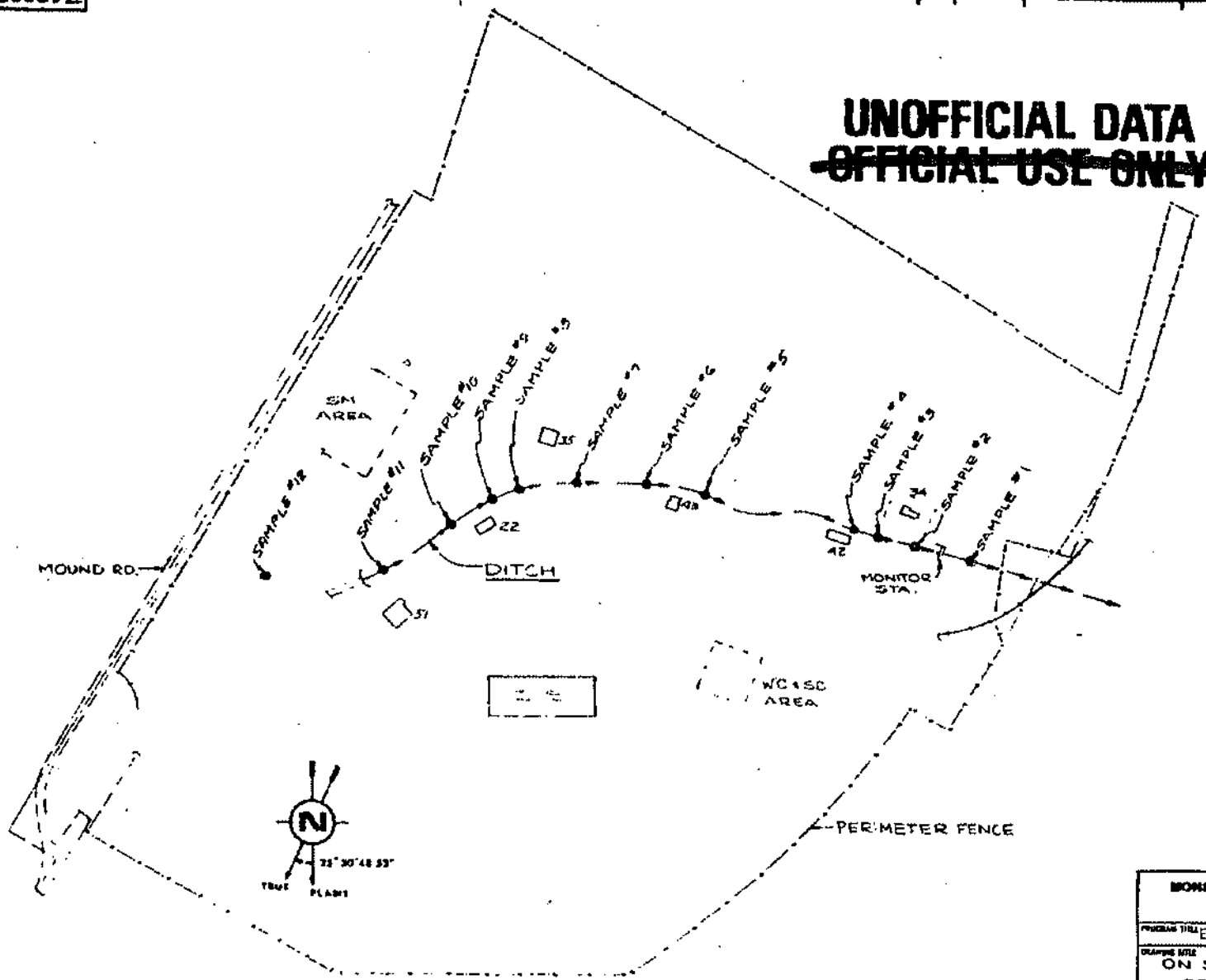
740722



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A		ORIGINAL ISSUE	
REV	DATE	REVISION	BY

DWG. TYPE
DWG. CLASSIFICATION
LEVEL & CAT. UNCL
BY RCR
TITLE
DATE 7-17-74
CODE IDENT NO 14066

MONSANTO RESEARCH CORPORATION
MOUND LABORATORY
MIAMISBURG, OHIO

PROGRAM TITLE ENVIRONMENTAL SURVEY PROJECT
DRAWING TITLE ON SITE CORE SAMPLES EFFLUENT DITCH

DESIGNED HCS	DATE 7/9/74	PROJ. ENGR.
CHECKED	DATE 7/9/74	ARCH. DIR.
DESIGN ENG.	DATE	ENG. MGR.
APPD	DATE	
SCALE NOTED		W.O. NO
JOB NO 740533	DWG NO SC740722 SHT 1 OF 2	

nCi/g

UNOFFICIAL DATA

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CORE SAMPLE RESULTS - DITCH

D1-1	0.0116 ± 0.0054
D1-2	0.000611 ± 0.000658
D1-3	0.000059 ± 0.000123
D1-4	0.000579 ± 0.000468
D1-5	0.000506 ± 0.000576

0.159 (LFE) silt
0.000001 (LFE) water

D1A-1	
D1A-2	
D1A-3	0.133 (LFE)
D1A-4	
D1A-5	

D2-1	0.0975 ± 0.0249
D2-2	0.0434 ± 0.0139
D2-3	0.000682 ± 0.000713
D2-4	0.000290 ± 0.000386
D2-5	0.000095 ± 0.000174

0.124 (LFE) silt
0.000002 (LFE) water

D3-1	0.00297 ± 0.00204
D3-2	0.000136 ± 0.000224
D3-3	0.000269 ± 0.000367
D3-4	0.000321 ± 0.000416
D3-5	0.000440 ± 0.000520

0.261 (LFE) silt
0.000004 (LFE) water

D4-1	0.0444 ± 0.0142
D4-2	0.000619 ± 0.000664
D4-3	0.000033 ± 0.000052
D4-4	0.000068 ± 0.000137
D4-5	0.000036 ± 0.000119

0.251 (LFE) silt
0.000003 (LFE) water

D5-1	0.115 ± 0.029
D5-2	0.244 ± 0.048
D5-3	0.144 ± 0.033
D5-4	0.000129 ± 0.000246
D5-5	0.000034 ± 0.000084

D6-1	0.535 ± 0.084
D6-2	0.0556 ± 0.0166
D6-3	0.00217 ± 0.00163
D6-4	0.000816 ± 0.000810
D6-5	0.000507 ± 0.000577

D7-1	0.162 ± 0.036
D7-2	0.0118 ± 0.0055
D7-3	0.000409 ± 0.000494
D7-4	0.000427 ± 0.000510
D7-5	0.000203 ± 0.000299

D8-1	
D8-2	0.00120 ± 0.00107
D8-3	0.000246 ± 0.000344
D8-4	0.000027 ± 0.000070
D8-5	0.000067 ± 0.000136

0.541 (LFE) silt
0.000003 (LFE) water

D9-1	0.00208 ± 0.00158
D9-2	
D9-3	0.000211 ± 0.000308
D9-4	0.000143 ± 0.000233
D9-5	0.000181 ± 0.000276

0.075 (LFE) silt
0.000003 (LFE) water

D10-1	0.00687 ± 0.00372
D10-2	0.000293 ± 0.000389
D10-3	0.000057 ± 0.000121
D10-4	0.000079 ± 0.000152
D10-5	0.00125 ± 0.00112

D11-1	0.0111 ± 0.0058
D11-2	0.508 ± 0.081
D11-3	0.236 ± 0.047
D11-4	0.0121 ± 0.0200
D11-5	0.0525 ± 0.0160

0.322 (LFE) silt
0.000009 (LFE) water

D12-1	0.000277 ± 0.000374
D12-2	0.000211 ± 0.000307
D12-3	0.000025 ± 0.000061
D12-4	0.000133 ± 0.000221
D12-5	0.000028 ± 0.000012

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UNOFFICIAL DATA

MONSANTO RESEARCH CORPORATION

PROJECT TITLE: ENVIRONMENTAL SURVEY PROJECT

ON SITE CORE SAMPLES
EFFLUENT DITCH

DRAWN: HLS

740522

MSC 740722
SHT 2 OF 2

EG&G-MOUND Inter-office Memo

From : CONSTRUCTION HEALTH PHYSICS
(JOE DICKEY & KEITH MCMAHAN)

Date : MARCH 23, 1989

Subject : URANIUM CLEANUP AT BLDG 34

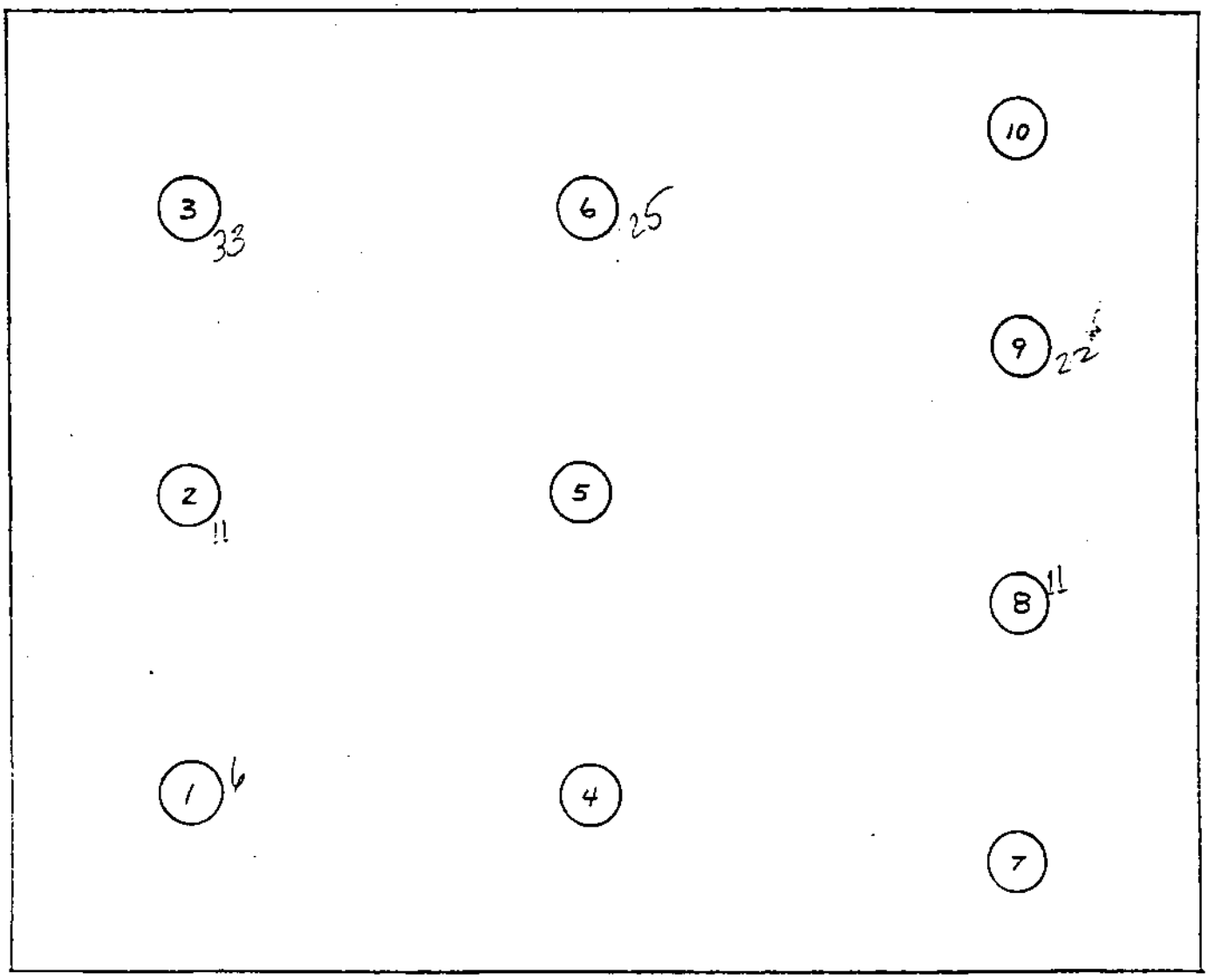
Reference :

To : DISTRIBUTION

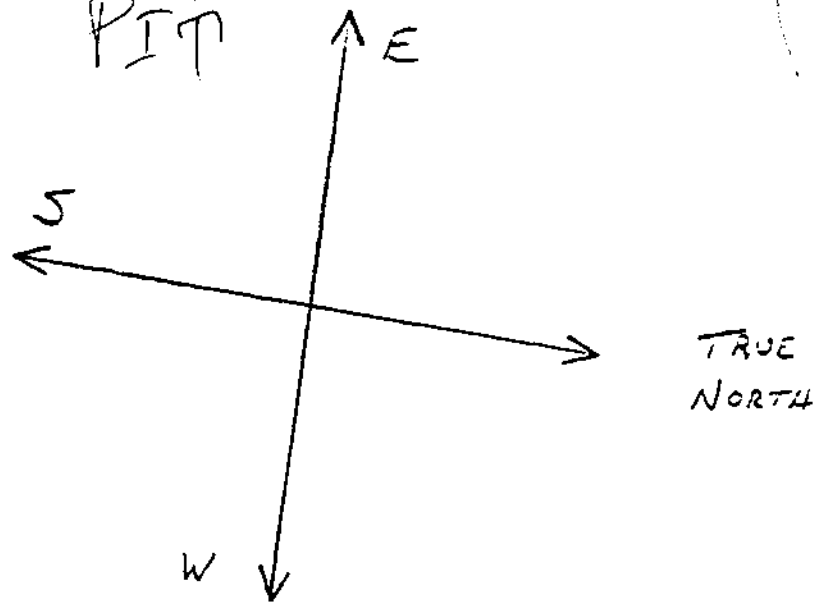
On March 16, 1989, clean up of depleted Uranium at the building 34 burn pit area was conducted. All personnel in the area were wearing blue radiation area clothing, shoe covers, gloves, half-mask respirators, hard hats and safety glasses. Air surrounding the area was sampled by 3 high volume vacuum pumps: one upstream of the excavation, one downstream, and one in the vicinity. All high volume filters were checked with a gas PAC at 15 minute intervals to ensure the contamination was not becoming airborne.

Decontamination of the area was performed until fidler readings were less than 1000 cpm above background on the out channel. At this point 10 soil samples were taken and sent to be gamma scanned to ensure the cleanup was completed.

Attached are a map, sample spots, and sample results.



CONTAMINATED AREA SAMPLE SPOTS
(AFTER DECON.)



NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: ____ Phone: ____

Product Code or Project No.: ____ Q.C. No.: ____ Requested ~~Completion~~ Date: 3/16/89

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg #34 - 1

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 - (Uranium)

Anal. Sample ID's: H89-0307 (2030.50M)

Results: (Pci/g)

Nuclide	Concentration ± Uncertainty
Pb-210	0.120 ± 0.07
Pb-214	0.209 ± 0.005
Bi-214	0.236 ± 0.007
RA-226	0.223 ± 0.006
Th-234	2.07 ± 0.027
RA-223	0.042 ± 0.001
U-235	0.027 ± 0.001
PA-234m	5.70 ± 0.270
Pb-212	0.092 ± 0.001
TL-208	0.039 ± 0.001
AC-228	0.168 ± 0.001
K-40	4.10 ± 0.080

DISTRIBUTION:

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Received by: ____

Analyzed by: Jack Y Jarvis 3/20/89

MRC-ML-1527 (7-82)

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: ____ Phone: ____

Product Code or Project No. ____ Q.C. No. ____ ~~Requested~~ Completion Date: 3/16/89

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34 - #2

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 - (Uranium)

Anal. Sample ID's: H89-0308 (1015.SPM)

Results:

Nuclide	Concentration (pCi/g) ± 1 sigma
Pb-214	0.199 ± 0.001
Bi-214	0.278 ± 0.001
Ra-226	0.239 ± 0.001
Th-234	2.54 ± 0.03
Ra-223	0.024 ± 0.001
U-235	0.035 ± 0.001
Pa-234m	10.6 ± 0.380
Pb-212	0.101 ± 0.001
Tl-208	0.057 ± 0.001
Ac-228	0.202 ± 0.001
Cs-137	0.010 ± 0.001

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Received by: ____

Analyzed by: Jack Y. Jarvis 3/20/89

MRC-ML-1527 (7-82)

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: Phone:

Product Code or Project No.: O.C. No.: Requested ~~Completion~~ Date: 3-16-89

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34 # 3

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 (Uranium)

Anal. Sample ID's: H89-0.317 (2071.5/m)

Results:

Nuclide	Concentration (Pci/g) ± 1 sigma
Pb-210	~~0.551~~ 0.511 ± 0.009
Pb-214	0.170 ± 0.001
Th-234	6.47 ± 0.06
Pa-234m	33.5 ± 1.18
Pb-212	0.091 ± 0.006
Tl-208	0.035 ± 0.004
Ac-228	0.132 ± 0.014
K-40	3.20 ± 0.105

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Received by:

Analyzed by: Jack Y. Jarvis 3/21/89

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: [ ] Phone: ____

Product Code or Project No.: ____ Q.C. No.: ____ Requested Completion Date: 3/16/89

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34 # 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 (Uranium)

Anal. Sample ID's: H89-0320 (2072.5Am)

Results:

Nuclide:	Concentration (Pci/g) ± 1 sigma
Pb-210	0.247 ± 0.028
Pb-214	0.300 ± 0.008
Th-234	0.479 ± 0.038
RA-223	0.043 ± 0.007
Pb-212	0.147 ± 0.007
TL-208	0.060 ± 0.005
AC-228	0.251 ± 0.016
Bi-214	0.336 ± 0.011
K-40	6.02 ± 0.139
RA-226	0.318 ± 0.020

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Analyzed by: Jack Y. Jarin 3/21/89

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: ____ Phone: ____

Product Code or Project No.: ____ Q.C. No.: ____ Requested ~~Completion~~ Date: 3/16/89

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34 #5

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 (Uranium)

Anal. Sample ID's: H89-0321 (2033 SPM)

Results:

Nuclide	Concentration ± 1 sigma (Bq/g)
Pb-210	0.347 ± 0.106
Pb-214	0.317 ± 0.012
Th-234	1.19 ± 0.057
Pb-212	0.174 ± 0.011
Ac-228	0.218 ± 0.025
Bi-214	0.350 ± 0.016
K-40	6.54 ± 0.206
Ra-226	0.334 ± 0.023

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Received by: [illegible] 3/21/89

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: ____ Phone: ____

Product Code or Project No.: ____ Q.C. No.: ____ Requested Completion Date: 3/16/84

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34 #6

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 (Uranium)

Anal. Sample ID's: H89-0322 (1018.5 pm)

Results:

Nuclide	Concentration (Bq/g) ± 1 Sigma
Pb-214	0.108 ± 0.008
Th-234	6.77 ± 0.099
Pa-234m	25.0 ± 1.04
Pb-212	0.055 ± 0.005
Tl-208	0.032 ± 0.005
Ac-228	0.101 ± 0.018

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NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: [ ] Phone: _____

Product Code or Project No. _____ Q.C. No. _____ Requested ~~Completion~~ Date: 3/16/89

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34 # 7

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 (Uranium)

Anal. Sample ID's: H89-0331 (1019.5 gm)

Results:

Nuclide	Concentration (Pci/g) ± 1 sigma
Pb-214	0.179 ± 0.006
Th-234	1.14 ± 0.046
Pb-212	0.072 ± 0.003
Tl-208	0.042 ± 0.003
Ac-228	0.143 ± 0.014
Bi-214	0.251 ± 0.012
Ra-226	0.215 ± 0.051

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Received by: _____

Analyzed by: Jack Y Jones 3/22/89

MRC-MJ-1527 (7-82)

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: ____ Phone: ____

Product Code or Project No.: ____ Q.C. No.: ____ Requested Completion Date: 3/16/89

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34 #8

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 (uranium)

Anal. Sample ID's: H89-~~2034~~ 0232 (2034, 5/m)

Results: Nuclide	Concentration (Pci/g) ± 1 sigma
Pb-210	0.127 ± 0.075
Pb-214	0.284 ± 0.008
Th-234	3.14 ± 0.042
Ra-223	0.065 ± 0.008
Pa-234m	11.5 ± 0.63
Pb-212	0.141 ± 0.008
Tl-208	0.061 ± 0.005
Ac-228	0.235 ± 0.015
Bi-214	0.310 ± 0.011
Ra-226	0.297 ± 0.018
K-40	5.81 ± 0.14

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Received by: Arch H. Davis 3/22/89

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: [ ] Phone: _____

Product Code or Project No. _____ Q.C. No. _____ Requested ~~Completion~~ Date: 3/16/89

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34 #9

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 (uranium)

Anal. Sample ID's: #89-0333 (1020 SPM)

Results:

Nuclide	Concentration (Pci/g) ± 1 sigma
Pb-214	0.143 ± 0.009
Th-234	1.49 ± 0.097
PA-234m	21.9 ± 1.25
Pb-212	0.082 ± 0.006
Tl-208	0.642 ± 0.006
AC-228	0.169 ± 0.021
Bi-214	0.186 ± 0.017
RA-226	0.164 ± 0.030

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Received by _____

Analyzed by: Jack L Davis 3/22/89

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: _____ Phone: _____

Product Code or Project No.: _____ Q.C. No.: _____ Requested Completion Date: 3/16/89

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34 #10

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 (uranium)

Anal. Sample ID's: H89-0334 (2035.5CM) (Soil/g)

Results:

Nuclide	Concentration ± 1 sigma
Pb-210	0.567 ± 0.063
Pb-214	0.206 ± 0.007
Th-234	0.552 ± 0.030
Pb-212	0.111 ± 0.006
Tl-208	0.046 ± 0.004
Ac-228	0.151 ± 0.015
~~[illegible]~~ JJ 3/24/89	
K-40	5.21 ± 0.122

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Received by: _____

Analyzed by: Frank Y. Francis 3/22/89

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Doug Draper Mail Station: _____ Phone: _____

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

Type of Sample (or Service): Soil

Requestor Sample ID's: Bldg 34, 6/17/87

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 scan this sample for isotopes

Anal. Sample ID's: H89-0102 3/3/89

Results:

Nuclide	Concentration ± 2 sigma
Th-234 & U-238	6,340 ± 127
Pa-234m	141,266 ± 1130
U-235	161 ± 12
Th-228	30,252 ± 4445

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Received by _____

Analyzed by Jack H. Harris 3/3/89

MRC-ML-1527 (7-82)

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Keith McMahan Mail Station: [ ] Phone: 3937

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

Type of Sample (or Service): 1" X 1" X ¼ solid slab

Requestor Sample ID's: Bldg 34

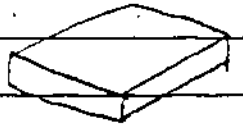
Sample Disposition: ☐ Discard ☑ Return

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

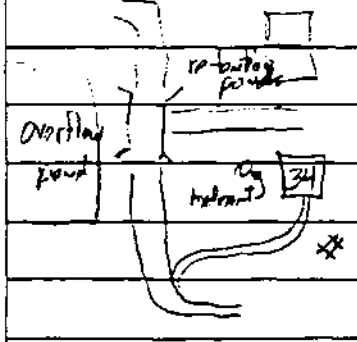
Analysis Desired, Comments

Anal. Sample ID's: Bldg 34

Results: U - 238 > 12-20-1988
U - 235 > sample extremely high in
U 238 > 500,000 pci/g
U 235 > 3000 pci/g



solid slab found by Keith McMahan
in Bldg. 34 while looking for
U after pile of dirt put back
in hole around H_2O hydrant.



U not found on surface of soil is probably
in proximity of hydrant.

NEV: 8/20/91 Keith indicates no U <3' around hydrant. Did
find filter particles near where box was under hydrant
when dirt hole didn't get put back underground

DISTRIBUTION:

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Received by _____

Analyzed by Zach Kami

MRC-ML-1527 (7-82)

SOIL SCREENING FACILITY BUILDING 30
MRC MOUND
WELL A & B

SAMPLE TYPE CONT
SAMPLE CONDITION WET
DATE SCREENED 06/30/87
DATE COLLECTED 06/30/87
SAMPLER NAME & HP [redacted]3810

WELL: ID.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PU-238	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION
A	15705	300	0.167	7797	1654	13.0	16	BLD 55 WEST
A	15706	300	0.167	62461	14067	107.3	573	RAILROAD LOADING BY TR 15

Doug -
these are the two samples Chet
of I told you about
Roy Mower

PREPARED BY : TROY J. FEARSON III
ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN THIS REPORT .

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 (416 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: 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.

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Received by _____

Analyzed by Jack G Jarvis 8/28/90

ML-1527 (7-82)

17-1094

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Keith McMahan 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 #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: 590 - 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.

