# SDMS US EPA Region V

*Imagery Insert Form*

**Document ID:** 171029

**Some images in this document may be illegible or unavailable in SDMS. Please see reason(s) indicated below:**

☐ Illegible due to bad source documents. Image(s) in SDMS is equivalent to hard copy.

**Specify Type of Document(s) / Comments:**

☐ Includes ____ COLOR or ___ RESOLUTION variations.
Unless otherwise noted, these pages are available in monochrome. The source document page(s) is more legible than the images. The original document is available for viewing at the Superfund Records Center.

**Specify Type of Document(s) / Comments:**

☐ Confidential Business Information (CBI).
This document contains highly sensitive information. Due to confidentiality, materials with such information are not available in SDMS. You may contact the EPA Superfund Records Manager if you wish to view this document.

**Specify Type of Document(s) / Comments:**

☒ Unscannable Material:
Oversized X or ____ Format.
Due to certain scanning equipment capability limitations, the document page(s) is not available in SDMS. The original document is available for viewing at the Superfund Records center.

**Specify Type of Document(s) / Comments:**

Maps Partially Scanned - B12 thru B15

☐ Document is available at the Records Center .

**Specify Type of Document(s) / Comments:**

Rev. 07/10/02

171629

WARZYN

137

Draft Report
Project No. 60251

Volume 1 of 5
Remedial Investigation Report
ACS NPL Site
Griffith, Indiana

Prepared for:
**Steering Committee**
**ACS PRP Group**

Prepared by:
**Warzyn Inc.**
**Chicago, Illinois**

June 1991

**REMEDIAL INVESTIGATION REPORT**
**AMERICAN CHEMICAL SERVICES NPL SITE**
**GRIFFITH, INDIANA**

**FINAL DRAFT: JUNE 14, 1991**


Page

1.0 INTRODUCTION ..... 1-1

1.1 Purpose of Report ..... 1-1
1.2 Report Organization ..... 1-2
1.3 Site Background ..... 1-3

1.3.1 Site Description ..... 1-3
1.3.2 Site History ..... 1-4

1.3.2.1 History of Site Operations ..... 1-4
1.3.2.2 History of Site Disposal Practices ..... 1-7

1.3.3 Previous Investigations ..... 1-9

2.0 INVESTIGATION METHODOLOGIES ..... 2-1

2.1 Geophysical Methods ..... 2-1
2.2 Monitoring Device Installation ..... 2-3

2.2.1 Upper Aquifer Monitoring Wells ..... 2-3
2.2.2 Lower Aquifer Monitoring Wells ..... 2-4
2.2.3 Piezometers ..... 2-5
2.2.4 Leachate Monitoring Wells ..... 2-6
2.2.5 Staff Gages ..... 2-6

2.3 Soil and Waste Sampling Procedures ..... 2-7

2.3.1 Soil Area Sampling (SA) ..... 2-7
2.3.2 Auger Probes (AP) ..... 2-7
2.3.3 Soil Borings (SB) ..... 2-8
2.3.4 Test Pit Excavations (TP) ..... 2-8

2.4 Surface Water/Sediment Sampling (SW/SD) ..... 2-10
2.5 Aquifer Sampling ..... 2-11

2.5.1 Aquifer Matrix Sampling (AM) ..... 2-11
2.5.2 Confining Layer Sampling ..... 2-12
2.5.3 Baildown Tests ..... 2-12

2.6 Groundwater Sampling ..... 2-14

2.6.1 Tracer Investigation ..... 2-14
2.6.2 Field Parameter Testing ..... 2-15
2.6.3 Monitoring Well Sampling (GW) ..... 2-15
2.6.4 Leachate Sampling (LW) ..... 2-16
2.6.5 Private Well Sampling (PW) ..... 2-17

3.0 FIELD OBSERVATIONS ..... 3-1

3.1 Introduction ..... 3-1
3.2 Landfill Investigation ..... 3-2
3.3 Surficial Sampling ..... 3-2

3.3.1 Former Incinerator Area ..... 3-3
3.3.2 Kapica Drum Recycling Area ..... 3-3

3.3.2.1 Phase I Investigation ..... 3-3
3.3.2.2 Phase II Investigation ..... 3-4

3.3.3 Surface Water Drainage Areas ..... 3-4

3.3.3.1 Phase I Investigation ..... 3-4
3.3.3.2 Phase II Investigation ..... 3-4

3.4 Buried Waste Investigation ..... 3-5

3.4.1 On-Site Containment Area ..... 3-5

3.4.1.1 Phase I Investigation ..... 3-6
3.4.1.2 Phase II Investigation ..... 3-8

3.4.2 Still Bottoms Area ..... 3-9

3.4.2.1 Phase I Investigation ..... 3-10
3.4.2.2 Phase II Investigation ..... 3-12

3.4.3 Treatment Lagoon Area ..... 3-12

3.4.3.1 Phase I Investigation ..... 3-13
3.4.3.2 Phase II Investigation ..... 3-14

Table of Contents (continued)


3.4.4 Fire Pond Area ..... 3-15

3.4.4.1 The Fire Pond ..... 3-15
3.4.4.2 Area West of Fire Pond ..... 3-15

3.4.5 Off-Site Containment and Kapica Area ..... 3-16

3.4.5.1 Phase I Investigation ..... 3-17
3.4.5.2 Phase II Investigation ..... 3-18

3.5 Groundwater Investigation ..... 3-22

3.5.1 Upper Aquifer Impacts ..... 3-23
3.5.2 Characterization of the Clay Confining Layer ..... 3-24
3.5.3 Lower Aquifer Impacts ..... 3-25
3.5.4 Groundwater Flow System ..... 3-25
3.5.5 Private Well Sampling ..... 3-26

4.0 PHYSICAL CHARACTERISTICS OF SITE ..... 4-1

4.1 Regional Climate ..... 4-1
4.2 Surface Features and Topography ..... 4-1
4.3 Site Geology ..... 4-2

4.3.1 Regional Setting ..... 4-2

4.3.1.1 Regional Glacial Geology ..... 4-2
4.3.1.2 Regional Bedrock Geology ..... 4-3

4.3.2 Site Glacial Geology ..... 4-3

4.3.2.1 Upper Sand and Gravel Unit (Upper Aquifer) ..... 4-4
4.3.2.2 Silty Clay Unit (Clay Confining Layer) ..... 4-4
4.3.2.3 Lower Sand and Gravel Unit (Lower Aquifer) ..... 4-5

4.3.3 Site Bedrock Geology ..... 4-5

4.4 Surface Water Hydrology ..... 4-6

4.4.1 Regional Hydrologic Setting ..... 4-6
4.4.2 Surface Water Run-off Routes ..... 4-7

4.5 Hydrogeology ..... 4-8

4.5.1 Regional Setting ..... 4-8

Table of Contents (continued)


4.5.1.1 Glacial Hydrostratigraphic Units ..... 4-8
4.5.1.2 Bedrock Aquifers ..... 4-10

4.5.2 Upper Aquifer ..... 4-11

4.5.2.1 Physical Testing and Documentation ..... 4-11
4.5.2.2 In-Situ Hydraulic Conductivity Tests ..... 4-12
4.5.2.3 Water Level Measurements ..... 4-14
4.5.2.4 Potentiometric Maps ..... 4-15
4.5.2.5 Hydraulic Gradients ..... 4-20
4.5.2.6 Groundwater Seepage Velocity ..... 4-22

4.5.3 Lower Aquifer ..... 4-23

4.5.3.1 Water Level Measurements ..... 4-24
4.5.3.2 Potentiometric Distribution ..... 4-24
4.5.3.3 In-Situ Hydraulic Conductivity Tests ..... 4-24
4.5.3.4 Hydraulic Gradients ..... 4-24
4.5.3.5 Groundwater Seepage Rate ..... 4-25

4.5.4 Clay Confining Layer ..... 4-25

4.5.4.1 Clay Surface Elevation and Thickness ..... 4-25
4.5.4.2 Physical Characteristics ..... 4-26
4.5.4.3 Vertical Gradients ..... 4-27
4.5.4.4 Potential Leakage across the Clay Confining Layer ..... 4-27

4.6 Groundwater Flow Dynamics ..... 4-28

5.0 NATURE AND EXTENT OF CONTAMINATION ..... 5-1

5.1 Summary of Phase I Findings ..... 5-3

5.2 Landfill Area ..... 5-6

5.2.1 Organics ..... 5-6
5.2.2 Inorganics ..... 5-7

5.3 Sediment and Surface Water ..... 5-7

5.3.1 Sediment Results ..... 5-8
5.3.2 Surface Water Results ..... 5-9

5.4 Waste/Soils ..... 5-10

Table of Contents (continued)


5.4.1 On-Site Containment Area ..... 5-12

5.4.1.1 Organic Wastes ..... 5-13
5.4.1.2 PCB Containing Wastes ..... 5-15
5.4.1.3 Inorganic Wastes ..... 5-16

5.4.2 Still Bottoms/Treatment Lagoon Area ..... 5-16

5.4.2.1 Organic Wastes ..... 5-17
5.4.2.2 PCB Containing Wastes ..... 5-18
5.4.2.3 Inorganic Wastes ..... 5-19

5.4.3 Area West of Fire Pond ..... 5-20
5.4.4 Former Incinerator Area ..... 5-20
5.4.5 Off-Site Containment Area ..... 5-21

5.4.5.1 Organic Wastes ..... 5-22
5.4.5.2 PCB Containing Wastes ..... 5-24
5.4.5.3 Inorganic Wastes ..... 5-25

5.4.6 Kapica-Pazmey Area ..... 5-25

5.4.6.1 Organic Wastes ..... 5-26
5.4.6.2 PCB Containing Wastes ..... 5-26
5.4.6.3 Inorganic Wastes ..... 5-27

5.5 Groundwater ..... 5-27

5.5.1 Upper Aquifer ..... 5-29

5.5.1.1 Organics ..... 5-29
5.5.1.2 Inorganics ..... 5-33

5.5.2 Lower Aquifer ..... 5-36

5.5.2.1 Organics ..... 5-36
5.5.2.2 Inorganics ..... 5-37

5.5.3 Private Wells ..... 5-37

6.0 CONTAMINANT FATE AND MIGRATION ..... 6-1

6.1 Introduction ..... 6-1
6.2 Groundwater ..... 6-1

6.2.1 Organic Contaminants ..... 6-1
6.2.2 Inorganic Contaminants ..... 6-7

Table of Contents (continued)

6.3 Surface Water and Sediments ..... 6-10
6.4 Air ..... 6-12

7.0 ENDANGERMENT ASSESSMENT ..... 7-1

7.1 Base Line Risk Assessment
7.2 Ecological Assessment

8.0 SUMMARY AND CONCLUSIONS ..... 8-1

8.1 Site Background ..... 8-1
8.2 Physical Setting ..... 8-3
8.3 Nature and Extent of Contamination ..... 8-8
8.4 Nature and Extent of Groundwater Contamination ..... 8-16
8.5 Risk Assessment ..... 8-21
8.6 Ecological Assessment ..... 8-24

9.0 REFERENCES ..... 9-1

## Table of Contents (continued)

## List of Tables


Table

1-1 Summary of Data Collected During RI
1-2 Disposal Practices by ACS
1-3 Event Chronology

2-1 Summary of Well Construction Details
2-2 Summary of Laboratory Physical Soil Analysis
2-3 Summary of Well Development Data
2-4 Summary of Aquifer Test Results
2-5 Water Levels and Elevations
2-6 Summary of Private Wells in the ACS Site Vicinity

4-1 Precipitation Records for Griffith, Indiana
4-2 Summary of Top of Clay Elevations
4-3 Table of Permeability Values Calculated from Grain Size Data
4-4 Summary of Horizontal Hydraulic Gradients
4-5 Horizontal Upper Aquifer Groundwater Seepage Velocity
4-6 Summary of Vertical Hydraulic Gradients
4-7 Clay Confining Layer Permeability and Seepage

5-1 Organic Compound Groupings
5-2 Sampling Results, Compound Groupings
5-3 Chemical Element Content of Natural Soils
5-4 Total Volatiles Concentration in ACS Site RI Phase I and Phase II Samples
5-5 Total PCBs Concentrations in ACS Site RI Phase I and Phase II Samples
5-6 Lead Concentrations in ACS Site RI Phase I and Phase II Samples
5-7 Classification of Dissolved Inorganic Constituents in Naturally Occurring Groundwater

6-1 Physical/Chemical Properties of Target Compound List Chemicals
6-2 Retardation Factors, Organics Detected in Upper Aquifer
6-3 Theoretical Contaminant Velocities Across Confining Layer
6-4 Theoretical Contaminant Velocities Through Upper Aquifer
6-5 Retardation Factors, Organics Detected in Lower Aquifer
6-6 Theoretical Contaminant Velocities Through Lower Aquifer
6-7 Summary of Important Solubility-Controlling Solids Reported in the Literature

Table of Contents (continued)

## List of Figures


Figure

1-1 Site Location Map
1-2 Waste Burial Areas

2-1 Soil Boring, Auger Probe, and Test Pit Locations (On-Site)
2-2 Soil Boring, Auger Probe, and Test Pit Locations (Off-Site)
2-3 Monitoring Well, Aquifer Matrix Sampling, Leachate Well, Piezometer, and Staff Gage Locations
2-4 Surface Water and Sediment Sampling Locations
2-5 Tracer Research Groundwater Sampling Points
2-6 Summary of Results of Tracer Research Investigation
2-7 Private Well Location Map
Regional Geologic Cross-Section
4-2 Location Map for Site Cross-Sections
4-3 Site Cross-Section A-A'
4-4 Site Cross-Sections B-B'
4-5 Site Cross-Sections C-C'
4-6 Site Cross-Sections D-D'
4-7 Top of Clay Contour Map
4-8 Top of Clay Measuring Points
4-9 Contour Map of Clay Thickness
4-10 Regional Potentiometric Surface, Unconsolidated Aquifer
4-11 USGS Map of ACS Site Vicinity
4-12 Site Surface Water Drainage
4-13 Private Well Location Map Illustrating Groundwater Flow in the Lower Aquifer
4-14 Distribution of Upper Aquifer Permeability
4-15 Groundwater and Surface Water Hydrographs
4-16 Water Level Measuring Point Location Map
4-17 Water Table Contour Map, April 6, 1990
4-18 Water Table Contour Map, August 17, 1989
4-18A Water Table Contour Map, February 14, 1991
4-19 Site Cross-Section Illustrating Clay Confining Layer Thickness
4-20 Effluent Sample Location Map
4-21 Upper Aquifer Groundwater Flow Paths
4-22 Potentiometric Surface, Lower Aquifer, July 18, 1990
4-23 Potentiometric Surface, Lower Aquifer, September 13, 1990
4-23A Potentiometric Surface, Lower Aquifer, February 14, 1991

5-1 Total Ethenes vs BETX
5-2 Total Ethanes vs BETX
5-3 PCBs vs BETX
5-4 Correlation Between VOCs and BETX
5-5 Chromium vs Lead

## List of Figures (continued)

5-6 Total VOC's On-Site Base Map
- 5-6a Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (1-4 feet below surface)
- 5-6b Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (4-7 feet below surface)
- 5-6c Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (7-9 feet below surface)
- 5-6d Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (9-14 feet below surface)
- 5-6e Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (14-19 feet below surface)
- 5-6f Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (19-24 feet below surface)

5-7 Total PCB's On-Site Base Map
- 5-7a Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (1-3 feet below surface)
- 5-7b Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (3-6 feet below surface)
- 5-7c Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (6-8 feet below surface)
- 5-7d Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (8-12 feet below surface)
- 5-7e Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (12-17 feet below surface)
- 5-7f Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (17-20 feet below surface)

5-8 Lead On-Site Base Map
- 5-8a Approximate Extent of Lead Containing Wastes (> 500 ppm), On-Site Areas (1-4 feet below surface)
- 5-8b Approximate Extent of Lead Containing Wastes (> 500 ppm), On-Site Areas (4-7 feet below surface)
- 5-8c Approximate Extent of Lead Containing Wastes (> 500 ppm), On-Site Areas (7-10 feet below surface)
- 5-8d Approximate Extent of Lead Containing Wastes (> 500 ppm), On-Site Areas (10-15 feet below surface)

5-9 Total VOC's Off-Site Base Map
- 5-9a Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (0-4 feet below surface)
- 5-9b Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (4-7 feet below surface)
- 5-9c Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (7-9 feet below surface)

List of Figures (continued)

5-9d Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (9-14 feet below surface)
5-9e Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (14-19 feet below surface)
5-9f Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (19-24 feet below surface)
5-9g Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (24-26 feet below surface)

5-10 Total PCB's Off-Site Base Map
5-10a Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (0-3 feet below surface)
5-10b Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (3-6 feet below surface)
5-10c Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (6-8 feet below surface)
5-10d Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (8-12 feet below surface)
5-10e Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (12-17 feet below surface)
5-10f Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (17-20 feet below surface)
5-10g Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (24-26 feet below surface)

5-11 Lead Off-Site Base Map
5-11a Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (1-4 feet below surface)
5-11b Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (4-7 feet below surface)
5-11c Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (7-10 feet below surface)
5-11d Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (10-15 feet below surface)
5-11e Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (15-23 feet below surface)

5-12 BETX Distribution (ug/l)
5-13 Chlorinated Ethane Distribution (ug/l)
5-14 Chloroethane Concentrations in the Lower Aquifer

6-1 Transformations of Chlorinated Aliphatic Hydrocarbons
6-2 Piper Trilinear Diagram of Lower Aquifer Monitoring Well Data
6-3 Piper Trilinear Diagram of Upper Aquifer Monitoring Well Data

## List of Appendices

Appendix
A Aerial Photographs
B Environmental Audit of ACS
C Geophysical Investigation Data
D Borings Logs for Soil Borings, Monitoring Wells, and Leachate Wells
E Monitoring Well and Leachate Well Construction Details
F Geotechnical Analysis Results
G Auger Probe Tables
H Test Pit Logs
I Aquifer Test Results
J Tracer Research Investigation
K Field Parameter Results
L Private Well Logs
M Precipitation Records for Griffith, Indiana
N Wetlands Investigation
O Groundwater Elevation Maps
P Groundwater and Surface Water Hydrographs

Q Analytical Data in Sample Number Order
- Q-1 Leachate Results
- Q-2 Soil Area Results
- Q-3 Surface Water Results
- Q-4 Sediment Results
- Q-5 Test Pit Results
- Q-6 Soil Boring Results
- Q-7 Waste Sample Results
- Q-8 Groundwater Results
- Q-9 Private Well Results
- Q-10 Field Quality Control Sample Results

R Summary Tables of Analytical Data
- R-1 Leachate Results
- R-2 Soil Area Results
- R-3 Surface Water Results
- R-4 Sediment Results
- R-5 Test Pit Results
- R-6 Soil Boring Results
- R-7 Waste Sample Results
- R-8 Groundwater Results
- R-9 Private Well Results

# SECTION 1
# INTRODUCTION

## 1.1 PURPOSE OF REPORT

This Remedial Investigation (RI) was performed to provide the data necessary for the completion of a Feasibility Study (FS) which will identify, evaluate, and prepare conceptual designs for remedial alternatives at the American Chemical Services (ACS) Site. The RI data collection activities were designed to meet the following objectives.

- To determine if the ACS Site poses a risk to public health, welfare, or the environment;
- To confirm or deny expected locations of hazardous substances on the site;
- To evaluate locations of suspected contamination on the site;
- To determine the extent and character of hazardous and/or toxic materials present at the site, including the horizontal and vertical distribution of potential sources of contamination;
- To determine the physical and chemical properties of each identified source area containing hazardous and/or toxic materials;
- To determine the nature and extent of actual and potential releases from source areas;
- To characterize the known and potential pathways for release of contaminants from source areas. Characterization of pathways includes evaluation of physical properties governing transport within given pathways; and
- To determine and document the type, extent, and magnitude of contamination of media by hazardous substances, as necessary, to assess endangerment to human health and the environment and to perform a FS.

The Final Work Plan for the ACS Site defined 11 tasks to be completed during the RI:

- Task 1 - Problem Definition
- Task 2 - Hydrogeologic Investigation
- Task 3 - Near Surface Contamination Investigation
- Task 4 - Phase II Site Characterization
- Task 5 - Feasibility Study Testing
- Task 6 - Data Validation
- Task 7 - Contaminant Pathway and Transport Evaluation
- Task 8 - Endangerment Assessment
- Task 9 - Remedial Investigation Report
- Task 10 - Community Relations Support
- Task 11 - Quality Assurance
- Task 12 - Technical Management

Subsequent to the approval of the Final Work Plan, a Supplemental Work Plan for the Phase II Remedial Investigation and a Supplemental Technical Investigation were developed and approved.

The scope of work for Task 1 has been completed both through the submittal of this report, and the previous submittal of Technical Memoranda. No work was performed under Task 5 and Task 10. The submittal of this report completes the scope of work for the remaining tasks, with the exception of Task 9. Task 9 will be complete with the submittal of the Final RI Report.

The types of data collection activities performed during the RI, and the presentation of the data obtained, are summarized in Table 1-1.

## 1.2 REPORT ORGANIZATION

This Draft RI report is comprised of 5 volumes. The volumes may be referenced by their respective contents which are as follows:

| | |
|---|---|
| Volume I | Draft RI Text with Tables and Figures |
| Volume II | Appendices A - H |
| Volume III | Appendices I - P |
| Volume IV | Appendix Q |
| Volume V | Appendix R |

The report describes the performance and findings of the RI. Data collected prior to the initiation of the RI have been considered, however, the majority of the analysis of site conditions relies on data collected as part of the RI.

The remainder of Section 1 provides a summary of the Site history, including site operations and previous investigations and is based on documentation submitted to EPA by ACS, personal interviews by Warzyn and other field notes. Section 2 presents the details of the field procedures used to collect the data. Section 3 describes the field observations in narrative form to provide the conceptual approach and logical sequence followed during the three-phased investigation. Section 4 contains a detailed characterization of the setting of the site, including topography, geology, hydrology, and hydrogeology. Section 5 provides a description of the nature and extent of contamination in the media across the site. Section 6 assesses current and potential contaminant migration from waste materials at the site to groundwater, surface water, sediments, and air. Section 7 presents the Endangerment Assessment.

## 1.3 SITE BACKGROUND

### 1.3.1 Site Description

The American Chemical Services (ACS) NPL Site (Site) is located at 420 South Colfax Avenue in Griffith, Indiana. The Site is located in the northeast one-quarter of the southeast one-quarter, Section 2, Township 35 North, Range 9 West, Lake County, Indiana (Figure 1-1). Although the Site name is ACS, the United States Environmental Protection Agency (U.S. EPA) has defined the Site as including the ACS property (19 acres) the Pazmey Corporation property (2 acres; formerly Kapica Drum, Inc.) and the inactive portion of the Griffith Municipal Landfill (about 15 acres).

Six areas of probable waste disposal have been identified at the Site, based on preliminary reports and the review of aerial photographs. These six areas have been assigned the following designations by U.S. EPA and ACS management: the

On-Site Containment Area, the Still Bottoms Area, Treatment Lagoon #1, the Off-Site Containment Area, the Kapica/Pazmey Area, and the Griffith Municipal Landfill. These designations will be used throughout this report to facilitate discussions about the Site. The location of each area is illustrated in Figure 1-2.

### 1.3.2 Site History

As described in the previous section, the Site consists of ACS, the inactive portion of the Griffith Municipal Landfill, and the Pazmey Corporation property (Kapica Area). ACS is an active chemical manufacturing facility which formerly accepted hazardous waste solvents for recycling under RCRA Interim Status. Due to a U.S. EPA enforcement action finalized in September 1990, ACS ceased accepting hazardous wastes and is currently undergoing full RCRA closure, under State oversight. The Griffith Municipal Landfill is an active solid waste facility. Pazmey corporation is no longer in operation.

The following sections summarize the history of the Site's operations, as described in available historical documents. Particular documents and resources used to construct the Site history include: aerial photos (Appendix A), "Initial Site Evaluation (Site 160) American Chemical Service, Griffith, Indiana", Camp Dresser & McKee Inc., 3/26/85 and "Aerial Photographic Analysis of Three Priority CERCLA Hazardous Waste Sites", EMSL, Office of Research and Development, U.S. EPA, 7/85. Other references utilized include interviews with ACS management, U.S. EPA files, Indiana State Board of Health (ISBH) Inspection Records, and previous reports developed for the Site. Information regarding Site operations was obtained during a November 1989 audit of the ACS facility by Warzyn personnel. The results of this audit are presented in Appendix B.

#### 1.3.2.1 History of Site Operations

ACS began operations as a solvent recovery facility in May 1955, and according to ACS personnel, solvent reclamation was the only operation performed on-Site until the late 1960s. Other operations performed at ACS include small batch

manufacturing, epoxidation, incineration, and secondary fuel blending. For purposes of discussing the history of ACS's operations, these operations will be divided into the following time intervals: pre-1970, 1970 to 1975, and 1975 to present. The development of the site is illustrated in the aerial photographs contained in Appendix A.

Pre-1970. ACS began operations in 1955, with reclamation of spent solvent waste being the only plant process. Reclaimed during this period were solvent mixtures containing alcohols, ketones, esters, chlorinateds, aromatics, aliphatics, and glycols which contained various residues. Reclamation was performed almost exclusively in batch evaporation units, which were charged by pumping directly from 55-gallon drums into the distillation units. Spent solvents were generally stored in 55-gallon drums at storage areas located throughout the Site. The still bottoms pond was used for the storage of still bottoms, prior to the installation of incinerators at the site.

Small batches of specialty chemicals were first manufactured at ACS in the late 1960's and early 1970's. These early manufacturing operations included treating rope with a fungicide, bromination, and treating ski cable. Specific chemicals manufactured included barium naphtherate, brominated vegetable oil, lacquers and paints, liquid soldering fluid, and polyethylene solutions in polybutene.

ACS installed its first incinerator in 1966, and a second in 1969. The incinerators were used to burn still bottoms and non-reclaimable materials generated at the Site, and off-Site wastes. The incinerators were dismantled at the Site in 1970. The shells were cut up and scrapped; the burners and blowers remain on-Site.

1970 to 1975. Reclamation of spent solvents continued to be the primary operation at ACS throughout this period. The solvents reclaimed remained similar to those in the pre-1970 period. However, an increasing percentage of shipments were received in bulk tanker trucks. A spent and reclaimed solvent

tank farm was constructed just east of the existing spent solvent tank farm. The distillation operation remained essentially the same, except that a fractional distillation column was added.

The batch manufacturing processes were expanded during this time period. A lard oil process which utilized tallow and animal rendering was used to manufacture a lubricant product. In 1971, the additive manufacturing area was built. Various detergents, lubricants, and chemical additives were manufactured, in addition to soldering flux. Raw material used in the manufacturing processes included xylene, furfural alcohol, various amines, methanol, formaldehyde, sodium hydroxide, and maleic anhydride. High boiling point aromatic solvent blends (boiling points higher than xylene and toluene) were utilized as reflux solvents.

The epoxidation plant was constructed in 1974. The epoxidation process creates a plasticizer. Materials used in the process include hydrogen peroxide, linseed oil, formic acid (catalyst), benzene (reaction solvent), and butanol.

1975 to 1990. Distillation units for solvent recovery had been replaced, but the types of units remained essentially the same. The types of solvent waste recovered also remained the same. Solvent recovery was the principal operation at the ACS facility until September 1990, when ACS lost interim status due to an EPA enforcement action. The spent solvent and reclaimed solvent tank farms which currently exist were constructed during this time period. The majority of spent solvent waste streams were shipped in bulk tanker trucks, although drummed wastes were still processed. The tanks used in the spent solvent recovery operation are currently undergoing closure, but are not expected to be dismantled. The current elevated hazardous waste drum unloading dock and storage area were built in the early 1970's, with spill containment curbing and a sump area being subsequently added.

The small batch manufacturing processes described in the preceeding section remained essentially the same over this time period. However, the lard oil and soldering flux manufacturing operations were discontinued.

The epoxidation operations described previously have remained essentially the same. However, toluene has replaced benzene as the reaction solvent. A bromination operation, utilizing hexane as the carrier solvent, was added in 1975.

The injection tank farm area, previously used for the former incinerator, is now used to store and blend waste streams for ACS's secondary fuel program. Waste streams are received from bulk tanker trucks, and in drummed form. The secondary fuels are loaded from the storage tanks into railcars or bulk tanker trucks.

Operations at the Griffith Municipal Landfill and Kapica/Pazmey Corp. The Griffith Municipal Landfill has been an active solid waste disposal facility since the 1950's. Kapica Drum, Inc. began operations in 1951. Kapica began picking up drums from ACS about 1955, according to a CERCLA 104(e) Information Request. In 1961, ACS sold a 2 acre parcel to John Kapica, and in 1962, Kapica began operation of his drum reclaiming business at the South Colfax Avenue location. Operations at Kapica Drum, Inc. consisted of drum reconditioning. Kapica Drum was sold to Pazmey Corporation in February 1980. The Pazmey Corporation property was sold to Darija Djurovic in March 1987.

1.3.2.2 History of Site Disposal Practices

Table 1-2 provides a summary of disposal practices at the ACS Site. Details regarding disposal practices are presented in the following sections. The development of the different disposal areas is illustrated in the aerial photographs contained in Appendix A.

Still Bottoms Pond and Treatment Lagoon #1. Still bottoms for the solvent recovery process were originally disposed of in the Still Bottoms Pond and Treatment Lagoon #1. The Still Bottoms Pond is visible in the aerial photograph

taken in 1958 (Appendix A). Treatment Lagoon #1 is illustrated in the 1970 photograph. The Still Bottoms Pond and Treatment Lagoon #1 were taken out of service in 1972, based on an inspection report from the Indiana State Board of Health. At this time, these two areas were drained and filled in with drums partially full of sludge materials. A portion of Treatment Lagoon #1 may have been incorporated into the present-day fire pond when it was constructed in November 1973.

Off-Site Containment Area. Between 1958 and 1975, the Off-Site Containment Area was utilized as a waste disposal area. This area is located south of the present facility (See Figure 1-2). The evolution of this area as a waste disposal area is illustrated in the aerial photographs contained in Appendix A. The area appears tree-covered and inactive in the 1950 aerial photograph. In the 1970 photograph, numerous drums are present in this area. In the 1973 photograph, the Off-Site Containment Area appears covered and inactive.

A variety of wastes were disposed of in this area, including the still bottoms from the Still Bottoms Pond and Treatment Lagoon #1. Between 1968 and 1970, wastes from on-Site incinerators were disposed of in this area. General refuse, an estimated 20,000 to 30,000 drums, and a tank truck partially full of solidified paint were also disposed of in the Off-Site Containment Area. It has been reported that the drums were punctured prior to disposal.

Use of the Off-Site Containment Area was discontinued in 1972, and the area was reportedly capped with 2 to 3 feet of soil. In 1980, a 31-acre parcel of property to the west of the Off-Site Containment Area was sold to the City of Griffith for an expansion of the City's municipal landfill. This transaction reportedly included a strip along the west edge of the Off-Site Containment Area.

On-Site Containment Area. During the mid-1960's, landfilling of drums was performed in the On-Site Containment Area (See Figure 1-2). Approximately 400 drums containing sludge and semi-solids of unknown types were reportedly disposed of in the On-Site Containment Area. The use of on-Site areas for drum storage is evident in the 1970 aerial photograph contained in Appendix A.

Incinerators. The incinerators previously mentioned operated between about 1966 or 1968 and 1970. The incinerators were located on the eastern portion of the property near Colfax Avenue (Figure 1-2). Over this time period, approximately 2 million gallons of on-Site and off-Site waste were reportedly burned per year in the incinerators.

At the present time, still bottoms from the solvent reclamation operations are disposed of off-Site. Waste solvents are either disposed of off-Site, or disposed of in ACS's secondary fuel blending program. Wastewater originating from the solvent reclamation, small batch, and epoxidation operations, as well as non-contact cooling water and water from boiler blowdown operations, is routed to the City of Griffith sewer system.

Griffith Municipal Landfill and Kapica/Pazmey. The Griffith Municipal Landfill has been in operation since the 1950's. Currently, the landfill accepts solid waste.

Kapica Drum, Inc. (later Pazmey Corporation) operated between 1951 and 1987. Kapica Drum, Inc. was sold to Pazmey Corporation in February, 1980. Rinse water from drums containing hazardous wastes was reportedly disposed of on the property, as were liquids from the drums to be reconditioned. Liquid waste from the drum washing operations at Kapica/Pazmey reportedly flowed onto ACS property intermittently between 1962 and 1983.

### 1.3.3 Previous Investigations

The first documented regulatory agency concern for the ACS facility was apparently expressed by the Indiana State Board of Health (ISBH) on April 12, 1972. Table 1-3 provides a chronology of site events and regulatory agency activities. This table has been modified from CDM, 3/26/85, Table 1.

During an inspection on April 12, 1972, the ISBH noted a number of environmental problems at the ACS Site, including the discharge of liquids onto

the ground. Over the period April 1972 to September 1973, numerous inspections of ACS were made by the ISBH. Concerns during these inspections centered around waste handling, spill prevention, and site maintenance. During the period September 1974 to September 1975, ISBH interest in the Site centered on allegations of discharging chemicals to the sanitary sewer and dumping chemicals on-site. There was little ISBH activity concerning ACS between September 1975 and December 1982 (CDM, 3/26/85).

U.S. EPA activities involving ACS began in February of 1980. At this time, U.S. EPA Region V made an Identification and Preliminary Assessment of ACS as a potential hazardous site (CDM, 3/26/85).

The first sampling at ACS by U.S. EPA was performed in May 1980 by the U.S. EPA Environmental Emergency and Investigation Branch. The purpose of this sampling was to determine if off-site migration of waste or leachate was occurring. This sampling event centered on the Off-Site Containment Area and the Griffith Landfill. Samples were obtained of soil, leachate and surface water (USEPA, 5/8/80). A variety of organic compounds were found present in the samples analyzed, including phenol, isophorone, napthalene, fluorene, phenanthrene, anthracene, bis (2-chloroethyl) ether, and phthalates (CDM, 3/26/85 and Weston, 10/23/89).

On September 9, 1980 an on-Site inspection/investigation was performed by the U.S. EPA Field Investigation Team (FIT). Noted during this investigation were a leachate spring along the northeast side of the Off-Site Containment Area, vegetation damage, and partially exposed drums (Ecology and Environment, 9/11/80).

In July, 1982, the U.S. EPA FIT installed four monitoring wells near the Off-Site Containment Area and the Griffith Landfill. Sampling of these wells indicated the presence of several volatile organic compounds, including chloroethane, benzene, and vinyl chloride (Weston, 12/84).

In June, 1983, an HRS score was assigned to the ACS Site. This score consisted of: Groundwater Route Score, 59.86; Surface Water Route Score, 8.89; Air Route Score, 0.00; Overall Average Score, 34.98.

On November 29, 1984, a site assessment of the ACS Site was performed by the U.S. EPA Technical Assistance Team (TAT). This site assessment centered on the Off-Site Containment Area and Treatment Lagoon #1. On December 12, 1984, the TAT made a Spill Prevention, Countermeasure, and Control (SPCC) inspection of the facility. No conditions were noted which could pose an imminent threat to the public safety, other than an abandoned fuel tank on the Off-Site Containment Area (Weston, 12/84).

In 1984, ATEC Associates, Inc. (ATEC) performed a Preliminary Hydrogeologic Site Assessment for ACS. This investigation consisted of the installation of soil borings, monitoring wells, groundwater sampling and analysis, water level measurements, and a site geophysical survey. Organic chemicals detected in the groundwater monitoring wells included benzene, ethylbenzene, toluene, and other acid/base/neutral compounds (ATEC, 1/14/85).

Preliminary planning documents for the RI/FS at ACS were developed for the U.S. EPA by Roy F. Weston. In 1986, a group of approximately 125 potentially responsible parties (PRPs) appointed a nine-member steering committee to organize, oversee and determine funding for the RI/FS. In conjunction with the U.S. EPA and the Steering Committee, Warzyn developed a Work Plan for the RI/FS in April 1988. The Work Plan was subsequently approved by the U.S. EPA. The field investigation for Phase I of the RI began in July of 1989.

On June 1, 1989, the U.S. EPA TAT conducted sampling at the Griffith Landfill. Two surface water samples, and one soil sample were collected. Numerous VOCs were detected in the samples, but were also detected in the blanks. Acid/base/neutral compounds were detected in one of the water samples (Weston, 10/23/89).

# SECTION 2
# INVESTIGATION METHODOLOGIES

The RI was planned to determine the nature and extent of contamination at the ACS NPL Site in the media of soils, surface water, sediment, and groundwater. Field Investigations were conducted in three phases. The general goal of Phase I was to identify the contaminated areas and media; the general goal of Phase II was to determine the extent and character of the contamination in the areas and media identified as contaminated. Phase III was conducted to establish the assumed rate of contaminant plume migration and to deterimine if the plume in the lower aquifer had moved off-Site. The same basic investigative methodologies were used during all phases of the investigation. The methods included: geophysical survey; installation of monitoring wells; construction of staff gages and piezometers; performance of auger probes and soil borings; the excavation of test pits; the collection of groundwater, surface water and sediment samples; and the performance of aquifer tests.

All the sampling and activities were conducted in accordance with the approved Quality Assurance Project Plan and Addenda. The remainder of this section provides the technical details of the field procedures used during both phases of the investigation.

## 2.1 Geophysical Methods

**Grid Layout**

Two grids were established for conducting geophysical surveys; one in the Off-Site Containment Area, and the other in the On-Site Containment Area. Each grid was monumented with marked flags on a 45-foot grid spacing. Gridded areas for geophysical surveys are shown on Figures 2-1 and 2-2.

At the Off-Site Containment Area grid, wooden stakes were set at twelve grid locations to provide more permanent benchmarks in case it became necessary to re-establish the grid. The general procedure followed when conducting the surveys was to traverse the area, collecting readings on the instrument each 15 feet. Traverse lines were spaced 15 feet apart, guided by the flagged lines.

**Magnetometer Survey**

A vertical magnetic gradient survey was conducted at the Off-Site Containment Area. An EDA Omni IV Tie-Line Magnetometer with gradiometer was used to obtain the data. The gradiometer sensor was considered most appropriate because: it is insensitive to fluctuations in the earth's magnetic field, it has a wide operation range, permitting the instrument's use in the earth's magnetic field, its wide operation range permits the instrument to be used in areas containing high amounts of ferrous metal which could preclude the use of a total field instrument, and because gradient resolution is significant for shallow targets.

The gradiometer instrument consisted of two total magnetic field sensors separated by 0.5 m, mounted on a vertical staff. The sensors recorded total magnetic field readings simultaneously and the gradient was calculated as a function of the sensor separation distance. The readings and station locations were stored in a data logger which was downloaded to a field computer daily.

The vertical gradient measurements were obtained on a 15 foot grid resulting in a total of 1,050 stations. Duplicate readings were recorded at approximately 75 stations for quality control purposes. The data is tabulated in Appendix C.

**EM Surveys**

Electromagnetic (EM) terrain conductivity surveys were conducted at the On-site and Off-site Containment Areas. The EM surveys were conducted by Fromm Applied Technology of Mequon, Wisconsin. The readings were obtained with an EM31D instrument with an attached data logger. The instrument was operated in the quadrature phase mode which provided direct terrain conductivity readings in millimhos per meter. The conductivity readings were obtained on 15-foot intervals at both areas. The data is tabulated in Appendix C.

In addition, the Still Bottoms Area was traversed with the EM instrument in the in-phase (metal detection) mode in order to verify the approximate dimensions of the disposal area.

## 2.2 Monitoring Device Installation

### 2.2.1 Upper Aquifer Monitoring Wells

Upper aquifer monitoring wells were constructed at six locations during Phase I. An additional 8 upper aquifer monitoring wells were installed during Phase II (Figure 2-3). The well borings were drilled using 4-1/4-inch ID hollow stem augers, and generally extended to the clay confining layer underlying the upper aquifer. Split spoon samples were collected at 2-1/2-foot intervals (ASTM D1586-84). Each split spoon sample was screened for volatile organic vapors using an HNu (11.7 eV lamp) and field classified by the supervising geologist. Boring logs for each monitoring well location are contained in Appendix D. Construction details are contained in Appendix E. Well completion details are summarized in Table 2-1.

Three samples of unconsolidated material were collected at each Phase I monitoring well for physical analyses in the Warzyn Geotechnical Laboratory. At each location, one split spoon sample was collected in the vadose zone, one split spoon sample was collected in the screened zone of the aquifer, and one sample was collected by Shelby tube (ASTM D1587) from the top of the clay confining layer beneath the upper aquifer. Shelby tube samples were collected by pushing the tube into the clay approximately 24 inches (or until refusal). The tube was left to stand for approximately 10 minutes to allow the clay to adhere to the inside of the tube.

Split spoon samples were submitted to the laboratory for grain-size analysis and Atterberg limits testing. The Shelby tube samples were submitted for laboratory permeability tests. The split spoon samples were collected in jars and chilled for transportation to the laboratory. Shelby tube samples were capped and sealed on both ends with hot wax prior to shipment. Results of geotechnical analysis for grain size and laboratory permeability are contained in Appendix F, and summarized in Table 2-2. Aquifer samples exhibited no plastic qualities, so Atterberg limits could not be assessed.

Upon completion of the borings, stainless steel (304) monitoring wells were installed with ten-foot, 0.01 inch slot, stainless steel screens located to intersect the water table. The casing and well screen were assembled and lowered to the pre-determined depth through the hollow stem auger. No. 30 flint sand was poured down around the well, inside of the augers as they were pulled up incrementally to assure a solid and uniform sand pack around the screen. A 1 1/2 to 2 1/2 foot bentonite seal was placed approximately 2 feet above the screen in the same manner. The remainder was filled with a cement-bentonite grout using a hose to tremie it down to the bentonite seal from the surface. A locking protective casing was then set into the cement, covering the well. Each well was marked with its respective number.

The split spoon samplers were decontaminated between each sample with a TSP wash and a potable water rinse. The drilling equipment and tools were steam cleaned before each well boring. The screens and riser were also steam cleaned and wrapped in plastic until installed.

### 2.2.2 Lower Aquifer Monitoring Wells

Four lower aquifer monitoring wells were installed during Phase II of the RI. Locations of these wells are illustrated in Figure 2-3. Boring logs and construction details for the wells are included in Appendices D and E.

The borings for the lower aquifer monitoring wells were advanced in the following manner. Each boring was drilled to the top of the clay confining layer with 4 1/4-inch I.D. hollow stem augers. Sampling of the boring was performed on 2 1/2 foot intervals to the top of the clay confining layer. After the confining layer was encountered, each boring was redrilled with 8 1/4-inch I.D. hollow stem augers equipped with a bottom wood plug. A 6-inch diameter permanent steel casing was placed in the boring and pounded approximately 1 foot into the clay layer. The annulus around the casing was tremie-grouted with cement-bentonite slurry, and the lower 3 feet of the casing were filled with the grout mixture. The grout was allowed to set up for at least 48 hours before additional drilling activities commenced.

After the grout had set up, the borings were advanced through the clay and into the lower aquifer using the rotary wash technique with a 4 7/8-inch diameter tri-cone roller bit. Both units were sampled continuously with a split spoon sampling device, and 5-inch diameter, threaded temporary casing was advanced as drilling progressed.

At a depth of approximately 10 feet below the top of the lower aquifer, each lower aquifer monitoring well was installed. Each well consists of 2-inch diameter, threaded, 304 stainless steel casing and 2-inch diameter, 0.010-inch slot, 304 stainless steel screen. Each screen is five feet in length. The casing and well screen were assembled and lowered to the pre-determined depth through the temporary casing. No. 30 flint sand was poured down around the well, inside of the temporary casing as it was pulled up incrementally to assure a solid and uniform sand pack around the screen. A bentonite seal at least 2 feet in thickness was placed approximately 2 feet above the screen in the same manner. The remainder was filled with a cement-bentonite grout using a hose to tremie it down to the bentonite seal from the surface. A locking protective casing was then set into the cement, covering the well. Each well was marked with its respective number. The SAP called for bentonite grout to be used above the bentonite seal to within 3 feet of the surface and for cement-bentonite grout from this point to the surface. However, based on a field decision cement-bentonite grout was used from the seal to the surface.

### 2.2.3 Piezometers

During Phase I, 41 piezometers were installed (Figure 2-3). Piezometer installation was accomplished in the following manner. Piezometer installation was completed following the guidelines described in the QAPP and SAP, except drilling was used on all installations, instead of jetting most of them into the ground as originally planned. The piezometer borings were drilled using 3-1/4-inch ID hollow stem augers. The holes were visually logged by the cuttings as they were brought up by the augers. The piezometer casings, screens and caps are constructed of 1 1/2 inch ID, threaded, flush-joint PVC. The screens are five feet

in length with 0.01 inch slots. The piezometers were assembled and lowered into the augers and set with the upper portion of the screen intersecting the water table. The augers were then removed, leaving the piezometer in place and allowing natural cave-in to occur around the screen. The annular space around the casing was then backfilled with cuttings to 2 feet below surface and the remainder filled with granular bentonite. Construction details for each piezometer are summarized in Table 2-1.

### 2.2.4 Leachate Monitoring Wells

The details of drilling and installation of the leachate wells were the same as those of the monitoring wells except there was no sampling of these boring locations and the casing and well screen were constructed of two-inch ID schedule 40 PVC materials. Boring logs are contained in Appendix D, and well construction details are summarized in Table 2-1.

### 2.2.5 Staff Gages

Ten staff gages were placed across the site to measure the surface water elevations (Figure 2-3). The staff gages consist of steel fence posts which were driven into the ground with a hammer. Elevations were established to the top of the staff gages by surveying. Measurements were made from the top of the staff gage to the surface of the water.

Due to very soft ground conditions at some of the locations, a few of the staff gages had to be driven further down than originally planned. After the second round of water levels, several staff gages were completely submerged in the water due to heavy rains. Since the survey had not yet taken place, these staff gages were replaced with longer ones. The old staff gages were left in place and both were surveyed so that adjustments could be made to the readings taken at those locations during the first two rounds of water levels.

## 2.3 Soil and Waste Sampling Procedures

### 2.3.1 Soil Area Sampling (SA)

Soil Area (SA) sampling was conducted at three different areas on the ACS site. Two of the areas are located in the Off-Site Containment Area, and one is located within the ACS facility.

A Soil Area sample consisted of a composite sample of soil collected from an interval below the ground surface (approximate three feet) at five discrete locations within a circular area about 50 feet in diameter. A volatile organic compound (VOC) sample was collected, consisting of a grab sample selected from one of the five discrete sampling locations. The VOC sample was selected to represent the highest contamination based on visual observation and HNu readings. Instead of using a shovel and hand bucket auger as specified in the QAPP and SAP, it was decided to use the drill rig equipped with the 3-inch outer diameter (o.d.) split-spoon sampler and solid flight augers for the Soil Area sampling. The boreholes created from the Soil Area samplings were backfilled with granular bentonite. The sampling equipment was decontaminated between each sampling location with a trisodium phosphate (TSP) wash, potable water rinse, and distilled water rinse.

### 2.3.2 Auger Probes (AP)

Review of historical data, aerial photographs and results of the geophysical survey provided a guide to waste burial areas. To optimize the selection of samples for contaminant assessment, an auger probe program was used to evaluate the vertical and horizontal extent of wastes in known burial areas, and to provide a preliminary indication of the types of waste buried. The auger probe program was not a part of the original field investigation as outlined in the QAPP and SAP, but was added during the field investigation after consultation with, and approval by, the PRP Steering committee and the U.S. EPA RPM. During the course of the RI, auger probes were performed at 83 locations. These auger probe locations are illustrated in Figures 2-1 and 2-2.

Auger probes were used for three purposes during the RI.

- In the Kapica/Pazmey area and the Off-Site Containment area, auger probes were used during Phase I to document the probable cause for 20 anomalies indicated during the geophysical survey. Auger probes were used during Phase II to further define waste burial areas located during Phase I.

- Geophysical surveys in the On-Site Containment Area indicated only one anomaly area. Therefore, auger probes were made in a 3 by 5 foot grid pattern across the area to provide a visual and HNu screening of the subsurface conditions.

- Above ground metallic tanks limited the utility of geophysics in the vicinity of the Still Bottoms Area and the Treatment Lagoon Area. Therefore, auger probes were used to delineate the extent of buried waste in these areas.

The general auger probe procedure consisted of advancing four-inch outer diameter solid flight augers to a predetermined depth with a drill rig, followed by pulling the augers up with minimal additional rotation. The material adhering to the augers was then examined visually and screened for organic vapors with an HNu to determine general thickness and character of the subsurface. The field observations and HNu readings for each of the auger probes are summarized in Appendix G.

### 2.3.3 Soil Borings (SB)

Seventy-three soil borings were drilled and sampled during the course of the RI. Locations of these borings are illustrated in Figures 2-1 and 2-2. Boring logs are contained in Appendix D.

Soil borings were generally advanced with 4 1/4 inch I.D. hollow stem augers. The soil borings were sampled with a split spoon (ASTM D1586-84) at 2 1/2-foot intervals from the surface to the base of each borehole. The samples were visually classified and screened for volatile organic compound vapors (VOCs) using an HNu with an 11.7 eV probe. If waste was encountered, sampling continued to a depth of at least 1 1/2 feet below the waste.

Samples collected for laboratory analysis were placed in the appropriate sampling containers for shipment to the laboratory for analysis. Quality Assurance Sampling, Chain-of-Custody protocols, sample handling, storing, and shipment, were conducted as specified in the Quality Assurance Project Plan (QAPP).

The split spoons were decontaminated between each sample with a TSP wash followed by a potable water rinse and distilled water rinse. Upon completion, each borehole was backfilled with bentonite grout or Holeplug to the surface. Although Holeplug was not specified as a material to seal boreholes in the SAP or QAPP, it was used because large subsurface gaps in the Off-Site Containment Area made it impractical to use bentonite grout to seal soil/waste borings in this area.

2.3.4 Test Pit Excavations (TP)

The RI Work Plan specified the excavation of test pits in three areas suspected to contain waste buried in drums, including the On-Site Containment Areas, the Still Bottoms Area, the filled Treatment Lagoon #1, and the Off-Site Containment Area (Figures 2-1 and 2-2). The original plan was to collect two samples at each test pit location. One sample at each location would be representative of the buried waste material, and the second would be collected deeper from the apparently natural soil beneath the buried waste.

Several modifications were made to the Work-Plan-specified procedure after consultation with the U.S. EPA remedial project manager (RPM) and representatives from the U.S. EPA's technical oversight consultant, Roy F. Weston.

- An additional test pit (TP-1) was excavated in the Kapica/Pazmey Area (Figure 2-2) in an area in which soil borings could not be made because of large amounts of metallic debris.

- Undersoil samples were collected during excavation only at test pits TP-1 and TP-2. At locations TP-3 through TP-7, the soil materials were generally fine sand, which tended to cave-in to the water table in spite of attempts to excavate deeper. Since the waste was buried partially below

the water table it was determined to be more practical to return later with a drill rig to collect the undersoil sample using hollow stem augers.

Test pits were excavated with a rubber tire mounted backhoe with a two-foot wide bucket, with one cubic yard capacity. The backhoe was used to dig a pit at each specified location to uncover buried waste or buried drums. Test pit logs were kept in the field. Copies are contained in Appendix H. Excavation and sampling operations were performed in Level B personal protective equipment.

Waste was composited from five separate areas within the bucket to constitute a waste sample. Each sample was placed in the appropriate sampling containers for shipment to the laboratory for analysis. Quality Assurance Sampling, Chain-of-Custody protocols, sample handling, storing, and shipment, were conducted as specified in the Quality Assurance Project Plan (QAPP).

After a representative sample was obtained, the excavation was backfilled with the material which had been removed during excavation, and smoothed flat with the backhoe bucket. Next, soil adhering to the backhoe was removed, and the machine was taken to the decontamination pad, where the bucket and backhoe arm were decontaminated by steam cleaning.

## 2.4 Surface Water/Sediment Sampling (SW/SD)

Surface water samples were collected at five locations during Phase I of the RI. Sampling locations are illustrated in Figure 2-4.

Each surface water sample was collected from the upper one foot of standing water, with care taken to avoid disturbing bottom sediments. A stainless steel sampling dipper was used to lift water from the water body and pour into the sampling bottles. Field measurements of temperature, pH, and specific conductance were made and recorded. Several proposed surface water sampling locations were not sampled, due to dry conditions.

After each sample was collected, the sample containers and equipment were transported back to the on-Site Warzyn field office. As stipulated in the SAP, the samples were not filtered. The samples were then preserved, packed, and transported under chain of custody as described in the Sampling and Analysis Plan. The sampling equipment was decontaminated by cleaning in a trisodium phosphate wash, followed by a potable water rinse, and a final rinse with distilled water. After decontamination, the equipment was sealed in plastic wrap for transportation to the next sampling location.

Sediment samples were collected at eleven locations during Phase I (Figure 2-4). At several of the locations, both surface water and sediment samples were collected. The sample designations for both media at these locations used corresponding numbers (i.e., SW-01 was collected at same location as SD-01).

Each sediment sample was collected using a stainless steel hand bucket auger. The auger was turned about six inches into the ground to remove sufficient sample volume. After each sample was collected, the sample containers and sampling equipment were transported back to the Warzyn field office. The samples were handled and transported under chain-of-custody protocols as described in the Sampling and Analysis Plan. The sampling equipment was decontaminated by cleaning in a trisodium phosphate rinse, followed by a potable water rinse, and a final rinse with distilled water. After decontamination, the equipment was sealed in plastic wrap for transportation to the next sampling location.

## 2.5 Aquifer Sampling

### 2.5.1 Aquifer Matrix Sampling (AM)

Aquifer matrix samples were collected for VOA and semivolatile compound analysis at five locations during Phase II. Sampling locations are illustrated in Figure 2-3.

Soil borings for aquifer matrix samples were advanced with 4 1/4-inch I.D. hollow stem augers. A sampling interval was chosen about midway through the thickness of the upper aquifer. The sampling interval was based on the results of

the Tracer groundwater investigation, which suggested that this depth interval should exhibit the highest contaminant concentrations. A three-inch diameter split spoon was used to collect a saturated sand sample of the upper aquifer. Samples were placed in appropriate containers and shipped to the laboratory following required chain-of-custody protocols.

### 2.5.2 Confining Layer Sampling

At each Phase I upper aquifer monitoring well, a Shelby tube sample of the top of the clay confining layer was collected for determination of laboratory permeability. The Shelby tube sample was obtained by pushing the tube approximately 24 inches into the clay confining layer, or until refusal. Each tube remained in the boring for approximately 10 minutes, to allow the clay to adhere to the inside of the tube. Laboratory permeability results are summarized in Table 2-2.

Sampling of the confining layer for grain size, porosity, total organic carbon (TOC) and Atterberg limits was performed at MW-7 and MW-9 during the Phase II investigation. A Shelby tube sample was obtained of the clay midway into the confining layer at these locations, and submitted for analysis. The results of this testing are summarized in Table 2-2. Appendix F contains the raw laboratory data.

### 2.5.3 Baildown Tests

Field hydraulic conductivity testing in the form of baildown tests was performed at each upper aquifer and lower aquifer monitoring well installed during the RI. The basic concept behind these tests is that the rate of rise of the water level in a well after "instantaneous" removal of a volume of water is a function of aquifer hydraulic conductivity.

Hydraulic conductivity testing was performed at each upper aquifer well as follows:

- An initial measurement of static water level was made.
- A volume of water was then displaced as rapidly as possible using a stainless steel bailer.
- Water level changes in the well were sensed and recorded by a pressure transducer located below water level in the well and connected to an electronic data logger. Water level measurements were collected automatically on logarithmically increasing time steps, starting at 0.003 minutes.

Hydraulic conductivity testing was performed at each lower aquifer well using the following procedure:

- An initial measurement of static water level was made.
- Pressurization equipment, using breathing-quality air, was used to depress the water level within the well to the desired depth.
- The air supply was turned off to instantaneously release air pressure from the well.
- Water level changes in the well were sensed and recorded by a pressure transducer located below water level in the well and connected to an electronic data logger. Water level measurements were collected automatically on logarithmically increasing time steps, starting at 0.003 minutes.

The analysis of the test data made use of a computational method presented by H. Bouwer, and R. Rice, 1977, "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells", Water Resources Research, Vol. 12, No.3, pp. 423-428. Analysis of the Phase II upper aquifer monitoring wells, and the lower aquifer monitoring wells, was accomplished utilizing Geraghty Miller's "AQTESOLV" aquifer test analysis computer software. This program performs analysis of test data using the method of Bouwer and Rice.

Hydraulic conductivity testing results are summarized in Table 2-3. Data generated during the analysis of the hydraulic conductivity data is contained in Appendix I.

## 2.6 Groundwater Sampling

### 2.6.1 Tracer Investigation

During Phase II of the RI, a shallow groundwater investigation was performed by Tracer Research Corporation to assist in defining the limits of the plume in the upper aquifer at the ACS Site. The Tracer Investigation was used as a field screening exercise to aid in monitoring well placement, and to aid in defining the edge of the contaminant plume using CLP verifiable analyses. During this investigation, 55 groundwater samples were analyzed from 38 sampling locations. Sampling locations are illustrated in Figure 2-5.

Samples were acquired for analysis in the following manner. At each location, a sampling probe consisting of a 7 to 14-foot length of 3/4-inch diameter hollow steel pipe equipped with a drive point was driven to the desired sampling depth. The 3/4-inch steel pipe was decontaminated between sampling locations. Once the required depth at each location had been achieved, the probe was withdrawn several inches to permit water inflow into the resulting hole. A length of 1/4-inch diameter polyethylene tubing was inserted through the sampling probe to the base of the hole. Water was drawn up through the polyethylene tube under a vacuum. The polyethylene tubing was dedicated to each sampling location, and discarded after use.

Groundwater samples were collected in 40-mL VOC vials that were filled approximately 3/4 full. Each vial was shaken prior to sample extraction to increase volatilization, and samples of the headspace in the VOC vials were obtained with a syringe, and then injected into a portable gas chromatograph for analysis. Compounds analyzed included benzene, toluene, ethylbenzene, xylenes, and total hydrocarbons. These compounds were selected because BETX compounds were found in Phase I samples to be representative of the upper aquifer contaminant plume. Figure 2-6 summarizes the results of the investigation. Appendix J contains the analytical data generated.

### 2.6.2 Field Parameter Testing

During Phase I, Phase II, and Phase III groundwater sampling, field parameter measurements of temperature, pH, and specific conductance were made at each well. In addition, field measurements of Oxidation/Reduction Potential (Redox) and Dissolved Oxygen content were made during Phase II, Round II sampling. Field parameters are summarized in Appendix K.

### 2.6.3 Monitoring Well Sampling (GW)

Two sampling rounds were performed at each of the Phase I and Phase II monitoring wells. The sampling procedure at each well included:

- measuring static water level with an electronic water level indicator or tape with attached "popper";
- purging well by bailing approximately three times the well volume;
- collecting appropriate volumes of groundwater, preserving, filtering (as necessary), handling and shipping to the analytical laboratory, in accordance with the protocols listed in the Sampling and Analysis Plan; and
- making field measurements of temperature, pH, and specific conductance.

Following purging, when water level had recovered, sample volumes were collected in the following order: (1) two 40-ml vials for volatile organic analysis, (2) four one-liter glass amber bottles for semi-volatile organic analysis, pesticides and PCBs, and (3) five one-liter polyethylene bottles for metals, cyanide, total organic carbon (TOC), nitrate-nitrite, ammonia, chemical oxygen demand (COD), chlorides, alkalinity, sulfate, total dissolved solids (TDS), and total suspended solids (TSS). One 250-ml polyethylene container was filled for field parameters. Preservatives were added to sample containers for metals, cyanide, TOC, nitrate-nitrite, ammonia, and COD within one hour of sample collection. The metal samples were field-filtered to remove solids to 0.45 microns before being preserved with the QED Quick Filter in-line pressure filtration system.

During Phase III, one round of groundwater samples have been collected from the eight lower aquifer monitoring wells and have been analyzed for volatile organic compounds. Samples have also been collected from upper aquifer perimeter wells MW-11, MW-12, MW-13, MW-14, MW-15, and the two Phase III upper aquifer wells (MW-19 and MW-20). Samples from these upper aquifer wells were also analyzed for volatile organics. An additional round of sampling will be performed at these wells over the period August to October 1991.

Quality Assurance Sampling, Chain-of-Custody protocols, sample handling, storing, and shipment, were conducted as specified in the Quality Assurance Project Plan (QAPP).

The sampling equipment (i.e., bailer and cable) were decontaminated before and after each sampling. The decontamination procedure for each equipment item was: a wash with trisodium phosphate (TSP) solution, a rinse with potable water, and a final rinse with distilled water. The decontaminated equipment was placed in clean plastic bags for transportation to the next sampling location.

Water level measurements were obtained on several occasions during the course of the RI, in addition to those obtained during routine groundwater sampling. These measurements are summarized in Table 2-4.

### 2.6.4 Leachate Sampling (LW)

Four (4) leachate water samples were collected from Griffith Municipal Landfill leachate wells LW-1 through LW-4. The samples were submitted for EPA Target Compound List (TCL) and Target Analyte (TAL) parameters. The sampling procedure at each leachate well included: measurement of static water/leachate elevation, removal of approximately three times the static volume of water/leachate, and field measurement of temperature, pH, and specific conductance. After the well had recharged from purging, sample volumes were collected in the following order: (1) two 40-ml vials for volatile organic compounds (VOCs); (2) four one-liter glass amber bottles for semi-volatiles, pesticides and PCB analysis; and (3) five, one-liter polyethylene bottles for

metals, cyanide, total organic carbon (TOC), nitrate-nitrite, ammonia, chemical oxygen demand (COD), chlorides, alkalinity, sulfate, total dissolved solids (TDS), and total suspended solids (TSS). One 250-ml polyethylene container was filled for field parameters. Preservatives were added to the metal, cyanide, TOC, nitrate-nitrite, ammonia, and COD within one hour of sample collection.

The sampling equipment (i.e., bailer and cable) were decontaminated before and after each sampling. The decontamination procedure for each equipment item was: a wash with trisodium phosphate (TSP) solution, a rinse with potable water, and a final rinse with distilled water. The decontaminated equipment was placed in clean plastic bags for transportation to the next sampling station.

Quality Assurance Sampling, Chain-of-Custody protocols, sample handling, storing, and shipment, were conducted as specified in the Quality Assurance Project Plan (QAPP).

Two additional leachate samples (LW05 and LW06) were collected from dewatering areas at the Griffith Landfill during Phase III (See Figure 2-4). These samples were analyzed for TCL and TAL parameters. The samples were collected with a stainless steel surface water sampling device. The samples were preserved as required, and chain-of-custody protocols, sample handling, storage, and shipment were performed as specified in the QAPP.

### 2.6.5 Private Well Sampling (PW)

Private well sampling was performed at eight locations during Phase II of the RI, and two locations during Phase III. Residences where private well samples were obtained are illustrated in Figure 2-7. Available well logs are contained in Appendix L. Each of the private wells sampled is screened in the lower aquifer; no upper aquifer wells were sampled. Private wells identified within the Site vicinity are presented in Table 2-5.

At each private well location, a sampling location was chosen where well water did not undergo any treatment or softening. The water was allowed to run for approximately 15 minutes, and field measurements of temperature, pH, and specific conductivity were obtained at five-minute intervals. A calculation of purge volume was made at each sampling location, by determining the rate of flow into a five-gallon pail.

Samples were collected in the same parameter sequence as followed for monitoring well samples. Preservatives were added as required. Private well samples were not filtered.

Quality Assurance Sampling, Chain-of-Custody protocols, sample handling, storing, and shipment, were conducted as specified in the Quality Assurance Project Plan (QAPP).

# SECTION 3
# FIELD OBSERVATIONS

## 3.1 INTRODUCTION

The Remedial Investigation was conducted in three phases. The purpose of Phase I was to evaluate the groundwater flow and character of potential contamination in the upper aquifer, and characterize buried waste at the ACS NPL Site. The purpose of Phase II was to complete delineation of any upper aquifer contamination, to delineate the vertical and horizontal extent of buried waste in the areas identified during the Phase I investigation, and to collect samples from wetlands surrounding the Site. A limited third phase was implemented to complete the groundwater delineation objectives of Phase II and to support the risk assessment assumptions at the Site.

A full understanding of the site characteristics and contamination results from an evaluation of all the sampling results from Phase I, II and III. That evaluation is provided in Sections 4, 5, and 6 of this report. The purpose of this section is to provide a narrative description of the RI, and how it progressed from Phase I through Phase III. As a result, the section describes Phase I sampling results, and does not focus on the Phase II and Phase III findings. This section should not be taken as an evaluation of the site conditions, but as a description of the conceptual approach to investigating the Site, and a summary of the rationale for the sampling which was conducted.

The Work Plan provided for the collection of 48 soil and waste samples to characterize the sources of contamination in Phase I, and the collection of an additional 20 samples in Phase II to complete the delineation of identified contamination. On the basis of the Phase I results, it was evident that 20 additional samples in Phase II would be insufficient to adequately characterize the full extent of contamination at the Site. Phase I identified 18 discreet areas of contamination at the Site. While VOCs were present in most areas, PCB and PAH contamination was less widespread. Since the presence of PCBs and PAHs has considerable impact on the cost of remediation, it was determined that it was necessary to more specifically define the horizontal and vertical extent of the various types of contaminants. This detailed definition was necessary to

determine volumes and types of wastes for the FS. The PRPs and Warzyn worked with the U.S. EPA RPM to develop a Supplemental Technical Investigation (STI) to supplement the Work Plan with an adequate number of appropriate samples. The supplemented Work Plan replaced the 20 full TCL/TAL Phase II samples with 109 samples collected from multiple depths at 59 locations.

The field work was conducted in four general areas: the landfill, surficial soil areas, buried waste, and groundwater. The remainder of this section of the RI Report presents the field observations from both Phases of the RI, with a focus on the rationale for selecting Phase II and Phase III sampling locations and parameters.

## 3.2 LANDFILL INVESTIGATION

The focus of the investigation in the Griffith Municipal Landfill Area was the inactive portion to the south and east (Figure 1-2). The investigation of the landfill included placement and sampling of four leachate head wells (LW-1 through LW-4) during Phase I. On the basis of the Phase I results, no additional investigation was necessary for Phase II. During Phase III, samples were obtained from the areas where leachate is being discharged in order to determine the characteristics of the leachate effluent.

Additional analytical data was collected from monitoring wells MW-1 and MW-15 located on the south boundary of the landfill. Water level data was collected at several piezometers and staff gages placed in and around the landfill to document groundwater flow conditions in this area. Water levels indicate leachate is generally not mounding but is discharging to the dewatering area.

## 3.3 SURFICIAL SAMPLING

Sampling of surficial soil, sediments and waters was conducted in both phases of the investigation. The sample groupings include soil area (SA) samples and surface water/sediment (SW, SD and SD/SW) sampling. Soil area samples were collected within the ACS facility at the site of the former incinerator and at the Kapica drum recycling area. Surface water and sediment samples were collected in the Fire Pond within the ACS facility, in the ditch west of the Off-Site Containment Area, and in the wetlands on the downgradient sides of the Site.

Surficial soil samples were required in the Work Plan near the On-Site Containment Area during Phase I. However, it was decided between the RPM and Warzyn during the field staking exercise prior to Site work that soil area samples collected in this location would not benefit the investigation because it was unlikely that the soils were contaminated. This conclusion was reached because of knowledge of past activities, recent filling and grading, and because of the high permeability of the soils. It was assumed that the high permeability would facilitate volatilization and natural washing due to precipitation.

### 3.3.1 Former Incinerator Area

During Phase I, one soil area sample (SA-3) was collected in the former incinerator area. The sample consisted of surficial soil material, collected from a depth of 6 to 18 inches and composited from five discrete areas into a single sample. The sample was analyzed for full TCL and TAL parameters. Phase I results indicated that additional sampling would not be necessary, since relatively low levels of contaminants were found at this location (See Table 5-2). Compounds detected included VOCs, BETX, phthalates, and PAHs.

### 3.3.2 Kapica Drum Recycling Area

3.3.2.1 Phase I Investigation. In the Phase I investigation, two soil area samples were collected at the Kapica/Pazmey area (SA-1 and SA-2). Locations are shown on Figure 2-2. The samples were composite samples from 6 to 18 inch depths at five discrete locations across an approximately 50 by 100 foot area. Sample SA-1 was located northwest of the Kapica building and SA-2 was located north of the building.

In both soil areas, the surface and near surface soils consisted of brown and gray sandy fill containing metal debris including drum lids and parts. Traces of colored organic material and sludge were noted throughout the area. Solvent-like odors were detected and elevated HNu readings were recorded on the boring logs (Appendix D). Samples were analyzed for full TCL and TAL parameters and found to contain PCB contamination, so additional sampling was planned for Phase II.

3.3.2.2 Phase II Investigation. Phase I results indicated PCBs were the contaminant of concern in surficial soils. To better document the horizontal and vertical distribution of PCBs in the surficial soils further PCB sampling was conducted in Phase II. The sampling consisted of making a grid of 12 shallow borings (SB-43 through SB-54) and collecting samples at two discrete depths, 0-1 foot and 3-4.5 feet. The sampling locations were layed-out across the Kapica Area in a regular grid with approximately 50-foot spacing.

3.3.3 Surface Water Drainage Areas

3.3.3.1 Phase I Investigation. The approved work plan designated 11 locations for collecting both surface water and sediment samples. During the pre-investigation Site meeting between the U.S. EPA and Warzyn, several of the locations allocated in the approved work plan were modified, and several of the locations were designated as sediment-only sampling locations. Changes in locations were appropriate because site operations, particularly in the landfill vicinity, have changed to different areas. In addition, some of the locations appropriate for sediment sampling did not contain standing water, so the surface water sample was eliminated for these locations.

Phase I sampling locations were designated as SD01 through SD09 and SW01 through SW08. These include: two water and sediment locations on the ACS facility (SD/SW01 and SD/SW02); two sediment locations in the marsh west of the ACS facility along a surface water run-off route (SD03 and SD04); one surface water and sediment location in the drainage ditch just west of the Off-Site Containment Area (SD/SW05); one sediment locations in the marshy area south of the landfill (SD06); three locations along the drainage ditch in the west marsh (SD/SW07A and SD07B) and between ACS and the landfill (SD07C); and two locations in the marshy areas east of the landfill (SD/SW08 and SD09). The samples were analyzed for full TCL and TAL parameters.

3.3.3.2 Phase II Investigation. Phase I sampling indicated low levels of PCBs in samples located along surface water drainage routes between ACS and the landfill. Phenolic compounds were detected in the surface water near the Off-Site Containment Area. Six additional sediment samples were collected in Phase II (SD10-SD15) and analyzed for full TCL and TAL parameters. These areas are locations where

groundwater discharges to the surface to form surface water run-off. The purpose of the sampling was to identify any contamination resulting from the discharge of contaminated groundwater.

## 3.4 BURIED WASTE INVESTIGATION

### 3.4.1 On-Site Containment Area

The On-Site Containment Area was identified and named by the U.S. EPA FIT team in 1985. It is a rectangular area approximately 250 feet north to south and 450 feet west to east, located in the northern third of the fenced ACS facility (Figure 1-2).

U.S. EPA reports indicated that the area was used to store drums of waste materials prior to 1975. An aerial photograph of the Site from 1970 (Appendix A) shows rows of ground cover in this area which it is reasonable to assume are drums. An aerial photograph from 1973 (Appendix A) indicates that the area is clear with no sign of drums on the ground surface. At the present time, the area is flat with no vegetation, no surface construction, and little debris. Coarse sand and gravel covers the entire area.

The field investigation for the On-Site Containment Area was conducted in two phases. The purpose of the first phase was to identify any potential contaminant sources in the area; the purpose of the second phase was to document the horizontal and vertical extent of the contamination, and to identify the concentrations of the contaminants present. Investigative procedures included the following:

Phase I

- Aerial photograph review
- A geophysics investigation
- 15 auger probes
- 1 test pit excavation
- 6 soil borings to collect soil samples at two depths
- Analysis of 12 soil samples for TCL/TAL parameters
- Surveying horizontal and vertical locations of auger probes, test pit and soil borings.

Phase II

- 6 additional soil borings to collect soil samples at three depths.
- Analysis of 18 soil samples for TCL volatile organic compounds.
- Surveying horizontal and vertical locations of soil borings.

3.4.1.1 Phase I Investigation.

Aerial Photographs Review

Aerial photographs of the Site vicinity from 1954, 1958, 1965, 1970, 1973, and 1980 were evaluated. These indicate that numerous drums were stored on the On-Site Containment Area from 1968 until after 1970. The evidence of drums is gone in an aerial photograph dated 1973 (Appendix A).

Geophysical Investigation

Prior to initiating any intrusive investigation methods, a geophysical survey was conducted across the On-Site Containment Area, using an Electromagnetic (EM) terrain conductivity instrument. Instrument readings were taken at each intersection of a 15-foot grid over the 250 by 450 foot On-Site Containment Area. The raw data and contour plots are contained in Appendix C.

The EM survey indicated one major conductivity anomaly and several small anomalies. The large anomaly was further investigated by making a test pit excavation. The others were investigated by auger probe.

Phase I Auger Probes

Since there was only large one geophysical anomaly, auger probes were used to identify the appropriate points to select locations for six sampling borings. A detailed description of the investigative method is included in Section 2 of this report.

Fifteen auger probes (AP-21 through AP-35) were made in a grid with approximately 100 foot spacing. The locations of several auger probes were modified from exact grid coordinates to investigate the minor geophysics anomaly areas. (A detailed description of the investigation methodology is included in Section 2 of this report.) The on-site geologist kept a written log of the observations and HNu readings for each auger probe. Please refer to Appendix G for further details.

Phase I Soil Borings

In accordance with the approved Work Plan, soil borings were made at six locations for the purpose of collecting samples for analysis from two separate depths. (A detailed description of the investigation methodology is included in Section 2 of this report.)

Soil borings SB-08 through SB-13 were collected in the On-Site Containment Area during Phase I of the investigation. The six locations were selected on the basis of the geophysical survey and auger probe findings and approved by U.S. EPA RPM.

The general procedure at each location was to drill with hollow stem auger, collecting split-spoon samples at 2.5-foot intervals. One soil sample was collected for laboratory analysis from two discrete depths in each borehole. The sampling intervals were selected (on the basis of visible evidence of contamination and HNu VOC readings) to represent the most highly contaminated zones in the boring. Each sample was analyzed for full TCL and TAL parameters.

Based on the EM survey and auger probe findings, specific soil boring locations were selected for subsurface soil sampling and analysis. Rationale for the selected soil boring locations are as follows:

SB-08 was drilled near auger probe AP-22 to identify the nature of elevated HNu readings and a petroleum-like odor in the underlying soils. Sample SB08-6' and SB08-10' were submitted for analysis.

SB09A was drilled near auger probe AP-34 to identify the nature of elevated HNu readings in the underlying near surface soils. However, while drilling SB09A, similar high HNu readings were not detected. Therefore, this boring location was abandoned and relocated further east toward AP-33. No samples from SB09A were submitted for analysis.

SB09 and
SB10 were drilled and sampled near auger probe AP-33 to identify the perimeter conditions of a mounded area in which drums are reported to be buried. AP-33 was drilled into the mounded area and did encounter several drum carcasses and/or lids. The HNu readings recorded were the most elevated in the On-Site Containment Area. Samples SB09-6', SB09-10', SB10-5' and SB10-10' were submitted for analysis.

SB11 was drilled and sampled near auger probe AP-24 to identify the nature of elevated HNu readings in the underlying soils. Samples SB11-5' and SB11-10' were submitted for analysis.

SB-12 was drilled and sampled near auger probe AP-28 to identify the nature of elevated HNu reading and possible staining in the underlying soils. Samples SB12-5' and SB12-10' were submitted for analysis.

SB-13 was drilled and sampled near auger probe AP-26 to identify the nature of elevated HNu readings and a napthalene-like odor in the underlying soils. Samples SB13-5' and SB13-10' were submitted for analysis.

At each of these soil boring locations with the exception of SB09A, the subsurface soils were sampled at 2.5-foot intervals to the end of the boring. Soil samples were collected for analytical purposes from the most contaminated interval based on visual observations and HNu readings. Each boring was extended beyond the visibly contaminated zone in order to collect an undersoil sample. Thus, two subsurface soil samples were collected from each soil boring for analytical purposes.

A test pit, TP-2, was excavated in the area with the large geophysics anomaly. This area is mounded slightly above the flat ground surface characteristic of most of the ACS facility. The drums appear to be buried on their sides and closely packed together. Various liquids were observed in soil surrounding the drums, such as brownish water, an oil-like liquid, and a viscous blue liquid leaking from several drums. The majority of drums were noted to be dented, corroded and/or mangled. Native soil was encountered at about 5 feet below the surface beneath the buried drums.

Two samples were collected from the test pit and submitted for laboratory analysis of TCL and TAL parameters. A sample from TP-2 was collected to represent the waste materials leaking from several of the drums and saturating the soil surrounding the drums. A sample from SB-10 was collected from the natural soil which underlies the drums and contaminated soils.

The laboratory test results are described and evaluated in Section 5.4 of this report.

3.4.1.2 Phase II Investigation. Phase I field observations and analytical results indicate that two discrete areas of contamination exist in the On-Site Containment Area. The East Area consists of most of the area and is characterized by relatively high levels of

volatile organic contamination at and below the water table. The West Area is the major geophysical anomaly area which was found to contain buried drums.

Phase I analytical results indicated:

| | |
|---|---|
| East Area | A majority of the Phase I samples indicated VOC contamination in the zone at and below the water table. |
| West Area | Both samples collected from the buried drum zone contained VOCs, PAHs, and PCBs. |

The purpose of the Phase II sampling in the East Area was to document the vertical and horizontal extent of VOC contamination in the subsurface. Sampling consisted of making 6 additional soil borings, which, together with Phase I sampling, make a 3 by 3 (9 point) sampling grid. The Phase II soil borings included SB55 through SB60. Locations are shown on Figure 2-1. Phase II samples were collected at two depths and laboratory analyzed for VOCs according to the following rationale:

| | |
|---|---|
| 7 feet | Approximately at the water table |
| 16 feet | At the base of the upper aquifer |

The purpose of Phase II sampling in West Area was to document the vertical and horizontal extent of subsurface contamination and to differentiate, to the degree possible, between the extent of VOC contamination and the extent of PCB contamination. Phase II sampling included eight additional soil borings (SB61 through SB68). Locations are shown on Figure 2-1). Phase II samples were collected at two depths and laboratory analyzed for VOCs and PCBs, according to the following rationale:

| | |
|---|---|
| 7 feet | Approximately at the water table |
| 16 feet | At the base of the upper aquifer |

The results of Phase II laboratory tests are described and evaluated in Section 5.3 of this report.

### 3.4.2 Still Bottoms Area

The Still-Bottoms Area was identified and named by the aerial photographs. It is an oval area approximately 100 by 150 feet in diameter in the central portion of the fenced

ACS facility (Figure 1-2). The east and west flank of the Still-Bottoms Area have been covered by the construction of aboveground holding tanks.

Reports indicate that the Still Bottoms Area was a bermed, aboveground lagoon used to temporarily store still-bottoms material prior to off-site disposal. The lagoon was reportedly closed during 1975. The closure consisted of filling the bermed area with solid materials and covering it with crushed rock.

The field investigation of the Still-Bottoms Area was conducted in two phases. The purpose of the first phase was to identify any potential contaminant sources below ground in the area; the purpose of the second phase was to document the horizontal and vertical extent of the contamination, and to further delineate the concentrations of the contaminants present. Investigative procedures included the following:

Phase I

- Aerial photograph review
- Two auger probes
- Two test pits
- Two soil borings to collect soil samples from below buried waste
- Analysis of four soil samples for TCL/TAL parameters
- Surveying horizontal and vertical location of auger probes, test pit and soil borings

Phase II

- Two additional soil borings to collect soil samples at one depth
- Four additional soil borings to collect soil samples at two depths each
- Surveying horizontal and vertical locations of soil borings

3.4.2.1 Phase I Investigation. Aerial photographs of the Site vicinity from 1954, 1958, 1965, 1970, 1973 and 1981 were reviewed (Appendix A contains copies of sections from the 1954, 1958, 1970, 1973, and 1981 photographs). These provided a preliminary indication of the location and horizontal extent of the bermed area. The area was further delineated with auger probes during the investigation.

As specified by the RI Work Plan, two test pits (TP-6 and TP-7) were excavated into the former Still-Bottoms Area. The area is slightly mounded above the flat surface between vertical aboveground storage tanks of the active ACS facility. Test pit TP-6 was excavated near the south end and TP-7 was excavated about 150 feet further north. Test pit logs are contained in Appendix H.

Buried drums were encountered in both TP-6 and TP-7 below about 3 feet of silty sandy fill. In TP-6, a blue liquid and various colored gels and solids were found in the sandy fill surrounding the buried drums. This material was collected for a waste sample (TP-6-4). The pit was excavated deeper to obtain the undersoil native soils sample and submitted for laboratory analysis of TCL and TAL parameters. Because of concern that further excavation might cause downward migration of the waste, a field decision was made to abandon the efforts of obtaining the native undersoil by excavation and to collect the undersoil at this location by soil boring.

The soils encountered at TP-7 contained an opaque solid jelly-like substance which was leaking from a corroded and dented drum. This material was sampled (TP-7-3) along with some of the surrounding stained sandy fill and submitted for TCL and TAL parameter analysis. After sampling, the test pit was backfilled with the removed material. The native undersoil sample at this location was also collected by soil boring.

Two soil borings with sampling and two auger probes were added during Phase I investigation activities. The two soil borings, SB-17 and SB-18, were drilled at test pit locations TP-6 and TP-7, respectively, to collect a sample of the soil from beneath the buried waste which had been encountered in the test pits. A soil sample was collected from each soil boring and submitted for laboratory analysis of TCL and TAL parameters. SB17-6.5' and SB18-7' were collected at those depths to represent the underlying native soil conditions below the buried drums identified during test pit excavations. Two auger probes, AP-40 and AP-41, were drilled to identify the northern boundary of the Still-Bottoms Area. The laboratory test results are described and evaluated in Section 5.4 of this report. Visual observations and HNu readings were recorded at each auger probe and compiled in Appendix G.

3.4.2.2 Phase II Investigation. Phase I field observations and analytical results indicated that there is a discrete area of contamination existing in the Still-Bottoms Area. Samples from the two areas collected by test pit and soil borings indicated high levels of VOCs and PAHs at both locations, and a low level of PCBs at one of the locations. Phase I sampling did not identify the lateral extent to the east and north.

The purpose of the Phase II sampling was to define the horizontal extent of VOC, semi-volatile and PCB contamination to the east and north and to provide additional data to evaluate potential PCB concentrations. Sampling consisted of performing six additional soil borings (SB-22, SB-23, SB-69, SB-70, SB-71 and SB-72). Results are discussed in Section 5.4. The Phase I soil boring samples (SB-22 and SB-23) were collected at one depth and analyzed for VOCs, semi-volatiles and PCBs. The depth of 12 feet below the ground surface was selected to represent the underlying native soil conditions (approximately 5 feet below the water table). Soil boring SB-22 was located midway between test pits TP-6 and TP-7, and SB-23 was located approximately 50 feet east-southeast of SB17.

The Phase II soil boring samples from SB-69, SB-70, SB-71, and SB-72 were collected at two depths and analyzed for VOCs, semi-volatiles and PCBs. The two sampling depths are 8 (approximately at the watertable) and 20.5 feet (at the base of the upper aquifer). These four borings locations were selected in accessible areas near the perimeter in the former Still-Bottoms Area. These locations represent the probable extent of contamination condition surrounding the buried drums of the Still-Bottoms Area.

### 3.4.3 Treatment Lagoon Area

The Treatment Lagoon Area was identified by the EPA FIT team and also by the aerial photographs. It is an oval area approximately 200 feet by 100 feet immediately east of existing fire pond within the active ACS facility (Both ponds are evident in the 1970 aerial photograph, Appendix A). The eastern boundary of the Treatment Lagoon Area is flanked by above-ground storage tanks near the Still-Bottoms Area.

Reports indicate the Treatment Lagoon was closed soon after the Still-Bottoms Area was filled. The closure reportedly consisted of filling the lagoon with solid material and covering it with crushed gravel. The area is currently a parking lot with a surface elevation 3 to 5 feet above the surrounding ground level.

The field investigation of the Treatment Lagoon Area was conducted in two phases. The purpose of the first phase was to document the characteristics of the buried contaminants. The purpose of the second phase was to define the horizontal and vertical extent of the contamination and to identify the concentrations of the contaminants present.

3.4.3.1 Phase I Investigation. Aerial photographs of the Site vicinity indicate that the existing fire pond was excavated west of the Treatment Lagoon in 1972, and that the Lagoon was filled in by 1973.

Prior to initiating intrusive investigation methods, a geophysical survey was conducted across the Treatment Lagoon Area, using an electromagnetic (EM) terrain conductivity instrument. The raw data and contour plots are contained in Appendix C.

As specified in the Work Plan, three test pits (TP3, TP4, and TP5) were excavated into the filled lagoon area. The test pits are arrayed south to north above the axis of the oval lagoon area.

Test pit TP-3 was excavated to a depth of about 9 feet. The subsurface soils consisted of approximately 8 feet of brown and black sand fill above the watertable. Staining and elevated HNu readings were detected at 7 to 8 feet. A drum was encountered buried at a depth of 9 feet and a viscous brown liquid accumulated in the bottom of the pit. A waste sample (TP-3-9 feet) was collected of the oil-saturated sand surrounding the drum. Attempts were made to continue the excavation deeper to collect the native undersoil sample, but the walls of the pit continually sloughed in. A field decision was made to abandon the attempt to dig below the waste and consider this location for a sample collected by a soil boring, later designated as SB-14.

The subsurface material at TP-4 was similar to that discovered at TP-3. A single drum was encountered about 8 feet below the surface and a thin brown liquid accumulated in the bottom of the pit. A saturated sand sample (TP-4-8') was collected to represent the waste sample and the pit was backfilled with the material which had been excavated. Soil sample SB-15 was later collected by auger to represent the undersoil at this location.

Test pit TP-5 was excavated at the northern end of the lagoon area. Many drums were observed buried about 2 feet below ground surface at TP-5. Similar thin brown liquid wastes accumulated in the bottom of the pit and were collected along with the sandy matrix for a waste sample (TP-5-3 feet). After sampling, the test pit was backfilled with the removed material.

During Phase I, seven auger probes (AP-36, AP-37, AP-38, AP-39, AP-42, AP-43 and AP-44) were drilled near the perimeter of the Treatment Lagoon to define the extent of the buried material within the Treatment Lagoon Area. The auger probes were drilled in areas near the estimated perimeter of the Treatment Lagoon which were also accessible to a drill rig. Visual observations and HNu readings were recorded at the probe location.

3.4.3.2 Phase II Investigation. The horizontal extent was determined in Phase I from the aerial photograph and auger probes. The Phase I sample analyses from TP-3, TP-4, and TP-5 indicated high levels of VOCs and PAHs in all three test pits and two of the three deeper soil borings. PCBs were not detected in any of the samples. The horizontal extent of the lagoon as indicated in the aerial photographs was confirmed by the Phase I findings, but the vertical extent remained uncertain.

The purpose of Phase II sampling was to delineate the vertical extent of contaminated soils. Phase II sampling consisted of making four additional soil borings (SB-21, SB-73, SB-74 and SB-75). Soil boring sample SB-21 was collected at two depths and analyzed for VOCs, PCBs and PAHs. This boring was located near the northeastern most perimeter of the Treatment Lagoon Area. The sample depth of 7 feet was selected to represent water table conditions and the 12 foot sample depth was selected to represent conditions 5 feet into the upper aquifer. The remaining three soil borings SB73, SB74 and SB75 were drilled near the Phase I test pits TP3, TP4 and TP5, respectively. Soil borings, sample depths and rationale are as follows:

- SB73 (5 feet) and SB75 (5 feet) to represent condition of fill material above the water table.
- SB73 (19 feet) and SB74 (19 feet) to represent condition of underlying native soil at the base of the upper aquifer.

- SB74 (15 feet) to represent the condition of underlying soil several feet below the buried material.

Phase II soil boring samples were analyzed for VOCs and semi-volatiles. The results of the Phase II laboratory tests are described and evaluated in Section 5.4.2 of this report.

3.4.4 Fire Pond Area

3.4.4.1 The Fire Pond. The Fire Pond was identified by aerial photographs and named by American Chemical Services (ACS) facility staff. It is an existing body of water that occupies an area 200 feet by 60 feet within the active ACS facility. The pond collects surface water runoff from the plant's storm sewer system.

The field investigation for the Fire Pond area was conducted during Phase I to identify any potential contaminant source in the pond itself. Sampling consisted of collecting surface water sample SW01 and sediment sample SD01. The results (Appendix Q-3 and Table 5-2) indicated only very low levels of VOCs in the surface water. Therefore, no further sampling was necessary in Phase II. PCBs and phthalates were detected in the sediment sample.

3.4.4.2 Area West of the Fire Pond. No Phase I field work or sampling was conducted in the area west of the existing Fire Pond. However, in Phase I during the construction of piezometer P-37 in that area, the auger cuttings were noted to contain traces of sludge-like product with elevated HNu readings. Later, when water level measurements were attempted in P-37, a brownish-red oily substance had accumulated in the piezometer.

It was thought that the liquid in the piezometer might indicate that a similar liquid was floating on the water table. Additional field work was proposed and conducted in the area west of the Fire Pond near Piezometer P-37 to determine the extent of soil and aquifer contamination in the area. Investigative procedures included the following:

- Nine auger probes
- One soil boring to collect a sample of waste material revealed in P-37
- Analysis of one sample for TCL/TAL parameters

The investigation was conducted by first making single, 10-foot deep auger probes 100 feet north, 100 feet west, and 100 feet south of P-38. When no waste was found floating on the water table at those locations, the distances were halved, and auger probes were made 50 feet in each of the three directions from P-38. These borings again showed no accumulation of floating waste, so the distance was halved again to 20 feet. The auger probe locations (AP-45 through AP-53) are shown on Figure 2-1.

No accumulation of floating waste was found at any of the nine auger probes (AP-45 through AP-53). However, the soil overlying the water table had an oily consistency, so a sample was collected of the soil at a depth of 7 feet, just above the water table (SB-20-7) and submitted for full TCL and TAL parameters. Laboratory results are described and evaluated in Section 5.4.

### 3.4.5 Off-Site Containment and Kapica Area

According to facility records and an interview with ACS facility personnel, the Off-Site Drum Containment Area was an area used to dispose of drums of waste material. The area, located south of the fenced ACS facility was owned by ACS and used for a number of years as an open dump for the drums and still bottoms waste. In the early 1970s, IDEM required ACS to close the area by building a berm around the 300 by 400 foot accumulation of drums and capping it with clay.

The north and west berm around the area are clearly visible on the Site topography map (Figure 2-2), because of the numerous closely spaced contour lines. No steep berms are evident on the south and east boundaries to indicate the extent in those directions. Rather, the ground surface slopes gently downward to the south and east.

The Kapica Drum Recycling area was used by Mr. Kapica from the 1960s to 1980 and then from 1981 to 1987 by Mr. Pazdro to recycle and clean used drums. According to the response by ACS to a U.S. EPA 104(e) information request, ACS did not conduct business with Mr. Pazdro following his purchase of the enterprise from Mr. Kapica. The ground surface is gravelly and has little vegetation. There are numerous pieces of metal debris, many drum lids and drum lid clasps scattered across the ground. In several locations, "pancakes" of rubbery material are seen. These "pancakes" are circular, several feet in diameter and several inches thick. They appear to be the organic aggregate knocked out of the bottom of used drums.

The field investigation for the Off-Site Containment area was conducted in two phases. The purpose of the first phase was to identify any potential contaminant sources above and below ground in the area; the purpose of the second phase was to document the horizontal and vertical extent of the contamination, and to identify the concentrations of the contaminants present. Investigative procedures included the following:

3.4.5.1 Phase I Investigation. The Phase I investigation was initiated by conducting EM and magnetometer geophysics surveys across the entire Off-Site Containment and Kapica Areas (Figure 1.2) in a 15-foot grid. Geophysical data and contour plots are included in Appendix C.

Twenty major anomaly areas were identified from the geophysical results. Five anomalies were identified in the Kapica vicinity and 15 across the remaining Off-Site Area to the north. Each of the anomalies was investigated by auger probe. Auger probes AP-1 through AP5 were performed in the Kapica area, and AP-6 through AP-20 were performed on the Off-Site Area. The methodology is summarized in Section 2.3.3 and the field observations of each is compiled in Appendix G.

The Work Plan states that nine soil boring locations would be selected across the Off-Site Containment and Kapica Areas and allocated full parameter TCL and TAL samples from two discrete depths at each. On the basis of the geophysical surveys and auger probe findings, six soil boring locations were selected on the Off-Site Containment Area and three locations were selected in the Kapica Area. Rationale for the selected locations are as follows. Analytical results are presented in Appendices Q-6 and R-6.

Kapica Area Soil Borings:

SB01 was drilled and sampled between auger probes AP-1 and AP-2 to investigate the nature of the elevated HNu readings in the stained soils near the northwest corner of the Kapica building. Samples SB01-3' and SB01-9' were submitted for analysis.

SB02 was drilled and sampled near auger probe AP-5 to identify the source of elevated HNu readings and the nature of underlying soil near several drum lids found at the surface. Samples SB02-7' (5.5' for VOCs) and SB02-8.5' were submitted for analysis.

SB03A was drilled near auger probe location AP-3 to identify the causes of the elevated HNu readings and stained underlying soils. Drilling was unsuccessful because of obstructions encountered directly below the ground surface. No samples from SB03A were submitted for analysis. Test pit TP-1 was made at this location and SB03 boring number was used for a boring at the Off-Site containment Area.

Off-Site Containment Area Soil Borings:

SB03 was drilled and sampled between auger probes AP-17 and AP-18 to investigate the nature of elevated HNu readings and the character of the buried fill. Sample SB03-12', SB03-17', and SB03-20' were submitted for analysis.

SB04 was drilled and sampled in a central location between auger probes AP-13 and AP-14. While drilling and sampling SB04, a dark viscous liquid was encountered approximately 5 feet below the ground surface. The liquid accumulated inside the hollow stem augers and coated the split-spoon sampler. Field sampling procedures were modified in order to collect a sample of the liquid waste. The soil boring was terminated at the 5 foot depth to avoid transporting the waste deeper with the auger. A sample of the liquid was submitted for the sample, SB04-5'.

SB04A was drilled and sampled about 10 feet south of SB04 to obtain a deeper sample. Sample SB04A-19' was collected and submitted for analysis.

SB05 was drilled and sampled between auger probes AP-12 and AP-15 to investigate the nature of the dark oily wastes encountered in the nearby probe locations. Similar waste material and undersoils were encountered and sampled at this location. Samples SB05-14' and SB05-17' were submitted for analysis.

SB06 was drilled and sampled near auger probe AP-6 to investigate the waste characteristics at that location. Samples SB06-11.5' and SB06-15' were collected and submitted for analysis.

SB07 was drilled and sampled near auger probe location AP-19 to investigate the waste material encountered at the location. Samples SB07-14' and SB07-19 were submitted for analysis.

3.4.5.2 Phase II Investigation. The evaluation of the Phase I data indicated that there are: 1) high levels of VOCs throughout much of the Off-Site Containment Area, and 2) relatively high levels of PAHs and PCBs at several locations in the eastern portion of the Off-Site Containment Area, and PCB contamination in the surficial soils at the

Kapica area. In addition, several surface ponds or lagoons were identified in aerial photographs from 1970 and 1973 between Kapica and the Off-Site Containment Area, and evaluation of the activities in the Kapica area suggested that there might be a potential for VOC accumulation in the water table zone.

It was agreed among the U.S. EPA, the PRP technical subcommittee, and Warzyn that the Phase II sampling designated in the approved Work Plan would be insufficient to adequately characterize the vertical and horizontal extent of contaminants. The Work Plan designated 20 sampling locations for Phase II. Phase I results showed that there were a broad range of contaminants at numerous locations at the Site. To better evaluate the remedial alternatives in the FS, it was evident that it would be necessary to further define understanding of the horizontal and vertical distribution of the various contaminants. Thus, the Phase II RI was supplemented with the Supplemental Technical Investigation (STI).

**Off-Site Containment Area.** Phase II sampling in the Off-Site Containment area was conducted to develop the data to differentiate the areas with only VOC contamination from the areas with VOCs mixed with PCBs. Three sub-areas were identified in the Off-Site Area.

Eight soil borings were made in the eastern part of the Off-Site Containment area to collect samples at three discrete depths for the analysis of VOCs and PCBs. The sampling locations, shown on Figure 2-2, include the following:

| | |
|---|---|
| SB24 | SB24R |
| SB25 | SB25R |
| SB26 | SB26R |
| SB27 | SB27RR |
| SB28 | |
| SB29 | |
| SB36 | |
| SB37 | |

Initially, each boring was drilled to a depth of 21 feet and discrete samples were collected at the 12-foot and 21-foot depths. Later, the borings designated with the "R"

suffix were re-drilled to the bottom of the upper aquifer (a depth between 24 and 29 feet) to collect a sample to evaluate potential accumulation of dense non-aqueous phase liquids (DNAPL) waste. All samples were submitted to the laboratory for the analysis VOCs and PCBs.

Soil borings SB36 and SB37 were conducted to complete sampling in the east central portion of the Off-Site Containment Area. Samples were collected from each boring at three depths, 10 feet, 17 feet and 23.5 feet and submitted for analysis of VOCs and PCBs.

The northwest portion of the Off-Site Containment area was further investigated by performing soil borings SB38 and SB39. These soil borings were sampled at three depths and each sample was submitted for analysis of VOCs and PCBs. The sample depths were as follows:

| | |
|---|---|
| 8-10 feet | approximate level of buried waste |
| 17-20 feet | native soil underlying buried waste |
| 23-25 feet | bottom of the upper aquifer |

The Phase I samples indicated that the waste buried in the Off-Site Containment Area was both widespread and consisted of VOCs, PAHs, and PCBs. It was apparent that further sampling should be conducted to the southwest to determine whether or not the area also contained buried waste. Therefore, soil borings were made and sampled in two new areas.

Soil borings SB28 and SB29 were drilled in the southern portion of the Off-Site Containment Area (Figure 2-2). The samples were collected from a depth of 8 feet to represent the water table zone and analyzed for full TCL and TAL parameters.

Twelve auger probes (AP-63 to AP-71) were drilled to a depth of 13.5 feet in the area southwest of the Off-Site Containment Area (locations shown on Figure 2-2). The observations are summarized in Appendix G. In general, many of the auger probes and soil borings contained evidence of municipal refuse buried in these areas at depths of from 3 to 10 feet, making it difficult to distinguish the boundary between the ACS waste and the Griffith Municipal Landfill. Three soil boring locations, SB-40, SB-41, and SB-

42, were selected to represent the subsurface conditions in this area. These soil borings were drilled in several locations before representative samples for soil analysis were obtained. The subsurface conditions at these three boring locations indicate that municipal waste may have been placed over buried ACS waste or directly adjacent to it. All samples were analyzed for full TCL and TAL parameters.

SB40 was advanced to a depth of 10 feet to collect a sample representative of the water table condition.

SB41 and
SB42 were both advanced to the bottom of the upper aquifer. At each location, one sample was collected at a depth of 5.5 feet to represent conditions at the water table and a second sample was collected at 23.5 feet to represent the conditions at the base of the upper aquifer.

During the Phase II sampling an area was observed where a dark oily substance was observed on the ground surface. The area is identified as waste sample WS01 (Figure 2.2). The waste appeared to be leaking from underground, so a series of six auger probes (AP-72 through AP-77) and three split-spoon samples were performed to document the vertical and horizontal extent. The probes and split-spoon samples indicate that oily waste is contained in an area 35 feet by 25 feet horizontally to a depth of 7 feet. A sample (WS01) was collected of the oily substance and submitted for full TCL/TAL analysis.

**Kapica Drum Recycling Area.** Phase II of the investigation in the Kapica vicinity was conducted for two purposes: 1) to document the vertical and horizontal extent of PCB contamination in the surficial soils and 2) to determine if there is significant VOC contamination in the water table zone. The investigation of surficial PCB contamination is discussed above in section 3.3.2.

To evaluate the potential for VOC contamination at the water table, 10 auger probes were performed (AP-54 through AP-57 and AP-78 through AP83) to provide a field screening of potential VOC contamination. On the basis of the auger probe observations, five soil borings were made to collect samples from the water table zone for VOC analysis. Samples were collected from the water table vicinity at the following soil boring locations and submitted to the laboratory for analysis of VOCs.

| | | | | |
|---|---|---|---|---|
| SB31 | SB43 | SB46 | SB49 | SB52 |
| SB32 | SB44 | SB47 | SB50 | SB53 |
| SB33 | SB45 | SB48 | SB51 | SB54 |

The soil boring logs are included in Appendix D. Analytical results are discussed in Section 5.4.

## 3.5 GROUNDWATER INVESTIGATION

The groundwater investigation was conducted to answer five questions: 1) what is the extent and character of upper aquifer contamination, 2) is the clay confining layer continuous beneath the site and how effective is it in protecting the lower aquifer from contamination, 3) to what extent is the lower aquifer affected, 4) what is the direction and rate of groundwater flow in the aquifers beneath the Site, and 5) are private wells downgradient from the Site affected.

Numerous monitoring devices have been installed at the Site during the investigation. Piezometers were installed in an approximate 200-foot grid across the site at the beginning of the Phase I investigation. Monitoring wells were installed in the upper aquifer in Phases I, II, and III, and in the lower aquifer in Phases II and III. Staff gages were installed in Phase I and maintained or replaced as necessary in subsequent phases.

Physical and chemical data were collected during the investigation. Physical data included: grain-size analysis of upper aquifer, confining layer and lower aquifer materials; water levels measured on at least four occasions at the piezometers, monitoring wells, and staff gages. Chemical data included: two rounds of samples collected from each monitoring well and analyzed for TCL organic and TAL inorganic, five samples of the aquifer matrix collected from within the contaminant plume in the upper aquifer, field screening to aid in selecting the optimal locations for Phase II upper aquifer wells, and sampling private wells adjacent to the Site.

The following subsections describe the procedures and sampling which were conducted to answer the questions. The actual data collected is presented and evaluated in Sections 5 through 7.

### 3.5.1 Upper Aquifer Impacts

Six monitoring wells (MW-1 through MW-6) were constructed during Phase I of the investigation (Figure 2-3). The locations were selected to surround the zones of potential contaminant sources.

The results of Phase I sampling indicated that groundwater contamination did extend in several directions from the site. A field screening procedure was used to aid in determining the extent of VOC contamination in the upper aquifer so that the Phase II wells could be placed near the outer edge of the contaminant plume, thereby documenting the horizontal extent within the upper aquifer.

The field screening, conducted by Tracer Research, consisted of collecting groundwater samples directly from the aquifer at several discrete depths and immediately analyzing them in the field by gas chromatography (GC). The GC was calibrated in the field for the analysis of benzene and total petroleum hydrocarbons. The detection limit for the compounds analyzed was approximately 0.1 ug/L, depending upon the conditions of measurement, i.e., sample size. The results provided an indication of the outer extent of upper aquifer contamination, and also showed that the highest concentrations levels were approximately 5 feet below the water table.

The following additional upper aquifer monitoring wells were constructed in Phase II:

| Well | Location | Comment |
|---|---|---|
| MW-11 | Northeast of ACS Inc. | Up gradient location |
| MW-12 | West of MW-5 ACS Inc. | At eastern edge of VOC plume identified by field screening. |
| MW-13 | Northwest of ACS Inc. | At northwestern edge of VOC plume identified by field screening. |
| MW-14 | West of ACS Inc. | Downgradient of the ACS facility, but at edge of plume as indicated by field screening. |
| MW-15 | South of Landfill | Field screening indicated "clean" along southern edge of landfill. Field screening identified trace level of benzene at this location. |

| | | |
|---|---|---|
| MW-16 | Interior of Site | Located down gradient of both ACS Inc. and the Off-Site Containment |
| MW-17 | East of Off-Site Area | At eastern edge of VOC plume identified by field screening. |
| MW-18 | East of MW-17 | Round 1 sampling results from MW-17 showed higher-than-trace levels of VOC contamination. MW-18 was constructed to better represent the outer extent of the upper aquifer plume. |

Based on the Phase II sampling results (See Table 5-2) additional upper aquifer wells were added during Phase III to define the extent of contamination in the southeastern corner of the site:

| Well | Location | Comment |
|---|---|---|
| MW-19 | South of MW-17 | Downgradient of MW-17 and MW-18, to confirm southeastern edge of plume |
| MW-20 | South of MW-17 | Confirmation of southeastern edge of plume |

3.5.2 Characterization of the Clay Confining Layer

The borings for all Phase I and II upper aquifer monitoring wells and three of the leachate headwells were extended until the clay confining layer was encountered. These depths were translated into elevations with the survey data and used to document that the approximate elevation of the top-of-clay was 620 feet msl.

In Phase II, 4 monitoring wells were screened in the lower aquifer (MW-7 through MW-10). During Phase III, 4 additional monitoring wells were screened in the lower aquifer (MW-21 through MW-24). During drilling, top and bottom of the clay layer was documented at these locations to document the thickness of the clay layer. There was difficulty in documenting the total thickness of clay at the initial location for monitoring well MW-10, because of poor sample recovery in the zone between elevation 610 and 620 feet msl. After several attempts to place the well, it was finally located near the northern boundary of the Site, northwest of the ACS Inc. facility.

The first MW-10 location is marked MW-10C on Figure 2-3. Three additional soil borings were made in the area northwest of ACS Inc. to confirm the top of clay elevation and the total thickness of the clay confining layer. Results are discussed in Section 4.5.4.1.

