DRAFT

Treatability Study in Support of Remediation by Natural Attenuation for Groundwater at Site ST-24

Columbus Air Force Base
Columbus, Mississippi

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DRAFT

TREATABILITY STUDY IN SUPPORT OF REMEDIATION BY NATURAL ATTENUATION FOR GROUNDWATER AT SITE ST-24

at

COLUMBUS AIR FORCE BASE
COLUMBUS, MISSISSIPPI

JULY 1997

Prepared for:

AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
TECHNOLOGY TRANSFER DIVISION
BROOKS AIR FORCE BASE
SAN ANTONIO, TEXAS

and

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TABLE OF CONTENTS

Page

ACRONYMS vii

SECTION 1 - INTRODUCTION 1-1

1.1 Scope and Objectives 1-2
1.2 Facility Background 1-5

SECTION 2 - SITE CHARACTERIZATION ACTIVITIES 2-1

2.1 Drilling, Soil Sampling, And Monitoring Point Installation 2-2
2.1.1 Geoprobe® Operation 2-2
2.1.1.1 Pre-Drilling Activities 2-5
2.1.1.2 Equipment Decontamination Procedures 2-5
2.1.1.3 Drilling and Soil Sampling 2-5
2.1.2 Temporary Monitoring Point Installation 2-9
2.1.2.1 Monitoring Point Materials Decontamination 2-9
2.1.2.2 Monitoring Point Casing and Screen 2-9
2.1.2.3 Sand Filter Pack and Annular Sealant 2-10
2.1.2.4 Protective Cover 2-10
2.1.3 Well Development 2-11
2.2 Groundwater Sampling 2-11
2.2.1 Preparation for Sampling 2-12
2.2.2 Well/Point Purging and Sample Collection 2-13
2.2.3 Onsite Chemical Parameter Measurement 2-14
2.2.4 Sample Handling 2-15
2.3 Aquifer Testing 2-16
2.4 Surveying 2-17

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

3.1 Surface Features 3-1
3.1.1 Topography 3-1
3.1.2 Surface Water Hydrology 3-1
3.2 Regional Geology And Hydrogeology 3-3
3.3 Site Geology And Hydrogeology 3-5
3.3.1 Lithology and Stratigraphic Relationships 3-5

TABLE OF CONTENTS (Continued)

Page

3.3.2 Groundwater Hydraulics....3-6
3.3.2.1 Flow Direction and Gradient....3-6
Figure 3.2 Locations of Hydrogeologic Cross-Sections....3-7
Figure 3.3 Hydrogeologic Cross-SectionA-A'....3-8
Figure 3.4 Hydrogeologic Cross-Section B-B'....3-9
3.3.2.2 Hydraulic Conductivity....3-12
3.3.2.3 Effective Porosity....3-13
3.3.2.4 Advective Groundwater Velocity....3-13
3.3.2.5 Preferential Flow Paths....3-13
3.3.3 Groundwater Use....3-14
3.4 Climate....3-14

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

4.1 Source Of Contamination....4-1
4.2 Soil Chemistry....4-1
4.2.1 Soil BTEX....4-2
4.2.2 Total Organic Carbon....4-2
4.3 Groundwater Chemistry....4-4
4.3.1 Dissolved Hydrocarbon Contamination....4-4
4.3.2 Chlorinated Solvent Contamination....4-9
4.3.3 Inorganic Chemistry and Geochemical Indicators of BTEX Biodegradation....4-10
4.3.3.1 Dissolved Oxygen....4-17
4.3.3.2 Nitrate/Nitrite....4-18
4.3.3.3 Ferrous Iron....4-20
4.3.3.5 Soluble Manganese....4-22
4.3.3.6 Sulfate....4-24
4.3.3.7 Ammonium....4-26
4.3.3.8 Methane in Groundwater....4-28
4.3.3.9 Alkalinity and Carbon Dioxide Evolution....4-30
4.3.3.10 Reduction/Oxidation Potential....4-31
4.3.3.11 pH....4-35
4.3.3.12 Temperature....4-37
4.3.4 Expressed Assimilative Capacity....4-37

TABLE OF CONTENTS (Continued)

Page

SECTION 5 - GROUNDWATER MODELING 5-1

5.1 General Overview 5-1
5.2 Conceptual Model Design And Assumptions 5-4
5.3 Initial Model Setup 5-4
5.3.1 Groundwater Gradient 5-5
5.3.2 BTEX Concentrations 5-5
5.3.3 Degradation Rates 5-5
5.3.3.1 Trimethylbenzene Tracer Method 5-6
5.3.3.2 Method of Buscheck and Alcantar 5-8
5.3.3.3 Selection of a Decay Rate Constant 5-11
5.4 Model Calibration 5-11
5.5 Sensitivity Analysis 5-13

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 6-2
6.1.2 Implementability 6-2
6.1.3 Cost 6-3
6.2 Factors Influencing Alternatives Development 6-3
6.2.1 Program Objectives 6-3
6.2.2 Contaminant Properties 6-4
6.2.3 Site-Specific Conditions 6-7
6.2.3.1 Physical Characteristics 6-7
6.2.3.2 Geochemical Characteristics 6-8
6.2.3.3 Potential Receptor Exposure Pathways 6-10
6.2.3.4 Remediation Goals for Shallow Groundwater 6-12
6.2.4 Summary of Remedial Option Screening 6-13
6.3 Brief Description Of Remedial Alternatives 6-17
6.3.1 Alternative 1 - RNA and Institutional Controls with Long-Term Groundwater Monitoring 6-17
6.3.2 Alternative 2 - Biosparging with Soil Vapor Extraction In and Downgradient from the Source Area, RNA, and Institutional Controls with Long-Term Groundwater Monitoring 6-19
6.3.3 Alternative 3 - Groundwater Extraction, RNA, and Institutional Controls with Long-Term Groundwater Monitoring 6-20

TABLE OF CONTENTS (Continued)

Page

6.4 Evaluation of Alternatives 6-21
6.4.1 Alternative 1 - RNA and Institutional Controls with Long-Term Groundwater Monitoring 6-21
6.4.1.1 Effectiveness 6-21
6.4.1.2 Implementability 6-23
6.4.1.3 Cost 6-24
6.4.2 Alternative 2 - Biosparging with Soil Vapor Extraction In and Downgradient from the Source Area, RNA, Institutional Controls, and Long-Term Groundwater Monitoring 6-25
6.4.2.1 Effectiveness 6-25
6.4.2.2 Implementability 6-26
6.4.2.3 Cost 6-27
6.4.3 Alternative 3 - Groundwater Extraction, RNA, and Institutional Controls with Long-Term Groundwater Water Monitoring 6-28
6.4.3.1 Effectiveness 6-28
6.4.3.2 Implementability 6-29
6.4.3.3 Cost 6-29
6.5 Recommended Remedial Approach 6-30

SECTION 7 - LONG-TERM MONITORING PLAN 7-1

7.1 Overview 7-1
7.2 Monitoring Networks 7-2
7.2.1 Long-Term Monitoring Wells 7-2
7.2.2 Sentry Wells 7-8
7.3 Groundwater Sampling 7-8
7.3.1 Analytical Protocol 7-9
7.3.2 Sampling Frequency 7-9

SECTION 8 - CONCLUSIONS AND RECOMMENDATIONS 8-1

SECTION 9 - REFERENCES 9-1

TABLE OF CONTENTS (Continued)

LIST OF TABLES

No.	Title	Page
2.1	Monitoring Point and Monitoring Well Completion Data	2-4
2.2	Analytical Protocols for Groundwater and Soil Samples	2-8
3.1	Summary of Groundwater Elevation Data	3-10
3.2	November 1996 Slug Test Results	3-12
4.1	Soil Analytical Data	4-3
4.2	Groundwater Quality Data Summary for Fuel Hydrocarbons	4-6
4.3	Coupled Oxidation Reactions for BTEX Compounds	4-12
4.4	Geochemical Data	4-15
4.5	Expressed Assimilative Capacity Of Site Groundwater	4-38
5.1	First-Order Rate Constant Calculation using 1,2,4-TMB as a Conservative Tracer	5-9
5.2	First-Order Rate Constant Calculation Using the Method of Buscheck and Alcantar (1995)	5-10
6.1	Groundwater Quality Standards	6-12
6.2	Initial Technical Implementability Screening of Technologies and Process Options for Groundwater Remediation	6-14
6.3	Alternative 1 - Cost Estimate	6-25
6.4	Alternative 2 - Cost Estimate	6-28
6.5	Alternative 3 - Cost Estimate	6-30
6.6	Summary of Remedial Alternatives Evaluation for Groundwater Remediation	6-31
7.1	Long-Term Monitoring Analytical Protocol	7-5
7.2	Point-of-Compliance Monitoring Analytical Protocol	7-7

LIST OF FIGURES

No.	Title	Page
1.1	Location of Columbus AFB	1-6
1.2	Site Map Site ST-24	1-7
2.1	Groundwater and Soil Sampling Locations	2-3
3.1	Topographic Map of the Columbus AFB Area	3-2
3.5	Water Table Elevations November 1996	3-11
4.1	Total Dissolved BTEX Isopleth Map November 1996	4-5

TABLE OF CONTENTS (Continued)

LIST OF FIGURES (Continued)

No.	Title	Page
4.2	TVH in Groundwater Isopleth Map November 1996	4-8
4.3	Dissolved Oxygen Isopleth Map November 1996	4-16
4.4	Nitrate (as N) in Groundwater Isopleth Map November 1996	4-19
4.5	Ferrous Iron in Groundwater Isopleth Map November 1996	4-21
4.6	Soluble Manganese is Groundwater Isopleth Map November 1996	4-23
4.7	Sulfate in Groundwater Isopleth Map November 1996	4-25
4.8	Ammonium (as N) in Groundwater Isopleth Map November 1996	4-27
4.9	Methane in Groundwater Isopleth Map November 1996	4-29
4.10	Carbon Dioxide in Groundwater Isopleth Map November 1996	4-32
4.11	Total Alkalinity in Groundwater Isopleth Map November 1996	4-33
4.12	Redox Potential in Groundwater November 1996	4-34
4.13	Sequence of Microbially Mediated Redox Processes	4-36
7.1	Proposed Locations For Long-Term Monitoring and Point-of-Compliance Wells	7-4

ACRONYMS

AAFES	Army and Air Force Exchange Services
AETC	Air Education and Training Command
AFB	Air Force Base
AFCEE	United States Air Force Center for Environmental Excellence
ASCII	American Standard Code for Information Interchange
ATC	Air Training Command
atm-m^3/mol	atmospheres-cubic meters per mole
BEIA	Biomedical and Environmental Information Analysis
bgs	below ground surface
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
°C	degrees Celsius
$CaCO_3$	calcium carbonate
DO	dissolved oxygen
ft/day	feet per day
ft/ft	foot per foot
ft/yr	feet per year
HDPE	high density polyethylene
Hg	mercury

ID	inside diameter
kg	kilogram(s)
L	liter(s)
LNAPL	light nonaqueous-phase liquid
LTM	long-term monitoring
µg	microgram(s)
MDEQ	Mississippi Department of Environmental Quality
mg	milligram(s)
mm	millimeter(s)
msl	mean sea level
mV	millivolt(s)
Parsons ES	Parsons Engineering Science, Inc.
PID	photoionization detector
POC	point of compliance
QC	quality control
RAO	remedial action objective
redox	reduction/oxidation
RNA	remediation by natural attenuation
SAC	Strategic Air Command
SAP	sampling and analysis plan

SVE	soil vapor extraction
TCE	trichloroethene
TetraMB	tetramethylbenzene
TEX	toluene, ethylbenzene, and xylenes
TMB	trimetheylbenzene
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
TS	Treatability Study
TVA	Tennessee Valley Authority
TVH	total volatile hydrocarbons
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
UST	underground storage tanks
VOC	volatile organic compound

EXECUTIVE SUMMARY

This report presents the results of a treatability study (TS) performed by Parsons Engineering Science, Inc. (Parsons ES) at Site ST-24, Columbus Air Force Base, Mississippi, to evaluate remediation by natural attenuation (RNA) of dissolved fuel-hydrocarbons in groundwater. The TS focused on the fate and transport of dissolved benzene, toluene, ethylbenzene, and xylenes (BTEX) in the shallow groundwater at Site ST-24. No mobile light, non-aqueous-phase liquid (LNAPL) or residual LNAPL above the water table was observed at Site ST-24. Samples also were analyzed for dissolved chlorinated solvents; however, the presence of dissolved chlorinated solvents, detected during a previous sampling event, was not confirmed. The site history and the results of the soil and groundwater investigations conducted previously also are summarized in this report.

Comparison of BTEX, electron acceptor, and biodegradation byproduct isopleth maps for ST-24 provides strong qualitative evidence of biodegradation of dissolved BTEX compounds. These geochemical data strongly suggest that biodegradation of dissolved fuel hydrocarbons is occurring at the site via aerobic respiration and the anaerobic processes of denitrification, iron reduction, sulfate reduction, nitrogen fixation and methanogenesis. Redox conditions and site geochemical parameters suggest that the dominant natural attenuation mechanism is nitrogen fixation. Patterns observed in the distribution of hydrocarbons, electron acceptors, and biodegradation byproducts further indicate that biodegradation is reducing dissolved BTEX concentrations in site groundwater.

An important component of this study was an assessment of the potential for contamination in groundwater to migrate from the source areas to potential receptor exposure points (i.e., beneath Base housing located to the west of Site ST-24). An analytical model was used to evaluate the fate and transport of dissolved BTEX in the

shallow groundwater under the influence of advection, dispersion, sorption, and biodegradation. Input parameters for the model were obtained from site data collected by Parsons ES. Model parameters that were not measured at the site were estimated using reasonable literature values.

The results of this demonstration suggest that RNA of dissolved BTEX contamination is occurring at Site ST-24; furthermore, the estimated rates of biodegradation, when coupled with sorption, dispersion, and dilution, should be sufficient to reduce and maintain dissolved BTEX concentrations to levels below current regulatory guidelines long before potential downgradient receptors could be adversely affected. Conservative modeling suggests that under current conditions, the dissolved BTEX will not migrate beyond the current plume extent, and dissolved BTEX contamination throughout the plume will be reduced by 85-percent by the year 2027. Future site activities will not change, and the risk to any Base personnel would be minimal, provided institutional controls for soil and groundwater are maintained. Institutional controls such as restrictions on shallow groundwater use at the site would prevent completion of receptor exposure pathways until RNA is complete. The Air Force therefore recommends implementation of RNA and long-term monitoring (LTM) with institutional controls.

To verify model predictions, and to ensure that the selected technologies are meeting objectives, the Air Force recommends using 7 LTM wells and 3 sentry wells to monitor the long-term migration and degradation of the dissolved BTEX plume. In addition to analyses used to verify the effectiveness of RNA, the groundwater samples should be analyzed for BTEX compounds by US Environmental Protection Agency (USEPA) Method SW8020. If data collected under the LTM program indicate that the selected remedial system is not sufficient to reduce BTEX concentrations at downgradient well locations to levels considered protective of human health and the environment, additional corrective actions may be required to remediate groundwater at the site.

SECTION 1

INTRODUCTION

This report was prepared by Parsons Engineering Science, Inc. (Parsons ES), and presents the results of a Treatability Study (TS) conducted to evaluate remediation by natural attenuation (RNA) of fuel-hydrocarbon contaminated groundwater at the former Army and Air Force Exchange Services (AAFES) Station (Site ST-24) at Columbus Air Force Base (AFB), Mississippi. The main emphasis of the work described herein was to evaluate the effectiveness of natural attenuation mechanisms in reducing dissolved fuel-hydrocarbon concentrations in groundwater.

As used in this report, RNA refers to a management strategy that relies on natural attenuation mechanisms to remediate contaminants dissolved in groundwater and to control receptor exposure risks associated with contaminants in the subsurface. The United States Environmental Protection Agency (USEPA) defines natural attenuation as (Wilson, 1996):

> *The naturally-occurring processes in soil and groundwater environments that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in those media. These in-situ processes include biodegradation, dispersion, dilution, adsorption, volatilization, and chemical or biological stabilization or destruction of contaminants.*

As suggested by this definition, mechanisms for natural attenuation of benzene and other organic compounds include advection, dispersion, dilution from recharge, sorption, volatilization, and biodegradation. Of these processes, biodegradation is the only mechanism working to transform contaminants into innocuous byproducts. Contaminant

destruction occurs through biodegradation when indigenous microorganisms work to bring about a reduction in the total mass of contamination in the subsurface without artificial intervention (e.g., the addition of nutrients). Patterns and rates of natural attenuation can vary markedly from site to site, and within a single contaminant plume at a given site, depending on governing physical and chemical processes.

1.1 Scope and Objectives

Parsons ES was retained by the United States Air Force Center for Environmental Excellence (AFCEE) Technology Transfer Division to conduct site characterization and groundwater modeling to evaluate the scientific defensibility of RNA with long-term monitoring (LTM) as a component of remediation for contaminated groundwater at Columbus AFB. The primary objective of this project was to determine whether natural attenuation processes for fuel hydrocarbons are occurring in groundwater at the site. These objectives were accomplished by:

- Reviewing previously reported hydrogeologic, soil, and groundwater data for the site;
- Conducting supplemental site characterization activities to determine the nature and extent of soil and groundwater contamination;
- Collecting geochemical data in support of RNA;
- Developing a conceptual hydrogeologic model of the shallow saturated zone, including the current distribution of contaminants;
- Evaluating site-specific data to determine whether natural processes of contaminant attenuation and destruction are occurring in groundwater for dissolved concentrations of fuel hydrocarbon compounds at the site;

- Designing and executing an analytical groundwater flow and contaminant fate and transport model for site hydrogeologic conditions;
- Simulating the fate and transport of benzene, toluene, ethylbenzene, and xylenes (BTEX) in groundwater under the influence of biodegradation, advection, dispersion, and adsorption using the calibrated flow and transport model;
- Evaluating a range of model input parameters to determine the sensitivity of the model to those parameters and to consider several contaminant fate and transport scenarios;
- Determining if natural processes are sufficient to reduce dissolved hydrocarbon plume expansion so that water quality standards can be met at a downgradient point (sentry well location);
- Developing remedial action objectives (RAOs) and reviewing available remedial technologies;
- Using the results of modeling to recommend the most appropriate remedial option based on specific effectiveness, implementability, and cost criteria; and
- Providing a LTM plan that includes LTM and sentry well locations and a sampling and analysis plan.

The field work conducted under this program was oriented toward collecting the supplementary hydrogeological and chemical data necessary to document and model natural attenuation mechanisms currently operating at the site. During November 1996, site characterization activities included use of the Geoprobe® direct-push technology for soil sample collection and temporary monitoring point installation; aquifer testing; and sampling and analysis of groundwater from temporary groundwater monitoring points and previously installed monitoring wells. Much of the hydrogeological and groundwater

chemical data necessary to evaluate RNA were available from previous investigations conducted at this site, from other sites with similar characteristics, or from technical literature.

Site-specific data were used to develop an analytical fate and transport model for the site to evaluate processes of natural attenuation. The modeling effort was used to simulate the movement of dissolved BTEX in the shallow saturated zone under the influence of biodegradation, advection, dispersion, and sorption. Results of the model were used to assess the potential for completion of other exposure pathways involving groundwater and to determine whether RNA with LTM is an appropriate and defensible remedial option for contaminated groundwater. The modeling results will be used to provide technical support for RNA with LTM remedial option during regulatory negotiations, as appropriate.

This report contains nine sections, including this introduction, and five 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 fate and transport model and design of the conceptual model for the site, lists model assumptions and input parameters, and describes the sensitivity analysis. Section 6 presents a comparative analysis of remedial alternatives and model results. 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 Geoprobe® borehole logs, monitoring point installation records, and slug test results. Appendix B presents soil and groundwater analytical results. Appendix C contains model input and output. Appendix D contains calculations for remedial option design and costing.

1.2 Facility Background

Columbus AFB is in northeastern Mississippi, in the northwestern portion of Lowndes County (Figure 1.1). The Base covers approximately 4,411 acres in a lightly urbanized area 10 miles north of Columbus, Mississippi. Columbus AFB was initially activated on February 9, 1942 as a pilot training facility. It was closed in 1946 and remained inactive until 1951, when it was reopened as a contract flying school operated by California Eastern Airways, Inc. On April 1, 1955, the United States Air Force (USAF) Air Training Command (ATC) transferred the Base to the Second Air Force of the Strategic Air Command (SAC). An active building program was instituted by SAC to prepare the Base for its mission as the home of a B-52 squadron and a KC-135 tanker squadron, both of which arrived in 1959. ATC regained jurisdiction of the Base on July 1, 1969. The current training missions at Columbus AFB require the use and maintenance of T-1, T-37, T-38, and AT-38 training aircraft. ATC became the Air Education and Training Command (AETC) on July 1, 1993. Base Realignment and Closure (BRAC) decisions in 1991, 1993, and 1995 continue to impact the mission and structure of the Base (Spencer, 1996b).

Site ST-24, the former AAFES Service Station, is located east of Independence Avenue between First and Second Streets in the central portion of the Base (Figure 1.2). The site contained three 10,000-gallon underground storage tanks (USTs), three fueling islands, and distribution lines for the refueling of privately owned vehicles. The USTs contained leaded, unleaded regular, and unleaded premium gasoline. The facility also had an oil UST that reportedly leaked. On December 10, 1988, the gasoline USTs failed a tightness test, and subsequently were taken out of service. All four USTs and associated piping were removed in 1989. Based upon the analyses of soil samples taken in the area of the former USTs, Parsons ES has assumed that all of the contaminated soil was removed from this area to just above the water table; however, this has not been documented. Contamination from the oil tank was observed during the UST removal, but all of the oil-

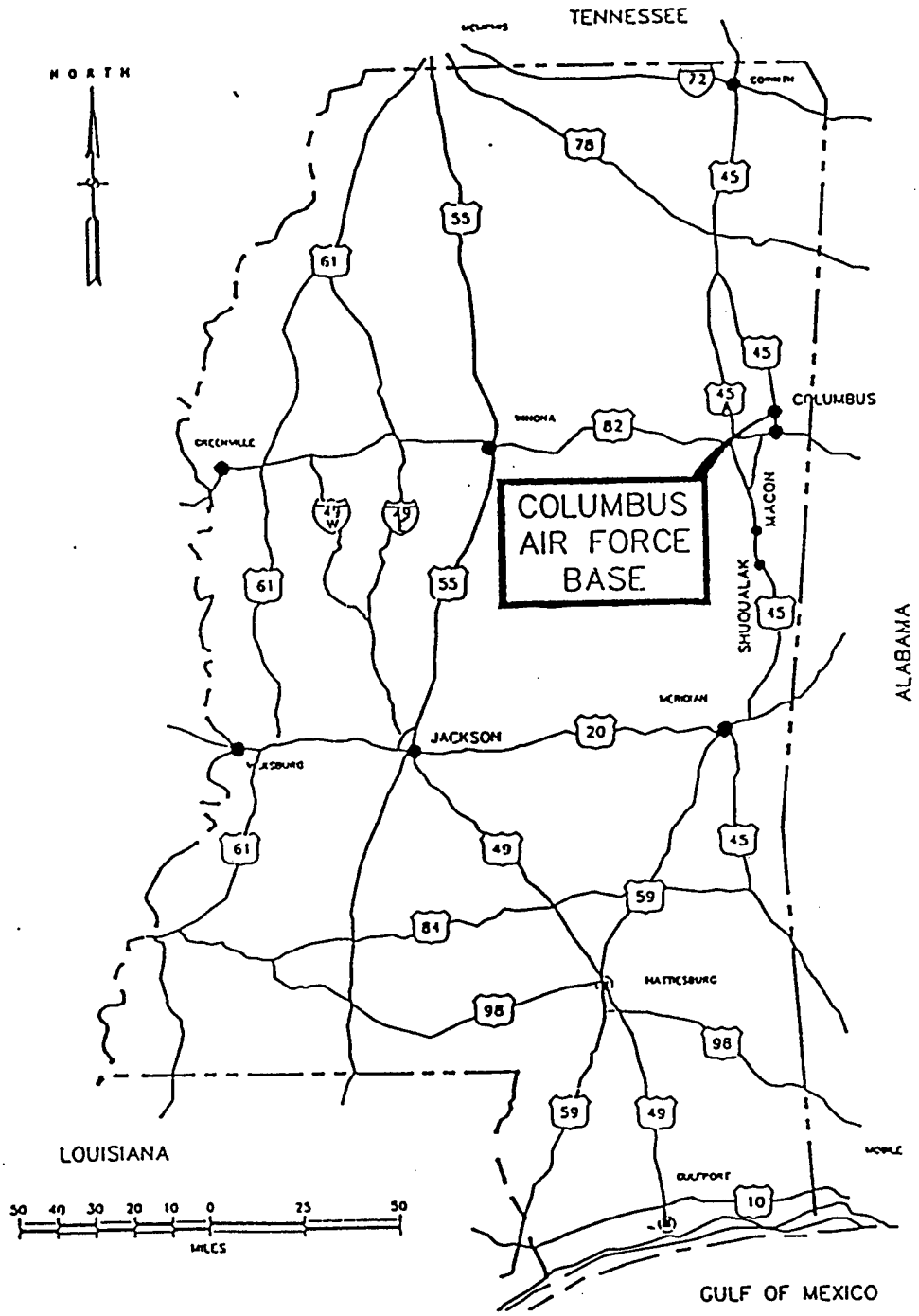

FIGURE 1.1

LOCATION OF COLUMBUS AFB

Site ST-24 RNA TS
Columbus AFB, Mississippi

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Denver, Colorado

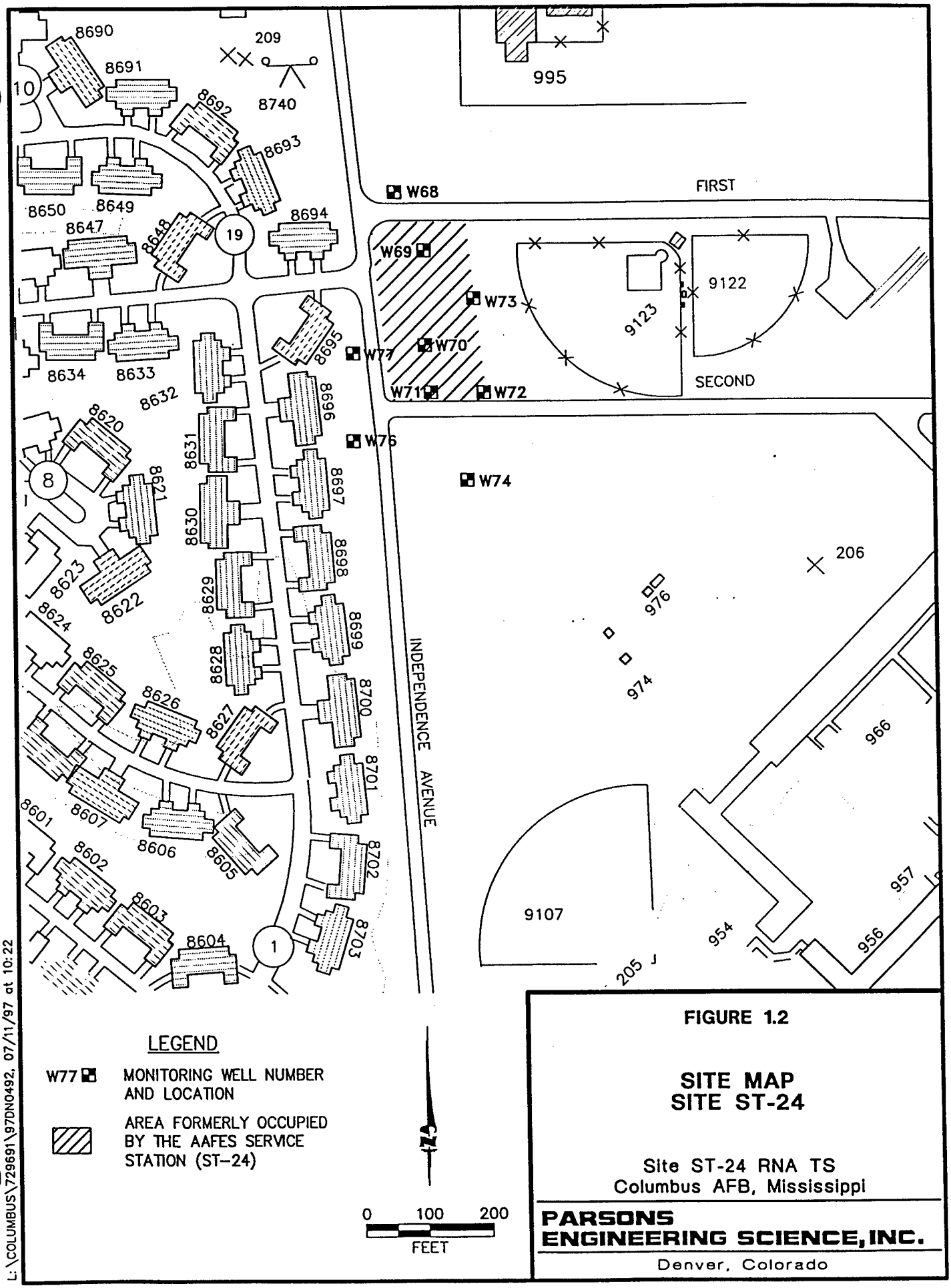

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FIGURE 1.2

SITE MAP
SITE ST-24

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

contaminated soil was not removed at that time (Spencer, 1996b). In May 1993, the remaining oil-contaminated soil was removed by the US Army Corps of Engineers (USACE) (CH2M Hill, 1995). The site has been restored, and is currently an open grassy field; there is no surface evidence of the former service station. There are currently nine groundwater wells located in the immediate vicinity of Site ST-24 (Figure 1.2)

SECTION 2

SITE CHARACTERIZATION ACTIVITIES

This section presents the methods used by Parsons ES personnel to collect site-specific data at Site ST-24 at Columbus AFB, Mississippi. To meet the requirements of the RNA demonstration, data were collected in one site characterization event. The site characterization was performed in November 1996, and consisted of monitoring point installation, soil and groundwater sampling, and aquifer testing to evaluate near-surface geology and geochemistry, aquifer properties, and the extent of soil and groundwater contamination for the area surrounding ST-24. Temporary groundwater monitoring point installation and soil sampling were accomplished during this investigation using the Geoprobe® direct-push system. Groundwater sampling was accomplished during this investigation using both temporary monitoring points and previously installed monitoring wells. Hydraulic conductivity (slug) tests were conducted at several of the site monitoring wells. Previously collected data were integrated with data collected as described above to develop the conceptual site model and to aid in the interpretation of the physical setting (Section 3) and contaminant distribution (Section 4).

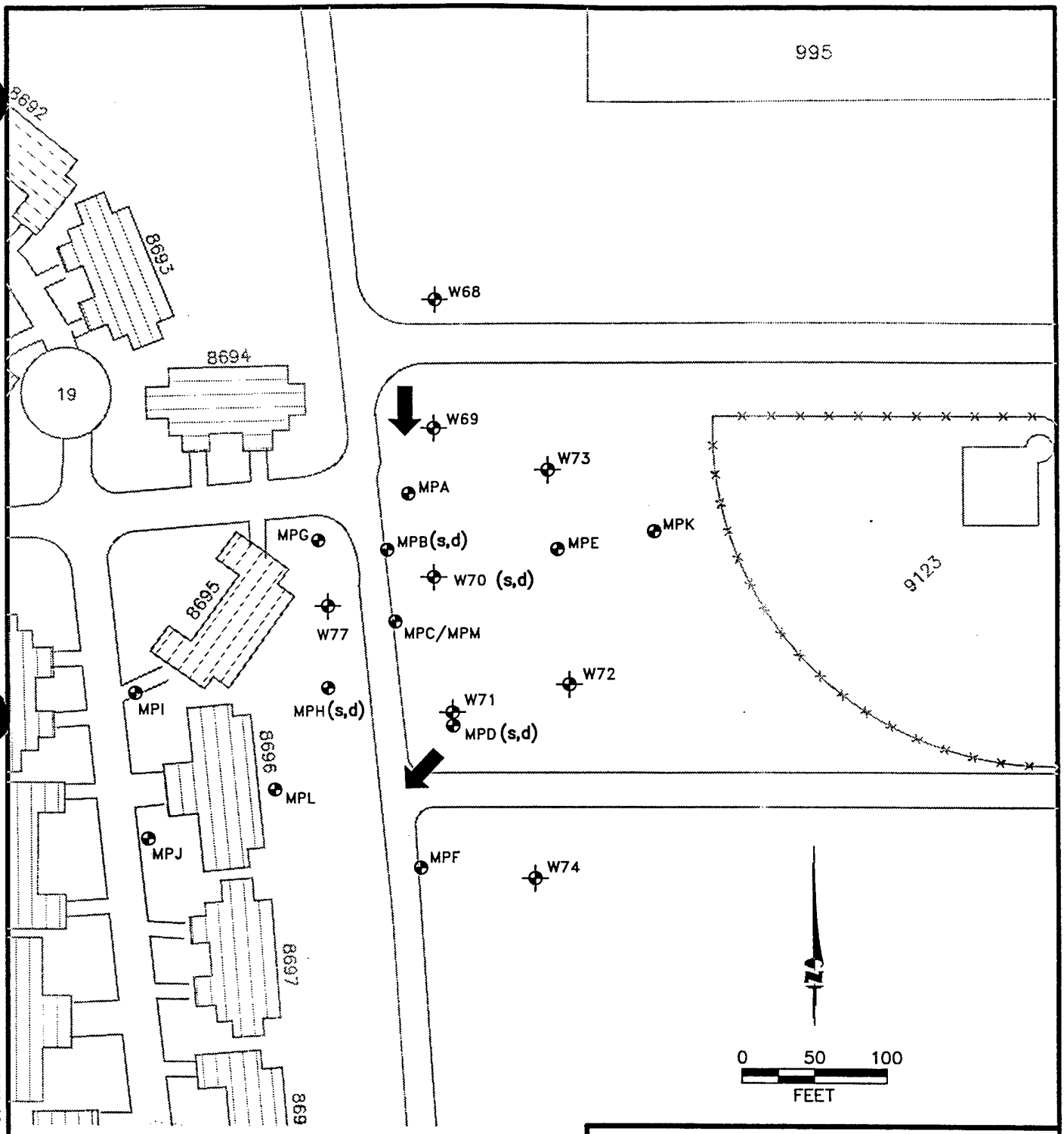
The following sections describe the procedures that were followed when collecting site-specific data. Additional details regarding investigative activities are presented in the work plan (Parsons ES, 1996).

2.1 DRILLING, SOIL SAMPLING, AND MONITORING POINT INSTALLATION

Drilling-related field work occurred between November 8 and November 16, 1996, and consisted of soil sampling and temporary groundwater monitoring point installation. Eighteen temporary groundwater monitoring points were installed at 14 locations to assist in the characterization of the shallow groundwater flow system at Site ST-24. These monitoring points were identified as MPA, MPB(s), MPB(d), MPD(s), MPD(d), MPE, MPF, MPG, MPH(s), MPH(d), MPI, MPJ, MPK(s), MPK(d), MPL, MPM, W70(d), and W77(d). The new points were installed in the locations shown on Figure 2.1. Table 2.1 presents monitoring well/point completion details. The nested points were installed adjacent to each other, with one point (designated by the suffix "s") screened near the water table surface, and with the deeper point (designated by the suffix "d") screened at the base of the unconsolidated shallow aquifer, immediately above a semi-impervious clay layer. A second monitoring point, MPM, was installed at the same location and depth as MPC because MPC could not be developed or sampled. The monitoring point locations were selected to provide the hydrogeologic data necessary for successful implementation of the fate and transport model and to support the RNA demonstration. These activities were performed according to the procedures described in the work plan (Parsons ES, 1996) and summarized in the following sections.

2.1.1 Geoprobe® Operation

The Geoprobe® system is a hydraulically powered percussion/probing machine used to advance sampling tools through unconsolidated soils. This system provides for the rapid collection of soil, soil gas, and groundwater samples at shallow depths while minimizing the generation of investigation-derived waste materials. For convenience, throughout this report, operation of the Geoprobe® is referred to as "drilling".



LEGEND

MPA — MONITORING POINT

W77 — MONITORING WELL

(s,d) — SHALLOW, DEEP

DIRECTION OF GROUNDWATER FLOW

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FIGURE 2.1

GROUNDWATER AND SOIL SAMPLING LOCATIONS

Site ST-24 RNA TS
Columbus AFB, Mississippi

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TABLE 2.1
MONITORING POINT AND MONITORING WELL COMPLETION DATA
SITE ST-24 RNA TS
COLUMBUS AIR FORCE BASE, MISSISSIPPI

Well Identification	Installation Date	Well Inside Diameter (Inches)	Screened Interval (Feet bgs)[a/]	Survey Northing (State Plane)[b/]	Survey Easting (State Plane)	Top of Casing Elevation (Feet msl)[c/]	Elevation Datum
New Monitoring Points							
MPA	11/9/96	0.375	19.1-19.6	1443457.9769	615624.9014	209.0	Top of Tubing
MPB(s)	11/9/96	0.375	18.9-19.4	1443418.8592	615610.0118	209.0	Top of Tubing
MPB(d)	11/9/96	0.375	28.4-28.9	1443418.8592	615610.0118	209.0	Top of Tubing
MPD(s)	11/9/96	0.375	19-19.5	1443368.9037	615614.2654	208.4	Top of Tubing
MPD(d)	11/9/96	0.375	28.6-29.1	1443368.9037	615614.2654	208.4	Top of Tubing
MPE	11/10/96	0.375	18.9-19.4	1443418.7517	615728.0933	208.2	Top of Tubing
MPF	11/10/96	0.375	19-19.5	1443197.2292	615631.9702	208.4	Top of Tubing
MPG	11/10/96	0.375	19-19.5	1443429.2569	615565.7435	209.1	Top of Tubing
MPH(s)	11/10/96	0.375	19.2-19.7	1443323.9337	615567.4470	208.3	Top of Tubing
MPH(d)	11/10/96	0.375	29-29.5	1443323.9337	615567.4470	208.5	Top of Tubing
MPI	11/10/96	0.375	18-18.5	1443319.1459	615435.8379	206.9	Top of Tubing
MPJ	11/16/96	0.375	20.6-21.1	1443217.3471	615444.3941	206.2	Top of Tubing
MPK(s)	11/10/96	0.375	17.7-18.2	1443431.3740	615794.4663	207.7	Top of Tubing
MPK(d)	11/10/96	0.375	26.5-27	1443431.3740	615794.4663	207.6	Top of Tubing
[illegible]PL	11/14/96	0.375	18.0-18.5	1443252.5809	615538.1359	206.5	Top of Tubing
[illegible]PM (MPC)	11/9/96	0.375	18.0-18.5	1443370.2946	615613.4789	208.8	Top of Tubing
W70(d)	11/10/96	0.375	27.5-28	1443398.2369	615647.1944	209.5	Top of Tubing
W77(d)	11/10/96	0.375	29-29.5	1443381.8863	615570.7410	209.0	Top of Tubing
Pre-Existing Monitoring Wells							
W68	5/15/89	2.0	10-20	1443590.6141	615643.5132	207.5	Top of PVC Casing
W69	5/19/89	2.0	5-20	1443502.8884	615642.5652	208.9	Top of PVC Casing
W70(s)	5/23/89	2.0	5-20	1443399.8006	615642.6427	208.3	Top of PVC Casing
W71	5/23/89	2.0	5-20	1443306.1899	615655.4957	207.8	Top of PVC Casing
W72	5/18/89	2.0	5-20	1443325.3992	615736.1057	206.8	Top of PVC Casing
W73	5/16/89	2.0	5-20	1443473.8001	615721.4309	207.3	Top of PVC Casing
W74	5/12/89	2.0	12-22	1443190.1939	615710.9057	206.3	Top of PVC Casing
W76	5/12/89	2.0	8-18	1443250.9041	615530.6381	205.5	Top of PVC Casing
W77(s)	5/16/89	2.0	6-16	1443379.8400	615566.7325	207.9	Top of PVC Casing

[a/] Feet bgs = feet below ground surface.

[b/] State Plane = State of Mississippi Plane Coordinate System.

[c/] Feet msl = feet above mean sea level.

2.1.1.1 Pre-Drilling Activities

All subsurface utility lines or other man-made subsurface features were located, and proposed drilling locations were cleared and approved by the Base prior to any drilling activities. Water used in equipment cleaning or grouting was obtained from a potable water supply designated by the Base. Suitability of the water source was verified by field personnel.

2.1.1.2 Equipment Decontamination Procedures

Prior to arriving at the site, and between each drilling location, all probe rods, tips, sleeves, pushrods, samplers, tools, and other downhole equipment were decontaminated using an Alconox® detergent and potable water solution followed by a potable water wash. Fittings, tips, and samplers also underwent an additional rinse with isopropyl alcohol followed by a final rinse with deionized water. Precautions were taken to minimize impact to the areas surrounding decontamination operations. All decontamination activities were conducted in a manner so that the excess water was controlled and not allowed to flow into any open borehole.

All decontamination fluids were collected and contained in 55-gallon drums. The contents of the drums were inspected prior to disposal. Because none of the water exhibited any signs of contamination, Base Civil Engineering was so notified, and the water was released to the sanitary sewer.

2.1.1.3 Drilling and Soil Sampling

Drilling was accomplished using the Geoprobe® direct-push technology. The boreholes were sampled continuously to the total depth of the borehole. Where two points were installed adjacent to each other (i.e., nested), only the deeper point was logged and sampled. The Geoprobe®-collected soil samples were obtained using 4-foot by 1.5-inch inside-diameter (ID) and 2-foot by 1-1/16 inch-ID sampling devices. The large sampler was used for the initial 10 feet of soil. The smaller sampler was then

used for the remainder of the borehole in an attempt to minimize the smearing of surface contamination into deeper portions of the borehole. A probe-drive sampler attached to the leading end of the probe rods serves as both the driving point and the sample collection device. To collect a soil sample, the sampler was pushed or driven to the desired sampling depth, the drive point was retracted to open the sampling barrel, and the sampler was subsequently pushed into the undisturbed soils. The soil cores were retained within a clear acetate liner inside the sampling barrel. The probe rods were then retracted, bringing the sampling device to the surface. The soil sample was then extruded from the liners for visual lithologic logging, photoionization detector (PID) headspace screening, and collection for chemical testing.

The Parsons ES field geologist observed drilling and monitoring point installation activities and maintained a detailed descriptive log of recovered subsurface materials. Final geologic borehole logs are presented in Appendix A. These logs contain:

- Sampled interval (top and bottom depth);
- Presence or absence of contamination based on odor, staining, and/or PID readings;
- Soil description, including color, major textural constituents, minor constituents, relative moisture content, plasticity of fines, cohesiveness, grain size, structure or stratification, and any other significant observations; and
- Lithologic contacts, with the depth to contacts and/or significant textural changes recorded to the nearest 0.1 foot.

Bags containing soil samples collected for the headspace screening procedure were quickly sealed and stored for 15 minutes or longer at the ambient temperature. Semiquantitative measurements were made by puncturing the bag seal with the PID probe and reading the concentration of the headspace gases. The PID relates the

concentration of total volatile organic compounds (VOCs) in the sample to an isobutylene calibration standard. The PID also was used to monitor for VOCs in the worker breathing zone.

Soil samples were collected from boreholes MPA, MPC, MPD, and MPF. Where no elevated PID headspace readings were encountered, samples were collected from immediately above the water table. Where PID readings were elevated, one of the samples submitted for laboratory analysis was from the interval giving the highest reading. Analytical sample containers and appropriate container lids were provided by Evergreen Analytical, Inc. of Wheat Ridge, Colorado. Personnel from Parsons ES performed the soil sampling.

The sample containers were filled completely to minimize headspace. The containers were sealed with Teflon® tape, and lids were placed over the tape and tightly closed. A sample label was firmly attached to the container side, and the following information was legibly and indelibly written on the label:

- Sample identification;
- Requested analyses;
- Sample depth;
- Sampling date; and
- Sample collector's initials.

After the samples were sealed and labeled, they were placed in a cooler with ice and held for transport to the laboratory. Soil samples were analyzed for the parameters listed in Table 2.2.

TABLE 2.2
ANALYTICAL PROTOCOLS FOR GROUNDWATER AND SOIL SAMPLES
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

MATRIX Analyte	METHOD	FIELD (F) OR ANALYTICAL LABORATORY (L)
WATER		
Total Iron	Colorimetric, Hach Method 8008 (or similar)	F
Ferrous Iron (Fe+2)	Colorimetric, Hach Method 8146 (or similar)	F
Ferric Iron (Fe+3)	Difference between total and ferrous iron	F
Manganese	Colorimetric, Hach Method 8034 (or similar)	F
Sulfide	Colorimetric, Hach Method 8131 (or similar)	F
Sulfate	Colorimetric, Hach Method 8051 (or similar)	F
Nitrate	Titrimetric, Hach Method 8039 (or similar)	F
Nitrite	Titrimetric, Hach Method 8507 (or similar)	F
Redox Potential	A2580B, direct-reading meter	F
Oxygen	Direct-reading meter	F
pH	E150.1/SW9040, direct-reading meter	F
Conductivity	E120.1/SW9050, direct-reading meter	F
Temperature	E170.1	F
Alkalinity (Carbonate [CO3-2] and Bicarbonate [HCO3-1])	Titrimetric, Hach Method 8221 (or similar)	F
Carbon Dioxide	CHEMetrics Method 4500	F
Nitrate	E300 or SW9056	L
Nitrite	E300 or SW9056	L
Chloride	E300 or SW9056	L
Sulfate	E300 or SW9056	L
Alkalinity	E150.1	L
Methane	RSKSOP 175[a/] or EAL-SOP-GC404	L
Total Organic Carbon	SW9060	L
Aromatic Hydrocarbons (Including Trimethylbenzene and Tetramethylbenzene)	SW8020A	L
Total Volatile Hydrocarbons	SW8015 Modified	L
Volatile Organic Compounds	SW8240B	L
SOIL		
Total Organic Carbon	SW9060	L
Moisture	ASTM D-2216	L
Aromatic Hydrocarbons	SW8020	L
Total Hydrocarbons	SW8015	L
Volatile Organic Compounds	SW8240B	L

[a/]RSKSOP = National Risk Management Laboratory standard operating procedure.

2.1.2 Temporary Monitoring Point Installation

Temporary groundwater monitoring points were installed in 18 boreholes at 14 locations under this program (Figure 2.1). Detailed monitoring point installation procedures are described in the following paragraphs.

2.1.2.1 Monitoring Point Materials Decontamination

Monitoring point completion materials were inspected by the field geologist and determined to be clean and acceptable prior to use. All monitoring point completion materials were factory sealed in plastic wrap. Pre-packaged casing, sand, and bentonite were used in well construction, and were inspected for possible external contamination before use. Materials that could not be cleaned to the satisfaction of the field geologist were not used.

2.1.2.2 Monitoring Point Casing and Screen

Upon completion of Geoprobe® soil sampling to the proper borehole termination depth, a temporary monitoring point was installed. The temporary monitoring points were constructed using Teflon®-lined, high-density, polyethylene (HDPE) tubing threaded through the center of the drive rods. The tube was attached to a 0.5-foot-long, 0.375-inch-diameter stainless steel, double-woven wire screen with 0.145-millimeter (0.037-inch) slot size. The screen was threaded into a dedicated stainless steel drive point/implant anchor that remained in place after the drive rods were removed. Purging and sampling followed directly.

For shallow monitoring points, the 6-inch screen was placed within the water table. Because of the very short screen length, it was not realistic to attempt to screen across the water table so that mobile light nonaqueous-phase liquid (LNAPL) could be detected (if present). Deep monitoring points were screened just above the base of the semi-confining clay layer. Screen positions were selected by the field hydrogeologist

after consideration was given to the geology and hydraulic characteristics of the stratum in which the monitoring points were screened.

Monitoring point construction details were noted on a monitoring point installation record and are summarized in Table 2.1. This information became part of the permanent field record for the site. Monitoring point installation records for ST-24 are presented in Appendix A.

2.1.2.3 Sand Filter Pack and Annular Sealant

Placement of a filter pack around the monitoring point casing screens was not possible (or necessary) because the sand borehole walls collapsed. Therefore, the temporary monitoring points were naturally sand-packed with the formation materials. Due to the sandy nature of the formation materials, well development and purging activities were accomplished without difficulty. A filter pack seal of sodium bentonite chips or grout was placed in the portion of the hole that remained open following collapse of the sandy borehole walls. This was typically the top 2 to 3 feet of the borehole.

2.1.2.4 Protective Cover

For all temporary monitoring points, protective 8-inch-diameter, flush-mount casings were set into a 2-foot-square concrete pad to a depth of 0.5 to 1.0 foot below ground surface (bgs). The casings were cemented in place with the bottom anchored in a 6-inch thick gravel pad in order to facilitate drainage of precipitation penetrating the protective casing. The tops of the covers were placed approximately at ground surface. Monitoring point identifications were permanently inscribed on the point casings and protective covers.

2.1.3 Well Development

Prior to sampling, the temporary monitoring points were developed. Typically, development removes sediment from inside the well casing and flushes fines, cuttings, and drilling fluids from the sand pack and the portion of the formation adjacent to the well screen. Use of the Geoprobe® system to place monitoring points eliminates cuttings and drilling fluids. Therefore, development of monitoring points is primarily intended to minimize the amount of fine sediment that might accumulate in the casing.

Monitoring point development was accomplished using a peristaltic pump with dedicated silicon tubing. The silicon tubing was attached to the Teflon®-lined tubing comprising the monitoring point casing, and directed through the peristaltic pump head. Development was continued until a minimum of 10 casing volumes of water were removed from the point and the groundwater pH, temperature, conductivity, and dissolved oxygen concentrations had stabilized. All development water was placed in 55-gallon drums. Drums were visually inspected prior to disposal. Because none of the development water exhibited any signs of contamination, Base Civil Engineering was so notified, and the water was released to the sanitary sewer.

2.2 GROUNDWATER SAMPLING

This section describes the procedures used for collecting groundwater samples. In order to maintain a high degree of quality control (QC) during this sampling event, the procedures described in the site work plan (Parsons ES, 1996) and summarized in this section were followed.

Groundwater sampling from 14 newly installed temporary monitoring points and the 9 existing monitoring wells (Figure 2.1) occurred between November 8 and 18, 1996. Monitoring well W76 was not sampled because an unknown object was blocking the inner casing. In addition, four deep monitoring points were not sampled in November 1996 because of poor recovery. Groundwater sampling forms were used to document

the specific details of the sampling event for each location. Groundwater samples were analyzed for the parameters listed in Table 2.2. Groundwater samples were analyzed by Parsons ES personnel in the field for alkalinity, ferrous iron, free carbon dioxide, pH, reduction/oxidation (redox) potential, soluble manganese, sulfide, sulfate, nitrite, nitrate, chloride, and temperature. Laboratory analyses for methane, nitrate and nitrite, sulfate, purgeable aromatic hydrocarbons, and total fuel carbon were performed by Evergreen Analytical, Inc.

2.2.1 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. Special care was taken to prevent contamination of the groundwater and extracted samples through cross contamination from improperly cleaned equipment; therefore, water level indicators and sampling equipment were thoroughly cleaned before and after field use and between uses at different sampling locations. In addition, a clean pair of new, disposable gloves was worn each time a different well/point was sampled.

All portions of sampling and test equipment that contacted the sample were thoroughly cleaned before use. This equipment included the water level probe and cable, equipment for measuring onsite groundwater chemical parameters, and other equipment that contacted the samples. All peristaltic pump tubing was dedicated to each sampling location. The following cleaning protocol was used:

- Clean with potable water and phosphate-free laboratory detergent;
- Rinse with potable water;
- Rinse with isopropyl alcohol;
- Rinse with distilled or deionized water; and

- Air dry prior to use.

Any deviations from these procedures were documented in the field scientist's field notebook and on the groundwater sampling form. Decontamination fluids were contained and managed as described in Section 2.1.1.2.

As required, field analytical equipment was calibrated according to the manufacturers' specifications prior to field use. This requirement applied specifically to onsite chemical measurements of dissolved oxygen (DO), temperature, conductivity, and pH.

Prior to removing any water from the existing monitoring wells, the static water level was measured. An electrical water level probe was used to measure the depth to groundwater below the well datum to the nearest 0.01 foot. After measurement of the static water level, the water level probe was lowered to the bottom of the well for measurement of total well depth (recorded to the nearest 0.01 foot). Mobile LNAPL (i.e., free product) was not encountered at ST-24. Based on these measurements, the volume of water to be purged from the monitoring wells was calculated. For the temporary monitoring points, the volume of water to be purged was estimated from the total depth of the monitoring point.

2.2.2 Well/Point Purging and Sample Collection

A peristaltic pump was used for well evacuation. For monitoring wells, both dedicated HDPE and silicon tubing were used. For monitoring points, dedicated silicon tubing was attached directly to the Teflon®-lined HDPE tubing used for the point casing. Purging consisted of removing at least three times the calculated casing volume prior to sample collection. Once three casing volumes were removed from the well, purging continued until the DO, temperature, and conductivity readings had

stabilized. Purge water was placed in 55-gallon drums and disposed of in the same manner as development water and decontamination fluids.

The same peristaltic pump and dedicated tubing arrangement was used to extract groundwater samples from each well or Geoprobe® point. The groundwater sample was transferred directly into the appropriate sample container. The water was carefully poured down the inner walls of the sample bottle to minimize aeration of the sample. Sample bottles for BTEX and total fuel carbon analysis were filled so that there was no headspace or air bubbles within the container. Table 2.2 lists the analyses performed on collected groundwater samples.

2.2.3 Onsite Chemical Parameter Measurement

Measurement of DO, pH, specific conductance, redox potential, and temperature was performed at the sampling location at the time of sample collection. All other field parameters were measured onsite by Parsons ES personnel at their temporary laboratory immediately following sample collection.

DO measurements were taken using a YSI-55® DO meter in a HDPE beaker at the outlet of the peristaltic pump. DO concentrations were recorded after the readings stabilized, and in all cases represent the lowest DO concentration observed.

Because the specific conductance, pH, redox potential, and temperature of groundwater can change significantly within a short time following sample acquisition, parameters were measured in the same beaker used for DO measurements. Conductivity and temperature were measured using an Extech® meter. Redox potential and pH were measured using an Orion® 250A meter.

An onsite laboratory staffed by Parsons ES personnel was used to analyze for several indicator parameters in groundwater samples collected from pre-existing monitoring wells and newly installed monitoring points (Table 2.1). A Hach® DR/700 colorimeter

was used to measure ferrous iron (Fe^{+2}), total iron (Fe), manganese (Mn^{+2}), and sulfide (S^{2-}). Titrations using Hach® reagents were conducted to measure alkalinity [as milligrams per liter (mg/L) calcium carbonate ($CaCO_3$)] and chloride (Cl^-); and CHEMtric® color tests were used to measure ammonia (NH_3) and carbon dioxide (CO_2). These analyses were completed for each groundwater sample after all sample containers had been filled. The sample to be analyzed was poured into a clean glass container, capped, and transported to the Parsons ES on-Base laboratory for analysis. Special care was taken to avoid aerating the sample in the sample container, which could influence the concentration of reduced species. The field holding time for each sample did not exceed 0.5 hour. Care was taken to minimize sample temperature changes and exposure to sunlight. Concentrations of these indicator parameters were not measured in soil samples.

2.2.4 Sample Handling

Evergreen Analytical, Inc. provided appropriate pre-preserved sample containers. Samples were delivered to the Parsons ES temporary laboratory within minutes of sample collection. Samples for those analyses not performed at the temporary laboratory were appropriately packaged and shipped by the Parsons ES field personnel to Evergreen Analytical, Inc. in Wheat Ridge, Colorado for analysis. The associated chain-of-custody documentation for the fixed-base laboratory was completed by the Parsons ES field personnel.

The sample containers were filled as described in Sections 2.2.3, 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;

- Requested analysis;
- Sample type (groundwater);
- Sampling date;
- Sampling time;
- Preservatives added; and
- Sample collector's initials.

2.3 AQUIFER TESTING

Slug tests were performed by Parsons ES in November 1996 in wells W68, W69, W70, W71, W74, and W77 (Figure 2.1) to provide estimates for the hydraulic conductivity of the shallow saturated zone in the vicinity of ST-24. Slug tests are single-well hydraulic tests used to estimate the hydraulic conductivity of an aquifer in the immediate vicinity of the tested well. Slug testing can be performed using either a rising head or a falling head test. Both rising head and falling head tests were used at this site. Detailed slug testing procedures are presented in the *Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater* (Wiedemeier *et al.*, 1995), hereafter referred to as the technical protocol document.

Data obtained during slug testing were analyzed using the computer program AQTESOLV® (Geraghty & Miller, Inc., 1994) and the methods of Bouwer and Rice (1976) and Bouwer (1989) for unconfined conditions. The results of slug testing are presented in Section 3.3 and Appendix A.

2.4 SURVEYING

After completion of field work in November 1996, the locations and elevations of all new monitoring points were surveyed by CH_2M Hill, a company licensed to perform land surveying. The horizontal locations and elevations of the measurement datum (top of well casing or top of outer casing) were measured relative to existing control points referenced to the Mississippi State plane coordinate system. Horizontal locations were surveyed to the nearest 0.5 foot. Measurement datum and ground surface elevations were surveyed to the nearest 0.1 foot and referenced to mean sea level (msl) elevation. Survey data are presented in Table 2.1 and Appendix A.

SECTION 3

PHYSICAL CHARACTERISTICS OF THE STUDY AREA

This section describes the physical characteristics of Site ST-24 as determined from data collected by Parsons ES in November 1996, in conjunction with data documented in previous reports on ST-24 and Columbus AFB (CH2M Hill, 1989 and 1995; Spencer, 1996a and 1996b). Investigative techniques used by Parsons ES to determine the physical characteristics of the site are discussed in Section 2.

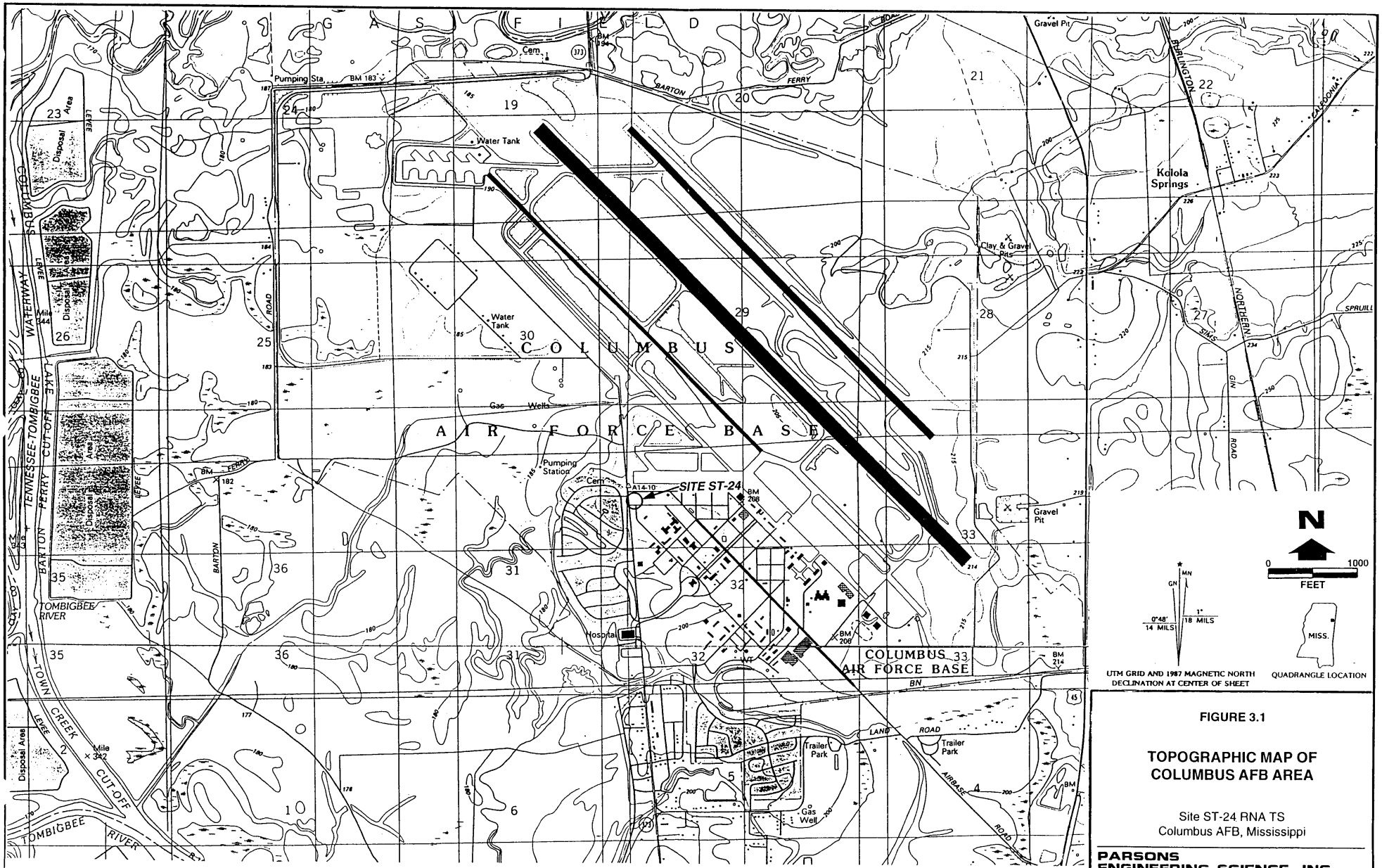
3.1 SURFACE FEATURES

3.1.1 Topography

Columbus AFB is located in northeastern Mississippi and lies in the Tombigbee and Tennessee River Hills physiographic district of the Gulf Coastal Plain (CH2M Hill, 1989). This area is characterized by a low, relatively flat terrain. Land surface elevations in the vicinity of Columbus AFB range from 180 to 220 feet above msl. A topographic map of Columbus AFB is presented as Figure 3.1.

3.1.2 Surface Water Hydrology

Columbus AFB is bounded to the west and north by the Tombigbee River and the Buttahatchie River, respectively. Surface water runoff from the Base primarily drains into the Tombigbee River, with exception of the northeastern portion of the Base, which drains into the Buttahatchie River. The northwestern corner of the Base lies within the 100-year floodplain of both rivers and occasionally floods (CH2M Hill, 1995).



Source: USGS, 1987.

FIGURE 3.1

TOPOGRAPHIC MAP OF COLUMBUS AFB AREA

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

3.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

The shallow subsurface geology in northeastern Mississippi consists of Cretaceous Gulf Coastal Plain sediments overlain by Quaternary alluvial sediments (CH2M Hill, 1989). The Cretaceous coastal plain sediments unconformably overlie an irregular surface of Paleozoic basement rocks (CH2M Hill, 1989).

Unconsolidated sediments comprise the upper 40 feet of subsurface geology at the Base. These sediments are alluvial and lower terrace deposits composed of sand and gravel overlying clay and sandy clay. Upper units of the Cretaceous Coastal Plain sediments consist of sand, silt, gravel, clay, and calcareous marine strata. Lower units of the Cretaceous Series comprise a southward-thickening wedge of sand, clay, shale, gravel, and calcareous strata of marine origin (CH2M Hill, 1989). The upper units of the Coastal Plain sediments that crop out in the vicinity of Columbus AFB lie on the eastern flank of the Mississippian Embayment, a southward-plunging structural syncline. The embayment is essentially a large trough that subsided as Cretaceous sediments were deposited in a shallow inland sea. Stratigraphic units in the vicinity of the Base slope toward the axis of the embayment syncline, though the southwest dip of strata is less than 20 feet per mile (CH2M Hill, 1989). This structural control has resulted in north-south trending outcrop belts in areas surrounding the Base. Paleozoic basement rocks crop out only in the northeastern corner of the state as Devonian and Mississippian sedimentary units.

Sandy Cretaceous sediments are the most important source of groundwater in Lowndes County. Recharge to these aquifers occurs mainly by downward infiltration of rainwater in outcrop areas (CH2M Hill, 1989). The regional hydrogeology within Lowndes County consists of two major hydrogeologic units: a surficial, unconfined alluvial aquifer and the deeper, confined to semi-confined Eutaw Aquifer. The surficial aquifer is part of the Upper Eutaw Formation, and includes the Tombigbee

sand member when present. The Eutaw Formation is generally identified by the presence of glauconitic sediments (Spencer, 1996a). The surficial aquifer averages less than 40 feet in thickness and consists of alluvial sand, silty clay, and gravel deposits. Previous studies show the regional hydraulic conductivity of the surficial aquifer to vary between 3.8 and 570 feet per day (ft/day) (CH2M Hill, 1989).

The semi-confining layer that separates the upper, surficial aquifer and the deeper, confined to semi-confined Eutaw Aquifer is estimated to be approximately 5 to 90 feet thick across the Base (CH2M Hill, 1995). This layer primarily consists of low-permeability silt and clay interlayered with sand and has hydraulic conductivities ranging from 1.9×10^{-2} ft/day to 1.7×10^{-4} ft/day (CH2M Hill, 1989). Eutaw sediments of the confining layer have been identified as greenish-gray, finely laminated clay in the vicinity of the Base (Spencer, 1996a).

The confined to semi-confined Eutaw Aquifer consists of both Eutaw Formation and Tuscaloosa Group sediments. The confined Eutaw Aquifer is about 150 feet thick in the vicinity of the Base and receives most of its recharge north of the Base at the formation outcrop (CH2M Hill, 1989). The regional groundwater flow direction within the Eutaw Aquifer in the vicinity of the Base is toward the west-southwest, coinciding with the regional dip of the Formation. The Eutaw Aquifer consists of tan to brown sand (called Tuscaloosa sand) with coarse gravel and lenses of clay (CH2M Hill, 1989). Previous studies show the hydraulic conductivity of the Eutaw Aquifer within the Base to vary between 2 and 30 ft/day, and to average 7 ft/day (Spencer, 1996a). Beneath the Eutaw Formation is the Tuscaloosa Group, which consists of coarse sand and gravel deposits. Columbus AFB operates three potable water supply wells completed in the Tuscaloosa Group, at depths of approximately 400 feet bgs (CH2M Hill, 1995).

Shallow groundwater in the vicinity of the Base is typically present within the surficial aquifer at approximately 15 feet bgs. However, it is reported that groundwater elevations in the surficial aquifer may vary seasonally by as much as 10 feet, depending on rainfall patterns (CH2M Hill, 1989). Aquifer recharge occurs by downward infiltration of rainwater through the relatively permeable alluvial deposits. Shallow groundwater within the northern section of the Base generally flows to the northwest toward the Buttahatchie River, while groundwater within the southern half of the Base, generally flows to the west-southwest toward the Tombigbee River (CH2M Hill, 1995; Spencer, 1996b).

3.3 SITE GEOLOGY AND HYDROGEOLOGY

Characterization of the subsurface sediments at Site ST-24 has been the objective of several investigations; the site geology and hydrogeology descriptions presented below were principally derived from a previous site inspection report (CH2M Hill, 1995) and the current investigation. There are currently nine groundwater monitoring wells associated with ST-24. As part of the current investigation, 18 monitoring points were installed at 14 locations using a Geoprobe®, including monitoring points at locations W77 and W70 (Figure 2.1).

3.3.1 Lithology and Stratigraphic Relationships

Surface soils at the site primarily consist of the upper terrace Prentiss-Rosella-Steens Association, which is composed of sand, silt, and clay loams, and the lower floodplain Cahaba-Prentiss-Guyton Association, which is composed of silty and clayey loams. The respective soil associations cover approximately equal areas of the Base, with the upper terrace soils more common in the southeastern half of the Base, and the lower floodplain soils more common in the northwestern section. Two to 10 feet of soil overlies approximately 40 feet of unconsolidated sediments composed of alluvial sand

and gravel. In turn, the unconsolidated sediments overly coastal plain clay and sandy clay deposits.

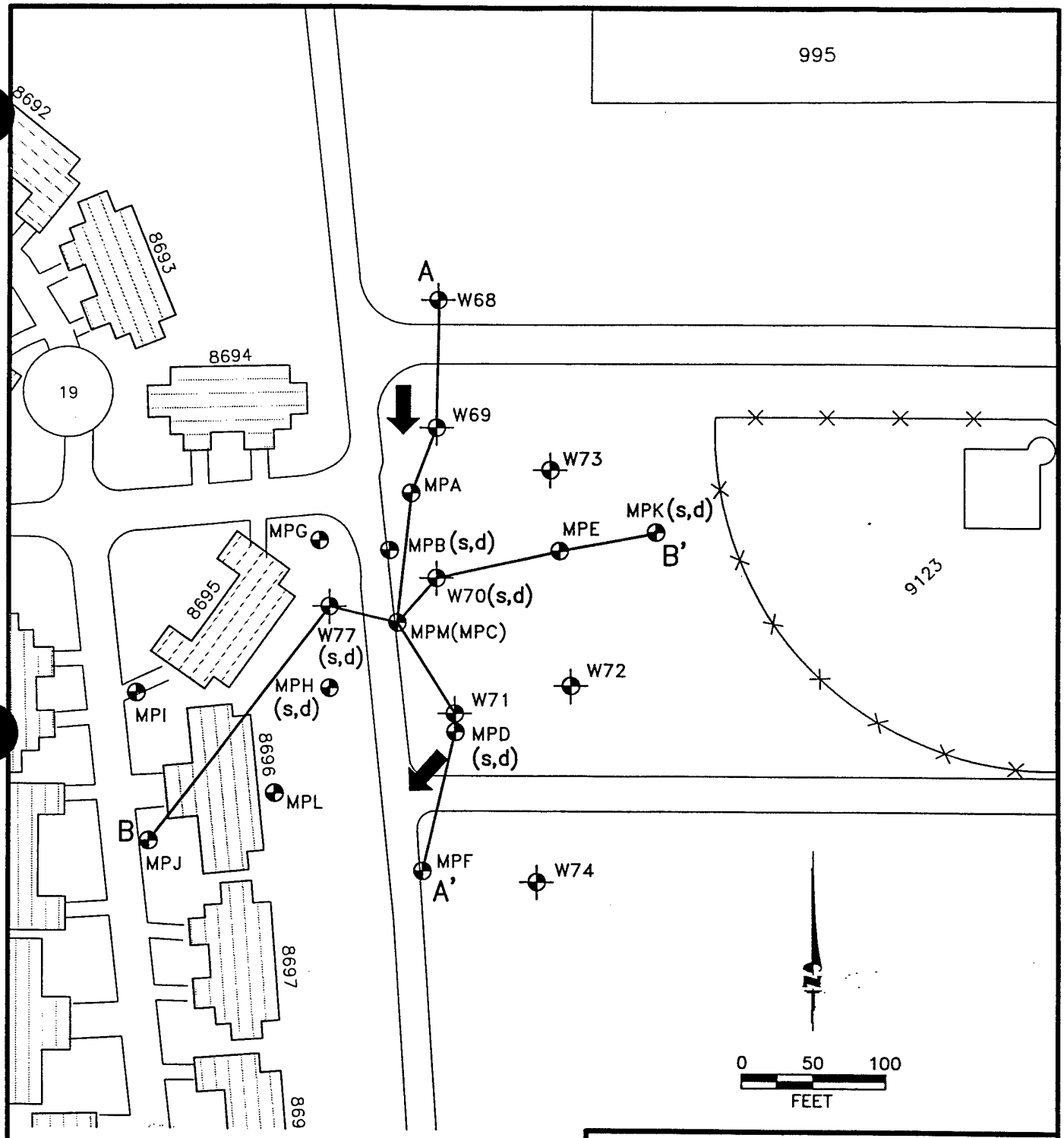
To illustrate these stratigraphic relationships, hydrogeologic sections have been developed from subsurface data derived from logs of previously installed monitoring wells and from the November 1996 Geoprobe® investigation. Figure 3.2 shows the locations of these sections. Because site groundwater flows in a southwesterly direction, both cross sections were developed to trace this flow path. Figure 3.3 presents hydrogeologic section A-A', and Figure 3.4 presents hydrogeologic section B-B'. In general, hydrogeologic sections A-A' and B-B' depict 2 to 10 feet of silty and clayey soils covering 3 to 10 feet of sand to sandy silt, which in turn, overly sandy to silty gravel. A dark gray clay was encountered at a depth of 24 feet bgs at MPJ, in the southwest portion of the state.

3.3.2 Groundwater Hydraulics

The water table at the site is located in the sediments of the surficial unconfined aquifer. Depth to groundwater is approximately 11 to 16 feet bgs across the site. A summary of groundwater measurements from November 1996 is presented in Table 3.1. Construction details for temporary monitoring points are presented in Table 2.1 and Appendix A.

3.3.2.1 Flow Direction and Gradient

Figure 3.5 shows groundwater elevations for ST-24 in November 1996. Due to anomalous water level measurements, MPF and W71 were not used for contouring. For nested monitoring point pairs, the shallow monitoring point groundwater elevation was used for contouring. Groundwater flows to the southwest with a nonuniform gradient ranging from 0.005 to 0.017 foot per foot (ft/ft), and averages 0.01 ft/ft across the site. These gradients are consistent with values observed in February 1995,



LEGEND

MPA — MONITORING POINT

W77 — MONITORING WELL

B——B' TRACE OF HYDROGEOLOGIC CROSS-SECTION

DIRECTION OF GROUNDWATER FLOW

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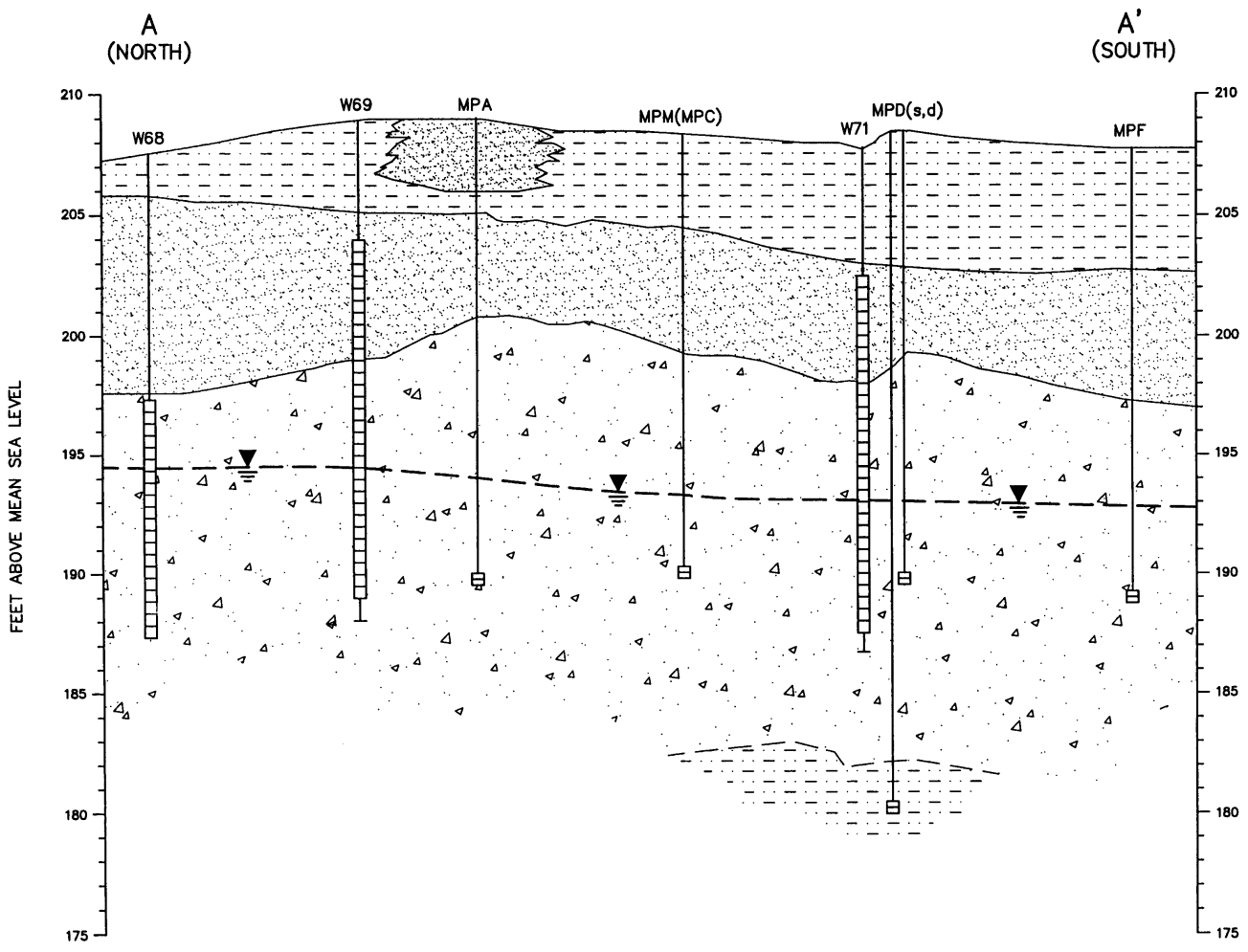
FIGURE 3.2

LOCATION OF HYDROGEOLOGIC CROSS-SECTIONS

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado



LEGEND

- SILTY CLAY TO CLAYEY SILT, SOME SAND
- SAND TO SANDY SILT
- SANDY TO SILTY GRAVEL, SOME CLAY
- WATER TABLE ELEVATION (NOVEMBER 1996)

Vertical Scale: 0, 5

Horizontal Scale: 0, 25, 50

Vertical Exaggeration 10x

FIGURE 3.3

HYDROGEOLOGIC CROSS-SECTION A-A'

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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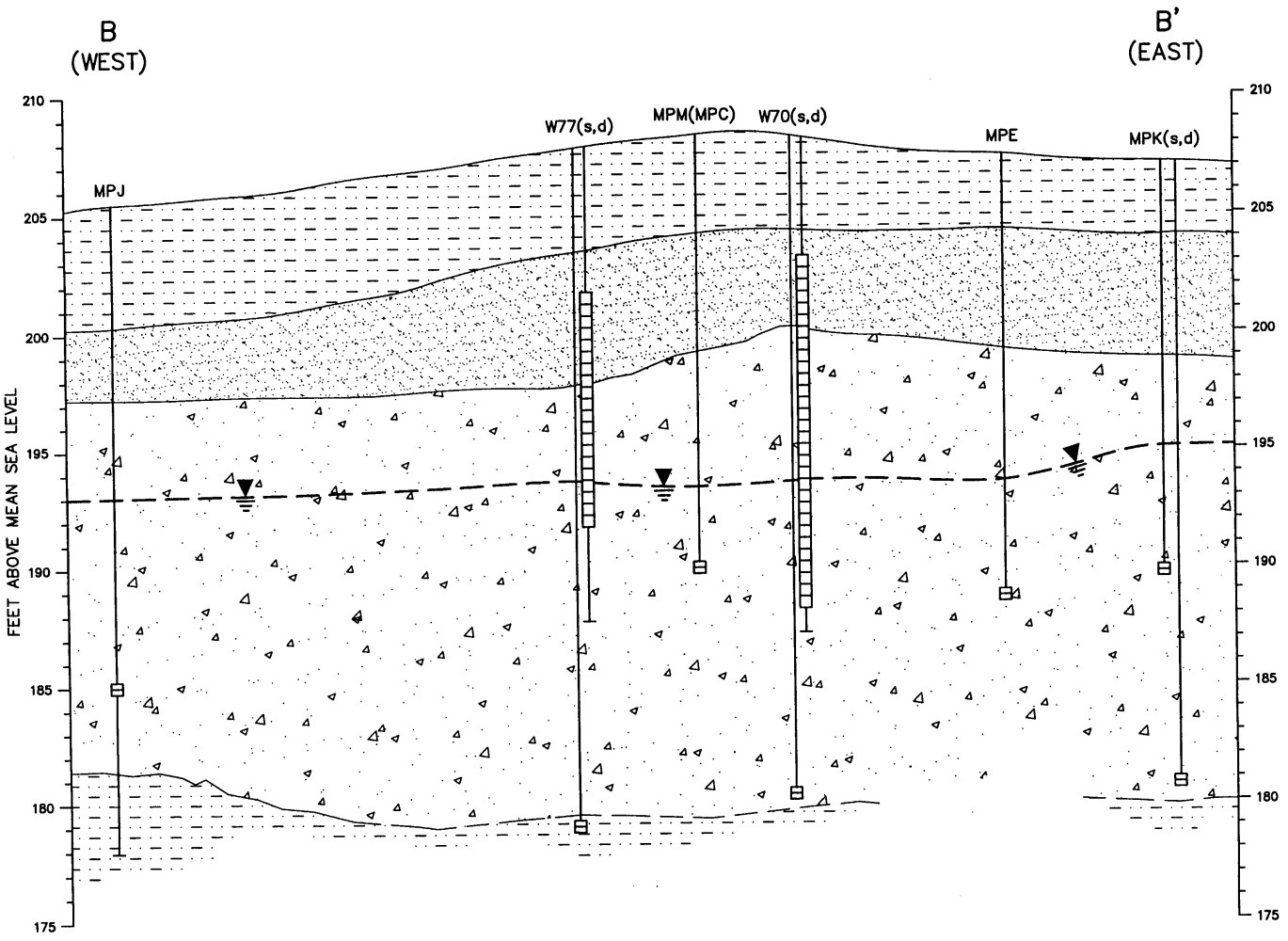

LEGEND

- SILTY CLAY TO CLAYEY SILT, SOME SAND
- SAND TO SANDY SILT
- SANDY TO SILTY GRAVEL, SOME CLAY
- WATER TABLE ELEVATION (NOVEMBER 1996)

Vertical Scale 0 5

Horizontal Scale 0 25 50

Vertical Exaggeration 10x

FIGURE 3.4

HYDROGEOLOGIC CROSS-SECTION B-B'

Site ST-24 RNA ST
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

DN0388, 07/17/97 at 14:07

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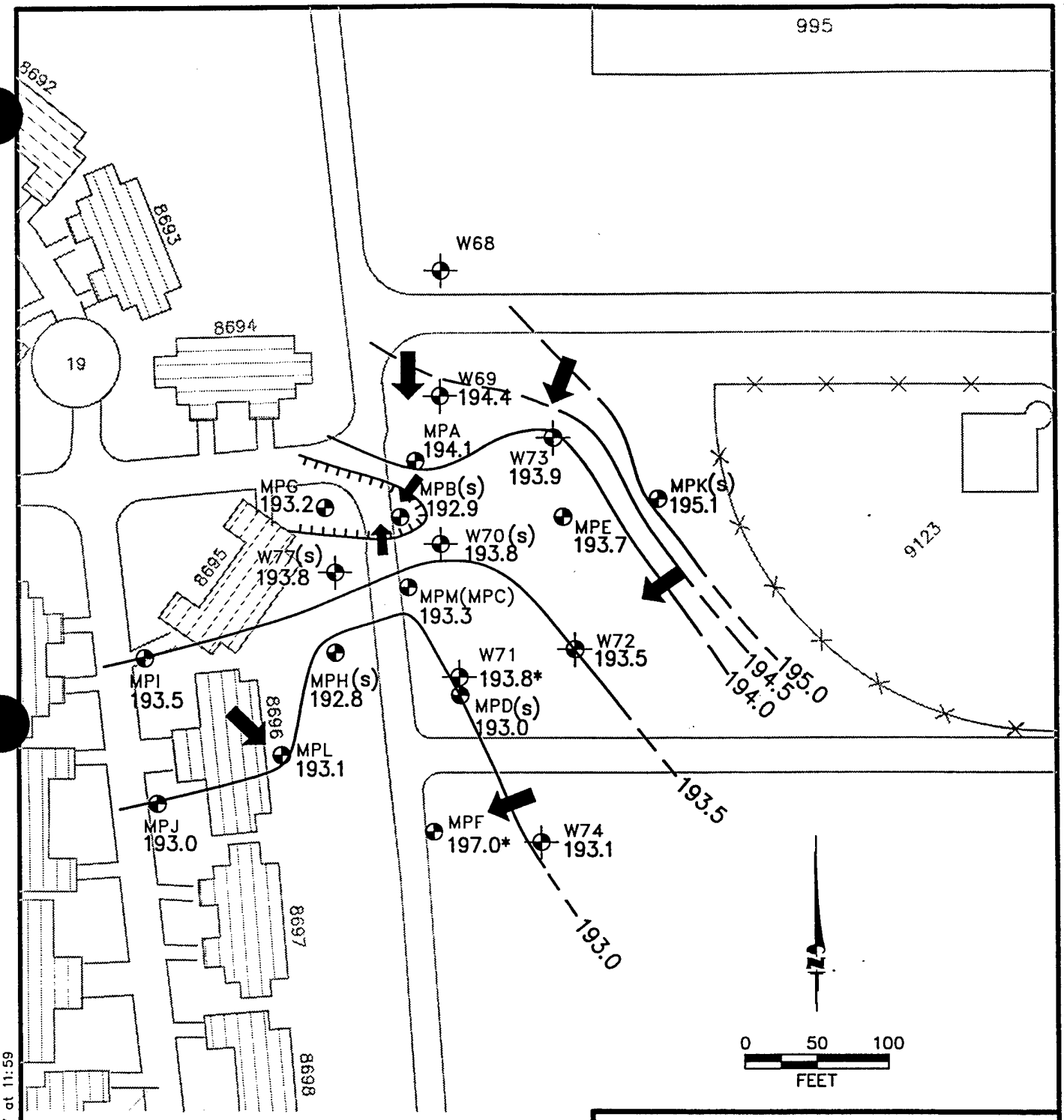
TABLE 3.1
SUMMARY OF GROUNDWATER ELEVATION DATA
NOVEMBER 1996
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Well/Point Identification	Elevation of Reference Point for Measurements (feet msl)[a/]	Depth to Groundwater (feet btc)[b/]	Groundwater Elevation (feet msl)
W69	208.9	14.5	194.4
W70 (s)	208.3	14.5	193.8
W70 (d)	209.5	16.5	193.0
W71	207.8	14.0	193.8
W72	206.8	13.3	193.5
W73	207.3	13.4	193.9
W74	206.3	13.2	193.1
W77 (s)	207.9	14.1	193.8
W77 (d)	209.0	17.8	191.2
MPA	209.0	14.9	194.1
MPB (s)	209.0	16.1	192.9
MPB (d)	209.0	14.2	194.8
MPM (MPC)	208.8	15.5	193.3
MPD (s)	208.4	15.4	193.0
MPD (d)	208.4	15.0	193.4
MPE	208.2	14.5	193.7
MPF	208.4	11.4	197.0
MPG	209.1	15.9	193.2
MPH (s)	208.3	15.5	192.8
MPH (d)	208.5	15.6	192.9
MPI	206.9	13.4	193.5
MPJ	206.2	13.2	193.0
MPK (s)	207.7	12.6	195.1
MPK (d)	207.6	12.5	195.1
MPL	206.5	13.4	193.1

[a/] Feet msl = feet above mean sea level.

[b/] Feet btc = feet below top of casing.



LEGEND

MPA 194.1 — MONITORING POINT WITH WATER TABLE ELEVATION (feet msl)

W77(s) 193.8 — MONITORING WELL WITH WATER TABLE ELEVATION (feet msl)

* NOT USED FOR CONTOURING

DIRECTION OF GROUNDWATER FLOW

L:\COLUMBU...91\97DN0322, 07/11/97 at 11:59

FIGURE 3.5

WATER TABLE ELEVATIONS NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

with a general southwest flow direction. However, local variations in groundwater direction are inconsistent between the two sampling events. In November 1996, a localized groundwater low was located near monitoring points MPG and MPB(s). The observed heads from November 1996 also were approximately 6 feet lower than the previous two sampling events in February and August. This variation may be due to seasonal fluctuations in recharge.

Four groundwater monitoring point pairs installed for this investigation were used to evaluate vertical hydraulic gradients at Site ST-24. Groundwater elevation data collected in November 1996 indicate upward vertical gradients of 0.147 ft/ft, 0.052 ft/ft, and 0.020 ft/ft for monitoring point pairs MPB(s)/MPB(d), MPD(s)/MPD(d), and MPH(s)/MPH(d), respectively. These upward gradients may be a result of semi-confining aquifer conditions, or a result of water level measurement error.

3.3.2.2 Hydraulic Conductivity

In November 1996, Parsons ES conducted falling and rising head slug tests at wells W68, W69, W70, W71, W74, and W77. Hydraulic conductivity was calculated using the method of Bower and Rice (1976), as described in Section 2. The results of these slug tests are summarized in Table 3.2. Hydraulic conductivities ranged from 35 ft/day to 81 ft/day, with an average hydraulic conductivity of 58 ft/day. The slug-test analyses are presented in Appendix A.

TABLE 3.2
NOVEMBER 1996 SLUG TEST RESULTS
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

WELL	HYDRAULIC CONDUCTIVITY (ft/min)	HYDRAULIC CONDUCTIVITY (ft/day)
W68	0.024	35
W69	0.051	73
W70	0.030	43
W71	0.055	79
W74	0.056	81
W77	0.024	35

3.3.2.3 Effective Porosity

Because of the difficulty involved in accurately determining effective porosity, published literature values for soil types comprising the shallow saturated zone were referenced (Walton, 1988; Domenico and Schwartz, 1990). Estimates of effective porosity for gravelly sand range from 0.20 to 0.35. An average effective porosity of 0.30 was assumed for the surficial aquifer at Site ST-24.

3.3.2.4 Advective Groundwater Velocity

The advective velocity of groundwater in the direction parallel to groundwater flow is given by:

$$\bar{v} = \frac{K}{n_e}\frac{dH}{dL}$$

Where: $\bar{v}$ = Average advective groundwater velocity [L/T]
K = Hydraulic conductivity [L/T] (58 ft/day)
dH/dL = Gradient [L/L] (0.01 ft/ft)
n_e = Effective porosity (0.30).

Using this relationship in conjunction with site-specific data, the average advective groundwater velocity at the site in November 1996 was 1.9 ft/day, or approximately 700 feet per year (ft/yr).

3.3.2.5 Preferential Flow Paths

No preferential contaminant migration pathways were identified during the field work phase of this project. There are a storm drainage system, electrical distribution system, water supply system, and some Base housing west of the site. It is unclear if the groundwater elevation lows at MPG and MPB(s) are a result of man-made features, but overall, man-made features are not anticipated to influence migration pathways.

3.3.3 Groundwater Use

Groundwater in the shallow aquifer is not used as a local source of potable water within the vicinity of the site, although there may be shallow wells that provide industrial water to the Base (Stewart, 1997). There are five deep on-Base wells that provide potable water to Columbus AFB, none of which are downgradient from the site. Three of these wells, Wells 363, 604, and 865, are screened at depths of 386 ft to 426 ft bgs, 396 ft to 443 ft bgs, and 430 ft to 470 ft bgs, respectively, within the Tuscaloosa Group of the Eutaw Aquifer. These wells are located approximately 4,050 feet, 3,800 feet, and 2,350 feet, respectively, southeast of the site. Columbus AFB plans to connect to the City of Columbus water system in 1997, and subsequently abandon these three wells (Stewart, 1997). Two other wells of unknown depth, Wells 1812 and 2052, also supply drinking water to individual buildings on the Base. These wells are located approximately 5,050 feet northwest and 8,200 feet northeast of the site. The four closest off-Base private wells, Wells R-83, R-84, R-85, and R-15, are located 3,300 feet east, 5,100 feet southeast, 5,350 feet southeast, and 6,450 feet south of the site, respectively. These wells are screened in the Eutaw Aquifer (CH2M Hill, 1989).