DISTRIBUTION:

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GOLDENROD COPY - REQUESTOR'S RECEIPT

ML-1527 (7-82)

Received by _____

Analyzed by Jack Y Jarvis 8/28/90

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: 590-1399

Results:

Nuclide:	Concentration ± 1 Sigma (pCi/g)
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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Received by _____

Analyzed by Jack Y. Jarvis 8/28/90

ML-1527 (7-82)
17-1094

NUCLEAR OPERATIONS ANALYTICAL REQUEST FOR ANALYSIS

TO BE FILLED OUT BY REQUESTOR

Requested by: Keith Mc Mahon 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 # 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: 590 – 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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Received by: _____

Analyzed by: Jack Y. Jarvis 8/28/90

ML-1527 (7-82)
17-1296

SOIL SCREENIG FACILITY
Data Management System

Type of sampled CONT
DAILY REPORT FOR July 11,1988

	SAMPLE NUMBER	DATE SCREEN	SAMPLER	SAMPLE TYPE	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION	WELL ID
1	8807111	07/11/88	[redacted] 5520	CONT	0.9	5	W2600 X S3200 #1	B
2	8807112	07/11/88	[redacted] 5520	CONT	0.6	28	W2600 X S3200 #2	A
3	8807113	07/11/88	[redacted] 5520	CONT	0.7	18	W2600 X S3200 #3	C
4	8807114	07/11/88	[redacted] 5520	CONT	1.2	67	W2600 X S3200 #4	C
5	8807115	07/11/88	[redacted] 5520	CONT	0.8	16	W2600 X S3200 #5	A
6	8807116	07/11/88	[redacted] 5520	CONT	1.0	52	W2600 X S3200 #6	B
7	8807117	07/11/88	[redacted] 5520	CONT	0.9	31	W2600 X S3200 #7	C
8	8807118	07/11/88	[redacted] 5520	CONT	1.5	131	W2600 X S3200 #8	A
9	8807119	07/11/88	[redacted] 5520	CONT	2.1	109	W2600 X S3200 #9	B

9 samples West of SM-PP WATER TOWER

≅ 1' Deep

880713

To be rmvd as part of Orphan Soil project.

Keith McMahan
5518

dirt

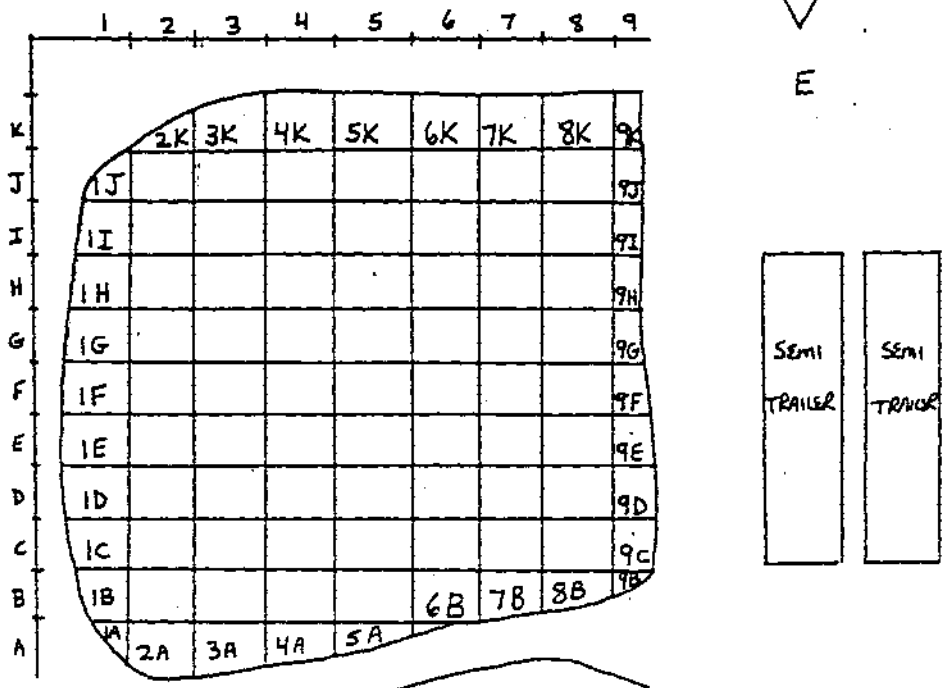
(originally from cleanout of Main Drain)

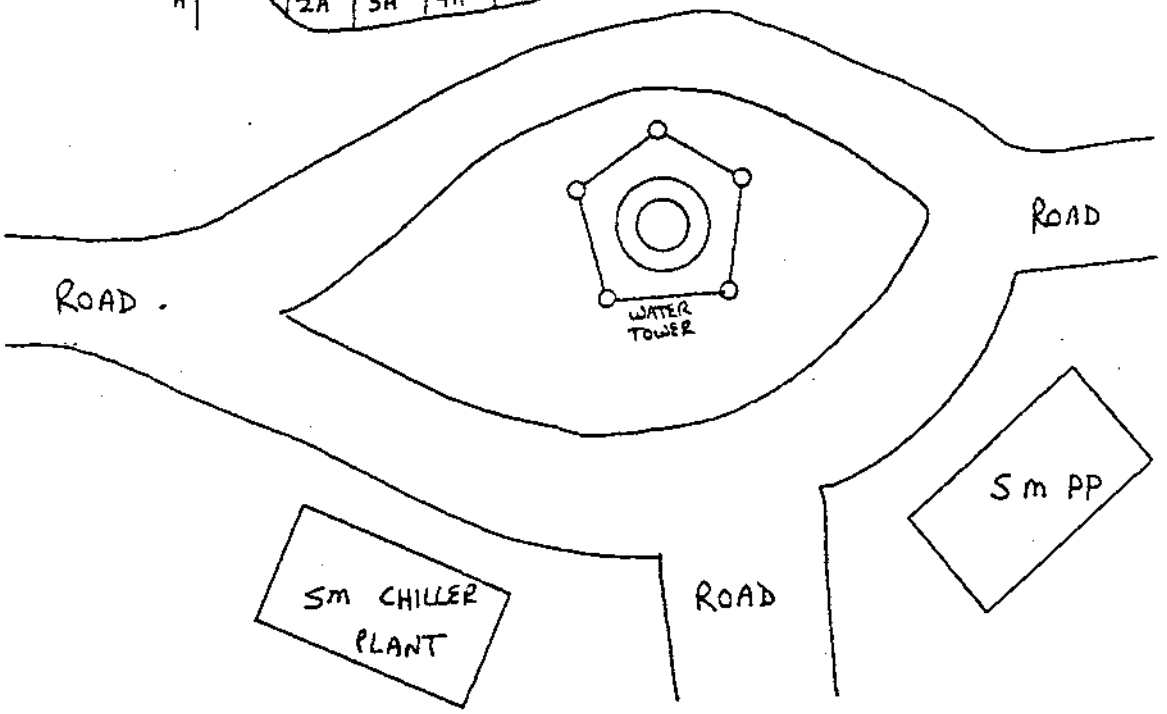
PREPARED BY : TROY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN THIS REPORT . [ANY QUESTION CALL EXT.4408]

OS H_2O

DSC 881108
① DDD scraped dirt into pile
② Filled 150 boxes
③ Spread remaining dirt out.





SURVEY CONDUCTED 9-22-88 BY THE FOLLOWING H.P. PERSONNEL:

KEITH McMAHAN GREG FULLENKAMP ERIC COLLINS

ROY MOWEN JOE DICKEY

2 SAMPLES FROM EACH 10' x 10' GRID

NO FIDLER READINGS > 200 cpm OVER BACKGROUND

SOIL SCREENIG FACILITY
Data Management System

CONT Sample's, taken by [redacted] 5518
DAILY REPORT FOR September 26,1988

SAMPLE NUMBER	DATE SCREEN	SAMPLER	SAMPLE TYPE	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION	WELL ID
1	09/26/88	[redacted] 5518	CONT	1.2		53: 1A) W2600 X S3150 DS H2O	C
2	09/26/88	5518	CONT	1.6		59: 1B) W2600 X S3150 DS H2O	C
3	09/26/88	5518	CONT	1.3		54: 1C) W2600 X S3150 DS H2O	C
4	09/26/88	5518	CONT	0.5		42: 1C) W2600 X S3150 DS H2O	B
5	09/26/88	5518	CONT	0.6		23: 1D) W2600 X S3150 DS H2O	B
6	09/26/88	5518	CONT	0.6		30: 1E) W2600 X S3150 DS H2O	B
7	09/26/88	5518	CONT	1.5		47: 1E) W2600 X S3150 DS H2O	C
8	09/26/88	5518	CONT	0.6		37: 1F) W2600 X S3150 DS H2O	B
9	09/26/88	5518	CONT	1.3		42: 1G) W2600 X S3150 DS H2O	C
10	09/26/88	5518	CONT	1.2		36: 1H) W2600 X S3150 DS H2O	C
11	09/26/88	5518	CONT	0.6		31: 1H) W2600 X S3150 DS H2O	B
12	09/26/88	5518	CONT	0.6		31: 1I) W2600 X S3150 DS H2O	B
13	09/26/88	5518	CONT	0.6		31: 1J) W2600 X S3150 DS H2O	B
14	09/26/88	5518	CONT	1.3		44: 2A) W2600 X S3150 DS H2O	C
15	09/26/88	5518	CONT	0.5		48: 2B) W2600 X S3150 DS H2O	B
16	09/26/88	5518	CONT	0.6		42: 2B) W2600 X S3150 DS H2O	B
17	09/26/88	5518	CONT	1.3		56: 2D) W2600 X S3150 DS H2O	C
18	09/26/88	5518	CONT	0.6		42: 2D) W2600 X S3150 DS H2O	B
19	09/26/88	5518	CONT	1.3		44: 2E) W2600 X S3150 DS H2O	C
20	09/26/88	5518	CONT	0.5		41: 2E) W2600 X S3150 DS H2O	B
21	09/26/88	5518	CONT	1.3		28: 2F) W2600 X S3150 DS H2O	C
22	09/26/88	5518	CONT	0.5		34: 2G) W2600 X S3150 DS H2O	B
23	09/26/88	5518	CONT	0.6		42: 2H) W2600 X S3150 DS H2O	B
24	09/26/88	5518	CONT	1.4		37: 2I) W2600 X S3150 DS H2O	C
25	09/26/88	5518	CONT	1.1		34: 2I) W2600 X S3150 DS H2O	C
26	09/26/88	5518	CONT	1.3		44: 2J) W2600 X S3150 DS H2O	C
27	09/26/88	5518	CONT	0.4		34: 2J) W2600 X S3150 DS H2O	B
28	09/26/88	5518	CONT	1.1		46: 2K) W2600 X S3150 DS H2O	C
29	09/26/88	5518	CONT	0.5		44: 3A) W2600 X S3150 DS H2O	B
30	09/26/88	5518	CONT	1.4		48: 3A) W2600 X S3150 DS H2O	C
31	09/26/88	5518	CONT	0.5		42: 3B) W2600 X S3150 DS H2O	B
32	09/26/88	5518	CONT	1.7		55: 3D) W2600 X S3150 DS H2O	C
33	09/26/88	5518	CONT	1.9		79: 3D) W2600 X S3150 DS H2O	C
34	09/26/88	5518	CONT	1.5		57: 3D) W2600 X S3150 DS H2O	C
35	09/26/88	5518	CONT	0.5		53: 3E) W2600 X S3150 DS H2O	B
36	09/26/88	5518	CONT	0.7		48: 3F) W2600 X S3150 DS H2O	B
37	09/26/88	5518	CONT	1.6		50: 3G) W2600 X S3150 DS H2O	C
38	09/26/88	5518	CONT	1.6		51: 3G) W2600 X S3150 DS H2O	C
39	09/26/88	5518	CONT	0.4		33: 3H) W2600 X S3150 DS H2O	B
40	09/26/88	5518	CONT	0.4		49: 3I) W2600 X S3150 DS H2O	B
41	09/26/88	[redacted] 5518	CONT	1.7		63: 3J) W2600 X S3150 DS H2O	C

PREPARED BY : MARY D. PEARSON III

SOIL SCREENIG FACILITY
Data Management System

CONT Sample's, taken by [redacted] 5518
DAILY REPORT FOR September 26,1988

SAMPLE NUMBER	DATE SCREEN	SAMPLER	SAMPLE TYPE	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION	WELL ID
1 88092664	09/26/88	[redacted] 5518	CONT	1.2	121	3K> W2600 X S3150 DS H20	3
2 88092665	09/26/88	5518	CONT	0.7	32	4A> W2600 X S3150 DS H20	3
3 88092666	09/26/88	5518	CONT	1.2	44	4A> W2600 X S3150 DS H20	3
4 88092669	09/26/88	5518	CONT	0.7	42	4C> W2600 X S3150 DS H20	3
5 88092670	09/26/88	5518	CONT	2.0	142	4C> W2600 X S3150 DS H20	3
6 88092671	09/26/88	5518	CONT	1.5	57	4D> W2600 X S3150 DS H20	3
7 88092673	09/26/88	5518	CONT	1.5	65	4E> W2600 X S3150 DS H20	3
8 88092674	09/26/88	5518	CONT	0.5	39	4E> W2600 X S3150 DS H20	3
9 88092677	09/26/88	5518	CONT	0.5	69	4G> W2600 X S3150 DS H20	3
10 88092678	09/26/88	5518	CONT	1.0	122	4G> W2600 X S3150 DS H20	3
11 88092680	09/26/88	5518	CONT	0.9	147	4H> W2600 X S3150 DS H20	3
12 88092681	09/26/88	5518	CONT	0.5	30	4I> W2600 X S3150 DS H20	3
13 88092682	09/26/88	5518	CONT	0.5	34	4I> W2600 X S3150 DS H20	3
14 88092685	09/26/88	5518	CONT	1.4	26	4K> W2600 X S3150 DS H20	3
15 88092686	09/26/88	5518	CONT	1.4	41	4K> W2600 X S3150 DS H20	3
16 88092687	09/26/88	5518	CONT	1.9	43	5A> W2600 X S3150 DS H20	3
17 88092688	09/26/88	5518	CONT	0.9	67	5A> W2600 X S3150 DS H20	3
18 88092689	09/26/88	5518	CONT	2.0	41	5B> W2600 X S3150 DS H20	3
19 88092691	09/26/88	5518	CONT	0.5	25	5D> W2600 X S3150 DS H20	3
20 88092693	09/26/88	5518	CONT	1.1	41	5D> W2600 X S3150 DS H20	3
21 88092694	09/26/88	5518	CONT	0.5	45	5D> W2600 X S3150 DS H20	3
22 88092696	09/26/88	5518	CONT	1.7	52	5E> W2600 X S3150 DS H20	3
23 88092698	09/26/88	5518	CONT	0.6	35	5F> W2600 X S3150 DS H20	3
24 88092699	09/26/88	5518	CONT	1.4	40	5G> W2600 X S3150 DS H20	3
28880926100	09/26/88	5518	CONT	0.5	40	5G> W2600 X S3150 DS H20	3
26880926103	09/26/88	5518	CONT	1.1	36	5I> W2600 X S3150 DS H20	3
27880926104	09/26/88	5518	CONT	0.4	35	5I> W2600 X S3150 DS H20	3
28880926105	09/26/88	5518	CONT	1.4	30	5J> W2600 X S3150 DS H20	3
29880926107	09/26/88	5518	CONT	1.4	43	5K> W2600 X S3150 DS H20	3
30880926108	09/26/88	5518	CONT	0.3	26	5K> W2600 X S3150 DS H20	3
31880926109	09/26/88	5518	CONT	0.6	51	6B> W2600 X S3150 DS H20	3
32880926111	09/26/88	5518	CONT	0.5	34	6C> W2600 X S3150 DS H20	3
33880926114	09/26/88	5518	CONT	0.5	33	6D> W2600 X S3150 DS H20	3
34880926115	09/26/88	5518	CONT	1.7	55	6E> W2600 X S3150 DS H20	3
35880926116	09/26/88	5518	CONT	1.7	58	6E> W2600 X S3150 DS H20	3
36880926117	09/26/88	5518	CONT	0.3	26	6F> W2600 X S3150 DS H20	3
37880926118	09/26/88	5518	CONT	0.3	16	6G> W2600 X S3150 DS H20	3
38880926121	09/26/88	5518	CONT	1.7	59	6H> W2600 X S3150 DS H20	3
39880926122	09/26/88	5518	CONT	1.1	37	6H> W2600 X S3150 DS H20	3
40880926123	09/26/88	5518	CONT	0.6	24	6I> W2600 X S3150 DS H20	3
41880926125	09/26/88	[redacted] 5518	CONT	0.5	75	6J> W2600 X S3150 DS H20	3

PREPARED BY : [illegible] VERSION [illegible]

SOIL SCREENIG FACILITY
Data Management System

CONT Sample's, taken by [redacted] 5518
DAILY REPORT FOR September 26,1988

SAMPLE NUMBER	DATE SCREEN	SAMPLER	SAMPLE TYPE	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION	WE ID
1880926127	09/26/88	[redacted] 5518	CONT	1.0		26: 6K> W2600 X S3150 OS H20	
2880926128	09/26/88	5518	CONT	1.3		41: 6K> W2600 X S3150 OS H20	
3880926129	09/26/88	5518	CONT	1.4		52: 7B> W2600 X S3150 OS H20	
4880926130	09/26/88	5518	CONT	0.6		43: 7B> W2600 X S3150 OS H20	
5880926132	09/26/88	5518	CONT	0.6		25: 7C> W2600 X S3150 OS H20	
6880926134	09/26/88	5518	CONT	1.1		40: 7D> W2600 X S3150 OS H20	
7880926136	09/26/88	5518	CONT	0.4		37: 7E> W2600 X S3150 OS H20	
8880926137	09/26/88	5518	CONT	1.2		33: 7F> W2600 X S3150 OS H20	
9880926139	09/26/88	5518	CONT	1.0		23: 7G> W2600 X S3150 OS H20	
10880926140	09/26/88	5518	CONT	0.3		4: 7G> W2600 X S3150 OS H20	
11880926142	09/26/88	5518	CONT	0.3		11: 7H> W2600 X S3150 OS H20	
12880926143	09/26/88	5518	CONT	1.5		65: 7I> W2600 X S3150 OS H20	
13880926145	09/26/88	5518	CONT	1.6		78: 7J> W2600 X S3150 OS H20	
14880926146	09/26/88	5518	CONT	0.3		24: 7J> W2600 X S3150 OS H20	
15880926147	09/26/88	5518	CONT	0.5		35: 7K> W2600 X S3150 OS H20	
16880926149	09/26/88	5518	CONT	1.8		71: 7K> W2600 X S3150 OS H20	
17880926150	09/26/88	5518	CONT	0.4		23: 8B> W2600 X S3150 OS H20	
18880926151	09/26/88	5518	CONT	0.3		11: 8C> W2600 X S3150 OS H20	
19880926153	09/26/88	5518	CONT	0.7		32: 8D> W2600 X S3150 OS H20	
20880926155	09/26/88	5518	CONT	0.4		27: 8E> W2600 X S3150 OS H20	
21880926156	09/26/88	5518	CONT	1.1		43: 8E> W2600 X S3150 OS H20	
22880926159	09/26/88	5518	CONT	1.6		50: 8G> W2600 X S3150 OS H20	
23880926160	09/26/88	5518	CONT	0.9		39: 8G> W2600 X S3150 OS H20	
24880926161	09/26/88	5518	CONT	0.6		29: 8H> W2600 X S3150 OS H20	
25880926162	09/26/88	5518	CONT	0.4		27: 8H> W2600 X S3150 OS H20	
26880926163	09/26/88	5518	CONT	1.4		45: 8J> W2600 X S3150 OS H20	
27880926166	09/26/88	5518	CONT	0.8		103: 8J> W2600 X S3150 OS H20	
28880926168	09/26/88	5518	CONT	0.4		10: 8K> W2600 X S3150 OS H20	
29880926169	09/26/88	5518	CONT	0.3		30: 9B> W2600 X S3150 OS H20	
30880926170	09/26/88	5518	CONT	0.4		0: 9B> W2600 X S3150 OS H20	
31880926172	09/26/88	5518	CONT	1.1		27: 9C> W2600 X S3150 OS H20	
32880926173	09/26/88	5518	CONT	0.3		8: 9D> W2600 X S3150 OS H20	
33880926175	09/26/88	5518	CONT	0.2		27: 9E> W2600 X S3150 OS H20	
34880926176	09/26/88	5518	CONT	1.1		32: 9E> W2600 X S3150 OS H20	
35880926177	09/26/88	5518	CONT	0.3		6: 9E> W2600 X S3150 OS H20	
36880926179	09/26/88	5518	CONT	1.2		39: 9G> W2600 X S3150 OS H20	
37880926181	09/26/88	5518	CONT	1.0		41: 9H> W2600 X S3150 OS H20	
38880926182	09/26/88	5518	CONT	0.4		15: 9H> W2600 X S3150 OS H20	
39880926185	09/26/88	5518	CONT	1.5		12: 9J> W2600 X S3150 OS H20	
40880926186	09/26/88	5518	CONT	0.5		-1: 9J> W2600 X S3150 OS H20	
41880926187	09/26/88	5518	CONT	0.8		14: 9K> W2600 X S3150 OS H20	

SOIL SCREENIG FACILITY
Data Management System

CONT Sample's, taken by [redacted] 5518
DAILY REPORT FOR September 26,1988

SAMPLE NUMBER	DATE SCREEN	SAMPLER	SAMPLE TYPE	TH 232 pCi/g	PU 239 pCi/g	GRID & SAMPLE LOCATION	WELL ID
19B0526155	09/26/88	[redacted] 5519	CONT	0.5		14: 9K> W2600 X 53150 05 H2L	5

SOIL SCREENIG FACILITY
Data Management System

CONT Sample's, taken by [redacted] 5518
DAILY REPORT FOR September 28,1988

SAMPLE NUMBER	DATE SCREEN	SAMPLER	SAMPLE TYPE	TH 232 pCi/g	PU 239 pCi/g	GRID & SAMPLE LOCATION	WELL ID
1 88092809	09/28/88	[redacted] 5518	CONT	0.9	.7	1A> W 2600 X S 3150 DS H20	E
2 88092810	09/28/88	5518	CONT	1.7	68	1B> W 2600 X S 3150 DS H20	C
3 88092811	09/28/88	5518	CONT	0.7	59	1D> W 2600 X S 3150 DS H20	E
4 88092812	09/28/88	5518	CONT	0.8	46	1F> W 2600 X S 3150 DS H20	E
5 88092813	09/28/88	5518	CONT	1.2	18	1G> W 2600 X S 3150 DS H20	C
6 88092814	09/28/88	5518	CONT	0.8	59	1I> W 2600 X S 3150 DS H20	E
7 88092815	09/28/88	5518	CONT	1.5	57	1J> W 2600 X S 3150 DS H20	C
8 88092816	09/28/88	5518	CONT	1.5	71	2A> W 2600 X S 3150 DS H20	C
9 88092817	09/28/88	5518	CONT	0.8	88	2D> W 2600 X S 3150 DS H20	E
10 88092818	09/28/88	5518	CONT	0.9	85	2E> W 2600 X S 3150 DS H20	E
11 88092819	09/28/88	5518	CONT	0.5	43	2F> W 2600 X S 3150 DS H20	E
12 88092820	09/28/88	5518	CONT	1.4	55	2G> W 2600 X S 3150 DS H20	C
13 88092821	09/28/88	5518	CONT	0.7	44	2H> W 2600 X S 3150 DS H20	E
14 88092822	09/28/88	5518	CONT	1.0	49	2K> W 2600 X S 3150 DS H20	C
15 88092823	09/28/88	5518	CONT	0.7	47	3B> W 2600 X S 3150 DS H20	E
16 88092824	09/28/88	5518	CONT	1.7	51	3D> W 2600 X S 3150 DS H20	C
17 88092825	09/28/88	5518	CONT	0.6	60	3E> W 2600 X S 3150 DS H20	E
18 88092826	09/28/88	5518	CONT	1.7	76	3F> W 2600 X S 3150 DS H20	C
19 88092827	09/28/88	5518	CONT	0.4	60	3H> W 2600 X S 3150 DS H20	E
20 88092828	09/28/88	5518	CONT	1.5	19	3I> W 2600 X S 3150 DS H20	C
21 88092829	09/28/88	5518	CONT	1.5	32	3J> W 2600 X S 3150 DS H20	C
22 88092830	09/28/88	5518	CONT	1.7	68	3K> W 2600 X S 3150 DS H20	E
23 88092831	09/28/88	5518	CONT	0.7	83	4B> W 2600 X S 3150 DS H20	E
24 88092832	09/28/88	5518	CONT	1.5	53	4D> W 2600 X S 3150 DS H20	C
25 88092833	09/28/88	5518	CONT	0.8	63	4E> W 2600 X S 3150 DS H20	E
26 88092834	09/28/88	5518	CONT	0.9	78	4F> W 2600 X S 3150 DS H20	E
27 88092835	09/28/88	5518	CONT	0.8	62	4F> W 2600 X S 3150 DS H20	E
28 88092836	09/28/88	5518	CONT	1.4	79	4G> W 2600 X S 3150 DS H20	C
29 88092837	09/28/88	5518	CONT	1.2	79	4I> W 2600 X S 3150 DS H20	C
30 88092838	09/28/88	5518	CONT	0.6	82	4K> W 2600 X S 3150 DS H20	E
31 88092839	09/28/88	5518	CONT	1.4	58	5B> W 2600 X S 3150 DS H20	C
32 88092840	09/28/88	5518	CONT	2.2	51	5D> W 2600 X S 3150 DS H20	C
33 88092841	09/28/88	5518	CONT	0.4	58	5E> W 2600 X S 3150 DS H20	E
34 88092842	09/28/88	5518	CONT	1.6	40	5F> W 2600 X S 3150 DS H20	C
35 88092843	09/28/88	5518	CONT	1.5	49	5H> W 2600 X S 3150 DS H20	C
36 88092844	09/28/88	5518	CONT	1.5	88	6H> W 2600 X S 3150 DS H20	C
37 88092845	09/28/88	5518	CONT	1.6	70	6J> W 2600 X S 3150 DS H20	C
38 88092846	09/28/88	5518	CONT	1.5	65	6K> W 2600 X S 3150 DS H20	C
39 88092847	09/28/88	5518	CONT	0.6	66	6D> W 2600 X S 3150 DS H20	E
40 88092848	09/28/88	5518	CONT	0.6	55	6D> W 2600 X S 3150 DS H20	E
41 88092849	09/28/88	[redacted] 5518	CONT	0.6	55	6F> W 2600 X S 3150 DS H20	E