Each lower aquifer monitoring well location is presented below:

| Well | Location | Rationale for Location |
|---|---|---|
| MW-7 | East of On-Site Area | Determination of gradient in lower aquifer. |
| MW-8 | North of On-Site Area | Determination of gradient in lower aquifer. |
| MW-9 | West of On-Site Area | Determination of gradient in lower aquifer. |
| MW-10 | Northwest of On-Site Area | Downgradient location. |
| MW-21 | West of MW-9 | Determination of plume extent |
| MW-22 | Southeast of Site | Upgradient location. |
| MW-23 | Downgradient of MW-9 | Determination of plume extent in vicinity of MW-9 |
| MW-24 | Northwest of Site | Determination of plume extent |

### 3.5.3 Lower Aquifer Impacts

In Phase II, four monitoring wells were screened in the lower aquifer to document groundwater flow direction and quality. Phase II sampling of MW-9 showed an impact to the lower aquifer, so four additional wells were added in Phase III to define the extent of the impact (see above). The exact boundaries of the plume were not determined, because wells were not drilled through areas of high upper aquifer contamination. However, results of the sampling of the lower aquifer wells indicate that contamination does not extend off-Site.

Because it could not be guaranteed that the lower aquifer wells were being constructed in "clean" upper aquifer areas, double casing drilling techniques were used to limit the potential for cross contamination from the upper aquifer. The procedure is described in Section 2.2.2.

### 3.5.4 Groundwater Flow System

The upper aquifer groundwater flow directions were documented by plotting water table maps for each of the rounds of water levels which were collected at the 41 piezometers, 12 monitoring wells, 4 leachate wells, and 10 staff gages. Bail tests were conducted at each monitoring well to provide an estimate of the hydraulic conductivity of the aquifer in the screened zone. The water tables maps and hydraulic properties were used to calculate potential groundwater flow rates and directions in the upper aquifer.

Water levels measured in the lower aquifer on three separate dates showed a consistent gradient to the north, indicating that groundwater flow is from north to south beneath the site. Baildown tests were also performed on each of the lower aquifer wells, to derive estimates of the hydraulic properties of the lower aquifer.

### 3.5.5 Private Well Sampling

During the planning stage of the project, U.S. EPA conducted a survey of the private wells within 1.5 miles of the ACS Site and developed a map showing the locations (see Figure 1-4 in the Work Plan). Phase II data indicated that groundwater flow in the lower aquifer was to the north. To identify all potential private wells downgradient of the Site, door-to-door canvas was conducted at all the buildings along Main Street in Griffith, (North of the Site) and at all buildings between Main Street and the Site.

On the basis of this information, water samples were collected from ten private wells adjacent to the Site. The locations included two wells north (directly downgradient) of the Site, one well south (up gradient) of the site, the six wells closest to the site, along Reder Road, east of the Off-Site Area and along Arbogast Avenue, east of the Griffith Landfill, and one well west of the landfill.

## SECTION 4.0
## PHYSICAL CHARACTERISTICS OF SITE

### 4.1 REGIONAL CLIMATE

The Site is located in an area characterized by a humid continental climate, where rainfall exceeds evapotranspiration. Weather patterns are controlled by the midcontinental location of the site area, and by proximity to Lake Michigan. Average annual precipitation in the site area is 37 inches per year; snowfall averages 30 to 40 inches per year. The average annual temperature is 50 $^{o}$F, with the average maximum being 85 $^{o}$F (July), and the average minimum temperature being 15$^{o}$F (January) (Hartke et al., 1975).

During the course of the Remedial Investigation, precipitation records were obtained for Griffith, Indiana. Precipitation is summarized in Table 4-1, and raw data is presented in Appendix M.

### 4.2 SURFACE FEATURES AND TOPOGRAPHY

The ACS Site is located in northwestern Indiana in Section 2, Township 35 North, Range 9 West in Griffith, Lake County, Indiana (Figure 1-1). This area lies within the Calumet Lacustrine Plain, a subdivision of the Northern Moraine and Lake Region (Hartke, et al., 1975).

The Calumet Lacustrine Plain is located within the lake bed of glacial Lake Chicago. The landscape is generally low-lying, and predominantly the result of continental glacial processes, and lacustrine processes associated with the formation of glacial Lake Chicago and present-day Lake Michigan. Dominant features of the landscape include three relict shorelines representing successively lower stages of glacial Lake Chicago, the high dunes of the present shoreline of Lake Michigan and abundant low-lying marsh and wetland areas.

The Calumet Lacustrine Plain is characterized by generally low relief, due to its location within the lake bed of glacial Lake Chicago. In the immediate vicinity of the Site, surface elevations range from about 650 to 630 ft, MSL. The higher

elevations represent relict sand dunes located east of the Site, while the lower elevations are associated with wetland areas to the west and south of the Site.

Wetland areas have been defined in the immediate vicinity of the site. These wetlands are described in detail in the report "Wetlands Delineation at American Chemical Services Hazardous Waste Site, Griffith, Indiana, IAG-DW14934313-0, U.S. Fish and Wildlife Service, August 13, 1990". This report is contained in Appendix N.

Surface features which have a great affect on the Site conditions include the ACS fire pond and the de-watering excavation at the Griffith Municipal Landfill. These features are major factors in the surface water drainage and groundwater infiltration of the Site; their effects are examined in Section 4.4.2.

## 4.3 SITE GEOLOGY

### 4.3.1 Regional Setting

#### 4.3.1.1 Regional Glacial Geology

A variety of unconsolidated materials are found within the limits of the Calumet Lacustrine Plain. These materials include fine lake silts and clays, paludal muck and peat, beach and dune sands, sand and gravel outwash, and glacial tills. These materials represent a complex depositional history, including fluctuating lake levels and associated beach and dune formation and the accumulation of sand and gravel outwash deposits (Hartke, et al., 1975).

The glacial deposits in the immediate site vicinity are approximately 130 feet thick. These deposits have been subdivided into four units: an upper sand and gravel unit, an intermediate clay unit, a lower sand and gravel unit, and a lower clay till unit which directly overlies bedrock. Three hydrostratigraphic units have been identified in the glacial deposits in the site vicinity. These units include, in descending order, an uppermost aquifer (Calumet Aquifer), a clay confining layer and a lower aquifer (Valparaiso Aquifer). Previous investigations have indicated that the clay confining layer may not be continuous south of the ACS Site (Hartke et al., 1975, Figure 15). However, the degree of interconnection between the

Calumet Aquifer and the Valparaiso Aquifer near the ACS Site, if any, was not determined in previous investigations. An idealized cross-section of the glacial deposits in Lake County, taken from Hartke et al., 1975, is presented in Figure 4-1. These units are discussed in greater detail under Section 4.3.2, Site Glacial Geology.

4.3.1.2 Regional Bedrock Geology

The bedrock geology in the Site area consists of more than 4,000 feet of Paleozoic shales, sandstones and carbonates, overlying Precambrian granitic basement. The youngest bedrock unit present in the Site area is Antrim Shale of Devonian age (approximately 260 million years old). The Devonian Detroit River and Traverse Formations, composed of limestone with some karst, underlie the town of Griffith (CDM, 3/26/85).

The bedrock units in the Site area are gently folded to form part of the Kankakee Arch, a saddlelike structure that forms a high between the Michigan Basin on the northeast and the Illinois Basin on the southwest. Regional dip is generally to the southeast, at a rate of five to seven feet per mile.

The bedrock surface is largely a preglacial erosional feature, and is not reflected by the surface topography. Bedrock surface elevations in the site area range from about 450 feet, Mean Sea Level (MSL) near Lake Michigan to about 650 feet, MSL in southern Lake and Porter counties. The higher bedrock elevations south of the site represent a northeast-southwest trending bedrock ridge of Devonian limestone and shale (Hartke, et al., 1975).

4.3.2 Site Glacial Geology

Three geologic units have been identified within the glacial deposits at the ACS Site. These units are: an upper sand and gravel unit, an intermediate silty clay unit, and a lower sand and gravel unit. The stratigraphic relationships among these units are illustrated in Figures 4-3 through 4-6, which are cross-sections of the ACS Site (Figure 4-2 is the cross-section location map).

The geologic characteristics and relationships among these units have been defined based on the installation of 73 soil borings, 18 monitoring wells, and 83 auger probes. In addition, geotechnical testing of selected samples was performed to analyze grain size, porosity, and Atterberg Limits.

Each geologic unit is discussed in detail in the following sections.

4.3.2.1 Upper Sand and Gravel Unit (Upper Aquifer)

The Upper Sand and Gravel Unit at the site generally consists of a brown to dark gray, fine to coarse sand with trace to little fine to coarse gravel, trace clay, and trace silt. It is generally classified as SP or SM under the Unified Soil Classification System. This unit often becomes siltier and finer grained near its contact with the underlying clay unit. In the site monitoring wells, the Upper Sand and Gravel Unit ranged in thickness from about 13 to 32 feet, with an average thickness of about 17 feet.

Geotechnical tests performed on samples of the Upper Sand and Gravel included grain size analysis, porosity, and total organic carbon. The results of these tests are summarized in Table 2-2.

4.3.2.2 Silty Clay Unit (Clay Confining Layer)

The clay layer found underlying the Upper Sand and Gravel Unit at the Site has been classified as a gray silty to lean clay with trace to some fine to medium sand and trace fine to coarse gravel. Some fractures were noted in this unit. Under the Unified Soil Classification System (USCS) the unit has been classified as a CL to CL-ML.

Laboratory tests on the silty clay layer included grain size analysis, porosity, Atterberg Limits, total organic carbon, and laboratory permeability. The results of these tests are summarized in Table 2-2.

The silty clay layer was encountered at elevations ranging from 614.4 to 625.4 ft, MSL. The lowest top of clay elevations were generally encountered in the

vicinity of the Griffith Landfill excavation. Generally, the top of clay was at an elevation of approximately 620 ft, MSL. Figure 4-7 provides a contour map of the top of the silty clay unit. Locations where the top of clay was measured to create this map are illustrated in Figure 4-8. Table 4-2 summarizes information regarding the top of clay elevations.

The silty clay layer was found to range in thickness from an estimated minimum of 2.5 feet at boring CB-1 to a maximum thickness of 18.1 feet at monitoring well MW-7. An isopach map of clay thickness is provided in Figure 4-9. This figure illustrates that the clay is thinnest in the northwestern portion of the site. There is no indication from the RI's subsurface investigations that the confining clay layer pinches out to the south near the ACS Site, as is suggested by Figure 4-1. Locally, the clay layer is thickest to the south and is continuous throughout the investigation area.

4.3.2.3 Lower Sand and Gravel Unit (Lower Aquifer)

The Lower Sand and Gravel Unit at the Site consists of a brown to dark gray fine to coarse sand with trace to some gravel and trace silt and pebbles. Under USCS classification, the soils from this unit are considered SP-SM. Silty layers and silty clay layers are common within the upper portion of this unit, based on borings performed for the lower aquifer wells at the site.

Laboratory tests performed on samples from the lower aquifer include grain size analysis, porosity, and total organic carbon. The results of these tests are summarized in Table 2-2.

The full thickness of this unit was not penetrated in any of the borings performed for the RI. However, the driller's log for an on-site water supply well indicates that this unit extends to bedrock at the Site (driller's log #33 in Appendix L).

4.3.3 Site Bedrock Geology

Bedrock was not encountered in any of the borings performed for the Remedial Investigation. However, limestone bedrock was encountered at a depth of 131

feet in one of the on-site water supply wells. Bedrock elevations are anticipated to be in the range of 500 to 550 ft, MSL in the immediate site vicinity (Torrenga Engineering, Inc., 11/88). Published information suggests that the uppermost bedrock units beneath the town of Griffith are the Devonian Detroit River and Traverse Formations. These are both carbonate formations which exhibit some karst development (CDM, 3/26/85).

## 4.4 SURFACE WATER HYDROLOGY

Figure 4-10 is a copy of the 1975 map which shows the continental divide for the Northwestern Indiana area. It suggests that the ACS Site is located on continental divide which separates run-off which flows into Lake Michigan to the north from run-off flowing into tributaries of the Mississippi River. However, both regional information and data collected at the site indicated that the ACS Site lies entirely within the southern drainage basin.

### 4.4.1 Regional Hydrologic Setting

The U.S. Geological Survey topographic map of the region (Figure 4-11) indicates that the local surface drainage is from the north to the southwest. The elevation of the ground surface is greater than 635 feet north of the site, and slopes generally down to 630 feet west and south of the site. The natural drainage appears to have been internal, into a wetland located a mile south of the site. Turkey Creek, which flows west to east approximately one mile south of the site, is adjacent to the southern border of the wetland and may provide some drainage of the wetland.

The wetland south of the site is bounded on the west by 630 foot contour lines and on the east by a 635 foot contour line. Turkey Creek flows within the 625 foot contour. A drainage ditch was cut in the wetland area west of the ACS facility and is indicated by the 631 foot contour line on Figure 4-12. It is likely that the ditch discharges to the dewatering area at the Griffith Landfill.

There appears to be no direct surface water connection between the Site and local streams or lakes. However groundwater does discharge to the wetlands south of the site, and those wetlands are drained by Turkey Creek one half to a mile further to the south.

4.4.2 Surface Water Run-off Routes

Data collected for this investigation also indicates that surface water runoff is toward the west and south. Ten staff gages were placed across the site. Staff gage SG-10, located northeast of the site consistently exhibits water elevations at about 635 ft msl. Staff gages SG-5 and SG-6, in the drainage ditch west of the site, consistently have water levels of 630 to 632 ft msl. The staff gage southeast of the site, SG-8 showed water elevations of 632 to 633, when there was standing water to be measured.

An area of apparent surface erosion extends to the north, away from the north ACS fence and toward the woods between the fence and the railroad. Water from this ditch may infiltrate into the ground in this woods. This possible surface water flow path is only active during precipitation events. Surface water flows past the site from north to south. To the north of ACS, surface water enters through a culvert under the railroad tracks. The culvert connects to a drainage ditch north of the railroad. Surface water entering through the culvert flows in the drainage ditch along the tracks (See Figure 4-12) following the 631 foot contour line. This ditch flows west along the northern site boundary and into the drainage ditch cut north to south through the marsh (Figure 4-12). In the current site configuration, there is no surface water runoff from the site as a whole. All surface water runoff is captured within the site boundaries in the form of internal drainage or infiltration.

Aerial photographs indicate that prior to landfill expansion to its current location in the early 1980s, the ditch continued on a line beneath the second and third set of tracks, to discharge to the wetland south of the presently active area. Water level measurements from this investigation indicate that the ditch is now dewatered both north and south of the active landfill area, by the landfill de-watering. Therefore, the ditch does not provide a surface water run-off route now, and it apparently has not since prior to 1980. The 631 ft contour line has been highlighted in Figure 4-12, west and northwest of the ACS facility, to indicate the location of the internal drainage pathway.

Surface water run-off from the ACS facility is captured in the storm drainage system within the facility, and is routed to one of three infiltration basins. The major basin is the Fire Pond; another is located at the old incinerator area; and the third is located along the western fence line, west of the Fire Pond (Figure 4-12).

Another ditch was cut from just west of the Off-Site Containment area, in a northwesterly direction. At one time it apparently drained the marshy area west of the Off-Site Containment area and north of the Landfill. The channel is presently partially filled in, but it is apparent from investigation data that it acts as a surface water flow path, maintaining adjacent groundwater levels at 632 feet or lower. The 632 ft contour line is highlighted on Figure 4-12 and it indicates that it provides internal drainage toward the de-watered landfill excavation.

## 4.5 HYDROGEOLOGY

### 4.5.1 Regional Setting

#### 4.5.1.1 Glacial Hydrostratigraphic Units.

Three hydrostratigraphic units have been identified in the glacial deposits in the site vicinity. These units include, in descending order, an uppermost aquifer (Calumet Aquifer), a clay confining layer and a lower aquifer (Valparaiso Aquifer). The potentiometric surface within the unconsolidated deposits in the site area is illustrated in Figure 4-10.

The uppermost aquifer in the Site area is the Calumet Aquifer. Based on regional information (Hartke, et al., 1975), this aquifer is composed of sand and gravel, ranges in thickness from 5 to 75 feet and exhibits an average thickness of about 20 feet. Based on well logs examined for the immediate vicinity of ACS, the aquifer ranges in thickness from 0 to about 37 feet. The aquifer is the surficial geologic unit exposed in many areas, and the water table is encountered within this unit. The water table may be present at the surface, or be encountered at depths of up to 90 feet in areas of high sand dunes. The aquifer is recharged directly from precipitation, and the water table fluctuates in direct response to

precipitation patterns. Since it is a shallow and generally unconfined aquifer, it is not extensively used for water supply purposes. Some residents more than 1/2 mile north of the Site have used the upper aquifer for drinking water purposes within the last three years. However, no wells were found in the immediate vicinity of the Site which were screened in the upper aquifer. Discharge from the aquifer is to Lake Michigan or to streams or drainageways which intersect the aquifer.

Beneath the Calumet Aquifer is a clay till. Water supply well logs for the site vicinity indicate that the thickness of the till is variable. Based on regional information, the clay till is absent in some areas, and ranges in thickness to about 50 feet in others. However, all borings made at or near the site show the clay till to be continuous. The till is regarded as an aquitard, separating the shallow Calumet Aquifer from the underlying Valparaiso Aquifer. The existing geologic literature is not clear as to whether the clay is a glacial till or a lacustrine deposit.

The lower aquifer in the Site area is the Valparaiso Aquifer. The Valparaiso Aquifer is composed of sand and gravel, and ranges from about 10 to about 90 feet in thickness, based on regional information (Hartke et al., 1975). Water well logs indicate that the lower aquifer can be in excess of 50 feet thick in the Site vicinity. Regional flow in the lower aquifer is to the north beneath the Site.

The majority of the private wells in the immediate site vicinity which are used for drinking water purposes are located to the east and northeast of the site. These wells draw water from the lower aquifer. There are numerous wells in the upper aquifer more than 1/2 mile north of the Site, but these wells are not generally used as drinking water supplies. Within the past three years, some residents have used these upper aquifer wells for drinking water purposes. The locations of private wells identified near the Site, and the flow directions within the lower aquifer as shown in Site wells, are illustrated in Figure 4-13. Available well logs are presented in Appendix L. Table 2-5 summarizes information obtained regarding wells identified near the site.

The Valparaiso Aquifer is recharged predominantly by leakage through the overlying till. The Valparaiso Aquifer is hydraulically connected to the Kankakee Outwash Aquifer to the south of the Site area, and may act as a recharge source for it (Hartke et al., 1975).

4.5.1.2 Bedrock Aquifers.

Limestones, dolomites, and shales of Silurian and Devonian age compose the shallow bedrock aquifer in the site area. This aquifer exists under confined conditions, and its potentiometric surface has the same approximate elevation of that of the unconsolidated aquifers (Hartke et al., 1975). Water is obtained from zones of enhanced permeability along joints, fractures, and solution cavities within the rock units. Depths at which the shallow bedrock aquifer is encountered range from about 15 feet in the area of the Kankakee Outwash Plain in the southern portions of Lake and Porter County, to about 270 feet along the Valparaiso Moraine (Hartke, et al., 1975). Private well logs indicate that the shallow bedrock aquifer is encountered at a depth of about 130 feet at the Site.

Maximum well yields of approximately 200 gallons per minute have been obtained from the shallow dolomite and limestone. A maximum production of about 20 gpm can be obtained from the shale units. Greatest well yields are obtained in the shallower portions of the aquifer, where solution activity has caused the greatest enhancement of permeability. The shallow bedrock aquifer is used most frequently as a water supply in the western portions of Lake County, where the Silurian carbonates are the uppermost bedrock units.

Cambro-Ordovician sandstones, encountered at depths in excess of 1,400 feet, form a potential deep aquifer in the Site area. The sandstone units of interest include, in ascending order, the upper portion of the Mount Simon Sandstone and the lower Eau Claire formation, the Galesville Sandstone, and the St. Peter Sandstone. These formations have not been developed as water supplies in the Site area, but have the potential for development (Hartke, et al., 1975).

4.5.2 Upper Aquifer

Prior investigations indicated that the upper aquifer contains buried waste so determining the characteristics of the upper aquifer was a major purpose of this investigation. The upper aquifer investigation for the RI consisted of: installing piezometers, leachate headwells, and staff gages; collecting samples from the monitoring and leachate wells; measuring water levels five times between August 17, 1989 and September 14, 1990; and conducting aquifer tests at all of the monitoring wells.

4.5.2.1 Physical Testing and Documentation. Boring logs were kept in the field by the supervising geologist at all soil boring and monitoring well locations. The log for each borehole is contained in Appendix D and locations are identified on Figures 2-1, 2-2 and 2-3.

During Phase I, a soil sample was collected from below the water table at the borings for each upper aquifer monitoring well (MW-1 through MW-6) and laboratory analyzed for grain size distribution. During Phase II, upper aquifer samples were collected at two locations (MW-7 and MW-9) and laboratory analyzed for grain size distribution, porosity, and total organic carbon (TOC).

The upper aquifer samples were more than 80 percent sand, except for the sample at MW-5 which was 43 percent gravel. There was very little gravel found in the other samples, and only trace amounts of silt and clay. Therefore, it is appropriate to classify the upper aquifer as a sand aquifer. The lab reports are compiled in Appendix F; Table 2-2 summarizes the laboratory results.

The permeability of aquifer materials is related to the grain-size distribution of granular porous media. A simple, but generally proven empirical relationship between grain size and permeability was developed in the last century by Hazen (Page 350, Freeze and Cherry, 1979). The Hazen equation relies on the effective grain size, $d_{10}$, and predicts a power-law relation with permeability (K):

$$K = A \cdot D_{10}^2$$

The $d_{10}$ value can be taken directly from the grain-size gradation curve as determined by sieve analysis, and it is the grain-size diameter at which 10 percent by weight of the soil particles are finer and 90 percent are coarser. For K in cm/sec, and $d_{10}$ in millimeters, the coefficient A = 1.

Appendix F contains the grain-size distribution curves for six vadose zone soil samples, eight upper aquifer samples, and two lower aquifer samples. The $d_{10}$ values for each sample are compiled on Table 4-3 and used to calculate permeability values. The samples from the vadose zone had the largest amount of fine-grained material, and therefore would exhibit the lowest permeability when saturated. The samples from the saturated portion of the upper aquifer appeared to fall into two distinct groups. The samples from the eastern part of the site consisted of less fine material than those from the western side. As a result, the calculated permeability values were about two times greater for the east side sediments than for the west side sediments. The sample from MW-1 (at the far south of the landfill) was the exception, with a higher $d_{10}$ (and therefore higher calculated permeability).

Where possible, soil borings were extended to reach the surface of the clay, and document the elevation of the top of clay. Clay elevation was documented at all monitoring well locations, three of the four leachate headwell locations and at several of the waste sampling locations. The field measurements are summarized in Table 4-2. Figure 4-7 is a contour map of the elevation of the surface of the clay based on the measurements in Table 4-2. The top of clay was found quite consistently within a foot or two of 620 ft msl. The notable exception is at leachate headwell LW-4, where it was encountered at 614.5 ft msl.

4.5.2.2 In-situ hydraulic conductivity tests. In-situ hydraulic conductivity (permeability) tests were conducted at all monitoring wells constructed for this investigation. The test procedures are discussed in Section 2.5.3 and the raw data and calculations are compiled in Appendix I. The permeability values from the tests are summarized in Table 2-3.

Average permeability values (K) for the upper aquifer material are:

Geometric Mean: $K = 7.9 \times 10^{-3}$ ft/min
$4.0 \times 10^{-3}$ cm/sec

The geometric mean is a more appropriate measure of the mean than the arithmetic mean since the probability density function for permeability is log-normal. According to Davis, 1969, " . . it appears to be a general rule that the statistical distribution of permeabilities within given geologic units are log-normal.".

Because of the natural log-normal distribution of permeability, it is expected that the values of the test will vary by one or more orders of magnitude. However, two distinct ranges of permeability are evident when the data is plotted on the base map (Figure 4-14). The permeability appears to be significantly greater along the eastern part of the site than in the monitoring wells along the western part.

The permeability calculations by the Hazen equation (Table 4-3) are separated by east and west side and these also show a significantly higher permeability (approximately 2 times higher) calculated for east side samples than for west side samples. Examination of the boring logs also indicates more coarse-grained materials were found in the east side upper aquifer.

Based on the in-situ hydraulic conductivity tests, the average values for the permeability in the upper aquifer on the east and west side are as follows:

East side Mean: $K = 1.5 \times 10^{-2}$ ft/min
$7.6 \times 10^{-3}$ cm/sec

West side Mean: $K = 2.9 \times 10^{-3}$ ft/min
$1.5 \times 10^{-3}$ cm/sec

The in-situ (bailtest) results are generally accepted as more representative of actual permeability values because they result from tests in the existing wells which are screened across more of the aquifer, and test the actual flow of

groundwater through the material. The samples analyzed by grain-size distribution represent only a small fraction of the monitoring well borehole, and the Hazen equation only uses the finest grained samples to derive a value. However, the grain-size results are useful in confirming both the order of magnitude of the permeability, and the areal change in permeability from east to west across the aquifer.

4.5.2.3 Water Level Measurements. During the investigation, the following devices were installed at the site to document the water elevations in the upper aquifer and surface water bodies on the site:

41 piezometers
14 monitoring wells
4 landfill headwells
10 staff gages

The location of each device is plotted on Figure 2-3. Water levels were first measured on August 17, 1989 and six more times during the year long investigation, with the final measurement on September 13, 1990. The measurements and calculated elevations are tabulated in Table 2-5.

The water elevation measurement recorded in Table 2-5 were used to plot hydrographs for the period from August 1989 to September 1990. Several of the hydrographs for key locations are compiled on Figure 4-15 and plots of all measurements are included in Appendix P. A complete round of water levels was not collected on July 18, 1990, but the water levels which were measured in the upper aquifer had declined an average of 1.06 inches from the April 6, 1990 measurement. A synthetic water elevation was calculated for each of the unmeasured locations by subtracting 1.06 from the April level and included in the hydrographs plots.

From top to bottom on Figure 4-15, the hydrographs represent SG-7, P-8, MW-5, LW-1, SG-5, and SG-2.

SG-7 is the staff gage located in the fire pond on the ACS facility. It consistently exhibited the highest water levels measured at the site.

P-8 is a piezometer east of the ACS facility. Water levels measured in it were generally higher than piezometers on-Site, indicating the regional gradient (beyond the influence of the fire pond) is from east to west.

MW-5 is the monitoring well in the southeast corner of the ACS facility. Its level is generally lower than P-8 and SG-7, indicating that it is downgradient of both.

LW-1 is the leachate head well located in the southeast corner of the landfill. It is one of the farthest south measurement points and indicates that there is a consistent southerly component to the horizontal gradient in the upper aquifer.

SG-5 is a staff gage located in the ditch at the north Site boundary where the ditch flows beneath the railroad tracks. The hydrograph indicates that the ditch provides a consistent groundwater discharge elevation for the upper aquifer 630 to 631 feet msl at this location.

SG-2 is the staff gage in the new landfill excavation at the Griffith Municipal Landfill. The hydrograph indicates that the excavation has been de-water from its high level of nearly 627 feet in September 1989 to a level below 622 feet in August 1990.

The annual rise and fall of groundwater levels is commonly referred to as the annual hydrograph. The hydrograph for SG-7 in the ACS fire pond does not follow the normal hydrograph precisely. It does exhibit the expected rise from the August 17 to the September 8 measurement dates, but then the water level declines until the November 15 measurement date, before returning to the normal increasing trend. The November 15 measurement was made during the ACS environmental audit. This hydrograph reflects the precipitation pattern of 1989 (which was an above-average year for precipitation) for Griffith, Indiana. This area experienced a very wet May, June, July, August, and September while October, November, and December had significantly less precipitation.

The staff gage in the landfill excavation shows a constant decline from September 1989 until the measurement in April 1990. Since the levels are always below any

other measured surface water or groundwater elevation, this indicates that the landfill was actively de-watered during the time span.

4.5.2.4 Potentiometric Maps. The piezometers, monitoring wells, headwells, and staff gages provide data points in an approximate 200-foot grid across the entire site (Figure 4-16). The measurements were used in the "Surfer" contouring software package (Golden Graphics, 1988) to generate watertable contour maps for data set. Plots for each of the water level measurement dates are included in Appendix O.

The potentiometric patterns indicate that there are two types of groundwater flow patterns. One pattern occurs consistently during the wet season, late fall to early spring, and is characterized by smoothly curving contour lines. The second pattern occurs during the drier season, after periods of precipitation; it is characterized by contour lines which are less smoothly curving. Each will be discussed in the next section.

The water table characteristic of the wet season is shown, in Figure 4-17, a plot of the data collected on April 6, 1990. The dry season, condition, following a precipitation event is shown in Figure 4-18. This latter plot will be discussed in the following section. The general groundwater flow pattern is similar in both.

There are four primary hydraulic controls in the upper aquifer flow pattern which are superimposed to create the observed potentiometric surface: 1) the regional gradient; 2) discharge to drainage ditches; 3) de-watering activities at the landfill; and 4), recharge which occurs primarily at the cleared and filled areas. A fifth minor control, is a ditch which extends northward from staff gage SG-1 for several hundred feet and discharges in to a marshy area with an elevation below 630 feet.

**Regional Gradient in Upper Aquifer.** U.S. Geological Survey topographic maps indicate that the regional groundwater flow is from northeast to southwest in the vicinity of the site. The topographic maps show wetlands on virtually all sides of

the site. Those on the north and east are generally circumscribed by contour lines with elevations of 635 ft msl, and those west and south of the site have surface elevations below 630 ft msl (Figure 4-11).

Turkey Creek, which flows west to east about a mile south of the site, is contained within contour lines indicating an elevation lower than 625 ft msl. Therefore, it is reasonable to assume that there is a southerly component to the gradient. However, the effects of the recharge and dewatering may mask its effect in the available measurement devices on the site.

Water levels at the staff gage northeast of the site (SG-10) and the monitoring wells northeast and east of the site are consistently the highest levels, generally with elevations of 634 to 635 ft msl. Water elevations were consistently 630 to 631 ft msl in the ditch which runs along the western boundary of the site (SG-6). These elevations are consistent with the surface topography and indicate that the regional groundwater flow in the upper aquifer is naturally from northeast to southwest with a gradient of approximately 0.002 (4 ft/2000 ft).

**Discharge to Drainage Ditches.** Two ditches apparently were cut to enhance drainage at the site. One ditch was cut north to south through the marshy area about 900 feet west of the ACS facility. Another ditch was cut from the area just west of the On-Site Containment Area, apparently to enhance de-watering in the northern part of the landfill.

The western ditch was already apparent in the 1955 aerial photograph. At the north end, it was cut back to the east and connected to a ditch flowing under the railroad tracks north of the ACS facility. Staff gage, SG-5, was placed at the location north of the ACS fence line, where it enters the site. The measured water elevation at SG-5 was consistent within a fraction of a foot the level measured at SG-6. The second ditch, north of landfill and west of the Off-Site Containment Area is clear in the 1970 aerial photographs but subsequently has been filled in along parts of its length.

Both ditches are below the 632 contour line on the map (in Figure 4-12, the 631 contour line has been highlighted north in northern half of the site, and the 632 contour line has been highlighted in the southern half). Except in the vicinity of the de-watered landfill area, the lowest groundwater levels at the site are between 630 and 632 feet. The levels of the ditches are in this range, so it is evident that these ditches provide a low resistance flow path for discharging groundwater. Each ditch results in a lowering of the water table and a skewing of the potentiometric contour lines. The northern ditch lowers the water table northwest of the site, skewing the potentiometric lines to indicate a more east to west flow than northeast to southwest. Discharge to the ditch is demonstrated by the higher surface water elevation in staff gauge SG-11, in comparison to staff gauge SG-5. Water levels measured at this staff gauge are higher than those measured on-Site. The southern ditch skews the contour lines beneath the Off-Site Containment area, around to a more north to south orientation.

**Landfill Dewatering.** De-watering has been continuous at the landfill at least since 1986. Both the original U.S. EPA contour map of the site (1986) and the base map developed for this investigation by aerial photography in 1989 show the active area of the landfill dewatered with a surface elevation in the excavation of 610 ft msl.

A new fill area was excavated north of the active area in the spring of 1989. It was initially dewatered, but then after a heavy rain at the end of May 1989, it was allowed to re-fill. Staff gage SG-2 was placed in the new excavation for this investigation. The surface water has varied between 621 and 626 ft msl during the year of investigation.

It is apparent that the landfill de-watering has kept the upper aquifer groundwater 6 to 10 ft below its natural level of approximately 630 ft msl in that area for at least the past four years. Prior to landfill operations, the groundwater flow direction was probably also in a westerly direction. However, the gradient was probably less steep than that observed under current conditions.

**Recharge at Cleared and Filled Areas.** Figure 4-19 presents a cross sectional drawing, sketched from the landfill excavation on the left, northeast to the fire pond, through the On-Site Containment Area, to staff gage SG-10 in the northeast. The water table is plotted from the August 17, 1989 measurements.

If there were no areas of major surficial recharge across the site, the water table would be represented by a straight line between the water level in the excavation, to staff gage SG-10. Instead, the water table shows significant mounding beneath the ACS facility. The fire pond water level is approximately 6 feet higher than the "no surficial recharge" line.

It is likely that infiltration of precipitation is enhanced across the entire fenced ACS facility. Under natural conditions, ground cover would consist of fine grained top soil and vegetation and the vegetation would take up and transpire much of the moisture which did infiltrate during the growing season from April to August each year. Within the fenced area, the surficial material is coarse-grained crushed limestone gravel and all vegetation has been eliminated. The crushed gravel may have hardened and formed a surface which would resist infiltration of surface water, and the lack of vegetation probably serves to limit the evapotranspiration.

During a site visit by Warzyn, John Murphy, an ACS employee, stated that several inches of precipitation result in a lot of surface water movement across the site. He pointed out four area basins which were constructed to capture and hold surface water and minimize run-off. These are shown by cross-hatch on Figure 4-12. They include the Fire Pond, which is fed by a storm sewer from the southeast part of the facility, and three other areas which provide local drainage. The water held in these impoundments has the potential to recharge the upper aquifer.

John Murphy also explained that the Fire Pond acts as a catchment basin for spills which might occur On-Site. The in-flow from the storm sewer has a compartment

with an inverted weir to contain liquid which might be floating on the water. In addition, there is an over flow pipe in the north wall of the Fire Pond. It discharges to the sanitary sewer service for the site. Its intake level is approximately 638 feet msl and its purpose, as reported by Mr. Murphy is to maintain the Fire Pond level below that elevation.

The water table contours across the landfill indicate mounding in the vicinity of piezometers P-12, P-13, and P-16. At one measurement point, P-18, the liquid elevation was consistently found to be about 10 feet higher than the surrounding measuring points, indicating extreme local mounding. The high liquid elevation at P-18 may be the result of the piezometer screening a perched zone within the landfill. That elevation was not included in the water table plots in Figures 4-17 and 4-18 and in Appendix O.

The water level contour lines are skewed to the south and west in the vicinity of the Off-Site Containment area, suggesting that significant recharge is occurring through the cap which was placed over the area. The amount of mounding in the Off-Site Containment is limited by surface discharge of groundwater into the drainage ditch which extends several hundred feet north from staff gage SG-1.

4.5.2.5 Hydraulic Gradients. In an isotropic aquifer, groundwater flow will move from areas of high water table to lower areas, following flow lines which cross the potentiometric contours at right angles. Since the upper aquifer is primarily sorted sand, it can be assumed that it is generally isotropic, and that therefore, the primary control on the direction of groundwater flow is the hydraulic gradient.

In all the watertable maps for this investigation, the fire pond has consistently exhibited the highest water elevation, and the potentiometric contour lines decline with distance from the pond. This pattern indicates that the primary groundwater flow at the site is radially outward from the fire pond. There are minor seasonal differences in the flow pattern. Figure 4-17 shows the water table

configuration during the wet season and Figure 4-18 shows the dry season water table. A similar radial flow pattern outward from the Fire Pond is apparent in both figures and the others included in Appendix O.

**Groundwater Flow During the Wet Season.** Groundwater flow in the upper aquifer can be represented by the five flow paths identified on Figure 4-21. Radial groundwater flow from the fire pond mound is represented by three "spokes" extending outward. Two supplemental flow paths are also shown. Two measurement locations along each flow line were selected as "end-points", and hydraulic gradients were calculated for each for five dates during the investigation (Table 4-4).

Groundwater flow path #1 is from the On-Site Containment area, northwest toward the drainage ditch in the vicinity of staff gage SG-5. The hydraulic gradient can be represented by the water elevations at the "end-points", piezometer P-32 and staff gage SG-5.

Groundwater flow path #2 flows from the fire pond mound west toward discharge in the landfill excavation. The hydraulic gradient can be represented by the water elevations at the "end-points", staff gage SG-7 and piezometer P-27.

Groundwater flow path #3 begins in the still bottoms area and flows south west towards landfill excavation. The hydraulic gradient can be represented by the water elevations at the "end-points", piezometers P-30 and P-5.

Groundwater flow path #4 begins beneath the fenced ACS facility, curves beneath the Off-Site Containment Area, and discharges to the small drainage ditch and the landfill excavation. The hydraulic gradient can be represented by the water elevations at the "end-points", piezometers P-4 and P-20. At the February measurements, the gradient was reversed (negative value) indicating a local reversal of groundwater flow from west to east).

Groundwater flow path #5 is to the east, outside the influence of the Fire Pond mound. It represents the regional flow which is diverted to the south by the mounding. The hydraulic gradient can be represented by the water elevations at the "end-points", monitoring wells MW-5 and MW-6.

**Groundwater Flow Pattern in the Dry Season.** The water table is raised due to precipitation events. The amount of the rise varies from area to area resulting in small mounds and depressions in the water table at the site. Figure 4-18 was constructed from water levels measured during the dry season, immediately after a precipitation event. (The water levels were measured on August 17, 1989, three days following a 1.5 inch rain in Griffith.) The water level contour plot indicates that the water table is raised locally in some places and less at other locations, resulting potentiometric lines which are less smoothly curved. For example, compare the 633 and 634 contour lines on Figure 4-17 to the 632 and 633 contour lines on Figure 4-18. The contour lines on Figure 4-18 suggest significantly different groundwater flow paths. So the net groundwater flow paths are a combination of the several different paths which occur.

For example, MW-15 is on the down gradient flow path for potential contaminant migration from the still bottoms area as shown in Figure 4-18. However, the analytical results indicate that monitoring well MW-15 is uncontaminated.

4.5.2.6 Groundwater Seepage Velocity. Estimates of the groundwater seepage rate in the upper aquifer can be calculated with the following equation (Freeze and Cherry, 1979), using the values for permeability (K), the hydraulic gradient (i) and the effective porosity (n).

$$V_S = \frac{Ki}{n}$$

where:

$V_S$ = Seepage Velocity
K = Permeability
i = Hydraulic Gradient
n = Effective Porosity

Specific values for each of the variables have been compiled for this investigation. Permeability values were calculated from the bail tests at each monitoring well,

porosity values were determined in the geotechnical laboratory for samples of the aquifer materials, and hydraulic gradients have been calculated for five discrete flow paths across the site (Table 4-4).

The permeability values and porosity values determined for this investigation are representative of a limited number of small points within the much larger aquifer. It is known that permeability values are log normally distributed throughout an aquifer and porosity values exhibit a normal distribution. Table 4-4 indicates that the hydraulic gradient varies along each flow path throughout the year. Therefore, it is appropriate to calculate a range of potential seepage velocities based on average permeability values for each variable.

Two calculations are included on Table 4-5. The first calculation uses the average permeability and effective porosity for the whole site, with the average gradient for each specific flow path. The second calculation is based on the specific permeability measured at the closest monitoring well, the average effective porosity, and the average hydraulic gradient for the specific flow path. These calculations indicate that groundwater flow rates at the site vary from about 20 feet/year to about 250 feet/year in the upper aquifer. The seasonal variation in gradient along each flow path is presented in Table 4-4.

### 4.5.3 Lower Aquifer

The lower aquifer monitoring wells were constructed during Phase II of the investigation which was begun in March 1990. The goal was to install a total of four lower aquifer wells, placing at least one directly down gradient from the area of known greatest contamination (the Still Bottoms and Treatment Lagoon Areas).

First, three lower aquifer wells, MW-7, MW-8, and MW-9, were constructed and then the reference elevations were established to NGVD (National Geodetic Vertical Datum of 1929). (Each of the well locations was selected to coincide with an upper aquifer well or piezometer so that vertical gradients could be calculated.) Next water levels were collected to calculate the horizontal hydraulic

gradient in the lower aquifer. The location of MW-10 was selected directly downgradient (north) of the center of the ACS facility.

4.5.3.1 Water Level Measurements. Water level measurements were made at all four of the lower aquifer wells on July 18, 1990 and September 13, 1990. The levels had previously been measured at the first three lower aquifer wells on April 6, 1990. The measured depths and calculated groundwater elevations are tabulated in Table 2-4.

4.5.3.2 Potentiometric Distribution. A contour plot of the potentiometric distribution has been developed for the two dates on which all four water levels were measured, July 18, 1990, and September 13, 1990. In each case the four water elevations fall on a single plane. Figures 4-22 and 4-23 show the north trending gradient.

4.5.3.3 In-situ Hydraulic Conductivity Tests. In situ hydraulic conductivity (permeability) tests were conducted at the four lower aquifer monitoring wells. The test procedures are discussed in Section 2.5.3 and the raw data and calculations are compiled in Appendix I. The permeability values from the tests are summarized in Table 2-3.

The permeability (K) values of the lower aquifer material ranged from $4.2 \times 10^{-2}$ ft/min at MW-9 to $4.6 \times 10^{-3}$ ft/min at MW-7 and MW-10. The geometric mean value for the four tests is:

Geometric Mean: $K = 4.4 \times 10^{-2}$ ft/min
$3.2 \times 10^{-2}$ cm/sec

4.5.3.4 Hydraulic Gradients.

**Horizontal Gradient.** The horizontal gradient is calculated as the decline in the potentiometric head along a flow line, divided by the distance over which the decline occurs. The gradient (i) in the lower aquifer, calculated from the July 18, 1990 water levels, was i = 0.00063 (0.6 ft/950 ft). The gradient indicated by the September 13, 1990 measurements was also i = 0.00063 (0.6 ft/950 ft).

4.5.3.5 Groundwater Seepage Rate. The same equation used in Section 4.5.2.6 to calculate horizontal groundwater seepage velocities in the upper aquifer can be calculated for the lower aquifer.

Groundwater Seepage Velocity: $V_S = 1.4 \times 10^{-4}$ ft/min
$= 73$ ft/year

**Where:** $K = 4.4 \times 10^{-2}$ ft/min
$i = 0.00063$
$n = 0.20$

A more conservative approach is to assume that the effective porosity is somewhat less than the total porosity. Since there is an inverse linear relationship between seepage velocity and effective porosity, a halving "n" would result in a doubling of the calculated seepage rate. Conversely, a higher effective porosity would result in a proportionally lower seepage rate.

On the basis of the data from this investigation, it is reasonable to estimate that the groundwater in the lower aquifer is moving northward beneath the ACS site at a seepage rate of between 50 and 100 feet per year.

4.5.4 Clay Confining Layer

Previous reports had indicated that there was a clay layer separating the upper aquifer from the lower aquifer. For this investigation, the existence and characteristics, including thickness, of the clay layer were documented by drilling to and through during the construction of monitoring wells, and by conducting additional soil borings at the end of Phase II in the northwest area to further evaluate the characteristics of the clay in that area.

4.5.4.1 Clay Surface Elevation and Thickness. The base of the upper aquifer is delineated by the upper surface of the clay layer. During the installation of all upper aquifer monitoring wells in Phases I and II, each boring was continued until the clay was encountered so that the elevation of the top of clay could be documented. Three of the four borings in the landfill made to construct leachate

headwells were extended until the clay was encountered. Several soil sampling borings in the On-Site Containment and Off-Site Containment areas were extended to the clay to collect samples to test for contamination at the bottom of the upper aquifer. The boreholes for installing the eight lower aquifer wells were used to document the existence of the clay. In addition, an additional investigation was performed northeast of the ACS facility by making soil borings CB-1, CB-2, and CB-3. The depths and thicknesses of clay defined during each aspect of the investigation are summarized on Table 4-2. These values were used to develop a top-of-clay contour map (Figure 4-7) and a clay layer isopach map (Figure 4-9). The clay layer is consistently found at an elevation within a foot or two of 620 ft msl. One exception is noted at landfill headwell LW-4, at which clay was encountered at elevation 614.5 ft msl. Investigations performed by the City of Griffith at the Griffith Landfill indicated that the clay varies in thickness from about 9 to 34 feet, and the the top clay elevation ranges from about 611 to 620 ft msl. The clay was noted to be thinnest at the northwest corner of the landfill.

4.5.4.2 Physical Characteristic. Samples of the clay layer were collected during both phases of the investigation and submitted to the geotechnical laboratory for physical testing. In Phase I, one sample was collected from the upper few feet of the clay layer at each of the six monitoring well locations. These samples were collected by Shelby tube so that undisturbed laboratory permeability testing could be conducted. During Phase II, samples were collected from the confining layer while drilling to install two of the lower aquifer monitoring wells. Samples were collected at the MW-7 and MW-9 locations and laboratory tested for grain size, Atterberg limits, total porosity and total organic carbon (TOC) content.

The clay vertical permeability values ranged from $5.8 \times 10^{-9}$ cm/sec to $6.7 \times 10^{-7}$ cm/sec with a geometric mean value of $4.8 \times 10^{-8}$ cm/sec (Table 4-7). Total porosity was laboratory measured for two samples from the clay layer. The total porosity values were 0.257 and 0.327 (unitless).

seepage rate at each of the four lower aquifer monitoring well locations are calculated in Table 4-7. For each calculation, the following values were used for each variable:

| | |
|---|---|
| Permeability (K) | the geometric mean permeability value ($4.8 \times 10^{-8}$) is used for all calculations. |
| Gradient (i) | the vertical gradient used is the one calculated for each lower aquifer monitoring well location. |
| Effective Porosity (n) | Effective porosity is generally less than the measured porosity, so a conservative value of 0.15 is used. This value is one half the average laboratory determined porosity: $((0.257+0.327)/2/2) = 0.15$. |

With these assumptions, it is calculated that the vertical seepage rate for groundwater between the upper and lower aquifer is between 0.24 ft/yr at MW-7 to 0.46 ft/yr at MW-10, where the clay layer is thinner. This represents the potential seepage rate for water through the clay. The seepage rate may be greater, if significant secondary permeability due to fractures is present in the clay. It should be recognized that the actual migration of contaminants would be siginficantly less because of retardation caused by the organic content of the clay layer and other factors such as ionic exchange within the clay. Attenuation and retardation will be discussed in detail in Section 6.

If significant differential leakage were occuring at a specific location, the result could be a mounding in the water levels of the lower aquifer. If mounding were occurring, it could be indicated by failure of the four lower aquifer water elevations to fall on a single plane. Since all lower aquifer water levels have consistently fallen on a single plain, differential leakage has not been indicated.

Local areas of leakage could also result in local depressions in the water table contour plots for the upper aquifer. The depressions could be apparent as

4.5.4.3 Vertical Gradients. Vertical gradients can be calculated by dividing the decline in potentiometric head over the distance across which the decline occurs. Water levels in both the upper and lower aquifer are known at the four lower aquifer monitoring well locations.

Each of the lower aquifer wells was constructed with a 5-ft screen located just below the bottom of the clay confining layer, so water levels in the lower aquifer well represent the potentiometric level at the base of the clay layer. Each lower aquifer well was placed at a location to coincide with either a piezometer or an upper aquifer monitoring well, and since these were constructed with screens intersecting the water table, the water levels measured, represent the watertable elevation.

Differences of 9 to 13 feet have been observed between the water levels of upper and lower aquifer wells. These represent strong downward gradients. However, it is unlikely that the gradient at each location is evenly distributed across the upper aquifer and clay layer. Because of the large disparity in the permeability of the sand upper aquifer and the clay layer, it is likely that the head drop is distributed primarily across the clay confining layer. Therefore, the most representative vertical gradient is calculated if the distance over which the head drop occurs is assumed to be the clay thickness at the specific location rather than across the measured distance between the screens in the upper and lower aquifer.

To calculate vertical gradients at each location, an "effective" screen separation was determined from the clay thickness measured at each lower aquifer monitoring well location (listed in Table 4-2). The vertical gradients calculated at the four lower aquifer wells are summarized on Table 4-6. The vertical gradients vary from 0.71 to 1.43. The average vertical gradient of approximately 1 (unitless).

4.5.4.4 Potential Leakage across the Clay Confining Layer. The potential vertical leakage across the clay confining layer can also be calculated as a groundwater seepage rate using with the equation used in Section 4.5.2.6. Values for the

contour lines with unexpected curves or bends, and these would be most apparent in "steady-state" conditions when there would be no other influences on water levels. The water table contour lines do show anomalous curves and bends, but they occur after rainfall events (see Section 4.5.2.5), which cause non-steady-state conditions. In steady-state conditions, the upper aquifer contour lines lack anomalous bends. Only one lower aquifer well exists near the Off-Site Containment Area, where leakage is suspected. It is doubtful that this well would exhibit mounding associated with a small amount of leakage.

Therefore, neither the upper nor lower aquifer water level plots indicate that groundwater is leaking across the clay layer. However, the contamination present in MW-09 is evidence that some leakage is occurring.

## 4.6 GROUNDWATER FLOW DYNAMICS

Groundwater flow and surface water flow are closely connected within the upper aquifer. At the present time, the primary controls on the upper aquifer groundwater flow system are 1) the surface water injection into the upper aquifer at the fire pond, and 2) the de-watering of the upper aquifer at the Griffith Municipal Landfill.

The upper aquifer groundwater flow system exhibits steady-state conditions at the present time, and the conditions have existed for at least the past 10 years. But it should be recognized that a change in surface water injection by ACS Inc., or a change in the landfill de-watering by the City of Griffith, could result in significant changes in the groundwater flow patterns in the upper aquifer.

## SECTION 5
## NATURE AND EXTENT OF CONTAMINATION

The primary purpose of the RI Report is to develop an understanding of the nature and extent of contaminants at the ACS Site. For completing the Endangerment Assessment, documentation of the chemical constituents of the contaminants and the specific locations of those contaminants is important. For the Feasibility Study, it is important to identify the zones of contamination which may need to be remediated, to determine the vertical and horizontal extent of the contamination in each media, and to document the characteristics of the contaminants which will be critical in selecting an appropriate remedy.

The purpose of this section is to identify discrete zones and media which are affected at the Site and to present a detailed indication of the horizontal and vertical extent in each zone, as well as a chemical characterization of each zone.

Later in this section, areas are delineated on the base map and volumes are calculated to aid in a conceptual understanding of the vertical and horizontal extent of contamination. Specifically, 1 ppm of total VOCs has been selected to represent areas of organic contamination and 500 ppm of lead has been selected to represent metals contamination. Contour lines of 1 ppm and 50 ppm have been used to represent PCB contamination. However, it is important to note that the purpose of this section does not extend to the defining areas or calculating actual volumes of waste requiring remediation. Those will be purposes of the Feasibility Study.

The data which will be used to thus define the characteristics and extent of contaminated zones were collected in two phases and a Supplemental Technical Investigation (STI). The general purpose of Phase I was to identify each zone of contamination. The purpose of Phase II and the STI was to document the horizontal and vertical extent of contamination and identify the homogeneity or variety of chemical constituents within each zone. Sampling was conducted in the following media during the field investigation.

- Soil/Waste - Split spoon subsurface samples collected in August-September 1989 and May-June 1990 during drilling operations, surface soil area composite samples collected during July-August 1989, and test pit samples collected during July-August 1989.

- Groundwater - Samples collected in August 1989, May 1990 and July 1990, from monitoring wells, subsurface aquifer matrix samples collected during drilling in May 1990, and private well samples, collected in May 1990.

- Surface Water - Samples collected in July 1989 from adjacent wetlands and drainage systems.

- Sediment - Samples collected in July 1989 and May/July 1990 from adjacent wetlands and drainage systems.

Phase I findings indicated that the subsurface contamination was more extensive than envisioned when the original scope of work was developed for the Work Plan. To adequately characterize the site contamination, the Phase II scope of work was modified and the STI was included. Section 5.1 briefly summarizes the findings from Phase I to provide an overall perspective of the entire investigation. The remaining subsections, 5.2 through 5.5, present the final characterization of each of the contaminated areas, based on the data collected during all RI tasks and Phases.

A detailed description of sampling methodologies, boring locations, etc., is described in Section 2. A narrative describing the sequence of sampling and the rationale for collecting each sample is provided in Section 3. Evaluation of the physical setting and the hydrologic and hydrogeologic regimes was presented in Section 4. Samples from the various media were analyzed for U.S. EPA Target Compound List (TCL) organics and Target Analyte List (TAL) metals and cyanide. Groundwater, surface water and private well samples were also analyzed for water quality indicator parameters. Detailed descriptions of analytical procedures and associated quality assurance can be found in the ACS Quality Assurance Project Plan (QAPP) (Warzyn, May 1989). Results of the laboratory analyses and a discussion of data quality can be found in Appendix Q. A tabular presentation of the data can be found in Appendix R. This section presents an evaluation of that analytical data.

## 5.1 Summary of Phase I Findings

A total of nine test pit waste samples, three soil surface area composite samples and 33 soil boring samples were collected from waste areas during the Phase I investigation. Due to the relatively large number of waste constituents detected, compounds were grouped together, where applicable, to assist in evaluating contaminant distribution. For example, there are certain organic compounds associated with degradation sequences (i.e., the formation of breakdown products from the parent compound) which were grouped separately, such as the chlorinated ethanes and ethenes. Other organic compounds were grouped based on their similar chemical characteristics. The specific compound groupings which were used are discussed below:

- BETX Compounds - Partially water soluble products from gasoline, oil and/or hydrocarbon products (i.e., benzene, ethyl benzene, toluene, xylene);

- Total Chlorinated Benzenes - Used as solvents and reagents from a variety of chemical manufacturing processes. Compounds in this group include chlorobenzene, hexachlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, and 1,2,4-trichlorobenzene;

- Total Chlorinated Ethenes - Chlorinated ethenes, including tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride. These compounds represent a potential degradation sequence, and are common industrial compounds;

- Total Chlorinated Ethanes - Chlorinated ethanes, including 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,1,1-trichloroethane, 1,2-dichloroethane, 1,1-dichloroethane, and chloroethane. These compounds represent a potential degradation sequence and are common industrial solvents;

- Ketones - Compounds found in resins, paint removers, cement adhesives and cleaning fluids (e.g., acetone, 2-butanone, 2-hexanone, 4-methyl-2-pentanone, isophorone);

- Plasticizers - Compounds associated with plastics and plastic making processes (e.g., phthalates);

- PCBs - Mixtures of chlorinated biphenyls identified as Aroclors, formerly used extensively in industrial applications.

- Polycyclic Aromatic Hydrocarbons (PAH) - A group of compounds associated with and derived from coal and oil, and the incomplete combustion of carbonaceous materials;

- Phenols - A group of chemicals of similar composition used in adhesives, epoxies, plastics and a variety of synthetic fibers and dyes. Compounds in the group include chlorinated, methylated, and nitrified phenols. Benzoic acid is also included with the phenols, because it may be a degradation product of the phenols.

Table 5-1 is a listing of specific compounds placed in the above groupings. Note that the compounds listed in the table do not contain all compounds detected in the various media, nor were all listed compounds detected in each media sampled. All significant contaminants are contained within these groups. Summaries of individual compounds detected in each sample are contained in Appendices Q and R.

Results of the Phase I investigation identified three general source areas of contamination at the ACS Site (Figure 1-2).

- the On-Site Containment Area;
- the Still Bottoms/Treatment Lagoon and adjacent areas; and
- the Off-Site Containment Area and Kapica/Pazmey Area.

While the concentrations and distribution of the organic contaminant groupings varied between and within the three source areas, the organic compounds present were generally the same, with the exception of the PCBs. For example, while the BETX group generally represented the highest concentration of organic contaminants in the waste areas, elevated concentrations of BETX were closely correlated to elevated concentrations of chlorinated ethenes, chlorinated ethanes, etc. (see Figure 5-1 and 5-2). However, correlation between BETX and PCBs did not exist (Figure 5-3). Therefore, for the purpose of describing the nature and extent of organic contaminants with respect to remediation, two categories of organic contaminants can be developed:

- Organic contaminants without PCB; and
- Organic contaminants with PCBs.

Figure 5-4 shows there is a direct correlation between the distribution and concentration of total VOCs and individual organic compounds (except PCBs).

The metals data from the Phase I waste samples were evaluated in the context of the U.S. EPA Publication, Trace Chemical Element Content of Natural Soils (1983). Table 5-3 provides the common ranges and average concentrations of metals in natural soils obtained from this publication. Twelve TAL metals were detected in one or more waste samples at concentrations in excess of the "common range" for natural soils (EPA 1983):

| | |
|---|---|
| Antimony | Lead |
| Barium | Magnesium |
| Cadmium | Mercury |
| Total Chromium | Selenium |
| Cobalt | Silver |
| Copper | Zinc |

As with organic contaminants, elevated metal concentrations were detected in each of the three source areas, however, metals distribution was considerably different from organics distribution.

Of the twelve metals detected in excess of the U.S. EPA "common range", total chromium and lead were the most prevalent. As shown in Figure 5-5, a logarithmic plot of Phase I lead concentrations versus total chromium concentrations indicate a strong correlation in the occurrence of these two elements. Therefore, lead concentrations were selected as an indicator of TAL metals distribution in the source areas. Correlation was not observed beteen lead and metals other than chromium.

In summary, Phase I data indicated that there were large areas of buried contamination with a wide range of contaminants. The Phase II sampling plan was modified and supplemented (with the STI) to provide an adequate number of sampling locations, with appropriate test parameters to delineate the vertical and horizontal extent of each potential source area.

The remaining sections present detailed descriptions and delineation of the nature and extent of contamination in each media using all Phase I, Phase II, and STI data and information. Table 5-2 provides a listing of the data groupings with the concentration of each group at each sampling point. Chemical groups are separated in columns; the sampling points are grouped in rows, by investigative area.

Section 5.2 discusses the landfill contamination. Section 5.3 presents the results of sediment and surface water sampling. Section 5.4 provides a characterization and delineation of contaminated soils and buried waste (exclusive of the municipal landfill). Section 5.5 describes the impact to groundwater in the upper and lower aquifer beneath the Site.

## 5.2 LANDFILL AREA

Leachate samples were collected during Phase I from the Griffith Municipal Landfill, at leachate wells LW01 through LW04 (Figure 2-3). The wells were screened in buried refuse and they are arrayed from southeast to northwest across the Landfill. LW01 is farthest to the southeast, representing the oldest part of the Landfill, and LW04, to the northwest, is near the newer, active part of the Landfill. Samples were analyzed for TCL, TAL, and water quality indicator parameters. Summaries of the laboratory results for the chemical analyses of leachate samples are contained in Appendix Q-1 and tabulated in Appendix R-1.

### 5.2.1 Organics

The TCL organics and tentatively identified compounds (TICs) detected in the leachate samples tended to be highest in samples from LW03 and LW04 located in the newer area of the landfill, where active biochemical decomposition of the refuse is apparently greater, due to enhanced availability of nutrients. Six of the nine organic groupings were detected in the leachate well samples. Chlorinated ethenes, chlorinated ethanes, and PCBs were not detected in the leachate samples.

Concentration ranges for each organic contaminant grouping detected in the leachate well samples were as follows:

- BETX 2.0 ug/L (LW02) to 244 ug/L (LW04)
- Chlorinated benzenes 8.0 ug/L (LW03) to 53 ug/L (LW04)
- Ketones 251 ug/L (LW04) to 1740 ug/L (LW03)
- Phthalates 5.0 ug/L (LW04) to 42 ug/L (LW03)
- PAHs 3.0 ug/L (LW04) to 43 ug/L (LW03)
- Phenols 7.0 ug/L (LW01) to 831 ug/L (LW03)

BETX are primary constituents of gasoline and as such, they are relatively commonly found in landfill leachate. The source of BETX in the leachate wells may be the Off-Site Containment Area. No organic contaminants (including BETX) were detected in monitoring wells MW-1 or MW-15, which are downgradient of the landfill in the upper aquifer. Phenols and ketones were detected in the leachate samples at levels similar to BETX.

### 5.2.2 Inorganics

Typically landfill leachates have a high inorganic component due to the breakdown of the waste material. Concentrations of most TAL metals, including cyanide, in leachate samples from the Griffith Municipal Landfill were highest at LW02. The exceptions were cadmium, selenium and silver at LW03, and arsenic, potassium and thallium at LW04.

The higher inorganic content at LW02 could be attributable to the higher suspended solids (TSS) in this sample. TSS in LW02 was 12,300 mg/L, compared to 6,050 mg/L at LW04, the next highest. Leachate samples are not field filtered, therefore, metals associated with suspended solids are included in the analysis. The remaining indicator parameters tended to increase in concentrations from LW01 and LW02 in the older part of the Landfill to LW03 and LW04 in the newer portion.

## 5.3 SEDIMENT AND SURFACE WATER

Samples of surface water and sediment were collected in July of 1989, and May and July of 1990. Sediment and surface water sample locations are shown in Figure 2-4. Laboratory results are contained in Appendices Q-3, Q-4, R-3, and R-4.

5.3.1 Sediment Results.

A total of 18 sediment samples were collected during both phases of the investigation and analyzed for TCL organics and TAL inorganics. Seven sediment samples were collected during Phase III and analyzed for total organic carbon for purposes of the ecological assessment.

The sediment sample locations were selected to represent several areas internal to the Site as well as the potential sediment accumulation areas at the Site boundaries. Seven general sediment areas were sampled:

- ACS facility - SD01, SD02;
- Wetlands north and west of ACS - SD03, SD04, SD10, SD11, SD12, SD16;
- Drainage ditch west of ACS - SD07A, SD07B;
- Drainage ditch north of landfill - SD07C;
- Wetlands West of Landfill - SD06, SD13, SD14;
- Wetlands East of Landfill - SD08, SD09; and
- Drainage from Off-Site Containment - SD05, SD15.

A number of organic and inorganic constituents were detected in the sediment samples, however, with the exception of sediment locations on or immediately adjacent to the Site, concentrations were relatively low, indicating only minor impacts to Off-Site sediments. The following briefly summarizes the analytical results in each of the seven general sediment sampling areas:

- ACS facility - Four of the nine organic contaminant groups were detected in SD01 and SD02. Phthalates and PCBs were detected in both samples, BETX and total phenols were detected in SD02. Lead levels at SD02 appeared slightly elevated relative to SD01. See Table 5-2 for concentrations.

- Wetlands north and west of ACS - Eight of the nine contaminant groups were detected in one or more of the six samples representing sediments in this area (Table 5-2). SD03 is located at a former drainage ditch location (1970 aerial photograph, Appendix A), and SD16 is located at what may have been a settling point for runoff from the ACS facility. This drainage ditch and settling point appeared to drain the Still Bottoms/Treatment Lagoon area in the 1970 aerial photograph and the contaminant groups detected in these samples may have originated from this drainage. SD10 is located adjacent to the railroad and elevated PAHs may be attributable to treated railroad ties. Lead and chromium levels were also somewhat elevated at SD16 in comparison to the other samples in this area.

- Drainage ditch west of ACS - Three contaminant groups were detected in the two samples from this area. Total PAHs and phthalates were detected in both SD07A and SD07B, total phenols were detected in SD07B only. These samples are located adjacent to the railroad, and compounds detected may be attributable to rail equipment and activities.

- Drainage ditch north of Landfill - Phthalates and PCBs were detected in SD07C. The landfill, railroad and ACS are potential sources at this location.

- Wetland west of Landfill - Total phenols, PAHs, phthalates and ketones were detected in one or more samples from this area (Table 5-2). The landfill is a potential source in this area, as is past drainage of the Kapica area and Off-Site Containment Area.

- Wetland east of Landfill - BETX, phenols, PAHs and phthalates were detected in one or both samples from this area (Table 5-2). The Landfill, Off-Site Containment or commercial operations along Reder Road are potential sources in this area.

- Drainage from Off-Site Containment - BETX, phenols, PAHs and phthalates were detected at SD05 immediately west of the Off-Site Containment (Table 5-2). This location was formerly part of a drainage system from the ACS facility, therefore, some of the contaminants may represent former runoff. However, groundwater discharge is likely the source of at least the BETX. Total phthalates and PAHs at SD15 may originate from either the adjacent railroad or the Off-Site Containment Area, where incinerator ash was reportedly disposed.

### 5.3.2 Surface Water Results

Five surface water samples were collected, two were internal to the Site, and three were on the perimeter of the Site:

Internal

- ACS facility - SW01, SW02

Perimeter

- Drainage from Off-Site Containment - SW05
- Ditch west of ACS - SW07A
- Wetlands east of Landfill - SW08.

With the exception of SW05, chemical concentrations in the surface water samples were relatively low. TAL metals and cyanide concentrations did not appear to be elevated in surface water samples.

- ACS facility - Trace amounts of 1,2-dichloroethene and 1,1-dichloroethane, both of which were detected in nearby soils were detected in the ACS Fire Pond (SW01). Aroclor 1248 was also reported at the detection limit at both SW01 and SW02, and is likely related to suspended solids in the surface water.

- Drainage from Off-Site Containment - Historical review indicates a ditch was cut between the Off-Site Containment area and the landfill, apparently to drain surface water toward the west. Over the years, sections of the ditch have become filled in so it is no longer a continuous surface water flow route. However, water levels measured at staff gage SG-5 indicate that the water level is similar to the surrounding groundwater level, and evaluation of the groundwater flow system (Section 4.5.2.4) indicates that groundwater discharges to this ditch. The water in the ditch is usually a rusty-red color with evidence of oily sheen on the surface. The ditch probably provides groundwater discharge from both the Off-Site Containment Area and the Municipal Landfill. The surface water samples collected from this ditch (SW05) contained the highest concentrations of VOCs of the surface waters sampled with BEXT (508 ug/L) and ketones (574 ug/L), as well as lower levels of chlorinated ethenes and ethanes. All the VOCs detected in SW05 were present in soils from the Off-Site Containment Area and groundwater. No pesticides or PCBs were detected in this sample.

- Ditch west of ACS - SW07A, contained chloroethane at 14 ug/L as the only detected organic target compound. This may be attributed to the discharge of contaminated groundwater.

- Wetlands east of Landfill - SW08 contained toluene at 8 ug/L, and total phenols at 635 ug/L. Contaminants at this location may originate from the commercial establishments along Reder Road. This is a light industrial area, with possible underground storage tanks and solvent use.

## 5.4 WASTE/SOILS

This section describes the nature and extent of TCL and TAL constituents within the various waste disposal areas. As previously discussed, a relatively large number of compounds were detected in the waste areas. Therefore, as described in Section 5.1, the extent of contaminated waste and soils was evaluated based on the three indicator groupings (total VOCs, total PCBs and lead). Visual observations and HNu readings obtained from subsurface auger probes were also considered in the determination of horizontal and vertical waste extent.

Six contaminant-extent base maps have been developed:

| Figure | Area and Contaminants Displayed |
|---|---|
| Figure 5-6 | On-Site Area, VOC contamination |
| Figure 5-7 | On-Site Area, PCB contamination |
| Figure 5-8 | On-Site Area, Lead contamination |
| Figure 5-9 | Off-Site Area, VOC contamination |
| Figure 5-10 | Off-Site Area, PCB contamination |
| Figure 5-11 | Off-Site Area, Lead contamination |

A series of overlays have been developed for each base map for discrete sampling depths (labeled as Figure 5-6a, 5-6b, etc.). Each overlay represents a specific depth interval, with the lowest interval generally representing the zone about 0-5 feet above the top of the clay confining layer. The overlays are scaled to "1 inch = 150 feet". By lining up the reference grid on an overlay with the associated base map (e.g., Figures 5-6 through 5-11), the reader may reference horizontal contamination to Site features. Note that the chemical concentrations shown on the overlays are "mg/kg" (ppm), the solid contour line represents the approximate extent of concentrations in excess of 1 mg/kg (ppm) for the total VOCs and PCBs, and 500 mg/kg (ppm) for lead. On the PCB overlays, a second contour line representing 50 mg/kg (ppm) total PCBs is included. The approximated extent of PCB concentrations in excess of 50 ppm is shaded for clarity when using multiple overlays.

The overlays were developed to aid in the conceptual analysis of the extent of impact and provide the delineation of substances necessary to proceed with the risk assessment and continue with the alternatives evaluation in the Feasibility Study. The depth and range of depths for each overlay were selected to best represent the data.

It is important to note the following. The selection of 1 ppm for VOCs, 1 ppm and 50 ppm for PCBs, and of 500 ppm for lead is arbitrary. The contour lines representing these concentrations were developed from a combination of laboratory data, field measurements and visual evidence of contamination. They do not delineate areas requiring or not requiring remediation. They are presented to aid in understanding the vertical and horizontal extent and variability of the contaminants at the Site. The

contour maps will be useful in the Feasibility Study to evaluate the potential extent of various contaminants, and the degree of mixing of various types of contamination, and to develop discrete areas and calculate volumes requiring remediation.

The following subsections describe the extent and location of contaminated wastes and soils within each of the various waste disposal areas (ie., On-Site Containment Area, etc.). Discussions on the nature of contaminants will generally be limited to the nine organic compound groups and metals. Laboratory results for the soil boring and test pit samples are contained in Appendices Q-5, Q-6, Q-7 and R-5, R-6, R-7. Table 5-2 provides a summary of the organic contaminant group results plus lead, chromium and total VOCs.

### 5.4.1 On-Site Containment Area

The On-Site Containment Area is a rectangular shaped area, approximately 250 feet north to south and 450 feet west to east, located in the northern third of the fenced ACS facility (Figure 1-2). Historical information and subsurface investigations during the RI indicate that drums are buried beneath at least a portion of this area. The buried drums are found in an area approximately 50 feet by 50 feet in the northwestern portion of the On-Site Containment Area, and appeared to be stacked three high in the test pit excavations. Their exact location is shown in Figure 1-2. It is possible that the drums represent a major source of potential contaminants in this area, although the soil sample analyses indicate several areas of soil contamination throughout the On-Site Containment Area.

A total of 44 Phase I and II soil boring and test pits samples were collected and analyzed from the On-Site Containment Area. Phase I samples were analyzed for TCL organics and TAL metals. The results of the analyses were used to identify specific locations and analytical parameters for focused sampling in Phase II and the STI. As a result, all 44 samples were analyzed for VOCs, 32 samples were also evaluated for pesticides/PCBs and 14 were evaluated for semi-volatile organics. Fifteen auger probes were also conducted in the area. A description of the sampling sequence and the rationale for the collection of individual samples and selected analytical parameters is provided in Section 3.4.1.

With the exception of a few localized areas in the western half of the On-Site Containment Area, most of the contaminants are non-PCB containing organic waste. The potential volume of soil with with greater than 1 ppm of VOC contamination in the On-Site Containment, is approximately 15,000 $yd^3$.

5.4.1.1 Organic Wastes. The approximate extent of organic wastes (greater than 1 ppm VOCs) in the On-Site Containment Area is shown in Figures 5-6a through 5-6f. Generally the zones of contaminated waste/soils are segregated between the western and eastern halves of the Containment Area.

Contamination in the western half extends from approximately 2 to 19 feet below surface and encompasses a total of approximately 5200 $yd^3$ of waste/soils. However, concentrations are highest near the surface (1 to 4 feet) and decrease with depth. The water table is located about 4 feet below ground surface.

Contamination in the eastern half on the Containment Area extends over a relatively larger horizontal area from approximately 4 to 19 feet below surface, encompassing nearly 10,000 $yd^3$ of material. Concentrations gradually increase with depth reaching maximum levels in the 9 to 14 foot depth interval, and subsequently dropping in the next depth interval.

The following describes total VOC extent at each depth interval in the On-Site Containment.

Figure 5-6a shows the approximate horizontal extent of total VOC contamination (> 1 ppm) at 1 to 4 feet below surface. The primary area of impacted soils and wastes at this depth occur in the western half of the On-Site Containment Area. Potentially 1100 $yd^3$ of soils have VOC concentrations above 1 ppm.

Figure 5-6b shows horizontal VOC extent at the 4 to 7 foot depth interval. Impacted wastes and soils at this depth are also primarily in the western half on the On-Site Containment Area, although a smaller zone of contamination can be seen in the northeastern corner of the eastern half. Approximately 400 $yd^3$ of >1 ppm wastes are located in the western portion, and 150 $yd^3$ in the eastern portion.

Figure 5-6c shows horizontal VOC extent at the 7 to 9 foot depth interval. VOC impacted wastes and soils at this depth interval of the On-Site Containment Area occur again in the central portion of the western half of this disposal area, and a relatively large portion of the eastern half. Greater than 1 ppm waste/soils volumes located in these areas amount to approximately 820 $yd^3$ in the western half and 2000 $yd^3$ in the eastern half.

Figure 5-6d shows horizontal VOC extent at the 9 to 14 foot depth interval. VOC impacted wastes and soils occur in approximately the same relative locations as the previous depth (7-9 ft). However, the contaminated area in the western half appears to be shifted slightly toward the south, and the horizontal extent in the eastern half is somewhat smaller. Calculated waste/soil volumes associated with these areas are higher due to the greater depth interval (5 ft). Approximately 1400 $yd^3$ of contaminated soils and wastes are potentially located in the western portion, while 4000 $yd^3$ may be contained in the eastern half.

Figure 5-6e shows the approximate VOC extent at the 14 to 19 foot depth interval. Generally, the primary impacts are in the eastern half extending to some extent to the western half of the On-Site Containment Area. Total potential volume of the impacted wastes and soils at this depth interval is approximately 5000 $yd^3$.

All nine organic compound groups were detected in the On-Site Containment Area. Generally the highest concentrations were detected in samples from test pit TP02, which showed buried drums, see Table 5-2 for contaminant concentrations from liquid sampled from leaking drums. Concentration ranges for the organic compound groups (with the exception of PCBs, discussed below) in the remaining subsurface soil samples are as follows:

- BEXT — 11 ug/kg to 3,002,000 ug/kg
- Chlorinated Benzenes — 2 ug/kg to 10,790 ug/kg
- Chlorinated Ethenes — 2 ug/kg to 1,110,000 ug/kg
- Chlorinated Ethanes — 1 ug/kg to 11,000 ug/kg
- Ketones — 4 ug/kg to 7,400 ug/kg
- Phthalates — 39 ug/kg to 15,086 ug/kg
- PAHs — 50 ug/kg to 121,338 ug/kg
- Phenols — 93 ug/kg to 2270 ug/kg

5.4.1.2 PCB Containing Wastes. PCB contaminated wastes were detected only in the western half of the On-Site Containment Area, and were relatively localized horizontally. Potentially 800 $yd^3$ of soil with total PCBs in excess of 1 ppm exist in the central portion of the western half of the On-Site Containment Area. These wastes extend from approximately 1 to 6 feet below surface. However, of the PCB contaminated waste/soils in this area, only 50 $yd^3$ located between 1 to 3 feet below the surface is in excess of 50 ppm. Another small area (approximately 180 $yd^3$) of PCBs in excess of 1 ppm but less than 50 ppm potentially exists at the 12 to 17 foot depth interval. Following is a discussion of total PCB extent a each depth interval in the On-Site Containment Area. Of the affected soil in this portion of the Site, only about 50 $yd^3$ contain PCBs in excess of 50 ppm.

Figure 5-7a shows the approximate horizontal extent of PCB containing wastes (< 1 ppm) in the 1 to 3 foot depth interval. Approximately 300 $yd^3$ of potential PCB contaminated wastes/soils occur in the central portion of the western half of the On-Site Containment Area.

Figure 5-7b shows the horizontal extent of PCB containing wastes at the 3 to 6 foot depth interval. As with the 1 to 3 foot depth interval, PCB contaminated wastes/soils appear to be localized in the central portion of the western half of this disposal area. Approximately 470 $yd^3$ of potentially contaminated wastes/soils with PCBs greater than 1 ppm are associated with this area.

Figures 5-7c and 5-7d show PCB contamination at the 6 to 8 foot depth interval and 8 to 12 foot depth interval respectively. Total PCB concentrations in excess of 1 ppm were not detected at this depth in the On-Site Containment Area.

Figure 5-7e shows PCB contamination at the 12 to 17 foot depth interval. A localized area of total PCB concentrations in excess of 1 ppm occurs in the western half of the On-Site Containments Area. Approximate volume of this area is 180 $yd^3$.

Figure 5-7f shows PCB contamination at the 17 to 20 foot depth interval, PCB concentrations in excess of 1 ppm were not detected at this depth in the On-Site Containment.

Total PCB concentrations in the On-Site Containment Area Samples ranged from 130 ug/kg to 26,000 ug/kg.

5.4.1.3 Inorganic Wastes

Elevated metals in the On-Site Containment appear to be limited to near surface soils in the western half of the area. Figure 5-8a shows the approximate extent of lead concentrations in excess of 500 ppm in the 1 to 4 foot depth interval. A localized area of elevated lead concentrations is apparent in the western half of the On-Site Containment Area. Volume of the potentially lead contaminated waste/soils in this area is approximately 100 $yd^3$.

Figures 5-8b through 5-8d show lead concentrations for the total depth intervals from 4 to 15 feet below ground surface. Lead concentrations in excess of 500 ppm were not detected at these depths in the On-Site Containment.

5.4.2 Still Bottoms/Treatment Lagoon Area

The Still Bottoms Area is an oval area approximately 100 feet in diameter in the central portion of the fenced ACS facility. Formerly, the Still Bottoms Area was a bermed, above ground lagoon used to temporarily store still-bottoms material prior to off-site disposal. The Treatment Lagoon Area is an oval area approximately 200 feet by 100 feet located between the ACS Firepond and the Still Bottoms Area. Both areas were subsequently filled in the 1970s, evidence of buried drums was noted in both areas (see Sections 3.4.2 and 3.4.3)

Twenty-two soil boring samples and five test pit samples were collected in the area of the Still Bottoms and Treatment Lagoon. In addition two auger probes were conducted in the Still Bottoms Area, and seven auger probes were conducted in the Treatment Lagoon Area. See Sections 3.4.2 and 3.4.3 for sampling rationale and field observations.

As with the On-Site Containment Area most of the contaminants detected in the Still Bottoms/Treatment Lagoon are non-PCB containing organics. Localized areas of PCB containing wastes were detected in the Still Bottoms and some metals were detected in both areas.

5.4.2.1 Organic Wastes

Organic wastes in the Still Bottoms/Treatment Lagoon Area extend vertically from approximately 3 to 23 feet below surface. Horizontal extent essentially includes both the Still Bottoms and the Treatment Lagoon. Total volume of potentially contaminated waste/soils in these two areas is approximately 22,000 $yd^3$.

Figure 5-6a shows the approximate horizontal extent of total VOC contamination (> 1 ppm) at 1 to 4 feet below surface. The primary area of impacted soils and wastes/soils at this depth occur in the northern half of the Still Bottoms Area extending into the Treatment Lagoon. Approximately 3200 $yd^3$ of >1 ppm wastes are potentially contaminated within this area.

Figure 5-6b shows horizontal VOC extent at the 4 to 7 foot depth interval. Impacted wastes and soils at this depth shift toward the south in the Still Bottoms Area extending into the Treatment Lagoon. Approximately 2600 $yd^3$ of >1 ppm wastes are associated with this area.

Figure 5-6c shows horizontal VOC extent at the 7 to 9 foot depth interval. VOC impacted wastes and soils at this depth interval occur in approximately the same relative area as the previous depth (4 to 7 feet). Waste/soil volume with >1 ppm VOCs in this area amounts to approximately 3900 $yd^3$.

Figure 5-6d shows horizontal VOC extent at the 9 to 14 foot depth interval. VOC impacted wastes and soils cover the greatest horizontal extent in this depth interval. Calculated waste/soil volume with >1 ppm of VOCs with this depth interval is approximately 5,900 $yd^3$.

Figure 5-6e shows approximate VOC extent at the 14 to 19 foot depth interval. While the primary impacts to soils occur in the Treatment Lagoon, some contamination may extend toward the Still Bottoms Area. Total potential volume of the >1 ppm wastes and soils in the Treatment Lagoon Area at this depth interval is approximately 2800 $yd^3$.

Figure 5-6f shows total VOC extent in the 19 to 24 foot depth interval. This figure indicates some contamination in the Still Bottoms Area down to this depth. Approximate volume of contaminated soils in excess of 1 ppm total VOC concentration is 4000 $yd^3$.

As with the On-Site Containment Area all nine organic compound groups were detected in the Still Bottoms and Treatment Lagoon Areas, and for the most part, highest concentrations were detected in samples from test pits which encountered buried drums. Concentration ranges for the organic compound groups (with the exception of PCBs, discussed below) in subsurface soil samples including test pits are as follows:

- BEXT - 66 - 34,670,000 ug/kg
- Chlorinated Benzenes - 45 - 62,500 ug/kg
- Chlorinated Ethenes - 31 - 2,000,000 ug/kg
- Chlorinated Ethanes - 8 - 21,000,000 ug/kg
- Ketones - 55 - 4,100,00 ug/kg
- Phthalates - 456 - 4,694,000 ug/kg
- PAHs - 351 - 1,057,900 ug/kg
- Phenols - 429 - 194,00 ug/kg

5.4.2.2 PCB Containing Wastes

PCBs were not detected in samples from the Treatment Lagoon Area. For the most part PCBs were detected in the southern half of the Still Bottoms Area in a relatively localized area from 3 to 12 feet below surface, and in the northern half in the 6 to 8 foot interval only. Total volume of potential PCB contaminated waste/soils in these areas is approximately 1000 $yd^3$, however, only an estimated 35 $yd^3$ contain PCBs in excess of 50 ppm.

PCBs were not detected in the Treatment Lagoon Area. Total PCB concentrations in excess of 50 ppm were detected in the Still Bottoms Areas only, at 6 to 8 feet below ground surface (Figure 5-7c). Approximately 35 $yd^3$ is represented by this area. PCB contaminated wastes/soils in excess of 1 ppm were detected in the Still Bottoms Area at the following volumes and depth intervals:

- 150 $yd^3$ at 3 to 6 feet below surface (Figure 5-7b).
- 400 $yd^3$ along the southern half, and 150 $yd^3$ in the central portion at 6 to 8 feet (Figure 5-7c).
- 200 $yd^3$ in the central portion at 8 to 12 feet deep (Figure 5-7d).
- 75 $yd^3$ in the central portion slightly above 1 ppm in concentration at 17 to 20 feet below surface (Figure 5-7f).

Total PCB concentrations in the Still Bottoms Area Samples ranged from 330 ug/kg to 74,000 ug/kg.

5.4.2.3 Inorganic Wastes

Lead was detected in both the Still Bottoms and the Treatment Lagoon. Concentrations in excess of 500 ppm, however, were limited to the shallow soils (1 to 4 feet) of the Still Bottoms, and soils from 1 to 4 feet and approximately 7 to 14 feet in the Treatment Lagoon. Total volume of potential metal contaminated waste/soils in the Still Bottoms/Treatment Lagoon is approximately 550 $yd^3$.

Figure 5-8a shows the approximate extent of lead concentrations in excess of 500 ppm in the 1 to 4 foot depth interval. Approximately 150 $yd^3$ of potential metal contaminated wastes/soils occur in the Still Bottoms Area.

Figure 5-8b shows lead concentrations for the depth interval from 4 to 7 feet below ground surface. Lead concentrations in excess of 500 ppm were not detected at this depth.

Figures 5-8c and 5-8d show lead concentrations at the 7 to 10 feet, and 10 to 15 foot depth interval respectively to be in excess of 500 ppm in the Treatment Lagoon Area. Approximate volume of metal contaminated wastes/soils in the 7 to 10 foot interval is 200 $yd^3$ and in the 10 to 15 foot interval is 200 $yd^3$.

Chromium and lead were the primary constituents detected in the Still Bottoms and Treatment Lagoon areas. Total chromium ranged from 8.7-1410 mg/kg, and lead ranged from 21.9-6300 mg/kg. Antimony, cadmium, copper, magnesium, mercury, selenium, and zinc were also detected.

5.4.3 Area West of Fire Pond

An area of contaminated subsurface soils was discovered west of the existing ACS Fire Pond during the RI. Review of the 1970 aerial photograph indicated this area may have been a former drainage ditch which has since been filled. One soil boring, SB20, was conducted in this area, and a sample of the contaminated soil collected.

Concentrations of the organic compound groups for this location were similar to those east of the Fire Pond, with all nine compound groups being detected. Based on the laboratory results for SB20, and the observations and HNu readings from nine subsurface auger probes, the extent of total VOC, total PCB contamination in this area was estimated. Metals concentrations were not elevated in this area.

Figure 5-6c (7 to 9 foot depth interval) shows the approximate horizontal extent of total VOCs in excess of 1 ppm. The volume of this area is approximately 3400 $yd^3$. Figure 5-7c (6 to 8 foot depth interval) shows the approximate extent of PCB contaminated waste/soils, the volume of the soils with PCBs in excess of 1 ppm in this area is calculated to be approximately 300 $yd^3$. Approximately 50 $yd^3$ may have PCBs in excess of 50 ppm.

5.4.4 Former Incinerator Area

The former incinerator area is a square 50 by 50 foot area located along the eastern portion of the fenced ACS facility. Total indicator contaminant concentrations in surface soils (SA03) from the former incinerator location were considerably less than in the waste disposal areas of the fenced ACS facility.

Total VOC concentration in SA03 was 980 ug/kg, with BETX as the only VOC group detected. Total PAHs were detected at 50 ug/kg, and total phthalates at 2600 ug/kg. The remaining organic compound groups, including PCBs, were not detected in SA03. TAL metal concentrations were not elevated at this location, lead concentration in SA03 was 25 mg/kg.

5.4.5 Off-Site Containment Area

The Off-Site Containment Area is located south of the fenced ACS facility. It is an approximately 300 by 400 foot area formerly used by ACS as a disposal area for drums of waste materials and still-bottom sludges. The area has since been covered with soil, although, a surficial oily waste seep was observed, during the RI, near the southwest corner. The Kapica/Pazmey Drum Area is also located in the Off-Site Containment Area at the far southern corner, however, Kapica/Pazmey will be discussed in Section 5.4.6.

Forty-three soil boring samples were collected in the Off-Site Containment Area. One waste sample, WS01, was collected from the surficial waste seep. Forty subsurface auger probes were also conducted in the Off-Site Containment Area. Refer to Section 3.4.5 for field observations and sampling rationale.

With the exclusion of the Kapica/Pazmey Area, two general zones of waste and contaminated soils exist in the Off-Site Containment Area; one in the northern portion where drums and wastes were buried by ACS, and the second in the southern portion west of the Kapica building.

With the exception of the surficial waste seep area, wastes in the Off-Site Containment are subsurface. The greatest volume of wastes are non-PCB organics, however, PCBs and metals were detected primarily in one localized area at depth in the northern portion, and at a number of small areas in the southern portion.

Soil borings and auger probes conducted in the northern portion of the Off-Site Containment Area generally encountered buried wastes at approximately eight feet deep (see Section 3.4.5). Therefore, with the exception of SB04-5' and SB42-5.5', samples collected in this portion of the Site were from 10 feet or more below the surface. The auger probes performed in this area suggest overlap of, or close proximity between, the waste disposed of at the Griffith Landfill, and waste buried in the Off-Site Containment Area. See Appendix G for summaries of the auger probes performed.

Figure 5-9c shows total VOCs greater than 1 ppm in the 7 to 9 foot interval; however, since samples were not collected in the northern portion at this depth, this Figure may not accurately depict the actual extent of VOCs in this area. The estimated total volume of soils with VOCs >1 ppm in the Off-Site Containment is 46,000 $yd^3$; however, there might be an additional 5,000 $yd^3$ contained in the 7 to 9 foot depth interval.

5.4.5.1 Organic Wastes

The approximate extent of organic wastes (greater than 1 ppm VOCs) in the Off-Site Containment Area is shown in Figures 5-9a through 5-9g. Actual concentrations are posted on these figures, as well. The 1 ppm isoconcentration contours are estimated from these concentrations, as well as auger probe observations and field notes. The organic wastes detected in the Off-Site Containment Area are primarily distributed along the southern portion, between the Kapica buildings and surficial waste seep, and in the northern half associated with the buried drums and ACS wastes. Total volume >1 ppm in the southern area (not including Kapica) is approximately 5200 $yd^3$ and extends vertically from surface in the seep area to approximately 14 feet deep, west of the Kapica building. Total volume in the buried drum area (north) is approximately 41,000 $yd^3$, extending primarily 9 to 25 feet below surface. The highest concentrations are in the 9 to 14 foot interval, decreasing substantially with depth. Since little analytical data was collected in the interval 0 to 9 feet, available data has been extrapolated over this interval, based on visual observations and HNu readings.

Figure 5-9a shows the approximate horizontal extent of total VOC contamination in excess of 1 ppm at 0 to 4 feet below surface. Approximately 600 $yd^3$ of potentially contaminated waste/soils are present in the surficial waste seep area in the southwest corner of the Off-Site Containment Area.

Figure 5-9b shows total VOC extent in the 4 to 7 foot depth interval. Two areas of contaminated waste/soils are show in this figure; approximately 470 $yd^3$ in the central portion of the Off-Site Containment; and 230 $yd^3$ directly west of the Kapica/Pazmey Area.

The 7 to 9 foot depth interval is shown in Figure 5-9c. A relatively large area of VOC contaminated waste/soils is shown northwest of the Kapica Pazmey Area extending toward the surficial waste seep area. Approximate volume of this area is 1600 $yd^3$.

Figure 5-9d shows VOC contamination at the 9 to 14 foot depth interval. Three areas of contaminated waste/soils are shown in this figure; an area directly west of the Kapica/Pazmey Area, amounting to approximately 1800 $yd^3$; an area directly east of the surficial waste seep area, approximately 1000 $yd^3$; and a relatively large area encompassing most of the north-central Off-Site Containment, approximate volume associated with this area is 15,000 $yd^3$.

Figures 5-9e and 5-9f, both show a large area of VOC contamination in the north-central Off-Site Containment, at the 14 to 19 foot and 19 to 24 foot intervals respectively. Affected waste/soil volumes amount to approximately 12,000 $yd^3$ within each interval, although concentrations in the lower (19 to 24 foot) interval are one to two orders of magnitude less.

Figure 5-9g shows VOC concentration at the 24 to 26 foot interval on top of the confining clay layer. Approximately 1500 $yd^3$ of soils at VOC concentrations greater than 1 ppm are within this interval.

The following concentration ranges of each organic contaminant group (with the exception of PCBs discussed below) were detected in the Off-Site Containment area samples:

- BEXT 17 - 254,500,000 ug/kg
- Chlorinated Benzenes 3 - 1,000,000 ug/kg
- Chlorinated Ethenes 44 - 65,000,000 ug/kg
- Chlorinated Ethanes 8 - 151,330,000 ug/kg
- Ketones 52 - 197,600,000 ug/kg
- Phthalates 54 - 19,136,000 ug/kg
- PAHs 273 - 3,487,700 ug/kg
- Phenols 180 - 1,054,000 ug/kg

5.4.5.2 PCB Containing Wastes

PCB concentrations in the soil and wastes in the Off-Site Containment Area are, for the most part, found at concentrations of less than 50 ppm. These levels of PCBs occur in scattered, localized areas at various depth between the Kapica building and the surficial waste seep, and primarily between 8 and 17 ft in the north central portion of the buried drum area. Approximate volume of soil/wastes potentially contaminated >1 ppm in the southern portion is 1250 $yd^3$ of which approximately 325 $yd^3$ may have concentrations greater than 50 ppm. Contaminated soils associated with the north central portion are approximately 4,000 $yd^3$; here, 1180 $yd^3$ may have PCB levels greater than 50 ppm.

Figure 5-10a shows the approximate extent of PCB contaminated waste/soils (> 1 ppm) in the 0 to 3 foot depth interval. Two localized areas of PCB contamination are shown in the Off-Site Containment at this depth. Approximately 300 $yd^3$ of potentially contaminated soils occur in the surficial waste seep area, and approximately 100 $yd^3$ occur midway between the seep area and Kapica/Pazmey. Only soils in the surficial seep area appear to have PCBs in excess of 50 ppm. The volume of the affected soil is estimated to be approximately 200 $yd^3$.

Figures 5-10b (3 to 6 feet), 5-10c (6 to 8 feet) and 5-10d (8 to 12 feet) show relatively small, localized areas northwest of Kapica/Pazmey containing PCB levels greater than 1 ppm.

- Figure 5-10b (3 to 6 feet). Approximately 75 $yd^3$ of soils contain PCBs in excess of 50 ppm, northwest of Kapica/Pazmey, and 100 $yd^3$ contain PCBs in excess of 1 ppm southeast of the surficial seep area.
- Figure 5-10c (6 to 8 feet). Approximately 50 $yd^3$ of soils with PCBs greater than 50 ppm, east of the surficial seep area, and approximately 70 $yd^3$ greater than 1 ppm, northwest of Kapica/Pazmey.
- Figure 5-10d (8 to 12 feet). Approximately 200 $yd^3$, east of the surficial seep area, and 200 $yd^3$ west of Kapica/Pazmey.

Two areas of potential PCB contaminated waste/soils also are shown on Figure 5-10d (8 to 12 feet) in the north-central Off-Site Containment Area. The larger area is approximately 900 $yd^3$, the smaller is approximately 300 $yd^3$. Only the larger area contains soils with PCBs concentrations in excess of 50 ppm.

Figure 5-10e also shows PCB concentrations greater than 1 ppm in the north-central Off-Site Containment at a depth interval of 12 to 17 feet. Approximate volume of soils with PCBs concentrations greater than 50 ppm is approximately 780 $yd^3$.

Figures 5-10f and 5-10g, both show some PCBs at depth in the Off-Site Containment, however, concentrations are relatively low and the extent of affected area is relatively small.

Actual total PCB concentrations in the Off-Site Containment Area samples ranged from 96 ug/kg to 1,400,000 ug/kg.

5.4.5.3 Inorganic Wastes

The distribution of wastes/soils in the Off-Site Containment potentially contaminated with metals is similar to the PCB wastes, but to a lessor extent. Total volume associated with the southern portion of this area is approximately 300 $yd^3$. Approximately 650 $yd^3$ of waste/soils potentially impacted by metals exists in the north central buried drum area.

Figure 5-11c shows extent of soil with lead concentrations in excess of 500 ppm at the 7 to 10 foot depth interval. One area of potential contamination in the Off-Site Containment is shown in this figure; 300 $yd^3$ directly west of Kapica/Pazmey.

Figures 5-11d (10 to 15 feet) shows approximately 650 $yd^3$ of soils with lead concentrations greater than 500 ppm in the north-central portion of the Off-Site Containment Area.

5.4.6 Kapica-Pazmey Area

The Kapica Drum recycling area is located in the far southeastern corner of the Off-Site Containment Area. The Kapica Area was used to recycle and clean drums for the

ACS facility. Observations in this area and results of the RI indicate that much of the waste was apparently disposed of directly on the ground surface.

Two soil area samples (SA01 and SA02) were collected immediately north and west of the Kapica buildings to address near surface soil contamination. A total of seventeen soil borings, one test pit and 15 auger probes were also conducted in the Kapica Area. Field observations, and rationale for selection of sampling locations and analytical parameters are described in Section 3.4.5.

5.4.6.1 Organic Wastes

The approximate extent of organic contamination (greater than 1 ppm total VOCs) in the Kapica/Pazmey area is shown in Figure 5-9a and 5-9b. Generally, the zone of contaminated soils extent from surface to 7 feet deep in an area north and west of the Kapica building.

A total of approximately 7200 $yd^3$ of contaminated soils are present in the Kapica/Pazmey Area, 4800 $yd^3$ are present in the 0 to 4 ft depth interval (Figure 5-9a) and 2400 $yd^3$ in the 4 to 7 ft depth interval.

All nine organic contaminant groups are present in the Kapica/Pazmey Area. Concentration ranges of each organic contaminant group with the exception of PCBs were as follows:

- BEXT 1 - 46,300,000 ug/kg
- Chlorinated Benzenes 18 - 27,000 ug/kg
- Chlorinated Ethenes 2 - 960,000 ug/kg
- Chlorinated Ethanes 5 - 1350 ug/kg
- Ketones 2 - 367,000 ug/kg
- Phthalates 177 - 698,100 ug/kg
- PAHs 54 - 157,300 ug/kg
- Phenols 280 - 34,300 ug/kg

5.4.6.2 PCB Containing Wastes

Soils containing PCBs at levels in excess of 1 ppm potentially extend from 0 to 6 feet below surface, in an area primarily north of the Kapica building. Figures 5-10a and 5-10b show the approximate extent of PCBs at the 0 to 3 ft and 3 to 6 ft depth intervals.

The volume of soils with PCB concentrations in excess of 1 ppm in the Kapica/Pazmey Area is approximately 2300 $yd^3$; 1300 $yd^3$ are located at the 0 to 3 ft depth, where approximately 300 $yd^3$ may contain greater than 50 ppm. Approximately 1000 $yd^3$ is located at the 3 to 6 ft depth. Actual PCB concentrations in the Kapica area, ranged from 4,200 mg/kg to 280,000 mg/kg.

5.4.6.3 Inorganic Wastes

The approximate extent of total lead concentrations in excess of 500 ppm in the Kapica/Pazmey area are shown in Figures 5-11a and 5-11b. Metals contaminated soils in the Kapica area are primarily in the 0 to 4 ft depth interval (700 $yd^3$) in an area west and north of the Kapica building. A smaller area (200 $yd^3$) of contaminated soils are present at the 4 to 7 ft depth interval north of the Kapica building. Total volume of metals contaminated soils in the Kapica/Pazmey area is approximately 900 $yd^3$. (Note: Volume is sensitive to actual thickness of metal-containing waste.)

## 5.5 GROUNDWATER

Twenty-four groundwater monitoring wells (MW01 through MW24) were installed during the Site RI (Figure 2-3). Eight of the 24 monitoring wells (MW07, MW08, MW09, MW10, MW21, MW22, MW23 and MW24) are screened in the lower aquifer. The remaining 16 wells are water table wells.

An additional monitoring well (MW10C) was installed into the lower aquifer, however, gas venting through this well prevented normal sampling. This well was replaced with MW10. Subsequent sampling of MW10C for VOC analysis only was conducted on July 25, 1990. Results of this analysis are described below.

Two rounds of samples were collected from each of the Phase I and Phase II monitoring wells with the exception of MW01, destroyed after the first sampling round. Samples were analyzed for TCL, TAL, and water quality indicator parameters. One round of samples was collected from the Phase III monitoring wells, and five existing perimeter monitoring wells, and analyzed for VOCs only (See Section 2.6.3).

In addition to the monitoring well samples, one round of private well samples was collected. Private well samples were analyzed for the same parameters as the monitoring wells during Phase II, except samples were not filtered for metals analysis, and low detection limit TCL and TAL methods were used as approved by U.S. EPA Region V Quality Assurance Section. The two private wells sampled during Phase III were analyzed for VOCs only.

In addition to groundwater sampling of water table wells, five aquifer matrix samples (AM1 through AM5) were collected from the saturated zone in the upper aquifer (Figure 2-3). The methods used to collect the aquifer matrix samples are described in Section 2. The objective of collecting the aquifer matrix samples was to determine chemical concentrations in the total sand/groundwater matrix in the contaminated groundwater plume. Results of TAL and TCL analyses of aquifer matrix samples are included with the soil borings data in Appendices Q-6 and R-6.

Summaries of the laboratory results for the chemical analyses of monitoring well and private well samples are contained in Appendices Q-8 and Q-9, and tabulated in Appendices R-8 and R-9.

The following discussion encompasses the organic and inorganic character of the groundwater in the upper and lower-aquifers, and a comparison with the potential contaminant source areas. As previously described, two rounds of samples were collected from each Phase I and Phase II monitoring well (with the exception of MW01 and MW10C); for purposes of this discussion, the higher concentration of the two rounds is reported with the sampling round noted. One round of samples was collected from the Phase III wells.

Section 3.6 of this Report describes the installation of monitoring wells and rationale for selected locations. Monitoring well MW18 was installed after the Round 1 results from MW17 indicated detectable levels of TCL parameters east of Colfax Avenue. The contaminants detected at MW17 may originate from sources other than the Site (eg. commercial establishments along Reder Road or Colfax Avenue), therefore, MW18 was installed to assess whether or not a plume extends from the Site toward the east. Analytical results for the sample from MW18, do not indicate that such a plume exists

as detectable levels of TCL constituents were not present at this location. Monitoring wells MW-19 and MW-20 were installed to further document the edge of the plume in the southeastern portion of the Site.

### 5.5.1 Upper Aquifer

The occurrence, concentration and distribution of contaminants in the upper aquifer reflects the groundwater flow paths described in Section 4. As groundwater flows from the Fire Pond toward the Griffith Municipal Landfill dewatering pit, some of the relatively soluble and therefore more mobile organic constituents associated with source areas described in Section 5.4, are detected downgradient. A discussion of the fate and migration of specific contaminants is presented in Section 6.

5.5.1.1 Organics. As with the buried wastes, the BETX group of organic compounds was widely distributed and was present at the highest concentration relative to other contaminants detected in the upper aquifer monitoring well samples. Figure 5-12 shows that the distribution of BETX contamination in the upper aquifer well samples and aquifer matrix samples occurs in essentially two contaminant plumes. The northern plume is attributed to disposal in the Still Bottoms area and Treatment Lagoon #1, while the southern plume is attributed to wastes disposed of in the Off-Site Containment Area. The highest total BETX concentrations were detected at MW03 (106,000 ug/L - Round 2). This well is located downgradient of the On-Site Containment Area under steady state groundwater flow conditions as were present during the second sampling round conducted in May 1990. Benzene at a concentration of only 1 ug/L was the only BETX detect in this well during Round 1. The low BETX concentrations detected in this well during Round 1 sampling (August 1989) may be indicative of changing flow conditions between sampling rounds. Elevated total BETX concentrations were also detected:

- downgradient of the Still Bottoms/Treatment Lagoon Area, MW04 (640 ug/L - Round 2) and MW05 (3,321 ug/L - Round 1); and
- downgradient of the Off-Site Containment Area, MW06 (1,800 ug/L - Round 2) and MW16 (2,160 ug/L - Round 2).

Benzene, for the most part, was the predominant constituent compound detected with the BETX grouping. The exception was MW17 (127 ug/L - Round 1), where ethyl benzene and xylenes were the only BETX constituent compounds detected.

Chlorinated ethanes were as widespread in the upper aquifer samples as the BETX group, however, overall concentrations were generally lower, with the plume centered downgradient of the Off-Site Containment Area (Figure 5-13). In 17 of the 22 samples in which chlorinated ethanes were detected, chloroethane was the sole constituent compound. In contrast to the BETX compounds, chloroethane was not widely detected in the waste soil samples collected during the RI. However, heavier chlorinated ethanes (i.e., trichlorethanes, dichloroethanes, etc.), and chlorinated ethenes (tetrachloroethene, trichloroethene, etc.) were commonly detected in the wastes. Both the chlorinated ethanes and ethenes have the potential to degrade to chloroethane (see Section 6).

The highest concentrations of chlorinated ethanes were detected at MW16 (4,000 ug/L - Round 2); at this location the predominant constituent compound was 1,1-dichloroethane (2,400 ug/L, with chloroethane at 1,600 ug/L). MW16 is located immediately downgradient of the Still Bottoms and Off-Site Containment Area, both contained elevated concentrations of the heavier chlorinated ethanes. Results of Phase III sampling indicate that MW19 and MW20 are very near the southeastern edge of the plume, as illustrated in Figure 5-13.

The remaining organic contaminant groupings were considerably less widespread than the BETX and chlorinated ethanes and, with exception of the ketones, were at considerably lower concentrations.

Total chlorinated ethenes were detected at four upper aquifer wells, MW02 (3 ug/L - Round 2), MW12 (1 ug/L - Round 2), MW16 (400 ug/L - Round 2) and MW17 (375 ug/L - Round 1). Total-1,2-dichloroethenes were the most frequently detected chlorinated ethene, occurring in all four wells. Tetrachloroethene and trichloroethene were also detected in MW17. The source of these contaminants appears to be outside ACS waste areas and the Griffith landfill. Vinyl chloride was detected in MW16, where the Round 1 concentration was 720 ug/L, and MW17 where the Round 2 concentration was 22 ug/L.

Total ketones were detected in four monitoring well samples: MW03 (2,300 ug/L - Round 2); MW04 (25 ug/L - Round 1), where acetone was the constituent compound; MW06 (35 ug/L - Round 1), where isophorone was the constituent compound; and MW16 (359,219 ug/L - Round 1), where 2-butanone (220,000 ug/L) was the predominant constituent, followed by acetone (84,000 ug/L), 4-methyl-2-pentanone (54,000 ug/L), 2-hexanone (1,200 ug/L), and isophorone (19 ug/L).

Total phenols were detected in eight upper aquifer well samples, with the highest concentrations from MW16 (2,275 ug/L - Round 1), where 4-methylphenol was the predominant constituent compound at 2,200 ug/L, and MW03 (428 ug/L - Round 2), where phenol was the predominant constituent at 240 ug/L. Total phenol concentrations from the remaining six wells (MW04, MW05, MW06, MW14, MW15 and MW17) ranged from 2 ug/L (MW17 - Round 1) to 31 ug/L (MW14 - Round 1), with the representative constituents being phenol and methylated phenols, with the exception of pentachlorophenol at MW06 (3 ug/L - Round 2) and MW17 (2 ug/L - Round 1).

Total phthalates were detected in six upper aquifer well samples (MW02, MW03, MW05, MW06, MW15 and MW17)at concentrations ranging from 2 ug/L (MW02 - Round 1) to 52 ug/L (MW17 - Round 1). Bis (2-ethyl hexyl) phthalate was the predominant constituent, with the exception of MW03, where diethylphthalate was detected at 9 ug/L - Round 2. Low concentrations of phthalate can be attributable to lab or sampling contamination due to their common use as plasticizers.

Total chlorinated benzenes were detected in five upper aquifer well samples (MW02, MW03, MW05, MW12 and MW17) at concentrations ranging from 2 ug/L (MW02 - Round 2) to 117 ug/L (MW05 - Round 1). Mono and dichloro benzenes were the constituent compounds detected.