3.4 CLIMATE

The climate in northeastern Mississippi is typified by short, cool winters and hot, humid summers. Precipitation averages 56 inches per year, and is evenly distributed throughout the year.

SECTION 4

NATURE AND EXTENT OF CONTAMINATION GROUNDWATER AND SOIL AND GEOCHEMISTRY

4.1 SOURCE OF CONTAMINATION

The periodic releases of gasoline and oil from the four former USTs and associated piping have been identified as the source of contamination at Site ST-24. However, neither the duration nor the volume of fuel leakage into the soil is known. Currently at Site ST-24, no visibly contaminated surface soils or stressed vegetation is present.

4.2 SOIL CHEMISTRY

During the November 1996 investigation, four soil samples were collected from four locations at Site ST-24. These soil sampling locations were identified as MPA, MPC, MPD, and MPF (Figure 2.1). Three of the samples (MPA, MPC, MPD) were analyzed for BTEX, trimethylbenzenes (TMBs), total recoverable petroleum hydrocarbons (TRPH), and VOCs. The fourth sample, MPF, was analyzed for TRPH, chlorinated VOCs, and total organic carbon (TOC) only. Samples taken from locations MPA, MPC, and MPD were collected from soils just above the groundwater table. The MPF soil sample was taken from below the groundwater table surface. Site soils were previously characterized in November 1994 (CH2M Hill, 1995), when soil samples were collected from 11 locations at depths of 4 and 9 feet bgs. The 1994 samples were analyzed for BTEX, total petroleum hydrocarbons (TPH), lead, and trichloroethene (TCE). Analytical results from the 1994 soil investigation suggest that low levels of fuel hydrocarbon, lead, and chlorinated solvent contamination exists throughout the shallow soils. Specific results of the CH_2M Hill soil investigation are

provided in Appendix B. The observed low concentrations of soil contaminants suggest that residual soil contamination is no longer a significant source for dissolved groundwater contamination at ST-24.

4.2.1 Soil BTEX

In November 1996, detectable concentrations of BTEX, TMB, and 1,2,3,4-tetramethylbenzene (TEMB) compounds were present in the soil samples collected from MPA and MPC. Elevated soil concentrations of TMB and TEMB compounds indicate that selective mass reduction of BTEX compounds has occurred in site soils. At MPA, the only BTEX compound detected above method detection limits was total xylenes. Of all the BTEX compounds, xylenes sorb the most strongly to soils; in addition, xylenes are less soluble in water than benzene, toluene, and ethylbenzene. The combined effects of high sorptivity, low solubility, and higher initial mass fraction, would result in a longer residence time for xylenes in the solid matrix than the other BTEX compounds. This explains the lone xylenes observation in the soil sample taken from MPA. Elevated TRPH results from the MPA sample suggest that fuel hydrocarbons other than the BTEX compounds are present in site capillary fringe soils near MPA. The majority of compounds included in the TRPH grouping also are more sorptive and less soluble than benzene. Soil analytical results from the November 1996 sampling event are presented in Table 4.1.

4.2.2 Total Organic Carbon

TOC concentrations are used to estimate the amount of organic matter sorbed to 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. In addition, TOC can be used as a gross indicator of organic compounds that are available as a source of carbon and electrons (i.e., substrate) for microbial activity.

TABLE 4.1
SOIL ANALYTICAL DATA
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Sample ID	Date Sampled	Depth (feet bgs)	Benzene (µg/kg)	Toluene (µg/kg)	Ethylbenzene (µg/kg)	Total Xylenes (µg/kg)	Total BTEX (µg/kg)	1,3,5-TMB (µg/kg)	1,2,4-TMB (µg/kg)	1,2,3-TMB (µg/kg)	1,2,3,4-TetraMB (µg/kg)	CAHs (µg/kg)	TRPH (mg/kg)
MPA	11/11/96	9-11	ND[a/]	ND	ND	30	30	390	840 E [b/]	310	120	ND	7.9
MPC	11/8/96	10-12	ND	ND	ND	ND	ND	0.7	ND	2.5	20	ND	ND
MPD	11/7/96	10-12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPF	11/7/96	16-18	NA[c/]	NA	NA	NA	NA	NA	NA	NA	NA	ND	ND

[a/] ND = Analyte not detected.

[b/] E = Extrapolated value.

[c/] NA = Not analyzed.

TOC content was analyzed for in the sample collected from an upgradient location (MPF (9-12 feet bgs)). TOC was not detected above the laboratory detection limit of 0.6 percent. However, this detection limit is high, suggesting that contaminant retardation could be significant in site soils.

4.3 GROUNDWATER CHEMISTRY

Three lines of evidence can be used to document the occurrence of natural attenuation: 1) geochemical evidence; 2) documented loss of contaminant mass at the field scale; and 3) microcosm studies. The first line of evidence (geochemical evidence) is the one used in this TS to support the occurrence of natural attenuation at Site ST-24. Because this line of evidence strongly suggests that natural attenuation is occurring at this site, and contaminant loss can be documented through long-term groundwater monitoring, a microcosm study was not deemed necessary.

4.3.1 Dissolved Hydrocarbon Contamination

The areal distribution of total dissolved BTEX in groundwater for November 1996 is presented on Figure 4.1. At monitoring well/point clusters, isopleths are drawn on the basis of the highest observed concentration, which at all locations was from the shallower groundwater monitoring well/point (Table 4.2). However, due to poor recovery from some of the deeper monitoring points not all of the 18 newly installed point were sampled in November 1996. The areal extent of the dissolved BTEX plume defined by the 10-microgram-per-liter (µg/L) contour is approximately 48,750 square feet (1.1 acres). Because of advective/dispersive transport mechanisms associated with groundwater flow (Figure 3.5), the dissolved BTEX plume is migrating from the source area along a south to southwest flow path toward Buildings 8696 and 8697.

The vertical distribution of dissolved BTEX along the main axis of the plume, approximately parallel to the direction of groundwater flow, is presently unknown. Within the source area, a total BTEX concentration of 601 mg/L was detected in a

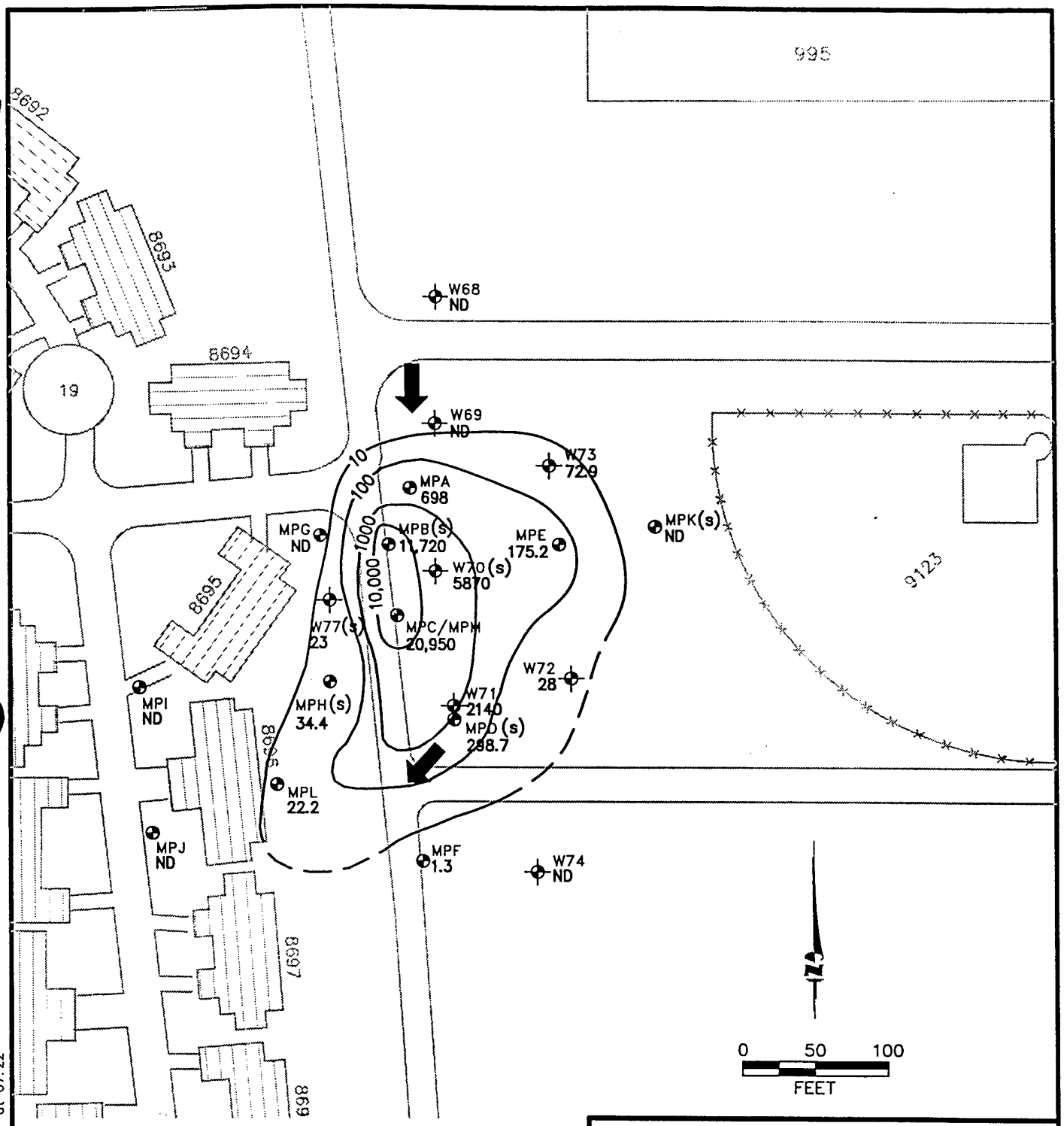


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FIGURE 4.1

TOTAL DISSOLVED BTEX ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

TABLE 4.2
GROUNDWATER QUALITY DATA SUMMARY
FOR FUEL HYDROCARBONS
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

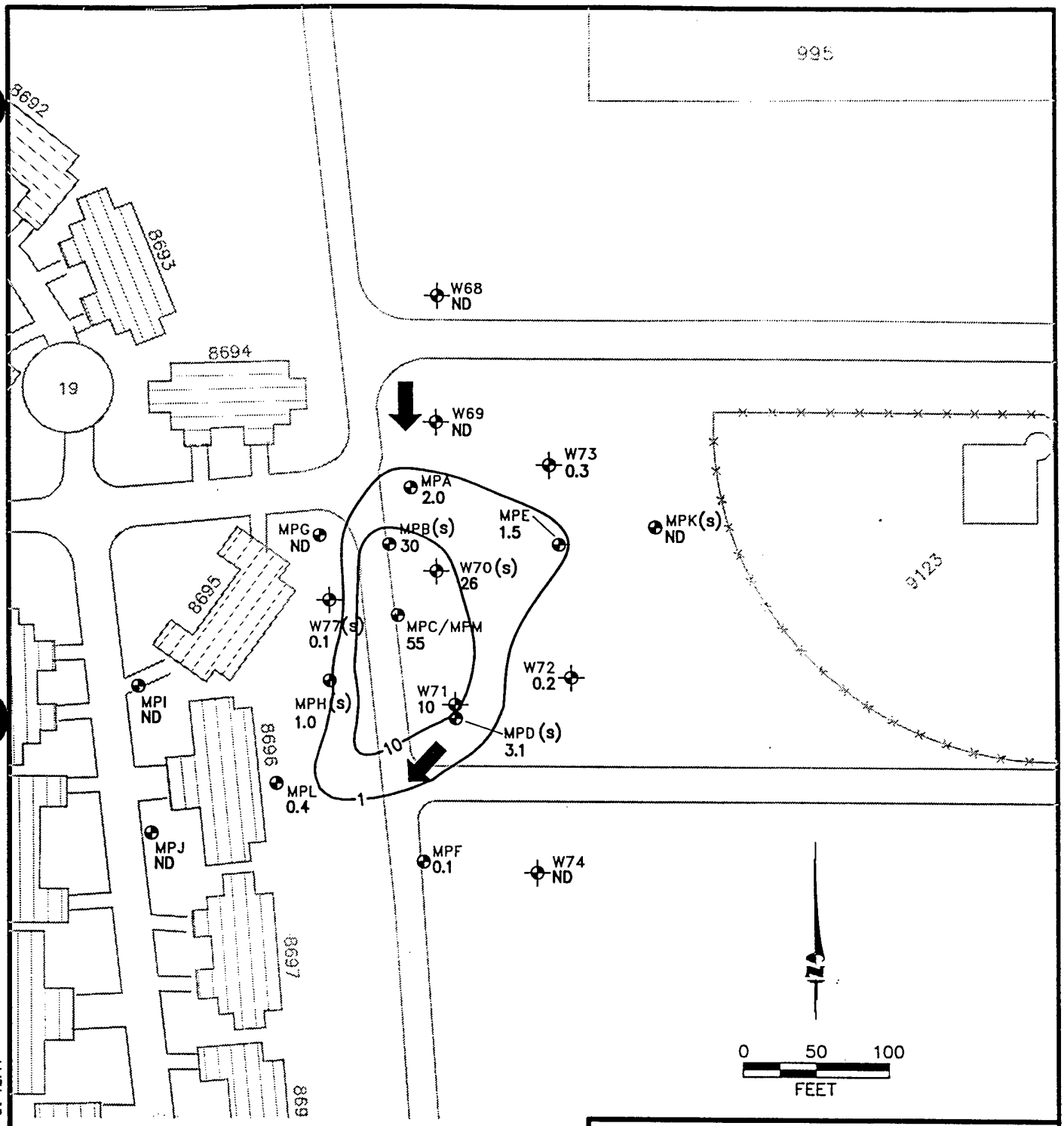
Sample ID	Date Sampled	Benzene (µg/L)	Toluene (µg/L)	Ethyl-benzene (µg/L)	Total Xylenes (µg/L)	Total BTEX (µg/L)	1,3,5-TMB (µg/L)	1,2,4-TMB (µg/L)	1,2,3-TMB (µg/L)	1,2,3,4-TetraMB (µg/L)	TVH-Gasoline (mg/L)
W68	11/8/96	ND[a/]	ND	ND	ND	ND	ND	ND	ND	ND	ND
W69	11/10/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W70(S)	11/10/96	190	2700	480	2500	5870	950	2700	670	280	26
W75[b/]	11/10/96	220	2700	470	2400	5790	960	2700	670	290	26
W70(D)	11/11/96	230	11	120	240	601	54	270	60	31	2.8
W71	11/10/96	140	600	420	980	2140	310	1200	350	150	10
W72	11/8/96	18	ND	10	ND	28	ND	ND	ND	15	0.2
W73	11/8/96	6.9	13	12	41	72.9	11.0	41.0	13.0	3.7	0.3
W74	11/8/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
W77	11/10/96	23	ND	ND	ND	23	ND	ND	ND	11	0.1
MPA	11/11/96	43	470	45	140	698	23	70	21	9.6	2.0
MPB(S)	11/12/96	920	5000	1000	4800	11720	580	1900	540	180	30
MPD(S)	11/13/96	46	5.7	200	47	298.7	19	54	18	96	3.1
MPE	11/11/96	73	2.0	99	1.2	175.2	1.7	2.2	1.3	68	1.5
MPF	11/12/96	ND	0.7	0.6	ND	1.3	ND	ND	ND	15	0.1
MPG	11/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPH(S)	11/13/96	18	0.6	15	0.8	34.4	ND	ND	ND	80	1.0
MPI	11/12/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPJ	11/18/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPK(S)	11/10/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPK(D)	11/11/96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
MPL	11/18/96	15	1.5	2.5	3.2	22.2	ND	ND	7.7	26	0.4
MPM	11/18/96	350	11000	1500	8100	20950	1400	4200	1200	ND	55

[a/] ND = Analyte not detected.

[b/] W75 is a duplicate sample of W70(S).

groundwater sample from W70(d), which is screened at approximately 27 to 27.5 feet bgs. W70(d) is the only well screened below 20 feet that was sampled for BTEX compounds; several other deep monitoring points were installed in November 1996; however, those monitoring points exhibited very low recovery. A clayey layer of undetermined thickness was encountered just below W70(d). A comparison of total BTEX concentrations in samples collected from W70(s) and W70(d) show that dissolved BTEX concentrations in the deep well decreased to approximately 10 percent of the total BTEX concentration observed in the shallow well. However, benzene concentrations in both the shallow and deep well are comparable, suggesting that at the plume core, degradation processes are not as effective at removing benzene from the system as the other BTEX compounds.

Total BTEX concentrations in groundwater ranged from not detected at wells W68, W69, W74, MPG, MPI, MPJ, and MPK (s and d) to 20,950 µg/L at MPC/MPM. Well MPC/MPM is adjacent to Independence Avenue, just west of the former service station (Figure 4.1). This area is reported by Base personnel to have formerly housed the three gasoline USTs and fuel dispensers. At MPF, just downgradient from where the waste oil UST was located, a low total dissolved BTEX concentration of 1.3 µg/L was detected. Total volatile hydrocarbons (TVH) (normalized to a gasoline standard) were analyzed for in all November 1996 groundwater samples. The results of the TVH analyses are shown on Figure 4.2 and are listed in Table 4.2. Concentrations of BTEX were detected in all groundwater samples where TVH was detected. Dissolved TVH concentrations ranged from 0.1 to 55 mg/L. As with the vertical delineation described above, benzene does not appear to be degrading as quickly as the other BTEX compounds. Benzene is approximately 1.5 to 8 percent of total dissolved BTEX at monitoring points MPM and MPB (the source area). However, further downgradient at monitoring points MPL and MPH, benzene is approximately 52 to 68 percent of total dissolved BTEX contamination. This difference in the mass fraction of benzene



LEGEND

MPA 2.0 — MONITORING POINT WITH DISSOLVED TVH–GASOLINE CONCENTRATION (mg/L)

W77 0.1 — MONITORING WELL WITH DISSOLVED TVH–GASOLINE CONCENTRATION (mg/L)

APPROXIMATE GROUNDWATER FLOW DIRECTION

—1— LINE OF EQUAL TVH CONCENTRATION (mg/L)

FIGURE 4.2

TVH IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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suggests that dissolved toluene, ethylbenzene, and xylenes are being preferentially attenuated over benzene at the site.

Although the areas of dissolved contamination correlate between the 1994 and the November 1996 sampling events, a more thorough comparison of historical dissolved BTEX concentrations to data collected in November 1996 is not performed in this TS for several important reasons. First, observed dissolved BTEX concentrations in groundwater monitoring wells in November 1996 are generally higher than reported historical concentrations. The increase in dissolved BTEX concentrations is not believed to indicate an actual increase in dissolved contaminant mass, but rather to reflect the result of differing sampling techniques from sampling event to sampling event. Parsons ES minimized sample disturbance by using a micropurge technique, as described in Section 2. Purging and sampling at a low flow rate with a peristaltic pump 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). In addition, although monitoring points installed in November 1996 were placed approximately in the location of Geoprobe® grab samples taken in 1994 (CH2M Hill, 1995) actual screened intervals do not correspond well enough with the 1994 grab sample intervals to support direct comparison of observed dissolved BTEX concentrations from the two sampling events.

4.3.2 Chlorinated Solvent Contamination

Although low concentrations of chlorinated solvents have previously been documented in soil and groundwater at the site, groundwater and soil samples collected in November 1996 do not confirm the earlier reported widespread, low levels of chlorinated solvent contamination. All soil and groundwater samples collected at Site ST-24 were analyzed for non-fuel-related VOCs; however no chlorinated solvents or

other VOCs were detected above the corresponding soil and groundwater detection limits.

4.3.3 Inorganic Chemistry and Geochemical Indicators of BTEX Biodegradation

Numerous laboratory and field studies have shown that hydrocarbon-degrading bacteria can participate in the degradation of many of the chemical components of jet fuel and gasoline, including the BTEX compounds (e.g., Jamison *et al.*, 1975; Atlas, 1981, 1984, and 1988; Gibson and Subramanian, 1984; Reinhard *et al.*, 1984; Young, 1984; Bartha, 1986; Wilson *et al.*, 1986, 1987, and 1990; Barker *et al.*, 1987; Baedecker *et al.*, 1988; Lee, 1988; Chiang *et al.*, 1989; Grbic-Galic, 1989 and 1990; Cozzarelli *et al.*, 1990; Leahy and Colewell, 1990; Altenschmidt and Fuchs, 1991; Alvarez and Vogel, 1991; Baedecker and Cozzarelli, 1991; Ball *et al.*, 1991; Bauman, 1991; Borden, 1991; Brown *et al.*, 1991; Edwards *et al.*, 1991 and 1992; Evans *et al.*, 1991a and 1991b; Haag *et al.*, 1991; Hutchins and Wilson, 1991; Hutchins *et al.*, 1991a and 1991b; Beller *et al.*, 1992; Bouwer, 1992; Edwards and Grbic-Galic, 1992; Thierrin *et al.*, 1992; Malone *et al.*, 1993; Davis *et al.*, 1994). Biodegradation of fuel hydrocarbons can occur when an indigenous population of hydrocarbon-degrading microorganisms is present in the aquifer and sufficient concentrations of electron acceptors, nutrients, and electron donors such as fuel hydrocarbons, are available to these organisms.

Microorganisms obtain energy for cell production and maintenance by facilitating thermodynamically advantageous redox reactions involving the transfer of electrons from electron donors to available electron acceptors. This results in the oxidation of the electron donor and the reduction of the electron acceptor. Electron donors at the site are natural organic carbon 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 oxygen, nitrate, ferric iron, sulfate, manganese, nitrogen gas, and carbon dioxide.

The driving force of BTEX degradation is electron transfer, which is quantified by the Gibbs free energy of the reaction ($\Delta G°_r$) (Stumm and Morgan, 1981; Godsey, 1994). The value of $\Delta G°_r$ represents the quantity of free energy consumed or yielded to the system during the reaction. Table 4.3 lists stoichiometry of the redox equations involving BTEX and the resulting $\Delta G°_r$. Although thermodynamically favorable, most of the reactions involved in BTEX oxidation cannot proceed abiotically because of the lack of activation energy. Microorganisms are capable of providing the necessary activation energy; however, they will facilitate only those redox reactions that have a net yield of energy (i.e., $\Delta G°_r < 0$). Microorganisms preferentially utilize electron acceptors while metabolizing fuel hydrocarbons (Bouwer, 1992). DO is utilized first as the prime electron acceptor. After the DO is consumed, anaerobic microorganisms use electron acceptors in the following order of preference: nitrate, manganese, ferric iron hydroxide, sulfate, nitrogen gas, and finally carbon dioxide.

Depending on the types and concentrations 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, nitrogen fixation, or nitrate reduction may dominate if the physical and chemical conditions in the subsurface favor use of these electron acceptors or processes. Anaerobic destruction of the BTEX compounds is associated with the accumulation of fatty acids, production of methane and ammonium, solubilization of iron and manganese, and reduction of nitrate and sulfate (Cozzarelli *et al.*, 1990; Wilson *et al.*, 1990). Environmental conditions and microbial competition ultimately determine which processes will dominate. Vroblesky and Chapelle (1994) show that

TABLE 4.3
COUPLED OXIDATION REACTIONS FOR BTEX COMPOUNDS
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Coupled Benzene Oxidation Reactions	$\Delta G°_r$ (kcal/mole Benzene)	$\Delta G°_r$ (kJ/mole Benzene)	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$7.5O_2 + C_6H_6 \Rightarrow 6CO_{2,g} + 3H_2O$ *Benzene oxidation /aerobic respiration*	-765.34	-3202	3.07:1
$6NO_3^- + 6H^+ + C_6H_6 \Rightarrow 6CO_{2,g} + 6H_2O + 3N_{2,g}$ *Benzene oxidation / denitrification*	-775.75	-3245	4.77:1
$3.75\,NO_3^- + C_6H_6 + 7.5\,H^+ + 0.75\,H_2O \Rightarrow 6\,CO_2 + 3.75\,NH_4^+$ *Benzene oxidation / nitrate reduction*	-524.1	-2193	2.98:1
$60H^+ + 30\underline{Fe(OH)_{3,a}} + C_6H_6 \Rightarrow 6CO_2 + 30Fe^{2+} + 78H_2O$ *Benzene oxidation / iron reduction*	-560.10	-2343	21.5:1
$30H^+ + 15\underline{MnO_2} + C_6H_6 \Rightarrow 6CO_{2,g} + 15Mn^{2+} + 18H_2O$ *Benzene oxidation / manganese reduction*	-765.45	-3202	10.56:1
$7.5H^+ + 3.75SO_4^{2-} + C_6H_6 \Rightarrow 6CO_{2,g} + 3.75H_2S^o + 3H_2O$ *Benzene oxidation / sulfate reduction*	-122.93	-514.3	4.61:1
$5\,N_2 + C_6H_6 + 10\,H^+ + 12\,H_2O \Rightarrow 6\,CO_2 + 10\,NH_4^+$ *Benzene oxidation / nitrogen fixation*	-104.8	-437.9	2.31:1
$4.5H_2O + C_6H_6 \Rightarrow 2.25CO_{2,g} + 3.75CH_4$ *Benzene oxidation / methanogenesis*	-32.40	-135.6	0.77:1

Coupled Toluene Oxidation Reactions	$\Delta G°_r$ (kcal/mole Toluene)	$\Delta G°_r$ (kJ/mole Toluene)	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$9O_2 + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 4H_2O$ *Toluene oxidation /aerobic respiration*	-913.76	-3823	3.13:1
$7.2NO_3^- + 7.2H^+ + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 7.6H_2O + 3.6N_{2,g}$ *Toluene oxidation / denitrification*	-926.31	-3875	4.85:1
$4.5NO_3^- + 9H^+ + 0.5H_2O + C_6H_5CH_3 \Rightarrow 7CO_2 + 4.5NH_4^+$ *Toluene oxidation / nitrate reduction*	-624.24	-2609	3.03:1
$72H^+ + 36\underline{Fe(OH)_{3,a}} + C_6H_5CH_3 \Rightarrow 7CO_2 + 36Fe^{2+} + 94H_2O$ *Toluene oxidation / iron reduction*	-667.21	-2792	21.86:1
$36H^+ + 18\underline{MnO_2} + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 18Mn^{2+} + 22H_2O$ *Toluene oxidation / manganese reduction*	-913.89	-3824	10.74:1
$9H^+ + 4.5SO_4^{2-} + C_6H_5CH_3 \Rightarrow 7CO_{2,g} + 4.5H_2S^o + 4H_2O$ *Toluene oxidation / sulfate reduction*	-142.86	-597.7	4.7:1
$6\,N_2 + C_6H_5CH_3 + 12\,H^+ + 14\,H_2O \Rightarrow 7\,CO_2 + 12\,NH_4^+$ *Toluene oxidation / nitrogen fixation*	-121.0	-505.8	2.35:1
$5H_2O + C_6H_5CH_3 \Rightarrow 2.5CO_{2,g} + 4.5CH_4$ *Toluene oxidation / methanogenesis*	-34.08	-142.6	0.78:1

TABLE 4.3 (CONTINUED)
COUPLED OXIDATION REACTIONS FOR BTEX COMPOUNDS
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Coupled Ethylbenzene Oxidation reactions	$\Delta G°_r$ (kcal/mole Ethyl-benzene)	$\Delta G°_r$ (kJ/mole Ethyl-benzene)	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$10.5O_2 + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5H_2O$ *Ethylbenzene oxidation /aerobic respiration*	-1066.13	-4461	3.17:1
$8.4NO_3^- + 8.4H^+ + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *Ethylbenzene oxidation / denitrification*	-1080.76	-4522	4.92:1
$5.25NO_3^- + 10.5H^+ + 0.25H_2O + C_6H_5C_2H_5 \Rightarrow 8CO_2 + 5.25NH_4^+$ *Ethylbenzene oxidation / nitrate reduction*	-746.04	-3118	3.07:1
$84H^+ + 42\underline{Fe(OH)_{3,a}} + C_6H_5C_2H_5 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *Ethylbenzene oxidation / iron reduction*	-778.48	-3257	22:1
$46H^+ + 22\underline{MnO_2} + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 22Mn^{2+} + 28H_2O$ *Ethylbenzene oxidation / manganese reduction*	-1066.27	-4461	11.39:1
$10.5H^+ + 5.25SO_4^{2-} + C_6H_5C_2H_5 \Rightarrow 8CO_{2,g} + 5.25H_2S^o + 5H_2O$ *Ethylbenzene oxidation / sulfate reduction*	-166.75	-697.7	4.75:1
$7N_2 + C_6H_5C_2H_5 + 14H^+ + 16H_2O \Rightarrow 8CO_2 + 14NH_4^+$ *Ethylbenzene oxidation / nitrogen fixation*	-138.4	-578.5	2.38:1
$5.5H_2O + C_6H_5C_2H_5 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *Ethylbenzene oxidation / methanogenesis*	-39.83	-166.7	0.79:1

Coupled m-Xylene Oxidation Reactions	$\Delta G°_r$ (kcal/mole *m*-xylene)	$\Delta G°_r$ (kJ/mole *m*-xylene)	Stoichiometric Mass Ratio of Electron Acceptor/Byproduct to Compound
$10.5O_2 + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5H_2O$ *m-Xylene oxidation /aerobic respiration*	-1063.25	-4448	3.17:1
$8.4NO_3^- + 8.4H^+ + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 9.2H_2O + 4.2N_{2,g}$ *m-Xylene oxidation / denitrification*	-1077.81	-4509	4.92:1
$5.25NO_3^- + 10.5H^+ + 0.25H_2O + C_6H_4(CH_3)_2 \Rightarrow 8CO_2 + 5.25NH_4^+$ *m-Xylene oxidation / nitrate reduction*	-743.52	-3108	3.07:1
$84H^+ + 42\underline{Fe(OH)_{3,a}} + C_6H_4(CH_3)_2 \Rightarrow 8CO_2 + 42Fe^{2+} + 110H_2O$ *m-Xylene oxidation / iron reduction*	-775.61	-3245	22:1
$46H^+ + 22MnO_2 + C_6H_4(CH_3)_2 \Rightarrow 8CO_2 + 22Mn^{2+} + 28H_2O$ *m-Xylene oxidation / manganese reduction*	-1063.39	-4449	11.39:1
$10.5H^+ + 5.25SO_4^{2-} + C_6H_4(CH_3)_2 \Rightarrow 8CO_{2,g} + 5.25H_2S^o + 5H_2O$ *m-Xylene oxidation / sulfate reduction*	-163.87	-685.6	4.75:1
$7N_2 + C_6H_4(CH_3)_2 + 14H^+ + 16H_2O \Rightarrow 8CO_2 + 14NH_4^+$ *m-Xylene oxidation / nitrogen fixation*	-141.3	-590.6	2.38:1
$5.5H_2O + C_6H_4(CH_3)_2 \Rightarrow 2.75CO_{2,g} + 5.25CH_4$ *m-Xylene oxidation / methanogenesis*	-36.95	-154.6	0.79:1

the dominant terminal electron accepting process can vary both temporally and spatially in an aquifer with fuel hydrocarbon contamination.

The November 1996 groundwater samples were analyzed for the geochemical parameters listed in Table 2.1. Results for these analyses are presented in Table 4.4. Site groundwater data for DO suggest that natural attenuation of hydrocarbons in the shallow aquifer is occurring by aerobic biodegradation. In addition, data for nitrate/nitrite, ferrous iron, soluble manganese, sulfate, ammonium, and methane suggest that anaerobic degradation via denitrification, iron reduction, manganese reduction, sulfate reduction, nitrogen fixation, and methanogenesis is occurring. Geochemical parameters for site groundwater are discussed in the following sections.

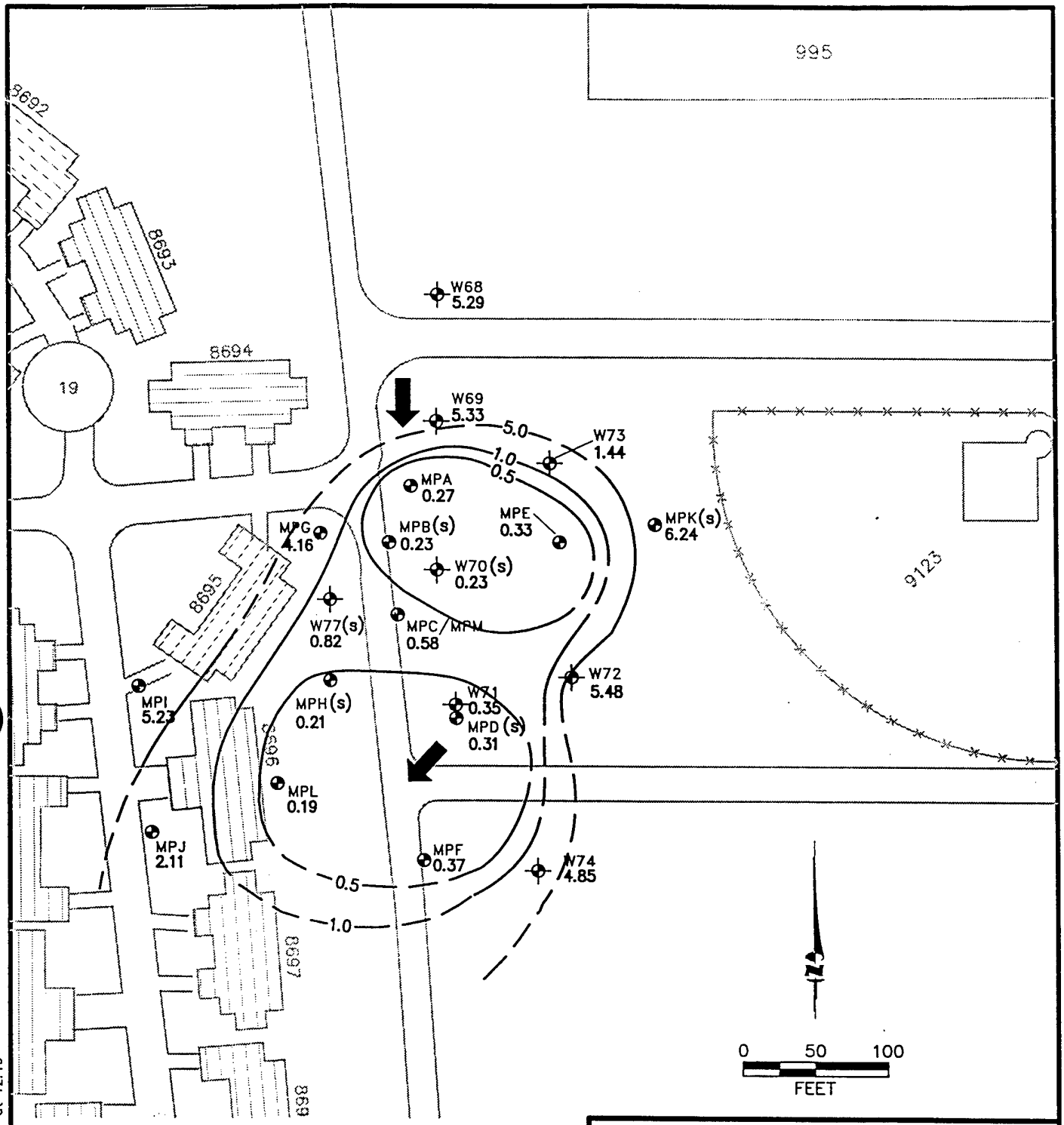
In the following sections, the assumption that BTEX can be treated as a given ratio of the constituent compounds has been made for two important reasons. First, overall biodegradation rates for each of the compounds are very similar to each other. Second, while degradation pathways are relatively well known for fuel hydrocarbons, the preferential degradation of one BTEX compound over another is difficult to predict from site to site, spatially or temporally. For instance, at Site ST-24, while toluene, ethylbenzene, and xylenes (TEX) appear to attenuate more rapidly than benzene within the anaerobic regions of the contaminant plume, it is not possible to draw conclusions regarding the individual TEX compounds. Furthermore, benzene attenuation appears to vary throughout the plume, with higher rates observed toward the aerobic plume fringes. In order to avoid making inaccurate conclusions on which BTEX compounds are degraded and when or where they are degraded in any given groundwater system, the compounds are treated as a ratio. This ratio provides a basis for more reliable conclusions about the spatial and temporal biodegradation of BTEX as one contaminant.

TABLE 4.4
GEOCHEMICAL DATA
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Sample ID	Date Sampled	Temp (°C)	pH	Conductivity (µS/cm)	Alkalinity (mg/L)	Redox Potential (mV)	Dissolved Oxygen (mg/L)	Carbon Dioxide (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	NO_2^- (mg/L)	NO_3^- (mg/L)	Ferrous Iron (mg/L)	Mn^{2+} (mg/L)	NH_4^+ (mg/L)	Methane (mg/L)	TOC (mg/L)
W68	11/8/96	20.8	4.6	50	< 5	263	5.29	70	4.6	0.43	ND[a/]	2.1	0.01	0.01	ND	ND	ND[a/]
W69	11/10/96	16.9	4.7	70	5	338	5.33	50	10.2	1.68	ND	0.57	ND	0.2	ND	ND	NA[b/]
W70(S)	11/10/96	21.1	5.8	150	55	-140	0.23	130	7.4	0.97	ND	ND	24.5	0.6	2	0.02	NA
W70(D)	11/11/96	20.0	6.2	160	44	-27	3.11	105	2.3	0.76	ND	ND	16.4	2.5	2	0.093	NA
W71	11/10/96	20.0	6.0	190	82	-31	0.35	140	6.1	2.92	ND	ND	34.2	1.5	5	1.76	NA
W72	11/8/96	17.6	5.8	120	49	122	5.48	70	4	2.60	ND	0.12	0.21	5.4	1	0.039	NA
W73	11/8/96	22.0	4.9	60	10	274	1.44	100	2.8	0.59	ND	1.1	0.01	1.8	0.1	ND	3.8
W74	11/8/96	21.0	4.6	30	4.5	274	4.85	70	2	3.78	ND	1	0.04	ND	ND	0.031	ND
W77	11/10/96	21.1	4.6	90	< 1	198	0.82	130	4.2	16.22	ND	0.99	0.03	0.1	ND	0.28	NA
MPA	11/11/96	22.1	5.8	NA	30	-95	0.27	90	11.2	3.30	ND	ND	13.25	ND	0.8	0.12	NA
MPB(S)	11/12/96	21.8	6.4	340	168	-129	0.23	200	3.5	6.54	ND	ND	63.75	1.9	> 10	1.26	NA
MPD(S)	11/13/96	20.2	6.1	184	80	-23	0.31	110	4.2	1.03	ND	ND	19.25	4.3	1	2.06	NA
MPE	11/11/96	20.7	6.3	190	65	-144	0.33	110	3.8	3.95	ND	ND	29.6	3.1	8	0.043	NA
MPF	11/12/96	22.0	5.7	140	45	-13	0.37	120	3.5	1.78	ND	ND	13.0	2.8	0.6	0.14	NA
MPG	11/11/96	23.5	4.7	50	2.5	140	4.16	100	3.5	0.38	ND	2.1	0.12	0.3	ND	ND	NA
MPH(S)	11/13/96	21.0	6.1	235	108	-35	0.21	160	3.7	1.41	ND	ND	25.5	2.9	2	1.87	NA
MPI	11/12/96	21.7	5.0	60	10	131	5.23	70	4.8	1.03	ND	1.5	0.10	0.1	ND	ND	NA
MPJ	11/18/96	20.5	5.3	56	13	120	2.11	70	3.4	0.85	ND	1.5	0.06	ND	ND	0.014	NA
MPK(S)	11/10/96	20.0	5.1	40	8	108	6.24	70	2	0.65	ND	0.53	0.07	ND	ND	ND	ND
MPK(D)	11/11/96	18.3	5.0	40	5	188	8.52	30	2	0.86	ND	1.7	0.12	0.1	ND	ND	ND
MPL	11/18/96	20.5	5.6	109	42	-234	0.19	160	4	2.54	ND	ND	8.65	2.2	0.6	0.33	NA
MPM	11/18/96	21.0	5.8	160	55	-158	0.58	140	5	2.29	ND	ND	15.55	1.1	1	0.16	NA

[a/] ND = Analyte not detected.

[b/] NA = Not analyzed.



LEGEND

MPA 0.27 — MONITORING POINT WITH DISSOLVED OXYGEN CONCENTRATION (mg/L)

W77 0.82 — MONITORING WELL WITH DISSOLVED OXYGEN CONCENTRATION (mg/L)

APPROXIMATE GROUNDWATER FLOW DIRECTION

0.5 — LINE OF EQUAL DISSOLVED OXYGEN CONCENTRATION (mg/L)

FIGURE 4.3

DISSOLVED OXYGEN ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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4.3.3.1 Dissolved Oxygen

DO concentrations measured in groundwater samples from monitoring wells and points in November 1996 ranged from 0.19 mg/L to 8.52 mg/L (Table 4.4). Figure 4.3 is an isopleth map showing the distribution of DO concentrations in shallow groundwater. Comparison of Figures 4.1 and 4.3 reveals that the area of depleted DO corresponds to the area of dissolved BTEX, thereby providing strong evidence that aerobic biodegradation of BTEX compounds is occurring at Site ST-24. Given that groundwater samples upgradient, downgradient, and cross-gradient from the source area had high DO levels, it is likely that DO is an important electron acceptor at this site.

The stoichiometry of BTEX mineralization to carbon dioxide and water caused by aerobic microbial biodegradation is presented in Table 4.3. The average mass ratio of oxygen to total BTEX is approximately 3.14 to 1. This translates to the mineralization of approximately 0.32 mg of BTEX for every 1.0 mg of DO consumed. With a site background DO concentration of approximately 6.2 milligrams per liter (mg/L) measured at MPK(s) and a decreased DO concentration in the source area of approximately 0.2 mg/L, the shallow groundwater at this site has the capacity to assimilate 1.93 mg/L (1,930 µg/L) of total BTEX through aerobic biodegradation. This is a conservative estimate of the assimilative capacity of DO because the recharge of oxygen through upgradient sources and precipitation infiltration has not been considered.

Furthermore, as a microbial population in the groundwater grows in response to the introduction of fuel hydrocarbons into the groundwater, new cell mass is generated. When cell mass production is accounted for, the mineralization of benzene to carbon dioxide and water is given by:

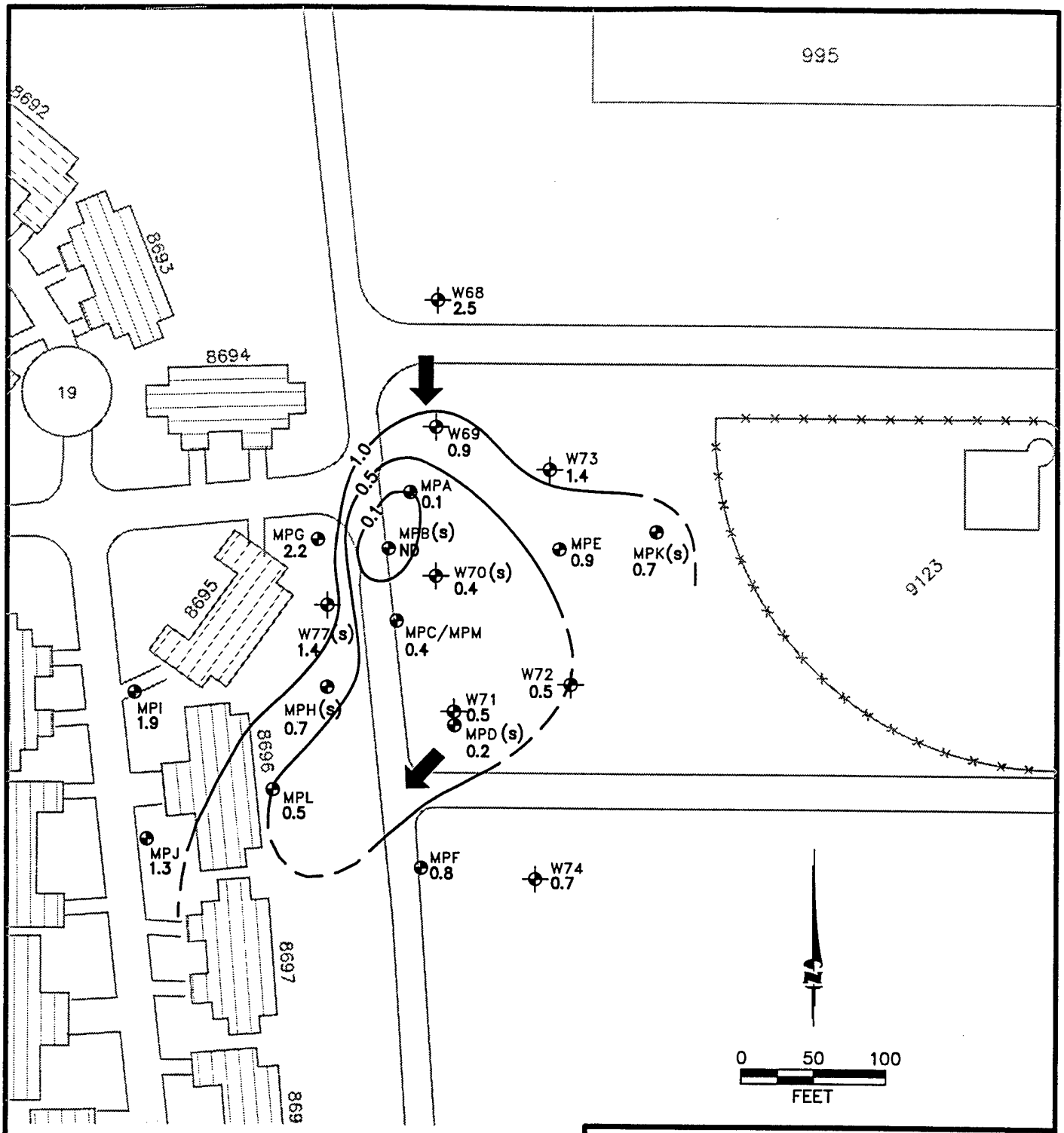
$$C_6H_6 + 2.5O_2 + HCO_3 + NH_4 \rightarrow C_5H_7O_2N + 2CO_2 + 2H_2O$$

This equation indicates that 5.0 fewer moles of DO are required to mineralize 1 mole of benzene when cell mass production is taken into account. On the basis of these stoichiometric relationships, 1.03 mg of oxygen are required to mineralize 1 mg of benzene, if cell mass production is taken into account. Similar calculations can be made for toluene, ethylbenzene, and the xylenes. These relationships show that on average, approximately 0.95 mg of BTEX is mineralized to carbon dioxide and water for every 1.0 mg of DO consumed.

Although this process results in more efficient utilization of electron acceptors, it is only applicable as the net cell mass of the microbial population continues to grow. Because groundwater contamination has been present at Site ST-24 for several years, it is expected that biomass production represents only a small percentage of the overall energy use because the assimilation of BTEX has reached steady-state. Therefore, the cell mass reaction equations no longer applies, and the assimilative capacity estimate based on no biomass production is considered more accurate. The steady-state production of cell mass as applied to anaerobic mechanisms is also likely, and the following estimates of anaerobic assimilative capacity given in the following subsections assume steady-state microbial populations (i.e., biomass production represents a very small fraction of energy use).

4.3.3.2 Nitrate/Nitrite

Concentrations of nitrate/nitrite [as nitrogen (N)] were measured in groundwater samples collected in November 1996. Table 4.4 summarizes measured nitrate/nitrite (as N) concentrations. Nitrite was not measured above the detection limit in any site groundwater sample. Figure 4.4 presents the distribution of nitrate (as N) in groundwater. The data suggest that reduced nitrate concentrations correspond to areas of groundwater BTEX contamination, and that nitrate is an electron acceptor at this site. Detectable nitrate concentrations at the site ranged from 0.1 to 2.5 mg/L.



LEGEND

MPA 0.1 — MONITORING POINT WITH NITRATE CONCENTRATION (mg/L)

W77 1.4 — MONITORING WELL WITH NITRATE CONCENTRATION (mg/L)

APPROXIMATE GROUNDWATER FLOW DIRECTION

—0.1— LINE OF EQUAL NITRATE CONCENTRATION (mg/L)

FIGURE 4.4

NITRATE (as N) in GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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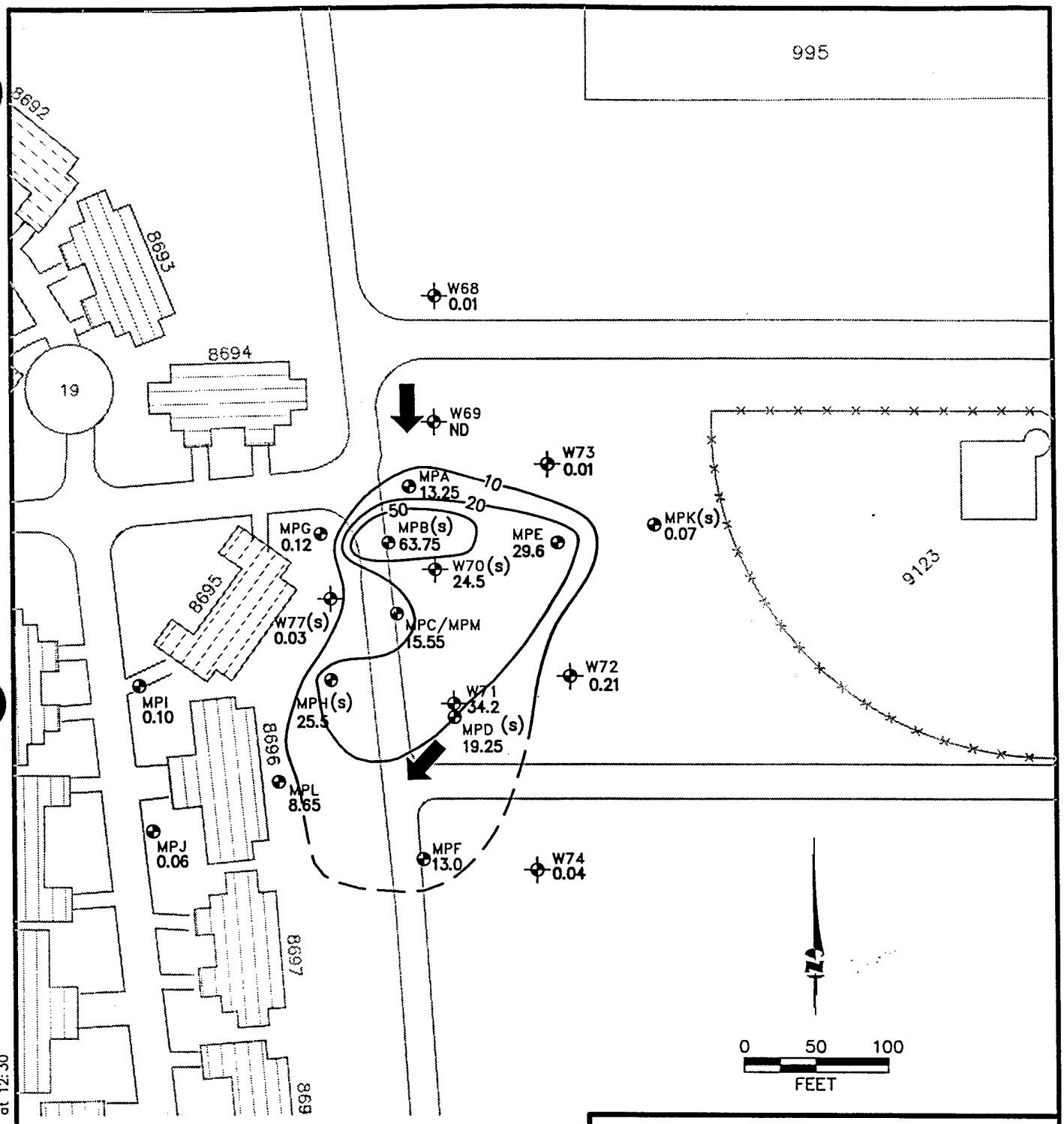
In the absence of microbial cell production, the stoichiometry of BTEX mineralization to carbon dioxide, water, and nitrogen through denitrification is presented in Table 4.3. The average mass ratio of nitrate to total BTEX is approximately 4.9 to 1. This translates to the mineralization of approximately 0.20 mg of BTEX for every 1.0 mg of nitrate consumed. This ratio of nitrate consumption assumes that nitrate/nitrogen is reported as nitrate (NO_3) rather than elemental nitrogen (N). The nitrate nitrogen concentrations shown in Table 4.4 are reported as N, and must be multiplied by 4.42 to be converted into nitrate nitrogen concentrations as NO_3.

Assuming a background concentration from upgradient well W68 of 2.5 mg/L (as N) or 11.1 mg/L (as NO_3) and a source area nitrate concentration of 0.1 mg/L (as N) or 0.4 mg/L (as NO_3), the shallow groundwater has the capacity to assimilate 2.14 mg/L (2,140 mg/L) of total BTEX through denitrification. Because biomass accumulation is not considered, the actual assimilative capacity attributable to denitrification could be somewhat higher.

4.3.3.3 Ferrous Iron

Ferrous iron (Fe^{2+}) concentrations were measured in groundwater samples collected in November 1996. Measured ferrous iron concentrations range from not detected to 63.75 mg/L. Table 4.4 summarizes ferrous iron concentrations, and Figure 4.5 presents an isopleth map showing the distribution of ferrous iron in groundwater. Comparison of Figures 4.1, 4.3, and 4.5 indicates that ferrous iron is being produced in the anaerobic portion of the BTEX plume due to the reduction of ferric iron hydroxide (Fe^{3+}) during anaerobic biodegradation of BTEX compounds. Background ferrous iron concentrations are less than 0.01 mg/L, as measured at wells with little or no BTEX concentration. Groundwater from monitoring MPB(s) had the highest observed ferrous iron concentration of 63.75 mg/L of Fe^{2+}. Elevated ferrous iron concentrations are a strong indication that anaerobic biodegradation of BTEX compounds is occurring in the shallow groundwater through iron reduction.



LEGEND

MPA 13.25 — MONITORING POINT WITH DISSOLVED FERROUS IRON CONCENTRATION (mg/L)

W77 0.03 — MONITORING WELL WITH DISSOLVED FERROUS IRON CONCENTRATION (mg/L)

APPROXIMATE GROUNDWATER FLOW DIRECTION

—10— LINE OF EQUAL DISSOLVED FERROUS IRON CONCENTRATION (mg/L)

ND NOT DETECTED

FIGURE 4.5

FERROUS IRON IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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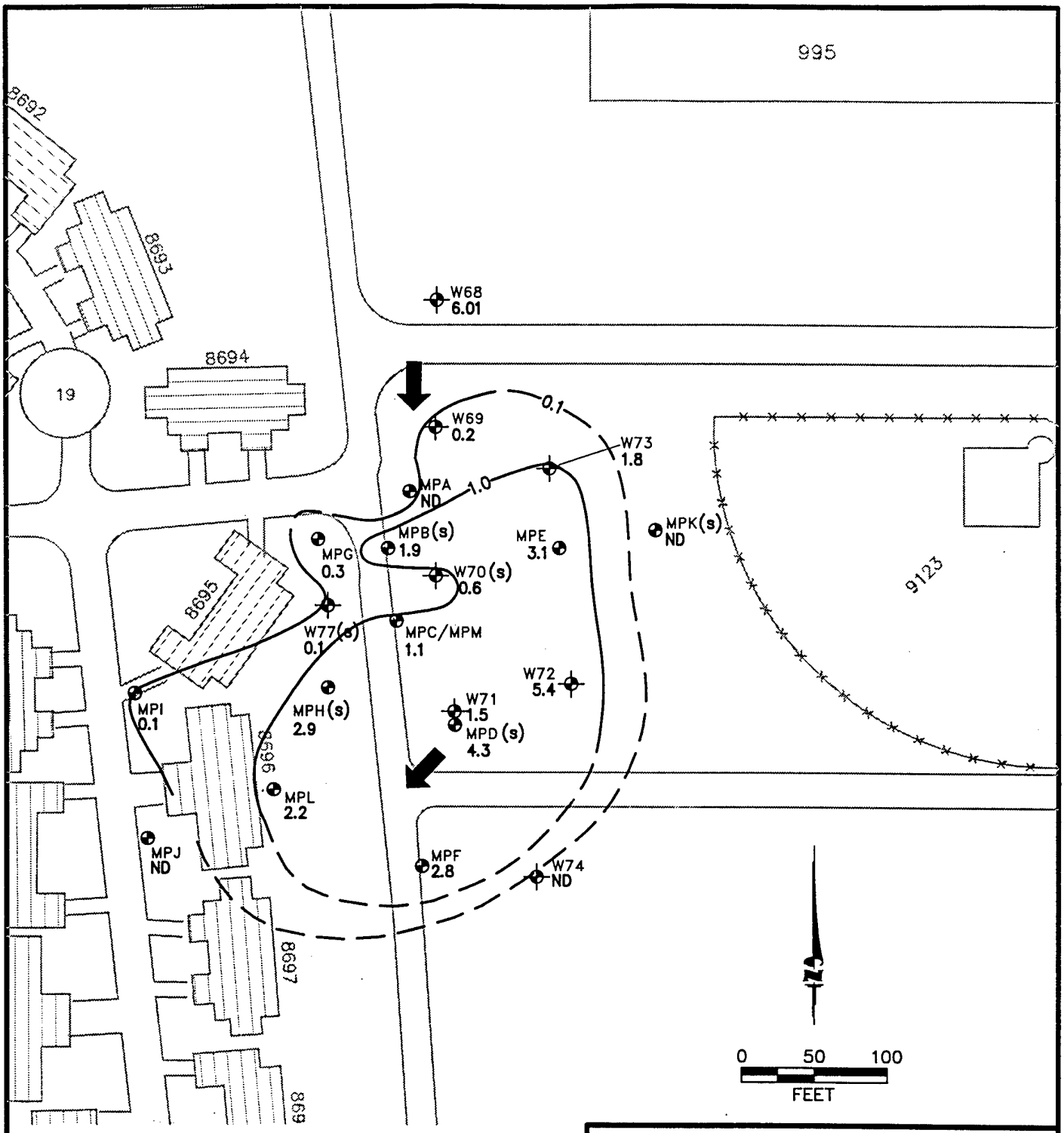
The stoichiometry of BTEX oxidation to carbon dioxide, ferrous iron, and water by microbial iron reduction is presented in Table 4.3. On average 37.5 moles of ferric iron hydroxide are required to metabolize one mole of total BTEX. Conversely, an average of 37.5 moles of ferrous iron are produced for each mole of total BTEX consumed. On a mass basis, this translates to approximately 21.8 mg ferrous iron produced for each 1 mg of total BTEX metabolized. Given a background ferrous iron concentration of less than 0.01 mg/L and a maximum observed ferrous iron concentration of 63.8 mg/L, the groundwater at Site ST-24 has the capacity to assimilate 2.93 mg/L (2,930 μg/L) of total BTEX through iron reduction. This is a conservative estimate of the assimilative capacity of iron because the 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.

Research suggests that the reduction of ferric iron to ferrous iron cannot proceed at all without microbial mediation (Lovley and Phillips, 1988; Lovley *et al.*, 1991; Chapelle, 1993). None of the common organic compounds found in low-temperature, neutral, reducing groundwater could reduce ferric oxyhydroxides to ferrous iron under sterile laboratory conditions (Lovley *et al.*, 1991). This means that the reduction of ferric iron requires microbial mediation by microorganisms with the appropriate enzymatic capabilities. Because the reduction of ferric iron cannot proceed without microbial intervention, the elevated concentrations of ferrous iron that were measured in the contaminated groundwater at the site are very strong indicators of microbial activity.

4.3.3.5 Soluble Manganese

Soluble manganese (Mn^{2+}) concentrations were measured in groundwater samples collected in November 1996. Table 4.4 summarizes soluble manganese concentrations, which ranged from below instrument detection limits to 5.4 mg/L in the groundwater



LEGEND

MPA ND	MONITORING POINT WITH DISSOLVED MANGANESE CONCENTRATION (mg/L)
W77 0.1	MONITORING WELL WITH DISSOLVED MANGANESE CONCENTRATION (mg/L)
	APPROXIMATE GROUNDWATER FLOW DIRECTION
—10—	LINE OF EQUAL DISSOLVED MANGANESE CONCENTRATION (mg/L)
ND	NOT DETECTED

FIGURE 4.6

SOLUBLE MANGANESE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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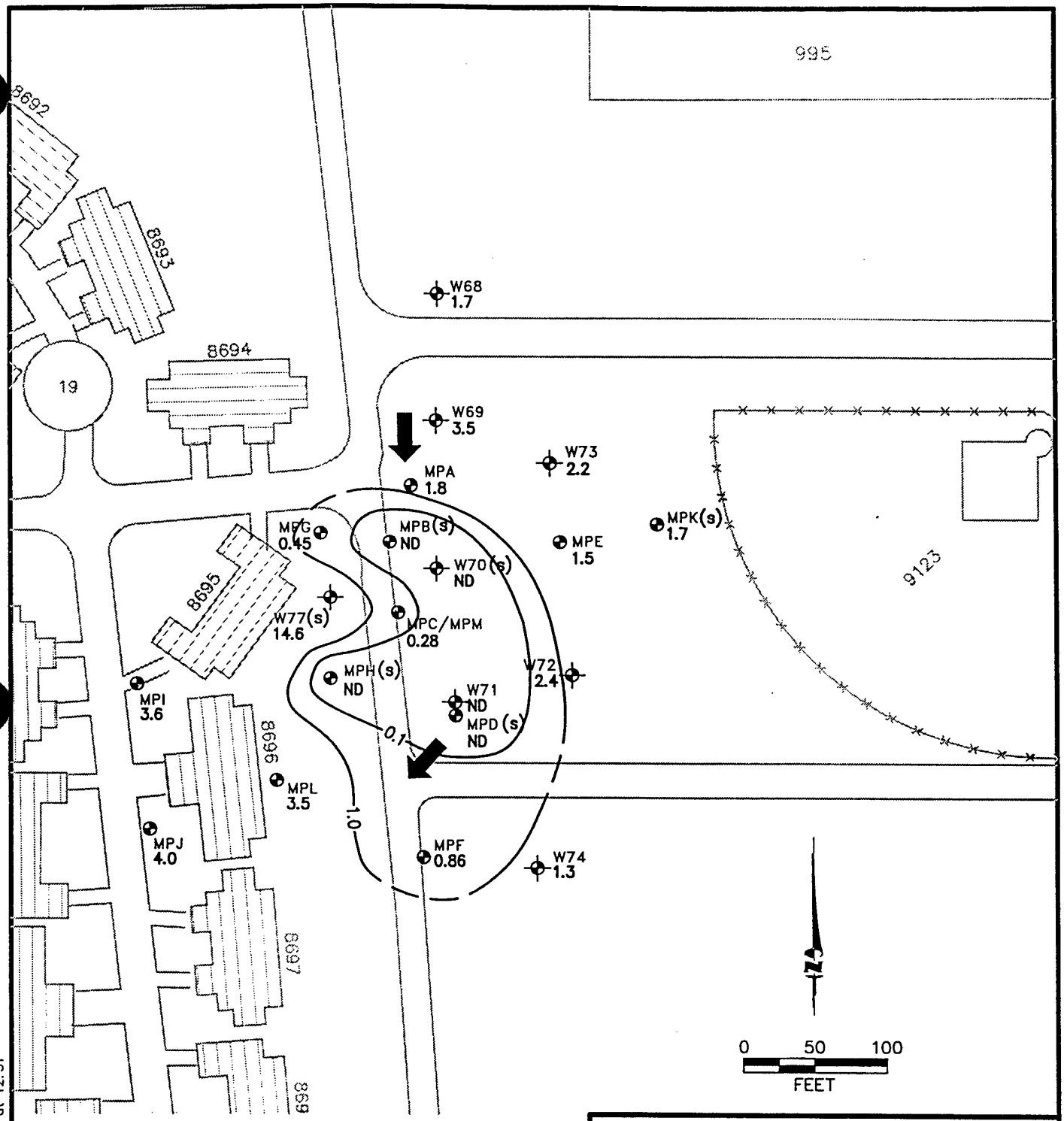
samples collected from Site ST-24. Figure 4.6 is an isopleth map showing the areal extent of soluble manganese in shallow groundwater. Comparison of Figures 4.6 and 4.1 shows graphically that soluble manganese is elevated above 1 mg/L within and southwest of the areas with the highest BTEX concentrations. Soluble manganese concentrations in shallow groundwater were most elevated in the downgradient southwest portion of the dissolved BTEX plume. Background concentrations of soluble manganese in the aquifer are generally less than 0.1 mg/L.

The stoichiometry of BTEX oxidation to carbon dioxide, soluble manganese, and water by manganese reduction through anaerobic microbial biodegradation is presented in Table 4.3. On average, 19 moles of manganese are required to metabolize one mole of total BTEX. Conversely, an average of 19 moles of soluble manganese are produced for each mole of total BTEX consumed. On a mass basis, this translates to approximately 11 mg of soluble manganese produced for each 1 mg of total BTEX metabolized. Given a background soluble manganese concentration of less than 0.1 mg/L and a maximum detected soluble manganese concentration in the source area of 5.4 mg/L, the shallow groundwater has the capacity to assimilate approximately 0.49 mg/L (490 µg/L) of total BTEX through manganese reduction. This assimilative capacity is a conservative estimate because calculations are based on observed soluble manganese concentrations and not on the amount of manganese dioxide available in the aquifer. Therefore, BTEX assimilative capacity through this process could be much higher.

4.3.3.6 Sulfate

Sulfate concentrations were measured in groundwater samples collected in November 1996. Sulfate concentrations at the site ranged from not detected to 14.6 mg/L. Table 4.4 summarizes measured sulfate concentrations. Figure 4.7 is an isopleth map showing the areal extent of sulfate in groundwater. Comparison of Figures 4.7 and 4.1 shows graphically that the areas of depleted sulfate concentrations



LEGEND

MPA 1.80 ⊕	MONITORING POINT WITH SULFATE CONCENTRATION (mg/L)
W77 14.6 ⊕	MONITORING WELL WITH SULFATE CONCENTRATION (mg/L)
⬅	APPROXIMATE GROUNDWATER FLOW DIRECTION
—0.1—	LINE OF EQUAL SULFATE CONCENTRATION (mg/L)
ND	NOT DETECTED

FIGURE 4.7

SULFATE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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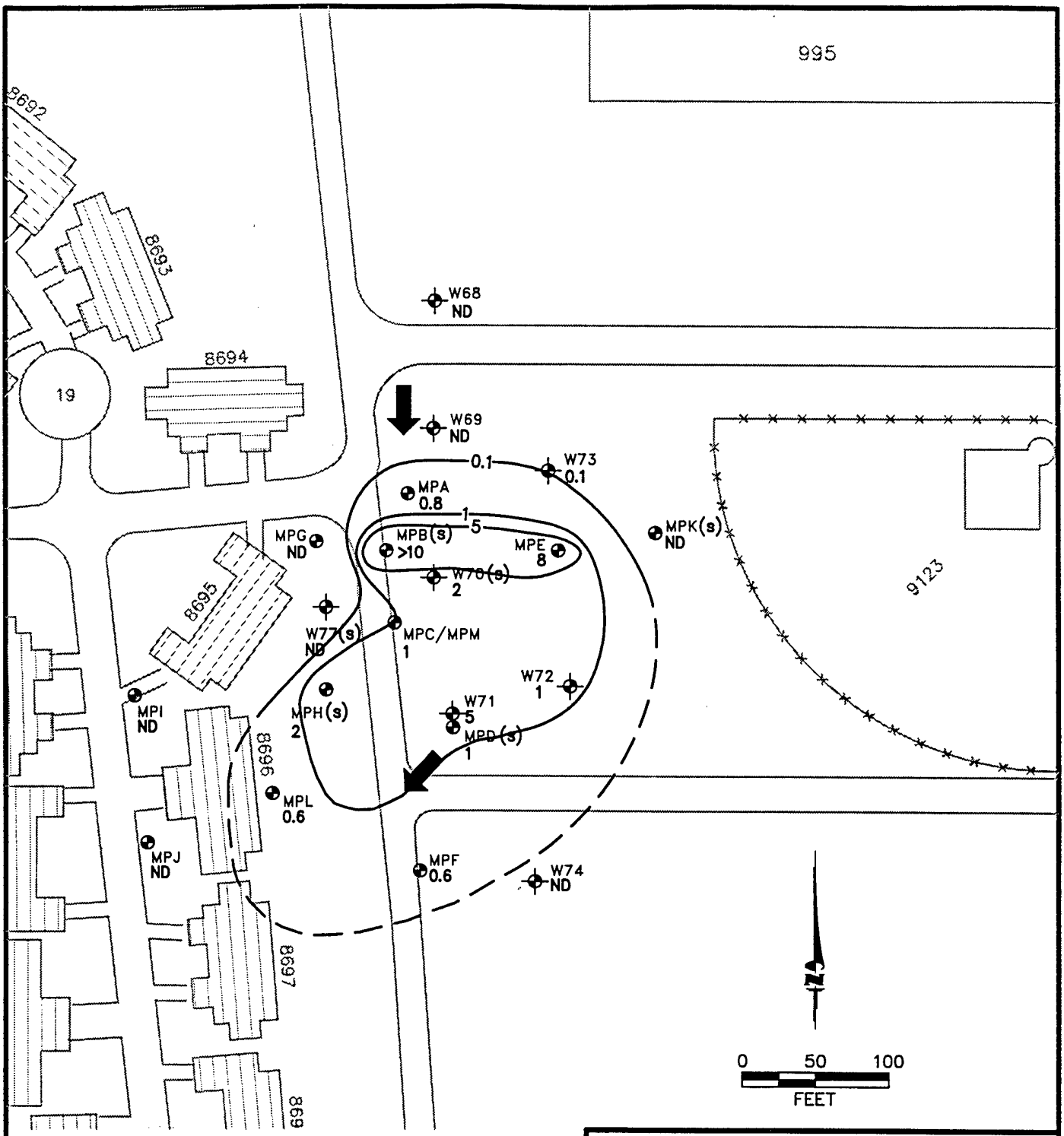
coincide with areas of groundwater BTEX contamination. This relationship is a strong indication that anaerobic biodegradation of BTEX compounds is occurring in the shallow groundwater through the microbially mediated process of sulfate reduction.

The stoichiometry of BTEX mineralization to carbon dioxide, sulfur, and water by sulfate reduction through anaerobic microbial biodegradation is presented in Table 4.3. The average mass ratio of sulfate to total BTEX is approximately 4.7 to 1. This translates to the mineralization of approximately 0.21 mg of total BTEX for every 1.0 mg of sulfate consumed. Shallow sulfate concentrations at several upgradient and side gradient locations ranged from 3.5 mg/L to 1.3 mg/L, with an average concentration of approximately 2.0 mg/L. Assuming a background sulfate concentration of 2.0 mg/L and a minimum sulfate concentration in the source area of less than 0.1 mg/L, the shallow groundwater at this site has the capacity to assimilate 0.42 mg/L (420 mg/L) of total BTEX through sulfate reduction.

4.3.3.7 Ammonium

The presence of ammonium in groundwater can result from either nitrate reduction (facilitated by microbes) or fixing of atmospheric nitrogen (also a microbial process). The production of cell mass is expected to be minimal as a result of the plume age; however, the fixation of atmospheric nitrogen may occur under the strongly anaerobic, methanogenic conditions observed at the site. The presence of ammonium in groundwater is a strong indication of microbial activity.

Ammonium (as N) concentrations measured in groundwater samples collected in November 1996 are summarized in Table 4.4. Figure 4.8 presents the areal extent of dissolved ammonium (as N) observed at Site ST-24. The average background ammonium concentration at Site ST-24 was less than 0.1 mg/L, whereas source area concentrations were measured in excess of 10 mg/L at MPB(s). Based on simple stochiometric calculations, the background nitrate concentrations are not high enough to



LEGEND

MPA 0.8 — MONITORING POINT WITH DISSOLVED AMMONIA CONCENTRATION (mg/L)

W77 ND — MONITORING WELL WITH DISSOLVED AMMONIA CONCENTRATION (mg/L)

APPROXIMATE GROUNDWATER FLOW DIRECTION

—0.1— LINE OF EQUAL DISSOLVED AMMONIA CONCENTRATION (mg/L)

ND NOT DETECTED

FIGURE 4.8

AMMONIUM (AS N) IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.

Denver, Colorado

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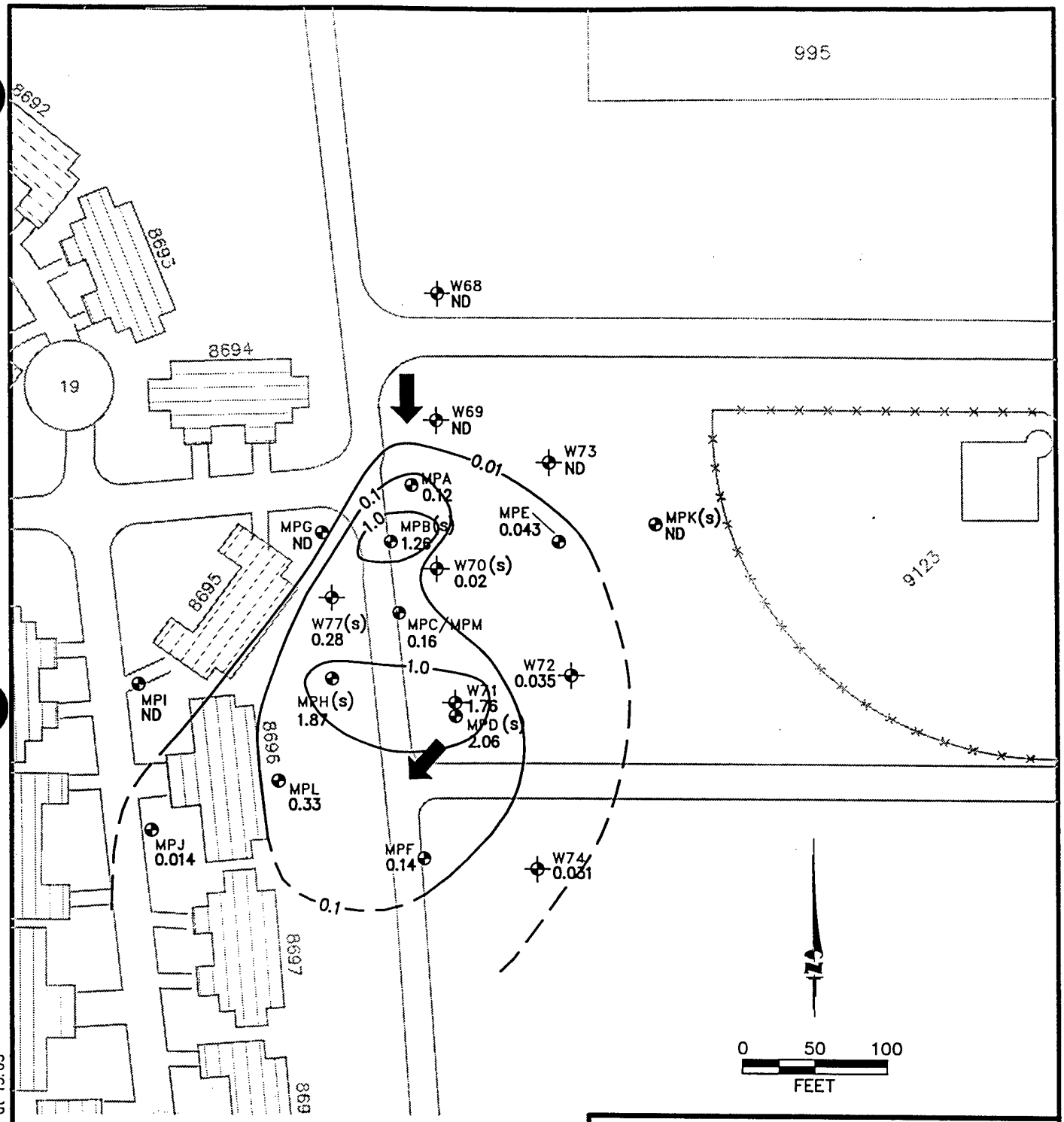
produce 10 mg/L of ammonium via nitrate reduction; therefore, nitrogen fixation must be occurring at Site ST-24.

The stoichiometry of BTEX oxidation to carbon dioxide and ammonium by microbial nitrogen fixation is presented in Table 4.3. On average 6.5 moles of nitrogen gas (N_2) are required to metabolize one mole of total BTEX. Conversely, an average of 13 moles of ammonium are produced for each mole of total BTEX consumed. On a mass basis, this translates to approximately 2.4 mg of ammonium produced for each 1 mg of total BTEX metabolized. This ratio of ammonium production assumes that ammonium/nitrogen is reported as ammonium (NH_4^+) rather than elemental nitrogen (N). The ammonium nitrogen concentrations shown in Table 4.4 are reported as N, and must be multiplied by 1.29 to be converted into ammonium concentrations as NH_4^+. Given a background ammonium (as NH_4^+) concentration of less than 0.13 mg/L and a maximum observed ammonium concentration of 12.9 mg/L (as NH_4^+), the groundwater at Site ST-24 has the capacity to assimilate 5.38 mg/L (5,380 μg/L) of total BTEX through nitrogen fixation. This is a conservative estimate of the assimilative capacity of nitrogen fixation because the calculation is based on observed ammonium concentrations and not on the amount of nitrogen gas available in the aquifer. Therefore, the nitrogen fixation assimilative capacity could be much higher.

4.3.3.8 Methane in Groundwater

Methane concentrations were measured in groundwater samples collected in November 1996. Table 4.4 summarizes methane concentrations, which ranged from below the method detection limit to 2.06 mg/L at the site. Figure 4.9 is an isopleth map showing the distribution of methane in groundwater. Comparison of Figures 4.9 and 4.1 shows graphically that elevated methane concentrations occur in areas with high dissolved BTEX concentrations. The highest methane concentrations were



LEGEND

MPA 0.12	MONITORING POINT WITH DISSOLVED METHANE CONCENTRATION (mg/L)
W77 0.28	MONITORING WELL WITH DISSOLVED METHANE CONCENTRATION (mg/L)
	APPROXIMATE GROUNDWATER FLOW DIRECTION
—1.0—	LINE OF EQUAL DISSOLVED METHANE CONCENTRATION (mg/L)
ND	NOT DETECTED

FIGURE 4.9

METHANE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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detected at MPD(s) and MPH(s), which suggests that carbon dioxide becomes a more favorable electron acceptor approximately 100 feet downgradient from the source.

The stoichiometry of BTEX oxidation to carbon dioxide and methane by methanogenesis is presented in Table 4.3. On average, approximately 1 mg of total BTEX is degraded for every 0.78 mg of methane produced. Given a maximum detected methane concentration of 2.06 mg/L and the assumption of negligible methane concentrations in background groundwater, the shallow groundwater has the expressed capacity to assimilate approximately 2.6 mg/L (2,600 µg/L) of total BTEX through methanogenesis. This is a conservative estimate of the assimilative capacity through methanogenesis because these calculations are based on observed methane concentrations and not on the amount of carbon dioxide (the electron acceptor in methanogenesis) available in the aquifer. As methanogenesis produces more carbon dioxide than it consumes (Table 4.3), an unlimited supply of carbon dioxide is theoretically available once the process of methanogenesis has been initiated. Methanogenesis is limited by the rate of reaction rather than the source of electron receptors. This estimate of assimilative capacity also conservatively assumes that all of the produced methane remains in solution; however, this assumption is not realistic as the solubility limit of methane in water is approached.

4.3.3.9 Alkalinity and Carbon Dioxide Evolution

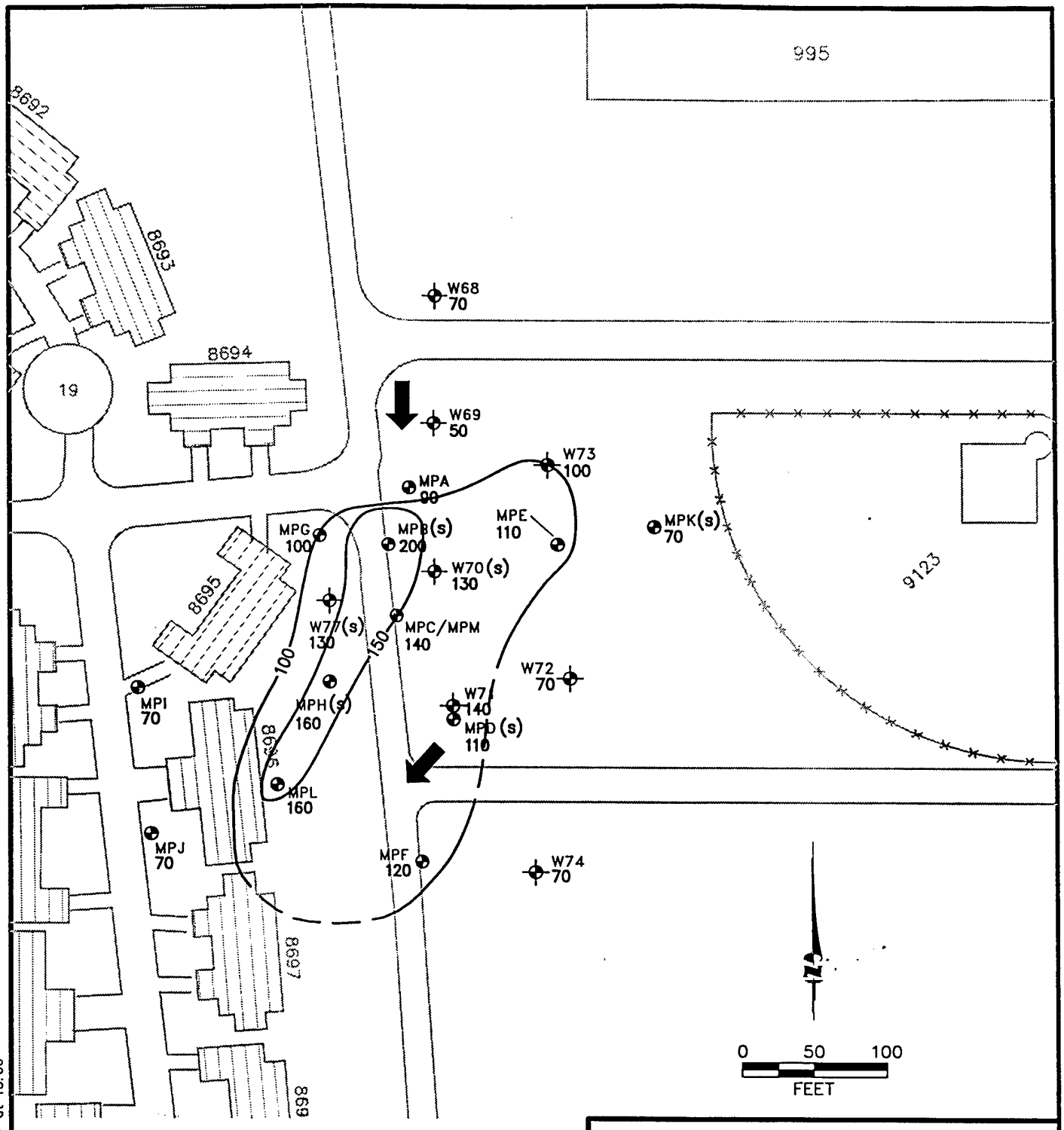
Carbon dioxide is produced during the biodegradation of petroleum hydrocarbons. In aquifers that have carbonate minerals as part of the matrix, carbon dioxide forms carbonic acid, which dissolves these minerals, increasing the alkalinity of the groundwater. Alkalinity is a measure of the ability of groundwater to buffer changes in pH caused by the addition of biologically generated acids. 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, 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 and total alkalinity (as $CaCO_3$) both were measured in groundwater samples collected in November 1996. Carbon dioxide and alkalinity concentrations are summarized in Table 4.4 and presented on Figures 4.10 and 4.11, respectively. Free carbon dioxide at Site ST-24 ranged from 50 to 200 mg/L. Comparison of Figures 4.1 and 4.10 show that areas with elevated dissolved BTEX concentration coincide with areas of elevated carbon dioxide concentrations. Total alkalinity at the site varied from less than 1 mg/L to 168 mg/L. This range of alkalinity may be sufficient to buffer potential changes in pH caused by biologically mediated BTEX oxidation reactions; therefore, data support the inference that aerobic and/or anaerobic biodegradation processes can occur without detrimental shifts in pH. Comparison of Figures 4.11 and 4.1 show increased alkalinity in locations characterized by elevated BTEX concentrations and in locations just downgradient from high BTEX contamination. Both trends suggest that groundwater contamination is being reduced to CO_2 via natural attenuation mechanisms. The CO_2 then flows downgradient and is incorporated in the groundwater system thus increasing the buffer capacity, or alkalinity.

4.3.3.10 Reduction/Oxidation Potential

Redox potential was measured at groundwater monitoring wells and points in November 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 acceptors are being reduced by microbes during BTEX oxidation. The redox potentials at the site range from 338 millivolts (mV) to -234 mV. Table 4.4 summarizes available redox potential data. The distribution of redox potentials is illustrated graphically on Figure 4.12. As expected, areas at the site with low redox



LEGEND

MPA 90 — MONITORING POINT WITH DISSOLVED CARBON DIOXIDE CONCENTRATION (mg/L)

W77 130 — MONITORING WELL WITH DISSOLVED CARBON DIOXIDE CONCENTRATION (mg/L)

APPROXIMATE GROUNDWATER FLOW DIRECTION

100 — LINE OF EQUAL DISSOLVED CARBON DIOXIDE CONCENTRATION (mg/L)

FIGURE 4.10

CARBON DIOXIDE IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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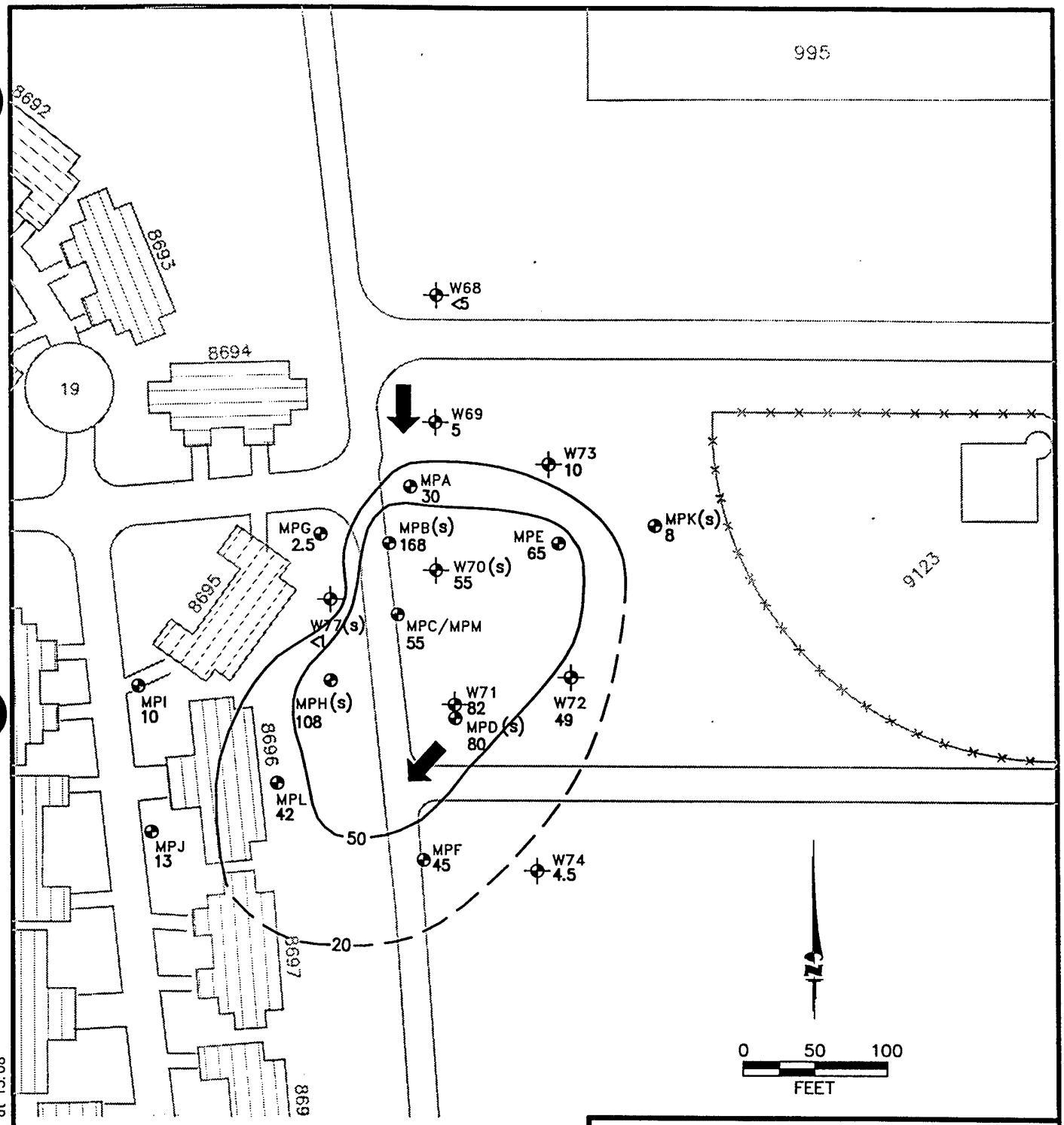

LEGEND

MPA 30 — MONITORING POINT WITH TOTAL ALKALINITY (mg/L)

W77 — MONITORING WELL WITH TOTAL ALKALINITY (mg/L)

APPROXIMATE GROUNDWATER FLOW DIRECTION

—20— LINE OF EQUAL ALKALINITY (mg/L)

FIGURE 4.11

TOTAL ALKALINITY IN GROUNDWATER ISOPLETH MAP NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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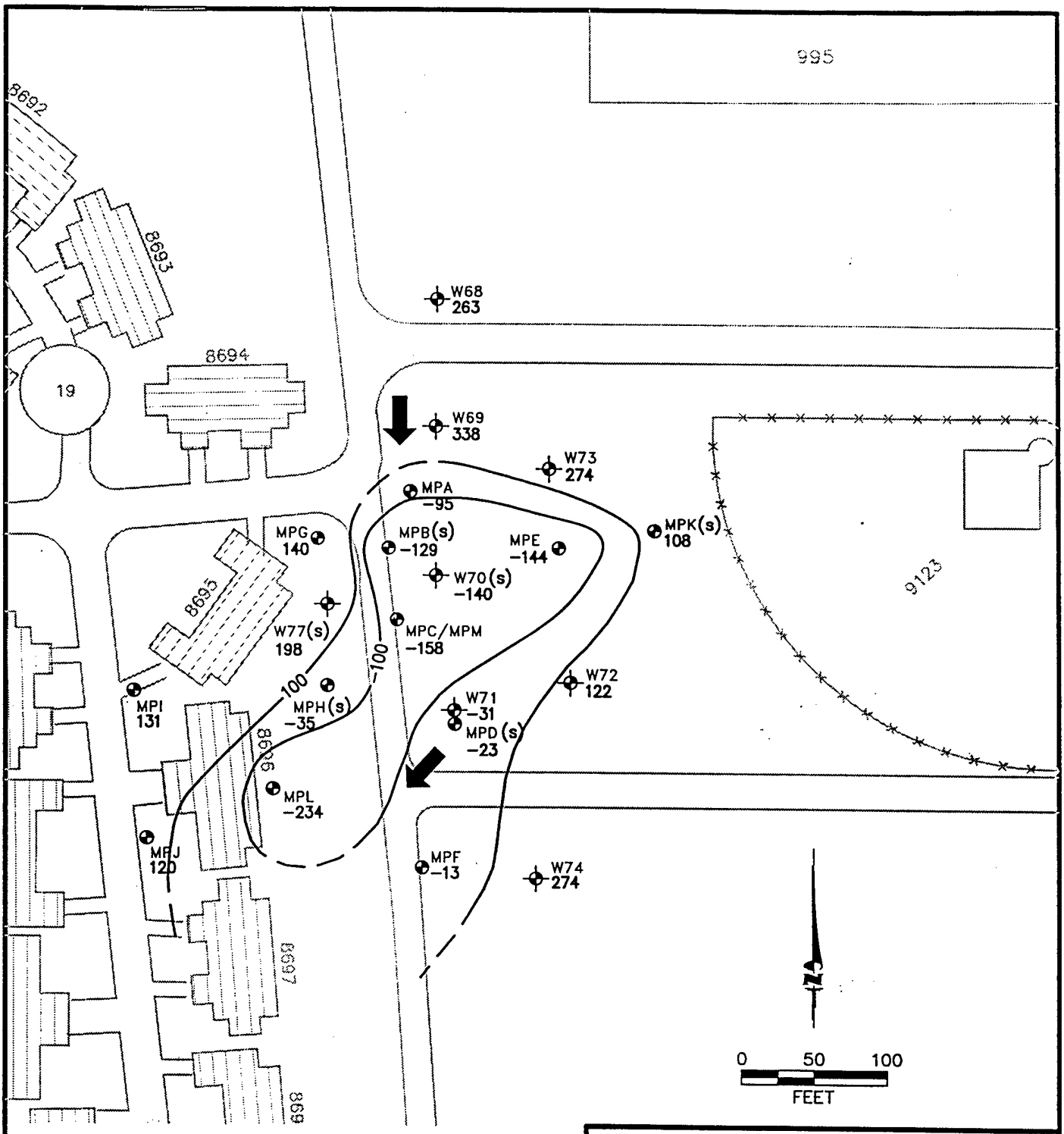

LEGEND

MPA −95 — MONITORING POINT WITH REDOX POTENTIAL (mV)

W77 198 — MONITORING WELL WITH REDOX POTENTIAL (mV)

APPROXIMATE GROUNDWATER FLOW DIRECTION

—10— LINE OF EQUAL REDOX POTENTIAL (mV)

FIGURE 4.12

REDOX POTENTIAL IN GROUNDWATER NOVEMBER 1996

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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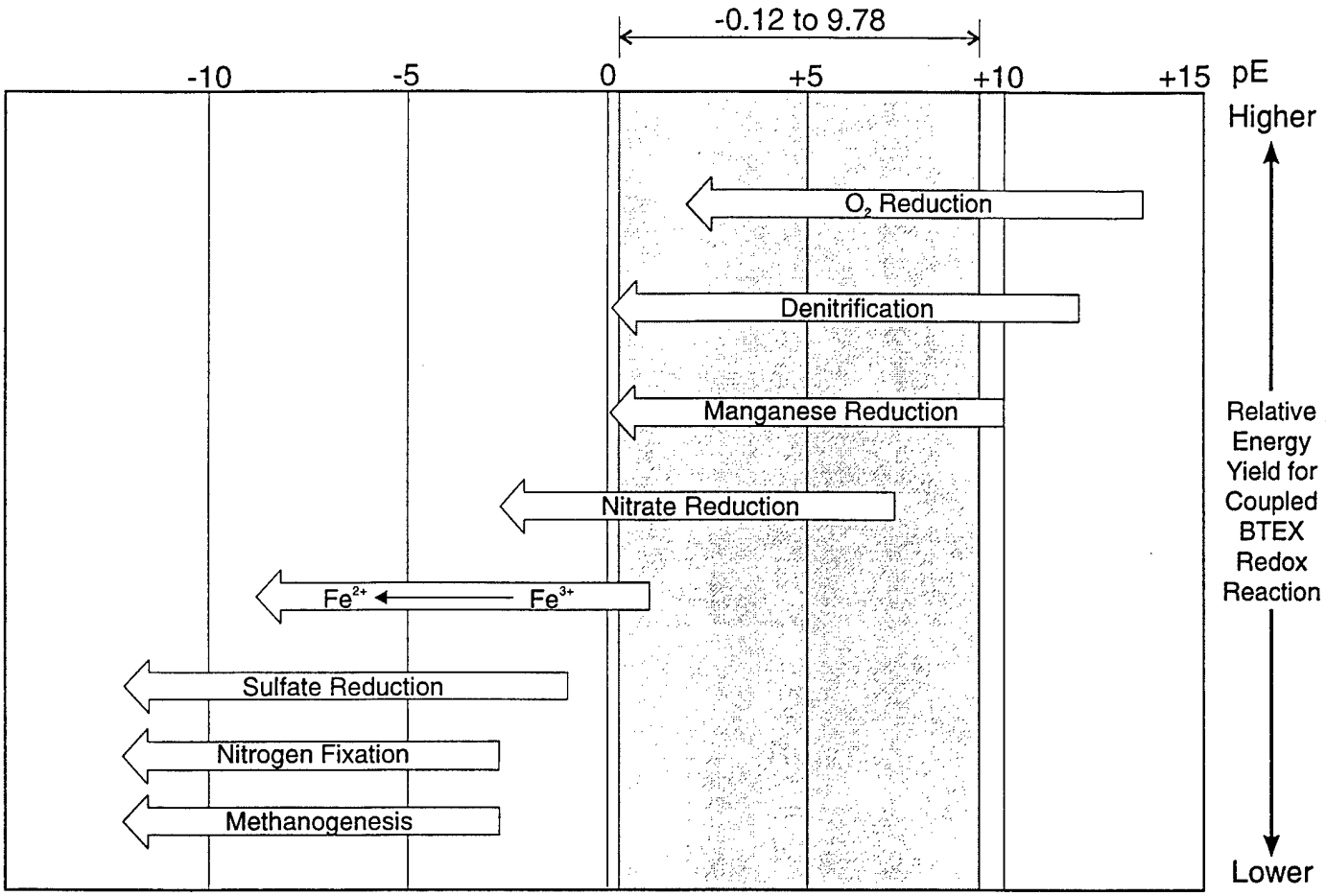
potentials appear to coincide with areas of elevated BTEX contamination, decreased DO, decreased nitrate/nitrite concentrations, elevated soluble manganese and iron, low sulfate concentrations, high dissolved ammonium concentrations, and elevated methane concentrations (compare Figure 4.12 with Figures 4.1, 4.3, 4.4, 4.8 and 4.9).