PREPARED BY : TERRY D. PEARSON III

SOIL SCREENIG FACILITY
Data Management System

CONT Sample's, taken by [redacted] 5518
DAILY REPORT FOR September 28,1988

SAMPLE NUMBER	DATE SCREEN	SAMPLER	SAMPLE TYPE	TH 232 pCi/g	PU 239 pCi/g	GRID & SAMPLE LOCATION	WELL ID
1	3B092850	09/28/88 [redacted]	5518	CONT	0.4	41: 6E> W 2600 X S 3150 DS H2O	3
2	3B092851	09/28/88 [redacted]	5518	CONT	0.5	52: 6I> W 2600 X S 3150 DS H2O	3
3	3B092852	09/28/88 [redacted]	5518	CONT	1.5	46: 7C> W 2600 X S 3150 DS H2O	3
4	3B092853	09/28/88 [redacted]	5518	CONT	0.5	43: 7D> W 2600 X S 3150 DS H2O	3
5	3B092854	09/28/88 [redacted]	5518	CONT	0.4	45: 7E> W 2600 X S 3150 DS H2O	3
6	3B092855	09/28/88 [redacted]	5518	CONT	1.2	26: 7F> W 2600 X S 3150 DS H2O	3
7	3B092856	09/28/88 [redacted]	5518	CONT	0.5	39: 7H> W 2600 X S 3150 DS H2O	3
8	3B092857	09/28/88 [redacted]	5518	CONT	1.2	95: 7I> W 2600 X S 3150 DS H2O	3
9	3B092858	09/28/88 [redacted]	5518	CONT	1.1	45: 8B> W 2600 X S 3150 DS H2O	3
10	3B092859	09/28/88 [redacted]	5518	CONT	1.6	41: 8C> W 2600 X S 3150 DS H2O	3
11	3B092860	09/28/88 [redacted]	5518	CONT	1.1	50: 8D> W 2600 X S 3150 DS H2O	3
12	3B092861	09/28/88 [redacted]	5518	CONT	1.4	29: 8F> W 2600 X S 3150 DS H2O	3
13	3B092862	09/28/88 [redacted]	5518	CONT	1.0	42: 8F> W 2600 X S 3150 DS H2O	3
14	3B092863	09/28/88 [redacted]	5518	CONT	1.2	45: 8I> W 2600 X S 3150 DS H2O	3
15	3B092864	09/28/88 [redacted]	5518	CONT	1.2	53: 8I> W 2600 X S 3150 DS H2O	3
16	3B092865	09/28/88 [redacted]	5518	CONT	1.5	52: 8K> W 2600 X S 3150 DS H2O	3
17	3B092866	09/28/88 [redacted]	5518	CONT	0.2	15: 9C> W 2600 X S 3150 DS H2O	3
18	3B092867	09/28/88 [redacted]	5518	CONT	0.2	19: 9D> W 2600 X S 3150 DS H2O	3
19	3B092868	09/28/88 [redacted]	5518	CONT	0.5	47: 9F> W 2600 X S 3150 DS H2O	3
20	3B092869	09/28/88 [redacted]	5518	CONT	0.6	62: 9F> W 2600 X S 3150 DS H2O	3
21	3B092870	09/28/88 [redacted]	5518	CONT	0.5	47: 9I> W 2600 X S 3150 DS H2O	3
22	3B092871	09/28/88 [redacted]	5518	CONT	0.7	52: 9I> W 2600 X S 3150 DS H2O	3
23	3B092872	09/28/88 [redacted]	5518	CONT	0.7	65: 6J> W 2600 X S 3150 DS H2O	3

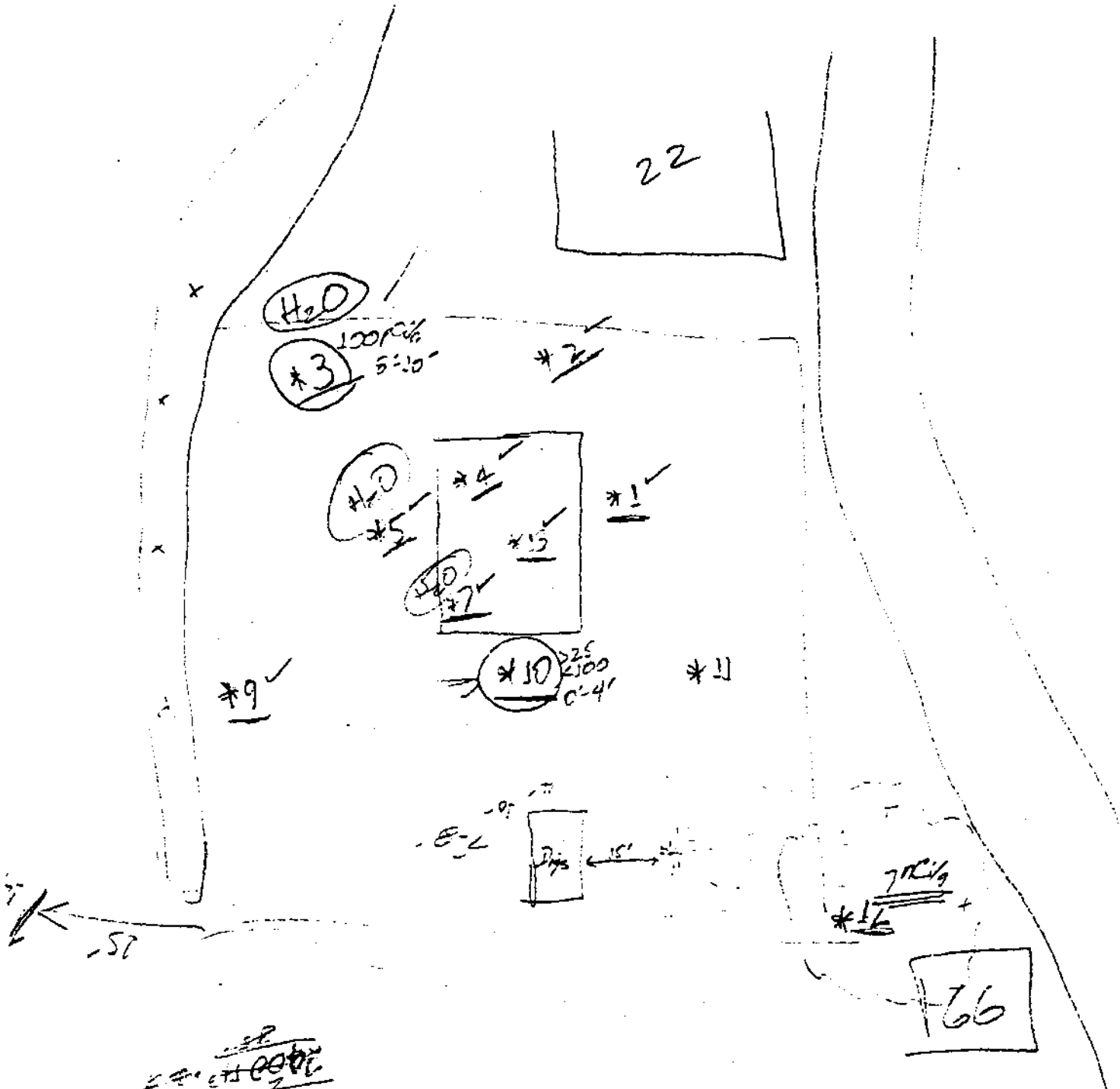
SOIL SCREENING FACILITY BUILDING 30
HRC MOUND
WELL B

SAMPLE TYPE CORI
SAMPLE CONDITION WET
DATE SCREENED 10/09/86
DATE COLLECTED 10/09/86
SAMPLER NAME & HP [redacted]3385

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PU-238	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION
34	13571	300	0.167	926	49117	0.6	6912	CORE BLDG 66 12 6' 4'-6'
35	13572	300	0.167	1315	797	1.1	0	CORE BLDG 66 12 8 6'-8'
36	13573	300	0.167	1057	1038	0.8	40	CORE BLDG 66 12 10 8'-10'
37	13574	300	0.167	832	702	0.5	-2	CORE BLDG 66 12 12' 10'-12'

PREPARED BY : IRBY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN


22
H2O
*3
100 PCi/g
5'-10'
*2
*4
*1
H2O
*5
*15
H2O
*7
*10
>25
<100
0'-4'
*11
*9
15'
7 PCi/g
*16
66
51

SOIL SCREENING FACILITY BUILDING 30
MRC MOUND
WELL A

SAMPLE TYPE CONT
SAMPLE CONDITION WET
DATE SCREENED 10/09/86
DATE COLLECTED 10/09/86
SAMPLER NAME & HP [redacted] 5385

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PU-238	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION
33	13568	300	0.167	390	455	0.0	0	CORE BLDG 66 12 SURFACE
34	13567	300	0.167	370	414	0.0	-5	CORE BLDG 66 12 2 0-2
35	13570	300	0.167	682	476	0.4	-4	CORE BLDG 66 12 4 2-4

PREPARED BY : TROY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN

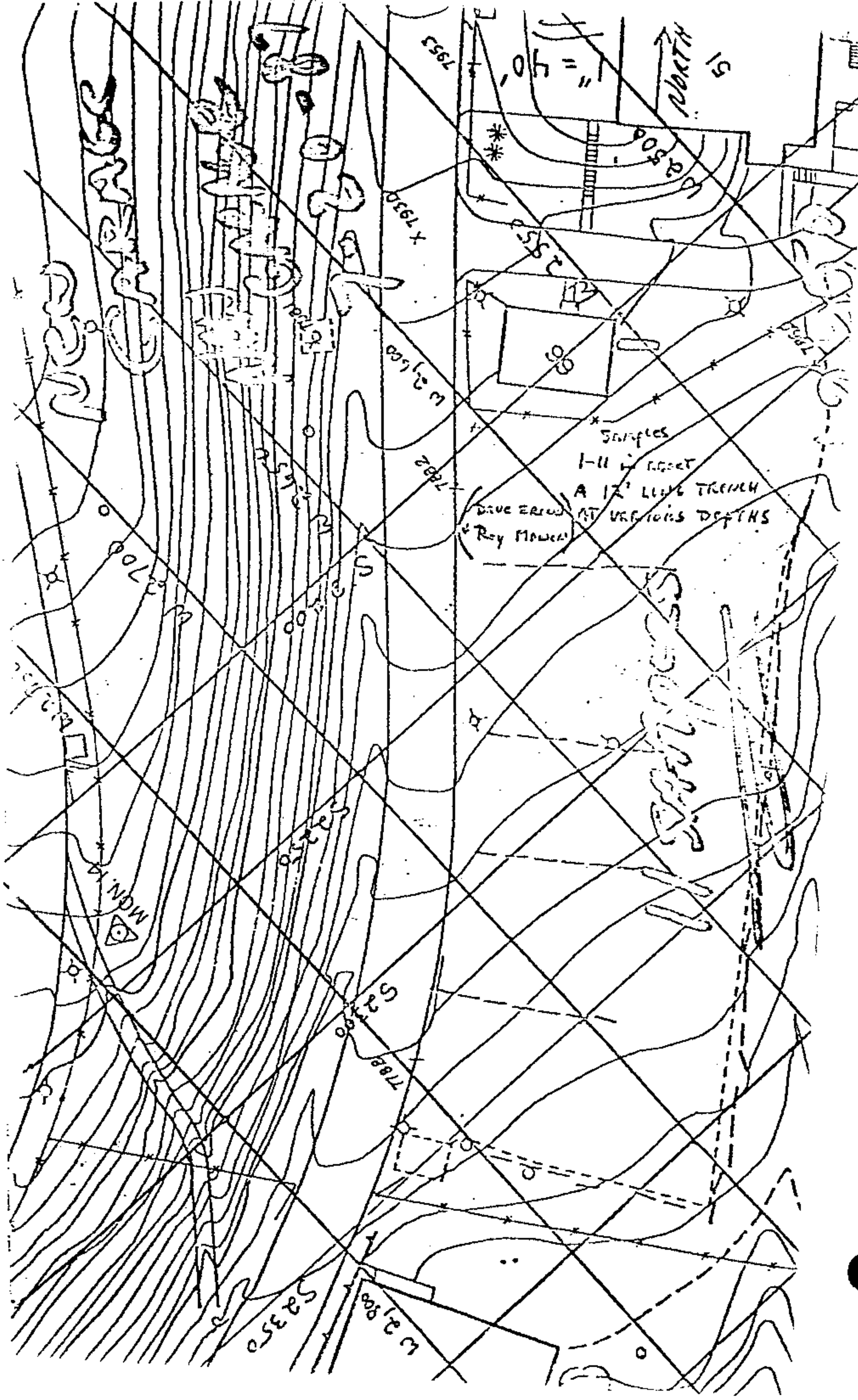
SOIL SCREENING FACILITY BUILDING 30
MRC MOUND
WELL A & B

SAMPLE TYPE CONT
SAMPLE CONDITION WET
DATE SCREENED 07/20/87
DATE COLLECTED 07/20/87
SAMPLER NAME & #: [redacted] 735

WELL	SAMPLE	DEPTH	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
ID	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	
A	16541	300	0.1e7	1502	16,811	5.1	1647	W2550 X 81125	#11		
A	16542	300	0.1e7	1e7	522	0.7	25	W2550 X 81125	#10		
A	16544	300	0.1e7	1056	581	1.3	51	W2550 X 81125	#4		
A	16545	300	0.1e7	1129	857	1.5	71	W2550 X 81125	#6		
A	16546	300	0.1e7	937	700	1.2	56	W2550 X 81125	#7		
A	16547	300	0.1e7	1189	776	1.4	53	W2550 X 81125	#3		
A	16548	300	0.1e7	1054	4075	1.3	1404	W2550 X 81125	#6		
A	16560	300	0.1e7	1076	474	1.2	61	W2550 X 81125	#1		S-2225
A	16561	300	0.1e7	1076	862	1.4	25	W2550 X 81125	#4		S-2225
A	16562	300	0.1e7	978	852	1.3	34	[illegible]			
A	16563	300	0.1e7	756	187	0.1	[illegible]	[illegible]			
A	16564	300	0.1e7	474	194	0.7	12	[illegible]			
A	16565	300	0.1e7	474	241	1.2	3	[illegible]			
A	16566	300	0.1e7	556	194	1.1	[illegible]	[illegible]			
A	16567	300	0.1e7	937	147	1.4	[illegible]	[illegible]			
A	16572	300	0.1e7	1417	638	1.1	31	W2550 X 81125 #1			S-2225
A	16577	300	0.1e7	990	502	1.4	17	W2550 X 81125 #3			S-2225

PREPARED BY : TROY W. FERRIER III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN THIS REPORT .



1" = 40'
NORTH
Samples
A 12' LONG TRENCH
AT VARIOUS DEPTHS

SOIL SCREENING FACILITY BUILDING 30
MRC MOUND
WELL A

SAMPLE TYPE CEM
SAMPLE CONDITION WET
DATE SCREENED 10/09/86
DATE COLLECTED 10/09/86
SAMPLER NAME & NF [redacted]9365

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PB-238	TH 232 pCi/g	PB 238 pCi/g	GRID & SAMPLE LOCATION
31	13568	300	0.167	390	455	0.0	0	CORE BLDG 66 12 SURFACE
32	13569	300	0.167	370	414	0.0	-5	CORE BLDG 66 12 2
33	13570	300	0.167	682	472	0.4	-4	CORE BLDG 66 12 4'
34	13575	300	0.167	721	569	0.5	10	CORE BLDG 66 HOLE 7 0-2
35	13576	300	0.167	806	577	0.6	9	CORE BLDG 66 HOLE 7 2'-4'
36	13577	300	0.167	926	606	0.9	10	CORE BLDG 66 HOLE 7 4 -6
37	13578	300	0.167	421	457	0.1	0	CORE BLDG 66 HOLE 7 6'-8'
38	13579	300	0.167	977	582	0.8	2	CORE BLDG 66 HOLE 7 8 -10
39	13580	300	0.167	876	593	0.7	9	CORE BLDG 66 HOLE 10'-12
40	13787	300	0.167	543	545	0.8	0	BURN AREA DUMPSTER

PREPARED BY : TROY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN
NOTES BELOW

SOIL SCREENING FACILITY BUILDING 30
ARC MOUND
WELL B

SAMPLE TYPE LENS
SAMPLE CONDITION WET
DATE SCREENED 10/09/86
DATE COLLECTED 10/09/86
SAMPLER NAME & HP [redacted]385

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PU-238	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION
33	13571	300	0.167	926	49117	0.6	6912	CORE BLDG 66 12 6
34	13572	300	0.167	1315	797	1.1	0	CORE BLDG 66 12 8
35	13573	300	0.167	1057	1033	0.8	40	CORE BLDG 66 12 10
36	13574	300	0.167	832	702	0.5	-2	CORE BLDG 66 12 12
37	13581	300	0.167	711	640	0.3	-8	CORE BLDG 66 HOLE 7 9 -2
38	13582	300	0.167	1643	894	1.5	6	CORE BLDG 66 HOLE 7 2 -4
39	13583	300	0.167	1165	770	0.9	-1	CORE BLDG 66 HOLE 7 4 -6
40	13584	300	0.167	798	663	0.5	-7	CORE BLDG 66 HOLE 7 6 -8
41	13585	300	0.167	1187	728	0.9	-7	CORE BLDG 66 HOLE 7 8 -10
42	13586	300	0.167	1175	781	0.9	1	CORE BLDG 66 HOLE 7 10 -12

PREPARED BY : TROY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN THIS REPORT .

SOIL SCREENING FACILITY BUILDING 30
MRC MOUND
WELL B

SAMPLE TYPE CONT
SAMPLE CONDITION WET
DATE SCREENED 10/07/86
DATE COLLECTED 10/07/86
SAMPLER NAME & HP [redacted]5385

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PB-238	TH 232 pCi/g	PB 238 pCi/g	GRID & SAMPLE LOCATION
9	13523	300	0.167	1458	1254	1.3	70	BEHIND BLDG 66 #1
10	13526	300	0.167	1832	5377	1.7	642	BEHIND BLDG 66 #4
11	13527	300	0.167	1405	4415	1.2	514	BEHIND BLDG 66 #3

PREPARED BY : IRBY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN THIS REPORT .

SOIL SCREENING FACILITY BUILDING 30
MRC MOUND
WELL A

SAMPLE TYPE CONT
SAMPLE CONDITION WET
DATE SCREENED 10/07/86
DATE COLLECTED 10/07/86
SAMPLER NAME & HP [redacted] 5385

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PB-238	TH 232 pCi/g	PB 238 pCi/g	GRID & SAMPLE LOCATION
7	13524	300	0.167	1370	2699	1.4	231	BEHIND BLDG 66 #2
8	13526	300	0.167	1552	4968	1.6	675	BEHIND BLDG 66 #5

PREPARED BY : TROY J. PLANSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN

SOIL SCREENING FACILITY BUILDING 30
ARC MOUND
WELL B

SAMPLE TYPE CORE
SAMPLE CONDITION WET
DATE SCREENED 10/10/86
DATE COLLECTED [illegible]
SAMPLER NAME & HP [redacted]386

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PU-238	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION
43	13593	300	0.167	1209	837	1.0	8	CORE BLDG 66 9 0-2
44	13594	300	0.167	1014	805	0.7	8	CORE BLDG 66 9 2 -4
45	13595	300	0.167	1106	818	0.8	8	CORE BLDG 66 9 4 -6
46	13596	300	0.167	1095	787	0.8	3	CORE BLDG 66 9 6 -8
47	13597	300	0.167	822	701	0.5	-2	CORE BLDG 66 9 8 -10
48	13598	300	0.167	1313	851	1.1	7	CORE BLDG 66 9 10 -12
49	13605	300	0.167	904	711	0.6	-3	CORE BLDG 66 13 0-2
50	13606	300	0.167	937	682	0.6	-8	CORE BLDG 66 13 2 -4
51	13607	300	0.167	937	638	0.6	-14	CORE BLDG 66 13 4 -6
52	13608	300	0.167	777	654	0.4	-8	CORE BLDG 66 13 6 -8
53	13609	300	0.167	816	679	0.5	-5	CORE BLDG 66 13 8 -10
54	13610	300	0.167	1176	830	0.9	8	CORE BLDG 66 13 10 -12

PREPARED BY : TROY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN
[illegible]

SOIL SCREENING FACILITY BUILDING 30
MRC MOUND
WELL A

SAMPLE TYPE CONT
SAMPLE CONDITION WET
DATE SCREENED 10/10/86
DATE COLLECTED 10/09/86
SAMPLER NAME & HP [redacted]5385

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PU-238	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION
41	13587	300	0.167	837	1055	0.7	83	CORE BLDG 66 10 0-2'
42	13588	300	0.167	766	769	0.6	40	CORE BLDG 66 10 2'-4'
43	13589	300	0.167	1454	694	1.5	10	CORE BLDG 66 10 4'-6'
44	13590	300	0.167	961	769	0.9	34	CORE BLDG 66 10 6'-8'
45	13591	300	0.167	597	491	0.3	1	CORE BLDG 66 10 8'-10'
46	13592	300	0.167	774	541	0.6	4	CORE BLDG 66 10 10'-12'
48	13599	300	0.167	1058	608	1.0	7	CORE BLDG 66 1 0-2'
49	13600	300	0.167	1058	636	1.0	11	CORE BLDG 66 1 2'-4'
50	13601	300	0.167	874	600	0.7	10	CORE BLDG 66 1 4'-6'
51	13602	300	0.167	1353	758	1.4	23	CORE BLDG 66 1 6'-8'
52	13603	300	0.167	571	526	0.3	7	CORE BLDG 66 1 8'-10'
53	13604	300	0.167	843	589	0.7	9	CORE BLDG 66 1 10'-12'

PREPARED BY : TOM J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN

SOIL SCREENING FACILITY BUILDING 30
HRC MOUND
WELL B

SAMPLE TYPE CONT
SAMPLE CONDITION WET
DATE SCREENED 10/13/86
DATE COLLECTED 10/10/86
SAMPLER NAME & HF [redacted]5385

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PU-238	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION
81	13669	300	0.167	1360	748	1.1	-8	CORE BLDG 66 #2 0-2
82	13670	300	0.167	948	653	0.6	-12	CORE BLDG 66 #2 2 -4
84	13671	300	0.167	1161	770	0.9	-1	CORE BLDG 66 #2 4'-6
85	13672	300	0.167	782	643	0.4	-10	CORE BLDG 66 #2 6 -8
86	13673	300	0.167	873	651	0.5	-11	CORE BLDG 66 #2 8'-10
87	13674	300	0.167	1157	819	0.9	7	CORE BLDG 66 #2 10 -12
88	13675	300	0.167	1320	801	1.1	0	CORE BLDG 66 #3 0-2
89	13676	300	0.167	907	779	0.6	7	CORE BLDG 66 #3 2'-4
90	13677	300	0.167	1246	739	1.0	-7	CORE BLDG 66 #3 4'-6'
91	13678	300	0.167	1111	1190	0.8	61	CORE BLDG 66 #3 6 -8
92	13679	300	0.167	1169	1489	0.9	102	CORE BLDG 66 #3 8'-10
93	13680	300	0.167	1097	1066	0.8	43	CORE BLDG 66 #3 10 -12

PREPARED BY : TROY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN THIS REPORT .