Total PAHs were detected in only four upper aquifer well samples (MW03, MW05, MW06 and MW17). Concentrations ranged from 3 ug/L (MW03 - Round 2) to 91 ug/L (MW05 - Round 2). Naphthalene and 2-methyl naphthalene were the constituent compounds detected.

PCBs were detected in two monitoring well samples MW04 (Aroclor 1248 at 2.6 ug/L ) and MW17 (Aroclor 1260 at 27 ug/L). Detects at both wells occurred during Round 1 only. PCBs were not detected in Round 2 monitoring well samples. PCBs are relatively insoluble in water, and are rarely detected in groundwater samples. Given the relatively low concentrations detected in the samples from MW04 and MW17, and the lack of duplication during Round 2, it is likely that the PCBs detected were either associated with suspended solids in the samples, or contamination resulting from sampling or laboratory procedures.

A number of volatile and semivolatile compounds not included in the contaminant groupings were detected in the upper aquifer well samples:

- Chloromethane - detected in MW03 (68 ug/L - Round 2)

- Methylene chloride - was reported in a number of samples, but subsequently qualified during data validation as not detected, due to associated blank contamination. This compound is frequently detected as a lab contaminant, however, it was not qualified in four samples; MW02 (1 ug/L - Round 2), MW13 (7 ug/L - Round 1), MW04 (380 ug/L - Round 1), and MW16 (520 ug/L - Round 2).

  Note: Methylene chloride was qualified according to US EPA Data Validation Guidelines, Laboratory Data Validation Functional Guidelines For Evaluating Organics Analyses, USEPA, February 1, 1988. Section IV(D) of this document states: "No positive sample results should be reported unless the concentration of the compound in the sample exceeds ten times the amount in any blank for the common contaminants listed below...". Since methylene chloride is one of the "common contaminants" listed in Section IV(D) of the Guidelines, sample concentrations less than ten times the associated laboratory blank were qualified as an estimated detection limit.

- bis(2-Chloroethyl)ether - detected in MW16 (250 ug/L - Round 1), MW03 (160 ug/L - Round 1), MW06 (22 ug/L - Round 2), and MW02, MW04 and MW05 at concentrations ranging from 6 ug/L to 8 ug/L (Round 1).

- bis(2-Chloroisopropyl)ether - detected in MW05 (67 ug/L - Round 2), MW12 (150 ug/L - Round 1), and MW03 (300 ug/L - Round 1).

- Benzoic acid - detected in MW16 at 1,900 ug/L (Round 1), and MW05, MW06 and MW15 at concentrations ranging from 3 ug/L to 13 ug/L (Rounds 1 and 2).

5.5.1.2 Upper Aquifer - Inorganics. Groundwater samples collected during both sampling rounds were analyzed for common inorganic parameters (TAL metals and cyanide, and groundwater quality indicators). These analyses were used to assess geochemical trends within the aquifer in order to aid in the determination of groundwater flow patterns and contaminant fate and migration. The inorganic analyses also are used to assess potential treatment alternatives.

Inorganic analyses results arranged by sample location are contained in Appendix Q-8. A tabular presentation of the data can be found in Appendix R-8.

Calcium, magnesium, sodium, bicarbonate, chloride and sulfate are major constituents common to naturally occurring groundwater (see Table 5-4). Concentrations of these constituents in groundwater is primarily a function of the composition, hydrology, and chemistry of the aquifer. Therefore, a discussion of these constituents as they relate to groundwater flow and contaminant fate and migration are discussed in Section 6.0.

Iron, potassium, fluoride and nitrate are typically minor constituents in naturally occurring groundwater (see Table 5-4). While concentrations of these constituents may be affected by the groundwater quality impacts of the wastes, they typically do not originate in the wastes.

The remaining elements are considered trace constituents in naturally occurring groundwater (Table 5-4). Concentrations of these constituents may or may not be directly related to the wastes. Natural and contaminant related variations in pH, redox, competing ions, etc., in groundwater may enhance the solubility of some of these metals from the aquifer soils, resulting in higher concentrations not necessarily originating in the waste. Variations in groundwater quality and the potential effect on trace metal fate and migration are discussed in greater detail in Section 6.0.

Evaluation of the trace metals and cyanide in upper aquifer groundwater samples is based on the higher of the two rounds of downgradient monitoring well sample results,

and the higher of either Round 1 or 2 results for the upgradient water table well MW11. However, since only one upgradient monitoring well is available, determination of a statistically significant change downgradient is not possible. A certain degree of natural, sampling and laboratory variation is expected; therefore, unless otherwise noted, an arbitrary factor of five times the the upgradient well concentration was considered significant for the purposes of describing the extent of elevated concentrations. Instances where an element was reported as not detected above the detection limit, two and one-half times the detection limit at the upgradient well was used.

Ten trace metals were detected in one or more upper aquifer well samples at concentrations at least five times the background well (MW11). Iron and potassium were also detected at concentrations that may be at least partially attributable to ACS wastes or the Griffith Municipal Landfill, rather than aquifer geochemistry. Apparent elevated trace metal concentrations occurred most frequently in samples from MW03 and MW04 adjacent to the On-Site Containment Area, and MW06 adjacent to the Off-Site Containment area:

- Arsenic - detected in samples from MW01, MW02, MW03, MW05, MW06, MW15 and MW16 at concentrations ranging from 6.9 ug/L (MW01 - Round 1) to 43.2 ug/L (MW03 - Round 2) compared to MW11 where it was reported as not detected above 2.0 ug/L. Arsenic was not detected as a predominant waste contaminant (see Section 5.1.3). Arsenic is a common, naturally occurring element whose solubility is strongly redox/pH dependant (see Section 6.0).

- Barium - detected in MW03 (520 ug/L - Round 1), MW05 (790 ug/L - Round 2), MW15 (1,130 ug/L - Round 2) and MW16 (1,840 ug/L - Round 2) compared to MW11, where it was reported as not detected above 200 ug/L. Barium was detected in waste samples in excess of the "common range" (EPA, 1983) and is a component of the Griffith Municipal Landfill leachate; both are potential sources of the slightly elevated barium concentrations detected in these groundwater samples.

- Cadmium - detected in MW04 (3.1 ug/L - Round 1) compared to 0.320 ug/L in MW11. This element was detected in wastes from the On-Site Containment Area in excess of the EPA common range (EPA, 1983).

- Total chromium - detected in samples from MW14 and MW16 at 2.0 ug/L (Round 2) and 3.9 ug/L (Round 1), respectively, compared to 0.33 ug/L in MW11.

- Iron - as previously described, iron is a minor rather than trace groundwater constituent, however, concentrations were at least five times the MW11 concentration (581 ug/L) in samples from MW02 (9,460 ug/L - Round 2), MW03 (51,800 ug/L - Round 2) and MW04 (39,000 ug/L - Round 2) MW05 (40,000 ug/L - Round 2) and MW16 (218,000 ug/L - Round 2). As with arsenic, iron is not predominant in the waste samples and its solubility is highly dependent upon groundwater redox/pH conditions (see Section 6.0).

- Manganese - detected in samples from MW05 (3,240 - Round 2), MW06 (3,990 ug/L - Round 2), MW03 (4,050 ug/L - Round 1), MW16 (4,180 ug/L - Round 1) and MW04 (4,250 ug/L - Round 1) compared to 359 ug/L at MW11. Manganese is a waste constituent, however, naturally occurring soil concentrations may vary considerably.

- Mercury - was detected in one upper aquifer monitoring sample (MW12) at a concentration of 1.7 ug/L (Round 2). While mercury was detected in a waste sample from the Site, MW12 is not immediately downgradient of the source areas. Mercury was not detected in the Round 1 sample from this well.

- Nickel - was detected in three samples during Round 1, only; MW04 (48 ug/L), MW06 (48 ug/L) and MW03 (53 ug/L), the detection limit for this element was 40 ug/L. Nickel was not detected in Round 2 samples.

- Potassium - as with iron, potassium is considered a minor constituent of groundwater. Concentrations of this element tended to increase from east to west across the Site (1,200 ug/L to 18,000 ug/L). However, considerably higher concentrations of this element detected in MW15 (95,800 ug/L - Round 2) are indicative of leachate impacts from the Griffith Municipal Landfill.

- Selenium - detected in the Round 1 samples, only, from MW01, MW04, and MW06 (2.1 ug/L, 6.2 ug/L and 2.1 ug/L, respectively).

- Vanadium - detected in Round 1 samples from MW03 and MW06 at 20.2 ug/L and 25.9 ug/L, respectively, compared to 3.4 ug/L at MW11.

- Zinc - detected in Round 1 samples from MW03, MW04, and MW06 at 343 ug/L, 510 ug/L, and 886 ug/L, respectively. The zinc concentration at MW11 was 51 ug/L.

5.5.2 Lower Aquifer

Evaluation of the lower aquifer chemistry is based on the three rounds of sample results from MW07 through MW10, and one round of VOC analysis at MW-21 through MW-24. Locations of the lower aquifer monitoring wells are shown in Figure 2-3. Only one sample round was collected from MW10C. This sample was analyzed for VOCs, only.

Lower aquifer contamination relative to the upper aquifer is limited, both with respect to nature of compounds detected and the extent. Considerable attenuation of contaminant levels downgradient of the impacted area is apparent.

5.5.2.1 Organics. The only TCL organics detected in lower aquifer monitoring wells were;

- Chloroethane - detected in MW09 at 440 ug/L (Round 1), 200 ug/L (Round 2), and 350 ug/L (Round 3) and in MW10C at 3 ug/L (only one round collected);
- bis(2-Chloroethyl)ether - detected in MW09 at 12 ug/L (Round 1) and 11 ug/L (Round 2); and
- 4-Methyl-2-pentanone - detected in MW10C at 3 ug/L (only one round collected).

The location of MW09 is horizontally downgradient of the highest concentrations of chloroethane in the upper aquifer (see Figure 5-13). The occurrence of chloroethane in samples from MW09 may be indicative of some contaminant migration through the aquitard; however, the downward migration is apparently limited, both with respect to contaminant type and horizontal distribution.

Monitoring well MW10 is downgradient of the most contaminated area of the upper aquifer (see Figure 5-12 and 5-13) and of MW09 in the lower aquifer. Even so, samples collected from MW10 were free of detectable quantities of TCL organics. The same was true of MW10C, with the exception of chloroethane at a concentration two orders of magnitude less than at MW09. This would tend to indicate that:

- The migration of the majority of upper aquifer contaminants (BETX, etc.) is effectively prevented by the aquitard;

- The horizontal extent or "window" of migration through the aquitard is limited to an area between MW09 and the Off-Site Containment or near the Griffith Landfill; and

- Concentrations of those contaminants that do penetrate the aquitard are substantially lower (at least two orders of magnitude) between MW09 and MW10/MW10C.

Monitoring wells MW-21, MW-23, and MW-24 were installed during Phase III to determine the extent of lower aquifer volatile organic contamination. Results of the sampling of these wells indicates that the plume is confined to the Site. The estimated extent of lower aquifer chloroethane contamination is illustrated in Figure 5-14.

The potential fate and migration of contaminants toward the lower aquifer is discussed in greater detail in Section 6.0.

5.5.2.2 Inorganics. Expected concentrations of dissolved constituents in groundwater were previously discussed in sub-section 5.5.1.2. As with the upper aquifer, trace metal concentrations in samples from MW08, MW09, and MW10 were evaluated, based on the background concentrations in the upgradient well MW07. Trace metal concentrations greater than five times background were not detected in the lower aquifer wells.

Mercury was detected in the Round 2 sample from MW10 (0.47 ug/L), slightly less than 2.5 times the detection limit (0.2 ug/L). Mercury was not detected in the Round 1 sample from this well, nor was it detected in the upper aquifer samples, with one exception MW12 (1.7 ug/L - Round 2 only).

5.5.3 Private Wells

Private well sampling was performed at eight locations during Phase II of the RI, and two locations during Phase III. Private well locations are shown in Figure 2-7. Results of the laboratory analyses of private well samples are presented in Appendices Q-9 and R-9. Note that low detection limit methods were used for the private well samples.

Therefore, sample quantitation limits have been reported with the sample results. Values reported in the above two appendices with a "U" or "R" data validation designation or laboratory qualifier, are considered not detected".

TCL volatiles, semivolatiles and pesticide/PCBs were not detected in the private well samples. Unknown semivolatile TICs were detected along with 2-methyl-2,4-pentadiol (10 ug/L as a TIC) in PW06 located north of the Site.

Trace metals detected in private well samples included barium, cadmium, lead, and zinc. These elements were not elevated in the lower aquifer sample collected at the Site and the latter three may be attributable to the water distribution system. Cadmium, lead and zinc are potential solder components (CRC, 1981) and may be present in the residential plumbing. In addition, zinc is commonly a component of galvanized pipe. Barium is a naturally occurring constituent and may be present in the aquifer as barite ($BaSO_4$), which is a fairly common mineral (Hem, 1970).

# SECTION 6
# CONTAMINANT FATE AND MIGRATION

## 6.1 Introduction

This section assesses current and potential contaminant migration from waste materials at the Site to groundwater, surface water/sediments and air.

## 6.2 Groundwater

Groundwater provides a primary migration pathway by which contaminant transport may occur. Groundwater flow at the ACS Site is described in Section 4.5 and contaminant distribution within the groundwater flow system is described in Section 5.5. This section describes the potential behavior of the identified chemical contaminants within the groundwater system.

The extent of chemical migration in groundwater is dependent upon many factors related to the geologic matrix, the hydrochemical environment, and the physical and chemical properties of the contaminant itself. The effect of these factors on compounds may be substantially different on organic and inorganic parameters.

### 6.2.1 Organic Contaminants

The fate and migration of organic contaminants in the subsurface environment can be affected by a number of chemical and physical reactions including hydrolysis, oxidation, reduction, volatization, adsorption and biodegradation. The major reactions effecting chemical transport in groundwater, however, are sorption (adsorption plus absorption) and biodegradation (Olsen and Davis, 1990).

Sorption. Hydrophobic compounds that dissolve in water will tend to absorb onto solid phases that the water comes in contact with. Since there is a large solid surface area available in soils, the relative mass of solute absorbed may be substantial. The amount of contaminant that may be absorbed by a soil is a function of soil grain size, mineral composition, organic content, solute composition and solid concentration. The

absorption capacity relationship is frequently expressed by the soil/water partitioning or distribution coefficient ($K_d$). $K_d$ values for specific contaminant compounds and can be estimated from octanol/water distribution coefficient ($K_{ow}$)(refer to Table 6-1) and the organic carbon content (Karickhoff, et al., 1979; Schwarzenbach and Westall, 1981; and Wilson et al., 1981). $K_{ow}$ describes the relative affinity of a solute for an organic and an aqueous phase. Therefore, it is not surprising that this parameter may also be used to describe the relative affinity of a contaminant for soil organic matter and water. In general, substances with relatively high log $K_{ow}$ values also have relatively high $K_d$ values and are therefore absorbed to a greater extent than compounds with low $K_{ow}$ values.

The distribution coefficient ($K_d$) may be applied to saturated zone contaminant transport as a means of estimating a contaminant's retardation factor ($R_F$). The retardation factor describes the affect of sorption in decreasing the rate of contaminant transport in the liquid phase relative to a conservative or nonreactive species ($R_F = 1$). For example, if $R_F = 10$, the contaminant chemical moves at one-tenth the velocity of the groundwater.

The retardation factor is related to the distribution coefficient according to the following equation:

$$R_F = 1 + (p_b/n) * K_d$$

Where:

$p_b$ = aquifer bulk density ($g/cm_3$)
n = effective porosity (unitless)
$K_d$ = distribution coefficient (ml/gm)

Distribution coefficients were calculated for several representative contaminant compounds (Table 6-2) based on total organic carbon (TOC) concentrations for aquifer soils obtained during Phase II drilling and from the compound specific organic carbon partitioning coefficient $K_{oc}$, (U.S. EPA, 1986).

Retardation factors were calculated based on the calculated $K_d$ values, the aquifer porosity (n) and an assumed bulk density ($P_b$) of 1.9 $gm/cm^3$. Values representative of upper and lower aquifer soils along the eastern (MW07) and western (MW09) portion of the Site are summarized in Table 6-2.

Since the $K_d$ for a compound is a function of the organic carbon content of the sorbing media, the absorption of organic chemicals in the aquifer and thus, transport retardation is strongly correlated to the organic carbon content (TOC) of the aquifer soils.

Samples for TOC analysis were collected from two locations each (MW07 and MW09) in the upper and lower aquifers and the confining layer. TOC values were highest in the confining layer at both MW07 (>16,000 mg/kg or 1.6%) and MW09 (12,000 mg/kg or 1.2%). Table 6-2 shows a wide range in the retardation factors for potential migration of various compounds across the confining layer. Retardation factors ranged from 1.26 (acetone) to 62,693 (PCBs) for the confining layer at MW07 and 1.15 (acetone) to 36,955 (PCBs) at MW09.

Calculated vertical seepage rates across the confining layer range from 0.24 ft/yr at MW07 to 0.46 ft/yr at MW10 (Table 4-7). Theoretical transport velocities for the upper aquifer organic contaminants can be calculated using the calculated range of vertical seepage rates and retardation factors, in the following relation:

$$C_V = V_S/R_F$$

Where:

$C_V$ = transport velocity (ft/yr)
$V_S$ = vertical seepage rate (ft/yr)
$R_F$ = retardation factor (dimensionless)

Theoretical transport velocities across the confining layer range from 0 ft/yr (essentially immobile) for PCBs across the entire Site, to 0.399 ft/yr for acetone in the vicinity of

MW09, assuming a seepage rate of 0.46 ft/yr (Table 4-3). Therefore, assuming the thickness of clay beneath areas of contaminated groundwater in the upper aquifer to range from 6 ft to 15 ft (see Figure 4-9), potential acetone migration across the confining layer would take approximately 15 to 37 years. Given the capacity of the confining layer to attenuate the migration of organic contaminants, it is not surprising that substantial contamination of the lower aquifer has not occurred.

Percent TOC in the upper aquifer soils at MW07 (1.4%) is nearly the same as in the confining layer. In fact, due to the higher effective porosity (0.287) in this area compared to the confining layer (0.257), calculated retardation factors in this area are slightly higher than in the confining layer. Percent TOC in the upper aquifer soils at MW09 (0.29%) results in considerably lower calculated retardation factors in this area (see Table 6-2).

Using the horizontal seepage velocities shown in Table 4-5, theoretical contaminant transport velocities were calculated along the five upper aquifer groundwater flow paths shown in Figure 4-19. Calculated retardation factors, based on upper aquifer soils at MW07 were used to generate theoretical transport velocities along Flow Path #5. Calculations along the remaining flow paths were based on upper aquifer soils at MW09.

Table 6-4 shows potential acetone migration ranging from approximately 19 ft/yr along Flow Path #3 to 128 ft/yr along Flow Path #2. However, acetone was not as prevalent in waste and groundwater samples as BETX, chlorinated ethenes and chlorinated ethanes. (see Section 5).

Benzene is the most mobile of the BETX compounds (see Table 6-4). Transport velocities for benzene range from approximately 7 ft/yr along Flow Path #5 to 54 ft/yr along Flow Path #2. Based on these transport velocities, it would take approximately 25 to 190 years for benzene to migrate one-quarter mile downgradient, assuming adsorption is the only attenuation mechanism. Ethylbenzene, toluene and xylene transport velocities are less than half those of benzene. This is likely a contributing factor to the higher occurrence of benzene in downgradient groundwater samples, as opposed to other BETX constituents.

1,1-Dichloroethene is the most mobile constituent of the chlorinated ethene group. Transport velocities for this compound range from 13 ft/yr along Flow Path #3 to 88 ft/yr along Flow Path #2. The least mobile constituent of the group is tetrachloroethene. Velocities for this compound range from 1.7 ft/yr along Flow Path #5 to 18 ft/yr along Flow Path #2. 1,1-Dichloroethene was the most widely detected of the chlorinated ethenes (see Section 5.5) which is consistent with its relative mobility. However, the chlorinated ethenes as a group were considerably less widespread than either the BETXs or chloroethane, which ,may suggest other mechanisms (e.g., biodegradation) as the primary attenuating factor for this group.

Chloroethane was the predominant chlorinated ethane detected in the upper aquifer. 1,1-Dichoroethane was also detected, but considerably less frequently (see Section 5.5). The calculated transport velocity for 1,1-dichloroethane ranges from 16 ft/yr along Flow Path #3 to 107 ft/yr along Flow Path #2, which is more than two times those for chloroethane; 5 ft/yr (Flow Path #5) to 44 ft/yr (Flow Path #2).

TOC in the lower aquifer soil was 0.31% at MW09, and 0.69% at MW07. Retardation factors for chloroethane and bis(2-chloroethyl)ether are calculated for both TOC values and are shown in Table 6-5. Since the lower aquifer detects were in the vicinity of MW09 only (see Section 5.5), theoretical contaminant transport velocities for the lower aquifer are based upon the soils at this well only.

The calculated horizontal seepage rate in the lower aquifer is 73 ft/yr (Figure 4-21). Using the equation above, the theoretical transport velocity for chloroethane in the lower aquifer was calculated as 22.3 ft/yr compared to 57.3 ft/yr for bis(2-chloroethyl)ether. Based on the above values, it would take approximately 60 years for chloroethane and 23 years for bis(2-chloroethyl)ether to migrate one-quarter mile downgradient. These estimated migration times assume no other attenuating mechanisms.

<u>Degradation.</u> Biodegradation may be an important environmental fate under the proper conditions. A number of laboratory investigations have demonstrated that

microbially mediated reductive dechlorination of chlorinated alkanes and chlorinated alkenes takes place in environments representative of groundwater systems (Bouwer and McCarty 1983, 1983a, Parsons et al, 1987, 1987a). Potential transformation pathways of chlorinated aliphatic hydrocarbons are shown in Figure 6-1 (from Davis and Olsen, 1990).

In general, the references suggest that chlorinated parent compounds, such as tetrachloroethene, trichloroethene and 1,1,1-trichloroethane, can be converted sequentially through loss of a chlorine atom to tri-, di-, or mono-chlorinated species by reductive dechlorination. This type of reaction appears to be microbially mediated. The reactions are favored under anaerobic or anoxic conditions. Substantial degradation may take place, especially if a non-halogenated carbon source is present to support normal bacteriological metabolism.

Soil and groundwater samples from the waste burial areas indicate relatively high concentrations of chlorinated ethenes and ethanes in association with non-halogenated wastes (BETX, ketones, etc.) (see Section 5).

Evidence of anaerobic or anoxic conditions may include low oxidation-reduction potential (pE), and a predominance of reduced nitrogen and sulfur species.

The measurement of representative pE in groundwater samples is difficult due to exposure to atmospheric oxygen. Even though samples collected at the Site for pE measurements were analyzed immediately following collection, and exposure to air was minimized, dissolved oxygen (DO) levels would result in slightly higher than actual pE values (Appendix K). Even so, the pE levels measured in samples from the upper aquifer wells located immediately downgradient of the waste areas (MW02, MW03, MW04, MW05, MW06 and MW16) were low, ranging from -91 mV to -25 mV, and are indicative of anoxic conditions in at least some portions of the upper aquifer.

Evidence of reductive dechlorination at the Site is apparent. Chlorinated ethenes and chlorinated ethanes are present with a non-halogenated carbon source (BETX, ketones, etc.) under anoxic conditions. While high concentrations of trichloroethene and trichloroethanes were detected in the waste areas, chloroethane, a probable degradation product (see Figure 6-1) was the predominant chlorinated constituent in the downgradient groundwater (see Figure 5-11).

The biodegradation of BETXs has also been documented (Barker and Patrick, 1987; Borden et al., 1986), however these investigations show oxygen is the primary electron acceptor. Therefore, these compounds appear to degrade more readily under aerobic conditions (Bouwer and McCarty, 1981). Aerobic degradation of BETX, likely is significant in the vadose and at the water table. In addition periodic fluctuations in groundwater levels would facilitate oxygenation of the upper aquifer. Evidence of anoxic conditions in groundwater immediately adjacent to the Site, however, may in part be responsible for the predominance of BETX in the upper aquifer (see Section 5.5). As dissolved oxygen concentrations increase further downgradient of the Site, natural aerobic biodegradation may be the major mechanism for BETX mass decrease.

### 6.2.2 Inorganic Contaminants

The fate and transport of inorganic species are dependent on the geological and chemical attenuation mechanisms acting within a specific environment. In general, chemical attenuation mechanisms are more important for the majority of the inorganic chemical species identified within the saturated zone at the Site. Therefore, biological attenuation mechanisms are not included within this discussion. Chemical attenuation of inorganic species consist of two primary mechanisms: precipitation/dissolution and sorption/desorption.

Precipitation. Precipitation of a mineral phase is generally controlled by solubility. Therefore, the thermodynamic behavior of various species may be used to predict the most stable phase that will form in a geologic environment. However, the thermochemical behavior of numerous trace elements (Pb, Cd, Ni, etc.) are not

adequately described within the literature, therefore, the evidence for the existence of solubility-controlling solid phases is often indirect, such as comparison of ion activity products to solubility products. Observed and speculated solid/mineral phases which may control the aqueous concentrations of selected metals are shown in Table 6-7. Hydroxide and carbonate solids are less soluble at neutral to high pH values. Therefore, these phases are important in most natural geologic materials (pH $\geq$ 7.0).

With the exception of MW13 and MW15, the observed pH of groundwater over most of the upper aquifer ranges from 6.33 to 6.97 S.U., therefore, hydroxide and carbonate precipitates would appear to be marginally favored. On the other hand, observed pH in the lower aquifer ranged from 7.04 to 7.80 S.U., here the formation of hydroxide or carbonate precipitates may be an important attenuating mechanism.

Formation of iron containing solids [e.g., $FeMoO_4$, $NiFe_2O_4$, $Fe_2$ $(SEO_3)_3$] may be a significant chemical attenuation mechanism for both cationic (e.g., Cr, Ni, Zn) and anionic (As, Cr, Mo, Se, V) species (Battelle, 1984).

Evidence of low redox potential (pE) in the upper aquifer (Appendix K) are indicative of reducing conditions. Under these conditions, the precipitation of sulfides (e.g., NiS, PbS) is expected to be an important chemical attenuation mechanism (Battelle, 1984).

Sorption/Desorption. Sorption/desorption reactions are dependent on the geologic matrix, the hydrochemical environment as well as the specific valence state and ionic radius of the adsorbed element. Important adsorbent media include the following:

- hydrous oxides of Al, Fe and Mn;
- amorphous aluminosilicates;
- organic matter; and
- lattice silicates or clay minerals;

Hydrochemical conditions influence adsorption by: 1) controlling ion speciation, 2) providing ions that compete for adsorption sites, and 3) affecting the net surface charge on amphoteric adsorbents (e.g., Fe and Mn oxides, amorphous aluminosilicates) and affecting base saturation and exchangeable acidity of cation exchange materials. Element speciation is controlled primarily by solution pH, pE and ion composition. Research indicates that for the most part, only uncomplexed ions, rather than complexed ions are adsorbed. Thus, hydrochemical conditions which favor complexation may reduce adsorption. Similarly, solution redox potential controls the valence of redox sensitive elements. For some elements (e.g., Cr) different valence states exhibit markedly different adsorption behavior. Most specific adsorbents (e.g., Fe, Mn oxides, amorphous aluminosilicates) have a pH-dependent surface charge. These constituents are positively charged at pH values below their point of zero charge (PZC), and negatively charged above. Thus, decreasing groundwater pH increases positive charge and factors anion retention, while increasing pH encourages cation adsorption.

The cationic elements are sorbed specifically and by ion exchange. Ion exchange dominates when the specific sorption capacity is exceeded. The affinity of specifically adsorbed cations for hydrous oxides decreases in the following order: Pb > Cu > Zn > Ni $\geq$ Cd. Some cationic elements, notably Cu and Hg, are strongly complexed by particulate organic materials. The sorption of most cationic elements increases with an increase in pH. Thus, the cations are significantly more mobile under acidic than basic conditions (Battelle, 1984).

Ligands (e.g., C1-, $SO_4^{2-}$, F- and organics) that form stable aqueous complexes with cations (e.g., $Pb^{2+}$, $Cu^{2+}$, $Ni^{2+}$, $Hg^{2+}$) reduce free cation activity and hence elemental adsorption. The presence of macro ions (e.g., $Ca^{2+}$, $Na^{+}$) and specifically absorbing ions (e.g., Cu, Zn, Cd) in solution also tend to reduce absorption through competition for cation exchange sites and specific adsorption sites, respectively.

Though considerable descriptive and qualitative information is available for some elements, it is not possible to quantitatively predict sorption behavior based upon mineralogy and groundwater composition.

While quantitative predictions on the fate and transport of inorganic constituents is difficult, the following hydrochemical conditions were observed based on Round 2 monitoring well sample results.

The major cation (calcium, magnesium, sodium and potassium) and anion (chloride, sulfate and carbonates) results from the Round 2 groundwater samples were plotted on trilinear diagrams.

Figure 6-2 shows a trilinear plot of groundwater composition from the lower aquifer monitoring wells. Calcium is the dominant cation and carbonates are major anions at these well locations. Generally, MW09 and MW10, along the western portion of the Site, are slightly higher in dissolved solids. Chlorides also comprise a greater percentage of the total anion concentration at MW09 and MW10, replacing sulfate as the secondary anion.

Figure 6-3 shows a trilinear plot of groundwater composition from the upper aquifer monitoring wells. As with the lower aquifer, calcium and carbonates are the dominant cation and anions respectively at most wells. Sodium is the dominant cation in the sample from MW05 while the sodium + potassium is dominant in MW15. Higher sodium concentrations at MW04, MW06 and MW18 result in no dominant cation species at these well locations. Chloride is the dominate anion or elevated at these wells. The highest dissolved inorganic concentrations were detected at MW16, chloride and bicarbonate were the highest at this well location, however, the dominant cation is calcium. The observed pH (6.33 S.U.) at this well was the lowest recorded at the Site, indicating slightly acidic conditions and possibly dissolution of aquifer soils (e.g., $CaCO_3$).

## 6.3 Surface water and Sediments

Contamination of surface water and sediment occurs primarily through overland transport of contaminated soils through erosion and/or discharge of contaminated groundwater.

Erosion. The movement of soil by water is dependent upon several factors, including the nature of erosive factors (rainfall amounts and intensities, snowmelt), physical

properties of the soil (degree of compaction, soil structure and infiltration rates), and surface conditions (vegetative cover, slope surface and surface roughness).

The majority of wastes at the Site were buried and therefore are not currently subject to surface erosion. However, two areas of surface soil contamination were identified during the RI; the former incinerator area located in the ACS facility; and the Kapica/Pazmey Area (see Figure 1-2).

Surface topography, vegetative cover and soil composition vary between these two locations. The former incinerator area is covered in gravel, as is most of the ACS facility. While runoff from the gravel may occur in areas of compaction, slope within the facility is relatively flat and potential for erosion of gravel and contaminated soil would be low. When runoff does occur, it likely follows the facility drainage system toward the ACS Firepond.

Surface soils in the vicinity of the Kapica/Pazmey Area are mostly vegetated. Topography in this area generally slopes to the north and west toward the low area between Off-Site Containment Area and the Griffith Municipal Landfill. Surface water and sediment samples (SW05 and SD05) collected in this low area generally contained the highest concentrations of contaminants detected. This would indicate runoff has or continues to occur in this area.

Discharge of contaminated groundwater to the surface wetlands may occur along western portions of the Site. Two predominant zones of upper aquifer contamination were identified during the RI west of the ACS facility and west of the Off-Site Containment Area (see Section 5.5). BETXs and chloroethane were the predominant contaminants detected (Figures 5-10 and 5-11).

BETXs and chloroethane (and to a lesser extent ketones) were detected in hydraulically connected downgradient (west) sediment and surface water samples (see Section 5.3.2). Discharge of contaminated groundwater may be a contributing factor to contamination in these areas.

## 6.4 Air

Volatization. Volatization may be a significant process resulting in the loss of contaminants from soils (Thibodeaux, 1979; Lyman and Reehl, 1981; Swallow and Gschwend, 1983). Volatization depends on several Site factors, including soil porosity and moisture content, surface wind speed, temperature, nature of the surface (e.g., hard packed, vegetative cover, paved, tilled, etc.), and contaminant properties, including Henry's Law constant and diffusivity. The process of volatization involves several steps, including desorption from soils, diffusion in water, interphase mass transfer, and diffusion in air.

Volatization is an important process in unsaturated soils, because in addition to the water and solid phases there is an air phase present. The air phase provides a connection to the atmosphere, which acts as a pathway for gaseous phase diffusion of VOCs through the unsaturated zone. A volatile solute will tend to partition between water and air phases, or between solid and air phases. The former equilibrium situation is defined by Henry's Law constant (Table 6-1). The latter situation would be described by an air/solid partition coefficient. However, little published information is available to allow estimation of such a coefficient. In the current situation, it is reasonable to assume that soil moisture sufficient to maintain a thin water film will remain most of the time. Therefore, the air/solid equilibrium is neglected and Henry's Law is used to describe the air/water solute distribution.

The substances with relatively high Henry's Law constants (Table 6-1) readily partition into the air phase so that relatively higher volatization losses from both the unsaturated zone and the water table will be observed for these substances.

Based on the relatively high Henry's Law constants presented in Table 6-1, it is apparent that volatization may be a significant fate for the chlorinated ethenes and ethanes, BETX and most other TCL volatile compounds contained within the unsaturated zone.

# SECTION 8
# SUMMARY AND CONCLUSIONS

A Remedial Investigation has been conducted at the American Chemical Service NPL Site in Griffith, Indiana, to define the Site conditions, including the extent of releases from the Site and to document the character of the source materials. This RI report has been generated for use in assessing the potential effects to public health and the environment, and to support the development and evaluation of viable remedial alternatives in the Feasibility Study.

The investigation was conducted in accordance with applicable U.S. EPA guidance. Three phases of investigation were completed.

## 8.1 SITE BACKGROUND

The American Chemical Services (ACS) NPL Site (Site) is located at 420 South Colfax Avenue in Griffith, Indiana. Although the Site name is ACS, the United States Environmental Protection Agency (U.S. EPA) has defined the Site as including the ACS property (19 acres) the Pazmey Corporation property (2 acres; formerly Kapica Drum, Inc.) and the inactive portion of the Griffith Municipal Landfill (about 15 acres).

Six areas of probable waste disposal were identified at the Site, based on preliminary reports and the review of aerial photographs. These six areas were assigned the following designations by U.S. EPA and ACS management: the On-Site Containment Area, the Still Bottoms Area, Treatment Lagoon #1, the Off-Site Containment Area, the Kapica/Pazmey Area, and the Griffith Municipal Landfill.

ACS began operations as a solvent recovery facility in May 1955, and according to ACS personnel, solvent reclamation was the only operation performed on-Site until the late 1960s. Solvent recovery remained the principal operation at ACS throughout its history. Small batches of specialty chemicals were first manufactured at ACS in the late 1960's and early 1970's. These early manufacturing operations included treating rope with a fungicide, bromination, and treating ski cable.

ACS installed its first incinerator in 1966, and a second in 1969. The incinerators were used to burn still bottoms and non-reclaimable materials generated at the Site, and off-Site wastes. The incinerators were removed from the Site in 1970, when their operation was discontinued.

Between 1970 and 1975, the batch manufacturing processes were expanded. A lard oil process which utilized tallow and animal rendering was used to manufacture a lubricant product. In 1971, an additive manufacturing area was built. Various detergents, lubricants, and chemical additives were manufactured, in addition to soldering flux. An epoxidation plant was constructed in 1974. The epoxidation process creates a plasticizer.

The ACS facility ceased to perform solvent recycling in September, 1990. Until that time it operated under RCRA interim status. A closure plan has been prepared for the final closure of the Site. The nature and extent of actions required of the owner and operator in respect the RCRA closure has not been finally determined.

The Griffith Municipal Landfill has been an active solid waste disposal facility since the 1950's. Kapica Drum, Inc. began operations in 1951. Operations at Kapica Drum, Inc. consisted of drum reconditioning. Kapica Drum was sold to Pazmey Corporation in February 1980. The Pazmey Corporation property was sold to Darija Djurovic in March 1987.

Still bottoms from the solvent recovery process were originally disposed of in the Still Bottoms Pond and Treatment Lagoon #1. The Still Bottoms Pond and Treatment Lagoon #1 were taken out of service in 1972. At this time, these two areas were drained and filled in with drums partially full of sludge materials.

Between 1958 and 1975, the Off-Site Containment Area was utilized as a waste disposal area. A variety of wastes were disposed of in this area, including the still bottoms from the Still Bottoms Pond and Treatment Lagoon #1. Between 1968 and 1970, wastes from on-Site incinerators were disposed of in this area. General refuse, drums, and a tank truck partially full of solidified paint were also repeatedly disposed of in the Off-Site

Containment Area. It has been reported that the drums were punctured prior to disposal. Use of the Off-Site Containment Area was discontinued in 1972, and the area was reportedly capped with 2 to 3 feet of soil.

During the mid-1960's, landfilling of drums was performed in the On-Site Containment Area. Approximately 400 drums containing sludge and semi-solids of unknown types were reportedly disposed of in the On-Site Containment Area. The incinerators operated between about 1966 or 1968 and 1970, during which time they reportedly were used to burn approximately 2 million gallons of on-Site and off-Site waste annually.

## 8.2 PHYSICAL SETTING

The ACS Site is located in northwestern Indiana within the Calumet Lacustrine Plain, a subdivision of the Northern Moraine and Lake Region (Hartke, et al., 1975). A variety of unconsolidated materials are found within the limits of the Calumet Lacustrine Plain. These materials include fine lake silts and clays, paludal muck and peat, beach and dune sands, sand and gravel outwash, and glacial tills.

The glacial deposits in the immediate Site vicinity are approximately 130 feet thick. These deposits have been subdivided into four units: an upper sand and gravel unit, an intermediate clay unit, a lower sand and gravel unit, and a lower clay till unit which directly overlies bedrock. The uppermost bedrock in the Site vicinity consists of the Devonian Detroit River and Traverse Formations, composed of limestone with some karst (CDM, 3/26/85).

Three geologic units have been identified within the glacial deposits at the ACS Site. These units are: an upper sand and gravel unit, an intermediate silty clay unit, and a lower sand and gravel unit. The Upper Sand and Gravel Unit at the Site generally consists of a brown to dark gray, fine to coarse sand with trace to little fine to coarse gravel, trace clay, and trace silt. In the Site monitoring wells, the Upper Sand and Gravel Unit ranged in thickness from about 13 to 32 feet, with an average thickness of about 17 feet.

The clay layer found underlying the Upper Sand and Gravel Unit at the Site has been classified as a gray silty to lean clay with trace to some fine to medium sand and trace fine to coarse gravel. The silty clay layer was found to range in thickness from an estimated minimum of 2.5 feet at boring CB-1 to a maximum thickness of 18.1 feet at monitoring well MW-7.

The Lower Sand and Gravel Unit at the Site consists of a brown to dark gray fine to coarse sand with trace to some gravel and trace silt and pebbles. The full thickness of this unit was not penetrated in any of the borings performed for the RI. However, the driller's log for an on-Site water supply well indicates that this unit extends to bedrock at the Site. Bedrock was not encountered in any of the borings performed for the Remedial Investigation.

Regional information suggests that the ACS Site is located on a surface water divide. To the north, the runoff flows into Lake Michigan; runoff from the other directions flows into tributaries of the Mississippi River. Site data indicate that the ACS Site lies entirely within the southern drainage basin.

The U.S. Geological Survey topographic map of the region indicates that the local surface drainage is from the north to the southwest. The elevation of the ground surface is greater than 635 feet north of the Site, and slopes generally down to 630 feet west and south of the Site. The natural drainage appears to have been into a wetland located a mile south of the Site. Turkey Creek, which flows west to east approximately one mile south of the Site, is adjacent to the southern border of the wetland and may provide some drainage of the wetland. There appears to be no direct surface water connection between the Site and local streams or lakes. However, groundwater does discharge to the wetlands south of the Site, and those wetlands are drained by Turkey Creek one half to a mile further to the south.

Data collected for this investigation also indicates that surface water runoff is toward the west and south. Determination of surface water runoff patterns is based on measurements at ten staff gages placed across the Site. Surface water flows past the Site

from north to south. A drainage ditch flows into the Site at the northern boundary directly north of the western ACS fence line, flows west along the northern Site boundary and into the drainage ditch cut north to south through the marsh west of the Site. In the current Site configuration, there is no surface water runoff from the Site as a whole. All surface water runoff is contained within the Site boundaries in the form of internal drainage or infiltration.

Three hydrostratigraphic units have been identified in the glacial deposits in the Site vicinity. These units include, in descending order, an uppermost aquifer (Calumet Aquifer), a clay confining layer and a lower aquifer (Valparaiso Aquifer). The uppermost aquifer in the Site area is the Calumet Aquifer. Based on regional information (Hartke, et al., 1975), this aquifer is composed of sand and gravel, ranges in thickness from 5 to 75 feet and exhibits an average thickness of about 20 feet. Regional flow in the calumet aquifer is to the north or to streams or drainageways which intersect the aquifer. Beneath the Calumet Aquifer is a clay till. The clay till is absent in some areas, and ranges in thickness to about 50 feet in others. The borings made during the RI indicate that the clay is continuous beneath the entire ACS Site. The till is regarded as an aquitard, separating the shallow Calumet Aquifer from the underlying Valparaiso Aquifer.

The lower aquifer in the Site area is the Valparaiso Aquifer. The Valparaiso Aquifer is composed of sand and gravel, and, ranges from about 10 to about 90 feet in thickness, (based on regional information (Hartke et al., 1975)). Water well logs indicate that the lower aquifer may be in excess of 50 feet thick in the Site vicinity. Regional flow in the lower aquifer is to the north beneath the Site. The majority of the private wells in the immediate Site vicinity draw water from the lower aquifer.

Limestones, dolomites, and shales of Silurian and Devonian age compose the shallow bedrock aquifer in the Site area. Private well logs indicate that the shallow bedrock aquifer is encountered at a depth of about 130 feet at the Site.

Monitoring wells, piezometers, leachate headwells, and surface water staff gages were installed at the ACS Site to investigate the hydrogeologic setting.

Upper Aquifer. Grain size analysis performed on upper aquifer samples indicated that the samples were more than 80 percent sand, with the exception of one sample from MW-5 which consisted of 43 percent gravel. Little gravel was found in the other samples, and only trace amounts of clay and silt.

In-situ hydraulic conductivity (permeability) tests were conducted at monitoring wells constructed for this investigation. Average permeability values (K) calculated for the upper aquifer material are:

Geometric Mean: $K = 7.9 \times 10^{-3}$ ft/min
$4.0 \times 10^{-3}$ cm/sec

Two distinct ranges of permeability are evident when the data from the in-situ hydraulic conductivity testing is plotted on a site base map. The permeability appears to be significantly greater along the eastern part of the Site than in the monitoring wells along the western part. Based on the in-situ aquifer tests, the average values for the permeability in the upper aquifer on the east and west side are as follows:

East side Mean: $K = 1.5 \times 10^{-2}$ ft/min
$7.6 \times 10^{-3}$ cm/sec

West side Mean: $K = 2.9 \times 10^{-3}$ ft/min
$1.5 \times 10^{-3}$ cm/sec

Water level measurements were made on numerous occasions during the course of the remedial investigation and potentiometric maps were produced for each set of data. The maps are included in the appendices. There are four primary hydraulic controls in the upper aquifer flow pattern which are superimposed to create the observed potentiometric surface: 1) the regional gradient; 2) discharge to drainage ditches; 3) de-watering activities at the landfill; and 4), recharge which occurs primarily at the cleared and filled areas. A fifth minor control, is a ditch which extends northward from staff gage SG-1 for several hundred feet and discharges into a marshy area having an elevation below 630 feet.

In all the watertable maps for this investigation, the fire pond has consistently exhibited the highest water elevation, and the potentiometric contour lines decline with distance from the pond. This pattern indicates that the primary groundwater flow at the Site is radially outward from the fire pond. There are minor seasonal differences in the flow pattern. However, a similar radial pattern is observed, both during the wet season and during the dry season. It appears that the groundwater flow in the upper aquifer is contained in the vicinity of the Site. The primary area of discharge for the upper aquifer is to the de-watering areas at the Griffith Municipal landfill.

Calculations of groundwater seepage velocity in the upper aquifer indicate that groundwater flow rates at the Site vary from about 20 feet/year to about 250 feet/year in the upper aquifer.

Lower Aquifer. Eight monitoring wells have been installed in the lower aquifer at the ACS Site. Groundwater elevations measured in these wells on three occasions illustrate a consistent north trending gradient. In situ hydraulic conductivity (permeability) tests were conducted at four lower aquifer monitoring wells. The permeability (K) values of the lower aquifer material ranged from $4.2 \times 10^{-2}$ ft/min at MW-9 to $4.6 \times 10^{-3}$ ft/min at MW-7 and MW-10, with a geometric mean value of $K = 4.4 \times 10^{-2}$ ft/min ($3.2 \times 10^{-2}$ cm/sec). Using this mean conductivity value and the hydraulic gradient of 0.00063, a groundwater seepage velocity of 73 ft/year was calculated for the lower aquifer.

Differences in groundwater elevation between the upper and lower aquifer of 9 to 13 feet were measured in the Site monitoring wells. Downward vertical gradients were calculated between the upper and lower aquifer across the clay confining layer. These calculations assume that head loss occurs only across the thickness of the clay. The vertical gradients calculated vary from 0.71 to 1.43, with an average downward gradient of approximately 1.

Estimates of potential vertical leakage across the clay confining layer were calculated using a hydraulic conductivity value of $4.8 \times 10^{-8}$ cm/sec, the vertical gradient for each lower monitoring well location, and an effective porosity of 0.15. With these

assumptions, it was calculated that the vertical seepage rate for groundwater between the upper and lower aquifer is between 0.24 ft/yr at MW-7 to 0.46 ft/yr at MW-10, where the clay layer is thinner. This represents the potential seepage rate for water through the clay. The calculation of a potential seepage rate for water through the clay may overstate the actual seepage and explain the lesser and slower migration of contaminants from the sources than hypothesized by calculations. Migration of contaminants has been inhibited by many other factors as demonstrated by the absence in the lower aquifer of most contaminants found at sources on the site.

## 8.3 NATURE AND EXTENT OF CONTAMINATION IN SOILS

The data which were used to define the characteristics and extent of contaminated zones were collected in three phases and a Supplemental Technical Investigation (STI) during the course of the RI. Data was collected through the installation of 24 monitoring wells, 41 piezometers, 10 staff gages, 5 leachate wells, 3 soil area samples, 83 auger probes, 73 soil borings, 2 test pits, 5 surface water samples, 11 sediment samples, and 10 private well samples.

During the three phases of the RI, sampling was conducted in the following media: soil/waste, groundwater, surface water, and sediment. Samples from the various media were analyzed for U.S. EPA Target Compound List (TCL) organics and Target Analyte List (TAL) metals and cyanide. Groundwater, surface water and private well samples were also analyzed for water quality indicator parameters.

Due to the relatively large number of waste constituents detected at the Site, compounds were grouped together, where appropriate, to assist in evaluating contaminant distribution. The specific compound groupings which were used are discussed below:

- BETX Compounds - Partially water soluble products from gasoline, oil and/or hydrocarbon products (i.e., benzene, ethyl benzene, toluene, xylene);

- Total Chlorinated Benzenes - Used as solvents and reagents from a variety of chemical manufacturing processes. Compounds in this group include chlorobenzene, hexachlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, and 1,2,4-trichlorobenzene;

- Total Chlorinated Ethenes - Chlorinated ethenes, including tetrachloroethene (PCE), trichloroethene (TCE), dichloroethene (DCE) and vinyl chloride. These compounds represent a potential degradation sequence, and are common industrial compounds;

- Total Chlorinated Ethanes - Chlorinated ethanes, including 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, 1,1,1-trichloroethane, 1,2-dichloroethane, 1,1-dichloroethane, and chloroethane. These compounds represent a potential degradation sequence and are common industrial solvents;

- Ketones - Compounds found in resins, paint removers, cement adhesives and cleaning fluids (e.g., acetone, 2-butanone, 2-hexanone, 4-methyl-2-pentanone, isophorone);

- Plasticizers - Compounds associated with plastics and plastic making processes (e.g., phthalates);

- PCBs - Mixtures of chlorinated biphenyls identified as Aroclors, formerly used extensively in industrial applications.

- Polycyclic Aromatic Hydrocarbons (PAH) - A group of compounds associated with and derived from coal and oil, and the incomplete combustion of carbonaceous materials;

- Phenols - A group of chemicals of similar composition used in adhesives, epoxies, plastics and a variety of synthetic fibers and dyes. Compounds in the group include chlorinated, methylated, and nitrified phenols. Benzoic acid is also included with the phenols, because it may be a degradation product of the phenols.

Three general source areas were identified from the Phase I data: the On-Site Containment Area, the Still Bottoms/Treatment Lagoon and adjacent areas, and the Off-Site Containment Area and Kapica/Pazmey Area.

While the concentrations and distribution of the organic contaminant groupings varied between and within the three source areas, the organic compounds present were generally the same, with the exception of the PCBs. For example, while the BETX group

generally represented the highest concentration of organic contaminants in the waste areas, elevated concentrations of BETX were closely correlated to elevated concentrations of chlorinated ethenes, chlorinated ethanes, etc. However, correlation between BETX and PCBs did not exist.

Therefore, for the purpose of describing the nature and extent of organic contaminants with respect to remediation, two categories of organic contaminants were developed: organic contaminants without PCBs; and organic contaminants with PCBs.

The metals data from the Phase I waste samples were evaluated in the context of the U.S. EPA Publication, Trace Chemical Element Content of Natural Soils (1983). Of the twelve metals detected in excess of the U.S. EPA "common range", total chromium and lead were the most prevalent. As shown in Figure 5-5 in the RI Report, a logarithmic plot of Phase I lead concentrations versus total chromium concentrations indicate a strong correlation in the occurrence of these two elements. Therefore, lead concentrations were selected as an indicator of TAL metals distribution in the source areas.

The phases of investigation performed after Phase I were designed to delineate vertical and horizontal extent of contamination in the source areas. The contamination encountered in each area is discussed in detail in Section 5 of the RI Report. A brief discussion of each area is presented below.

Leachate samples were collected during Phase I from the Griffith Municipal Landfill, at leachate wells LW01 through LW04. The TCL organics and tentatively identified compounds (TICs) detected in the leachate samples tended to be highest in samples from LW03 and LW04 located in the newer area of the landfill, where active biochemical decomposition of the refuse is apparently greater. The six organic groupings detected in the leachate well samples included BETX, Chlorinated benzenes, Ketones, Phthalates, PAHs, and Phenols.

Concentration ranges for each organic contaminant grouping detected in the leachate well samples were as follows:

| | |
|---|---|
| • BETX | 2.0 ug/L (LW02) to 244 ug/L (LW04) |
| • Chlorinated benzenes | 8.0 ug/L (LW03) to 53 ug/L (LW04) |
| • Ketones | 251 ug/L (LW04) to 1740 ug/L (LW03) |
| • Phthalates | 5.0 ug/L (LW04) to 42 ug/L (LW03) |
| • PAHs | 3.0 ug/L (LW04) to 43 ug/L (LW03) |
| • Phenols | 7.0 ug/L (LW01) to 831 ug/L (LW03) |

Typically landfill leachates have a high inorganic component due to the breakdown of the waste material. Concentrations of most TAL metals, including cyanide, in leachate samples from the Griffith Municipal Landfill were highest at LW02.

Seven general sediment areas were sampled and analyzed for TCL organics and TAL inorganics. The following briefly summarizes the analytical results in each of the seven general sediment sampling areas:

- ACS facility - Four of the nine organic contaminant groups were detected in SD01 and SD02. Phthalates and PCBs were detected in both samples at somewhat elevated levels, BETX and total phenols were detected in SD02 at relatively low concentrations. Lead levels at SD02 appeared slightly elevated.

- Wetlands north and west of ACS - Eight of the nine contaminant groups were detected in one or more of the six samples representing sediments in this area. With the exception of PCBs and phthalates at SD16, and total PAHs at SD10, most concentrations were relatively low. Lead and chromium levels were also somewhat elevated at SD16.

- Drainage ditch west of ACS - Three contaminant groups were detected in the two samples from this area. Total PAHs and phthalates were detected at low to moderate concentration in both SD07A and SD07B, total phenols were detected in SD07B only.

- Drainage ditch north of Landfill - Phthalates and PCBs were detected in SD07C.

- Wetland west of Landfill - Total phenols, PAHs, phthalates and ketones were detected in one or more samples from this area.

- Wetland east of Landfill - BETX, phenols, PAHs and phthalates were detected in one or both samples from this area.

- Drainage from Off-Site Containment - BETX, phenols, PAHs and phthalates were detected at relatively high concentrations at SD05 immediately west of the Off-Site Containment.

Five surface water samples were collected; two were internal to the Site, and three were on the perimeter of the Site. The following is a summary of the sampling results from each area:

- ACS facility - Trace amounts of 1,2-dichloroethene and 1,1-dichloroethane, both of which were detected in nearby soils were detected in the ACS Fire Pond (SW01). Aroclor 1248 was also reported at the detection limit at both SW01 and SW02, and is likely related to suspended solids in the surface water.

- Drainage from Off-Site Containment - Historical review indicates a ditch was cut between the Off-Site Containment area and the landfill, apparently to drain surface water toward the west. Over the years, sections of the ditch have become filled in so it is no longer a continuous surface water flow route. The surface water samples collected from this ditch (SW05) contained the highest concentrations of VOCs of the surface waters sampled with BETX (508 ug/L) and ketones (574 ug/L), as well as lower levels of chlorinated ethenes and ethanes. All the VOCs detected in SW05 were present in soils from the Off-Site Containment Area and groundwater. No pesticides or PCBs were detected in this sample.

- Ditch west of ACS - SW07A, contained chloroethane at 14 ug/L as the only detected organic target compound.

- Wetlands east of Landfill - SW08 contained toluene at 8 ug/L, and total phenols at 635 ug/L.

A relatively large number of compounds were detected in the waste areas. As was previously discussed, the extent of contaminated waste and soils was evaluated based on the three indicator groupings (total VOCs, total PCBs and lead). Visual observations and HNu readings obtained from subsurface auger probes were also considered in the determination of horizontal and vertical waste extent. The following summarizes the distribution of buried wastes at the Site.

On-Site Containment Area. The On-Site Containment Area is a rectangular shaped area, approximately 250 feet north to south and 450 feet west to east, located in the northern third of the fenced ACS facility. Historical information and subsurface investigations during the RI indicate that drums are buried beneath at least a portion of this area. The buried drums are found in an area approximately 50 feet by 50 feet in size, and appeared to be stacked three high in the test pit excavation. It is possible that the drums represent the major source of potential contaminants in this area.

With the exception of a few localized areas in the western half of the On-Site Containment Area, most of the contaminants are non-PCB containing organic waste.

All nine organic compound groups were detected in the On-Site Containment Area. Generally the highest concentrations were detected in samples from test pit TP02, which showed buried drums. Concentration ranges for the organic compound groups (with the exception of PCBs) in the remaining subsurface soil samples are as follows:

- BEXT — 11 ug/kg to 3,002,000 ug/kg
- Chlorinated Benzenes — 2 ug/kg to 10,790 ug/kg
- Chlorinated Ethenes — 2 ug/kg to 1,110,000 ug/kg
- Chlorinated Ethanes — 1 ug/kg to 11,000 ug/kg
- Ketones — 4 ug/kg to 7,400 ug/kg
- Phthalates — 39 ug/kg to 15,086 ug/kg
- PAHs — 50 ug/kg to 121,338 ug/kg
- Phenols — 93 ug/kg to 2270 ug/kg

PCB contaminated wastes were detected only in the western half of the On-Site Containment Area, and were relatively localized horizontally. Total PCB concentrations in the On-Site Containment Area samples ranged from 130 ug/kg to 26,000 ug/kg.

Elevated metals in the On-Site Containment Area appear to be limited to near surface soils in the western half of the Area.

Still Bottoms/Treatment Lagoon Area. The Still Bottoms Area is an oval area approximately 100 feet in diameter in the central portion of the fenced ACS facility. The Treatment Lagoon Area is an oval area approximately 200 feet by 100 feet located between the ACS Fire Pond and the Still Bottoms Area.

As with the On-Site Containment Area, most of the contaminants detected in the Still Bottoms/Treatment Lagoon are non-PCB containing organics. Localized areas of PCB containing wastes were detected in the Still Bottoms and some metals were detected in both areas.

All nine organic compound groups were detected in the Still Bottoms and Treatment Lagoon Areas, and for the most part, highest concentrations were detected in samples from test pits which encountered buried drums. Concentration ranges for the organic compound groups (with the exception of PCBs) in subsurface soil samples including test pits are as follows:

- BEXT - 66 - 34,670,000 ug/kg
- Chlorinated Benzenes - 45 - 62,500 ug/kg
- Chlorinated Ethenes - 31 - 2,000,000 ug/kg
- Chlorinated Ethanes - 8 - 21,000,000 ug/kg
- Ketones - 55 - 4,100,00 ug/kg
- Phthalates - 456 - 4,694,000 ug/kg
- PAHs - 351 - 1,057,900 ug/kg
- Phenols - 429 - 194,00 ug/kg

PCBs were not detected in the Treatment Lagoon Area. Total PCB concentrations in the Still Bottoms Area samples ranged from 330 ug/kg to 74,000 ug/kg.

Chromium and lead were the primary inorganic constituents detected. Total chromium ranged from 8.7-1410 mg/kg, and lead ranged from 21.9-6300 mg/kg. Antimony, cadmium, copper, magnesium, mercury, selenium, and zinc were also detected.

Area West of Fire Pond. An area of contaminated subsurface soils was discovered west of the existing ACS Fire Pond during the RI. One soil boring, SB20, was conducted in this area, and a sample of the contaminated soil collected.

Concentrations of the organic compound groups for this location were similar to those east of the Fire Pond, with all nine compound groups being detected. Metals concentrations were not elevated in this area.

Former Incinerator Area. The former incinerator area is a square 50 by 50 foot area located along the eastern portion of the fenced ACS facility. Total indicator contaminant concentrations in surface soils (SA03) from the former incinerator location were considerably less than in the waste disposal areas of the fenced ACS facility.

Total VOC concentration in SA03 was 980 ug/kg, with BETX as the only VOC group detected. Total PAHs were detected at 50 ug/kg, and total phthalates at 2600 ug/kg. The remaining organic compound groups, including PCBs, were not detected in SA03. TAL metal concentrations were not elevated at this location.

Off-Site Containment Area. The Off-Site Containment Area is located south of the fenced ACS facility. It is an approximately 300 by 400 foot area formerly used by ACS as a disposal area for drums of waste materials and still-bottom sludges. The greatest volume of wastes detected in this area are non-PCB organics. However, PCBs and metals were detected primarily in one localized area at depth in the northern portion, as well as at a number of small areas in the southern portion of the Off-Site Area.

The following concentration ranges of each organic contaminant group (with the exception of PCBs) were detected in the Off-Site Containment area samples:

- BEXT 17 - 254,500,000 ug/kg
- Chlorinated Benzenes 3 - 1,000,000 ug/kg
- Chlorinated Ethenes 44 - 65,000,000 ug/kg
- Chlorinated Ethanes 8 - 151,330,000 ug/kg
- Ketones 52 - 197,600,000 ug/kg
- Phthalates 54 - 19,136,000 ug/kg
- PAHs 273 - 3,487,700 ug/kg
- Phenols 180 - 1,054,000 ug/kg

PCB concentrations in the soil and wastes in the Off-Site Containment Area are, for the most part, found at concentrations of less than 50 ppm. These levels of PCBs occur in scattered, localized areas at various depths between the Kapica building and a surficial waste seep near the southwest corner of the off-Site area. Actual total PCB concentrations in the Off-Site Containment Area samples ranged from 96 ug/kg to 1,400,000 ug/kg.

The distribution of wastes/soils in the Off-Site Containment potentially contaminated with metals is similar to that of the PCB wastes, but to a lesser extent.

Kapica-Pazmey Area. The Kapica Drum recycling area is located in the far southeastern corner of the Off-Site Containment Area. The Kapica Area was used to recycle and clean drums for the ACS facility, as well as other non related customers. Observations in this area and results of the RI indicate that much of the waste was apparently disposed of directly on the ground surface.

All nine organic contaminant groups are present in the Kapica/Pazmey Area. Concentration ranges of each organic contaminant group with the exception of PCBs were as follows:

| | |
|---|---|
| • BEXT | 1 - 46,300,000 ug/kg |
| • Chlorinated Benzenes | 18 - 27,000 ug/kg |
| • Chlorinated Ethenes | 2 - 960,000 ug/kg |
| • Chlorinated Ethanes | 5 - 1350 ug/kg |
| • Ketones | 2 - 367,000 ug/kg |
| • Phthalates | 177 - 698,100 ug/kg |
| • PAHs | 54 - 157,300 ug/kg |
| • Phenols | 280 - 34,300 ug/kg |

Soils containing PCBs at levels in excess of 1 ppm are found primarily in an area north of the Kapica building. Actual PCB concentrations in the Kapica area ranged from 4,20 ug/kg to 280,000 ug/kg.

Metals contaminated soils in the Kapica area are primarily found to the west and north of the Kapica building.

## 8.4 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

Twenty-four groundwater monitoring wells (MW01 through MW24) were installed during the Site RI. Eight of the 24 monitoring wells (MW07, MW08, MW09, MW10, MW21, MW22, MW23, and MW24) are screened in the lower aquifer. The remaining 16 wells are water table wells.

Upper Aquifer. The occurrence, concentration and distribution of contaminants in the upper aquifer reflects the groundwater flow paths previously described. As groundwater flows from the Fire Pond toward the Griffith Municipal Landfill dewatering pit, some of the relatively soluble, and therefore more mobile, organic constituents associated with source areas are detected downgradient.

As with the buried wastes, the BETX group of organic compounds was widely distributed in the upper aquifer and was present at the highest concentration relative to other contaminants detected in the upper aquifer monitoring well samples. The highest total BETX concentrations were detected at MW03 (106,000 ug/L - Round 2). This well is located downgradient of the On-Site Containment Area under steady state groundwater flow conditions as were present during the second sampling round conducted in May 1990. Benzene, for the most part, was the predominant constituent compound detected within the BETX grouping.

Chlorinated ethanes were as widespread in the upper aquifer samples as the BETX group, however, overall concentrations were generally lower, with the plume centered downgradient of the Off-Site Containment Area.

The highest concentrations of chlorinated ethanes were detected at MW16 (4,000 ug/L - Round 2); at this location the predominant constituent compound was 1,1-dichloroethane (2,400 ug/L, with chloroethane at 1,600 ug/L). MW16 is located immediately downgradient of the Still Bottoms and Off-Site Containment Area. Both of these areas contained elevated concentrations of the heavier chlorinated ethanes.

The remaining organic contaminant groupings were considerably less widespread than the BETX and chlorinated ethanes and, with exception of the ketones, were at considerably lower concentrations.

Ten trace metals were detected in one or more upper aquifer well samples at concentrations at least five times the background well (MW11). Iron and potassium were also detected at concentrations that may be at least partially attributable to ACS wastes or the Griffith Municipal Landfill, rather than aquifer geochemistry. Apparently,

elevated trace metal concentrations occurred most frequently in samples from MW03 and MW04 adjacent to the On-Site Containment Area, and MW06 adjacent to the Off-Site Containment area. Trace metals detected include: arsenic, barium, cadmium, total chromium, manganese, mercury, nickel, potassium, selenium, vanadium, and zinc.

Lower Aquifer. Lower aquifer contamination relative to the upper aquifer is limited, both with respect to nature of compounds detected and the extent. Considerable attenuation of contaminant levels downgradient of the impacted area is apparent.

The only TCL organics detected in lower aquifer monitoring wells were: chloroethane, bis(2-Chloroethyl)ether, and 4-Methyl-2-pentanone. Trace metal concentrations greate than five times background were not detected in the lower aquifer wells. The maximum concentration of chloroethane was 440 ug/L at MW-9. The other lower aquifer wells confirm that the contaminants do not extend off-Site.

Private Wells. Private well sampling was performed at eight locations during Phase II of the RI, and 2 locations during Phase III. TCL volatiles, semivolatiles and pesticide/PCBs were not detected in the private well samples. Trace metals detected in private well samples included barium, cadmium, lead, and zinc. These elements were not elevated in the lower aquifer sample collected at the Site and the latter three may be attributable to the water distribution system.

Groundwater provides a primary migration pathway by which contaminant transport m occur. This section describes the potential behavior of the identified chemical contaminants within the groundwater system. The major reactions affecting chemical transport in groundwater are sorption (adsorption plus absorption) and biodegradation (Olsen and Davis, 1990).

Distribution coefficients were calculated for several representative contaminant compounds (Table 6-2, RI Report) based on total organic carbon (TOC) concentrations for aquifer soils obtained during Phase II drilling and from the compound specific organic carbon partitioning coefficient $K_{OC}$, (U.S. EPA, 1986). Retardation factors were calculated based on the calculated $K_d$ values, the aquifer porosity (n) and bulk density

($P_b$). Values representative of upper and lower aquifer soils along the eastern (MW07) and western (MW09) portion of the Site are summarized in Table 6-2 of the RI Report. Retardation factors ranged from 1.26 (acetone) to 62,693 (PCBs) for the confining layer at MW07 and 1.15 (acetone) to 36,955 (PCBs) at MW09.

Transport velocities for the upper aquifer organic contaminants were calculated using the calculated range of vertical seepage rates and retardation factors. Theoretical transport velocities across the confining layer range from 0 ft/yr (essentially immobile) for PCBs across the entire Site, to 0.399 ft/yr for acetone in the vicinity of MW09, assuming a seepage rate of 0.46 ft/yr. Therefore, assuming the thickness of clay beneath areas of contaminated groundwater in the upper aquifer to range from 6 ft to 15 ft, potential acetone migration across the confining layer would take approximately 15 to 37 years.

Benzene is a good indicator of the groundwater contamination in the upper aquifer. It is the most mobile of the BETX compounds. Transport velocities were calculated for the upper aquifer and values ranged between 7 and 54 feet per year. Moving at these velocities, it would take 25 to 190 years for benzene to migrate one-quarter mile downgradient, assuming adsorption is the only attenuation mechanism.

1,1-Dichloroethene is the most mobile constituent of the chlorinated ethene group. Transport velocities for this compound ranges from 13 to 88 feet per year in the upper aquifer. Transport velocities calculated for tetrachloroethene, the least mobile constituent of the group, ranged from 1.7 to 18 feet per year.

The calculated horizontal seepage rate for water in the lower aquifer is 73 ft/yr. The theoretical transport velocity for chloroethane in the lower aquifer was calculated as 22 feet per year compared to 57 feet per year for bis(2-chloroethyl)ether. Based on the above values, it would take approximately 60 years for chloroethane and 23 years for bis(2-chloroethyl)ether to migrate one-quarter mile downgradient. These estimated migration times assume no other attenuating mechanisms.

Migration of contaminants has not occurred at the rate or rates calculated. Apparently, a combination of factors, indigenous to the Site, have served to retard migration, with the result that the bulk of contaminants of concern remain at source locations.

Evidence of reductive dechlorination at the Site is apparent. Chlorinated ethenes and chlorinated ethanes are present with a non-halogenated carbon source (BETX, ketones, etc.) under anoxic conditions. While high concentrations of trichloroethene and trichloroethanes were detected in the waste areas, chloroethane, a probable degradation product was the predominant chlorinated constituent in the downgradient groundwater.

Contamination of surface water and sediment occurs primarily through overland transport of contaminated soils through erosion and/or discharge of contaminated groundwater. The majority of wastes at the Site were buried and therefore are not currently subject to surface erosion. However, two areas of surface soil contamination were identified during the RI; the former incinerator area located in the ACS facility; and the Kapica/Pazmey Area.

Surface topography, vegetative cover and soil composition vary between these two locations. The former incinerator area is covered in gravel, as is most of the ACS facility. While runoff from the gravel may occur in areas of compaction, slope within the facility is relatively flat and potential for erosion of gravel and contaminated soil would be low. When runoff does occur, it likely follows the facility drainage system toward the ACS Firepond.

Surface soils in the vicinity of the Kapica/Pazmey Area are mostly vegetated. Topography in this area generally slopes to the north and west toward the low area between Off-Site Contaminant Area and the Griffith Municipal Landfill. Surface water and sediment samples (SW05 and SD05) collected in this low area generally contained the highest concentrations of contaminants detected. This would indicate runoff has or continues to occur in this area.

Discharge of contaminated groundwater to the surface wetlands may occur along western portions of the Site. Two predominant zones of upper aquifer contamination were identified during the RI west of the ACS facility and west of the Off-Site Contaminant Area. BETXs and chloroethane were the predominant contaminants detected.

BETXs and chloroethane (and to a lesser extent ketones) were detected in hydraulically connected downgradient (west) sediment and surface water samples. Discharge of contaminated groundwater may be a contributing factor to contamination in these areas.

## 8.5 RISK ASSESSMENT

**There are no apparent risks to human health associated with Site contamination currently. There is the potential of risk to human health only if continued migration of contaminated groundwater is not prevented.**

The baseline risk assessment was performed consistent with the Risk Assessment Guidance for Superfund (RAGS, U.S. EPA 1989) in coordination with the U.S. EPA RPM and Technical Support Group.

Non-cancer health effect risks were estimated by calculation of hazard quotients (HQ). For a given exposure pathway, the hazard quotients for all chemicals of concern are added to arrive at a total. This total value is referred to as the hazard index (HI) for the exposure pathway. A HI or HQ in excess of unity (1) may represent a potential health risk associated with exposure via a particular pathway or chemical.

The cancer risk value is an estimate of an individual's lifetime likelihood of developing cancer over and above the existing background chance of developing cancer. A cancer risk of $1 \times 10^{-6}$, for example, may be interpreted as an increased risk of one in one million of developing cancer over a person's lifetime. This risk may also be interpreted on a population basis, to predict that one additional case of cancer may occur in a population of one million people. For known or suspected carcinogens, the $1 \times 10^{-6}$ risk level is used by U.S. EPA as a "point of departure" below which risks are not considered to be of concern. Cancer risks which are between $1 \times 10^{-6}$ and $1 \times 10^{-4}$ may or may not be acceptable, depending on other risk management factors.

Current Land Use. Current land use health risks associated with exposure to contaminated Site media were evaluated for off-Site residents, trespassers, and on-Site workers at the ACS facility. The likelihood of exposure to populations from any of the pathways in the risk assessment is considered to be low and generally results in risk estimates that are conservative.

Off-Site residents were considered hypothetically to be exposed to contaminants released to groundwater and air under current land use conditions. Risk to adults and children was considered separately, as was exposure to groundwater from the lower and upper aquifers. Risks to off-Site residents which might occur if off-Site residents were actually exposed under this hypothetical scenario included:

- A non-cancer hazard index (HI) greater than 1 for children as a result of dermal exposure to 2-butanone.
- A total cancer risk to children exposed to groundwater from the upper aquifer of $4.9 \times 10^{-2}$, attributed mainly to dermal exposure to benzene.
- A total pathway HI for off-Site residents exposed to contaminants in air and groundwater of 1.8.
- A total cancer risk for off-Site adults of $6.6 \times 10^{-4}$, attributable mainly to ingestion of arsenic and bis(2-chloroethyl) ether from groundwater.

Hypothetical Site trespassers were assumed to be exposed to contaminants from surfac soils, surface water, sediments, and fugitive dusts and volatiles. Quantified risks for this hypothetical scenario included:

- A total HI for all pathways of $1.5 \times 10^{2}$, due mainly to ingestion and dermal absorption of surface soils at Kapica-Pazmey.
- A total cancer risk for all pathways of $6.3 \times 10^{-3}$, attributed mainly to dermal contact with benzene, inhalation of volatiles, and exposure to PCBs.

ACS facility workers were assumed to be exposed hypothetically via inhalation of fugitive dusts from Kapica-Pazmey and volatiles released from buried waste. Risks for this hypothetical scenario included:

- A HI of 3.2, due mainly to VOC emissions from buried wastes.

- A cancer risk of $1.6 \times 10^{-3}$, due mainly to inhalation of VOCs (primarily 1,1-dichloroethene, chloroform, and carbon tetrachloride).

Future Land Use. Future land-use health risks were based on exposure to contaminated Site media by residents living on-Site. It is emphasized that it is highly unlikely that this would be a reasonable future scenario at the Site. Residents were assumed to be exposed to soils at specific parts of the Site independent of the other areas, e.g., the Off-Site Containment area exclusively. The only difference in risk associated with each specific portion of the Site came from soil exposure, since exposure to groundwater and surface water was assumed to be the same throughout the Site. Risks associated with this unlikely future land use scenario included:

- The non-cancer hazard index for exposure to contaminated groundwater from the upper aquifer was estimated at $2.4 \times 10^{3}$, due primarily to dermal exposure to 2-butanone. The cancer risk was approximately $1.4 \times 10^{-1}$, due mainly to benzene exposure.

- The non-cancer hazard quotients for surface water (2.2) and sediments (2.0) were attributed primarily to dermal exposure to 2-butanone. The cancer risk due to surface water exposure was $1.1 \times 10^{-4}$, attributed mainly to dermal exposure to benzene. Sediment cancer risk was $2.2 \times 10^{-4}$, as a result of exposure to carcinogenic PAHs and PCBs.

- The non-cancer hazard index for inhalation of VOCs was 5.3, due primarily to exposure to n-chain alkanes. The cancer hazard risk was $2.7 \times 10^{-3}$, as a result of possible exposure to 1,1-dichloroethene, 1,1,1-trichloroethane, and chloroform.

- Non-cancer and cancer HI values in excess of unity associated with exposure to soils in the various Site areas were due to the presence of various volatile organics and metals. Among the chemicals of concern were tetrachloroethene, PCBs, carbon tetrachloride, and PAHs.

- The cancer risk appeared greatest for a resident residing at the Off-Site Containment Area ($2.9 \times 10^{-1}$).

## 8.6 ECOLOGICAL ASSESSMENT

The ACS Site includes some natural habitat as well as industrial properties. Although there is limited open surface water habitat, there are wetlands on the Site and in the Site area. Terrestrial areas support mature oak forests in undeveloped areas.

Chemicals of potential ecological concern at the ACS Site include TCL compounds and TAL metals found in the Site surface waters, sediments, and soils. Most organic compounds are not readily absorbed by aquatic and wetland plant species. Because habitat for aquatic fauna is limited, organic compounds do not likely present an appreciable source of hazard to Site open water or wetland habitats. Some metals found in Site surface waters exceeded U.S. EPA Ambient Water Quality Criteria and may present an environmental concern. Although sediment samples were below background levels for soils for TAL metals, derived sediment quality criteria could not be developed for assessment of ecological effects of nonpolar organic compounds. Sediment quality criteria will be developed and discussed when TOC data become available.

**To be completed with data generated for Ecological Assessment**

## SECTION 9
## REFERENCES


ATEC Associates, Inc., January 1985. Phase I Report, Preliminary Hydrogeologic Site Assessment, American Chemical Services, Griffith, Indiana.

Barker, J.F., G.C. Patrick, and D. Major, 1987. Natural Attenuation of Aromatic Hydrocarbons in a Shallow Sand Aquifer. Groundwater Monitoring Review. Winter 1987, pp. 64-71.

Battelle, Pacific Northwest Laboratories, 1984. Chemical Attenuation Rates, Coefficients, and Constants in Leachate Migration, Volume 1:A Critical Review EPRA EA-3356, Volume 1.

Bouwer, E.J. and P.L. McCarty, 1983. Transformations of Halogenated Organic Compounds Under the Denitrification Conditions. Applied and Environmental Microbiology 45(4): 1296-1299.

Bouwer, E.J. and P.L. McCarty, 1983a. Transformations of 1- and 2-carbon halogenated aliphatic organic compounds under methanogenic conditions. Applied and Environmental Microbiology 45(4) 1286-1294.

Camp Dresser & McKee Inc., March 26, 1985. Initial Site Evaluation Report, American Chemical Service, Inc., Griffith, Indiana.

Davis, S.N., 1969. Porosity and Permeability of Natural Materials. Flow Through Porous Media, ed. R.J.M. De Wiest.

Ecology and Environment, Correspondence, September 11, 1989.

Freeze, R., and Cherry, J., 1979. Groundwater, 604 pp.

Hartke, E.J., Hill, J.R., and M. Reshkin, 1975. Environmental Geology of Lake and Porter Counties, Indiana--An Aid to Planning, Environmental Study 8, Department of Natural Resources, Geological Survey Special Report 11, 56 p.

Hem, J.D., 1970. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey Water-Supply Paper 1473.

Karickhoff, S.W., D.S. Brown, and T.A. Scott, 1979. Sorption of Hydrophobic Pollutants on Natural Sediments. Water Research v. 13, pp. 241-248.

Kleopfer, R.D., D.M Easley, B.B. Hass, Jr., T. G. Deihl, 1985. Anaerobic Degradation of Trichloroethylene in Soil, Environmental Science and Technology 19(3): 277-280.

Lyman, W.J., W.F. Reehl and D.H. Rosenblatt. 1981. Handbook of Chemical Property Estimation Methods: Environmental Behavior of Organic Compounds. McGraw-Hill.

Olsen, R.L. and A. Davis, 1990. Predicting the Fate and Transport of Organic Compounds in Groundwater Parts 1 and 2. Hazardous Materials Control 3(3): 39-64, and 3(4): 18-37.

O'Toole, M.M., July 1985. Aerial Photographic Analysis of Three Priority CERCLA Hazardous Waste Sites, TS-AMD-84025/84700-12B, Contract No. 68-03-3245, U.S. EPA Environmental Monitoring Systems Laboratory.

Parsons, F., Wood, P.R. and DeMarco, J., 1984. Transformations of Tetrachloroethene and Trichloroethene in Microcosms and Groundwater, J. AWWA, February 1984, pp. 56-59.

Schwarzenbach, R. and Westall, 1981. Transport of Nonpolar Organic Compounds from Surface Water to Groundwater: Laboratory Sorption Studies. Environmental Science and Technology v. 15, pp. 360-1367.

Swallow, J.A. and P.M. Gschwend. 1983. Volatilization of Organic Compounds from Unconfined Aquifers. Proceedings, 3rd National Symposium on Aquifer Restoration and Groundwater Monitoring. May 1983. Columbus, OH. National Water Well Association. Worthington, OH.

U.S. EPA, 1986. Superfund Public Health Evaluation Manual. U.S. EPA/540/1-86/060 (OSWER Directive 9285.4-1) U.S. EPA Office of Emergency and Remedial Response, Washington, D.C.

U.S. EPA, 1988. Laboratory Data Validation, Functional Guidelines for Evaluating Organics Analyses. U.S. EPA Hazardous Site Evaluation Division, Washington, D.C.

U.S. EPA, 1985. Laboratory Data Validation, Functional Guidelines for Evaluating Inorganics Analyses. U.S. EPA Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency, 1983. Office of Solid Waste and Emergency Response, Hazardous Waste Land Treatment Publication SW-874, April 1983, p. 273, Table 6.46.

U.S. EPA, May 1980. Field Sampling Report, American Chemical Service and Griffith City Landfill, Griffith Indiana.

U.S. Fish and Wildlife Service, August 13, 1990. Wetlands Delineation at American Chemical Services Hazardous Waste Site, Griffith, Indiana, IAG-DW14934313-0.

Verschueren, K., 1983. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co., New York.

Vogel, T.M., C.S. Criddle, and P.L. McCarty, 1987. Transformations of Halogenated Aliphatic Compounds. Environmental Science and Technology 21(8): 722-735.

Vogel, T.M., and P.L. McCarty, 1987. Abiotic and Biotic Transformations of 1,1,1-Trichloroethane under Methanogenic Conditions. Environmental Science and Technology 21(12): 1208-1213.

Roy F. Weston, Inc., October 23, 1989. Correspondence.

Roy F. Weston, Inc., December 1984. Site Assessment for American Chemical Service, Griffith, Indiana, prepared for U.S. EPA Region V, Contract No. 68-95-0017.

Wilson, J.T., C.G. Enfield, W.J. Dunlap, R.L. Cosby, D.A. Foster and L.B. Buskin. 1981. Transport and Fate of Selected Organic Pollutants in a Sandy Soil. Journal of Environmental Quality, v. 10, pp. 501-506.

JDD/jlv/PJV
[jlv-603-97]

Job No. 15090
Date: 03/21/90

# FALLING HEAD PERMEABILITY TEST

FWI Engineering Associates, Inc., 8383 Greenway Blvd., Middleton, WI 53562 Phone: (608) 231-4770

| | |
|---|---|
| PROJECT | ACS |
| LOCATION | GRIFFITH, INDIANA |
| SAMPLE (a) | BORING: MW9 |
| DEPTH (ft) | 21.0 - 23.0 |
| SOIL DESCRIPTION | Brown Lean CLAY, Some Sand, Little Gravel (CL) |
| SAMPLE DIAMETER (cm) | 7.4 |
| SAMPLE AREA, A($cm^2$) | 42.6 |

| | INITIAL | FINAL |
|---|---|---|
| SAMPLE LENGTH, L(cm) | 19.3 | 19.3 |
| MOISTURE CONTENT, % | 18.8 | 18.5 |
| DRY DENSITY (lb/cu ft) | 110.0 | 110.0 |
| PERCENT COMPACTION | - | - |

| RUN | COEFFICIENT OF PERMEABILITY, k(cm/sec) |
|---|---|
| 1 | 6.5E-08 |
| 2 | 9.4E-08 |
| 3 | 3.9E-08 |
| 4 | 6.0E-09 |
| 5 | 4.8E-09 |
| 6 | 1.6E-08 |
| 7 | 1.8E-08 |
| 8 | 1.3E-08 |
| 9 | 2.2E-08 |
| 10 | 3.4E-08 |
| 11 | 3.4E-08 |
| 12 | 3.0E-08 |

AVERAGE COEFFICIENT OF PERMEABILITY = 3.3E-08 cm/sec
(Based on run numbers 10 through 12)

FORMULA: $k = \frac{2.3aL}{At} \log_{10} \frac{h_0}{h_1}$, Where a = cross-sectional area of standpipe,
t = time for water level to fall from initial height, $h_0$, to final height, $h_1$
(All other terms are defined above)

FOOTNOTES: (a) This permeability test was performed on a relatively undisturbed 3-inch diameter Shelby tube sample.

CHECKED BY: [illegible] DATE: 4/10/90 APPROVED BY: CAF DATE: 4/10

FWI

TABLE 2-1
SUMMARY OF
WELL CONSTRUCTION DETAILS
American Chemical Services NPL Site
Remedial Investigation
Griffith, Indiana

| | P-26 | P-27 | P-28 | P-29 | P-30 | P-31 | P-32 | P-33 | P-34 | P-35 | P-36 | P-37 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Surface Elevation (ft MSL) | 631.2 | 636.0 | 640.8 | 638.5 | 639.6 | 638.2 | 639.3 | 637.2 | 637.1 | 637.9 | 641.9 | 639.3 |
| Total Depth of Boring (ft) | 8.0 | 10.0 | 14.5 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 15.0 | 10.0 |
| T.O.I.C. Elevation (ft MSL) | 634.23 | 639.68 | 644.53 | 642.34 | 642.49 | 641.05 | 641.79 | 640.08 | 639.38 | 641.72 | 644.82 | 641.37 |
| Well Materials | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC |
| Screen Materials | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC |
| Screen Length (ft) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Slot Size (in) | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| Geologic Formation at Screen | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand |
| Depth to Clay | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Elevation of Clay | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Top of Seal - Depth (ft) | 0.0 | 1.6 | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| - Elevation (ft MSL) | 631.2 | 634.4 | 636.8 | 638.5 | 639.6 | 638.2 | 639.3 | 637.2 | 637.1 | 637.9 | 641.9 | 639.3 |
| Top of Sand Pack - Depth (ft) | 1.0 | 3.5 | 5.5 | 2.3 | 3.2 | 2.4 | 2.0 | 2.3 | 2.8 | 1.5 | 4.5 | 3.0 |
| - Elevation (ft MSL) | 630.2 | 632.5 | 635.3 | 636.2 | 636.4 | 635.8 | 637.3 | 634.9 | 634.3 | 636.4 | 637.4 | 636.3 |
| Top of Screen - Depth (ft) | 2.0 | 5.0 | 6.5 | 3.0 | 4.0 | 4.0 | 4.0 | 4.0 | 5.0 | 3.0 | 7.0 | 5.0 |
| - Elevation (ft MSL) | 629.2 | 631.0 | 634.3 | 635.5 | 635.6 | 634.2 | 635.3 | 633.2 | 632.1 | 634.9 | 634.9 | 634.3 |
| Bottom of Well Point - Depth (ft) | 7.0 | 10.0 | 11.5 | 8.0 | 9.0 | 9.0 | 9.0 | 9.0 | 10.0 | 8.0 | 12.0 | 10.0 |
| - Elevation (ft MSL) | 624.2 | 626.0 | 629.3 | 630.5 | 630.6 | 629.2 | 630.3 | 628.2 | 627.1 | 629.9 | 629.9 | 629.3 |
| Map Coordinates: North | 7360.6 | 7020.4 | 7485.8 | 6619.0 | 6815.8 | 7159.0 | 7007.9 | 7130.3 | 6692.0 | 6583.5 | 6842.0 | 6948.9 |
| East | 4726.5 | 4903.7 | 5882.6 | 5738.0 | 5606.5 | 5480.3 | 5741.8 | 5218.7 | 5279.7 | 5506.7 | 5412.1 | 5329.7 |
| Completion Date | 28-Jul-89 | 28-Jul-89 | 28-Jul-89 | 07-Aug-89 | 07-Aug-89 | 07-Aug-89 | 07-Aug-89 | 08-Aug-89 | 08-Aug-89 | 08-Aug-89 | 08-Aug-89 | 08-Aug-89 |

NOTES: T.O.I.C. - Top of Inner Well Casing
ID - Inside Diameter
SS - Stainless Steel
MSL - Mean Sea Level
NA - Data Not Available

TABLE 2-1
SUMMARY OF
WELL CONSTRUCTION DETAILS
American Chemical Services NPL Site
Remedial Investigation
Griffith, Indiana

| | P-38 | P-39 | P-40 | P-41 |
|---|---|---|---|---|
| Ground Surface Elevation (ft MSL) | 637.8 | 638.8 | 636.5 | 635.6 |
| Total Depth of Boring (ft) | 10.0 | 10.0 | 10.0 | 10.0 |
| T.O.I.C. Elevation (ft MSL) | 639.87 | 641.49 | 639.31 | 638.53 |
| Well Materials | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC |
| Screen Materials | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC |
| Screen Length (ft) | 5.0 | 5.0 | 5.0 | 5.0 |
| Slot Size (in) | 0.010 | 0.010 | 0.010 | 0.010 |
| Geologic Formation at Screen | Sand | Sand | Sand | Sand |
| Depth to Clay | NA | NA | NA | NA |
| Elevation of Clay | NA | NA | NA | NA |
| Top of Seal - Depth (ft) | 0.0 | 0.0 | 0.0 | 0.0 |
| - Elevation (ft MSL) | 637.8 | 638.8 | 636.5 | 635.6 |
| Top of Sand Pack - Depth (ft) | 3.3 | 2.5 | 0.7 | 1.0 |
| - Elevation (ft MSL) | 634.5 | 636.3 | 635.8 | 634.6 |
| Top of Screen - Depth (ft) | 5.0 | 4.0 | 2.0 | 2.0 |
| - Elevation (ft MSL) | 632.8 | 634.8 | 634.5 | 633.6 |
| Bottom of Well Point - Depth (ft) | 10.0 | 9.0 | 7.0 | 7.0 |
| - Elevation (ft MSL) | 627.8 | 629.8 | 629.5 | 628.6 |
| Map Coordinates: North | 6992.3 | 6902.0 | 7228.9 | 7353.1 |
| East | 5148.6 | 5939.7 | 5879.9 | 5702.1 |
| Completion Date | 08-Aug-89 | 10-Aug-89 | 10-Aug-89 | 10-Aug-89 |

NOTES: *T.O.I.C. - Top of Inner Well Casing*
ID - Inside Diameter
SS - Stainless Steel
MSL - Mean Sea Level
NA - Data Not Available

TABLE 2-2
Summary of Laboratory Physical Soil Analysis
American Chemical Services NPL Site
Remedial Investigation
Griffith, Indiana

| Hydrogeological Unit | Sample Depth (ft) | Bottom Elevation (msl) | Well Number | Material Description (USCS) | Initial Moisture Content (%) | Wet Sieve % Gr | Wet Sieve % Sand | Hydrometer % Silt | Hydrometer % Clay | Porosity | Total Organic Carbon(a) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vadose Zone | 3.5-5.0 | 630.7 | MW-1 | Black Fine SAND, Some Silt, Little Clay (SM) | 25.4 | 0.0 | 81.5 | 12.5 | 6.1 | NM | NM |
| Vadose Zone | 3.5-5.0 | 629.8 | MW-2 | Brown Fine-Medium SAND, Little Silt & Clay, Trace Gravel (SP-SM) | 16.4 | 1.3 | 85.5 | 6.3 | 6.8 | NM | NM |
| Vadose Zone | 1.0-2.5 | 631.6 | MW-3 | Brown Fine SAND, Trace Silt & Clay (SP) | 21.7 | 0.0 | 95.6 | 1.8 | 2.7 | NM | NM |
| Vadose Zone | 3.5-5.0 | 633.2 | MW-4 | Brown Fine-Coarse SAND, Little Gravel, Trace Silt & Clay (SP) | 21.7 | 7.1 | 84.6 | 4.2 | 4.1 | NM | NM |
| Vadose Zone | 3.5-5.0 | 634.4 | MW-5 | Brown Fine-Coarse SAND, Little Gravel & Silt, Trace Clay (SP-SM) | 13.0 | 10.2 | 76.9 | 8.5 | 4.3 | NM | NM |
| Vadose Zone | 6.0-7.5 | 645.5 | MW-6 | Brown Fine SAND, Trace Clay (SP) | 3.7 | 0.0 | 98.7 | 0.3 | 1.0 | NM | NM |
| Upper Aquifer | 13.5-15.0 | 620.7 | MW-1 | Gray Fine SAND, Trace Silt & Clay (SP) | 15.6 | 0.0 | 95.8 | 2.8 | 1.4 | NM | NM |
| Upper Aquifer | 11.0-12.5 | 622.3 | MW-2 | Gray Fine-Coarse SAND, Little Silt, Trace Clay & Gravel (SP-SM) | 19.4 | 2.0 | 87.8 | 6.0 | 4.2 | NM | NM |
| Upper Aquifer | 11.0-12.5 | 621.6 | MW-3 | Gray Fine-Medium SAND, Trace Silt & Clay (SP-SM) | 22.1 | 0.0 | 92.6 | 4.4 | 3.0 | NM | NM |
| Upper Aquifer | 11.0-12.5 | 625.7 | MW-4 | Brown Fine-Coarse SAND, Little Gravel, Trace Silt & Clay (SP-SM) | 15.8 | 8.9 | 83.5 | 4.6 | 3.0 | NM | NM |
| Upper Aquifer | 8.5-10.0 | 629.4 | MW-5 | Gray Fine-Coarse SAND & GRAVEL, Little Silt, Trace Clay (SP-GM) | 16.4 | 43.2 | 47.4 | 6.8 | 2.6 | NM | NM |
| Upper Aquifer | 21.0-22.5 | 630.5 | MW-6 | Brown Fine-Coarse SAND, Trace Silt, Clay & Gravel (SP) | 19.0 | 1.0 | 94.4 | 2.4 | 2.2 | NM | NM |
| Upper Aquifer | 10.0-17.0 | 621.7 | MW-7 | Brown Fine-Coarse SAND, Little Gravel & Silt, Trace Clay (SP-SM) | NM | 7.6 | 83.2 | 6.4 | 2.8 | 0.278 | 14000 |
| Upper Aquifer | 10.0-16.0 | 619.9 | MW-9 | Brown Fine-Medium SAND, Little Silt, Trace Clay & Gravel (SP-SM) | NM | 1.1 | 88.9 | 5.5 | 4.5 | 0.311 | 2900 |

TABLE 2-2 (con't)
Summary of Laboratory Physical Soil Analysis
American Chemical Services NPL Site
Remedial Investigation

| Hydrogeological Unit | Sample Depth (ft) | Bottom Elevation (msl) | Well Number | Material Description (USCS) | Initial Moisture Content (%) | Wet Sieve % Gr | Wet Sieve % Sand | Hydrometer % Silt | Hydrometer % Clay | Porosity | Total Organic Carbon(a) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lower Aquifer | 45.0-50.0 | 588.7 | MW-7 | Brown Fine-Medium SAND, Trace Silt, Clay & Gravel (SP-SM) | NM | 1.4 | 92.3 | 4.4 | 1.9 | 0.295 | 6800 |
| Lower Aquifer | 26.0-35.0 | 600.9 | MW-9 | Brown Fine-Medium SAND, Little Silt, Trace Clay & Gravel (SP-SM) | NM | 2.3 | 89.6 | 5.7 | 2.4 | 0.298 | 3100 |
| | | | | | | Average Permeability (K) (cm/s) | | | | | |
| Confining Layer | 15.0-17.0 | 618.7 | MW-1 | Gray Lean CLAY, Trace Sand (CL) | 22.0 | 6.0E-08 | | | | NM | NM |
| Confining Layer | 20.0-22.0 | 612.8 | MW-2 | Gray Lean CLAY, Trace Sand (CL) | 19.3 | 3.8E-08 | | | | NM | NM |
| Confining Layer | 15.0-17.0 | 617.1 | MW-3 | Gray Lean CLAY, Trace Sand (CL) | 16.1 | 3.2E-08 | | | | NM | NM |
| Confining Layer | 18.0-20.0 | 618.2 | MW-4 | Gray Lean CLAY, Trace Sand (CL) | 14.4 | 6.7E-07 | | | | NM | NM |
| Confining Layer | 21.0-23.0 | 616.4 | MW-5 | Gray Lean CLAY, Trace Sand (CL) | 16.2 | 5.8E-09 | | | | NM | NM |
| Confining Layer | 32.0-34.0 | 619.0 | MW-6 | Gray Lean CLAY, Trace Sand (CL) | 16.5 | 3.6E-08 | | | | NM | NM |
| Confining Layer | 23.0-25.0 | 613.7 | MW-7 | Brown Lean CLAY, Little Sand, Trace Gravel (CL) LL=33, PI=19 | 13.0 | 7.9E-08 | | | | 0.257 | >16000(b) |
| Confining Layer | 21.0-23.0 | 612.9 | MW-9 | Brown Lean CLAY, Some Sand, Little Gravel (CL) LL=21, PI=10 | 18.0 | 3.3E-08 | | | | 0.327 | 12000(b) |

Notes:
LL - Liquid Limit ( The water content of the sample when it has a shear strength of 1 g/sq.cm)
PL - Plastic Limit (The range in water content between the liquid limit and the plastic limit)
Wet Sieve (Test performed to measure percent of silt and clay in the sample)
Hydrometer (Test performed to measure percent of gravel and sand in the sample)
(msl) - Elevation in Mean Sea Level
NM - Not Measured
Falling Head Permeability Test was performed on a relatively undisturbed 3-inch Shelby tube sample
(a) - Total Organic Carbon (mg/kg dry wt.)
(b) - Total Organic Carbon Analyzed from jar samples not shelby tube samples

Table 2-3

**Summary of Well Development Data**
**American Chemical Service NPL Site**
**Remedial Investigation**
**Griffith, Indiana**

| Well No. | Date | Depth of Well | Water Level | Column | One Volume | Volume Purged | Comments |
|---|---|---|---|---|---|---|---|
| MW01 | 7/26/89 | 16.86 | 5.34 | 11.52 | 1.9 | 20 | No odor, cloudy |
| MW02 | 7/26/89 | 18.21 | 6.55 | 11.66 | 1.9 | 20 | Slight odor, cloudy |
| MW03 | 7/27/90 | 17.16 | 4.53 | 12.63 | 2.1 | 25 | Strong leachate odor, cloudy |
| MW04 | 7/27/90 | 18.35 | 6.53 | 11.82 | 2.0 | 25 | Strong odor, cloudy |
| MW05 | 7/27/90 | 20.23 | 7.33 | 12.90 | 2.1 | 25 | Slight odor, cloudy |
| MW06 | 7/26/89 | 29.94 | 21.73 | 8.21 | 1.35 | 28.5 | Slight odor, cloudy |
| MW07 | 3/16/90 | 50.57 | 18.08 | 32.50 | 5.33 | 55 | No odor, cloudy |
| MW08 | 3/19/90 | 47.55 | 17.68 | 29.87 | 5.0 | 50 | No odor, cloudy |
| MW09 | 3/21/90 | 37.57 | 15.86 | 21.71 | 3.6 | 36 | No odor, cloudy |
| MW10 | 5/4/90 | 37.60 | 13.05 | 24.55 | 4.1 | 42 | Slight odor, cloudy |
| MW10C | 7/12/90 | ~25 | ~7 | ~18 | ~3.0 | 5 | Bubbling water and venting gas |
| MW11 | 3/30/90 | 20.55 | 4.79 | 15.76 | 2.6 | 30 | No odor, cloudy |
| MW12 | 4/2/90 | 20.55 | 6.80 | 13.75 | 2.2 | 25 | No odor, cloudy |
| MW13 | 4/5/90 | 15.55 | 3.08 | 12.47 | 2.1 | 21 | Leachate odor, cloudy |
| MW14 | 4/12/90 | 16.30 | 6.89 | 9.41 | 1.5 | 17 | Medium recharge, slight odor, cloudy |
| MW15 | 4/12/90 | 16.85 | 4.15 | 12.70 | 2.1 | 21 | No odor, cloudy |
| MW16 | 4/12/90 | 17.55 | 6.17 | 11.38 | 1.9 | 20 | Strong leachate odor, cloudy |
| MW17 | 4/12/90 | 22.85 | 12.25 | 10.60 | 1.8 | 20 | Petroleum odor with oil sheen, cloudy |
| MW18 | 6/30/90 | 21.30 | 8.03 | 13.27 | 2.2 | 24 | No odor, cloudy |

Notes:

Depth of well and water level in feet below ground surface.
Column in feet.
Volumes in gallons.
Volume purged at least 10 times one volume.

# Table 2-4. Summary of Aquifer Test Results.

## Upper Aquifer Wells

| East Side Monitoring Wells | K ft/min | | | | | |
|---|---|---|---|---|---|---|
| MW-4 | 2.8E-03 | | | | | |
| MW-5 | 2.3E-02 | | | | | |
| MW-6 | 2.9E-02 | | | | | |
| MW-11 | 2.6E-03 | 6.3E-03 | | | | |
| MW-12 | 3.8E-02 | | | | | |
| MW-15 | 4.0E-02 | | | | | |
| MW-17 | 1.5E-01 | | | | | |
| MW-18 | 6.9E-03 | | | | | |
| Avg: | 1.5E-02 | ft/min | 2.6E-04 | ft/sec | 22.2 | ft/day |
| Min: | 2.6E-03 | ft/min | 4.4E-05 | ft/sec | 3.80 | ft/day |
| Max: | 1.5E-01 | ft/min | 2.5E-03 | ft/sec | 216 | ft/day |

| West Side Monitoring Wells | K ft/min | | | | | |
|---|---|---|---|---|---|---|
| MW-1 | 3.5E-03 | | | | | |
| MW-2 | 2.9E-03 | | | | | |
| MW-3 | 4.2E-03 | | | | | |
| MW-13 | 1.0E-02 | | | | | |
| MW-14 | 4.3E-03 | | | | | |
| MW-16 | 3.0E-04 | | | | | |
| Avg: | 2.9E-03 | ft/min | 4.8E-05 | ft/sec | 4.14 | ft/day |
| Min: | 3.0E-04 | ft/min | 5.0E-06 | ft/sec | 0.433 | ft/day |
| Max: | 1.0E-02 | ft/min | 1.7E-04 | ft/sec | 15.0 | ft/day |

**Upper Aquifer Summary**

| | | |
|---|---|---|
| **Geometric Mean:** | **7.9E-03** | **ft/min** |
| (15 values) | **1.3E-04** | **ft/sec** |
| | **11.3** | **ft/day** |

# Table 2-4 (continued). Summary of Aquifer Test Results.

## Lower Aquifer Monitoring Wells

| Monitoring Wells | K ft/min | | | | | |
|---|---|---|---|---|---|---|
| MW-7 | 4.6E-02 | | | | | |
| MW-8 | 4.3E-02 | | | | | |
| MW-9 | 4.2E-02 | | | | | |
| MW-10 | 4.6E-02 | | | | | |
| Avg: | 4.4E-02 | ft/min | 7.4E-04 | ft/sec | 63.6 | ft/day |
| Min: | 4.2E-02 | ft/min | 7.0E-04 | ft/sec | 60.34 | ft/day |
| Max: | 4.6E-02 | ft/min | 7.7E-04 | ft/sec | 66.2 | ft/day |

Notes:

Permeability values obtained by bail testing.
Raw data and calculations are in Appendix I.