Figure 4.13 presents the redox potential range (expressed as potential energy, pE) for Site ST-24. The pE range observed at the site may be higher than the theoretical optimum pE for various electron acceptor reactions (Norris *et al.*, 1994). This discrepancy is a common problem associated with measuring oxidizing potential using field instruments. It is likely that the platinum electrode probes are not sensitive to some of the redox couples (e.g., sulfate/sulfide, CO_2/methane). Many authors have noted that field-measured redox data alone cannot be used to reliably predict the electron acceptors that may be operating at a site (Stumm and Morgan, 1981; Godsey, 1994; Lovley *et al.*, 1994). Integrating redox measurements with analytical data on reduced and oxidized chemical species allows a more thorough and reasonable interpretation of which electron acceptors are being used to biodegrade site contaminants.

4.3.3.11 pH

pH was measured for groundwater samples collected from groundwater monitoring points and monitoring wells in November 1996. These measurements are summarized in Table 4.4. The pH of a solution is the negative logarithm of the hydrogen ion concentration [H^+]. Groundwater pH measured at the site ranges from 4.6 to 6.4 standard units. This range of pH overlaps the optimal range for BTEX-degrading microbes; however, a significant number of observed pHs were below the optimal range. This may retard the rate of biodegradation; nevertheless, other geochemical indicators (discussed in prior subsections) demonstrate that biodegradation is occurring. Alkalinity measurements also suggested that groundwater $CaCO_3$ levels are sufficient to completely buffer changes in pH. In addition, as groundwater pH becomes



Notes

Range of pE (potential energy) measured at Site ST-24

1. These reactions would be expected to occur in sequence if the system is moving toward equilibrium.

2. These redox processes occur in order of their energy-yielding potential (provided microorganisms are available to mediate a specific reaction). Reduction of a highly oxidized species decreases the pE of the system.

3. The pE of the system determines which electron acceptors are available for oxidation.

4. Redox sequence is paralleled by an ecological succession of biological mediators.

Adapted from Stumm and Morgan, 1981.

FIGURE 4.13

SEQUENCE OF MICROBIALLY MEDIATED REDOX PROCESSES

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

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increasingly acidic, fungi may predominate over bacteria in successfully biodegrading hydrocarbons (Atlas, 1988; Brock *et al.*, 1994).

4.3.3.12 Temperature

Groundwater temperature was measured at groundwater monitoring points and monitoring wells in November 1996. Table 4.4 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 groundwater varied from 16.9 degrees Celsius (°C) to 22.1°C. These temperatures span a range that is optimal for psychrophilic, hydrocarbon-degrading microorganisms.

4.3.4 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 biodegradation, denitrification, iron reduction, nitrogen fixation, methanogenesis, and, to a limited extent, sulfate and manganese reduction. Unexpectedly, nitrogen fixation at this particular site appears to be dominating natural attenuation processes. On the basis of the stoichiometry presented in Table 4.4 and observed background electron acceptors, the expressed BTEX assimilative capacity of groundwater at Site ST-24 is at least 15,890 µg/L (Table 4.5).

A closed system with 2 liters of water can be used to help visualize the physical meaning of assimilative capacity. Assume that the first liter contains no fuel hydrocarbons, but it contains fuel degrading microorganisms and has an assimilative capacity of exactly "x" µg of fuel hydrocarbons. The second liter has no assimilative capacity; however, it contains fuel hydrocarbons. As long as these 2 liters of water are kept separate, biodegradation of the fuel hydrocarbons will not occur. If these 2 liters are combined in a closed system, biodegradation will commence and continue until the

fuel hydrocarbons are depleted, the electron acceptors are depleted, or the environment becomes acutely toxic to the fuel degrading microorganisms. Assuming a nonlethal environment, if fewer than "x" µg of fuel hydrocarbons were in the second liter, all of the fuel hydrocarbons would eventually degrade given a sufficient time; likewise, if greater than "x" µg of fuel hydrocarbons were in the second liter of water, only "x" µg of fuel hydrocarbons would ultimately degrade.

TABLE 4.5
EXPRESSED ASSIMILATIVE CAPACITY OF SITE GROUNDWATER
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Electron Acceptor or Process	Expressed BTEX Assimilative Capacity (µg/L)
Aerobic Respiration	1,930
Denitrification	2,140
Iron Reduction	2,930
Manganese Reduction	490
Sulfate Reduction	420
Nitrogen Fixation	5,380
Methanogenesis	2,600
Expressed Assimilative Capacity	15,890

The groundwater beneath Site ST-24 is an open system, which continually receives additional electron receptors from upgradient and from the percolation of precipitation. This means that the assimilative capacity is not fixed as it is in a closed system, and therefore cannot be compared directly to contaminant concentrations in the groundwater. Rather, the expressed assimilative capacity of groundwater is intended to serve as a qualitative tool. Although the expressed assimilative capacity at this site is less than the highest measured total BTEX concentration (20,950 µg/L), the fate of BTEX in groundwater and the potential impact on receptors is dependent on the relationship between the kinetics of biodegradation and the solute transport velocity (Chappelle, 1994). This significant expressed assimilative capacity is a strong indicator that biodegradation is occurring and is sufficient to limit migration of the contaminant plume.

At Site ST-24 natural attenuation mechanisms could eliminate all groundwater BTEX contamination if the current concentrations of electron acceptors are maintained. Clean, upgradient groundwater and precipitation recharge could provide this continuous source of electron acceptors to the microbial population. Furthermore, the probable contaminant source (the service station and associated USTs) has been removed, preventing future introduction of additional soil and groundwater contaminants. Because groundwater advective velocity at ST-24 is 700 ft/yr, and because dissolved BTEX has not been observed in monitoring locations approximately 200 feet downgradient from the source area (MPG, MPI, MPJ), it is suggested that natural attenuation processes are controlling further downgradient migration of the dissolved contaminant plume. RNA of BTEX in groundwater should, therefore, be considered an effective option when selecting a final remedial solution for contaminated groundwater at Site ST-24.

SECTION 5
GROUNDWATER MODELING

5.1 GENERAL OVERVIEW

To help estimate degradation rates for dissolved BTEX at ST-24 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) predict the future extent and concentration of the dissolved contaminant plume by modeling the combined effects of advection, dispersion, sorption, and biodegradation; (2) assess the potential for exposure of downgradient receptors to contaminant concentrations that exceed regulatory standards intended to be protective of human health and the environment; and (3) provide technical support for the RNA option at post-modeling regulatory negotiations. The model was developed using site-specific data and conservative assumptions about governing physical and chemical processes. Because of the conservative nature of model input, the reduction in contaminant mass caused by natural attenuation is expected to exceed model predictions. This analysis is not intended to represent an assessment of potential risks posed by site contamination.

Partial differential equations that describe groundwater flow and/or solute transport can be solved analytically or numerically. Analytical methods (models) provide exact, closed-form solutions, and numerical methods (models) provide approximate solutions. The type of model selected to simulate site conditions depends on the complexity of the problem, the amount of available data, the importance of the decisions that will be based upon the model, and project scope. Analytical models are the simplest to set up

and solve, allowing the user to evaluate many scenarios in a relatively short time. However, analytical models are restricted in the nature of the problems for which they can be used, and for some transport problems they may become so complex and unwieldy that the use of numerical methods may be more efficient. Numerical methods are more efficient for those systems that are too complex for analytical methods. Theoretically there are no limits on the characteristics of the hydrogeological system and the properties of the solute(s) that can be simulated using a numerical model code. There are, however, practical limits on the ways in which the system and any reactions within it can be represented. The basic input parameters for both types of models typically include groundwater seepage velocity, hydraulic conductivity, saturated thickness of the aquifer, porosity, source area configuration, source area contaminant concentrations, leakage rates, dispersion coefficients, solute retardation values, and solute decay rates.

If limited data are available, or the hydrogeologic conditions are simple, an analytical model can be selected to simulate contaminant fate and transport. Analytical models provide exact, closed-form solutions to the governing advection/dispersion equation by making significant simplifying assumptions. The more closely the actual system approximates these assumptions, the more accurate the analytical model will be at predicting groundwater flow and solute fate and transport. Because of the nature of the simplifying assumptions, analytical models may overestimate or underestimate the spread of contamination. By making assumptions that will ensure the model will overpredict contaminant concentrations and travel distances (or at least not underpredict them), the model predictions will be conservative. The more conservative a model is, the more confidence there should be that potential downgradient receptors will not be impacted by site contamination. Analytical solutions are generally limited to steady, uniform flow or radial flow conditions, and should not be used for groundwater flow or

solute transport problems in strongly anisotropic flow conditions or heterogeneous media.

Numerical solutions provide approximate solutions to the advection/dispersion equation. Numerical models are less burdened by simplifying assumptions and are capable of addressing more complicated problems. Unlike analytical models, numerical models allow subsurface heterogenieties and varying aquifer parameters to be simulated, as well as transient conditions (i.e., one or more properties or conditions change over time), if the requisite data are available. Many of the assumptions required for the analytical solutions are not necessary when numerical techniques are used to solve the governing solute transport equation. However, a greater amount of site-specific data is needed to implement a numerical model, and the solutions are inexact numerical approximations. The added complexity of performing a numerical model typically is not warranted unless the spatial distribution of input parameters is well documented.

Analytical models were selected to evaluate contaminant fate and transport at ST-24. Analytical models were determined to be appropriate for this site because hydrogeologic conditions are uniform, limited spatial geochemical and contaminant concentration information is available, and remediation of vadose zone soils within the site source area has already been performed. The models used with ST-24 data provided first-order solute decay solutions for a semi-infinite system with a point source of diminishing concentration (van Genuchten and Alves, 1982). The models assume a homogeneous, isotropic aquifer; a uniform, constant-velocity flow field in the x-direction only; a constant longitudinal hydrodynamic dispersion; a first-order rate of decay for biodegradation of site contaminants; and a linear sorption rate.

5.2 CONCEPTUAL MODEL DESIGN AND ASSUMPTIONS

Before developing a groundwater model, it is important to develop a reasonable interpretation of aquifer conditions. On the basis of the data presented in Section 3, the shallow saturated zone was conceptualized and modeled as a shallow unconfined, aquifer composed of sandy to silty gravel with some clay (Figure 3.3). Water level data suggest a relatively uniform local groundwater flow system with a slight upward vertical component.

Geochemical data presented in Section 4 suggest that biodegradation of site contaminants is occurring. In particular, BTEX compounds are being degraded by aerobic respiration and the anaerobic processes of denitrification, ferric iron reduction, manganese reduction, sulfate reduction, nitrogen fixation, and methanogenesis. Current analytical data on dissolved BTEX concentrations and implemented remedial actions were used for model calibration and to support source reduction assumptions. Furthermore, the maximum downgradient BTEX concentration is below state and federal groundwater guidelines, suggesting that dissolved BTEX concentrations above the Mississippi Department of Environmental Quality (MDEQ, 1991) standards are not migrating beneath Base housing located west of Site ST-24. In addition, due to prior remediation of site soils, the lack of residual soil LNAPL above the groundwater table and the absence of mobile LNAPL suggest there is not a significant continuing source of dissolved BTEX contamination at Site ST-24.

5.3 INITIAL MODEL SETUP

Where possible, the initial setup for the models was based on site data. Where site-specific data were not available (e.g., for effective porosity), reasonable assumptions were made on the basis of widely accepted literature values. The analytical model solution is based on calculations for retarded flow with biodegradation and a decaying source (van Genuchten and Alves, 1982). The following sections describe the basic

model setup. The analytical model parameters that were varied during model calibration are discussed in Section 5.4.

5.3.1 Groundwater Gradient

The November 1996 water table elevation map presented on Figure 3.5 was used to determine the hydraulic gradient. Groundwater flow in the vicinity of the site is to the south with an average gradient of approximately 0.01 ft/ft. In the absence of historical groundwater elevation data, it was assumed that the November 1996 water levels and gradient are representative of steady-state conditions. Groundwater data, also collected in November 1996, suggest a slight upward vertical gradient, indicative of a semi-confining aquifer.

5.3.2 BTEX Concentrations

The total dissolved BTEX concentrations obtained from laboratory analytical results were used for model development. Table 4.2 presents November 1996 dissolved BTEX concentration data. Figure 4.1 shows the areal distribution of dissolved groundwater BTEX in November 1996. The shape and distribution of the total BTEX plume are the result of advective-dispersive transport and biodegradation of dissolved BTEX contamination originating from the source areas at ST-24. The BTEX concentrations from the November 1996 site investigation were used in the models to project future downgradient concentrations.

5.3.3 Degradation Rates

Available data strongly suggest that aerobic and anaerobic biodegradation of dissolved BTEX is occurring at the site. In November 1996, combined anaerobic processes accounted for more than 85 percent of the assimilative capacity of site groundwater (Table 4.5). As with a large number of biological processes, biodegradation can generally be described using a first-order rate constant and the equation:

$$\frac{C}{C_0} = e^{-kt}$$

where: C = Contaminant Concentration at Time t
C_0 = Initial Contaminant Concentration
k = Coefficient of Anaerobic Decay (anaerobic rate constant)
t = time

Two methods of calculating rate constants are currently available to quantify rates of biodegradation at the field scale and are applicable for use with available site data. The first method involves the use of a biologically recalcitrant compound found in the dissolved BTEX plume that can be used as a conservative tracer. The second method, proposed by Buscheck and Alcantar (1995), involves interpretation of a steady-state contaminant plume configuration and is based on the one-dimensional steady-state analytical solution to the advection/dispersion equation presented by Bear (1979).

5.3.3.1 Trimethylbenzene Tracer Method

To calculate rate constants, the apparent degradation rate must be normalized for the effects of dilution caused by advective/dispersive processes and sorption. This can be 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 to biodegradation. Observed BTEX concentration data can be normalized to 1,3,5-TMB, 1,2,4-TMB, and/or 1,2,3-TMB or another tracer with similar physiochemical properties. The TMB compounds can serve as good tracers because they can be biologically recalcitrant under anaerobic conditions, and they have sorptive properties similar to the BTEX compounds (Cozzarelli *et al.*, 1990 and 1994). Thus, TMBs are assumed to respond similarly to the processes of advection, dispersion, and sorption without experiencing a reduction in concentration due to biodegradation. Under aerobic conditions, TMB compounds are less recalcitrant, leading to reduction in TMB concentrations by biological processes in addition to dispersion, dilution, and

sorption. This in turn results in the calculation of an overly low, albeit conservative, rate constant.

The normalized (corrected) concentration of a compound is the concentration of the compound that would be expected at one point (B) located downgradient from another point (A) after correcting for the effects of dispersion, dilution, and sorption between points A and B. One relationship that can be used to calculate the corrected contaminant concentration is:

$$C_{B,Corr} = C_B(TMB_A/TMB_B)$$

where:
$C_{B,Corr}$ = Corrected concentration of compound at Point B
C_B = Measured concentration of compound at Point B
TMB_A = Measured TMB concentration at Point A
TMB_B = Measured TMB concentration at Point B

A log-linear plot of the corrected contaminant concentrations along a flow path versus e travel time from the source can be used to determine whether the data set can be described using a first-order exponential equation (i.e., r^2 is greater than approximately 0.9). When this occurs, the exponential slope can be used as the rate constant. Once again, if aerobic conditions exist along the selected flow path, the rate constant calculation will be conservative because TMBs are not recalcitrant under aerobic conditions.

An average rate constant for BTEX decay at Site ST-24 was determined from November 1996 BTEX and TMB data. The selected flow path (from MPC/MPM through W71 to MPL) is anaerobic. Table 5.1 presents the data for a first-order rate constant calculation for BTEX using 1,2,4-TMB as a conservative tracer. The TMB-corrected total BTEX concentration represents the theoretical BTEX concentration at a point if biodegradation were the only process affecting BTEX concentrations. The

graph that accompanies the table illustrates that a rate constant of 0.044 day^{-1} is predicted. TMB should serve as a conservative tracer because TMB is not completely recalcitrant under anaerobic conditions. Therefore, the rate constant is expected to be higher than calculated using this technique. Furthermore, downgradient from well MPL, the biodegradation rate constant would be expected to increase because the aquifer becomes aerobic. Typically, aerobic degradation rates exceed anaerobic degradation rates (Borden and Bedient, 1986).

5.3.3.2 Method of Buscheck and Alcantar

Buscheck and Alcantar (1995) derive a relationship that allows calculation of first-order decay rate constants for steady-state plumes. This method involves coupling the regression of contaminant concentration (plotted on a logarithmic scale) versus distance downgradient (plotted on a linear scale) to an analytical solution for one-dimensional, steady-state, contaminant transport that includes advection, dispersion, sorption, and biodegradation. For a steady-state plume, the first-order decay rate is given by (Buscheck and Alcantar, 1995):

$$\lambda = \frac{v_c}{4\alpha_x}\left(\left[1 + 2\alpha_x\left(\frac{k}{v_x}\right)\right]^2 - 1\right)$$

where:
- λ = first-order decay rate
- v_c = retarded contaminant velocity in the x-direction
- α_x = dispersivity
- k/v_x = slope of line determined from a log-linear plot of contaminant concentration versus distance downgradient along flow path

The first-order decay rate includes biodegradation resulting from both aerobic and anaerobic processes; however, in the absence of oxygen, the first-order rate is equivalent to the anaerobic decay rate. Table 5.2 presents the data for a first-order rate constant calculation for BTEX using November 1996 data at ST-24 and the method

TABLE 5.1
FIRST-ORDER RATE CONSTANT CALCULATION USING 1,2,4-TMB AS A CONSERVATIVE TRACER

SITE ST-24 RNA TS

COLUMBUS AFB, MISSISSIPPI

Point	Distance Downgradient (ft)	Travel Time Between Upgradient and Downgradient Points (days)	Measured Total BTEX Concentration (µg/L)	Measured 1,2,4-Trimethylbenzene Concentration (µg/L)	Trimethylbenzene-Corrected Total BTEX Concentration (µg/L)
MPC/MPM	0	0	20,950	6800	20,950
W71	73	49	2,140	1860	2,879
MPL	208	139	22.2	8	46

v_c = 1.5 ft/day (for benzene)

PLOT OF TMB-CORRECTED TOTAL BTEX CONCENTRATION VERSUS TRAVEL TIME

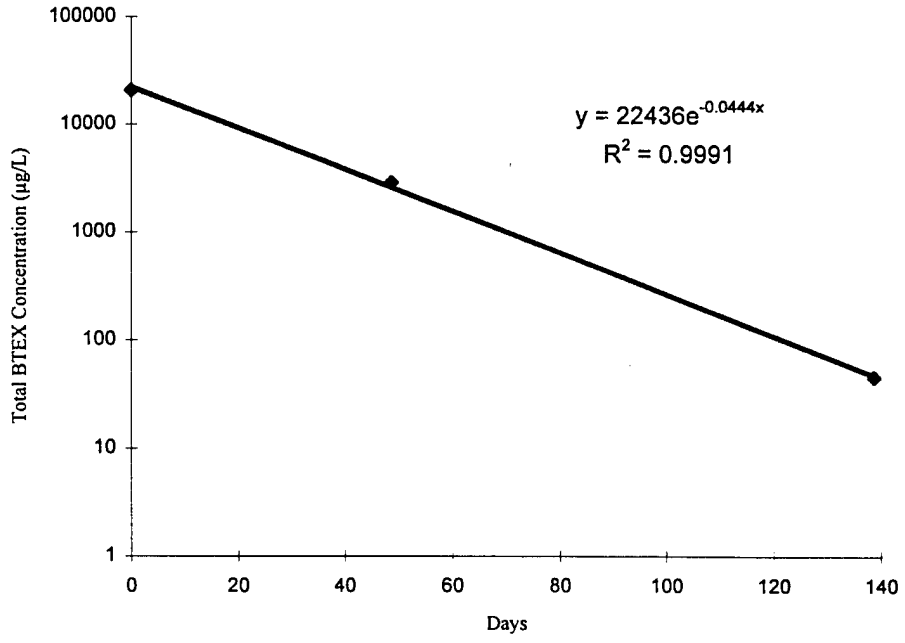


TABLE 5.2

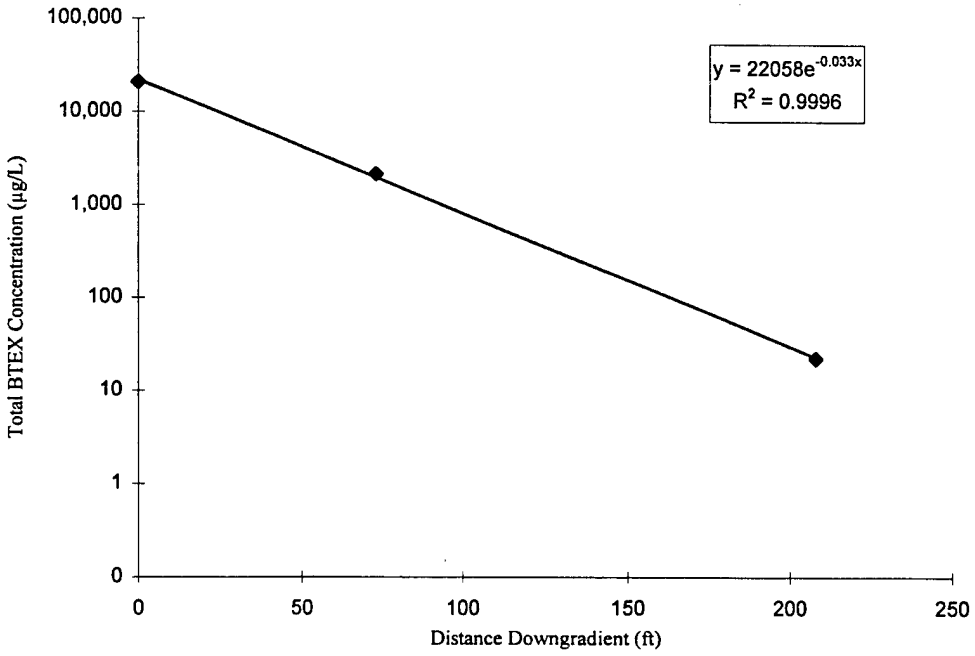
FIRST-ORDER RATE CONSTANT CALCULATION USING THE METHOD OF BUSCHECK AND ALCANTAR (1995)

SITE ST-24 RNA TS

COLUMBUS AFB, MISSISSIPPI

Point	Distance Downgradient from Source (ft)	Total BTEX (µg/L) Oct-96
MPC/MPM	0	20,950
W71	73	2,140
MPL	208	22.2

PLOT OF TOTAL BTEX CONCENTRATION VERSUS DISTANCE



$$\lambda = v_c/4\alpha_x([1+2\alpha_x(k/v_x)]^2-1)$$

where	v_c =	1.5000	ft/day
	α_x =	20	ft
	k/v =	0.033	ft^{-1}
therefore	λ =	0.082	day^{-1}

proposed by Buscheck and Alcantar (1995). An exponential fit to the data estimates a log-linear slope of 0.033. This value translates to a decay constant of 0.082 day^{-1}

5.3.3.3 Selection of a Decay Rate Constant

A review of recent literature indicates that higher rate constants generally have been observed in anaerobic plumes at other sites. For example, Chapelle (1994) reported that at two different sites with anaerobic groundwater conditions the 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}); Buscheck *et al.* (1993) report first-order attenuation rates in a range of 0.001 to 0.01 day^{-1}; andStauffer *et al.* (1994) report rate constants of 0.01 and 0.018 day^{-1} for benzene and *p*-xylene, respectively. A first-order rate constant of 0.08 day^{-1} was used in the two analytical models run for this site.

5.4 MODEL CALIBRATION

Calibration of the contaminant fate and transport model is an important component in the development of a defensible groundwater model. It demonstrates that the model is capable of predicting observed hydraulic and contaminant conditions given conditions observed in the past. The analytical flow models presented herein were calibrated using current analytical data for initial contaminant concentrations and altering source input, source decay rates, and solute decay rates until modeled data matched current observed BTEX concentrations. The model was calibrated over a 4-year period spanning the time from the removal of site contaminated soils to November 1996 using a hydraulic gradient of 0.01 ft/ft, hydraulic conductivity of 58 ft/day, and effective porosity of 0.3.

To calibrate the model, an 8-percent annual source decay rate and an 8-percent daily solute decay rate were used. An 8-percent annual source decay rate may be an accurate

representation of site conditions because a rate of this magnitude could account for natural degradation of the source (residual LNAPL below the water table) as well as dissolution of the source into groundwater. The 0.08-day^{-1} solute decay rate was selected on the basis of calculations presented in Section 5.3.3. The calibrated model also assumes a source input term of 46.5 mg/L per year of BTEX, attributable to residual LNAPL in site soils below the water table, and uses the source area BTEX concentration of 20,950 mg/L measured in November 1996.

TOC was not measured above the 0.06-percent method detection limit in the soil sample collected from the saturated zone, upgradient from the source area. Using the method detection limit as an approximation of TOC levels in site soils, contaminant migration was modeled with retardation resulting from sorption. Modeled contaminant (i.e., benzene) velocities were approximately two-thirds of the advective groundwater velocity. Even though it is unclear whether soil TOC levels are significantly less than 0.06 percent, it is expected that some sorption, and therefore some contaminant retardation with respect to groundwater velocity, is occurring.

Using these input parameters, the model successfully reproduced November 1996 BTEX concentrations observed at the source area (point MPC/MPM), 72 feet downgradient from the source area (well W71), and along the leading plume edge (point MPL). Where the calibrated model differed from the observed BTEX concentrations, modeled concentration were slightly higher. Consequently, the total dissolved contaminant mass predicted from the models is approximately equal to or slightly higher than the mass estimated from the observed contaminant concentrations. Thus, the model is considered conservative. Model input and output are included in Appendix C.

5.5 SENSITIVITY ANALYSIS

The purpose of the sensitivity analysis is to determine the effect of varying model input parameters on model output. The sensitivity analysis for the analytical models was conducted on individual runs of the calibrated model by varying hydraulic conductivity (±2 times), the TOC content (±10 times), effective porosity (±25%), dispersivity (±2 times), and the solute decay rate (±2 times). The annual rate of source decay is varied to duplicate effects of certain remedial alternative in Section 6. To perform the sensitivity analyses, the model was run with the same input as the calibrated model except for the tested parameter. The models were run for a 4-year period so the effects could be compared to November 1996 plume conditions simulated by the calibrated model, also using a 4-year period. Model output data from the sensitivity analysis are presented in Appendix C.

The results of the sensitivity analysis suggest that the calibrated model is most sensitive to hydraulic conductivity, solute decay, and TOC, and less sensitive to effective porosity and dispersivity. Increasing hydraulic conductivity significantly increased the distance of plume migration, and the downgradient concentrations of dissolved contaminants, because advective/dispersive mechanisms are more significant with the higher groundwater velocity that results from a higher hydraulic conductivity. Conversely, decreasing the hydraulic conductivity to half the observed value decreased the distance of plume migration and the dissolved contaminant concentrations to below observed conditions in November 1996. Increasing the TOC content of the aquifer matrix decreased the distance of plume migration below the observed conditions in November 1996, and decreased dissolved BTEX concentrations throughout the plume to below those levels observed in late 1996. Decreasing the TOC content had the opposite effects on the modeled BTEX plume. Changes in the modeled dissolved BTEX plume due to increases and decreases in effective porosity are similar to the

changes observed with varying TOC; however effective porosity changes had a noticeably smaller effect on the predicted plume than changing TOC values. Increases and decreases in dispersivity values had a similar, but less pronounced, effect on the predicted contaminant plume as did changes in the hydraulic conductivity. Increasing the solute decay rate by two caused the model to produce a contaminant plume of much less size and mass than observed in November 1996. Decreasing the solute decay rate made the predicted 1996 plume much larger and more contaminated than the observed plume in November 1996.

The hydraulic conductivity, dispersivity, and effective porosity values used in the calibrated model are valid because they are similar to documented or widely accepted values. Based on sensitivity analysis, the ranges for other model input parameters used to produce the simulated BTEX plumes are feasible, given the observed BTEX concentrations, the conservative assumptions made in constructing the simulation, and the strong geochemical evidence of aerobic and anaerobic biodegradation. The models were calibrated to known endpoints in a continuum of known past contaminant levels. Results of predictive models are presented in Section 6.

SECTION 6

COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents the development and comparative analysis of groundwater remedial alternatives for contaminated groundwater at Site ST-24. The intent of this evaluation is to determine if RNA of groundwater is an appropriate and cost-effective remedial approach to consider when developing final remedial strategies for the study area, especially when combined with other remedial technologies.

Section 6.1 presents the criteria used to evaluate 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 for shallow groundwater contamination at the site were evaluated based on 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 focuses on the potential use of RNA and source reduction technologies to reduce dissolved BTEX concentrations in the shallow groundwater below Mississippi State regulatory action levels (MDEQ Office of

Pollution Control, Groundwater Division, Groundwater Quality Standards, Section 3, Numerical Groundwater Standards, 1991).

6.1.1 Long-Term Effectiveness and Permanence

Each remedial technology or remedial alternative (which can be a combination of remedial approaches such as RNA and institutional controls) was analyzed to determine how effectively it will minimize groundwater plume expansion so that groundwater quality standards can be achieved at downgradient sentry wells. The expected technical effectiveness based on case histories from other sites with similar conditions also is evaluated. The ability to minimize potential impacts on surrounding facilities and operations is considered. Also, the ability of each remedial alternative to protect both current and potential future receptors from potential risks associated with potentially completed exposure pathways is qualitatively assessed. This evaluation criterion also includes permanence and the ability to reduce contaminant mass, toxicity, and volume. Time to implementation and time until protection is achieved are described. 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, also is 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, 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 (adjusted to present worth) of each remedial alternative was estimated for relative comparison. An estimate of capital costs, and operating and post-implementation costs for site monitoring and controls is included. An annual adjustment factor of 7 percent was assumed in present-worth calculations. The annual adjustment factor, or discount rate, is the difference between the rate of inflation and the cost of money (USEPA, 1993).

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 site. Factors considered included the objectives of the AFCEE natural attenuation demonstration program; site-specific contaminant, groundwater, and soil properties; current and future land uses; and potential receptors and exposure pathways. The following section briefly describes 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 study area.

6.2.1 Program Objectives

The intent of the RNA demonstration program sponsored by AFCEE is to develop a systematic process for scientifically investigating and documenting natural subsurface attenuation processes that can be factored into overall site remediation plans. The objective of this program and the specific demonstration at Columbus AFB is to provide solid evidence of RNA of dissolved fuel hydrocarbons 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 that demonstrate that natural processes of contaminant degradation can often reduce

contaminant concentrations in groundwater below acceptable cleanup standards before completion of potential receptor exposure pathways.

Because the objective of this program is to study natural processes in the saturated zone rather than all contaminated media (e.g., soil, soil gas, etc.), technologies have been evaluated based primarily 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 also 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 remediate all contaminated media. Additional program objectives set forth by AFCEE include cost effectiveness and minimization of waste. Technologies that may best meet these AFCEE criteria include institutional controls, soil vapor extraction (SVE), bioventing, bioslurping, passive drain collection, biosparging, and RNA. Under this program, slurry walls, sheet piling, carbon adsorption, and groundwater extraction with *ex situ* biological or chemical treatment of groundwater are not considered attractive technologies.

6.2.2 Contaminant Properties

The site-related contaminants considered as part of this demonstration in the study area are the BTEX compounds. The primary source of contamination at Site ST-24 is the release into site soils of fuel products from four leaky USTs and their associated distribution lines. The USTs contained leaded gasoline, unleaded regular gasoline, unleaded premium gasoline, and heating oil. The four USTs, three fueling islands, and distribution lines were removed in 1989. At this time, not all contaminated soil was excavated. In May 1993, the remaining contaminated soil was removed by USACE (CH2M Hill, 1995). The physiochemical characteristics of gasoline and the individual BTEX compounds will greatly influence the effectiveness and selection of a remedial technology.

Gasoline is classified as an LNAPL with a liquid density of approximately 0.73 g/cc at 20°C [Biomedical and Environmental Information Analysis (BEIA), 1989]. Because gasoline is less dense than water, the LNAPL may become concentrated in the capillary fringe. Some of the individual gasoline constituents sorb very well to the soil matrix, others dissolve quickly into percolating groundwater, and yet others may volatilize into soil vapor. This "weathering" process results in a variable distribution of individual gasoline components in the soil, soil atmosphere, and groundwater with time and distance from the release (BEIA, 1989). Constituents in gasoline range from slightly to highly soluble in water. Overall solubility is approximately 300 mg/L. Gasoline also can act as 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 a petroleum mixture. These characteristics allow the BTEX compounds to leach more rapidly from contaminated soil into groundwater, and to migrate as dissolved contamination (Lyman *et al.*, 1992). All of the BTEX compounds are highly susceptible 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, caetaldehyde, 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 and toluene (Kenaga and Goring, 1980; Means *et al.*, 1980; Hassett *et al.*, 1983; Fetter, 1993). 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). A compilation of literature values for sorption coefficients suggests that xylenes sorb to soil with approximately the same strength as ethylbenzene (Wiedemeier *et al.*, 1995). 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).

On the basis of these physiochemical characteristics, RNA, bioventing, SVE, and biosparging could all be effective options for collecting, destroying, and/or treating

BTEX at Site ST-24. Some of these options are considered less desirable after considering site-specific conditions (Section 6.2.3).

6.2.3 Site-Specific Conditions

Three general categories of site-specific characteristics were considered when identifying remedial approaches for comparative evaluation as part of this demonstration. The first category was physical characteristics such as groundwater depth, hydraulic conductivity, gradient, flow direction, and soil type. The second category was the site geochemistry, or how the site contaminants are interacting with electron acceptors, microorganisms, and other site contaminants. Both of these categories influence the types of remedial technologies most appropriate for the site. The third category involved assumptions about future land use and potential receptor exposure pathways. Each of these site-specific characteristics has influenced the development of remedial alternatives included in the comparative evaluation.

6.2.3.1 Physical Characteristics

Site geology and hydrogeology 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. The estimated average hydraulic conductivity at ST-24 is 0.0403 ft/min (58 ft/day) (Section 3.3.2.2), which is characteristic of clean, fine- to medium-grained sand (Freeze and Cherry, 1979). This contributes to a moderately high advective groundwater velocity, estimated at 700 ft/yr.

Although the relatively high hydraulic conductivities of the study area can result in greater plume expansion and migration, this same characteristic also can enhance the effectiveness of other remedial technologies, such as groundwater extraction,

biosparging, and RNA. For example, it should be less expensive and time-consuming to capture and treat a contaminant plume using a network of extraction wells in an area of high hydraulic conductivity because each well could envelope a larger area of influence and sustain a higher flow rate. The effectiveness of biosparging also may be increased in highly conductive and/or homogeneous aquifers because of reduced entry pressures and short-circuiting, and increased mixing of sparge air and groundwater. In addition, greater hydraulic conductivity would increase the amount of contaminant mass traveling through a biosparging network. Given a moderately high groundwater velocity, the effectiveness of natural attenuation can increase as a result of enhanced dilution and dispersion of the contaminant mass. The movement of contaminant mass within the subsurface away from the source area also can bring contaminants into contact with a larger mass of electron acceptors, thereby increasing rates of biodegradation.

Like hydraulic conductivity, the organic carbon content of native phreatic zone soils can affect the effectiveness of remedial alternatives. Soils across the phreatic surface in the study area have a low TOC content (less than 0.06 percent), and therefore, the soils have a correspondingly low sorptive potential. However, sorptive capacity is sufficient to cause a difference in the groundwater and contaminant velocities. The difference between contaminant and groundwater velocity increases the effectiveness of biodegradation in the source area because there are fresh electron acceptors flowing past the slower moving dissolved contaminant mass.

6.2.3.2 Geochemical Characteristics

To satisfy the requirements of indigenous microbial activity and RNA, the aquifer also must provide an adequate and available carbon or energy source (e.g., fuel hydrocarbon contamination), electron acceptors, essential nutrients, and 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 TS, indicate that

this site is characterized by adequate and available carbon/energy sources and electron acceptors to support measurable biodegradation of fuel hydrocarbon contamination by indigenous microorganisms. DO, nitrate, ferric iron, sulfate, carbon dioxide, and dissolved nitrogen represent sources of significant electron acceptor capacity for the biodegradation of BTEX compounds at Site ST-24 (Table 4.6). The average pH in shallow site groundwater ranged between 4.6 and 6.4 standard units in November 1996. This is lower than the optimal range for biodegradation of 6 to 8 standard pH units and bacteria populations can be expected to decrease, in turn reducing the rate of BTEX biodegradation (Wiedemeier *et al.*, 1995). Nevertheless, biodegradation has been observed to be occurring at a fairly high rate at this site. Redox potentials ranged from 338 to -234 mV in November 1996 (Figure 4.8), and suggest a groundwater environment that is both oxidizing and reducing. The changes in geochemical parameters at the site suggest that aerobic biodegradation, nitrate reduction, iron reduction, sulfate reduction, nitrogen fixation, and methanogenesis (consistent with observed geochemical indicator trends discussed in Section 4), are reducing fuel contamination in groundwater. Groundwater data presented in Section 4 strongly support this conclusion.

Microbe addition was not considered a viable remedial approach for this site on the basis of observed geochemical trends that suggest that significant microbial activity is likely occurring. Fuel-hydrocarbon-degrading microorganisms are ubiquitous in the subsurface, 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).

6.2.3.3 Potential Receptor Exposure Pathways

A pathways analysis identifies the potential human and ecological receptors that could 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 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 the potential for pathway completion. If a completed exposure pathway exists (e.g., surface water contact), potential long-term remedial options still may be sufficient to maintain exposure concentrations below regulatory action levels. Establishing site-specific, risk-based cleanup levels is beyond the scope of this TS.

Assumptions about current and future land uses 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 a site must be remediated.

Site ST-24 is currently used as a recreational (open space) area. The site is surrounded by Base housing to the west of the site and recreational areas (e.g., open spaces, softball fields) to the north, south, and east sides of the site. In the hydraulically connected downgradient direction (southwest), recreational areas and Base housing extend for at least 3,000 feet. There are no downgradient on-Base wells that provide potable water to Columbus AFB. The closest off-Base private wells are

located 3,300 feet to the east and 5,100 feet to the southeast of Site ST-24. Observed BTEX concentrations (Figure 4.1) and modeling results (Section 5) suggest that contaminant concentrations emanating from Site ST-24 are attenuated long before reaching the downgradient Base boundary, located 1,000 feet southwest of Site ST-24.

Under reasonable current land use assumptions, potential receptors include Base intrusive workers and possibly downgradient Base residents, because the model results suggest that the dissolved BTEX plume will not migrate far enough to pose a threat to potential receptors exposed at the nearest downgradient off-Base well. Workers could be exposed to site-related contamination in shallow groundwater or soils beneath the water table if these materials are removed or exposed during future construction excavations or remedial activities. Residents could possibly be exposed to groundwater VOCs that have migrated beneath Base housing and volatilzed into contaminated soil vapors that could seep into housing basements via cracks in the foundation. However, modeling presented in Section 5 suggest that under current conditions contaminated groundwater will not migrate beneath Base housing. Groundwater from the shallow aquifer downgradient from Site ST-24 is not currently used to meet any demands at Columbus AFB. Currently, there are five deep on-Base wells that provide potable water to Columbus AFB, none of which are downgradient from the site. Columbus AFB plans to connect to the City of Columbus water system in 1997.

The potential future exposure pathways involving Base workers are identical to those under current conditions. Given the current and future land use scenarios, the use of RNA at this site will require that the source area be maintained as recreational property, and that restrictions on shallow groundwater use be enforced in areas downgradient from the site until RNA and/or engineered source removal can reduce contaminants to regulatory action levels. If source reduction technologies such as SVE, bioventing, or excavation are implemented, they will have some impact on the short-

and long-term land use options, and some level of institutional control and worker protection during remediation may be required.

6.2.3.4 Remediation Goals for Shallow Groundwater

The federal MCLs for BTEX and other VOCs (MDEQ,1991) are adopted as the state water quality MCLs by the MDEQ (MDEQ Office of Pollution Control, Groundwater Division, Groundwater Quality Standards, Section 3, Numerical Groundwater Standards, 1991). MCLs for the BTEX compounds are presented in Table 6.1. Although it is unlikely that groundwater from Site ST-24 would be ingested by humans because there are no current downgradient water supplies in close proximity to the site and the Base is converting to a City supply system in the near future, the state MCL of 5 µg/L for benzene will be used to evaluate the effectiveness, implementability, and cost of remedial alternatives in this TS.

TABLE 6.1
GROUNDWATER QUALITY STANDARDS
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Compound	State Maximum Contaminant Level (µg/L)[a/]
Benzene	5
Toluene	1,000
Ethylbenzene	700
Xylenes	10,000

[a/] Source: MDEQ Office of Pollution Control, Groundwater Division, Groundwater Quality Standards, Section 3, Numerical Groundwater Standards, 1991.

For this TS, the primary remedial action objective (RAO) for evaluation of remediation technologies for shallow groundwater is to reduce contaminant concentrations in groundwater to below state regulatory criteria at downgradient sentry wells. To accomplish this, remedial alternatives focus on limiting migration of the

dissolved contaminant plume away from Site ST-24 toward Base housing, while relying on RNA to reduce contaminant concentrations throughout the plume.

Viable remedial alternatives must be able to achieve MCLs or other risk-based standards that are protective of human health and the environment. Use of risk-based cleanup goals developed specifically for Site ST-24 groundwater may allow compliance with less stringent groundwater quality standards. If groundwater concentrations protective of human health and the environment can be negotiated with the state on the basis of site-specific exposure scenarios, the time and cost of the proposed remedial alternative (Section 6.5) could potentially be decreased.

In summary, available data suggest that completed exposure pathways involving human and ecological receptors exposed to contaminated groundwater do not exist under current conditions. The site is currently used as a recreational area, and no intrusive activities are planned in the near future. The required period of any groundwater and soil institutional controls associated with the selected remedial technology is likely to expire before any anticipated future land use changes.

6.2.4 Summary of Remedial Option Screening

Several remedial options have been identified and screened for use in treating the shallow groundwater at the site. Table 6.2 identifies the initial remedial technologies and approaches 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 RNA demonstration, physiochemical properties of BTEX, and other site-specific characteristics such as hydrogeology, geochemistry, land use assumptions, potential receptor 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 options retained for development of remedial

TABLE 6.2
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost	Retain
Long-Term Monitoring	Periodic Groundwater Monitoring	Confirmation Wells	Many wells and monitoring points are available to confirm the progress of remediation. Sufficient space exists for additional wells.	Necessary for all remedia-tion strategies	Low	Yes
		Point-of-Compliance Wells	Sufficient distance exists between the plume and point-of-compliance to locate several wells.	Necessary	Low	Yes
Institutional Controls	Groundwater Use Control	Land Use Control/Regulate Well Permits	The plume lies within the Base boundary, and land and groundwater use are under Base jurisdiction.	Necessary	Low	Yes
		Seal/Abandon Existing Wells	No production wells are known to exist in the current or predicted plume area.	Not required at this site	Low	No
		Point-of-Use Treatment	No shallow groundwater is extracted from the plume area for any use.	Poor	Moderate	No
	Public Education	Meetings/ Newsletters	Base public relations and environmental management offices have many information avenues to workers and residents.	Necessary	Low	Yes
Containment of Plume	Hydraulic Controls	Interceptor Trench Collection	No likely receptors downgradient of site. Groundwater gradients are low. Hydraulic conductivity of site soils favors pumping.	Low	Moderate	No
		Groundwater Extraction	Would prevent downgradient migration of dissolved contaminants beneath Base housing; however, only marginally complies with program objectives.	Moderate	Moderate	Yes
	Physical Controls	Slurry Walls/Grout Curtains	Although implementable, the technology would be costly and ineffective because of high groundwater velocity and consequently large groundwater volume.	Low	High	No
		Sheet Piling	Although implementable, the technology would be costly and ineffective because of high groundwater velocity and consequently large groundwater volume.	Low	High	No
	Reactive/ Semi-Permeable Barriers	Biologically Active Zones	Degradation of BTEX can be stimulated by allowing groundwater to flow through a nutrient-rich barrier. Although implementable, the technology is new and unproven.	Moderate	High	No

TABLE 6.2 (continued)
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF
TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost	Retain
In Situ Groundwater Treatment	Biological	Oxygen and/or Nutrient Enhanced Biodegradation (Biosparging)	Nutrients are injected downgradient of plume to limit plume migration by enhancing biodegradation and reducing BTEX concentrations. Implementable, and technology may enhance natural attenuation processes.	Moderate	Low	Yes
	Chemical/ Physical	Natural Attenuation	A combination of natural biological, chemical, and physical removal mechanisms which occur to varying degrees on every site. Groundwater sampling at Site ST-24 indicates that this is an ongoing remediation process.	High	Low	Yes
		Air Sparging (Volatilization)	Injection of air into contaminated aquifer creating a mass transfer of BTEX into air bubbles and vadose zone. Similar to biosparging in effectiveness; however, more mass is transferred rather than destroyed.	Moderate	Low	No
Source Removal/ Groundwater Remediation	Groundwater Extraction	Vertical Pumping Wells	Source area of groundwater plume is pumped by installing submersible pumps in source area wells. Limited by contaminant mass transfer rates into the groundwater; therefore, for steady-state or shrinking plumes it is comparable to RNA in effectiveness.	Moderate	Moderate	No
Aboveground Groundwater Treatment	Biological	Bioreactors	High flow rates require excessive retention times and large reactors. BTEX is often volatilized in these systems.	Moderate	High	No
	Chemical/ Physical	Air Stripping	Cost-effective technology for removing BTEX from groundwater at high flow rates. Potential permitting for air emissions.	High	Moderate	Yes
		Activated Carbon	Cost prohibitive for more concentrated BTEX. Creates a carbon disposal problem.	Moderate	High (O&M)	No
		Direct Discharge to Industrial Waste Water Treatment Plant (IWWTP)	Implementable option only when an IWWTP is readily available and capable of handling BTEX, TPH, chlorinated solvent, and hydraulic loading. IWWTP not available for this site.	High	Low	No
		UV/Ozone Reactors	High flow rates require lengthy retention times and large, costly reactors.	Moderate	High	No

TABLE 6.2 (concluded)
INITIAL TECHNICAL IMPLEMENTABILITY SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR GROUNDWATER REMEDIATION
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

General Response Action	Technology Type	Process Option	Implementability	Effectiveness	Relative Cost	Retain
Treated Groundwater Disposal	Discharge to IWWTP or Sanitary Sewer	IWWTP	Implementable option only when an IWWTP is available and capable of handling hydraulic loading. IWWTP is not available.	High	Low	No
		Sanitary Sewer	Implementable option only when access to a sanitary sewer exists and hydraulic loading is acceptable.	High	Low	Yes
	Treated Groundwater Reinjection	Vertical Injection Wells	Injection wells subject to clogging, high maintenance, and permitting.	Moderate	Moderate	No
		Injection Trenches	Requires large trenches and can be subject to injection well permitting.	Moderate	Moderate	No
	Discharge to Surface Waters	Storm Drains	Generally requires NPDES or other discharge permit	High	Low	Yes
Source Removal/Soil Remediation	Excavation/ Treatment	Landfilling	Excavation has already been performed at this site. For reasons of risk and cost reduction, in-situ methods preferable when possible.	Moderate	Moderate	No
		Biological Landfarming	Excavation has already been performed at this site. For reasons of risk and cost reduction, *in-situ* methods preferable when possible.	Moderate	Moderate	No
		Thermal Desorption	Excavation has already been performed at this site. For reasons of risk and cost reduction, *in-situ* methods preferable when possible.	Moderate	High	No
	In Situ	Bioventing	Air injection/extraction to increase soil oxygen levels and stimulate biodegradation of fuel residuals.	Moderate to High	Low	Yes
		Soil Vapor Extraction	Vapor extraction has been successfully implemented at other sites. Highly implementable in sandy soils and effective for BTEX in unsaturated soils. May be subject to air permitting.	High	Low to Moderate	Yes
		Soil Washing	Water and/or surfactant solution are forced through zones of residual contamination to enhance contaminant partitioning into the groundwater. Most effective in homogeneous sandy soils.	Low	High	No

alternatives and comparative analysis include institutional controls, RNA, LTM, biosparging/SVE, and groundwater pumping.

6.3 BRIEF DESCRIPTION OF REMEDIAL ALTERNATIVES

This section describes how remedial technologies retained from the screening process were combined into three remedial alternatives for the study area. Sufficient information on each remedial alternative is provided to facilitate a comparative analysis of effectiveness, implementability, and cost in Section 6.4.

6.3.1 Alternative 1 - RNA and Institutional Controls with Long-Term Groundwater Monitoring

RNA is achieved when natural attenuation mechanisms bring about a reduction in the total mass of a contaminant in the soil or dissolved in groundwater. RNA 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, RNA will reduce dissolved contaminant concentrations below numerical concentration goals intended to be protective of human health and the environment. As indicated by the evidence of RNA described in Section 4, these processes are occurring in the vicinity of Site ST-24 and will continue to reduce contaminant mass in the plume area.

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 from the plume 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.

Long-term monitoring would be performed at a regular frequency and would consist of sampling a set of wells, including upgradient, source area, plume extent, and sentry monitoring wells. The site- and alternative-specific LTM strategy is provided in Section 7. On the basis of predictive contaminant fate and transport model results (Section 6.4), it is unlikely that contaminant concentrations exceeding MDEQ groundwater MCLs would approach a potential receptor exposure point. Nevertheless, LTM is the technical mechanism used to evaluate the progress of natural attenuation processes and to ensure that remedial objectives are being met. Detection of benzene in excess of the MDEQ MCL of 5 µg/L at any sentry well may require additional evaluation to assess BTEX migration and to determine the probable extent of migration, or to determine if additional corrective action is necessary. Regulatory standards for other detected fuel compounds are much higher; therefore, it is unlikely that these standards would be exceeded sooner than would the benzene standard. In either case, land use restrictions would require reevaluation.

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

6.3.2 Alternative 2 - Biosparging with Soil Vapor Extraction In and Downgradient from the Source Area, RNA, and Institutional Controls with Long-Term Groundwater Monitoring

This alternative is identical to Alternative 1 except that a biosparging system would be used to enhance the biodegradation of organic contaminants in subsurface soils and groundwater by supplying oxygen to indigenous microbes using low-flow air injection in the ST-24 source area. The biosparging system would also be used to minimize downgradient migration of dissolved contamination by placing a line of sparging wells perpendicular to the observed groundwater flow direction just upgradient from the Base housing to the west of site ST-24. The biosparging system is intended to be operated at a low rate of air injection that significantly reduces emissions into the atmosphere while maximizing *in situ* biodegradation. An SVE system could be used in conjunction with the biosparging system to prevent migration of contaminated soil gas toward the nearby Base housing. If it is determined that the efficiency of the biosparging system would be improved by substantially increasing the air injection rate, the SVE system also could be expanded to recover virtually all injected gases and displaced soil vapors prior to discharge to the atmosphere.

On the basis of Parsons ES experience in the application of biosparging technology, two vertical air injection wells installed within the source area, defined as the area of contaminated vadose zone soils and groundwater, should be sufficient to remediate the contamination surrounding the former USTs and fuel distribution systems. Another three air injection wells would be installed west of Independence Avenue in order to prevent dissolved groundwater contamination from migrating beneath the Base housing located west of the site. Approximately five shallow vapor monitoring points also would be installed for measurement of the effectiveness of the injection wells. The SVE component of the biosparging system also is designed in two portions. Five vapor extraction points would be located between Independence Avenue and just downgradient from the proposed biosparging curtain to intercept the migration of any

potential contaminated soil gas toward the on-Base residences. Another two SVE points would be placed in the source area to prevent migration of contaminated vapors to the recreational area just above the source area.

The conceptual design assumes that biosparging points would be 30 feet deep with 10 feet of screen located approximately 15 feet beneath the water table. Biosparging well are also assumed to have an approximate radius of influence of 25 feet. SVE points would be 15 feet deep with no more than 10 feet of screen. The conceptual radius of influence for each SVE point is 35 feet. To conservatively estimate the cost of remediation, it was assumed that the biosparging system coupled with SVE would be operated for 5 years.

As with Alternative 1, institutional controls and LTM would be required. LTM wells would be the same as described for Alternative 1.

6.3.3 Alternative 3 - Groundwater Extraction, RNA, and Institutional Controls with Long-Term Groundwater Monitoring

Groundwater extraction at Site ST-24 would be performed for plume containment rather than source reduction. Two 8-inch-diameter groundwater extraction wells would be placed just downgradient from the source and just upgradient from the Base housing along Independence Avenue in the observed groundwater flow direction. The groundwater extraction wells will prevent contaminated groundwater from migrating beneath any Base housing just west of ST-24 and prevent completion of any potential receptor pathways. Because groundwater extraction is not proposed for source reduction it would not appreciably reduce the predicted length of time required for RNA to complete groundwater remediation. In addition, because the groundwater extraction system potentially generates a large volume of waste requiring treatment and disposal, the alternative does not comply well with objectives of the AFCEE initiative.

As with Alternative 1, institutional controls and LTM would be required. LTM wells would be the same as described for Alternative 1.

6.4 Evaluation of Alternatives

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

6.4.1 Alternative 1 - RNA and Institutional Controls with Long-Term Groundwater Monitoring

6.4.1.1 Effectiveness

Alternative 1 is based on the effectiveness of natural processes that minimize contaminant migration and reduce contaminant mass over time, and the effectiveness of institutional controls. Model-NA was used to simulate the migration and biodegradation of the BTEX plume assuming that only natural physical weathering (e.g., dissolution, volatilization) decreases BTEX loading in the source areas. Model-NA assumes that site remediation relies entirely on natural attenuation mechanisms. Model results predicted that natural attenuation mechanisms will continue to limit BTEX migration and reduce contaminant mass and toxicity. BTEX (and specifically benzene) concentrations should not exceed state MCLs at the sentry wells. Groundwater monitoring at the LTM and sentry wells will allow for continued evaluation of BTEX migration and ensure the safety of this alternative. However, while this alternative would not cease to be protective if the BTEX plume were intercepted by the sentry wells, such an instance would indicate that site conditions should be reevaluated.

The calibrated model (Section 5) was used as the foundation for predicting future plume migration assuming natural attenuation processes alone were working to reduce the dissolved contaminant mass at Site ST-24. The future predictions based on the

calibrated model input terms is called Model-NA. Model-NA is intended to predict the fate and transport of dissolved BTEX compounds if engineered remedial action is not implemented at Site ST-24.

Because the fuel spill and site history of ST-24 is not well documented, the model assumed a source of 46.5 mg/L that was conservatively decayed at an annual rate of 8 percent to approximate the plume shape observed in November 1996. This decay rate is conservative because weathering and natural attenuation processes both will steadily decrease the amount of BTEX in both the source area and throughout the dissolved contaminant plume. Therefore, Model-NA is considered to be the "worst case-scenario" for dissolved contaminants at Site ST-24.

Contaminant plume migration predictions from Model-NA suggest a relatively slow plume recession with total dissolved BTEX concentrations falling below 5 µg/L after 107 years. Assuming that benzene remains approximately 5 percent of the total dissolved BTEX in the source area, benzene concentrations should fall below 5 µg/L in 70 years. Assuming an 8-percent annual source decay rate, Model-NA predicts that more than 95 percent of the total dissolved contaminant mass will be degraded in 40 years (by 2037), and more than 85 percent of the dissolved contaminant mass would be degraded in 30 years (by 2027). Model outputs, including graphs of total dissolved BTEX concentration versus time and distance, are provided in Appendix C.

The effectiveness of this remedial alternative requires that future intrusive site activities or construction activities 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 saturated soil to the surface. Long-term land use restrictions would be required to ensure that shallow groundwater is not pumped or removed for potable use within a radius of approximately 500 feet from the margins of the existing BTEX plume. Existing health

and safety plans should be enforced to reduce worker exposures during any site excavation or installing and monitoring additional wells.

Compliance with program goals is one component of the long-term effectiveness evaluation criterion. Alternative 1 would satisfy program objectives designed to promote RNA as a component of site remediation and to scientifically document natural processes. Limited drill cuttings would be generated during construction of new monitoring wells. This alternative also satisfies program goals for cost effectiveness and waste minimization.

Apart from the administrative concerns associated with the enforcement of long-term land use restrictions and long-term groundwater monitoring programs, this remedial alternative should provide reliable, continued protection. For costing purposes, it is assumed that the model is overly conservative and that dissolved benzene concentrations will exceed state and federal criteria throughout the plume for approximately 30 years under Alternative 1. Furthermore, it is assumed that sampling will be performed for 30 years, annually for 5 years and every second year for the next 25 to demonstrate that RNA will uniformly reduce all dissolved BTEX compounds to levels below regulatory criteria.

6.4.1.2 Implementability

Alternative 1 is not technically difficult to implement. Installation of any additional LTM and sentry wells and monitoring of groundwater are standard procedures. Long-term management efforts would be required to ensure proper sampling and analysis 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. In summary, the use of RNA at this site will require that the source area be maintained as recreational property, and

that restrictions on shallow groundwater use be enforced in areas downgradient from the site until the site has been remediated. Therefore, with the exception of any subsurface work at the site, the potential risk of exposure to fuel hydrocarbons for Base personnel will remain the same. If required, the public and the regulators would have to be informed of the benefits and limitations of the RNA option. Educational programs are not difficult to implement. Where the effectiveness of this option has been demonstrated, 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. Capital costs are limited to the construction of five new LTM wells and three new sentry wells. Included in the $232,212 total present-worth cost estimate for Alternative 1 are the costs of maintaining institutional controls and long-term groundwater monitoring at 10 LTM and sentry wells for 30 years, annually for 5 years and every second year for 25 more years. If after 30 years the contaminant plume has not been completely attenuated, LTM would be continued. It is recommended that conditions at ST-24 be reevaluated after 20 years of LTM because model predictions of the fate and transport of groundwater contamination at the study area are conservative, and groundwater remediation may be faster than predicted (Section 5.7). If the groundwater plume at the site recedes more rapidly than predicted or disappears, then monitoring may be eliminated.

TABLE 6.3
ALTERNATIVE 1 - COST ESTIMATE
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Capital Costs	Cost
Design/Construct 8 LTM/Sentry Wells	$20,761
Monitoring Costs (per Sampling Event)	**Cost per Event**
Conduct Groundwater Sampling at 10 wells (annually for 5 years, every other year for 25 more years)	$11,410
Maintain Institutional Controls/Public Education (30 years)	$5,000
Project Management and Reporting (30 years)	$4,747
Present Worth of Alternative 1 [a/]	**$232,212**

[a/] Based on an annual adjustment factor of 7 percent (USEPA, 1993).

6.4.2 Alternative 2 - Biosparging with Soil Vapor Extraction In and Downgradient from the Source Area, RNA, Institutional Controls, and Long-Term Groundwater Monitoring

6.4.2.1 Effectiveness

The effectiveness of RNA and institutional controls with LTM is discussed for Alternative 1 in Section 6.4.1.1. Biosparging is an established technology for reducing source contamination and controlling plume migration. The goal of biosparging would be to effect the removal of BTEX from the source area so that RNA of dissolved contaminants in the groundwater could proceed without the continual infusion of additional contaminants. In addition, a downgradient biosparging curtain just west of Independence Avenue would prevent any migration of dissolved contaminants beneath Base housing. SVE would be coupled with biosparging to prevent migration of contaminated vapors into on-Base housing and recreation areas. The model suggests that reduction of the source would enhance the effectiveness of RNA, expedite the decrease in the size of the BTEX plume, and prevent migration of contaminated groundwater beneath Base housing.

To estimate the impact of biosparging on the fate and transport of dissolved BTEX in the shallow groundwater, a model that incorporated a conservative source decay rate of 50-percent per year was performed. Model results (Model-BB) suggest that maximum dissolved BTEX concentrations will rapidly decrease both in the source area and at the leading edge of the contaminant plume. Approximately 5 years after implementation of biosparging (calendar year 2004), Model-BB predicts that more than 95 percent of the dissolved contaminant mass will have been completely degraded. Model-BB predicts the complete degradation of the dissolved BTEX contamination in just over 17 years. Model output, including graphs of concentration versus time and distance, are provided in Appendix C.

Alternative 2 should provide reliable, continuous protection with little risk from temporary system failures. This alternative also complies with AFCEE program goals because RNA remains the predominant remediation method for fuel hydrocarbons dissolved in groundwater at the site. This remedial alternative, however, will result in the generation of additional contaminated drill cuttings that may require treatment and/or disposal. Furthermore, off-gas from the SVE system may require expensive treatment prior to atmospheric release.

6.4.2.2 Implementability

Installing and operating a biosparging/SVE system to reduce residual fuel hydrocarbons in the source areas is more complex than Alternative 1; however, major obstacles are not anticipated. Installation of the biosparging/SVE system involves standard engineering design and construction, including the installation of air injection wells, vapor extraction wells, a regenerative blower system (2 blowers), electrical supply, and system integration.

Installation and operation of a biosparging/SVE system would require an increased commitment of labor hours and other resources to maintain and monitor the system.

Periodic maintenance would be required for the regenerative blowers. Weekly system checks are recommended, and operating data such as injection pressures or extraction vacuum and flow rates would be manually recorded. It is conservatively estimated that the biosparging/SVE system would be operational for 5 years. In addition, an SVE air emissions permit may need to be obtained prior to system start-up. The technical and administrative implementability concerns associated with the natural attenuation and LTM components of this remedial alternative are similar to those discussed for Alternative 1.

6.4.2.3 Cost

The estimated capital and operating costs of Alternative 2 are shown in Table 6.4. The total present-worth cost of Alternative 2 is $552,802. The cost of Alternative 2 is increased from the cost of Alternative 1 by the addition of the biosparging and SVE systems, including system design, construction, operation, and maintenance (including SVE off-gas treatment using carbon). It is assumed that the biosparging/SVE system would operate for 5 years after installation. LTM is assumed to occur annually for 5 years and every other year for 5 more years to ensure that natural attenuation is reducing BTEX concentrations to below regulatory criteria throughout the groundwater plume and to verify that contamination does not reach the sentry wells. The capital expense and annual costs for LTM and institutional controls are assumed to be the same as for Alternative 1.

TABLE 6.4
ALTERNATIVE 2 - COST ESTIMATE
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Capital Costs	Cost
Design/Construct 8 LTM/Sentry Wells	$20,761
Design/Construct 5-Well Biosparging System and 7-Well SVE System	$169,443
Operation, Maintenance, and Monitoring Costs	**Cost per annum or event**
Operate and Maintain Biosparging/SVE System with Off-gas Treatment (5 years)	$54,440
Annual Report (5 years)	$5,676
Conduct Groundwater Sampling at 10 wells (annually for 5 years, every other year for 5 years)	$11,410
Maintain Institutional Controls/Public Education (10 years)	$5,000
Project Management and Reporting (10 years)	$4,747
Present Worth of Alternative 2 [a/]	**$552,802**

[a/] Based on an annual adjustment factor of 7 percent (USEPA, 1993).

6.4.3 Alternative 3 - Groundwater Extraction, RNA, and Institutional Controls with Long-Term Groundwater Water Monitoring

6.4.3.1 Effectiveness

Groundwater extraction is an established technology for controlling plume migration. The extraction of contaminated groundwater will prevent plume migration beneath Base housing located to the west of Site ST-24, thereby preventing any completion of potential exposure pathways. Simulation of the effect of groundwater extraction was not performed; however, because source reduction is not occurring, remediation time is the same as predicted for Model-NA.

Alternative 3 should provide reliable, continuous protection for downgradient receptors. This alternative, however, does not comply well with all of the AFCEE program goals because of the generation of soil and water waste requiring treatment and disposal. In addition, contaminants are not destroyed, rather transferred to another phase still requiring more treatment. As with Alternatives 1 and 2, this alternative would require RNA with LTM and institutional controls to remediate the contaminated groundwater.

6.4.3.2 Implementability

Groundwater extraction would be labor intensive and expensive to implement. The option would require additional site investigation, design and engineering, installation, and a weekly commitment to operate and maintain the extraction and air stripper systems. Treated groundwater may be disposed of in the sanitary sewer at minimal cost, however, if treated groundwater does not meet the requirements for disposal in the sewer more expensive methods of disposal may have to be considered. In addition, an air emissions permit may need to be obtained for the air stripper prior to system start-up. The technical and administrative implementability concerns associated with the RNA, LTM, and institutional controls of this remedial alternative are similar to those discussed for Alternatives 1 and 2.

6.4.3.3 Cost

The estimated capital and operating costs of Alternative 3 are shown in Table 6.5. The total present-worth cost of Alternative 3 is $844,162. The cost of Alternative 3 is more than the costs of Alternative 2 because it is assumed that groundwater extraction be performed for 15 years (half the assumed RNA time) and will not lessen remediation time or long-term monitoring requirements. However, the cost could be significantly higher if off-gas treatment for the air stripper is required. The present-worth cost for LTM and institutional controls is the same as Alternative 1 because it is assumed that the groundwater extraction systems contains the contaminant plume without treating the

source. The annual costs for LTM and institutional controls are assumed to be the same as for Alternatives 1 and/or 2.

6.5 RECOMMENDED REMEDIAL APPROACH

Three remedial alternatives have been evaluated for remediation of the shallow groundwater at the study area. Components of the alternatives evaluated include biosparging/SVE, groundwater extraction, RNA with LTM of groundwater, and institutional controls. Table 6.6 summarizes the results of the evaluation based upon effectiveness, implementability, and cost criteria. Despite the increase in estimated remediation time from Alternative 2, the Air Force recommends Alternative 1 as the most cost-effective option for risk reduction at the study area.

TABLE 6.5
ALTERNATIVE 3 - COST ESTIMATE
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Capital Costs	Cost
Design/Construct 8 LTM/Sentry Wells	$20,761
Design/Construct/Install Groundwater Extraction and Treatment System	$165,008
Operation, Maintenance, and Monitoring Costs	**Cost per annum or event**
Conduct Groundwater Sampling at 10 wells (annually for 5 years and every other year for 25 years))	$11,410
Maintain Groundwater Extraction System (15 years)	$44,120
Maintain Institutional Controls/Public Education (30 years)	$5,000
Project Management and Reporting (30 years)	$4,747
Present Worth of Alternative 3 [a/]	**$884,162**

[a/] Based on an annual adjustment factor of 7 percent (USEPA, 1993).

TABLE 6.6
SUMMARY OF REMEDIAL ALTERNATIVES EVALUATION FOR GROUNDWATER REMEDIATION
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Remedial Alternative	Effectiveness	Implementability	Present-Worth Cost Estimate
Alternative 1			
- Natural Attenuation - Long-Term Monitoring - Institutional Controls	Contaminant mass, volume, and toxicity will be significantly reduced and plume leading edge would continue to recede. MCLs for BTEX are not likely to be exceeded at POC wells.	Readily implementable. Long-term management, groundwater use controls, and monitoring required for an estimated 30 years. If MCLs are exceeded at POC, additional remedial work may be required.	$232,212
Alternative 2			
- Biosparging with SVE - Natural Attenuation - Long-Term Monitoring - Institutional Controls	Similar to Alternative 1, with the addition of biosparging and SVE systems. BTEX mass, volume, and toxicity would be reduced more rapidly than in Alternative 1, and SVE system would treat contaminated vapors forced into soils from biosparging activities.	Readily implementable. Installation of biosparging/SVE system should present no problems. Biosparging estimated to continue for 5 years. Long-term management, groundwater controls, and monitoring required for an estimated 10 years. If MCLs are exceeded at POC, additional remedial work may be required.	$552,802
Alternative 3			
- Groundwater Extraction - Natural Attenuation - Long-Term Monitoring - Institutional Controls	Similar to Alternative 1, with the addition of a groundwater extraction system. BTEX mass, volume, and toxicity will not be reduced more rapidly than in Alternative 1; however, migration of dissolved contaminants beneath Base housing will be prevented.	Readily implementable. Installation and operation of groundwater extraction system will be costly and labor intensive. Groundwater extraction estimated to continue for 15 years. Long-term management, groundwater controls, and monitoring required for an estimated 30 years. If MCLs are exceeded at POC, additional remedial work may be required.	$844,162

All three alternatives make use of natural attenuation mechanisms to reduce dissolved BTEX mass, migration, and toxicity. In addition, Alternative 2 would use active *in situ* techniques to reduce the magnitude of continuing sources and prevent migration of contaminated groundwater from migrating beneath Base housing. Implementation of Alternative 2 would substantially decrease the time frame for BTEX remediation, but would require greater capital expenditures. Alternative 3 would not decrease remediation time for dissolved BTEX compounds because it interrupts a potential exposure pathway without eliminating the source. Alternative 3 also would require greater capital expenditures than RNA with or without a biosparging/SVE system. Alternative 3 is considered the least favorable of the three evaluated alternatives because groundwater extraction simply transfers contaminants to another phase, which then requires further treatment and disposal. Furthermore, Alternative 3 is no more effective at reducing the remediation time frame or eliminating contaminant mass than Alternative 1.

All three remedial alternatives are implementable and effectively reduce potential hydrocarbon migration and toxicity in the groundwater. All three alternatives should be acceptable to the public and regulatory agencies because they are protective of human health and the environment and reduce groundwater contamination. Implementation of any of the three alternatives will require land use and groundwater use controls to be enforced. Groundwater monitoring would be required for the respective projected cleanup periods. Because of conservative modeling assumptions, overly conservative remediation time model estimates, and the lack of mobile LNAPL and residual LNAPL above the water table, the assumed 30-year remediation time for Alternative 1 is considered to be conservative. Because the 30-year estimate is believed to be conservative, the proposed LTM period is consistent with federal recommendations that proposed or implemented remedial activities at a site should not exceed 30 years in duration (USEPA, 1988).

The final evaluation criterion used to compare each of the remedial alternatives was cost. It is the opinion of the Air Force that the additional cost of Alternative 2 does not justify the reduced risk resulting from the decrease in the time required to remediate the dissolved BTEX plume and the residual soil contamination below the water table. In addition, the costs of Alternative 3 are not considered justifiable because future exposure to potential receptors at the site will be stemming from of the lack of plume migration. Alternative 1 will cost effectively reduce the level of contamination and maintain the necessary degree of protection to potential receptors at the site, and is the recommended remedial alternative for Site ST-24. If risk assessment demonstrates an unacceptable risk as a result of contaminant migration toward the Base residential housing, the Air Force would recommend Alternative 2 over Alternative 3 because of the source reduction provided by the biosparging/SVE system. A LTM plan for groundwater, including a generic sampling and analysis plan, is provided in Section 7.

SECTION 7

LONG-TERM MONITORING PLAN

7.1 OVERVIEW

In keeping with the requirements of the selected remedial alternative for Site ST-24 at Columbus AFB (RNA with institutional controls and LTM), a long-term groundwater monitoring plan has been developed. The purpose of this component of the suggested remedial alternative for the site is to assess site conditions over time, confirm the effectiveness of natural processes at reducing contaminant mass and minimizing contaminant migration, assess compliance with regulatory cleanup goals, and evaluate the need for additional remediation.

The LTM plan consists of identifying the location of two separate groundwater monitoring networks and developing a groundwater sampling and analysis strategy to demonstrate attainment of site-specific remediation goals and to verify the predictions of the model developed for ST-24. The strategy described in this section is designed to monitor plume migration over time and to verify that RNA is occurring at rates sufficient to protect potential receptors. In the event that data collected under this LTM program indicate that natural processes are insufficient to protect human health and the environment, contingency controls to augment the beneficial effects of RNA would be necessary.

7.2 MONITORING NETWORKS

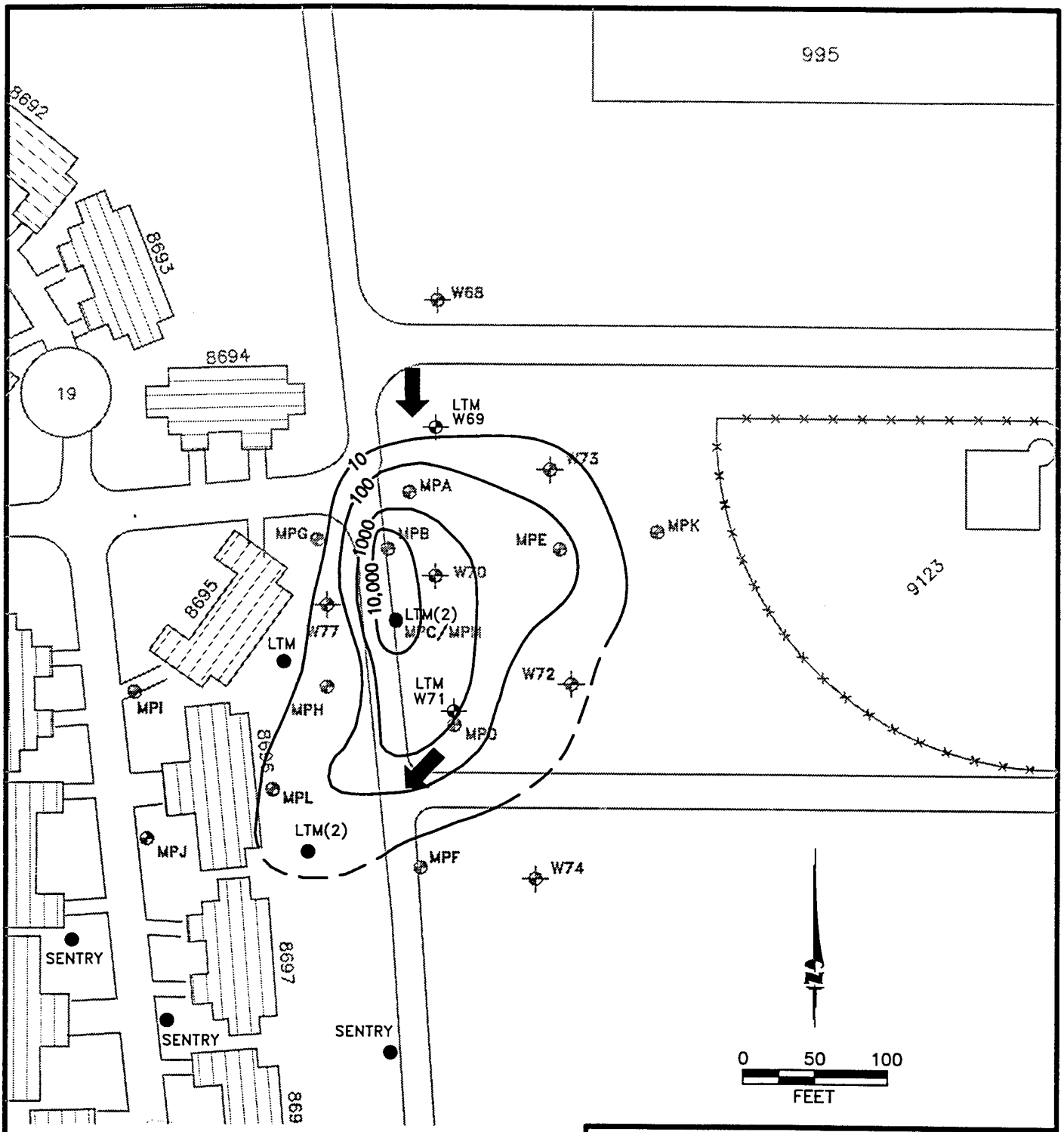
Two separate sets of wells will be utilized at the site as part of the LTM component of the remedial alternative. The first set will consist of seven LTM wells located in, upgradient from, and downgradient from the observed contaminant plume to verify that natural attenuation is occurring at rates sufficient to minimize plume expansion and reduce BTEX concentrations. This network of wells will consist of five monitoring wells screened across the water table (shallow wells) to provide short-term confirmation of the effectiveness of natural attenuation. The remaining two wells will be screened in deeper saturated intervals of the surficial aquifer. These deeper wells will be screened immediately above the silty clay layer at approximately 30 feet bgs. The second set of wells will consist of three sentry wells at locations along a line perpendicular to the general direction of groundwater flow, approximately 150 feet southwest of monitoring point MPL. The purpose of the sentry wells is to verify that no BTEX concentrations exceeding state criteria migrate beyond the area under institutional control. Conservative model results suggest that the BTEX plume front should not reach the sentry wells. The proposed LTM and sentry well locations are presented on Figure 7.1

7.2.1 Long-Term Monitoring Wells

At five locations, groundwater wells within, upgradient from, and downgradient from the current BTEX plume will be used to monitor the effectiveness of RNA in reducing total contaminant mass and minimizing contaminant migration at Site ST-24. Of the seven wells proposed for the LTM network, two (W69 and W71) have been installed during previous investigations. The remaining five wells would be installed upon implementation of this plan. Figure 7.1 identifies the proposed locations for wells to be used for LTM. This well network will supplement the three proposed sentry wells (see Section 7.2.2) to provide evidence of continuing RNA and to allow additional response time if site conditions change.

Existing well W69 is proposed for monitoring the background groundwater quality in the shallow portion of the surficial aquifer. A nested pair of wells is proposed to replace the MPC/MPM monitoring point nest to monitor the shallow and deep groundwater at the location of the highest dissolved BTEX concentration observed in November 1996. A new well is proposed for installation in the shallow saturated interval between Building 8695, Building 8696, and Independence Avenue, to monitor plume migration in the direction of these residences. Typically, downgradient wells are installed within the anaerobic and aerobic treatment zones; however, because the aerobic treatment zone appears to be minimal at this site, monitoring will occur at the downgradient plume extent. Existing monitoring well W71 is proposed to monitor the contaminant plume's anaerobic core, while a cluster nested pair of wells is proposed for approximately 50 feet south-southeast of MPL to monitor dissolved contaminant concentrations near the plumes leading edge. The remaining existing wells (W68, W70, W72, W73, W74, and W77) would not be used for LTM because they are either upgradient of the source area or they are not in the direct flow path downgradient from the source area.

The five new LTM monitoring wells will have 10-foot screened intervals. Shallow wells will be screened across the water table with approximately 8 feet of the 10-foot screen positioned below the water table. Deeper wells will be screened in the sandy to silty gravel overlying the silty clay at a depth of approximately 30 feet. At least 1 foot of screen will be installed in the clay unit to ensure that the deepest portion of the surficial aquifer is within the screened interval. However, to verify the continuity of the clay unit beneath Site ST-24, it is suggested that the clay unit is tagged during installation of all new LTM and sentry wells. Sampling frequency and analytical parameters to be monitored are discussed in Section 7.3.



LEGEND

- LTM ● — PROPOSED LOCATION FOR LONG-TERM MONITORING WELL
- W77 LTM ⊕ — PROPOSED LONG-TERM MONITORING WELL
- SENTRY ● — PROPOSED SENTRY WELL/LOCATION
- ◀ — APPROXIMATE GROUNDWATER FLOW DIRECTION
- —10— — LINE OF EQUAL BTEX CONCENTRATION (µg/L), NOVEMBER 1996

FIGURE 7.1

LONG-TERM MONITORING AND SENTRY WELL LOCATIONS

Site ST-24 RNA TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

L:\COLUMBUS\729691\97DN0640, 07/17/97 at 14:44

TABLE 7.1
LONG-TERM MONITORING ANALYTICAL PROTOCOL
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

Analyte	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Ferrous Iron (Fe^{2+})	Colorimetric A3500-Fe D	Field only	Elevated ferrous iron concentrations may be indicative of the anaerobic biodegradation process of iron reduction	Annually for 5 Years, Every Other Year for 25 more Years	Collect 100 mL of water in a glass container; acidify with hydrochloric acid per method	Field
Ferrous Iron (Fe^{2+})	Colorimetric HACH 25140-25	Alternate method; field only	Same as above.	Annually for 5 Years, Every Other Year for 25 more Years	Collect 100 mL of water in a glass container	Field
Temperature	E170.1	Field only	Metabolism rates for microorganisms depend on temperature	Annually for 5 Years, Every Other Year for 25 more Years	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	Annually for 5 Years, Every Other Year for 25 more Years	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	Annually for 5 Years, Every Other Year for 25 more Years	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 groundwater system	Annually for 5 Years, Every Other Year for 25 more Years	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 USEPA procedure	Substrate for microbial respiration if oxygen is depleted	Annually for 5 Years, Every Other Year for 25 more Years	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C; analyze within 48 hours	Fixed-base
Ammonium (NH_4^+)	Colorimetric CHEMetrics K-1510	Field only	Confirm nitrogen fixation and/or nitrate reduction	Annually for 5 Years, Every Other Year for 25 more Years	Collect 100–250 mL of water in a glass or plastic container; analyze immediately	Field

TABLE 7.1 (concluded)
LONG-TERM MONITORING ANALYTICAL PROTOCOL
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

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	Annually for 5 Years, Every Other Year for 25 more Years	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 groundwater influences and is influenced by biologically mediated reactions; the redox potential of groundwater may range from more than 200 mV to less than -400 mV	Annually for 5 Years, Every Other Year for 25 more Years	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 USEPA Natural Risk Management Research Laboratory	The presence of methane suggests BTEX degradation via an anaerobic pathway utilizing carbon dioxide (carbonate) as the electron acceptor (methanogenesis). The presence of ethane and ethene suggest that cometabolism of vinyl chloride is occurring.	Annually for 5 Years, Every Other Year for 25 more Years	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	Annually for 5 Years, Every Other Year for 25 more Years	Collect water samples in a 40 mL VOA vial with zero headspace; cool to 4°C; add hydrochloric acid to pH $\leq$2	Fixed-base

a/ Analytical methods from the Air Force protocol document and the AFCEE Handbook are presented by Wiedemeier *et al.* (1995).

TABLE 7.2
POINT-OF-COMPLIANCE MONITORING ANALYTICAL PROTOCOL
SITE ST-24 RNA TS
COLUMBUS AFB, MISSISSIPPI

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	Annually for 5 Years, Every Other Year for 25 more Years	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	Annually for 5 Years, Every Other Year for 25 more Years	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	Annually for 5 Years, Every Other Year for 25 more Years	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 groundwater system	Annually for 5 Years, Every Other Year for 25 more Years	Collect 100–250 mL of water in a glass or plastic container	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	Annually for 5 Years, Every Other Year for 25 more Years	Collect water samples in a 40 mL VOA vial with zero headspace; cool to 4°C; add hydrochloric acid to pH $\leq$2	Fixed-base

a/ Analytical methods from the Air Force protocol document and the AFCEE Handbook are presented by Wiedemeier *et al.* (1995).

7.2.2 Sentry Wells

Three sentry monitoring wells are proposed for installation at the site (Figure 7.1). These locations, however, should be considered tentative because of numerous aboveground housing units and underground utility corridors. It is recommended that the sentry well locations be finalized upon implementation of this plan. The locations presented on Figure 7.1 are approximately 150 (see Section 7.2) feet downgradient from the current leading edge of the BTEX plume. The sentry wells are more than 1,000 feet from the southwestern Base boundary.

The purpose of sentry wells is to verify that no contaminated groundwater exceeding state criteria migrates beyond the area under institutional control. Although model results strongly suggest that the contaminant plume will not migrate beyond this area at concentrations exceeding chemical-specific state MCLs (Table 6.1), these sentry wells are the technical mechanisms used to demonstrate protection of human health and the environment and compliance with site-specific numerical RAOs. These wells will be installed and monitored to assure that the selected remedy is providing the anticipated level of risk reduction and remediation at the site. Sampling frequency and analytical parameters to be monitored are discussed in Section 7.3.

As with the LTM wells, the sentry wells will be screened in the same hydrogeologic units 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 dissolved BTEX plume in the shallow groundwater at this site.

7.3 GROUNDWATER SAMPLING

To ensure that sufficient contaminant removal is occurring at Site ST-24 to meet site RAOs, the long-term groundwater monitoring plan includes a comprehensive sampling

and analysis plan (SAP). Groundwater samples will be collected and analyzed from LTM and sentry wells to verify that natural processes are effectively reducing contaminant mass and mobility. Reductions in toxicity will be implied by mass reduction. The SAP also is aimed at assuring RNA can achieve regulatory action levels for dissolved BTEX compounds.

7.3.1 Analytical Protocol

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

7.3.2 Sampling Frequency

Each of the 10 LTM and sentry wells will be sampled annually for the first 5 years of LTM. Thereafter, review meetings could be scheduled to determine future LTM frequency. For example, if LTM demonstrates the effectiveness of the proposed remedial alternative at this site, the sampling frequency could be reduced to once every two years or sampling could be eliminated. For the purpose of projecting costs in Section 6, it was assumed that LTM would proceed at a frequency of every other year for years 6 through 30 (calendar years 2003 through 2027). Conversely, if the data collected at any time during the monitoring period indicate the need for additional remedial activities at the site as a result of significant plume expansion or eminent pathway completion, the sampling frequency should be adjusted accordingly.

SECTION 8
CONCLUSIONS AND RECOMMENDATIONS

This report presents the results of a TS conducted to evaluate RNA of fuel-hydrocarbon-contaminated groundwater at Site ST-24, Columbus AFB, Mississippi. Specifically, analytical models were used in conjunction with site-specific geologic, hydrologic, and laboratory analytical data to evaluate the migration and biodegradation of BTEX compounds dissolved in groundwater.

A geochemical line of evidence was used to document RNA at ST-24. Comparison of BTEX, electron acceptor, and biodegradation byproduct isopleth maps for groundwater at Site ST-24 provides strong geochemical evidence of BTEX biodegradation. Geochemical data strongly suggest that biodegradation of fuel hydrocarbons is occurring at the site via aerobic respiration and the anaerobic processes of denitrification, iron reduction, sulfate reduction, nitrogen fixation, and methanogenesis. Rates of biodegradation were estimated from observed contaminant concentrations and the method of Buscheck and Alcantar (1995).