SOIL SCREENING FACILITY BUILDING 30
MRC MOUND
WELL A

SAMPLE TYPE CONT
SAMPLE CONDITION WET
DATE SCREENED 10/15/86
DATE COLLECTED 10/10/86
SAMPLER NAME & HP [redacted]5385

REC. NO.	SAMPLE NUMBER	GRAMS	WEIGHT FACTOR	GROSS CTS TH-232	GROSS CTS PU-238	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION
22	13657	300	0.167	1070	699	1.9	5	CORE BLDG 66 #4 0-2'
23	13658	300	0.167	1219	608	1.2	5	CORE BLDG 66 #4 2 -4'
24	13659	300	0.167	665	524	0.4	4	CORE BLDG 66 #4 4 -6'
25	13660	300	0.167	998	593	0.9	6	CORE BLDG 66 #4 6'-8
26	13661	300	0.167	918	584	0.8	7	CORE BLDG 66 #4 8'-10
27	13662	300	0.167	551	562	0.3	13	CORE BLDG 66 #4 10 -12
28	13663	300	0.167	1053	636	1.0	11	CORE BLDG 66 #5 0-2
29	13664	300	0.167	1219	657	1.2	10	CORE BLDG 66 #5 2 -4
30	13665	300	0.167	805	506	0.6	-2	CORE BLDG 66 #5 4'-6'
31	13666	300	0.167	721	508	0.5	0	CORE BLDG 66 #5 6 -8'
32	13667	300	0.167	803	512	0.6	-1	CORE BLDG 66 #5 8'-10
33	13668	300	0.167	1026	970	0.9	64	CORE BLDG 66 #5 10 -12

PREPARED BY : TROY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN THIS REPORT .

:E T) FE SIGHT SURVEY SAMPLES RAN AT 400 seconds (WET)

DATE 6-25-8

AMPLE #	GROSS CTS PU	Pci/g	GROSS CTS Th	Pci/g	LOCATION
9898	815	11.2	2724	4.8	BLDG 61 FENCE LINE #1
9899	1322	15.6	5611	10.7	BLDG 61 F.L # 1.B
9900	494	13.4	729	0.7	BLDG 61 F.L # 1.C
9901	452	6.2	718	0.7	BLDG 61 F.L # 1.D
9902	423	7.3	505	0.3	BLDG 61 F.L # 1.E
9903	474	8.0	958	1.2	BLDG 61 F.L # 1.F
9904	427	4.4	628	0.6	BLDG 61 F.L # 1.G
9905	453	5.5	746	0.8	BLDG 61 F.L # 1.H
9906	436	7.6	574	0.6	BLDG 61 F.L # 1.I
9907	377	-2.9	530	0.4	BLDG 61 F.L # 1.J
9908	441	10.9	494	0.3	BLDG 61 F.L # 1.K
9909	552	15.7	997	-0.8	BLDG 61 F.L # 1.L
9910	515	16.2	759	1.0	BLDG 61 F.L # 2.A
9911	750	58.1	1856	3.7	BLDG 61 F.L # 2.B
9912	476	9.6	747	1.0	BLDG 61 F.L # 2.C
9913	495	6.3	972	1.5	BLDG 61 F.L # 2.D
9914	442	6.0	666	0.8	BLDG 61 F.L # 2.E
9915	443	6.9	639	0.6	BLDG 61 F.L # 2.F
9916	441	9.9	528	0.4	BLDG 61 F.L # 2.G

TYPE SIGHT SURVEY SAMPLES RAN AT 400 seconds (WET)

DATE 6-25-

SAMPLE #	GROSS CTS PU	Pci/g	GROSS CTS Th	Pci/g	LOCATION
9917	468	8.3	742	0.8	BLDG 61 F.L #2.H
9918	470	13.2	592	0.5	BLDG 61 F.L #2.I
9919	494	13.6	720	0.7	BLDG 61 F.L #2.J
9920	462	12.7	560	0.4	BLDG 61 F.L #2.K
9921	492	15.1	657	0.6	BLDG 61 F.L #2.L

TO FEBRUARY 1 [illegible] RUN AT [illegible]

File #	Gross cts Pu	Pci/g	Gross cts Th	Pci/g	Location
938	441	10.7	502	0.3	BLDG-61 - FL - 1.AA
939	449	7.3	661	0.6	BLDG-61 - FL - 1.BB
940	403	0.7	609	0.5	BLDG-61 - FL - 1.CC
941	568	8.8	1325	2.0	BLDG-61 - FL - 1.DD
942	545	19.7	821	1.0	BLDG-61 - FL - 2.AA
943	549	22.5	753	0.8	BLDG-61 - FL - 2.BB
944	477	8.5	790	0.9	BLDG-61 - FL - 2.CC
945	503	11.6	840	1.0	BLDG-61 - FL - 2.DD
946	573	20.6	960	1.2	BLDG-61 - FL - 3.AA
947	534	20.9	717	0.7	BLDG-61 - FL - 3.BB
948	524	21.2	644	0.6	BLDG-61 - FL - 3.CC
949	492	8.7	872	1.1	BLDG-61 - FL - 3.DD
950	475	11.4	682	0.7	BLDG-61 - FL - 3.EE
951	570	9.6	1309	2.0	BLDG-61 - FL - 4.A
952	556	22.5	792	0.9	BLDG-61 - FL - 4.B
953	523	22.1	608	0.5	BLDG-61 - FL - 4.C
954	467	11.1	644	0.6	BLDG-61 - FL - 4.D
955	493	14.0	701	0.7	BLDG-61 - FL - 4.E
956	443	4.6	716	0.7	BLDG-61 - FL - 4.F

TYPE _____ SAMPLES RAN AT GOODSPEEDS (WAT)

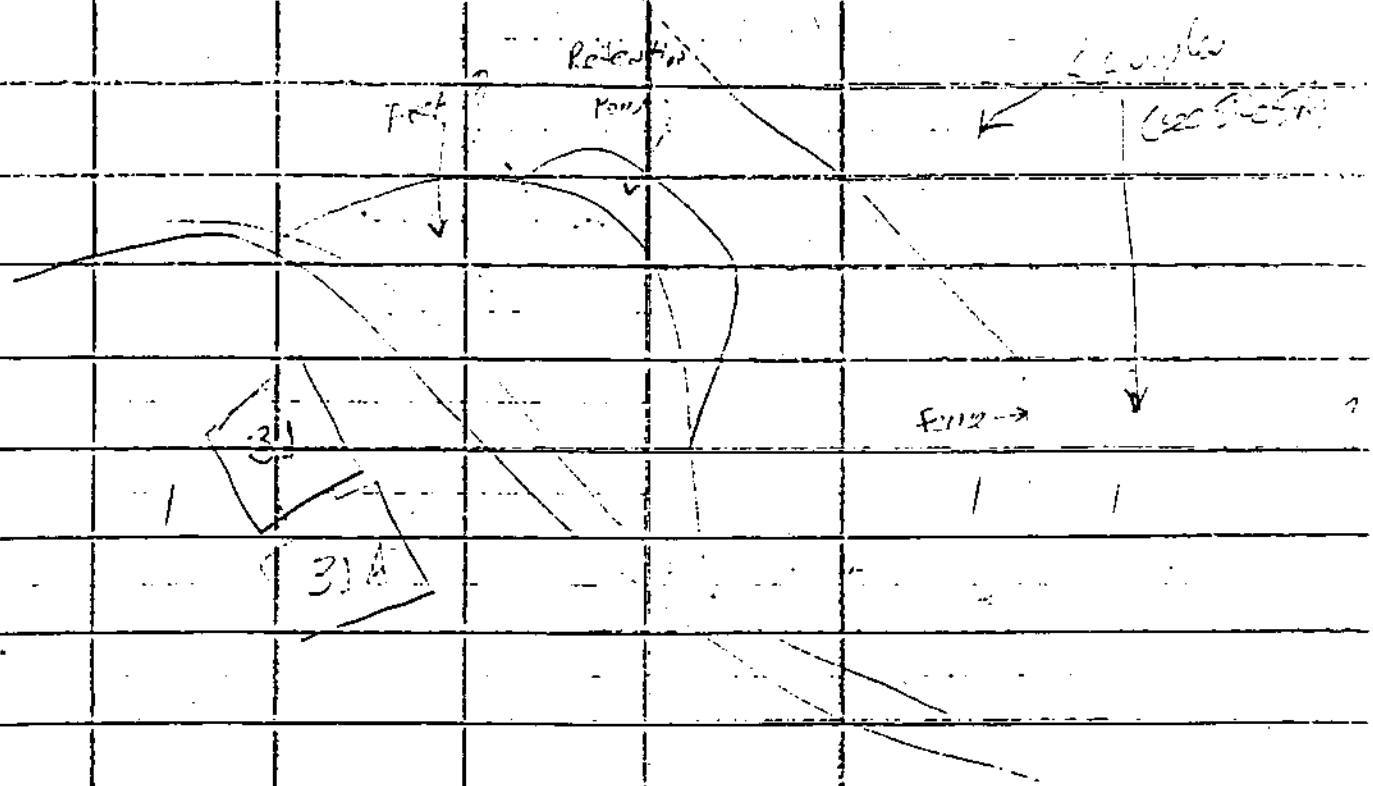
DATE [illegible]

Tape #	GROSS CTS PU	Pci/g	GROSS CTS Th	Pci/g	LOCATION
9957	516	15.3	795	9.1	BLDG 61 - FL - 4.G
9958	481	14.8	603	5.2	BLDG 61 - FL - 4.H
9959	459	7.2	726	7.7	BLDG 61 - FL - 4.I
9960	439	4.0	711	7.4	BLDG 61 - FL - 4.J
9961	538	13.2	995	13.1	BLDG 61 - FL - 4.K
9962	441	4.6	703	7.2	BLDG 61 - FL - 4.L
9963	452	16.7	791	9.0	BLDG 61 - FL - 4.M
9964	452	4.0	791	9.0	BLDG 61 - FL - 4.N
9965	436	2.5	743	8.0	BLDG 61 - FL - 4.O
9966	710	21.9	1734	28.1	BLDG 61 - FL - 5.A
9967	620	20.1	1257	18.4	BLDG 61 FL - 5.B
9968	667	30.5	1190	1.7	BLDG 61 FL - 5.C
9969	521	20.2	661	0.6	BLDG 61 FL - 5.D
9970	509	21.0	560	0.4	BLDG 61 FL - 5.E
9971	505	12.9	808	0.9	BLDG 61 FL - 5.F
9972	512	10.9	917	1.1	BLDG 61 FL - 5.G
9973	488	12.2	732	0.7	BLDG 61 FL - 5.H
9974	525	18.2	751	0.8	BLDG 61 FL - 5.I
9975	583	19.9	1115	1.5	BLDG 61 FL - 5.J

TYPE _____ SAMPLES RAN AT 400 SECONDS (NET)

DATE 6/26/01

TAPE #	GROSS CTS PU	Pci/g	GROSS CTS Th	Pci/g	LOCATION
9976	566	21.0	903	1.1	BLDG 61 - FL - S.K
9977	571	15.5	1116	1.5	BLDG 61 - FL - S.L
9978	510	15.3	760	0.8	BLDG 61 - FL - S.M
9979	508	11.3	882	1.0	BLDG 61 - FL - S.N
9980	461	14.3	499	0.3	BLDG 61 - FL - S.O
9981	466	9.0	707	0.7	BLDG 61 - FL - S.P



S.S. SAMPLES RAN AT 400 SECONDS (WET) Rader's Hill 7-18-84

SAMPLE #	GROSS CNTS.	Pu	Pci/g Pu	GROSS CNT/H	Pci/g Th	LOCATION			
5634	348	-1.6	449	.3	FLAG 335	SAMPLE	#1	1'-2.5'
5635	399	8.4	406	.2			#2	5'
5636	430	8.6	583	.6			#3	7½'
5637	409	7.5	498	.4			#4	10'
5638	544	34.4	369	.1	FLAG 335	SAMPLE	#5	10½'
5639	529	25.1	603	.6	FLAG 336	SAMPLE	#1	1'-2.5'
5640	442	7.2	709	.8			#2	3.5'-5'
5641	495	14.4	472	.4			#3	6'-7.5'
5642	363	2.5	396	.2			#4	8.5'-10'
5643	425	12.5	418	.2	FLAG 336	SAMPLE	#5	11'-12'
5644	441	6.7	717	.9	FLAG 337	SAMPLE	#1	1'-2.5'
5645	483	14.7	688	.8			#2	2'-5'
5646	458	11.9	636	.7	FLAG 337	SAMPLE	#3	6.5'
5647	433	12.7	459	.3	FLAG 338	SAMPLE	#1	1'-2.5'
5648	420	5.3	640	.7			#2	5'
5649	490	10.3	585	.6			#3	7.5'
5650	344	-4.0	506	.4	FLAG 338	SAMPLE	#4	10'
5651	398	5.6	497	.4	FLAG 339	SAMPLE	#1	2.5'
5652	410	1.9	696	.8			#2	5'
5653	435	9.1	596	.6			#3	7.5'
5654	421	6.4	606	.6	FLAG 339	SAMPLE	#4	9.5'
5655	507	19.1	681	.8	FLAG 340	SAMPLE	#1	2.5'
5656	417	1.2	765	.9			#2	5'
5657	423	11.1	457	.3	FLAG 340	SAMPLE	#3	6.5'
5658	377	-0.4	578	.6	FLAG 341	SAMPLE	#1	2.5'
5659	436	9.0	605	.6			#2	5'
5660	456	4.8	871	1.2			#3	7.5'
5661	399	7.9	423	.3	FLAG 341	SAMPLE	#4	10'
5662	514	14.3	890	1.2	FLAG 342	SAMPLE	#1	2.5'
5663	433	11.5	502	.4			#2	5'
5664	387	-2.0	695	.8			#3	7'
5665	377	2.1	494	.4	FLAG 342	SAMPLE	#4	9.5'
5666	460	9.0	750	.9	FLAG 343	SAMPLE	#1	2.5'
5667	502	20.4	725	.9			#2	5'
5668	351	-0.8	441	.3	FLAG 343	SAMPLE	#3	7'
5669	439	9.2	617	.6	FLAG 344	SAMPLE	#1	2.5'
70	417	8.8	500	.4			#2	4'

S.S SAMPLES RAN @ 400 SECONDS (WET) 7-18-89

SAMPLE #	Pu GROSS CNTS	Pu Pci/g	Th GROSS CNTS.	Th Pci/g	LOCATION				
5671	401	5.1	533	.5	FLAG	344	SAMPLE	#3	7.5'
5672	377	4.6	407	.2	FLAG	344	SAMPLE	#4	9.5'
5673	424	14.2	354	.1	FLAG	346	SAMPLE	#1	2.5'
5674	476	7.9	884	1.2				#2	5'
5675	345	1.2	331	.1	FLAG	346	SAMPLE	#3	7'
5676	428	1.5	818	1.1	FLAG	347	SAMPLE	#1	2.5'
5677	468	10.8	736	.9				#2	5'
5678	425	5.2	671	.8	FLAG	347	SAMPLE	#3	6.5'
5679	486	14.7	708	.8	FLAG	348	SAMPLE	#1	5'
5680	421	8.7	528	.5				#2	7.5'
5681	404	6.4	504	.4	FLAG	348	SAMPLE	#3	7.5'
5682	428	7.5	609	.6	FLAG	349	SAMPLE	#1	2.5'
5683	237	-17.9	348	.1				#2	5'
5684	370	5.0	350	.1				#3	7.5'
5685	381	3.0	486	.4	FLAG	349	SAMPLE	#4	10'

SOIL SCREENIG FACILITY
Data Management System

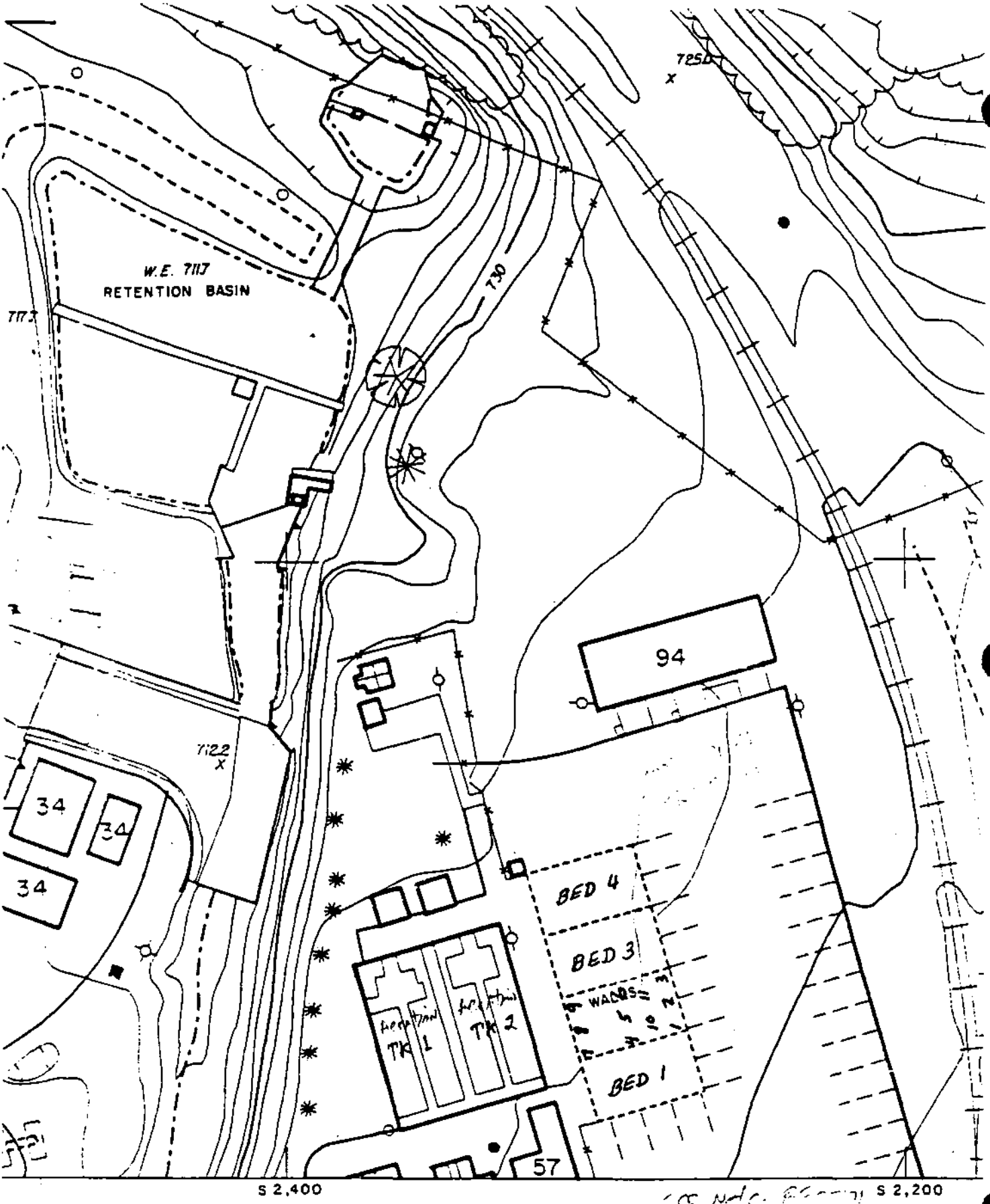
CONT Sample's, taken by [redacted] 9542
DAILY REPORT FOR August 25,1988

SAMPLE NUMBER	DATE SCREEN	SAMPLER	SAMPLE TYPE	TH 232 pCi/g	PU 238 pCi/g	GRID & SAMPLE LOCATION	WELL ID
1	88082251 : 08/25/88 :	[redacted] 9542	: CONT :	22.1:	172:	#1 @ SURFACE W4275 X S2300 (BED	: A
2	88082252 : 08/25/88 :	[redacted] 9542	: CONT :	13.2:	344:	#2 @ SURFACE W4275 X S2300 (BED	: B
3	88082253 : 08/25/88 :	[redacted] 9542	: CONT :	8.6:	30:	#3 @ SURFACE W4275 X S2300 (BED	: C
4	88082254 : 08/25/88 :	[redacted] 9542	: CONT :	17.8:	243:	#4 @ SURFACE W4275 X S2300 (BED	: A
5	88082255 : 08/25/88 :	[redacted] 9542	: CONT :	2.1:	67:	#5 @ SURFACE W4275 X S2300 (BED	: B
6	88082256 : 08/25/88 :	[redacted] 9542	: CONT :	0.8:	16:	#6 @ SURFACE W4275 X S2300 (BED	: C
7	88082257 : 08/25/88 :	[redacted] 9542	: CONT :	63.0:	1235:	#7 @ SURFACE W4275 X S2300 (BED	: A
8	88082258 : 08/25/88 :	[redacted] 9542	: CONT :	1.9:	78:	#8 @ SURFACE W4275 X S2300 (BED	: B
9	88082259 : 08/25/88 :	[redacted] 9542	: CONT :	24.9:	111:	#9 @ SURFACE W4275 X S2300 (BED	: C
10	88082510 : 08/25/88 :	[redacted] 9542	: CONT :	35.9:	992:	#10 @ SURFACE W4275 X S2300 (BED	: A
11	88082511 : 08/25/88 :	[redacted] 9542	: CONT :	0.8:	45:	#11 @ SURFACE W4275 X S2300 (BED	: B
12	88082512 : 08/25/88 :	[redacted] 9542	: CONT :	2.4:	20:	#12 @ SURFACE W4275 X S2300 (BED	: C
13	88082513 : 08/25/88 :	[redacted] 9542	: CONT :	0.9:	0:	#13 @ SURFACE W4275 X S2300 (BED	: A
14	88082514 : 08/25/88 :	[redacted] 9542	: CONT :	0.8:	39:	#14 @ SURFACE W4275 X S2300 (BED	: B
15	88082515 : 08/25/88 :	[redacted] 9542	: CONT :	3.4:	23:	#15 @ SURFACE W4275 X S2300 (BED	: C

15 Samples taken from SD Bed #3, all Samples were on surface, as indicated, and are marked accordingly on Map. In General, stronger readings seem to Be located in the Southwest corner, Additional samples may be necessary, to determine how deep. It is assumed to contain mostly Th 232, and that some of this Th 232 Bled over into the Pu 238, causing higher reading from Pu 238 [redacted]

PREPARED BY : TROY J. PEARSON III

ALL SOIL SAMPLE ARE RAN FOR 400 SEC UNLESS SPECIFIED IN THIS REPORT. [illegible]



W4250X S2280

SAMPLES COLLECTED BY K. McMAHON + J. DICKEY

NO DIALECT READINGS ON WALLS. FIDLER READINGS ON WALL - BACKGROUND

FIDLER READINGS ON SOIL - 50-100K

SOIL SCANNING FACILITY MCA RECORD

DISTRIBUTION:

R.R. DAILY
D.G. DRAPER
FILE

		SAMPLE TYPE
SAMPLE TYPE	:CONSTRUCTION	SM
SAMPLE CONDITION	: WET	PP
DATE (When Collected)	:4/18/86	WTS
DATE (When Screened)	:4/21/86	CONT.
SAMPLE TAKEN BY	[redacted] 5385	SS
		41

MCA WELL "B"

SAMPLE#	GRAMS	Pu Wt.FACTOR	GROSS Ct Th	GROSS Ct Pu	Pu-238 pCi/g	Th-232 pCi/g	LOCATION AND DEPTH
12609	300	0.167	555	491	3	0.2	BLDG 48 HILLSIDE #1

SCREEN BY:

Review By:_____ Approved By:_____

MCA WELL "B" WEEKLY CALIBRATION LOG

MCA DOE#: 87679
MCA SN#: 80545
PROBE DOE#: 97385
PROBE SN#: DR593

STANDARDS	CT./400 sec. Pu Window	CT./400 sec. Th Window	CT - BKG	Ct/pCi
BKG STANDARD	393	376		
Pu-238 STANDARD #1044 = 169.4 pCi/gr	11700		11307	66.75
Pu-238 STANDARD #1045 = 746.8 pCi/gr	4765		4372	5.85
Pu-238 STANDARD #1046 = 2216 pCi/gr	10174		9781	4.41
Th-230 STANDARD #2244 = 44.5 pCi/gr	26557		26181	588.34

PREPARED BY: [redacted] 5315 DATE 4/21/86

REVIEWED BY_____DATE_____APPROVED BY:_____DATE_____

SOIL SCANNING FACILITY MCA RECORD

		SAMPLE TYPE	DISTRIBUTION:
			R.R. DAILY
SAMPLE TYPE	:CONSTRUCTION	SM	D.S. DRAPER
SAMPLE CONDITION	:WET	PP	FILE
DATE (When Collected)	:4/17/86	WTS	
DATE (When Screened)	:4/18/86	CONT.	
SAMPLE TAKEN BY	[redacted] 5385	SS	
		41	

MCA WELL "A"

SAMPLE#	GRAMS	Pu WT.FACTOR	GROSS Ct Th	GROSS Ct Pu	Pu-238 pCi/g	Th-232 pCi/g	LOCATION AND DEPTH
12605	300	0.167	2415	209788	38861	4.2	BLDG 48 HILLSIDE #1

MCA WELL "B"