ACSRI Table 2-4/PJV/JAW

TABLE 2-5
Water Levels and Elevations
ACS NPL Site
Griffith, Indiana

| Location | Coordinates East | Coordinates North | TOC | Ground Elev | Clay Elev | August 17, 1989 Depth to Water | August 17, 1989 Water Elev | September 8, 1989 Depth to Water | September 8, 1989 Water Elev | November 15, 1989 Depth to Water | November 15, 1989 Water Elev | February 2, 1990 Depth to Water | February 2, 1990 Water Elev | April 6, 1990 Depth to Water | April 6, 1990 Water Elev | July 18, 1990 Depth to Water | July 18, 1990 Water Elev | September 13, 1990 Depth to Water | September 13, 1990 Water Elev |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P-1 | 5700 | 6365 | 642.85 | 641.2 | | 8.61 | 634.24 | 8.32 | 634.53 | | | 8.46 | 634.39 | 7.19 | 635.66 | | | | |
| P-2 | 5577 | 6165 | 645.59 | 642.5 | | 11.55 | 634.04 | 11.36 | 634.23 | | | 11.57 | 634.02 | 10.17 | 635.42 | | | | |
| P-3 | 5453 | 6469 | 639.89 | 638.0 | | 5.72 | 634.17 | 5.23 | 634.66 | | | 5.37 | 634.52 | 4.44 | 635.45 | | | | |
| P-4 | 5432 | 6228 | 639.28 | 636.9 | | 5.42 | 633.86 | 5.22 | 634.06 | | | 5.48 | 633.80 | 3.98 | 635.30 | | | 4.32 | 634.96 |
| P-5 | 5285 | 6510 | 636.62 | 635.6 | | 3.58 | 633.04 | 2.64 | 633.98 | | | 2.47 | 634.15 | 1.94 | 634.68 | | | 2.82 | 633.80 |
| P-6 | 5148 | 6551 | 638.77 | 636.7 | | 6.67 | 632.10 | 5.93 | 632.84 | | | 5.21 | 633.56 | 5.27 | 633.50 | | | | |
| P-7 | 5950 | 6640 | 643.64 | 641.2 | | 9.30 | 634.34 | 8.89 | 634.75 | | | 8.80 | 634.84 | 7.76 | 635.88 | | | | |
| P-8 | 6157 | 6735 | 639.21 | 636.8 | | 4.99 | 634.22 | 4.47 | 634.74 | | | 4.00 | 635.21 | 3.23 | 635.98 | | | 3.88 | 635.33 |
| P-9 | 6134 | 6994 | 638.90 | 637.8 | | 4.78 | 634.12 | 4.28 | 634.62 | | | 3.72 | 635.18 | 3.22 | 635.68 | | | | |
| P-10 | 5413 | 5852 | 649.37 | 646.9 | | 15.73 | 633.64 | 15.65 | 633.72 | | | 15.87 | 633.50 | 14.38 | 634.99 | | | | |
| P-11 | 5199 | 5900 | 649.17 | 647.0 | | 15.52 | 633.65 | 15.64 | 633.53 | | | 16.05 | 633.12 | 14.57 | 634.60 | | | 14.48 | 634.69 |
| P-12 | 5076 | 5723 | 650.11 | 646.7 | | 16.86 | 633.25 | 16.83 | 633.28 | | | 17.18 | 632.93 | 15.68 | 634.43 | | | | |
| P-13 | 4878 | 5735 | 651.48 | 649.4 | | 18.33 | 633.15 | 18.35 | 633.13 | | | 18.80 | 632.68 | 17.18 | 634.30 | | | | |
| P-14 | 4955 | 5965 | 649.35 | 647.4 | | 15.57 | 633.78 | 15.48 | 633.87 | | | 16.22 | 633.13 | 15.13 | 634.22 | | | | |
| P-15 | 4884 | 6198 | 639.06 | 637.4 | | 7.12 | 631.94 | 6.86 | 632.20 | | | 6.29 | 632.77 | 5.11 | 633.95 | | | 5.90 | 633.16 |
| P-16 | 4673 | 5748 | 647.84 | 646.2 | | 14.40 | 633.44 | 14.31 | 633.53 | | | 15.05 | 632.79 | 13.22 | 634.62 | | | | |
| P-17 | 4628 | 6009 | 650.62 | 648.5 | | 18.05 | 632.57 | 17.96 | 632.66 | | | 18.22 | 632.40 | 16.35 | 634.27 | | | | |
| P-18 | 4632 | 6223 | 647.97 | 644.3 | | 3.35 | 644.62 | 3.04 | 644.93 | | | 5.05 | 642.92 | 5.05 | 642.92 | | | | |
| P-19 | 4977 | 5043 | 639.64 | 637.5 | | 7.34 | 632.30 | 6.96 | 632.68 | | | 6.88 | 632.76 | 6.03 | 633.61 | | | | |
| P-20 | 5104 | 6233 | 643.15 | 640.1 | | 10.05 | 633.10 | 9.37 | 633.78 | | | 9.24 | 633.91 | 8.25 | 634.90 | | | 8.38 | 634.77 |
| P-21 | 4834 | 6475 | 634.81 | 632.3 | | 5.15 | 629.66 | 4.19 | 630.62 | | | 3.96 | 630.85 | 4.21 | 630.60 | | | | |
| P-22 | 4636 | 6732 | 634.33 | 632.2 | | 7.21 | 627 12 | 5.62 | 628.71 | | | 4.95 | 629.38 | 5.34 | 628.99 | | | | |
| P-23 | 4689 | 7018 | 636.17 | 632.5 | | 7.88 | 628.29 | 6.65 | 629.52 | | | 11.80 | 624.37 | 5.38 | 630.79 | | | | |
| P-24 | 5002 | 7178 | 636.08 | 633.3 | | 5.71 | 630.37 | 4.48 | 631.60 | | | 3.80 | 632.28 | 4.33 | 631.75 | | | | |
| P-25 | 5156 | 7489 | 635.33 | 632.1 | | 4.22 | 631.11 | 3.46 | 631.87 | | | 3.36 | 631.97 | 3.37 | 631.96 | | | | |
| P-26 | 4727 | 7361 | 634.23 | 631.2 | | 4.87 | 629.36 | 3.62 | 630.61 | | | 3.32 | 630.91 | 3.50 | 630.73 | | | 4.22 | 630.01 |
| P-27 | 4904 | 7020 | 639.68 | 636.0 | | 10.40 | 629.28 | 9.75 | 629.93 | | | 8.10 | 631.58 | 7.84 | 631.84 | | | 8.96 | 630.72 |
| P-28 | 5883 | 7486 | 644.53 | 640.8 | | 11.60 | 632.93 | 10.93 | 633.60 | | | 10.12 | 634.41 | 9.67 | 634.86 | | | 10.50 | 634.03 |
| P-29 | 5738 | 6619 | 642.34 | 638.5 | | 7.24 | 635.10 | 7.56 | 634.78 | | | 7.63 | 634.71 | 6.48 | 635.86 | | | | |
| P-30 | 5607 | 6816 | 642.49 | 639.6 | | 7.90 | 634.59 | 7.47 | 635.02 | 8.60 | 633.89 | 7.61 | 634.88 | 6.68 | 635.81 | | | 7.04 | 635.45 |
| P-31 | 5480 | 7159 | 641.05 | 638.2 | | 6.98 | 634.07 | 6.24 | 634.81 | 7.25 | 633.80 | 5.96 | 635.09 | 5.94 | 635.11 | | | | |
| P-32 | 5742 | 7008 | 641.79 | 639.3 | | 7.54 | 634.25 | 7.03 | 634.76 | | | 6.67 | 635.12 | 6.33 | 635.46 | | | 6.87 | 634.92 |
| P-33 | 5219 | 7130 | 640.08 | 637.2 | | 6.82 | 633.26 | 4.87 | 635.21 | 6.69 | 633.39 | 4.94 | 635.14 | 5.65 | 634.43 | | | | |
| P-34 | 5280 | 6692 | 639.38 | 637.1 | | 5.76 | 633.62 | 4.91 | 634.47 | 6.98 | 632.40 | 5.27 | 634.11 | 4.69 | 634.69 | | | | |
| P-35 | 5507 | 6584 | 641.72 | 637.9 | | 7.37 | 634.35 | 6.92 | 634.80 | 7.92 | 633.80 | 7.13 | 634.59 | 6.16 | 635.56 | | | | |
| P-36 | 5412 | 6842 | 644.82 | 641.9 | | 10.26 | 634.56 | 9.54 | 635.28 | 10.33 | 634.49 | 9.57 | 635.25 | 8.80 | 636.02 | | | | |
| P-37 | 5330 | 6949 | 641.37 | 639.3 | | 6.39 | 634.98 | 5.71 | 635.66 | 6.36 | 635.01 | product | | product | | | | | |
| P-38 | 5149 | 6992 | 639.87 | 637.8 | | 6.63 | 633.24 | 5.29 | 634.58 | 7.22 | 632.65 | 5.10 | 634.77 | 5.34 | 634.53 | | | | |
| P-39 | 5940 | 6902 | 641.49 | 638.8 | | 7.92 | 633.57 | 6.72 | 634.77 | | | 6.40 | 635.09 | 5.69 | 635.80 | | | | |
| P-40 | 5880 | 7229 | 639.31 | 636.5 | | 5.45 | 633.86 | 4.84 | 634.47 | | | 4.27 | 635.04 | 4.15 | 635.16 | | | | |
| P-41 | 5702 | 7353 | 638.53 | 635.6 | | 5.09 | 633.44 | 4.37 | 634.16 | | | 3.75 | 634.78 | 3.66 | 634.87 | | | | |

TABLE 2-6
SUMMARY OF PRIVATE WATER SUPPLY WELLS IN THE ACS SITE VICINI[illegible] GRI[illegible] [illegible]NDIANA

| Map Number | Owner | Location | Distance From Site | Date Drilled | Screened Interval (ft.) | Formation | Use of Well(s) | Well Diameter (in.) | Static Water Level | Pumping Data | Log Avail-able |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Sylvester Reder | 1048 Reder | 300 ft. E-SE | 5/3/60 | 51.5-56 | Sand | Home | 1 | 25 | Pumped for 1 hr at 15 gpm | Yes |
| 2 | Griffith Airport | 1701 E. Main St | 4300 ft. E-NE | 1/4/84 | 59-65 | Sand | Public Bathroom | 4 | | | |
| 3 | Keen Foundry* | Main Street | 2900 ft. N-NW | 10/26/71 | 55-63 | Sand | Industry | 3 | 17 | Pumped for 4 hrs at 30 gpm | Yes |
| 4 | Keen Foundry* | Main Street | 2900 ft. N-NW | 6/28/67 | 52-81 | Sand | Industry | 8 | 18 | Pumped for 4 hrs at 175 gpm | Yes |
| 5 | Pinkstaff | 743 S. Cline Ave | 3000 ft SW | 12/3/59 | 65-69 | | Home | 1 | | Pumped for 1 hr at 15 gpm | Yes |
| 6 | Van Fleet | 1523 E. Elm St | 1.3 mile NE | 11/5/59 | 46-50 | | Home | 1 | | Pumped for 1 hr at 15 gpm | Yes |
| 7 | Russel Banister | 1525 E. Elm St | 1.3 mile NE | 11/5/59 | 36-40 | | Home | 1 | | Pumped for 1 hr at 15 gpm | Yes |
| 8 | Cheever Park* | 301 S. Colfax St | 1100 ft NE | 8-24-83 | 54-58 | Sand | Public | 1.25 | 3 | Pumped for 1 hr at 12 gpm | Yes |
| 9 | Auton Goal | 1106 S. Broad St | 1.1 mile S-SW | 7/27/71 | 56-61 | Sand | Home | 1.25 | 8 | Pumped for 0.5 hr at 10 gpm | Yes |
| 10 | Kirt Evans | 1026 S. Arbogast St | 2500 ft S | 2/26/73 | 46-51 | Sand | Home | 1.25 | | Pumped for 2 hrs at 12 gpm | Yes |
| 11 | C. Saint-Angelo | 1710 S. Arbogast St | 3500 ft S | 9/23/71 | 57-65 | Sand | Home | 3 | 15 | Pumped for 2 hrs at 12 gpm | Yes |
| 12 | John Price | 1105 S. Cline Ave | 1.4 mile W-SW | 8/12/71 | 52-57 | Sand | Home | 1.25 | 17 | Pumped for 2 hrs at 10 gpm | Yes |
| 13 | Frank Roziek | 1201 S. Cline Ave | 1.5 mile W-SW | 8/13/69 | 52-56 | Sand | Home | 1.25 | 10 | Pumped for 0.5 hr at 10 gpm | Yes |
| 14 | James Cooke Jr. | 1617 S. Cline Ave | 2.2 mile SW | 3/3/73 | 56-61 | Sand | Home | 1.25 | | Pumped for 2 hr at 12 gpm | Yes |
| 15 | Andrew Chmieleuiski | 1699 S. Cline Ave | 2.4 mile SW | 6/12/73 | 47-52 | Sand | Home | 1.5 | | Pumped for 2 hrs at 12 gpm | Yes |
| 17 | J. Sparks | 1704 S. Cline Ave | 2.6 mile W-SW | 8/7/84 | 55-63 | Sand | Home | 4 | 21 | Pumped for 1.5 hrs. at 15 gpm | Yes |
| 18 | David Chorba | 331 Golfview Dr | 3.4 mile SW | 5/11/85 | 28-33 | Sand | Irrigation | 1.5 | 15 | Pumped at 20 gpm | Yes |
| 19 | Guy Cordy | S. Cline Ave | 3400 ft W-SW | 12/9/60 | 131 | Limestone | Home | 4 | 6 | Pumped for 3 hrs at 20 gpm | Yes |
| 20 | | NE 1/4,SW 1/4 Sec 35 | 1.2 mile N-NW | 12/9/44 | 65-85 | Sand | | 12 | 15 | Pumped for 1 hr at 320 gpm | Yes |
| 21 | | SW 1/4,SW 1/4 Sec 35 | 3900 ft N-NW | 8/7/46 | 82 | Sand | | 18 | | | Yes |
| 22 | | SW 1/4,SW 1/4 Sec 35 | 3900 ft N-NW | 3/3/59 | | | | 18 | | | Yes |

TABLE 2-5
Water Levels and Elevations
ACS NPL Site
Griffith, Indiana

| Location | Coordinates East | Coordinates North | TOC | Ground Elev | Clay Elev | August 17, 1989 Depth to Water | August 17, 1989 Water Elev | September 8, 1989 Depth to Water | September 8, 1989 Water Elev | November 15, 1989 Depth to Water | November 15, 1989 Water Elev | February 2, 1990 Depth to Water | February 2, 1990 Water Elev | April 6, 1990 Depth to Water | April 6, 1990 Water Elev | July 18, 1990 Depth to Water | July 18, 1990 Water Elev | September 13, 1990 Depth to Water | September 13, 1990 Water Elev |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW-1 | 4305 | 5783 | 638.16 | 635.7 | 621.0 | 5.50 | 632.66 | 4.03 | 634.13 | | | NF | | NF | | | | | |
| MW-2 | 5033 | 6839 | 638.14 | 634.8 | 617.0 | 6.87 | 631.27 | 5.65 | 632.49 | | | 5.11 | 633.03 | 5.46 | 632.68 | | | | |
| MW-3 | 5341 | 7359 | 636.56 | 634.1 | 620.0 | 4.48 | 632.08 | 3.48 | 633.08 | | | 3.02 | 633.54 | 3.31 | 633.25 | | | | |
| MW-4 | 6112 | 7126 | 641.06 | 638.2 | 619.0 | 7.08 | 633.98 | 6.51 | 634.55 | | | 5.95 | 635.11 | 5.48 | 635.58 | | | | |
| MW-5 | 5788 | 6482 | 642.20 | 639.4 | 618.0 | 7.89 | 634.31 | 7.53 | 634.67 | | | 7.60 | 634.60 | 6.40 | 635.80 | | | 6.79 | 635.41 |
| MW-6 | 5298 | 5520 | 655.25 | 653.0 | 621.0 | 22.17 | 633.08 | 22.08 | 633.17 | | | 22.33 | 632.92 | 20.88 | 634.37 | | | 20.97 | 634.28 |
| MW-7 | 6112 | 6732 | 641.51 | 638.7 | 618.2 | | | | | | | | | 18.64 | 622.86 | 19.80 | 621.71 | 18.90 | 622.61 |
| MW-8 | 5934 | 7506 | 640.49 | 638.2 | 617.0 | | | | | | | | | 18.17 | 622.32 | 19.30 | 621.19 | 18.35 | 622.14 |
| MW-9 | 4893 | 6991 | 639.05 | 635.9 | 619.3 | | | | | | | | | 16.54 | 622.51 | 17.57 | 621.48 | 16.62 | 622.43 |
| MW-10 | 5200 | 7784 | 635.58 | 633.0 | 619.2 | | | | | | | | | | | 14.58 | 621.00 | 13.64 | 621.94 |
| MW-11 | 6377 | 7329 | 640.52 | 637.5 | 617.2 | | | | | | | | | 5.28 | 635.24 | 6.37 | 634.15 | | |
| MW-12 | 6019 | 6352 | 642.79 | 639.7 | 619.5 | | | | | | | | | 6.92 | 635.87 | 7.84 | 634.95 | | |
| MW-13 | 5051 | 7814 | 634.17 | 631.9 | 619.1 | | | | | | | | | 3.11 | 631.06 | 4.03 | 630.14 | 3.59 | 630.58 |
| MW-14 | 4882 | 6995 | 638.59 | 636.0 | 619.2 | | | | | | | | | 6.68 | 631.91 | 8.91 | 629.68 | 7.93 | 630.66 |
| MW-15 | 4720 | 5002 | 637.91 | 635.2 | 620.3 | | | | | | | | | 4.12 | 633.79 | 5.07 | 632.84 | | |
| MW-16 | 5065 | 6596 | 638.54 | 636.3 | 619.5 | | | | | | | | | 6.42 | 632.12 | 7.05 | 631.49 | | |
| MW-17 | 5656 | 5677 | 647.10 | 648.3 | | | | | | | | | | 12.18 | 634.92 | 12.87 | 634.23 | | |
| MW-18 | 5836 | 5746 | 644.88 | 645.4 | 625.4 | | | | | | | | | | | 9.74 | 635.14 | | |
| LW-1 | 4807 | 5070 | 644.61 | 642.4 | 619.0 | 12.22 | 632.39 | 11.81 | 632.80 | | | 11.78 | 632.83 | 10.69 | 633.92 | | | 11.12 | 633.49 |
| LW-2 | 4662 | 5465 | 649.89 | 647.4 | 621.0 | 17.20 | 632.69 | 16.90 | 632.99 | | | 16.97 | 632.92 | 15.82 | 634.07 | | | | |
| LW-3 | 4483 | 5821 | 645.63 | 643.3 | | 12.70 | 632.93 | 11.49 | 634.14 | | | 12.02 | 633.61 | 11.29 | 634.34 | | | | |
| LW-4 | 4229 | 6132 | 643.30 | 641.5 | 610.0 | 10.46 | 632.84 | 9.95 | 633.35 | | | 10.00 | 633.30 | 9.39 | 633.91 | | | 8.44 | 634.86 |
| | | | OLD | NEW | | OLD | | OLD | | | | | | | | | | | |
| SG-1 | 5009 | 6167 | 632.77 | 633.28 | | 1.65 | 631.12 | 1.56 | 631.21 | | | NF | | NF | | | | 2.11 | 631.17 |
| SG-2 | 4464 | 6852 | 626.42 | 627.76 | | 0.71 | 625.71 | -0.04 | 626.46 | | | 2.83 | 624.93 | 4.50 | 621.92 | | | | |
| SG-3 | 4180 | 7123 | 629.55 | 632.08 | | | | -0.10 | 629.65 | | | 0.90 | 631.18 | 1.30 | 630.78 | | | | |
| SG-4 | 5228 | 6611 | 633.43 | 635.22 | | 0.80 | 632.63 | -0.03 | 633.46 | | | 1.40 | 633.82 | 1.22 | 634.00 | | | | |
| SG-5 | 5466 | 7713 | 632.47 | 632.47 | | 1.98 | 630.49 | 1.87 | 630.60 | | | 1.53 | 630.94 | 1.68 | 630.79 | | | 1.81 | 630.66 |
| SG-6 | 4494 | 8076 | 630.73 | 632.49 | | 0.39 | 630.34 | 0.18 | 630.55 | | | 1.54 | 630.95 | 1.74 | 630.75 | | | | |
| SG-7 | 5406 | 6891 | 636.67 | 637.59 | | 0.63 | 636.04 | 0.54 | 636.13 | 1.32 | 635.35 | 1.90 | 635.69 | 1.45 | 636.14 | | | 0.91 | 636.68 |
| SG-8 | 5483 | 5202 | 636.07 | 636.07 | | | dry | | dry | | | 2.91 | 633.16 | 2.30 | 633.77 | | | | |
| SG-9 | 3846 | 6336 | 632.59 | 632.59 | | | dry | | dry | | | NF | | | | | | dry | |
| SG-10 | 6698 | 7263 | 635.39 | 635.39 | | 0.47 | 634.92 | 0.41 | 634.98 | | | 0.38 | 635.01 | +0.41 | 635.80 | | | NF | |

Notes:
(1) Blank: Indicates the data were not available.
(2) NF: Measurement location was not found for data collection.
(3) OLD/NEW: When measurement location became non-functioning, a new measurement location was installed and the new reference elevation was determined.

ACSRI Table 2-5/TJM/JAW

TABLE 2-6
SUMMARY OF PRIVATE WATER SUPPLY WELLS IN THE ACS SITE VICINI[illegible] [illegible]RIFFITH, INDIANA

| Map Number | Owner | Location | Distance From Site | Date Drilled | Screened Interval (ft.) | Formation | Use of Well(s) | Well Diameter (in.) | Static Water Level | Pumping Data | Log Available |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | Robert & Musetta Yeager | 1600 E. Main | 3800 ft NE | 1955 | 58 ft T.D. | Sand | Home | | | | No |
| 46 | Leon Charbonneau* | 1043 Reder Road | 300 ft E | 1/88 | 60 ft T.D. | | Home | | | | No |
| 47 | Richard Swiss | 333 South Broad St. | 1400 ft NW | | Unknown | | Utility | | | | No |
| 48 | John Sands | 224 Avenue "D" | 800 ft W | 1981 | 28 ft T.D. | | Utility | | | | No |
| 49 | Todd Fullgraf | 341 South Broad | 1300 ft NW | 8/88 | 15 ft T.D. | | Utility | | | | No |
| 50 | Anthony Cadle | 345 South Broad | 1300 ft NW | 5/88 | 14 ft T.D. | Sand | Utility | | | | No |
| 51 | Lavern & Janet Ehrhart | 1549 E. Main | 3500 ft NE | 1983 | 70 ft T.D. | Sand and clay | Utility | | | | No |
| 52 | Wilbur Bramlet | 1543 E. Main | 3500 ft NE | 1950s | 28 ft T.D. | Sand | Home | | | | No |
| 53 | James Jaracz | 113 E. Avenue "C" | 1[illegible]00 ft NW | | 15 ft T.D. | | Utility | | | | No |
| 54 | John Hines | 518 S. Renseelaer | 700 ft W | | 8 ft T.D. | Sand | Utility | | | | No |
| 55 | Mr. Cash | 2830 45th St. | 2.3 miles N | 7/1/59 | 89 | | Home | | | | Yes |
| 56 | John Rosinko | 2830 45th St. | 2.3 miles N | 10/13/59 | 71 | | Home | | | | Yes |
| 57 | Tom Lolhema | 201 Glenwood | 3000 ft N | | | | | | | | No |
| 58 | Steve Lane | 118 Arbogast | 2500 ft N | | | Sand | Lawn watering | | | | No |
| 59 | Howard Schweitzer | 208 E. Ave A. | 2200 ft NW | | | | Lawn watering | | | | No |
| 60 | George Dorin | 139 Dwiggins | 2500 ft N | | 15 | | Lawn watering | | | | No |
| 61 | Ternel | 141 Dwiggins | 2500 ft N | | 13.5 | | Lawn watering | | | | No |
| 62 | Skifano | 144 Dwiggins | 2500 ft N | | 13 | | Lawn watering | | | | No |
| 63 | Williams | 132 Dwiggins | 2500 ft N | | | | | | | | No |
| 64 | Fowler | 136 Jay | 2500 ft N | | 9 | | | | | | No |
| 65 | Litia | 140 Jay | 2500 ft N | | 15 | | | | | | No |

TABLE 2-6
SUMMARY OF PRIVATE WATER SUPPLY WELLS IN THE ACS SITE VICINI GRIFFITH, INDIANA

| Map Number | Owner | Location | Distance From Site | Date Drilled | Screened Interval (ft.) | Formation | Use of Well(s) | Well Diameter (in.) | Static Water Level | Pumping Data | Log Avail-able |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | | SW 1/4,SW 1/4 Sec 35 | 1 mile N-NW | 5/1/43 | | | | 18 | | | Yes |
| 24 | | SW 1/4,SW 1/4 Sec 35 | 3800 ft NW | 11/10/59 | | | | 18 | | | Yes |
| 25 | | NW 1/4,SE 1/4 Sec 2 | ON SITE | 7/27/56 | 56-76 | Gravel | | 8 | | | Yes |
| 26 | Indiana Pipe Line Co. | SE 1/4,NE 1/4 Sec 3 | 1600 ft W-NW | 1/23/43 | 56-68 | Sand | | 8 | | | Yes |
| 27 | | NE 1/4,NW 1/4 Sec 2 | 1800 ft N-NE | 2/5/54 | 86 | Sand | | 18 | | | Yes |
| 28 | | SE 1/4,NE 1/4 Sec 3 | 1 mile W-NW | 5/22/45 | 43 | Sand | | 18 | | | Yes |
| 29 | | SW 1/4,SW 1/4 Sec 35 | 3300 ft N-NW | 6/2/39 | 60 | Sand | | | | | Yes |
| 30 | C&O R.R. | SE 1/4,NW 1/4 Sec 2 | 800 ft N-NW | 12/7/51 | 148 | Limestone | | 4 | | | Yes |
| 31 | C&O R.R. | NW 1/4,SE 1/4 Sec 2 | 1300 ft NW | 12/5/39 | 62-82 | Sand | Industry | 12 | 18 | Pumped at 330 gmp | Yes |
| 32 | American Chemical | Colfax Street | ON SITE | 9/14/71 | 69-74 | Sand | Industry | 1.25 | 22 | Pumped for 2 hrs at 15 gpm | Yes |
| 33 | American Chemical | Colfax Street | ON SI E | 2/24/72 | 265 | Limestone | Home | | | Pumped for 2 hrs at 10 gpm | Yes |
| 34 | Packaging Corp (2 wells) | 300 W. Main | 4000 ft NW | 11/10/59 | 54 & 86 ft TD | Sand | | | | | Yes |
| 35 | Salisbury Eng | Main St | 3800 ft E-NE | 5/10/72 | 74-82 | Sand | Home | 3 | | Pumped for 2 hrs at 18 gpm | Yes |
| 36 | Arthur Hegedus* | 1009 S. Wood St | 2100 ft S-SW | 6/5/73 | 48-53 | Sand | Home | 1.5 | | Pumped for 2 hrs at 10 gpm | Yes |
| 37 | David Reder | 1046 Reder Road | 400 ft E | 1955; 6/89 | 45 & 75 ft T.D. | Sand | Utility | | | | No |
| 38 | Patricia Gatlin | 1544 E. Main | 3600 ft E | 1960 | 95 ft T.D. | | Drinking/utility | | | | No |
| 39 | Mary Johnson | 1624 E. Main | 4000 ft NE | 66;redrilled 19 | 70+ ft T.D. | | Home | | | | No |
| 40 | Franklin Floyd* | 1033 Reder Road | 300 ft E | | 65 ft T.D. | Sand | Utility | | | | No |
| 41 | Oscar Anderson | 202 E. Avenue "D" | 900 ft W | 1948;1950 | 9 & 14 ft TD | and and grave | Utility | | | | No |
| 42 | Benson Breeden | 1547 E. Main | 3700 ft NE | 1950s | 22 ft T.D. | Sand | Home | | | | No |
| 43 | Raymond White | 524 S. Lafayette | 1000 ft W | 1974 | 23 ft T.D. | Sand | Utility | | | | No |
| 44 | Albert Bakker | 1540 E. Main | 3500 ft NE | 1964 | Unknown | Sandy gravel | Utility | | | | No |

TABLE 4-1
1/89 - 7/90 Precipitation Record for Griffith, Indiana

| DATE | January 1989 | February 1989 | March 1989 | April 1989 | May 1989 | June 1989 | July 1989 | August 1989 | September 1989 | October 1989 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | 3.1 Rain | |
| 2 | | 0.05 Rain | | | 0.2 Rain | 3.65 Rain | | | 0.1 Rain | |
| 3 | | 0.15 Snow | | 0.8 Rain | 0.15 Rain | 3.65 Rain | | | | |
| 4 | | 0.5 Snow | 0.4 Rain | 0.5 Rain | | | | | | |
| 5 | | 0.6 Snow | 0.2 Rain | 0.2 Rain | 0.3 Rain | 0.9 Rain | | 0.4 Rain | | |
| 6 | 0.8 Rain | 0.3 Snow | 0.2 Rain | 0.1 Rain | | | | | 0.2 Rain | 0.3 Rain |
| 7 | 0.1 Rain | | | | 0.5 Rain | | | | 1 Rain | |
| 8 | | | | | | | | | 0.2 Rain | |
| 9 | | | | 0.2 Rain | 0.3 Rain | | | 0.2 Rain | 0.6 Rain | |
| 10 | | | | | | | | 1 Rain | 0.2 Rain | Tr Rain |
| 11 | | | | | | | | | | |
| 12 | 0.2 Rain | | | | | 0.7 Rain | 0.8 Rain | | | |
| 13 | | 0.2 Snow | | | 0.1 Rain | 0.4 Rain | | | 0.7 Rain | |
| 14 | 0.12 Snow | | | | 0.1 Rain | | | | 0.7 Rain | |
| 15 | | 0.1 Snow | | | | | | 1.5 Rain | 0.1 Rain | |
| 16 | | 0.52 R&S | | 0.1 Rain | | | | 0.2 Rain | | |
| 17 | | | | | | 0.3 Rain | | | | 0.8 Rain |
| 18 | | | 0.83 R&S | 0.3 Rain | | | | | | 0.2 Rain |
| 19 | | | | 0.4 Rain | 0.1 Rain | | 3.1 Rain | | | 0.1 Rain |
| 20 | | 0.08 Snow | 0.1 Rain | | 1.2 Rain | | 0.6 Rain | 0.5 Rain | | 1.8 Rain&Snow |
| 21 | | | 0.3 Rain&Snow | | | | 1.2 Rain | | | 0.3 Rain |
| 22 | | | | | | | 0.2 Rain | | | |
| 23 | | 1.2 Snow | | | | | | 0.7 Rain | | |
| 24 | | | | | | | | 0.2 Rain | | |
| 25 | | | | | 1.5 Rain | | 0.1 Rain | | | |
| 26 | 0.3 Rain | 0.02 Snow | | | 0.2 Rain | | | | | |
| 27 | | | | | | 0.6 Rain | | | | |
| 28 | | | 0.4 Rain | 0.5 Rain | | 0.3 Rain | | | | |
| 29 | 0.3 Rain | | 0.7 Rain | | 1.5 Rain | | | 0.2 Rain | | |
| 30 | 0.1 Rain | | | | 1 Rain | | 1 Rain | 0.1 Rain | | |
| 31 | | | | | 0.2 Rain | | | | | |
| | Precipitation Total = 1.92 | Precipitation Total = 3.72 | Precipitation Total = 3.13 | Precipitation Total = 3.1 | Precipitation Total = 7.35 | Precipitation Total = 10.5 | Precipitation Total = 7.0 | Precipitation Total = 5 | Precipitation Total = 6.9 | Precipitation Total = 3.5 |

Notes:
Those measurements taken in the form of snow have been reduced by 90% to approximate the amount of liquid precipitation.
Data used to prepare this table are contained in Appendix M.

TABLE 2-6
SUMMARY OF PRIVATE WATER SUPPLY WELLS IN THE ACS SITE VICINI, GRIFFITH, INDIANA

| Map Number | Owner | Location | Distance From Site | Date Drilled | Screened Interval (ft.) | Formation | Use of Well(s) | Well Diameter (in.) | Static Water Level | Pumping Data | Log Avail-able |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 68 | Ron Austgen* | 1002 Reder Road | 200 ft E | | | | Home | | | | No |
| 69 | James Garmon* | 1009 Reder Road | 200 ft E | | | | Home | | | | No |
| 70 | Thomas Jones | 525 S. Rensselaer | 700 ft W | | 50-56 | | Irrigation | | | | No |

Notes:
A blank in the table indicates information is not available.
An asterisk (*) indicates that the well was sampled during the RI.

V251RI Table 2-6/VR/JAW

TABLE 4-1, Cont.
1/89 – 7/90 Precipitation Record for Griffith, Indiana

| DATE | November 1989 | December 1989 | January 1990 | February 1990 | March 1990 | April 1990 | May 1990 | June 1990 | July 1990 |
|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | 0.2 Rain | | 0.2 Rain | | | 0.15 Rain |
| 2 | | | | 0.6 Rain | | 0.4 Rain | | | |
| 3 | | | | | | 0.1 Rain | | | |
| 4 | | | 0.55 Rain | 0.2 Rain | | 0.15 Rain | 1.5 Rain | | |
| 5 | | | 0.2 Rain | | | | 0.4 Rain | | |
| 6 | 0.1 Rain | | | | 0.5 Rain&Snow | | | 0.1 Rain | |
| 7 | 0.5 Rain | | | | | | | | |
| 8 | | 0.1 Snow | | | Tr Rain | | | 2.1 Rain | |
| 9 | | | | | 1 Rain | | | | |
| 10 | 0.1 Rain | | 0.2 Rain | | 0.25 Rain | 0.6 Rain | 2.5 Rain | | 0.7 Rain |
| 11 | 0.05 Rain | 0.4 Snow | | | 0.6 Rain | 0.2 Rain | 0.2 Rain | | 1.9 Rain |
| 12 | | | | | 0.1 Rain | 0.4 Rain | 0.7 Rain | | 0.1 Rain |
| 13 | | | | | | | 1.5 Rain | | |
| 14 | | 0.18 Snow | | 0.05 Rain | | 0.8 Rain | | 0.8 Rain | |
| 15 | 1.4 Rain | | | 5.5 Rain&Snow | | 0.1 Rain | 0.1 Rain | | 0.2 Rain |
| 16 | 1.5 Rain | | | 0.15 Rain | | | 0.4 Rain | | 0.1 Rain |
| 17 | | | 0.9 Rain | 0.23 Rain/Snow | | 0.2 Rain | 0.5 Rain | 0.3 Rain | 0.1 Rain |
| 18 | | | 0.15 Rain | | | | | 0.1 Rain | |
| 19 | | 0.2 Snow | | | 0.2 Rain&Snow | | | | 0.1 Rain |
| 20 | | 0.1 Snow | 0.1 Rain | | | 0.1 Rain | 0.5 Rain | 0.1 Rain | 2.5 Rain |
| 21 | | 0.1 Snow | 0.2 Rain | | | 1.4 Rain | | | 0.6 Rain |
| 22 | | | 0.1 Rain | 0.7 Rain | 0.1 Rain | | | | 0.6 Rain |
| 23 | 0.8 Snow | | | 1.5 Rain/Snow | 1 Rain | | | 0.5 Rain | 0.4 Rain |
| 24 | | | | 0.2 Snow | | | | 0.1 Rain | |
| 25 | | | 1.1 Rain | 0.11 Snow | | | 0.1 Rain | | |
| 26 | | 0.1 Snow | 0.35 Rain/Snow | | | | 1.2 Rain | | 0.6 Rain |
| 27 | | 0.05 Snow | | | | | | 0.2 Rain | |
| 28 | 0.2 Rain | | | | | | | 0.2 Rain | |
| 29 | | | | | 0.3 Rain | | | 1 Rain | 0.2 Rain |
| 30 | | 0.1 Rain | | | 0.5 Rain | | | 0.1 Rain | 0.25 Rain |
| 31 | | | | | 0.1 Rain | | | | |
| | Precipitation Total = 4.65 | Precipitation Total = 1.33 | Precipitation Total = 3.85 | Precipitation Total = 9.44 | Precipitation Total = 4.65 | Precipitation Total = 4.65 | Precipitation Total = 9.6 | Precipitation Total = 5.6 | Precipitation Total = 8.5 |

Notes:
Those measurements taken in the form of snow have been reduced by 90% to approximate the amount of liquid precipitation.
*Data used to prepare this table are contained in Appendix M.*

V251RI TABLE 4-1/JAW/TJM

TABLE 4-2
Summary of Top of Clay Elevations
American Chemical Service NPL Site
Remedial Investigation
Griffith, Indiana

| Well/Boring Number | Ground Elevation | Depth to Clay | Top of Clay Elevation | Thickness of Clay | Base of Clay Elevation |
|---|---|---|---|---|---|
| MW-1 | 635.7 | 15.0 | 620.7 | | |
| MW-2 | 634.8 | 19.0 | 615.8 | | |
| MW-3 | 634.1 | 14.0 | 620.1 | | |
| MW-4 | 638.2 | 19.5 | 618.7 | | |
| MW-5 | 639.4 | 21.0 | 618.4 | | |
| MW-6 | 653.0 | 32.0 | 621.0 | | |
| MW-7 | 638.7 | 20.5 | 618.2 | 18.1 | 600.1 |
| MW-8 | 638.2 | 21.2 | 617.0 | 11.0 | 606.0 |
| MW-9 | 635.9 | 16.6 | 619.3 | 8.5 | 610.8 |
| MW-10 | 633.0 | 13.8 | 619.2 | 6.4 | 612.8 |
| MW-10C | 634.7 | 15.7 | 619.0 | 4.3 | 614.7 |
| MW-11 | 637.5 | 20.3 | 617.2 | | |
| MW-12 | 639.7 | 20.2 | 619.5 | | |
| MW-13 | 631.9 | 12.8 | 619.1 | | |
| MW-14 | 636.0 | 16.8 | 619.2 | | |
| MW-15 | 635.2 | 14.9 | 620.3 | | |
| MW-16 | 636.3 | 16.8 | 619.5 | | |
| MW-17 | 648.3 | NA | NA | | |
| MW-18 | 645.4 | 20.0 | 625.4 | | |
| LW-1 | 642.4 | 23.0 | 619.4 | | |
| LW-2 | 647.4 | 26.0 | 621.4 | | |
| LW-4 | 641.4 | 27.0 | 614.4 | | |
| MW-10A | 634.3 | 15.5 | 618.8 | 4.5 | 614.3 |
| MW-10B | 634.2 | 16.8 | 617.4 | ~1.5 | ~615.9 |

TABLE 4-2 (con't)
Summary of Top of Clay Elevations
American Chemical Services NPL Site
Remedial Investigation

| Well/Boring Number | Ground Elevation | Depth to Clay | Top of Clay Elevation | Thickness of Clay | Base of Clay Elevation |
|---|---|---|---|---|---|
| SB24R | 646.6 | 25.6 | 621.0 | | |
| SB25R | 645.6 | 28.0 | 617.6 | | |
| SB55 | 637.4 | 15.2 | 622.2 | | |
| SB56 | 637.9 | 15.2 | 622.7 | | |
| SB58 | 637.0 | 15.3 | 621.7 | | |
| SB61 | 636.8 | 15.0 | 621.8 | | |
| SB62 | 637.1 | 15.4 | 621.7 | | |
| SB63 | 637.1 | 15.3 | 621.8 | | |
| SB66 | 637.8 | 15.8 | 622.0 | | |
| SB67 | 637.4 | 15.3 | 622.1 | | |
| CB-1 | 633.0 | 14.0 | 619.0 | 2.5 | 616.5 |
| CB-2 | 632.0 | 11.0 | 621.0 | 7.3 | 613.7 |
| CB-3 | 633.0 | 13.0 | 620.0 | 13.0 | 607.0 |

Notes:
Depth of Clay in Feet Below Ground Surface
Thickness of Clay in Feet
Elevations in Mean Sea Level
NA - Not Encountered

V251RI Table 4-2/TJM/JAW

Table 4-3. Permeability Values Calculated from Grain Size Data.

Vadose Zone

| Well Location | Sample Elevation | D10 (mm) | Permeability | | | |
|---|---|---|---|---|---|---|
| MW-1 | 631 - 633 | 0.0145 | 2.1E-04 | cm/sec | 4.1E-04 | ft/min |
| MW-2 | 630 - 633 | 0.0179 | 3.2E-04 | cm/sec | 6.3E-04 | ft/min |
| MW-3 | 632 - 634 | 0.1030 | 1.1E-02 | cm/sec | 2.1E-02 | ft/min |
| MW-4 | 633 - 635 | 0.1128 | 1.3E-02 | cm/sec | 2.5E-02 | ft/min |
| MW-5 | 634 - 636 | 0.0278 | 7.7E-04 | cm/sec | 1.5E-03 | ft/min |
| MW-6 | 646 - 648 | 0.1361 | 1.9E-02 | cm/sec | 3.6E-02 | ft/min |

East Side, Upper Aquifer

| Well Location | Sample Elevation | D10 (mm) | Permeability | | | |
|---|---|---|---|---|---|---|
| MW-4 | 626 - 628 | 0.1358 | 1.8E-02 | cm/sec | 3.6E-02 | ft/min |
| MW-5 | 629 - 631 | 0.1022 | 1.0E-02 | cm/sec | 2.1E-02 | ft/min |
| MW-6 | 631 - 633 | 0.1728 | 3.0E-02 | cm/sec | 5.9E-02 | ft/min |
| MW-7 | 622 - 629 | 0.1393 | 1.9E-02 | cm/sec | 3.8E-02 | ft/min |
| | | Geometric Mean: | 1.8E-02 | cm/sec | 3.6E-02 | ft/min |

West Side, Upper Aquifer

| Well Location | Sample Elevation | D10 (mm) | Permeability | | | |
|---|---|---|---|---|---|---|
| MW-1 | 621 - 623 | 0.1075 | 1.2E-02 | cm/sec | 2.3E-02 | ft/min |
| MW-2 | 622 - 624 | 0.0715 | 5.1E-03 | cm/sec | 1.0E-02 | ft/min |
| MW-3 | 622 - 624 | 0.0890 | 7.9E-03 | cm/sec | 1.6E-02 | ft/min |
| MW-9 | 620 - 626 | 0.0750 | 5.6E-03 | cm/sec | 1.1E-02 | ft/min |
| | | Geometric Mean: | 7.2E-03 | cm/sec | 1.4E-02 | ft/min |

Lower Aquifer

| Well Location | Sample Elevation | D10 (mm) | Permeability | | | |
|---|---|---|---|---|---|---|
| MW-7 | 589 - 594 | 0.2286 | 5.2E-02 | cm/sec | 1.0E-01 | ft/min |
| MW-9 | 601 - 610 | 0.1766 | 3.1E-02 | cm/sec | 6.1E-02 | ft/min |

Notes:

D10 values summarizes in Appendix F.

Permeability Calculated by Hazen Equation (Page 350, Freeze and Cherry, 1979).

Table 4-4. Horizontal Gradients in the Upper Aquifer.

| Variable | Flow Path #1 | | Flow Path #2 | | Flow Path #3 | | Flow Path #4 | | Flow Path #5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| **End Points** | | | | | | | | | | |
| Up/Down Gradient | P-32 | SG-5 | SG-7 | P-27 | P-30 | P-5 | P-4 | P-20 | MW-5 | MW-6 |
| Separation (dL) | | 760 ft | | 450 ft | | 455 ft | | 325 ft | | 1085 ft |
| **Water Elevation** | | | | | | | | | | |
| August 17, 1989 | 634.25 | 630.49 | 636.04 | 629.28 | 634.59 | 633.04 | 633.86 | 633.10 | 634.31 | 633.08 |
| September 8, 1990 | 634.76 | 630.60 | 636.13 | 629.93 | 635.02 | 633.98 | 634.06 | 633.78 | 634.67 | 633.17 |
| February 2, 1990 | 635.12 | 630.94 | 635.69 | 631.58 | 634.88 | 634.15 | 633.80 | 633.91 | 634.60 | 632.92 |
| April 6, 1990 | 635.46 | 630.79 | 636.14 | 631.84 | 635.81 | 634.68 | 635.30 | 634.90 | 635.80 | 634.37 |
| September 13, 1990 | 634.92 | 630.66 | 636.68 | 630.72 | 635.45 | 633.80 | 634.96 | 634.77 | 635.41 | 634.28 |
| **Water Elevation Difference (dH)** | | | | | | | | | | |
| August 17, 1989 | | 3.76 | | 6.76 | | 1.55 | | 0.76 | | 1.23 |
| September 8, 1990 | | 4.16 | | 6.20 | | 1.04 | | 0.28 | | 1.50 |
| February 2, 1990 | | 4.18 | | 4.11 | | 0.73 | | -0.11 | | 1.68 |
| April 6, 1990 | | 4.67 | | 4.30 | | 1.13 | | 0.40 | | 1.43 |
| September 13, 1990 | | 4.26 | | 5.96 | | 1.65 | | 0.19 | | 1.13 |
| **Horizontal Gradient** | | | | | | | | | | |
| August 17, 1989 | | 0.0049 | | 0.0150 | | 0.0034 | | 0.0023 | | 0.0011 |
| September 8, 1990 | | 0.0055 | | 0.0138 | | 0.0023 | | 0.0009 | | 0.0014 |
| February 2, 1990 | | 0.0055 | | 0.0091 | | 0.0016 | | -0.0003 | | 0.0015 |
| April 6, 1990 | | 0.0061 | | 0.0096 | | 0.0025 | | 0.0012 | | 0.0013 |
| September 13, 1990 | | 0.0056 | | 0.0132 | | 0.0036 | | 0.0006 | | 0.0010 |
| Average | | 0.0055 | | 0.0121 | | 0.0027 | | 0.0009 | | 0.0013 |

Notes:

Water levels summarized in Table 2-5.

Flow Paths shown on Figure 4-19.

HGRAD4-4/PJV/JAW

## Table 4-5. Upper Aquifer Horizontal Groundwater Seepage Rates

| Variable | | Flow Path #1 | Flow Path #2 | Flow Path #3 | Flow Path #4 | Flow Path #5 |
|---|---|---|---|---|---|---|
| **Groundwater Seepage Rate Based on Geometric Mean Permeability for Site** | | | | | | |
| K | (permeability) | 7.9E-03 ft/min | 7.9E-03 ft/min | 7.9E-03 ft/min | 7.9E-03 ft/min | 7.9E-03 ft/min |
| i | (gradient) | 0.0056 | 0.0121 | 0.0027 | 0.0009 | 0.0013 |
| n | (effective porosity) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Vs | (seepage rate) | 2.2E-04 ft/min | 4.8E-04 ft/min | 1.1E-04 ft/min | 3.7E-05 ft/min | 5.1E-05 ft/min |
| | | **115** ft/yr | **252** ft/yr | **56** ft/yr | **19** ft/yr | **27** ft/yr |
| **Groundwater Seepage Rate Based on Permeability at Nearest Monitoring Well.** | | | | | | |
| Nearest Monitoring Well: | | MW-3 | MW-3 | MW-2 | MW-5 | MW-5 |
| K | (permeability) | 4.2E-03 ft/min | 4.2E-03 ft/min | 2.9E-03 ft/min | 2.3E-02 ft/min | 2.3E-02 ft/min |
| i | (gradient) | 0.0056 | 0.0121 | 0.0027 | 0.0009 | 0.0013 |
| n | (effective porosity) | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| Vs | (seepage rate) | 1.2E-04 f min | 2.6E-04 ft/min | 3.9E-05 ft/min | 1.1E-04 ft/min | 1.5E-04 ft/min |
| | | **61** ft/yr | **134** ft/yr | **20** ft/yr | **57** ft/yr | **78** ft/yr |

Notes:

Flow Paths shown on Figure 4-19.
Permeability values summarized on Table 2-4.
Average hydraulic gradients calculated on Table 4-4.
Effective Porosity assumed to be 0.2.

GWV4-6PJV/JAW

## TABLE 4-6. Vertical Hydraulic Gradients Between Upper and Lower Aquifers.

| Well Nest | Clay Thickness (effective separation) | Groundwater Elevations (ft msl) 4/6/90 | 7/18/90 | 9/13/90 | Average Gradient |
|---|---|---|---|---|---|
| P-8 | | 635.98 | | 635.33 | |
| MW-7 | | 622.86 | 621.71 | 622.61 | |
| Difference: | 18 ft | 13.12 | | 12.72 | |
| Vertical Gradient: | | 0.73 | | 0.71 | 0.72 |
| P-28 | | 634.86 | | 634.03 | |
| MW-8 | | 622.32 | 621.19 | 622.14 | |
| Difference: | 11 ft | 12.54 | | 11.89 | |
| Vertical Gradient: | | 1.14 | | 1.08 | 1.11 |
| MW-14 | | 631.91 | 629.68 | 630.66 | |
| MW-9 | | 622.51 | 621.48 | 622.43 | |
| Difference: | 8.5 ft | 9.4 | 8.2 | 8.23 | |
| Vertical Gradient: | | 1.11 | 0.96 | 0.97 | 1.01 |
| MW-13 | | 631.06 | 630.14 | 630.58 | |
| MW-10 | | | 621.00 | 621.94 | |
| Difference: | 6.4 ft | | 9.14 | 8.64 | |
| Vertical Gradient: | | | 1.43 | 1.35 | 1.39 |

Notes:

The effective screeen separation is assumed to be the thickness of the clay confining layer.

Water levels are derived from Table 2-5.

Positive values indicate gradients are downward.

VGRAD4-6PJV/JAW

# Table 4-7. Clay Confining Layer Permeability and Seepage

## Laboratory Measurments

| Monitoring Well | Laboratory Permeability | Laboratory Porosity |
|---|---|---|
| MW-1 | 6.0E-08 cm/sec | Not Measured |
| MW-2 | 3.8E-08 cm/sec | Not Measured |
| MW-3 | 3.2E-08 cm/sec | Not Measured |
| MW-4 | 6.7E-07 cm/sec | Not Measured |
| MW-5 | 5.8E-09 cm/sec | Not Measured |
| MW-6 | 3.6E-08 cm/sec | Not Measured |
| MW-7 | 7.9E-08 cm/sec | 0.257 |
| MW-9 | 3.3E-08 cm/sec | 0.327 |
| Geom. Mean: | 4.8E-08 cm/sec | |
| Minimum: | 5.8E-09 cm/sec | |
| Maximum: | 6.7E-07 cm/sec | |

## Seepage Rate Calculation

| Location | Average Permeability | Vertical Gradient | Average Porosity | Vertical Seepage Rate |
|---|---|---|---|---|
| MW-7 | 4.8E-08 cm/sec | 0.72 | 0.15 | 2.3E-07 cm/sec<br>0.24 ft/yr |
| MW-8 | 4.8E-08 cm/sec | 1.11 | 0.15 | 3.5E-07 cm/sec<br>0.37 ft/yr |
| MW-9 | 4.8E-08 cm/sec | 1.01 | 0.15 | 3.2E-07 cm/sec<br>0.33 ft/yr |
| MW-10 | 4.8E-08 cm/sec | 1.39 | 0.15 | 4.4E-07 cm/sec<br>0.46 ft/yr |

Notes:

Laboratory values summarized in Table 2-2.
Vertical Gradients averaged from Table 4-6.
Effective porosity calculated as 0.5 x average measured porosity.

**Table 5-1**

**Organic Compound Groupings**
**American Chemical Services NPL Site**
**Remedial Investigation**

| BETX Compounds | Chlorinated Benzenes | Chlorinated Ethenes |
|---|---|---|
| Benzene | Chlorobenzene | Vinyl Chloride |
| Toluene | 1,3-Dichlorobenzene | 1,1-Dichloroethene |
| Ethylbenzene | 1,4-Dichlorobenzene | Total-1,2-Dichloroethenes |
| Total Xylenes | 1,2-Dichlorobenzene | Trichloroethene |
| | 1,2,4-Trichlorobenzene | Tetrachloroethene |
| | Hexachlorobenzene | |

| Chlorinated Ethanes | Ketones | Phthalates |
|---|---|---|
| Chloroethane | Acetone | Dimethylphthalate |
| 1,1-Dichloroethane | 2-Butanone | Diethylphthalate |
| 1,2-Dichloroethane | 4,-Methyl-2-Pentanone | Di-n-butylphthalate |
| 1,1,1-Trichloroethane | 2-Hexanone | Butylbenzylphthalate |
| 1,1,2-Trichloroethane | Isophorone | bis(2-Ethylhexyl)phthalate |
| 1,1,2,2-Tetrachloroethane | | |

| PCBs | PAHs | Phenols |
|---|---|---|
| Aroclor 1242 | Naphthalene | Phenol |
| Aroclor 1248 | 2-Methylnaphthalene | Benzyl Alcohol |
| Aroclor 1254 | Acenaphthylene | 2-methylphenol |
| Aroclor 1260 | Acenaphthene | 4-Methylphenol |
| | Fluorene | 2,4-Dimethylphenol |
| | Phenanthrene | Benzoic Acid |
| | Anthracene | 2,4-Dichlorophenol |
| | Fluoranthene | 4-Chloro-3-Methylphenol |
| | Pyrene | 2,4,5-Trichlorophenol |
| | Benzo(b)anthracene | 4-Nitrophenol |
| | Chrysene | Pentachlorophenol |
| | Benzo(b)fluoranthene | |
| | Benzo(k)fluoranthene | |
| | Benzo(a)pyrene | |
| | Indeno(1,2,3-cd)pyrene | |
| | Dibenzo(a,h)anthracene | |
| | Benzo(g,h,i)perylene | |

TABLE 5-2

Sampling Results, Compound Groupings
ACS Site, Griffith, Indiana

| Sample ID | Sample Depth | VOCs | PCBs | PHENOLS | PAHs | PHTHALATES | CHLORINATED ETHENES | CHLORINATED ETHANES | BETX | CHLORINATED BENZENES | KETONES | CHROMIUM | LEAD | Waste Area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACS-SA03-03 | 3 | 980 | | | 50 | 2600 | | | 980 | | | 11.2 | 25.5 | 1 |
| ACS-SB08-06 | 6 | | | | 2130 | 57 | | | | | | 8.7 | 12.8 | 1 |
| ACS-SB08-10 | 10 | 18900 | | 93 | 3450 | 119 | | | 18823 | 122 | 75 | | 2.9 | 1 |
| ACS-SB09-06 | 6 | 190 | | | | 170 | | | | | 190 | | 6.6 | 1 |
| ACS-SB09-10 | 10 | 363 | | 99 | 370 | 39 | | | 125 | 110 | 238 | 6.7 | 5 | 1 |
| ACS-SB10-05 | 5 | 268370 | 26600 | 160 | 121338 | 15086 | 3020 | 2800 | 262550 | 3370 | | 7.5 | 7.8 | 1 |
| ACS-SB10-10 | 10 | 14830 | | 718 | 1800 | 410 | 1450 | 360 | 12630 | 9450 | 390 | 4.6 | 6.6 | 1 |
| ACS-SB11-05 | 5 | 120 | | | 54 | 85 | 44 | 15 | 38 | | 23 | 4.8 | 3 | 1 |
| ACS-SB11-10 | 10 | 30560 | | 1646 | 590 | 118 | 3590 | 5900 | 20700 | 10790 | | | 3.6 | 1 |
| ACS-SB12-05 | 5 | 599870 | 870 | | | | 18870 | 1500 | 573300 | | | 4.8 | 3 | 1 |
| ACS-SB12-10 | 10 | 43640 | 990 | 2270 | | 200 | 4800 | 610 | 30600 | 430 | 7400 | 22.5 | 43.9 | 1 |
| ACS-SB13-05 | 5 | 495 | | 177 | | 57 | 50 | 8 | 290 | | 144 | 5 | 4.5 | 1 |
| ACS-SB13-10 | 10 | 53670 | | 1450 | 1700 | 89 | | | 53020 | 3200 | 650 | 9.1 | 7.5 | 1 |
| ACS-SB35-17 | 17 | | 10500 | * | * | * | | | | | | * | * | 1 |
| ACS-SB55-07 | 7 | 4123000 | * | * | * | * | 1110000 | 11000 | 3002000 | | | * | * | 1 |
| ACS-SB55-16 | 16 | 103190 | * | * | * | * | 29160 | 220 | 73810 | | | * | * | 1 |
| ACS-SB56-07 | 7 | 188 | * | * | * | * | | | 188 | | | * | * | 1 |
| ACS-SB56-16 | 16 | 412 | * | * | * | * | | | 410 | 2 | | * | * | 1 |
| ACS-SB57-07 | 7 | 1280 | * | * | * | * | 59 | 117 | 1084 | | 11 | * | * | 1 |
| ACS-SB57-16 | 16 | 30200 | * | * | * | * | 2300 | 1020 | 25500 | 180 | 1200 | * | * | 1 |
| ACS-SB58-07 | 7 | 14540 | * | * | * | * | 7990 | 970 | 5580 | | | * | * | 1 |
| ACS-SB58-16 | 16 | 24830 | * | * | * | * | 3490 | 1640 | 19700 | | | * | * | 1 |
| ACS-SB59-07 | 7 | 20550 | * | * | * | * | 210 | | 20100 | 240 | | * | * | 1 |
| ACS-SB59-16 | 16 | 29910 | * | * | * | * | 300 | | 29310 | 300 | | * | * | 1 |
| ACS-SB60-07 | 7 | 188600 | * | * | * | * | 111000 | 2800 | 74800 | | | * | * | 1 |
| ACS-SB60-16 | 16 | 10120 | * | * | * | * | 1190 | 890 | 8040 | | | * | * | 1 |
| ACS-SB61-07 | 7 | 6220 | | * | * | * | 300 | 910 | 5010 | | | * | * | 1 |
| ACS-SB61-16 | 16 | 13720 | | * | * | * | 380 | 760 | 12580 | | | * | * | 1 |
| ACS-SB62-07 | 7 | 3764 | 130 | * | * | * | 90 | 80 | 3260 | 2 | 320 | * | * | 1 |
| ACS-SB62-16 | 16 | 826 | | * | * | * | 82 | 21 | 553 | | 160 | * | * | 1 |
| ACS-SB63-07 | 7 | 659 | | * | * | * | | | 409 | | 250 | * | * | 1 |
| ACS-SB63-15.5 | 15.5 | 36 | | * | * | * | | 1 | 35 | | | * | * | 1 |
| ACS-SB64-07 | 7 | 56365 | 230 | * | * | * | 24 | 5 | 56335 | | | * | * | 1 |
| ACS-SB64-16 | 16 | 148 | | * | * | * | | | 144 | | 4 | * | * | 1 |
| ACS-SB65-07 | 7 | 1990 | | * | * | * | | | 1990 | | | * | * | 1 |
| ACS-SB65-16 | 16 | 516 | | * | * | * | | | 516 | | | * | * | 1 |
| ACS-SB66-07 | 7 | 102 | 700 | * | * | * | 5 | 2 | 11 | | 84 | * | * | 1 |
| ACS-SB66-16 | 16 | 45 | | * | * | * | | | 45 | | | * | * | 1 |
| ACS-SB67-07 | 7 | 197 | | * | * | * | 5 | 7 | 91 | 3 | 87 | * | * | 1 |
| ACS-SB67-16 | 16 | 30 | | * | * | * | 3 | 2 | 25 | | | * | * | 1 |
| ACS-SB68-07 | 7 | 173 | | * | * | * | 2 | 3 | 41 | | 127 | * | * | 1 |
| ACS-SB68-16 | 16 | 155 | | * | * | * | 4 | 2 | 36 | | 110 | * | * | 1 |
| ACS-TP02-03 | 3 | 264700000 | 500000 | 38200 | 197200 | 194500 | 5900000 | 20000000 | 238800000 | 4000 | 88000 | 271 | 1440 | 1 |
| ACS-TP02-05 | 5 | 2159600 | 38800 | 400 | 30090 | 29900 | 195200 | 330000 | 1628000 | | 3900 | 9 | 22.4 | 1 |
| ACS-SB14-11 | 11 | 43810 | | 4740 | 6583 | 35630 | 200 | 310 | 14000 | 1248 | 51300 | 10.2 | 21.9 | 2 |
| ACS-SB15-13 | 13 | 5620000 | | 174000 | 324800 | 2791000 | 420000 | 110000 | 4410000 | 9200 | 1660000 | 307 | 1290 | 2 |
| ACS-SB16-06 | 6 | 4996000 | | | 69000 | 410000 | 263000 | 312000 | 4020000 | 3800 | 401000 | 23.5 | 42.4 | 2 |

Table 1-2

Summary of Disposal Practices
American Chemical Services, Inc. and Kapica Drum, Inc.
American Chemical Services NPL Site
Remedial Investigation

| Disposal Practice | Period | Type | Quantity | Location | Comments |
|---|---|---|---|---|---|
| AMERICAN CHEMICAL SERVICE, INC. | | | | | |
| Landfilling | 1955-1977 | | | Off-site Containment Area | Containers punctured as they were landfilled |
| | | 55 gal. drums of PCB contaminated waste | 6 drums | | |
| | | Non-reclaimable still bottoms | | | |
| | | Drums containing solidified materials Ex: Latex paint, solid resin | | | |
| | 1956-1975 | Distillation bottoms | 10,000 cy | | |
| | | Solid material rec'd for reclamation | | | |
| | | Solid material rec'd for incineration | | | |
| | | Paper | | | |
| | | Incinerator ashes | 68 cy | | |
| | | Ignitable and corrosive hazardous wastes | | | |
| | | Chlorinated solvent, acetone and MEK bottoms | | | |
| | | Spent cresylic acid, cyanide and chromium from plating | | | |
| | | Lead pigments | | | |
| | | Empty bottles that had contained 2,4,D and 2,4,5-TP | Several 100 cases | | |
| | | 1 tank truck containing 500 gallons solidified paint | | | |

Table 1-2
(continued)
Summary of Data Collected During RI
American Chemical Services NPL Site
Remedial Investigation

| Disposal Practice | Period | Type | Quantity | Location | Comments |
|---|---|---|---|---|---|
| Landfilling | Mid 60's | Sludge and semi-solids of unknown type | 400 drums | On-site Containment area | |
| Landfilling | 1969-1975 | Solids in drums-questionable as to content, but probably solvent solids of benzene, Amylacetate, dimethyl aniline, diethylether | 200 drums | Treatment Pond #1 or Off-site Containment Area | During this time the 2,4,D and 2,4,5-TP plus an unknown amount of DDT was incinerated |
| Landfilling | 1955-1967 | Trash | | City of Griffith Indiana Landfill | |
| | | Retained samples (contained hazardous substances) | 10 gal/wk | | |
| Pond Disposal | 1955-1972 | Still bottoms sludges from reclamation processes sludges containing 1,1,1-trichloroethane, trichloroethylene, methylene chloride, toluene, benzene, and other low boiling solvents | 253,510 gal still bottoms sludge and 2,000 partially filled drums | Old Still Bottoms Pond (125' dia x 4.5' deep) | |
| | | Partially filled drums of semi-solid paint, lacquer and ink waste | 41,612 gal sludge; 1,000 partially filled drums | Old Treatment Pond #1 (180' x 70' x 3' deep) | Treatment Pond #1 and the still bottoms pond were filled and sealed in 1972. During closing the liquid portion of Treatment Pond #1 and the Still Bottom Pond were drained leaving the heavy sludges. Drums were placed on top of the pond, punctured and crushed. Ponds were "closed off" by sand fill and compacting |
| | 1968-1976 | Aqueous phase containing small quantities of organic (some hazardous) solvents | | Treatment Pond #2 (Fire Pond) (180'x70'x10' deep) | Supposedly biodegradable wastewater overflow from Treatment Pond #1 and API oil decanter was discharged here. Overflow from Treatment Pond #2 went to the marsh from 1968-1974 and to the POTW from 1974 to present |

Table 1-2
Continued
Summary of Data Collected During RI
American Chemical Services NPL Site
Remedial Investigation

| Disposal Practice | Period | Type | Quantity | Location | Comments |
|---|---|---|---|---|---|
| Treatment Pond Inter-connections | | | | | |
| API Oil Decanter | 1963-1967 | 1,1,1-trichloroethane, trichloroethylene, methylene chloride, toluene, benzene and other low boiling solvents | | API oil decanter | Dimensions are 15'x15'x5'<br>1963-1967-wastewater flowed directly to marsh<br>1967-1972-wastewater flowed to TP #1 then to marsh<br>1972-1974-wastewater flowed to TP #2 then to marsh |
| Trenches | 1955-1976 | Reclamation residues containing above-mentioned compounds | | Trench #1 (1'x2'x125') | Conducted wastewater to Trench #2 |
| | 1955-1976 | Reclamation residues containing above-mentioned compounds | | Trench #2 (1'x2'x110') | 1955-1963-conducted wastewater from reclamation facility to marsh<br>1963-1976-to API oil decanter<br>Replaced in 1976 by a close-pipe system |
| | 1963-1976 | Aqueous phase w/small quantities of organic (some hazardous) solvents | | Trench #3 (1'x2'x70') | (1963-1967): conducted wastewater from API oil decanter to marsh. All trenches are presently filled, and the area is used as a roadway |
| KAPICA DRUM, INC. (Later Pazmey Corp.) | | | | | |
| DISPOSAL OF CONTENTS | | | | | |
| | 1961-1971 | If drums sent to Kapica contained liquid, the contents were dumped on the ground | 330 $yd^3$ | Kapica Dump site | |
| | | OR | | | |
| | | Combined to generate full drums | 2,500 drums | Griffith Sanitary Landfill | |
| | 1978-1980 | Paint residue sludge from Kapica Drums, Inc. | 250 gal/wk | ACS sludge box | For disposal of Gary Development Landfill |

Table 1-2
Continued
Summary of Data Collected During RI
American Chemical Services NPL Site
Remedial Investigation

| Disposal Practice | Period | Type | Quantity | Location | Comments |
|---|---|---|---|---|---|
| DISPOSAL OF RINSE WATER | | | | | |
| | 1961-1971 | Unknown | Unknown | West end of Kapica property | |
| Drum Washing | 1962-1983 | Liquid Waste | | Flowed intermittently onto ACS property from Kapica Drums, Inc. and Pazmey Corp. | |
| Drum Reconditioning | 1962-July 1980 | Empty drums from ACS were picked up and reconditioned by Kapica | | Kapica Drums | After August, 1980, ACS bought new drums from Kapica (who sold out to Pazmey in 2/80) |
| | 1962-1980 | 1,000 gal. $H_2O$ containing 600 lbs. NaOH(s) + 400 lbs $Na_3PO_4$(s) | 3 times/year | Unknown | Used for washing drums at Kapica |

Notes:
Table has been modified from: "Initial Site Evaluation", Camp Dresser and McKee, Inc., March 26, 1985, Table 3.
Information contained in Table 3 is from the ACS response to U.S. EPA Request for Information (October 18, 1984).

V251RI Table 1-2/JAW/mp/PJV

**TABLE 1-3**

**Event Chronology**
**Summary of Data Collected During RI**
**American Chemical Services NPL Site**
**Remedial Investigation**

| Date | Event |
|---|---|
| 1950's | Griffith Landfill begins operations. |
| 1951 | Kapica Drum begins operations. |
| 1954 | Aerial photograph available (Appendix A). |
| May 1955 | ACS begins operations as a solvent recovery facility. |
| 1958 | Aerial photograph available (Appendix A). |
| 1955-1968 | "Occasional" leaking of drums in drum storage area. |
| 1960s | Leaching and/or runoff from the Still Bottoms Pond reportedly kills off vegetation in marsh area to west of site. |
| 1968 | Small fire in drum storage area; several hundred gallons of material spilled. |
| 1970 | Aerial photograph available (Appendix A). |
| 1972 | Still Bottoms Pond and Treatment Lagoon #1 taken out of service. Use of Off-Site Containment Area discontinued. |
| 1973 | Aerial photograph available (Appendix A). |
| 1972-1973 | ISBH inspections and concern regarding waste handling, site maintenance and spill prevention. |
| 1974-1975 | ISBH expresses concerns regarding discharge of chemicals to sewer and alleged dumping. |
| Feb 1980 | U.S. EPA makes identification and preliminary assessment of ACS as potential hazardous site. |
| May 8-9, 1980 | U.S. EPA samples soil, leachate and surface water in vicinity of Griffith Landfill and Off-Site Containment Area. Leachate noted emanating from Off-Site Containment Area and Griffith Landfill. |

**TABLE 1-3**
(Continued)
**Summary of Data Collected During RI**
**American Chemical Services NPL Site**
**Remedial Investigation**

| Date | Event |
|---|---|
| Aug 19, 1980 | U.S. EPA requires ACS to provide containment measures to prevent oily discharge from the Off-Site Containment Area. |
| Sep 9, 1980 | U.S. EPA FIT performs on-site investigation/inspection. Leachate springs and vegetation damage noted in Off-Site Containment Area. |
| 1981 | Aerial photograph available (Appendix A). |
| July 1982 | U.S. EPA FIT installs four monitoring wells at ACS Site. |
| June 1983 | ACS receives a composite HRS Score of 34.98. |
| Sep 1983 | Pazmey Corporation receives notice of violation from ISBH for allowing run-off of caustic rinsewater onto the ground. |
| 1984 | Seven private wells are sampled in the Site vicinity by the Lake County Health Department. |
| 1984 | ATEC performs a Preliminary Hydrogeologic Site Assessment for ACS. |
| Nov 29, 1984 | Site Assessment is performed by the U.S. EPA TAT centering on the Off-Site Containment Area and the area of Treatment Lagoon #1. |
| 1986 | Steering Committee formed by PRPs to organize, oversee, and determine funding of RI/FS. |
| 1987 | Operation of Kapica Drum/Pazmey Corp. discontinued. |
| Mar 1987 | Roy F. Weston develops Final Work Plan for ACS for U.S. EPA. |
| Apr 1988 | Warzyn Engineering Inc. develops a Work Plan for the ACS RI/FS and receives U.S. EPA approval. |
| June 30, 1988 | Effective date of Administrative Order of Consent (AOC). |
| July 1989 | Phase I field work commences at the ACS Site. |

**TABLE 1-3**
(Continued)
**Summary of Data Collected During RI**
**American Chemical Services NPL Site**
**Remedial Investigation**

| Date | Event |
|---|---|
| June 1, 1989 | U.S. EPA TAT conducts soil and groundwater sampling at the Griffith Landfill. |
| Mar 1990 | Phase II investigation commences at the ACS Site. |

251RI Table 1-3/JAW/jaw/PJV

TABLE 2-1
SUMMARY OF
WELL CONSTRUCTION DETAILS
American Chemical Services NPL Site
Remedial Investigation
Griffith, Indiana

| | MW-01 | MW-02 | MW-03 | MW-04 | MW-05 | MW-06 | MW-07 | MW-08 | MW-09 | MW-10 | MW-10C | MW-11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Surface Elevation (ft MSL) | 635.7 | 634.8 | 634.1 | 638.2 | 639.4 | 653.0 | 638.7 | 638.2 | 635.9 | 633.0 | 634.7 | 637.5 |
| Total Depth of Boring (ft) | 17.0 | 22.0 | 15.0 | 20.0 | 22.0 | 34.0 | 50.0 | 47.0 | 35.0 | 35.0 | 25.0 | 21.0 |
| T.O.I.C. Elevation (ft MSL) | 638.16 | 638.14 | 636.56 | 641.06 | 642.20 | 655.25 | 641.51 | 640.49 | 639.05 | 635.58 | 637.59 | 640.52 |
| Well Materials | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS |
| Screen Materials | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS |
| Screen Length (ft) | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 10.0 |
| Slot Size (in) | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| Geologic Formation at Screen | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand |
| Depth to Clay | 15.0 | 19.0 | 14.0 | 19.5 | 21.0 | 32.0 | 20.5 | 21.2 | 16.6 | 13.8 | 15.7 | 20.3 |
| Elevation of Clay | 620.7 | 615.8 | 620.1 | 618.7 | 618.4 | 621.0 | 618.2 | 617.0 | 619.3 | 619.2 | 619.0 | 617.2 |
| Top of Seal - Depth (ft) | 2.1 | 2.0 | 1.5 | 4.0 | 3.0 | 15.0 | 30.0 | 31.0 | 23.6 | 24.0 | 15.4 | 2.5 |
| - Elevation (ft MSL) | 633.6 | 632.8 | 632.6 | 634.2 | 636.4 | 638.0 | 608.7 | 607.2 | 612.3 | 609.0 | 619.3 | 635.0 |
| Top of Sand Pack - Depth (ft) | 3.1 | 3.8 | 3.5 | 5.3 | 5.0 | 17.0 | 38.0 | 33.5 | 26.0 | 26.7 | 17.7 | 4.8 |
| - Elevation (ft MSL) | 632.6 | 631.0 | 630.6 | 632.9 | 634.4 | 636.0 | 600.7 | 604.7 | 609.9 | 606.3 | 617.0 | 632.7 |
| Top of Screen - Depth (ft) | 4.5 | 6.5 | 4.5 | 7.0 | 7.5 | 20.0 | 42.8 | 40.0 | 30.0 | 30.0 | 20.0 | 7.5 |
| - Elevation (ft MSL) | 631.2 | 628.3 | 629.6 | 631.2 | 631.9 | 633.0 | 595.9 | 598.2 | 605.9 | 603.0 | 614.7 | 630.0 |
| Bottom of Well Point - Depth (ft) | 14.5 | 16.5 | 14.5 | 17.0 | 17.5 | 30.0 | 47.8 | 45.0 | 35.0 | 35.0 | 25.0 | 17.5 |
| - Elevation (ft MSL) | 621.2 | 618.3 | 619.6 | 621.2 | 621.9 | 623.0 | 590.9 | 593.2 | 600.9 | 598.0 | 609.7 | 620.0 |
| Map Coordinates: North | 5783.0 | 6838.7 | 7358.7 | 7126.3 | 6482.0 | 5520.1 | 6732.1 | 7506.4 | 6990.5 | 7783.5 | 7553.5 | 7328.8 |
| East | 4304.6 | 5033.1 | 5340.6 | 6112.2 | 5788.1 | 5297.6 | 6112.4 | 5934.1 | 4893.1 | 5199.7 | 5229.3 | 6377.4 |
| Completion Date | 25-Jul-89 | 24-Jul-89 | 21-Jul-89 | 20-Jul-89 | 19-Jul-89 | 18-Jul-89 | 14-Mar-90 | 16-Mar-90 | 21-Mar-90 | 01-May-90 | 03-Apr-90 | 29-Mar-90 |

NOTES: T.O.I.C. - Top of Inner Well Casing
ID - Inside Diameter
SS - Stainless Steel
MSL - Mean Sea Level
NA - Data Not Available

TABLE 2-1
SUMMARY OF
WELL CONSTRUCTION DETAILS
American Chemical Services NPL Site
Remedial Investigation
Griffith, Indiana

| | MW-12 | MW-13 | MW-14 | MW-15 | MW-16 | MW-17 | MW-18 | LW-01 | LW-02 | LW-03 | LW-04 | P-01 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Surface Elevation (ft MSL) | 639.7 | 631.9 | 636.0 | 635.2 | 636.3 | 648.3 | 645.4 | 642.4 | 647.4 | 643.3 | 641.5 | 641.2 |
| Total Depth of Boring (ft) | 22.5 | 15.0 | 17.0 | 17.0 | 17.0 | 25.0 | 23.5 | 25.0 | 27.5 | 23.5 | 28.5 | 12.5 |
| T.O.I.C. Elevation (ft MSL) | 642.79 | 634.17 | 638.59 | 637.91 | 638.54 | 647.10 | 644.88 | 644.61 | 649.89 | 645.63 | 643.30 | 642.85 |
| Well Materials | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID PVC | 2"ID PVC | 2"ID PVC | 2"ID PVC | 1.5" PVC |
| Screen Materials | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID SS | 2"ID PVC | 2"ID PVC | 2"ID PVC | 2"ID PVC | 1.5" PVC |
| Screen Length (ft) | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 5.0 |
| Slot Size (in) | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| Geologic Formation at Screen | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | F-M Sand | Refuse | Refuse | Refuse | Refuse | Sand |
| Depth to Clay | 20.2 | 12.8 | 16.8 | 14.9 | 16.8 | NA | 20.0 | 23.0 | 26.0 | NA | 27.0 | NA |
| Elevation of Clay | 619.5 | 619.1 | 619.2 | 620.3 | 619.5 | NA | 625.4 | 619.4 | 621.4 | NA | 614.5 | NA |
| Top of Seal - Depth (ft) | 2.8 | 1.0 | 1.5 | 2.0 | 2.3 | 8.3 | 7.0 | 9.0 | 13.0 | 8.0 | 12.0 | 0.0 |
| - Elevation (ft MSL) | 636.9 | 630.9 | 634.5 | 633.2 | 634.0 | 640.0 | 638.4 | 633.4 | 634.4 | 635.3 | 629.5 | 641.2 |
| Top of Sand Pack - Depth (ft) | 5.1 | 2.0 | 3.0 | 3.0 | 4.0 | 10.0 | 9.5 | 11.0 | 14.5 | 11.3 | 14.0 | 6.0 |
| - Elevation (ft MSL) | 634.6 | 629.9 | 633.0 | 632.2 | 632.3 | 638.3 | 635.9 | 631.4 | 632.9 | 632.0 | 627.5 | 635.2 |
| Top of Screen - Depth (ft) | 7.5 | 3.3 | 5.5 | 4.4 | 6.0 | 13.0 | 12.0 | 14.5 | 17.5 | 13.5 | 17.0 | 7.0 |
| - Elevation (ft MSL) | 632.2 | 628.6 | 630.5 | 630.8 | 630.3 | 635.3 | 633.4 | 627.9 | 629.9 | 629.8 | 624.5 | 634.2 |
| Bottom of Well Point - Depth (ft) | 17.5 | 13.3 | 15.5 | 14.5 | 16.0 | 23.0 | 22.0 | 24.5 | 27.5 | 23.5 | 27.0 | 12.0 |
| - Elevation (ft MSL) | 622.2 | 618.6 | 620.5 | 620.7 | 620.3 | 625.3 | 623.4 | 617.9 | 619.9 | 619.8 | 614.5 | 629.2 |
| Map Coordinates: North | 6351.7 | 7814.4 | 6995.3 | 5002.2 | 6596.4 | 5677.3 | 5745.7 | 5070.4 | 5464.9 | 5821.0 | 6132.2 | 6365.2 |
| East | 6018.6 | 5051.4 | 4881.6 | 4719.6 | 5065.2 | 5656.3 | 5836.4 | 4806.8 | 4662.4 | 4482.6 | 4229.1 | 5699.7 |
| Completion Date | 30-Mar-90 | 04-Apr-90 | 04-Apr-90 | 04-Apr-90 | 05-Apr-90 | 05-Apr-90 | 29-Jun-90 | 12-Jul-89 | 13-Jul-89 | 13-Jul-89 | 14-Jul-89 | 05-Jul-89 |

NOTES: T.O.I.C. - Top of Inner Well Casing
ID - Inside Diameter
SS - Stainless Steel
MSL - Mean Sea Level
NA - Data Not Available

TABLE 2-1
SUMMARY OF
WELL CONSTRUCTION DETAILS
American Chemical Services NPL Site
Remedial Investigation
Griffith, Indiana

| | P-02 | P-03 | P-04 | P-05 | P-06 | P-07 | P-08 | P-09 | P-10 | P-11 | P-12 | P-13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Surface Elevation (ft MSL) | 642.5 | 638.0 | 636.9 | 635.6 | 636.7 | 641.2 | 636.8 | 637.8 | 646.9 | 647.0 | 646.7 | 649.4 |
| Total Depth of Boring (ft) | 12.0 | 10.0 | 10.0 | 10.0 | 10.0 | 15.0 | 6.0 | 9.0 | 20.0 | 15.0 | 20.0 | 20.0 |
| T.O.I.C. Elevation (ft MSL) | 645.59 | 639.89 | 639.28 | 636.62 | 638.77 | 643.64 | 639.21 | 638.90 | 649.37 | 649.17 | 650.11 | 651.48 |
| Well Materials | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC |
| Screen Materials | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC |
| Screen Length (ft) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Slot Size (in) | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| Geologic Formation at Screen | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand |
| Depth to Clay | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Elevation of Clay | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Top of Seal - Depth (ft) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 10.0 | 5.0 | 9.5 | 10.0 |
| - Elevation (ft MSL) | 642.5 | 638.0 | 636.9 | 635.6 | 636.7 | 641.2 | 636.8 | 637.8 | 636.9 | 642.0 | 637.2 | 639.4 |
| Top of Sand Pack - Depth (ft) | 5.0 | 2.5 | 2.0 | 2.0 | 3.0 | 6.0 | 1.0 | 1.5 | 12.0 | 7.0 | 11.5 | 12.0 |
| - Elevation (ft MSL) | 637.5 | 635.5 | 634.9 | 633.6 | 633.7 | 635.2 | 635.8 | 636.3 | 634.9 | 640.0 | 635.2 | 637.4 |
| Top of Screen - Depth (ft) | 6.5 | 4.0 | 3.0 | 3.5 | 5.0 | 10.0 | 1.5 | 3.0 | 15.0 | 10.0 | 14.0 | 15.0 |
| - Elevation (ft MSL) | 636.0 | 634.0 | 633.9 | 632.1 | 631.7 | 631.2 | 635.3 | 634.8 | 631.9 | 637.0 | 632.7 | 634.4 |
| Bottom of Well Point - Depth (ft) | 11.5 | 9.0 | 8.0 | 8.5 | 10.0 | 15.0 | 6.5 | 8.0 | 20.0 | 15.0 | 19.0 | 20.0 |
| - Elevation (ft MSL) | 631.0 | 629.0 | 628.9 | 627.1 | 626.7 | 626.2 | 630.3 | 629.8 | 626.9 | 632.0 | 627.7 | 629.4 |
| Map Coordinates: North | 6165.1 | 6469.4 | 6228.2 | 6510.2 | 6550.9 | 6639.5 | 6734.8 | 6994.0 | 5851.6 | 5900.0 | 5722.7 | 5735.0 |
| East | 5577.3 | 5452.8 | 5432.2 | 5285.1 | 5148.1 | 5949.8 | 6157.0 | 6134.3 | 5413.0 | 5199.3 | 5076.3 | 4878.1 |
| Completion Date | 05-Jul-89 | 06-Jul-89 | 06-Jul-89 | 06-Jul-89 | 06-Jul-89 | 07-Jul-89 | 07-Jul-89 | 07-Jul-89 | 10-Jul-89 | 10-Jul-89 | 11-Jul-89 | 11-Jul-89 |

NOTES: T.O.I.C. - Top of Inner Well Casing
ID - Inside Diameter
SS - Stainless Steel
MSL - Mean Sea Level
NA - Data Not Available

TABLE 2-1
SUMMARY OF
WELL CONSTRUCTION DETAILS
American Chemical Services NPL Site
Remedial Investigation
Griffith, Indiana

| | P-14 | P-15 | P-16 | P-17 | P-18 | P-19 | P-20 | P-21 | P-22 | P-23 | P-24 | P-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ground Surface Elevation (ft MSL) | 647.4 | 637.4 | 646.2 | 648.5 | 644.3 | 637.5 | 640.1 | 632.3 | 632.2 | 632.5 | 633.3 | 632.1 |
| Total Depth of Boring (ft) | 20.0 | 9.0 | 20.0 | 20.0 | 13.0 | 10.0 | 12.0 | 8.0 | 10.0 | NA | NA | NA |
| T.O.I.C. Elevation (ft MSL) | 649.35 | 639.06 | 647.84 | 650.62 | 647.97 | 639.64 | 643.15 | 634.81 | 634.33 | 636.17 | 636.08 | 635.33 |
| Well Materials | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC |
| Screen Materials | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC | 1.5" PVC |
| Screen Length (ft) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Slot Size (in) | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 | 0.010 |
| Geologic Formation at Screen | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand | Sand |
| Depth to Clay | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Elevation of Clay | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Top of Seal - Depth (ft) | 0.0 | 0.0 | 10.0 | 9.0 | 2.0 | 0.0 | 3.4 | 0.0 | 2.5 | NA | NA | NA |
| - Elevation (ft MSL) | 647.4 | 637.4 | 636.2 | 639.5 | 642.3 | 637.5 | 636.7 | 632.3 | 629.7 | NA | NA | NA |
| Top of Sand Pack - Depth (ft) | 7.0 | 1.5 | 12.0 | 11.5 | 4.0 | 2.5 | 5.0 | 1.5 | 3.6 | NA | NA | NA |
| - Elevation (ft MSL) | 640.4 | 635.9 | 634.2 | 637.0 | 640.3 | 635.0 | 635.1 | 630.8 | 628.6 | NA | NA | NA |
| Top of Screen - Depth (ft) | 13.0 | 3.0 | 15.0 | 15.0 | 8.0 | 5.0 | 6.0 | 2.5 | 5.0 | NA | NA | NA |
| - Elevation (ft MSL) | 634.4 | 634.4 | 631.2 | 633.5 | 636.3 | 632.5 | 634.1 | 629.8 | 627.2 | NA | NA | NA |
| Bottom of Well Point - Depth (ft) | 18.0 | 8.0 | 20.0 | 20.0 | 13.0 | 10.0 | 11.0 | 7.5 | 10.0 | NA | NA | NA |
| - Elevation (ft MSL) | 629.4 | 629.4 | 626.2 | 628.5 | 631.3 | 627.5 | 629.1 | 624.8 | 622.2 | NA | NA | NA |
| Map Coordinates: North | 5965.0 | 6197.6 | 5747.5 | 6009.2 | 6222.7 | 5043.4 | 6233.2 | 6475.2 | 6731.9 | 7018.4 | 7178.0 | 7488.7 |
| East | 4954.8 | 4884.1 | 4672.9 | 4628.4 | 4631.7 | 4976.9 | 5104.3 | 4834.4 | 4635.7 | 4688.5 | 5001.5 | 5156.2 |
| Completion Date | 11-Jul-89 | 11-Jul-89 | 11-Jul-89 | 12-Jul-89 | 12-Jul-89 | 12-Jul-89 | 25-Jul-89 | 25-Jul-89 | 25-Jul-89 | NA | NA | NA |

NOTES: T.O.I.C. - Top of Inner Well Casing
ID - Inside Diameter
SS - Stainless Steel
MSL - Mean Sea Level
NA - Data Not Available

TABLE 5-2 (cont)

Sampling Results, Compound Groupings
ACS Site, Griffith, Indiana

| Sample ID | Sample Depth | VOCs | PCBs | PHENOLS | PAHs | PHTHALATES | CHLORINATED ETHENES | CHLORINATED ETHANES | BETX | CHLORINATED BENZENES | KETONES | CHROMIUM | LEAD | Waste Area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACS-SB17-06.5 | 6.5 | 6618000 | 47000 | 93100 | 259500 | 466000 | 550000 | 103000 | 5570000 | 62500 | 1180000 | 13.9 | 88.2 | 2 |
| ACS-SB18-07 | 7 | 5529000 | 28000 | | 288000 | 999100 | 607000 | 42000 | 2940000 | 6000 | 239000 | 8.7 | 104 | 2 |
| ACS-SB21-07 | 7 | 187 | | 429 | 590 | 4070 | 31 | 8 | 66 | | 121 | * | * | 2 |
| ACS-SB21-12 | 12 | 13170 | | 990 | 1380 | 4479 | 2390 | 340 | 10440 | 45 | | * | * | 2 |
| ACS-SB22-12 | 12 | 5359000 | 35000 | 7100 | 156800 | 442000 | 286000 | | 5024000 | 6300 | | * | * | 2 |
| ACS-SB23-12 | 12 | 60640 | | 1120 | 11300 | 11071 | 8200 | 930 | 44300 | 200 | 6620 | * | * | 2 |
| ACS-SB69-08 | 8 | 6690000 | 330 | 16500 | 253900 | 1017500 | 958000 | 139000 | 5446000 | 34680 | 252000 | * | * | 2 |
| ACS-SB69-21.5 | 21.5 | 9986 | 1300 | 7400 | 6179 | 19680 | 406 | 212 | 1839 | 1132 | 10700 | * | * | 2 |
| ACS-SB70-08 | 8 | 6952300 | 74000 | 2300 | 593590 | 127400 | 322000 | 57000 | 6560000 | 14900 | 10000 | * | * | 2 |
| ACS-SB70-20.5 | 20.5 | 3250 | | 856 | 1340 | 557 | 180 | | 3070 | | 55 | * | * | 2 |
| ACS-SB71-08 | 8 | 1862200 | 20000 | | 154500 | 533600 | 195000 | 17100 | 1570000 | 5300 | | * | * | 2 |
| ACS-SB71-20.5 | 20.5 | 29180 | | 2360 | 351 | 1143 | 180 | 8200 | 12800 | | 16200 | * | * | 2 |
| ACS-SB72-08 | 8 | 9710 | | 1160 | 2360 | 2900 | 3270 | | 2440 | | 6700 | * | * | 2 |
| ACS-SB72-20.5 | 20.5 | 283300 | | 2870 | 940 | 1374 | 223000 | | 49300 | 140 | 350 | * | * | 2 |
| ACS-SB73-05 | 5 | 663100 | | 8000 | 38660 | 245100 | 76100 | 12000 | 462000 | 1620 | 109000 | * | * | 2 |
| ACS-SB73-19 | 19 | 90100 | | 2521 | | 456 | 9400 | 3200 | 54100 | 8380 | 23400 | * | * | 2 |
| ACS-SB74-05 | 5 | 17240 | | 1970 | 1339 | 13886 | | | 8660 | | 8300 | * | * | 2 |
| ACS-SB74-19 | 19 | 758160 | | 12506 | 33210 | 205500 | 59400 | 15760 | 456000 | 860 | 299000 | * | * | 2 |
| ACS-SB75-15 | 15 | 15546000 | | 39500 | 122740 | 422300 | 2000000 | 750000 | 12220000 | 6400 | 780000 | * | * | 2 |
| ACS-TP03-09 | 9 | 16146000 | | 77000 | 353200 | 1604600 | 740000 | 290000 | 11634000 | | 1770000 | 187 | 671 | 2 |
| ACS-TP04-08 | 8 | 2362800 | | 8800 | 28300 | 76900 | 1790000 | 26100 | 502600 | | 39200 | 62.2 | 286 | 2 |
| ACS-TP05-03 | 3 | 36330000 | | 84000 | 315000 | 2060000 | 1130000 | | 34670000 | | 530000 | 82 | 331 | 2 |
| ACS-TP06-04 | 4 | 19690000 | | 194000 | 1057900 | 4694000 | 1020000 | 170000 | 16000000 | | 4100000 | 1410 | 6300 | 2 |
| ACS-TP07-03 | 3 | 36280000 | | 2800 | 131000 | 924000 | 190000 | 21000000 | 11400000 | | 29000 | 19.6 | 88 | 2 |
| ACS-SB20-07 | 7 | 51240 | 76000 | 12900 | 932[illegible]0 | 188200 | 1460 | 480 | 11100 | 31570 | 82000 | 28.8 | 45.4 | 3 |
| ACS-SB03-12 | 12 | 2442900 | | | 2050[illegible]0 | 230000 | 235000 | 18000 | 2169100 | | 14000 | 15.4 | 169 | 4 |
| ACS-SB03-17 | 17 | 33023000 | | 553000 | 976800 | 3998000 | 1830000 | 1300000 | 23393000 | 49500 | 5400000 | 89.9 | 357 | 4 |
| ACS-SB03-20 | 20 | [illegible]9190 | | 43400 | 2652 | 13450 | 580 | | 2310 | | 60500 | 6.6 | 4.9 | 4 |
| ACS-SB04-05 | 5 | 4578300 | | | | | | | 61300 | | 4517000 | | 2.3 | 4 |
| ACS-SB04A-19 | 19 | 315100 | | 68500 | 5900 | 7250 | 2700 | | 21400 | | 342000 | 6.8 | 10.9 | 4 |
| ACS-SB05-14 | 14 | 3286670 | 80000 | 91000 | 3021300 | 19136000 | 572390 | 287000 | 980000 | 129580 | 4420000 | 139 | 726 | 4 |
| ACS-SB05-17 | 17 | 25170 | 460 | 9760 | 4343 | 9571 | 450 | | 5420 | 140 | 24000 | 11.8 | 28.4 | 4 |
| ACS-SB06-11.5 | 11.5 | 15193000 | | 113400 | 379100 | 1741100 | 2160000 | 290000 | 12063000 | | 1160000 | 225 | 955 | 4 |
| ACS-SB06-15 | 15 | 3100000 | 30000 | 63770 | 129610 | 358900 | 490000 | 140000 | 2230000 | 3300 | 360000 | 21.2 | 38 | 4 |
| ACS-SB07-14 | 14 | 194630000 | | | | | 26700000 | 151330000 | 14340000 | | 1730000 | * | * | 4 |
| ACS-SB07-19 | 19 | 8230000 | 44000 | 94000 | 167270 | 135690 | 3400000 | 660000 | 4170000 | 24300 | 62000 | 23 | 20.6 | 4 |
| ACS-SB24-12 | 12 | 33184200 | | 1054000 | 12305[illegible]0 | 1603000 | 2184200 | 679000 | 26690000 | 76200 | 2747000 | * | * | 4 |
| ACS-SB24-21 | 21 | 603920 | | 25610 | 58[illegible]7 | 23282 | 18400 | 3920 | 195100 | 1064 | 393000 | * | * | 4 |
| ACS-SB24R-26 | 26 | 93440 | 6100 | | | | 958 | 81 | 65210 | | 26900 | * | * | 4 |
| ACS-SB25-11 | 11 | 2156800 | 35000 | 67700 | 74000 | 165000 | 390000 | 152000 | 1600000 | 10000 | 34400 | * | * | 4 |
| ACS-SB25-21 | 21 | 13162 | | 3365 | 620 | 2072 | 104 | 39 | 791 | 100 | 12570 | * | * | 4 |
| ACS-SB25R-29 | 29 | 213 | 96 | | | | 81 | 10 | 120 | | | * | * | 4 |
| ACS-SB26-11 | 11 | 41100000 | | 14300 | 46000 | 279400 | 1600000 | 3740000 | 8260000 | | 27519000 | * | * | 4 |
| ACS-SB26-21 | 21 | 9290 | | 20700 | 1300 | 900 | 1480 | 230 | 3280 | 140 | 4398 | * | * | 4 |
| ACS-SB26R-26 | 26 | 409170 | 210 | | | | 197100 | 19160 | 146800 | 170 | 32000 | * | * | 4 |
| ACS-SB27-11 | 11 | 2884000 | 74000 | 79000 | 382500 | 1304700 | 323000 | 56000 | 2395000 | 33400 | 400000 | * | * | 4 |

TABLE 5-2 (cont)

Sampling Results, Compound Groupings
ACS Site, Griffith, Indiana

| Sample ID | Sample Depth | VOCs | PCBs | PHENOLS | PAHs | PHTHALATES | CHLORINATED ETHENES | CHLORINATED ETHANES | BETX | CHLORINATED BENZENES | KETONES | CHROMIUM | LEAD | Waste Area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACS-SB27-21 | 21 | 37650 | | 29220 | 990 | 2260 | 260 | | 20590 | 456 | 17130 | * | * | 4 |
| ACS-SB27RR-24 | 24 | 239710 | 1040 | | | | 18990 | 7190 | 118280 | 35000 | 60000 | * | * | 4 |
| ACS-SB28-08 | 8 | 3892000 | 250000 | 52700 | 333700 | 1144900 | 273000 | 49000 | 3370000 | 13900 | 330000 | 30.1 | 236 | 4 |
| ACS-SB29-08 | 8 | 567100 | 31000 | 12000 | 53000 | 350500 | 21900 | 27140 | 183810 | | 42700 | 30.7 | 59.5 | 4 |
| ACS-SB30-10 | 10 | 522100000 | 44000 | 965000 | 890000 | 9249000 | 65000000 | 7600000 | 254500000 | 1000000 | 197600000 | 3750 | 17200 | 4 |
| ACS-SB36-10 | 10 | 87665 | | * | * | * | 355 | 219 | 25522 | | 61400 | * | * | 4 |
| ACS-SB36-17 | 17 | 424300 | 9200 | * | * | * | | | 418300 | | 6000 | * | * | 4 |
| ACS-SB36-23.5 | 23.5 | 30000 | 200 | * | * | * | 330 | | 15570 | | 14100 | * | * | 4 |
| ACS-SB37-10 | 10 | 293500 | 84000 | * | * | * | 5500 | | 127000 | | 161000 | * | * | 4 |
| ACS-SB37-17 | 17 | 3865000 | 71000 | * | * | * | 430000 | 152000 | 3227000 | | | * | * | 4 |
| ACS-SB37-23.5 | 23.5 | 13721 | 790 | * | * | * | 44 | 61 | 474 | | 13011 | * | * | 4 |
| ACS-SB38-10 | 10 | 3713000 | | 119000 | 661100 | 595800 | 290000 | 77000 | 3300000 | 21840 | | * | * | 4 |
| ACS-SB38-20 | 20 | 215400 | | 26900 | 6276 | 16870 | 400 | | 16000 | 250 | 205800 | * | * | 4 |
| ACS-SB38-23.5 | 23.5 | 748530 | | 27300 | 3397 | 4942 | 3010 | 380 | 51140 | 83 | 694420 | * | * | 4 |
| ACS-SB39-10 | 10 | 5274700 | | 238000 | 1077600 | 3444000 | 270000 | 135000 | 3206000 | 41700 | 3296000 | * | * | 4 |
| ACS-SB39-17 | 17 | 421880 | | 25900 | 1290 | 3260 | 9600 | 3880 | 20800 | | 397000 | * | * | 4 |
| ACS-SB39-23.5 | 23.5 | 42945 | | 19357 | 273 | 347 | 6053 | 1837 | 17290 | 3 | 16850 | * | * | 4 |
| ACS-SB40-10 | 10 | 3291400 | 26000 | 46800 | 181920 | 942800 | 181000 | 17800 | 2731100 | 7460 | 820000 | 14.3 | 35.8 | 4 |
| ACS-SB41-05.5 | 5.5 | 26 | 2780 | 180 | 31800 | 100350 | | | 17 | 93 | 149 | 6.8 | 5.5 | 4 |
| ACS-SB41-23.5 | 23.5 | 70 | | 250 | | 54 | | 8 | 62 | | 100 | 26.6 | 143 | 4 |
| ACS-SB42-05.5 | 5.5 | 69 | 220 | | 7480 | 1470 | | | 69 | | | 12.9 | 42.7 | 4 |
| ACS-SB42-20 | 20 | 149 | | 625 | | | | | 97 | | 52 | 9.4 | 9 | 4 |
| ACS-WS01-01 | 1 | 6885000 | 1400000 | 675000 | 3487700 | 15434000 | 145000 | | 6740000 | 126900 | 290000 | 142 | 226 | 4 |
| ACS-SA01-03 | 3 | 80936 | 59000 | 3670 | 30390 | 444350 | 162 | 95 | 80320 | | 8530 | 859 | 10700 | 5 |
| ACS-SA02-03 | 3 | 1740000 | 32000 | 20600 | 45920 | 324700 | 357600 | | 1353200 | 6790 | 40000 | 1300 | 5810 | 5 |
| ACS-SB01-03 | 3 | 7260 | | 420 | 18110 | 172000 | 240 | 150 | 5900 | 200 | 1810 | 70 | 401 | 5 |
| ACS-SB01-09 | 9 | 96 | | | 933 | 3010 | | | 93 | | 2 | 6 | 18.1 | 5 |
| ACS-SB02-05.5 | 5.5 | 679900 | | * | * | * | 40900 | | 639000 | | | * | * | 5 |
| ACS-SB02-07 | 7 | | 9600 | 34300 | 65230 | 160100 | | | | 260 | 65000 | 1010 | 4060 | 5 |
| ACS-SB02-08.5 | 8.5 | 103 | | 280 | 54 | 1839 | | | 25 | | 1678 | 4.8 | 5 | 5 |
| ACS-SB43-01 | 1 | | 11700 | * | * | * | | | | | | * | * | 5 |
| ACS-SB43-04.5 | 4.5 | 1 | | * | * | * | | | 1 | | | * | * | 5 |
| ACS-SB44-04.5 | 4.5 | 4563000 | 12000 | * | * | * | 516000 | | 3670000 | 27000 | 90000 | * | * | 5 |
| ACS-SB45-01 | 1 | | 22000 | * | * | * | | | | | | * | * | 5 |
| ACS-SB45-04.5 | 4.5 | 3650 | 4200 | * | * | * | 140 | | 3510 | | | * | * | 5 |
| ACS-SB46-04.5 | 4.5 | 173150 | 27100 | * | * | * | 22600 | 1350 | 147900 | | | * | * | 5 |
| ACS-SB47-04.5 | 4.5 | 207599 | | * | * | * | 431 | 479 | 193150 | 18 | 13290 | * | * | 5 |
| ACS-SB48-01 | 1 | | 49000 | * | * | * | | | | | | * | * | 5 |
| ACS-SB48-04.5 | 4.5 | 155140 | | * | * | * | 540 | | 151000 | | 3600 | * | * | 5 |
| ACS-SB49-04.5 | 4.5 | 36 | | * | * | * | | 5 | 31 | | | * | * | 5 |
| ACS-SB50-01 | 1 | | 7100 | * | * | * | | | | | | * | * | 5 |
| ACS-SB50-04.5 | 4.5 | 435 | | * | * | * | 2 | | 433 | | | * | * | 5 |
| ACS-SB51-04.5 | 4.5 | 2336000 | 50000 | * | * | * | 93000 | | 2243000 | | | * | * | 5 |
| ACS-SB52-04.5 | 4.5 | 839 | | * | * | * | | | 734 | 47 | | * | * | 5 |
| ACS-SB53-04.5 | 4.5 | 78 | | * | * | * | | | 78 | | | * | * | 5 |
| ACS-SB54-04.5 | 4.5 | 419 | | * | * | * | | | 333 | 86 | | * | * | 5 |
| ACS-TP01-03.5 | 3.5 | 47530000 | 280000 | 28000 | 157300 | 698100 | 960000 | | 46300000 | | 367000 | 3080 | 16200 | 5 |

TABLE 5-2 (cont)

Sampling Results, Compound Groupings
ACS Site, Griffith, Indiana

| Sample ID | Sample Depth | VOCs | PCBs | PHENOLS | PAHs | PHTHALATES | CHLORINATED ETHENES | CHLORINATED ETHANES | BETX | CHLORINATED BENZENES | KETONES | CHROMIUM | LEAD | Waste Area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACS-TP01-06 | 6 | 125 | | 2530 | | 177 | | | 14 | | 110 | 7 | 5.4 | 5 |
| ACS-LW01-01 | | 5 | | | | | | | 5 | | | 41.2 | 130 | 6 |
| ACS-LW02-01 | | 2 | | 19 | | | | | 2 | | | 288 | 1370 | 6 |
| ACS-LW03-01 | | 1371 | | 831 | 38 | 42 | | | 137 | 2 | 1234 | 120 | 530 | 6 |
| ACS-LW04-01 | | 462 | | 129 | 3 | 5 | | | 244 | 53 | 170 | 120 | 660 | 6 |
| ACS-AM01-10 | | 30830 | | 515 | | 46 | | | 30830 | | | 3.9 | 5.1 | 7 |
| ACS-AM02-12 | | 5690 | | 150 | | | | | 5690 | | | 3.7 | 4.9 | 7 |
| ACS-AM03-12 | | 677 | | 496 | 367 | | | | 117 | | 560 | 3.1 | 5.3 | 7 |
| ACS-AM04-12 | | 42690 | | 370 | | | 160 | | 42530 | | | 7 | 7.7 | 7 |
| ACS-AM05-12 | | 56200 | | 700 | | 82 | 1400 | | 37600 | | 17200 | 2.6 | 4 | 7 |
| ACS-GWMW02-01 | | | | | | 2 | | | | | | | | 7 |
| ACS-GWMW02-02 | | 161 | | | | | 3 | 130 | 25 | 2 | | | | 7 |
| ACS-GWMW03-01 | | 1 | | 71 | 3 | 8 | | | 1 | 26 | | | | 7 |
| ACS-GWMW03-02 | | 108048 | | 428 | | 9 | | 1900 | 106080 | 32 | | | | 7 |
| ACS-GWMW04-01 | | 900 | 2.6 | 10 | | | | | 520 | | | | | 7 |
| ACS-GWMW04-02 | | 896 | | 3 | | | | 256 | 640 | | | | | 7 |
| ACS-GWMW05-01 | | 3577 | | 29 | 80 | 3 | | 160 | 3321 | 117 | | | | 7 |
| ACS-GWMW05-02 | | 1904 | | | 91 | | | 44 | 1800 | 106 | | | | 7 |
| ACS-GWMW06-01 | | 1142 | | 4 | | | | 140 | 1002 | | 35 | | | 7 |
| ACS-GWMW06-02 | | 2040 | | 6 | 7 | 29 | | 240 | 1800 | | 25 | | | 7 |
| ACS-GWMW09-01 | | 440 | | | | | | 440 | | | | | | 7 |
| ACS-GWMW09-02 | | 200 | | | | | | 200 | | | | | | 7 |
| ACS-GWMW10C-01 | | 6 | | | | | | 3 | | | 3 | | | 7 |
| ACS-GWMW11-02 | | 2 | | | | 2 | | 2 | | | | | | 7 |
| ACS-GWMW12-01 | | 27 | | | | | | 23 | | 4 | | | | 7 |
| ACS-GWMW12-02 | | 43 | | | | | 1 | 24 | 12 | 6 | | 1.1 | | 7 |
| ACS-GWMW13-01 | | 509 | | | | | | 500 | 2 | | | | | 7 |
| ACS-GWMW13-02 | | 140 | | | | | | 140 | | | | | | 7 |
| ACS-GWMW14-01 | | 5 | | 31 | | | | 3 | 2 | | | | | 7 |
| ACS-GWMW14-02 | | 13 | | | | | | 7 | 6 | | | 2 | | 7 |
| ACS-GWMW15-01 | | | | 12 | | | | | | | | | 4.6 | 7 |
| ACS-GWMW15-02 | | 4 | | | | 9 | | 4 | | | | | | 7 |
| ACS-GWMW16-01 | | 365290 | | 2275 | | | 250 | 3500 | 1620 | | 359219 | 3.9 | 3.2 | 7 |
| ACS-GWMW16-02 | | 302740 | | | | | 400 | 4000 | 2160 | | 295800 | 2.7 | | 7 |
| ACS-GWMW17-01 | | 502 | 27 | 2 | 63 | 52 | 375 | | 127 | 7 | | | | 7 |
| ACS-SD01-01 | | 2 | 590 | | | 350 | | | | | | 7.3 | 8.2 | 8 |
| ACS-SD02-01 | | 5 | 21600 | 190 | | 13330 | | | 3 | | | 21 | 279 | 8 |
| ACS-SD03-01 | | 2 | 290 | | | | | | | | | 4.3 | 3.6 | 8 |
| ACS-SD04-01 | | 112 | | | | | | | 110 | | | 8.9 | 4.6 | 8 |
| ACS-SD05-01 | | 14389 | | 610 | 7348 | 4570 | | | 14386 | | | 28.5 | 152 | 8 |
| ACS-SD06-01 | | 8 | | | 868 | 180 | | | | | | 24.6 | 89.7 | 8 |
| ACS-SD07A-01 | | | | | 8950 | 2500 | | | | | | 19.8 | 59.6 | 8 |
| ACS-SD07B-01 | | 44 | | 230 | 523 | 680 | | | | | | 26.4 | 61.9 | 8 |
| ACS-SD07C-01 | | | 460 | | | 450 | | | | | | 34.1 | 93.2 | 8 |
| ACS-SD08-01 | | 24 | | | 112 | 120 | | | 24 | | | 8.9 | 23.1 | 8 |

TABLE 5-2 (cont)

Sampling Results, Compound Groupings
ACS Site, Griffith, Indiana

| Sample ID | Sample Depth | VOCs | PCBs | PHENOLS | PAHs | PHTHALATES | CHLORINATED ETHENES | CHLORINATED ETHANES | BETX | CHLORINATED BENZENES | KETONES | CHROMIUM | LEAD | Waste Area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACS-SD09-01 | | 170 | | 47 | 3225 | 109 | | | 170 | | | 10.7 | 35.5 | 8 |
| ACS-SD10-01 | | 69 | | 100 | 4630 | | 6 | 40 | 23 | | | 7.8 | 31.3 | 8 |
| ACS-SD11-01 | | 3 | | | 146 | 100 | | 3 | | | | 12.7 | 45.4 | 8 |
| ACS-SD12-01 | | | | 58 | 100 | 100 | | | | | | 14.3 | 63.3 | 8 |
| ACS-SD13-01 | | | | 270 | 186 | | | | | | | 13.4 | 65.1 | 8 |
| ACS-SD14-01 | | 11 | | | 22[illegible] | 820 | | | | | 11 | 31.5 | 59.2 | 8 |
| ACS-SD15-01 | | | | | 6[illegible] | | | | | | | 5.4 | 23.4 | 8 |
| ACS-SD16-01 | | | 5400 | | 1[illegible] | 2394 | | | | 140 | | 273 | 702 | 8 |
| ACS-SW01-01 | | 3 | 0.5 | | | | 1 | 2 | | | | 7.8 | 6.3 | 8 |
| ACS-SW02-01 | | 38 | 0.84 | | | | | | | | 38 | 8.3 | 23.8 | 8 |
| ACS-SW05-01 | | 1111 | | 51 | | | 3 | 31 | 508 | | 574 | 28 | 4.2 | 8 |
| ACS-SW07A-01 | | 14 | | | | | | 14 | | | | | 4.6 | 8 |
| ACS-SW08-01 | | 8 | | 635 | | | | | 8 | | | 5 | 16.2 | 8 |

* Compounds not analyzed.