To obtain the data necessary for the RNA demonstration, Parsons ES collected and analyzed soil and groundwater samples from the site. Site-specific geologic, hydrologic, and chemical data were then used in the analytical 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 aquifer materials similar

to those found at the site. Conservative aquifer parameters were used to construct the flow model for this site. Therefore, the model results presented herein represent conservative predictions of groundwater BTEX plume fate and transport.

For one model simulation (Model-NA), it was assumed that conditions that produced the calibrated model would persist for the duration of the simulation. Model-NA included a solute decay rate (i.e., biodegradation rate) of 8 percent per day, and a source decay rate of 8 percent per year. This scenario suggests that the plume is stable/shrinking and therefore will not migrate beyond the November 1996 extent. The model predicts 85 percent of the dissolved contaminant mass will be lost in 30 years via natural attenuation processes. Model-BB assumed a contaminant source reduction through use of a biosparging/SVE system, using a geometric source decay rate of 50 percent per year for 5 years. Results for this model suggest that the contaminant plume will rapidly recede after the start of biosparging activities and source area dissolved BTEX concentrations will be below the 5-µg/L state MCL for benzene 10 years after the implementation of the biosparging/SVE remedial alternative. A third remedial alternative, groundwater extraction, was evaluated but not modeled because it would be a plume containment technology not a source reduction technology; therefore, the groundwater extraction alternative assumed a cleanup time identical to that predicted with Model-NA.

The results of this study suggest that RNA of dissolved BTEX compounds is occurring at Site ST-24. Given that the models predict no impact to known receptors at the modeled rates of BTEX plume migration, the Air Force is recommending RNA, institutional controls, and LTM to remediate site groundwater impacted by BTEX. Because the site is located on an active, secured installation, all future site activities will occur under the direct supervision of the Air Force. The estimated rates of biodegradation, when coupled with sorption, dispersion, and dilution, should be more than sufficient to reduce and maintain dissolved BTEX concentrations to levels below

current regulatory standards long before potential downgradient receptors could be adversely affected. Construction activities in the plume area, and groundwater use in and downgradient from the plume area, should be restricted until groundwater contaminant concentrations decrease below state MCLs for BTEX. Currently, the toluene concentrations in all Site ST-24 groundwater samples are below the state MCL for toluene. Ethylbenzene and total xylenes exceeded their respective state MCLs in a groundwater sample from one sampling location within the source area. In all remaining groundwater samples, ethylbenzene and xylene were below the MCLs. Benzene was detected above the state MCL in several groundwater samples. Therefore, benzene will likely be the only BTEX compound of concern with respect to any closure activities.

To verify the results of the modeling effort, and to ensure that RNA is occurring at rates sufficient to protect potential downgradient receptors, groundwater from seven LTM wells should be sampled and analyzed for the parameters listed in Table 7.1. In addition, three sentry wells should be installed downgradient from the BTEX plume and sampled for the parameters listed in Table 7.2. Figure 7.1 shows suggested locations for the LTM and sentry wells. Each of the 10 LTM and sentry wells will be sampled annually for the first 5 years of LTM. After five years, the results from LTM should be evaluated to determine whether sampling will cease, will decrease in frequency, or will continue at the rate of every year. If dissolved BTEX concentrations in groundwater collected from the sentry wells exceed regulatory criteria, additional evaluation or corrective action may be necessary at this site.

SECTION 9

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APPENDIX A

APPENDIX A-1

GEOLOGIC BORING LOGS

GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: ST-24 MPC
CLIENT: AFCEE
JOB NO.: 729691
LOCATION: COLUMBUS AFB
GEOLOGIST: J. Hartfelder
COMENTS:

CONTRACTOR:
RIG TYPE:
DRLG METHOD: GEOPROBE
BORING DIA.: 1.5"
DRLG FLUID:

DATE SPUD: 11/6/96
DATE CMPL.: 11/6/96
ELEVATION:
TEMP: 70°
WEATHER: partly cloudy

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1			0-2' Silty Clay, reddish brown					0 gas			
				2-4' SAA					0			
	5			4-6' Sand, red sandblk					0			
				8-9' SAA					0			
				9-10' Stone with sand, brown, moist					0 ~ppm			
	10			10-12' Stone with sand, brown, moist, odor					200			
				12-14' Sand and gravel in clay matrix, red to brown, wet, moderate hydrocarbon odor	▽				320			
	15											
	20											
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

▽ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.: ST-24 MPD (North) CONTRACTOR: Parsons ES DATE SPUD: 11/7/96
CLIENT: AFCEE RIG TYPE: Geoprobe DATE CMPL.: 11/7/96
JOB NO.: 729691 DRLG METHOD: Push ELEVATION: G.S.
LOCATION: COLUMBUS AFB BORING DIA.: 1.5" TEMP: 60°
GEOLOGIST: J. Hartfelder DRLG FLUID: NA WEATHER: cloudy/Rainy
COMENTS:

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Sample Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1			0-2' SILT w/ clay, brown, moist, no odor								
			CL	2-4' CLAY, reddish brown, moist, no odor					36.2			
	5			4-6' SILTY CLAY, reddish brown, moist, no odor, tightly packed					42.0			
				6-8' Silt some clay, reddish brown, moist, no odor					54.6			
				8-9' SAA					25.5			
	10			9-10' gravel and sand in clay matrix, moist, no odor					45.3			
		Bag		12-13' ~~no recovery~~ SAA with gravel and sand, large gravel, ~~little~~ SAND, silt, gravel, wet, no odor- moisture								
				10-12' gravel and sand in clay matrix, moist, petroleum odor					82.2 ~12'			
			SC SW	14-16' GRAVEL, sand, silt, ~~and~~ clay matrix, wet, strong hydrocarbon odor					133 ~14'			
	15			16-18' SAME AS ABOVE					>10,000			
				18-20' SAA					46.5			
	20			20-22' SAA					125			
				22-24' No recovery					106			
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

GEOLOGIC BORING LOG

Sheet 1 of 1

BORING NO.:	ST24 MP-F	CONTRACTOR:	Parsons ES	DATE SPUD:	11/7/96
CLIENT:	AFCEE	RIG TYPE:	GEOPROBE	DATE CMPL.:	11/7/96
JOB NO.:	729691	DRLG METHOD:	PUSH	ELEVATION:	GS
LOCATION:	COLUMBUS AFB	BORING DIA.:	1.5"	TEMP:	600
GEOLOGIST:	BRAD LEWIS	DRLG FLUID:	NA	WEATHER:	OVERCAST
COMENTS:					

Elev (ft)	Depth (ft)	Pro-file	US CS	Geologic Description	Sample No.	Depth (ft)	Sample Type	Penet Res	PID(ppm)	TLV(ppm)	TOTAL BTEX(ppm)	TPH (ppm)
	1			0-2' SILT w/ clay, brown moist, organics, no hydrocarbon odor					61.2			
	5		CL	2-4' CLAY, brown, moist, no odor					95.2			
				4-5' SAME AS ABOVE								
				5-6' SILT, brown, tight, no odor					130			
				6-8' SILT, light brown, tight, no odor moist			1		73.2			
				8-10 ~~SILT~~ same as above					77.3			
	10			10-10.5 SAME								
			SC SW	10.5-12 GRAVEL AND SAND IN CLAY MATRIX. SOME PEBBLES OVER 1 CM DIAMETER. MOIST NO ODOR					70.3			
				12-14 SAND w/ GRAVEL, moist, light brown no odor					23.3			
	15			14-16 SAME BUT WET					28.3			
				16-18 SAME AS ABOVE			TOC TPH		171			
	20											
	25											
	30											
	35											

NOTES

bgs – Below Ground Surface
GS – Ground Surface
TOC – Top of Casing
NS – Not Sampled
SAA – Same As Above

SAMPLE TYPE

D – DRIVE
C – CORE
G – GRAB

▼ Water level drilled

FIGURE 3.4

GEOLOGIC BORING LOG

Sites ST-24 and LF-06
Intrinsic Remediation TS
Columbus AFB, Mississippi

PARSONS ENGINEERING SCIENCE, INC.
Denver, Colorado

APPENDIX A-2

MONITORING POINT DEVELOPMENT FORMS

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020 Job Name: AFCEE RNA
Location Columbus AFB, ST24 by RN/JH/CS/BL Date: 11/4 , 1996
Well Number W70D (ST24) Measurement Datum _____

Pre-Development Information Time (Start): ~~1445~~ 1630

Water Level: — Total Depth of Well: 29

Water Characteristics

Color LT BROWN Clear (Cloudy)
Odor: None Weak (Moderate) Strong
Any Films or Immiscible Material _____
pH 5.97 Temperature(°C) 18.1
Specific Conductance(µS/cm) 210
Disolved Oxygen (mg/L) 6.95

Interim Water Characteristics

Gallons Removed	0.1	0.15	0.2	0.3 ~~0.25~~	0.4
pH	5.88	5.90	6.00	6.06	6.08
Temperature (°C)	19.6	20.3	20.1	20.3	~~19.9~~ 20.4
Specific Conductance(µS/cm)	160	160	150	150	150
Disolved Oxygen (mg/L)	5.28	2.50	2.66	2.45	2.41

Post-Development Information Time (Finish): 1700

Water Level: — Total Depth of Well: ~29

Approximate Volume Removed: 0.4 gal

Water Characteristics

Color H brown Clear Cloudy (light cloudy)
Odor: None (Weak) Moderate Strong
Any Films or Immiscible Material _____
pH 6.12 Temperature(°C) 20.3
Specific Conductance(µS/cm) 150
Disolved Oxygen (mg/L) 2.99

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number MPA (ST24)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/11, 1996
Measurement Datum

Pre-Development Information

Time (Start): 1300

Water Level: —

Total Depth of Well: 19-21

Water Characteristics

Color Brown Clear (Cloudy)
Odor: None Weak (Moderate) Strong
Any Films or Immiscible Material
pH 6.08 Temperature(°C) 20.3
Specific Conductance(µS/cm) 170
Disolved Oxygen (mg/L) 1.29

Interim Water Characteristics

Gallons Removed	0.2	0.4	0.8	1.0	1.2
pH	5.83	5.81	5.81	5.82	5.85
Temperature (°C)	21.6	21.8	22.1	22.1	22.1
Specific Conductance(µS/cm)	530	790	1,600	2,390	2,160 *
Disolved Oxygen (mg/L)	1.33	1.04	0.55	0.42	0.40

Post-Development Information

Time (Finish): 1315

Water Level: —

Total Depth of Well: 19-21

Approximate Volume Removed: 1.2

Water Characteristics

Color light suspended solids Clear (Cloudy)
Odor: None Weak (Moderate) Strong
Any Films or Immiscible Material —
pH 5.82 Temperature(°C) 22.1
Specific Conductance(µS/cm) 2,800
Disolved Oxygen (mg/L) 0.35

Comments:

* CONDUCTIVITY METER PROBE MAY BE MALFUNCTIONING

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number MW13(S) (ST24)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/12, 1996
Measurement Datum —

Pre-Development Information

Time (Start): 1515

Water Level: —

Total Depth of Well: 219-21

Water Characteristics

Color ORANGE BROWN Clear (Cloudy)
Odor: None Weak (Moderate) Strong
Any Films or Immiscible Material —
pH 6.20 Temperature(°C) 19.2
Specific Conductance(µS/cm) 470
Disolved Oxygen (mg/L) 0.39

Interim Water Characteristics

Gallons Removed	0.3	0.6	0.9	
pH	6.22	6.27	6.33	
Temperature (°C)	21.3	21.5	21.9	
Specific Conductance(µS/cm)	390	380	350	
Disolved Oxygen (mg/L)	0.33	0.27	0.24	C

Post-Development Information

Time (Finish): 1530

Water Level: —

Total Depth of Well: —

Approximate Volume Removed: 0.9

Water Characteristics

Color lt suspended solids (Clear) Cloudy
Odor: None Weak Moderate (Strong)
Any Films or Immiscible Material —
pH 6.37 Temperature(°C) 21.8
Specific Conductance(µS/cm) 340
Disolved Oxygen (mg/L) 0.25

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number ST24 MPB(D)

Job Name: AFCEE-RNA
by RN/JH/CS/BL/RMH Date: 11/12, 1996
Measurement Datum NA

Pre-Development Information

Time (Start): 1555

Water Level: NA

Total Depth of Well: ?

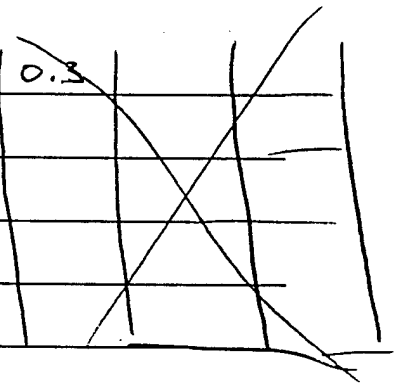
Water Characteristics

Well Did not develop - no water purged.

Color NR Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH Temperature(°C)
Specific Conductance(µS/cm)
Disolved Oxygen (mg/L)

Interim Water Characteristics

Gallons Removed 0.3
pH
Temperature (°C)
Specific Conductance(µS/cm)
Disolved Oxygen (mg/L)



Post-Development Information

Time (Finish):

Water Level:

Total Depth of Well:

Approximate Volume Removed:

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH Temperature(°C)
Specific Conductance(µS/cm)
Disolved Oxygen (mg/L)

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number MPC (ST24)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/ , 1996
Measurement Datum —

Pre-Development Information

Time (Start): 1125

Water Level: _____ Total Depth of Well: _____

Water Characteristics

Did Not Develop

Color _____ Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material _____
pH _____ Temperature(°C) _____
Specific Conductance(µS/cm) _____
Disolved Oxygen (mg/L) _____

Interim Water Characteristics

Gallons Removed _____

pH _____

Temperature (°C) _____

Specific Conductance(µS/cm) _____

Disolved Oxygen (mg/L) _____

Post-Development Information

Time (Finish): _____

Water Level: _____ Total Depth of Well: _____

Approximate Volume Removed: _____

Water Characteristics

Color _____ Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material _____
pH _____ Temperature(°C) _____
Specific Conductance(µS/cm) _____
Disolved Oxygen (mg/L) _____

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Job Name: AFCEE-RNA
Location Columbus AFB, ST24
by RN/JH/CS/BL Date: 11/13, 1996
Well Number ~~ST24D(D)~~ ST24 MPD(S) (ISMH 11/21/96)
Measurement Datum

Pre-Development Information
Time (Start): 0700

Water Level: —
Total Depth of Well: ~29

Water Characteristics

Color BROWN
Clear (Cloudy)
Odor: None Weak Moderate (Strong)
Any Films or Immiscible Material —
pH 6.11 Temperature(°C) 18.7
Specific Conductance(µS/cm) 223
Disolved Oxygen (mg/L) 1.05

Interim Water Characteristics

Gallons Removed	0.2	0.4	0.6	0.8	1.0
pH	6.09	6.07	6.09	6.08	6.09
Temperature (°C)	19.5	19.8	19.9	20.0	20.0
Specific Conductance(µS/cm)	187	186	185	185	185
Disolved Oxygen (mg/L)	1.30	0.74	0.55	0.48	0.47

Post-Development Information
Time (Finish): 0718

Water Level: —
Total Depth of Well: —

Approximate Volume Removed: 1.0

Water Characteristics

Color (H suspended solids)
(Clear) Cloudy
Odor: None Weak (Moderate) Strong
Any Films or Immiscible Material —
pH 6.07 Temperature(°C) 20.0
Specific Conductance(µS/cm) 184
Disolved Oxygen (mg/L) 0.41

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number MPWE (ST24)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/11, 1996
Measurement Datum —

Pre-Development Information

Time (Start): 0930

Water Level: —

Total Depth of Well: 19-21

Water Characteristics

Color BROWN Clear (Cloudy)
Odor: None (Weak) Moderate Strong
Any Films or Immiscible Material NONE
pH 6.29 Temperature(°C) 18-3
Specific Conductance(µS/cm) 220
Disolved Oxygen (mg/L) 0.67

Interim Water Characteristics

Gallons Removed	0.2	0.4	0.7	0.9
pH	6.29	6.30	6.27	6.26
Temperature (°C)	19.9	20.2	20.3	20.4
Specific Conductance(µS/cm)	200	200	200	190
Disolved Oxygen (mg/L)	1.22	1.29	0.88	0.70

Post-Development Information

Time (Finish): 0945

Water Level: —

Total Depth of Well: ~19-21

Approximate Volume Removed: 0.9

Water Characteristics

Color LIGHT CLOUDY Clear Cloudy
Odor: None (Weak) Moderate Strong
Any Films or Immiscible Material —
pH 6.29 Temperature(°C) 20.5
Specific Conductance(µS/cm) 190
Disolved Oxygen (mg/L) 0.62

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number MPF (ST24)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/12, 1996
Measurement Datum

Pre-Development Information

Time (Start): 0750

Water Level: —

Total Depth of Well: 19-21

Water Characteristics

Color Brown Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material
pH 5.67 Temperature(°C) 18.5
Specific Conductance(µS/cm) 250
Disolved Oxygen (mg/L) 1.51

Interim Water Characteristics

Gallons Removed	0.2	0.4	0.8	1.0	1.2
pH	5.54	5.55	5.62	5.69	5.71
Temperature (°C)	20.8	21.1	21.5	21.7	21.8
Specific Conductance(µS/cm)	150	140	140	140	140
Disolved Oxygen (mg/L)	3.77	2.27	1.29	0.58	0.50

Post-Development Information

Time (Finish): 0820

Water Level: —

Total Depth of Well: 19-21

Approximate Volume Removed: 1.2

Water Characteristics

Color lt brown Clear (Cloudy)
Odor: None (Weak) Moderate Strong
Any Films or Immiscible Material
pH 5.71 Temperature(°C) 21.8
Specific Conductance(µS/cm) 140
Disolved Oxygen (mg/L) 0.49

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number MPG

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/11 1996
Measurement Datum —

Pre-Development Information

Time (Start): 1445

Water Level: —

Total Depth of Well: 19.21

Water Characteristics

Color BROWN Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.41 Temperature(°C) 21.4
Specific Conductance(µS/cm) ~~80~~ 80
Disolved Oxygen (mg/L) 3.43

Interim Water Characteristics

Gallons Removed	0.3	0.6	0.9	1.1
pH	4.84	4.73	4.75	4.78
Temperature (°C)	22.8	23.0	23.2	23.2
Specific Conductance(µS/cm)	50	50	50	50
Disolved Oxygen (mg/L)	4.58	4.33	4.21	4.20

Post-Development Information

Time (Finish): 1500

Water Level: —

Total Depth of Well: 19.21

Approximate Volume Removed: 1.1

Water Characteristics

Color LIGHT SUSPENDED SOLIDS (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 4.81 Temperature(°C) 23.2
Specific Conductance(µS/cm) 50
Disolved Oxygen (mg/L) 4.19

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Job Name: AFCEE-RNA
Location Columbus AFB, ST24
by RN/JH/CS/BL Date: 11/13, 1996
Well Number SB24-MPH(S)
Measurement Datum –

Pre-Development Information
Time (Start): 945

Water Level: ~15' (estimated)
Total Depth of Well: ~19.5'

Water Characteristics

Color slt g-brown
Clear (Cloudy)
Odor: None Weak (Moderate) Strong
Any Films or Immiscible Material NO
pH 4.38
Temperature(°C) 20.2
Specific Conductance(µS/cm) 2.78
Disolved Oxygen (mg/L) 0.83

Interim Water Characteristics

Gallons Removed 0.5 9:50
pH 6.06
Temperature (°C) 20.9
Specific Conductance(µS/cm) 2.38
Disolved Oxygen (mg/L) 0.34
-35.6 Redox

Post-Development Information
Time (Finish): 952

Water Level:
Total Depth of Well:

Approximate Volume Removed: 1 gall

Water Characteristics

Color brown-light
(Clear) Cloudy
Odor: None Weak (Moderate) Strong
Any Films or Immiscible Material –
pH 6.06
Temperature(°C) 21.0
Specific Conductance(µS/cm) 237
Disolved Oxygen (mg/L) 0.28

Comments:
-34.8 Redox

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number MPT (ST24)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/12, 1996
Measurement Datum —

Pre-Development Information

Time (Start): 0940

Water Level: _____

Total Depth of Well: _____

Water Characteristics

Color ORANGE BROWN Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.13 Temperature(°C) 19.0
Specific Conductance(µS/cm) 70
Disolved Oxygen (mg/L) 4.25

Interim Water Characteristics

Gallons Removed	0.3	0.6	0.9	1.2
pH	4.84	5.10	5.08	5.03
Temperature (°C)	20.9	21.3	21.6	21.7
Specific Conductance(µS/cm)	60 ~~5.44~~	60	60	60
Disolved Oxygen (mg/L)	5.44	5.37	5.28	5.26

Post-Development Information

Time (Finish): 0955

Water Level: _____

Total Depth of Well: _____

Approximate Volume Removed: 1.2

Water Characteristics

Color light suspended solids (Clear) Cloudy
Odor: (None) Weak — Moderate Strong
Any Films or Immiscible Material —
pH 5.03 Temperature(°C) 21.7
Specific Conductance(µS/cm) 60
Disolved Oxygen (mg/L) 5.25

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number MPJ (ST24)

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/18, 1996
Measurement Datum

Pre-Development Information

Time (Start): 0940

Water Level:

Total Depth of Well:

Water Characteristics

Color Brown Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material No
pH 5.68 Temperature(°C) 19.7
Specific Conductance(µS/cm) 71
Disolved Oxygen (mg/L) 1.78

Interim Water Characteristics

Time 9:50

Gallons Removed 1 gallon
pH 5.31
Temperature (°C) 20.4
Specific Conductance(µS/cm) 56
Disolved Oxygen (mg/L) 2.15
Redox 120

Post-Development Information

Time (Finish): 955

Water Level: —

Total Depth of Well: —

Approximate Volume Removed: 1.5 gallons

Water Characteristics

Color (Clear) Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material —
pH 5.33 Temperature(°C) 20.5
Specific Conductance(µS/cm) 56
Disolved Oxygen (mg/L) 2.11

Comments: Redox 120

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ST24
Well Number MPK(S) ST24

Job Name: AFCEE-RNA 11/10/96
by RNJH CS BL Date: 10/Oct. 11, 1996
Measurement Datum

Pre-Development Information

Time (Start): 1447

Water Level: ≈15.00'

Total Depth of Well: ≈19-21'

Water Characteristics

Color brown Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material Nc
pH 5.78 Temperature(°C) 18.3
Specific Conductance(µS/cm) 60
Disolved Oxygen (mg/L) 4.27

Interim Water Characteristics

Gallons Removed	0.2	0.3	0.5
pH	5.21	5.13	5.12
Temperature (°C)	19.3	19.5	19.4
Specific Conductance(µS/cm)	40	40	40
Disolved Oxygen (mg/L)	6.20	6.31	6.42

Post-Development Information

Time (Finish): 1458

Water Level: unknown

Total Depth of Well: 19-21'

Approximate Volume Removed: 0.5 gal

Water Characteristics

Color light suspended solids Clear Cloudy
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material No
pH 5.12 Temperature(°C) 19.4
Specific Conductance(µS/cm) 40
Disolved Oxygen (mg/L) 6.42

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020 Job Name: AFCEE-RNA
Location Columbus AFB, ST24 by RN/JH/CS/BL Date: 11/11, 1996
Well Number MPK(D) ST24 Measurement Datum —

Pre-Development Information Time (Start): 0710

Water Level: — Total Depth of Well: ≈29

Water Characteristics

Color ORANGE BROWN Clear (Cloudy)
Odor: (None) Weak Moderate Strong
Any Films or Immiscible Material None
pH 6.05 Temperature(°C) 16.9
Specific Conductance(µS/cm) 190
Disolved Oxygen (mg/L) 0.36

Interim Water Characteristics

Gallons Removed	0.2	0.4	0.5	0.6
pH	5.33	4.93	4.87	4.84
Temperature (°C)	18.0	18.8	18.5	18.5
Specific Conductance(µS/cm)	50	40	40	40
Disolved Oxygen (mg/L)	7.51	7.72	8.17	8.15

Post-Development Information Time (Finish): 0740

Water Level: — Total Depth of Well: ≈29

Approximate Volume Removed: 0.6

Water Characteristics

Color CLEAR Clear (MURKY) Cloudy
Odor: (None) Weak — Moderate Strong
Any Films or Immiscible Material —
pH 4.84 Temperature(°C) 18.4
Specific Conductance(µS/cm) 40
Disolved Oxygen (mg/L) 8.18

Comments:

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB, ~~LF6~~ ST24
Well Number MPL

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/18, 1996
Measurement Datum

Pre-Development Information

Time (Start): 0905

Water Level: –

Total Depth of Well:

Water Characteristics

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material Ni
pH 5.79 Temperature(°C) 20.1
Specific Conductance(µS/cm) 120
Disolved Oxygen (mg/L) 0.38

Interim Water Characteristics

Gallons Removed 1.5
pH 5.63
Temperature (°C) 20.5
Specific Conductance(µS/cm) 109
Disolved Oxygen (mg/L) 0.22

Post-Development Information

Time (Finish): ~~0830~~ 0850

Water Level:

Total Depth of Well:

Approximate Volume Removed: 4.0 gallons

Water Characteristics

as of 0830

Color Clear Cloudy
Odor: None Weak Moderate Strong
Any Films or Immiscible Material
pH 5.63 Temperature(°C) 20.5
Specific Conductance(µS/cm) 109
Disolved Oxygen (mg/L) 0.19

Comments:

No Sheen, Moderate Odor

MONITORING POINT DEVELOPMENT RECORD

Job Number: 729691.32020
Location Columbus AFB (ST24)
Well Number MPM

Job Name: AFCEE-RNA
by RN/JH/CS/BL Date: 11/18, 1996
Measurement Datum

Pre-Development Information

Time (Start): 0650

Water Level: —

Total Depth of Well:

Water Characteristics

Color ORANGE BROWN Clear (Cloudy)
Odor: None Weak (Moderate) Strong
Any Films or Immiscible Material
pH 5.76 Temperature(°C) 20.4
Specific Conductance(µS/cm) 159
Disolved Oxygen (mg/L) 2.82

Interim Water Characteristics

Gallons Removed 0.3

pH 5.82

Temperature (°C) 20.6

Specific Conductance(µS/cm) 158

Disolved Oxygen (mg/L) 2.40

Post-Development Information

Time (Finish): 0710

Water Level:

Total Depth of Well:

Approximate Volume Removed: 0.7

Water Characteristics

Color CLEAR (Clear) Cloudy
Odor: None Weak Moderate (Strong)
Any Films or Immiscible Material SHEEN
pH 5.82 Temperature(°C) 20.8
Specific Conductance(µS/cm) 160
Disolved Oxygen (mg/L) 0.99

Comments:
SHEEN

APPENDIX A-3

GROUNDWATER SAMPLING FORMS

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W68 (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/8, 1996 0820 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 50°F SUNNY
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: GOOD
INNER PVC CASING CONDITION IS: GOOD
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): NO LID

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH 14.25 TD=20 FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed: 3 GALLONS
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. W08 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (ST24)

[ ] Bailer made of:_____

[ ] Pump, type:_

[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	0755	0759	0805			Meausred with
Temp (°C)	20.8	20.7	20.8			
pH	4.58	4.65	4.60			
Cond (µS/cm)	50	50	50			
DO (mg/L)	5.48	5.31	5.29			
Redox (mV)	238.4	252.4	262.5			
Salinity						
~~Nitrate~~	1gal	2gal	3gal			
Sulfate						
Ferrous Iron						

7 [ ] SAMPLE CONTAINERS (material, number, size): 10 VOAs for BTEX, TVH-G, METHANE

1 125ml plastic for Anions

1 Amber glass TOC 14ml

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MW9 (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/10/96, 1996 720 (a.m)/p.m.
SAMPLE COLLECTED BY (JH/BL/CS/RN) of Parsons ES
WEATHER: 32°F partly cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - (IS NOT) APPARENT
STEEL CASING CONDITION IS: ok
INNER PVC CASING CONDITION IS: ok
WATER DEPTH MEASUREMENT DATUM (IS - (IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): no lid

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH 15.03' FT. BELOW DATUM
Measured with: total depth = 20.7'

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed: 2.5 gal
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. W69 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (STZ4)

[ ] Bailer made of:_____
[X] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	654	701	707	715		Meausred with
Temp (°C)	19.3	19.6	18.6	16.9		
pH	4.23	4.65	4.67	4.66		
Cond (µS/cm)	70	70	70	70		
DO (mg/L)	4.91	4.45	4.56	5.33		
Redox (mV)	293.1	355.8	359.7	338.0		
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~	0.5	1.5	2	2.5		

current purge

7 [ ] SAMPLE CONTAINERS (material, number, size): 10 VOAs methanol, VOC, BTEX/TTH-G
1 125ml plastic unions

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method HCl Containers: VOAs
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W70 (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/10/96, 1996 1345 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 50°F Sunny
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): lid cracked

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH 14.95 FT. BELOW DATUM
Measured with: total depth 20.1

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: strong hydrocarb odor
Other comments:

Groundwater Sampling Record

Monitoring Well No. W70 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (STZY)

[ ] Bailer made of:_____

[X] Pump, type: peristaltic

[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1311	1319	1326			Meausred with
Temp (°C)	21.0	20.7	20.9	21.1		
pH	5,73	5.84	5.82	5,84		
Cond (µS/cm)	110	130 ~~140~~	130	150		
DO (mg/L)	0.33	0.27	0.25	0.23		
Redox (mV)	~~-90~~ -112.0	-107.3	-134.1	-140.3		
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~ purge volume	1.	1.5	2	2.5		

7 [ ] SAMPLE CONTAINERS (material, number, size): 16 VOAs VOCs, methane, BTEX/TVH-G-
1 125ml plastic anions
Duplicate Sample W-75 7 VOAs VOCs, BTEX/TVH-G (at 645)

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method HCl Containers: VOAs
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W71 (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/10/96, 1996 0850 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 40°F Sunny
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH 15.48' FT. BELOW DATUM
Measured with: total depth - 19.5'

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed: 2.5 gal
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: moderate hydrocarbon odor
Other comments:

Groundwater Sampling Record

Monitoring Well No. W71 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (ST24)

[ ] Bailer made of:_____
[X] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	829	834	839	843		Meausred with
Temp (°C)	~~19.725.0~~	19.9	20.0	20.0		
pH	6.04	6.00	6.02	6.01		
Cond (µS/cm)	190	190	190	190		
DO (mg/L)	0.40	0.39	0.36	0.35		
Redox (mV)	-13.7	-32.4	-71.0	-31.0		
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~	0.5	1.0	1.5	2		

amount purged

7 [ ] SAMPLE CONTAINERS (material, number, size):_____

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method HCl Containers: VOAs
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W72 (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/8/96, 1996 0850 a.m./p.m.
SAMPLE COLLECTED BY (JH)/BL/CS/RN of Parsons ES
WEATHER: 40° Partly cloudy
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - (IS NOT)) APPARENT
STEEL CASING CONDITION IS: poor
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - (IS NOT)) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[X] MONITORING WELL REQUIRED REPAIR (describe): No lid

Check-off
1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:
WATER DEPTH 13.80' Total Depth = ~~20'~~ 15.9' gth FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed: ~~2.5gal~~ gth 1.5gal
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: hydrocarbon odor slight
Other comments:

Groundwater Sampling Record

Monitoring Well No. W72 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (ST24)

[ ] Bailer made of:_____
[ ] Pump, type:_____
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1624	1640	1646			Meausred with
Temp (°C)	19.3	18.0	17.6			
pH	5.67	5.80	5.83			
Cond (µS/cm)	110	120	120			
DO (mg/L)*	4.27	3.12	5.48			
Redox (mV)*	126.9	117.8	122.0			
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~ Amount Purged	0.5gal	1gal	1.5 gal# 2gal			

7 [ ] SAMPLE CONTAINERS (material, number, size): 10 VOAs Methane, VOCs, Brex/TVH-G
1-125 ml plastic Anions

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method HCl Containers: VOAs
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: *created sample, & well went dry, Constant bubbles going through Sample

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W73 (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/8/96, 1996 1117 (a.m.) p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 50°F Sunny
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: poor
INNER PVC CASING CONDITION IS: ok
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH 14.00' TD = 18.01' FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: brown
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. W73 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (STZ4)

[ ] Bailer made of:_____
[A] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1047	1051				Meausred with
Temp (°C)	21.8	22.0				
pH	gal 4.89	4.91				
Cond (µS/cm)	60	60				
DO (mg/L)	1.60	1.44				
Redox (mV)	279.3	274.0				
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~ Purge Amount	0.5gal	1gal				

7 [ ] SAMPLE CONTAINERS (material, number, size): 3-~~8~~ gal VOAs VOCs, 3- methane, 4- BTEX/TVH-G
1, 125 ml plastic for anions
1, 145 ml glass for TOC

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[X] Preservatives added:

Method HCl Containers: VOAs
Method H_2SO_4 Containers: 145 ml glass
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: pumped well dry after removing ~1 gal

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W74 (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/8/96, 1996 1515 a.m./p.m.
SAMPLE COLLECTED BY: (JH/BL) CS/RN of Parsons ES
WEATHER: Sunny 50° F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOC

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - (IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - (IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[X] MONITORING WELL REQUIRED REPAIR (describe): no cover

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH 13.77 Total Depth = 22.70 FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed: 4.5 gal
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: no odor
Other comments:

Groundwater Sampling Record

Monitoring Well No. W74 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (ST24)

[ ] Bailer made of: _____
[X] Pump, type: peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1439	1447	1456	1505		Meausred with
Temp (°C)	21.1	21.2	21.1	21.0		
pH	4.34	4.43	4.43	4.59		
Cond (µS/cm)	30	30	30	30		
DO (mg/L)	4.74	4.75	4.79	4.85		
Redox (mV)	270.4	270.4	272.3	273.5		
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~						
Amount purged	1 gal	2 gal	3 gal	4.5 gal		

7 [ ] SAMPLE CONTAINERS (material, number, size): 3-VOC, 3-Methane, 4-BTEX/TVH-G VOAs VOA 6-VOC MS/MSD, 1-Anions, 1-TOC

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[X] Preservatives added:

Method HCl Containers: 16 VOCs, Methane, BTEX/TVH-G
Method H_2SO_4 Containers: 1 TOC
Method _____ Containers: _____
Method _____ Containers: _____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: MS/MSD samples collected for VOCs

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MW77 (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/16/96, 1996 1030 a.m./p.m.
SAMPLE COLLECTED BY (JH/BL/CS/RN) of Parsons ES
WEATHER:
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:

[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - (IS NOT) APPARENT
STEEL CASING CONDITION IS: OK
INNER PVC CASING CONDITION IS: OK
WATER DEPTH MEASUREMENT DATUM (IS - (IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH 14.52' FT. BELOW DATUM
Measured with: total depth = 19.2

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. W77 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (STZ4)

[ ] Bailer made of:_____
[X] Pump, type: peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	959	1005	1009	1014	1018	Meausred with
Temp (°C)	20.9	20.9	20.0	21.1	21.1	
pH	4.62	4.61	4.60	4.62	4.61	
Cond (µS/cm)	90	90	90	90	90	
DO (mg/L)	1.86	1.16	1.04	0.88	0.82	
Redox (mV)	161.8	189.7	192.0	199.3	197.6	
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~ amount purged	0.5	1	1.5	2	2.5	

7 [ ] SAMPLE CONTAINERS (material, number, size): 10 VOAs BTEX/TPH-G, VOCs, methane
1,125ml plastic anions

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method HCl Containers: VOCs
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL W70D (ST24) (number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/11, 1996 1715 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: cloudy 45°
DATUM FOR WATER DEPTH MEASUREMENT (Describe): —

MONITORING WELL CONDITION:

[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. W70D (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (ST 24)

[ ] Bailer made of:_____

[ ] Pump, type:_

[ ] Other, describe:_____

_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1700	1705	1709	1714		Meausred with
Temp (°C)	19.8	20.0	20.1	20.0		
pH	6.06	6.07	6.09	6.16		
Cond (µS/cm)	150	150	150	160		
DO (mg/L)	5.02	4.22	3.34	3.11		
Redox (mV)	-25.2	-29.3	-26.7	-27.3		
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~ Gallons	0.05	0.1	0.15	0.2		

7 [ ] SAMPLE CONTAINERS (material, number, size): 4 x 40ml glass BTEX/TVH-.
3 40ml glass methane
3 " " VOC
1 125ml plastic anions

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

_____

_____

_____

_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24MPA
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/11, 1996 1330 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: SUNNY 60°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): —

MONITORING WELL CONDITION:

[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method: PERISTALTIC
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. ST24MPW.A (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type:_
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1318	1321	1325	1327		Meausred with
Temp (°C)	22.2	22.2	22.2	22.1		
pH	5.85	5.83	5.83	5.84		
Cond (µS/cm)	EQUIPMENT MALFUNCTION					
DO (mg/L)	0.31	0.30	0.27	0.27		
Redox (mV)	-97.5	-95.0	-94.1	-94.7		
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~	0.2	0.4	0.8	1.0		

gallons

7 [ ] SAMPLE CONTAINERS (material, number, size):

4 BTEX/TVH-G
3 METHANE
3 VOCs
1 ANIONS

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

Groundwater Sampling Record

Monitoring Well No. ST-34MP15 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type:_____
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1530	1532	1535			Meausred with
Temp (°C)	21.8	21.8	21.8			
pH	6.37	6.37	6.38			
Cond (µS/cm)	340	340	340			
DO (mg/L)	0.25	0.24	0.23			
Redox (mV)	-126.4	-127.2	-128.5			
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~	0.2	0.4	0.6			

Gallons

7 [ ] SAMPLE CONTAINERS (material, number, size):

4 40 ml glass BTEX/TVH-G
3 40 ml glass METHANE
3 40 ml glass VOC
1 125 ml plastic ANIONS

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration:
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24 ~~MPD(D)~~ MPD(S)
(number)

BMH 11/21/96

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/13, 1996 0740 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: RAIN 45°F

NOTE: MPD(D) and MPD(S) were mislabeled in the field. The well was relabeled on 11/19/96.

DATUM FOR WATER DEPTH MEASUREMENT (Describe): _____

MONITORING WELL CONDITION:
[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: _____
INNER PVC CASING CONDITION IS: _____
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): _____

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH _____
Items Cleaned (List): _____

2 [ ] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with: _____

WATER DEPTH _____ FT. BELOW DATUM
Measured with: _____

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: _____
Odor: _____
Other Comments: _____

4 [ ] WELL EVACUATION:
Method: PERISTALTIC
Volume Removed: _____
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: MODERATE
Other comments: _____

Groundwater Sampling Record

Monitoring Well No. ~~ST24 MPE(1)~~ (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: MPD(1)

[ ] Bailer made of:_____
[ ] Pump, type:_
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	0722	0725	0728	0730		Meausred with
Temp (°C)	20.1	20.1	20.2	20.2		
pH	6.08	6.09	6.09	6.08		
Cond (µS/cm)	184	184	184	184		
DO (mg/L)	0.35	0.36	0.33	0.31		
Redox (mV)	-20.4	-22.4	-22.7	-22.8		
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~ gallons ~~0.1~~	0.1	0.3	0.5	0.7		

7 [ ] SAMPLE CONTAINERS (material, number, size):

4 40 ml BTEX/TVH-G
3 40 ml METHANE
3 40 ml VOCS
1 125 ml ANIONS

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24- ~~MPD(S)~~ MPD(D)
(number) BMH 11/21/96

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/13, 1996 _____ a.m./p.m.
SAMPLE COLLECTED BY: JH/~~BL~~/CS/~~RN~~ of Parsons ES
WEATHER: 45° Overcast
DATUM FOR WATER DEPTH MEASUREMENT (Describe): —

MONITORING WELL CONDITION:
[ ] LOCKED: [X] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: good
INNER PVC CASING CONDITION IS: N/A
WATER DEPTH MEASUREMENT DATUM (IS - ~~IS NOT~~) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): _____

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Isopropanol + distilled water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH — estimate 15' FT. BELOW DATUM
Measured with: —

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: _____
Odor: _____
Other Comments: _____

4 [ ] WELL EVACUATION:
Method: Peristaltic pump
Volume Removed: _____
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: _____
Other comments: _____

Groundwater Sampling Record

Monitoring Well No. ST24-~~MPD~~(S) (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: MPD(D)

[ ] Bailer made of:_____

[X] Pump, type: Peristaltic

[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time						Meausred with
Temp (°C)						YSI 55
pH						Orion 250A
Cond (µS/cm)						
DO (mg/L)						YSI 55
Redox (mV)						Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

7 [ ] SAMPLE CONTAINERS (material, number, size):_____

10 VOAs

1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____

Method_____ Containers:_____

Method_____ Containers:_____

[ ] Preservatives added:

Method HCl Containers: VOAs

Method_____ Containers:_____

Method_____ Containers:_____

Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled

[X] Container Lids Taped

[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24MPE
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/11, 1996 1000 (a.m)/p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: PARTLY CLOUDY 50°
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TMPLANT

MONITORING WELL CONDITION:
[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 0.5 gal
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: WEAK
Other comments:

Groundwater Sampling Record

Monitoring Well No. MP6 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (ST24)

[ ] Bailer made of:_____
[ ] Pump, type:_____
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	0945	0948	0952	0957		Meausred with
Temp (°C)	20.6	20.7	20.7	20.7		
pH	6.26	6.28	6.27	6.26		
Cond (µS/cm)	190	190	190	190		
DO (mg/L)	0.46	0.38	0.34	0.33		
Redox (mV)	-119.9	-129.6	-138.3	-143.6		
Salinity						
Nitrate						
Sulfate						
~~Ferrous~~ Iron	0.2	0.7	1.5	2.5		

Sul

7 [ ] SAMPLE CONTAINERS (material, number, size): 4 40ml BTEX/TVH+GRO
3 " METHANE
3 " VOC
1 60 125ml ANIONS

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24MPE
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/12, 1996 0840 a.m./p.m.
SAMPLE COLLECTED BY: JH/BD/CS/RN of Parsons ES
WEATHER: PARTLY CLOUDY 45°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): —

MONITORING WELL CONDITION:
[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: WEAK
Other comments:

Groundwater Sampling Record

Monitoring Well No. S7a4MPF (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type:_
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time 21.9	0825	0827	0829	0831		Meausred with
Temp (°C)	~~21.7~~	21.9	22.0	22.0		
pH	5.75	5.72	5.72	5.73		
Cond (µS/cm)	140	140	140	140		
DO (mg/L)	0.43	0.40	0.37	0.37		
Redox (mV)	-12.7	-12.1	-12.3	-12.6		
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~	0.2	0.3	0.4	0.5		

5 gallons

7 [ ] SAMPLE CONTAINERS (material, number, size):

4	40ml	BTEX/TVH-G
3	"	METHANE
3	"	VOC
1	125ml	ANIONS

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24 MPG
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/11, 1996 1515 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 55° SUNNY
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:

[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method: PERISTALTIC
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. 524 MPG (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type:_
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1502	1506	1510			Meausred with
Temp (°C)	23.3	23.4	23.5			
pH	4.78	4.73	4.74			
Cond (µS/cm)	50	50	50			
DO (mg/L)	4.15	4.13	4.16			
Redox (mV)	126.5	133.6	139.5			
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~ gallons	0.2	0.5	0.9			

7 [ ] SAMPLE CONTAINERS (material, number, size):

4	40 ml	BTEX/TVH-G
3	40 "	METHANE
3	40 "	VOC
1	125 "	ANIONS

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24-MPH(S)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/13, 1996 _____ a.m./p.m.
SAMPLE COLLECTED BY: JH/BLACS/RN of Parsons ES
WEATHER: 50° Overcast, occasional
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:

[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

WATER DEPTH _____ FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method:
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. MPH(S)-ST24 (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of: _____
[X] Pump, type: Peristaltic
[ ] Other, describe: _____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	945	950	954	958	1002	Meausred with
Temp (°C)	20.2	20.9	21.0	20.8	21.0	YSI 55
pH	4.83	6.06	6.06	6.10	6.10	Orion 250A
Cond (µS/cm)	278	238	237	236	235	HACH Meter
DO (mg/L)	0.38	0.34	0.28	0.25	0.26	YSI 55
Redox (mV)	-41.9	-35.6	-34.8	-33.7	-34.9	Orion 250A
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

7 [ ] SAMPLE CONTAINERS (material, number, size): 10 VOAs, 1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

[X] Preservatives added:

Method HCl Containers: VOAs
Method _____ Containers: _____
Method _____ Containers: _____
Method _____ Containers: _____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: _____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL STUMP I
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/12, 1996 1010 a.m./p.m.
SAMPLE COLLECTED BY: JH/BD/CS/RN of Parsons ES
WEATHER: OVERCAST 45°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe):

MONITORING WELL CONDITION:

[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed:
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: NONE
Other comments:

Groundwater Sampling Record

Monitoring Well No. 524 MP I (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type:_____
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	0956	0958	1000			Meausred with
Temp (°C)	21.7	21.6	21.7			
pH	5.05	5.03	5.01			
Cond (µS/cm)	60	60	60			
DO (mg/L)	5.28	5.25	5.23			
Redox (mV)	+110.2	+112.8	130.7			
Salinity						
Nitrate						
Sulfate						
Ferrous Iron	0.2	0.4	0.6			

7 [ ] SAMPLE CONTAINERS (material, number, size): 4 40ml glass BTEX/TVH-G
3 " " METHANE
3 " " VOC
1 125ml plast. ANIONS

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MPJ (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/18/96, 1996 955 (a.m./p.m.)
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: 60° Overcast
DATUM FOR WATER DEPTH MEASUREMENT (Describe): implant

MONITORING WELL CONDITION: Incomplete
[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: Good
INNER PVC CASING CONDITION IS: —
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH distilled water
Items Cleaned (List): probes

2 [ ] PRODUCT DEPTH — FT. BELOW DATUM
Measured with: —

WATER DEPTH — FT. BELOW DATUM
Measured with: —

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: Cloudy brown
Odor: none
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 1.5 gallon
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: none
Other comments:

Groundwater Sampling Record

Monitoring Well No. MP-J (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD: (ST24

[ ] Bailer made of:_____
[X] Pump, type:_ Peristaltic
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	940	945	950	955		Meausred with
Temp (°C)	19.7	20.4	20.4	20.5		YSI 55
pH	5.68	5.38	5.30	5.33		Orion 0SOA
Cond (µS/cm)	71	56	56	56		Hach meter
DO (mg/L)	1.78	2.20	2.15	2.01		YSI 55
Redox (mV)		124	120	120		Orion 0SOA
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						

gallons 0.3 0.6 1.0 1.5

7 [ ] SAMPLE CONTAINERS (material, number, size):_____
10 VOAs
1 Poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[X] Preservatives added:

Method HCl Containers: VOAs
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[ ] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24MPK(S)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/10, 1996 _____ a.m./p.m.
SAMPLE COLLECTED BY: JH/BD/CS/RN of Parsons ES
WEATHER: _____
DATUM FOR WATER DEPTH MEASUREMENT (Describe): _____

MONITORING WELL CONDITION:
[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS: _____
INNER PVC CASING CONDITION IS: _____
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe): _____

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH _____
Items Cleaned (List): _____

2 [ ] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with: _____

WATER DEPTH UNKNOWN TO = 19.21 FT. BELOW DATUM
Measured with: _____

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: _____
Odor: _____
Other Comments: _____

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 1.5
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: NONE
Other comments: _____

Groundwater Sampling Record

Monitoring Well No. STAMPIC(S) (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type:_____
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	1502	1505	1508			Meausred with
Temp (°C)	19.9	20.1	20.0			
pH	5.08	5.09	5.11			
Cond (µS/cm)	40	40	40			
DO (mg/L)	6.16	6.26	6.24			
Redox (mV)	104.1	108.1	108.3			
Salinity						
~~Nitrate~~	.1gal	.3gal	.5gal			
Sulfate						
Ferrous Iron						

7 [ ] SAMPLE CONTAINERS (material, number, size):

4 40 ml glass BTEX/TVH.G
3 40 ml glass METHANE
3 40 ml glass VOC
1 125ml plastic ANIONS
1 145ml Amber glass TOC

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24MPK(D)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/11, 1996 0750 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES
WEATHER: PARTLY CLOUDY 40°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): TOP OF PLANT NO WATER LEVEL

MONITORING WELL CONDITION:

[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: light suspended solids
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 0.3
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments:

Groundwater Sampling Record

Monitoring Well No. STAMP(D) (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type:_
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	0742	0744	0747			Meausred with
Temp (°C)	18.0	18.2	18.3			
pH	4.89	4.97	4.95			
Cond (µS/cm)	40	40	40			
DO (mg/L)	9.27	8.44	8.52			
Redox (mV)	149.1	191.3	187.6			
Salinity						
Nitrate						
Sulfate						
~~Ferrous Iron~~	0.1	0.2	0.3			

541

7 [ ] SAMPLE CONTAINERS (material, number, size):
4 40ml glass BTEX/TVH-G
3 40ml glass METHANE
3 40ml glass VOC
1 125ml plastic ANIONS
1 145ml amber glass TOC

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS:_____

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL MPL (ST24)
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/18, 1996 0930 a.m./p.m.
SAMPLE COLLECTED BY: JH/BL/CS/RN of Parsons ES CAP
WEATHER: Over cast - 60°F
DATUM FOR WATER DEPTH MEASUREMENT (Describe): Implant

MONITORING WELL CONDITION:
[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH Distilled Water
Items Cleaned (List): Probes

2 [ ] PRODUCT DEPTH _____ FT. BELOW DATUM
Measured with:

WATER DEPTH _____ FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance: cloudy brown
Odor: slight
Other Comments:

4 [ ] WELL EVACUATION:
Method: Peristaltic
Volume Removed: 4.0 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors:
Other comments: Clear

ST24

Groundwater Sampling Record

Monitoring Well No. MPL (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[ ] Pump, type:_____
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

CBL 25.0 25.0 ~~25.0~~ 20.4 CBL

Time	0814	0818	0822	0826	0830	Meausred with
Temp (°C)	~~25.0~~	~~25.0~~	20.4	20.5	20.5	
pH	5.64	5.64	5.63	5.65	5.63	
Cond (µS/cm)	111	110	109	109	109	
DO (mg/L)	0.25	0.23	0.22	0.21	0.19	
Redox (mV)	-289.3	-265.4	-258.1	-242.9	-234.1	
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						
Gallons	0.5	1.0	1.5	2.0	2.5	

7 [ ] SAMPLE CONTAINERS (material, number, size): MPL

VOA - 4 BTEX/TVH-G *
VOA - 3 VOCs
VOA - 3 Methane
Plastic 1 - Anions

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added:

Method HCL Containers: VOAs
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[X] Container Sides Labeled
[X] Container Lids Taped
[X] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: Duplicate W3 collected at MPL at 0845
- VOA - 4 BTEX/TVH-G
VOA - 3 VOCs

* BTEX/TVH Bottle Sample Collected approximately 15 minutes after other 3 MPL BTEX/TVH-G Bottles
- Purging prematurely terminated
- Purging restarted and allowed to equilibrate for approximately 2 minutes before collecting this bottle!

GROUNDWATER SAMPLING RECORD

Sampling Location Columbus AFB - ST24
Sampling Dates 11/04/96-11/24/96

GROUND WATER SAMPLING RECORD - MONITORING WELL ST24 MPM
(number)

REASON FOR SAMPLING: [X] Regular Sampling; [ ] Special Sampling;
DATE AND TIME OF SAMPLING: 11/16, 1996 0735 a.m./p.m.
SAMPLE COLLECTED BY: JH/BD/CS/RN of Parsons ES
WEATHER: OVERCAST 50
DATUM FOR WATER DEPTH MEASUREMENT (Describe): — IMPLANT

MONITORING WELL CONDITION:

[ ] LOCKED: [ ] UNLOCKED
WELL NUMBER (IS - IS NOT) APPARENT
STEEL CASING CONDITION IS:
INNER PVC CASING CONDITION IS:
WATER DEPTH MEASUREMENT DATUM (IS - IS NOT) APPARENT
[ ] DEFICIENCIES CORRECTED BY SAMPLE COLLECTOR
[ ] MONITORING WELL REQUIRED REPAIR (describe):

Check-off

1 [ ] EQUIPMENT CLEANED BEFORE USE WITH
Items Cleaned (List):

2 [ ] PRODUCT DEPTH FT. BELOW DATUM
Measured with:

WATER DEPTH FT. BELOW DATUM
Measured with:

3 [ ] WATER-CONDITION BEFORE WELL EVACUATION (Describe):
Appearance:
Odor:
Other Comments:

4 [ ] WELL EVACUATION:
Method: PERISTALTIC
Volume Removed: 1.0 gallons
Observations: Water (slightly - very) cloudy
Water level (rose - fell - no change)
Water odors: SMOKE
Other comments: SILTY

ST 24

Groundwater Sampling Record

Monitoring Well No. MPM (Cont'd)

5 [ ] SAMPLE EXTRACTION METHOD:

[ ] Bailer made of:_____
[X] Pump, type: PERISTALTIC
[ ] Other, describe:_____

Sample obtained is [X] GRAB; [ ] COMPOSITE SAMPLE

6 [ ] ON-SITE MEASUREMENTS:

Time	0700	0707	0713	0718	0722	Meausred with
Temp (°C)	20.9	20.9	20.8	21.0	21.0	YSI 55
pH	5.70	5.81	5.82	5.80	5.81	ORION 250
Cond (µS/cm)	158	160	160	160	160	HACH
DO (mg/L)	2.80	1.54	0.99	0.71	0.58	YSI 55
Redox (mV)	-38.8	-63.2	-67.1	-141.4	-158.2	ORION 250
Salinity						
Nitrate						
Sulfate						
Ferrous Iron						
	0.3	0.5	0.7	0.9	1.0	

7 [ ] SAMPLE CONTAINERS (material, number, size): 10 40ml glass
1 125ml poly

8 [ ] ON-SITE SAMPLE TREATMENT:

[ ] Filtration: Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

[ ] Preservatives added: HCl
Method pre added Containers: 40ml vial
Method_____ Containers:_____
Method_____ Containers:_____
Method_____ Containers:_____

9 [ ] CONTAINER HANDLING:

[ ] Container Sides Labeled
[ ] Container Lids Taped
[ ] Containers Placed in Ice Chest

10 [ ] OTHER COMMENTS: SHEEN ON WATER

MB

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, VA MS

SAMPLE DATE: 11/8/96

SAMPLE I.D.: METHOD BLANK ON DI WATER

FILTERED (circle): YES NO

COLOR / ODOR:

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1029	1032	0.00 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1023	1033	0.002 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1025	1034	0.2 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1026	1034	0.01 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1037	1042	0.27 mg/L	DI or 50mg/L
						mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L		Same glassware as		mg/L	DI
					sulfide	mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1039	1041	-0.00 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1025	1028	-0.000 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 100 — Titrate with 0.16 N H_2SO_4 — Digit Multiplier = 0.1 — 36 digits

CHEMet Color Tests:

Ammonia	0 ppm
CO_2 (0 mL A-1910 added for sulfide interference)	<10 ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

MS

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, MS

SAMPLE DATE: 11/10/96

SAMPLE I.D.: MS ON DI

FILTERED (circle) YES NO

COLOR / ODOR:

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L					mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L					mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L		0825	0832	5.9	mg/L	sample
5 mg/L							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L		0834	0838	1.26	mg/L	sample
2 mg/L							mg/L	sample
Sulfate	45.000	0 - 100 mg/L	~~0.20~~	0820	0826	27.14	mg/L	DI or (50)mg/L
25 mg/L						26.00	mg/L	(DI) or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L					mg/L	DI
							mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L		0845	0847	1.3	mg/L	sample
2 mg/L							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L					mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity Sample Size = Digit Multiplier = digits

Titrate with N H_2SO_4

CHEMet Color Tests:

Ammonia ppm

CO_2 (mL A-1910 added for sulfide interference) ppm

Technician: _____

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

MSD

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~WA~~ MS

SAMPLE DATE: 11/10/96

SAMPLE I.D.: MSD ON DI

FILTERED (circle): YES NO

COLOR / ODOR:

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L					mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L					mg/L	sample
							mg/L	sample
Nitrate 5mg/L	50.05.1	0 - 30.0 mg/L		0825	0832	5.7	mg/L	sample
							mg/L	sample
Total Iron 2mg/L	50.03.1	0 - 5.10 mg/L		0834	0838	1.07	mg/L	sample
							mg/L	sample
Sulfate 25mg/L	45.000	0 - 100 mg/L		0820	0826	27.35	mg/L	DI or 50mg/L
						26.11	mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L					mg/L	DI
							mg/L	DI
Manganese 2mg/L	52.13.1	0 - 20.0 mg/L		0845	0847	1.3	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L					mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity Sample Size = Digit Multiplier = digits

Titrate with N H_2SO_4

CHEMet Color Tests:

Ammonia ppm

CO_2 (mL A-1910 added for sulfide interference) ppm

Technician: _____

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~WA~~ MS

SAMPLE DATE: 11/8/96

SAMPLE I.D.: W68

FILTERED (circle): YES (NO)

COLOR / ODOR: CLEAR / NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0902	0905	0.01	mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0909	0919	0.002	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0917	0923	2.5	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	0918	0921	0.05	mg/L	sample
				0939	0944	0.16	mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1 ~~1~~	~~0926~~	0929	0.00	mg/L	DI or 50mg/L
			1			0.43	mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1000	1002	6.2	mg/L	DI
							mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	0926	0929	0.06	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1008	1014	0.008	mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 100 — Titrate with 1.6 N H_2SO_4 — Digit Multiplier = 1.0 — 55 digits

CHEMet Color Tests:

Ammonia	0	ppm
CO_2 (0 mL A-1910 added for sulfide interference)	70	ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

1D

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~MS~~ MS

SAMPLE DATE: 11/8/96

SAMPLE I.D.: WGK DUPLICATE

FILTERED (circle): YES (NO)

COLOR / ODOR: CLEAR / NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0902	0905	0.00 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0909	0919	0.001 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0917	0923	2.5 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	0918	0921	0.03 mg/L	sample
						-0.16 mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	~~0926~~	~~0929~~	~~0.01~~ mg/L	DI or 50mg/L
						0.16 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1000	1002	5.7 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	0926	0929	0.01 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1008	1014	0.008 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 100 mL

Titrate with 0.16 N H_2SO_4

Digit Multiplier = 0.1

30 digits

CHEMet Color Tests:

Ammonia		0 ppm
CO_2	(0 mL A-1910 added for sulfide interference)	70 ppm

Technician: BC

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~MI~~ MS

SAMPLE DATE: 11/10/96

SAMPLE I.D.: IN 69

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0744	0747	0.00 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0750	0800	0.005 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0755	0801	0.9 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	0758	0801	0.02 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	0807	0812	1.68 mg/L	DI or 50mg/L
						0.54 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	0809	0811	12.0 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	0802	0804	0.2 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	0810	0815	0.012 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 20 Digit Multiplier = 0.5 | 10 digits

Titrate with 0.16 N H_2SO_4

CHEMet Color Tests:

Ammonia	0	ppm
CO_2 (0 mL A-1910 added for sulfide interference)	50	ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, MS

SAMPLE DATE: 11/10/96

SAMPLE I.D.: W 70

FILTERED (circle): (YES) NO

COLOR / ODOR: NONE / STRONG HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	1401	1404	4.90 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1404	1416	0.004 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1412	1418	0.4 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	10	1414	1417	2.79 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1422	1428	-0.16 mg/L	DI or 50mg/L
						0.97 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1425	1427	12.2 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1419	1421	0.6 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1426	1431	0.045 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100ml Digit Multiplier = 1.0 55 digits

Titrate with 1.6 N H_2SO_4

CHEMet Color Tests:

Ammonia 2 ppm

CO_2 (○ mL A-1910 added for sulfide interference) ~~130~~ ppm

130

Technician: BL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~MI~~ MS

SAMPLE DATE: 11/11/96

SAMPLE I.D.: W70D

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR/MODERATE HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	1808	1811	3.28 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1810	1820	0.04 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1816	1822	0.5 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	5	1819	1824	3.29 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1829	1834	-0.65 mg/L	DI or 50mg/L
						0.76 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1831	1833	3.3 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1828	1830	2.1 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1832	1837	0.014 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 50 Digit Multiplier = 2 22 digits

Titrate with 1.6 N H_2SO_4

CHEMet Color Tests:

Ammonia 2 ppm

CO_2 (0 mL A-1910 added for sulfide interference) 105 ppm

Technician: BL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, MS

SAMPLE DATE: 11/10/96

SAMPLE I.D.: W71

FILTERED (circle): YES (NO)

COLOR / ODOR: CLEAR / STRONG HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	10	0917	0920	~~3.50~~ mg/L	sample
						3.28 mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0922	0933	0.007 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0930	0937	0.4 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	10	0931	0934	3.53 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1000	1005	2.00 mg/L	DI or 50mg/L
						2.92 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1002	1004	10.5 mg/L	DI
						mg/L	DI
* Manganese	52.13.1	0 - 20.0 mg/L	1	0940	0942	0.3 mg/L	sample
				1014	1017	1.5 mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1003	1008	0.028 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 100ml — Titrate with 1.6 N H_2SO_4 — Digit Multiplier = 1.0 — 79 digits

CHEMet Color Tests:

Ammonia	4 ppm
CO_2 (0 mL A-1910 added for sulfide interference)	130 ppm

Technician: BL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

* SAMPLE TURNED YELLOW AFTER REAGENT ADDITION, NOT VIOLET

60

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~MW~~ MS

SAMPLE DATE: 11/10/96

SAMPLE I.D.: W71 DUPLICATE

FILTERED (circle): YES (NO)

COLOR / ODOR: CLEAR/STRONG HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	10	0917	0920	3.42 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0924	0937	0.003 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0930	0937	0.5 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	10	0931	0934	3.49 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1000	1005	2.00 mg/L	DI or 50mg/L
						2.81 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1002	1004	10.5 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	0940	0944	1.1 mg/L	sample
				1014	1017	1.5 mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1003	1008	0.027 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 100 ml; Titrate with 1.6 N H_2SO_4; Digit Multiplier = 1.0; 82 digits

CHEMet Color Tests:

Ammonia	5 ppm
CO_2 (0 mL A-1910 added for sulfide interference)	140 ppm

Technician: BL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

& SAMPLE TURNED YELLOW AFTER REAGENT ADDITION, NOT VIOLET

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~WA~~ MS

SAMPLE DATE: 11/8/96

SAMPLE I.D.: W72

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR/ SLIGHT HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1735	1738	0.21	mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1738	1748	0.003	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1743	1749	0.5	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1746	1749	0.24	mg/L	sample
						3.23	mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1754	1759	2.60	mg/L	DI or 50mg/L
							mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1755	1758	5.9	mg/L	DI
							mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1751	1753	5.4	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1757	1802	0.051	mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 50ml Digit Multiplier = 0.2 245 digits

Titrate with ~~0.16~~ 0.16 N H_2SO_4

CHEMet Color Tests:

Ammonia	1.0 ppm
CO_2 (0 mL A-1910 added for sulfide interference)	70 ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~VA~~ MS

SAMPLE DATE: 11/8/96

SAMPLE I.D.: W73

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR, BAD ODOR
PROBABLY NOT HYDROCARBON

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1238	1241	0.01	mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1243	1253	0.004	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1250	1256	1.4	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1251	1254	0.04	mg/L	sample
							mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1300	1305	-0.16	mg/L	DI or 50mg/L
						0.59	mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1302	1304	3.5	mg/L	DI
							mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1253	1257	1.8	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1303	1306	0.013	mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 50 — Titrate with 0.16 N H_2SO_4 — Digit Multiplier = 0.2 — 50 digits

CHEMet Color Tests:

Ammonia	0.1	ppm
CO_2 (0 mL A-1910 added for sulfide interference)	100	ppm

Technician: BL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, MS

SAMPLE DATE: 11/8/96

SAMPLE I.D.: W-74

FILTERED (circle): YES (NO)

COLOR / ODOR: CLEAR / NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1542	1545	0.04 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1545	1555	0.002 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1550	1556	0.7 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1552	1555	0.26 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1601	1606	3.78 mg/L	DI or (50mg/L)
						2.97 mg/L	(DI) or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1602	1604	2.9 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1558	1600	0.0 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1604	1609	0.039 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 100 — Titrate with 0.16 N H_2SO_4 — Digit Multiplier = 0.1 — 45 digits

CHEMet Color Tests:

Ammonia: 0 ppm

CO_2: (0 mL A-1910 added for sulfide interference) — 70 ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~MI~~ MS

SAMPLE DATE: 11/10/96

SAMPLE I.D.: W77

FILTERED (circle): YES (NO)

COLOR / ODOR: CLEAR / NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1048	1051	0.03 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1052	1102	0.004 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1058	1104	1.4 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1100	1103	0.20 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1110	1115	14.97 mg/L	DI or 50mg/L
						16.22 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1112	1114	5.9 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1105	1107	0.1 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1113	1118	0.013 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 100 — Titrate with 0.16 N H_2SO_4 — Digit Multiplier = 0.1 — 510 digits

CHEMet Color Tests:

Ammonia		0 ppm
CO_2	(0 mL A-1910 added for sulfide interference)	130 ppm

Technician: JL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~VA~~ MS

SAMPLE DATE: 11/11/96

SAMPLE I.D.: STAMPA

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / MODERATE HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	1355	1358	2.65 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1356	1406	0.004 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1403	1404	0.1 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	5	1405	1408	2.66 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1414	1420	3.30 mg/L	DI or 50mg/L
						mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1417	1419	13.6 mg/L	DI
						mg/L	DI
☆ Manganese	52.13.1	0 - 20.0 mg/L	1	1410	1422	-0.0 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1418	1423	0.034 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 50 — Titrate with 0.16 N H_2SO_4 — Digit Multiplier = 0.2 — 150 digits

CHEMet Color Tests:

Ammonia	0.8	ppm
CO_2 (0 mL A-1910 added for sulfide interference)	90	ppm

Technician: BL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

☆ SAMPLE TURNED YELLOW AFTER REAGENT ADDITION, NOT VIOLET

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, MW MS

SAMPLE DATE: 11/12/96

SAMPLE I.D.: SB4MPBS

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / STRONG HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	10	1555	1558	>5.1	mg/L	sample
			25	1600	1603	[illegible]	mg/L	sample
						2.55	mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1558	1608	0.000	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1607	1613	-0.2	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	25	1611	1614	2.99	mg/L	sample
							mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1620	1626	4.33	mg/L	DI or 50mg/L
						6.54	mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1622	1624	9.4	mg/L	DI
							mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1616	16[illegible]21	1.9	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1624	1629	0.014	mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 100 — Titrate with 1.6 N H_2SO_4 — Digit Multiplier = 1 — 168 digits

CHEMet Color Tests:

Ammonia: >10 ppm

CO_2: 200 ppm (0 mL A-1910 added for sulfide interference)

Technician: BC

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

SAMPLE TURNED YELLOW AFTER REAGENT ADDITION, VIOLET COLOR CAME AFTER 3-4 minutes

SAMPLE HAD TURNED PALE YELLOW W/O ANY ADDED REAGENT

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~NM~~ MS

SAMPLE DATE: 11/13/96

SAMPLE I.D.: 3T24MPDB(S)

FILTERED (circle): (YES) NO (BMW 12,14)

COLOR / ODOR: CLEAR/ MODERATE HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	0751	0754	3.85 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	08753	0804	0.002 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0802	0808	0.2 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	5	0804	0807	3.76 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	0810	0817	2.54 mg/L	DI or (50mg/L)
						1.03 mg/L	(DI) or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	0813	0816	5.7 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	0806	0808	4.3 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	0814	0819	0.020 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 50 ml; Titrate with 1.6 N H_2SO_4; Digit Multiplier = 2; 40 digits

CHEMet Color Tests:

Ammonia	1	ppm
CO_2	110	ppm

(0 mL A-1910 added for sulfide interference)

Technician: BC

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~VA~~ MS

SAMPLE DATE: 11/11/96

SAMPLE I.D.: SIZ4MPE

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR/MODERATE HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L		~~1028~~		mg/L	sample
			10	1034	1037	2.96 mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1040	1052	0.003 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1048	1054	0.9 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	10	1050	1053	3.04 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1102	1108	3.78 mg/L	DI or 50mg/L
						3.03 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1104	1106	7.4 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1058	1100	2.9 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1106	1111	0.032 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 20 ml Digit Multiplier = 5 | 13 digits

Titrate with 1.6 N H_2SO_4

CHEMet Color Tests:

Ammonia	8	ppm
CO_2 (0 mL A-1910 added for sulfide interference)	100	ppm

Technician: BL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~VA~~ MS

SAMPLE DATE: 11/11/96

SAMPLE I.D.: STAMPE DUPLICATE

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / MODERATE HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L				mg/L	sample
			10	1034	1037	2.80 mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L				mg/L	sample
			1	1040	1052	0.004 mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1048	1054	0.7 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	10	1050	1053	2.96 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1102	1107	3.95 mg/L	DI or (50mg/L)
						3.03 mg/L	(DI) or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1104	1106	7.0 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1058	1100	3.1 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1106	1111	0.033 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 20 ml; Titrate with 0.16 N H_2SO_4; Digit Multiplier = 0.5; 123 digits

CHEMet Color Tests:

Ammonia	8	ppm
CO_2 (6 mL A-1910 added for sulfide interference)	110	ppm

Technician: BC

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~MN~~ MS

SAMPLE DATE: 11/12/96

SAMPLE I.D.: SB4 MPF

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / WEAK HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	0900	0903	2.60 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0902	0914	0.003 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0911	0917	0.8 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	5	0913	0916	2.53 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	0922	0927	-0.32 mg/L	DI or (50) mg/L
						1.78 mg/L	(DI) or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	0924	0926	5.3 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	0917	0919	2.8 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	0925	0930	0.021 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 20 — Titrate with 1.6 N H_2SO_4 — Digit Multiplier = 5 — 9 digits

CHEMet Color Tests:

Ammonia	0.6	ppm
CO_2 (0 mL A-1910 added for sulfide interference)	120	ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~VA~~ MS

SAMPLE DATE: 11/11/96

SAMPLE I.D.: S124MPG

FILTERED (circle): (YES) NO

COLOR / ODOR:

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1533	1536	0.12 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1535	1545	0.002 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1540	1546	2.2 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1543	1546	0.12 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1549	1554	-0.27 mg/L	DI or 50mg/L
						0.38 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1551	1553	4.6 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1547	1550	0.3 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1552	1557	0.010 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 100ml Digit Multiplier = 0.1 25 digits

Titrate with 0.16 N H_2SO_4

CHEMet Color Tests:

Ammonia 0 ppm

CO_2 (0 mL A-1910 added for sulfide interference) 100 ppm

Technician: BL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~VA~~ MS

SAMPLE DATE: 11/19/96

SAMPLE I.D.: S124MPHS

FILTERED (circle): (YES) NO

COLOR / ODOR: MODERATE HYDROCARBON ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	10	1017	1020	2.55 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1014	1024	0.003 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1020	1026	0.7 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	10	1022	1025	2.60 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1032	1037	-0.97 mg/L	DI or 50mg/L
						1.41 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1036	1038	5.4 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1029	1031	2.9 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1039	1044	0.022 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 50ml

Titrate with 1.6 N H_2SO_4

Digit Multiplier = 2 → 54 digits

CHEMet Color Tests:

Ammonia: 2 ppm

CO_2 (0 mL A-1910 added for sulfide interference): 160 ppm

Technician: BL

[a/] Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, MS

SAMPLE DATE: 11/12/96

SAMPLE I.D.: STAMPI

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1033	1036	0.10	mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1037	1047	0.003	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1043	1049	1.9	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1045	1048	0.13	mg/L	sample
							mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1100	1106	0.27	mg/L	DI or (50) mg/L
						0.92	mg/L	(DI) or 50 mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1103	1106	6.5	mg/L	DI
							mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1053	1055	0.0	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1105	1110	0.021	mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 20 — Titrate with 0.16 N H_2SO_4 — Digit Multiplier = 0.5 — 16 digits

CHEMet Color Tests:

Ammonia: 0 ppm

CO_2: 70 ppm (0 mL A-1910 added for sulfide interference)

Technician: BC

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~MA~~ MS

SAMPLE DATE: 11/12/96

SAMPLE I.D.: STA 4 MPT DUPLICATE

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1033	1036	0.10 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1037	1047	0.002 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1043	1049	1.7 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1045	1048	0.13 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1100	1106	-0.3a mg/L	DI or (50)mg/L
						1.03 mg/L	(DI) or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1103	1106	6.6 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1055	1053	0.1 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1105	11405	1110	0.030 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 20 Digit Multiplier = 0.5 19 digits

Titrate with 0.16 N H_2SO_4

CHEMet Color Tests:

Ammonia 0 ppm

CO_2 (0 mL A-1910 added for sulfide interference) 20 ppm

Technician: BC

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, MISSISSIPPI

SAMPLE DATE: 11/18/96

SAMPLE I.D.: ST24 - MPJ

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1020	1023	0.06	mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1022	1032	0.002	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1028	1034	1.3	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1030	1033	0.07	mg/L	sample
							mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1037	1042	0.85	mg/L	DI or 50mg/L
						0.84	mg/L	DI or 50mg/L
Manganese	52.13.1	0 - 20.0 mg/L	1	1034	1036	0.0	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1040	1045	0.016	mg/L	DI
							mg/L	DI

chloride — 1039 — 1041 — 5.0

HACH Titrations:

Alkalinity — Sample Size = 20 / 0.16N — DM = 0.5 — 25 digits

~~Chloride — Sample Size =~~ ~~digits~~

CHEMet Color Tests:

Ammonia — 0 ppm

CO_2 — (0 mL A-1910 added for sulfide interference) — 70 ppm

Technician: BC

[a/] Sulfate and sulfide blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~WA~~ MS

SAMPLE DATE: 11/10/96

SAMPLE I.D.: S124MPKS

FILTERED (circle): (YES) NO

COLOR / ODOR: ~~AG~~ CLEAR NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading	Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	1529	1532	0.07 mg/L	sample
						mg/L	sample
						mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	1530	1540	0.003 mg/L	sample
						mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	1536	1542	0.7 mg/L	sample
						mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	1539	1542	0.10 mg/L	sample
						mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	1546	1551	0.16 mg/L	DI or (50mg/L)
						0.65 mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	1548	1550	2.7 mg/L	DI
						mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	1542	1544	0.0 mg/L	sample
						mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	1549	1554	0.012 mg/L	DI
						mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 100 ml; Titrate with 1.6 N H_2SO_4

Digit Multiplier = 1.0; 28 digits (ABOUT 8)

CHEMet Color Tests:

Ammonia	0	ppm
CO_2 (0 mL A-1910 added for sulfide interference)	70	ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~VA~~ MS

SAMPLE DATE: 11/11/96

SAMPLE I.D.: STAMPICD

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / NO ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	1	0841	0844	0.12	mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0843	0853	0.002	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0849	0855	1.7	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	1	0851	0854	0.14	mg/L	sample
							mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	0858	0904	-1.13	mg/L	DI or (50mg/L)
						0.86	mg/L	(DI) or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	0901	0903	3.0	mg/L	DI
							mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	0856	0858	0.1	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	0902	0907	0.011	mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity Sample Size = 50ml

Titrate with 0.16 N H_2SO_4

Digit Multiplier = 0.2 → 25 digits

CHEMet Color Tests:

Ammonia	0	ppm
CO_2 (0 mL A-1910 added for sulfide interference)	30	ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~VA~~ MS

SAMPLE DATE: 11/18/96

SAMPLE I.D.: 5724 MPL (W76 REPLACEMENT)

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / STRONG ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	0929	0932	1.73	mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0931	0942	0.002	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0936	0944	0.5	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	5	0940	0943	1.72	mg/L	sample
							mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	0953	0958	2.54	mg/L	DI or 50mg/L
						1.69	mg/L	DI or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	0955	0957	5.0	mg/L	DI
							mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	0947	0949	2.0	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	0956	1001	0.009	mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 20 — Digit Multiplier = 5 — 7 digits

Titrate with 1.6 N H_2SO_4

CHEMet Color Tests:

Ammonia: 0.6 ppm

CO_2 (0 mL A-1910 added for sulfide interference): 160 ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

21D

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, MISSISSIPPI

SAMPLE DATE: 11/18/96

SAMPLE I.D.: STA4 MPL DUPLICATE

FILTERED (circle): (YES) NO

COLOR / ODOR: CLEAR / STRONG ODOR

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Time Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	0929	0932	1.53	mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0931	0942	0.002	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0938	0944	0.5	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	5	0940	0943	1.70	mg/L	sample
						1.44	mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	0953	0958	~~5.2~~	mg/L	DI or 50mg/L
						0.60	mg/L	DI or 50mg/L
Manganese	52.13.1	0 - 20.0 mg/L	1	0947	0949	2.2	mg/L	sample
							mg/L	sample
Sulfide	61.12.1.	0 - 0.600 mg/L	1	0956	1001	0.009	mg/L	DI
							mg/L	DI
Chloride			1	0955	0957	5.2		

HACH Titrations:

Alkalinity — Sample Size = 100 / 1.6 N — DM = 1 — 42 digits

~~Chloride — Sample Size =~~ ~~digits~~

CHEMet Color Tests:

Ammonia — 0.6 ppm

CO_2 — (0 mL A-1910 added for sulfide interference) — 150 ppm

Technician: BL

[a/] Sulfate and sulfide blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

[b/] Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

ON-SITE MEASUREMENTS
HACH AND CHEMets ANALYSES
COLUMBUS AIR FORCE BASE, ~~VA~~ MS

SAMPLE DATE: 11/6/96

SAMPLE I.D.: S124 MPM

FILTERED (circle): (YES) NO

Direct Meter Measurements:

Temp		°C/°F (circle)
pH		SU
Conductivity		µS/cm
Dissolved Oxygen		mg/L
Redox Potential		mV

COLOR / ODOR: CLEAR / STRONG HYDROCARBON ODOR

HACH DR/700 Measurements:

Analyte	Program	Range	Dilution	Reagent Mixed	Time Measured	Reading		Blank[a/,b/]
Ferrous	50.01.1	0 - 5.10 mg/L	5	0754	0757	3.11	mg/L	sample
							mg/L	sample
							mg/L	sample
Nitrite	50.08.1	0 - 0.350 mg/L	1	0756	0807	0.003	mg/L	sample
							mg/L	sample
Nitrate	50.05.1	0 - 30.0 mg/L	1	0804	0810	0.4	mg/L	sample
							mg/L	sample
Total Iron	50.03.1	0 - 5.10 mg/L	5	0805	0809	3.07	mg/L	sample
						3.04	mg/L	sample
Sulfate	45.000	0 - 100 mg/L	1	0817	0823	[illegible]	mg/L	DI or 50mg/L
						2.29	mg/L	(DI) or 50mg/L
Chloride	45.02.1	0 - 20.0 mg/L	1	0820	0822	6.4	mg/L	DI
							mg/L	DI
Manganese	52.13.1	0 - 20.0 mg/L	1	0814	0817	1.1	mg/L	sample
							mg/L	sample
Sulfide	61.12.1	0 - 0.600 mg/L	1	0821	0827	0.019	mg/L	DI
							mg/L	DI

HACH Titrations:

Alkalinity — Sample Size = 20ml; Titrate with 1.6 N H_2SO_4; Digit Multiplier = 5; 11 digits

CHEMet Color Tests:

Ammonia	1	ppm
CO_2 (0 mL A-1910 added for sulfide interference)	140	ppm

Technician: BL

a/ Sulfate, sulfide, and chloride blanks contain respective reagents;
Ferrous iron, total iron, nitrate, nitrite, and manganese blanks are without reagents.

b/ Ferrous, total iron and manganese blanks should be diluted accordingly if samples are diluted.