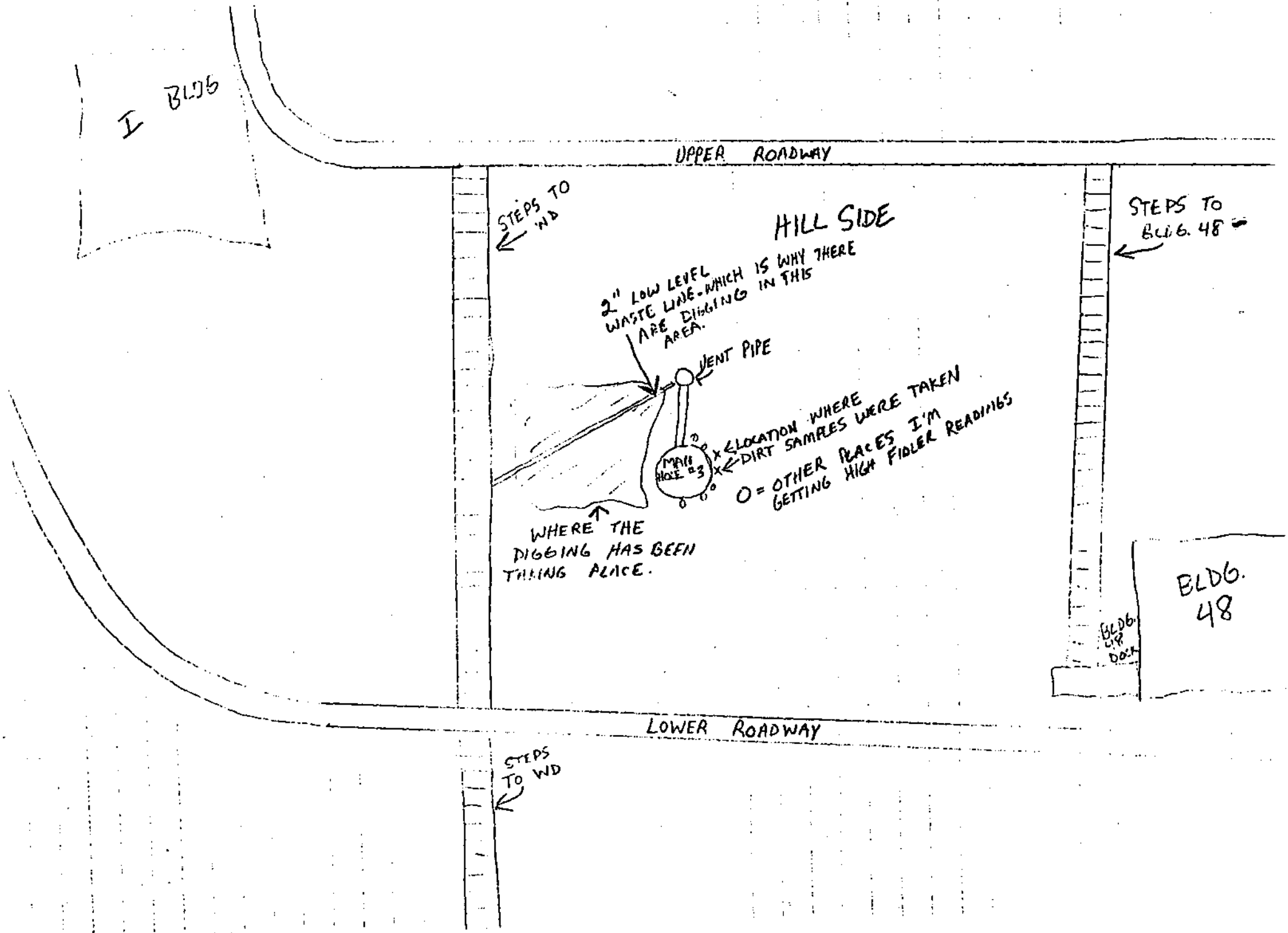
SAMPLE#	GRAMS	Pu Wt.FACTOR	GROSS Ct Th	GROSS Ct Pu	Pu-238 pCi/g	Th-232 pCi/g	LOCATION AND DEPTH
12606	300	0.167	4149	67129	11602	5.4	BLDG 48 HILLSIDE #1

SCREEN BY [redacted] [redacted] 5315

Review By:_____ Approved By:_____

4-18-86

HPGe	Pu238	Am241
12605	31.7 nCi/g	✓
12606	23.0 nCi/g	✓


I BLDG
UPPER ROADWAY
STEPS TO WD
HILL SIDE
STEPS TO BLDG. 48
2" LOW LEVEL WASTE LINE - WHICH IS WHY THERE ARE DIGGING IN THIS AREA.
VENT PIPE
MAN HOLE #3
X ← LOCATION WHERE DIRT SAMPLES WERE TAKEN
O = OTHER PLACES I'M GETTING HIGH FIDLER READINGS
WHERE THE DIGGING HAS BEEN TAKING PLACE.
BLDG. 48
BLDG. UP DOWN
LOWER ROADWAY
STEPS TO WD

APPENDIX F

LOCATION COORDINATES IN

SOUTH/WEST AND NORTH/EAST

F.1. SITE SURVEY PROJECT SURFACE LOCATIONS

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0001	1475	1175	1497310.63	599629.91
S0002	1400	1325	1497440.86	599524.25
S0003	1375	1350	1497473.95	599511.80
S0004	1400	1350	1497451.18	599501.48
S0005	1325	1375	1497529.81	599509.67
S0006	1175	1400	1497676.75	599548.81
S0007	1225	1400	1497631.21	599528.17
S0008	1350	1400	1497517.36	599476.58
S0009	1300	1425	1497573.22	599474.44
S0010	1125	1475	1497753.25	599501.14
S0011	1250	1475	1497639.40	599449.54
S0012	1605	1200	1497202.54	599553.48
S0013	1580	1225	1497235.63	599541.03
S0014	1755	1225	1497076.23	599468.79
S0015	1855	1225	1496985.15	599427.52
S0016	1505	1250	1497314.26	599549.22
S0017	1605	1250	1497223.18	599507.94
S0018	1805	1250	1497041.01	599425.38
S0020	1125	1525	1497773.89	599455.60
S0021	1300	1525	1497614.50	599383.36
S0022	1300	1550	1497624.81	599360.59
S0023	1325	1575	1497612.36	599327.50
S0024	1135	1625	1497806.06	599360.39
S0025	1375	1650	1497597.78	599238.55
S0026	1375	1675	1497608.10	599215.78
S0027	1110	1700	1497859.79	599302.39
S0028	1210	1700	1497768.71	599261.12
S0029	1425	1700	1497572.88	599172.37
S0030	1450	1700	1497550.11	599162.05
S0031	1400	1750	1497616.29	599137.15
S0032	1350	1775	1497672.15	599135.01
S0033	1450	1775	1497581.07	599093.74
S0034	1855	1600	1497139.94	599085.96
S0035	1780	1625	1497218.57	599094.14
S0036	1830	1625	1497173.03	599073.50
S0037	1730	1675	1497284.76	599069.24
S0038	1630	1700	1497386.16	599087.75
S0039	1680	1700	1497340.62	599067.11
S0040	1705	1700	1497317.85	599056.79
S0041	1605	1725	1497419.25	599075.30
S0042	1655	1725	1497373.71	599054.66
S0043	1755	1725	1497282.62	599013.38
S0044	1505	1775	1497530.97	599071.03
S0045	1555	1775	1497485.43	599050.39
S0046	1680	1775	1497371.58	598998.80
S0047	1490	1785	1497548.76	599068.12
S0048	1855	1785	1497216.31	598917.45
S0049	1860	0900	1496846.44	599721.47
S0050	2200	0910	1496540.89	599572.02
S0051	2085	0925	1496651.82	599605.83
S0052	1950	1000	1496805.75	599593.24
S0053	2050	1000	1496714.66	599551.96
S0054	2085	1000	1496682.78	599537.51
S0055	1885	1050	1496885.59	599574.53
S0056	2310	1050	1496498.49	599399.10
S0057	1925	1150	1496890.43	599466.93

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0058	2050	1150	1496776.58	599415.34
S0059	2085	1150	1496744.70	599400.89
S0060	1885	1175	1496937.19	599460.67
S0061	2265	0925	1496487.88	599531.53
S0062	2365	0925	1496396.79	599490.25
S0063	2440	0925	1496328.48	599459.29
S0064	2490	0925	1496282.94	599438.65
S0065	2615	0950	1496179.40	599364.28
S0066	2290	1050	1496516.70	599407.35
S0067	1985	1225	1496866.74	599373.85
S0068	2035	1225	1496821.20	599353.22
S0069	2085	1225	1496775.66	599332.58
S0070	2135	1225	1496730.12	599311.94
S0071	1385	1250	1497423.56	599598.75
S0072	1960	1350	1496941.11	599270.32
S0073	2010	1350	1496895.57	599249.68
S0074	2085	1350	1496827.26	599218.72
S0075	2100	1350	1496813.59	599212.53
S0076	1885	1450	1497050.70	599210.20
S0077	2010	1450	1496936.85	599158.60
S0078	2135	1450	1496822.99	599107.00
S0079	2440	1250	1496462.63	599163.27
S0080	2615	1250	1496303.24	599091.03
S0081	2415	1300	1496506.04	599128.05
S0082	2365	1350	1496572.22	599103.14
S0083	2390	1400	1496570.09	599047.28
S0084	2440	1450	1496545.19	598981.10
S0085	2415	1490	1496584.47	598954.99
S0086	2465	1490	1496538.93	598934.35
S0087	2515	1490	1496493.39	598913.71
S0088	2590	1490	1496425.08	598882.75
S0090	1970	1525	1497004.24	599106.80
S0091	2185	1575	1496829.05	598972.51
S0092	2085	1585	1496924.26	599004.68
S0093	1935	1600	1497067.08	599052.93
S0094	1885	1625	1497122.94	599050.80
S0095	2210	1625	1496826.92	598916.65
S0096	1960	1650	1497064.94	598997.07
S0097	2060	1650	1496973.86	598955.79
S0098	2160	1650	1496882.78	598914.52
S0099	2235	1650	1496814.47	598883.56
S0100	2045	1685	1497001.97	598930.11
S0101	2160	1735	1496917.87	598837.09
S0102	2010	1750	1497060.68	598885.35
S0103	2110	1750	1496969.60	598844.07
S0104	2195	1760	1496896.31	598799.88
S0105	2340	1525	1496667.23	598954.07
S0106	2415	1525	1496598.92	598923.11
S0107	2465	1525	1496553.38	598902.47
S0108	2565	1525	1496462.30	598861.19
S0109	2540	1600	1496516.02	598803.20
S0110	2315	1675	1496751.92	598827.76
S0111	2565	1675	1496524.21	598724.57
S0112	2515	1700	1496580.07	598722.44
S0113	2265	1725	1496818.10	598802.86
S0114	2365	1750	1496737.34	598738.81

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0115	2515	1750	1496600.71	598676.89
S0116	2340	1775	1496770.43	598726.36
S0117	2415	1775	1496702.11	598695.40
S0118	2615	1775	1496519.95	598612.85
S0119	2770	0925	1496027.91	599323.07
S0120	2695	0950	1496106.54	599331.26
S0121	2845	0950	1495969.91	599269.34
S0122	2970	0975	1495866.38	599194.97
S0124	2945	1050	1495920.11	599136.98
S0125	2970	1125	1495928.30	599058.35
S0126	2820	1150	1496075.24	599097.49
S0127	3050	1000	1495803.83	599139.18
S0128	3250	1050	1495642.31	599011.08
S0129	3025	1075	1495857.56	599081.19
S0130	3075	1075	1495812.02	599060.55
S0131	3100	1075	1495789.25	599050.23
S0132	3100	1100	1495799.57	599027.46
S0133	3225	1100	1495685.72	598975.86
S0134	3375	1175	1495580.05	598845.63
S0135	2670	1225	1496242.82	599091.10
S0137	2720	1350	1496248.88	598956.61
S0138	2795	1375	1496190.89	598902.88
S0139	2670	1400	1496315.06	598931.70
S0140	2845	1425	1496165.98	598836.70
S0141	2770	1450	1496244.62	598844.88
S0142	2695	1500	1496333.57	598830.30
S0143	3050	1200	1495886.39	598957.01
S0144	3375	1225	1495600.69	598800.09
S0145	3175	1250	1495793.17	598859.87
S0146	3225	1300	1495768.27	598793.69
S0147	3175	1350	1495834.45	598768.79
S0148	3325	1350	1495697.83	598706.87
S0149	3025	1375	1495981.40	598807.94
S0150	3025	1400	1495991.72	598785.17
S0152	3050	1475	1495999.90	598706.54
S0153	3175	1475	1495886.05	598654.94
S0154	3325	1495	1495757.68	598574.80
S0155	2770	1550	1496285.89	598753.80
S0156	2645	1600	1496420.39	598759.86
S0158	2645	1675	1496451.35	598691.55
S0159	2645	1750	1496482.30	598623.23
S0160	2620	1775	1496515.39	598610.78
S0161	2795	1775	1496356.00	598538.55
S0162	2845	1775	1496310.46	598517.91
S0163	2870	1775	1496287.69	598507.59
S0164	3175	1505	1495898.43	598627.61
S0165	3300	1750	1495885.71	598352.86
S0166	3350	1750	1495840.17	598332.22
S0167	3225	1775	1495964.34	598361.05
S0168	3275	1775	1495918.80	598340.41
S0169	3010	1790	1496166.36	598436.13
S0170	3025	1790	1496152.70	598429.94
S0171	3200	1790	1495993.30	598357.71
S0172	3555	1285	1495461.51	598671.14
S0173	3465	1315	1495555.86	598680.96
S0175	3580	1375	1495475.89	598578.84

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0176	3590	1375	1495466.78	598574.72
S0177	3510	1385	1495543.77	598598.63
S0178	3465	1410	1495595.08	598594.43
S0179	3555	1410	1495513.10	598557.28
S0180	3400	1425	1495660.47	598607.60
S0181	3605	1425	1495473.75	598522.98
S0182	3690	1435	1495400.46	598478.79
S0183	3565	1450	1495520.51	598516.72
S0184	3680	1455	1495417.82	598464.70
S0185	3590	1460	1495501.86	598497.30
S0186	3615	1460	1495479.09	598486.98
S0187	3635	1485	1495471.20	598455.95
S0188	3680	1485	1495430.21	598437.37
S0190	3605	1505	1495506.78	598450.12
S0191	3430	1525	1495674.43	598504.14
S0192	3705	1525	1495423.95	598390.62
S0193	3605	1575	1495535.67	598386.36
S0194	3455	1600	1495682.61	598425.51
S0195	3580	1625	1495579.08	598351.14
S0196	3455	1650	1495703.25	598379.96
S0197	3550	1650	1495616.73	598340.75
S0198	3705	1675	1495485.87	598254.00
S0199	3480	1680	1495692.87	598342.32
S0200	3555	1725	1495643.13	598270.37
S0201	3705	1625	1495465.23	598299.54
S0202	3430	1675	1495736.34	598367.51
S0203	3630	1700	1495564.50	598262.19
S0204	3680	1700	1495518.96	598241.55
S0205	3810	1505	1495320.06	598365.50
S0206	3855	1575	1495307.96	598283.16
S0207	3785	1650	1495402.68	598243.75
S0208	3765	1660	1495425.02	598242.89
S0209	3765	1675	1495431.22	598229.23
S0210	3860	1675	1495344.69	598190.02
S0211	3960	1675	1495253.60	598148.74
S0212	3860	1725	1495365.33	598144.47
S0213	3935	1750	1495307.33	598090.75
S0214	3985	1775	1495272.11	598047.34
S0215	4035	1775	1495226.57	598026.70
S0216	3760	1795	1495485.30	598121.99
S0217	1255	1850	1497789.64	599105.92
S0218	1385	1875	1497681.55	599029.48
S0219	1280	1900	1497787.50	599050.06
S0220	1275	1950	1497812.70	599006.58
S0221	1425	1995	1497694.65	598903.67
S0222	1410	2035	1497724.82	598873.43
S0223	1460	2035	1497679.28	598852.79
S0224	1335	2050	1497799.33	598890.73
S0225	1360	2075	1497786.88	598857.64
S0226	1400	2075	1497750.44	598841.13
S0227	1435	2085	1497722.69	598817.57
S0228	1805	1850	1497288.68	598878.89
S0229	1655	1875	1497435.62	598918.03
S0230	1525	1895	1497562.29	598953.48
S0231	1530	1950	1497580.44	598901.32
S0232	1730	1950	1497398.27	598818.76

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0233	1505	2000	1497623.85	598866.10
S0234	1555	2000	1497578.30	598845.46
S0235	1505	2050	1497644.49	598820.55
S0236	1580	2075	1497586.49	598766.83
S0237	1680	2075	1497495.41	598725.55
S0238	1830	2075	1497358.78	598663.63
S0239	1505	2125	1497675.44	598752.24
S0240	1655	2125	1497538.82	598690.33
S0241	1755	2150	1497458.06	598626.28
S0242	1505	2200	1497706.40	598683.93
S0243	1830	2200	1497410.38	598549.78
S0244	1730	2225	1497511.79	598568.28
S0245	1630	2250	1497613.19	598586.79
S0246	1730	2300	1497542.74	598499.97
S0247	1780	2300	1497497.20	598479.33
S0248	1830	2300	1497451.66	598458.69
S0249	1630	2325	1497644.15	598518.48
S0250	1730	2350	1497563.38	598454.43
S0251	1580	2375	1497710.33	598493.58
S0252	1780	2375	1497528.16	598411.02
S0253	1830	2375	1497482.62	598390.38
S0254	1500	2425	1497803.83	598481.06
S0255	1605	2425	1497708.20	598437.72
S0256	1705	2425	1497617.11	598396.44
S0257	1730	2425	1497594.34	598386.12
S0258	1830	2425	1497503.26	598344.84
S0259	1755	2450	1497581.89	598353.03
S0260	1630	2475	1497706.06	598381.85
S0261	1855	2475	1497501.13	598288.98
S0262	1650	2500	1497698.17	598350.83
S0263	1655	2500	1497693.61	598348.76
S0264	1730	2500	1497625.30	598317.81
S0265	1655	2525	1497703.93	598325.99
S0266	1680	2525	1497681.16	598315.67
S0267	1730	2525	1497635.62	598295.03
S0268	1655	2575	1497724.57	598280.45
S0269	1830	2575	1497565.18	598208.22
S0270	1730	2625	1497676.90	598203.95
S0271	1755	2650	1497664.45	598170.86
S0272	1960	1825	1497137.18	598837.68
S0273	1885	1850	1497215.81	598845.86
S0274	1985	1875	1497135.05	598781.82
S0275	2135	1900	1497008.75	598697.13
S0276	2035	1925	1497110.15	598715.63
S0277	1960	1950	1497188.78	598723.82
S0278	2010	2025	1497174.20	598634.87
S0279	1885	2075	1497308.69	598640.93
S0280	2060	2075	1497149.29	598568.69
S0281	2110	2075	1497103.75	598548.05
S0282	2290	1825	1496836.61	598701.46
S0283	2340	1875	1496811.71	598635.28
S0284	2390	1925	1496786.80	598569.10
S0285	2440	1950	1496751.58	598525.69
S0286	2265	2025	1496941.93	598529.61
S0287	2440	2025	1496782.54	598457.38
S0288	2465	2025	1496759.77	598447.06

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0289	2265	2050	1496952.25	598506.84
S0290	2290	2050	1496929.48	598496.52
S0291	2515	2050	1496724.55	598403.65
S0292	2615	2050	1496633.46	598362.37
S0293	2265	2075	1496962.57	598484.07
S0295	2390	2075	1496848.72	598432.47
S0296	2440	2075	1496803.18	598411.83
S0297	2515	2075	1496734.87	598380.88
S0298	2315	2085	1496921.16	598454.32
S0299	2355	2085	1496884.73	598437.81
S0300	2365	2085	1496875.62	598433.68
S0301	1885	2125	1497329.33	598595.39
S0302	2110	2125	1497124.39	598502.51
S0303	2160	2125	1497078.85	598481.87
S0304	2085	2150	1497157.48	598490.06
S0305	1885	2175	1497349.97	598549.84
S0306	1985	2175	1497258.88	598508.57
S0307	2060	2175	1497190.57	598477.61
S0308	2160	2225	1497120.13	598390.79
S0309	2235	2225	1497051.82	598359.83
S0310	1985	2275	1497300.16	598417.48
S0311	2135	2325	1497184.18	598310.02
S0312	2185	2325	1497138.64	598289.39
S0313	2060	2350	1497262.81	598318.21
S0314	1910	2375	1497409.75	598357.36
S0316	2365	2125	1496892.13	598397.25
S0317	2515	2125	1496755.51	598335.33
S0318	2365	2175	1496912.77	598351.71
S0319	2315	2210	1496972.76	598340.47
S0320	2375	2210	1496918.11	598315.70
S0321	2265	2225	1497024.49	598347.45
S0322	2465	2225	1496842.32	598264.89
S0323	2540	2225	1496774.01	598233.93
S0324	2540	2275	1496794.65	598188.39
S0325	2490	2275	1496840.19	598209.03
S0326	2590	2325	1496769.75	598122.21
S0327	2515	2350	1496848.38	598130.40
S0328	2465	2350	1496893.92	598151.04
S0329	2290	2375	1497063.64	598200.50
S0330	2340	2375	1497018.10	598179.86
S0331	1885	2425	1497453.16	598322.14
S0332	1910	2425	1497430.39	598311.82
S0333	2060	2425	1497293.77	598249.90
S0334	2135	2425	1497225.46	598218.94
S0335	2185	2425	1497179.91	598198.30
S0336	1885	2450	1497463.48	598299.37
S0337	2160	2450	1497213.00	598185.85
S0338	1910	2475	1497451.03	598266.28
S0339	2110	2475	1497268.87	598183.72
S0340	1910	2500	1497461.35	598243.50
S0344	2290	2425	1497084.28	598154.96
S0345	2290	2450	1497094.60	598132.19
S0346	2365	2450	1497026.28	598101.23
S0347	2440	2475	1496968.29	598047.50
S0348	2540	2500	1496887.53	597983.45
S0349	2565	2500	1496864.76	597973.13

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0350	2365	2525	1497057.24	598032.92
S0351	2290	2550	1497135.87	598041.11
S0352	2415	2550	1497022.02	597989.51
S0353	2590	2550	1496862.63	597917.27
S0354	2465	2550	1496976.48	597968.87
S0355	2465	2600	1496997.12	597923.33
S0356	2365	2625	1497098.52	597941.84
S0357	2340	2675	1497141.93	597906.61
S0358	2565	2675	1496936.99	597813.74
S0359	2645	1810	1496507.07	598568.58
S0360	2895	1810	1496279.36	598465.39
S0361	2945	1810	1496233.82	598444.75
S0362	2005	1835	1497100.32	598809.99
S0363	2770	1850	1496409.73	598480.55
S0364	2655	1860	1496518.60	598518.91
S0365	2670	1875	1496511.13	598499.06
S0366	2695	2000	1496539.96	598374.89
S0367	2770	2000	1496471.65	598343.93
S0368	2870	2000	1496380.56	598302.65
S0369	2920	2000	1496335.02	598282.01
S0370	2555	2050	1496688.11	598387.13
S0371	2820	2050	1496446.74	598277.75
S0372	2920	2050	1496355.66	598236.47
S0373	3350	1810	1495864.94	598277.57
S0374	3250	1825	1495962.21	598305.19
S0375	3300	1825	1495916.67	598284.55
S0376	3375	1875	1495869.00	598208.05
S0377	3200	1900	1496038.71	598257.52
S0378	3325	1975	1495955.82	598137.61
S0379	3250	2000	1496034.45	598145.79
S0380	3300	2000	1495988.91	598125.15
S0381	3075	2025	1496204.16	598195.26
S0382	3150	2025	1496135.85	598164.30
S0383	3200	2050	1496100.63	598120.89
S0384	3375	2050	1495941.23	598048.65
S0385	3505	1850	1495740.27	598177.16
S0386	3605	1850	1495649.19	598135.88
S0387	3480	1875	1495773.36	598164.71
S0388	2795	2125	1496500.47	598219.75
S0389	2920	2125	1496386.62	598168.16
S0390	2670	2150	1496624.65	598248.58
S0391	2720	2200	1496599.74	598182.40
S0392	2895	2225	1496450.67	598087.39
S0393	2645	2250	1496688.70	598167.82
S0394	2745	2250	1496597.61	598126.54
S0395	2820	2275	1496539.62	598072.81
S0396	2760	2300	1496604.59	598074.81
S0397	2770	2300	1496595.48	598070.68
S0398	2945	2325	1496446.40	597975.67
S0399	2745	2350	1496638.89	598035.46
S0400	2895	2350	1496502.27	597973.54
S0401	2645	2375	1496740.29	598053.96
S0402	2770	2375	1496626.44	598002.37
S0403	2705	2385	1496689.77	598020.09
S0404	3110	2125	1496213.56	598089.73
S0406	3225	2200	1496139.77	597973.95