Notes: 1 - Waste or Sample Are(1) On-Site Containment Area
(2) Still Bottoms/Treatment Lagoon
(3) Area West of Firepond
(4) Off-Site Containment Area
(5) Kapica/Pazmey Area
(6) Griffith Municipal Landfill
(7) Groundwater
(8) Surface Water/Sediment

JDD/jdd/JAH

**Table 5-3**

**Chemical Element Content of Natural Soils**
**American Chemical Services NPL Site**
**Remedial Investigation**

| Element | Common Range (ppm) | Average (ppm) | Element | Common Range (ppm) | Average (ppm) |
|---|---|---|---|---|---|
| Aluminum | 10,000-300,000 | 71,000 | Lithium | 5-200 | 20 |
| Antimony | 2-10 | - | Magnesium | 600-6,000 | 5,000 |
| Arsenic | 1-50 | 5 | Manganese | 20-3,000 | 600 |
| Barium | 100-3,000 | 430 | Mercury | 0.01-0.3 | .03 |
| Beryllium | 0.1-40 | 6 | Molybdenum | 0.2-5 | 2 |
| Boron | 2-100 | 10 | Nickel | 5-500 | 40 |
| Bromine | 1-10 | 5 | Radium | $8 \times 10^{-5}$ | |
| Cadmium | 0.01-0.7 | .06 | Rubidium | 50-500 | 10 |
| Cesium | 0.3-25 | 6 | Selenium | 0.1-2 | .3 |
| Chlorine | 20-900 | 100 | Silver | 0.01-5 | .05 |
| Chromium | 1-1,000 | 100 | Strontium | 50-1,000 | 200 |
| Cobalt | 1-40 | 8 | Tin | 2-200 | 10 |
| Copper | 2-100 | 30 | Tungsten | | 1 |
| Fluorine | 10-4,000 | 200 | Uranium | 0.9-9 | 1 |
| Gallium | 0.4-300 | 30 | Vanadium | 20-500 | 100 |
| Gold | | 1 | Yitrium | 25-250 | 50 |
| Iodine | 0.1-40 | 5 | Zinc | 10-300 | 50 |
| Lanthanum | 1-5,000 | 30 | Zirconium | 60-2,000 | 300 |
| Lead | 2-200 | 10 | | | |

Reference: U.S. EPA Office of Solid Waste and Emergency Response, Hazardous Waste Land Treatment, SW-874 (April, 1983) Page 273, Table 6.46

V251RI Table 5/JDD/PJV

**TABLE 5-4**
**Summary of Data Collected During RI**
**American Chemical Services NPL Site**
**Remedial Investigation**

**Classification of Dissolved Inorganic Constituents in Naturally Occurring Groundwater (from Davis and DeWiest, 1966)**

Major Constituents (greater than 5 mg/L)

| | |
|---|---|
| Bicarbonate alkalinity | Magnesium |
| Calcium | Sodium |
| Chloride | Sulfate |

Minor Constituents (0.01-10.0 mg/L)

| | |
|---|---|
| Fluoride | Nitrate |
| Iron | Potssium |

Trace Constituents (less than 0.1 mg/L)

| | |
|---|---|
| Aluminum | Manganese |
| Antimony | Nickel |
| Arsenic | Phosphate |
| Barium | Selenium |
| Beryllium | Silver |
| Cadmium | Thallium |
| Chromium | Vanadium |
| Cobalt | Zinc |
| Copper | |

## Table 6-1

## Physical/Chemical Properties of Target Compound List Chemicals

| | Density g/cc | Molecular Weight (g/mole) | Water Solubility (mg\l) | Vapor Pressure (mm Hg) | Henry's Law Constant (atm-m3/mole) | Organic Carbon Partition Coefficient (ml/g) | Octanol Water Partition Coefficient ($log_{10}$) |
|---|---|---|---|---|---|---|---|
| **Volatile** | | | | | | | |
| Chloromethane | 0.92 | 50 | 6.50E+03 | 4.31E+03 | 4.40E-02 | 3.5E+01 | 0.95 |
| Vinyl Chloride | 1.37 | 63 | 2.67E+03 | 2.66E+03 | 8.19E-02 | 5.7E+01 | 1.38 |
| Methylene Chloride | 1.33 | 85(4) | 2.00E+04(4) | 3.60E+02(4) | 2.03E-03 | 8.8E+00 | 1.30 |
| Acetone | 0.79 | 58 | 1.00E+06 | 2.70E+02 | 2.06E-05 | 2.2E+00 | -0.24 |
| 1,1-Dichloroethene | 1.22 | 97 | 2.25E+03 | 6.00E+02 | 3.40E-02 | 6.5E+01 | 1.84 |
| 1,1-Dichloroethane | 1.18 | 99 | 5.50E+03 | 1.82E+02 | 4.31E-03 | 3.0E+01 | 1.79 |
| 1,2-Dichloroethene (Trans) | 1.26 | 97 | 6.30E+03 | 3.24E+02 | 6.56E-03 | 5.9E+01 | 0.48 |
| Chloroform | 1.48 | 119 | 8.20E+03 | 1.51E+02 | 2.87E-03 | 3.1E+01 | 1.97 |
| 2-Butanone | 0.81 | 72(4) | 3.5E+05(4) | 7.8E+01(4) | 2.74E-05 | 4.5E+00 | 0.26(4) |
| 1,1,1-Trichloroethane | 1.34 | 133 | 1.50E+03 | 1.23E+02 | 1.44E-02 | 1.5E+02 | 2.5 |
| Carbon Tetrachloride | 1.59 | 154 | 7.57E+02 | 9.00E+01 | 2.41E-02 | 1.1E+02 | 2.64 |
| Trichloroethene | 1.46 | 131 | 1.10E+03 | 5.79E+01 | 9.10E-03 | 1.3E+02 | 2.38 |
| 1,1,2-Trichloroethane | 1.44 | 133 | 4.50E+03 | 3.00E+01 | 1.17E-03 | 5.6E+01 | 2.47 |
| Benzene | 0.88 | 78 | 1.75E+03 | 9.52E+01 | 5.59E-03 | 8.3E+01 | 2.12 |
| 4-Methyl-2-Pentanone | 0.80 | 100(4) | 1.70E+04(4) | 6.0E+00(4) | -- | -- | -- |
| Tetrachloroethene | 1.62 | 166 | 1.50E+02 | 1.78E+01 | 2.59E-02 | 3.6E+02 | 2.6 |
| Toluene | 0.87 | 92 | 5.35E+02 | 2.81E+01 | 6.37E-03 | 3.0E+02 | 2.73 |
| Chlorobenzene | 1.11 | 113 | 4.66E+02 | 1.17E+01 | 3.72E-03 | 3.3E+02 | 2.84 |
| Ethylbenzene | 0.87 | 106 | 1.52E+02 | 7.00E+00 | 6.43E-03 | 1.1E+03 | 3.15 |
| Xylenes (total) | 0.90 | 106 | 1.98E+02 | 1.00E+01 | 7.04E-03 | 2.4E+02 | 3.26 |
| 2-Hexanone | 0.83 | 102.2 | 3.5E+04 | 2.0E+00 | -- | 1.4E+01 | 1.38 |
| 1,2-Dichloroethane | 1.25 | 99 | 8.52E+03 | 6.40E+01 | 9.78E-04 | 1.4E+01 | 1.48 |
| Cis-1,2-Dichloroethene | 1.28 | 97 | 3.50E+03 | 2.08E+02 | 7.58E-03 | 4.9E+01 | 0.70 |
| Chloroethane | 0.92 | 64.5 | 3.33E+03 | 4.57+02 | -- | 5.0E+01 | 1.54 |
| **Semivolatile** | | | | | | | |
| Phenol | 1.07* | 94 | 9.30E+04 | 3.41E-01 | 4.54E-07 | 1.4E+01 | 1.46 |
| 2-Chlorophenol | 1.26 | 128(4) | 2.60E+04(4) | -- | -- | -- | 2.50(4) |
| 1,2-Dichlorobenzene | 1.30 | 147 | 1.00E+02 | 1.00E+00 | 1.93E-03 | 1.7E+03 | 3.60 |
| 2-Methylphenol | 1.03 | 108(4) | 3.10E+04(4) | 2.40E-01(4) | -- | -- | -- |
| 4-Methylphenol | 1.02 | 108(4) | 2.40E+04(4) | 1.10E-01(4) | -- | -- | 1.92(4) |
| Isophorone | 0.92 | 138(4) | 1.2E+04(4) | 3.8E-01(4) | -- | -- | -- |
| Benzoic Acid | 1.27* | 122(4) | 2.9E+04(4) | -- | -- | -- | 1.87(4) |
| Naphthalene | 0.96 | 128(4) | 3.0E+01(4) | -- | -- | -- | 3.01(4) |
| 2-Methylnaphthalene | 1.01 | 142(5) | 2.5E-02(5) | -- | -- | -- | -- |
| 2-Chloronaphthalene | 1.14* | 162(5) | 1.17E+01 | -- | -- | -- | -- |
| Dimethylphthalate | 1.19 | 194(4) | 5.00E+03(4) | -- | -- | -- | -- |

**Table 6-1**

| | Density g/cc | Molecular Weight (g/mole) | Water Solubility (mg\l) | Vapor Pressure (mm Hg) | Henry's Law Constant (atm-m$^3$/mole) | Organic Carbon Partition Coefficient (ml/g) | Octanol Water Partition Coefficient ($log_{10}$) |
|---|---|---|---|---|---|---|---|
| Acenaphthylene | 0.90* | 152 | 3.93E+00 | 2.90E-02 | 1.48E-03 | 2.5E+03 | 3.7 |
| Acenaphthene | 1.02* | 154 | 3.42E+00 | 1.55E-03 | 9.20E-05 | 4.6E+03 | 4.00 |
| Dibenzofuran | 1.09* | 220(4) | -- | -- | -- | -- | -- |
| Fluorene | 1.20* | 116 | 1.69E+00 | 7.10E-04 | 6.42E-05 | 7.3E+03 | 4.20 |
| Pentachlorophenol | 1.98 | 266 | 1.40E+01 | 1.10E-04 | 2.75E-06 | 5.3E+04 | 5.01 |
| Phenanthrene | 0.98* | 178 | 1.00E+00 | 6.80E-04 | 1.59E-04 | 1.4E+04 | 4.46 |
| Anthracene | 1.28* | 178 | 4.50E-02 | 1.95E-04 | 1.02E-03 | 1.4E+04 | 4.45 |
| Fluoranthene | 1.25* | 202 | 2.06E-01 | 5.00E-06 | 6.46E-06 | 3.8E+04 | 4.90 |
| Pyrene | 1.27* | 202 | 1.32E-01 | 2.50E-06 | 5.04E-06 | 3.8E+04 | 4.88 |
| Butylbenzylphthalate | 1.10 | 312(4) | 2.9E+00(4) | 8.6E-06(4) | -- | -- | 4.78(4) |
| Benzo(a)anthracene | -- | 228 | 5.70E-03 | 2.20E-08 | 1.16E-06 | 1.4E+06 | 5.60 |
| Bis(2-Ethylhexyl)Phthalate | -- | 391 | -- | -- | -- | -- | -- |
| Chrysene | 1.27 | 228 | 1.80E-03 | 6.30E-09 | 1.05E-06 | 2.0E+05 | 5.61 |
| Di-n-octylphthalate | 0.99 | 390(4) | 2.85E-01(4) | 1.34E+01(4) | -- | -- | -- |
| Benzo(b)fluoranthene | -- | 252 | 1.40E-02 | 5.00E-07 | 1.19E-05 | 5.5E+05 | 6.06 |
| Benzo(k)fluoranthene | -- | 252 | 4.30E-03 | 5.10E-07 | 3.94E-05 | 5.5E+05 | 6.06 |
| Benzo(a)pyrene | -- | 252 | 1.20E-03 | 5.60E-09 | 1.55E-06 | 5.5E+06 | 6.06 |
| Indeno(1,2,3-cd)pyrene | -- | 276 | 5.30E-04 | 1.00E-10 | 6.86E-08 | 1.6E+06 | 6.50 |
| Dibenz(a,h)anthracene | -- | 278 | 5.00E-04 | 1.00E-10 | 7.33E-08 | 3.3E+06 | 6.80 |
| Benzo(g,h,i,)perylene | -- | 276 | 7.00E-04 | 1.03E-10 | 5.34E-08 | 1.6E+06 | 6.51 |
| Bis(2-chloroethyl)ether | 1.22 | 143 | 1.02E+04 | 7.10E-01 | 1.35E-05 | 1.39E+01 | 1.50 |
| Bis(2-chloroisopropyl)ether | 1.11 | 171 | 1.70E+03 | 8.50E-01 | 1.13E-04 | 6.1E+01 | 2.10 |
| Diethylphthalate | 1.12 | 222 | 8.96E+02 | 3.50E-03 | 1.14E-06 | 1.42E+02 | 142 |
| Di-n-butylphthalate | 1.05 | 278 | 1.30E+01 | 1.00E-05 | 2.82E-07 | 1.70E+05 | 5.60 |
| 1,4-Dichlorobenzene | 1.46 | 147 | 7.90E+01 | 1.18E+00 | 2.89E-03 | 1.7E+03 | 3.60 |
| 1,3-Dichlorobenzene | 1.29 | 147 | 1.23E+02 | 2.28E+00 | 3.59E-03 | 1.7E+03 | 3.60 |
| Pesticide | | | | | | | |
| Polychlorinated biphenyls | | 328 | 3.10E-02 | 7.70E-05 | 1.07E-03 | 5.3E+05 | 6.04 |
| Heavy Metal | | | | | | | |
| Chromium III and VI | | 52 | -- | 0.00E+00 | NA | -- | -- |
| Lead | | 207 | -- | 0.00E+00 | NA | -- | -- |

a All values were obtained from the U.S. EPA Superfund Public Health Evaluation Manual (SPHEM), 1986 unless otherwise referenced. (--) indicates property not identified. Below are definitions of chemical properties.

Density of VOCs generally recorded at a temperature of 20° relative to water at 4°C. However, "*" values were recorded at a different temperature (Refer to reference #6).

Water Solubility is the maximum concentration of a chemical that dissolves in pure water at a specific temperature and pH. Values are given for a neutral pH and a temperature range of 20 to 40° C. The rate at which a chemical is leached from a waste by infiltrating precipitation is a function of its solubility in water. The more soluble compounds are expected to be leached much more readily and rapidly than less soluble chemicals. The water solubilities presented in the literature indicate that the volatile organic chemicals are usually several orders of magnitude more water soluble than the base/neutral organic compounds (e.g., PAHs, PCBs).

**Table 6-1**
(Continued)

Vapor pressure provides an indication of the rate at which a chemical in its pure state volatilizes. Values are given for a temperature range of 20 to 30° C. It is of primary significance where environmental interfaces such as surface soil/air and surface water/air occur. Volatilization is not as important when evaluating groundwater and subsurface soils. Chemicals with higher vapor pressures are expected to enter the atmosphere much more readily than chemicals with lower vapor pressures. Vapor pressures for monocyclic aromatic (toluene) and chlorinated aliphatics (TCE) are generally many times higher than vapor pressure for phthalate esters (bis(2-ethylhexyl)phthalate), polynuclear aromatic hydrocarbons (PAHs), and pesticides.

Henry's Law Constant is important in evaluating air exposure pathways. Values for Henry's Law Constant (H) were calculated using the following equation and the values previously recorded for solubility, vapor pressure, and molecular weight:

$$H(\text{atm-m}^3/\text{mole}) = \frac{\text{Vapor Pressure (atm) x Mole Weight (g/mole)}}{\text{Water Solubility (g/m}^3)}$$

Organic Carbon Partition Coefficient (Koc) is a measure of the tendency for organics to be adsorbed by soil and sediment and is expressed as:

$$\text{Koc} = \frac{\text{mg chemical adsorbed/kg organic carbon}}{\text{mg chemical dissolved/liter of solution}}$$

The Koc is chemical specific and is largely independent of soil properties. In general, the Koc is inversely related to its environmental mobility. Refer to SPHEM for sources of the values.

The Octanol/Water Partition Coefficient is ;ed to estimate bioconcentration factors in aquatic organisms. A linear relationship between the octanol/water partition coefficient and the uptake of chemicals by fatty tissues of animal and human receptors (the bioconcentration factor) has bcen determined. It is also useful in estimating the sorption and desorption of compounds by organic soils, where experimental values are not available.

(4) Verschueren, K. Handbook of Environmental Data on Organic Chemicals. Van Nostrand Reinhold Co., New York, 1983.

(5) Mackay, D. and Shire, W. Y. A critical review of Henry's Law constants for chemicals of environmental interest. J. Phys. Chem. Ref. Data. 10(4):1175-1199, 1981.

(6) Weast, R.C. (ed) Handbook of Chemistry and Physics 54th Edition. CRC Press, Cleveland, 1973.

TABLE 6-2

RETARDATION FACTORS
ORGANICS DETECTED IN UPPER AQUIFER
ACS SITE, GRIFFITH, INDIANA

| | | MW-7 EAST | | | MW-9 WEST | | |
|---|---|---|---|---|---|---|---|
| | | UPPER | CONFINING | LOWER | UPPER | CONFINING | LOWER |
| | n = | 0.287 | 0.257 | 0.295 | 0.311 | 0.327 | 0.298 |
| | Foc = | 1.40% | 1.60% | 0.68% | 0.29% | 1.20% | 0.31% |
| UPPER AQUIFER COMPOUND | Koc | Rf | Rf | Rf | Rf | Rf | Rf |
| Chloromethane | 35 | 4.24 | 5.14 | 2.53 | 1.62 | 3.44 | 1.69 |
| Vinyl chloride | 57 | 7.99 | 7.74 | 3.50 | 2.01 | 4.97 | 2.13 |
| Chloroethane | 115 | 15.10 | 14.60 | 6.04 | 3.04 | 9.02 | 3.27 |
| Methylene chloride | 8.8 | 2.08 | 2.04 | 1.39 | 1.16 | 1.41 | 1.17 |
| Acetone | 2.2 | 1.27 | 1.26 | 1.10 | 1.04 | 1.15 | 1.04 |
| 1,1-Dichloroethene | 30 | 4.68 | 4.55 | 2.31 | 1.53 | 3.09 | 1.59 |
| cis-1,2-Dichloroethene | 49 | 7.01 | 6.80 | 3.15 | 1.87 | 4.42 | 1.97 |
| 1,2-Dichloroethane | 14 | 2.72 | 2.66 | 1.61 | 1.25 | 1.98 | 1.28 |
| 2-Butanone | 4.5 | 1.55 | 1.53 | 1.20 | 1.08 | 1.31 | 1.09 |
| Trichloroethene | 126 | 16.45 | 15.90 | 6.52 | 3.23 | 9.79 | 3.49 |
| Benzene | 83 | 11.18 | 10.82 | 4.64 | 2.47 | 6.79 | 2.64 |
| 4-Methyl-2-pentanone | 21 | 3.58 | 3.48 | 1.92 | 1.37 | 2.46 | 1.42 |
| 2-Hexanone | 14 | 2.72 | 2.66 | 1.61 | 1.25 | 1.98 | 1.28 |
| Tetrachloroethene | 364 | 45.64 | 44.06 | 16.94 | 7.45 | 26.38 | 8.19 |
| Toluene | 300 | 37.79 | 36.49 | 14.14 | 6.32 | 21.92 | 6.93 |
| Chlorobenzene | 330 | 41.47 | 40.04 | 15.45 | 6.85 | 24.01 | 7.52 |
| Ethylbenzene | 1100 | 135.91 | 131.12 | 49.18 | 20.49 | 77.70 | 22.74 |
| total-Xylenes | 240 | 30.44 | 29.39 | 11.51 | 5.25 | 17.73 | 5.74 |
| Polychlorinated biphenyls | 530000 | 65003.33 | 62693.61 | 23213.20 | 9391.03 | 36955.13 | 10476.50 |
| Phenol | 14.2 | 2.74 | 2.68 | 1.62 | 1.25 | 1.99 | 1.28 |
| bis(2-chloroethyl)ether | 13.9 | 2.70 | 2.64 | 1.61 | 1.25 | 1.97 | 1.27 |
| 1,3-Dichlorobenzene | 1700 | 209.50 | 202.09 | 75.45 | 31.12 | 119.53 | 34.60 |
| 1,4-Dichlorobenzene | 1700 | 209.50 | 202.09 | 75.45 | 31.12 | 119.53 | 34.60 |
| 1,2-Dichlorobenzene | 1700 | 209.50 | 202.09 | 75.45 | 31.12 | 119.53 | 34.60 |
| 2-Methylphenol | 15 | 2.84 | 2.77 | 1.66 | 1.27 | 2.05 | 1.30 |
| bis(2-chloroisopropyl)ether | 61 | 8.48 | 8.22 | 3.67 | 2.08 | 5.25 | 2.21 |
| 4-Methylphenol | 17 | 3.08 | 3.01 | 1.74 | 1.30 | 2.19 | 1.34 |
| Isophorone | 25 | 4.07 | 3.96 | 2.09 | 1.44 | 2.74 | 1.49 |
| Benzoic acid | 57 | 7.99 | 7.74 | 3.50 | 2.01 | 4.97 | 2.13 |
| Naphthalene | 672 | 83.42 | 80.49 | 30.43 | 12.91 | 47.86 | 14.28 |
| Diethylphthalate | 142 | 18.42 | 17.80 | 7.22 | 3.52 | 10.90 | 3.81 |
| Pentachlorophenol | 53000 | 6501.23 | 6270.26 | 2322.22 | 940.00 | 3696.41 | 1048.55 |
| Di-n-butylphthalate | 170000 | 20850.81 | 20109.95 | 7446.42 | 3012.90 | 11854.21 | 3361.07 |
| 2,4-Dimethylphenol | ? | | | | | | |
| 4-Chloro-3-methylphenol | ? | | | | | | |
| 2-methylnaphthalnene | ? | | | | | | |
| bis(2-ethylhexyl)phthalate | ? | | | | | | |

Retardation Factor (Rf) = 1 + (Pb/n) * Kd

where:

Pb = Aquifer bulk density (g/cm3)
n = effective porosity
Kd = Distribution coefficient

Kd = Koc * Foc

where:

Koc = Organic Carbon Partition Coefficient
Foc = Organic Carbon Fraction (%)

JAH/jah/JDD

Table 6-3

Theoretical Contaminant Velocities Across Confining Layer
ACS Site, Griffith, Indiana

| COMPOUND | (1) Rf(MW07) | (2) Cv Range (ft/yr) | (1) Rf(MW09) | (2) Cv Range (ft/yr) |
|---|---|---|---|---|
| Chloromethane | 5.14 | 0.047 - 0.089 | 3.44 | 0.070 - 0.134 |
| Vinyl chloride | 7.74 | 0.031 - 0.059 | 4.97 | 0.048 - 0.092 |
| Chloroethane | 14.60 | 0.016 - 0.032 | 9.02 | 0.027 - 0.051 |
| Methylene chloride | 2.04 | 0.118 - 0.225 | 1.61 | 0.149 - 0.285 |
| Acetone | 1.26 | 0.190 - 0.365 | 1.15 | 0.208 - 0.399 |
| 1,1-Dichloroethene | 4.55 | 0.053 - 0.101 | 3.09 | 0.078 - 0.149 |
| cis-1,2-Dichloroethene | 6.80 | 0.035 - 0.068 | 4.42 | 0.054 - 0.104 |
| 1,2-Dichloroethane | 2.66 | 0.090 - 0.173 | 1.98 | 0.121 - 0.233 |
| 2-Butanone | 1.53 | 0.157 - 0.300 | 1.31 | 0.183 - 0.350 |
| Trichloroethene | 15.90 | 0.015 - 0.029 | 9.79 | 0.025 - 0.047 |
| Benzene | 10.82 | 0.022 - 0.043 | 6.79 | 0.035 - 0.068 |
| 4-Methyl-2-pentanone | 3.48 | 0.069 - 0.132 | 2.46 | 0.097 - 0.187 |
| 2-Hexanone | 2.66 | 0.090 - 0.173 | 1.98 | 0.121 - 0.233 |
| Tetrachloroethene | 44.06 | 0.005 - 0.010 | 26.38 | 0.009 - 0.017 |
| Toluene | 36.49 | 0.007 - 0.013 | 21.92 | 0.011 - 0.021 |
| Chlorobenzene | 40.04 | 0.006 - 0.011 | 24.01 | 0.010 - 0.019 |
| Ethylbenzene | 131.12 | 0.002 - 0.004 | 77.70 | 0.003 - 0.006 |
| total-Xylenes | 29.39 | 0.008 - 0.016 | 17.73 | 0.014 - 0.026 |
| olychlorinated biphenyls | 62693.61 | 0.000 - 0.000 | 36955.13 | 0.000 - 0.000 |
| Phenol | 2.68 | 0.090 - 0.172 | 1.99 | 0.121 - 0.231 |
| bis(2-chloroethyl)ether | 2.64 | 0.091 - 0.174 | 1.97 | 0.122 - 0.234 |
| 1,3-Dichlorobenzene | 202.09 | 0.001 - 0.002 | 119.53 | 0.002 - 0.004 |
| 1,4-Dichlorobenzene | 202.09 | 0.001 - 0.002 | 119.53 | 0.002 - 0.004 |
| 1,2-Dichlorobenzene | 202.09 | 0.001 - 0.002 | 119.53 | 0.002 - 0.004 |
| 2-Methylphenol | 2.77 | 0.087 - 0.166 | 2.05 | 0.117 - 0.225 |
| bis(2-chloroisopropyl)ether | 8.22 | 0.029 - 0.056 | 5.25 | 0.046 - 0.088 |
| 4-Methylphenol | 3.01 | 0.080 - 0.153 | 2.19 | 0.110 - 0.210 |
| Isophorone | 3.96 | 0.061 - 0.116 | 2.74 | 0.087 - 0.168 |
| Benzoic acid | 7.74 | 0.031 - 0.059 | 4.97 | 0.048 - 0.092 |
| Naphthalene | 80.49 | 0.003 - 0.006 | 47.86 | 0.005 - 0.010 |
| Diethylphthalate | 17.80 | 0.013 - 0.026 | 10.90 | 0.022 - 0.042 |
| Pentachlorophenol | 6270.26 | 0.000 - 0.000 | 3696.41 | 0.000 - 0.000 |
| Di-n-butylphthalate | 20109.95 | 0.000 - 0.000 | 11854.21 | 0.000 - 0.000 |
| 2,4-Dimethylphenol | Not Determined | | | |
| 4-Chloro-3-methylphenol | Not Determined | | | |
| 2-methylnaphthalene | Not Determined | | | |
| bis(2-ethylhexyl)phthalate | Not Determined | | | |

Notes: 1 - Retardation factors (Rf) calculated based on total organic carbon content in confining layer at MW07 and MW09 (see Table 6-?)
2 - Contaminant velocity (Cv) range based on calculated vertical seepage rates (Vs) from 0.24 ft/yr to 0.46 ft/yr (see Table 4-7), Cv = Vs/Rf.

JDD/jdJ/JAH

Table 6-4

Theoretical Contaminant Velocities Through Upper Aquifer
ACS Site, Griffith, Indiana

| UPPER AQUIFER COMPOUND | (1) Rf (MW09) | Contaminant Velocity (Cv) (ft/yr) (2) Flow Path #1 | Flow Path #2 | Flow Path #3 | Flow Path #4 | (1) Rf (MW07) | Cv (ft/yr) (2) Flow Path #5 |
|---|---|---|---|---|---|---|---|
| Chloromethane | 1.62 | 37.65 | 82.72 | 12.35 | 35.19 | 4.24 | 18.40 |
| Vinyl chloride | 2.01 | 30.35 | 66.67 | 9.95 | 28.36 | 7.99 | 9.76 |
| Chloroethane | 3.04 | 20.07 | 44.08 | 6.58 | 18.75 | 15.10 | 5.17 |
| Methylene chloride | 1.16 | 52.59 | 115.52 | 17.24 | 49.14 | 2.08 | 37.50 |
| Acetone | 1.04 | 58.65 | 128.85 | 19.23 | 54.81 | 1.27 | 61.42 |
| 1,1-Dichloroethene | 1.53 | 39.87 | 87.58 | 13.07 | 37.25 | 4.68 | 16.67 |
| cis-1,2-Dichloroethene | 1.87 | 32.62 | 71.66 | 10.70 | 30.48 | 7.01 | 11.13 |
| 1,2-Dichloroethane | 1.25 | 48.80 | 107.20 | 16.00 | 45.60 | 2.72 | 28.68 |
| 2-Butanone | 1.08 | 56.50 | 124.11 | 18.52 | 52.79 | 1.55 | 50.26 |
| Trichloroethene | 3.23 | 18.87 | 41.46 | 6.19 | 17.63 | 16.45 | 4.74 |
| Benzene | 2.47 | 24.69 | 54.24 | 8.10 | 23.07 | 11.18 | 6.98 |
| 4-Methyl-2-pentanone | 1.37 | 44.46 | 97.66 | 14.58 | 41.54 | 3.58 | 21.81 |
| 2-Hexanone | 1.25 | 48.88 | 107.37 | 16.03 | 45.67 | 2.72 | 28.71 |
| Tetrachloroethene | 7.45 | 8.19 | 17.99 | 2.68 | 7.65 | 45.64 | 1.71 |
| Toluene | 6.32 | 9.66 | 21.22 | 3.17 | 9.03 | 37.79 | 2.06 |
| Chlorobenzene | 6.85 | 8.91 | 19.57 | 2.92 | 8.33 | 41.47 | 1.88 |
| Ethylbenzene | 20.49 | 2.98 | 6.54 | 0.98 | 2.78 | 135.91 | 0.57 |
| Total-Xylenes | 5.25 | 11.61 | 25.51 | 3.81 | 10.85 | 30.44 | 2.56 |
| Polychlorinated biphenyls | 9391.03 | 0.01 | 0.01 | 0.00 | 0.01 | 65003.33 | 0.00 |
| Phenol | 1.25 | 48.74 | 107.06 | 15.98 | 45.54 | 2.74 | 28.45 |
| bis(2-chloroethyl)ether | 1.25 | 48.95 | 107.52 | 16.05 | 45.74 | 2.70 | 28.84 |
| 1,3-Dichlorobenzene | 31.12 | 1.96 | 4.31 | 0.64 | 1.83 | 209.50 | 0.37 |
| 1,4-Dichlorobenzene | 31.12 | 1.96 | 4.31 | 0.64 | 1.83 | 209.50 | 0.37 |
| 1,2-Dichlorobenzene | 31.12 | 1.96 | 4.31 | 0.64 | 1.83 | 209.50 | 0.37 |
| 2-Methylphenol | 1.27 | 48.19 | 105.87 | 15.80 | 45.03 | 2.84 | 27.47 |
| bis(2-chloroisopropyl)ether | 2.08 | 29.32 | 64.40 | 9.61 | 27.39 | 8.48 | 9.20 |
| 4-Methylphenol | 1.30 | 46.88 | 102.98 | 15.37 | 43.81 | 3.08 | 25.28 |
| Isophorone | 1.44 | 42.28 | 92.87 | 13.86 | 39.50 | 4.07 | 19.18 |
| Benzoic acid | 2.01 | 30.35 | 66.67 | 9.95 | 28.36 | 7.99 | 9.76 |
| Naphthalene | 12.91 | 4.73 | 10.38 | 1.55 | 4.42 | 83.42 | 0.94 |
| Diethylphthalate | 3.52 | 17.35 | 38.11 | 5.69 | 16.21 | 18.42 | 4.24 |
| Pentachlorophenol | 940.00 | 0.06 | 0.14 | 0.02 | 0.06 | 6501.23 | 0.01 |
| Di-n-butylphthalate | 3012.90 | 0.02 | 0.04 | 0.01 | 0.02 | 20850.81 | 0.00 |
| 2,4-Dimethylphenol | | Not Determined | | | | | |
| 4-Chloro-3-methylphenol | | Not Determined | | | | | |
| 2-methylnaphthalene | | Not Determined | | | | | |
| bis(2-ethylhexyl)phthalate | | Not Determined | | | | | |

Notes: 1 - Retardation factors (Rf) calculated based on total organic carbon content in upper aquifer soils at MW07 and MW09 (see Table 6-?)

2 - Contaminant velocity (Cv) based on calculated horizontal seepage rates (Vs) along Flow Path #1 (61 ft/yr), Flow Path #2 (134 ft/yr), Flow Path #3 (20 ft/yr), Flow Path #4 (57 ft/yr) and Flow Path #5 (78 ft/yr) see Figure 4-19 for flow path locations, and Table 4-5 for seepage rate calculations, Cv = Vs/Rf.

JDD/jdd/JAH

TABLE 6-5

RETARDATION FACTORS
ORGANICS DETECTED IN LOWER AQUIFER
ACS SITE, GRIFFITH, INDIANA

| | | MW07 LOWER | MW09 LOWER |
|---|---|---|---|
| | n = | 0.295 | 0.298 |
| | Foc = | 0.68% | 0.31% |
| LOWER AQUIFER COMPOUND | Koc | Rf | Rf |
| Chloroethane | 115 | 6.04 | 3.27 |
| bis(2-chloroethyl)ether | 13.9 | 1.61 | 1.27 |

Retardation Factor (Rf) = 1 + (Pb/n) * Kd

where:
Pb = Aquifer bulk density (g/cm3)
n = effective porosity
Kd = Distribution coefficient

Kd = Koc * Foc

where:
Koc = Organic Carbon Partition Coefficient
Foc = Organic Carbon Fraction (%)

JAH/jah/JDD

Table 6-6

Theoretical Contaminant Velocities Through Lower Aquifer
ACS Site, Griffith, Indiana

| LOWER AQUIFER COMPOUND | Rf (MW09) | Contaminant Velocity (ft/yr) |
|---|---|---|
| Chloroethane | 3.27 | 22.30 |
| bis(2-chloroethyl)ether | 1.27 | 57.27 |

Notes: 1 - Retardation factors (Rf) calculated based on total organic carbon content in lower aquifer at MW09 (see Table 6-?)
2 - Contaminant velocity (Cv) based on calculated horizontal seepage rate (Vs) of 73 ft/yr (see Figure 4-21), Cv = Vs/Rf.

JDD/jdd/JAH

Table 6-7

SUMMARY OF IMPORTANT SOLUBILITY-CONTROLLING SOLIDS REPORTED IN THE LITERATURE[a]

| Element | Observed/Predicted[b] | Speculated[c] |
|---|---|---|
| Al | $Al(OH)_3$, $KAl_3(SO_4)_2(OH)_6$, $AlOHSO_4$, Kaolinite, Montmorillonite | |
| As | | $FeAsO_4$, AsS or $As_2S_3$ |
| Ba | $BaSO_4$ | |
| Be | | $Be(OH)_2$ |
| Cd | $CdCO_3$, $Cd_3(PO_4)_2$ | $(Ca,Cd)CO_3$ |
| Cr | $Cr(OH)_3$ | $FeCr_2O_4$ |
| Cu | $Cu(OH)_2$ | $Cu_2(PO_4)_3$, $Cu_2(OH)_2CO_3$ |
| Fe | $Fe(OH)_3$, $Fe_3(OH)_8$, $FeCO_3$ | |
| Hg | HgS | |
| Pb | $Pb(OH)_2$, $PbCO_3$, $Pb_3(PO_4)_2$, $Pb_4O(PO_4)_2$, $Pb_5(PO_4)_3OH$ | |
| Mn | $MnCO_3$, Mn-oxides | |
| Mo | $PbMoO_4$ | $FeMoO_4$, $Fe_2(MoO_4)_3$ |
| Ni | NiS | $NiFe_2O_4$ |
| Se | | $Fe_2(SeO_3)_3$ |
| S | $CaSO_4$, $Al_4(OH)_{10}SO_4 \cdot 5H_2O$, $KAl_3(SO_4)_2(OH)_6$ | |
| V | | $Fe_2(VO_3)_2$, $VO(OH)_2 \cdot H_2O$ |
| Zn | $Zn(OH)_2$, $ZnCO_3$, $ZnSiO_4$ | $ZnFe_2O_4$ |

(a) After Battelle, Pacific Northwest Laboratories, 1984. All solid phases are not expected in all environments; e.g., hydroxides and carbonate solids are expected only under near neutral to alkaline conditions and sulfides (e.g., HgS, NiS) are expected only under very reducing conditions.

(b) Solids whose presence has been established through physical observations of geologic materials or through similarities in ion activity products with the solubility products.

(c) The formation and presence of Fe-containing compounds are speculated primarily based on adsorption experiments or observed association of other elements with iron oxides.

**TABLE 1-1**
**Summary of Data Collected During RI**
**American Chemical Services NPL Site**
**Remedial Investigation**

| Activity | Data Generated | Presentation |
|---|---|---|
| PHASE I | | |
| Review avail. info. | Site History, Physical Setting<br>Local Groundwater Usage | Sections 1,4<br>Figures 4-1, 4-8, 4-11<br>Tables 1-2, 1-3, 2-6<br>Appendices A, B, L |
| Survey Site Boundaries | Site Grid<br>Site Boundary Location | Figure 1-1 |
| Geophysical Survey | EM Survey (Off & On-Site)<br>Magnetic Survey (Off-Site)<br>EM In-Phase (Still Bottoms) | Section 3<br>Appendix C |
| Surface Water Survey | Surface Water Measurement Locations | Figure 2-3 |
| Install Piezometer Grid | Groundwater Elevation Measurement Locations | Figure 2-3<br>Table 2-1 |
| Install Monitoring Wells | Boring Logs<br>Construction Details<br>Site Stratigraphy | Section 4<br>Figures 4-2 to 4-7<br>Tables 2-1, 2-3, 4-2<br>Appendices D, E and K |
| Install Leachate Wells | Construction Details | Section 4<br>Figure 2-3<br>Table 2-1 |
| Effluent Sampling | Analytical data | Appendices Q and R |
| Perimeter Well Sampling | Analytical Data | Section 5<br>Appendices K, Q and R |
| Leachate Well Sampling | Analytical Data | Section 5<br>Appendices K, Q and R |

**TABLE 1-1**
**(continued)**
**Summary of Data Collected During RI**
**American Chemical Services NPL Site**
**Remedial Investigation**

| Activity | Data Generated | Presentation |
|---|---|---|
| Surface Water/Sediment Sampling | Analytical Data<br>Appendices K, Q and R | Section 5 |
| Soil Borings/Test Pits/ Surface Soil | Boring Logs<br>Waste Extent<br>Analytical Data<br>Site Stratigraphy | Sections 3, 4, and 5<br>Figures 2-1, 2-2, 4-3 to 4-7<br>Table 4-2<br>Appendices D, H, Q, R |
| Auger Probes | Waste area definition<br>HNu Readings | Section 3<br>Figures 2-1 and 2-2<br>Appendix H |
| Aquifer Testing | Permeability Data | Section 4<br>Figure 4-12<br>Table 2-4<br>Appendix I |
| Physical Testing At 6 Monitoring Wells | Grain Size Data<br>Permeability Data | Section 4<br>Tables 2-2 and 4-3<br>Appendix F |
| Private Well Sampling | Analytical Data | Section 5<br>Appendices K, Q, and R |
| Water Level Measurements | Groundwater Elevations | Section 4<br>Figures 4-13 to 4-16, 4-19<br>Table 2-5<br>Appendix O |
| Climatological Data Collection | Precipitation records for 1/89-90 | Section 4<br>Table 4-1<br>Appendix M |
| PHASE II | | |
| Install Lower Aquifer Wells | Boring Logs<br>Construction Details<br>Stratigraphy | Section 4<br>Figures 4-2 to 4-7<br>Tables 2-1, 2-3, 4-2<br>Appendices D and E |

**TABLE 1-1**
**(continued)**
**Summary of Data Collected During RI**
**American Chemical Services NPL Site**
**Remedial Investigation**

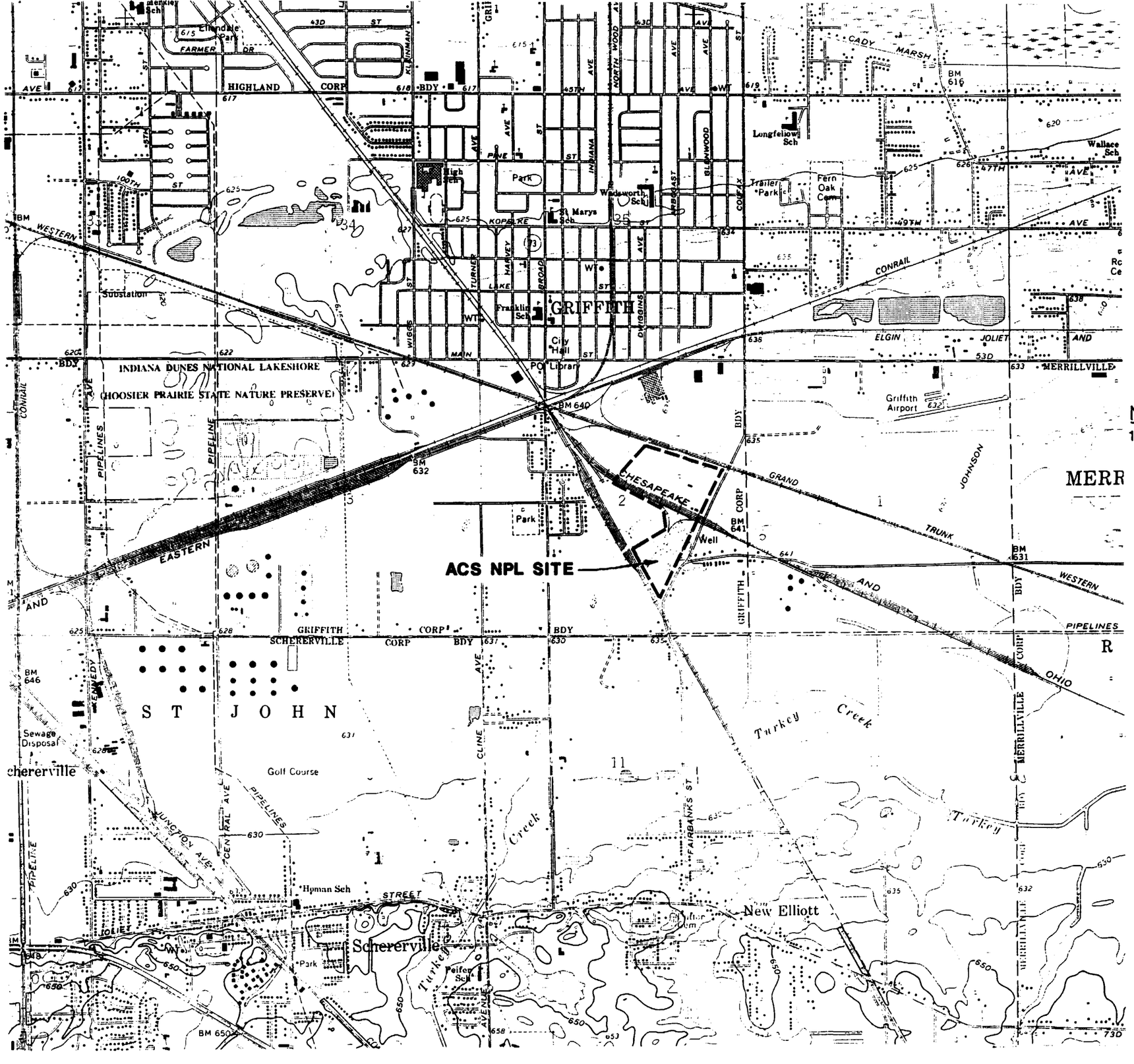
| Activity | Data Generated | Presentation |
|---|---|---|
| Water Level Measurements | Groundwater Elevations | Section 4<br>Tables 2-5, 4-4, 4-6<br>Figures 4-13 to 4-16, 4-19, |
| | 4-21 | Appendix O |
| Tracer Groundwater Investigation | VOC Scan Data | Sections 3 and 5<br>Figures 2-5 and 2-6<br>Appendix J |
| Install Upper Aquifer Wells | Boring Logs<br>Construction Details<br>Site stratigraphy | Section 4<br>Table 2-1, 2-3, and 4-2<br>Appendices D and E<br>Figures 4-2 to 4-7 |
| Collect Aquifer Matrix Samples | Analytical results | Figure 2-3<br>Appendices Q and R |
| Groundwater Sampling | Analytical Data | Section 5<br>Appendices K, Q and R |
| Aquifer Testing | Permeability Data | Section 4<br>Tables 2-4, 4-5, 4-7<br>Figure 4-12<br>Appendix I |
| Physical Testing | Grain Size; Porosity; TOC; Atterberg Limits | Section 4<br>Tables 2-2, 4-3<br>Appendix F |
| Sediment Sampling | Analytical Data | Section 5<br>Figure 2-4<br>Appendices Q and R |
| Wetland Delineations | Report by US Fish and Wildlife | Appendix N |
| Auger Probes | Waste extent and Hnu Readings | Section 3<br>Appendix G |

**TABLE 1-1**
**(continued)**
**Summary of Data Collected During RI**
**American Chemical Services NPL Site**
**Remedial Investigation**

| Activity | Data Generated | Presentation |
|---|---|---|
| Soil borings and Soil Sampling<br>Site Stratigraphy | Analytical Data<br>Boring Logs<br>4-7. Table 4-2<br>Waste Extent | Section 3, 4 and 5<br>Figures 2-1, 2-2, and 4-3 to<br><br>Appendices D, Q and R |
| Field measurements of pH, T, DO, Redox, | Groundwater quality | Section 5<br>Appendix |
| Environmental Audit | Details of Site History/ Processes | Section 1<br>Table 1-3<br>Appendix B |

251RI TABLE 1-1JAW/PJV

SEECO-4




## NOTES

1. BASE MAP DEVELOPED FROM HIGHLAND & ST. JOHN, INDIANA 7.5 MINUTE USGS TOPOGRAPHIC QUADRANGLE MAPS DATED 1968 AND 1962, RESPECTIVELY, PHOTOREVISED 1980.

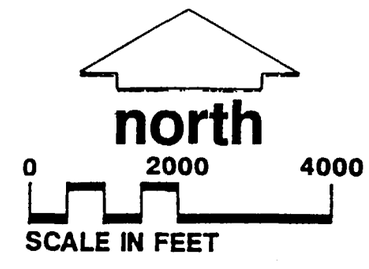



FIGURE 1-1

Designed By
Drawn By D.L.L.
Checked By JHW
Approved By
Date 9/21/90
Reference
Revisions
WARZYN
WARZYN ENGINEERING INC
SITE LOCATION MAP
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA
Sheet Number
Project Number 60251
B1
WARZYN

MASTER BLUE PRINT INC. 616240

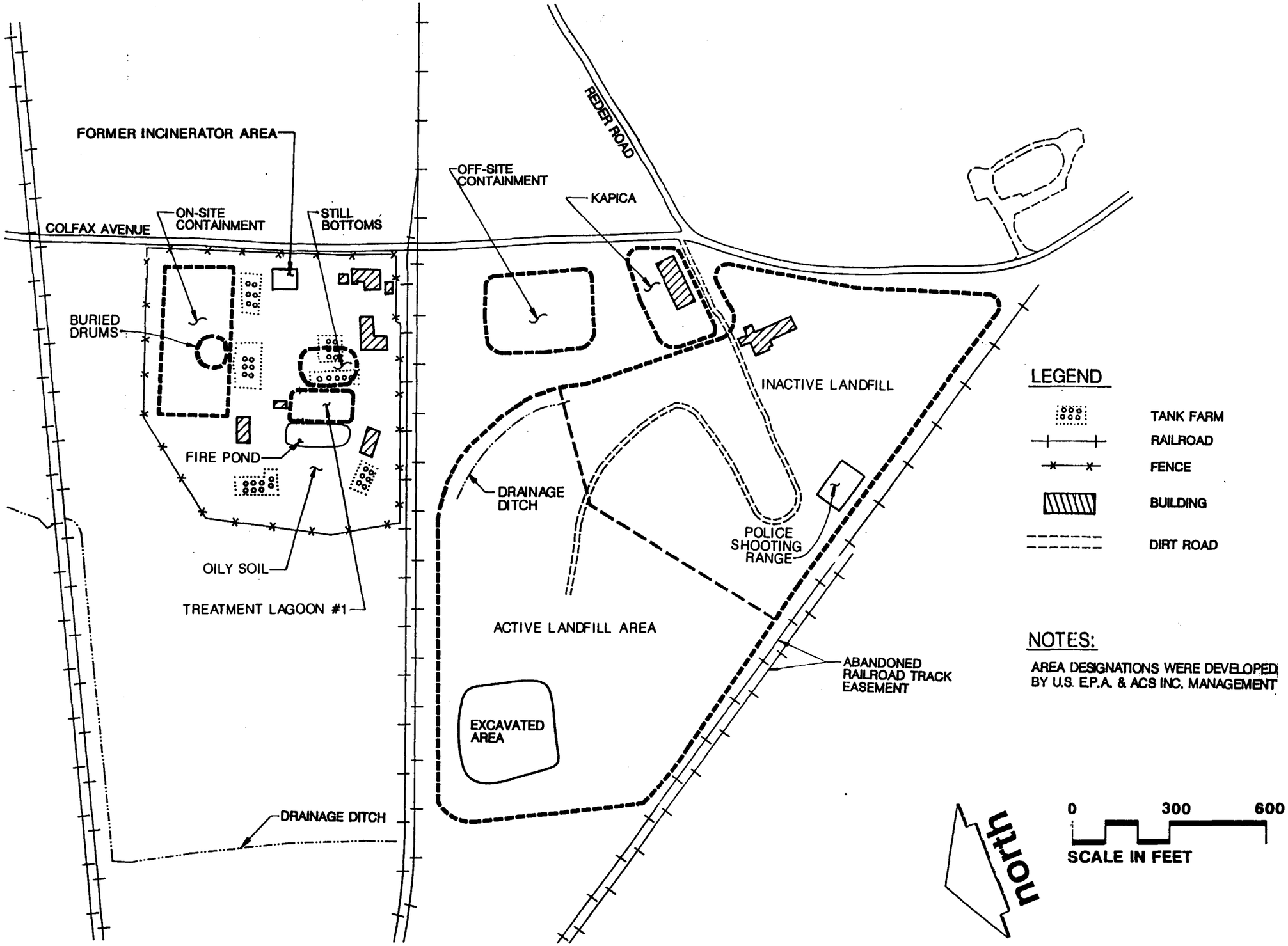
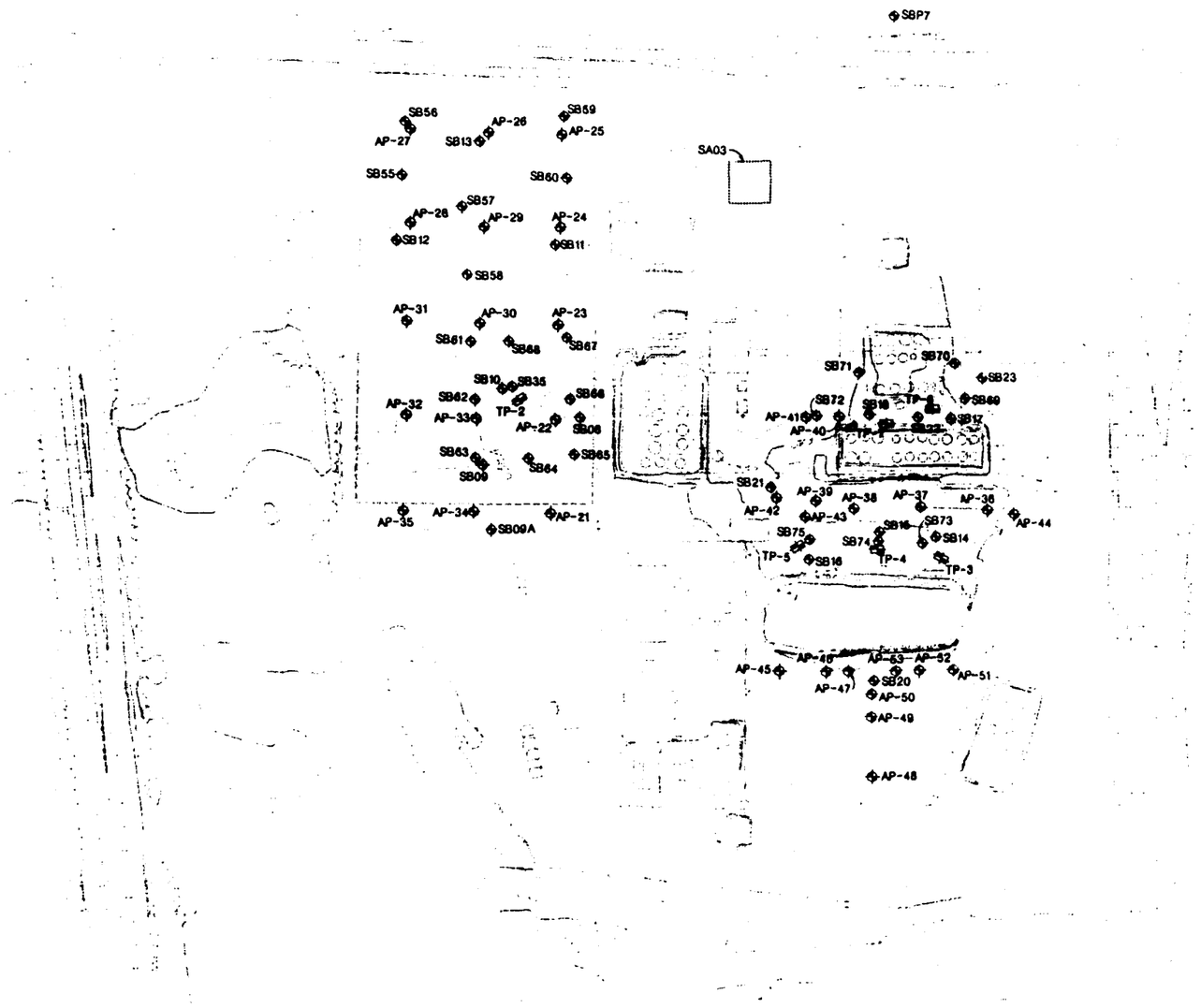



FIGURE 1-2

Designed by
Drawn by DLL, ELR
Checked by JAW
Approved by
Date 9/21/90
Reference
Date • By • Appd
WARZYN
WARZYN ENGINEERING INC.
© 1987 - Warzyn Engineering Inc. - All Rights Reserved
Revisions
WASTE BURIAL AREAS
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFITH, IN DIANA
Sheet Number
Project Number 60251
B2
WARZYN

MASTER BLUE PRINT INC. 516240




## LEGEND

| | |
|---|---|
| ---- | GEOPHYSICS INVESTIGATION AREA |
| SB-01 | SOIL BORING LOCATION & NUMBER |
| AP-01 | AUGER PROBE LOCATION & NUMBER |
| TP-1 | TEST PIT LOCATION & NUMBER |
| SA01 | SOIL AREA LOCATION & NUMBER |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 8, 1988. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1988 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
3. SOIL BORINGS SB01 TO SB18 AND AUGER PROBES AP-1 TO AP-44 FOR PHASE I WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN AUGUST AND SEPTEMBER 1989.
4. SOIL BORINGS SB20 TO SB75 AND AUGER PROBES AP-45 TO AP-83 FOR PHASE II WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN MAY AND JUNE 1990.
5. LOCATIONS FOR SOIL BORINGS WITH SAMPLING AND TEST PITS WERE FIELD LOCATED BY EWI ENGINEERING ASSOC. SURVEYORS.
6. LOCATIONS OF AUGER PROBES ARE APPROXIMATE.
7. SOIL BORING NUMBERS SB19 AND SB34 DO NOT EXIST.

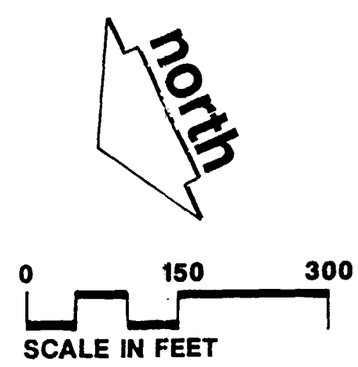



FIGURE 2-1

Date : By : App'd

WARZYN
WARZYN ENGINEERING, INC.

Designed By TJM
Drawn By D.L.L.
Checked By JAW
Approved By
Date 9/21/90
Revisions
Reference

© 1990 - Warzyn Engineering, Inc. - All Rights Reserved

SOIL BORING, AUGER PROBE & TEST PIT LOCATIONS (ON-SITE)
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B3

WARZYN

MASTER BLUE PRINT INC. 516248

## LEGEND

| | |
|---|---|
| ---- | GEOPHYSICS INVESTIGATION AREA |
| SB-01 | SOIL BORING LOCATION & NUMBER |
| AP-01 | AUGER PROBE LOCATION & NUMBER |
| TP-1 | TEST PIT LOCATION & NUMBER |
| SA01 | SOIL AREA LOCATION & NUMBER |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 8, 1985. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1986 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
3. SOIL BORINGS SB01 TO SB18 AND AUGER PROBES AP-1 TO AP-44 FOR PHASE I WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN AUGUST AND SEPTEMBER 1988.
4. SOIL BORINGS SB20 TO SB75 AND AUGER PROBES AP-45 TO AP-83 FOR PHASE II WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN MAY AND JUNE 1990.
5. LOCATIONS FOR SOIL BORINGS WITH SAMPLING AND TEST PITS WERE FIELD LOCATED BY EWI ENGINEERING ASSOC. SURVEYORS.
6. LOCATIONS OF AUGER PROBES ARE APPROXIMATE.
7. SOIL BORING NUMBERS SB19 AND SB34 DO NOT EXIST.

north

0 150 300

SCALE IN FEET

FIGURE 2-2

Designed By TGM
Drawn By D.L.L.
Checked By JAW
Approved By
Date 9/21/90
Reference
Revisions
Date - By - Appr'd
WARZYN
WARZYN ENGINEERING INC.

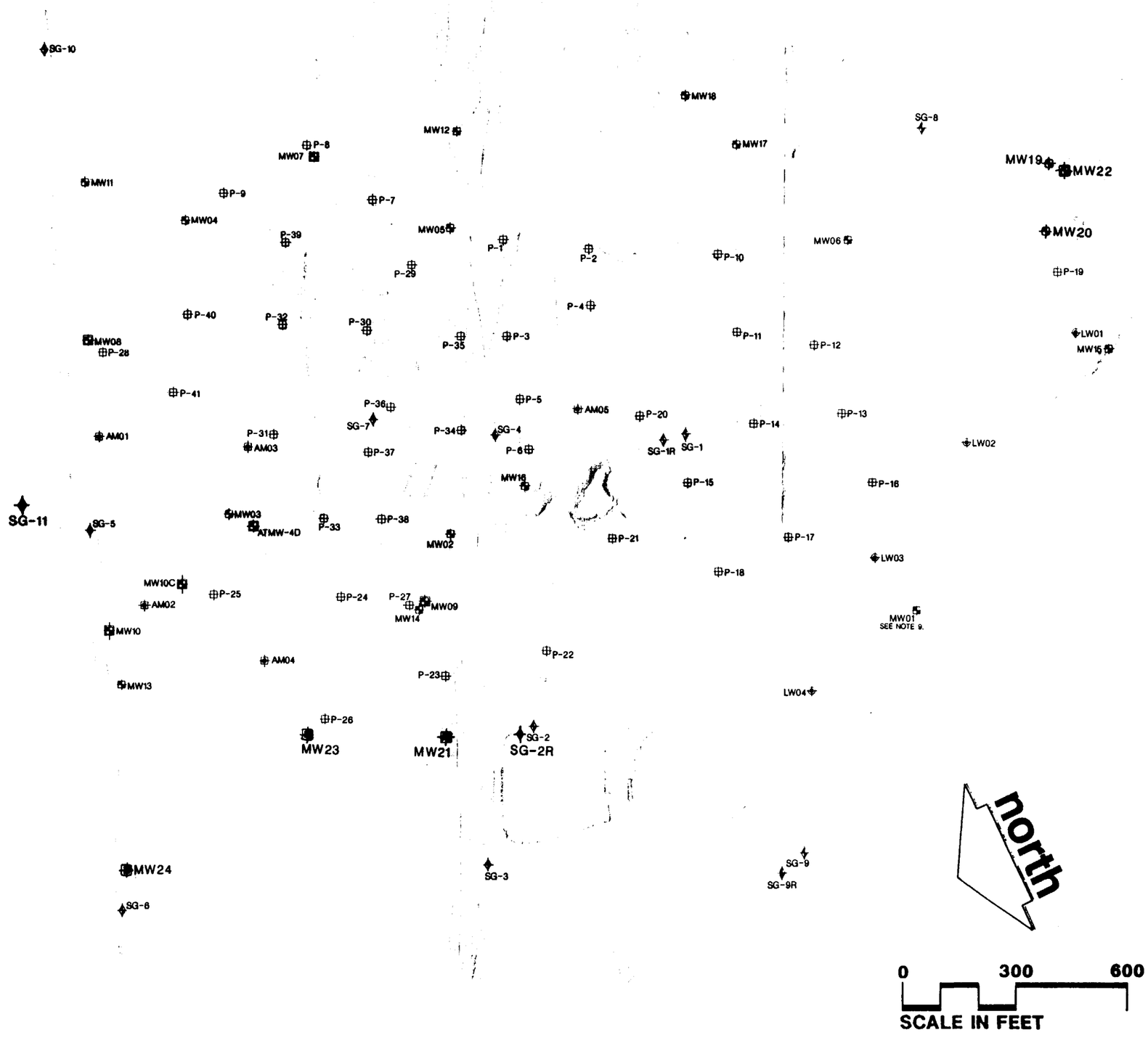
SOIL BORING, AUGER PROBE & TEST PIT LOCATIONS (OFF-SITE)
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B4

WARZYN

© 1987 - Warzyn Engineering Inc. - All Rights Reserved

MASTER BLUE PRINT INC. 818248




## LEGEND

| | |
|---|---|
| ----- | GEOPHYSICS INVESTIGATION AREA |
| MW01 | UPPER AQUIFER MONITORING WELL LOCATION & NUMBER |
| MW10 | LOWER AQUIFER MONITORING WELL LOCATION & NUMBER |
| LW01 | LEACHATE HEADWELL LOCATION & NUMBER |
| P-1 | PIEZOMETER LOCATION & NUMBER |
| SG-1 | STAFF GAUGE LOCATION & NUMBER |
| AM01 | AQUIFER MATRIX SAMPLE LOCATION & NUMBER |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC. ON NOVEMBER 8, 1985. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH.
2. MONITORING WELL MW01, STAFF GAUGES SG1 AND SG9 HAVE BEEN DESTROYED. STAFF GAUGES SG-1R AND SG-9R ARE THE CORRESPONDING REPLACEMENT STAFF GAUGES.
3. VERTICAL SITE DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
4. MONITORING WELL ATMW-4D WAS DRILLED AND INSTALLED BY ATEC ENGINEERING ASSOC. ON SEPTEMBER 27, 1985. THE LOCATION OF ATMW-4D IS APPROXIMATE.
5. MONITORING WELL MW01 TO MW06 WERE DRILLED AND INSTALLED BY EXPLORATION TECHNOLOGY INC (ETI) UNDER THE SUPERVISION OF WARZYN DURING THE PHASE I INVESTIGATION IN JULY 1989.
6. MONITORING WELL MW07 TO MW18 WERE DRILLED AND INSTALLED BY EXPLORATION TECHNOLOGY INC (ETI) UNDER THE SUPERVISION OF WARZYN DURING THE PHASE II INVESTIGATION IN MARCH THROUGH JUNE 1990.
7. LOCATIONS OF MONITORING WELLS, PIEZOMETERS, AND SURFACE WATER STAFF GAUGES WERE FIELD LOCATED BY EWI ENGINEERING ASSOC. SURVEYORS.
8. STAFF GAUGES ARE CONSTRUCTED OF IRON POLES AND WERE INSTALLED BY WARZYN.
9. MONITORING WELL MW-01 WAS DESTROYED BY ROAD CONSTRUCTION DURING SPRING 1990.
10. MONITORING WELLS MW-19 TO MW-24 WERE DRILLED AND INSTALLED BY EXPLORATION TECHNOLOGY INC. (ETI) AND JOHN MATHES & ASSOCIATES UNDER THE SUPERVISION OF WARZYN DURING THE PHASE III INVESTIGATION IN DECEMBER 1990 & JANUARY 1991.

north

0 300 600

SCALE IN FEET

FIGURE 2-3

Designed by TBM
Drawn by D.L.L.
Checked by JAW
Approved by
Date 9/21/90
Reference

Date • By • App'd

WARZYN
WARZYN ENGINEERING INC.

• 1987 - Warzyn Engineering Inc. - All Rights Reserved

MONITORING WELL, LEACHATE WELL, PIEZOMETER & STAFF GAUGE LOCATIONS

REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number
60251 B5

WARZYN

MASTER BLUE PRINT INC. 518248

## LEGEND

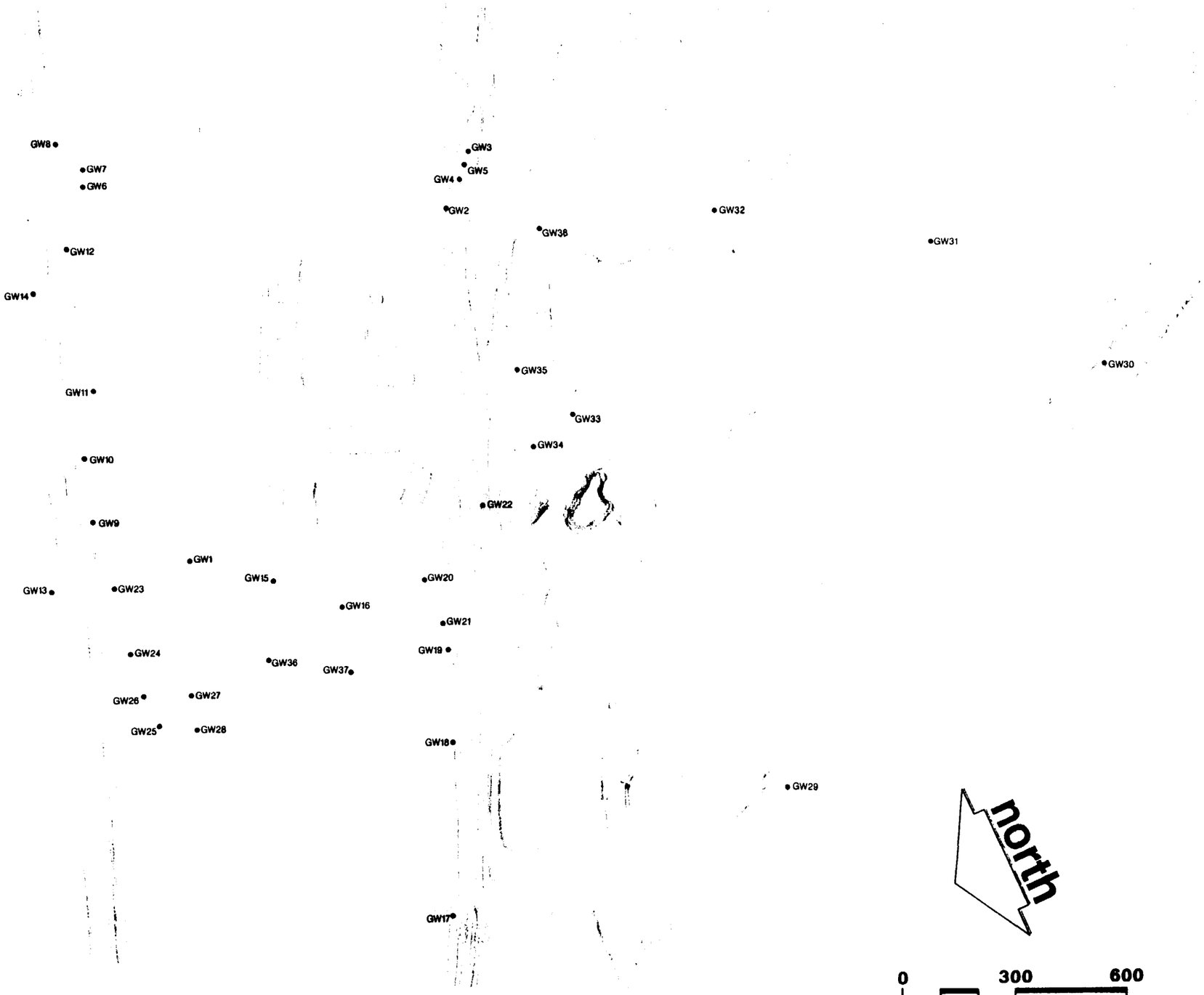
| | |
|---|---|
| ---- | GEOPHYSICS INVESTIGATION AREA |
| ▲ SD01 | SEDIMENT SAMPLE LOCATION & NUMBER |
| * SW01 | SURFACE WATER SAMPLE LOCATION & NUMBER |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 8, 1985. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
3. SURFACE WATER AND SEDIMENT SAMPLES WERE COLLECTED BY WARZYN. PHASE I SAMPLES SD01 THROUGH SD09 AND SW01, SW02, SW05, SW07A AND SW08 WERE COLLECTED IN JULY 1989. PHASE II SEDIMENT SAMPLES SD10 THROUGH SD14 WERE COLLECTED ON MAY 23, 1990. PHASE II SAMPLES SD15 AND SD16 WERE COLLECTED ON JULY 3, 1990 AND RESAMPLED FOR VOCS ONLY ON JULY 25, 1990.
4. LOCATIONS OF SURFACE WATER AND SEDIMENT SAMPLES WERE FIELD LOCATED BY EWI ENGINEERING ASSOC. SURVEYORS.
5. SAMPLES LW5 AND LW6 ARE LEACHATE EFFLUENT SAMPLES COLLECTED FROM TWO DEWATERING AREAS AT THE GRIFFITH LANDFILL DURING PHASE III.

FIGURE 2-4

Designed by TGM
Drawn by D.L.L.
Checked by JAW
Approved by
Date 9/21/90
Reference
Date • By • App'd
WARZYN
WARZYN ENGINEERING INC.
Revisions
SURFACE WATER & SEDIMENT SAMPLING LOCATIONS
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA
Project Number 60251
B6
WARZYN
© 1987 - Warzyn Engineering Inc. - All Rights Reserved
MASTER BLOC PRINT No. 519348




## LEGEND

---- GEOPHYSICS INVESTIGATION AREA

●GW1 GROUNDWATER SAMPLING POINT LOCATION & NUMBER

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 8, 1985. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
3. ALL GROUNDWATER SAMPLE POINTS WERE PART OF A SHALLOW GROUNDWATER INVESTIGATION PERFORMED BY TRACER RESEARCH CORPORATION UNDER SUPERVISION BY WARZYN ENGINEERING INC. (MARCH 26, 1990 THROUGH APRIL 2, 1990).
4. GROUNDWATER WAS COLLECTED BY DRIVING HOLLOW PROBES WITH DETACHABLE DRIVE POINTS TO A SPECIFIED DEPTH BELOW THE WATER TABLE. A GROUNDWATER SAMPLE WAS COLLECTED IN A 40 ML VOC VIAL. THE HEADSPACE OF EACH SAMPLE WAS ANALYZED FOR BENZENE, ETHYL BENZENE, TOLUENE, XYLENES, AND TOTAL PETROLEUM HYDROCARBONS USING A POTABLE VARIAN 3300 (FID) GAS CHROMATOGRAPH. ALL SAMPLE AND ANALYTICAL EQUIPMENT WAS CONTAINED IN A 4-WHEEL DRIVE TRACER VAN.
5. GROUNDWATER SAMPLE POINT LOCATIONS ARE APPROXIMATE.
6. REPORT OF FINDINGS IS COMPILED IN APPENDIX J.

FIGURE 2-5

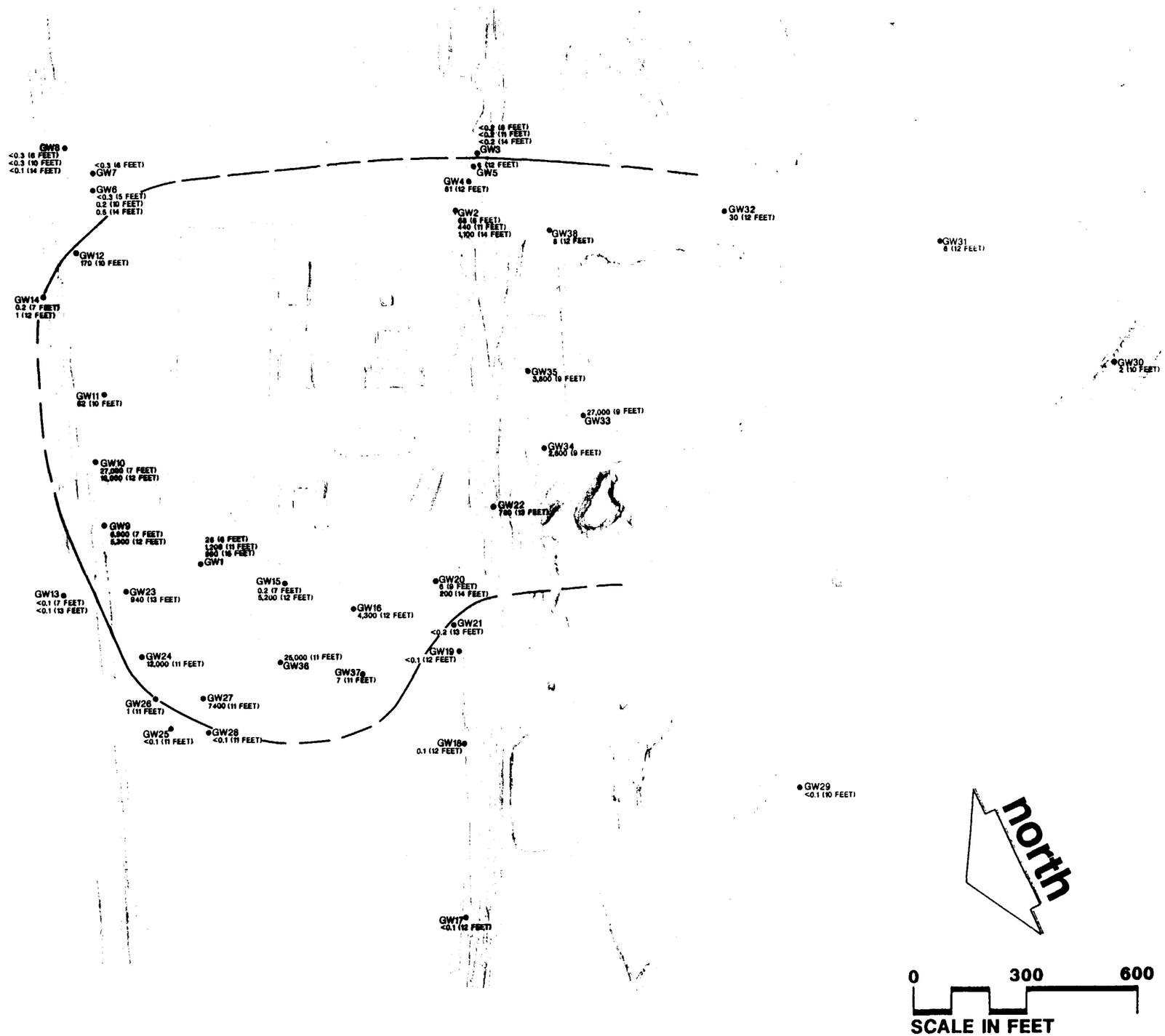
Designed by TJM
Drawn by D.L.L.
Checked by JAW
Approved by
Date 4/21/90
Revisions
Date · By · Appd
WARZYN
WARZYN ENGINEERING INC.

TRACER RESEARCH GROUNDWATER SAMPLING POINTS
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B7
WARZYN

© 1991 - Warzyn Engineering Inc. - All Rights Reserved

MASTER BLUE PRINT No. 010248




## LEGEND

| | |
|---|---|
| ---- | GEOPHYSICS INVESTIGATION AREA |
| ●GW1 | GROUNDWATER SAMPLING POINT LOCATION & NUMBER |
| 2,400 | TOTAL BENZENE CONCENTRATION MEASURED IN GROUNDWATER (ug/l) |
| (6 FEET) | SAMPLING DEPTH IN FEET BELOW GROUND SURFACE |
| —— | ESTIMATED OUTER HORIZONTAL EXTENT OF BENZENE PLUME – AT OR < 1.0 ug/l BENZENE (DASHED WHERE INFERRED) |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 8, 1985. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
3. ALL GROUNDWATER SAMPLE POINTS WERE PART OF A SHALLOW GROUNDWATER INVESTIGATION PERFORMED BY TRACER RESEARCH CORPORATION UNDER SUPERVISION BY WARZYN ENGINEERING INC. (MARCH 26, 1990 THROUGH APRIL 2, 1990).
4. GROUNDWATER WAS COLLECTED BY DRIVING HOLLOW PROBES WITH DETACHABLE DRIVE POINTS TO A SPECIFIED DEPTH BELOW THE WATER TABLE. A GROUNDWATER SAMPLE WAS COLLECTED IN A 40 ML VOC VIAL. THE HEADSPACE OF EACH SAMPLE WAS ANALYZED FOR BENZENE, ETHYL BENZENE, TOLUENE, XYLENES, AND TOTAL PETROLEUM HYDROCARBONS USING A POTABLE VARIAN 3300 (FID) GAS CHROMATOGRAPH. ALL SAMPLE AND ANALYTICAL EQUIPMENT WAS CONTAINED IN A 4-WHEEL DRIVE TRACER VAN.
5. GROUNDWATER SAMPLE POINT LOCATIONS ARE APPROXIMATE.
6. REPORT OF FINDINGS IS COMPILED IN APPENDIX J.

FIGURE 2-6

Date - By - Appd | Revisions

WARZYN
WARZYN ENGINEERING INC

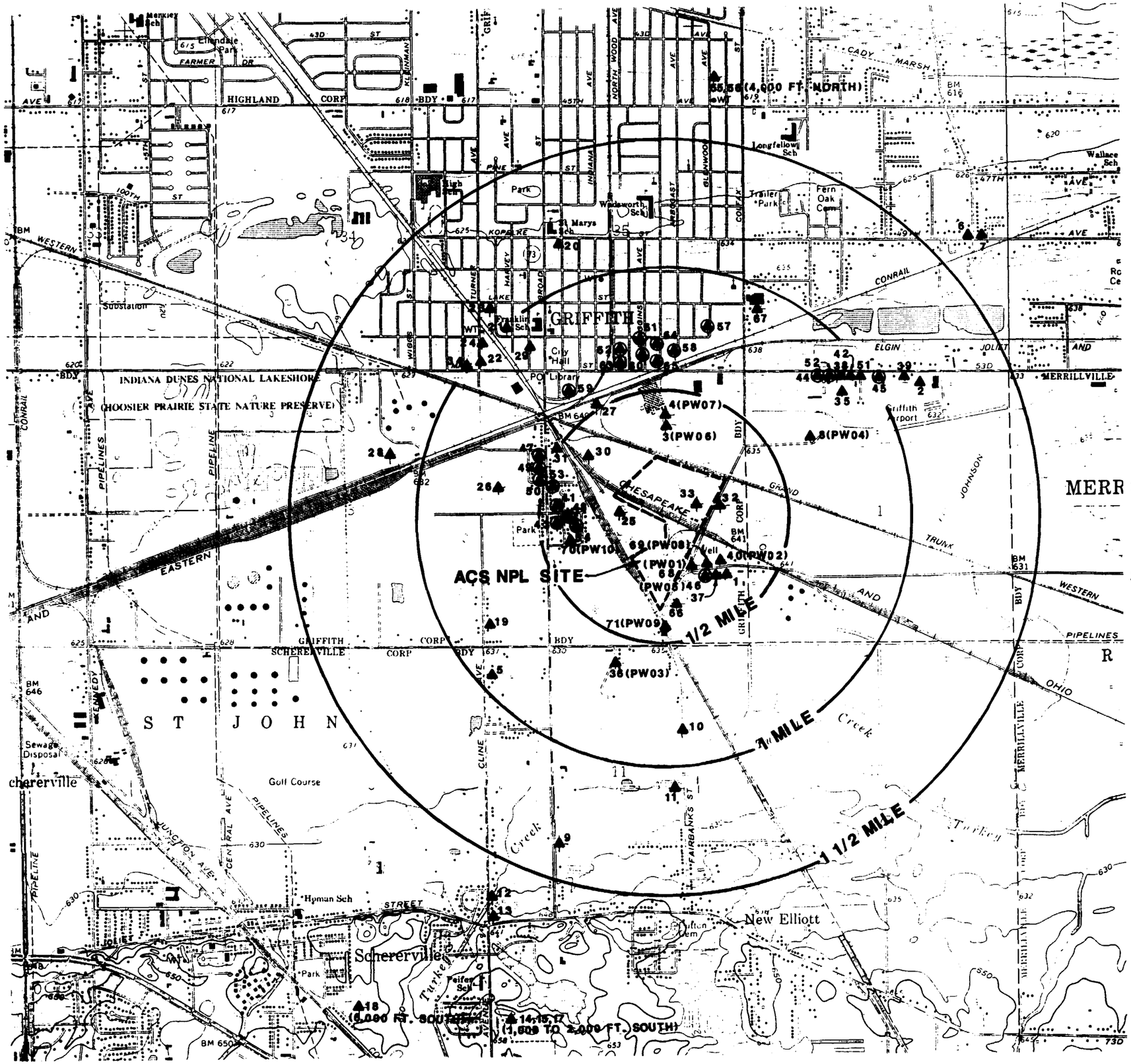
Designed By TSM | Drawn By D.L.L. | Checked By JAW
Approved By RJV | Date 9/21/90 | Reference

SUMMARY OF RESULTS OF TRACER RESEARCH INVESTIGATION
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B8
WARZYN

© 1987 - Warzyn Engineering Inc. - All Rights Reserved

MASTER BLUE PRINT INC. 516348




## LEGEND

- UPPER AQUIFER PRIVATE WELL LOCATION
- LOWER AQUIFER PRIVATE WELL LOCATION
- (PW01) PRIVATE WELL SAMPLING LOCATION

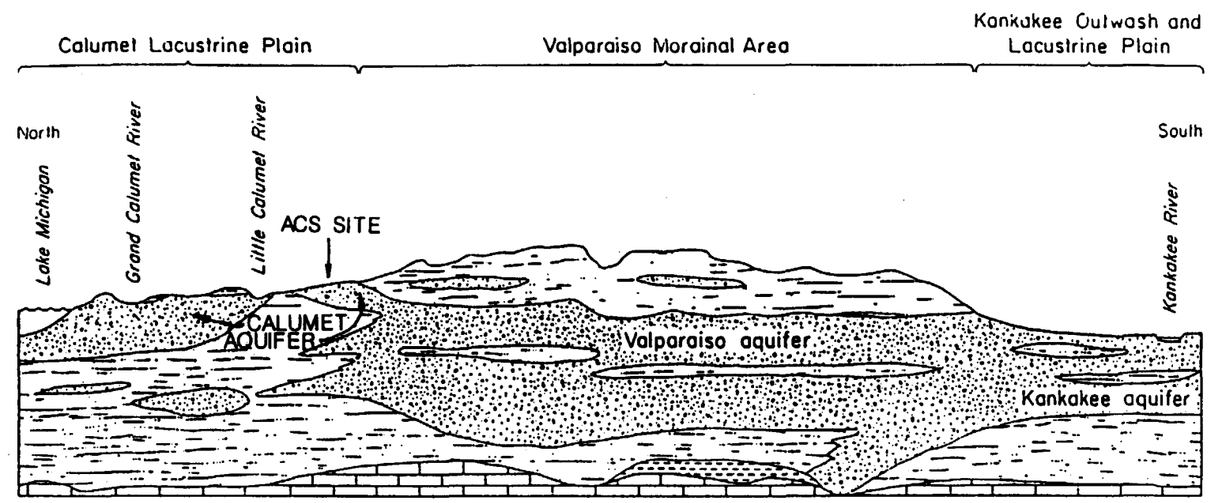
## NOTES

1. BASE MAP DEVELOPED FROM HIGHLAND & ST. JOHN, INDIANA 7.5 MINUTE USGS TOPOGRAPHIC QUADRANGLE MAPS DATED 1968 AND 1962 RESPECTIVELY, PHOTOREVISED 1980.
2. PRIVATE WELL DATA WAS OBTAINED FROM THE INDIANA DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER WELL LOGS, OR A USEPA SURVEY, OR A WARZYN DOOR TO DOOR SURVEY.
3. SUMMARY OF PRIVATE WELLS LOCATED ON THIS MAP IS INCLUDED IN TABLE 2-6.
4. INDIANA DEPARTMENT OF NATURAL RESOURCES WELL LOGS ARE INCLUDED IN APPENDIX L.
5. PRIVATE WELL SAMPLING WAS CONDUCTED BY WARZYN ENGINEERING INC. ON JUNE 13 & 14, 1990.

FIGURE 2-7

Checked by JAW
Date 7/21/90
Designed by TJM
Drawn by D.L.L.
Approved by RJK
WARZYN
WARZYN ENGINEERING INC.
PRIVATE WELL LOCATION MAP
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA
60251 B9
WARZYN

MASTER BLUE PRINT INC. 518248




EXPLANATION

Till or clay

Shale

Sand and (or) gravel

Limestone or dolomite

## NOTES

1. CROSS-SECTION EXTENDS NORTH-SOUTH THROUGH LAKE COUNTY.
2. CROSS-SECTION HAS BEEN MODIFIED FROM HARTKE,ET.AL 1975, FIGURE 15.

0 5 10

SCALE IN MILES

FIGURE 4-1

Designed by JAW
Drawn by D.L.L.
Checked by JAW
Date 9/21/90
Approved by
Revisions

WARZYN
WARZYN ENGINEERING INC.

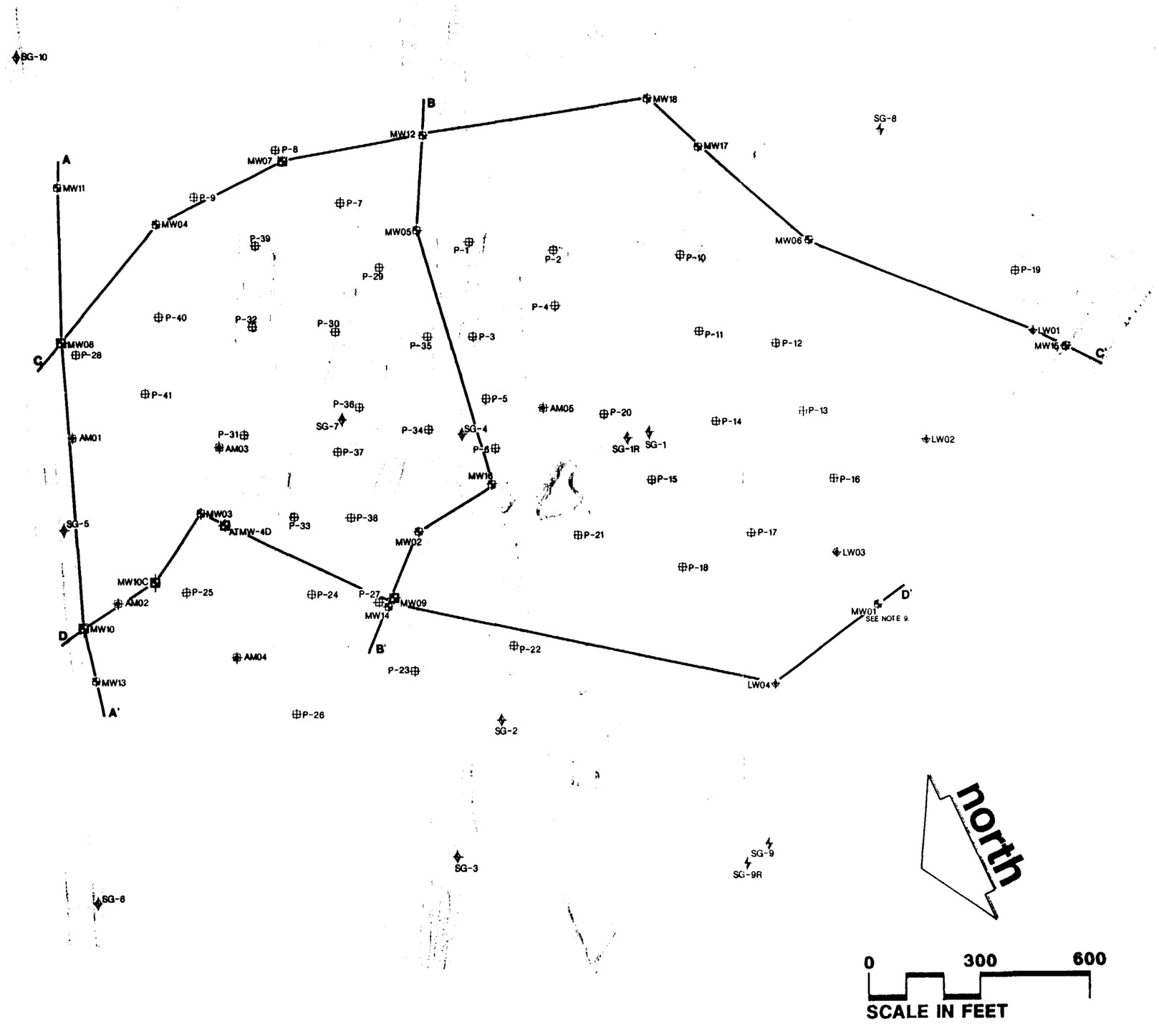
REGIONAL GEOLOGIC CROSS-SECTION

REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B10

WARZYN

MASTER BLUE PRINT INC. 818248




## LEGEND

| | |
|---|---|
| ---- | GEOPHYSICS INVESTIGATION AREA |
| MW01 | UPPER AQUIFER MONITORING WELL LOCATION & NUMBER |
| MW10 | LOWER AQUIFER MONITORING WELL LOCATION & NUMBER |
| LW01 | LEACHATE HEADWELL LOCATION & NUMBER |
| P-1 | PIEZOMETER LOCATION & NUMBER |
| SG-1 | STAFF GAUGE LOCATION & NUMBER |
| AM01 | AQUIFER MATRIX SAMPLE LOCATION & NUMBER |
| —— | GEOLOGIC CROSS-SECTION LOCATION |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC. ON NOVEMBER 8, 1985. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH.
2. MONITORING WELL MW01, STAFF GAUGES SG1 AND SG9 HAVE BEEN DESTROYED. STAFF GAUGES SG-1R AND SG-9R ARE THE CORRESPONDING REPLACEMENT STAFF GAUGES.
3. VERTICAL SITE DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
4. MONITORING WELL ATMW-4D WAS DRILLED AND INSTALLED BY ATEC ENGINEERING ASSOC. ON SEPTEMBER 27, 1985. THE LOCATION OF ATMW-4D IS APPROXIMATE.
5. MONITORING WELL MW01 TO MW06 WERE DRILLED AND INSTALLED BY EXPLORATION TECHNOLOGY INC (ETI) UNDER THE SUPERVISION OF WARZYN DURING THE PHASE I INVESTIGATION IN JULY 1989.
6. MONITORING WELL MW07 TO MW18 WERE DRILLED AND INSTALLED BY EXPLORATION TECHNOLOGY INC (ETI) UNDER THE SUPERVISION OF WARZYN DURING THE PHASE II INVESTIGATION IN MARCH THROUGH JUNE 1990.
7. LOCATIONS OF MONITORING WELLS, PIEZOMETERS, AND SURFACE WATER STAFF GAUGES WERE FIELD LOCATED BY EWI ENGINEERING ASSOC. SURVEYORS.
8. STAFF GAUGES ARE CONSTRUCTED OF IRON POLES AND WERE INSTALLED BY WARZYN.
9. MONITORING WELL MW-01 WAS DESTROYED BY ROAD CONSTRUCTION DURING SPRING 1990.

FIGURE 4-2

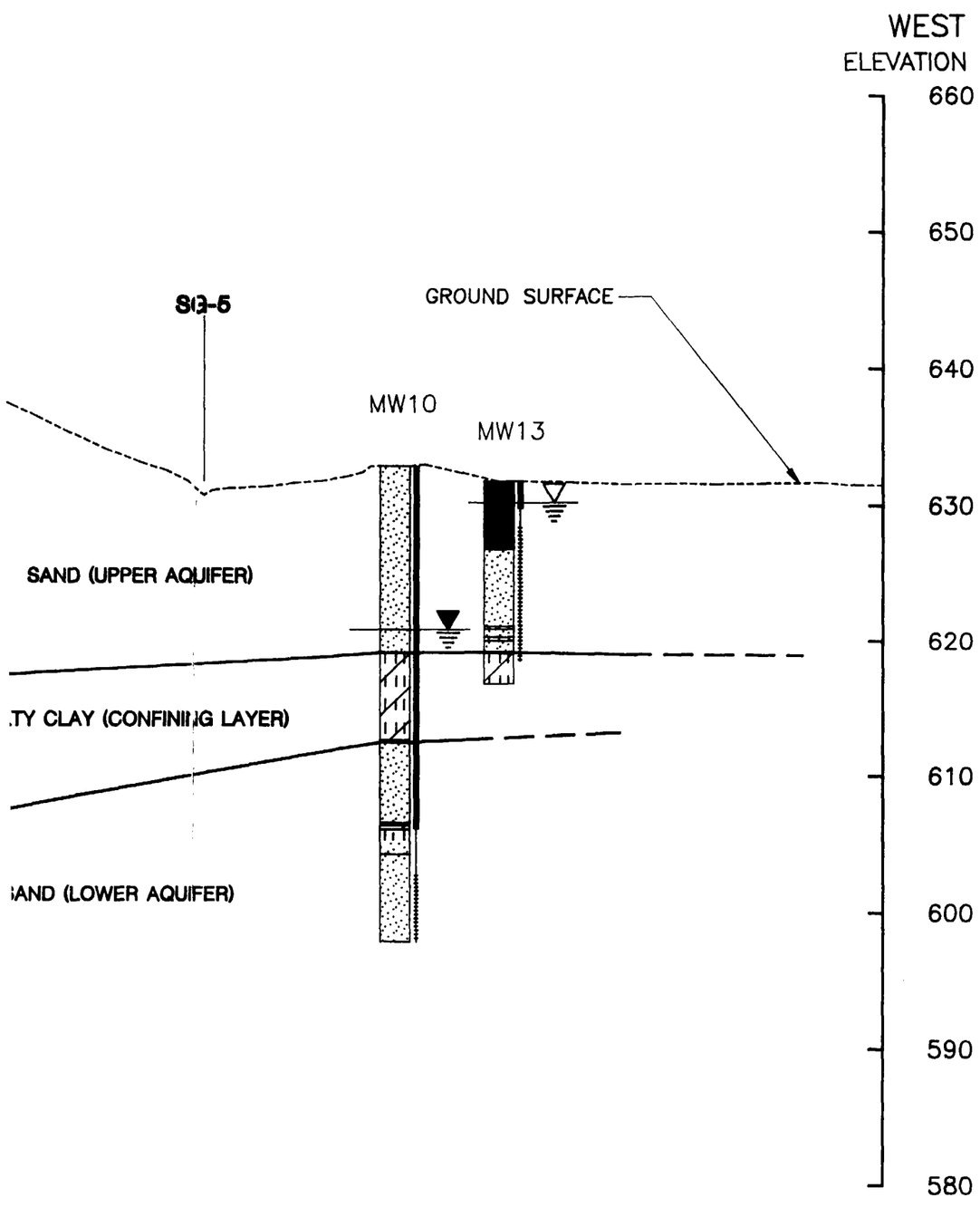
Designed by TM
Drawn by D.L.L.
Checked by JAW
Approved by
Date 9/21/91
Revisions
Date • By • App'd
WARZYN
WARZYN ENGINEERING INC.

LOCATION MAP FOR SITE CROSS-SECTIONS
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B11
WARZYN

© 1991 • Warzyn Engineering Inc. • All Rights Reserved

MASTER BLUE PRINT INC. 516240



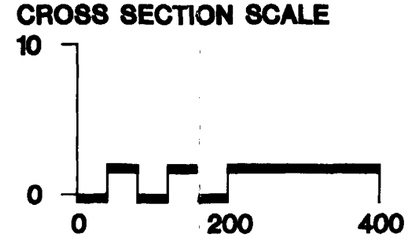

## LEGEND

- LEAN CLAY
- SILTY CLAY
- SANDY LEAN CLAY
- FILL
- CLEAN GRAVEL
- CLAYEY GRAVEL
- SILTY GRAVEL
- SANDY GRAVEL
- SILT
- GRAVELLY SILT
- SILTY SAND
- PEAT OR ORGANIC SILT OR CLAY
- CLEAN SAND
- CLAYEY SAND
- CLAYEY SAND
- GRAVELLY SAND
- SANDY SILT
- TOPSOIL
- UPPER AQUIFER WATER LEVEL
- LOWER AQUIFER WATER LEVEL

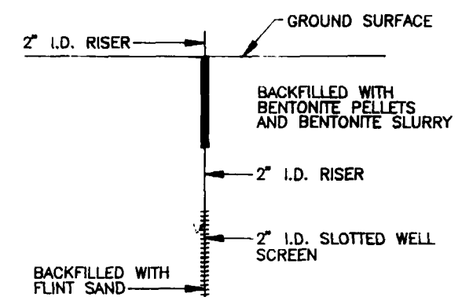
## NOTES

1. THE STRATUM LINES ARE BASED ON INTERPOLATION BETWEEN BORINGS AND MAY NOT REPRESENT ACTUAL SUBSURFACE CONDITIONS.
2. CROSS SECTION LOCATIONS ARE SHOWN ON FIGURE 4–2.
3. FOR THE PURPOSE OF ILLUSTRATING SUBSOIL CONDITIONS ON THE CROSS SECTIONS, SOME OF THE BORING LOGS HAVE BEEN SIMPLIFIED. FOR A DETAILED DESCRIPTION OF SUBSURFACE CONDITIONS AT INDIVIDUAL BORINGS, REFER TO SOIL BORING LOGS, APPENDIX D OF TEXT.
4. FOR COMPLETE MONITORING WELL INSTALLATION DETAILS REFER TO APPENDIX E OF TEXT.
5. CROSS SECTIONS HAVE BEEN VERTICALLY EXAGGERATED TWENTY TIMES.
6. HORIZONTAL DISTANCES ARE MEASURED WITH RESPECT TO THE CENTER OF EACH SOIL BORING LOCATION.
7. EXISTING GROUND SURFACE WAS TAKEN FROM FIGURE 2–3. FURNISHED BY CHICAGO AERIAL SURVEY DATED 11 3,1989.
8. ELEVATIONS ARE SHOWN IN REFERENCE TO U.S.G.S. DATUM.
9. QUESTION MARKS AT THE CONTACTS BETWEEN SUBSOIL TYPES INDICATES THE CONTACTS ARE INFERRED.
10. MONITORING WELL ATMW–4D WAS INSTALLED BY ATEC ASSOCIATES ON SEPTEMBER 27, 1985.
11. THE GROUNDWATER ELEVATIONS SHOWN ARE BASED ON WATER LEVELS OBTAINED BY WARZYN ENGINEERING, INC. ON JULY 18, 1990. WHERE NOT MEASURED DIRECTLY, WATER LEVELS HAVE BEEN EXTRAPOLATED FROM THE WATER TABLE AND POTENTIOMETRIC SURFACE MAPS CONSTRUCTED FOR THAT DATE.

**CROSS SECTION SCALE**




**SCALE IN FEET**
**VERTICAL EXAGGERATION: TWENTY TIMES**



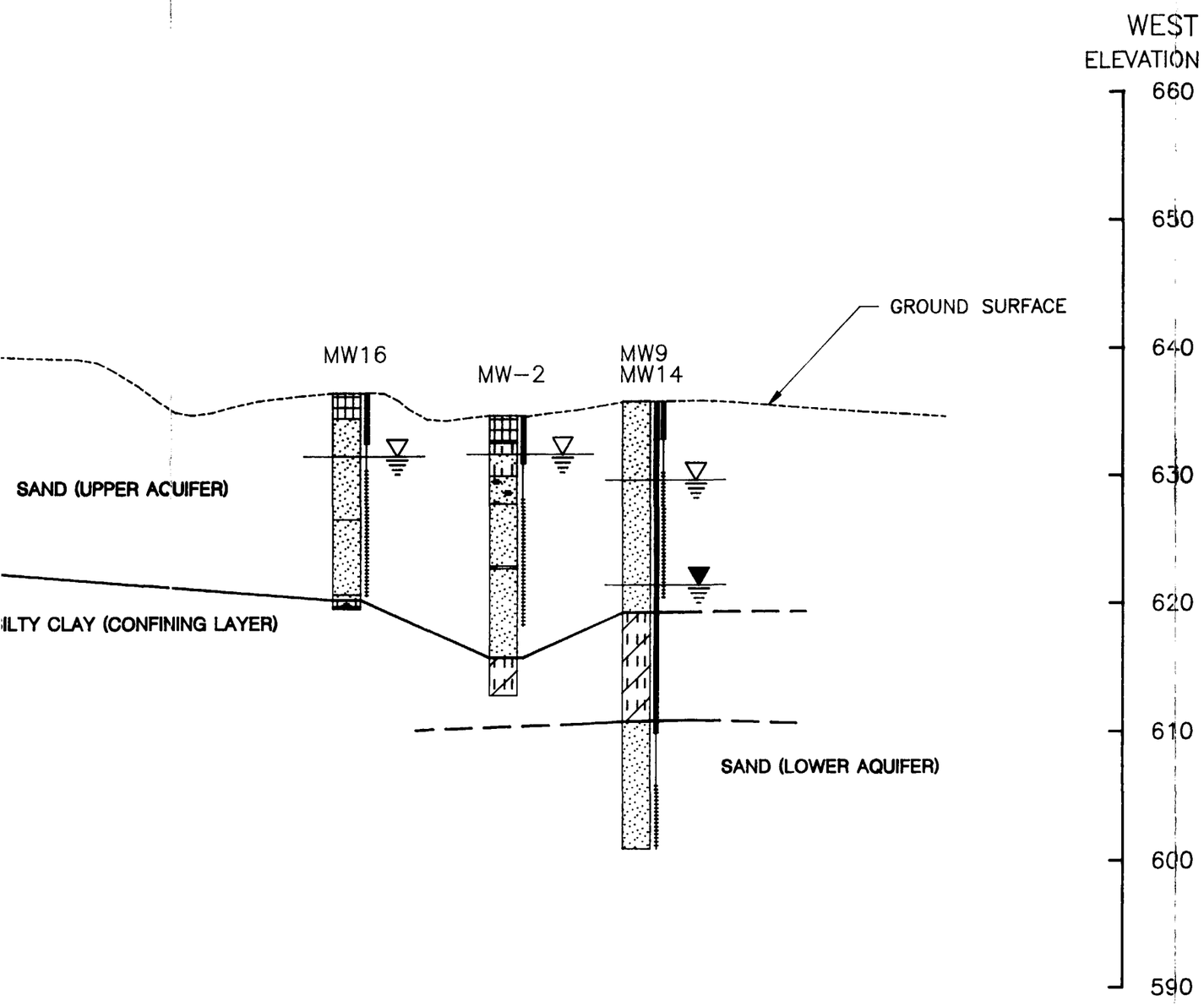

**TYPICAL WELL INSTALLATION DETAIL**

**FIGURE 4–3**

Designed By: TJM
Drawn By: ELR
Checked By: JAW
Approved By: PJ
Date: 9/21/90
References:
File Path:
Revisions
Date
By
Job No.
WARZYN
WARZYN ENGINEERING INC.
© 1990 Warzyn Engineering Inc. All Rights Reserved.

SITE CROSS-SECTION A-A'
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

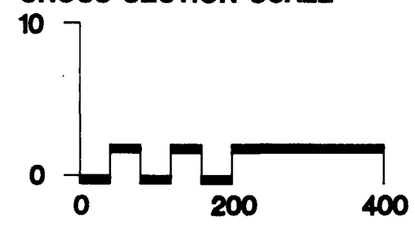
Project Number
60251 B12
WARZYN




## NOTES

1. REFER TO FIGURE 4-3 FOR LEGEND AND ADDITIONAL NOTES.

**CROSS SECTION SCALE**




**SCALE IN FEET**
**VERTICAL EXAGGERATION: TWENTY TIMES**

**FIGURE 4-4**

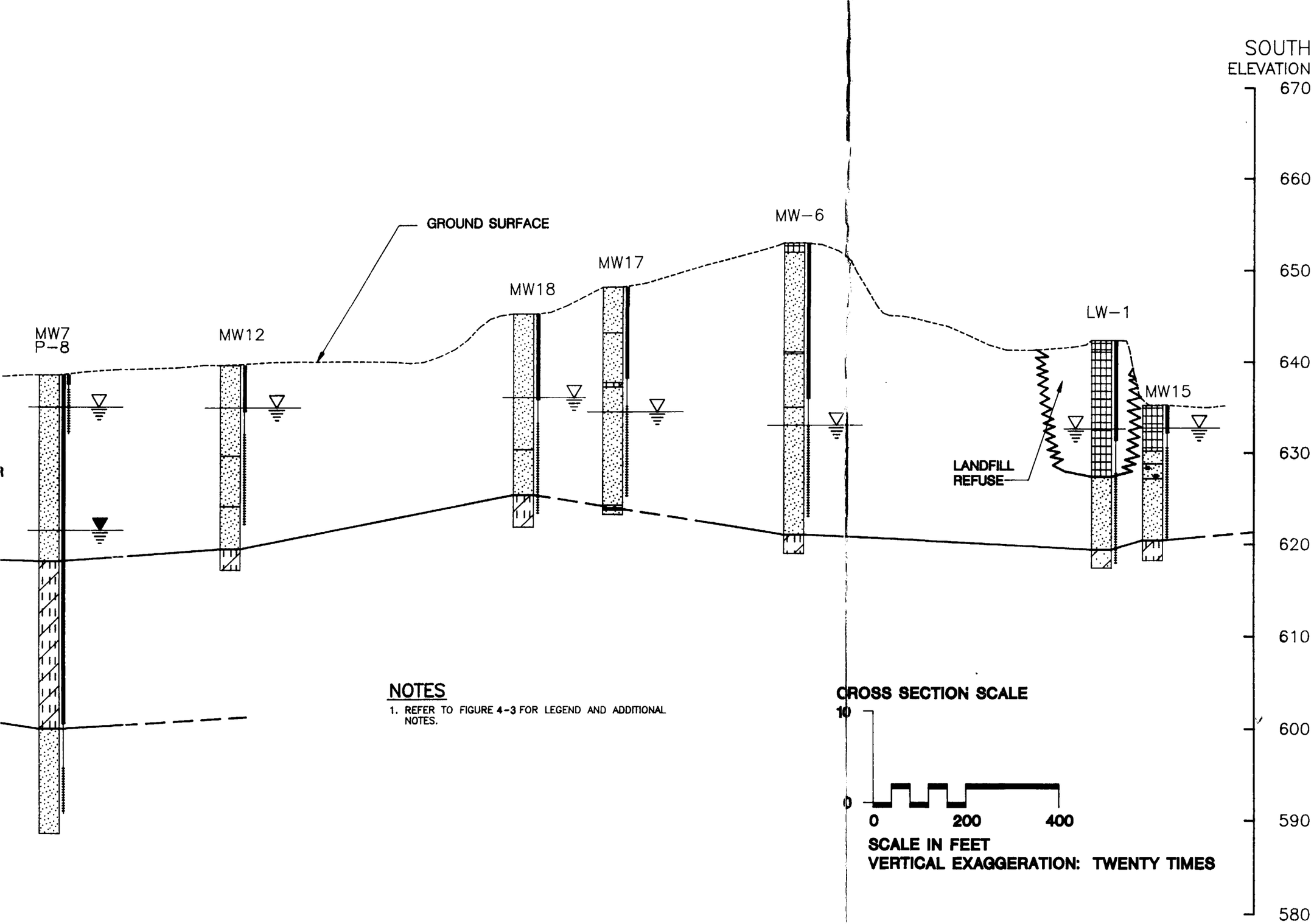
Designed By: JTM
Drawn By: ELR
Checked By: JAW
Approved By: RJV
Date: 9/21/90
Reference:
Revisions
Date - By - App'd
File Path:

WARZYN
WARZYN ENGINEERING INC.

