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EXECUTIVE SUMMARY

This report presents the results of the investigation performed by Parsons Engineering Science, Inc. (Parsons ES) at Bolling Air Force Base (AFB), District of Columbia to evaluate the use of intrinsic remediation (natural attenuation) with long-term monitoring (LTM) as a remedial option for dissolved benzene, toluene, ethylbenzene, and xylene (BTEX) contamination in the shallow saturated zone. Parsons ES conducted field investigations during August 1994 and June 1996 at the former Car Care Center Site (Building 41). The source of the contamination was leaking underground storage tanks and other associated equipment. BTEX and total volatile hydrocarbons (TVH) was determined to be dissolved in groundwater and adsorbed to soils. Residual light nonaqueous phase liquid (LNAPL) was found throughout the soil column, both above and below the groundwater interface. However, minimal mobile LNAPL (free product) was observed at the site during the field investigations. This study focused on the impact of the dissolved BTEX and residual LNAPL on the shallow groundwater system at the site. Potential electron acceptors were analyzed to quantify ongoing biodegradation. Site history and the results of soil and groundwater investigations conducted previously are also summarized in this report.

An important component of this study was an assessment of the potential for contamination in groundwater to migrate from the former Car Care Center Site (Building 41) to potential receptors. The Bioplume II model was used to estimate the rate and direction of dissolved BTEX movement through the shallow saturated zone under the influence of advection, dispersion, sorption, and biodegradation. Input parameters for the Bioplume II model were obtained from data collected by Parsons ES during August 1994. Extensive site-specific data were used for model calibration and implementation. Model parameters not measured at the site were either obtained from previous site characterization data or supplemented using established literature values for similar aquifer materials.

The groundwater sampling activities and analytical results from both the August 1994 and June 1996 sampling events suggest that natural attenuation mechanisms are occurring at the site. Fate and transport modeling results suggest that dissolved BTEX contamination present in groundwater poses no significant risk to human health or the environment in its present, or predicted future, concentration and distribution. The Air Force therefore recommends that intrinsic remediation with LTM be implemented for dissolved BTEX contamination found in groundwater at the former Car Care Center Site (Building 41). To enhance these natural processes, the Air Force also recommends installation of a soil vapor extraction (SVE) system. Under this treatment alternative, the Air Force Center for Environmental Excellence (AFCEE) will provide a specialized computer-controlled internal combustion engine (ICE) system to power the SVE system. The ICE system provides off-gas treatment due to the combustion process. Because the ICE system is costly to operate over extended time periods, the system would be converted to a bioventing system once BTEX concentrations in the soil gas are reduced.

FINAL
INTRINSIC REMEDIATION
ENGINEERING EVALUATION/COST ANALYSIS
FOR THE CAR CARE CENTER
at
BOLLING AIR FORCE BASE
WASHINGTON, D.C.

January 1997

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
TECHNOLOGY TRANSFER DIVISION
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3-4238

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY ES-1

SECTION 1 - INTRODUCTIO 1-1

1.1 Scope and Objectives 1-1
1.2 Facility Background 1-3
1.2.1 Operational History 1-3
1.2.2 Current Remedial Activities 1-7

SECTION 2 - SITE CHARACTERIZATION ACTIVITIES 2-1

2.1 Cone Penetrometry, Laser-Induced Fluorometry, and Soil Sampling Activities 2-5
2.1.1 Pre-Drilling Activities 2-5
2.1.2 Cone Penetrometry Procedures 2-5
2.1.3 Laser-Induced Fluorometry 2-6
2.1.4 Soil Sampling Procedures 2-8
2.1.5 Equipment Decontamination Procedu 2-9
2.2 Monitoring Point Installation and Monitoring ... evelopment 2-9
2.2.1 Well Locations and Completion Intervals 2-10
2.2.2 Groundwater Monitoring Point Installation Procedures 2-10
2.2.2.1 Monitoring Point Installation 2-10
2.2.2.2 Monitoring Point Development 2-11
2.2.2.3 Water Level Measurements 2-12
2.2.2.4 Well Location and Datum Survey 2-12
2.3 Groundwater Sampling 2-12
2.3.1 Groundwater Sampling Locations 2-13
2.3.1.1 Monitoring Well Sampling Locations 2-13
2.3.1.2 Monitoring Point Locations 2-13
2.3.2 Preparation for Sampling 2-14
2.3.2.1 Equipment Cleaning 2-14
2.3.2.2 Equipment Calibration 2-14
2.3.3 Sampling Procedures 2-14
2.3.3.1 Groundwater Monitoring Well and Monitoring Point Sampling 2-15
2.3.4 Onsite Chemical Parameter Measurement 2-16
2.3.4.1 Dissolved Oxygen Measurements 2-16
2.3.4.2 Reduction/Oxidation Potential Measurements 2-16
2.3.4.3 Temperature, pH, and Electric Conductance 2-16
2.3.5 Sample Handling 2-16
2.3.5.1 Sample Preservation 2-16

TABLE OF CONTENTS (Continued)

Page

2.3.5.2 Sample Container and Labels....2-16
2.3.5.3 Sample Shipment....2-17
2.4 Aquifer Testing....2-17

SECTION 3 - PHYSICAL CHARACTERISTICS OF THE STUDY AREA....3-1

3.1 Surface Features....3-1
3.1.1 Topography and Surface Water Hydrology....3-1
3.1.2 Manmade Features....3-1
3.2 Regional Geology and Hydrogeology....3-3
3.3 Site Geology and Hydrogeology....3-3
3.3.1 Lithology and Stratigraphic Relationships....3-4
3.3.2 Groundwater Hydraulics....3-4
3.3.2.1 Groundwater Flow Direction and Gradient....3-4
3.3.2.2 Hydraulic Conductivity....3-13
3.3.2.3 Advective Groundwater Velocity....3-13
3.3.3 Preferential Flow Paths....3-13
3.3.4 Groundwater Use....3-13
3.4 Climatological Characteristics....3-14

SECTION 4 - NATURE AND EXTENT OF CONTAMINATION AND SOIL AND GROUNDWATER GEOCHEMISTRY....4-1

4.1 Source of Contamination....4-1
4.2 Soil Chemistry....4-1
4.2.1 Residual Contamination....4-1
4.2.1.1 Soil BTEX Contamination....4-3
4.2.1.2 Soil TVH Contamination....4-7
4.2.2 Total Organic Carbon....4-7
4.3 Groundwater Chemistry....4-8
4.3.1 Dissolved Contamination....4-8
4.3.1.1 BTEX in Groundwater....4-8
4.3.2 Groundwater Geochemistry....4-17
4.3.2.1 Dissolved Oxygen....4-20
4.3.2.2 Nitrate/Nitrite....4-24
4.3.2.3 Ferrous Iron....4-29
4.3.2.4 Sulfate....4-34
4.3.2.5 Methane....4-38
4.3.2.6 Manganese....4-40
4.3.2.7 Reduction/Oxidation Potential....4-41
4.3.2.8 Alkalinity and Carbon Dioxide Evolution....4-41
4.3.2.9 pH....4-45
4.3.2.10 Temperature....4-45
4.3.3 Expressed Assimilative Capacity....4-45

TABLE OF CONTENTS (Continued)

Page

SECTION 5 - GROUNDWATER MODELING 1

5.1 General Overview and Model Description 5-1
5.2 Conceptual Model Design and Assumptions 5-2
5.3 Initial Model Setup 5-3
5.3.1 Grid Design and Boundary Conditions 5-3
5.3.2 Groundwater Elevation and Gradient 5-6
5.3.3 BTEX Concentrations 5-6
5.3.4 Electron Acceptors (Oxygen and Nitrate) 5-6
5.3.5 Anaerobic Degradation Rates 5-8
5.4 Model Calibration 5-9
5.4.1 Water Table Calibration 5-9
5.4.2 BTEX Plume Calibration 5-13
5.4.2.1 Discussion of Parameters Varied During Plume Calibration 5-14
5.5 Sensitivity Analysis 5-18
5.6 Model Results 5-23
5.6.1 No Source Removal (Model CAL2) 5-24
5.6.2 Twenty-Percent Annual Source Removal (Model SR20) 5-27
5.6.3 Thirty-Three-Percent Annual Source Removal (Model SR33) 5-27
5.6.4 Observed Contaminant Plume versus Model Predictions 5-32
5.7 Conclusions 5-32

SECTION 6 - COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES 6-1

6.1 Remedial Alternative Evaluation Criteria 6-1
6.1.1 Long-Term Effectiveness and Permanence 6-1
6.1.2 Implementability 6-2
6.1.3 Cost 6-2
6.2 Factors Influencing Alternatives Development 6-2
6.2.1 Program Objectives 6-2
6.2.2 Contaminant Properties 6-3
6.2.3 Site-Specific Conditions 6-4
6.2.3.1 Groundwater and Soil Characteristics 6-4
6.2.3.2 Potential Exposure Pathways 6-6
6.2.3.3 Remediation Goals for Shallow Groundwater 6-7
6.2.4 Summary of Remedial Technology Screening 6-8
6.3 Brief Description Of Remedial Alternatives 6-8
6.3.1 Alternative 1 - Passive Mobile LNAPL Removal, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring 6-14
6.3.2 Alternative 2 - Passive Mobile LNAPL Removal, Bioventing in the Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring 6-15

TABLE OF CONTENTS (Continued)

Page

6.3.3 Alternative 3 - Passive Mobile LNAPL Removal, Soil Vapor Extraction with Off-Gas Treatment, Bioventing in Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring 6-16
6.4 Evaluation Of Alternatives 6-17
6.4.1 Alternative 1 - Passive Mobile LNAPL Removal, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring 6-18
6.4.1.1 Effectiveness 6-18
6.4.1.2 Implementability 6-19
6.4.1.3 Cost 6-19
6.4.2 Alternative 2 - Passive Mobile LNAPL Removal, Bioventing in the Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring 6-21
6.4.2.1 Effectiveness 6-21
6.4.2.2 Implementability 6-21
6.4.2.3 Cost 6-22
6.4.3 Alternative 3 - Passive Mobile LNAPL Removal, Soil Vapor Extraction with Off-Gas Treatment, Bioventing in Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring 6-22
6.4.3.1 Effectiveness 6-22
6.4.3.2 Implementability 6-24
6.4.3.3 Cost 6-24
6.5 Recommended Remedial Approach 6-24

SECTION 7 - LONG-TERM MONITORING PLAN 7-1

7.1 Overview 7-1
7.2 Monitoring Networks 7-1
7.2.1 Long-Term Monitoring Wells 7-5
7.2.2 Point-of-Compliance Wells 7-5
7.3 Groundwater Sampling 7-5
7.3.1 Analytical Protocol 7-8
7.3.2 Sampling Frequency 7-8

SECTION 8 - CONCLUSIONS AND RECOMMENDATIONS 8-1

SECTION 9 - REFERENCES 9-1

TABLE OF CONTENTS (Continued)

APPENDICES

Appendix A - Boring Logs, Well Completion Diagrams, and Slug Test Results
Appendix B - Groundwater Elevation and LNAPL Thickness Data
Appendix C - Soil and Groundwater Analytical Data
Appendix D - Gridded Model Input and Calibration Results
Appendix E - Gridded Input Data and Bioplume II Model Output
Appendix F - Costing Worksheets and Present Worth Calculations

LIST OF TABLES

No.	Title	Page
2.1	CPT Activity and Well Completion Summary	2-2
3.1	Water Level Elevation Data	3-11
4.1	Fuel Hydrocarbon Compounds Detected in Soil	4-4
4.2	Fuel Hydrocarbon Compounds Detected in Groundwater	4-10
4.3	Groundwater Geochemical data	4-18
4.4	Expressed Assimilative Capacity of Site Groundwater	4-48
5.1	Bioplume II Model Input Parameters	5-10
5.2	Calculation of Retardation Coefficients	5-17
6.1	Point-of-Compliance Remediation Goals	6-9
6.2	Initial Technical Implementability Screening of Technologies and Process Options for Groundwater Remediation	6-10
6.3	Alternative 1 - Cost Estimate Passive Mobile LNAPL Removal, Intrinsic Remediation, and institutional Controls with Long-Term Groundwater Monitoring	6-20
6.4	Alternative 2 - Cost Estimate Passive Mobile LNAPL Removal, Bioventing in the Source Area, Intrinsic Remediation and Institutional Controls with Long-Term Groundwater Monitoring	6-23
6.5	Alternative 3 - Passive Mobile LNAPL Removal, Soil Vapor Extraction with Off-Gas Treatment, Bioventing in Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring	6-25
6.6	Summary of Present-Worth Analysis for Selected Remedial Alternatives	6-26
7.1	Long-Term Monitoring Analytical Protocol	7-2
7.2	Point-of-Compliance Monitoring Analytical Record	7-4

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

No.	Title	Page
1.1	Regional Location Map	1-4
1.2	Bolling AFB Site Map	1-5
1.3	Site Map	1-6
2.1	Sampling Locations	2-4
2.2	Schematic of Laser-Induced Fluorescence Cone Penetrometer Probe	2-7
3.1	Subsurface Utility Locations	3-2
3.2	Hydrogeologic Cross-Section Locations	3-5
3.3	Hydrogeologic Cross-Section A-A'	3-6
3.4	Hydrogeologic Cross-Section B-B'	3-7
3.5	Hydrogeologic Cross-Section C-C'	3-8
3.6	Potentiometric Surface Maps	3-10
4.1	Approximate Extent of LNAPL	4-2
4.2A	Shallow Soil Hydrocarbon Contamination	4-5
4.2B	Deep Soil Hydrocarbon Contamination	4-6
4.3	Total Dissolved BTEX Isopleth Map, January 1994	4-9
4.4	Total Dissolved BTEX Isopleth Maps	4-12
4.5	Cross-Section Location Map for Vertical Extent of Dissolved BTEX	4-13
4.6	Vertical Profile of Total BTEX Isopleth for Groundwater Cross-Section D-D'	4-14
4.7	Vertical Profile of Total BTEX Isopleth for Groundwater Cross-Section E-E'	4-15
4.8	Dissolved Oxygen Isopleth Maps	4-21
4.9	Vertical Profile of Dissolved Oxygen Isopleth for Groundwater Cross-Section D-D'	4-22
4.10	Vertical Profile of Dissolved Oxygen Isopleth for Groundwater Cross-Section E-E'	4-23
4.11	Nitrate + Nitrite (as Nitrogen) Isopleth Maps for Groundwater	4-26
4.12	Vertical Profile of Dissolved Nitrate Isopleth for Groundwater Cross-Section D-D'	4-27
4.13	Vertical Profile of Dissolved Nitrate Isopleth for Groundwater Cross-Section E-E'	4-28
4.14	Ferrous Iron Isopleth Maps for Groundwater	4-30
4.15	Vertical Profile of Dissolved Iron (Fe^{+2}) Isopleth for Groundwater Cross-Section D-D'	4-31
4.16	Vertical Profile of Dissolved Iron (Fe^{+2}) Isopleth for Groundwater Cross-Section E-E'	4-32
4.17	Sulfate Isopleth Maps for Groundwater	4-35
4.18	Vertical Profile of Dissolved Sulfate Isopleth for Groundwater Cross-Section D-D'	4-36
4.19	Vertical Profile of Dissolved Sulfate Isopleth Groundwater Cross-Section E-E'	4-37
4.20	Dissolved Manganese and Methane Isopleth Maps for Groundwater	4-39
4.21	Redox Potential Maps for Groundwater	4-42

TABLE OF CONTENTS (Continued)

LIST OF FIGURES (Continued)

No.	Title	Page
4.22	Vertical Profile of Redox Potential in Groundwater Cross-Section D-D'	4-43
4.23	Vertical Profile of Redox Potential in Groundwater Cross-Section E-E'	4-44
4.24	Carbon Species in Groundwater June 1996	4-46
5.1	Model Grid	5-4
5.2	Calibrated Potentiometric Surface Map	5-12
5.3	Calibrated and Observed Dissolved BTEX Plumes, August 1994	5-15
5.4	Plot of Total BTEX vs Distance Along Plume Centerline with Varying Hydraulic Conductivity (K)	5-19
5.5	Plot of Total BTEX vs Distance Along Plume Centerline with Varying Coefficient of Reaeration	5-20
5.6	Plot of Total BTEX vs Distance Along Plume Centerline with Varying Dispersivity	5-21
5.7	Plot of Total BTEX vs Distance Along Plume Centerline with Varying Retardation Coefficient (R)	5-22
5.8	Model Results, BTEX Concentrations, No Source Removal, T=20 Years	5-25
5.9	Model Results, BTEX Concentrations, No Source Removal, T=30 Years	5-26
5.10	Model Results, BTEX Concentrations, 20% Annual Source Removal, T=7 Yrs	5-28
5.11	Model Results, BTEX Concentrations, 20% Annual Source Removal, T=10 Yrs	5-29
5.12	Model Results, BTEX Concentrations, 33% Annual Source Removal, T=5 Yrs	5-30
5.13	Model Results, BTEX Concentrations, 33% Annual Source Removal, T=11 Yrs	5-31
5.14	Predicted and Observed Dissolved BTEX Plumes, 1996	5-33
7.1	Proposed Point-of-Compliance and Long-Term Monitoring Well Placement	7-6
7.2	Proposed Monitoring Well Completion Diagram	7-7

The Air Force recommends using four LTM wells to verify Bioplume II model predictions and to monitor long-term migration and degradation of dissolved BTEX. Also, three point-of-compliance (POC) monitoring wells are recommended to establish a compliance boundary for the site. In order to monitor effectiveness of the intrinsic remediation program, these wells should be sampled on a semiannual basis for at least 11 years. If the data collected during this period supports the anticipated effectiveness of intrinsic remediation, the sampling frequency can be reduced to once every year. The groundwater samples should be analyzed for BTEX compounds by USEPA Method SW8020. If BTEX concentrations in groundwater from the POC wells exceed the District of Columbia's target cleanup levels of 5 microgram per liter (µg/L) for benzene, 1,000 µg/L for toluene, 700 µg/L for ethylbenzene, or 10,000 µg/L for total xylenes, additional corrective actions may be required to remediate groundwater at the site.

SECTION 1

INTRODUCTION

Parsons Engineering Science, Inc. (Parsons ES) prepared this Engineering report to evaluate the use of intrinsic remediation (natural attenuation) for remediation of fuel-hydrocarbon-contaminated groundwater at the Car Care Center, Bolling Air Force Base (AFB), District of Columbia (DC). Previous investigations determined that gasoline had been released into the soil and shallow groundwater at the site. The main emphasis of the work described herein was to evaluate the potential for naturally occurring degradation mechanisms to reduce dissolved fuel-hydrocarbon concentrations in groundwater to levels that are protective of human health and the environment.

1.1 SCOPE AND OBJECTIVES

Parsons ES was retained by the United States Air Force Center for Environmental Excellence (AFCEE) to conduct site characterization and groundwater modeling in support of intrinsic remediation with long-term monitoring (LTM). Intrinsic remediation is a risk management strategy that relies on natural attenuation to control exposure to contaminants in the subsurface. The scope of work for this project involved the following tasks:

- Reviewing existing hydrogeologic data and soil and groundwater quality data for the site;
- Conducting supplemental site characterization activities to determine the nature and extent of soil and groundwater contamination and to collect geochemical data in support of intrinsic remediation;
- Developing a conceptual hydrogeologic model of the shallow saturated zone, including the current distribution of contaminants;
- Determining whether naturally occurring degradation processes are occurring in site groundwater;
- Designing and setting up the Bioplume II model for site hydrogeologic conditions;
- Performing sensitivity analyses with a range of model input parameters to ensure that several contaminant fate and transport scenarios are considered;
- Determining whether naturally occurring processes are sufficient to minimize benzene, toluene, ethylbenzene, and total xylene (BTEX) plume expansion so that

groundwater quality standards are met at a downgradient point of compliance (POC);

- Conducting a preliminary exposure pathway analysis for fuel hydrocarbon contamination in groundwater;
- Developing remedial action objectives (RAOs) and reviewing available remedial technologies;
- Using model results to recommend the most appropriate remedial option based on specific effectiveness, implementability, and cost criteria; and
- Providing a LTM plan that includes POC wells, and a sampling and analysis plan.

During August 1994, Parsons ES and the United States Army Corps of Engineers (USACE) performed site characterization activities for the intrinsic remediation investigation. The activities consisted of cone penetrometer testing (CPT) in conjunction with laser-induced fluorometry (LIF) using the USACE's cone penetrometer truck. Initially, site lithology using CPT, and the extent of the light nonaqueous liquid (LNAPL) plume using LIF, were determined during concurrent pushes. These data determined the need for additional groundwater sampling locations. Permanent and temporary monitoring points then were installed to characterize the site hydrogeology and groundwater geochemistry and to further define the contaminant plume. Parsons ES then performed groundwater, LNAPL, and soil sampling activities utilizing the previously existing wells and newly installed monitoring points.

Bioplume II and site-specific data were used to develop a contaminant fate and transport model for the site. Using the results of the model, a preliminary exposure pathway analysis was performed. As part of the Engineering Evaluation/Cost Analysis (EE/CA), this modeling effort had three primary objectives: 1) to predict the future extent and concentration of a dissolved contaminant plume by modeling the combined effects of advection, dispersion, sorption, and biodegradation; 2) to assess the possible risk to potential downgradient receptors; and 3) to provide technical support during regulatory negotiations for intrinsic remediation with LTM, as appropriate.

Several remedial options were evaluated during this EE/CA, including mobile LNAPL removal, groundwater extraction and treatment (i.e., pump and treat), soil vapor extraction (SVE), bioventing, biosparging, and natural contaminant attenuation with LTM. Hydrogeologic and groundwater chemical data necessary to evaluate the various remedial options were collected under this program. However, the field work conducted under this program was oriented toward the collection of hydrogeologic data to be used as input into Bioplume II and to support intrinsic remediation.

This report contains nine sections, including this introduction, and six appendices. Section 2 summarizes site characterization activities. Section 3 summarizes the physical characteristics of the study area. Section 4 describes the nature and extent of soil and groundwater contamination and the geochemistry of soil and groundwater at the site. Section 5 describes the conceptual model developed for the site, Bioplume II model assumptions and input parameters, sensitivity analyses, model output, and the

results of the Bioplume II modeling. Section 6 describes remedial alternatives evaluation criteria and presents a comparative analysis of selected options. Section 7 presents the LTM plan for the site. Section 8 presents the conclusions of this work and provides recommendations for further work at the site. Section 9 lists the references used to develop this document. Appendix A contains boring logs and well completion diagrams. Appendix B presents groundwater elevation and LNAPL thickness data. Appendix C contains soil and groundwater analytical results. Appendix D contains gridded model input parameters and model calibration results. Appendix E contains a diskette of the Bioplume model input and output data in ASCII format. Appendix F contains the costing worksheets and present worth calculations developed during the comparative analysis of selected remedial options.

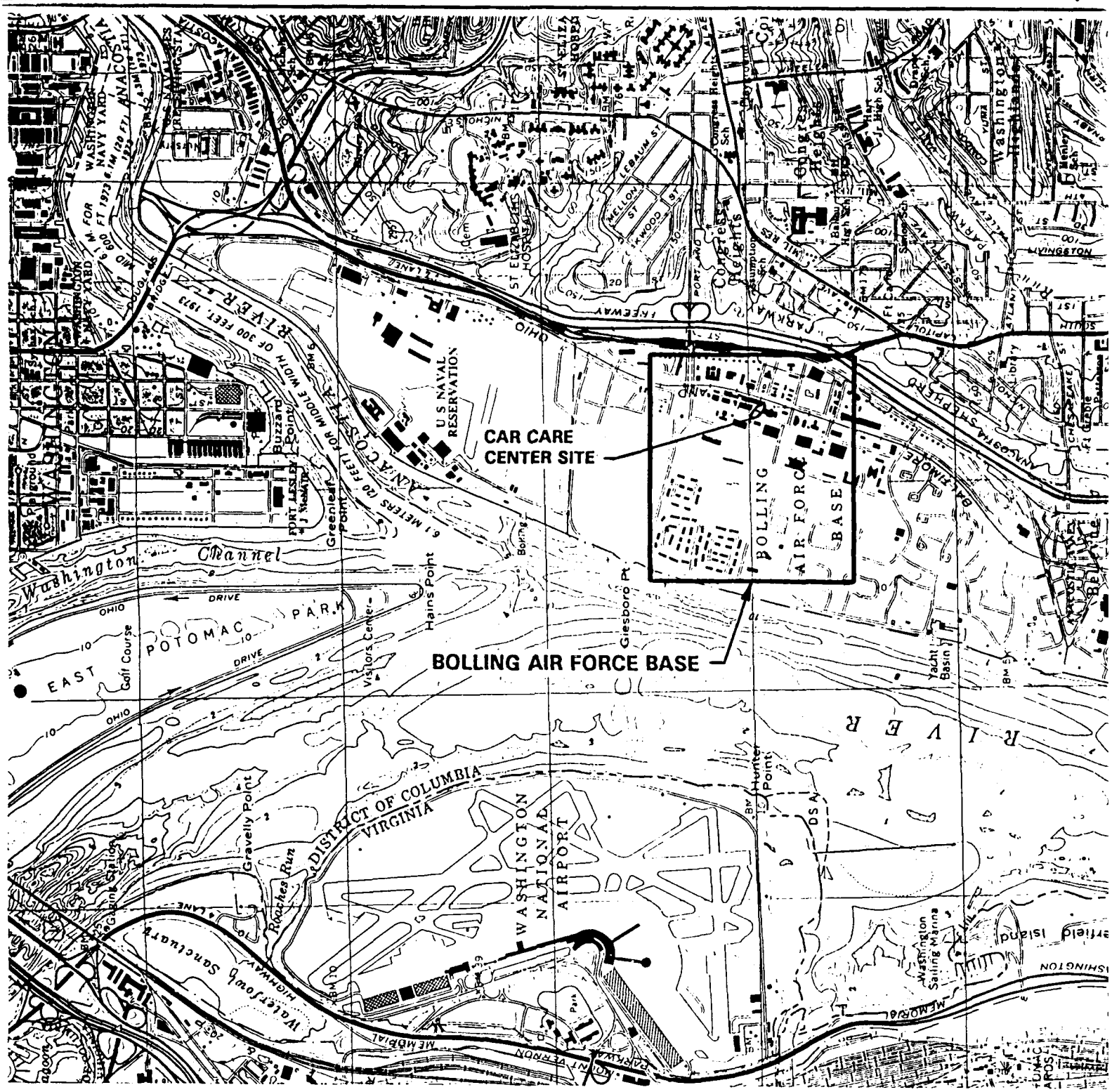
1.2 FACILITY BACKGROUND

Bolling AFB is located at 38° 51'N latitude, 77° 01'W longitude in the inner margin of the Atlantic Coastal Plain Physiographic Province. The base is located in the southern portion of Washington, DC near the confluence of the Potomac and the Anacostia Rivers. The Car Care Center, Building 41 (ST-04), is located on the eastern side of Bolling AFB approximately 2,500 feet east of the Potomac River. Bolling AFB comprises approximately 620 acres of land including annexes, easements, and leased property. Most of the area surrounding Bolling AFB is highly developed urban properties. Bolling AFB is bordered on the north by Anacostia Naval Air Station. The southern property line is bordered by the Navy's Bellevue Housing Annex and the Naval Research Laboratory. The apparent groundwater flow direction is toward the Potomac River. Figure 1.1 is a regional location map showing the position of Bolling AFB relative to the surrounding area.

For the purposes of the work described herein, the Car Care Center Site at Building 41 (ST-04) includes the property of the Car Care Center, and the adjacent properties that contain monitoring wells. This area includes Building 13, Building 503, Building 518, and the parking lot across Brookley Avenue. The following sections describe the previous and current uses of the Car Care Center Site. Figure 1.2 is a site map showing the Car Care Center Site and surrounding features of the base.

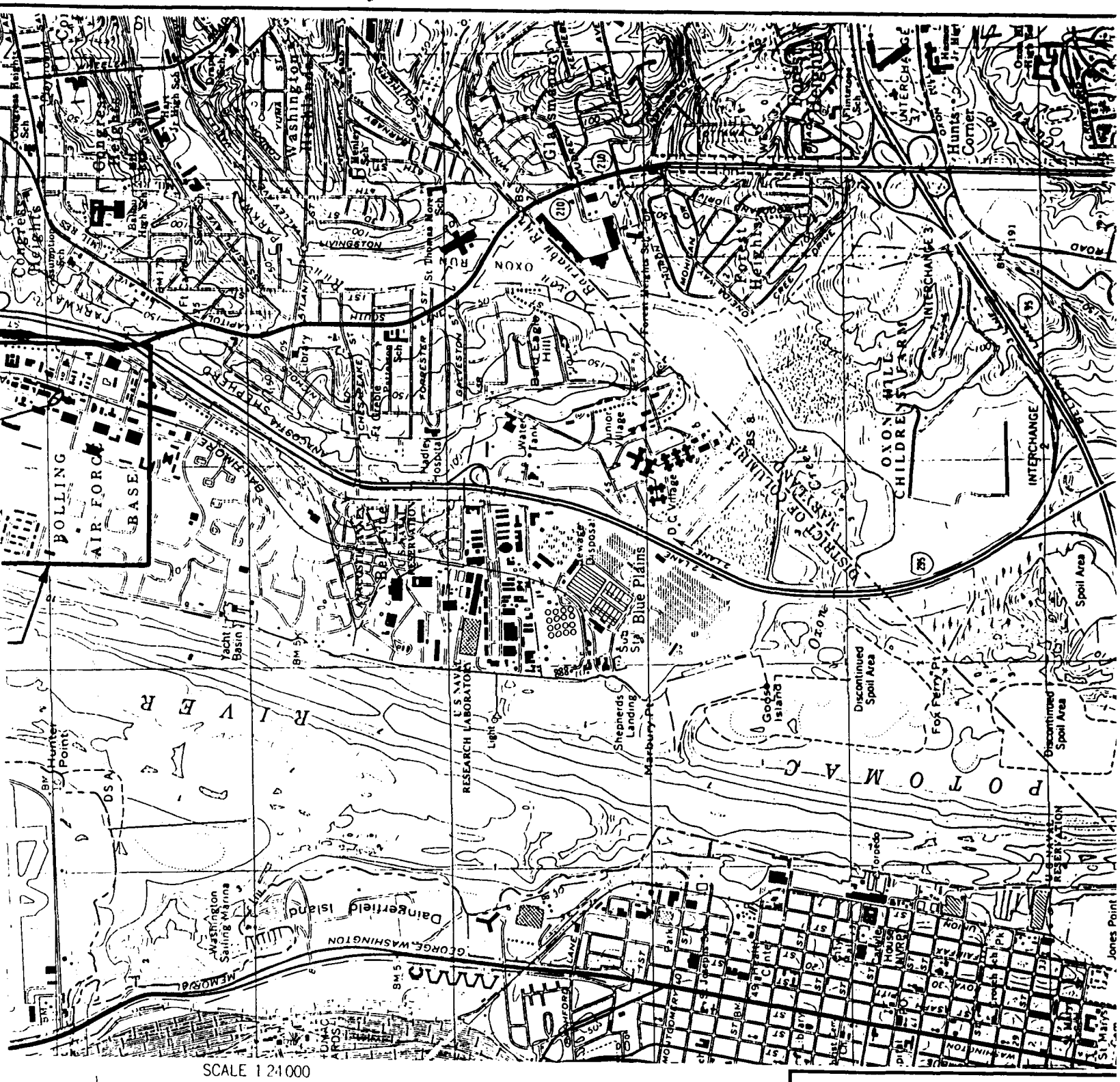
1.2.1 Operational History

The Car Care Center served as an auto repair and fueling facility for Bolling AFB from 1936 to 1982. It ceased gasoline fueling operations in 1982 (Baker, 1994) when the site's underground storage tanks (USTs) were taken out of service. At the time of this remedial investigation, the facility provided automobile maintenance services as its primary function. The Car Care Center recently moved to a new location on the Base. As a result, the Car Care Center Site is no longer functioning as a service station. The Car Care Center (Building 41) utilized several USTs for the storage of gasoline and waste oils. Two former 12,000-gallon gasoline USTs located near the southeast corner of the Car Care Center facility (Figure 1.3) were removed in 1983. The remaining 12,000-gallon gasoline UST was located near the northeast corner of the facility. Baker Environmental, Inc. removed this UST during the week of 8 August 1994. Four 275-gallon USTs were used on the property for the storage of waste oils. The waste oil USTs were abandoned in place during the early 1980s and removed in 1995.



Source: USGS, 1982

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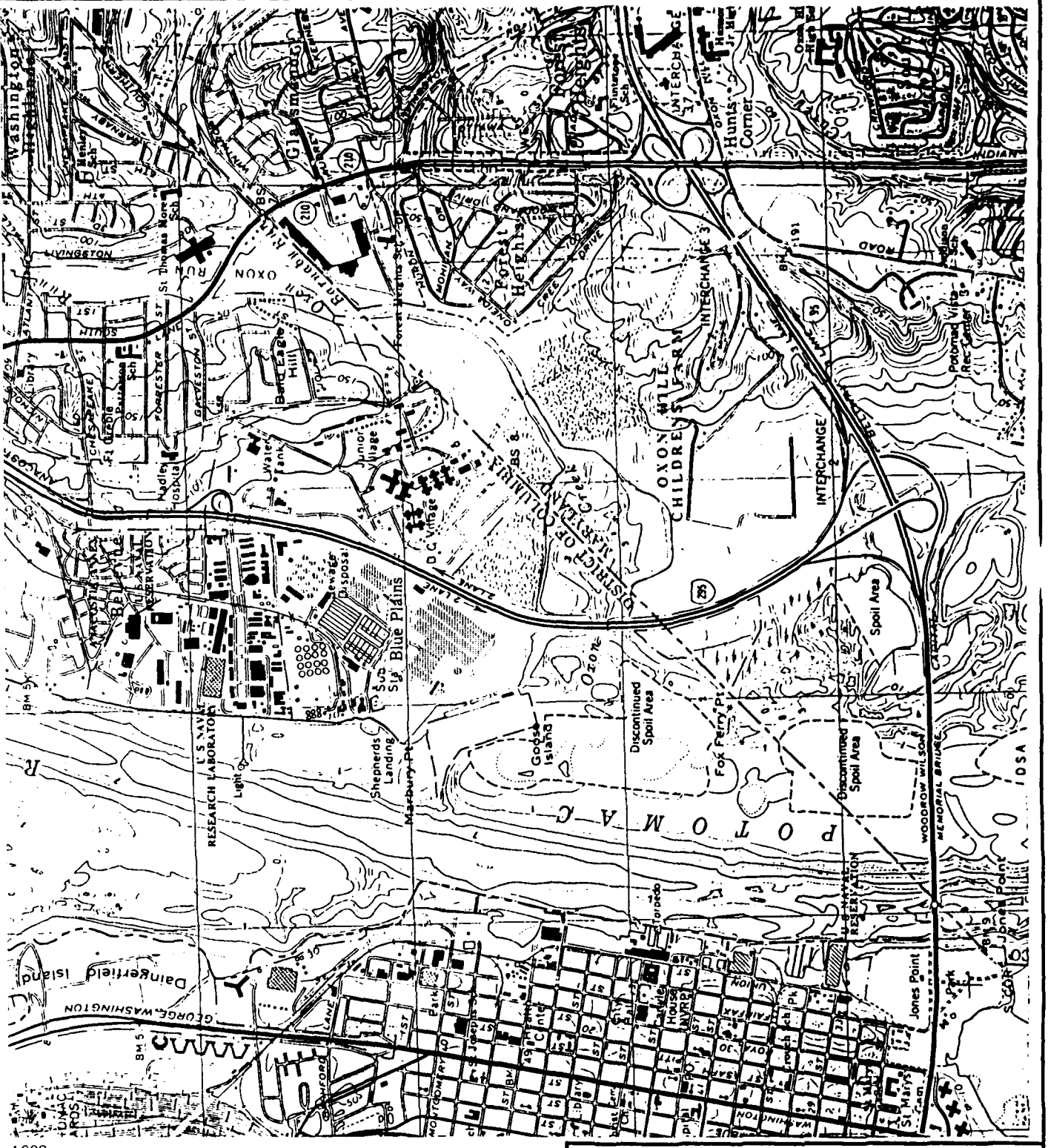
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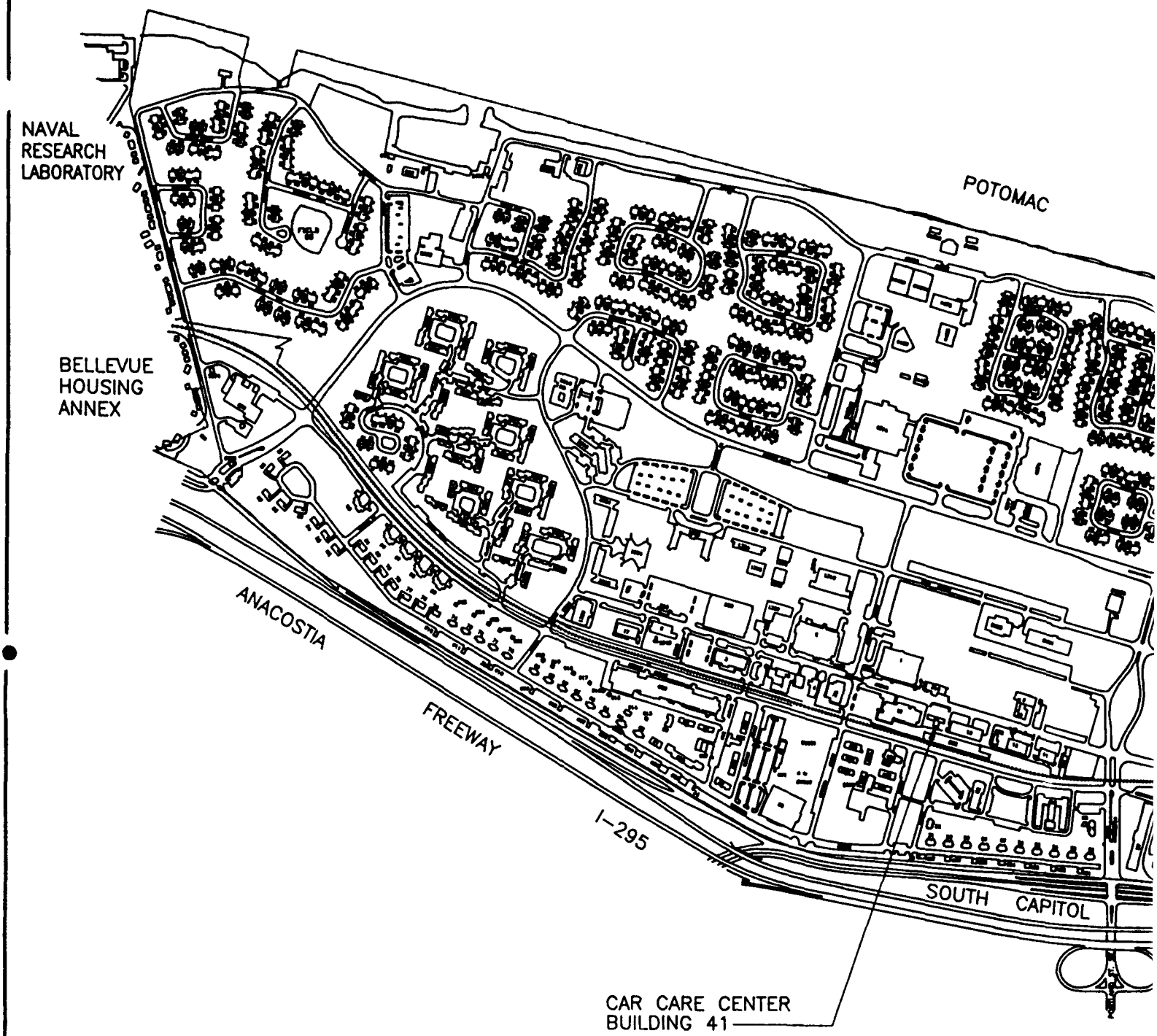
CONTOUR INTERVAL 10 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929
BATHYMETRIC CONTOUR INTERVAL 1 METER WITH SUPPLEMENTARY
0.5 METER CONTOURS—DATUM IS MEAN LOW WATER
THE RELATIONSHIP BETWEEN THE TWO DATUMS IS VARIABLE
THE MEAN RANGE OF TIDE IS APPROXIMATELY 0.9 METER

Regional Location M

Car Care Center Sit
Intrinsic Remediation E
Bolling AFB, DC

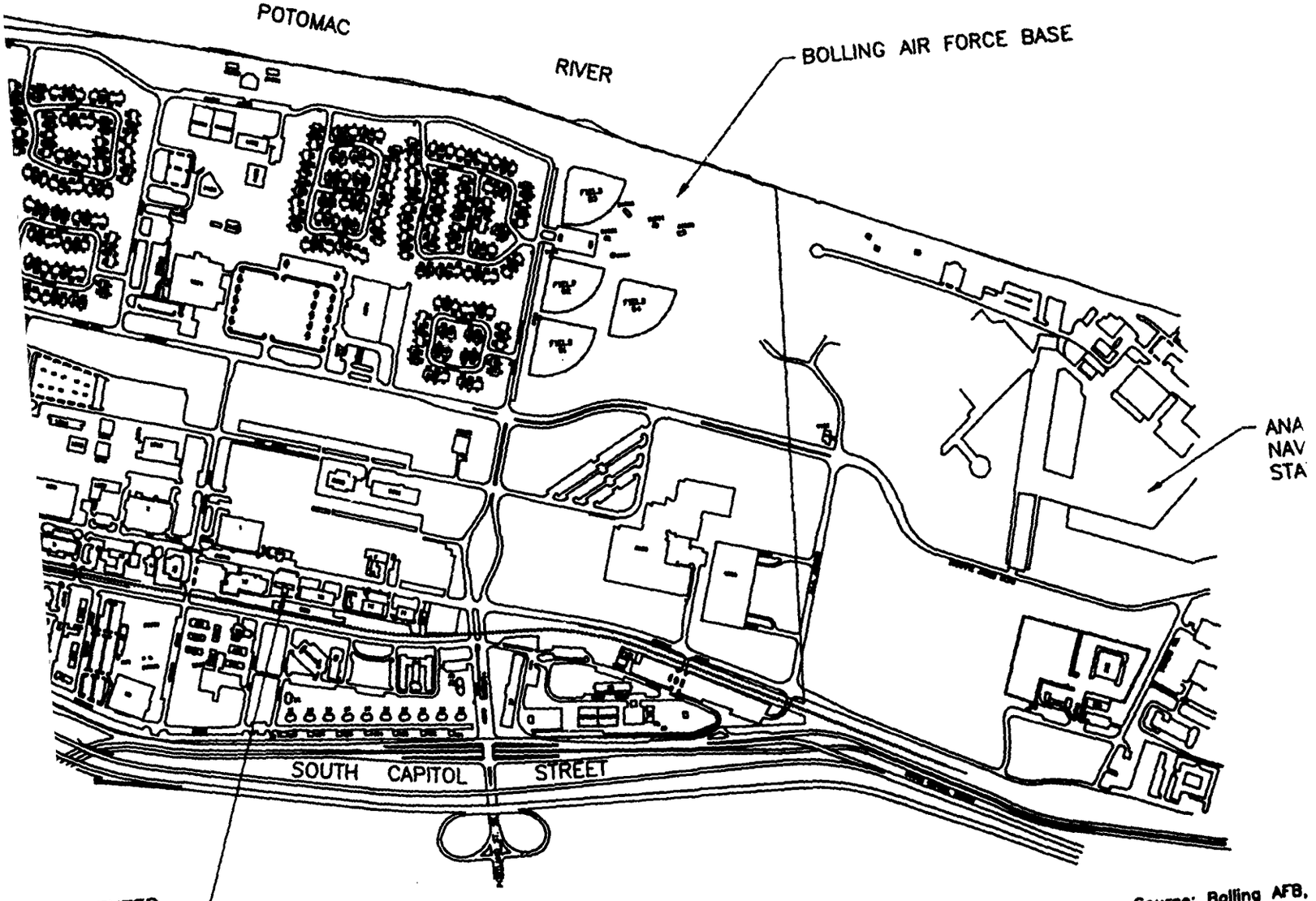
Figure 1.1


Washington
Forest Glen
Hunts Corner
Forest Heights
Oxon Hill
Childress
Blue Plains
Bellevue
Barnaby Woods
Fort Stanton
Fort Chaplin
Junior Village
D.C. Village
Water Tank
Ladley Hospital
Nichols Ave
Livingston Rd
Oxon Run
Chesapeake
Forrester
Gresham
Alabama Ave
Good Hope Rd
Pennsylvania Ave
Suitland Pkwy
Interchange 1
Interchange 2
Interchange 3
Spoil Area
Discontinued Spoil Area
Fox Ferry Pt
Godsey Island
Shepherds Landing
Marbury Pt
Light
Torpedo
Jones Point
Woodrow Wilson Memorial Bridge
Potomac
Dalgrenfield Island
George Washington
Rosa
Ozone
Stanton Park
Capitol Hill
Navy Yard
Navy Museum
Navy Hill
Fire Boat House
St Mary's Cem
Pumping Sta
Forest Heights Sch
Thomas Moore Sch
Patuxent Vista Recreation
Research Laboratory
Reservation
Bolling Air Force Base
Bolling Field
Bolling Air Force Base Reservation
Bolling Air Force Base Reservation
Bolling Air Force Base Reservation



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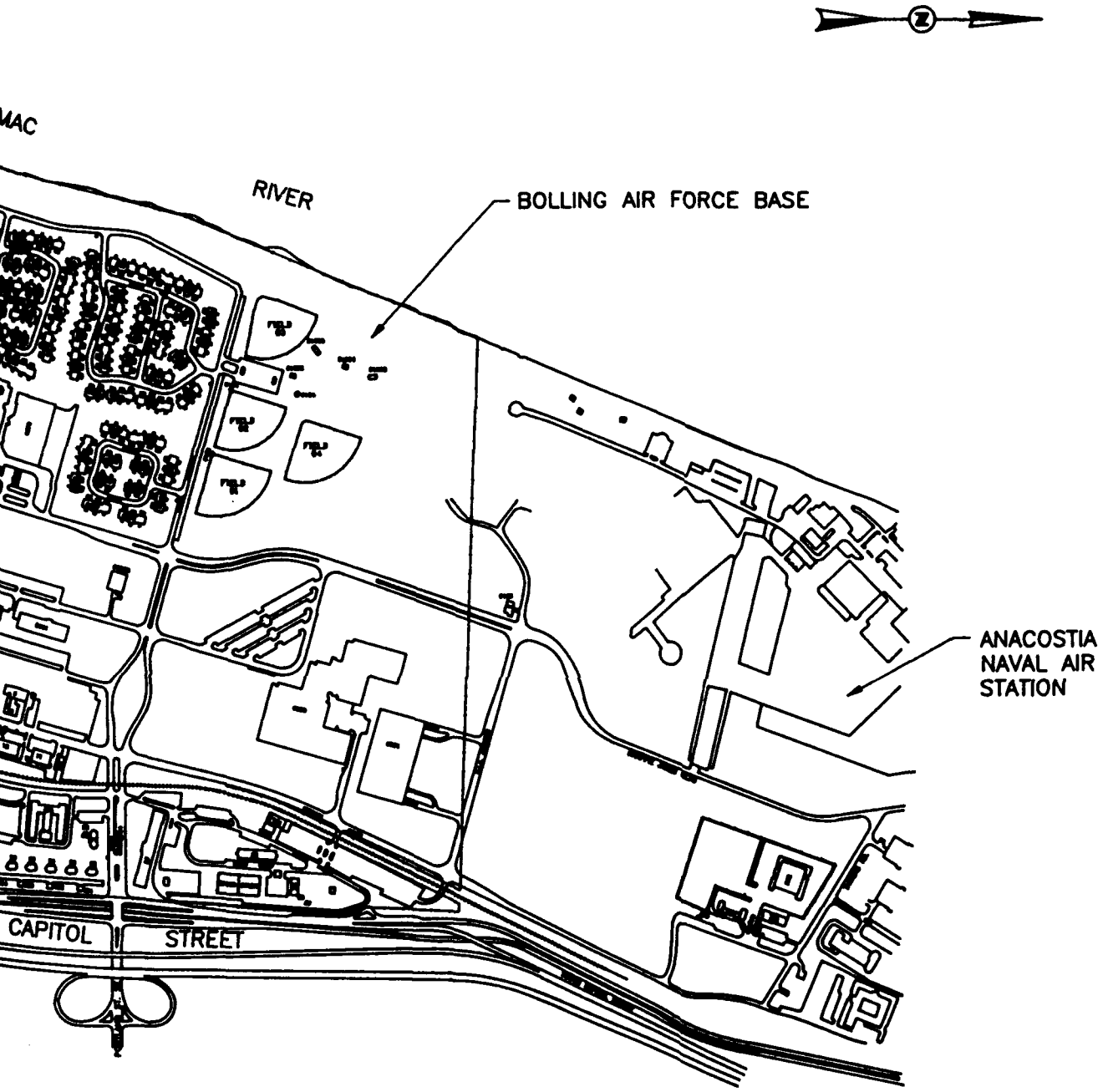
Source: Bolling AFB, 19

Bolling AFB Site

Car Care Center
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Figure 1.2

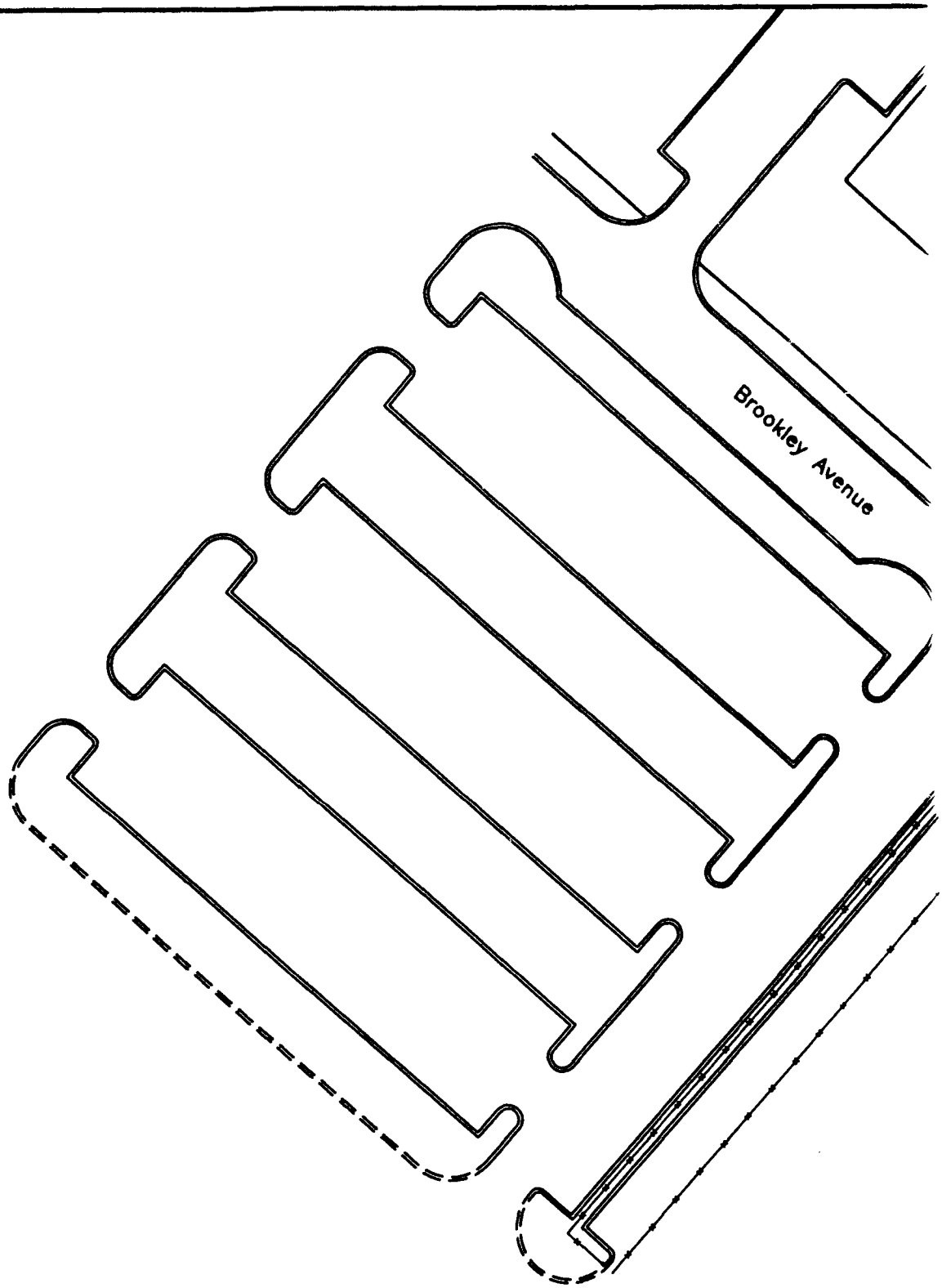


Source: Bolling AFB, 1994.

Bolling AFB Site Map

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

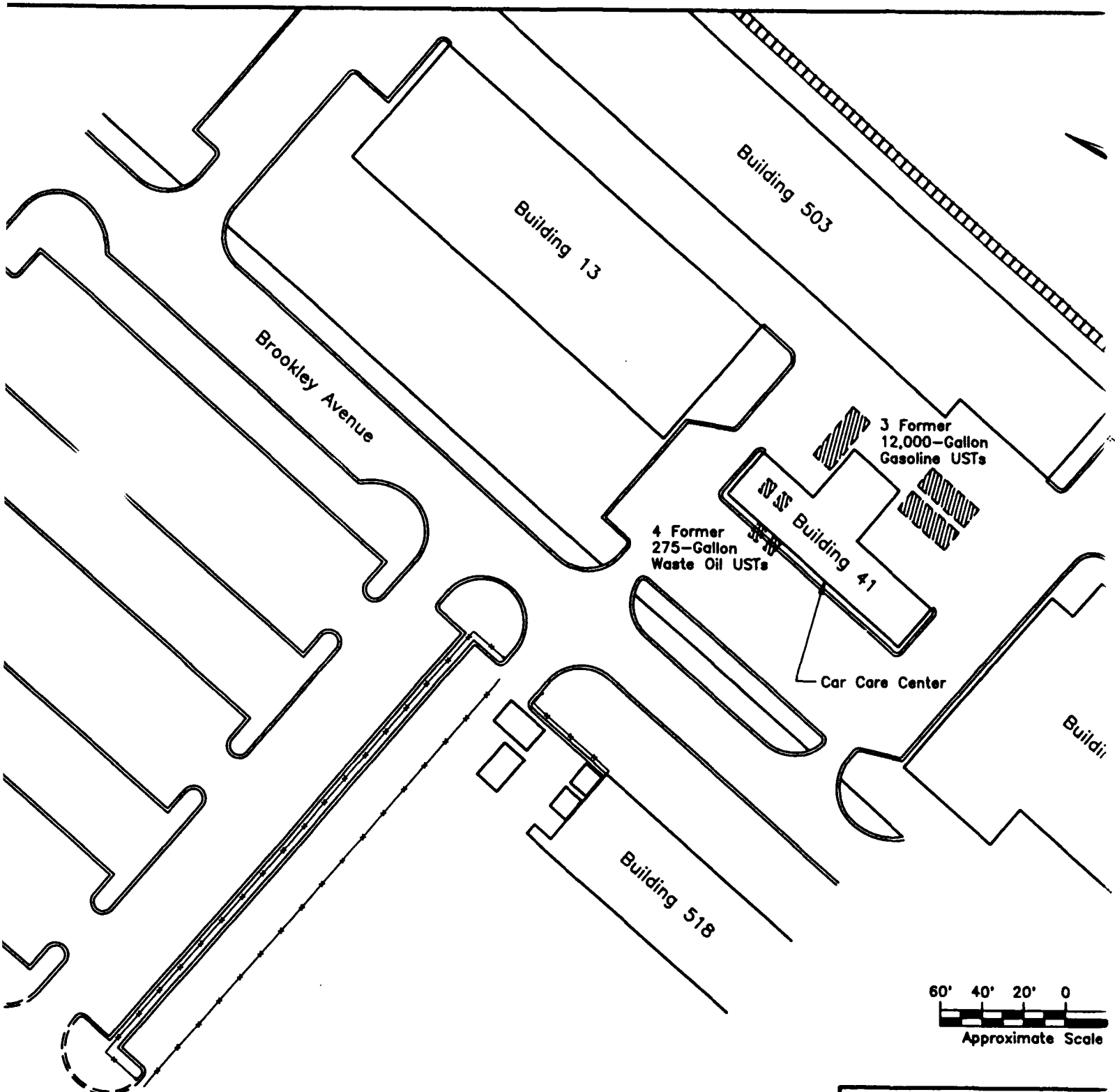
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LEGEND

Former underground storage tanks (USTs).

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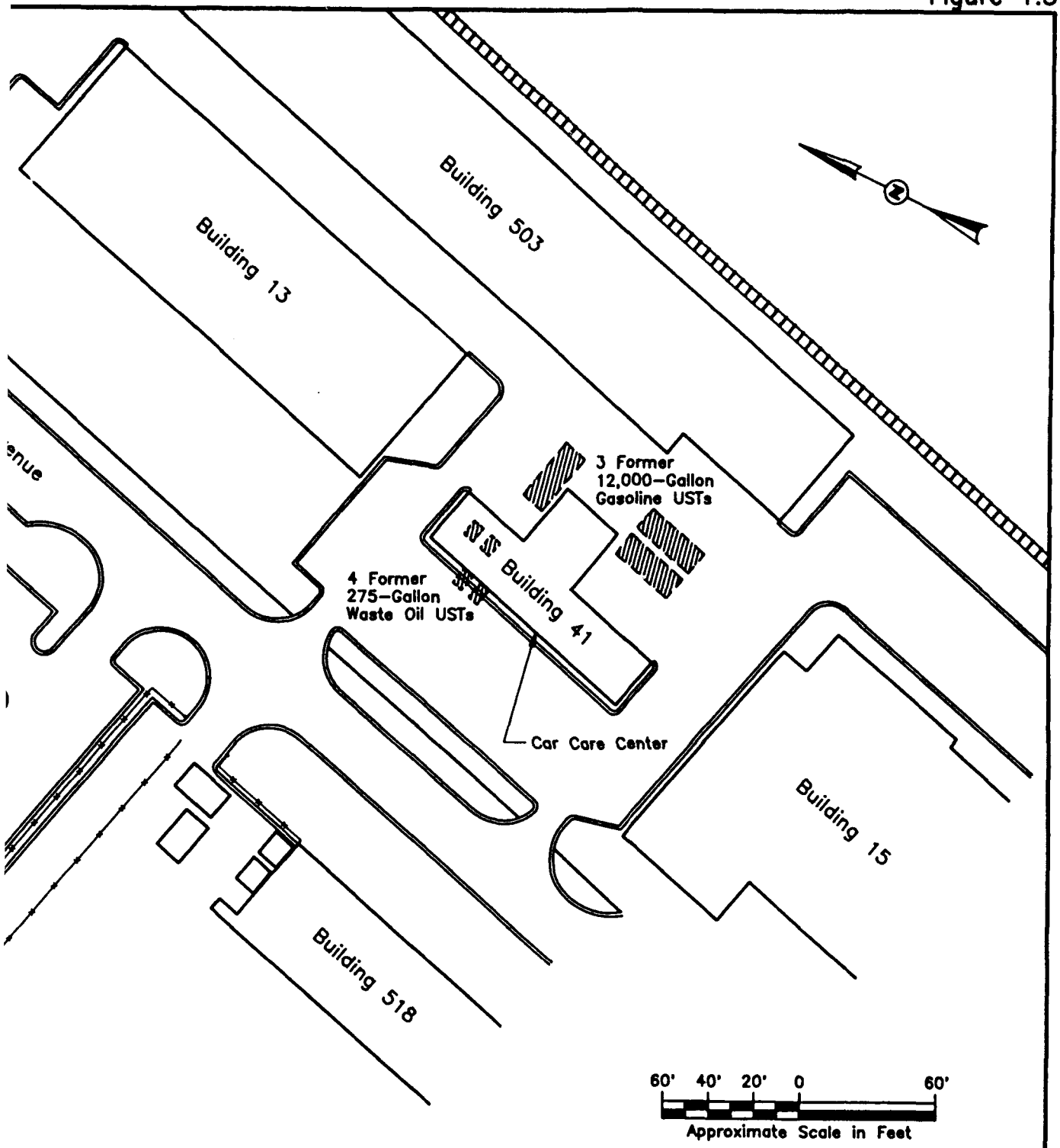


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Bolling AFB

PARSONS ENG

Figure 1.3



Site Map

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

The locations of all the tanks formerly located onsite are shown in Figure 1.3.

Baker (1994) reported that three known product releases occurred at the site. The exact dates and volumes of the releases are unknown. Soil and groundwater contamination was observed during removal of the USTs. Several investigations have been performed onsite to determine the potential impact to site soil and groundwater. The results of these investigations are covered in several reports, including:

- ATEC Environmental Consultants (ATEC), Phase II Environmental Assessment Soil Contamination Delineation, March 1990;
- ATEC, Contaminant Assessment Report, June 1990;
- Baker Environmental, Inc. (Baker), Final Project Plans Remedial Investigations/Feasibility Study, December 1993; and
- Baker, Draft Remedial Investigation Report, May 1994.

The site-specific data presented in Sections 3, 4, and 5 are based on a review of these documents and on data collected by Parsons ES during the August 1994 and June 1996 field investigations.

1.2.2 Current Remedial Activities

Past abatement measures at the site included hand-bailing/hand-skimming of LNAPL from site monitoring wells. During March 1990, monitoring wells MW-3, MW-4, and MW-6 intermittently contained free product. Since that time, these wells have been bailed on a weekly basis to remove free product. Bailing activities were discontinued during May 1994, because the volumes of recovered product was minimal. Bolling AFB was not able to provide a summary of the actual product volumes recovered from the wells. However, this volume is expected to be relatively small due to the minimal LNAPL thicknesses observed by Parsons ES during August 1994.

In October 1996, an internal combustion engine/soil vapor extraction (ICE/SVE) system was installed at the former Car Care Center. Using a V2 ICE unit, the ICE/SVE system ran from October 16 until October 20. During this time period the ICE/SVE unit removed 144 pounds of total volatile hydrocarbons (TVH) from the site's underlying soils. On October 20, the ICE/SVE system was shut down, because of extremely high TVH concentrations in the effluent. A larger ICE unit, a V4 model, is scheduled to replace the V2 ICE unit during the week on November 4, 1996. The startup and optimization of the model V4 ICE unit at the former Car Care Center is anticipated during the week of November 11, 1996.

SECTION 2

SITE CHARACTERIZATION ACTIVITIES

This section presents the methods used by Parsons ES to collect the site-specific data at Bolling AFB, DC for the intrinsic remediation demonstration during August 1994 and June 1996. Prior investigations (Baker, 1994; ATEC, 1990) have approximately defined the dissolved and adsorbed contaminant plumes. As a first task, Parsons ES reviewed water level and chemical concentration data (Baker, 1994) from existing site wells to identify potential CPT, LIF, and monitoring point locations. Parsons ES marked these locations on a map for use by Bolling AFB to obtain the necessary utility clearances.

The August 1994 site characterization proceeded in four phases. Parsons ES and USACE utilized several investigative techniques to perform the intrinsic remediation demonstration. Phase I consisted of characterizing the site lithology and free product plume. These activities were performed concurrently with the USACE's CPT and LIF probe. Phase II consisted of soil boring and sampling using the USACE's Hoggen Toggler® soil sampler. Phase III included the installation of temporary and permanent groundwater monitoring points. The monitoring points consisted of 0.5-inch-diameter screens and casings, as discussed in subsequent sections of this report. The USACE surveyed these sampling locations during Phase III. Phase IV consisted of groundwater sampling from previously existing wells and the newly installed monitoring points.

For the purposes of this report, the term "drilling" was used generally to represent CPT/LIF testing and monitoring point installations using direct push technologies. To minimize confusion among CPT/LIF test points, soil sample locations, and monitoring point installations, Parsons ES utilized a single prefix (CPT) for all tests at a single location. The field log books and laboratory reports utilize additional prefixes to distinguish between sample types. Construction details of existing monitoring wells, USACE installed monitoring points, CPT/LIF tests, and soil sample locations are presented in Table 2.1. Test locations are shown in Figure 2.1. Data collected under this program were used to aid with interpretation of the physical setting (Section 3), contaminant distribution (Section 4), and to develop the conceptual site model (Section 5).

Parsons ES collected the following physical, chemical, and hydrogeologic data during the field work phase of the EE/CA:

- Detailed analysis of subsurface media;
- Estimation of extent and thickness of LNAPL in monitoring wells;

TABLE 2.1

CPT ACTIVITY AND WELL COMPLETION SUMMARY
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Well Number[a]	Easting (ft)	Northing (ft)	CPT[b] Profile Available (Y/N)	LIF[c] Profile Available (Y/N)	Soil Sample[d] Interval (ft bls)[e]	Datum Elevation[f] (ft msl)[g]	Total Depth (ft)	Inner Well Diameter (inch)	Screen Length (ft)	Depth to Screen		Permanent or Temporary (P/T)
										Top (ft)	Base (ft)	
MONITORING POINTS												
CPT-02S	796499.72	367430.24	Y	Y	NS[h]	22.26	23.2	0.5	3.28	19.4	22.6	T
CPT-02D	796499.72	367430.24	Y	Y	NS	22.24	33.3	0.5	3.28	29.4	32.6	T
CPT-08S	796448.47	367290.43	Y	Y	NS	21.49	23.2	0.5	3.28	17.3	20.5	T
CPT-08D	796448.47	367290.43	Y	Y	NS	21.42	33.2	0.5	3.28	29.4	32.6	T
CPT-09S	796437.62	367361.83	Y	Y	17.8 - 19.9	20.97	23.2	0.5	3.28	19.4	22.6	T
CPT-09D	796437.62	367361.83	Y	Y	22.5 - 24.7	20.95	33.2	0.5	3.28	29.0	32.2	T
CPT-10S	796522.68	367393.74	Y	Y	NS	21.17	23.2	0.5	3.28	19.3	22.5	T
CPT-10D	796522.68	367393.74	Y	Y	NS	21.21	33.2	0.5	3.28	29.4	32.6	T
CPT-11S	796428.55	367400.03	Y	Y	11 - 13.2	20.77	23.2	0.5	3.28	19.3	22.5	T
CPT-11D	796428.55	367400.03	Y	Y	17.5 - 19.7 22 - 24.2	21.01	33.2	0.5	3.28	29.3	32.5	T
CPT-16S	796353.82	367330.04	Y	Y	NS	20.40	23.2	0.5	3.28	19.3	22.5	T
CPT-16D	796353.82	367330.04	Y	Y	NS	20.38	33.2	0.5	3.28	29.4	32.6	T
CPT-18S[i]	796362.37	367482.66	Y	Y	NS		23.2	0.5	0.5	22.7	23.2	T
CPT-18D	796362.37	367482.66	Y	Y	NS		33.2	0.5	0.5	32.7	33.2	T
CPT-19S	796330.26	367570.50	N	N	NS	24.97	27.2	0.5	3.28	23.7	27.0	P
CPT-19D	796330.26	367570.50	N	N	NS	24.96	37.2	0.5	3.28	33.5	36.8	P
CPT-20S	796344.62	367614.68	N	N	NS	24.80	27.2	0.5	3.28	23.2	26.5	P
CPT-20D	796344.62	367614.68	N	N	NS	24.79	37.2	0.5	3.28	32.9	36.2	P
CPT-21S	796345.11	367669.96	N	N	NS	22.25	23.2	0.5	3.28	19.8	23.1	P
CPT-21D	796345.11	367669.96	N	N	NS	22.08	33.2	0.5	3.28	29.3	32.6	P
CPT-22S	796292.19	367707.48	N	N	NS	21.97	23.2	0.5	3.28	18.7	22.0	P
CPT-22D	796292.19	367707.48	N	N	NS	22.07	33.2	0.5	3.28	28.7	32.0	P
PREVIOUSLY INSTALLED MONITORING WELLS												
MW-1	796558.83	367215.24	N	N	NS	21.68	25	4	10	13.18	23.18	P
MW-2[j]	796557.89	367351.09	N	N	NS	21.68	25	4	10	13.18	23.18	T
MW-3	796456.09	367408.79	N	N	NS	21.14	25	4	10	13.14	23.14	P
MW-4	796459.27	367356.49	N	N	NS	21.27	25	4	10	12.77	22.77	P
MW-5	796451.75	367291.07	N	N	NS	21.37	26	4	10	13.77	23.77	P
MW-6	796396.76	367471.49	N	N	NS	21.55	26	4	10	13.55	23.55	P
MW-7	796524.70	367639.32	N	N	NS	21.97	29	4	15	13.83	28.07	P
MW-8	796388.43	367705.80	N	N	NS	26.49	27	4	15	12.15	26.12	P
MW-9	796608.06	367191.46	N	N	NS	22.15	30	4	15	15.12	29.01	P
MW-10	796281.58	367416.62	N	N	NS	20.76	29	4	15	14.02	28.04	P
MW-11[j]	NA	NA	N	N	NS	NA	NA	4	NA	NA	NA	P

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TABLE 2.1- CONTINUED

CPT ACTIVITY AND WELL COMPLETION SUMMARY
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Well Number[a/]	Easting (ft)	Northing (ft)	CPT[b/] Profile Available (Y/N)	LIF[c/] Profile Available (Y/N)	Soil Sample[d/] Interval (ft bls)[e/]	Datum Elevation[f/] (ft msl)[g/]	Total Depth (ft)	Inner Well Diameter (inch)	Screen Length (ft)	Depth to Screen		Permanent or Temporary (P/T)
										Top (ft)	Base (ft)	
CPT TEST POINTS												
CPT-1	796561.30	367206.02	Y	Y	NS	21.80	33.2	N/A	N/A	N/A	N/A	T
CPT-3	796372.27	367527.47	Y	Y	9.7 - 11.7 22 - 24.5	20.98	48.2	N/A	N/A	N/A	N/A	T
CPT-4	796387.77	367560.41	Y	Y	NS	21.29	26.2	N/A	N/A	N/A	N/A	T
CPT-5	796279.46	367564.06	Y	Y	NS	20.79	26.2	N/A	N/A	N/A	N/A	T
CPT-6	796445.89	367322.72	Y	Y	NS	21.69	28.2	N/A	N/A	N/A	N/A	T
CPT-7	796472.05	367336.06	Y	Y	10.75 - 11.5 14 - 17.2 20 - 22.2	21.83	29.8	N/A	N/A	N/A	N/A	T
CPT-12	796400.67	367316.89	Y	Y	NS	21.70	29.8	N/A	N/A	N/A	N/A	T
CPT-13	796411.60	367348.28	Y	Y	NS	20.78	29.8	N/A	N/A	N/A	N/A	T
CPT-14	796385.19	367411.76	Y	Y	14 - 15.3 20 - 22.3	21.60	29.8	N/A	N/A	N/A	N/A	T
CPT-15	796456.97	367469.46	Y	Y	NS	20.65	29.0	N/A	N/A	N/A	N/A	T
CPT-17	796477.41	367539.62	Y	Y	NS	20.68	25.8	N/A	N/A	N/A	N/A	T
CPT-23	796288.10	367399.53	N	Y	NS	20.77	29.5	N/A	N/A	N/A	N/A	T
CPT-24	796606.92	367181.50	N	N	10 - 10.7 20 - 20.7	22.20	20.7	N/A	N/A	N/A	N/A	T

[a/] See Figure 2.1 for monitoring well and CPT test locations

[b/] CPT = Cone Penetrometer test to determine soil lithology

[c/] LIF = Lazer-induced fluorescence test

[d/] Sampled soil using a Hoggentoggler[4] soil sampler

[e/] ft bls = feet below land surface

[f/] Datum elevation refers to top of casing for wells and piezometers and to land surface for CPT test points.

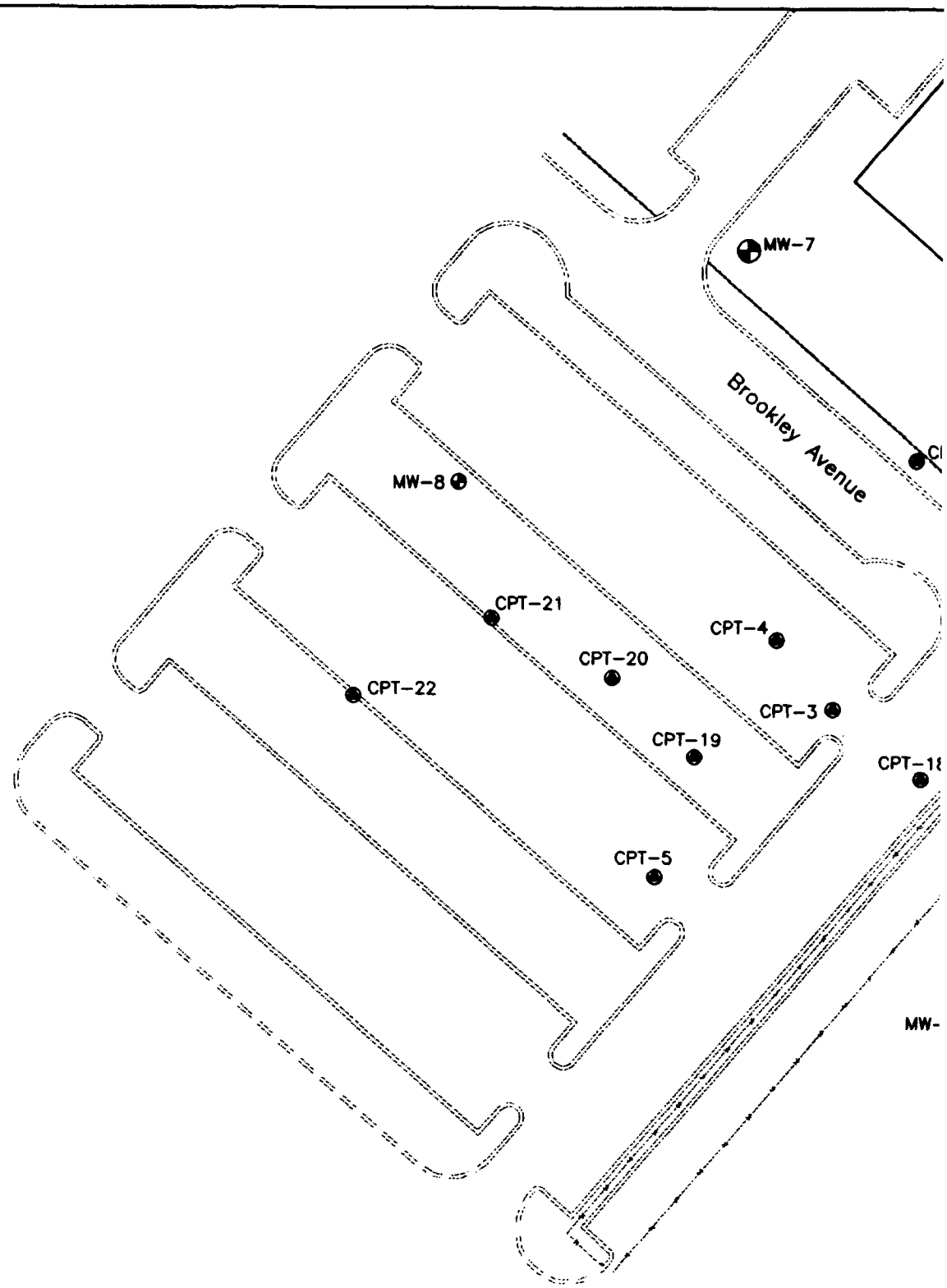
[g/] ft msl = feet above mean sea level

[h/] NS = no sample was collected

[i/] For CPT-18, a Geoprobe was utilized to collect water samples. Water level measurements were not possible at this location.

[j/] MW-2 was destroyed during UST removal, and MW-11was installed to replace it.

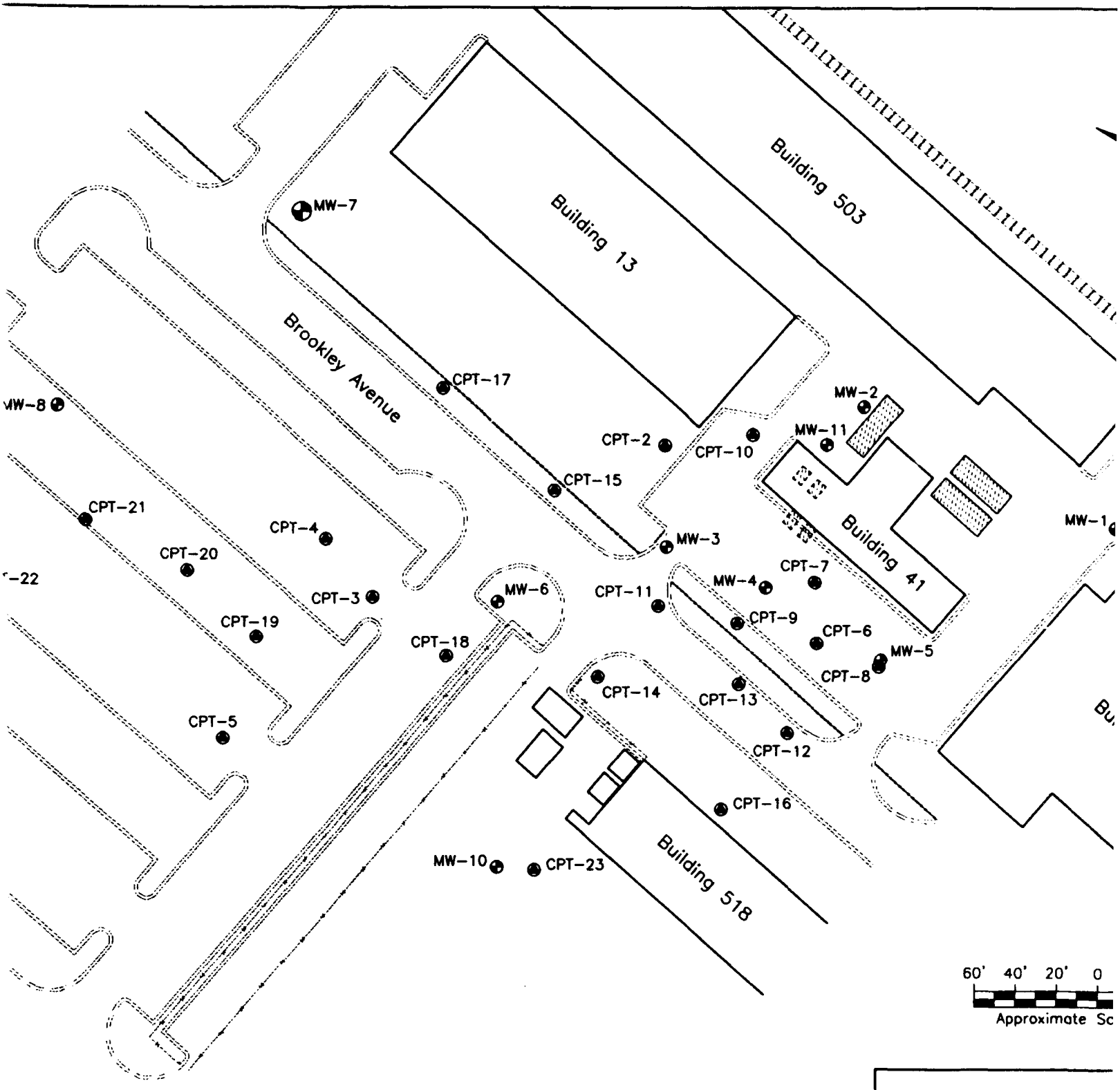
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- Former underground storage tanks (USTs).
- MW-1 Existing monitoring well.
- CPT-1 Monitoring point and CPT test location installed by CPT rig.

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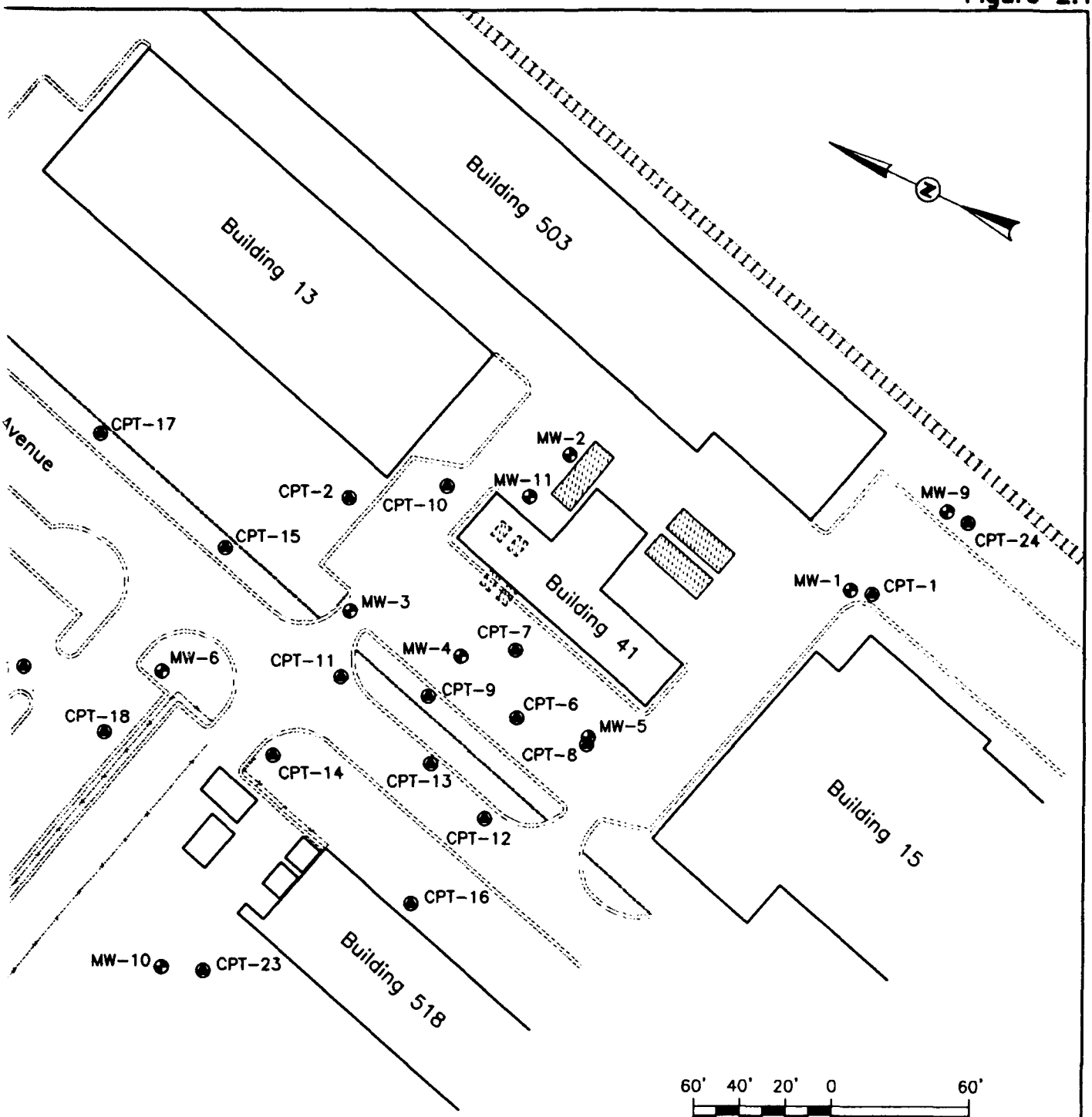


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Figure 2.1



Sampling Locations

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

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- Depth from measurement datum to the water table or potentiometric surface in monitoring wells and monitoring points;
- Location of potential groundwater recharge and discharge areas;
- BTEX, trimethylbenzenes (TMBs), and total volatile hydrocarbon (TVH) concentrations in soil;
- Total organic carbon (TOC) concentrations in select soil samples;
- Chemical analysis of free product to determine the mass fraction of BTEX;
- Dissolved oxygen (DO), nitrate, ferrous iron, sulfate, methane, and TOC concentrations in groundwater;
- Temperature, specific conductance, reduction/oxidation (redox) potential, total alkalinity, and pH of groundwater; and
- BTEX, TMBs, and TVH concentrations in groundwater.

Section 2.1 describes the procedures used to determine site lithology, delineate free product, and sample soil. Section 2.2 discusses the procedures for installing monitoring points, and developing monitoring wells. Section 2.3 presents the procedures for groundwater sampling.

2.1 CONE PENETROMETRY, LASER-INDUCED FLUOROMETRY, AND SOIL SAMPLING ACTIVITIES

CPT-related activities took place between 1 August 1994 and 12 August 1994. CPT, LIF, and soil sampling were accomplished using the procedures described in the following sections. Parsons ES and the USACE staff performed lithologic logging with CPT and LNAPL delineation with LIF during Phase I of the field activities. These tests were performed concurrently during the same push with the USACE's cone penetrometer truck, providing an expedient and effective means of investigating the site.

2.1.1 Pre-Drilling Activities

Parsons ES obtained all necessary digging, drilling, and groundwater monitoring well installation permits prior to mobilization. In addition, all utility lines were located and proposed drilling locations were cleared prior to any drilling activities. The USACE staff utilized an onsite potable water supply for drilling, equipment cleaning, and grouting. The Bolling AFB point of contact verified this source prior to use.

2.1.2 Cone Penetrometry Procedures

Eighteen CPT tests (Table 2.1) were performed at the Car Care Center Site (CPT-1 through CPT-18). CPT lithologic information and boring logs from previous investigations were utilized to delineate subsurface geological conditions. Appendix A contains CPT lithologic logs. Parsons ES developed soil descriptions and lithologic cross-sections to compare stratigraphy below the Car Care Center site. This

stratigraphic information is discussed in Section 3. Periodic soil samples were collected in Phase II field activities to manually compare CPT computed readings to actual soil samples, which validated the CPT data. Observed soil types corresponded very well to the CPT test data.

The intrinsic remediation study utilized a cone penetrometer truck to determine the site lithology, measure LIF response, collect soil samples, and install groundwater monitoring points at the site. The truck's weight provides the necessary reaction mass to force an instrumented probe into the ground. The penetrometer equipment is mounted on a 3-axle Kenworth® chassis that provides an overall push capability of 43,000 pounds. A pair of large hydraulic cylinders bolted to the truck frame provides the penetration force.

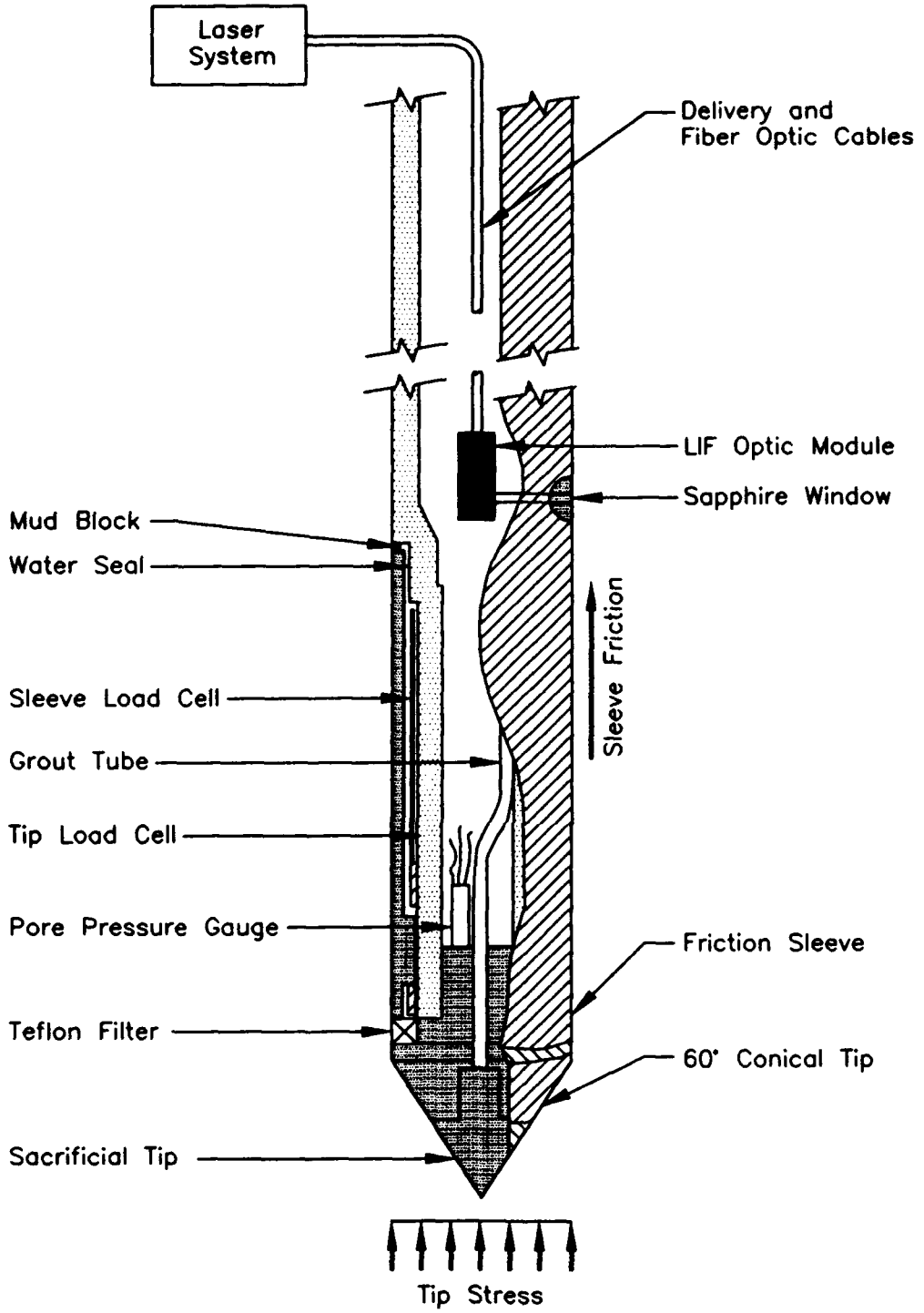
The penetrometer probe is of standard dimensions, having a 1.405-inch outside diameter (OD), 60-degree conical tip, and a 1.405-inch OD by 5.27-inch-long friction sleeve (Figure 2.2). Inside the probe, two load cells independently measure the vertical resistance against the conical tip and the side friction along the sleeve. Each load cell inside the probe is a cylinder of uniform cross section that contains four strain gauges in a full-bridge circuit. Forces are sensed by the load cells, and the data are transmitted from the probe assembly via a cable running through the push tubes. The analog data are digitized, recorded, and plotted by computer in the penetrometry truck. The penetrometer is usually advanced into the soil at a constant rate of 48 inches per minute, although this rate must sometimes be reduced (e.g., when hard layers are encountered). The magnitude of the penetration force is a function of compressibility and, most importantly, permeability.

2.1.3 Laser-Induced Fluorometry

Laser-induced fluorometry was utilized in Phase I to delineate areas of free product and excessive soil hydrocarbon concentrations. Nineteen LIF tests were performed at the Car Care Center Site (CPT-1 through CPT-18, and CPT-23). Parsons ES delineated the potential hydrocarbon source using the LIF data in combination with soil analyses. This information is summarized in Section 4. Direct printouts of the LIF logs are provided in Appendix A.

The USACE's LIF system utilized a nitrogen-based laser optics fluorometer tool, which scans for fluorescent compounds as it is pushed though the soil. The known propensity of aromatic or chlorinated hydrocarbons to fluoresce under ultraviolet wavelengths has allowed the use of LIF technology in conjunction with CPT technology to detect gross hydrocarbon contamination and soil characteristics, simultaneously. The LIF/CPT system has a sapphire window in the side of the CPT probe, which allows a laser to scan the soil for fluorescent compounds as the LIF/CPT penetrometer rod pushes through soil (Figure 2.2). Assuming that aromatic hydrocarbons are simultaneously solvenated with other fuel-hydrocarbon constituents, the magnitude of aromatic fluorescence is indicative of hydrocarbon contamination in a soil matrix. The push tubes act as a conduit for the fiber optic cable and a 6-pair electrical conductor. This wiring connects the laser spectrometer and CPT data acquisition systems to the CPT probe.

Figure 2.2



Schematic of Laser-Induced Fluorescence Cone Penetrometer Probe

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

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The basic laser system components of the CPT/LIF instrumentation are a Nd:YAG® pump laser, two separate and independent rhodomine dye lasers, frequency-doubling crystals which convert the visible-dye laser output to ultraviolet, a fiber optic probe, a monochromator for wavelength resolution of the return fluorescence, a photomultiplier tube to convert photons into an electrical signal, a digital oscilloscope for waveform capture, and a control computer. The cone penetrometer's fiber optic probe consists of a delivery and collection fiber, a protective sheath, a fiber optic mount within the cone, and a sapphire window (Figure 2.2). The uphole portion of the system is adaptable to either groundwater monitoring fiber optic probes or an optical cone penetrometer probe. Optimal wavelengths to be used during a continuous CPT push are determined during each push. The computer selects the wavelength with the strongest fluorescence signal to correlate contamination. Past experience suggested that a wavelength of less than 275 nanometers (nm) may be appropriate for detecting the fluorescence of fuel hydrocarbons.

2.1.4 Soil Sampling Procedures

Parsons ES collected soil samples from the CPT rig during Phase II of the field activities. Soil sampling served to fulfill four purposes:

- Validate the lithological data collected during CPT tests,
- Determine actual hydrocarbon concentrations in soils,
- Correlate the LIF laser direct readings to actual laboratory results (Figures 4.2a and 4.2b), and
- Determine background soil geochemistry.

Parsons ES chose six CPT locations (CPT-03, CPT-07, CPT-09, CPT-11, CPT-14, and CPT-24) from which to collect soil samples (Table 2.1). These samples, in combination with the LIF data, provide horizontal and vertical delineation of hydrocarbon contamination in site soils. Parsons ES collected several soil samples from each test location to provide a vertical profile. Overall, 17 soil samples were collected, including duplicates and quality assurance/quality control (QA/QC) samples. The field logs and analytical reports reference these soil samples with a soil boring (SB) prefix followed by a number. This number refers to the CPT location indicated on all EE/CA report figures. To minimize confusion within tables and figures, the CPT prefix is utilized instead of the SB prefix.

Soil sampling was accomplished during this investigation using a Hoggen Toggler® stainless steel soil sampler. The dimensions of the Hoggen Toggler® spoon were approximately 1 inch (diameter) by 8 inches (long). The sampler is coupled to the penetrometer rod and pushed into the soil. While the Hoggen Toggler® cone is in position, soil is prevented from entering the sampling tube until the desired depth is achieved. To operate the unit, the sampling tube is pushed to the required depth and then raised a few inches. The driller unlocks the cone from inside the truck, allowing the cone to automatically retract into the sampler barrel during sample collection. The USACE operator pulled the sampling apparatus from the ground as quickly as possible. The Hoggen Toggler® sampling apparatus allowed collection of a 8-inch-long

continuous sample. Recovery efficiencies for samples in saturated soils were occasionally reduced because of spillage of the soil from the device after extraction. To mitigate this problem, soil samples were compressed *in situ* with the penetrometer and Hoggen Toggler® assembly to expel the pore water before extraction. Compressed soil samples were then extracted and measured to give a description of the soil stratigraphy accurate for the length of soil core taken.

Soil samples were obtained from each location at a discrete depth. This depth typically corresponded to the interval with the highest LIF reading. The soil samples were removed from the sampler and placed in clean glass jars for laboratory analysis. During previous natural attenuation projects, a portion of the soil sample was placed in a clean glass jar for photoionization detector (PID) headspace measurements. However, the small volume of the Hoggen Toggler® sampling device did not allow for enough soil recovery to permit split PID analyses within one discrete sample tube. Because LIF peak readings were generally observed in thin lenses within the soil profile, sample length was minimized in order to correlate LIF readings to the analytical results. Since the PID results only provide a qualitative measure of volatile organic compounds (VOC), omission of these screenings does not effect the overall intent of the project.

The Parsons ES field hydrogeologist observed CPT and LIF testing, soil sampling, and monitoring point installation activities. The field hydrogeologist maintained descriptive notes of subsurface materials recovered. Observed soil classification types compared very favorably to the soil classifications determined by the CPT tests.

2.1.5 Equipment Decontamination Procedures

Prior to arriving onsite, and between each test location, CPT push rods were cleaned with an automatic steam-cleaning system (rod cleaner) as the rods were withdrawn from the ground. A vacuum system located beneath the CPT truck was used to recover cleaning water. Use of this system resulted in nearly 100-percent recovery of steam-cleaning rinseate from the rod cleaner. Rinseate was generated only as the rods moved past the cleaner, thereby minimizing liquid waste generation. Only potable water was used for decontamination. Rinseate was collected in 55-gallon drums provided by USACE. Filled 55-gallon drums were then staged in an area designated by the Bolling AFB point of contact. Bolling AFB arranged for disposal of the water through a local waste disposal company.

The soil samplers were disassembled upon sample collection and manually cleaned with a high-pressure steam/hot water wash. Contaminated soils (i.e., cuttings) were not generated during any field activities. Fuel, lubricants, and other similar substances were handled in a manner consistent with accepted safety procedures and standard operating practices. Well completion materials were not stored near or in areas that could be affected by these substances.

2.2 MONITORING POINT INSTALLATION AND MONITORING WELL DEVELOPMENT

Monitoring wells MW-1 through MW-10, installed during previous investigations, were constructed using standard hollow-stem auger (HSA) drilling techniques.

Standard split-spoon sampling was performed during well construction. Parsons ES reviewed boring logs for selected monitoring wells (Baker, 1994) to determine potential monitoring point screen interval locations prior to drilling. Upon completion of the CPT/LIF investigation, the USACE installed 11 multi-depth groundwater sampling points using the CPT rig. As a result, 22 additional sampling points were available to Parsons ES for groundwater sampling. Groundwater samples were collected from 10 monitoring wells and 18 monitoring points. All monitoring wells and monitoring points were utilized to determine groundwater elevation.

2.2.1 Well Locations and Completion Intervals

Ten multi-depth (nested) monitoring points were installed to help characterize the shallow groundwater flow system at the Car Care Center Site. These monitoring point locations are identified as CPT-02, CPT-08 through CPT-11, CPT-16, and CPT-19 through CPT-22. Monitoring points were not installed at location CPT-18 due to lack of available casing material at the time of construction. A Geoprobe® was used at CPT-18 to collect representative water samples from depths similar to the other monitoring point screened intervals. Because CPT-18 was temporary and not cased, water level information was not obtained from this location. Table 2.1 presents well completion details for all previously existing wells and monitoring points located on the site. These locations are shown in Figure 2.1. The chosen monitoring point locations were selected to provide the hydrogeologic data necessary to adequately characterize the site.

Upon completion of Phase III activities, the USACE surveyed the top of casing horizontal and vertical locations for existing wells and newly installed monitoring points. These measurements were recorded relative to the Bolling AFB coordinate system. Survey data are summarized in Table 2.1

2.2.2 Groundwater Monitoring Point Installation Procedures

This section describes the procedures and equipment used for installation of new groundwater monitoring points with the CPT apparatus.

2.2.2.1 Monitoring Point Installation

Groundwater monitoring points were installed at 11 locations under this program. Detailed monitoring point installation procedures are described in the following paragraphs. At all locations, two separate points (each screened at different depths) were installed. At each location, the point with the shallowest screened interval was designated with the suffix "S", while the deep point was designated with the suffix "D" (e.g., CPT-02S or CPT-02D). Monitoring point completion diagrams are included in Appendix A.

2.2.2.1.1 Monitoring Point Materials Decontamination

Monitoring point construction materials were inspected by the field hydrogeologist and determined to be clean and acceptable prior to use. All monitoring point construction materials were factory sealed. Materials were inspected for possible

external contamination before use. Materials that could not be cleaned to the satisfaction of the field hydrogeologist were not used.

2.2.2.1.2 Monitoring Point Screen and Casing

The Parsons ES field hydrogeologist considered the LIF data and hydraulic characteristics of the stratum to select the screened interval for each monitoring point. During set-up at each new monitoring point location, the USACE first cored through any existing concrete to allow access to the ground surface. A steel conical tip was inserted onto a 1-meter section of screen. Then, the screen and tip was hydraulically forced into the ground to the required depth. Installation of a discrete sand pack was not possible. Construction details were noted on a Monitoring Point Installation Record form (Appendix A) and are summarized in Table 2.1. Monitoring point screens were constructed of flush-threaded, Schedule 40 polyvinyl chloride (PVC) with a 0.5-inch inside diameter (ID). The screens were factory slotted with 0.010-inch openings. Each well had a 3.28-foot screen length.

Casing with flush-mounted threads was added in 3.28-foot increments as the screen was pushed into the ground. Monitoring point casing was constructed of Schedule 40 PVC with an 0.5-inch ID. All monitoring point casing sections were flush-threaded; glued joints were not used. Upon monitoring point completion to the proper termination depth, the monitoring point casing was cut to approximately 4 inches above land surface. The field hydrogeologist verified and recorded the hole depth and the lengths of all casing sections. All lengths and depths were measured to the nearest 0.1 foot. The casing was fitted with a plastic cap constructed of the same type of material as the casing. The cap was vented to maintain ambient atmospheric pressure within the well casing. Barriers were then installed at each point until the point was either finished with a protective flush-mounted cover or permanently abandoned. This information became part of the permanent field record for the site.

2.2.2.1.3 Flush-Mount Protective Cover

Monitoring points CPT-19 through CPT-22 were permanently constructed to serve as POC wells. These were constructed inside 6-inch-diameter manways with flush-mounted steel covers. Upon sample collection, the remaining monitoring points (CPT-2, CPT-8, CPT-9, CPT-10, CPT-11, CPT-16, and CPT-18) were abandoned and grouted to the surface. Each permanent monitoring point was completed with an at-grade protective steel cover. The at-grade covers were cemented in place using a concrete pad of approximately 1-foot by 1-foot dimensions. All permanent monitoring points were completed with concrete pads that slope gently away from the protective casing to facilitate runoff during precipitation events.

2.2.2.2 Monitoring Point Development

Prior to sampling, newly installed monitoring points were developed with a peristaltic pump. Monitoring point development removes sediment from inside the monitoring point casing and flushes fines from the formation adjacent to the monitoring point screen. In points with a PVC casing, the pump's suction tubing was regularly lowered to the bottom of the well so that fines were agitated and removed from the well with the development water. Development was continued until turbidity was

minimized and the pH, temperature, specific conductivity, DO concentration, and redox potential of the groundwater had stabilized. All well development waters were collected in 55-gallon drums and transported to the Bolling AFB designated drum storage area.

2.2.2.3 Water Level Measurements

Water levels were measured at each monitoring point prior to purging and sampling. Measurements were made using an electric water level probe capable of recording to the nearest 0.01 foot. Free product thickness could not be determined within the 0.5-inch-diameter monitoring points due to the width of the oil/water interface probe. However, the field geologist noted the presence of an oily phase during monitoring point development. LNAPL thickness was measured in all monitoring wells. During the last day on the site, the water levels were measured in all site monitoring wells and monitoring points to obtain a snapshot of the potentiometric surface at the site. This information was utilized to develop the potentiometric surface map for Bioplume II model calibration.

2.2.2.4 Well Location and Datum Survey

The locations and elevations of the new monitoring points were surveyed by USACE personnel soon after well completion. The horizontal locations were measured relative to established Bolling AFB coordinates. Horizontal coordinates were measured to the nearest 1 foot. Vertical location of the adjacent ground surface was measured relative to the existing monitoring wells that had known northing, easting, and top of casing elevation data. Survey results are presented in Table 2.1.

2.3 GROUNDWATER SAMPLING

This section describes the procedures used for collecting groundwater quality samples during the August 1994 and June 1996 sampling events. Parsons ES utilized the following sampling procedures in order to maintain a high degree of QC during sampling events. Sampling of monitoring wells and points is described in Section 2.3.3.1. Sample analysis was performed by Evergreen Analytical, Inc., Wheatridge, Colorado (Evergreen Analytical).

Activities that occurred during groundwater sampling are summarized below:

- Assembly and preparation of equipment and supplies;
- Inspection of the well integrity (for monitoring well sampling), including
  - Protective cover, cap and lock,
  - External surface seal and pad,
  - Well stick-up, cap, and datum reference, and
  - Internal surface seal;
- Groundwater sampling, including

- Water level measurements,
- Visual inspection of water,
- Well casing or monitoring point evacuation,
- Onsite measurement of physical parameters, and
- Sampling;

- Sample preservation and transport, including
  - Sample preparation,
  - Sample labeling,
  - Transport of samples to Evergreen via. overnight courier;
- Completion of sampling records; and
- Sample disposition.

Detailed groundwater sampling and handling procedures are presented in following sections.

2.3.1 Groundwater Sampling Locations

Groundwater samples were collected from existing monitoring wells and from newly installed groundwater monitoring points.

2.3.1.1 Monitoring Well Sampling Locations

Groundwater samples were collected from 10 existing monitoring wells (MW-1 through MW-10), during the 1994 sampling event. In June 1996, groundwater samples were collected from 6 monitoring wells (MW-1 and MW-7 through MW-11). All wells were purged using a peristaltic pump with dedicated polyethylene tubing. A dedicated disposable bailer was used to collect the samples in August 1994, and in June 1996 samples were collected using a peristaltic pump and dedicated polyethylene tubing. Additional sampling procedures are discussed in Section 2.3.3. Locations of these wells are indicated on Figure 2.1.

2.3.1.2 Monitoring Point Locations

Groundwater samples were collected from 18 monitoring points across the site during the August 1994 sampling event. The deep and shallow intervals were sampled at CPT-2, CPT-8 through CPT-11, CPT- 16, and CPT-18. However, only the deep samples were collected at CPT-19 through CPT-22. Adequate purge and sample volumes could not be obtained from these shallow locations. During the June 1996 sampling event, CPT-19 through CPT-22 were sampled, and once again only deep points were sampled because adequate purge and sample volumes could not be obtained from these shallow locations. Monitoring points were purged and sampled using a

peristaltic pump and dedicated tubing (where needed). Locations of groundwater monitoring points are indicated on Figure 2.1.

2.3.2 Preparation for Sampling

All equipment used for sampling was assembled and properly cleaned and calibrated (if required) prior to arriving in the field. In addition, all record-keeping materials were gathered prior to leaving the office.

2.3.2.1 Equipment Cleaning

All portions of sampling and test equipment that contacted the samples were thoroughly cleaned before use. This equipment included the water level probe and cable, lifting line, test equipment for onsite use, and other equipment that contacted the samples or was placed downhole. The following cleaning protocol was used:

- Cleaned with potable water and phosphate-free laboratory detergent;
- Rinsed with potable water;
- Rinsed with isopropanol;
- Rinsed with distilled or deionized water;
- Air dried prior to use.

Any deviations from these procedures were documented in the field scientist's field notebook and on the groundwater sampling form.

2.3.2.2 Equipment Calibration

As required, field analytical equipment were calibrated according to the manufacturer's specifications prior to field use. This applied to equipment used for onsite chemical measurements of DO, redox potential, pH, specific conductivity, and temperature.

2.3.3 Sampling Procedures

Special care was taken to prevent cross-contamination of the groundwater, groundwater samples, and sampling equipment. Water level probes and cable used to determine static water levels and well total depths were thoroughly cleaned before and after field use and between uses at different sampling locations according to the procedures presented in Section 2.3.2.1. Generally, sample probes were utilized within a flow-through container which was installed downstream of the peristaltic pump. Samples were either collected using dedicated polyethylene tubing and a peristaltic pump, or from a dedicated bailer. In addition, the sampler donned a new pair of disposable nitrile gloves at each sampling station.

2.3.3.1 Groundwater Monitoring Well and Monitoring Point Sampling

2.3.3.1.1 Preparation of Location

The area around each monitoring well/point was cleared of foreign materials, such as brush, rocks, and debris prior to sampling. This prevented sampling equipment from inadvertently contacting debris around the monitoring well/point.

2.3.3.1.2 Water Level and Total Depth Measurements

Prior to removing any water from the monitoring well or monitoring point, the static water level was measured. An electric water level probe was used to measure the depth to groundwater to the nearest 0.01 foot below the datum. After measuring the static water level, the field scientist slowly lowered the water level probe to the bottom of the monitoring point. The total depth was measured to the nearest 0.01 foot.

2.3.3.1.3 Monitoring Well/Point Purging

The volume of water to be purged from the monitoring well/point was calculated. The field scientist purged at least three times the calculated volume from the well/point using a peristaltic pump and dedicated tubing. Parsons ES maintained a low flowrate from the peristaltic pump during purging and sampling all monitoring wells/points. This minimizes evaporation (boiling) of the water in the suction line due to decreased pressures, minimizes excess mixing and aeration in the sample container, and ensures that the well does not become dry (entrain air in the suction line). All purge water was placed in 55-gallon drums and disposed of by Bolling AFB. The emptied drums remained with Bolling AFB for reuse.

2.3.3.1.4 Sample Extraction

The following sample extraction procedures are designed to minimize sampled disturbance and subsequent volatilization of VOCs. Generally, the VOC concentration data collected under the intrinsic remediation program are higher than data gathered previously at the site. However, concentrations once again begin to decrease when using the same sampling techniques during LTM. This implies that fewer VOCs are lost from the samples while following the protocols developed under the intrinsic remediation program.

Dedicated high-density polyethylene (HDPE) tubing and a peristaltic pump were used to extract groundwater samples from the monitoring points. The suction end of the tubing was slowly lowered down the casing to prevent splashing. A dedicated disposable bailer was used to collect the groundwater sample from monitoring wells. The samples were transferred directly into the appropriate sample container(s), with water carefully poured down the inner walls of the sample bottle to minimize aeration of the sample. Sample containers were filled completely (zero headspace) to minimize volatilization.

Excess water collected during sampling was placed into the 55-gallon drums used for monitoring well/point purge waters. Upon project completion, Parsons ES transported the drums to the Bolling AFB designated drum storage location.

2.3.4 Onsite Chemical Parameter Measurement

Most chemical parameters of groundwater can change significantly within a short time following sample acquisition. As a result, these parameters were measured in the field immediately after collection. The following procedure was utilized during groundwater sampling for all direct reading instruments (e.g., DO, redox, pH, temperature, and electric conductivity). An Erlenmeyer flask was installed downstream from the peristaltic pump to form a flow-through chamber for the sampling probes. As a result, a continuous measurement from the direct reading instruments was possible. The extracted groundwater flowed over the probes while immersed in the Erlenmeyer flask. This effectively produces a flow-through cell that minimizes aeration of the sample. Pumping continued until the readings stabilized. The stabilized reading was recorded.

2.3.4.1 Dissolved Oxygen Measurements

DO measurements were taken using an Orion® model 840 (or similar DO measurement instrument) using the above described procedures. DO concentrations were determined while the probe was immersed in an Erlenmeyer flask. This effectively minimized aeration of the sample. DO concentrations were recorded after the readings stabilized. In all cases, the lowest DO concentration was recorded.

2.3.4.2 Reduction/Oxidation Potential Measurements

Redox potential measurements were taken using an Orion® model 290A redox potential meter. Redox potential measurements were recorded after the readings stabilized and generally represent the lowest redox potential observed.

2.3.4.3 Temperature, pH, and Electric Conductance

Temperature and pH were determined with an Orion® model 290A meter with an ion select probe. These parameters were recorded after the readings stabilized and generally represent the average reading after stabilization. Electrical conductance was not measured during either sampling event.

2.3.5 Sample Handling

2.3.5.1 Sample Preservation

Evergreen Analytical added any necessary chemical preservatives to sample containers prior to sampling.

2.3.5.2 Sample Container and Labels

Sample containers and appropriate container lids were provided by Evergreen Analytical. The sample containers were filled as described in Section 2.3.3.1.4, and the container lids were tightly closed. The sample label was firmly attached to the container side, and the following information was legibly and indelibly written on the label:

- Facility name;
- Sample identification;
- Sample type (i.e., groundwater);
- Sampling date;
- Sampling time;
- Preservatives added; and,
- Sample collector's initials.

2.3.5.3 Sample Shipment

The samples were sealed, labeled, and placed in an iced cooler. Then, coolers were packaged for transport to Evergreen Analytical via Federal Express® priority delivery. The following packaging and labeling procedures were followed:

- Sample was packaged to prevent leakage or vaporization from its container;
- Shipping container was labeled with
  - Sample collector's name, address, and telephone number;
  - Laboratory's name, address, and telephone number;
  - Description of sample;
  - Quantity of sample; and
  - Date of shipment.

Generally, the packaged samples were hand-delivered directly to the Federal Express® facility at the end of each day.

2.4 AQUIFER TESTING

Prior to initiation of the field activities, Parsons ES reviewed the slug test methodologies performed by Baker (1994) at the Car Care Center Site. Baker performed slug tests in monitoring wells MW-7, MW-8, MW-9, and MW-10. These methodologies appeared consistent with the protocols established for the Intrinsic Remediation program (Wiedemeier *et al.*, 1994). Hydraulic conductivity (K) was calculated from established analytical methods (Bouwer and Rice, 1976; Bouwer, 1989). Reported K values were reasonable for the aquifer material at the site. K values also were consistent among the four wells tested. As a result, Parsons ES did not perform additional aquifer testing at the site.

SECTION 3

PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section incorporates data collected during investigations by ATEC (1990) and Baker (1994) with data from more recent investigations conducted by Parsons ES. The investigative techniques used by Parsons ES to determine the physical characteristics of the Car Care Center Site are discussed in Section 2.

3.1 SURFACE FEATURES

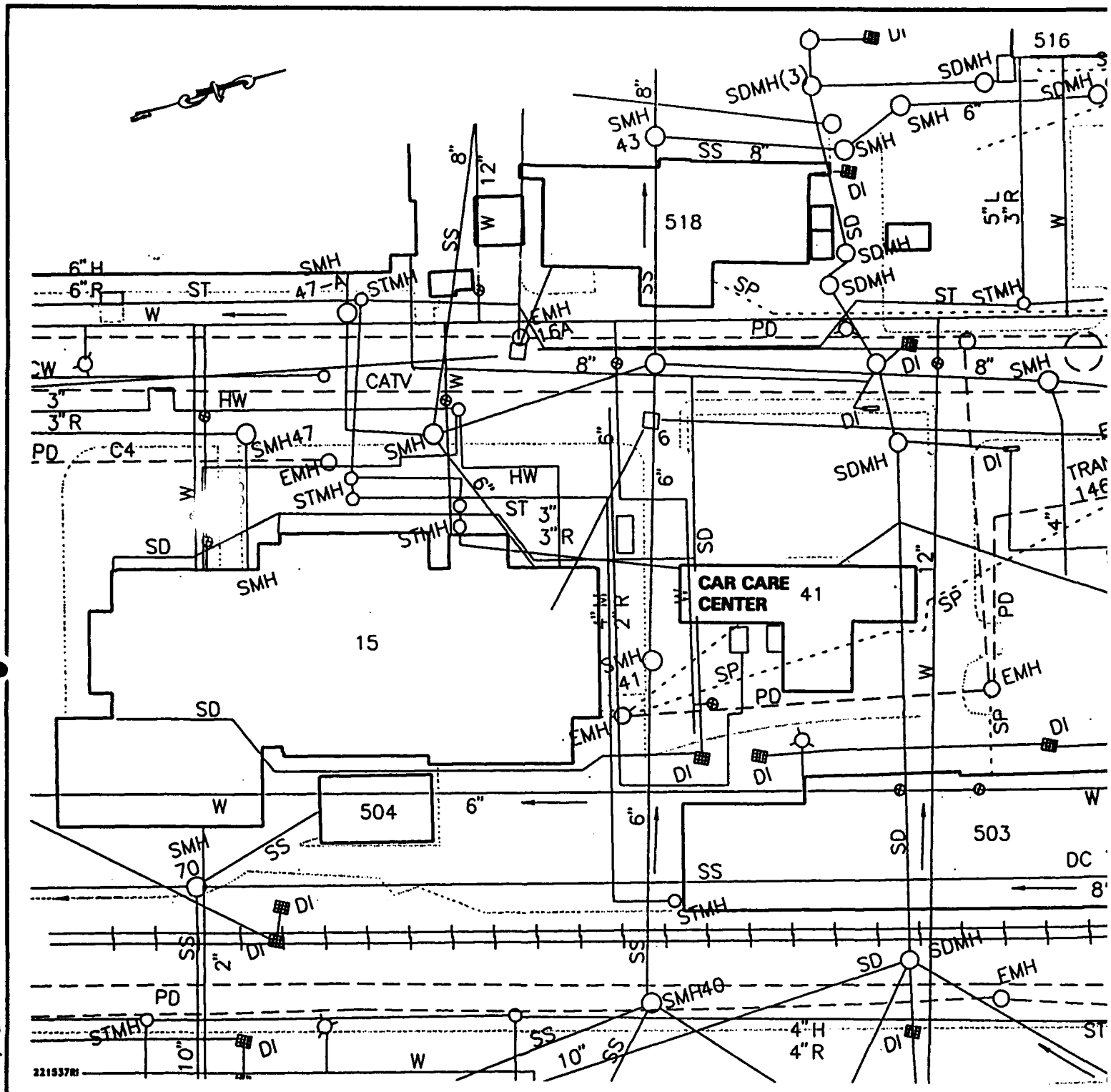
3.1.1 Topography and Surface Water Hydrology

The Car Care Center Site is located in the floodplain along the eastern shore of the Potomac River, just south of the confluence of the Potomac and Anacostia River (Figure 1.1). The ground surface at the base is nearly level, with the exception of a steep rise along the eastern boundary of the base corresponding to the terraces above the Potomac River floodplain. The floodplain area within Bolling AFB has been extensively filled during development of the base for flood control. In addition, the Potomac shoreline was filled and extended during the 1930s and 1940s to provide additional space for base expansion (Baker, 1994). The Car Care Center is located at approximately 22 feet above mean sea level (msl), 20 feet above the Potomac River. Any significant elevation changes at Bolling AFB and surrounding areas are the result of erosion, filled wetlands, and/or stream channel development.

The entire Washington, DC area is drained by the Potomac River, which is fed by its local tributaries: the Anacostia River and Rock Creek in the north, and Difficult Run, Pimmit Run, Holes Run and Accotink Creek in the south. Surface water runoff at the base, which is not intercepted by the base storm water drainage system, flows westward overland toward the Potomac River. There are no naturally occurring surface water bodies in the vicinity of the Car Care Center. There are several manmade features at or near the site that may influence surface water runoff. These features are discussed in Section 3.1.2.

3.1.2 Manmade Features

Land surface cover at the Car Care Center and adjacent areas consists of grassy landscaped areas, asphalt paving, concrete overlays, buildings, and other impervious structures. The majority of the precipitation that falls on the base either infiltrates into the subsurface or is captured by the storm water drainage system. Numerous subsurface utilities, including storm sewers, are located in the vicinity of the Car Care Center. Figure 3.1 shows the subsurface utility layout in the vicinity of the Car Care Center. Subsurface utilities in the vicinity of the site probably have little influence on

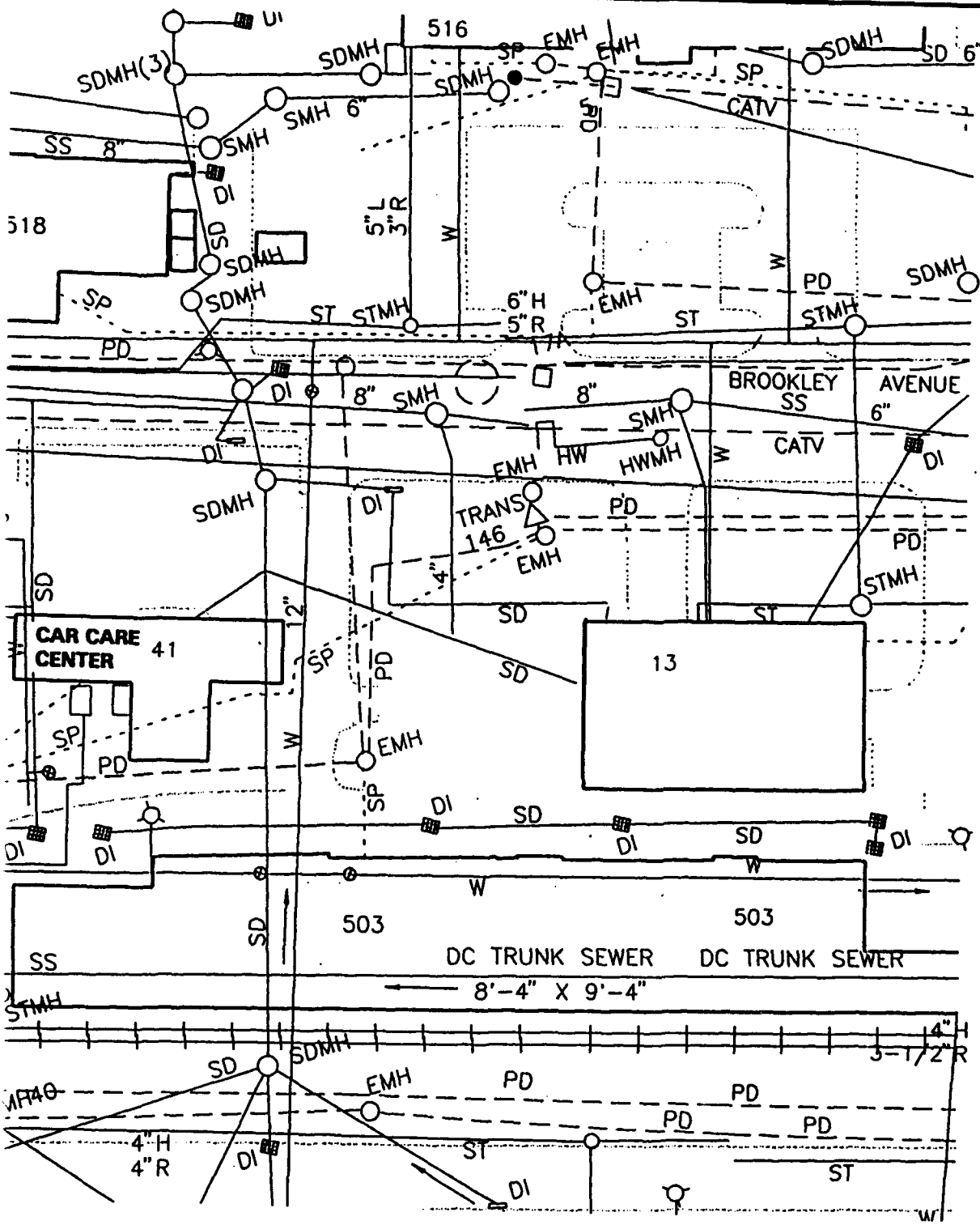


LEGEND

- RAILROAD
- FENCE LINE
- PROPERTY LINES-IN FEE
- PROPERTY LINES-EASEMENT
- W — WATER LINE
- M — METER
- WATER VALVE
- WATER HYDRANT
- PUMP STATION

Source: Baker, 1994.

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LEGEND

SD	STORM DRAINA
SDMH	STORM DRAINA
DI	STORM DRAINA
DI	STORM DRAINA
	STORM DRAINA
CW	CHILLED WATE
HW	HIGH TEMPERA
ST	STEAM LINE
CWMH, HWMH, STMH	HEATING AND C
NG	NATURAL GAS
	NATURAL GAS
R	REGULATOR
	DRIP POT
PD	PRIMARY DISTRI
SP	SECONDARY DIS
EMH	ELECTRICAL MA
TRANS	TRANSFORMER
CATV	CABLE TELEVISI
T	TELEPHONE LIN
	COMMUNICATION
	ANTENNA SITE
	SERVICE NODE
	FLOW DIRECTIO
SS	SANITARY SEWE
SMH	SANITARY SEWE
CO	CLEAN OUT

50' 25' 0 50'

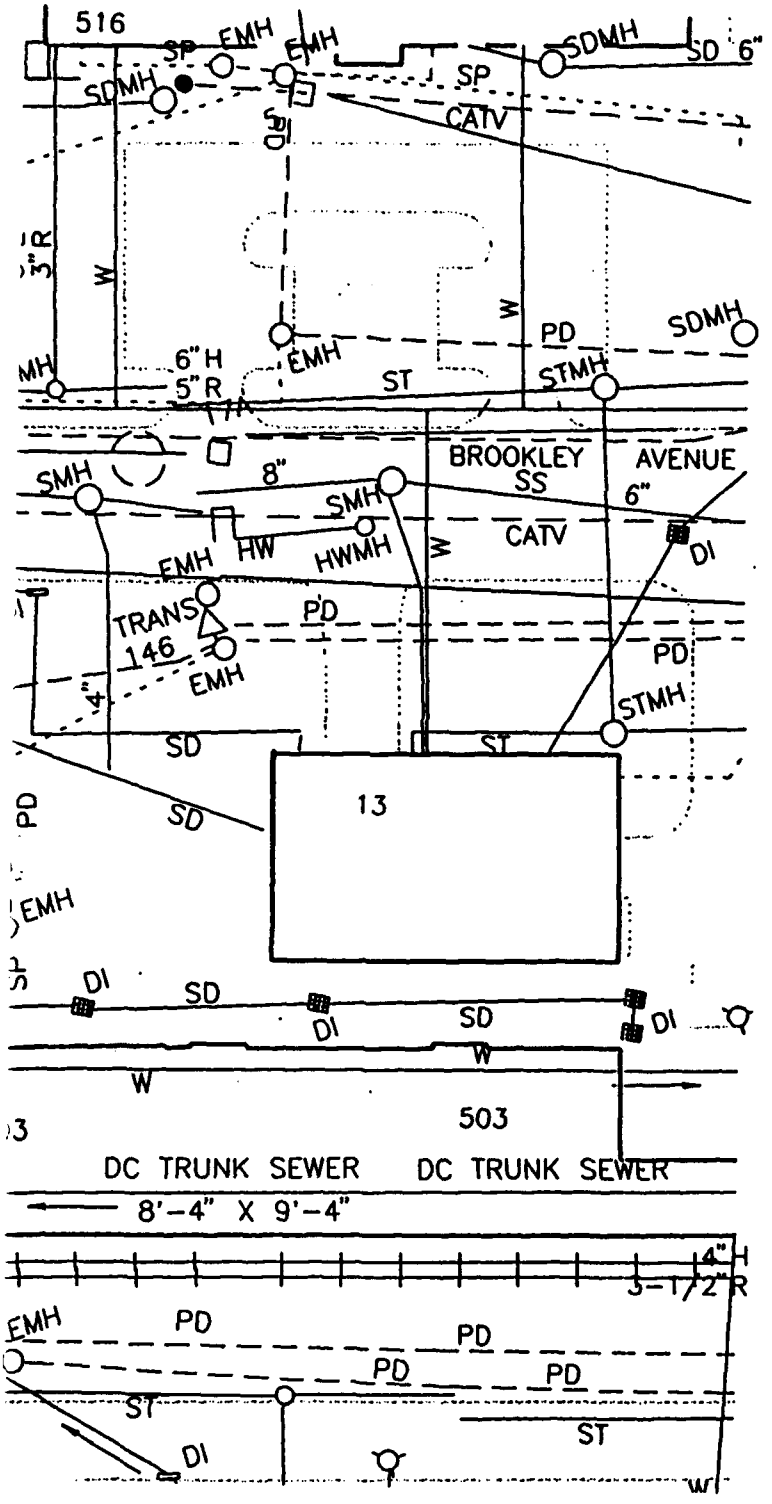
Approximate Scale in Feet

Subsurface Utility

Car Care Cente
Intrinsic Remediati
Bolling AFB,

PARSONS ENGI

Figure 3.1



LEGEND

SD	STORM DRAINAGE LINE
SDMH	STORM DRAINAGE MANHOLE
DI	STORM DRAINAGE SURFACE INLET
DI	STORM DRAINAGE CURB INLET
	STORM DRAINAGE HEADWALL
CW	CHILLED WATER LINE
HW	HIGH TEMPERATURE WATER LINE
ST	STEAM LINE
CWMH, HWMH, STMH	HEATING AND COOLING MANHOLE
NG	NATURAL GAS LINE
	NATURAL GAS VALVE
R	REGULATOR
	DRIP POT
PD	PRIMARY DISTRIBUTION LINE
SP	SECONDARY DISTRIBUTION LINE
EMH	ELECTRICAL MANHOLE
TRANS	TRANSFORMER
CATV	CABLE TELEVISION LINE
T	TELEPHONE LINE
	COMMUNICATIONS MANHOLE
	ANTENNA SITE
	SERVICE NODE
	FLOW DIRECTION ARROW
SS	SANITARY SEWER GRAVITY LINE
SMH	SANITARY SEWER MANHOLE
CO	CLEAN OUT

50' 25' 0 50'

Approximate Scale in Feet

Subsurface Utility Locations

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

groundwater flow because the water table is about 20 feet below land surface (bls), substantially deeper than typical utility trench depths. However, utility trenches may affect subsurface infiltration and flow of water and contaminants in the vadose zone.

3.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

Washington, DC straddles the fall line which separates the Piedmont Physiographic Province on the northwest from the Atlantic Coastal Plain Physiographic Province on the southeast (Smith, 1976). The fall line passes from Fort Belvoir, Virginia on the south through Roosevelt Island and DC to Silver Spring, Maryland on the north. Bolling AFB is located along the inner margin of the Atlantic Coastal Plain Physiographic Province, a wide wedge-shaped belt of Cretaceous to Recent sedimentary deposits (Foster, 1950). The Coastal Plain terrain consists of well dissected to gently rolling upland areas and flat lowland areas. Surface features include hills, terraces, and well defined stream valleys with steep walls and flat floodplains.

The Atlantic Coastal Plain deposits consist of unconsolidated sediments made up of mixtures of interlayered clay, silt, sand, shell, and gravel approximately 700 to 1,000 feet thick. These sediments thicken to the southeast and dip toward the east (Darton, 1950). The Coastal Plain sediments feather onto crystalline igneous and metamorphic Piedmont rocks along the fall line in northwestern Washington DC. The Piedmont rocks dip steeply to the east. Because the Coastal Plain sediments were deposited under a wide range of subaerial and near-shore environments, the strata are not continuous over long distances (Johnston, 1978).

The area between the main portion of the Base and the uplands along the eastern border is underlain by Pleistocene and Recent river terrace deposits of the Pamlico Formation. These deposits consist of up to 30 feet of sand, gravel, silt, and clay, and may be overlain by fill. Cretaceous sediments of the Potomac Group, consisting of silty clay interbedded with sand and gravel lenses, underlie the Quaternary deposits. Potomac Group sediments outcrop in the upland area in the extreme eastern portion of Bolling AFB. These sediments include sands and clay of the Cretaceous Patapsco Formation and the dark-gray massive Arundel Clay. The Patapsco Formation is one of the more productive aquifers in the Washington, DC area (Johnston, 1978).

A soil survey of the District of Columbia (Smith, 1976) indicates that Bolling AFB is underlain by a variety of surficial soils. These soils primarily consist of (1) Udorthents; heterogeneous earthy fill materials placed over drained areas of a floodplain, (2) Luka-Lindside-Codorus association; deep, nearly level, moderately well drained soils underlain by stratified alluvial sediment or dredge material on a floodplain, and some (3) Urban Land; developed areas where more than 80 percent of the surface is covered by asphalt, concrete, buildings, or other impervious surfaces. Because the Washington DC area has not been glaciated, uplands and hillsides are typically covered by deep residual soils.

3.3 SITE GEOLOGY AND HYDROGEOLOGY

Characterization of the vadose zone and shallow unconfined aquifer at the Car Care Center Site has been the objective of several investigations. For this study, 24 locations were investigated using CPT in conjunction with LIF to examine site

lithology and hydrocarbon contamination. During the investigations of August 1994 and June 1996, there were 10, 4-inch-diameter groundwater monitoring wells (MW-1, MW-2 and MW-3 through MW-11), and four pairs of permanent nested 0.5-inch-diameter monitoring points (CPT-19 through CPT-22, shallow and deep intervals). Seven pairs of temporary nested 0.5-inch-diameter monitoring points (CPT-2, CPT-8, CPT-9, CPT-10, CPT-11, CPT-16, and CPT-18; shallow and deep intervals) were also installed and sampled during the initial August 1994 site investigation. MW-2 was sampled during the August 1994 sampling event, was destroyed shortly there after, and replaced with MW-11 which was sampled in June 1996. Figure 3.2 shows the locations of the monitoring wells and the CPT test points. To minimize confusion among CPT test points, LIF test points, and monitoring point installations, a single prefix (CPT) was used to label all locations of CPT testing and all monitoring points installed with the cone penetrometer rig. Table 2.1 presents a summary of the actual tests performed and available well and monitoring point completion information.

3.3.1 Lithology and Stratigraphic Relationships

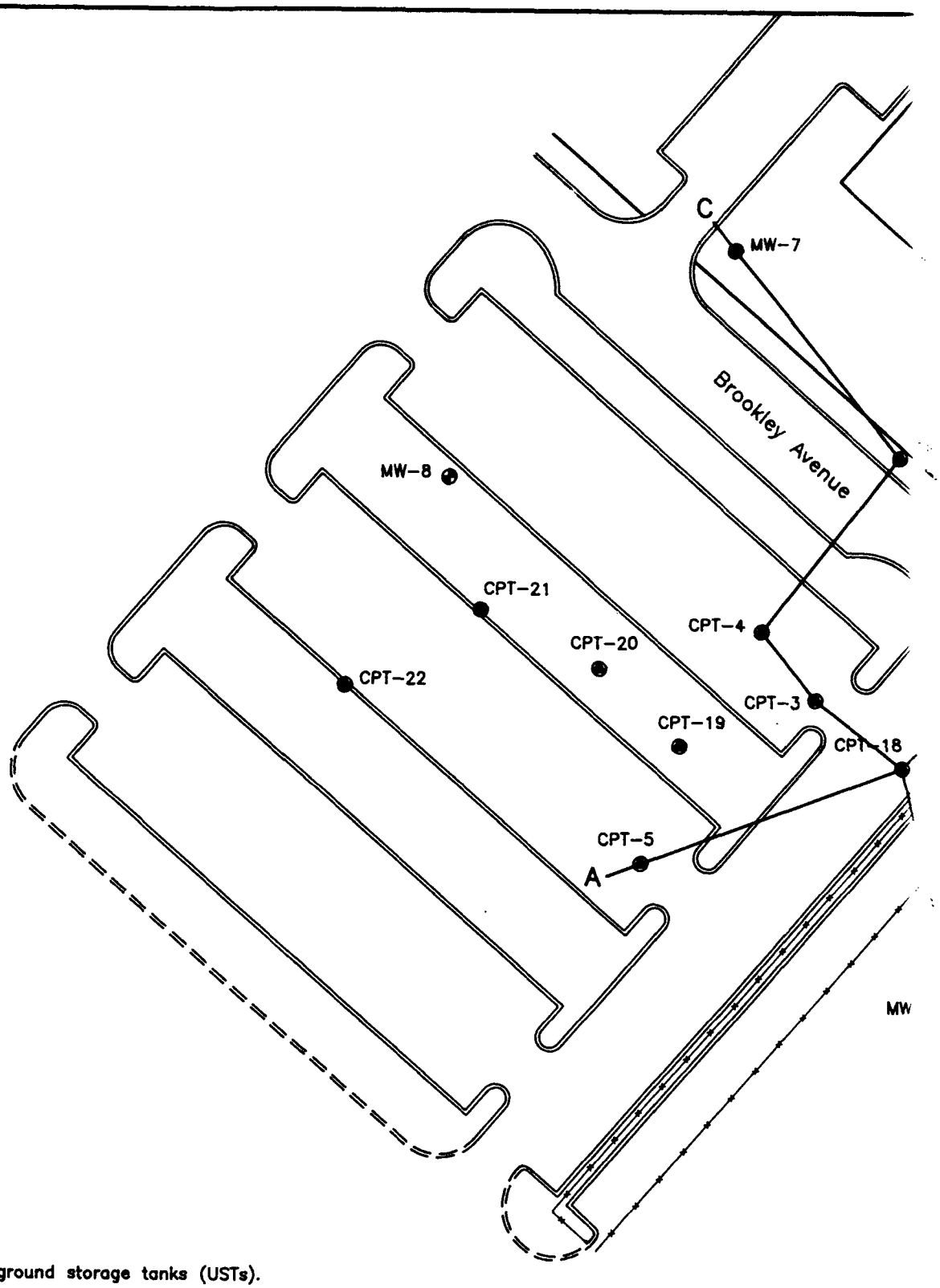
The sediments underlying the Car Care Center consist of naturally deposited interbedded alluvial sands, silts, clays, and gravel. The top 5 to 15 feet of sediment consists of a continuous bed of sand with silt, dipping and becoming thicker to the north. A localized clay lens about 1 to 2 feet thick has been observed at approximately 10 to 15 feet bls in the area along the north side of the Car Care Center. A discontinuous layer of sand with minor amounts of gravel from 6 to 11 feet bls was present in some areas. Underlying these sediments is a 3- to 5-foot thick region of clay interbedded with silt. This in turn, is underlain by sand with silt and minor amounts of clay. Below about 20 feet bls, sand with gravel is present. The actual base of the surficial aquifer was not determined with certainty during this or previous investigations. Baker (1994) reported that the sandy-gravel zone may extend to 700 to 1,000 feet bls. Because these are alluvial sediments, many units are discontinuous and vary in thickness along their length. Some strata pinch out entirely within the study area. The clay layers may act to form localized small-scale perched aquifers, thereby producing relatively shallow regions of hydrocarbon contamination, as observed at CPT-12 and CPT-13 (Appendix A). Although the subsurface geology at the site is classified as mostly sand with varying amounts of silt, gravel and clay, an attempt to differentiate between more and less permeable layers was performed to clarify where perched groundwater conditions might exist at the site.

These stratigraphic relationships are illustrated by hydrogeologic sections A-A', B-B', and C-C'. Figure 3.2 shows the location of these sections. Figure 3.3 displays hydrogeologic section A-A' which is oriented approximately parallel to the direction of groundwater flow. Figures 3.4 and 3.5 display hydrogeologic sections B-B' and C-C', respectively, which are oriented approximately perpendicular to the direction of groundwater flow.

3.3.2 Groundwater Hydraulics

3.3.2.1 Groundwater Flow Direction and Gradient

The uppermost hydrogeologic unit at Bolling AFB consists of an unconfined aquifer within the alluvium, river terrace deposits, and fill materials. Groundwater flow

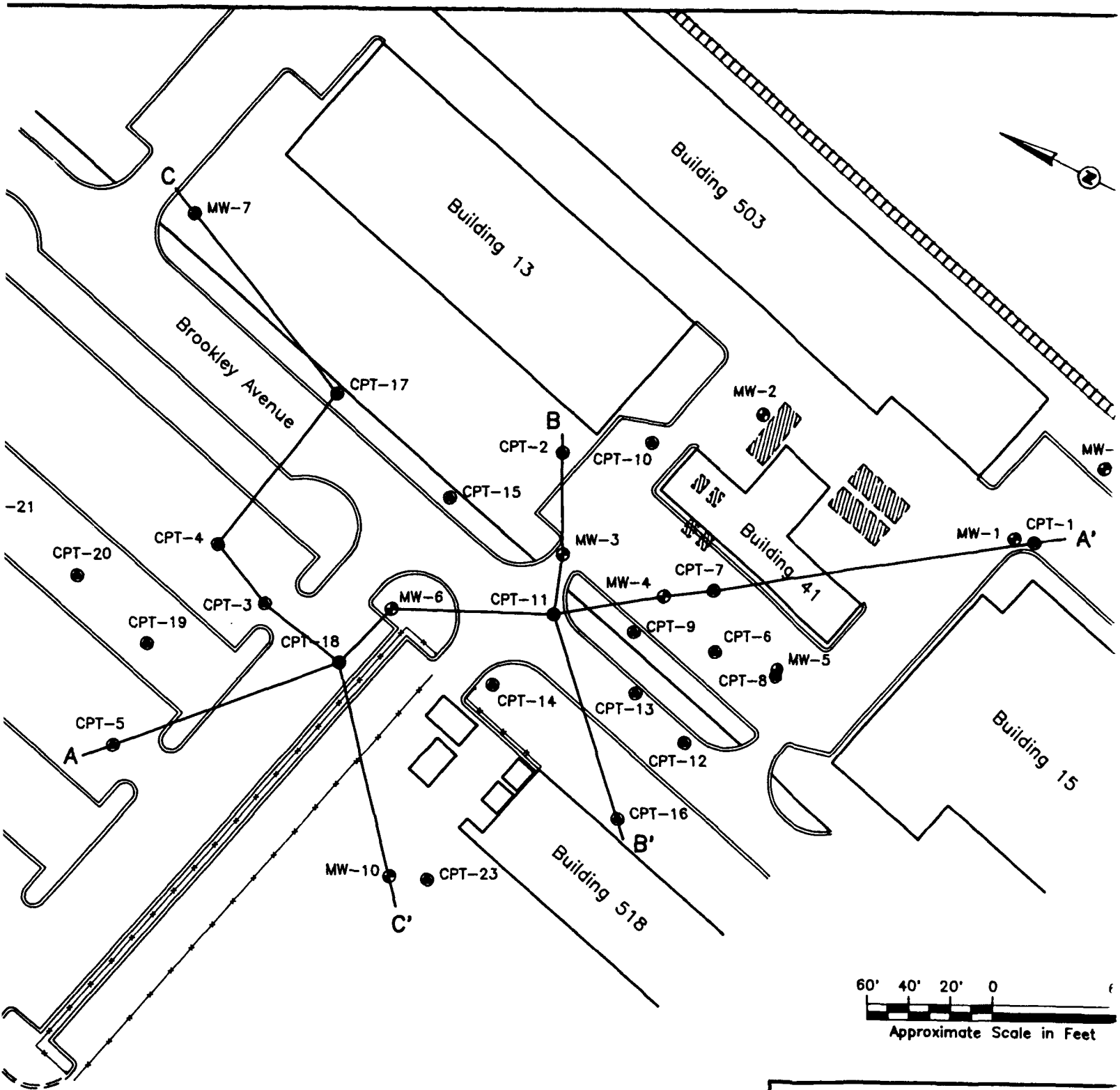


LEGEND

- Former underground storage tanks (USTs).
- MW-1 ⊕ Existing monitoring well.
- CPT-1 ● Monitoring point and CPT test location installed by CPT rig.