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0407	3160	2210	1496203.11	597991.67
S0408	3255	2235	1496126.90	597929.68
S0409	3235	2255	1496153.37	597919.72
S0410	3200	2260	1496187.31	597929.62
S0411	3150	2300	1496249.36	597913.82
S0412	3135	2310	1496267.16	597910.91
S0413	3050	2325	1496350.77	597932.33
S0414	3375	2325	1496054.75	597798.18
S0415	3085	2350	1496329.21	597895.11
S0416	3150	2350	1496270.00	597868.28
S0417	3225	2350	1496201.69	597837.32
S0418	3350	2350	1496087.84	597785.72
S0419	3275	2375	1496166.47	597793.91
S0420	2695	2425	1496715.39	597987.78
S0421	2800	2450	1496630.07	597921.67
S0422	2820	2475	1496622.18	597890.64
S0423	2855	2475	1496590.30	597876.20
S0424	2875	2490	1496578.27	597854.28
S0425	2945	2500	1496518.64	597816.28
S0426	2910	2510	1496554.65	597821.62
S0427	2670	2525	1496779.44	597907.02
S0428	2970	2550	1496516.51	597760.42
S0429	2670	2575	1496800.08	597861.48
S0430	2645	2625	1496843.49	597826.26
S0431	2845	2625	1496661.32	597743.70
S0432	2895	2635	1496619.91	597713.95
S0433	2695	2650	1496808.27	597782.85
S0434	2770	2650	1496739.95	597751.89
S0435	2945	2650	1496580.56	597679.65
S0436	2730	2685	1496790.83	597736.52
S0437	3100	2450	1496356.82	597797.84
S0438	3150	2474	1496321.19	597755.34
S0439	3075	2500	1496400.23	597762.61
S0440	3375	2500	1496126.98	597638.78
S0441	3350	2525	1496160.07	597626.33
S0442	3375	2550	1496147.62	597593.24
S0443	3300	2575	1496226.26	597601.43
S0444	3100	2600	1496418.74	597661.21
S0445	3010	2635	1496515.16	597666.48
S0446	3375	2650	1496188.90	597502.16
S0447	3025	2675	1496518.01	597623.86
S0448	3455	1900	1495806.45	598152.26
S0449	3530	1900	1495738.14	598121.30
S0450	3430	1950	1495849.86	598117.03
S0451	3480	1975	1495814.64	598073.62
S0452	3680	1975	1495632.47	597991.07
S0453	3430	2000	1495870.50	598071.49
S0454	3530	2000	1495779.42	598030.21
S0455	3680	2000	1495642.79	597968.30
S0456	3730	2025	1495607.57	597924.89
S0457	3405	2675	1496171.90	597467.00
S0458	3870	1810	1495391.30	598062.93
S0459	3940	1825	1495333.74	598020.37
S0460	4010	1835	1495274.11	597982.37
S0461	3870	1850	1495407.82	598026.49
S0462	3910	1860	1495375.51	598000.87

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0463	4045	1860	1495252.55	597945.15
S0464	4055	1910	1495264.08	597895.48
S0465	3790	1925	1495511.64	597991.20
S0466	3770	1950	1495540.18	597976.69
S0467	4110	1975	1495240.81	597813.57
S0468	3825	2025	1495521.04	597885.67
S0469	3860	2025	1495489.16	597871.23
S0470	4060	2025	1495306.99	597788.67
S0471	3555	2150	1495818.56	597883.27
S0472	3505	2175	1495874.42	597881.14
S0473	3655	2200	1495748.12	597796.45
S0474	3430	2215	1495959.25	597875.66
S0475	3555	2225	1495849.52	597814.96
S0476	3530	2250	1495882.61	597802.51
S0477	3665	2250	1495759.65	597746.78
S0478	3465	2260	1495945.94	597820.23
S0479	3505	2275	1495915.70	597790.06
S0480	3580	2275	1495847.39	597759.10
S0481	3430	2285	1495988.14	597811.91
S0482	3390	2300	1496030.77	597814.75
S0483	3480	2310	1495952.92	597768.50
S0484	3415	2335	1496022.44	597772.56
S0485	3705	2350	1495764.49	597639.19
S0486	3810	2125	1495575.98	597800.78
S0487	3835	2125	1495553.21	597790.46
S0488	3835	2135	1495557.34	597781.35
S0489	3860	2150	1495540.76	597757.37
S0490	4135	2175	1495300.60	597621.09
S0491	4010	2200	1495424.77	597649.91
S0492	3985	2250	1495468.18	597614.69
S0493	4010	2275	1495455.73	597581.60
S0494	4135	2275	1495341.88	597530.00
S0495	4010	2300	1495466.05	597558.83
S0496	4135	2300	1495352.20	597507.23
S0497	3935	2325	1495544.68	597567.02
S0498	3860	2350	1495623.31	597575.21
S0499	4135	2350	1495372.84	597461.69
S0500	3960	2375	1495542.55	597511.16
S0501	3455	2425	1496023.16	597674.07
S0502	3655	2425	1495840.99	597591.51
S0503	3680	2425	1495818.22	597581.19
S0504	3655	2500	1495871.95	597523.20
S0505	3755	2525	1495791.19	597459.15
S0506	3480	2550	1496051.99	597549.90
S0507	3730	2550	1495824.28	597446.70
S0508	3430	2575	1496107.85	597547.77
S0509	3680	2575	1495880.14	597444.57
S0510	3580	2625	1495991.86	597440.31
S0511	3730	2625	1495855.24	597378.39
S0512	3380	2675	1496194.67	597477.32
S0513	3860	2475	1495674.91	597461.35
S0514	3960	2475	1495583.83	597420.07
S0515	4060	2475	1495492.75	597378.80
S0516	4135	2475	1495424.43	597347.84
S0517	3910	2500	1495639.69	597417.94
S0518	3910	2550	1495660.33	597372.40

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0519	4010	2575	1495579.57	597308.35
S0520	3835	2625	1495759.60	597335.05
S0521	4035	2625	1495577.43	597252.49
S0522	4135	2625	1495486.35	597211.21
S0523	4110	2650	1495519.44	597198.76
S0524	3860	2675	1495757.47	597279.19
S0525	4010	2675	1495620.84	597217.27
S0526	3860	2700	1495767.79	597256.42
S0527	3935	2700	1495699.48	597225.46
S0528	4165	1875	1495149.44	597881.95
S0529	4190	1875	1495126.67	597871.63
S0530	4225	1900	1495105.11	597834.41
S0531	4265	1900	1495068.68	597817.90
S0532	4215	1905	1495116.28	597833.99
S0533	4220	1905	1495111.73	597831.92
S0534	4225	1910	1495109.24	597825.31
S0535	4230	1920	1495108.81	597814.13
S0536	4290	1950	1495066.55	597762.04
S0537	4315	1950	1495043.77	597751.72
S0538	4165	1975	1495190.72	597790.87
S0539	4340	2000	1495041.64	597695.86
S0540	4165	2050	1495221.68	597722.56
S0541	4265	2075	1495140.91	597658.51
S0542	4390	2075	1495027.06	597606.91
S0543	4265	2200	1495192.51	597544.65
S0544	4465	2325	1495061.94	597348.24
S0545	4415	2350	1495117.80	597346.11
S0546	4465	2350	1495072.26	597325.47
S0547	4375	2365	1495160.43	597348.96
S0548	4380	2370	1495157.94	597342.34
S0549	4165	2375	1495355.83	597426.54
S0550	4290	2375	1495241.98	597374.94
S0551	4390	2375	1495150.89	597333.66
S0552	4370	2380	1495171.17	597337.36
S0553	4375	2385	1495168.68	597330.74
S0554	4165	2450	1495386.79	597358.22
S0555	4165	2525	1495417.75	597289.91
S0556	4265	2550	1495336.98	597225.86
S0557	4265	2575	1495347.30	597203.09
S0558	4240	2600	1495380.39	597190.64
S0559	4340	2600	1495289.31	597149.36
S0560	4390	2600	1495243.77	597128.72
S0561	4265	2625	1495367.94	597157.55
S0562	4290	2625	1495345.17	597147.23
S0563	4190	2650	1495446.57	597165.74
S0564	4240	2650	1495401.03	597145.10
S0565	4190	2675	1495456.89	597142.97
S0566	4240	2675	1495411.35	597122.33
S0567	4290	2675	1495365.81	597101.69
S0568	4215	2700	1495444.44	597109.88
S0569	4545	2475	1495050.99	597178.60
S0570	4595	2475	1495005.45	597157.96
S0571	4645	2525	1494980.55	597091.78
S0572	4570	2525	1495048.86	597122.74
S0573	4620	2550	1495013.64	597079.33
S0574	4745	2675	1494951.38	596913.87

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0575	4525	2355	1495019.68	597296.15
S0576	4545	2375	1495009.72	597269.68
S0577	1765	2715	1497682.17	598107.53
S0578	1830	2800	1497658.05	598003.28
S0579	2135	2775	1497369.93	597900.15
S0580	2160	2775	1497347.16	597889.83
S0581	2010	2900	1497535.38	597837.89
S0582	2085	2900	1497467.07	597806.94
S0583	2035	2950	1497533.25	597782.03
S0584	2060	2950	1497510.48	597771.71
S0585	2035	2975	1497543.57	597759.26
S0586	1910	3025	1497678.06	597765.32
S0587	2060	3050	1497551.76	597680.63
S0588	2085	3075	1497539.30	597647.54
S0589	2135	3125	1497514.40	597581.36
S0590	2010	3175	1497648.89	597587.42
S0591	2160	3225	1497532.91	597479.96
S0592	2060	3275	1497644.63	597475.69
S0593	2230	3275	1497489.79	597405.52
S0594	2095	3320	1497631.33	597420.26
S0595	2160	3335	1497578.32	597379.77
S0596	2220	3350	1497529.86	597341.34
S0597	2185	3385	1497576.18	597323.91
S0598	2140	3400	1497623.36	597328.82
S0599	2220	3425	1497560.82	597273.02
S0600	2210	3460	1497584.37	597245.27
S0601	2220	3555	1497614.48	597154.62
S0602	2565	2725	1496957.63	597768.20
S0603	2415	2750	1497104.58	597807.34
S0604	2465	2750	1497059.04	597786.70
S0605	2340	2780	1497185.27	597810.98
S0606	2440	2800	1497102.44	597751.48
S0607	2450	2850	1497113.98	597701.81
S0608	2540	2925	1497062.96	597596.35
S0609	2845	2750	1496712.92	597629.85
S0610	2645	2800	1496915.72	597666.86
S0611	2745	2800	1496824.64	597625.58
S0612	2920	2800	1496665.25	597553.35
S0613	2870	2825	1496721.11	597551.22
S0614	2945	2825	1496652.80	597520.26
S0615	2670	2875	1496923.91	597588.23
S0616	2845	2875	1496764.52	597515.99
S0617	2720	2875	1496878.37	597567.59
S0618	2945	2875	1496673.43	597474.72
S0619	2820	2925	1496807.93	597480.77
S0620	2945	2925	1496694.07	597429.17
S0621	2645	2950	1496977.64	597530.24
S0622	2590	3025	1497058.70	597484.63
S0623	2515	3050	1497137.33	597492.82
S0625	2590	3150	1497110.29	597370.77
S0626	2375	3200	1497326.76	597413.98
S0627	2365	3225	1497346.19	597395.34
S0628	2575	3225	1497154.91	597308.65
S0629	2265	3275	1497457.91	597391.07
S0630	2415	3275	1497321.29	597329.16
S0631	2490	3275	1497252.97	597298.20

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0632	2565	3275	1497184.66	597267.24
S0633	2645	3025	1497008.60	597461.92
S0634	2845	3050	1496836.75	597356.60
S0635	2870	3075	1496824.30	597323.51
S0636	2820	3100	1496880.16	597321.38
S0637	2670	3125	1497027.11	597360.52
S0638	2720	3125	1496981.57	597339.88
S0639	2820	3125	1496890.48	597298.61
S0640	2895	3225	1496863.45	597176.56
S0641	2770	3250	1496987.62	597205.39
S0642	2795	3240	1496960.72	597204.18
S0643	2645	3275	1497111.80	597234.22
S0644	2970	3275	1496815.78	597100.06
S0645	2990	3290	1496803.75	597078.15
S0646	2995	3290	1496799.20	597076.08
S0647	2610	3340	1497170.51	597189.46
S0648	2340	3350	1497420.56	597291.80
S0649	2390	3350	1497375.02	597271.16
S0650	2565	2400	1496823.48	598064.22
S0651	2290	3450	1497507.38	597221.36
S0652	2265	3550	1497571.43	597140.60
S0653	2390	3550	1497457.57	597089.00
S0654	2290	3575	1497558.97	597107.51
S0655	2565	3575	1497308.50	596993.99
S0656	2695	3375	1497107.53	597122.50
S0657	2720	3400	1497095.08	597089.40
S0658	2870	3400	1496958.46	597027.49
S0659	2945	3450	1496910.78	596950.99
S0660	2870	2475	1496576.63	597870.01
S0661	2745	3500	1497113.59	596988.00
S0662	2870	3500	1496999.73	596936.40
S0663	2945	3500	1496931.42	596905.45
S0664	2670	3525	1497192.22	596996.19
S0665	2770	3525	1497101.14	596954.91
S0666	2670	3575	1497212.86	596950.65
S0667	2770	3575	1497121.78	596909.37
S0668	2870	3575	1497030.69	596868.09
S0670	3175	2705	1496393.77	597534.62
S0671	3075	2725	1496493.11	597557.68
S0672	3300	2725	1496288.17	597464.80
S0673	3275	2775	1496331.58	597429.58
S0674	3375	2775	1496240.50	597388.30
S0675	3100	2800	1496501.30	597479.05
S0676	3150	2825	1496466.08	597435.64
S0677	3075	2850	1496544.71	597443.82
S0678	3151	2850	1496475.48	597412.45
S0679	3175	2875	1496463.94	597379.78
S0680	3275	2900	1496383.18	597315.73
S0681	3250	2925	1496416.27	597303.28
S0682	3075	2950	1496585.98	597352.74
S0683	3405	2725	1496192.54	597421.46
S0684	3455	2725	1496146.99	597400.82
S0685	3505	2725	1496101.45	597380.18
S0686	2580	2750	1496954.29	597739.23
S0687	2580	2775	1496964.61	597716.46
S0688	3655	2775	1495985.47	597272.72

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0689	3530	2800	1496109.64	597301.55
S0690	3605	2800	1496041.33	597270.59
S0691	3705	2825	1495960.56	597206.54
S0692	3710	2825	1495956.01	597204.48
S0693	3430	2850	1496221.36	597297.29
S0694	3755	2875	1495935.66	597140.36
S0695	3505	2925	1496184.01	597198.02
S0696	3580	2925	1496115.70	597167.06
S0697	3420	2950	1496271.75	597210.33
S0698	3580	2950	1496126.02	597144.29
S0699	4390	3250	1495512.08	596536.68
S0700	4440	3250	1495466.54	596516.05
S0701	4165	3275	1495727.33	596606.79
S0702	4415	3295	1495507.88	596485.38
S0703	3785	3325	1496094.09	596718.11
S0704	3835	3325	1496048.55	596697.47
S0705	3875	3325	1496012.11	596680.95
S0706	4035	3325	1495866.38	596614.91
S0707	4135	3325	1495775.30	596573.63
S0708	3785	3375	1496114.73	596672.56
S0709	4010	3425	1495930.43	596534.15
S0710	4135	3425	1495816.58	596482.55
S0711	3960	3450	1495986.29	596532.01
S0712	4085	3475	1495882.76	596457.65
S0713	3785	3500	1496166.33	596558.71
S0714	3985	3525	1495994.48	596453.38
S0715	3835	3525	1496131.10	596515.30
S0716	4040	3545	1495952.64	596412.46
S0717	4030	3550	1495963.81	596412.04
S0718	4035	3550	1495959.26	596409.97
S0719	4020	3555	1495974.98	596411.61
S0720	4015	3560	1495981.60	596409.12
S0721	4010	3565	1495988.22	596406.63
S0722	4000	3570	1495999.39	596406.20
S0723	3785	3575	1496197.28	596490.40
S0724	3860	3575	1496128.97	596459.44
S0725	3990	3575	1496010.56	596405.78
S0726	3980	3580	1496021.74	596405.35
S0727	3975	3583	1496027.53	596404.68
S0728	3970	3585	1496032.91	596404.92
S0729	3960	3590	1496044.08	596404.50
S0730	3950	3595	1496055.25	596404.07
S0731	3375	3075	1496364.33	597115.05
S0732	3075	3100	1496647.90	597216.12
S0733	3150	3100	1496579.59	597185.16
S0734	3325	3100	1496420.19	597112.92
S0735	3250	3125	1496498.83	597121.11
S0736	3250	3175	1496519.47	597075.57
S0737	3075	3200	1496689.18	597125.03
S0738	3275	3200	1496507.01	597042.48
S0739	3025	3250	1496755.36	597100.13
S0740	3100	3250	1496687.05	597069.17
S0741	3225	3250	1496573.19	597017.57
S0742	3050	3275	1496742.91	597067.04
S0743	3075	3275	1496720.14	597056.72
S0744	3225	3275	1496583.51	596994.80

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0745	3010	3285	1496783.47	597074.44
S0746	3005	3295	1496792.15	597067.40
S0747	3010	3295	1496787.60	597065.34
S0748	3300	3295	1496523.46	596945.63
S0749	3480	3075	1496268.70	597071.71
S0750	3530	3075	1496223.15	597051.07
S0751	3605	3075	1496154.84	597020.11
S0752	3655	3100	1496119.62	596976.70
S0753	3455	3150	1496322.43	597013.72
S0754	3580	3150	1496208.57	596962.12
S0755	3655	3150	1496140.26	596931.16
S0756	3705	3150	1496094.72	596910.52
S0757	3480	3175	1496309.97	596980.63
S0758	3505	3200	1496297.52	596947.54
S0759	3630	3200	1496183.67	596895.94
S0760	3720	3200	1496101.69	596858.79
S0761	3430	3225	1496376.16	596955.73
S0762	3655	3275	1496191.86	596817.31
S0763	3075	3325	1496740.78	597011.18
S0764	3350	3325	1496490.30	596897.67
S0765	3225	3350	1496614.47	596926.49
S0766	3350	3350	1496500.62	596874.89
S0767	3075	3400	1496771.74	596942.87
S0768	3225	3400	1496635.11	596880.95
S0769	3300	3400	1496566.80	596849.99
S0770	3025	3425	1496827.60	596940.74
S0771	3075	3425	1496782.06	596920.10
S0772	3050	3475	1496825.47	596884.87
S0773	3200	3500	1496699.16	596800.19
S0774	3075	3550	1496833.65	596806.24
S0775	3350	3575	1496593.49	596669.96
S0776	3405	3325	1496440.20	596874.96
S0777	3430	3325	1496417.43	596864.64
S0778	3555	3325	1496303.58	596813.04
S0779	3580	3325	1496280.81	596802.73
S0780	3650	3325	1496217.05	596773.83
S0781	3755	3350	1496131.73	596707.72
S0782	3480	3375	1496392.53	596798.46
S0783	3580	3400	1496311.77	596734.41
S0784	3730	3400	1496175.14	596672.50
S0785	3480	3475	1496433.81	596707.38
S0786	3655	3475	1496274.41	596635.14
S0787	3400	3550	1496537.63	596672.09
S0788	3480	3550	1496464.77	596639.07
S0789	3730	3550	1496237.06	596535.87
S0790	3390	3560	1496550.87	596667.11
S0791	3555	3575	1496406.77	596585.34
S0792	3860	2750	1495788.43	597210.87
S0793	4010	2750	1495651.80	597148.96
S0794	4085	2800	1495604.13	597072.46
S0795	3910	2825	1495773.84	597121.92
S0796	4110	2850	1495602.00	597016.60
S0797	3810	2875	1495885.57	597117.66
S0798	4135	2875	1495589.55	596983.51
S0799	3960	2900	1495759.26	597032.97
S0800	3810	2900	1495895.89	597094.89

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0801	4135	2900	1495599.87	596960.73
S0802	3985	2925	1495746.81	596999.88
S0803	4080	2925	1495660.28	596960.67
S0804	3810	2950	1495916.52	597049.35
S0805	4085	2950	1495666.05	596935.83
S0806	4135	2950	1495620.51	596915.19
S0807	4190	2705	1495469.28	597115.64
S0808	4290	2705	1495378.19	597074.37
S0809	4165	2800	1495531.26	597039.43
S0810	4190	2825	1495518.81	597006.34
S0811	4265	2825	1495450.50	596975.39
S0812	4365	2825	1495359.42	596934.11
S0813	4215	2875	1495516.68	596950.48
S0814	4290	2875	1495448.37	596919.52
S0815	4365	2875	1495380.06	596888.57
S0816	4390	2875	1495357.28	596878.25
S0817	4240	2975	1495535.19	596849.08
S0818	4265	2975	1495512.42	596838.76
S0819	4315	2975	1495466.88	596818.12
S0820	4390	2975	1495398.56	596787.16
S0821	4415	2975	1495375.79	596776.84
S0822	3985	3005	1495779.83	596927.01
S0823	4035	3005	1495734.29	596906.38
S0824	4085	3025	1495697.01	596867.52
S0825	4135	3125	1495692.74	596755.80
S0826	4010	3050	1495775.64	596875.71
S0827	4135	3050	1495661.78	596824.11
S0828	4085	3075	1495717.64	596821.98
S0829	4135	3100	1495682.42	596778.57
S0830	3810	3125	1495988.76	596889.95
S0831	4060	3125	1495761.05	596786.76
S0832	3935	3225	1495916.19	596747.27
S0833	4135	3225	1495734.02	596664.71
S0834	4110	3250	1495767.11	596652.26
S0835	3810	3275	1496050.68	596753.33
S0836	4265	3025	1495533.06	596793.22
S0837	4340	3050	1495475.06	596739.49
S0838	4265	3100	1495564.01	596724.91
S0839	4440	3100	1495404.62	596652.67
S0840	4315	3125	1495528.79	596681.50
S0841	4215	3175	1495640.51	596677.23
S0842	4340	3200	1495536.98	596602.87
S0843	4190	3225	1495683.92	596642.01
S0844	4240	3250	1495648.70	596598.60
S0845	4315	3250	1495580.39	596567.64
S0846	4290	3305	1495625.86	596527.87
S0847	4165	3325	1495747.97	596561.25
S0848	4290	3325	1495634.12	596509.65
S0849	4215	3325	1495702.43	596540.61
S0850	4340	3325	1495588.58	596489.01
S0851	4365	3350	1495576.13	596455.92
S0852	4165	3375	1495768.61	596515.71
S0853	4240	3375	1495700.30	596484.75
S0854	4315	3375	1495631.99	596453.79
S0855	4140	3425	1495812.02	596480.48
S0856	4165	3475	1495809.89	596424.62

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0858	4520	2750	1495187.28	596938.44
S0859	4495	2800	1495230.69	596903.22
S0860	4445	2825	1495286.55	596901.08
S0861	4420	2850	1495319.64	596888.63
S0862	4620	2850	1495137.47	596806.08
S0863	4375	2875	1495370.95	596884.44
S0864	4595	2875	1495170.56	596793.63
S0865	4445	2900	1495317.51	596832.77
S0866	4495	2900	1495271.97	596812.13
S0867	4545	2900	1495226.43	596791.49
S0868	4395	2925	1495373.37	596830.64
S0869	4620	2925	1495168.43	596737.76
S0870	4620	2950	1495178.75	596714.99
S0872	4645	2975	1495166.30	596681.90
S0873	4620	2990	1495195.26	596678.56
S0874	4575	3025	1495250.70	596665.26
S0875	4820	3025	1495027.54	596564.13
S0876	4780	3030	1495066.04	596576.08
S0877	4640	3035	1495195.62	596629.32
S0878	4705	3035	1495136.42	596602.49
S0879	4795	3060	1495064.76	596542.57
S0880	4845	3075	1495025.41	596508.26
S0881	4830	3095	1495047.33	596496.24
S0882	4720	3100	1495149.59	596537.09
S0883	4740	3125	1495141.69	596506.07
S0884	4580	3135	1495291.55	596563.00
S0885	4770	3160	1495128.81	596461.80
S0886	4605	3175	1495285.29	596516.25
S0887	4675	3175	1495221.53	596487.35
S0888	4840	3180	1495073.31	596414.69
S0889	4695	3200	1495213.64	596456.33
S0890	4530	3210	1495368.05	596515.33
S0891	4610	3210	1495295.18	596482.31
S0892	4775	3225	1495151.09	596400.53
S0893	4630	3230	1495285.22	596455.83
S0894	4815	3230	1495116.72	596379.47
S0895	4680	3260	1495252.06	596407.87
S0896	4870	3260	1495079.01	596329.44
S0897	4535	3270	1495388.26	596458.61
S0898	4575	3270	1495351.83	596442.10
S0899	4820	3275	1495130.74	596336.42
S0900	4730	3280	1495214.78	596369.01
S0901	4630	3290	1495309.99	596401.18
S0902	4790	3290	1495164.26	596335.14
S0903	4830	3295	1495129.89	596314.07
S0904	4875	3295	1495088.90	596295.50
S0905	4950	3250	1495002.01	596305.53
S0906	4975	3300	1494999.88	596249.67
S0907	4925	3315	1495051.61	596256.64
S0908	4975	3325	1495010.20	596226.90
S0909	5000	3415	1495024.58	596134.60
S0910	5020	3435	1495014.62	596108.13
S0911	4900	3440	1495125.98	596153.11
S0912	5025	3465	1495022.45	596078.74
S0913	5035	3540	1495044.30	596006.30
S0914	4986	3550	1495093.06	596017.42