© 1990 Warzyn Engineering Inc. All Rights Reserved.

SITE CROSS-SECTION B-B'
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251
B13




## NOTES

1. REFER TO FIGURE 4-3 FOR LEGEND AND ADDITIONAL NOTES.

FIGURE 4-5

WARZYN
WARZYN ENGINEERING INC.

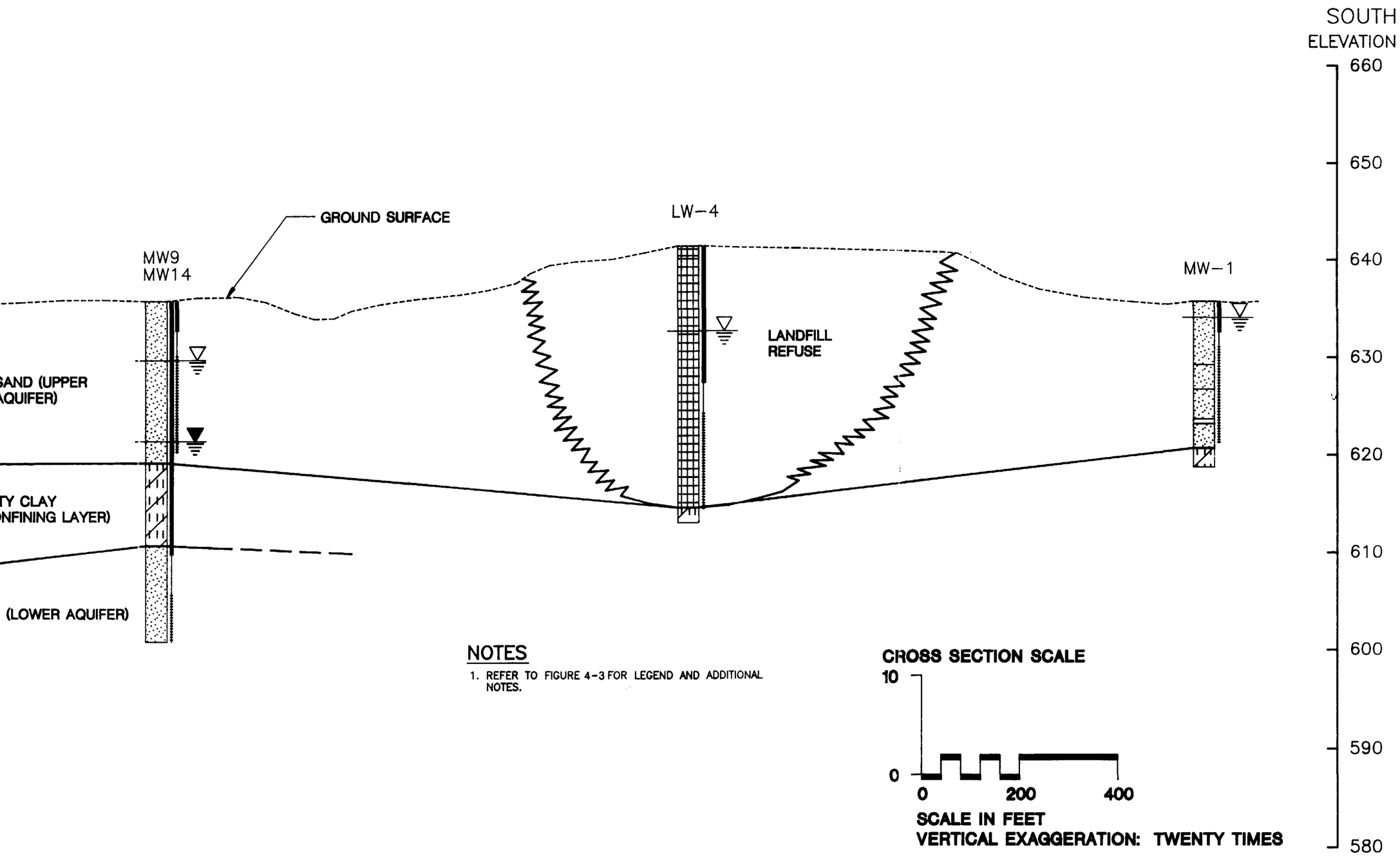
Designed By: TJM
Drawn By: ELR
Checked By: JEW
Approved By: PSV
Date: 9/21/91
Revisions
Date
References
File Public
© 1991 Warzyn Engineering Inc. All Rights Reserved.

SITE CROSS-SECTION C-C'

REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B14

WARZYN




## NOTES

1. REFER TO FIGURE 4-3 FOR LEGEND AND ADDITIONAL NOTES.

FIGURE 4-6

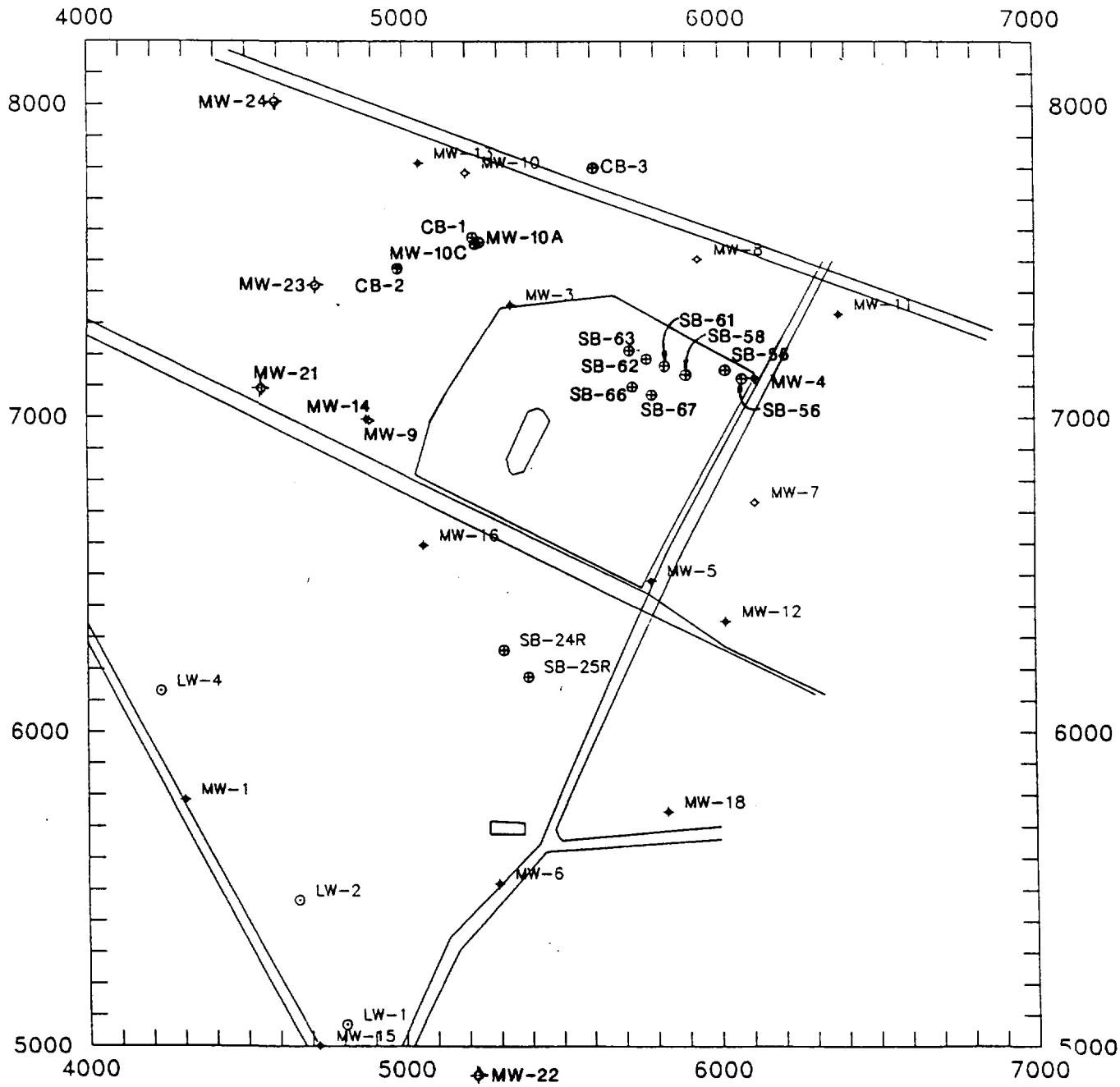
WARZYN
WARZYN ENGINEERING INC.

Designed By: TBM
Drawn By: ELR
Checked By: JKW
Approved By: RJV
Date: 9/21/90
Reference:
Revisions:
File Path:

SITE CROSS-SECTION D-D'

REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251
B15




## NOTES

1. CLAY ELEVATIONS ARE SUMMARIZED IN TABLE 4-2.

## LEGEND

- ◆ UPPER AQUIFER MONITORING WELL LOCATION
- ◇ LOWER AQUIFER MONITORING WELL LOCATION
- ⊙ LEACHATE WELL LOCATION
- ⊕ SOIL BORING LOCATION

north

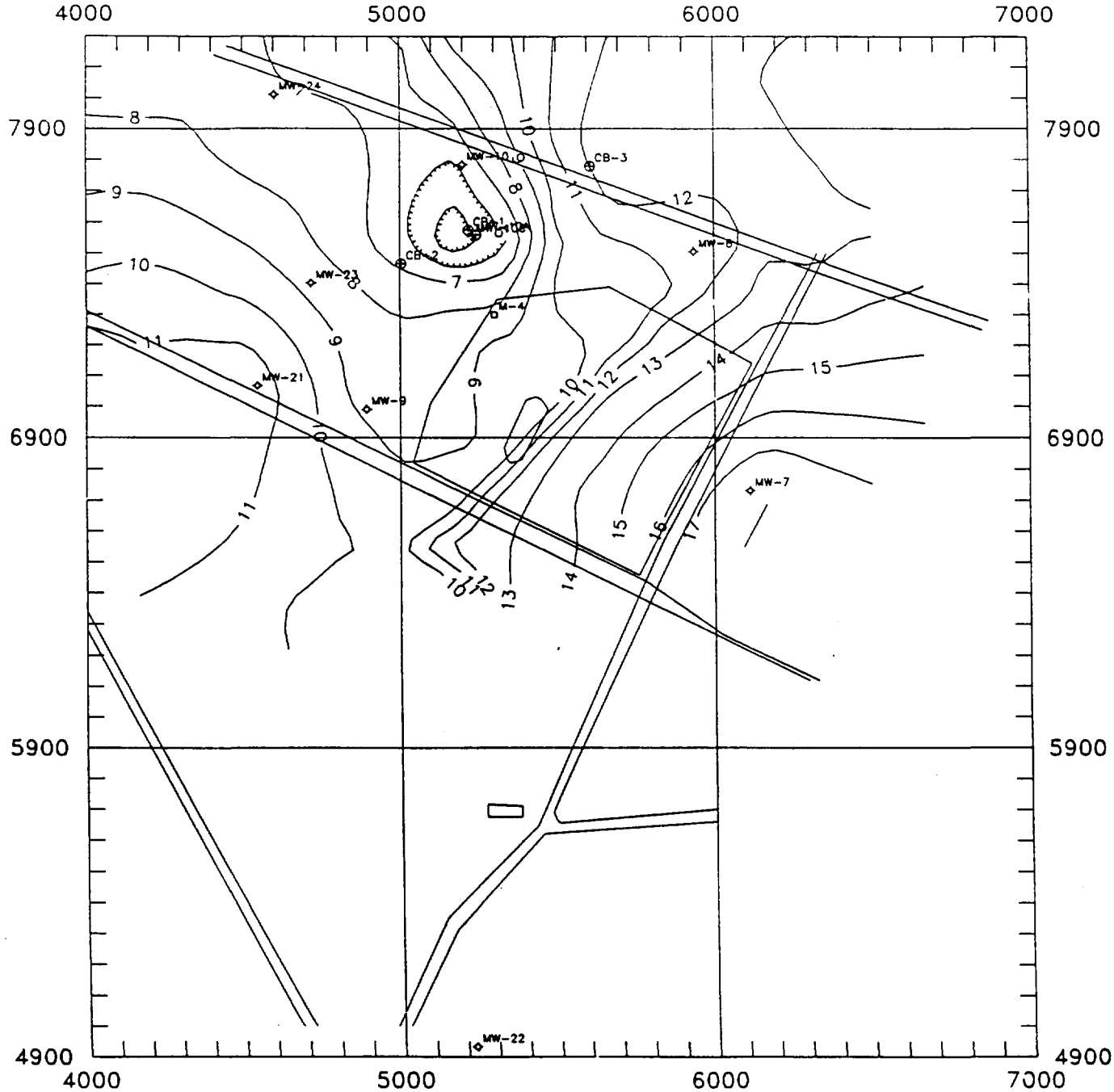
0 500 1000

SCALE IN FEET

**FIGURE 4-8**

| | | | |
|---|---|---|---|
| WARZYN | TOP OF CLAY MEASURING POINTS | Drawn D.L.L., T.J.M., J.A.W. Checked JAW | App'd. |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | Date 9/21/90 |
| | | | 60251 A2 |

TELEDYNE POST N40683




## LEGEND

- ◇ LOWER AQUIFER MONITORING WELL LOCATION
- ⊕ SOIL BORING LOCATION
- ~ CLAY THICKNESS CONTOUR LINE
- □ ATEC ASSOC. MONITORING WELL

## NOTES

1. TABLE 4-2 SUMMARIZES CLAY THICKNESS MEASUREMENTS.
2. FIGURE 4-8 ILLUSTRATES TOP OF CLAY MEASURING POINTS.

north

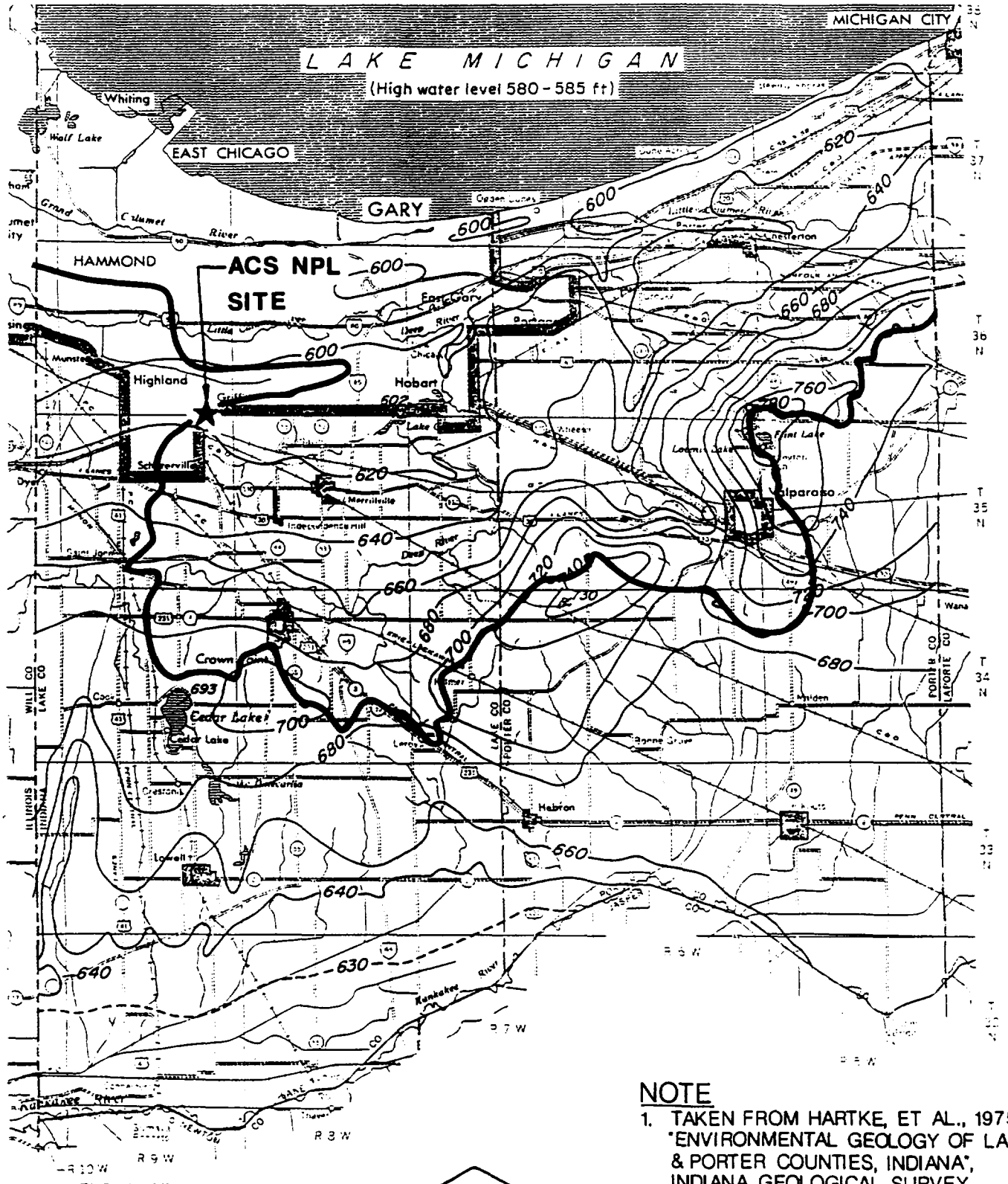
0 500 1000

SCALE IN FEET

**FIGURE 4-9**

| | | | |
|---|---|---|---|
| WARZYN | THICKNESS OF CLAY CONFINING LAYER | Drawn DLL, TJM, JAW | Checked JAW | App'd. RJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 A3 |

Drafting Standards ____ PM ____ Lead Professional ____ Division ____ Section ____ Other ____ DATE ____ INI ____




NOTE

1. TAKEN FROM HARTKE, ET AL., 1975 "ENVIRONMENTAL GEOLOGY OF LAKE & PORTER COUNTIES, INDIANA", INDIANA GEOLOGICAL SURVEY SPECIAL REPORT 11.

FIGURE 4-1(

| | | | |
|---|---|---|---|
| WARZYN | REGIONAL POTENTIOMETRIC SURFACE UNCONSOLIDATED AQUIFER<br>REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Drawn O.L.L. Checked JAW<br>Revisions | App'd. [illegible]<br>Date 9/21/90<br>60251 A4 |

Drafting Standards
Lead Professional
Section
Division
Other

## LEGEND

- GEOPHYSICS INVESTIGATION AREA
- STORM SEWER
- CATCH BASIN
- POTENTIAL SURFACE WATER DRAINAGE AREAS
- INFILTRATION BASINS
- SURFACE WATER FLOW DIRECTION

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 8, 1985. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.

north

0 300 600

SCALE IN FEET

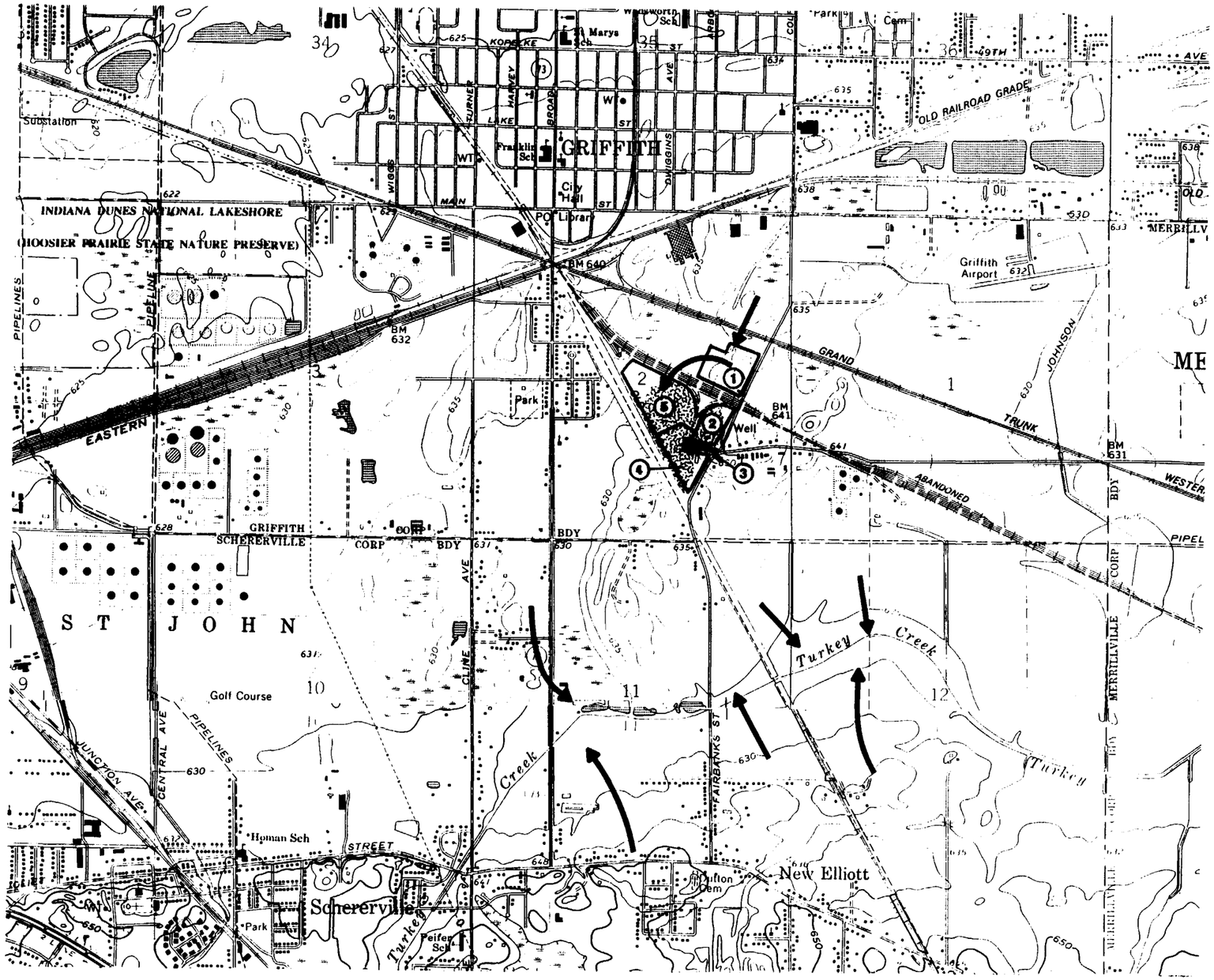
FIGURE 4-12

Designed by PSV
Drawn by D.L.L.
Checked by JAW
Approved by PG Uf
Date 9/21/90
Reference
Revisions
Date • By • Appr'd
WARZYN
WARZYN ENGINEERING INC.

SITE SURFACE WATER DRAINAGE
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B16
WARZYN

MASTER BLUE PRINT INC. 516940




## LEGEND

1. AMERICAN CHEMICAL SERVICES FENCED FACILITY
2. OFF-SITE CONTAINMENT AREA
3. KAPICA AREA
4. OLD GRIFITH MUNICIPAL LANDFILL
5. ACTIVE AREA OF GRIFITH MUNICIPAL LANDFILL

→ SURFACE WATER FLOW DIRECTION

## NOTES

1. BASE MAP DEVELOPED FROM HIGHLAND & ST. JOHN, INDIANA 7.5 MINUTE USGS TOPOGRAPHIC QUADRANGLE MAPS DATED 1968 AND 1962 RESPECTIVELY, PHOTOREVISED 1980.

north

0 2000 4000

SCALE IN FEET

FIGURE 4-11

Designed by RJV
Drawn by D.L.L.
Checked by JAW
Approved by RJV
Date 9/21/90
Reviewer

WARZYN
WARTH ENGINEERING INC

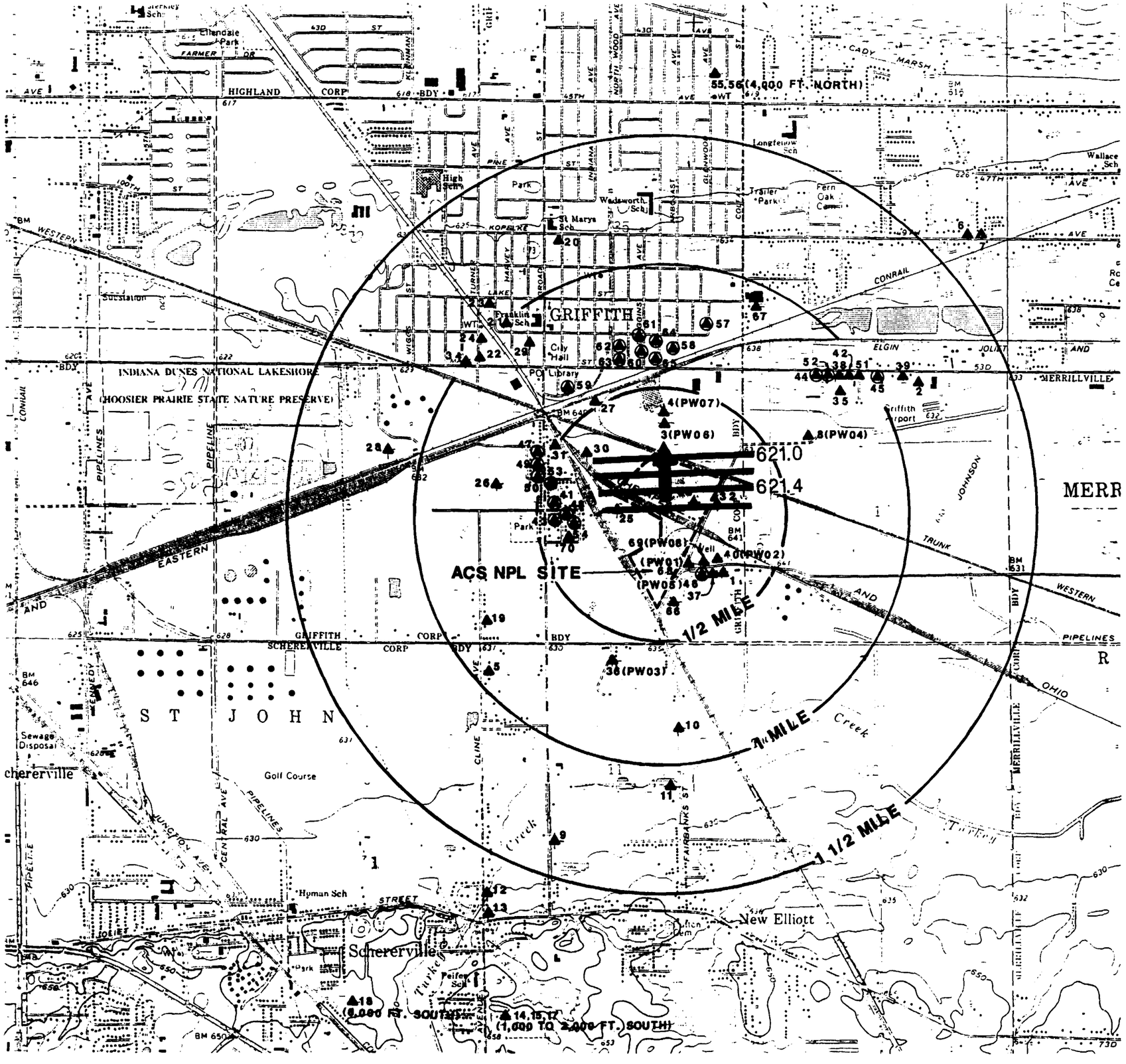
USGS MAP OF ACS SITE VICINITY

REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B17

WARZYN

MASTER BLUE PRINT INC. 516240




## LEGEND

- UPPER AQUIFER PRIVATE WELL LOCATION
- LOWER AQUIFER PRIVATE WELL LOCATION
- (PW01) PRIVATE WELL SAMPLING LOCATION
- POTENTIOMETRIC CONTOUR OF LOWER AQUIFER
- GROUNDWATER FLOW DIRECTION IN LOWER AQUIFER

## NOTES

1. BASE MAP DEVELOPED FROM HIGHLAND & ST. JOHN, INDIANA 7.5 MINUTE USGS TOPOGRAPHIC QUADRANGLE MAPS DATED 1968 AND 1962 RESPECTIVELY, PHOTOREVISED 1980.
2. PRIVATE WELL DATA WAS OBTAINED FROM THE INDIANA DEPARTMENT OF NATURAL RESOURCES, DIVISION OF WATER WELL LOGS, OR A USEPA SURVEY, OR A WARZYN DOOR TO DOOR SURVEY.
3. SUMMARY OF PRIVATE WELLS LOCATED ON THIS MAP IS INCLUDED IN TABLE 2-6.
4. INDIANA DEPARTMENT OF NATURAL RESOURCES WELL LOGS ARE INCLUDED IN APPENDIX L.
5. PRIVATE WELL SAMPLING WAS CONDUCTED BY WARZYN ENGINEERING INC. ON JUNE 13 & 14, 1990.

north

0 2000 4000

SCALE IN FEET

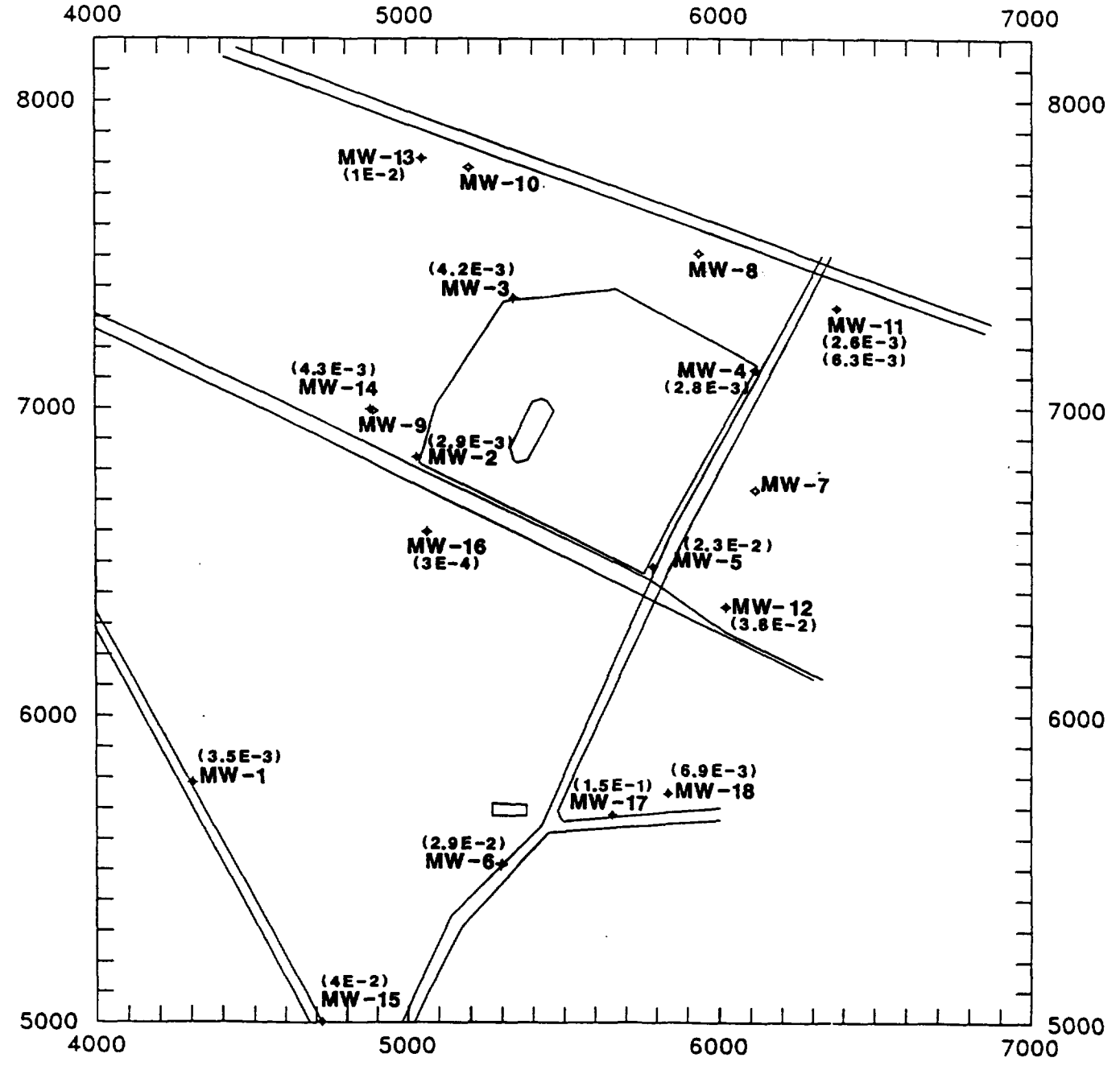
FIGURE 4-13

Drawn by D.L.L. Checked by JAW
Designed by JAW Date 9/21/90
Approved by PVA Revisions

WARZYN
WARZYN ENGINEERS, INC.

PRIVATE WELL LOCATION MAP ILLUSTRATING GROUNDWATER FLOW IN LOWER AQUIFER
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

60251 B18
WARZYN




## LEGEND

◆ UPPER AQUIFER MONITORING WELL LOCATION

◇ LOWER AQUIFER MONITORING WELL LOCATION

(3.5E-2) HYDRAULIC CONDUCTIVITY IN ft/min

north

0 500 1000

SCALE IN FEET

**FIGURE 4-14**

| | | | |
|---|---|---|---|
| WARZYN | **DISTRIBUTION OF UPPER AQUIFER PERMEABILITY**<br>REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Drawn O.L.L., JA.W., T.J.M<br>Revisions | Checked JAW<br>App'd. [illegible]<br>Date 9/21/90 |
| | | | 60251 **A5** |

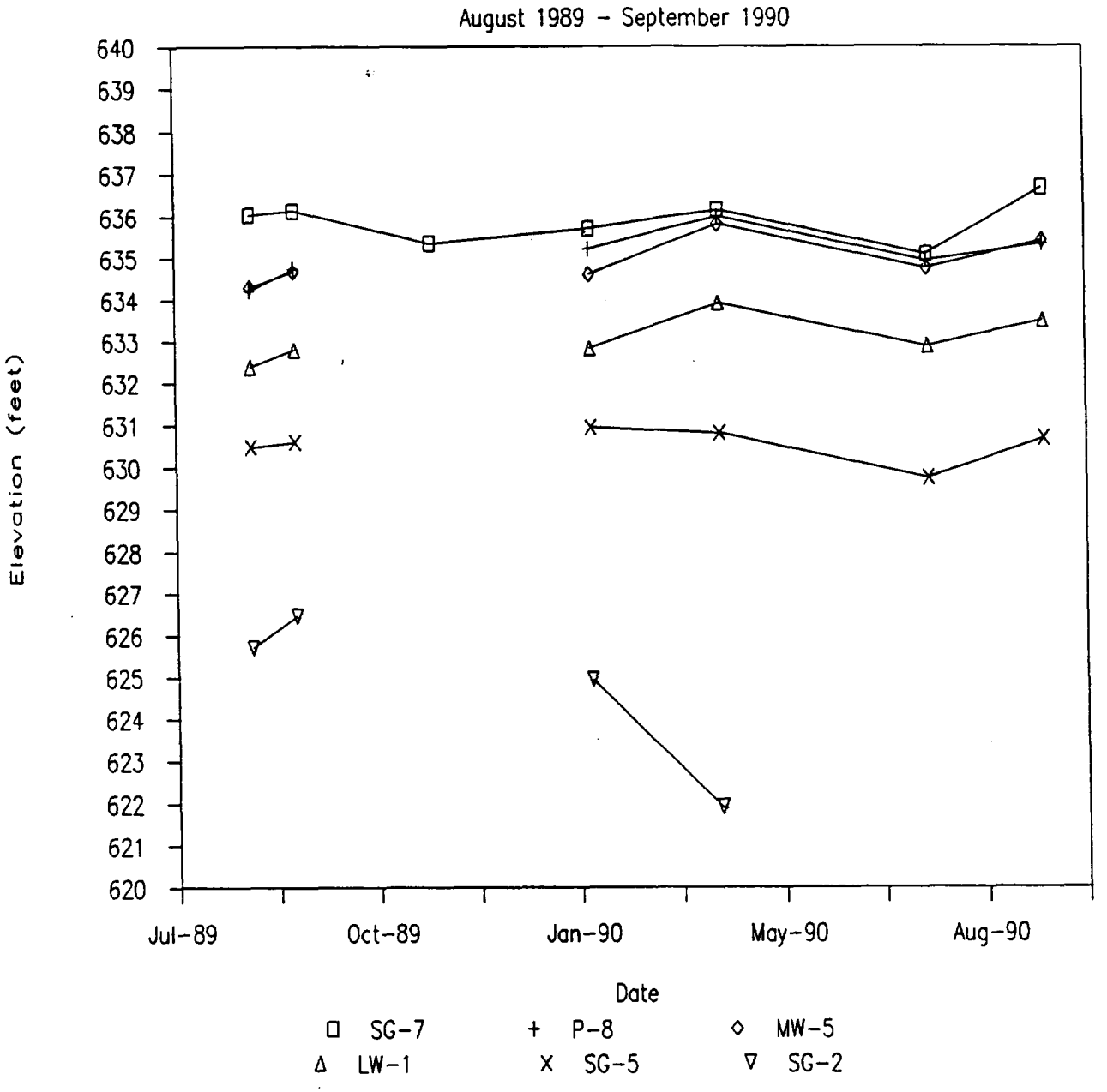
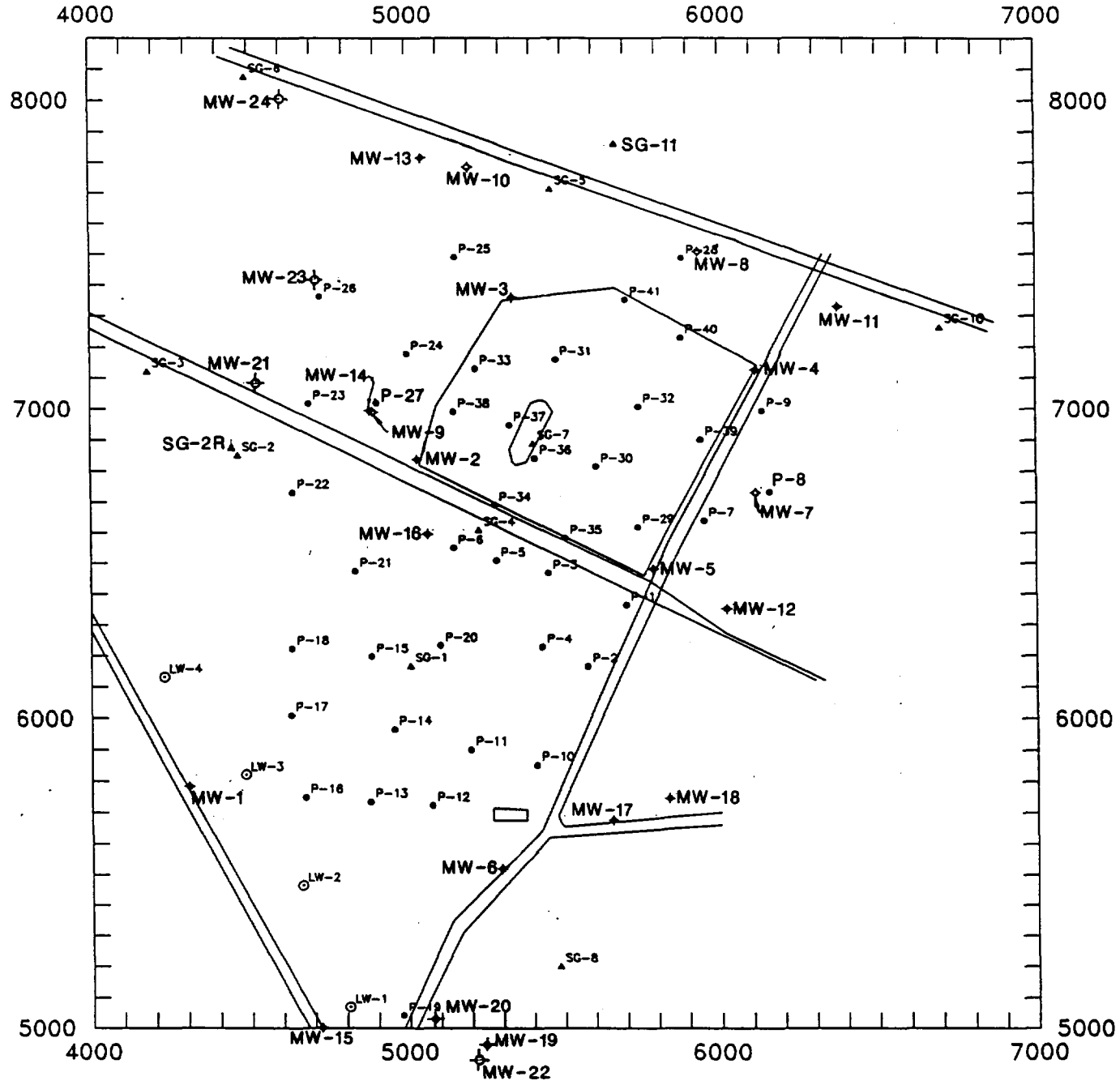



**FIGURE 4-15**

| | | | | |
|---|---|---|---|---|
| WARZYN | SITE HYDROGRAPHS | Drawn DLL, TJM, JAW | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 A6 |

TELEDYNE POST N40683




## LEGEND

- ◆ UPPER AQUIFER MONITORING WELL LOCATION
- ◇ LOWER AQUIFER MONITORING WELL LOCATION
- ⊙ LEACHATE WELL LOCATION
- ● PIEZOMETER LOCATION
- ▲ STAFF GAUGE LOCATION

north

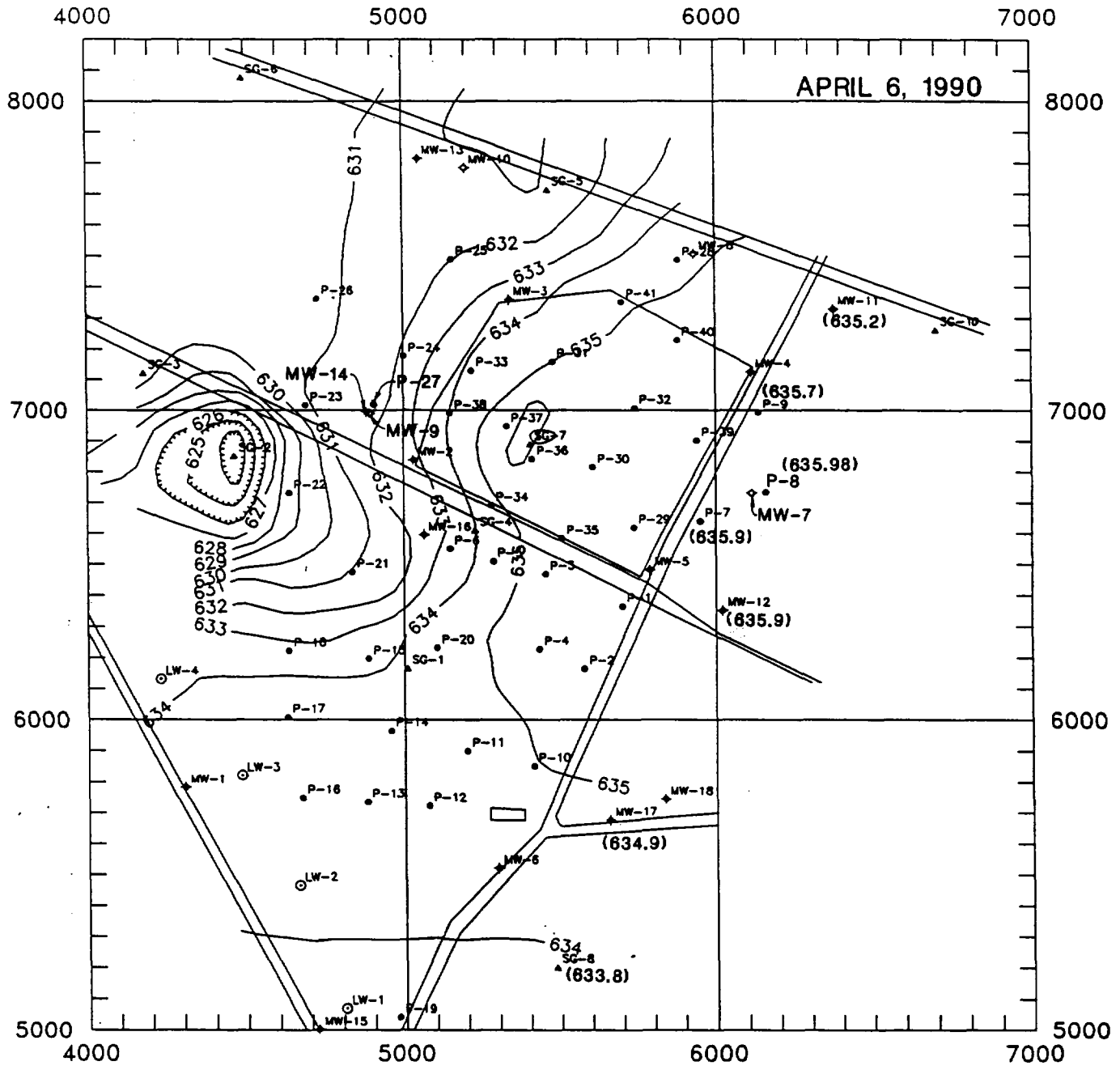
0 500 1000

SCALE IN FEET

**FIGURE 4-16**

| | | | |
|---|---|---|---|
| WARZYN | **WATER LEVEL MEASURING POINT LOCATION MAP** | Drawn D.L.L., T.J.M., J.A.W. Checked JAW | App'd: RJ VH |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | Date 9/21/96 |
| | | | 60251 **A7** |

TELEDYNE POST N40683




## LEGEND

(632.7) GROUNDWATER ELEVATION

◆ UPPER AQUIFER MONITORING WELL LOCATION

◇ LOWER AQUIFER MONITORING WELL LOCATION

⊙ LEACHATE WELL LOCATION

● PIEZOMETER LOCATION

▲ STAFF GAUGE LOCATION

—620— WATER LEVEL CONTOUR LINE

## NOTES

1. A GROUNDWATER ELEVATION FOR MW-1 WAS NOT AVAILABLE. THIS WELL WAS DESTROYED PRIOR TO WATER LEVEL MEASUREMENT.
2. THE GROUNDWATER ELEVATION AT P-18 WAS NOT USED IN MAP CONSTRUCTION. THE ELEVATION AT THIS PIEZOMETER WAS APPROXIMATELY 10 FT. HIGHER THAN ADJACENT GROUNDWATER ELEVATIONS.

0 500 1000

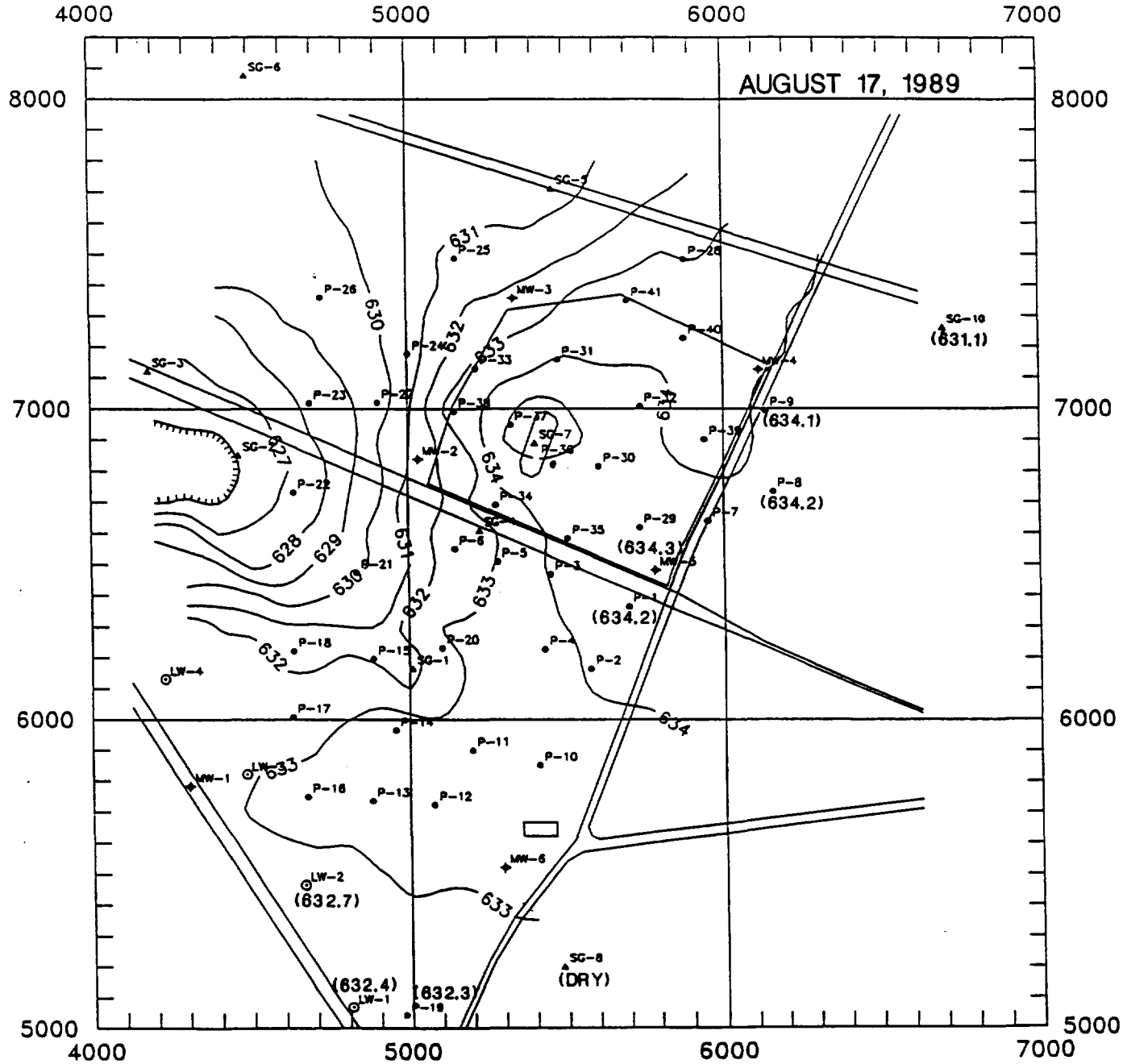
SCALE IN FEET

north

**FIGURE 4-17**

| | | | |
|---|---|---|---|
| WARZYN | WATER TABLE CONTOUR MAP<br>APRIL 6, 1990<br>REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Drawn D.L.L., T.J.M., J.A.W.<br>Revisions | Checked JAW<br>App'd. PJV<br>Date 9/21/90 |
| | | | 60251 **A8** |

TELEDYNE POST N40683




## LEGEND

(632.7) GROUNDWATER ELEVATION

UPPER AQUIFER MONITORING WELL LOCATION

LOWER AQUIFER MONITORING WELL LOCATION

LEACHATE WELL LOCATION

PIEZOMETER LOCATION

STAFF GAUGE LOCATION

—620— WATER LEVEL CONTOUR LINE

## NOTES

1. THE GROUNDWATER ELEVATION AT P-18 WAS NOT USED IN MAP CONSTRUCTION. THE ELEVATION AT THIS PIEZOMETER WAS APPROXIMATELY 10 FT. HIGHER THAN ADJACENT GROUNDWATER ELEVATIONS.

north

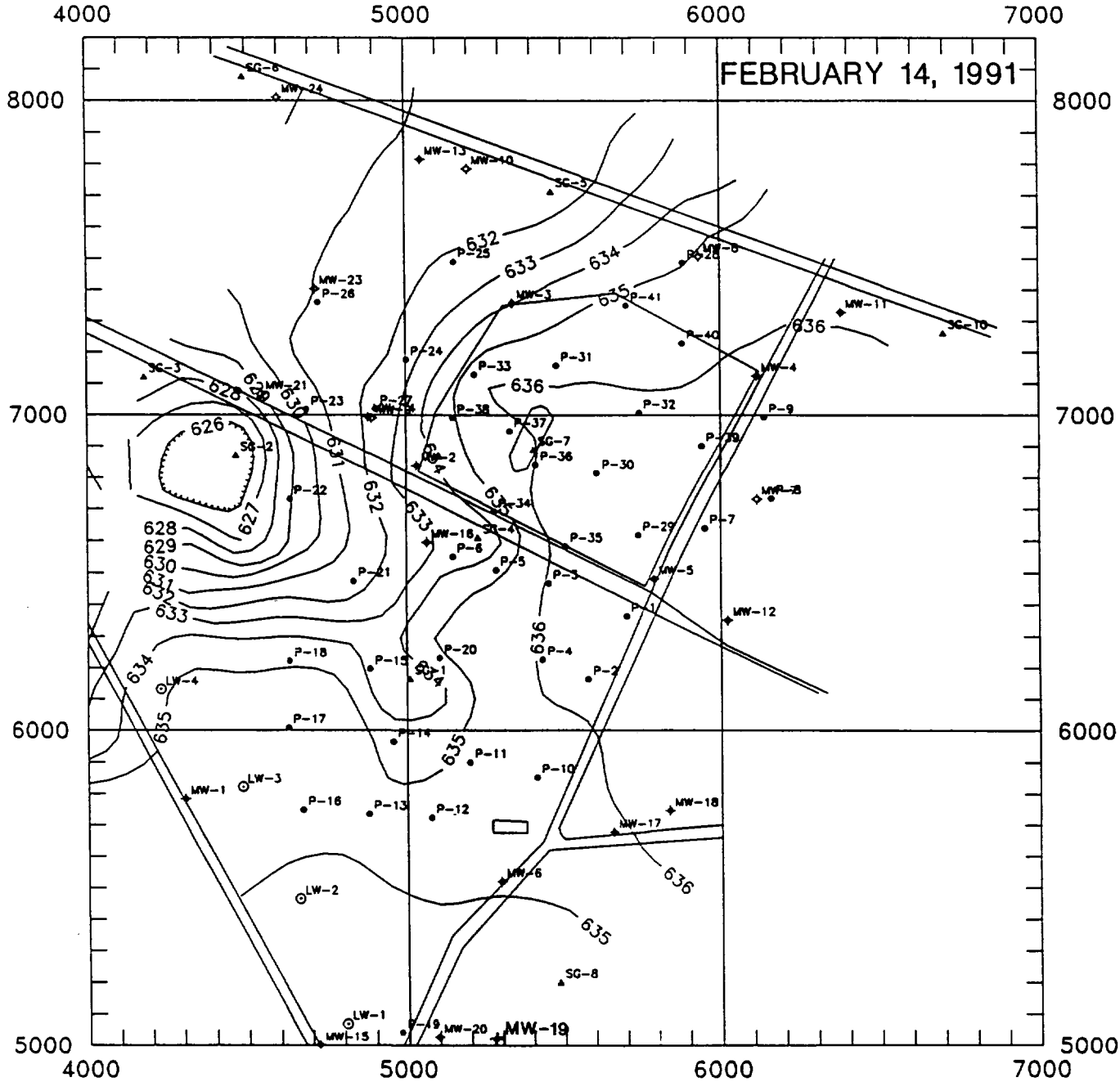
0 500 1000

SCALE IN FEET

**FIGURE 4-18**

| | | | |
|---|---|---|---|
| WARZYN | WATER TABLE CONTOUR MAP AUGUST 17, 1989 | Drawn D.L.L., T.J.M., J.A.W. | Checked JAW | App'd. |
| | REMEDIAL INVESTIGATION AMERICAN CHEMICAL SERVICES NPL SITE GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 A9 |

TELEDYNE POST N40683




## LEGEND

- UPPER AQUIFER MONITORING WELL LOCATION
- LOWER AQUIFER MONITORING WELL LOCATION
- LEACHATE WELL LOCATION
- PIEZOMETER LOCATION
- STAFF GAUGE LOCATION
- —620— WATER LEVEL CONTOUR LINE

0 500 1000

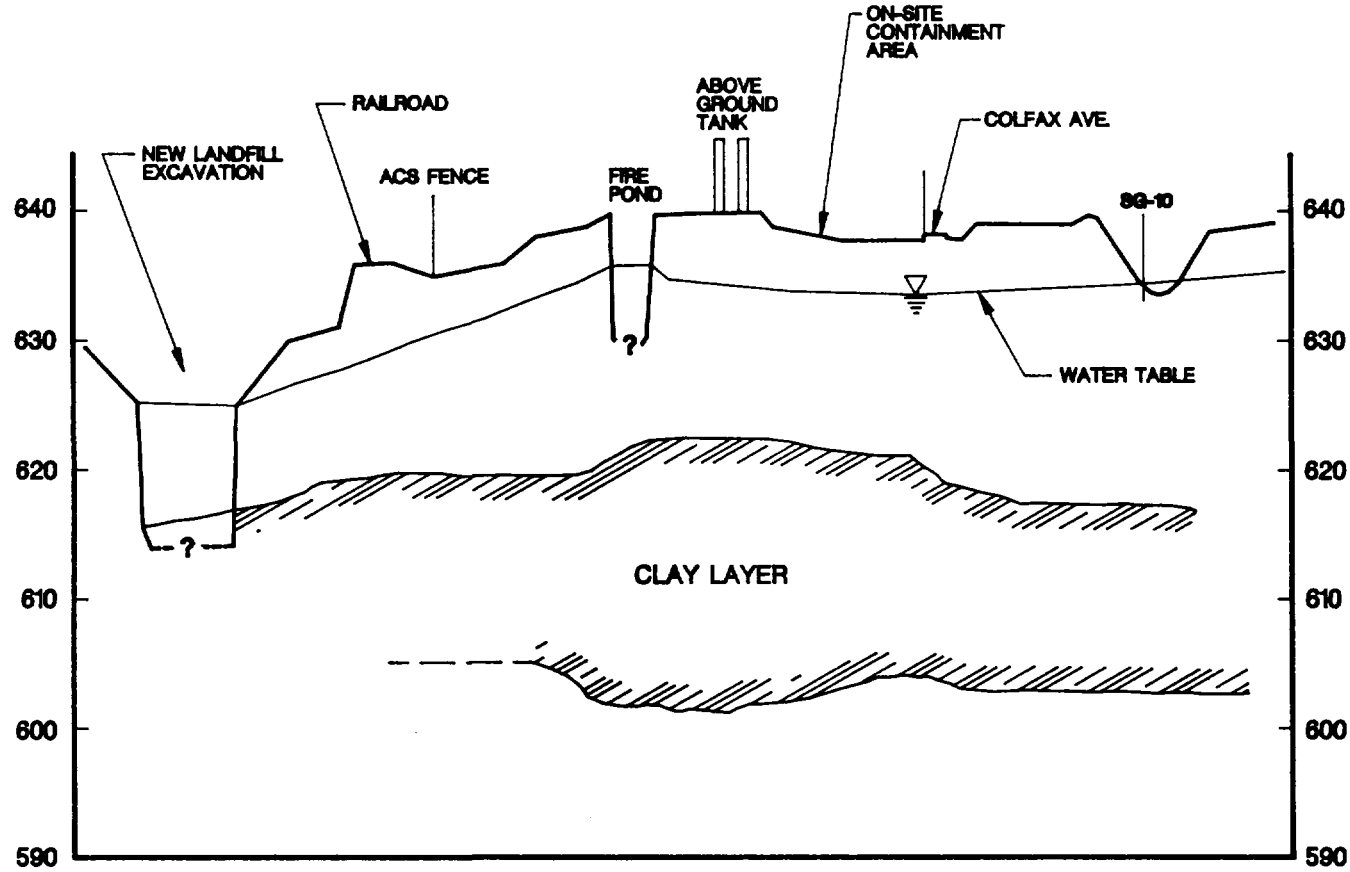
SCALE IN FEET

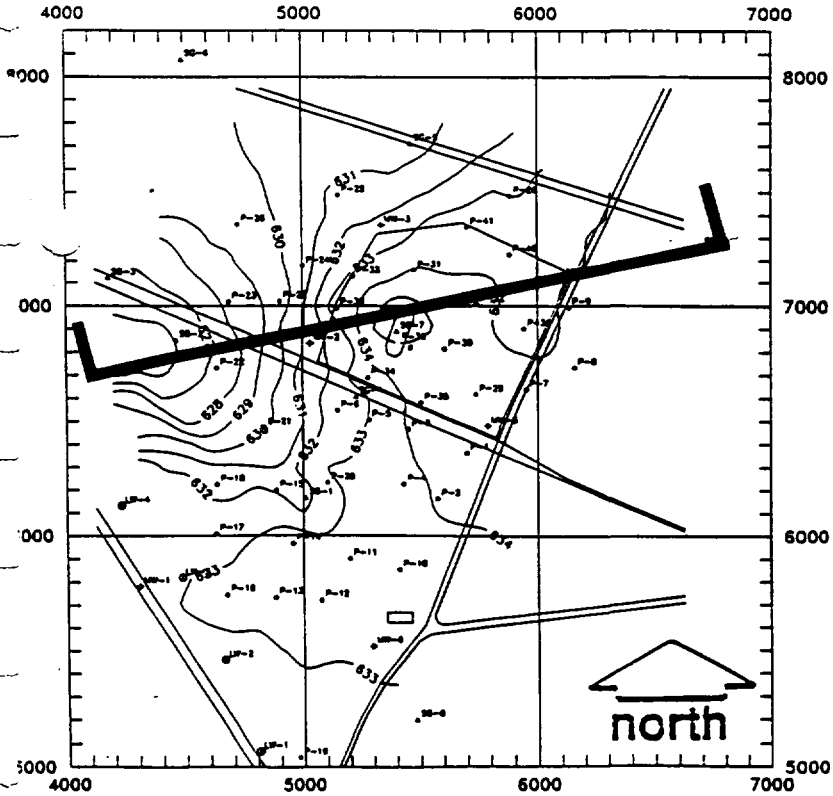
north

**FIGURE 4-18A**

| | | | |
|---|---|---|---|
| WARZYN | UPPER AQUFER WATER TABLE CONTOUR MAP, FEBRUARY 14, 1991 | Drawn D.L.L., JAW | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | Date 6/13/91 |
| | | | 60251 **A24** |

QUALITY CONTROL
Working Standards DATE
Lead Professional DATE
Section
PM
Division
Other



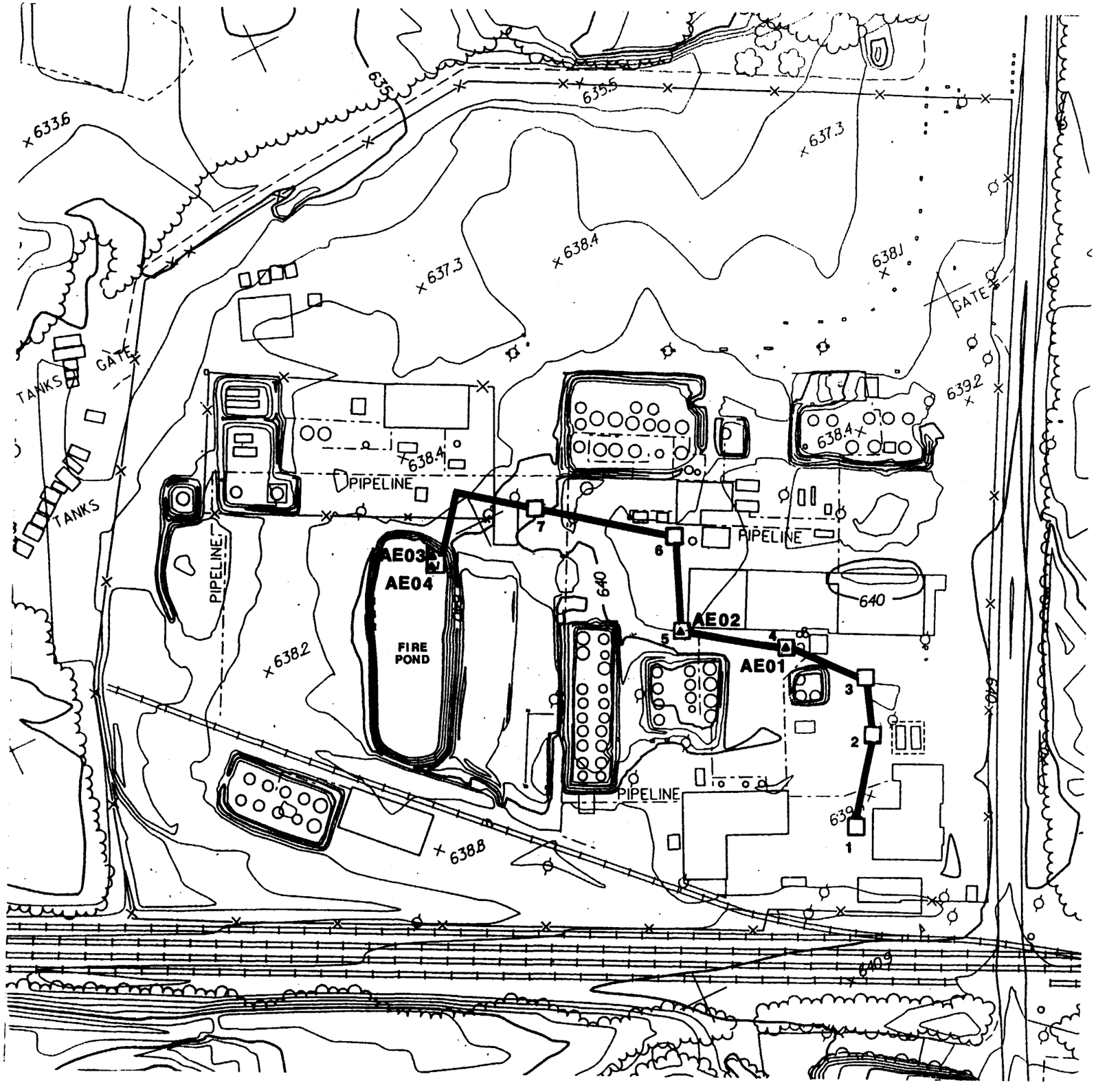




## NOTES

1. DEPTH OF FIRE POND AND NEW LANDFILL EXCAVATION UNKNOWN.

**FIGURE 4-19**

| | | | | |
|---|---|---|---|---|
| WARZYN | SITE CROSS-SECTION ILLUSTRATING CLAY CONFINING LAYER THICKNESS<br>REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Drawn ELR,DLL,TJM,JAW<br>Revisions | Checked JAW | App'd. PJV<br>Date 9/21/96<br>60251 **A10** |




## LEGEND

- STORM SEWER
- CATCH BASIN
- EFFLUENT SAMPLING LOCATION

## NOTES

1. AT SAMPLING LOCATION AE01 SAMPLE WAS COLLECTED FROM 7" OF WATER FOUND IN CATCH BASIN.
2. AT SAMPLE LOCATION AE02 SAMPLE WAS COLLECTED FROM 5.5" OF WATER FOUND IN CATCH BASIN.
3. AT SAMPLE LOCATION AE03, SAMPLE WAS COLLECTED BY SKIMMING WATER OFF THE SURFACE.
4. AT SAMPLE LOCATION AE04 SAMPLE WAS COLLECTED FROM THE BOTTOM OF CATCH BASIN (16" DEEP).
5. EFFLUENT SAMPLING WAS CONDUCTED BY WARZYN ENGINEERING INC. ON NOVEMBER 15, 1989.
6. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & McKEE INC. ON NOVEMBER 8, 1985. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.

north

0 100 200

SCALE IN FEET

FIGURE 4-20

WARZYN
WARZYN ENGINEERING INC

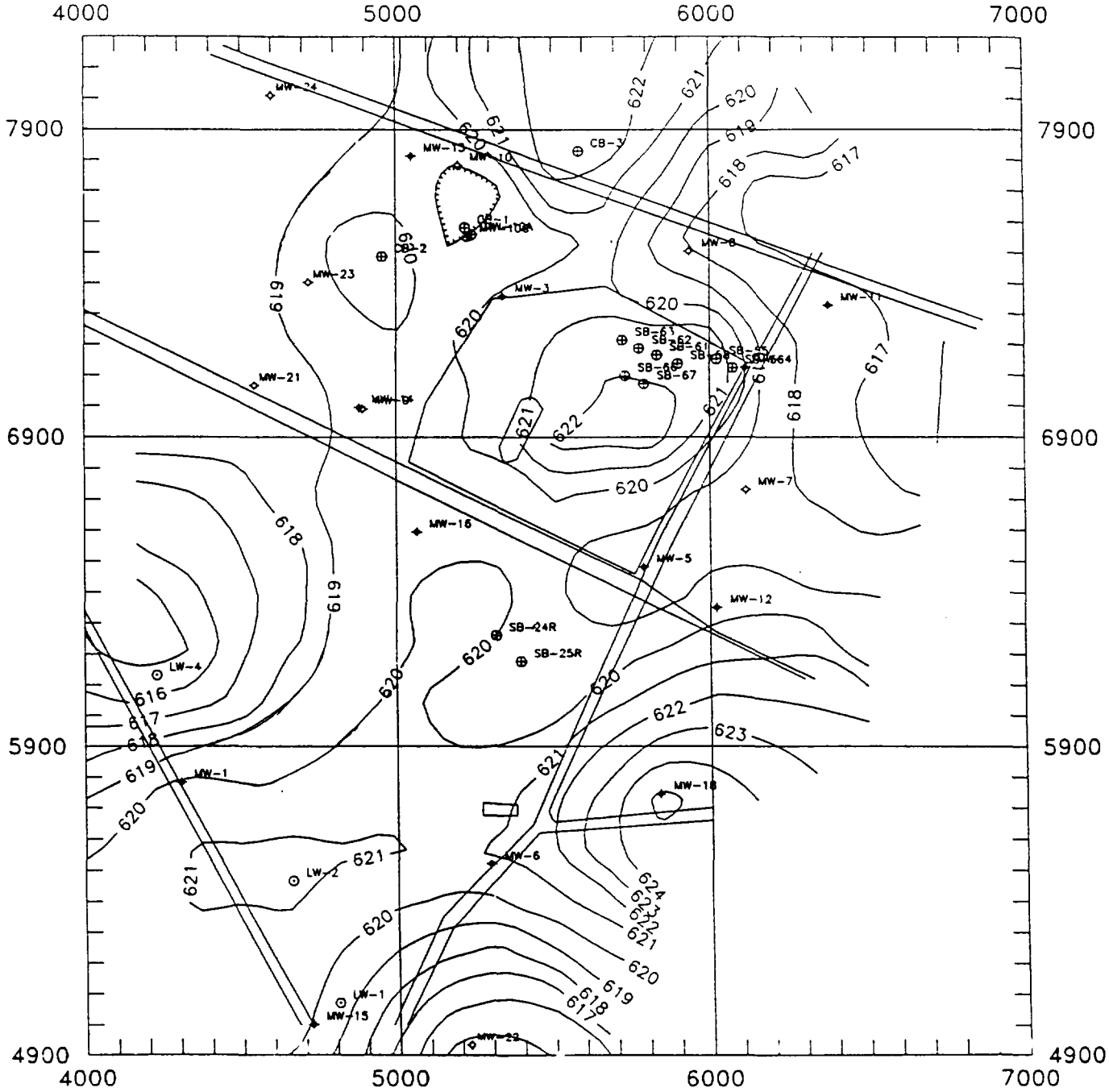
Designed By TSM
Drawn By E.J.B.
Checked By JAW
Approved By RQW
Date 9/21/90

EFFLUENT SAMPLE LOCATION MAP
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPC SITE
GRIFFITH, INDIANA

Project Number 60251 B19

WARZYN

MASTER BLUE PRINT INC. 616240




## NOTES

1. CLAY MEASUREMENT POINTS ARE PLOTTED ON FIGURE 4-8

## LEGEND

- ◆ UPPER AQUIFER MONITORING WELL LOCATION
- ◇ LOWER AQUIFER MONITORING WELL LOCATION
- ⊙ LEACHATE WELL LOCATION
- ⊕ SOIL BORING LOCATION

north

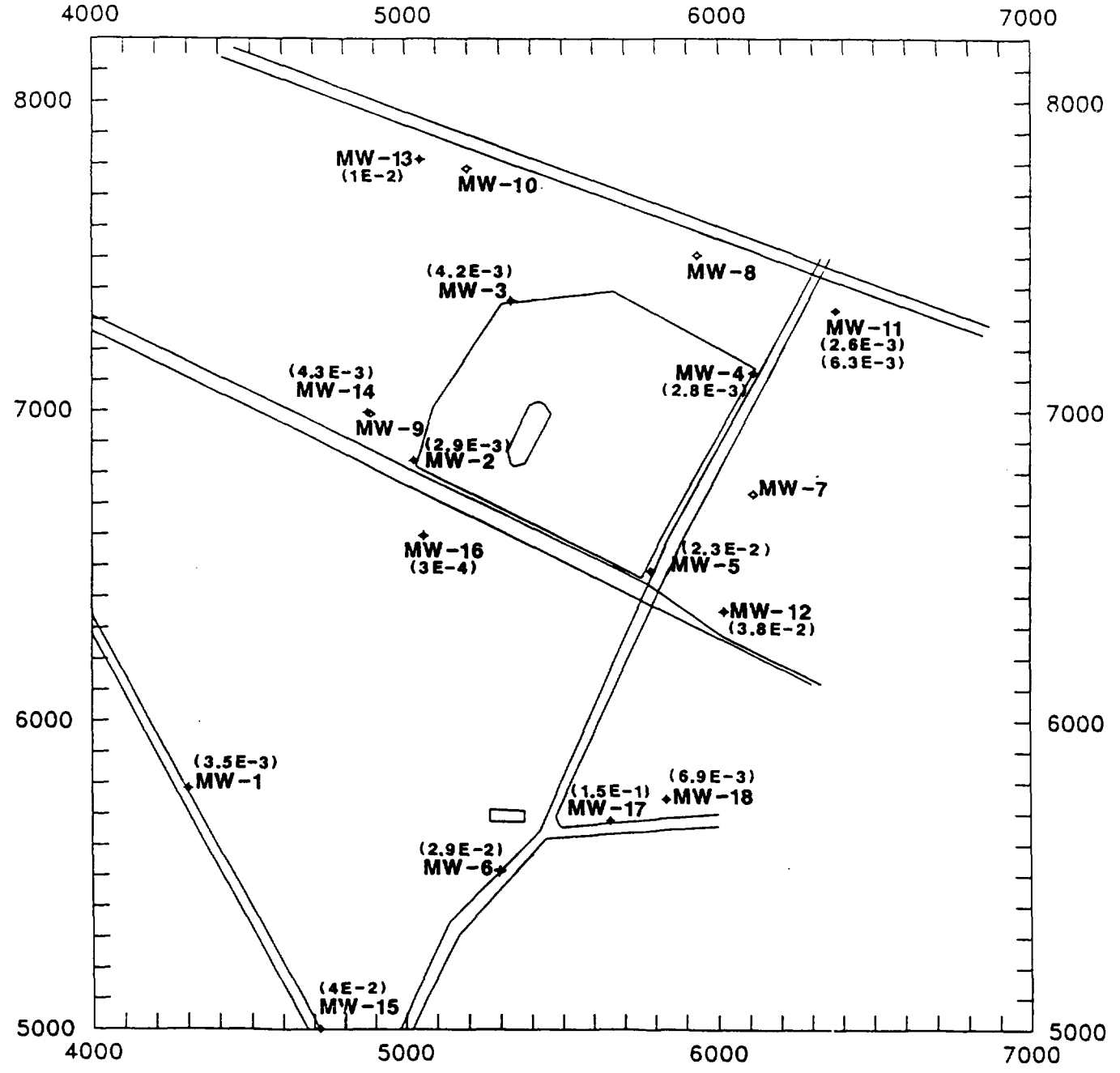
0 500 1000

SCALE IN FEET

**FIGURE 4-7**

| | | | |
|---|---|---|---|
| WARZYN | TOP OF CLAY CONTOUR MAP | Drawn O.L.L., T.J.M., J.A.W. Checked JAW | Appd. |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | Date 9/21/90 |
| | | | 60251 A1 |

TELEDYNE POST N140683




## LEGEND

◆ UPPER AQUIFER MONITORING WELL LOCATION

◇ LOWER AQUIFER MONITORING WELL LOCATION

(3.5E-2) HYDRAULIC CONDUCTIVITY IN ft/min

north

0 500 1000

SCALE IN FEET

**FIGURE 4-14**

| | | | |
|---|---|---|---|
| WARZYN | **DISTRIBUTION OF UPPER AQUIFER PERMEABILITY**<br>REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Drawn O.L.L., J.A.W., T.J.M. Checked J.A.N.<br>Revisions | App'd: [illegible]<br>Date 9/21/90<br>60251 **A5** |

Drafting Standards ____ PM ____ DATE ____
Lead Professional ____ Division ____ INITIALS ____ DATE ____
Section ____ Other ____

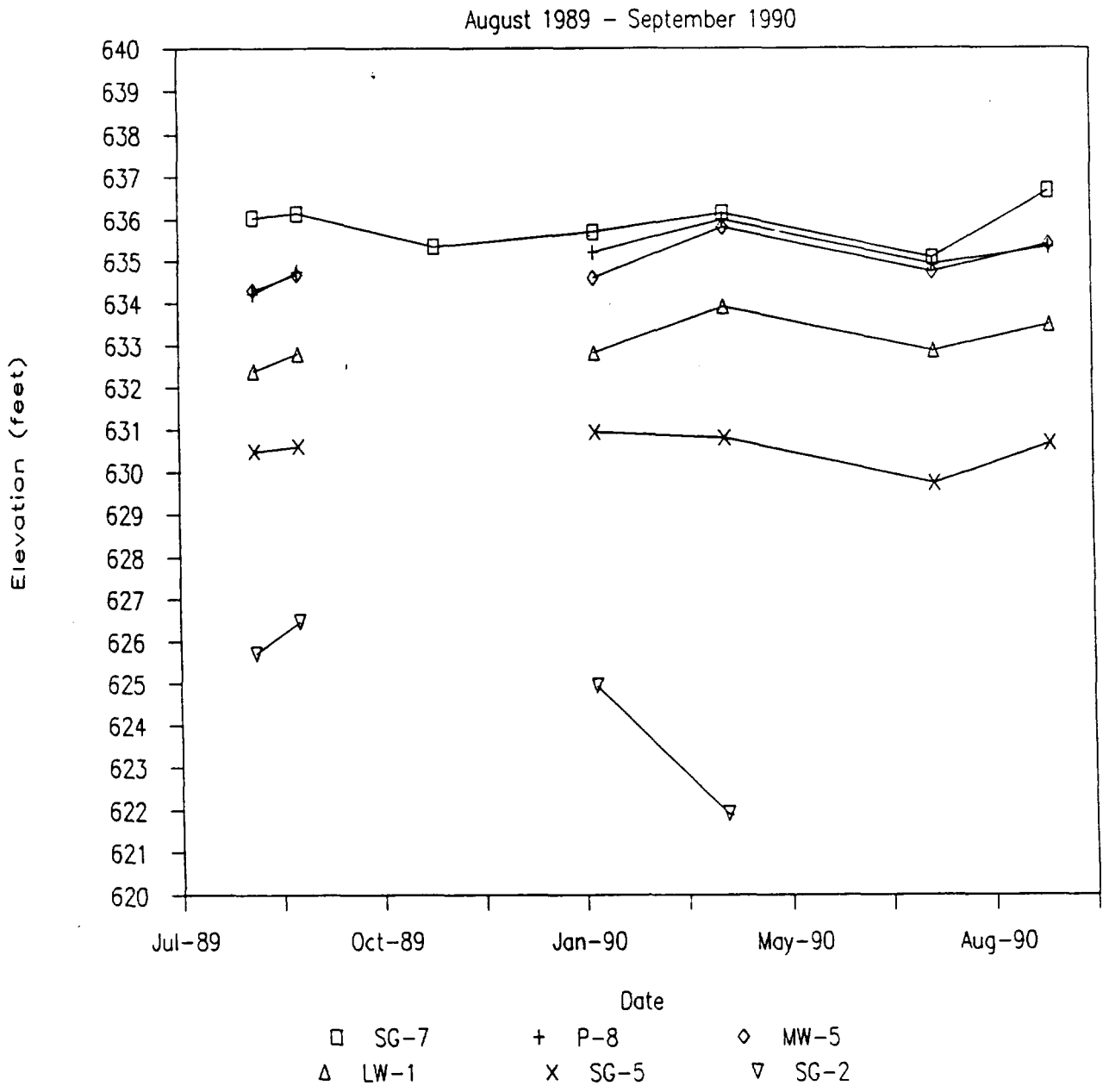
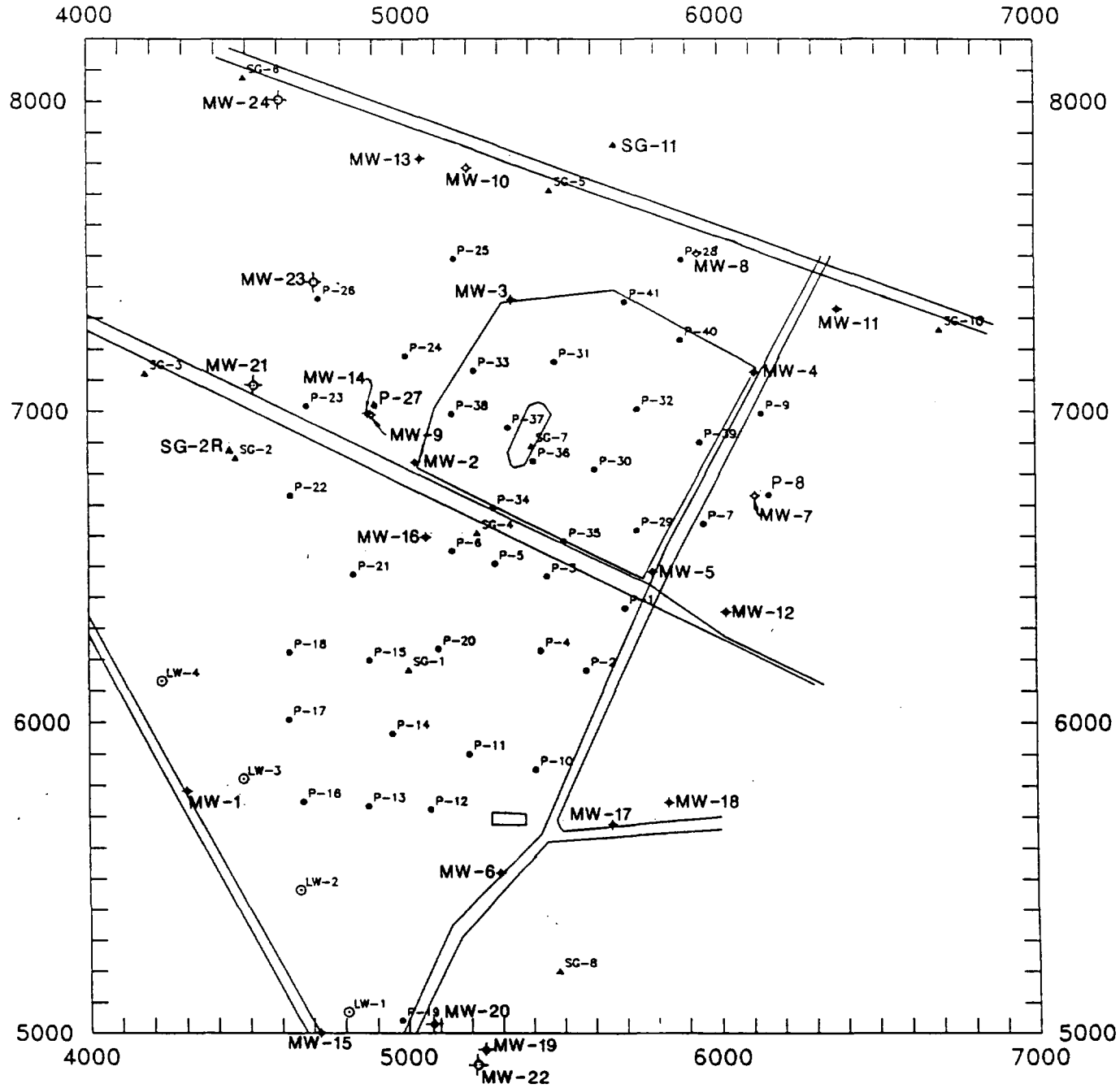



**FIGURE 4-15**

| | | | | |
|---|---|---|---|---|
| WARZYN | SITE HYDROGRAPHS | Drawn DLL, TJM, JAW | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 **A6** |

TELEDYNE POST




## LEGEND

- ◆ UPPER AQUIFER MONITORING WELL LOCATION
- ◇ LOWER AQUIFER MONITORING WELL LOCATION
- ⊙ LEACHATE WELL LOCATION
- ● PIEZOMETER LOCATION
- ▲ STAFF GAUGE LOCATION

north

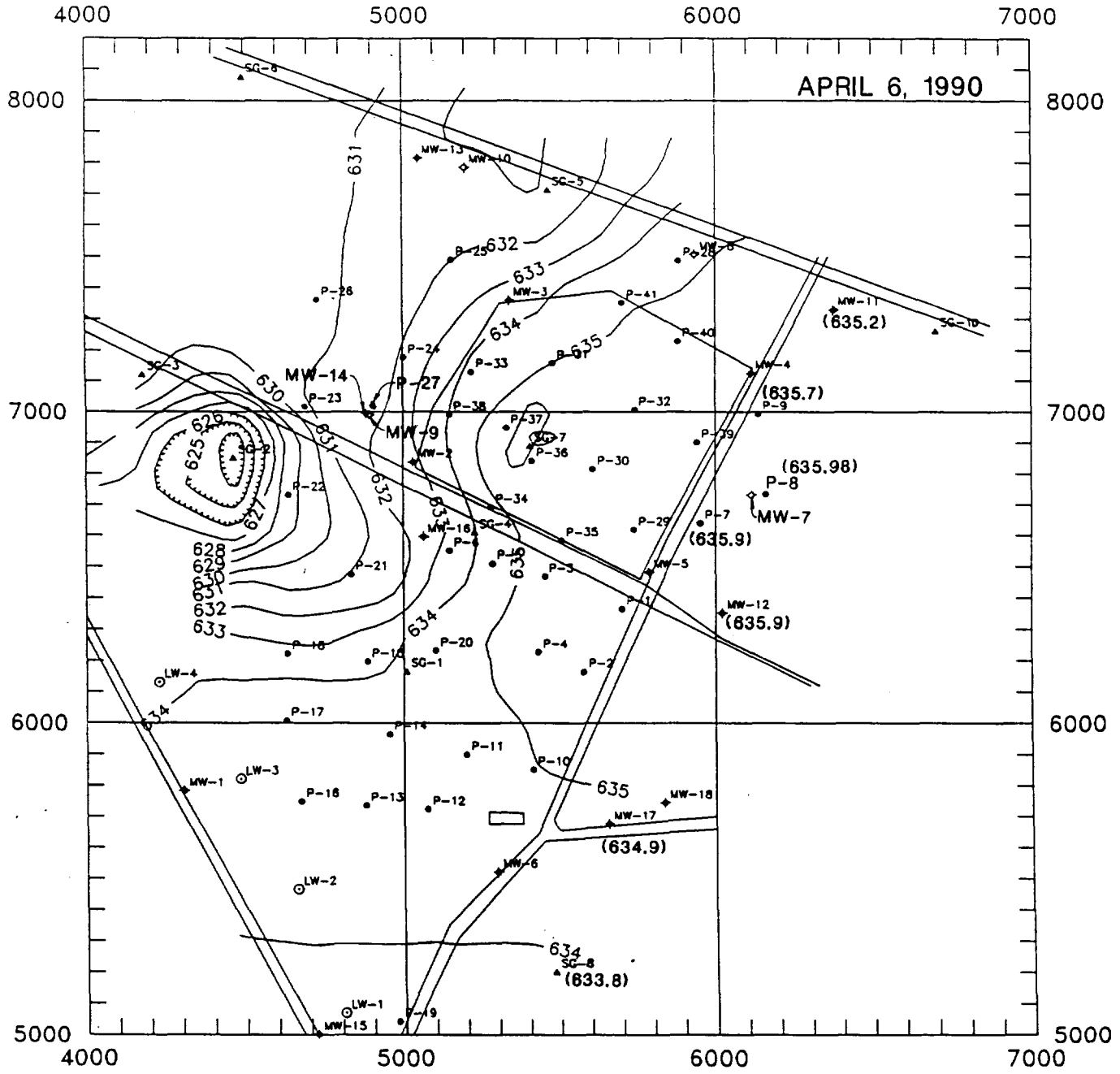
0 500 1000

SCALE IN FEET

**FIGURE 4-16**

| | | | |
|---|---|---|---|
| WARZYN | **WATER LEVEL MEASURING POINT LOCATION MAP**<br>REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Drawn D.L.L., T.J.M., J.A.W. Checked JAW<br>Revisions | App'd: RJ Vf<br>Date 9/21/96<br>60251 **A7** |

TELEDYNE POST N40683




## LEGEND

(632.7) GROUNDWATER ELEVATION

◆ UPPER AQUIFER MONITORING WELL LOCATION

◇ LOWER AQUIFER MONITORING WELL LOCATION

⊙ LEACHATE WELL LOCATION

● PIEZOMETER LOCATION

▲ STAFF GAUGE LOCATION

—620— WATER LEVEL CONTOUR LINE

## NOTES

1. A GROUNDWATER ELEVATION FOR MW-1 WAS NOT AVAILABLE. THIS WELL WAS DESTROYED PRIOR TO WATER LEVEL MEASUREMENT.
2. THE GROUNDWATER ELEVATION AT P-18 WAS NOT USED IN MAP CONSTRUCTION. THE ELEVATION AT THIS PIEZOMETER WAS APPROXIMATELY 10 FT. HIGHER THAN ADJACENT GROUNDWATER ELEVATIONS.