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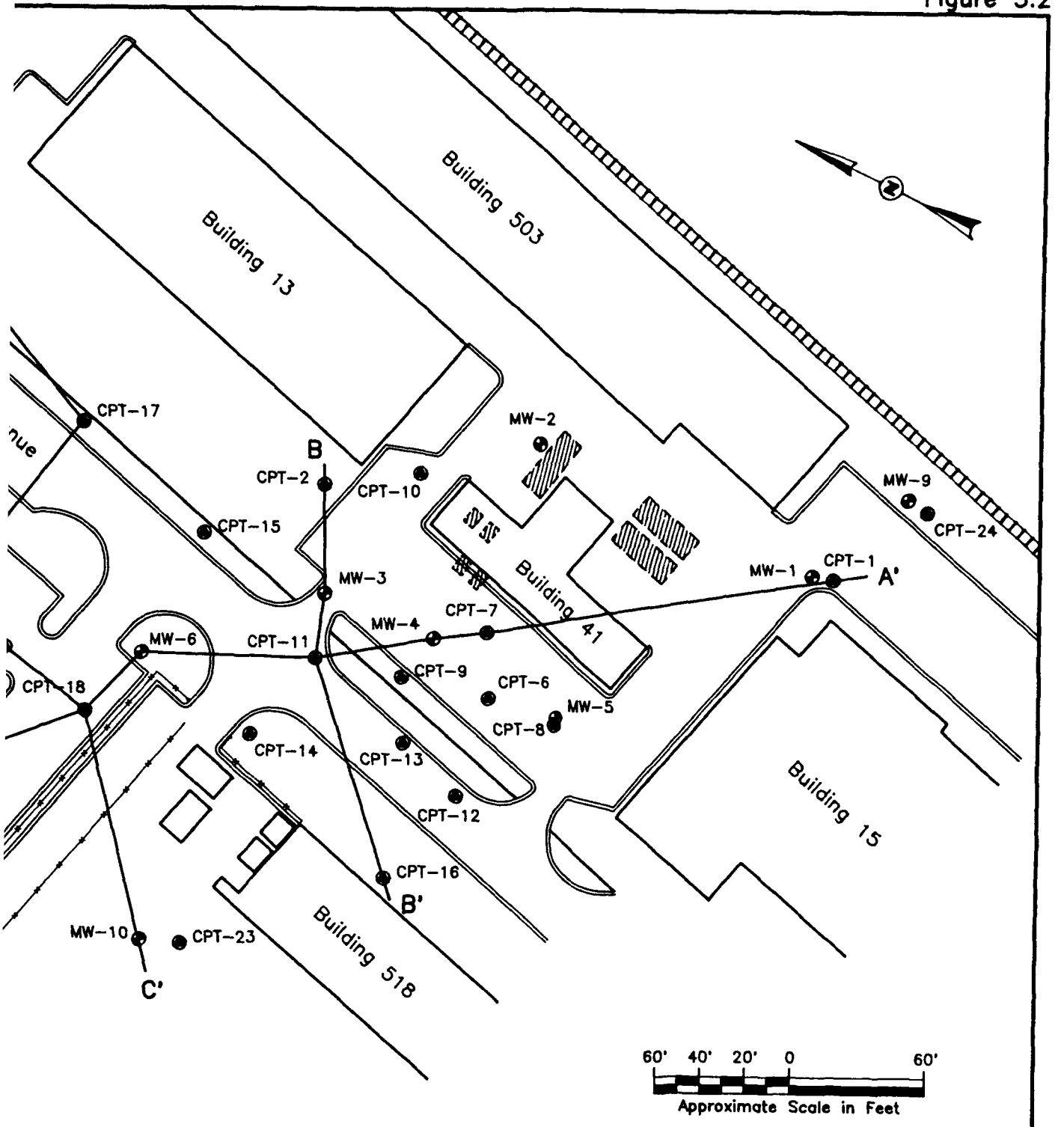


Hydrogeologic Cross-Section L

Car Care Center Site
Intrinsic Remediation EE
Bolling AFB, DC

PARSONS ENGINEERING

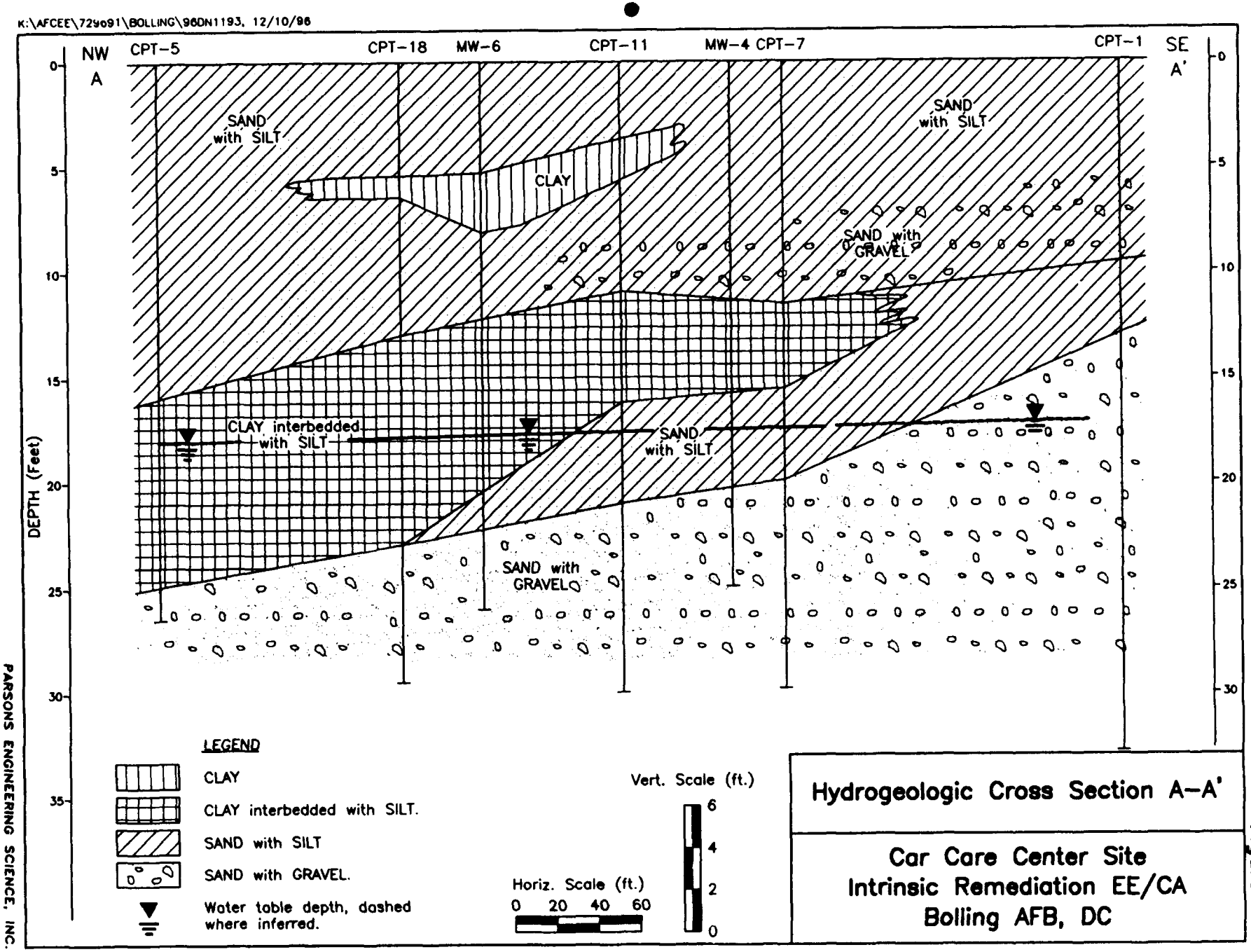
Figure 3.2



Hydrogeologic Cross-Section Locations

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

PARSONS ENGINEERING SCIENCE, INC.

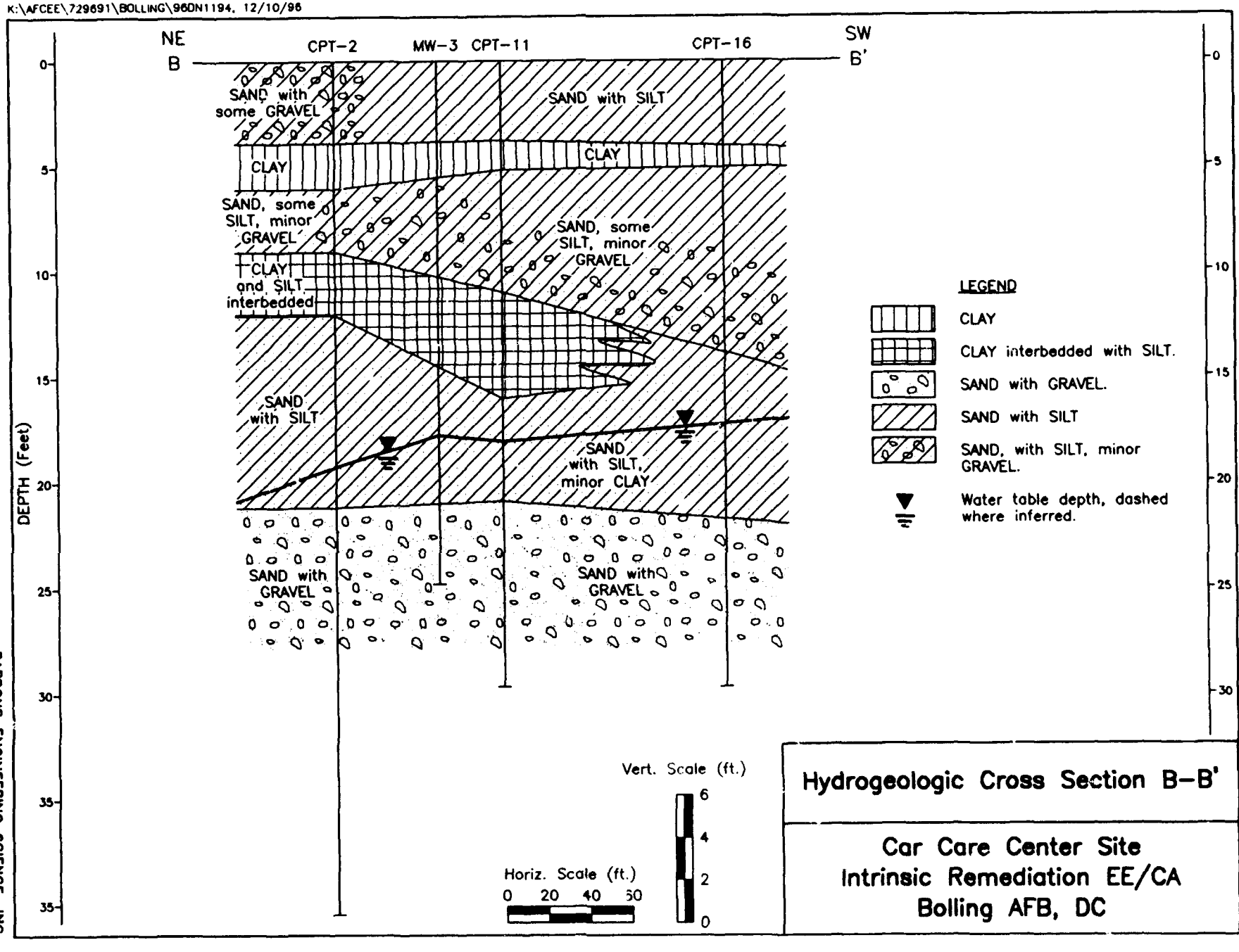


Hydrogeologic Cross Section A–A'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 3.3

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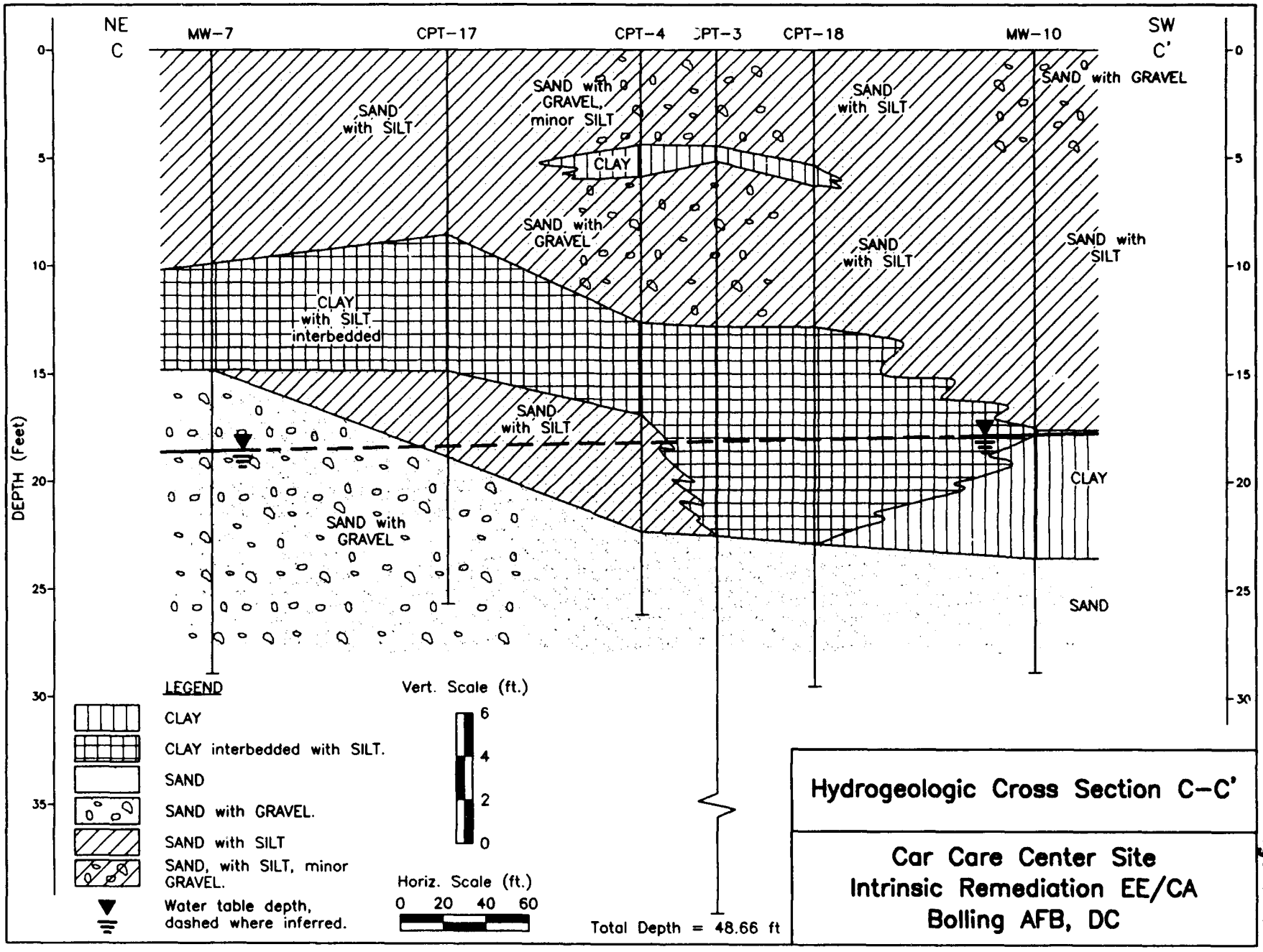


Hydrogeologic Cross Section B–B'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 3.4

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Hydrogeologic Cross Section C–C'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

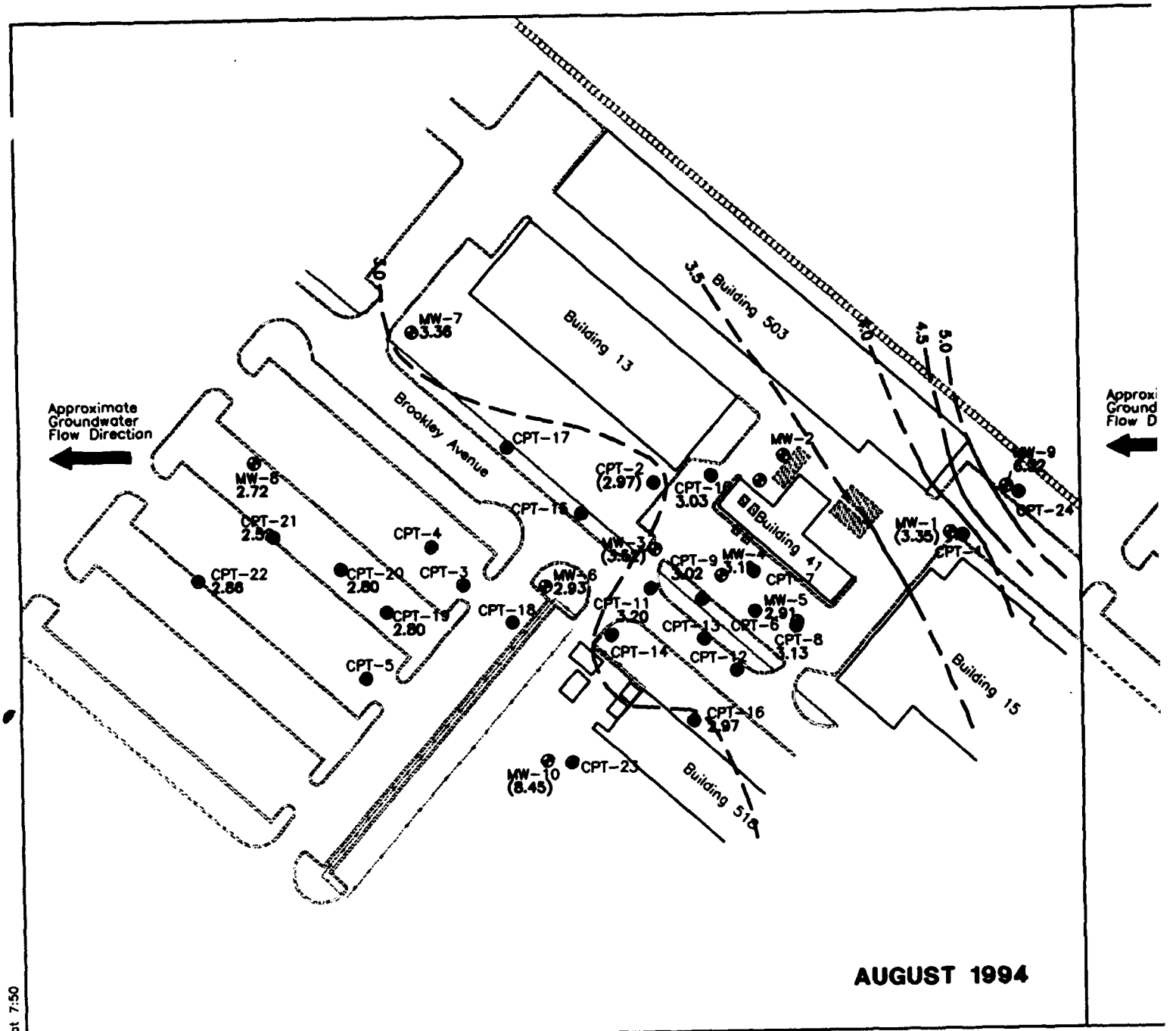
Figure 3.5

directions within the surficial unconfined aquifer are generally westerly toward the Potomac River. Groundwater at the Car Care Center Site is typically encountered at a depth of approximately 20 feet bls. However, a perched water table has also been observed at the site at depths ranging from 8 to 12 feet bls in several borings and monitoring wells.

Groundwater elevations within the shallow aquifer range from approximately 2 to 5 feet msl and approximately 9 to 10 feet msl in the perched zone near MW-10. Figure 3.6 compares two potentiometric surface maps of the unconfined aquifer at the site based on groundwater elevations measured in monitoring wells and monitoring points collected during both the August 1994 and the June 1996 sampling events (Table 3.1). Groundwater elevations observed in some wells were anomalous and were not used in construction of the potentiometric surface map. The water level in MW-10, for example, is much higher than in surrounding wells and monitoring points. In June 1996, monitoring well MW-10 and deep monitoring points CPT-19 and CPT-20 had considerably higher water levels than the surrounding wells. These anomalies at CPT-19 and CPT-20 could result from location in a landscaped area that is regularly watered, and intermittent impermeable clay layers that exist throughout the site and are present just upgradient of CPT-19 and 20. Either of these combinations or a combination of both could lead to a perched water table in the immediate vicinity of CPT-19 and CPT-20. The direction of groundwater flow (Figure 3.6) in the unconfined aquifer at the site, based on groundwater elevations in site monitoring wells and monitoring points taken during both sampling events, is to the west northwest toward the Potomac River.

The average horizontal hydraulic gradient reported by Baker (1994) was 0.0028 foot/foot. The observed gradient developed from the data collected during that investigation was higher in the upgradient area of the site and leveled out substantially in the direction of the river. A sharp rise in site topography near the upgradient portion of the site due to the Potomac floodplain terraces (see Section 3.1.1) may account for the higher observed gradient. A horizontal gradient of 0.026 foot/foot was calculated in the vicinity of MW-9, which indicates the magnitude of change in horizontal hydraulic gradient near the upgradient site boundary. A gradient of approximately 0.0014 foot/foot was measured through the center of the site between MW-4 and CPT-20 from the August 1994 site investigation. The 0.0014 foot/foot gradient value is more indicative of head potential within the primary area of plume migration because the 0.0028 foot/foot value partially includes the higher head conditions observed near the upgradient site boundary (Figure 3.6).

Vertical gradients were calculated across the site at the multidepth monitoring points. Vertical gradients ranged from 0.17 foot/foot (upward) at CPT-22 to -0.13 foot/foot (downward) at CPT-21. The average vertical hydraulic gradient was -0.0040 foot/foot (downward). Vertical gradient variances can be effected by several factors including localized infiltration zones (e.g., storm retention ditches, leaking utility piping), regional discharge areas (e.g., rivers or lakes), presence of inconsistent surface cover, and varying lithological structures. Because CPT-21 and CPT-22 are in the same general vicinity, they are likely effected similarly by local infiltration. As a result, the observed variations in vertical gradient are likely due to lithological differences which likely exist randomly across the site. Due to this circumstance, definitive conclusions cannot be drawn regarding the effects of vertical hydraulic



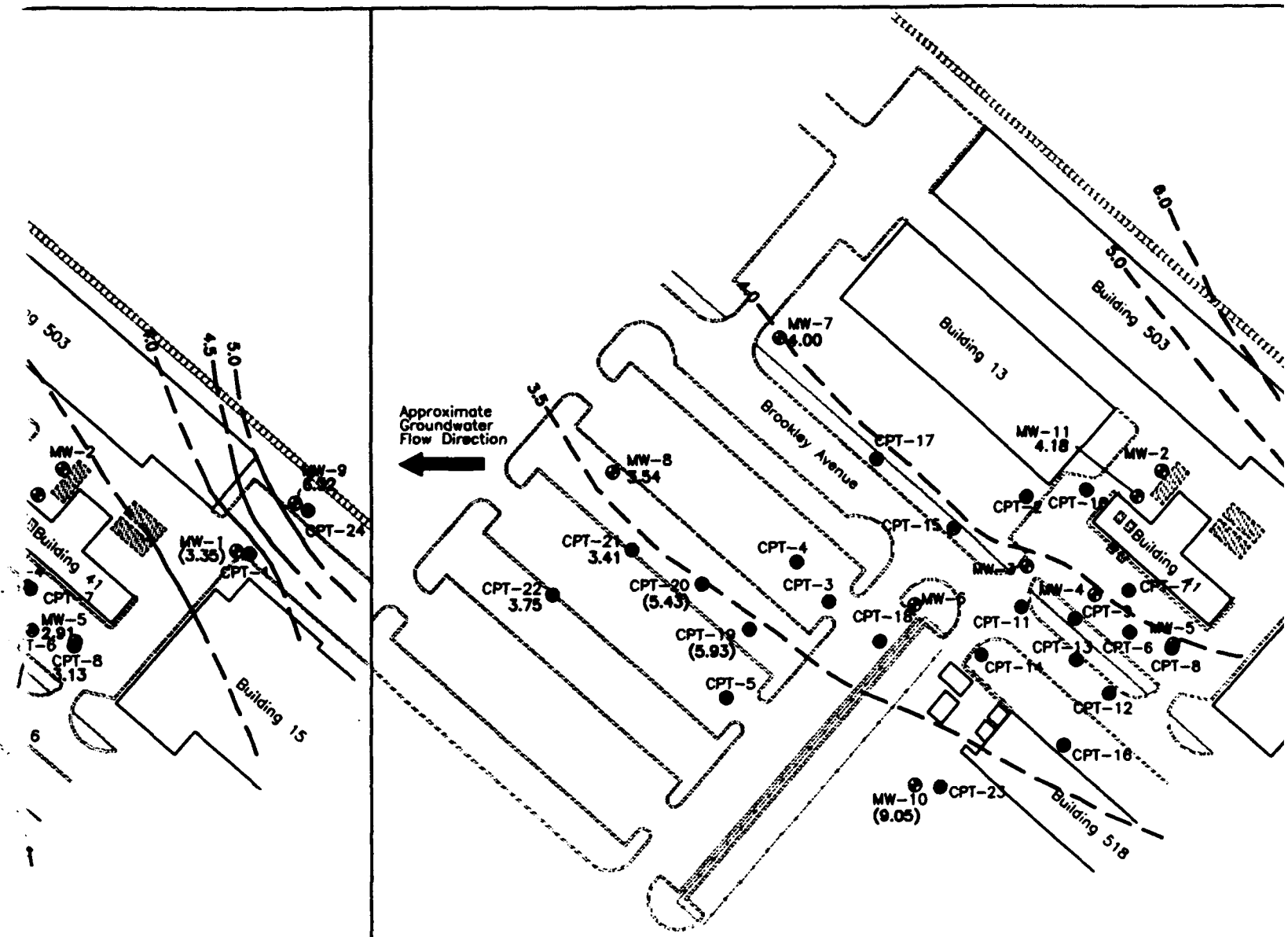
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
2.72	Groundwater potentiometric surface (feet)
(3.52)	Data not utilized to construct contours.
—— 3.0 ——	Groundwater potentiometric surface contour (feet)

NOTE:

1. Isopleth map was developed using data fro deep CPT points and monitoring wells.

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AUGUST 1994

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

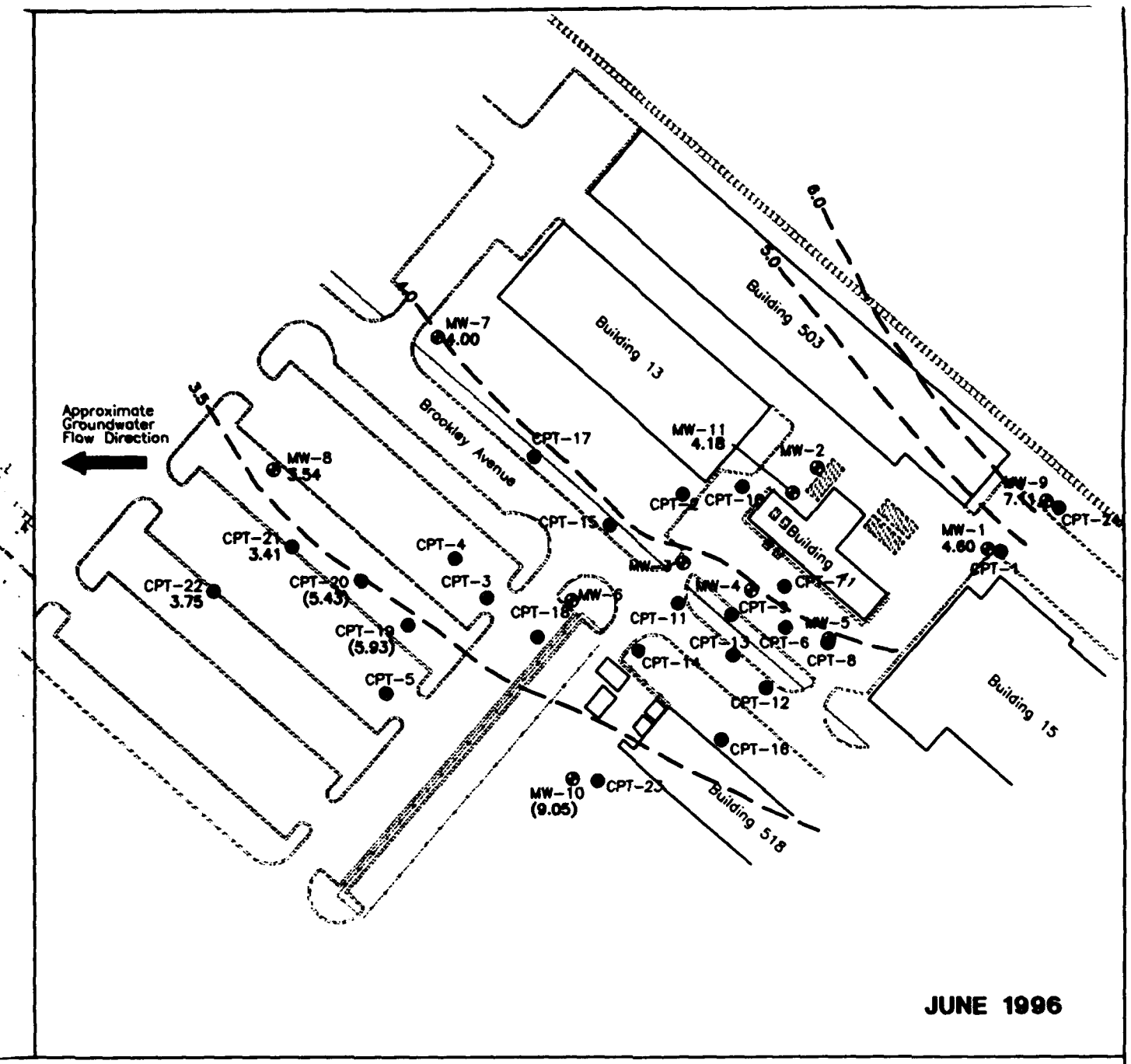
100' 50' 0 100'

Approximate Scale in Feet

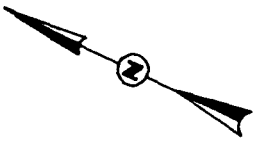
Potentiometric Surfa

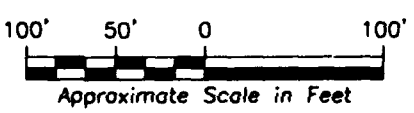
Car Care Center
Intrinsic Remediatio
Bolling AFB,

PARSONS ENGIN



JUNE 1996





:sing data from
. g wells.

Potentiometric Surface Maps

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

TABLE 3.1

WATER LEVEL ELEVATION DATA
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Sample Location[a]	Date	Easting (feet)	Northing (feet)	Datum Elevation[b] (feet msl)[c]	Total Depth (feet btoc)[d]	Product Thickness (feet)	Water Depth (feet btoc)	Potentiometric Surface Elevation (feet msl)
Monitoring Points								
CPT-02S	8/94	796500	367430	22.26	23.2	0.00	19.61	2.65
CPT-02D	8/94	796500	367430	22.24	33.3	0.00	19.27	2.97
CPT-08S	8/94	796448	367290	21.49	23.2	0.00	18.25	3.24
CPT-08D	8/94	796448	367290	21.42	33.2	0.00	18.29	3.13
CPT-09S	8/94	796438	367362	20.97	23.2	0.00	17.92	3.05
CPT-09D	8/94	796438	367362	20.95	33.2	0.00	17.93	3.02
CPT-10S	8/94	796523	367394	21.17	23.2	0.00	18.13	3.04
CPT-10D	8/94	796523	367394	21.21	33.2	0.00	18.18	3.03
CPT-11S	8/94	796429	367400	20.77	23.2	0.00	17.85	2.92
CPT-11D	8/94	796429	367400	21.01	33.2	0.00	17.81	3.20
CPT-16S	8/94	796354	367330	20.40	23.2	0.00	17.42	2.98
CPT-16D	8/94	796354	367330	20.38	33.2	0.00	17.41	2.97
CPT-18S	8/94	796362	367483	21	23.2	NA[e]	NA	NA
CPT-18D	8/94	796362	367483	21	33.2	NA	NA	NA
CPT-19S	8/94	796330	367571	24.97	27.2	0.00	21.24	3.73
CPT-19S	6/96	796330	367571	24.97	27.2	0.00	17.24	7.73
CPT-19D	8/94	796330	367571	24.96	37.2	0.00	22.16	2.80
CPT-19D	6/96	796330	367571	24.96	37.2	0.00	19.03	5.93
CPT-20S	8/94	796345	367615	24.80	27.2	0.00	20.83	3.97
CPT-20S	6/96	796345	367615	24.80	27.2	0.00	17.80	7.00
CPT-20D	8/94	796345	367615	24.79	37.2	0.00	21.99	2.80
CPT-20D	6/96	796345	367615	24.79	37.2	0.00	19.36	5.43
CPT-21S	8/94	796345	367670	22.25	23.2	0.00	18.50	3.75
CPT-21S	6/96	796345	367670	22.25	23.2	0.00	17.46	4.79
CPT-21D	8/94	796345	367670	22.08	33.2	0.00	19.56	2.52
CPT-21D	6/96	796345	367670	22.08	33.2	0.00	18.67	3.41
CPT-22S	8/94	796292	367707	21.97	23.2	0.00	20.80	1.17
CPT-22S	6/96	796292	367707	21.97	23.2	0.00	5.60	16.37
CPT-22D	8/94	796292	367707	22.07	33.2	0.00	19.21	2.86
CPT-22D	6/96	796292	367707	22.07	33.2	0.00	18.32	3.75

TABLE 3.1

WATER LEVEL ELEVATION DATA
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Sample Location[a]	Date	Easting (feet)	Northing (feet)	Datum Elevation[b] (feet msl)[c]	Total Depth (feet btoc)[d]	Product Thickness (feet)	Water Depth (feet btoc)	Potentiometric Surface Elevation (feet msl)
Previously Installed Monitoring Wells								
MW-1	8/94	796559	367215	21.68	25	0.00	18.33	3.35
MW-1	6/96	796559	367215	21.68	25	0.00	17.08	4.60
MW-2	8/94	796558	367351	21.68	25	0.15[f]	NA	NA
MW-3	8/94	796456	367409	21.14	25	0.32[g]	17.62	3.52
MW-4	8/94	796459	367356	21.27	25	0.00	18.08	3.19
MW-5	8/94	796452	367291	21.37	26	0.00	18.46	2.91
MW-6	8/94	796397	367471	21.55	26	0.00	18.62	2.93
MW-7	8/94	796525	367639	21.97	29	0.00	18.61	3.36
MW-7	6/96	796525	367639	21.97	29	0.00	17.97	4.00
MW-8	8/94	796388	367706	26.49	27	0.00	23.77	2.72
MW-8	6/96	796388	367706	26.49	27	0.00	22.95	3.54
MW-9	8/94	796608	367191	22.15	30	0.00	15.83	6.32
MW-9	6/96	796608	367191	22.15	30	0.00	15.04	7.11
MW-10	8/94	796282	367417	20.76	29	0.00	12.31	8.45
MW-10	6/96	796282	367417	20.76	29	0.00	11.71	9.05
MW-11	6/96	NA	NA	NA	NA	0.47	17.50	NA

[a] See Figure 3.6 and Figure 4.1 for sample locations.
[b] Datum elevation is from top of well casing.
[c] feet msl = feet above mean sea level
[d] feet btoc = feet below top of casing
[e] NA = not available
[f] Measured product thickness on August 6, 1994. Monitoring well destroyed after this date.
[g] Measured product thickness on August 9, 1994. Free-product not present on August 11, 1994.

gradients on contaminant migration. Observed vertical and horizontal migration patterns of dissolved BTEX and inorganic geochemical parameters are discussed in Section 4.

3.3.2.2 Hydraulic Conductivity

As discussed in Section 2.4, Parsons ES reviewed the slug test methodologies performed by Baker (1994) at the Car Care Center Site, prior to initiation of the field activities. These methodologies appeared consistent with the protocols established for the Intrinsic Remediation program (Wiedemeier *et al.*, 1994), and the hydraulic conductivity (K) values reported by Baker were within the acceptable range for sandy materials (Freeze and Cherry, 1979). Therefore additional slug tests were not performed and the following is a summary of the Baker (1994) results. Slug tests were conducted in monitoring wells MW-7, MW-8, MW-9, and MW-10. Reported K values ranged from 5.8×10^{-5} foot/second (foot/sec) in MW-7 to 5.8×10^{-6} foot/sec in MW-9. The average hydraulic conductivity was reported to be 2.9×10^{-5} foot/sec.

3.3.2.3 Advective Groundwater Velocity

Baker Environmental, Inc. (1994) calculated the average advective groundwater flow velocity from Darcy's Law. Using the average hydraulic conductivity of 2.9×10^{-5} foot/sec, the reported horizontal hydraulic gradient of 0.0028 foot/foot, and an assumed effective porosity of 0.35, Baker calculated an groundwater flow velocity of 7.3 feet/year.

As a result of groundwater sampling during the August 1994 field activities, Parsons ES determined that the contaminant plume is approximately 560 feet long (see Section 4.3.1.1). An overall plume formation time of 76 years was calculated, assuming completely conservative transport. However, the historical record indicates actual plume formation time was approximately 25 to 30 years. Based upon this brief analysis, the reported average hydraulic conductivity (2.9×10^{-5} foot/sec) may be lower than the actual overall value for the site because it does not adequately describe the overall length of the BTEX plume. Parsons ES developed a groundwater model for the site and calibrated this model to the observed site conditions. As a result, an apparent hydraulic conductivity was calculated (see Section 5.0) for use within the transport model.

3.3.3 Preferential Flow Paths

No preferential contaminant migration pathways were identified at the site. Although numerous subsurface utilities underlie the area of investigation, no effects on contaminant distribution or groundwater flow pattern were noted. Subsurface utilities at this site are not sufficiently deep to influence groundwater flow.

3.3.4 Groundwater Use

Groundwater from the surficial unconfined aquifer at Bolling AFB is not exploited for potable water supply. There were no drinking water supply wells identified on or near the base (Baker, 1994). Within a 4-mile radius of the base, no users of groundwater in the surficial aquifer were identified. Potable water supply for the base

and the surrounding area is obtained from the Blue Plains Treatment Plant located south of Bolling AFB. This plant obtains its water from the Potomac River (Freeman, 1994).

3.4 CLIMATOLOGICAL CHARACTERISTICS

The Washington, DC area has a temperate climate resulting from its latitude and its close proximity to the Atlantic Ocean. Spring and fall are characterized by a succession of warm and cold periods associated with storm activity. Summers and winters are humid, intensifying the respective heat and cold of the seasons (Flohn, 1969). The mean precipitation for the base is approximately 42 inches per year (Baker, 1994). Daily temperatures, on average, range from 27 to 86 degrees Fahrenheit (ES, 1985). Potential net infiltration of precipitation into the subsurface was calculated to be 5.6 inches annually (Baker, 1994). The prevailing wind direction during the summer months is from the south, while during the fall and winter the winds originate from the northwest.

SECTION 4

NATURE AND EXTENT OF CONTAMINATION AND SOIL AND GROUNDWATER GEOCHEMISTRY

4.1 SOURCE OF CONTAMINATION

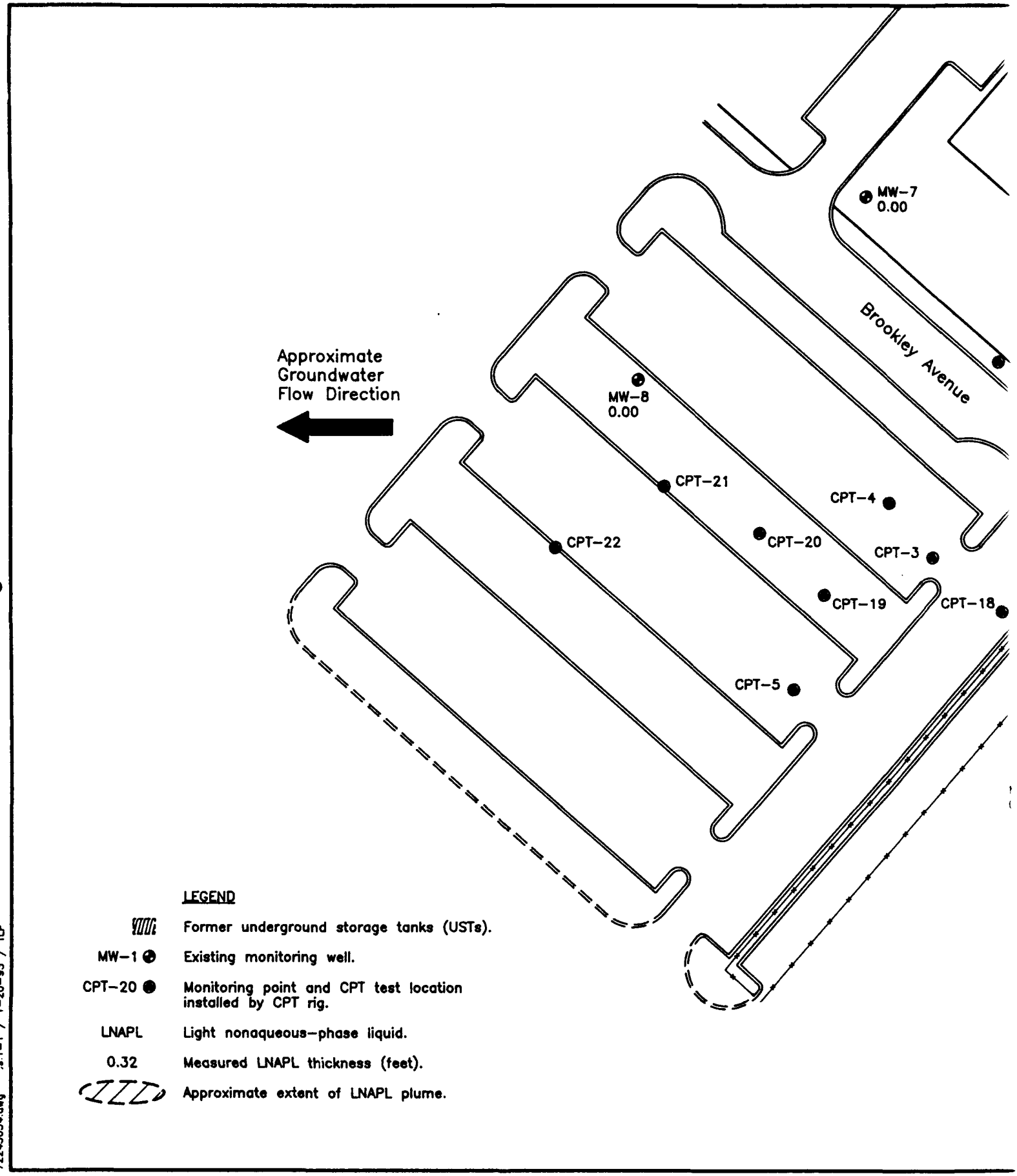
The Car Care Center facility ceased dispensing gasoline in 1982. Prior to that time, three known releases had occurred. The exact details, dates, and volumes of these releases were not available at the time this report was prepared. However, the earliest release may have occurred over 15 years ago. Data from this study suggest that the former 12,000-gallon gasoline UST, which was located near the northeastern corner of the facility, was likely a large contributor to the groundwater contaminant plume. Several highly contaminated soil samples collected from the northwest side of the Car Care Center (Building 41) indicate possible releases from the dispensers and/or fuel lines. The LIF data indicated soil contamination beneath the entire Car Care Center site and extending across Brookley Avenue.

Remedial activities performed on site have included removal of the three gasoline USTs, excavation of residual soil contamination near the USTs, removal of dispensers and underground fuel piping, recovery of free product from monitoring wells, and removal of four waste oil USTs. As evident from the LIF data and analytical results from soil samples, areas of significant soil contamination still exist. These areas are likely acting as continuing hydrocarbon sources for groundwater contamination.

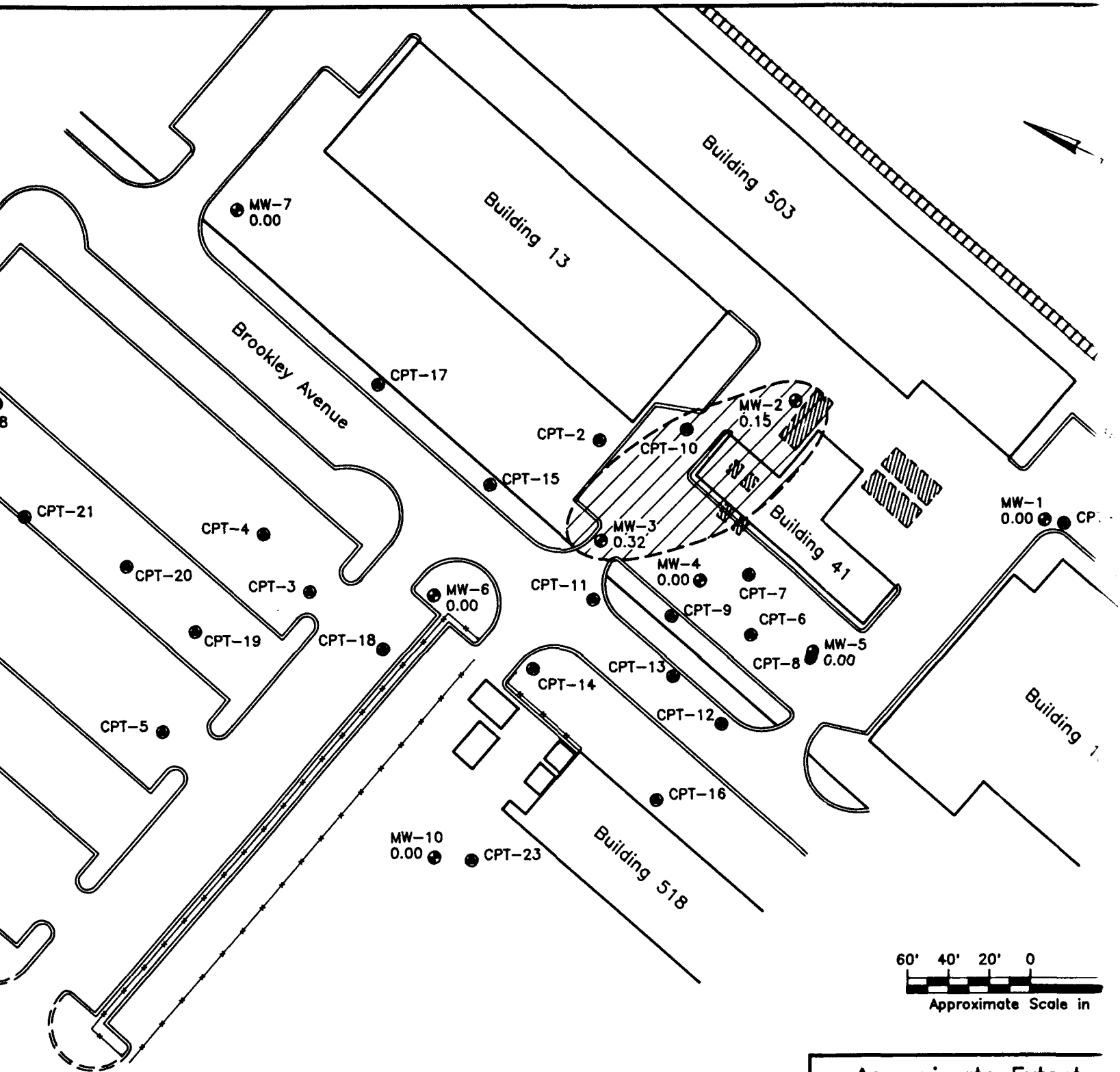
4.2 SOIL CHEMISTRY

4.2.1 Residual Contamination

Residual LNAPL is defined as the LNAPL that is trapped in the aquifer by cohesive and capillary forces. Therefore, residual LNAPL will not flow within the aquifer nor will it flow from the aquifer matrix into a well under the influence of gravity. Mobile LNAPL is defined as the LNAPL that is free to flow in the aquifer and that will flow from the aquifer matrix into a well under the influence of gravity. During the August 1994 sampling event, minimal mobile LNAPL thicknesses (Table 3.1) were detected in monitoring wells MW-2 and MW-3 (Figure 4.1) during the early phases of this investigation. In August 1994, a mobile LNAPL sample taken from MW-3 was submitted for composition analysis. Results suggest mobile LNAPL at the Car Care Center is weathered gasoline. BTEX composition, percent by weight, is as follows: benzene 0.3%, toluene 4.5%, ethylbenzene 1.3%, xylenes 7.7%. During the June 1996 sampling event, free product was only measured in MW-11; MW-2 and MW-3 had been removed. The following sections describe the residual LNAPL contamination found at the Car Care Center.



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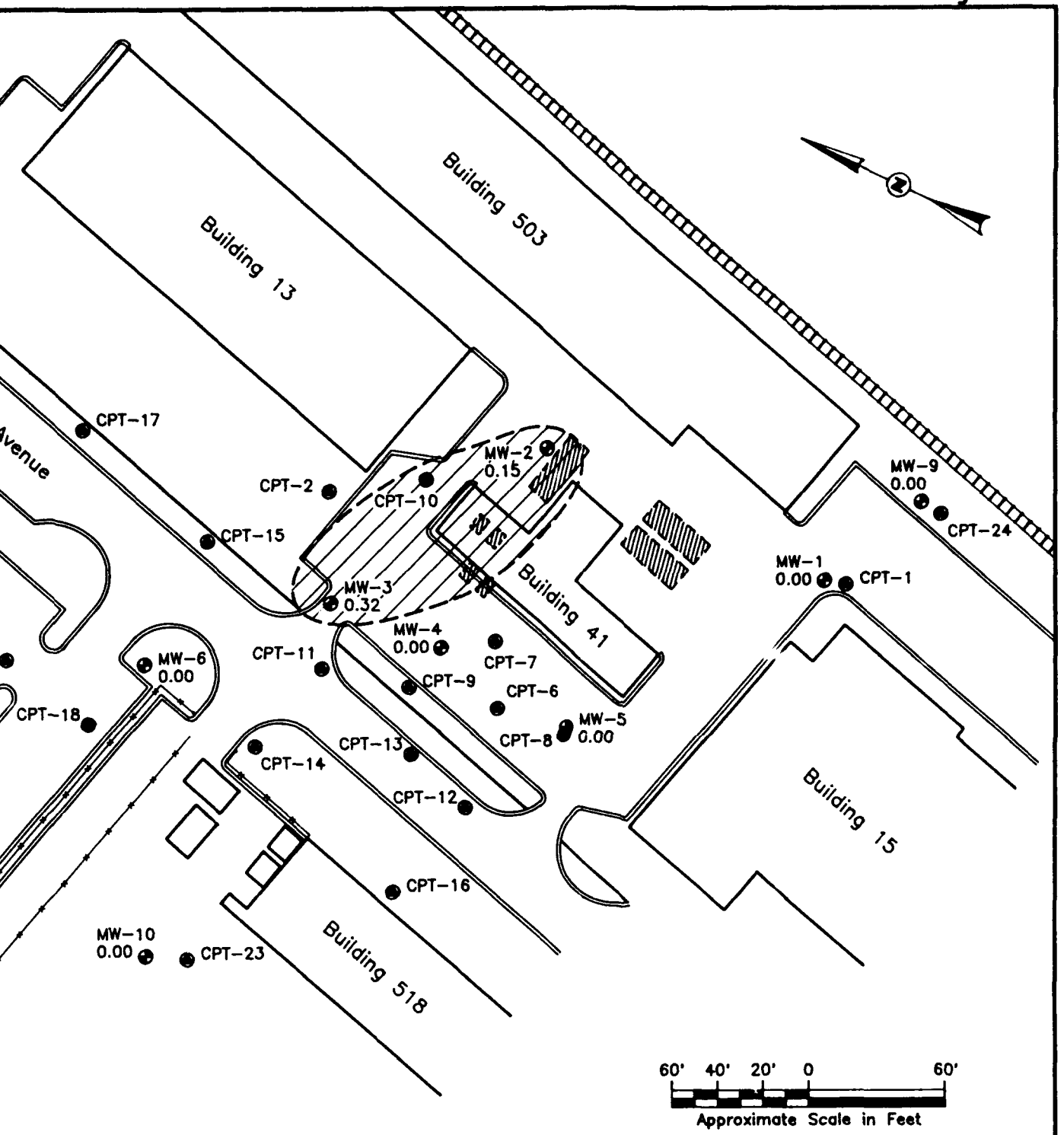


Approximate Extent
August 6, 19

Car Care Center
Intrinsic Remediation
Bolling AFB, D

PARSONS ENGINE

Figure 4.1



Approximate Extent of LNAPL
August 6, 1994

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

4.2.1.1 Soil BTEX Contamination

Residual hydrocarbon contamination resulting from vertical and lateral migration of free and dissolved hydrocarbons was found over a wide area at the Car Care Center Site during the August 1994 site investigation. Soil samples were not collected during the June 1996 sampling event. It appears that the hydrocarbons detected by LIF are primarily residual LNAPL and not mobile LNAPL, because monitoring points and monitoring wells installed at or near these locations have contained only minimal free product on an infrequent basis. Table 4.1 contains analytical results for BTEX and TVH in soils. Figures 4.2a and 4.2b show the extent of contaminated soil as determined from laboratory analytical results and LIF data. Because the LIF direct printouts indicate background signal noise ranging from 0-200 relative intensity (counts), a LIF reading of approximately 200 relative intensity (counts) was considered background for the site.

Figure 4.2a shows the highest analytical results and LIF readings from 5 to 15 feet bls. Shallow soil contamination (Figure 4.2a) appears to extend at least to CPT-11, CPT-12, and CPT-13 in the downgradient direction. CPT-7 has the greatest BTEX concentration (350,000 μg/kg) in the shallow zone. Because the shallow zone is at least 5 feet above the groundwater table, BTEX detected at CPT-7 indicates that the former fuel lines and/or dispensers located along the northwestern side of the property may have contributed to the release. The zone of shallow residual LNAPL contamination in soil appears to be approximately 150 feet wide by 180 feet long.

Figure 4.2b presents LIF readings and BTEX and TVH analytical data from 15 to 25 feet bls at the Car Care Center Site from the August 1994 site investigation. Deep soil contamination may have resulted from mobile LNAPL movement in the aquifer and from adsorption of constituents onto the aquifer matrix. The zone of deep soil contamination (Figure 4.2b) appears to extend to CPT-3 and CPT-14 in the downgradient direction as indicated by soil analytical results. However, LIF data suggest that CPT-16, CPT-18, and CPT-23 also are impacted. Soil collected from CPT-9 at 18 feet bls had the highest BTEX (670,000 μg/kg) concentrations at the site. However, BTEX concentrations were the same order of magnitude at CPT-7 and CPT-11. As a result, future remedial options should consider the residual LNAPL contamination in these areas. The zone of deep residual LNAPL contamination is approximately 300 feet wide by 300 feet long (Figure 4.2b).

Mobile LNAPL is present near the groundwater table as determined by liquid gasoline present within site monitoring wells. Furthermore, high LIF readings were measured near the water table in most CPT locations west of the Car Care Center building. The LIF data for CPT-7, CPT-12, and CPT-13 (Appendix A) suggests that a 7- to 10-foot thick band of LNAPL resides across the water table. This smear zone is created by groundwater fluctuations, which may trap LNAPL contamination both above and below the groundwater surface.

In addition, stratigraphic data from locations CPT-7, CPT-12, and CPT-13 (Appendix A) indicate the presence of clay lenses at approximately 13 feet bls. The measured depth to groundwater at these locations is approximately 17 feet bls. As a result, it appears that the clay lenses are retaining residual hydrocarbons above the groundwater table.

TABLE 4.1

FUEL HYDROCARBON COMPOUNDS DETECTED IN SOIL
AUGUST 1994
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Sample Location[a]	Sample Depth (ft bls)[b]	Benzene (µg/kg)	Toluene (µg/kg)	Ethyl-benzene (µg/kg)	m,p-Xylene (µg/kg)	o-Xylene (µg/kg)	Total BTEX[c] (µg/kg)	Total Volatile Hydrocarbons[d] (µg/kg)	Total Organic Carbon[e] (mg/kg)	Total Alkalinity[f] (mg CaCO3/kg)
Soil Test Locations										
CPT-3	9.7 - 11.7	0.5 <	0.7 J	0.5 <	0.6 J	0.5 <	1.3	110 <	NS	NS
CPT-3	22 - 24.4	56 <	280 J	3700	16000	6000	26000	620000	NS	NS
CPT-3 (Replicate)	22 - 24.4	55 <	500 J	1600	6300	3300	12000	220000	NS	NS
CPT-7	10.8 - 11.4	4700 J	92000	41000	150000	60000	350000	4800000	NS	NS
CPT-7	14 - 17.2	3600	56000	27000	94000	46000	230000	2300000	NS	NS
CPT-7	20 - 22.2	11000	170000	64000	220000	100000	410000	6400000	NS	NS
CPT-9	17.8 - 19.9	20000	210000	75000	250000	120000	670000	12000000	NS	NS
CPT-9	22.5 - 24.7	57 <	1100	3600	15000	8000	28000	40000	NS	NS
CPT-11	11 - 13.2	1.7 J	2.9 J	0.5 J	1.9 J	1.0 J	8.0	110 <	NS	NS
CPT-11	17.5 - 19.7	7300	140000	57000	210000	90000	500000	4300000	NS	NS
CPT-11	22 - 24.2	370 J	3500	1200	5100	2000	12000	40000	NS	NS
CPT-14	14.7 - 15.3	1.1 J	2.8 J	0.5 J	2.4 J	1.0 J	7.8	120 <	NS	NS
CPT-14 (Replicate)	14.7 - 15.3	4.7 J	28	4.7 J	21	6.0	64.4	600	NS	NS
CPT-14	20 -21.3	600 <	37000	18000	72000	28000	160000	1600000	NS	NS
CPT-24	10 - 10.7	0.5 <	1.1 J	0.5 <	1.4 J	0.7 J	3.2	120 <	1500	NS
CPT-24	16	NS	NS	NS	NS	NS	NS	NS	NS	28.8 <
CPT-24	20 - 20.7	0.5 <	0.7 J	0.5 <	1.0 J	0.5 <	1.7	140 <	600	NS
Free-product Analysis										
MW-3(Free Prod.)		0.3%	4.5%	1.3%	5.4%	2.3%	13.8%	49%	NS	NS

[a] See Figure 4.2 for sample locations

[b] ft bls = feet below land surface

[c] Quantified by Method SW8020

[d] Quantified by Method SW5030/SW8015M

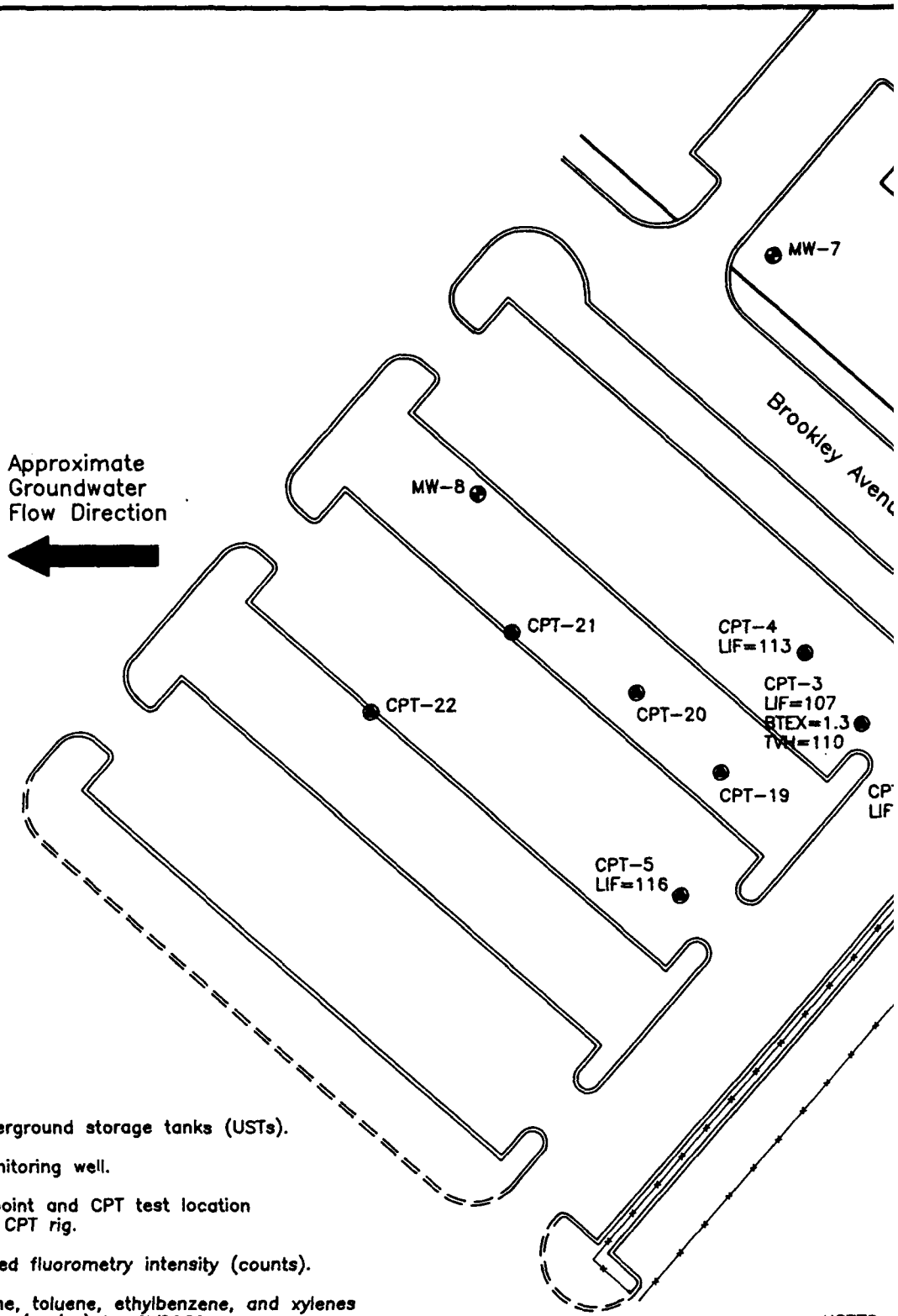
[e] Quantified by Method A5310C

[f] Quantified by Method 310.1

Qualifiers:

< Compound concentration less than reportable detection limit

J Indicates an estimated value when the compound is detected, but is below the Practical Quantification Limit.



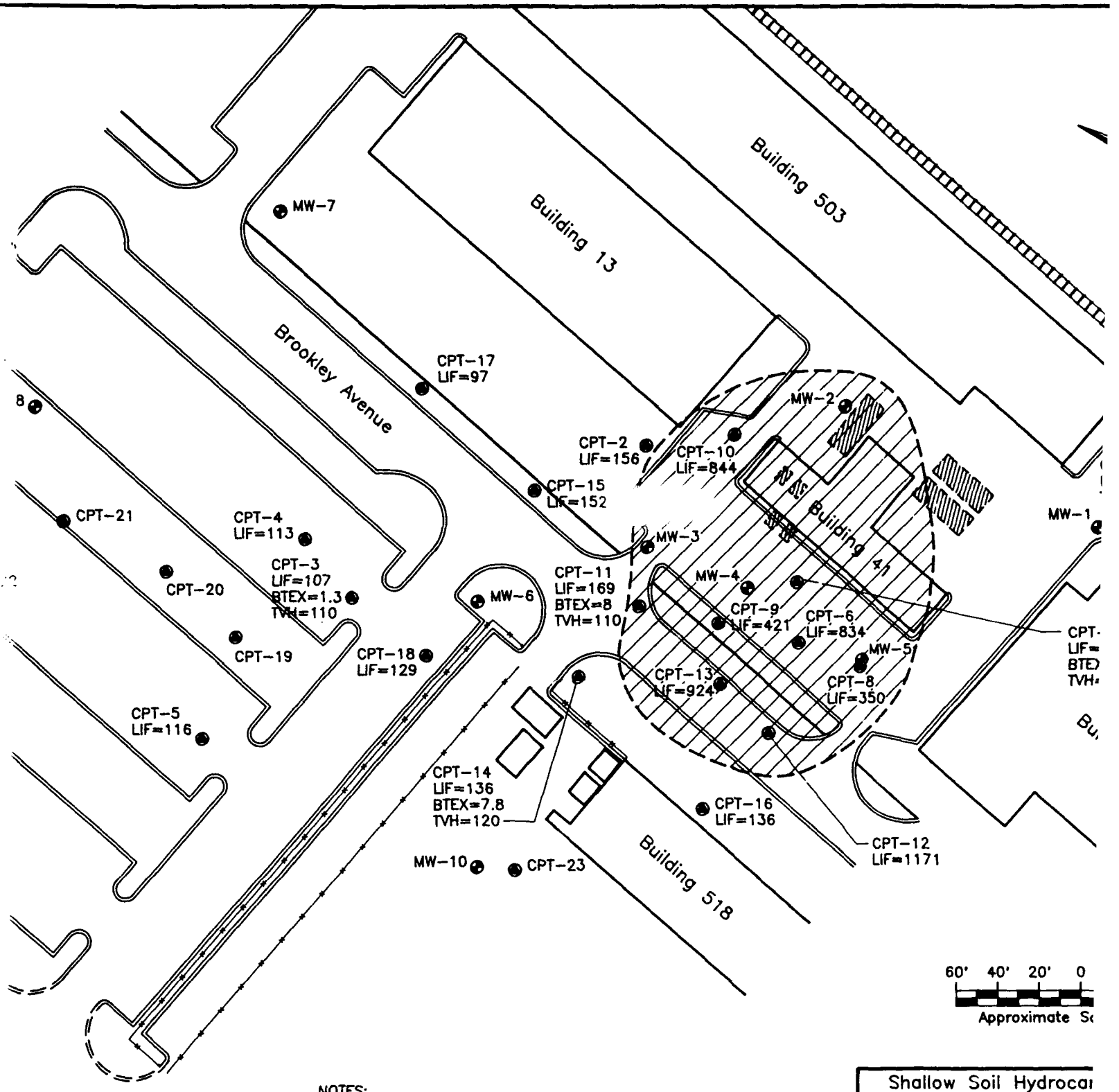
LEGEND

	Former underground storage tanks (USTs).
MW-1	Existing monitoring well.
CPT-1	Monitoring point and CPT test location installed by CPT rig.
LIF=107	Laser-induced fluorometry intensity (counts).
BTEX=1.3	Total benzene, toluene, ethylbenzene, and xylenes concentration (ug/kg) by SW8020.
TVH=110	Total volatile hydrocarbon concentration (ug/kg) by SW8015 (modified).
	Region containing oily phase hydrocarbon and/or soil hydrocarbon contamination.

NOTES:

1. LIF i
betw
2. LIF
back

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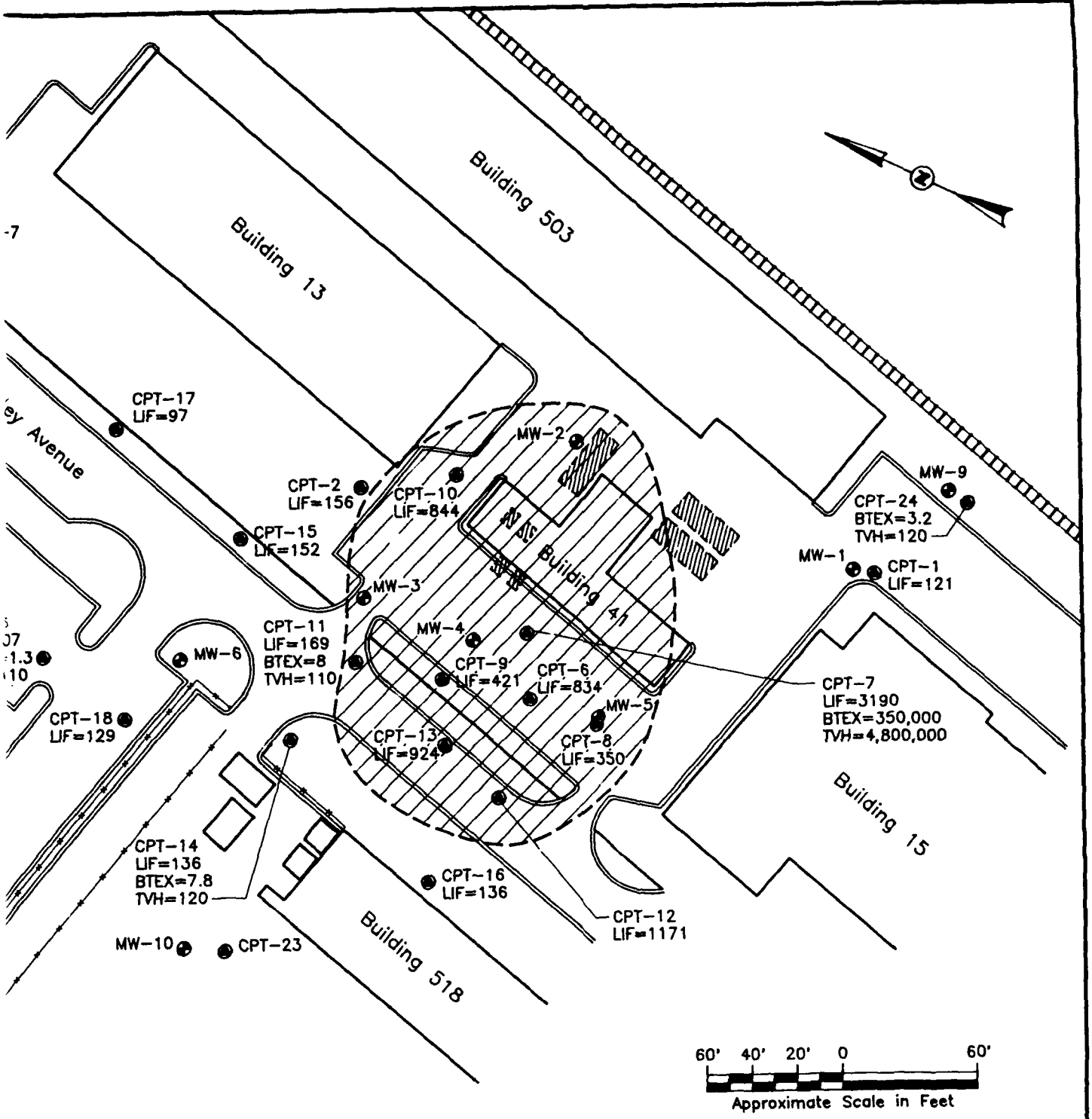
NOTES:

1. LIF intensity data are for largest peaks between 5 and 15 feet BLS.
2. LIF count of less than 200 is considered background (BG).

Shallow Soil Hydrocar
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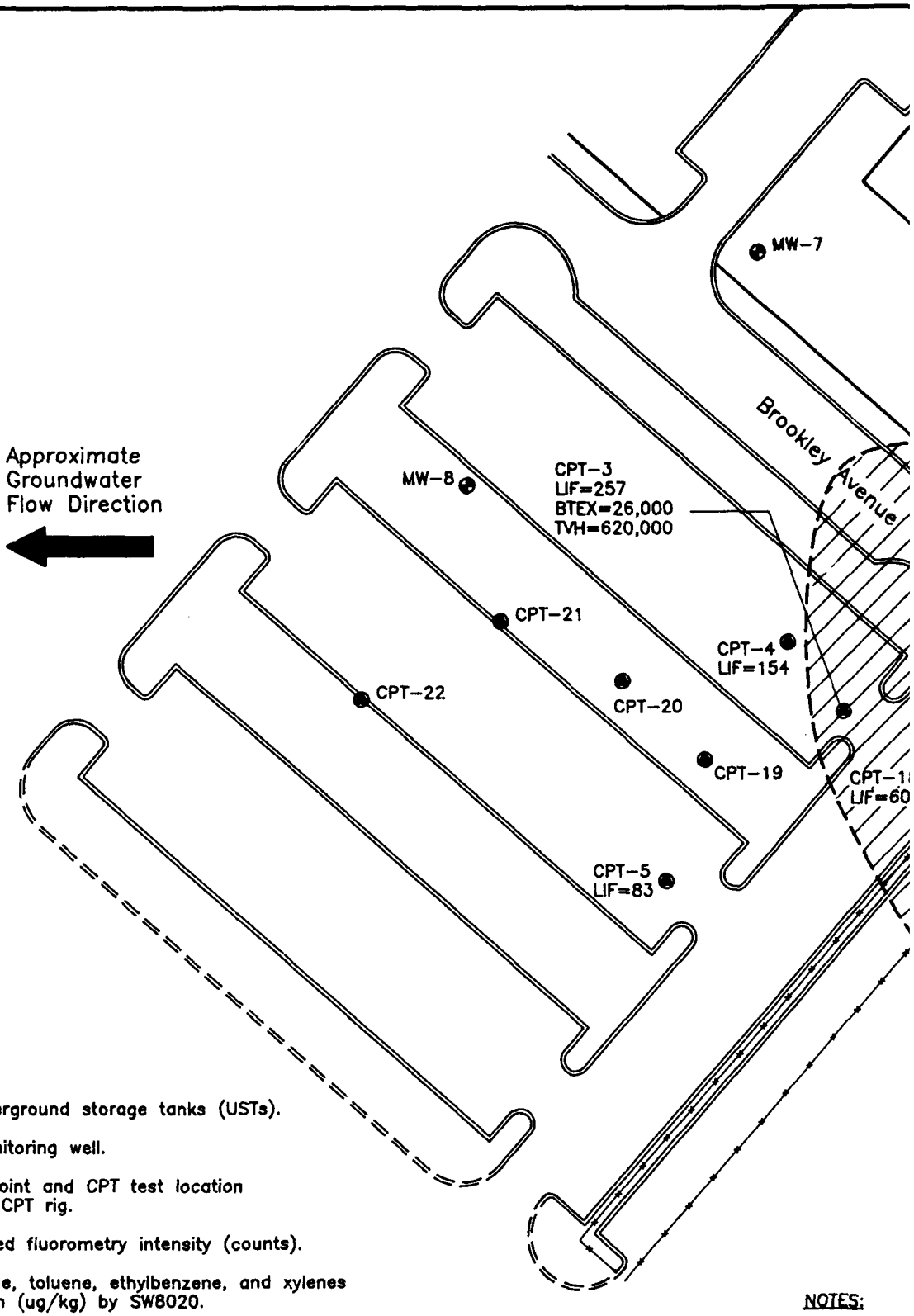
NOTES:

1. LIF intensity data are for largest peaks between 5 and 15 feet BLS.
2. LIF count of less than 200 is considered background (BG).

Shallow Soil Hydrocarbon Contamination as Indicated by CPT/LIF and Laboratory Analytical Results

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

PARSONS ENGINEERING SCIENCE, INC.



LEGEND

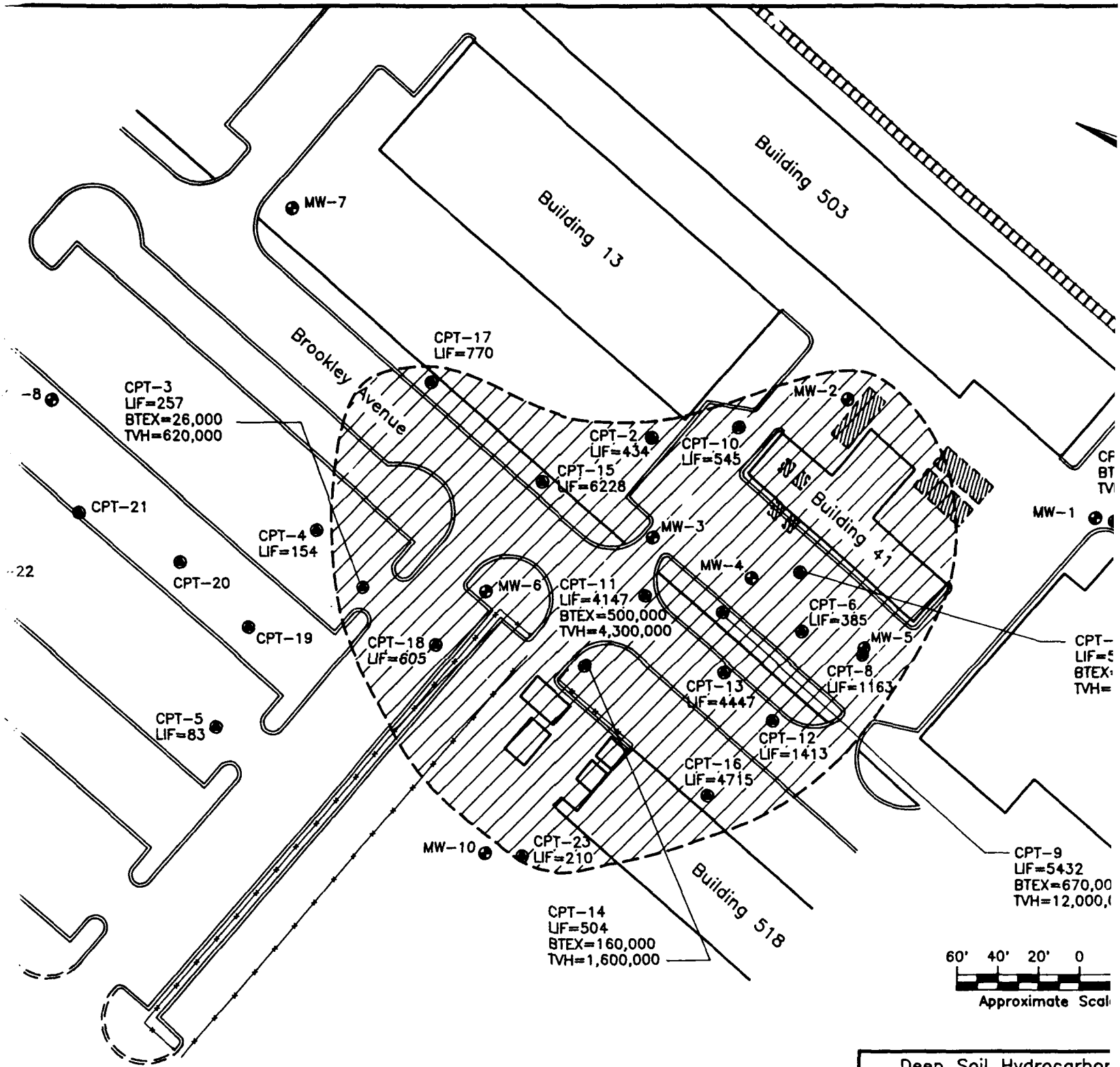
	Former underground storage tanks (USTs).
MW-1	Existing monitoring well.
CPT-1	Monitoring point and CPT test location installed by CPT rig.
LIF=107	Laser-induced fluorometry intensity (counts).
BTEX=1.3	Total benzene, toluene, ethylbenzene, and xylenes concentration (ug/kg) by SW8020.
TVH=110	Total volatile hydrocarbon concentration (ug/kg) by SW8015 (modified).
	Region containing oily phase hydrocarbon and/or soil hydrocarbon contamination.

NOTES:

1. LIF inten
between

2. LIF coun
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NOTES:

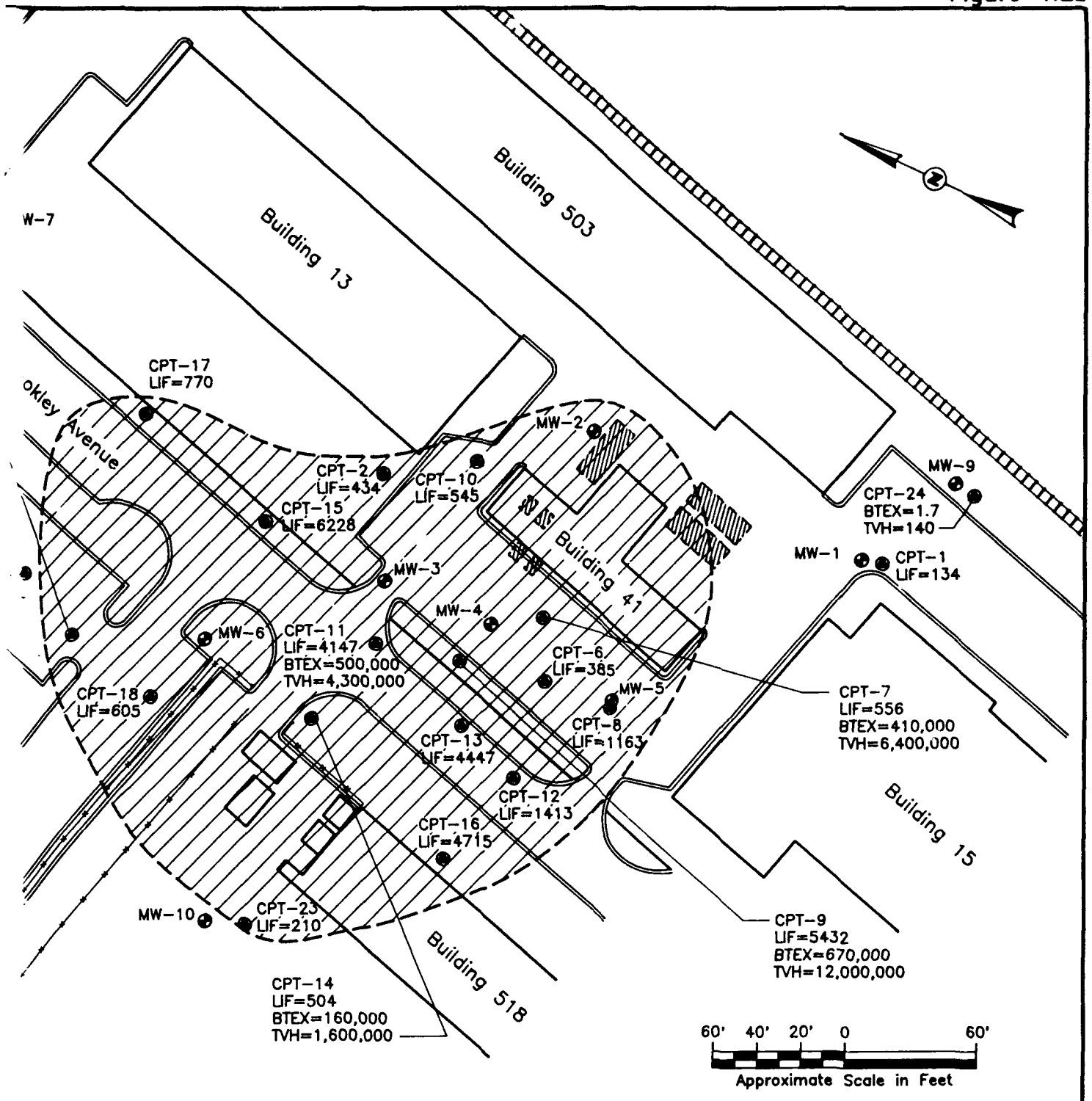
1. LIF intensity data are for largest peaks between 15 and 25 feet BLS.
2. LIF count of less than 200 is considered background (BG).

Deep Soil Hydrocarbor
as Indicated by C
Laboratory Analyti

Car Care Cer
Intrinsic Remedic
Bolling AFE

PARSONS EI

Figure 4.2b



NOTES:

1. LIF intensity data are for largest peaks between 15 and 25 feet BLS.
2. LIF count of less than 200 is considered background (BG).

Deep Soil Hydrocarbon Contamination as Indicated by CPT/LIF and Laboratory Analytical Results

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

PARSONS ENGINEERING SCIENCE, INC.

In August 1994, benzene was detected in shallow and deep soil samples from CPT-7, CPT-9, and CPT-11 in concentrations ranging from 3,600 µg/kg to 20,000 µg/kg. A low benzene concentration was detected at location CPT-14 (1.1 µg/kg) at a shallow soil depth of 14.7 to 15.3 feet bls. This location is downgradient of the shallow residual LNAPL plume, but it is near the center of the deep residual LNAPL plume. The deep soil sample from 20 to 21.3 feet bls at CPT-14 contained BTEX at 160,000 µg/kg. This demonstrates that at one time, mobile LNAPL, which originated in the shallow zone near the Car Care Center facility has migrated to deeper soils downgradient of its original location. The shallow soil contaminated zone is more limited in extent than the deeper zone. Because the shallow clay layer may be intermittent, a continuous perched water-bearing zone may not exist. As a result, mobile LNAPL may lack the mechanism to migrate laterally in the shallow zone. As a result, it migrates vertically under the influence of gravity, which has resulted in an accumulation near the water table.

4.2.1.2 Soil TVH Contamination

TVH was detected at all locations where BTEX was detected. No soil samples for TVH were collected in June 1996. Table 4.1 contains soil TVH data with a practical quantification limit of <110 µg/kg. A graphical representation of the August 1994 TVH data is provided in Figures 4.2a and 4.2b. Evergreen Analytical quantified TVH concentrations by comparison to a gasoline standard, which is the reported source of contamination. Typical total BTEX concentrations in fresh gasoline are approximately 14% to 21%. Evergreen Analytical quantified total BTEX and TVH in the soil samples. Then, Parsons ES calculated the average ratio of total BTEX to TVH observed in the soil samples in order to estimate the degree of LNAPL weathering which has occurred. Total BTEX percentages in soil ranged from 1.2% to 70%, with an average of 12%. Because TVH analyses only quantify lighter hydrocarbon fractions (generally compounds lighter than naphthalene), this comparison overestimates the fraction of BTEX within the LNAPL below the site. Thus, it is likely that the fuel below the site has weathered and BTEX soil concentrations have likely decreased over time.

4.2.2 Total Organic Carbon

TOC concentrations are used to estimate the amount of organic matter sorbed on soil particles or trapped in the interstitial passages of a soil matrix. The TOC concentration in the saturated zone is an important parameter used to estimate the amount of contaminant that could potentially be sorbed to the aquifer matrix. Sorption results in retardation of the contaminant plume relative to the average advective groundwater velocity. Parsons ES obtained two core samples from location CPT-24 for TOC analyses during the August 1994 site investigation. This location was suspected to be free from hydrocarbon contamination. TOC values range from 600 to 1,500 mg/kg (0.06 to 0.15 percent) (Table 4.1).

4.3 GROUNDWATER CHEMISTRY

4.3.1 Dissolved Contamination

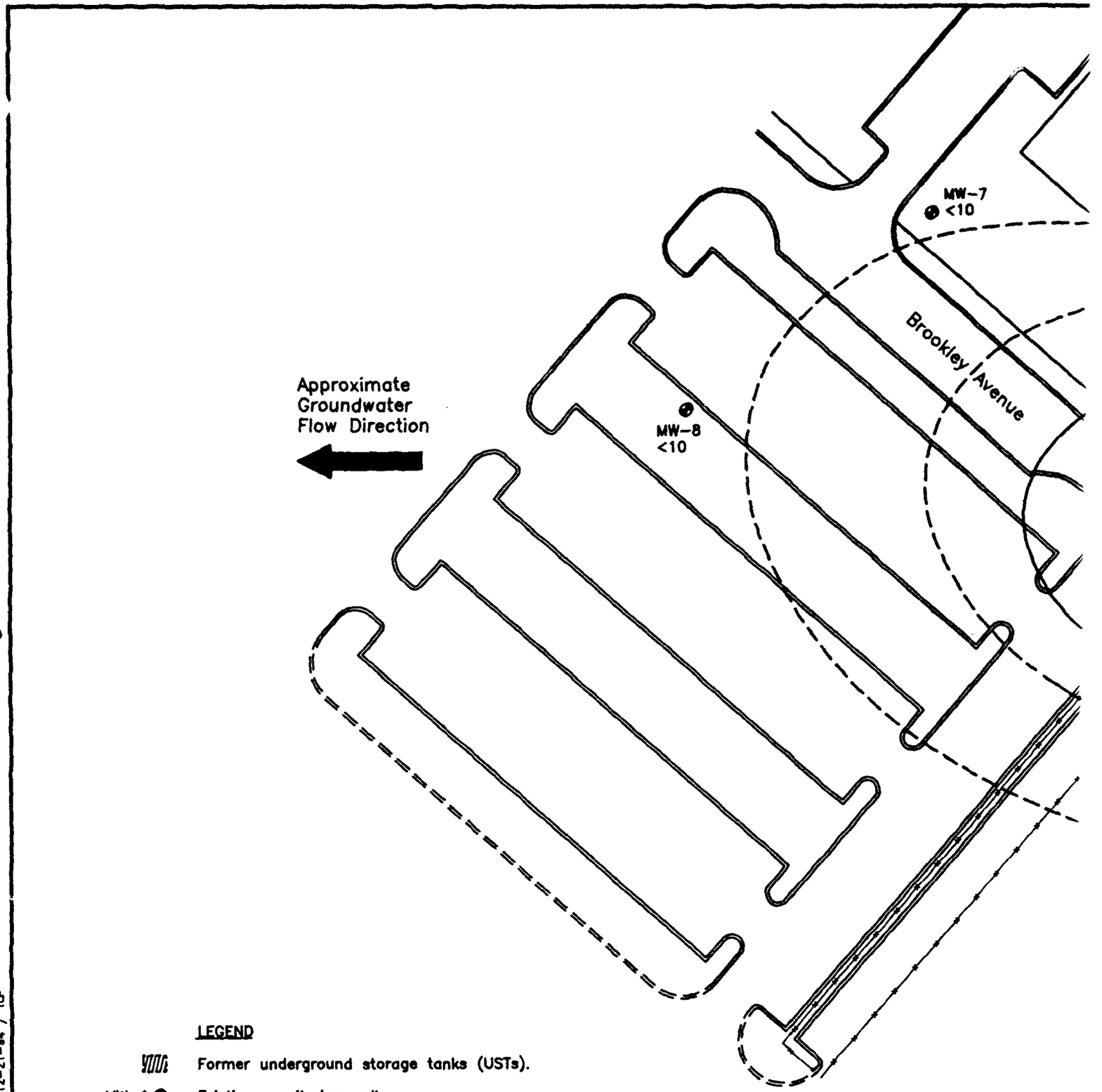
Groundwater samples were collected in January 1994 during a previous site investigation (Baker, 1994). The BTEX data from that investigation are shown on Figure 4.3. During the intrinsic remediation site investigation conducted in August 1994, Parsons ES collected another round of groundwater samples to more thoroughly define the dissolved hydrocarbon plume. In addition to the August 1994 sampling event, Parsons ES collected a confirmation round of groundwater samples in June 1996 to provide data on contaminant loss and plume migration, to confirm the effect of biodegradation mechanisms on dissolved BTEX concentrations, and to evaluate the accuracy of the model predictions. Table 4.2 summarizes groundwater analytical data collected under both Parsons ES sampling events.

4.3.1.1 BTEX in Groundwater

Figure 4.4 is a comparison of August 1994 and June 1996 observed total BTEX dissolved in groundwater. Isopleths are drawn based on the maximum concentration detected at each location. Two vertical concentration profiles also were generated for dissolved BTEX concentrations in August 1994, as well as for other dissolved constituents at the site. A cross-section location map showing concentration profile locations is shown in Figure 4.5. Figure 4.6 is a vertical profile of August 1994 BTEX isopleths along the centroid of the plume (cross-section D-D'). Figure 4.7 is a vertical profile of August 1994 BTEX isopleths perpendicular to plume migration (cross-section E-E').

Dissolved BTEX contamination is migrating to the northwest in the general direction of groundwater flow. However, the migration is slightly more to the west than indicated by previous reports (Baker, 1994). As defined by the 10 microgram per liter (µg/L) total BTEX isopleth, the plume, in both 1994 and 1996, is greater than 630 feet long and approximately 300 feet at its widest. The apparent thickness of the BTEX plume is 25 to 30 feet, as defined by the 100-µg/L contour. The actual base of the surficial aquifer is not known. As indicated by the August 1994 vertical profile (Figure 4.6), the plume is migrating downward in the vicinity of CPT-11, MW-6, and CPT-18. Vertical migration is not apparent downgradient of CPT-18, but the plume geometry is not well defined beyond that point. As discussed in Section 3.3.2.1, the effects of vertical hydraulic gradients on contaminant plume migration are inconclusive.

Nineteen monitoring points and wells sampled at the site during August 1994 contained groundwater with reportable dissolved benzene concentrations above the DC Department of Consumer and Regulatory Affairs (DCRA) target cleanup value and the federal maximum contaminant level (MCL) of 5 µg/L . Where detected in August 1994, benzene concentrations ranged from 0.6 µg/L in CPT-22D to 44,000 µg/L at CPT-11S. Toluene concentrations exceeded the DCRA criterion and federal MCL for dissolved toluene (1,000 µg/L) in thirteen locations. Toluene concentrations ranged from 1.6 µg/L at MW-9 and MW-10 to 57,000 µg/L at CPT-11S. Most toluene concentrations were in the range of 10,000 to 35,000 µg/L. Sample concentrations at thirteen locations exceeded the DCRA criterion and federal MCL (700 µg/L) for ethylbenzene. In August 1994, ethylbenzene concentrations ranged from 0.6 µg/L at



LEGEND

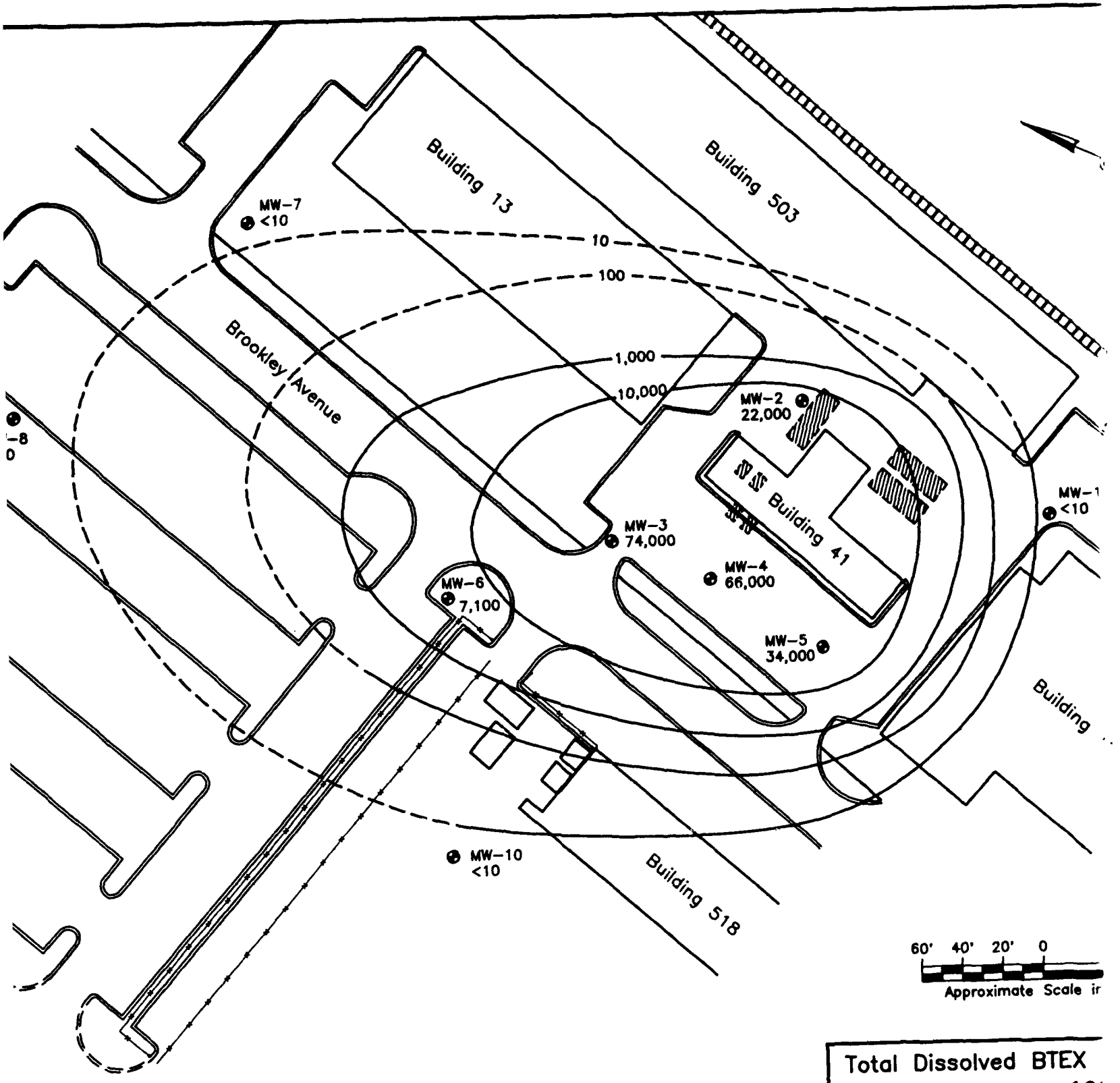
	Former underground storage tanks (USTs).
MW-1	Existing monitoring well.
7,100	Total benzene, toluene, ethylbenzene and xylene (BTEX) concentration (ug/L).
—— 100 ——	Total BTEX concentration (ug/L) contour, dashed where inferred.

NOTE:

1. Isopleth m
monitoring

Reference: Baker Environmental, Inc., May 1994.

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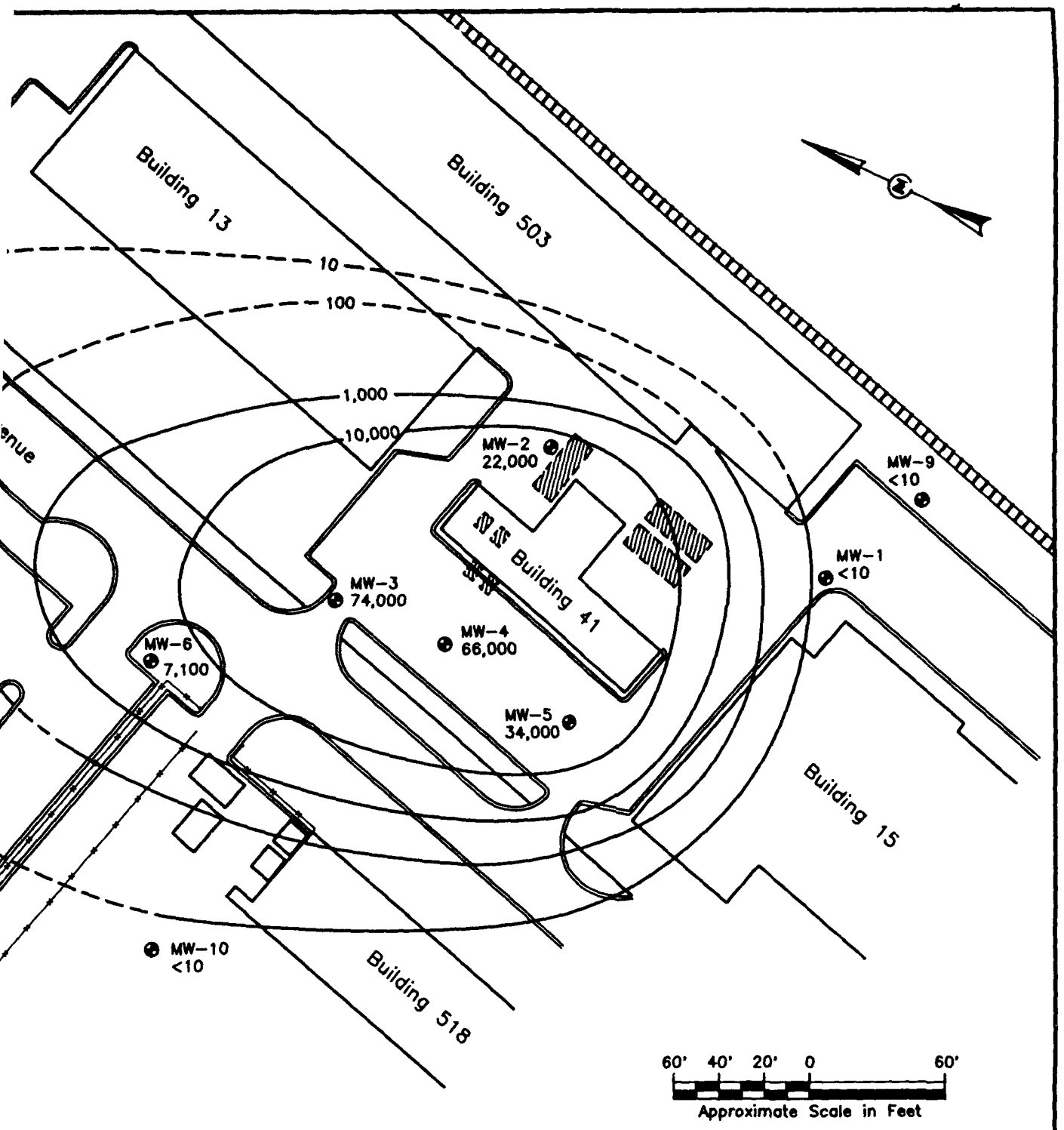


NOTE:

1. Isopleth map was developed using data from monitoring wells only.

Total Dissolved BTEX
January 19

Car Care Cente
Intrinsic Remediatic
Bolling AFB,



Total Dissolved BTEX Isopleth Map
January 1994

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

IE:

Isopleth map was developed using data from monitoring wells only.

TABLE 4.2
FUEL HYDROCARBON COMPOUNDS DETECTED IN GROUNDWATER
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

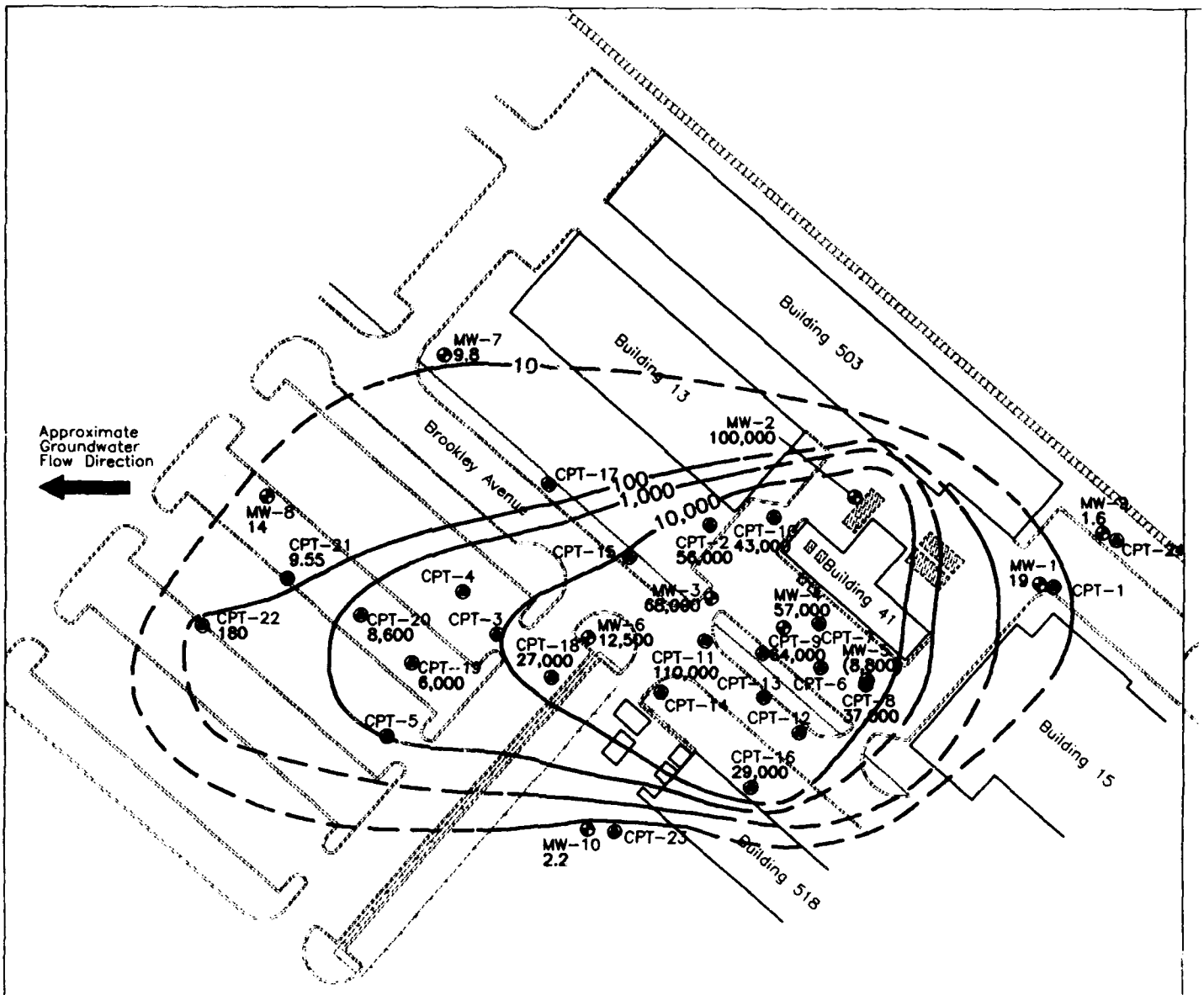
Sample Location[a/]	Date	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylene (µg/L)	Total BTEX[b/] (µg/L)	1,3,5-Trimethyl-benzene[b/] (µg/L)	1,2,4-Trimethyl-benzene[b/] (µg/L)	1,2,3-Trimethyl-benzene[b/] (µg/L)	Total Volatile Hydrocarbons[c/] (mg/L)
Monitoring Points												
CPT-2D	Aug-94	9.6	64	7.4	29	13	42	120	3.5 J	13	2 J	0.6
CPT-2S	Aug-94	21000	25000	1900	5100	3300	8400	56000	290 J	1100	200 J	76
CPT-8D	Aug-94	2.1 J	83	17	59	27	86	190	4.1	12	4.5	0.6
CPT-8S	Aug-94	1600	25000	1700	6000	3000	9000	37000	260 J	1100	210 J	82
CPT-9D	Aug-94	47	16 U	31	34	61	95	190	0.6 J	26	4.3	0.7
CPT-9S	Aug-94	25000	29000	1600	5500	2800	8300	64000	230 J	960	180 J	200
CPT-10D	Aug-94	0.8 J	8.3	1.0 J	3.4 J	1.5	4.9	15	0.4 <	0.6 J	0.4 <	0.1 <
CPT-10S	Aug-94	7300	25000	1800	5600	3100	8700	43000	240	1000	190 J	61
CPT-11D	Aug-94	1600	170	410	630	240	870	3100	18 J	270	49	13
CPT-11S	Aug-94	44000	57000	1600	5500	2900	8400	110000	210 J	820	160 J	160
CPT-16D	Aug-94	56	300	520	870	48	918	1800	37	250	92	8
CPT-16S	Aug-94	400	21000	1100	4300	2200	6500	29000	280 J	720	170 J	124
CPT-18D	Aug-94	17000	2500	1600	4900	910	5810	27000	180	920	210	89
CPT-18S	Aug-94	64	4800	1300	4800	2200	7000	13000	140	790	100	50
CPT-19S	Jun-96	14	6.5	11	NA	NA	7.9	39.4	ND	0.5	ND	0.2
CPT-19D	Aug-94	750	370 J	980	3400	560	3960	6000	160 J	690	130 J	49
CPT-19D	Jun-96	1400	700	1800	NA	NA	6000	9900	250	1100	340	31
CPT-20S	Jun-96	1.5	1	7.5	NA	NA	1	11	ND	ND	ND	0.1
CPT-20D	Aug-94	2300	640	1600	3900	200 J	4100	8600	240	970	200	46
CPT-20D	Jun-96	450	180	1900	NA	NA	700	3230	140	500	80	13
CPT-21S	Jun-96	1.3	0.6	ND	NA	NA	0.5	2.4	ND	ND	ND	ND
CPT-21D	Aug-94	0.4 <	5.0 U	1.0 J	0.8	3.1 J	3.9	9.9	0.4 <	0.4 <	1.3 J	0.1
CPT-21D	Jun-96	430	7.6	4.9	NA	NA	0.9	443.4	ND	0.5	2.2	1.5
CPT-21D (Duplicate)	Aug-94	0.4 <	4.2 U	1.0 J	0.8 B	3.2 J	4	9.2	0.4 <	0.5 J	1.4 J	1.5
CPT-22D	Aug-94	0.6 J	72	15	56	36	92	180	7.5	35	7.6	0.5
CPT-22D	Jun-96	470	1.1	7	NA	NA	5.8	483.9	1.0	ND	2.3	2.3

TABLE 4.2
FUEL HYDROCARBON COMPOUNDS DETECTED IN GROUNDWATER
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Sample Location[a/]	Date	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	m,p-Xylene (µg/L)	o-Xylene (µg/L)	Total Xylene (µg/L)	Total BTEX[b/] (µg/L)	1,3,5-Trimethyl-benzene[b/] (µg/L)	1,2,4-Trimethyl-benzene[b/] (µg/L)	1,2,3-Trimethyl-benzene[b/] (µg/L)	Total Volatile Hydrocarbons[c/] (mg/L)
Previously Installed Monitoring Wells												
MW-1	Aug-94	3.5 J	7.5 U	0.4 <	5.0	3 J	8	19	0.4 <	0.4 <	0.4 <	1
MW-1	Jun-96	6.52	ND	0.8	NA	NA	0.5	7.8	ND	ND	0.6	0.2
MW-2	Aug-94	2900	31000	2600	63000	5000	68000	100000	670	2500	430	750
MW-3	Aug-94	14000	33000	3000	12000	5800	17800	68000	800	2700	630	56
MW-4	Aug-94	21000	26000	2100	7400	3900	11300	60000	470	2000	360 J	130
MW-4 (Duplicate)	Aug-94	19000	23000	1800	6600 B	3400	10000	54000	400	1700	300 J	130
MW-5	Aug-94	1500	3100	410	2500	1300	3800	8800	260 J	870	180 J	28
MW-6	Aug-94	2700	8000	460	1400	890	2290	13000	60 J	230 J	50 J	53
MW-6 (Duplicate)	Aug-94	2400	7200	450	1300 B	880	2180	12000	49	250 J	30	39
MW-7	Aug-94	0.8 J	3.1 U	0.6 J	3.0	2.3	5.3	9.8	0.4 J	1.1 J	0.4 <	0.1 <
MW-7	Jun-96	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND
MW-8	Aug-94	1.1 J	4.0 U	0.8 J	4.4	3.8 J	8.2	14	0.5 J	1.4 J	0.4 J	0.1 <
MW-8	Jun-96	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND
MW-9	Aug-94	0.4 <	1.6 U	0.4 <	0.4 <	0.4 <	<0.8	1.6	0.4 <	0.4 <	0.4 <	0.2
MW-9	Jun-96	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND
MW-10	Aug-94	0.4 <	1.6 U	0.4 <	0.6 U	0.4 <	<0.4	2.2	0.4 <	0.4 <	0.4 <	0.1 <
MW-10	Jun-96	ND	ND	ND	NA	NA	ND	ND	ND	ND	ND	ND
MW-11	Jun-96	9000	25000	2300	NA	NA	13000	49300	480	1600	530	110

[a/] See Figure 4.4 for sample locations.
[b/] Quantified by EPA Method 602
[c/] Quantified by SW8015 modified

Qualifiers:
< Compound concentration less than reportable detection limit.
J Indicates an estimated value when the compound is detected, but is below the Practical Quantification Limit.
B Compound found in blank and sample.
E Extrapolated value
U Compound not detected above reported value



AUGUST 1994

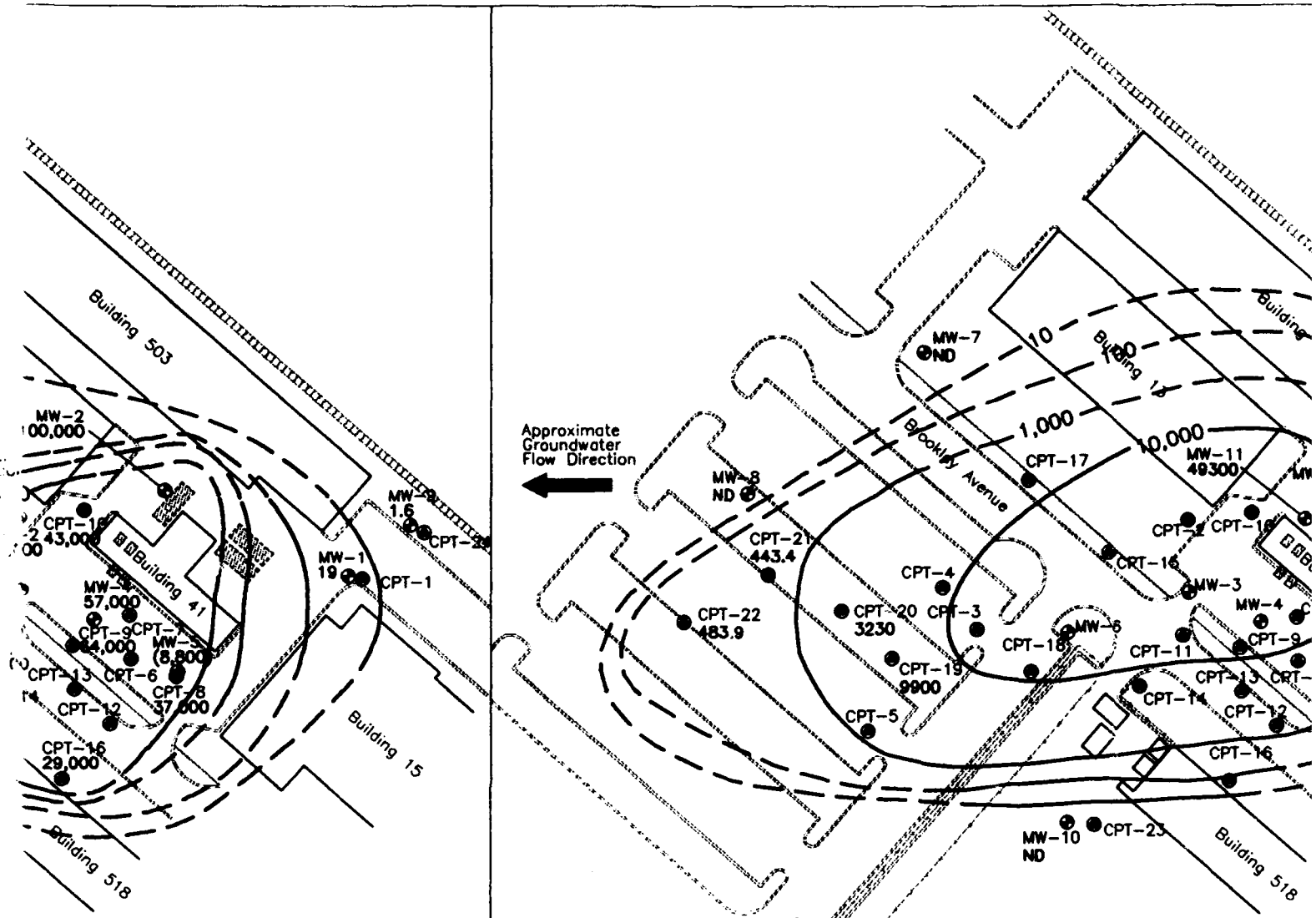
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
8,600	Total benzene, toluene, ethylbenzene and xylene (BTEX) concentration (ug/L) by SW8020.
(8,800)	Data not utilized to construct contours.
—— 100 ——	Total BTEX concentration (ug/L) contour, dashed where inferred.

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

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AUGUST 1994

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

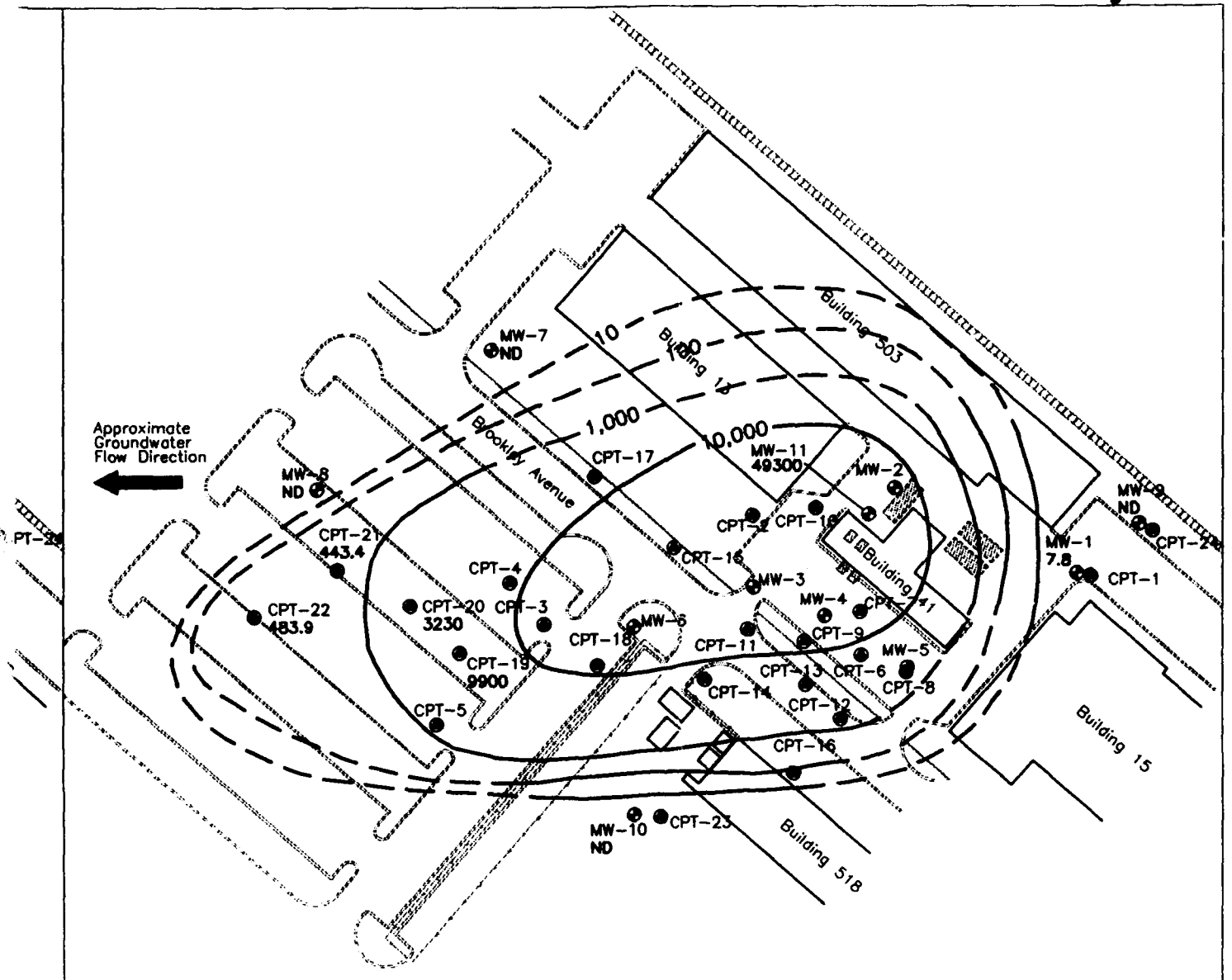
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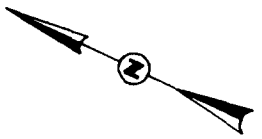
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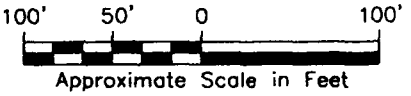
Total Dissolv

Car C
Intrinsic
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Figure 4.4

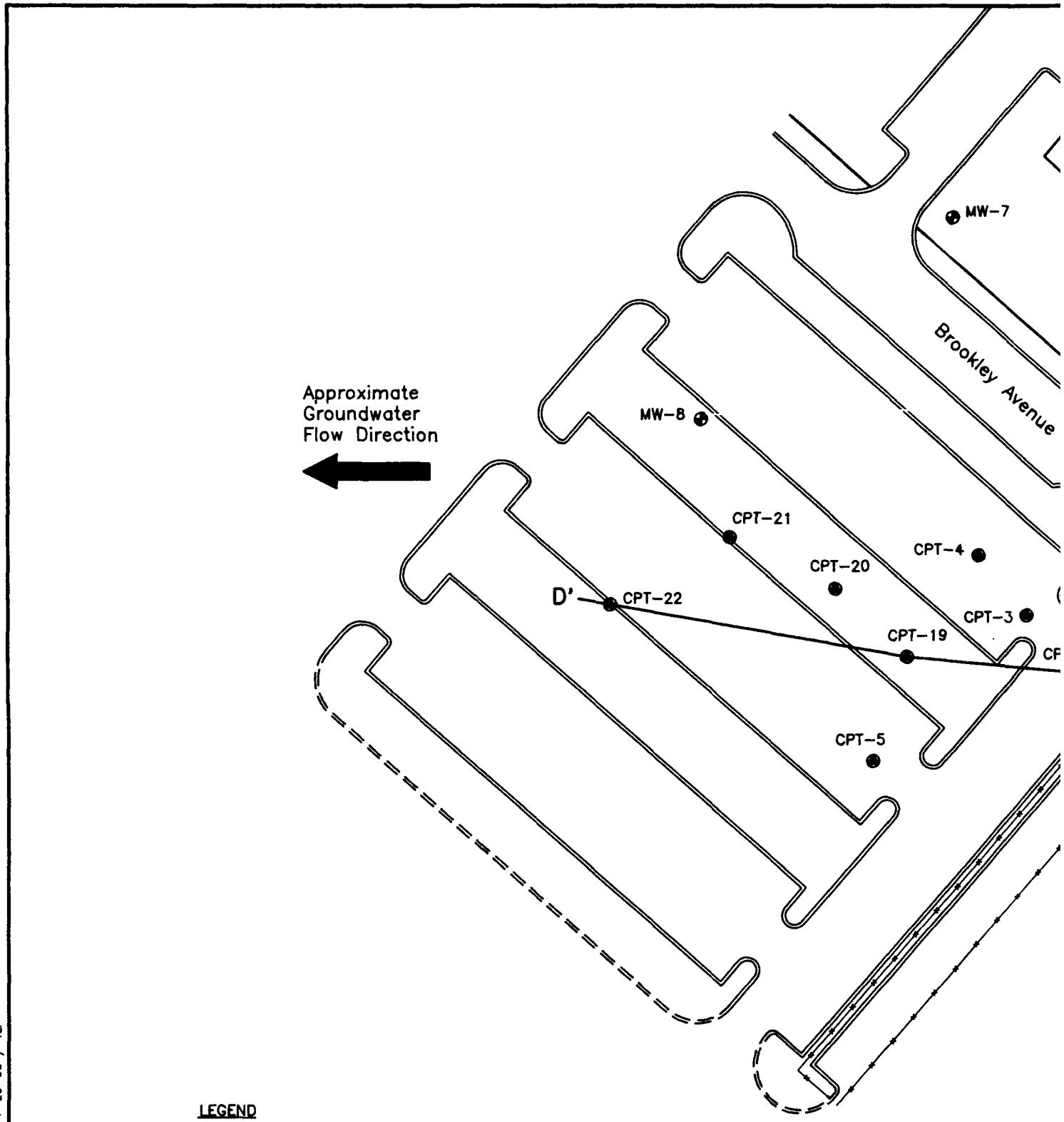




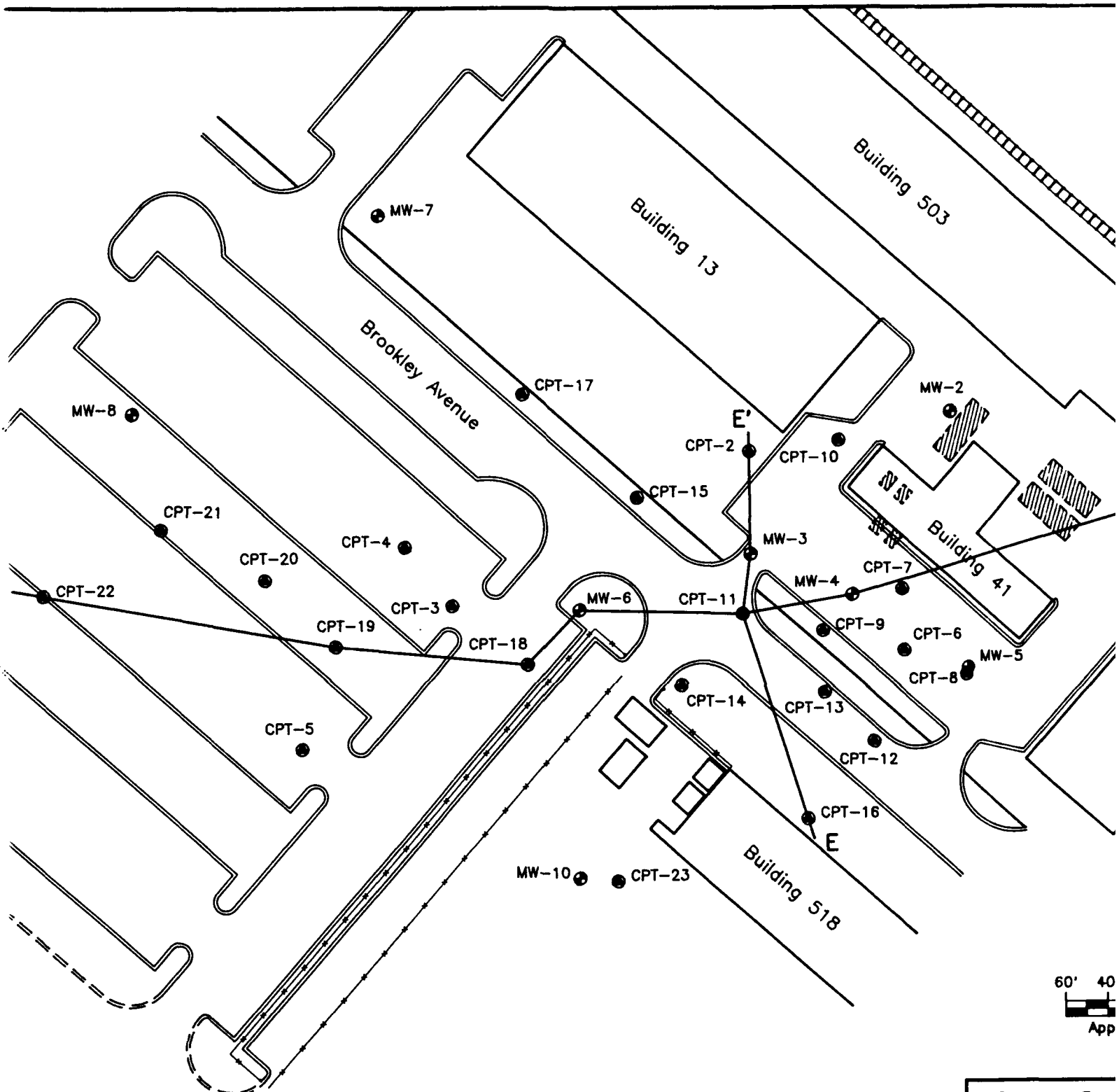


Total Dissolved BTEX Isopleth Maps

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

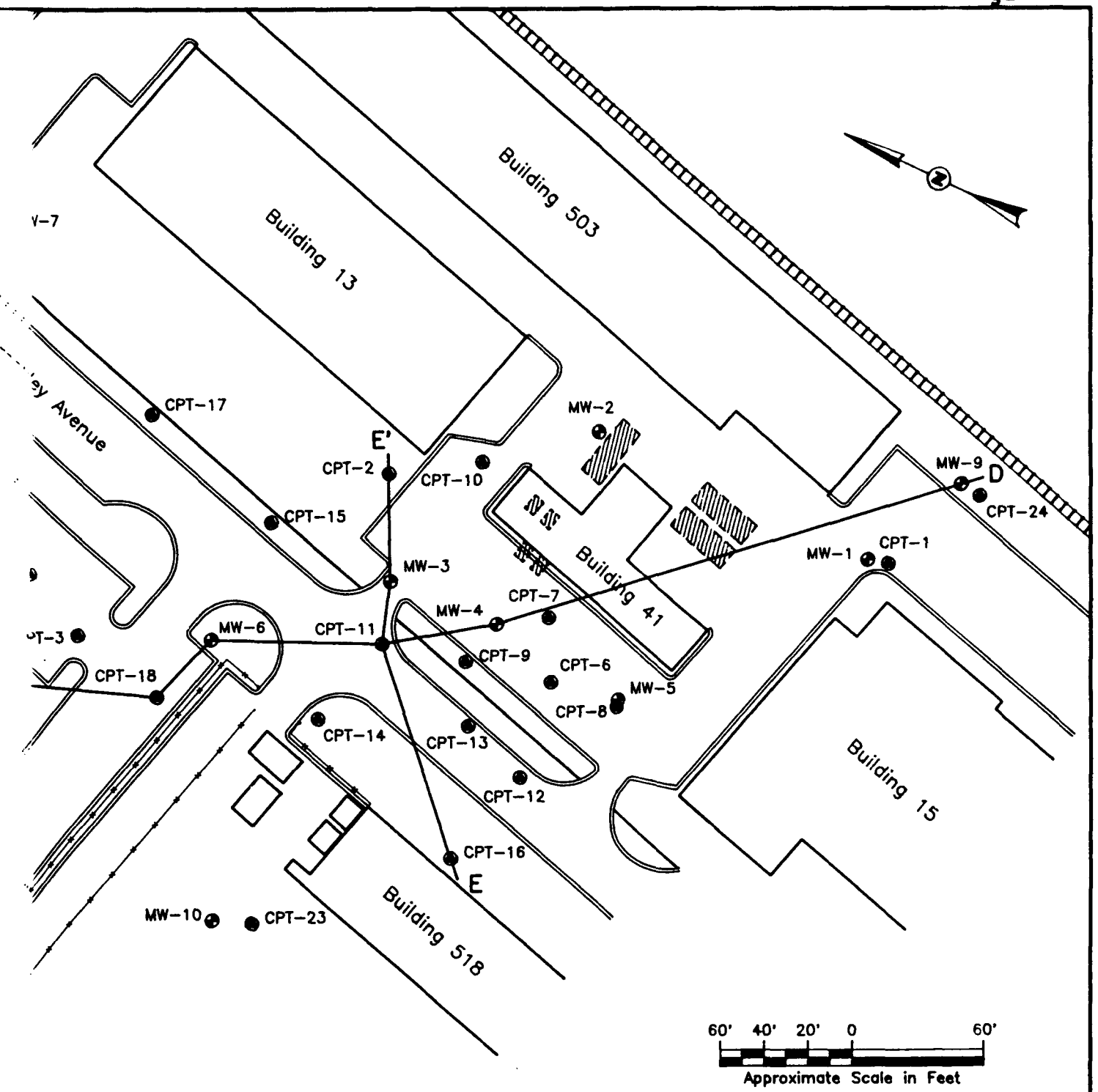


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Cross–Sec
Vertical Ex

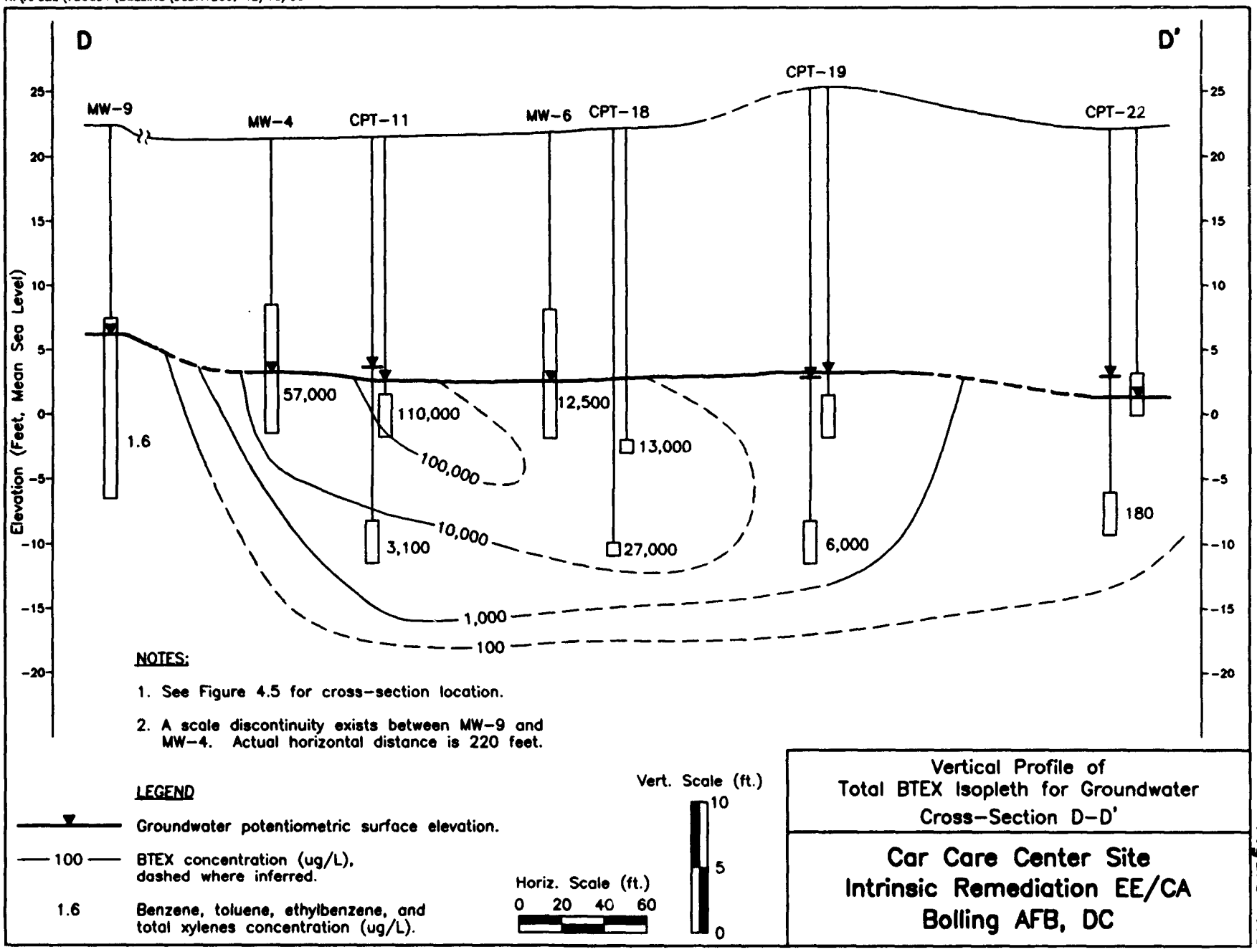
Car
Intrinsic
B



Cross–Section Location Map for Vertical Extent of Dissolved BTEX

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

K:\AFCEE\729691\BOLLING\96DN1200, 12/10/96

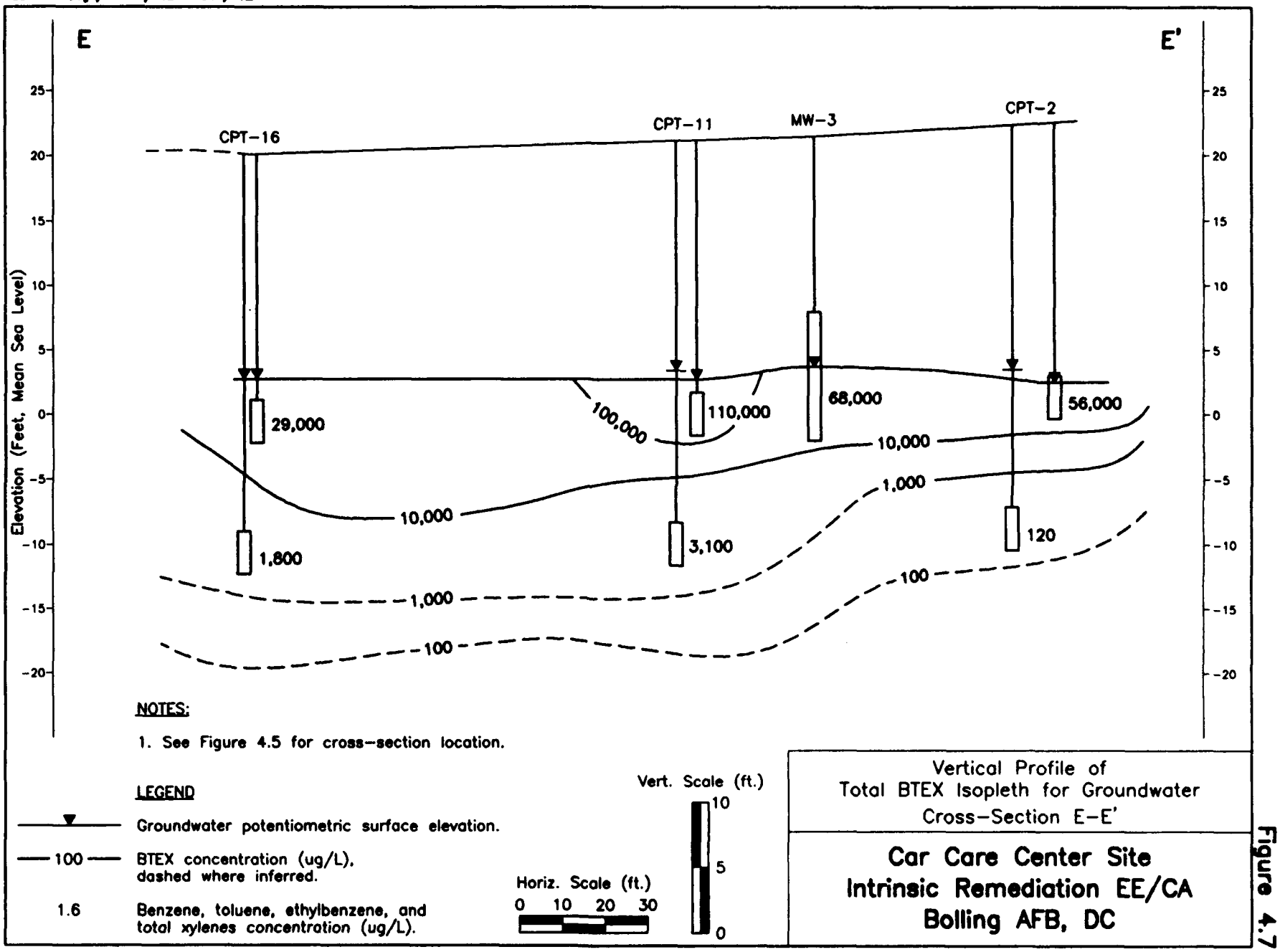


Vertical Profile of
Total BTEX Isopleth for Groundwater
Cross-Section D-D'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.6

72245044.dwg / 1=1 / 12-7-94 / TLP



NOTES:

1. See Figure 4.5 for cross-section location.

LEGEND

Groundwater potentiometric surface elevation.

100 — BTEX concentration (ug/L), dashed where inferred.

1.6 Benzene, toluene, ethylbenzene, and total xylenes concentration (ug/L).

Horiz. Scale (ft.)
0 10 20 30

Vert. Scale (ft.)
10
5
0

Vertical Profile of
Total BTEX Isopleth for Groundwater
Cross-Section E-E'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.7

MW-7 to 3,000 µg/L at MW-3. Generally, ethylbenzene was detected at lower concentrations than benzene or toluene. Finally, total xylene concentrations in August 1994 ranged from approximately 3 µg/L at CPT-10D, MW-7, and MW-8, to 68,000 µg/L at MW-2. The highest concentration was detected in MW-2, near the former 12,000-gallon gasoline UST that was recently removed. Total xylenes concentrations elsewhere generally ranged from 5,000 to 10,000 µg/L. The DCRA target cleanup level and federal MCL for total xylenes is 10,000 µg/L.

In June 1996, the highest concentration for each BTEX compound was detected in the sample from monitoring well MW-11 that was installed in 1996 to replace source area well MW-2 which was destroyed during site remediation activities. Seven of the thirteen monitoring points and wells sampled at the site contained groundwater with dissolved benzene concentrations above the DCRA criterion (and federal MCL). Where detected in June 1996, benzene concentrations ranged from 1.3 µg/L in CPT-21S to 9,000 µg/L at MW-11. Toluene concentrations exceeded the DCRA criterion and federal MCL for dissolved toluene at only MW-11 during the June 1996 sampling event. Toluene concentrations ranged from 0.6 µg/L at CPT-21S to 25,000 µg/L. Three sample concentrations exceeded the DCRA criterion and federal MCL for ethylbenzene in June 1996. Ethylbenzene concentrations ranged from 0.8 µg/L at MW-1 to 2,300 µg/L. In general, ethylbenzene was detected at higher concentrations than toluene. Where detected, total xylene concentrations ranged from approximately 0.5 µg/L at CPT-20S, and MW-1 to 13,000 µg/L at MW-11. The DCRA target cleanup level and federal MCL for total xylenes is 10,000 µg/L.