APPENDIX A-4

SLUG TEST RESULTS

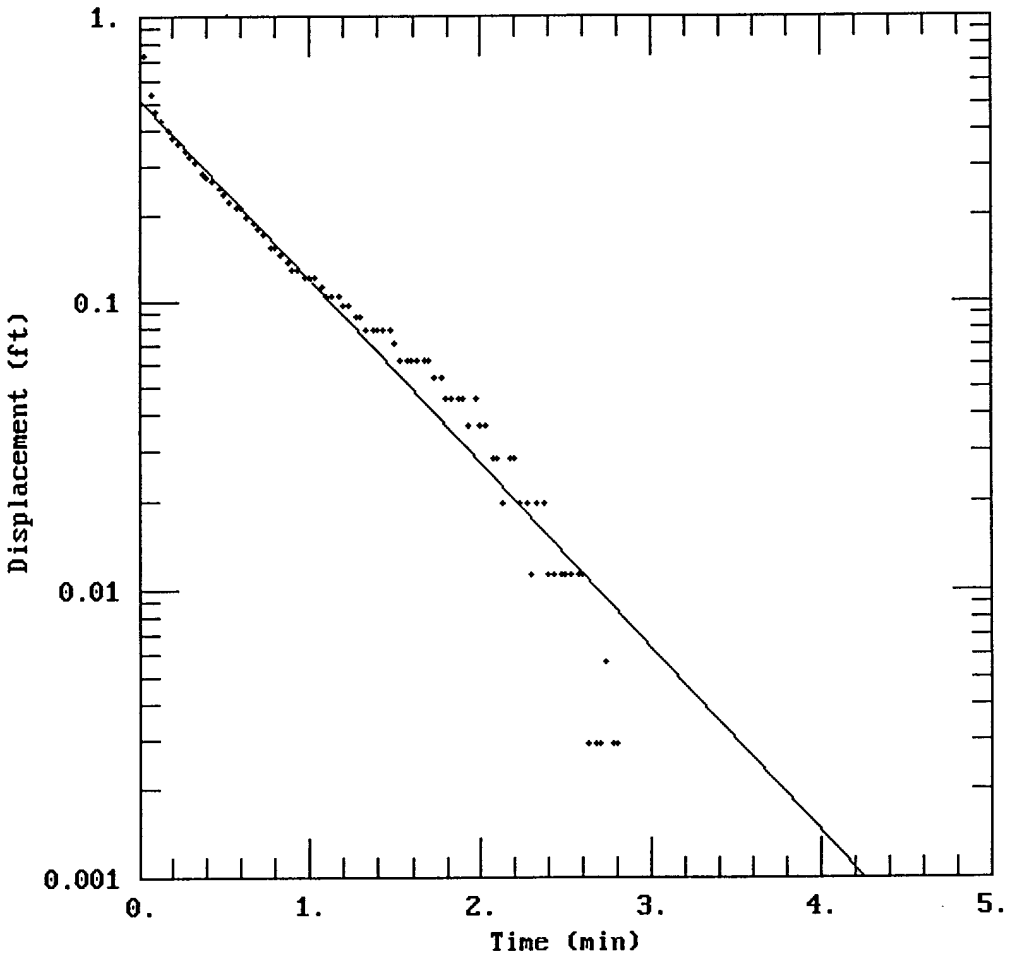
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 74 Falling Head Test 1



DATA SET:
W7424F1.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.735 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 9.09 ft

PARAMETER ESTIMATES:
K = 0.01828 ft/min
y0 = 0.5094 ft

AQTESOLV

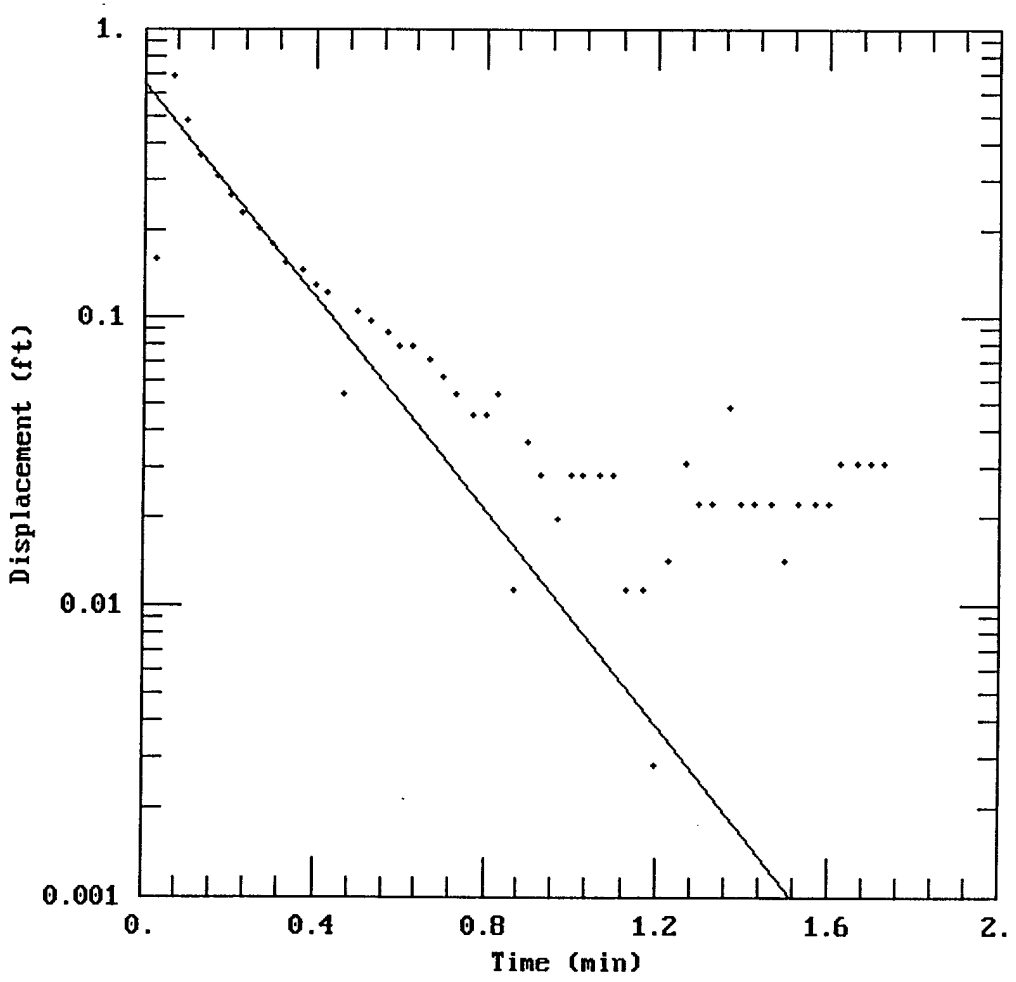
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 74 Rising Head Test 1



DATA SET:
W7424R1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.191 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 9.09 ft

PARAMETER ESTIMATES:
K = 0.05301 ft/min
y0 = 0.6416 ft

AQTESOLV

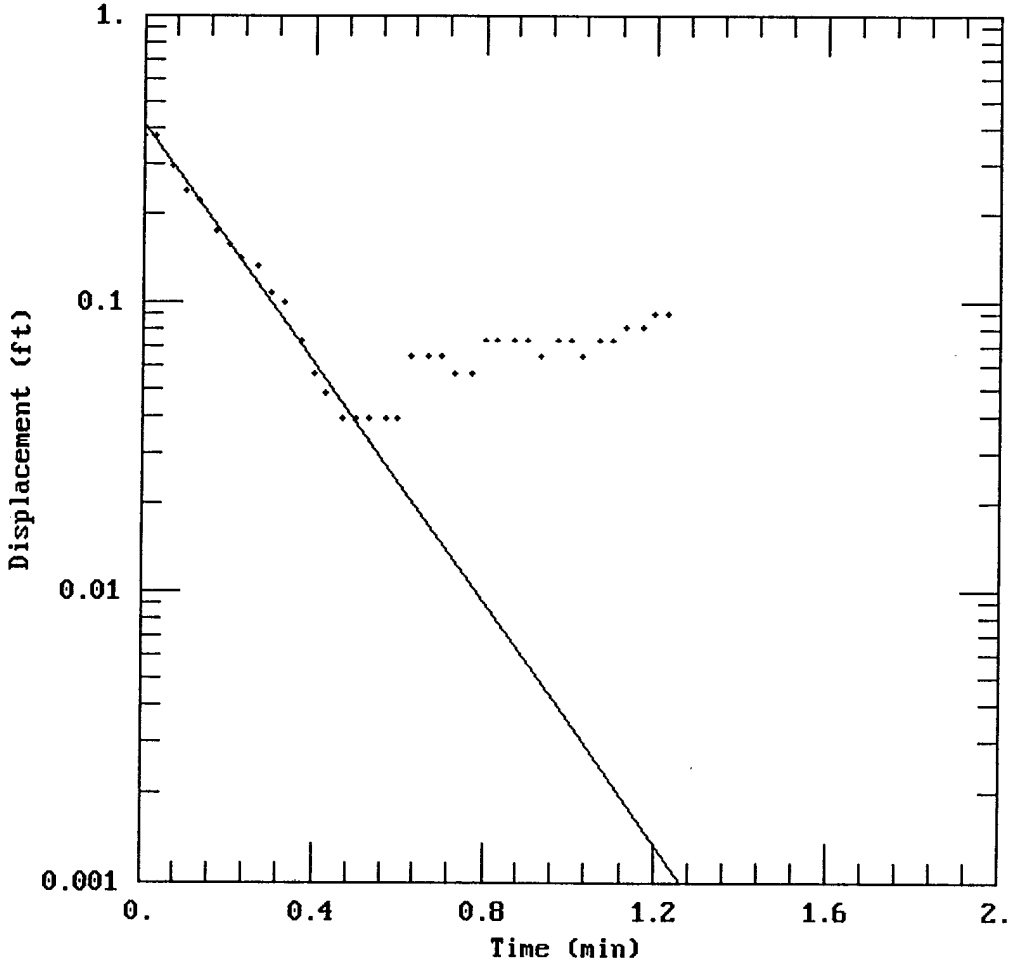
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 74 Falling Head Test 2



DATA SET:
W7424F2.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.377 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 9.09 ft

PARAMETER ESTIMATES:
K = 0.05947 ft/min
y0 = 0.4138 ft

AQTESOLV

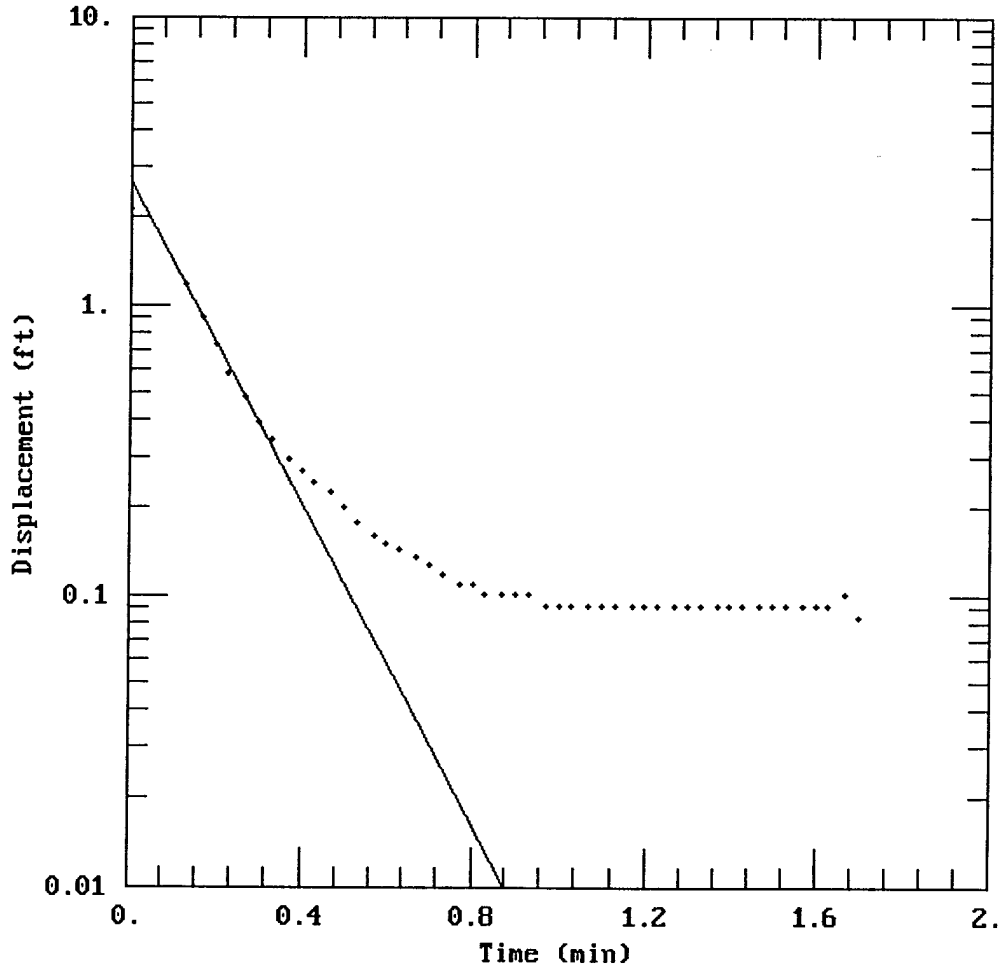
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 69 Falling Head Test 1



DATA SET:
W6924I1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 2.13 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 5.52 ft

PARAMETER ESTIMATES:
K = 0.06832 ft/min
y0 = 2.647 ft

AQTESOLV

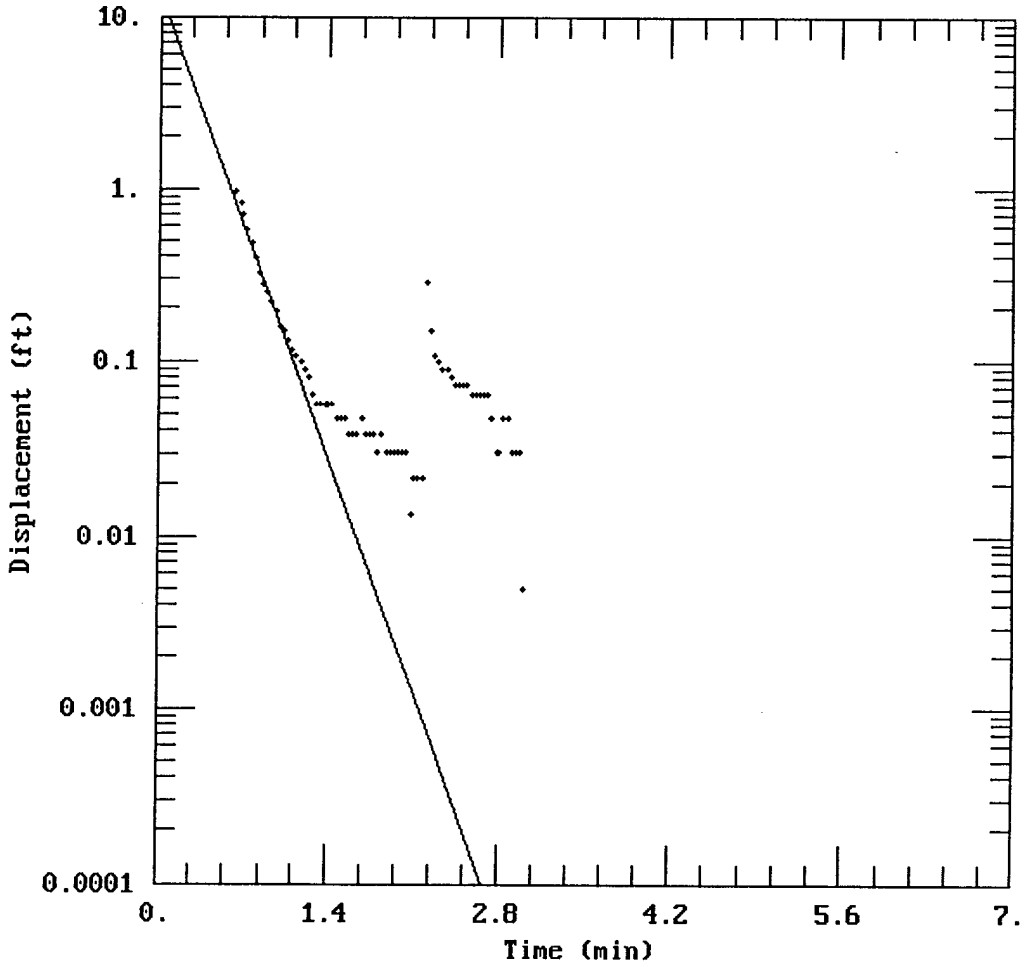
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 69 Falling Head Test 2



DATA SET:
W6924F2.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.9584 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 5.52 ft

PARAMETER ESTIMATES:
K = 0.04766 ft/min
y0 = 14.11 ft

AQTESOLV

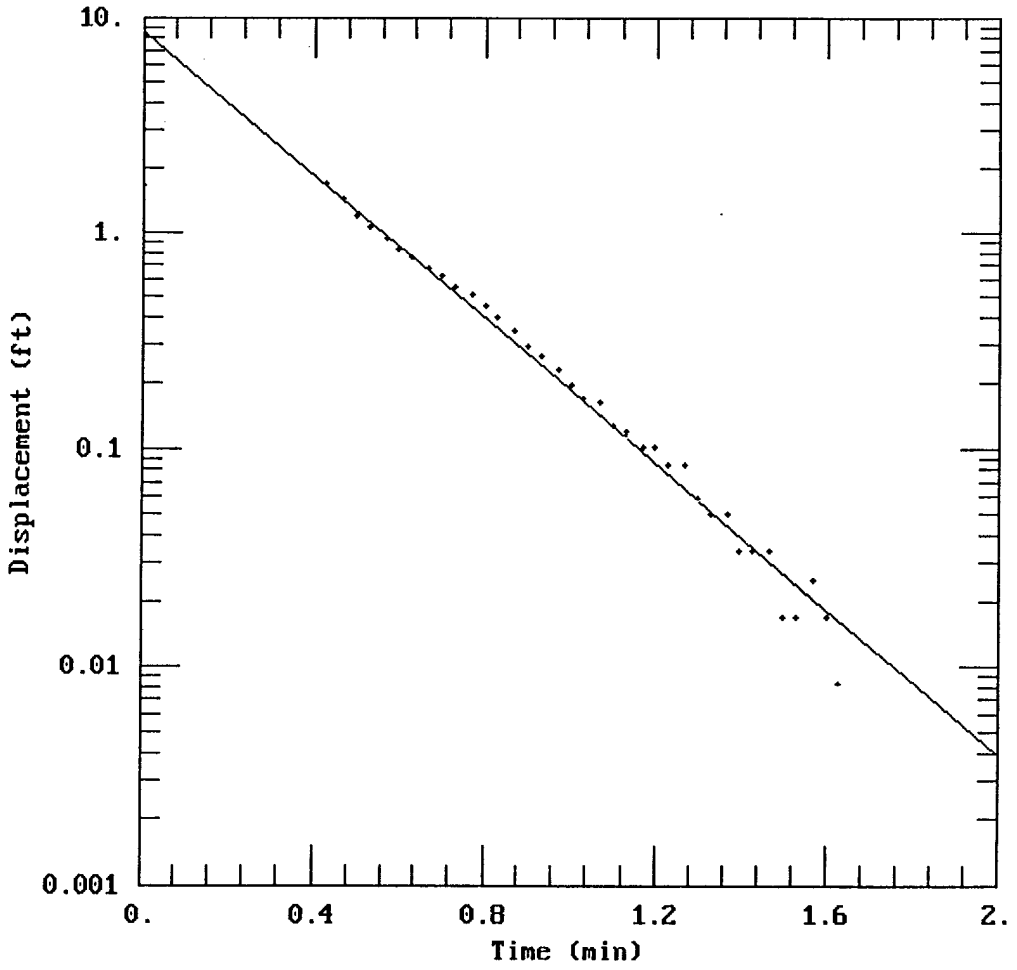
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 69 Rising Head Test 1



DATA SET:
W6924R1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.682 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 5.52 ft

PARAMETER ESTIMATES:
K = 0.04134 ft/min
y0 = 8.495 ft

AQTESOLV

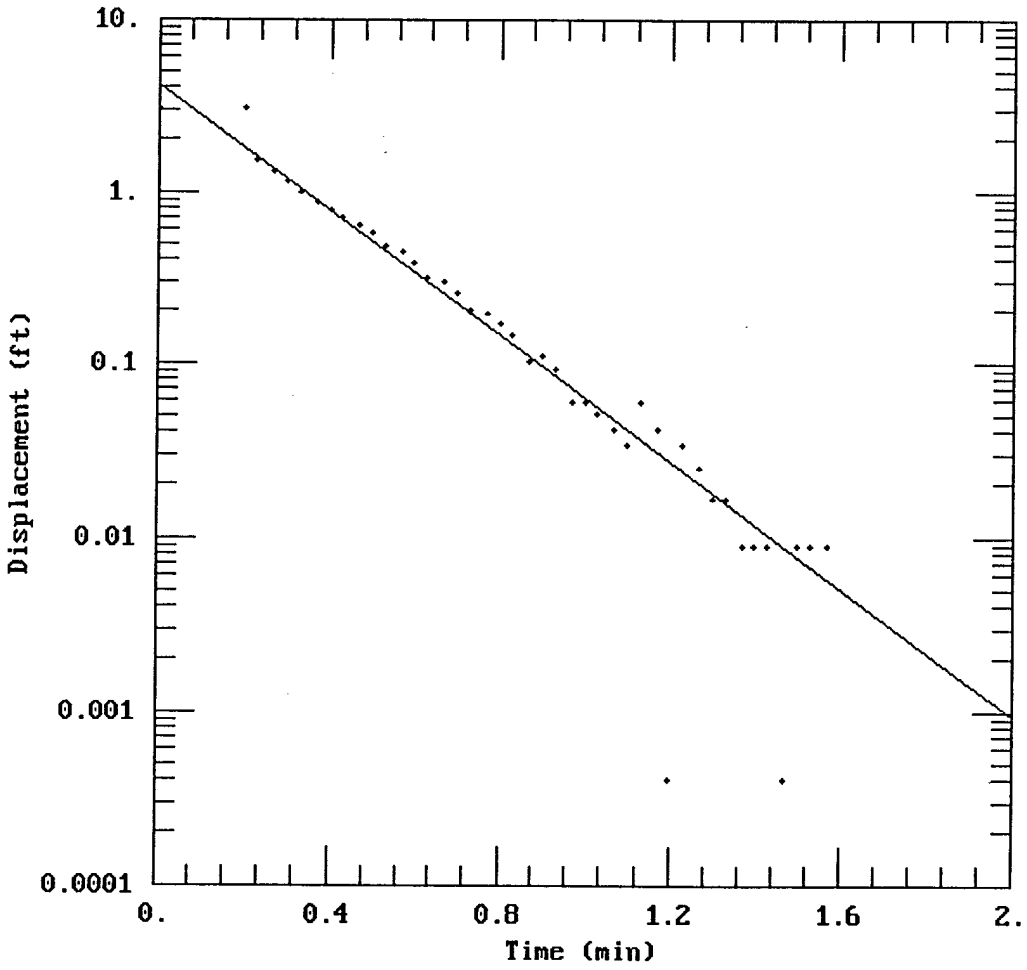
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 69 Rising Head Test 2



DATA SET:
W6924R2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 3.025 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 5.52 ft

PARAMETER ESTIMATES:
K = 0.04513 ft/min
y0 = 4.138 ft

AQTESOLV

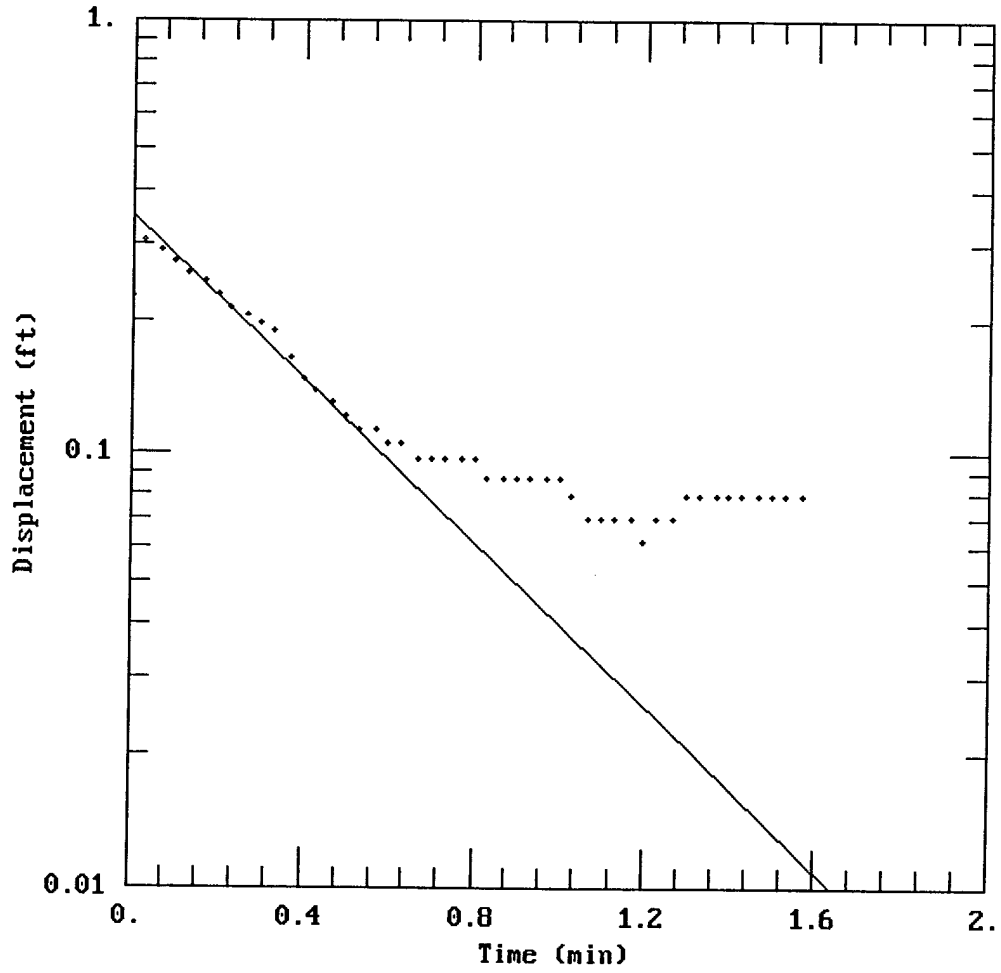
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 68 Falling Head Test 1



DATA SET:
W68241I.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.2279 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 7.75 ft

PARAMETER ESTIMATES:
K = 0.0258 ft/min
y0 = 0.3491 ft

AQTESOLV

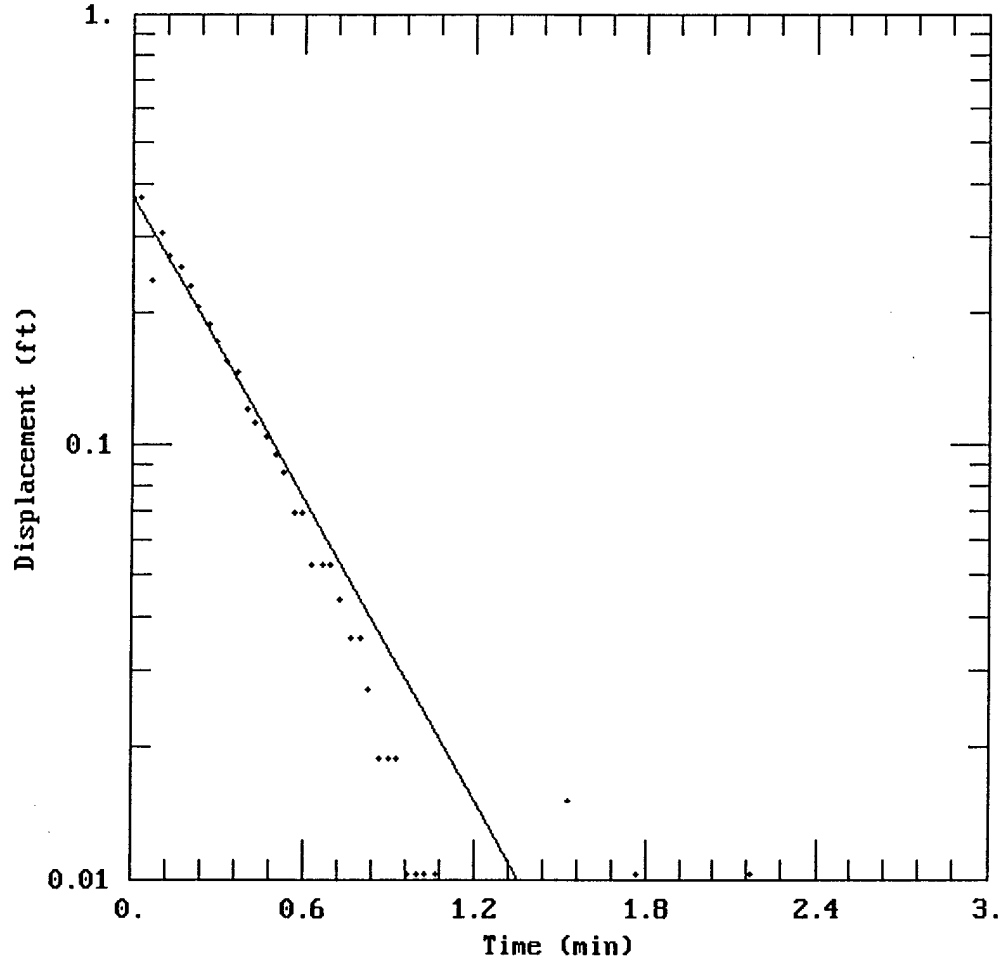
CLIENT [redacted]EE

[redacted]MPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 68 Falling Head Test 2



DATA SET:
W68241.2.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.3718 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 7.75 ft

PARAMETER ESTIMATES:
K = 0.03183 ft/min
y0 = 0.3711 ft

AQTESOLV

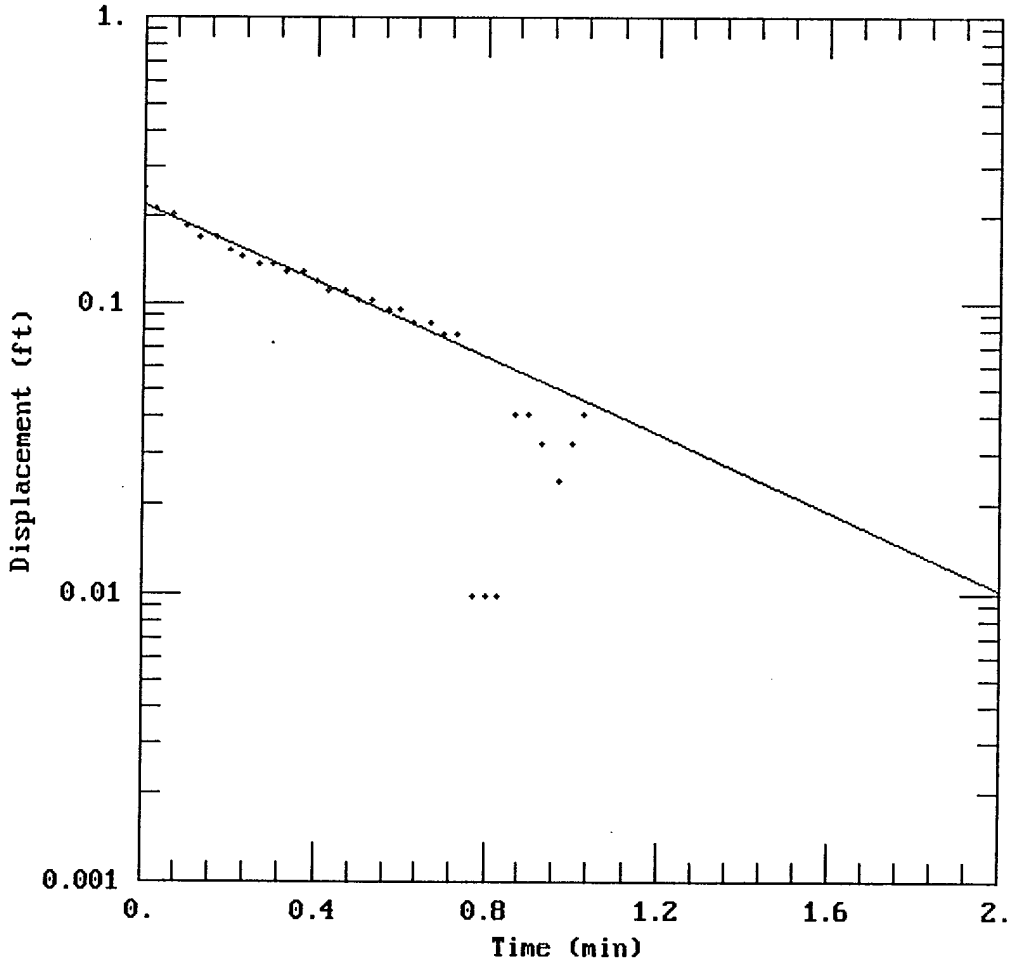
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 68 Rising Head Test 2



DATA SET:
W6824R2.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.253 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 7.75 ft

PARAMETER ESTIMATES:
K = 0.01832 ft/min
y0 = 0.2219 ft

AQTESOLV

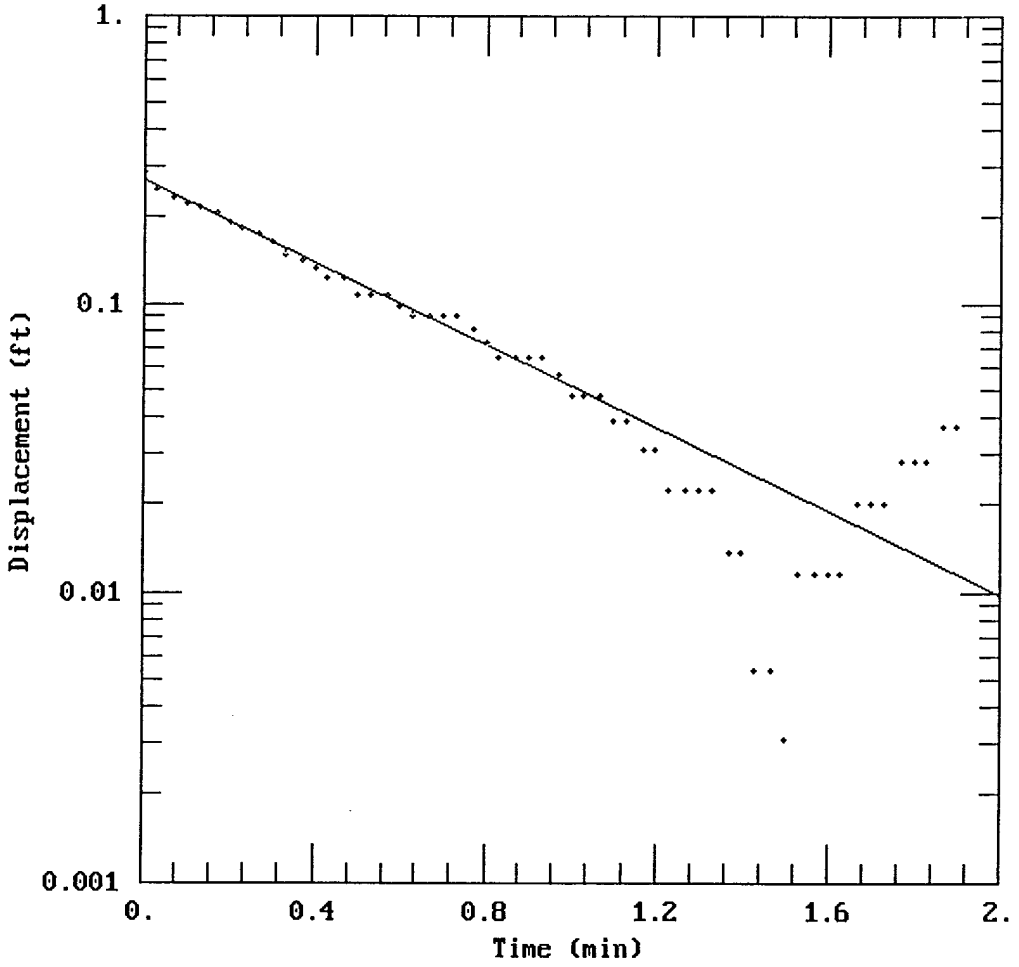
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 68 Rising Head Test 1



DATA SET:
W6824R1.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.287 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 7.75 ft

PARAMETER ESTIMATES:
K = 0.01971 ft/min
y0 = 0.268 ft

AQTESOLV

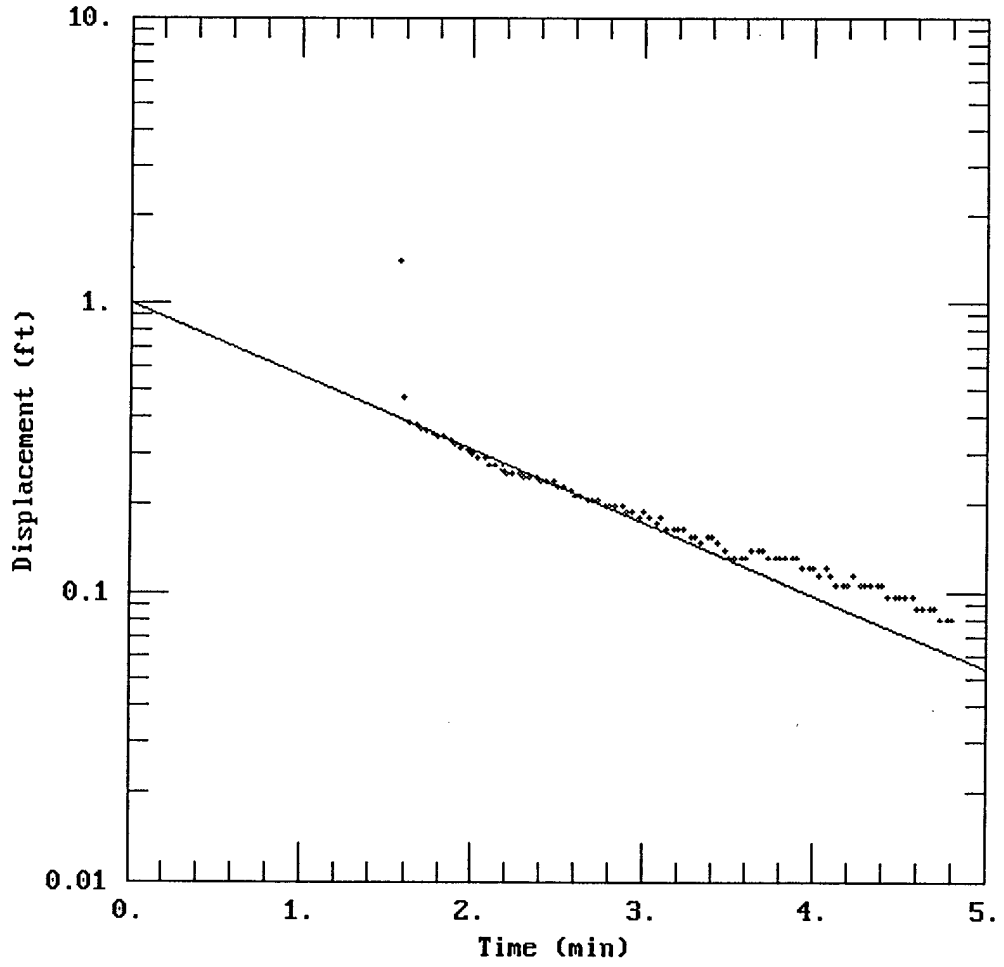
CLIENT [redacted]EE

[redacted]MPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 77 Falling Head Test 1



DATA SET:
W7724I1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.301 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 4.59 ft

PARAMETER ESTIMATES:
K = 0.005886 ft/min
y0 = 0.9942 ft

AQTESOLV

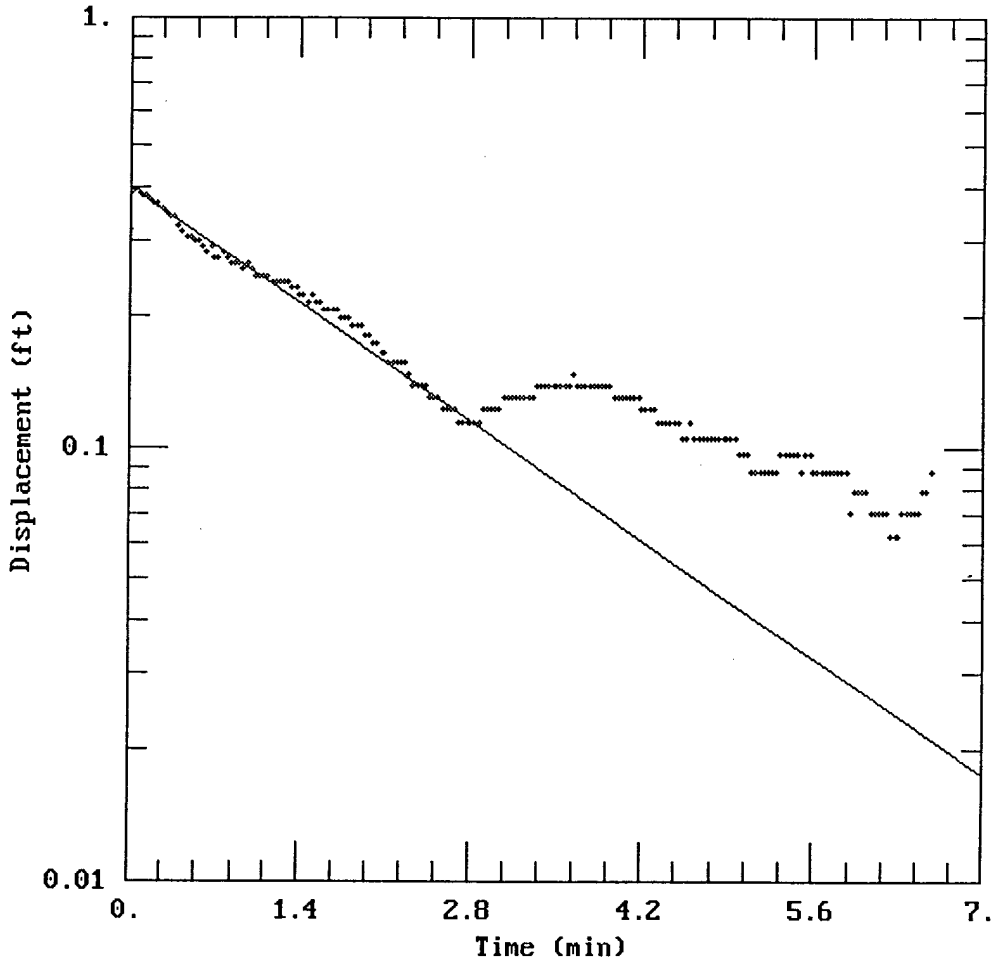
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 77 Falling Head Test 2



DATA SET:
W772412.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.32 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 4.59 ft

PARAMETER ESTIMATES:
K = 0.004493 ft/min
y0 = 0.4003 ft

AQTESOLV

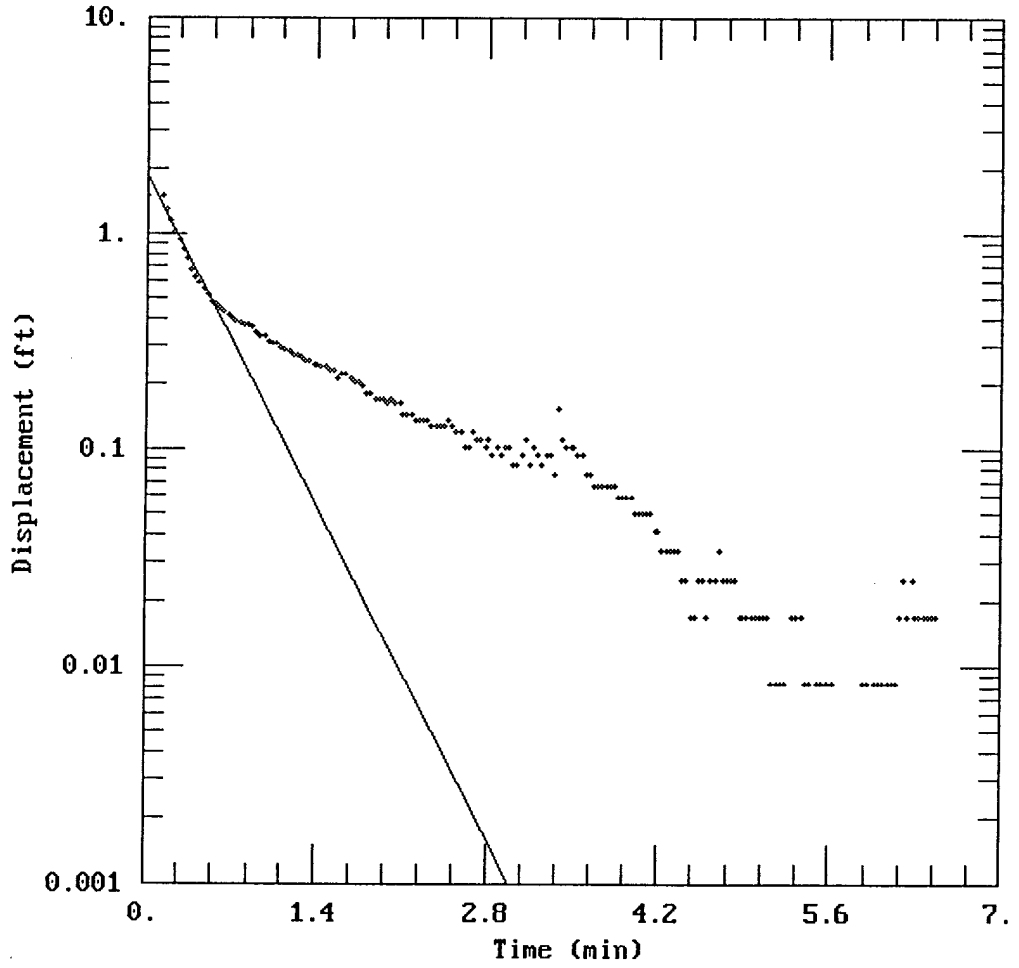
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 77 Rising Head Test 1



DATA SET:
W7724R1.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.496 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 4.59 ft

PARAMETER ESTIMATES:
K = 0.02546 ft/min
y0 = 1.863 ft

AQTESOLV

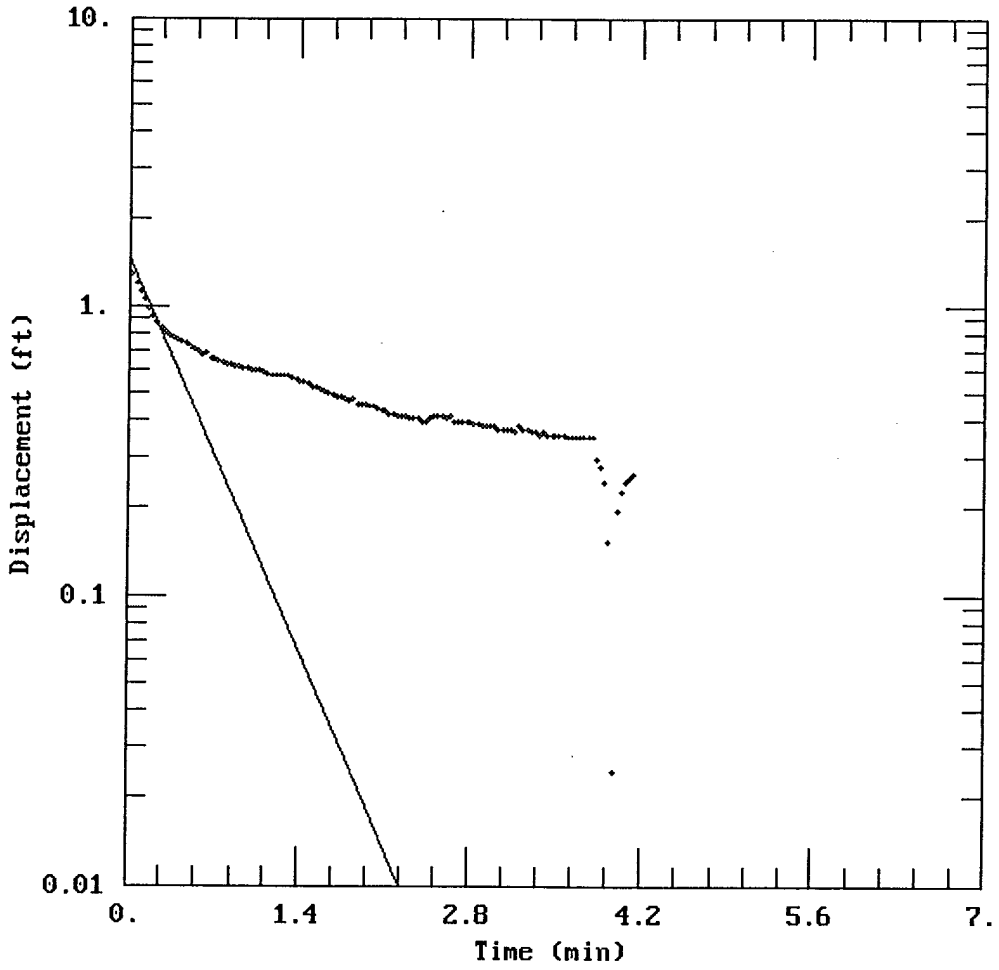
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 77 Rising Head Test 2



DATA SET:
W7724R2.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 1.428 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 4.59 ft

PARAMETER ESTIMATES:
K = 0.02241 ft/min
y0 = 1.464 ft

AQTESOLV

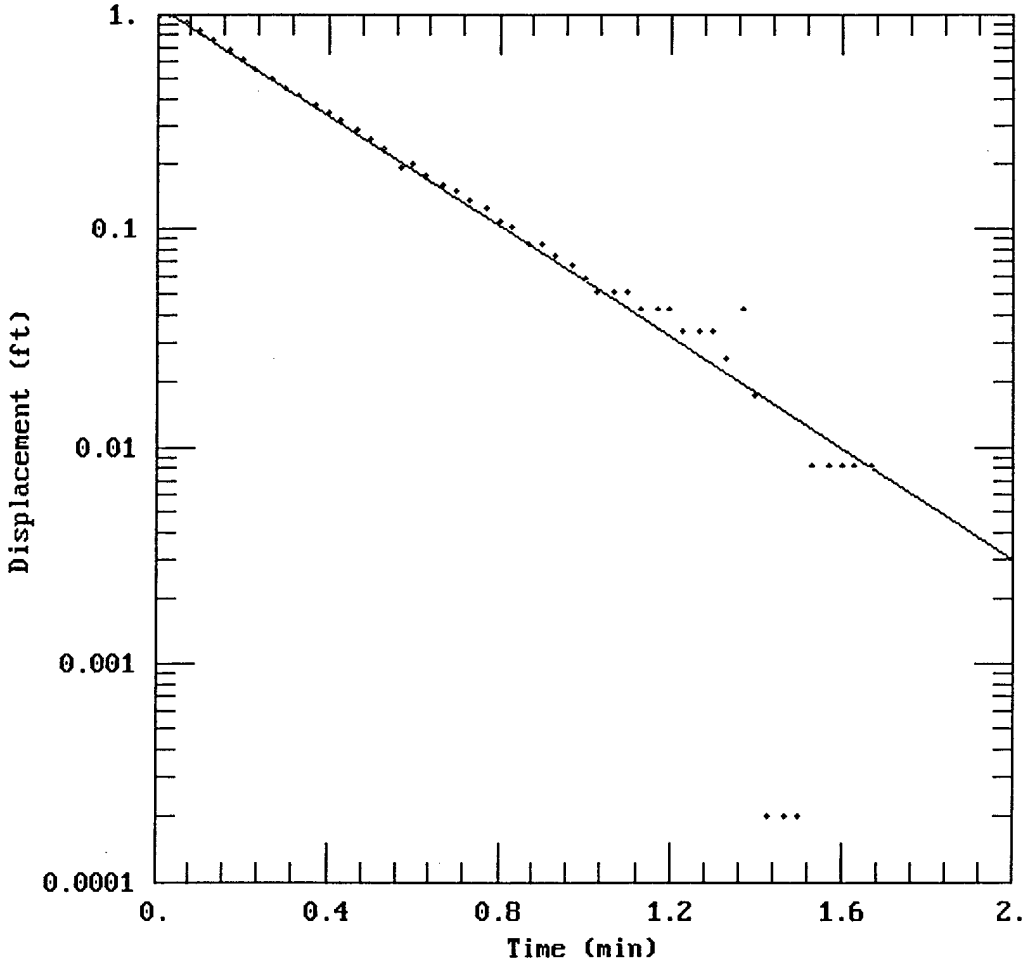
CLIENT [redacted]EE

[redacted]MPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 70 Falling Head Test 2



DATA SET:
W702412.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.972 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 5.13 ft

PARAMETER ESTIMATES:
K = 0.031 ft/min
y0 = 1.11 ft

AQTESOLV

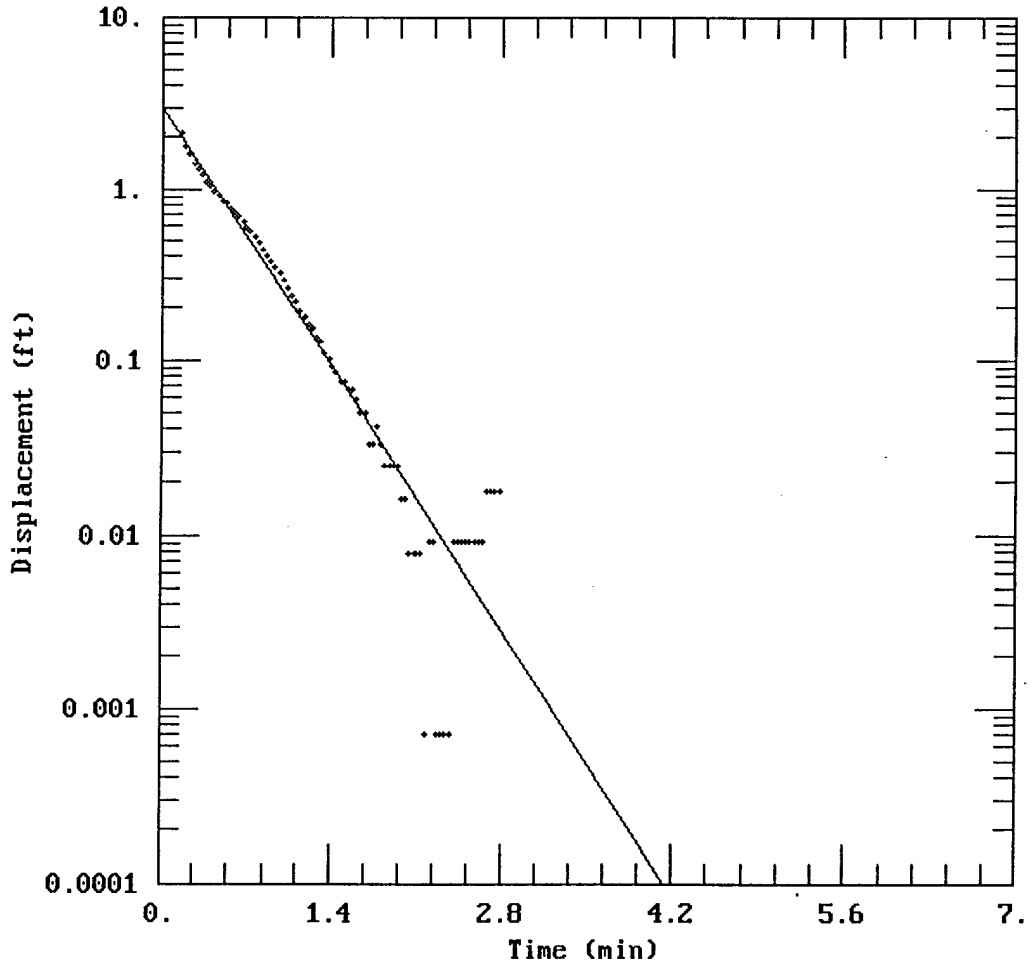
CLIENT: [redacted]CEE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 70 Rising Head Test 1



DATA SET:
W7024R1.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 2.13 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 5.13 ft

PARAMETER ESTIMATES:
K = 0.02613 ft/min
y0 = 2.951 ft

AQTESOLV

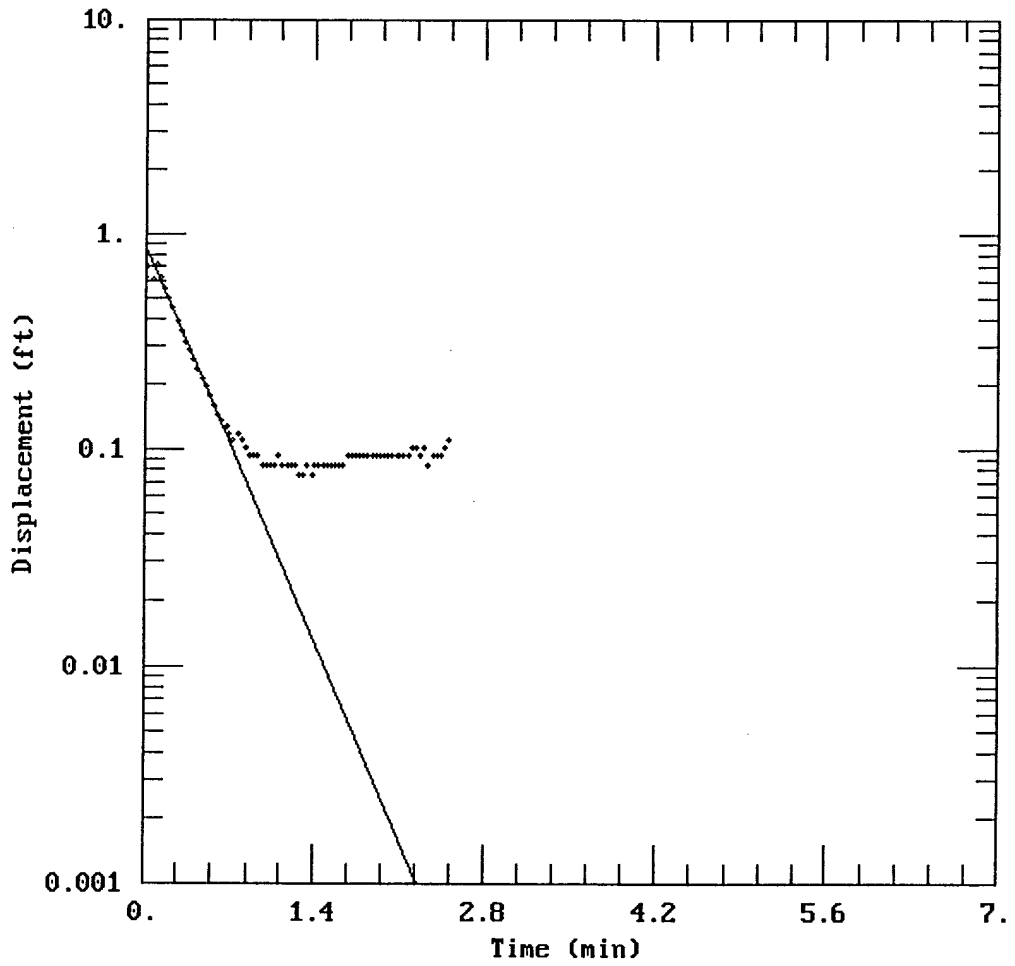
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 70 Falling Head Test 1



DATA SET:
W7024I1.AQT
03/03/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.619 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 5.13 ft

PARAMETER ESTIMATES:
K = 0.03148 ft/min
y0 = 0.8754 ft

AQTESOLV

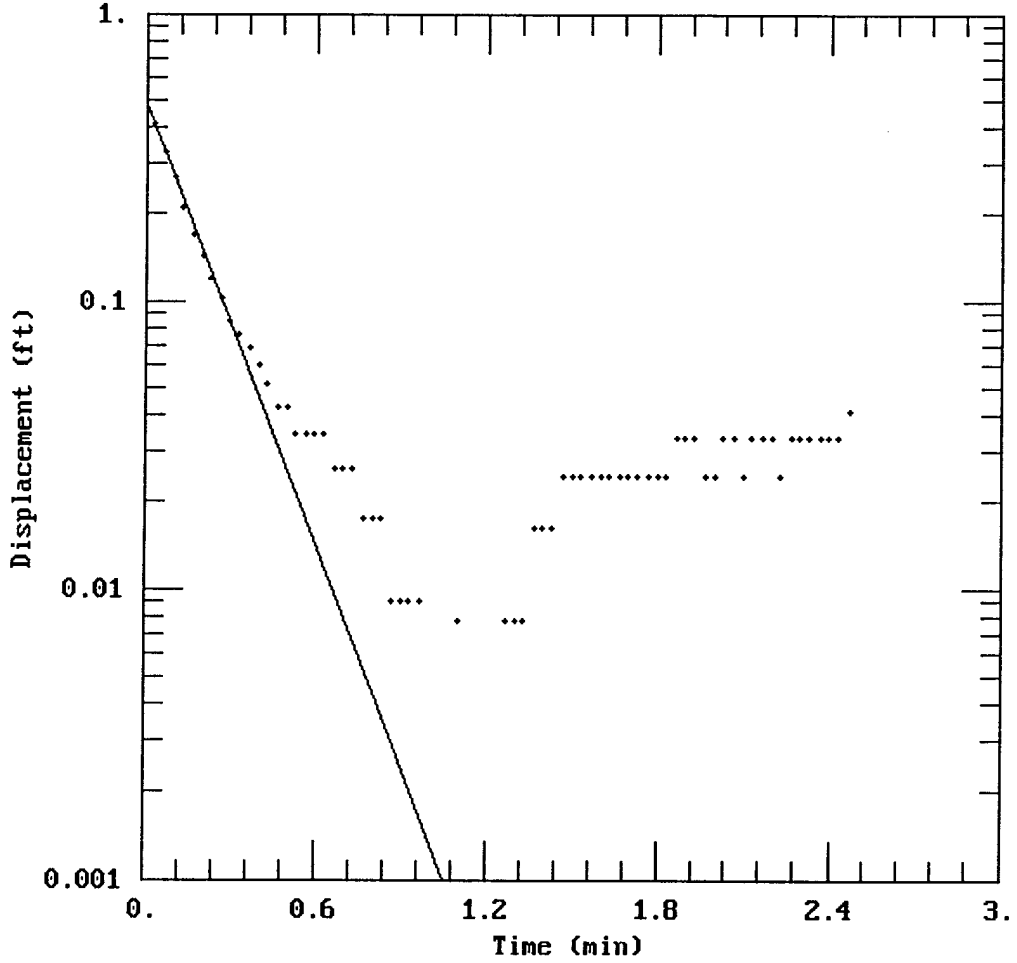
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 71 Rising Head Test 2



DATA SET:
W7124R2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.457 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 3.95 ft

PARAMETER ESTIMATES:
K = 0.05546 ft/min
y0 = 0.4813 ft

AQTESOLV

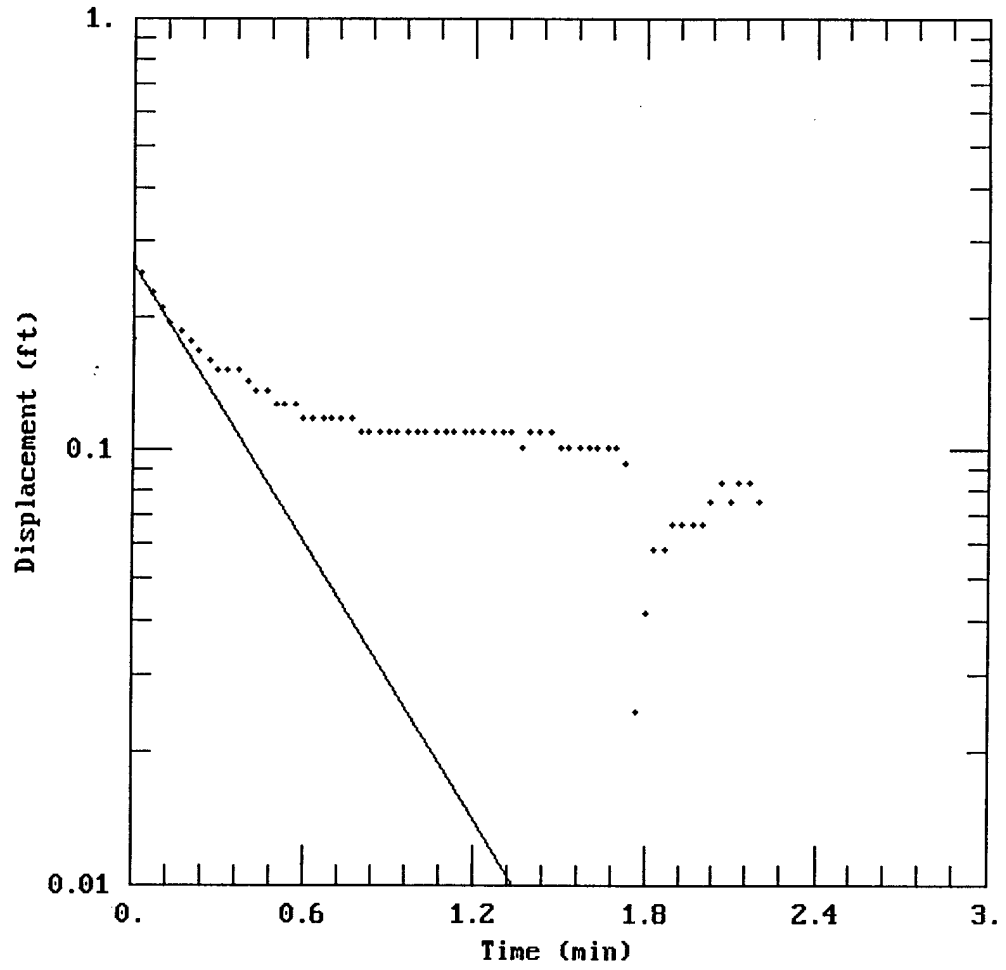
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 71 Falling Head Test 2



DATA SET:
W7124I2.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.1774 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 3.95 ft

PARAMETER ESTIMATES:
K = 0.02313 ft/min
y0 = 0.2642 ft

AQTESOLV

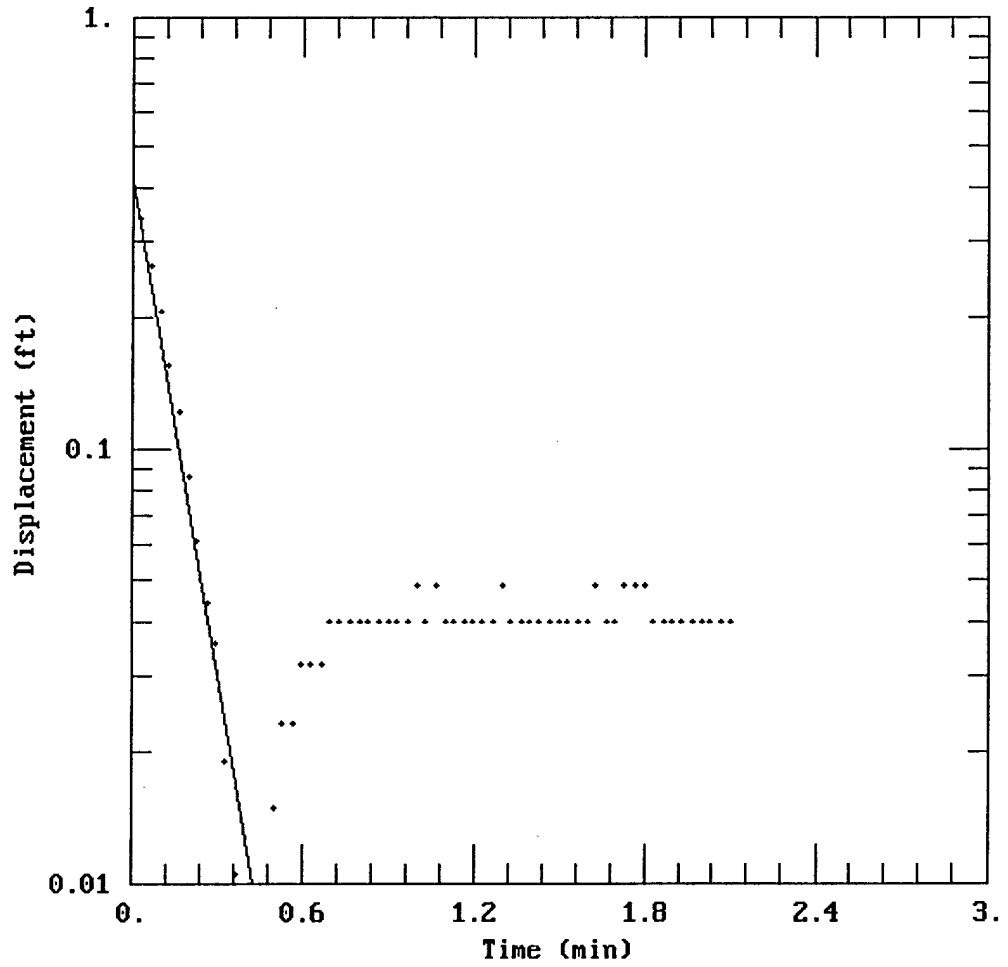
CLIENT: [redacted]EE

COMPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 71 Rising Head Test 1



DATA SET:
W7124R1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.38 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 3.95 ft

PARAMETER ESTIMATES:
K = 0.08196 ft/min
y0 = 0.4157 ft

AQTESOLV

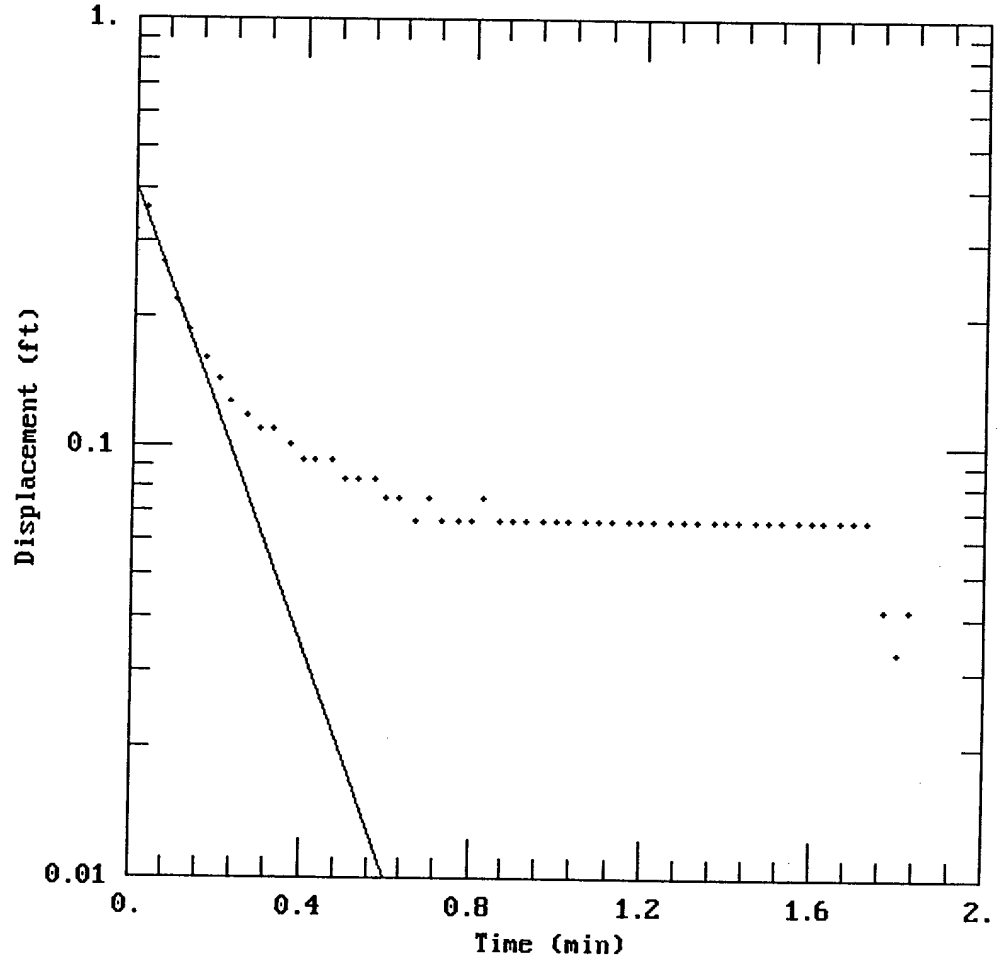
CLIENT: [redacted]EE

[redacted]MPANY: Parsons E.S.

LOCATION: Columbus AFB, Mississippi

PROJECT: 729691.32050

Well 71 Falling Head Test 1



DATA SET:
W7124I1.AQT
03/07/97

AQUIFER MODEL:
Unconfined

SOLUTION METHOD:
Bouwer-Rice

TEST DATA:
H0= 0.321 ft
r_c= 0.083 ft
r_w= 0.66 ft
L = 10. ft
b = 40. ft
H = 3.95 ft

PARAMETER ESTIMATES:
K = 0.05847 ft/min
y0 = 0.4105 ft

AQTESOLV

APPENDIX B

SOIL AND GROUNDWATER ANALYTICAL RESULTS

Evergreen Analytical Laboratory

CASE NARRATIVE

Evergreen Analytical Laboratory (EAL) Projects: 96-3990, 96-3996, 96-4004, 96-4020, 96-4033, 96-4047, 96-4058, 96-4064 and 96-4081

Parsons Engineering Science, Inc. (PES) Project: Columbus AFB 729691.32010

Sample Receipt

Soil and groundwater samples were received between November 9 and 19, 1996 from Columbus AFB for analysis under Subcontract 729691.00000. Refer to the check-in portion of the EAL Chain of Custody for specific information regarding the condition of samples upon receipt. Refer to the EAL Work Order Summary for 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 Work Order Summary lists 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 Petroleum Hydrocarbons TVPH, Method SW8015M

All samples were analyzed for BTEX/TVPH within holding time.

Several samples were analyzed at dilutions ranging from a dilution factor of 5 to 200 due to elevated levels of contaminants. The reporting limits have been raised accordingly.

Total Organic Carbon in Soil

Total Organic Carbon (TOC) in soils 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 reports from Huffman are included.

Disk Deliverables

The disk deliverables are included with the hard copy data package. MS/MSD and LCS results are not 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.

Reporting limits have been adjusted to reflect percent moisture in all soil samples or increases due to dilutions.

A hard copy of each spreadsheet from the diskette is included. The name for each spreadsheet is located in the top left corner on the first page of each printout.

Patricia A. McClellan

Patricia A. McClellan, Program Manager
12/6/96

Evergreen Analytical, Inc.

96-3990

WORK ORDER Summary

15-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-3990-01A	ST24-MPC(10'-12')	% Moisture for dry weight calculation		Soil	2	08-Nov-96	11-Nov-96	25-Nov-96	06-Dec-96
96-3990-02B	LF6-MPJ(18')	% Moisture for dry weight calculation			9			25-Nov-96	06-Dec-96
96-3990-03B	ST24-MPF(16-18)	% Moisture for dry weight calculation				07-Nov-96		25-Nov-96	05-Dec-96
96-3990-04A	ST24-MPD(10-12)	% Moisture for dry weight calculation			2			25-Nov-96	05-Dec-96
96-3990-05I	W68	Anions by IC Cl,NO2,NO3,SO4		Groundwater	Cl1	08-Nov-96		25-Nov-96	10-Nov-96
96-3990-06I	W73	Anions by IC Cl,NO2,NO3,SO4						25-Nov-96	10-Nov-96
96-3990-07I	W74	Anions by IC Cl,NO2,NO3,SO4						25-Nov-96	10-Nov-96
96-3990-08I	W72	Anions by IC Cl,NO2,NO3,SO4						25-Nov-96	10-Nov-96
96-3990-01A	ST24-MPC(10'-12')	BTEX (Parsons List)		Soil	2		11-Nov-96	25-Nov-96	22-Nov-96
96-3990-01C	ST24-MPC(10'-12') MS	BTEX (Parsons List) Take from Bottle A			9			25-Nov-96	22-Nov-96
96-3990-01D	ST24-MPC(10'-12') MSD	BTEX (Parsons List) Take from Bottle A						25-Nov-96	22-Nov-96
96-3990-04A	ST24-MPD(10-12)	BTEX (Parsons List)			2	07-Nov-96		25-Nov-96	21-Nov-96
96-3990-05A	W68	BTEX (Parsons List)		Groundwater		08-Nov-96		25-Nov-96	22-Nov-96
96-3990-06A	W73	BTEX (Parsons List)						25-Nov-96	22-Nov-96
96-3990-07A	W74	BTEX (Parsons List)						25-Nov-96	22-Nov-96
96-3990-07M		BTEX (Parsons List)						25-Nov-96	22-Nov-96
96-3990-07N		BTEX (Parsons List)						25-Nov-96	22-Nov-96
96-3990-08A	W72	BTEX (Parsons List)						25-Nov-96	22-Nov-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

Evergreen Analytical, Inc.

96-3990

WORK ORDER Summary

15-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-3990-05J	W68	Methane		Groundwater	2	08-Nov-96	11-Nov-96	25-Nov-96	22-Nov-96
96-3990-06J	W73	Methane						25-Nov-96	22-Nov-96
96-3990-07J	W74	Methane						25-Nov-96	22-Nov-96
96-3990-07K	W74 MS	Methane						25-Nov-96	22-Nov-96
96-3990-07L	W74 MSD	Methane						25-Nov-96	22-Nov-96
96-3990-08J	W72	Methane						25-Nov-96	22-Nov-96
96-3990-01B	ST24-MPC(10'-12')	Purgeable Halocarbons 8010		Soil	9		11-Nov-96	25-Nov-96	22-Nov-96
96-3990-01C	ST24-MPC(10'-12') MS	Purgeable Halocarbons 8010 Take from Bottle A						25-Nov-96	22-Nov-96
96-3990-01D	ST24-MPC(10'-12') MSD	Purgeable Halocarbons 8010 Take from Bottle A						25-Nov-96	22-Nov-96
96-3990-02B	LF6-MPJ(18')	Purgeable Halocarbons 8010						25-Nov-96	22-Nov-96
96-3990-03B	ST24-MPF(16-18)	Purgeable Halocarbons 8010				07-Nov-96		25-Nov-96	21-Nov-96
96-3990-04B	ST24-MPD(10-12)	Purgeable Halocarbons 8010						25-Nov-96	21-Nov-96
96-3990-05F	W68	Purgeable Halocarbons 8010		Groundwater		08-Nov-96		25-Nov-96	22-Nov-96
96-3990-06F	W73	Purgeable Halocarbons 8010						25-Nov-96	22-Nov-96
96-3990-07F	W74	Purgeable Halocarbons 8010						25-Nov-96	22-Nov-96
96-3990-07P	W74 MS	Purgeable Halocarbons 8010						25-Nov-96	22-Nov-96
96-3990-07Q	W74 MSD	Purgeable Halocarbons 8010						25-Nov-96	22-Nov-96
96-3990-08E	W72	Purgeable Halocarbons 8010						25-Nov-96	22-Nov-96
96-3990-02A	LF6-MPJ(18')	Total Organic Carbon		Soil	Cl1			25-Nov-96	15-Nov-96
96-3990-03A	ST24-MPF(16-18)	Total Organic Carbon			2	07-Nov-96		25-Nov-96	14-Nov-96
96-3990-[redacted]	W68	Total Organic Carbon		Groundwater	Cl1	08-Nov-96		25-Nov-96	[redacted]-96

# = S[redacted] list. See sample comments or test information.
HT = Holding Time expiration date

Evergreen Analytical, Inc.

96-3990

WORK ORDER Summary

15-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Phone: (303) 831-8100
FAX: (303) 831-8208

Client Project ID: 729691.32010

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-3990-06E	W73	Total Organic Carbon		Groundwater	Cll	08-Nov-96	11-Nov-96	25-Nov-96	06-Dec-96
96-3990-07E	W74	Total Organic Carbon						25-Nov-96	06-Dec-96
96-3990-01A	ST24-MPC(10'-12')	TRPH		Soil	2			25-Nov-96	06-Dec-96
96-3990-02A	LF6-MPJ(18')	TRPH			Cll			25-Nov-96	06-Dec-96
96-3990-03A	ST24-MPF(16-18)	TRPH			2	07-Nov-96		25-Nov-96	05-Dec-96
96-3990-04A	ST24-MPD(10-12)	TRPH						25-Nov-96	05-Dec-96
96-3990-05A	W68	TVH (Gasoline)		Groundwater		08-Nov-96		25-Nov-96	22-Nov-96
96-3990-06A	W73	TVH (Gasoline)						25-Nov-96	22-Nov-96
96-3990-07A	W74	TVH (Gasoline)						25-Nov-96	22-Nov-96
96-3990-08A	W72	TVH (Gasoline)						25-Nov-96	22-Nov-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Page 1 of 1

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 Suite 900
CITY Denver STATE CO ZIP 80290
PHONE# (303) 831-8100 FAX # (303) 83-8208 FAX RESULTS Y / N

CLIENT CONTACT (print) Jenny Hartfelder
CLIENT PROJ. I.D. 729691-32010
EAL. QUOTE # P.O.# 729691.32010
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ UST
☐ Other (Specify)*
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Jennifer Hartfelder
(print) Jennifer Hartfelder

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	Soil/Solid / Air / Gas	Oil / Sludge / Multi-phase	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)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	TPH	MSMSD	TOC / AIK (6J only)	VOCs 8240B 8260 8010	Anions Cl, NO2, NO3, SO4	Methane GC 404	For Laboratory use only
ST24-MPC(10-12')	11/8/96	1000	2		X								X							X	X	X		X			01 A/B Split Re
LFG-MPJ(18')	11/8/96	1700	2		X															X			X	X			02 A/B Split Re
ST24-MPF(16-18)	11/7/96	0900	2		X															X			X	X			03 A/B Split Req
ST24-MPD(10-12)	11/7/96	1030	2		X								X							X				X			04 A/B Split Re
W68	11/8/96	0820	12	X									X	X									X	X	X	X	05 A→L
W73	11/8/96	1117	12	X									X	X									X	X	X	X	06 A→L
W74	11/8/96	1515	18	X									X	X								X	X	X	X	X	07 A→R
W72	11/8/96	1650	11	X									X	X										X	X	X	08 A→K
Trip Blank													X	X													09 A
Sample Fraction													A,B,C,D							A							Loc 11, 2, CL1
Instructions:			Container										HW							HW							

Trip Blank for 8020/~~8015~~ 8010. All request for 8260 should be 8010.

ST24-MPC(10-12') 1115/1115D for 8010, 8020/~~8015~~ pm ~~Methane~~ 11/12 W74 needs MS/MSD for B 8010 + METHANE

Relinquished by:	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Jennifer Hartfelder	11/8/96 1915						

RUSH Y (N)

Project Revision Notice
New Project Request

Date: 11/11/96 Time: 3:00 Project # 96 3990

Start new project: Y (N)

Reason for revision:

_____ Due Date Modified

_____ Method Revision

_____ Additional analyses requested on original project

_____ Miscellaneous (specify): Analyze trip blank for 8010, 8020/8015 Soils are TRPH 418.1. ST24-MPC (10'-12') needs ms/msd for 8010 + BTEX. W74 needs ms/msd for BTEX, 8010, methane

Description of changes: _____

Client Name: Parsons ES Client Contact: Jenny Hartfelder

EAL Contact: Patty Due Date: 11/25/96

* Only include additional analyses on original project if the project is still open.

cc: JDP___ SWT___ WKH___ MAB___ MSM___
SX.REC X QA/QC X SALES X FILE (orig)

Note: Originator must identify persons to receive the Notice/Request.

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	: MB3111296	Client Project Number	: 729691.32010
Date Prepared	: 11/12/96	Lab Project Number	: 96-3990
Dilution Factor	: 1.0	Matrix	: Water
		Lab File Number	: TVB31111025

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/12/96	U	0.1	mg/L
Benzene	71-43-2	11/12/96	U	0.4	ug/L
Toluene	108-88-3	11/12/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/12/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/12/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/12/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/12/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/12/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/12/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/12/96	U	0.5	ug/L
FID Surrogate Recovery:		97%		70%-130%	(Li
PID Surrogate Recovery:		100%		70%-123%	(Li

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

K. Hollman
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	: MB3111396	Client Project Number	: 729691.32010
Date Prepared	: 11/13/96	Lab Project Number	: 96-3990
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB31111055

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/13/96	U	0.1	mg/L
Benzene	71-43-2	11/13/96	U	0.4	ug/L
Toluene	108-88-3	11/13/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/13/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/13/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/13/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/13/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/13/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/13/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/13/96	U	0.5	ug/L
Surrogate Recovery:		97%		70%-130%	(Limits)
Surrogate Recovery:		98%		70%-123%	(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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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.

M. Blecha
Analyst

K. Hoffman
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	: ST24-MPC(10'-12')	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3990-01	Lab Project Number	: 96-3990
Date Sampled	: 11/8/96	Matrix	: Soil
Date Received	: 11/9/96	Lab File Number(s)	: TVB31111037
Date Prepared	: 11/12/96	Method Blank	: MB3111296
FID Dilution Factor	: 1.0	Soil Extracted?	: NO
PID Dilution Factor	: 1.0	Soil Moisture	: 8.10%

Compound Name	Cas Number	Analysis Date	Sample* Concentration	RL*	Units
TVH-Gasoline	----	NA	NA	NA	NA
Benzene	71-43-2	11/12/96	U	0.4	ug/kg
Toluene	108-88-3	11/12/96	U	0.4	ug/kg
Chlorobenzene	108-90-7	11/12/96	U	0.4	ug/kg
Ethyl Benzene	100-41-4	11/12/96	U	0.4	ug/kg
Total Xylenes (m,p,o)	1330-20-7	11/12/96	U	0.4	ug/kg
1,3,5-Trimethylbenzene	108-67-8	11/12/96	0.7	0.4	ug/kg
1,2,4-Trimethylbenzene	95-63-6	11/12/96	U	0.4	ug/kg
1,2,3-Trimethylbenzene	526-73-8	11/12/96	2.5	0.4	ug/kg
1,2,3,4-Tetramethylbenzene	488-23-3	11/12/96	20	0.5	ug/kg
FID Surrogate Recovery:		NA		50%-125%	(Limits)
PID Surrogate Recovery:		91%		50%-115%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: * = Dry Basis

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.

M. Bleckie
Analyst

K. Hollman
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	: ST24-MPD(10'-12')	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3990-04	Lab Project Number	: 96-3990
Date Sampled	: 11/7/96	Matrix	: Soil
Date Received	: 11/9/96	Lab File Number(s)	: TVB31111040
Date Prepared	: 11/12/96	Method Blank	: MB3111296
FID Dilution Factor	: 1.0	Soil Extracted?	: NO
PID Dilution Factor	: 1.0	Soil Moisture	: 10.10%

Compound Name	Cas Number	Analysis Date	Sample* Concentration	RL*	Units
TVH-Gasoline	----	NA	NA	NA	NA
Benzene	71-43-2	11/12/96	U	0.4	ug/kg
Toluene	108-88-3	11/12/96	U	0.4	ug/kg
Chlorobenzene	108-90-7	11/12/96	U	0.4	ug/kg
Ethyl Benzene	100-41-4	11/12/96	U	0.4	ug/kg
Total Xylenes (m,p,o)	1330-20-7	11/12/96	U	0.4	ug/kg
1,3,5-Trimethylbenzene	108-67-8	11/12/96	U	0.4	ug/kg
1,2,4-Trimethylbenzene	95-63-6	11/12/96	U	0.4	ug/kg
1,2,3-Trimethylbenzene	526-73-8	11/12/96	U	0.4	ug/kg
1,2,3,4-Tetramethylbenzene	488-23-3	11/12/96	U	0.6	ug/kg
FID Surrogate Recovery:	NA			50%-125%	(Limits)
PID Surrogate Recovery:	88%			50%-115%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: * = Dry Basis

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

K. Hollman
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	: W68	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3990-05	Lab Project Number	: 96-3990
Date Sampled	: 11/8/96	Matrix	: Water
Date Received	: 11/9/96	Lab File Number(s)	: TVB31111041
Date Prepared	: 11/12/96	Method Blank	: MB3111296
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/12/96	U	0.1	mg/L
Benzene	71-43-2	11/12/96	U	0.4	ug/L
Toluene	108-88-3	11/12/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/12/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/12/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/12/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/12/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/12/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/12/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/12/96	U	0.5	ug/L
FID Surrogate Recovery:		91%		70%-130%	(Limits)
PID Surrogate Recovery:		94%		70%-123%	(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

K. Hollman
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	: W73	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3990-06	Lab Project Number	: 96-3990
Date Sampled	: 11/8/96	Matrix	: Water
Date Received	: 11/9/96	Lab File Number(s)	: TVB31111042
Date Prepared	: 11/12/96	Method Blank	: MB3111296
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/12/96	0.3	0.1	mg/L
Benzene	71-43-2	11/12/96	6.9	0.4	ug/L
Toluene	108-88-3	11/12/96	13	0.4	ug/L
Chlorobenzene	108-90-7	11/12/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/12/96	12	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/12/96	41	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/12/96	11	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/12/96	41	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/12/96	13	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/12/96	3.7	0.5	ug/L
FID Surrogate Recovery:		102%		70%-130%	(Limits)
PID Surrogate Recovery:		97%		70%-123%	(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

K. Hallman
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	: W74	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3990-07	Lab Project Number	: 96-3990
Date Sampled	: 11/8/96	Matrix	: Water
Date Received	: 11/9/96	Lab File Number(s)	: TVB31111043
Date Prepared	: 11/12/96	Method Blank	: MB3111296
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/12/96	U	0.1	mg/L
Benzene	71-43-2	11/12/96	U	0.4	ug/L
Toluene	108-88-3	11/12/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/12/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/12/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/12/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/12/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/12/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/12/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/12/96	U	0.5	ug/L
FID Surrogate Recovery:		100%		70%-130%	(Limits)
PID Surrogate Recovery:		95%		70%-123%	(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	: W72	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3990-08	Lab Project Number	: 96-3990
Date Sampled	: 11/8/96	Matrix	: Water
Date Received	: 11/9/96	Lab File Number(s)	: TVB31111044
Date Prepared	: 11/12/96	Method Blank	: MB3111296
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/12/96	0.2	0.1	mg/L
Benzene	71-43-2	11/12/96	18	0.4	ug/L
Toluene	108-88-3	11/12/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/12/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/12/96	10	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/12/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/12/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/12/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/12/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/12/96	15	0.5	ug/L
PID Surrogate Recovery:		96%		70%-130%	(Limits)
PID Surrogate Recovery:		96%		70%-123%	(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.
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RL = Reporting Limit.
NA = Not Available/Not Applicable.
PID = Photoionization detector.
FID = Flame ionization detector.
TVH = Total Volatile Hydrocarbons.

Analyst

K. Hollman
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	: Trip Blank	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3990-09	Lab Project Number	: 96-3990
Date Sampled	: NA	Matrix	: Water
Date Received	: 11/9/96	Lab File Number(s)	: TVB31111035
Date Prepared	: 11/12/96	Method Blank	: MB3111296
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/12/96	U	0.1	mg/L
Benzene	71-43-2	11/12/96	U	0.4	ug/L
Toluene	108-88-3	11/12/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/12/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/12/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/12/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/12/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/12/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/12/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/12/96	U	0.5	ug/L
FID Surrogate Recovery:		95%		70%-130%	(Limits)
PID Surrogate Recovery:		99%		70%-123%	(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.

M. Blecha
Analyst

K Hollman
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.	: ST24-MPC(10'-12')	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-01	Lab Work Order	: 96-3990
Date Sampled	: 11/8/96	EPA Method No.	: 602/8020
Date Received	: 11/9/96	Matrix	: Soil
Date Prepared	: 11/13/96	Lab File Number(s)	: TVB31111056,58
Date Analyzed	: 11/13/96	Method Blank	: MB3111396
Instrument Name	: TVHBTEX3	Dilution Factor	: 1.0

Compound	Spike Added (ug/kg)	Sample Concentration (ug/kg)	Concentration (ug/kg) MS	Concentration (ug/kg) MSD	Comments
Benzene	20.0	0.0	19.6	19.7	
Toluene	20.0	0.0	19.4	19.8	
Chlorobenzene	20.0	0.0	19.4	19.5	
Ethylbenzene	20.0	0.0	19.4	19.4	
m,p-Xylene	20.0	0.0	19.3	19.3	
o-Xylene	20.0	0.0	19.6	19.5	
1,3,5-TMB	20.0	0.7	20.1	20.1	
1,2,4-TMB	20.0	0.0	18.8	19.1	
1,2,3-TMB	20.0	2.3	20.0	20.5	
1,2,3,4-TeMB	20.0	18.6	30.6	27.9	
Surrogate	100.0	91%	88%	89%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC Limits RPD	QC Limits %REC
Benzene		98.0	98.5	0.5	25	39 - 150
Toluene		97.0	99.0	2.0	25	46 - 148
Chlorobenzene		97.0	97.5	0.5	25	55 - 135
Ethylbenzene		97.0	97.0	0.0	25	32 - 160
m,p-Xylene		96.5	96.5	0.0	25	25 - 150
o-Xylene		98.0	97.5	0.5	25	25 - 150
1,3,5-TMB		97.0	97.0	0.0	25	25 - 150
1,2,4-TMB		94.0	95.5	1.6	25	25 - 150
1,2,3-TMB		88.5	91.0	2.8	25	25 - 150
1,2,3,4-TeMB		60.0	46.5	25	25	25 - 150
Surrogate		88.0	89.0	NA	NA	50 - 150

* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

M. Bleaha
Analyst

K. Hoffman
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.	: W74	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-07	Lab Work Order	: 96-3990
Date Sampled	: 11/8/96	EPA Method No.	: 602/8020
Date Received	: 11/9/96	Matrix	: Water
Date Prepared	: 11/13/96	Lab File Number(s)	: TVB31111059,60
Date Analyzed	: 11/13/96	Method Blank	: MB3111396
Instrument Name	: TVHBTEX3	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	20.0	19.7	
Toluene	20.0	0.0	19.8	19.6	
Chlorobenzene	20.0	0.0	20.0	19.7	
Ethylbenzene	20.0	0.0	19.9	19.7	
m,p-Xylene	20.0	0.0	19.4	19.2	
o-Xylene	20.0	0.0	19.6	19.4	
1,3,5-TMB	20.0	0.0	20.4	20.0	
1,2,4-TMB	20.0	0.0	20.0	19.5	
1,2,3-TMB	20.0	0.0	19.9	19.4	
1,2,3,4-TeMB	20.0	0.0	20.1	19.0	
Surrogate	100.0	95%	93%	92%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC Limits RPD	QC Limits %REC
Benzene		100.0	98.5	1.5	25	39 - 150
Toluene		99.0	98.0	1.0	25	46 - 148
Chlorobenzene		100.0	98.5	1.5	25	55 - 135
Ethylbenzene		99.5	98.5	1.0	25	32 - 160
m,p-Xylene		97.0	96.0	1.0	25	25 - 150
o-Xylene		98.0	97.0	1.0	25	25 - 150
1,3,5-TMB		102.0	100.0	2.0	25	25 - 150
1,2,4-TMB		100.0	97.5	2.5	25	25 - 150
1,2,3-TMB		99.5	97.0	2.5	25	25 - 150
1,2,3,4-TeMB		100.5	95.0	5.6	25	25 - 150
Surrogate		93.0	92.0	NA	NA	70 - 130

* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

M. Bleeker
Analyst

K. Hoffman
Approved

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.	: W74	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-07	Lab Work Order	: 96-3990
Date Sampled	: 11/8/96	EPA Method No.	: 5030/8015 Modified
Date Received	: 11/9/96	Matrix	: Water
Date Prepared	: 11/12/96	Lab File Number(s)	: TVB31111045,46
Date Analyzed	: 11/12/96	Method Blank	: MB3111296
Instrument Name	: TVHBTEX3	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	1.66	83.0%	55 - 128
Surrogate **	---	---	---	87%	70 - 130

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC Limits RPD	QC Limits %REC
Gasoline	2.00	1.65	82.5%	0.6	50	50 - 150
Surrogate **	---	---	89%	NA	NA	70 - 130

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

Comments:

M. Bleeker
Analyst

K. Hoffman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St.
Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS3111396-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/13/96	Method	: 602/8020
Date Analyzed	: 11/13/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB31111054

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit % Recovery
Benzene	71-43-2	19.1	95.5	50 - 150
Toluene	108-88-3	18.9	94.5	50 - 150
Chlorobenzene	108-90-7	17.6	88.0	50 - 150
Ethyl Benzene	100-41-4	19.0	95.0	50 - 150
m,p-Xylene	108-38-3	37.4	93.5	50 - 150
o-Xylene	106-42-3 95-47-6	18.9	94.5	50 - 1[redacted]
MTBE	1634-04-4	20.0	100.0	50 - 150
1,3,5-Trimethylbenzene	108-67-8	19.5	97.5	50 - 150
1,2,4-Trimethylbenzene	95-63-6	17.9	89.5	50 - 150
1,2,3-Trimethylbenzene	526-73-8	21.9	109.5	50 - 150
1,2,3,4-Tetramethylbenzene	488-23-3	19.1	95.5	50 - 150
Surrogate Recovery:		88%		70 - 130

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.

M. Bleeha
Analyst

Approved

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	: LCS3111496-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/14/96	Method	: 602/8020
Date Analyzed	: 11/14/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB31111086

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit % Recovery
Benzene	71-43-2	18.8	94.0	50 - 150
Toluene	108-88-3	18.5	92.5	50 - 150
Chlorobenzene	108-90-7	17.5	87.5	50 - 150
Ethyl Benzene	100-41-4	18.8	94.0	50 - 150
m,p-Xylene	108-38-3 106-42-3	40.0	100.0	50 - 150
[redacted]ne	95-47-6	18.8	94.0	50 - 150
MTBE	1634-04-4	20.2	101.0	50 - 150
1,3,5-Trimethylbenzene	108-67-8	19.6	98.0	50 - 150
1,2,4-Trimethylbenzene	95-63-6	18.0	90.0	50 - 150
1,2,3-Trimethylbenzene	526-73-8	21.9	109.5	50 - 150
1,2,3,4-Tetramethylbenzene	488-23-3	19.9	99.5	50 - 150
Surrogate Recovery:		99%		70 - 130

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.
N[redacted]lot available/Not analyzed.

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB111896	Client Project No.	: 729691.32010
Date Prepared	: 11/18/96	Lab Project No.	: 96-3990
Date Analyzed	: 11/18/96	Lab File No.	: HALL1118\012F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW3990.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112096	Client Project No.	: 729691.32010
Date Prepared	: 11/20/96	Lab Project No.	: 96-3990
Date Analyzed	: 11/20/96	Lab File No.	: HALL1120\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW3990.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPC(10'-12')	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-01	Lab Project No.	: 96-3990
Date Sampled	: 11/08/96	Matrix	: Soil
Date Received	: 11/09/96	Lab File No.	: HALL1120\005F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.1
Percent Moisture	: 8.1		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	U	0.43
Chloroethane	75-00-3	U	0.43
1,1-Dichloroethene	75-35-4	U	0.43
Dichloromethane	75-09-2	U	0.43
trans-1,2-Dichloroethene	156-60-5	U	0.43
1,1-Dichloroethane	75-34-3	U	0.43
cis-1,2-Dichloroethene	156-59-4	U	0.43
1,1,1-Trichloroethane	71-55-6	U	0.43
Carbon Tetrachloride	56-23-5	U	0.43
Trichloroethene	79-01-6	U	0.43
1,1,2-Trichloroethane	79-00-5	U	0.43
Tetrachloroethene	127-18-4	U	0.43
1,1,1,2-Tetrachloroethane	79-00-5	U	0.43
Chlorobenzene	108-90-7	U	0.46
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]9
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.43
1,2-Dichlorobenzene	95-50-1	U	0.43

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	89%	70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPF(16-18')	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-03	Lab Project No.	: 96-3990
Date Sampled	: 11/07/96	Matrix	: Soil
Date Received	: 11/11/96	Lab File No.	: HALL1120\009F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.1
Percent Moisture	: 10.6		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	U	0.45
Chloroethane	75-00-3	U	0.45
1,1-Dichloroethene	75-35-4	U	0.45
Dichloromethane	75-09-2	U	0.45
trans-1,2-Dichloroethene	156-60-5	U	0.45
1,1-Dichloroethane	75-34-3	U	0.45
cis-1,2-Dichloroethene	156-59-4	U	0.45
1,1,1-Trichloroethane	71-55-6	U	0.45
Carbon Tetrachloride	56-23-5	U	0.45
Trichloroethene	79-01-6	U	0.45
1,1,2-Trichloroethane	79-00-5	U	0.45
Tetrachloroethene	127-18-4	U	0.45
1,1,1,2-Tetrachloroethane	79-00-5	U	0.45
Chlorobenzene	108-90-7	U	0.47
1,1,2,2-Tetrachloroethane	79-34-5	U	0.61
2-Chlorotoluene	95-49-8	U	0.45
4-Chlorotoluene	106-49-8	U	0.45
1,3-Dichlorobenzene	541-73-1	U	0.45
1,2-Dichlorobenzene	95-50-1	U	0.45

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	90%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW3990.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPD(10-12')	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-04	Lab Project No.	: 96-3990
Date Sampled	: 11/07/96	Matrix	: Soil
Date Received	: 11/11/96	Lab File No.	: HALL1120\010F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.1
Percent Moisture	: 10.1		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	U	0.44
Chloroethane	75-00-3	U	0.44
1,1-Dichloroethene	75-35-4	U	0.44
Dichloromethane	75-09-2	U	0.44
trans-1,2-Dichloroethene	156-60-5	U	0.44
1,1-Dichloroethane	75-34-3	U	0.44
cis-1,2-Dichloroethene	156-59-4	U	0.44
1,1,1-Trichloroethane	71-55-6	U	0.44
Carbon Tetrachloride	56-23-5	U	0.44
Trichloroethene	79-01-6	U	0.44
1,1,2-Trichloroethane	79-00-5	U	0.44
Tetrachloroethene	127-18-4	U	0.44
1,1,1,2-Tetrachloroethane	79-00-5	U	0.44
Chlorobenzene	108-90-7	U	0.46
1,1,2,2-Tetrachloroethane	79-34-5	U	0.6
2-Chlorotoluene	95-49-8	U	
4-Chlorotoluene	106-49-8	U	
1,3-Dichlorobenzene	541-73-1	U	0.44
1,2-Dichlorobenzene	95-50-1	U	0.44

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W68	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-05	Lab Project No.	: 96-3990
Date Sampled	: 11/08/96	Matrix	: WATER
Date Received	: 11/11/96	Lab File No.	: HALL1118\013F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/18/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	89%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW3990.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W73	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-06	Lab Project No.	: 96-3990
Date Sampled	: 11/08/96	Matrix	: WATER
Date Received	: 11/09/96	Lab File No.	: HALL1118\01[illegible]10[illegible]
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/18/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.5[illegible]
2-Chlorotoluene	95-49-8	U	0[illegible]
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	84%	70% - 130% (QC limits)	

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W74	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-07	Lab Project No.	: 96-3990
Date Sampled	: 11/08/96	Matrix	: WATER
Date Received	: 11/09/96	Lab File No.	: HALL1118\015F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/18/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	85%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W72	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-08	Lab Project No.	: 96-3990
Date Sampled	: 11/08/96	Matrix	: WATER
Date Received	: 11/11/96	Lab File No.	: HALL1118\019F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/18/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.5
2-Chlorotoluene	95-49-8	U	0
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: Trip Blank	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3990-09	Lab Project No.	: 96-3990
Date Sampled	: NA	Matrix	: WATER
Date Received	: 11/09/96	Lab File No.	: HALL1118\020F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/18/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	78%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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HLW3990.XLS; 11/25/96

Method 8010 Quality Control Samples

Date Performed: 11/18/96

Reference Standard: V832

Analyte	M	Method Blank	Sample	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range % L - % H	Low - High
Vinyl Chloride	w			16.908	16.944	17.349	20.0	0.2	85%	85%		87%		28 - 163	5.60 - 32.60
Chloroethane	*			16.852	17.301	18.449	20.0	2.6	84%	87%		92%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			16.967	17.135	19.201	20.0	1.0	85%	86%		96%		28 - 167	5.60 - 33.40
Dichloromethane	*			19.389	19.307	19.726	20.0	0.4	97%	97%		99%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			16.676	16.507	17.237	20.0	1.0	83%	83%		86%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*			20.436	20.185	21.513	20.0	1.2	102%	101%		108%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*			21.203	20.514	21.552	20.0	3.3	106%	103%		108%		-	-
1,1,1-Trichloroethane	*			21.151	20.698	21.173	20.0	2.2	106%	103%		106%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			20.66	19.898	21.854	20.0	3.8	103%	99%		109%		43 - 143	8.60 - 28.60
Trichloroethene	w			21.399	21.064	22.801	20.0	1.6	107%	105%		114%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			21.949	21.954	22.131	20.0	0.0	110%	110%		111%		39 - 136	7.80 - 27.20
Tetrachloroethene	*			21.056	19.822	20.891	20.0	6.0	105%	99%		104%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			20.201	19.398	20.183	20.0	4.1	101%	97%		101%		-	-
Chlorobenzene	*			20.949	19.881	20.386	20.0	5.2	105%	99%		102%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			23.623	22.065	22.525	20.0	6.8	118%	110%		113%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			20.615	19.38	20.854	20.0	6.2	103%	97%		104%		-	-
4-Chlorotoluene	*			20.152	18.279	21.977	20.0	9.7	101%	91%		110%		-	-
1,3-Dichlorobenzene	*			19.035	18.923	19.267	20.0	0.6	95%	95%		96%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*			18.104	18.004	19.627	20.0	0.6	91%	90%		98%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "*".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:

All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:

Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must be t[redacted] One recovery outside limits and the other acceptable, is a w[redacted] Repeated failure requires corrective action.
Recove[redacted]ide guidelines should be compared to historical data availa[redacted]etermine if corrective action is required.