0 500 1000

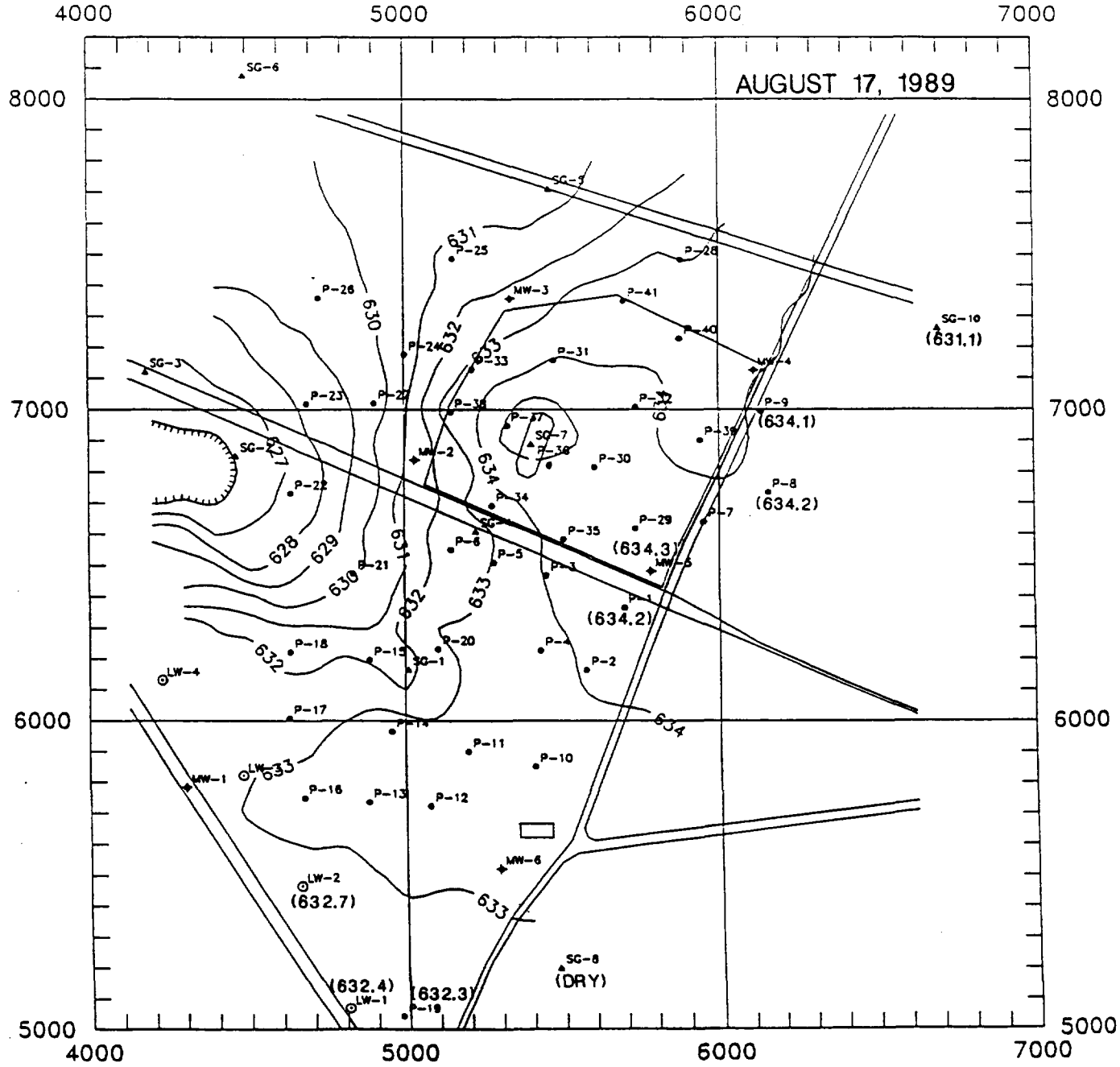
SCALE IN FEET

north

**FIGURE 4-17**

| | | | |
|---|---|---|---|
| WARZYN | WATER TABLE CONTOUR MAP APRIL 6, 1990 | Drawn D.L.L., T.J.M., J.A.W. | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION AMERICAN CHEMICAL SERVICES NPL SITE GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 A8 |

TELEDYNE POST N40683




## LEGEND

(632.7) GROUNDWATER ELEVATION

◆ UPPER AQUIFER MONITORING WELL LOCATION

✧ LOWER AQUIFER MONITORING WELL LOCATION

⊙ LEACHATE WELL LOCATION

● PIEZOMETER LOCATION

▲ STAFF GAUGE LOCATION

—620— WATER LEVEL CONTOUR LINE

## NOTES

1. THE GROUNDWATER ELEVATION AT P-18 WAS NOT USED IN MAP CONSTRUCTION. THE ELEVATION AT THIS PIEZOMETER WAS APPROXIMATELY 10 FT. HIGHER THAN ADJACENT GROUNDWATER ELEVATIONS.

north

0 500 1000

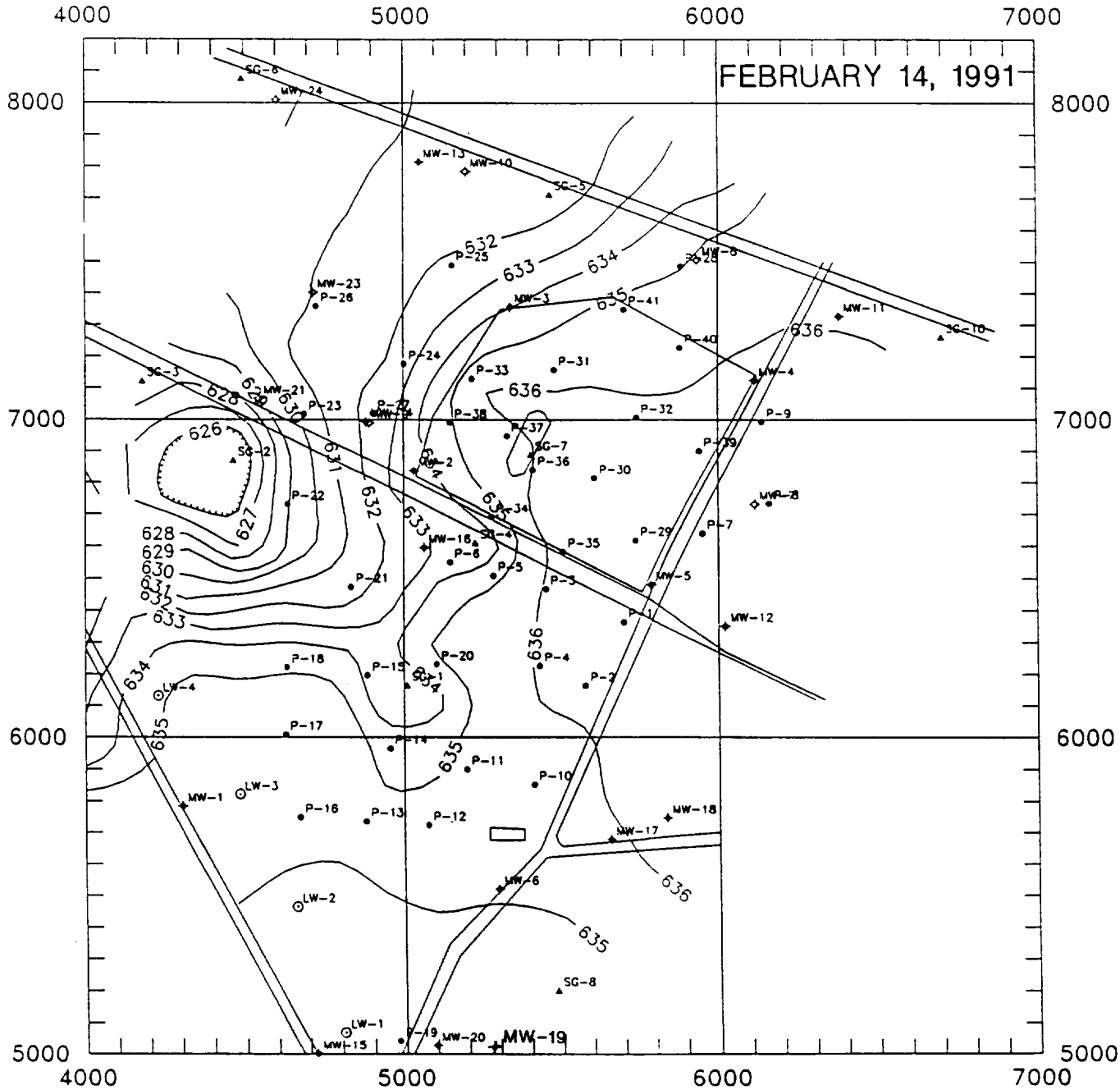
SCALE IN FEET

**FIGURE 4-18**

| | | | |
|---|---|---|---|
| WARZYN | **WATER TABLE CONTOUR MAP AUGUST 17, 1989** | Drawn D.L.L., T.J.M., J.A.W. | Checked JAW | App'd. |
| | REMEDIAL INVESTIGATION AMERICAN CHEMICAL SERVICES NPL SITE GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 **A9** |

Drafting Standards INITIALS DATE
Lead Professional PM INITIALS DATE
Section Division
Other

TELEDYNE POST 514068




## LEGEND

- UPPER AQUIFER MONITORING WELL LOCATION
- LOWER AQUIFER MONITORING WELL LOCATION
- LEACHATE WELL LOCATION
- PIEZOMETER LOCATION
- STAFF GAUGE LOCATION
- —620— WATER LEVEL CONTOUR LINE

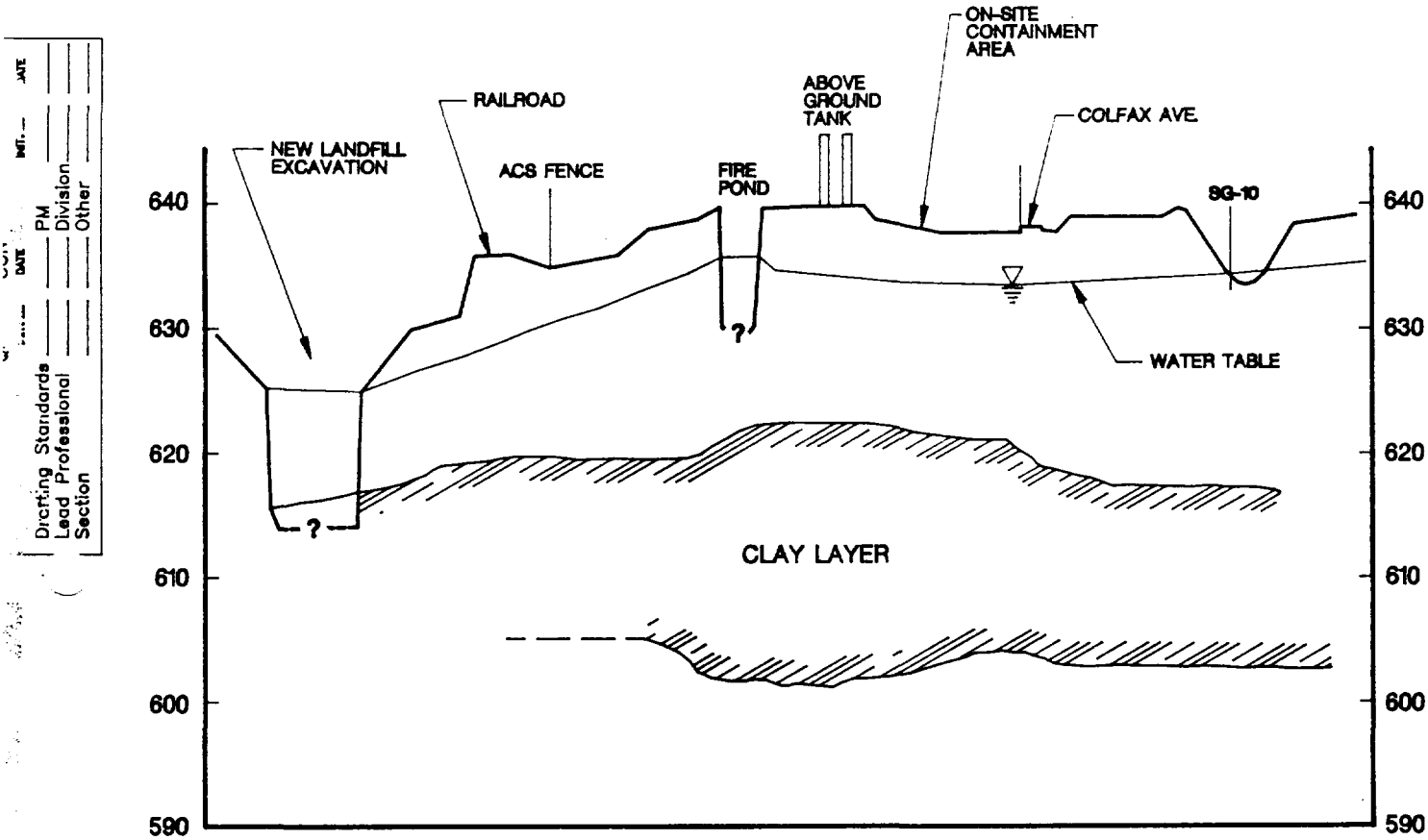
0 500 1000

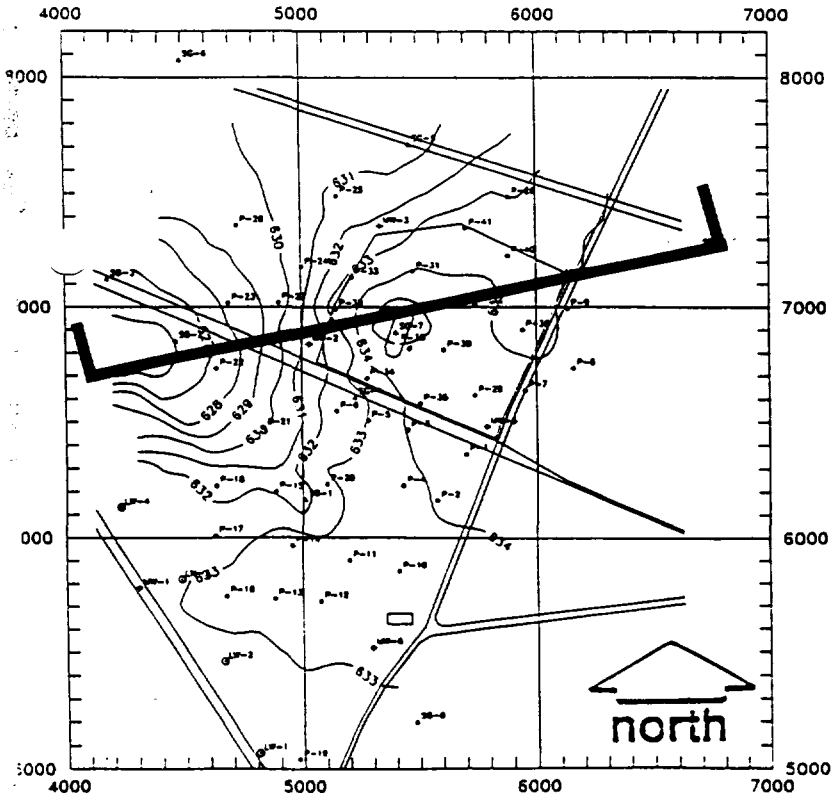
SCALE IN FEET

north

**FIGURE 4-18A**

| | | | |
|---|---|---|---|
| WARZYN | **UPPER AQUFER WATER TABLE CONTOUR MAP, FEBRUARY 14, 1991** | Drawn D.L.L., JAW | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | Date 6/13/91 |
| | | | 60251 **A24** |



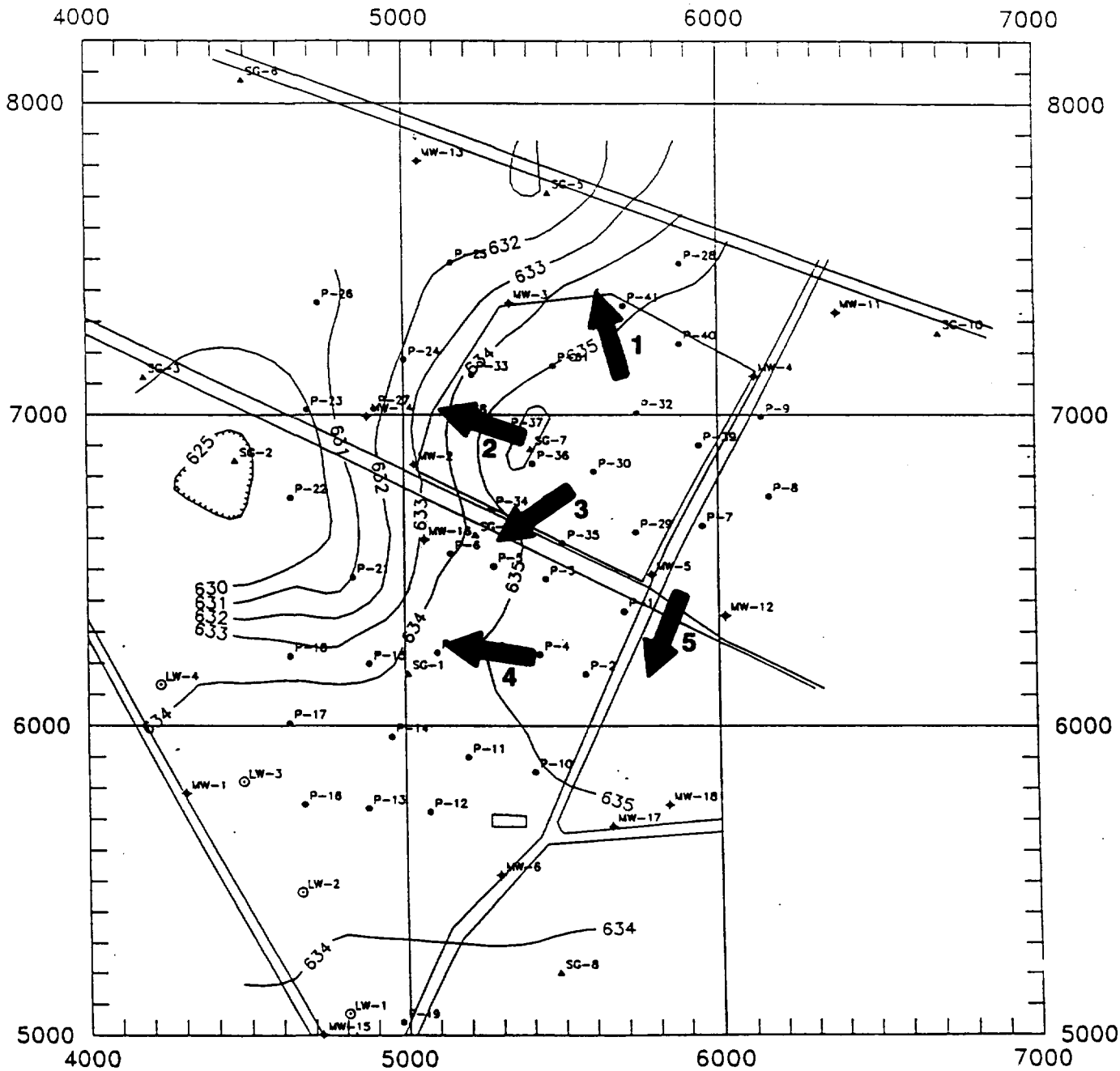




## NOTES

1. DEPTH OF FIRE POND AND NEW LANDFILL EXCAVATION UNKNOWN.

**FIGURE 4-19**

| | | | |
|---|---|---|---|
| WARZYN | SITE CROSS-SECTION ILLUSTRATING CLAY CONFINING LAYER THICKNESS<br>REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Drawn ELR,DLL,TJM,JAW<br>Revisions | Checked JAW<br>App'd. PJV<br>Date 9/21/96<br>60251 A10 |




## LEGEND

- UPPER AQUIFER MONITORING WELL LOCATION
- LEACHATE WELL LOCATION
- PIEZOMETER LOCATION
- STAFF GAUGE LOCATION
- 1 GROUNDWATER FLOW PATH

## NOTES

1. GROUNDWATER FLOW PATHS ARE DESCRIBED IN TABLE 4-5.

north

0 500 1000

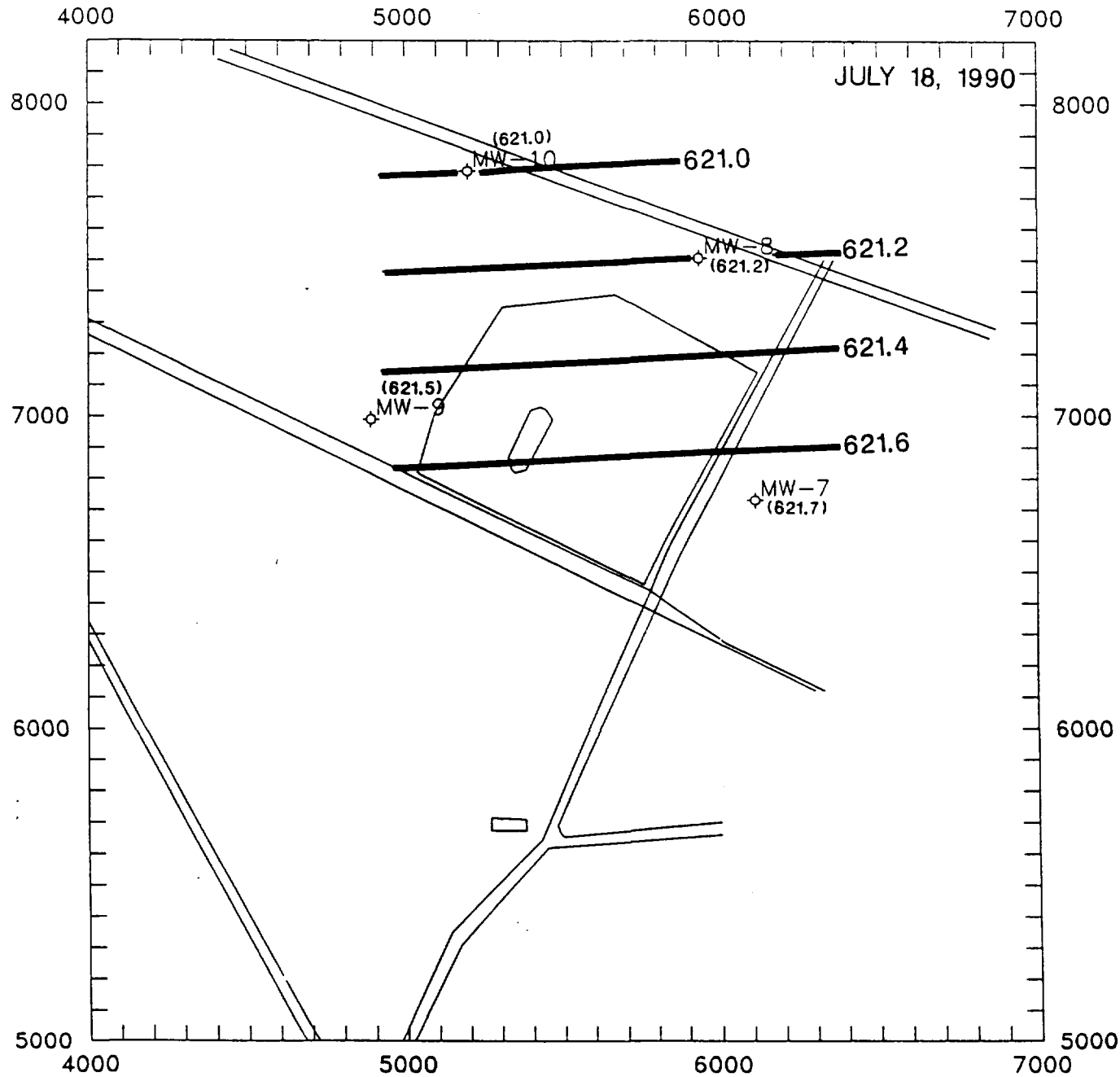
SCALE IN FEET

**FIGURE 4-21**

| | | | |
|---|---|---|---|
| WARZYN | UPPER AQUIFER GROUNDWATER FLOW PATHS | Drawn DLL, TJM, JAW | Checked JAW | App'd. BVJ |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 A11 |

Drafting Standards
Lead Professional
Section
DATE
PM
Division
Other

TELEDYNE POST 940683




## LEGEND

- ⊹ LOWER AQUIFER MONITORING WELL LOCATION
- (621.5) MEASURED GROUNDWATER ELEVATION
- ——— POTENTIOMETRIC SURFACE CONTOUR LINE

north

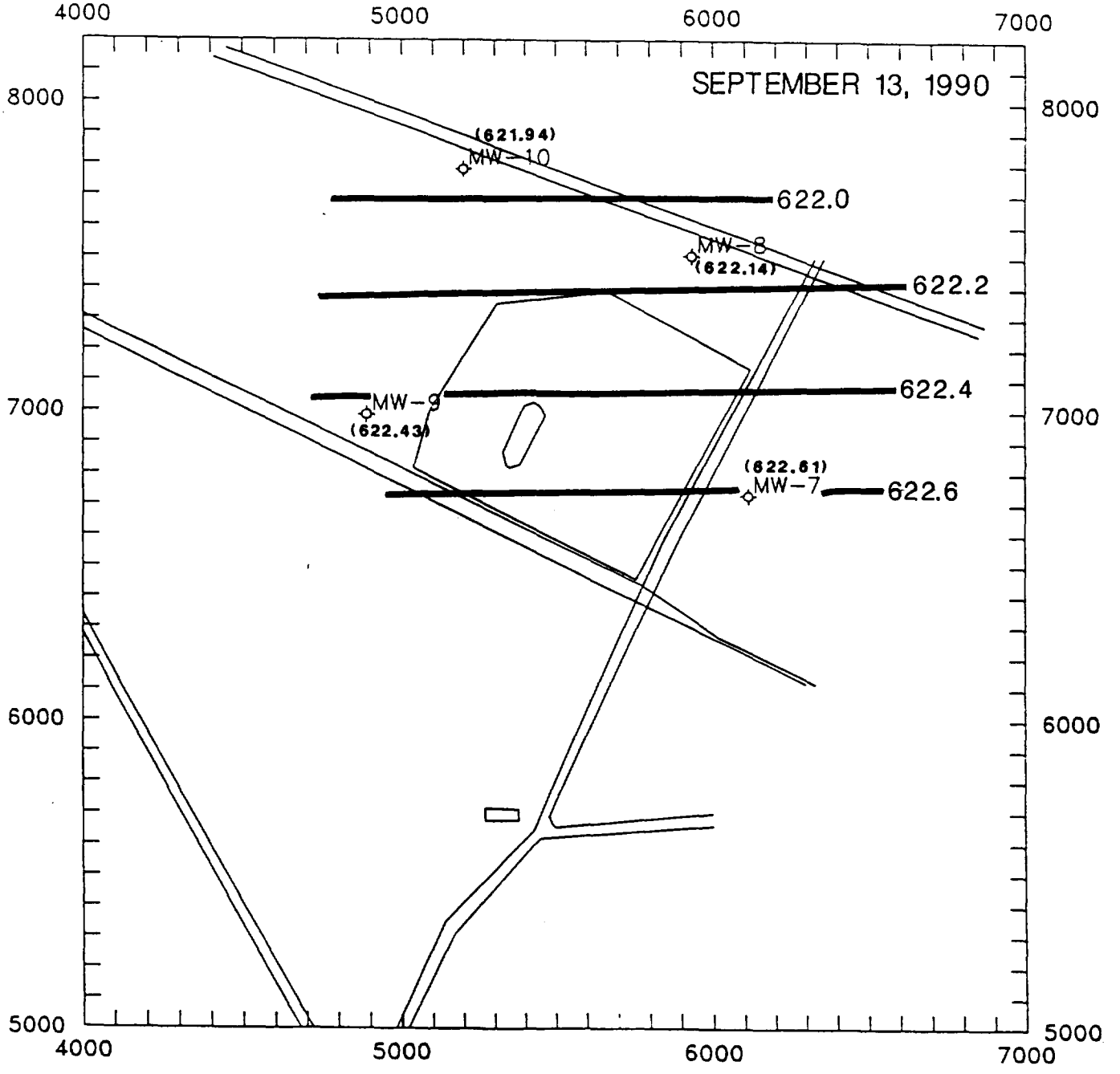
0 500 1000

SCALE IN FEET

**FIGURE 4-22**

| | | | |
|---|---|---|---|
| WARZYN | POTENTIOMETRIC SURFACE, LOWER AQUIFER, JULY 18, 1990 | Drawn D.L.L., T.J.M., J.A.W. | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 A12 |

TELEDYNE POST N40683




LEGEND

⊕ LOWER AQUIFER MONITORING WELL LOCATION

(622.43) MEASURED GROUNDWATER ELEVATION

POTENTIOMETRIC SURFACE CONTOUR LINE

north

0 500 1000

SCALE IN FEET

**FIGURE 4-23**

| | | | |
|---|---|---|---|
| WARZYN | POTENTIOMETRIC SURFACE, LOWER AQUIFER, SEPTEMBER 13, 1990 | Drawn DJL, TJM, JAW, | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 A13 |

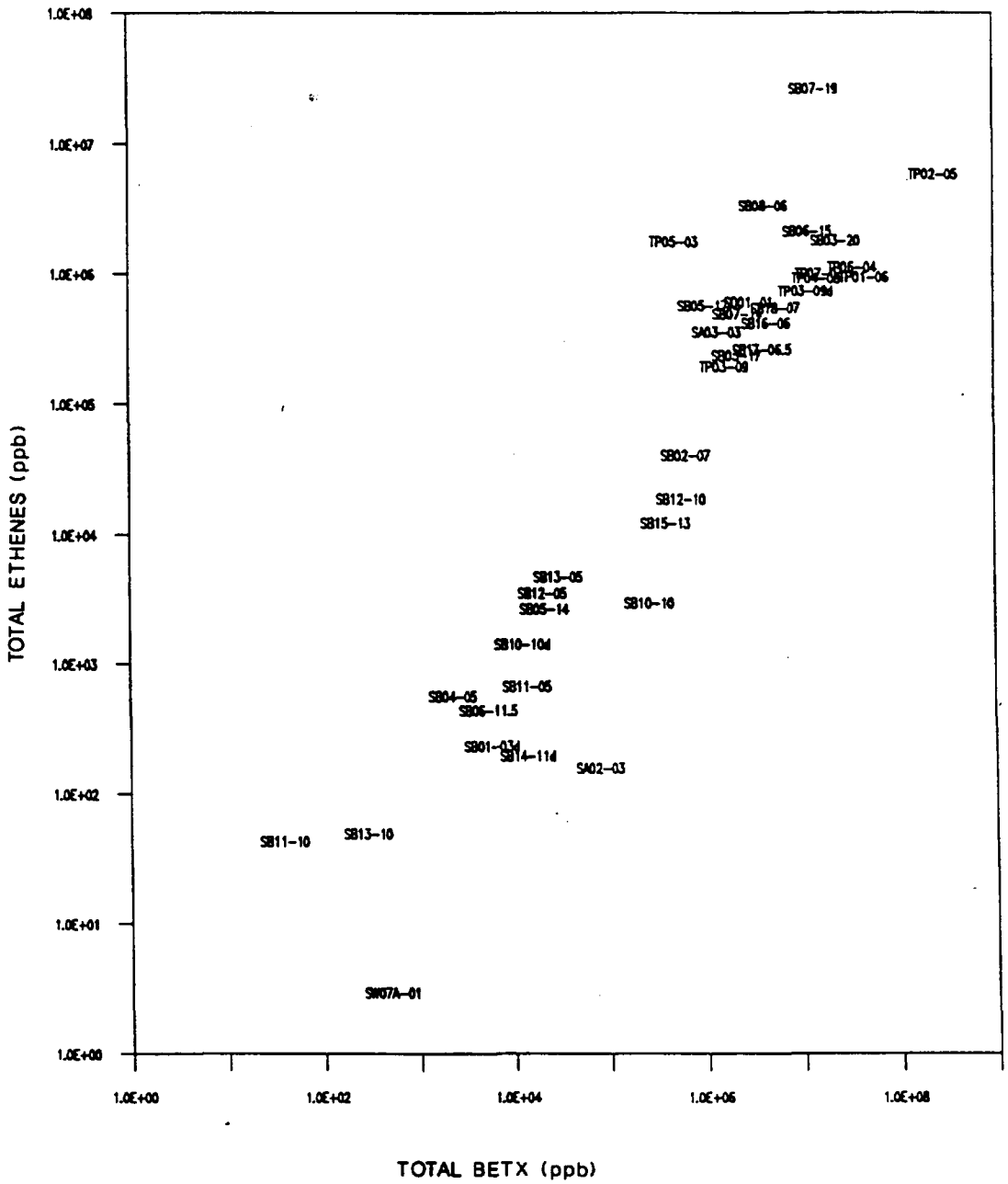



**FIGURE 5-1**

| | | | | |
|---|---|---|---|---|
| WARZYN | TOTAL ETHENES vs BETX | Drawn DLL & P.J.V | Checked JAW | App'd PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/96 |
| | | | | 60251 **A14** |

TELEDYNE POST

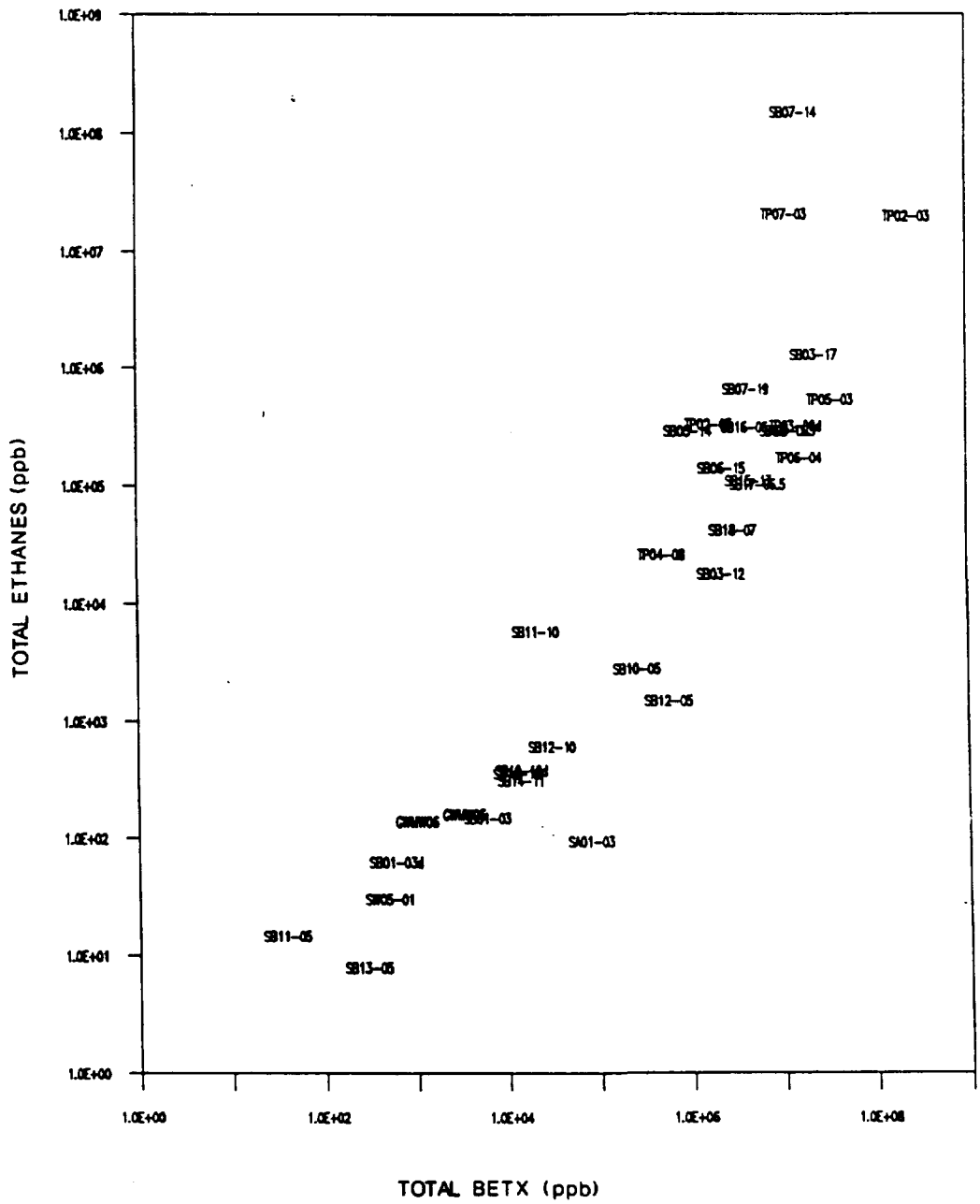



**FIGURE 5-2**

| | | | | |
|---|---|---|---|---|
| WARZYN | TOTAL ETHANES vs BETX | Drawn DLL & PJV | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/96 |
| | | | | 60251 **A15** |

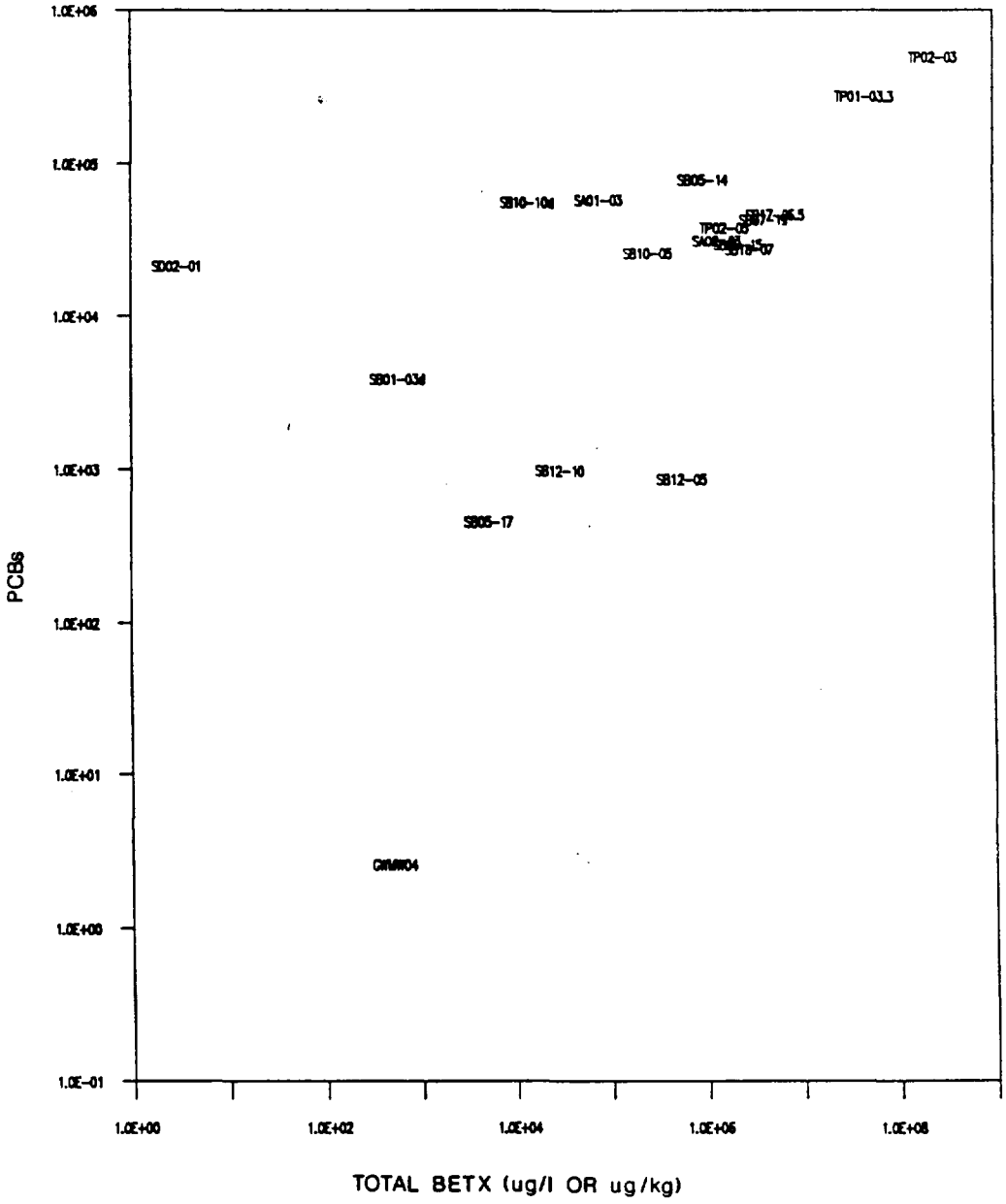



**FIGURE 5-3**

| | | | | |
|---|---|---|---|---|
| WARZYN | **PCBs vs BETX** | Drawn DLL & PJV | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 **A16** |

TELEDYNE POST

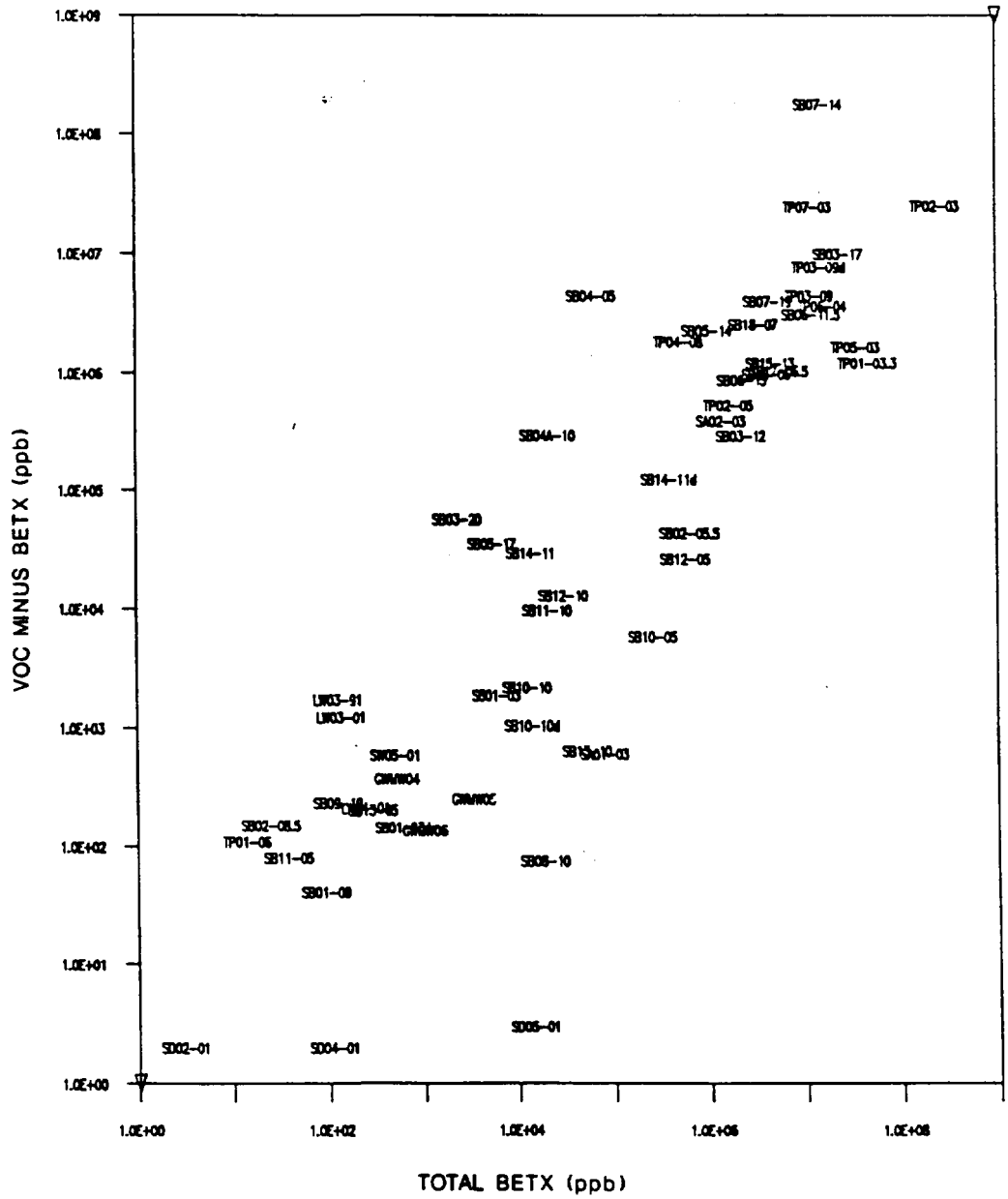



**FIGURE 5-4**

| | | | |
|---|---|---|---|
| WARZYN | CORRELATION BETWEEN VOCs & BETX | Drawn DLL & PJV | Checked JAW | App'd. PJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 **A17** |

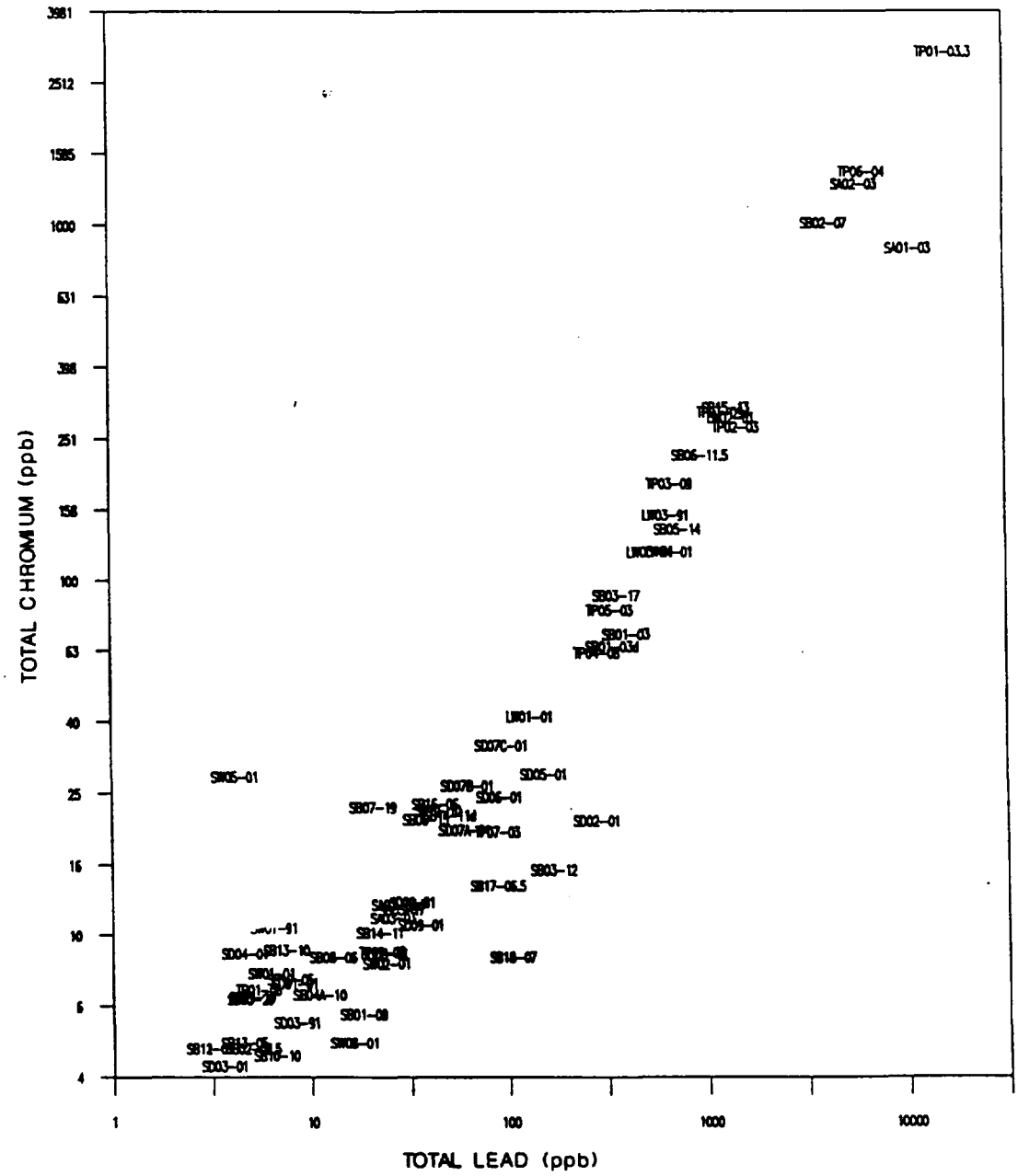
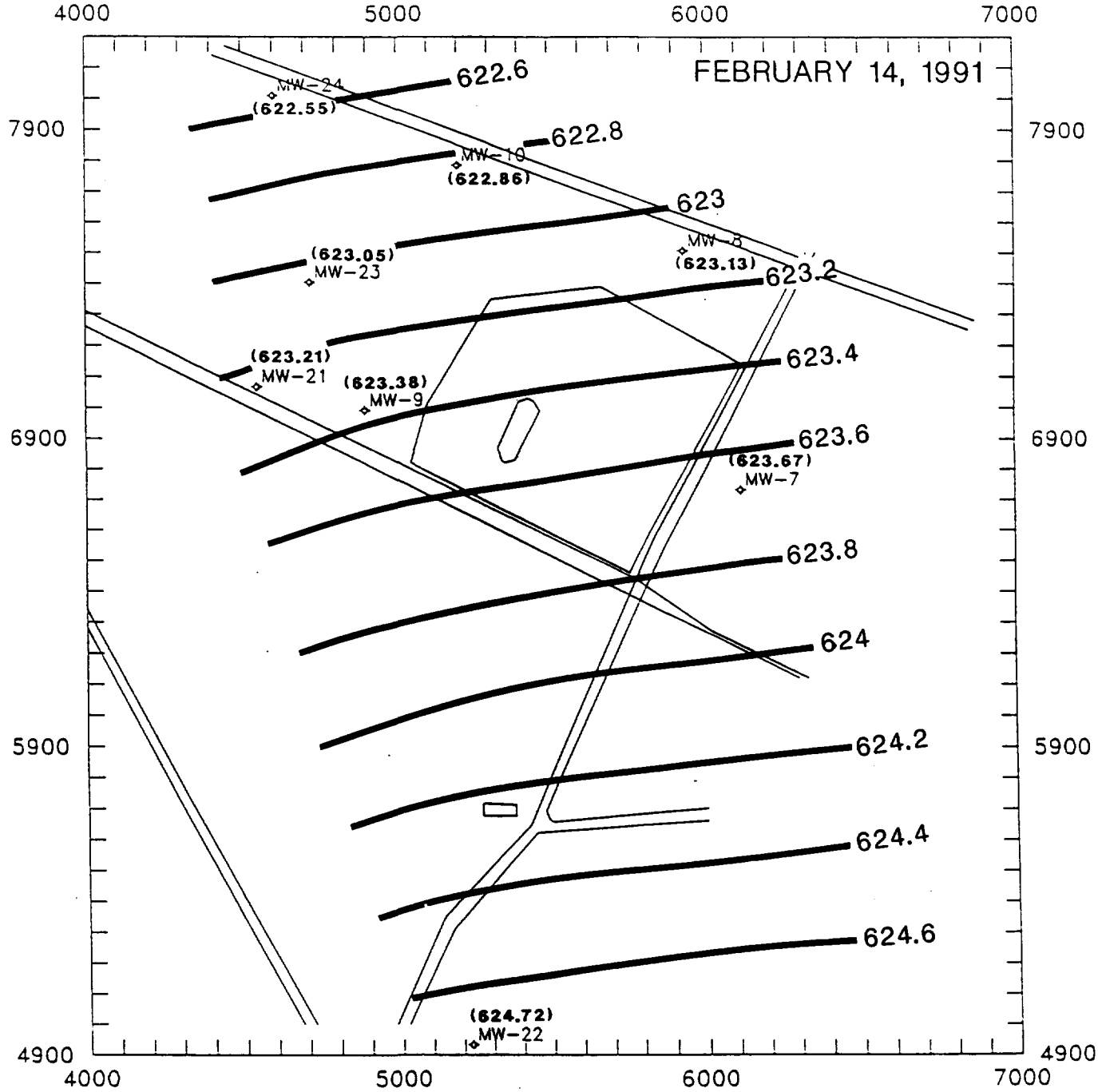



**FIGURE 5-5**

| | | | |
|---|---|---|---|
| WARZYN | CHROMIUM vs LEAD | Drawn DLL & PJV | Checked JAW | App'd. RJV |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 9/21/90 |
| | | | | 60251 **A18** |

Drawing Standards ____ PM ____
Lead Professional ____ Division ____
Section ____ Other ____




## LEGEND

- ◇ LOWER AQUIFER MONITORING WELL LOCATION
- (623.34) MEASURED GROUNDWATER ELEVATION
- ▬ POTENTIOMETRIC SURFACE CONTOUR LINE

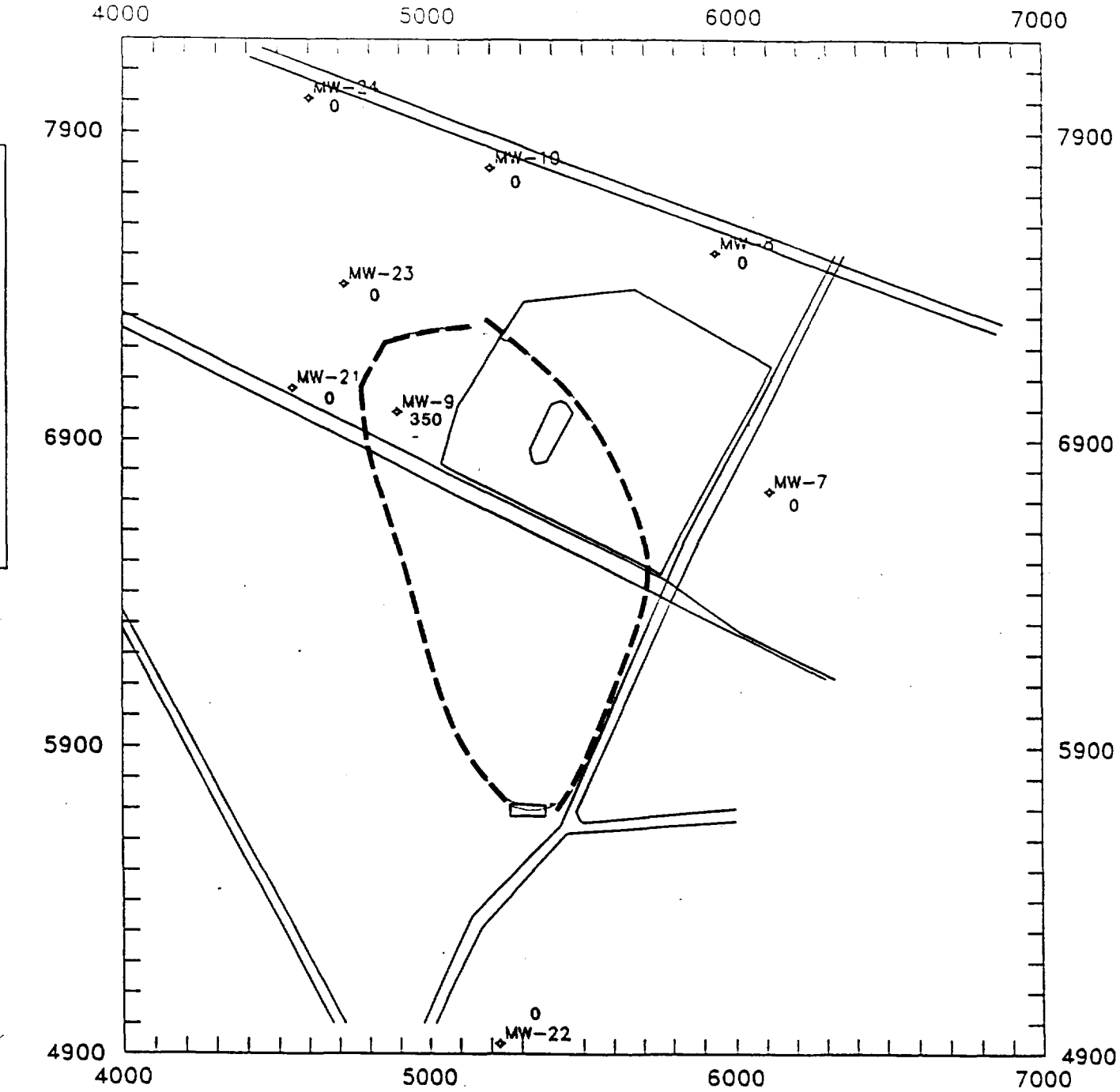
north

0 500 1000

SCALE IN FEET

**FIGURE 4-23A**

| | | | |
|---|---|---|---|
| WARZYN | POTENTIOMETRIC SURFACE, LOWER AQUIFER, FEBRUARY 14, 1991 | Drawn D.L.L., J.A.W. Checked JAW | App'd. RJLf |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | Date 6/13/91 |
| | | | 60251 **A22** |




## LEGEND

- ◆ UPPER AQUIFER MONITORING WELL LOCATION
- — — — ESTIMATED BOUNDARY OF CHLOROETHANE PRESENCE IN LOWER AQUIFER
- 0 CHLOROETHANE CONCENTRATION (ug/l)

north

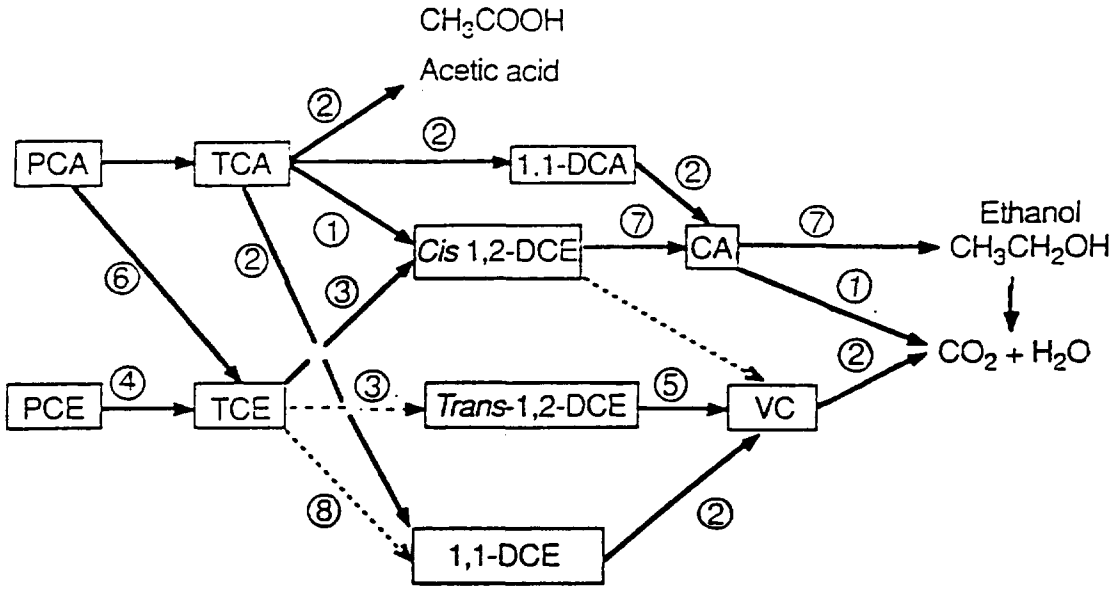
0 500 1000

SCALE IN FEET

**FIGURE 5-14**

| | | | |
|---|---|---|---|
| WARZYN | CHLOROETHANE CONCENTRATIONS IN LOWER AQUFER (JAN. 16, 17 & 18, 1991) | Drawn D.L.L. Checked | App'd: PJ Vert |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | Date 6/13/91 |
| | | | 60251 A25 |

TELEDYNE POST




| Path reference: | Major mechanism | Footnotes |
|---|---|---|
| [1] From Reference 28<br>[2] From Reference 29<br>[3] From Reference 30<br>[4] From Reference 31<br>[5] From Reference 2<br>[6] From Reference 32<br>[7] From Reference 33<br>[8] From Reference 34 | Biodegradation<br>↓<br>Abiotic elimination<br>Biodegradation | ----- Minor pathway<br>*Cis*-1,2-DCE generated at approximately 30 times the concentration of *trans*-1,2-DCE (3) and by a factor of 25:1 (8). |

PCA = Tetrachloroethane
1,1,1–TCA = 1,1,1–Trichloroethane
1,1–DCA = 1,1–Dichloroethane
*Cis*–1,2–DCE = *Cis*–1,2–Dichloroethane
CA = Chloroethane
PCE = Tetrachloroethene
TCE = Trichloroethane
*Trans*–1,2–DCE = *Trans*–1,1–Dichloroethane
VC = Vinyl chloride
1,1–DCE = 1,1–Dichloroethane

From: Olsen and Davis, 1990.

**FIGURE 6-1**

| | | | |
|---|---|---|---|
| WARZYN | TRANSFORMATIONS OF CHLORINATED ALIPHATIC HYDROCARBONS<br>REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Drawn DLL<br>Revisions | Checked JAW<br>App'd. [illegible]<br>Date 11/15/90 |
| | | | 60251 **A21** |

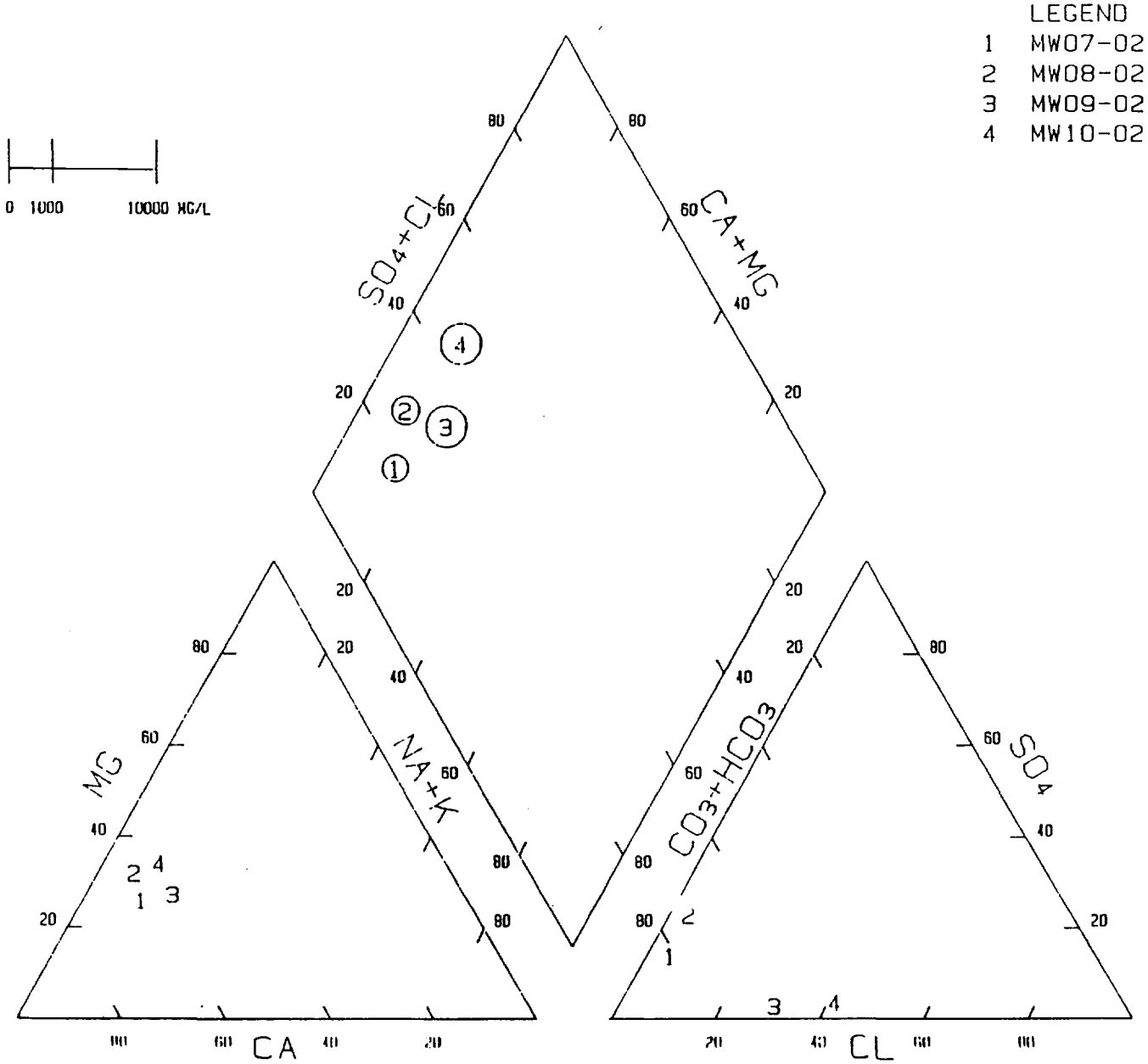



**FIGURE 6-2**

| | | | |
|---|---|---|---|
| WARZYN | **PIPER TRILINEAR DIAGRAM OF LOWER AQUIFER MONITORING WELL DATA** | Drawn DLL | Checked JAW | App'd. |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 11/15/20 |
| | | | | 60251 **A22** |

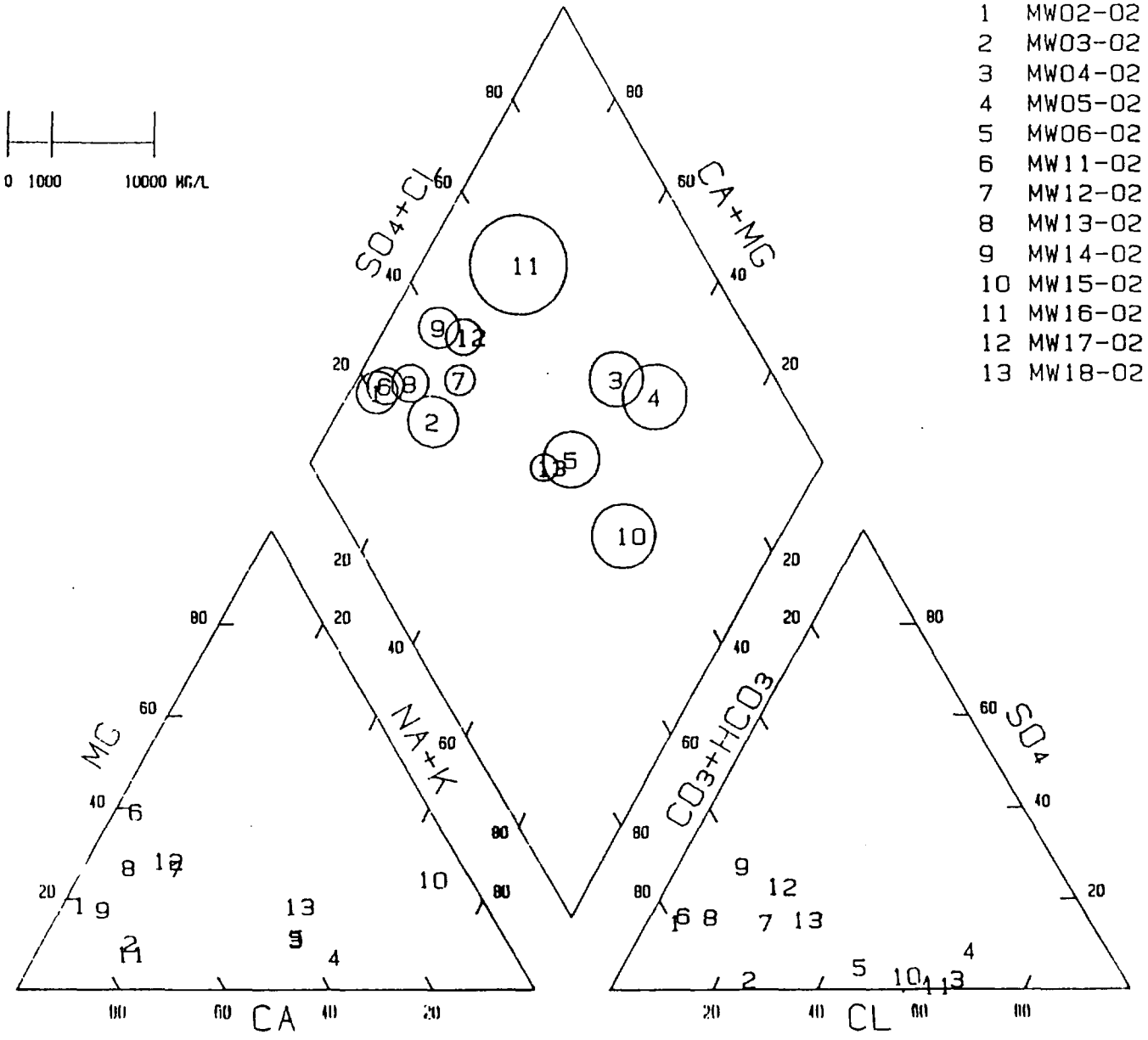



**FIGURE 6-3**

| | | | |
|---|---|---|---|
| WARZYN | PIPER TRILINEAR DIAGRAM OF UPPER AQUIFER MONITORING WELL DATA | Drawn DLL | Checked JAW | App'd. |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | | Date 11/1/26 |
| | | | | 60251 **A23** |

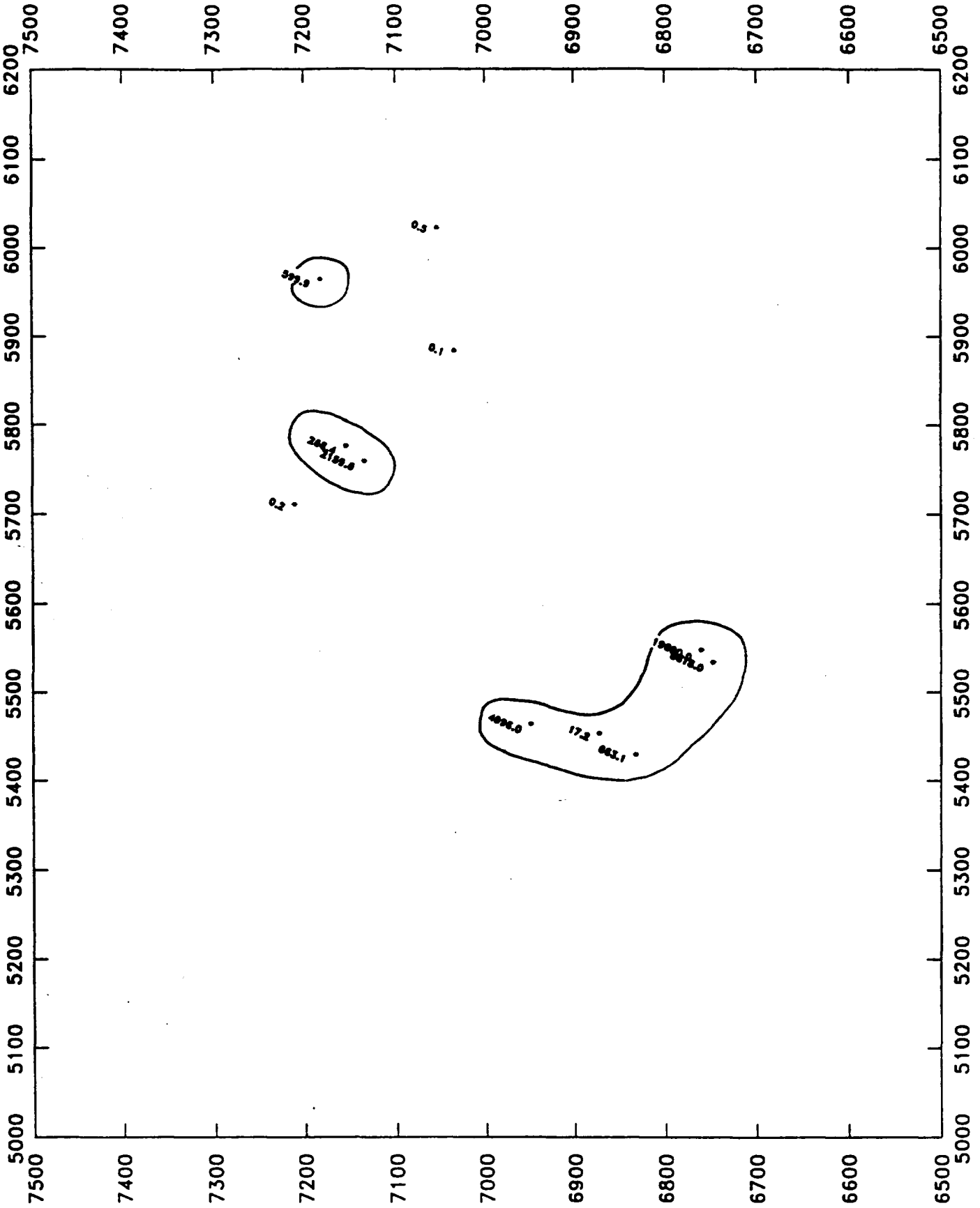



Figure 5-6b Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (4-7 feet below surface). Posted Values are in ppm (mg/kg).

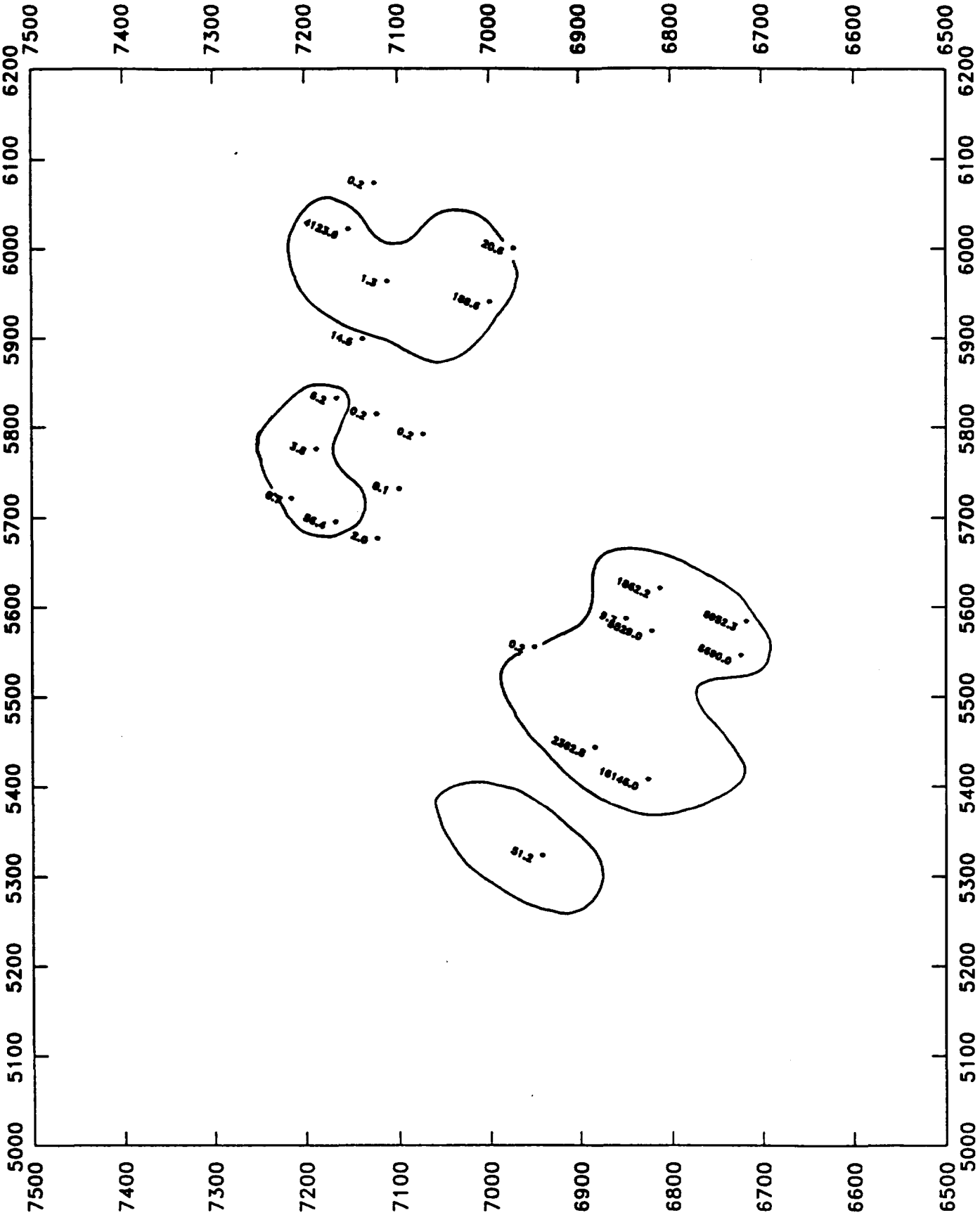



Figure 5-6c Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas 7-9 feet below surface). Posted Values are in ppm (mg/kg).

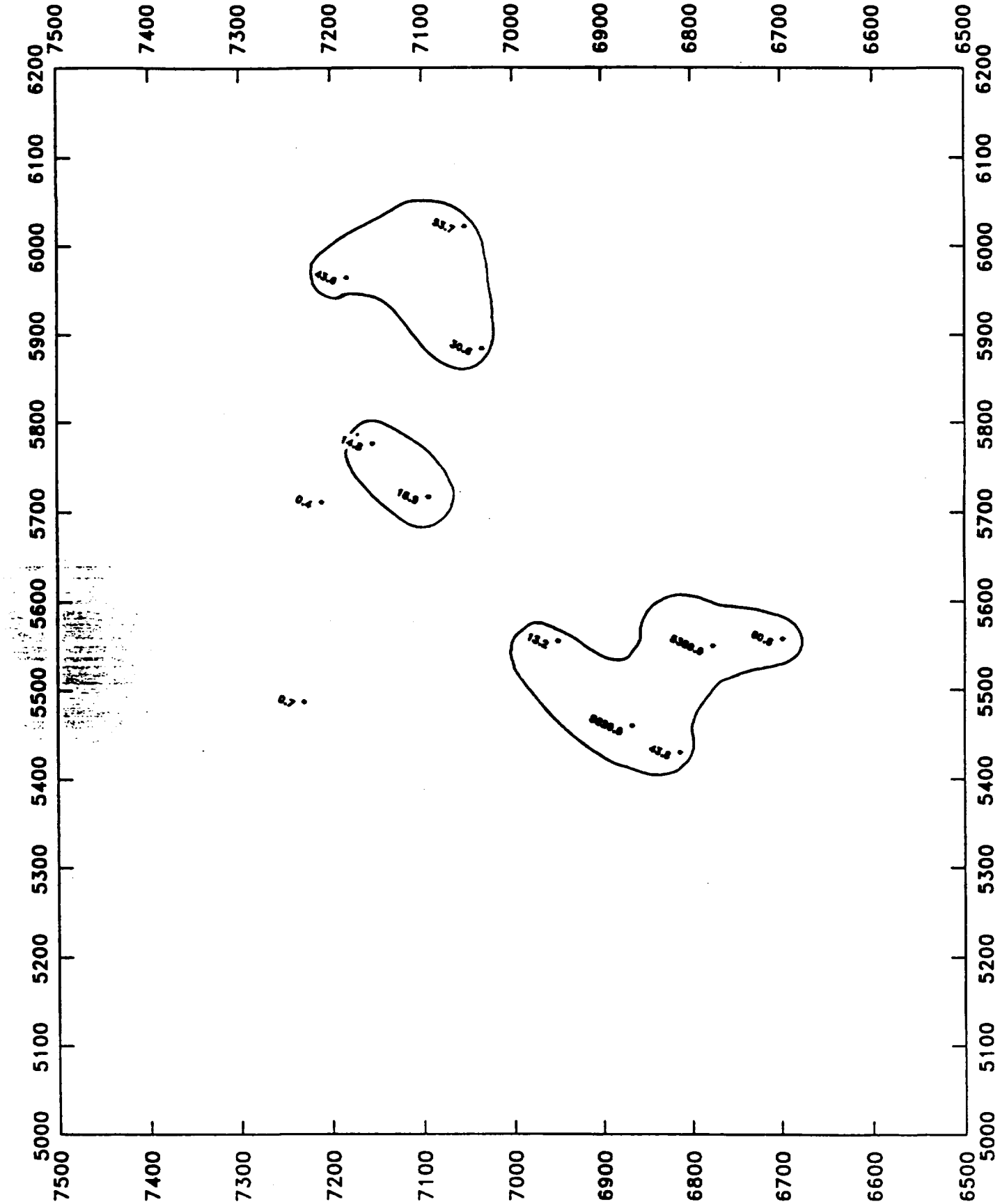



**Figure 5-6d** Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (9-14 feet below surface). Posted Values are in ppm (mg/kg).

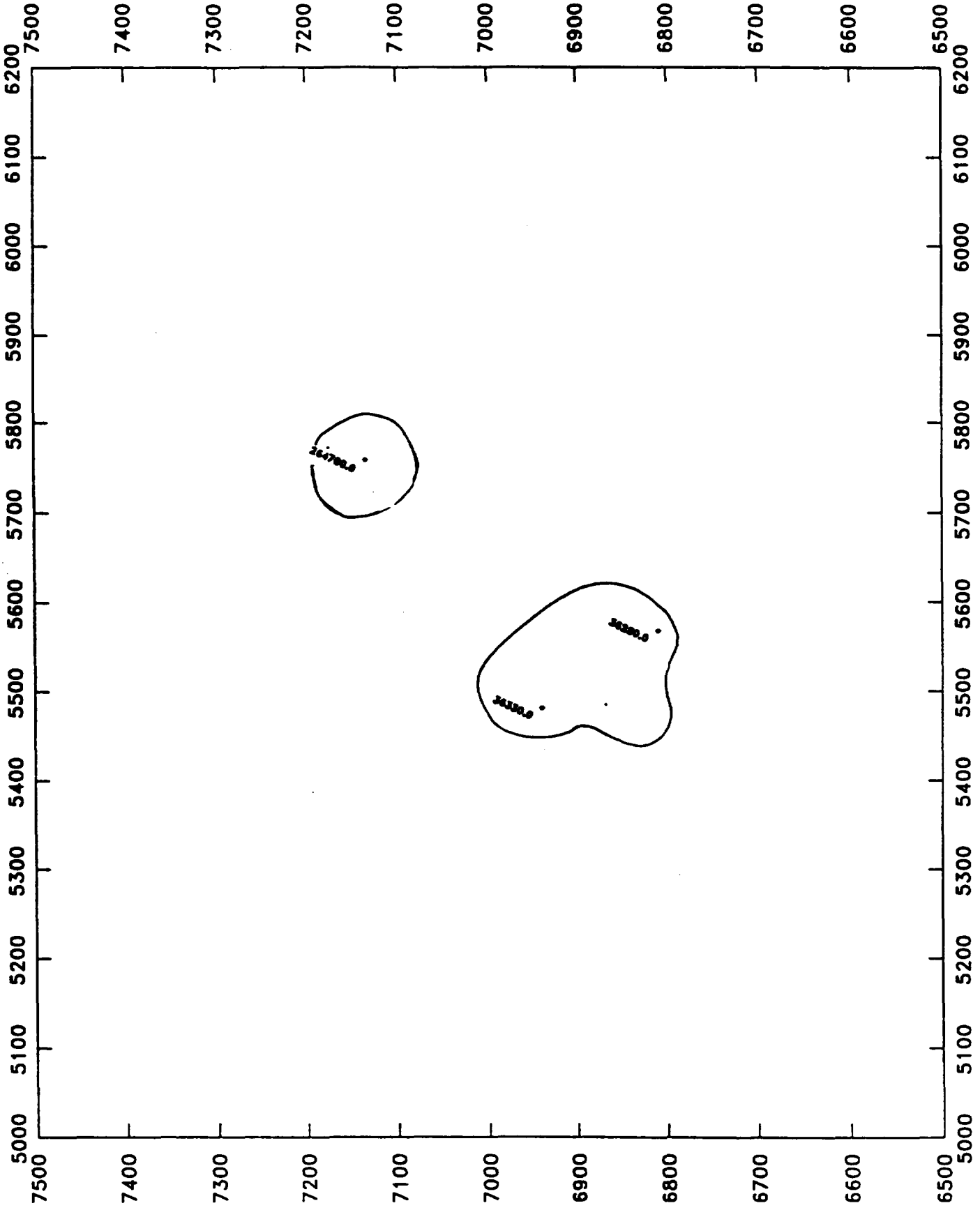



Figure 5-6a Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (1-4 feet below surface). Posted Values are in ppm (mg/kg).

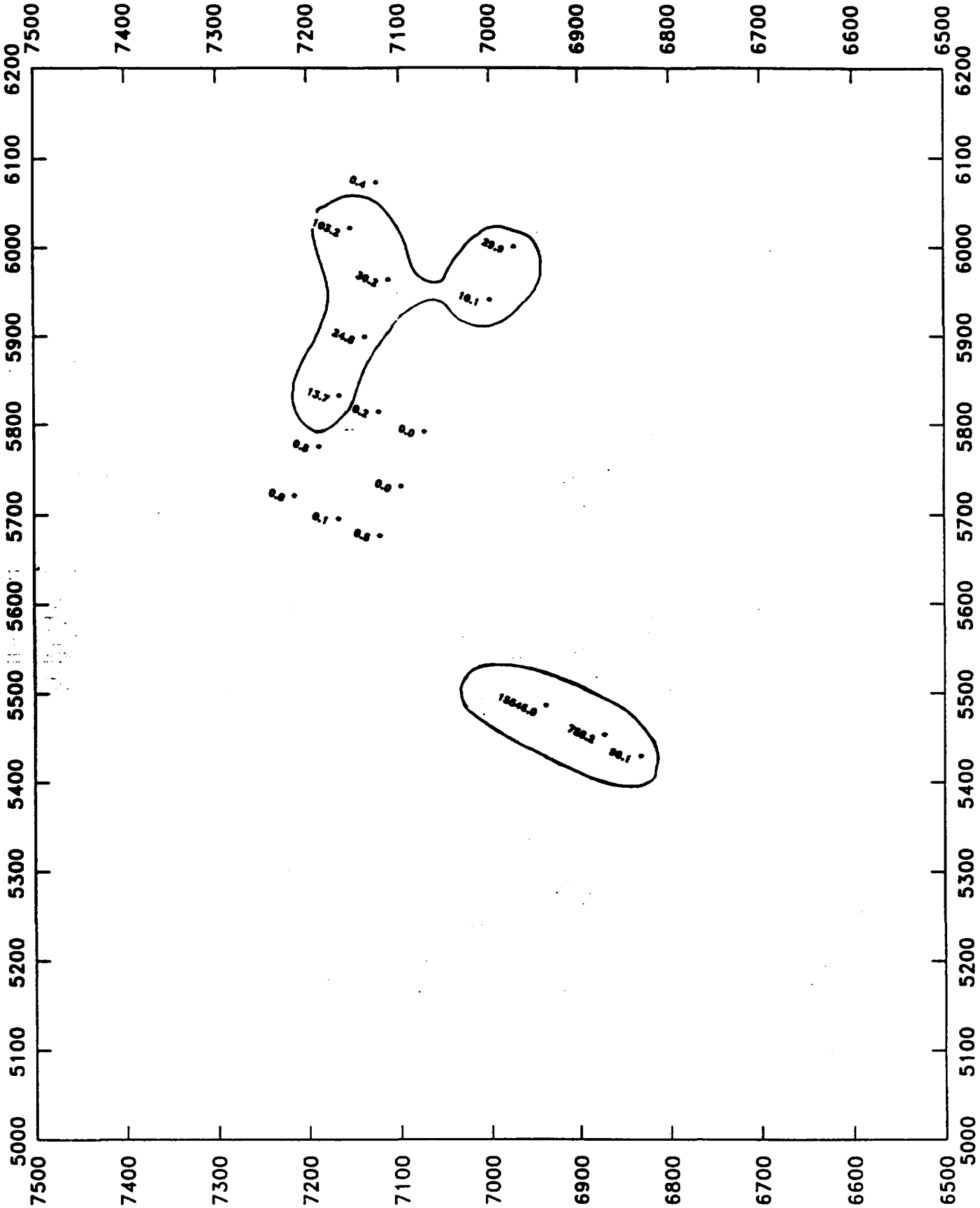



Figure 5-6e Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas (14-19 feet below surface). Posted Values are in ppm (mg/kg).

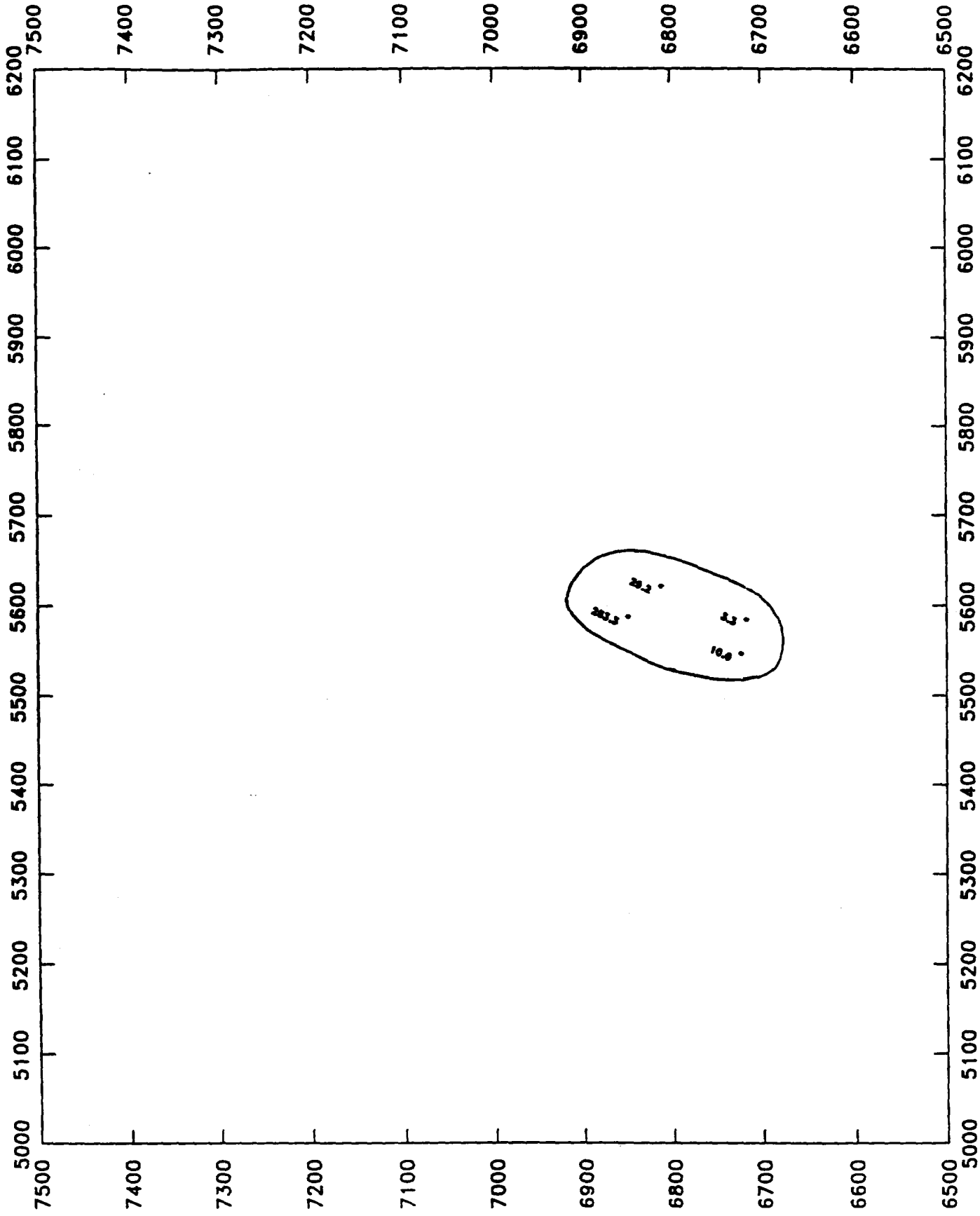
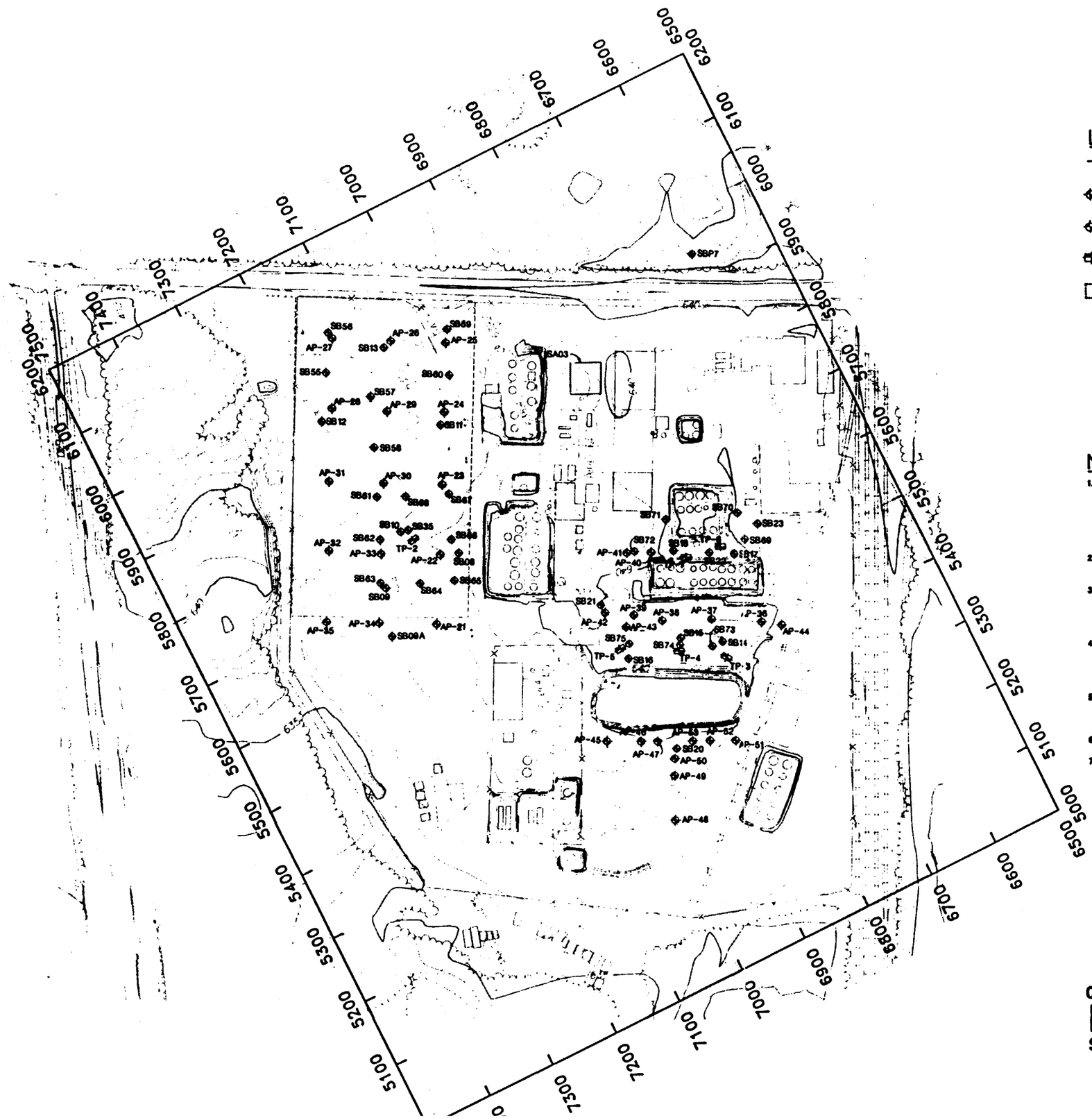



**Figure 5-6f** Approximate Extent of Total Volatile Wastes (> 1 ppm), On-Site Areas 19-24 feet below surface). Posted Values are in ppm (mg/kg).




## LEGEND

| | |
|---|---|
| ---- | GEOPHYSICS INVESTIGATION AREA |
| SB-01 | SOIL BORING LOCATION & NUMBER |
| AP-01 | AUGER PROBE LOCATION & NUMBER |
| TP-1 | TEST PIT LOCATION & NUMBER |
| SA01 | SOIL AREA LOCATION & NUMBER |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 6, 1986. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
3. SOIL BORINGS SB01 TO SB18 AND AUGER PROBES AP-1 TO AP-44 FOR PHASE I WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN AUGUST AND SEPTEMBER 1989.
4. SOIL BORINGS SB20 TO SB75 AND AUGER PROBES AP-45 TO AP-53 FOR PHASE II WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN MAY AND JUNE 1990.
5. LOCATIONS FOR SOIL BORINGS WITH SAMPLING AND TEST PITS WERE FIELD LOCATED BY EWI ENGINEERING ASSOC. SURVEYORS.
6. LOCATIONS OF AUGER PROBES ARE APPROXIMATE.
7. SOIL BORING NUMBERS SB19 AND SB34 DO NOT EXIST.

north

0 150 300

SCALE IN FEET

FIGURE 5-8

Designed By
Drawn By: JC
Checked By: JPD
Approved By
Date: 11/2/90
Revisions
Date • By • Description
WARZYN
WARZYN ENGINEERING INC.

LEAD ON-SITE BASE MAP
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number
60251 B22
WARZYN

© 1997 - Warzyn Engineering Inc. - All Rights Reserved

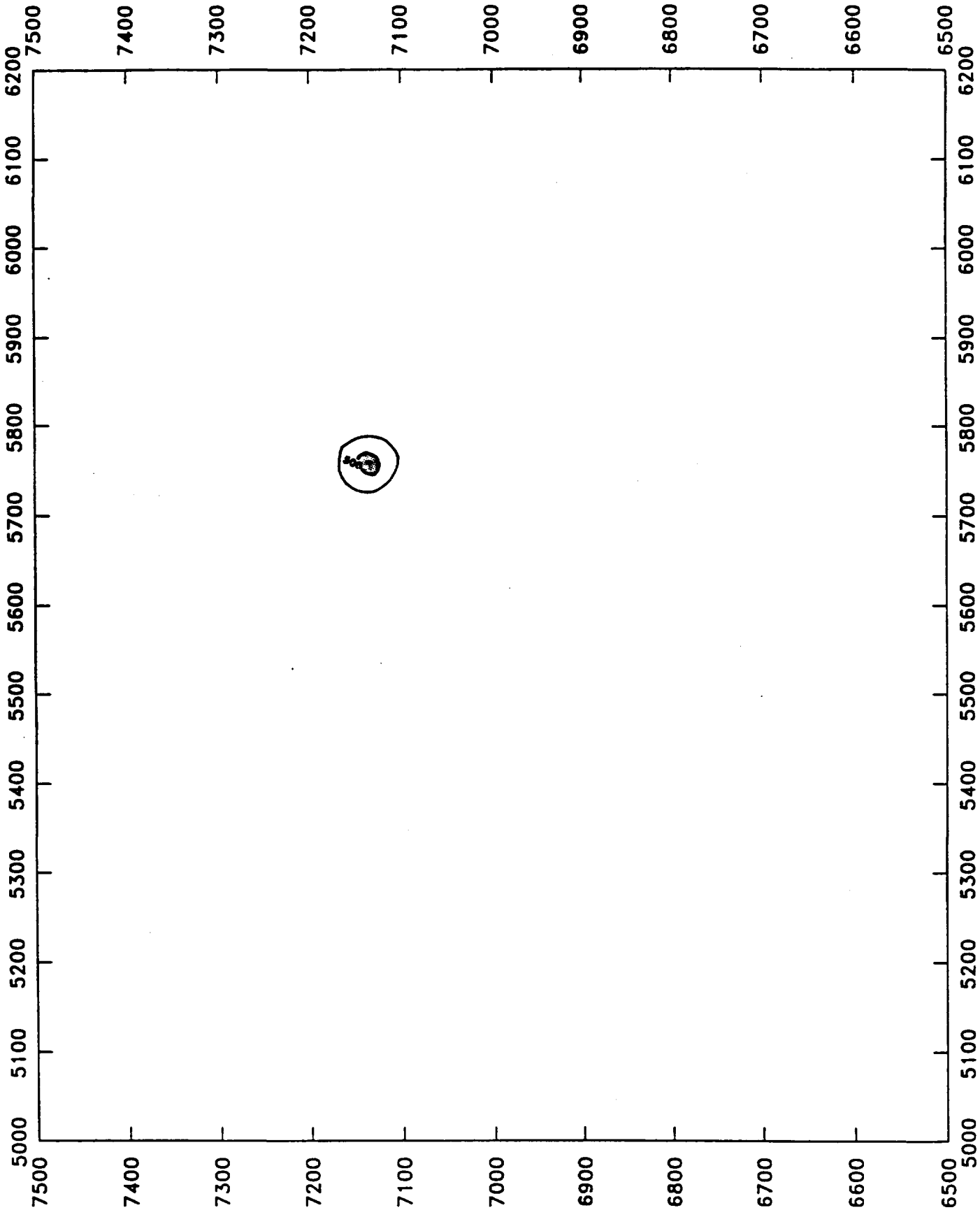



Figure 5-7a Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (1-3 feet below surface)

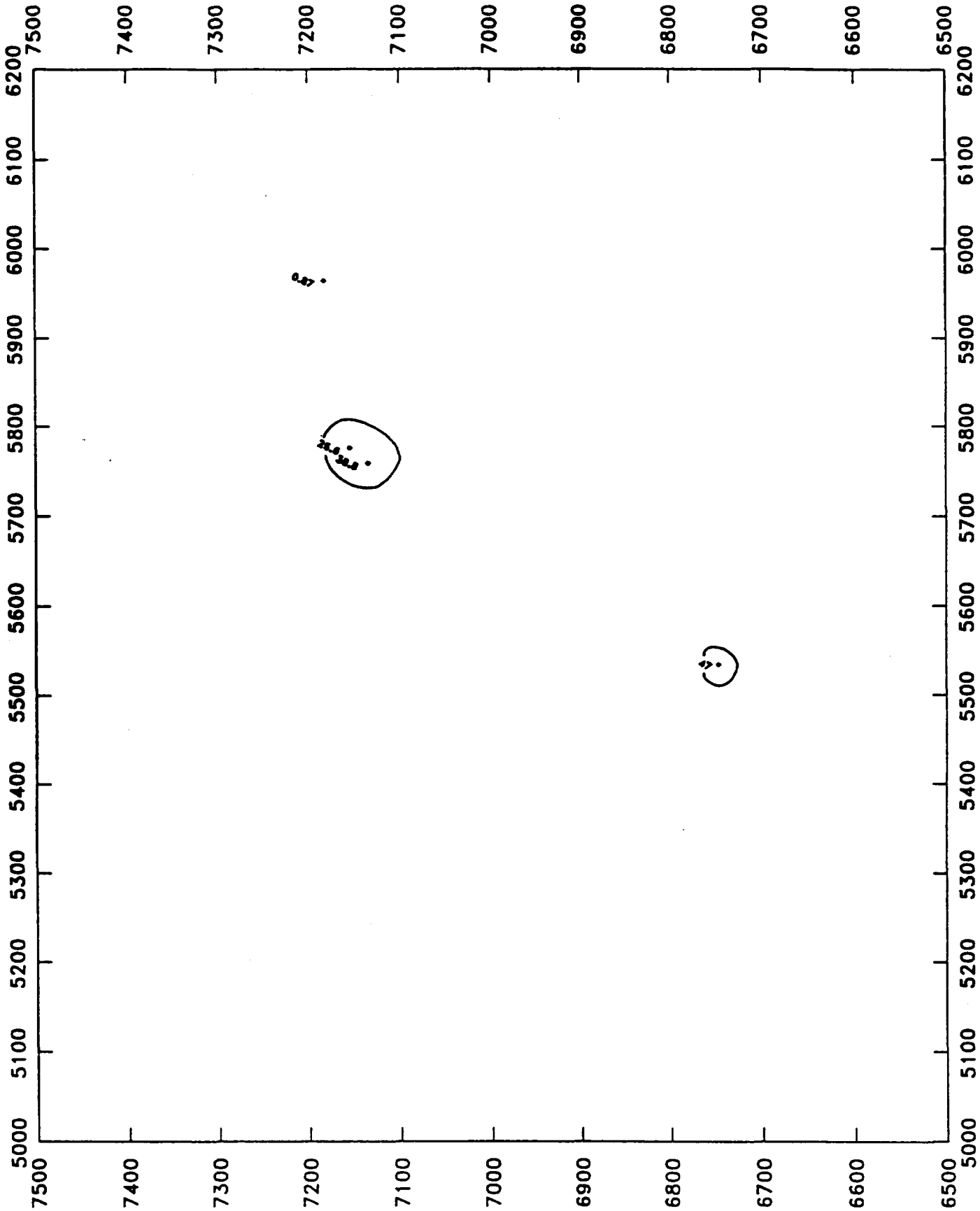



Figure 5-7b Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (3-6 feet below surface)

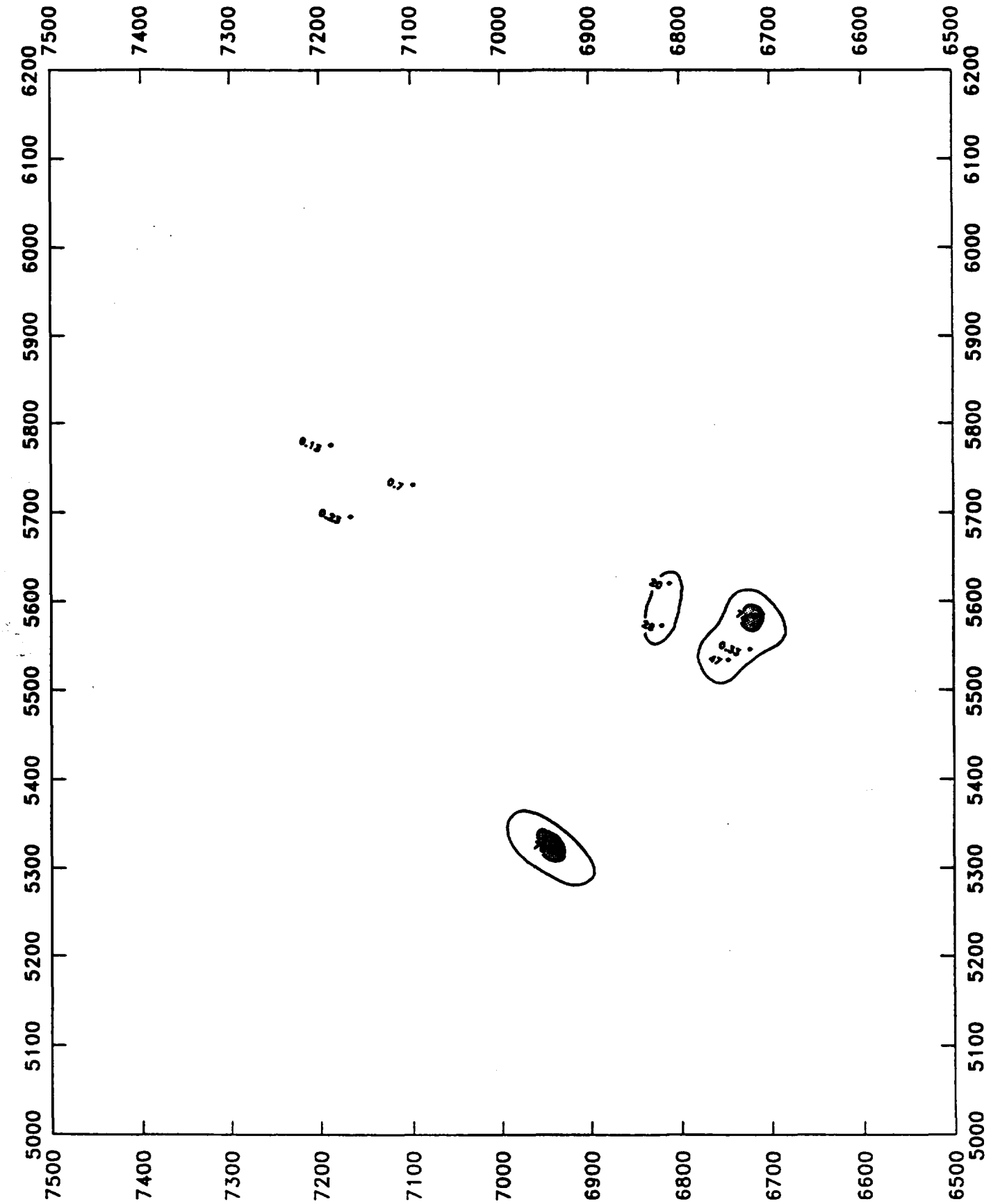



Figure 5-7c Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (6-8 feet below surface)

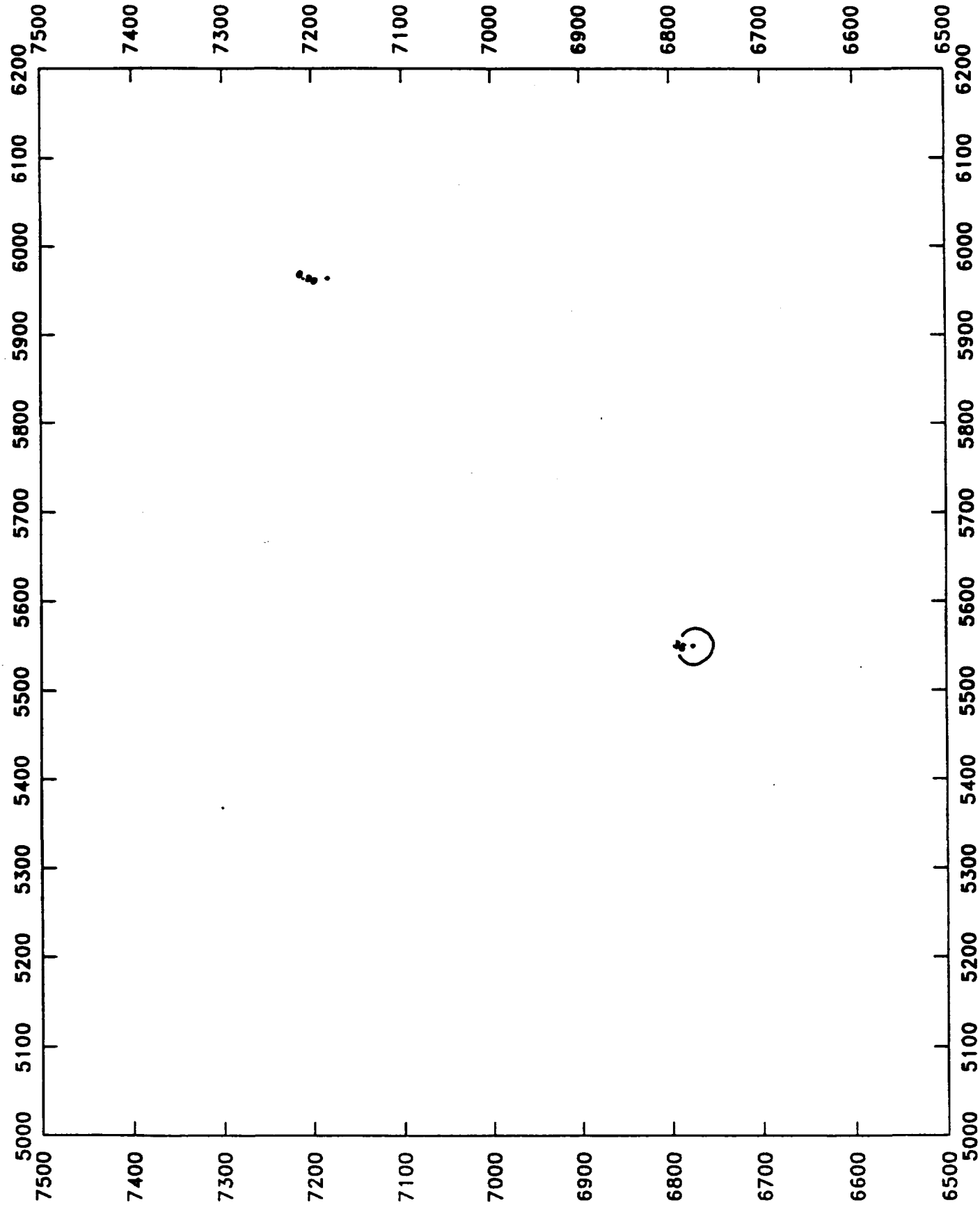



Figure 5-7d Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (8-12 feet below surface)

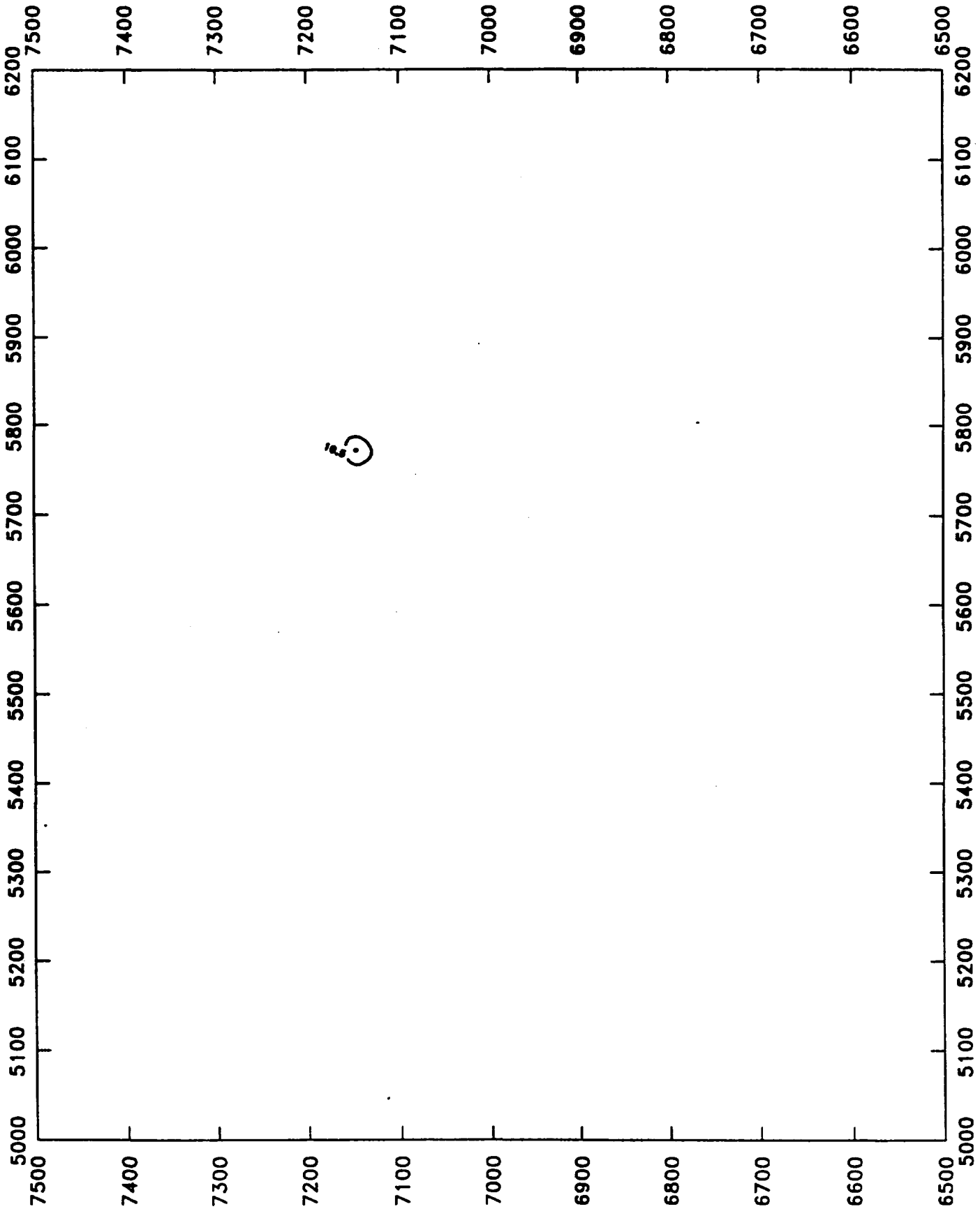



Figure 5-7e Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (12-17 feet below surface)

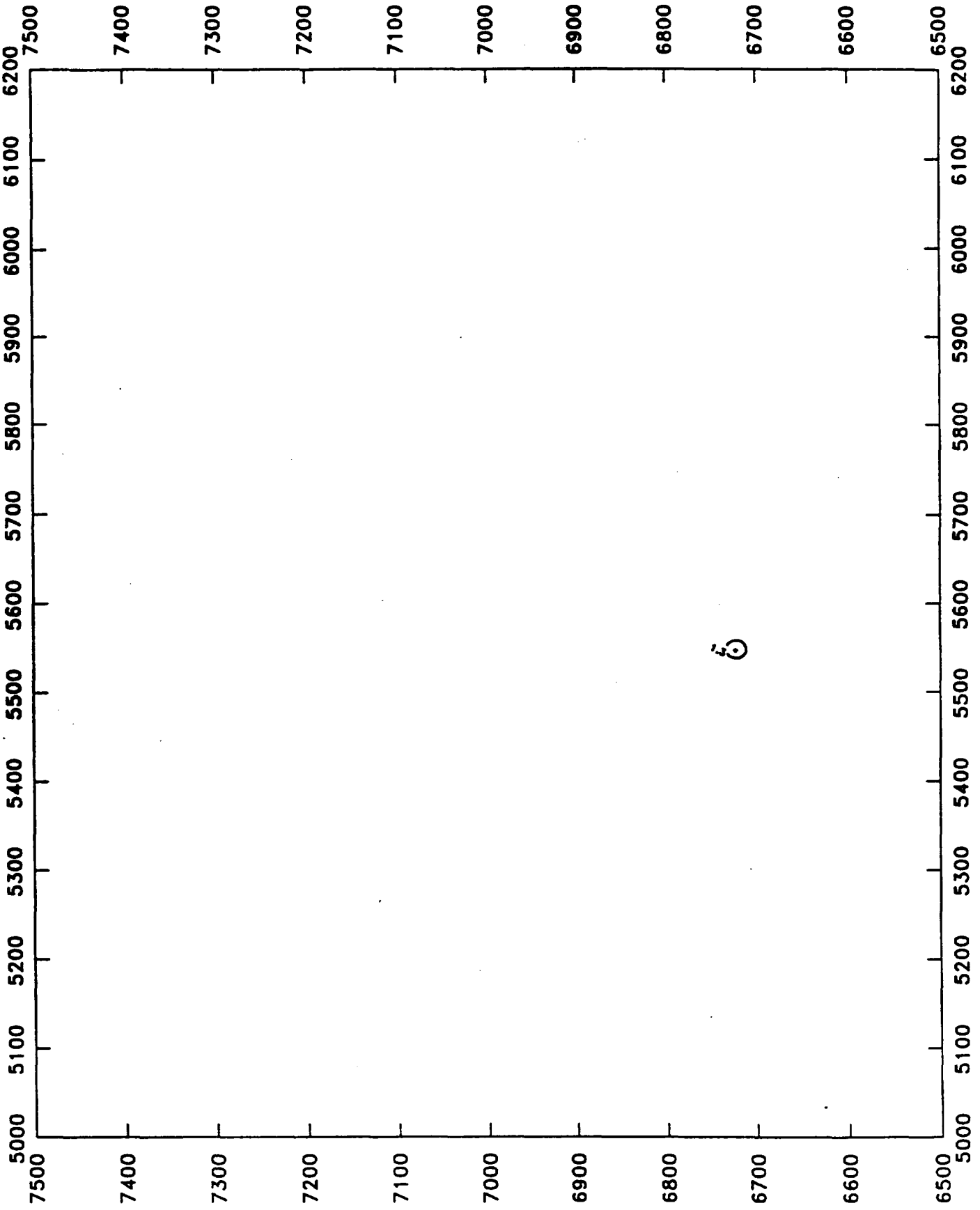
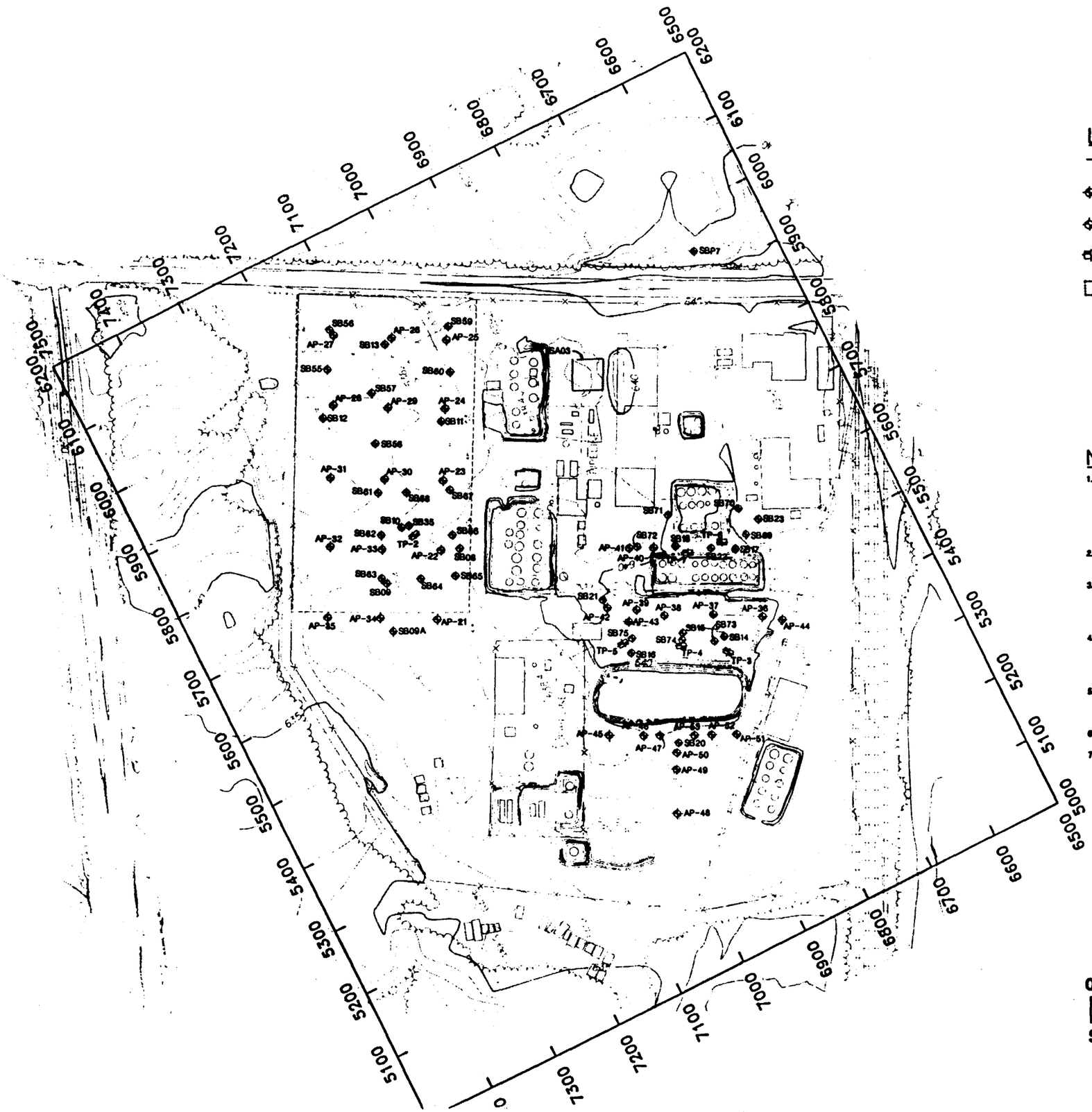



Figure 5-7f Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), On-Site Areas (17-20 feet below surface)




## LEGEND

| | |
|---|---|
| ---- | GEOPHYSICS INVESTIGATION AREA |
| SB-01 | SOIL BORING LOCATION & NUMBER |
| AP-01 | AUGER PROBE LOCATION & NUMBER |
| TP-1 | TEST PIT LOCATION & NUMBER |
| SA01 | SOIL AREA LOCATION & NUMBER |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 8, 1986. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
3. SOIL BORINGS SB01 TO SB18 AND AUGER PROBES AP-1 TO AP-44 FOR PHASE I WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN AUGUST AND SEPTEMBER 1989.
4. SOIL BORINGS SB20 TO SB75 AND AUGER PROBES AP-45 TO AP-53 FOR PHASE II WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN MAY AND JUNE 1990.
5. LOCATIONS FOR SOIL BORINGS WITH SAMPLING AND TEST PITS WERE FIELD LOCATED BY EWI ENGINEERING ASSOC. SURVEYORS.
6. LOCATIONS OF AUGER PROBES ARE APPROXIMATE.
7. SOIL BORING NUMBERS SB19 AND SB34 DO NOT EXIST.

north

0 150 300

SCALE IN FEET

FIGURE 5-7

Checked By JDD
Date 11/2/90
Reference
Drawn By JC
Designed By
Approved By
Date • By • Page
WARZYN
WARZYN ENGINEERING INC.
Revisions
TOTAL PCB's ON-SITE BASE MAP
REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA
Project Number
60251 B21
WARZYN
© 1991 - Warzyn Engineering Inc. - All Rights Reserved

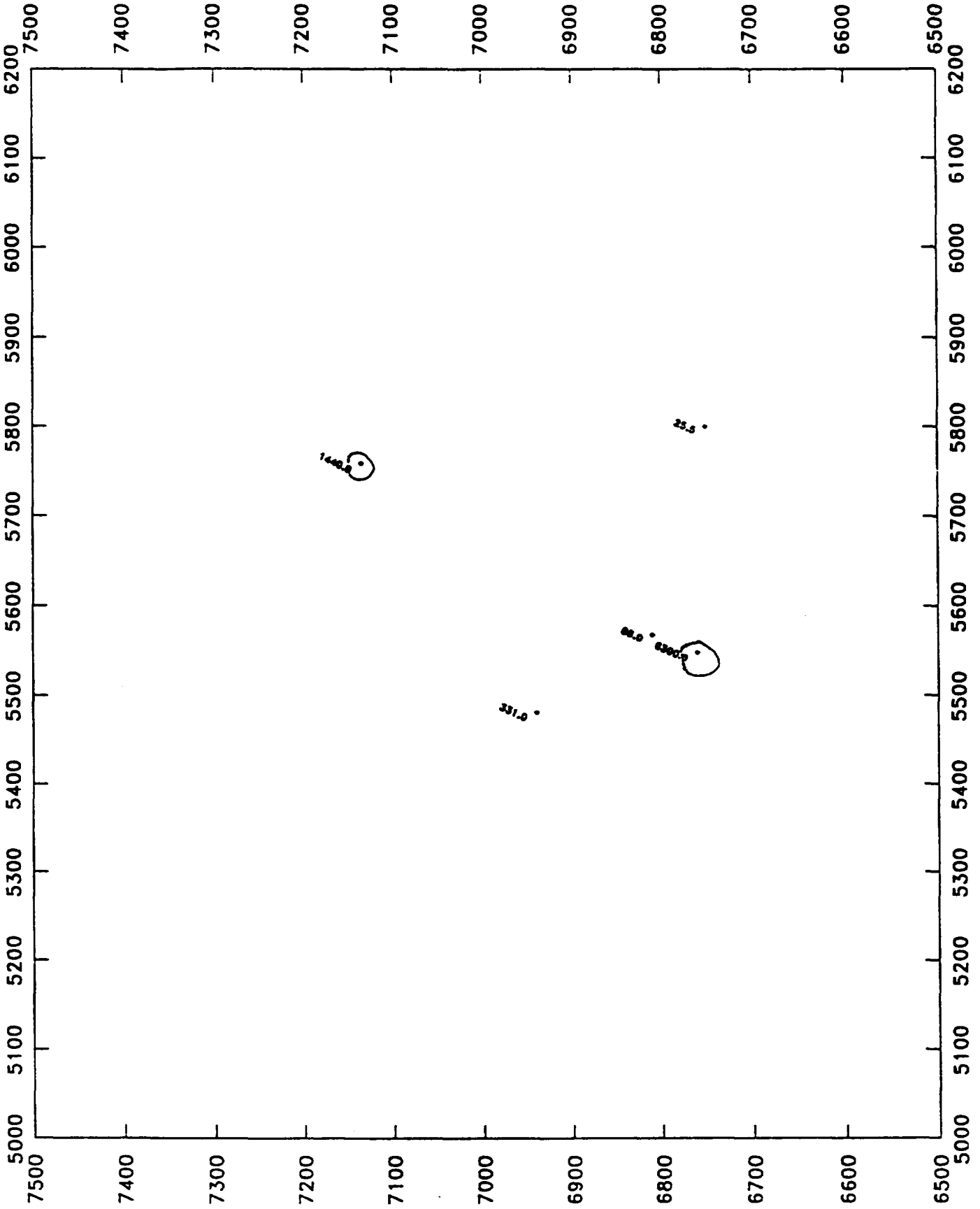



Figure 5-8a Approximate Extent of Lead Containing Wastes (> 500 ppm), On-Site Areas (1-4 feet below surface). Posted Values are in ppm (mg/kg).