Comparison of BTEX concentrations from the 1994 and 1996 sampling events suggest several possible trends. First, total BTEX concentration in the source area appears to be decreasing. Although a direct comparison of historical concentrations at a single source area location is not possible because all former source area monitoring wells and monitoring points were abandoned during remediation activities prior to the 1996 sampling event, a new source area well MW-11, was installed in early 1996 as a replacement for former MW-2. In August 1994, the total dissolved BTEX concentration in MW-2 was 100,000 µg/L. For comparison, the total dissolved BTEX concentration detected in MW-11 from June 1996 was 49,300 µg/L, less than half of the previous MW-2 concentration. Furthermore, a concentration of 49,300 µg/L is less than 1994 concentrations in six of the seven sampled locations at the core of the plume (MW-2, MW-3, MW-4, CPT-2, CPT-9, CPT-10, and CPT-11). This suggests that the rate of BTEX dissolution from the source to the groundwater is decreasing with time.

A second observed trend is the decrease in total dissolved BTEX concentrations at cross-gradient sampling locations between 1994 and 1996. At the four cross-gradient wells MW-7, MW-8, MW-9, and MW-10, total dissolved BTEX dropped from low detected concentrations of less than 15 µg/L in 1994 to below detection limits in 1996. This suggests that the rate of dissolved BTEX biodegradation exceeds the rate at which dissolved BTEX is migrating in the direction transverse to the primary groundwater flow direction.

A final trend suggests that the total dissolved BTEX plume is continuing to expand in the downgradient direction. The two furthest downgradient groundwater monitoring locations, CPT-21D and CPT-22D, both experienced large increases in total dissolved BTEX concentrations from 1994 to 1996: 9.55 µg/L to 443 µg/L at CPT-21D and 180

µg/L to 484 µg/L at CPT-22D. This trend indicates that the rate of biodegradation is not capable of containing the influx of dissolved BTEX at the leading edge of the plume. As, would be expected, with total dissolved BTEX concentrations decreasing in the source area and increasing at the leading edge of the plume, a mix of increasing and decreasing concentrations is observed through the plume interior such as at location CPT-19D and CPT-20D.

4.3.2 Groundwater Geochemistry

Microorganisms obtain energy for cell production and maintenance by facilitating the transfer of electrons from electron donors to electron acceptors. This results in the oxidation of the electron donor and the reduction of the electron acceptor. Potential electron donors at the Car Care Center Site are natural organic carbon constituents and fuel hydrocarbon compounds. Fuel hydrocarbons are completely degraded or detoxified if they are utilized as the primary electron donor for microbial metabolism (Bouwer, 1992). Electron acceptors are elements or compounds that occur in relatively oxidized states and include DO (O_2), nitrate (NO_3^{-2}), ferric iron (Fe^{+3}), manganese dioxide (MnO_2), sulfate (SO_4^{-2}), and carbon dioxide (CO_2). Microorganisms preferentially utilize electron acceptors while metabolizing fuel hydrocarbon (Bouwer, 1992). DO is utilized first by aerobic organisms as the primary electron acceptor. After the DO is consumed, anaerobic microorganisms use electron acceptors in the following order of preference: nitrate, ferric iron/ manganese dioxide, sulfate, and finally carbon dioxide.

Depending on the type of electron acceptors present (e.g., nitrate, sulfate, carbon dioxide), pH conditions, and redox potential, anaerobic biodegradation can occur by denitrification, ferric iron reduction, sulfate reduction, or methanogenesis. Other, less common anaerobic degradation mechanisms such as manganese reduction may dominate if the physical and chemical conditions in the subsurface favor use of these electron acceptors. Anaerobic destruction of the BTEX compounds is associated with the accumulation of fatty acids, production of methane, solubilization of iron and manganese, and reduction of nitrate and sulfate (Cozzarelli *et al.*, 1990; Wilson *et al.*, 1990). Environmental conditions and microbial competition will ultimately determine which processes will dominate. Vroblesky and Chapelle (1994) show that the dominant terminal electron accepting process can vary both temporally and spatially in an aquifer with fuel hydrocarbon contamination.

Car Care Center data for electron acceptors, from both sampling events, indicate intrinsic remediation of hydrocarbons in the shallow aquifer may be occurring by aerobic oxidation, denitrification, ferric iron reduction, manganese reduction, sulfate reduction, and methanogenesis. This is evidenced by significant changes in the groundwater geochemistry in comparison to background conditions found at the former Car Care Center. Areas of the site that have the greatest magnitude of change in the geochemical parameter concentrations generally correspond well with areas of low redox potentials and high BTEX concentrations. Table 4.3 summarizes groundwater geochemical data gathered during the intrinsic remediation demonstration in August 1994, and the one year update in June 1996 at Bolling AFB. Geochemical parameters for the Car Care Center Site are discussed in the following sections.

TABLE 4.3
GROUNDWATER GEOCHEMICAL DATA
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Sample Location[a/]	Date	Water Temp.[b/] (°C)	pH[b/]	Conductivity[b/] (mmhos/cm)	Dissolved Oxygen[b/] (mg/L)	Redox Potential[b/] (mV)	Total Alkalinity[c/] (mg/L)	Nitrate[d/] (mg/L)	Nitrite[d/] (mg/L)	Sulfate[d/] (mg/L)	Hydrogen Sulfide[d/] (mg/L)	Ferrous Iron (mg/L)	Methane[e/] (mg/L)	Mn^{2+} (mg/L)	CO_2 (mg/L)
Monitoring Points															
CPT-02S	Aug-94	21.5	6.03	57.8	0.85	-112	27.9	0.0	0.008	41	0.0	7.2	NS	NA	NA
CPT-02D	Aug-94	21.2	6.60	23.7	0.72	-92	NS[f/]	0.35	0.025	46	0.0	2.9	NS	NA	NA
CPT-08S	Aug-94	22.6	6.32	9.4	0.62	-413	132	0.0	0.0	28	0.0	6.4	NS	NA	NA
CPT-08D	Aug-94	22.2	4.88	88.7	2.2	-215	266	2.4	0.006	65	0.0	0.025	NS	NA	NA
CPT-09S	Aug-94	22.6	4.48	109	0.30	-414	69.0	0.0	0.002	55	0.0	0.61	NS	NA	NA
CPT-09D	Aug-94	22.4	6.05	24.8	0.26	-296	9.02	2.6	0.016	41	0.0	5.4	NS	NA	NA
CPT-10S	Aug-94	23.0	6.11	22.1	0.39	-477	124	0.0	0.0	0.90	0.0	0.59	NS	NA	NA
CPT-10D	Aug-94	22.3	5.26	69.5	2.1	-60	6.96	4.7	0.025	56	0.0	3.4	NS	NA	NA
CPT-11S	Aug-94	21.6	4.75	94.6	0.33	-328	108	0.0	0.0	72	0.0	2.8	NS	NA	NA
CPT-11D	Aug-94	21.9	6.29	11.4	0.24	-189	< 5.00	1.1	0.002	31	0.0	8.1	NS	NA	NA
CPT-16S	Aug-94	24.0	5.04	106.4	0.77	-243	17.7	0.0	0.092	44	0.0	0.04	NS	NA	NA
CPT-16D	Aug-94	24.6	6.59	24.2	0.35	-177	122	0.70	0.0	25	0.0	8.4	NS	NA	NA
CPT-18S	Aug-94	24.0	4.46	140.3	0.29	-258	22.8	1.2	0.016	16	0.0	0.44	NS	NA	NA
CPT-18D	Aug-94	23.1	6.62	18.1	0.28	-58	17.6	0.0	0.003	30	0.0	NS	NS	NA	NA
CPT-19S	Aug-94	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA
CPT-19S	Jun-96	19.90	5.00	NA	5.53	120	50.00	8.60	ND	44.4	NA	0.000	ND	0.0	20
CPT-19D	Aug-94	23.6	6.12	31.2	0.88	-108	106	0.0	0.0	14	0.0	12	0.31	NA	NA
CPT-19D	Jun-96	19.6	6.00	NA	2.80	-110	140	0.11	ND	0.88	NA	16.25	0.7	4.2	170
CPT-20S	Aug-94	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA
CPT-20S	Jun-96	18.80	5.00	NA	7.12	138	25.00	5.50	ND	35.2	NA	0.080	0.003	0	NA
CPT-20D	Aug-94	22.7	6.44	13.3	0.36	-266	94.3	0.0	0.0	36	0.0	5.8	NS	NA	NA
CPT-20D	Jun-96	18.9	6.00	NA	2.77	-154	150	0.068	ND	0.95	NA	20.25	9.1	5.8	170
CPT-21S	Aug-94	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA
CPT-21S	Jun-96	20.40	5.00	NA	1.51	88	60.00	0.077	ND	9.6	NA	10.450	0.021	0.6	70
CPT-21D	Aug-94	21.6	5.33	7.4	0.35	-352	5.2	0.60	0.025	62.4	0.0	0.090	NS	NA	NA
CPT-21D	Jun-96	19.2	7.70	NA	0.05	165	100	ND	ND	36.2	NA	0.200	2.1	13.6	70
CPT-21D (Duplicate	Aug-94	NS	NS	NS	NS	NS	165	NS	NS	NS	NS	NS	NS	NA	NA
CPT-22S	Aug-94	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NA	NA
CPT-22S	Jun-96	18.30	NA	NA	6.24	115.70	NA	NA	NA	NA	NA	NA	NA	NA	NA
CPT-22D	Aug-94	21.0	6.21	24.8	0.80	-189	109	2.9	0.12	48	0.0	0.055	<0.001	NA	NA
CPT-22D	Jun-96	19.6	NA	NA	0.06	191	60	0.33	0.21	35.5	NA	0.3	4	8.8	100

TABLE 4.3
GROUNDWATER GEOCHEMICAL DATA
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Sample Location[a/]	Date	Water Temp.[b/] (°C)	pH[b/]	Conductivity[b/] (mmhos/cm)	Dissolved Oxygen[b/] (mg/L)	Redox Potential[b/] (mV)	Total Alkalinity[c/] (mg/L)	Nitrate[d/] (mg/L)	Nitrite[d/] (mg/L)	Sulfate[d/] (mg/L)	Hydrogen Sulfide[d/] (mg/L)	Ferrous Iron (mg/L)	Methane[e/] (mg/L)	Mn^{2+} (mg/L)	CO_2 (mg/L)
Previously Installed Monitoring Wells															
MW-1	Aug-94	25.6	6.46	33.0	1.2	57	17.7	0.0	0.0	11	0.0	8.9	NS	NA	NA
MW-1	Jun-96	21.9	5.50	NA	2.0	-81	1100	0.062	ND	2.1	NA	15.7	0.171	2.5	250
MW-2	Aug-94	NS	NS	NS	NS	NS	< 5.00	0.50	NS	12	0.0	8.4	NS	NA	NA
MW-3	Aug-94	20.0	5.33	89.9	0.89	32	165	0.50	0.0	38	NS	6.6	1.37	NA	NA
MW-4	Aug-94	23.4	6.12	49.1	1.4	-110	67.7	1.4	0.027	0.40	0.0	6.1	0.005	NA	NA
MW-5	Aug-94	NS	NS	NS	NS	NS	167	NS	NS	NS	NS	NS	NS	NA	NA
MW-6	Aug-94	25.0	6.14	49.7	0.25	112	215	2.0	0.55	44	0.0	0.48	<0.001	NA	NA
MW-6 (Duplicate)	Aug-94	NS	NS	NS	NS	NS	46.7	NS	NS	NS	NS	NS	NS	NA	NA
MW-7	Aug-94	21.9	4.63	115	1.0	234	49.4	18	0.026	91	NS	0.10	<0.001	NA	NA
MW-7	Jun-96	18.6	4.50	NA	4.4	166.70	10	11.800	ND	82.7	NA	0.00	ND	4.3	70
MW-8	Aug-94	20.9	5.43	90.0	0.94	175	< 5.00	0.60	0.010	25	0.0	4.7	0.003	NA	NA
MW-8	Jun-96	18.9	4.50	NA	3.36	165	NA	0.760	ND	38	NA	4.15	0.003	1.6	80
MW-9	Aug-94	25.4	6.33	38.9	5.2	270	< 5.00	2.0	0.021	54	0.0	0.05	<0.001	NA	NA
MW-9	Jun-96	18.4	5.50	NA	7.5	176	70.00	5.200	ND	73.2	NA	0.00	ND	0.1	100
MW-10	Aug-94	24.1	4.64	114	4.8	285	142	13	0.004	53	0.0	0.10	<0.001	NA	NA
MW-10	Jun-96	20.9	4.50	NA	4.0	137	20	17.200	ND	53.9	NA	0.01	ND	1.1	100
MW-11	Jun-96	19.0	6.000	NA	1.250	-94	700.00	0.140	ND	0.97	NA	11.4	5	7.9	120

[a/] See Figure 4.5 for sample locations
[b/] Quantified by portable field instruments. See Section 2.0
[c/] Quantified by Method A403
[d/] Quantified by HACH field tests
[f/] NS = Not sampled

4.3.2.1 Dissolved Oxygen

DO concentrations were measured at monitoring points and existing monitoring wells during the August 1994 and June 1996 sampling events. Table 4.3 provides a summary of measured DO concentrations. Figure 4.8 provides two isopleth maps showing the distribution of DO concentrations in groundwater for August 1994 and June 1996. Figure 4.9 and Figure 4.10 are vertical profiles through the August 1994 DO plume. Comparison of Figure 4.4 with Figure 4.8, Figure 4.6 with Figure 4.9, and Figure 4.7 with Figure 4.10 shows graphically that areas with elevated total BTEX concentrations correlate with areas of reduced DO concentrations. The lowest observed DO concentration in August 1994 was 0.24 mg/L measured at CPT-11D. The lowest DO concentrations measured in the June 1996 sampling event was 0.05 mg/L measured at CPT-21D. Based on the 1994 background DO levels measured at MW-9 (5.2 mg/L), and a 1996 background DO of 7.5 mg/L (MW-9) it is likely that DO was and continues to be an important electron acceptor at the Car Care Center Site. This is a strong indication that aerobic biodegradation of the BTEX compounds is occurring at the site.

The anomalously high DO concentrations observed at CPT-19D and CPT-20D can be traced to the suspected perched water table in the immediate vicinity (Figure 3.1). The frequent watering of the grassy area around CPT-19 and CPT-20 and the presence of subsurface clay layers have caused the groundwater beneath the two points to become perched. This results from the additional water becoming trapped between the surface and the impermeable subsurface clay layer. Water used for landscaping purposes is usually high in DO because it is in contact with the atmosphere, therefore when water filters down through site soils it increases DO concentrations found in site groundwater.

The following equations describe the overall stoichiometry of aromatic hydrocarbon mineralization caused by microbial biodegradation. In the absence of microbial cell production, the oxidation (mineralization) of benzene to carbon dioxide and water is given by:

$$C_6H_6 + 7.5O_2 \rightarrow 6CO_{2(g)} + 3H_2O$$

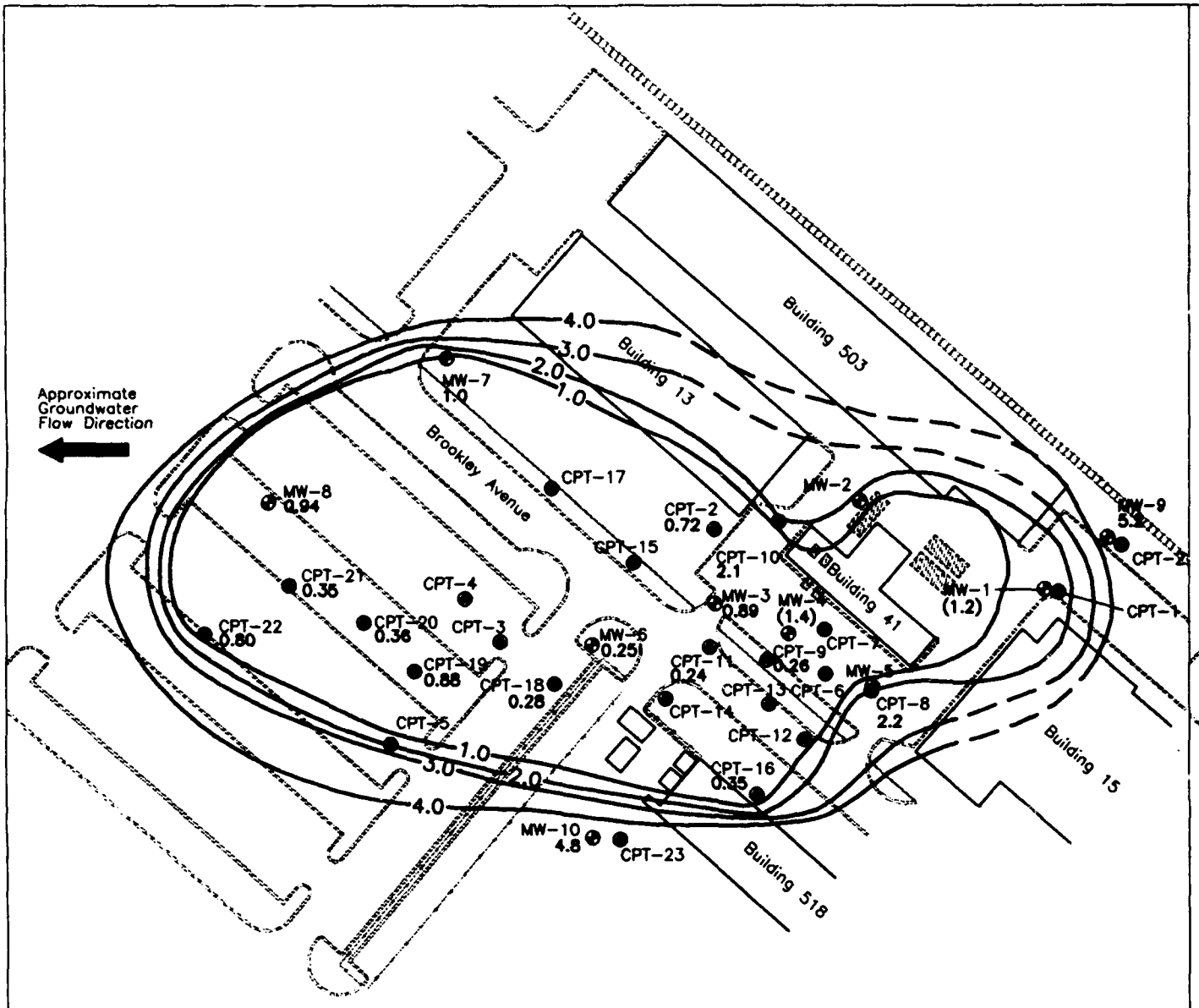
Therefore, 7.5 moles of oxygen are required to metabolize 1 mole of benzene. On a mass basis, the ratio of oxygen to benzene is given by:

Molecular weights:	Benzene	6(12) + 6(1) = 78 gm/mole
	Oxygen	7.5(32) = 240 gm/mole

Mass Ratio of Oxygen to Benzene = 240/78 = 3.08:1

Therefore, in the absence of microbial cell production, 3.08 mg of oxygen are required to completely metabolize 1 mg of benzene.

Similar calculations can be completed for toluene (3.13 mg oxygen to 1 mg toluene), ethylbenzene (3.17 mg oxygen to 1 mg ethylbenzene), and xylenes (3.17 mg oxygen to 1 mg xylene). The average mass ratio of oxygen to total BTEX is thus 3.14:1. This means that approximately 0.32 mg of BTEX is mineralized for every 1.0 mg of DO consumed. As a conservative estimate, a background DO concentration



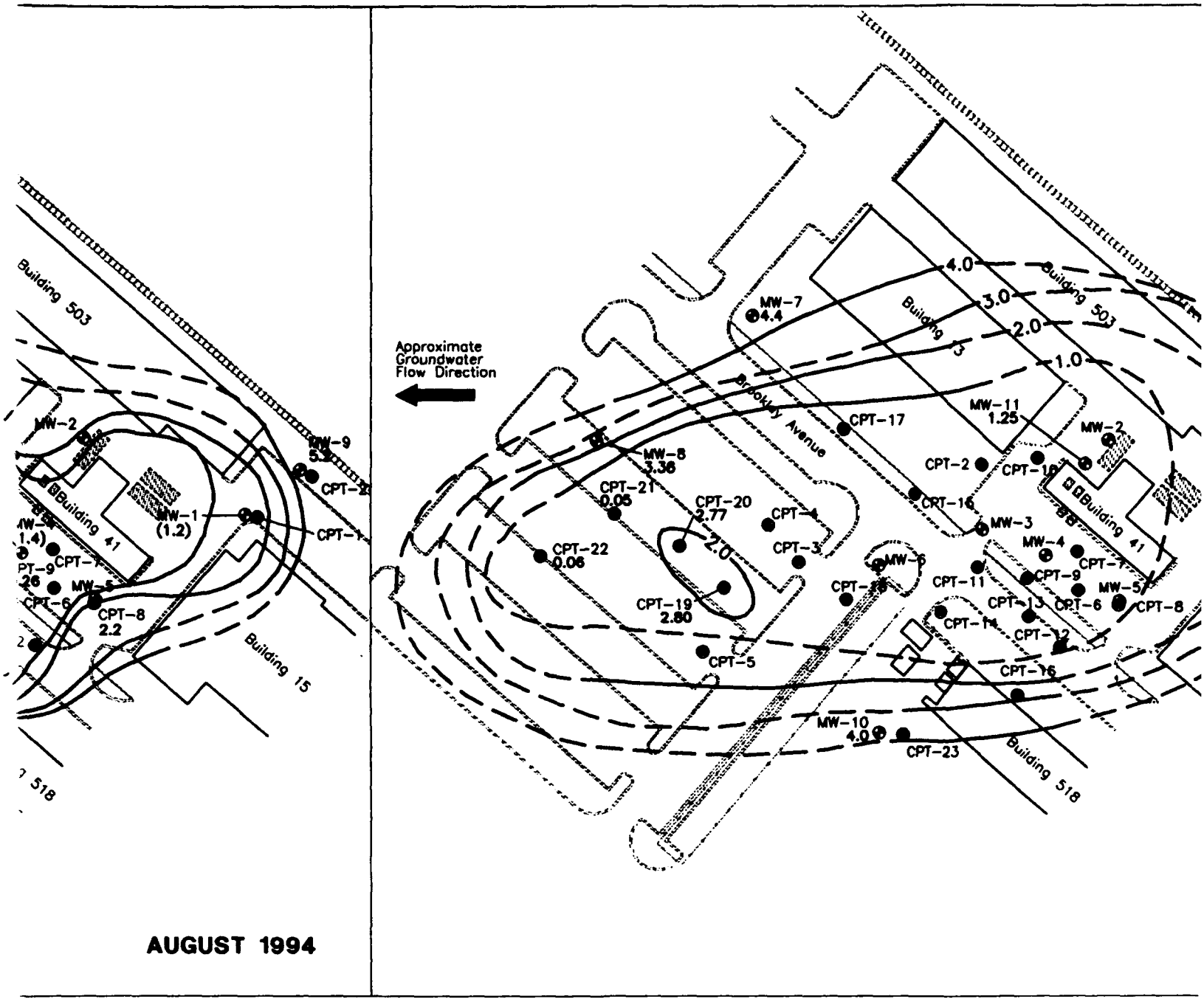
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
0.36	Dissolved oxygen concentration (mg/L).
(1.2)	Data not utilized to develop contours.
—— 1.0 ——	Dissolved oxygen contour (mg/L), dashed where inferred.

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

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AUGUST 1994

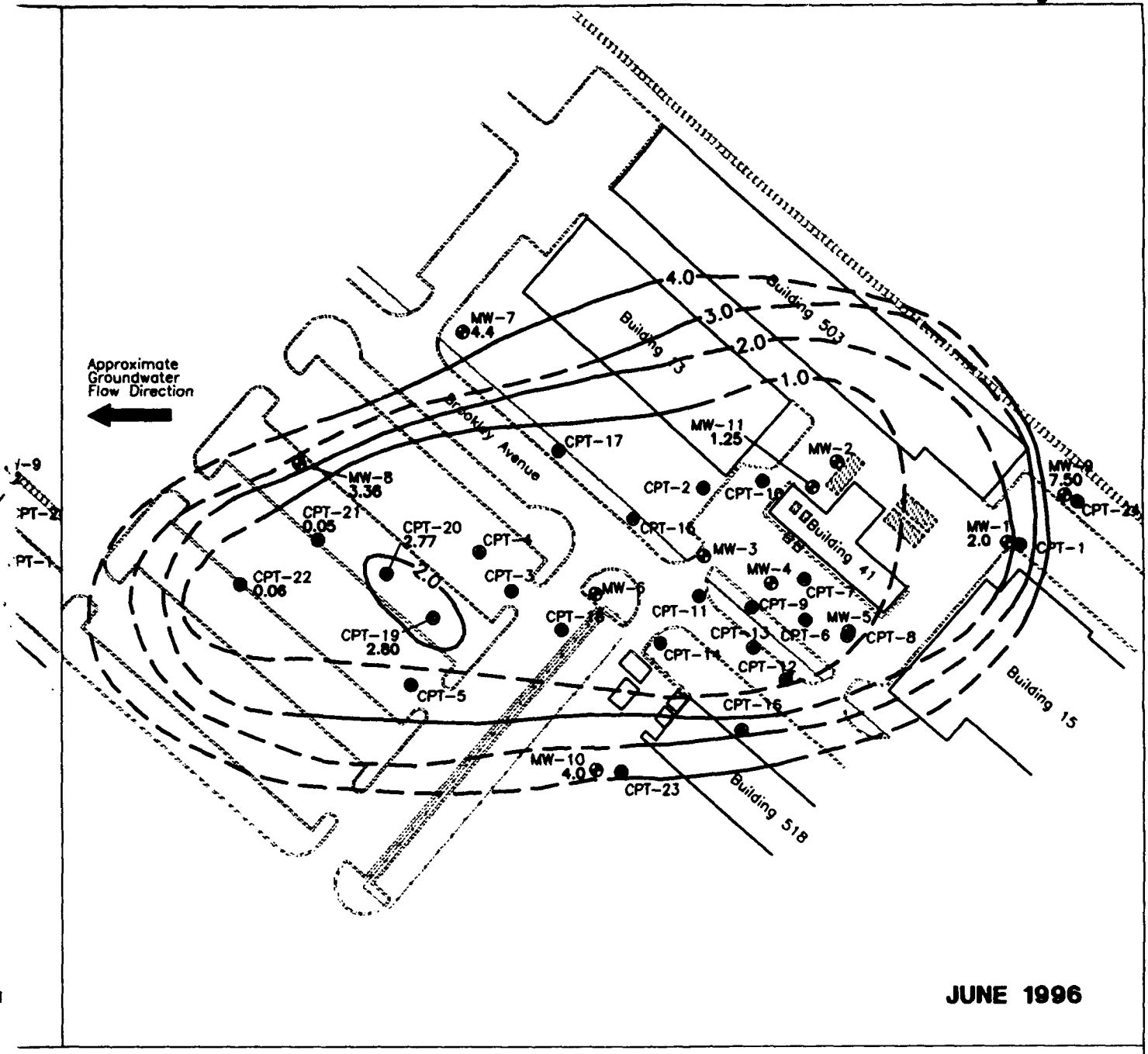
pleth map was developed using data from
ep CPT points and monitoring wells.

Dissolved Oxygen I

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Bolling AFI

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Figure 4.8



100' 50' 0 100'

Approximate Scale in Feet

Dissolved Oxygen Isopleth Maps

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

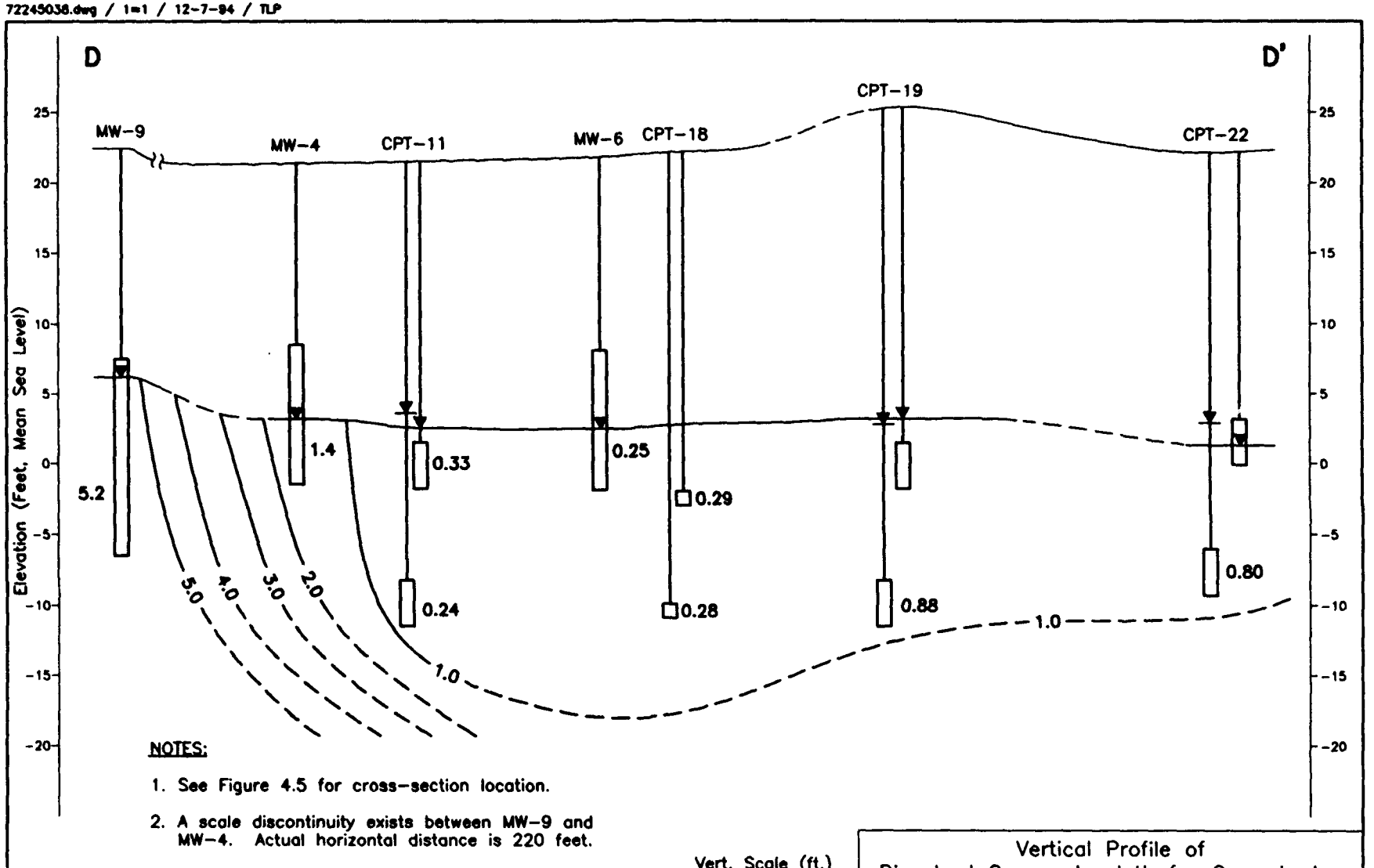
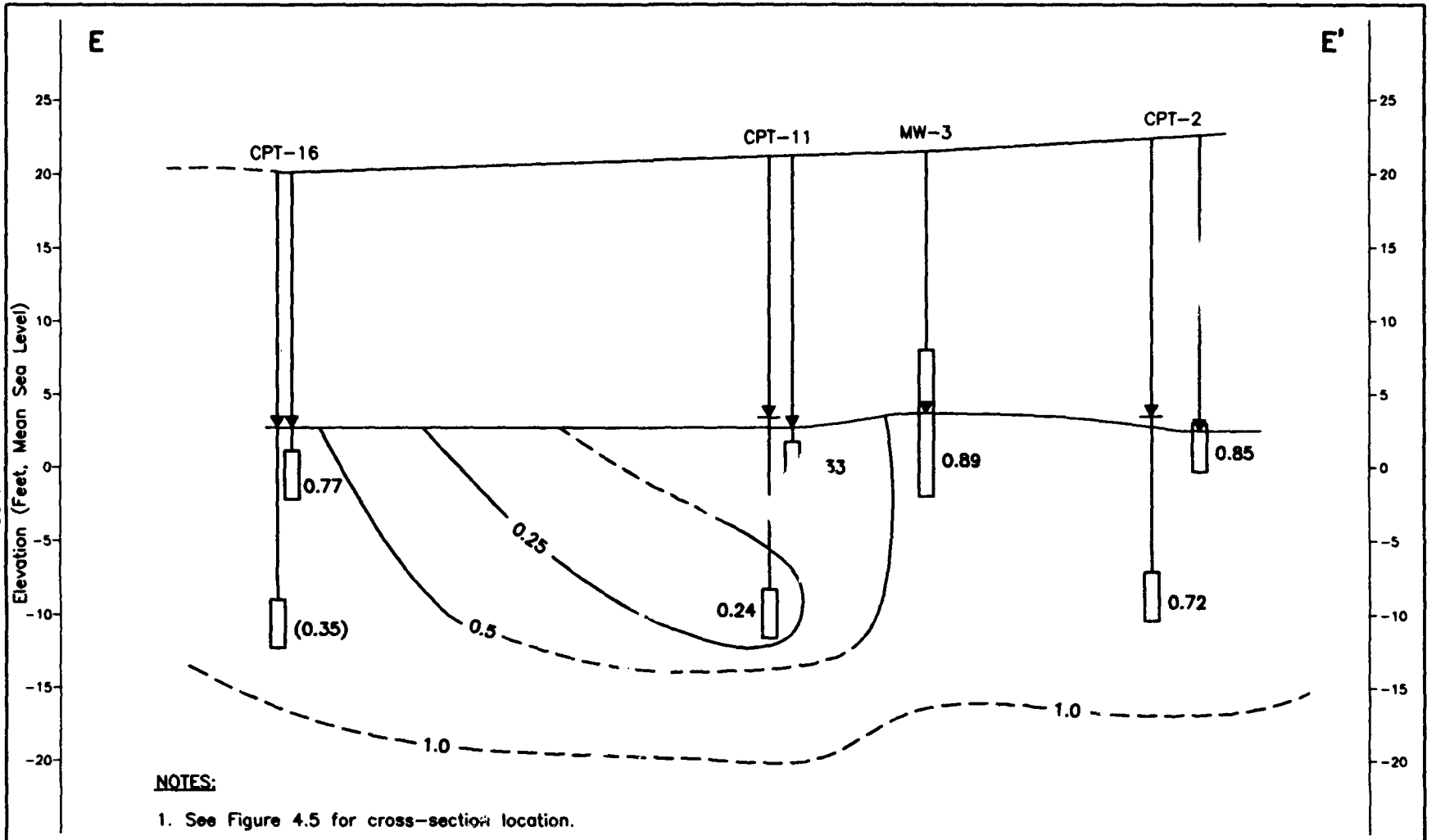

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D
D'
MW-9
MW-4
CPT-11
MW-6
CPT-18
CPT-19
CPT-22
Elevation (Feet, Mean Sea Level)
25
20
15
10
5
0
-5
-10
-15
-20
5.2
1.4
0.33
0.25
0.29
0.24
0.28
0.88
0.80
5.0
4.0
3.0
2.0
1.0
1.0
NOTES:
1. See Figure 4.5 for cross-section location.
2. A scale discontinuity exists between MW-9 and MW-4. Actual horizontal distance is 220 feet.
LEGEND
Groundwater potentiometric surface elevation.
5.0
Dissolved oxygen concentration (mg/L), dashed where inferred.
5.25
Dissolved oxygen concentration (mg/L).
Horiz. Scale (ft.)
0 20 40 60
Vert. Scale (ft.)
10
5
0
Vertical Profile of
Dissolved Oxygen Isopleth for Groundwater
Cross-Section D-D'
Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.9

72245045.dwg / 1=1 / 1-23-95 / TLP



NOTES:

1. See Figure 4.5 for cross-section location.

LEGEND

▼	Groundwater potentiometric surface elevation.
1.0	Dissolved oxygen concentration (mg/L), dashed where inferred.
0.77	Dissolved oxygen concentration (mg/L).
(0.35)	Data not utilized to construct contours.

Horiz. Scale (ft.)
0 10 20 30

Vert. Scale (ft.)
10
5
0

Vertical Profile of
Dissolved Oxygen Isopleth for Groundwater
Cross-Section E-E'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.10

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of 5 mg/L was assumed for the August 1994 sampling event. Based on this assumption, the shallow groundwater at this site had the capacity to assimilate 1.6 mg/L (1,600 µg/L) of total BTEX. Background DO for the June 1996 sampling event was estimated as 7 mg/L (based on DO concentration at MW-9). Using this estimate, the shallow groundwater at the former Car Care Center has the capacity to assimilate 2.2 mg/L (2,200 µg/L) of total BTEX during aerobic respiration. These are conservative estimates of the assimilative capacity of DO because microbial cell mass production was not taken into account by the stoichiometry shown above. This increase in aerobic assimilative capacity over two years, suggests that upgradient groundwater continues to provide significant amounts of dissolved oxygen, and possibly other electron acceptors, to the microbial population at the Car Care Center site.

When cell mass production is accounted for, the mineralization of benzene to carbon dioxide and water is given by:

$$C_6H_6 + 2.5O_2 + HCO_3^{-1} + NH_4^{+1} \rightarrow C_5H_7O_2N + 2CO_{2(g)} + 2H_2O$$

Note that only 2.5 moles of DO are required to mineralize 1 mole of benzene when cell mass production is taken into account. On a mass basis, the ratio of DO to benzene is given by:

Molecular weights: Benzene 6(12) + 6(1) = 78 gm/mole

Oxygen 2.5(32)= 80 gm/mole

Mass Ratio of Oxygen to Benzene = 80/78 = 1.03:1

Based on these stoichiometric relationships, 1.03 mg of oxygen are required to convert 1 mg of benzene into biomass, CO_2, and H_2O. Similar calculations can be made for toluene, ethylbenzene, and xylenes. Based on these calculations, approximately 0.97 mg of BTEX is converted into biomass and mineralized to carbon dioxide and water for every 1.0 mg of DO consumed. With an August 1994 background DO concentration of approximately 5 mg/L, the shallow groundwater at this site has the capacity to assimilate 4.8 mg/L (4,800 µg/L) of total BTEX if microbial cell mass production is taken into account. Using a June 1996 background DO concentration of approximately 7 mg/L translates to the capacity to assimilate 6.8 mg/L (6,800 µg/L) of total BTEX, if microbial cell mass production is taken into account. Because the contaminant plume has been present at the site for many years, the only location where microbial cell mass is likely to be increasing is at the leading edge of the plume which is still advancing.

4.3.2.2 Nitrate/Nitrite

Concentrations of nitrate + nitrite (as N) were measured at groundwater monitoring points and at existing monitoring wells in August 1994 and June 1996. Table 4.3 shows these concentrations. The observed nitrate concentrations were generally on the order of 10 to 100 times larger than nitrite concentrations. As a result, only nitrate concentrations were considered to be an important indicator of ongoing denitrification at the site. In August 1994, high nitrate concentrations were observed at MW-7 (18 mg/L) and MW-10 (13 mg/L). Both of these wells have relatively low (close to

background) BTEX concentrations and high concentrations of dissolved oxygen. More moderate nitrate concentrations were observed at CPT-10D (4.7 mg/L) and MW-9 (2.0 mg/L) which also have low BTEX concentrations and aerobic conditions. June 1996 nitrate + nitrite data, correspond very closely to data collected in 1994. Concentrations of nitrate observed during the June 1996 sampling event, ranged from 0.056 mg/L to 17.2 mg/L. Figure 4.11 provides two isopleth maps showing the distribution of nitrate + nitrite (as N) in groundwater for both the August 1994 and June 1996. Comparison with Figure 4.4 shows graphically that areas with elevated total BTEX concentrations have decreased nitrate + nitrite concentrations. Figures 4.12 and 4.13 are vertical profiles of nitrate concentrations from August 1994 data along cross-sections D-D' and E-E', respectively.

The low nitrate concentrations observed in the center of the BTEX plume indicate that anaerobic biodegradation of BTEX is occurring through the microbially mediated process of denitrification. Nitrate reduction may be a significant removal mechanism if actual background nitrate concentrations are above 10 mg/L as nitrogen (N). However, as a conservative assumption, a background nitrate concentration of 5.0 mg/L as N for both sampling events was utilized in this analysis to estimate assimilative capacity by denitrification. Since the nitrate concentrations in Table 4.3 are reported as mg/L as N, the values must be multiplied by 4.42 to be converted to mg/L as NO_3^-.

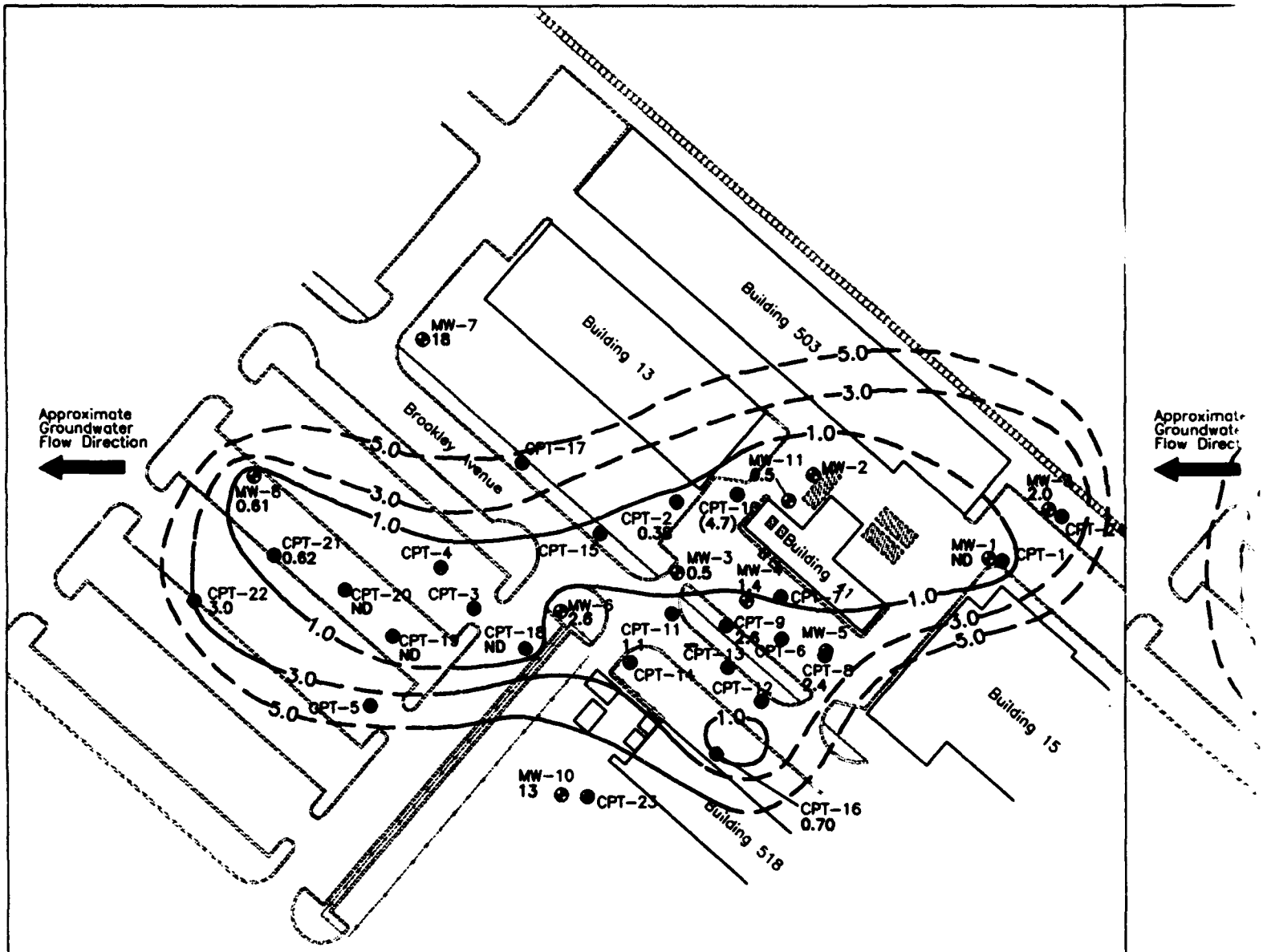
In the absence of microbial cell production, the biodegradation of benzene to carbon dioxide and water by the denitrification process is given by:

$$6NO_3^- + 6H^+ + C_6H_6 \rightarrow 6CO_{2(g)} + 6H_2O + 3N_{2(g)}$$

Based on this relationship, 6 moles of nitrate are required to mineralize 1 mole of benzene. On a mass basis, the ratio of nitrate to benzene is given by:

Molecular weights:	Benzene	6(12) + 6(1) = 78 gm/mole
	Nitrate	14+3(16) = 62 gm/mole
	Mass ratio of nitrate to benzene = 6(62)/78 = 4.77:1	

In the absence of microbial cell production, 4.77 mg of nitrate are required to completely mineralize 1 mg of benzene. Similar calculations can be completed for toluene (4.85 mg nitrate to 1 mg toluene), ethylbenzene (4.92 mg nitrate to 1 mg ethylbenzene), and the xylenes (4.92 mg nitrate to 1 mg xylene). The average mass ratio of nitrate consumed to total BTEX degraded is 4.86:1. This means that approximately 0.20 mg of BTEX is mineralized for every 1.0 mg of nitrate consumed. With an assumed background nitrate concentration of 22.1 mg/L as NO_3^-(5 mg/L as N multiplied by the conversion factor of 4.42), for both August 1994 and June 1996, the shallow groundwater at this site has the capacity to assimilate 4.4 mg/L (4,400 μg/L) of total BTEX during denitrification. This is a very conservative estimate of the assimilative capacity of nitrate because microbial cell mass production has not been taken into account by the stoichiometry shown above (Section 4.3.2.1). The similarity between August 1994 and June 1996 site nitrate concentrations and denitrification assimilative capacities suggest that denitrification remains an important biodegradation mechanism and that nitrate is being replenished at the site via upgradient groundwater sources.



AUGUST 1994

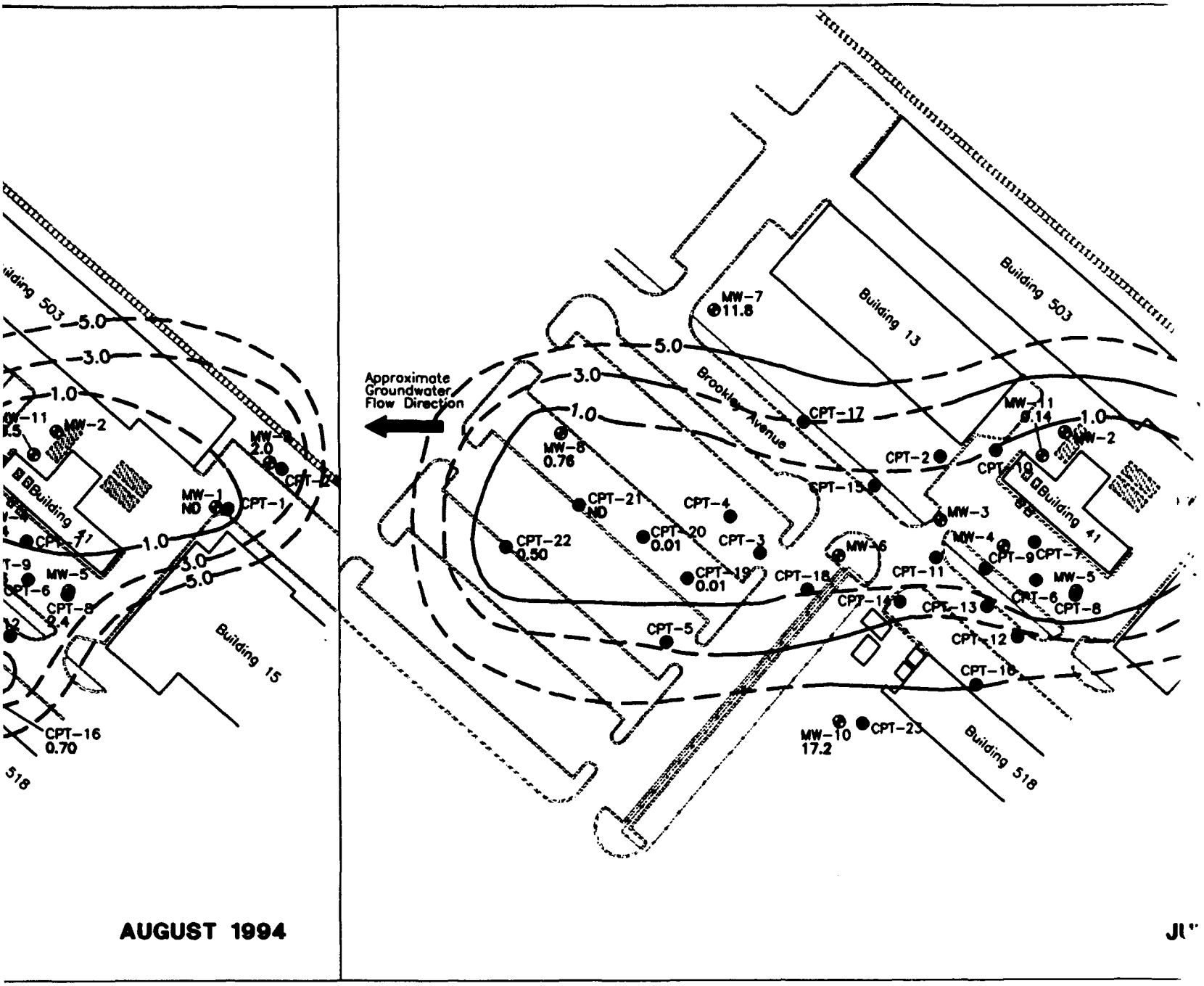
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
3.0	Dissolved nitrate + nitrite (as nitrogen) concentration (mg/L as N).
(0.38)	Data not used to construct contours.
—— 5.0 ——	Dissolved nitrate + nitrite (as nitrogen) contour (mg/L), dashed where inferred.

NOTE:

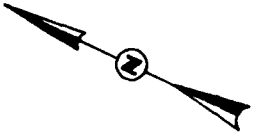
1. Isopleth map was developed using data from deep CPT points and monitoring wells.

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AUGUST 1994

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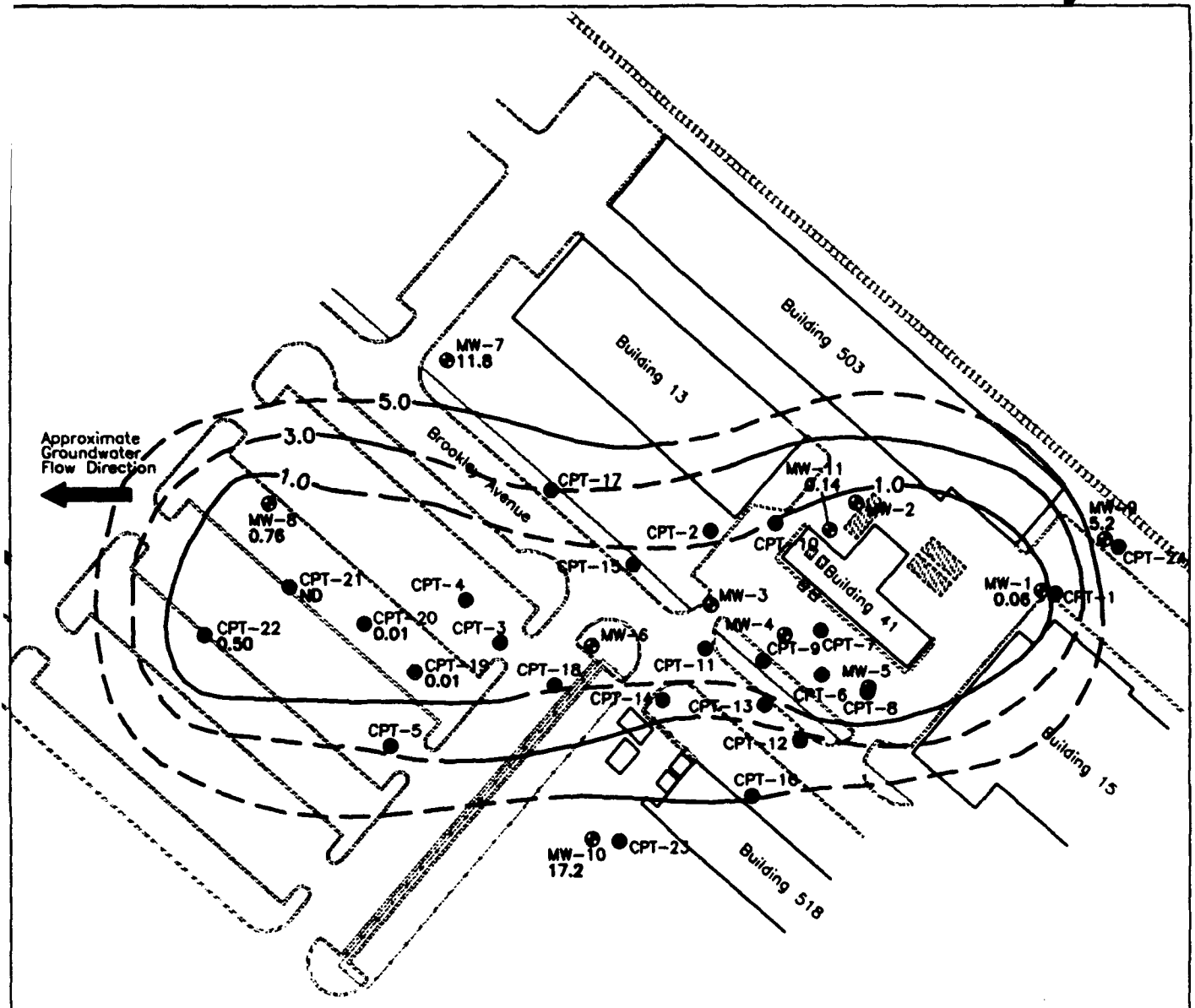
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Nitrate + Nitrite (as
Isopleth Maps for Gr

Car Care Center
Intrinsic Remediatior
Bolling AFB, D

PARSONS ENGINE

Figure 4.11



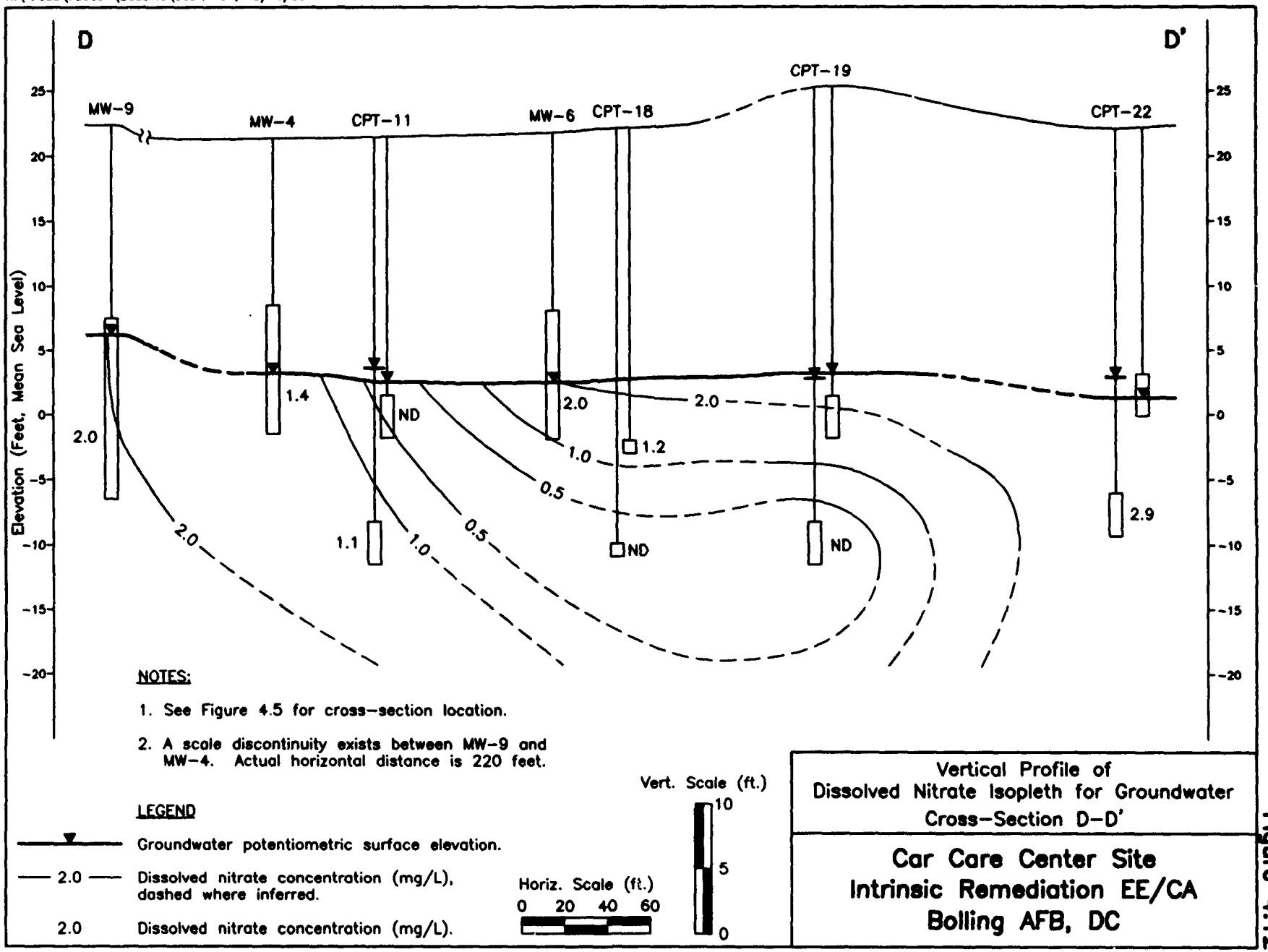
JUNE 1996

Nitrate + Nitrite (as Nitrogen) Isopleth Maps for Groundwater

Car Care Center Site Intrinsic Remediation EE/CA Bolling AFB, DC

PARSONS ENGINEERING SCIENCE, INC.

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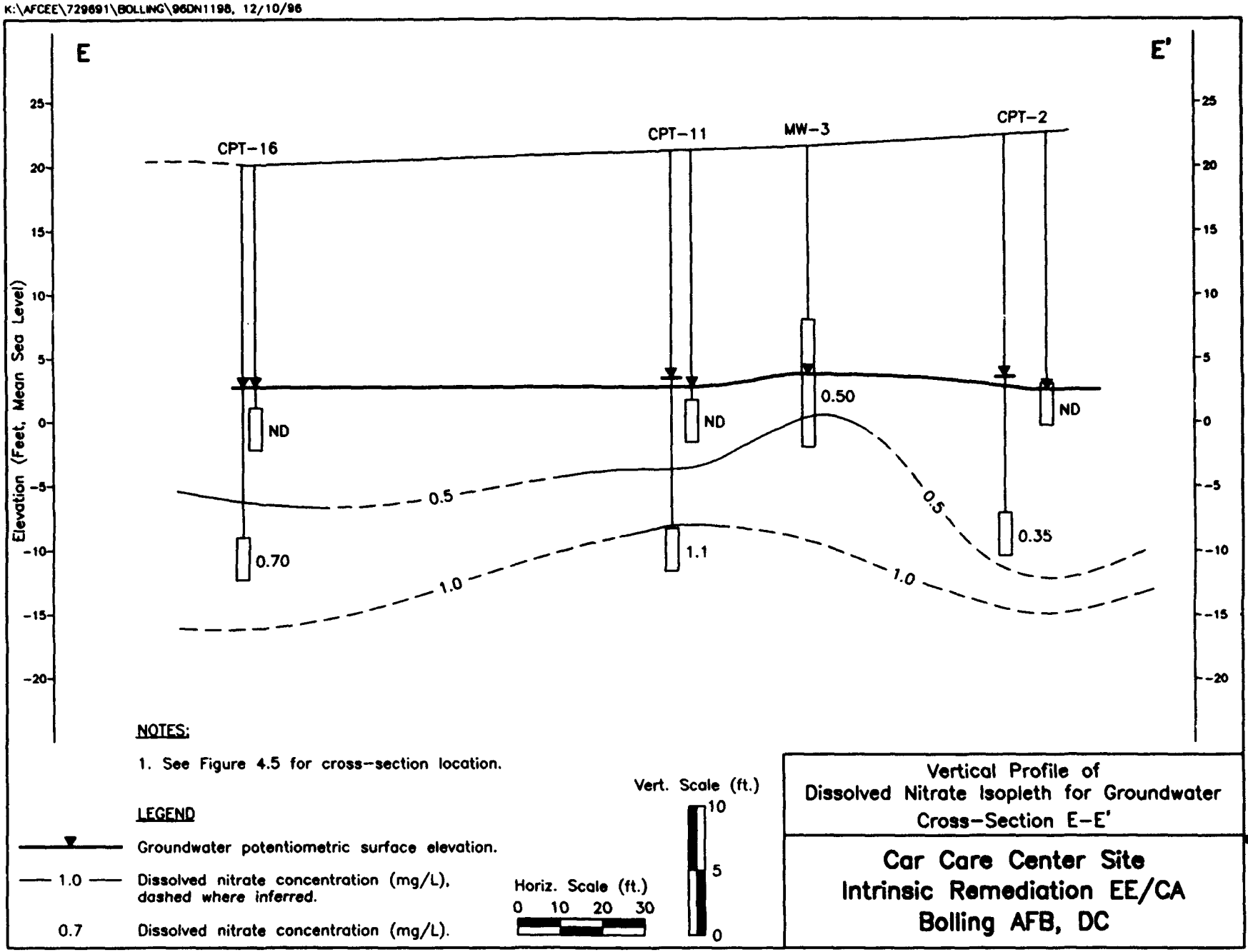
Vertical Profile of
Dissolved Nitrate Isopleth for Groundwater
Cross-Section D-D'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.12

PARSONS ENGINEERING SCIENCE, INC.

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NOTES:

1. See Figure 4.5 for cross-section location.

LEGEND

Groundwater potentiometric surface elevation.

1.0 — Dissolved nitrate concentration (mg/L), dashed where inferred.

0.7 Dissolved nitrate concentration (mg/L).

Horiz. Scale (ft.)
0 10 20 30

Vert. Scale (ft.)
10
5
0

Vertical Profile of
Dissolved Nitrate Isopleth for Groundwater
Cross-Section E-E'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

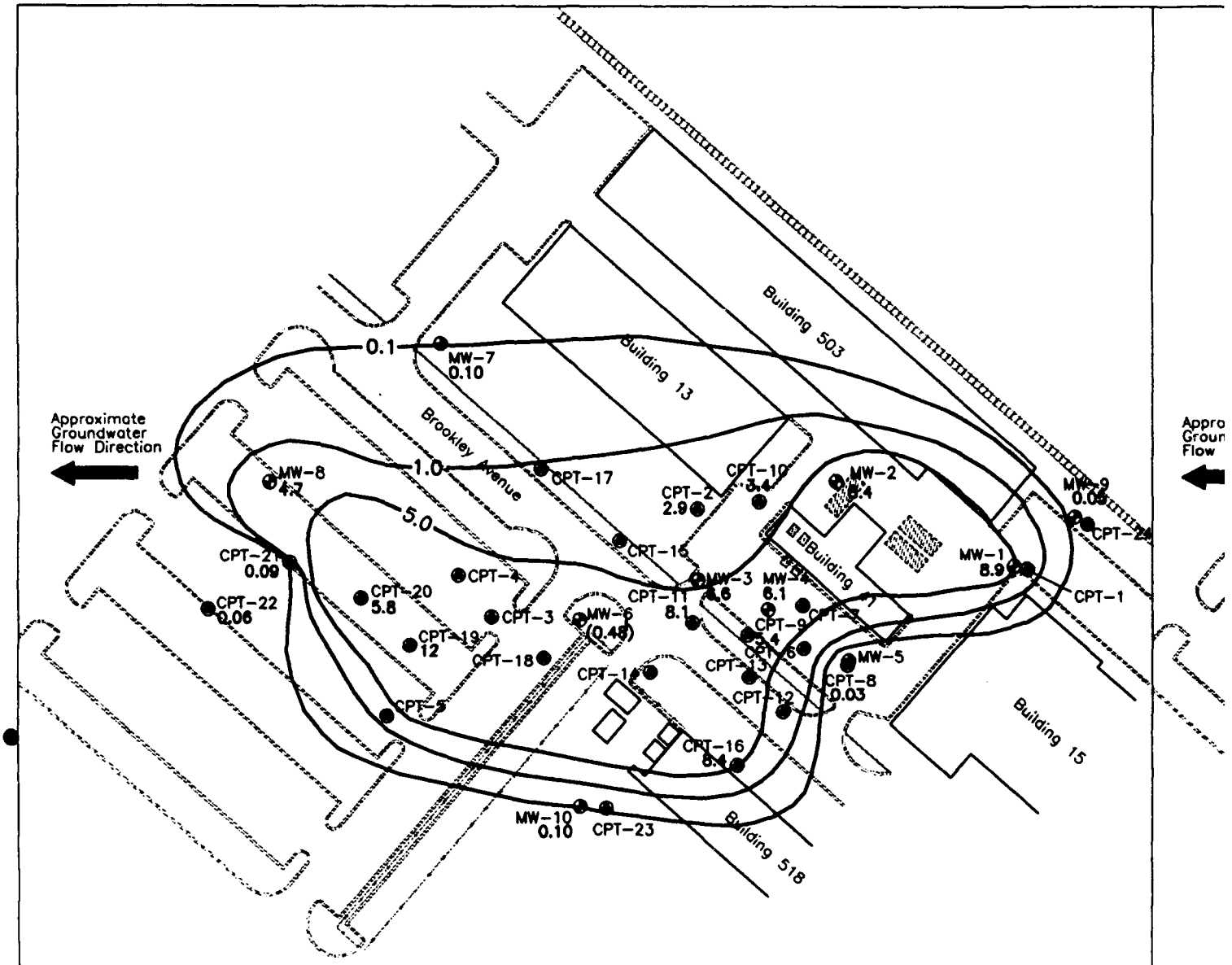
Figure 4.13

4.3.2.3 Ferrous Iron

Ferrous iron concentrations were measured at groundwater monitoring points and at existing monitoring wells in August 1994 and June 1996. Table 4.3 summarizes ferrous iron concentrations observed at the site. Figure 4.14 provides two isopleth maps comparing the distribution of ferrous iron in groundwater from the two sampling events. Figures 4.15 and 4.16 are vertical profiles of observed ferrous iron concentrations from the August 1994 site investigation at the Car Care Center Site. Comparison of Figures 4.14 and 4.4 shows graphically that the areas with the highest ferrous iron concentration also have the highest BTEX concentration. This suggests that ferric iron is being reduced to ferrous iron during biodegradation of BTEX compounds. The highest measured ferrous iron concentration in August 1994, 12 mg/L, was detected at CPT-19D. This location is downgradient of the areas that contain the highest BTEX concentrations. Ferrous iron is possibly being converted in the plume center, then is migrating downgradient with the groundwater. High ferrous iron concentrations were also detected in August 1994 at MW-2 (8.4 mg/L), MW-3 (6.6 mg/L), MW-4 (6.1 mg/L), CPT-11D (8.1 mg/L), and CPT-16D (8.4 mg/L), all of which are located near the center of the BTEX plume. The elevated ferrous iron concentration in MW-1 (8.9 mg/L) was inconsistent with the previous trend, as BTEX concentrations are low at this location. Background levels of ferrous iron are generally at or below 0.1 mg/L, as measured at wells with little or no known BTEX contamination.

In June 1996, the highest measured ferrous iron concentration of 20.3 mg/L was detected at CPT-20D. Additional high ferrous iron concentrations were detected in June 1996 at CPT-19D (16.0 mg/L), MW-11 (11.4 mg/L), and CPT-21S (10.5 mg/L). All of these elevated ferrous iron concentrations were observed in sampling locations which are located just downgradient, or in the area of the highest BTEX concentrations observed in groundwater. The increased ferrous iron concentration at MW-1, observed in both 1994 and 1996 sampling events, could suggest an alternate source of ferrous iron just upgradient from MW-1. Measurements of DO, nitrate, and BTEX in groundwater samples from MW-1 suggest that an upgradient source of fuel hydrocarbons, not related to the Car Care Center site, could exist. However, the significant decrease in dissolved BTEX concentrations at MW-1 suggest that this unknown upgradient source is being biodegraded at similar rates as the contaminant plume at the former Car Care Center.

Background levels of ferrous iron are generally at or below 0.1 mg/L, as measured at wells with little or no known BTEX contamination. August 1994 and June 1996 ferrous iron plumes (Figure 4.14) suggest that iron reduction is still a very important biodegradation mechanism at the site, because ferrous iron concentrations continue to be elevated in the groundwater just downgradient from the source area near Car Care Center.



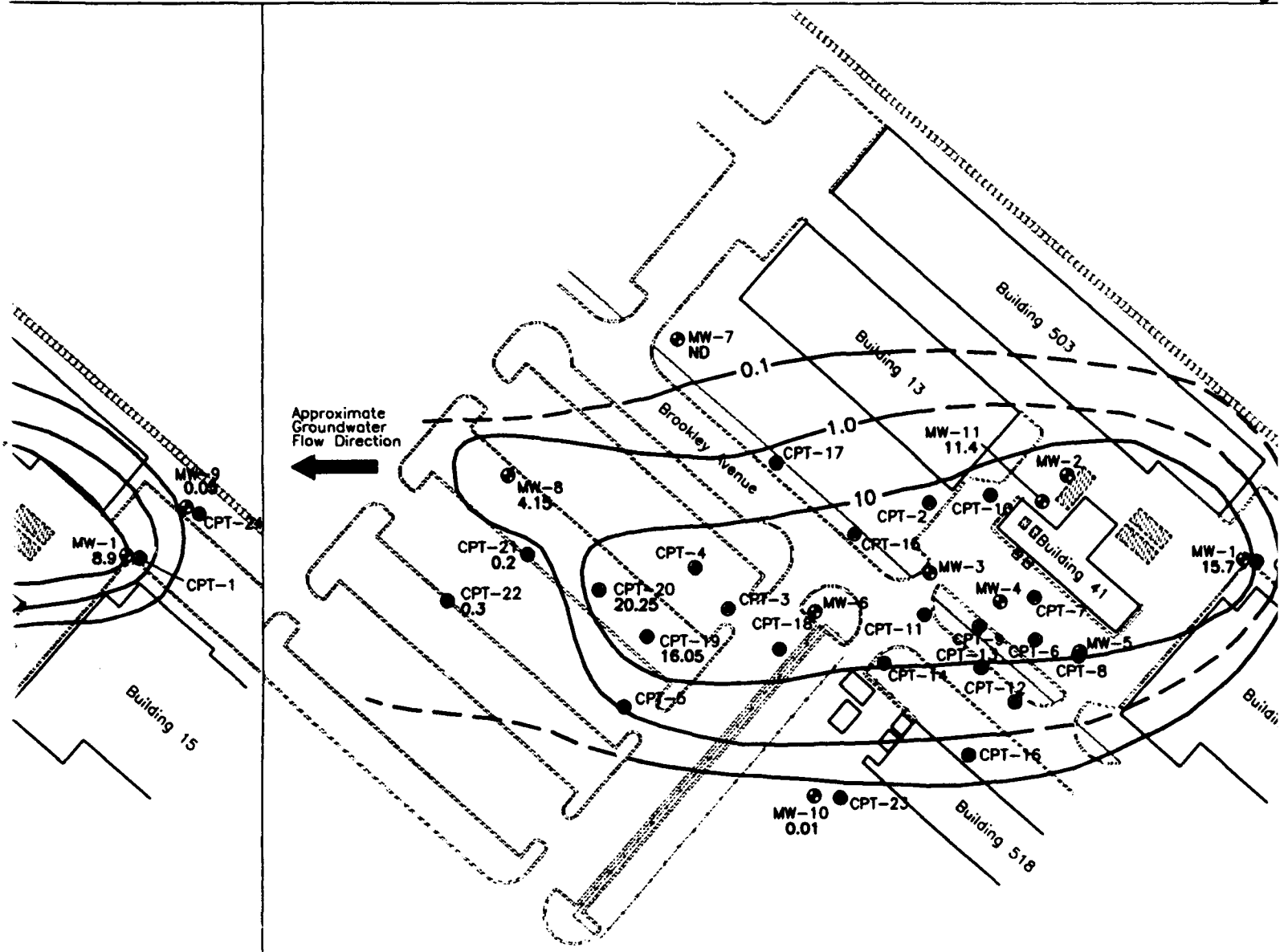
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
8.85	Dissolved ferrous iron (Fe^{+2}) concentration (mg/L).
(0.48)	Data not used to construct contours.
—— 2.0 ——	Dissolved ferrous iron (Fe^{+2}) contour (mg/L), dashed where inferred.

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

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AUGUST 1994

JUNE 19

developed using data from
and monitoring wells.

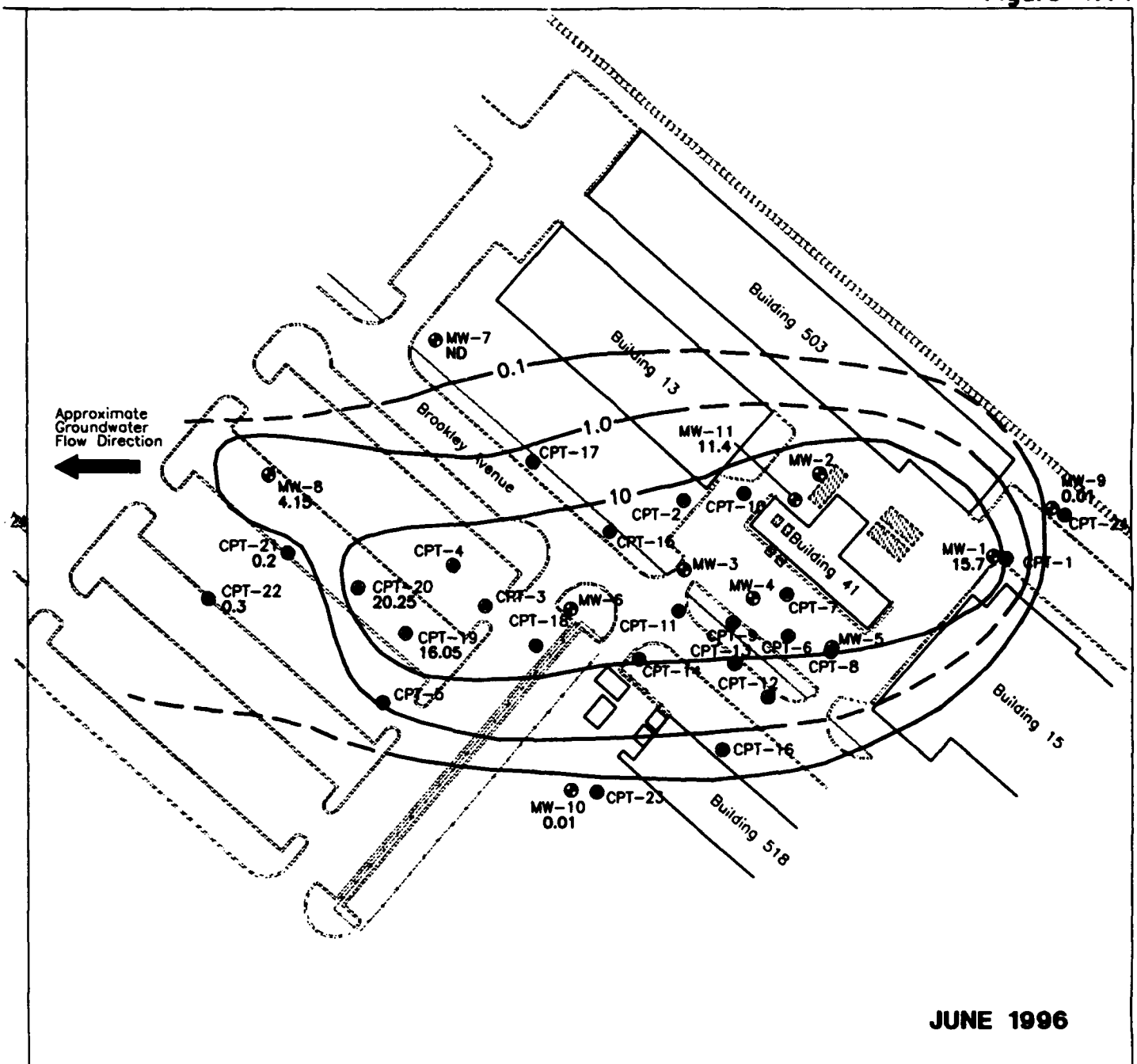
100' 50' 0 100'

Approximate Scale in Feet

Ferrous Iron Isopleth Ma
for Groundwater

Car Care Center Site
Intrinsic Remediation EE/
Bolling AFB, DC

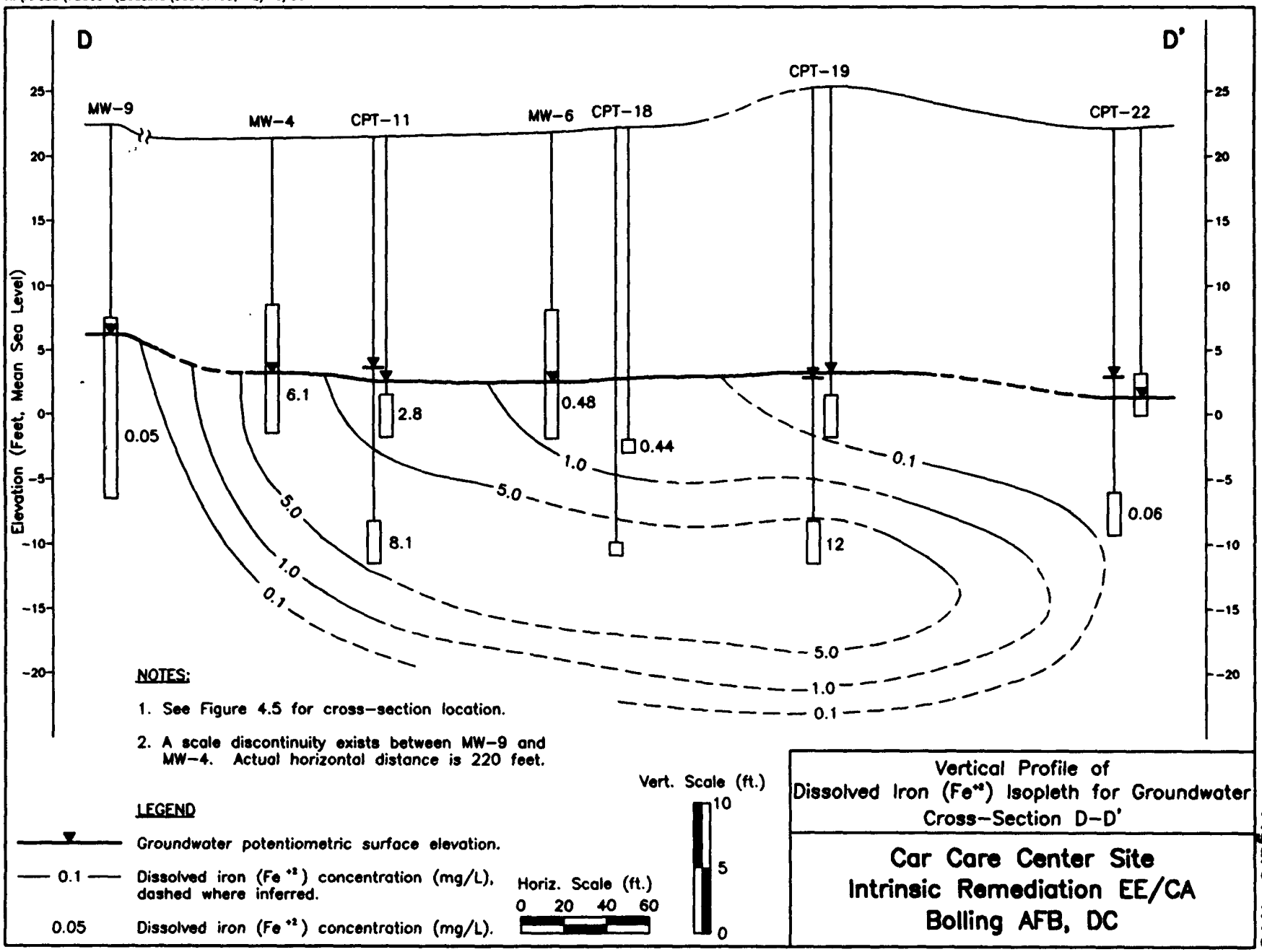
Figure 4.14



Ferrous Iron Isopleth Maps for Groundwater

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

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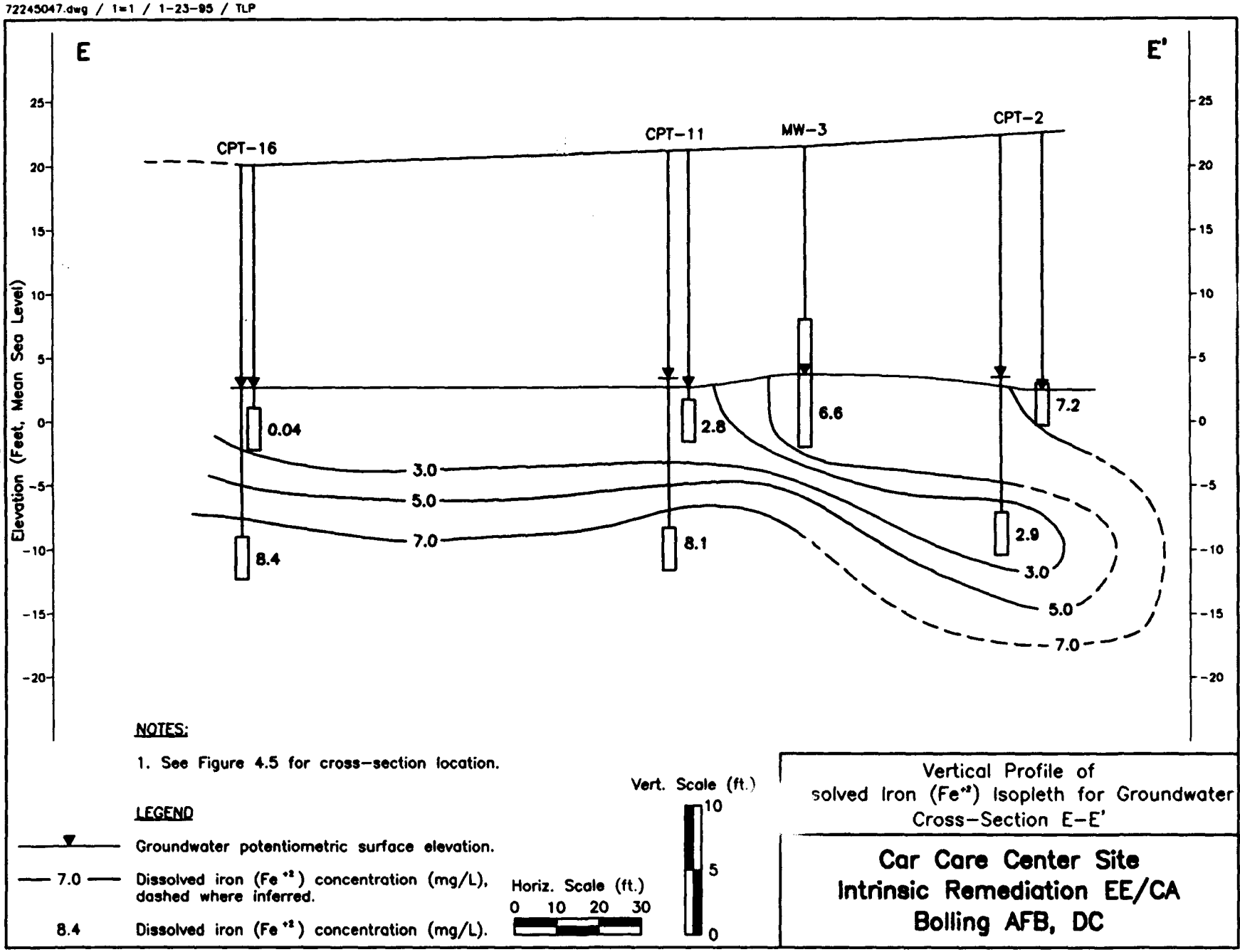


Vertical Profile of Dissolved Iron (Fe^{+2}) Isopleth for Groundwater Cross-Section D-D'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.15

72245047.dwg / 1=1 / 1-23-95 / TLP



NOTES:

1. See Figure 4.5 for cross-section location.

LEGEND

Groundwater potentiometric surface elevation.

7.0 — Dissolved iron (Fe^{+2}) concentration (mg/L), dashed where inferred.

8.4 Dissolved iron (Fe^{+2}) concentration (mg/L).

Horiz. Scale (ft.)
0 10 20 30

Vert. Scale (ft.)
10
5
0

Vertical Profile of
solved Iron (Fe^{+2}) Isopleth for Groundwater
Cross-Section E-E'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.16

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The following equations describe the overall stoichiometry of benzene degradation by iron reduction. In the absence of microbial cell production, the mineralization of benzene by iron reduction is given by:

$$60H^{+} + 30Fe(OH)_{3(s)} + C_6H_6 \rightarrow 6CO_2 + 30Fe^{2+} + 78H_2O$$

Therefore, 30 moles of ferric iron are required to metabolize 1 mole of benzene. On a mass basis, the ratio of ferric iron to benzene is given by:

Molecular weights:	Benzene	6(12) + 6(1) = 78 gm/mole
	Ferric Iron	30(106.85) = 3200 gm/mole

Mass ratio of ferric iron to benzene = 3200/78 = 41.0:1

Therefore, in the absence of microbial cell production, 41.0 mg of ferric iron are required to completely metabolize 1 mg of benzene. Alternatively, the mass ratio of ferrous iron produced during respiration to benzene degraded can be calculated and is given by:

Molecular weights:	Benzene	6(12) + 6(1) = 78 gm/mole
	Ferrous Iron	30(55.85) = 1675 gm/mole

Mass ratio of ferrous iron to benzene = 1675/78 = 21.5:1

Therefore, 21.5 mg of ferrous iron are produced during mineralization of 1 mg of benzene.

Similar calculations can be completed for toluene (21.86 mg of Fe^{2+} produced during mineralization of 1 mg of toluene), ethylbenzene (22 mg of Fe^{2+} produced during mineralization of 1 mg of ethylbenzene), and the xylenes (22 mg of Fe^{2+} produced during mineralization of 1 mg of xylene). The average mass ratio of Fe^{2+} produced during total BTEX mineralization is thus 21.8:1. This means that approximately 1 mg of BTEX is mineralized for every 21.8 mg of Fe^{2+} produced.

The highest Fe^{2+} concentration observed in August 1994 was 12 mg/L. This suggests that the shallow groundwater at this site has the capacity to assimilate 0.55 mg/L (550 µg/L) of total BTEX during iron reduction. In June 1996, the highest ferrous iron concentration observed at the Car Care Center was 20.3 mg/L, suggesting that the groundwater has the capacity to assimilate 0.93 mg/L (or 930 µg/L). These are conservative estimates of the assimilative capacity of iron because microbial cell mass production has not been taken into account by the stoichiometry shown above (Section 4.3.2.1). In addition, this calculation is based on observed ferrous iron concentrations and not on the amount of ferric hydroxide available in the aquifer. Therefore, iron assimilative capacity could be much higher.

4.3.2.4 Sulfate

Sulfate concentrations were measured at groundwater monitoring points and at existing monitoring wells in August 1994 and June 1996. Table 4.3 summarizes sulfate concentrations measured at the site. Figure 4.17 provides two isopleth maps showing the distribution of sulfate in groundwater in the 1994 and 1996 sampling events. Figures 4.18 and 4.19 are vertical profiles of the dissolved sulfate plume in August 1994. Comparison of Figures 4.17 and 4.4 shows graphically that the areas with the lowest sulfate concentrations have the highest BTEX concentrations. This suggests that the sulfate is being reduced during biodegradation of BTEX compounds. In August 1994, the highest measured sulfate concentration was 91 mg/L measured at MW-7. Significant sulfate concentrations were also observed at CPT-8D (65 mg/L), CPT-10D (56 mg/L), and CPT-21D (62 mg/L) which are located at the fringes of the BTEX plume. August 1994 background sulfate concentrations ranged from 50 mg/L to approximately 91 mg/L. As a conservative estimate, the background sulfate concentration for the site was assumed to be 50 mg/L. Complete sulfate depletion was noted only at MW-4 (0.4 mg/L), which is one of the most contaminated wells. Generally, sulfate concentrations were reduced to approximately 12 mg/L near the center of the BTEX plume.

The highest measured sulfate concentration in June 1996, 83 mg/L, was also measured at MW-7. Sulfate concentrations were also high at MW-9 (73 mg/L), and MW-10 (54 mg/L). A conservative background sulfate concentration of 54 mg/L, from MW-10, was assumed from June 1996 data. Almost complete sulfate depletion was noted at MW-11 (0.97 mg/L), CPT-20D (0.95 mg/L), and CPT-19D (0.88 mg/L).

Hydrogen sulfide is an end product of the sulfate reduction reaction. In August 1994, concentrations of hydrogen sulfide (Table 4.3) were measured in site monitoring wells and monitoring points. However, hydrogen sulfide was not detected at the site. This result may be due to the strong affinity of certain aquifer matrices for the sulfide ion. High levels of iron and manganese compounds are generally contained within the aquifer matrices. The sulfide ion will react with iron and manganese to form insoluble metallic sulfides. As a result, the absence of hydrogen sulfide in site groundwater does not negate the evidence of sulfate reduction. Hydrogen sulfide was not measured in groundwater samples taken from the site during the June 1996 sampling event.

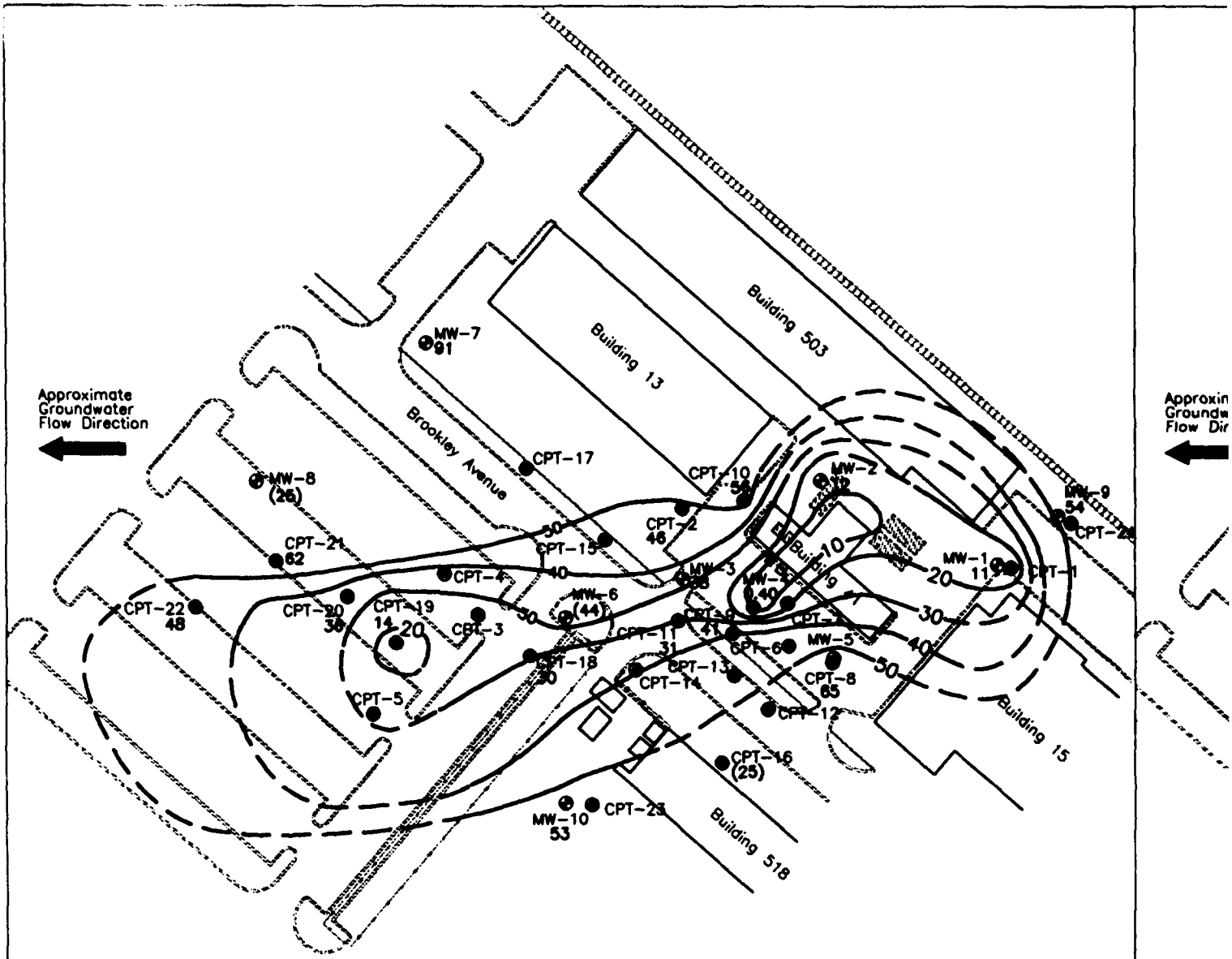
The following equations describe the overall stoichiometry of BTEX oxidation by sulfate reduction caused by anaerobic microbial biodegradation. In the absence of microbial cell production, the biodegradation of benzene is given by:

$$7.5H^{+} + 3.75SO_4^{2-} + C_6H_6 \rightarrow 6CO_{2(g)} + 3.75H_2S_{(g)} + 3H_2O$$

Therefore, 3.75 moles of sulfate are required to mineralize 1 mole of benzene. On a mass basis, the ratio of sulfate to benzene is given by:

Molecular weights:	Benzene	6(12) + 6(1) = 78 gm/mole
	Sulfate	32.06+4(16) = 96.06 gm/mole

Mass ratio of sulfate to benzene = 3.75(96.06)/78 = 4.6:1



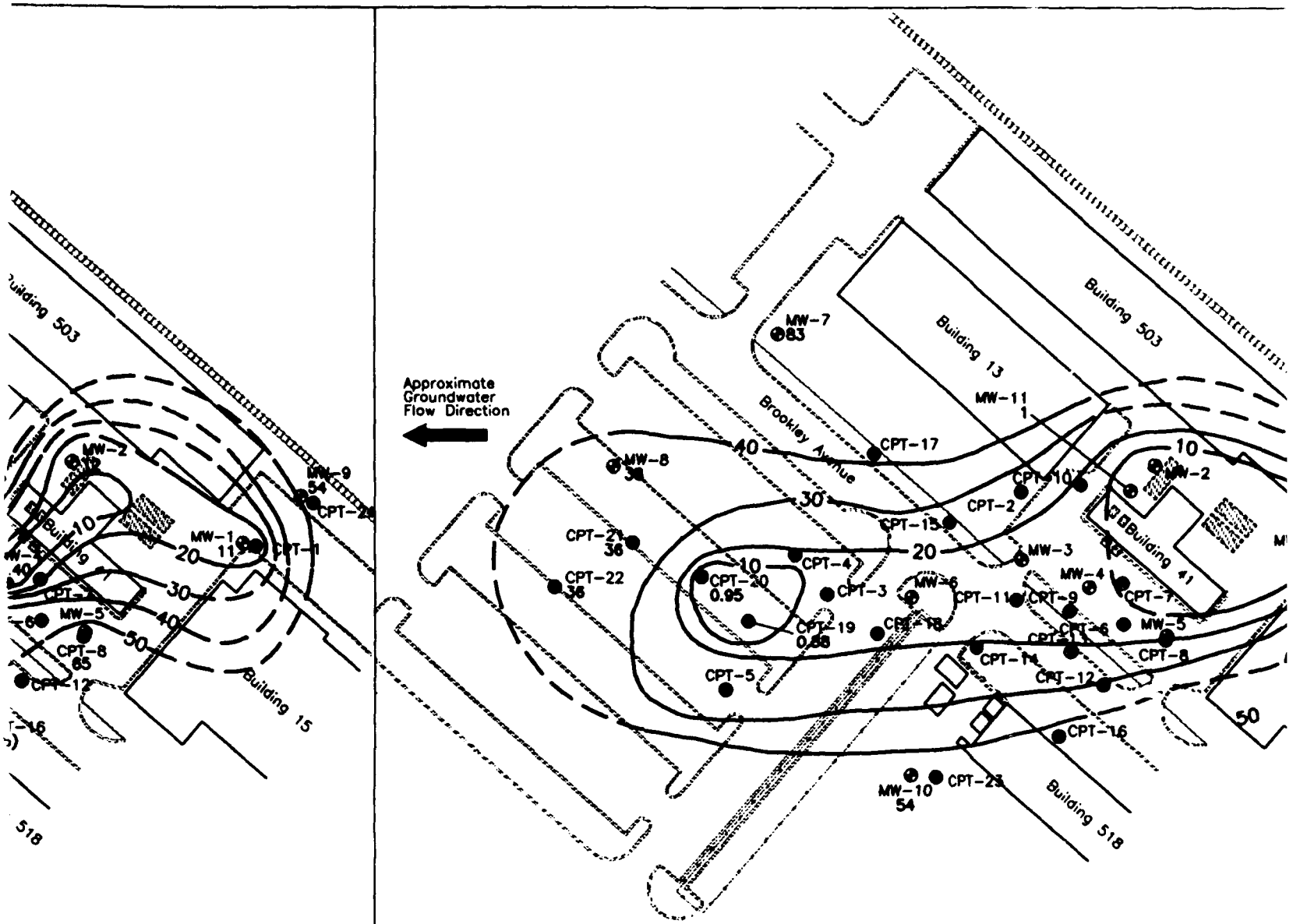
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
62	Dissolved sulfate concentration (mg/L).
(25)	Data not used to construct contours.
—— 20 ——	Dissolved sulfate concentration contour (mg/L), dashed where inferred.

NOTE:

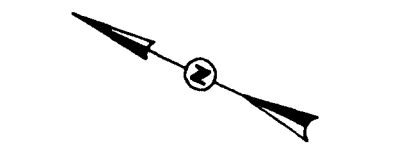
1. Isopleth map was developed using data from deep CPT points and monitoring wells.

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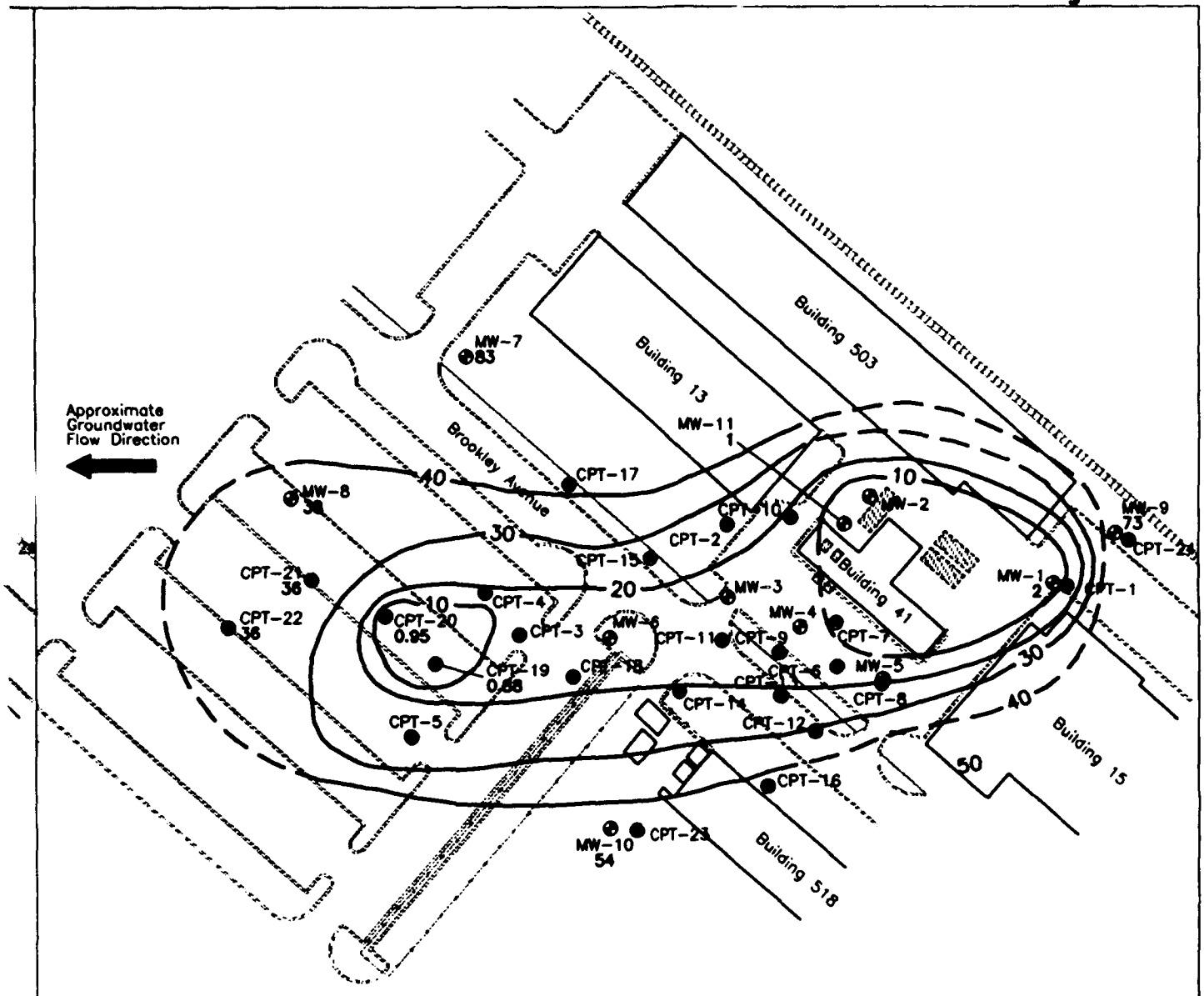
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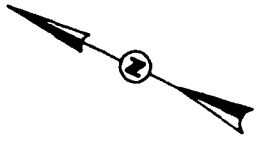
Sulfate Isopleth
for Groundwa

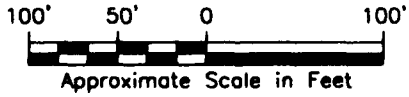
Car Care Center
Intrinsic Remediatio
Bolling AFB,

PARSONS ENGIN

Figure 4.17





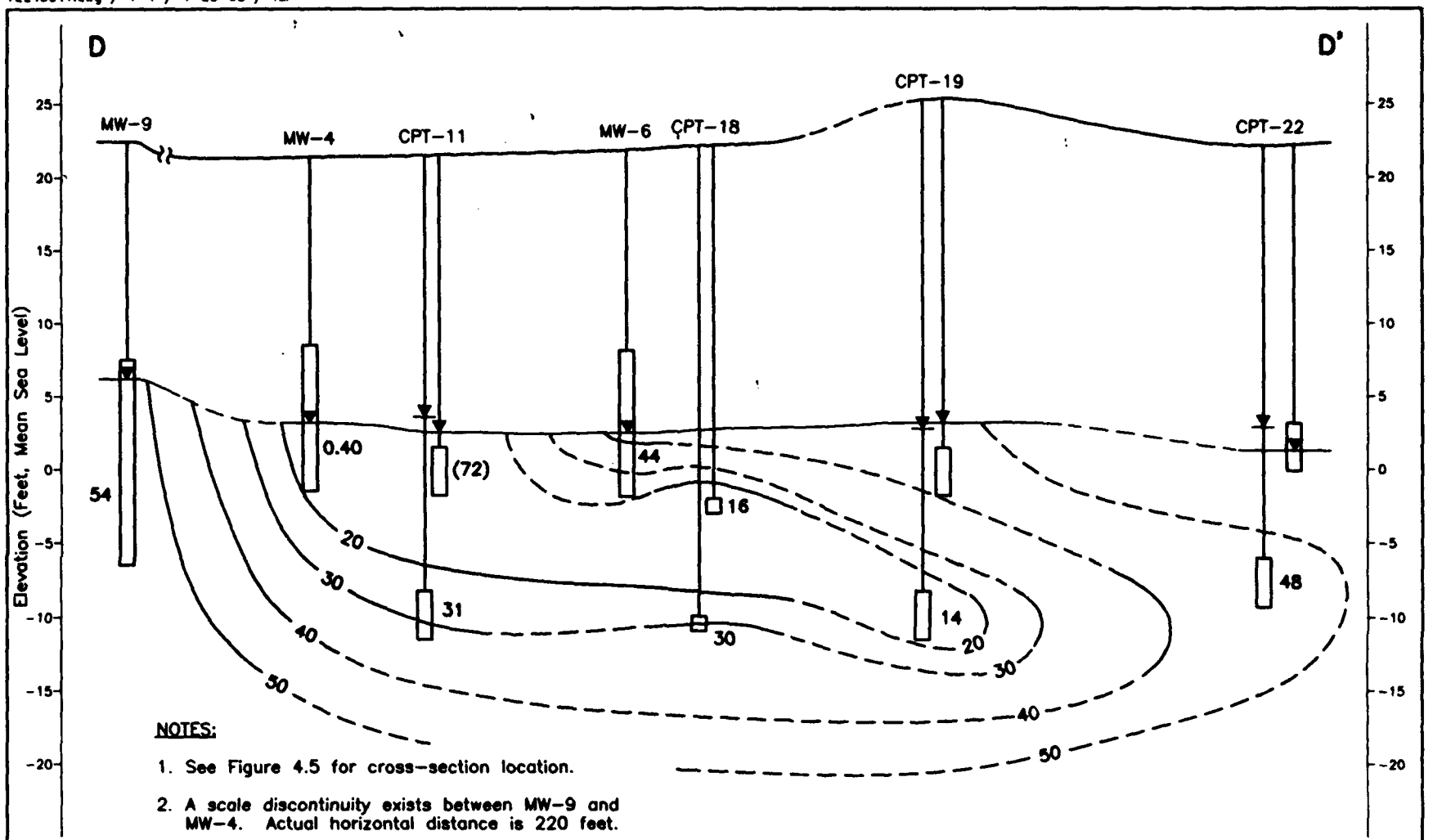


from

Sulfate Isopleth Maps for Groundwater

**Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC**

PARSONS ENGINEERING SCIENCE, INC.



NOTES:

1. See Figure 4.5 for cross-section location.
2. A scale discontinuity exists between MW-9 and MW-4. Actual horizontal distance is 220 feet.

LEGEND

▼	Groundwater potentiometric surface elevation.
50	Dissolved sulfate concentration (mg/L), dashed where inferred.
54	Dissolved sulfate concentration (mg/L).
(72)	Data not utilized to construct contours.

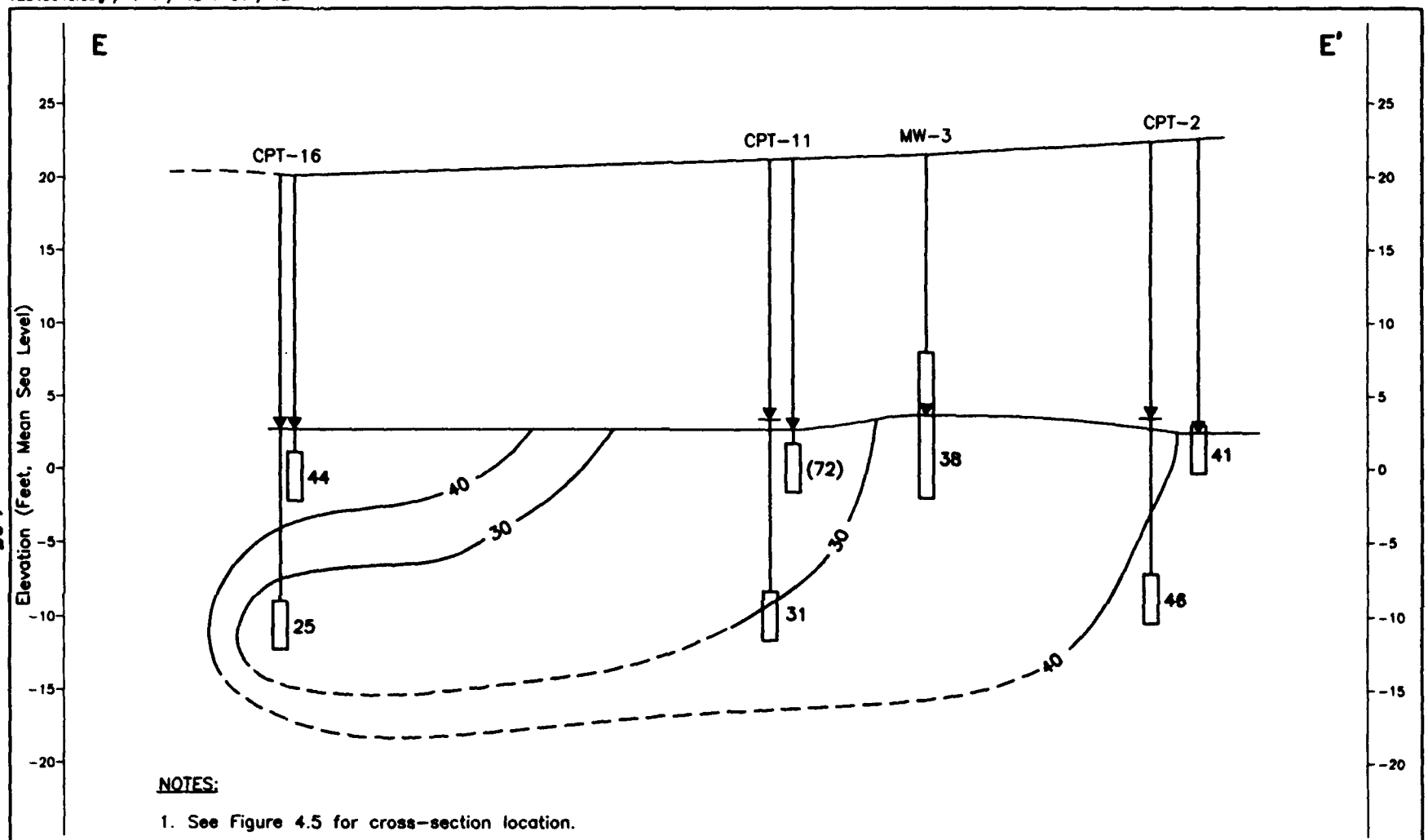
Horiz. Scale (ft.)
0 20 40 60

Vert. Scale (ft.)
10
5
0

Vertical Profile of
Dissolved Sulfate Isopleth for Groundwater
Cross-Section D-D'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.18



NOTES:

1. See Figure 4.5 for cross-section location.

LEGEND

▼———	Groundwater potentiometric surface elevation.
— 30 —	Dissolved sulfate concentration (mg/L), dashed where inferred.
44	Dissolved sulfate concentration (mg/L).
(72)	Data not utilized to construct contours.

Horiz. Scale (ft.)
0 10 20 30

Vert. Scale (ft.)
10
5
0

Vertical Profile of
Dissolved Sulfate Isopleth for Groundwater
Cross-Section E-E'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.19

Therefore, in the absence of microbial cell production, 4.6 mg of sulfate are required to completely mineralize 1 mg of benzene. Similar calculations can be completed for toluene (4.7 mg sulfate to 1 mg toluene), ethylbenzene (4.75 mg sulfate to 1 mg ethylbenzene), and the xylenes (4.75 mg sulfate to 1 mg xylene). The average mass ratio of sulfate to total BTEX is thus 4.7:1. This means that approximately 0.21 mg of BTEX is mineralized for every 1.0 mg of sulfate consumed. Assuming a background sulfate concentration of 50 mg/L in August 1994, the shallow groundwater at this site has the capacity to assimilate 10 mg/L (10,000 μg/L) of total BTEX during sulfate reduction. In June 1996, a background sulfate concentration of 54 mg/L was observed, suggesting that the groundwater at the site has the capacity to assimilate 11 mg/L (11,000 μg/L) of total BTEX during sulfate reduction. Again, these are very conservative estimates of the assimilative capacity of sulfate because microbial cell mass production has not been taken into account by the stoichiometry shown above (Section 4.3.2.1). Comparison of August 1994 and June 1996 site sulfate concentrations suggest, once again, that sulfate reduction continues to be an important biodegradation mechanism at the Car Care Center.

4.3.2.5 Methane

Methane concentrations were measured at groundwater monitoring points and at existing monitoring wells in January 1995 and June 1996. Table 4.3 summarizes the measured methane concentrations. No observable trends could be discerned from January 1995 methane data, but the monitoring points (i.e., CPT-19, 20, and 21) downgradient from the highest BTEX concentrations were not sampled. Consequently, no general conclusions could be drawn about the importance of methanogenic BTEX biodegradation at the site. However, June 1996 methane data for the Car Care Center site, show significant increases in groundwater methane concentrations downgradient from the source area. Figure 4.20 presents an isopleth map showing the distribution of methane in groundwater based on data collected in June 1996. Comparison of Figure 4.20 with Figure 4.4 shows graphically that the core of the dissolved BTEX plume downgradient from the source generally correlates with center of the area with elevated methane concentration.

The following equations describe the overall stoichiometry of benzene oxidation by methanogenesis where carbon dioxide is utilized as the terminal electron acceptor. In the absence of microbial cell production, the mineralization of benzene is given by:

$$C_6H_6 + 4.5H_2O \rightarrow 2.25CO_2 + 3.75CH_4$$

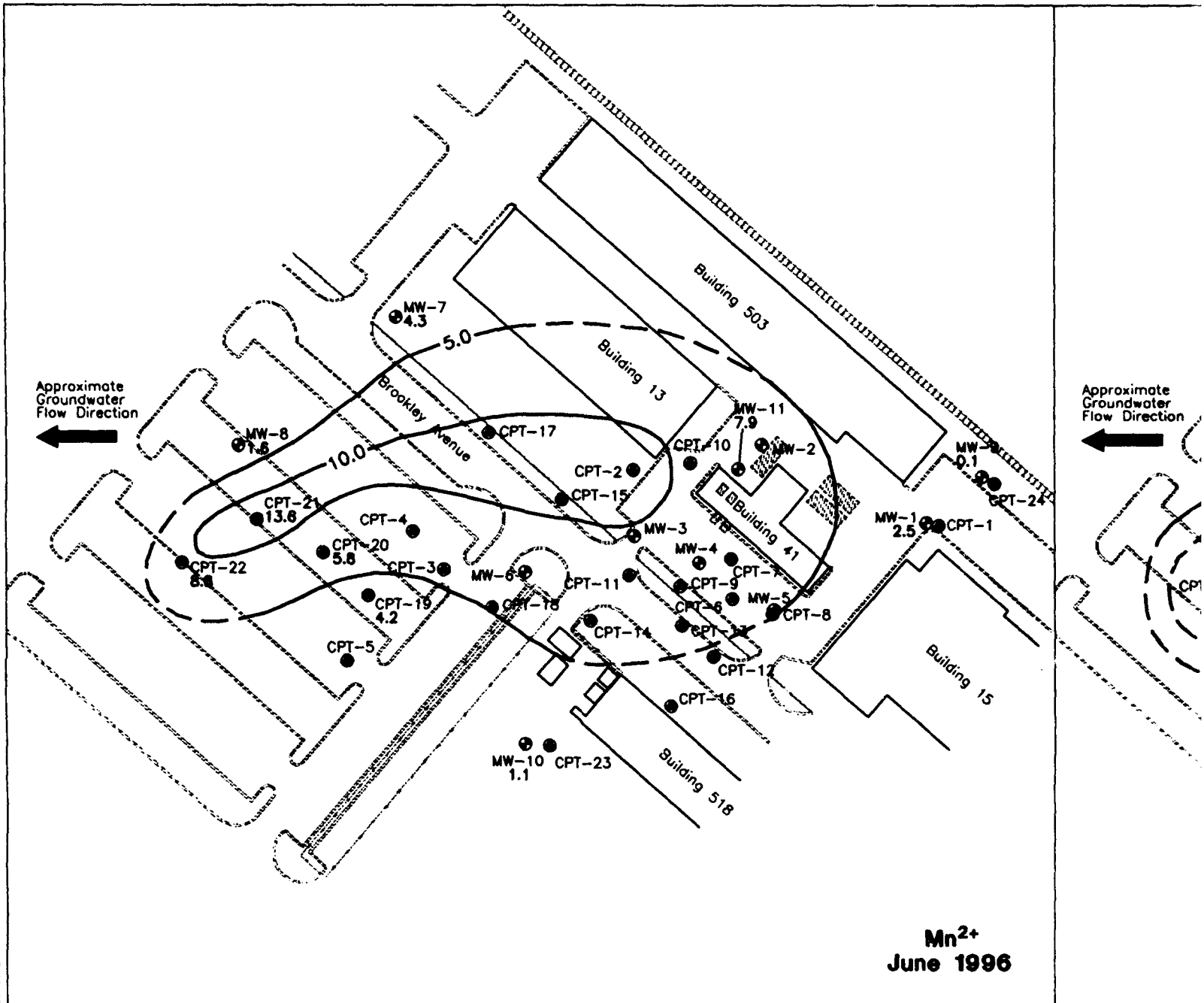
The mass ratio of methane produced during respiration to benzene degraded can be calculated and is given by:

Molecular weights: Benzene 6(12) + 6(1) = 78 gm/mole

Methane 12 +4(1) = 16 gm/mole

Mass ratio of methane to benzene = 3.75(16)/78 = 0.77:1

Therefore, 0.77 mg of methane is produced during mineralization of 1 mg of benzene.



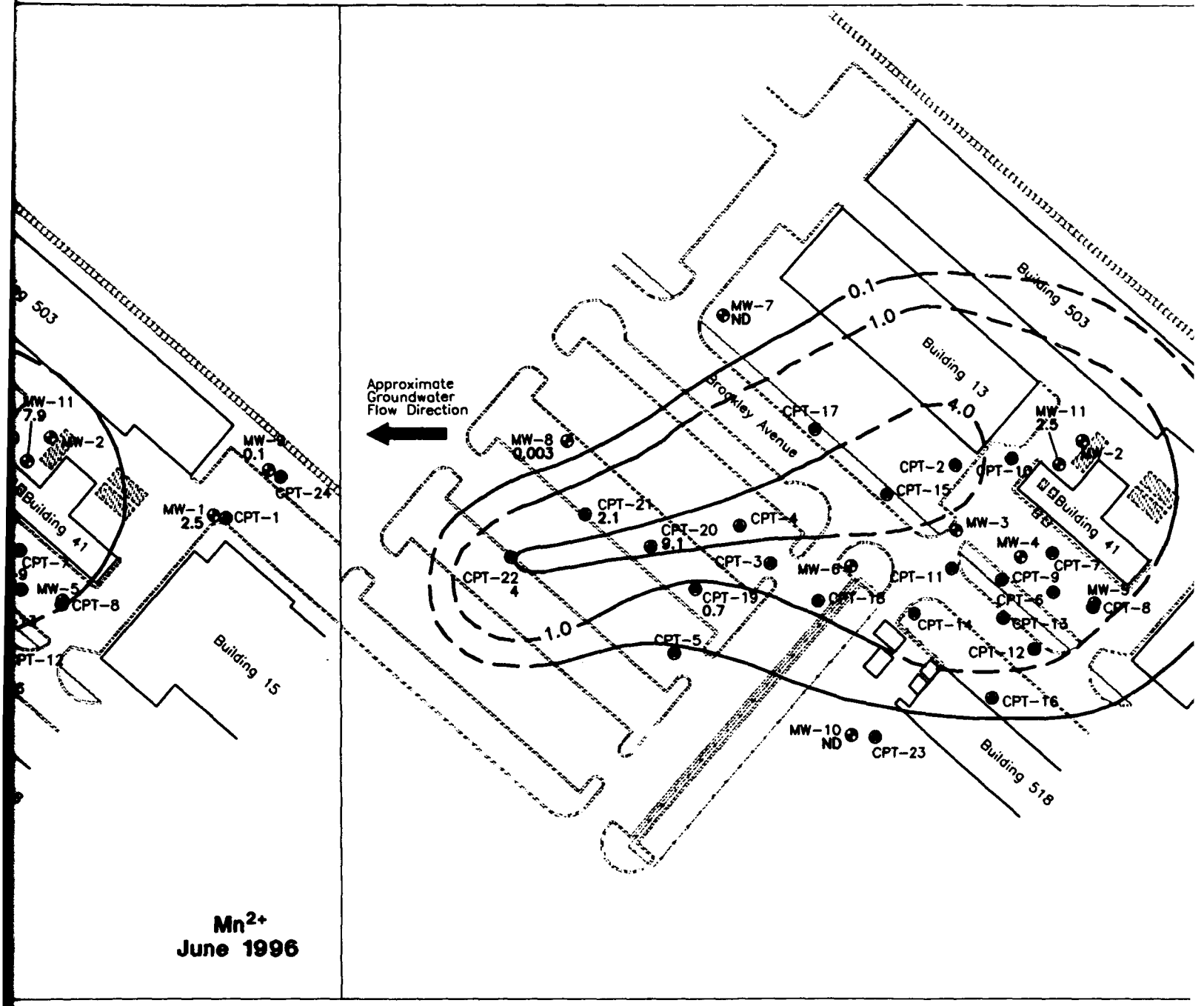
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
16	Dissolved manganese or methane concentration (mg/L).
—10—	Dissolved manganese or methane concentration contour (mg/L), dashed where inferred.

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

K:\AFCEE\729s..\BOLLING\98DN0967.DWG 12/20/98 at 8:12



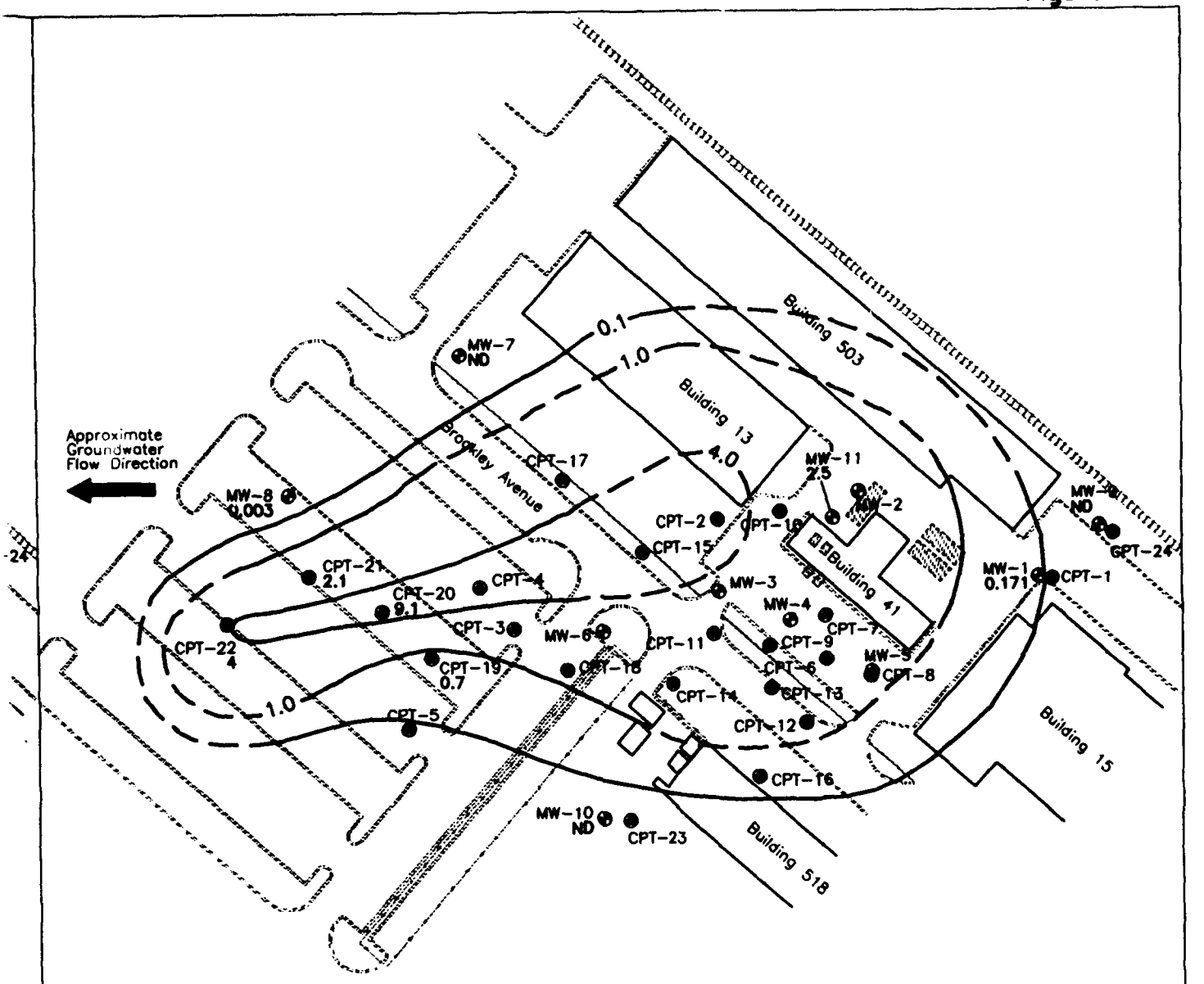
NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

Dissolved Manganese Isopleth Maps for C

Car Care Cent
Intrinsic Remediati
Bolling AFB,

Figure 4.20



METHANE
JUNE 1996

100' 50' 0 100'

Approximate Scale in Feet

ed using data from
nitoring wells.

Dissolved Manganese and Methane Isopleth Maps for Groundwater

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Similar calculations can be completed for toluene (0.78 mg of methane produced during mineralization of 1 mg of toluene), ethylbenzene (0.79 mg of methane produced during mineralization of 1 mg of ethylbenzene), and the xylenes (0.79 mg of methane produced during mineralization of 1 mg of xylene). The average mass ratio of methane produced during total BTEX mineralization is 0.78:1. This means that approximately 1 mg of BTEX is mineralized for every 0.78 mg of methane produced. In June 1996, the highest measured methane concentration was 9.1 mg/L (CPT-20D). This suggests that the shallow groundwater at this site has the capacity to assimilate up to 11.7 mg/L (11,700 µg/L) of total BTEX during methanogenesis. Again, this is a conservative estimate of the assimilative capacity of methanogenesis because microbial cell mass production is not taken into account by the stoichiometry shown above (Section 4.3.2.1). In addition, these calculations are based on observed methane concentrations and not on the amount of carbon dioxide available in the aquifer. Therefore, methanogenic assimilative capacity could be much higher.

4.3.2.6 Manganese

Soluble manganese (Mn^{2+}) concentrations were measured at groundwater monitoring points and at existing monitoring wells in June 1996. Table 4.3 summarizes soluble manganese concentrations observed at the site. Figure 4.20 presents an isopleth map showing the distribution of Mn^{2+} in groundwater. Comparison of Figures 4.20 and 4.4 shows graphically that the areas with the highest soluble manganese concentration also have the highest BTEX concentration. This suggests that insoluble forms of manganese (i.e., manganese dioxide) is being reduced to Mn^{2+} during biodegradation of BTEX compounds. The highest measured Mn^{2+} concentration, 13.6 mg/L, was detected at CPT-21D. This location is downgradient of the areas that contain the highest BTEX concentrations. Similar to ferrous iron, Mn^{2+} is possibly being produced in the plume center, then is migrating downgradient with the groundwater. In June 1996, elevated soluble manganese concentrations also were detected at MW-11 (7.9 mg/L), CPT-22D (8.8 mg/L), and CPT-20D (5.8 mg/L). Background levels of soluble manganese are approximately 0.1 mg/L, as measured at MW-9, which is upgradient from the source area at the Car Care Center.

The following equations describe the overall stoichiometry of benzene oxidation by manganese reduction where carbon dioxide is utilized as the terminal electron acceptor. In the absence of microbial cell production, the mineralization of benzene is given by:

$$30H^{+} + 15\ MnO_2 + C_6H_6 \rightarrow 6CO_2 + 15Mn^{2+} + 18H_2O$$

Therefore, 15 moles of soluble manganese are produced during the metabolism of 1 mole of benzene. The mass ratio of soluble manganese produced during respiration to benzene degraded can be calculated and is given by:

Molecular weights: Benzene $6(12) + 6(1) = 78$ gm/mole

Mn^{2+} $55 = 55$ gm/mole

Mass ratio of Mn^{2+} to benzene = $15(55)/78 = 10.6:1$

Therefore, 10.6 mg of Mn^{2+} is produced during mineralization of 1 mg of benzene.

Similar calculations can be completed for toluene (10.7 mg of Mn^{2+} produced during mineralization of 1 mg of toluene), ethylbenzene (11.4 mg of Mn^{2+} produced during mineralization of 1 mg of ethylbenzene), and the xylenes (11.4 mg of Mn^{2+} produced during mineralization of 1 mg of xylene). The average mass ratio of Mn^{2+} produced during total BTEX mineralization is 11.0:1. On a mass basis, this translates to approximately 11.0 mg of soluble manganese produced for each 1 mg of total BTEX metabolized. Given a background soluble manganese concentration of approximately 0.1 mg/L and a maximum detected soluble manganese concentration in the source area of 13.6 mg/L, the shallow groundwater has the capacity to assimilate approximately 1.2 mg/L (1,200 µg/L) of total BTEX through manganese reduction. This assimilative capacity is conservative estimate because calculations are based on observed soluble manganese concentrations and not on the amount of manganese dioxide available in the aquifer and solid soil matrix. Therefore, manganese assimilative capacity could be much higher.

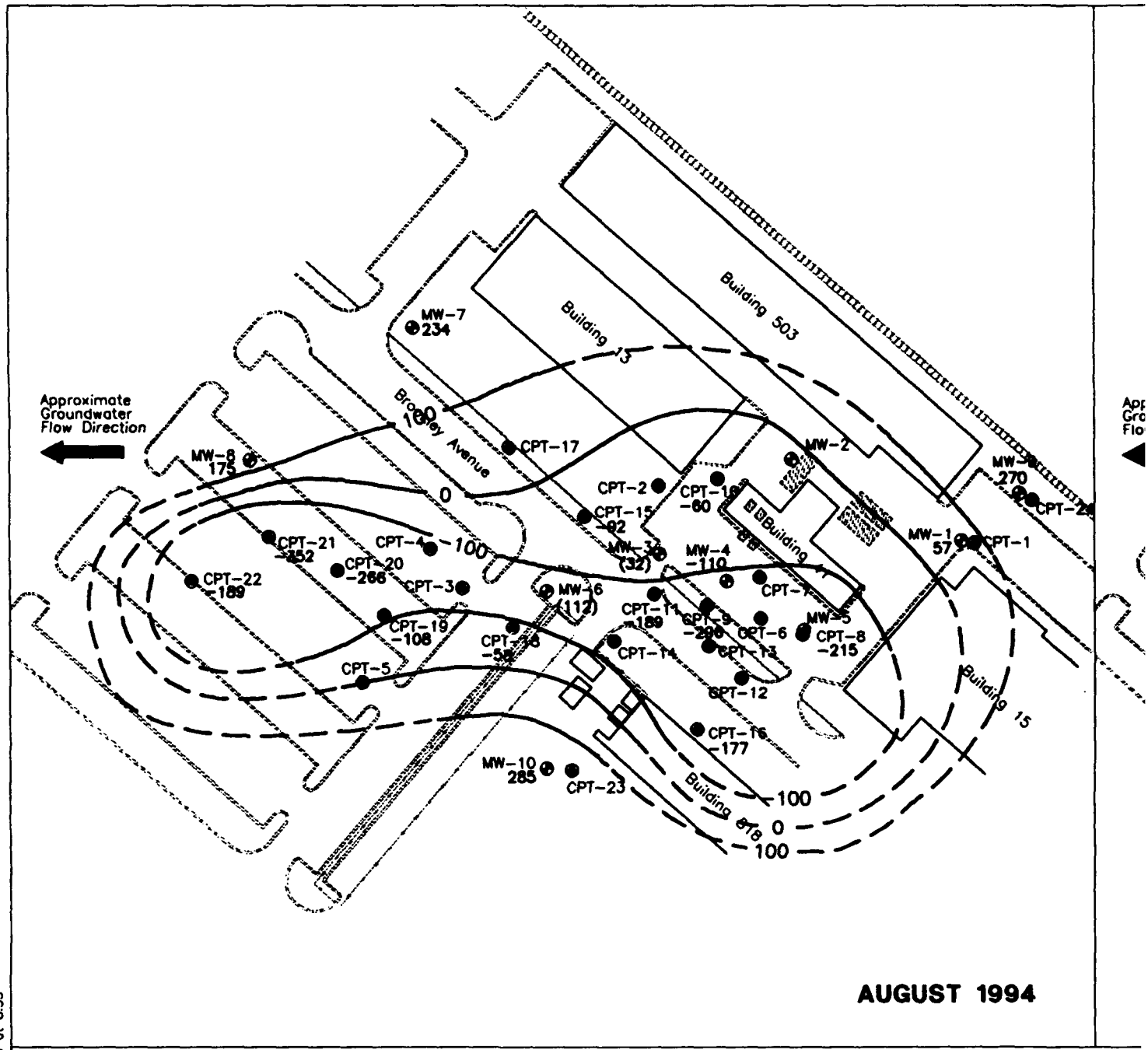
4.3.2.7 Reduction/Oxidation Potential

Redox potentials were measured at groundwater monitoring points and at existing monitoring wells in August 1994 and June 1996. Redox potential is a measure of the relative tendency of a solution to accept or transfer electrons. The redox potential of a groundwater system depends on which electron acceptor is being reduced by microbes during BTEX oxidation. The redox potential at the Car Care Center Site during the August 1994 sampling event ranged from 285 millivolts (mV) to -477 mV. June 1996 redox measurements ranged from 176 mV to -154 mV. Table 4.3 summarizes available redox potential data. Figure 4.21 provides two maps that graphically illustrate the distribution of redox potentials for both sampling events. Figures 4.22 and 4.23 indicate the vertical redox profiles at the Car Care Center Site for data collected during August 1994. August 1994 redox values decreased to values below -200 mV in the vicinity of CPT-08, CPT-09, CPT-20, and CPT-21. In June 1996, areas at the site with low redox potentials coincide with areas of low DO, nitrate, and sulfate concentrations and elevated BTEX, ferrous iron, and methane concentrations.

4.3.2.8 Alkalinity and Carbon Dioxide Evolution

Carbon dioxide is produced during the bioremediation of petroleum hydrocarbons. In aquifers that have carbonate minerals as part of the matrix, carbon dioxide forms carbonic acid, which dissolves these minerals, increasing the alkalinity of the groundwater. An increase in alkalinity (measured as $CaCO_3$) in an area with BTEX concentrations elevated above background conditions can be used to infer the amount of petroleum hydrocarbon destroyed through aerobic respiration, denitrification, manganese reduction, ferric iron reduction, and sulfate reduction. In addition, carbon dioxide produced in these aerobic and anaerobic reactions can be cycled in the methanogenic reactions to continue BTEX biodegradation through methanogenesis.

Free carbon dioxide was measured in groundwater samples collected in June 1996. These measurements are summarized in Table 4.3 and illustrated for the shallow groundwater in Figure 4.24. Carbon dioxide evolution above background concentrations, approximately 100 mg/L, is occurring as a result of combined aerobic



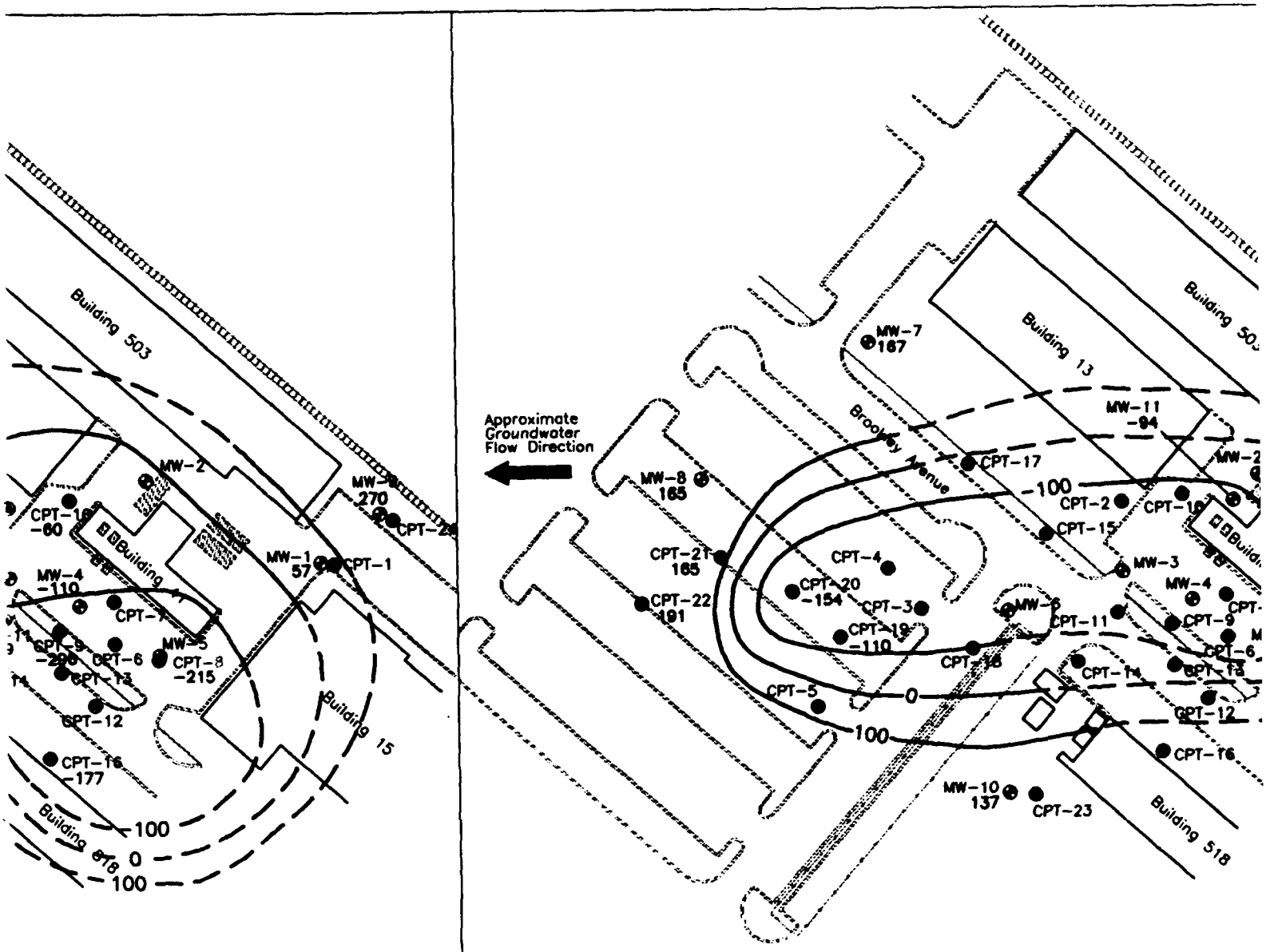
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
-266	Redox potential (mV).
(112)	Data not used to construct contours.
—200—	Redox potential contour (mV), dashed where inferred.