Method 8010 Quality Control Samples

Date Performed: 11/20/96

Reference Standard: V832

Analyte	M	Method Blank	Sample	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range % L - % H	Low - High
Vinyl Chloride	w			17.226	18.778	16.256	20.0	8.6	86%	94%		81%		28 - 163	5.60 - 32.60
Chloroethane	*			19.441	20.379	17.960	20.0	4.7	97%	102%		90%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			20.375	20.645	18.587	20.0	1.3	102%	103%		93%		28 - 167	5.60 - 33.40
Dichloromethane	*			18.521	18.937	16.707	20.0	2.2	93%	95%		84%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			21.022	18.231	22.187	20.0	14.2	105%	91%		111%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*			21.856	21.82	19.615	20.0	0.2	109%	109%		98%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*			21.822	22.318	20.357	20.0	2.2	109%	112%		102%		-	-
1,1,1-Trichloroethane	*			22.424	22.204	20.021	20.0	1.0	112%	111%		100%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			22.141	22.265	20.392	20.0	0.6	111%	111%		102%		43 - 143	8.60 - 28.60
Trichloroethene	w			23.375	21.741	21.927	20.0	7.2	117%	109%		110%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			20.396	20.983	20.658	20.0	2.8	102%	105%		103%		39 - 136	7.80 - 27.20
Tetrachloroethene	*			21.021	21.906	19.818	20.0	4.1	105%	110%		99%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			19.417	19.696	19.055	20.0	1.4	97%	98%		95%		-	-
Chlorobenzene	*			20.605	20.827	20.203	20.0	1.1	103%	104%		101%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			16.705	18.018	20.856	20.0	7.6	84%	90%		104%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			20.776	20.362	18.851	20.0	2.0	104%	102%		94%		-	-
4-Chlorotoluene	*			19.41	19.097	19.178	20.0	1.6	97%	95%		96%		-	-
1,3-Dichlorobenzene	*			18.359	18.772	18.187	20.0	2.2	92%	94%		91%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*			17.172	17.647	15.926	20.0	2.7	86%	88%		80%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "**".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:

All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:

Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must be taken. One recovery outside limits and the other acceptable, is a warning. Repeated failure requires corrective action. Recoveries outside guidelines should be compared to historical data available to determine if corrective action is required.

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB111496	Client Project No.	: 729691.32010
Date Extracted/Prepared	: 11/14/96	Lab Work Order	: 96-3990
Date Analyzed	: 11/14/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175M
		Matrix	: Water
		Lab File No.	: GAS1114002

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

Approved

AF3990.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W68	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3990-05	Lab Work Order	: 96-3990
Date Sampled	: 11/8/96	Dilution Factor	: 1.00
Date Received	: 11/9/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114012

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

[redacted]perature	: 71 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.
[redacted]Not Available/Not Applicable.

Analyst

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W73	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3990-06	Lab Work Order	: 96-3990
Date Sampled	: 11/8/96	Dilution Factor	: 1.00
Date Received	: 11/9/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114013

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	: 71.1 F	Saturation Concentration	Meth		
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		
Head space created *	: 2.5 ml				
Methane Area	: 0 ug				

Atomic weight(Methane) : 16 g

* = Could not displace 4mls of water do to sample matrix.

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

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W74	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3990-07	Lab Work Order	: 96-3990
Date Sampled	: 11/8/96	Dilution Factor	: 1.00
Date Received	: 11/9/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114014

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.031	0.002

[illegible]perature	: 71.2 F	Saturation Concentration	Meth	0.007351393
Amount Injected	: 0.5 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.023197542
Head space created	: 4 ml			
Methane Area	: 170.953 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.
[illegible] = Not Available/Not Applicable.

Analyst

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W72	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3990-08	Lab Work Order	: 96-3990
Date Sampled	: 11/8/96	Dilution Factor	: 1.00
Date Received	: 11/9/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114015

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.039	0.002

Temperature	: 71.6 F	Saturation Concentration	Meth	0.0
Amount Injected	: 0.5 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.0296290
Head space created	: 4 ml			
Methane Area	: 218.514 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

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AF3990.XLS

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

RSKSOP-175M Gas Method
Methane, Ethane, Ethene LCS Report Form

LCS No.	: LCS111496	EPA Method No.	: RSKSOP-175M
Date Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Method Blank	: GB111496
E.A. LCS Source No.	: 1719	Lab File No.	: GAS1114010

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	370	74	64-90
Ethene Gas	500	0	213	43	37-58
Ethane Gas	500	0	321	64	53-83

Spike Recovery: 0 out of (3) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane, ethane, ethene 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

Date Sampled	: 11/08/96	Client Project ID.	: 729691.32010
Date Received	: 11/09/96	Lab Project Number	: 96-3990
Date Prepared	: 11/09/96	Method	: EPA 300.0
Date Analyzed	: 11/09/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride mg/L	Dilution Factor
96-3990-05	W68	Water	4.6	1
96-3990-05 Duplicate	W68 Duplicate	Water	4.6	1
96-3990-06	W73	Water	2.8	1
96-3990-07	W74	Water	2.0	1
96-3990-08	W72	Water	4.0	1
Method Blank	(11/09/96)	Water	<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-3990-05	W68 Matrix Spike	10.0	4.6	14.9	103
96-3990-05	W68 Matrix Spike Dup	10.0	4.6	14.4	98
MS/MSD RPD					4.8

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/08/96	Client Project ID.	: 729691.32010
Date Received	: 11/09/96	Lab Project Number	: 96-3990
Date Prepared	: 11/09/96	Method	: EPA 300.0
Date Analyzed	: 11/09/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N mg/L	Dilution Factor
96-3990-05	W68	Water	<0.076	1
96-3990-05 Duplicate	W68 Duplicate	Water	<0.076	1
96-3990-06	W73	Water	<0.076	1
96-3990-07	W74	Water	<0.076	1
96-3990-08	W72	Water	<0.076	1
Method Blank	(11/09/96)	Water	<0.076	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-3990-05	W68 Matrix Spike	10.0	<0.25	9.8	98
96-3990-05	W68 Matrix Spike Dup	10.0	<0.25	9.6	96
MS/MSD RPD					1.7

* = Quality assurance results reported as Nitrite (NO_2).

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled : 11/08/96
Date Received : 11/09/96
Date Prepared : 11/09/96
Date Analyzed : 11/09/96

Client Project ID. : 729691.32010
Lab Project Number : 96-3990
Method : EPA 300.0
Detection Limit : 0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N mg/L	Dilution Factor
96-3990-05	W68	Water	2.1	1
96-3990-05 Duplicate	W68 Duplicate	Water	2.1	1
96-3990-06	W73	Water	1.1	1
96-3990-07	W74	Water	1.0	1
96-3990-08	W72	Water	0.12	1
Method Blank	(11/09/96)	Water	<0.056	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-3990-05	W68 Matrix Spike	10.0	9.2	19.3	101
96-3990-05	W68 Matrix Spike Dup	10.0	9.2	19.1	99
MS/MSD RPD					1.9

* = Quality assurance results reported as Nitrate (NO_3).

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/08/96	Client Project ID.	: 729691.32010
Date Received	: 11/09/96	Lab Project Number	: 96-3990
Date Prepared	: 11/09/96	Method	: EPA 300.0
Date Analyzed	: 11/09/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate mg/L	Dilution Factor
96-3990-05	W68	Water	1.7	1
96-3990-05 Duplicate	W68 Duplicate	Water	1.7	1
96-3990-06	W73	Water	2.2	1
96-3990-07	W74	Water	1.3	1
96-3990-08	W72	Water	2.4	1
Method Blank	(11/09/96)	Water	<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-3990-05	W68 Matrix Spike	10.0	1.7	10.9	93
96-3990-05	W68 Matrix Spike Dup	10.0	1.7	10.8	91
MS/MSD RPD					2.1

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Total Recoverable Petroleum Hydrocarbons

Date Sampled	: 11/7,8/96	Client Project ID.	: 729691-32010
Date Received	: 11/8/96	Lab Project Number	: 96-3990
Date Prepared	: 11/13/96	Method	: EPA 418.1
Date Analyzed	: 11/13/96		

Evergreen Sample #	Client Sample ID.	Matrix	TRPH	Units
96-3990-01	ST24-MPC (10'-12')	Soil	<3.6	mg/Kg
96-3990-02	LF6-MPJ (18')	Soil	<3.9	mg/Kg
96-3990-03	ST24-MPF (16'-18')	Soil	<3.7	mg/Kg
96-3990-03 Duplicate	ST24-MPF (16'-18') Duplicate	Soil	<3.7	mg/Kg
96-3990-04	ST24-MPD (10'-12')	Soil	<3.7	mg/Kg

Method Blank (11/13/96) subtracted 3.4 mg/Kg

Results reported on a dry weight basis.

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Total Organic Carbon

Date Sampled	: 11/8/96	Client Project ID.	: 729691-32010
Date Received	: 11/9/96	Lab Project Number	: 96-3990
Date Prepared	: 11/11/96	Method	: EPA 415.1
Date Analyzed	: 11/11/96	Detection Limit	: 1.0 mg C/L

Evergreen Sample #	Client Sample ID.	Matrix	TOC (mg C/L)	Dilution Factor
96-3990-05	W68	Water	<1.0	1
96-3990-06	W73	Water	3.8	1
96-3990-07	W74	Water	<1.0	1
96-3990-07 Duplicate	W74 Duplicate	Water	<1.0	1
Method Blank	(11/11/96)		<1.0	

Quality Assurance

		Spike Amount (mgC/L)	Sample Result (mgC/L)	Spike Result (mgC/L)	% Recovery
96-3990-07	W74 Matrix Spike	10.0	<1.0	10.5	105
96-3990-07	W74 Matrix Spike Dup	10.0	<1.0	11.2	112
MS/MSD RPD					6.8

Analyst

Approved

CUSTOMER #:
02604

HUFFMAN
LABORATORIES, INC.
Quality Analytical Services Since 1936
4630 Indiana Street • Golden, CO 80403
Phone: (303) 278-4455 • FAX: (303) 278-7012

DEC 0 1996

DATE 12/4/96
LAB# 234[redacted]
P.O. SEE [redacted]
RCD 11/20/96

ANALYSIS REPORT

PATTY MC CLELLEN
EVERGREEN ANALYTICAL, INC
4036 YOUNGFIELD STREET
WHEAT RIDGE CO 80033

P.O. # 013549 & 013550/PROJ 96-3990 & 96-3996

SEQUENCE/ SAMPLE ID	01 LF6-MPJ (18')	02 LF6-MPL (14-18)	03 ST24-MPF(16-18)
CARBONATE C---%	<0.02	<0.02	<0.02
TOTAL CARBON--%	<0.05	<0.05	<0.05
ORGANIC C-----%	<0.05	<0.05	<0.05

THE SAMPLES ARE NOT HOMOGENEOUS.

[redacted]STOMER #:
02604

HUFFMAN
LABORATORIES, INC.
Quality Analytical Services Since 1936
4630 Indiana Street • Golden, CO 80403
Phone: (303) 278-4455 • FAX: (303) 278-7012

DATE 12/4/96
LAB# 234196
P.O. SEE BELC
RECD 11/20/96

ANALYSIS REPORT

PATTY MC CLELLEN
EVERGREEN ANALYTICAL, INC
4036 YOUNGFIELD STREET
WHEAT RIDGE CO 80033

P.O. # 013549 & 013550/PROJ 96-3990 & 96-3996

	96-3990-02	96-3996-09	96-3990-03
SEQUENCE/ SAMPLE ID	01 LF6-MPJ (18')	02 LF6-MPL (14-18)	03 ST24-MPF(16-18)
CARBONATE C---%	<0.02	<0.02	<0.02
TOTAL CARBON--%	<0.05	<0.05	<0.05
ORGANIC C-----%	<0.05	<0.05	<0.05

[redacted] SAMPLES ARE NOT HOMOGENEOUS.

Percent Moisture	15.3%	14.09%	10.6%
Dry Wt. Result	< 0.06	< 0.06	< 0.06

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Analysis Report

Date Sampled : 11/8/96
Date Received : 11/9/96
Date Prepared : 11/14/96
Date Analyzed : 11/14/96

Client Project ID. : 729691-32010
Lab Project Number : 96-3990
Method : EPA 310.1
Detection Limit : 5.0 mg $CaCO_3$/L

Evergreen Sample #	Client Sample ID.	Matrix	Total Alkalinity (mg $CaCO_3$/L)	Dilution Factor
96-3990-05	W68	Water	<5.0	1
96-3990-06	W73	Water	7.2	1
96-3990-07	W74	Water	<5.0	1
96-3990-07 Duplicate	W74 Duplicate	Water	<5.0	1
Method Blank	(11/14/96)		<5.0	

Quality Assurance

Reference	True Value (mg$CaCO_3$/L)	Result (mg$CaCO_3$/L)	% Recovery
ERA Minerals	120	112	94

Lot # 0725-96-11

Analyst

Approved

Evergreen Analytical, Inc.

96-3996

WORK ORDER Summary

18-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691-32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-3996-09A	LF6-MPL(14-18)	% Moisture for dry weight calculation		Soil	D1	09-Nov-96	11-Nov-96	25-Nov-96	07-Dec-96
96-3996-02K	W69	Anions by IC Cl,NO2,NO3,SO4		Groundwater		10-Nov-96		25-Nov-96	12-Nov-96
96-3996-03K	W71	Anions by IC Cl,NO2,NO3,SO4						25-Nov-96	12-Nov-96
96-3996-04K	W77	Anions by IC Cl,NO2,NO3,SO4						25-Nov-96	12-Nov-96
96-3996-06K	W70	Anions by IC Cl,NO2,NO3,SO4						25-Nov-96	12-Nov-96
96-3996-08K	ST24 MPKS	Anions by IC Cl,NO2,NO3,SO4						25-Nov-96	12-Nov-96
96-3996-01A	W75	BTEX (Parsons List)			2			25-Nov-96	24-Nov-96
96-3996-02A	W69	BTEX (Parsons List)						25-Nov-96	24-Nov-96
96-3996-03A	W71	BTEX (Parsons List)						25-Nov-96	24-Nov-96
96-3996-04A	W77	BTEX (Parsons List)						25-Nov-96	24-Nov-96
96-3996-06A	W70	BTEX (Parsons List)						25-Nov-96	24-Nov-96
96-3996-08A	ST24 MPKS	BTEX (Parsons List)						25-Nov-96	24-Nov-96
96-3996-09A	LF6-MPL(14-18)	BTEX (Parsons List)		Soil	D1	09-Nov-96		25-Nov-96	23-Nov-96
96-3996-09C	LF6-MPL(14-18) MS	BTEX (Parsons List)						25-Nov-96	23-Nov-96
96-3996-09D	LF6-MPL(14-18) MSD	BTEX (Parsons List)						25-Nov-96	23-Nov-96
96-3996-02H	W69	Methane		Groundwater	2	10-Nov-96		25-Nov-96	24-Nov-96
96-3996-03H	W71	Methane						25-Nov-96	24-Nov-96
96-3996-04H	W77	Methane						25-Nov-96	24-Nov-96
96-3996-06H	W70	Methane						25-Nov-96	24-Nov-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

11/18/96

Evergreen Analytical, Inc.

WORK ORDER Summary

96-3996

18-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691-32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-3996-08H	ST24 MPKS	Methane		Groundwater	2	10-Nov-96	11-Nov-96	25-Nov-96	24-Nov-96
96-3996-01E	W75	Purgeable Halocarbons 8010			9			25-Nov-96	24-Nov-96
96-3996-02E	W69	Purgeable Halocarbons 8010						25-Nov-96	24-Nov-96
96-3996-03E	W71	Purgeable Halocarbons 8010						25-Nov-96	24-Nov-96
96-3996-04E	W77	Purgeable Halocarbons 8010						25-Nov-96	24-Nov-96
96-3996-05A	Field Blank-1	Purgeable Halocarbons 8010		Water				25-Nov-96	24-Nov-96
96-3996-06E	W70	Purgeable Halocarbons 8010		Groundwater				25-Nov-96	24-Nov-96
96-3996-07A	Trip Blank-2	Purgeable Halocarbons 8010		Water				25-Nov-96	24-Nov-96
96-3996-08E	ST24 MPKS	Purgeable Halocarbons 8010		Groundwater				25-Nov-96	24-Nov-96
96-3996-09A	LF6-MPL(14-18)	Purgeable Halocarbons 8010		Soil	D1	09-Nov-96		25-Nov-96	23-Nov-96
96-3996-09C	LF6-MPL(14-18) MS	Purgeable Halocarbons 8010						25-Nov-96	23-Nov-96
96-3996-09D	LF6-MPL(14-18) MSD	Purgeable Halocarbons 8010						25-Nov-96	23-Nov-96
96-3996-08K	ST24 MPKS	Total Alkalinity		Groundwater		10-Nov-96		25-Nov-96	24-Nov-96
96-3996-09B	LF6-MPL(14-18)	Total Alkalinity		Soil		09-Nov-96		25-Nov-96	07-Dec-96
96-3996-08L	ST24 MPKS	Total Organic Carbon		Groundwater		10-Nov-96		25-Nov-96	08-Dec-96
96-3996-09B	LF6-MPL(14-18)	Total Organic Carbon		Soil		09-Nov-96		25-Nov-96	16-Nov-96
		TRPH						25-Nov-96	07-Dec-96
96-3996-01A	W75	TVH (Gasoline)		Groundwater	2	10-Nov-96		25-Nov-96	24-Nov-96
96-3996-02A	W69	TVH (Gasoline)						25-Nov-96	24-Nov-96
96-3996-03A	W71	TVH (Gasoline)						25-Nov-96	24-Nov-96
96-3996-04A	W77	TVH (Gasoline)						25-Nov-96	24-Nov-96
96-3996-06A	W70	TVH (Gasoline)						25-Nov-96	24-Nov-96
96-3996-08A	ST24 MPKS	TVH (Gasoline)						25-Nov-96	24-Nov-96

# = Spec[redacted] See sample comments or test information.
HT = F[redacted]ime expiration date.

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Page 1 of 1

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 Suite 900
CITY Denver STATE CO ZIP 80290
PHONE# (303) 831-8100 FAX # (303) 831-8208 FAX RESULTS Y / N

CLIENT CONTACT (print) Jenny Hartfelder
CLIENT PROJ. I.D. 729691.32010
EAL. QUOTE # P.O.# 729691.32010
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ UST
☐ Other (Specify)*
*expedited turnaround subject to additional fee

Sampler Name:
(signature) Jennifer Hartfelder
(print) Jennifer Hartfelder

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid / Air / Gas	MATRIX: Oil / Sludge / Multi-phase	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)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	VOCs 8240 EC/C	Anions Cl, NO2, NO3, SO4	Methane GC/404	TOC/AIC Wastewater only	MS/MSD	For Laboratory use only
W75	11/10/96	0645	7	X										X	X						X					01
W69	11/10/96	0720	11	X										X	X						X	X	X			02
W71	11/10/96	0650	11	X										X	X						X	X	X			03
W77	11/10/96	1030	11	X										X	X						X	X	X			04
Field Blank-1	11/10/96	1112	3	X																	X					05
W70	11/10/96	1345	11	X										X	X						X	X	X			06
Trip Blank-2	11/10/96		1	X																	XA					07
ST24MPKS	11/10/96	1510	12	X										X	X						X	X	X	X		08
LF6-MPL(14-18)	11/9/96	900	2		X									XA						XB	XA			XB	XA	09 4Um
																					EB	K	HIJ	L		
Sample Fraction														AB	QD						~~EB~~	~~K~~	~~HIJ~~	~~L~~		Loc X D1,2,9
Instructions: Container														4oV	4oV						4oV	BSP	4oV	BSA		

LF6-MPL(14-18) MS/MSD for 8010, 8020/~~8015m~~ 8015m and methane

Jennifer Hartfelder 11/11/96 1015

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
							11/11/96

RUSH Y (N)

Project Revision Notice
New Project Request

Date: 11/11/96 Time: 3:00 Project # 96-3996

Start new project: Y N

Reason for revision:

_____ Due Date Modified

_____ Method Revision

_____ Additional analyses requested on original project

_____ Miscellaneous (specify): Analyze MS/MSD for 8020, 8010 per ~~per hand~~ per sample LF6-MH (14-15),

Description of changes: All samples should be 8010 not 8260.

Client Name: Parsons ES Client Contact: Jenny Hartfelder

EAL Contact: Patty Due Date: 11/25/96

* Only include additional analyses on original project if the project is still open.

cc: JDP___ SWT___ WKH___ MAB___ MSM___
SX.REC X QA/QC X SALES X FILE (orig)

Note: Originator must identify persons to receive the Notice/Request.

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	: MB1111396	Client Project Number	: 729691.32010
Date Prepared	: 11/13/96	Lab Work Order	: 96-3996
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB11113005

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	---	11/13/96	U	0.1	mg/L
Benzene	71-43-2	11/13/96	U	0.4	ug/L
Toluene	108-88-3	11/13/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/13/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/13/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/13/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/13/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/13/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/13/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/13/96	U	0.5	ug/L
FID Surrogate Recovery:		100%		50%-150%	(Limits)
ID Surrogate Recovery:		108%		50%-150%	(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.

N. Dianne Mills
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	: MB1111496	Client Project Number	: 729691.32010
Date Prepared	: 11/14/96	Lab Work Order	: 96-3996
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB11113029

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	U	0.1	mg/L
Benzene	71-43-2	11/14/96	U	0.4	ug/L
Toluene	108-88-3	11/14/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	U	0.5	ug/L
FID Surrogate Recovery:		102%		50%-150%	
PID Surrogate Recovery:		102%		50%-150%	

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.

H. Diane Mills
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	: W75	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3996-01	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Matrix	: WATER
Date Received	: 11/11/96	Lab File Number(s)	: TVB11113012,31
Date Prepared	: 11/13,14/96	Method Blank	: MB1111496
FID Dilution Factor	: 50		MB1111396
PID Dilution Factor	: 50; 5.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	26	5.0	mg/L
Benzene	71-43-2	11/14/96	220	20	ug/L
Toluene	108-88-3	11/14/96	2700	20	ug/L
Chlorobenzene	108-90-7	11/13/96	U	2.0	ug/L
Ethyl Benzene	100-41-4	11/14/96	470	20	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	2400	20	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	960	20	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	2700	20	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	670	20	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	290	25	ug/L
FID Surrogate Recovery:		103%		50%-150%	(Limits)
PID Surrogate Recovery:		104%; 102%		50%-150%	(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. 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	: W69	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3996-02	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Matrix	: WATER
Date Received	: 11/11/96	Lab File Number(s)	: TVB11113013
Date Prepared	: 11/13/96	Method Blank	: MB1111396
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/13/96	U	0.1	mg/L
Benzene	71-43-2	11/13/96	U	0.4	ug/L
Toluene	108-88-3	11/13/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/13/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/13/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/13/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/13/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/13/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/13/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/13/96	U	0.5	ug/L
FID Surrogate Recovery:		98%		50%-150%	
PID Surrogate Recovery:		96%		50%-150%	(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.

H. Diane Mills
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	: W71	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3996-03	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Matrix	: WATER
Date Received	: 11/11/96	Lab File Number(s)	: TVB11113020,41
Date Prepared	: 11/13,14/96	Method Blank	: MB1111496
FID Dilution Factor	: 20		MB1111396
PID Dilution Factor	: 20; 5.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	10	2.0	mg/L
Benzene	71-43-2	11/14/96	140	8.0	ug/L
Toluene	108-88-3	11/14/96	600	8.0	ug/L
Chlorobenzene	108-90-7	11/13/96	U	2.0	ug/L
Ethyl Benzene	100-41-4	11/14/96	420	8.0	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	980	8.0	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	310	8.0	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	1200	8.0	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	350	8.0	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	150	10	ug/L
D Surrogate Recovery:		97%		50%-150%	(Limits)
PID Surrogate Recovery:		97%; 98%		50%-150%	(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.
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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: W77	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3996-04	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Matrix	: WATER
Date Received	: 11/11/96	Lab File Number(s)	: TVB11113030
Date Prepared	: 11/14/96	Method Blank	: MB1111496
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	0.1	0.1	mg/L
Benzene	71-43-2	11/14/96	23	0.4	ug/L
Toluene	108-88-3	11/14/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	11	0.5	ug/L
FID Surrogate Recovery:		103%		50%-150%	
PID Surrogate Recovery:		103%		50%-150%	(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	: W70	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3996-06	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Matrix	: WATER
Date Received	: 11/11/96	Lab File Number(s)	: TVB11113034,43
Date Prepared	: 11/14/96	Method Blank	: MB1111496
FID Dilution Factor	: 50		
PID Dilution Factor	: 50; 5.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	---	11/14/96	26	5.0	mg/L
Benzene	71-43-2	11/14/96	190	20	ug/L
Toluene	108-88-3	11/14/96	2700	20	ug/L
Chlorobenzene	108-90-7	11/14/96	U	2.0	ug/L
Ethyl Benzene	100-41-4	11/14/96	480	20	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	2500	20	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	950	20	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	2700	20	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	670	20	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	280	25	ug/L
D Surrogate Recovery:		101%		50%-150%	(Limits)
PID Surrogate Recovery:		101%; 98%		50%-150%	(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.
VH = 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	: Trip Blank-2	Client Project Number	: 72[illegible]691.32010
Lab Sample Number	: 96-3996-07	Lab Work Order	: 96[illegible]3996
Date Sampled	: NA	Matrix	: W[illegible]TER
Date Received	: 11/11/96	Lab File Number(s)	: T[illegible]B11113042
Date Prepared	: 11/14/96	Method Blank	: M[illegible]B1111496
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	---	11/14/96	U	0.1	mg/L
Benzene	71-43-2	11/14/96	U	0.4	ug/L
Toluene	108-88-3	11/14/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	U	0.5	ug/L
FID Surrogate Recovery:		101%		50%-150%	([illegible]
PID Surrogate Recovery:		98%		50%-150%	(Li[illegible])

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

PMcClell
Approved

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: ST24MPKS	Client Project Number	: 729691.32010
Lab Sample Number	: 96-3996-08	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Matrix	: WATER
Date Received	: 11/11/96	Lab File Number(s)	: TVB11113035
Date Prepared	: 11/14/96	Method Blank	: MB1111496
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	U	0.1	mg/L
Benzene	71-43-2	11/14/96	U	0.4	ug/L
Toluene	108-88-3	11/14/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	U	0.5	ug/L
FID Surrogate Recovery:		103%		50%-150%	(Limits)
PID Surrogate Recovery:		98%		50%-150%	(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 Hoffman
Analyst

P McClella
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.	: W69	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3996-02	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	EPA Method No.	: 602/8020
Date Received	: 11/11/96	Matrix	: WATER
Date Prepared	: 11/13/96	Lab File Number(s)	: TVB11113016, 17
Date Analyzed	: 11/13/96	Method Blank	: MB1111396
Instrument Name	: TVHBTEX1	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	19.1	20.3	
Toluene	20.0	0.0	17.7	18.9	
Chlorobenzene	20.0	0.0	18.2	19.6	
Ethylbenzene	20.0	0.0	18.3	19.5	
m,p-Xylene	20.0	0.0	18.0	18.9	
o-Xylene	20.0	0.0	18.1	19.5	
1,3,5-TMB	20.0	0.0	18.5	18.6	
1,2,4-TMB	20.0	0.0	18.1	18.2	
1,2,3-TMB	20.0	0.0	18.5	18.9	
1,2,3,4-TeMB	20.0	0.0	17.4	17.5	
Surrogate	100.0	96%	94%	96%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC# Limits RPD	QC# Limits %REC
Benzene		95.5	101.5	6.1	18	62 - 129
Toluene		88.5	94.5	6.6	25	55 - 133
Chlorobenzene		91.0	98.0	7.4	9	66 - 122
Ethylbenzene		91.5	97.5	6.3	15	60 - 127
m,p-Xylene		90.0	94.5	4.9	20	44 - 146
o-Xylene		90.5	97.5	7.4	16	57 - 131
1,3,5-TMB		92.5	93.0	0.5	16	63 - 129
1,2,4-TMB		90.5	91.0	0.6	16	55 - 136
1,2,3-TMB		92.5	94.5	2.1	13	64 - 127
1,2,3,4-TeMB		87.0	87.5	0.6	23	53 - 132
Surrogate		94.0	96.0	NA	NA	82 - 115

= Limits extablished 10/1/96,HDM
* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

K. Hollman
Analyst

Approved

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.	: W69	Client Project No	: 729691.32010
Lab Sample No.	: 96-3996-02	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	EPA Method No.	: 5030/8015 Modified
Date Received	: 11/11/96	Matrix	: WATER
Date Prepared	: 11/13/96	Lab File Number(s)	: TVB11113014, 15
Date Analyzed	: 11/13/96	Method Blank	: MB1111396
Instrument Name	: TVHBTEX1	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	1.81	90.5%	62 - 126
Surrogate **	---	---	---	100%	70 - 121

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC (#) Limits RPD	QC (#) Limits %REC
Gasoline	2.00	1.79	89.5%	1.1	42.3	62 - 126
Surrogate **	---	---	94%	NA	NA	70 - 121

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 10/2/96, KSH

Comments:

L. Duane Mills
Analyst

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	: LCS1111396	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/13/96	Method	: 602/8020
Date Analyzed	: 11/13/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB11113006

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	21.8	109.0	75 - 110
Toluene	108-88-3	20.4	102.0	75 - 110
Chlorobenzene	108-90-7	19.2	96.0	69 - 110
Ethyl Benzene	100-41-4	21.0	105.0	74 - 110
m,p-Xylene	108-38-3	40.3	100.8	73 - 110
o-Xylene	106-42-3 95-47-6	22.4	112.0	74 - 11
MTBE	1634-04-4	18.6	93.0	59 - 129
1,3,5-Trimethylbenzene	108-67-8	21.8	109.0	70 - 110
1,2,4-Trimethylbenzene	95-63-6	19.7	98.5	73 - 110
1,2,3-Trimethylbenzene	526-73-8	23.7	118.5	84 - 122
1,2,3,4-Tetramethylbenzene	488-23-3	21.6	108.0	67 - 116
Surrogate Recovery:		102%		82 - 115

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 updated 10/02/96 for TVHBTEX1. SWT

L. Diane Meds
Analyst

P McClellan
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS1111396	Matrix	: WATER
Date Prepared	: 11/13/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/13/96	Instrument Name	: TVHBTEX1
Lab File Number(s)	: TVB11113008		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	1.78	89.0	83 - 120
Surrogate Recovery:		106%		70 - 121

QUALIFIERS
B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 9/24/96 for TVHBTEX1. HDM

H. Diane Mills
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS1111496	Matrix	: WATER
Date Prepared	: 11/14/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/14/96	Instrument Name	: TVHBTEX1
Lab File Number(s)	: TVB11113036		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.11	105.5	83 - 120
Surrogate Recovery:		107%		70 - 12

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 9/24/96 for TVHBTEX1. HDM

H. Deane Mills
Analyst

P. McClellan
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St.
Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS1111496		Dilution Factor	:	1.00
Date Extracted/Prepared	: 11/14/96		Method	:	602/8020
Date Analyzed	: 11/14/96		Matrix	:	Water
Spike Amount (ug/L)	: 20.0		Lab File No.	:	TVB11113037

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	19.6	98.0	75 - 110
Toluene	108-88-3	18.4	92.0	75 - 110
Chlorobenzene	108-90-7	16.9	84.5	69 - 110
Ethyl Benzene	100-41-4	18.2	91.0	74 - 110
m,p-Xylene	108-38-3 106-42-3	35.2	88.0	73 - 110
[redacted]ene	95-47-6	18.3	91.5	74 - 114
MTBE	1634-04-4	13.1	65.5	59 - 129
1,3,5-Trimethylbenzene	108-67-8	19.0	95.0	70 - 110
1,2,4-Trimethylbenzene	95-63-6	17.6	88.0	73 - 110
1,2,3-Trimethylbenzene	526-73-8	21.5	107.5	84 - 122
1,2,3,4-Tetramethylbenzene	488-23-3	19.3	96.5	67 - 116
Surrogate Recovery:		98%		82 - 115

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.
[redacted]Limits updated 10/02/96 for TVHBTEX1. SWT

N. Diane Miller
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB111896	Client Project No.	: 729691-32010
Date Prepared	: 11/18/96	Lab Project No.	: 96-3996
Date Analyzed	: 11/18/96	Lab File No.	: HALL1118\012F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[redacted]
4-Chlorotoluene	106-49-8	U	
1,3-Dichlorobenzene	541-73-1	U	
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)	

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

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Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112096	Client Project No.	: 729691-32010
Date Prepared	: 11/20/96	Lab Project No.	: 96-3996
Date Analyzed	: 11/20/96	Lab File No.	: HALL1120\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW3996.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W75	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-01	Lab Project No.	: 96-3996
Date Sampled	: 11/10/96	Matrix	: Water
Date Received	: 11/11/96	Lab File No.	: HALL1118\021F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/19/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	76%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W69	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-02	Lab Project No.	: 96-3996
Date Sampled	: 11/10/96	Matrix	: Water
Date Received	: 11/11/96	Lab File No.	: HALL1118\022F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/19/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
-Chlorotoluene	95-49-8	U	0.4
-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	85%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW3996.XLS; 11/25/96

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Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W71	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-03	Lab Project No.	: 96-3996
Date Sampled	: 11/10/96	Matrix	: Water
Date Received	: 11/11/96	Lab File No.	: HALL1118\023F01
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/19/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	
4-Chlorotoluene	106-49-8	U	
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	81%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W77	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-04	Lab Project No.	: 96-3996
Date Sampled	: 11/10/96	Matrix	: Water
Date Received	: 11/11/96	Lab File No.	: HALL1118\024F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/19/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
-Chlorotoluene	95-49-8	U	0.4
-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	93%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW3996.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: Field Blank-1	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-05	Lab Project No.	: 96-3996
Date Sampled	: 11/10/96	Matrix	: Water
Date Received	: 11/11/96	Lab File No.	: HALL1120\018F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	87%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: W70	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-06	Lab Project No.	: 96-3996
Date Sampled	: 11/10/96	Matrix	: Water
Date Received	: 11/11/96	Lab File No.	: HALL1118\038F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/19/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	90%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW3996.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: Trip Blank-2	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-07	Lab Project No.	: 96-3996
Date Sampled	: 11/10/96	Matrix	: Water
Date Received	: 11/11/96	Lab File No.	: HALL1120\019F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.5
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	0.[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	78%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24 MPKS	Client Project No.	: 729691-32010
Lab Sample No.	: 96-3996-08	Lab Project No.	: 96-3996
Date Sampled	: 11/10/96	Matrix	: Water
Date Received	: 11/11/96	Lab File No.	: HALL1120\031F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	73%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW3996.XLS; 11/25/96

Method 8010 Quality Control Samples

Date Performed: 11/20/96

Reference Standard: V832

Analyte	M	Method Blank	Sample	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range % L - % H	Low - High
Vinyl Chloride	w			18.178	18.291	16.256	20.0	0.6	91%	91%		81%		28 - 163	5.60 - 32.60
Chloroethane	*			19.363	18.68	17.960	20.0	3.6	97%	93%		90%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			20.216	19.612	18.587	20.0	3.0	101%	98%		93%		28 - 167	5.60 - 33.40
Dichloromethane	*			19.494	18.851	16.707	20.0	3.4	97%	94%		84%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			22.478	17.459	22.187	20.0	25.1	112%	87%		111%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*			21.974	21.272	19.615	20.0	3.2	110%	106%		98%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*			21.962	21.508	20.357	20.0	2.1	110%	108%		102%		-	-
1,1,1-Trichloroethane	*			22.33	21.586	20.021	20.0	3.4	112%	108%		100%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			22.959	21.401	20.392	20.0	7.0	115%	107%		102%		43 - 143	8.60 - 28.60
Trichloroethene	w			22.35	21.795	21.927	20.0	2.5	112%	109%		110%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			19.81	19.718	20.658	20.0	0.5	99%	99%		103%		39 - 136	7.80 - 27.20
Tetrachloroethene	*			22.146	21.483	19.818	20.0	3.0	111%	107%		99%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			20.194	18.999	19.055	20.0	6.1	101%	95%		95%		-	-
Chlorobenzene	*			21.615	20.557	20.203	20.0	5.0	108%	103%		101%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			16.539	17.403	20.856	20.0	5.1	83%	87%		104%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			20.328	20.224	18.851	20.0	0.5	102%	101%		94%		-	-
4-Chlorotoluene	*			19.25	18.381	19.178	20.0	4.6	96%	92%		96%		-	-
1,3-Dichlorobenzene	*			20.885	18.201	18.187	20.0	13.7	104%	91%		91%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*			18.319	16.784	15.926	20.0	8.7	92%	84%		80%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "*".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:

All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:

Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must b[redacted] One recovery outside limits and the other acceptable, is a [redacted]. Repeated failure requires corrective action.
Recov[redacted]tside guidelines should be compared to historical data availa[redacted]determine if corrective action is required.

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB111496	Client Project No.	: 729691.32010
Date Extracted/Prepared	: 11/14/96	Lab Work Order	: 96-3996
Date Analyzed	: 11/14/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175M
		Matrix	: Water
		Lab File No.	: GAS1114002

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

AF3996.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W69	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3996-02	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Dilution Factor	: 1.00
Date Received	: 11/11/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114016

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	: 71 F	Saturation Concentration	Meth		
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		
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

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AF3996.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W71	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3996-03	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Dilution Factor	: 20.00
Date Received	: 11/11/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114018

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	1.76	0.04

Temperature	: 71.3 F	Saturation Concentration	Meth	0.42339496
Amount Injected	: 0.025 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	1.335783833
Head space created	: 4 ml			
Methane Area	: 492.292 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

Approved

AF3996.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W71	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3996-03Dup	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Dilution Factor	: 20.00
Date Received	: 11/11/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114019

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	1.80	0.04

Temperature	: 71.4 F	Saturation Concentration	Meth	0.4
Amount Injected	: 0.025 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	1.3661118
Head space created	: 4 ml			
Methane Area	: 503.564 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

Approved

AF3996.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W77	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3996-04	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Dilution Factor	: 20.00
Date Received	: 11/11/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114020

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.28	0.04

Temperature	: 71.5 F	Saturation Concentration	Meth	0.068180339
Amount Injected	: 0.025 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.215023545
Head space created	: 4 ml			
Methane Area	: 79.275 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.
N/A = Not Available/Not Applicable.

Analyst

Approved

AF3996.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: W70	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3996-06	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Dilution Factor	: 5.00
Date Received	: 11/11/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114021

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.02	0.01

Temperature	: 71.8 F	Saturation Concentration	Meth	0.00	g
Amount Injected	: 0.1 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.01627861	
Head space created	: 4 ml				
Methane Area	: 24.02 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

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24MPKS	Client Project No.	: 729691.32010
Lab Sample Number	: 96-3996-08	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	Dilution Factor	: 1.00
Date Received	: 11/11/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114022

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	: 72 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.
= Not Available/Not Applicable.

Analyst

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

RSKSOP-175M Gas Method
Methane Gas Matrix Spike / Matrix Spike Duplicate Report

Client Sample No.	: ST24MPKS	Client Project No.	: 729691.32010
Lab Sample No.	: 96-3996-08	Lab Work Order	: 96-3996
Date Sampled	: 11/10/96	EPA Method No.	: RSKSOP-175M
Date Received	: 11/11/96	Matrix	: Water
Date Prepared	: 11/14/96	Method Blank	: GB111496
Date Analyzed	: 11/14/96	Lab File No's.	: GAS1114023,024
E.A. MS/MSD Spike Source No.	: 1886		

Compound	Spike Added (ug)	Sample Concentration (ug)	MS Concentration (ug)	MS %REC	QC Limits %REC
Methane Gas	500	0	406	81	47-88

Compound	Spike Added (ug)	MSD Concentration (ug)	MSD %REC	RPD	QC Limits RPD	QC Limits %REC
Methane Gas	500	411	82	1.2	0-16.4	47-88

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

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

RSKSOP-175M Gas Method
Methane, Ethane, Ethene LCS Report Form

LCS No.	: LCS111496	EPA Method No.	: RSKSOP-175M
Date Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Method Blank	: GB111496
E.A. LCS Source No.	: 1719	Lab File No.	: GAS1114010

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	370	74	64-90
Ethene Gas	500	0	213	43	37-58
Ethane Gas	500	0	321	64	53-83

Spike Recovery: 0 out of (3) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane, ethane, ethene 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

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/10/96	Client Project ID.	: 729691.32010
Date Received	: 11/11/96	Lab Project Number	: 96-3996
Date Prepared	: 11/11/96	Method	: EPA 300.0
Date Analyzed	: 11/11/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride mg/L	Dilution Factor
96-3996-02	W69	Water	10.2	1
96-3996-02 Duplicate	W69 Duplicate	Water	10.5	1
96-3996-03	W71	Water	6.1	1
96-3996-04	W77	Water	4.2	1
96-3996-06	W70	Water	7.4	1
96-3996-08	ST24MPKS	Water	2.0	1
Method Blank	(11/11/96)	Water	<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-3996-02	W69 Matrix Spike	10.0	10.2	20.5	103
96-3996-02	W69 Matrix Spike Dup	10.0	10.2	20.2	100
MS/MSD RPD					3.2

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/10/96	Client Project ID.	: 729691.32010
Date Received	: 11/11/96	Lab Project Number	: 96-3996
Date Prepared	: 11/11/96	Method	: EPA 300.0
Date Analyzed	: 11/11/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N mg/L	Dilution Factor
96-3996-02	W69	Water	<0.076	1
96-3996-02 Duplicate	W69 Duplicate	Water	<0.076	1
96-3996-03	W71	Water	<0.076	1
96-3996-04	W77	Water	<0.076	1
96-3996-06	W70	Water	<0.076	1
96-3996-08	ST24MPKS	Water	<0.076	1
Method Blank	(11/11/96)	Water	<0.076	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-3996-02	W69 Matrix Spike	10.0	<0.25	9.4	94
96-3996-02	W69 Matrix Spike Dup	10.0	<0.25	9.5	95
MS/MSD RPD					1.4

* = Quality assurance results reported as Nitrite (NO_2).

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/10/96	Client Project ID.	: 729691.32010
Date Received	: 11/11/96	Lab Project Number	: 96-3996
Date Prepared	: 11/11/96	Method	: EPA 300.0
Date Analyzed	: 11/11/96	Detection Limit	: 0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N mg/L	Dilution Factor
96-3996-02	W69	Water	0.57	1
96-3996-02 Duplicate	W69 Duplicate	Water	0.57	1
96-3996-03	W71	Water	<0.056	1
96-3996-04	W77	Water	0.99	1
96-3996-06	W70	Water	<0.056	1
96-3996-08	ST24MPKS	Water	0.53	1
Method Blank	(11/11/96)	Water	<0.056	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-3996-02	W69 Matrix Spike	10.0	2.5	11.4	89
96-3996-02	W69 Matrix Spike Dup	10.0	2.5	11.6	91
MS/MSD RPD					2.2

* = 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

Date Sampled : 11/10/96
Date Received : 11/11/96
Date Prepared : 11/11/96
Date Analyzed : 11/11/96

Client Project ID. : 729691.32010
Lab Project Number : 96-3996
Method : EPA 300.0
Detection Limit : 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate mg/L	Dilution Factor
96-3996-02	W69	Water	3.5	1
96-3996-02 Duplicate	W69 Duplicate	Water	3.6	1
96-3996-03	W71	Water	<0.25	1
96-3996-04	W77	Water	14.6	1
96-3996-06	W70	Water	<0.25	1
96-3996-08	ST24MPKS	Water	1.7	1
Method Blank	(11/11/96)	Water	<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-3996-02	W69 Matrix Spike	10.0	3.5	12.7	92
96-3996-02	W69 Matrix Spike Dup	10.0	3.5	12.8	93
MS/MSD RPD					1.2

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Total Organic Carbon

Date Sampled	: 11/10/96	Client Project ID.	: 729691.32010
Date Received	: 11/11/96	Lab Project Number	: 96-3996
Date Prepared	: 11/21/96	Method	: EPA 415.1
Date Analyzed	: 11/21/96	Detection Limit	: 1.0 mg C/L

Evergreen Sample #	Client Sample ID.	Matrix	TOC	mg C/L	Dilution Factor
96-3996-08	ST24 MPKS	Water	<1.0		1
96-3996-08 Duplicate	ST24 MPKS Duplicate	Water	<1.0		1
Method Blank	(11/21/96)		<1.0		

Quality Assurance

		Spike Amount (mgC/L)	Sample Result (mgC/L)	Spike Result (mgC/L)	% Recovery
96-3996-08	ST24 MPKS Matrix Spike	10.0	<1.0	10.3	103
96-3996-08	ST24 MPKS Matrix Spike Dup	10.0	<1.0	10.4	104
MS/MSD RPD					1.3

Analyst

Approved

CUSTOMER #:
[redacted]02604

HUFFMAN
LABORATORIES, INC.
Quality Analytical Services Since 1936
4630 Indiana Street • Golden, CO 80403
Phone: (303) 278-4455 • FAX: (303) 278-7012

DATE 12/4/96
LAB# 234196
P.O. SEE BELOW
RECD 11/20/96

ANALYSIS REPORT

PATTY MC CLELLEN
EVERGREEN ANALYTICAL, INC
4036 YOUNGFIELD STREET
WHEAT RIDGE CO 80033

P.O. # 013549 & 013550/PROJ 96-3990 & 96-3996

SEQUENCE/ SAMPLE ID	96-3990-02 01 LF6-MPJ (18')	96-3996-09 02 LF6-MPL (14-18)	96-3990-03 03 ST24-MPF(16-18)
CARBONATE C---%	<0.02	<0.02	<0.02
TOTAL CARBON--%	<0.05	<0.05	<0.05
ORGANIC C-----%	<0.05	<0.05	<0.05

[redacted]SAMPLES ARE NOT HOMOGENEOUS.

Percent Moisture	15.3%	14.09%	10.6%
Dry Wt. Result	< 0.06	< 0.06	< 0.06

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Analysis Report

Date Sampled	: 11/10/96	Client Project ID.	: 729691.32010
Date Received	: 11/11/96	Lab Project Number	: 96-3996
Date Prepared	: 11/14/96	Method	: EPA 310.1
Date Analyzed	: 11/14/96	Detection Limit	: 5.0 mg $CaCO_3$/L

Evergreen Sample #	Client Sample ID.	Matrix	Total Alkalinity (mg $CaCO_3$/L)	Dilution Factor
96-3996-08	ST24MPKS	Water	9.8	1
96-3996-08 Duplicate	ST24MPKS Duplicate	Water	9.9	1
Method Blank	(11/14/96)		<5.0	

Quality Assurance

Reference	True Value (mg$CaCO_3$/L)	Result (mg$CaCO_3$/L)	% Recovery
ERA Minerals	120	112	94

Lot # 0725-96-11

Analyst

Approved

Evergreen Analytical, Inc.

96-4004

WORK ORDER Summary

15-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Phone: (303) 831-8100
FAX: (303) 831-8208

Client Project ID: 729691-32010

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4004-02A	ST24-MPA(9'-11')	% Moisture for dry weight calculation		Soil	D2	11-Nov-96	12-Nov-96	26-Nov-96	09-Dec-96
96-4004-01H	ST24-MPK(D)	Anions by IC Cl,NO2,NO3,SO4		Water				26-Nov-96	13-Nov-96
96-4004-03H	ST24-MPE	Anions by IC Cl,NO2,NO3,SO4						26-Nov-96	13-Nov-96
96-4004-04H	ST24-MPA	Anions by IC Cl,NO2,NO3,SO4						26-Nov-96	13-Nov-96
96-4004-05H	ST24-MPG	Anions by IC Cl,NO2,NO3,SO4						26-Nov-96	13-Nov-96
96-4004-06H	ST24-W70(D)	Anions by IC Cl,NO2,NO3,SO4						26-Nov-96	13-Nov-96
96-4004-01D	ST24-MPK(D)	BTEX (Parsons List)			2			26-Nov-96	25-Nov-96
96-4004-02A	ST24-MPA(9'-11')	BTEX (Parsons List)		Soil	D2			26-Nov-96	25-Nov-96
96-4004-03D	ST24-MPE	BTEX (Parsons List)		Water	2			26-Nov-96	25-Nov-96
96-4004-04D	ST24-MPA	BTEX (Parsons List)						26-Nov-96	25-Nov-96
96-4004-05D	ST24-MPG	BTEX (Parsons List)						26-Nov-96	25-Nov-96
96-4004-06D	ST24-W70(D)	BTEX (Parsons List)						26-Nov-96	25-Nov-96
96-4004-07A	Trip Blank #3	BTEX (Parsons List)			9			26-Nov-96	25-Nov-96
96-4004-01I	ST24-MPK(D)	Methane			2			26-Nov-96	25-Nov-96
96-4004-03I	ST24-MPE	Methane						26-Nov-96	25-Nov-96
96-4004-04I	ST24-MPA	Methane						26-Nov-96	25-Nov-96
96-4004-05I	ST24-MPG	Methane						26-Nov-96	25-Nov-96
96-4004-06I	ST24-W70(D)	Methane						26-Nov-96	25-Nov-96
96-4004-01A	ST24-MPK(D)	Purgeable Halocarbons 8010			9			26-Nov-96	25-Nov-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

11/15/96

Evergreen Analytical, Inc.

96-4004

WORK ORDER Summary

15-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691-32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4004-02A	ST24-MPA(9'-11')	Purgeable Halocarbons 8010		Soil	D2	11-Nov-96	12-Nov-96	26-Nov-96	25-Nov-96
96-4004-03A	ST24-MPE	Purgeable Halocarbons 8010		Water	9			26-Nov-96	25-Nov-96
96-4004-04A	ST24-MPA	Purgeable Halocarbons 8010						26-Nov-96	25-Nov-96
96-4004-05A	ST24-MPG	Purgeable Halocarbons 8010						26-Nov-96	25-Nov-96
96-4004-06A	ST24-W70(D)	Purgeable Halocarbons 8010						26-Nov-96	25-Nov-96
96-4004-07A	Trip Blank #3	Purgeable Halocarbons 8010						26-Nov-96	25-Nov-96
96-4004-01L	ST24-MPK(D)	Total Alkalinity			D2			26-Nov-96	25-Nov-96
		Total Organic Carbon						26-Nov-96	09-Dec-96
96-4004-02C	ST24-MPA(9'-11')	TRPH		Soil				26-Nov-96	09-Dec-96
96-4004-01D	ST24-MPK(D)	TVH (Gasoline)		Water	2			26-Nov-96	25-Nov-96
96-4004-03D	ST24-MPE	TVH (Gasoline)						26-Nov-96	25-Nov-96
96-4004-04D	ST24-MPA	TVH (Gasoline)						26-Nov-96	25-Nov-96
96-4004-05D	ST24-MPG	TVH (Gasoline)						26-Nov-96	25-Nov-96
96-4004-06D	ST24-W70(D)	TVH (Gasoline)						26-Nov-96	25-Nov-96

= Special list See sample comments or test information

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 Suite 900
CITY Denver STATE CO ZIP 80290
PHONE# (303) 831-8100 FAX # (303) 831-8208 FAX RESULTS Y / N

Sampler Name:
(signature) [signature]
(print) Brad Lewis

CLIENT CONTACT (print) Jenny Hartfelder
CLIENT PROJ. I.D. 729691-32010
EAL. QUOTE # P.O.# 729691-32010
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ UST
☐ Other (Specify)*
*expedited turnaround subject to additional fee

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid / Air / Gas	MATRIX: Oil / Sludge / Multi-phase	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle) 8010	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	Anions (Cl, NO3, SO4)	Methane GC 4Ov	TOC/Alkalinity
ST24-MPK(D)	11/11/96	0750	12	X			X						X	X							X	X	X
ST24-MPA(9'-11')	11/11/96	0730	2		X		X						X							X				
ST24-MPE	11/11/96	1000	11	X			X						X	X							X	X	
ST24-MPA	11/11/96	1330	11	X			X						X	X							X	X	
ST24-MPG	11/11/96	1515	11	X			X						X	X							X	X	
ST24-W70(D)	11/11/96	1715	11	X			X						X	X							X	X	
Trip Blank #3	11/11/96		1				X						X										
Sample Fraction							40V						40V							125P	40V	125P	
Instructions:							8260						8260							H	HX	L	

EAL use only
Do not write in shaded area
W.O. # 96-4004
B.O.F. #
C/S (O) 113 / 1050
C/S (I) 113 / 1050
Cooler Temp. °C 4
Seals Intact Y / N (NA)
Samples Pres. (Y) / N / NA
Headspace Y / N / NA
Loc 40M
Cont 1, 2, 2

3 Vials rec'd for ST24-MPK(D) not marked on C.O.C.
ST24 prefix not on sample bottle labels for ST24-W70(D)

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
[signature]	11/11/96 1840	PhBlack	11/12/96 09:10				

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	: MB2111396	Client Project Number	: 729691-32010
Date Prepared	: 11/13/96	Lab Work Order	: 96-4004
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB2113007

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/13/96	U	0.1	mg/L
Benzene	71-43-2	11/13/96	U	0.4	ug/L
Toluene	108-88-3	11/13/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/13/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/13/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/13/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/13/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/13/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/13/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/13/96	U	0.5	ug/L
FID Surrogate Recovery:		100%		70%-126%	
PID Surrogate Recovery:		101%		76%-127%	

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.

M. Becker
Analyst

K. Hollman
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	: MB2111496	Client Project Number	: 729691-32010
Date Prepared	: 11/14/96	Lab Work Order	: 96-4004
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB2113021

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	U	0.1	mg/L
Benzene	71-43-2	11/14/96	U	0.4	ug/L
Toluene	108-88-3	11/14/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	U	0.5	ug/L
Surrogate Recovery:		88%		70%-126%	(Limits)
D Surrogate Recovery:		93%		76%-127%	(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.

M. Bleha
Analyst

K Hollman
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	: MB3111396	Client Project Number	: 729691-32010
Date Prepared	: 11/13/96	Lab Work Order	: 96-4004
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB31111055

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	NA	NA	NA	mg/L
Benzene	71-43-2	11/13/96	U	0.4	ug/L
Toluene	108-88-3	11/13/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/13/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/13/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/13/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/13/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/13/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/13/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/13/96	U	0.5	ug/L
FID Surrogate Recovery:		NA		70%-126%	(Li
PID Surrogate Recovery:		98%		76%-127%	(Li

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.

M. Blecha
Analyst

K. Hollman
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	: MEB111496	Client Project Number	: 729691-32010
Date Prepared	: 11/14/96	Lab Work Order	: 96-4004
Dilution Factor	: 125	Matrix	: WATER/MeOH
		Lab File Number	: TVB31111084

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	NA	NA	NA	NA
Benzene	71-43-2	11/14/96	U	500	ug/kg
Toluene	108-88-3	11/14/96	U	500	ug/kg
Chlorobenzene	108-90-7	11/14/96	U	500	ug/kg
Ethyl Benzene	100-41-4	11/14/96	U	500	ug/kg
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	500	ug/kg
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	500	ug/kg
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	500	ug/kg
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	500	ug/kg
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	U	625	ug/kg
Surrogate Recovery:		NA		50%-150%	(Limits)
Surrogate Recovery:		93%		50%-150%	(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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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.

M. Bleaha
Analyst

K. Hillman
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	: ST24-MPK(D)	Client Project Number	: 729691-32010
Lab Sample Number	: 96-4004-01	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Matrix	: WATER
Date Received	: 11/12/96	Lab File Number(s)	: TVB2113008
Date Prepared	: 11/13/96	Method Blank	: MB2111396
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/13/96	U	0.1	mg/L
Benzene	71-43-2	11/13/96	U	0.4	ug/L
Toluene	108-88-3	11/13/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/13/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/13/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/13/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/13/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/13/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/13/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/13/96	U	0.5	
FID Surrogate Recovery:		93%		70%-126%	(Lim
PID Surrogate Recovery:		98%		76%-127%	(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.

M. Blecha
Analyst

K. Hollman
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	: ST24-MPA(9'-11')	Client Project Number	: 729691-32010
Lab Sample Number	: 96-4004-02	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Matrix	: SOIL
Date Received	: 11/12/96	Lab File Number(s)	: TVB31111071
Date Prepared	: 11/13/96	Method Blank	: MB3111196
FID Dilution Factor	: 5.0	Soil Extracted?	: NO
PID Dilution Factor	: 5.0	Soil moisture	: 10.71%

Compound Name	Cas Number	Analysis Date	Sample# Concentration		RL#	Units
TVH-Gasoline	----	NA		NA	NA	NA
Benzene	71-43-2	11/13/96		U	2.0	ug/kg
Toluene	108-88-3	11/13/96		U	2.0	ug/kg
Chlorobenzene	108-90-7	11/13/96		U	2.0	ug/kg
Ethyl Benzene	100-41-4	11/13/96		U	2.0	ug/kg
Total Xylenes (m,p,o)	1330-20-7	11/13/96	30		2.0	ug/kg
1,3,5-Trimethylbenzene	108-67-8	11/13/96	390		2.0	ug/kg
1,2,4-Trimethylbenzene	95-63-6	11/13/96	840	E+	2.0	ug/kg
1,2,3-Trimethylbenzene	526-73-8	11/13/96	310		2.0	ug/kg
1,2,3,4-Tetramethylbenzene	488-23-3	11/13/96	120		2.5	ug/kg
FID Surrogate Recovery:		NA			50%-150%	(Limits)
PID Surrogate Recovery:		123%			50%-150%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: + = 1,2,4-TMB was reanalyzed at DF=125 (TVB31111085/MEB111496) resulting in undetected (U) results. The sample was probably not homogeneous.
Based on dry weight.

QUALIFIERS and DEFINITIONS:

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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.

M. Blecha
Analyst

K Hollman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St.
Wheat Ridge, CO 80033
(303) 425-6021

SAMPLE Number	: ST24-MPA(9'-11')
% WET SOIL	: 10.71%
Dilution Factor	: 5.0
Lab File No.	: 96-4004-02

Compound Name	Number	ug/Kg	% DRY
TVH-Gasoline	---	1400.0 14.17	~~1567.9~~ 15.84 =16
Benzene	71-43-2		0.0
Toluene	108-88-3	0.4	~~0.5~~ U@2.2
Chlorobenzene	108-90-7		0.0
Ethyl Benzene	100-41-4	1.1	~~1.3~~ U@2.2
m,p-Xylene	108-38-3	16.0	18.0
o-Xylene	106-42-3 95-47-6	10.3	11.6
TOTAL XYLENE			29.6
1,3,5-Trimethylbenzene	108-67-8	345.0	386.4
1,2,4-Trimethylbenzene	95-63-6	752.1	842.3
1,2,3-Trimethylbenzene	526-73-8	280.1	313.7
1,2,3,4-Tetramethylbenzene	488-23-3	110.0	123.2

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	: ST24-MPE	Client Project Number	: 729691-32010
Lab Sample Number	: 96-4004-03	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Matrix	: WATER
Date Received	: 11/12/96	Lab File Number(s)	: TVB2113011,025
Date Prepared	: 11/13,14/96	Method Blanks	: MB2111396, MB2111496
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0; 10		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/13/96	1.5	0.1	mg/L
Benzene	71-43-2	11/13/96	73	0.4	ug/L
Toluene	108-88-3	11/13/96	2.0	0.4	ug/L
Chlorobenzene	108-90-7	11/13/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	99	4.0	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/13/96	1.2	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/13/96	1.7	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/13/96	2.2	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/13/96	1.3	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/13/96	68	0.5	ug/L
PID Surrogate Recovery:		145% *		70%-126%	(Limits)
PID Surrogate Recovery:		133% *; 98%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: * = High Surrogate Recovery due to hydrocarbon interference.

QUALIFIERS and DEFINITIONS:

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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.

M. Bleiler
Analyst

K. Hollman
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	: ST24-MPA	Client Project Number	: 729691-32010
Lab Sample Number	: 96-4004-04	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Matrix	: WATER
Date Received	: 11/12/96	Lab File Number(s)	: TVB2113013,026
Date Prepared	: 11/13,14/96	Method Blanks	: MB2111396, MB2111496
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0; 100		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	2.0	0.1	mg/L
Benzene	71-43-2	11/14/96	43	0.4	ug/L
Toluene	108-88-3	11/14/96	470	40	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	45	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	140	40	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	23	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	70	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	21	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	9.6	0.5	ug/L
FID Surrogate Recovery:		104%		70%-126%	(Lim
PID Surrogate Recovery:		104%; 97%		76%-127%	(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.

M. Blecha
Analyst

K. Hollman
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	: ST24-MPG	Client Project Number	: 729691-32010
Lab Sample Number	: 96-4004-05	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Matrix	: WATER
Date Received	: 11/12/96	Lab File Number(s)	: TVB2113014
Date Prepared	: 11/13/96	Method Blank	: MB2111396
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	U	0.1	mg/L
Benzene	71-43-2	11/14/96	U	0.4	ug/L
Toluene	108-88-3	11/14/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	U	0.5	ug/L
FID Surrogate Recovery:		99%		70%-126%	(Limits)
PID Surrogate Recovery:		101%		76%-127%	(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.

M. Blecha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: ST24-W70(D)	Client Project Number	: 729691-32010
Lab Sample Number	: 96-4004-06	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Matrix	: WATER
Date Received	: 11/12/96	Lab File Number(s)	: TVB2113019,28
Date Prepared	: 11/13,14/96	Method Blanks	: MB2111396, MB2111496
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0; 100		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	2.8	0.1	mg/L
Benzene	71-43-2	11/14/96	230	40	ug/L
Toluene	108-88-3	11/14/96	11	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	120	40	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	240	40	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	54	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	270	40	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	60	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	31	0.5	ug/L
FID Surrogate Recovery:		114%		70%-126%	(Limits)
PID Surrogate Recovery:		106%; 97%		76%-127%	(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.

M. Blecha
Analyst

Ann McCall
Approved

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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: TRIP BLANK#3	Client Project Number	: 729691-32010
Lab Sample Number	: 96-4004-07	Lab Work Order	: 96-4004
Date Sampled	: NA	Matrix	: WATER
Date Received	: 11/12/96	Lab File Number(s)	: TVB2113024
Date Prepared	: 11/14/96	Method Blank	: MB2111496
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	U	0.1	mg/L
Benzene	71-43-2	11/14/96	U	0.4	ug/L
Toluene	108-88-3	11/14/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	U	0.5	ug/L
FID Surrogate Recovery:		88%		70%-126%	(Limits)
PID Surrogate Recovery:		97%		76%-127%	(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.

M. Blecha
Analyst

PM McClellan
Approved

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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: ST24-MPK(D)	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4004-01	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	EPA Method No.	: 5030/8015 Modified
Date Received	: 11/12/96	Matrix	: WATER
Date Prepared	: 11/14/96	Lab File Number(s)	: TVB2113009,010
Date Analyzed	: 11/14/96	Method Blank	: MB2111496
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	1.92	96.1%	55 - 128
Surrogate **	---	---	---	109%	70 - 130

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC Limits RPD	QC Limits %REC
Gasoline	2.00	2.00	100.1%	4.0	50	50 - 150
Surrogate **	---	---	112%	NA	NA	70 - 130

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

Comments:

M. Bleeker
Analyst

K Hollman
Approved

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(303) 425-6021

EPA 602/8020 Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: ST24-MPG	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4004-05	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	EPA Method No.	: 602/8020
Date Received	: 11/12/96	Matrix	: WATER
Date Prepared	: 11/13,14/96	Lab File Number(s)	: TVB2113022,16
Date Analyzed	: 11/14/96	Method Blanks	: MB21113/1496
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	21.7	20.5	
Toluene	20.0	0.0	21.0	19.8	
Chlorobenzene	20.0	0.0	20.9	19.5	
Ethylbenzene	20.0	0.0	21.1	19.8	
m,p-Xylene	20.0	0.0	21.1	19.8	
o-Xylene	20.0	0.0	20.9	19.6	
1,3,5-TMB	20.0	0.0	14.4	11.1	
1,2,4-TMB	20.0	0.0	20.2	18.7	
1,2,3-TMB	20.0	0.0	20.9	19.1	
1,2,3,4-TeMB	20.0	0.0	20.2	18.1	
Surrogate	100.0	101%	102%	92%	% RECOVERY

Compound		MS % RECOVERY		MSD % RECOVERY		RPD		QC# Limits RPD	QC# Limits %REC
Benzene		108.5		102.5		5.7		17	61 - 129
Toluene		105.0		99.0		5.9		18	61 - 127
Chlorobenzene		104.5		97.5		6.9		16	68 - 122
Ethylbenzene		105.5		99.0		6.4		18	63 - 126
m,p-Xylene		105.5		99.0		6.4		18	60 - 130
o-Xylene		104.5		98.0		6.4		18	62 - 128
1,3,5-TMB		72.0		55.5	*	25.9	*	18	69 - 117
1,2,4-TMB		101.0		93.5		7.7		23	69 - 119
1,2,3-TMB		104.5		95.5		9.0		16	71 - 118
1,2,3,4-TeMB		101.0		90.5		11.0		27	67 - 125
Surrogate		102.0		92.0		NA		NA	76 - 127

= Limits established 10/15/96, KSH
* = Values outside of QC limits.

RPD: 1 out of (10) outside limits.
Spike Recovery: 1 out of (20) outside limits.

Comments: * = Spike was reanalyzed with a similar low recovery.
See LCS2111396-BTEX and LCS2111496-BTEX.

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Analyst

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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS3111396-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/13/96	Method	: 602/8020
Date Analyzed	: 11/13/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB31111054

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit % Recovery
Benzene	71-43-2	19.1	95.5	50 - 150
Toluene	108-88-3	18.9	94.5	50 - 150
Chlorobenzene	108-90-7	17.6	88.0	50 - 150
Ethyl Benzene	100-41-4	19.0	95.0	50 - 150
m,p-Xylene	108-38-3	37.4	93.5	50 - 150
o-Xylene	106-42-3 95-47-6	18.9	94.5	50 - 150
MTBE	1634-04-4	20.0	100.0	50 - 150
1,3,5-Trimethylbenzene	108-67-8	19.5	97.5	50 - 150
1,2,4-Trimethylbenzene	95-63-6	17.9	89.5	50 - 150
1,2,3-Trimethylbenzene	526-73-8	21.9	109.5	50 - 150
1,2,3,4-Tetramethylbenzene	488-23-3	19.1	95.5	50 - 150
Surrogate Recovery:		88%		70 - 130

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.

M. Blecha
Analyst

Approved

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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS3111496-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/14/96	Method	: 602/8020
Date Analyzed	: 11/14/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB31111086

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit % Recovery
Benzene	71-43-2	18.8	94.0	50 - 150
Toluene	108-88-3	18.5	92.5	50 - 150
Chlorobenzene	108-90-7	17.5	87.5	50 - 150
Ethyl Benzene	100-41-4	18.8	94.0	50 - 150
m,p-Xylene	108-38-3	40.0	100.0	50 - 150
[redacted]ne	106-42-3 95-47-6	18.8	94.0	50 - 150
MTBE	1634-04-4	20.2	101.0	50 - 150
1,3,5-Trimethylbenzene	108-67-8	19.6	98.0	50 - 150
1,2,4-Trimethylbenzene	95-63-6	18.0	90.0	50 - 150
1,2,3-Trimethylbenzene	526-73-8	21.9	109.5	50 - 150
1,2,3,4-Tetramethylbenzene	488-23-3	19.9	99.5	50 - 150
Surrogate Recovery:		99%		70 - 130

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.
N = [redacted]lot available/Not analyzed.

Analyst

Approved

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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS2111396-GAS	Matrix	: WATER
Date Prepared	: 11/13/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/13/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVB2113003		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.16	108.0	81 - 128
Surrogate Recovery:		123%		70 - 126

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 10/1/96 for TVHBTEX2. MAB

M. Bleeker
Analyst

K. Hollman
Approved

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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS2111396-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/13/96	Method	: 602/8020
Date Analyzed	: 11/13/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB2113004

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	20.8	104.0	75 - 116
Toluene	108-88-3	20.3	101.5	75 - 118
Chlorobenzene	108-90-7	18.3	91.5	73 - 115
Ethyl Benzene	100-41-4	19.9	99.5	80 - 122
m,p-Xylene	108-38-3	38.6	96.5	76 - 120
[redacted]ene	106-42-3 95-47-6	20.1	100.5	76 - 118
MTBE	1634-04-4	21.4	107.0	75 - 115
1,3,5-Trimethylbenzene	108-67-8	19.8	99.0	64 - 118
1,2,4-Trimethylbenzene	95-63-6	18.2	91.0	75 - 111
1,2,3-Trimethylbenzene	526-73-8	22.6	113.0	82 - 127
1,2,3,4-Tetramethylbenzene	488-23-3	20.7	103.5	72 - 131
Surrogate Recovery:		106%		76 - 127

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.
N[redacted]Not available/Not analyzed.
[redacted]Limits established 10/1/96 for TVHBTEX2. MAB

M. Rheaton
Analyst

K. Hillman
Approved

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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS2111496-GAS	Matrix	: WATER
Date Prepared	: 11/14/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/14/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVB2113030		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.26	112.9	81 - 128
Surrogate Recovery:		87%		70 - 126

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 10/1/96 for TVHBTEX2. MAB

M. Bleeks
Analyst

K Hollman
Approved

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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS2111496-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/14/96	Method	: 602/8020
Date Analyzed	: 11/14/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB2113031

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	21.1	105.5	75 - 116
Toluene	108-88-3	20.5	102.5	75 - 118
Chlorobenzene	108-90-7	18.7	93.5	73 - 115
Ethyl Benzene	100-41-4	20.3	101.5	80 - 122
m,p-Xylene	108-38-3	39.4	98.5	76 - 120
[redacted]ne	106-42-3 95-47-6	20.6	103.0	76 - 118
MTBE	1634-04-4	20.1	100.5	75 - 115
1,3,5-Trimethylbenzene	108-67-8	20.9	104.5	64 - 118
1,2,4-Trimethylbenzene	95-63-6	18.6	93.0	75 - 111
1,2,3-Trimethylbenzene	526-73-8	23.1	115.5	82 - 127
1,2,3,4-Tetramethylbenzene	488-23-3	21.0	105.0	72 - 131
Surrogate Recovery:		100%		76 - 127

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.
N[redacted]lot available/Not analyzed.
*[redacted]Limits established 10/1/96 for TVHBTEX2. MAB

M. Blecha
Analyst

K Hollman
Approved

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Method 8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB111896	Client Project No.	: 729691-32010
Date Prepared	: 11/18/96	Lab Project No.	: 96-4004
Date Analyzed	: 11/18/96	Lab File No.	: HALL1118\012F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)	

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4004.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
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Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112096	Client Project No.	: 729691-32010
Date Prepared	: 11/20/96	Lab Project No.	: 96-4004
Date Analyzed	: 11/20/96	Lab File No.	: HALL1120\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4004.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPK(D)	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4004-01	Lab Project No.	: 96-4004
Date Sampled	: 11/11/96	Matrix	: Water
Date Received	: 11/12/96	Lab File No.	: HALL1120\021F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	76%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

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HLW4004.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPA(9'-11')	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4004-02	Lab Project No.	: 96-4004
Date Sampled	: 11/11/96	Matrix	: SOIL
Date Received	: 11/12/96	Lab File No.	: HALL1120\016F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.1
Percent Moisture	: 10.71		

Compound	CAS #	Concentration(ug/Kg)	RL(ug/Kg)
Vinyl Chloride	75-01-4	U	0.45
Chloroethane	75-00-3	U	0.45
1,1-Dichloroethene	75-35-4	U	0.45
Dichloromethane	75-09-2	U	0.45
trans-1,2-Dichloroethene	156-60-5	U	0.45
1,1-Dichloroethane	75-34-3	U	0.45
cis-1,2-Dichloroethene	156-59-4	U	0.45
1,1,1-Trichloroethane	71-55-6	U	0.45
Carbon Tetrachloride	56-23-5	U	0.45
Trichloroethene	79-01-6	U	0.45
1,1,2-Trichloroethane	79-00-5	U	0.45
Tetrachloroethene	127-18-4	U	0.45
1,1,1,2-Tetrachloroethane	79-00-5	U	0.45
Chlorobenzene	108-90-7	U	0.47
1,1,2,2-Tetrachloroethane	79-34-5	U	0.6
2-Chlorotoluene	95-49-8	U	0.45
4-Chlorotoluene	106-49-8	U	0.45
1,3-Dichlorobenzene	541-73-1	U	0.45
1,2-Dichlorobenzene	95-50-1	U	0.45

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPE	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4004-03	Lab Project No.	: 96-4004
Date Sampled	: 11/11/96	Matrix	: Water
Date Received	: 11/12/96	Lab File No.	: HALL1118\033F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/19/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	85%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPA	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4004-04	Lab Project No.	: 96-4004
Date Sampled	: 11/11/96	Matrix	: Water
Date Received	: 11/12/96	Lab File No.	: HALL1118\034F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/19/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	81%	70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPG	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4004-05	Lab Project No.	: 96-4004
Date Sampled	: 11/11/96	Matrix	: Water
Date Received	: 11/12/96	Lab File No.	: HALL1118\035F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/19/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	
4-Chlorotoluene	106-49-8	U	
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	84%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-W70(D)	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4004-06	Lab Project No.	: 96-4004
Date Sampled	: 11/11/96	Matrix	: Water
Date Received	: 11/12/96	Lab File No.	: HALL1118\036F0101
Date Prepared	: 11/18/96	Method Blank	: RB111896
Date Analyzed	: 11/19/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	82%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: Trip Blank #3	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4004-07	Lab Project No.	: 96-4004
Date Sampled	: 11/11/96	Matrix	: Water
Date Received	: 11/12/96	Lab File No.	: HALL1120\022F010
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.5
2-Chlorotoluene	95-49-8	U	0
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	80%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB111496	Client Project No.	: 729691.32010
Date Extracted/Prepared	: 11/14/96	Lab Work Order	: 96-4004
Date Analyzed	: 11/14/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175M
		Matrix	: Water
		Lab File No.	: GAS1114002

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.
N/A = Not Available/Not Applicable.

Analyst

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24-MPK(D)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4004-01	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Dilution Factor	: 1.00
Date Received	: 11/12/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114029

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		
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		
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

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24-MPE	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4004-03	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Dilution Factor	: 1.00
Date Received	: 11/12/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114030

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.043	0.002

Temperature	: 71.7 F	Saturation Concentration	Meth	0.010383236
Amount Injected	: 0.5 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.032733768
Head space created	: 4 ml			
Methane Area	: 241.457 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.
N/A = Not Available/Not Applicable.

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24-MPA	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4004-04	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Dilution Factor	: 1.00
Date Received	: 11/12/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114031

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.120	0.002

Temperature	: 72 F	Saturation Concentration	Meth	0.02	
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.0910251	
Head space created	: 4 ml				
Methane Area	: 671.816 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

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24-MPA	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4004-04Dup	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Dilution Factor	: 1.00
Date Received	: 11/12/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114032

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.119	0.002

Temperature	: 71.9 F	Saturation Concentration	Meth	0.02861394	
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.09017319	
Head space created	: 4 ml				
Methane Area	: 665.403 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.
= Not Available/Not Applicable.

Analyst

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24-MPG	Client Project No.	: 729[illegible]91.32010
Lab Sample Number	: 96-4004-05	Lab Work Order	: 96-[illegible]004
Date Sampled	: 11/11/96	Dilution Factor	: 1.0[illegible]
Date Received	: 11/12/96	Method	: RSK SOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: G[illegible]S1114033

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	: 72.4 F	Saturation Concentration	Meth		
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		
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.

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EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24-W70(D)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4004-06	Lab Work Order	: 96-4004
Date Sampled	: 11/11/96	Dilution Factor	: 1.00
Date Received	: 11/12/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114034

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.093	0.002

[illegible]perature	: 73.3 F	Saturation Concentration	Meth	0.022485321
[illegible]mount Injected	: 0.5 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.0706734
Head space created	: 4 ml			
Methane Area	: 522.885 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.
[illegible] = Not Available/Not Applicable.

Analyst

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

RSKSOP-175M Gas Method
Methane, Ethane, Ethene LCS Report Form

LCS No.	: LCS111496	EPA Method No.	: RSKSOP-175M
Date Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Method Blank	: GB111496
E.A. LCS Source No.	: 1719	Lab File No.	: GAS1114010

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	370	74	64-90
Ethene Gas	500	0	213	43	37-58
Ethane Gas	500	0	321	64	53-83

Spike Recovery: 0 out of (3) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane, ethane, ethene 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

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/11/96	Client Project ID.	: 729691.32010
Date Received	: 11/12/96	Lab Project Number	: 96-4004
Date Prepared	: 11/12/96	Method	: EPA 300.0
Date Analyzed	: 11/12/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride mg/L	Dilution Factor
96-4004-01	ST24-MPK(D)	Water	2.0	1
96-4004-03	ST24-MPE	Water	3.8	1
96-4004-04	ST24-MPA	Water	11.2	1
96-4004-04 Duplicate	ST24-MPA Duplicate	Water	10.9	1
96-4004-05	ST24-MPG	Water	3.5	1
96-4004-06	ST24-W70(D)	Water	2.3	1
Method Blank	(11/12/96)	Water	<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4004-04	ST24-MPA Matrix Spike	10.0	11.2	20.5	93
96-4004-04	ST24-MPA Matrix Spike Dup	10.0	11.2	20.9	97
MS/MSD RPD					4.1

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/11/96	Client Project ID.	: 729691.32010
Date Received	: 11/12/96	Lab Project Number	: 96-4004
Date Prepared	: 11/12/96	Method	: EPA 300.0
Date Analyzed	: 11/12/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N mg/L	Dilution Factor
96-4004-01	ST24-MPK(D)	Water	<0.076	1
96-4004-03	ST24-MPE	Water	<0.076	1
96-4004-04	ST24-MPA	Water	<0.076	1
96-4004-04 Duplicate	ST24-MPA Duplicate	Water	<0.076	1
96-4004-05	ST24-MPG	Water	<0.076	1
96-4004-06	ST24-W70(D)	Water	<0.076	1
Method Blank	(11/12/96)	Water	<0.076	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4004-04	ST24-MPA Matrix Spike	10.0	<0.25	9.2	92
96-4004-04	ST24-MPA Matrix Spike Dup	10.0	<0.25	9.4	94
MS/MSD RPD					2.2

* = Quality assurance results reported as Nitrite (NO_2).

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/11/96	Client Project ID.	: 729691.32010
Date Received	: 11/12/96	Lab Project Number	: 96-4004
Date Prepared	: 11/12/96	Method	: EPA 300.0
Date Analyzed	: 11/12/96	Detection Limit	: 0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N mg/L	Dilution Factor
96-4004-01	ST24-MPK(D)	Water	1.7	1
96-4004-03	ST24-MPE	Water	<0.056	1
96-4004-04	ST24-MPA	Water	<0.056	1
96-4004-04 Duplicate	ST24-MPA Duplicate	Water	<0.056	1
96-4004-05	ST24-MPG	Water	2.1	1
96-4004-06	ST24-W70(D)	Water	<0.056	1
Method Blank	(11/12/96)	Water	<0.056	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4004-04	ST24-MPA Matrix Spike	10.0	<0.25	9.3	93
96-4004-04	ST24-MPA Matrix Spike Dup	10.0	<0.25	9.2	92
MS/MSD RPD					0.6

* = 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

Date Sampled	: 11/11/96	Client Project ID.	: 729691.32010
Date Received	: 11/12/96	Lab Project Number	: 96-4004
Date Prepared	: 11/12/96	Method	: EPA 300.0
Date Analyzed	: 11/12/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate mg/L	Dilution Factor
96-4004-01	ST24-MPK(D)	Water	0.42	1
96-4004-03	ST24-MPE	Water	1.5	1
96-4004-04	ST24-MPA	Water	1.8	1
96-4004-04 Duplicate	ST24-MPA Duplicate	Water	1.8	1
96-4004-05	ST24-MPG	Water	0.45	1
96-4004-06	ST24-W70(D)	Water	<0.25	1
Method Blank	(11/12/96)	Water	<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4004-04	ST24-MPA Matrix Spike	10.0	1.8	10.5	88
96-4004-04	ST24-MPA Matrix Spike Dup	10.0	1.8	10.5	88
MS/MSD RPD					0

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Total Recoverable Petroleum Hydrocarbons

Date Sampled	: 11/11/96	Client Project ID.	: 729691-32010
Date Received	: 11/12/96	Lab Project Number	: 96-4004
Date Prepared	: 11/13/96	Method	: EPA 418.1
Date Analyzed	: 11/13/96		

Evergreen Sample #	Client Sample ID.	Matrix	TRPH	Units
96-4004-02	ST24-MPA(9'-11')	Soil	7.9	mg/Kg
96-4004-02 Duplicate	ST24-MPA(9'-11') Duplicate	Soil	6.9	mg/Kg

Method Blank (11/13/96) subtracted	3.4	mg/Kg

Results reported on a dry weight basis.

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Total Organic Carbon

Date Sampled	: 11/11/96	Client Project ID.	: 729691.32010
Date Received	: 11/12/96	Lab Project Number	: 96-4004
Date Prepared	: 11/21/96	Method	: EPA 415.1
Date Analyzed	: 11/21/96	Detection Limit	: 1.0 mg C/L

Evergreen Sample #	Client Sample ID.	Matrix	TOC	mg C/L	Dilution Factor
96-4004-01	ST24-MPK (D)	Water	<1.0		1
96-4004-01 Duplicate	ST24-MPK (D) Duplicate	Water	<1.0		1
Method Blank	(11/21/96)		<1.0		

Quality Assurance

		Spike Amount (mgC/L)	Sample Result (mgC/L)	Spike Result (mgC/L)	% Recovery
96-3996					
96-3996-08	ST24 MPKS Matrix Spike	10.0	<1.0	10.3	103
96-3996-08	ST24 MPKS Matrix Spike Dup	10.0	<1.0	10.4	104
MS/MSD RPD					1.3

Analyst

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Analysis Report

Date Sampled	: 11/11/96	Client Project ID.	: 729691-32010
Date Received	: 11/12/96	Lab Project Number	: 96-4004
Date Prepared	: 11/14/96	Method	: EPA 310.1
Date Analyzed	: 11/14/96	Detection Limit	: 5.0 mg $CaCO_3$/L

Evergreen Sample #	Client Sample ID.	Matrix	Total Alkalinity (mg $CaCO_3$/L)	Dilution Factor
96-4004-01	ST24-MPK (D)	Water	<5.0	1
96-4004-01 Duplicate	ST24-MPK (D) Duplicate	Water	<5.0	1

Method Blank (11/14/96) <5.0

Quality Assurance

Reference	True Value (mg$CaCO_3$/L)	Result (mg$CaCO_3$/L)	% Recovery
ERA Minerals	120	112	94

Lot # 0725-96-11

Analyst

Approved

Evergreen Analytical, Inc.