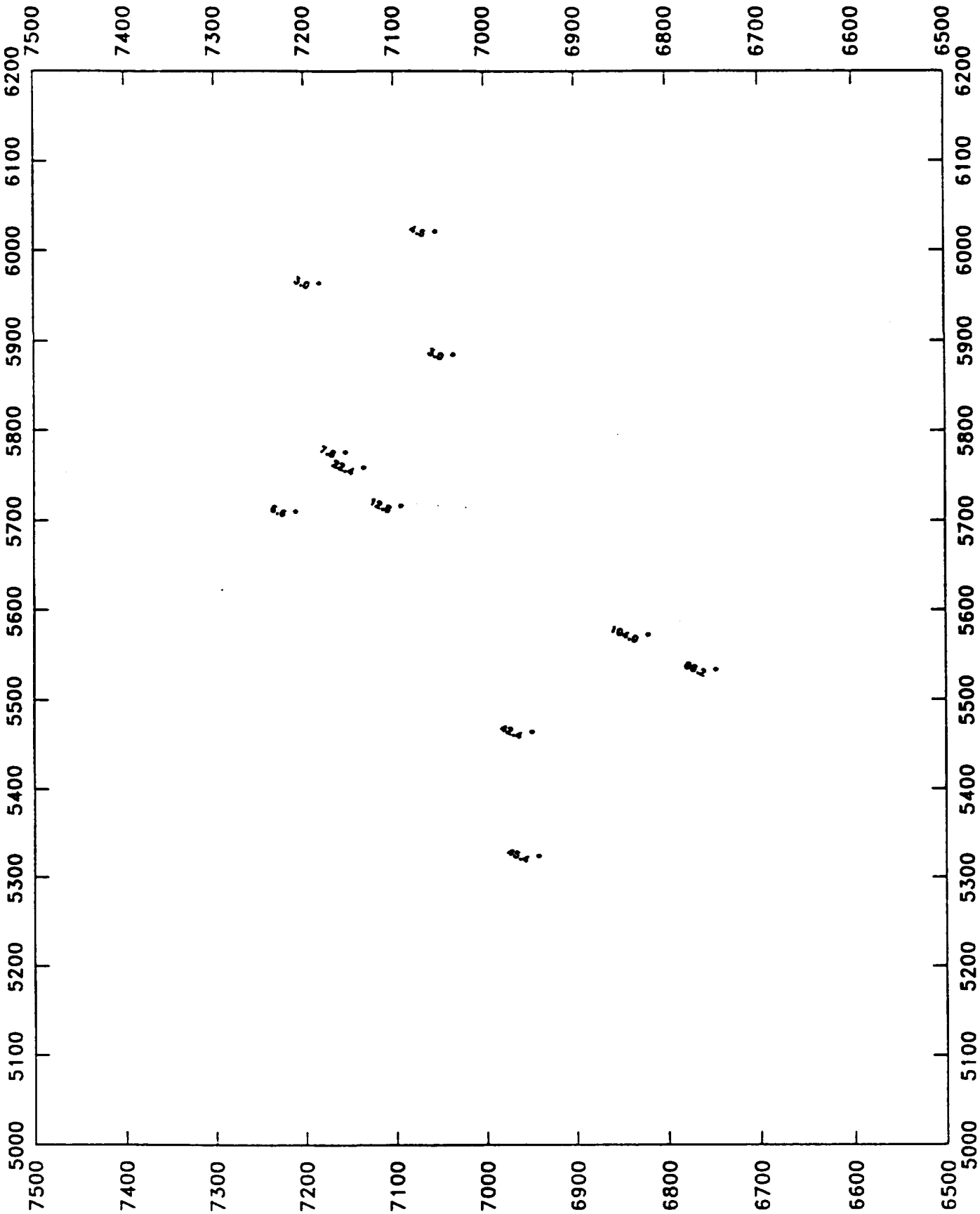



Figure 5-8b Approximate Extent of Lead Containing Wastes (> 500 ppm), On-Site Areas (4-7 feet below surface). Posted Values are in ppm (mg/kg).

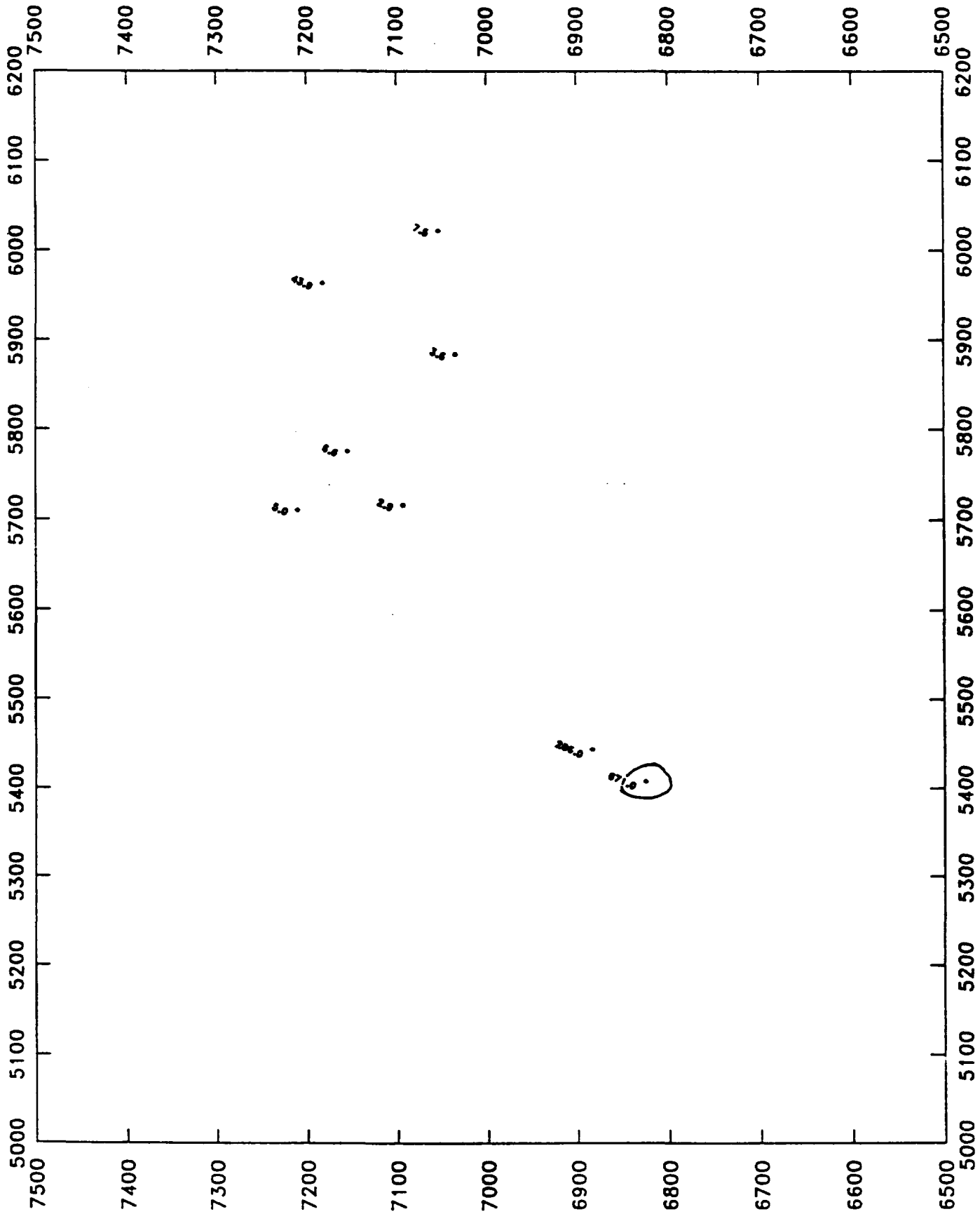



Figure 5-8c Approximate Extent of Lead Containing Wastes (> 500 ppm), On-Site Areas (7-10 feet below surface). Posted Values are in ppm (mg/kg).

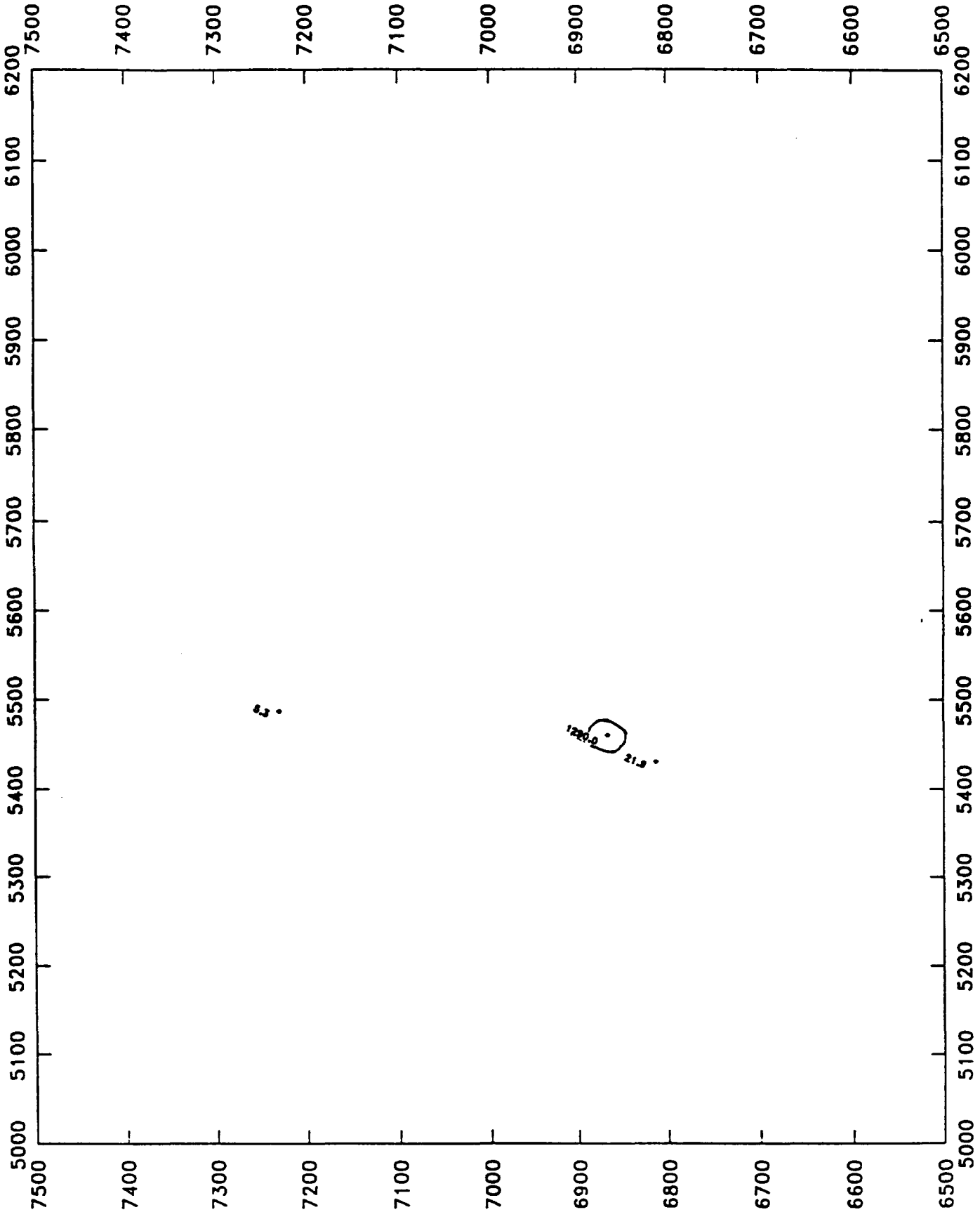
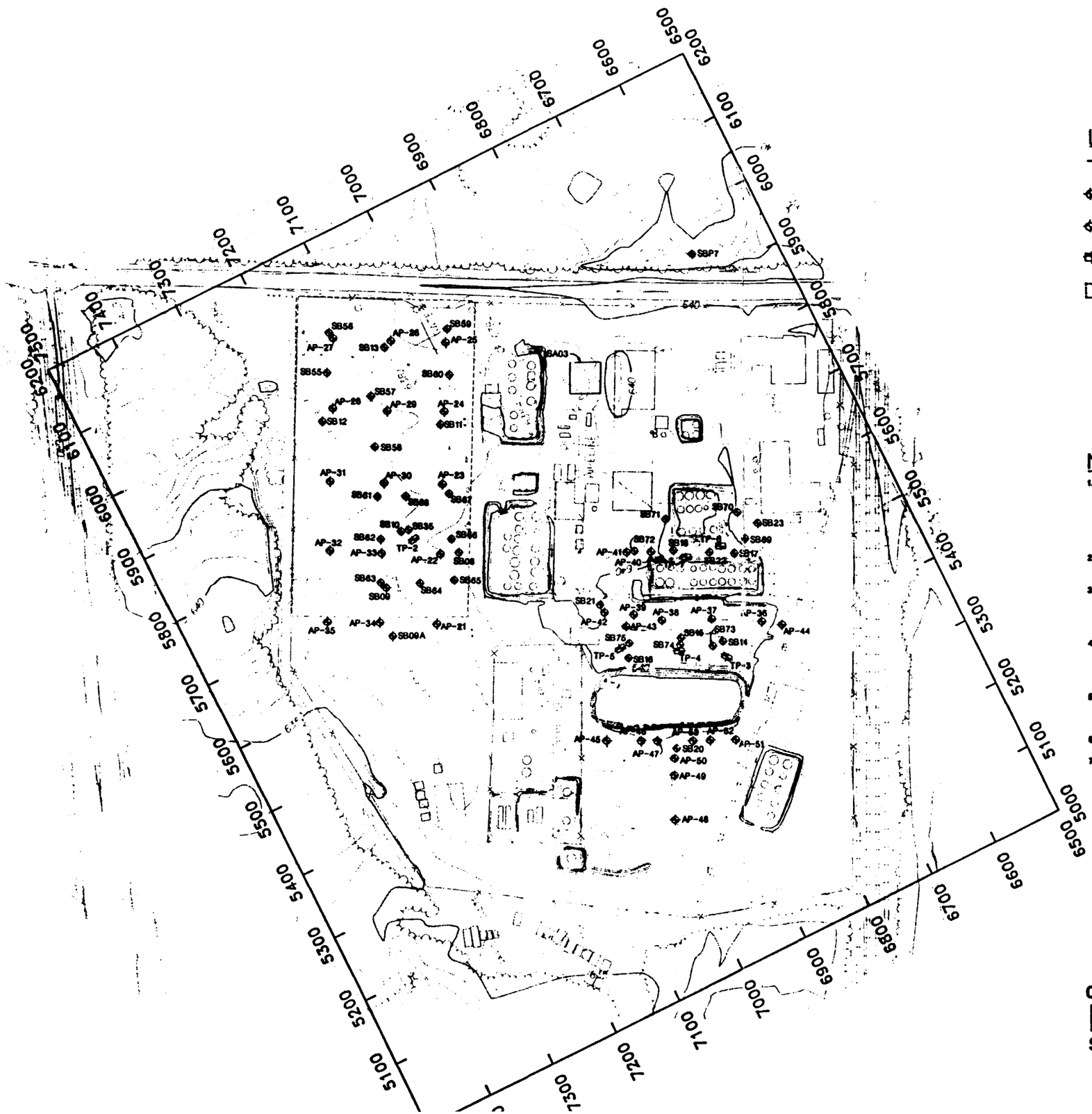



Figure 5-8d Approximate Extent of Lead Containing Wastes (> 500 ppm), On-Site Areas (10-15 feet below surface). Posted Values are in ppm (mg/kg).




## LEGEND

| | |
|---|---|
| ---- | GEOPHYSICS INVESTIGATION AREA |
| SB-01 | SOIL BORING LOCATION & NUMBER |
| AP-01 | AUGER PROBE LOCATION & NUMBER |
| TP-1 | TEST PIT LOCATION & NUMBER |
| SA01 | SOIL AREA LOCATION & NUMBER |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 6, 1986. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
3. SOIL BORINGS SB01 TO SB18 AND AUGER PROBES AP-1 TO AP-44 FOR PHASE I WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN AUGUST AND SEPTEMBER 1989.
4. SOIL BORINGS SB20 TO SB75 AND AUGER PROBES AP-45 TO AP-63 FOR PHASE II WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN MAY AND JUNE 1990.
5. LOCATIONS FOR SOIL BORINGS WITH SAMPLING AND TEST PITS WERE FIELD LOCATED BY EWI ENGINEERING ASSOC. SURVEYORS.
6. LOCATIONS OF AUGER PROBES ARE APPROXIMATE.
7. SOIL BORING NUMBERS SB19 AND SB34 DO NOT EXIST.

north

0 150 300

SCALE IN FEET

FIGURE 5-6

Date: By: Appr'd

WARZYN
WARZYN ENGINEERING INC.

Designed by
Approved by
Drawn by JC
Checked by JDD
Date 11/2/90
Reference

TOTAL VOC's ON-SITE BASE MAP

REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B20

WARZYN

© 1991 - Warzyn Engineering Inc. - All Rights Reserved

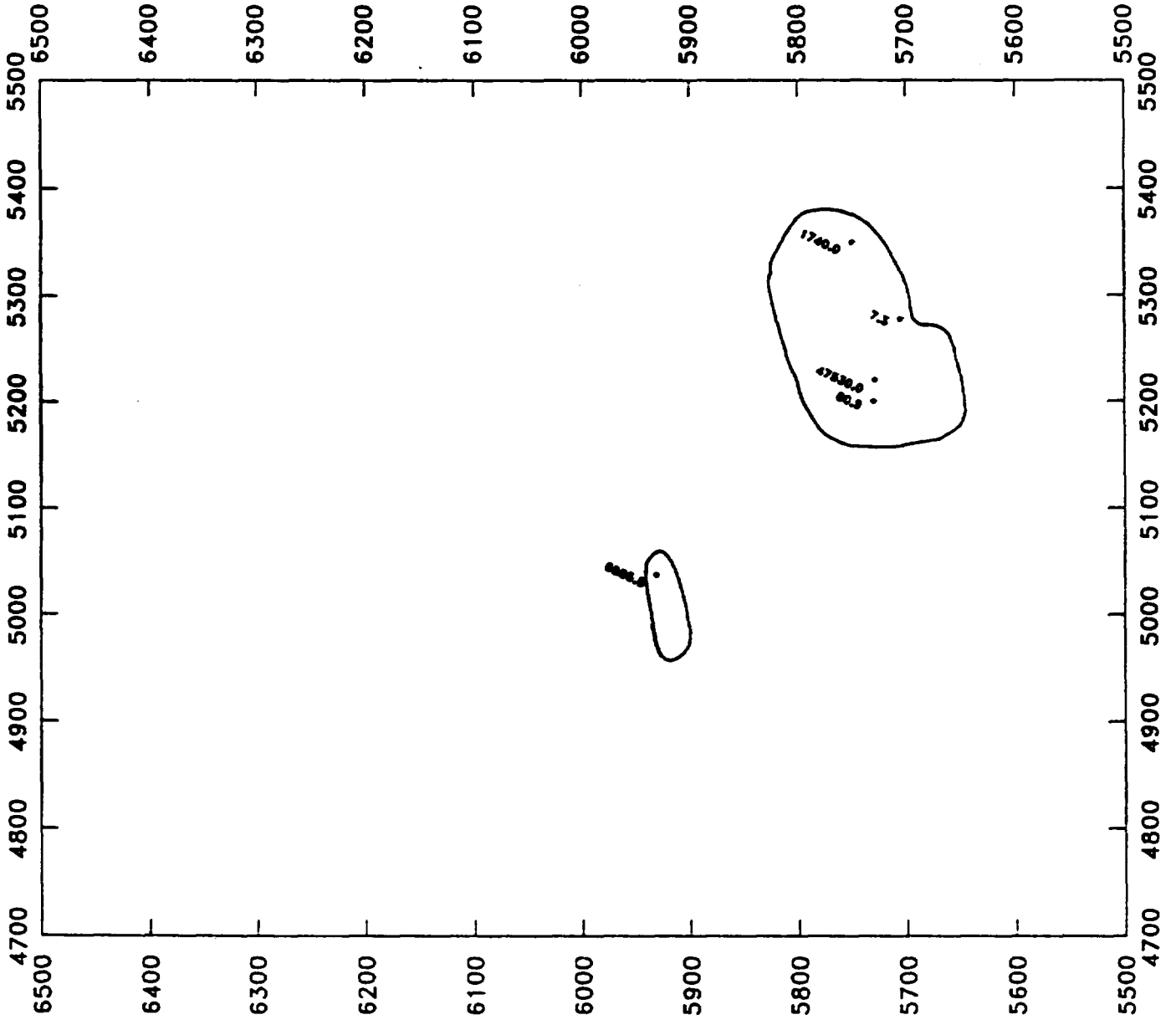



Figure 5-9a Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (0-4 feet below surface). Posted Values are in ppm (mg/kg).

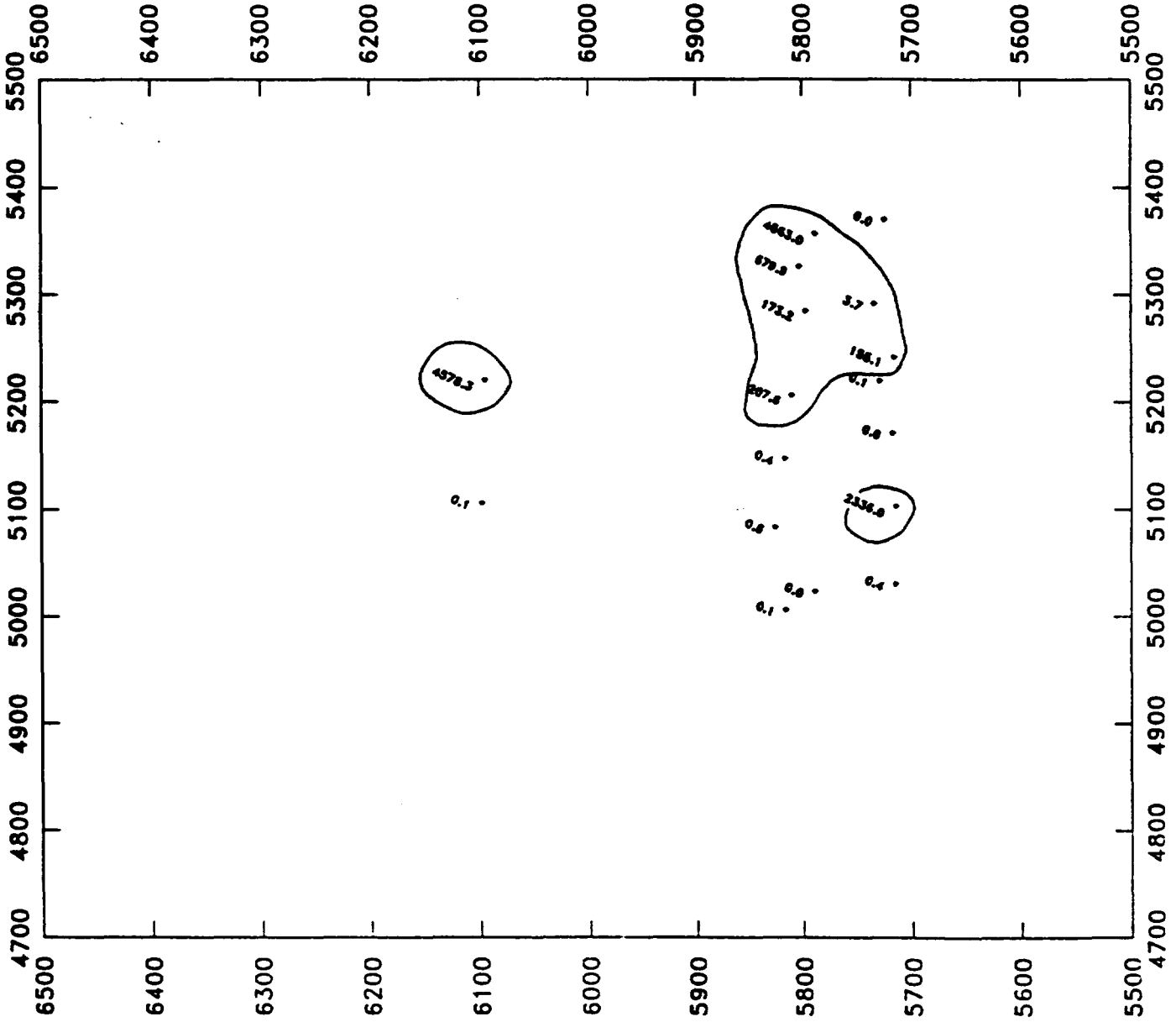



Figure 5-9b Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (4-7 feet below surface). Posted Values are in ppm (mg/kg).

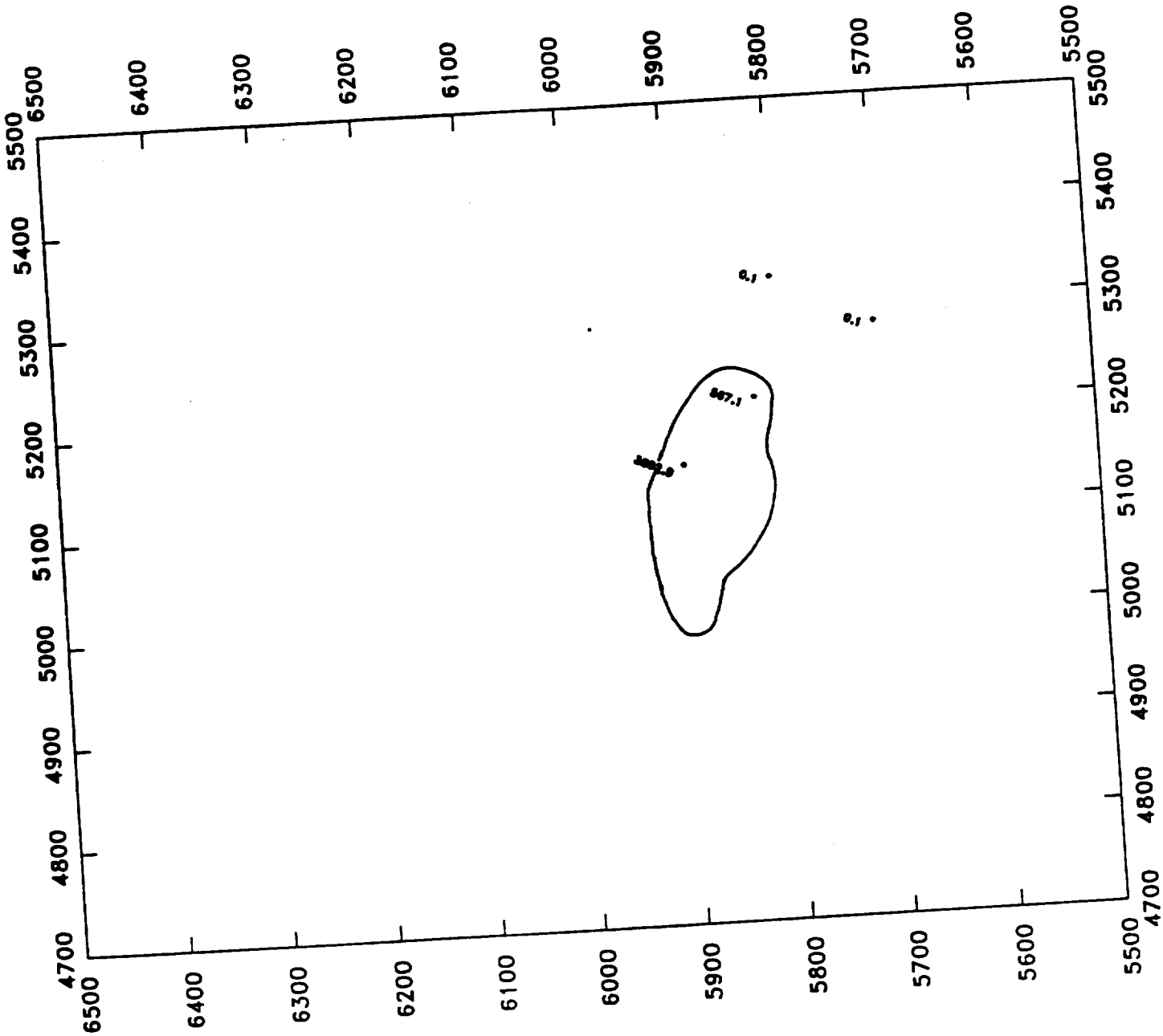



Figure 5-9c Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (7-9 feet below surface). Posted Values are in ppm (mg/kg).

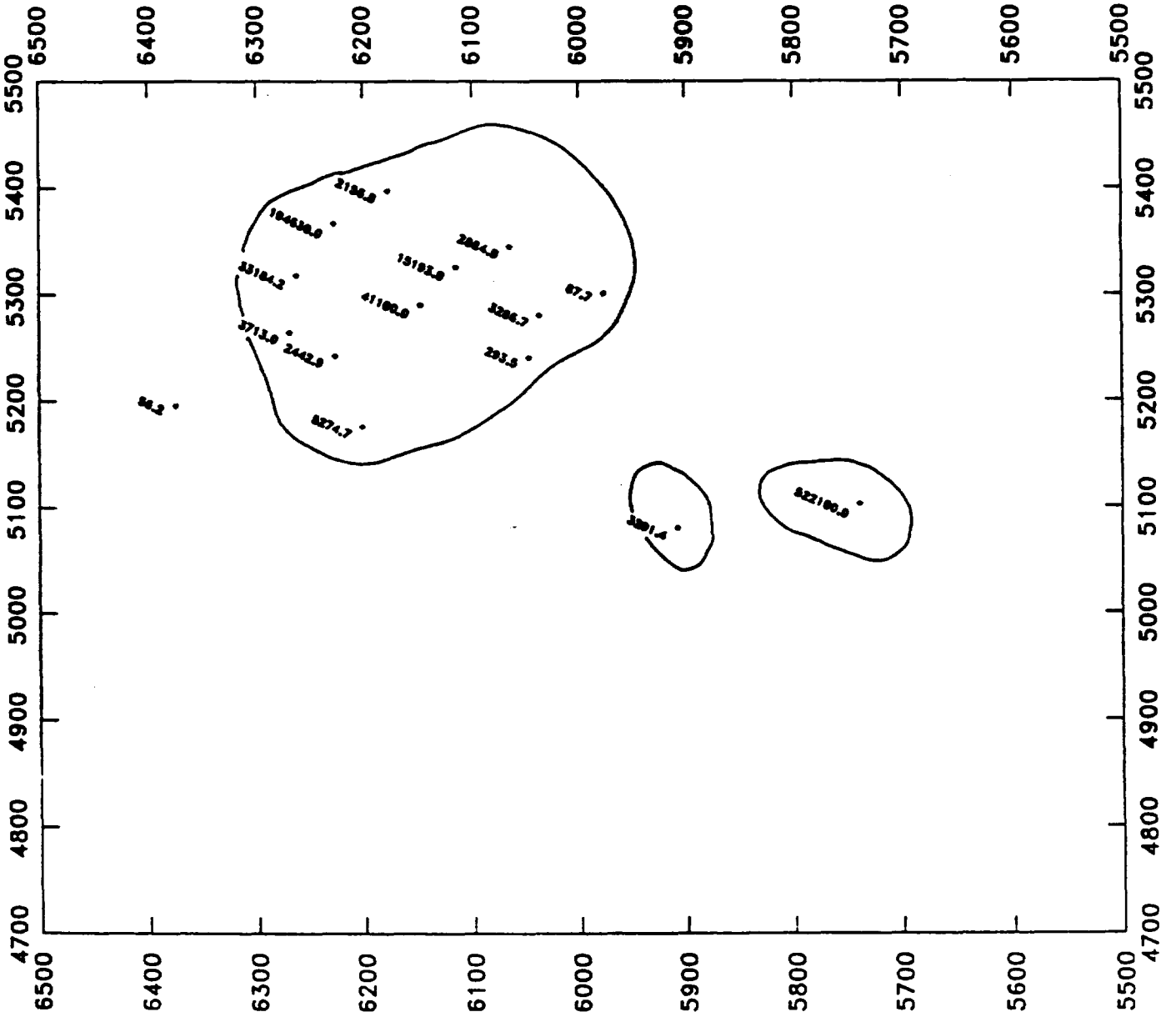



Figure 5-9d Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (9-14 feet below surface). Posted Values are in ppm (mg/kg).

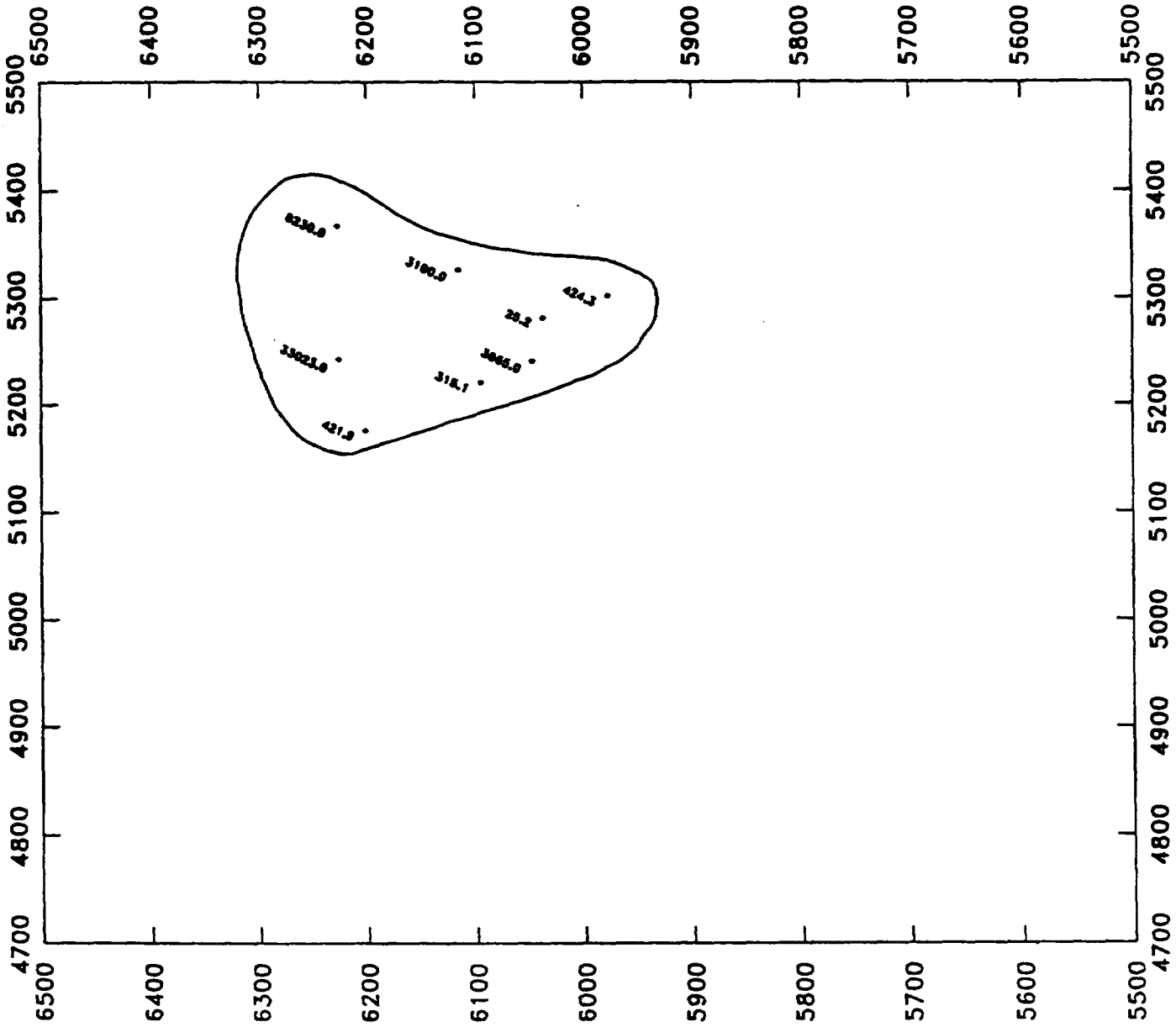



Figure 5-9e Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (14-19 feet below surface). Posted Values are in ppm (mg/kg).

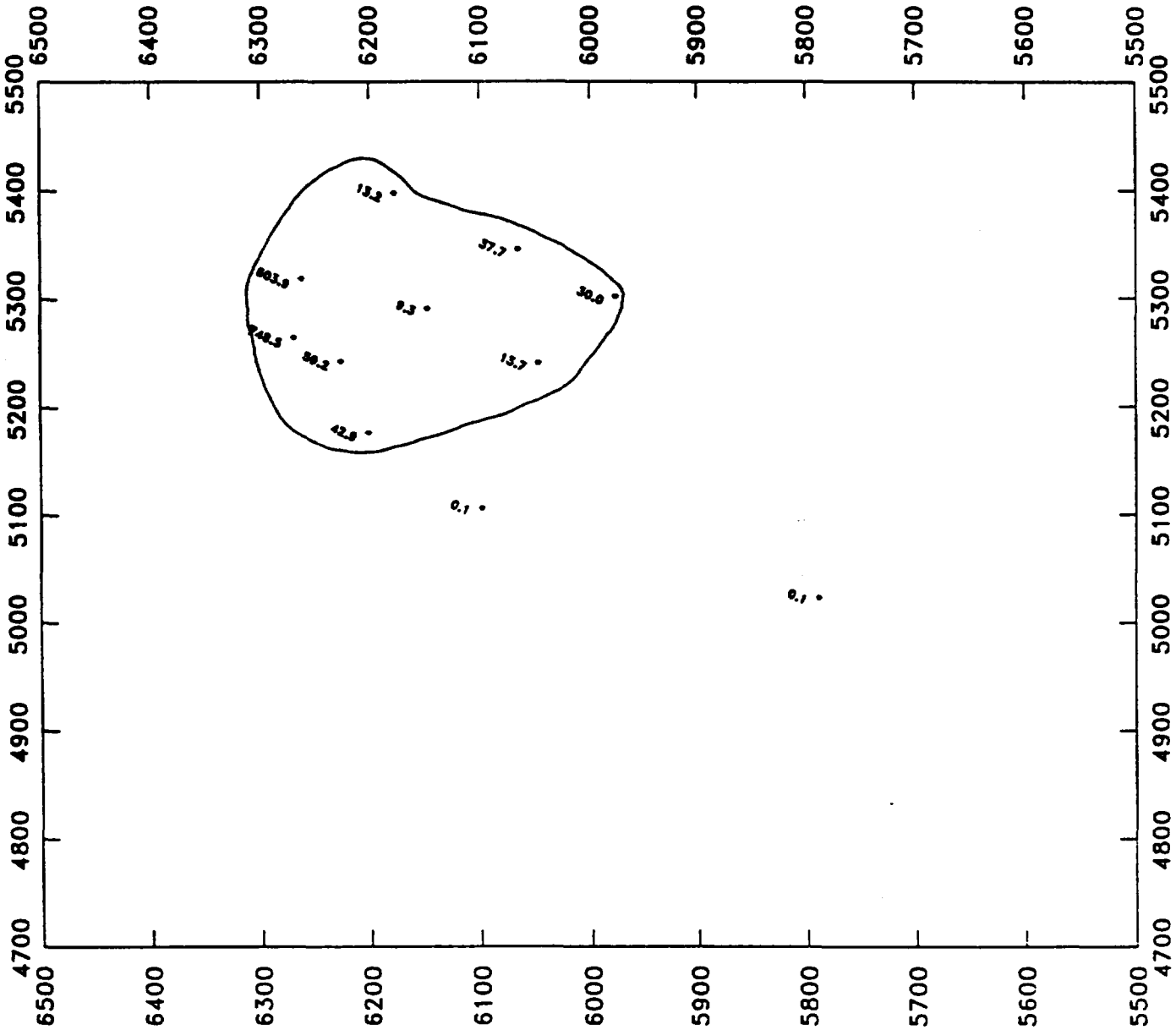



Figure 5-9f Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (19-24 feet below surface). Posted Values are in ppm (mg/kg).

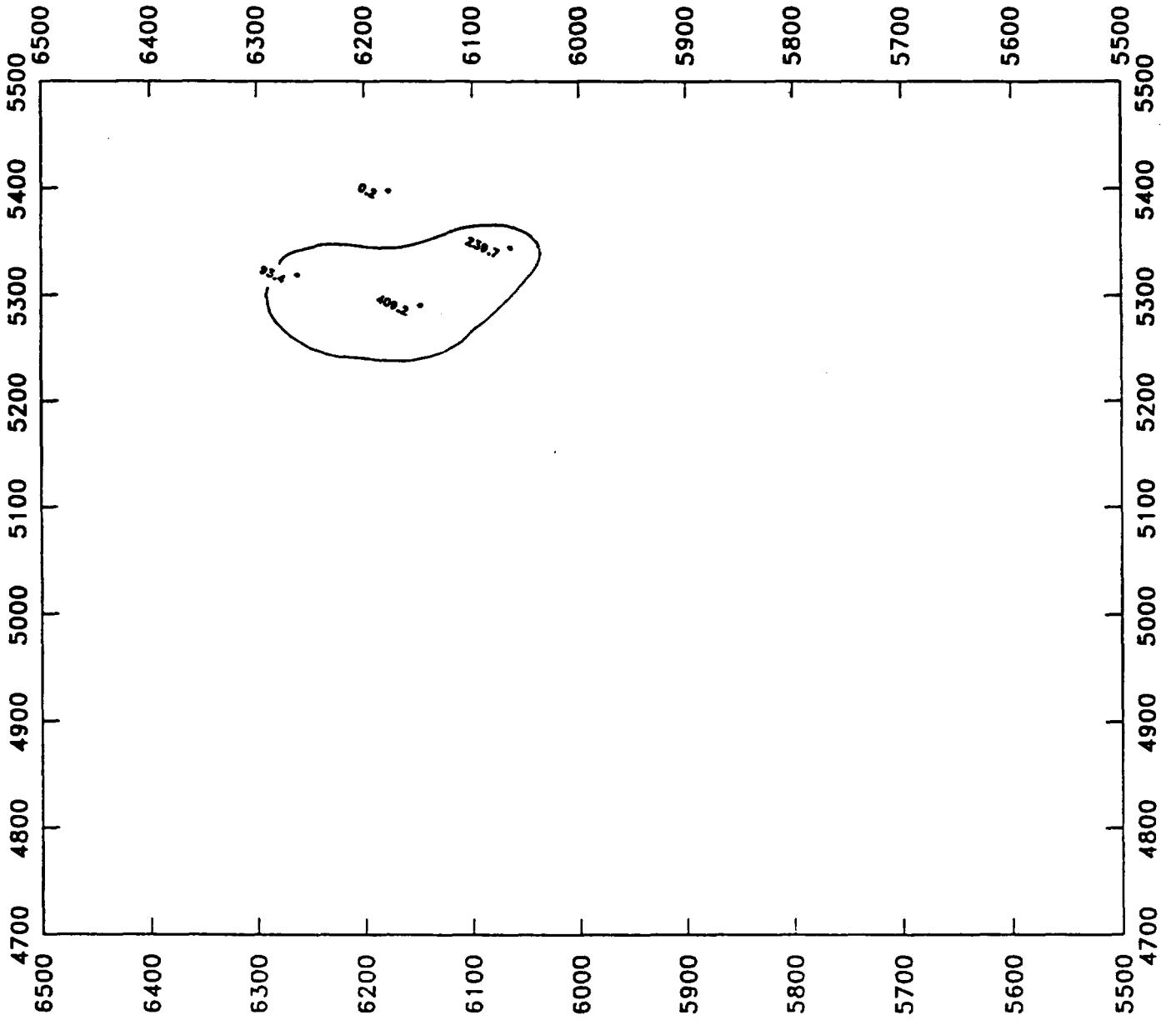



Figure 5-9g Approximate Extent of Total Volatile Wastes (> 1 ppm), Off-Site Areas (24-26 feet below surface). Posted Values are in ppm (mg/kg).

## LEGEND

| | |
|---|---|
| ---- | GEOPHYSICS INVESTIGATION AREA |
| SB-01 | SOIL BORING LOCATION & NUMBER |
| AP-01 | AUGER PROBE LOCATION & NUMBER |
| TP-1 | TEST PIT LOCATION & NUMBER |
| SA01 | SOIL AREA LOCATION & NUMBER |

## NOTES

1. INITIAL BASE MAP WAS DEVELOPED FOR CAMP DRESSER & MCKEE INC ON NOVEMBER 6, 1986. MAP HAS BEEN UPDATED FROM AN AERIAL PHOTOGRAPH OF THE SITE FLOWN ON NOVEMBER 3, 1989 BY GEONEX CHICAGO AERIAL SURVEY, INC. THE BASE MAP WAS UPDATED BASED ON THE AERIAL PHOTOGRAPH BY GEONEX.
2. VERTICAL DATUM IS USGS DATUM. CONTOUR INTERVAL IS (1) ONE FOOT.
3. SOIL BORINGS SB01 TO SB18 AND AUGER PROBES AP-1 TO AP-44 FOR PHASE I WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN AUGUST AND SEPTEMBER 1989.
4. SOIL BORINGS SB20 TO SB75 AND AUGER PROBES AP-45 TO AP-83 FOR PHASE II WERE DRILLED BY EXPLORATION TECHNOLOGY INC. (ETI) UNDER THE SUPERVISION OF WARZYN IN MAY AND JUNE 1990.
5. LOCATIONS FOR SOIL BORINGS WITH SAMPLING AND TEST PITS WERE FIELD LOCATED BY EWI ENGINEERING ASSOC. SURVEYORS.
6. LOCATIONS OF AUGER PROBES ARE APPROXIMATE.
7. SOIL BORING NUMBERS SB19 AND SB34 DO NOT EXIST.

north

0 150 300

SCALE IN FEET

FIGURE 5-10

Checked by JOD
Date 11/2/90
Revisions
Drawn by JC
Designed by
Approved by
© 1991 - Warzyn Engineering Inc. - All Rights Reserved

WARZYN
WARZYN ENGINEERING INC.

Date - By - Appvl.

TOTAL PCB's OFF-SITE BASE MAP

REMEDIAL INVESTIGATION
AMERICAN CHEMICAL SERVICES
NPL SITE
GRIFFITH, INDIANA

Project Number 60251 B24

WARZYN

MASTER BLUE PRINT INC. 818248

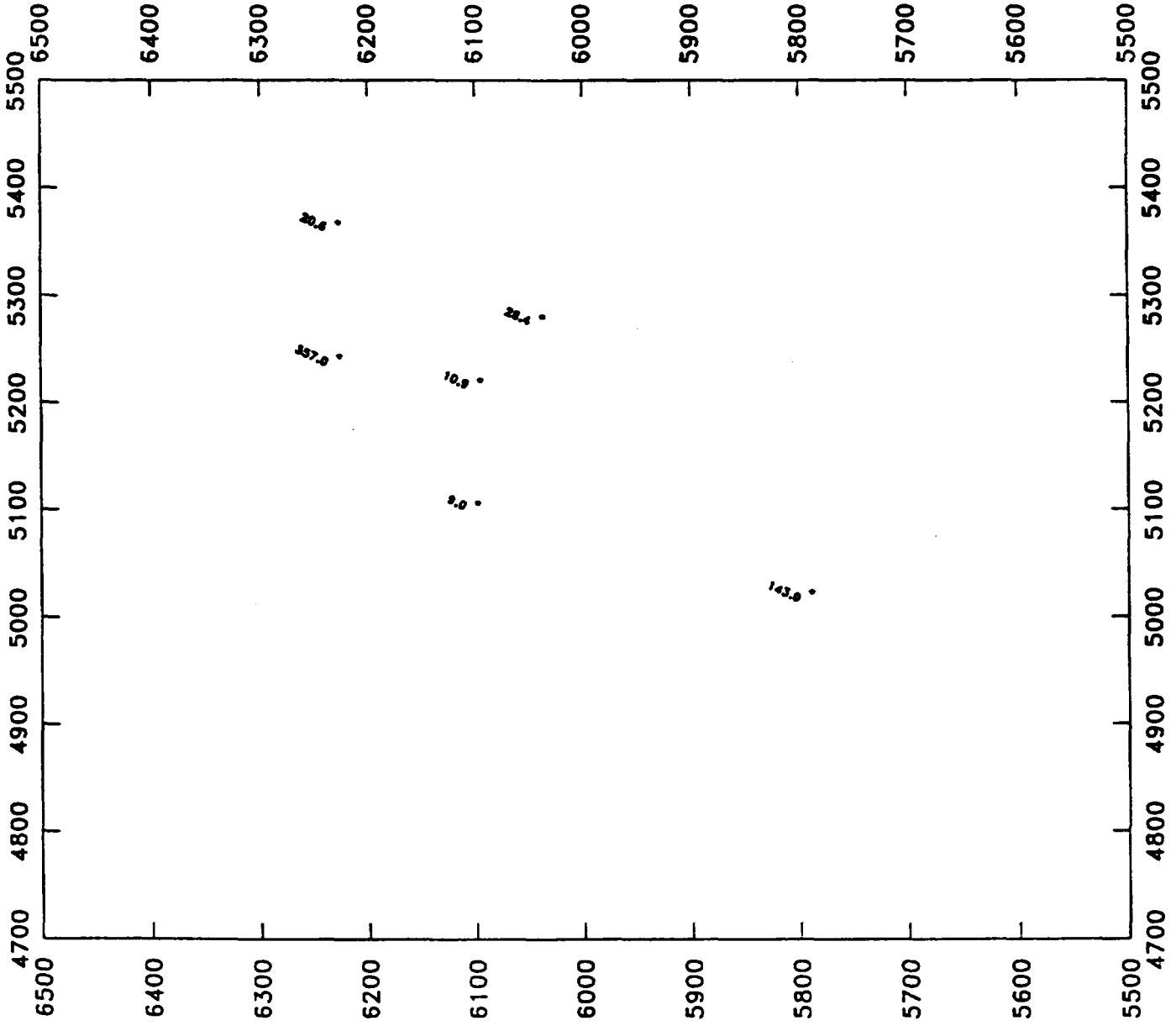



Figure 5-11e Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (15-23 feet below surface). Posted Values are in ppm (mg/kg).

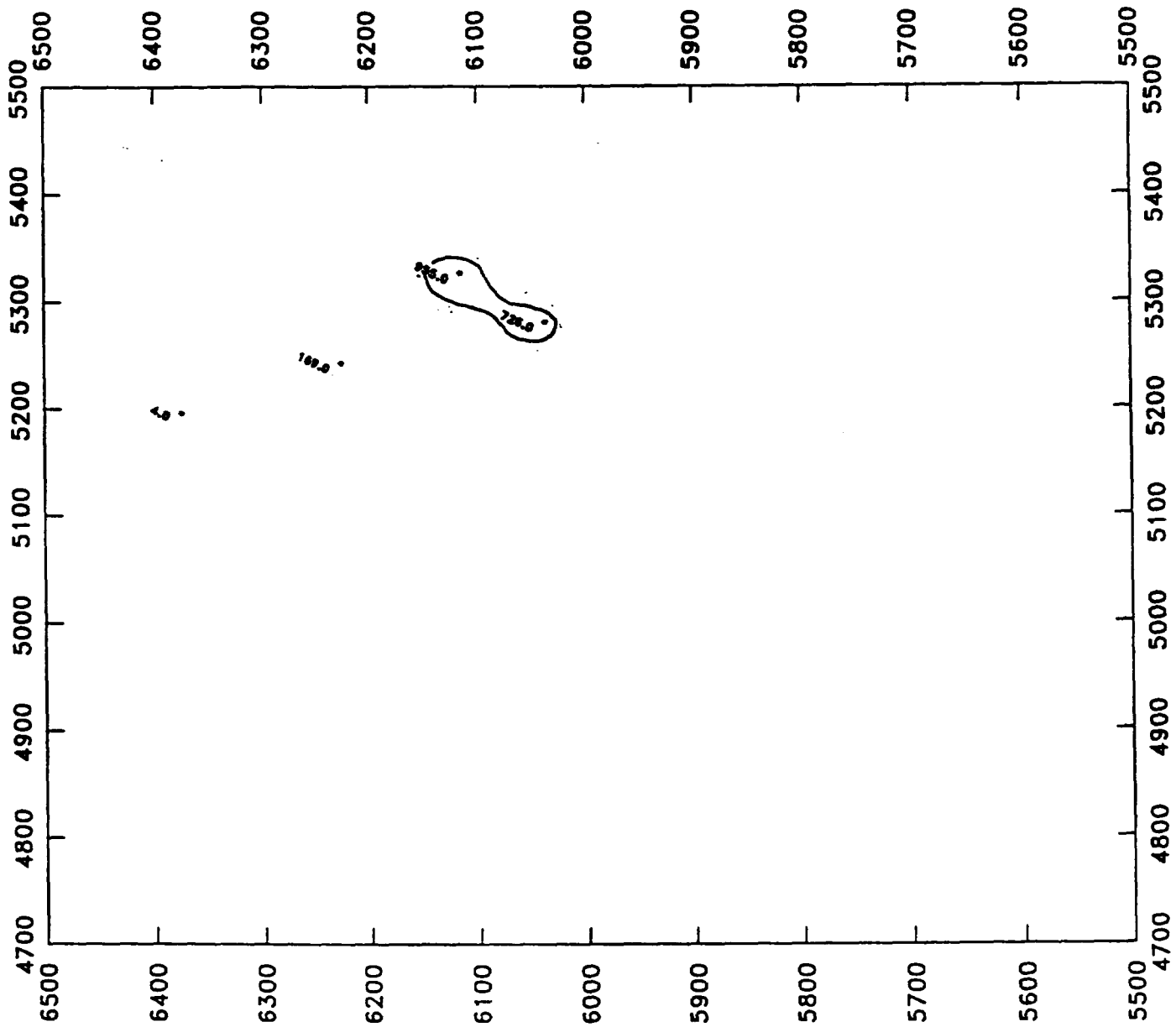



Figure 5-11d Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (10-15 feet below surface). Posted Values are in ppm (mg/kg).

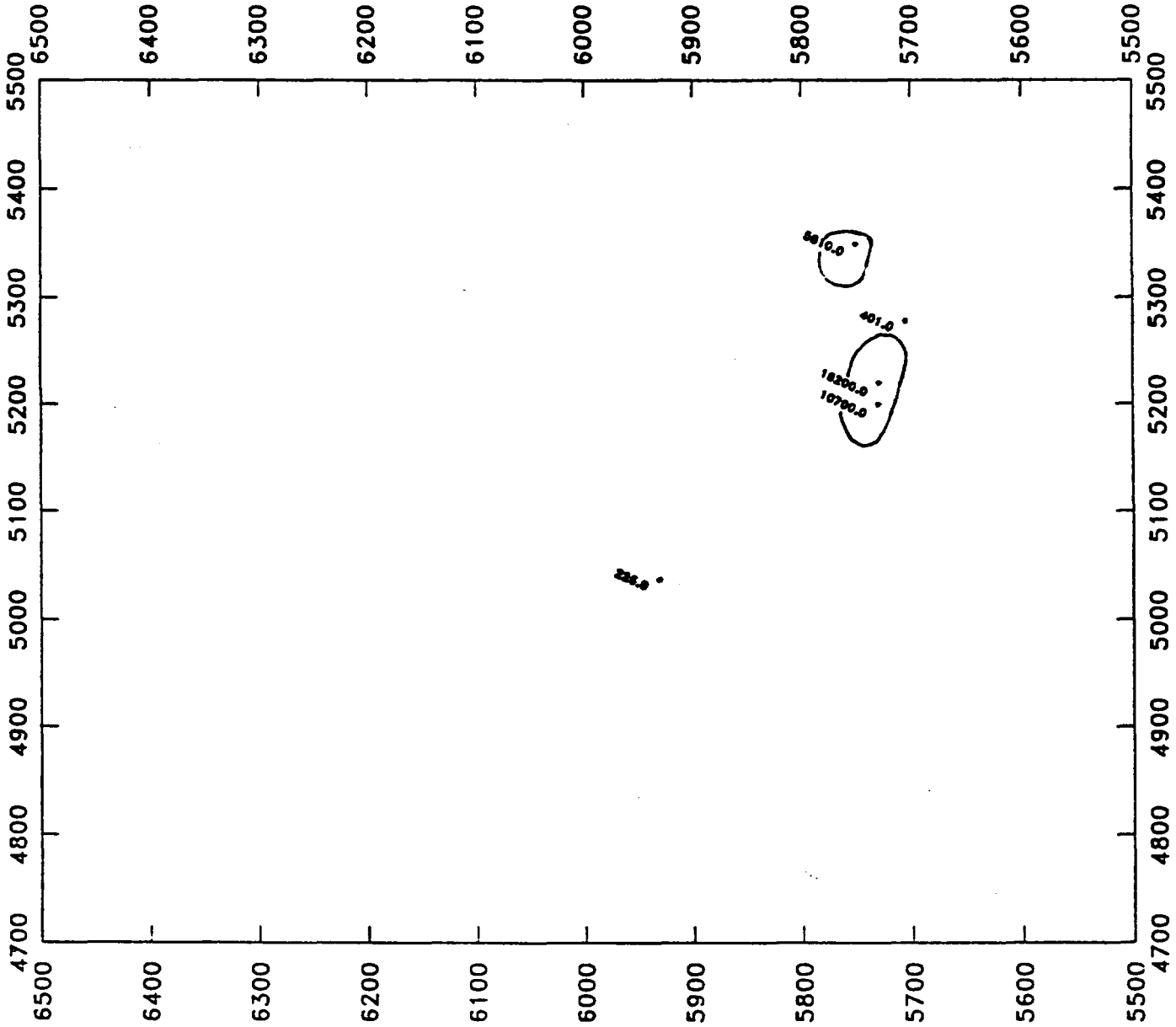



Figure 5-11a Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (1-4 feet below surface). Posted Values are in ppm (mg/kg).

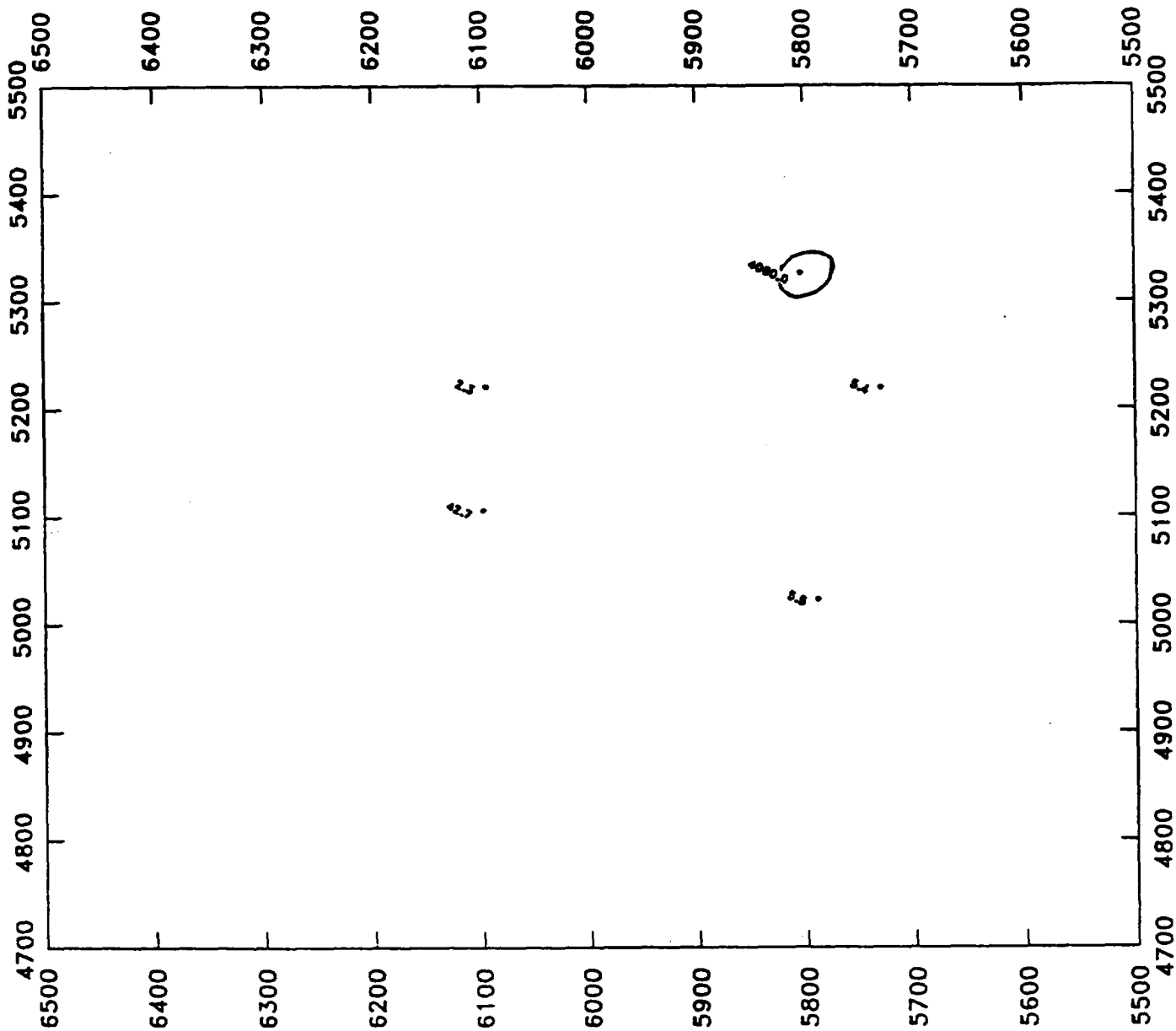



Figure 5-11b Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (4-7 feet below surface). Posted Values are in ppm (mg/kg).

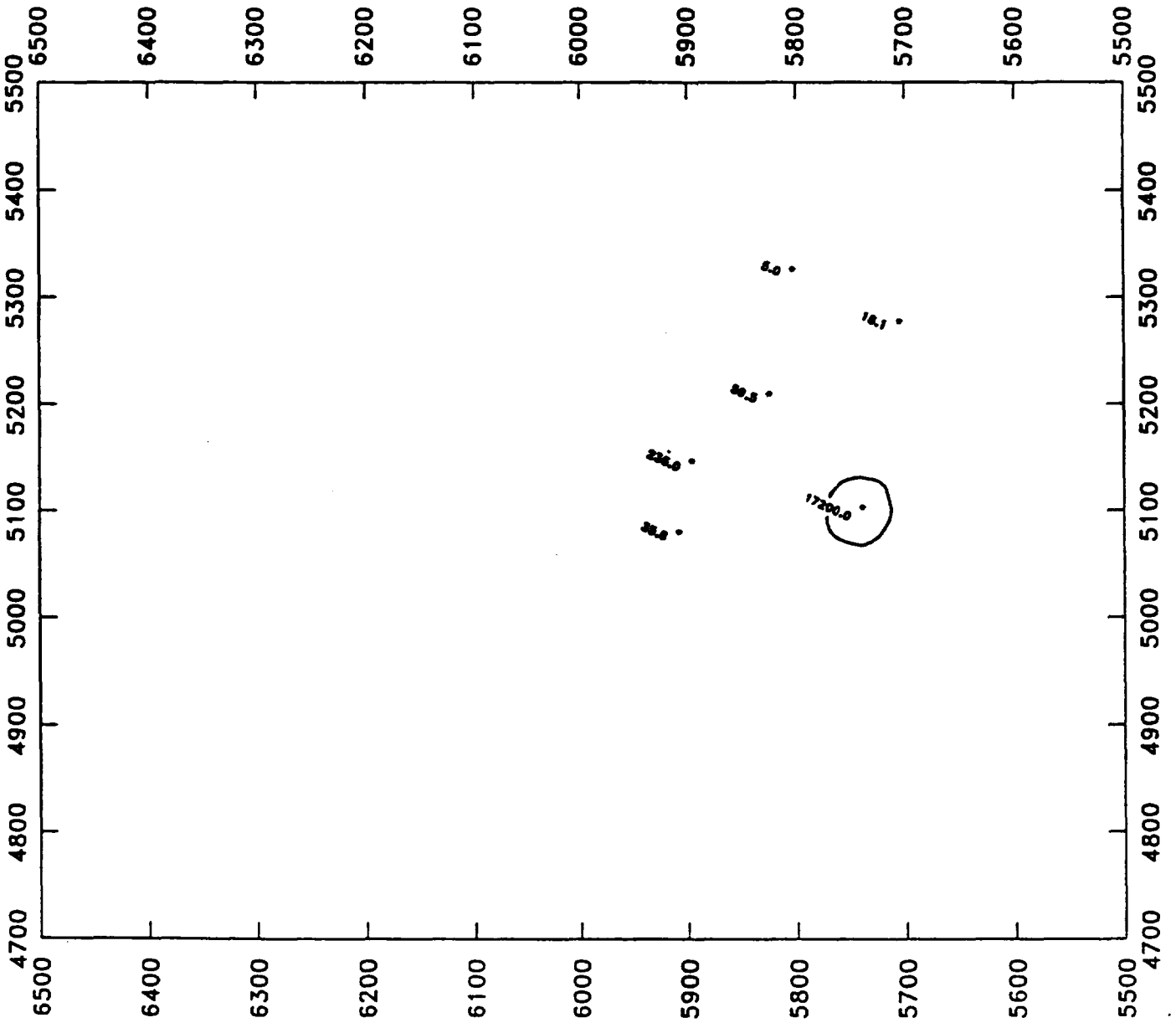
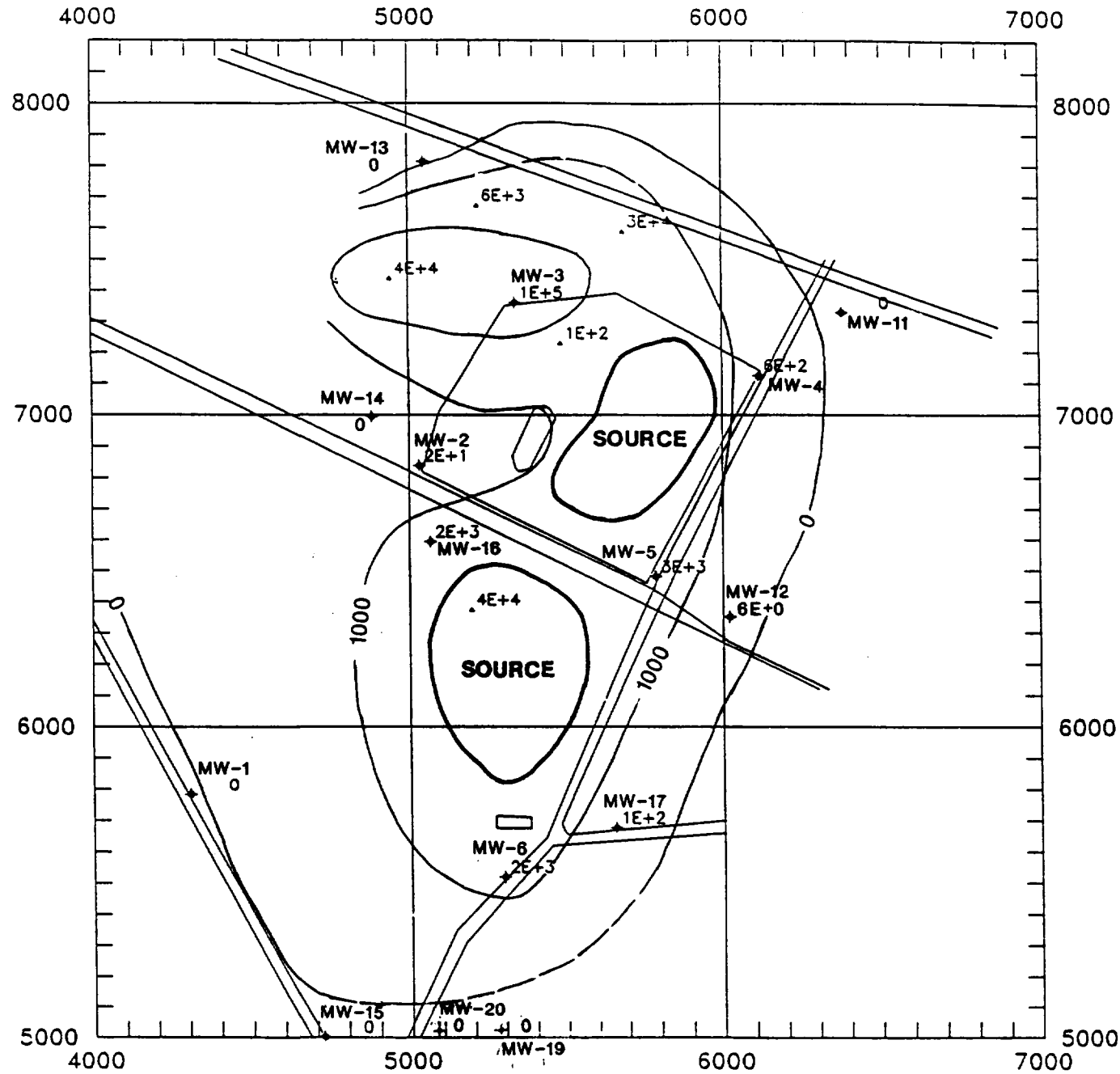



Figure 5-11c Approximate Extent of Lead Containing Wastes (> 500 ppm), Off-Site Areas (7-10 feet below surface). Posted Values are in ppm (mg/kg).




## LEGEND

- ◆ UPPER AQUIFER MONITORING WELL LOCATION
- ~ ISO-CONCENTRATION LINE
- ▲ AQUIFER MATRIX SAMPLE

## NOTES

1. SAMPLES WERE COLLECTED FROM MW-11, MW-12, MW13, MW-15, MW-19 AND MW-20 IN JANUARY 1991. ALL OTHER SAMPLES WERE COLLECTED DURING PHASE II OF THE INVESTIGATION.

north

0 500 1000

SCALE IN FEET

**FIGURE 5-12**

| | | | |
|---|---|---|---|
| WARZYN | UPPER AQUFER BETX DISTRIBUTION (ug/l) | Drawn DLL, TJM, JAW | Checked |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | App'd. PJH<br>Date 6/13/91<br>60251 A24 |

TELEDYNE POST

WARZYN

138

**Draft Report**
**Project No. 60251**

**Volume 2 of 5**
**Remedial Investigation Report**
**ACS NPL Site**
**Griffith, Indiana**

Prepared for:
**Steering Committee**
**ACS PRP Group**

Prepared by:
**Warzyn Inc.**
**Chicago, Illinois**

June 1991

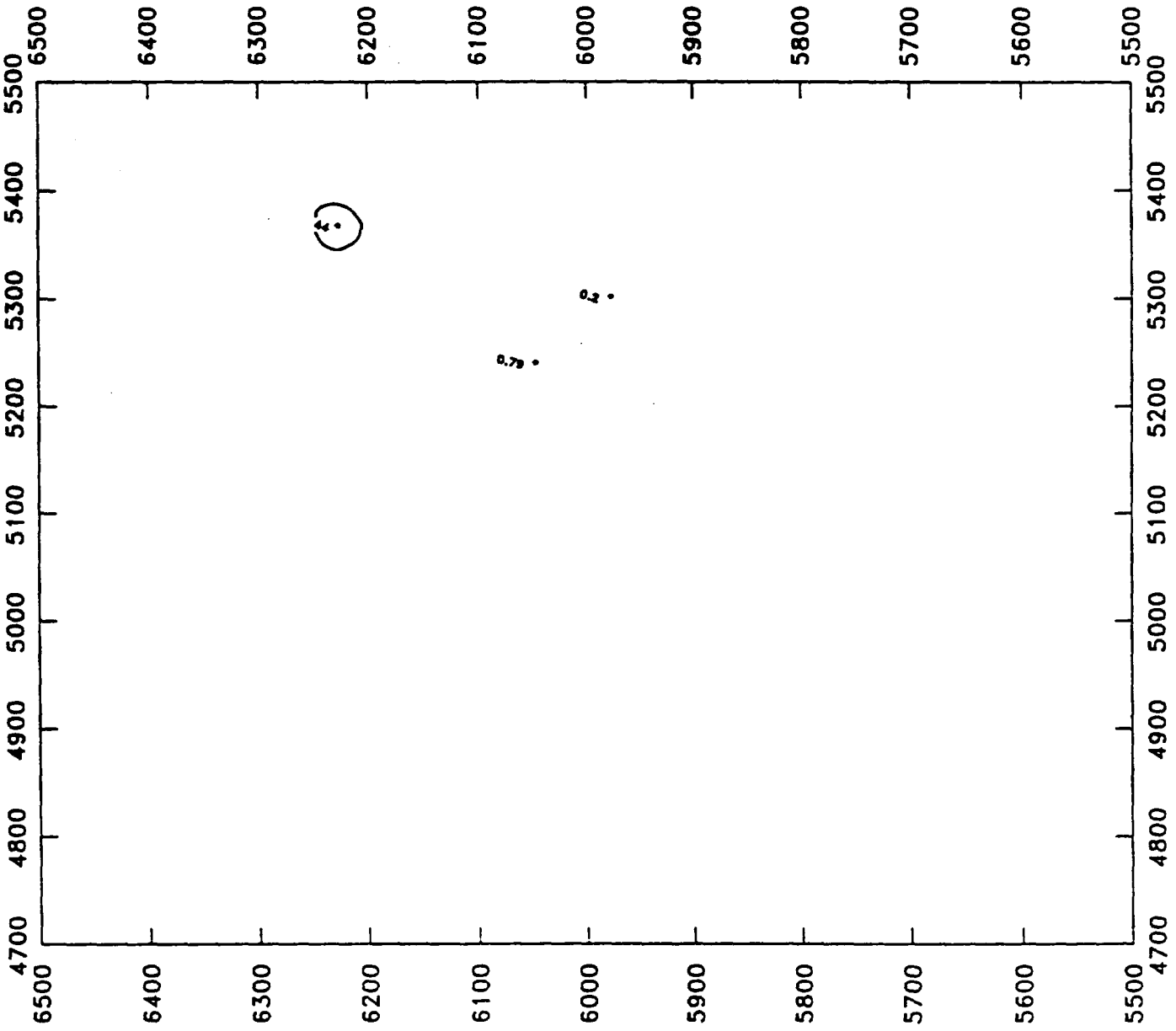



Figure 5-10f Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (17-20 feet below surface)

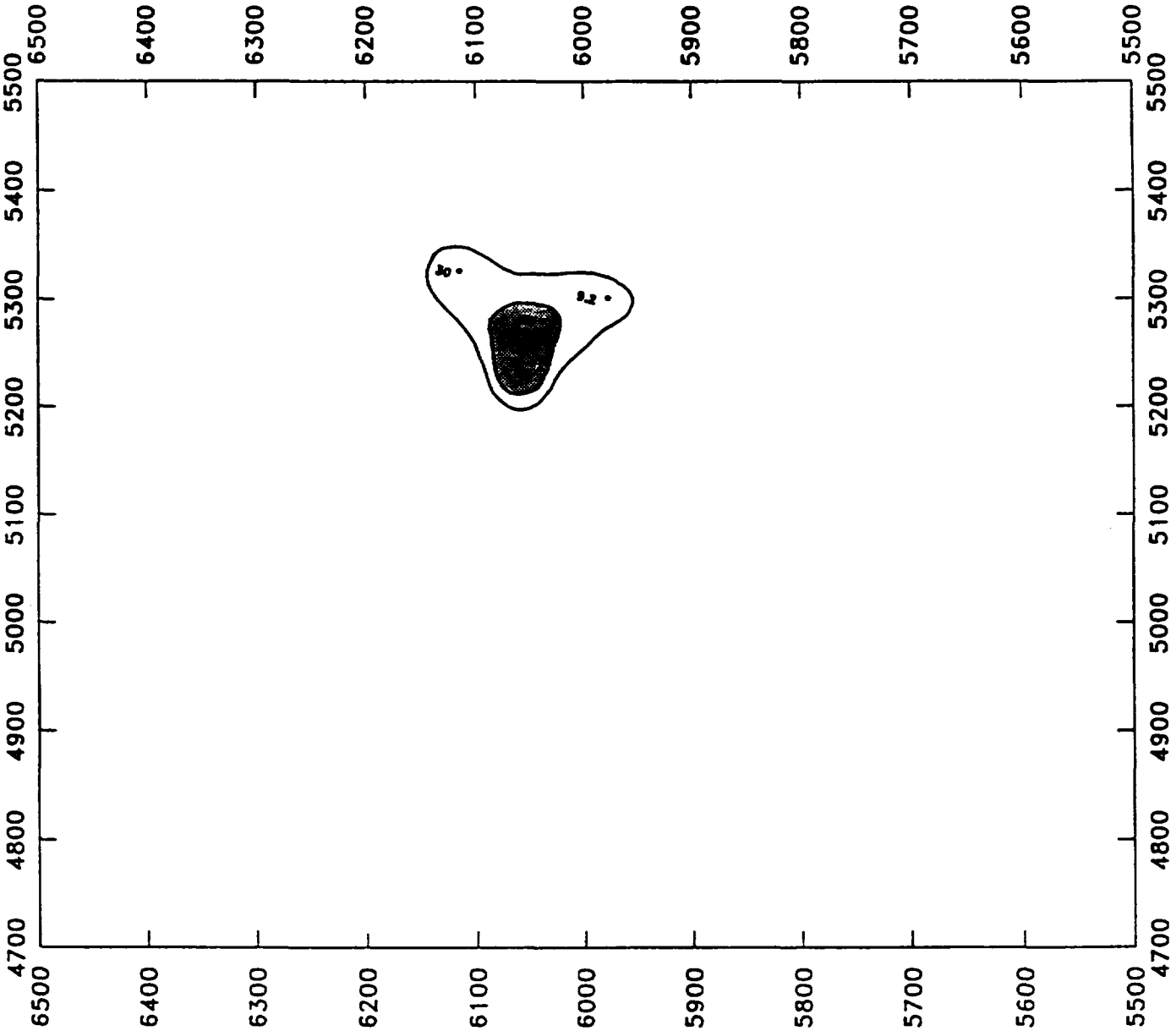



Figure 5-10e Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (12-17 feet below surface)

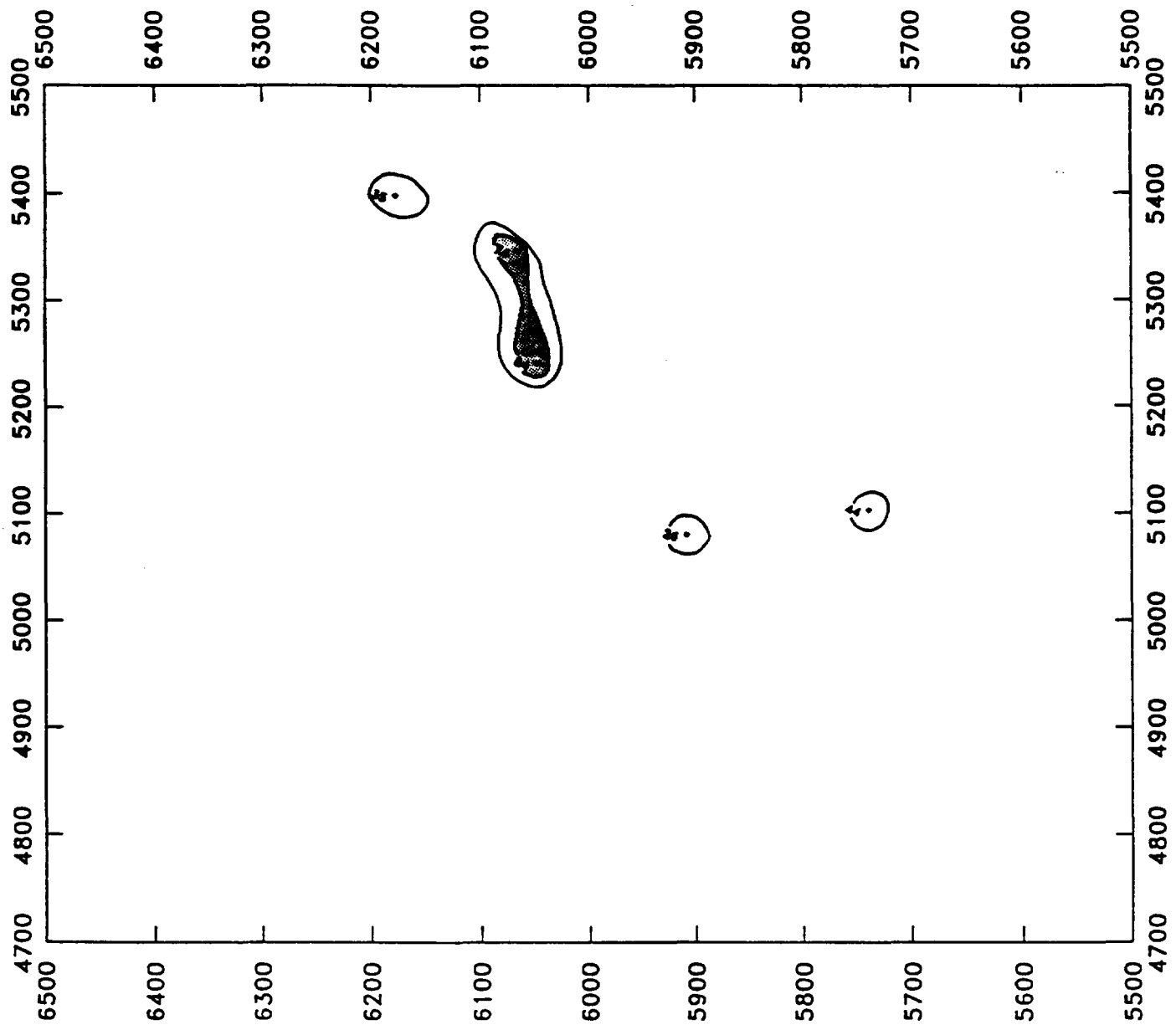



Figure 5-10d Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (8-12 feet below surface)

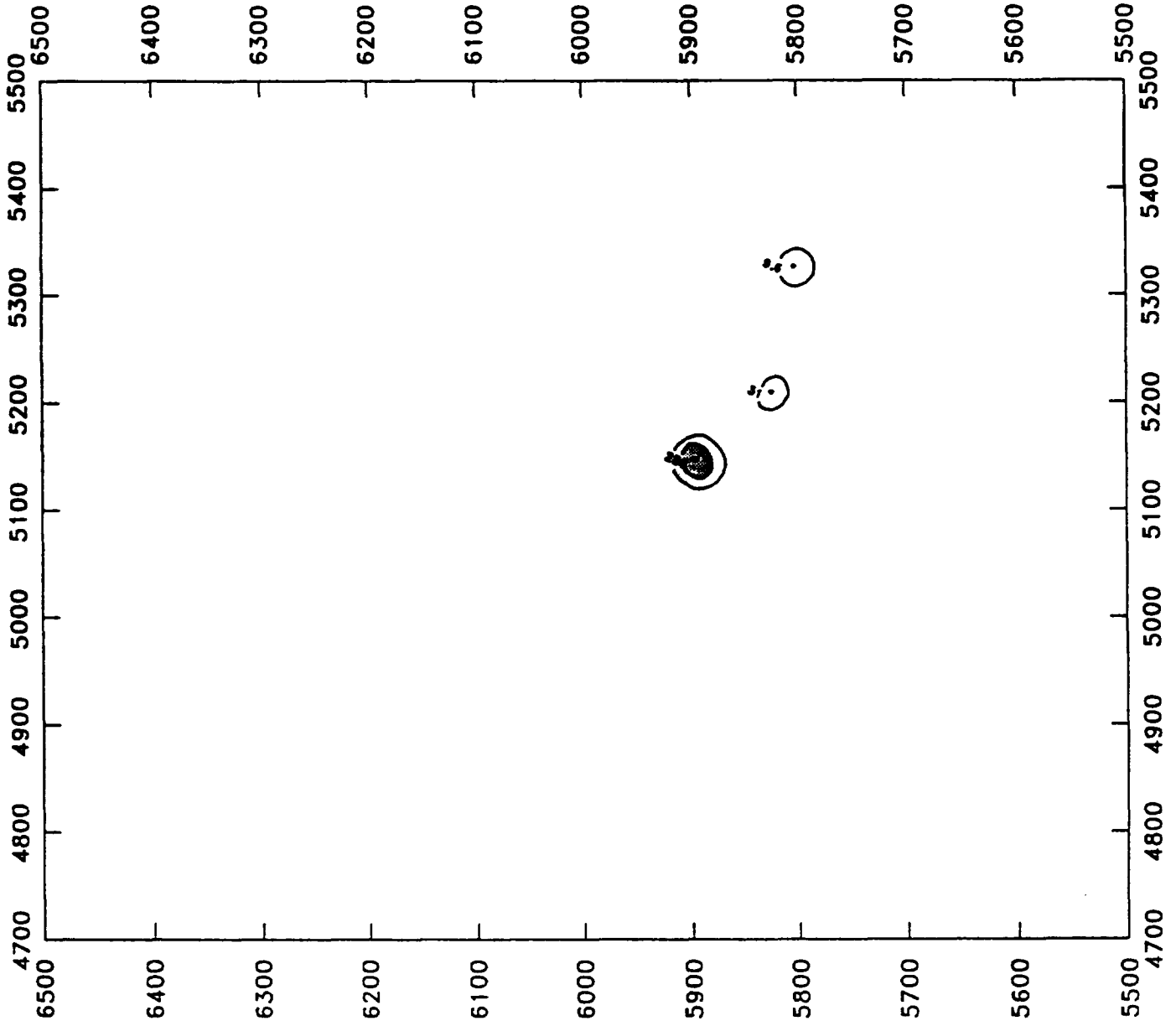



Figure 5-10c Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (6-8 feet below surface)

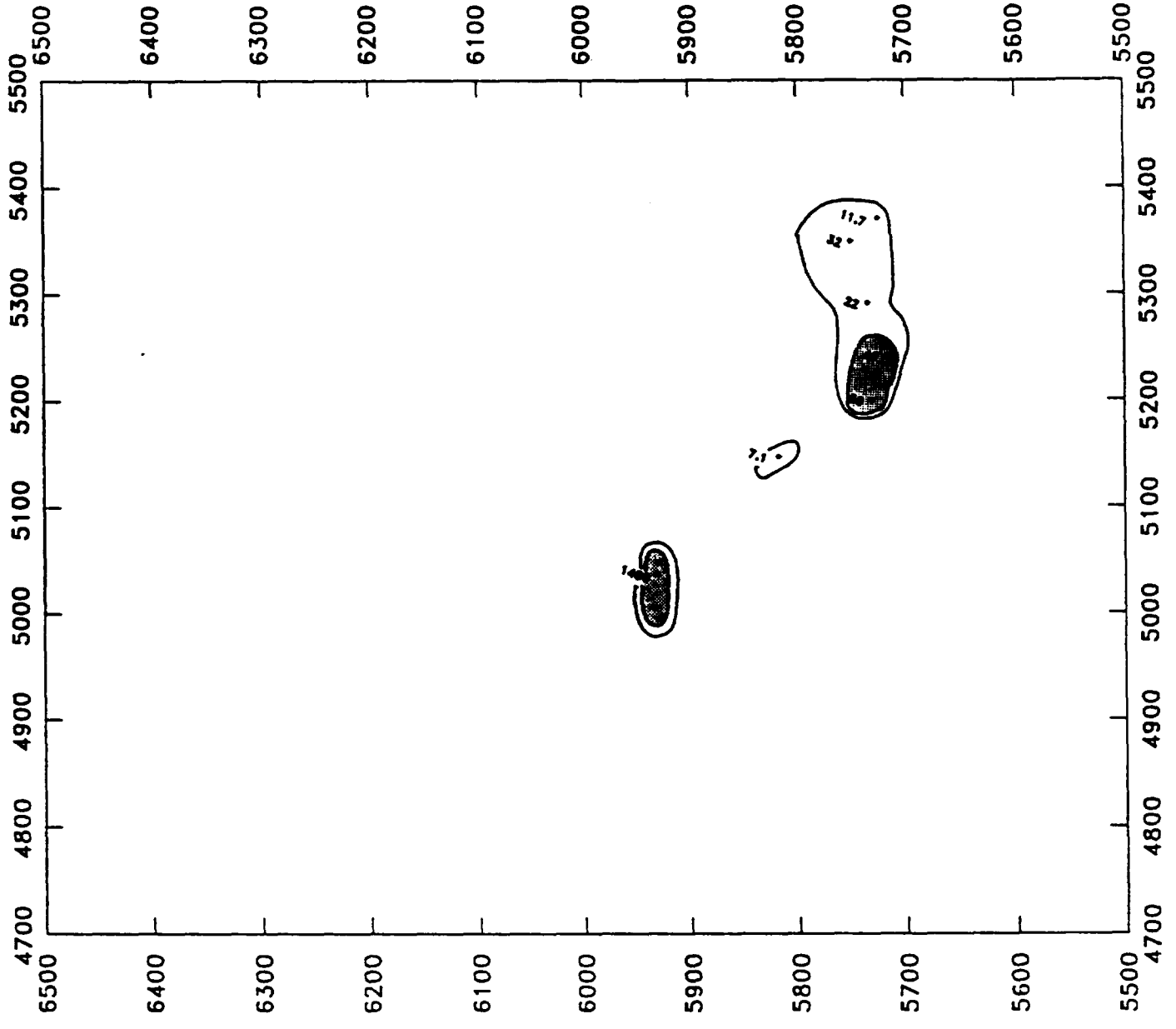



Figure 5-10a Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (0-3 feet below surface)

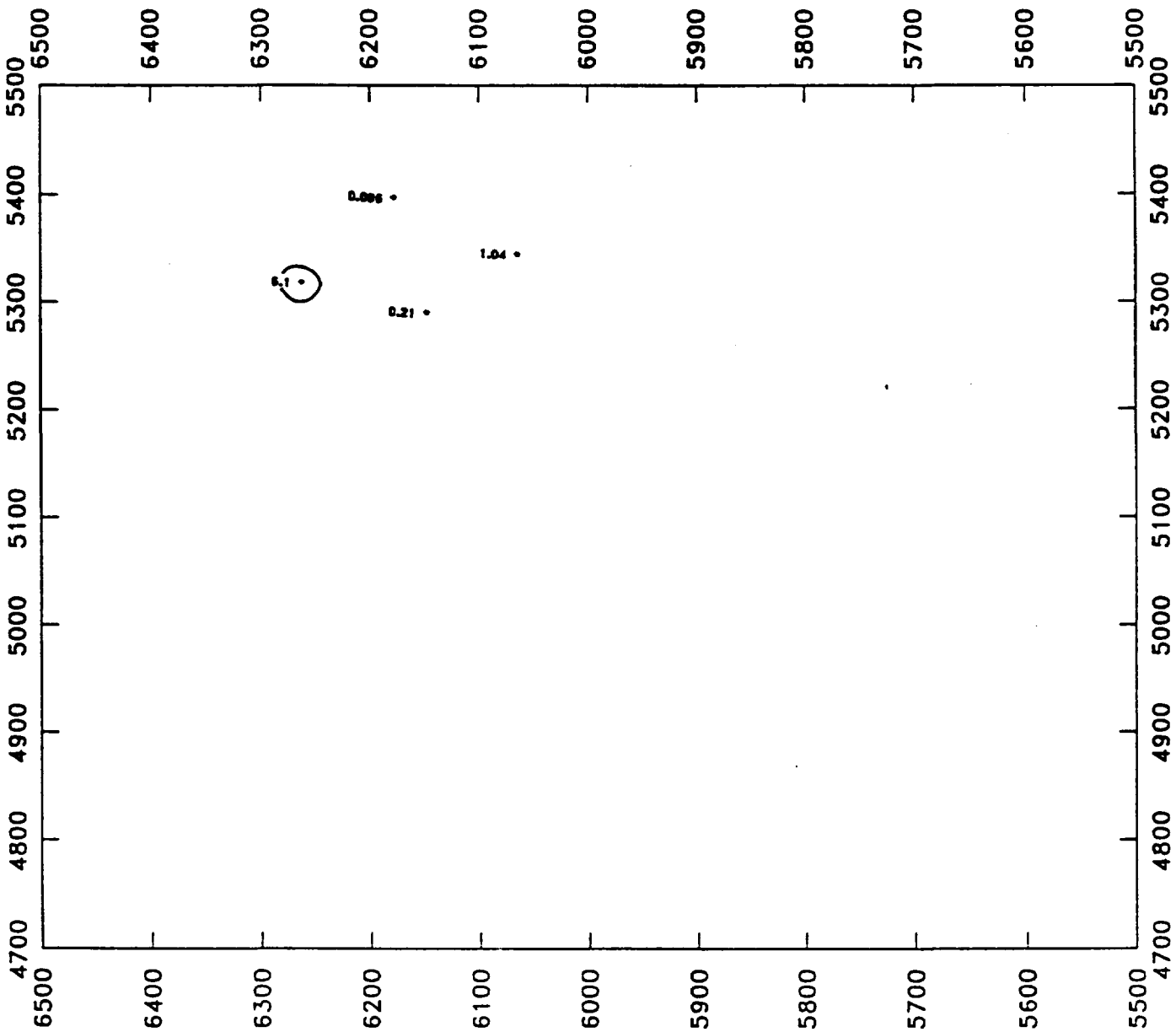
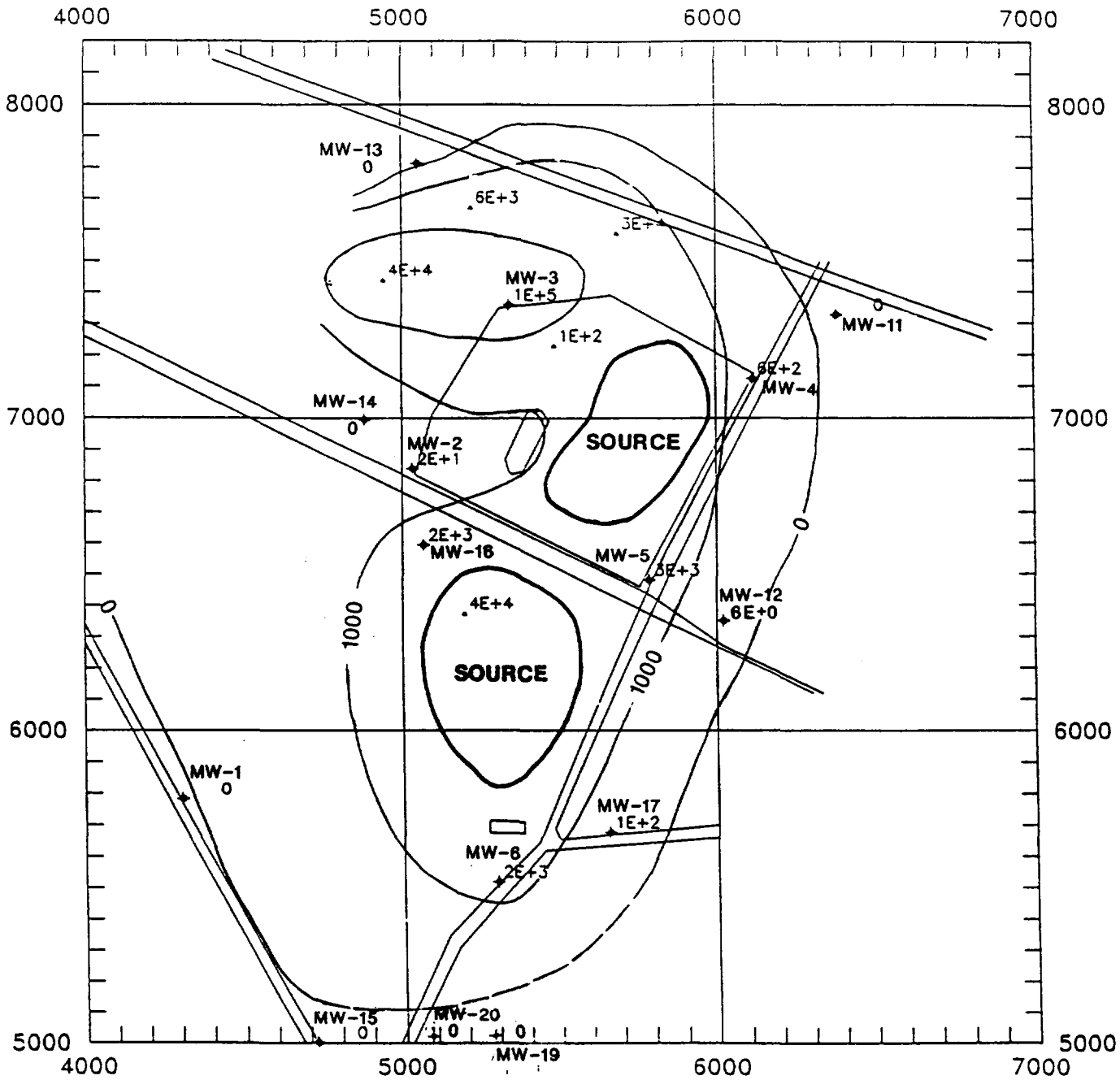



Figure 5-10g Approximate Extent of Total PCB Containing Wastes (> 1 ppm, shaded >50 ppm), Off-Site Areas (24-26 feet below surface)




## LEGEND

- ◆ UPPER AQUIFER MONITORING WELL LOCATION
- ~ ISO-CONCENTRATION LINE
- ▲ AQUIFER MATRIX SAMPLE

## NOTES

1. SAMPLES WERE COLLECTED FROM MW-11, MW-12, MW13, MW-15, MW-19 AND MW-20 IN JANUARY 1991. ALL OTHER SAMPLES WERE COLLECTED DURING PHASE II OF THE INVESTIGATION.

north

0 500 1000

SCALE IN FEET

**FIGURE 5-12**

| | | | |
|---|---|---|---|
| WARZYN | UPPER AQUIFER BETX DISTRIBUTION (ug/l) | Drawn DLL, TJM, JAW | Checked |
| | REMEDIAL INVESTIGATION<br>AMERICAN CHEMICAL SERVICES<br>NPL SITE<br>GRIFFITH, INDIANA | Revisions | App'd. [illegible] |
| | | | Date 6/13/91 |
| | | | 60251 A24 |

TELEDYNE POST