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

K:\AFCEE\729...\BOLLING\96DN0951.DWG 12/20/96 at 8:33



AUGUST 1994

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

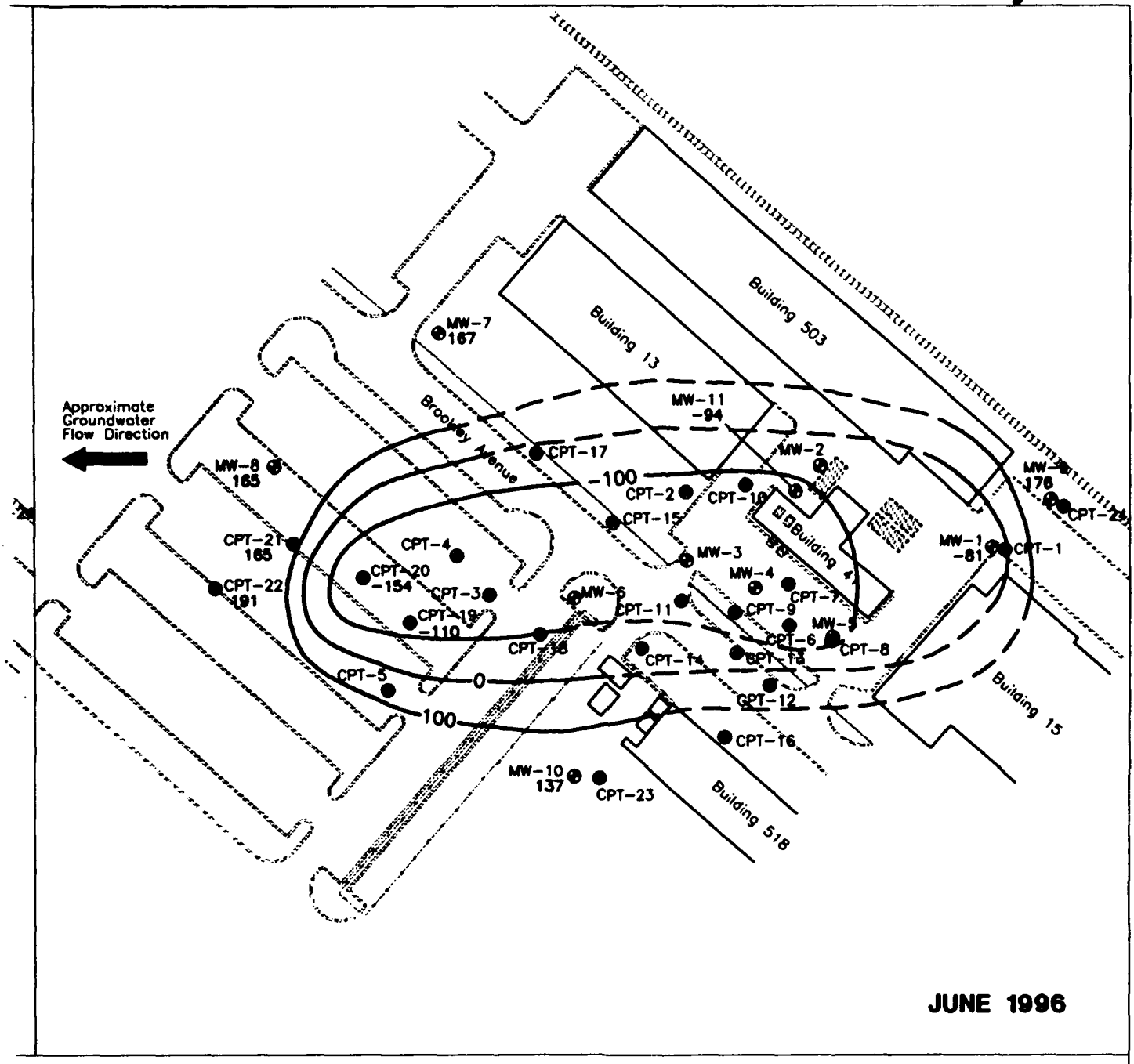
100' 50' 0 100'

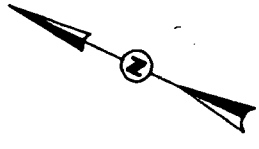
Approximate Scale in Feet

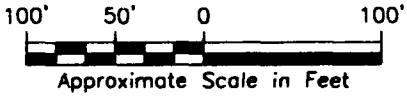
Redox
for

Car C
Intrinsic R
Boll

Figure 4.21

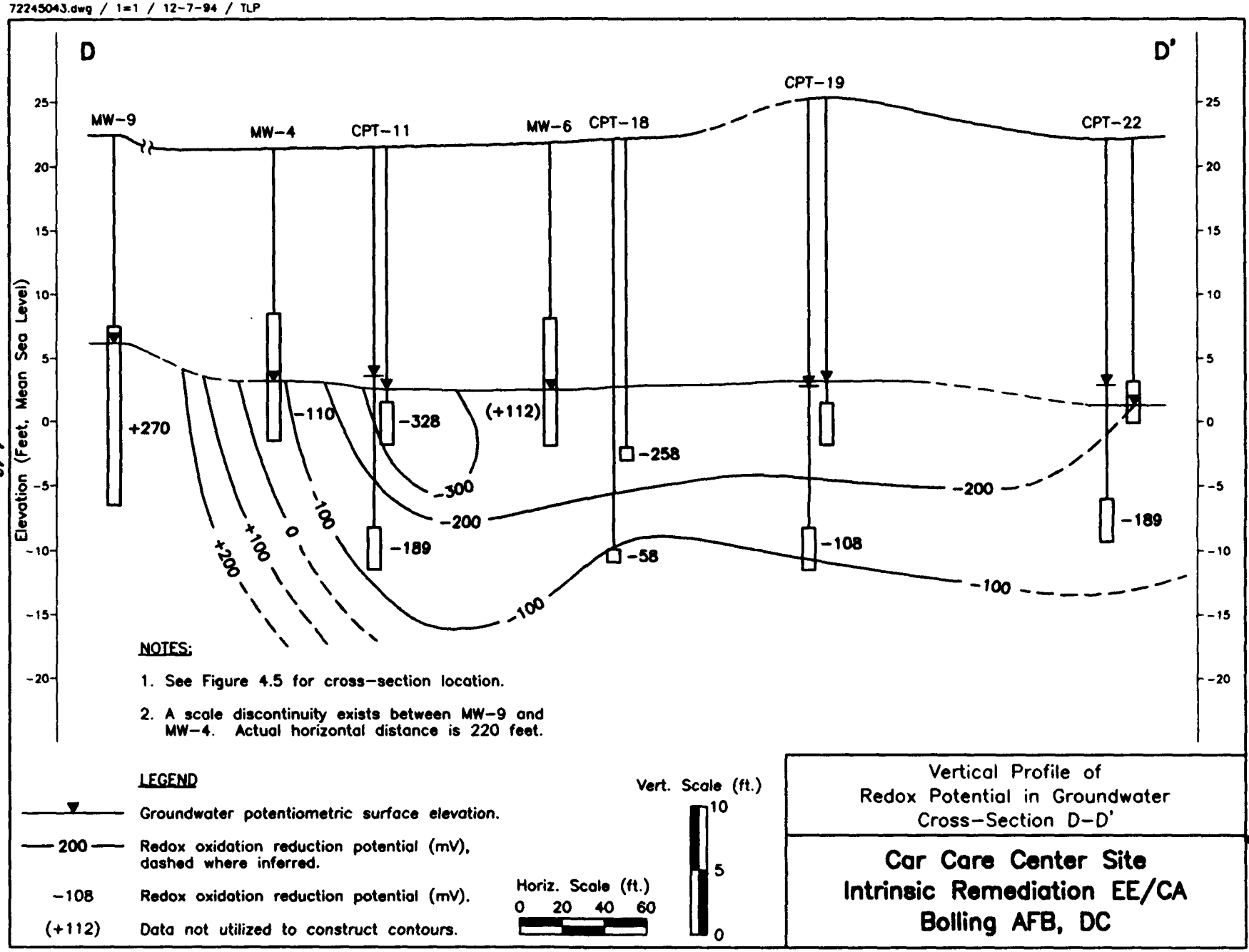






Redox Potential Maps for Groundwater

Car Care Center Site Intrinsic Remediation EE/CA Bolling AFB, DC

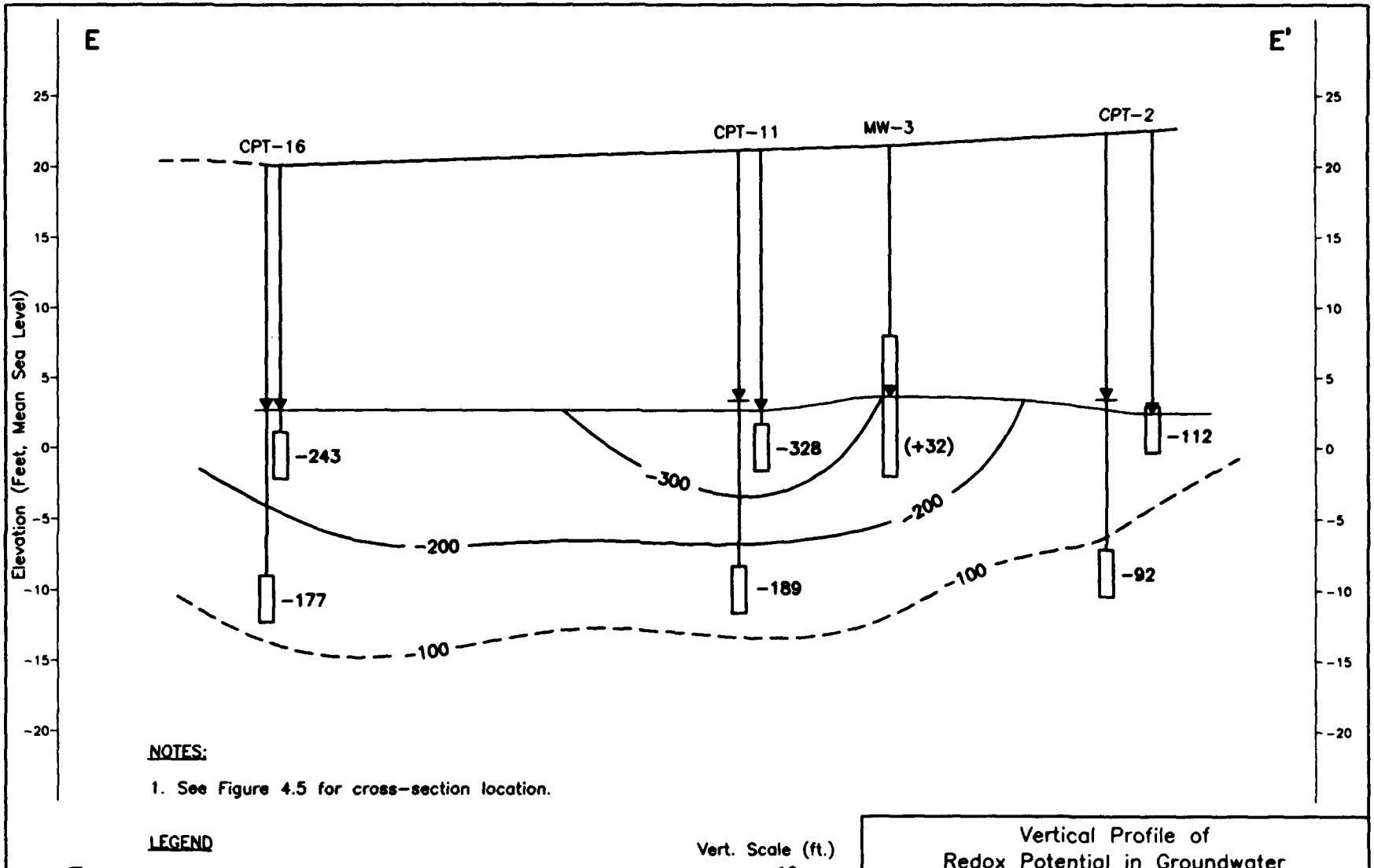


Vertical Profile of
Redox Potential in Groundwater
Cross-Section D-D'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.22

72245050.dwg / 1=1 / 12-7-94 / TLP



NOTES:

1. See Figure 4.5 for cross-section location.

LEGEND

▼	Groundwater potentiometric surface elevation.
100	Redox oxidation reduction potential (mV), dashed where inferred.
-177	Redox oxidation reduction potential (mV).
(+32)	Data not utilized to construct contours.

Horiz. Scale (ft.)
0 10 20 30

Vert. Scale (ft.)
10
5
0

Vertical Profile of
Redox Potential in Groundwater
Cross-Section E-E'

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

Figure 4.23

PARSONS ENGINEERING SCIENCE, INC.

and anaerobic biodegradation processes. A direct estimation of the aquifer assimilative capacity based on carbon dioxide evolution is not possible because of the complex carbonate/bicarbonate balance. However, total alkalinity (as $CaCO_3$) also was measured in groundwater samples collected in both August 1994 and June 1996. These measurements are summarized in Table 4.3. June 1996 total alkalinity data also is illustrated for shallow groundwater in Figure 4.21. Alkalinity is a measure of the ability of groundwater to buffer changes in pH caused by the addition of biologically generated acids. Furthermore, alkalinity can be used in certain situations to estimate the assimilative capacity of groundwater (Wiedemeier *et al.*, 1994). In August 1994, total alkalinity at the site ranged from <5.0 mg/L to approximately 266 mg/L. In June 1996, total alkalinity at the Car Care Center ranged from 20 mg/L to approximately 1,100 mg/L. This range of alkalinity is sufficient to buffer potential changes in pH caused by biologically mediated BTEX oxidation reactions; therefore, it supports the inference that aerobic and/or anaerobic biodegradation processes are occurring without detrimental shifts in pH. At least, sufficient alkalinity and observed increases in carbon dioxide levels are supportive of an amenable environment for intrinsic biodegradation as observed by evolved carbon dioxide. Additionally, comparison of alkalinity concentrations and elevated BTEX concentrations (Figures 4.24 and 4.4) suggest that increased carbonate concentrations could be directly related to increased carbon dioxide concentrations from the mineralization of the BTEX compounds via natural attenuation processes.

4.3.2.9 pH

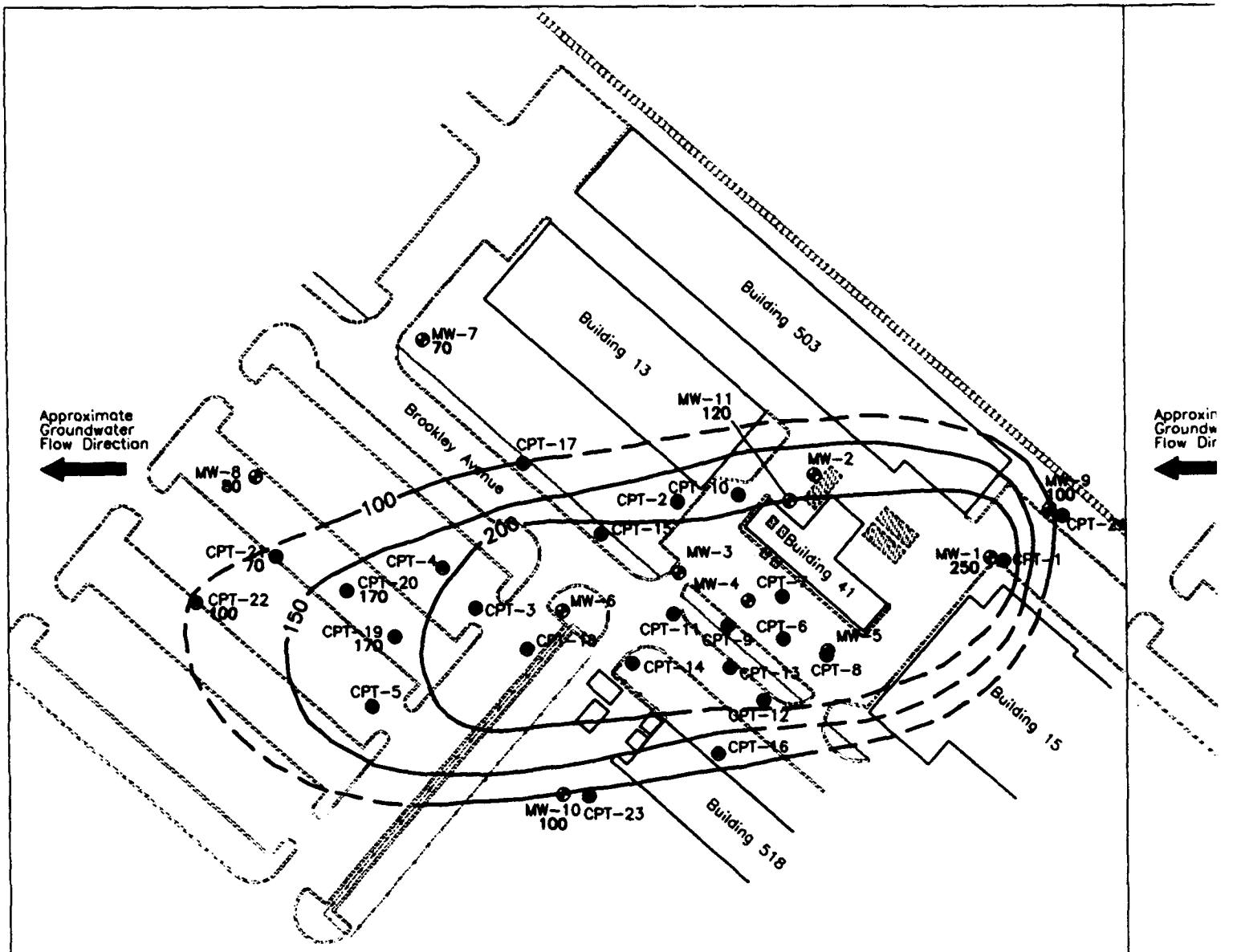
pH was measured at groundwater monitoring points and existing monitoring wells in August 1994 and June 1996. These measurements are summarized in Table 4.3. The pH of a solution is the negative logarithm of the hydrogen ion concentration $[H^+]$. Groundwater pH at the Car Care Center Site ranged from 4.46 to 6.62 in August 1994, and from 4.50 to 7.70 in June 1996. These are acceptable ranges for BTEX-degrading microbes. Usually, pH values between 4.5 and 5.5 are generally considered to be less than optimal for BTEX biodegradation. However, the groundwater geochemistry discussed in previous sections suggests that strong natural attenuation patterns occur at the site; therefore, it is doubtful that groundwater pH is impeding biodegradation processes.

4.3.2.10 Temperature

Groundwater temperature was measured at groundwater monitoring points and existing monitoring wells in August 1994 and June 1996. Table 4.3 summarizes groundwater temperature readings. Temperature affects the types and growth rates of bacteria that can be supported in the groundwater environment, with higher temperatures generally resulting in higher growth rates. Temperatures in the shallow saturated zone varied from 20.0 degrees Celsius (°C) to 25.6°C in August 1994, and from 18.3°C to 21.9°C in June 1996. These ranges are relatively high temperatures for shallow groundwater, suggesting that bacterial growth rates could be high.

4.3.3 Expressed Assimilative Capacity

The data presented in the preceding sections suggest that mineralization of BTEX compounds is occurring through the microbially mediated processes of aerobic



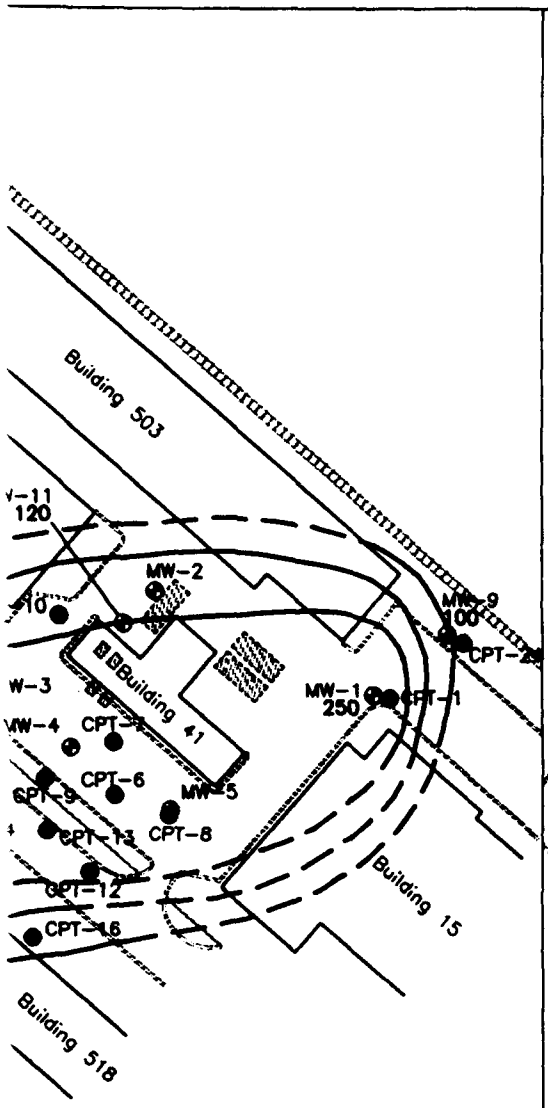
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
160	Concentration (units as shown).
—100—	Concentration contour, dashed where inferred.

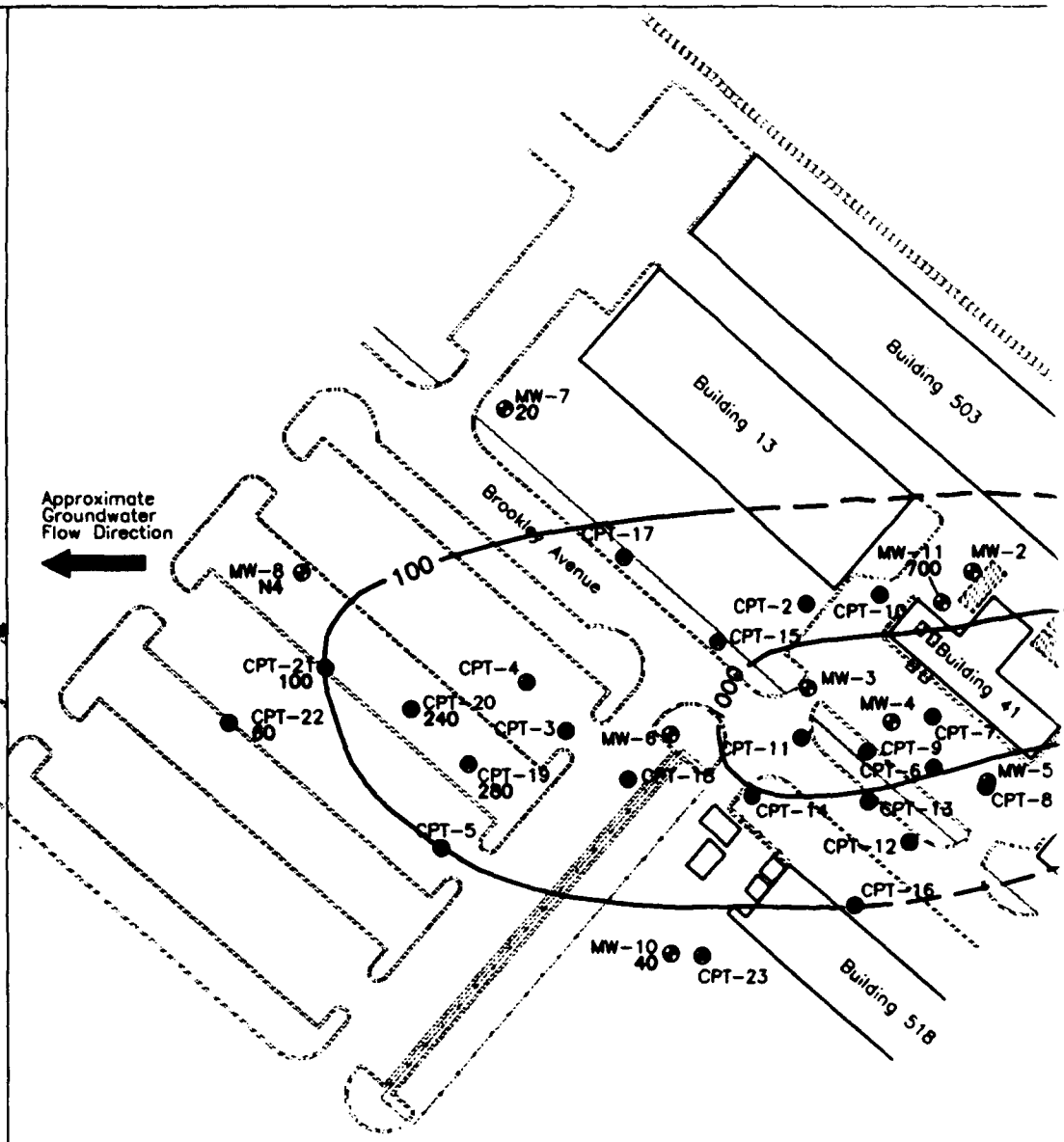
NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

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CO_2 (mg/L)



TOTAL ALKALINITY (

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

100' 50' 0 100'

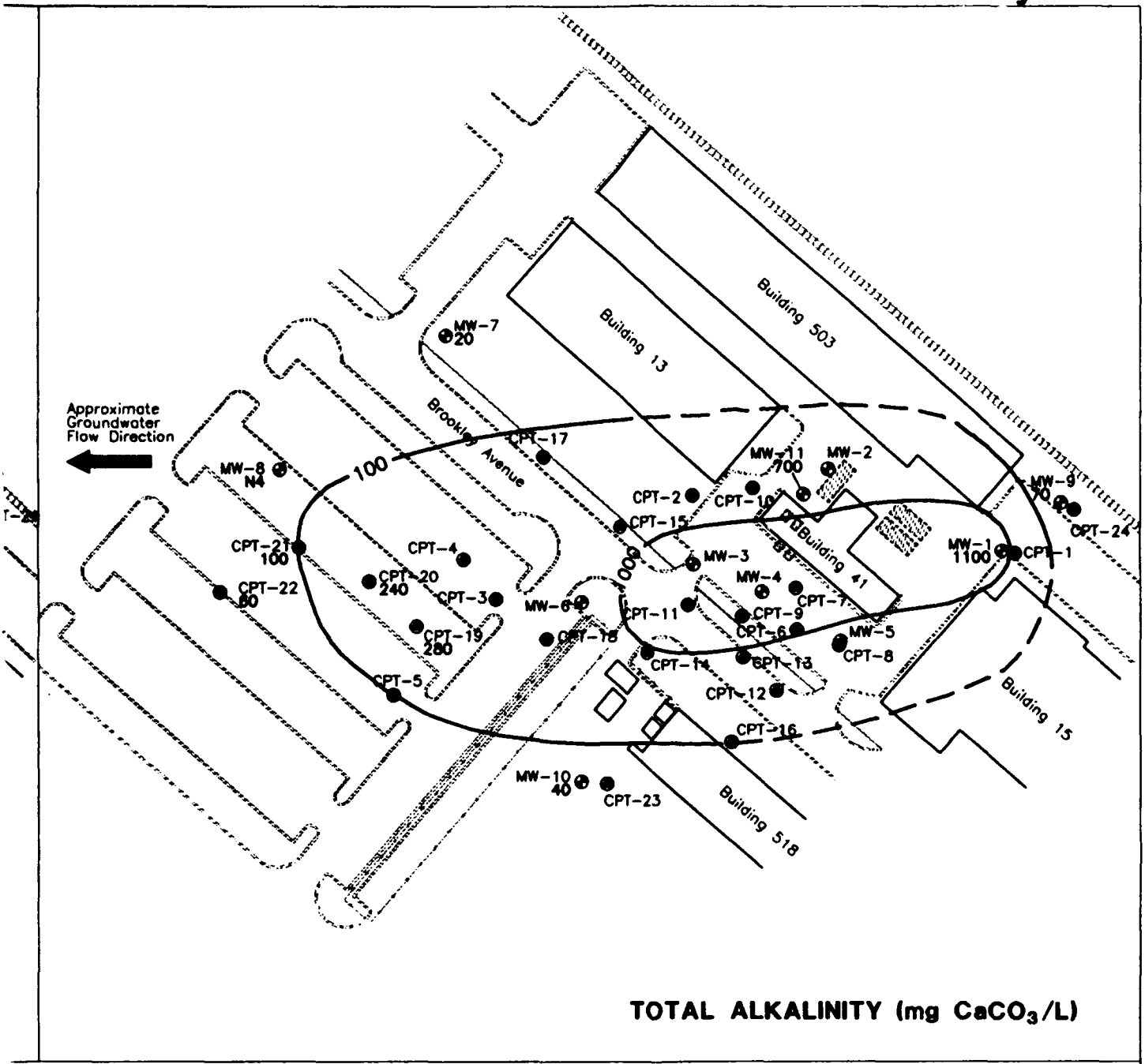
Approximate Scale in Feet

Carbon Species
June 1

Car Care C
Intrinsic Remed
Bolling A

PARSONS

Figure 4.24



Carbon Species in Groundwater
June 1996

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

PARSONS ENGINEERING SCIENCE, INC.

respiration, denitrification, iron reduction, sulfate reduction, manganese reduction and methanogenesis. Based on the stoichiometry presented in these sections and August 1994 groundwater data, the expressed BTEX assimilative capacity of groundwater at the Car Care Center Site is at least 16,550 µg/L (Table 4.4). In June 1996, the expressed BTEX assimilative capacity of groundwater at the Car Care Center Site is at least 31,430 µg/L (Table 4.4). The calculations presented in these earlier sections are conservative because they do not account for microbial cell mass production. In addition, the measured concentrations of ferrous iron, soluble manganese, and methane may not be the maximum achievable. The highest measured dissolved total BTEX concentration observed in August 1994 at the site was 110,000 µg/L (measured at CPT-11S). This concentrations is just below the maximum solubility of BTEX from fresh gasoline reported to be approximately 135,000 µg/L (Wiedemeier *et al.*, 1994). In June 1996, the highest total BTEX concentration of 49,300 µg/L was measured at MW-11. As a result, the calculated expressed assimilative capacities of groundwater are less than the maximum dissolved BTEX concentration for their respective years. Additional modeling activities are presented in Section 5 to evaluate the effect to the nearest potential downgradient receptor point (the Potomac River) located 0.5 mile downgradient from the site.

TABLE 4.4
EXPRESSED ASSIMILATIVE CAPACITY OF SITE GROUNDWATER
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Electron Acceptor or Process	August 1994 Expressed BTEX Assimilative Capacity (µg/L)	June 1996 Expressed BTEX Assimilative Capacity (µg/L)
Dissolved Oxygen	1,600	2,200
Denitrification	4,400	4,400
Ferric Hydroxide	550	930
Sulfate Reduction	10,000	11,000
Methanogenesis	NA	11,700
Manganese Reduction	NA	1,200
Total Expressed Assimilative Capacity	16,550	31,430
Highest observed Total BTEX Concentration	110,000	49,300

NA - not available

SECTION 5

GROUNDWATER MODELING

5.1 GENERAL OVERVIEW AND MODEL DESCRIPTION

In order to help estimate degradation rates for dissolved BTEX compounds at the former Car Care Center Site (Building 41) and to help predict the future migration of these compounds, Parsons ES modeled the fate and transport of the dissolved BTEX plume. The modeling effort had three primary objectives: 1) to predict the future extent and concentration of the dissolved contaminant plume by modeling the combined effects of advection, dispersion, sorption, and biodegradation; 2) to assess the possible risk to potential downgradient receptors; and 3) to provide technical support for the natural attenuation remedial option at post-modeling regulatory negotiations. The model was developed using site-specific data and conservative assumptions about governing physical and chemical processes. Due to the conservative nature of the model input, the reduction in contaminant mass resulting from the process of natural attenuation is expected to exceed model predictions. This analysis is not intended to represent a baseline assessment of potential risks posed by site contamination.

The Bioplume II model was used to estimate the potential for dissolved BTEX migration and degradation by naturally occurring mechanisms operating at the former Car Care Center Site (Building 41). The Bioplume II code incorporates advection, dispersion, sorption, and biodegradation to simulate contaminant plume migration and degradation. The model is based upon the USGS Method of Characteristics (MOC) two-dimensional (2-D) solute transport model of Konikow and Bredehoeft (1978). The model was modified by researchers at Rice University to include a biodegradation component that is activated by a superimposed DO plume. Based on the work of Borden and Bedient (1986), the model assumes a reaction between DO and BTEX that is instantaneous relative to the advective groundwater velocity. Bioplume II solves the USGS 2-D solute transport equation twice, once for hydrocarbon concentrations in the aquifer and once for a DO plume. The two plumes are combined using superposition at every particle move to simulate the instantaneous, biologically-mediated, reaction between hydrocarbons and oxygen.

In recent years, it has become apparent that anaerobic processes such as denitrification, iron reduction, sulfate reduction, and methanogenesis can be important BTEX degradation mechanisms (Grbic'-Galic', 1990; Beller *et al.*, 1992; Edwards *et al.*, 1992; Edwards and Grbic'-Galic', 1992, Grbic'-Galic' and Vogel, 1987; Lovley *et al.*, 1989; Hutchins, 1991). As evidenced from the data specified in Section 4, anaerobic biodegradation is occurring at the former Car Care Center Site. However, as a conservative estimate only oxygen and nitrate were used as electron acceptors during Bioplume II modeling.

In order to verify the results of the Bioplume II model, Parsons ES calculated a first-order decay coefficient using methods specified by Wiedemeier *et al.* (1994) and site specific data. An analytical model (Bear, 1979) was utilized that incorporates one-dimensional advection, dispersion, retardation, and first-order decay. A comparison between numerical and analytical model results was then performed to validate the Bioplume II input parameters and to compare Bioplume II and analytical model output results. A discussion of model results are provided in Section 5.6.1. The analytical model is provided in Appendix D. The following subsections discuss in more detail the model setup, input parameters and assumptions, model calibration, and simulation results.

5.2 CONCEPTUAL MODEL DESIGN AND ASSUMPTIONS

Prior to developing a groundwater model, it is important to determine if sufficient data are available to provide a reasonable estimate of aquifer conditions. In addition, it is important to ensure that any limiting assumptions can be justified. The most important assumption made when using the Bioplume II model is that oxygen-limited biodegradation is occurring at the site. The Bioplume II model assumes that the limiting factors for biodegradation are: 1) the presence of an indigenous hydrocarbon degrading microbial population, and 2) sufficient background electron acceptor concentrations. Data and information presented in Sections 3 and 4 suggest that oxygen, nitrate, ferric hydroxide, sulfate, and carbon dioxide (methanogenesis) are being used as electron acceptors for aerobic and anaerobic biodegradation. To be conservative, only oxygen and nitrate were used as electron acceptors in the Bioplume II model presented herein. The rate of reaction for denitrification is relatively fast, as compared to the advective groundwater velocity. As a result, the instantaneous reaction assumption is valid.

Based on the data presented in Section 3, the shallow saturated zone was conceptualized and modeled as a shallow unconfined aquifer composed of silty sand (Figures 3.3, 3.4, and 3.5). The depth of the saturated zone was conceptualized at the site to be 30 feet. The actual thickness is not known with certainty; however, the base of the aquifer may be 700 to 1,000 feet bls. Given the contaminated zone is only 25 to 30 feet thick (Section 4.3.1.1), Parsons ES utilized a saturated thickness of 30 feet as a reasonable estimate for the thickness of the model domain. Bioplume II assumes a constant solute concentration throughout the entire depth of the cell.

The use of a 2-D model is appropriate at the former Car Care Center Site (Building 41) because the saturated interval is relatively homogenous, and the local flow system, as defined by gradients, will likely minimize significant downward vertical migration of dissolved BTEX contamination. The vertical BTEX concentration profiles (Figure 4.6 and 4.7) suggest minor downward migration may be occurring in the vicinity of the source area. However, this may be due to diffusion of BTEX away from the source area, because a downward migration trend is not prevalent throughout the remaining sections of the plume. Because residual and mobile LNAPL contamination still exists at the site, model simulations include continuing sources of dissolved BTEX contamination.

5.3 INITIAL MODEL SETUP

Where possible, the initial setup for this model was based on site data. Where site-specific data were not available (e.g., effective porosity, reaeration coefficient), reasonable assumptions for the types of materials comprising the shallow aquifer were made based on widely accepted literature values. The following sections describe the basic model setup. A sensitivity analysis was performed for the input parameters, known to have the most significant effect on model results, by varying input values. Those Bioplume II model parameters that were varied during model calibration are discussed in Section 5.4.2.1.

5.3.1 Grid Design and Boundary Conditions

The Bioplume II model assumes a non-bending longitudinal axis along the primary direction of groundwater flow. Because the Bioplume II model was based on the finite difference numerical procedure, the model domain was subdivided in to evenly spaced grids. The maximum grid size for the Bioplume II model is limited to 20 columns by 30 rows and the dimension of each column and row can range from 0.1 to 999.9 feet. A grid size of 20 cells (transverse or x-direction) by 30 cells (longitudinal or y-direction) was used to model the former Car Care Center Site (Building 41). Each grid cell was 30 feet wide by 35 feet long (i.e., the grid was oriented so that the longest dimension was parallel to the overall direction of groundwater flow). The model grid covers an area of 630,000 square feet, or approximately 14.5 acres. The full extent of the model grid is indicated on Figure 5.1.

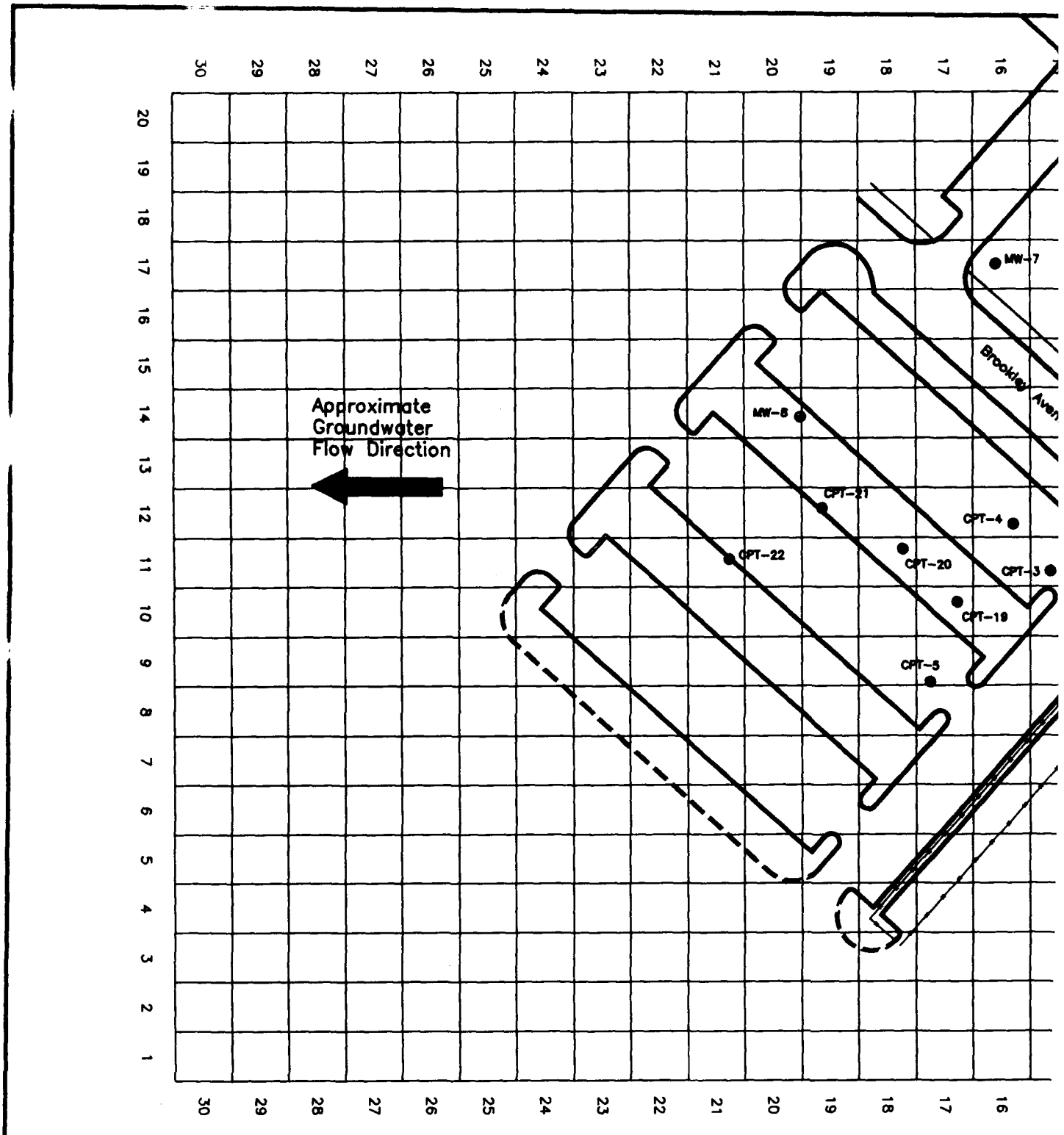
Model boundaries are mathematical statements that represent hydrogeologic boundaries, such as areas of specified head (e.g., surface water bodies or contour lines of constant hydraulic head) or specified flux. Hydrogeologic boundaries are represented by three mathematical statements that describe the hydraulic head at the model boundaries. These include:

1) Specified-head boundaries (Dirichlet condition) for which the head is determined as a function of location and time only. Surface water bodies exhibit constant head conditions. Specified-head boundaries are expressed mathematically as:

$$\text{Head} = f(x,y,z,t)$$

where f is the function symbol, x, y, and z are position coordinates, and t is time.

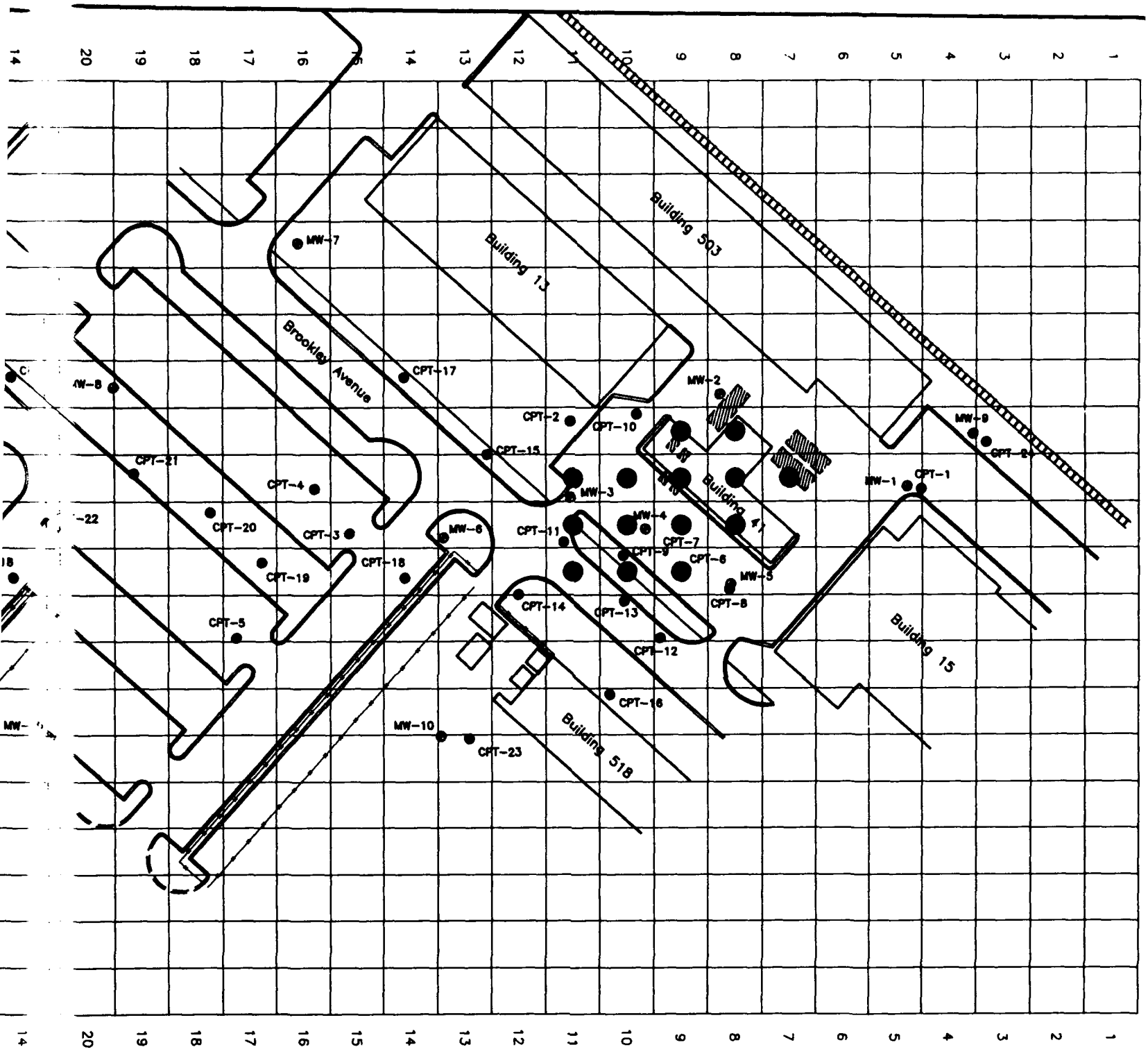
2) Specified-flow boundaries (Neumann conditions) for which the mathematical description of the flux across the boundary is given. The flux is defined as a volumetric flow rate per unit area (e.g., $ft^3/ft^2/day$). No-flow boundaries are a



LEGEND

- Former underground storage tanks (USTs).
- MW-1 ⊕ Existing monitoring well.
- CPT-1 ● Monitoring point and CPT test location installed by CPT rig.
- ● Location of simulated BTEX injection well.

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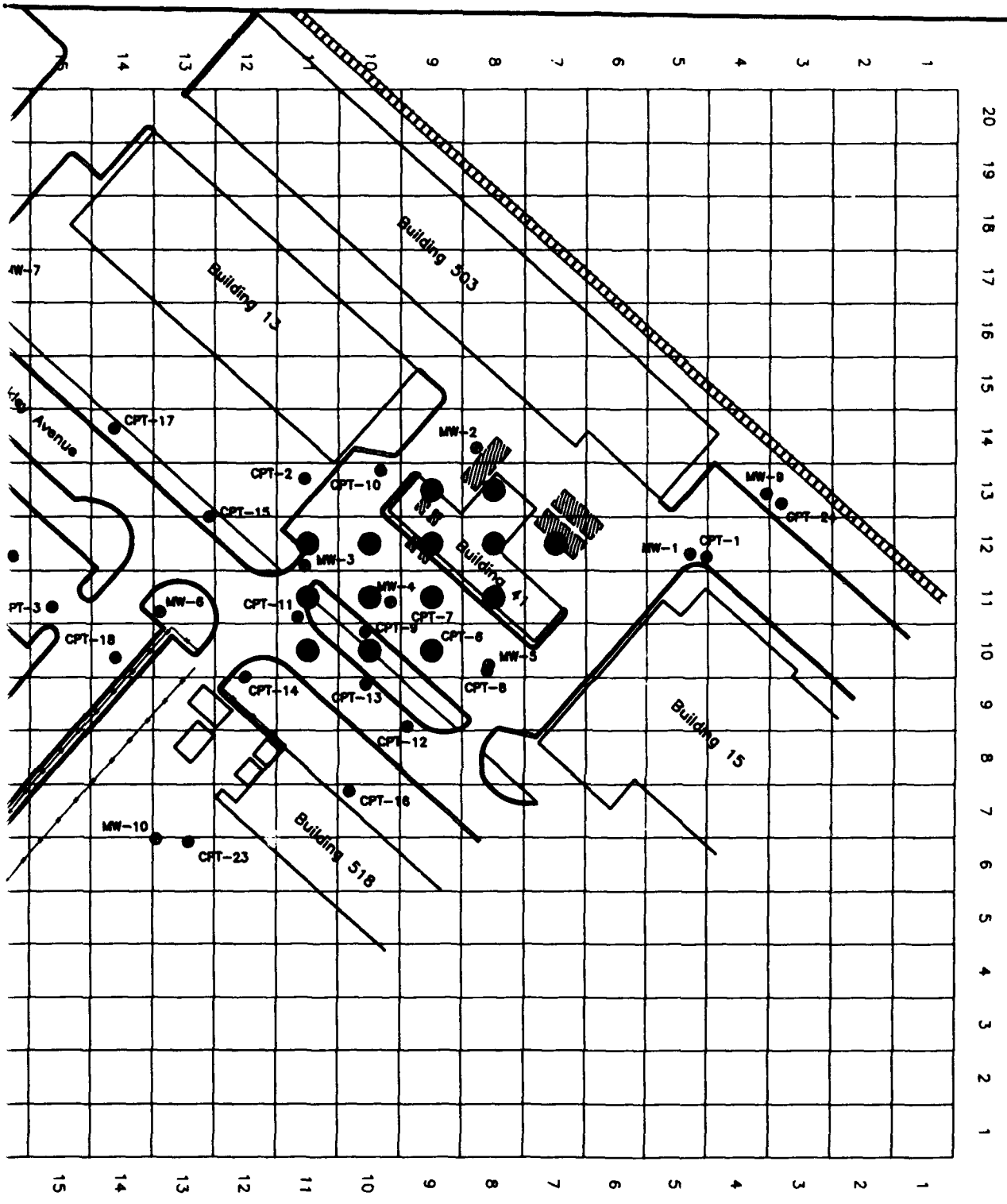


Model Grid

Car Care Center
Intrinsic Remediation
Bolling AFB,

PARSONS ENGINI

Figure 5.1



Model Grid

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

PARSONS ENGINEERING SCIENCE, INC.

special type of specified flow boundary and are set by specifying the flux to be zero. Examples of no-flow boundaries include groundwater divides and impermeable hydrostratigraphic units. Specified-flux boundaries are expressed mathematically as:

$$Flux = f(x,y,z,t)$$

3) Head-dependent flow boundaries (Cauchy or mixed-boundary conditions) where the flux across the boundary is calculated from a given boundary head value. This type of flow boundary is sometimes referred to as a mixed-boundary condition because it is a combination of a specified-head boundary and a specified-flow boundary. Head-dependent flow boundaries are used to model leakage across semipermeable boundaries. Head-dependent flow boundaries are expressed mathematically as (Bear, 1979):

$$Flux = (Ho - H)K'/B'$$

Where:
- H = Head in the zone being modeled (generally the zone containing the contaminant plume)
- Ho = Head in external zone (separated from plume by semipermeable layer)
- K' = Hydraulic conductivity of semipermeable layer
- B' = Thickness of semipermeable layer.

Natural hydraulic boundaries are modeled using a combination of the three types of model boundary conditions listed above. When possible, hydrologic boundaries such as surface water bodies, groundwater divides, contour lines, or hydrologic barriers should coincide with the perimeter of the model. In areas lacking obvious hydrologic boundaries, specified-head or specified-flux boundaries can be specified at the model perimeter if the boundaries are far enough removed from the contaminant plume that transport calculations are not affected. Bioplume II requires the entire model domain to be bounded by zero-flux cells (also known as no-flow cells), with other boundary conditions established within the subdomain specified by the no-flow cells.

Specified-head boundaries for the model were set on the southeastern and northwestern perimeter of the model grid to simulate groundwater flow to the northwest as observed at the site. Heads for the specified-head boundaries were set at the approximate location of the water table indicated by water level data. The head of the southeastern boundary (upgradient) was estimated to be from 4.25 to 14.75 feet above msl in order to simulate the steep gradients observed at the upgradient boundary. However, plume formation and transport only occur in the portion of the model domain where the water table surface is relatively flat. As a result, mass transport in the plume is not affected by the boundary conditions used to reproduce the observed water table conditions.

Parsons ES chose not to utilize the Potomac River as the model downgradient boundary due to its excessive distance from the site. An alternate model boundary was chosen in order to maintain resolution of the BTEX plume and to avoid potential

boundary interferences. As a result, downgradient model boundary was defined by an assumed downgradient position of the 2.0-foot water table contour. The location of this contour was estimated by extrapolation from available water table elevation and flow gradient data.

The southwestern and northeastern (lateral) model boundaries were configured as no-flow (specified flux) boundaries. Flux through these boundaries is assumed to be zero because flow is generally parallel to these boundaries.

5.3.2 Groundwater Elevation and Gradient

The water table elevation map presented in Figure 3.5 was used to define the starting heads for input into the Bioplume II model. Groundwater flow in the vicinity of the former Car Care Center Site (Building 41) is to the south with an average gradient of approximately 0.014 foot/foot (see Section 3.3.2.1). A comparison of the hydraulic gradients calculated by Parsons ES and Baker (1994) suggest that there are no significant seasonal variations in groundwater flow direction, and that seasonal gradients consistently vary around the average of approximately 0.014 foot/foot. As a result, it was assumed that the observed water levels were representative of steady-state conditions. As described in Section 5.4.1, the model was calibrated to the observed water table.

5.3.3 BTEX Concentrations

August 1994 total dissolved BTEX concentrations obtained from laboratory analytical results for each well and monitoring point location were used for model development. At each multidepth monitoring point, the highest BTEX concentration observed at that location was used as the representative concentration. Table 4.2 presents dissolved BTEX concentration data. Figure 4.4 shows the spatial distribution of dissolved BTEX compounds in August 1994.

The BTEX plume observed in August 1994 covers an area of approximately 126,000 square feet (2.9 acres). The shape and distribution of the total BTEX plume is the result of advective-dispersive transport, sorption, and biodegradation of dissolved BTEX contamination. As described in Section 5.4.2, the simulated BTEX plume was calibrated to closely approximate the observed BTEX plume.

5.3.4 Electron Acceptors (Oxygen and Nitrate)

As discussed previously, the Bioplume II model assumes an instantaneous reaction between the BTEX plume and the DO plume. The discussion presented in Section 4 suggests that DO, nitrate, ferric iron, manganese, sulfate, and carbon dioxide are being used as electron acceptors for biodegradation of BTEX compounds at the former Car Care Center Site (Building 41). To be conservative, the total BTEX plume at the site was modeled assuming that DO and nitrate were the only electron acceptors being utilized for the biodegradation of BTEX compounds at a rate that is instantaneous relative to the advective groundwater flow velocity.

Groundwater samples collected, during August 1994, in uncontaminated portions of the aquifer suggest that the background DO concentration at the site was 5.2 mg/L.

Background oxygen levels were assumed to be 5 mg/L for Bioplume II model development. Table 4.3 presents DO data for the site. Figure 4.8 presents the August 1994 DO isopleth map, and Figures 4.9 and 4.10 show the vertical profiles. Gridded oxygen input data are included in Appendix D. Nitrate and nitrite concentrations in groundwater were determined from site monitoring wells and monitoring points. Groundwater samples collected from uncontaminated portions of the aquifer suggest that background nitrate concentrations ranged from 13 to 18 mg/L (as nitrogen). However, due to spatial position of the August 1994 nitrate plume (Figure 4.11), the 5.0 mg/L (as nitrogen) contour was the largest significant isopleth. Therefore, background nitrate levels were assumed to be 5 mg/L (as nitrogen) for Bioplume II model development. Table 4.3 presents nitrate data for the site. Figure 4.8 presents nitrate isopleth map for August 1994.

The upgradient specified-head cells in the Bioplume II model require background DO (or electron acceptors) to be input as a single constant concentration at each upgradient boundary cell. As a result, nitrate concentration must be converted to an oxygen equivalent. As a first step, the equivalent weight of oxygen must be added to the nitrate, expressed as N, to convert to ionic nitrate:

Molecular weight of N = 14 gm/mole
Molecular weight of O = 16 gm/mole
Molecular weight of NO_3^- = 62 gm/mole

The percentage of N in NO_3^- is 14/62 = 22.58 percent. Therefore, 1 gm of NO_3^- (as N) is equivalent to 1/0.2258 = 4.43 gm of ionic NO_3^-. To convert nitrate (as N) into ionic nitrate concentrations, the measured nitrate (as N) concentration must be multiplied by 4.43.

Assuming complete mineralization of benzene to carbon dioxide and water, the reactions for aerobic respiration and denitrification are as follows:

Aerobic Respiration

$$C_6H_6 + 7.5O_2 = 6CO_2 + 3H_2O$$

Denitrification

$$6NO_3^- + 6H^+ + C_6H_6 = 6CO_2 + 6H_2O + 3N_{2(g)}$$

Based on this stoichiometry, 7.5 moles of DO are required to biodegrade 1 mole of benzene, and 6 moles of nitrate are required to biodegrade 1 mole of benzene. On a mass basis:

(7.5 moles O_2)(32 gm/mole O_2) = 240 gm O_2
(6 moles NO_3^-)(62 gm/mole NO_3^-)= 372 gm NO_3^-

From these relationships, it is apparent that on a mass basis more ionic nitrate than DO is required to oxidize a unit mass of benzene. By dividing the mass of ionic nitrate required to degrade one mole of benzene by the mass of DO required to degrade one mole of benzene, a ratio is derived that can be applied to ionic nitrate concentrations to obtain equivalent oxygen concentrations. This ratio is:

240 gm O_2/372 gm NO_3^- = 0.645 gm of O_2-equivalent ionic nitrate per/gram of NO_3^-

Therefore, 10 gm of NO_3^- has an O_2 equivalence of:

(10 gm NO_3^-)(0.645 gm of O_2-equivalent ionic nitrate per gm of NO_3^-) = 6.45 gm

From these relationships, the following calculation must be performed to convert NO_3^- (as N) to an equivalent DO concentration:

(NO_3^-(as N) (gm/L))(4.43 gm NO_3^- (ion)/gm NO_3^-(as N))(0.65 gm O_2 eq./gm NO_3^-)

This relationship was used to convert measured nitrate (as N) concentrations into oxygen-equivalent ionic nitrate concentrations. For example, the 5 mg/L (as nitrogen) background nitrate concentration is converted to 14.5 mg/L (as O_2 equivalent). To do this, an isopleth map of nitrate (as N) was prepared and gridded. An O_2 equivalent of 19.5 mg/L was assumed for the starting condition at all model cells prior to the introduction of fuel contamination. It was further assumed that this concentration would be continually introduced at the upgradient boundary.

5.3.5 Anaerobic Degradation Rates

In order to calculate first-order decay rate constants in the anaerobic core of the plume, the apparent degradation rate must be normalized for the effects of dilution caused by advective-dispersive processes. This is accomplished by normalizing the concentration of each contaminant to the concentration of a component of gasoline (a tracer) that has similar sorptive properties but that is fairly recalcitrant. Observed concentration data can be normalized to 1,3,5-TMB, 1,2,4-TMB, and 1,2,3-TMB or another tracer with similar physiochemical properties. The TMB suite serves as a good tracer because it is known to be recalcitrant to microbial degradation under anaerobic conditions, and has sorptive properties similar to the BTEX compounds.

First-order decay constants were calculated based on BTEX and TMB data from August 1994 (presented in Table 4.2). Rate constant calculations are included in Appendix D. Calculated rate constants for the Car Care Center Site (Building 41) ranged from 0.0001 to 0.0004 day^{-1}. A review of recent literature indicates that higher rate constants have been observed at other sites. For example, Chapelle (1994) reported that at two different sites with anaerobic conditions, the anaerobic rate constants were both approximately 0.01 day^{-1}. Wilson *et al.* (1994) report first-order anaerobic biodegradation rates of 0.05 to 1.3 $week^{-1}$ (0.007 to 0.185 day^{-1}). Stauffer *et al.* (1994) reports rate constants of 0.01 day^{-1} and 0.018 day^{-1} for benzene and p-xylene, respectively. The calculated first-order decay rate for this site is relatively low. A major controlling factor for the rate of biodegradation is the quantity of electron acceptors that are flushed from upgradient areas through the contaminated zone. This low decay coefficient is likely a result of the minimal groundwater flow rate reported at the site.

Because nitrate was included in the Bioplume II model, and to be conservative, first-order decay was not included within the model.

5.4 MODEL CALIBRATION

Model calibration is an important component in the development of any numerical groundwater model. Calibration of the flow model demonstrates that the model is capable of matching hydraulic conditions observed at the site. Calibration of a contaminant transport model superimposed upon the calibrated flow model helps verify that contaminant loading and transport conditions are being appropriately simulated. The numerical flow model presented herein was calibrated by altering transmissivity in a trial-and-error fashion until simulated heads approximated observed field values within a prescribed accuracy. After calibration of the flow model, the numerical transport model was calibrated by altering transport parameters in a trial-and-error fashion until the simulated BTEX plume approximated observed field values. Table 5.1 lists input parameters used for the modeling effort. Model input and output is included in Appendix D.

5.4.1 Water Table Calibration

The shallow water table at the former Car Care Center Site was assumed to be influenced only by continuous recharge and discharge at the constant-head cells established at the upgradient and downgradient model boundaries. To be conservative, recharge of the aquifer through rainfall (which would add water, thereby increasing dilution of the plume) was not included in the model. Potential recharge by other sources was omitted because of a lack of reliable data. Only the initial water levels at the constant-head cells and the transmissivity values were varied to calibrate the water table surface. The model was calibrated under steady-state conditions.

Hydraulic conductivity is an important aquifer characteristic that determines the ability of the water-bearing strata to transmit groundwater. Transmissivity is the product of the hydraulic conductivity and the thickness of the aquifer. An accurate estimate of hydraulic conductivity is important to help quantify advective groundwater flow velocities and to define the flushing potential of the aquifer and the quantity of electron-acceptor-charged groundwater that is entering the site from upgradient locations. As indicated by the work of Rifai *et al.* (1988), the Bioplume II model is particularly sensitive to variations in hydraulic conductivity. Lower values of hydraulic conductivity result in a slower-moving plume that degrades at a slower rate because less oxygen, nitrate, iron, sulfate, and carbon dioxide is available for biodegradation. Higher values of hydraulic conductivity result in a faster-moving plume that degrades faster because more electron acceptors are available for biodegradation.

Saturated thickness data from previous reports, geologic logs, and water level measurements were used in conjunction with the average hydraulic conductivity as determined from slug tests performed by Baker in 1994 (5.8×10^{-5} feet/sec to 5.8×10^{-6} feet/sec) to estimate an initial uniform transmissivity for the entire model domain. Several pre-calibration model runs were made to determine if model input parameters were appropriate. The simulations were run for 50 years (the approximate operational lifetime of the Car Care Center) to determine if the initial parameters would

TABLE 5.1
BIOPLUME II MODEL INPUT PARAMETERS
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Parameter	Description	CAL2 Calibrated Model Setup	SR20	SR33
NTIM	Max. number of time steps in a pumping period	5	5	5
NPMP	Number of Pumping Periods	1	5	5
NX	Number of nodes in the X direction	20	20	20
NY	Number of node s in the Y direction	30	30	30
NPMAX	Maximum number of Particles NPMAX=(NX-2)(NY-2)(NPTPND) + (N_S[a]) (NPTPND) + 250	4966	4966	4966
NPNT	Time step interval for printing data	1	1	1
NITP	Number of iteration parameters	7	7	7
NUMOBS	Number of observation points	10	0	0
ITMAX	Maximum allowable number of iterations in ADIP[b]	200	200	200
NREC	Number of pumping or injection wells	14	14	14
NPTPND	Initial number of particles per node	9	9	9
NCODES	Number of node identification codes	2	2	2
NPNTMV	Particle movement interval (IMOV)	0	0	0
NPNTVL	Option for printing computed velocities	0	0	0
NPNTD	Option to print computed dispersion equation coefficients	0	0	0
NPDELC	Option to print computed changes in concentration	0	0	0
NPNCHV	Option to punch velocity data	0	0	0
NREACT	Option for biodegradation, retardation and decay	1	1	1
PINT	Pumping period (years)	50	15	15
TOL	Convergence criteria in ADIP	0.001	0.001	0.001
POROS	Effective porosity	0.35	0.35	0.35
BETA	Characteristic length (long. dispersivity; feet)	25	25	25
S	Storage Coefficient	0 (Steady-State)	0	0
TIMX	Time increment multiplier for transient flow	NA[c]	NA	NA
TINIT	Size of initial time step (seconds)	NA	NA	NA
XDEL	Width of finite difference cell in the x direction (feet)	30	30	30
YDEL	Width of finite difference cell in the y direction (feet)	35	35	35
DLTRAT	Ratio of transverse to longitudinal dispersivity	0.1	0.1	0.1
CELDIS	Maximum cell distance per particle move	0.5	0.5	0.5
ANFCTR	Ratio of Tyy to Txx	1 (Isotropic)	1	1
DK	Distribution coefficient	0.047	0.047	0.047
RHOB	Bulk density of the solid (grams/cubic centimeter)	1.6	1.6	1.6
THALF	Half-life of the solute	0	0	0
DEC1	Anaerobic decay coefficient	0	0	0
DEC2	Reaeration coefficient (day^{-1})	0.003	.003	.003
F	Stoichiometric Ratio of Hydrocarbon to Oxygen	3.1	3.1	3.1

[a] N_S = Number of nodes which represent fluid sources

[b] ADIP = Alternating - direction implicit procedure (subroutine for solving groundwater flow equation)

[c] NA = Not applicable

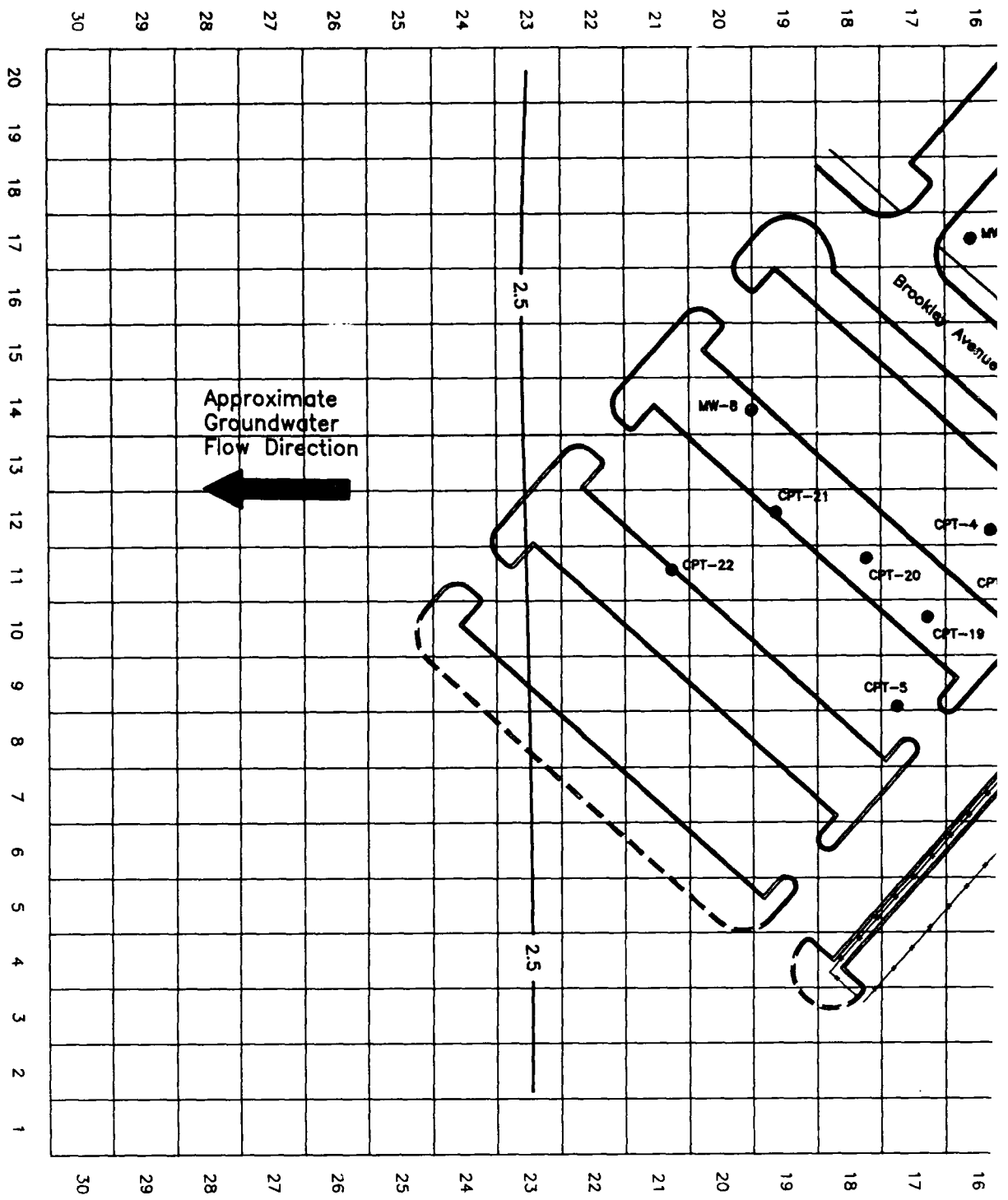
produce reasonable simulations, and to provide a preliminary estimate of BTEX injection rates (see Section 5.4.2 for additional information on BTEX injection). During these simulations, it became apparent that the use of the original hydraulic conductivity values estimated from site data prevented reproduction of the observed site conditions. BTEX plumes simulated in these initial runs were all less than one-third the length of the observed plume. Varying transport parameters such as the retardation factor, the reaeration coefficient, and the longitudinal dispersivity within reasonable ranges did not increase the plume length substantially. As a result, model hydraulic conductivities were increased until the observed plume length was adequately reproduced. The resulting average model conductivity (and hence transmissivity) value was 4.8 times greater than that reported by Baker (1994). The resulting transmissivity of 0.0051 feet^2/sec was used for initial model setup. Because slug test data at best provide a measurement of conductivity within an order-of-magnitude, this change is not excessive. Model sensitivity to transmissivity (hydraulic conductivity times saturated thickness) is discussed in Section 5.5.

To better match heads in the model to observed values, the transmissivities were then progressively varied in blocks and rows until the simulated water levels for cells corresponding to selected well locations matched the observed water levels as closely as possible. Figure 5.2 shows the calibrated water table. Calibrated model hydraulic conductivities ranged from 1.7×10^{-4} feet/sec to 3.4×10^{-6} feet/sec. Water level elevation data from cells associated with 10 monitoring wells and monitoring points were used to compare measured and simulated heads for calibration. The 10 selected cell locations each contained one of the following wells: MW-1, MW-3, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, CPT-8D, and CPT-22D. The root mean squared (RMS) error is commonly used to express the average difference between simulated and measured heads. RMS error is the average of the squared differences between measured and simulated heads, and can be expressed as:

$$RMS = \left[\frac{1}{n} \cdot \sum_{i=1}^{n} \left[\left(h_m - h_s \right)_i \right]^2 \right]^{0.5}$$

Where: n = the number of points where heads are being compared
h_m = measured head value
h_s = simulated head value.

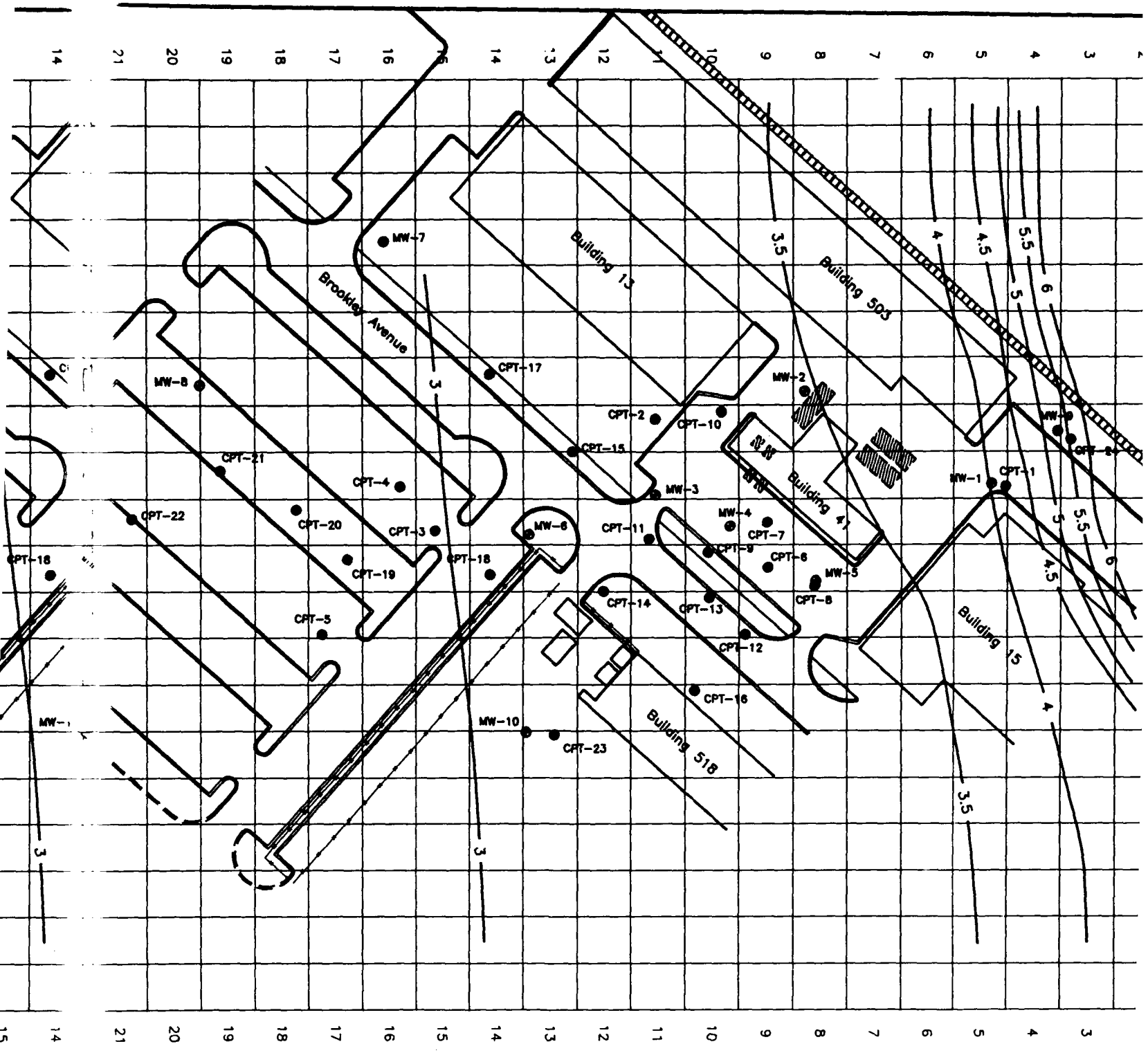
The RMS error between observed and calibrated values at the 10 comparison points was 0.30 feet, which corresponds to a calibration error of 2.4 percent (water levels dropped a maximum of 12.6 feet over the length of the model grid). RMS error calculations are summarized in Appendix D. A plot of measured vs. calibrated heads shows a random distribution of points around a straight line, as shown in Appendix D. Deviation of points from a straight line should be randomly distributed in such a plot of results from computer simulations (Anderson and Woessner, 1992).



LEGEND

- Former underground storage tanks (USTs).
- MW-1 — Existing monitoring well.
- CPT-1 — Monitoring point and CPT test location installed by CPT rig.
- 2.5 — Potentiometric surface (feet above mean sea level) contour.

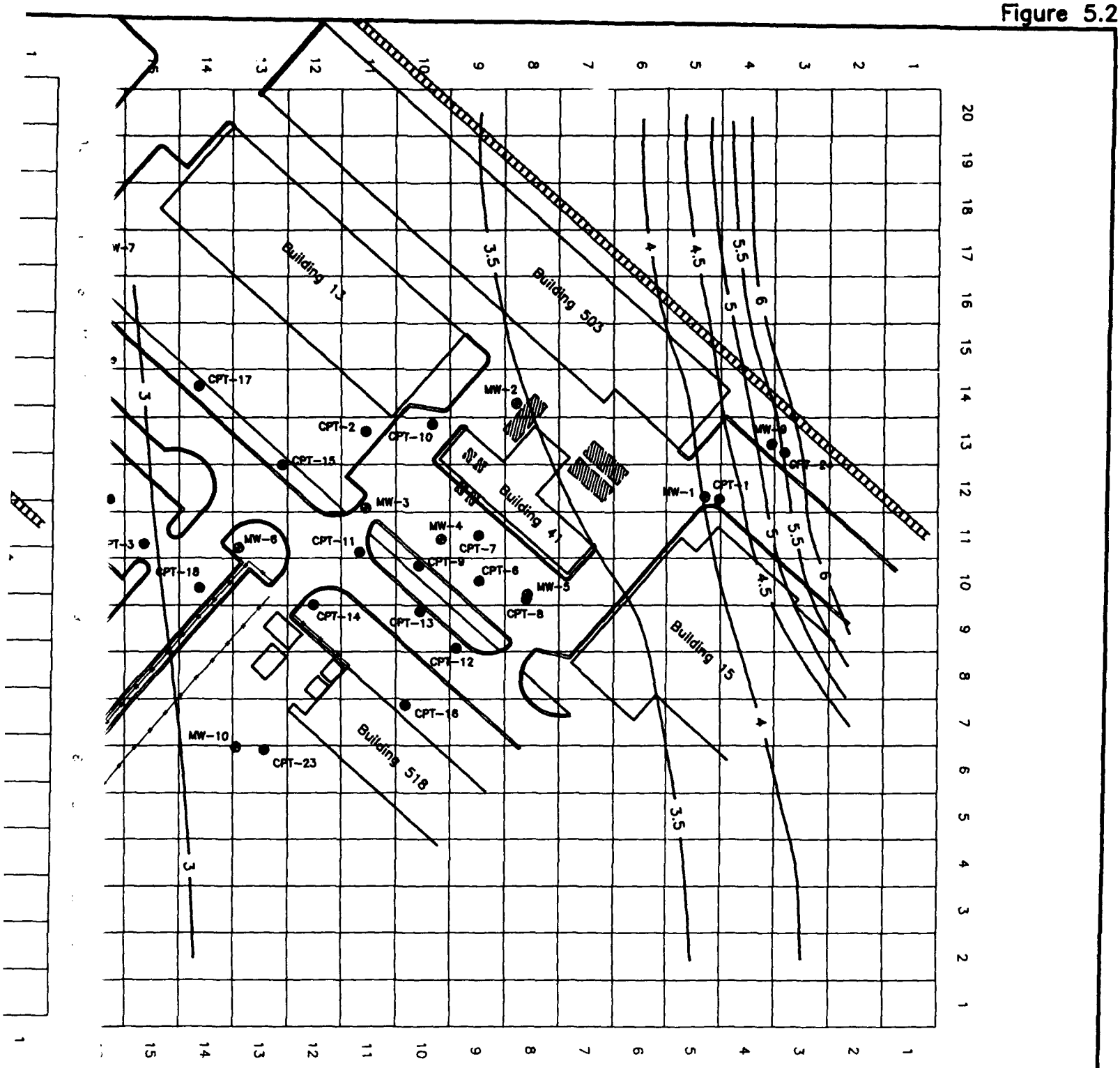
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Figure 5.2



Calibrated Potentiometric Surface Map

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

The coefficient of correlation (R^2) is a measure of the similarity between two data sets. In the event that R^2 is equivalent to 1, then the data are a perfect match. The R^2 for this plot was 0.65, indicating that the difference between the simulated and observed heads is not exact. This low R^2 value is partially due to the steep gradients observed along the upgradient site boundary, which were difficult to model accurately. Also, the site monitoring wells typically do not fall within the center of a model grid. Because the Bioplume II model provides block-centered data, the simulated and observed heads typically will not be exact. The slope and intercept of the regression curve is another indication of exactness between the simulated and observed heads. If the data is a good match, the slope and y-intercept of the regression line should be 1.0 ft/ft and 0.0 foot, respectively. For this data, the slope of the regression line was 0.95 ft/ft and the y-intercept was 0.0 foot, indicating a satisfactory match between the simulated and observed heads.

In solving the groundwater flow equation, Bioplume II establishes the water table surface and calculates an overall hydraulic balance that accounts for the numerical difference between flux into and out of the system. The hydraulic mass balance for the calibrated model was excellent, with 99.8 percent of the water flux into and out of the system being numerically accounted for (i.e., a 0.2 percent error). According to Anderson and Woessner (1992), a mass balance error of around 1 percent is acceptable, while Konikow (1978) indicates an error of less than 0.1 percent is ideal.

5.4.2 BTEX Plume Calibration

Model input parameters affecting the distribution and concentration of the simulated BTEX plume were modified so that model predictions matched dissolved total BTEX concentrations observed in August 1994. To do this, model runs were made using the calibrated steady-state hydraulic parameters coupled with the introduction of contaminants. For this site, the calibration also involved a time element. The exact dates and volumes of the releases are unknown because the historical record for these events is not complete. Leaks from the USTs and piping may have occurred gradually over a long period of time. However, spills likely occurred as early as 20 to thirty years ago. As a result, the plume calibration simulations were made with a time constraint of 20 years; in other words, computed BTEX plume concentrations and configurations were compared to August 1994 data after 20 years of simulation time incorporating the introduction of contaminants into the groundwater.

Because mobile and residual LNAPL are present in the vicinity of the water table at the site, it was necessary to include model injection wells to simulate partitioning of BTEX compounds from the residual phase into the groundwater. The location of the injection wells is shown on Figure 5.1. Locations of injection wells were based on the known locations of mobile and residual LNAPL (see Figure 4.1, 4.2a, and 4.2b), the extent of groundwater contamination indicated on Figure 4.4, and the locations of the USTs and fuel piping.

While the term "injection well" suggests contaminants are being introduced at a point, Bioplume II assumes that contamination introduced at a well instantly equilibrates throughout the entire cell in which the well is located. The injection rate for the cells was set at 4.6×10^{-6} cubic foot per second (ft^3/sec), a value low enough so that the flow calibration and water balance was not affected. Relatively high BTEX

concentrations were injected in upgradient injection wells because of the low pumping rate and the influx of oxygen introduced at the upgradient constant head cells. Replenishment of oxygen quickly degraded BTEX concentrations at the head of the plume, which in turn required larger injection concentrations of BTEX to produce observed BTEX contours. Based on assumptions outlined in Section 5.3.4, it was assumed that the initial DO concentration was uniformly 5.0 mg/L and initial nitrate concentration was uniformly 5.0 mg/l (as nitrogen), and that water with these concentrations would be continually introduced at the upgradient boundary.

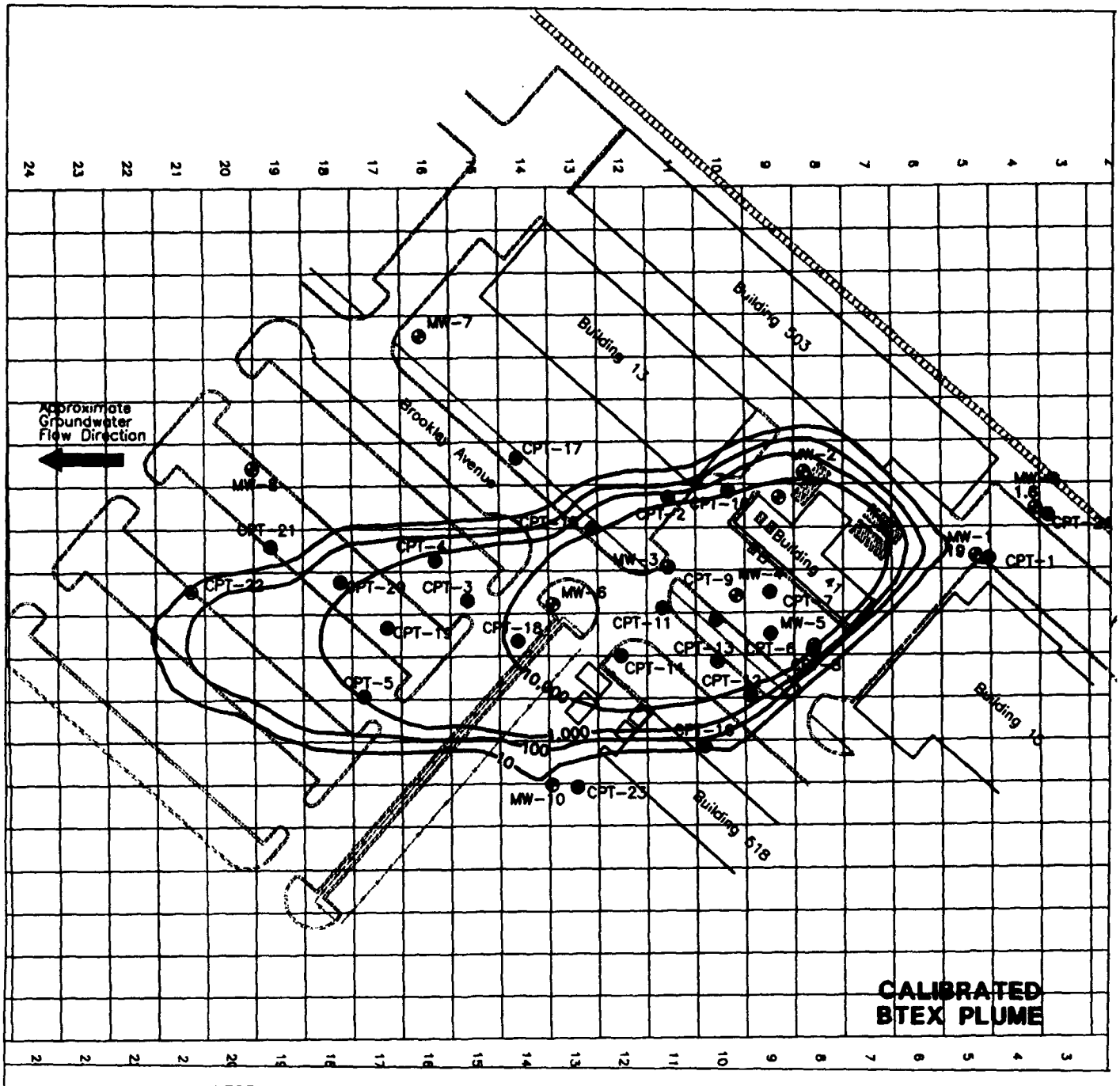
Total BTEX injection concentrations were determined by varying the injection concentration for the various wells until the modeled total BTEX plume approximated the total BTEX plume observed in August 1994. By varying the injection well concentrations, the coefficient of retardation, dispersivity, and the reaeration coefficient, the BTEX plume was calibrated reasonably well to the existing plume in terms of migration distance and BTEX concentrations in the source area. The calibrated plume configuration is shown and compared to the August 1994 observed BTEX plume on Figure 5.3.

The calibrated model plume, while not identical to the observed BTEX plume, compares favorably. Differences in modeled and actual plume shapes and concentrations are caused by physical, chemical, and biological variations within the shallow saturated zone that result from natural aquifer heterogeneity. The downgradient extent of the computed 10 µg/L contour is similar to the observed 10 µg/L contour, and the computed 100 µg/L BTEX contour is similar to the 100 µg/L contour interpreted from the observed concentrations. The area delineated by the computed 1,000 µg/L contour is slightly smaller than the area of the observed 1,000 µg/L contour along the western edge of the plume. However, these differences are relatively minor. In addition, the downgradient extent of the computed 10,000 µg/L BTEX contour is similar to the observed 10,000 µg/L contour's extent.

The computed plume does not have concentrations as high as the concentration observed at CPT-11S (110,000 µg/L), with a maximum simulated concentration of 30,200 µg/L computed for the cell containing CPT-11S. However, the measurement at CPT-11S was made at a discrete interval within the aquifer, while the model is indicating a concentration that is averaged for the entire model cell depth. Measured BTEX concentrations in CPT-11D were 3,100 µg/L, which further emphasizes the effect of vertical averaging within the model. Increasing the BTEX loading rates high enough to produce concentrations over 50,000 µg/L in the source ea resulted in a plume that was much longer and wider than the observed plume.

5.4.2.1 Discussion of Parameters Varied During Plume Calibration

As noted previously, the transport parameters varied during plume calibration were dispersivity, the coefficient of retardation, and the reaeration coefficient. Those parameters were generally varied with the intent of altering plume migration so that the observed plume extent was reproduced. While these parameters were varied with this common intent, each had a slightly different impact on the size and shape of the simulated plume.



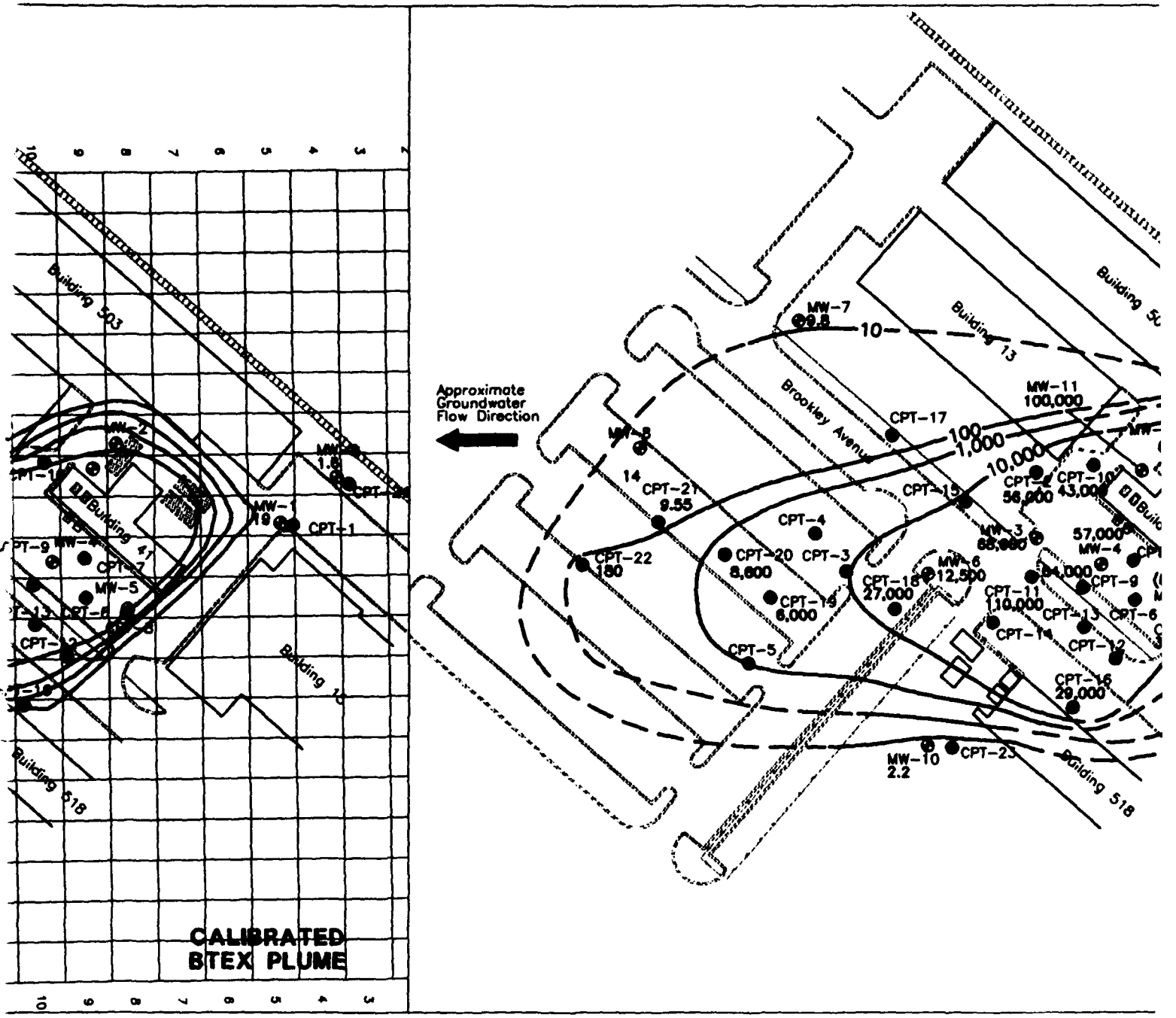
LEGEND

▨	Former underground storage tanks (USTs).
MW-1 ⊕	Existing monitoring well.
CPT-20 ●	Monitoring point installed by CPT rig.
8,600	Total benzene, toluene, ethylbenzene and xylene (BTEX) concentration (ug/L) by SW8020.
(8,600)	Data not utilized to construct contours.
——100——	Total BTEX concentration (ug/L) contour, dashed where inferred.

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

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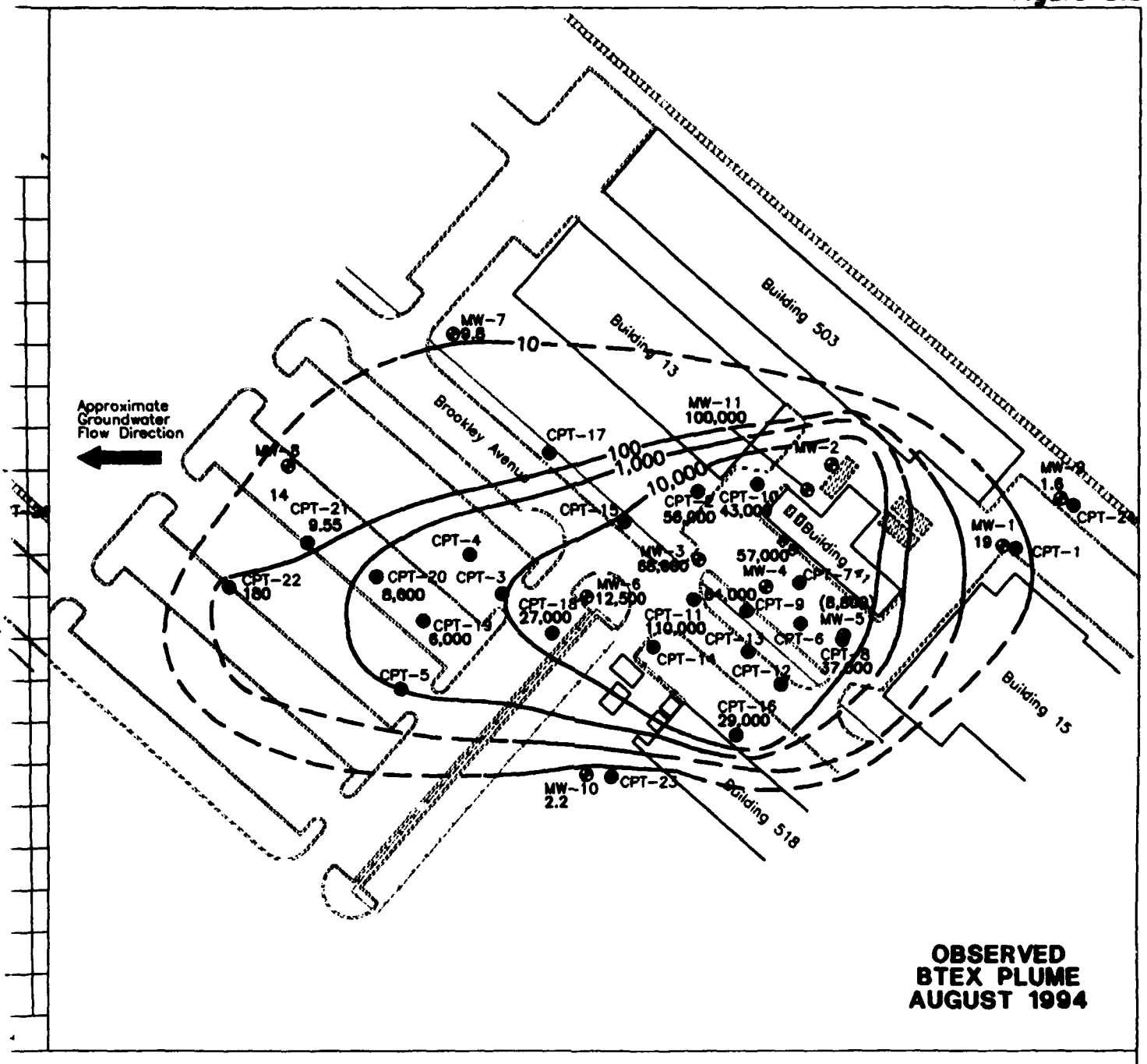
NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

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BTEX Plu

Car
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Figure 5.3



OBSERVED BTEX PLUME AUGUST 1994

Calibrated and Observed Dissolved BTEX Plumes, August 1994

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

5 4.2.1.1 Dispersivity

Much controversy surrounds the concepts of dispersion and dispersivity. Longitudinal dispersivity values are typically considered to be scale dependent. In other words, for a given sediment type, dispersivity values will depend upon the distance traveled by the solute. Gelhar *et al.*(1985) performed a critical review of various field experiments and found the longitudinal dispersivities varied from 0.03 feet to 18,000 feet. It may be inferred from this report that longitudinal dispersivity may range from 5 to 200 feet for the plume length reported for the former Car Care Center Site. Longitudinal dispersivity was originally estimated as 15 feet, using one-tenth (0.1) of the distance between center of the source area and the longitudinal centroid of the August 1994 plume (see Figure 4.4). Dispersivity estimation calculations are included in Appendix D. Transverse dispersivity values generally are estimated as one-tenth (0.1) of the longitudinal dispersivity values (Domenico and Schwartz, 1990).

During plume calibration, longitudinal dispersivity was raised to 25 feet from the original estimate of 15 feet. This was done to allow the computed BTEX plume to extend slightly further downgradient and also to help increase the lateral extent of the plume to better match the observed extent.

5.4.2.1.2 Coefficient of Retardation

Retardation of the BTEX compounds relative to the advective velocity of the groundwater occurs when BTEX molecules are sorbed to the aquifer matrix. The coefficients of retardation for the BTEX compounds were calculated based on measured TOC concentrations in the soils in and near the saturated zone at the site, an assumed bulk density of 1.6 grams/cubic centimeter (Freeze and Cherry, 1979), and published values of the soil sorption coefficient (K_{oc}) for the BTEX compounds, as listed by Wiedemeier *et al.* (1994). The results of these calculations are summarized in Table 5.2. To be conservative, the minimum retardation coefficient calculated for the BTEX compounds (R=1.25) was used for initial model input. The lower the assumed coefficient of retardation, the farther the BTEX plume will migrate downgradient. During plume calibration, the coefficient of retardation was gradually raised from the initial value of 1.25 to a value of 4.2 and also decreased to a value of 1. This analysis suggests that the initial retardation coefficient (R=1.25) adequately describes the formation of the present-day BTEX plume. As a result, this value was used in the final model simulations.

5 4.2.1.3 Reaeration Coefficient

The reaeration coefficient is a first-order rate constant used by Bioplume II to simulate the replenishment of oxygen into the groundwater by soil-gas diffusion and rainwater infiltration. A reaeration coefficient of 0.003 day^{-1} was initially estimated, based on other documented Bioplume II modeling efforts (see, for example, Rifai *et al.*, 1988). Use of the reaeration coefficient is justified at this site because of the shallow water table and the relatively high DO concentrations observed in site groundwater. During plume calibration, the reaeration coefficient was varied from the initial value of 0.003 day^{-1} to values of 0.03 day^{-1} and 0.0003 day^{-1}. This analysis suggested that the initial retardation coefficient (0.003 day^{-1}) adequately describes the

Table 5.2

CALCULATION OF RETARDATION COEFFICIENTS
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Compound	K_{oc}[a/] (L/kg)	Maximum Fraction Organic Carbon[b/]	Minimum Fraction Organic Carbon[b/]	Average Fraction Organic Carbon[b/]	Distribution Coefficient K_d (L/kg)			Bulk Density (L/kg)[d/]	Effective Porosity[d/]	Coefficient of Retardation		
					Maximum[c1/]	Minimum[c2/]	Average[c3/]			Maximum	Minimum	Average
Benzene	79	0.0015	0.0006	0.00105	0.119	0.0474	0.0830	1.6	0.3	1.63	1.25	1.44
Toluene	190	0.0015	0.0006	0.00105	0.285	0.114	0.200	1.6	0.3	2.52	1.61	2.06
Ethylbenzene	468	0.0015	0.0006	0.00105	0.702	0.281	0.491	1.6	0.3	4.74	2.50	3.62
m-Xylene	405	0.0015	0.0006	0.00105	0.608	0.243	0.425	1.6	0.3	4.24	2.30	3.27
o-Xylene	422	0.0015	0.0006	0.00105	0.633	0.253	0.443	1.6	0.3	4.38	2.35	3.36
p-Xylene	357	0.0015	0.0006	0.00105	0.536	0.214	0.375	1.6	0.3	3.86	2.14	3.00

NOTES:

[a/] From technical protocal (Wiedemeier *et al.*, 1994)

[b/] From site data within areas containing noncontaminated sediment

[c1/] K_d = Maximum Fraction Organic Carbon x K_{oc}

[c2/] K_d = Minimum Fraction Organic Carbon x K_{oc}

[c3/] K_d = Average Fraction Organic Carbon x K_{oc}

[d/] Literature values

formation of the present-day BTEX plume. As a result, this value was used in the final model simulations.

5.5 SENSITIVITY ANALYSIS

The purpose of the sensitivity analysis is to determine the effect of varying model input parameters on model output. Based on the work of Rifai *et al.* (1988), the Bioplume II model is most sensitive to changes in the coefficient of reaeration, the coefficient of anaerobic decay, and the hydraulic conductivity of the media, and is less sensitive to changes in the retardation factor, porosity, and dispersivity. A first-order anaerobic decay coefficient was not used because nitrate was included in the original oxygen map to simulate anaerobic biodegradation at the site. Because the coefficient of anaerobic decay was set to zero, the sensitivity analysis was conducted by varying the hydraulic conductivity (and therefore transmissivity) and the coefficient of reaeration. Because of the potential for large dispersivity values at the site, a sensitivity analysis also was performed for this parameter. In addition, a sensitivity analysis was performed for the retardation coefficient.

To perform the sensitivity analyses, individual runs of the model were made with the same input as the calibrated model, except that one of the aforementioned parameters was varied. The models were run for 20 years, just as the calibrated model, so that the independent effect of each variable could be assessed. As a result, eight sensitivity runs of the calibrated model were made, with the following variations:

1) Hydraulic conductivity uniformly increased by a factor of 5;

2) Hydraulic conductivity uniformly decreased by a factor of 0.2;

3) Longitudinal dispersivity increased to 50 feet;

4) Longitudinal dispersivity decreased to 5 feet;

5) Reaeration coefficient increased to 0.03 day^{-1};

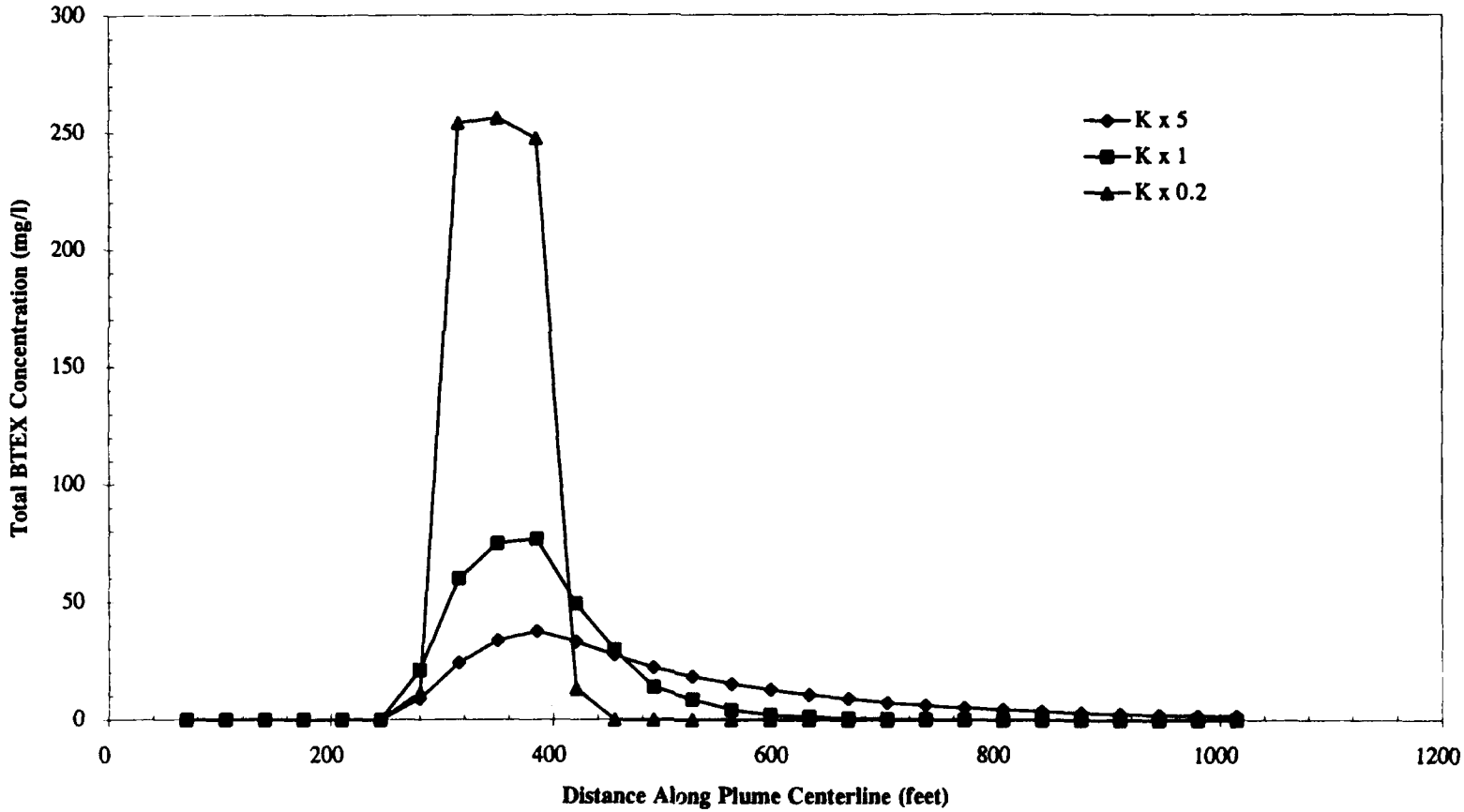
6) Reaeration coefficient decreased to 0.0003 day^{-1};

7) Retardation coefficient increased to 4.2; and

8) Retardation coefficient decreased to 1 (i.e. no retardation).

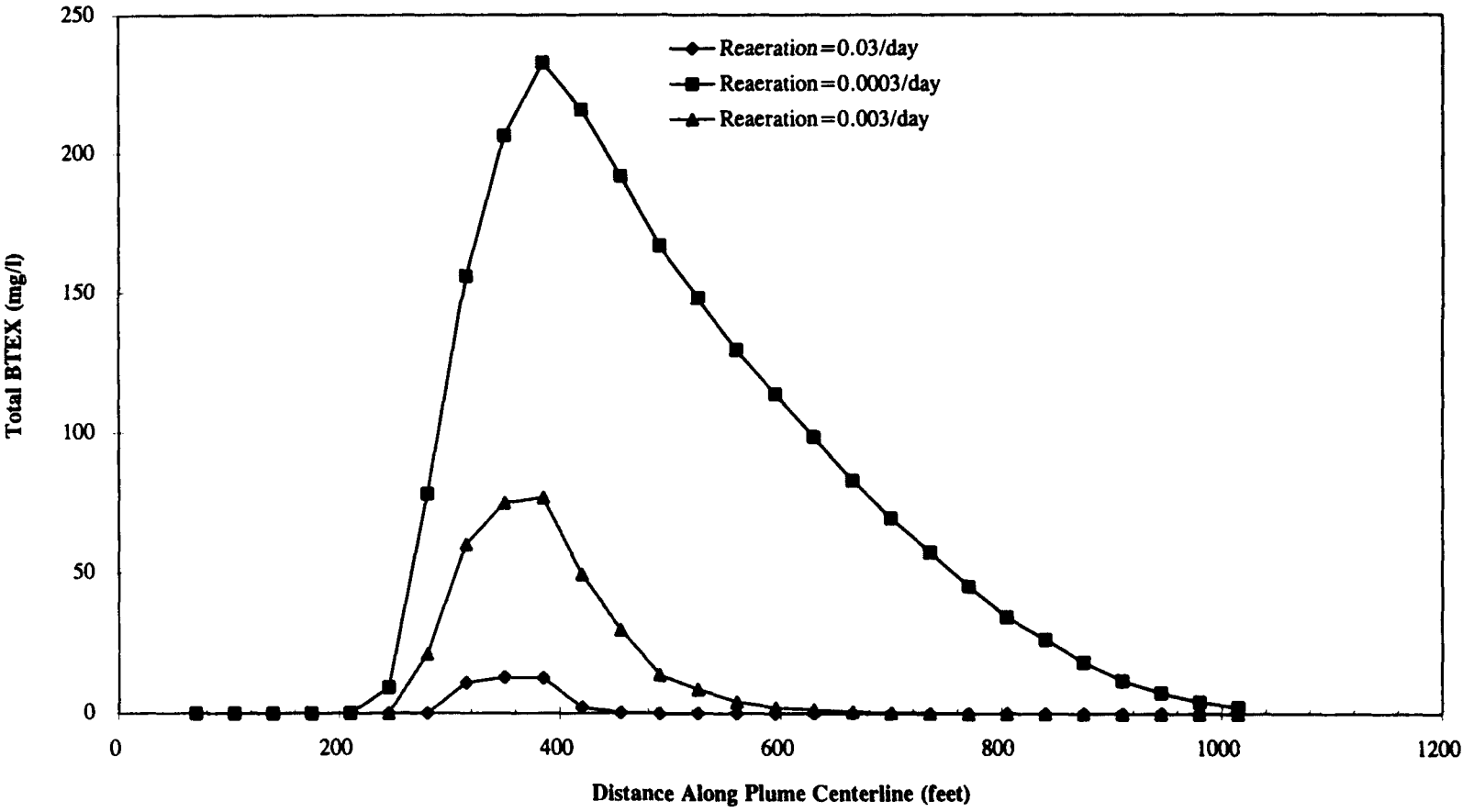
The results of the sensitivity analyses are shown graphically in Figures 5.4, 5.5, 5.6, and 5.7. These figures display the modeled BTEX concentrations versus distance along the centerline of the plume. This manner of displaying data is useful because the plume is narrow and migrates parallel to the model grid. Furthermore, the figures allow easy visualization of the changes in BTEX concentration caused by varying model input parameters.

FIGURE 5.4
PLOT OF TOTAL BTEX VS DISTANCE ALONG PLUME CENTERLINE WITH VARYING HYDRAULIC CONDUCTIVITY (K)
CAR CARE CENTER SITE, INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC



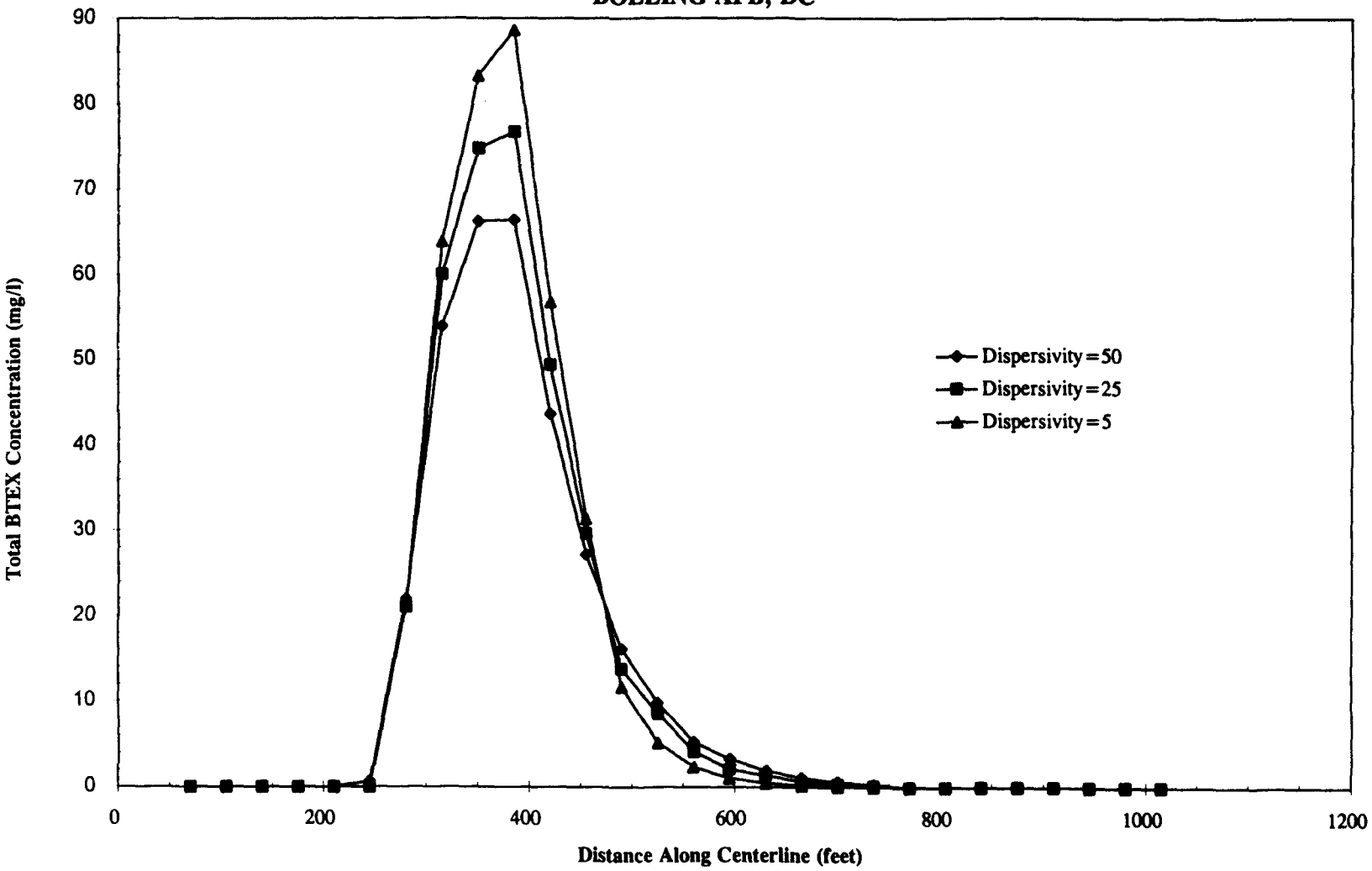
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FIGURE 5.5
PLOT OF TOTAL BTEX VS DISTANCE ALONG PLUME CENTERLINE WITH VARYING COEFFICIENT OF REAERATION
CAR CARE CENTER SITE INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC



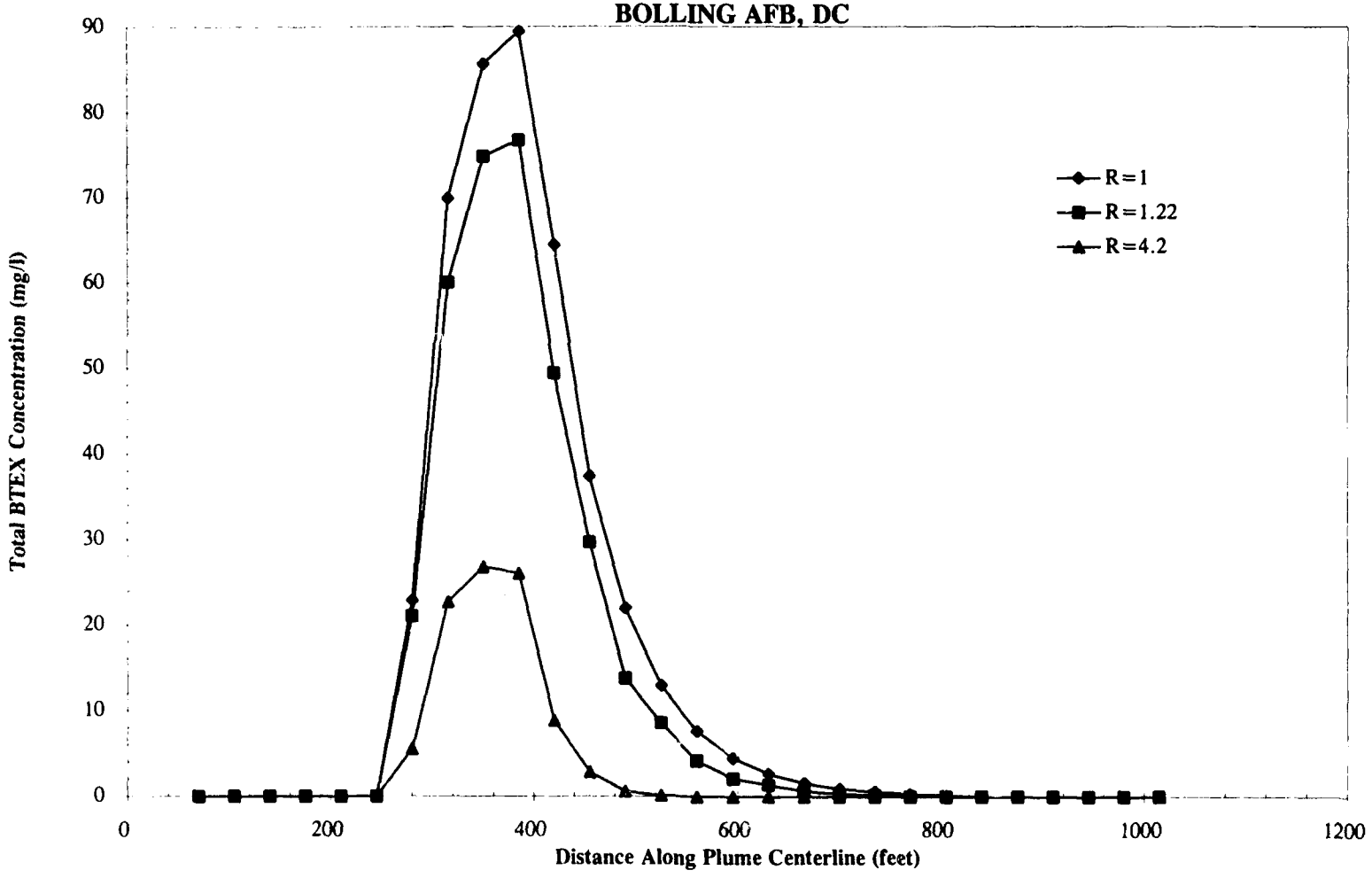
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FIGURE 5.6
PLOT OF TOTAL BTEX VS DISTANCE ALONG
PLUME CENTERLINE WITH VARYING DISPERSIVITY
CAR CARE CENTER SITE INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC



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FIGURE 5.7
PLOT OF TOTAL BTEX VS DISTANCE ALONG PLUME CENTERLINE WITH VARYING RETARDATION COEFFICIENT (R)
CAR CARE CENTER SITE, INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC



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Uniformly increasing the hydraulic conductivity in the model by a factor of 5 drastically increased the migration rate and biodegradation rate of the plume (Figure 5.4). In relation to the calibrated plume, the plume formed by the model with the higher hydraulic conductivity had a lower peak (due to increased biodegradation) and was spread much further downgradient (due to increased advective flow). This was caused by an increased influx of electron acceptors in the highly conductive aquifer, increasing biodegradation of the plume in the source area. Also, the higher groundwater velocity produced greater downgradient spreading of the BTEX plume. In contrast, decreasing the hydraulic conductivity by a factor of 0.2 slowed plume migration, which in turn caused an increase in modeled BTEX levels in the source area and a decreased downgradient plume extent. Increased BTEX concentrations in the source area are caused by a reduction in the quantity of electron acceptors being brought into contact with the plume from upgradient locations.

The effect of varying the coefficient of reaeration is shown in Figure 5.5. Increasing the reaeration coefficient from 0.003 day^{-1} to 0.03 day^{-1} significantly decreased BTEX concentrations and restricted plume migration. By reducing the reaeration coefficient by an order of magnitude (to 0.0003 day^{-1}), the length of the modeled BTEX plume increased greatly, as did the maximum concentration. The downgradient end of the plume extended approximately 600 feet past its observed location.

Figure 5.6 illustrates the effects of varying longitudinal dispersivity. This model is relatively insensitive to dispersivity. Decreasing the dispersivity reduced the migration distance for the BTEX plume and slightly increased peak concentrations. Lowering dispersivity keeps the plume from spreading out into more electron acceptor-rich portions of the aquifer. Conversely, increasing dispersivity produced slightly lower BTEX concentrations in the source area and increased the plume migration distance.

Figure 5.7 shows the sensitivity of the model to the coefficient of retardation. The coefficient of retardation was decreased from the calibrated value of 1.22 to 1, which results in no retardation. Removing retardation from the model slightly increased the maximum BTEX concentrations and the downgradient plume migration distance. Increasing the coefficient of retardation to 4.2 significantly decreased the peak plume concentrations and limited the migration of the plume.

The results of the sensitivity analysis suggest that the calibrated model used for this report is reasonable. Changing the coefficient of reaeration, hydraulic conductivity, or the coefficient of retardation can significantly affect the predicted BTEX concentrations and distribution so that conditions observed in August 1994 are not reasonably reproduced.

5.6 Model Results

The Bioplume II model was run under steady-state conditions with no contaminant source removal (model CAL2), 20-percent annual source removal (model SR20), and 33-percent annual source removal (model SR33) until the plume reached steady-state equilibrium (no source removal) or until the plume disappeared (source removal scenarios). As previously mentioned, continuing sources of groundwater contamination at the site exist mainly in the form of soil contamination and residual LNAPL

contamination. Only, minimal mobile LNAPL thicknesses were observed within site monitoring wells. Contaminant source reduction in concert with natural attenuation can significantly reduce the longevity of the dissolved BTEX contamination at the site.

Although the results of each model run varied depending on the amount of source injection concentration over time, two trends were consistently observed:

1) The plume shape in each simulation is elongated due to rapid advective transport of BTEX contamination and rapid biodegradation of BTEX at the plume periphery;

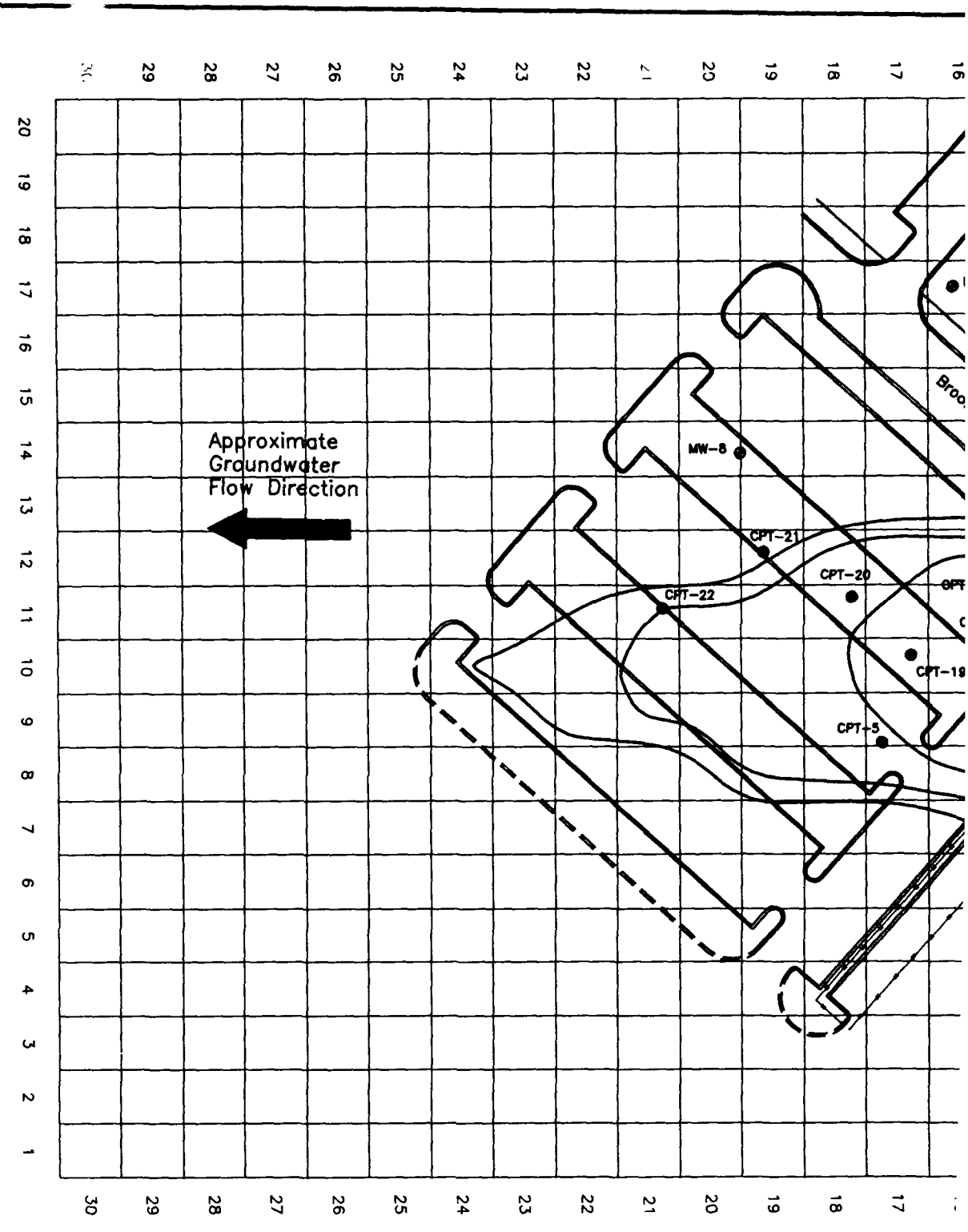
2) Model SR20 required 5 years to accomplish source removal whereas model SR33 required 3 years to accomplish source removal. When plume migration is compared starting from the time of source removal completion, there are minimal differences between the models. The hydrocarbon plume disappears approximately 10 ye[illegible]e source is completely removed for both scenarios. This occur[illegible] replenished electron acceptor concentrations eventually exceed the dissolved BTEX concentrations introduced into the aquifer by a ratio greater than 3.1:1

The following sections describe the results of each model scenario.

5.6.1 No Source Removal (Model CAL2)

Model CAL2 simulated the migration and biodegradation of the BTEX plume assuming no source weathering or removal. First-order decay was not included within the model. This model assumed that the conditions that produced the calibrated model continued, including injection of BTEX compounds at the same rates. This simulation was run to predict conditions up to 30 years beyond the calibrated model end time, or 30 years past 1994. Contaminant migration within the simulation was relatively slow because of the moderate hydraulic conductivity and shallow hydraulic gradient at the site. The Bioplume II model predicted that the plume would reach steady-state equilibrium within approximately 30 years. Figures 5.8 and 5.9 show the predicted total BTEX concentrations at years 20 and 30. The plume migrates in the expected direction, and within 20 years nearly reaches the computed steady-state extents.

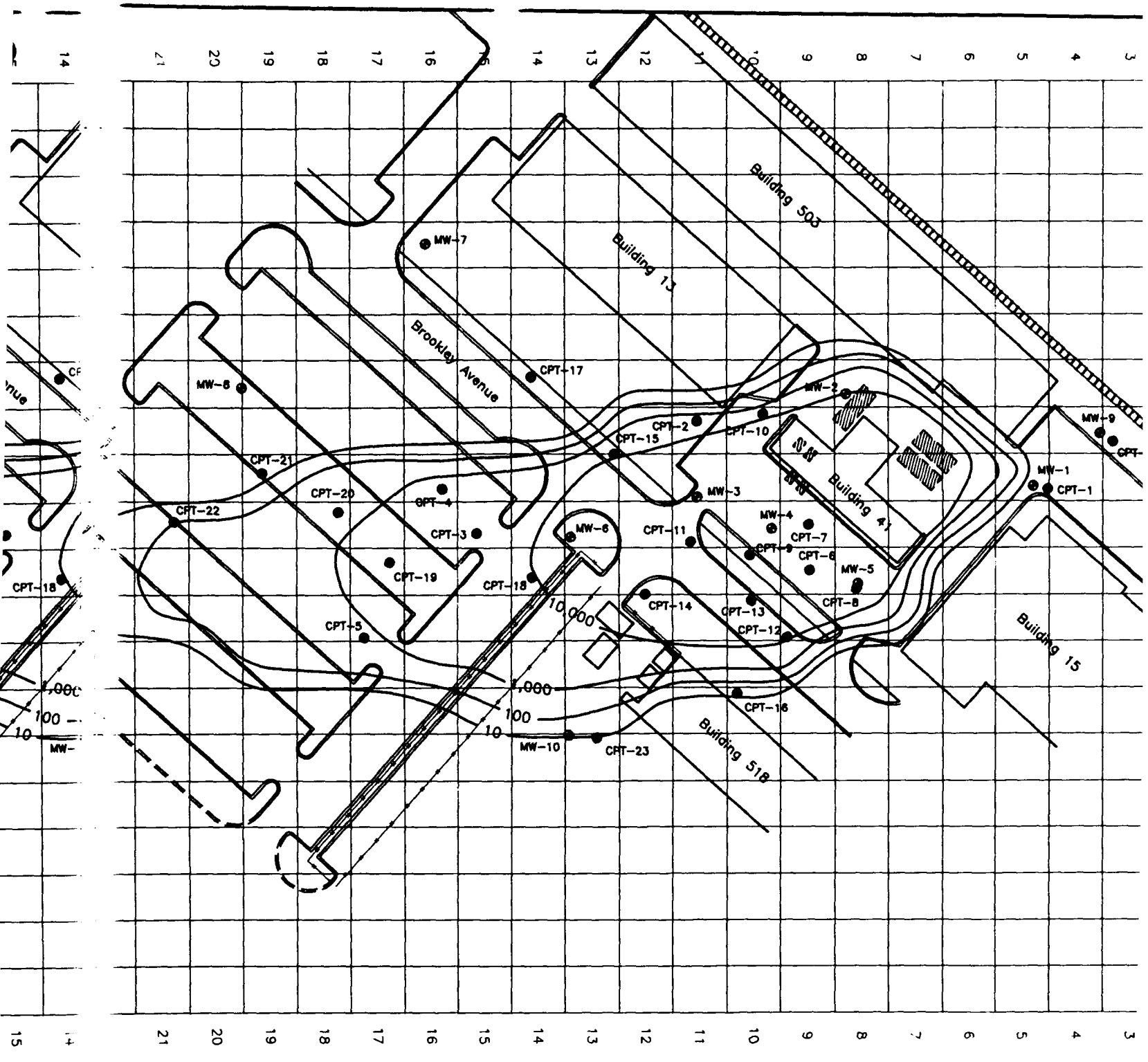
In order to verify the results of model CAL2, Parsons ES calculated a first-order decay coefficient using methods specified by Wiedemeier *et al.* (1994) and site specific data. An analytical model (Bear, 1979) was utilized which incorporates one-dimensional advection, dispersion, retardation, and first-order decay. As discussed in previous report sections, calculated rate constants for the Car Care Center Site (Building 41) ranged from 0.0001 to 0.0004 day^{-1}. This value is low as compared to typical literature values. However, this result may be valid because a low groundwater flow velocity (22 feet/yr) was calculated for this site. A major controlling factor for the rate of biodegradation is the quantity of electron acceptors which are flushed from upgradient areas through the contaminated zone.



LEGEND

- Former underground storage tanks (USTs).
- MW-1 — Existing monitoring well.
- CPT-1 — Monitoring point and CPT test location installed by CPT rig.
- 100 — Total benzene, toluene, ethylbenzene, and xylene (BTEX) concentration (ug/L) contour.

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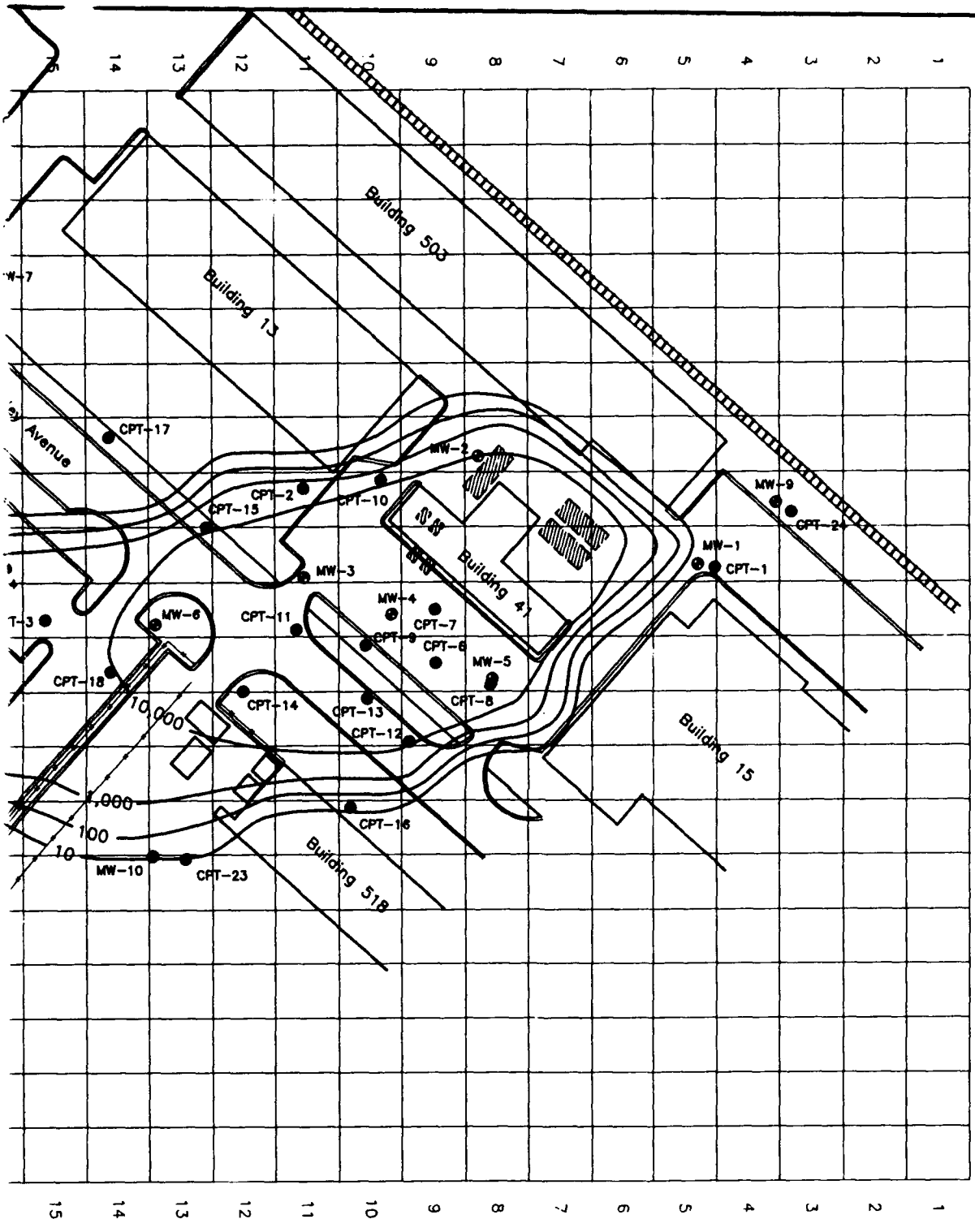


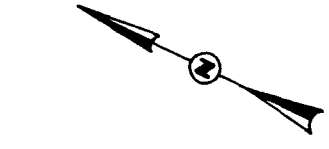
rig.

Model Result
No Source

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Intrinsic
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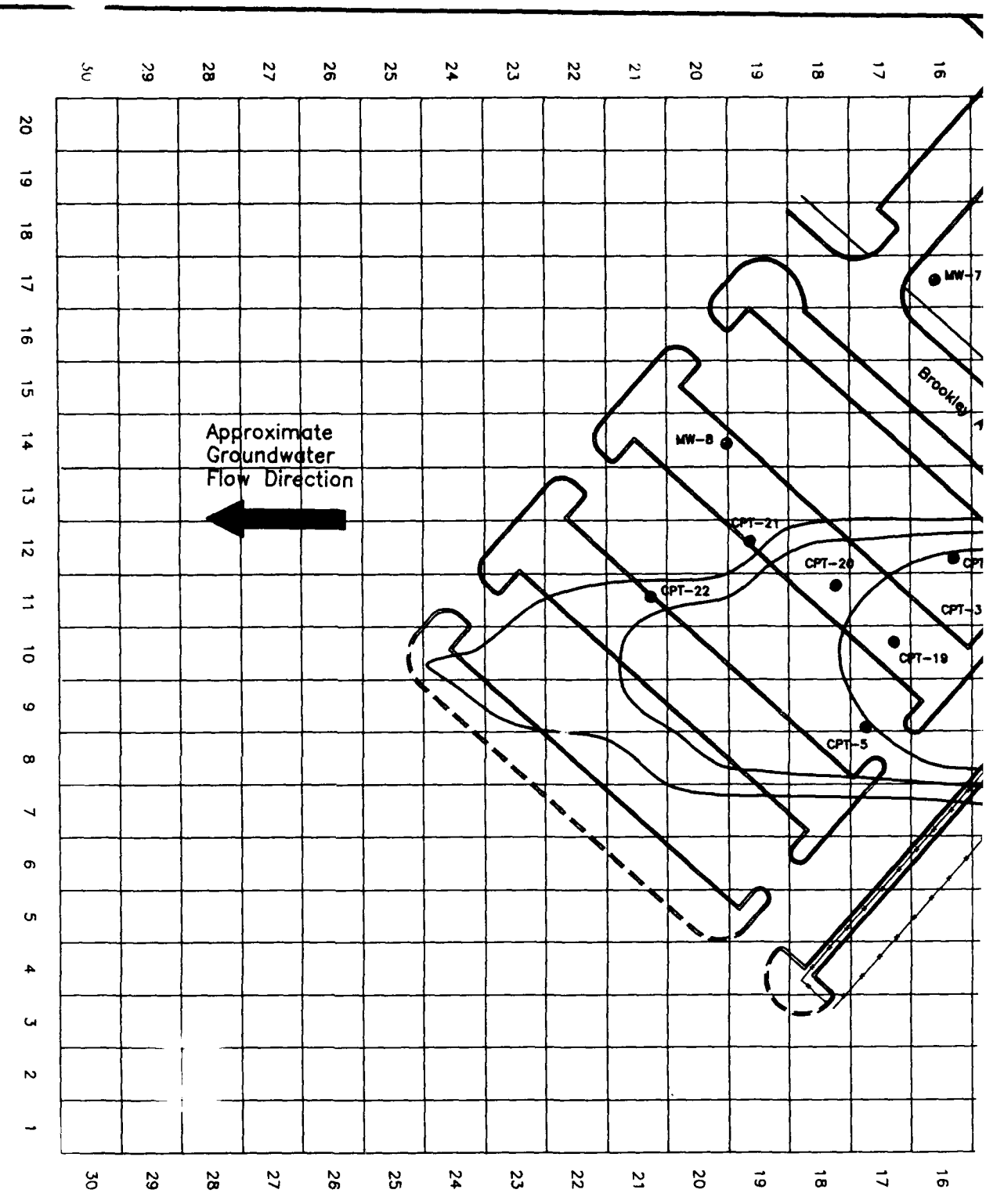
Figure 5.8





Model Results, BTEX Concentrations, No Source Removal, T=20 Years

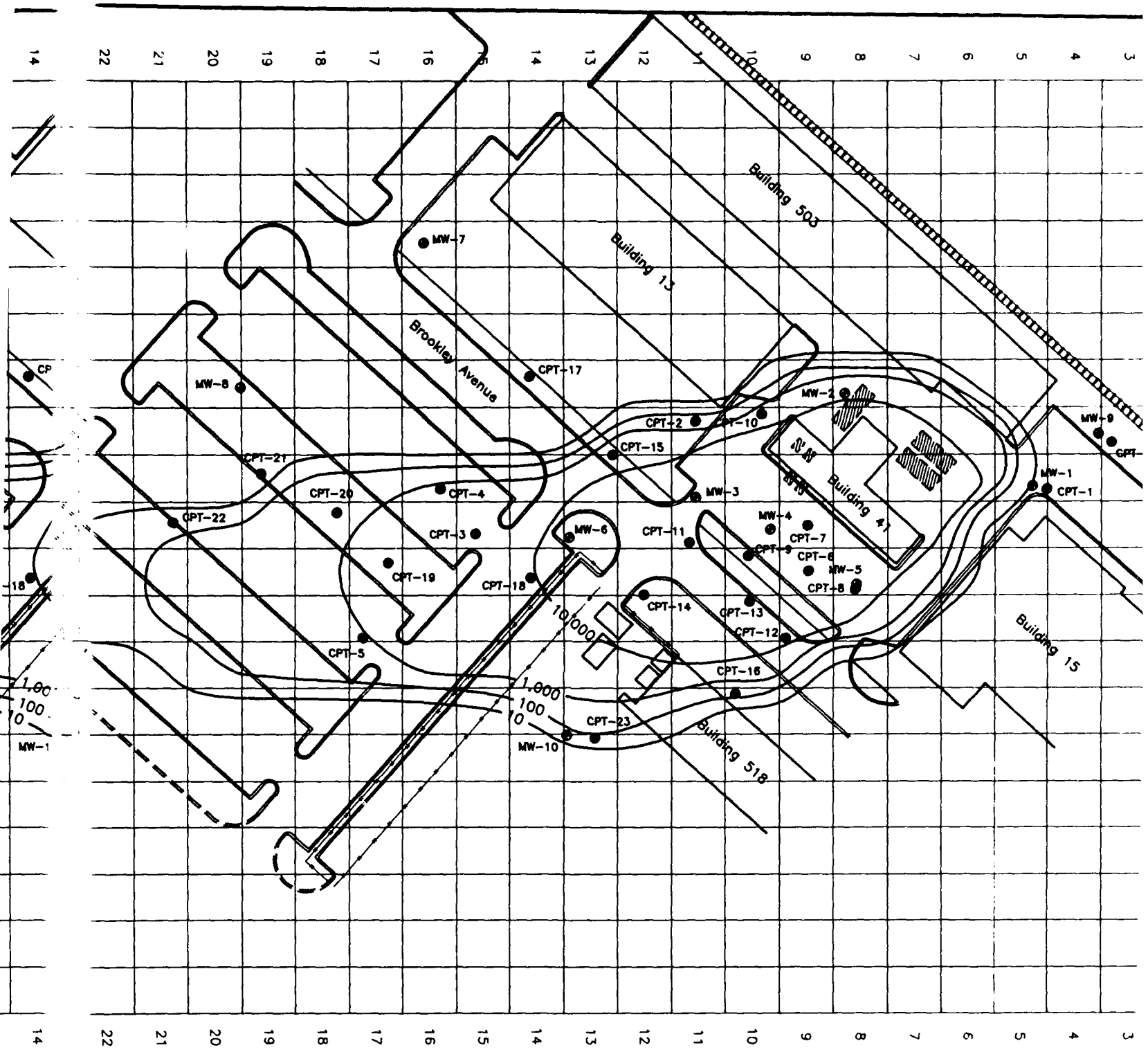
Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC



LEGEND

- Former underground storage tanks (USTs).
- MW-1 — Existing monitoring well.
- CPT-1 — Monitoring point and CPT test location installed by CPT rig.
- 100 — Total benzene, toluene, ethylbenzene, and xylene (BTEX) concentration (ug/L) contour.