96-4020

WORK ORDER Summary

15-Nov-96

Report To: Dave Moutoux

Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Phone: (303) 831-8100
FAX: (303) 831-8208

Client Project ID: 729691-32010

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4020-01G	ST24 MPF	Anions by IC Cl,NO2,NO3,SO4		Water	D3	12-Nov-96	13-Nov-96	27-Nov-96	14-Nov-96
96-4020-02G	ST24 MPI	Anions by IC Cl,NO2,NO3,SO4						27-Nov-96	14-Nov-96
96-4020-03G	ST24 MPBS	Anions by IC Cl,NO2,NO3,SO4						27-Nov-96	14-Nov-96
96-4020-01D	ST24 MPF	BTEX (Parsons List)			2			27-Nov-96	26-Nov-96
96-4020-02D	ST24 MPI	BTEX (Parsons List)						27-Nov-96	26-Nov-96
96-4020-03D	ST24 MPBS	BTEX (Parsons List)						27-Nov-96	26-Nov-96
96-4020-04A	Trip Blank #3	BTEX (Parsons List)						27-Nov-96	26-Nov-96
96-4020-01H	ST24 MPF	Methane						27-Nov-96	26-Nov-96
96-4020-02H	ST24 MPI	Methane						27-Nov-96	26-Nov-96
96-4020-03H	ST24 MPBS	Methane						27-Nov-96	26-Nov-96
96-4020-01A	ST24 MPF	Purgeable Halocarbons 8010			9			27-Nov-96	26-Nov-96
96-4020-02A	ST24 MPI	Purgeable Halocarbons 8010						27-Nov-96	26-Nov-96
96-4020-03A	ST24 MPBS	Purgeable Halocarbons 8010						27-Nov-96	26-Nov-96
96-4020-04A	Trip Blank #3	Purgeable Halocarbons 8010			2			27-Nov-96	26-Nov-96
96-4020-01D	ST24 MPF	TVH (Gasoline)						27-Nov-96	26-Nov-96
96-4020-02D	ST24 MPI	TVH (Gasoline)						27-Nov-96	26-Nov-96
96-4020-03D	ST24 MPBS	TVH (Gasoline)						27-Nov-96	26-Nov-96
96-4020-04A	Trip Blank #3	TVH (Gasoline)						27-Nov-96	26-Nov-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

pm 11/15/96

CHAIN OF CUSTODY RECORD / ANALYTICAL SERVICES REQUEST

Page 1 of 1

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 SUITE 700
CITY DENVER STATE CO ZIP 80290
PHONE# (303) 831-8100 FAX # (303) 831-8208 FAX RESULTS Y / N
Sampler Name:
(signature)
(print) Brad Lewis

CLIENT CONTACT (print) Jenny Hartfelder
CLIENT PROJ. I.D. 729691-32010
EAL. QUOTE # P.O.# 729691-32010
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ UST
☐ Other (Specify)*
*expedited turnaround subject to additional fee

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid / Air / Gas	MATRIX: Oil / Sludge / Multi-phase	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/8240/5242 (circle) 8010	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	Anions (Cl⁻, NO₃, SO₄)	METHANE GC 404					For Laboratory use only
ST24 MPI	11/12/96	0840	11	X				X						X	X							X	X				01
ST24 MPI	11/12/96	1010	11	X				X						X	X							X	X				02
ST24MPBS	11/12/96	1545	11	X				X						X	X							X	X				03
TRIP BLANK #3	11/12/96		1					X						X	X												04A
Sample Fraction								40V						40V							125P	40V					Loc 2 A+ DB
Instructions:			Container					RC						D-F							G	H3					

Sample bottle for Trip Blank #3 labeled #4. Analyze trip blank for 8010, 8020/8015m gm per Jenny Hartfelder

Relinquished By:	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
	11/4/96 1730		11/13/96				

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	: MB1111496	Client Project Number	: 729691.32010
Date Prepared	: 11/14/96	Lab Work Order	: 96-4020
Dilution Factor	: 1.0	Matrix	: Water
		Lab File Number	: TVB11113029

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	U	0.1	mg/L
Benzene	71-43-2	11/14/96	U	0.4	ug/L
Toluene	108-88-3	11/14/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	U	0.5	ug/L
FID Surrogate Recovery:		102%		50%-150%	(Limits)
D Surrogate Recovery:		102%		50%-150%	(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

K. Hollman
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	: MB1111596	Client Project Number	: 729691.32010
Date Prepared	: 11/15/96	Lab Work Order	: 96-4020
Dilution Factor	: 1.0	Matrix	: Water
		Lab File Number	: TVB11113058

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	U	0.1	mg/L
Benzene	71-43-2	11/15/96	U	0.4	ug/L
Toluene	108-88-3	11/15/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/15/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/15/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	U	0.5	ug/L
FID Surrogate Recovery:		94%		50%-150%	(Limits)
PID Surrogate Recovery:		94%		50%-150%	

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

K. Hollman
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	: MB1111896	Client Project Number	: 729691.32010
Date Prepared	: 11/18/96	Lab Work Order	: 96-4020
Dilution Factor	: 1.0	Matrix	: Water
		Lab File Number	: TVB11118005

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/18/96	U	0.1	mg/L
Benzene	71-43-2	11/18/96	U	0.4	ug/L
Toluene	108-88-3	11/18/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/18/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/18/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/18/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/18/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/18/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/18/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/18/96	U	0.5	ug/L
PID Surrogate Recovery:		115%		50%-150%	(Limits)
FID Surrogate Recovery:		118%		50%-150%	(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

K. Hollman
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	: ST24 MPF	Client Project Number	: 72[illegible]91.32010
Lab Sample Number	: 96-4020-01	Lab Work Order	: 96[illegible]020
Date Sampled	: 11/12/96	Matrix	: W[illegible]r
Date Received	: 11/13/96	Lab File Number(s)	: TV[illegible]11113044
Date Prepared	: 11/14/96	Method Blank	: M[illegible]1111496
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/14/96	0.1	0.1	mg/L
Benzene	71-43-2	11/14/96	U	0.4	ug/L
Toluene	108-88-3	11/14/96	0.7	0.4	ug/L
Chlorobenzene	108-90-7	11/14/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/14/96	0.6	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/14/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/14/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/14/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/14/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/14/96	15	0.5	ug/L
FID Surrogate Recovery:		102%		50%-150%	(L[illegible]
PID Surrogate Recovery:		99%		50%-150%	(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

K Hollman
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	: ST24 MPI	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4020-02	Lab Work Order	: 96-4020
Date Sampled	: 11/12/96	Matrix	: Water
Date Received	: 11/13/96	Lab File Number(s)	: TVB11113051
Date Prepared	: 11/14/96	Method Blank	: MB1111496
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	U	0.1	mg/L
Benzene	71-43-2	11/15/96	U	0.4	ug/L
Toluene	108-88-3	11/15/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/15/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/15/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	U	0.5	ug/L
FID Surrogate Recovery:		96%		50%-150%	(Limits)
PID Surrogate Recovery:		95%		50%-150%	(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

K. Hollman
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	: ST24 MPBS		Client Project Number	:	729691.32010
Lab Sample Number	: 96-4020-03		Lab Work Order	:	96-4020
Date Sampled	: 11/12/96		Matrix	:	Water
Date Received	: 11/13/96		Lab File Number(s)	:	TVB11113062,52
Date Prepared	: 11/14,15/96		Method Blank	:	MB1111596
FID Dilution Factor	: 50				MB1111496
PID Dilution Factor	: 50;1.0				

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	30	5.0	mg/L
Benzene	71-43-2	11/15/96	920	20	ug/L
Toluene	108-88-3	11/15/96	5000	20	ug/L
Chlorobenzene	108-90-7	11/15/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/15/96	1000	20	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	4800	20	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	580	20	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	1900	20	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	540	20	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	180	25	ug/L
FID Surrogate Recovery:		105%		50%-150%	(Li
PID Surrogate Recovery:		105%;85%		50%-150%	(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	: Trip Blank #3	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4020-04	Lab Work Order	: 96-4020
Date Sampled	: NA	Matrix	: Water
Date Received	: 11/13/96	Lab File Number(s)	: TVB11118022
Date Prepared	: 11/18/96	Method Blank	: MB1111896
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/18/96	U	0.1	mg/L
Benzene	71-43-2	11/18/96	U	0.4	ug/L
Toluene	108-88-3	11/18/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/18/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/18/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/18/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/18/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/18/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/18/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/18/96	U	0.5	ug/L
FID Surrogate Recovery:		97%		50%-150%	(Limits)
PID Surrogate Recovery:		94%		50%-150%	(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, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
TVH Matrix Spike/Matrix Spike Duplicate Data Report

Client Sample No.	: ST24 MPF	Client Project No	: 729691.32 0
Lab Sample No.	: 96-4020-01	Lab Work Order	: 96-4020
Date Sampled	: 11/12/96	EPA Method No.	: 5030/8015 odified
Date Received	: 11/13/96	Matrix	: Water
Date Prepared	: 11/14/96	Lab File Number(s)	: TVB11113045
Date Analyzed	: 11/14/96	Method Blank	: MB1111496
Instrument Name	: TVHBTEX1	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	0.11	1.93	91.0%	62 - 126
Surrogate **	---	---	---	101%	70 - 121

Compound	Spike Added (mg/L)	MSD Concentration (mg/L)	MSD %REC	RPD	QC (#) Limits RPD	QC (#) Limits %REC
Gasoline	2.00	1.92	90.5%	0.6	42.3	62 - 126
Surrogate **	---	---	102%	NA	NA	70 - 121

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 10/2/96, KSH

Comments:

Analyst

K Hollman
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.	: ST24 MPF	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4020-01	Lab Work Order	: 96-4020
Date Sampled	: 11/12/96	EPA Method No.	: 602
Date Received	: 11/13/96	Matrix	: Water
Date Prepared	: 11/14/96	Lab File Number(s)	: TVB11113047,48
Date Analyzed	: 11/14/96	Method Blank	: MB1111496
Instrument Name	: TVHBTEX1	Dilution Factor	: 1.0

Compound	Spike Added (ug/L)	Sample Concentration (ug/L)	Concentration (ug/L)		Comments
			MS	MSD	
Benzene	20.0	0.0	20.8	20.4	
Toluene	20.0	0.7	18.3	18.1	
Chlorobenzene	20.0	0.0	17.7	17.4	
Ethylbenzene	20.0	0.6	18.0	17.8	
m,p-Xylene	20.0	0.0	18.1	17.9	
o-Xylene	20.0	0.0	18.2	17.8	
1,3,5-TMB	20.0	0.0	17.5	17.5	
1,2,4-TMB	20.0	0.0	16.8	17.2	
1,2,3-TMB	20.0	0.0	17.6	17.5	
1,2,3,4-TeMB	20.0	14.6	30.3	30.4	
Surrogate	100.0	99%	94%	99%	% RECOVERY

Compound		MS % RECOVERY	MSD % RECOVERY	RPD	QC# Limits	
					RPD	%REC
Benzene		104.0	102.0	1.9	18	62 - 129
Toluene		88.0	87.0	1.1	25	55 - 133
Chlorobenzene		88.5	87.0	1.7	9	66 - 122
Ethylbenzene		87.0	86.0	1.2	15	60 - 127
m,p-Xylene		90.5	89.5	1.1	20	44 - 146
o-Xylene		91.0	89.0	2.2	16	57 - 131
1,3,5-TMB		87.5	87.5	0.0	16	63 - 129
1,2,4-TMB		84.0	86.0	2.4	16	55 - 136
1,2,3-TMB		88.0	87.5	0.6	13	64 - 127
1,2,3,4-TeMB		78.5	79.0	0.6	23	53 - 132
Surrogate		94.0	99.0	NA	NA	82 - 115

= Limits extablished 10/1/96,HDM
* = Values outside of QC limits.

RPD: 0 out of (10) outside limits.
Spike Recovery: 0 out of (20) outside limits.

Comments:

Analyst

Approved

MSBTMB1;MSB4020.XLS; 11/19/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS1111496	Matrix	: WATER
Date Prepared	: 11/14/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/14/96	Instrument Name	: TVHBTEX1
Lab File Number(s)	: TVB11113036		

Compound Name	Theoretical Concentration (mg/L)	LCS - Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.11	105.5	83 - 120
Surrogate Recovery:		107%		70 - 121

QUALIFIERS
B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 9/24/96 for TVHBTEX1. HDM

H. Deane Mills
Analyst

P. McClelland
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St.
Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS1111496	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/14/96	Method	: 602/8020
Date Analyzed	: 11/14/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB11113037

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	19.6	98.0	75 - 110
Toluene	108-88-3	18.4	92.0	75 - 110
Chlorobenzene	108-90-7	16.9	84.5	69 - 110
Ethyl Benzene	100-41-4	18.2	91.0	74 - 110
m,p-Xylene	108-38-3 106-42-3	35.2	88.0	73 - 110
[redacted]ene	95-47-6	18.3	91.5	74 - 114
MTBE	1634-04-4	13.1	65.5	59 - 129
1,3,5-Trimethylbenzene	108-67-8	19.0	95.0	70 - 110
1,2,4-Trimethylbenzene	95-63-6	17.6	88.0	73 - 110
1,2,3-Trimethylbenzene	526-73-8	21.5	107.5	84 - 122
1,2,3,4-Tetramethylbenzene	488-23-3	19.3	96.5	67 - 116
Surrogate Recovery:		98%		82 - 115

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.
[redacted]Limits updated 10/02/96 for TVHBTEX1. SWT

N. Diane Mills
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS1111896	Matrix	: WATER
Date Prepared	: 11/18/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/18/96	Instrument Name	: TVHBTEX1
Lab File Number(s)	: TVB11118008		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.09	104.5	83 - 120
Surrogate Recovery:		121%		70 - 121

QUALIFIERS
B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA=Not Available/Not Applicable.
** = Limits established 9/24/96 for TVHBTEX1. HDM

H. Diane Mills
Analyst

P. McClellan
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St.
Wheat Ridge, CO 80033
(303) 425-6021

EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS1111896	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/18/96	Method	: 602/8020
Date Analyzed	: 11/18/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB11118021

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	19.1	95.5	75 - 110
Toluene	108-88-3	18.1	90.5	75 - 110
Chlorobenzene	108-90-7	17.1	85.5	69 - 110
Ethyl Benzene	100-41-4	18.3	91.5	74 - 110
m,p-Xylene	108-38-3 106-42-3	35.0	87.5	73 - 110
o-Xylene	95-47-6	19.0	95.0	74 - 114
MTBE	1634-04-4	19.2	96.0	59 - 129
1,3,5-Trimethylbenzene	108-67-8	18.9	94.5	70 - 110
1,2,4-Trimethylbenzene	95-63-6	17.5	87.5	73 - 110
1,2,3-Trimethylbenzene	526-73-8	21.0	105.0	84 - 122
1,2,3,4-Tetramethylbenzene	488-23-3	18.7	93.5	67 - 116
Surrogate Recovery:		92%		82 - 115

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 updated 10/02/96 for TVHBTEX1. SWT

N. Duane Miles
Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112096	Client Project No.	: 729691-32010
Date Prepared	: 11/20/96	Lab Project No.	: 96-4020
Date Analyzed	: 11/20/96	Lab File No.	: HALL1120\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	88%	70% - 130% (QC limits)	

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112196	Client Project No.	: 729691-32010
Date Prepared	: 11/21/96	Lab Project No.	: 96-4020
Date Analyzed	: 11/21/96	Lab File No.	: HALL1121\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
-Chlorotoluene	106-49-8	U	0.4
,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	81%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24 MPF	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4020-01	Lab Project No.	: 96-4020
Date Sampled	: 11/12/96	Matrix	: Water
Date Received	: 11/13/96	Lab File No.	: HALL1120\023F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	[redacted]
4-Chlorotoluene	106-49-8	U	
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	81%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24 MPI	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4020-02	Lab Project No.	: 96-4020
Date Sampled	: 11/12/96	Matrix	: Water
Date Received	: 11/13/96	Lab File No.	: HALL1120\024F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/20/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	82%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24 MPBS	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4020-03	Lab Project No.	: 96-4020
Date Sampled	: 11/12/96	Matrix	: Water
Date Received	: 11/13/96	Lab File No.	: HALL1121\013F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 10.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	4
Chloroethane	75-00-3	U	4
1,1-Dichloroethene	75-35-4	U	4
Dichloromethane	75-09-2	U	4
trans-1,2-Dichloroethene	156-60-5	U	4
1,1-Dichloroethane	75-34-3	U	4
cis-1,2-Dichloroethene	156-59-4	U	4
1,1,1-Trichloroethane	71-55-6	U	4
Carbon Tetrachloride	56-23-5	U	4
Trichloroethene	79-01-6	U	4
1,1,2-Trichloroethane	79-00-5	U	4
Tetrachloroethene	127-18-4	U	4
1,1,1,2-Tetrachloroethane	79-00-5	U	4
Chlorobenzene	108-90-7	U	4.2
1,1,2,2-Tetrachloroethane	79-34-5	U	5.4
2-Chlorotoluene	95-49-8	U	4
4-Chlorotoluene	106-49-8	U	4
1,3-Dichlorobenzene	541-73-1	U	4
1,2-Dichlorobenzene	95-50-1	U	4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	78%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES: Sample dilution required to meet surrogate Q.C.

Analyst

Approved

PAR8010W.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: Trip Blank #3	Client Project No.	: 729691-32010
Lab Sample No.	: 96-4020-04	Lab Project No.	: 96-4020
Date Sampled	: 11/12/96	Matrix	: Water
Date Received	: 11/13/96	Lab File No.	: HALL1120\026F0101
Date Prepared	: 11/20/96	Method Blank	: RB112096
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	0.83 J	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
-Chlorotoluene	95-49-8	U	0.4
-Chlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	80%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

PAR8010W.XLS; 11/25/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB111496	Client Project No.	: 729691.32010
Date Extracted/Prepared	: 11/14/96	Lab Work Order	: 96-4020
Date Analyzed	: 11/14/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175M
		Matrix	: Water
		Lab File No.	: GAS1114002

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

Approved

AF4020.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24MPF	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4020-01	Lab Work Order	: 96-4020
Date Sampled	: 11/12/96	Dilution Factor	: 5.00
Date Received	: 11/13/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114025

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.14	0.01

Temperature	: 70.5 F	Saturation Concentration	Meth	0.034450315
Amount Injected	: 0.1 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.108852614
Head space created	: 4 ml			
Methane Area	: 160.225 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

Approved

AF4020.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24MPI	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4020-02	Lab Work Order	: 96-4020
Date Sampled	: 11/12/96	Dilution Factor	: 1.00
Date Received	: 11/13/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114026

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	U	0.002

Temperature	: 70.2 F	Saturation Concentration	Meth		
Amount Injected	: 0.5 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth		
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

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AF4020.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24MPBS	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4020-03	Lab Work Order	: 96-4020
Date Sampled	: 11/12/96	Dilution Factor	: 10.00
Date Received	: 11/13/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Lab File No.	: GAS1114027

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	1.26	0.02

Temperature	: 70.6 F	Saturation Concentration	Meth	0.303890371
Amount Injected	: 0.05 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.96002083
Head space created	: 4 ml			
Methane Area	: 706.682 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

Approved

AF4020.XLS

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

RSKSOP-175M Gas Method
Methane, Ethane, Ethene LCS Report Form

LCS No.	: LCS111496	EPA Method No.	: RSKSOP-175M
Date Prepared	: 11/14/96	Matrix	: Water
Date Analyzed	: 11/14/96	Method Blank	: GB111496
E.A. LCS Source No.	: 1719	Lab File No.	: GAS1114010

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	370	74	64-90
Ethene Gas	500	0	213	43	37-58
Ethane Gas	500	0	321	64	53-83

Spike Recovery: 0 out of (3) outside limits.

Note: The LCS was made by taking the sample and displacing 4ml of headspace with a 1% methane, ethane, ethene 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

Date Sampled	: 11/12/96	Client Project ID.	: 729691.32010
Date Received	: 11/13/96	Lab Project Number	: 96-4020
Date Prepared	: 11/13/96	Method	: EPA 300.0
Date Analyzed	: 11/13/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride mg/L	Dilution Factor
96-4020-01	ST24 MPF	Water	3.5	1
96-4020-01 Duplicate	ST24 MPF Duplicate	Water	3.5	1
96-4020-02	ST24 MPI	Water	4.8	1
96-4020-03	ST24 MPBS	Water	3.5	1
Method Blank	(11/13/96)		<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4020-01	ST24 MPF Matrix Spike	10.0	3.5	13.2	97
96-4020-01	ST24 MPF Matrix Spike Dup	10.0	3.5	13.2	97
MS/MSD RPD					0.3

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/12/96	Client Project ID.	: 729691.32010
Date Received	: 11/13/96	Lab Project Number	: 96-4020
Date Prepared	: 11/13/96	Method	: EPA 300.0
Date Analyzed	: 11/13/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N mg/L	Dilution Factor
96-4020-01	ST24 MPF	Water	<0.076	1
96-4020-01 Duplicate	ST24 MPF Duplicate	Water	<0.076	1
96-4020-02	ST24 MPI	Water	<0.076	1
96-4020-03	ST24 MPBS	Water	<0.076	1
Method Blank	(11/13/96)		<0.076	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4020-01	ST24 MPF Matrix Spike	10.0	<0.25	9.6	96
96-4020-01	ST24 MPF Matrix Spike Dup	10.0	<0.25	9.4	94
MS/MSD RPD					1.7

* = Quality assurance results reported as Nitrite (NO_2).

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/12/96	Client Project ID.	: 729691.32010
Date Received	: 11/13/96	Lab Project Number	: 96-4020
Date Prepared	: 11/13/96	Method	: EPA 300.0
Date Analyzed	: 11/13/96	Detection Limit	: 0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N mg/L	Dilution Factor
96-4020-01	ST24 MPF	Water	<0.056	1
96-4020-01 Duplicate	ST24 MPF Duplicate	Water	<0.056	1
96-4020-02	ST24 MPI	Water	1.5	1
96-4020-03	ST24 MPBS	Water	<0.056	1
Method Blank	(11/13/96)		<0.056	

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)*	Spike Result (mg/L)	% Recovery
96-4020-01	ST24 MPF Matrix Spike	10.0	<0.25	9.4	94
96-4020-01	ST24 MPF Matrix Spike Dup	10.0	<0.25	9.2	92
MS/MSD RPD					2.6

* = Quality assurance results reported as Nitrate (NO_3).

Analyst

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
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Anion Report

Date Sampled	: 11/12/96	Client Project ID.	: 729691.32010
Date Received	: 11/13/96	Lab Project Number	: 96-4020
Date Prepared	: 11/13/96	Method	: EPA 300.0
Date Analyzed	: 11/13/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate mg/L	Dilution Factor
96-4020-01	ST24 MPF	Water	0.86	1
96-4020-01 Duplicate	ST24 MPF Duplicate	Water	0.86	1
96-4020-02	ST24 MPI	Water	3.6	1
96-4020-03	ST24 MPBS	Water	<0.25	1
Method Blank	(11/13/96)		<0.25	

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4020-01	ST24 MPF Matrix Spike	10.0	0.86	10.2	93
96-4020-01	ST24 MPF Matrix Spike Dup	10.0	0.86	10.2	94
MS/MSD RPD					0.9

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: ST24-MPD(D)	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4033-01	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Matrix	: WATER
Date Received	: 11/14/96	Lab File Number(s)	: TVB31115010,28
Date Prepared	: 11/15,16/96	Method Blank	: MB3111596, MB3111696
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0; 5.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	3.1	0.1	mg/L
Benzene	71-43-2	11/15/96	46	0.4	ug/L
Toluene	108-88-3	11/15/96	5.7	0.4	ug/L
Chlorobenzene	108-90-7	11/15/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/16/96	200	2.0	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	47	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	19	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	54	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	18	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	96	0.5	ug/L
[illegible]urrogate Recovery:		136%	*	70%-126%	(Limits)
[illegible]Surrogate Recovery:		98%; 120%		76%-127%	(Limits)

Notes: Total Xylenes consist of three isomers, two of which co-elute. The Xylene RL is for a single peak.

Comments: * = High Surrogate Recovery due to hydrocarbon interference.

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

DMcClell
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	: ST24-MPH(S)	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4033-02	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Matrix	: WATER
Date Received	: 11/14/96	Lab File Number(s)	: TVB31115011
Date Prepared	: 11/15/96	Method Blank	: MB3111596
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/15/96	1.0	0.1	mg/L
Benzene	71-43-2	11/15/96	18	0.4	ug/L
Toluene	108-88-3	11/15/96	0.6	0.4	ug/L
Chlorobenzene	108-90-7	11/15/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/15/96	15	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/15/96	0.8	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/15/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/15/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/15/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/15/96	80	0.5	ug/L
FID Surrogate Recovery:		110%		70%-126%	(Li
PID Surrogate Recovery:		103%		76%-127%	(Li

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.

M. Blecha
Analyst

K. Hallman
Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPD(D)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4033-01	Lab Project No.	: 96-4033
Date Sampled	: 11/13/96	Matrix	: Water
Date Received	: 11/14/96	Lab File No.	: HALL1121\014F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
Chlorotoluene	106-49-8	U	0.4
3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	83%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4033.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPH(S)	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4033-02	Lab Project No.	: 96-4033
Date Sampled	: 11/13/96	Matrix	: Water
Date Received	: 11/14/96	Lab File No.	: HALL1121\015F0101
Date Prepared	: 11/21/96	Method Blank	: RB112196
Date Analyzed	: 11/21/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	
4-Chlorotoluene	106-49-8	U	
1,3-Dichlorobenzene	541-73-1	U	
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	78%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4033.XLS; 11/26/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24-MPD(D)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4033-01	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Dilution Factor	: 20.00
Date Received	: 11/14/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121008

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	2.06	0.04

[redacted]rature	: 74.2 F	Saturation Concentration	Meth	0.498195092
A[redacted]t Injected	: 0.025 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	1.563231184
Head space created	: 4 ml			
Methane Area	: 579.264 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.

[redacted]

Analyst

Approved

AF4033.XLS

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24-MPH(S)	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4033-02	Lab Work Order	: 96-4033
Date Sampled	: 11/13/96	Dilution Factor	: 20.00
Date Received	: 11/14/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/21/96	Matrix	: Water
Date Analyzed	: 11/21/96	Lab File No.	: GAS1121009

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	1.87	0.04

Temperature	: 74 F	Saturation Concentration	Meth	0.451
Amount Injected	: 0.025 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	1.4178492
Head space created	: 4 ml			
Methane Area	: 525.195 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

AF4033.XLS

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/13/96	Client Project ID.	: 729691.32010
Date Received	: 11/14/96	Lab Project Number	: 96-4033
Date Prepared	: 11/14/96	Method	: EPA 300.0
Date Analyzed	: 11/14/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride mg/L	Dilution Factor
96-4033-01	ST24-MPD(D)	Water	4.2	1
96-4033-02	ST24-MPH(S)	Water	3.7	1
96-4033-03	W81	Water	14.4	1
96-4033-04	LF6-MPM	Water	6.5	1
96-4033-04 Duplicate	LF6-MPM Duplicate	Water	6.5	1
96-4033-05	W22	Water	3.8	1
96-4033-06	W1	Water	3.7	1
Method Blank	(11/14/96)	Water	<0.25	1

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4033-04	LF6-MPM Matrix Spike	10.0	6.5	16.2	97
96-4033-04	LF6-MPM Matrix Spike Dup	10.0	6.5	16.4	98
MS/MSD RPD					1.7

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/13/96	Client Project ID.	: 729691.32010
Date Received	: 11/14/96	Lab Project Number	: 96-4033
Date Prepared	: 11/14/96	Method	: EPA 300.0
Date Analyzed	: 11/14/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N mg/L	Dilution Factor
96-4033-01	ST24-MPD(D)	Water	<0.076	1
96-4033-02	ST24-MPH(S)	Water	<0.076	1
96-4033-03	W81	Water	<0.076	1
96-4033-04	LF6-MPM	Water	<0.076	1
96-4033-04 Duplicate	LF6-MPM Duplicate	Water	<0.076	1
96-4033-05	W22	Water	<0.076	1
96-4033-06	W1	Water	<0.076	1
Method Blank	(11/14/96)	Water	<0.076	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4033-04	LF6-MPM Matrix Spike	10.0	<0.25	9.4	94
96-4033-04	LF6-MPM Matrix Spike Dup	10.0	<0.25	9.2	92
MS/MSD RPD					1.9

* = Quality assurance results reported as Nitrite (NO_2).

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled : 11/13/96
Date Received : 11/14/96
Date Prepared : 11/14/96
Date Analyzed : 11/14/96

Client Project ID. : 729691.32010
Lab Project Number : 96-4033
Method : EPA 300.0
Detection Limit : 0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N mg/L	Dilution Factor
96-4033-01	ST24-MPD(D)	Water	<0.056	1
96-4033-02	ST24-MPH(S)	Water	<0.056	1
96-4033-03	W81	Water	<0.056	1
96-4033-04	LF6-MPM	Water	1.3	1
96-4033-04 Duplicate	LF6-MPM Duplicate	Water	1.3	1
96-4033-05	W22	Water	<0.056	1
96-4033-06	W1	Water	<0.056	1
Method Blank	(11/14/96)	Water	<0.056	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4033-04	LF6-MPM Matrix Spike	10.0	5.7	15.4	97
96-4033-04	LF6-MPM Matrix Spike Dup	10.0	5.7	15.6	99
MS/MSD RPD					2.2

* = Quality assurance results reported as Nitrate (NO_3).

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled : 11/13/96
Date Received : 11/14/96
Date Prepared : 11/14/96
Date Analyzed : 11/14/96

Client Project ID. : 729691.32010
Lab Project Number : 96-4033
Method : EPA 300.0
Detection Limit : 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate mg/L	Dilution Factor
96-4033-01	ST24-MPD(D)	Water	<0.25	1
96-4033-02	ST24-MPH(S)	Water	<0.25	1
96-4033-03	W81	Water	3.8	1
96-4033-04	LF6-MPM	Water	0.27	1
96-4033-04 Duplicate	LF6-MPM Duplicate	Water	0.27	1
96-4033-05	W22	Water	11.0	1
96-4033-06	W1	Water	11.6	1
Method Blank	(11/14/96)	Water	<0.25	1

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4033-04	LF6-MPM Matrix Spike	10.0	0.27	9.4	91
96-4033-04	LF6-MPM Matrix Spike Dup	10.0	0.27	9.4	92
MS/MSD RPD					0.5

Analyst

Approved

EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Analysis Report

Date Sampled	: 11/13/96	Client Project ID.	: 729691.32010
Date Received	: 11/14/96	Lab Project Number	: 96-4033
Date Prepared	: 11/14/96	Method	: EPA 310.1
Date Analyzed	: 11/14/96	Detection Limit	: 5.0 mg $CaCO_3$/L

Evergreen Sample #	Client Sample ID.	Matrix	Total Alkalinity (mg $CaCO_3$/L)	Dilution Factor
96-4033-01	ST24-MPD(D)	Water	75.9	1
96-4033-02	ST24-MPH(S)	Water	112	1
96-4033-03	W81	Water	298	1
96-4033-04	LF6-MPM	Water	7.1	1
96-4033-05	W22	Water	<5.0	1
96-4033-06	W1	Water	<5.0	1
6-4033-06 Duplicate	W1 Duplicate	Water	<5.0	1
Method Blank	(11/14/96)		<5.0	

Quality Assurance

Reference	True Value (mg$CaCO_3$/L)	Result (mg$CaCO_3$/L)	% Recovery
ERA Minerals	120	113	94

Lot # 0725-96-11

Analyst

Approved

Evergreen Analytical, Inc.

96-4081

WORK ORDER Summary

22-Nov-96

Report To: Dave Moutoux
Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Client Project ID: 729691.32010

Phone: (303) 831-8100
FAX: (303) 831-8208

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4081-01K	ST24-MPM	Anions by IC Cl,NO2,NO3,SO4		Groundwater	CR4	18-Nov-96	19-Nov-96	04-Dec-96	20-Nov-96
96-4081-02K	LF06-MPG	Anions by IC Cl,NO2,NO3,SO4						04-Dec-96	20-Nov-96
96-4081-03K	ST24-MPL	Anions by IC Cl,NO2,NO3,SO4						04-Dec-96	20-Nov-96
96-4081-05K	LF06-MPF(S)	Anions by IC Cl,NO2,NO3,SO4						04-Dec-96	20-Nov-96
96-4081-07K	ST24-MPJ	Anions by IC Cl,NO2,NO3,SO4						04-Dec-96	20-Nov-96
96-4081-08K	LF06-MPB	Anions by IC Cl,NO2,NO3,SO4						04-Dec-96	20-Nov-96
96-4081-01D	ST24-MPM	BTEX Parsons			2			04-Dec-96	02-Dec-96
96-4081-02D	LF06-MPG	BTEX Parsons						04-Dec-96	02-Dec-96
96-4081-03D	ST24-MPL	BTEX Parsons						04-Dec-96	02-Dec-96
96-4081-04D	W3	BTEX Parsons						04-Dec-96	02-Dec-96
96-4081-05D	LF06-MPF(S)	BTEX Parsons						04-Dec-96	02-Dec-96
96-4081-06D	LF06-MPV	BTEX Parsons						04-Dec-96	02-Dec-96
96-4081-07D	ST24-MPJ	BTEX Parsons						04-Dec-96	02-Dec-96
96-4081-08D	LF06-MPB	BTEX Parsons						04-Dec-96	02-Dec-96
96-4081-01H	ST24-MPM	Methane						04-Dec-96	02-Dec-96
96-4081-02H	LF06-MPG	Methane						04-Dec-96	02-Dec-96
96-4081-03H	ST24-MPL	Methane						04-Dec-96	02-Dec-96
96-4081-05H	LF06-MPF(S)	Methane						04-Dec-96	02-Dec-96

# = Special list. See sample comments or test information.
HT = Holding Time expiration date.

pm 11/22/96

Evergreen Analytical, Inc.

96-4081

WORK ORDER Summary

22-Nov-96

Report To: Dave Moutoux

Parsons Engineering Science
1700 Broadway Suite 900
Denver, CO 80290

Phone: (303) 831-8100
FAX: (303) 831-8208

Client Project ID: 729691.32010

Comments:

Sample ID	Client Sample ID	Analysis	#	Matrix	Loc	Collection	Received	Due	HT
96-4081-07H	ST24-MPJ	Methane		Groundwater	2	18-Nov-96	19-Nov-96	04-Dec-96	02-Dec-96
96-4081-08H	LF06-MPB	Methane						04-Dec-96	02-Dec-96
96-4081-01A	ST24-MPM	Purgeable Halocarbons 8010			9			04-Dec-96	02-Dec-96
96-4081-02A	LF06-MPG	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-03A	ST24-MPL	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-04A	W3	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-05A	LF06-MPF(S)	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-06A	LF06-MPV	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-07A	ST24-MPJ	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-08A	LF06-MPB	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-09A	ST24 Field Blank	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-10A	LF06 Field Blank	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-11A	Trip Blank	Purgeable Halocarbons 8010						04-Dec-96	02-Dec-96
96-4081-01D	ST24-MPM	TVH (Gasoline)			2			04-Dec-96	02-Dec-96
96-4081-02D	LF06-MPG	TVH (Gasoline)						04-Dec-96	02-Dec-96
96-4081-03D	ST24-MPL	TVH (Gasoline)						04-Dec-96	02-Dec-96
96-4081-04D	W3	TVH (Gasoline)						04-Dec-96	02-Dec-96
96-4081-05D	LF06-MPF(S)	TVH (Gasoline)						04-Dec-96	02-Dec-96
96-4081-06D	LF06-MPV	TVH (Gasoline)						04-Dec-96	02-Dec-96
96-4081-07D	ST24-MPJ	TVH (Gasoline)						04-Dec-96	02-Dec-96
96-4081-08D	LF06-MPB	TVH (Gasoline)						04-Dec-96	02-Dec-96

# = S[illegible]ist. See sample comments or test information.
HT = H[illegible]ng 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

Sampler Name:
(signature) Bruce M. Henry
(print) Bruce M. Henry

CLIENT CONTACT (print)
CLIENT PROJ. I.D. 729691.32010
EAL. QUOTE # P.O.# 729691.32010
TURNAROUND REQUIRED* ☒ STD (2 wks) ☐ UST
☐ Other (Specify)*
*expedited turnaround subject to additional fee

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid / Air / Gas	MATRIX: Oil / Sludge / Multi-phase	ANALYSIS REQUESTED: TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle) 8010 ppm	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8020/602 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	METHANE (RSKSOP 175 mod)	ANIONS (Cl- NO3 PO4, SO4)				EAL use only Do not write in shaded area
ST24-MPM	11/18/96	0725	11	X				X						X	X						X	X				01A → K
LF06-MPG		0800	11					X						X	X						X	X				02A → K
ST24-MPL		0830	11					X						X	X						X	X				03A → K
W3		0845	7					X						X	X											04 A-G
LF06-MPF(S)		0930	11					X						X	X						X	X				05 A → K
LF06-MPV		0950	7					X						X	X											06 A → G
ST24-MPJ		0955	11					X						X	X						X	X				07 A → K
LF06-MPB		1130	11					X						X	X						X	X				08 A → K
ST24 FIELD BLANK		1430	3					X																		09 A → C
LF06 FIELD BLANK	↓	1500	3	↓				X																		010 A → C
Sample Fraction								A8V						DEFG							H18	K				Loc 9, 2, CR4
Instructions:								40c						4DV							40V	125				Cont

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Bruce Henry	11/18/96	[signature]	11/19/96 0930				

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

Sampler Name:
(signature) BRAD LEWIS
(print)

CLIENT CONTACT (print)
CLIENT PROJ. I.D. 724691.32010
EAL. QUOTE # P.O.# 724691.32010

TURNAROUND REQUIRED* [X] STD (2 wks) ☐ UST
☐ Other (Specify)*
*expedited turnaround subject to additional fee

Please **PRINT** all information:

CLIENT SAMPLE IDENTIFICATION	DATE SAMPLED	TIME	No. of Containers	MATRIX: Water-Drinking/Discharge/Ground (circle)	MATRIX: Soil / Solid / Air / Gas	MATRIX: Oil / Sludge / Multi-phase	TCLP VOA/BNA/Pest/Herb/Metals (circle)	VOA 8260/624/524.2 (circle) 8010 pm	BNA 8270/625 (circle)	Pesticides 8080/608 (circle)	Pest/PCBs 8080/608/508 (circle)	PCB Screen	Herbicides 8150/515 (circle)	BTEX 8021/8020 (circle)/MTBE (circle)	TVPH 8015mod. (Gasoline)	TEPH 8015mod. (Diesel)	Total Metals-DW / NPDES / SW846 (circle & list metals below)	Dissolved Metals - DW / SW846 (circle & list metals below)	Oil & Grease 413.1	TRPH 418.1	EAL use only Do not write in shaded area
TRIP BLANK	11/18/96		1	X				X													OIL A
Sample Fraction																					Loc
Instructions:																					Cont

Run Trip Blank for 8010 only

W.O. #
B.O.F. #
C/S (O) /
C/S (I) /
Cooler Temp. °C
Seals Intact Y / N / NA
Samples Pres. Y / N / NA
Headspace Y / N / NA

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time	Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Date/Time
Bruce [redacted]	11/18/96						

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	: MB2112096	Client Project Number	: 729691.32010
Date Prepared	: 11/20/96	Lab Work Order	: 96-4081
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB21120007

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
FID Surrogate Recovery:		91%		70%-126%	(Limits)
PID Surrogate Recovery:		99%		76%-127%	(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.

M. Blucher
Analyst

K. Hollman
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	: MB2112196	Client Project Number	: 729691.32010
Date Prepared	: 11/21/96	Lab Work Order	: 96-4081
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB21120028

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/21/96	U	0.1	mg/L
Benzene	71-43-2	11/21/96	U	0.4	ug/L
Toluene	108-88-3	11/21/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/21/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/21/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/21/96	U	0.5	ug/L
FID Surrogate Recovery:		81%		70%-126%	(Li
PID Surrogate Recovery:		91%		76%-127%	(L

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.

M. Blecha
Analyst

K. Hollman
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	: MB2112596	Client Project Number	: 729691.32010
Date Prepared	: 11/25/96	Lab Work Order	: 96-4081
Dilution Factor	: 1.0	Matrix	: WATER
		Lab File Number	: TVB21125003

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/25/96	U	0.1	mg/L
Benzene	71-43-2	11/25/96	U	0.4	ug/L
Toluene	108-88-3	11/25/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/25/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/25/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/25/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/25/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/25/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/25/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/25/96	U	0.5	ug/L
FID Surrogate Recovery:		87%		70%-126%	(Limits)
PID Surrogate Recovery:		93%		76%-127%	(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.

M. Blecha
Analyst

K. Hillman
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	: ST24-MPM	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4081-01	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Matrix	: WATER
Date Received	: 11/19/96	Lab File Number(s)	: TVB21120014,30
Date Prepared	: 11/20,21/96	Method Blank	: MB2112096
FID Dilution Factor	: 200		MB2112196
PID Dilution Factor	: 10; 200		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/21/96	55	20	mg/L
Benzene	71-43-2	11/21/96	350	80	ug/L
Toluene	108-88-3	11/21/96	11000	80	ug/L
Chlorobenzene	108-90-7	11/20/96	U	4.0	ug/L
Ethyl Benzene	100-41-4	11/21/96	1500	80	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/21/96	8100	80	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/21/96	1400	80	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/21/96	4200	80	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/21/96	1200	80	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	5.0	ug/L
FID Surrogate Recovery:		88%		70%-126%	(L
PID Surrogate Recovery:		118%; 96%		76%-127%	(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.

M. Blicha
Analyst

K. Hollman
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	: ST24-MPL	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4081-03	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Matrix	: WATER
Date Received	: 11/19/96	Lab File Number(s)	: TVB21120009
Date Prepared	: 11/20/96	Method Blank	: MB2112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	0.4	0.1	mg/L
Benzene	71-43-2	11/20/96	15	0.4	ug/L
Toluene	108-88-3	11/20/96	1.5	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	2.5	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	3.2	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	7.7	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	26	0.5	ug/L
Surrogate Recovery:		121%		70%-126%	(Limits)
Surrogate Recovery:		115%		76%-127%	(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.
= Total Volatile Hydrocarbons.

M. Blanton
Analyst

K. Hollman
Approved

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Methods 602/8020 and 5030/8015 Modified Data Report

Client Sample Number	: ST24-MPJ	Client Project Number	: 729691.32010
Lab Sample Number	: 96-4081-07	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Matrix	: WATER
Date Received	: 11/19/96	Lab File Number(s)	: TVB21120012
Date Prepared	: 11/20/96	Method Blank	: MB2112096
FID Dilution Factor	: 1.0		
PID Dilution Factor	: 1.0		

Compound Name	Cas Number	Analysis Date	Sample Concentration	RL	Units
TVH-Gasoline	----	11/20/96	U	0.1	mg/L
Benzene	71-43-2	11/20/96	U	0.4	ug/L
Toluene	108-88-3	11/20/96	U	0.4	ug/L
Chlorobenzene	108-90-7	11/20/96	U	0.4	ug/L
Ethyl Benzene	100-41-4	11/20/96	U	0.4	ug/L
Total Xylenes (m,p,o)	1330-20-7	11/20/96	U	0.4	ug/L
1,3,5-Trimethylbenzene	108-67-8	11/20/96	U	0.4	ug/L
1,2,4-Trimethylbenzene	95-63-6	11/20/96	U	0.4	ug/L
1,2,3-Trimethylbenzene	526-73-8	11/20/96	U	0.4	ug/L
1,2,3,4-Tetramethylbenzene	488-23-3	11/20/96	U	0.5	ug/L
FID Surrogate Recovery:		100%		70%-126%	(Limits)
PID Surrogate Recovery:		108%		76%-127%	(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.

M. Bleckan
Analyst

Approved

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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS2112096-GAS	Matrix	: WATER
Date Prepared	: 11/20/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/20/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVB21120003		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.16	107.8	81 - 128
Surrogate Recovery:		116%		70 - 126

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 10/1/96 for TVHBTEX2. MAB

M. Nicolia
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS2112096-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/20/96	Method	: 602/8020
Date Analyzed	: 11/20/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB21120004

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	21.4	107.0	75 - 116
Toluene	108-88-3	20.7	103.5	75 - 118
Chlorobenzene	108-90-7	19.0	95.0	73 - 115
Ethyl Benzene	100-41-4	20.4	102.0	80 - 122
m,p-Xylene	108-38-3	39.2	98.0	76 - 120
o-Xylene	106-42-3 95-47-6	20.6	103.0	76 - [redacted]
MTBE	1634-04-4	20.8	104.0	75 - 115
1,3,5-Trimethylbenzene	108-67-8	20.3	101.5	64 - 118
1,2,4-Trimethylbenzene	95-63-6	18.6	93.0	75 - 111
1,2,3-Trimethylbenzene	526-73-8	23.3	116.5	82 - 127
1,2,3,4-Tetramethylbenzene	488-23-3	21.1	105.5	72 - 131
Surrogate Recovery:		103%		76 - 127

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 10/1/96 for TVHBTEX2. MAB

Analyst

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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS2112196-GAS	Matrix	: WATER
Date Prepared	: 11/21/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/21/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVB21120049		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.25	112.7	81 - 128
Surrogate Recovery:		112%		70 - 126

QUALIFIERS

B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 10/1/96 for TVHBTEX2. MAB

Analyst

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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS2112196-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/21/96	Method	: 602/8020
Date Analyzed	: 11/21/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB21120050

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	21.3	106.5	75 - 116
Toluene	108-88-3	20.4	102.0	75 - 118
Chlorobenzene	108-90-7	18.7	93.5	73 - 115
Ethyl Benzene	100-41-4	20.2	101.0	80 - 122
m,p-Xylene	108-38-3	38.8	97.0	76 - 120
o-Xylene	106-42-3 95-47-6	20.4	102.0	76 - [illegible]
MTBE	1634-04-4	20.2	101.0	75 - 115
1,3,5-Trimethylbenzene	108-67-8	19.9	99.5	64 - 118
1,2,4-Trimethylbenzene	95-63-6	18.4	92.0	75 - 111
1,2,3-Trimethylbenzene	526-73-8	22.8	114.0	82 - 127
1,2,3,4-Tetramethylbenzene	488-23-3	20.4	102.0	72 - 131
Surrogate Recovery:		101%		76 - 127

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 10/1/96 for TVHBTEX2. MAB

Analyst

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TOTAL VOLATILE HYDROCARBONS (TVH as Gasoline)
Laboratory Control Sample (LCS)

LCS Number	: LCS2112296-GAS	Matrix	: WATER
Date Prepared	: 11/22/96	Method Numbers	: EPA 5030/8015 Modified
Date Analyzed	: 11/22/96	Instrument Name	: TVHBTEX2
Lab File Number(s)	: TVB21120076		

Compound Name	Theoretical Concentration (mg/L)	LCS Concentration (mg/L)	LCS % Recovery	QC Limit % Recovery
Gasoline	2.00	2.15	107.7	81 - 128
Surrogate Recovery:		118%		70 - 126

QUALIFIERS
B = TVH as Gasoline found in blank also.
E = Extrapolated value. Value exceeds calibration range.
NA = Not Available/Not Applicable.
** = Limits established 10/1/96 for TVHBTEX2. MAB

M. Bleeker
Analyst

K. Hollman
Approved

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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS2112296-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/22/96	Method	: 602/8020
Date Analyzed	: 11/22/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB21120077

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	21.0	105.0	75 - 116
Toluene	108-88-3	20.3	101.5	75 - 118
Chlorobenzene	108-90-7	18.6	93.0	73 - 115
Ethyl Benzene	100-41-4	20.0	100.0	80 - 122
m,p-Xylene	108-38-3	38.4	96.0	76 - 120
o-Xylene	106-42-3 95-47-6	20.2	101.0	76 - 1
MTBE	1634-04-4	20.3	101.5	75 - 115
1,3,5-Trimethylbenzene	108-67-8	19.8	99.0	64 - 118
1,2,4-Trimethylbenzene	95-63-6	18.3	91.5	75 - 111
1,2,3-Trimethylbenzene	526-73-8	22.7	113.5	82 - 127
1,2,3,4-Tetramethylbenzene	488-23-3	20.6	103.0	72 - 131
Surrogate Recovery:		100%		76 - 127

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 10/1/96 for TVHBTEX2. MAB

M. Blackman
Analyst

K. Hollman
Approved

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Wheat Ridge, CO 80033
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EPA 602/8020 Data Report
Laboratory Control Sample (LCS)

LCS Number	: LCS2112596-BTEX	Dilution Factor	: 1.00
Date Extracted/Prepared	: 11/25/96	Method	: 602/8020
Date Analyzed	: 11/25/96	Matrix	: Water
Spike Amount (ug/L)	: 20.0	Lab File No.	: TVB21125016

Compound Name	Cas Number	LCS Concentration (ug/L)	LCS % Recovery	QC Limit** % Recovery
Benzene	71-43-2	21.7	108.5	75 - 116
Toluene	108-88-3	20.8	104.0	75 - 118
Chlorobenzene	108-90-7	19.1	95.5	73 - 115
Ethyl Benzene	100-41-4	20.6	103.0	80 - 122
m,p-Xylene	108-38-3	39.5	98.8	76 - 120
o-Xylene	106-42-3 95-47-6	20.8	104.0	76 - 118
[redacted]	1634-04-4	20.0	100.0	75 - 115
1,3,5-Trimethylbenzene	108-67-8	21.0	105.0	64 - 118
1,2,4-Trimethylbenzene	95-63-6	18.7	93.5	75 - 111
1,2,3-Trimethylbenzene	526-73-8	23.2	116.0	82 - 127
1,2,3,4-Tetramethylbenzene	488-23-3	20.6	103.0	72 - 131
Surrogate Recovery:		99%		76 - 127

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.
** [redacted]limits established 10/1/96 for TVHBTEX2. MAB

M. Blaha
Analyst

K. Hollman
Approved

EVERGREEN ANALYTICAL, INC.
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(303) 425-6021

Method 8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112696	Client Project No.	: 729691.32010
Date Prepared	: 11/26/96	Lab Project No.	: 96-4081
Date Analyzed	: 11/26/96	Lab File No.	: HALL1126\005F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	[illegible]
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	84%	70% - 130% (QC limits)	

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4081.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Method Blank Report

Method Blank	: RB112596	Client Project No.	: 729691.32010
Date Prepared	: 11/25/96	Lab Project No.	: 96-4081
Date Analyzed	: 11/25/96	Lab File No.	: HALL1125\004F0101

Compound	CAS #	Concentration (ug/L)	RL(ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
2-Chlorotoluene	95-49-8	U	0.4
[illegible]Chlorotoluene	106-49-8	U	0.4
[illegible]-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	85%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4081.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPM	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-01	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\007F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/26/96	Dilution Factor	: 10.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	4
Chloroethane	75-00-3	U	4
1,1-Dichloroethene	75-35-4	U	4
Dichloromethane	75-09-2	U	4
trans-1,2-Dichloroethene	156-60-5	U	4
1,1-Dichloroethane	75-34-3	U	4
cis-1,2-Dichloroethene	156-59-4	U	4
1,1,1-Trichloroethane	71-55-6	U	4
Carbon Tetrachloride	56-23-5	U	4
Trichloroethene	79-01-6	U	4
1,1,2-Trichloroethane	79-00-5	U	4
Tetrachloroethene	127-18-4	U	4
1,1,1,2-Tetrachloroethane	79-00-5	U	4
Chlorobenzene	108-90-7	U	4.2
1,1,2,2-Tetrachloroethane	79-34-5	U	5.4
2-Chlorotoluene	95-49-8	U	
4-Chlorotoluene	106-49-8	U	
1,3-Dichlorobenzene	541-73-1	U	4
1,2-Dichlorobenzene	95-50-1	U	4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	86%	70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4081.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
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Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPL	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-03	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1125\025F0101
Date Prepared	: 11/25/96	Method Blank	: RB112596
Date Analyzed	: 11/25/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
[redacted]hlorotoluene	95-49-8	U	0.4
[redacted]hlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	77%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

HLW4081.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
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Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24-MPJ	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-07	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\010F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/26/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.5[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery	(1-Chloro-2-Fluoro-Benzene) :	81%	70% - 130% (QC limits)

QUALIFIERS:

U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

Analyst

Approved

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: ST24 Field Blank	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-09	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\012F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/26/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.54
[illegible]hlorotoluene	95-49-8	U	0.4
[illegible]hlorotoluene	106-49-8	U	0.4
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :	79%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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HLW4081.XLS; 11/27/96

EVERGREEN ANALYTICAL, INC.
4036 Youngfield, Wheat Ridge, CO 80033
(303) 425-6021

Method 601/8010 Chlorinated VOC's Sample Report

Client Sample No.	: Trip Blank	Client Project No.	: 729691.32010
Lab Sample No.	: 96-4081-11	Lab Project No.	: 96-4081
Date Sampled	: 11/18/96	Matrix	: Water
Date Received	: 11/19/96	Lab File No.	: HALL1126\014F0101
Date Prepared	: 11/26/96	Method Blank	: RB112696
Date Analyzed	: 11/26/96	Dilution Factor	: 1.0

Compound	CAS #	Concentration (ug/L)	RL (ug/L)
Vinyl Chloride	75-01-4	U	0.4
Chloroethane	75-00-3	U	0.4
1,1-Dichloroethene	75-35-4	U	0.4
Dichloromethane	75-09-2	U	0.4
trans-1,2-Dichloroethene	156-60-5	U	0.4
1,1-Dichloroethane	75-34-3	U	0.4
cis-1,2-Dichloroethene	156-59-4	U	0.4
1,1,1-Trichloroethane	71-55-6	U	0.4
Carbon Tetrachloride	56-23-5	U	0.4
Trichloroethene	79-01-6	U	0.4
1,1,2-Trichloroethane	79-00-5	U	0.4
Tetrachloroethene	127-18-4	U	0.4
1,1,1,2-Tetrachloroethane	79-00-5	U	0.4
Chlorobenzene	108-90-7	U	0.42
1,1,2,2-Tetrachloroethane	79-34-5	U	0.[illegible]
2-Chlorotoluene	95-49-8	U	[illegible]
4-Chlorotoluene	106-49-8	U	0.[illegible]
1,3-Dichlorobenzene	541-73-1	U	0.4
1,2-Dichlorobenzene	95-50-1	U	0.4

Surrogate Recovery (1-Chloro-2-Fluoro-Benzene) :		80%	70% - 130% (QC limits)

QUALIFIERS:
U = Compound analyzed for, but not detected above the Reporting Limit.
B = Compound in blank and sample. Compare blank and sample data.
E = Extrapolated value. Concentration exceeds the upper limit of the calibration.
RL = Reporting Limit (at or above method detection limit).

NOTES:

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Method 8010 Qua[redacted]ontrol Samples

Date Performed: 11/25/96

Reference Standard: V832

Analyte	M	Method Blank	Sample 96-4081-04 (W3)	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range % L - % H	Low - High
Vinyl Chloride	w			13.54	13.727	18.990	20.0	1.4	68%	69%		95%		28 - 163	5.60 - 32.60
Chloroethane	*			16.201	14.949	19.126	20.0	8.0	81%	75%		96%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			16.473	15.459	20.419	20.0	6.4	82%	77%		102%		28 - 167	5.60 - 33.40
Dichloromethane	*			17.623	18.424	20.034	20.0	4.4	88%	92%		100%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			20.188	19.596	23.784	20.0	3.0	101%	98%		119%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*			18.842	18.67	21.414	20.0	0.9	94%	93%		107%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*			20.016	19.941	22.186	20.0	0.4	100%	100%		111%		-	-
1,1,1-Trichloroethane	*			19.93	18.549	22.183	20.0	7.2	100%	93%		111%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			18.477	18.237	22.648	20.0	1.3	92%	91%		113%		43 - 143	8.60 - 28.60
Trichloroethene	w			20.117	20.487	22.990	20.0	1.8	101%	102%		115%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			20.914	21.006	22.570	20.0	0.4	105%	105%		113%		39 - 136	7.80 - 27.20
Tetrachloroethene	*			18.383	17.822	21.544	20.0	3.1	92%	89%		108%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			18.142	18.093	20.455	20.0	0.3	91%	90%		102%		-	-
Chlorobenzene	*			19.424	19.639	21.968	20.0	1.1	97%	98%		110%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			25.559	22.149	24.990	20.0	14.3	128%	111%		125%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			18.947	17.594	19.676	20.0	7.4	95%	88%		98%		-	-
4-Chlorotoluene	*			17.606	17.619	20.176	20.0	0.1	88%	88%		101%		-	-
1,3-Dichlorobenzene	*			17.888	17.47	18.673	20.0	2.4	89%	87%		93%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*			17.708	16.249	17.743	20.0	8.6	89%	81%		89%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "*".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:

All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:

Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must be taken. One recovery outside limits and the other acceptable, is a warning. Repeated failure requires corrective action. Recoveries outside guidelines should be compared to historical data available to determine if corrective action is required.

Method 8010 Quality Control Samples

Date Performed: 11/26/96 ST24-MAJ

Reference Standard: V832

Analyte	M	Method Blank	Sample 96-4081-07	Sample Spike	Spike Dup.	Control Spike	Spike Amt	RPD	Spike Recoveries Sample	Dup	#	Control	#	QC Recovery Range % L - % H	Low - High
Vinyl Chloride	w			15.78	16.558	15.956	20.0	4.8	79%	83%		80%		28 - 163	5.60 - 32.60
Chloroethane	*			17.185	17.476	17.587	20.0	1.7	86%	87%		88%		46 - 137	9.20 - 27.40
1,1-Dichloroethene	*			18.4	18.015	18.007	20.0	2.1	92%	90%		90%		28 - 167	5.60 - 33.40
Dichloromethane	*			18.345	19.173	18.341	20.0	4.4	92%	96%		92%		25 - 162	5.00 - 32.40
trans-1,2-Dichloroethene	*			21.581	22.357	21.922	20.0	3.5	108%	112%		110%		38 - 155	7.60 - 31.00
1,1-Dichloroethane	*			19.744	19.895	18.017	20.0	0.8	99%	99%		90%		47 - 132	9.40 - 26.40
cis-1,2-Dichloroethene	*			20.092	20.368	20.178	20.0	1.4	100%	102%		101%		-	-
1,1,1-Trichloroethane	*		0.131	21.94	21.457	18.110	20.0	2.2	109%	107%		91%		41 - 138	8.20 - 27.60
Carbon Tetrachloride	*			20.22	19.616	17.849	20.0	3.0	101%	98%		89%		43 - 143	8.60 - 28.60
Trichloroethene	w			21.084	21.439	18.588	20.0	1.7	105%	107%		93%		35 - 146	7.00 - 29.20
1,1,2-Trichloroethane	w			20.882	21.88	17.663	20.0	4.7	104%	109%		88%		39 - 136	7.80 - 27.20
Tetrachloroethene	*			19.699	19.867	16.052	20.0	0.8	98%	99%		80%		26 - 162	5.20 - 32.40
1,1,1,2-Tetrachloroethane	*			19.471	19.753	15.565	20.0	1.4	97%	99%		78%		-	-
Chlorobenzene	*			19.334	20.22	13.743	20.0	4.5	97%	101%		69%		1 - 150	0.16 - 30.00
1,1,2,2-Tetrachloroethane	*			22.397	22.913	16.730	20.0	2.3	112%	115%		84%		8 - 184	1.60 - 36.80
2-Chlorotoluene	*			18.282	18.755	13.096	20.0	2.6	91%	94%		65%		-	-
4-Chlorotoluene	*			17.969	18.363	11.033	20.0	2.2	90%	92%		55%		-	-
1,3-Dichlorobenzene	*			17.034	18.515	8.943	20.0	8.3	85%	93%		45%		7 - 187	1.40 - 37.40
1,2-Dichlorobenzene	*			16.48	17.368	8.788	20.0	5.2	82%	87%		44%		0 - 208	0.00 - 41.60

M = Applicable matrices. (* = Soil and Water. w = Water only.)

= Marks a spike recovery out of limits.
If recovery is outside method limit, marked with "*".
If recovery is outside a guideline, marked with "~".
If the sample spike recovery is outside the limit and the control spike is outside the limit also, the control is marked with "**" or "~~".

Notes on recovery limits:

All spiked analytes must be detected even if low limit is 0.
For analytes not listed in the method, recovery limits of 50-150% will be used as guidelines until limits can be established.

Corrective Actions:

Unacceptable sample spike recovery requires acceptable control spike recovery. If both recoveries are outside limits, corrective action must be [redacted]. One recovery outside limits and the other acceptable, is a w[redacted]g. Repeated failure requires corrective action.
Recove[redacted]tside guidelines should be compared to historical data availa[redacted]determine if corrective action is required.

EVERGREEN ANALYTICAL, INC.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form
Method Blank Report

Method Blank Number	: GB112296	Client Project No.	: 729691.32010
Date Extracted/Prepared	: 11/22/96	Lab Work Order	: 96-4081
Date Analyzed	: 11/22/96	Dilution Factor	: 1.00
		Method	: RSKSOP-175M
		Matrix	: Water
		Lab File No.	: GAS1122002

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

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4036 Youngfield St. Wheat Ridge, CO 80033
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Methane Report Form

Client Sample Number	: ST24-MPM	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4081-01	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Dilution Factor	: 10.00
Date Received	: 11/19/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122022

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.16	0.02

Temperature	: 70.6 F	Saturation Concentration	Meth	0.038
Amount Injected	: 0.05 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.12130777
Head space created	: 4 ml			
Methane Area	: 89.296 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.

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4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Methane Report Form

Client Sample Number	: ST24-MPL	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4081-03	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Dilution Factor	: 10.00
Date Received	: 11/19/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122024

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.33	0.02

Temperature	: 69 F	Saturation Concentration	Meth	0.080086849	
Amount Injected	: 0.05 ml				
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.25376866	
Head space created	: 4 ml				
Methane Area	: 186.238 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.

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Methane Report Form

Client Sample Number	: ST24-MPJ	Client Project No.	: 729691.32010
Lab Sample Number	: 96-4081-07	Lab Work Order	: 96-4081
Date Sampled	: 11/18/96	Dilution Factor	: 1.00
Date Received	: 11/19/96	Method	: RSKSOP-175M
Date Extracted/Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Lab File No.	: GAS1122027

Compound Name	Cas Number	Sample Concentration mg/L	RL mg/L
Methane	74-82-8	0.014	0.002

Temperature	: 69.1 F	Saturation Concentration	Meth	0.00[redacted]4
Amount Injected	: 0.5 ml			
Total Volume of Sample	: 43 ml	Concentration in Head Space	Meth	0.01061444
Head space created	: 4 ml			
Methane Area	: 77.913 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

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

RSKSOP-175M Gas Method
Methane LCS Report Form

LCS No.	: LCS112296	EPA Method No.	: RSKSOP-175M
Date Prepared	: 11/22/96	Matrix	: Water
Date Analyzed	: 11/22/96	Method Blank	: GB112296
E.A. LCS Source No.	: 1886	Lab File No.	: GAS1122009

Compound	Spike Added (ug)	Method Blank Concentration (ug)	LCS Concentration (ug)	LCS %REC	QC Limits %REC
Methane Gas	500	0	417	83	64-90

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

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EVERGREEN ANALYTICAL, Inc.
4036 Youngfield St. Wheat Ridge, CO 80033
(303) 425-6021

Anion Report

Date Sampled	: 11/18/96	Client Project ID.	: 729691.32010
Date Received	: 11/19/96	Lab Project Number	: 96-4081
Date Prepared	: 11/19/96	Method	: EPA 300.0
Date Analyzed	: 11/19/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Chloride mg/L	Dilution Factor
96-4081-01	ST24-MPM	Water	5.0	1
96-4081-01 Duplicate	ST24-MPM Duplicate	Water	5.1	1
96-4081-02	LF06-MPG	Water	3.3	1
96-4081-03	ST24-MPL	Water	4.0	1
96-4081-05	LF06-MPF(S)	Water	6.4	1
96-4081-07	ST24-MPJ	Water	3.4	1
96-4081-08	LF06-MPB	Water	2.8	1
Method Blank	(11/19/96)	Water	<0.25	1

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4081-01	ST24-MPM Matrix Spike	10.0	5.0	14.0	90
96-4081-01	ST24-MPM Matrix Spike Dup	10.0	5.0	13.8	88
MS/MSD RPD					1.6

Analyst

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(303) 425-6021

Anion Report

Date Sampled	: 11/18/96	Client Project ID.	: 729691.32010
Date Received	: 11/19/96	Lab Project Number	: 96-4081
Date Prepared	: 11/19/96	Method	: EPA 300.0
Date Analyzed	: 11/19/96	Detection Limit	: 0.076 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrite-N mg/L	Dilution Factor
96-4081-01	ST24-MPM	Water	<0.076	1
96-4081-01 Duplicate	ST24-MPM Duplicate	Water	<0.076	1
96-4081-02	LF06-MPG	Water	<0.076	1
96-4081-03	ST24-MPL	Water	<0.076	1
96-4081-05	LF06-MPF(S)	Water	<0.076	1
96-4081-07	ST24-MPJ	Water	<0.076	1
96-4081-08	LF06-MPB	Water	<0.076	1
Method Blank	(11/19/96)	Water	<0.076	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4081-01	ST24-MPM Matrix Spike	10.0	<0.25	9.3	93
96-4081-01	ST24-MPM Matrix Spike Dup	10.0	<0.25	9.3	93
MS/MSD RPD					0

* = Quality assurance results reported as Nitrite (NO_2).

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Anion Report

Date Sampled	: 11/18/96	Client Project ID.	: 729691.32010
Date Received	: 11/19/96	Lab Project Number	: 96-4081
Date Prepared	: 11/19/96	Method	: EPA 300.0
Date Analyzed	: 11/19/96	Detection Limit	: 0.056 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Nitrate-N mg/L	Dilution Factor
96-4081-01	ST24-MPM	Water	<0.056	1
96-4081-01 Duplicate	ST24-MPM Duplicate	Water	<0.056	1
96-4081-02	LF06-MPG	Water	<0.056	1
96-4081-03	ST24-MPL	Water	<0.056	1
96-4081-05	LF06-MPF(S)	Water	<0.056	1
96-4081-07	ST24-MPJ	Water	1.5	1
96-4081-08	LF06-MPB	Water	3.2	1
Method Blank	(11/19/96)	Water	<0.056	1

Quality Assurance *

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4081-01	ST24-MPM Matrix Spike	10.0	<0.25	9.0	90
96-4081-01	ST24-MPM Matrix Spike Dup	10.0	<0.25	9.0	90
MS/MSD RPD					0.7

* = Quality assurance results reported as Nitrate (NO_3).

Analyst

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Anion Report

Date Sampled	: 11/18/96	Client Project ID.	: 729691.32010
Date Received	: 11/19/96	Lab Project Number	: 96-4081
Date Prepared	: 11/19/96	Method	: EPA 300.0
Date Analyzed	: 11/19/96	Detection Limit	: 0.25 mg/L

Evergreen Sample #	Client Sample ID.	Matrix	Sulfate mg/L	Dilution Factor
96-4081-01	ST24-MPM	Water	0.28	1
96-4081-01 Duplicate	ST24-MPM Duplicate	Water	0.28	1
96-4081-02	LF06-MPG	Water	8.8	1
96-4081-03	ST24-MPL	Water	3.5	1
96-4081-05	LF06-MPF(S)	Water	13.4	1
96-4081-07	ST24-MPJ	Water	4.0	1
96-4081-08	LF06-MPB	Water	48.9	10
Method Blank	(11/19/96)	Water	<0.25	1

Quality Assurance

		Spike Amount (mg/L)	Sample Result (mg/L)	Spike Result (mg/L)	% Recovery
96-4081-01	ST24-MPM Matrix Spike	10.0	0.28	9.4	91
96-4081-01	ST24-MPM Matrix Spike Dup	10.0	0.28	9.3	90
MS/MSD RPD					1.4

Analyst

Approved

APPENDIX C

ANALYTICAL MODEL OUTPUT

APPENDIX C-1

ANALYTICAL MODEL-NA, 8% SOURCE DECAY COEFFICIENT

Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (46.5 mg/L source decaying at 8% per year, with a 0.08 day-1 solute decay coefficent, Constant Time, Variable Location)

[redacted]rogeologic Data

Hydraulic conductivtiy	$K := 17.71 \cdot \frac{m}{day}$
Hydraulic gradient	$I := 0.01 \cdot \frac{ft}{ft}$
Effective porosity	$n_e := 0.3$
Total porosity	$n := 0.37$
Longitudinal dispersivity	$\alpha_x := 6 \cdot m$
Concentration of Injected Contaminant	$C_s := 46.5 \cdot \frac{mg}{liter}$
Initial Dissolved Contaminant Concentration	$C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.08 \cdot \frac{1}{day}$
Source Decay Rate	$\gamma := 0.00022 \cdot \frac{1}{day}$
[redacted]oil sorption coefficient (EPA, 1990)	$K_{oc} := 79 \cdot \frac{mL}{gm}$
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$
Organic carbon content	$f_{oc} := 0.06 \cdot \%$
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$ $R = 1.211$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.59 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.487 \cdot \frac{m}{day}$
[redacted]ongitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 38.126 \cdot \frac{ft^2}{day}$

Present (4 years since source removal in 1993)

Initial Plume Distribution Calculation

$j := 0..1000$ $\quad t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

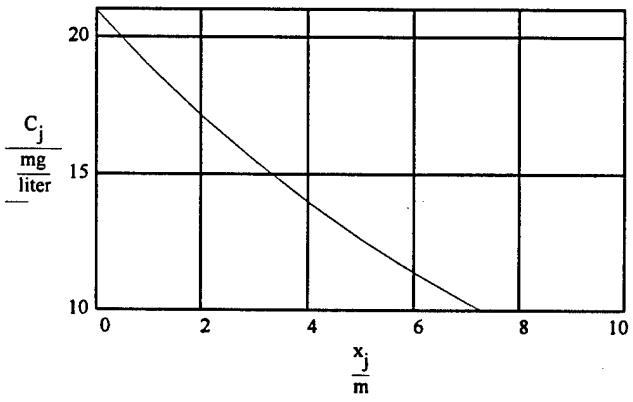
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

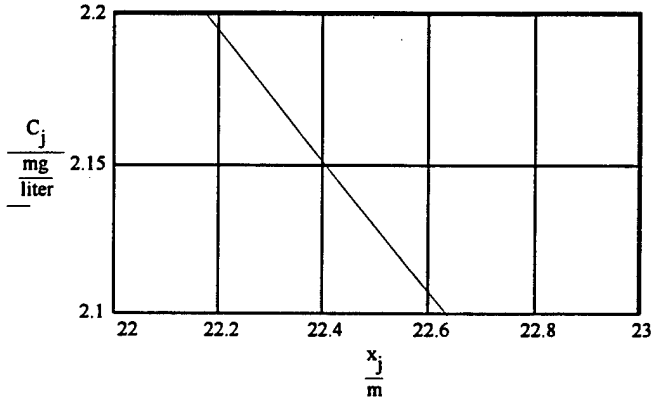
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

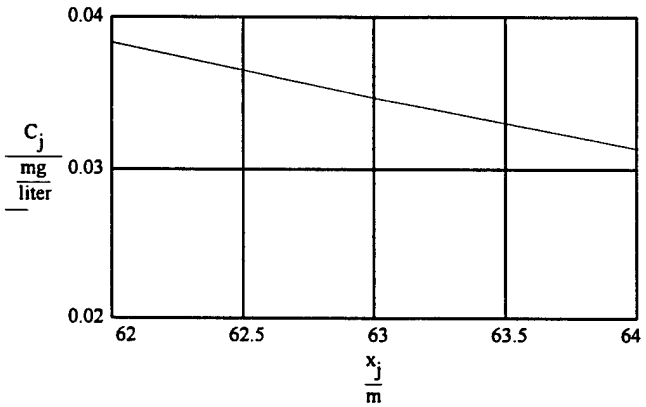
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



5 years from present (2002)

Initial Plume Distribution Calculation

$j := 0..1000$ $\quad t := 3285 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

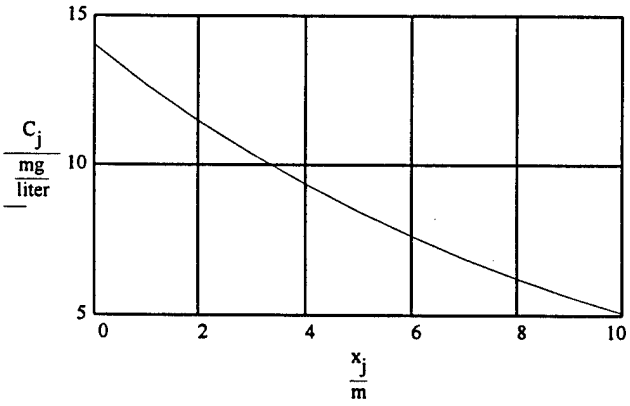
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

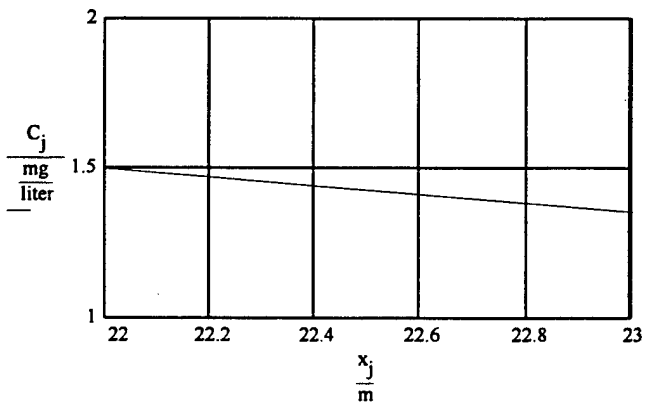
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

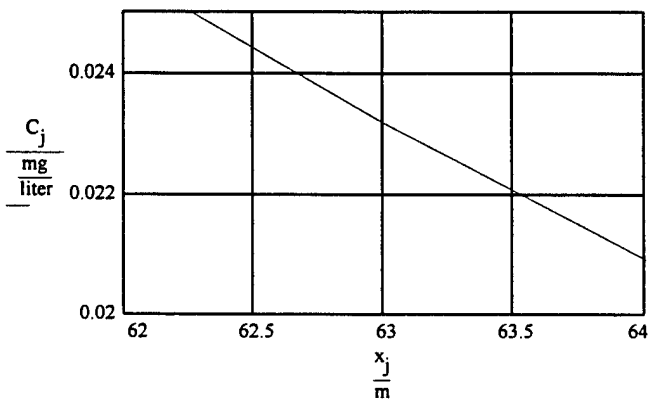
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



10 years from present (2007)

Initial Plume Distribution Calculation

$j := 0..1000$ $t := 5110 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

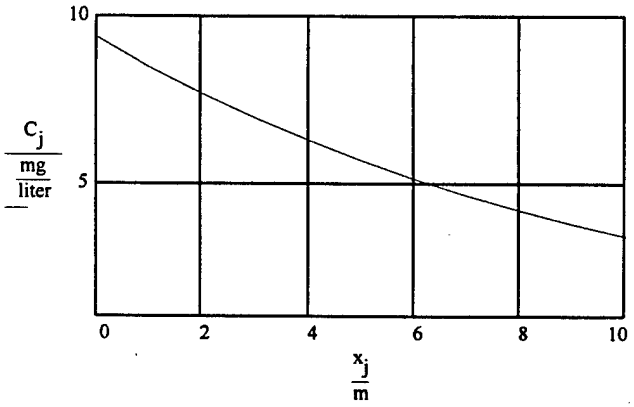
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

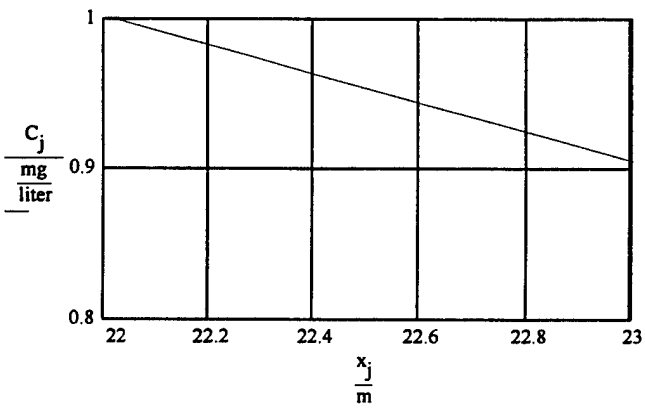
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

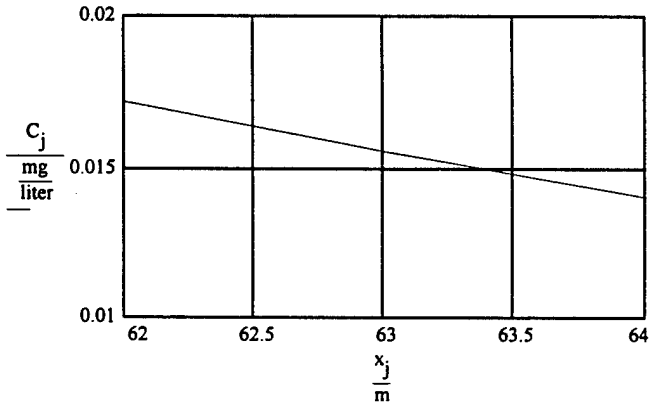
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



15 years from present (2012)

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $t := 6935 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

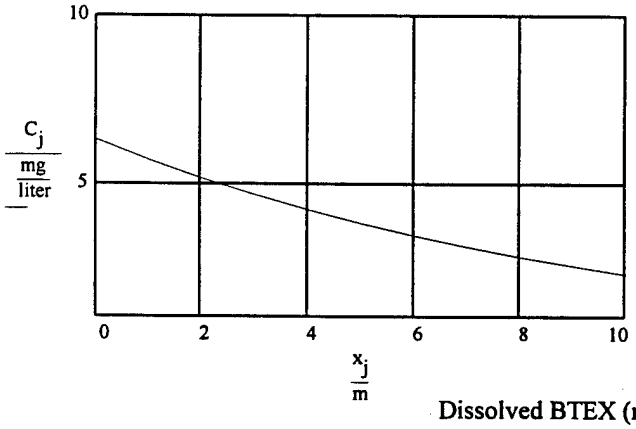
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

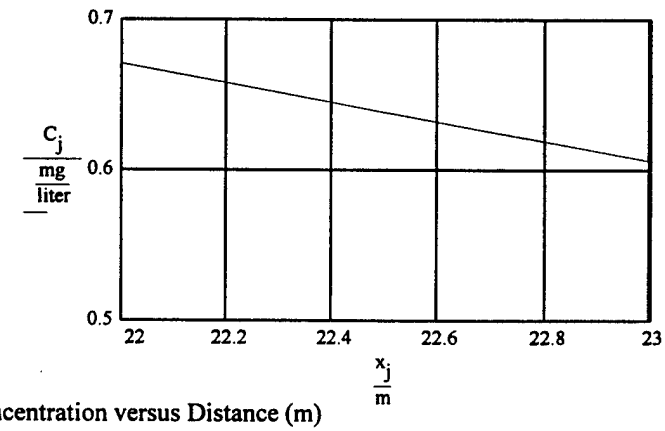
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

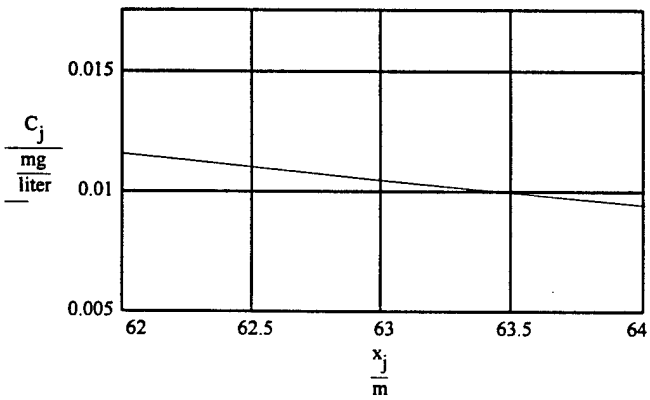
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



20 years from present (2017)

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $\quad t := 8760 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

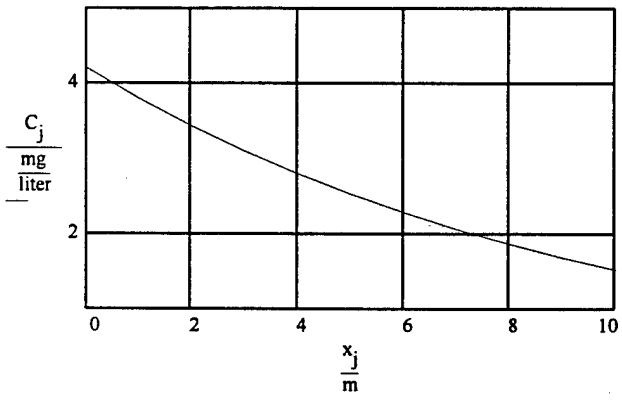
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

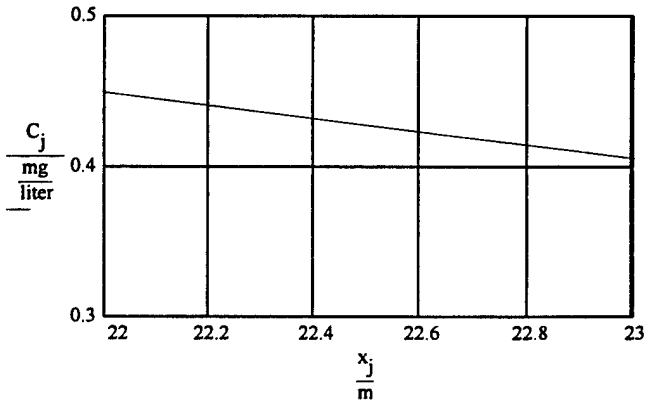
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

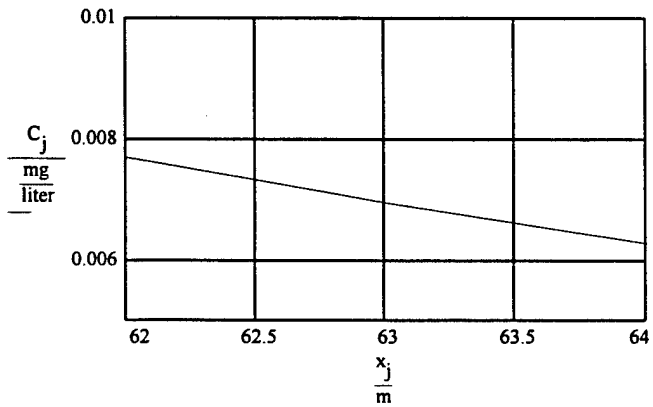
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



25 years from present (2022)

Initial Plume Distribution Calculation

$j := 0..1000$ $\quad t := 10585 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

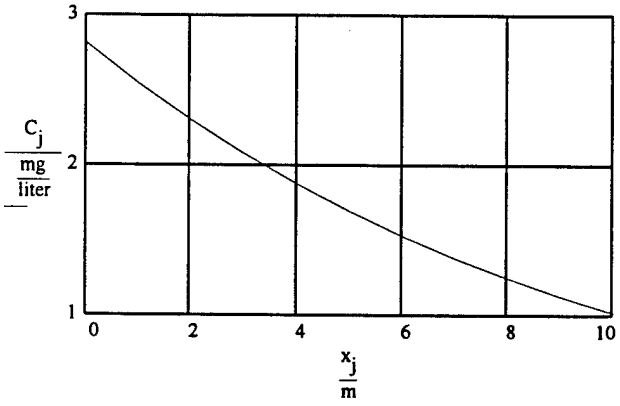
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

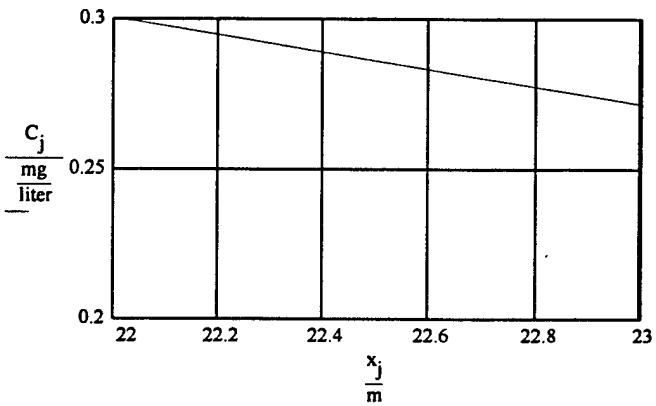
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

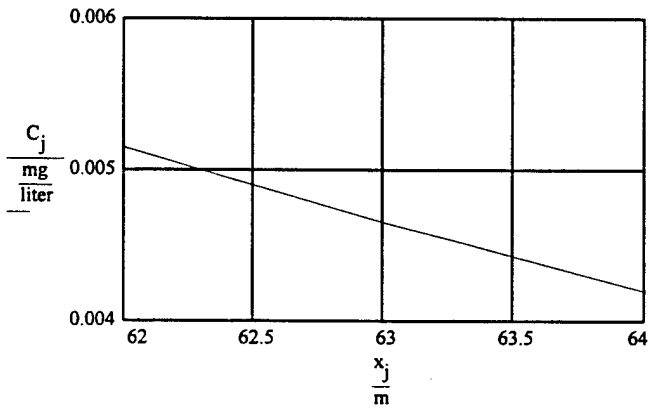
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



30 years from present (2027)

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $t := 12410 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

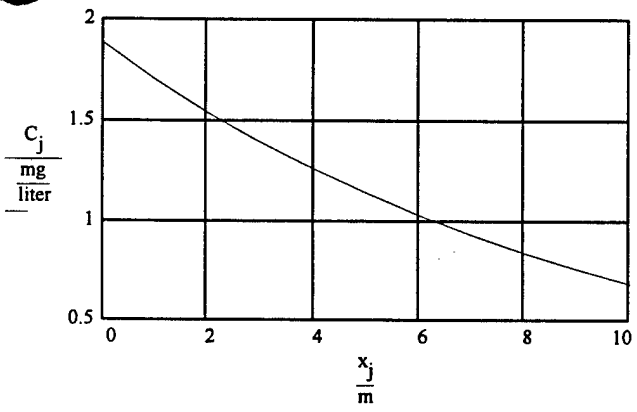
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

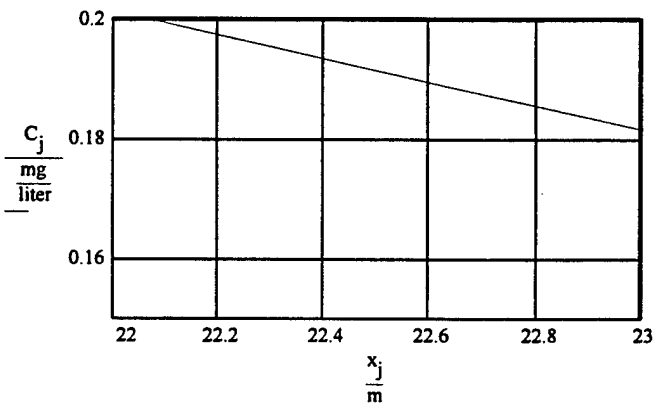
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

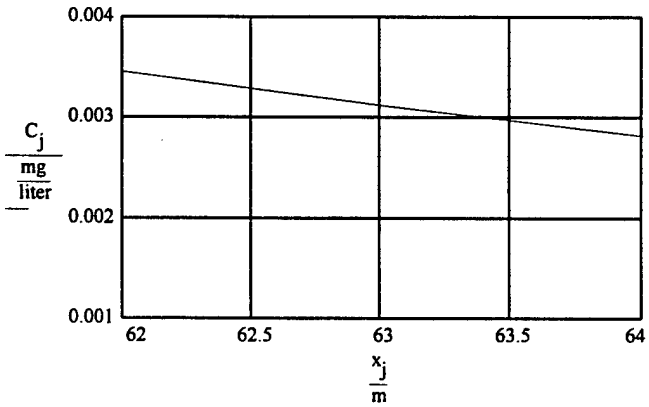
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



35 years from present (2032)

Initial Plume Distribution Calculation

$j := 0..1000$ $\quad t := 14235 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

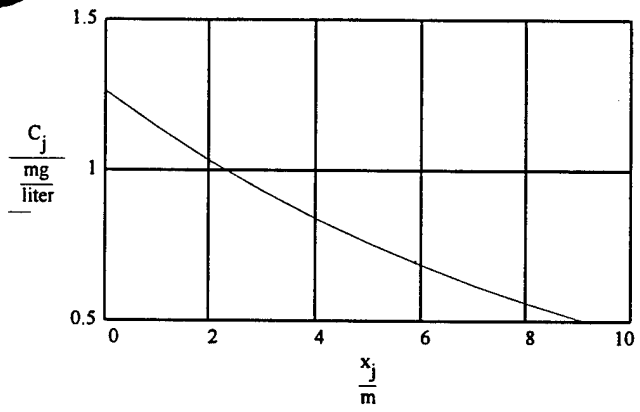
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

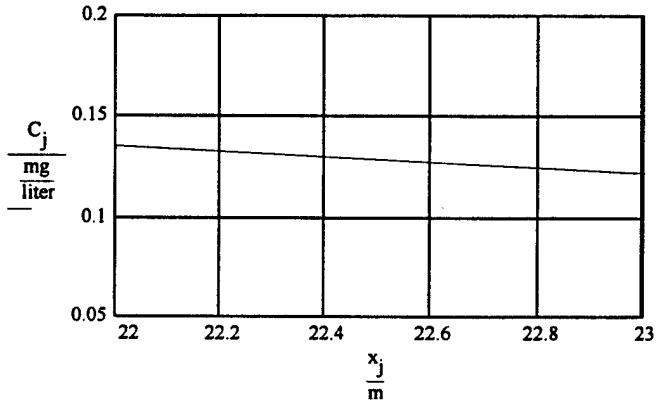
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

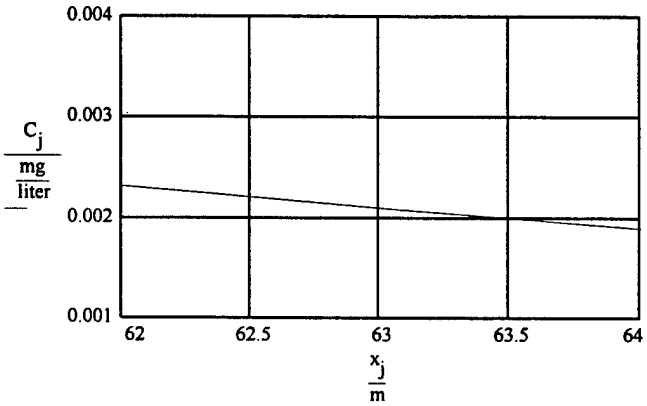
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



40 years from present (2037)

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $\quad t := 16060 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

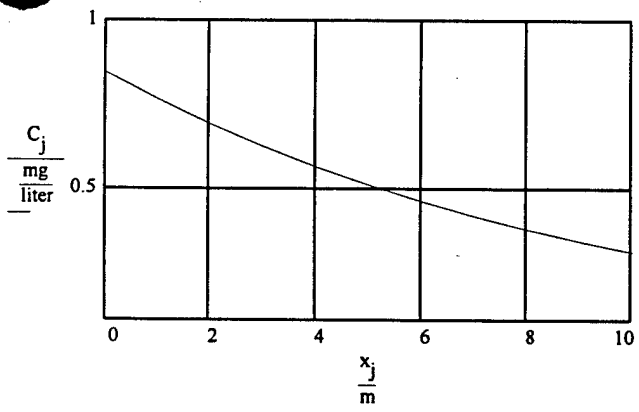
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

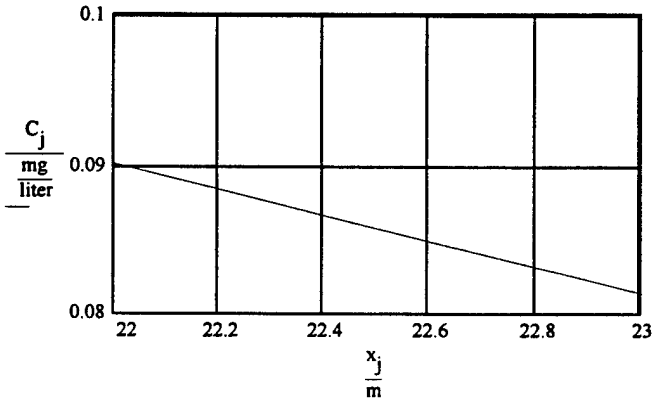
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

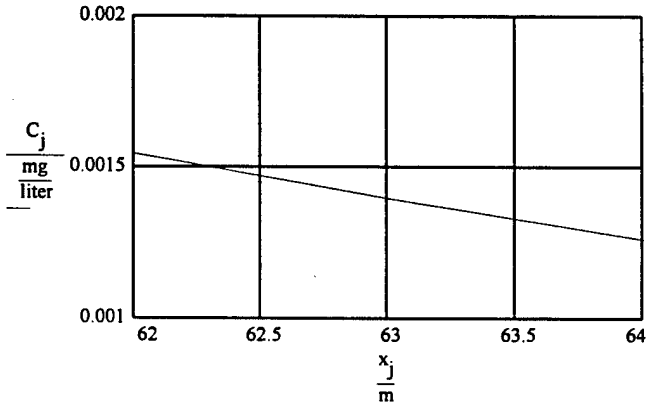
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



45 years from present (2042)

Initial Plume Distribution Calculation

$j := 0..1000$ $\quad t := 17885 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

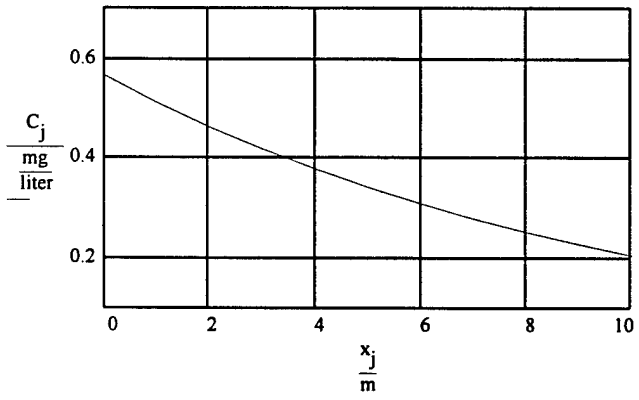
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

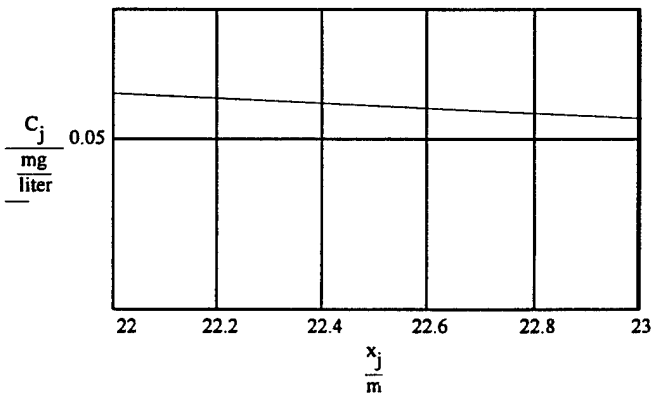
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

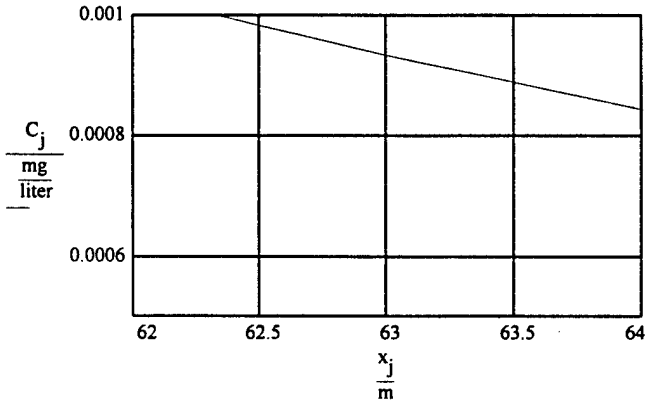
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



50 years from present (2047)

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $t := 19710 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

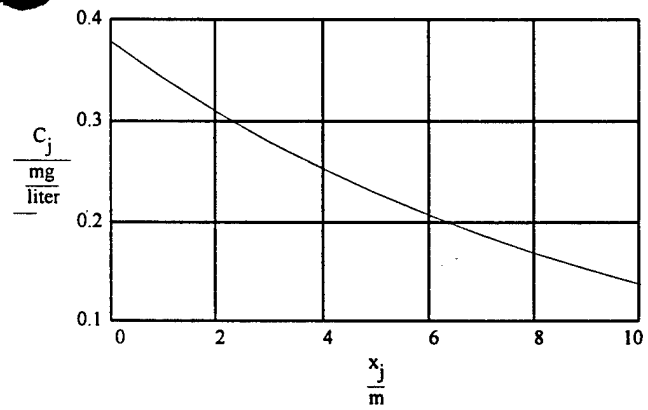
$$C_j = C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