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0915	5055	3600	1495050.85	595943.39
S0916	5080	3675	1495059.04	595864.76
S0917	5010	3680	1495124.86	595889.10
S0918	2315	3625	1497556.84	597051.64
S0919	2515	3625	1497374.68	596969.09
S0920	2615	3625	1497283.59	596927.81
S0921	2465	3700	1497451.18	596921.42
S0922	2540	3700	1497382.87	596890.46
S0923	2615	3700	1497314.55	596859.50
S0924	2440	3725	1497484.27	596908.96
S0925	2565	3825	1497411.69	596766.28
S0926	2590	3825	1497388.92	596755.96
S0927	2490	3875	1497500.64	596751.70
S0928	2540	3875	1497455.10	596731.06
S0929	2590	3875	1497409.56	596710.42
S0930	2645	3625	1497256.27	596915.43
S0931	2970	3625	1496960.25	596781.27
S0932	2670	3650	1497243.82	596882.34
S0933	2475	3675	1497431.75	596940.06
S0934	2870	3675	1497071.97	596777.01
S0935	2670	3700	1497264.46	596836.79
S0936	3920	3700	1496125.92	596320.82
S0937	2995	3725	1496978.76	596679.87
S0938	2870	3750	1497102.93	596708.70
S0939	2945	3750	1497034.62	596677.74
S0940	2670	3800	1497305.74	596745.71
S0941	2845	3800	1497146.34	596673.48
S0942	2945	3800	1497055.26	596632.20
S0943	2645	3875	1497359.46	596687.72
S0944	2615	3925	1497407.43	596654.56
S0945	2515	3950	1497508.83	596673.07
S0946	2465	4000	1497575.01	596648.17
S0947	2540	4025	1497517.02	596594.44
S0948	2515	4075	1497560.43	596559.21
S0949	2590	4100	1497502.44	596505.49
S0950	2565	4125	1497535.53	596493.03
S0951	2645	3925	1497380.10	596642.18
S0952	3870	3925	1496264.34	596136.52
S0953	3945	3925	1496196.02	596105.56
S0954	2645	3975	1497400.74	596596.64
S0955	2945	3975	1497127.49	596472.80
S0956	2645	4000	1497411.06	596573.87
S0957	2745	4000	1497319.98	596532.59
S0958	2770	4000	1497297.21	596522.27
S0959	2945	4000	1497137.81	596450.03
S0960	2720	4100	1497384.03	596451.82
S0961	2645	4125	1497462.66	596460.01
S0962	2770	4125	1497348.81	596408.41
S0963	2845	4125	1497280.49	596377.46
S0964	2945	4125	1497189.41	596336.18
S0965	3325	3925	1496760.74	596361.49
S0966	3125	3950	1496953.22	596421.27
S0967	3275	3950	1496816.60	596359.35
S0968	3225	3975	1496872.46	596357.22
S0969	3125	4025	1496984.18	596352.96
S0970	3075	4050	1497040.04	596350.83

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S0971	3025	4075	1497095.91	596348.70
S0972	2730	4225	1497426.52	596333.84
S0973	2855	4225	1497312.66	596282.24
S0974	2830	4250	1497345.75	596269.79
S0975	2580	4275	1497583.78	596350.22
S0976	2780	4275	1497401.62	596267.66
S0977	2630	4325	1497558.88	596284.04
S0978	2635	4325	1497554.32	596281.97
S0979	2580	4350	1497614.74	596281.91
S0980	2680	4350	1497523.66	596240.63
S0981	2630	4375	1497579.52	596238.50
S0982	3025	3625	1496910.15	596758.57
S0983	3325	3625	1496636.90	596634.74
S0984	3275	3650	1496692.77	596632.60
S0985	3250	3675	1496725.86	596620.15
S0986	3250	3875	1496808.41	596437.99
S0987	3350	3875	1496717.33	596396.71
S0988	3475	3605	1496492.02	596591.03
S0989	3480	3605	1496487.47	596588.97
S0990	3630	3625	1496359.10	596508.84
S0991	3680	3625	1496313.56	596488.20
S0992	3580	3635	1496408.77	596520.37
S0993	3630	3650	1496369.42	596486.07
S0994	3680	3650	1496323.88	596465.43
S0995	3400	3705	1496601.62	596530.91
S0996	3405	3775	1496625.96	596465.09
S0997	3450	3800	1496595.29	596423.74
S0998	3405	3800	1496636.28	596442.32
S0999	3530	3800	1496522.42	596390.72
S1000	3630	3800	1496431.34	596349.44
S1001	3405	3825	1496646.59	596419.55
S1002	3400	3850	1496661.47	596398.84
S1003	3430	3850	1496634.14	596386.46
S1004	3780	3720	1496261.69	596360.39
S1005	3800	3720	1496243.47	596352.14
S1006	3820	3720	1496225.26	596343.88
S1007	3820	3725	1496227.32	596339.33
S1008	3755	3730	1496288.59	596361.60
S1009	3900	3730	1496156.52	596301.75
S1010	3795	3750	1496260.41	596326.87
S1011	3710	3760	1496341.96	596352.85
S1012	3800	3760	1496259.99	596315.70
S1013	3820	3760	1496241.77	596307.45
S1014	4000	3775	1496084.01	596219.48
S1015	3870	3780	1496204.48	596268.59
S1016	3650	3800	1496413.12	596341.19
S1017	3750	3800	1496322.04	596299.91
S1018	3850	3800	1496230.96	596258.63
S1019	3650	3805	1496415.19	596336.63
S1020	3830	3810	1496253.30	596257.78
S1021	3980	3810	1496116.68	596195.86
S1022	3610	3820	1496457.81	596339.48
S1023	3700	3820	1496375.84	596302.33
S1024	3895	3820	1496198.22	596221.84
S1025	3590	3825	1496478.09	596343.18
S1026	4130	3830	1495988.31	596115.73

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S1027	3880	3840	1496220.14	596209.81
S1028	3660	3850	1496424.65	596291.52
S1029	3950	3850	1496160.51	596171.81
S1030	3930	3860	1496182.86	596170.96
S1031	3520	3870	1496560.42	596331.09
S1032	3720	3875	1496380.32	596243.98
S1033	3610	3880	1496482.58	596284.83
S1034	3500	3890	1496586.90	596321.13
S1035	3480	3895	1496607.18	596324.83
S1036	3690	3895	1496415.90	596238.15
S1037	3460	3900	1496627.46	596328.53
S1038	3575	3900	1496522.71	596281.06
S1039	3980	3900	1496153.83	596113.89
S1040	4000	3900	1496135.61	596105.63
S1041	3640	3920	1496471.76	596236.01
S1042	3525	3925	1496578.57	596278.93
S1043	4030	3930	1496120.67	596065.92
S1044	3480	3940	1496625.75	596283.84
S1045	3600	3940	1496516.45	596234.31
S1046	4020	3940	1496133.90	596060.94
S1047	4070	3960	1496096.62	596022.09
S1048	3550	3970	1496574.38	596227.62
S1049	4060	3980	1496113.98	596008.00
S1050	3510	3990	1496619.07	596225.92
S1051	4110	4010	1496080.82	595960.03
S1052	4090	4020	1496103.17	595959.18
S1053	4140	4050	1496070.01	595911.22
S1054	4120	4060	1496092.35	595910.36
S1055	4200	4080	1496027.74	595859.12
S1056	4180	4100	1496054.22	595849.16
S1057	4220	4150	1496038.42	595787.11
S1058	4200	4160	1496060.77	595786.26
S1059	4230	4200	1496049.95	595737.44
S1060	4205	4205	1496074.79	595743.21
S1061	4260	4240	1496039.14	595688.62
S1062	4240	4250	1496061.48	595687.77
S1063	4300	4280	1496019.22	595635.68
S1064	4280	4300	1496045.69	595625.72
S1065	4340	4300	1495991.04	595600.95
S1066	4320	4320	1496017.51	595590.99
S1067	4400	4340	1495952.90	595539.75
S1068	4380	4350	1495975.25	595538.90
S1070	4460	4360	1495906.51	595496.77
S1071	4430	4380	1495942.09	595490.94
S1072	4480	4410	1495908.93	595442.97
S1073	4450	4420	1495940.38	595446.25
S1074	4470	4470	1495942.80	595392.45
S1076	4440	4480	1495974.26	595395.72
S1077	4430	4540	1496008.13	595345.20
S1078	4470	4540	1495971.70	595328.69
S1079	4490	4580	1495969.99	595284.00
S1080	4460	4590	1496001.45	595287.28
S1081	4480	4640	1496003.87	595233.48
S1082	4520	4640	1495967.44	595216.97
S1083	4500	4700	1496010.42	595170.58
S1084	4540	4700	1495973.99	595154.06

Surface Location Coordinates (ft)

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
S1085	4530	4750	1496003.73	595112.65
S1086	4550	4760	1495989.64	595095.29
S1087	2515	2825	1497044.45	597697.75
S1089	2920	2725	1496634.29	597621.66
S1090	2670	2750	1496872.31	597702.08
S1091	2770	2750	1496781.23	597660.81
S1092	3362	2185	1496008.80	597931.06

F.2. SITE SURVEY PROJECT CORE LOCATIONS

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
C0001	1480	1500	1497440.23	599331.83
C0002	1860	1200	1496970.28	599448.22
C0003	2180	1420	1496769.62	599115.75
C0004	2240	1200	1496624.16	599291.37
C0005	1480	1800	1497564.06	599058.58
C0006	1480	2100	1497687.90	598785.33
C0007	1860	1800	1497217.95	598901.73
C0008	2030	1885	1497098.19	598754.13
C0009	2040	1885	1497089.08	598750.00
C0010	2350	1900	1496812.92	598608.38
C0011	2400	1925	1496777.69	598564.97
C0012	2300	1950	1496879.10	598583.48
C0013	2375	2000	1496831.42	598506.98
C0014	2300	2025	1496910.06	598515.16
C0015	2315	2025	1496896.39	598508.97
C0016	2350	2050	1496874.83	598471.75
C0017	2475	2050	1496760.98	598420.16
C0018	2240	1800	1496871.83	598744.87
C0019	2290	2025	1496919.16	598519.29
C0020	2315	2075	1496917.03	598463.43
C0021	2340	2075	1496894.26	598453.11
C0022	1860	2100	1497341.78	598628.48
C0023	1830	2125	1497379.42	598618.09
C0024	2200	2125	1497042.42	598465.36
C0025	2290	2150	1496970.76	598405.44
C0026	2142.4	2362.7	1497193.00	598272.63
C0027	2104.9	2371.9	1497230.95	598279.73
C0028	1755	2375	1497550.93	598421.34
C0029	2184.3	2374.1	1497159.54	598244.95
C0030	2063.6	2395.0	1497278.11	598275.74
C0031	2204.7	2396.6	1497150.25	598216.04
C0032	2340	2175	1496935.54	598362.03
C0033	1860	2400	1497465.61	598355.23
C0034	2010	2405	1497331.05	598288.76
C0035	2212.9	2405.8	1497146.58	598204.27
C0036	2220	2425	1497148.03	598183.86
C0037	2178	2428.6	1497187.78	598197.91
C0038	2210	2500	1497188.10	598119.67
C0039	2110	2525	1497289.50	598138.18
C0040	2185	2525	1497221.19	598107.22
C0041	2210	2550	1497208.74	598074.13
C0042	2060	2575	1497355.68	598113.28
C0043	2210	2625	1497239.70	598005.82
C0044	2235	2650	1497227.25	597972.73
C0045	2240	2400	1497119.50	598198.37
C0046	2550	2440	1496853.65	598033.97
C0047	2470	2485	1496945.09	598026.01
C0048	2480	2500	1496942.18	598008.22
C0049	2460	2515	1496966.59	598002.81
C0050	2430	2530	1497000.10	598001.53
C0051	2385	2540	1497045.22	598011.00
C0052	2405	2555	1497033.19	597989.08
C0053	2400	2570	1497043.94	597977.48
C0054	2380	2570	1497062.16	597985.74
C0055	2265	2575	1497168.96	598028.66
C0056	2420	2590	1497033.98	597951.01

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
C0057	2405	2600	1497051.77	597948.10
C0058	2395	2605	1497062.94	597947.67
C0059	2415	2610	1497046.79	597934.86
C0060	2400	2620	1497064.58	597931.94
C0061	2390	2630	1497077.81	597926.96
C0062	2315	2675	1497164.70	597916.93
C0063	3370	1850	1495863.23	598232.88
C0064	3340	1860	1495894.68	598236.16
C0065	3340	1870	1495898.81	598227.05
C0066	3320	1880	1495921.16	598226.20
C0067	2620	2100	1496649.55	598314.76
C0068	3370	2160	1495991.19	597950.53
C0069	3320	2235	1496067.69	597902.85
C0070	3300	2240	1496087.97	597906.55
C0071	3280	2245	1496108.25	597910.26
C0072	3260	2250	1496128.53	597913.96
C0073	3240	2260	1496150.88	597913.11
C0074	3210	2270	1496182.33	597916.38
C0075	2620	2400	1496773.38	598041.51
C0076	3000	2400	1496427.27	597884.66
C0077	3680	1950	1495622.15	598013.84
C0078	3755	1975	1495564.16	597960.11
C0079	3415	2050	1495904.80	598032.14
C0080	3705	2050	1495640.66	597912.44
C0081	3400	2090	1495934.97	598001.90
C0082	3630	2080	1495721.35	597916.07
C0083	3825	1875	1495459.12	598022.30
C0084	3935	1885	1495363.06	597967.78
C0085	3840	1915	1495461.97	597979.67
C0086	3935	1925	1495379.57	597931.35
C0087	4010	1925	1495311.26	597900.39
C0088	4050	1925	1495274.82	597883.88
C0089	3950	1935	1495370.04	597916.05
C0090	3910	1950	1495412.66	597918.90
C0091	3790	1965	1495528.15	597954.77
C0092	3825	1980	1495502.46	597926.66
C0093	3390	2130	1495960.59	597969.60
C0094	3835	2160	1495567.66	597758.58
C0095	3900	2160	1495508.45	597731.75
C0096	3875	2190	1495543.61	597714.75
C0097	3380	2400	1496081.15	597727.80
C0098	3760	2470	1495763.93	597507.18
C0099	4265	1965	1495095.51	597758.70
C0100	4275	1975	1495090.53	597745.46
C0101	4285	1985	1495085.55	597732.23
C0102	4295	1995	1495080.57	597718.99
C0103	4300	2060	1495102.84	597657.72
C0104	4365	2085	1495053.96	597608.12
C0105	4140	2100	1495265.09	597687.33
C0106	4315	2105	1495107.76	597610.54
C0107	4375	2170	1495079.94	597526.57
C0108	4250	2200	1495206.17	597550.85
C0109	4325	2225	1495148.18	597497.12
C0110	4390	2230	1495091.04	597465.73
C0111	4165	2250	1495304.23	597540.39
C0112	4300	2250	1495181.27	597484.67

F.3. AREA 19 (WTS) LOCATIONS

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
C0113	4140	2275	1495337.32	597527.94
C0114	4200	2275	1495282.67	597503.17
C0115	4395	2275	1495105.06	597422.68
C0116	4315	2305	1495190.31	597428.38
C0117	4520	2400	1495042.81	597257.23
C0118	2145	2725	1497340.18	597941.56
C0119	2210	2735	1497285.11	597905.63
C0120	2195	2805	1497327.66	597848.06
C0121	2095	2810	1497420.81	597884.78
C0122	2010	2925	1497545.70	597815.12
C0123	2115	2975	1497470.70	597726.24
C0124	1855	3000	1497717.84	597810.79
C0125	2185	3085	1497452.35	597597.15
C0126	2265	2725	1497230.88	597892.03
C0127	2340	2725	1497162.57	597861.07
C0128	2365	2750	1497150.12	597827.98
C0129	2290	2715	1497203.98	597890.82
C0130	2265	2800	1497261.84	597823.72
C0131	2500	2800	1497047.80	597726.71
C0132	2465	2825	1497089.99	597718.39
C0134	2465	2850	1497100.31	597695.62
C0135	2490	2850	1497077.54	597685.30
C0136	2515	2850	1497054.77	597674.98
C0137	2290	2875	1497270.03	597745.09
C0138	2340	2875	1497224.49	597724.45
C0139	2390	2875	1497178.95	597703.81
C0140	2450	2875	1497124.30	597679.04
C0141	2400	2880	1497171.90	597695.13
C0142	2390	2900	1497189.26	597681.04
C0143	2415	2900	1497166.49	597670.72
C0144	2500	2900	1497089.07	597635.63
C0145	2498.9	2885.7	1497084.17	597649.11
C0146	2465	2975	1497151.91	597581.77
C0147	2620	2700	1496897.22	597768.26
C0148	2590	3040	1497064.89	597470.97
C0149	2610	3040	1497046.67	597462.71
C0150	2590	3055	1497071.08	597457.30
C0151	2610	3055	1497052.86	597449.05
C0152	2565	3065	1497097.98	597458.51
C0153	2610	3070	1497059.05	597435.38
C0154	2610	3080	1497063.18	597426.28
C0155	2600	3090	1497076.42	597421.30
C0156	2600	3075	1497070.23	597434.96
C0157	2590	3125	1497099.97	597393.54
C0158	2620	3000	1497021.05	597495.02
C0159	2620	3100	1497062.33	597403.93
C0160	2745	3180	1496981.50	597279.47
C0161	2240	3300	1497491.00	597378.62
C0162	2620	3300	1497144.89	597221.77
C0163	2645	3325	1497132.43	597188.68
C0164	2720	3325	1497064.12	597157.72
C0165	2980	3325	1496827.31	597050.39
C0166	2795	3375	1497016.45	597081.22
C0167	2770	3450	1497070.18	597023.22
C0168	2670	3475	1497171.58	597041.73
C0169	2720	3575	1497167.32	596930.01

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
C0170	3000	2700	1496551.10	597611.41
C0171	3000	3000	1496674.94	597338.16
C0172	3000	3100	1496716.21	597247.08
C0173	3000	3250	1496778.13	597110.45
C0174	3380	3000	1496328.82	597181.30
C0175	3640	3000	1496092.01	597073.98
C0176	3010	3310	1496793.79	597051.67
C0177	3090	3310	1496720.92	597018.65
C0178	3380	3300	1496452.66	596908.05
C0179	3480	3580	1496477.15	596611.74
C0180	3760	2700	1495858.87	597297.69
C0181	4140	2700	1495512.76	597140.84
C0182	4140	3000	1495636.59	596867.59
C0183	4140	3300	1495760.42	596594.34
C0184	4795	2875	1494988.40	596711.07
C0185	4605	2960	1495196.54	596712.08
C0186	4845	2975	1494984.14	596599.35
C0187	4630	2995	1495188.22	596669.88
C0188	4520	3000	1495290.47	596710.73
C0189	4780	3050	1495074.30	596557.87
C0190	4860	3050	1495001.43	596524.84
C0191	4675	3100	1495190.57	596555.67
C0192	4900	3140	1495002.15	596426.36
C0193	4900	3300	1495068.19	596280.62
C0194	2240	3600	1497614.84	597105.37
C0195	2620	3600	1497268.72	596948.52
C0196	3000	4135	1497143.44	596304.37
C0197	3000	3900	1497046.44	596518.41
C0198	2620	4135	1497489.56	596461.22
C0199	3000	3600	1496922.61	596791.66
C0200	3275	3675	1496703.09	596609.83
C0201	3380	3600	1496576.49	596634.80
C0202	3480	3625	1496495.73	596570.75
C0203	3760	3650	1496251.01	596432.40
C0204	3405	3675	1496584.68	596556.17
C0205	3515	3675	1496484.49	596510.77
C0206	3425	3725	1496587.10	596502.37
C0207	3630	3725	1496400.38	596417.75
C0208	3680	3725	1496354.84	596397.12
C0209	3635	3730	1496397.89	596411.14
C0210	3605	3750	1496433.47	596405.30
C0211	3465	3780	1496573.37	596435.77
C0212	3505	3780	1496536.94	596419.26
C0213	4860	3260	1495088.12	596333.57
C0214	4550	3500	1495469.54	596242.93
C0215	4100	3540	1495895.93	596392.25
C0216	5050	3740	1495113.19	595817.94
C0217	3740	3750	1496310.51	596349.58
C0218	4450	3840	1495700.97	595974.53
C0219	3460	3940	1496643.97	596292.10
C0220	3100	4140	1497054.42	596258.53
C0221	5000	4190	1495344.49	595428.71
C0222	5230	4190	1495134.99	595333.77
C0223	4140	4260	1496156.69	595719.94
C0224	4600	4270	1495741.84	595520.95
C0225	3850	4360	1496462.11	595748.57

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
C0226	2690	4370	1497522.80	596218.28
C0227	3620	4480	1496721.14	595734.21
C0228	5530	4480	1494981.45	594945.79
C0229	5200	4500	1495290.28	595063.79
C0230	4650	4600	1495832.52	595199.74
C0231	4350	4630	1496118.15	595296.25
C0232	4930	4720	1495627.02	594974.86
C0233	3230	4760	1497191.94	595640.16
C0234	3550	4960	1496983.03	595325.90
C0235	3880	4960	1496682.46	595189.68
C0236	4620	4980	1496016.70	594866.01
C0237	5270	5040	1495449.43	594543.05
C0238	5680	5040	1495075.99	594373.81
C0239	4230	5050	1496400.82	594963.24
C0240	3000	5100	1497541.78	595425.41
C0241	4570	5330	1496206.71	594567.86
C0242	4980	5370	1495849.78	594362.18
C0243	5340	5430	1495546.65	594158.93
C0244	4325	5500	1496500.04	594514.15
C0245	3830	5520	1496959.16	594700.26
C0246	3480	5600	1497310.97	594771.86
C0247	3680	5650	1497149.44	594643.77
C0248	1100	1500	1497786.34	599488.69
C0249	1860	1500	1497094.11	599174.97
C0250	2930	1255	1496018.39	598956.45
C0251	2850	0980	1495977.74	599239.95
C0252	3015	1445	1496019.40	598748.31
C0253	2715	1670	1496385.52	598667.21
C0254	3630	1325	1495409.70	598603.75
C0255	3425	1505	1495670.73	598524.42
C0256	2240	2100	1496995.66	598471.62
C0257	2010	2550	1497390.91	598156.69
C0258	2235	2600	1497206.61	598018.27
C0259	2085	2675	1497374.19	598011.87
C0260	3360	2185	1496010.62	597931.88
C0262	4750	2700	1494957.15	596889.04
C0263	3245.3	3777.2	1496772.32	596529.01
C0264	3254.3	3724.8	1496742.50	596573.02
C0265	3322.9	3752.4	1496691.41	596519.56
C0266	3328.7	3808.2	1496709.16	596466.34
C0267	3342.9	3670.8	1496639.51	596585.63
C0268	3400.6	3716.1	1496605.65	596520.55
C0269	3418.2	3751.3	1496604.15	596481.23
C0270	3441.5	3791.9	1496599.69	596434.63
C0271	3483.1	3865.9	1496592.34	596350.06
C0272	3524.0	3801.1	1496528.34	596392.19
C0273	3413.3	3682.1	1496580.05	596546.28
C0274	3478.5	3737.9	1496543.70	596468.54
C0275	3447.0	3529.9	1496486.53	596671.00
C0276	3642.8	3648.1	1496356.98	596482.51
C0277	3587.2	3640.5	1496404.48	596512.39
C0278	3542.0	3628.3	1496440.62	596542.16
C0279	3565.3	3567.8	1496394.42	596587.64
C0280	3710.7	3705.2	1496318.70	596402.48
C0281	3591.4	3784.3	1496460.02	596379.68
C0282	3500.9	3679.3	1496499.10	596512.67

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
C0283	2139.2	2411.5	1497216.06	598229.50
C0284	2236.2	2495.9	1497162.55	598112.59
C0285	2212.0	2478.9	1497177.57	598138.06
C0286	2184.0	2464.1	1497196.96	598163.10
C0287	2151.6	2450.7	1497220.94	598188.68
C0288	2119.3	2438.6	1497245.37	598213.03
C0289	2081.0	2422.7	1497273.69	598243.33
C0290	2102.1	2401.5	1497245.72	598253.93
C0291	2490.3	2915.3	1497104.22	597625.70