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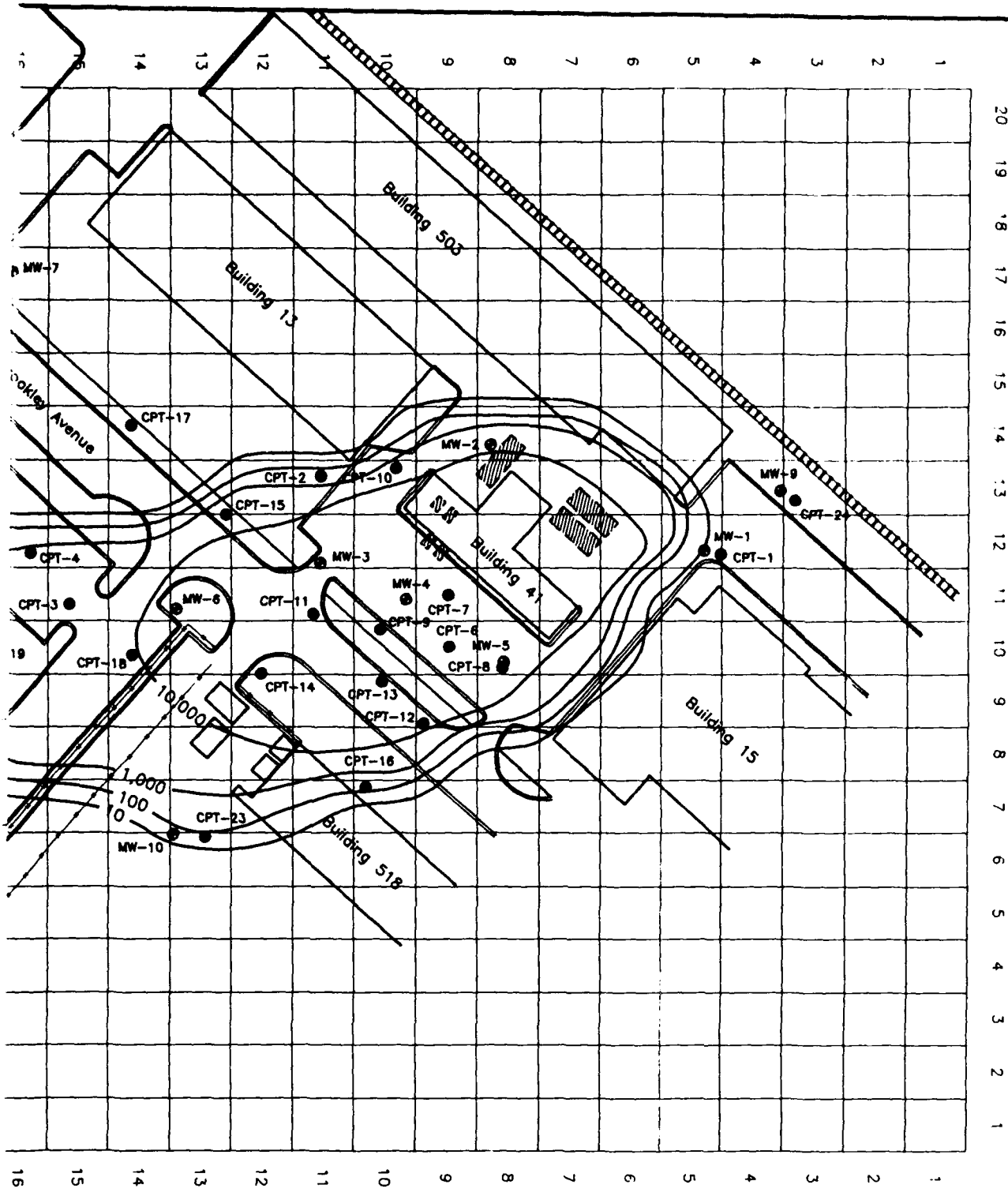


Model Result
No Source

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PT rig.
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Figure 5.9



Model Results, BTEX Concentrations,
No Source Removal, T=30 Years

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

A comparison between numerical and analytical model results was performed to validate the CAL2 model input parameters. Analytical model results are provided in Appendix D. Parsons ES utilized CPT-11 as the source area within the model because it had the highest BTEX concentration among wells at the Car Care Center Site and it is approximately located at the most downgradient extent of the residual LNAPL plume (Figure 4.2a). Model CAL2 suggests that the BTEX will achieve steady-state at approximately 460 feet downgradient from this location. Analytical model results (Appendix D) agree favorably with the CAL2 model results. The analytical model which incorporates advection, dispersion, retardation, and a first-order decay coefficient of 0.0003 day^{-1} compares closely with the CAL2 model results.

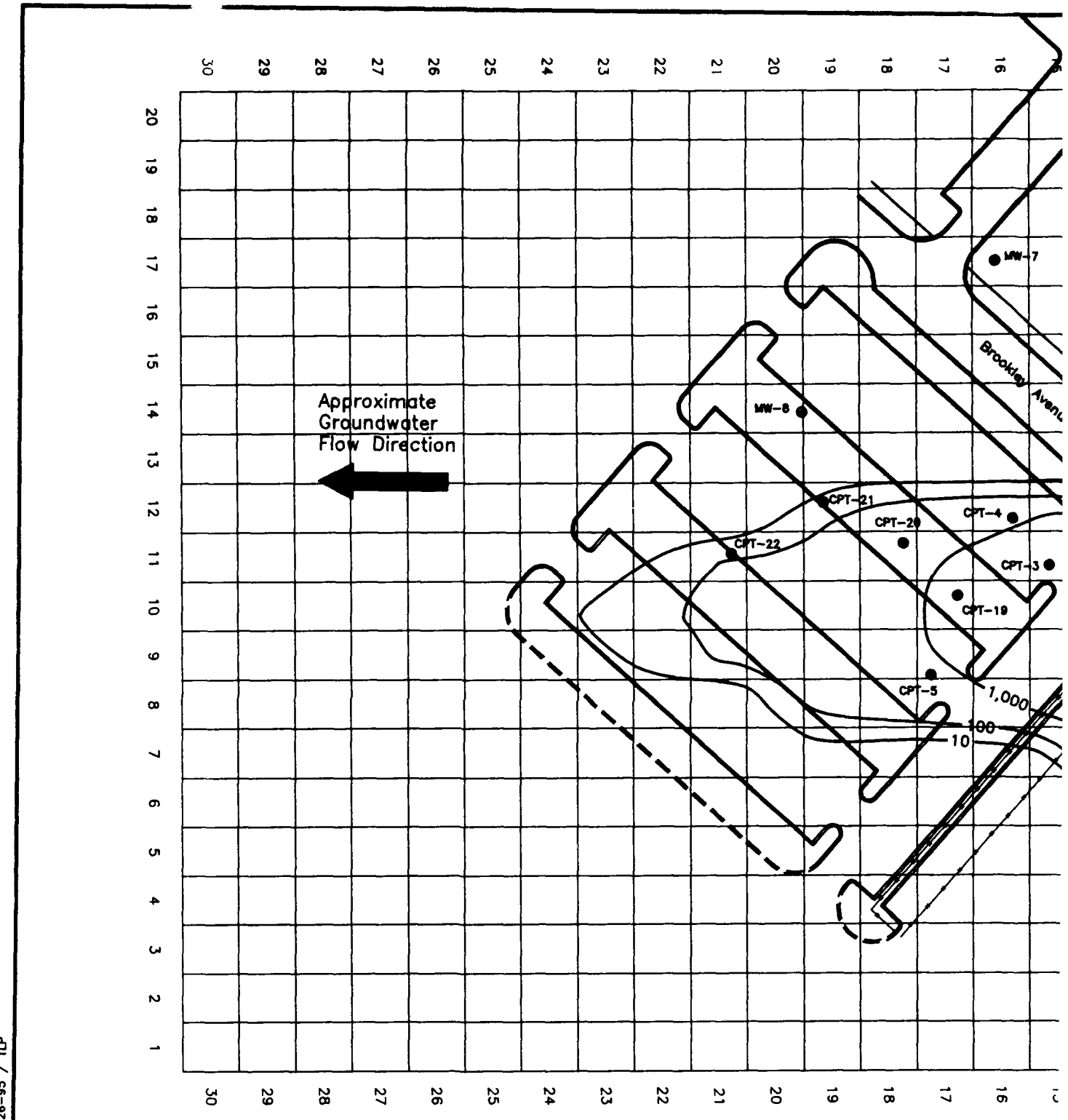
5.6.2 Twenty-Percent Annual Source Removal (Model SR20)

Model SR20 simulated the migration and biodegradation of the BTEX plume assuming a linear 20-percent annual reduction in source BTEX concentrations resulting from natural weathering processes and limited source removal through a remedial option such as bioventing. Model SR20 is identical to model CAL2 with the exception of the 20-percent annual source removal term. The concentration of hydrocarbons introduced into the system by the injection wells was reduced by 20 percent of the original amount per year for 5 years. The BTEX plume extent for years 1 through 4 of this simulation were nearly identical to those predicted in model CAL2; however, source area concentrations were predicted to decrease.

Figures 5.10 and 5.11 show the results of this model for 7 years and 10 years after initiating source removal, respectively. Seven years after initiation of source removal (Figure 5.10), the plume had receded noticeably and the maximum BTEX concentration was reduced to 3,783 μg/L. Ten years after initiation of source removal (Figure 5.11), the plume was approximately 30 percent of its original area and the center of the plume moved approximately 240 ft downgradient from the center of the source area. At that time, the maximum predicted concentration of BTEX was only 574 μg/L. After 13 years since initiation of source removal, the maximum BTEX concentration in the center of the plume decreased to 66 μg/L. The simulated BTEX plume had not migrated any further downgradient. This suggests DCRA target cleanup levels will be met within 13 years under this model scenario. Within 15 years after initiation of source removal, the BTEX plume disappears completely prior to reaching the downgradient end of the model grid (approximately 700 ft downgradient of the original plume center).

5.6.3 Thirty-Three-Percent Annual Source Removal (Model SR33)

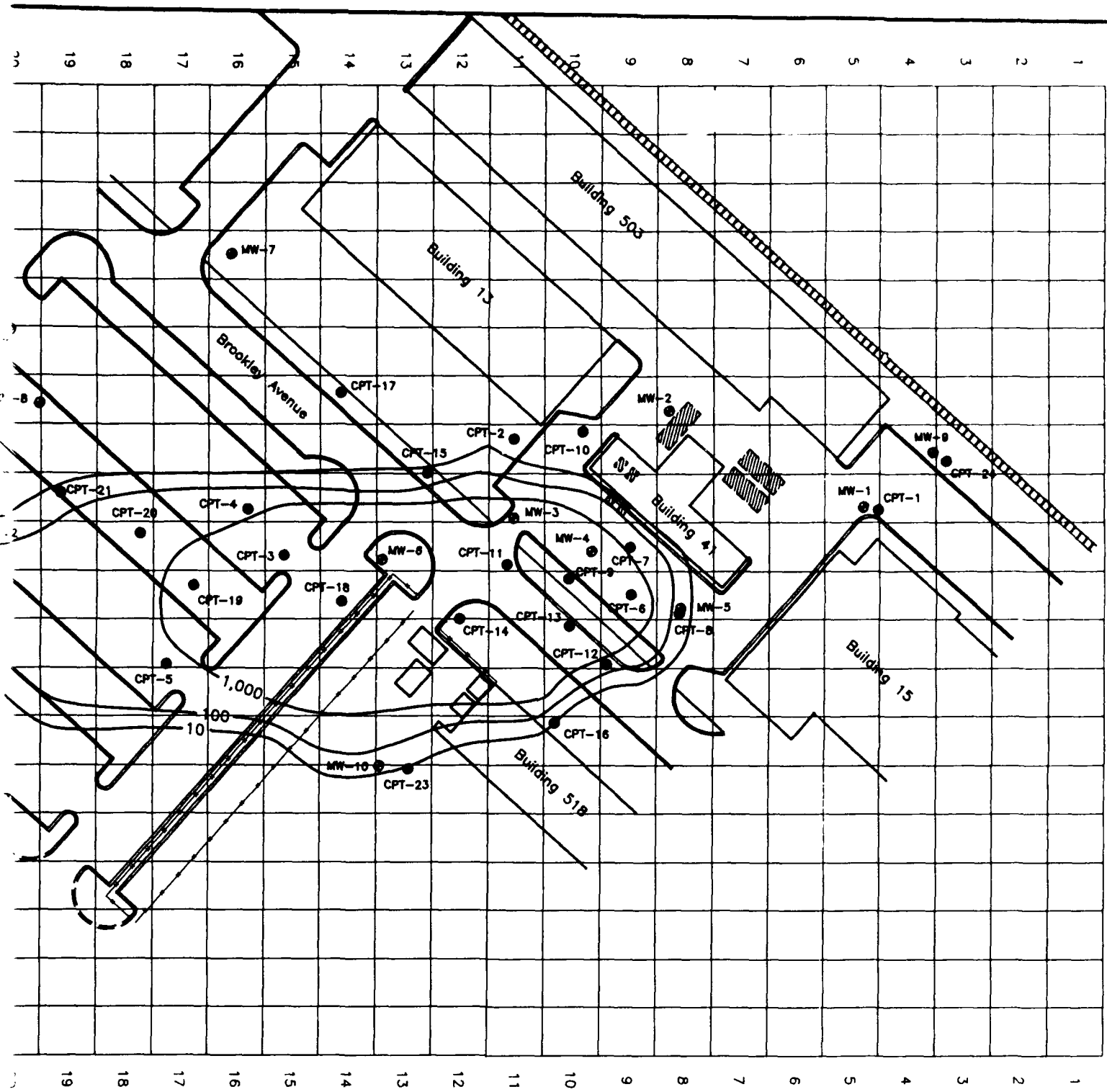
Model SR33 simulated the migration and biodegradation of the BTEX plume assuming a 33-percent annual reduction in source BTEX concentrations resulting from natural weathering processes and more active source removal through a combination of remedial alternatives such as SVE, biosparging, and/or bioventing. Model SR33 is identical to model CAL2 with the exception of the 33-percent annual source removal term. Figures 5.12 and 5.13 show the results of this model at 5 and 11 years after initiation of source removal. The model predicted an approximate 25 percent reduction in BTEX plume area 5 years after initiation of source removal (Figure 5.12). At that time, the maximum predicted BTEX concentration was 5,768 μg/L. At 11 years after



LEGEND

- Former underground storage tanks (USTs).
- MW-1 ⊕ Existing monitoring well.
- CPT-1 ● Monitoring point and CPT test location installed by CPT rig.
- —100— Total benzene, toluene, ethylbenzene, and xylene (BTEX) concentration (ug/L) contour.

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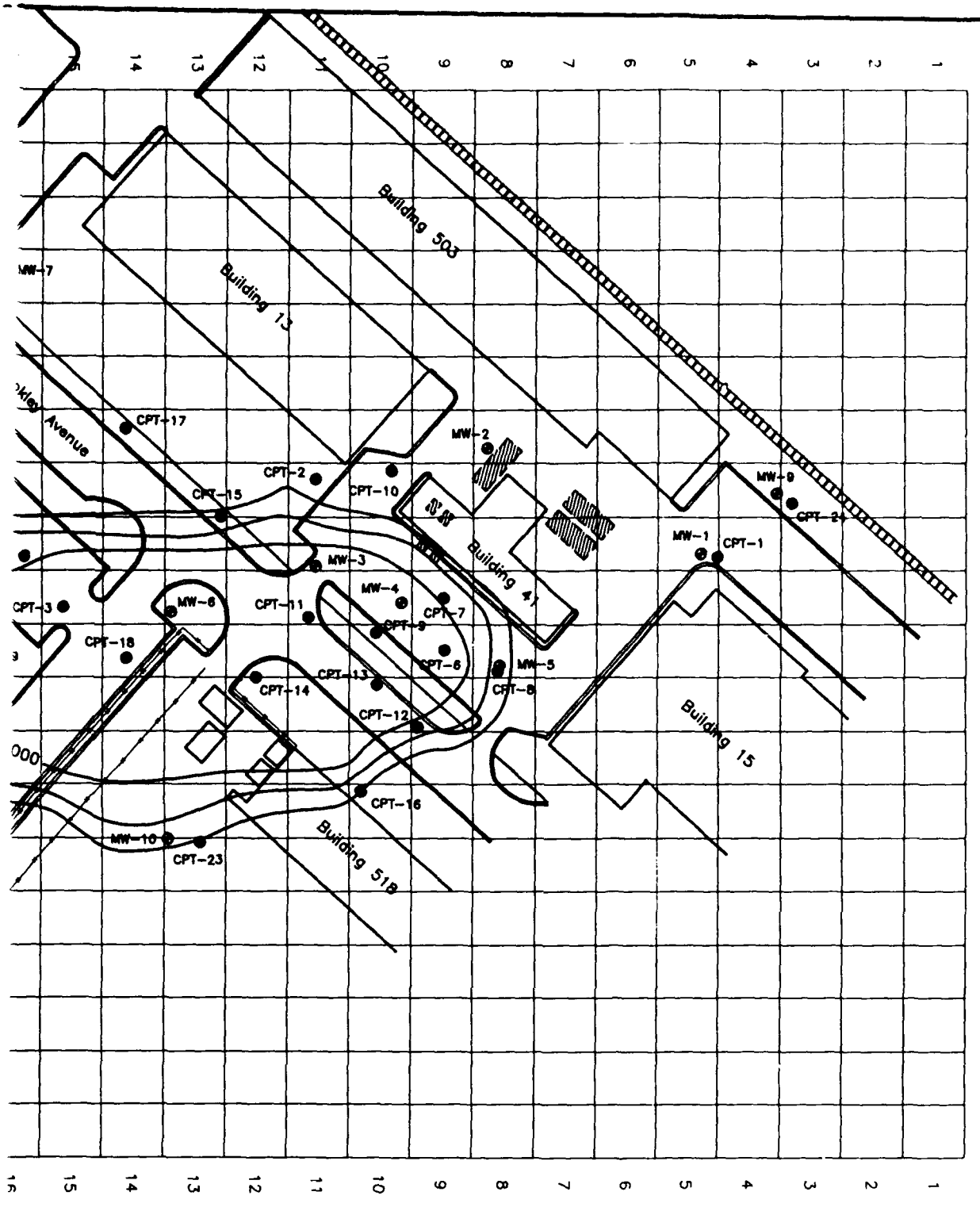


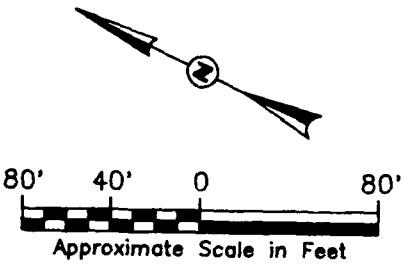
Model Results, BTEX Con
20% Annual Source Remov

Car Care Center
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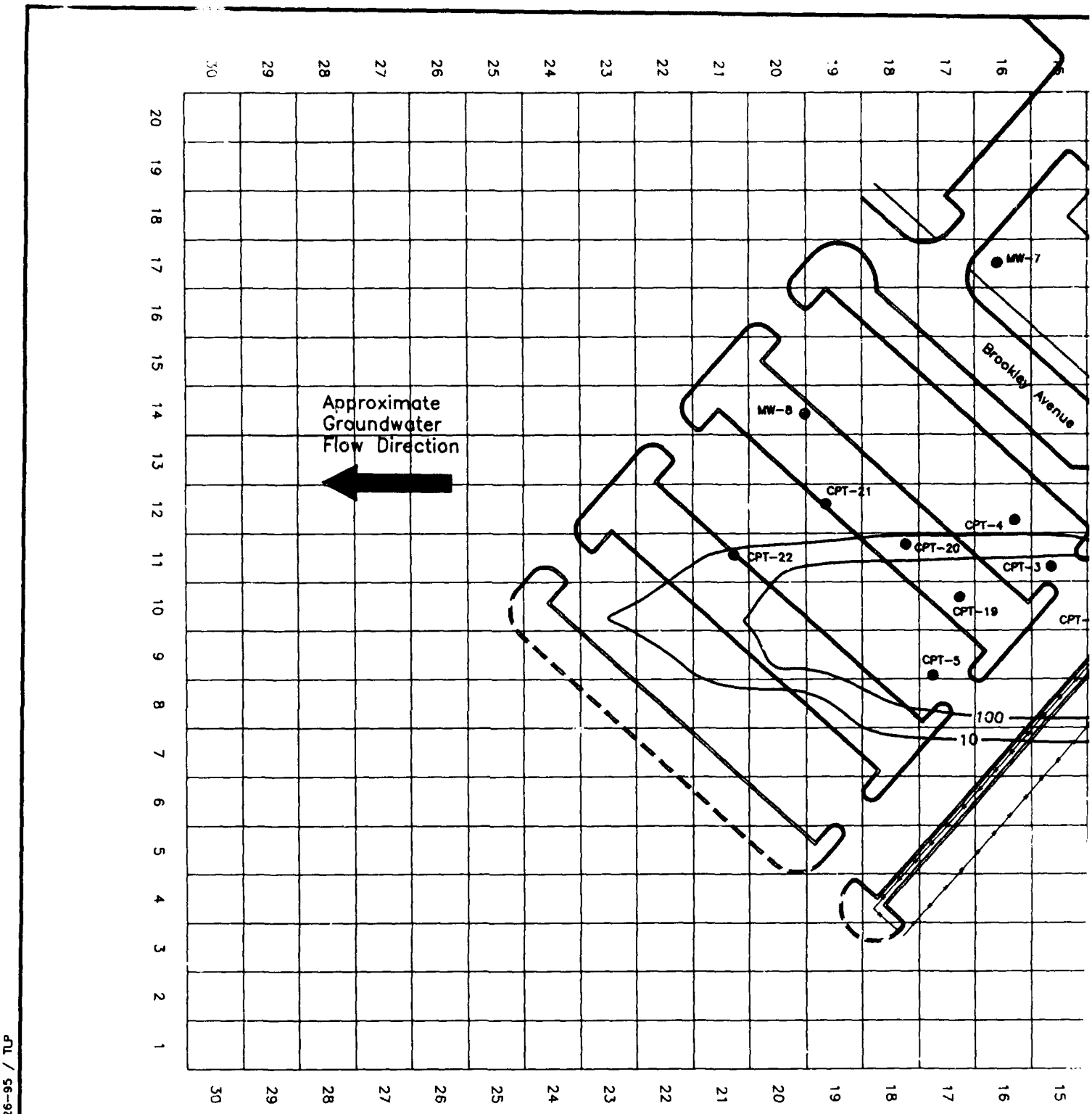
Figure 5.10





Model Results, BTEX Concentrations,
20% Annual Source Removal, T=7 Yrs

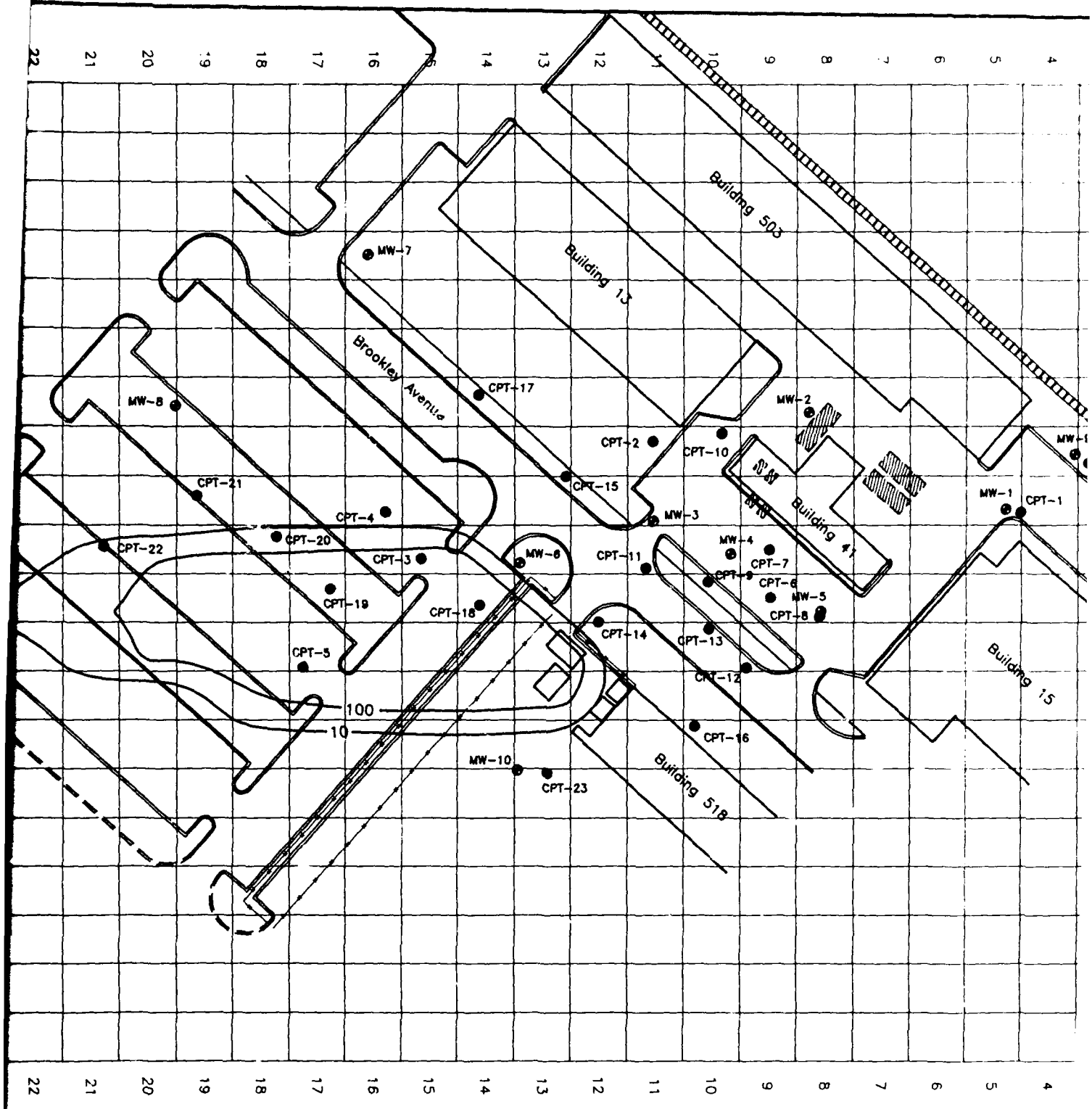
Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC



LEGEND

- Former underground storage tanks (USTs).
- MW-1 — Existing monitoring well.
- CPT-1 — Monitoring point and CPT test location installed by CPT rig.
- 100 — Total benzene, toluene, ethylbenzene, and xylene (BTEX) concentration (ug/L) contour.

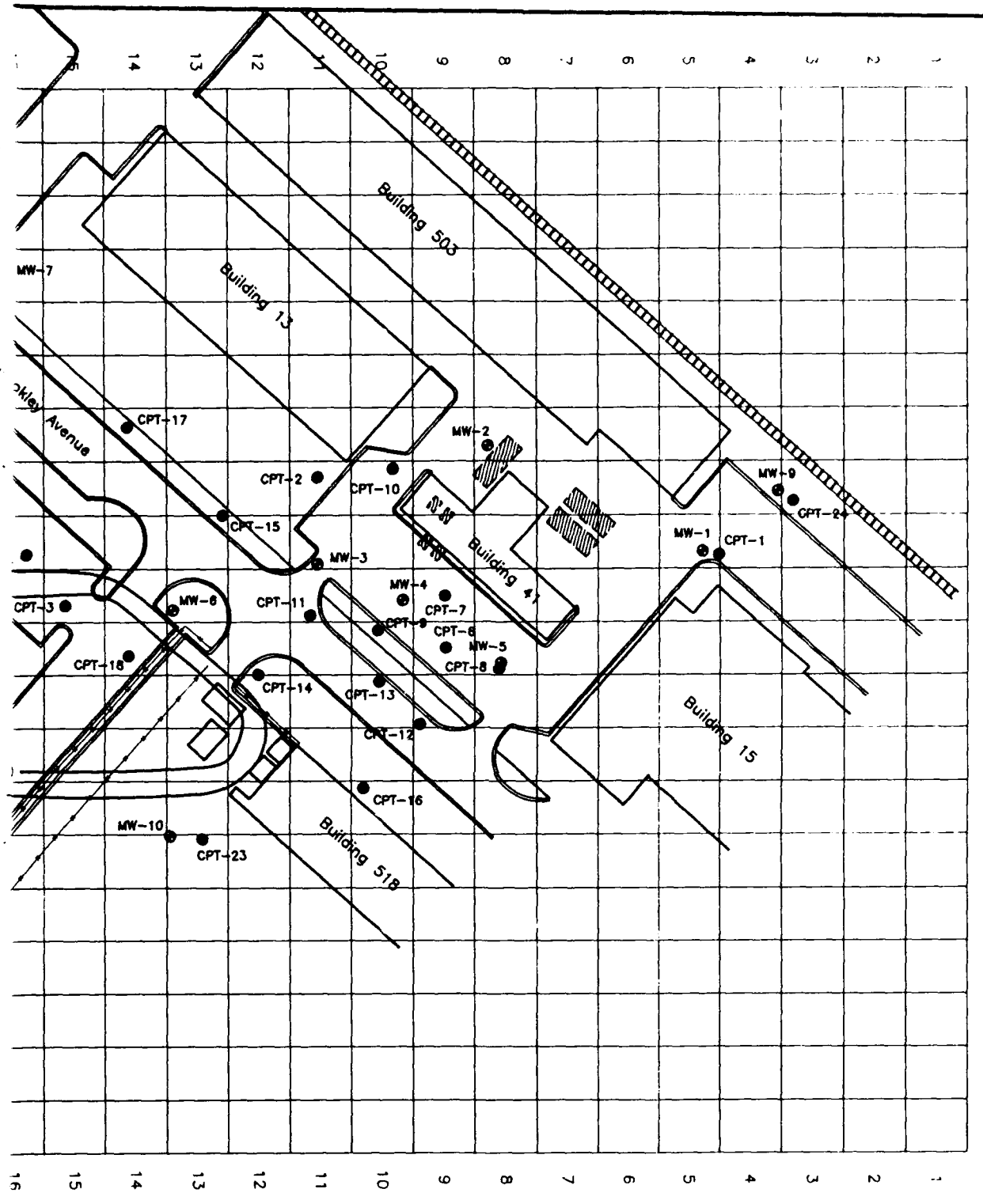
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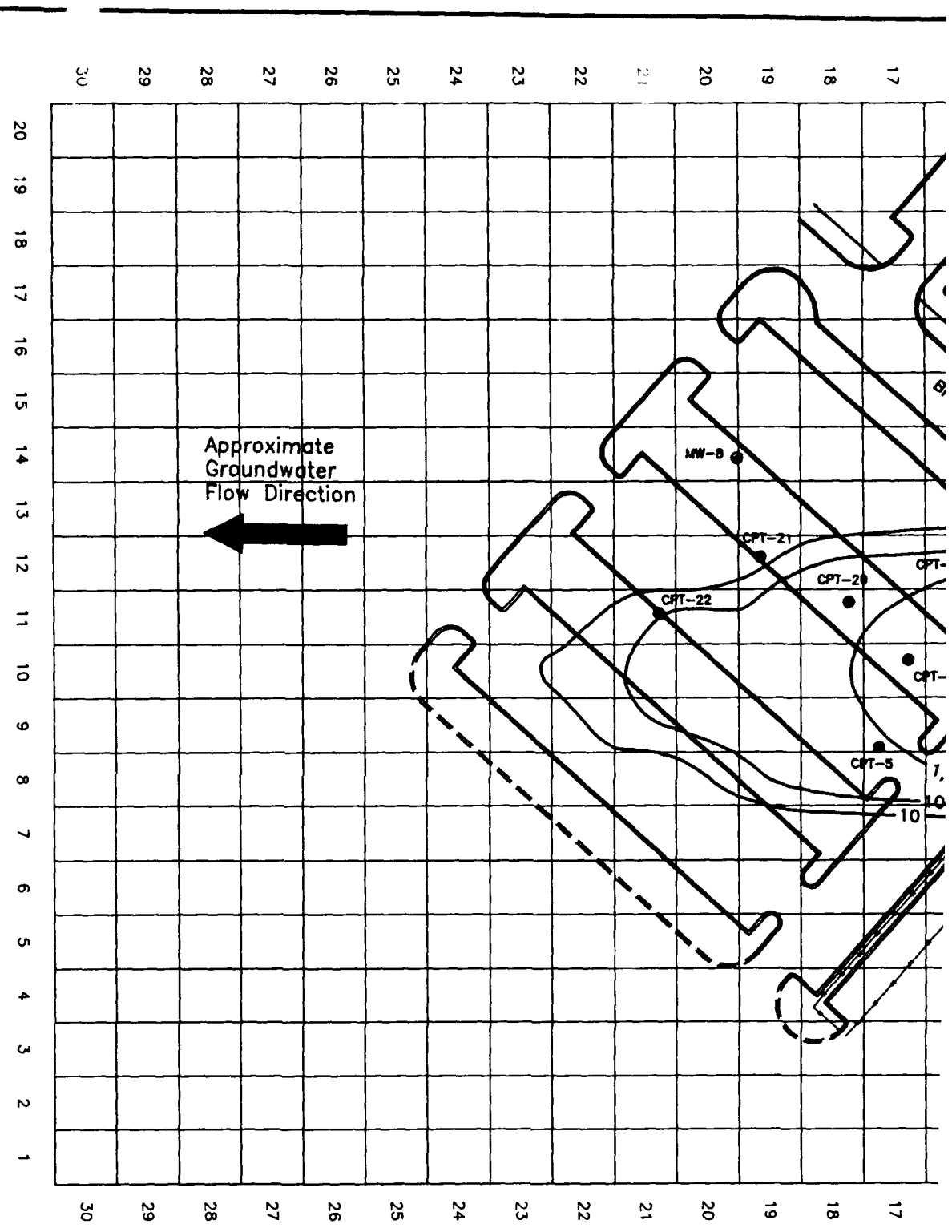
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Model Results, BTEX Concentrations
20% Annual Source Removal, T=10 Yrs

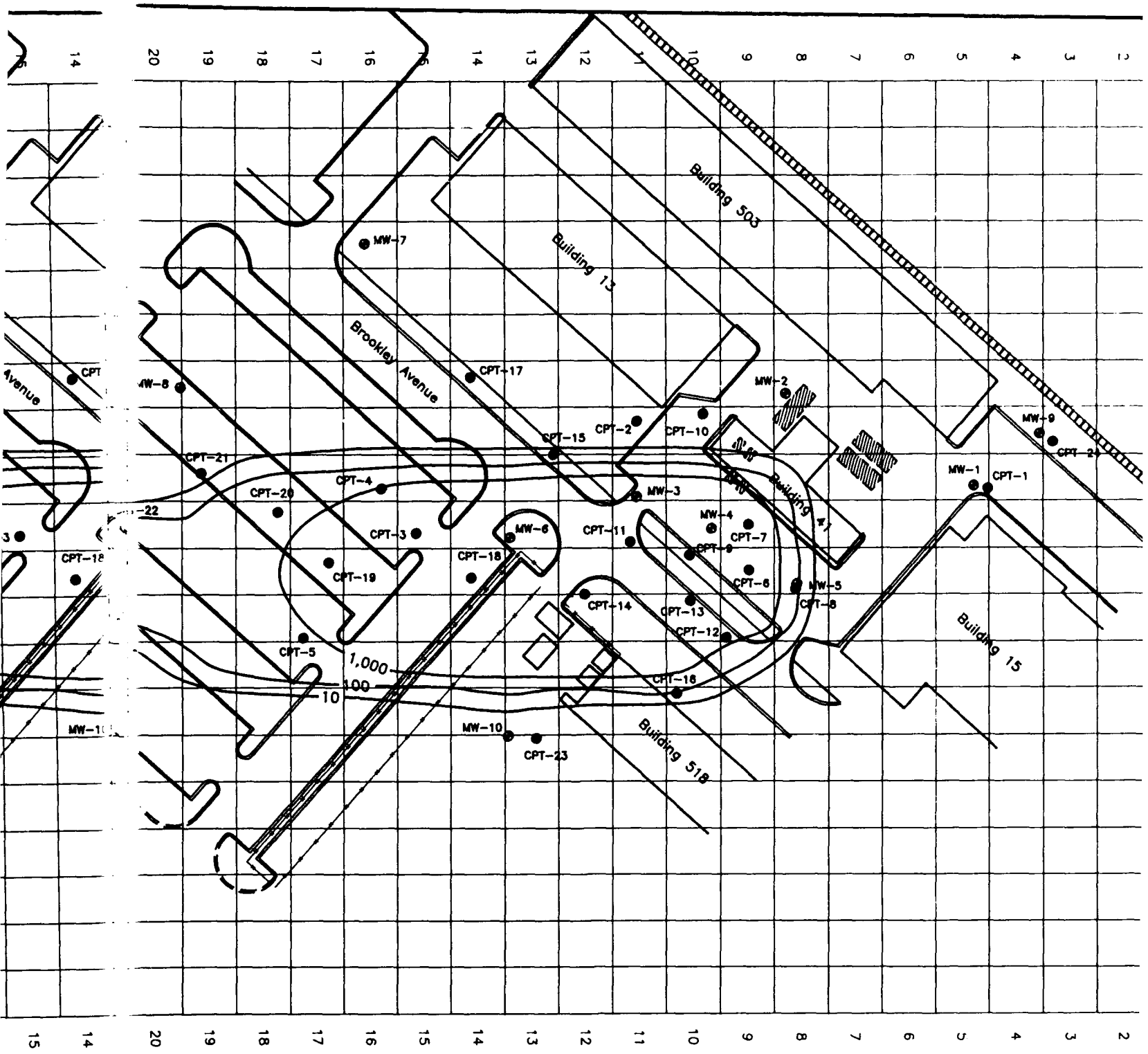
Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC



LEGEND

- Former underground storage tanks (USTs).
- MW-1 — Existing monitoring well.
- CPT-1 — Monitoring point and CPT test location installed by CPT rig.
- 100 — Total benzene, toluene, ethylbenzene, and xylene (BTEX) concentration (ug/L) contour.

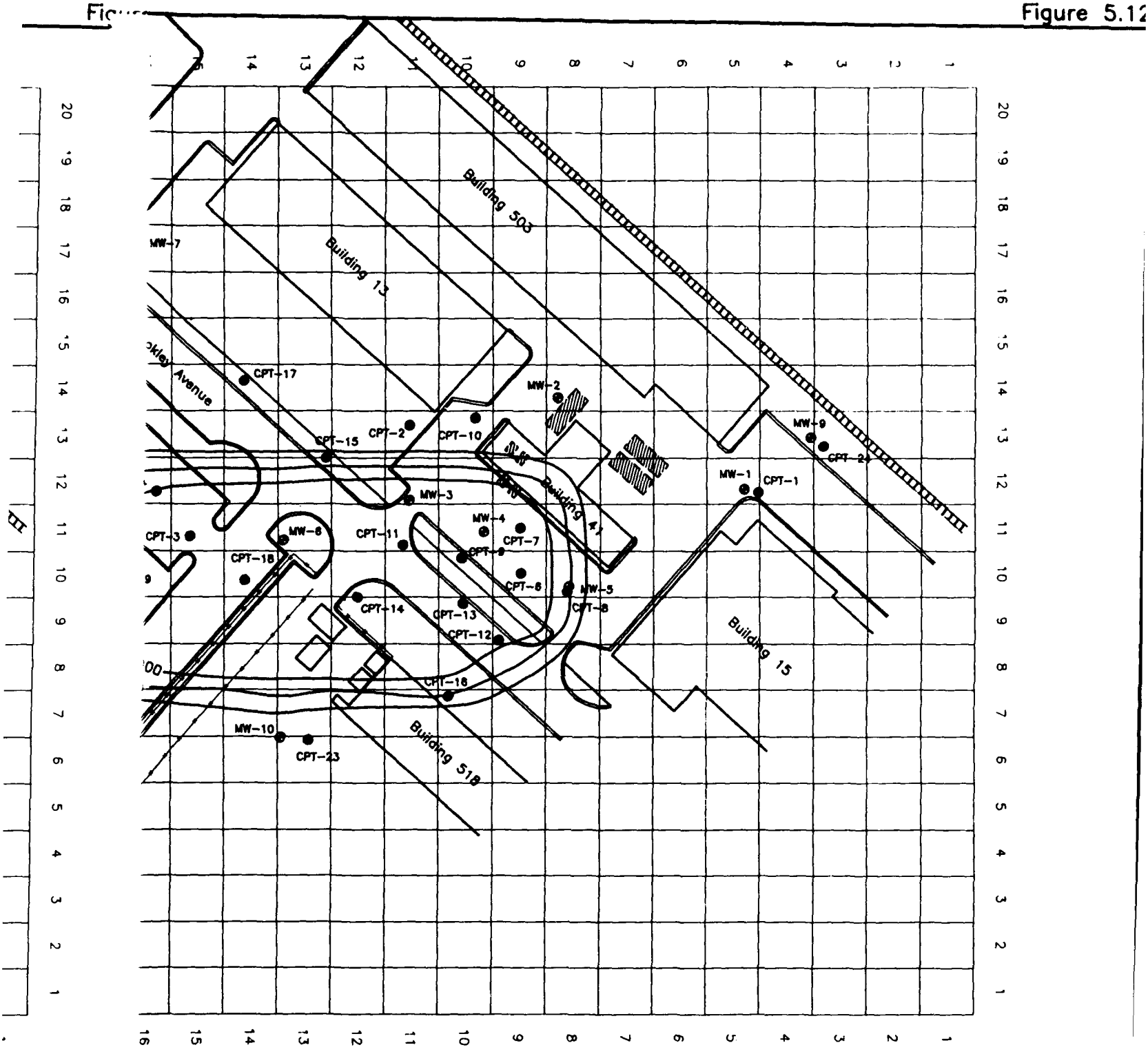
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Model Results, BT
33% Annual Source

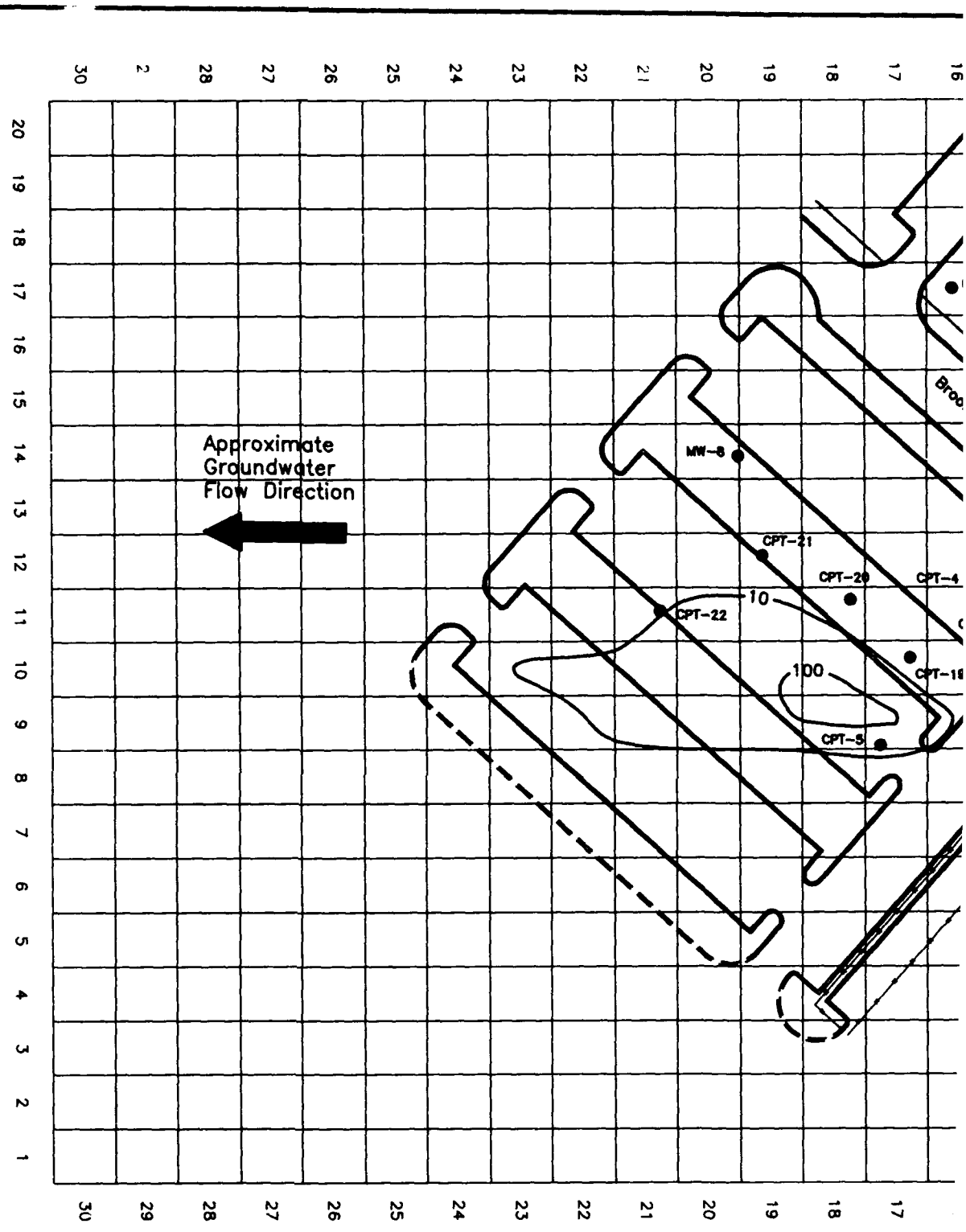
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Model Results, BTEX Concentrations,
33% Annual Source Removal, T=5 Yrs

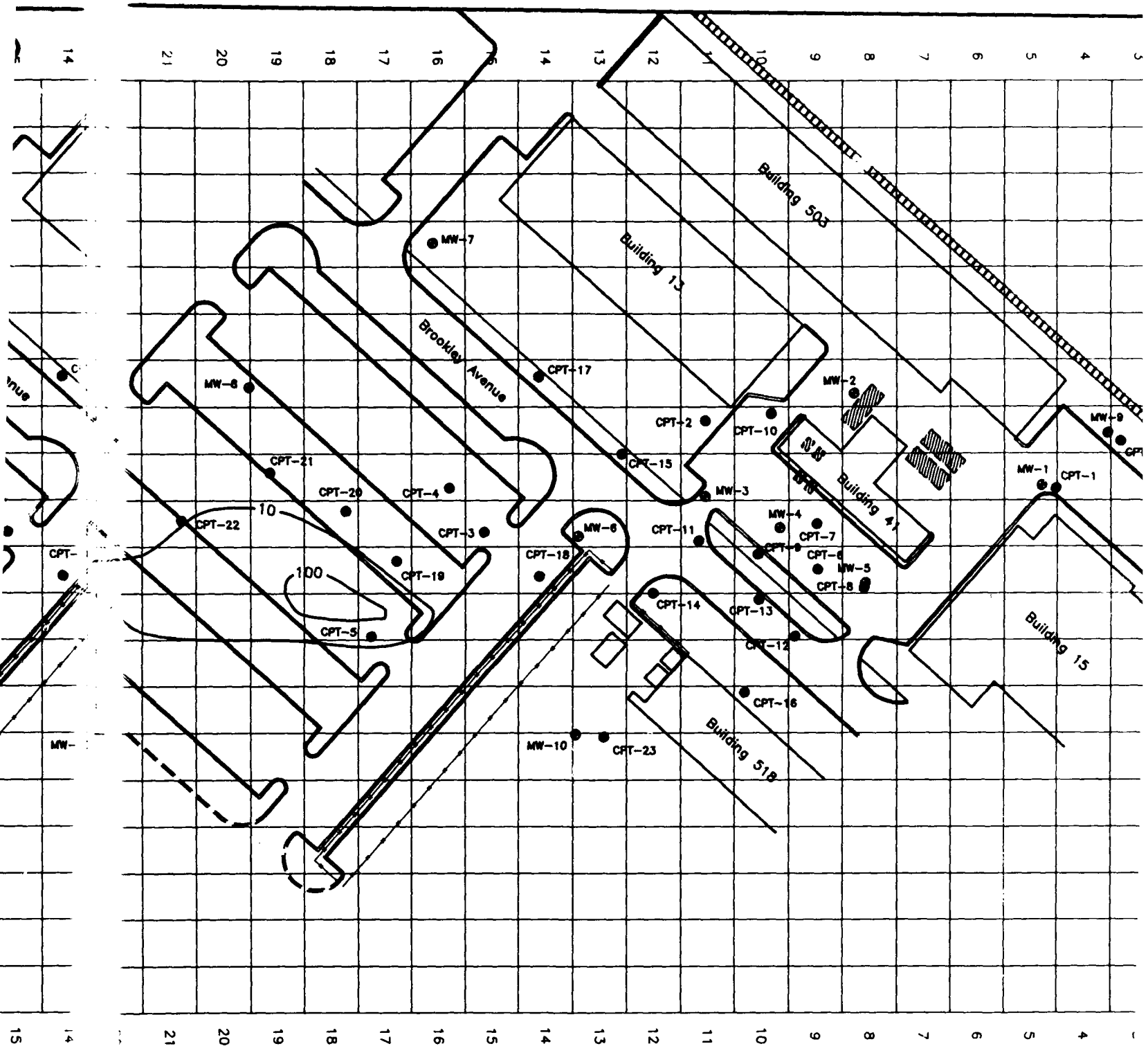
Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC



LEGEND

- Former underground storage tanks (USTs).
- MW-1 ⊕ Existing monitoring well.
- CPT-1 ● Monitoring point and CPT test location installed by CPT rig.
- —100— Total benzene, toluene, ethylbenzene, and xylene (BTEX) concentration (ug/L) contour.

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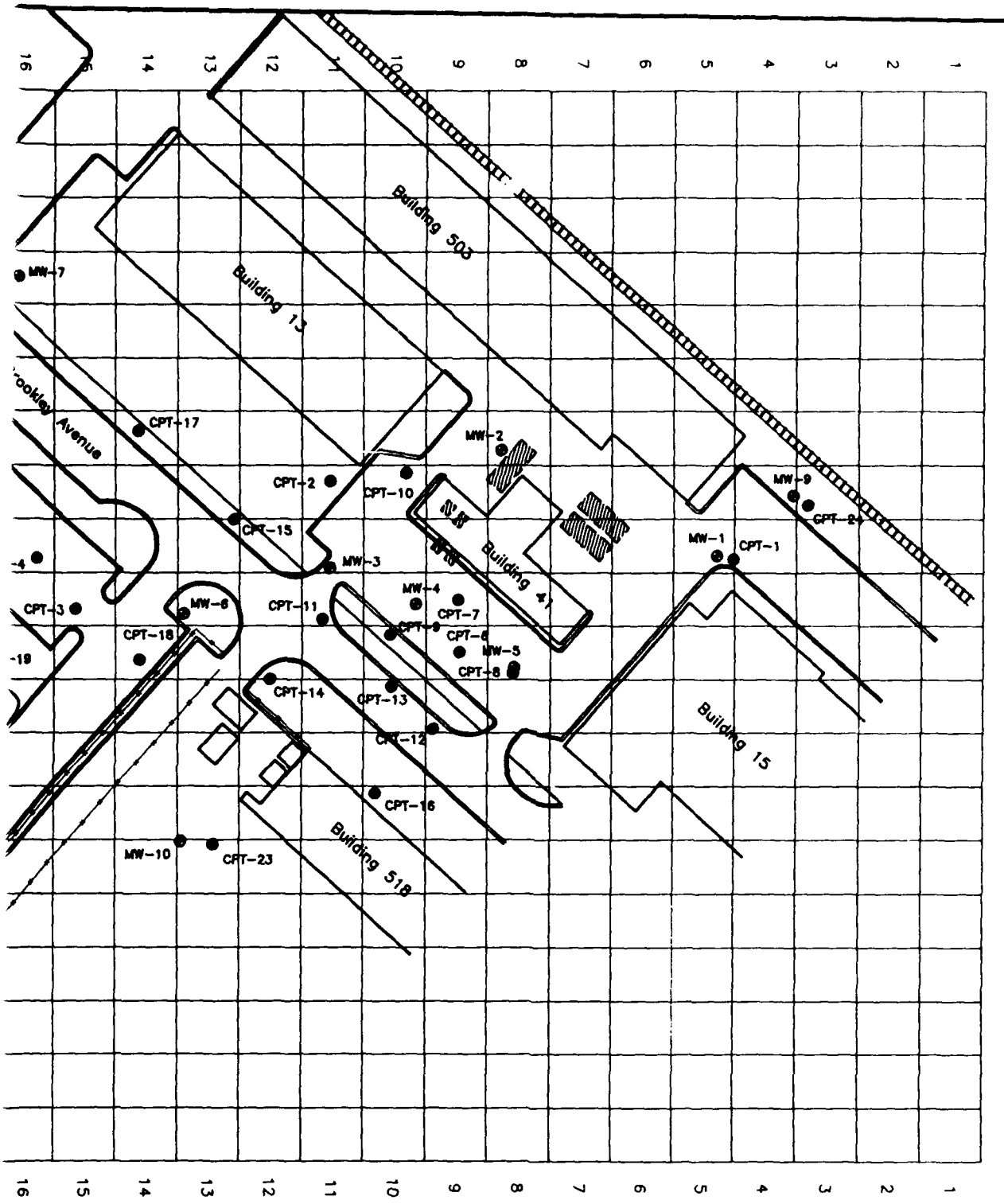


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Model Resul
33% Annual

Car
Intrinsic
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Figure 5.13



Model Results, BTEX Concentrations, 33% Annual Source Removal, T=11 Yrs

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

initiation of source removal (Figure 5.13), the center of the plume has migrated approximately 280 ft downgradient and the peak concentration in the center of the plume is only 113 µg/L. Model SR33 output for times greater than 11 years suggest that the BTEX plume will not migrate any further downgradient. This suggests DCRA target cleanup levels will be met within 11 years under this model scenario. Within 13 years after initiation of source removal, the BTEX plume disappears completely prior to reaching the downgradient end of the model grid plume. As a result, it is doubtful that the BTEX plume will ever reach the Potomac River, the closest potential downgradient receptor point.

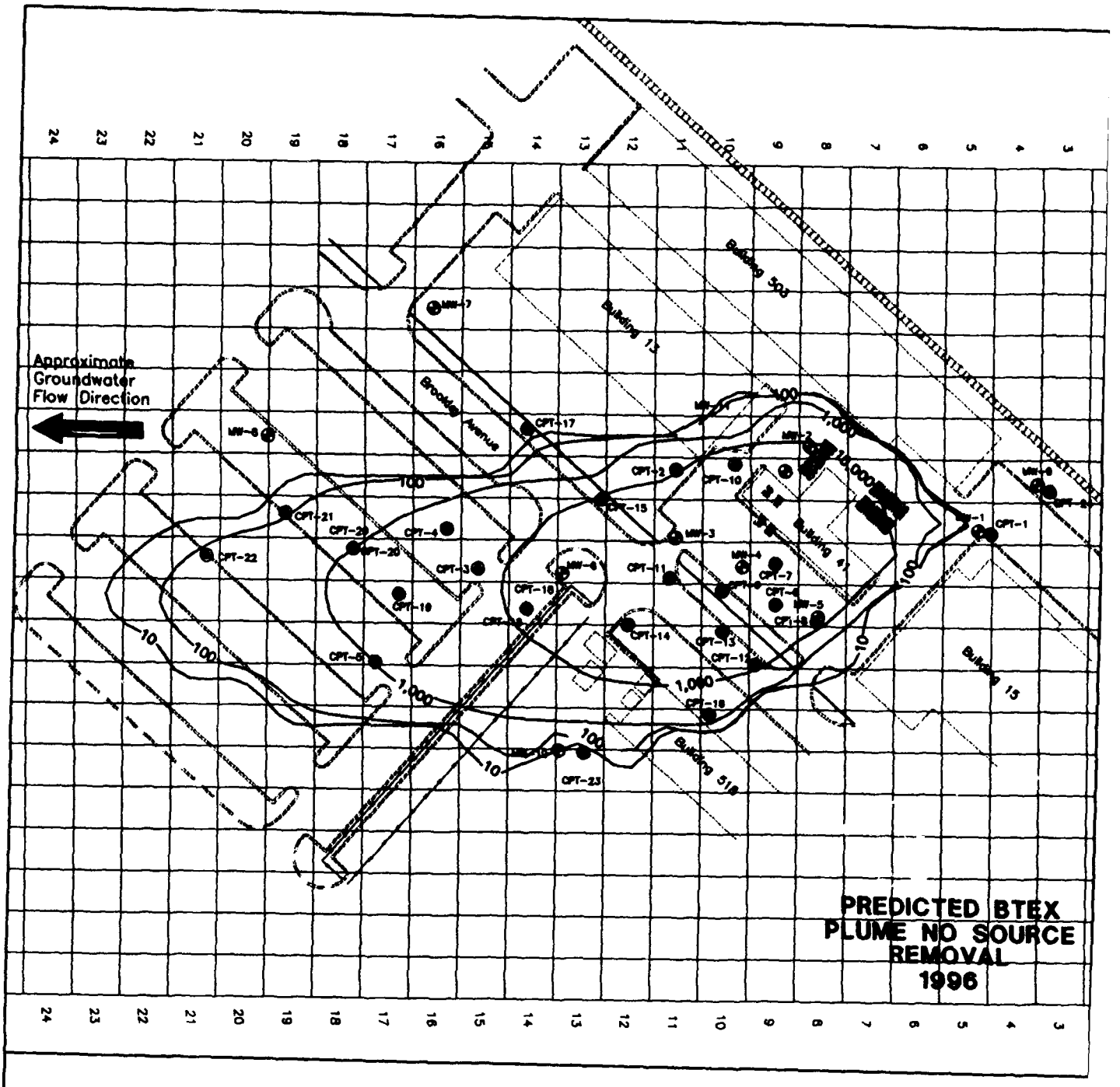
5.6.4 Observed Contaminant Plume versus Model Predictions

Groundwater data collected in June 1996 allows for the direct comparison of observed contaminant plume migration and predicted model results. Even though no active remediation has occurred since the August 1994, the observed dissolved BTEX plume in June 1996 (Figure 4.4) indicates that source area concentrations have decreased while the leading edge of the plume has migrated slightly to the northwest. Figure 5.14 presents the predicted contaminant plume for the year 1996 assuming no source removal alongside the observed contaminant plume from June 1996. Both the slight decrease in source area concentrations and the minimal northwesterly migration of the leading edge of the June 1996 BTEX plume are very similar to the predicted 1996 plume assuming no source removal. Using CPT-19, CPT-20, CPT-21, and CPT-22 as points of comparison, the observed increase in dissolved contamination near the leading edge of the plume, in June 1996, seems to slightly exceed model predictions for the downgradient migration distance of the 10,000 µg/L, 1,000 µg/L, and 100 µg/L isopleths in two years.

With the implementation of a new source removal technology, i.e. SVE system, the dissolved contaminant plume is expected to decrease significantly within the next two years (the expected running time of SVE operations). In November 1996 a SVE system was installed at the former Car Care Center. SVE operations are expected to significantly decrease TVPH concentrations in source area soils by 1998, which in turn should reduce the dissolution of additional fuel constituents to groundwater and consequently limit the migration of water soluble fuel hydrocarbons in the site groundwater. With the start-up of the SVE system, the dissolved BTEX plume will begin to respond similarly to model predictions for the 20 to 33 percent annual source removal scenarios presented in Figures 5.10 and 5.11.

5.7 Conclusions

The results of three Bioplume II model scenarios for the former Car Care Center Site (Building 41) suggest that the dissolved BTEX plume front is not likely to migrate more than 100 feet downgradient from its August 1994 position. The first scenario, model CAL2, conservatively assumed that conditions that produced the calibrated model would remain constant (i.e., there would be no reduction in source loading). The second and third scenarios (models SR20 and SR33, respectively) assumed that source area remediation would reduce BTEX loading rates. CAL2 results suggest that within 30 years, the BTEX plume will reach its maximum extent, approximately 460 feet downgradient from the northwest property boundary along Brookley Avenue,



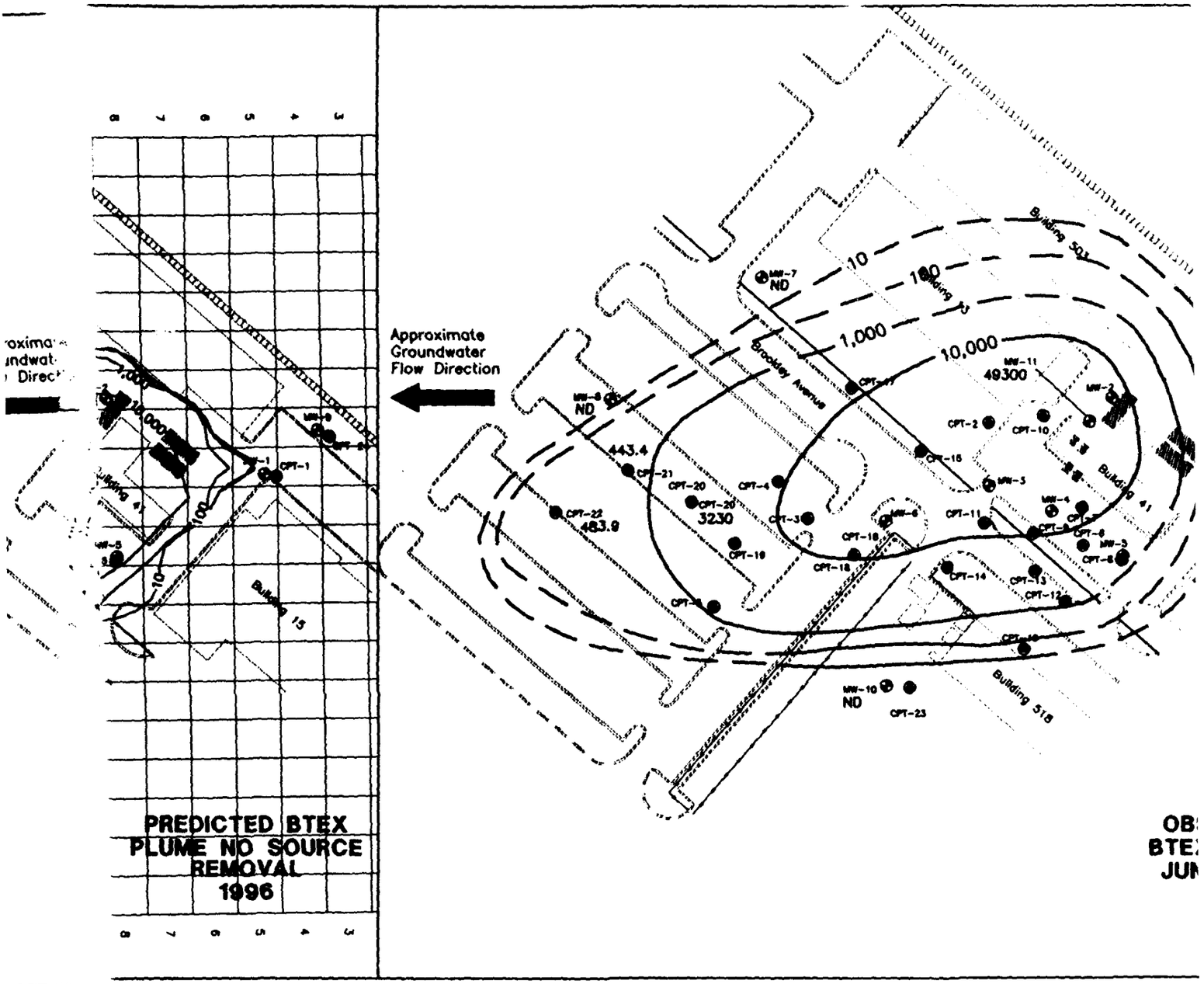
LEGEND

	Former underground storage tanks (USTs).
MW-1	Existing monitoring well.
CPT-20	Monitoring point installed by CPT rig.
8,600	Total benzene, toluene, ethylbenzene and xylene (BTEX) concentration (ug/L) by SW8020.
(8,800)	Data not utilized to construct contours.
100	Total BTEX concentration (ug/L) contour, dashed where inferred.

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

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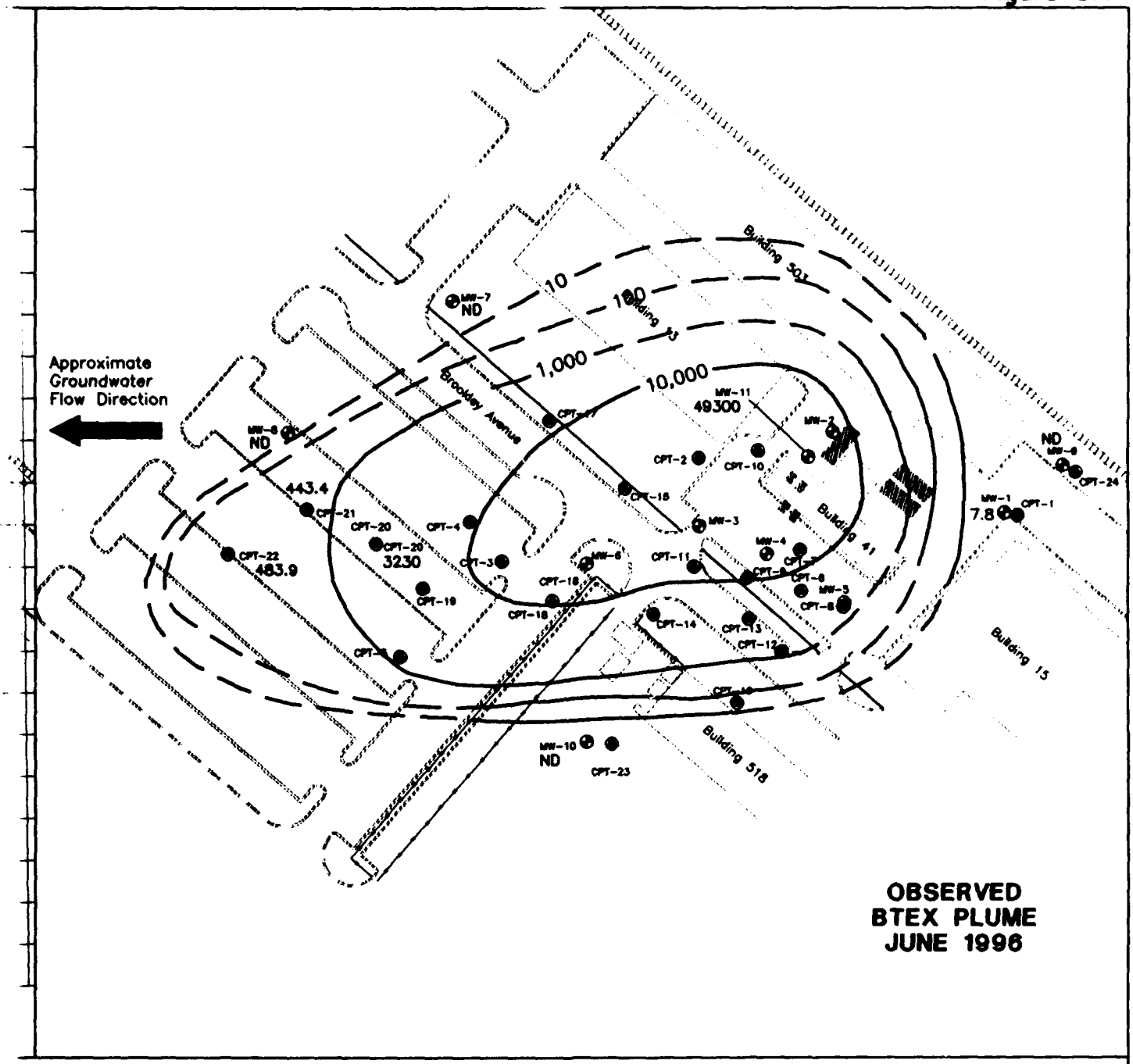
was developed using data from
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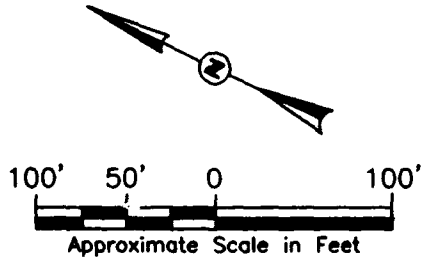
Predicted and Obser
BTEX Plumes,

Car Care Cent
Intrinsic Remediati
Bolling AFB,

PARSONS ENG

Figure 5.14





Predicted and Observed Dissolved BTEX Plumes, 1996

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

before stabilizing. Results of SR20 and SR33 suggest that after source reduction and removal, the BTEX plume will migrate no more than 450 feet from the northwest property boundary along Brookley Avenue before the BTEX concentrations decrease below 1 µg/l. Model simulations conducted during this project are extremely conservative for several reasons, including the following:

1) Aerobic respiration, denitrification, iron reduction, sulfate reduction, and methanogenesis are all occurring at this site; however, only DO and nitrate are considered as electron acceptors during model simulations;

2) The stoichiometry used to determine the ratio between DO plus nitrate-equivalent DO and BTEX assumed that no microbial cell mass was produced during the reaction. As discussed in Section 4.3.2.1, this approach may be conservative by a factor of three.

3) The highest DO concentration observed at the site was 5.2 mg/L. The highest DO concentration assumed during model simulations was 5.0 mg/L. In addition, the highest observed nitrate concentration observed at the site was 18 mg/L (as nitrogen). The highest nitrate concentration assumed during model simulations was 5 mg/L.

4) The lowest coefficient of retardation for benzene (1.22) was used for model simulations. Coefficient of retardation values for the other BTEX compounds range from 1.61 to 4.74. Use of the low coefficient of retardation tends to increase the distance traveled by the simulated BTEX plume, but provides a more accurate estimate of benzene transport.

Models CAL2, SR20, and SR33 represent endpoints in a continuum of probable scenarios at the Car Care Center Site. CAL2 represents the "worst case" in that it assumes BTEX dissolution into the aquifer will continue indefinitely, while BTEX loading rates should decrease as the residual product weathers and the continuing dissolution removes more and more of those compounds. Model SR20 and SR33 are more optimistic predictions that assume source remediation will result in proportional decreases in BTEX dissolution. It is likely that future site conditions will fall somewhere between these endpoints, with the plume not migrating as far as indicated by CAL2, but with BTEX in the source area persisting longer than predicted by SR20 and SR33.

SECTION 6

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents the development and comparative analysis of three groundwater remedial alternatives for the Car Care Center Site (Building 41) at Bolling AFB. The intent of this evaluation is to determine if intrinsic remediation is an appropriate and cost-effective remedial technology to consider when developing final remedial strategies for the Car Care Center Site, especially when combined with other conventional remedial technologies.

Section 6.1 presents the evaluation criteria used to assess groundwater remedial alternatives. Section 6.2 discusses the development of remedial alternatives considered as part of this demonstration project. Section 6.3 provides a brief description of each of these remedial alternatives. Section 6.4 provides a more detailed analysis of the remedial alternatives using the defined remedial alternative evaluation criteria. The results of this evaluation process are summarized in Section 6.5.

6.1 REMEDIAL ALTERNATIVE EVALUATION CRITERIA

The evaluation criteria used to identify appropriate remedial alternatives were adapted from those recommended by the USEPA (1988) for selecting remedies for Superfund sites (OSWER Directive 9355.3-01). These criteria included (1) long-term effectiveness and permanence, (2) technical and administrative implementability, and (3) relative cost. The following sections briefly describe the scope and purpose of each evaluation criterion. This report does not include a complete discussion of applicable or relevant and appropriate requirements (ARARs) for the site. Rather, this report focuses on the potential use of intrinsic remediation and source reduction technologies to reduce BTEX concentrations within the shallow groundwater to levels that do not pose unacceptable risks to human health or the environment.

6.1.1 Long-Term Effectiveness and Permanence

Each remedial technology or remedial alternative (which can be a combination of remedial technologies such as intrinsic remediation and institutional controls) was analyzed to determine how effectively it will minimize groundwater plume expansion so that groundwater quality standards can be achieved at a downgradient point of compliance (POC). The expected technical effectiveness was evaluated based on case histories from other sites with similar conditions. The ability to minimize potential impacts to surrounding facilities and operations was considered. Also, the ability of each remedial alternative to protect both current and potential future receptors from potential risks was qualitatively assessed by conservatively estimating whether a potential receptor exposure pathway involving groundwater could be completed, either

now or in the future. These evaluation criteria also include the ability for the groundwater to reduce contaminant mass, toxicity, and volume. Time to implementation and time until protection is achieved are discussed. Long-term reliability for providing continued protection, including an assessment of potential for failure of the technology and the potential threats resulting from such a failure, was also evaluated.

6.1.2 Implementability

The technical implementation of each remedial technology or remedial alternative was evaluated in terms of technical feasibility and availability. Potential shortcomings and difficulties in construction, operations, maintenance, and monitoring are presented and weighed against perceived benefits. Requirements for any post-implementation site controls such as LTM and land use restrictions are described. Details on administrative feasibility in terms of the likelihood of public acceptance and the ability to obtain necessary approvals are discussed.

6.1.3 Cost

The total cost (present worth) of each remedial alternative was estimated for relative comparison. An estimate of capital costs, and operations and post-implementation costs for site monitoring and controls is included. An annual adjustment factor of 7 percent was assumed in present worth calculations, as recommended by OSWER Directive No. 9355.3-20. The annual adjustment factor is the difference between the rate of inflation, and the cost of money (EPA, 1988).

6.2 FACTORS INFLUENCING ALTERNATIVES DEVELOPMENT

Several factors were considered during the identification and screening of remedial technologies for addressing shallow groundwater contamination at the Bolling AFB Car Care Center Site. Factors considered included the objectives of the natural attenuation demonstration program; contaminant, groundwater, and soil properties; present and future land use; and potential exposure pathways. The following sections briefly describe each of these factors and how they were used to narrow the list of potentially applicable remedial technologies to the final remedial alternatives considered for the Car Care Center Site.

6.2.1 Program Objectives

The intent of the intrinsic remediation demonstration program sponsored by AFCEE is to develop a systematic process for scientifically investigating and documenting naturally occurring subsurface attenuation processes that can be factored into overall site remediation plans. The objectives of this program and the specific Car Care Center Site study are to provide solid evidence of intrinsic remediation of dissolved fuel hydrocarbon so that this information can be used to develop an effective groundwater remediation strategy. A secondary goal of this multi-site initiative is to provide a series of regional case studies which demonstrate that natural processes of contaminant degradation can often reduce contaminant concentrations in groundwater to below acceptable cleanup standards before completion of potential exposure pathways.

Because the objective of this program is to study natural processes in the saturated zone rather than all contaminated media (soil, soil gas, etc.), technologies have been evaluated based on their potential impact on shallow groundwater and phreatic soils. Technologies that can reduce vadose zone contamination and partitioning of contaminants into groundwater also have been evaluated. Many of the source removal technologies evaluated in this section will reduce soil and soil gas contamination, but it is important to emphasize that the remedial alternatives developed in this document are not intended to directly remediate all contaminated site media. For example, remediation of contamination in the vadose zone can reduce contaminant leaching, further increasing the effectiveness of natural attenuation mechanisms.

Additional program objectives set forth by AFCEE include cost effectiveness and minimization of waste. Technologies that may meet these criteria include institutional controls, SVE, bioventing, biosparging, hydraulic containment, and intrinsic remediation. Soil excavation, slurry walls, sheet piling, carbon adsorption, *ex situ* biological or chemical treatment, groundwater pump and treat, and onsite/offsite disposal are not attractive technology candidates for this site.

6.2.2 Contaminant Properties

The site-related contaminants considered as part of this demonstration at the Car Care Center Site are the BTEX compounds. The source of this contamination is weathered gasoline present as residual contamination in the vadose zone, capillary fringe, and saturated soil on the Car Care Center property. The physiochemical characteristics of both gasoline and the individual BTEX compounds will greatly influence the effectiveness and selection of a remedial technology.

Petroleum hydrocarbon mixtures, such as gasoline, are comprised of over 300 compounds with different physiochemical characteristics. Gasoline is classified as an LNAPL with a liquid density of approximately 0.73 gram per cubic centimeter (g/cc) at 20°C (BEIA, 1989). Because gasoline is less dense than water, the LNAPL may become concentrated in the capillary fringe. The individual gasoline constituents can also sorb very well to the soil matrix or volatilize into soil vapor. Constituents in gasoline range from slightly to highly soluble in water. Overall solubility is approximately 300 mg/L. Gasoline is also a primary substrate for biological metabolism. Simultaneous biodegradation of aliphatic, aromatic, and alicyclic hydrocarbons has been observed. In fact, mineralization rates of hydrocarbons in mixtures, such as gasoline, may be faster than mineralization of the individual constituents as a result of cometabolic pathways (Jamison *et al.*, 1975; Perry, 1984).

The BTEX compounds are generally volatile, highly soluble in water, and adsorb less strongly to soil than other hydrocarbons in the petroleum mixture. These characteristics allow the BTEX compounds to leach more rapidly from contaminated soil into groundwater and migrate as dissolved contamination (Lyman *et al.*, 1992). All of the BTEX compounds are highly amenable to *in situ* degradation by both biotic and abiotic mechanisms.

Benzene is very volatile with a vapor pressure of 76 millimeters of mercury (mm Hg) at 20°C and a Henry's Law Constant of approximately 0.0054 atmosphere-cubic meters per mole (atm-m^3/mol) at 25°C (Hine and Mookerjee, 1975; Jury *et al.*, 1984).

The solubility of pure benzene in water at 20°C has been reported to be 1,780 mg/L (Verschueren, 1983). Benzene is normally biodegraded to carbon dioxide, with catechol as a short-lived intermediate (Hopper, 1978; Ribbons and Eaton, 1992).

Toluene is also volatile, with a vapor pressure of 22 mm Hg at 20°C and a Henry's Law Constant of about 0.0067 atm-m^3/mol at 25°C (Pankow and Rosen, 1988; Hine and Mookerjee, 1975). Toluene sorbs more readily to soil media relative to benzene, but still is very mobile. The solubility of pure toluene in water at 20°C is approximately 515 mg/L at 20°C (Verschueren, 1983). Toluene has been shown to degrade to pyruvate, acetaldehyde, and completely to carbon dioxide via the intermediate catechol (Hopper, 1978; Wilson *et al.*, 1986; Ribbons and Eaton, 1992).

Ethylbenzene has a vapor pressure of 7 mm Hg at 20°C and a Henry's Law Constant of 0.0066 atm-m^3/mol (Pankow and Rosen, 1988; Valsaraj, 1988). Ethylbenzene sorbs more strongly to soils than benzene but less strongly than toluene (Abdul *et al.*, 1987). Pure ethylbenzene is also less soluble than benzene and toluene in water at 152 mg/L at 20°C (Verschueren, 1983; Miller *et al.*, 1985). Ethylbenzene ultimately degrades to carbon dioxide via its intermediate 3-ethylcatechol (Hopper, 1978; Ribbons and Eaton, 1992).

The three isomers of xylene have vapor pressures ranging from 7 to 9 mm Hg at 20°C and Henry's Law Constants of between 0.005 and 0.007 atm-m^3/mol at 25°C (Mackay and Wolkoff, 1973; Hine and Mookerjee, 1975; Pankow and Rosen, 1988). Of all of the BTEX compounds, xylenes sorb most strongly to soil, but still can leach from soil into the groundwater (Abdul *et al.*, 1987). Pure xylenes have water solubilities of 152 to 160 mg/L at 20°C (Bohon and Claussen, 1951; Mackay and Shiu, 1981; Isnard and Lambert, 1988). Xylenes can degrade to carbon dioxide via pyruvate carbonyl intermediates (Hopper, 1978; Ribbons and Eaton, 1992).

Based on these physiochemical characteristics, intrinsic remediation, SVE, bioventing, biosparging, and groundwater extraction/air stripping technologies could all be effective at collecting, destroying, and/or treating BTEX contaminants at the Car Care Center Site.

6.2.3 Site-Specific Conditions

Two general categories of site-specific characteristics were considered when identifying remedial technologies for comparative evaluation as part of this demonstration project. The first category was physical characteristics such as groundwater depth, gradient, flow direction, and soil type, which influence the types of remedial technologies most appropriate for the site. The second category involved assumptions about future land use and potential exposure pathways. Each of these site-specific characteristics have influenced the selection of remedial alternatives included in the comparative evaluation.

6.2.3.1 Groundwater and Soil Characteristics

Site geology and hydrogeology will have a profound effect on the transport of contaminants and the effectiveness and scope of required remedial technologies at a given site. Hydraulic conductivity is perhaps the most important aquifer parameter

governing groundwater flow and contaminant transport in the subsurface. The velocity of the groundwater and dissolved contamination is directly related to the hydraulic conductivity of the saturated zone. Rising head slug tests, completed at the Car Care Center Site during January 1994 (Baker, 1994), indicated that hydraulic conductivity of the shallow aquifer ranged from 5.8×10^{-5} to 5.8×10^{-6} ft/sec. These values, when utilized in a contaminant transport model, did not adequately reproduce the observed plume extent. In order to develop a more representative transport model, Parsons ES utilized a slightly higher average hydraulic conductivity value (1.44×10^{-4} ft/sec) within this model. However, hydraulic conductivity values within the model ranged from 1.7×10^{-4} to 3.4×10^{-6} ft/sec (see Section 5.4.1). These values are characteristic of the aquifer materials (see Sections 3 and 5 of this report) observed at the site. The average hydraulic conductivity in combination with the relatively flat hydraulic gradient observed at this site yields a groundwater flow velocity of 22 ft/year. This moderate velocity directly influences the fate and transport of contaminants by limiting the rate of contamination migration. As a result, the shallow groundwater plume has migrated relatively slowly at the site.

Although a moderate hydraulic conductivity can result in some plume expansion and migration, this same characteristic will also enhance the effectiveness of other remedial technologies, such as groundwater extraction, biosparging, and intrinsic remediation. For example, it should be less expensive and time-consuming to capture and treat the contaminant plume using a network of extraction wells in areas of moderate to high hydraulic conductivity. The effectiveness of biosparging may also be increased in sandy aquifers because of reduced entry pressure, increased radius of influence. Greater hydraulic conductivity also increases the amount of contaminant mass traveling through the biosparging network. Contaminant recovery may also be maximized when contaminants are not significantly sorbed to and retarded by phreatic soil. The relatively low TOC content of Bolling AFB aquifer materials (0.06 to 0.15 percent) will tend to minimize sorption and allow mobility of BTEX compounds

The movement of contaminants within the subsurface away from the source will also increase the effectiveness of natural biodegradation processes by distributing the contaminant mass into areas enriched with electron acceptors. To satisfy the requirements of indigenous microbial activity and intrinsic remediation, the aquifer must also provide an adequate and available carbon or energy source, electron acceptors, essential nutrients, proper ranges of pH, temperature, and redox potential.

Data collected as part of the field work phase of this demonstration project and described in Sections 3 and 4 of this document indicate that the Car Care Center Site is characterized by adequate and available carbon/energy sources and electron acceptors that support measurable biodegradation of gasoline contamination by indigenous microorganisms. Dissolved sulfate, carbon dioxide (which is utilized during methanogenesis), oxygen, and nitrate represent significant sources of electron acceptor capacity for the biodegradation of BTEX compounds at the site. Further, because fuel hydrocarbon-degrading microorganisms have been known to thrive under a wide range of temperature and pH conditions (Freeze and Cherry, 1979), the physical and chemical conditions of the groundwater and phreatic soil at the Car Care Center Site are not likely to inhibit microorganism growth.

Fuel hydrocarbon-degrading microorganisms are ubiquitous, and as many as 28 hydrocarbon-degrading isolates (bacteria and fungi) have been discovered in different soil environments (Davies and Westlake, 1979; Jones and Eddington, 1968). Indigenous microorganisms have a distinct advantage over microorganisms injected into the subsurface to enhance biodegradation because indigenous microorganisms are well adapted to the physical and chemical conditions of the subsurface in which they reside (Goldstein *et al.*, 1985). Microbe addition was not considered a viable remedial technology for the Car Care Center Site.

6.2.3.2 Potential Exposure Pathways

An exposure pathway analysis identifies the potential human and ecological receptors that could potentially come into contact with site-related contamination and the pathways through which these receptors might be exposed. To have a completed exposure pathway, there must be a source of contamination, a potential mechanism(s) of release, a pathway of transport to an exposure point, an exposure point, and a receptor. If any of these elements do not exist, the exposure pathway is considered incomplete, and receptors will not come into contact with site-related contamination. Evaluation of the potential long-term effectiveness of any remedial technology or remedial alternative as part of this demonstration project includes determining if the approach will be sufficient and adequate to minimize plume expansion so that potential exposure pathways involving shallow groundwater are incomplete.

Assumptions about current and future land use at a site form the basis for identifying potential receptors, potential exposure pathways, reasonable exposure scenarios, and appropriate remediation goals. USEPA (1991) advises that the land use associated with the highest (most conservative) potential level of exposure and risk that can reasonably be expected to occur should be used to guide the identification of potential exposure pathways and to determine the level to which the site must be remediated. The source area consists of fuel storage facilities that are now defunct, and retail facilities associated with the former Car Care Center. The groundwater plume originating from the Car Care Center is migrating to the northwest, and has impacted shallow groundwater in an area extending from the source area to the parking lot across Brookley Avenue (Figure 4.4). The parking lots located northwest of the Car Care Center and across Brookley Avenue overlie most of the contaminant plume. Warehouses, roadways, maintenance buildings, and office buildings are located on adjacent properties. The current land use within and downgradient from the contaminant plume is entirely industrial.

Under reasonable current land use assumptions, potential receptors include only worker populations. It is unlikely that workers could be exposed to site-related contamination in phreatic soils or shallow groundwater unless this material is removed during future construction excavations or remedial activities. As groundwater is located at a depth of approximately 18 to 20 feet bls, it is unlikely that utility workers could be exposed to shallow groundwater contamination. Shallow groundwater is not currently used to meet any water supply demands at Bolling AFB. All on-base water supply demands are met by water piped in from the Blue Plains Water Treatment Facility located south of Bolling AFB. Exposure pathways involving other environmental media such as shallow soils and soil gas in the source area were not considered as part of this project, but should be considered in overall site remediation

decisions. In the event future construction activities are planned for the Car Care Center Site (Building 41), special precautions should be taken to ensure environmental safety and limit worker exposure.

Migration of contaminated shallow groundwater resulting in a discharge into the Potomac River could complete an exposure pathway to human or ecological receptors via dermal contact or possible ingestion. However, it is very unlikely that detectable concentrations could reach the river. The Potomac River is located approximately 2,800 feet downgradient from the leading edge of the contaminant plume. A conservative tracer would require approximately 130 years to reach the river. However, fate and transport modeling suggests that the contaminant plume will not travel this distance due to natural attenuation. In the unlikely event that contaminants reach the Potomac River, BTEX concentrations probably will be instantly diluted to below analytical detection limits.

Assumptions about hypothetical future land uses must also be made to ensure that the remedial technology or alternative considered for shallow groundwater at the site is adequate and sufficient to provide long-term protection. No changes in land use are anticipated in the foreseeable future, so a continued industrial land use assumption is appropriate. As a result, potential future receptors include only worker populations. The potential future exposure pathways involving workers are identical to those under current conditions provided shallow groundwater is not used to meet industrial water demands. In summary, the use of intrinsic remediation technology at this site will require that the source area be maintained as industrial property and that restrictions on groundwater use be enforced in areas downgradient of the Car Care Center Site to the Potomac River. If source removal technologies such as SVE, bioventing, LNAPL recovery, biosparging, or groundwater pump and treat are implemented, they will have some impact on the short- and long-term land use options and will require some level of institutional control and worker protection during remediation.

6.2.3.3 Remediation Goals for Shallow Groundwater

Model results suggest that BTEX compounds are not likely to move more that 460 feet downgradient from the source area (measured from the northwest property boundary along Brookley Avenue), assuming contaminants are introduced into the aquifer at a constant rate. Without source removal, the contaminant plume should reach steady-state conditions within 30 years. As source area remediation proceeds, and as residual LNAPL weathers, BTEX loading rates will decrease, and the extent of BTEX migration will likely be much more limited. Therefore, a location of approximately 650 to 700 feet beyond the northwest property has been identified as the POC for groundwater remedial activities because this appears to be the maximum extent of future contaminant migration. This is a suitable location for monitoring and for demonstrating compliance with protective groundwater quality standards, such as promulgated federal MCLs or DCRA target cleanup criteria.

This remedial strategy assumes that compliance with promulgated, single-point remediation goals is not necessary if site-related contamination does not pose a threat to human health or the environment (i.e., the exposure pathway is incomplete). Thus, the magnitude of required remediation in areas that can and will be placed under institutional control is different from the remediation that is required in areas that may

be available for unrestricted use. The primary RAO for shallow groundwater within and downgradient of the Car Care Center Site is minimizing plume expansion to prevent exposure of downgradient receptors to concentrations of BTEX in groundwater at levels that pose a risk. This means that viable remedial alternatives must be able to achieve concentrations that minimize plume migration and/or expansion. The RAO for shallow groundwater at the POC is attainment of DCRA's target cleanup levels and federal drinking water MCLs for each of the BTEX compounds listed in Table 6.1. Although it is unlikely that groundwater would be ingested by humans, this level of long-term protection is appropriate, because the shallow groundwater in this area is classified by DCRA as a potential potable water source.

In summary, available data suggest that there is no complete potential exposure pathway at the Car Care Center Site under current conditions. It is not likely that potential exposure pathways involving shallow groundwater would be complete under future land use assumptions, provided use of groundwater as a potable or industrial source of water is prohibited by institutional controls within the source area and approximately 700 feet downgradient from the source area (measured from the northwest site property boundary along Brookley Avenue). Thus, institutional controls are likely to be a necessary component of any groundwater remediation strategy for this site. The required duration of these institutional controls may vary depending on the effectiveness of the selected remedial technology at reducing contaminant mass and concentration in the groundwater.

6.2.4 Summary of Remedial Technology Screening

Several remedial technologies have been identified and screened for use in treating the shallow groundwater at the Car Care Center Site. Table 6.2 identifies the initial remedial technologies considered as part of this demonstration and those retained for detailed comparative analysis. Screening was conducted systematically by considering the program objectives of the AFCEE intrinsic remediation demonstration, physiochemical properties of the BTEX compounds, and other site-specific characteristics such as hydrogeology, land use assumptions, potential exposure pathways, and appropriate remediation goals. All of these factors will influence the technical effectiveness, implementation, and relative cost of technologies for remediating shallow groundwater underlying and migrating from the site. The remedial technologies retained for development of remedial alternatives and comparative analysis include institutional controls, intrinsic remediation, LTM, bioventing, SVE, mobile LNAPL removal, and biosparging.

6.3 BRIEF DESCRIPTION OF REMEDIAL ALTERNATIVES

This section describes how remedial technologies retained from the screening process were combined into two remedial alternatives for the Car Care Center Site. Sufficient information on each remedial alternative has been provided to facilitate a comparative analysis of effectiveness, implementability, and cost in Section 6.4.

TABLE 6.1

POINT-OF-COMPLIANCE REMEDIATION GOALS
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Compound	DCRA Target Cleanup Levels and Federal MCLs (µg/L)
Benzene	5
Toluene	1,000
Ethylbenzene	700
Total Xylenes	10,000

TABLE 6.2

INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF
TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
CAR CARE CENTER SITE INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

General Response Action	Technology Type	Process Option	Implementability	Retain
Long-Term Monitoring	Periodic Groundwater Monitoring	Confirmation Wells	Many existing wells are available to confirm the progress of remediation.	Yes
		Point-of-Compliance Wells	Sufficient distance exists between the plume and point-of-compliance to locate several wells.	Yes
Institutional Controls	Groundwater Use Control	Land Use Control/Regulate Well Permits	Plume area is currently within the base boundary and land-use and groundwater use are under base jurisdiction.	Yes
		Seal/Abandon Existing Wells	No production wells are known to exist in the existing or predicted plume area.	No
		Point-of-Use Treatment	No groundwater is extracted from the plume area for any use.	No
	Public Education	Meetings/ Newsletters	Base public relations and environmental management offices have many information avenues to inform workers and residents.	Yes
Containment of Plume	Hydraulic Controls	Passive Drain Collection	No likely receptors downgradient of site. Installation disruptive to base operations. Prohibitive due to groundwater depth.	No
		Minimum Pumping/Gradient Control	Vertical pumping wells could be located along the leading edge of plume to intercept and halt the advance of the plume. Required pumping rates would be excessive, increasing treatment costs. No likely receptors downgradient of site.	No
	Physical Controls	Slurry Walls/Grout Curtains	Requires significant disruption of a base operations. Limited effectiveness.	No
		Sheet Piling	Requires significant disruption to base operations. Limited effectiveness.	No
	Reactive/Semi-Permeable Barriers	Biologically Active Zones	Natural biodegradation of BTEX compounds can be stimulated by allowing contaminated groundwater to flow through an aquifer zone which has enhanced oxygen and nutrient conditions. Not practical for excessive contaminant concentrations.	No

TABLE 6.2 (Continued)

INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF
TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
CAR CARE CENTER SITE INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

General Response Action	Technology Type	Process Option	Implementability	Retain
In Situ Treatment	Biological	Oxygen and/or Nutrient Enhanced Biodegradation (Biosparging)	Differs from biologically active zone in that oxygen and/or nutrients are injected in source area and allowed to migrate downgradient. This method can more rapidly reduce higher BTEX concentrations in and immediately downgradient of the source area. Not proven to be any more effective than natural attenuation.	No
	Chemical/ Physical	Intrinsic Remediation	A combination of natural biological, chemical, and physical removal mechanisms which occur to varying degrees on every site. Groundwater sampling at the Car Care Center Site indicates that this is a major, ongoing remediation process.	Yes
		Air Sparging (Volatilization)	Injection of air into contaminated aquifer creating a mass transfer of BTEX into air bubbles and into vadose zone. Limited radius of influence, short-circuiting, and diffuse air emissions are common problems.	No
Aboveground Groundwater Treatment	Groundwater Extraction	Vertical Pumping Wells	Entire groundwater plume is pumped by installing numerous wells with submersible pumps. High cost and major disruption to area. Not effective until residual LNAPL is remediated.	No
		Downgradient Horizontal Drains	See Passive Drain Collection.	No
	Biological	Bioreactors	High flow rates require excessive retention times and large reactors. BTEX is often volatilized in these systems.	No
	Chemical/ Physical	Air Stripping	Cost-effective technology for removing varying concentrations of BTEX at higher flow rates. Permitting for air emissions may be required. Not effective as a final remediation measure unless the residual LNAPL is remediated.	No
		Activated Carbon	Cost prohibitive for more concentrated BTEX. Creates a carbon disposal problem.	No
		UV/Ozone Reactors	High flow rates require excessive retention times and large, expensive reactors.	No

TABLE 6.2 (Continued)

INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF
TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
CAR CARE CENTER SITE INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

General Response Action	Technology Type	Process Option	Implementability	Retain
Aboveground Treatment	Direct Discharge to Industrial Waste Water Treatment Plant (IWWTP)	IWWTP	Viable option when an IWWTP is available and capable of handling BTEX and hydraulic loading. Plume dimensions and sandy conditions would require very high hydraulic loading in order to control the plume.	No
Treated Groundwater Disposal	Discharge to IWWTP or Sanitary Sewer	IWWTP	Viable option when access to industrial sewer exists and hydraulic loading is acceptable. Same as above.	No
		Sanitary Sewer	Viable option when access to sanitary sewer exists and hydraulic loading is acceptable. Same as above.	No
	Treated Groundwater Reinjection	Vertical Injection Wells	Not recommended due to clogging and high maintenance.	No
		Injection Trenches	Less clogging than wells, but large trenches are required and can be subject to injection well permitting.	No
	Discharge to Surface Waters	Storm Drains	Viable option but generally requires NPDES or other discharge permit. Groundwater extraction is unlikely.	No
Source Removal/Soil Remediation	Mobile LNAPL Recovery	Dual-Pump Systems	Best suited for sites with >1 foot mobile LNAPL where aboveground groundwater treatment already exists	No
		Skimmer Pumps/Passive Bailers/Wicks	Best suited for sites with <1 foot mobile LNAPL where groundwater pumping is undesirable.	Yes
		Total Fluids Pumping	Best suited for sites with thin saturated zones where excessive groundwater will not be pumped.	No
		Bioslurping	Combined vapor extraction, bioventing, and mobile LNAPL recovery system has been operated at some sites with limited success. Minimal product at site.	No
		Hand Bailing	The limited quantity of mobile LNAPL at the site makes this method ineffective.	No
	Excavation/ Treatment	Biological Landfarming	Deep excavation is not feasible at this site due to surface structures.	No

TABLE 6.2 (Concluded)

INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF
TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
CAR CARE CENTER SITE INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

General Response Action	Technology Type	Process Option	Implementability	Retain
Source Removal/Soil Remediation (cont'd)	Excavation/ Treatment (cont'd)	Thermal Desorption	Deep excavation is not feasible at this site due to surface structures and ongoing base operations.	No
	In Situ	Bioventing	Air injection to stimulate biodegradation of fuel residuals. Systems currently operating at other locations at Bolling AFB.	Yes
		Soil Vapor Extraction	Sandy soils with a deep groundwater table suggest this option may be successful and economical. Requires expensive off-gas treatment.	Yes

6.3.1 Alternative 1 - Passive Mobile LNAPL Removal, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring

In the past, Bolling AFB employed a contractor to hand-bail mobile LNAPL from site monitoring wells. However, this practice was discontinued in May 1994 due to the minimal mobile LNAPL that was being recovered. Manual removal of small quantities of product from site wells was costly and time consuming, with little overall benefit. Under Alternative 1, LNAPL removal would commence in select wells (i.e., those containing product) using passive, in-well, product-selective passive skimmers. These devices will continuously "bail" floating product from a well. The passive skimmers typically have a collection chamber on the bottom of the skimmer to hold recovered product. The canisters would be emptied manually on an as-needed basis.

Passive remediation would continue through intrinsic remediation mechanisms. Intrinsic remediation is achieved when naturally occurring attenuation mechanisms bring about a reduction in the total mass of a contaminant in the soil or dissolved in groundwater. Intrinsic remediation results from the integration of several subsurface attenuation mechanisms that are classified as either destructive or nondestructive. Destructive attenuation mechanisms include biodegradation, abiotic oxidation, and hydrolysis. Nondestructive attenuation mechanisms include sorption, dilution (caused by dispersion and infiltration), and volatilization. In some cases, intrinsic remediation will reduce dissolved contaminant concentrations below numerical concentration goals, thus protecting human health and the environment. Based on the existing evidence of intrinsic remediation described in Section 4, these processes are occurring at the Car Care Center Site and will continue to reduce contaminant mass in the plume area.

Model CAL2 assumes that the residual LNAPL will be a continuous constant source of contaminants. In reality, the hydrocarbon leaching rate will diminish over time. In addition, the model assumes that intrinsic remediation is the sole removal mechanism for contaminant mass in the subsurface; however, passive LNAPL removed is included as a component of this alternative. As a result, the continuous source assumption provides a conservative estimate. Actual plume dimensions will likely be smaller than those predicted herein. As indicated in Section 5.6.1, model CAL2 results suggest that intrinsic remediation will stabilize the BTEX plume within 25 to 30 years. The plume could extend to a maximum of 460 feet downgradient (Figure 5.9) from the source area (as measured from the northwest property boundary along Brookley Avenue).

Implementation of Alternative 1 would require the use of institutional controls such as land use restrictions and LTM. Land use restrictions may include placing long-term restrictions on soil excavation within the source area and long-term restrictions on groundwater well installations within and downgradient of the source area. The intent of these restrictions would be to reduce potential receptor exposure to contaminants by legally restricting activities within areas affected by site-related contamination.

As a minimum, groundwater monitoring would be conducted twice annually for 30 years as part of this remedial technology to evaluate the progress of natural attenuation processes. Based on the potential plume migration suggested by model CAL2, it is unlikely that benzene concentrations exceeding the DCRA target cleanup level of 5 µg/L would be present more that 460 feet downgradient of the source area as measured from the property boundary along Brookley Avenue. This would be true even if it

were assumed that model contaminant concentrations are all benzene rather than total BTEX.

Because there are no apparent downgradient receptors, POC wells should be placed 300 to 400 feet downgradient of the modeled maximum plume extent (i.e., approximately 700 feet downgradient of the Car Care Center western property boundary along Brookley Avenue). In addition, LTM wells within, upgradient, and immediately downgradient from the existing BTEX plume will be used to monitor the effectiveness of intrinsic remediation. LTM wells are further described in Section 7.2.1. Detection of benzene in excess of 5 µg/L at the POC wells may require additional evaluation and modeling to assess BTEX migration, or to determine if additional corrective actions would be necessary. Land use restrictions would also require reevaluation.

Public education on the selected alternative will be developed to inform base personnel and local residents of the scientific principles underlying source reduction and intrinsic remediation. This education could be accomplished through public meetings, presentations, press releases, and posting of signs where appropriate. Periodic site reviews could also be conducted every year using data collected from the long-term groundwater monitoring program. The purpose of these periodic reviews will be to evaluate the extent of contamination, assess contaminant migration and attenuation through time, document the effectiveness of source removal and institutional controls, and reevaluate the need for additional remedial actions.

6.3.2 Alternative 2 - Passive Mobile LNAPL Removal, Bioventing in the Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring

Pilot-scale bioventing tests have been conducted at two separate locations on Bolling AFB. These study areas include the Heat Plant (Building 18) and the Former Tank Farm located across from Building 5300. These tests were initiated during 1993, and have operated for approximately 1 year. Preliminary results from these studies indicate that bioventing may be an appropriate remedial technology at the Car Care Center Site due to the sandy soil conditions and deep soil contamination. A soil gas study would be required at the Car Care Center Site during the pilot study to determine whether oxygen-limited conditions exist in vadose zone soils. A vent well and vapor monitoring points would be installed during the soil gas study in order to conduct the pilot test. Upon completion of the soil gas study, a pilot study would then be performed to determine oxygen and hydrocarbon utilization rates. Pilot study results would be used to design a full-scale bioventing system capable of remediating the residual LNAPL contained in the unsaturated zone.

During design of a bioventing system, caution must be taken to ensure that the air injection process will not force volatile hydrocarbon vapors into surrounding buildings and sumps. Because numerous buildings exist within and adjacent to the Car Care Center, engineered controls must be provided to ensure health and safety of Base personnel and property.

On the basis of successful interim results of the Heat Plant (Building 18) and/or Former Tank Farm bioventing projects, a bioventing system can be conceptualized for

the Car Care Center Site. In order for the bioventing system to be effective, it must be capable of introducing oxygen (air) to the subsurface at sufficient rates in order to promote *in situ* biodegradation of hydrocarbons in the vadose zone. A typical full-scale bioventing system for the Car Care Center Site might consist of a series of vertical or horizontal air-injection wells installed on the facility's property throughout the vadose zone where residual LNAPL contamination is present (Figures 4.2a and 4.2b). A small blower would provide a suitable volumetric air flow rate necessary to oxygenate soils. This treatment will reduce the mass of hydrocarbon leaching into groundwater, increasing the effectiveness of natural attenuation mechanisms.

Model SR20 assumes significant BTEX loading rate reductions can occur due to bioventing. In model SR20, the source is reduced by 20 percent of the original amount per year for a 5-year period. This time period is conservative for remediation systems such as bioventing. After 5 years of source removal, the Bioplume II model predicts that the combination of source reduction and intrinsic remediation within the BTEX plume will significantly reduce its size and concentration. Under this scenario, model results show that it is unlikely that BTEX compounds would not migrate more than 450 feet (Figure 5.11) as measured from the northwestern property boundary along Brookley Avenue. The maximum dissolved BTEX concentrations in the plume are reduced below approximately 10 µg/L after 13 years of treatment.

This alternative is identical to Alternative 1 except that bioventing was implemented in order to remediate the residual LNAPL contamination located within the Car Care Center property. As with Alternative 1, institutional controls and LTM would be required. Due to the shorter time frame, semi-annual groundwater monitoring will continue only for 13 years. POC wells would be installed in the same locations indicated in the previous section.

6.3.3 Alternative 3 - Passive Mobile LNAPL Removal, Soil Vapor Extraction with Off-Gas Treatment, Bioventing in Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring

This alternative is identical to Alternative 2 except that SVE would be used in combination with bioventing. Initially, SVE would be used to reduce high VOC concentrations in the primary source areas of the site (e.g., the former 12,000-gallon UST location, and west of Building 41). Bioventing alone (Alternative 2) may have a detrimental affect of forcing VOCs into surrounding buildings and sumps. During SVE, soil-gas vapors are drawn towards the vent well, minimizing the potential for off-site migration of vapors. SVE is typically operated at higher flow rates than bioventing. As a result, SVE can remove greater quantities of VOCs from subsurface soils. Because SVE is a more aggressive treatment remedy, implementing this alternative can shorten the required remediation time period.

A primary difference between SVE and bioventing is the rate at which air is moved through the subsurface. Bioventing employs low air flow rates, supplying oxygen to the subsurface to promote biodegradation, whereas SVE utilizes larger air volumes to optimize volatilization. Due to the high levels of VOCs at the site, bioventing alone may not supply adequate oxygen to the subsurface. Contaminant loading rates would eventually decrease, but more slowly than if SVE, and bioventing were combined. As a result, bioventing could be optimized by initially operating the bioventing system in a

SVE mode to remove the high concentrations of VOCs. Due to the reaeration process, SVE and bioventing may also increase the DO content of the groundwater and promote more rapid degradation of BTEX compounds in the plume and in saturated soil.

After the initial VOC concentrations in the primary source areas are reduced, a bioventing system could easily be combined with the SVE system, or used alone. Bioventing would be implemented at this site by injecting air several feet above the groundwater surface, allowing air (oxygen) to move upward through the vadose zone. If needed, SVE would then be utilized to extract the hydrocarbons volatilized from the subsurface, effectively controlling the migration of soil vapors.

VOC concentrations in the effluent of the SVE system initially are expected to be high. As a result, off-gas treatment is assumed to be necessary. Numerous effective methods exist for treating VOC emissions, including thermal treatment, catalytic oxidation (CatOx), and activated carbon adsorption. As part of an innovative technology evaluation initiative, AFCEE has demonstrated the effectiveness of using a modified internal combustion engine (ICE) to simultaneously recover and treat VOC laden soil gas. The hydrocarbon vapors recovered from a well are utilized by the ICE unit as a source of fuel. The combustion process within the ICE unit creates a vacuum and powers the SVE process. In the event that the extracted soil gas does not contain adequate thermal value, then a supplemental fuel is added (e.g., liquid-propane [LP] gas or natural gas). Through evaluation of the ICE system and other applicable technologies, AFCEE has determined that this method can be very effective at reducing VOC emissions.

Model SR33 was run to simulate this alternative. Model SR33 is similar to model SR20, except model SR33 assumes more rapid reductions in the hydrocarbon loading rates to simulate a more aggressive treatment alternative such as SVE in combination with bioventing, and passive skimming. This combined treatment system was assumed to be capable of removing residual LNAPL contamination from the primary source areas in approximately 3 years. As a result, in model SR33, the source is reduced by 33 percent of the original amount every year for 3 years. After 3 years of source removal, the Bioplume II model predicts that combining source reduction and intrinsic remediation will significantly reduce the size and concentration of the BTEX plume. Under this scenario, model results show that it is unlikely that BTEX compounds would migrate more than 425 feet (Figure 5.13) from the northwestern property boundary along Brookley Avenue. This distance is similar to the distance predicted by bioventing alone (model SR20). However, the BTEX plume dissipates within 11 years.

As with Alternative 1, passive skimming, institutional controls and LTM would be required. However, due to the shorter time frame, semi-annual groundwater monitoring will continue for only 11 years. Point-of-compliance wells would be installed in the same locations indicated in the previous section.

6.4 EVALUATION OF ALTERNATIVES

This section provides a comparative analysis based on the effectiveness, implementability and cost criteria for the three previously discussed remedial alternatives. A summary of this evaluation is presented in Section 6.5.

6.4.1 Alternative 1 - Passive Mobile LNAPL Removal, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring

6.4.1.1 Effectiveness

Section 5 of this document presents the results of the Bioplume II model completed to support the intrinsic remediation alternative at the Car Care Center Site. Continual BTEX injection into groundwater was incorporated into model CAL2 to simulate the effects of continuous leaching of hydrocarbons from the source area. The CAL2 model results suggest that natural attenuation mechanisms will limit contaminant migration and reduce contaminant mass and toxicity downgradient of the plume. Benzene concentrations should not exceed the DCRA target cleanup level at the proposed POC well locations discussed in Section 7. Groundwater monitoring at the POC wells and LTM wells will ensure the protectiveness of this alternative. In the event BTEX is detected in a POC well at concentrations that exceed DCRA target cleanup levels, this LTM plan does not cease to be protective. The Potomac River is located over 2,800 feet from the Car Care Center Site, and it is the only known potential receptor exposure point in the area. In the event BTEX is detected in POC wells, the site conditions would be reevaluated to determine whether additional remedial actions are appropriate for the site.

The effectiveness of this remedial alternative requires that excavations or drilling within the source area be conducted only by properly protected site workers. Reasonable land use assumptions for the plume area indicate that exposure is unlikely unless excavation or drilling activities bring contaminated soil to the surface. Long-term land use restrictions will be required to ensure that shallow groundwater will not be pumped or removed for potable use within and approximately 1,000 feet in all directions from the existing BTEX plume. Existing health and safety plans should be enforced to reduce risks from any proposed remedial installation and during installation of additional POC and LTM wells.

Compliance with program goals is one component of the long-term effectiveness evaluation criterion. Alternative 1 will satisfy program objectives designed to promote intrinsic remediation as a component of site remediation and to scientifically document naturally occurring processes. Alternative 1 is based on the effectiveness of naturally occurring processes that minimize contaminant migration and reduce contaminant mass over time, and the effectiveness of institutional controls. As described earlier, the Bioplume II model results suggest that naturally occurring processes will minimize further BTEX plume migration to within 460 feet downgradient of the source area as measured from the northwest property boundary along Brookley Avenue. The sensitivity analyses completed on the Bioplume II model for this site (Section 5) suggests that even under the most conservative (i.e., worst-case) conditions, the naturally occurring processes at the Car Care Center Site should reduce contaminant migration so that the maximum distance traveled by the plume is unlikely to be beyond the proposed POC wells.

Aside from the administrative concerns associated with enforcement of long-term land use restrictions and long-term groundwater monitoring programs, this remedial alternative should provide reliable, cost-effective protection. For cost comparison purposes, it was assumed that passive product skimming would operate for a period of

3 years. Because LNAPL was observed in monitoring wells MW-2 and MW-3 during the August 1994 investigation, these wells were chosen for product skimming. However, since both MW-2 and MW-3 were destroyed just after the 1994 sampling event their replacements MW-11 and MW-3R, respectively, could be used for product skimming. In the event that additional wells are added near the primary source area in conjunction with the planned remedial activities, Parsons ES also assumed that two additional wells would be used for product skimming (four total). After 3 years, any recoverable mobile LNAPL will likely be removed from all site monitoring wells. Given that minimal mobile LNAPL has been observed at the site, a 3-year duration is a realistic assumption.

For costing purposes, Parsons ES assumed intrinsic remediation and LTM will continue for a 30-year period. This time frame was chosen because this is the modeled period of time required for the plume to reach steady-state conditions, assuming no source reductions. During this time period, predicted dissolved benzene concentrations will exceed the DCRA target cleanup level within the center of the BTEX plume. However, the DCRA target cleanup level should not be exceeded at the proposed POC well locations.

6.4.1.2 Implementability

Alternative 1 is not technically difficult to implement. Passive LNAPL skimming is similar to hand-bailing, however, it is not as labor intensive. Under this alternative, additional remedial measures are not planned. Installation of POC wells and semiannual groundwater monitoring are both standard procedures. Long-term management efforts will be required to ensure that proper sampling procedures are followed. Periodic site reviews should be conducted to confirm the adequacy and completeness of LTM data and verify the effectiveness of this remediation approach. There also may be administrative concerns associated with long-term enforcement of groundwater use restrictions. Future land use within the source area may be impacted by leaving contaminated soil and groundwater in place. Regulators, Base officials, Base employees, and the public would have to be informed of the benefits and limitations of the intrinsic remediation option. Educational programs are not difficult to implement, and the initial regulatory reaction to this alternative has been positive.

6.4.1.3 Cost

The cost of Alternative 1 is summarized in Table 6.3. A more complete breakdown and present worth analysis of these costs is provided in Appendix F. Capital costs are limited to the construction of three new POC wells and one new LTM well. The total present worth cost of mobile LNAPL recovery for a period of 3 years, and implementation of the LTM plan for 30 years is $487,000 total present worth. Also included are the costs of maintaining institutional controls and long-term groundwater monitoring for a total of 30 years.

TABLE 6.3

ALTERNATIVE 1 - COST ESTIMATE
PASSIVE MOBILE LNAPL REMOVAL, INTRINSIC REMEDIATION, AND INSTITUTIONAL CONTROLS WITH LONG-TERM GROUNDWATER MONITORING
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

	Capital Costs ($)
Install 3 POC wells and 1 LTM well	$14,885
Passive Skimmer Installation/Set-Up	$1,650
Operation, Maintenance and Monitoring Costs	**Annual Cost ($)**
Continued LNAPL Recovery and Reporting (3 years)	$12,830
Conduct Semiannual Groundwater Monitoring of 4 LTM and 3 POC wells (30 years)	$17,120
Semiannual Reporting (30 years)	$9,824
Maintain Institutional Controls/Public Education (30 years)	$5,000
Project Management (30 years)	$3,120
Present Worth of Alternative 1 [a/]	**$487,000**

[a/] Based on an annual adjustment factor of 7 percent.

See Appendix F for breakdown of costs and present worth analysis.

6.4.2 Alternative 2 - Passive Mobile LNAPL Removal, Bioventing in the Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring

6.4.2.1 Effectiveness

Two additional Bioplume II models (SR20 and SR33) were performed to evaluate the effectiveness of source reductions typically associated with selected remedial alternatives. Model SR20 simulates the effects of a bioventing system that reduces the source concentration at a rate of 20 percent of the original concentration every year for 5 years. Model results suggest that if bioventing is chosen as a source reduction alternative, the BTEX plume will be significantly reduced in size and concentration. Under this scenario, model results show that it is unlikely that BTEX compounds would migrate more than 450 feet from the source area as measured from the northwest property boundary along Brookley Avenue. The maximum concentration within the dissolved BTEX plume should be reduced to approximately 10 µg/L after 13 years. Benzene concentrations should not exceed the DCRA target cleanup levels at the proposed POC well locations.

As discussed in Section 6.4.1, the effectiveness of this remedial alternative requires that excavations or drilling within the source area be conducted only by properly protected site workers. Reasonable land use assumptions for the plume area indicate that exposure is unlikely unless excavation or drilling activities bring contaminated soil to the surface. As with Alternative 1, long-term land use restrictions will be required.

Alternative 2 will satisfy program objectives designed to promote intrinsic remediation as a component of site remediation and to scientifically document naturally occurring processes. This alternative is based on the effectiveness of the bioventing system to remove residual LNAPL from the Car Care Center Site within a 5-year period. Once BTEX leaching rates are reduced, intrinsic remediation will then minimize contaminant migration and reduce contaminant mass in groundwater.

6.4.2.2 Implementability

Alternative 2 is not technically difficult to implement. As with Alternative 1, passive mobile LNAPL skimming will be used at the Car Care Center Site from four site monitoring wells. Bioventing systems have been operating at other sites on Bolling AFB, with favorable results. The bioventing system would consist of a series of air injection wells connected to a small blower by underground piping. This equipment is fairly common within the environmental industry. Because the alternative does not directly affect the residual LNAPL at the site, DCRA may not approve of bioventing as the primary source control measure for the site. Also, the oxygen demand may initially be too high to augment with bioventing alone due to the presence of high VOC concentrations in subsurface soils. As a result, bioventing may not provide adequate removal of the residual LNAPL at the site. During this evaluation, costs for pilot testing were provided to determine whether additional measures may be required to remove excessive residual LNAPL from the site.

During design of a bioventing system, caution should be taken to ensure that the air injection process will not force volatile hydrocarbon vapors into surrounding buildings

and sumps. Because numerous buildings exist within and adjacent to the Car Care Center, engineered controls must be provided to ensure health and safety of Base personnel and property. Due to the high VOC concentrations present in the subsurface, very low air injection rates may be necessary in order to control VOC migration. This may limit the effectiveness of the bioventing system, until VOC concentrations have been reduced.

6.4.2.3 Cost

The cost of Alternative 2 is summarized in Table 6.4. A more complete breakdown and present worth analysis of these costs are provided in Appendix F. Capital costs are limited to the construction of three new POC wells, one new LTM well, eight vent wells, eight vapor monitoring points, and the bioventing system. As with Alternative 1, passive mobile LNAPL removal is proposed for a period of 3 years. The bioventing system would operate for 5 years. LTM would continue for 13 years during bioventing system operation. The overall cost of passive mobile LNAPL removal, the bioventing system installation and operation, and implementation of the LTM plan is $529,000 total present worth. Also included are the costs of maintaining institutional controls for a total of 13 years.

6.4.3 Alternative 3 - Passive Mobile LNAPL Removal, Soil Vapor Extraction with Off-Gas Treatment, Bioventing in Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring

6.4.3.1 Effectiveness

An additional Bioplume II model (SR33) was performed to evaluate the effectiveness of source reductions associated with a SVE system in combination with bioventing, and passive mobile LNAPL removal. Model SR33 assumed source concentrations would be reduced at a rate of 33 percent of the original concentration every year for 3 years. Model results suggest that if SVE and bioventing were chosen as the remedial alternative, the BTEX plume would be significantly reduced in size and concentration. Under this scenario, BTEX plume reductions occur slightly faster than for bioventing and passive LNAPL skimming alone. Model results suggest that it is unlikely that BTEX compounds would migrate more than 425 feet from the source area, as measured from the property boundary along Brookley Avenue. The maximum dissolved BTEX concentration within the plume is reduced to approximately 100 µg/L after 11 years of treatment. Benzene concentrations should not exceed the DCRA target cleanup level at the proposed POC well locations. The effectiveness of this remedial alternative requires the same land use restrictions and institutional controls as discussed for Alternatives 1 and 2.

Alternative 3 will satisfy program objectives designed to promote intrinsic remediation as a component of site remediation and to scientifically document naturally occurring processes. This alternative is based on the effectiveness of the combined SVE and bioventing system to reduce residual BTEX concentrations within a 3-year period. The model predicts that after leaching rates are reduced, the intrinsic remediation processes will then minimize contaminant migration and reduce contaminant mass in the groundwater within 11 years.

TABLE 6.4

ALTERNATIVE 2 - COST ESTIMATE
PASSIVE MOBILE LNAPL REMOVAL, BIOVENTING IN THE SOURCE AREA, INTRINSIC REMEDIATION, AND INSTITUTIONAL CONTROLS WITH LONG-TERM GROUNDWATER MONITORING
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

	Capital Costs ($)
Install 3 POC wells and 1 LTM well	$14,885
Develop Work Plans	$5,268
Install Test Wells and Conduct Bioventing Pilot Study	$14,928
Design Full-Scale Bioventing System and Procure Bids	$9,179
Install Passive LNAPL Skimmers	$1,650
Install Bioventing System	$57,045
Operation, Maintenance and Monitoring Costs	**Annual Cost ($)**
Passive LNAPL Recovery and Reporting (3 years)	$14,514
Sample Bioventing System, Prepare Bioventing System Performance Reports, and Utility Costs (5 years)	$21,490
Conduct Semiannual Groundwater Monitoring of 4 LTM and 3 POC wells (13 years)	$17,120
Semiannual Reporting (13 years)	$9,824
Maintain Institutional Controls/Public Education (13 years)	$5,000
Project Management (13 years)	$3,120
Present Worth of Alternative 1 [a/]	**$529,000**

[a/] Based on an annual adjustment factor of 5 percent.

See Appendix F for breakdown of costs and present worth analysis

6.4.3.2 Implementability

Alternative 3 is not technically difficult to implement. SVE and bioventing technology is easy to implement. As with Alternatives 1 and 2, passive mobile LNAPL skimming will be performed within four site monitoring wells. The conceptual SVE and bioventing system will consist of a series of air extraction and injection wells. For estimating purposes, five air extraction wells, three bioventing wells, and a total of eight vapor monitoring points were proposed. The SVE system would be powered by a small ICE unit, provided by AFCEE at no additional cost to the Base, which will treat the extracted VOCs in the soil gas. The provided estimate for Alternative 3 also includes costs for obtaining an air emission permit from DCRA. A small pressure blower will be required to power the bioventing system. Both the ICE unit and the blower will be connected to the air extraction/injection wells by underground piping. All required equipment is readily obtainable.

The SVE system would likely be operated for 6 to 12 months to remove the initially high excess VOC concentrations from the soil gas. Parsons ES assumed a 12-month duration for the purposes of this estimate. After that time, the SVE system would be dismantled and the bioventing system would be installed and operated for the remaining 2 years. This conversion period would depend on the ability of bioventing (alone) to sustain oxygenated conditions in the subsurface.

6.4.3.3 Cost

The cost of Alternative 3 is summarized in Table 6.5. A more complete breakdown and present worth analysis of these costs are provided in Appendix F. Necessary costs were included in this analysis to perform short-term pilot testing for the SVE and bioventing systems. Capital costs are limited to the construction of three new POC wells, three new LTM wells, eight vent wells, eight vapor monitoring points, the bioventing system, piping costs, and four passive skimmers. The ICE unit is already owned by the AFCEE. As a result, capital costs for the unit are not required. Transportation costs for the ICE unit were included. As with Alternatives 1 and 2, mobile LNAPL is proposed to continue for 3 years. The ICE is assumed to operate for the first year and the bioventing system is assumed to operate for the remaining 2-year period. LTM will initiate upon remedial system installation and continue for 11 years. The overall cost of passive LNAPL removal, the bioventing systems, remedial system installations, and implementation of the LTM plan is $485,000 total present worth. Also included are the costs of maintaining institutional controls and long-term groundwater monitoring for a total of 11 years.

6.5 RECOMMENDED REMEDIAL APPROACH

Three remedial alternatives have been evaluated for remediation of the shallow groundwater at the Car Care Center Site. Components of the alternatives include intrinsic remediation with LTM, bioventing, and SVE using an ICE unit, and bioventing. Tables 6.2, 6.3, 6.4, and 6.5 summarize the results of the evaluation based upon effectiveness, implementability, and cost criteria. Table 6.6 summarizes the costs for the three selected alternatives. Alternative 1 may not be accepted by DCRA because it did not actively address the residual LNAPL remaining source area. Also, Alternative 2 may potentially affect adjacent buildings due to VOC migration in

TABLE 6.5

ALTERNATIVE 3 - PASSIVE MOBILE LNAPL REMOVAL; SOIL VAPOR EXTRACTION WITH OFF-GAS TREATMENT, AND BIOVENTING IN THE SOURCE AREA, INTRINSIC REMEDIATION, AND INSTITUTIONAL CONTROLS WITH LONG-TERM GROUNDWATER MONITORING
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

	Capital Costs ($)
Install 3 POC wells and 1 LTM well	$14,885
Develop Work Plans	$5,268
Install Test Wells and Conduct SVE/Bioventing/ Pilot Study	$14,928
Design SVE/Bioventing/Biosparging System and Procure Bids	$14,471
Install Passive LNAPL Skimmers	$1,650
Install SVE/Bioventing/System	$60,263
Operation, Maintenance and Monitoring Costs	**Annual Cost ($)**
Continued LNAPL Recovery and Reporting (3 years)	$14,514
Sample SVE (ICE) System, Prepare System Performance Reports, and Utility Costs (1 year)	$42,069
Sample Bioventing System, Prepare System Performance Reports, and Utility Costs (2 years)	$21,720
Conduct Semiannual Groundwater Monitoring of 4 LTM and 3 POC wells (11 years)	$17,120
Semiannual Reporting (11 years)	$9,824
Maintain *Institutional Controls/Public Education* (11 years)	$5,000
Project Management (11 years)	$3,120
Present Worth of Alternative 1 [a/]	**$484,800**

[a/] Based on an annual adjustment factor of 7 percent.

See Appendix F for breakdown of costs and present worth analysis.

TABLE 6.6

SUMMARY OF PRESENT-WORTH ANALYSIS FOR SELECTED REMEDIAL ALTERNATIVES
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

ALTERNATIVE	PRESENT WORTH ($)
Alternative 1 - Passive Mobile LNAPL Removal, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring	$487,000
Alternative 2 - Passive Mobile LNAPL Removal, Bioventing in the Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring	$529,000
Alternative 3 [a/] - Passive Mobile LNAPL Removal, Soil Vapor Extraction with Off-Gas Treatment, Bioventing in Source Area, Intrinsic Remediation, and Institutional Controls with Long-Term Groundwater Monitoring	$484,800

[a/] Alternative 3 was the selected remedial option.

the vadose zone. Based on these evaluations, the Air Force recommends Alternative 3 as achieving the best combination of risk reduction and cost effectiveness.

In October 1996, an ICE/SVE system was installed at the former Car Care Center. Using a V2 ICE unit, the ICE/SVE system ran from October 16 until October 20. During this time period the ICE/SVE unit removed 144 pounds of total volatile hydrocarbons (TVH) from the site's underlying soils. On October 20, the ICE/SVE system was shut down, because of extremely high TVH concentrations in the effluent. A larger ICE unit, a V4 model, is scheduled to replace the V2 ICE unit during the week on November 4, 1996. The startup and optimization of the model V4 ICE unit at the former Car Care Center is anticipated in mid November, 1996.

It is likely that natural attenuation alone (Alternative 1) will not accomplish the remedial objectives for the site, due to extensive residual LNAPL contamination at the Car Care Center Site. Based on all the effectiveness criteria, Alternative 3 will make maximum use of intrinsic remediation mechanisms to reduce plume migration and toxicity while providing the added benefits of enhanced *in situ* soil remediation in the source area and the introduction of additional oxygen (through infiltration and re-aeration) into the groundwater. Implementation of Alternative 3 will require land-use and groundwater-use controls and semiannual groundwater monitoring for approximately 11 years after startup of the ICE system.

The final evaluation criterion used to compare each of the three remedial alternatives was cost. It is the opinion of the Air Force that the Alternative 3 is the most economical remedial alternative for the site. Because Alternative 3 is a more aggressive remedial approach, active remediation time frame is reduced to approximately 3 years and LTM is reduced to approximately 11 years, reducing the overall present value cost for this alternative, as compared to Alternatives 2 and 3.

SECTION 7

LONG-TERM MONITORING PLAN

7.1 OVERVIEW

In keeping with the requirements of the preferred remedial alternative for the Car Care Center Site (passive LNAPL recovery, SVE via an ICE system, bioventing, and intrinsic remediation with LTM), a long-term groundwater monitoring plan must be developed. The purpose of this component of the preferred remedial alternative for the site is to assess conditions over time; confirm the effectiveness of LNAPL recovery, SVE, bioventing, and naturally occurring processes at reducing contaminant mass and minimizing contaminant migration; and evaluate the need for additional remediation.

To demonstrate attainment with both levels of site-specific remediation goals and to verify the predictions of the Bioplume II model developed for the Car Care Center Site, the LTM plan consists of identifying the location of two separate groundwater monitoring networks and developing a groundwater sampling and analysis strategy. The strategy described in this section is designed to monitor plume migration over time and to verify that intrinsic remediation is occurring at rates sufficient to protect potential receptors. In the event that data collected under this LTM program indicate that naturally occurring processes (in addition to LNAPL recovery, SVE, and bioventing) are insufficient to protect human health and the environment, contingency controls to augment the beneficial effects of intrinsic remediation would be necessary.

7.2 MONITORING NETWORKS

Two separate sets of wells will be used at the site as part of the LTM program. The first set will consist of four LTM wells located in, upgradient, and downgradient of the observed BTEX plume to verify the results of the Bioplume II modeling effort and to ensure that natural attenuation is occurring at rates sufficient to minimize plume expansion (i.e., meet the first level of RAOs for the site). This network of wells will consist of existing and proposed wells screened within the shallow aquifer to provide short-term confirmation and verification of the quantitative groundwater modeling results. The second set of groundwater monitoring wells will be located approximately 700 feet downgradient from the source area (northwest property boundary along Brookley Avenue). The purpose of the POC wells is to verify that no BTEX compounds exceeding DCRA target cleanup values and federal MCLs migrate beyond the area under institutional control (i.e., meet the second level of RAOs for the site). This network will consist of three groundwater monitoring wells screened across the first 10 feet of the shallow aquifer. The LTM and POC wells will be sampled for analysis of the parameters listed in Tables 7.1 and 7.2, respectively.

TABLE 7.1

LONG-TERM MONITORING ANALYTICAL PROTOCOL
CAR CARE CENTER SITE INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Ferrous (Fe^{2+})	Colorimetric A3500-Fe D	Field only	Elevated ferrous iron concentrations may be indicative of the anaerobic biodegradation process of iron reduction	Semiannually	Collect 100 mL of water in a glass container; acidify with hydrochloric acid per method	Field
Ferrous (Fe^{2+})	Colorimetric HACH 25140-25	Alternate method; field only	Elevated ferrous iron concentrations may be indicative of the anaerobic biodegradation process of iron reduction	Semiannually	Collect 100 mL of water in a glass container	Field
Temperature	E170.1	Field only	Metabolism rates for microorganisms depend on temperature	Semiannually	N/A	Field
Dissolved Oxygen	Dissolved oxygen meter	Refer to Method A4500 for a comparable laboratory procedure	The oxygen concentration is a data input to the Bioplume II model; concentrations less than 1 mg/L generally indicate an anaerobic pathway	Semiannually	Collect 300 mL of water in biochemical oxygen demand bottles; analyze immediately; alternately, measure dissolved oxygen in situ	Field
pH	E150.1/SW9040, direct reading meter	Protocols/Handbook methods[a/]	Aerobic and anaerobic processes are pH-sensitive	Semiannually	Collect 100–250 mL of water in a glass or plastic container; analyze immediately	Field
Conductivity	E120.1/SW9050, direct reading meter	Protocols/Handbook methods	General water quality parameter used as a marker to verify that site samples are obtained from the same ground water system	Semiannually	Collect 100–250 mL of water in a glass or plastic container	Field
Nitrate (NO_3^{-1})	IC method E300 or method SW9056; colorimetric, method E353.2	Method E300 is a Handbook method; method SW9056 is an equivalent procedure	Substrate for microbial respiration if oxygen is depleted	Semiannually	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C; analyze within 48 hours	Fixed-base

TABLE 7.1 (CONCLUDED)

LONG-TERM MONITORING ANALYTICAL PROTOCOL
CAR CARE CENTER SITE INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Sulfate (SO_4^{-2})	IC method E300 or method SW9056 or HACH SulfaVer 4 method	Method E300 is a Handbook method; method SW9056 is an equivalent procedure. HACH method is Photometric	Substrate for anaerobic microbial respiration	Semiannually	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C	Fixed-base or field (for HACH method)
Redox potential	A2580 B	Measurements are made with electrodes; results are displayed on a meter; samples should be protected from exposure to atmospheric oxygen	The redox potential of ground water influences and is influenced by biologically mediated reactions; the redox potential of ground water may range from more than 200 mV to less than -400 mV	Semiannually	Collect 100–250 mL of water in a glass container, filling container from bottom; analyze immediately	Field
Methane	RSKSOP-114 modified to analyze water samples for methane by headspace sampling with dual thermal conductivity and flame ionization detection.	Method published and used by the US Environmental Protection Agency Robert S. Kerr Laboratory	The presence of methane suggests BTEX degradation via an anaerobic pathway utilizing carbon dioxide (carbonate) as the electron acceptor (methanogenesis)	Semiannually	Collect water samples in 40 mL volatile organic analysis (VOA) vials with butyl gray/Teflon-lined caps (zero headspace); cool to 4°C	Fixed-base
Aromatic hydrocarbons (BTEX)	Purge and trap GC method SW8020	Handbook method; analysis may be extended to higher molecular weight alkylbenzenes	BTEX is the primary target analyte for monitoring natural attenuation; BTEX concentrations must also be measured for regulatory compliance	Semiannually	Collect water samples in a 40 mL VOA vial with zero headspace; cool to 4°C; add hydrochloric acid to pH 2	Fixed-base

[a] Protocol methods are presented by Wiedemeier *et al.*, 1994. Handbook refers to "AFCEE Handbook to Support the Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study (RI/FS).

TABLE 7.2

POINT-OF COMPLIANCE MONITORING ANALYTICAL PROTOCOL
CAR CARE CENTER SITE INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Temperature	E170.1	Field only	Well development	Semiannually	N/A	Field
Dissolved Oxygen	Dissolved oxygen meter	Refer to method A4500 for a comparable laboratory procedure	The oxygen concentration is a data input to the Bioplume model; concentrations less than 1 mg/L generally indicate an anaerobic pathway	Semiannually	Collect 300 mL of water in biochemical oxygen demand bottles; analyze immediately; alternately, measure dissolved oxygen in situ	Field
pH	E150.1/SW9040, direct reading meter	Protocols/Handbook methods[a/]	Aerobic and anaerobic processes are pH-sensitive	Semiannually	Collect 100–250 mL of water in a glass or plastic container; analyze immediately	Field
Conductivity	E120.1/SW9050, direct reading meter	Protocols/Handbook methods	General water quality parameter used as a marker to verify that site samples are obtained from *the same ground water system*	Semiannually	Collect 100–250 mL of water in a glass or plastic container	Field
Redox potential	A2580 B	Measurements are made with electrodes; results are displayed on a meter; samples should be protected from exposure to atmospheric oxygen	The redox potential of ground water influences and is influenced by biologically mediated reactions; the redox potential of ground water may range from more than 200 mV to less than -400 mV	Semiannually	Collect 100–250 mL of water in a glass container, filling container from bottom; analyze immediately	Field
Aromatic hydrocarbons (BTEX)	Purge and trap GC method SW8020	Handbook method; analysis may be extended to higher molecular weight alkylbenzenes	BTEX is the primary target analyte for monitoring natural attenuation; BTEX concentrations must also be measured for regulatory compliance	Semiannually	Collect water samples in a 40 mL VOA vial with zero headspace; cool to 4°C; add hydrochloric acid to pH 2	Fixed-base

[a/] Protocol methods are presented by Wiedemeier *et al.*, 1994. Handbook refers to "AFCEE Handbook to Support the Installation Restoration Program (IRP) Remedial Investigation/Feasibility Study (RI/FS).

7.2.1 Long-Term Monitoring Wells

Four groundwater wells within, upgradient, and downgradient of the existing BTEX contaminant plume will be used to monitor the effectiveness of intrinsic remediation in reducing total contaminant mass and minimizing contaminant migration at the Car Care Center Site. These wells will follow the contaminant flow path with one well located in each of the following areas: the anaerobic treatment zone, the aerobic treatment zone, and downgradient from the aerobic treatment zone.

At three locations, existing or replacement wells will be used for this purpose. Well MW-4R will be used to monitor conditions near the plume core, while CPT-22D will be used to monitor conditions in the aerobic treatment zone. Monitoring well MW-9 will be used for monitoring upgradient of the plume. One new well should be installed downgradient of the plume. Figure 7.1 identifies the proposed locations of the new well and the existing wells to be used for LTM. This network will supplement the POC wells to provide early confirmation of model predictions and to allow additional response time if necessary. The new LTM well will be constructed with a 10-foot screen, with approximately 8 feet of the screen below the water table. All LTM wells will be sampled and analyzed for the parameters listed in Table 7.1 to verify the effectiveness of the intrinsic remediation remedial alternative.

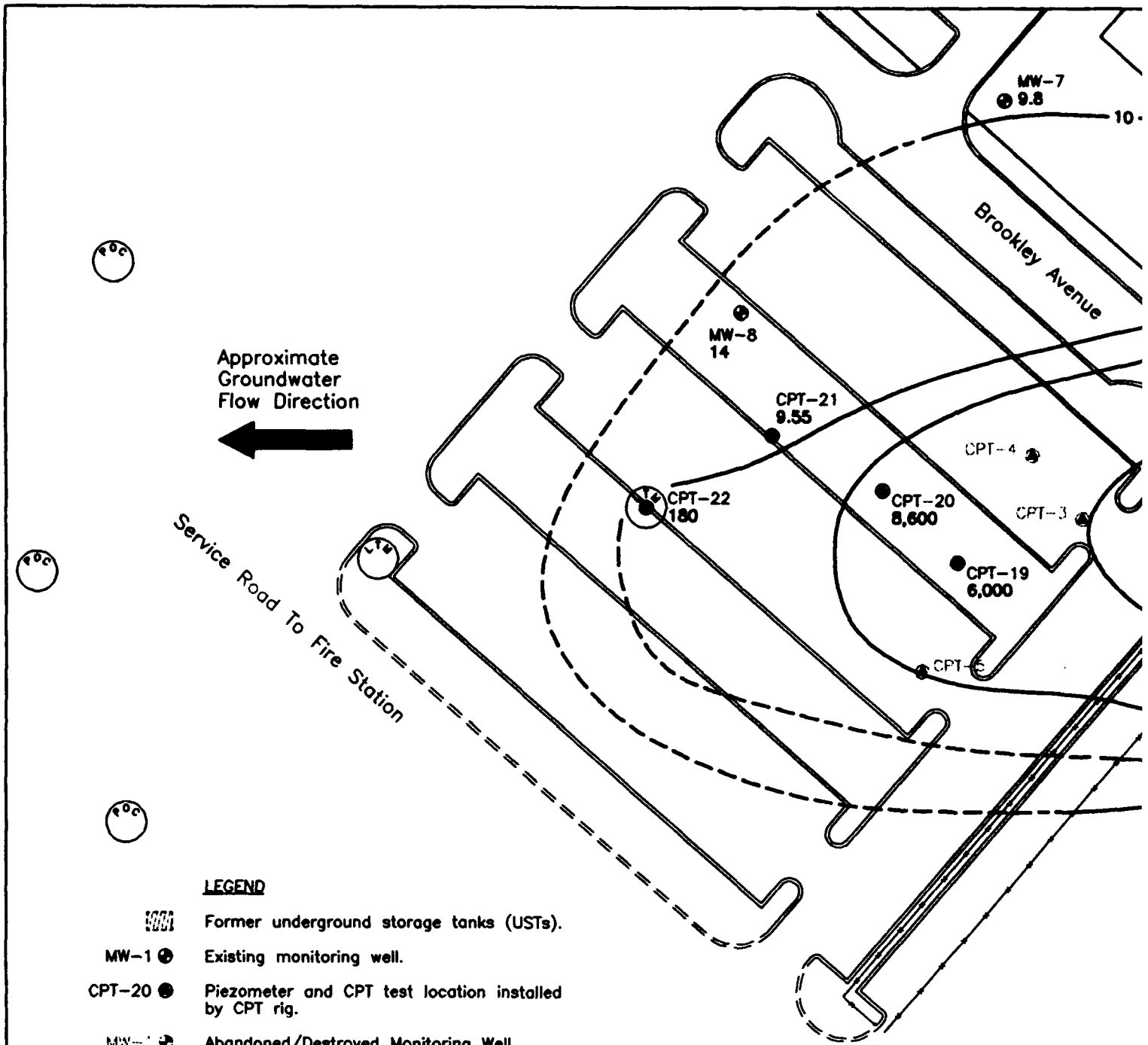
7.2.2 Point-of-Compliance Wells

Three POC monitoring wells should be installed approximately 650 feet downgradient of the source area. Figure 7.1 shows the proposed locations of these wells. The purpose of the POC wells is to verify that no contaminated groundwater exceeding DCRA target cleanup values and federal MCLs migrates beyond the area under institutional control. Although model results suggest that the contaminant plume will not migrate beyond this location at concentrations exceeding chemical-specific federal MCLs, these POC wells are the technical mechanisms used to demonstrate protection of human health and the environment and compliance with site-specific numerical remediation goals. These wells will be installed and monitored for the parameters listed in Table 7.2 to assure that the selected remedy is providing the anticipated level of risk reduction and remediation at the site.

As with the LTM wells, the POC wells will also be screened in the same hydrogeologic unit as the contaminant plume. Data presented in this report concerning the nature and extent of contamination at the site suggest that a 10-foot screen with approximately 8 feet of screen below the groundwater surface will be sufficient to intercept the contaminant plume at this site. Figure 7.2 is a proposed groundwater monitoring well completion diagram for both the LTM well and the POC wells.