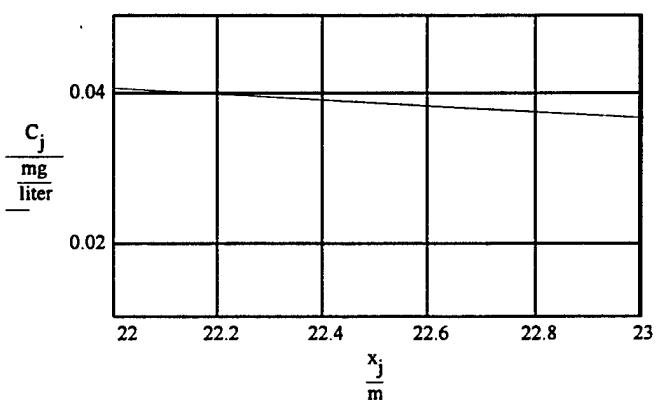
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

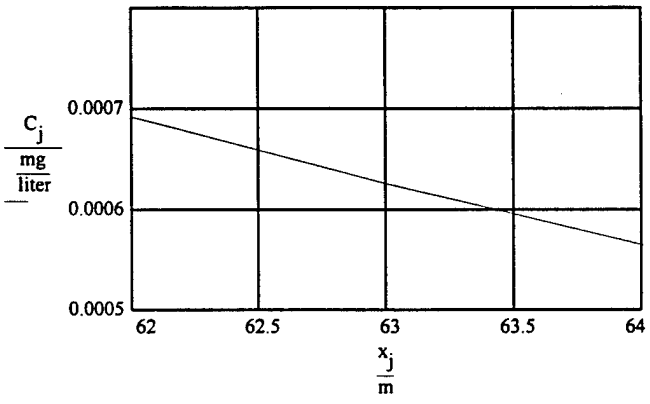
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (46.5 mg/L source decaying at 8% per year, a 0.08 day-1 solute decay coefficient, Constant Location, Variable Time)

[redacted]rogeologic Data

Hydraulic conductivtiy $K := 17.71 \cdot \frac{m}{day}$

Hydraulic gradient $I := 0.01 \cdot \frac{ft}{ft}$

Effective porosity $n_e := 0.30$

Total porosity $n := 0.37$

Longitudinal dispersivity (EPRI, 1985) $\alpha_x := 6 \cdot m$

Concentration of Injected Contaminant $C_s := 46.5 \cdot \frac{mg}{liter}$

Initial Dissolved Contaminant Concentration $C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate $\lambda := 0.08 \cdot \frac{1}{day}$

Source Decay Rate $\gamma := 0.00022 \cdot \frac{1}{day}$

[redacted]oil sorption coefficient (EPA, 1990) $K_{oc} := 79 \cdot \frac{mL}{gm}$

Bulk density (Freeze and Cherry, 1979) $\rho_b := 1.65 \cdot \frac{gm}{cm^3}$

Organic carbon content $f_{oc} := 0.06 \cdot \%$

Retardation coefficient $R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$ $R = 1.211$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water) $v_x := \frac{K \cdot I}{n_e}$ $v_x = 0.59 \cdot \frac{m}{day}$

Contaminant velocity $v_c := \frac{v_x}{R}$ $v_c = 0.487 \cdot \frac{m}{day}$

[redacted]Longitudinal dispersion coefficient $D_x := \alpha_x \cdot v_x$ $D_x = 38.126 \cdot \frac{ft^2}{day}$

1 meter downgradient from the source area (MPM/MPC)

[redacted] l Plume Distribution Calculation

year := 365·day i := 1 .. 120 x := 1·m

Δt := 1·year

$t_i := \Delta t \cdot i$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

$$C_i := C_0 \cdot \exp\left(-\lambda \cdot t_i\right) \cdot \left[\left(1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \frac{v_x^2 \cdot t_i}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{\left(R \cdot x - v_x \cdot t_i\right)^2}{4 \cdot D_x \cdot R \cdot t_i}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^2 \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right) \ldots \right.$$

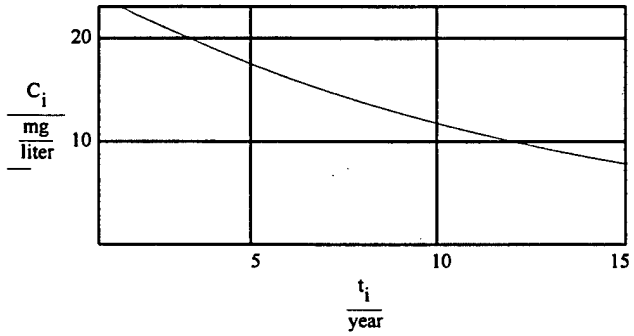
$$\left. + C_s \cdot \exp\left(-\gamma \cdot t_i\right) \cdot \left(\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots \right.\right.$$

$$\left. + \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots \right.$$

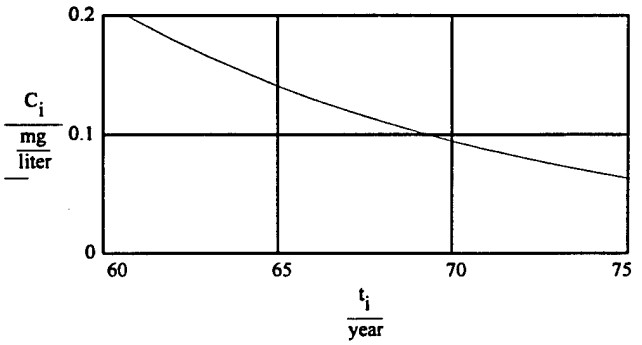
$$\left. \left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i\right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right) \right]$$

[redacted]

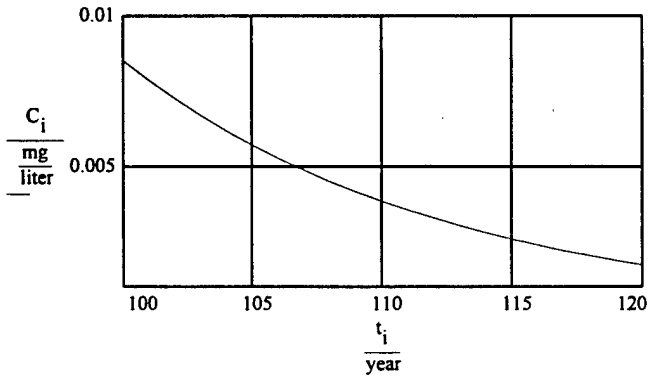
Concentration of BTEX (mg/L) versus Time (years)



Concentration of BTEX (mg/L) versus Time (years)



Concentration of BTEX (mg/L) versus Time (years)



[redacted]

22 meters downgradient from the source area (W71)

Initial Plume Distribution Calculation

year := 365·day i := 1 .. 120 x := 22·m

Δt := 1·year

$t_i := \Delta t \cdot i$

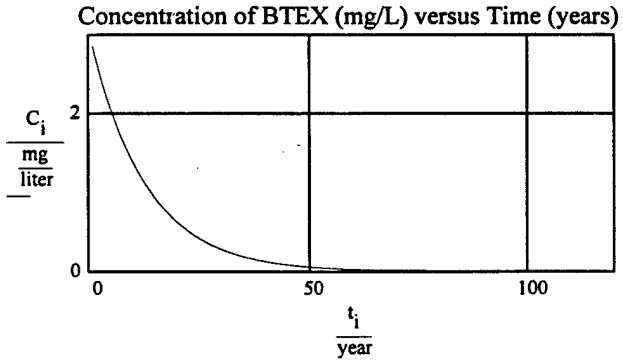
For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

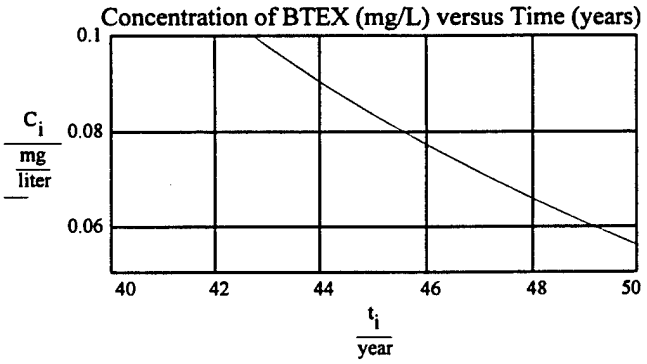
$$C_i := C_o \cdot \exp\left(-\lambda \cdot t_i\right) \cdot \left[\left(1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \frac{v_x^2 \cdot t_i}{\pi \cdot D_x \cdot R} \cdot \exp\left(-\frac{\left(R \cdot x - v_x \cdot t_i\right)^2}{4 \cdot D_x \cdot R \cdot t_i}\right) + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^2 \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right) \ldots \right.$$

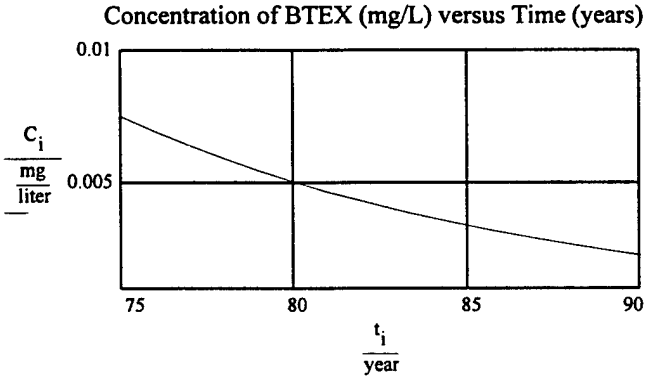
$$+ C_s \cdot \exp\left(-\gamma \cdot t_i\right) \cdot \left(\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right] \right] \ldots \right.$$

$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right) \right]$$







41 meters downgradient from source area (MPL)

[redacted]l Plume Distribution Calculation

$i := 1 .. 120$ $x := 41 \cdot m$

$year := 365 \cdot day$ $\Delta t := 1 \cdot year$

$t_i := \Delta t \cdot i$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

$$C_i := C_0 \cdot \exp\left(-\lambda \cdot t_i\right) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \frac{v_x^2 \cdot t_i}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{\left(R \cdot x - v_x \cdot t_i\right)^2}{4 \cdot D_x \cdot R \cdot t_i}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^2 \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right] \ldots$$

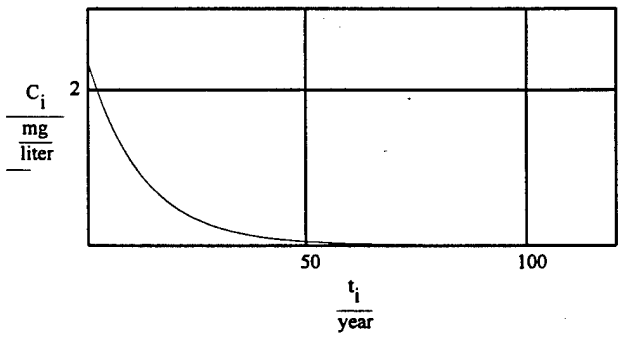
$$+ C_s \cdot \exp\left(-\gamma \cdot t_i\right) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot \frac{x}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right] \right] \ldots \right.$$

$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot \frac{x}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right] \right] \ldots$$

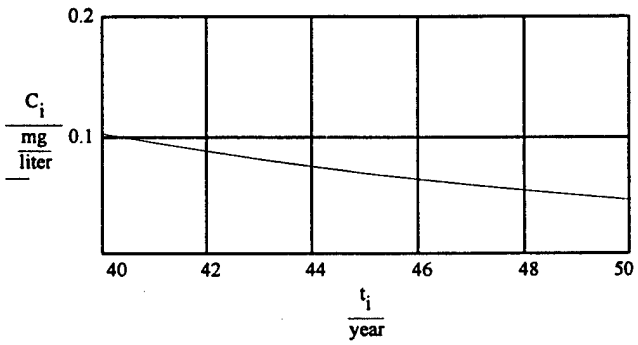
$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right]$$

[redacted]

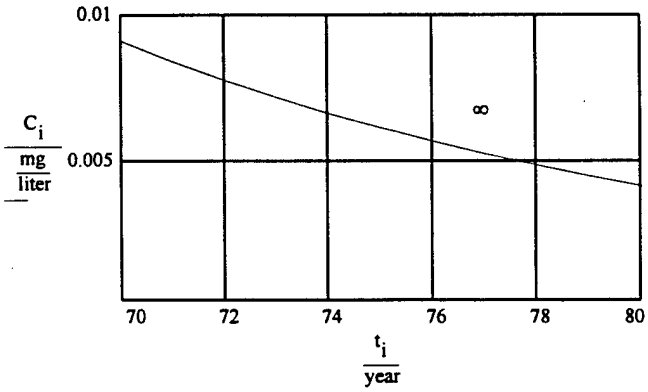
Concentration of BTEX (mg/L) versus Time (years)



Concentration of BTEX (mg/L) versus Time (years)



Concentration of BTEX (mg/L) versus Time (years)



[redacted]

APPENDIX C-2

ANALYTICAL MODEL-BB, 50% SOURCE DECAY COEFFICIENT

Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (46.5 mg/L source decaying at 50% per year, a 0.08 day-1 solute decay coefficient, Constant Time, Variable Location)

[redacted]rogeologic Data

Hydraulic conductivtiy $K := 17.71 \cdot \frac{m}{day}$

Hydraulic gradient $I := 0.01 \cdot \frac{ft}{ft}$

Effective porosity $n_e := 0.3$

Total porosity $n := 0.37$

Longitudinal dispersivity $\alpha_x := 6 \cdot m$

Concentration of Injected Contaminant $C_s := 46.5 \cdot \frac{mg}{liter}$

Initial Dissolved Contaminant Concentration $C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate $\lambda := 0.08 \cdot \frac{1}{day}$

Source Decay Rate $\gamma := 0.00137 \cdot \frac{1}{day}$

[redacted]oil sorption coefficient (EPA, 1990) $K_{oc} := 79 \cdot \frac{mL}{gm}$

Bulk density (Freeze and Cherry, 1979) $\rho_b := 1.65 \cdot \frac{gm}{cm^3}$

Organic carbon content $f_{oc} := 0.06 \cdot \%$

Retardation coefficient $R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$ $R = 1.211$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water) $v_x := \frac{K \cdot I}{n_e}$ $v_x = 0.59 \cdot \frac{m}{day}$

Contaminant velocity $v_c := \frac{v_x}{R}$ $v_c = 0.487 \cdot \frac{m}{day}$

Longitudinal dispersion coefficient $D_x := \alpha_x \cdot v_x$ $D_x = 38.126 \cdot \frac{ft^2}{day}$

[redacted]

After 1 year of Biosparging (1998)

Initial Plume Distribution Calculation

$j := 0..1000$ $\quad t := 1825 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

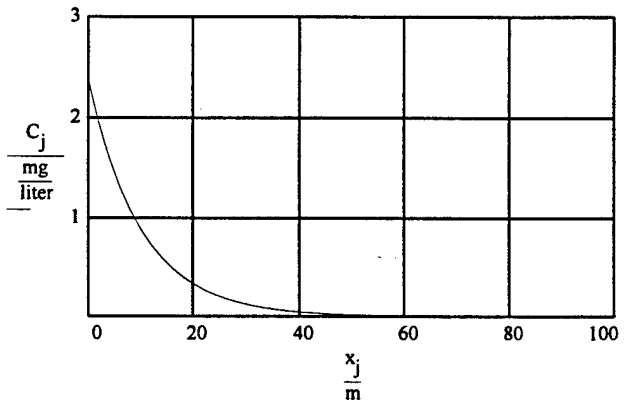
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

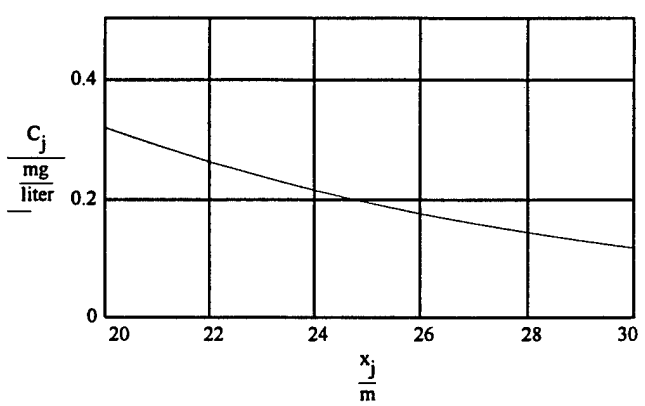
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

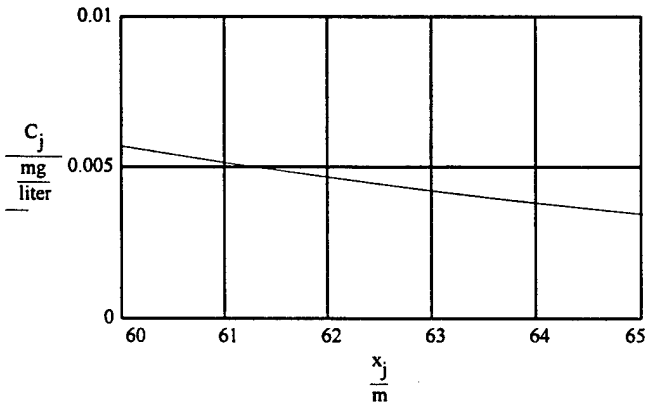
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



After 2 years of Biosparging (1999)

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $t := 2190 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

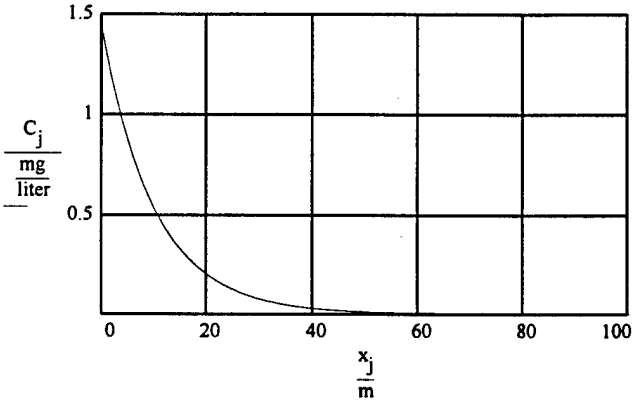
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

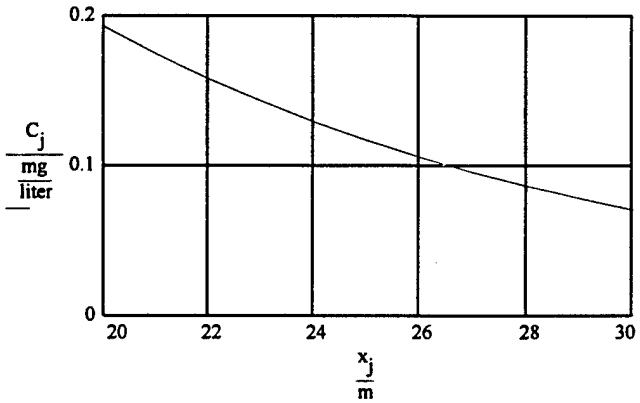
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

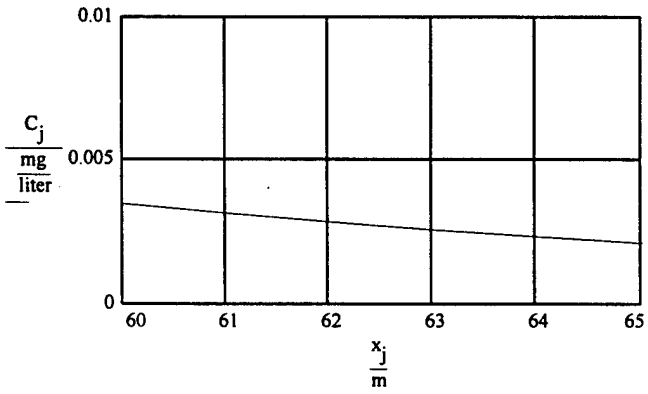
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



After 3 years of Biosparging (2000)

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $\quad t := 2555 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

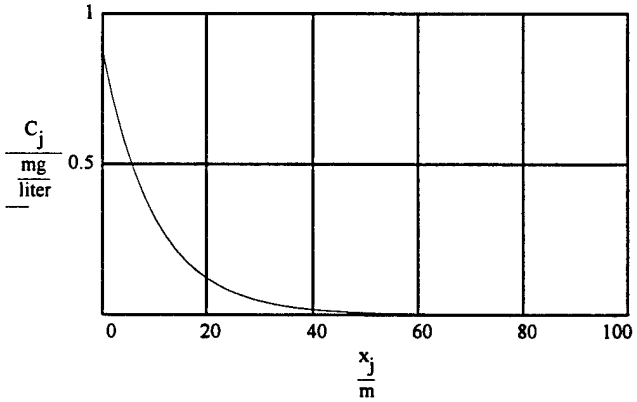
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

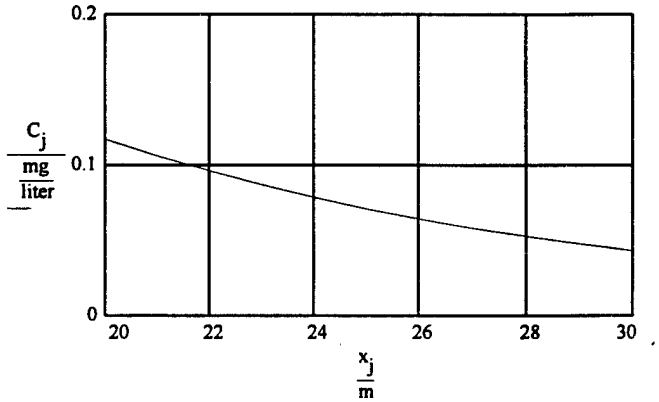
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

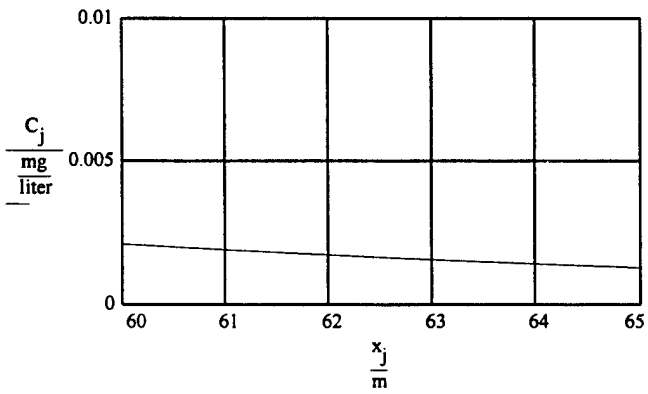
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



After 4 years of Biosparging (2001)

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $\quad t := 2920 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

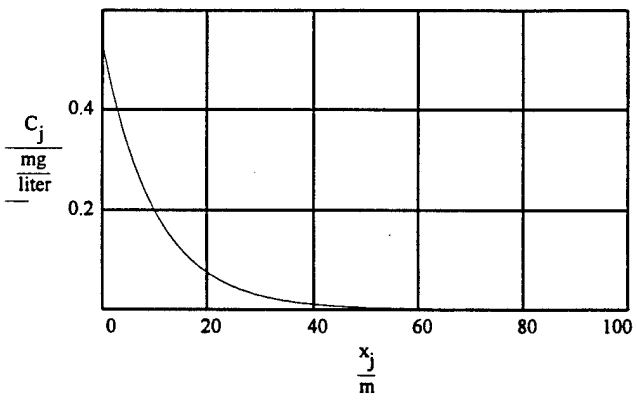
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left(- \frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right) + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot \frac{x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

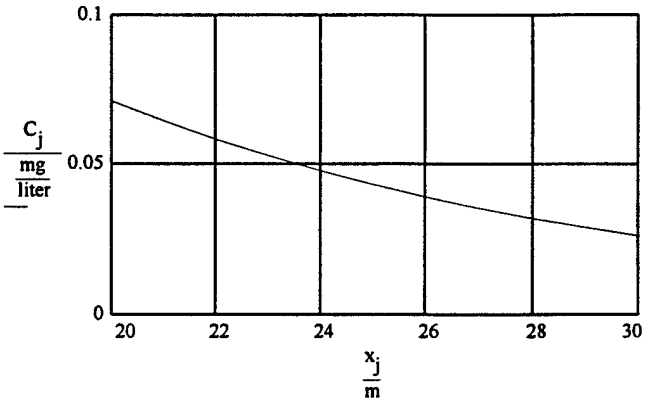
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot \frac{x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right) \right]$$

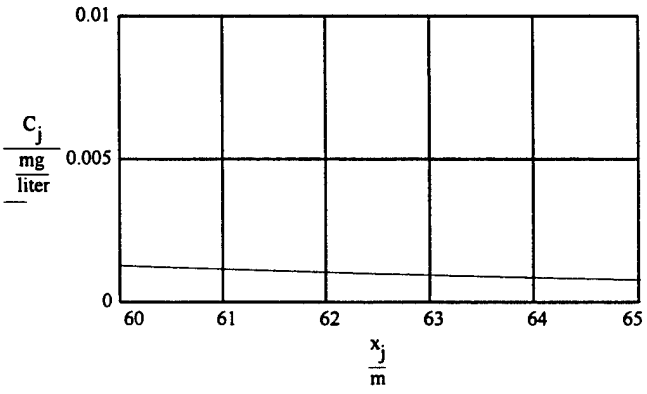
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



After 5 years of Biosparging (2002)

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $\quad t := 3285 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

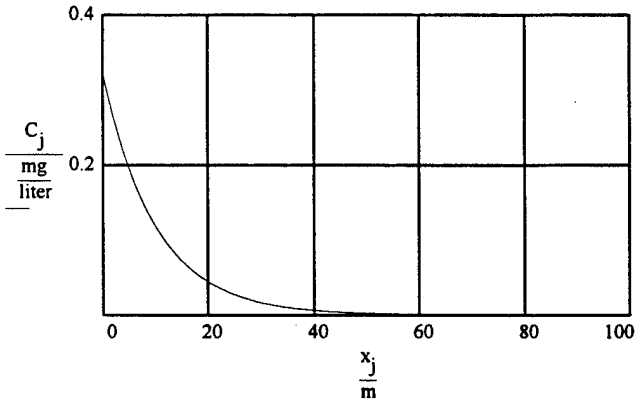
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[- \frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

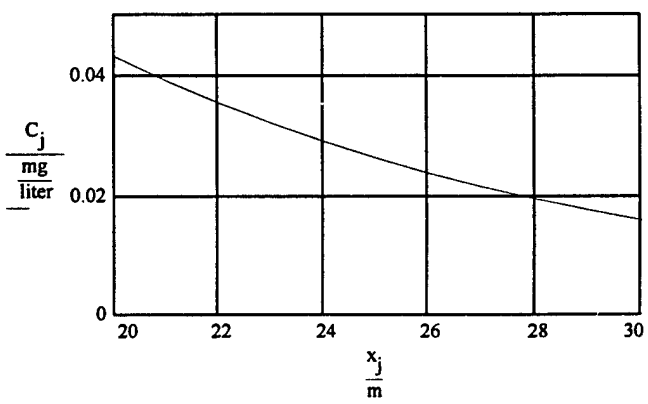
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

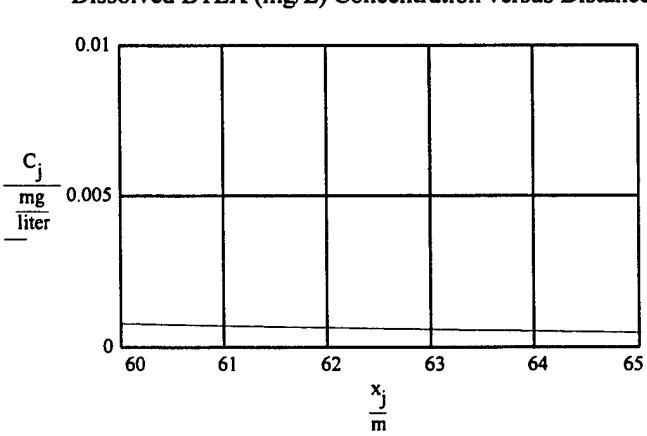
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Transient Solution to the Advective-Dispersive Equation for One-Dimensional Flow, Type Three Boundary Condition (46.5 mg/L source decaying 50% per year, a 0.08 day-1 solute decay coefficient, Constant Location, Variable Time)

[redacted]rogeologic Data

Hydraulic conductivtiy	$K := 17.71 \cdot \frac{m}{day}$
Hydraulic gradient	$I := 0.01 \cdot \frac{ft}{ft}$
Effective porosity	$n_e := 0.30$
Total porosity	$n := 0.37$
Longitudinal dispersivity (EPRI, 1985)	$\alpha_x := 6 \cdot m$
Concentration of Injected Contaminant	$C_s := 46.5 \cdot \frac{mg}{liter}$
Initial Dissolved Contaminant Concentration	$C_o := 0 \cdot \frac{mg}{liter}$

Retardation Coefficient Calculation

Solute Decay Rate	$\lambda := 0.08 \cdot \frac{1}{day}$
Source Decay Rate	$\gamma := 0.00137 \cdot \frac{1}{day}$
[redacted]oil sorption coefficient (EPA, 1990)	$K_{oc} := 79 \cdot \frac{mL}{gm}$
Bulk density (Freeze and Cherry, 1979)	$\rho_b := 1.65 \cdot \frac{gm}{cm^3}$
Organic carbon content	$f_{oc} := 0.06 \cdot \%$
Retardation coefficient	$R := 1 + \frac{\rho_b \cdot K_{oc} \cdot f_{oc}}{n}$ $R = 1.211$

Groundwater Hydraulics Calculations

Groundwater velocity (pore-water)	$v_x := \frac{K \cdot I}{n_e}$	$v_x = 0.59 \cdot \frac{m}{day}$
Contaminant velocity	$v_c := \frac{v_x}{R}$	$v_c = 0.487 \cdot \frac{m}{day}$
[redacted]Longitudinal dispersion coefficient	$D_x := \alpha_x \cdot v_x$	$D_x = 38.126 \cdot \frac{ft^2}{day}$

1 meter downgradient from source area (MPC/MPM)

[redacted]ial Plume Distribution Calculation

year := 365·day i := 1 .. 20 x := 1·m

Δt := 1·year

$t_i := \Delta t \cdot i$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

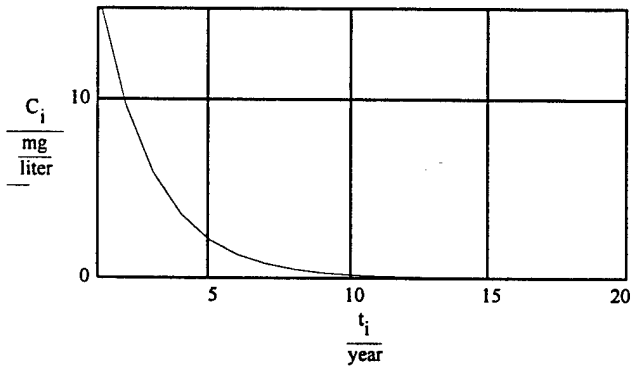
$$C_i := C_0 \cdot \exp\left(-\lambda \cdot t_i\right) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \frac{v_x^2 \cdot t_i}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x - v_x \cdot t_i)^2}{4 \cdot D_x \cdot R \cdot t_i}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^2 \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp\left(-\gamma \cdot t_i\right) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots \right.$$

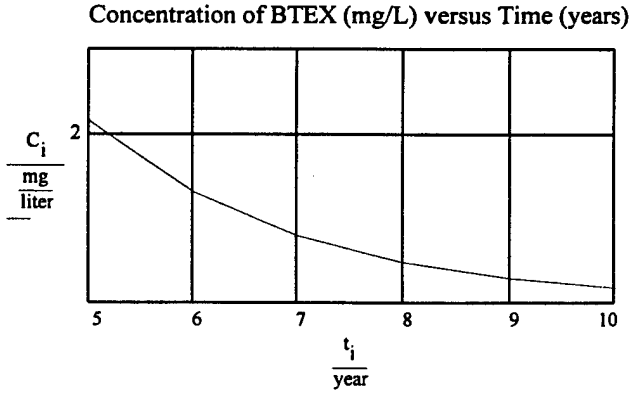
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i\right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right]$$

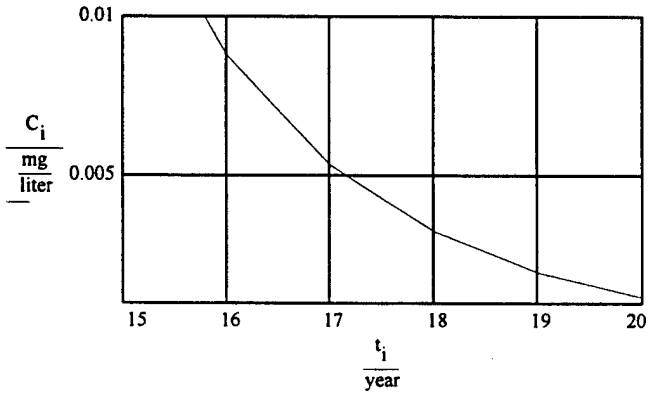
Concentration of BTEX (mg/L) versus Time (years)



Concentration of BTEX (mg/L) versus Time (years)



Concentration of BTEX (mg/L) versus Time (years)



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22 meter downgradient from source area (W71)

[redacted]ial Plume Distribution Calculation

year := 365·day i := 1 .. 20 x := 22·m

$\Delta t := 1 \cdot year$

$t_i := \Delta t \cdot i$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

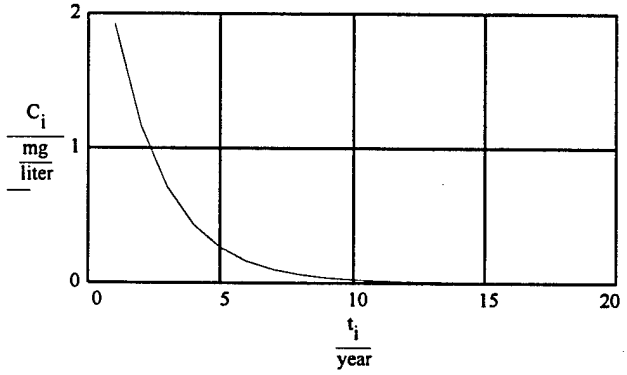
$$C_i := C_0 \cdot \exp\left(-\lambda \cdot t_i\right) \cdot \left[\left(1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \frac{v_x^2 \cdot t_i}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{\left(R \cdot x - v_x \cdot t_i\right)^2}{4 \cdot D_x \cdot R \cdot t_i}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^2 \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right) \ldots \right.$$

$$+ C_s \cdot \exp\left(-\gamma \cdot t_i\right) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots \right.$$

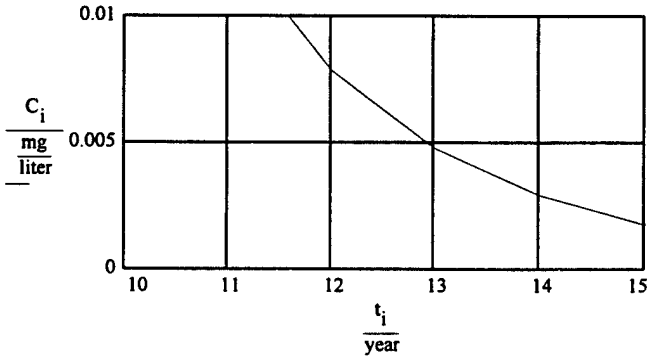
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}\right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}\right] \cdot x}{2 \cdot D_x}\right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right]\right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)}\right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i\right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right]$$

Concentration of BTEX (mg/L) versus Time (years)



Concentration of BTEX (mg/L) versus Time (years)



41 meters downgradient from the source area (MPL)

[redacted]ial Plume Distribution Calculation

week := 7·day i := 1..2700 x := 41·m

Δt := 1·week

$t_i := \Delta t \cdot i$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

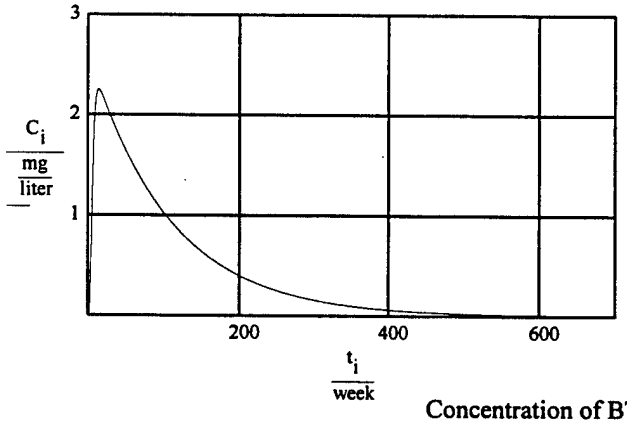
$$C_i := C_o \cdot \exp\left(-\lambda \cdot t_i\right) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x - v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) - \frac{v_x^2 \cdot t_i}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{\left(R \cdot x - v_x \cdot t_i\right)^2}{4 \cdot D_x \cdot R \cdot t_i}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x}{D_x} + \frac{v_x^2 \cdot t_i}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp\left(-\gamma \cdot t_i\right) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x - t_i \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right] \right] \ldots \right.$$

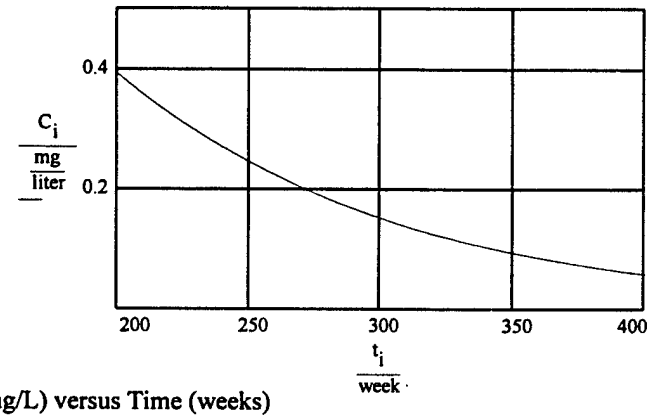
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x + t_i \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x}{D_x} - (\lambda - \gamma) \cdot t_i \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x + v_x \cdot t_i}{2 \cdot \sqrt{D_x \cdot R \cdot t_i}}\right)\right) \right]$$

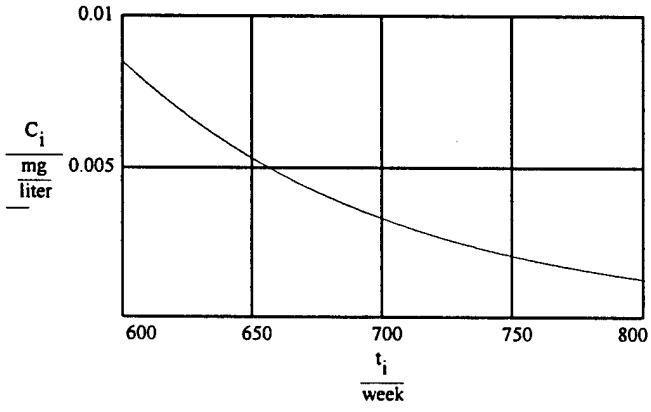
Concentration of BTEX (mg/L) versus Time (weeks)



Concentration of BTEX (mg/L) versus Time (weeks)



Concentration of BTEX (mg/L) versus Time (weeks)



APPENDIX C-3

ANALYTICAL MODEL SENSITIVITY ANALYSES

Sensitivity Analysis of Hydrualic Conductivity (2 times less than observed value) - Present

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

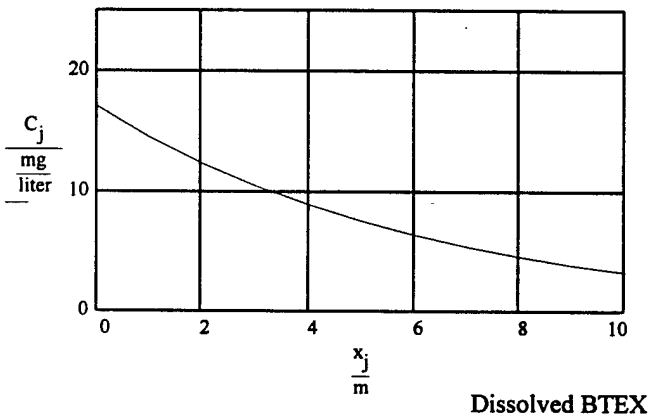
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

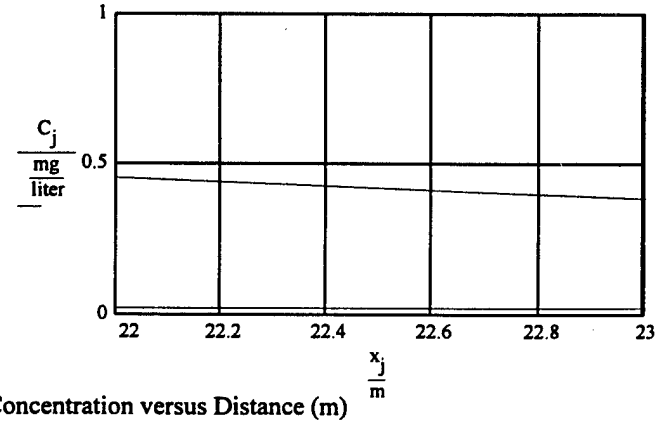
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

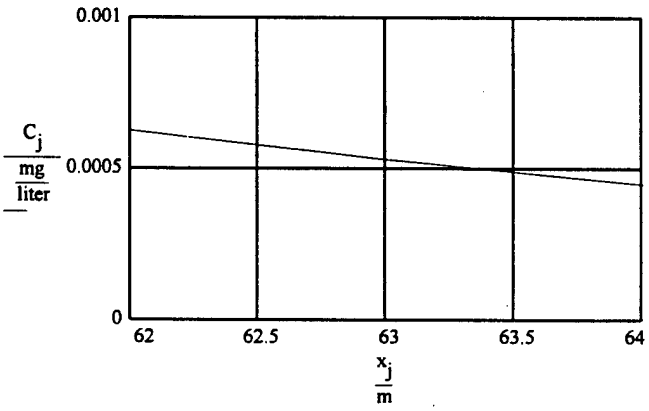
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Hydraulic Conductivity (2 times greater than observed) - Present

Initial Plume Distribution Calculation

$j := 0..1000$ $t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

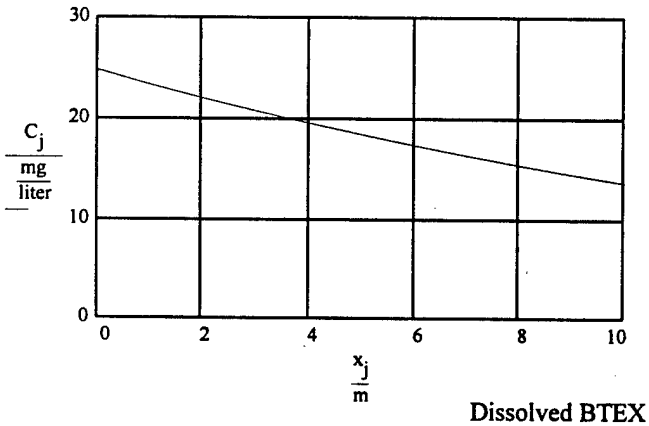
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

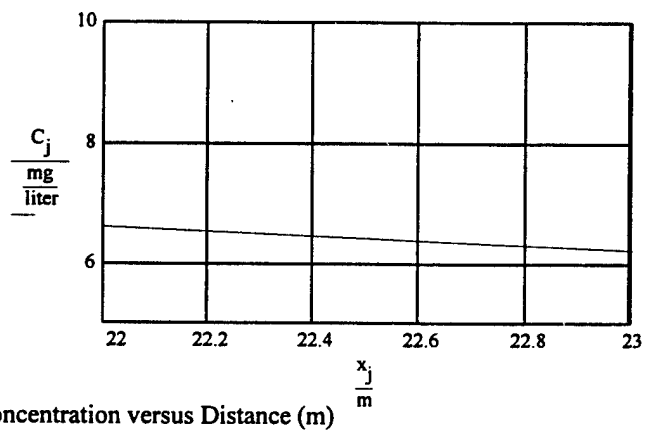
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

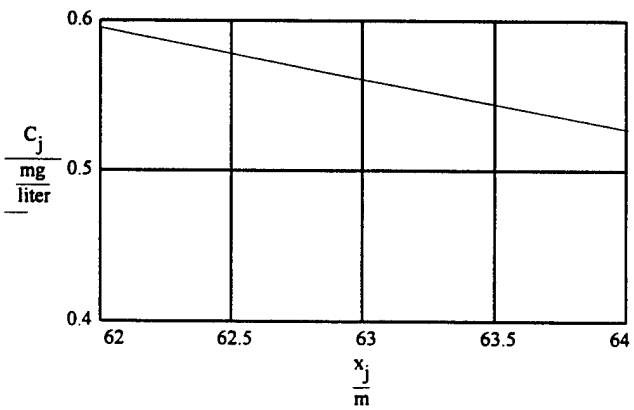
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Total Organic Carbon Content (10 times less than observed value) - Present

Initial Plume Distribution Calculation

$j := 0..1000$ $\quad t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

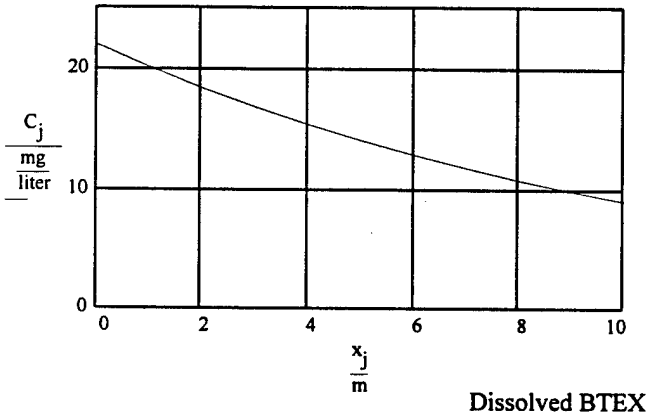
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf} \frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left(1 - \operatorname{erf} \frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

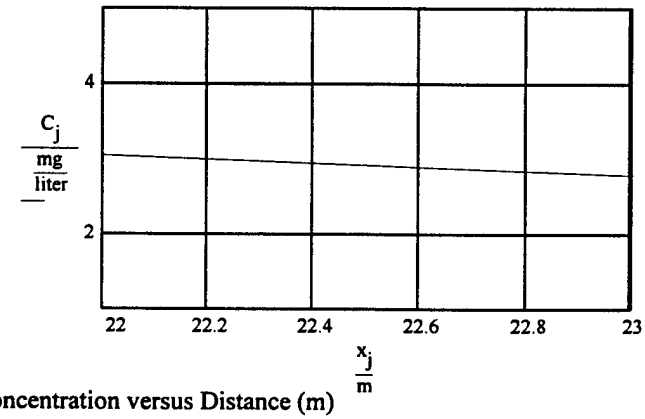
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf} \frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right]$$

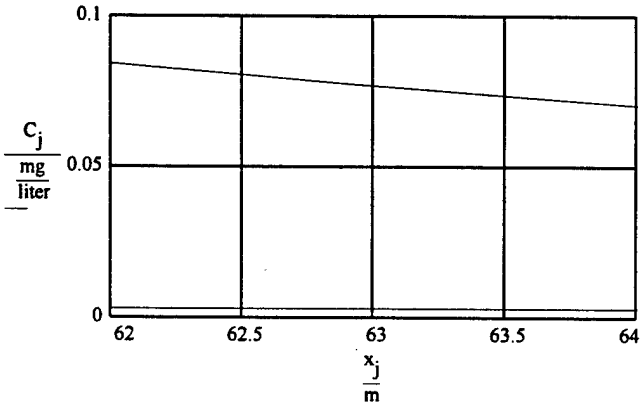
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Total Organic Carbon Content (10 times greater than observed value) - Present

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $\quad t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

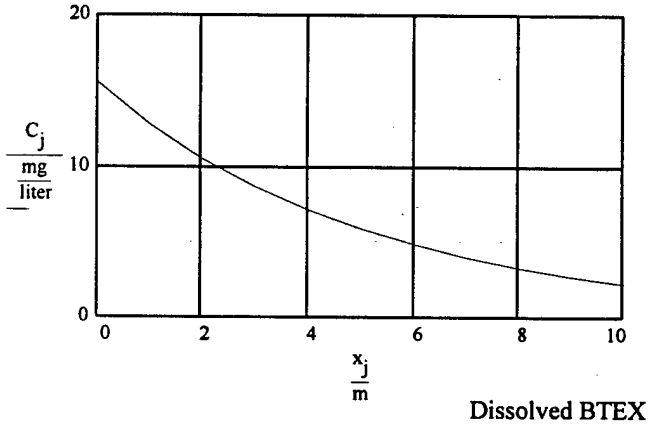
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[- \frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

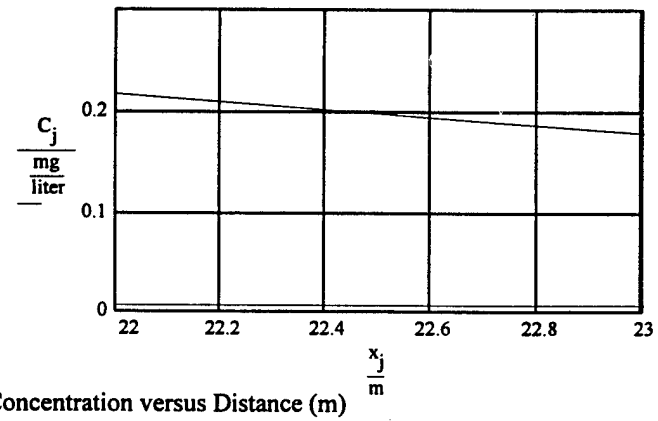
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

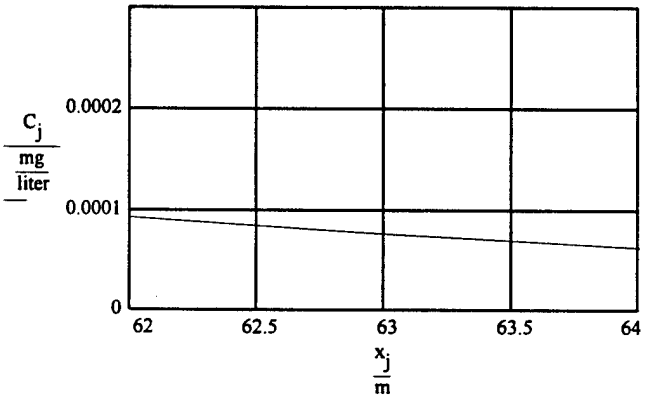
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Effective Porosity (25 percent less than observed value) - Present

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

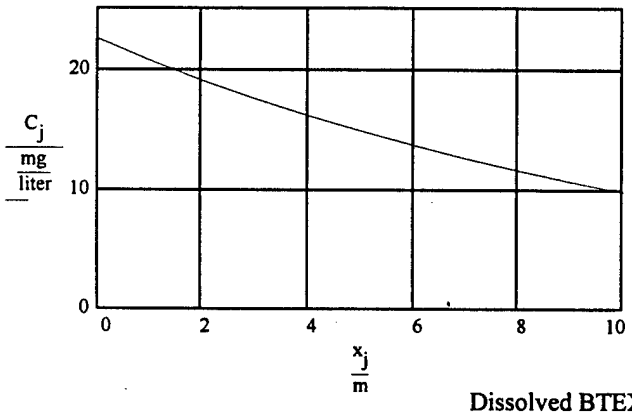
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

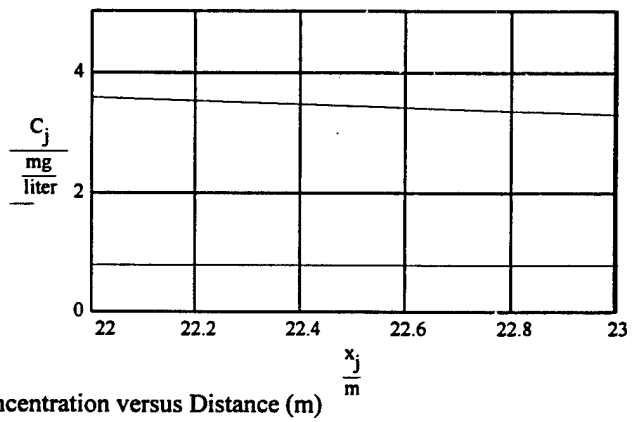
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

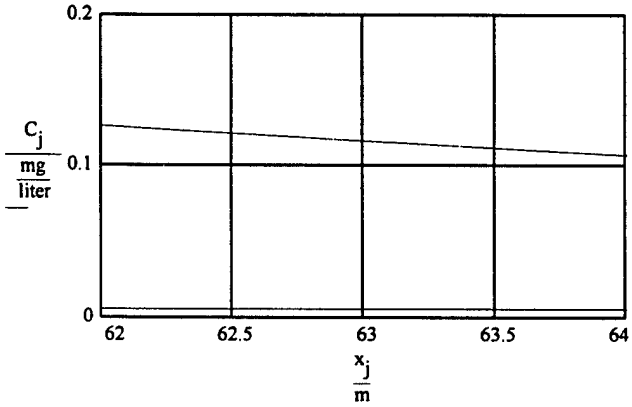
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Effective Porosity (25 percent greater than observed value) - Present

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

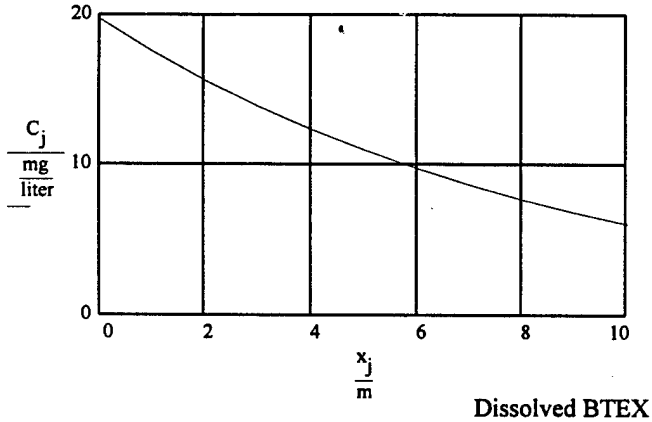
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

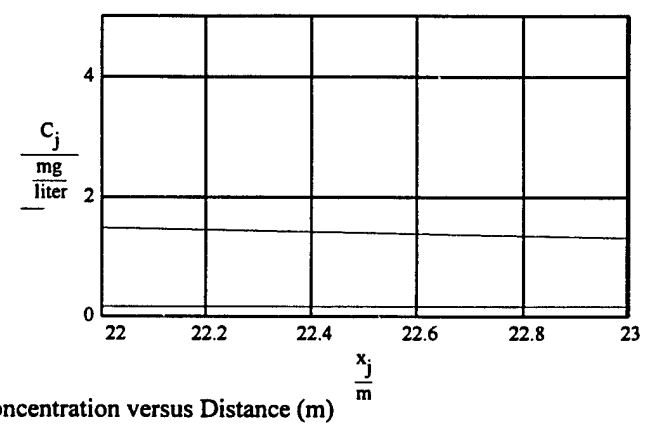
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

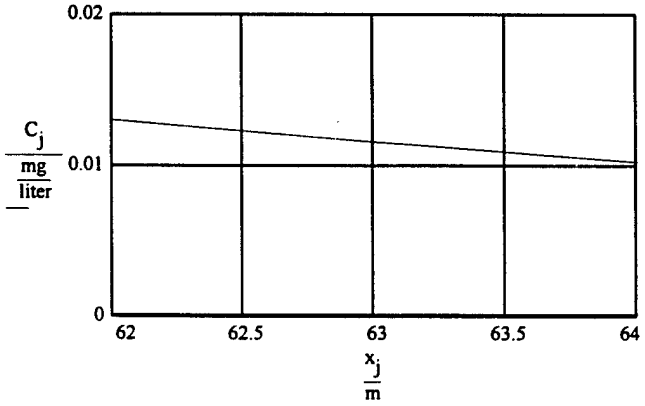
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



I:\columbus\rptst24\model\SENSXE1.MCD

Sensitivity Analysis of Dispersivity (2 times less than observed value) - Present

ial Plume Distribution Calculation

$j := 0 .. 1000$ $\quad t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

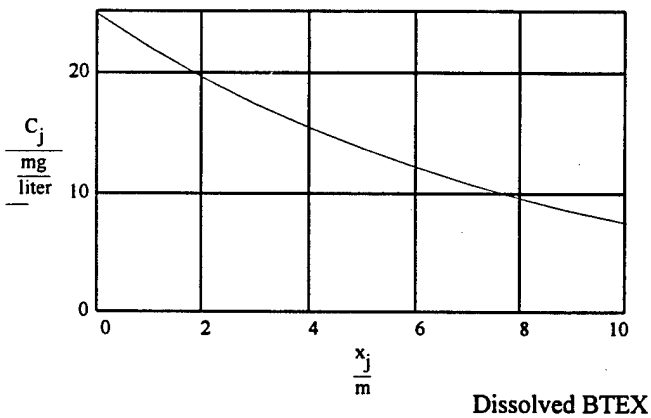
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

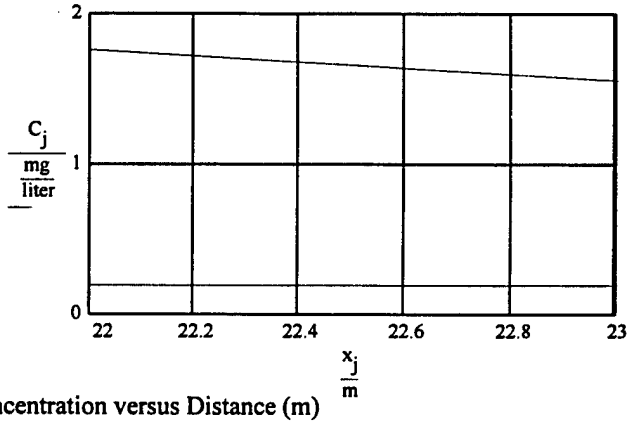
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

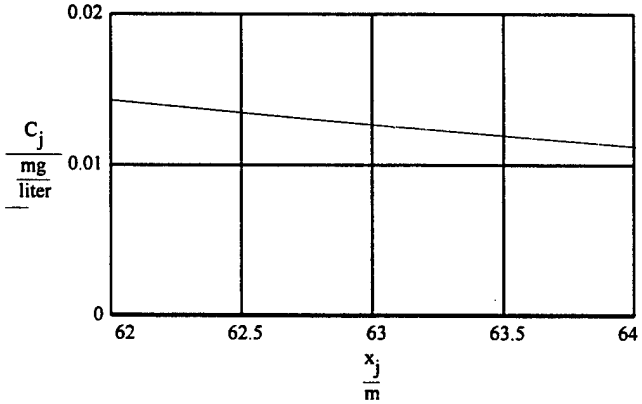
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Dispersivity (2 times greater than observed value) - Present

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

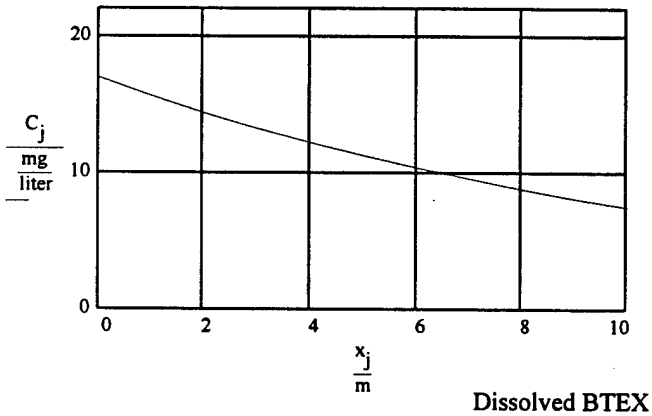
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

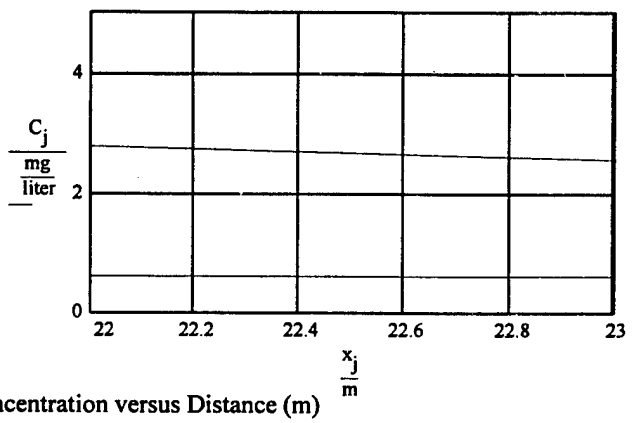
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

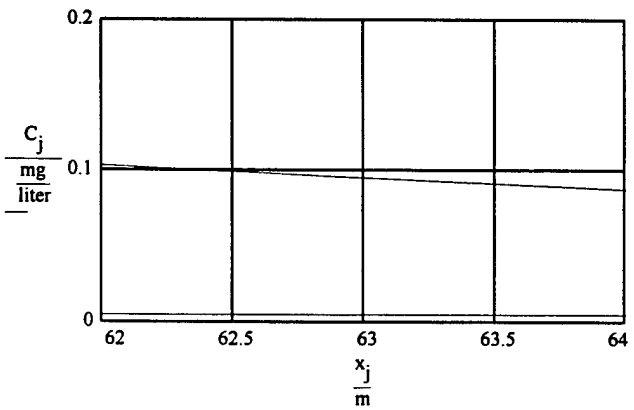
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Solute Decay Rate (2 times less than observed value) - Present

Initial Plume Distribution Calculation

$j := 0 .. 1000$ $t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

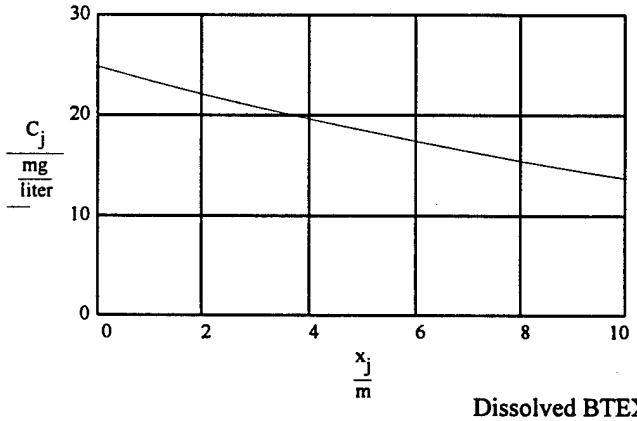
$$C_j := C_0 \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t} \right] + \frac{1}{2} \cdot \left[1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R} \right] \cdot \exp\left(\frac{v_x \cdot x_j}{D_x} \right) \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

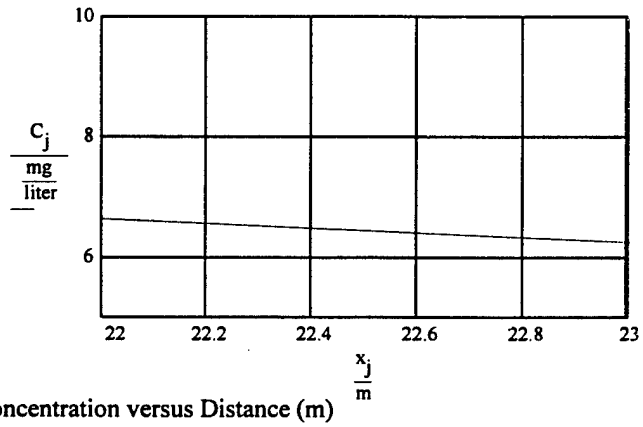
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left[1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right) \right] \right]$$

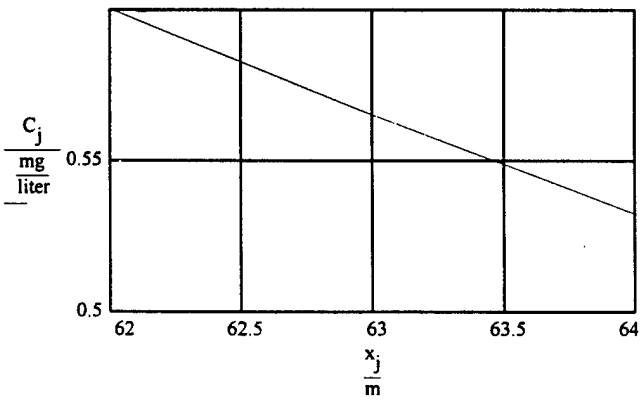
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Sensitivity Analysis of Solute Decay Rate (2 times greater than observed value) - Present

Initial Plume Distribution Calculation

$j := 0..1000$ $\quad t := 1460 \cdot day$

$\Delta x := 1 \cdot m$

$x_j := \Delta x \cdot j$

For Retarded Flow with Biodegradation and a Decaying Source (van Genuchten and Alves, 1982)

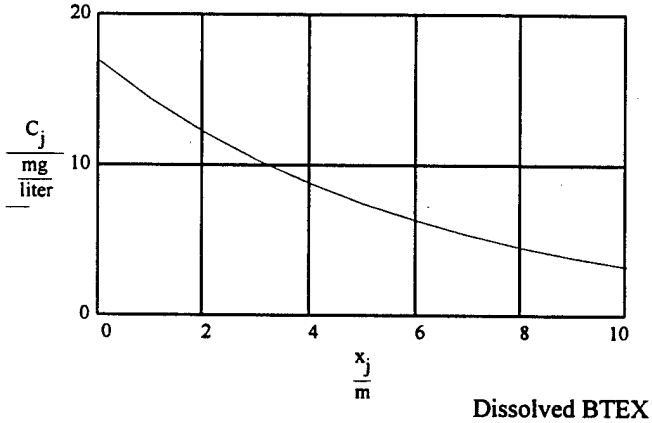
$$C_j := C_o \cdot \exp(-\lambda \cdot t) \cdot \left[1 - \frac{1}{2} \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j - v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) - \frac{v_x^2 \cdot t}{\pi \cdot D_x \cdot R} \cdot \exp\left[-\frac{(R \cdot x_j - v_x \cdot t)^2}{4 \cdot D_x \cdot R \cdot t}\right] + \frac{1}{2} \cdot \left(1 + \frac{v_x \cdot x_j}{D_x} + \frac{v_x^2 \cdot t}{D_x \cdot R}\right) \cdot \exp\left(\frac{v_x \cdot x_j}{D_x}\right) \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right] \ldots$$

$$+ C_s \cdot \exp(-\gamma \cdot t) \cdot \left[\left[\frac{v_x}{v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j - t \cdot \left[v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right]}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots \right.$$

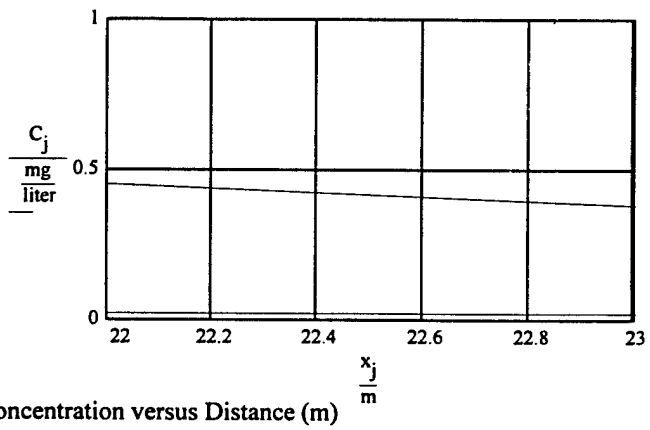
$$+ \left[\frac{v_x}{v_x - v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}} \right] \cdot \exp\left[\frac{\left[v_x + v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)} \right] \cdot x_j}{2 \cdot D_x} \right] \cdot \left[1 - \operatorname{erf}\left[\frac{R \cdot x_j + t \cdot v_x \cdot \sqrt{1 + \frac{4 \cdot D_x \cdot R}{v_x^2} \cdot (\lambda - \gamma)}}{2 \cdot \sqrt{D_x \cdot R \cdot t}} \right] \right] \ldots$$

$$\left. + \left[\frac{v_x^2}{2 \cdot D_x \cdot R \cdot (\lambda - \gamma)} \right] \cdot \exp\left[\frac{v_x \cdot x_j}{D_x} - (\lambda - \gamma) \cdot t \right] \cdot \left(1 - \operatorname{erf}\left(\frac{R \cdot x_j + v_x \cdot t}{2 \cdot \sqrt{D_x \cdot R \cdot t}}\right)\right) \right]$$

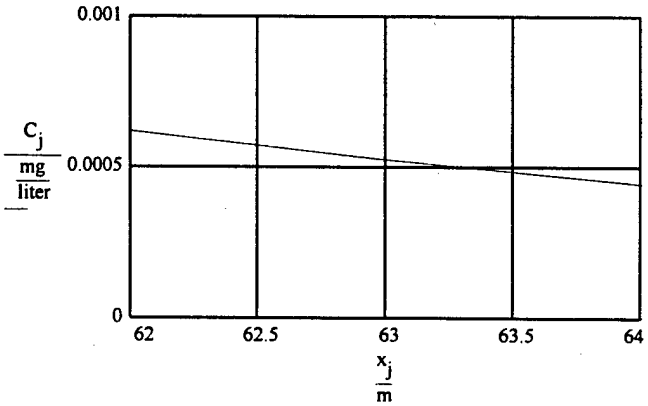
Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



Dissolved BTEX (mg/L) Concentration versus Distance (m)



APPENDIX D

COST ESTIMATE CALCULATIONS

Present Worth Analysis — Annual Adjustment Factor = 7%

Alternative 1: Natural Attenuation with Institutional Controls and Long-Term Groundwater Monitoring	years	Present Worth ($)	Cost ($) at Year Indicated: Year: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	30
Maintain Institutional Controls	30	$62,045	$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	$5,000	$5,000
Long-term Monitoring																							
Install New Wells	1	$19,403	$20,761	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Groundwater Sampling (annual)	5	$46,783	$11,410	$11,410	$11,410	$11,410	$11,410	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Groundwater Sampling (every other year)	25	$45,075	$0	$0	$0	$0	$0	$0	$11,410	$0	$11,410	$0	$11,410	$0	$11,410	$0	$11,410	$0	$11,410	$0	$11,410	$0	$0
Reporting/Project Mgmt (annual)	30	$58,906	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747
Subtotal Present Worth ($)		$232,212																					

Total Present Worth Cost ($): $232,212

Present Worth Analysis

Annual Adjustment Factor = 7%

Alternative 2: Natural Attenuation and Biosparging and SVE with Institutional Controls and Long-Term Monitoring		Present Worth	Cost ($) at Year Indicated									
	years	($)	Year: 1	2	3	4	5	6	7	8	9	10
Biosparging/SVE System												
System Installation	1	$158,358	$169,443	$0	$0	$0	$0	$0	$0	$0	$0	$0
System Maintenance	5	$223,215	$54,440	$54,440	$54,440	$54,440	$54,440	$0	$0	$0	$0	$0
Annual Report	5	$23,273	$5,676	$5,676	$5,676	$5,676	$5,676	$0	$0	$0	$0	$0
Subtotal Present Worth ($)		$404,845										
Maintain Institutional Controls	10	$35,118	$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 Wells	1	$19,403	$20,761	$0	$0	$0	$0	$0	$0	$0	$0	$0
Groundwater Sampling (annual)	5	$46,783	$11,410	$11,410	$11,410	$11,410	$11,410	$0	$0	$0	$0	$0
Groundwater Sampling (every other year)	5	$13,312	$0	$0	$0	$0	$0	$0	$11,410	$0	$11,410	$0
Reporting/Project Mgmt (annual)	10	$33,341	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747
Subtotal Present Worth ($)		$147,957										

Total Present Worth Cost ($): $552,802

Present Worth Analysis — **Annual Adjustment Factor = 7%**

Alternative 3: Natural Attenuation and Groundwater Extraction and Treatment with Institutional Controls and Long-Term Monitoring		Present Worth	Cost ($) at Year Indicated																			
	years	($)	Year: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	30
Groundwater Pump and Treat System																							
System Installation	1	$154,213	$165,008	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
System Maintenance	15	$401,841	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$44,120	$0	$0	$0	$0	$0	$0
Annual Report	15	$55,895	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$6,137	$0	$0	$0	$0	$0	$0
Subtotal Present Worth ($)		$611,950																					
Maintain Institutional Controls	30	$62,045	$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	$5,000	$5,000
Long-term Monitoring																							
Install New Wells	1	$19,403	$20,761	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Groundwater Sampling (annual)	5	$46,783	$11,410	$11,410	$11,410	$11,410	$11,410	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Groundwater Sampling (every other year)	25	$45,075	$0	$0	$0	$0	$0	$0	$11,410	$0	$11,410	$0	$11,410	$0	$11,410	$0	$11,410	$0	$11,410	$0	$11,410	$0	$0
Reporting/Project Mgmt (annual)	30	$58,906	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747	$4,747
Subtotal Present Worth ($)		$232,212																					

Total Present Worth Cost ($): $844,162

Alternatives 1, 2, and 3: Long-Term Monitoring and Institutional Controls
Standard Rate Schedule

Billing Category Cost Code/(Billing Category)	Billing Rate	Task 1 (hrs)	Install New LTM/POC Wells ($)	Task 2 (hrs)	Sampling ($)	Task 3 (hrs)	Reporting & PM ($)
Word Processor 88/(15)	$30	0	$0	0	$0	8	$240
CADD Operator 58/(25)	$47	4	$188	0	$0	16	$752
Technician 42/(50)	$40	10	$400	30	$1,200	10	$400
Staff Level 16/(65)	$57	80	$4,560	30	$1,710	20	$1,140
Project Level 12/(70)	$65	4	$260	4	$260	10	$650
Senior Level 10/(80)	$85	1	$85	0	$0	3	$255
Principal 02/(85)	$97	0	$0	0	$0	0	$0
Total Labor (hrs|$)		99	$5,493	64	$3,170	67	$3,437
ODCs							
Phone			$30		$0		$50
Photocopy			$20		$0		$150
Mail			$100		$400		$60
Computer			$150		$0		$400
CAD			$0		$0		$450
WP			$0		$0		$200
Travel			$1,000		$2,000		$0
Per Diem			$1,358		$780		$0
Equpt. & Supplies			$400		$200		$0
Total ODCs			$3,058		$3,380		$1,310
Outside Services							
LTM/POC Well Installation Costs [a/]			$12,210		$0		$0
Laboratory Fees [b/]			$0	10 LTM, 2 qa/qc	$4,860		$0
Other: Maintain Institutional Controls			$0		$0		$5,000
Total Outside Services			$12,210		$4,860		$5,000

Proposal Estimate	Task 1	Task 2	Task 3
Labor	$5,493	$3,170	$3,437
ODC's	$3,058	$3,380	$1,310
Outside Services	$12,210	$4,860	$5,000
Total by Task	$20,761	$11,410	$9,747

Total Labor	$12,100
Total ODCs	$7,748
Total Outside Services	$22,070
Total Project	$41,918

Task 1: Install New LTM/POC Wells
Task 2: Sampling per Event
Task 3: Reporting and PM per Sampling Event

Alternative 3: Groundwater Extraction and Treatment System

Standard Rate Schedule

Billing Category Cost Code/(Billing Category)	Billing Rate	Design & Install Task (hrs)	Design & Install Recovery System ($)	System Monitoring/ Task (hrs)	System Monitoring/ Maintenance (weekly)($)	Completion Task 3 (hrs)	Completion Report ($)
Word Processor 88/(15)	$30	40	$1,200	0	$0	8	$240
CADD Operator 58/(25)	$47	120	$5,640	0	$0	16	$752
Technician 42/(50)	$40	260	$10,400	400	$16,000	16	$640
Staff Level 16/(65)	$57	260	$14,820	100	$5,700	40	$2,280
Project Level 12/(70)	$65	120	$7,800	40	$2,600	24	$1,560
Senior Level 10/(80)	$85	10	$850	0	$0	5	$425
Principal 02/(85)	$97	2	$194	0	$0	0	$0
Total Labor (hrs|$)		812	$40,904	540	$24,300	109	$5,897
ODCs							
Phone			$200		$60		$10
Photocopy			$100		$0		$50
Mail			$100		$120		$40
Computer			$200		$0		$40
CAD			$240		$0		$60
WP			$100		$0		$40
Air fare/Travel (per trip) (two pers. one trip)	$500	2	$1,000	12	$6,000		$0
Vehicle (per day) (14 field, drill and install)	$55	14	$770	36	$1,980		$0
Per Diem (per day)	$85	24	$2,040	36	$3,060		$0
Eqpt. & Supplies	$1,000	1	$1,000		$500		$0
Total ODCs			$5,750		$11,720		$240
Outside Services							
Well Installation			$22,600		$0		$0
Soil Disposal			$600		$0		$0
Equipment Costs			$46,000		$0		$0
System Installation			$37,576		$0		$0
Contingency (10 % of above services)			$10,678		$0		$0
Analytical (initial 3 samp., 2 per mnth plus QC)	$300	3	$900	27	$8,100		$0
Other			$0		$0		$0
Total Outside Services			$118,354		$8,100		$0

Estimate		Task 1	Task 2	Task 3
Labor		$40,904	$24,300	$5,897
ODC's		$5,750	$11,720	$240
Outside Services		$118,354	$8,100	$0
Total by Task		$165,008	$44,120	$6,137
Total Labor		$71,101		
Total ODCs		$17,710		
Total Outside Services		$126,454		
Total Project		$215,265		

Task 1: Groundwater pump and treat system design and installation and report
Task 2: Monthly Site Time and Travel Costs (per year)
Task 3: Report Preparation

Alternative 2: Biosparging/SVE

Standard Rate Schedule

Billing Category / Cost Code/(Billing Category)	Billing Rate	Design & Install Task 1 (hrs)	Design & Install Recovery System ($)	System Monitoring/ Maintenance Task 2 (hrs)	System Monitoring/ Maintenance (monthly / 1 yr)	Completion Report Task 3 (hrs)	Completion Report ($)
Word Processor 88/(15)	$30	40	$1,200	0	$0	8	$240
CADD Operator 58/(25)	$47	160	$7,520	0	$0	8	$376
Technician 42/(50)	$40	300	$12,000	400	$16,000	16	$640
Staff Level 16/(65)	$57	300	$17,100	100	$5,700	40	$2,280
Project Level 12/(70)	$65	120	$7,800	40	$2,600	24	$1,560
Senior Level 10/(80)	$85	20	$1,700	0	$0	4	$340
Principal 02/(85)	$97	2	$194	0	$0	0	$0
Total Labor (hrs|$)		942	$47,514	540	$24,300	100	$5,436
ODCs							
Phone			$200		$60		$10
Photocopy			$100		$0		$50
Mail			$100		$120		$40
Computer			$200		$0		$40
CAD			$240		$0		$60
WP			$100		$0		$40
Air fare/Travel (per trip) (2 per., pilot & install)	$500	4	$2,000	12	$6,000		$0
Vehicle (per day) (18 days, pilot and install)	$55	18	$990	24	$1,320		$0
Per Diem (per day)	$85	36	$3,060	24	$2,040		$0
Eqpt. & Supplies	$500	1	$500	1	$500		$0
Total ODCs			$7,490		$10,040		$240
Outside Services							
Well Installation			$33,125		$0		$0
Disposal			$1,200		$0		$0
Equipment Costs			$21,000		$0		$0
System Installation			$45,620		$0		$0
Contingency (10 % of above services)			$10,094		$0		$0
Analytical (pilot test 8, 2 per mnth plus QC)	$300	8	$2,400	27	$8,100		$0
Local Subcontractor (maintenance)	$500	0	$0	12	$6,000		$0
Carbon	$500	2	$1,000	12	$6,000		$0
Total Outside Services			$114,439		$20,100		$0

Estimate		Task 1	Task 2	Task 3
Labor		$47,514	$24,300	$5,436
ODC's		$7,490	$10,040	$240
Outside Services		$114,439	$20,100	$0
Total by Task		$169,443	$54,440	$5,676
Total Labor		$77,250		
Total ODCs		$17,770		
Total Outside Services		$134,539		
Total Project		$229,559		

Task 1: SVE/Sparge system deisgn and installation and report
Task 2: Monthly Site Time and Travel Costs (per year)
Task 3: Report Preparation

Columbus AFB Backup Calculations

Alternatives 1, 2 and 3: Long-term Monitoring

Misc calculations

Number of LTM wells:		
Number of wells:	8	
Depth each:	20	ft

Cost calculations

Description	Unit	Qty.	Unit Price	Subtotal	Total	Source (If applicable)
Well Installation					$ 11,100	
Mobilization	ea	1	$ 2,000	$ 2,000		
Well Installation	ln ft	160	$ 50	$ 8,000		
Soil Disposal	drum	11	$ 100	$ 1,100		
Subtotal	-	-	-		$ 11,100	
Contingency	ls	10%	$ 11,100	$ 1,110	$ 1,110	
TOTAL					**$ 12,210**	

Columbus AFB Backup Calculations

Alternative 2: Biosparging/SVE System

Misc calculations

Number of vent/sparge wells:		
Number of sparge wells	5 x 30	ft
Number of SVE wells:	7 x 15	ft
Disposal Fees		
Soil Disposal		
Equipment Costs		
Trench Volume/Area		
Width:	1	ft
Depth:	3.5	ft
Length:	700	ft
Volume:	2,450	cf
	91	cy
Surface Area:	700	sf
	78	sy

Cost calculations

Description	Unit	Qty.	Unit Price	Subtotal	Total	Source (If applicable)
Well Installation					$ 33,125	
Mobilization	ea	2	$ 1,500	$ 3,000		Assuming 2 xmobe , one for pilot test
Well Installation	ln ft	255	$ 75	$ 19,125		Assumes no surface completion
Add. monitor. pts.	ea.	10	$ 1,000	$ 10,000		Estimate
PID and misc equi	day	8	$ 125	$ 1,000		Estimate
					$ 1,200	
Soil Disposal	drum	12	$ 100	$ 1,200		Assuming non-hazadous
Equipment Costs					$ 21,000	
SVE blower/syste	ea	1	$ 10,000	$ 10,000		Includes skid mounted blower etc.
Sparge blower	ea	1	$ 3,000	$ 3,000		Mounted on SVE skid
Electronics & PLC	ea	2	$ 2,500	$ 5,000		Estimate
Valves, gauges, ho	ls	1	$ 1,000	$ 1,000		Estimate
Carbon	ea	2	$ 1,000	$ 2,000		Assume 2 x 55 gallon drums in series
System Installation					$ 45,620	
Mob/Demob	ea	1	$1,500	$ 1,500		Estimate
Trenching	cy	91	$5.05	$ 458		Means 022 254 0050
Pipe laying	ln ft	700	$13.05	$ 9,135		Means 151 701 0550/026 686 2800
Backfill	cy	91	$17.20	$ 1,561		Means 022 204 0600
Compaction	cy	91	$5.10	$ 463		Means 022 204 0600
Pavement Base	sy	78	$5.25	-		Means 022 308 0100
Reseeding	sy	78	$ 2	$ 149		Means 029 304 0310
Piping	lf	700	$9.30	$ 6,510		Means 151 551 1880
Mechanical	man hr	40	$ 39	$ 1,553		Means Q-1 crew
Electrical	ls	1	$ 4,000	$ 4,000		Estimate for electrician
Electrical supply	ls	1	$ 10,000	$ 10,000		Estimate to provide power supply
Slab	cy	3	$97.00	$ 291		Means 033 130 4700
Building	ls	1	$10,000	$ 10,000		Estimate, (residential area)
Subtotal	-	-	-		$ 100,945	
Contingency	ls	10%	$ 100,945	$ 10,094	$ 10,094	
TOTAL					**$ 111,039**	

Columbus AFB Backup Calculations

Alternative 3: Groundwater Extraction System

Misc calculations

Number of recovery wells		
8-inch recovery wells	2 x 40	ft
Disposal		
Soil Disposal		
Trench Volume/Area		
Width:	1	ft
Depth:	3.5	ft
Length:	300	ft
Volume:	1,050	cf
	39	cy
Surface Area:	300	sf
	33	sy

Cost calculations

Description	Unit	Qty.	Unit Price	Subtotal	Total	Source (If applicable)
Well Installation					$ 22,600	
Mobilization	ea	1	$ 2,000	$ 2,000		Assuming 2 xmobe , one for pilot test
Well Installation	ln ft	80	$ 120	$ 9,600		Includes well devel., screen, steel case.
Add. monitor. pts.	ea	5	$ 2,000	$ 10,000		Estimate
PID and misc equi	day	8	$ 125	$ 1,000		Estimate
					$ 600	
Soil Disposal	drum	6	$ 100	$ 600		Assuming non-hazadous
Equipment Costs					$ 46,000	
Submersible pump	ea	2	$ 2,500	$ 5,000		Estimate
Air Stripper	ea	1	$ 35,000	$ 35,000		Estimate, low profile 1-75 gpm
Electronics & PLC	ea	1	$ 5,000	$ 5,000		Estimate
Valves, gauges, ho	ls	1	$ 1,000	$ 1,000		Estimate
System Installation					$ 37,576	
Mob/Demob	ea	1	$1,500	$ 1,500		Estimate
Trenching	cy	39	$5.05	$ 196		Means 022 254 0050
Pipe laying	ln ft	300	$13.05	$ 3,915		Means 151 701 0550/026 686 2800
Well vault boxes	ea	2	$1,200	$ 2,400		Estimate, concrete with spring cover
Backfill	cy	39	$17.20	$ 669		Means 022 204 0600
Compaction	cy	39	$5.10	$ 198		Means 022 204 0600
Pavement Base	sy	33	$5.25	-		Means 022 308 0100
Reseeding	sy	33	$ 2	$ 64		Means 029 304 0310
Piping	lf	300	$9.30	$ 2,790		Means 151 551 1880
Mechanical	man hr	40	$ 39	$ 1,553		Means Q-1 crew
Electrical	ls	1	$ 4,000	$ 4,000		Estimate for electrician
Electrical supply	ls	1	$ 10,000	$ 10,000		Estimate to provide power supply
Slab	cy	3	$97.00	$ 291		Means 033 130 4700
Building	ls	1	$10,000	$ 10,000		Estimate, (needed for residen.area)
Subtotal	-	-	-		$ 106,776	
Contingency	ls	10%	$ 106,776	$ 10,678	$ 10,678	
TOTAL					$ 117,454	

hubzones as of 8 Mar 00

Company Name	Address line 1	Address line 2	City	State	Zip Code	DUNS Number
A BETTER LASER SERVICE	1100 WICOMICO ST., SUITE 733		BALTIMORE	MD	21230-206	867671364
A Plus Services Unlimited	2300 West Commerce, Suite 303		San Antonio	TX	78207	154564728
A Plus Services Unlimited	2300 West Commerce, Suite 303		San Antonio	TX	78207	154564728
A TOUCH OF SASS INC	34 W 119TH ST		NEW YORK	NY	10026-140	003903437
A TOUCH OF SASS INC	34 W 119TH ST		NEW YORK	NY	10026-140	003903437
A WILLIAMS TRUCKING & BACKHOE TRENCHING INC	65 BARTLETT ST		BROOKLYN	NY	11206-503	103666749
A WILLIAMS TRUCKING & BACKHOE TRENCHING INC	65 BARTLETT ST		BROOKLYN	NY	11206-503	103666749
A&C Environmental Services, Inc.	2045 N. Lawrence Street		Philadelphia	PA	19122	
A&E Digital Print & Copy Center	493 King St. Suite 101		Charleston	SC	29403	962463691
A&M Builders, Inc.	1010 E. 2nd St.		Tulsa	OK	74120	186095162
A&M Builders, Inc.	1010 E. 2nd St.		Tulsa	OK	74120	186095162
A&S Paving Inc.	527 W. 29th Street		Tucson	AZ	85713	184905347
A/B Electrical Services, Inc.	3687 Cicotte		Detroit	MI	48210	948566880
Aa Med Care, Inc.	198 Memorial Dr., Se		Atlanta	GA	30312	184228161
Aa Med Care, Inc.	198 Memorial Dr., Se		Atlanta	GA	30312	184228161
AAA MACHINE METAL STAMPING & MANUFACTURING	438 VINE ST		SAN ANTONIO	TX	78210-256	078488442
Abacus Building & Design Services, Inc.	737 Parker St		Newark	NJ	7104	109498274
ABEX DATA SYSTEMS INC	12 Anthony Street		Newark	NJ	7107	197329428
ABEX DATA SYSTEMS INC	12 Anthony Street		Newark	NJ	7107	197329428
ABS, Inc. Clothing & Exports	3404 W. Papago St. Suite 106		Phoenix	AZ	85009	009464749
AC DATA SYSTEMS, INC	806 W CLEARWATER LOOP	Suite C	POST FALLS	ID	83854	824788434
AC INC	PO BOX 17069	1085 JORDAN RD	HUNTSVILLE	AL	35810-706	063685903
Accurate cabling Inc.	506 North Barker		Mount Vernon	WA	98273	079664079
Accurate cabling Inc.	506 North Barker		Mount Vernon	WA	98273	079664079
Ace Printery, Inc.	41 Walnut Street		Hartford	CT	6120	055510192
ACME Auto Rental of San Antonio, INc.	3532 SW Military Drive		San Antonio	TX	78211	
ACME WORLDWIDE ENTERPRISES INC	1601 Randolph Rd., SE	Suite 110 South	ALBUQUERQUE	NM	87106-427	878009299
ACT ABATEMENT CORP	255 ERVING AVE		LAWRENCE	MA	01841-362	797848264
ADOLPH FARMER CONSTRUCTION INC	1139 E JERSEY ST	SUITE 409	ELIZABETH	NJ	07201-243	113076129
ADOLPHS STEAM CLEANING CARPET & JANITORIAL	PO BOX 11484		OKLAHOMA CITY	OK	73136-048	808758171
ADOLPHS STEAM CLEANING CARPET & JANITORIAL	PO BOX 11484		OKLAHOMA CITY	OK	73136-048	808758171
Advanced Micro Products, Registred company name: RK & DC Enterp	45 south Main Street Suite #370		Dayton	OH	45402	619671936
Advanced Micro Products, Registred company name: RK & DC Enterp	45 south Main Street Suite #370		Dayton	OH	45402	619671936
Advanced Systems Technology, Inc.	4111 W. Gore Boulevard		Lawton	OK	73505	122590797
Advanced Systems Technology, Inc.	12249 Science Drive	Suite 150	Orlando	FL	32826	075186114 - 0001
Advanced Systems Technology, Inc.	766 Shrewsbury Avenue		Tinton Falls	NJ	7724	603517475 - 0002
Advanced Systems Technology, Inc.	4111 W. Gore Boulevard		Lawton	OK	73505	122590797
AERO TEC INDUSTRIES INC	PO BOX 1216		SEMINOLE	OK	74818-121	119060887
AERO TEC INDUSTRIES INC	PO BOX 1216		SEMINOLE	OK	74818-121	119060887
AFA CONSTRUCTION INC	1300 Clay Street	Suite 600	Oakland	CA	94949-611	943267112
AFA CONSTRUCTION INC	1300 Clay Street	Suite 600	Oakland	CA	94949-611	943267112
Afco Technologies, Inc.	1535 Brady Blvd.		San Antonio	TX	78237	097488688
AFRAM INTERNATIONAL ENVIRONMENTAL CONSULTING	2907 N. Hampton Rd, Ste 104,		Dallas	TX	76006-868	877045013
AGE Refining, Inc.	1131 East Commerce Street, Suite 208		San Antonio	TX	78205	787398759 - 7240
AGE Refining, Inc.	1131 East Commerce St.		San Antonio	TX	78205	