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
19-1	2389.22	2917.99	1497197.40	597664.97
19-2	2474.63	2905.89	1497114.61	597640.74
19-3	2419.20	2901.81	1497163.42	597667.34
19-4	2435.14	2893.98	1497145.66	597667.89
19-5	2446.61	2901.09	1497138.15	597656.68
19-6	2459.51	2899.40	1497125.71	597652.89
19-7	2478.77	2884.00	1497101.81	597658.97
19-8	2492.89	2890.94	1497091.81	597646.82
19-9	2498.91	2906.29	1497092.66	597630.35
19-10	2533.61	2912.81	1497063.75	597610.09
19-11	2567.69	2891.07	1497023.73	597615.82
19-12	2607.83	2864.84	1496976.35	597623.15
19-13	2646.08	2843.67	1496932.77	597626.64
19-14	2694.28	2817.72	1496878.15	597630.38
19-15	2735.84	2791.35	1496829.41	597637.24
19-16	2764.85	2775.76	1496796.56	597639.47
19-17	2825.90	2736.96	1496724.93	597649.61
19-18	2869.02	2712.64	1496675.62	597653.96
19-19	2910.83	2684.47	1496625.91	597662.36
19-20	2958.42	2659.29	1496572.17	597665.65
19-21	2996.07	2635.91	1496528.23	597671.40
19-22	3042.02	2611.46	1496476.28	597674.71
19-23	3060.62	2613.27	1496460.09	597665.38
19-24	3049.10	2607.32	1496468.12	597675.56
19-25	3081.72	2586.23	1496429.71	597681.30
19-26	3085.81	2574.70	1496421.22	597690.11
19-27	3096.70	2561.41	1496405.82	597697.72
19-28	3100.38	2544.13	1496395.33	597711.94
19-29	3080.17	2528.50	1496407.29	597734.52
19-30	3114.58	2518.45	1496371.80	597729.47
19-31	3126.78	2505.45	1496355.32	597736.28
19-32	3176.97	2490.97	1496303.63	597728.75
19-33	2936.47	2517.09	1496533.47	597804.23
19-34	3266.02	2461.90	1496210.52	597718.47
19-35	3312.99	2448.51	1496162.21	597711.28
19-36	3362.09	2438.96	1496113.55	597699.71
19-37	3426.84	2410.91	1496042.99	597698.53
19-38	3455.03	2406.09	1496015.33	597691.28
19-39	3467.81	2393.77	1495998.60	597697.23
19-40	3482.24	2383.51	1495981.22	597700.62
19-41	3493.48	2377.83	1495968.64	597701.15
19-42	3487.74	2355.72	1495964.74	597723.66
19-43	3513.25	2319.78	1495926.67	597745.86
19-44	3555.80	2294.67	1495877.55	597751.17
19-45	3602.66	2279.81	1495828.73	597745.36
19-46	3650.82	2242.47	1495769.46	597759.49
19-47	3688.55	2230.57	1495730.18	597754.76
19-48	3577.89	2304.08	1495861.31	597733.48
19-49	3537.70	2285.48	1495890.24	597767.01
19-50	3510.81	2344.32	1495939.02	597724.52
19-51	3489.36	2395.15	1495979.54	597687.08
19-52	3468.02	2404.77	1496002.95	597687.12
19-53	3188.67	2481.14	1496288.91	597732.87
19-54	3146.88	2492.90	1496331.83	597739.41
19-55	3144.19	2503.36	1496338.60	597730.99
19-56	3134.08	2516.19	1496353.10	597723.48

Location	Mound Plant West	Mound Plant South	Ohio State Plane East (x)	Ohio State Plane North (y)
19-57	3108.15	2504.63	1496371.95	597744.71
19-58	3099.82	2579.94	1496410.62	597679.56
19-59	3095.49	2596.64	1496421.46	597666.13
19-60	3027.87	2620.15	1496492.76	597672.63
19-61	3071.20	2581.59	1496437.37	597689.87
19-62	3051.79	2596.55	1496461.23	597684.25

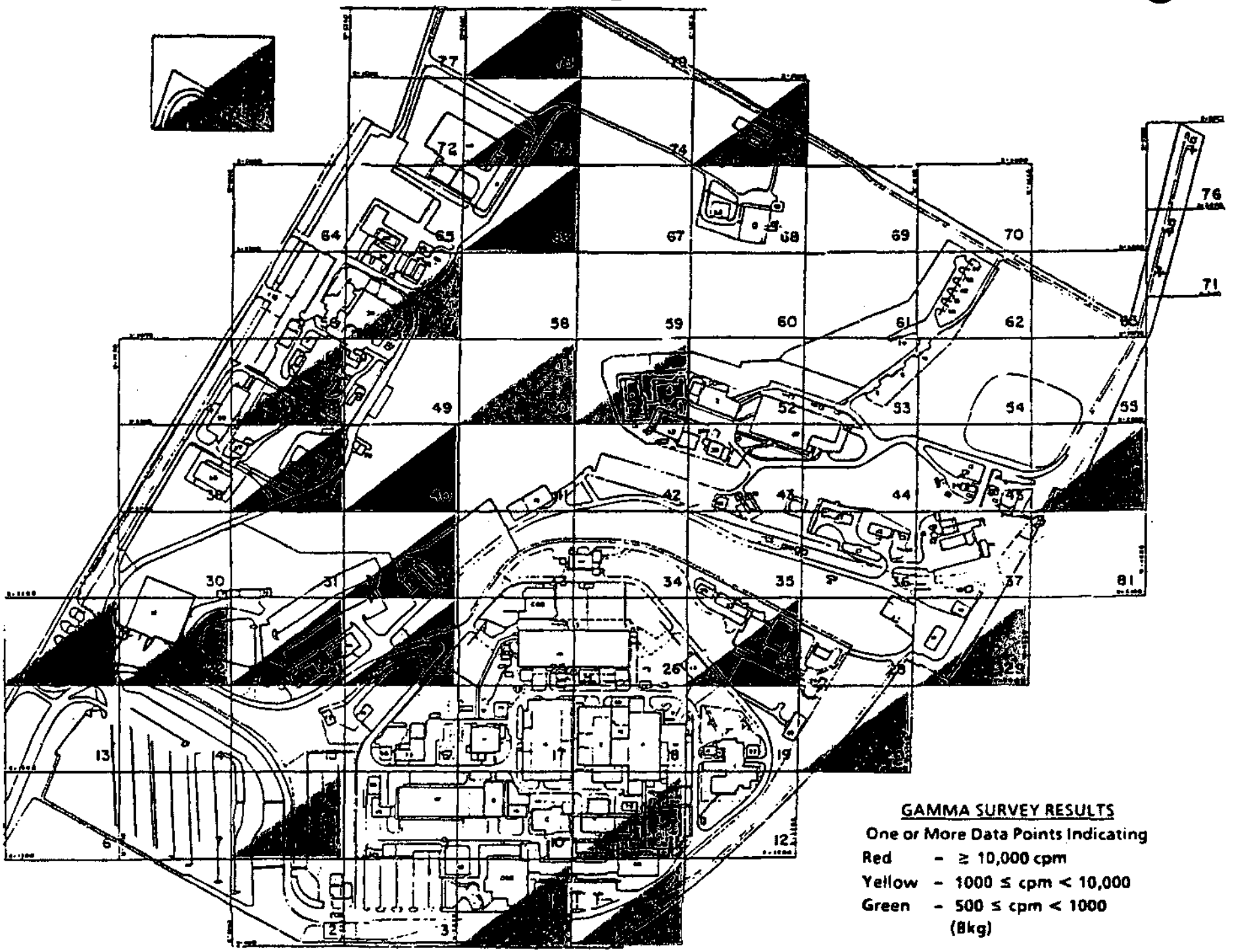


Plate 2. General representation of site survey results - plutonium-238 gamma survey.

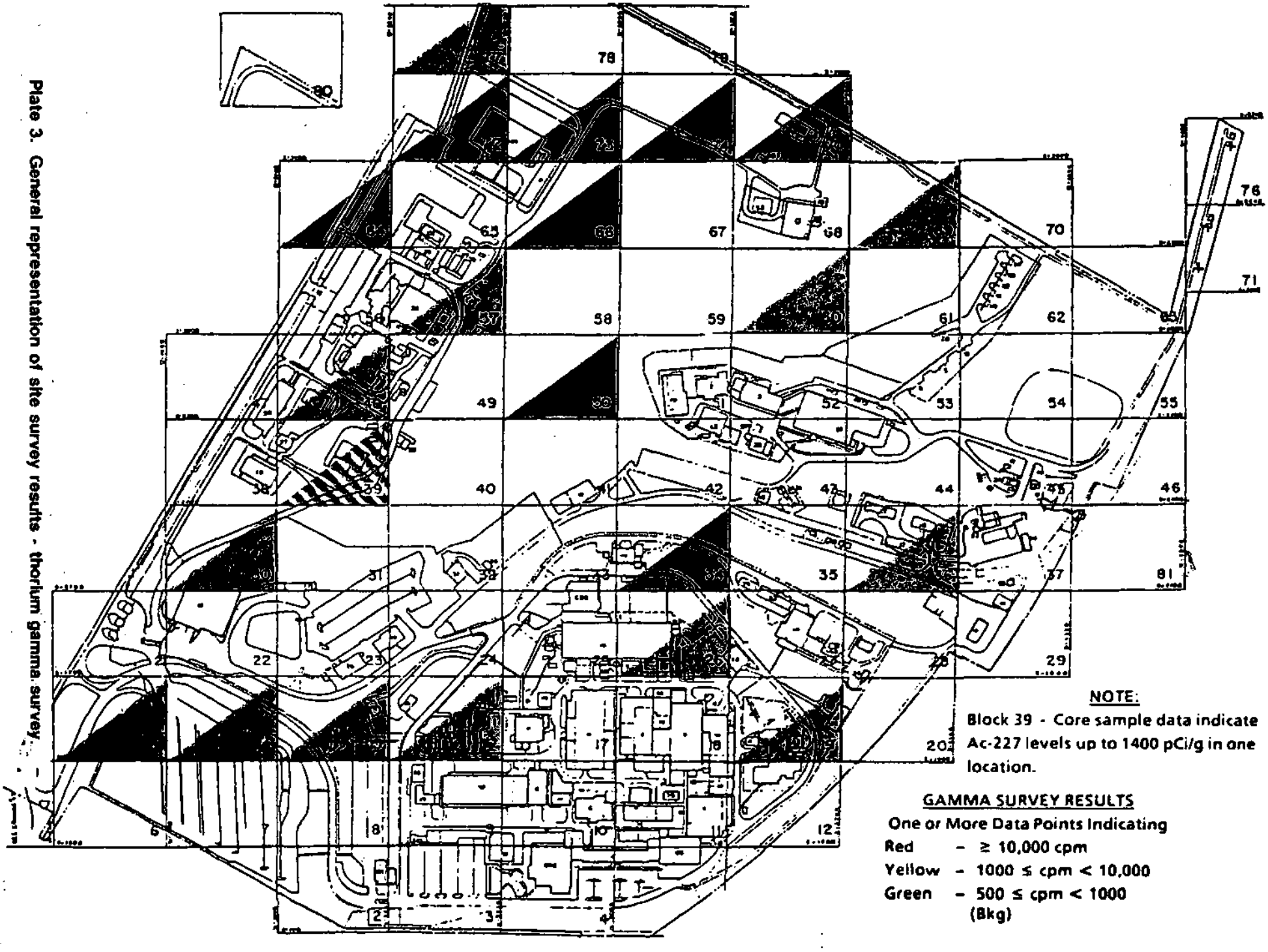


Plate 3. General representation of site survey results - thorium gamma survey.

MATCH LINE

MATCH LINE

AREA 18

AREA 2

AREA 22

AREA 1

SPOILS DISPOSAL AREA

CONRAIL RAILROAD

BENNER ROAD

TN
GN
MN

1981 magnetic north declination at center of plant. Magnetic north is 3 degrees west of true north. Declination between state plane (grid) north is 1.13 degrees west of true north.

ER PROGRAM

MOUND PLANT

Miamisburg, Ohio

PLATE 1
(2 of 2)

Site Survey Project
Site Survey Project Sampling Locations

Prepared for

Site Scoping Report: Volume 3,
Radiological Site Survey

Map Location

Surface Location
Core Location
Potential Release Site
Elevated Activity

0 50 100 150 200
Scale in Feet
1 inch = 100 feet

Grid system is based on the Ohio State Plane Coordinate System

NOTE: Accuracy of surface locations is +/- 25 feet.

WESTON
MANAGERS DESIGNERS/CONSULTANTS

5301 CENTRAL AVENUE N.E.
SUITE 1000
ALBUQUERQUE, NM 87108
PHONE: (505) 255-1445

c:\dgn\moundb\core2.dgn 040591

ER PROGRAM

MOUND PLANT

Miamisburg, Ohio

PLATE 4
Site Survey Project
Plutonium Concentrations

Prepared for
Site Scoping Report: Volume 3,
Radiological Site Survey

1981 magnetic north declination at center of plant. Magnetic north is 3 degrees west of true north. Declination between state plane (grid) north is 1.13 degrees west of true north.

GRID SYSTEM IS BASED ON THE OHIO STATE PLANE COORDINATE SYSTEM

MOUND, MAX. Pu CONC. IN SOIL SAMPLES (pCi/g) -34000 (FUMX34.CMD)

MOUND, posting values for CONTOURED Pu CONC. IN SAMPLES (pCi/g) (PUMXpost1.CMD)

J:\DGN\MOUNDB\M0765 062193

NOTES:

1. The electronic base map data file was obtained by WESTON from Woolpert Consultants, Inc., Dayton, Ohio. The data were photogrammetrically complied from aerial photography dated 12/08/85.

2. WESTON converted MOUND plant coordinates to Ohio State Plane Coordinates using an algorithm provided by Oak Ridge National Laboratory, Grand Junction Project Office.

3. Area west of Dayton-Cincinnati Pike was digitized from a hand drafted map, dated 3/12/86 from Monstanto Research Corp.

The data used in this map are from the Site Survey Project. Contours were generated by computer software (Radian Corporation, Contour Plotting System®, "CPS/PC"®) using the highest reported concentration at each sample location regardless of sample type (surface of subsurface). The combination of 1,138 surface sample locations and 291 core sample locations resulted in a total of 1,280 plutonium subsurface/surface soil data points. The concentrations of plutonium ranged from 0.01 pCi/g to 34,000 pCi/g. For the purposes of contouring only, the peak value of 34,000 pCi/g was removed prior to contouring. The next highest value was 1,103 pCi/g.

53 Structures
Paved Roadway
Unpaved Roadway
Railroad
Water
Fences
Retaining Wall
Mound Plant Boundary
Isopleth contour line

0 100 200 400 600 800 1000
Scale in Feet

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 5
Site Survey Project
Thorium Concentrations

Prepared for

Site Scoping Report: Volume 3, Radiological Site Survey

1981 magnetic north declination at center of plant. Magnetic north is 3 degrees west of true north. Declination between state plane (grid) north is 1.13 degrees west of true north.

Grid system is based on the Ohio State Plane Coordinate System

NOTES:

- 53 Structures
- Paved Roadway
- Unpaved Roadway
- Railroad
- Water
- Fences
- Retaining Wall
- Mound Plant Boundary
- Isopleth contour line

1. The electronic base map data file was obtained by WESTON from Woolpert Consultants, Inc., Dayton, Ohio. The data were photogrammetrically complied from aerial photography dated 12/08/85.

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3. Area west of Dayton-Cincinnati Pike was digitized from a hand drafted map, dated 3/12/86 from Monsanto Research Corp.

The data used in this map are from the Site Survey Project. Contours were generated by computer software (Radian Corporation, Contour Plotting System®, "CPS/PC"®) using the highest reported concentration at each sample location regardless of sample type (surface of subsurface). The combination of the 1,138 surface sample locations and 291 core sample locations resulted in a total of 1,315 thorium subsurface/surface data points. The thorium concentrations ranged from 0.3 pCi/g to 254.3 pCi/g.

0 100 200 400 600 800 1000
Scale in Feet

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MOUND, posting values for CONTOURED Th CONC. IN SAMPLES (pCi/g) {THMAX.CMD}
MOUND, CONTOURED Th CONC. IN SAMPLES (pCi/g) {THMXpost.CMD}
Ø62193
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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

Legend
- Structure
- Paved road
- Dirt road
- Water
- Mound Plant Boundary
- 0215 Surface Location
- 0002 Core Location
- Potential Release Site
- Elevated Activity
- 19-17 Sampling Location for Verification Survey of Former WTS Pipeline

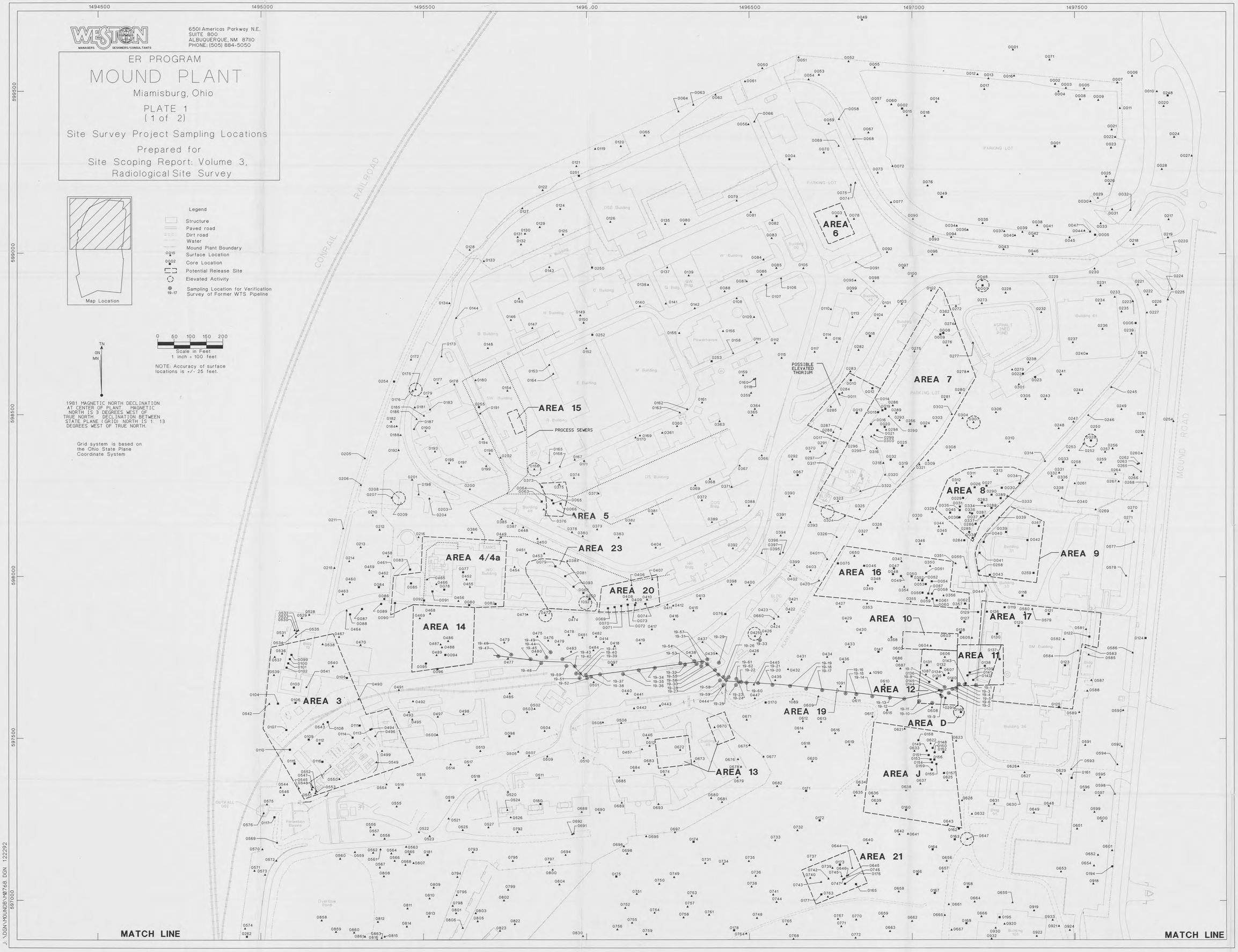
0 50 100 150 200
Scale in Feet
1 inch = 100 feet

NOTE: Accuracy of surface locations is +/- 25 feet.

TN
GN
MN

1981 MAGNETIC NORTH DECLINATION AT CENTER OF PLANT. MAGNETIC NORTH IS 3 DEGREES WEST OF TRUE NORTH. DECLINATION BETWEEN STATE PLANE (GRID) NORTH IS 1. 13 DEGREES WEST OF TRUE NORTH.

Grid system is based on the Ohio State Plane Coordinate System



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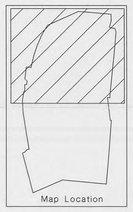
ER PROGRAM
MOUND PLANT

Miamisburg, Ohio

PLATE 1
(1 of 2)

Site Survey Project Sampling Locations

Prepared for
Site Scoping Report: Volume 3,
Radiological Site Survey



Legend

- Structure
- Paved road
- Dirt road
- Water
- Mound Plant Boundary
- 0015 Surface Location
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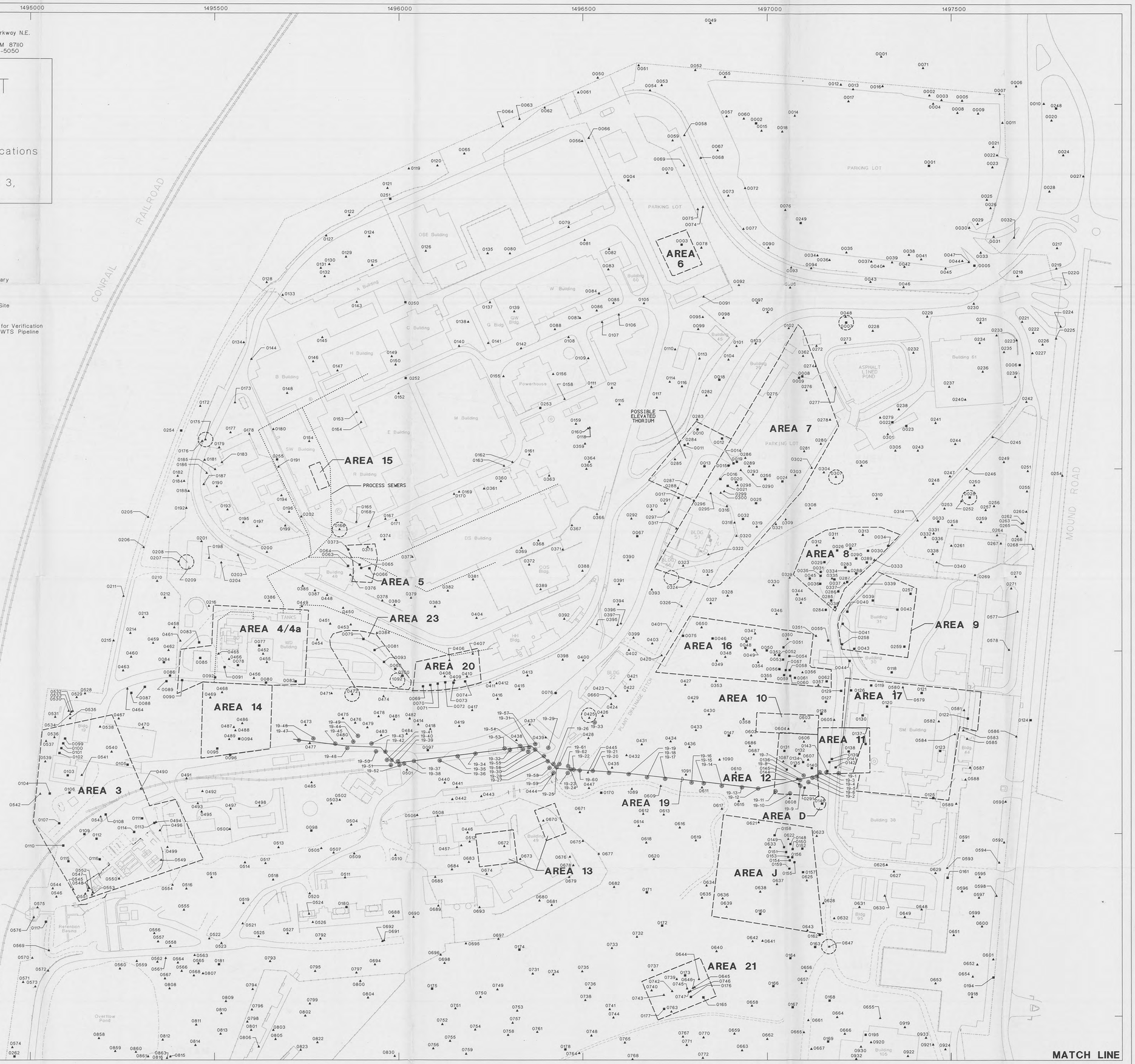

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