7.3 GROUNDWATER SAMPLING

To ensure that sufficient contaminant removal is occurring at the Car Care Center Site to protect human health and the environment and meet site-specific remediation goals, the long-term groundwater monitoring plan includes a comprehensive sampling and analysis plan. Both LTM and POC wells will be sampled and analyzed semiannually to verify that naturally occurring processes are effectively reducing contaminant mass and mobility. Reduction in toxicity will be implied by mass



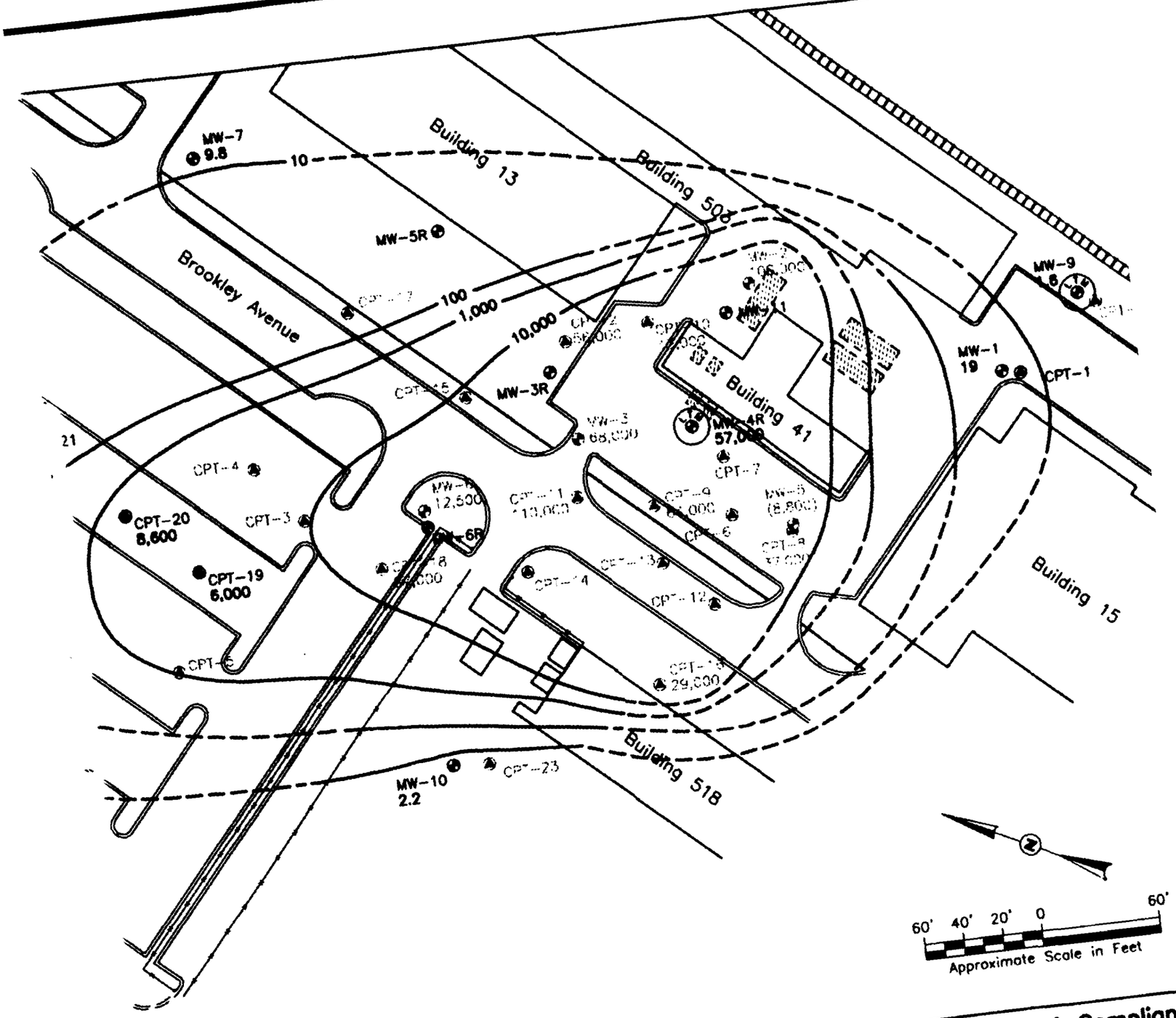
LEGEND

	Former underground storage tanks (USTs).
MW-1	Existing monitoring well.
CPT-20	Piezometer and CPT test location installed by CPT rig.
MW-1	Abandoned/Destroyed Monitoring Well
CPT-20	Abandoned CPT Test Location
8,600	Total benzene, toluene, ethylbenzene and xylene (BTEX) concentration (ug/L) by SW8020.
(190)	Data not utilized to construct contours.
100	Total BTEX concentration (ug/L) contour, dashed where inferred.
LTM	Proposed long-term monitoring well.
POC	Proposed point-of-compliance monitoring well.

NOTE:

1. Isopleth
deep CPT

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Proposed Point-of-Compliance Long-Term Monitoring Well Place

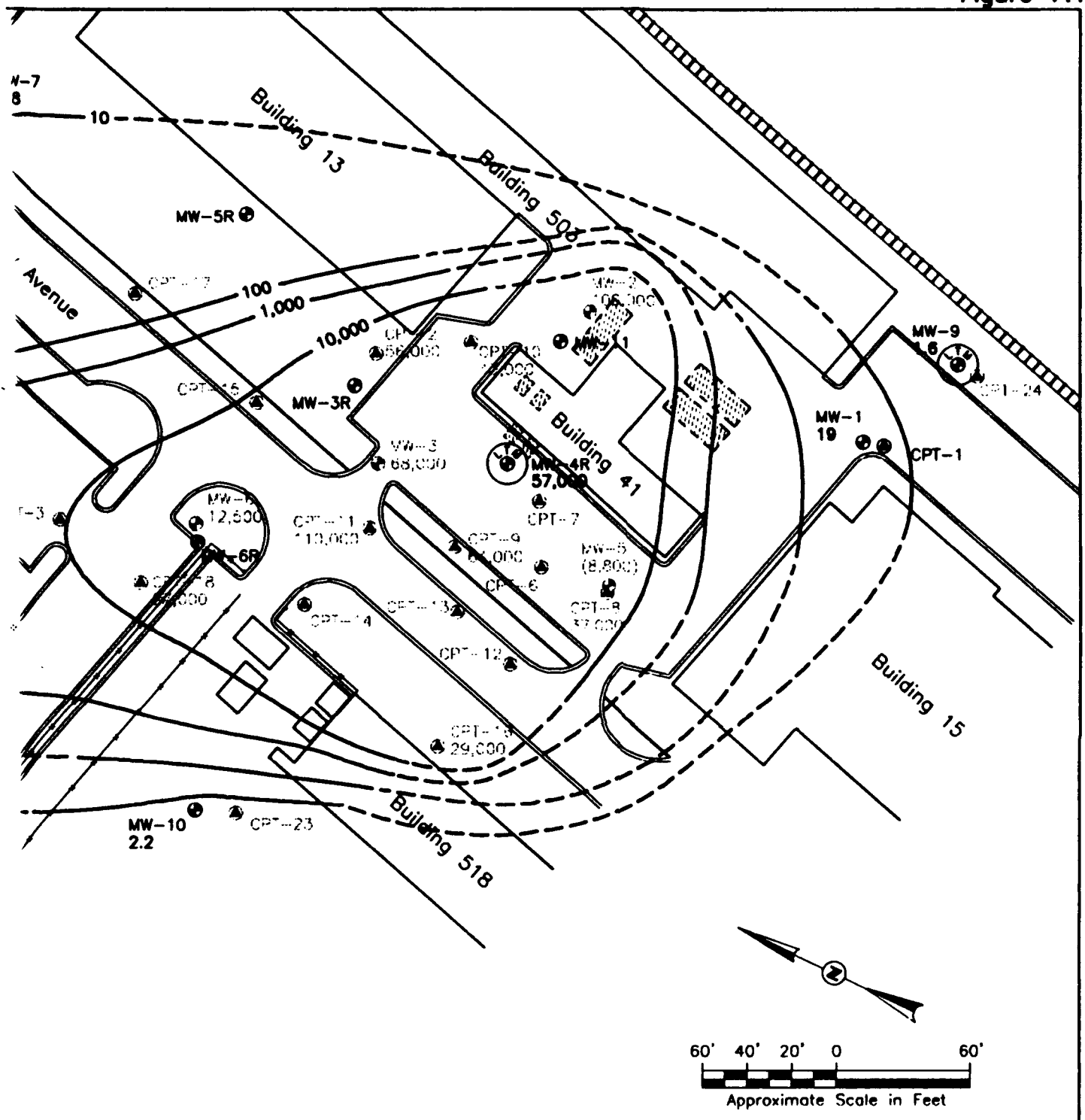
Car Care Center Site Intrinsic Remediation EE/CA Bolling AFB, DC

PARSONS ENGINEERING SCIEN

NOTE:

1. Isopleth map was developed using data from deep CPT points and monitoring wells.

Figure 7.1



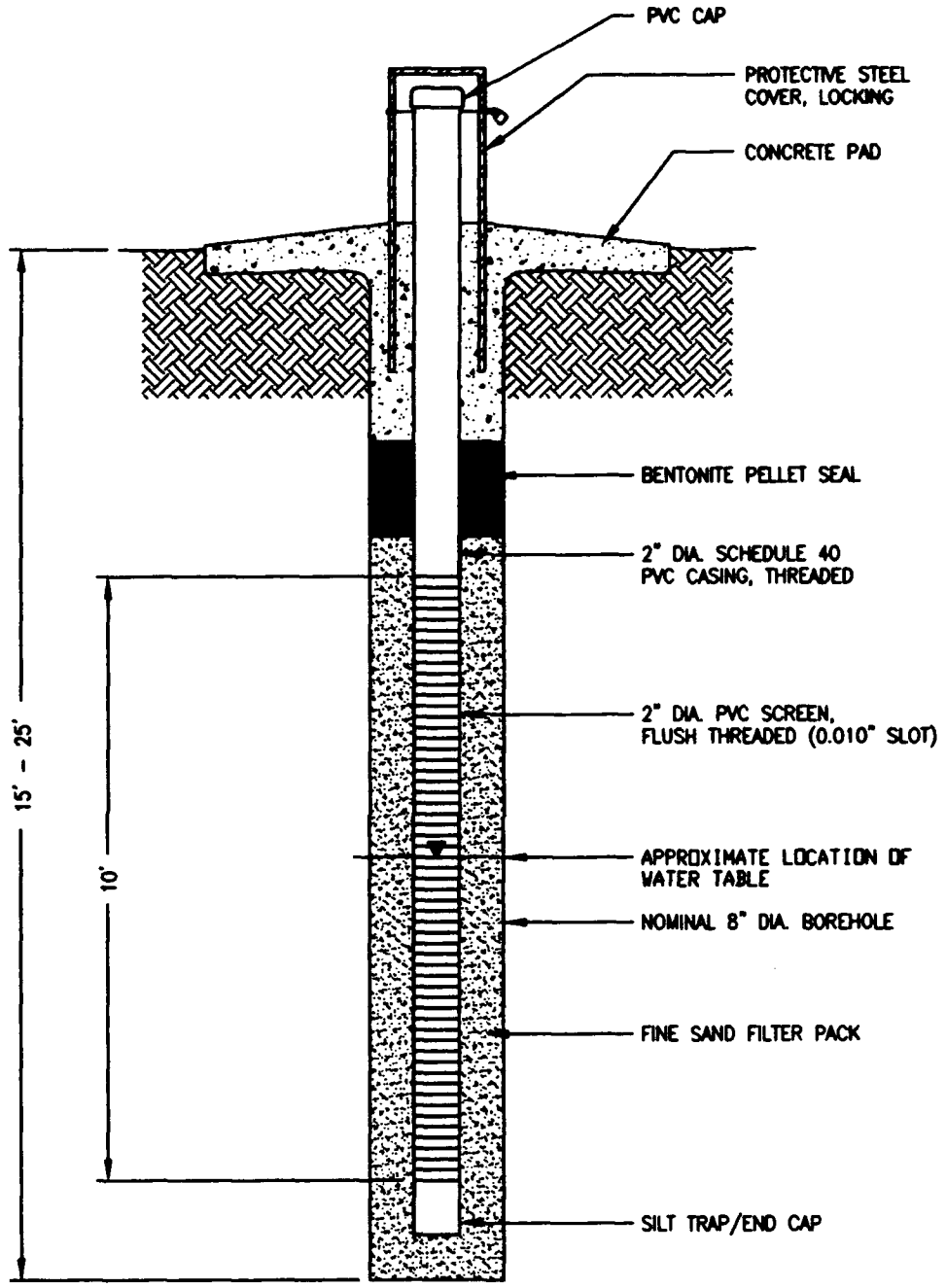
Proposed Point-of-Compliance and Long-Term Monitoring Well Placement

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

NOTE:

. Isopleth map was developed using data from deep CPT points and monitoring wells.

Figure 7.2



Note: Drawing is not to scale.

Proposed Monitoring Well Completion Diagram

Car Care Center Site
Intrinsic Remediation EE/CA
Bolling AFB, DC

72245067.dwg / 1=1 / 1-23-96 / TLP

reduction. The sampling and analysis plan will also be aimed at assuring that intrinsic remediation can achieve site-specific remediation concentration goals for BTEX compounds and protect human health and the environment.

7.3.1 Analytical Protocol

All LTM and POC wells in the LTM program will be sampled and analyzed to determine compliance with chemical-specific remediation goals and to verify the effectiveness of intrinsic remediation at the site. Water level measurements will be made during each sampling event. Groundwater samples will be analyzed for the parameters listed in Tables 7.1 and 7.2. A site-specific groundwater sampling and analysis plan should be prepared prior to initiating the LTM program.

7.3.2 Sampling Frequency

Each of the LTM and POC sampling points will be sampled twice each year for 11 years. If the data collected during this time period supports the anticipated effectiveness of the intrinsic remediation alternative at this site, the sampling frequency can be reduced to once every year for all wells in the LTM program, or eliminated. If the data collected at any time during the monitoring period indicate the need for additional remedial activities at the site, sampling frequency should be adjusted accordingly. Likewise, if the data collected during this period supports the anticipated effectiveness of intrinsic remediation, the sampling frequency can be reduced to once every year. The groundwater samples should be analyzed for BTEX compounds by USEPA Method SW8020. If BTEX concentrations in groundwater from the POC wells exceed the District of Columbia's target Cleanup levels of 5 microgram per liter (µg/L) for benzene, 1,000 µg/L for toluene, 700 µg/L for ethylbenzene, or 10,000 µg/L for total xylenes, additional corrective actions may be required to remediate groundwater at the site.

SECTION 8

CONCLUSIONS AND RECOMMENDATIONS

This report presents the results of a contaminant assessment conducted to evaluate the use of intrinsic remediation (natural attenuation) for remediation of fuel-hydrocarbon-contaminated groundwater at the Car Care Center Site (Building 41), Bolling AFB, DC. Specifically, the finite-difference groundwater model Bioplume II was used in conjunction with site-specific geologic, hydrologic, and laboratory analytical data to simulate the migration and biodegradation of fuel hydrocarbon compounds dissolved in groundwater. Groundwater contaminant and geochemical data collected in August 1994 and June 1996 strongly suggest that aerobic biodegradation of fuel hydrocarbons is occurring at the site. In addition, the data also suggest that anaerobic biodegradation is occurring via sulfate reduction, denitrification, iron and manganese reduction, and methanogenesis.

To evaluate intrinsic remediation, Parsons ES collected and analyzed soil and groundwater samples from the site. Physical and chemical data collected under this program were supplemented with data collected during previous site characterization events. Site-specific geologic, hydrogeologic, and laboratory analytical data from August 1994 were then used in the Bioplume II numerical groundwater model to simulate the effects of advection, dispersion, sorption, and biodegradation on the fate and transport of the dissolved BTEX plume. Extensive site-specific data were used for model implementation. Model parameters that could not be obtained from existing site data were estimated using widely accepted literature values for sediments similar to those found at the site. Conservative aquifer parameters were used to construct the Bioplume II model for this study.

For one simulation (model CAL2), it was assumed that BTEX compounds will continue to enter the aquifer at a constant rate. That rate was the same rate used to produce the initial calibrated model. Predictions based on model CAL2 show that the BTEX plume equilibrates after 25 to 30 years, with the leading edge of the plume stabilizing approximately 460 feet beyond the Car Care Center property boundary along Brookley Avenue. For a second simulation (model SR20), it was assumed that BTEX loading rates were significantly decreased by bioventing over a 5-year period. A third simulation (model SR33), assumed that BTEX loading rates were decreased over a 3-year period by a combination of SVE, and bioventing technologies. Results of the SR20 and SR33 models represent optimistic scenarios in which dissolved BTEX compounds would degrade to below detectable concentration in 13 years or less.

Groundwater data collected in June 1996 allows for the direct comparison of observed contaminant plume migration and predicted model results. Even though no active remediation has occurred since the August 1994, the observed dissolved BTEX

plume in June 1996 (Figure 4.4) indicates that source area concentrations have decreased while the leading edge of the plume has migrated slightly to the northwest. Both the slight decrease in source area concentrations and the minimal northwesterly migration of the leading edge of the June 1996 BTEX plume are very similar to the predicted 1996 plume assuming no source removal. Using several points for comparison, the observed increase in dissolved contamination near the leading edge of the plume, in June 1996, seems to slightly exceed model predictions for the downgradient migration distance of the 10,000 µg/L, 1,000 µg/L, and 100 µg/L isopleths for 1996. However, groundwater data collected in June 1996 continue to suggest that several natural attenuation processes are decreasing source area concentrations of dissolved BTEX contamination and limiting plume migration.

The results of this study suggest that natural attenuation of BTEX compounds is occurring at the Car Care Center Site to the extent that the dissolved concentrations of these compounds in groundwater should be reduced to levels below current regulatory guidelines long before potential downgradient receptors could be adversely affected (i.e., the potential contaminant migration pathway will not be complete for any of the potential receptors described in Section 6.2). However, the Air Force has recommended a more aggressive remedial option consisting of SVE and bioventing system in combination with passive LNAPL removal, natural attenuation, institutional controls, and LTM at the Car Care Center Site. This alternative would address the source of contamination and reduce cleanup times while remaining cost-effective. To accomplish this recommendation, construction activities and groundwater use in and downgradient from the source area should be restricted for a period of approximately 11 years or until groundwater contaminant concentrations decrease below DCRA target cleanup values. Groundwater samples should be collected on an semiannual basis during LTM to monitor plume migration, allowing continual reevaluation of the proposed remedial time frame.

In October 1996, the first component of the preferred remedial alternative was implemented through installation of an ICE/SVE system at the former Car Care Center. Using a V2 ICE unit, the ICE/SVE system ran from October 16 until October 20. During this time period the ICE/SVE unit removed 144 pounds of total volatile hydrocarbons (TVH) from the site's underlying soils. On October 20, the ICE/SVE system was shut down, because of extremely high TVH concentrations in the effluent. A larger ICE unit, a V4 model, replaced the V2 ICE unit during November 1996.

With the implementation of a new source removal technology, i.e. SVE system, the dissolved contaminant plume is expected to decrease significantly within the next two years (the expected running time of SVE operations). SVE operations are expected to significantly decrease TVPH concentrations in source area soils by 1998, which in turn should reduce the dissolution of additional fuel constituents to groundwater and consequently limit the migration of water soluble fuel hydrocarbons in the site groundwater. Results from future monitoring of the dissolved BTEX plume are anticipated to show more rapid decrease in contamination than CAL2 model predictions and perhaps comparable to model predictions for the 20 to 33 percent annual source removal scenarios.

To verify the results of the Bioplume II modeling effort and the implemented remedial option, and to ensure that natural attenuation is occurring at rates sufficient to

protect potential downgradient receptors, groundwater from three existing monitoring wells, one proposed LTM well, and three proposed POC wells should be sampled semiannually and analyzed for the parameters listed in Tables 7.1 and 7.2. The three POC groundwater monitoring wells will be installed downgradient from the predicted maximum travel distance of the BTEX plume, at approximately 650 feet downgradient of the source area. If dissolved BTEX concentrations in the POC wells are found to exceed the federal MCL and DCRA target cleanup values of 5 µg/L for benzene, 1,000 µg/L for toluene, 700 µg/L for ethylbenzene, or 10,000 µg/L for total xylenes, additional evaluations or corrective actions may be necessary at this site.

SECTION 9

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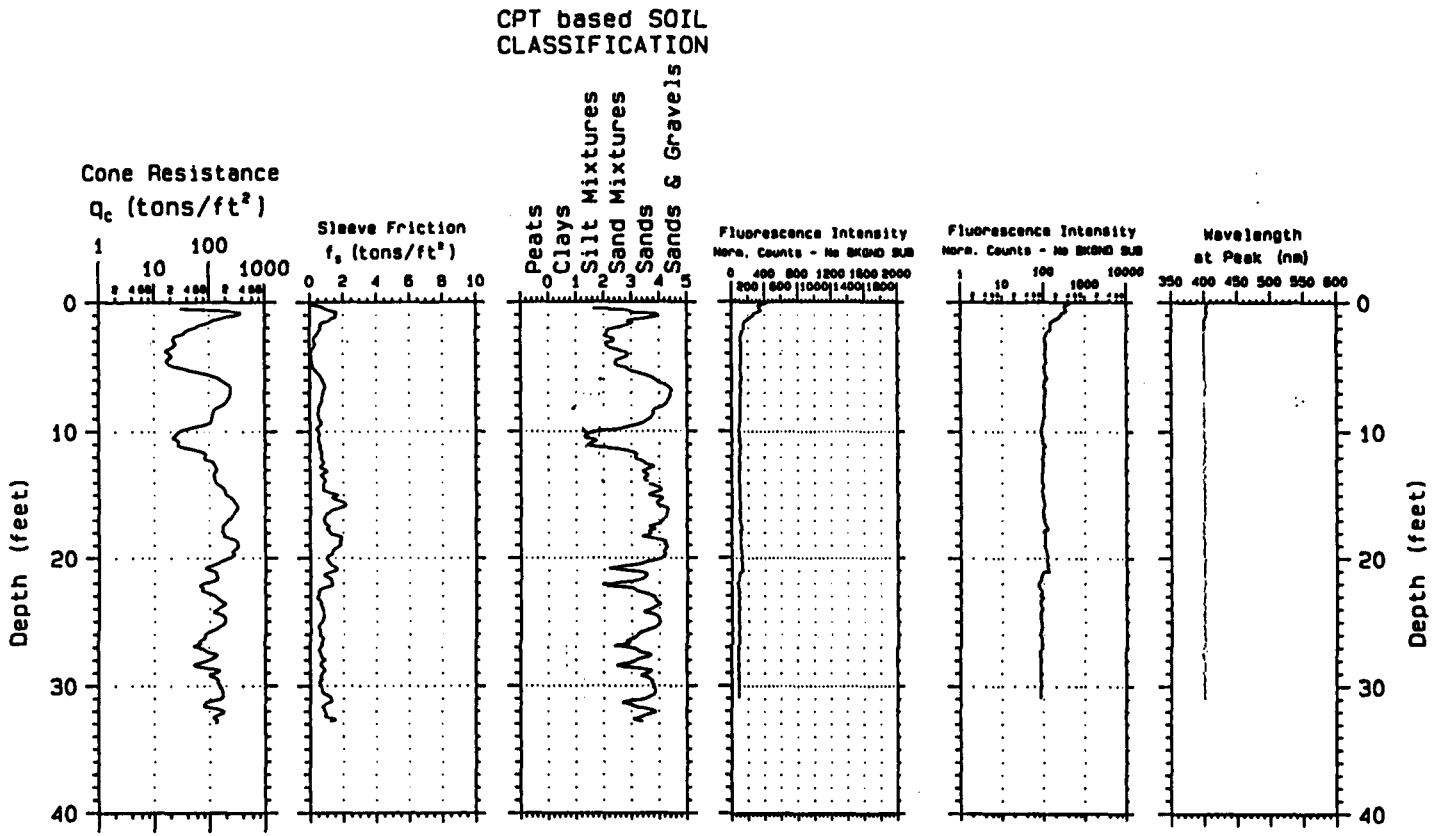
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Location: CPT-1



Laser Induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

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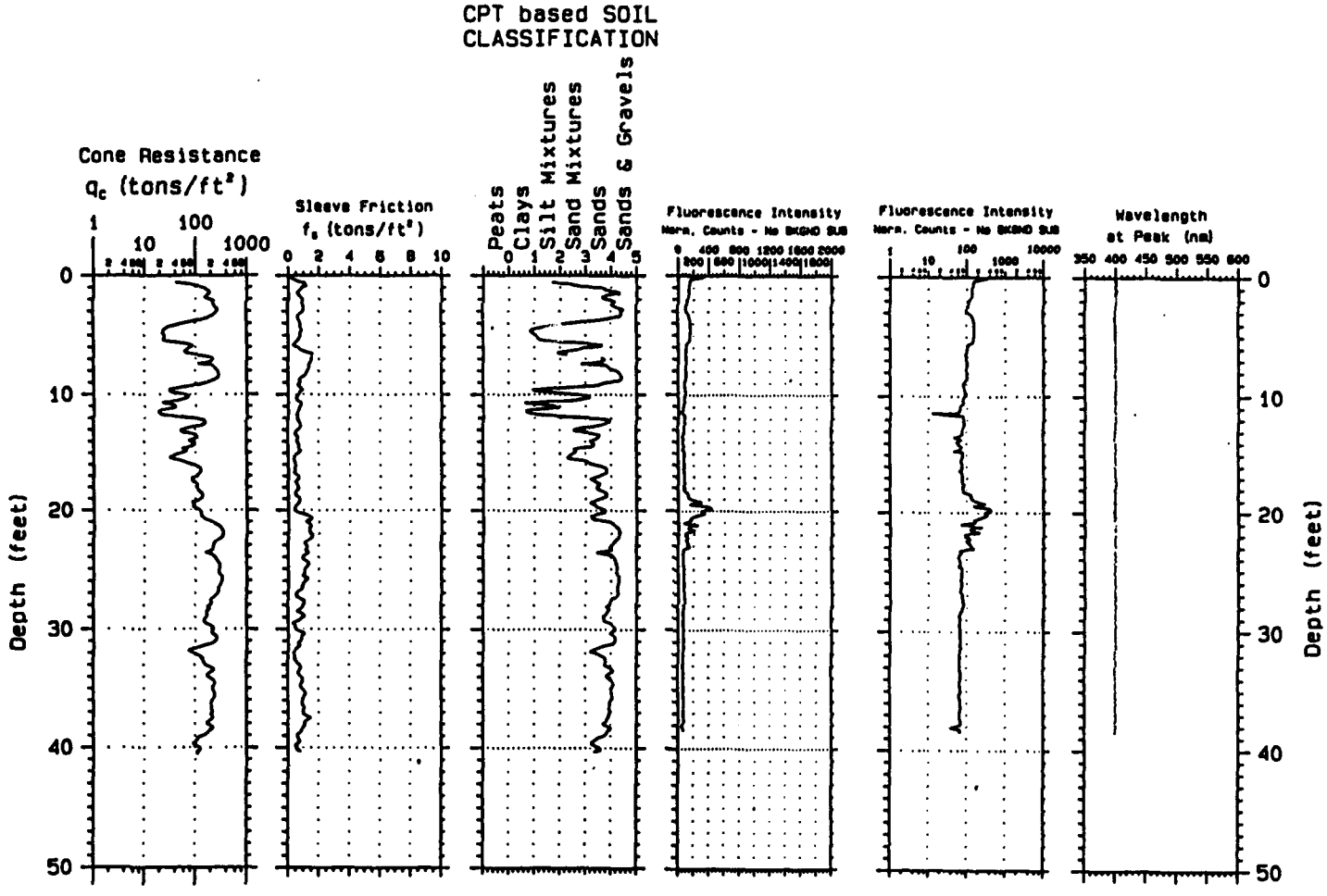
Project; Bolling AFB

Probe Depth; 33.04

Probing date; 08-01-1994

CPT; 01FB01

Location: CPT-2



Probing date: 08-01-1994

Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

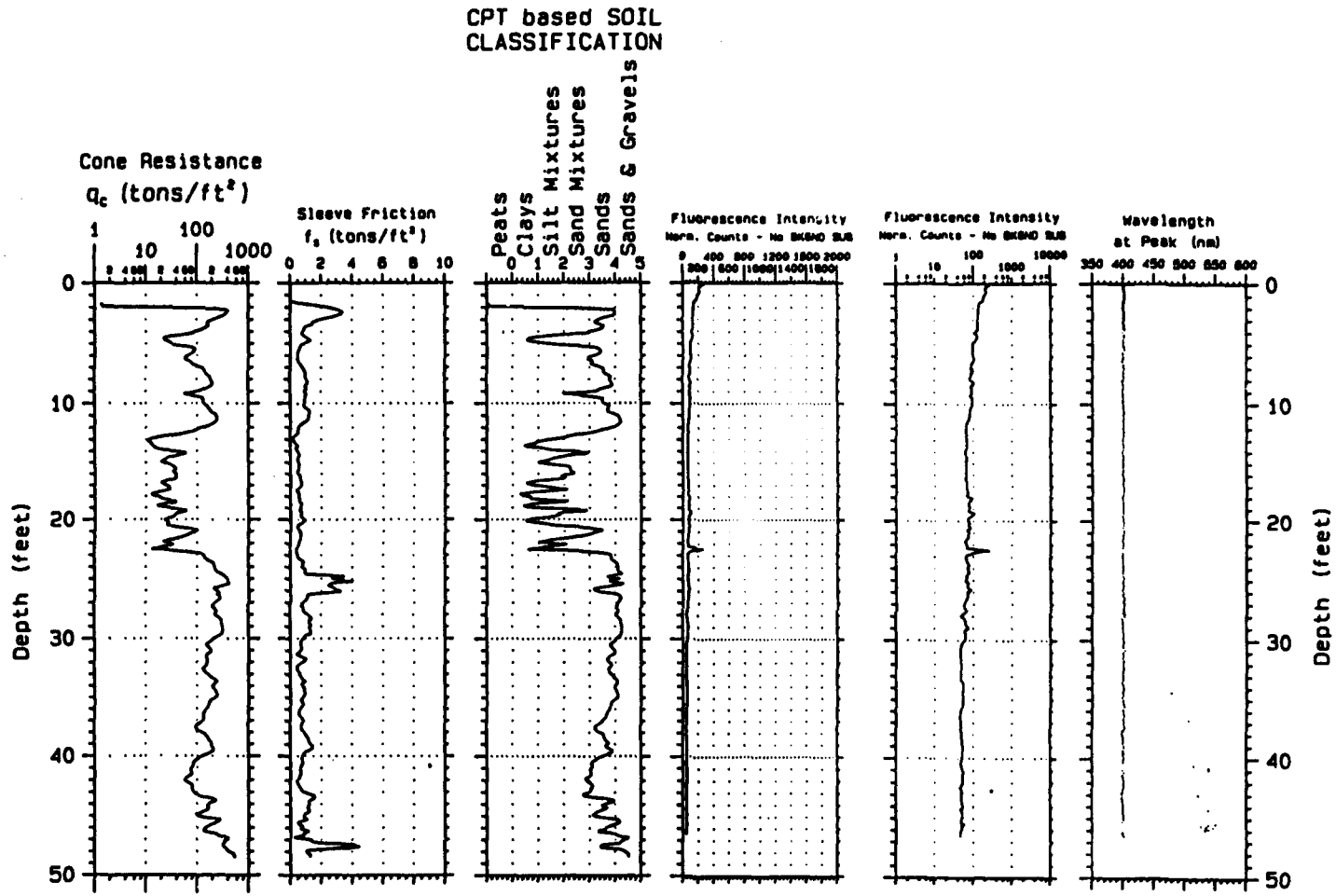
Site Characterization and Analysis Penetrometer System

Project; Bolling AFB

Probe Depth; 40.64

CPT; 2FB02

Location: CPT-3



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

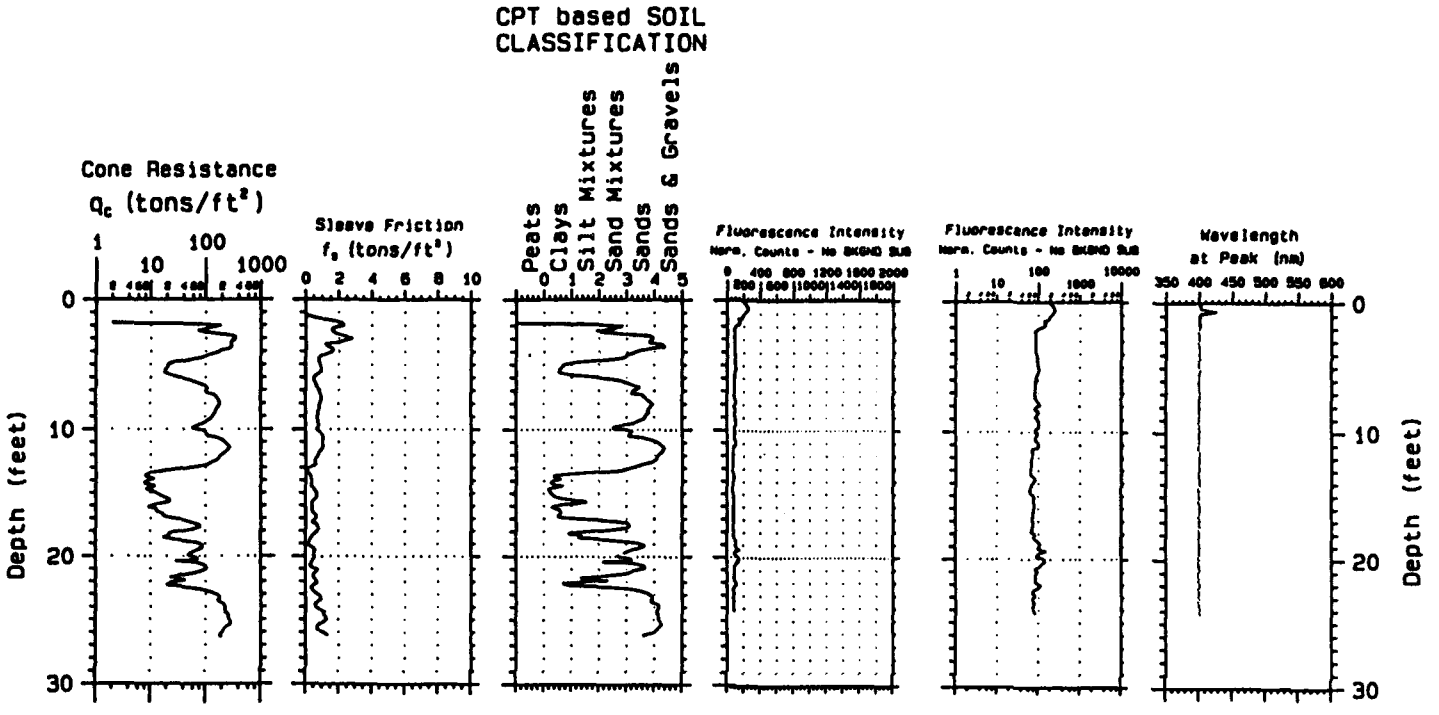
Project; Bolling AFB

Probe Depth; 48.66

Probing date; 08-01-1994

CPT; 3FB03

Location: CPT-4



Probing date: 08-01-1994

Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

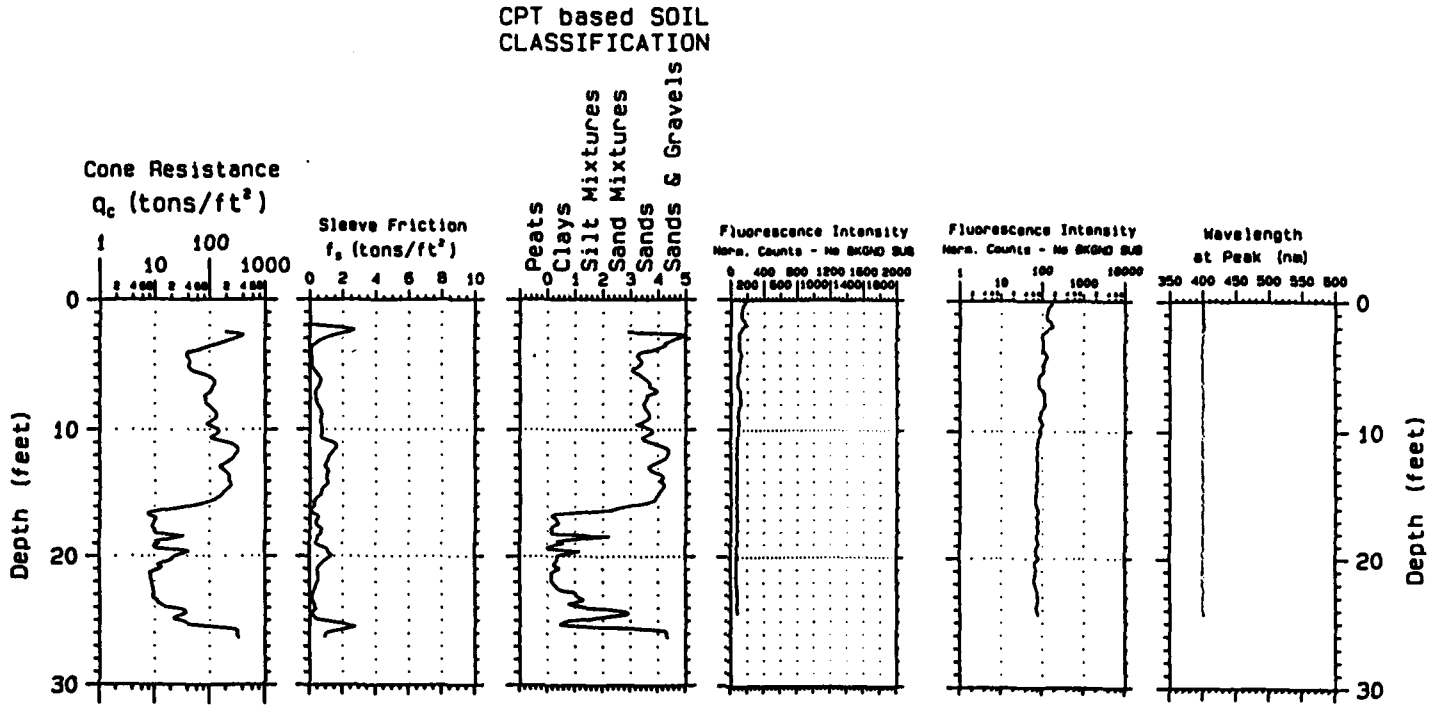
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Project; Bolling AFB

Probe Depth; 26.51

CPT; 4FB04

Location: CPT-5



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

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Site Characterization and Analysis Penetrometer System

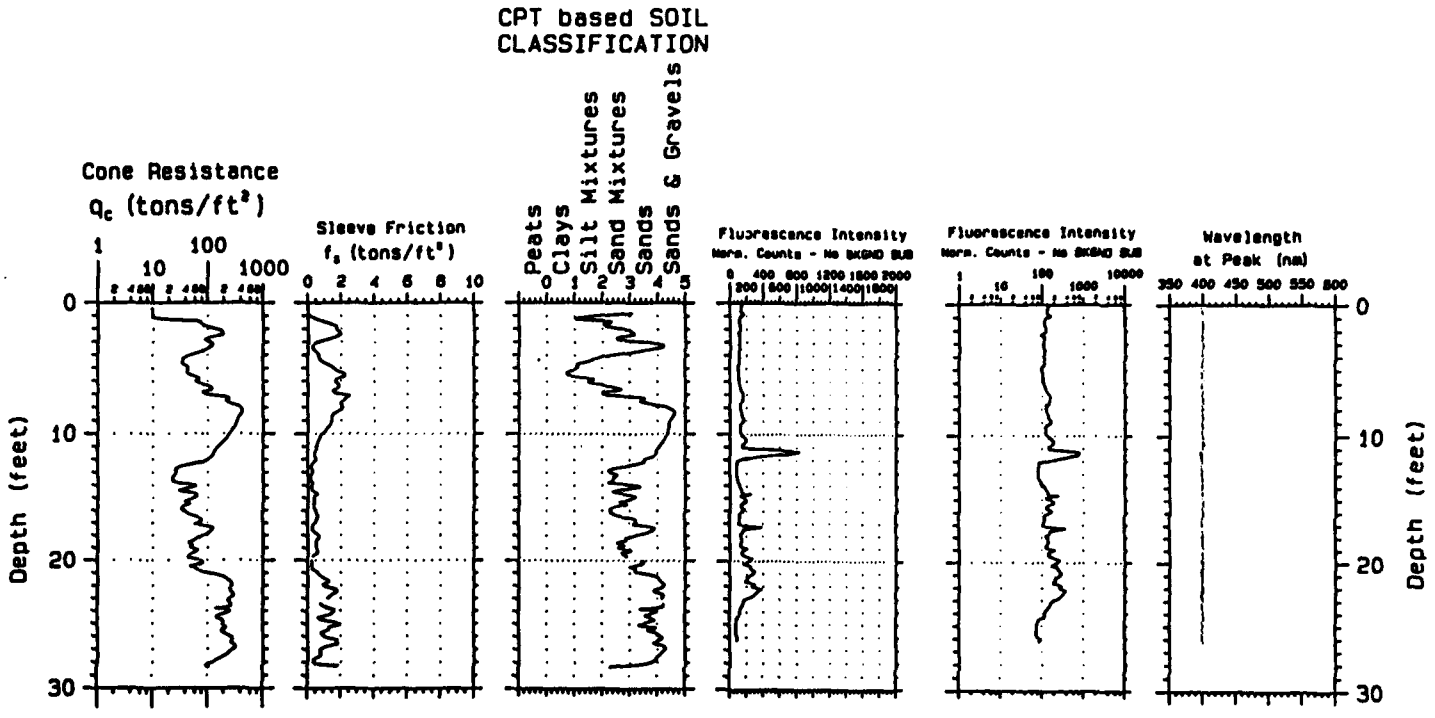
Project; Bolling AFB

Probe Depth; 26.60

Probing date: 08-01-1994

CPT; 5FB05

Location: CP



Probing date: 08-02-1994

Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

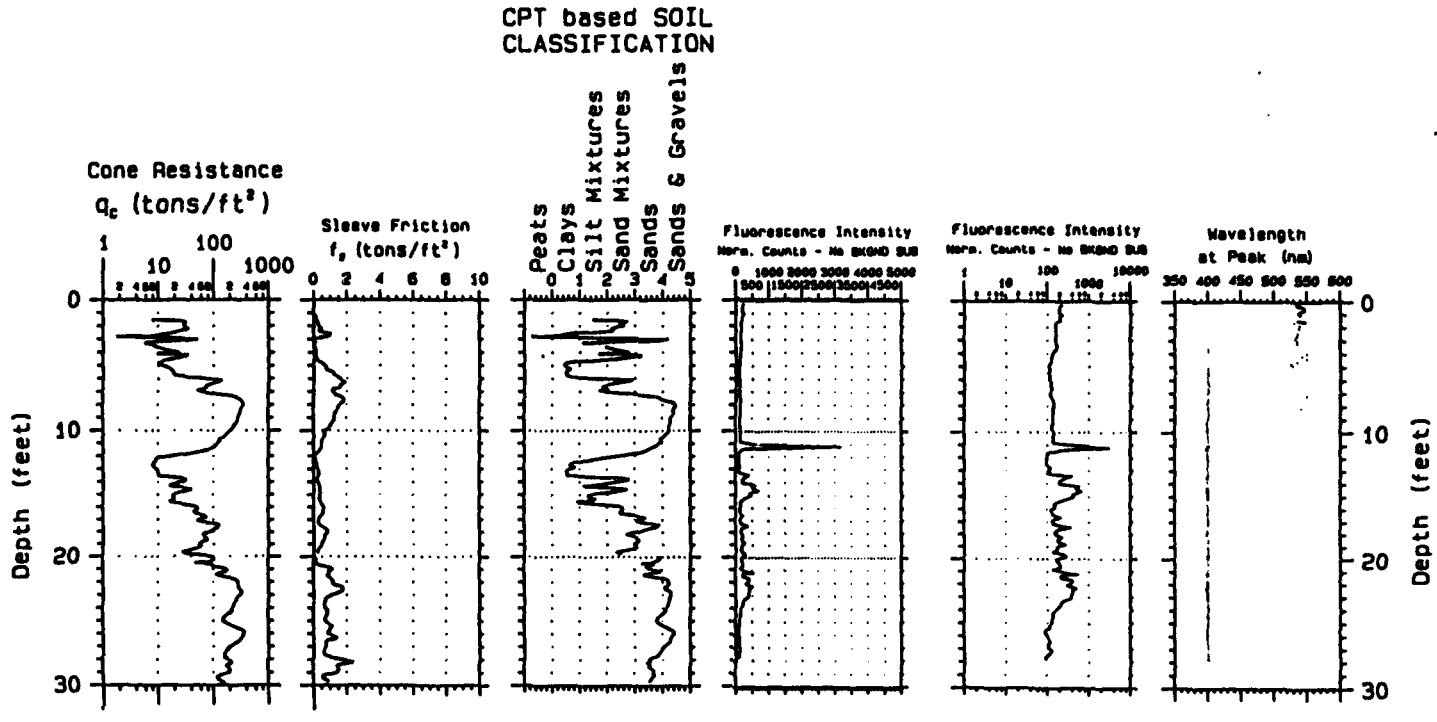
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Project: Bolling AFB

Probe Depth: 28.58

CPT; 6FB06

Location: CPT-



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

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Site Characterization and Analysis Penetrometer System

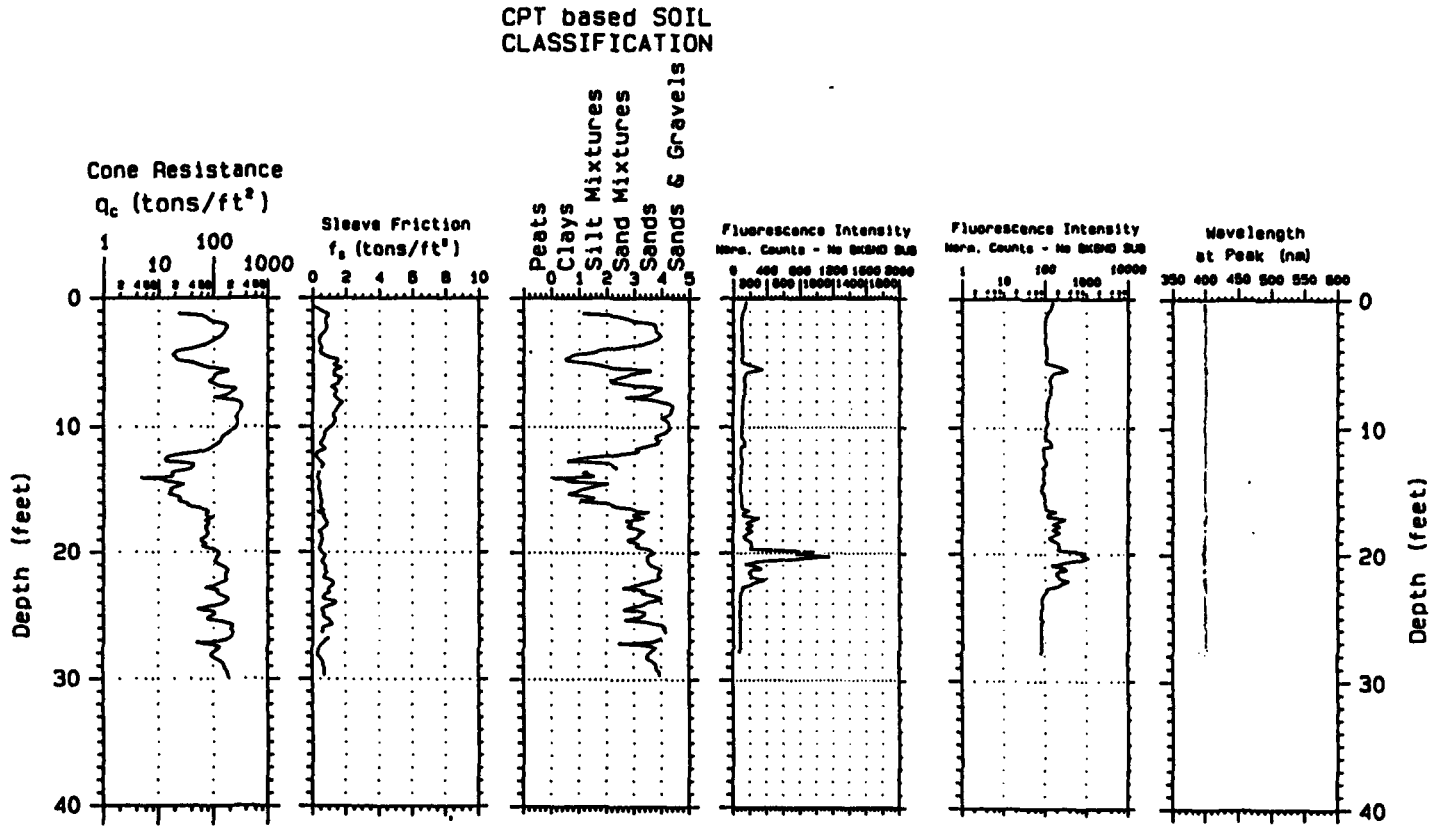
Project; Bolling AFB

Probe Depth; 29.95

Probing date; 08-02-1994

CPT; 7FB07

Location: CPT-8



Probing date: 08-02-1994

Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

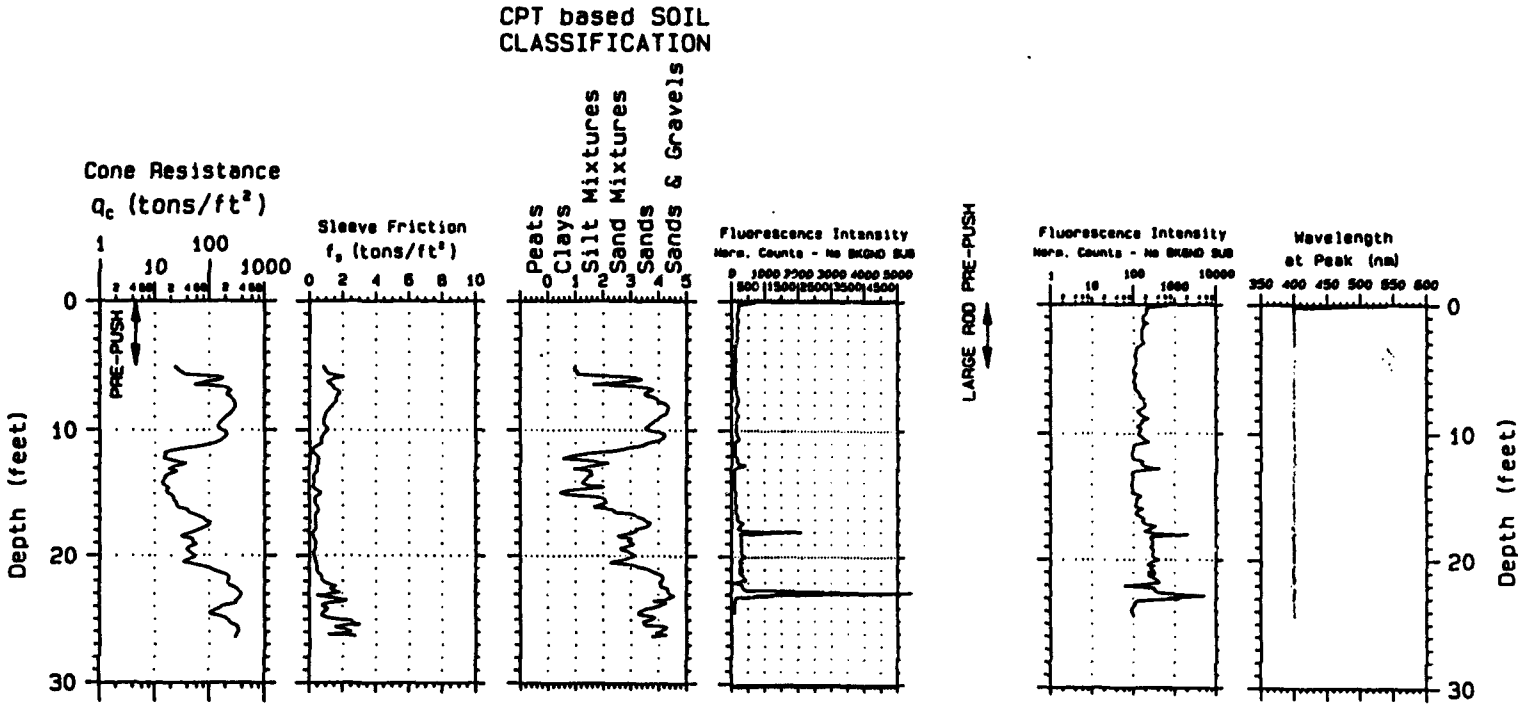
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Project: Bolling AFB

Probe Depth: 30.03

CPT; 8FB08

Location: CPT-9



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

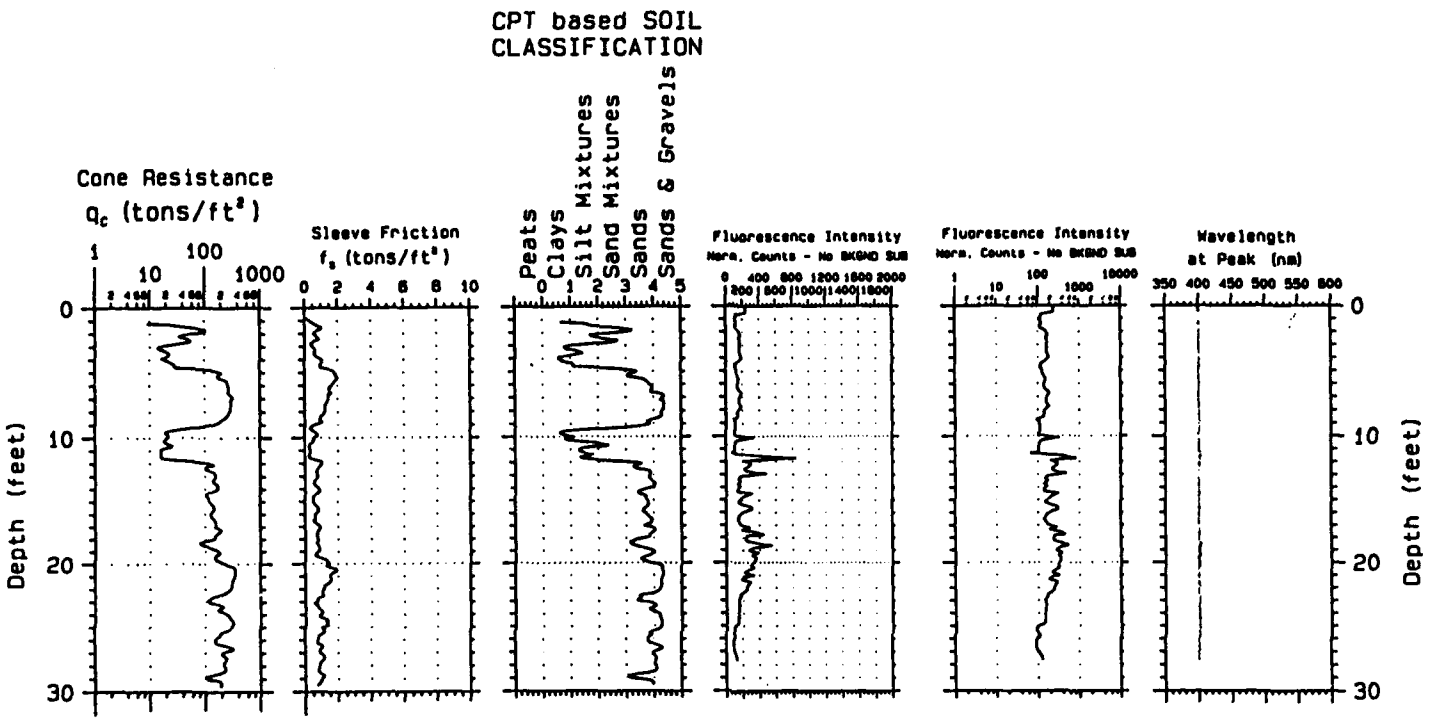
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Probe Depth; 26.60

Probing date; 08-02-1994

CPT; 11FB09

Location: CPT-13



Probing date: 08-02-1994

Laser Induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

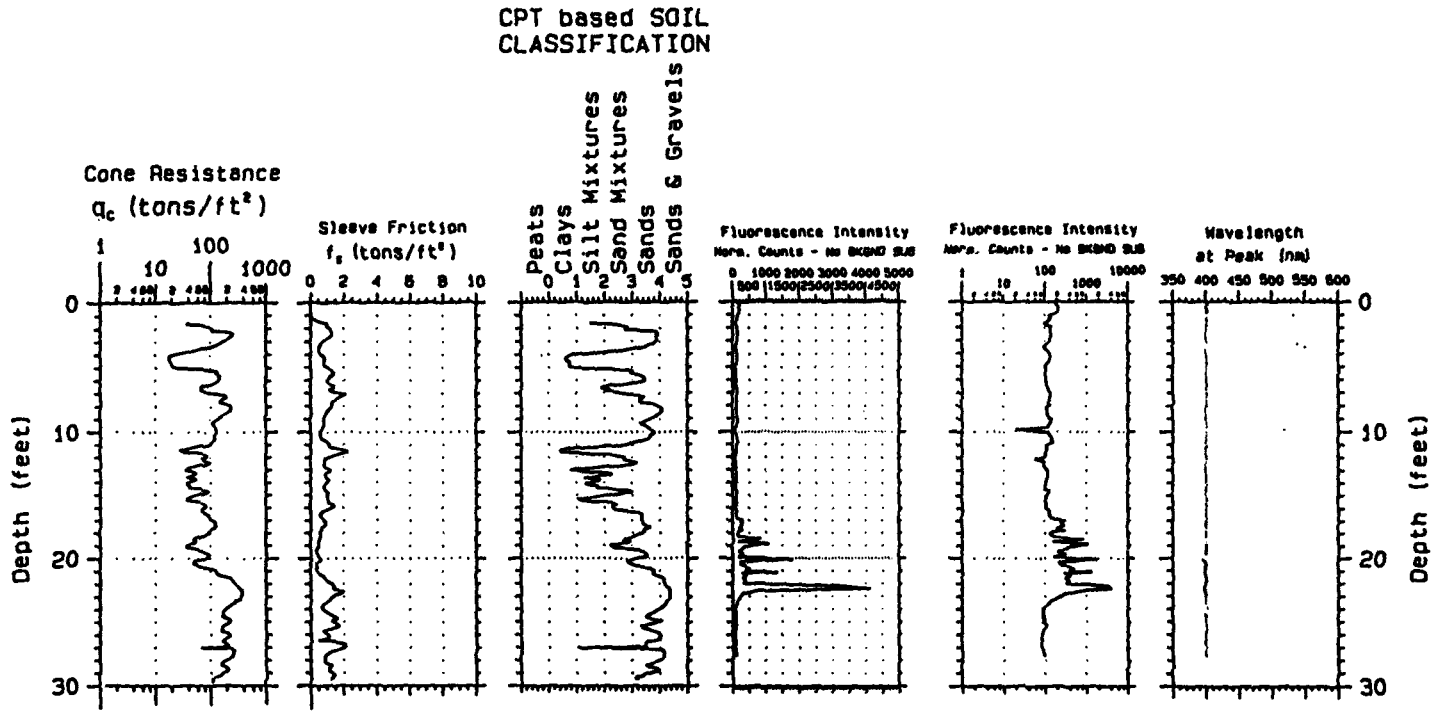
Site Characterization and Analysis Penetrometer System

Project; Bolling AFB

Probe Depth; 29.81

CPT; 12FB10

Location: CPT-11



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

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Site Characterization and Analysis Penetrometer System

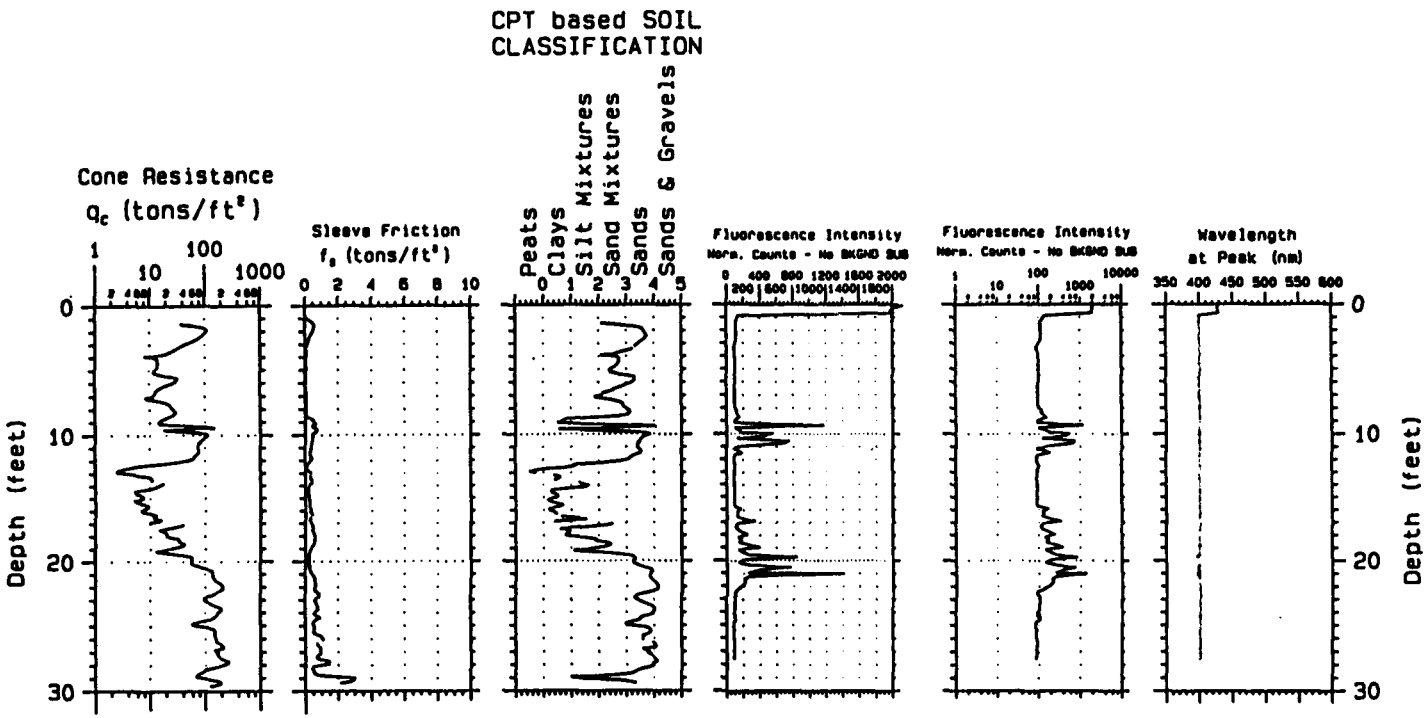
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CPT; 13FB11

Probing date; 08-02-1994

Location: CPT-12



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

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Site Characterization and Analysis Penetrometer System

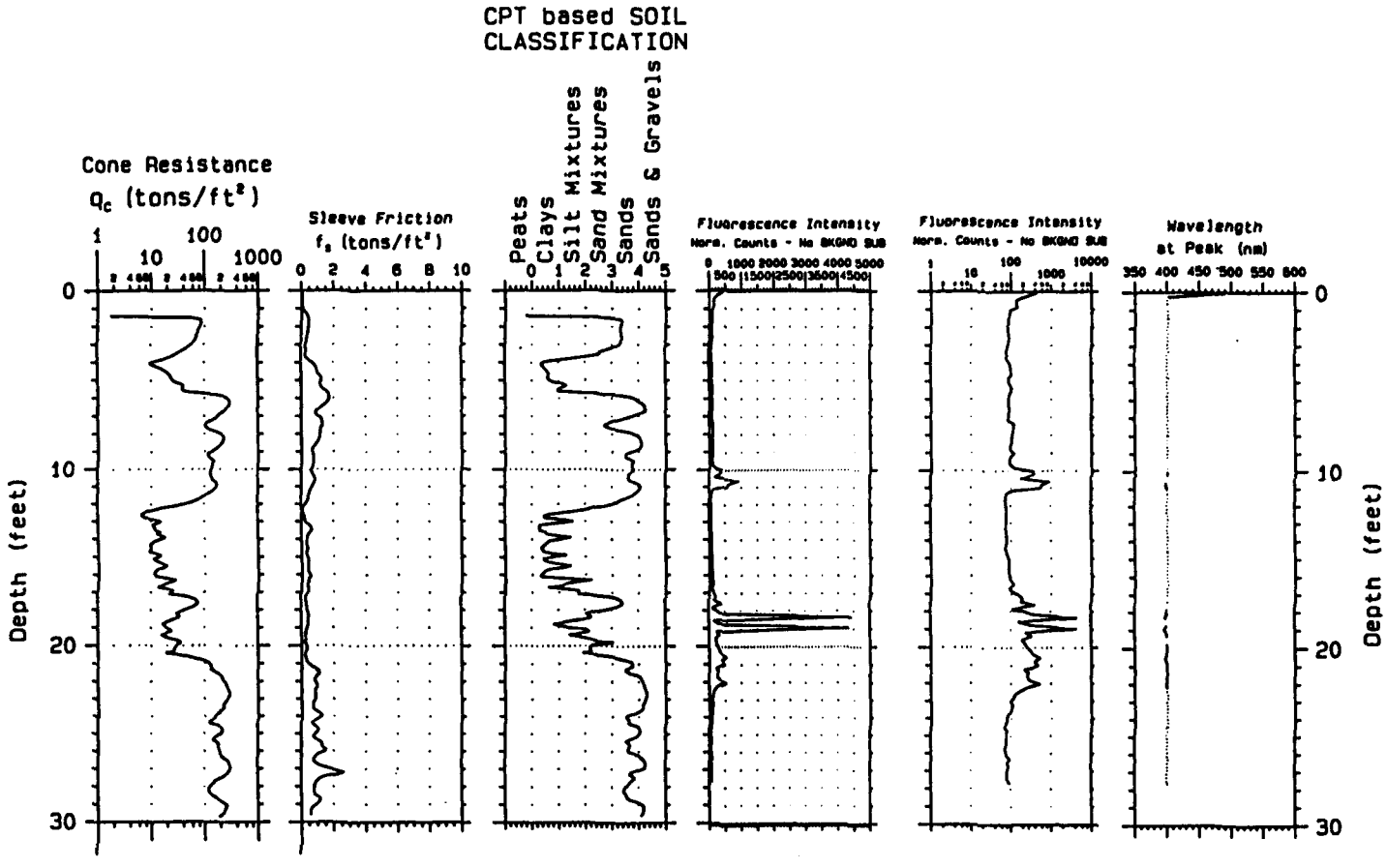
Project; Bolling AFB

Probe Depth; 29.72

CPT; 14FB12

Probing date; 08-02-1994

Location: CPT-13



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

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Site Characterization and Analysis Penetrometer System

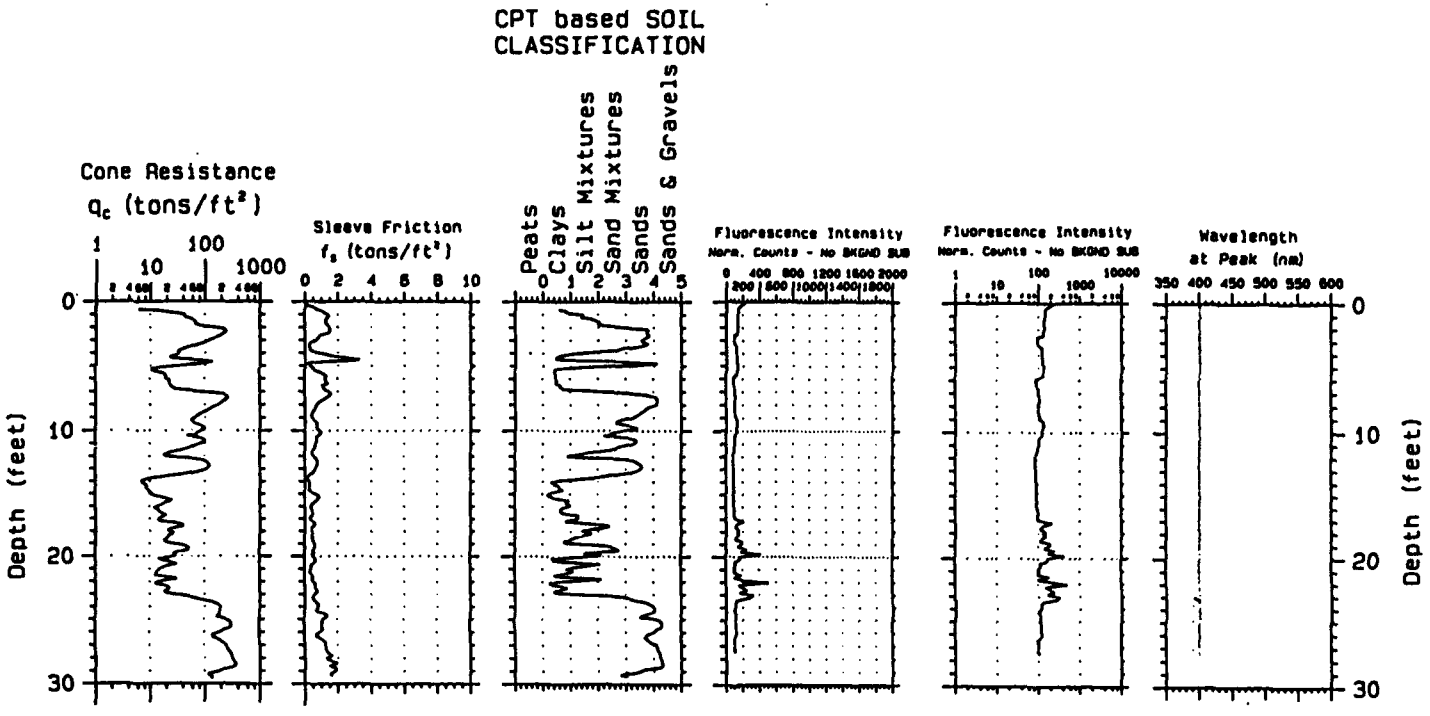
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Probe Depth: 29.84

Probing date: 08-02-1994

CPT; 15FB13

Location: CPT-1



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

Probing date: 08-03-1994

SCAPS

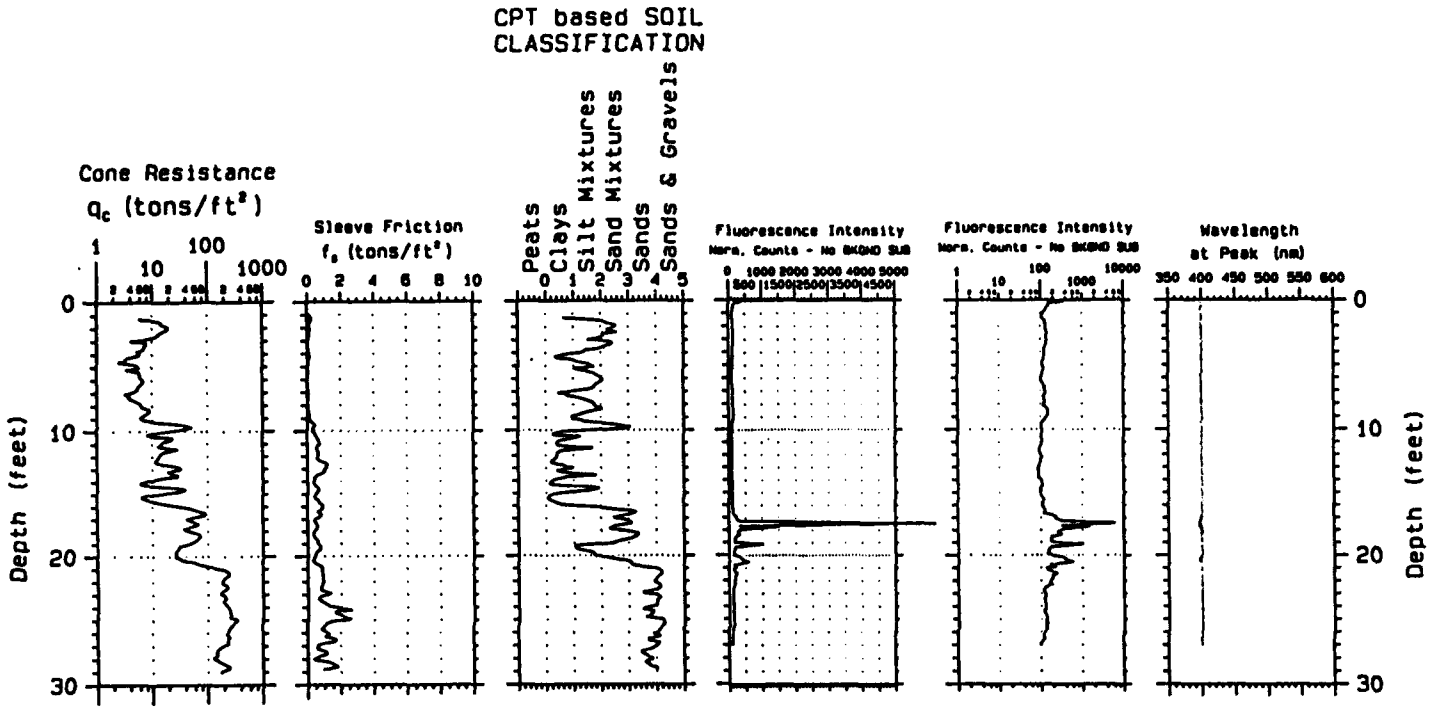
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Project; Bolling AFB

Probe Depth; 29.70

CPT; 16FB14

Location: CPT-15



Probing date: 08-03-1994

Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

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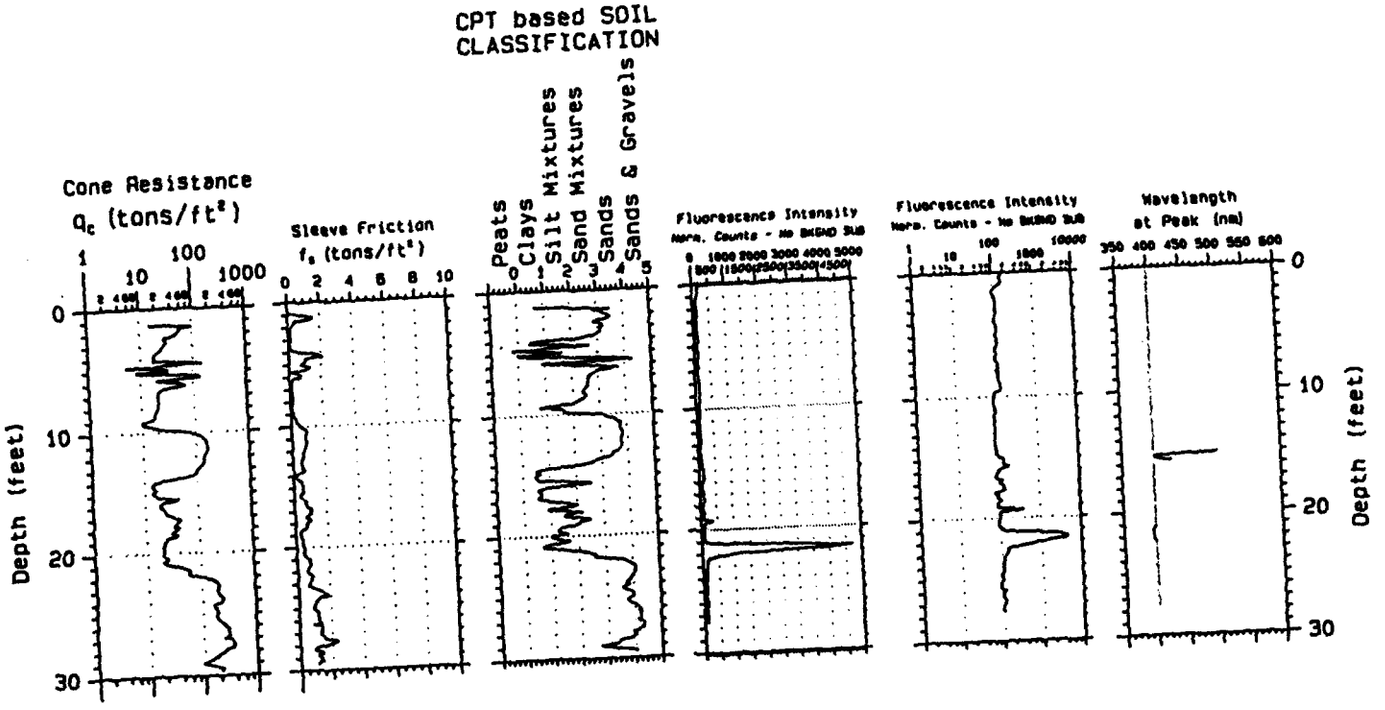
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Project; Bolling AFB

Probe Depth; 29.16

CPT; 38FB15

Location: CPT-16



Project: Bolling AFB
Probe Depth: 29.77

Laser Induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

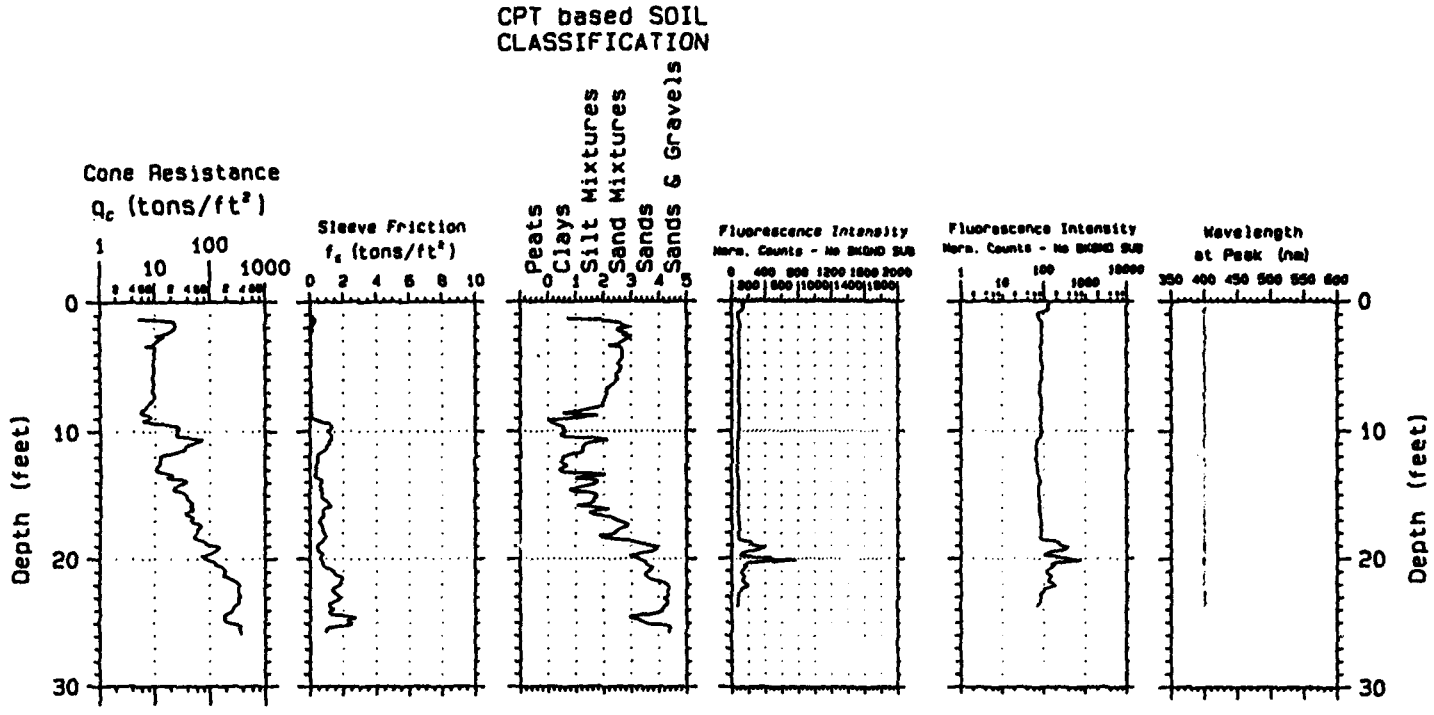
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Site Characterization and Analysis Penetrometer System

CPT; 39FB16

Probing date: 08-04-1994

Location: CPT



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

Project; Bolling AFB

Probe Depth; 25.93

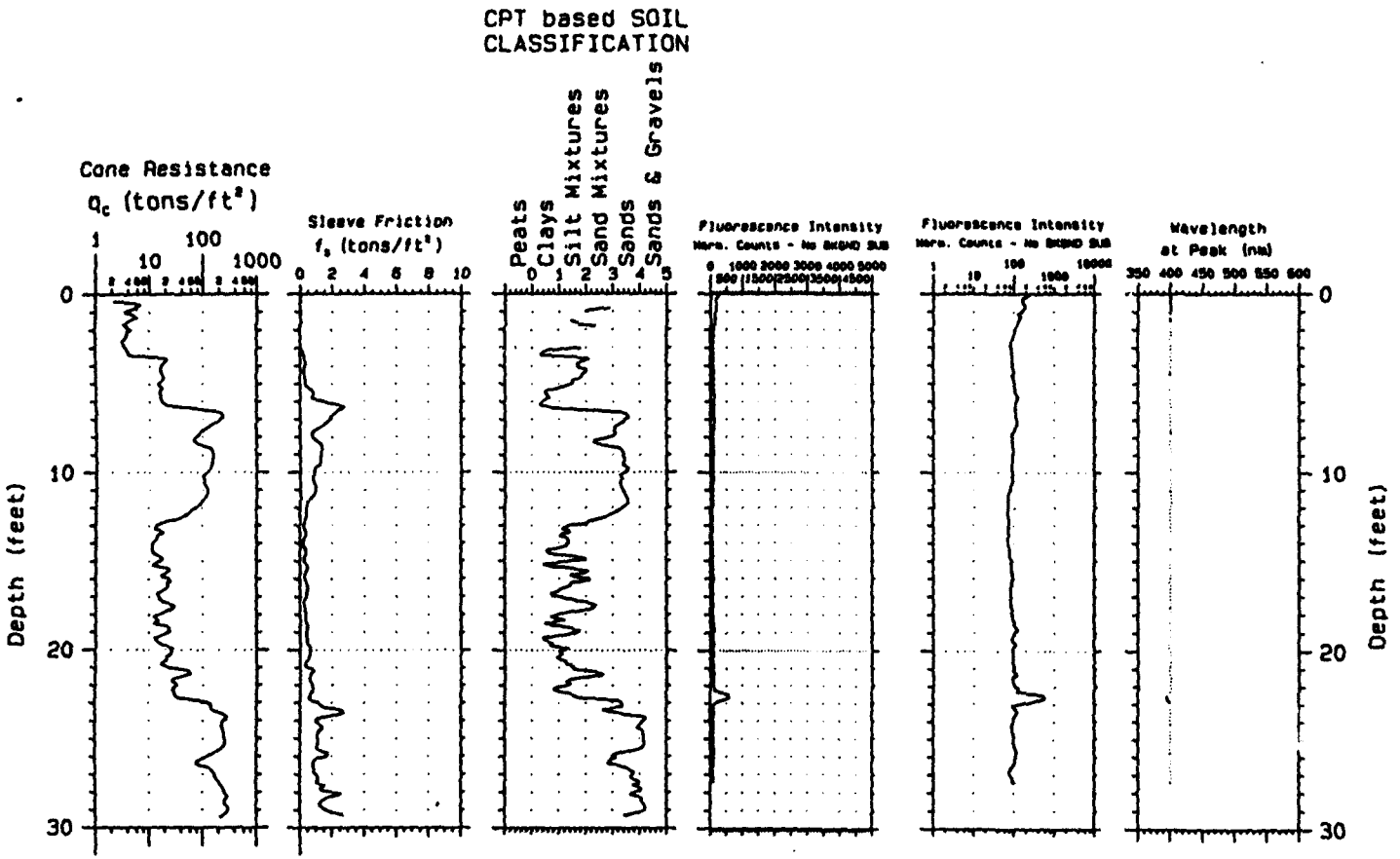
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SCAPS

Site Characterization and Analysis Penetrometer System

CPT; 40FB17

Location: CP 18



Laser induced fluorescence at POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

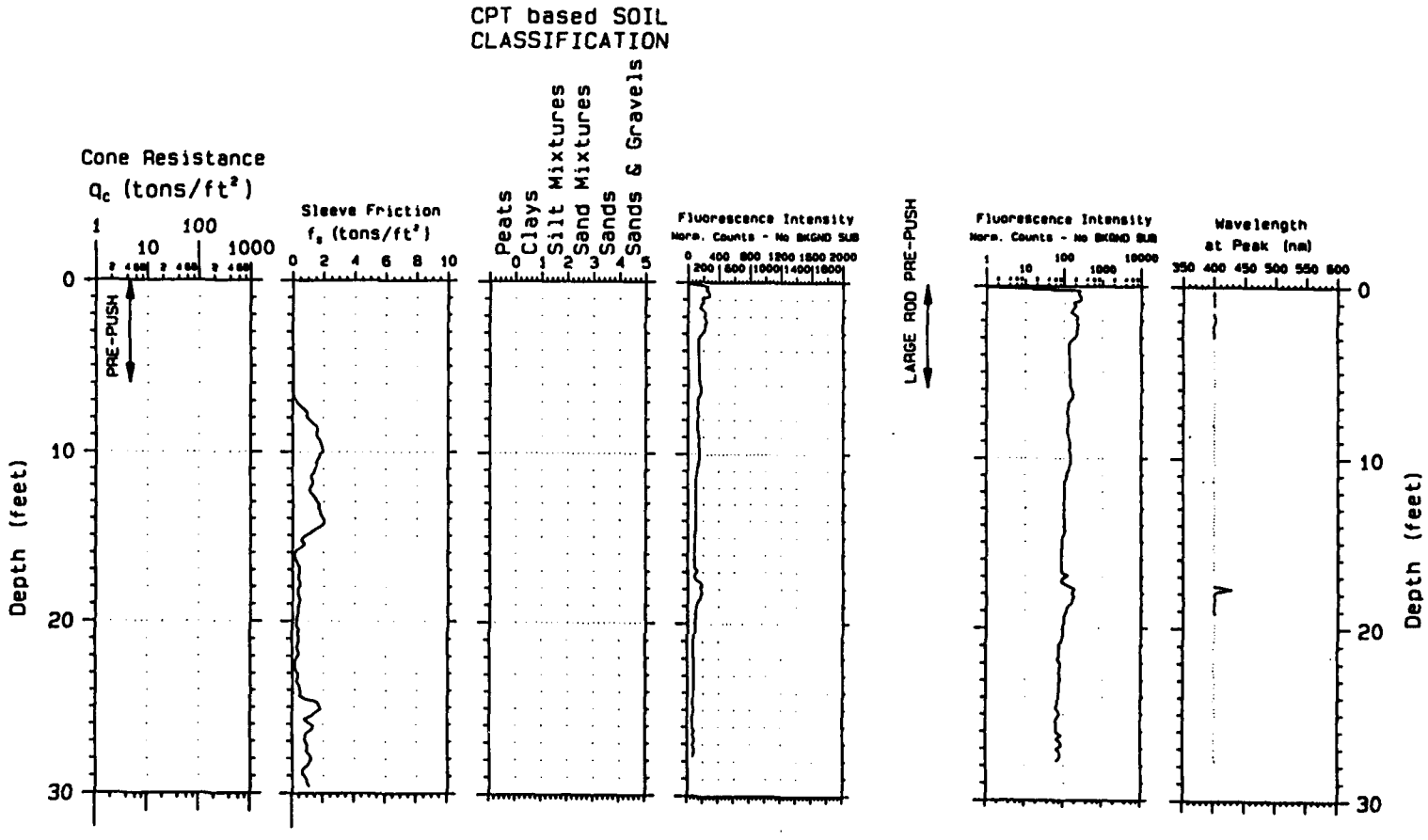
Project; Bolling AFB

Probe Depth; 29.59

CPT; 42FB18

08-04-1994

Location: CPT23



Laser induced fluorescence of POL via fiber optics

U.S.Army Engineer District Kansas City Geotechnical Branch

SCAPS

Site Characterization and Analysis Penetrometer System

Project; Bolling AFB

Probe Depth; 29.92

Probing date; 08-08-1994

CPT; 67FB23

MONITORING POINT INSTALLATION RECORD

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JOB NUMBER 722450.08 INSTALLATION DATE 8/4/94 LOCATION

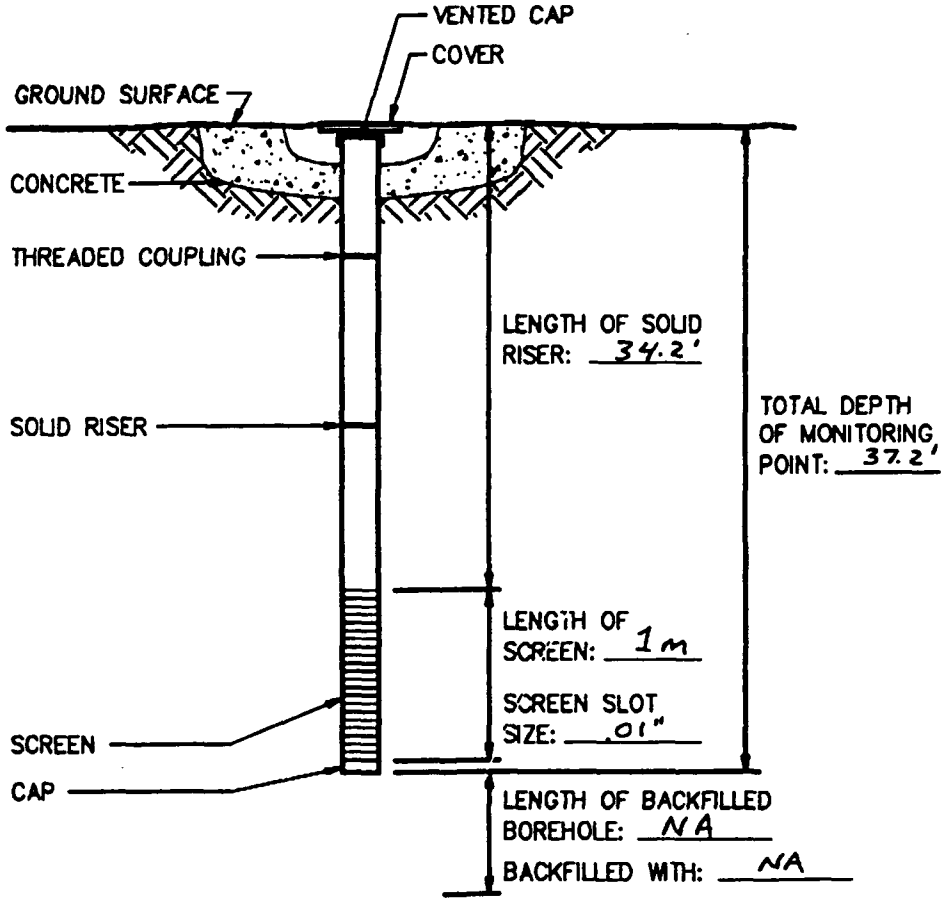
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DATUM FOR WATER LEVEL MEASUREMENT TOC

SCREEN DIAMETER & MATERIAL 1/2" PVC (ID) SLOT SIZE 10 (.01")

RISER DIAMETER & MATERIAL 1/2" PVC (ID) BOREHOLE DIAMETER 1 3/4"

CONE PENETROMETER CONTRACTOR U.S. ARMY COE ES REPRESENTATIVE S. GLENNIE



(NOT TO SCALE)

STABILIZED WATER LEVEL 22.16 FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH 36.8 FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Bolling Air Force Base, D.C.

ENGINEERING-SCIENCE, INC.
Denver, Colorado

94DN0363, 04/05/94 at 15:22

MONITORING POINT INSTALLATION RECORD

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JOB NUMBER 722450.08 INSTALLATION DATE 8/4/94 LOCATION

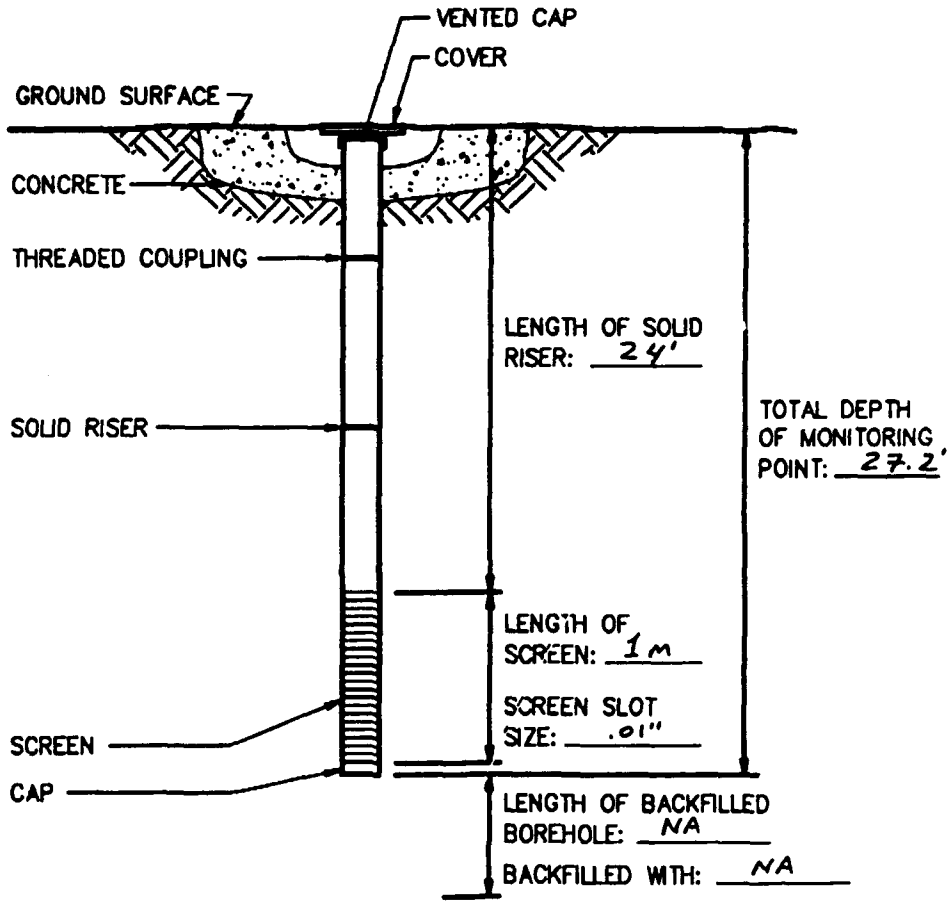
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DATUM FOR WATER LEVEL MEASUREMENT TOP

SCREEN DIAMETER & MATERIAL ½" ID PVC SLOT SIZE 10 (.01")

RISER DIAMETER & MATERIAL ½" ID PVC BOREHOLE DIAMETER 13/4"

CONE PENETROMETER CONTRACTOR U.S. Army CoE ES REPRESENTATIVE S. GLENNIE



(NOT TO SCALE)

STABILIZED WATER LEVEL 20.83 FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH 26.5 FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Bolling Air Force Base, D.C.

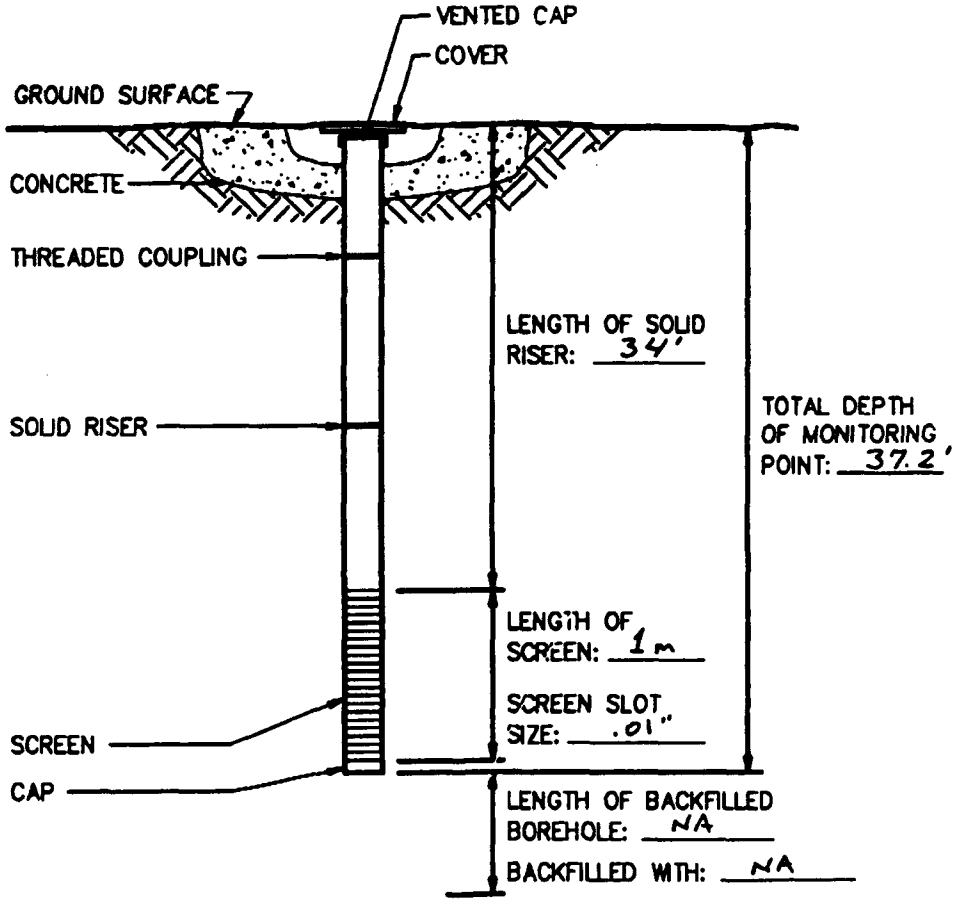
ENGINEERING-SCIENCE, INC.

Denver, Colorado

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MONITORING POINT INSTALLATION RECORD

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JOB NUMBER 722450.08 — INSTALLATION DATE 8/4/94 — LOCATION
DATUM ELEVATION 24.79 — GROUND SURFACE ELEVATION
DATUM FOR WATER LEVEL MEASUREMENT TOC
SCREEN DIAMETER & MATERIAL ½" ID PVC — SLOT SIZE 10 (.01")
RISER DIAMETER & MATERIAL ½" ID PVC — BOREHOLE DIAMETER 1 3/4"
CONE PENETROMETER CONTRACTOR U.S. Army COE — ES REPRESENTATIVE S. GLENNIE



(NOT TO SCALE)

STABILIZED WATER LEVEL 21.99 FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH 36.2 FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Bolling Air Force Base, D.C.

ENGINEERING-SCIENCE, INC.
Denver, Colorado

94DN0363, 04/05/94 at 15:22

MONITORING POINT INSTALLATION RECORD

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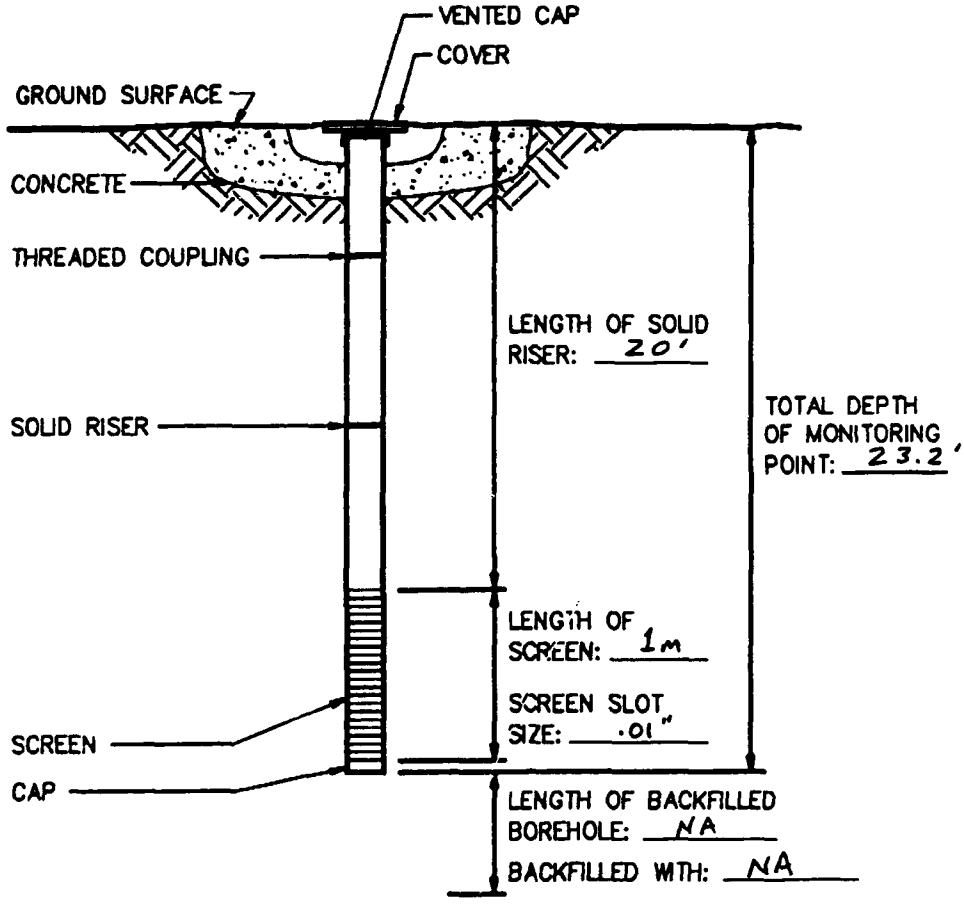
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DATUM FOR WATER LEVEL MEASUREMENT TOC

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RISER DIAMETER & MATERIAL ½" ID PVC — BOREHOLE DIAMETER 1 3/4"

CONE PENETROMETER CONTRACTOR U.S. Army COE — ES REPRESENTATIVE S. GLENNIE



(NOT TO SCALE)

STABILIZED WATER LEVEL 18.50 FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH 23 FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Bolling Air Force Base, D.C.

ENGINEERING-SCIENCE, INC.
Denver, Colorado

94DN0363, 04/05/94 at 15:22

MONITORING POINT INSTALLATION RECORD

JOB NAME BOLLING AFB MONITORING POINT NUMBER CPT-21D

JOB NUMBER 722450.08 INSTALLATION DATE 8/5/94 LOCATION

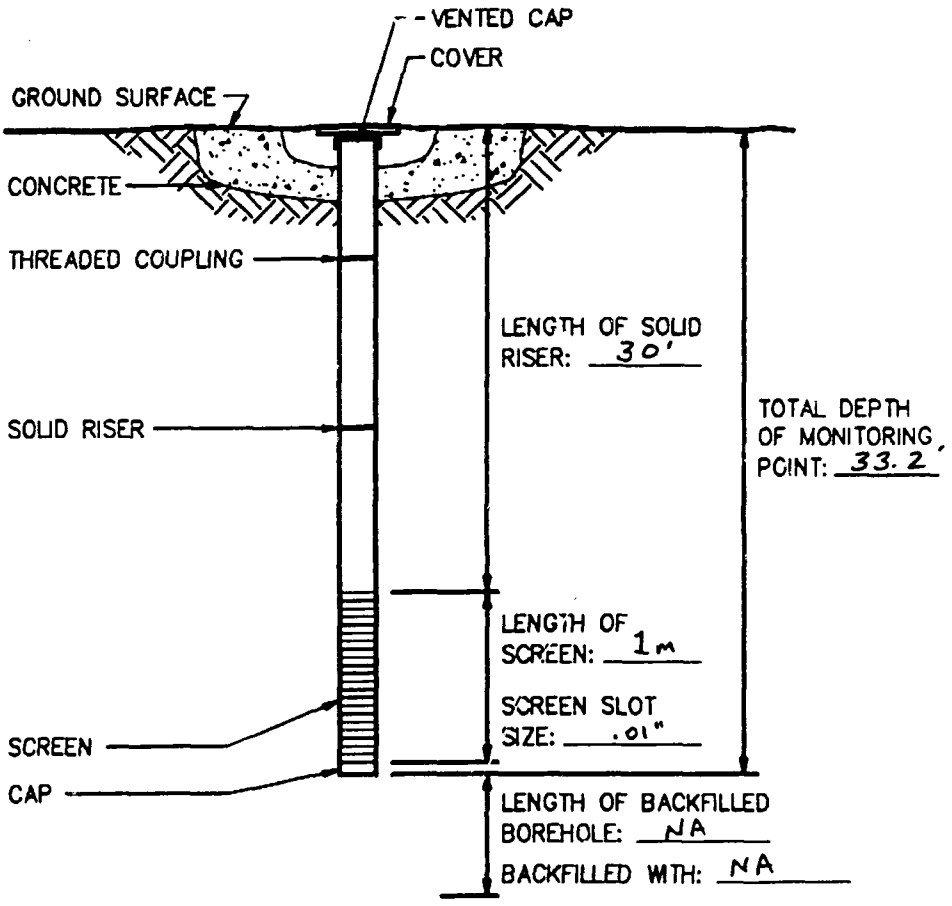
DATUM ELEVATION 22.08 GROUND SURFACE ELEVATION

DATUM FOR WATER LEVEL MEASUREMENT TOC

SCREEN DIAMETER & MATERIAL ½" ID PVC SLOT SIZE .10 (.01")

RISER DIAMETER & MATERIAL ½" ID PVC BOREHOLE DIAMETER 1 3/4"

CONE PENETROMETER CONTRACTOR U.S. Army COE ES REPRESENTATIVE S. GLENNIE



(NOT TO SCALE)

STABILIZED WATER LEVEL 19.56 FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH 32.6 FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Bolling Air Force Base, D.C.

ENGINEERING-SCIENCE, INC.
Denver, Colorado

94DN0363, 04/05/94 at 15:22

MONITORING POINT INSTALLATION RECORD

JOB NAME BOLLING AFB MONITORING POINT NUMBER CPT-225

JOB NUMBER 722450.08 INSTALLATION DATE 8/5/94 LOCATION

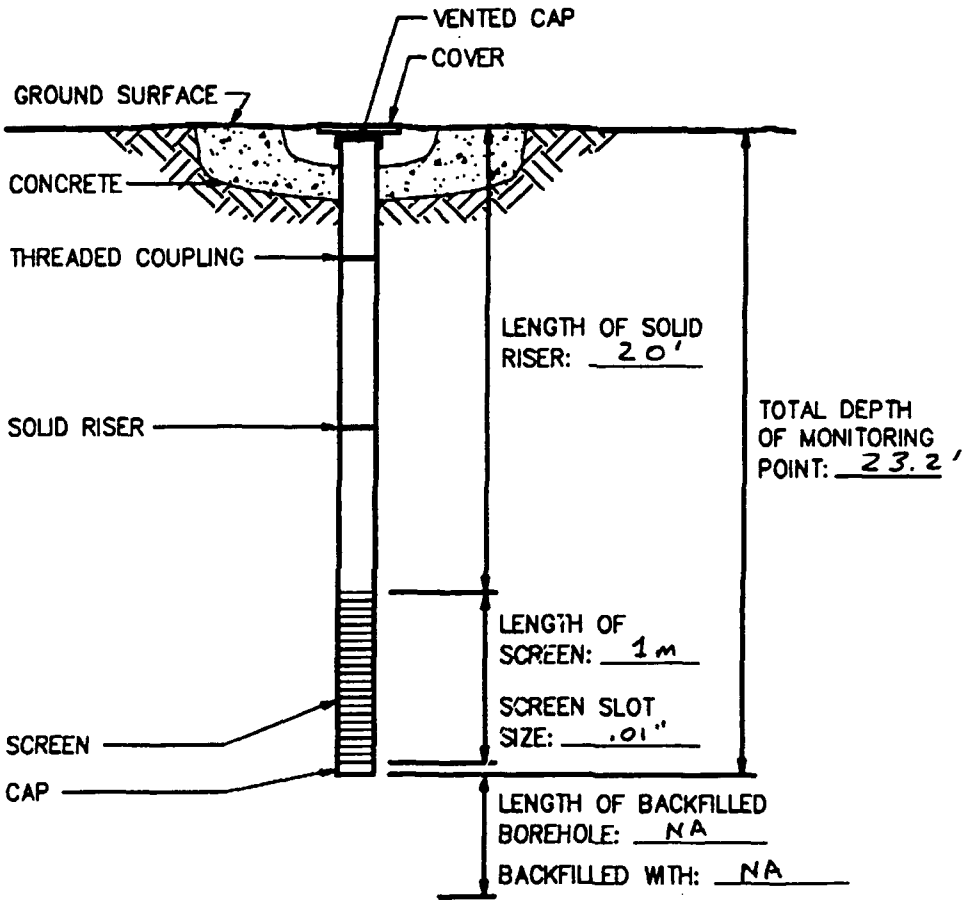
DATUM ELEVATION 21.97 GROUND SURFACE ELEVATION

DATUM FOR WATER LEVEL MEASUREMENT TOC

SCREEN DIAMETER & MATERIAL 1/2" ID PVC SLOT SIZE 10 (.01")

RISER DIAMETER & MATERIAL 1/2" ID PVC BOREHOLE DIAMETER 1 3/4"

CONE PENETROMETER CONTRACTOR U.S. Army COE ES REPRESENTATIVE S. GLENNIE



(NOT TO SCALE)

STABILIZED WATER LEVEL 20.80 FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH 22 FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Boiling Air Force Base, D.C.

ENGINEERING-SCIENCE, INC.
Denver, Colorado

94DN0363, 04/05/94 at 15:22

MONITORING POINT INSTALLATION RECORD

JOB NAME BOLLING AFB MONITORING POINT NUMBER CPT-22D

JOB NUMBER 722450.08 INSTALLATION DATE _____ LOCATION _____

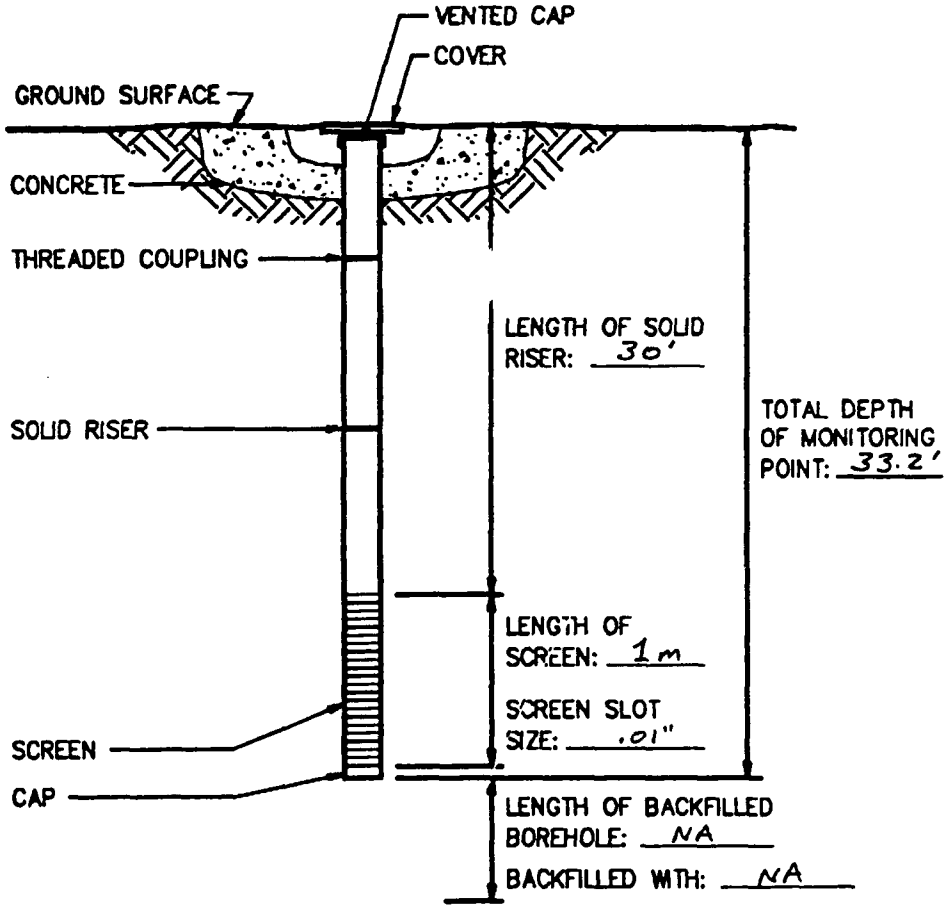
DATUM ELEVATION 22.87 GROUND SURFACE ELEVATION _____

DATUM FOR WATER LEVEL MEASUREMENT TOC

SCREEN DIAMETER & MATERIAL 1/2" ID PVC SLOT SIZE 10 (.01")

RISER DIAMETER & MATERIAL 1/2" ID PVC BOREHOLE DIAMETER 1 3/4"

CONE PENETROMETER CONTRACTOR U.S. Army CoE ES REPRESENTATIVE S. GLENNIE



(NOT TO SCALE)

STABILIZED WATER LEVEL 19.21 FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH 32 FEET BELOW DATUM.

GROUND SURFACE _____ FEET

MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Bolling Air Force Base, D.C.

ENGINEERING-SCIENCE, INC.

Denver, Colorado

94DN0363, 04/05/94 at 15:22

MONITORING POINT INSTALLATION RECORD

JOB NAME BOLLING AFB — MONITORING POINT NUMBER CPT-195

JOB NUMBER 722450.08 — INSTALLATION DATE 8/4/94 — LOCATION

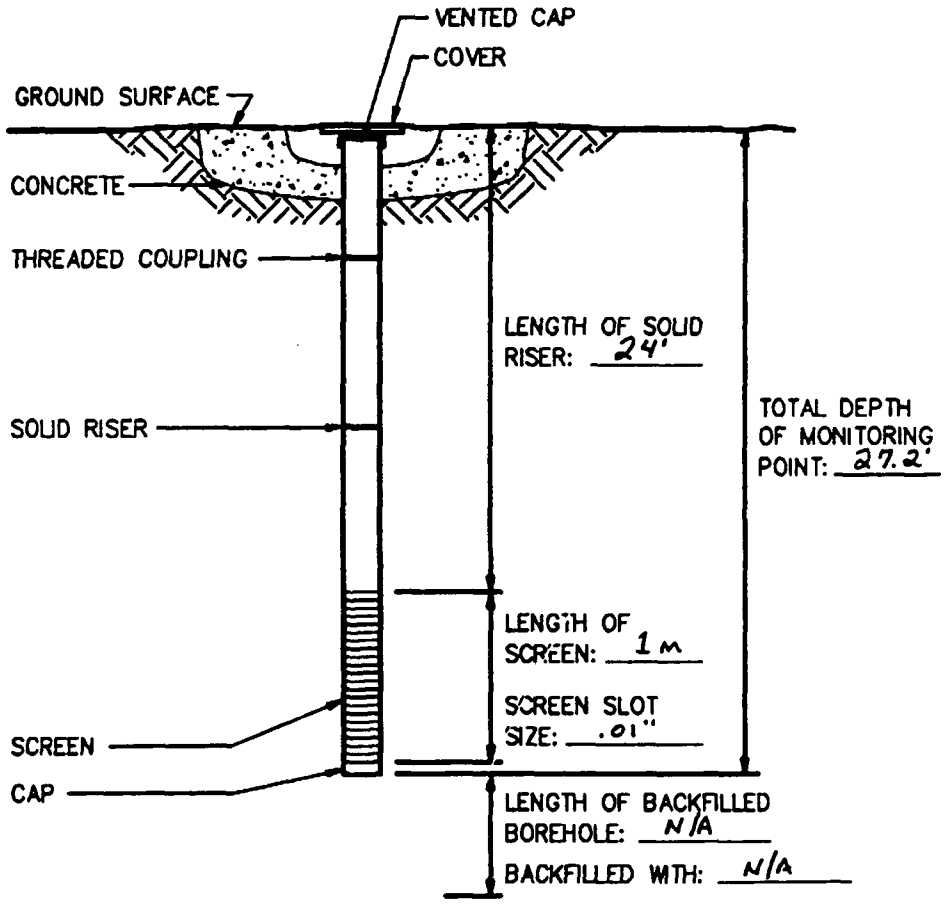
DATUM ELEVATION 24.97 — GROUND SURFACE ELEVATION

DATUM FOR WATER LEVEL MEASUREMENT TOC

SCREEN DIAMETER & MATERIAL ½" PVC (I.D.) — SLOT SIZE 10 (.01")

RISER DIAMETER & MATERIAL ½" PVC (I.D.) — BOREHOLE DIAMETER 1 3/4"

CONE PENETROMETER CONTRACTOR U.S. Army CoE — ES REPRESENTATIVE S. GLENNIE



(NOT TO SCALE)

STABILIZED WATER LEVEL 21.24 FEET BELOW DATUM.

TOTAL MONITORING POINT DEPTH 27.0 FEET BELOW DATUM.

GROUND SURFACE _____ FEET

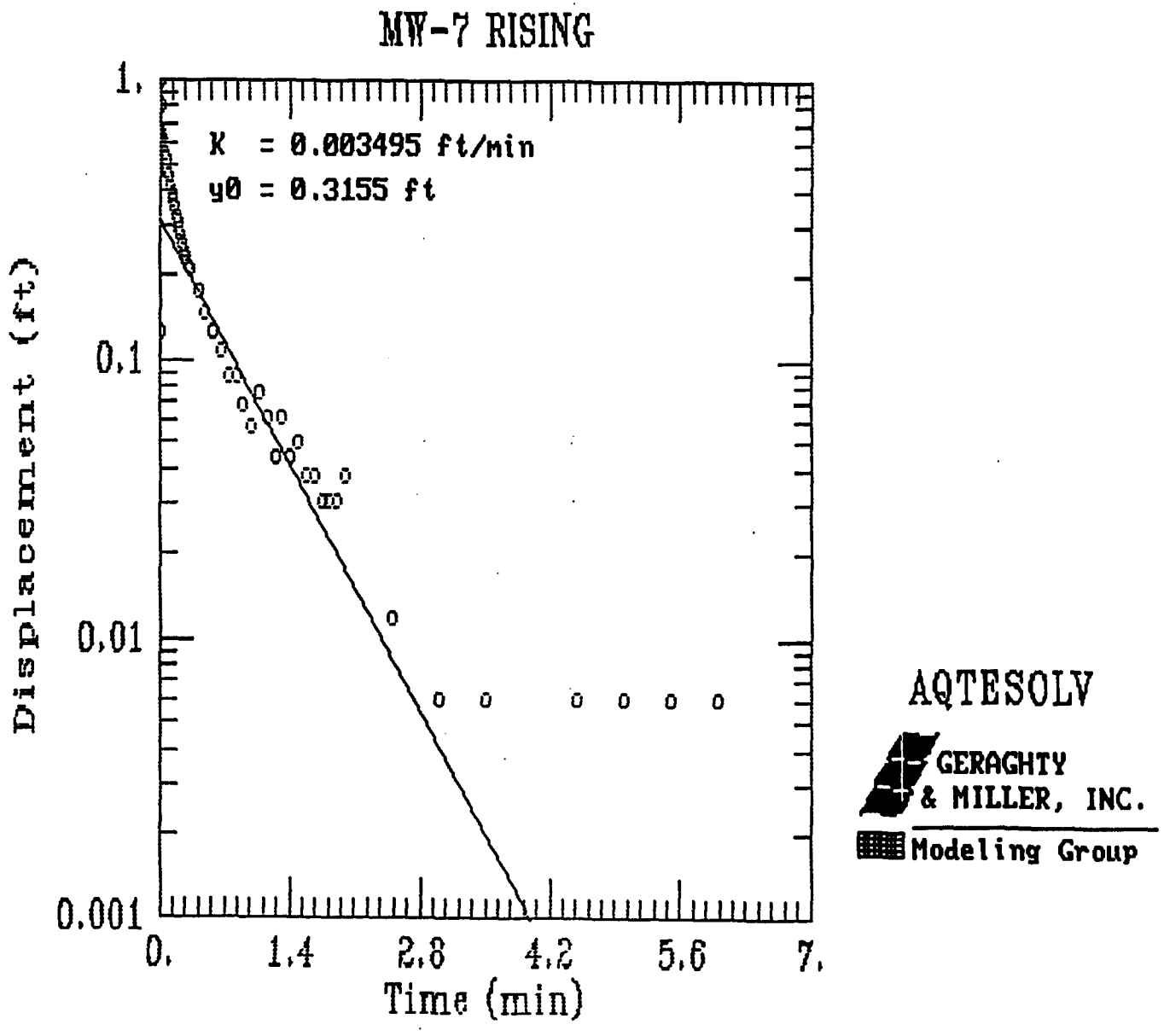
MONITORING POINT INSTALLATION RECORD

Intrinsic Remediation Demonstration
Bolling Air Force Base, D.C.

ENGINEERING-SCIENCE, INC.
Denver, Colorado

94DN0363, 04/05/94 at 15:22

SLUG TEST RESULTS FROM BAKER ENVIRONMENTAL, INC. (1994)


MW-7 RISING
K = 0.003495 ft/min
y0 = 0.3155 ft
Displacement (ft)
1.
0.1
0.01
0.001
0.
1.4
2.8
4.2
5.6
7.
Time (min)
AQTESOLV
GERAGHTY
& MILLER, INC.
Modeling Group

<<

0.3166	0.215	0.19993	0.015069	1
0.3333	0.209	0.19518	0.013821	1
0.4166	0.177	0.17311	0.0038895	1
0.5	0.145	0.15352	-0.0085151	1
0.5833	0.126	0.13616	-0.010158	1
0.6666	0.107	0.12076	-0.013762	1
0.75	0.088	0.10709	-0.019093	1
0.8333	0.088	0.094984	-0.006984	1
0.9166	0.069	0.084244	-0.015244	1
1	0.057	0.074708	-0.017708	1
1.0833	0.076	0.066261	0.0097388	1
1.1666	0.063	0.058769	0.0042308	1
1.25	0.044	0.052117	-0.0081167	1
1.3333	0.063	0.046224	0.016776	1
1.4166	0.044	0.040998	0.0030024	1
1.5	0.05	0.036357	0.013643	1
1.5833	0.038	0.032246	0.005754	1
1.6666	0.038	0.0286	0.0093999	1
1.75	0.031	0.025363	0.0056373	1
1.8333	0.031	0.022495	0.008505	1
1.9166	0.031	0.019952	0.011048	1
2	0.038	0.017693	0.020307	1
2.5	0.012	0.0086104	0.0033896	1
3	0.006	0.0041902	0.0018098	1
3.5	0.006	0.0020392	0.0039608	1
4.5	0.006	0.00048294	0.0055171	1
5	0.006	0.00023502	0.005765	1
5.5	0.006	0.00011437	0.0058856	1
6	0.006	5.566E-005	0.0059443	1
10	0.006	1.751E-007	0.0059998	1

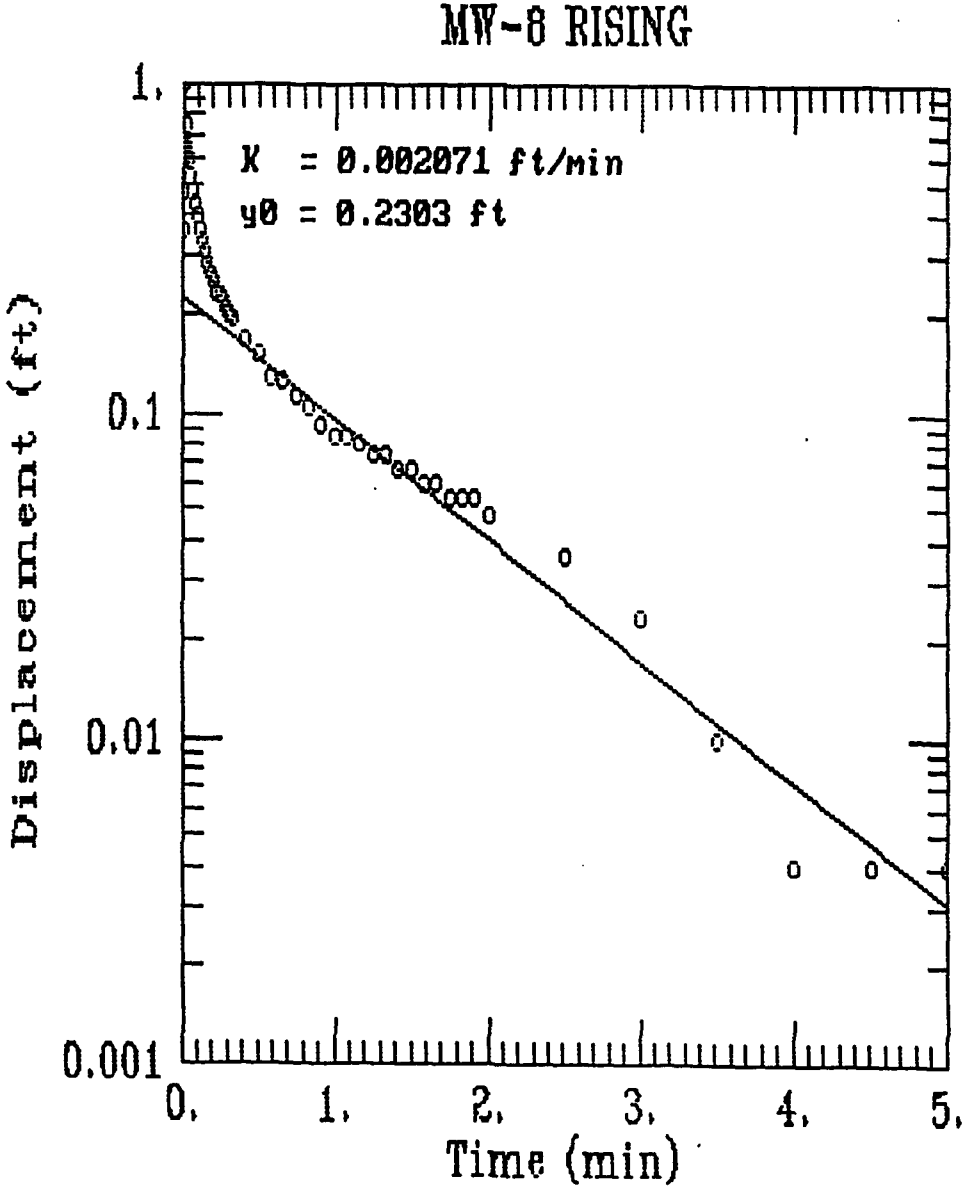
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RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	3.4950E-003
y0 =	3.1545E-001

<<


MW-6 RISING
K = 0.002071 ft/min
y0 = 0.2303 ft
Displacement (ft)
1.
0.1
0.01
0.001
0.
1.
2.
3.
4.
5.
Time (min)

<<

0.3333	0.194	0.17271	0.021287	1
0.4166	0.168	0.16072	0.0072791	1
0.5	0.149	0.14955	-0.00054859	1
0.5833	0.13	0.13916	-0.009165	1
0.6666	0.124	0.1295	-0.0055023	1
0.75	0.112	0.1205	-0.0085001	1
0.8333	0.105	0.11213	-0.0071334	1
0.9166	0.093	0.10435	-0.011348	1
1	0.086	0.097094	-0.011094	1
1.0833	0.086	0.090353	-0.0043525	1
1.1666	0.08	0.084079	-0.0040791	1
1.25	0.074	0.078234	-0.0042344	1
1.3333	0.074	0.072802	0.0011976	1
1.4166	0.067	0.067747	-0.00074748	1
1.5	0.067	0.063038	0.0039619	1
1.5833	0.061	0.058661	0.0023388	1
1.6666	0.061	0.054588	0.0064119	1
1.75	0.055	0.050794	0.0042065	1
1.8333	0.055	0.047267	0.0077332	1
1.9166	0.055	0.043985	0.011015	1
2	0.048	0.040927	0.0070727	1
2.5	0.036	0.026572	0.009428	1

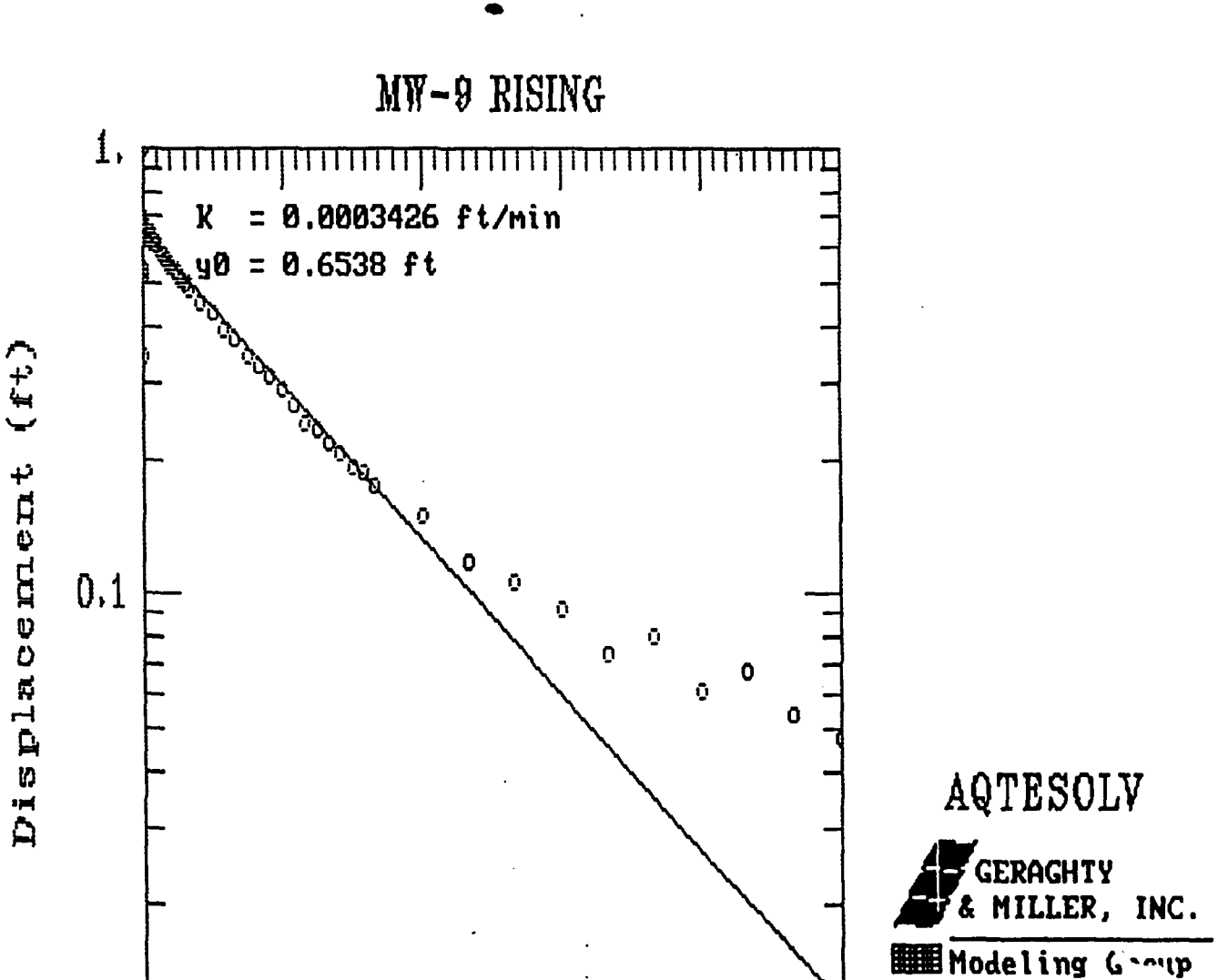
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RESULTS FROM VISUAL CURVE MATCHING

UAL MATCH PARAMETER ESTIMATES

	Estimate
K =	2.0707E-003
y0 =	2.3034E-001

<<


MW-9 RISING
K = 0.0003426 ft/min
y0 = 0.6538 ft
Displacement (ft)
1.
0.1
0.01
0.
6.
12.
18.
24.
30.
Time (min)
AQTESOLV
GERAGHTY
& MILLER, INC.
Modeling Group

<<

0.1166	0.656	0.64372	0.01228	1
0.1333	0.656	0.64229	0.013711	1
0.15	0.663	0.64086	0.022139	1
0.1666	0.65	0.63944	0.010556	1
0.1833	0.65	0.63802	0.011978	1
0.2	0.65	0.6366	0.013397	1
0.2166	0.644	0.6352	0.0088043	1
0.2333	0.65	0.63378	0.016217	1
0.25	0.644	0.63237	0.011626	1
0.2666	0.637	0.63098	0.0060242	1
0.2833	0.65	0.62957	0.020427	1
0.3	0.631	0.62817	0.0028275	1
0.3166	0.631	0.62678	0.0042161	1
0.3333	0.637	0.62539	0.01161	1
0.4166	0.618	0.61848	-0.00048355	1
0.5	0.612	0.61165	0.00035485	1
0.5833	0.612	0.60489	0.0071096	1
0.6666	0.599	0.59821	0.00078969	1
0.75	0.587	0.5916	-0.0045961	1
0.8333	0.58	0.58506	-0.0050628	1
0.9166	0.58	0.5786	0.0013984	1
1	0.568	0.5722	-0.0042042	1
1.0833	0.561	0.56589	-0.004885	1
1.1666	0.549	0.55964	-0.010636	1
1.25	0.542	0.55345	-0.011448	1
1.3333	0.536	0.54734	-0.011336	1
1.4166	0.536	0.54129	-0.0052914	1
1.5	0.523	0.53531	-0.012306	1
1.5833	0.517	0.52939	-0.012395	1
1.6666	0.511	0.52355	-0.012548	1
1.75	0.511	0.51776	-0.0067597	1
1.8333	0.498	0.51204	-0.014042	1
1.9166	0.498	0.50639	-0.008387	1
2	0.479	0.50079	-0.021788	1
2.5	0.454	0.4685	-0.014496	1
3	0.428	0.43829	-0.010285	1
3.5	0.39	0.41002	-0.020023	1
4	0.371	0.38358	-0.012583	1
4.5	0.339	0.35885	-0.019849	1
5	0.327	0.33571	-0.0087089	1
5.5	0.308	0.31406	-0.0060612	1
6	0.289	0.29381	-0.0048095	1
6.5	0.263	0.27486	-0.011864	1
7	0.244	0.25714	-0.013139	1
7.5	0.232	0.24056	-0.0085582	1
8	0.219	0.22505	-0.0060462	1
8.5	0.206	0.21053	-0.0045345	1
9	0.194	0.19696	-0.0029585	1
9.5	0.187	0.18426	0.0027421	1
10	0.175	0.17238	0.0026237	1
12	0.149	0.13203	0.016967	1
14	0.118	0.10113	0.016868	1
16	0.105	0.077463	0.027537	1
18	0.092	0.059334	0.032666	1
20	0.073	0.045447	0.027553	1
22	0.08	0.034811	0.045189	1
24	0.061	0.026664	0.034336	1
26	0.067	0.020423	0.046577	1
28	0.054	0.015643	0.038357	1

30	0.048	0.011982	0.036018	1
32	0.048	0.0091779	0.038822	1
34	0.048	0.0070299	0.04097	1
36	0.054	0.0053846	0.048615	1
38	0.048	0.0041244	0.043876	1
40	0.035	0.0031591	0.031841	1
42	0.035	0.0024198	0.03258	1
44	0.035	0.0018534	0.033147	1
46	0.035	0.0014197	0.03358	1
48	0.029	0.0010874	0.027913	1
50	0.029	0.00083291	0.028167	1
52	0.029	0.00063797	0.028362	1
54	0.035	0.00048866	0.034511	1
56	0.022	0.00037429	0.021626	1
58	0.029	0.00028669	0.028713	1
60	0.016	0.0002196	0.01578	1
62	0.022	0.0001682	0.021832	1
64	0.035	0.00012884	0.034871	1
66	0.022	9.8683E-005	0.021901	1
68	0.035	7.5587E-005	0.034924	1
70	0.029	5.7897E-005	0.028942	1
72	0.022	4.4347E-005	0.021956	1
74	0.022	3.3968E-005	0.021966	1
76	0.029	2.6018E-005	0.028974	1
78	0.016	1.9929E-005	0.01598	1
80	0.016	1.5265E-005	0.015985	1
82	0.022	1.1692E-005	0.021988	1
84	0.016	8.9556E-006	0.015991	1
86	0.022	6.8597E-006	0.021993	1
88	0.029	5.2542E-006	0.028995	1
90	0.022	4.0245E-006	0.021996	1
92	0.029	3.0826E-006	0.028997	1
94	0.022	2.3612E-006	0.021998	1
96	0.029	1.8086E-006	0.028998	1
98	0.022	1.3853E-006	0.021999	1
100	0.003	1.0611E-006	0.0029989	1

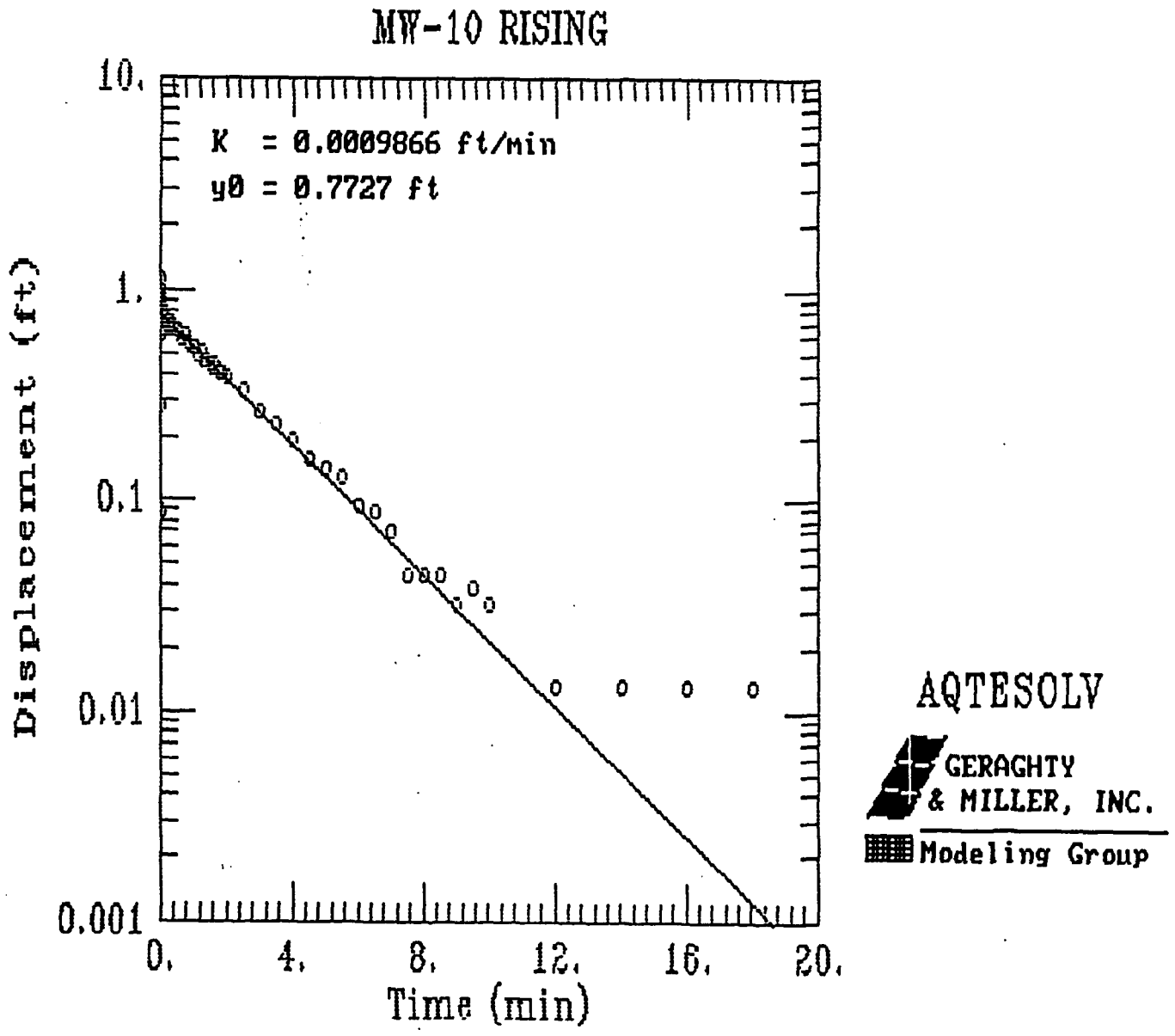
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RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	3.4264E-004
y0 =	6.5380E-001

<<


MW-10 RISING
K = 0.0009866 ft/min
y0 = 0.7727 ft
Displacement (ft)
10.
1.
0.1
0.01
0.001
0.
4.
8.
12.
16.
20.
Time (min)
AQTESOLV
GERAGHTY
& MILLER, INC.
Modeling Group

<<

0.0266	0.806	0.76546	0.040537	1
0.03	0.749	0.76454	-0.015536	1
0.0333	0.876	0.76364	0.11236	1
0.05	0.781	0.75911	0.021889	1
0.0666	0.793	0.75464	0.038363	1
0.0833	0.774	0.75016	0.023837	1
0.1	0.736	0.7[illegible]2	-0.009716	1
0.1166	0.724	0.74132	-0.017321	1
0.1333	0.717	0.73693	-0.019926	1
0.15	0.724	0.73256	-0.0085571	1
0.1666	0.698	0.72824	-0.03024	1
0.1833	0.698	0.72392	-0.025922	1
0.2	0.711	0.71963	-0.0086305	1
0.2166	0.717	0.71539	0.0016105	1
0.2333	0.711	0.71115	-0.00014812	1
0.25	0.705	0.70693	-0.0019319	1
0.2666	0.698	0.70277	-0.0047658	1
0.2833	0.679	0.6986	-0.019599	1
0.3	0.673	0.69446	-0.021457	1
0.3166	0.686	0.69036	-0.0043648	1
0.3333	0.667	0.68627	-0.019272	1
0.4166	0.66	0.66622	-0.0062155	1
0.5	0.641	0.64672	-0.0057223	1
0.5833	0.635	0.62782	0.0071781	1
0.6666	0.59	0.60947	-0.019474	1
0.75	0.603	0.59164	0.011359	1
0.8333	0.559	0.57435	-0.01535	1
0.9166	0.546	0.55756	-0.011565	1
1	0.527	0.54125	-0.014251	1
1.0833	0.527	0.52543	0.0015674	1
1.1666	0.495	0.51008	-0.015077	1
1.25	0.502	0.49515	0.0068478	1
1.3333	0.463	0.48068	-0.017681	1
1.4166	0.457	0.46663	-0.0096334	1
1.5	0.444	0.45298	-0.0089799	1
1.5833	0.432	0.43974	-0.0077416	1
1.6666	0.444	0.42689	0.01711	1
1.75	0.413	0.4144	-0.0013995	1
1.8333	0.4	0.40229	-0.0022887	1
1.9166	0.394	0.39053	0.0034682	1
2	0.381	0.3791	0.001895	1
2.5	0.336	0.31728	0.018722	1
3	0.267	0.26553	0.0014657	1
3.5	0.229	0.22223	0.0067708	1
4	0.197	0.18599	0.011013	1
4.5	0.159	0.15565	0.0033453	1
5	0.14	0.13027	0.0097305	1
5.5	0.127	0.10902	0.017976	1
6	0.095	0.091244	0.0037561	1
6.5	0.089	0.076363	0.012637	1
7	0.07	0.063909	0.0060906	1
7.5	0.044	0.053487	-0.0094867	1
8	0.044	0.044764	-0.00076371	1
8.5	0.044	0.037463	0.0065367	1
9	0.032	0.031354	0.00064642	1
9.5	0.038	0.02624	0.01176	1
10	0.032	0.021961	0.010039	1
12	0.013	0.010774	0.0022262	1
14	0.013	0.0052856	0.0077144	1

16	0.013	0.0025931	0.010407	1
18	0.013	0.0012721	0.011728	1
22	0.013	0.00030618	0.012694	1
24	0.013	0.00015021	0.01285	1
26	0.006	7.3693E-005	0.0059263	1
28	0.019	3.6153E-005	0.018964	1
30	0.006	1.7737E-005	0.0059823	1
32	0.006	8.7015E-006	0.0059913	1
34	0.006	4.2689E-006	0.0059957	1
36	0.019	2.0943E-006	0.018998	1
40	0.006	5.0406E-007	0.0059995	1
44	0.006	1.2132E-007	0.0059999	1
48	0.019	2.9199E-008	0.019	1
50	0.006	1.4325E-008	0.006	1
62	0.006	1.9972E-010	0.006	1
74	0.019	2.7846E-012	0.019	1
78	0.019	6.702E-013	0.019	1
80	0.006	3.2879E-013	0.006	1
84	0.006	7.9135E-014	0.006	1
86	0.006	3.8823E-014	0.006	1
88	0.006	1.9046E-014	0.006	1
90	0.006	9.3441E-015	0.006	1
94	0.006	2.249E-015	0.006	1
96	0.006	1.1033E-015	0.006	1
98	0.013	5.4128E-016	0.013	1
100	0.006	2.6555E-016	0.006	1

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RESULTS FROM VISUAL CURVE MATCHING

VISUAL MATCH PARAMETER ESTIMATES

	Estimate
K =	9.8657E-004
y0 =	7.7275E-001

<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>

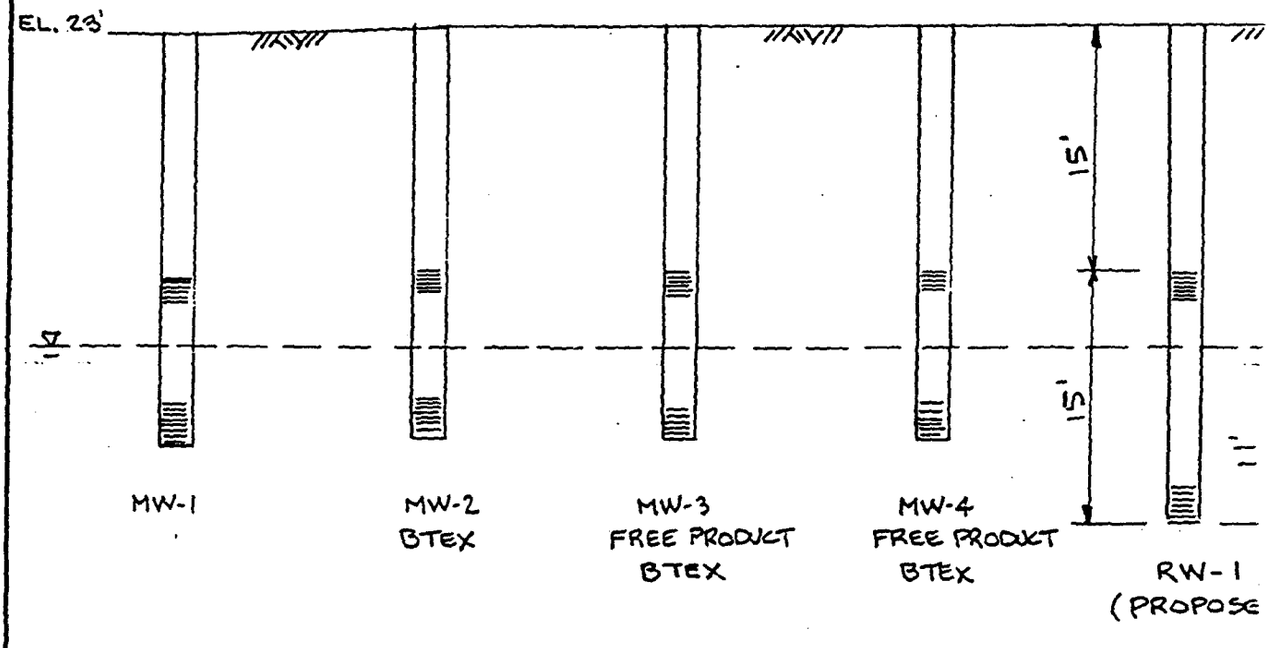
S.O. No. _____

Subject: BOLLING AIR FORCE BASE - CAR CARE CENTER
BASIS OF DESIGN Sheet No. ____ of ____
GROUNDWATER EXTRACTION Drawing No. _____

Computed by _____ Checked By _____ Date _____

Baker

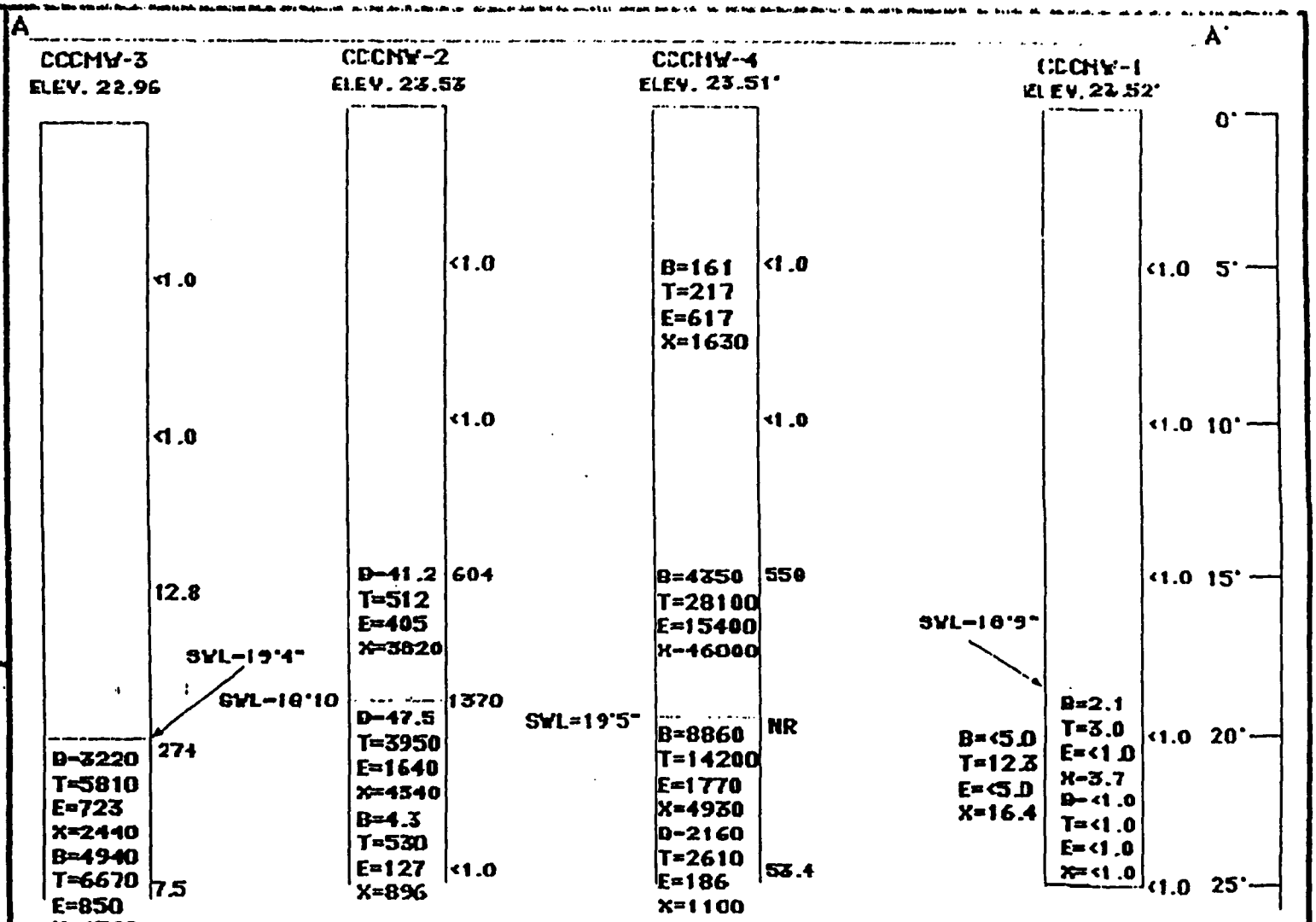
REF: PHASE II ENVIRONMENTAL ASSESSMENT, ATEC INC, MARCH 199(



HYDRAULIC CONDUCTIVITY - INCONCLUSIVE SLUG TESTS PERFORMED BY BAKER 9/92. FIELD GEOLOGIST ASSUMES WELLS NOT PROPERLY DEVELOPED WHEN INSTALLED.

RADIUS OF INFLUENCE - GEOLOGIST RECOMMENDS ASSUMPTION TH AQUIFER CHARACTERISTICS ARE SIMILAR TO HEAT PLANT (LOCATED 1200' AWAY). R = 95'

RI/FS FOR CAR CARE CENTER HAS NOT BEEN COMPLETED - GW CONTAMINATION NOT FULLY DELINEATED (MW-6 NOT SAMPLED) HOWEVER, MW-6 HAD FREE PRODUCT DURING SITE VISIT 9/92. THERE PLACE RECOVERY WELL. TO INFLUENCE MW-3, 4 & 6 (FREE PRODUC FOUND) AND MW-2 (GW CONTAMINATED)



ppm = parts per million
ppb = parts per billion
SWL = static water level on 3/15/90
B = benzene (ppb)
T = toluene (ppb)
E = ethylbenzene (ppb)
X = xylenes (ppb)
TPH = total petroleum hydrocarbons

Black lettering = TPH (soil/ppm)
Red lettering = BTEX (soil)
Purple lettering = BTEX (water on 3/9/90)
Green lettering = BTEX (water on 3/16/90)
Depths measured from surface elevation
NR = No sample recovered

FIGURE 12:
CAR CARE CENTER
MONITORING WELL SAMPLE PROFILE

DATE: March 27, 1990
SCALE: Not to scale
DRAWN BY: Bill Bymaster
JOB NUMBER 27-80012

ATEC ENVIRONMENTAL CONSULTANTS
Division of ATEC Assoc. of Va, Inc
4076 Walney Road
Chantilly, Virginia 22021-2919
(703) 631-3383

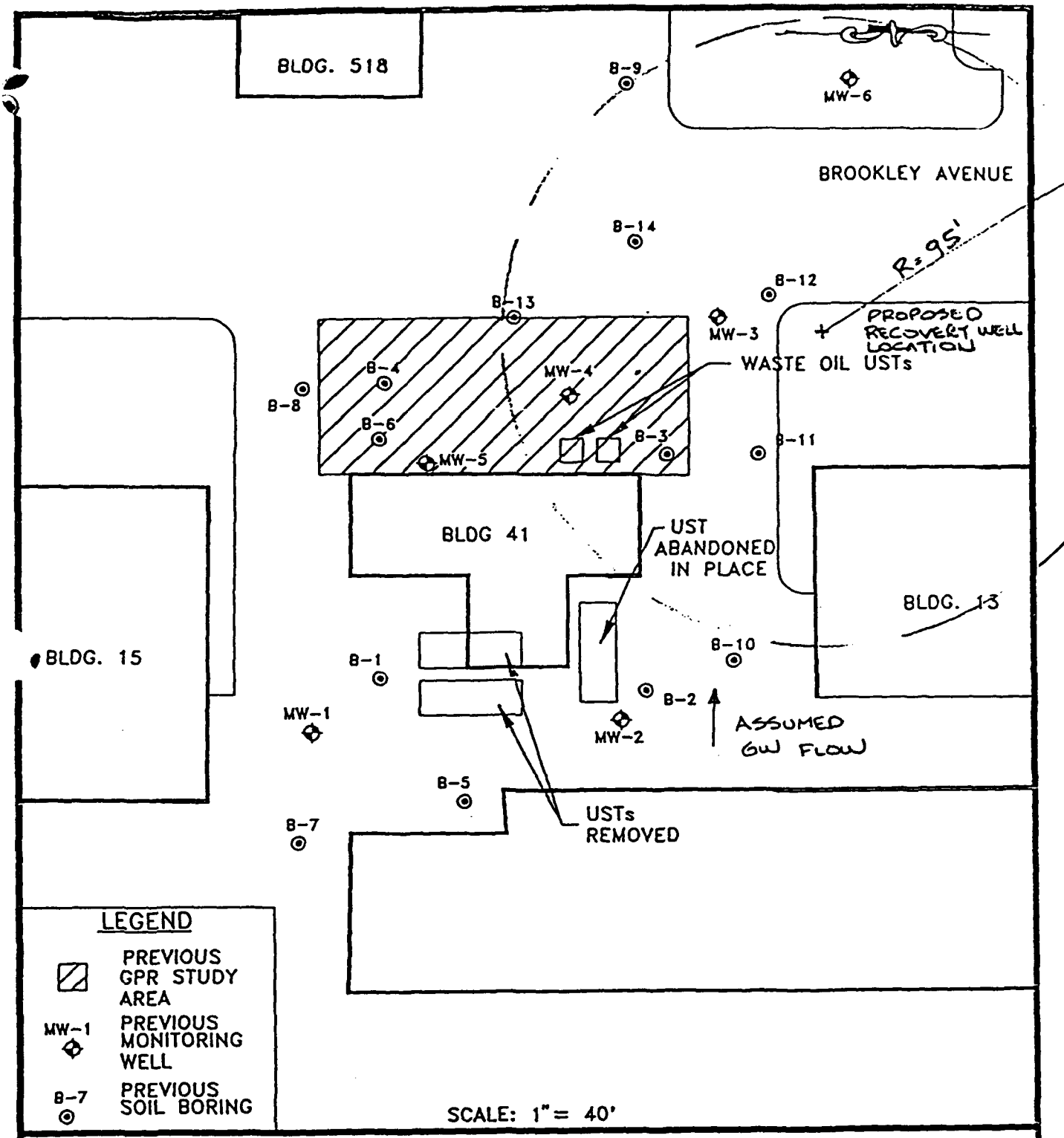


FIGURE 2-4
CAR CARE CENTER-BUILDING 41
LOCATION MAP
SHOWING PREVIOUS INVESTIGATION LOCATIONS

BOLLING AIR FORCE BASE

SE1000C
Environmental Logger
10/01 15:01

slug test
CCC-1

Unit# 01606 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	12203
Reference	0.000
Linearity	0.120
Scale factor	19.890
Offset	-0.140
Delay mSEC	50.000

Step 0 10/01 13:22:26

Elapsed Time	INPUT 1
0.0000	3.993
0.0033	3.905
0.0066	3.898
0.0100	3.936
0.0133	3.943
0.0166	3.943
0.0200	3.911
0.0233	3.949
0.0266	3.917
0.0300	3.867
0.0333	3.892
0.0500	3.892
0.0666	3.848
0.0833	3.823
0.1000	3.767
0.1166	3.792
0.1333	3.773
0.1500	3.760
0.1666	3.748
0.1833	3.741
0.2000	3.729
0.2166	3.716
0.2333	3.704
0.2500	3.691
0.2666	3.685
0.2833	3.672
0.3000	3.666
0.3166	3.653
0.3333	3.647
0.4166	3.603
0.5000	3.565

0.5833	3.534
0.6666	3.496
0.7500	3.471
0.8333	3.440
0.9166	3.414
1.0000	3.389
1.0833	3.370
1.1666	3.352
1.2500	3.333
1.3333	3.314
1.4166	3.295
1.5000	3.276
1.5833	3.264
1.6666	3.245
1.7500	3.232
1.8333	3.220
1.9166	3.201
2.0000	3.188
2.5000	3.113
3.0000	3.044
3.5000	2.981
4.0000	2.924
4.5000	2.868
5.0000	2.817
5.5000	2.780
6.0000	2.742
6.5000	2.691
7.0000	2.660
7.5000	2.629
8.0000	2.597
8.5000	2.566
9.0000	2.534
9.5000	2.509
10.0000	2.490
12.0000	2.440
14.0000	2.377
16.0000	2.327
18.0000	2.283
20.0000	2.245
22.0000	2.214
24.0000	2.176
26.0000	2.144
28.0000	2.126
30.0000	2.100
32.0000	2.082
34.0000	2.050
36.0000	2.019
38.0000	2.012
40.0000	1.994
42.0000	1.962
44.0000	1.949
46.0000	1.931
48.0000	1.905
50.0000	1.887

52.0000	1.868
54.0000	1.843
56.0000	1.843
58.0000	1.817
60.0000	1.805
62.0000	1.792

SE1000C
Environmental Logger
10/01 14:59

Slug test

CCC-2

Unit# 01606 Test 0

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	12203
Reference	0.000
Linearity	0.120
Scale factor	19.890
Offset	-0.140
Delay mSEC	50.000

Step 0 10/01 09:58:21

Elapsed Time	INPUT 1
0.0000	2.302
0.0033	3.792
0.0066	3.660
0.0100	3.559
0.0133	3.565
0.0166	3.540
0.0200	3.591
0.0233	3.540
0.0266	3.509
0.0300	3.434
0.0333	3.415
0.0500	3.408
0.0666	3.245
0.0833	3.132
0.1000	3.019
0.1166	2.918
0.1333	2.899
0.1500	2.742
0.1666	2.660
0.1833	2.578
0.2000	2.497
0.2166	2.415
0.2333	2.339
0.2500	2.264
0.2666	2.195
0.2833	2.132
0.3000	2.075
0.3166	2.019
0.3333	1.968
0.4166	1.811
0.5000	1.748

0.5833	1.704
0.6666	1.673
0.7500	1.654
0.8333	1.635
0.9166	1.616
1.0000	1.604
1.0833	1.591
1.1666	1.585
1.2500	1.572
1.3333	1.566
1.4166	1.553
1.5000	1.553
1.5833	1.541
1.6666	1.541
1.7500	1.534
1.8333	1.528
1.9166	1.522
2.0000	1.522
2.5000	1.490
3.0000	1.472
3.5000	1.453
4.0000	1.440
4.5000	1.421
5.0000	1.415
5.5000	1.402
6.0000	1.390
6.5000	1.371
7.0000	1.358
7.5000	1.352
8.0000	1.346
8.5000	1.340
9.0000	1.327
9.5000	1.314
10.0000	1.308
12.0000	1.295
14.0000	1.251
16.0000	1.239
18.0000	1.214
20.0000	1.195
22.0000	1.176
24.0000	1.151
26.0000	1.126
28.0000	1.107
30.0000	1.075
32.0000	1.069
34.0000	1.050
36.0000	1.038
38.0000	1.012
40.0000	1.000
42.0000	0.987
44.0000	0.968
46.0000	0.956
48.0000	0.943
50.0000	0.931

52.0000	0.918
54.0000	0.905
56.0000	0.887
58.0000	0.880
60.0000	0.861
62.0000	0.849
64.0000	0.843
66.0000	0.830
68.0000	0.817
70.0000	0.805
72.0000	0.799
74.0000	0.786
76.0000	0.773
78.0000	0.761
80.0000	0.748
82.0000	0.748
84.0000	0.736
86.0000	0.729
88.0000	0.710
90.0000	0.717
92.0000	0.704
94.0000	0.698
96.0000	0.692
98.0000	0.685
100.000	0.679
110.000	0.648

SE1000C
Environmental Logger
09/29 11:16

Slug test
CCC-5'

Unit# 01606 Test 1

Setups:	INPUT 1
Type	Level (F)
Mode	TOC
I.D.	12203
Reference	0.000
Linearity	0.120
Scale factor	19.890
Offset	-0.140
Delay mSEC	50.000

Step 0 09/29 09:45:17

Elapsed Time	INPUT 1
0.0000	3.654
0.0033	5.169
0.0066	4.327
0.0100	4.050
0.0133	3.981
0.0166	3.893
0.0200	3.817
0.0233	3.799
0.0266	3.767
0.0300	3.861
0.0333	3.868
0.0500	3.566
0.0666	3.390
0.0833	3.270
0.1000	3.201
0.1166	3.050
0.1333	2.918
0.1500	2.830
0.1666	2.755
0.1833	2.692
0.2000	2.591
0.2166	2.528
0.2333	2.472
0.2500	2.428
0.2666	2.390
0.2833	2.359
0.3000	2.334
0.3166	2.308
0.3333	2.289
0.4166	2.208
0.5000	2.157

0.5833	2.120
0.6666	2.095
0.7500	2.076
0.8333	2.057
0.9166	2.038
1.0000	2.025
1.0833	2.019
1.1666	2.006
1.2500	1.994
1.3333	1.988
1.4166	1.981
1.5000	1.975
1.5833	1.969
1.6666	1.962
1.7500	1.956
1.8333	1.950
1.9166	1.944
2.0000	1.944
2.5000	1.925
3.0000	1.900
3.5000	1.887
4.0000	1.881
4.5000	1.868
5.0000	1.856
5.5000	1.856
6.0000	1.843
6.5000	1.843
7.0000	1.837
7.5000	1.830
8.0000	1.824
8.5000	1.824
9.0000	1.818
9.5000	1.818
10.0000	1.811
12.0000	1.799
14.0000	1.793
16.0000	1.786
18.0000	1.793
20.0000	1.793
22.0000	1.774
24.0000	1.780
26.0000	1.780
28.0000	1.774
30.0000	1.774
32.0000	1.774
34.0000	1.767
36.0000	1.767
38.0000	1.767
40.0000	1.761
42.0000	1.761
44.0000	1.761
46.0000	1.761
48.0000	1.761
50.0000	1.755

52.0000	1.755
54.0000	1.755
56.0000	1.755
58.0000	1.761
60.0000	1.749
62.0000	1.755
64.0000	1.755
66.0000	1.749
68.0000	1.749
70.0000	1.749
72.0000	1.730
74.0000	1.749
76.0000	1.749
78.0000	1.742
80.0000	1.736
82.0000	1.742

APPENDIX B

GROUNDWATER ELEVATION AND MOBILE LNAPL THICKNESS DATA
CAR CARE CENTER SITE
INTRINSIC REMEDIATION EE/CA
BOLLING AFB, DC

Sample Location[a]	Date	Easting (feet)	Northing (feet)	Datum Elevation[b] (feet msl)[c]	Total Depth (feet btoc)[d]	Product Thickness (feet)	Water Depth (feet btoc)	Potentiometric Surface Elevation (feet msl)
Monitoring Points								
CPT-02S	8/94	796500	367430	22.26	23.2	0.00	19.61	2.65
CPT-02D	8/94	796500	367430	22.24	33.3	0.00	19.27	2.97
CPT-08S	8/94	796448	367290	21.49	23.2	0.00	18.25	3.24
CPT-08D	8/94	796448	367290	21.42	33.2	0.00	18.29	3.13
CPT-09S	8/94	796438	367362	20.97	23.2	0.00	17.92	3.05
CPT-09D	8/94	796438	367362	20.95	33.2	0.00	17.93	3.02
CPT-10S	8/94	796523	367394	21.17	23.2	0.00	18.13	3.04
CPT-10D	8/94	796523	367394	21.21	33.2	0.00	18.18	3.03
CPT-11S	8/94	796429	367400	20.77	23.2	0.00	17.85	2.92
CPT-11D	8/94	796429	367400	21.01	33.2	0.00	17.81	3.20
CPT-16S	8/94	796354	367330	20.40	23.2	0.00	17.42	2.98
CPT-16D	8/94	796354	367330	20.38	33.2	0.00	17.41	2.97
CPT-18S	8/94	796362	367483	21	23.2	NA[e]	NA	NA
CPT-18D	8/94	796362	367483	21	33.2	NA	NA	NA
CPT-19S	8/94	796330	367571		27.2	0.00	21.24	3.73
CPT-19S	6/96	796330	367571		27.2	0.00	17.24	7.73
CPT-19D	8/94	796330	367571		37.2	0.00	22.16	2.80
CPT-19D	6/96	796330	367571	24	37.2	0.00	19.03	5.93
CPT-20S	8/94	796345	367615	24.80	27.2	0.00	20.83	3.97
CPT-20S	6/96	796345	367615	24.80	27.2	0.00	17.80	7.00
CPT-20D	8/94	796345	367615	24.79	37.2	0.00	21.99	2.80
CPT-20D	6/96	796345	367615	24.79	[illegible]	0.00	19.36	5.43
CPT-21S	8/94	796345	367670	22.25	23	0.00	18.50	3.75
CPT-21S	6/96	796345	367670	22.25	23	0.00	17.46	4.79
CPT-21D	8/94	796345	367670	22.08	33.2	0.00	19.56	2.52
CPT-21D	6/96	796345	367670	22.08	33.2	0.00	18.67	3.41
CPT-22S	8/94	796292	367707	21.97	23.2	0.00	20.80	1.17
CPT-22S	6/96	796292	367707	21.97	23.2	0.00	5.60	16.37
CPT-22D	8/94	796292	367707	22.07	33.2	0.00	19.21	2.86
CPT-22D	6/96	796292	367707	22.07	33.2	0.00	18.32	3.75
Previously Installed Monitoring Wells								
MW-1	8/94	796559	367215	21.68	25	0.00	18.33	3.35
MW-1	6/96	796559	367215	21.68	25	0.00	17.08	4.60
MW-2	8/94	796558	367351	21.68	25	0.15[f]	NA	NA
MW-3	8/94	796456	367409	21.14	25	0.32[g]	17.62	3.52
MW-4	8/94	796459	367356	21.27	25	0.00	18.08	3.19
MW-5	8/94	796452	367291	21.37	26	0.00	18.46	2.91
MW-6	8/94	796397	367471	21.55	26	0.00	18.62	2.93
MW-7	8/94	796525	367639	21.97	29	0.00	18.61	3.36
MW-7	6/96	796525	367639	21.97	29	0.00	17.97	4.00
MW-8	8/94	796388	367706	26.49	27	0.00	23.77	2.72
MW-8	6/96	796388	367706	26.49	27	0.00	22.95	3.54
MW-9	8/94	796608	367191	22.15	30	0.00	15.83	6.32
MW-9	6/96	796608	367191	22.15	30	0.00	15.04	7.11
MW-10	8/94	796282	367417	20.76	29	0.00	12.31	8.45
MW-10	6/96	796282	367417	20.76	29	0.00	11.71	9.05
MW-11	6/96	NA	NA	NA	NA	0.47	17.50	NA

[a] See Figure 3.6 and Figure 4.1 for sample locations

[b] Datum elevation is from top of well casing

[c] feet msl = feet above mean sea level

[d] feet btoc = feet below top of casing

[e] NA = not available

[f] Measured product thickness on August 6, 1994. Monitoring well destroyed after this date.

[g] Measured product thickness on August 9, 1994. Free-product not present on August 11, 1994.

Evergreen

September 20, 1994

MS GAIL SAXTON
ENGINEERING SCIENCE
1700 BROADWAY SUITE 900
DENVER CO 80209

Data Report : 94-2981
Client Project : Bolling AFB

Dear Ms. Saxton:

Enclosed are the analytical results for the samples shown in the Sample Log Sheet. The enclosed data have been reviewed for quality assurance. If you have any questions concerning the reported information, please contact Mark Mensik, Project Manager, or me.

Please Note: Samples marked for return on the Sample Log Sheet are considered hazardous, unsuitable for municipal disposal or were placed on hold at your request. Samples considered hazardous or unsuitable for municipal disposal will be returned to you immediately. Samples placed on hold will be returned and samples not considered hazardous will be disposed of one (1) month from the date of this letter.

The invoice for this work will be mailed to your Accounts Payable department shortly.

Thank you for using the services of Evergreen Analytical.

Sincerely,

Jack Barney/Mja

Jack Barney
President

JJ

Evergreen Analytical, Inc. 4036 Youngfield St. Wheat Ridge, CO 80033-3862 (303) 425-6021 FAX (303) 425-6854

Evergreen

CASE NARRATIVE

Evergreen Analytical Project #: 94-2981

Engineering Science, Inc. (ES) Project: Bolling AFB (722450.02)

Sample Receipt

On August 8, 10, 11 and 12, 1994, 17 soil samples, 31 water samples and one free product sample were received in good condition at Evergreen Analytical Laboratory (EAL). Samples SB-14(14'BLS) and SB-14(20'-21'4") were mislabelled on the chain-of-custody (coc) as SB-14(14'-14'8") and SB-14(14'8"-15'4"), respectively. This was confirmed by Todd Wiedemeier of ES to Mark Mensik of EAL, and has been noted on the coc and the EAL Check-in Record. Refer to the EAL Sample Log Sheet for specific log-in information and cross-reference of EAL and ES sample identifications.

BTEX, Soil Matrix, Method 8020

There were no quality control anomalies to report.

Samples SB14(20'-21'4"), SB7(10'9"-11'5"0) and SB3(22'-24'5") were initially analyzed at dilution factors of 1250, 1250 and 125, respectively, due to suspected high levels of contamination. Analysis of these samples confirmed the suspected high level of background contamination. These samples were not reanalyzed at a lower dilution because the high background contamination most likely would have swamped the detector and possibly shut down the instrument. Thus, the practical quantitation limit (PQL) reported for these samples is 6000, 6000 and 560 µg/Kg, respectively (after adjustment for %moisture). Several of the compound concentrations were less than the PQL and have been flagged as estimated (J). Other compounds were non-detected and have been flagged "U", indicating the compound was not detected at or below the associated method detection limit, which is a factor of 10 lower than the PQL.

BTEX, Trimethylbenzene Isomers, Water Matrix, Method 8020

The water samples for BTEX and Trimethylbenzene isomers were analyzed using SW846 Method 8020. The data reports indicate a PQL of 4.0 µg/L. The method detection limit (MDL) for waters by this method is 0.4 µg/L. All results reported as non-detected are done so using the qualifier "U". All results reported as non-detected (U) are considered non-detected at the MDL. Additionally, results reported as detected above the MDL but less than the PQL are qualified as estimated and flagged with a "J".

The trip blanks were not analyzed since the coc requested they be held.

Total Volatile Hydrocarbons-Gasoline (TVH), Method 8015 Modified
There were no quality control anomalies to report.

Total Organic Carbon
Total organic carbon (TOC) was analyzed by Huffman Laboratories of Golden, Colorado. TOC was determined by analyzing for total carbon (TC) and inorganic (carbonate) carbon (CC), then calculating the difference as TOC. The report from Huffman is included. The other sample on the report is from the ES Carswell AFB project.

Methane
Methane was analyzed using a modified version of a draft method provided by ES. The method, identified as RSKSOP-147, is described below:

Water samples were collected in 40ml VOA vials. A 10ml volume was removed to create headspace. The samples were then heated at 105°F, for a minimum of 30 minutes, to liberate any methane present. A sample of the headspace was drawn out of the vial through the septum with a 500 µl air tight syringe and injected into the GC.

Since only one bottle was received for this analysis, samples were screened during the removal of the 10ml of sample to determine the sample injection volume. "Clean" samples were run with a full 500 µl injection volume. Other samples were run at either 100 or 50 µl injection volumes. Injection volumes below 50 µl are not accurate so some samples may have been under diluted.

Given the limited sample volume and the syringe limitations, every attempt was made to perform the analysis as consistently as possible from sample to sample, and to provide usable, reliable data.

Alkalinity, Method 310.1
There were no quality control anomalies to report.

Anions (Nitrate as N, Sulfate) Method 300.0
There were no quality control anomalies to report.

Samples CPT-18S, CPT-18D and MW-2 were received at EAL after the holding time of 48 hours had expired for the analysis of nitrate as N. The results are reported as Nitrite + Nitrate as N. All other nitrate as N results were analyzed within holding time.

Mark J. Mersik, Project Manager
™

ergreen Analytical Sample Log Sheet Project # 94-2981

te(s) Sampled: 08/3✓,5▪,6¥,8†,9◂,10★,11$/94 COC Date Due: 08/25/94

te Received: 08/08,10,11,12/94 Holding Time(s): NO_3-▪8/7,¥8,†10,◂11,★12,$13/94
Methane-▪8/12,¥13,†15,◂16,★17,$18/94
Alk,BTEX/TVH(W/HCL)▪8/19,¥20,†22,◂23,★24,$25/94
BTEX,TVH(S)-✓8/17,†22/94

ient Project I.D.: Bolling AFB Rush STANDARD

ient: Engineering Science Shipping Charges N/A

dress: 1700 Broadway Suite 900 E.A. Cooler # 307,389,331
Denver, CO 80202 Airbill #'s FEDEX-95188-330,341,514,315

ntact: Gail Saxton Custody Seal Intact? Y
Cooler X Bottles ___

ient Contract # 722450.08020 COC Present Y
Sample Tags Present? Y

one #831-8100 Fax #831-8208 Sample Tags Listed? Y
Sample(s) Sealed? Y

ecial Invoicing/Billing

ecial Instructions SEE ENGINEERING SCIENCE CONTRACT #722450.08020. *SAMPLES
ED BTEX SPLIT. **SAMPLE I.D. FROM SAMPLE BOTTLE. BTEX & TVH RESULTS NEED
) BE REPORTED ON A DRY WIEGHT BASIS.

Lab #	Client ID#	Analysis	Mtx	Btl	Loc
92382	SB54(14'8"-15'4")	▪✓BTEX,TVH	S	2WM	2
92388	SB47(12'-13'8")	▪✓BTEX,TVH	S	2WM	2
92398	MW-3(Free Product)	▪◂%BTEX,%TVH	LW	40V	2
92380A	SB14(14BLS)**	✓BTEX	S	2WM	2
92381A	SB14(20'-21'4")**	✓BTEX	S	2WM	2
92383A	SB7(10'9"-11'5")	✓BTEX	S	2WM	2
92384A	SB7(14'-17'2")	✓BTEX	S	2WM	2
92385A	SB7(20'-22'2")	✓BTEX	S	2WM	2
92386A	SB9(17'9"-19'11")	✓BTEX	S	2WM	2
92387A	SB9(22'6"-24'8")	✓BTEX	S	2WM	2
92389A	SB11(11'-11'2")	✓BTEX	S	2WM	2
92390A	SB11(17'6"-19'8")	✓BTEX	S	2WM	2
92391A	SB11(22'-24'2")	✓BTEX	S	2WM	2
92392A	SB1(9'8"-11'8")	✓BTEX	S	2WM	2
92393A	SB1(22'-24'5")	✓BTEX	S	2WM	2
92414A	SB-9S	†BTEX	S	2WM	2
416A	SB-9D	†BTEX	S	2WM	2

-Sample to be returned
oute GC/MS ___ GC 4 Metals ___ Wet Chem 2 SxPrep ___ Acctg 1
To
SxRec C Adm C QA/QC C Sales C File Orig

age 1 of 5 Page(s) Custodian/Date: MB 8/12/94

#	Client ID#	Analysis	Mtx	Btl	Loc
2394A/B	MW-9	◄BTEX+TMB 602	W	40V	2
2395A/B	MW-4	◄BTEX+TMB 602	W	40V	2
2396A/B	MW-11	◄BTEX+TMB 602	W	40V	2
2397A/B	MW-5	◄BTEX+TMB 602	W	40V	2
2399A/B	CPT-2D	◄BTEX+TMB 602	W	40V	2
2400A/B	CPT-16D	◄BTEX+TMB 602	W	40V	2
2401A/B	CPT-16S	◄BTEX+TMB 602	W	40V	2
2402A/B	MW-3	◄BTEX+TMB 602	W	40V	2
2403A/B	CPT-18S	■BTEX+TMB 602	W	40V	2
2404A/B	CPT-18D	■BTEX+TMB 602	W	40V	2
2405A/B	MW-2	¥BTEX+TMB 602	W	40V	2
2406A/B	CPT-8S	†BTEX+TMB 602	W	40V	2
2407A/B	CPT-8D	†BTEX+TMB 602	W	40V	2
2408A/B	CPT-10S	†BTEX+TMB 602	W	40V	2
2409A/B	CPT-10D	†BTEX+TMB 602	W	40V	2
2410A/B	CPT-9S	†BTEX+TMB 602	W	40V	2
2411A/B	CPT-9D	†BTEX+TMB 602	W	40V	2
2412A/B	CPT-11S	†BTEX+TMB 602	W	40V	2
2413A/B	CPT-11D	†BTEX+TMB 602	W	40V	2
2489A/B	CPT-22D	‡BTEX+TMB 602	W	40V	2
2490A/B	CPT-21D	‡BTEX+TMB 602	W	40V	2
2491A/B	CPT-50D	‡BTEX+TMB 602	W	40V	2
2492A/B	CPT-20D	‡BTEX+TMB 602	W	40V	2
2493A/B	CPT-19D	‡BTEX+TMB 602	W	40V	2
2494A/B	MW-7	‡BTEX+TMB 602	W	40V	2
2495A/B	MW-8	‡BTEX+TMB 602	W	40V	2
2496A/B	MW-10	‡BTEX+TMB 602	W	40V	2
2570A/B	MW-1	§BTEX+TMB 602	W	40V	2
2571A/B	MW-6	§BTEX+TMB 602	W	40V	2
2572A/B	CPT-12S	§BTEX+TMB 602	W	40V	2
2573A/B	CPT-2S	§BTEX+TMB 602	W	40V	2
2427A-502A	TRIP BLANK	HOLD	W	40V	2
2574A-577A	TRIP BLANK	HOLD	W	40V	2
2380B	SB14(14BLS)**	√TVH	S	2WM	2
2381B	SB14(20'-21'4")**	√TVH	S	2WM	2
2383B	SB7(10'9"-11'5")	√TVH	S	2WM	2
2384B	SB7(14'-17'2")	√TVH	S	2WM	2
2385B	SB7(20'-22'2")	√TVH	S	2WM	2
2386B	SB9(17'9"-19'11")	√TVH	S	2WM	2
2387B	SB9(22'6"-24'8")	√TVH	S	2WM	2
2389B	SB11(11'-13'2")	√TVH	S	2WM	2
2390B	SB11(17'6"-19'8")	√TVH	S	2WM	2
2391B	SB11(22'-24'2")	√TVH	S	2WM	2
2392B	SB1(9'8"-11'8")	√TVH	S	2WM	2
2393B	SB1(22'-24'5")	√TVH	S	2WM	2
2414B	SB-9S	†TVH,TOC	S	2WM	2/OUT
2416B	SB-9D	†TVH,TOC	S	2WM	2/OUT

Project # 94-2981

*Sample to be returned

	Client ID#	Analysis	Mtx	Btl	Loc
194C/D	MW-9	◂TVH	W	40V	2
195C/D	MW-4	◂TVH	W	40V	2
196C/D	MW-11	◂TVH	W	40V	2
197C/D	MW-5	◂TVH	W	40V	2
199C/D	CPT-2D	◂TVH	W	40V	2
400C/D	CPT-16D	◂TVH	W	40V	2
401C/D	CPT-16S	◂TVH	W	40V	2
402C/D	MW-3	◂TVH	W	40V	2
403C/D	CPT-18S	■TVH	W	40V	2
404C/D	CPT-18D	■TVH	W	40V	2
405C/D	MW-2	¥TVH	W	40V	2
406C/D	CPT-8S	†TVH	W	40V	2
407C/D	CPT-8D	†TVH	W	40V	2
408C/D	CPT-10S	†TVH	W	40V	2
409C/D	CPT-10D	†TVH	W	40V	2
410C/D	CPT-9S	†TVH	W	40V	2
411C/D	CPT-9D	†TVH	W	40V	2
412C/D	CPT-11S	†TVH	W	40V	2
413C/D	CPT-11D	†TVH	W	40V	2
489C/D	CPT-22D	‡TVH	W	40V	2
490C/D	CPT-21D	‡TVH	W	40V	2
491C/D	CPT-50D	‡TVH	W	40V	2
492C/D	CPT-20D	‡TVH	W	40V	2
493C/D	CPT-19D	‡TVH	W	40V	2
494C/D	MW-7	‡TVH	W	40V	2
495C/D	MW-8	‡TVH	W	40V	2
496C/D	MW-10	‡TVH	W	40V	2
570C/D	MW-1	§TVH	W	40V	2
571C/D	MW-6	§TVH	W	40V	2
572C/D	CPT-12S	§TVH	W	40V	2
573C/D	CPT-2S	§TVH	W	40V	2
394G	MW-9	◂Methane	W	40V	2
395G	MW-4	◂ "	W	40V	2
396G	MW-11	◂ "	W	40V	2
397G	MW-5	◂ "	W	40V	2
399G	CPT-2D	◂ "	W	40V	2
400G	CPT-16D	◂ "	W	40V	2
401G	CPT-16S	◂ "	W	40V	2
402G	MW-3	◂ "	W	40V	2
403G	CPT-18S	■ "	W	40V	2
404G	CPT-18D	■ "	W	40V	2
405G	MW-2	¥ "	W	40V	2
406G	CPT-8S	† "	W	40V	2
407G	CPT-8D	† "	W	40V	2
408G	CPT-10S	† "	W	40V	2
409G	CPT-10D	† "	W	40V	2
410G	CPT-9S	† "	W	40V	2
411G	CPT-9D	† "	W	40V	2
412G	CPT-11S	† "	W	40V	2
413G	CPT-11D	† "	W	40V	2
489G	CPT-22D	‡ "	W	40V	2
490G	CPT-21D	‡ "	W	40V	2
491G	CPT-50D	‡ "	W	40V	2
192G	CPT-20D	‡ "	W	40V	2
493G	CPT-19D	‡ "	W	40V	2

Project # 94-2981

Sample to be returned

#	Client ID#	Analysis	Mtx	Btl	Loc
494G	MW-7	★Methane	W	40V	2
495G	MW-8	★ "	W	40V	2
496G	MW-10	★ "	W	40V	2
570G	MW-1	★ "	W	40V	2
571G	MW-6	★ "	W	40V	2
572G	CPT-32S	★ "	W	40V	2
573G	CPT-2S	★ "	W	40V	2
394E	MW-9	◂Alkalinity	W	500P	D1
395E	MW-4	◂ "	W	500P	"
396E	MW-11	◂ "	W	500P	"
397E	MW-5	◂ "	W	500P	"
399E	CPT-2D	◂ "	W	500P	"
400E	CPT-16D	◂ "	W	500P	"
401E	CPT-16S	◂ "	W	500P	"
402E	MW-3	◂ "	W	500P	"
403E	CPT-18S	■ "	W	500P	"
404E	CPT-18D	■ "	W	500P	"
405E	MW-2	▼ "	W	500P	"
406E	CPT-8S	† "	W	500P	"
407E	CPT-8D	† "	W	500P	"
408E	CPT-10S	† "	W	500P	"
409E	CPT-10D	† "	W	500P	"
410E	CPT-9S	† "	W	500P	"
411E	CPT-9D	† "	W	500P	"
412E	CPT-11S	† "	W	500P	"
413E	CPT-11D	† "	W	500P	"
489E	CPT-22D	★ "	W	500P	"
490E	CPT-21D	★ "	W	500P	"
491E	CPT-50D	★ "	W	500P	"
492E	CPT-20D	★ "	W	500P	"
493E	CPT-19D	★ "	W	500P	"
494E	MW-7	★ "	W	500P	"
495E	MW-8	★ "	W	500P	"
496E	MW-10	★ "	W	500P	"
570E	MW-1	★ "	W	500P	"
571E	MW-6	★ "	W	500P	"
572E	CPT-32S	★ "	W	500P	"
573E	CPT-2S	★ "	W	500P	"
415A	SB-9M	† "	S	2WM	"
194F	MW-9	◂NO, as N,SO,	W	500P	"
195F	MW-4	◂ "	W	500P	"
196F	MW-11	◂ "	W	500P	"
197F	MW-5	◂ "	W	500P	"
199F	CPT-2D	◂ "	W	500P	"
400F	CPT-16D	◂ "	W	500P	"
401F	CPT-16S	◂ "	W	500P	"
402F	MW-3	◂ "	W	500P	"
403F	CPT-18S	■ "	W	500P	"
404F	CPT-18D	■ "	W	500P	"
405F	MW-2	▼ "	W	500P	"
406F	CPT-8S	† "	W	500P	"
407F	CPT-8D	† "	W	500P	"
408F	CPT-10S	† "	W	500P	"
409F	CPT-10D	† "	W	500P	"

Sample to be returned

	Client ID#	Analysis	Mtx	Btl	Loc
10F	CPT-9S	† NO_3 as N, SO_4	W	500P	"
11F	CPT-9D	† "	W	500P	"
12F	CPT-11S	† "	W	500P	"
13F	CPT-11D	† "	W	500P	"
89F	CPT-22D	★ "	W	500P	"
90F	CPT-21D	★ "	W	500P	"
91F	CPT-50D	★ "	W	500P	"
92F	CPT-20D	★ "	W	500P	"
93F	CPT-19D	★ "	W	500P	"
94F	MW-7	★ "	W	500P	"
95F	MW-8	★ "	W	500P	"
96F	MW-10	★ "	W	500P	"
70F	MW-1	$ "	W	500P	"
71F	MW-6	$ "	W	500P	"
72F	CPT-32S	$ "	W	500P	"
73F	CPT-2S	$ "	W	500P	"

mple to be returned

CHAIN OF CUSTODY RECORD & ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.

4036 Youngfield
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854

COMPANY Engineering-Science
ADDRESS 4101 Harrison Oaks Blvd.
CITY Cary STATE NC ZIP 27513
PHONE # 919-677-0080 FAX # 919-677-0118 FAX RESULTS Y / (N)

COMPANY CONTACT (print) Don Malone
PROJECT I.D. Bolling AFB, 722450.0802e
P.O. # 722450.08020
TURNAROUND REQUIRED* 30 days
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Saskia Hoffer
(print) Saskia Hoffer

Evergreen Analytical Cooler No 307

All samples preserved in ice. SH

SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No of Containers	MATRIX: Water / Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid (circle)	MATRIX: Sludge/Slurry (circle)	MATRIX: Oil/Organic Liquid (circle)	MATRIX: Multiphase (identify phase to be analyzed)	ANALYSIS REQUESTED: TCLP VOA/BNA/Pesticides/Metals (circle)	VOA 8260/8240/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB 8080/PCB Screen (circle)	BTEX 8020/602 (circle) MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVH 8015mod (Gasoline)	TEH 8015mod (Diesel)	Total Metals-DW / NPDES / SW846 Dissolved Metals (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Notes
SB-14 (14'-14'8")	8/3/94	8:20	2		X										X		X		*[SB-14(14'8LS]			*
SB-14 (14'8"-15'4")	8/3/94	8:50	2		X		Sample were		not received						X		X		*[SB-14(20-21'4"]			*
SB-54 (11'8"-15'4")	8/3/94	9:20	1		X										X		X					only enough soil for 4oz bottle
SB-7 (10'9"-11'5")	8/3/94	10:10	1		X										X		X					" " " " "
SB-7 (14'-17'2")	8/3/94	10:20	2		X										X		X					*
SB-7 (20'-22'2")	8/3/94	10:47	2		X										X		X					*
SB-9 (17'9"-19'11")	8/3/94	12:45	2		X										X		X					*
SB-9 (22'6"-24'8")	8/3/94	13:15	2		X										X		X					*
SB-47 (12'-13'8")	8/3/94	13:59	1		X										X		X					same as SB-54

Instructions: [Time sample id, not id listed on SAMPLE ID column. Refer to Check-in Record.] with the amount of soil we got from each site

Project # 722450.08020

* there were numerous recovery problems therefore only one BTEX bottle was taken.

Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Saskia Hoffer	8/4 8:30	Mary Steele	0830				
Relinquished by (Signature)	Date/Time	Received by (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
			08/8/94				

CHAIN OF CUSTODY RECORD & ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.

4036 Youngfield
Wheat Ridge Colorado 80033
(303) 425-6021
FAX (303) 425-6854

COMPANY Engineering - Science
ADDRESS 401 Harrison Oaks Blvd
CITY Cary STATE NC ZIP 27513
PHONE # 919-677-0080 FAX # 919-677-0118

COMPANY CONTACT (print) Don Malone
PROJECT I.D. Bolling AFB. 722450.0802
P.O. # 722450.0802
FAX RESULTS Y / (N)
TURNAROUND REQUIRED* 30 days
*expedited turnaround subject to additional fee

Sampler Name
(signature) Saskia Hoffer
(print) Saskia Hoffer

Evergreen Analytical Cooler No 307

All samples preserved in ice. SH

SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water / Drinking/Discharge/Ground (circle)	Soil/Solid (circle)	Sludge/Slurry (circle)	Oil/Organic Liquid (circle)	Multiphase (identify phase to be analyzed)	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/8240/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB 8080/PCB Screen (circle)	BTEX 8020/602 (circle) MTBE (circle)	TRPH 418.1/ON & Grease 413.1 (circle)	TVH 8015mod (Gasoline)	TEH 8015mod (Diesel)	Total Metals-DW / NPDES / SW846 Dissolved Metals (circle & list metals below)	Total Metals - DW / SW846 (circle & list metals below)	Notes
SB-11 (11'-13'2")	8/3/94	8:50	2		X										X		X					*
SB-11 (17'6"-19'8")	8/3/94	14:15	2		X										X		X					*
SB-11 (22'-24'2")	8/3/94	14:25	2		X										X		X					*
SB-3 (9'8"-11'8")	8/3/94	15:02	2		X										X		X					*
SB-3 (22'-24'5")	8/3/94	15:21	2		X										X		X					*

Instructions:

Project # 722450.0802

*only one bottle for BTEX analyses collected per site interval

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Saskia Hoffer	8/4 8:30	Mary Collaska	8/8/94 08:30				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Page 1 of 2

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Engineering-Science
ADDRESS 501 Harrison Oaks Blvd Suite 210
CITY Cary STATE NC ZIP 27513
PHONE # 919-677-0080 FAX # 919-677-0118 FAX RESULTS Y / (N)

CLIENT CONTACT (print) Don McAlone
PROJECT I.D. Bolling AFB CCC
P.O. # 72450.0802
TURNAROUND REQUIRED* 30 Days
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Saskia Hoffer
(print) Saskia Hoffer
Evergreen Analytical Cooler No ES COOLER *
Cooler Received

8/11/94

Please **PRINT** all information.

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water: Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	ANALYSIS REQUESTED: TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Alkalinity	NO_3 + SO_4	Mn/Fe	EAL use only Do not write in shaded area: EAL Sample No.
MW-9	8/9/94	10:20	7	X									X		X				X	X	X	
MW-9	8/9/94	11:00	7	X									X		X				X	X	X	
MW-11	8/9/94	11:00	7	X									X		X				X	X	X	
MW-5	8/9/94	11:00	7	X									X		X				X	X	X	
MW-3 (Free Product)	8/9/94	12:15	1			X							X		X							
CPT-2D	8/9/94	12:45	7	X									X		X				X	X	X	
[redacted]	[redacted]	[redacted]	7	X									X		X				X	X	X	
CPT-16D	8/9/94	13:45	7	X									X		X				X	X	X	
CPT-16S	8/9/94	16:48	7	X									X		X				X	X	X	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]									[redacted]		[redacted]				[redacted]			
HT:																						Location
DD:																						Container Size

Instructions: Please analyze MW-3 free product samples for % BTEX + TVH
Please RETURN Cooler to address on INSIDE LID.
All Samples put on ice

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Saskia Hoffer	8/9 19:00	Mary Blechd	1030				

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Engineering-Science
ADDRESS 401 Harrison Oaks Blvd, Suite 210
CITY Cary STATE NC ZIP 27513
PHONE # (919) 677-0080 FAX # 919-677-0118 FAX RESULTS Y / (N)

CLIENT CONTACT (print) Don Malone
PROJECT I.D. Bolling AFB, CCC
P.O. # 72450.08020
TURNAROUND REQUIRED 7 days (mfm 8/11)
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Saskia Hoffer
(print) Saskia Hoffer
Evergreen Analytical Cooler No.: ES COOLER
Cooler Received

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	NO3 + SO4	Alkalinity	Methane	EAL Sample No.
MW-3	8/9/94	17:30	7	X									Y		X				X	X	X		
HT:																						Location	
DD:																						Container Size	

EAL use only
Do not write in shaded area

EAL
Project #
Custodian

Instructions:
*Please Return Cooler to address on inside lid
All samples put on ice.

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Saskia Hoffer	8/9 18:00	Mary Collector	1030				

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Engineering-Science
ADDRESS 4701 Harrison Clerks Blvd, Suite 210
CITY Cary STATE NC ZIP 27513
PHONE# 919-677-0080 FAX # 919-677-0118 FAX RESULTS Y / (N)

CLIENT CONTACT (print) Don Malone
PROJECT I.D. 722450.08, Bolling AFB
P.O. #
TURNAROUND REQUIRED* 30 days
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Saskia Hoffer
(print) Saskia Hoffer
Evergreen Analytical Cooler No. #389
Cooler Received

8/11/94

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	VPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Alkalinity	Nitrate + Sulfate	Methane	EAL Sample No.
CPT-18S	8/5/94	11:03	7	X										X		X				X	X	X	
CPT-18D	8/5/94	13:00	7	X										X		X				X	X	X	
MW-2	8/6/94	14:40	7	X										X		X				X	X	X	
CPT-8S	8/8/94	08:09	7	X										X		X				X	X	X	
CPT-8D	8/8/94	08:30	7	X										X		X				X	X	X	
CPT-10S	8/8/94	11:20	7	X										X		X				X	X	X	
CPT-10D	8/8/94	10:24	7	X										X		X				X	X	X	
CPT-9S	8/8/94	16:09	7	X										X		X				X	X	X	
CPT-9D	8/8/94	12:10	7	X										X		X				X	X	X	
CPT-11S	8/8/94	17:40	7	X										X		X				X	X	X	
HT:																							Location
DD:																							Container Size

Holds Not Required

EAL use only
Do not write in shaded area

EAL
Project #
Custodian

Instructions: All samples were put on ice

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Saskia Hoffer	8/9 7:22	Mary Riedler	1021				

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.

4036 Youngfield
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854

COMPANY Engineering Science
ADDRESS 401 Harrison Oaks Blvd, Suite 210
CITY Cary STATE NC ZIP 27513
PHONE # 919-677-0080 FAX # 919-677-0718 FAX RESULTS Y / (N)

COMPANY CONTACT (print) Don Malone
PROJECT I.D. Bolling AFB, CCC
P.O. # 722450.08020
TURNAROUND REQUIRED* 30 days mjm 8/11/94
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Saskia Hoffer
(print) Saska Hoffer

Evergreen Analytical Cooler No. #389

	SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water - Drinking/Discharge/(Groundw) (circle)	MATRIX: Soil/y Solid (circle)	MATRIX: Sludge/Slurry (circle)	MATRIX: Oil/Organic Liquid (circle)	MATRIX: Multiphase (identify phase to be analyzed)	ANALYSIS REQUESTED: TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB 8080/PCB Screen (circle)	BTEX 8020/602 (circle) MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVH 8015mod. (Gasoline)	TEH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below) Dissolved Metals - DW / SW846 (circle & list metals below)	Nitrate + Sulfate	Methane	Alkalinity	TOC		Notes
X	BCPT-11D	8/8/94	17:11	7	X											X		X				X	X	X			
X	SB-9S	8/8/94	14:30	2		X										X		X							X		only enough for 2 bottles
X	SB-9M	8/8/94	14:45	1		X																		X			only enough for 1 bottle
X	SB-9D	8/8/94	15:00	2		X										X		X							X		only enough for 2 bottles

Instructions: all samples will put on ice.

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Saskia Hoffer	8/9 7:33am	Mary Beth	10:30				
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
		8/10/94					

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Engineering-Science
ADDRESS 401 Harrison Oaks Blvd
CITY Cary STATE NC ZIP 27513
PHONE# 919-677-0080 FAX # 919-677-0118 FAX RESULTS Y (N)

CLIENT CONTACT (print) Don Malone
PROJECT I.D. Bolling AFB, CCC
P.O. # 72250.08020
TURNAROUND REQUIRED* 30 7days mpm 8/15/94
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Saskia Hoffer Donald Malone
(print) Saskia Hoffer, D. Malone, S. Glennie
Evergreen Analytical Cooler No. #331
Cooler Received

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	Soil / Solid	Oil / Sludge	ANALYSIS REQUESTED: TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Alkalinity	NO3 + SO4	Methane	EAL Sample No.
CPT-22D	8/10/94	7:50	7	X										X		X				X	X	X	
CPT-~~23~~21D	8/10/94	9:40	7	X										X		X				X	X	X	
CPT-50D	8/10/94	9:40	7	X										X		X				X	X	X	
CPT-20D	8/10/94	10:55	7	X										X		X				X	X	X	
CPT-19D	8/10/94	12:50	7	X										X		X				X	X	X	
MW-7	8/10/94	15:30	7	X										X		X				X	X	X	
MW-8	8/10/94	16:35	7	X										X		X				X	X	X	
MW-10	8/10/94	17:45	7	X										X		X				X	X	X	
HT:																							Location
DD:																							Container Size

EAL use only: Do not write in shaded area
EAL
Project #
Custodian

Instructions:
Please note that labels on 50D are correct some bottle might have marker on them that say 50S but all labels say 50D - 50D is correct. All samples put on ice.

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Saskia Hoffer	8/10 18:00	Marcus Parker	8/11 1015				

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Engineering-Science
ADDRESS 901 Harrison Oaks Blvd
CITY Cary STATE NC ZIP 27513
PHONE # 919-677-0080 FAX # 919-677-0118

CLIENT CONTACT (print) Don Malone
PROJECT I.D. Dowling AFB, CCC
P.O. # 72450.08020
TURNAROUND REQUIRED* 30 7 days
*expedited turnaround subject to additional fee

FAX RESULTS Y (N)

Sampler Name:
(signature) Bruce Hoffa Douglas
(print) Saskia Hoffa, Don Malone

Evergreen Analytical Cooler No. #320
Cooler Received

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	ANALYSIS REQUESTED: TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	NO3	Methane	Alkalinity	EAL Sample No.
MW-1	8/11/94	11:00	7	X										X		X				X	X	X	
MW-6	8/11/94	11:45	7	X										X		X				X	X	X	
CPT-32S	8/11/94	11:45	7	X										X		X				X	X	X	
CPT-2S	8/11/94	12:30	7	X										X		X				X	X	X	
HT:																							Location
DD:																							Container Size

EAL use only
Do not write in shaded area

EAL
Project #
Custodian

Instructions:

All samples put on ice

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Saskia Hoffa	8/11	Mary Blecka	8/12/94				

Evergreen Analytical Sample Receipt/Check-in Record

Date & Time Rec'd: 8/08/94 0830 Shipped Via: Fed Ex 958188315
(Airbill # if applicable)

Client : Engineering Science

Client Project ID(s): Bolling AFB, 422450.08020

EAL Project #(s): 94- EAL Cooler(s): (Y) N

Cooler#	307							
Ice packs	(Y) melted N	Y	N	Y	N	Y	N	Y	N
Temperature °C	19.7							

	Y	N	N/A
1. Custody seal(s) present:	✓		
Seals on cooler intact	✓		
Seals on bottle intact	✓		
2. Chain of Custody present:	✓		
3. Containers broken or leaking: (Comment on COC if Y)		✓	
4. Containers labeled:	✓		
5. COC agrees w/ bottles received: (Comment on COC if N)	✓		
6. COC agrees w/ labels: (Comment on COC if N)	* first two samples listed do not agree w/ labels		
7. Headspace in VOA vials-waters only (comment on COC if Y)			✓
8. VOA samples preserved:			✓
9. pH measured on metals, cyanide or phenolics*:			✓
List discrepancies			
*Non-EAL provided containers only, water samples only.			
10. Metal samples present:		✓	
Total ____ , Dissolved ____			
D or PD to be filtered:			
T,TR,D,PD to be Preserved:			
11. Short holding times:		✓	
Specify parameters			
12. Multi-phase sample(s) present:		✓	
13. COC signed w/ date/time:	✓		

Comments: * Per Todd W. to MJM 8/8 @ 1500: SB-14(14'-14'8") ~~should be~~ on COC is actual the samples received labelled as SB-14(14'BLS) and SB14(14'8"-15'4") on COC is actually sample received labelled as SB-14(20-21'4").

(Additional comments on back)

Custodian Signature/Date: Mary Blecha 8/08/94

Evergreen Analytical Sample Receipt/Check-in Record 9518833c

Date & Time Rec'd: 8/10/94 1030 Shipped Via: Fed Ex 9518834, (Airbill # if applicable)

Client : Engineering Science

Client Project ID(s): Bolling AFP CCC

EAL Project #(s): 94- 2984 EAL Cooler(s): (Y) N

Cooler#	102, client								
Ice packs	(Y)	N	Y	N	Y	N	Y	N	Y	N
Temperature °C	12.4								

	Y	N	N/A
1. Custody seal(s) present:	✓		
Seals on cooler intact	✓		
Seals on bottle intact			
2. Chain of Custody present:	✓		
3. Containers broken or leaking: (Comment on COC if Y)		✓	
4. Containers labeled:	✓		
5. COC agrees w/ bottles received: (Comment on COC if N)	✓		
6. COC agrees w/ labels: (Comment on COC if N)	✓		
7. Headspace in VOA vials-waters only (comment on COC if Y)		✓	
8. VOA samples preserved:	✓		
9. pH measured on metals, cyanide or phenolics*:			
List discrepancies			
*Non-EAL provided containers only, water samples only.			
10. Metal samples present:		✓	
Total _____ , Dissolved _____			
D or PD to be filtered:			
T,TR,D,PD to be Preserved:			
11. Short holding times: nitrates (48 hrs)	✓		
Specify parameters			
12. Multi-phase sample(s) present:		✓	
13. COC signed w/ date/time:	✓		

Comments: _____

(Additional comments on back)

Custodian Signature/Date: Mary Decker 8/10/94

Evergreen Analytical Sample Receipt/Check-in Record

Date & Time Rec'd: 8/11/94 1015 Shipped Via: Fed Ex 958188574
(Airbill # if applicable)

Client : Engineering Science

Client Project ID(s): Bolling AFB, CCC

EAL Project #(s): 94- 2981 EAL Cooler(s): (Y) N

Cooler#									
Ice packs	(Y)	N	Y	N	Y	N	Y	N	Y	N
Temperature °C	14.5								

	Y	N	N/A
1. Custody seal(s) present:	✓		
Seals on cooler intact	✓		
Seals on bottle intact			
2. Chain of Custody present:	✓		
3. Containers broken or leaking: (Comment on COC if Y)		✓	
4. Containers labeled:	✓		
5. COC agrees w/ bottles received: (Comment on COC if N)	✓		
6. COC agrees w/ labels: (Comment on COC if N)	✓		
7. Headspace in VOA vials-waters only (comment on COC if Y)		✓	
8. VOA samples preserved:	✓		
9. pH measured on metals, cyanide or phenolics*:			
List discrepancies			
*Non-EAL provided containers only, water samples only.			
10. Metal samples present:		✓	
Total _____ , Dissolved _____			
D or PD to be filtered:			
T,TR,D,PD to be Preserved:			
11. Short holding times:	✓		
Specify parameters nitrate 48hrs			
12. Multi-phase sample(s) present:		✓	
13. COC signed w/ date/time:	✓		

Comments: _____

(Additional comments on back)

Custodian Signature/Date: Mary Dlucha 8/11/94

Evergreen Analytical Sample Receipt/Check-in Record

Date & Time Rec'd: 8/12/94 1030 Shipped Via: FEDEX 9558188845
(Airbill # if applicable)

Client : Engineering Science

Client Project ID(s): Bolling AFB, CCC

EAL Project #(s): 94- 2981 EAL Cooler(s): (Y) N

Cooler#	320								
Ice packs	(Y)	N	Y	N	Y	N	Y	N	Y	N
Temperature °C									

	Y	N	N/A
1. Custody seal(s) present:	✓		
Seals on cooler intact	✓		
Seals on bottle intact			
2. Chain of Custody present:	✓		
3. Containers broken or leaking: (Comment on COC if Y)		✓	
4. Containers labeled:	✓		
5. COC agrees w/ bottles received: (Comment on COC if N)			
6. COC agrees w/ labels: (Comment on COC if N)	✓		
7. Headspace in VOA vials-waters only (comment on COC if Y)		✓	
8. VOA samples preserved:	✓		
9. pH measured on metals, cyanide or phenolics*:		✓	
List discrepancies			
*Non-EAL provided containers only, water samples only.			
10. Metal samples present:		✓	
Total _____ , Dissolved _____			
D or PD to be filtered:			
T,TR,D,PD to be Preserved:			
11. Short holding times:		✓	
Specify parameters			
12. Multi-phase sample(s) present:		✓	
13. COC signed w/ date/time:	✓		

Comments: _____

(Additional comments on back)

Custodian Signature/Date: Mary Blecha 8/12/94

Evergreen

P.O. # 10949

OUTSIDE CONTRACTOR ANALYSIS REQUEST
&
CHAIN-OF-CUSTODY

Analytical Lab: Huffman

Address: _____ Phone: _____

_____ Contact: _____

Results Required By: Standard

Please analyze the following samples as described below:

No. of Samples Shipped: 3

Project No.	Sample No.	Date/Time Sampled	Matrix	Analysis Requested
94-2981	SB-9D	8/9/94 1500	S	TOC
94-2981	SB-9S mgn	8/9/94 1430	S	TOC
94-3009	ST14-W10(13.8) (13.10)	8/9/94 1639	S	TOC

RUSH SERVICES (FOR EXTRA FEE): YES _____ NO X

IF ANY QUESTIONS OR PROBLEMS CONTACT: Shea Greiner

PLEASE FAX THE RESULTS TO: Mark Mensik ~~Carl Smits~~

PLEASE MAIL WRITTEN RESULTS TO: ~~Carl Smits~~ Mark Mensik

SAMPLES RELINQUISHED BY: Rebecam 8/8/94 10:11 a.m.

METHOD OF SHIPMENT: _____ DATE:/TIME _____

SAMPLES RECEIVED BY: _____ DATE:/TIME 8-11-94 10:11 A.M.

CUSTODY SEAL INTACT: YES _____ NO _____

coc frm

Evergreen Analytical, Inc. 4036 Youngfield St. Wheat Ridge, CO 80033-3862 (303) 425-6021 FAX (303) 425-6854

Soil/Sediment Analytes/Methods													
Method	SW8020												
Sample ID	Benzene (ug/kg)	Benzene flag	Toluene (ug/kg)	Toluene flag	Ethyl Benzene (ug/kg)	Ethyl Benzene flag	M&P-xylene (ug/kg)	M&P-xylene flag	O-xylene (ug/kg)	O-xylene flag	Total Xylenes (ug/kg)	Total Xylenes flag	Total BTEX (ug/kg)
SB14(14BLS)	1.1	J	2.8	J	0.5	J	2.4	J	1.0	J	3.4	J	7.8
SB14(20'-21'4")	600	<	37000		18000		72000		28000		100000		160000
SB54(14'8"-15'4")	4.7	J	28		4.7	J	21		6.0		27		64.4
SB7(10'9"-11'6")	4700	J	92000		41000		150000		60000		210000		350000
SB7(14'-17'2")	3600		56000		27000		94000		46000		140000		230000
SB7(20'-22'2")	11000		170000		64000		220000		100000		320000		410000
SB9(17'9"-18'11")	20000		210000		75000		250000		120000		370000		670000
SB9(22'6"-24'8")	57	<	1100		3600		16000		8000		23000		28000
SB47(12'-13'8")	56	<	500	J	1600		6300		3300		9600		12000
SB11(11'-13'2")	1.7	J	2.9	J	0.5	J	1.9	J	1.0	J	2.9	J	8.0
SB11(17'6"-19'8")	7300		140000		57000		210000		90000		300000		500000
SB11(22'-24'2")	370	J	3500		1200		5100		2000		7100		12000
SB3(9'8"-11'8")	0.5	<	0.7	J	0.5	<	0.6	J	0.5	<	0.6	J	1.3
SB3(22'-24'5")	56	<	280	J	3700		16000		6000		22000		26000
SB-9S	0.5	<	1.1	J	0.5	<	1.4	J	0.7	J	2.1	J	3.2
SB-9D	0.5	<	0.7	J	0.5	<	1.0	J	0.5	<	1.0	J	1.7
SB-9M													
MW-3(Free Prod.)	0.3%		4.5%		1.3%		5.4%		2.3%		7.7%		13.8%

* Notice that units are in '%' not 'ug/kg'

9/16/94

	Soil/Sediment Analytes/Methods (continued)							
	418.1		SW5030/SW8015M		A5310C		310.1	
Total BTEX flag	Total Petroleum Hydro-carbons (mg/kg)	TPH flag	Total Volatile Hydro-carbons (ug/kg)	TVH flag	Total Organic Carbon (mg/kg)	Total Organic Carbon flag	Total Alkalinity (mgCaCO3/L)	Total Alkalinity flag
			120	<				
			1600000					
			600					
			4800000					
			2300000					
			6400000					
			12000000					
			40000					
			220000					
			110	<				
			4300000					
			40000					
			110	<				
			620000					
			120	<	1500			
			140	<	600			
							28.8	<
			49%					

Aqueous Analytes/Methods														
Method:	SW8020													
Sample ID	Benzene (µg/L)	Benzene flag	Toluene (µg/L)	Toluene flag	Ethyl Benzene (µg/L)	Ethyl Benzene flag	M&P-xylene (µg/L)	M&P-xylene flag	O-xylene (µg/L)	O-xylene flag	Total Xylenes (µg/L)	Total Xylenes flag	Total BTEX (µg/L)	Total BTEX flag
MW-9	0.4	<	1.6	BJ	0.4	<	0.4	<	0.4	<	0.4	<	1.6	
MW-4	21000		26000	B	2100		7400		3900		11000		60000	
MW-11	19000		23000	B	1800		6600	B	3400		10000	B	54000	
MW-5	1500		3100	B	410		2500	B	1300		3800	B	8800	
CPT-2D	9.6		64	B	7.4		29	B	13		42	B	120	
CPT-16S	400		21000	B	1100		4300	B	2200		6500	B	29000	
CPT-16D	56		300	B	520		870	B	48		920	B	1800	
MW-3	14000		33000	BE	3000		12000		5800		18000	B		
CPT-18S	64		4800		1300		4800		2200		7000		13000	
CPT-18D	17000		2500		1600		4900		910		5800		27000	
MW-2	2900		31000		2600		63000		5000		68000		100000	
CPT-8S	1600		25000		1700		6000		3000		9000		37000	
CPT-8D	2.1	J	83		17		59		27		86		190	
CPT-10S	7300		25000		1800		5600	B	3100		8700	B	43000	
CPT-10D	0.8	J	8.3		1.0	J	3.4	J	1.5		4.9		15	
CPT-9S	25000		29000		1600		5500		2800		8300		64000	
CPT-9D	47		16	B	31		34	B	61		95	B		
CPT-11S	44000		57000		1600		5500		2900		8400		110000	
CPT-11D	1600		170	B	410		630	B	240		870	B	360	
CPT-22D	0.6	J	72	B	15		56	B	36		92	B	180	
CPT-21D	0.4	<	5.0	B	1.0	J	0.8	B	3.1	J	3.9	BJ	9.9	
CPT-50D	0.4	<	4.2	B	1.0	J	0.8	B	3.2	J	4.0	B	9.2	
CPT-20D	2300		640	B	1600		3900	B	200	J	4100	B	8600	
CPT-19D	750		370	BJ	980		3400	B	560		3900	B	6000	
MW-7	0.8	J	3.1	BJ	0.6	J	3.0	B	2.3		5.3	B	9.8	
MW-8	1.1	J	4.0	J	0.8	J	4.4		3.8	J	8.2	B	14	
MW-10	0.4	<	1.6	BJ	0.4	<	0.6	BJ	0.4	<	0.6	BJ	2.2	
MW-1	3.5	J	7.5	BJ	0.4	<	5.0	B	3	J	8	B	19	
MW-6	2700		8000	B	460		1400	B	890		2300	B	13000	
CPT-32S	2400		7200	B	450		1300	B	880		2200	B	12000	
CPT-2S	21000		25000	B	1900		5100	B	3300		8400	B		
MW-3(FP)														

Aqueous Analytes/Methods (continued)															
SW8020 cont.						SW8015 modified		Field tests				E300			
1,3,5-Trimethyl-benzene (µg/L)	1,3,5-TMB flag	1,2,4-Trimethyl-benzene (µg/L)	1,2,4-TMB flag	1,2,3-Trimethyl-benzene (µg/L)	1,2,3-TMB flag	Total Hydro-carbons (TVH/TEH) (mg/L)	TVH/TEH flag	pH (units) (field)	Conductivity (umhos/cm) (field)	Dissolved Oxygen (mg/L) (field)	Redox Potential (millivolts) (field)	Nitrogen Nitrate + Nitrite (mg/L)	Nitrogen Nitrate + Nitrite flag	Sulfate (anion) (mg/L)	Sulfate (anion) flag
0.4	<	0.4	<	0.4	<	0.2/						5.14	<	46.9	
470		2000		360	J	130/						0.056	<	3.67	
400		1700		300	J	130/						0.056	<	3.61	
260	J	870		180	J	28/						0.056	<	1.32	
3.5	J	13		2	J	0.6/						0.657		36.7	
280	J	720		170	J	124/						0.569		40.4	
37		250		92		8.0/						0.671		24.5	
800		2700		630		56/						0.056	<	19.5	
140		790		100		50/						0.056	<	14.5	
180		920		210		89/						0.107		1.50	
670		2500		430		750/						0.056	<	2.49	
260	J	1100		210	J	82/						0.056	<	0.358	
4.1		12		4.5		0.6/						2.32		66.9	
240		1000		190	J	61/						0.056	<	1.15	
0.4	<	0.6	J	0.4	<	0.1/	</					2.95		49.6	
230	J	960		180	J	200/						0.056	<	26.0	
0.6	J	26		4.3		0.7/						0.580		37.6	
210	J	820		160	J	160/						0.056	<	50.0	
18	J	270		49		13/						0.056	<	21.1	
7.5		35		7.6		0.5/						1.04		47.6	
0.4	<	0.4	<	1.3	J	0.1/						0.056	<	55.8	
0.4	<	0.5	J	1.4	J	1.5/						0.056	<	55.1	
240		970		200		46/						0.056	<	0.250	<
160	J	690		130	J	49/						0.056	<	0.250	<
0.4	J	1.1	J	0.4	<	0.1/	</					16.3		90.0	
0.5	J	1.4	J	0.4	J	0.1/	</					0.522		23.5	
0.4	<	0.4	<	0.4	<	0.1/	</					12.0		50.9	
0.4	<	0.4	<	0.4	<	1.0/						0.056	<	1.72	
60	J	230	J	50	J	53/						0.694		39.9	
49		250	J	30		39/						0.508		44.8	
290	J	1100		200	J	76/						0.056	<	31.0	

Aqueous Analytes/Methods (continued)													
E300 cont.		SW7380 or SW6010		SW6010/SW7460		E365.4		RSKSOP-147		A5310C		A403	
Chloride (anion) (mg/L)	Chloride (anion) flag	Total Iron (mg/L)	Total Iron flag	Total Manganese (µg/L)	Total Manganese flag	Total Phosphate (mg/L)	Total Phosphate flag	Methane (mg/L)	Methane flag	Dissolved Organic Carbon (mg/L)	Dissolved Organic Carbon flag	Total Alkalinity (mg/L)	Total Alkalinity flag
								10	<			492	
								200				167	
								3800				165	
								100	<			215	
								3400				106	
								1900				6.96	
								1200				69	
								50	<			67.7	
								270				5.00	<
								1200				124	
								8400				233	
								1600				165	
								83				5.2	
								340				266	
								10	<			27.9	
								1400				17.7	
								160				109	
								470				9.02	
								200				132	
								21				22.8	
								700				17.7	
								390				17.6	
								3800				122	
								1600				108	
								21				5.00	<
								22				5.00	<
								10	<			5.00	<
								220				142	
								350				46.7	
								300				49.4	
								1200				94.3	

DATA QUALIFIERS

E = Extrapolated value.

U = Compound analyzed for, but not detected.

B = Compound found in blank and sample. Compare blank and sample data.

J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).

PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.

NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-9	Client Project No.	: Bolling AFB
Lab Sample Number	: X92394	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 1.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/20/94	Lab File No.	: BX1082014
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2		U	4
Toluene	108-88-3	1.6	BJ	4
Ethyl Benzene	100-41-4		U	4
Total Xylene (m/p + o)	1330-20-7		U	4
1,3,5-trimethylbenzene	108-67-8		U	4
1,2,4-trimethylbenzene	95-63-6		U	4
1,2,3-trimethylbenzene	526-73-8		U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 91%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-4	Client Project No.	: Bolling AFB
Lab Sample Number	: X92395	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/20/94	Lab File No.	: BX1082015
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	*		*
Toluene	108-88-3	*		*
Ethyl Benzene	100-41-4	2100		400
Total Xylene (m/p + o)	1330-20-7	11000	B	400
1,3,5-trimethylbenzene	108-67-8	470		400
1,2,4-trimethylbenzene	95-63-6	2000		400
1,2,3-trimethylbenzene	526-73-8	360	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082212 for noted values, df=500, 08/22/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 101%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-4	Client Project No.	: Bolling AFB
Lab Sample Number	: X92395	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 500.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/20/94	Lab File No.	: BX1082212
		Method Blank No.	: MB082294

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	21000		2000
Toluene	108-88-3	26000	B	2000
Ethyl Benzene	100-41-4	*		*
Total Xylene (m/p + o)	1330-20-7	*		*
1,3,5-trimethylbenzene	108-67-8	*		*
1,2,4-trimethylbenzene	95-63-6	*		*
1,2,3-trimethylbenzene	526-73-8	*		*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082015 for noted values, df=100, 08/20/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 101%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-11	Client Project No.	: Bolling AFB
Lab Sample Number	: X92396	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082022
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	19000		400
Toluene	108-88-3	23000	B	400
Ethyl Benzene	100-41-4	1800		400
Total Xylene (m/p + o)	1330-20-7	10000	B	400
1,3,5-trimethylbenzene	108-67-8	400		400
1,2,4-trimethylbenzene	95-63-6	1700		400
1,2,3-trimethylbenzene	526-73-8	300	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 95%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-5	Client Project No.	: Bolling AFB
Lab Sample Number	: X92397	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082023
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	1500		400
Toluene	108-88-3	3100	B	400
Ethyl Benzene	100-41-4	410		400
Total Xylene (m/p + o)	1330-20-7	3800	B	400
1,3,5-trimethylbenzene	108-67-8	260	J	400
1,2,4-trimethylbenzene	95-63-6	870		400
1,2,3-trimethylbenzene	526-73-8	180	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 83%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-2D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92399	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 1.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082024
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	9.6		4
Toluene	108-88-3	64	B	4
Ethyl Benzene	100-41-4	7.4		4
Total Xylene (m/p + o)	1330-20-7	42	B	4
1,3,5-trimethylbenzene	108-67-8	3.5	J	4
1,2,4-trimethylbenzene	95-63-6	13		4
1,2,3-trimethylbenzene	526-73-8	2	J	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 91%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-16S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92401	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082027
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	400		400
Toluene	108-88-3	21000	B	400
Ethyl Benzene	100-41-4	1100		400
Total Xylene (m/p + o)	1330-20-7	6500	B	400
1,3,5-trimethylbenzene	108-67-8	280	J	400
1,2,4-trimethylbenzene	95-63-6	720		400
1,2,3-trimethylbenzene	526-73-8	170	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 85%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-16D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92400	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 5.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22/94	Lab File No.	: BX1082208
		Method Blank No.	: MB082294

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	56		20
Toluene	108-88-3	300	B	20
Ethyl Benzene	100-41-4	520		20
Total Xylene (m/p + o)	1330-20-7	920	B	20
1,3,5-trimethylbenzene	108-67-8	37		20
1,2,4-trimethylbenzene	95-63-6	250		20
1,2,3-trimethylbenzene	526-73-8	92		20

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 111%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available

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BTEX Data Report

Client Sample Number	: MW-3	Client Project No.	: Bolling AFB
Lab Sample Number	: X92402	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22/94	Lab File No.	: BX1082211
		Method Blank No.	: MB082294

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	14000		400
Toluene	108-88-3	33000	BE	400
Ethyl Benzene	100-41-4	3000		400
Total Xylene (m/p + o)	1330-20-7	18000	B	400
1,3,5-trimethylbenzene	108-67-8	800		400
1,2,4-trimethylbenzene	95-63-6	2700		400
1,2,3-trimethylbenzene	526-73-8	630		400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 106%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-18S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92403	Lab Project No.	: 94-2981
Date Sampled	: 8/5/94	Dilution Factor	: 1.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1081904
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	64	4
Toluene	108-88-3	*	*
Ethyl Benzene	100-41-4	*	*
Total Xylene (m/p + o)	1330-20-7	*	*
1,3,5-trimethylbenzene	108-67-8	140	4
1,2,4-trimethylbenzene	95-63-6	*	*
1,2,3-trimethylbenzene	526-73-8	100	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081908 for noted values, df = 100, 08/19/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 147% Co-eluting peaks.
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-18S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92403	Lab Project No.	: 94-2981
Date Sampled	: 8/5/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1081908
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	*	*
Toluene	108-88-3	4800	400
Ethyl Benzene	100-41-4	1300	400
Total Xylene (m/p + o)	1330-20-7	7000	400
1,3,5-trimethylbenzene	108-67-8	*	*
1,2,4-trimethylbenzene	95-63-6	790	400
1,2,3-trimethylbenzene	526-73-8	*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081904 for noted values, df=1, 08/19/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 115%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-18D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92404	Lab Project No.	: 94-2981
Date Sampled	: 8/5/94	Dilution Factor	: 10.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1081905
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	*	*
Toluene	108-88-3	*	*
Ethyl Benzene	100-41-4	*	*
Total Xylene (m/p + o)	1330-20-7	*	*
1,3,5-trimethylbenzene	108-67-8	180	40
1,2,4-trimethylbenzene	95-63-6	920	40
1,2,3-trimethylbenzene	526-73-8	210	40

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081909 for noted values, df=100, 08/19/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 123% Co-eluting peaks.
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-18D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92404	Lab Project No.	: 94-2981
Date Sampled	: 8/5/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1081909
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	17000	400
Toluene	108-88-3	2500	400
Ethyl Benzene	100-41-4	1600	400
Total Xylene (m/p + o)	1330-20-7	5800	400
1,3,5-trimethylbenzene	108-67-8	*	*
1,2,4-trimethylbenzene	95-63-6	*	*
1,2,3-trimethylbenzene	526-73-8	*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081905 for noted values, df=10, 08/19/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 106%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-2	Client Project No.	: Bolling AFB
Lab Sample Number	: X92405	Lab Project No.	: 94-2981
Date Sampled	: 8/6/94	Dilution Factor	: 50.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/20/94	Lab File No.	: BX1081922
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	2900	200
Toluene	108-88-3	*	*
Ethyl Benzene	100-41-4	2600	200
Total Xylene (m/p + o)	1330-20-7	*	*
1,3,5-trimethylbenzene	108-67-8	670	200
1,2,4-trimethylbenzene	95-63-6	2500	200
1,2,3-trimethylbenzene	526-73-8	430	200

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081907 for noted values, df = 5000, 08/19/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 92%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-2	Client Project No.	: Bolling AFB
Lab Sample Number	: X92405	Lab Project No.	: 94-2981
Date Sampled	: 8/6/94	Dilution Factor	: 5000.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/20/94	Lab File No.	: BX1081922
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	*	*
Toluene	108-88-3	31000	20000
Ethyl Benzene	100-41-4	*	*
Total Xylene (m/p + o)	1330-20-7	68000	20000
1,3,5-trimethylbenzene	108-67-8	*	*
1,2,4-trimethylbenzene	95-63-6	*	*
1,2,3-trimethylbenzene	526-73-8	*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081922 for noted values, df=50, 08/19/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 109%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-8S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92406	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1081911
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	1600		400
Toluene	108-88-3	25000	*	2000
Ethyl Benzene	100-41-4	1700		400
Total Xylene (m/p + o)	1330-20-7	9000		400
1,3,5-trimethylbenzene	108-67-8	260	J	400
1,2,4-trimethylbenzene	95-63-6	1100		400
1,2,3-trimethylbenzene	526-73-8	210	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082005 for noted values, df = 500, 08/20/94; the chromatogram is included.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 112%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-8D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92407	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 1.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1081912
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	2.1 J	4
Toluene	108-88-3	83	4
Ethyl Benzene	100-41-4	17	4
Total Xylene (m/p + o)	1330-20-7	86	4
1,3,5-trimethylbenzene	108-67-8	4.1	4
1,2,4-trimethylbenzene	95-63-6	12	4
1,2,3-trimethylbenzene	526-73-8	4.5	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 103%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-10S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92408	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 50.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/20/94	Lab File No.	: BX1082008
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	*		*
Toluene	108-88-3	*		*
Ethyl Benzene	100-41-4	1800		200
Total Xylene (m/p + o)	1330-20-7	8700	B	200
1,3,5-trimethylbenzene	108-67-8	240		200
1,2,4-trimethylbenzene	95-63-6	1000		200
1,2,3-trimethylbenzene	526-73-8	190	J	200

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081913 for noted values, df=500, 08/19/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 117% Co-eluting peaks.
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-10S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92408	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 500.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/20/94	Lab File No.	: BX1081913
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	7300	2000
Toluene	108-88-3	25000	2000
Ethyl Benzene	100-41-4	*	*
Total Xylene (m/p + o)	1330-20-7	*	*
1,3,5-trimethylbenzene	108-67-8	*	*
1,2,4-trimethylbenzene	95-63-6	*	*
1,2,3-trimethylbenzene	526-73-8	*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082008 for noted values, df=50, 08/20/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 106%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-10D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92409	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 1.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1081914
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	0.8	J	4
Toluene	108-88-3	8.3		4
Ethyl Benzene	100-41-4	1	J	4
Total Xylene (m/p + o)	1330-20-7	4.9		4
1,3,5-trimethylbenzene	108-67-8		U	4
1,2,4-trimethylbenzene	95-63-6	0.6	J	4
1,2,3-trimethylbenzene	526-73-8		U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 98%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-9S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92410	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1081916
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	*		*
Toluene	108-88-3	*		*
Ethyl Benzene	100-41-4	1600		400
Total Xylene (m/p + o)	1330-20-7	8300		400
1,3,5-trimethylbenzene	108-67-8	230	J	400
1,2,4-trimethylbenzene	95-63-6	960		400
1,2,3-trimethylbenzene	526-73-8	180	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082006 for noted values, df=500, 08/20/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 87%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-9S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92410	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 500.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1082006
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	25000	2000
Toluene	108-88-3	29000	2000
Ethyl Benzene	100-41-4	*	*
Total Xylene (m/p + o)	1330-20-7	*	*
1,3,5-trimethylbenzene	108-67-8	*	*
1,2,4-trimethylbenzene	95-63-6	*	*
1,2,3-trimethylbenzene	526-73-8	*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081916 for noted values, df = 100, 08/19/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 104%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-9D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92411	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 1.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/20/94	Lab File No.	: BX1082010
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	47		4
Toluene	108-88-3	16	B	4
Ethyl Benzene	100-41-4	31		4
Total Xylene (m/p + o)	1330-20-7	95	B	4
1,3,5-trimethylbenzene	108-67-8	0.6	J	4
1,2,4-trimethylbenzene	95-63-6	26		4
1,2,3-trimethylbenzene	526-73-8	4.3		4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 109%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-11S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92412	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 100.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1081918
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	*		*
Toluene	108-88-3	*		*
Ethyl Benzene	100-41-4	1600		400
Total Xylene (m/p + o)	1330-20-7	8400		400
1,3,5-trimethylbenzene	108-67-8	210	J	400
1,2,4-trimethylbenzene	95-63-6	820		400
1,2,3-trimethylbenzene	526-73-8	160	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082007 for noted values, df=500, 08/20/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 87%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-11S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92412	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 500.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Lab File No.	: BX1082007
		Method Blank No.	: MB081994

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	44000	2000
Toluene	108-88-3	57000	2000
Ethyl Benzene	100-41-4	*	*
Total Xylene (m/p + o)	1330-20-7	*	*
1,3,5-trimethylbenzene	108-67-8	*	*
1,2,4-trimethylbenzene	95-63-6	*	*
1,2,3-trimethylbenzene	526-73-8	*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081918 for noted values, df=100, 08/19/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 87%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-11D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92413	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 10.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082020
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	1600		40
Toluene	108-88-3	170	B	40
Ethyl Benzene	100-41-4	410		40
Total Xylene (m/p + o)	1330-20-7	870	B	40
1,3,5-trimethylbenzene	108-67-8	18	J	40
1,2,4-trimethylbenzene	95-63-6	270		40
1,2,3-trimethylbenzene	526-73-8	49		40

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 97%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-22D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92489	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	Dilution Factor	: 1.00
Date Received	: 8/11/94	Method	: 8020
Date Extracted/Prepared	: 8/20/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082029
		Method Blank No.	: MB082094

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	0.6	J	4
Toluene	108-88-3	72	B	4
Ethyl Benzene	100-41-4	15		4
Total Xylene (m/p + o)	1330-20-7	92	B	4
1,3,5-trimethylbenzene	108-67-8	7.5		4
1,2,4-trimethylbenzene	95-63-6	35		4
1,2,3-trimethylbenzene	526-73-8	7.6		4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 77%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-21D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92490	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	Dilution Factor	: 1.00
Date Received	: 8/11/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22/94	Lab File No.	: BX1082209
		Method Blank No.	: MB082294

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2		U	4
Toluene	108-88-3	5	B	4
Ethyl Benzene	100-41-4	1	J	4
Total Xylene (m/p + o)	1330-20-7	3.9	BJ	4
1,3,5-trimethylbenzene	108-67-8		U	4
1,2,4-trimethylbenzene	95-63-6		U	4
1,2,3-trimethylbenzene	526-73-8	1.3	J	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 82%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-50D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92491	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	Dilution Factor	: 1.00
Date Received	: 8/11/94	Method	: 8020
Date Extracted/Prepared	: 8/21/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082107
		Method Blank No.	: MB082194

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2		U	4
Toluene	108-88-3	4.2	B	4
Ethyl Benzene	100-41-4	1	J	4
Total Xylene (m/p + o)	1330-20-7	4	B	4
1,3,5-trimethylbenzene	108-67-8		U	4
1,2,4-trimethylbenzene	95-63-6	0.5	J	4
1,2,3-trimethylbenzene	526-73-8	1.4	J	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 122% Co-eluting peaks.
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-20D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92492	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	Dilution Factor	: 10.00
Date Received	: 8/11/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22/94	Lab File No.	: BX1082214
		Method Blank No.	: MB082294

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2		*	*
Toluene	108-88-3	640	B	40
Ethyl Benzene	100-41-4	1600		40
Total Xylene (m/p + o)	1330-20-7		*	*
1,3,5-trimethylbenzene	108-67-8	240		40
1,2,4-trimethylbenzene	95-63-6	970		40
1,2,3-trimethylbenzene	526-73-8	200		40

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082108 for noted values, df=100, 08/21/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 99%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-20D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92492	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	Dilution Factor	: 100.00
Date Received	: 8/11/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22/94	Lab File No.	: BX1082108
		Method Blank No.	: MB082194

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	2300		400
Toluene	108-88-3		*	*
Ethyl Benzene	100-41-4		*	*
Total Xylene (m/p + o)	1330-20-7	4100	B	400
1,3,5-trimethylbenzene	108-67-8		*	*
1,2,4-trimethylbenzene	95-63-6		*	*
1,2,3-trimethylbenzene	526-73-8		*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082214 for noted values, df=10, 08/21/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 116%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-19D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92493	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	Dilution Factor	: 100.00
Date Received	: 8/11/94	Method	: 8020
Date Extracted/Prepared	: 8/21/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082109
		Method Blank No.	: MB082194

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	750		400
Toluene	108-88-3	370	BJ	400
Ethyl Benzene	100-41-4	980		400
Total Xylene (m/p + o)	1330-20-7	3900	B	400
1,3,5-trimethylbenzene	108-67-8	160	J	400
1,2,4-trimethylbenzene	95-63-6	690		400
1,2,3-trimethylbenzene	526-73-8	130	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 97%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-7	Client Project No.	: Bolling AFB
Lab Sample Number	: X92494	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	Dilution Factor	: 1.00
Date Received	: 8/11/94	Method	: 8020
Date Extracted/Prepared	: 8/21/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082111
		Method Blank No.	: MB082194

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	0.8	J	4
Toluene	108-88-3	3.1	BJ	4
Ethyl Benzene	100-41-4	0.6	J	4
Total Xylene (m/p + o)	1330-20-7	5.3	B	4
1,3,5-trimethylbenzene	108-67-8	0.4	J	4
1,2,4-trimethylbenzene	95-63-6	1.1	J	4
1,2,3-trimethylbenzene	526-73-8		U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 103%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-8	Client Project No.	: Bolling AFB
Lab Sample Number	: X92495	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	Dilution Factor	: 1.00
Date Received	: 8/11/94	Method	: 8020
Date Extracted/Prepared	: 8/21/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082112
		Method Blank No.	: MB082194

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	1.1	J	4
Toluene	108-88-3	4	B	4
Ethyl Benzene	100-41-4	0.8	J	4
Total Xylene (m/p + o)	1330-20-7	8.2	B	4
1,3,5-trimethylbenzene	108-67-8	0.5	J	4
1,2,4-trimethylbenzene	95-63-6	1.4	J	4
1,2,3-trimethylbenzene	526-73-8	0.4	J	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 91%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-10	Client Project No.	: Bolling AFB
Lab Sample Number	: X92496	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	Dilution Factor	: 1.00
Date Received	: 8/11/94	Method	: 8020
Date Extracted/Prepared	: 8/21/94	Matrix	: Water
Date Analyzed	: 8/21/94	Lab File No.	: BX1082113
		Method Blank No.	: MB082194

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2		U	4
Toluene	108-88-3	1.6	BJ	4
Ethyl Benzene	100-41-4		U	4
Total Xylene (m/p + o)	1330-20-7	0.6	BJ	4
1,3,5-trimethylbenzene	108-67-8		U	4
1,2,4-trimethylbenzene	95-63-6		U	4
1,2,3-trimethylbenzene	526-73-8		U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 101%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available

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BTEX Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS081694	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/16/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/16/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1081610

Compound Name	Cas Number	LCS Concentration ug/L	QC Limit ug/L
Benzene	71-43-2	40	29-47
Toluene	108-88-3	38	30-42
Ethyl Benzene	100-41-4	38	31-43
m/p-Xylene	NA	38	31-42
o-Xylene	95-47-6	38	31-42
Chlorobenzene	108-90-7	NA	NA
1,3,5-trimethylbenzene	108-67-8	NA	NA
1,2,4-trimethylbenzene	95-63-6	NA	NA
1,2,3-trimethylbenzene	526-73-8	NA	NA

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene :
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS081994	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/19/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/19/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1081919

Compound Name	Cas Number	LCS Concentration ug/L	QC Limit ug/L
Benzene	71-43-2	33	29-47
Toluene	108-88-3	31	30-42
Ethyl Benzene	100-41-4	31	31-43
m/p-Xylene	NA	30	31-42
o-Xylene	95-47-6	32	31-42
Chlorobenzene	108-90-7	NA	NA
1,3,5-trimethylbenzene	108-67-8	NA	NA
1,2,4-trimethylbenzene	95-63-6	NA	NA
1,2,3-trimethylbenzene	526-73-8	NA	NA

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 92%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS082094	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/20/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/20/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1082012

Compound Name	Cas Number	LCS Concentration ug/L	QC Limit ug/L
Benzene	71-43-2	38	29-47
Toluene	108-88-3	35	30-42
Ethyl Benzene	100-41-4	36	31-43
m/p-Xylene	NA	35	31-42
o-Xylene	95-47-6	36	31-42
Chlorobenzene	108-90-7	NA	NA
1,3,5-trimethylbenzene	108-67-8	NA	NA
1,2,4-trimethylbenzene	95-63-6	NA	NA
1,2,3-trimethylbenzene	526-73-8	NA	NA

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 92%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS082194	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/21/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/21/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1082115

Compound Name	Cas Number	LCS Concentration ug/L	QC Limit ug/L
Benzene	71-43-2	42	29-47
Toluene	108-88-3	38	30-42
Ethyl Benzene	100-41-4	38	31-43
m/p-Xylene	NA	37	31-42
o-Xylene	95-47-6	39	31-42
Chlorobenzene	108-90-7	NA	NA
1,3,5-trimethylbenzene	108-67-8	NA	NA
1,2,4-trimethylbenzene	95-63-6	NA	NA
1,2,3-trimethylbenzene	526-73-8	NA	NA

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene :
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS082294	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/22/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/22/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1082218

Compound Name	Cas Number	LCS Concentration ug/L	QC Limit ug/L
Benzene	71-43-2	34	29-47
Toluene	108-88-3	32	30-42
Ethyl Benzene	100-41-4	32	31-43
m/p-Xylene	NA	31	31-42
o-Xylene	95-47-6	32	31-42
Chlorobenzene	108-90-7	NA	NA
1,3,5-trimethylbenzene	108-67-8	NA	NA
1,2,4-trimethylbenzene	95-63-6	NA	NA
1,2,3-trimethylbenzene	526-73-8	NA	NA

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 80%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available

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BTEX Data Report

Client Sample Number	: MW-1	Client Project No.	: Bolling AFB
Lab Sample Number	: X92570	Lab Project No.	: 94-2981
Date Sampled	: 8/11/94	Dilution Factor	: 5.00
Date Received	: 8/12/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22/94	Lab File No.	: BX1082215
		Method Blank No.	: MB082294

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	3.5	J	20
Toluene	108-88-3	7.5	BJ	20
Ethyl Benzene	100-41-4		U	20
Total Xylene (m/p + o)	1330-20-7	8	BJ	20
1,3,5-trimethylbenzene	108-67-8		U	20
1,2,4-trimethylbenzene	95-63-6		U	20
1,2,3-trimethylbenzene	526-73-8		U	20

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 96%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: MW-6	Client Project No.	: Bolling AFB
Lab Sample Number	: X92571	Lab Project No.	: 94-2981
Date Sampled	: 8/11/94	Dilution Factor	: 100.00
Date Received	: 8/12/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22/94	Lab File No.	: BX1082216
		Method Blank No.	: MB082294

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	2700		400
Toluene	108-88-3	8000	B	400
Ethyl Benzene	100-41-4	460		400
Total Xylene (m/p + o)	1330-20-7	2300	B	400
1,3,5-trimethylbenzene	108-67-8	60	J	400
1,2,4-trimethylbenzene	95-63-6	230	J	400
1,2,3-trimethylbenzene	526-73-8	50	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 96%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-32S	Client Project No.	: Boiling AFB
Lab Sample Number	: X92572	Lab Project No.	: 94-2981
Date Sampled	: 8/11/94	Dilution Factor	: 1.00
Date Received	: 8/12/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22/94	Lab File No.	: BX1082218
		Method Blank No.	: MB082194

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	*	*
Toluene	108-88-3	*	*
Ethyl Benzene	100-41-4	*	*
Total Xylene (m/p + o)	1330-20-7	*	*
1,3,5-trimethylbenzene	108-67-8	49	4
1,2,4-trimethylbenzene	95-63-6	*	*
1,2,3-trimethylbenzene	526-73-8	30	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082219 for noted values, df=100, 08/22/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 269% Co-eluting peaks.
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-32S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92572	Lab Project No.	: 94-2981
Date Sampled	: 8/11/94	Dilution Factor	: 100.00
Date Received	: 8/12/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22/94	Lab File No.	: BX1082219
		Method Blank No.	: MB082294

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	2400		400
Toluene	108-88-3	7200	B	400
Ethyl Benzene	100-41-4	450		400
Total Xylene (m/p + o)	1330-20-7	2200	B	400
1,3,5-trimethylbenzene	108-67-8		*	*
1,2,4-trimethylbenzene	95-63-6	250	J	400
1,2,3-trimethylbenzene	526-73-8		*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082118 for noted values, df=1, 08/21/94.
MDL = 0.4 ug/L.
Surrogate Recovery:

a,a,a,-Trifluorotoluene	90%
QC Reporting Limits	: 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = *Practical Quantitation Limit.* The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-2S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92573	Lab Project No.	: 94-2981
Date Sampled	: 8/11/94	Dilution Factor	: 500.00
Date Received	: 8/12/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/23/94	Lab File No.	: BX1082220
		Method Blank No.	: MB082294

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	21000		2000
Toluene	108-88-3	25000	B	2000
Ethyl Benzene	100-41-4		*	*
Total Xylene (m/p + o)	1330-20-7	8400	B	2000
1,3,5-trimethylbenzene	108-67-8		*	*
1,2,4-trimethylbenzene	95-63-6		*	*
1,2,3-trimethylbenzene	526-73-8		*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082122 for noted values, df=100, 08/21/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 85%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: CPT-2S	Client Project No.	: Boiling AFB
Lab Sample Number	: X92573	Lab Project No.	: 94-2981
Date Sampled	: 8/11/94	Dilution Factor	: 100.00
Date Received	: 8/12/94	Method	: 8020
Date Extracted/Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/23/94	Lab File No.	: BX1082122
		Method Blank No.	: MB082194

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2	*		*
Toluene	108-88-3	*		*
Ethyl Benzene	100-41-4	1900		400
Total Xylene (m/p + o)	1330-20-7	*		*
1,3,5-trimethylbenzene	108-67-8	290	J	400
1,2,4-trimethylbenzene	95-63-6	1100		400
1,2,3-trimethylbenzene	526-73-8	200	J	400

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1082220 for noted values, df=500, 08/22/94.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 99%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Method Blank Report

Method Blank Number	: MB081994	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/19/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/19/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1081902

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	U	4
Toluene	108-88-3	U	4
Ethyl Benzene	100-41-4	U	4
Total Xylene (m/p + o)	1330-20-7	U	4
1,3,5-trimethylbenzene	108-67-8	U	4
1,2,4-trimethylbenzene	95-63-6	U	4
1,2,3-trimethylbenzene	526-73-8	U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 106%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Method Blank Report

Method Blank Number	: MB082094	Client Project No.	: Boiling AFB
Date Extracted/Prepared	: 8/20/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/20/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1082017

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2		U	4
Toluene	108-88-3	2.5	J*	4
Ethyl Benzene	100-41-4		U	4
Total Xylene (m/p + o)	1330-20-7	0.5	J	4
1,3,5-trimethylbenzene	108-67-8		U	4
1,2,4-trimethylbenzene	95-63-6		U	4
1,2,3-trimethylbenzene	526-73-8		U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = High Toluene in blank caused by contamination in surrogate.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 94%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Method Blank Report

Method Blank Number	: MB082194	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/21/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/21/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1082103

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2		U	4
Toluene	108-88-3	2.1	*J	4
Ethyl Benzene	100-41-4		U	4
Total Xylene (m/p + o)	1330-20-7	0.5	J	4
1,3,5-trimethylbenzene	108-67-8		U	4
1,2,4-trimethylbenzene	95-63-6		U	4
1,2,3-trimethylbenzene	526-73-8		U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = High Toluene in blank caused by contamination in surrogate.
MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 111%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Method Blank Report

Method Blank Number	: MB082294	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/22/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/22/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1082203

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2		U	4
Toluene	108-88-3	1.4	B	4
Ethyl Benzene	100-41-4		U	4
Total Xylene (m/p + o)	1330-20-7	0.7	B	4
1,3,5-trimethylbenzene	108-67-8		U	4
1,2,4-trimethylbenzene	95-63-6		U	4
1,2,3-trimethylbenzene	526-73-8		U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

MDL = 0.4 ug/L.
Surrogate Recovery:
a,a,a,-Trifluorotoluene : 104%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Water Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: CPT-10D	**Client Project No.**	: Bolling AFB
Lab Sample No.	: X92409	**Lab Project No.**	: 94-2981
Date Sampled	: 8/8/94	**EPA Method No.**	: 8020
Date Received	: 8/10/94	**Matrix**	: Water
Date Prepared	: 8/19/94	**Lab File Number(s)**	: BX1081923,24
Date Analyzed	: 8/20/94	**Method Blank**	: MB081994

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	MS Concentration (ug/L)	MS %REC	QC Limits %REC
Benzene	20	0.8	12.9	60.5	65-121
Toluene	20	8.3	18	48.5	69-117
Ethyl Benzene	20	1	13	60	68-118
m/p-Xylene	20	3.4	14.6	56	66-116
o-Xylene	20	1.5	13.6	60.5	73-117

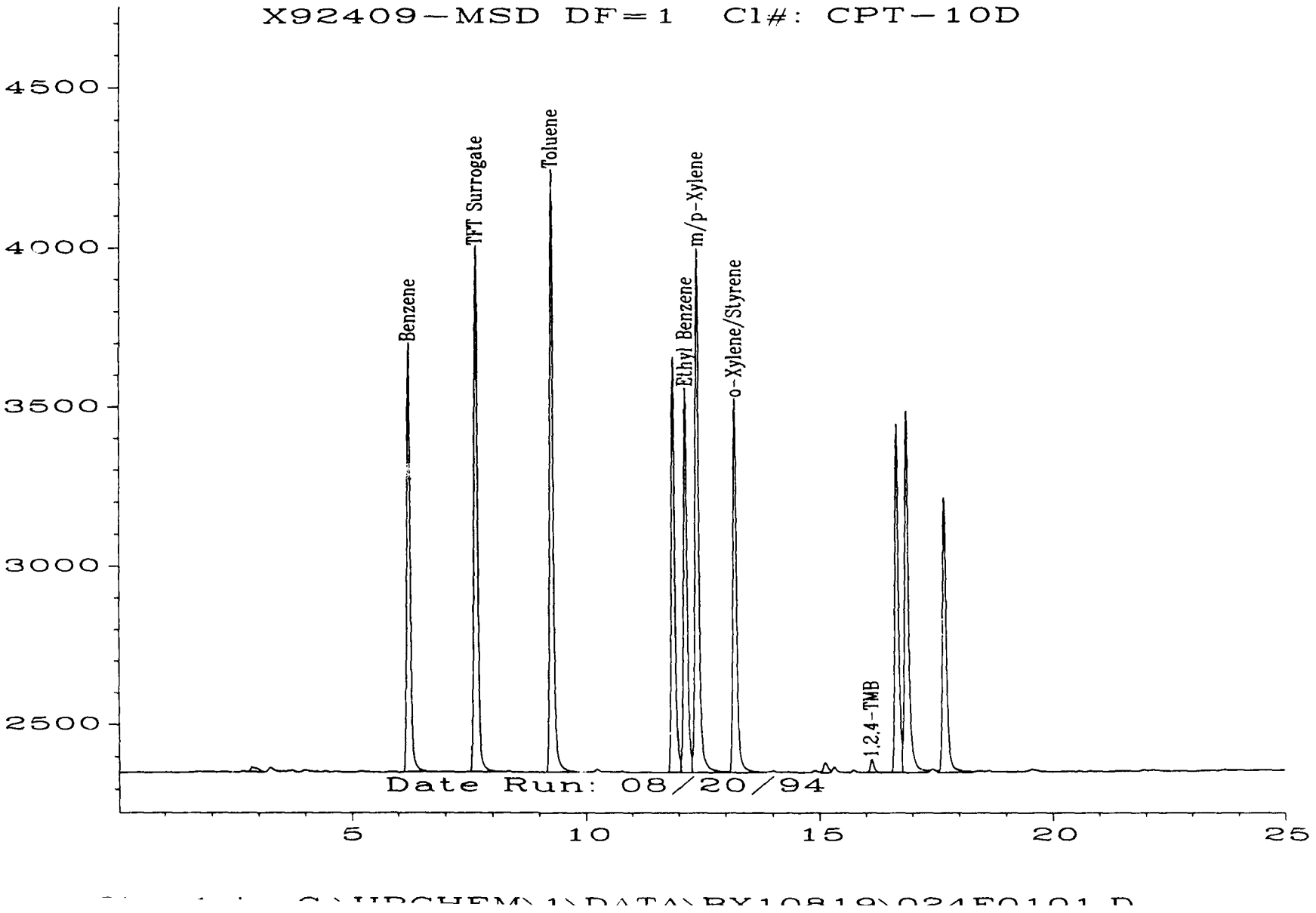
Compound	Spike Added (ug/L)	MSD Concentration (ug/L)	MS %REC	RPD	QC Limits RPD	QC Limits %REC
Benzene	20	18.7	89.5	38.7	17.4	65-121
Toluene	20	26.3	90	59.9	15.8	69-117
Ethyl Benzene	20	19.1	90.5	40.5	11.9	68-118
m/p-Xylene	20	21.3	89.5	46.0	15.4	66-116
o-Xylene	20	19.5	90	39.2	13.2	73-117

* = Values outside of QC limits.

RPD: 5 out of (5) outside limits.

Spike Recovery: 5 out of (10) outside limits.

Comments: CJC
Note: MS has low surrogate recovery (56%).


X92409-MSD DF=1 Cl#: CPT-10D
4500
4000
3500
3000
2500
Benzene
TFT Surrogate
Toluene
Ethyl Benzene
m/p-Xylene
o-Xylene/Styrene
1,2,4-TMB
Date Run: 08/20/94
5
10
15
20
25

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BTEX Water Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: MW-9	Client Project No.	: Bolling AFB
Lab Sample No.	: X92394	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	EPA Method No.	: 8020
Date Received	: 8/10/94	Matrix	: Water
Date Prepared	: 8/20/94	Lab File Number(s)	: BX1082018,19
Date Analyzed	: 8/20,21/1994	Method Blank	: MB082094

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	MS Concentration (ug/L)	MS %REC	QC Limits %REC
Benzene	20	0	18.9	94.5	65-121
Toluene	20	1.6	20.2	93	69-117
Ethyl Benzene	20	0	19	95	68-118
m/p-Xylene	20	0	18.8	94	66-116
o-Xylene	20	0	19	95	73-117

Compound	Spike Added (ug/L)	MSD Concentration (ug/L)	MS %REC	RPD	QC Limits RPD	QC Limits %REC
Benzene	20	18.6	93	1.6	17.4	65-121
Toluene	20	19.6	90	3.3	15.8	69-117
Ethyl Benzene	20	18.5	92.5	2.7	11.9	68-118
m/p-Xylene	20	18.4	92	2.2	15.4	66-116
o-Xylene	20	18.5	92.5	2.7	13.2	73-117

* = Values outside of QC limits.

RPD: 0 out of (5) outside limits.

Spike Recovery: 0 out of (10) outside limits.

Comments: CJC

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BTEX Water Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: MW-10	Client Project No.	: Bolling AFB
Lab Sample No.	: X92396	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	EPA Method No.	: 8020
Date Received	: 8/11/94	Matrix	: Water
Date Prepared	: 8/21/94	Lab File Number(s)	: BX1082120,21
Date Analyzed	: 8/22/94	Method Blank	: MB082194

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	MS Concentration (ug/L)	MS %REC	QC Limits %REC
Benzene	20	0	17.5	87.5	65-121
Toluene	20	1.6	15.3	68.5	69-117
Ethyl Benzene	20	0	17.6	88	68-118
m/p-Xylene	20	0.6	17.5	84.5	66-116
o-Xylene	20	0	17.7	88.5	73-117

Compound	Spike Added (ug/L)	MSD Concentration (ug/L)	MS %REC	RPD	QC Limits RPD	QC Limits %REC
Benzene	20	17.5	87.5	0.0	17.4	65-121
Toluene	20	15.9	71.5	4.3	15.8	69-117
Ethyl Benzene	20	17.7	88.5	0.6	11.9	68-118
m/p-Xylene	20	17.8	86	1.8	15.4	66-116
o-Xylene	20	18	90	1.7	13.2	73-117

* = Values outside of QC limits.

RPD: 0 out of (5) outside limits.

Spike Recovery: 1 out of (10) outside limits.

Comments: CJC

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BTEX Data Report

Client Sample Number	: MW-3(Free Product)	Client Project No.	: Bolling AFB
Lab Sample Number	: X92398	Lab Project No.	: 94-2981
Date Sampled	: 8/9/94	Dilution Factor	: 500000
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/24/94	Matrix	: Product
Date Analyzed	: 8/24/94	Lab File No.	: BX1082413
Methanol Extract	: Yes	Method Blank No.	: MEB082494

Compound Name	Cas Number	Sample Concentration %		PQL %
Benzene	71-43-2	0.3		0.2
Toluene	108-88-3	4.5	B	0.2
Ethyl Benzene	100-41-4	1.3		0.2
Total Xylene (m/p + o)	1330-20-7	7.7	B	0.2
Total BTEX		13.8		

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:

a,a,a,-Trifluorotoluene	: 111%
QC Reporting Limits	: 55%-127%

QUALIFIERS:

E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB14(14BLS)	Client Project No.	: Bolling AFB
Lab Sample Number	: X92380	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081705
Methanol Extract	: No	Method Blank No.	: MB081794

Compound Name	Cas Number	Sample Concentration** ug/kg		PQL ug/kg
Benzene	71-43-2	1.1	J	5
Toluene	108-88-3	2.8	J	5
Ethyl Benzene	100-41-4	0.5	J	5
Total Xylene (m/p + o)	1330-20-7	3.4	J	5

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 110%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB14(20'-21'4")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92381	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1250.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081715
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg	PQL ug/kg
Benzene	71-43-2	U	6000
Toluene	108-88-3	37000	6000
Ethyl Benzene	100-41-4	18000	6000
Total Xylene (m/p + o)	1330-20-7	100000	6000

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 105%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB54(14'8"-15'4")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92382	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081706
Methanol Extract	: No	Method Blank No.	: MB081794

Compound Name	Cas Number	Sample Concentration ug/kg		PQL ug/kg
Benzene	71-43-2	4.7	J	4.7
Toluene	108-88-3	28		4.7
Ethyl Benzene	100-41-4	4.7	J	4.7
Total Xylene (m/p + o)	1330-20-7	27		4.7

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 113%
QC Reporting Limits : 55%-127%
QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB7(10'9"-11'5")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92383	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1250.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081716
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg	PQL ug/kg
Benzene	71-43-2	4700 J	6000
Toluene	108-88-3	92000	6000
Ethyl Benzene	100-41-4	41000	6000
Total Xylene (m/p + o)	1330-20-7	210000	6000

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 89%
QC Reporting Limits : 55%-127%

QUALIFIERS:

** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB7(14'-17'2")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92384	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 125.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081613
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg	PQL ug/kg
Benzene	71-43-2	3600	500
Toluene	108-88-3	*	*
Ethyl Benzene	100-41-4	*	*
Total Xylene (m/p + o)	1330-20-7	*	*

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081717 for noted values, df=1250, 08/17/94.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 180% Co-eluting peaks.
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB7(14'-17'2")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92384	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1250.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081717
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg	PQL ug/kg
Benzene	71-43-2	*	*
Toluene	108-88-3	56000	6200
Ethyl Benzene	100-41-4	27000	6200
Total Xylene (m/p + o)	1330-20-7	140000	6200

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
* = See BX1081613 for Benzene value (180%), df=125, 08/16/94.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 87%
QC Reporting Limits : 55%-127%
QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB7(20'-22'2")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92385	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1250.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/18/94	Lab File No.	: BX1081719
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg	PQL ug/kg
Benzene	71-43-2	11000	5700
Toluene	108-88-3	170000	5700
Ethyl Benzene	100-41-4	64000	5700
Total Xylene (m/p + o)	1330-20-7	320000	5700

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:

a,a,a,-Trifluorotoluene	: 97%
QC Reporting Limits	: 55%-127%

QUALIFIERS:

** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB9(17'9"-19'11")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92386	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1250.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/18/94	Lab File No.	: BX1081720
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg	PQL ug/kg
Benzene	71-43-2	20000	6000
Toluene	108-88-3	210000	6000
Ethyl Benzene	100-41-4	75000	6000
Total Xylene (m/p + o)	1330-20-7	370000	6000

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 113%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB9(22'6"-24'8")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92387	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 125.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/18/94	Lab File No.	: BX1081723
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg	PQL ug/kg
Benzene	71-43-2	U	570
Toluene	108-88-3	1100	570
Ethyl Benzene	100-41-4	3600	570
Total Xylene (m/p + o)	1330-20-7	23000	570

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 114%
QC Reporting Limits : 55%-127%
QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = *Extrapolated value*
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB47(12'-13'8")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92388	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 125.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/16/94	Matrix	: Soil
Date Analyzed	: 8/16/94	Lab File No.	: BX1081606
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg		PQL ug/kg
Benzene	71-43-2		U	550
Toluene	108-88-3	500	J	550
Ethyl Benzene	100-41-4	1600		550
Total Xylene (m/p + o)	1330-20-7	9600		550

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 119%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB11(11'-13'2")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92389	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081707
Methanol Extract	: No	Method Blank No.	: MB081794

Compound Name	Cas Number	Sample Concentration** ug/kg		PQL ug/kg
Benzene	71-43-2	1.7	J	4.6
Toluene	108-88-3	2.9	J	4.6
Ethyl Benzene	100-41-4	0.5	J	4.6
Total Xylene (m/p + o)	1330-20-7	2.9	J	4.6

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 111%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB11(17'6"-19'8")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92390	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1250.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/18/94	Lab File No.	: BX1081721
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg	PQL ug/kg
Benzene	71-43-2	7300	5700
Toluene	108-88-3	140000	5700
Ethyl Benzene	100-41-4	57000	5700
Total Xylene (m/p + o)	1330-20-7	300000	5700

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 101%
QC Reporting Limits : 55%-127%
QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB11(22'-24'2")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92391	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 125.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/16/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081622
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg	PQL ug/kg
Benzene	71-43-2	370 J	560
Toluene	108-88-3	3500	560
Ethyl Benzene	100-41-4	1200	560
Total Xylene (m/p + o)	1330-20-7	7100	560

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 88%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB3(9'8"-11'8")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92392	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 1.00
Date Received	: 94	Method	: 8020
Date Extracted/Prepared	5/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081624
Methanol Extract	: No	Method Blank No.	: MB081694

Compound Name	Cas Number	Sample Concentration** ug/kg		PQL ug/kg
Benzene	71-43-2		U	4.6
Toluene	108-88-3	0.7	J	4.6
Ethyl Benzene	100-41-4		U	4.6
Total Xylene (m/p + o)	1330-20-7	0.6	J	4.6

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 81%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available

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BTEX Data Report

Client Sample Number	: SB3(22'-24'5")	Client Project No.	: Bolling AFB
Lab Sample Number	: X92393	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	Dilution Factor	: 125.00
Date Received	: 8/8/94	Method	: 8020
Date Extracted/Prepared	: 8/16/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081627
Methanol Extract	: Yes	Method Blank No.	: MEB081694

Compound Name	Cas Number	Sample Concentration** ug/kg		PQL ug/kg
Benzene	71-43-2		U	560
Toluene	108-88-3	280	J	560
Ethyl Benzene	100-41-4	3700		560
Total Xylene (m/p + o)	1330-20-7	22000		560

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 87%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

Analyst

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BTEX Data Report

Client Sample Number	: SB-9S	Client Project No.	: Bolling AFB
Lab Sample Number	: X92414	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 1.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/16/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081629
Methanol Extract	: No	Method Blank No.	: MB081694

Compound Name	Cas Number	Sample Concentration** ug/kg		PQL ug/kg
Benzene	71-43-2		U	4.8
Toluene	108-88-3	1.1	J	4.8
Ethyl Benzene	100-41-4		U	4.8
Total Xylene (m/p + o)	1330-20-7	2.1	J	4.8

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 58%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report

Client Sample Number	: SB-9D	Client Project No.	: Bolling AFB
Lab Sample Number	: X92416	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	Dilution Factor	: 1.00
Date Received	: 8/10/94	Method	: 8020
Date Extracted/Prepared	: 8/17/94	Matrix	: Soil
Date Analyzed	: 8/17/94	Lab File No.	: BX1081709
Methanol Extract	: No	Method Blank No.	: MB081794

Compound Name	Cas Number	Sample Concentration** ug/kg		PQL ug/kg
Benzene	71-43-2		U	5.5
Toluene	108-88-3	0.7	J	5.5
Ethyl Benzene	100-41-4		U	5.5
Total Xylene (m/p + o)	1330-20-7	1	J	5.5

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 92%
QC Reporting Limits : 55%-127%

QUALIFIERS:
** = All sample results and PQLs are reported on a dry weight basis.
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Method Blank Report

Method Blank Number	: MB081694	**Client Project No.**	: Bolling AFB
Date Extracted/Prepared	: 8/16/94	**Lab Project No.**	: 94-2981
Date Analyzed	: 8/16/94	**Dilution Factor**	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1081602

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	U	4
Toluene	108-88-3	U	4
Ethyl Benzene	100-41-4	U	4
Total Xylene (m/p + o)	1330-20-7	U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:

a,a,a,-Trifluorotoluene	: 105%
QC Reporting Limits	: 77%-116%

QUALIFIERS:

E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Method Blank Report

Method Blank Number	: MB081794	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/17/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/17/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1081702

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	U	4
Toluene	108-88-3	U	4
Ethyl Benzene	100-41-4	U	4
Total Xylene (m/p + o)	1330-20-7	U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.
Note: High surrogate recovery due to increased sensitivity of initial runs.

Surrogate Recovery:
a,a,a,-Trifluorotoluene : 118%
QC Reporting Limits : 77%-116%

QUALIFIERS:
E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Method Blank Report

Method Blank Number	: MEB081694	**Client Project No.**	: Bolling AFB
Date Extracted/Prepared	: 8/16/94	**Lab Project No.**	: 94-2981
Date Analyzed	: 8/16/94	**Dilution Factor**	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1081609

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	U	4
Toluene	108-88-3	U	4
Ethyl Benzene	100-41-4	U	4
Total Xylene (m/p + o)	1330-20-7	U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:

a,a,a,-Trifluorotoluene	: 101%
QC Reporting Limits	: 77%-116%

QUALIFIERS:

E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Method Blank Report

Method Blank Number	: MEB081694	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/17/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/17/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1081714

Compound Name	Cas Number	Sample Concentration ug/L	PQL ug/L
Benzene	71-43-2	U	4
Toluene	108-88-3	U	4
Ethyl Benzene	100-41-4	U	4
Total Xylene (m/p + o)	1330-20-7	U	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:

a,a,a,-Trifluorotoluene	: 93%
QC Reporting Limits	: 77%-116%

QUALIFIERS:

E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Data Report
Method Blank Report

Method Blank Number	: MEB082494	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 8/24/94	Lab Project No.	: 94-2981
Date Analyzed	: 8/24/94	Dilution Factor	: 1.00
		Method	: 8020
		Matrix	: Water
		Lab File No.	: BX1082410

Compound Name	Cas Number	Sample Concentration ug/L		PQL ug/L
Benzene	71-43-2		U	4
Toluene	108-88-3	0.6	J	4
Ethyl Benzene	100-41-4		U	4
Total Xylene (m/p + o)	1330-20-7	0.5	J	4

Note: Total Xylene consist of three isomers, two of which co-elute.
The Xylene PQL is for a single peak.

Surrogate Recovery:

a,a,a,-Trifluorotoluene	: 100%
QC Reporting Limits	: 77%-116%

QUALIFIERS:

E = Extrapolated value
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
J = Indicates an estimated value when the compound is detected, but is below the Practical Quantitation Limit (PQL).
PQL = Practical Quantitation Limit. The PQL is equal to the dilution factor multiplied by ten times the Method Detection Limit as determined by EPA SW846, Vol. 1B, Part II, pa. 8000-14.
NA = Not available.

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BTEX Soil Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: SB3(9'8"-11'8")	Client Project No.	: Bolling AFB
Lab Sample No.	: X92392	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	EPA Method No.	: 8020
Date Received	: 8/8/94	Matrix	: Soil
Date Prepared	: 8/16/94	Lab File Number(s)	: BX1081625,26
Date Analyzed	: 8/17/94	Method Blank	: MEB081694

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	MS Concentration (ug/L)	MS %REC	QC Limits %REC
Benzene	20	0	12.1	60.5	51-109
Toluene	20	0.6	12.6	60	48-106
Ethyl Benzene	20	0	12.3	61.5	45-111
m/p-Xylene	20	0.5	12.5	60	39-113
o-Xylene	20	0	12.5	62.5	43-113

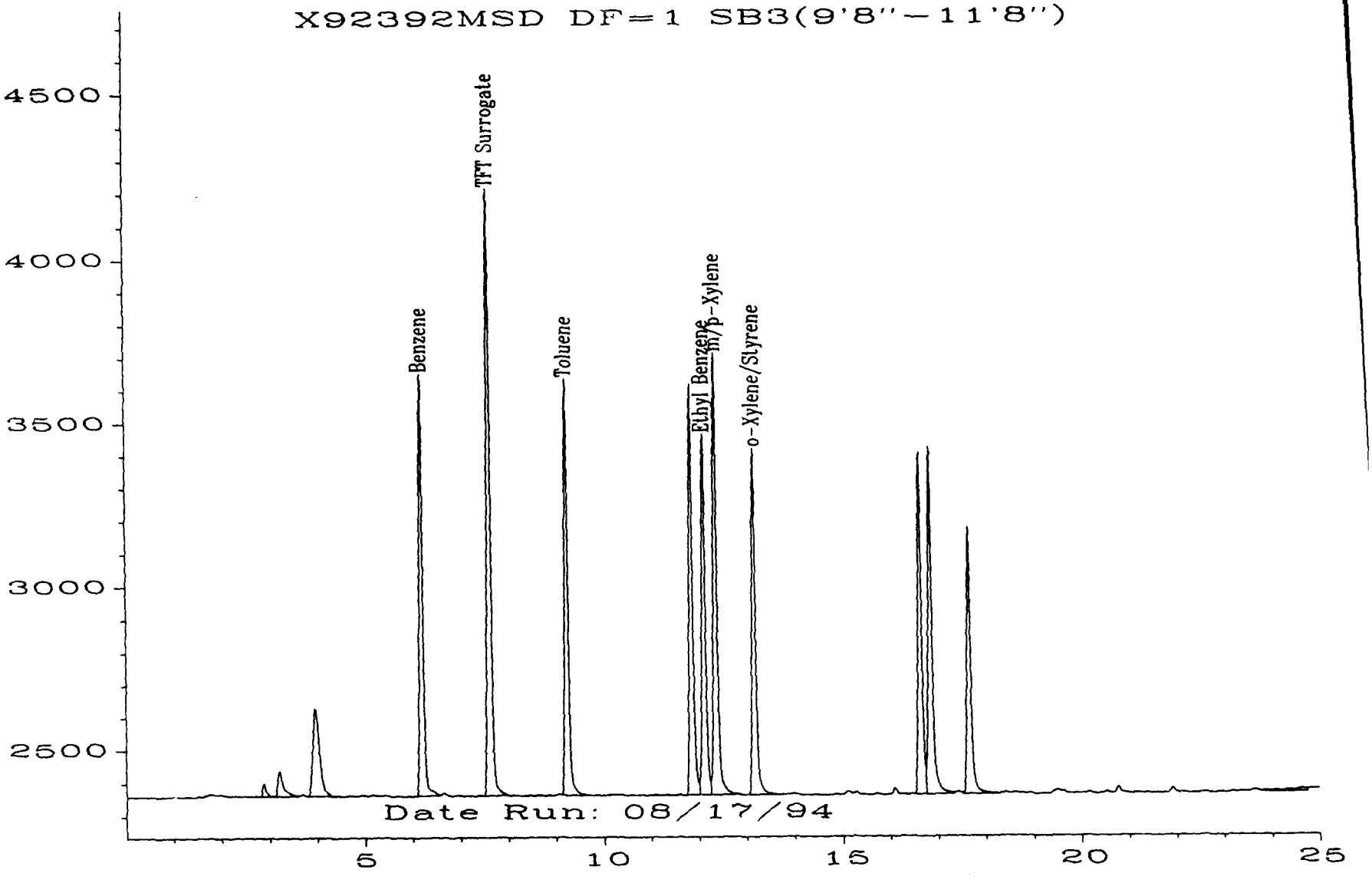
Compound	Spike Added (ug/L)	MSD Concentration (ug/L)	MS %REC	RPD	QC Limits RPD	QC Limits %REC
Benzene	20	12.4	62	2.4	18.7	51-109
Toluene	20	12.7	60.5	0.8	17.4	48-106
Ethyl Benzene	20	12.4	62	0.8	17.9	45-111
m/p-Xylene	20	12.5	60	0.0	17.0	39-113
o-Xylene	20	12.5	62.5	0.0	19.1	43-113

* = Values outside of QC limits.

RPD: 0 out of (5) outside limits.

Spike Recovery: 0 out of (10) outside limits.

Comments: CJC
These results are not adjusted for % moisture.



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TOTAL VOLATILE HYDROCARBONS (TVH)

Date Sampled	: 8/3,8,9/1994	Client Project Number	: Bolling AFB
Date Received	: 8/8,10/1994	Lab Project Number	: 94-2981
Date Prepared	: 8/15,16/94	Matrix	: Soil
Date Analyzed	: 8/15,16/94	Method Number	: 5030/Mod.8015

Evergreen Sample #	Client Sample #	Surrogate Recovery	TVH * mg/Kg	MDL mg/Kg
MB081594	Method Blank	100%	U	0.1
X92380	SB-14(14'BLS)	101%	U	0.12
X92381	SB-14(20-21'4")	115%	1600	2.4
X92382	SB-54(14'8"-15'4")	96%	0.6	0.12
X92383	SB-7(10'9"-11'5")	122%	4800	6.0
X92384	SB-7(14'-17'2")	129%	2300	6.2
X92385	SB-7(20'-22'2")	[1]	6400	5.7
X92386	SB-9(17'9"-19'11")	[1]	12000	6.0
X92387	SB-9(22'6"-24'8")	117%	40	0.22
X92388	SB-47(12'-13'8")	104%	220	0.22
X92389	SB-11(11'-13'2")	97%	U	0.11
X92390	SB-11(17'6"-19'8")	130%	4300	5.7
X92391	SB-11(22'-24'2")	98%	40	1.1
X92392	SB-3(9'8"-11'8")	93%	U	0.11
X92393	SB-3(22'-24'5")	99%	620	5.6
X92414	SB-9S	97%	U	0.12
X92416	SB-9D	98%	U	0.14

[1] = Unable to separate surrogate from analyte.

QUALIFIERS
* = All results and MDLs reported on a dry weight basis.
U = TVH analyzed for but not detected.
B = TVH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
MDL = Method Detection Limit

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TOTAL VOLATILE HYDROCARBONS
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: SB-14(14'BLS)	Client Project No.	: Bolling AFB
Lab Sample No.	: X92380	Lab Project No.	: 94-2981
Date Sampled	: 8/3/94	EPA Method No.	: 8015 Mod.
Date Received	: 8/8/94	Matrix	: Soil
Date Prepared	: 8/15/94	Method Blank	: MB081594
Date Analyzed	: 8/15/94		

Compound	Spike Added (mg/Kg)	Sample Concentration (mg/Kg)	MS Concentration (mg/Kg)	MS %REC	QC Limits %REC
Gasoline	10	0	10.2	102	60-140

Compound	Spike Added (mg/Kg)	MSD Concentration (mg/Kg)	MS %REC	RPD	QC Limits RPD	QC Limits %REC
Gasoline	10	7.7	77	27.9	50	60-140

* = Values outside of QC limits.

RPD: 0 out of (1) outside limits.

Spike Recovery: 0 out of (2) outside limits.

Comments: NA = Not analyzed/not applicable.

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TOTAL VOLATILE HYDROCARBONS (TVH)

Date Sampled	: 8/9/94	Client Project Number	: Bolling AFB, 722450.08020
Date Received	: 8/10/94	Lab Project Number	: 94-2981
Date Prepared	: 9/2/94	Matrix	: Product
Date Analyzed	: 9/2,3/94	Method Number	: 5030/Mod.8015

Evergreen Sample #	Client Sample #	Surrogate Recovery	TVH mg/Kg	MDL mg/Kg
MB090294	Method Blank	100%	U	0.1
X92398	MW-3(Free Product)	138%	490000	5

QUALIFIERS
U = TVH analyzed for but not detected.
B = TVH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
MDL = Method Detection Limit

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TOTAL VOLATILE HYDROCARBONS (TVH)

Date Sampled	: 8/8/94	Client Project Number	: Bolling AFB
Date Received	: 8/10/94	Lab Project Number	: 94-2981
Date Prepared	: 8/15/94	Matrix	: Water
Date Analyzed	: 8/15,16/94	Method Number	: 5030/Mod.8015

Evergreen Sample #	Client Sample #	Surrogate Recovery	TVH mg/L	MDL mg/L
MB081594	Method Blank	100%	U	0.1
X92413	CPT-11D	103%	13	0.5

QUALIFIERS
U = TVH analyzed for but not detected.
B = TVH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
MDL = Method Detection Limit

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TOTAL VOLATILE HYDROCARBONS (TVH)

Date Sampled	: 8/6,8/1994	Client Project Number	: Bolling AFB
Date Received	: 8/10/94	Lab Project Number	: 94-2981
Date Prepared	: 8/18/94	Matrix	: Water
Date Analyzed	: 8/18/94	Method Number	: 5030/Mod.8015

Evergreen Sample #	Client Sample #	Surrogate Recovery	TVH mg/L	MDL mg/L
MB081894	Method Blank	100%	U	0.1
X92405	MW-2	97%	750	50
X92407	CPT-8D	99%	0.6	0.1
X92408	CPT-10S	98%	61	0.5
X92409	CPT-10D	100%	U	0.1
X92411	CPT-9D	99%	0.7	0.1

QUALIFIERS
U = TVH analyzed for but not detected.
B = TVH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
MDL = Method Detection Limit

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TOTAL VOLATILE HYDROCARBONS (TVH)

Date Sampled	: 8/5,8/1994	Client Project Number	: Bolling AFB
Date Received	: 8/10/94	Lab Project Number	: 94-2981
Date Prepared	: 8/19/94	Matrix	: Water
Date Analyzed	: 8/19/94	Method Number	: 5030/Mod.8015

Evergreen Sample #	Client Sample #	Surrogate Recovery	TVH mg/L	MDL mg/L
MB081994	Method Blank	100%	U	0.1
X92403	CPT-18S	88%	50	1
X92404	CPT-18D	102%	89	1
X92406	CPT-8S	101%	82	1
X92410	CPT-9S	105%	200	1
X92412	CPT-11S	103%	160	1

QUALIFIERS
U = TVH analyzed for but not detected.
B = TVH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
MDL = Method Detection Limit

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TOTAL VOLATILE HYDROCARBONS (TVH)

Date Sampled	: 8/9/94	Client Project Number	: Bolling AFB
Date Received	: 8/10/94	Lab Project Number	: 94-2981
Date Prepared	: 8/22/94	Matrix	: Water
Date Analyzed	: 8/22,23/94	Method Number	: 5030/Mod.8015

Evergreen Sample #	Client Sample #	Surrogate Recovery	TVH mg/L	MDL mg/L
MB082294	Method Blank	100%	U	0.1
X92394	MW-9	98%	0.2	0.1
X92395	MW-4	90%	130	2
X92396	MW-11	93%	130	2
X92397	MW-5	84%	28	0.5
X92399	CPT-2D	88%	0.6	0.1
X92400	CPT-16D	98%	8	0.1
X92402	MW-3	97%	56	1

QUALIFIERS
U = TVH analyzed for but not detected.
B = TVH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
MDL = Method Detection Limit

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TOTAL VOLATILE HYDROCARBONS (TVH)

Date Sampled	: 8/9,10,11/94	Client Project Number	: Bolling AFB
Date Received	: 8/10,11/94	Lab Project Number	: 94-2981
Date Prepared	: 8/23,24/94	Matrix	: Water
Date Analyzed	: 8/23,24/94	Method Number	: 5030/Mod.8015

Evergreen Sample #	Client Sample #	Surrogate Recovery	TVH mg/L	MDL mg/L
32394	Method Blank	100%	U	0.1
2401	CPT-16S	100%	124	0.5
X92489	CPT-22D	102%	0.5	0.1
X92490	CPT-21D	82%	0.1	0.1
X92491	CPT-50D	100%	1.5	0.1
X92492	CPT-20D	105%	46	1
X92493	CPT-19D	103%	49	1
X92494	MW-7	63%	U	0.1
X92495	MW-8	104%	U	0.1
X92496	MW-10	97%	U	0.1

QUALIFIERS
U = TVH analyzed for but not detected.
B = TVH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
MDL = Method Detection Limit

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TOTAL VOLATILE HYDROCARBONS (TVH)
PAGE 2

Date Sampled	: 8/9,10,11/94	Client Project Number	: Bolling AFB
Date Received	: 8/10,11/94	Lab Project Number	: 94-2981
Date Prepared	: 8/23,24/94	Matrix	: Water
Date Analyzed	: 8/23,24/94	Method Number	: 5030/Mod.8015

Evergreen Sample #	Client Sample #	Surrogate Recovery	TVH mg/L	MDL mg/L
X92570	MW-1	101%	1.0	0.5
X92571	MW-6	100%	53	0.1
X92572	CPT-32S	100%	39	0.1
X92573	CPT-2S	102%	76	2

QUALIFIERS
U = TVH analyzed for but not detected.
B = TVH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
MDL = Method Detection Limit

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TOTAL VOLATILE HYDROCARBONS
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: CPT-22D	Client Project No.	: Bolling AFB
Lab Sample No.	: X92489	Lab Project No.	: 94-2981
Date Sampled	: 8/10/94	EPA Method No.	: 8015 Mod.
Date Received	: 8/12/94	Matrix	: Water
Date Prepared	: 8/24/94	Method Blank	: MB082394
Date Analyzed	: 8/24/94		

Compound	Spike Added (mg/L)	Sample Concentration (mg/L)	MS Concentration (mg/L)	MS %REC	QC Limits %REC
Gasoline	10	0.5	13	125	60-140

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MS %REC	RPD	QC Limits RPD	QC Limits %REC
Gasoline	10	12	115	8.3	50	60-140

* = Values outside of QC limits.

RPD: 0 out of (1) outside limits.

Spike Recovery: 0 out of (2) outside limits.

Comments: NA = Not analyzed/not applicable.

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TOTAL VOLATILE HYDROCARBONS
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: CPT-10D	Client Project No.	: Bolling AFB
Lab Sample No.	: X92409	Lab Project No.	: 94-2981
Date Sampled	: 8/8/94	EPA Method No.	: 8015 Mod.
Date Received	: 8/10/94	Matrix	: Water
Date Prepared	: 8/19/94	Method Blank	: MB081894
Date Analyzed	: 8/19/94		

Compound	Spike Added (mg/L)	Sample Concentration (mg/L)	MS Concentration (mg/L)	MS %REC	QC Limits %REC
Gasoline	10	0.3	5.6	53	60-140

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MS %REC	RPD	QC Limits RPD	QC Limits %REC
Gasoline	10	7.2	69	26.2	50	60-140

* = Values outside of QC limits.

RPD: 0 out of (1) outside limits.

Spike Recovery: 1 out of (2) outside limits.

Comments: NA = Not analyzed/not applicable.

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TOTAL VOLATILE HYDROCARBONS (TVH)
Laboratory Control Sample (LCS)

LCS Number	: LCS081594	Client Project Number	: Bolling AFB
Date Prepared	: 8/15/94	Lab Project Number	: 94-2981
Date Analyzed	: 8/16/94	Matrix	: Water
Sequence Number	: TVH0815	Method Number	: 3500/Mod. 8015

Compound Name	Theoretical Concentration mg/L	LCS Concentration mg/ L	QC Limit mg/L
Gasoline	5	4.4	3.5-6.5

QUALIFIERS
U = TEH analyzed for but not detected.
B = TEH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
NA = Not Available.

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TOTAL VOLATILE HYDROCARBONS (TVH)
Laboratory Control Sample (LCS)

LCS Number	: LCS81894	Client Project Number	: Bolling AFB
Date Prepared	: 8/18/94	Lab Project Number	: 94-2981
Date Analyzed	: 8/19/94	Matrix	: Water
Sequence Number	: TVH0818	Method Number	: 3500/Mod. 8015

Compound Name	Theoretical Concentration mg/L	LCS Concentration mg/ L	QC Limit mg/L
Gasoline	5	4.7	3.5-6.5

QUALIFIERS
U = TEH analyzed for but not detected.
B = TEH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
NA = Not Available.

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TOTAL VOLATILE HYDROCARBONS (TVH)
Laboratory Control Sample (LCS)

LCS Number	: LCS82294	Client Project Number	: Bolling AFB
Date Prepared	: 8/22/94	Lab Project Number	: 94-2981
Date Analyzed	: 8/22/94	Matrix	: Water
Sequence Number	: TVH0822	Method Number	: 3500/Mod. 8015

Compound Name	Theoretical Concentration mg/L	LCS Concentration mg/ L	QC Limit mg/L
Gasoline	5	5.8	3.5-6.5

QUALIFIERS
U = TEH analyzed for but not detected.
B = TEH found in blank as well as sample (blank data should be compared).
E = Extrapolated value.
NA = Not Available.

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Methane Data Report

		Client Project No.	: Bolling AFB
Date Sampled	: 08/5-6/94	Lab Project No.	: 94-2981
Date Received	: 08/10/94	Dilution Factor	: see below
Date Prepared	: 08/12/94	Method	: FID
Date Analyzed	: 08/12/94	Matrix	: Water

Evergreen Sample #	Client Sample #	Matrix	Concentration mg/L	EDL* mg/L
MB081294	Method Blank	Water	U	10 (DF=1)
x92403	CPT-18S	Water	270	100 (DF=10)
x92404	CPT-18D	Water	1200	100 (DF=10)
x92405	MW-2	Water	8400	100 (DF=10)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Estimated Detection Limit.
B = Compound also found in the blank, blank data should be compared.
* = Indicates the Estimated Detection Limit.
E = Extrapolated value.

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Methane Data Report

Client Project No.: Bolling AFB
Date Sampled : 08/8/94
Lab Project No. : 94-2981
Date Received : 08/10/94
Dilution Factor : see below
Date Prepared : 08/15/94
Method : FID
Date Analyzed : 08/15/94
Matrix : Water

Evergreen Sample #	Client Sample #	Matrix	Concentration mg/L	EDL* mg/L
MB081594	Method Blank	Water	U	10 (DF=1)
x92406	CPT-8S	Water	1600	100 (DF=10)
x92407	CPT-8D	Water	83	10 (DF=1)
x92408	CPT-10S	Water	340	100 (DF=10)
x92409	CPT-10D	Water	U	10 (DF=1)
x92410	CPT-9S	Water	1400	100 (DF=10)
x92411	CPT-9D	Water	160	100 (DF=10)
x92412	CPT-11S	Water	470	100 (DF=10)
x92413	CPT-11D	Water	200	100 (DF=10)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Estimated Detection Limit.
B = Compound also found in the blank, blank data should be compared.
* = Indicates the Estimated Detection Limit.
E = Extrapolated value.

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Methane Data Report

		Client Project No.	: Bolling AFB
Date Sampled	: 08/9/94	Lab Project No.	: 94-2981
Date Received	: 08/10/94	Dilution Factor	: see below
Date Prepared	: 08/16/94	Method	: FID
Date Analyzed	: 08/16/94	Matrix	: Water

Evergreen Sample #	Client Sample #	Matrix	Concentration mg/L	EDL* mg/L
MB081694	Method Blank	Water	U	10 (DF=1)
x92394	MW-9	Water	U	10 (DF=1)
x92395	MW-4	Water	200	100 (DF=10)
x92396	MW-11	Water	3800	100 (DF=10)
x92397	MW-5	Water	U	100 (DF=10)
x92399	CPT-2D	Water	3400	100 (DF=10)
x92400	CPT-16D	Water	1200	100 (DF=10)
x92401	CPT-16S	Water	1900	50 (DF=5)
x92402	MW-3	Water	U	50 (DF=5)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Estimated Detection Limit.
B = Compound also found in the blank, blank data should be compared.
* = Indicates the Estimated Detection Limit.
E = Extrapolated value.

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Methane Data Report

Client Project No.: Bolling AFB
Date Sampled : 08/10/94
Lab Project No. : 94-2981
Date Received : 08/11/94
Dilution Factor : see below
Date Prepared : 08/17/94
Method : FID
Date Analyzed : 08/17/94
Matrix : Water

Evergreen Sample #	Client Sample #	Matrix	Concentration mg/L	EDL* mg/L
MB081794	Method Blank	Water	U	10 (DF=1)
x92489	CPT-22D	Water	21	10 (DF=1)
x92490	CPT-21D	Water	700	10 (DF=1)
x92491	CPT-50D	Water	390	10 (DF=1)
x92492	CPT-20D	Water	3800	50 (DF=5)
x92493	CPT-19D	Water	1600	50 (DF=5)
x92494	MW-7	Water	21	10 (DF=1)
x92495	MW-8	Water	22	10 (DF=1)
x92496	MW-10	Water	U	10 (DF=1)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Estimated Detection Limit.
B = Compound also found in the blank, blank data should be compared.
* = Indicates the Estimated Detection Limit.
E = Extrapolated value.

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Methane Data Report

Client Project No.: Bolling AFB
Date Sampled : 08/11/94
Lab Project No. : 94-2981
Date Received : 08/12/94
Dilution Factor : see below
Date Prepared : 08/18/94
Method : FID
Date Analyzed : 08/18/94
Matrix : Water

Evergreen Sample #	Client Sample #	Matrix	Concentration mg/L	EDL* mg/L
MB081894	Method Blank	Water	U	10 (DF=1)
x92570	MW-1	Water	220	10 (DF=1)
x92571	MW-6	Water	350	50 (DF=5)
x92572	CPT-32S	Water	300	50 (DF=5)
x92573	CPT-2S	Water	1200	50 (DF=5)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Estimated Detection Limit.
B = Compound also found in the blank, blank data should be compared.
* = Indicates the Estimated Detection Limit.
E = Extrapolated value.

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Anions Analyses

Date Sampled : 8/5,6/94
Date Received : 8/10/94
Date Prepared : 8/10/94
Date Analyzed : 8/10/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit : 0.056 mg/L
Method : EPA 300.0

Evergreen Sample #	Client Sample ID	Matrix	Nitrite + Nitrate-N (mg/L)
X92403	CPT-18S	WATER	<0.056
X92404	CPT-18D	WATER	0.107
X92405	MW-2	WATER	<0.056
Method Blank 8/10/94			<0.056

NOTE: Combined NO_2-N + NO_3-N reported; as samples were received outside of holding time.

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Anions

Date Sampled : 8/8,9/94
Date Received : 8/10/94
Date Prepared : 8/10/94
Date Analyzed : 8/10/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit : 0.056 mg/L
Method : EPA 300.0

Evergreen Sample #	Client Sample ID	Matrix	Nitrate-N (mg/L)
X92394	MW-9	WATER	5.14
X92395	MW-4	WATER	<0.056
X92396	MW-11	WATER	<0.056
X92397	MW-5	WATER	<0.056
X92399	CPT-2D	WATER	0.657
X92400	CPT-16D	WATER	0.671
X92401	CPT-16S	WATER	0.569
X92401 DUP	CPT-16S	WATER	0.556
X92402	MW-3	WATER	<0.056
X92406	CPT-8S	WATER	<0.056
X92407	CPT-8D	WATER	2.32
X92408	CPT-10S	WATER	<0.056
X92409	CPT-10D	WATER	2.95
X92410	CPT-9S	WATER	<0.056
X92411	CPT-9D	WATER	0.580
X92412	CPT-11S	WATER	<0.056
X92413	CPT-11D	WATER	<0.056
Method Blank 8/10/94			<0.056

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
X92401	CPT-16S Matrix Spike	2.26	0.569	2.57	88.5
X92401	CPT-16S Matrix Spike Dup.	2.26	0.569	2.51	85.9
	MS/MSD RPD				2.98
X92401/X92401 Dup. RPD					2.31

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Anions Analyses

Date Sampled : 8/10/94
Date Received : 8/11/94
Date Prepared : 8/11/94
Date Analyzed : 8/11/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit : 0.056 mg/L
Method : EPA 300.0

Evergreen Sample #	Client Sample ID	Matrix	Nitrate-N (mg/L)
X92489	CPT-22D	WATER	1.04
X92490	CPT-21D	WATER	<0.056
X92491	CPT-50D	WATER	<0.056
X92492	CPT-20D	WATER	<0.056
X92493	CPT-19D	WATER	<0.056
X92494	MW-7	WATER	16.3
X92495	MW-8	WATER	0.522
X92495 DUP	MW-8	WATER	0.526
X92496	MW-10	WATER	12.0
Method Blank 8/11/94			<0.056

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
X92495	MW-8 Matrix Spike	2.26	0.522	2.51	88.0
X92495	MW-8 Matrix Spike Dup.	2.26	0.522	2.37	81.8
	MS/MSD RPD				7.30
X92495/X92495 Dup. RPD					0.76

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Anions Analyses

Date Sampled : 8/11/94
Date Received : 8/12/94
Date Prepared : 8/12/94
Date Analyzed : 8/12/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit : 0.056 mg/L
Method : EPA 300.0

Evergreen Sample #	Client Sample ID	Matrix	Nitrate-N (mg/L)
X92570	MW-1	WATER	<0.056
X92571	MW-6	WATER	0.694
X92571 DUP	MW-6	WATER	0.696
X92572	CPT-32S	WATER	0.508
X92573	CPT-2S	WATER	<0.056
Method Blank 8/12/94			<0.056

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
X92571	MW-6 Matrix Spike	2.26	0.694	2.66	87.0
X92571	MW-6 Matrix Spike Dup.	2.26	0.694	2.62	85.2
	MS/MSD RPD				2.09
X92571/X92571 Dup. RPD					0.29

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Anions Analyses

Date Sampled : 8/8,9/94
Date Received : 8/10/94
Date Prepared : 8/10,11/94
Date Analyzed : 8/10,11/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit : 0.250 mg/L
Method : EPA 300.0

Evergreen Sample #	Client Sample ID	Matrix	Sulfate (mg/L)
X92394	MW-9	WATER	46.9
X92395	MW-4	WATER	3.67
X92396	MW-11	WATER	3.61
X92397	MW-5	WATER	1.32
X92399	CPT-2D	WATER	36.7
X92400	CPT-16D	WATER	24.5
X92401	CPT-16S	WATER	40.4
X92401 DUP	CPT-16S	WATER	39.8
X92402	MW-3	WATER	19.5
X92403	CPT-18S	WATER	14.5
X92404	CPT-18D	WATER	1.50
X92405	MW-2	WATER	2.49
X92406	CPT-8S	WATER	0.358
X92407	CPT-8D	WATER	66.9
X92408	CPT-10S	WATER	1.15
X92409	CPT-10D	WATER	49.6
X92410	CPT-9S	WATER	26.0
X92411	CPT-9D	WATER	37.6
X92412	CPT-11S	WATER	50.0
X92413	CPT-11D	WATER	21.1
Method Blank 8/10/94			<0.250
Method Blank 8/11/94			<0.250

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
X92401	CPT-16S Matrix Spike	10.0	40.4	51.0	106
X92401	CPT-16S Matrix Spike Dup.	10.0	40.4	50.5	101
	MS/MSD RPD				4.83
X92401/X92401 Dup. RPD					1.50

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Anions Analyses

Date Sampled : 8/10/94
Date Received : 8/11/94
Date Prepared : 8/11/94
Date Analyzed : 8/11/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit : 0.250 mg/L
Method : EPA 300.0

Evergreen Sample #	Client Sample ID	Matrix	Sulfate (mg/L)
X92489	CPT-22D	WATER	47.6
X92490	CPT-21D	WATER	55.8
X92491	CPT-50D	WATER	55.1
X92492	CPT-20D	WATER	<0.250
X92493	CPT-19D	WATER	<0.250
X92494	MW-7	WATER	90.0
X92495	MW-8	WATER	23.5
X92495 DUP	MW-8	WATER	23.5
X92496	MW-10	WATER	50.9
Method Blank 8/11/94			<0.250

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
X92495	MW-8 Matrix Spike	10.0	23.5	33.1	96.0
X92495	MW-8 Matrix Spike Dup.	10.0	23.5	32.5	90.0
	MS/MSD RPD				6.45
X92495/X92495 Dup. RPD					0.00

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Anions Analyses

Date Sampled : 8/11/94
Date Received : 8/12/94
Date Prepared : 8/12/94
Date Analyzed : 8/12/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit : 0.250 mg/L
Method : EPA 300.0

Evergreen Sample #	Client Sample ID	Matrix	Sulfate (mg/L)
X92570	MW-1	WATER	1.72
X92571	MW-6	WATER	39.9
X92571 DUP	MW-6	WATER	40.0
X92572	CPT-32S	WATER	44.8
X92573	CPT-2S	WATER	31.0
Method Blank 8/12/94			<0.250

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
X92571	MW-6 Matrix Spike	10.0	39.9	49.6	97.0
X92571	MW-6 Matrix Spike Dup.	10.0	39.9	49.9	100.0
	MS/MSD RPD				3.05
X92571/X92571 Dup. RPD					0.25

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Miscellaneous Analyses

Date Sampled : 8/9/94
Date Received : 8/10/94
Date Prepared : 8/12/94
Date Analyzed : 8/12/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit : 5.00 $mgCaCO_3/L$
Method : EPA 310.1

Evergreen Sample #	Client Sample ID	Matrix	Alkalinity ($mgCaCO_3/L$)
X92394	MW-9	Water	492
X92395	MW-4	Water	167
X92396	MW-11	Water	165
X92397	MW-5	Water	215
X92399	CPT-2D	Water	106
X92400	CPT-16D	Water	69.0
X92401	CPT-16S	Water	6.96
X92402	MW-3	Water	67.7
X92402 Dup	MW-3 Dup	Water	60.7
Method Blank 8/12/94			<5.00

Quality Assurance

	True Value ($mgCaCO_3/L$)	Result ($mgCaCO_3/L$)	% Recovery
Spex reference Minerals (8/12/94)	24.2	24.8	102
X92402/X92402 Dup RPD			10.9%

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Miscellaneous Analyses

Date Sampled : 8/5,6,8/94
Date Received : 8/10/94
Date Prepared : 8/12/94
Date Analyzed : 8/12/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit : 5.00 $mgCaCO_3/L$
Method : EPA 310.1

Evergreen Sample #	Client Sample ID	Matrix	Alkalinity ($mgCaCO_3/L$)
X92403	CPT-18S	Water	<5.00
X92404	CPT-18D	Water	124
X92405	MW-2	Water	233
X92406	CPT-8S	Water	165
X92407	CPT-8D	Water	5.20
X92408	CPT-10S	Water	266
X92409	CPT-10D	Water	27.9
X92410	CPT-9S	Water	17.7
X92411	CPT-9D	Water	109
X92412	CPT-11S	Water	9.02
X92412 Dup	CPT-11S Dup	Water	9.43
X92413	CPT-11D	Water	132
Method Blank 8/12/94			<5.00

X92412/X92412 Dup RPD 4.44%

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Miscellaneous Analyses

Date Sampled : 8/8,10/94
Date Received : 8/10,11/94
Date Prepared : 8/18/94
Date Analyzed : 8/18/94

Client Project ID. : Bolling AFB
Lab Project No. : 94-2981
Detection Limit Water: 5.00 $mgCaCO_3/L$
Method : EPA 310.1

Evergreen Sample #	Client Sample ID	Matrix	Alkalinity ($mgCaCO_3/L$)
X92415	SB-9M	Soil	<28.8*
X92489	CPT-22D	Water	22.8
X92490	CPT-21D	Water	17.7
X92490 Dup	CPT-21D Dup	Water	17.9
X92491	CPT-50D	Water	17.6
X92492	CPT-20D	Water	122
X92493	CPT-19D	Water	108
X92494	MW-7	Water	<5.00
X92495	MW-8	Water	<5.00
X92496	MW-10	Water	<5.00
Method Blank 8/18/94			<5.00

Quality Assurance

	True Value ($mgCaCO_3/L$)	Result ($mgCaCO_3/L$)	% Recovery
Spex reference Minerals (8/18/94)	24.2	22.3	92.0

X92490/X92490 Dup RPD 1.12%

* Result calculated on a dry weight basis, % moisture = 13.2, units = $mgCaCO_3/Kg$

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(303)425-6021

Miscellaneous Analyses

Date Sampled	: 8/11/94	Client Project ID.	: Bolling AFB
Date Received	: 8/12/94	Lab Project No.	: 94-2981
Date Prepared	: 8/18/94	Detection Limit	: 5.00 $mgCaCO_3/L$
Date Analyzed	: 8/18/94	Method	: EPA 310.1

Evergreen Sample #	Client Sample ID	Matrix	Alkalinity ($mgCaCO_3/L$)
X92570	MW-1	Water	142
X92571	MW-6	Water	46.7
X92572	CPT-32S	Water	49.4
X92573	CPT-2S	Water	94.3
Method Blank 8/18/94			<5.00

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HUFFMAN
LABORATORIES, INC.
Quality Analytical Services Since 1936
4630 Indiana Street • Golden, CO 80403

NO: CLP ANALYSIS RESULTS

Date: 09/09/94
Lab Name: Huffman Labs
Contact: Sue Zeller
Sample Matrix: soils Huffman Lab #: 252794

Client Smp#	Lab ID #	Element/ Compound	Dilution Factor	Results	Units	Prep Date	Analysis Date	Sample Size(g)	Method #	Instrument ID
SB-9D	25279401	TC	NA	0.19	%	NA	08/26/94	0.915	Leco CR12	#7
SB-9D	25279401	TC	NA	0.20	%	NA	08/26/94	1.941	Leco CR12	#7
SB-9S	25279402	TC	NA	0.06	%	NA	08/26/94	0.958	Leco CR12	#7
ST14-W05*	25279403	TC	NA	6.97	%	NA	08/26/94	1.089	Leco CR12	#7
SB-9D	25279401	CC	NA	0.04	%	NA	08/22/94	0.136	COU-02	#3
SB-9D	25279401	CC	NA	0.05	%	NA	08/22/94	0.389	COU-02	#3
SB-9S	25279402	CC	NA	<0.02	%	NA	08/22/94	0.173	COU-02	#3
ST14-W05*	25279403	CC	NA	6.69	%	NA	08/22/94	0.033	COU-02	#3
SB-9D	252	TOC	NA	0.15	%	NA	NA	NA	by calc	NA
SB-9D	252	TOC	NA	0.15	%	NA	NA	NA	by calc	NA
SB-9S	25279402	TOC	NA	0.06	%	NA	NA	NA	by calc	NA
ST14-W05*	25279403	TOC	NA	0.28	%	NA	NA	NA	by calc	NA

'8.4-9.1)

TC detection limit = 0.05%
CC detection limit = 0.02%
TOC detection limit = 0.05%

HUFFMAN
LABORATORIES, INC.
Quality Analytical Services Since 1936
4630 Indiana Street • Golden, CO 80403

SEP 1 3 1994

..ON-CLP ANALYSIS RESULTS
LABORATORY CONTROL STANDARD

Date: 09/09/94
Lab Name: Huffman Labs
Contact: Sue Zeller Huffman Lab #: 252794

LABORATORY CONTROL STANDARD

Lab ID #	Source	Element/ Compound	True Value	Found Value	% R	Units	Date	Method #	Instrument ID
LCS	BN 4384	TC	3.35	3.34	100	%	08/26/94	Leco CR12	#7
LCS	BN 4056	CC	11.33	11.29	100	%	08/22/94	COU-02	#3

SPIKE RECOVERY

Lab ID #	Source	Element/ Compound	True Value	Found Value	% R	Units	Date	Method #	Instrument ID
SPIKE	BN 3716	TC	13200	13015	99	ug C	08/26/94	Leco CR12	#7
SPIKE DUP	BN 3716	TC	15000	14315	95	ug C	08/26/94	Leco CR12	#7
SPIKE	BN 3716	CC	804	762	95	ug C	08/22/94	COU-02	#3
SPIKE DUP	BN 3716	CC	1312	1299	99	ug C	08/22/94	COU-02	#3

Evergreen

Post-it® Fax Note 7671	Date	# of pages ▶ 3
To Dan Medina	From Dave Maitland	
Co./Dept. Corp	Co Denver	
Phone #	Phone #	
Fax #	Fax #	

722450.08050

February 10, 1995

MR TODD WIEDEMEIER
PARSON ENGINEERING SCIENCE INC
1700 BROADWAY SUITE 900
DENVER CO 80290

Data Report : 95-0313
Client Project : BOLLING AFB

Dear Mr. Wiedemeier:

Enclosed are the analytical results for the samples shown in the Sample Log Sheet. The enclosed data have been reviewed for quality assurance. If you have any questions concerning the reported information, please contact Carl Smits, Vice President of Quality Assurance, or me.

Please Note: Samples marked for return on the Sample Log Sheet are considered hazardous, unsuitable for municipal disposal or were placed on hold at your request. Samples considered hazardous or unsuitable for municipal disposal will be returned to you immediately. Samples placed on hold will be returned and samples not considered hazardous will be disposed of one (1) month from the date of this letter.

The invoice for this work will be mailed to your Accounts Payable department shortly.

Thank you for using the services of Evergreen Analytical.

Sincerely,

Jack Barney
President

RECEIVED
FEB 13 1995

TM

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303)425-6021

Methane Data Report

Date Sampled : 01/26/95
Date Received : 01/27/95
Date Prepared : 02/09/95
Date Analyzed : 02/09/95

Client Project No.: Bolling AFB
Lab Project No. : 95-0313
Dilution Factor : see below
Method : RSKSOP-175
Matrix : Water

Evergreen Sample #	Client Sample #	Matrix	Concentration mg/L	EDL* mg/L
MB020995	Method Blank	Water	U	0.001 (DF=1)
x02516	MW-3	Water	1.37	0.005 (DF=5)
x02517	MW-4	Water	0.005	0.001 (DF=1)
x02518	MW-6	Water	U	0.001 (DF=1)
x02519	MW-7	Water	U	0.001 (DF=1)
x02520	MW-8	Water	0.003	0.001 (DF=1)
x02521	MW-9	Water	U	0.001 (DF=1)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Estimated Detection Limit.
B = Compound also found in the blank, blank data should be compared.
* = Indicates the Estimated Detection Limit.
E = Extrapolated value.

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303)425-6021

Methane Data Report

		Client Project No.	: Bolling AFB
Date Sampled	: 01/26/95	Lab Project No.	: 95-0313
Date Received	: 01/27/95	Dilution Factor	: see below
Date Prepared	: 02/09/95	Method	: RSKSOP-175
Date Analyzed	: 02/09/95	Matrix	: Water

Evergreen Sample #	Client Sample #	Matrix	Concentration mg/L	EDL* mg/L
MB020995	Method Blank	Water	U	0.001 (DF=1)
x02522	MW-10	Water	U	0.001 (DF=1)
x02523	CPT-19	Water	0.31	0.001 (DF=1)
x02524	CPT-22	Water	U	0.001 (DF=1)
x02525	MW-12	Water	U	0.001 (DF=1)
x02526	Fblk	Water	U	0.001 (DF=1)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Estimated Detection Limit.
B = Compound also found in the blank, blank data should be compared.
* = Indicates the Estimated Detection Limit.
E = Extrapolated value.

Analyst

Approved

Evergreen

February 10, 1995

MR TODD WIEDEMEIER
PARSON ENGINEERING SCIENCE INC
1700 BROADWAY SUITE 900
DENVER CO 80290

Data Report : 95-0313
Client Project : BOLLING AFB

Dear Mr. Wiedemeier:

Enclosed are the analytical results for the samples shown in the Sample Log Sheet. The enclosed data have been reviewed for quality assurance. If you have any questions concerning the reported information, please contact Carl Smits, Vice President of Quality Assurance, or me.

Please Note: Samples marked for return on the Sample Log Sheet are considered hazardous, unsuitable for municipal disposal or were placed on hold at your request. Samples considered hazardous or unsuitable for municipal disposal will be returned to you immediately. Samples placed on hold will be returned and samples not considered hazardous will be disposed of one (1) month from the date of this letter.

The invoice for this work will be mailed to your Accounts Payable department shortly.

Thank you for using the services of Evergreen Analytical.

Sincerely,

Jack Barney
President

RECEIVED
FEB 13 1995

™

Evergreen Analytical Sample Log Sheet

Project # 95-0313

Date(s) Sampled: 01/26/95 COC

Date Due: 02/10/95

Date Received: 01/27/95 1030

Holding Time(s): 02/09/95

Client Project I.D. BOLLING AFB

Rush STANDARD

Client: PARSONS ENGINEERING SCIENCE, INC.

Address: 1700 BROADWAY, SUITE 900
DENVER, CO 80290

Contact: TODD WIEDEMEIER

Client P.O. 722450.08050

Phone #831-8100 Fax #831-8208

Shipping Charges 5.00

E.A. Cooler # N/A

Airbill # FED.EX. 1952788390

Custody Seal Intact? Y
Cooler X Bottles ___
COC Present Y
Sample Tags Present? Y
Sample Tags Listed? Y
Sample(s) Sealed? Y

Special Invoicing/Billing

Special Instructions

Lab ID #	Client ID#	Analysis	Mtx	Btl	Loc
[illegible]516A	MW-3	METHANE	W	40V	#2
K02517A	MW-4	METHANE	W	40V	#2
K02518A	MW-6	METHANE	W	40V	#2
K02519A	MW-7	METHANE	W	40V	#2
K02520A	MW-8	METHANE	W	40V	#2
K02521A	MW-9	METHANE	W	40V	#2
K02522A	MW-10	METHANE	W	40V	#2
K02523A	CPT-19	METHANE	W	40V	#2
K02524A	CPT-22	METHANE	W	40V	#2
K02525A	MW-12	METHANE	W	40V	#2
K02526A	Fblk	METHANE	W	40V	#2
K02527A	TRIP BLANK	HOLD	W	40V	#2

R=Sample to be returned

Route To GC/MS ___ GC 2 Metals ___ Wet Chem ___ SxPrep ___ Acctg 1

SxRec C QA/QC C Sales C File Orig

Page 1 of 1 Page(s)

Custodian/Date: Kam 1/27/95

Evergreen Analytical Inc.

4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY PARSONS ENG. SCIENCE, INC
ADDRESS 10521 ROSEHAVEN ST
CITY FAIRFAX STATE VA ZIP 22030
PHONE# 703/591-7575 FAX # 703/591-1305 FAX RESULTS Y / N

CLIENT CONTACT (print) AFCEE - Bolling AFB
PROJECT I.D. 722450.08050
P.O. #
TURNAROUND REQUIRED*
*expedited turnaround subject to additional fee

Sampler Name (signature)
(print) STEVEN GLENNIE
Evergreen Analytical Cooler No.
Cooler Received

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	METHANE	EAL Sample No.
MW-3	1-26-95	1010	3	✓																3	
MW-4	1-26-95	1020	3	✓																3	
MW-6	1-26-95	1035	3	✓																3	
MW-7	1-26-95	1055	3	✓																3	
MW-8	1-26-95	1105	3	✓																3	
MW-9	1-26-95	1150	3	✓																3	
MW-10	1-26-95	1210	3	✓																3	
CPT-19B SPG	1-26-95	1420	3	✓																3	
CPT-22	1-26-95	1515	3	✓																3	
MW-12	1-2695	1330	3	✓																3	
HT:																					Location
DD:																					Container Size

EAL use only
Do not write in shaded area

EAL
Project #
Custodian

Instructions: RESULTS TO: PARSON'S ES
DENVER CO
ATTN: TODD WIEDEMEIER

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
	1-26-95 1715	K. Middleton	1/27/95 1030				

Evergreen Analytical Inc.

4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY PARSONS ENG. SCIENCE
ADDRESS 10521 ROSEHAVEN ST
CITY FAIRFAX STATE VA ZIP 22030
PHONE# 703-591-7575 FAX # 703-591-1305 FAX RESULTS Y / N

CLIENT CONTACT (print) AFCEE - Bolling AFB
PROJECT I.D. 722450, 08050
P.O. #
TURNAROUND REQUIRED*
*expedited turnaround subject to additional fee

Sampler Name:
(signature)
(print) STEVEN GLENNIE
Evergreen Analytical Cooler No.
Cooler Received

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	METHANE	EAL Sample No.
Fblk	1-26-95	1445	3	✓																3	
HT:																					Location
DD:																					Container Size

Instructions: RESULTS TO: PARSONS ES
DENVER CO
ATTN: TODD WIEDEMEIER

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
[signature]	1/26/95 1715	K. Middleton	1/27/95 1030				

Evergreen Analytical Sample Receipt/Check-in Record

Date & Time Rec'd: 1/27/95 1030 Shipped Via: ~~UPS~~ (Airbill # if applicable)

Client : Parsons Eng. Science Inc.

Client Project ID(s): 722450.08050

EAL Project #(s): 95-0313 EAL Cooler(s): (Y) N

Cooler#	client								
Ice packs	(Y)	N	Y	N	Y	N	Y	N	Y	N
Temperature °C	6								

	Y	N	N/A
1. Custody seal(s) present:	✓		
Seals on cooler intact	✓		
Seals on bottle intact		✓	
2. Chain of Custody present:	✓		
3. Containers broken or leaking: (Comment on COC if Y)		✓	
4. Containers labeled:	✓		
5. COC agrees w/ bottles received: (Comment on COC if N)	✓		
6. COC agrees w/ labels: (Comment on COC if N)	✓		
7. Headspace in VOA vials-waters only (comment on COC if Y)		✓	
8. VOA samples preserved:		✓	
9. pH measured on metals, cyanide or phenolics*:		✓	
List discrepancies			
*Non-EAL provided containers only, water samples only.			
10. Metal samples present:		✓	
Total _____ , Dissolved _____			
D or PD to be filtered:			
T,TR,D,PD to be Preserved:			
11. Short holding times:		✓	
Specify parameters			
12. Multi-phase sample(s) present:		✓	
13. COC signed w/ date/time:	✓		

Comments:

(Additional comments on back)

Custodian Signature/Date: K. Middleton 1/27/95

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303)425-6021

Methane Data Report

		Client Project No.	: Bolling AFB
Date Sampled	: 01/26/95	Lab Project No.	: 95-0313
Date Received	: 01/27/95	Dilution Factor	: see below
Date Prepared	: 02/09/95	Method	: RSKSOP-175
Date Analyzed	: 02/09/95	Matrix	: Water

Evergreen Sample #	Client Sample #	Matrix	Concentration mg/L	EDL* mg/L
MB020995	Method Blank	Water	U	0.001 (DF=1)
x02516	MW-3	Water	1.37	0.005 (DF=5)
x02517	MW-4	Water	0.005	0.001 (DF=1)
x02518	MW-6	Water	U	0.001 (DF=1)
x02519	MW-7	Water	U	0.001 (DF=1)
x02520	MW-8	Water	0.003	0.001 (DF=1)
x02521	MW-9	Water	U	0.001 (DF=1)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Estimated Detection Limit.
B = Compound also found in the blank, blank data should be compared.
* = Indicates the Estimated Detection Limit.
E = Extrapolated value.

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303)425-6021

Methane Data Report

		Client Project No.	: Bolling AFB
Date Sampled	: 01/26/95	Lab Project No.	: 95-0313
Date Received	: 01/27/95	Dilution Factor	: see below
Date Prepared	: 02/09/95	Method	: RSKSOP-175
Date Analyzed	: 02/09/95	Matrix	: Water

Evergreen Sample #	Client Sample #	Matrix	Concentration mg/L	EDL* mg/L
MB020995	Method Blank	Water	U	0.001 (DF=1)
x02522	MW-10	Water	U	0.001 (DF=1)
x02523	CPT-19	Water	0.31	0.001 (DF=1)
x02524	CPT-22	Water	U	0.001 (DF=1)
x02525	MW-12	Water	U	0.001 (DF=1)
x02526	Fblk	Water	U	0.001 (DF=1)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Estimated Detection Limit.
B = Compound also found in the blank, blank data should be compared.
* = Indicates the Estimated Detection Limit.
E = Extrapolated value.

Analyst

Approved

Evergreen Analytical Laboratory

CASE NARRATIVE

Evergreen Analytical Laboratory (EAL) Projects: 96-1794, 96-1796

Parsons Engineering Science, Inc. (PES) Project : Bolling AFB
729691.08110

Sample Receipt

Groundwater samples were received on June 1 and 3, 1996 at EAL for analysis under subcontract 722450.SC02. Refer to the EAL Check-in Record for specific information regarding the condition of samples upon receipt. Refer to the EAL Work Order Summary for specific log-in information and cross-reference of EAL and PES sample identifications.

Data Package

All data are reported in one comprehensive package that is segregated based upon EAL project number. Each EAL project represents a group of samples received on a given day. The EAL Sample Work Order summarizes the samples represented in each EAL project.

A separate invoice for each EAL project number will be generated.

Quality assurance data may overlap from one EAL project to another. All required matrix spike/matrix spike duplicate (MS/MSD) and laboratory control samples (LCS) were analyzed when required and also are included in the data package.

BTEX, Method SW8020/Total Volatile Hydrocarbons TVH, Method SW8015M

All samples were analyzed for BTEX/TVH within holding time.

Several samples were analyzed at dilutions ranging from a dilution factor of 10 to 500 due to elevated levels of contaminants of interest. The reporting limits have been adjusted accordingly.

There are no quality control anomalies to report.

Methane, Method RSKSOP175M
All samples submitted for Methane analysis were analyzed within holding time.

Several samples were analyzed at dilutions ranging from a dilution factor of 50 to 100 due to elevated levels of methane present. The reporting limits were increased accordingly.

There are no quality control anomalies to report.

General Chemistry
There were no quality control anomalies to report for Anions by Method 300.0 or Alkalinity by Method 310.1 with the following exception: samples for NO_2 and NO_3 analysis received on June 3 in EAL project 96-1796 were received outside of holding time. The instructions on the chain of custody indicated to analyze regardless.

Disk Deliverables
The disk deliverables are included with the hard copy data package. MS/MSD and laboratory duplicate samples are not included on the disk. A PES requested duplicate for sample 20S BTEX/TVH is included on the disk. Please note that blank spaces in the laboratory detection limit and/or practical quantitation limit (PQL) column indicate that there is no detection limit or PQL for that analyte.

A hard copy of each spreadsheet from the diskette is included. The name for each spreadsheet is located in the top left corner of the first page of each printout.

Patricia A. McClellan, Program Manager
6/19/96

Evergreen Analytical, Inc.

96-1794

WORK ORDER Summary

03-Jun-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.08110 Bolling AFB

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-1794-01G	21S	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4		Water	CR4	30-May-96	01-Jun-96	17-Jun-96	01-Jun-96
96-1794-02H	21D	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4						17-Jun-96	01-Jun-96
96-1794-03H	22D	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4						17-Jun-96	01-Jun-96
96-1794-04H	23D	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4				31-May-96		17-Jun-96	02-Jun-96
96-1794-05H	20D	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4						17-Jun-96	02-Jun-96
96-1794-06H	20S	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4						17-Jun-96	02-Jun-96
96-1794-07H	19S	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4						17-Jun-96	02-Jun-96
96-1794-08H	19D	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4						17-Jun-96	02-Jun-96
96-1794-09H	24D	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4						17-Jun-96	02-Jun-96
96-1794-10H	MW-8	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4						17-Jun-96	02-Jun-96
96-1794-11H	MW-7	ANIONS by ION CHROMATOGRAPHY Cl, NO2, NO3, SO4						17-Jun-96	02-Jun-96
96-1794-01A	21S	BTEX + TMB/TVPH (Parsons List)			2	30-May-96		10-Jun-96	13-Jun-96
96-1794-02A	21D	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	13-Jun-96
96-1794-03A	22D	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	13-Jun-96
96-1794-04A	23D	BTEX + TMB/TVPH (Parsons List)				31-May-96		10-Jun-96	14-Jun-96
96-1794-05A	20D	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	14-Jun-96
96-1794-06A	20S	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	14-Jun-96
96-1794-06B		BTEX + TMB/TVPH (Parsons List)						10-Jun-96	14-Jun-96
96-1794-06C		BTEX + TMB/TVPH (Parsons List)						10-Jun-96	14-Jun-96

= Special list. See sample comments or test information.
HT = Holding Time expiration date.

Evergreen Analytical, Inc.

96-1794

WORK ORDER Summary

03-Jun-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.08110 Bolling AFB

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-1794-06D	20S	BTEX + TMB/TVPH (Parsons List)		Water	2	31-May-96	01-Jun-96	10-Jun-96	14-Jun-96
96-1794-07A	19S	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	14-Jun-96
96-1794-08A	19D	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	14-Jun-96
96-1794-09A	24D	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	14-Jun-96
96-1794-10A	MW-8	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	14-Jun-96
96-1794-11A	MW-7	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	14-Jun-96
96-1794-12A	Trip Blank	BTEX + TMB/TVPH (Parsons List)						10-Jun-96	
96-1794-01E	21S	Methane				30-May-96		17-Jun-96	13-Jun-96
96-1794-02E	21D	Methane						17-Jun-96	13-Jun-96
96-1794-03E	22D	Methane						17-Jun-96	13-Jun-96
96-1794-04E	23D	Methane				31-May-96		17-Jun-96	14-Jun-96
96-1794-05E	20D	Methane						17-Jun-96	14-Jun-96
96-1794-06E	20S	Methane						17-Jun-96	14-Jun-96
96-1794-07E	19S	Methane						17-Jun-96	14-Jun-96
96-1794-08E	19D	Methane						17-Jun-96	14-Jun-96
96-1794-09E	24D	Methane						17-Jun-96	14-Jun-96
96-1794-10E	MW-8	Methane						17-Jun-96	14-Jun-96
96-1794-11E	MW-7	Methane						17-Jun-96	14-Jun-96
96-1794-02I	21D	TOTAL ALKALINITY			CR4	30-May-96		17-Jun-96	13-Jun-96
96-1794-03I	22D	TOTAL ALKALINITY						17-Jun-96	13-Jun-96

= Special list. See sample comments or test information.
HT = Holding Time expiration date.

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Hagens Es
ADDRESS 1700 Broadway, Ste 900
CITY Denver STATE CO ZIP 80290
PHONE# 303-831-8100 FAX # 303-831-9208 FAX RESULTS Y / (N)

CLIENT CONTACT (print) Dave Matrix
PROJECT I.D. 724691.0211D Boiling AFB
EAL. QUOTE # _____ P.O.# _____
TURNAROUND REQUIRED* ☐ STD (2 wks) ☐ STD UST (3 day)
☐ Other (Specify) _____
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Jessica Hoffer
(print) S Hoffer J Jones
Evergreen Analytical Cooler No. 11
Cooler Received _____

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	ANALYSIS REQUESTED: TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Methane	C, NO3, NO2, SO4	Alkalinity	EAL use only Do not write in shaded area: EAL Sample No.
21S	5/30/96	1700	7	X										X	X					X	X		01 A/B/C/D/E/F/G
21D	5/30/96	1430	9	X										X	X					X	X	X	02 ↓ Light
22D	5/30/96	1615	9	X										X	X					X	X	X	03 ↓ ↓
23D	5/31/96	0545	8	X										X	X					X	X		04 A/B/C/D/E/F/G/H
20D	5/31/96	0545	8	X										X	X					X	X		05
20S *	5/31/96	1000	8	X										X	X					X	X		06
19S	5/31/96	1200	8	X										X	X					X	X		07
19D	5/31/96	1140	8	X										X	X					X	X		08
24D	5/31/96	1140	8	X										X	X					X	X		09
MW-8	5/31/96	1430	8	X										X	X					X	X		010
HT:														A/B	C/D					E/F/G	I		Location 2, CR4
DD:																							Container Size 40v, 125, 250

Instructions: Note: All VOAs have HCl in them even if not labeled so!
* Please sample both BTEX VOAs and both TVH VOAs! Thank you → Just sample and report both values for ~~each~~ 20S!

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Jessica S Hoffer	05/31/96	FSDSX	05/31/96				6/1/96

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY SAA
ADDRESS SAA
CITY _____ STATE _____ ZIP _____
PHONE# _____ FAX # _____ FAX RESULTS Y / N

CLIENT CONTACT (print) SAA
PROJECT I.D. _____
EAL. QUOTE # _____ P.O.# _____
TURNAROUND REQUIRED* ☐ STD (2 wks) ☐ STD UST (3 day)
☐ Other (Specify) _____
*expedited turnaround subject to additional fee

Sampler Name:
(signature) _____
(print) _____
Evergreen Analytical Cooler No. 11
Cooler Received _____

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Grounds (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	ANALYSIS REQUESTED: TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Methane	NO_3, NO_2, Cl, SO_4^{2-}	EAL Sample No.
MW-7	5/31/GL	15:45	8	X										X		X				X	X	011A/B/C/D/E/F/G/H
Trip Blank	-	-	1	X										X		X						012A
HT:																						Location 2, C124
DD:																						Container Size 40y, 250y, 125y

EAL use only
Do not write in shaded area

EAL Project # 96-1794
Custodian J

Instructions:

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
[signature]	5/31	FEDEX	5/31				

Evergreen Analytical Sample Receipt/Check-in Record

Date & Time Rec'd: 6/1/16 1000 Shipped Via: FEDEX 553416181
(Airbill # if applicable)

Client : Parsons ES

Client Project ID(s): 729691.08110 BAFB

EAL Project #(s): 96- EAL Cooler(s): (Y) N

Cooler#	11								
Ice packs	(Y)	N	Y	N	Y	N	Y	N	Y	N
Temperature °C	5								

	Y	N	N/A
1. Custody seal(s) present:	✓		
Seals on cooler intact	✓		
Seals on bottle intact			✓
2. Chain of Custody present:	✓		
3. Samples Radioactive: (Comment on COC if >0.5mr/h)		✓	
4. Containers broken or leaking: (Comment on COC if Y)		✓	
5. Containers labeled:	✓		
6. COC agrees w/ bottles received: (Comment on COC if N)	✓		
7. COC agrees w/ labels: (Comment on COC if N)	✓		
8. Headspace in vials-waters only: (Comment on COC if Y)		✓	
9. VOA samples preserved:	✓		
10. pH measured on metals, cyanide or phenolics*:			✓
List discrepancies			
11. Metal samples present:		✓	
Total ____ , Dissolved ____ , TCLP ____			
D or PD to be filtered:			
T,TR,D,PD to be Preserved:			
12. Short holding times:		✓	
Specify parameters			
13. Multi-phase sample(s) present:		✓	
14. COC signed w/ date/time:	✓		

*Non-EAL provided containers only, water samples only.

Comments:

(Additional comments on back)

Custodian Signature/Date: JB

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB060396-W	Client Project Number	: 729691.08110 Bolling AF
Date Prepared	: 6/3/96	Lab Work Order	: 96-1794
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVBX0603003

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/3/96	U	0.1	mg/L
Benzene	71-43-2	6/3/96	U	0.4	ug/L
Toluene	108-88-3	6/3/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/3/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/3/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/3/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/3/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/3/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/3/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/3/96	U	0.5	ug/L
FID Surrogate Recovery:		92%		70%-130%	(Limits)
PID Surrogate Recovery:		96%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K Hollman
Analyst

Approved

TVBP1794.XLS; 6/5/96; 1

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB060496-W	Client Project Number	: 729691.08110 Bolling AFB
Date Prepared	: 6/4/96	Lab Work Order	: 96-1794
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVBX0603041

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	U	0.1	mg/L
Benzene	71-43-2	6/4/96	U	0.4	ug/L
Toluene	108-88-3	6/4/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/4/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	U	0.5	ug/L
FID Surrogate Recovery:		120%		70%-130%	(Limits)
PID Surrogate Recovery:		102%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

Approved

TVBP1794.XLS; 6/5/96; 14

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 21S	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-01	Lab Work Order	: 96-1794
Date Sampled	: 5/30/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603012
Date Prepared	: 6/3/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/3/96	U	0.1	mg/L
Benzene	71-43-2	6/3/96	1.3	0.4	ug/L
Toluene	108-88-3	6/3/96	0.6	0.4	ug/L
Chlorobenzene	108-90-7	6/3/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/3/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/3/96	0.5	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/3/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/3/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/3/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/3/96	U	0.5	ug/L
FID Surrogate Recovery:		114%		70%-130%	(Limits)
PID Surrogate Recovery:		103%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

A. McCall
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 21D	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-02	Lab Work Order	: 96-1794
Date Sampled	: 5/30/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603023,45
Date Prepared	: 6/3,4/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		MB060496-W
PID Dilution Factor	: 1.0, 10		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	1.5	0.1	mg/L
Benzene	71-43-2	6/4/96	430	4.0	ug/L
Toluene	108-88-3	6/4/96	7.6	0.4	ug/L
Chlorobenzene	108-90-7	6/4/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	4.9	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	0.9	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	0.5	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	2.2	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	7.4	0.5	ug/L
FID Surrogate Recovery:		122%		70%-130%	(Limits)
PID Surrogate Recovery:		105%, 103%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 22D	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-03	Lab Work Order	: 96-1794
Date Sampled	: 5/30/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603024,46
Date Prepared	: 6/3,4/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		MB060496-W
PID Dilution Factor	: 1.0, 10		

Compound Name	Cas Number	Analysis Date	Sample Concentration		RL	Units
TVH-Gasoline	----	6/4/96	2.3		0.1	mg/L
Benzene	71-43-2	6/4/96	470		4.0	ug/L
Toluene	108-88-3	6/4/96	1.1		0.4	ug/L
Chlorobenzene	108-90-7	6/4/96		U	0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	7.0		0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	5.8		0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	1.0		0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96		U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	2.3		0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	13		0.5	ug/L
FID Surrogate Recovery:		121%			70%-130%	(Limits)
PID Surrogate Recovery:		104%,103%			70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
= Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hallman
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 23D	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-04	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603048
Date Prepared	: 6/4/96	Method Blank	: MB060496-W
FID Dilution Factor	: 20		
PID Dilution Factor	: 20		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	14	2.0	mg/L
Benzene	71-43-2	6/4/96	490	8.0	ug/L
Toluene	108-88-3	6/4/96	180	8.0	ug/L
Chlorobenzene	108-90-7	6/4/96	U	8.0	ug/L
Ethyl Benzene	100-41-4	6/4/96	2000	8.0	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	710	8.0	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	150	8.0	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	510	8.0	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	87	8.0	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	120	10	ug/L
FID Surrogate Recovery:		119%		70%-130%	(Limits)
PID Surrogate Recovery:		102%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 20D	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-05	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603051
Date Prepared	: 6/4/96	Method Blank	: MB060496-W
FID Dilution Factor	: 20		
PID Dilution Factor	: 20		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	13	2.0	mg/L
Benzene	71-43-2	6/4/96	450	8.0	ug/L
Toluene	108-88-3	6/4/96	180	8.0	ug/L
Chlorobenzene	108-90-7	6/4/96	U	8.0	ug/L
Ethyl Benzene	100-41-4	6/4/96	1900	8.0	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	700	8.0	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	140	8.0	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	500	8.0	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	80	8.0	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	120	10	ug/L
FID Surrogate Recovery:		123%		70%-130%	(Limits)
PID Surrogate Recovery:		106%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

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RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 20S	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-06A	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603038
Date Prepared	: 6/4/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	0.1	0.1	mg/L
Benzene	71-43-2	6/4/96	1.5	0.4	ug/L
Toluene	108-88-3	6/4/96	1.0	0.4	ug/L
Chlorobenzene	108-90-7	6/4/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	7.5	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	1.0	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6		U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	U	0.5	ug/L
FID Surrogate Recovery:		116%		70%-130%	(Limits)
PID Surrogate Recovery:		102%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: Sediment in VOA.

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
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RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K Hollman
Analyst

Approved

TVBP1794.XLS; 6/5/96; 7

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 20S	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-06C	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603043
Date Prepared	: 6/4/96	Method Blank	: MB060496-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	U	0.1	mg/L
Benzene	71-43-2	6/4/96	0.6	0.4	ug/L
Toluene	108-88-3	6/4/96	0.5	0.4	ug/L
Chlorobenzene	108-90-7	6/4/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	5.7	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	1.8	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	1.3	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	U	0.5	ug/L
ID Surrogate Recovery:		123%		70%-130%	(Limits)
PID Surrogate Recovery:		103%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: No sediment in VOA.

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

P. McClell
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 19S	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-07	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603025
Date Prepared	: 6/3/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	0.2	0.1	mg/L
Benzene	71-43-2	6/4/96	14	0.4	ug/L
Toluene	108-88-3	6/4/96	6.5	0.4	ug/L
Chlorobenzene	108-90-7	6/4/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	11	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	7.9	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	0.5	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	U	0.5	ug/L
FID Surrogate Recovery:		120%		70%-130%	(Limits)
PID Surrogate Recovery:		106%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = *Extrapolated value. Value exceeds calibration range.*
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = *Reporting Limit.*
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

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Analyst

Ann McClell
Approved

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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 19D	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-08	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603034,49
Date Prepared	: 6/3,4/1996	Method Blank	: MB060396-W
FID Dilution Factor	: 50		MB060496-W
PID Dilution Factor	: 10, 50		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	31	5.0	mg/L
Benzene	71-43-2	6/4/96	1400	20	ug/L
Toluene	108-88-3	6/4/96	700	20	ug/L
Chlorobenzene	108-90-7	6/4/96	U	4.0	ug/L
Ethyl Benzene	100-41-4	6/4/96	1800	20	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	6000	20	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	250	4.0	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	1100	20	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	340	4.0	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	130	5.0	ug/L
FID Surrogate Recovery:		121%		70%-130%	(Limits)
PID Surrogate Recovery:		103%,102%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

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Analyst

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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: 24D	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-09	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603035,50
Date Prepared	: 6/3,4/96	Method Blank	: MB060396-W
FID Dilution Factor	: 50		MB060496-W
PID Dilution Factor	: 10, 50		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	32	5.0	mg/L
Benzene	71-43-2	6/4/96	1600	20	ug/L
Toluene	108-88-3	6/4/96	750	20	ug/L
Chlorobenzene	108-90-7	6/4/96	U	4.0	ug/L
Ethyl Benzene	100-41-4	6/4/96	1800	20	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	6100	20	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	260	4.0	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	1100	20	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	350	4.0	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	140	5.0	ug/L
ID Surrogate Recovery:		120%		70%-130%	(Limits)
PID Surrogate Recovery:		104%,102%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

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TVBP1794.XLS; 6/5/96; 10

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: MW-8	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-10	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603026
Date Prepared	: 6/3/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	U	0.1	mg/L
Benzene	71-43-2	6/4/96	U	0.4	ug/L
Toluene	108-88-3	6/4/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/4/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	U	0.5	ug/L
FID Surrogate Recovery:		119%		70%-130%	(Limits)
PID Surrogate Recovery:		105%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

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TVBP1794.XLS; 6/5/96; 11

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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: MW-7	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-11	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603030
Date Prepared	: 6/3/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	U	0.1	mg/L
Benzene	71-43-2	6/4/96	U	0.4	ug/L
Toluene	108-88-3	6/4/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/4/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	U	0.5	ug/L
FID Surrogate Recovery:		119%		70%-130%	(Limits)
PID Surrogate Recovery:		105%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

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Analyst

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EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: Trip Blank	Client Project Number	: 729691.08110 Bolling AFB
Lab Sample Number	: 96-1794-12	Lab Work Order	: 96-1794
Date Sampled	: NA	Matrix	: WATER
Date Received	: 5/31/96	Lab File Number(s)	: TVBX0603010
Date Prepared	: 6/3/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/3/96	U	0.1	mg/L
Benzene	71-43-2	6/3/96	U	0.4	ug/L
Toluene	108-88-3	6/3/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/3/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/3/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/3/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/3/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/3/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/3/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/3/96	U	0.5	ug/L
FID Surrogate Recovery:		100%		70%-130%	(Limits)
PID Surrogate Recovery:		99%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = *Total Volatile Hydrocarbons.*

K. Hollman
Analyst

PMcClella
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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS060396-GW	Matrix	: WATER
Date Prepared	: 6/3/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 6/4/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVBX0603017		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	1.93	96.5	82 - 133
Surrogate Recovery:		122%		70 - 128

QUALIFIERS
B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 5/21/96 for TVHBTEX2. KSH

K. Holman
Analyst

A. McClellan
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St.
Wheat Ridge, CO 80033
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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS060396-BW	Dilution Factor	: 1.00
Date Extracted/Prepared	: 6/3/96	Method	: 602/8020
Date Analyzed	: 6/4/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVBX0604018

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	18.9	94.5	75 - 119
Toluene	108-88-3	18.9	94.5	78 - 121
Chlorobenzene	108-90-7	18.4	92.0	79 - 119
Ethyl Benzene	100-41-4	18.8	94.0	80 - 123
m,p-Xylene	108-38-3	37.7	94.3	79 - 124
o-Xylene	106-42-3 95-47-6	19.1	95.5	78 - 122
MTBE	1634-04-4	22.4	112.0	50 - 150
1,3,5-Trimethylbenzene	108-67-8	17.1	85.5	71 - 127
1,2,4-Trimethylbenzene	95-63-6	18.7	93.5	76 - 118
1,2,3-Trimethylbenzene	526-73-8	23.0	115.0	75 - 131
1,2,3,4-Tetramethylbenzene	488-23-3	21.4	107.0	67 - 138
Surrogate Recovery:		106%		70 - 128

NOTES: m,p-xylene = 40.0 ppb spike.

QUALIFIERS:
E = Extrapolated value. Value exceeds that of the calibration range.
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
= Not available/Not analyzed.
= Limits established 5/21/96 for TVHBTEX2. KSH

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Analyst

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EVERGREEN ANALYTICAL, INC.
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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS060496-W	Matrix	: WATER
Date Prepared	: 6/4/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 6/5/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVBX0603057		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	1.92	96.0	82 - 133
Surrogate Recovery:		125%		70 - 128

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 5/21/96 for TVHBTEX2. KSH

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EVERGREEN ANALYTICAL, INC.
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Wheat Ridge, CO 80033
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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS060496-BW	Dilution Factor	: 1.00
Date Extracted/Prepared	: 6/4/96	Method	: 602/8020
Date Analyzed	: 6/5/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVBX0603058

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	19.1	95.5	75 - 119
Toluene	108-88-3	19.0	95.0	78 - 121
Chlorobenzene	108-90-7	18.6	93.0	79 - 119
Ethyl Benzene	100-41-4	19.1	95.5	80 - 123
m,p-Xylene	108-38-3 106-42-3	38.2	95.5	79 - 124
o-Xylene	95-47-6	19.3	96.5	78 - 122
MTBE	1634-04-4	NA	NA	50 - 150
1,3,5-Trimethylbenzene	108-67-8	17.2	86.0	71 - 127
1,2,4-Trimethylbenzene	95-63-6	18.8	94.0	76 - 118
1,2,3-Trimethylbenzene	526-73-8	23.0	115.0	75 - 131
1,2,3,4-Tetramethylbenzene	488-23-3	21.3	106.5	67 - 138
Surrogate Recovery:		106%		70 - 128

NOTES: m,p-xylene = 40.0 ppb spike.

QUALIFIERS:
E = Extrapolated value. Value exceeds that of the calibration range.
U = Compound analyzed for, but not detected.
B = Compound found in blank and sample. Compare blank and sample data.
NA = Not available/Not analyzed.
= Limits established 5/21/96 for TVHBTEX2. KSH

K Hollman
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB060796	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 6/7/96	Lab Work Order	: 96-1794
Date Analyzed	: 6/7/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175
		Matrix	: Water
		Lab File No.	: GAS0607002

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
"" = Not Available/Not Applicable.

Analyst

Approved

AF1794.XLS

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSK-175 Gas Method
Methane LCS Report Form

LCS No.	: LCS060796	EPA Method No.	: RSKSOP-175
Date Prepared	: 6/7/96	Matrix	: Water
Date Analyzed	: 6/7/96	Method Blank	: GB060796
E.A. LCS Source No.	: 1719	Lab File No.	: GAS0607009

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	404	81	67-85

Spike Recovery: 0 out of (1) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available.

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EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Methane Report Form

Client Sample Number	: 21S	Client Project No.	: Bolling AFB
Lab Sample Number	: 96-1794-01	Lab Work Order	: 96-1794
Date Sampled	: 5/30/96	Dilution Factor	: 1.00
Date Received	: 6/1/96	Method	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	Matrix	: Water
Date Analyzed	: 6/7/96	Lab File No.	: GAS0607015

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.021	0.002

nperature	: 71.8 F	Saturation	Meth	0.004997483
Amount Injected	: 0.5 ml	Concentration		
Total Volume of Sample	: 43 ml	Concentration	Meth	0.015751898
Head space created	: 4 ml	in Head Space		
Methane Area	: 116.214 ug			

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

T. Hollman
Analyst

Approved

AF1794.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: 21D	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-02	**Lab Work Order**	: 96-1794
Date Sampled	: 5/30/96	**Dilution Factor**	: 50.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607016

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	2.1	0.1

nperature	: 71.9 F	Saturation	Meth	0.499178557
Amount Injected	: 0.01 ml	Concentration		
Total Volume of Sample	: 43 ml	Concentration	Meth	1.573097685
Head space created	: 4 ml	in Head Space		
Methane Area	: 232.163 ug			

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hollman
Analyst

P. McCleb
Approved

AF1794.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: 22D	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-03	**Lab Work Order**	: 96-1794
Date Sampled	: 5/30/96	**Dilution Factor**	: 50.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607017

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	4.0	0.1

Temperature	: 72 F	Saturation Concentration	Meth	0.956661966
Amount Injected	: 0.01 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	3.014231088
Head space created	: 4 ml			
Methane Area	: 444.934 ug			

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hollman
Analyst

P. McClell
Approved

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: 23D	Client Project No.	: Bolling AFB
Lab Sample Number	: 96-1794-04	Lab Work Order	: 96-1794
Date Sampled	: 5/31/96	Dilution Factor	: 100.00
Date Received	: 6/1/96	Method	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	Matrix	: Water
Date Analyzed	: 6/7/96	Lab File No.	: GAS0607019

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	8.5	0.2

Temperature	: 72.1 F	Saturation Concentration	Meth		2.038331971
Amount Injected	: 0.005 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		6.421126623
Head space created	: 4 ml				
Methane Area	: 474.004 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hallman
Analyst

P.M. Clell
Approved

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: 20D	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-05	**Lab Work Order**	: 96-1794
Date Sampled	: 5/31/96	**Dilution Factor**	: 100.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607020

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	9.1	0.2

Temperature	: 72 F	Saturation Concentration	Meth		2.188771642
Amount Injected	: 0.005 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		6.896337222
Head space created	: 4 ml				
Methane Area	: 508.988 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hollman
Analyst

Approved

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(303) 425-6021

Methane Report Form

Client Sample Number	: 20S	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-06	**Lab Work Order**	: 96-1794
Date Sampled	: 5/31/96	**Dilution Factor**	: 1.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607021

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	**74-82-8**	0.003	0.002

Temperature	: 72.2 F	Saturation	Meth		0.000604958
Amount Injected	: 0.5 ml	Concentration			
Total Volume of Sample	: 43 ml	Concentration	Meth		0.001905372
Head space created	: 4 ml	in Head Space			
Methane Area	: 14.068 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hollman
Analyst

Bm°Clell
Approved

AF1794.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: 19S	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-07	**Lab Work Order**	: 96-1794
Date Sampled	: 5/31/96	**Dilution Factor**	: 1.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607022

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	: 71.8 F	Saturation Concentration	Meth		0
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		0
Head space created	: 4 ml				
Methane Area	: 0 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hollman
Analyst

P. McClell
Approved

AF1794.XLS

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: 19D	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-08	**Lab Work Order**	: 96-1794
Date Sampled	: 5/31/96	**Dilution Factor**	: 50.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607023

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.7	0.1

Temperature	: 72.3 F	Saturation Concentration	Meth	0.178017123	
Amount Injected	: 0.01 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.560576265	
Head space created	: 4 ml				
Methane Area	: 82.794 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hollman
Analyst

Approved

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: 24D	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-09	**Lab Work Order**	: 96-1794
Date Sampled	: 5/31/96	**Dilution Factor**	: 50.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607024

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.7	0.1

Temperature	: 72.2 F	Saturation Concentration	Meth	0.178466499	
Amount Injected	: 0.01 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.562097065	
Head space created	: 4 ml				
Methane Area	: 83.003 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hollman
Analyst

P. McClell
Approved

AF1794.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: 24D	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-09Dup	**Lab Work Order**	: 96-1794
Date Sampled	: 5/31/96	**Dilution Factor**	: 50.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607025

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.7	0.1

Temperature	: 72.3 F	Saturation Concentration	Meth	0.179702818	
Amount Injected	: 0.01 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.565884521	
Head space created	: 4 ml				
Methane Area	: 83.578 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hollman
Analyst

Approved

AF1794.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: MW-8	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-10	**Lab Work Order**	: 96-1794
Date Sampled	: 5/31/96	**Dilution Factor**	: 1.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607026

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.003	0.002

Temperature	: 72 F	Saturation Concentration	Meth		0.000753359
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		0.00237367
Head space created	: 4 ml				
Methane Area	: 17.519 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hollman
Analyst

Approved

AF1794.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: MW-7	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1794-11	**Lab Work Order**	: 96-1794
Date Sampled	: 5/31/96	**Dilution Factor**	: 1.00
Date Received	: 6/1/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607027

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

mperature	: 72.5 F	Saturation	Meth		0
Amount Injected	: 0.5 ml	Concentration			
Total Volume of Sample	: 43 ml	Concentration	Meth		0
Head space created	: 4 ml	in Head Space			
Methane Area	: 0 ug				

Atomic weight(Methane) : 16 g

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

K. Hallman
Analyst

Ann Clell
Approved

AF1794.XLS

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

729691.08110

Date Sampled	: 5/30,31/96	Client Project ID.	: Bolling AFB
Date Received	: 6/01/96	Lab Project Number	: 96-1794
Date Prepared	: 6/01/96	Method	: EPA 300.0
Date Analyzed	: 6/01/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride (mg/L)	Dilution Factor
96-1794-01	21S	Water	26.2	1
96-1794-02	21D	Water	93.1	10
96-1794-03	22D	Water	60.9	10
96-1794-04	23D	Water	142	10
96-1794-05	20D	Water	145	10
96-1794-06	20S	Water	51.2	10
96-1794-07	19S	Water	357	10
96-1794-08	19D	Water	53.1	10
96-1794-09	24D	Water	54.2	10
96-1794-10	MW-8	Water	33.7	1
96-1794-11	MW-7	Water	127	10
Method Blank	(6/01/96)		<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-1794-01	21S Matrix Spike	10.0	26.2	36.5	104
96-1794-01	21S Matrix Spike Dup	10.0	26.2	35.2	90
MS/MSD RPD					14

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

729691.08110

Date Sampled	: 5/30,31/96	Client Project ID.	: Bolling AFB
Date Received	: 6/01/96	Lab Project Number	: 96-1794
Date Prepared	: 6/01/96	Method	: EPA 300.0
Date Analyzed	: 6/01/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N (mg/L)	Dilution Factor
96-1794-01	21S	Water	<0.076	1
96-1794-02	21D	Water	<0.076	1
96-1794-03	22D	Water	0.21	1
96-1794-04	23D	Water	<0.76**	10
96-1794-05	20D	Water	<0.76**	10
96-1794-06	20S	Water	<0.076	1
96-1794-07	19S	Water	<0.76**	10
96-1794-08	19D	Water	<0.076	1
96-1794-09	24D	Water	<0.076	1
96-1794-10	MW-8	Water	<0.076	1
96-1794-11	MW-7	Water	<0.76**	10
Method Blank	(6/01/96)		<0.076	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-1794-01	21S Matrix Spike	10.0	<0.25	9.3	93
96-1794-01	21S Matrix Spike Dup	10.0	<0.25	9.2	92
MS/MSD RPD					1.2

* = Quality assurance results reported as Nitrite (NO_2)
** = Raised detection limit due to matrix interference.

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

729691.08110

Date Sampled	: 5/30,31/96	Client Project ID.	: Bolling AFB
Date Received	: 6/01/96	Lab Project Number	: 96-1794
Date Prepared	: 6/01/96	Method	: EPA 300.0
Date Analyzed	: 6/01/96	Detection Limit	: 0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N (mg/L)	Dilution Factor
96-1794-01	21S	Water	0.077	1
96-1794-02	21D	Water	<0.056	1
96-1794-03	22D	Water	0.33	1
96-1794-04	23D	Water	0.056	1
96-1794-05	20D	Water	0.068	1
96-1794-06	20S	Water	5.5	1
96-1794-07	19S	Water	8.6	10
96-1794-08	19D	Water	0.11	1
96-1794-09	24D	Water	0.14	1
96-1794-10	MW-8	Water	0.76	1
96-1794-11	MW-7	Water	11.8	10
Method Blank	(6/01/96)		<0.25	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-1794-01	21S Matrix Spike	10.0	0.34	9.8	94
96-1794-01	21S Matrix Spike Dup	10.0	0.34	9.5	92
MS/MSD RPD					3.0

* = Quality assurance results reported as Nitrate (NO_3)

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

729691.08110

Date Sampled	30,31/96	Client Project ID.	: Bolling AFB
Date Received	1/96	Lab Project Number	: 96-1794
Date Prepared	: 6/01/96	Method	: EPA 300.0
Date Analyzed	: 6/01/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate (mg/L)	Dilution Factor
96-1794-01	21S	Water	9.6	1
96-1794-02	21D	Water	36.2	10
96-1794-03	22D	Water	35.5	10
96-1794-04	23D	Water	0.81	1
96-1794-05	20D	Water	0.95	1
96-1794-06	20S	Water	35.2	1
96-1794-07	19S	Water	44.4	10
96-1794-08	19D	Water	0.49	1
96-1794-09	24D	Water	1.0	1
96-1794-10	MW-8	Water	38.0	10
96-1794-11	MW-7	Water	82.7	10
Method Blank			<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-1794-01	21S Matrix Spike	10.0	9.6	19.5	99
96-1794-01	21S Matrix Spike Dup	10.0	9.6	19.0	94
MS/MSD RPD					5.5

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Analysis Report

729691.08110

Date Sampled	: 5/30/96	Client Project ID.	: Bolling AFB
Date Received	: 6/1/96	Lab Project Number	: 96-1794
Date Prepared	: 6/6/96	Method	: EPA 310.1
Date Analyzed	: 6/6/96	Detection Limit	: 5.0 mg $CaCO_3$/L

Evergreen Sample #	Client Sample ID.	Matrix	Total Alkalinity (mg $CaCO_3$/L)	Dilution Factor
96-1794-02	21D	Water	91.0	1
96-1794-03	22D	Water	36.4	1
Method Blank	(6/6/96)		<5.0	

Quality Assurance

Reference	True Value (mg$CaCO_3$/L)	Result (mg$CaCO_3$/L)	% Recovery
ERA Alkalinity/Fluoride Lot #0814-95-0	120	124	103

Analyst

Approved

Evergreen Analytical, Inc.

96-1796

WORK ORDER Summary

03-Jun-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: Bolling AFB

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-1796-01E	MW-10	ANIONS by ION CHROMATOGRAPHY Cl,NO3NO2,SO4		Water	D1	31-May-96	03-Jun-96	17-Jun-96	02-Jun-96
96-1796-02E	MW-9	ANIONS by ION CHROMATOGRAPHY Cl,NO3NO2,SO4						17-Jun-96	02-Jun-96
96-1796-03E	MW-1	ANIONS by ION CHROMATOGRAPHY Cl,NO3NO2,SO4						17-Jun-96	02-Jun-96
96-1796-04E	MW-11	ANIONS by ION CHROMATOGRAPHY Cl,NO3NO2,SO4						17-Jun-96	02-Jun-96
96-1796-01A	MW-10	BTEX + TMB/TVPH (Parsons List)			2			06-Jun-96	14-Jun-96
96-1796-02A	MW-9	BTEX + TMB/TVPH (Parsons List)						06-Jun-96	14-Jun-96
96-1796-03A	MW-1	BTEX + TMB/TVPH (Parsons List)						06-Jun-96	14-Jun-96
96-1796-04A	MW-11	BTEX + TMB/TVPH (Parsons List)						06-Jun-96	14-Jun-96
96-1796-05A	Field Blank	BTEX + TMB/TVPH (Parsons List)						06-Jun-96	14-Jun-96
96-1796-06A	MW-9MS/MSD	BTEX + TMB/TVPH (Parsons List)						06-Jun-96	14-Jun-96
96-1796-06B		BTEX + TMB/TVPH (Parsons List)						17-Jun-96	14-Jun-96
96-1796-01F	MW-10	Methane						17-Jun-96	14-Jun-96
96-1796-02F	MW-9	Methane						17-Jun-96	14-Jun-96
96-1796-03F	MW-1	Methane						17-Jun-96	14-Jun-96
96-1796-04F	MW-11	Methane						17-Jun-96	14-Jun-96
96-1796-01I	MW-10	TOTAL ALKALINITY			D1			17-Jun-96	14-Jun-96
96-1796-02I	MW-9	TOTAL ALKALINITY						17-Jun-96	14-Jun-96
96-1796-04I	MW-11	TOTAL ALKALINITY						17-Jun-96	14-Jun-96

= Special list. See sample comments or test information.
HT = Holding Time expiration date.

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Evergreen Analytical Inc.
4036 Youngfield St.
Wheat Ridge, Colorado 80033
(303) 425-6021
FAX (303) 425-6854
(800) 845-7400

COMPANY Parsons ES
ADDRESS 1700 Broadway, Ste 900
CITY Denver STATE CO ZIP 80290
PHONE# 303-831-8100 FAX # 303-831-8208 FAX RESULTS Y / (N)

CLIENT CONTACT (print) Dave Mouton
PROJECT I.D. Billing AFB
EAL. QUOTE # P.O.#
TURNAROUND REQUIRED* ☐ STD (2 wks) ☐ STD UST (3 day)
☐ Other (Specify)
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Julie Hoffa / Courtesy Copy
(print) S. Hoffa / J. Jones

Evergreen Analytical Cooler No. Parsons #1
Cooler Received
Please return cooler to Parsons

Please **PRINT** when done all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid	MATRIX: Oil / Sludge	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle)	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	Herbicides 8150/515 (circle)	PCB Screen	BTEX 8020/602 (circle)/MTBE (circle)	TRPH 418.1/Oil & Grease 413.1 (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Cl-, NO2, NO3, SO4	Methane	Alkalinity	EAL Sample No.
MW-10	5/31/96	1715	9	X										X		X				X	X	X	01A/B/C/D/E/F/G/H/I
MW-9	5/31/96	1830	9	X										X		X				X	X	X	02
MW-1	5/31/96	1945	8	X										X		X				X	X	X H	03A/B/C/D/E/F/G/H
MW-11	5/31/96	2030	9	X										X		X				X	X	X	04A/B/C/D/E/F-H/I
Field Blank	5/31/96	2000	1	X										X		X							05A
MW-9 MS/MSD														✓		✓							06A/B/C/D*
																							* Bottles returned for above MW9 sample
HT:																							Location 2, CR
DD:																							Container Size

EAL use only Do not write in shaded area
EAL Project # 96-1796
Custodian J

Instructions: Please analyze for NO2 + NO3 even if holding times are exceeded!
Note: all VOAs have HCl even if not written on label!

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Julie Hoffa	6/1 10:00	FEDEX	6/1 10:00				

Evergreen Analytical Sample Receipt/Check-in Record

Date & Time Rec'd: 6/3/96 0930 Shipped Via: FedEx
(Airbill # if applicable)

Client : Parsons ES

Client Project ID(s): Bolling AFB

EAL Project #(s): 96-1796 EAL Cooler(s): Y (N)

Cooler#	NA								
Ice packs	(Y)	N	Y	N	Y	N	Y	N	Y	N
Temperature °C	7>13								

	Y	N	N/A
1. Custody seal(s) present:		✓	
Seals on cooler intact		✓*	✓*
Seals on bottle intact			✓
2. Chain of Custody present:	✓		
3. Samples Radioactive: (Comment on COC if >0.5mr/h)		✓	
4. Containers broken or leaking: (Comment on COC if Y)		✓	
5. Containers labeled:	✓		
6. COC agrees w/ bottles received: (Comment on COC if N)		✓	**
7. COC agrees w/ labels: (Comment on COC if N)	✓		
8. Headspace in vials-waters only: (Comment on COC if Y)		✓	
9. VOA samples preserved:	✓		
10. pH measured on metals, cyanide or phenolics*:			✓
List discrepancies			

*Non-EAL provided containers only, water samples only.

11. Metal samples present:		✓	
Total ____ , Dissolved ____ , TCLP ____			
D or PD to be filtered:			
T,TR,D,PD to be Preserved:			
12. Short holding times:		✓	
Specify parameters			
13. Multi-phase sample(s) present:		✓	
14. COC signed w/ date/time:	✓		

Comments: **MW 9 - Received 2 bottles each for MS/MSD for BTEX+TMB+TVH which are not listed on COC

* Cooler taped shut - no custody seal present on cooler or bottles.

(Additional comments on back)

Custodian Signature/Date: 6/3/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB060396-W	Client Project Number	: Bolling AFB
Date Prepared	: 6/3/96	Lab Work Order	: 96-1796
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVBX0603003

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/3/96	U	0.1	mg/L
Benzene	71-43-2	6/3/96	U	0.4	ug/L
Toluene	108-88-3	6/3/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/3/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/3/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/3/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/3/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/3/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/3/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/3/96	U	0.5	ug/L
PID Surrogate Recovery:		92%		70%-130%	(Limits)
FID Surrogate Recovery:		96%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report
Method Blank Report

Method Blank Number	: MB060496-W	Client Project Number	: Bolling AFB
Date Prepared	: 6/4/96	Lab Work Order	: 96-1796
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVBX0603041

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	U	0.1	mg/L
Benzene	71-43-2	6/4/96	U	0.4	ug/L
Toluene	108-88-3	6/4/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/4/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	U	0.5	ug/L
PID Surrogate Recovery:		120%		70%-130%	(Limits)
FID Surrogate Recovery:		102%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: MW-10	Client Project Number	: Bolling AFB
Lab Sample Number	: 96-1796-01	Lab Work Order	: 96-1796
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 6/3/96	Lab File Number(s)	: TVBX0603011
Date Prepared	: 6/3/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/3/96	U	0.1	mg/L
Benzene	71-43-2	6/3/96	U	0.4	ug/L
Toluene	108-88-3	6/3/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/3/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/3/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/3/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/3/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/3/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/3/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/3/96	U	0.5	ug/L
FID Surrogate Recovery:		100%		70%-130%	(Limits)
PID Surrogate Recovery:		99%		70%-128%	(Limits)

Notes: *Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.*

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

P. McCleel
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: MW-9	Client Project Number	: Bolling AFB
Lab Sample Number	: 96-1796-02	Lab Work Order	: 96-1796
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 6/3/96	Lab File Number(s)	: TVBX0603008
Date Prepared	: 6/3/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/3/96	U	0.1	mg/L
Benzene	71-43-2	6/3/96	U	0.4	ug/L
Toluene	108-88-3	6/3/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/3/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/3/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/3/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/3/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/3/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/3/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/3/96	U	0.5	ug/L
FID Surrogate Recovery:		91%		70%-130%	(Limits)
PID Surrogate Recovery:		96%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: MW-1	Client Project Number	: Bolling AFB
Lab Sample Number	: 96-1796-03	Lab Work Order	: 96-1796
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 6/3/96	Lab File Number(s)	: TVBX0603044
Date Prepared	: 6/4/96	Method Blank	: MB060496-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration		RL	Units
TVH-Gasoline	----	6/4/96	0.2		0.1	mg/L
Benzene	71-43-2	6/4/96	6.5		0.4	ug/L
Toluene	108-88-3	6/4/96		U	0.4	ug/L
Chlorobenzene	108-90-7	6/4/96	0.7		0.4	ug/L
Ethyl Benzene	100-41-4	6/4/96	0.8		0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	0.5		0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96		U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96		U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	0.6		0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96		U	0.5	ug/L
FID Surrogate Recovery:		121%			70%-130%	(Limits)
PID Surrogate Recovery:		104%			70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K. Hollman
Analyst

P. McClellan
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: MW-11	Client Project Number	: Bolling AFB
Lab Sample Number	: 96-1796-04	Lab Work Order	: 96-1796
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 6/3/96	Lab File Number(s)	: TVBX0603032,47,61
Date Prepared	: 6/3,4/96	Method Blank	: MB060396-W
FID Dilution Factor	: 100		MB060496-W
PID Dilution Factor	: 10, 100, 500		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/4/96	110	10	mg/L
Benzene	71-43-2	6/4/96	9,000	40	ug/L
Toluene	108-88-3	6/5/96	25,000	200	ug/L
Chlorobenzene	108-90-7	6/4/96	U	4.0	ug/L
Ethyl Benzene	100-41-4	6/4/96	2,300	40	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/4/96	13,000	40	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/4/96	480	4.0	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/4/96	1,600	40	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/4/96	530	4.0	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/4/96	190	5.0	ug/L
FID Surrogate Recovery:		122%		70%-130%	(Limits)
PID Surrogate Recovery:		104,103,104%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: Field Blank	Client Project Number	: Bolling AFB
Lab Sample Number	: 96-1796-05	Lab Work Order	: 96-1796
Date Sampled	: 5/31/96	Matrix	: WATER
Date Received	: 6/3/96	Lab File Number(s)	: TVBX0603009
Date Prepared	: 6/3/96	Method Blank	: MB060396-W
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	6/3/96	U	0.1	mg/L
Benzene	71-43-2	6/3/96	U	0.4	ug/L
Toluene	108-88-3	6/3/96	U	0.4	ug/L
Chlorobenzene	108-90-7	6/3/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	6/3/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	6/3/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	6/3/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	6/3/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	6/3/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	6/3/96	U	0.5	ug/L
FID Surrogate Recovery:		121%		70%-130%	(Limits)
PID Surrogate Recovery:		105%		70%-128%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments:

QUALIFIERS and DEFINITIONS:

E = Extrapolated value. Value exceeds calibration range.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
J = Indicates an estimated value when the compound is detected, but is below the Reporting Limit.
RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

K Holloman
Analyst

Approved

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: MW-9 MS/MSD	Client Project No.	: Bolling AFB
Lab Sample No.	: 96-1796-06	Lab Work Order	: 96-1796
Date Sampled	: 5/31/96	EPA Method No.	: 602/8020
Date Received	: 6/3/96	Matrix	: WATER
Date Prepared	: 6/3/96	Lab File Number(s)	: TVBX0603021,022
Date Analyzed	: 6/4/96	Method Blank	: MB060396-W
Instrument Name	: TVHBTEX2	Dilution Factor	: 1.0

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	Concentration (ug/L) MS	Concentration (ug/L) MSD	Comments
Benzene	20.0	0.0	18.6	18.5	
Toluene	20.0	0.0	18.6	18.5	
Chlorobenzene	20.0	0.0	19.2	19.2	
Ethylbenzene	20.0	0.0	18.6	18.6	
m,p-Xylene	20.0	0.0	18.6	18.4	
o-Xylene	20.0	0.0	18.9	18.9	
1,3,5-TMB	20.0	0.0	18.5	18.5	
1,2,4-TMB	20.0	0.0	19.2	19.2	
1,2,3-TMB	20.0	0.0	19.6	19.7	
1,2,3,4-TeMB	20.0	0.0	20.7	20.7	
Surrogate	100.0	96%	106%	106%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC# Limits RPD	QC# Limits %REC
Benzene		93.0	92.5	0.5	21	60 - 132
Toluene		93.0	92.5	0.5	21	60 - 132
Chlorobenzene		96.0	96.0	0.0	19	67 - 127
Ethylbenzene		93.0	93.0	0.0	22	62 - 130
m,p-Xylene		93.0	92.0	1.1	21	58 - 136
o-Xylene		94.5	94.5	0.0	23	60 - 133
1,3,5-TMB		92.5	92.5	0.0	25	71 - 118
1,2,4-TMB		96.0	96.0	0.0	34	68 - 120
1,2,3-TMB		98.0	98.5	0.5	22	72 - 118
1,2,3,4-TeMB		103.5	103.5	0.0	34	68 - 125
Surrogate		106.0	106.0	NA	NA	70 - 128

= Limits established 5/22/96, KSH.
* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments: _____

K. Hoffman
Analyst

Approved

MSBP1796.XLS; 6/4/96

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: MW-9 MS/MSD	Client Project No.	: Bolling AFB
Lab Sample No.	: 96-1796-06	Lab Work Order	: 96-1796
Date Sampled	: 5/31/96	EPA Method No.	: 5030/8015 Modified
Date Received	: 6/3/96	Matrix	: WATER
Date Prepared	: 6/3/96	Lab File Number(s)	: TVBX0603019,020
Date Analyzed	: 6/4/96	Method Blank	: MB060396-W
Instrument Name	: TVHBTEX2	Dilution Factor	: 1.0

Compound	Spike Added (mg/L)	Sample Concentration (mg/L)	MS Concentration (mg/L)	MS %REC	QC (#) Limits %REC
Gasoline	2.00	0.00	1.74	87.0%	5 - 129
Surrogate **	---	---	---	121%	70 - 128

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC (#) Limits RPD	QC (#) Limits %REC
Gasoline	2.00	1.71	85.5%	1.7	44.1	57 - 129
Surrogate **	---	---	119%	NA	NA	70 - 128

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes:
NA = Not analyzed/not applicable.
* = Values outside of QC limits.
** = 1,2,4-Trichlorobenzene
= Limits established 5/22/96, KSH.

Comments:

K. Hoffman
Analyst

Approved

MST1796.XLS; 6/4/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB060796	Client Project No.	: Bolling AFB
Date Extracted/Prepared	: 6/7/96	Lab Work Order	: 96-1796
Date Analyzed	: 6/7/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175
		Matrix	: Water
		Lab File No.	: GAS0607002

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF1796.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: MW-10	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1796-01	**Lab Work Order**	: 96-1796
Date Sampled	: 5/31/96	**Dilution Factor**	: 1.00
Date Received	: 6/3/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607010

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	: 71.9 F	Saturation Concentration	Meth		0
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		0
Head space created	: 4 ml				
Methane Area	: 0 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF1796.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: MW-9	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1796-02	**Lab Work Order**	: 96-1796
Date Sampled	: 5/31/96	**Dilution Factor**	: 1.00
Date Received	: 6/3/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607011

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	**74-82-8**	U	0.002

Temperature	: 71.6 F	Saturation Concentration	Meth		0
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		0
Head space created	: 4 ml				
Methane Area	: 0 ug				

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF1796.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: MW-1	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1796-03	**Lab Work Order**	: 96-1796
Date Sampled	: 5/31/96	**Dilution Factor**	: 1.00
Date Received	: 6/3/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607012

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.171	0.002

nperature	: 71.9 F	Saturation	Meth	0.041196148
Amount Injected	: 0.5 ml	Concentration		
Total Volume of Sample	: 43 ml	*Concentration*	Meth	0.129824416
Head space created	: 4 ml	in Head Space		
Methane Area	: 957.996 ug			

Atomic weight(Methane) : 16 g

Qualifiers

E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF1796.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: MW-11	**Client Project No.**	: Bolling AFB
Lab Sample Number	: 96-1796-04	**Lab Work Order**	: 96-1796
Date Sampled	: 5/31/96	**Dilution Factor**	: 50.00
Date Received	: 6/3/96	**Method**	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Lab File No.**	: GAS0607013

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
ıane	74-82-8	2.5	0.1

ıperature	: 72.1 F	Saturation	Meth	0.594643932
∧mount Injected	: 0.01 ml	Concentration		
Total Volume of Sample	: 43 ml	Concentration	Meth	1.873239511
Head space created	: 4 ml	in Head Space		
Methane Area	: 276.563 ug			

Atomic weight(Methane) : 16 g

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF1796.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: MW-11	Client Project No.	: Bolling AFB
Lab Sample Number	: 96-1796-04Dup	Lab Work Order	: 96-1796
Date Sampled	: 5/31/96	Dilution Factor	: 50.00
Date Received	: 6/3/96	Method	: RSKSOP-175
Date Extracted/Prepared	: 6/7/96	Matrix	: Water
Date Analyzed	: 6/7/96	Lab File No.	: GAS0607014

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	2.4	0.1

Temperature	: 72 F	Saturation Concentration	Meth		0.578586828
Amount Injected	: 0.01 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		1.822999624
Head space created	: 4 ml				
Methane Area	: 269.095 ug				
Atomic weight(Methane)	: 16 g				

Qualifiers
E = Extrapolated value.
U = Compound analyzed for, but not detected.
B = Compound also found in the blank.
RL = Reporting Limit.
NA = Not Available/Not Applicable.

Analyst

K. Hollman
Approved

AF1796.XLS

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSK-175 Gas Method
Methane Gas Matrix Spike / Matrix Spike Duplicate Report

Client Sample No.	: MW-9	Client Project No.	: Bolling AFB
Lab Sample No.	: 96-1796-02	Lab Work Order	: 96-1796
Date Sampled	: 5/31/96	EPA Method No.	: RSKSOP-175
Date Received	: 6/3/96	Matrix	: Water
Date Prepared	: 6/7/96	Method Blank	: GB060796
Date Analyzed	: 6/7/96	Lab File No's.	: GAS0607028,030
E.A. MS/MSD Spike Source No.	: 1719		

Compound	Spike Added (ug)	Sample Concentration (ug)	MS Concentration (ug)	MS %REC	QC Limits %REC
Methane Gas	500	0	314	63	40-89

Compound	Spike Added (ug)	MSD Concentration (ug)	MSD %REC	RPD	QC Limits RPD	QC Limits %REC
Methane Gas	500	309	62	1.6	0-24.4	40-89

RPD: 0 out of (1) outside limits.
Spike Recovery: 0 out of (2) outside limits.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available

Note: The Spike was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

Analyst

Approved

MS1796.XLS; 6/10/96

Evergreen Analytical, Inc.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

RSK-175 Gas Method
Methane LCS Report Form

LCS No.	: LCS060796	**EPA Method No.**	: RSKSOP-175
Date Prepared	: 6/7/96	**Matrix**	: Water
Date Analyzed	: 6/7/96	**Method Blank**	: GB060796
E.A. LCS Source No.	: 1719	**Lab File No.**	: GAS0607009

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	404	81	67-85

Spike Recovery: 0 out of (1) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane gas and shaking the VOA for 5 minutes. Then injecting 50 ul from the headspace into the GC resulting in a theoretical concentration of 500 ug.

Notes
* = Values outside of QC limits.
NA = Not analyzed/not available.

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

729691.08110

Date Sampled	: 5/31/96	Client Project ID.	: Bolling AFB
Date Received	: 6/03/96	Lab Project Number	: 96-1796
Date Prepared	: 6/05/96	Method	: EPA 300.0
Date Analyzed	: 6/05/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride mg/L	Dilution Factor
96-1796-01	MW-10	Water	464	50
96-1796-02	MW-9	Water	35.1	10
96-1796-03	MW-1	Water	89.6	10
96-1796-04	MW-11	Water	85.3	10

Method Blank (6/05/96) <0.25

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-1829-01	CPT-1D Matrix Spike	10.0	16.0	25.6	95
96-1829-01	CPT-1D Matrix Spike Dup	10.0	16.0	25.3	93
MS/MSD RPD					2.4

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

729691.08110

Date Sampled	: 5/31/96	Client Project ID.	: Bolling AFB
Date Received	: 6/03/96	Lab Project Number	: 96-1796
Date Prepared	: 6/05/96	Method	: EPA 300.0
Date Analyzed	: 6/05/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N ** mg/L	Dilution Factor
96-1796-01	MW-10	Water	<0.76 ***	10
96-1796-02	MW-9	Water	<0.076	1
96-1796-03	MW-1	Water	<0.076	1
96-1796-04	MW-11	Water	<0.076	1

Method Blank (6/05/96) <0.076

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-1829-01	CPT-1D Matrix Spike	10.0	<0.25	9.7	97
96-1829-01	CPT-1D Matrix Spike Dup	10.0	<0.25	9.5	95
MS/MSD RPD					2.9

* = Quality assurance results reported as Nitrite (NO_2).
** = Samples received outside of holding time for this analyte.
*** = Raised detection limit due to matrix interference.

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

729691.08110

Date Sampled	: 5/31/96	Client Project ID.	: Bolling AFB
Date Received	: 6/03/96	Lab Project Number	: 96-1796
Date Prepared	: 6/05/96	Method	: EPA 300.0
Date Analyzed	: 6/05/96	Detection Limit	: 0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N ** mg/L	Dilution Factor
96-1796-01	MW-10	Water	17.2	10
96-1796-02	MW-9	Water	5.2	1
96-1796-03	MW-1	Water	0.062	1
96-1796-04	MW-11	Water	0.14	1

Method Blank (6/05/96) <0.056

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-1829-01	CPT-1D Matrix Spike	10.0	2.1	11.2	91
96-1829-01	CPT-1D Matrix Spike Dup	10.0	2.1	10.9	88
MS/MSD RPD					3.7

* = Quality assurance results reported as Nitrate (NO_3).
** = Samples received outside of holding time for this analyte.

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

729691.08110

Date Sampled	: 5/31/96	Client Project ID.	: Bolling AFB
Date Received	: 6/03/96	Lab Project Number	: 96-1796
Date Prepared	: 6/05/96	Method	: EPA 300.0
Date Analyzed	: 6/05/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate mg/L	Dilution Factor
96-1796-01	MW-10	Water	53.9	10
96-1796-02	MW-9	Water	73.2	10
96-1796-03	MW-1	Water	2.1	1
96-1796-04	MW-11	Water	0.97	1

Method Blank (6/05/96) <0.25

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-1829-01	CPT-1D Matrix Spike	10.0	33.6	45.2	116
96-1829-01	CPT-1D Matrix Spike Dup	10.0	33.6	45.0	114
MS/MSD RPD					1.7

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Analysis Report

729691.08110

Date Sampled	: 5/31/96	Client Project ID.	: Bolling AFB
Date Received	: 6/3/96	Lab Project Number	: 96-1796
Date Prepared	: 6/6/96	Method	: EPA 310.1
Date Analyzed	: 6/6/96	Detection Limit	: 5.0 mg $CaCO_3$/L

Evergreen Sample #	Client Sample ID.	Matrix	Total Alkalinity (mg $CaCO_3$/L)	Dilution Factor
96-1796-01	MW-10	Water	5.5	1
96-1796-02	MW-9	Water	70.3	1
96-1796-04	MW-11	Water	237	1
Method Blank	(6/6/96)		<5.0	

Quality Assurance

Reference	True Value ($mgCaCO_3$/L)	Result ($mgCaCO_3$/L)	% Recovery
ERA Alkalinity/Fluoride Lot #0814-95-0	120	124	103

Analyst

Approved

APPENDIX D

GRIDDED MODEL INPUT AND CALIBRATION RESULTS

APPENDIX D1

POTENTIOMETRIC HEADS AT MODEL BOUNDARIES

X-AXIS

20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
																				1
0	14.8	14.8	13.8	10.8	9.8	8.3	7.8	7.5	7.3	6.5	6.0	5.3	4.5	4.5	4.5	4.3	4.3	4.3	0	2
																				3
																				4
																				5
																				6
																				7
																				8
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																				21
																				22
																				23
																				24
																				25
																				26
																				27
																				28
0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	0	29
																				30

Y-AXIS

Units are shown in feet above mean sea level.
Each cell is 30 feet (x-axis) by 35 feet (y-axis)

APPENDIX D2

TOTAL BTEX PLUME MAP AT TIME=0

X-AXIS

20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	5	10	10	5	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	5	50	70	60	50	10	0	0	0	0	0	0	0	0
0	0	0	0	0	0	70	400	500	400	400	100	10	0	0	0	0	0	0	0
0	0	0	0	0	100	8000	10000	10000	5000	900	300	200	10	0	0	0	0	0	0
0	0	0	0	5	1000	100000	90000	80000	70000	8000	800	500	80	0	0	0	0	0	0
0	0	0	0	10	100	1000	5000	10000	60000	8000	4000	1000	200	100	8	0	0	0	0
0	0	0	0	20	25	30	800	10000	60000	9000	5000	2000	1000	100	10	0	0	0	0
0	0	0	0	20	40	90	900	10000	70000	10000	5000	1000	200	100	10	0	0	0	0
0	0	0	5	25	50	90	800	10000	40000	20000	2000	800	100	5	0	0	0	0	0
0	0	0	10	30	60	90	900	8000	20000	30000	4000	800	100	5	0	0	0	0	0
0	0	0	10	30	60	90	1000	7000	10000	27000	5000	800	80	5	0	0	0	0	0
0	0	0	10	30	60	90	1000	4000	7000	8000	5000	900	60	5	0	0	0	0	0
0	0	0	10	30	60	90	500	4000	5000	7000	2000	900	50	8	0	0	0	0	0
0	0	0	5	30	40	70	100	2000	4000	6000	2000	900	50	8	0	0	0	0	0
0	0	0	0	20	40	60	90	500	1500	2000	1000	300	40	5	0	0	0	0	0
0	0	0	0	5	20	40	60	100	700	900	500	100	20	5	0	0	0	0	0
0	0	0	0	0	0	10	40	90	300	500	200	80	10	0	0	0	0	0	0
0	0	0	0	0	0	0	10	50	50	100	80	20	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	10	10	10	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Units are shown in µg/L
Each Cell is 30 feet (x-axis) by 35 feet (y-axis)

Appendix D3

Dissolved Oxygen Grid

X-AXIS

20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	1
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	3
5	5	5	5	5	5	5	5	4.2	4.6	4.5	5	5	5	5	5	5	5	5	5	4
5	5	5	5	5	4.5	4	2.9	2.9	2.9	3	4	5	5	5	5	5	5	5	5	5
5	5	5	5	5	4	3	2.9	2.9	2.9	2.9	3.2	4.8	5	5	5	5	5	5	5	6
5	5	5	5	4.2	3	2.9	2.8	2.8	2.8	2.5	2.8	3.8	4.9	5	5	5	5	5	5	7
5	5	5	4.5	3.5	2.9	2.8	2.5	2.3	2.2	2.1	2.1	3.7	4	5	5	5	5	5	5	8
5	5	5	4.2	3	2.8	2.3	2.3	1.9	1	0.7	0.8	0.9	3.5	5	5	5	5	5	5	9
5	5	4.7	3.9	2.9	2.5	2	1	0.9	0.9	0.3	0.3	0.3	2.5	5	5	5	5	5	5	10
5	5	4.6	3.5	2.8	2	1	0.7	0.8	0.2	0.2	0.3	0.5	3	5	5	5	5	5	5	11
5	5	4.5	3.2	2.1	1	0.8	0.6	0.4	0.2	0.2	0.4	0.8	3.7	5	5	5	5	5	5	12
5	5	4	3	1.5	0.9	0.7	0.4	0.3	0.2	0.3	0.8	1	3.9	4.9	5	5	5	5	5	13
5	5	4	2.5	1	0.8	0.7	0.4	0.3	0.2	0.3	0.8	1	4	4.8	5	5	5	5	5	14
5	5	4	2	0.9	0.8	0.7	0.4	0.3	0.3	0.3	0.8	1.5	4	4.8	5	5	5	5	5	15 Y-AXIS
5	5	4.2	1	0.9	0.9	0.7	0.4	0.3	0.4	0.8	0.9	3	4.2	5	5	5	5	5	5	16
5	5	4.8	1.8	1	0.9	0.6	0.4	0.3	0.4	0.8	1	3.2	4.2	5	5	5	5	5	5	17
5	5	5	3	1	0.9	0.6	0.4	0.3	0.4	0.8	2	3.6	4.3	5	5	5	5	5	5	18
5	5	5	4	2	0.9	0.9	0.4	0.35	0.4	0.8	3.2	4	4.6	5	5	5	5	5	5	19
5	5	5	5	3.5	0.9	0.9	0.5	0.5	0.8	2	3.5	4.5	5	5	5	5	5	5	5	20
5	5	5	5	5	3	1.5	0.9	0.9	1	3.5	4	5	5	5	5	5	5	5	5	21
5	5	5	5	5	5	4	3.5	3.5	3.5	4.5	5	5	5	5	5	5	5	5	5	22
5	5	5	5	5	5	5	4.8	4.5	4.8	5	5	5	5	5	5	5	5	5	5	23
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	24
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	25
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	26
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	27
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	28
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	29
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	30

Units are shown in mg/l
Each cell is 30 feet (x-axis) by 35 feet (y-axis)

Appendix D4

Dissolved Nitrate (as N) Grid

X-AXIS

20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	1
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	2
5	5	5	5	5	5	4	2	4	5	5	5	5	5	5	5	5	5	5	5	3
5	5	5	5	5	5	2.5	0	0	3	5	5	5	5	5	5	5	5	5	5	4
5	5	5	5	5	5	2.5	1	0	2	4	5	5	5	5	5	5	5	5	5	5
5	5	5	5	5	5	2.5	1	0.5	1	3	5	5	5	5	5	5	5	5	5	6
5	5	5	5	5	5	3	1	0.5	1	2	4	5	5	5	5	5	5	5	5	7
5	5	5	5	5	5	3	2.5	1	1	1	3	5	5	5	5	5	5	5	5	8
5	5	5	5	5	5	5	2.5	1	1	2.5	3	5	5	5	5	5	5	5	5	9
5	5	5	5	5	5	4	3	0.5	1	3	4	5	5	5	5	5	5	5	5	10
5	5	5	5	5	5	3	0.5	0.5	1	3	4	5	5	5	5	5	5	5	5	11
5	5	5	5	5	5	4	2	0.5	0.5	3	5	5	5	5	5	5	5	5	5	12
5	5	5	5	5	5	5	2.5	0.5	2	3	5	5	5	5	5	5	5	5	5	13
5	5	5	5	5	5	5	5	2	0	0	3	5	5	5	5	5	5	5	5	14
5	5	5	5	5	5	5	5	3	0	0	1	4	5	5	5	5	5	5	5	15 Y-AXIS
5	5	5	5	5	5	5	5	3	0	0	0.5	4	5	5	5	5	5	5	5	16
5	5	5	5	5	5	5	4	2	0	0	0.5	3	5	5	5	5	5	5	5	17
5	5	5	5	5	5	5	2.5	0	0	0.5	1	3	5	5	5	5	5	5	5	18
5	5	5	5	5	5	3	0	0	0.5	0.5	1	3	5	5	5	5	5	5	5	19
5	5	5	5	5	5	1	0.5	0.5	2	2	3	5	5	5	5	5	5	5	5	20
5	5	5	5	5	5	3	2.5	2.5	3	5	5	5	5	5	5	5	5	5	5	21
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	22
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	23
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	24
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	25
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	26
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	27
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	28
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	29
5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	30

Units are shown in mg/l
Each cell is 30 feet (x-axis) by 35 feet (y-axis)

Appendix D5

Dissolved Nitrate (as O2 equivalents) Grid

X-AXIS

20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	1
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	2
14.5	14.5	14.5	14.5	14.5	14.5	11.6	5.8	11.6	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	3
14.5	14.5	14.5	14.5	14.5	14.5	7.2	0.0	0.0	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	4
14.5	14.5	14.5	14.5	14.5	14.5	7.2	2.9	0.0	5.8	11.6	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	5
14.5	14.5	14.5	14.5	14.5	14.5	7.2	2.9	1.4	2.9	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	6
14.5	14.5	14.5	14.5	14.5	14.5	8.7	2.9	1.4	2.9	5.8	11.6	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	7
14.5	14.5	14.5	14.5	14.5	14.5	8.7	7.2	2.9	2.9	2.9	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	8
14.5	14.5	14.5	14.5	14.5	14.5	14.5	7.2	2.9	2.9	7.2	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	9
14.5	14.5	14.5	14.5	14.5	14.5	11.6	8.7	1.4	2.9	8.7	11.6	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	10
14.5	14.5	14.5	14.5	14.5	14.5	8.7	1.4	1.4	2.9	8.7	11.6	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	11
14.5	14.5	14.5	14.5	14.5	14.5	11.6	5.8	1.4	1.4	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	12
14.5	14.5	14.5	14.5	14.5	14.5	14.5	7.2	1.4	5.8	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	13
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	5.8	0.0	0.0	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	8.7	0.0	0.0	2.9	11.6	14.5	14.5	14.5	14.5	14.5	14.5	14.5	15 Y-AXIS
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	8.7	0.0	0.0	1.4	11.6	14.5	14.5	14.5	14.5	14.5	14.5	14.5	16
14.5	14.5	14.5	14.5	14.5	14.5	14.5	11.6	5.8	0.0	0.0	1.4	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	17
14.5	14.5	14.5	14.5	14.5	14.5	14.5	7.2	0.0	0.0	1.4	2.9	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	18
14.5	14.5	14.5	14.5	14.5	14.5	8.7	0.0	0.0	1.4	1.4	2.9	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	19
14.5	14.5	14.5	14.5	14.5	14.5	2.9	1.4	1.4	5.8	5.8	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	20
14.5	14.5	14.5	14.5	14.5	14.5	8.7	7.2	7.2	8.7	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	21
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	22
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	23
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	24
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	25
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	26
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	27
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	28
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	29
14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	30

Units are shown in mg/l
Each cell is 30 feet (x-axis) by 35 feet (y-axis)

Appendix D6

Dissolved Oxygen and Nitrate (as O2 equivalents) Grid

X-AXIS

20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	1
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	2
19.5	19.5	19.5	19.5	19.5	19.5	16.6	10.8	16.6	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	3
19.5	19.5	19.5	19.5	19.5	19.5	12.2	5.0	4.2	13.3	19.0	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	4
19.5	19.5	19.5	19.5	19.5	19.0	11.2	5.8	2.9	8.7	14.6	18.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	5
19.5	19.5	19.5	19.5	19.5	18.5	10.2	5.8	4.3	5.8	11.6	17.7	19.3	19.5	19.5	19.5	19.5	19.5	19.5	19.5	6
19.5	19.5	19.5	19.5	18.7	17.5	11.6	5.7	4.2	5.7	8.3	14.4	18.3	19.4	19.5	19.5	19.5	19.5	19.5	19.5	7
19.5	19.5	19.5	19.0	18.0	17.4	11.5	9.7	5.2	5.1	5.0	10.8	18.2	18.5	19.5	19.5	19.5	19.5	19.5	19.5	8
19.5	19.5	19.5	18.7	17.5	17.3	16.8	9.5	4.8	3.9	7.9	9.5	15.4	18.0	19.5	19.5	19.5	19.5	19.5	19.5	9
19.5	19.5	19.2	18.4	17.4	17.0	13.6	9.7	2.3	3.8	9.0	11.9	14.8	17.0	19.5	19.5	19.5	19.5	19.5	19.5	10
19.5	19.5	19.1	18.0	17.3	16.5	9.7	2.1	2.2	3.1	8.9	11.9	15.0	17.5	19.5	19.5	19.5	19.5	19.5	19.5	11
19.5	19.5	19.0	17.7	16.6	15.5	12.4	6.4	1.8	1.6	8.9	14.9	15.3	18.2	19.5	19.5	19.5	19.5	19.5	19.5	12
19.5	19.5	18.5	17.5	16.0	15.4	15.2	7.6	1.7	6.0	9.0	15.3	15.5	18.4	19.4	19.5	19.5	19.5	19.5	19.5	13
19.5	19.5	18.5	17.0	15.5	15.3	15.2	14.9	6.1	0.2	0.3	9.5	15.5	18.5	19.3	19.5	19.5	19.5	19.5	19.5	14
19.5	19.5	18.5	16.5	15.4	15.3	15.2	14.9	9.0	0.3	0.3	3.7	13.1	18.5	19.3	19.5	19.5	19.5	19.5	19.5	15 Y-AXIS
19.5	19.5	18.7	15.5	15.4	15.4	15.2	14.9	9.0	0.4	0.8	2.3	14.6	18.7	19.5	19.5	19.5	19.5	19.5	19.5	16
19.5	19.5	19.3	16.3	15.5	15.4	15.1	12.0	6.1	0.4	0.8	2.4	11.9	18.7	19.5	19.5	19.5	19.5	19.5	19.5	17
19.5	19.5	19.5	17.5	15.5	15.4	15.1	7.6	0.3	0.4	2.2	4.9	12.3	18.8	19.5	19.5	19.5	19.5	19.5	19.5	18
19.5	19.5	19.5	18.5	16.5	15.4	9.6	0.4	0.4	1.8	2.2	6.1	12.7	19.1	19.5	19.5	19.5	19.5	19.5	19.5	19
19.5	19.5	19.5	19.5	18.0	15.4	3.8	1.9	1.9	6.6	7.8	12.2	19.0	19.5	19.5	19.5	19.5	19.5	19.5	19.5	20
19.5	19.5	19.5	19.5	19.5	17.5	10.2	8.1	8.1	9.7	18.0	18.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	21
19.5	19.5	19.5	19.5	19.5	19.5	18.5	18.0	18.0	18.0	19.0	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	22
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.3	19.0	19.3	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	23
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	24
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	25
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	26
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	27
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	28
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	29
19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	19.5	30

Units are shown in mg/l
Each cell is 30 feet (x-axis) by 35 feet (y-axis)

Appendix D7

Groundwater Model Calibration Error

Location	Actual Water Level	Calibrated Water Level	h_m-h_a	Deviation from Mean $\lvert(h_m-h_a)\rvert$	Deviation from Mean $(h_m-h_a)^2$
MW-1	3.35	3.81	0.460	0.460	0.211
MW-3	3.52	3.24	-0.277	0.277	0.077
MW-4	3.19	3.29	0.097	0.097	0.009
MW-5	2.91	3.37	0.462	0.462	0.213
MW-6	2.93	3.11	0.179	0.179	0.032
MW-7	3.36	2.95	-0.406	0.406	0.164
MW-8	2.72	2.70	-0.025	0.025	0.001
MW-9	6.32	5.25	-1.070	1.070	1.145
CPT-8D	3.13	3.37	0.242	0.242	0.059
CPT-22	2.86	2.63	-0.231	0.231	0.053
Totals:	34.29	33.722064	-0.567936	3.448154	1.96507804

n=	10
ME=	-0.0567936
MAE=	0.3448154
RMS=	0.44329201

Notes:

h_m = Calibrated Water Level

h_a = Actual Water Level

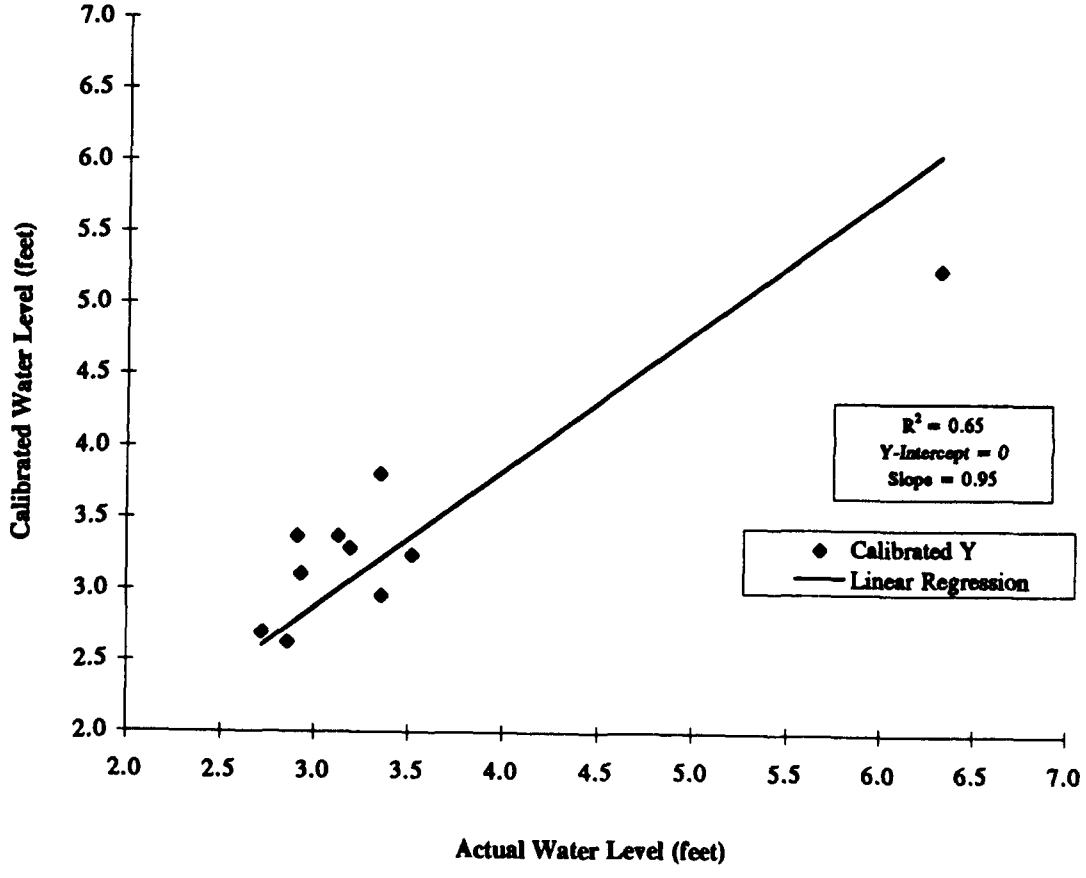
n = Number of Observations

ME = Mean Error = $1/n * SUM(h_m-h_a)$

MAE = Mean Absolute Error = $1/n * SUM|(h_m-h_a)|$

RMS = Root Mean Square Error = $(1/n * SUM(h_m-h_a)^2)^{0.5}$

Appendix D7
Bolling AFB Groundwater Model
Calibration Error Plot



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9/30/96/7:10 PM

APPENDIX D8
ESTIMATION OF LONGITUDINAL DISPERSIVITY

Assumptions: A. Plume migration is sufficiently aligned along the longitudinal axis of the grid to calculate a longitudinal moment.

B. Longitudinal dispersivity is 1/10 of the distance from the contamination source to the center of contamination.

From Appendix D2, an estimate for the center of mass will be taken by calculating the longitudinal moment around cell (10,3) which is near the source of contamination.

Row	Mass (ug/l)	Distance From Cell (10,3) (ft)	Mass x Distance (ug-ft/L)
2	0	35	0
3	0	70	0
4	30	105	3,150
5	245	140	34,300
6	1,880	175	329,000
7	34,510	210	7,247,100
8	350,385	245	85,844,325
9	89,418	280	25,037,040
10	87,985	315	27,715,275
11	97,360	350	34,076,000
12	73,875	385	28,441,875
13	63,995	420	26,877,900
14	51,075	455	23,239,125
15	26,155	490	12,815,950
16	19,648	525	10,315,200
17	15,203	560	8,513,680
18	5,555	595	3,305,225
19	2,450	630	1,543,500
20	1,230	665	817,950
21	310	700	217,000
22	30	735	22,050
23	0	770	0
24	0	805	0
25	0	840	0
26	0	875	0
27	0	910	0
28	0	945	0
29	0	980	0
Totals:	921,339		296,395,645

Now, estimate the longintudinal centroid of the plume:

Σ(mass x distance)/Σ(mass) in feet: 320
Estimated distance from cell (10,3) to the centroid in feet: 150
Estimated Longitudinal Dispersivity (Dist. x 0.1) in feet: 15

Appendix D9

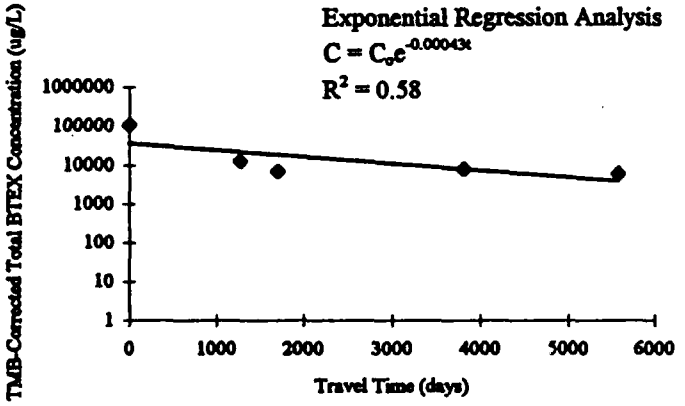
Data for First-Order Rate Constant Calculation using Conservative Tracer

Sampling Location	Distance Downgradient (m)	Travel Time Upgradient and Downgradient Point (days)	Measured Total BTEX Concentration (ug/L)	Total Trimethylbenzene Concentration (ug/L)	Trimethylbenzene-Corrected Total BTEX Concentration (ug/L)
CPT-11	0	0	110000	337	110000
MW-6	23	1278	12500	334	12612
CPT-18	31	1709	27000	1310	6884
CPT-20	70	3816	8600	1410	7990
CPT-22	102	5575	180	50	5066

v_x = 0.0603 ft/day

v_x = 0.0184 m/day

Plot of Trimethylbenzene-Corrected Total BTEX Concentration versusTime



Appendix D9

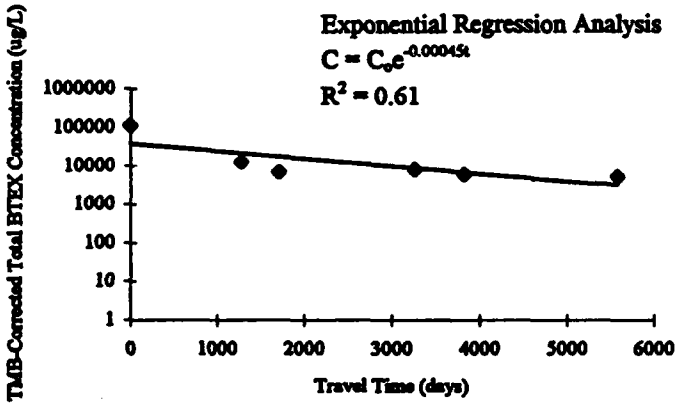
Data for First-Order Rate Constant Calculation using Conservative Tracer

Sampling Location	Distance Downgradient (m)	Travel Time Upgradient and Downgradient Point (days)	Measured Total BTEX Concentration (ug/L)	Total Trimethylbenzene Concentration (ug/L)	Trimethylbenzene-Corrected Total BTEX Concentration (ug/L)
CPT-11	0	0	110000	337	110000
MW-6	23	1278	12500	334	12612
CPT-18	31	1709	27000	1310	6884
CPT-19	60	3252	6000	980	8020
CPT-20	70	3816	8600	1410	5977
CPT-22	102	5575	180	50	5066

v_x = 0.0603 ft/day

v_x = 0.0184 m/day

Plot of Trimethylbenzene-Corrected Total BTEX Concentration versusTime



APPENDIX D9.
BTEX Mass Lost Due to Biodegradation and First Order Rate Constant Calculations
August 1994
Car Care Center Site
Intrinsic Remediation EE/CA
Boiling AFB, DC

Compound	Location (meters Downgradient of Source)															
	MW-4 (0) Measured Concentration (mg/L)	CPT-18 (160) Measured Concentration (mg/L)	CPT-18 (160) Corrected Concentration[a] (mg/L)	Percent Lost to Biodegradation Between A and B	Residence Time (weeks)	First Order Rate Constant Between MW-4 and CPT-19[b] (week^{-1})	CPT-19 (253) Measured Concentration (mg/L)	Point C Corrected Concentration[a] (mg/L)	Percent Lost to Biodegradation Between B and C	Residence Time (weeks)	First Order Rate Constant Between CPT-18 and CPT-19[b] (week^{-1})	CPT-22 (309) Measured Concentration (mg/L)	CPT-22 (309) Corrected Concentration[a] (mg/L)	Percent Lost to Biodegradation Between CPT-19[b] and CPT-22	Residence Time (weeks)	First Order Rate Constant Between CPT-19[b] and CPT-22 (week^{-1})
Benzene	21000	17000	34725	-75	381	-0.001	750	1003	94	221	0.013	1	12	98	333	0.012
Toluene	26000	2500	5401	79	381	0.004	570	495	80	221	0.007	72	1411	-681	333	-0.004
ethylbenzene	2100	1600	3456	-65	381	-0.001	980	1310	18	221	0.001	15	294	70	333	0.004
m & p-xylene	7400	4900	10085	-43	381	-0.001	3400	4545	7	221	0.000	26	1098	68	333	0.005
o-xylene	3000	910	1966	39	381	0.002	560	749	18	221	0.001	26	706	-26	333	-0.001
Total BTEX	69400	26910	56133	4	381	0.000	6060	8102	70	221	0.005	180	3521	42	333	0.002
Total TMB	2030	1310	2830	0	381	0.000	980	1310	0	221	0.000	20	980	0	333	0.000

a/ See text for calculation of corrected concentration.
b/ See text for calculation of first order rate constant.

advective ground water velocity = 0.42 ft/week = 22 ft/year
distance between MW-4 and CPT-18 = 160 feet
distance between CPT-18 and CPT-19 = 93
distance between CPT-19 and CPT-22 = 140

APPENDIX D9
STEADY-STATE SOLUTION TO THE ADVECTIVE-DISPERSIVE EQUATION ONE DIMENSIONAL FLOW, TYPE ONE BOUNDARY CONDITION (CONSTANT SOURCE WITH 0.004 DAY^{-1} FIRST-ORDER DECAY)

Hydrogeologic Data

Hydraulic conductivtiy $K := 1.7 \cdot 10^{-4} \cdot \frac{ft}{sec}$ $K = 14.688 \cdot \frac{ft}{day}$

Hydraulic gradient $I := 0.0014 \cdot \frac{ft}{ft}$

Effective porosity (Baker, 1994) $n_e := 0.35$

Total porosity $n := 0.35$

Longitudinal dispersivity (Parsons ES, 1985) $\alpha_x := 25 \cdot ft$

Retardation Coefficient Calculation

Maximum Contaminant Concentration $C_o := 110 \cdot \frac{mg}{liter}$

Contaminant Decay Rate $\lambda := .0004 \cdot \frac{1}{day}$

Minimum soil sorption coefficient (Wiedemeier et al., 1994) $K_{oc} := 79 \cdot \frac{mL}{gm}$

Particle mass density (Freeze and Cherry, 1979) $\rho_s := 2.6 \cdot \frac{gm}{cm^3}$

Bulk density (Freeze and Cherry, 1979) $\rho_b := \rho_s \cdot (1 - n)$ $\rho_b = 1.69 \cdot \frac{gm}{cm^3}$

Minimum organic carbon content $f_{oc} := 0.06 \cdot \%$

Retardation coefficient $R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$ $R = 1.229$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water) $v_x := \frac{K \cdot I}{n_e}$ $v_x = 21.459 \cdot \frac{ft}{yr}$

Contaminant velocity $v_c := \frac{v_x}{R}$ $v_c = 0.048 \cdot \frac{ft}{day}$

Longitudinal dispersion coefficient $D_x := \alpha_x \cdot v_x$ $D_x = 1.469 \cdot \frac{ft^2}{day}$

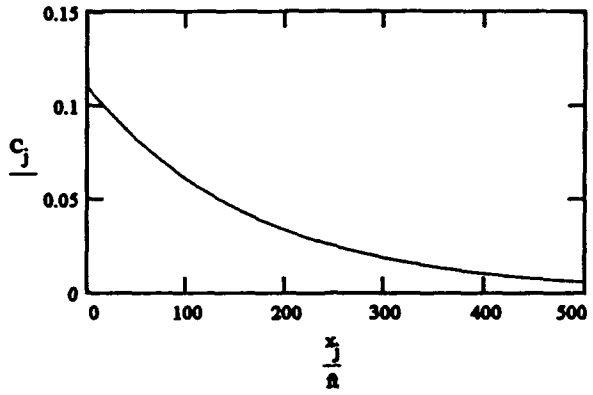
$j := 0..500$

$\Delta x := 1 \cdot ft$

$x_j := \Delta x \cdot j$

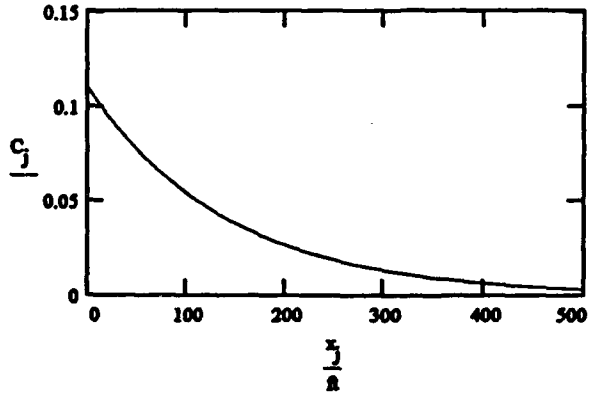
For Unretarded Flow with Biodegradation (Bear, 1979, p. 642, Domenico and Schwartz, 1990)

$$C_j := (C_o) \cdot \exp\left[\frac{x_j}{2 \cdot \alpha_x} \cdot \left[1 - \sqrt{1 + \left[\frac{4 \cdot \lambda \cdot \alpha_x}{(v_x)}\right]}\right]\right]$$



For Retarded Flow with Biodegradation (Wexler, 1992 p. 20, eq. 62)

$$C_j := C_o \cdot \exp\left[\frac{x_j}{2 \cdot \frac{D_x}{R}} \cdot \left[\frac{v_x}{R} - \sqrt{\left(\frac{v_x}{R}\right)^2 + 4 \cdot \lambda \cdot \frac{D_x}{R}}\right]\right]$$



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APPENDIX D9
STEADY-STATE SOLUTION TO THE ADVECTIVE-DISPERSIVE EQUATION ONE DIMENSIONAL FLOW, TYPE ONE BOUNDARY CONDITION (CONSTANT SOURCE WITH 0.003 DAY^{-1} FIRST-ORDER DECAY)

Hydrogeologic Data

Hydraulic conductivtiy $K := 1.7 \cdot 10^{-4} \cdot \frac{ft}{sec}$ $K = 14.688 \cdot \frac{ft}{day}$

Hydraulic gradient $I := 0.0014 \cdot \frac{ft}{ft}$

Effective porosity (Baker, 1994) $n_e := 0.35$

Total porosity $n := 0.35$

Longitudinal dispersivity (Parsons ES, 1985) $\alpha_x := 25 \cdot ft$

Retardation Coefficient Calculation

Maximum Contaminant Concentration $C_o := 110 \cdot \frac{mg}{liter}$

Contaminant Decay Rate $\lambda := .0003 \cdot \frac{1}{day}$

Minimum soil sorption coefficient (Wiedemeier et al., 1994) $K_{oc} := 79 \cdot \frac{mL}{gm}$

Particle mass density (Freeze and Cherry, 1979) $\rho_s := 2.6 \cdot \frac{gm}{cm^3}$

Bulk density (Freeze and Cherry, 1979) $\rho_b := \rho_s \cdot (1 - n)$ $\rho_b = 1.69 \cdot \frac{gm}{cm^3}$

Minimum organic carbon content $f_{oc} := 0.06 \cdot \%$

Retardation coefficient $R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$ $R = 1.229$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water) $v_x := \frac{K \cdot I}{n_e}$ $v_x = 21.459 \cdot \frac{ft}{yr}$

Contaminant velocity $v_c := \frac{v_x}{R}$ $v_c = 0.048 \cdot \frac{ft}{day}$

Longitudinal dispersion coefficient $D_x := \alpha_x \cdot v_x$ $D_x = 1.469 \cdot \frac{ft^2}{day}$

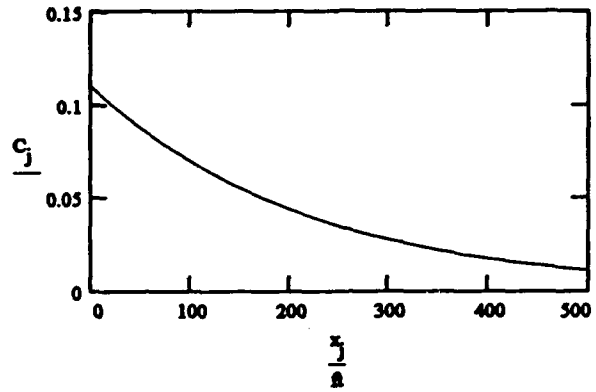
$j := 0 .. 500$

$\Delta x := 1 \cdot ft$

$x_j := \Delta x \cdot j$

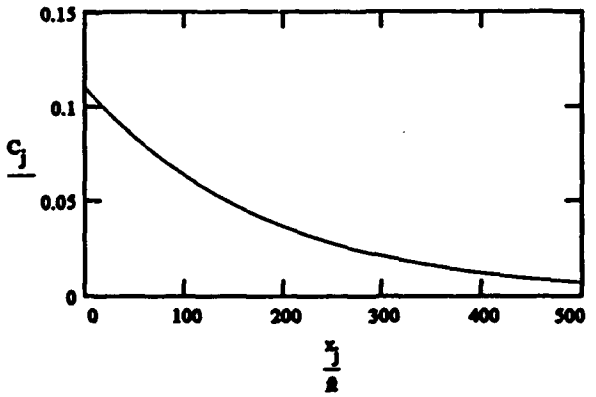
For Unretarded Flow with Biodegradation (Bear, 1979, p. 642, Domenico and Schwartz, 1990)

$$C_j := (C_o) \cdot \exp\left[\frac{x_j}{2 \cdot \alpha_x} \cdot \left[1 - \sqrt{1 + \left[\frac{4 \cdot \lambda \cdot \alpha_x}{(v_x)}\right]}\right]\right]$$



For Retarded Flow with Biodegradation (Wexler, 1992 p. 20, eq. 62)

$$C_j := C_o \cdot \exp\left[\frac{x_j}{2 \cdot \frac{D_x}{R}} \cdot \left[\frac{v_x}{R} - \sqrt{\left(\frac{v_x}{R}\right)^2 + 4 \cdot \lambda \cdot \frac{D_x}{R}}\right]\right]$$



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APPENDIX E

GRIDDED INPUT DATA AND BIOPLUME II MODEL OUTPUT

APPENDIX F

COSTING WORKSHEETS AND PRESENT WORTH CALCULATIONS

Alternatives 1, 2, and 3: Passive LNAPL Recovery

Standard Rate Schedule

Billing Category / Cost Code/(Billing Category)	Billing Rate	Installation/ Set-up (hrs)	Task 1 ($)	Bi-Monthly Site Work (hrs)	Task 2 ($)	2 Semi-Annual Reports (hrs)	Task 3 ($)
Word Processor 88/(15)	$30	2	$60	0	$0	4	$120
CADD Operator 58/(25)	$47	0	$0	0	$0	4	$188
Technician 42/(50)	$40	15	$600	240	$9,600	0	$0
Staff Level 16/(65)	$57	0	$0	0	$0	12	$684
Project Level 12/(70)	$65	2	$130	24	$1,560	2	$130
Senior Level 10/(80)	$85	0	$0	2	$170	0	$0
Principal 02/(85)	$97	0	$0	0	$0	0.5	$49
Total Labor (hrs/$)		19	$790	266	$11,330	22.5	$1,171
ODCs							
Phone			$10		$60		$10
Photocopy			$0		$0		$20
Mail			$0		$0		$20
Computer			$0		$0		$40
CAD			$0		$120		$60
WP			$0		$0		$40
Travel			$50		$1,200		$0
Eqpt. & Supplies			$800		$120		$0
Total ODCs			$860		$1,500		$190
Outside Services							
Drums, 2 per year			$0		$0		$80
Product Disposal ($1.80/gallon)			$0		$0		$243
including pick-up fees			$0		$0		$0
Laboratory Fees			$0		$0		$0
Other			$0		$0		$0
Total Outside Services			$0		$0		$323

Proposal Estimate	Task 1	Task 1	Task 2
Labor	$790	$11,330	$1,171
ODC's	$860	$1,500	$190
Outside Services	$0	$0	$323
Total by Task	$1,650	$12,830	$1,684

Total Labor	$13,291
Total ODCs	$2,550
Total Outside Services	$323
Total Project	$16,164

Task 1: Installation/Set-up
Task 2: Bimonthly Site Time and Travel Costs (per year)
Task 3: Report Preparation and Product Disposal (per year)

Alternatives 1, 2, and 3: Long-Term Monitoring

Standard Rate Schedule

Billing Category Cost Code/(Billing Category)	Billing Rate	Task 1 (hrs)	Install New LTM/POC Wells ($)	Task 2 (hrs)	Annual Sampling Costs ($)	Task 3 (hrs)	Annual Reporting Costs and PM ($)
Word Processor 88/(15)	$30	0	$0	8	$240	30	$900
CADD Operator 58/(25)	$47	0	$0	0	$0	40	$1,880
Technician 42/(50)	$40	5	$200	80	$3,200	20	$800
Staff Level 16/(65)	$57	50	$2,850	80	$4,560	40	$2,280
Project Level 12/(70)	$65	2	$130	8	$520	80	$5,200
Senior Level 10/(80)	$85	1	$85	4	$340	6	$510
Principal 02/(85)	$97	0	$0	0	$0	2	$194
Total Labor (hrs/$)		58	$3,265	180	$8,860	218	$11,764
ODCs							
Phone			$10		$0		$40
Photocopy			$10		$0		$40
Mail			$20		$200		$50
Computer			$0		$0		$400
CAD			$0		$0		$450
WP			$0		$0		$200
Travel			$540		$2,160		$0
Eqpt. & Supplies			$300		$500		$0
Total ODCs			$880		$2,860		$1,180
Outside Services							
Drilling Cost (4 wells to @ $45/ft) + mobe			$9,100		$0		$0
Soil Loading/Hauling/Disposal @$100/drum			$1,200		$0		$0
			$0		$0		$0
Laboratory Fees (BTEX/TVH), $150ea, 2 sets/yr		soil	$440	4 LTM, 3 POC, 2qa/qc,	$5,400		$0
Other: Maintain Institutional Controls			$0		$0		$5,000
Total Outside Services			$10,740		$5,400		$5,000

Proposal Estimate	Task 1	Task 2	Task 3
Labor	$3,265	$8,860	$11,764
ODC's	$880	$2,860	$1,180
Outside Services	$10,740	$5,400	$5,000
Total by Task	$14,885	$17,120	$17,944

Total Labor	$23,889
Total ODCs	$4,920
Total Outside Services	$21,140
Total Project	$49,949

Task 1: Install New LTM/POC Wells
Task 2: Annual Sampling Costs
Task 3: Annual Costs for Semiannual Reporting, PM, and Maintaining Institutional Controls

Alternative 2: Bioventing System Design and Installation

Standard Rate Schedule

Billing Category Cost Code/(Billing Category)	Billing Rate	Task 1	Work Plan ($)	Task 2	Pilot Study Field Work ($)	Task 3	Full-Scale Design ($)	Task 4	Bid ($)	Task 5	Installation ($)	Task 6	O&M, + 2 Semi-Annual Reports ($)
Word Processor 88/(15)	30	20	$600	0	$0	20	$600	10	$300	5	$150	32	$960
CADD Operator 58/(25)	47	15	$705	0	$0	20	$940	0	$0	0	$0	30	$1,410
Technician 42/(50)	40	0	$0	40	$1,600	0	$0	0	$0	0	$0	80	$3,200
Staff Level 16/(65)	57	40	$2,280	24	$1,368	80	$4,560	40	$2,280	80	$4,560	140	$7,980
Project Level 12/(70)	65	10	$650	50	$3,250	20	$1,300	0	$0	80	$5,200	30	$1,950
Senior Level 10/(80)	85	0	$0	4	$340	5	$425	5	$425	10	$850	5	$425
Principal 02/(85)	97	4	$388	0	$0	2	$194	1	$97	5	$485	2	$194
Total Labor (hrs/$)		89	$4,623	118	$6,558	147	$8,019	56	$3,102	180	$11,245	319	$16,119
ODCs													
Phone			$20		$20		$30		$20		$40		$100
Photocopy			$30		$0		$100		$100		$0		$200
Mail			$45		$0		$30		$0		$0		$75
Computer			$200		$0		$500		$200		$0		$600
CAD			$150		$0		$300		$0		$0		$0
WP			$200		$0		$200		$100		$0		$300
Travel			$0		$1,350		$0		$0		$1,200		$1,800
Eqpt. & Supplies			$0		$950		$0		$0		$1,750		$600
Total ODCs			$645		$2,320		$1,160		$420		$3,050		$3,675
Outside Services													
Drilling Cost			$0	1-VW, 3-MPs	$5,250		$0		$0	8 VWs, 8-MPs	$26,000		$0
Soil Loading/Hauling/Disposal			$0		$200		$0		$0		$200		$0
@$100/drum			$0		$0		$0		$0				$0
Electrical Costs			$0		$0		$0		$0		$0		$1,546
Natural Gas Costs			$0		$0		$0		$0		$0		$0
Laboratory Fees			$0		$600		$0		$0		$1,550		$2,100
Construction Costs			$0		$0		$0		$0		$14,000		$0
Total Outside Services			$0		$6,050		$0		$0		$41,750		$3,646

Proposal Estimate	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6
Labor	$4,623	$6,558	$8,019	$3,102	$11,245	$16,119
ODC's	$645	$2,320	$1,160	$420	$3,050	$3,675
Outside Services	$0	$6,050	$0	$0	$41,750	$3,646
Total by Task	$5,268	$14,928	$9,179	$3,522	$56,045	$23,440

Total Labor	$49,666
Total ODCs	$11,270
Total Outside Services	$51,446
Total Project	$112,382

Task 1: Work Plan Development
Task 2: Bioventing Pilot Study
Task 3: Design
Task 4: Prepare and Solicit Bids
Task 5: System Installation
Task 6: System Operation, Maintenance, Quarterly Monitoring, Semi-Annual Reporting, and Project Management

Alternative 3: Soil Vapor Extraction/Bioventing System Design and Installation, and Operation and Maintenance

Standard Rate Schedule

Category Cost Code/(Billing Category)	Rate	Task 1	Work Plan ($)	Task 2	Pilot Studies ($)	Task 3	Design ($)	Task 4	Bid ($)	Task 5	ICE System Installation ($)	Task 6	Quart., 1st Year, ICE System, 2 Semi-Annual Reports ($)	Task 7	Quart., 2nd-3rd Years, Bioventing System, 2 Semi-Annual Reports ($)
Word Processor 88/(15)	$30	20	$600	0	$0	20	$600	10	$300	5	$150	32	$960	32	$960
CADD Operator 58/(25)	$47	15	$705	0	$0	30	$1,410	0	$0	0	$0	30	$1,410	30	$1,410
Technician 42/(50)	$40	0	$0	40	$1,600	0	$0	0	$0	0	$0	0	$0	80	$3,200
Staff Level 16/(65)	$57	40	$2,280	24	$1,368	80	$4,560	40	$2,280	94	$5,358	352	$20,064	140	$7,980
Project Level 12/(70)	$65	10	$650	50	$3,250	40	$2,600	0	$0	80	$5,200	50	$3,250	30	$1,950
Senior Level 10/(80)	$85	0	$0	4	$340	5	$425	5	$425	10	$850	8	$680	5	$425
Principal 02/(85)	$97	4	$388	0	$0	2	$194	1	$97	5	$485	4	$388	2	$194
Total Labor (hrs)($)		89	$4,623	118	$6,558	177	$9,789	56	$3,102	194	$12,043	476	$26,752	319	$16,119
ODCs															
Phone			$20		$20		$30		$20		$40		$100		$100
Photocopy			$30		$0		$100		$100		$0		$200		$200
Mail			$45		$0		$30		$0		$0		$75		$75
Computer			$200		$0		$500		$200		$0		$600		$600
CAD			$150		$0		$300		$0		$0		$450		$450
WP			$200		$0		$200		$100		$0		$300		$300
Travel			$0		$1,350		$0		$0		$1,260		$1,530		$1,080
Eqpt. & Supplies			$0		$950		$0		$0		$1,750		$600		$600
Total ODCs			$645		$2,320		$1,160		$420		$3,050		$3,855		$3,405
Outside Services															
Drilling Cost			$0	1-VW and 3-MPs	$5,250		$0		$0	8 VWs, 8-MPs	$26,000		$0		$0
Soil Loading/Hauling/Disposal @$100/drum			$0		$200		$0		$0		$200		$0		$0
Electrical Costs for Bioventing Unit			$0		$0		$0		$0		$300		$0		$0
LP Fuel Costs for ICE Unit			$0		$0		$0		$0		$0		$6,912		$1,546
VR Systems Remote Dial-up			$0		$0		$0		$0		$0		$4,800		$0
AFCEE ICE Unit (Transportation to Bolling AFB)			$0		$0		$0		$0		$820		$500		$500
Laboratory Fees			$0		$600		$0		$0		$1,850		$1,200		$2,100
Construction Costs			$0		$0		$0		$0		$16,000		$0		$0
Total Outside Services			$0		$6,050		$0		$0		$45,170		$13,412		$4,146

Proposal Estimate	Task 1	Task 2	Task 3	Task 4	Task 5	Task 6	Task 7
Labor	$4,623	$6,558	$9,789	$3,102	$12,043	$26,752	$16,119
ODC's	$645	$2,320	$1,160	$420	$3,050	$3,855	$3,405
Outside Services	$0	$6,050	$0	$0	$45,170	$13,412	$4,146
Total by Task	$5,268	$14,928	$10,949	$3,522	$60,263	$44,019	$23,670

Total Labor	$78,986
Total ODCs	$14,855
Total Outside Services	$68,778
Total Project	$162,619

Task 1: Work Plan Development
Task 2: Vapor Extraction/Bioventing/Air Sparging Pilot Study
Task 3: Design
Task 4: Prepare and Solicit Bids
Task 5: System Installation
Task 6: ICE System Operation, Maintenance, Semiannual Monitoring, and Project Management
Task 7: Bioventing System Operation, Maintenance, Semiannual Monitoring, and Project Management

Present Worth Analysis Annual Discount Rate = 7%

Alternative 1: Passive Mobile LNAPL Removal, Intrinsic Remediation, and Institutional Controls with LTM	Present Worth ($)	Cost ($) at Year Indicated										
		Year: 1	2	3	4	5	6	7	8	9	10	11
LNAPL Recovery (3 years)												
Installation/Set-up	$1,542	$1,650	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bimonthly Site Work	$33,670	$12,830	$12,830	$12,830	$0	$0	$0	$0	$0	$0	$0	$0
2 Semiannual Reports	$4,419	$1,684	$1,684	$1,684	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Present Worth ($)	$38,089											
Maintain Institutional Controls (30 years)	$62,045	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Long-term Monitoring												
Install New LTM/POC Wells	$13,911	$14,885	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Semiannual Sampling (30 years)	$212,443	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120
Semiannual Reporting (30 years)	$121,906	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824
Project Management (30 years)	$38,716	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120
Subtotal Present Worth ($)	$449,022											

Total Present Worth Cost ($): $487,111

Cost ($) at Year Indicated																		
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120
$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824
$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120

Present Worth Analysis Annual Discount Rate = 7%

Alternative 2: Passive Mobile LNAPL Removal, Bioventing in the Source Area, Intrinsic Remediation, and Institutional Controls with LTM	Present Worth ($)	Cost ($) at Year Indicated: Year: 1	2	3	4	5	6	7	8	9	10	11
LNAPL Recovery (3 years)												
Installation/Set-up	$4,330	$1,650	$0	$0	$0							
Bimonthly Site Work	$33,670	$12,830	$12,830	$12,830	$0	$0	$0	$0	$0	$0	$0	$0
2 Semiannual Reports	$4,419	$1,684	$1,684	$1,684	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Present Worth ($)	$38,089											
Bioventing System Design, Installation, and Operation (5 years)												
Develop Work Plan	$4,923	$5,268	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Install Test Wells, Conduct Pilot Study	$13,951	$14,928	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Design System	$8,579	$9,179	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Prepare Bid Package	$3,292	$3,522	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Install System	$52,379	$56,045	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Project Management (5 years)	$7,995	$1,950	$1,950	$1,950	$1,950	$1,950	$0	$0	$0	$0	$0	$0
O&M, Prepare Semiannual Reports, Utility Costs (5 years)	$88,113	$21,490	$21,490	$21,490	$21,490	$21,490	$0	$0	$0	$0	$0	$0
Subtotal Present Worth ($)	$179,232											
Maintain Institutional Controls (13 years)	$46,968	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Long-term Monitoring												
Install New LTM/POC Wells	$13,911	$14,885	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Semiannual Sampling (13 years)	$143,083	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120	$17,120
Semiannual Reporting (13 years)	$82,106	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824	$9,824
Project Management (13 years)	$26,076	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120	$3,120
Subtotal Present Worth ($)	$312,143											

Total Present Worth Cost ($): $529,465

Cost ($) at Year Indicated																		
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$5,000	$5,000	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$17,120	$17,120	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$9,824	$9,824	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$3,120	$3,120	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Present Worth Analysis Annual Discount Rate = 7%

Alternative 3: Passive Mobile LNAPL Removal, Soil Vapor Extraction via. ICE and Bioventing in the Source Area Intrinsic Remediation, and Institutional Controls with LTM	Present Worth ($)	Cost ($) at Year Indicated										
		Year: 1	2	3	4	5	6	7	8	9	10	11
LNAPL Recovery (3 years)												
Installation/ Set-up	$4,330	$1,650	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Monthly Site Work	$33,670	$12,830	$6,480	$6,480	$0	$0	$0	$0	$0	$0	$0	$0
2-Semiannual Reports	$4,419	$1,684	$1,684	$1,684	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal Present Worth ($)	$38,089											
Vapor Extraction via ICE (for 1 year), Bioventing During years 2 and 3, System Design, Installation, and Operation and Maintenance												
Develop Work Plan	$4,923	$5,268	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Install Test Wells, Conduct Pilot Study	$13,951	$14,928	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Design System	$10,233	$10,949	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Prepare Bid Package	$3,292	$3,522	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Install System	$56,321	$60,263	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Project Management (3 years)	$5,117	$1,950	$1,950	$1,950	$0	$0	$0	$0	$0	$0	$0	$0
ICE System O&M, Reporting, and Utilities (for 1 year)	$39,317	$42,069	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Bioventing System O&M, Reporting and Utilities (for years 2 and 3)	$36,701	$0	$21,720	$21,720	$0	$0	$0	$0	$0	$0	$0	$0
	$169,855											
Maintain Institutional Controls (11 years)	$37,493	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Long-term Monitoring (11 years)												
Install New LTM/POC Wells	$13,911	$14,885	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Semiannual Sampling (11 years)	$128,377	$17,120	$8,318	$8,318	$8,318	$8,318	$8,318	$8,318	$8,318	$8,318	$8,318	$8,318
Semiannual Reporting (11 years)	$73,667	$9,824	$6,340	$6,340	$6,340	$6,340	$6,340	$6,340	$6,340	$6,340	$6,340	$6,340
Project Management (11 years)	$23,396	$3,120	$1,950	$1,950	$1,950	$1,950	$1,950	$1,950	$1,950	$1,950	$1,950	$1,950
Subtotal Present Worth ($)	$276,845											

Total Present Worth Cost ($): $484,789

Cost ($) at Year Indicated																		
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0